SOURCEBOOK OF ELECTRONIC CIRCUITS

BOOKS by JOHN MARKUS

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HANDBOOK OF ELECTRONIC CONTROL CIRCUITS

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TELEVISION AND RADIO REPAIRING

SOURCEBOOK OF ELECTRONIC CIRCUITS

Over 3,000 modern electronic circuits complete with values of all parts, organized in 100 logical chapters for quick reference and convenient browsing

JOHN MARKUS

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SOURCEBOOK OF ELECTRONIC CIRCUITS

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Preface

More than 3,000 electronic circuits, published largely within the past five years, are presented here in 100 logically organized chapters for convenient reference and browsing by practical electronic engineers and technicians. Circuits in a given category are arranged side by side for easy comparison and selection, much as at a smorgasbord table. Each circuit has the values of all significant components, an identifying title, a concise description of circuit function, performance data, and application ideas. This information will generally be sufficient for use as a starting point in redesigning a circuit to meet other requirements. For those who need further information, each circuit also has a citation giving the title of the original article, its author, and its exact location in the original publication.

Engineering libraries, particularly in foreign countries, will find this volume a highly acceptable substitute for the original sources when facing limitations on budgets or shelf space. Most users will find that sufficient information is given with each circuit to meet their needs, thereby making a file of original sources unnecessary.

For the average circuit search, start with the alphabetically arranged table of contents at the front of the book. This will show almost at a glance the chapters that are most likely to contain the desired type of circuit. The random arrangement of circuits within a chapter encourages the browsing that so often turns up an unexpectedly valuable idea.

If a chapter search fails to give the exact circuit needed, use the back-of-book index. Here the circuits are indexed in depth under a variety of type and application names, combined with hundreds of *see* and *See also* cross references that will speed comprehensive searching for a particular circuit even when it is combined with other circuits. The result is a desktop information-retrieval system for the most significant transistor and tube circuits developed in recent years. With it, you can retrieve a desired circuit within a matter of minutes, as compared to the hours or days usually required to get results from costly computer-based information systems.

One goal of this book is to provide a maximum of circuit information in minimum space. Accordingly, there is an absolute minimum of repetition in each circuit description. To get maximum information, the chapter title, the bold-face circuit heading, and the original title in the citation should be read along with the description and the circuit itself.

On those few occasions when additional information is desired, most users will go to a library for the original source of a circuit. The citations therefore give volume and issue number for publications, in accordance with the preferences of librarians. For those who have their own files, the equivalent years and issue dates for the two most frequently cited publications—*Electronics* and *EEE*—can be quickly determined from handy tables following the table of contents. Here also are listed the abbreviations most frequently used on the diagrams and in the text, with meanings.

The values of the important components are given for every circuit, since these help an engineer to read the circuit and redesign it for his own needs. The development of a working circuit for a new application is speeded tremendously when the design work can be started with a working circuit, instead of starting from scratch. Research and experimentation are thereby cut to a minimum, so that even a single use of this pioneering circuit-retrieval search book could pay for its initial cost many times over.

Although the majority of the circuits are recent semiconductor designs, important new electron-tube circuits are adequately represented because there are still many applications where only tubes can do the required job.

Never before have so many circuits, complete with values, been collected in a single volume for such convenient reference, to provide the desired circuit within minutes and at the same time tell where further information on it can be obtained. Results are obtained in only a fraction of the time that would be required to scan the hundreds of magazines and books from which this volume was compiled.

To the original publications cited in this volume and to their authors and editors should go the real credit for making possible this contribution to the advancement of electronic circuit design. Particular credit goes to publisher Jim Randolph and editor Lewis Young of *Electronics* for recognizing the importance of easy retrieval of the many valuable circuit design articles they have published. Specific credit must be given also to George Rostky, editor of *EEE*, for approving the inclusion of diagrams from his famous "Circuit Design Award" section. Other sources, equally appreciated but too numerous to mention here, are credited in the individual citations.

To artist and orchid-hybridizer Jack Quint, more active than ever in Florida retirement, goes full credit for arranging the thousands of circuits on these pages so well, each unmistakably associated with its own text.

John Markus

Contents

ABBREVIATIONS USED

a-c alternating current
adf automatic direction finder
a-f audio frequency
afc automatic frequency control
agc automatic gain control
a-m amplitude modulation
amp ampere
bcd binary coded decimal
C Centigrade
CB Citizens Band
CCTV closed-circuit television
cm centimeter
cps cycle per second
cr cathode-ray
cro cathode-ray oscilloscope
crt cathode-ray tube
c-w continuous-wave
db decibel
dbm decibels above 1 milliwatt
d-c direct current
DCTL diode-capacitor-transistor logic
ecg electrocardiograph
eeg electroencephalograph
fet field effect transistor
f-m frequency modulation
ft feet
gc gigacycle
G-M Geiger-Muller
gto gate turnoff
hr hour
Hz hertz
IC integrated circuit
i-f intermediate frequency
iff identification friend or foe
K kilohm
kc kilocycle
kv kilovolt
kw kilowatt
ma milliampere
Mc megacycle
meg megohm
mfd microfarad
mh millihenry
MHz megahertz
microamp microampere
microsec microsecond
mil 0.001 inch
millimicrosec millimicrosecond
millisec millisecond
mm millimeter
mmfd micromicrofarad
mono monostable multivibrator
mos fet metal-oxide semiconductor field-effect transistor
mti moving target indicator
mv millivolt
mvbr multivibrator
mw milliwatt
na nanoampere
nipo negative input positive output
npn negative-positive-negative
nrz nonreturn-to-zero
nsec nanosecond
nw nanowatt
pam pulse-amplitude modulation
pcm pulse-code modulation
pf picofarad
pino positive input negative output
p-m phase modulation
pnp positive-negative-positive
pnpn positive-negative-positive-negative
p-p peak-to-peak
ppm pulse per minute
pps pulse per second
preamp preamplifier
prf pulse repetition frequency
prr pulse repetition rate
pwm pulse width modulation
RC resistor-capacitor
RCTL resistor-capacitor-transistor logic
RDTL resistor-diode-transistor logic
r-f radio frequency
rfi radio frequency interference
rms root mean square
rpm revolutions per minute
RTL resistor-transistor logic
rz return-to-zero
scope oscilloscope
scr silicon controlled rectifier
scs silicon controlled switch
sec second
s/n signal-to-noise
sq cm square centimeter
ssb single sideband
sync synchronizing
td tunnel diode
t-r transmit-receive
tv television
twt traveling-wave tube
uhf ultrahigh frequency
ujt unijunction transistor
v volt
v-a volt-ampere
vco voltage-controlled oscillator
vfo variable-frequency oscillator
vhf very high frequency
vlf very low frequency
vswr voltage standing wave ratio
vu volume unit
w watt

GUIDE TO VOLUME AND ISSUE NUMBER

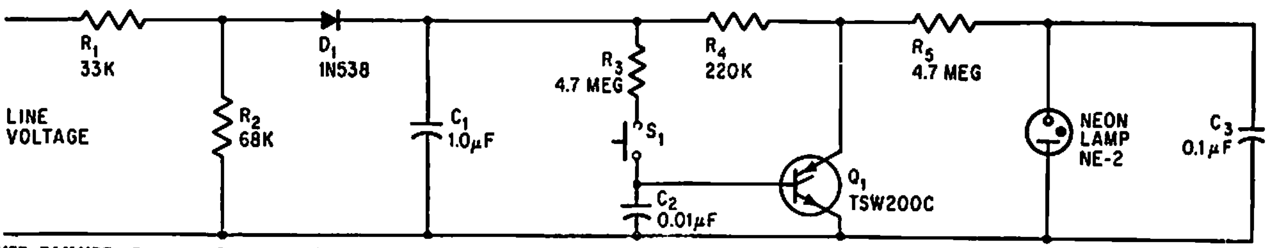
ELECTRONICS

Vol.	*Year*	*Date of Issue No. 1*	*Frequency*
31	1958	Jan. 3	Every 7 days
32	1959	Jan. 2	Every 7 days
33	1960	Jan. 1	Every 7 days
34	1961	Jan. 6	Every 7 days
35	1962	Jan. 5	Every 7 days
36	1963	Jan. 4	Every 7 days
37	1964	Jan. 3	Every 7 days
37	1964	Mar. 23 (No. 12)	Every 14 days
38	1965	Jan. 11	Every 14 days
39	1966	Jan. 10	Every 14 days
40	1967	Jan. 9	Every 14 days

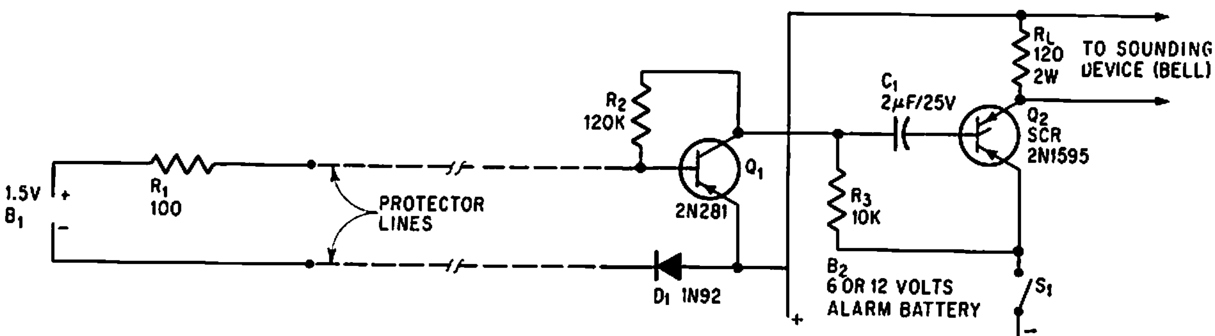
EEE

10	1962	Jan.	Monthly
11	1963	Jan.	Monthly
12	1964	Jan.	Monthly
13	1965	Jan.	Monthly
14	1966	Jan.	Monthly
15	1967	Jan.	Monthly

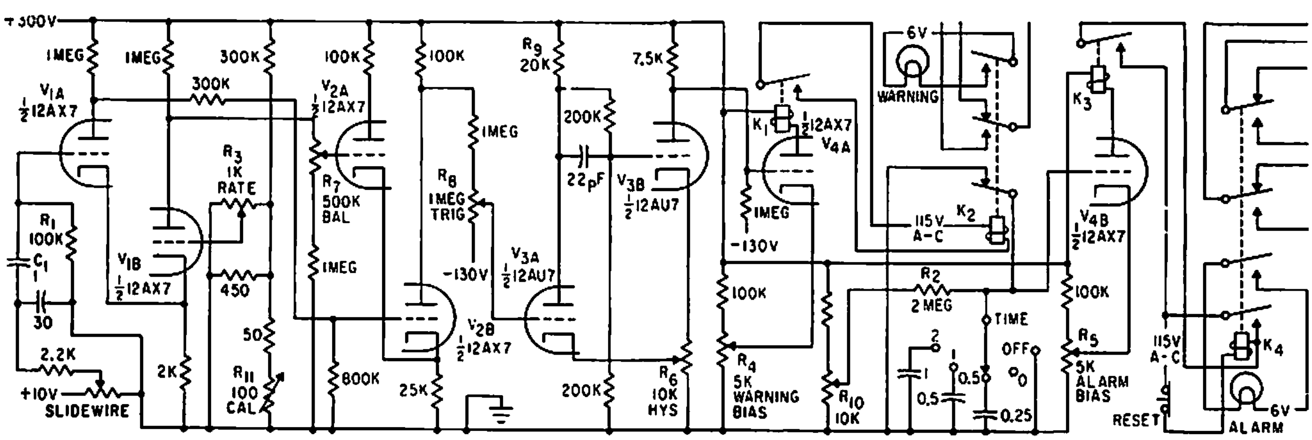
CHAPTER 1
Alarm Circuits



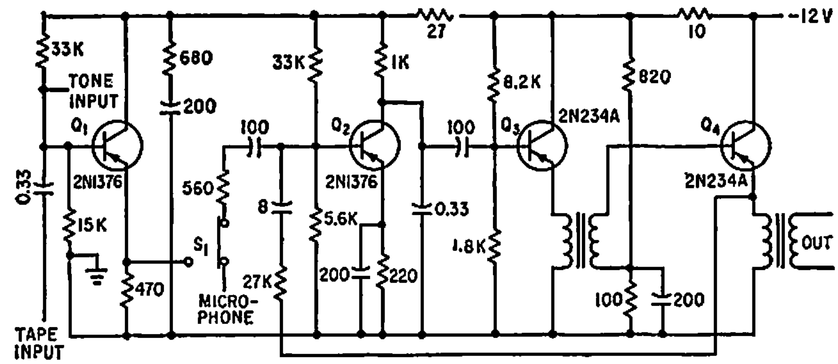
POWER FAILURE—Current of 0.5 ma through R4 holds scr Q1 on normally. After power failure, scr will not fire again because it has no gate current. Line voltage across scr then makes neon relaxation oscillator flash warning signal. Depressing S1 resets circuit.—R. K. Honeycutt, SCR Monitors Power Failure, *Electronics*, 38:15, p 63.



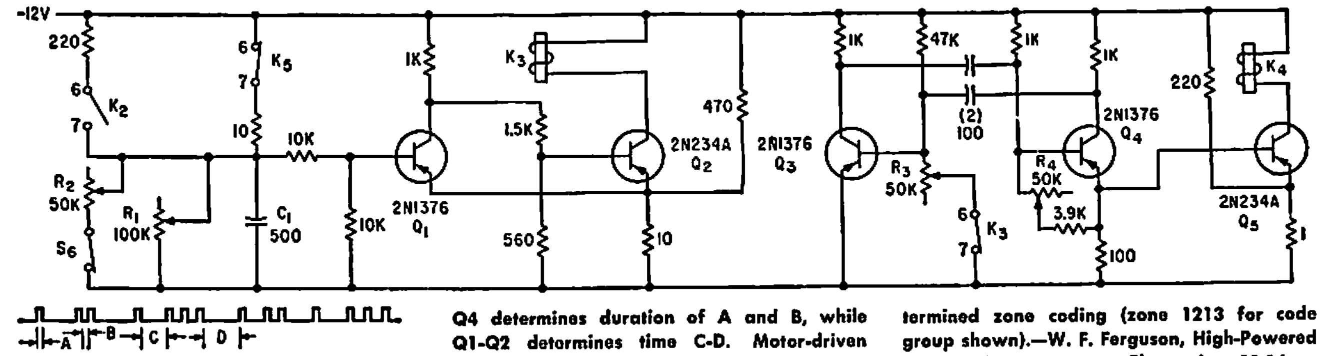
INTRUDER ALARM—Circuit responds to break or short in loop of foil or wire encircling area to be protected, by reacting to change in normal current drain of 500 microamp from 1.5-v battery in protector loop. Circuit is reset after an alarm by opening S1 momentarily.—W. Vollenweider, Low-Current Alarm, *Electronics*, 39:5, p 105–106.



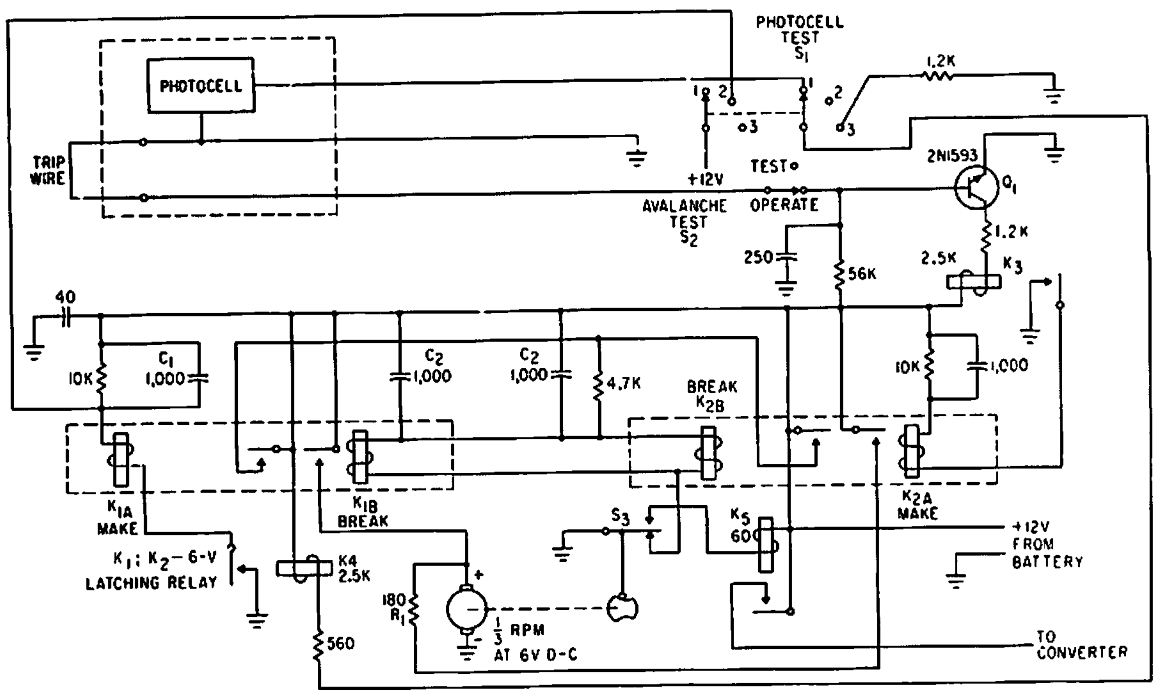
RATE-OF-RISE HEAT ALARM WITH DELAY—Thermocouple senses rise in temperature of machinery or heat of fire, and feeds servo null-balance recorder having repeater slidewire. Output of slidewire is differentiated by C1-R1 and compared with reference rise rate voltage at grid of V1B. When amplified difference at output of V2 switches Schmitt trigger V3, V4A conducts and energizes K1. Additional triode and relays provide time delay for alarm lamp.—T. L. Greenwood, Indicator Warns of Excessive Rise Rates, *Electronics*, 35:7, p 54–56.



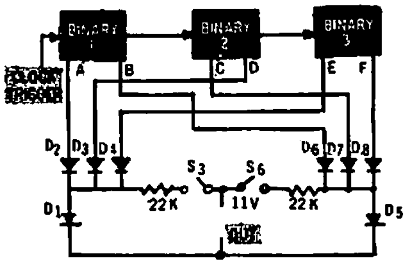
SIREN PREAMPLIFIER—Supplies signals to remote power amplifiers and loudspeakers of fire and civil defense systems. Input can be from electronic siren generator, magnetic tape, or microphone.—W. F. Ferguson, High-Powered Audio Alarm Systems, *Electronics*, 33:16, p 70–72.



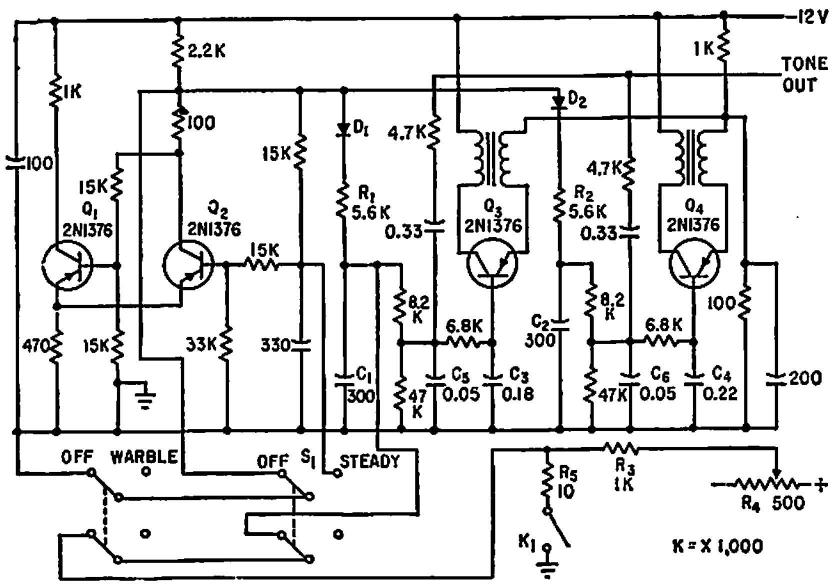
ALARM SYSTEM CODER—Used to generate zone codes for fire alarm. Multivibrator Q3-Q4 determines duration of A and B, while Q1-Q2 determines time C-D. Motor-driven stepping switches (not shown) determine the number of K4 operations to provide predetermined zone coding (zone 1213 for code group shown).—W. F. Ferguson, High-Powered Audio Alarm Systems, *Electronics*, 33:16, p 70–72.



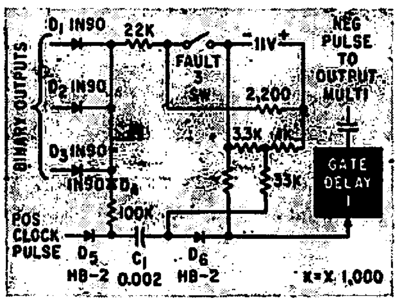
TRIP-WIRE ALARM—Control circuit turns converter, transmitter, and modulator on through relay contacts, to make 1,680-kc hybrid transmitter send tone-modulated signals to central station when trip wire is broken by avalanche. Daylight on photocell initiates test transmission daily.—G. Neal and S. A. Stone, Hybrid Telemeter Detects Avalanches, *Electronics*, 34:50, p 72–73.



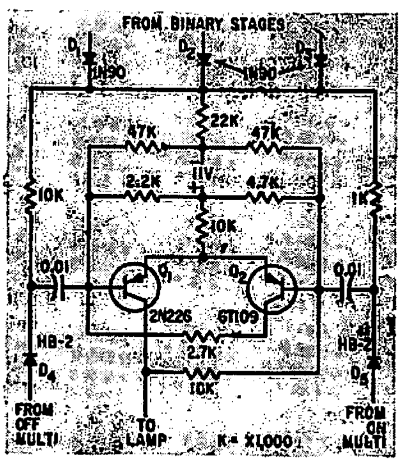
CODER MATRIX—Circuit shows portion of coder matrix associated with microwave system false alarm circuits, having switches S3 and S6.—J. B. Bullock, Pulse-Coded Fault Alarm in Microwave Systems, *Electronics*, 33:1, p 82–84.



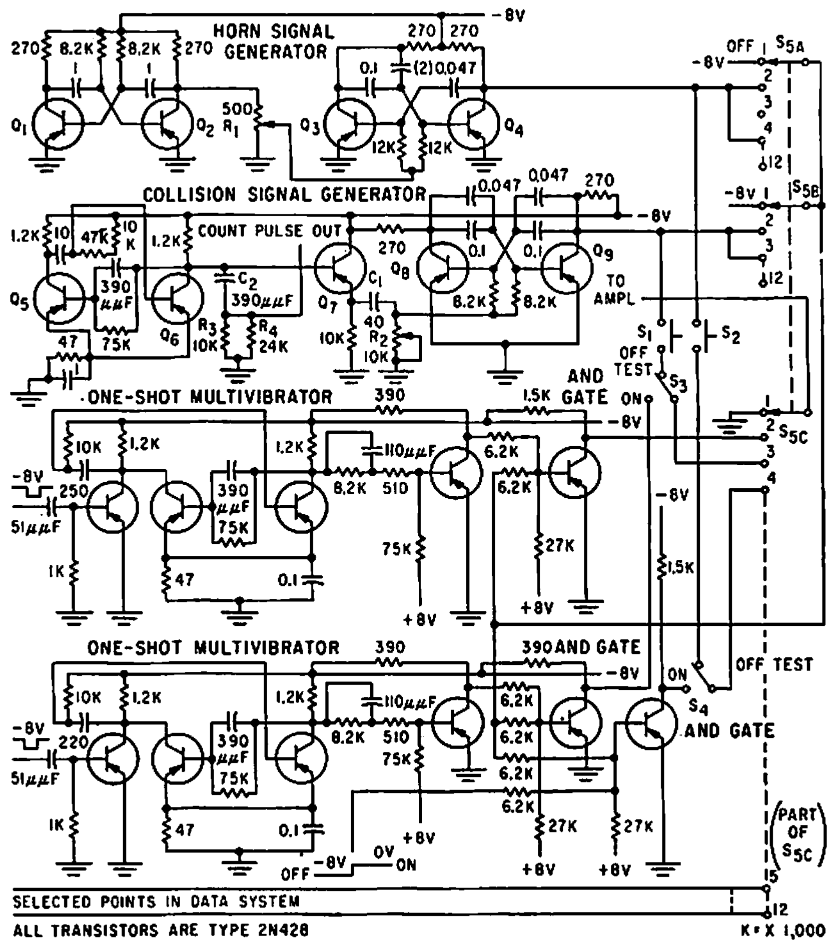
SIREN WARBLE GENERATOR—Generates single-tone and warble signals. Blocking oscillators Q3 and Q4, having slightly different frequencies, are frequency-modulated by triangular-wave output of low-frequency mvbr Q1-Q2, to produce siren-type wail.—W. F. Ferguson, High-Powered Audio Alarm Systems, *Electronics*, 33:16, p 70–72.



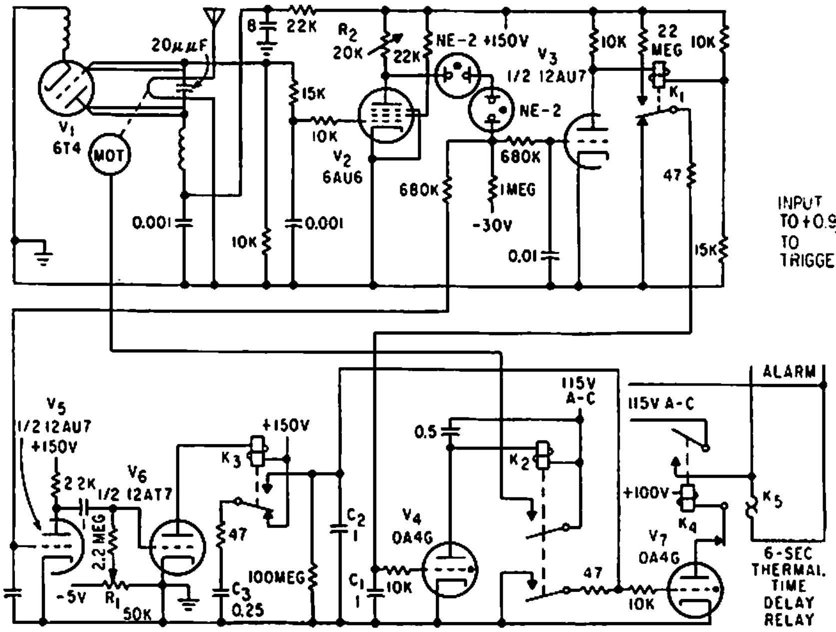
FAULT-SENSING SWITCH—When fault in microwave system has effect of closing switch 3, gated delay shortens output pulse for that function when binary input signals are negative.—J. B. Bullock, Pulse-Coded Fault Alarm in Microwave Systems, *Electronics*, 33:1, p 82–84.



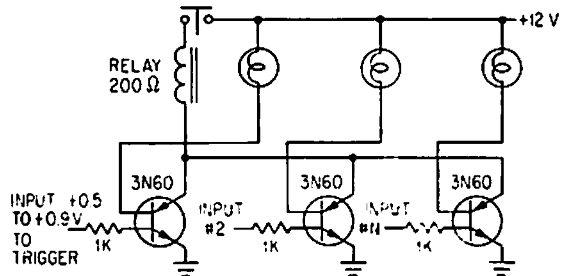
ALARM LAMP DRIVER—Lamp receives power only when combination of signals from binary stages and mvbr is correct combination of polarities to represent microwave system fault to be indicated by remotely located lamp.—J. B. Bullock, Pulse-Coded Fault Alarm in Microwave Systems, *Electronics*, 33:1, p 82–84.



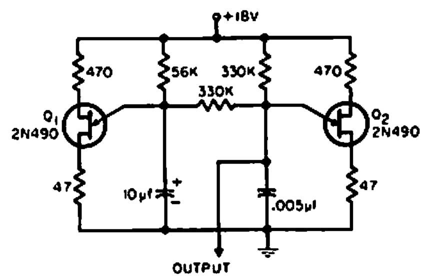
COMPUTER FAULT ALARM—Audible alarm system gives distinctive indication of fault location in digital computer and data processing equipment. Horn and collision signal sounds are generated by electronic circuits shown, for monitoring two circuits. Mixing these two signals produces battle stations sound for monitoring third circuit.—S. Fierston, Alarm Circuit Warns of Faults in Digital Systems, *Electronics*, 32:27, p 48–49.



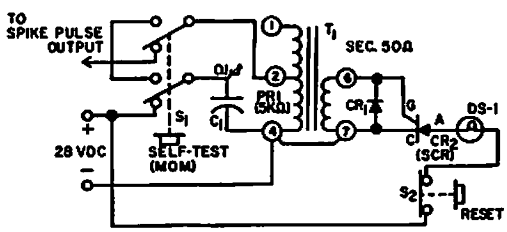
VHF INTRUSION ALARM—Based on fact that object moving toward or away from antenna causes phase relationship of radiated and reflected waves to shift through 2 pi radians at antenna for each half-wavelength of movement. Varying phase changes amplitude of oscillation, detected by circuit and used to turn on alarm. Drift in oscillator grid voltage activates timing motor which adjusts degree of coupling between oscillator tank and antenna, to make alarm self-adjusting.—G. A. Whitlow, VHF Intrusion Alarm is Self-Adjusting, *Electronics*, 32:35, p 62–66.



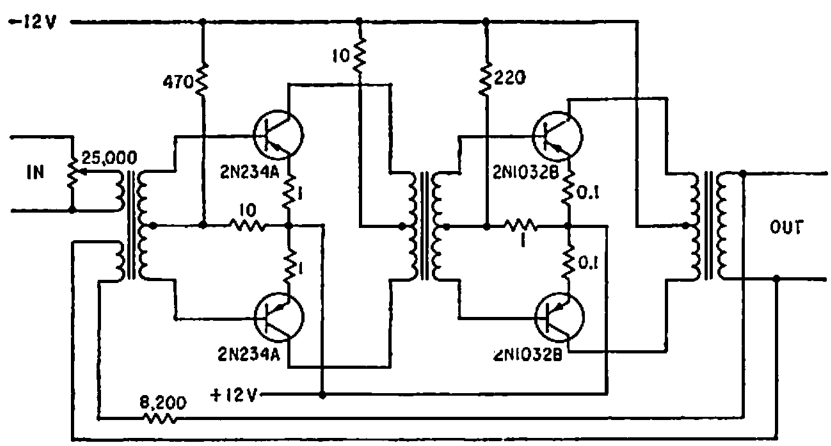
MULTIPLE-INPUT OVERVOLTAGE ALARM—Lamp load of each silicon-controlled switch lights when its input exceeds threshold voltage, to identify input that is responsible for pulling in relay that sounds alarm or shuts down equipment. Lamps also serve to suppress rate effect.—R. A. Stasior, How to Suppress Rate Effect in PNPN Devices, *Electronics*, 37:2, p 30–33.



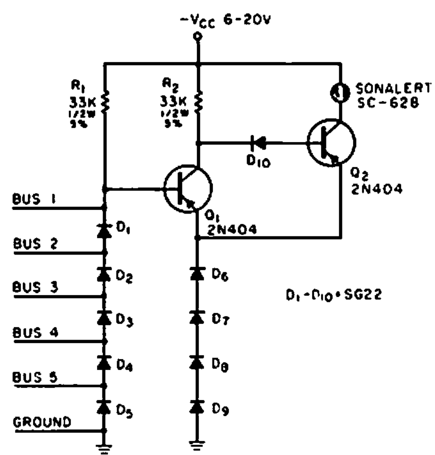
VARYING-FREQUENCY OSCILLATOR—Output frequency of alarm tone generator changes continuously. With suitable amplifier and loudspeaker, can easily be heard in noisy environments where single tone or amplitude-modulated tone would go unnoticed.—A. Mall, Varying-Frequency Warning Alarm, *EEE*, 12:7, p 25.



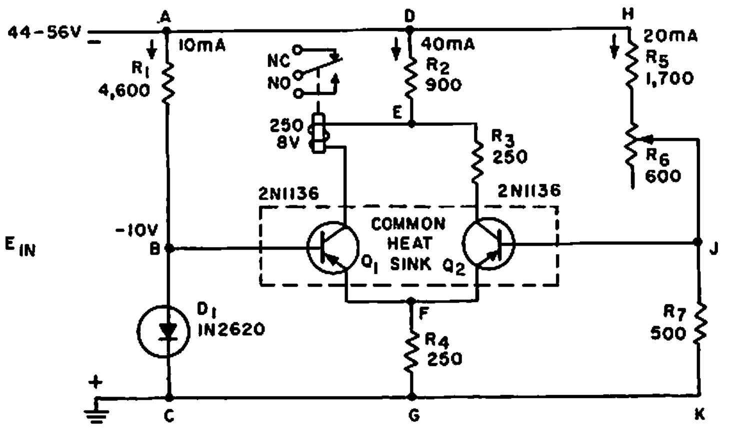
TRANSIENT PULSE DETECTOR—Determines occurrence of single spike pulse having maximum amplitude of 50 v at 2 ma and duration of 1 millisec. Spike pulse is stepped down by transformer to 5 v at 20 ma, which is sufficient to fire GE C10 scr, causing 28-v lamp to come on. When reset button is pressed, scr cuts off, lamp goes out, and circuit is ready for another spike. C1 is 0.1 mfd and CR1 is 1N270.—Transient Spike Pulse Detector, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 204.



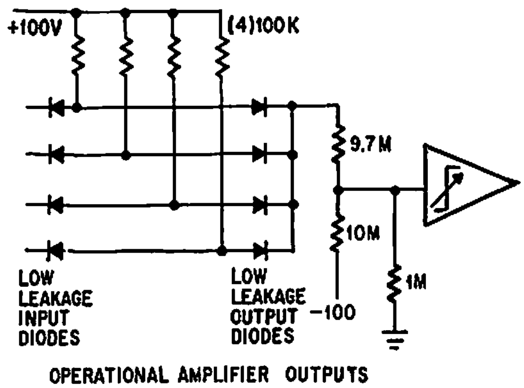
SIREN POWER AMPLIFIER—Four-transistor class AB audio amplifier delivers 200 w to four loudspeakers. Standby power drain is 12 w. Input is obtained from warble generator.—W. F. Ferguson, High-Powered Audio Alarm Systems, *Electronics*, 33:16, p 70–72.



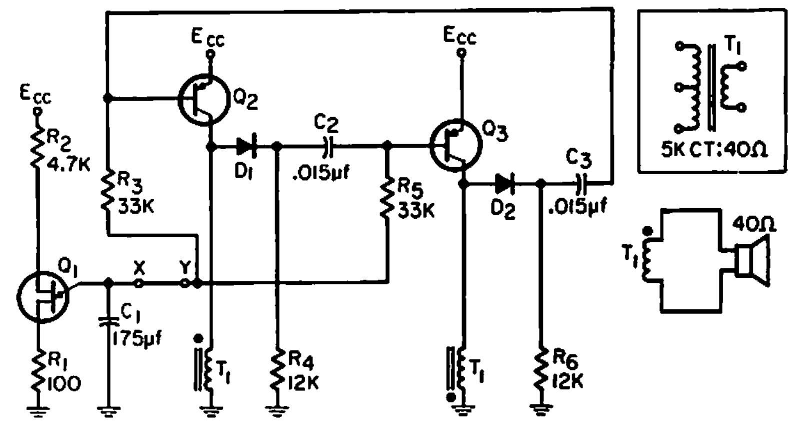
SHORT-CIRCUIT ALARM—Sounds an alarm if a short occurs between any two of five different voltage buses or between any bus and ground. Used in checking complicated point-to point backplane wiring for computers, to detect wiring errors or solder splashes.—J. J. Russo, Short-Circuit Alarm, *EEE*, 13:6, p 66–68.



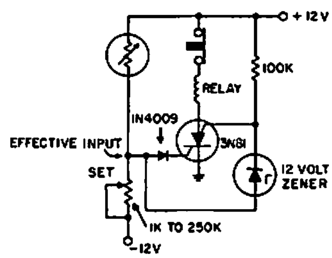
LOW-VOLTAGE ALARM—Two-transistor alarm senses 0.2-v drop in telephone system and turns on local or remote signalling apparatus. If relay and R3 are interchanged, circuit will operate as high-voltage alarm.—C. J. Kieffer, Simple Low-Voltage Alarm, *Electronics*, 35:18, p 44–45.



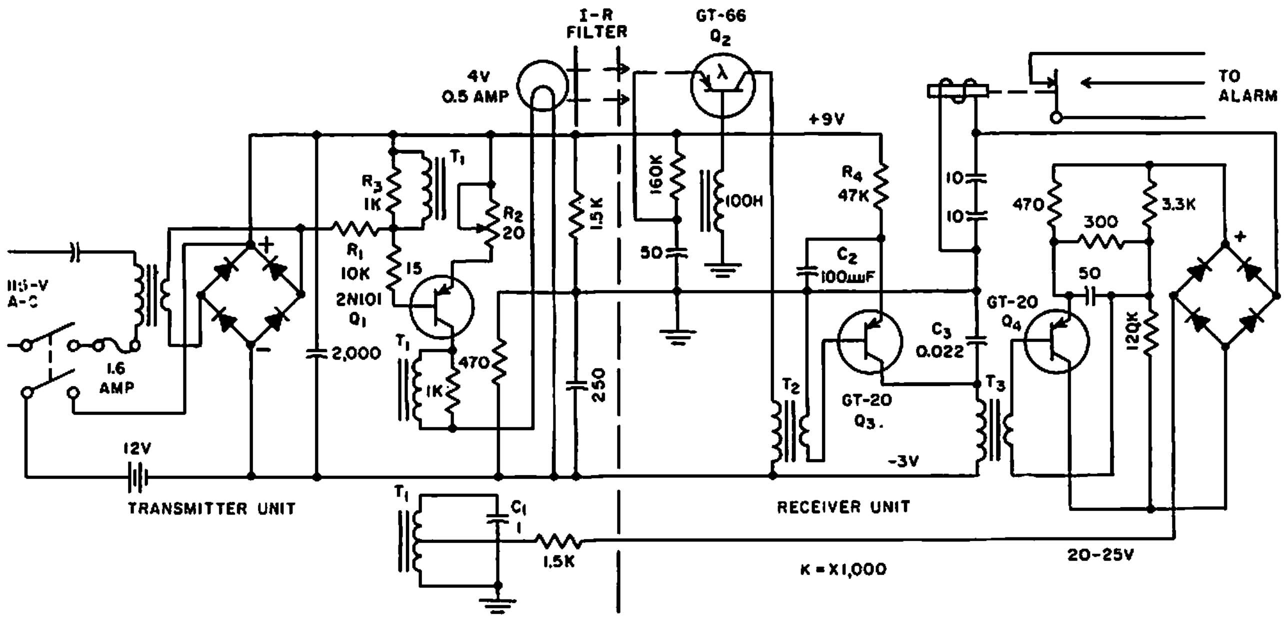
POSITIVE LIMIT ALARM—Operational trigger trips when any output of analog computer goes off scale (above +99 v).—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



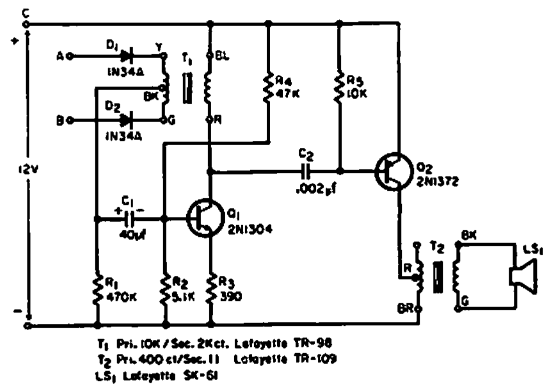
WAILING SIREN—C1 is discharged periodically by ujt Q1, which resets voltage-controlled oscillator to beginning of its frequency sweep. Controlled oscillator also serves as power amplifier, to reduce number of components required. Circuit draws 10 ma from 9-v battery.—F. J. Harris, Simple Wailing Siren Circuit, *EEE*, 14:6, p 94.



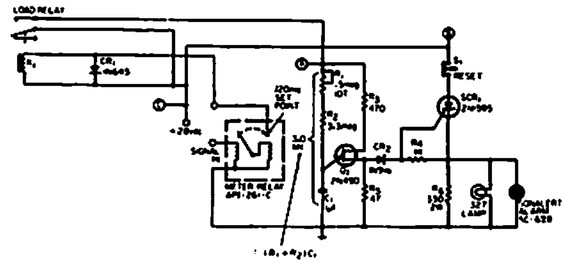
VOLTAGE-SENSING ALARM—Silicon controlled switch is triggered by input signal more than 1 v above or below ground.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 425.



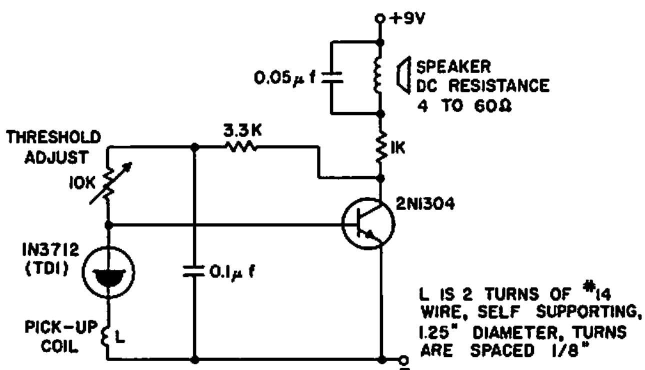
INFRARED BURGLAR ALARM—Has electronically modulated infrared light source and synchronous phase-sensitive demodulator pickup unit. Pulsed-light technique overcomes adverse effects of continuous or varying ambient light. Alarm goes off if power supply or interconnecting wires are tampered with. Floating 12-v battery takes over load only if power supply fails. C1 tunes T1 to 55-cps oscillator frequency.—S. Bagno and J. Fasal, Intruder Alarm Uses Phase-Sensitive Detector, *Electronics*, 31:7, p 102–105.



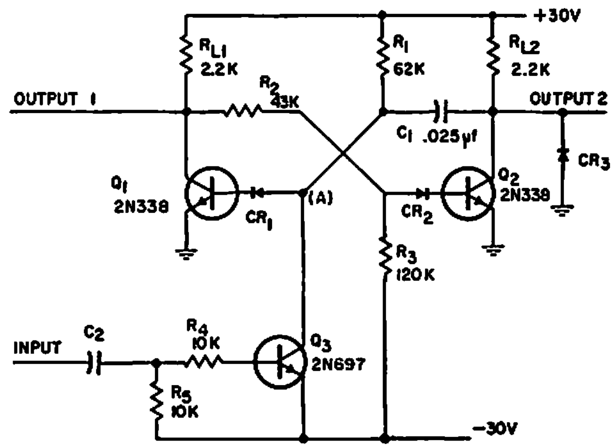
DIFFERENTIAL-VOLTAGE ALARM—Detector circuit with high sensitivity and stability, followed by audio amplifier, serves as differential voltage or current alarm. Input may be d-c or low-frequency a-c. Output is distinctive series of audio beeps or continuous tone, occurring only when preselected polarity unbalance is present at input.—C. E. Miller, Differential-Voltage or Current Alarm Circuit, *EEE*, 12:7, p 25.



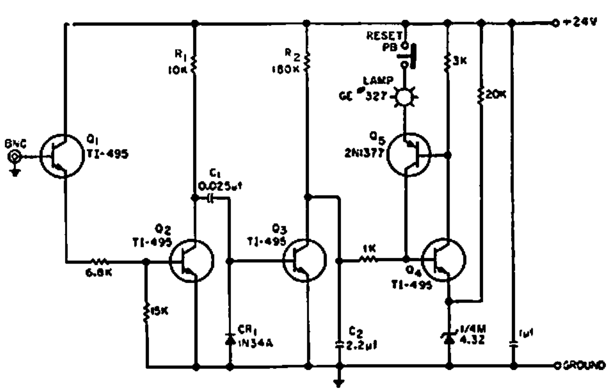
GYRO FAULT ALARM—Circuit sounds alarm if gyro wheel is locked up, as indicated by input signal remaining at high current or voltage level for longer than preset interval. Circuit can also be used as pulse-level discriminator.—R. L. Sazpansky, Pulse-Level Discriminator and Fault Indicator, *EEE*, 13:8, p 68.



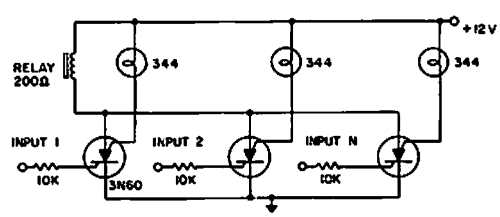
200-MC R-F RADIATION DETECTOR—Gives 1,800-cps alarm tone when signal is picked up by coil or by small slot antenna serving as sensor.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 363.



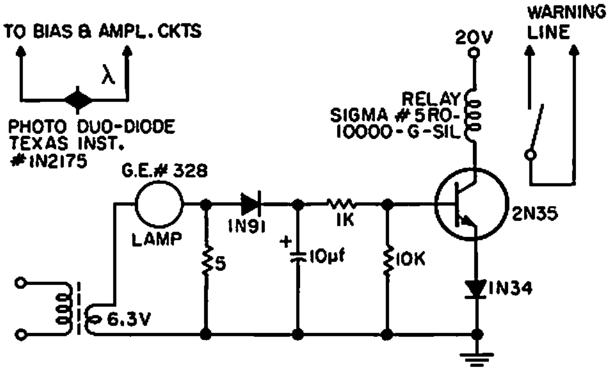
PULSE AND D-C MONITOR—Indicates presence of continuous train of pulses, absence of one or more pulses in train, and dropout of d-c level beyond predetermined time interval. Uses controlled monostable mvbr. With d-c inputs, C2 is shorted. With values shown for R1 and C1, output occurs 1.07 millisec after last pulse.—Pulse and DC Monitor Circuit, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 201.



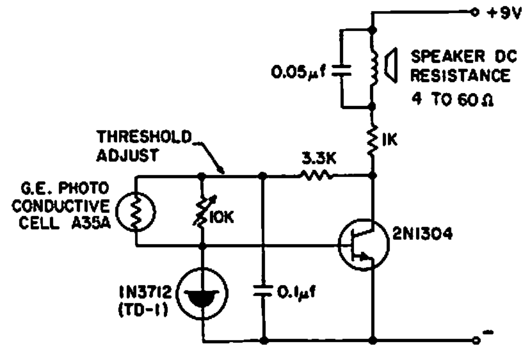
MISSING-PULSE DETECTOR—Warning light comes on to indicate occasional skipping of timing pulse or gate trigger having 20-pps rate, with durations ranging from 2 microsec to 30 millisec. Detector is triggered if interval between any two pulses exceeds 75 millisec, and must then be reset by pushbutton.—H. S. Reichard, Missing Pulse Detector, *EEE*, 10:6, p 35.



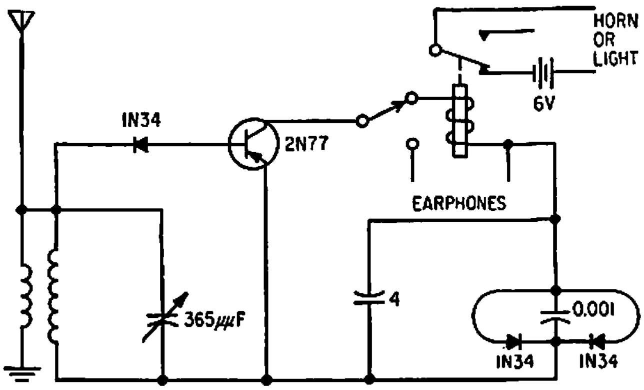
MULTIPLE-INPUT ALARM—Any of several inputs will pull in common alarm relay, with corresponding lamp giving visual indication of triggered circuit. For higher-current lamps, use 3N81 silicon controlled switches.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 425.



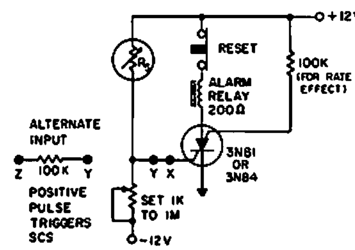
LAMP BURNOUT ALARM—Used when photocells and lamps are employed to detect end of magnetic tape, load point, or bad spot. Failure of lamp can cause serious trouble in magnetic tape handler. With circuit shown, when lamp burns out, transistor can no longer energize relay, and relay contact closes to actuate alarm at computer console.—J. E. Kienle and R. W. Wooldridge, Photocell Lamp Burnout Warning Circuit, *EEE*, 10:8, p 27–28.



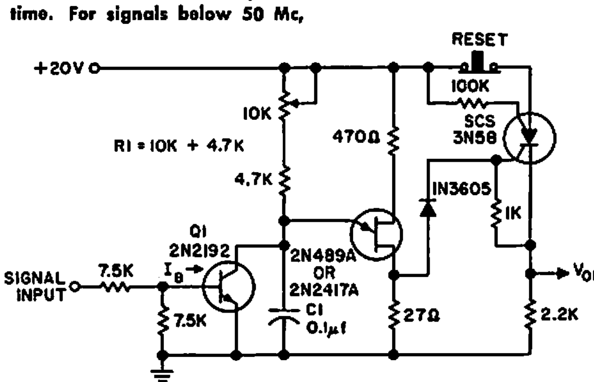
LIGHT DETECTOR—Gives 1,800-cps alarm tone when illumination on photocell exceeds predetermined level, which can be below 0.1 foot-candle near 5,500 angstroms.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 363.



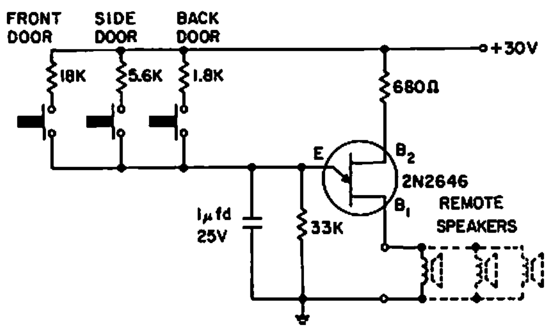
SIGNAL-POWERED ALARM RECEIVER—On arrival of carrier signal at frequency to which antenna and input are tuned, transistor pulls in relay, applying battery power to horn or light. No power is drawn from battery during standby time. For signals below 50 Mc, best pickup is obtained with single-wire antenna 150 feet long, at right angles to line-of-sight path and as high as possible.—L. R. Crump, Radio Waves Power Transistor Circuits, *Electronics*, 31:19, p 63–65.



RESISTANCE-TRIGGERED ALARM—Silicon controlled switch is triggered when temperature-, light-, or radiation-sensitive resistor Rs up to 1 meg drops below value of preset potentiometer. Interchanging Rs and potentiometer will trigger alarm on increase in sensing resistor.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 425.

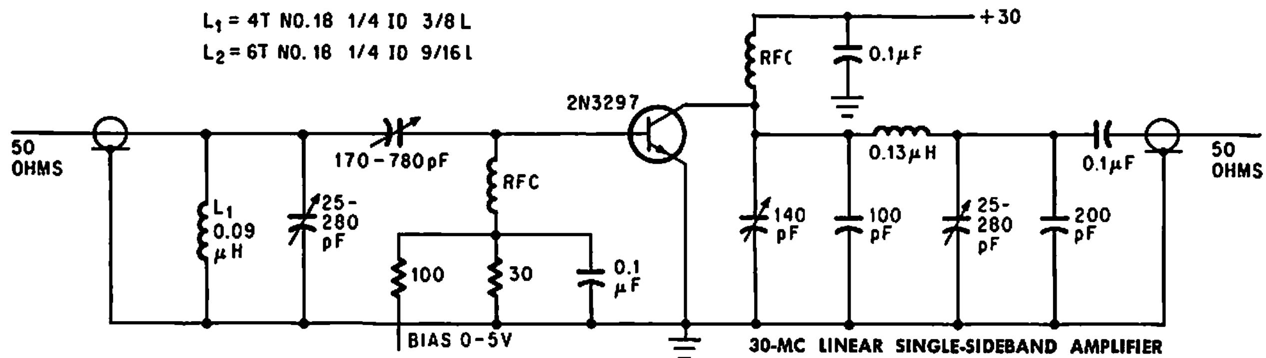


SIGNAL DROPOUT DETECTOR—Used to provide indication of momentary dropout of d-c, a-c, or pulse input signal. Time between disappearance of signal and indication of fault is adjustable. Output signal remains until scs is turned off by momentarily opening reset switch.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 336.

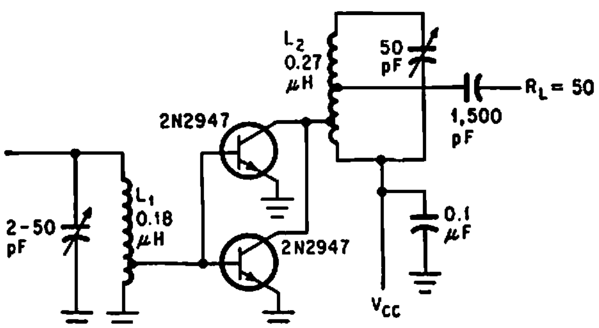


ELECTRONIC DOORBELL—Single unijunction transistor oscillates at different tone for each door.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 380.

CHAPTER 2
Amplifier Circuits

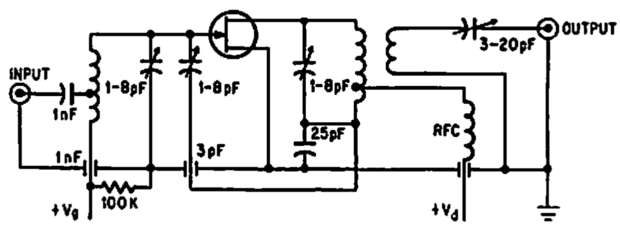


30-MC LINEAR SINGLE-SIDEBAND AMPLIFIER—Single silicon transistor with impedance-matching network and pi output network delivers 20 w of r-f peak envelope power, with all odd-order distortion products at least 30 db down.—R. C. Hejhall, Getting Transistors Into Single-Sideband Amplifiers, *Electronics*, 37:17, p 72–75.

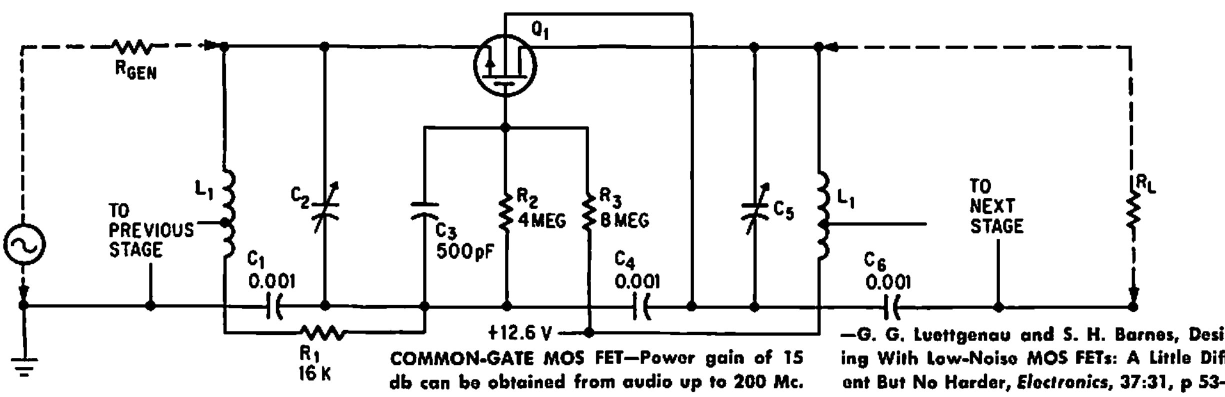


L_1 = 4T NO. 14, 1/2 ID 5/8 L, TAPPED 1/2 T FROM GND L_2 = 4T 1/8 COP. TUBE 3/4 ID 1" L, TAPPED 1/2 T FROM GND

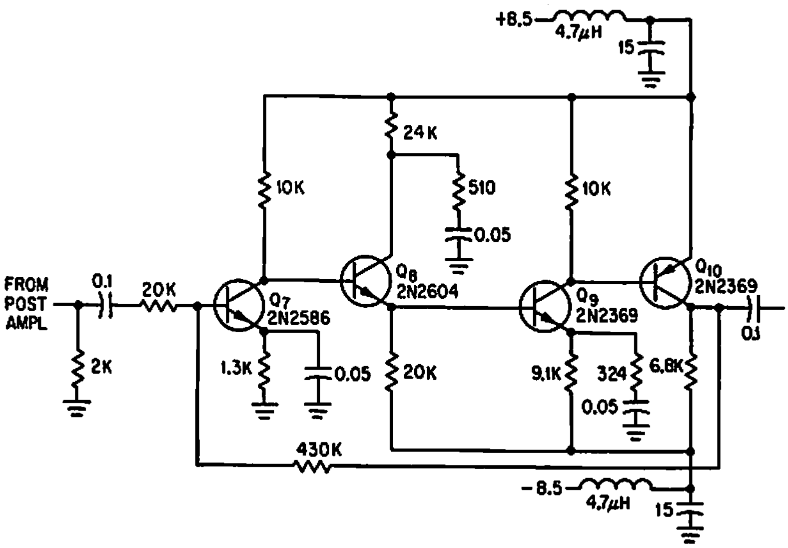
50-MC 40-W POWER AMPLIFIER—Paralleled silicon transistors operating as class C are biased on by incoming r-f signal, hence stop conducting when there is no signal.—R. C. Hejhall, Getting Transistors Into Single-Sideband Amplifiers, *Electronics*, 37:17, p 72–75.



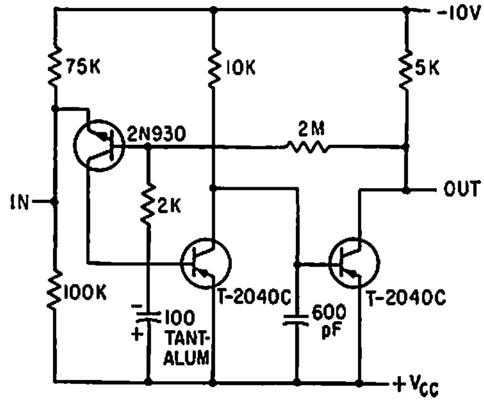
100-MC FET AMPLIFIER—Low-cost insulated-gate fet circuit can handle signals up to several volts in uhf range, with inherently low cross-modulation distortion.—Low-Cost Power Booster, *Electronics*, 37:14, p 29–30.



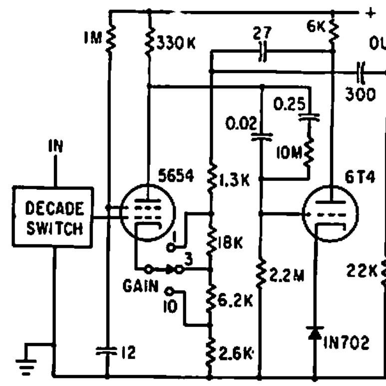
COMMON-GATE MOS FET—Power gain of 15 db can be obtained from audio up to 200 Mc.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



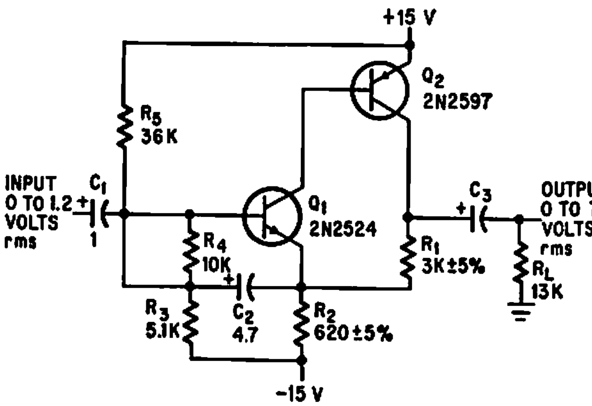
DISCRIMINATOR AMPLIFIER—Direct-coupled voltage amplifier with a-c coupling at input and output has loop gain of 36 for bandwidth of 1 Mc, including low-impedance driver Q10.—R. Cuikay and T. Callahan, Orbiting Observatory to Measure Stars' Dim Light, *Electronics*, 37:9, p 28–31.



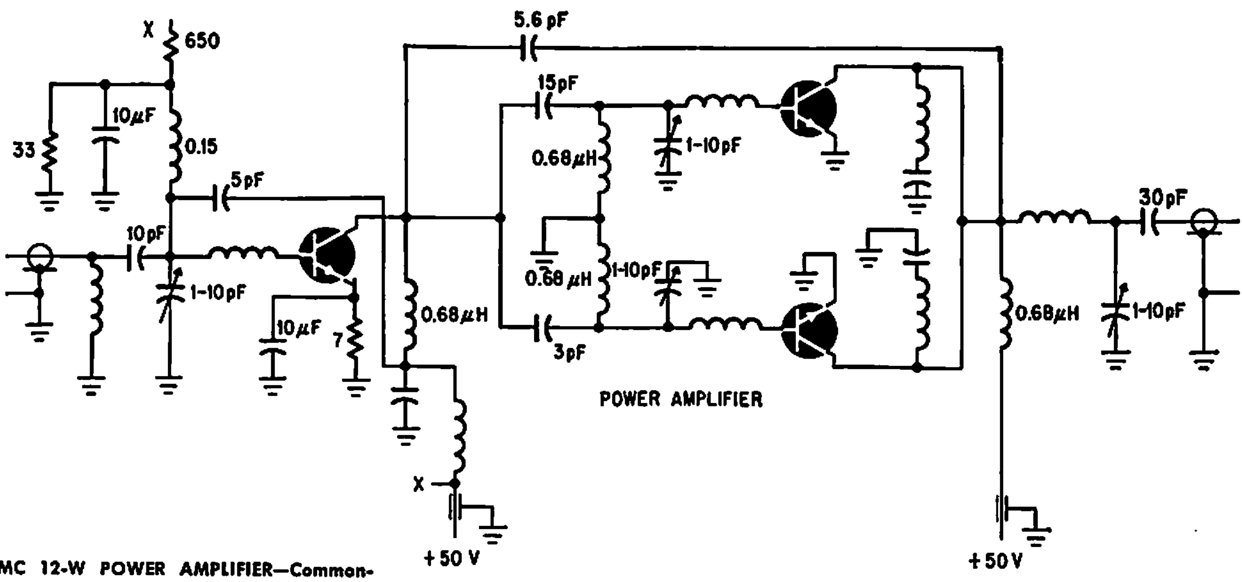
60 DB GAIN AT 1 CPS TO 1 MC—Direct coupled a-c amplifier with feedback and current-derived stabilization uses only two capacitors. —P. Laakmann, Direct Coupling Shrinks Amplifier Size and Cost, *Electronics*, 36:12, p 66–68.



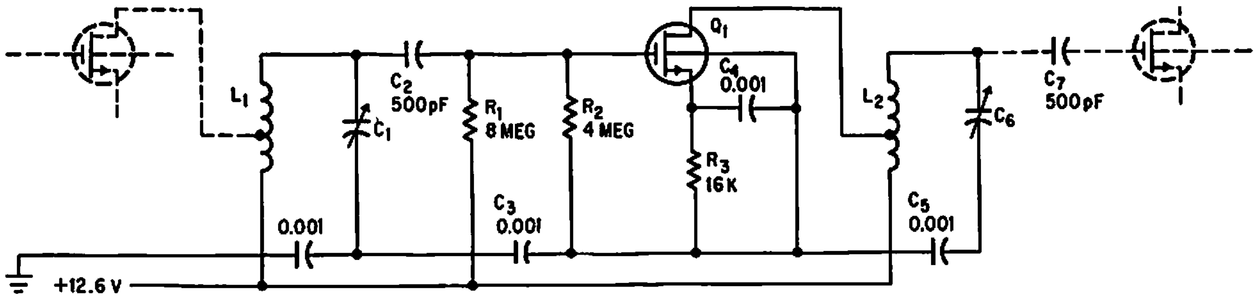
RESPONSE BELOW 2 CPS—With input resistance of 1,000 meg, piezoelectric gage amplifier gives gain choices of 1, 3, or 10 for loads above 2,500 ohms. Decade input switch can provide choice of shunt capacitances for trimming sensitivity of gages.—Extending Piezoelectric Gage L-F Response, *Electronics*, 36:4, p 100–103.



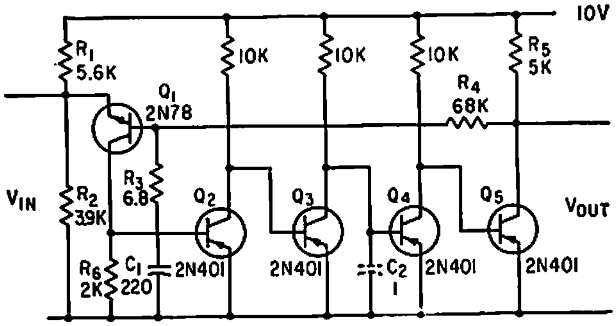
COMPLEMENTARY-TRANSISTOR AMPLIFIER—Bootstrapping and negative feedback provide 220,000-ohm input impedance and 60,000-ohm output impedance, with stabilized gain over wide temperature range.—L. J. Ernst, Complementary Amplifier Offers High Input Impedance, *Electronics*, 37:16, p 92–93.



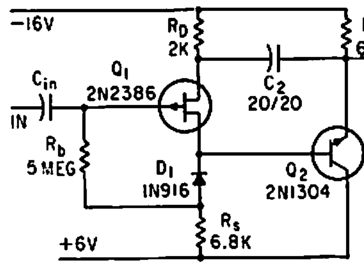
250-MC 12-W POWER AMPLIFIER—Common-emitter circuits operating class C serve for driver and parallel-connected power amplifier transistors. Total gain is 12 db.—N. Downs and B. van Sutphin, Solid-State Transmitter Ready for UHF Telemetry, *Electronics*, 37:17, p 76–80.



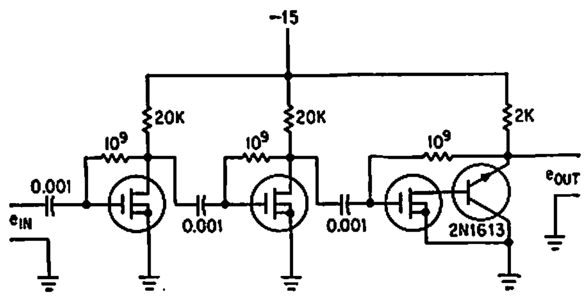
UNNEUTRALIZED MOS FET—Low drain-gate capacitance is needed for high power gains above 2 Mc from common-source mos fet.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



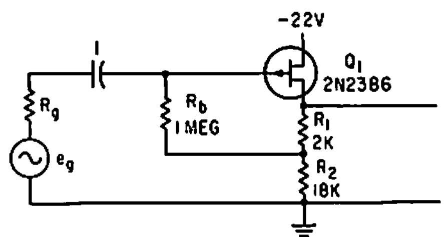
CURRENT-DERIVED STABILIZATION—Bridge-derived stabilization in direct-coupled a-c amplifier provides current sensitivity of 0.1 microamp per ma of output current.—P. Laakmann, Direct Coupling Shrinks Amplifier Size and Cost, *Electronics*, 36:12, p 66–68.



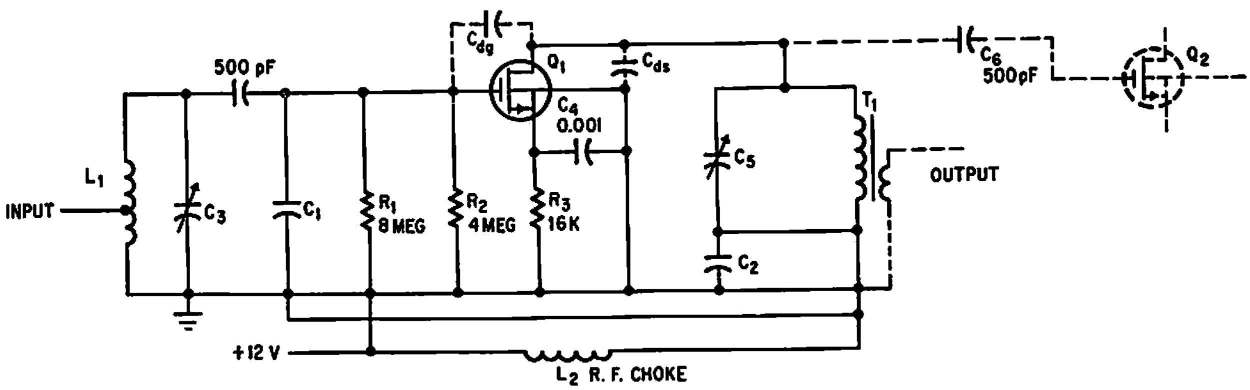
SOURCE FOLLOWER WITH REDUCED GATE-TO-DRAIN CAPACITANCE—Diode D1 gives maximum a-c bootstrapping of gate bias resistance while providing required d-c bias. Emitter-follower Q2 couples to drain of fet Q1 a signal in phase with input, to give extremely low input capacitance.—T. R. Bignall, How to Get Maximum Input Impedance with Field-Effect Transistors, *Electronics*, 36:10, p 44–46.



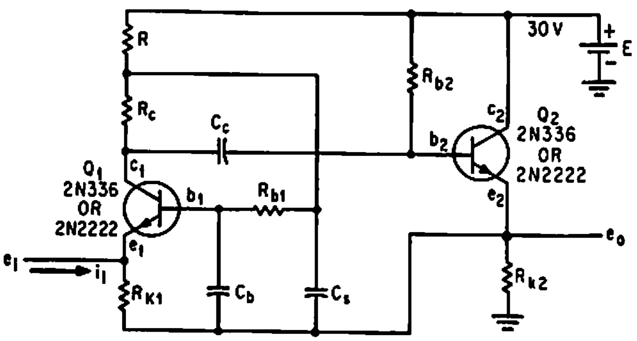
BROADBAND WITH GAIN OF 1,350—Metal-oxide semiconductor transistors (p-mosts) in Darlington configuration give high input impedance and low output impedance from 5 cps to 72 kc.—F. M. Wanlass, Novel Field-Effect Device Provides Broadband Gain, *Electronics*, 36:44, p 30–33.



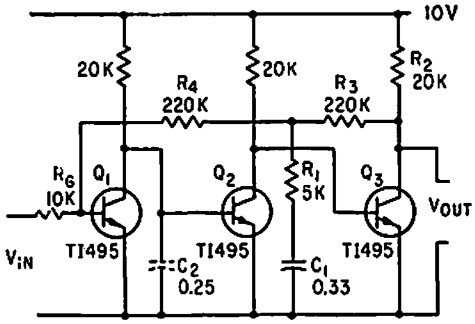
SOURCE FOLLOWER USES BOOTSTRAPPING—Bandwidth is 10 cps to 10 kc, d-c input impedance is 10 meg, and input impedance at 10 kc is above 1 meg for input signals from 1 mv to 10 mv.—T. R. Bignall, How to Get Maximum Input Impedance with Field-Effect Transistors, *Electronics*, 36:10, p 44–46.



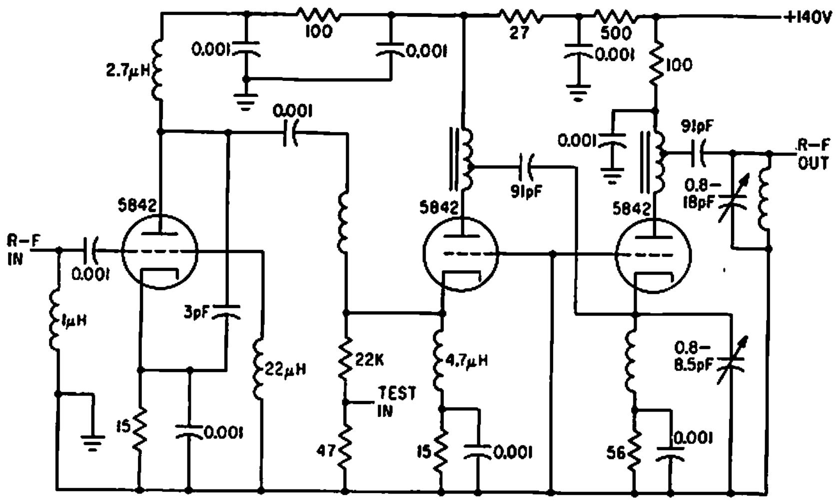
NEUTRALIZED MOS FET—Delivers power gain of 20 db at 100 Mc, with common-source connection.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



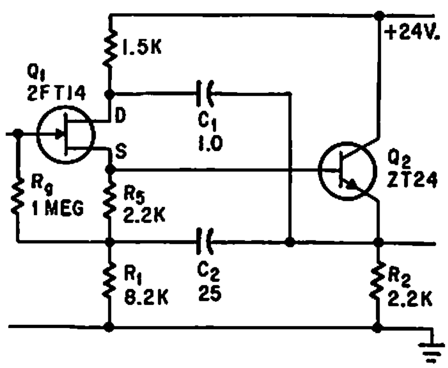
UNITY-GAIN BUFFER—Positive gain of unity is obtained with high input impedance, low output impedance, negligible phase shift, and without phase reversal. Can be used for isolating resolvers from loads.—D. K. Phillips, Unity-Gain Buffer Acquires Precision by Feedback, *Electronics*, 36:51, p 36–37.



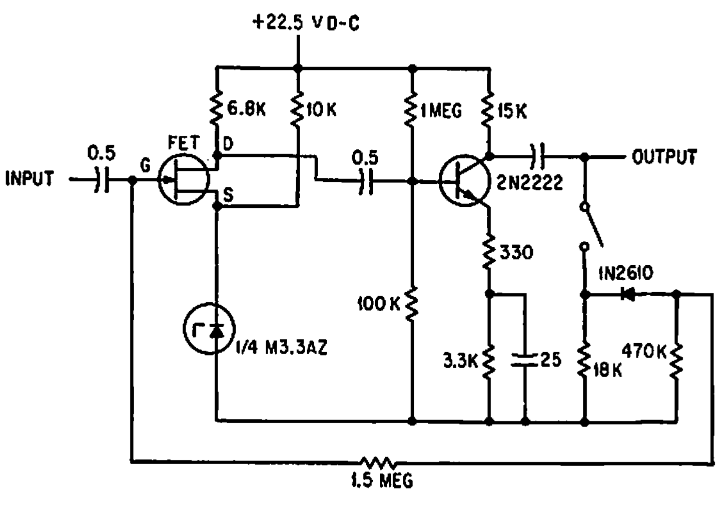
STABILIZED DIRECT-COUPLED A-C AMPLIFIER—Current-derived stabilization gives simple amplifier using only one capacitor. Adding C2 improves stability but lowers cutoff frequency.—P. Laakmann, Direct Coupling Shrinks Amplifier Size and Cost, *Electronics*, 36:12, p 66–68.



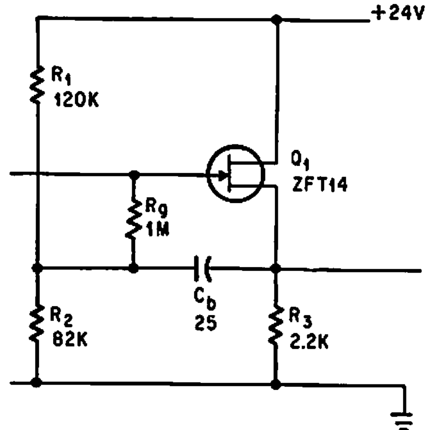
GROUNDED-GRID BROADBAND—Grounded-cathode preamplifier has plate load that provides increasing gain with increasing frequency to drive following two tubes in cascade. Both source and load impedances are 50 ohms.—Broadband VHF Amplifier Covers 30 to 260 Mc Range, *Electronics*, 35:4, p 102.



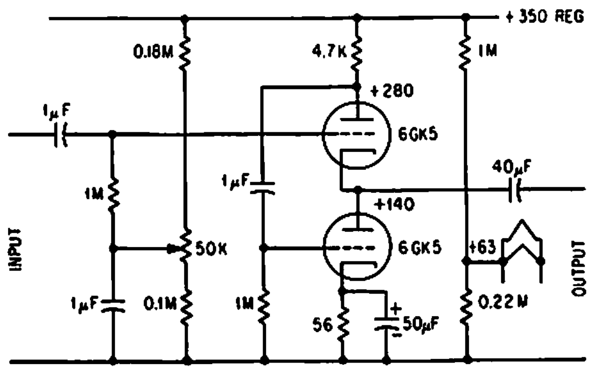
WIDEBAND FET—Feedback and bootstrapping techniques give overall input capacitance of 0.4 pf for 30-pf gate capacitance of fet. Transistor serves as source follower.—B. Down, Using Feedback in FET Circuit to Reduce Input Capacitance, *Electronics*, 37:31, p 63–65.



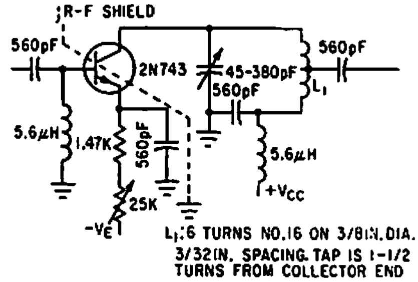
LOW-NOISE FET AMPLIFIER—Agc feedback extends input level to 150 mv.—L. E. Clark, E. B. Mack, and R. C. Hejhall, Highlights of Small-Signal Circuit Design, *Electronics*, 36:49, p 46–50.



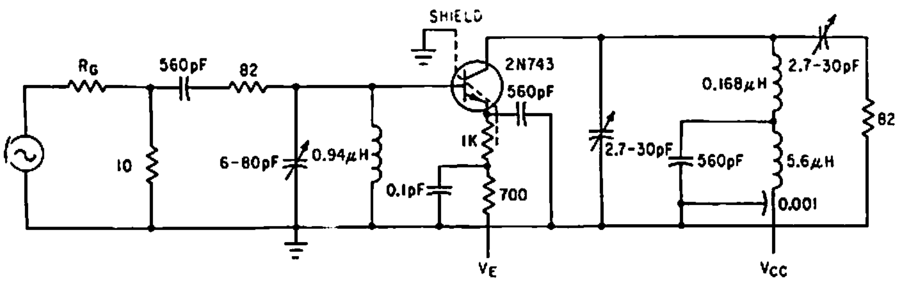
FET SOURCE-FOLLOWER—Voltage-divider biasing increases input impedance. R3 provides negative feedback.—B. Down, Using Feedback in FET Circuit to Reduce Input Capacitance, *Electronics*, 37:31, p 63–65.



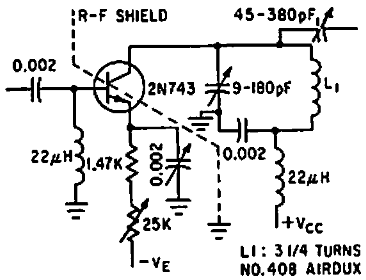
CASCODE FOLLOWER—Output is 20 v peak-to-peak into 1,000 ohms, down to 5 cps, with high stability.—R. W. Johnson, Circuit with a Twist: The Cascode Follower, *Electronics*, 36:49, p 69–70.



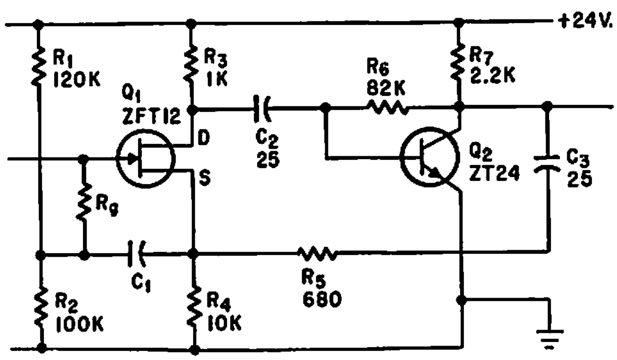
60-MC LOW-NOISE—Noise figure is only 6 db for generator resistance of 150 ohms.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



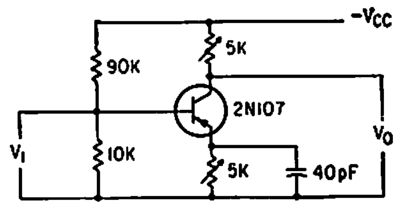
SMALL-SIGNAL 60-MC—Epitaxial 2N743 is operated common-emitter at signal frequency and common-base for biasing. Unneutralized gain per stage is 17 db.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



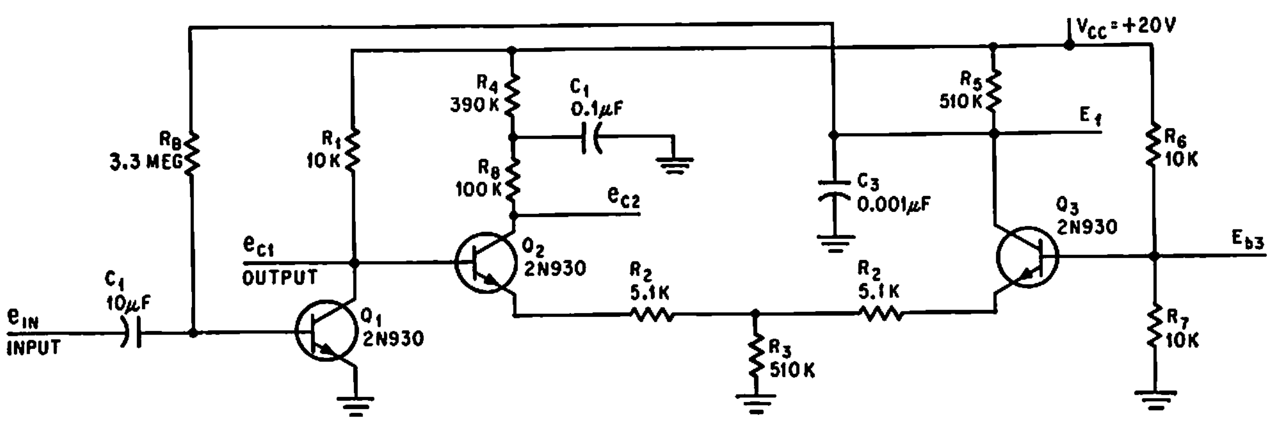
30-MC LOW-NOISE—Noise figure is only 4 db for generator resistance of 200 ohms.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



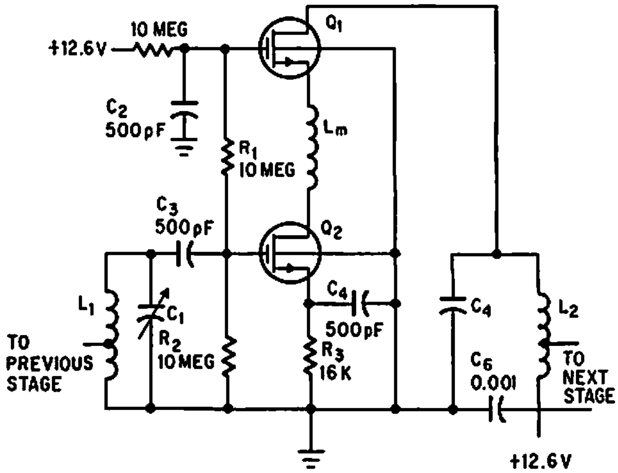
50-MEG INPUT IMPEDANCE—Feedback from Q2 to fet Q1 boosts input impedance.—B. Down, Using Feedback in FET Circuit to Reduce Input Capacitance, *Electronics*, 37:31, p 63–65.



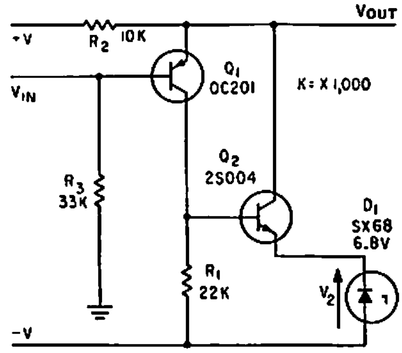
MAGNETICALLY CONTROLLED TRANSISTOR—Uncapped pnp germanium alloy junction transistor placed in strong magnetic field shows gain variation with flux density, with direction and amount of gain depending on direction of magnetic field.—R. W. Lado et al., Magnetic Fields Vary Transistor Gain, *Electronics*, 34:5, p 68–70.



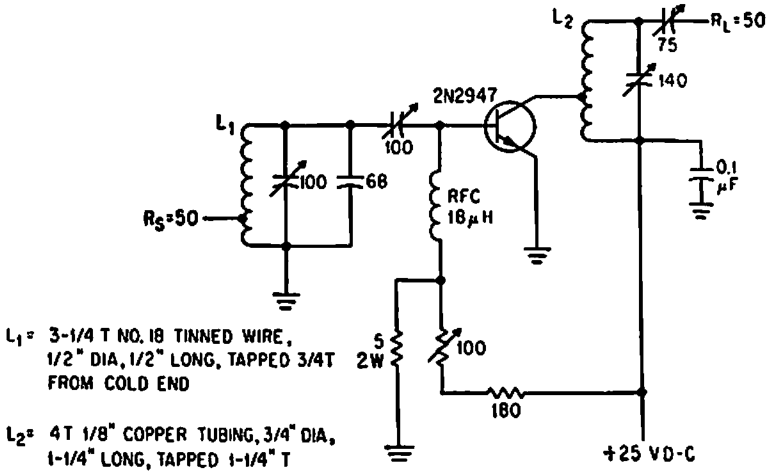
CONSTANT GAIN—Differential amplifier Q2-Q3 regulates bias of Q1 to keep gain constant despite variations in load or in circuit components.—R. C. Lavigne and L. L. Kleinberg, Amplifier Gain is Constant Despite Changes in Load, *Electronics*, 38:13, p 75–77.



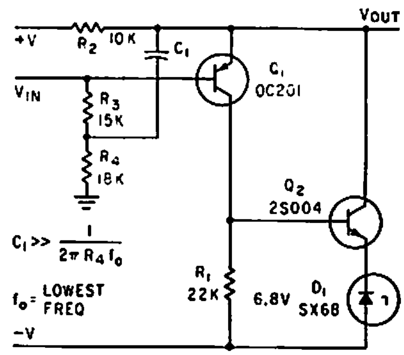
CASCODE MOS FET—Power gain is slightly higher than for neutralized common-source stage.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



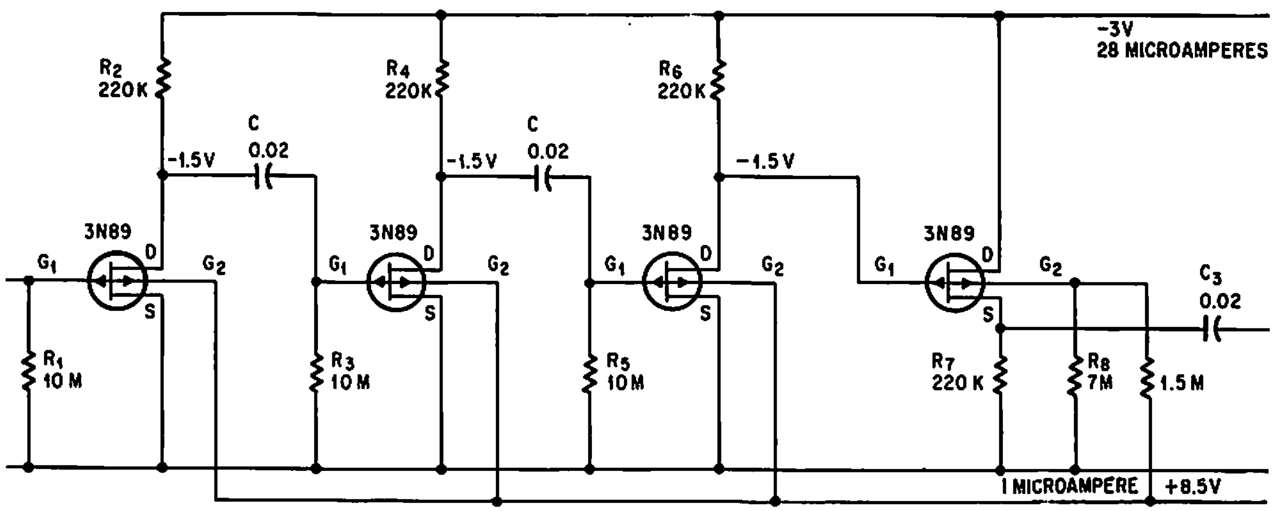
COMPOUNDED EMITTER-FOLLOWER—Compounded emitter-follower with feedback, operated as complementary pair, gives higher input impedance, higher gain, and lower output impedance than conventional emitter-follower.—T. K. Hemingway and J. Willis, Transistor Pairs Improve Emitter-Follower Performance, *Electronics*, 35:21, p 48–49.



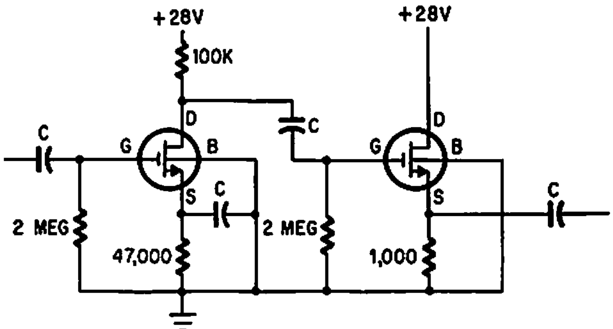
30-MC LINEAR SSB—Power gain is 13 db and output is 8 w peak envelope power.—L. E. Clark, E. B. Mack, and R. C. Hejhall, Highlights of Small-Signal Circuit Design, *Electronics*, 36:49, p 46–50.



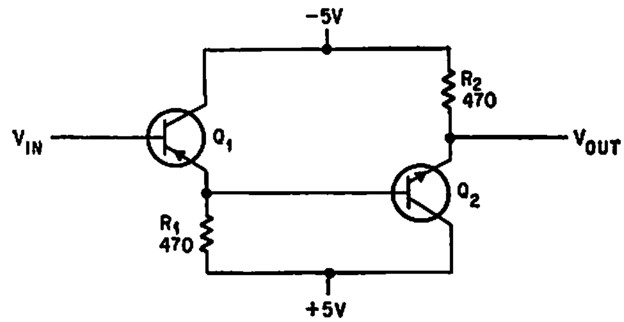
MODIFIED EMITTER-SQUARED FOLLOWER—Complementary transistor arrangement of feedback amplifier is modified to reduce shunting effect of R3 by applying positive feedback voltage that artificially increases value of R3.—T. K. Hemingway and J. Willis, Transistor Pairs Improve Emitter-Follower Performance, *Electronics*, 35:21, p 48–49.



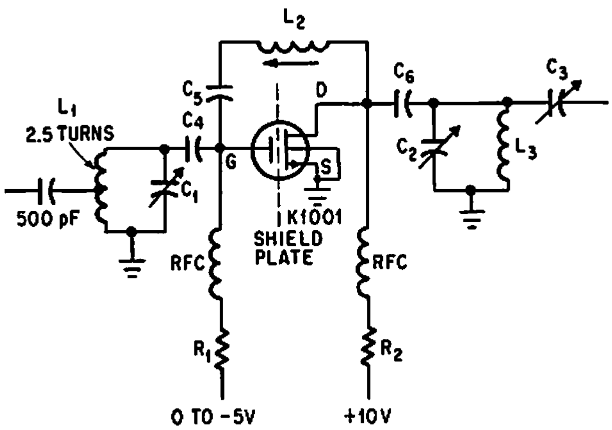
FET MICROPOWER—Voltage gain is 60 db from 1 cps to 30 kc, with 0.5 v rms maximum output voltage, for power drain under 100 microwatts. First three transistors should be matched.—J. S. Sherwin, An FET Micropower Amplifier, *Electronics*, 37:31, p 74–75.



TWO-STAGE MOS FET—Pair of 3N98 transistors give voltage gain of 10 with low output impedance.—D. M. Griswold, Understanding and Using the MOS FET, *Electronics*, 37:31, p 66–70.

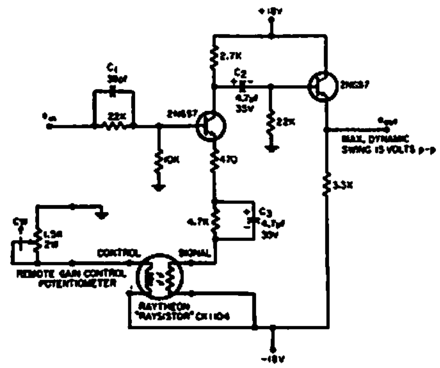


BROADBAND IMPEDANCE TRANSFORMER—Darlington circuit gives unity gain from d-c up to several Mc, using any complementary pair of transistors having sufficiently high gain and cutoff frequency.—I. Ingemarsson, Darlington Maintains Constant Unity Gain, *Electronics*, 38:22, p 69.

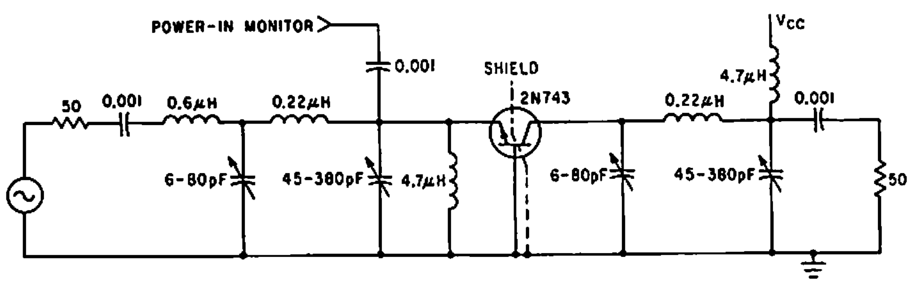


COMPONENT VALUES			
C_1	0.9–7 pF	L_1	5 TURNS, $\frac{5''}{8}$ x $\frac{1''}{2}$ NO. 20 WIRE, 0.29 μH
C_2	0.9–7 pF	L_2	MILLER TYPE 20A107RBI OR EQUIV. 0.125–0.079 μH
C_3	0.9–7 pF	L_3	5 TURNS, $\frac{5''}{8}$ x $\frac{1''}{2}$ NO. 20 WIRE
C_4	500 pF		
C_5	500 pF	R_1	6,800 OHMS
C_6	500 pF	R_2	2,200 OHMS

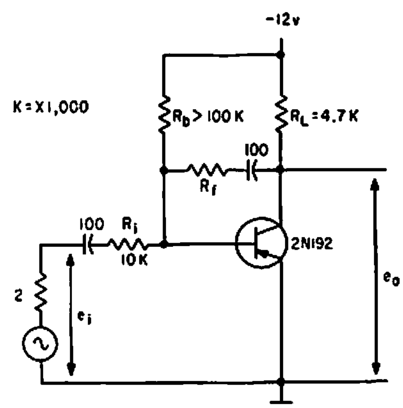
200-MC FET NEUTRALIZED AMPLIFIER—Capacitor C5 between drain and gate provides neutralization by nullifying feedback. Neutralized stable gain at 250 Mc is 8 db. Bandwidth is 12 Mc.—P. E. Kolk and I. A. Maloff, The Field-Effect Transistor as High-Frequency Amplifier, *Electronics*, 37:31, p 71–74.



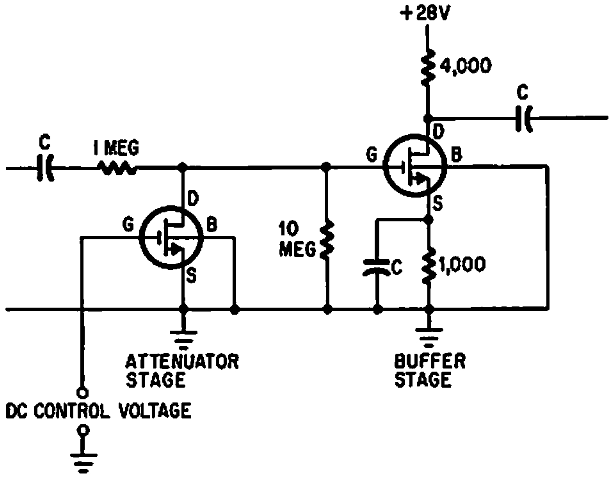
REMOTE GAIN CONTROL—Permits adjusting gain of wideband amplifier over full range from maximum to zero with two-wire low-voltage line up to 1,000 feet long. Control and signal circuits are completely isolated. Components shown give maximum gain of 1.—R. S. Young, Amplifier with Remote Gain Control, *EEE*, 12:8, p 71.



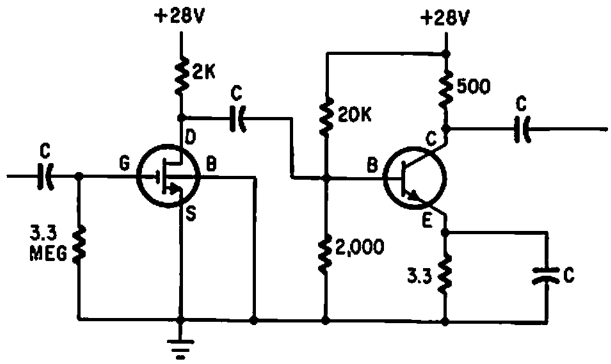
LOW-SUPPLY-VOLTAGE VHF—Good high-frequency parameters of epitaxial mesa transistor give high gain and efficiency at supply voltage of only 12 v. Output is 0.5 w at 70 Mc.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



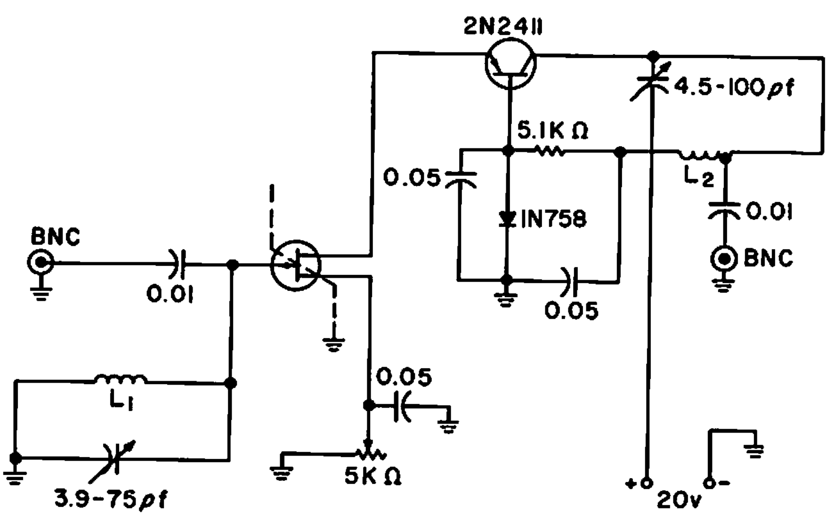
NONLINEAR FEEDBACK LOOP—Type WE41A copper-oxide varistor for Rf in feedback loop gives radically different voltage-gain characteristic than silicon diode for Rf, but both give exponential response and increase dynamic range.—J. C. Looney, Designing Amplifiers with Nonlinear Feedback, *Electronics*, 34:13, p 46–49.



VOLTAGE-CONTROLLED ATTENUATOR—Can attenuate input signals 70 db when mos fet is followed by high-impedance load such as common-source mos fet amplifier.—D. M. Griswold, Understanding and Using the MOS FET, *Electronics*, 37:31, p 66–70.

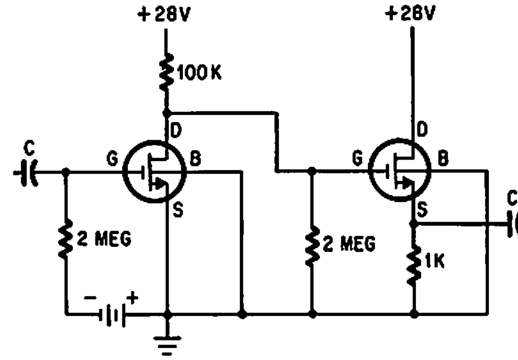


MOS FET WITH NPN—FET input stage serves as high-to-low impedance transformer for power transistor and gives very high power gain.—D. M. Griswold, Understanding and Using the MOS FET, *Electronics*, 37:31, p 66–70.

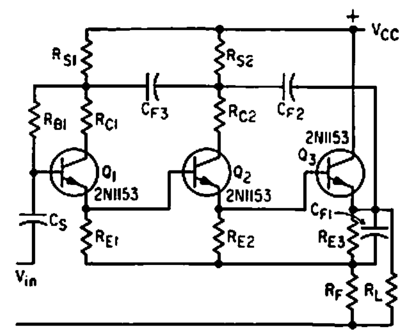


L_1, L_2 18 turns B&W 3004 Minductor; L_2 tapped 1 3/4 turns from ground.

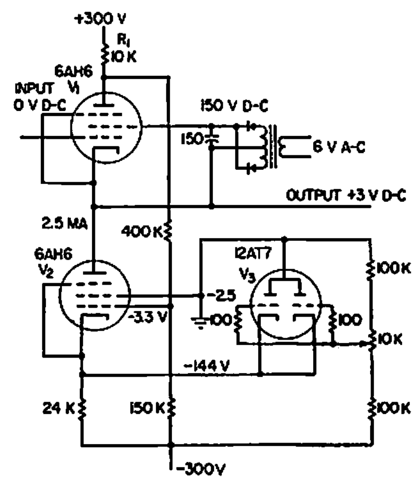
TUNED 10-MC AMPLIFIER WITHOUT NEUTRALIZATION—Low reverse transfer of cascode connection makes possible stable operation of common-source fet. Transducer gains are 20.6 db and 25.3 db for 2N2497 and 2N2499 respectively.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 142.



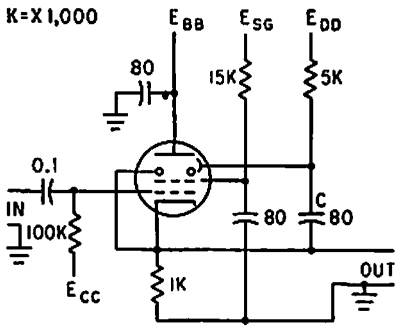
DIRECTLY COUPLED MOS FET—Eliminates coupling capacitors but requires additional bias supply.—D. M. Griswold, Understanding and Using the MOS FET, *Electronics*, 37:31, p 66–70.



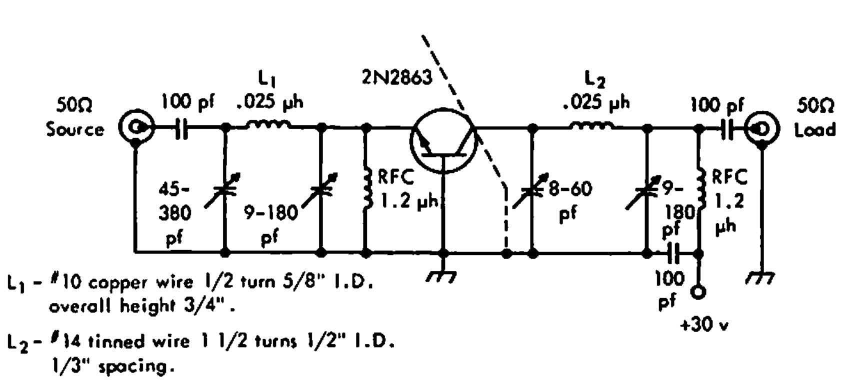
100-MEG INPUT IMPEDANCE—Variation of Darlington connection gives low-noise amplifier with high input impedance. Thermal and shot noise are much lower than flicker, leakage, and surface noise.—I. Levine, High Input Impedance Transistor Circuits, *Electronics*, 33:36, p 50–52.



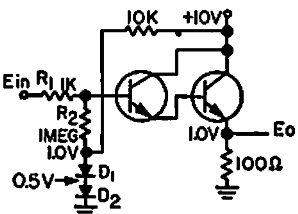
CATHODE FOLLOWER WITH 0.99963 GAIN—Used to couple high-impedance source to low-impedance output without attenuating or loading source signal. Output impedance is 50 ohms and response is flat within 3 db from d-c to 250 kc. Circuit delivers outputs from −140 to +210 v at −0.8 to +2 ma. Feedback through pentode helps maintain unity gain.—Cathode-Follower Gain Approaches Unity, *Electronics*, 31:1, p 94–96.



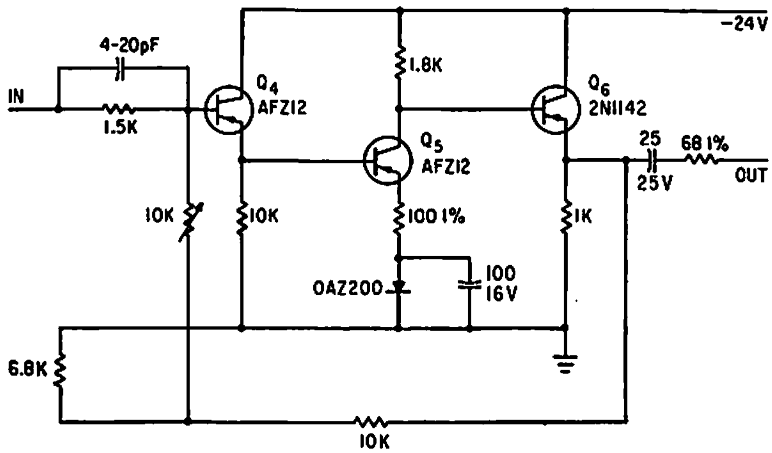
SECONDARY-EMISSION-PENTODE CATHODE FOLLOWER—Circuit is enhanced by connecting dynode back to cathode. Uses degenerative feedback, to achieve high-performance impedance transformation. Can be used to match high-impedance source to low-impedance load.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



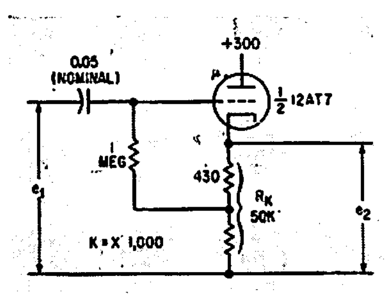
160-MC 750-MW POWER STAGE—Pi matching networks at input and output optimize transistor performance in class C operation. Efficiency is 25% and 3-db bandwidth is 15 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 318.



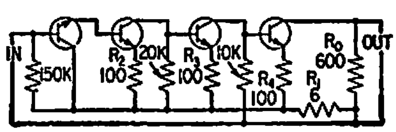
TEMPERATURE-COMPENSATED DARLINGTON—Modified Darlington includes two diodes and additional resistor. With these, temperature changes up to 50°C have no effect on output.—R. C. Going, Temperature-Stabilized Darlington, *EEE*, 11:7, p 28–29.



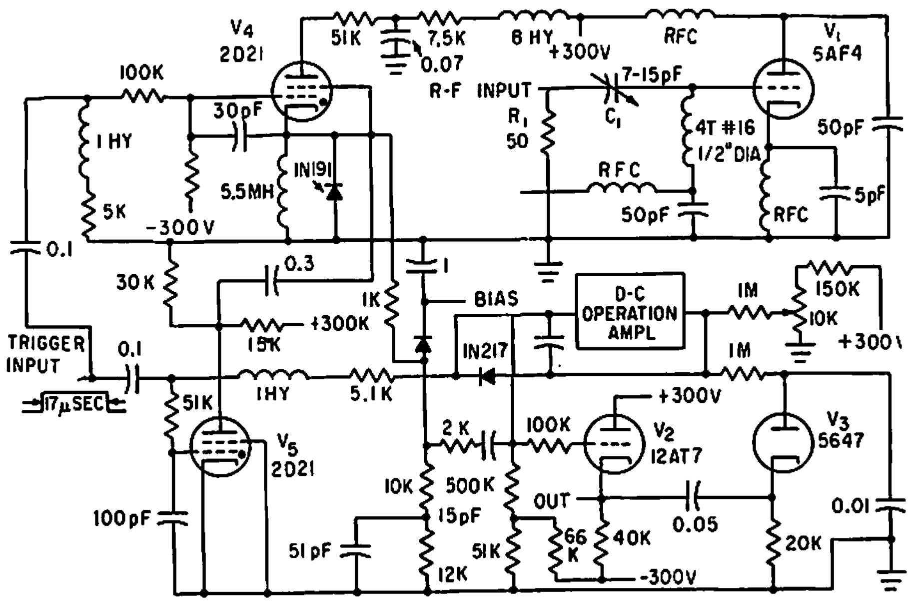
CABLE-DRIVING AMPLIFIER—Used between wideband integrator and 185-ohm cable. With voltage gain of 3, bandwidth is 18 Mc without overshoot for pulse signals.—S. Berglund and S. Westerlund, Probes for Plasma Research with Wideband Integrators, *Electronics*, 35:24, p 44–45.



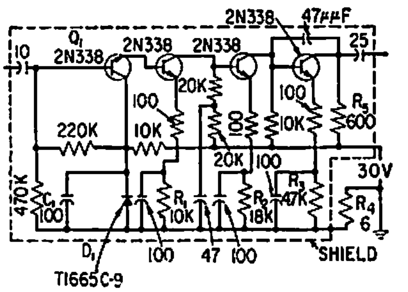
TRIODE CATHODE FOLLOWER—Effective gain stability factor is approximately equal to reciprocal of amplification factor of tube.—G. M. Davidson and R. F. Brady, Unity-Gain Amplifier Offers High Stability, *Electronics*, 33:9, p 66–67.



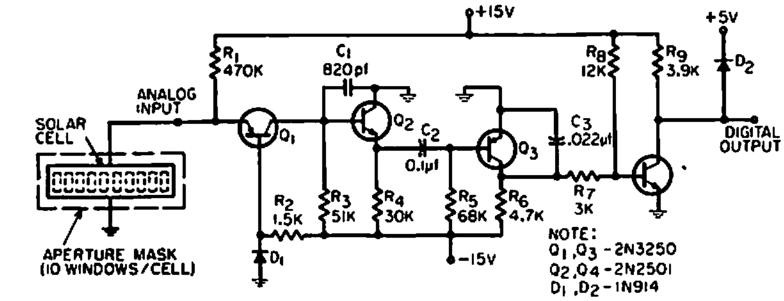
BOOSTING INPUT IMPEDANCE—Circuit shows how voltage gain in transistor amplifier can be exchanged for input impedance through use of negative feedback. At same time, voltage gain is made more independent of transistor parameters.—Feedback Increases Input Impedance, *Electronics*, 32:11, p 150–153.



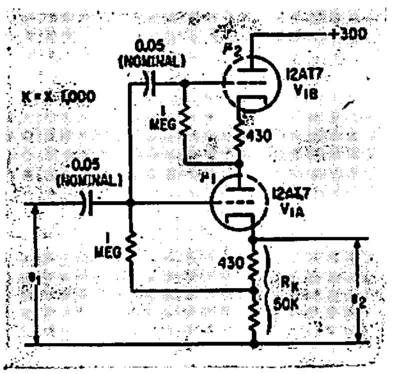
STABLE SUPERREGENERATIVE—Agc circuit transforms grid-pulsed superregenerative amplifier V1 into noncritical circuit that is stable for long periods when controlled by pulse generator V4-V5, which in turn is controlled by external trigger pulse source.—J. H. Kuck, Automatic Gain Control for Superregenerative Amplifiers, *Electronics*, 34:29, p 76–79.



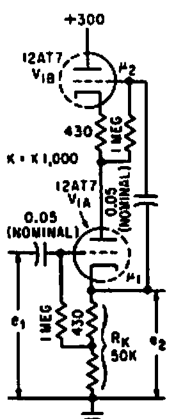
STABILIZING GAIN—Use of negative feedback in four-stage direct-coupled amplifier keeps gain constant within 1 db of 40 db from 6 cps to 300 kc. Input impedance is 8 meg and output impedance is 600 ohms.—Feedback Increases Input Impedance, *Electronics*, 32:11, p 150–153.



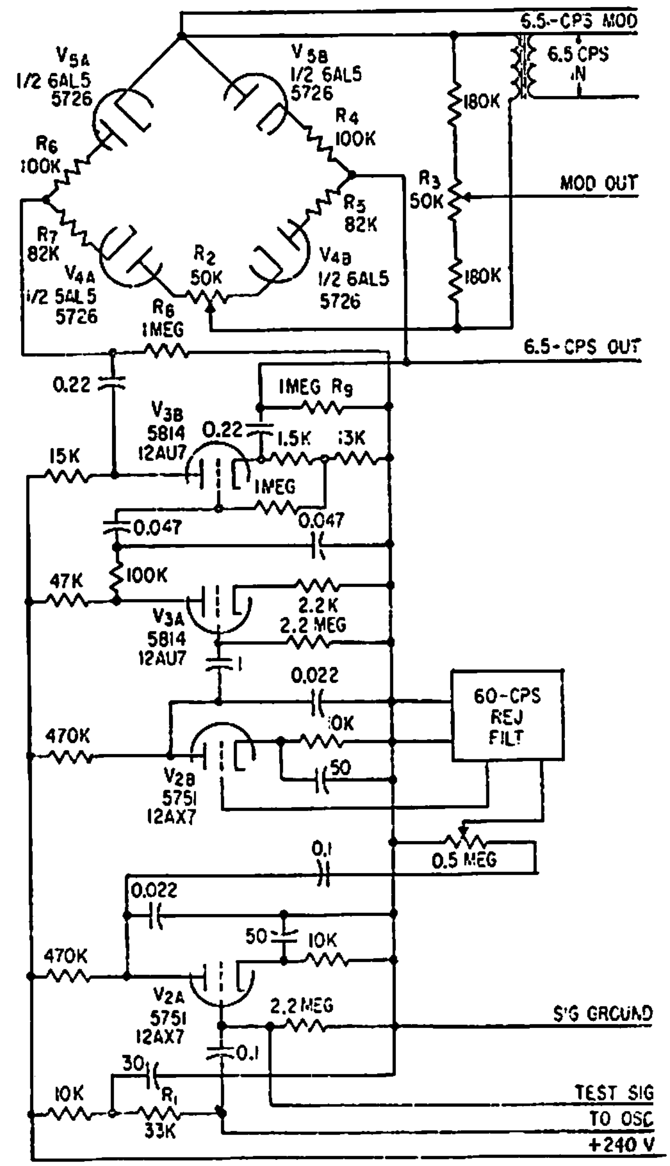
SOLAR-CELL AMPLIFIER—Used with multi-aperture solar cells to generate 10 strobe pulses. Eight circuits with cells are needed to generate 80 strobe pulses for reading conventional punched card.—G. R. Hoarn, Multi-Aperture Solar Cell Amplifier, *EEE*, 14:4, p 43–44.



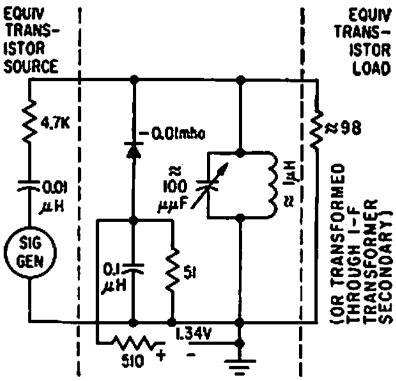
ISOLATION AMPLIFIER—Gain stability and input impedance are much better than conventional cathode follower. Feedback capacitor goes between triode grids, but may also go between grid of V1B and cathode of V1A.—G. M. Davidson and R. F. Brady, Unity-Gain Amplifier Offers High Stability, *Electronics*, 33:9, p 66–67.



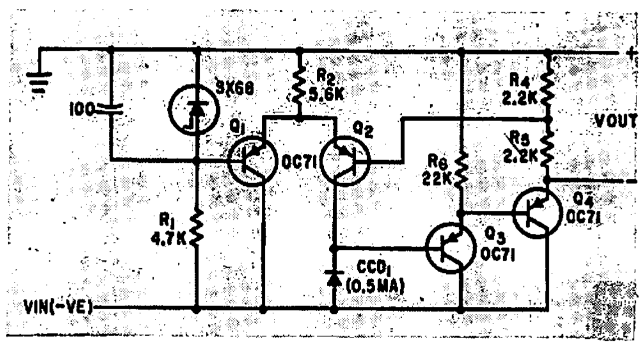
ISOLATION AMPLIFIER—Effective gain stability factor is approximately equal to reciprocal of product of amplification factors of two halves of tube. Gives high transmission accuracy, with high input impedance.—G. M. Davidson and R. F. Brady, Unity-Gain Amplifier Offers High Stability, *Electronics*, 33:9, p 66–67.



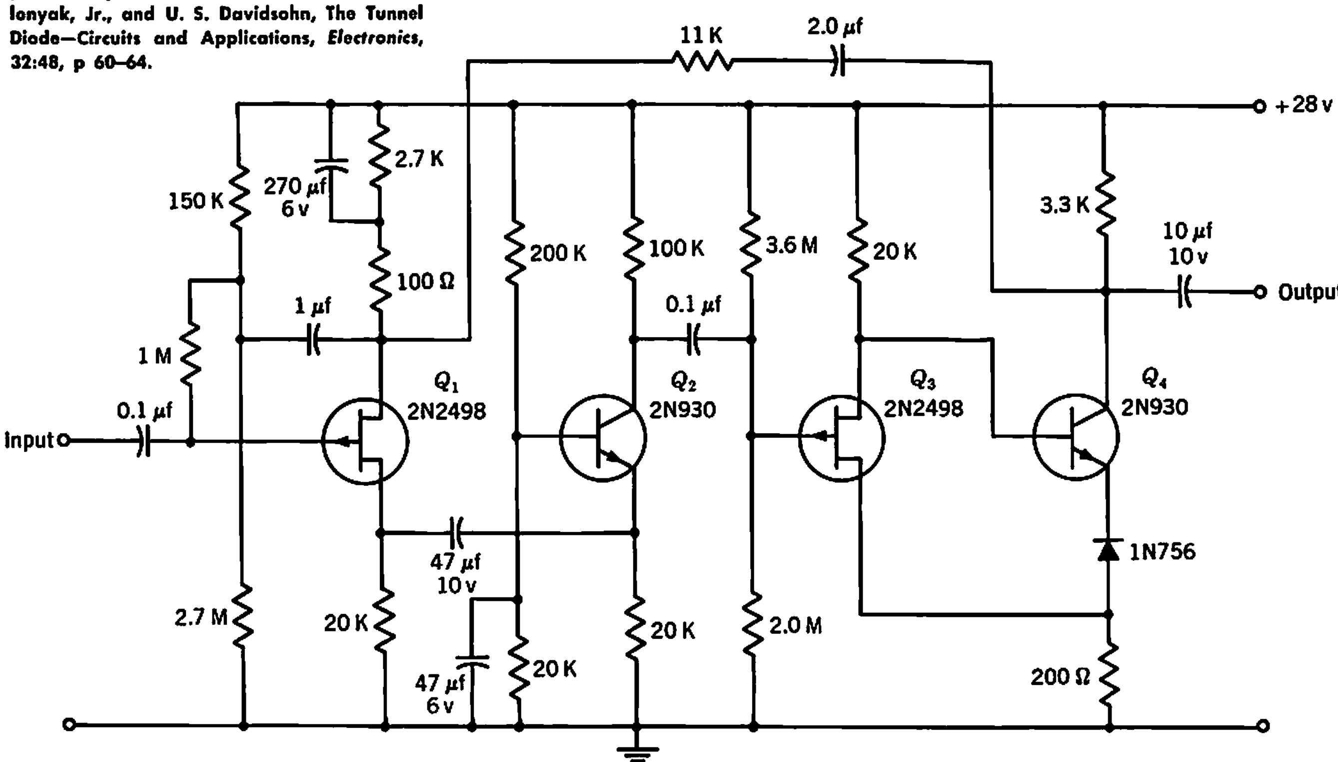
6.5-CPS AMPLIFIER—Consists of three triode stages (V2A, V2B, and V3A). Peaks at about 6.5 cps, with 18 db attenuation at each octave. Double-T rejection filter between V2A and V2B attenuates any 60-cps pickup. Overall gain is 80 db. Phase inverter V3B provides 180° out-of-phase signal for full-wave phase-sensitive bridge rectifier that uses reference signal. Output is rectified error signal for infrared analyzer used to detect leaks in automobile air-suspension systems.—P. G. Balko, Infrared Finds Auto Suspension Leaks, *Electronics*, 31:49, p 82–85.



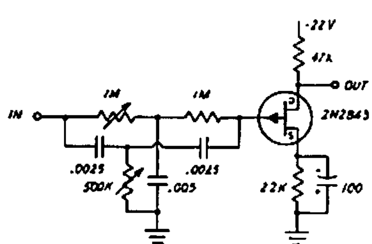
445-KC TUNNEL-DIODE AMPLIFIER—Has approximately 20 db gain.—I. A. Lesk, N. Holonyak, Jr., and U. S. Davidsohn, The Tunnel Diode—Circuits and Applications, *Electronics*, 32:48, p 60–64.



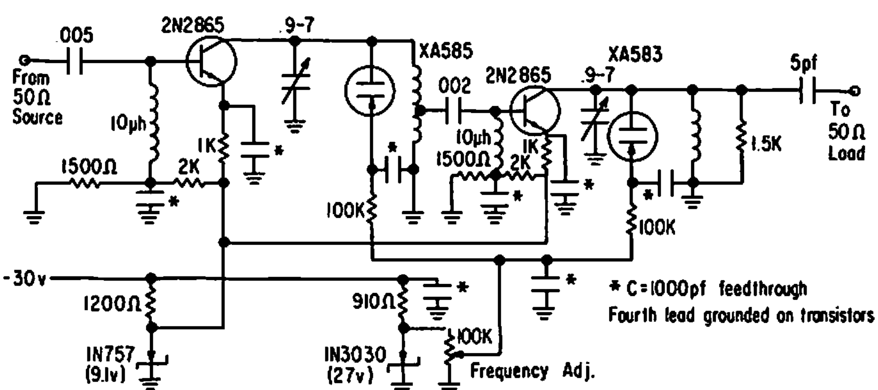
HIGH-GAIN VOLTAGE STABILIZER—Use of constant-current diode as collector load increases overall gain of amplifier from 500 to about 700.—T. K. Hemingway, Applications of the Constant-Current Diode, *Electronics*, 34:42, p 60–63.



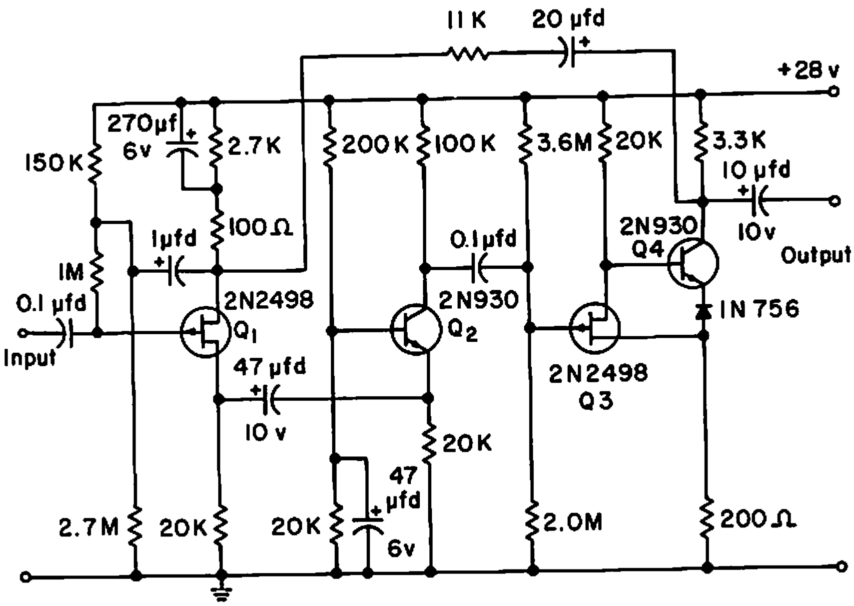
HIGH-INPUT-IMPEDANCE A-C AMPLIFIER—Gives input impedance of 30 meg without sacrificing bandwidth or noise performance. Voltage gain is 40 db. Technique involves bootstrapping fet Q1 and using fixed bias for its gate. Q2 is operated grounded-base to reduce Miller capacitance of field effect at high frequencies.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 520.



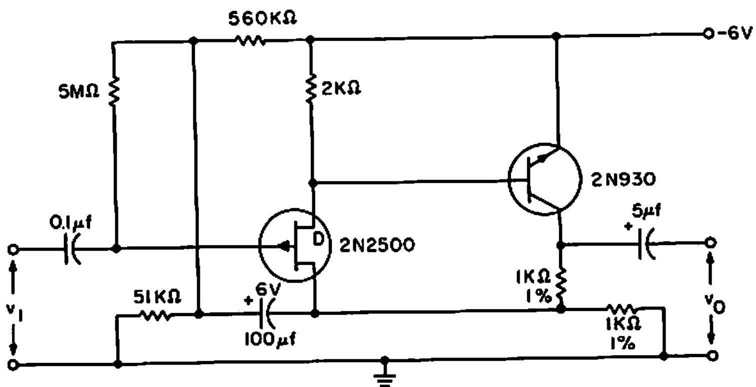
60-CPS BANDSTOP AMPLIFIER—With fet as output buffer to give near-infinite load impedance, twin-T notch filter gives up to 50 db attenuation at notch frequency.—FET's and RC Networks (Siliconix ad), *Electronics*, 39:4, p 71.



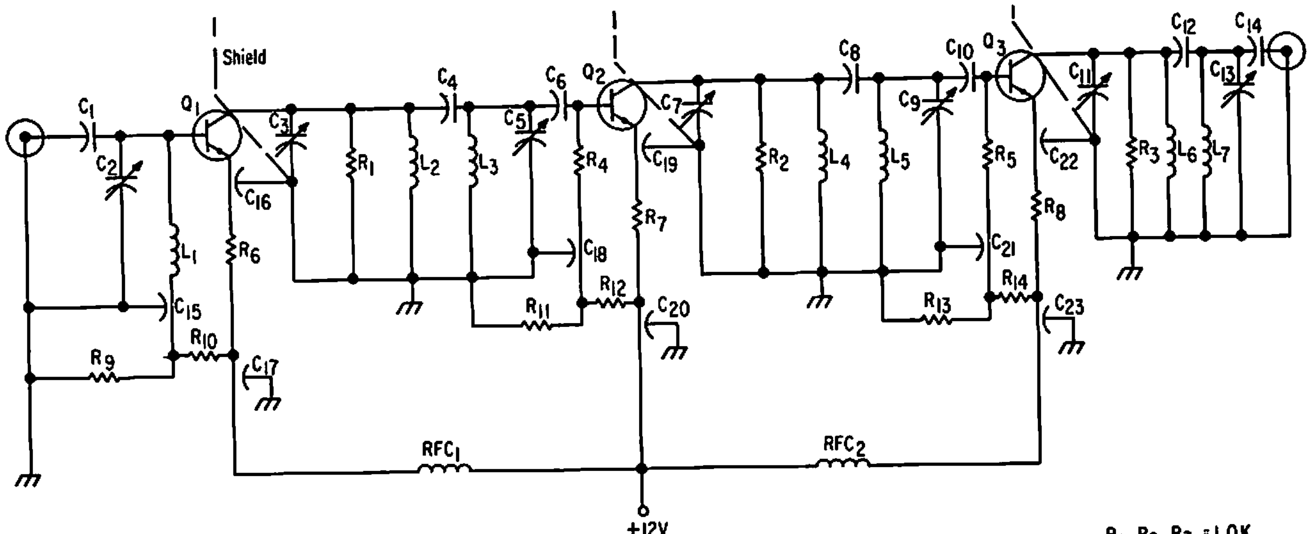
VOLTAGE-TUNED 60 TO 90 MC—Gives over 40 db gain with 50-ohm source and load. Untuned input allows constant source impedance over tunable frequency range of silicon XA585 voltage-variable capacitance diodes, with excellent stability and tracking.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 297.



A-C COUPLED CASCODE—Circuit is uniquely suited to increasing bandwidth of low-noise amplifier by reducing Miller effect and permitting independent adjustment of operating conditions for optimum noise performance.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 143.



BOOTSTRAPPED FET SOURCE-FOLLOWER—Gives 6 db gain for high-impedance transducer output, when 5-meg gate bias resistor is bootstrapped to the source through 100-mfd electrolytic.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 67.

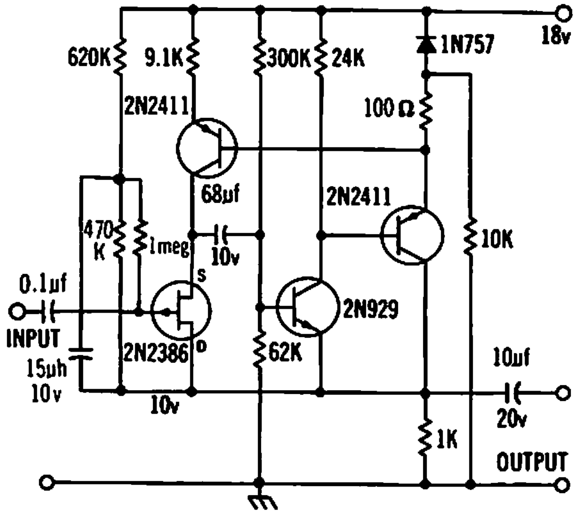


Q_1 - Q_3 = 2N2996
C_1 = 50pf
C_2 = 9-180pf
$C_3, C_5, C_7, C_9, C_{11}, C_{13}$ = 9-180pf
C_4, C_8, C_{12} = 12pf

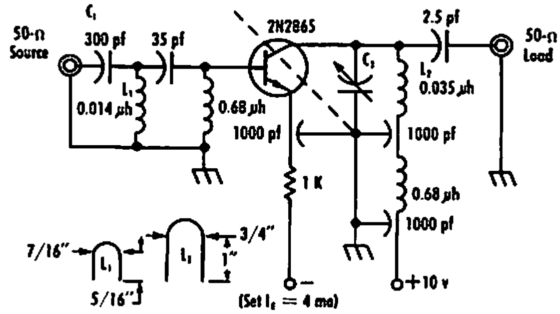
C_6, C_{10}, C_{14} = 25pf
C_{15} to C_{23} = 0.0015μf
RFC_1 - RFC_2 = 15μh
L_1 to L_7 = 0.27μh

R_1, R_2, R_3 = 1.0K
R_4, R_5 = 100 OHMS
R_6, R_7, R_8 = 1.5K
R_9 to R_{14} = 3.0K

30-MC DOUBLE-TUNED—Proper loading provides good stability along with gain of 21 db per stage, despite inherent instability of 2N2996 at this frequency. Total power gain is thus 63 db, for noise figure of 2.3 db and bandwidth of 3 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 310.

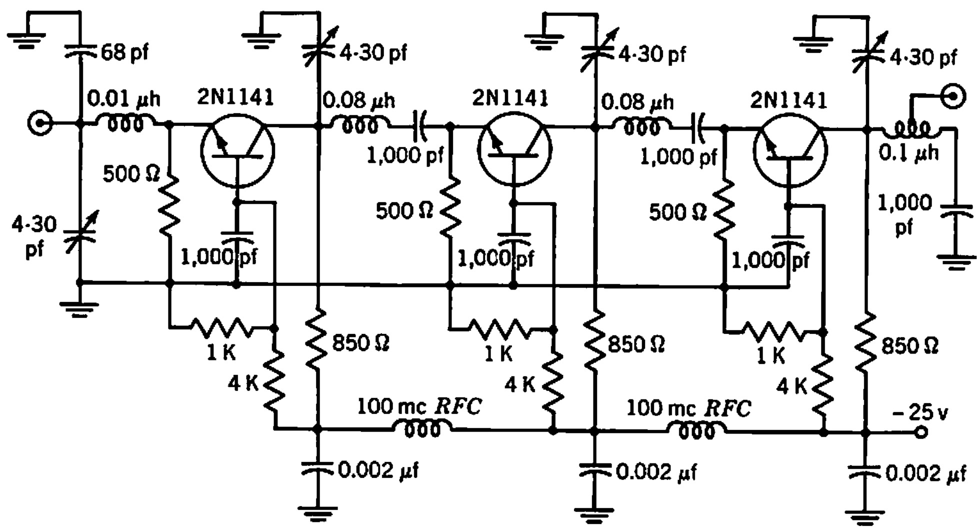


WIDEBAND UNITY-GAIN FET—Input impedance is about 100 meg, and response is within 3 db from below 10 cps to 1 Mc for 100K generator resistance.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 296.



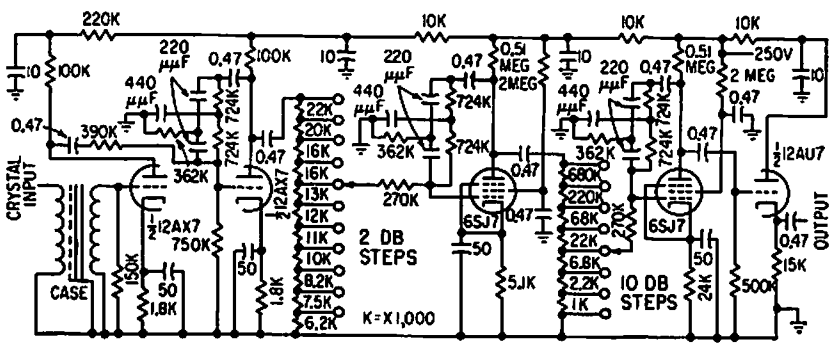
C_1 = 300-pf undipped ceramic capacitor
Bypass capacitors = Aerovox Hi-Q EF4, 1000 pf, 1000 v
C_2 = 1.8-13 pf, set at 7 pf
L_1 = 0.014 μh: copper strip, 1/32" x 5/16", bent to 7/16" diam. Q_u = 200
L_2 = 0.035 μh: copper strip, 1/32" x 3/8", bent to 3/4" diam. Q_u ~ 300

250-MC R-F FOR MILITARY VHF BAND—Gives 12.5 db gain and noise figure of only 5 db, with excellent stability.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 297.

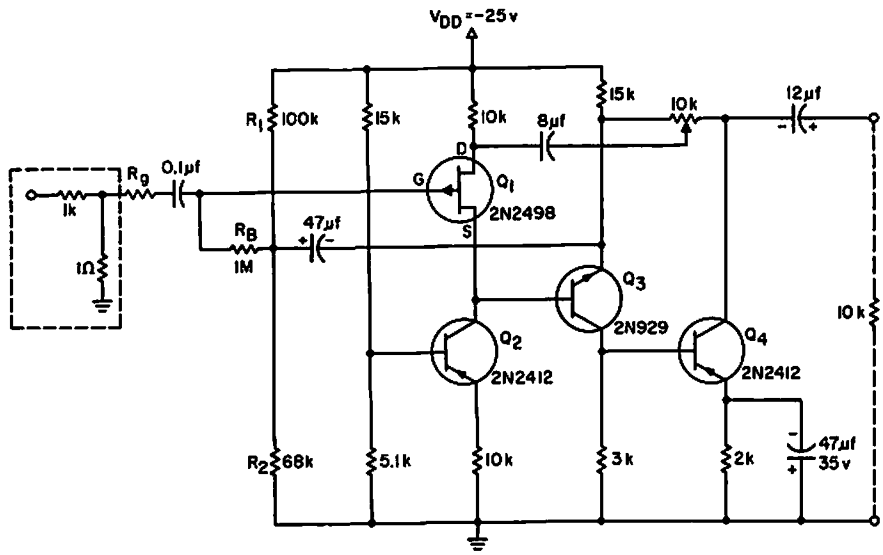


0.08 and 0.1 μh coils are 3 and 4 turns respectively of No. 18 tinned bus wire, 1/4" diameter
0.01 μh coil is 1 turn of NO. 00 enameled wire, 3/8" diameter.

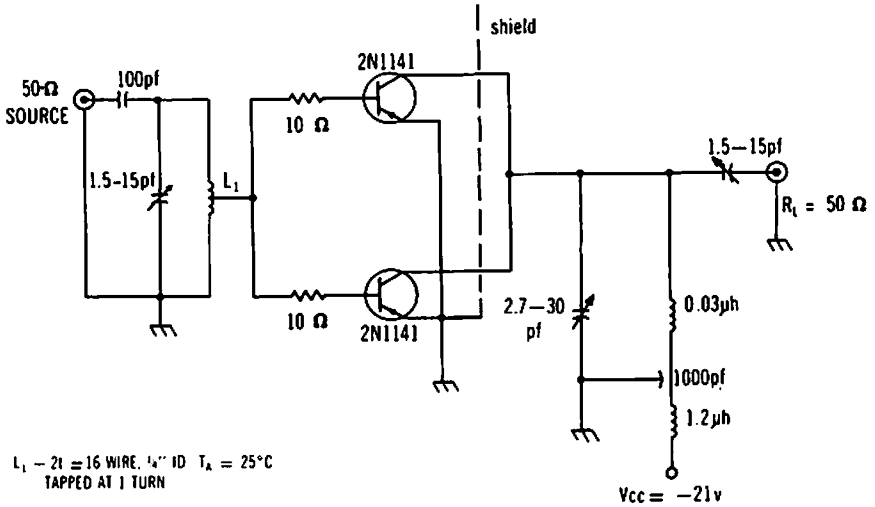
100-MC CASCADED—Uses mismatch design technique to obtain desired overall gain of 37.5 db at bandwidth of 9 Mc for three cascaded stages.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 290.



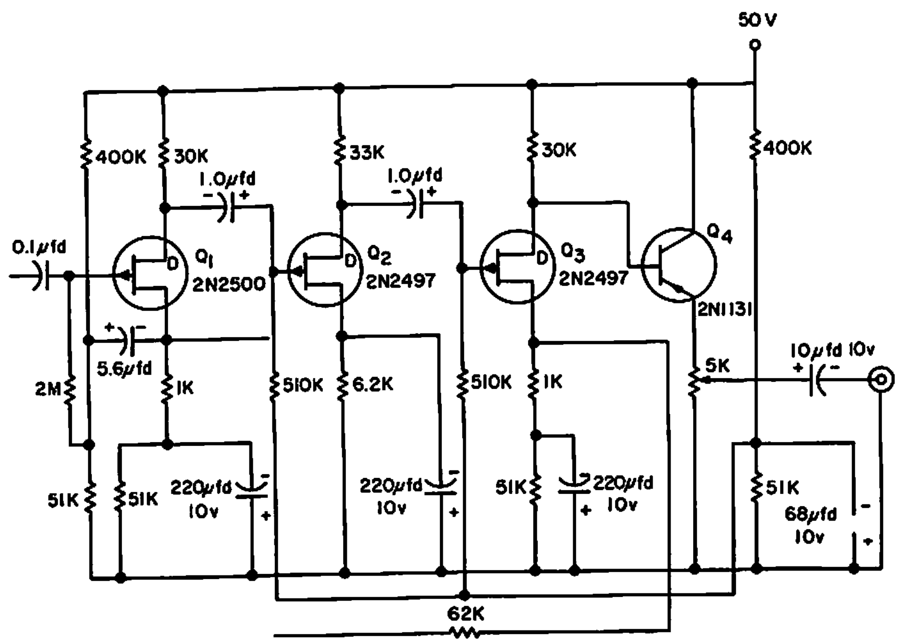
WIDEBAND AMPLIFIER—Twin-T amplifier is used between crystal detector and cro of microwave spectrometer for studying electron resonance phenomenon in paramagnetic materials.—R. R. Unterberger, Microwave Spectrometer Tests Electron Resonance, *Electronics*, 32:11, p 142–144.



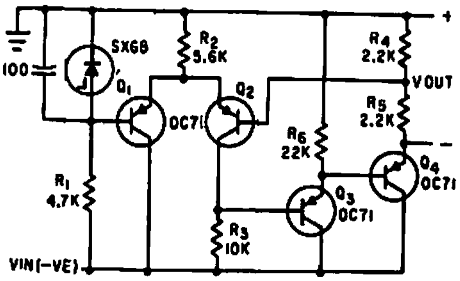
DOUBLE-BOOTSTRAPPED FET—Both drain and source are bootstrapped in 6-db high-input-impedance amplifier, to reduce effect of fet capacitances so they are insignificant compared to stray circuit capacitances at input terminal. 10-K pot provides gain compensation adjustment.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 69.



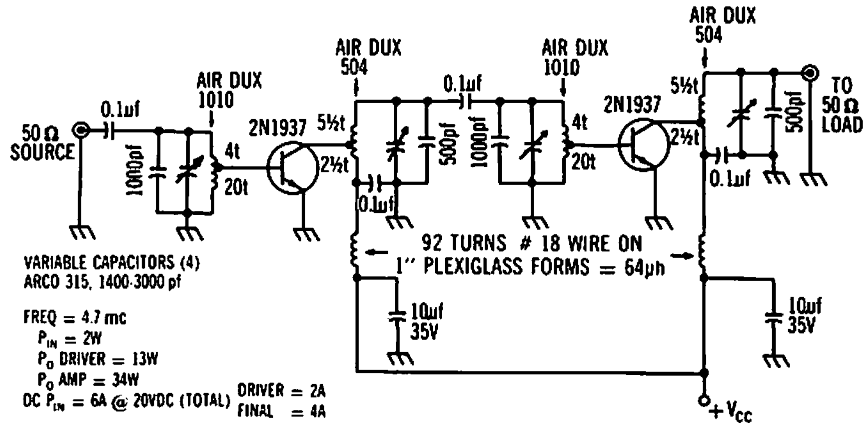
173-MC POWER AMPLIFIER—Uses two 2N1141's in parallel to deliver average of 400 mw, with power gain of 11.5 db and collector efficiency of 42%. Has excellent large-signal performance.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 320.



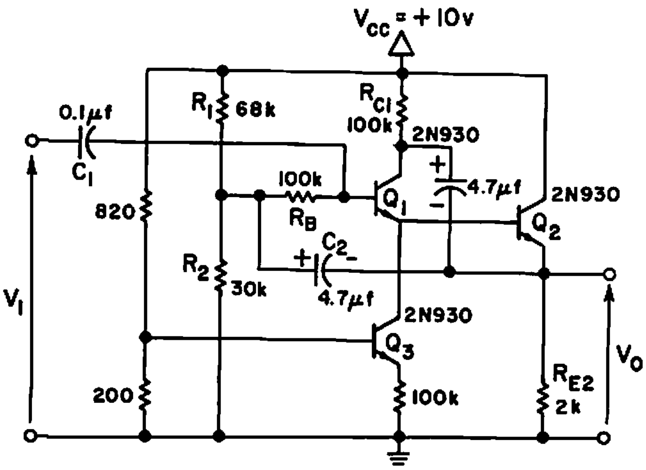
THREE-FET A-C AMPLIFIER—Can be used in applications requiring amplification of microvolt signals, as in ultrasensitive preamps for null detectors, medical research equipment, recorders, oscilloscopes, and low-level transducers. With 100K generator resistance, amplifier 3-db bandwidth is 1 cps to 40 kc.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 107.



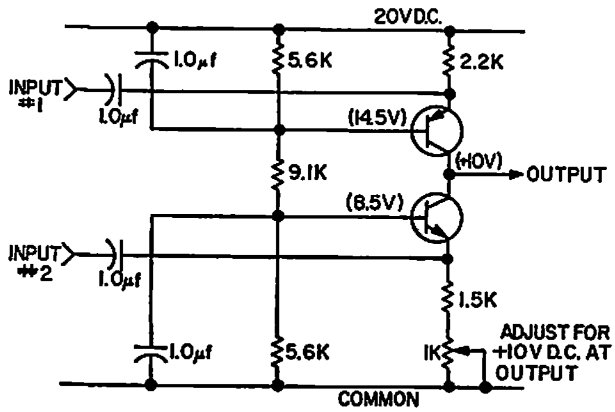
SIGNAL VOLTAGE STABILIZER—Main amplifier is followed by emitter-followers to reduce fraction of d-c load current flowing in collector load of amplifier. In this conventional arrangement, overall gain is only about 500.—T. K. Hemingway, Applications of the Constant-Current Diode, *Electronics*, 34:42, p 60–63.



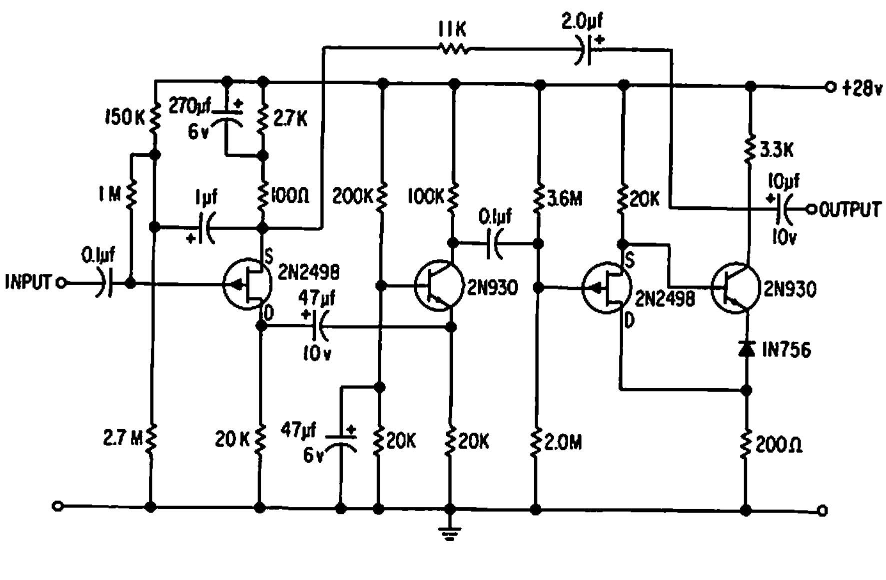
4.7-MC DRIVER AND AMPLIFIER—Common-emitter connection gives good power gain with collector-emitter voltage of 20 v, though gain varies with frequency.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 316.



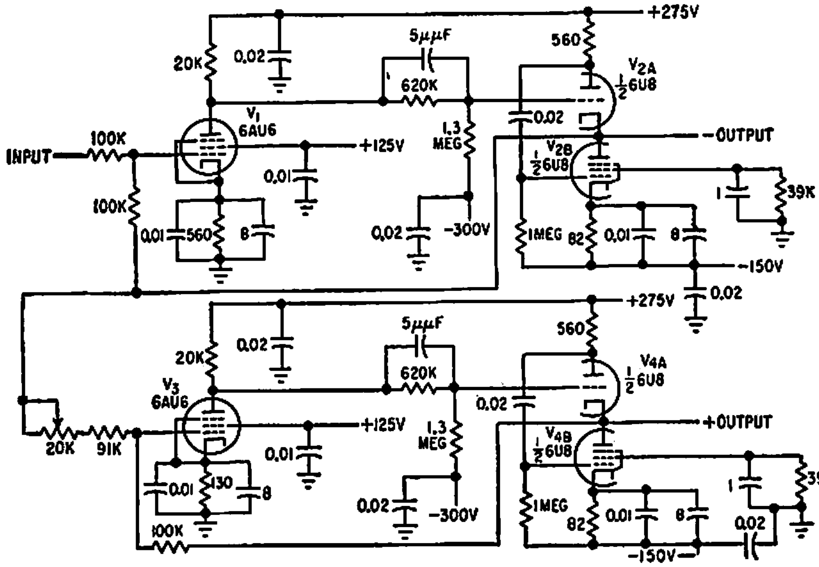
CASCADED EMITTER-FOLLOWER WITH CURRENT BIAS—Improved frequency response is obtained by biasing Q1 with current generator in emitter leg. Input impedance is 6 meg. Frequency response is within 3 db from 10 cps to 1 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 181.



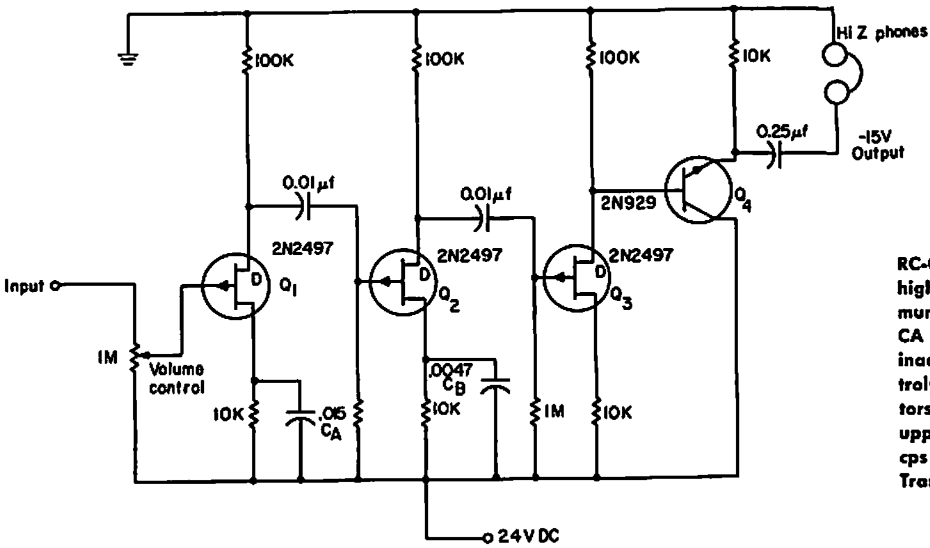
HIGH VOLTAGE GAIN—Provides gain of 3,500 into 10-meg load, by operating transistor in common-base configuration and using constant-current source in collector circuit. Circuit is balanced, so either transistor can operate as gain stage while other serves as current source. Feedback overcomes problem of critical d-c bias.—A. J. Adler, High-Gain Amplifier, *EEE*, 11:8, p 31.



LOW-LEVEL 1 CPS TO 500 KC—Features include input impedance above 30 meg and noise figure below 3 db over wide range of generator resistances. Bootstrapping of input stage enhances high input impedance of fet. Will operate down to 1 cps without need for large capacitors. Upper frequency limit is 500 kc for generator resistance of 100K. Voltage gain is stable within 0.5 db of 40, from −55 to +125°C.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 290.

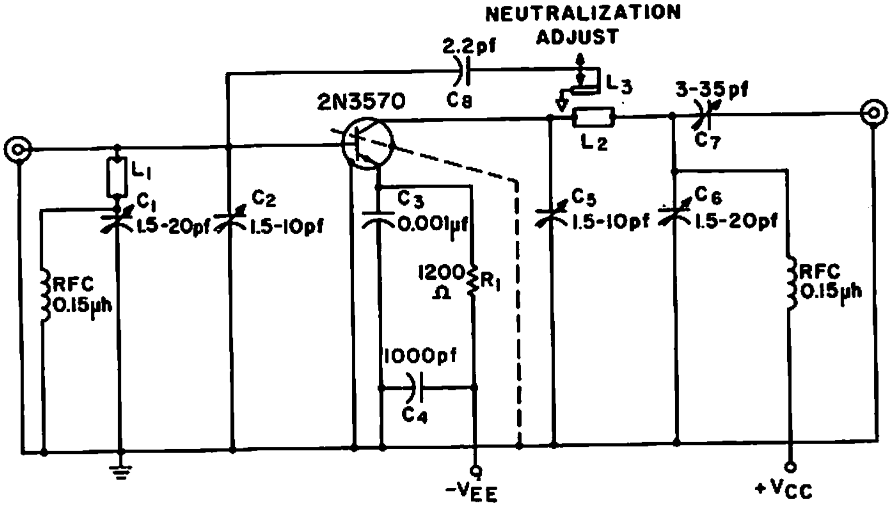


LOW SOURCE IMPEDANCE—Tubes V1 and V2 provide single-phase inversion with output impedance below 0.5 ohm over 50-kc passband when feedback loop is closed. Output of V2 feeds identical combination V3-V4 to provide second output in phase with input to V1. Trim adjustment is provided to insure unity gain for both outputs. Used in automatic doppler cycle counter for measuring position and velocity of missiles.—B. E. Keiser, Digital-Counter Techniques Increase Doppler Uses, *Electronics*, 32:21, p 46–50.

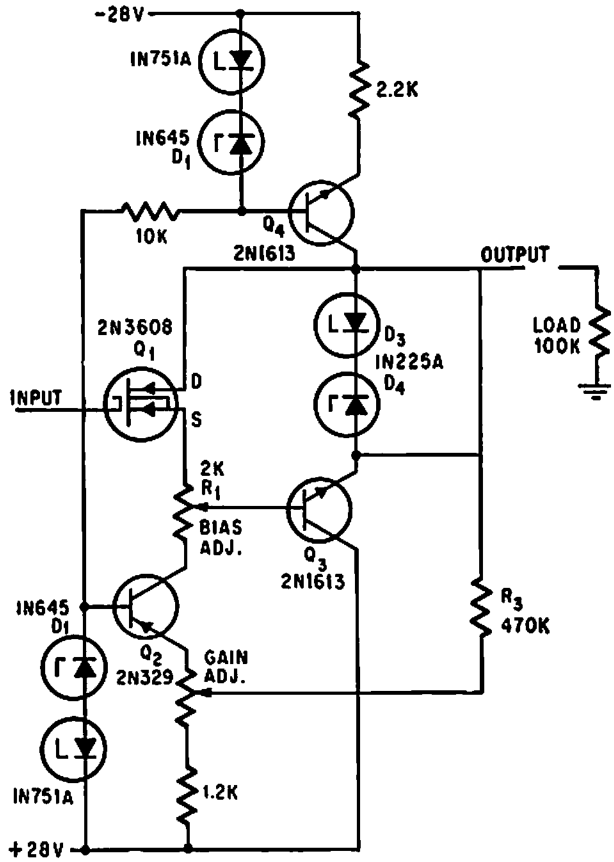


RC-COUPLED FET AMPLIFIER—Used to drive high-impedance headphones in optical communication system. Series peaking capacitors CA and CB compensate for high-frequency inadequacies in rest of system. No large electrolytics are needed. Without peaking capacitors, amplifier voltage gain is about 400 and upper and lower break frequencies are 17 cps and 35 kc.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 64.

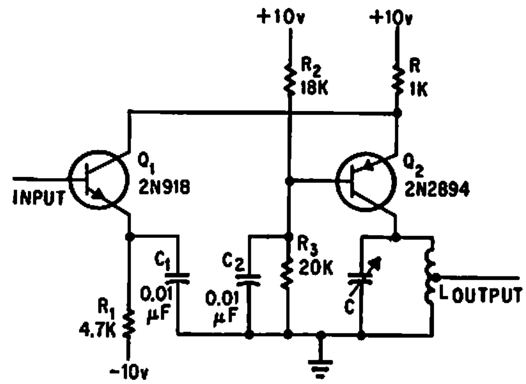
500-MC NEUTRALIZED AMPLIFIER—Small-signal circuit provides 17 db gain and noise figure of only 3 db. Input impedance is 51 ohms and output impedance is 1,300 ohms in parallel with 1.8 pf. Neutralizing voltage is obtained from coupling loop L3, which is silver-plated strip of beryllium copper running parallel to L2.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 299.



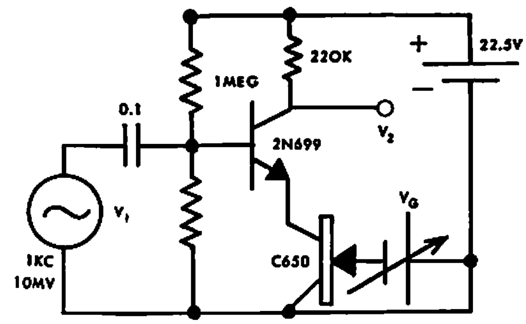
L_1=SILVER-PLATED BRASS ROD—1 9/16" LENGTH, 1/4" DIA.
L_2=SILVER-PLATED BRASS ROD—2 1/8" LENGTH, 1/4" DIA.



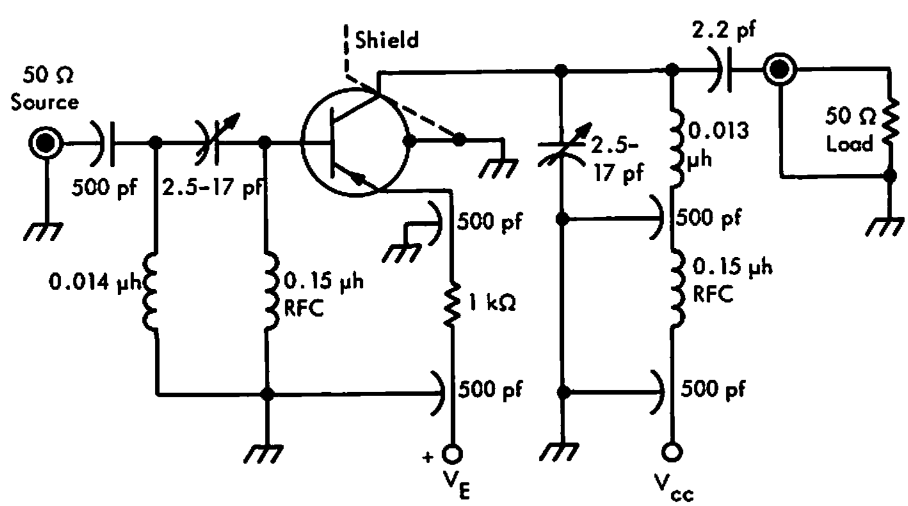
INFINITE INPUT RESISTANCE—Uses metal oxide semiconductor field effect transistor as buffer to give input impedance of 10^{15} ohms. Amplifier gain is unity within 0.1% for 100K load. When adjusted, output equals input within 10 mv over allowable range of 10 v above or below ground.—A. D. Delagrange. Amplifier Provides 10^{15}-Ohm Input Resistance, *Electronics*, 39:17, p 99.



STABLE 600-MC CASCODE—Gives high gain without external capacitor to neutralize negative feedback of collector-base junction.—M. D. Wood, Cascode Amplifier Stabilized by Reducing Internal Feedback, *Electronics*, 38:11, p 70.



GAIN-CONTROLLED LOG AMPLIFIER—Based on fact that gain of common-emitter fet stage is almost inversely proportional to emitter resistance, and resistance of fet operating below cutoff is linear function of grid voltage. Can be used as agc amplifier and as multiplier.—Y. J. Lubkin, Gain Controlled Log Amplifier, *EEE*, 10:9, p 91.



450-MC R-F AMPLIFIER—Gives average power gain of 8.6 db, bandwidth of 48 Mc, and noise figure of 6 db. Uses linear active network, designed with Linvill chart. Load inductance was minimized by removing most of the Teflon from TO-18 socket so only thin disk, approximately chassis thickness, remains. —Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 97.

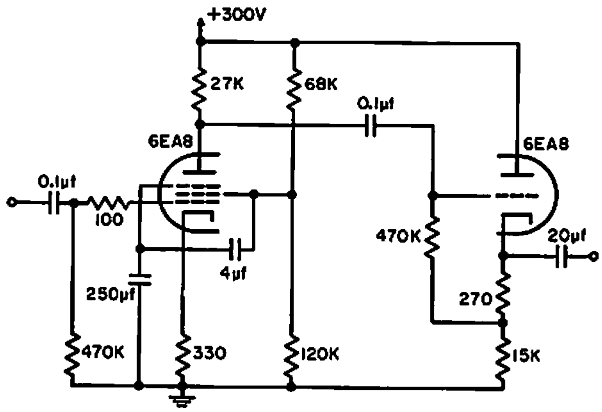
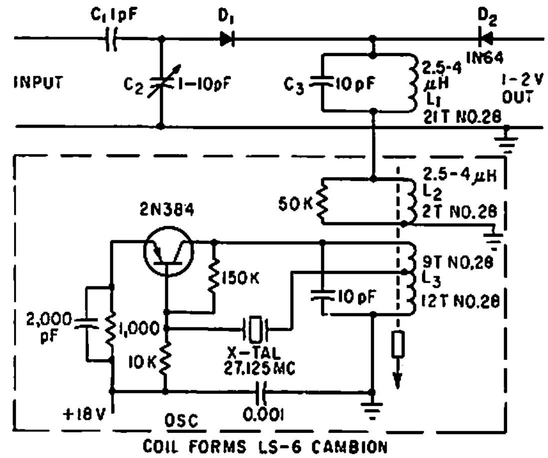
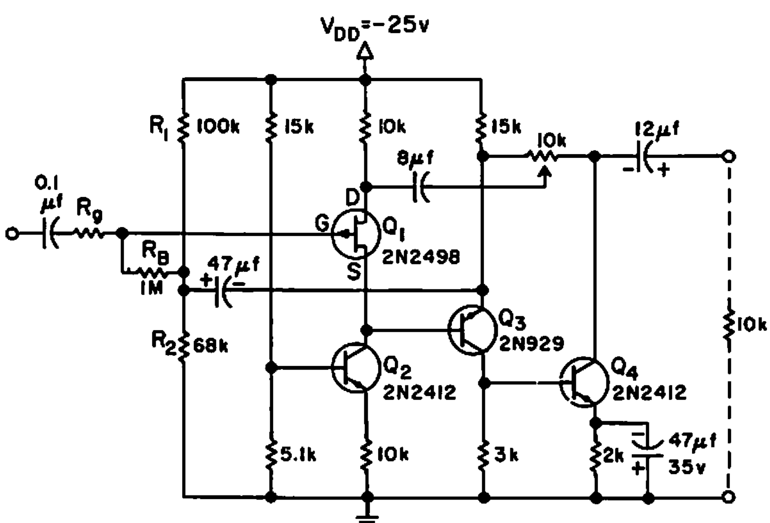


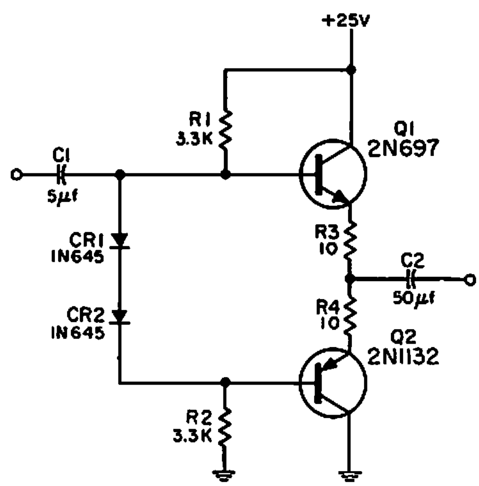
PLATE-CATHODE FOLLOWER—Has low output impedance, good gain stability, wide response, and low distortion, making it ideal as bridge driver for Wien-bridge oscillator. —K. H. Liu, Plate-Cathode Follower Wien-Bridge Oscillator, *EEE*, 11:2, p 27.



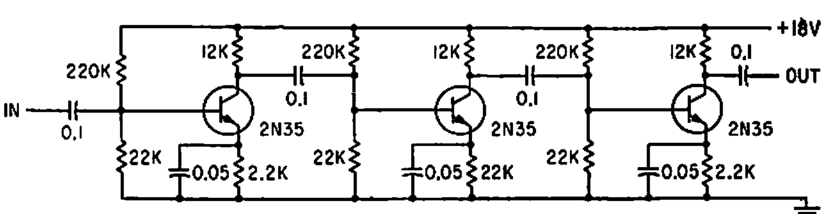
HIGH-IMPEDANCE PARAMETRIC AMPLIFIER—Wide-band amplifier uses diode biased with r-f to give 40-db gain. Input impedance is above 10 gigohms, and frequency response is within 3 db from 3 cps to 200 kc. Diode D1 is energy storage element. Crystal-controlled transistor oscillator is pump frequency source.—D. Reveti, Diode Amplifier Has Ten-Gigohm Input Impedance, *Electronics*, 34:51, p 38–40.



HIGH-INPUT-Z FET AMPLIFIER—Bias current is obtained from common-base current generator Q2. Q3 and Q4 function as complementary current multiplier. Bootstrapping for RB is obtained directly from emitter of Q3. Voltage gain is 2 and input impedance is 200 meg. Response is flat within 3 db from 1 to 500 kc with generator resistance of 1 meg.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 187.

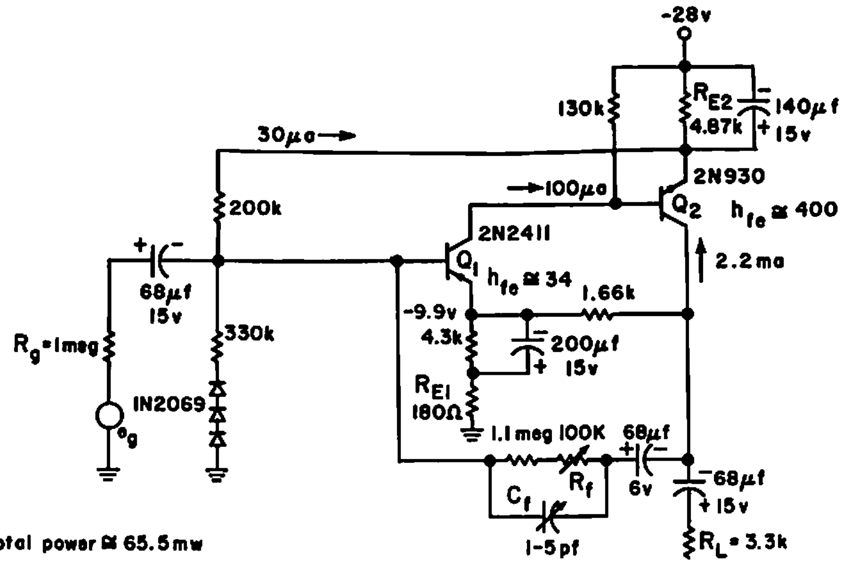


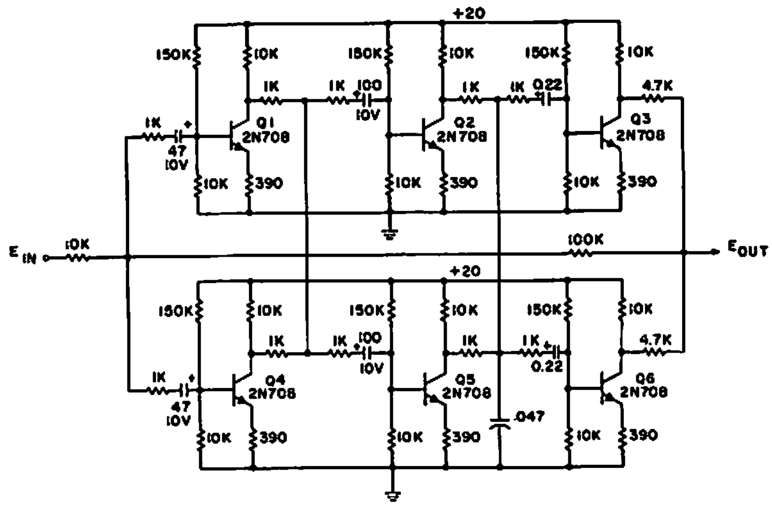
PREFERRED EMITTER-FOLLOWER—Used to match high-impedance circuit to low-impedance load. Will accept positive and negative pulses or sinusoidal input. Low output impedance for pulses results in high operating speed into capacitive loads. Bandwidth for 600-ohm source impedance is 50 cps to 3.5 Mc. Voltage amplification is 0.8 and power gain is 12 db.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, 1962, PSC 22 (originally PC 222), p 22–2.



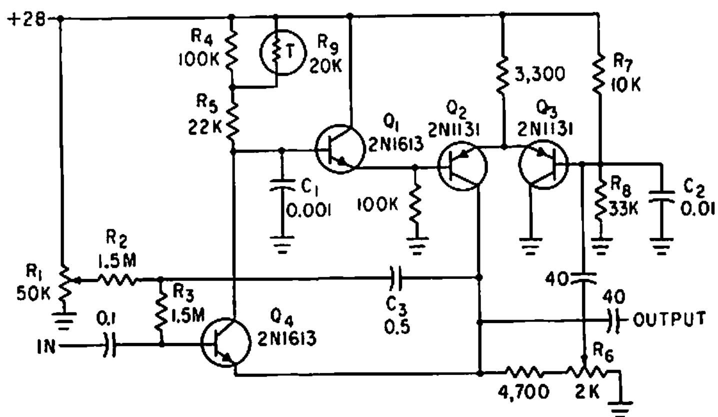
100-DB AMPLIFIER—Used in distortion monitor to drive indicating vtvm.—G. H. Smith, Distortion Monitor Checks Linear Amplifier Characteristics, *Electronics*, 34:27, p 57–59.

DIODE-STABILIZED BIAS—Positive shunt feedback cancels shunt impedance of bias network and transistor. RE1 is made small to obtain gain of 10; as a result, input impedance is limited to 1.5 meg. Excellent bias stability is obtained. Three diodes compensate for variations in base-emitter voltage of Q1, and negative d-c feedback from RE2 further increases bias stability. Response is flat within 3 db from 100 cps to 500 kc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 184.

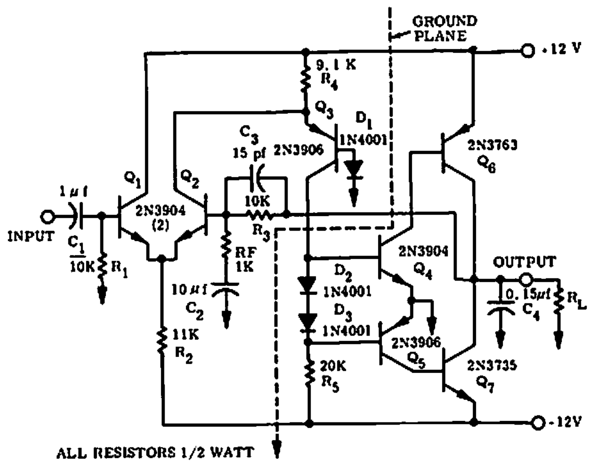




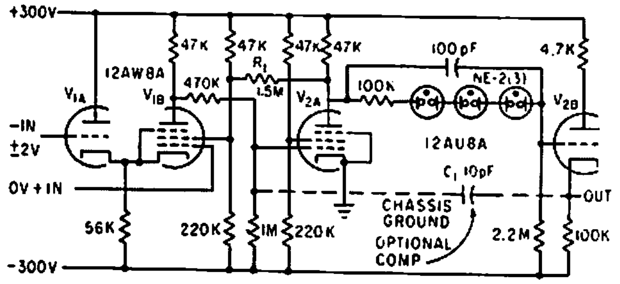
PASSIVE REDUNDANCY IN A-C AMPLIFIER—Uses two amplifiers connected in parallel on individual-stage basis, with 1K isolation resistors between stages. Amplifier is operational type having closed-loop gain of 10, open-loop gain of 1,000, and 3-db open-loop frequency response from 30 to 1,500 cps. Both open-loop gain and frequency response are functions of failure mode of circuit, with most types of failure affecting performance only slightly.—T. B. Booker, Designing Redundant Analog Amplifiers, *EEE*, 13:2, p 55–59.



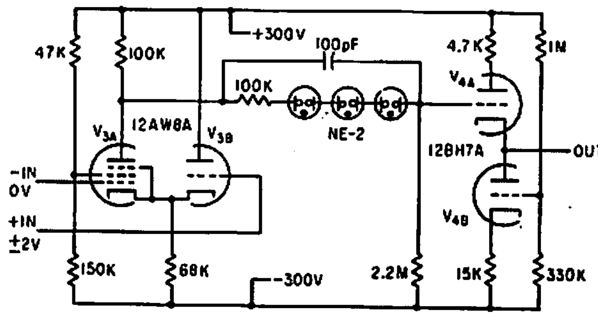
ADJUSTABLE INPUT IMPEDANCE—Q4, Q1, and Q2 in negative feedback loop encompass Q2 and Q3 in positive loop, to give stable amplifier with input conductance of zero (infinite impedance) and unity gain for almost any output load, with output of 10 v p-p at 1 ma.—R. L. Willett, Positive and Negative Feedback Multiply Amplifier Input Impedance, *Electronics*, 34:27, p 52–53.



4-W WIDE-BAND AMPLIFIER—Uses complementary transistors for operation up to 100 kc with low distortion. Output is class B. All leads should be kept short, to minimize tendency to oscillate.—N. Freyling, "A 4-Watt Wide-Band Solid-State Amplifier," Motorola Application Note AN-209, Mar. 1966.

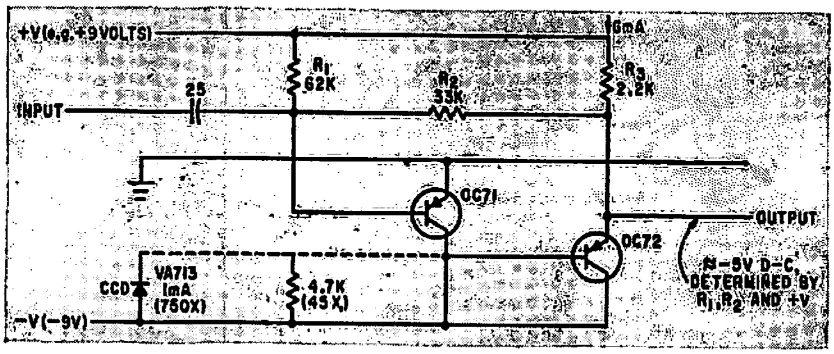


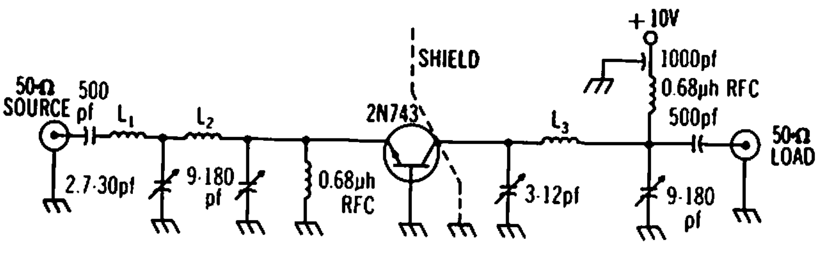
16-KC COMPENSATED OPERATIONAL AMPLIFIER—Uses pentode V2A as voltage amplifier to provide up to 140 v peak signals at grid of output cathode follower V2A. Will go up to 50 kc without compensation.—H. Koerner, How to Extend Operational Amplifier Response, *Electronics*, 33:46, p 90–91.



50-KC OPERATIONAL AMPLIFIER—Develops full rated output of 100 v into 10,000-ohm load up to 50 kc. Open-loop gain is 36 db. —H. Koerner, How to Extend Operational Amplifier Response, *Electronics*, 33:46, p 90–91.

CONSTANT-CURRENT DIODE AS COLLECTOR LOAD—Gain is 45 with 4.7K resistive load, and increases to 750 with CCD as load. Gain-reducing effect of external load paralleling CCD can be eliminated by using emitter-follower to isolate load from collector circuit. —T. K. Hemingway, Applications of the Constant-Current Diode, *Electronics*, 34:42, p 60–63.

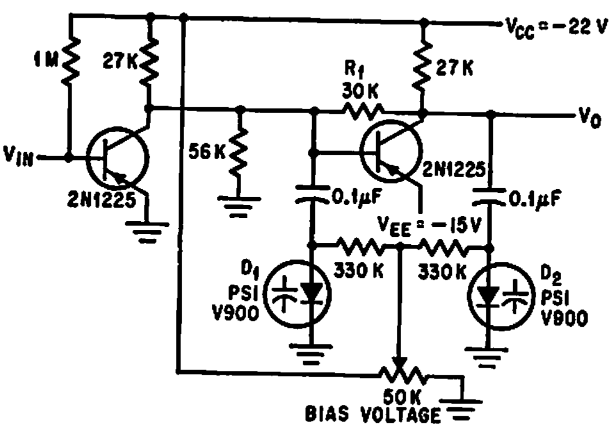


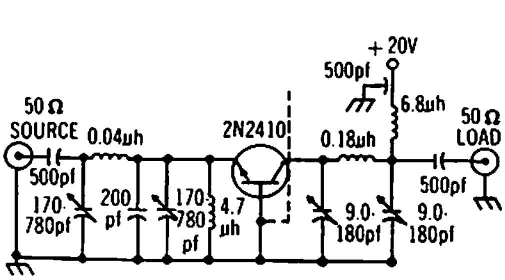


INDUCTANCE DATA

COIL NO	AIR DUX NO	NO TURNS
L_1	404	5
L_2	408	2
L_3	404	3

250-MC POWER AMPLIFIER—Gives good performance for both small and large signals. —Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 320.

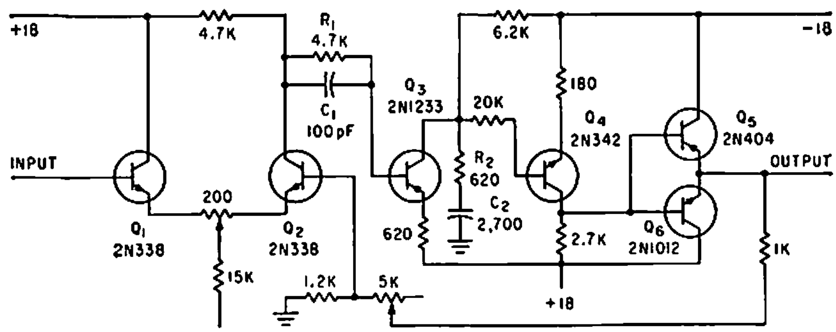




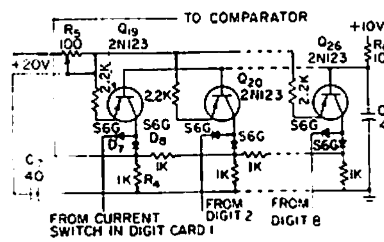
ADJUSTABLE-BANDWIDTH AMPLIFIER—Bandwidth can be varied from 190 to 280 kc by varying bias voltage on varicap diodes between 0 and 10 v. Used in frequency-response equalization and other system applications requiring automatically adjustable bandwidth in low-pass circuit.—M. G. Wilson, Low-pass Amplifier with Adjustable Bandwidth, *Electronics*, 39:11, p 90–91.

50-MC POWER AMPLIFIER—Power output is up to 1 w and collector efficiency above 50% for common-base operation.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 317.

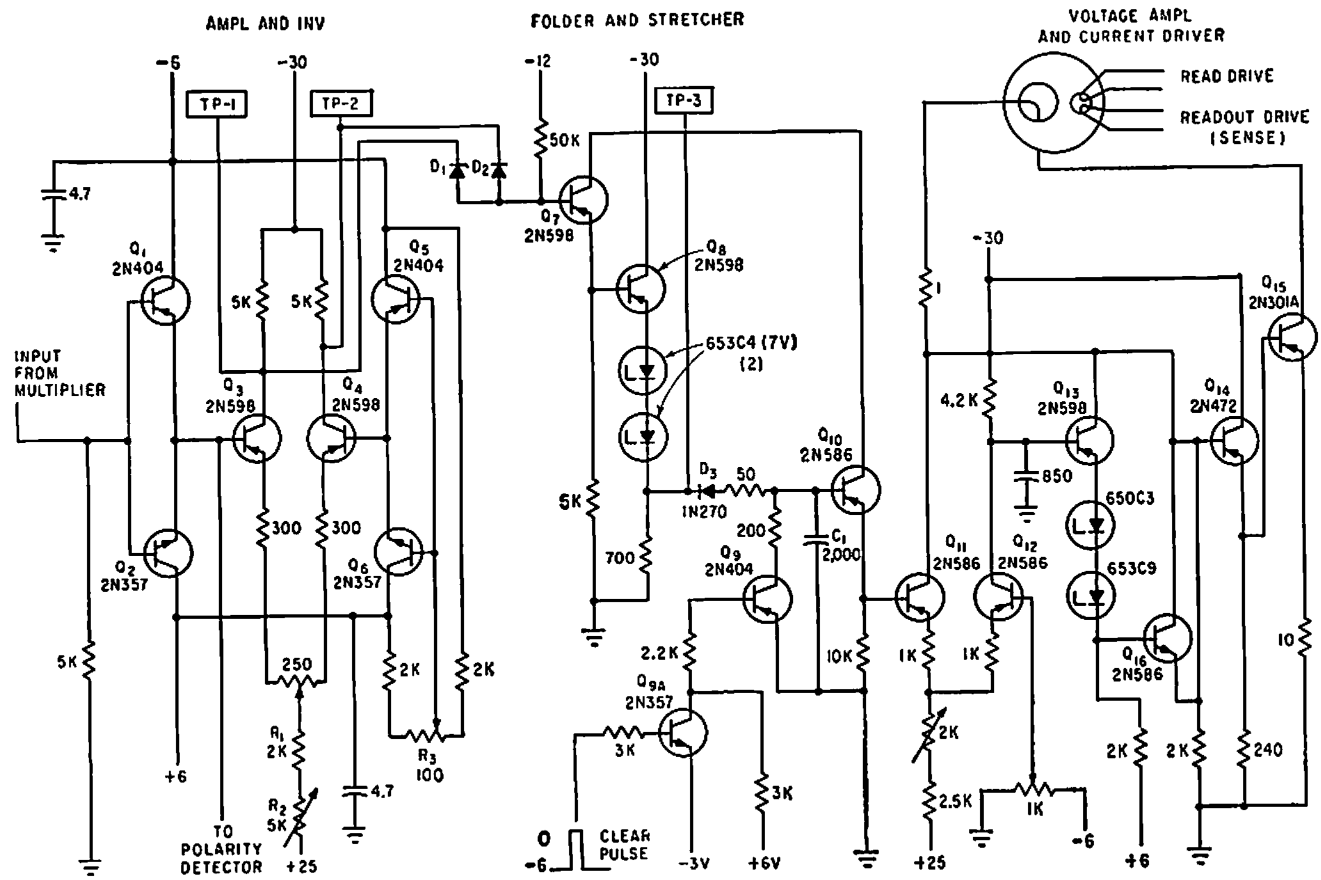
CHAPTER 3
Analog Circuits



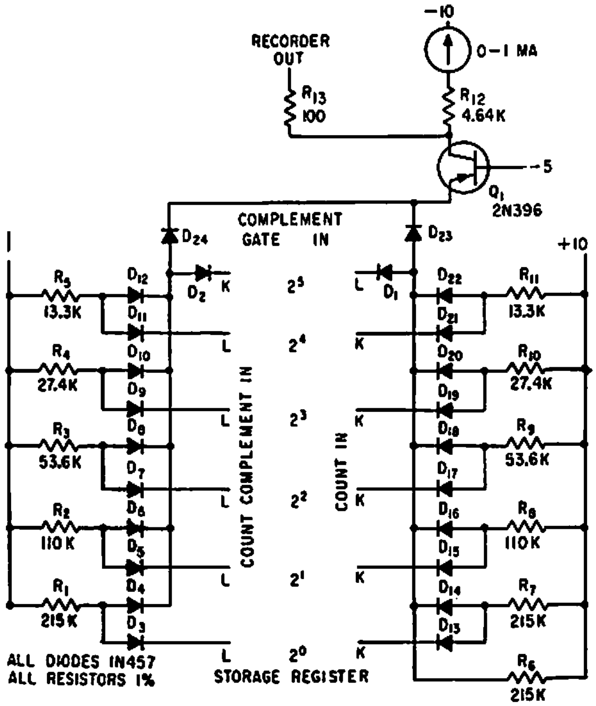
ANALOG DIFFERENTIAL AMPLIFIER—Input impedance is above 300,000 ohms and output impedance 1 ohm, in d-c amplifier for analog input channel. Q3 and Q4 provide gain and phase inversion for feedback through complementary emitter-follower Q5-Q6 to differential amplifier Q1-Q2.—N. Aron and C. Granger, Analog-To-Digital Converter Uses Transfluxors, *Electronics*, 35:20, p 62–66.



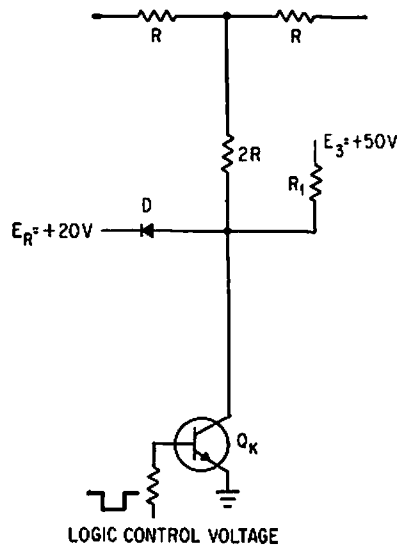
SUMMING AND WEIGHTING NETWORK—Consists of eight identical circuits. Precise value of direct current from constant-current source, fed into first node of resistive ladder network, produces 2.5-v step at summing and weighting network output, or half of maximum analog input of 5 v.—W. B. Towles, Transistorized Analog-Digital Converter, *Electronics*, 31:31, p 90–93.



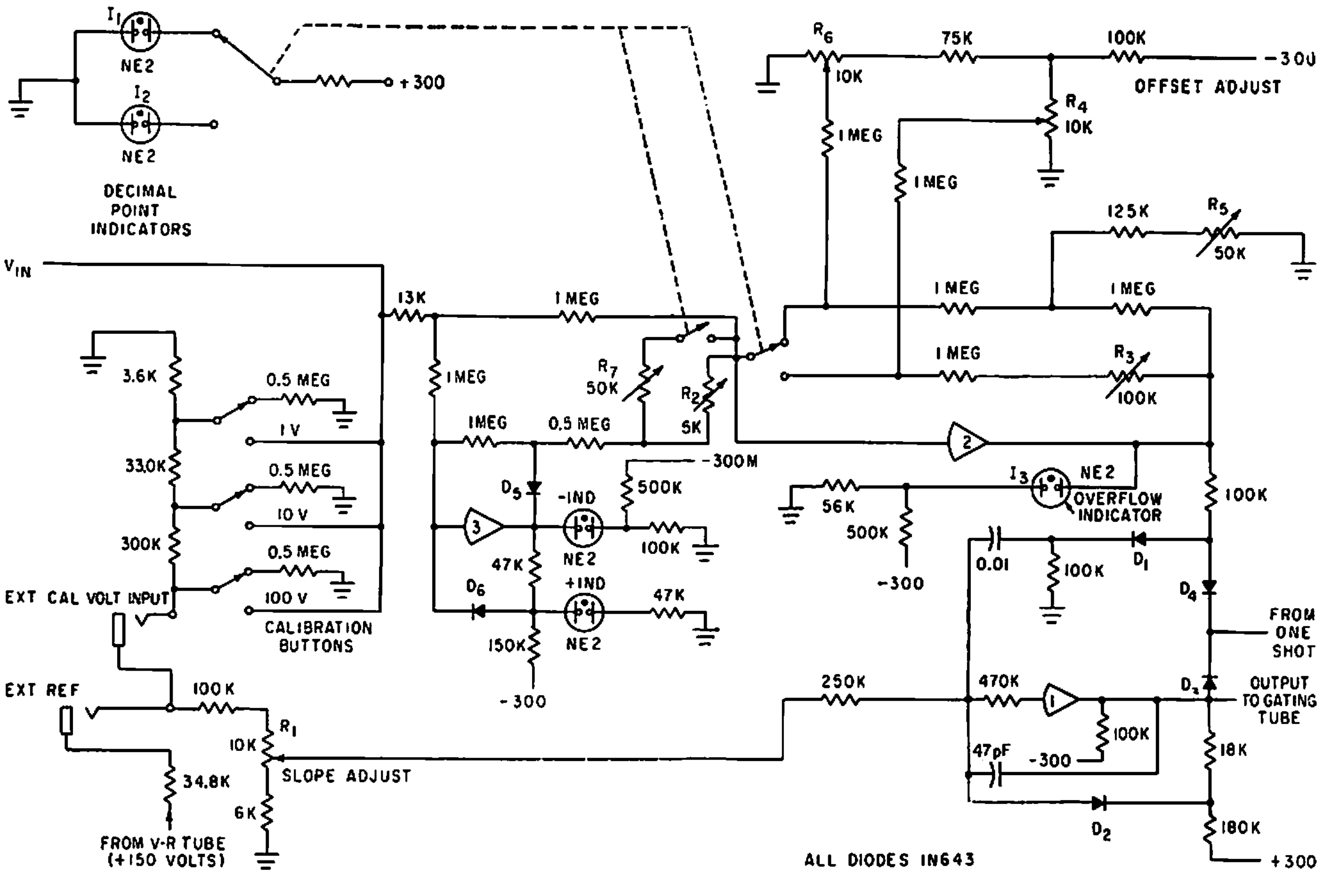
INVERTER AND PULSE STRETCHER—Circuit takes sampled output of multiplexer and provides current required for driving transfluxor in analog-digital converter that produces six-bit binary Gray code.—N. Aron and C. Granger, Analog-To-Digital Converter Uses Transfluxors, *Electronics*, 35:20, p 62–66.



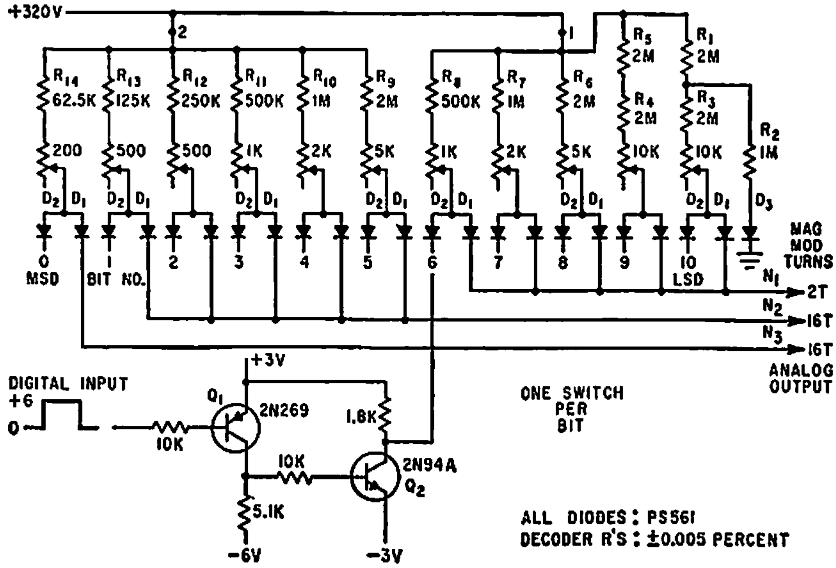
DIGITAL-ANALOG CONVERTER—Converts binary digits to analog form.—K. H. Brackney and D. R. Gosch, Pulse Comparator Circuit Measures Frequency Jitter, *Electronics*, 34:27, p 54–56.



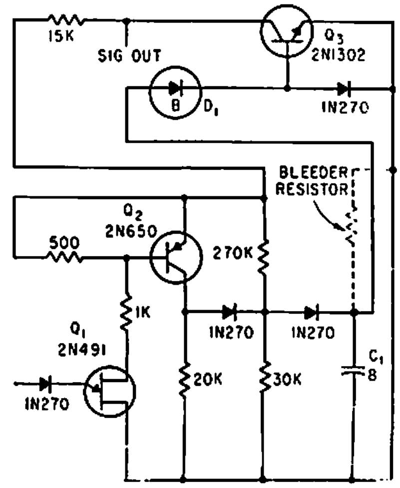
LADDER-TYPE NETWORK DECODER—Transistor replaces spdt switch for binary conversion of analog signal. Transistor's own saturation voltage (shown as ground for simplicity) serves as lower reference, while diode provides upper reference. Chief drawback is poor temperature stability.—C. R. Pearman and A. E. Popodi, How to Design High-Speed D-A Converters, *Electronics*, 37:8, p 28–32.



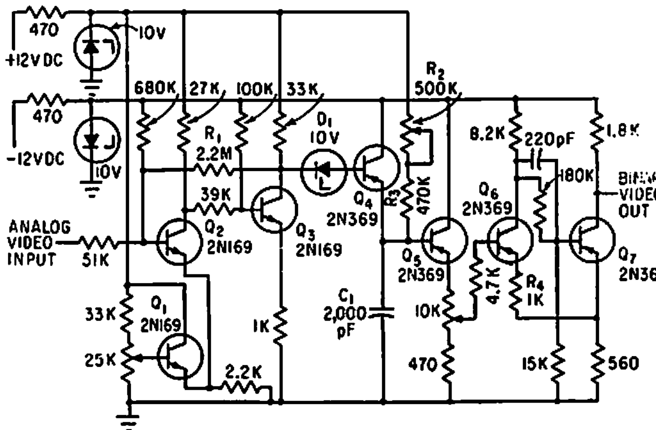
DIGITAL VOLTMETER CALIBRATOR—Calibration voltages of 100, 10, and 1 v are derived from reference voltage, for use in calibrating digital voltmeter in which analog voltage is converted to pulse whose width is proportional to input amplitude. Used for gating clock pulses into digital counters for voltage readout.—B. Barker and M. McMahan, Digital Voltmeter Employs Voltage-To-Time Converter, *Electronics*, 34:18, p 67–69.



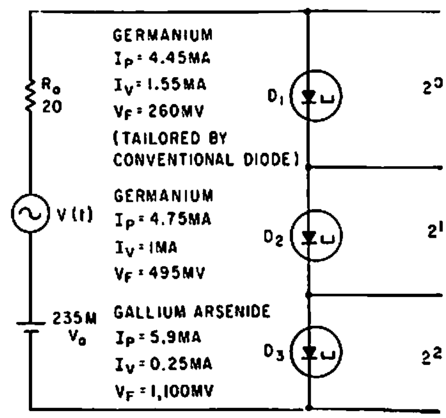
ELEVEN-BIT DECODER—Well-regulated transistor power supply and binary-weighted network of precision wire-wound resistors give high-precision conversion of 11-bit digital value to current analog. Output goes to magnetic modulator. Regulated 320-v supply (not shown) uses silicon junction diodes in full-wave bridge, with silicon zener diode as reference.—N. Aron, Precise Converter Takes Current Analog of Digital Voltage Pulses, *Electronics*, 35:32, p 68–71.



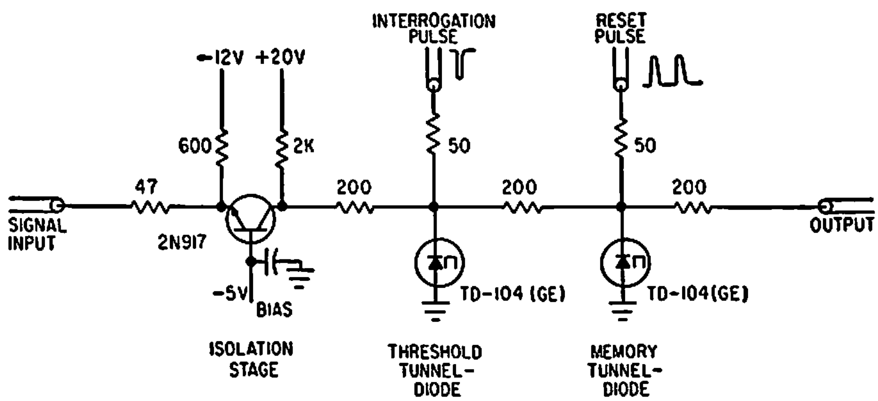
UJT CONVERTER FOR ACCELEROMETER—Converts digital output to voltage analog that indicates rate of acceleration or, when bleeder resistor is removed, actual distance traveled.—F. W. Kear, Unijunction Transistor Pulse-Circuit Design, *Electronics*, 35:21, p 58–60.



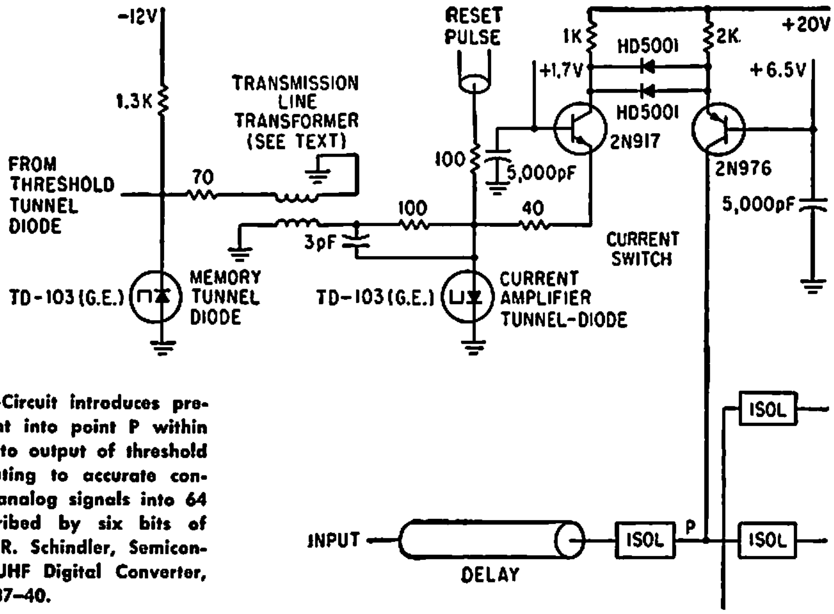
VIDEO PROCESSOR—Analog video input from closed-circuit tv microscope is converted to binary video output by difference amplifier Q1-Q2, squaring amplifier Q3, pulse shaper Q4, and emitter-follower Q5 which buffers R-C network from Schmitt trigger Q6-Q7.—N. F. Izzo and W. Coles, Blood-Cell Scanner Identifies Rare Cells, *Electronics*, 35:17, p 52–57.



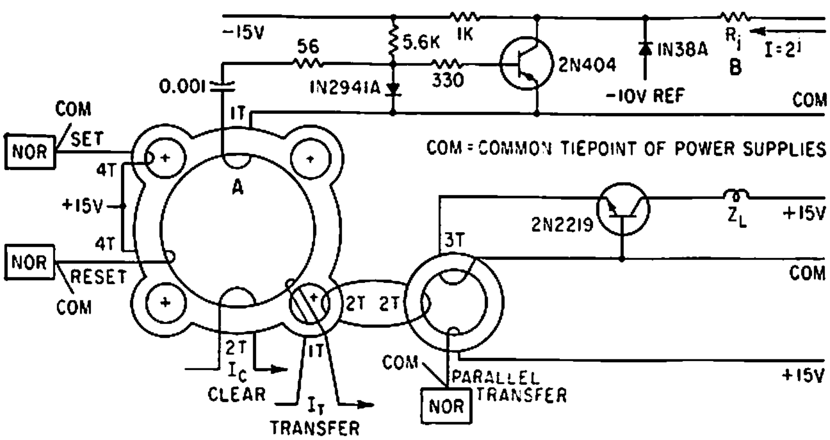
THREE DIODES PROVIDE 8 STATES—Three different tunnel diodes, each switching at a different input voltage level, act together to convert analog input voltage to digital form. —B. Rabinovici and J. Klapper, Designing Tunnel-Diode Circuits Using Composite Characteristics, *Electronics*, 35:7, p 46–48.



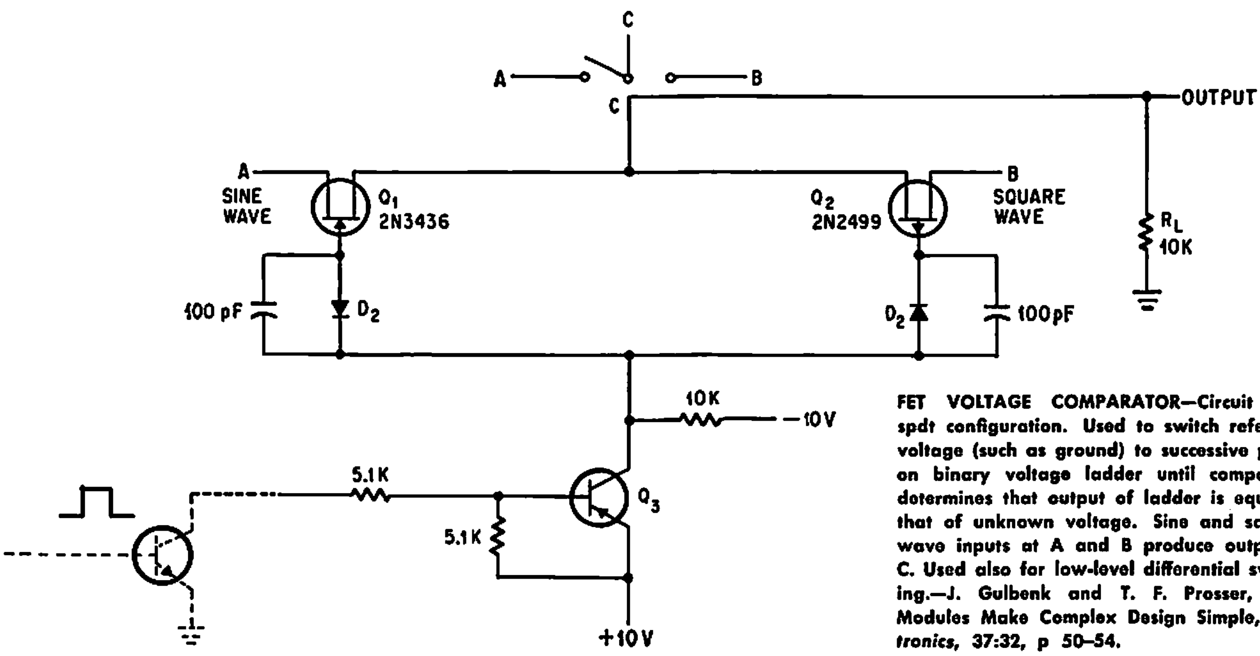
50-MC SAMPLING AND THRESHOLD CIRCUIT—Threshold tunnel diode receives signal current to be sampled and interrogation pulses repeating at 50 Mc. Diode fires when signal current is below threshold level, making memory tunnel diode switch into its high-voltage state. Current level differences of less than 50 microamp can be resolved in 0.3 nsec, sufficient for converting input into six bits corresponding to 64 levels.—H. R. Schindler, Semiconductor Circuits in a UHF Digital Converter, *Electronics*, 36:35, p 37–40.



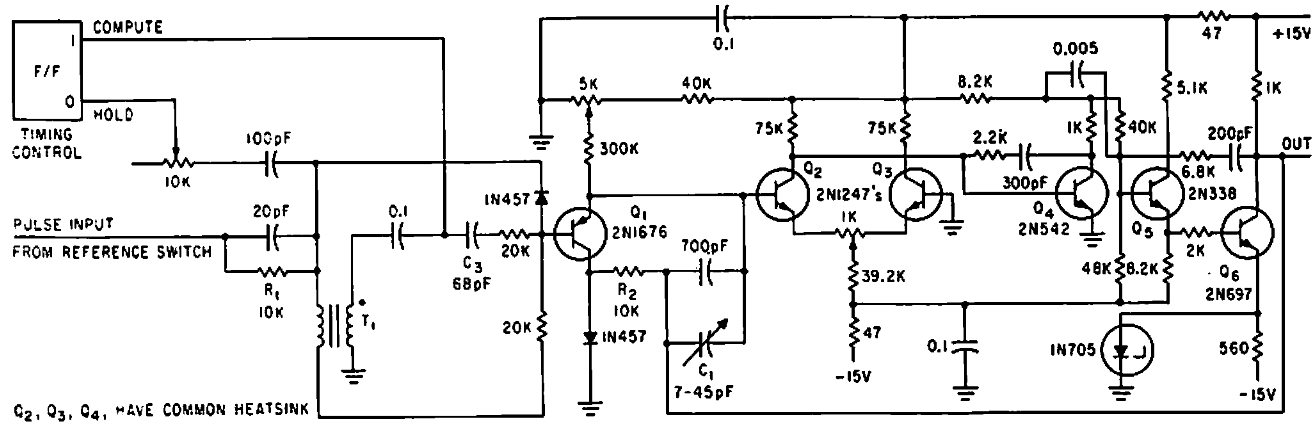
WEIGHTING CIRCUIT—Circuit introduces precise amount of current into point P within few nsec in response to output of threshold tunnel diode, contributing to accurate conversion of wideband analog signals into 64 levels that are described by six bits of binary language.—H. R. Schindler, Semiconductor Circuits in a UHF Digital Converter, *Electronics*, 36:35, p 37–40.



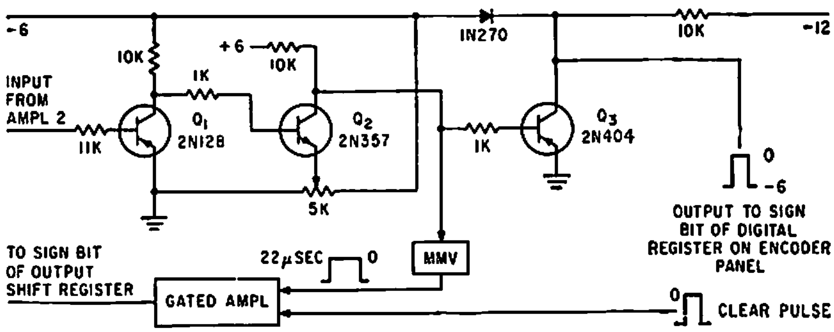
TUNNEL DIODES READ 5-APERTURE CORE—Circuit also controls switching of binary weighted current generators used in analog-digital converter.—W. G. Trabold, Tunnel Diodes Save Parts—Continuous Readout of Magnetic Cores, *Electronics*, 36:36, p 38–39.



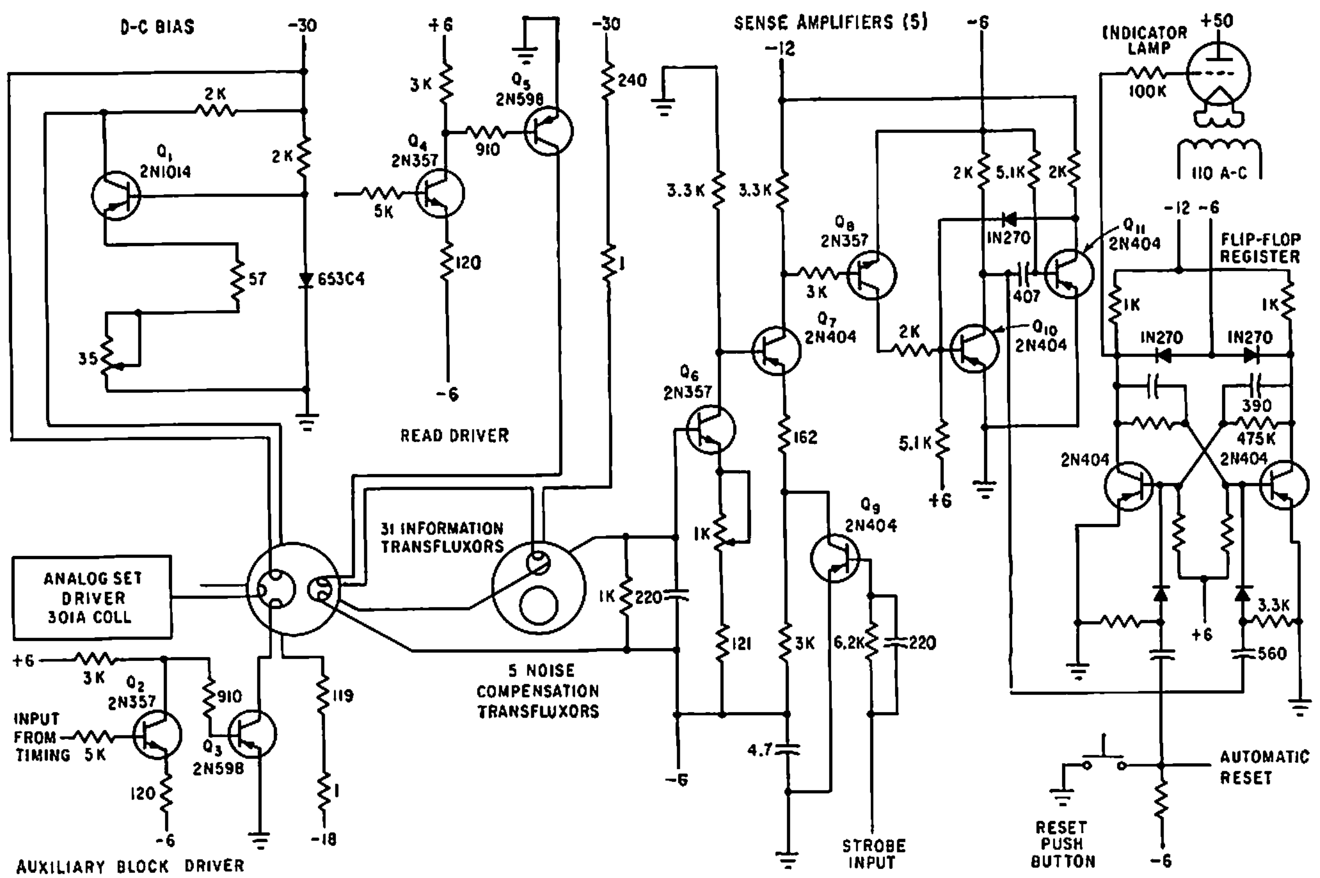
FET VOLTAGE COMPARATOR—Circuit uses spdt configuration. Used to switch reference voltage (such as ground) to successive points on binary voltage ladder until comparator determines that output of ladder is equal to that of unknown voltage. Sine and square-wave inputs at A and B produce output at C. Used also for low-level differential switching.—J. Gulbenk and T. F. Prosser, How Modules Make Complex Design Simple, *Electronics*, 37:32, p 50–54.



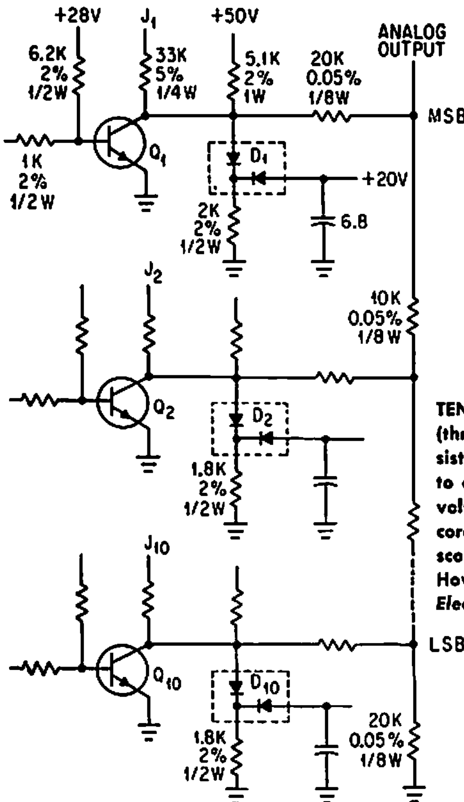
COMPUTE AMPLIFIER—Converts digital output of reference switch for serial decoder to equivalent analog voltage and holds voltage for transfer to hold amplifier.—R. M. Centner and J. R. Wilkinson, New Approach to Serial Decoding Eliminates Static Storage, *Electronics*, 35:34, p 32–35.



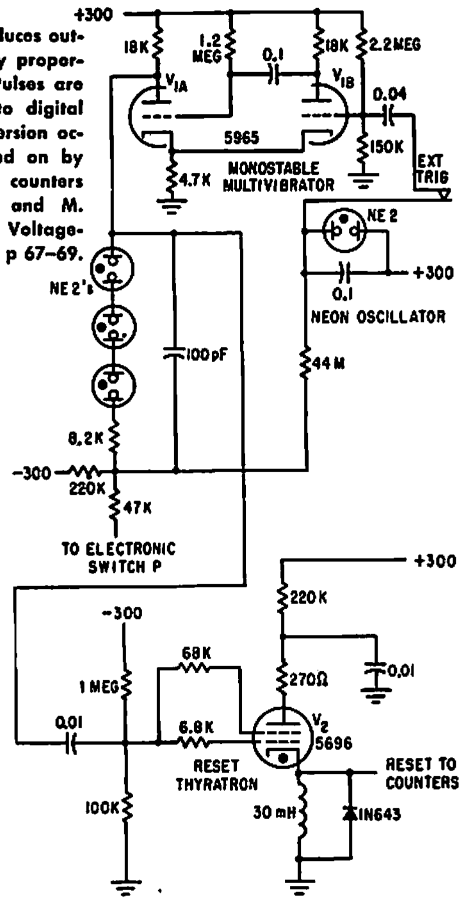
POLARITY DETECTOR—Q1-Q2 amplify negative analog samples greater than 100 mv, to provide sharp pulse output for driving monostable mvbr in analog-digital converter. —N. Aron and C. Granger, Analog-To-Digital Converter Uses Transfluxors, *Electronics*, 35:20, p 62–66.



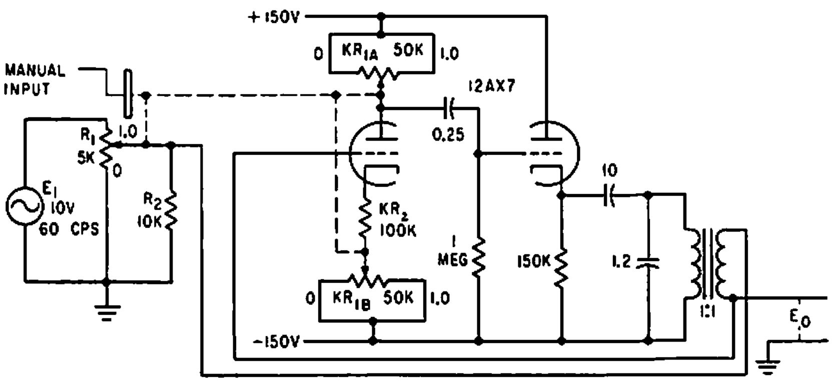
ENCODER—Used between transfluxor and digital shift register of converter that changes analog inputs to six-bit binary Gray code. —N. Aron and C. Granger, Analog-To-Digital Converter Uses Transfluxors, *Electronics*, 35:20, p 62–66.



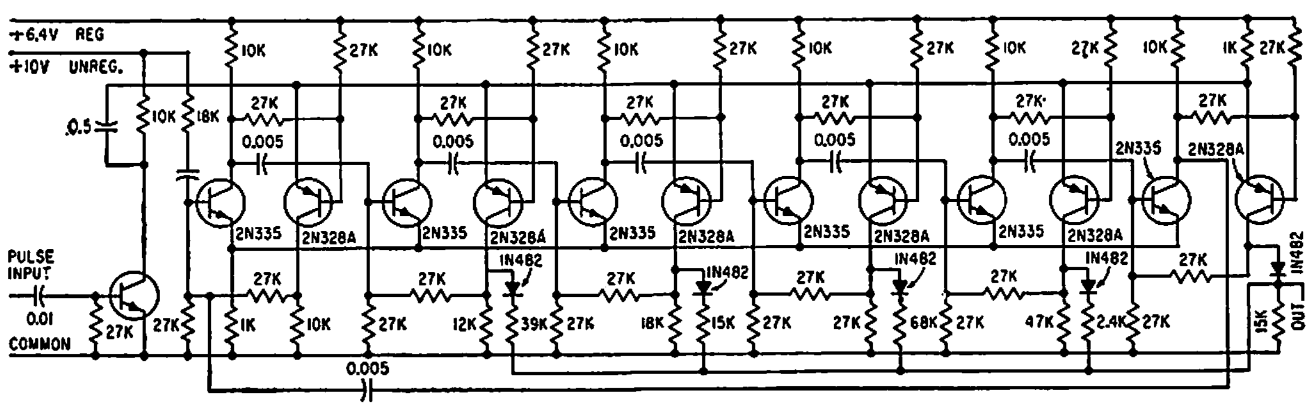
TEN-BIT D/A CONVERTER—Ten identical stages (three are shown) use selected 2N2501 transistors and matched FA2054 clamping diodes to convert digital signals to equivalent analog voltages for driving servomotors, pen recorders, and deflection circuits of oscilloscopes.—C. R. Pearman and A. D. Popodi, How to Design High-Speed D-A Converters, *Electronics*, 37:8, p 28–32.



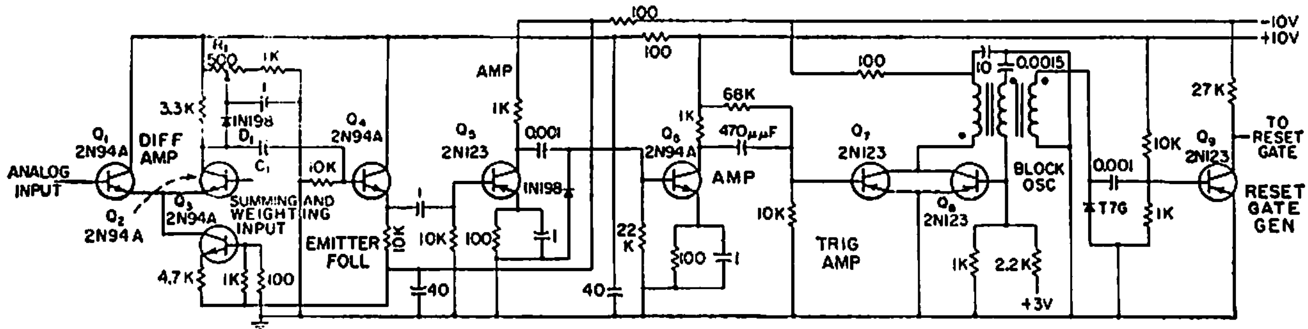
VOLTAGE-TO-TIME CONVERTER—Produces output pulse whose width is accurately proportional to unknown input voltage. Pulses are then used to gate clock pulses into digital counters for voltage readout. Conversion occurs each time converter is switched on by monostable mvbr. Thyratron resets counters after each conversion.—B. Barker and M. McMahan, Digital Voltmeter Employs Voltage-To-Time Converter, *Electronics*, 34:18, p 67–69.



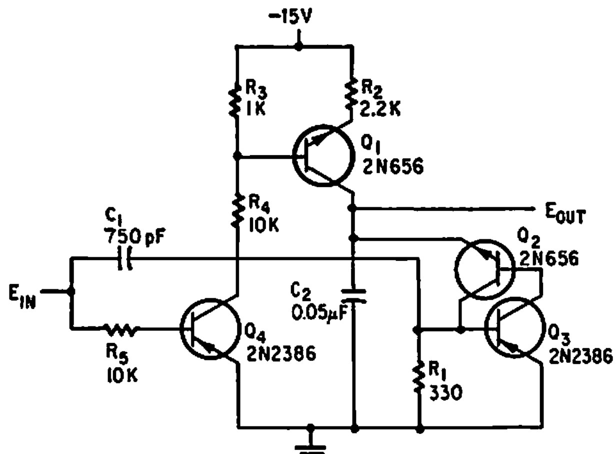
POTENTIOMETER ERROR COMPUTER—Compensation technique eliminates need for precise high-gain isolation amplifiers when linear potentiometers are used as precision voltage dividers in analog computing circuits. Error is reduced by factor of 100.—M. Kanner, How to Reduce Errors in Loaded Potentiometers, *Electronics*, 32:34, p 34–35.



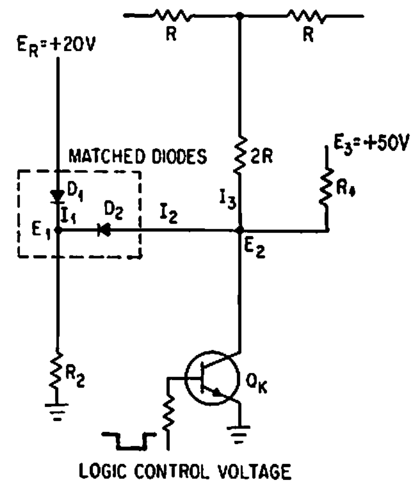
RANDOM-PULSE CONVERTER—Transforms random information, as from radiation counter and micrometeorite detector, into analog form suitable for multiplexing, and provides memory between events.—O. B. King, Multiplexing Techniques for Satellite Applications, *Electronics*, 32:44, p 58–62.



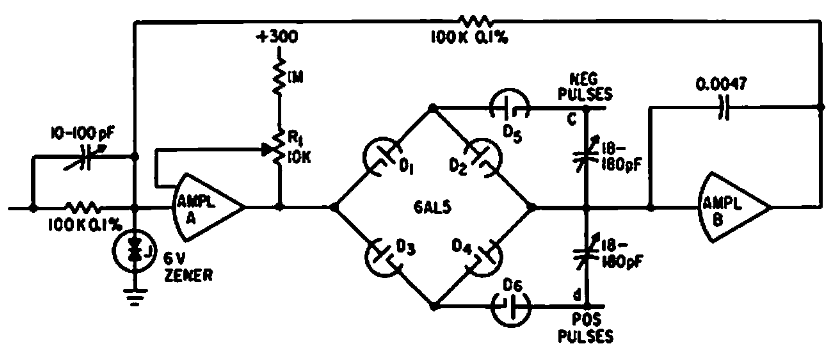
COMPARATOR—Comparator action begins when summing and weighting output exceeds analog input and negative pulse is coupled through C1. Trailing edge of blocking oscillator pulse activates reset-rate generator.—W. B. Towles, Transistorized Analog-Digital Converter, *Electronics*, 31:31, p 90–93.



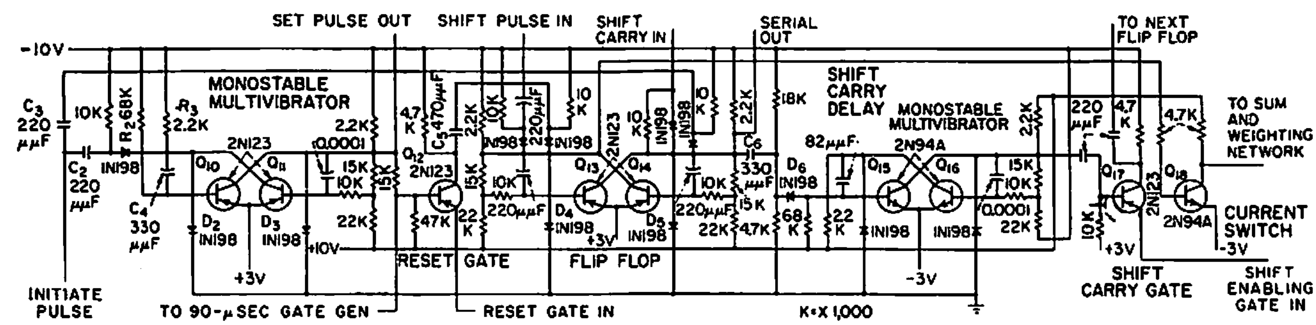
PULSE WIDTH TO ANALOG DEMODULATOR—Circuit integrates incoming pulse and holds final value until next pulse arrives. Output then returns to zero for next integration. Output range is 0 to 10 v for input pulse width range of 0 to 1 microsec.—D. Knowlton, Modulated Pulse Width Converted to Analog Voltage, *Electronics*, 38:20, p 99–100.



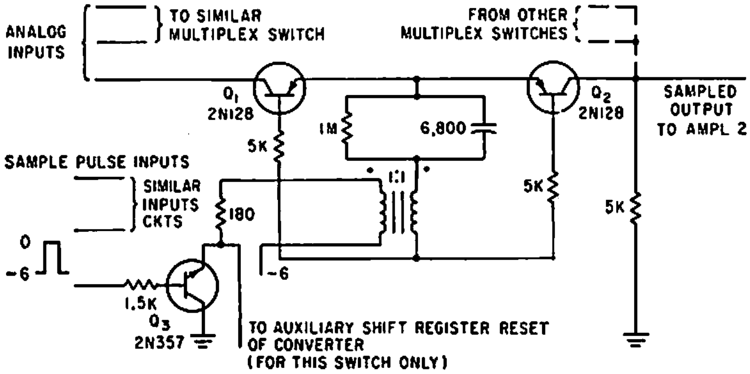
TEMPERATURE-COMPENSATED DECODER—Matched diodes in ladder-type network decoder change one reference voltage of transistor switch to compensate for temperature effects.—C. R. Pearman and A. E. Popodi, How to Design High-Speed D-A Converters, *Electronics*, 37:8, p 28–32.



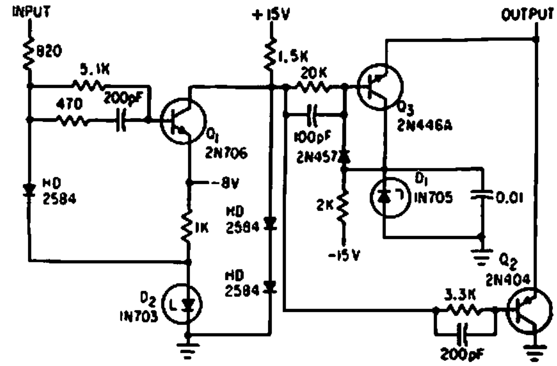
ANALOG SAMPLE-HOLD CIRCUIT—Uses diode bridge as switching circuit. Operational amplifier A delivers maximum current of 10 ma. Chopper-stabilized operational amplifier B delivers 100 v at 10 ma.—T. A. Brubaker, Precision Analog Memory Has Extended Frequency Response, *Electronics*, 34:39, p 141–143.



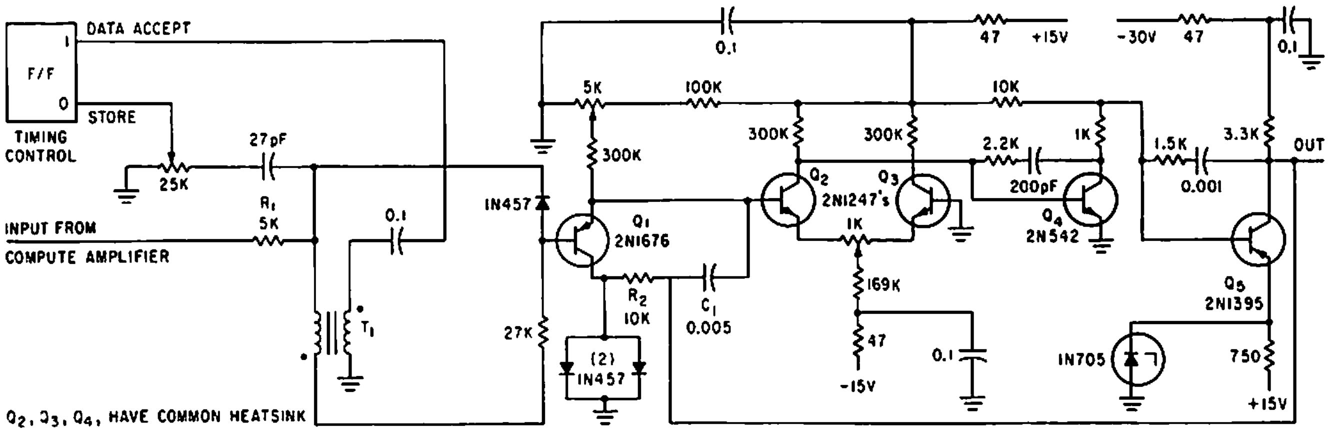
CODING DIGIT CARD—Initiate pulse starts coding in digit card of analog-digital converter and ultimately provides positive shift-carry pulse for next card. Codes inputs up to 5 v at maximum sampling rate of 5,000 inputs per second with 0.5% accuracy. Eight binary-digit result is shifted out serially at 100,000 digits per second.—W. B. Towles, Transistorized Analog-Digital Converter, *Electronics*, 31:31, p 90–93.



SAMPLER AND MULTIPLEXER—Sample of signal input voltage is fed to output when sampling pulse from external digital timing matrix is applied to primary of pulse transformer through Q3.—N. Aron and C. Granger, Analog-To-Digital Converter Uses Transfluxors, *Electronics,* 35:20, p 62–66.

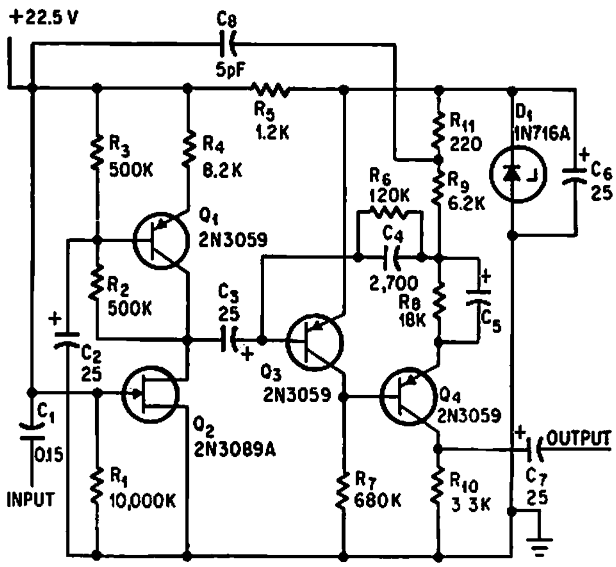


REFERENCE SWITCH—Provides low-zero-offset 5-microsec pulses with stabilized amplitude, obtained from synchronous flip-flop. Output pulses switch from zero to −5 v, for driving compute and hold amplifiers of serial decoder.—R. M. Centner and J. R. Wilkinson, New Approach to Serial Decoding Eliminates Static Storage, *Electronics,* 35:34, p 32–35.

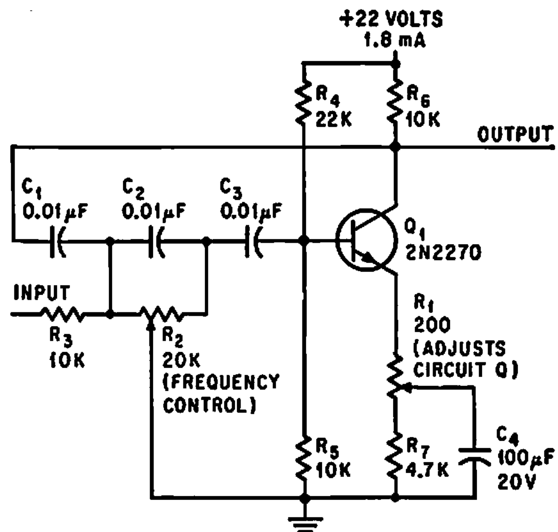


HOLD AMPLIFIER—Samples output of compute amplifier at end of each word, to provide d-c output for serial decoder and permit time-sharing of computer amplifier. Full-scale output is −10 v d-c.—R. M. Centner and J. R. Wilkinson, New Approach to Serial Decoding Eliminates Static Storage, *Electronics,* 35:34, p 32–35.

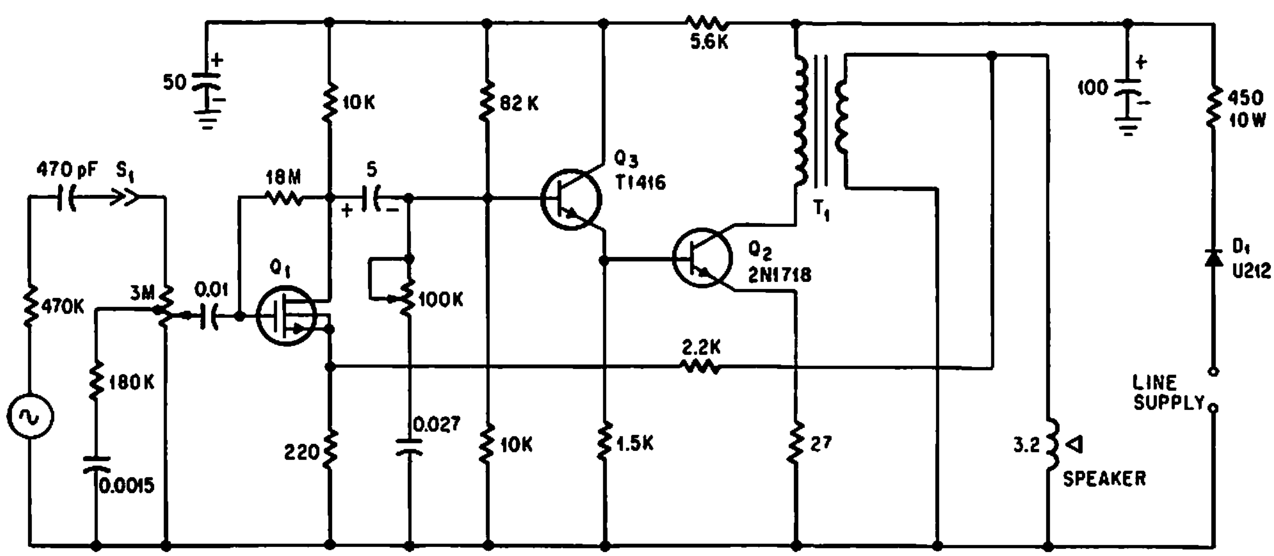
CHAPTER 4
Audio Circuits



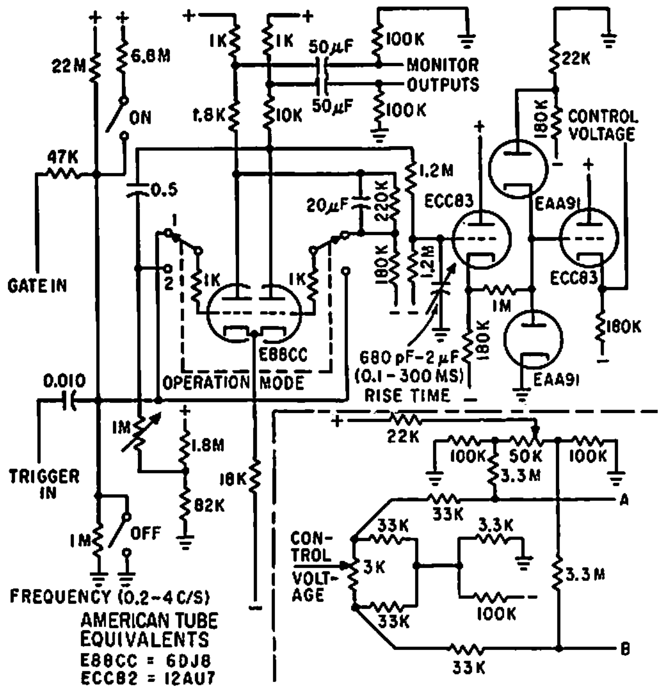
SINGLE-FET CASCODE—Costs less than two-fet version, but has somewhat poorer stability. Voltage gain is 500 for 33,000-ohm output impedance.—B. Smith, Low-Noise FETs Sound Good To Circuit Designers, *Electronics*, 37:31, p 58–62.



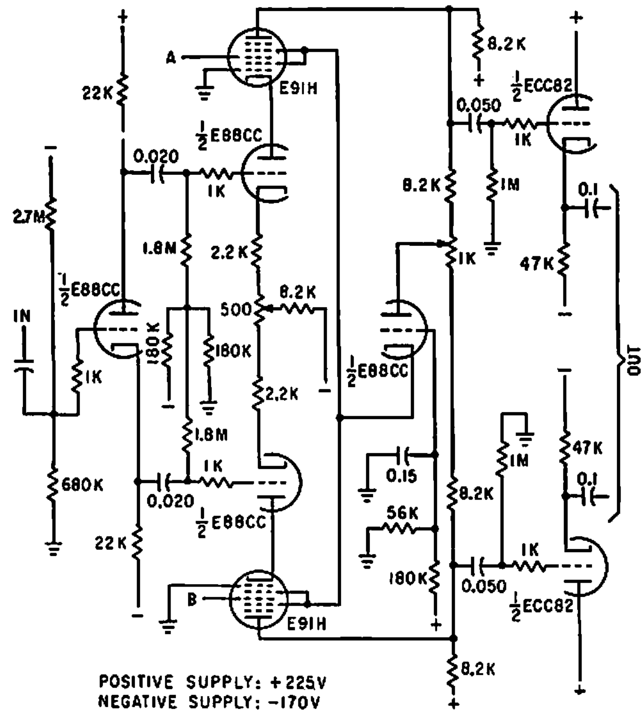
TUNED A-F—R2 tunes three-step ladder network of feedback loop from 800 to 1,000 cps. Circuit is stable. Used in a-c bridge.—J. F. Delpech, Simple Circuit Tunes Audio Amplifier, *Electronics*, 38:6, p 84–85.



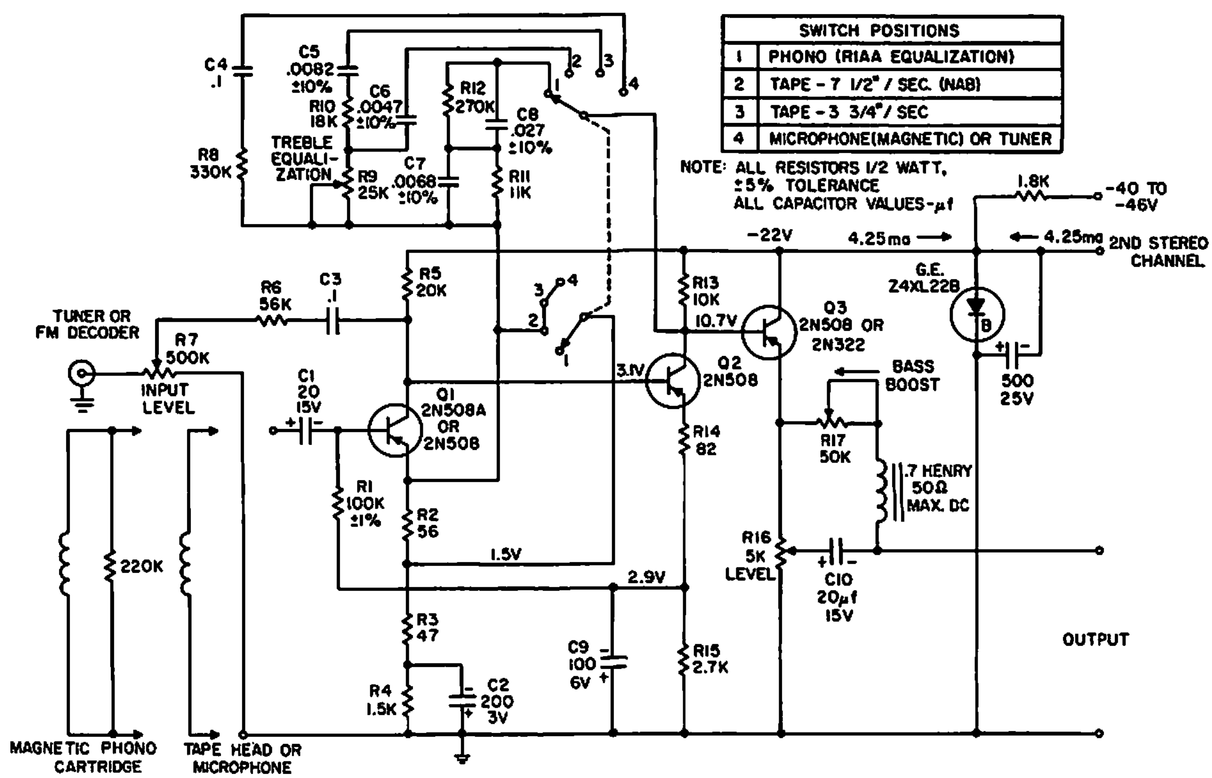
PHONO PREAMP—High input impedance of mos fet will not load ceramic cartridge represented by 470K and 470 pf. Q2 as emitter-follower driver transforms low input impedance of Q3 to sufficiently high value for required voltage gain at power output of 1 w.—V. Harrap et al., Researchers Turn to Germanium For a MOS Field-Effect Transistor, *Electronics*, 37:30, p 64–68.



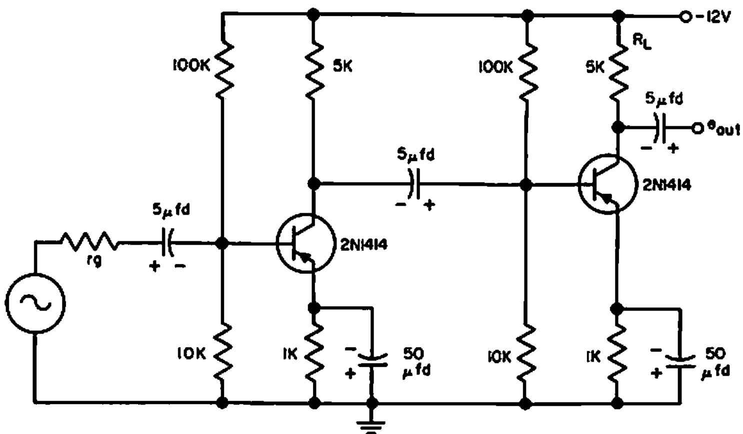
DRIVER FOR FADER—Can be operated either in free-running mode or in triggered or gated mode, to produce control voltage that will drive electronic fader. Correction network at lower right transfers control voltage to fader and minimizes switching transient.—E. de Boer, Electronic Fader for Auditory Research, *Electronics,* 33:50, p 85–87.



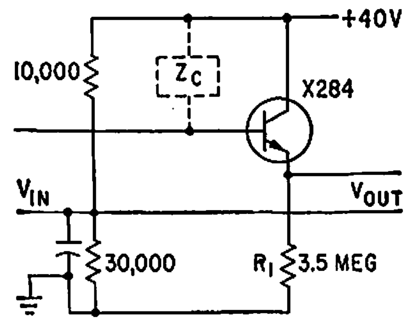
ELECTRONIC FADER—Used to fade audio signals on and off without producing audible switching transients. Signals from matching network of driver are applied to points A and B.—E. de Boer, Electronic Fader for Auditory Research, *Electronics,* 33:50, p 85–87.



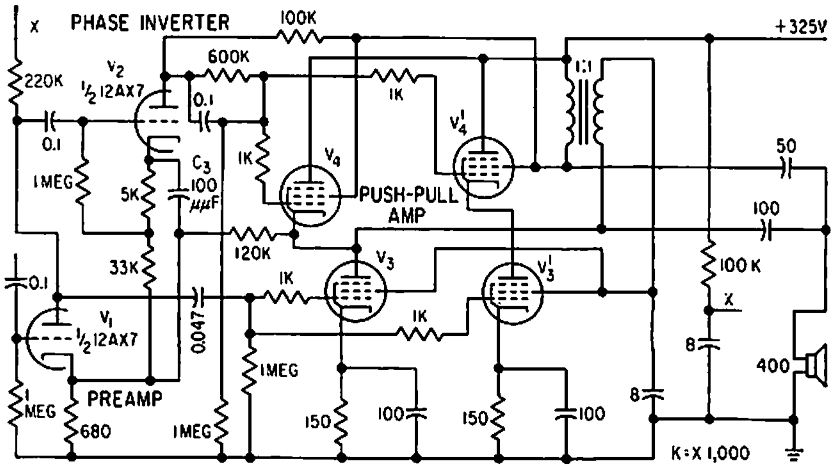
PHONO, TAPE, AND MICROPHONE PREAMP—Total harmonic or intermodulation distortion is less than 0.3% at reference level output of 1 v. Will take most magnetic pickup impedances. Equalized output is constant within 1 db from 40 cps to 12 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 252.



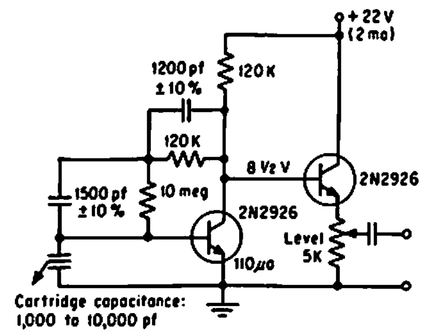
2-STAGE R-C COUPLED AUDIO AMPLIFIER—Input impedance for basic circuit is about 1,300 ohms. Design equations are given.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 242.



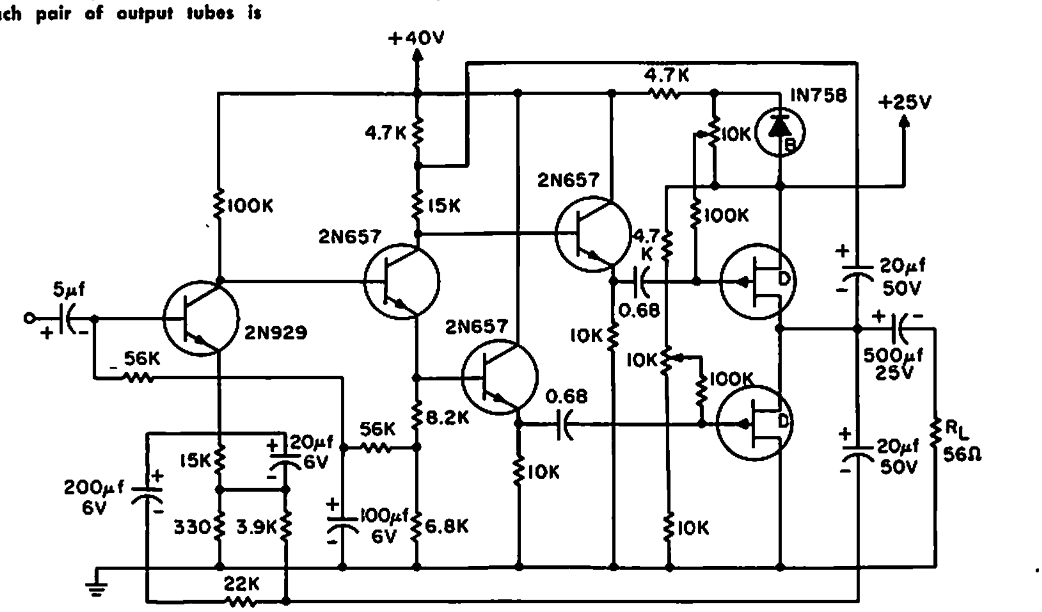
100-MEG INPUT RESISTANCE—High d-c input resistance is obtained with grounded-collector circuit operating under starved conditions. A-c input impedances of 100 meg are obtainable at audio frequencies, as required for photoconductive devices.—B. M. Bramson, Starved Transistors Raise D-C Input Resistance, *Electronics*, 32:5, p 54–55.



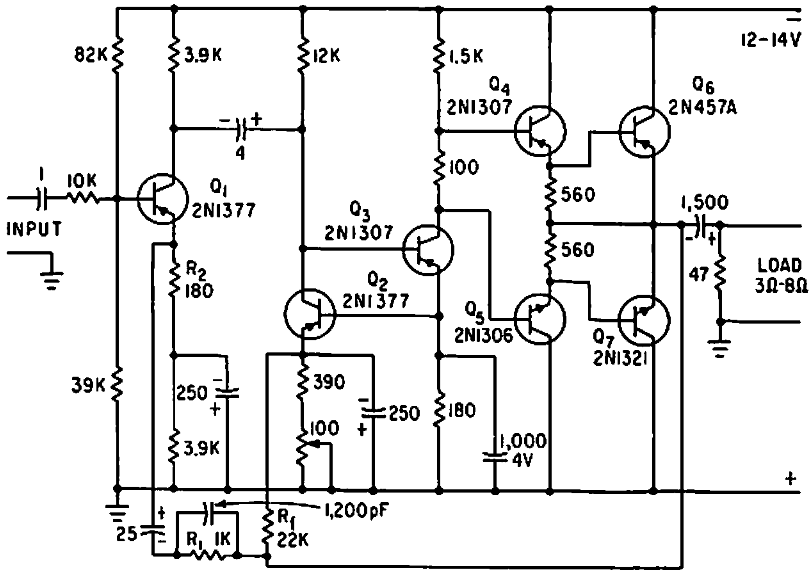
20-W SINGLE-ENDED PUSH-PULL OUTPUT—Doubling number of output power tubes doubles power output and halves loudspeaker impedance requirement. Separate cathode R-C assembly for each pair of output tubes is recommended, but only one double choke is required. All pentodes are 6CW5.—J. Rodrigues De Miranda, Push-Pull Amplifiers Drive Speaker Directly, *Electronics*, 31:29, p 76–79.



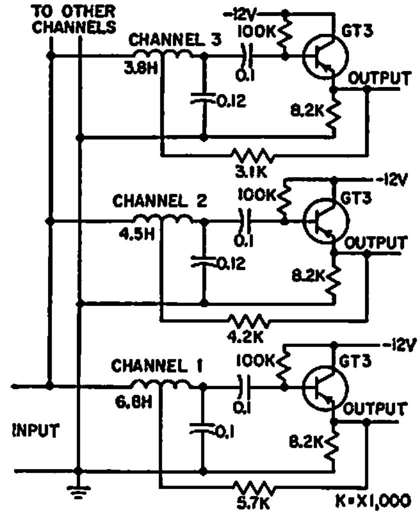
PHONO PREAMP—Two planar passivated silicon transistors give RIAA equalization for ceramic cartridge.—General Electric Co. (ad), *Electronics*, 37:17, p 38.



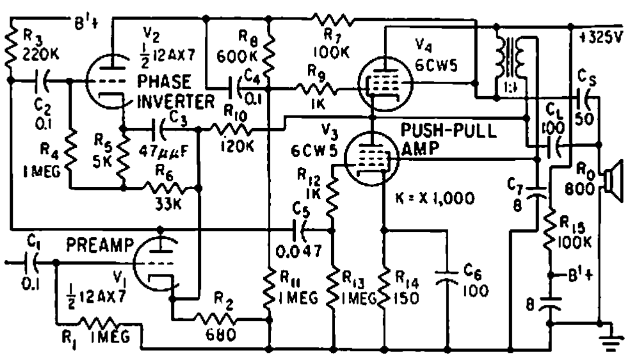
1-WATT FET AUDIO AMPLIFIER—Voltage amplifier is followed by split-load phase inverter and push-pull output stage. Emitter-followers drive output stage to improve frequency response, with coupling through nonelectrolytic capacitors.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 98.



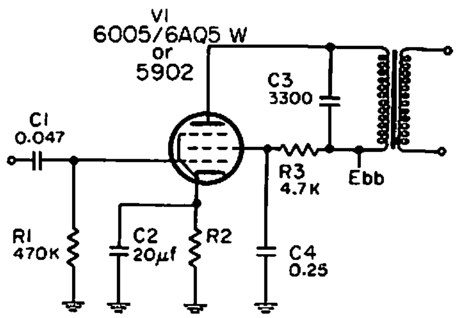
COMPLEMENTARY-SYMMETRY AUDIO AMPLIFIER—Provides nearly maximum power theoretically available from single d-c supply. Distortion is low. Large feedbacks, both a-c and d-c, make amplifier insensitive to unbalance of output transistors.—R. S. Richards, How to Design Transformerless Audio-Frequency Power Amplifiers, *Electronics*, 35:46, p 50–52.



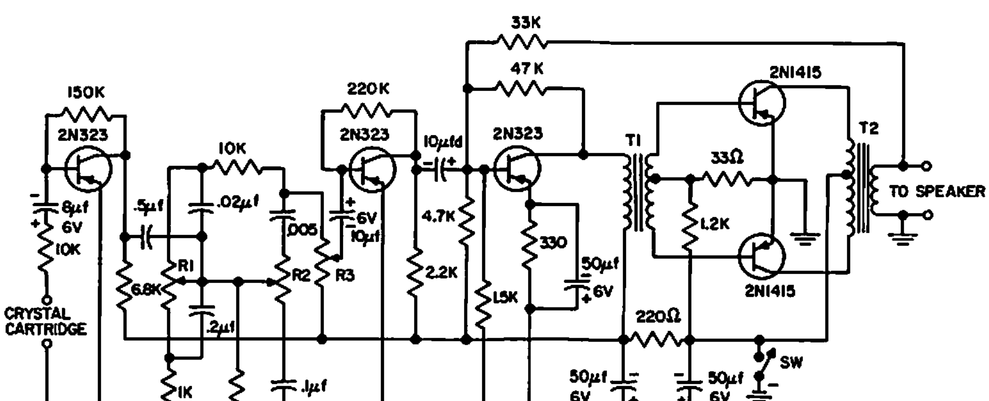
Q MULTIPLIER—Circuit shows three channels of multi-channel selective a-f amplifier (190, 216.5, and 235 cps) using various coil-capacitor combinations with transistor Q multiplier to provide staggered resonant frequencies. Used in frequency-selective calling systems.—G. B. Miller, Transistor Q Multiplier for Audio Frequencies, *Electronics*, 31:19, p 79–81.



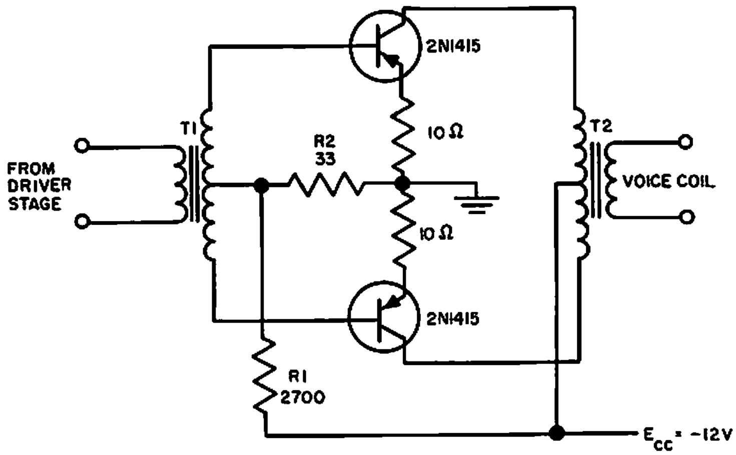
10-W SINGLE-ENDED PUSH-PULL OUTPUT—Feeds voice coil directly, making output transformer unnecessary. First preamplifying stage has positive feedback to point of oscillation, while amplifier and output stages have negative feedback. Circuit has low distortion, flat response, and only a few degrees of phase shift over audio range.—J. Rodrigues De Miranda, Push-Pull Amplifiers Drive Speaker Directly, *Electronics*, 31:29, p 76–79.



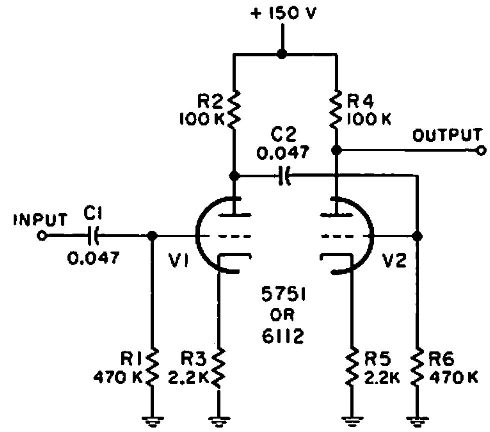
PREFERRED POWER AMPLIFIER—For 6AQ5W, with plate supply of 250 v, output is 115 v to transformer at 2.21 w for 6 v rms input. For 5902, with plate supply of 150 v, output to transformer is 75 v at 0.8 w for 5 v rms input.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 61, p 61–2.



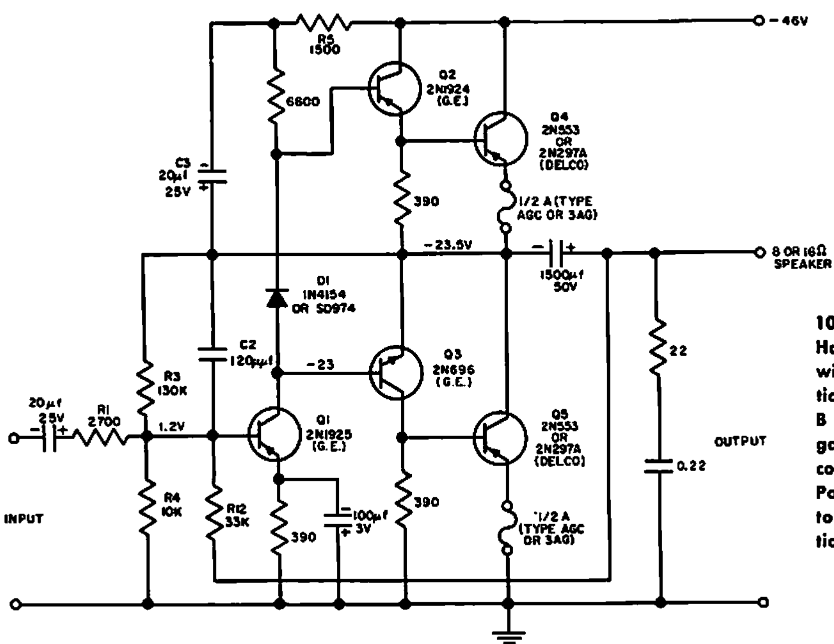
6-V PHONO AMPLIFIER—Provides 300 mw at 10% distortion. Bass control R1 and treble control R2 are 50K linear taper. Volume control R3 is 10K audio taper.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 376.



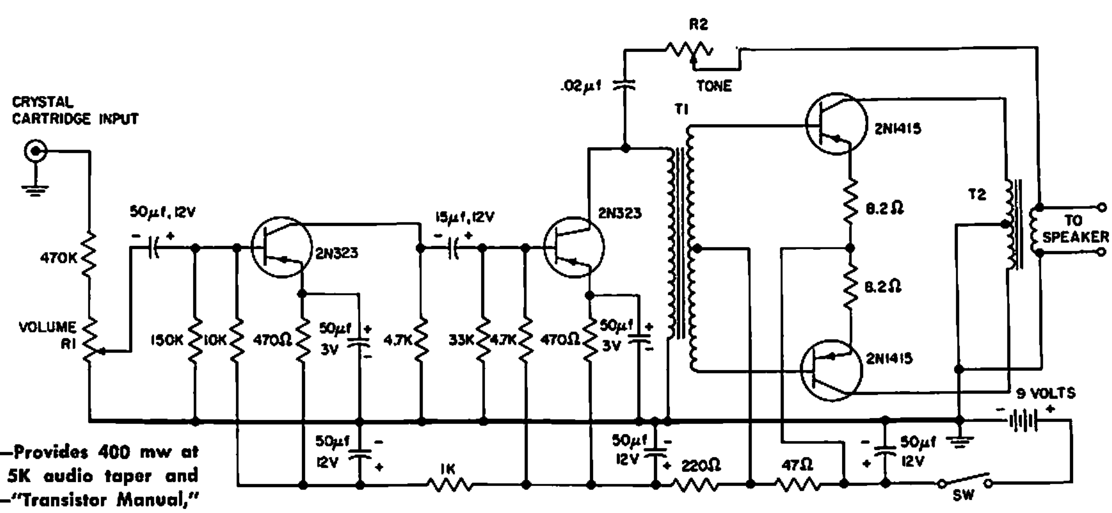
BASIC CLASS-B PUSH-PULL OUTPUT—Design procedures are given. Resistor in emitter leads prevent thermal runaway when ambient temperature is below 55°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 242.



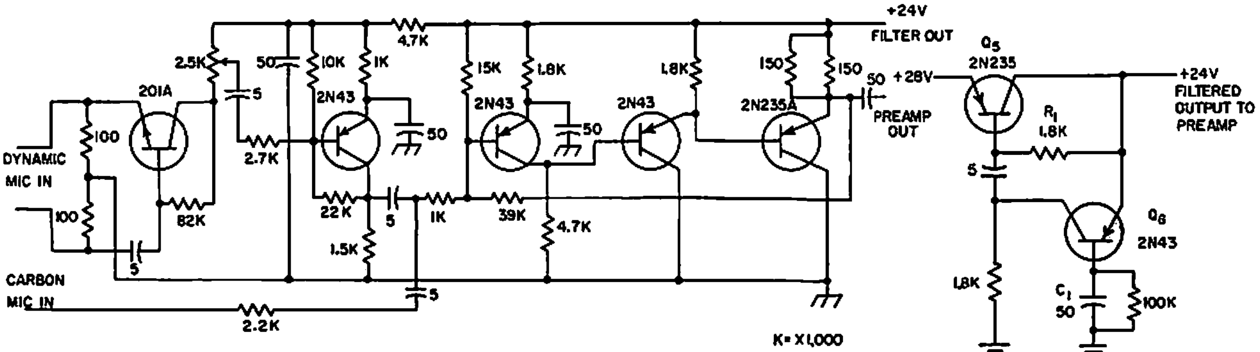
PREFERRED VOLTAGE AMPLIFIER—Amplifies 10 to 70-mv signals to level needed to drive audio power amplifier. For 5751, amplification is 335, maximum output is 23 v rms, and 3-db response is 10 cps to 20 kc. For 6112, maximum output is 26 v rms, amplification is 370, and 3-db bandwidth is 10 cps to 30 kc. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 60, p 60–2.



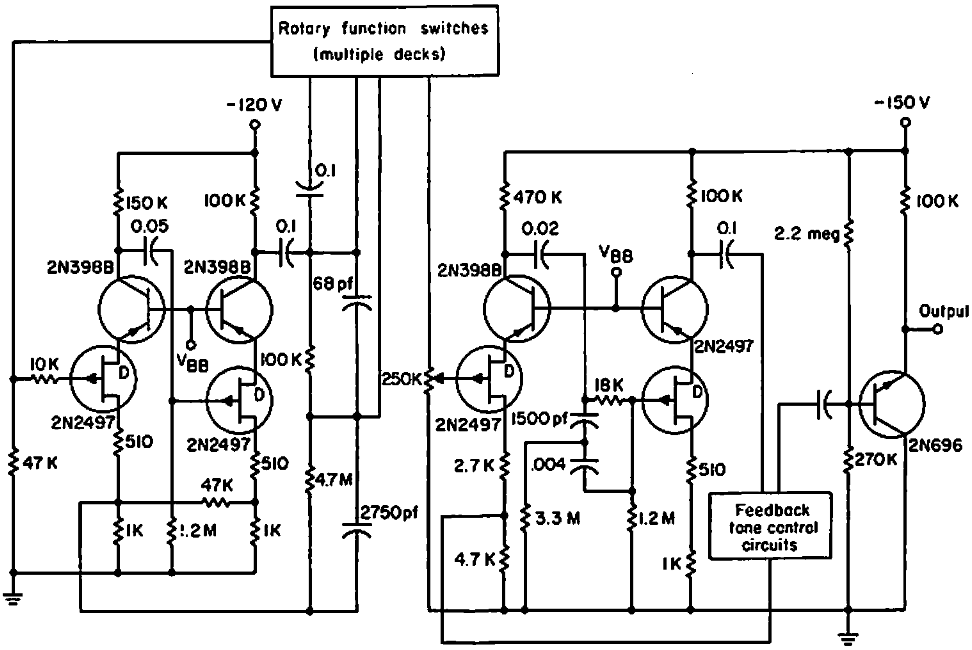
10-W DIRECT-COUPLED POWER AMPLIFIER—Has excellent low-frequency response, along with d-c feedback for temperature stabilization of all stages. Q2 and Q3 operate class B in Darlington connection to increase current gain. Fuses protect output transistors against continuous sine-wave output above 10 kc. Power response at 1 w is flat from 30 cps to 15 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 260.



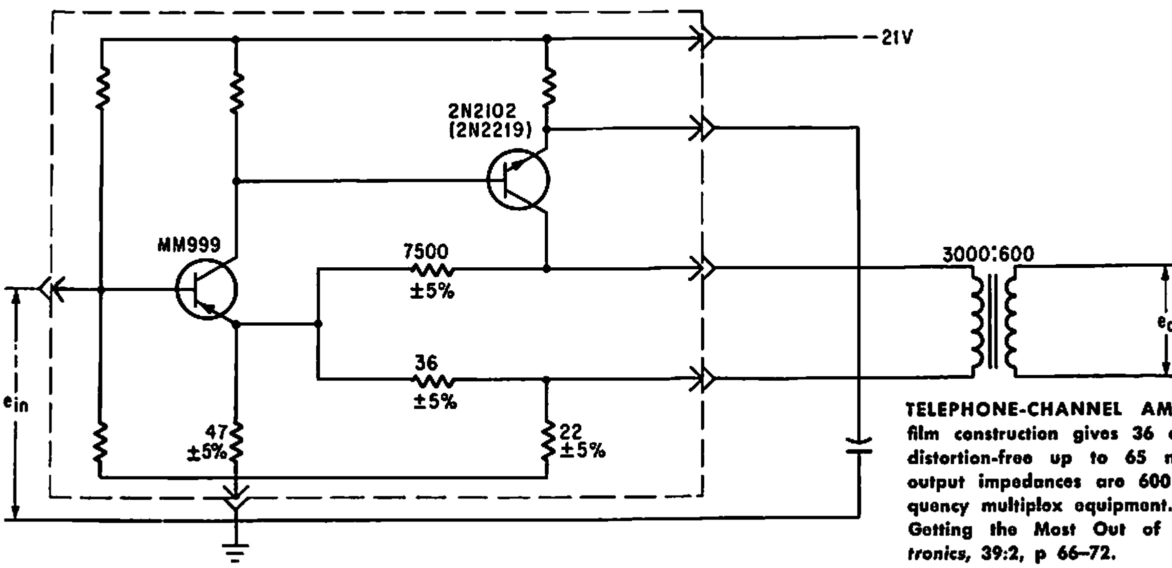
9-V PHONO AMPLIFIER—Provides 400 mw at 10% distortion. R1 is 5K audio taper and R2 is 25K linear taper.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 377.



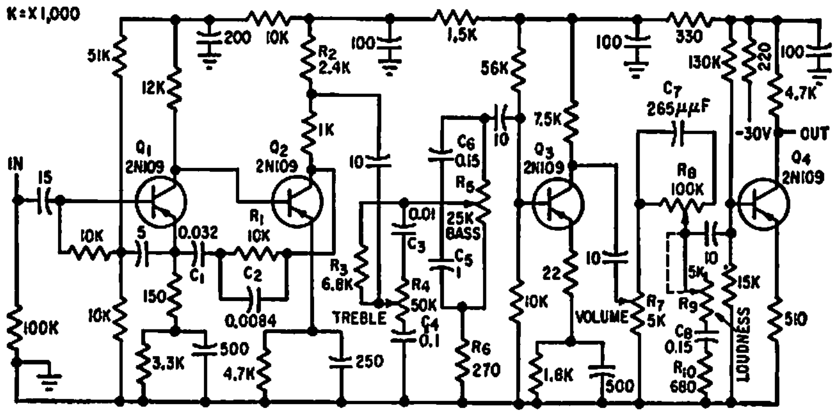
ZONED PUBLIC ADDRESS IN PLANE—Uses single preamplifier and up to five power amplifiers and speakers to distribute sound uniformly throughout seating area of plane. Air-ground output switch acts on all amplifiers simultaneously to compensate for different noise levels on ground than in air.—Transistorized P-A System Adjusts to Aircraft Noise, *Electronics*, 31:7, p 106–107.



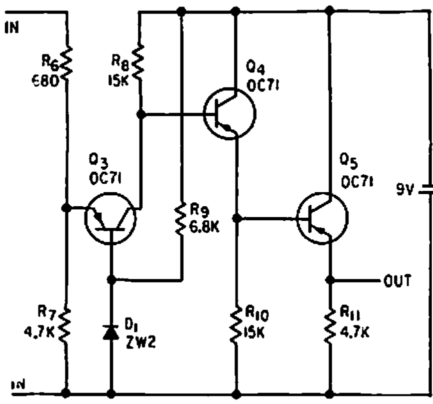
HI-FI FET PREAMP—Breakdown voltage of commercial fet's is extended by using direct-coupled cascode connection with low-cost germanium transistor.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 73.



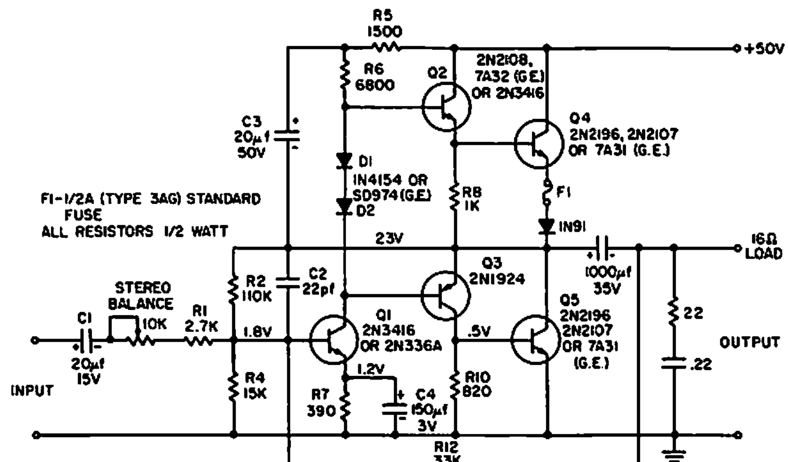
TELEPHONE-CHANNEL AMPLIFIER—Thick-film construction gives 36 db gain and is distortion-free up to 65 mw. Input and output impedances are 600 ohms, for frequency multiplex equipment.—N. A. Zellmer, Getting the Most Out of Feedback, *Electronics*, 39:2, p 66–72.



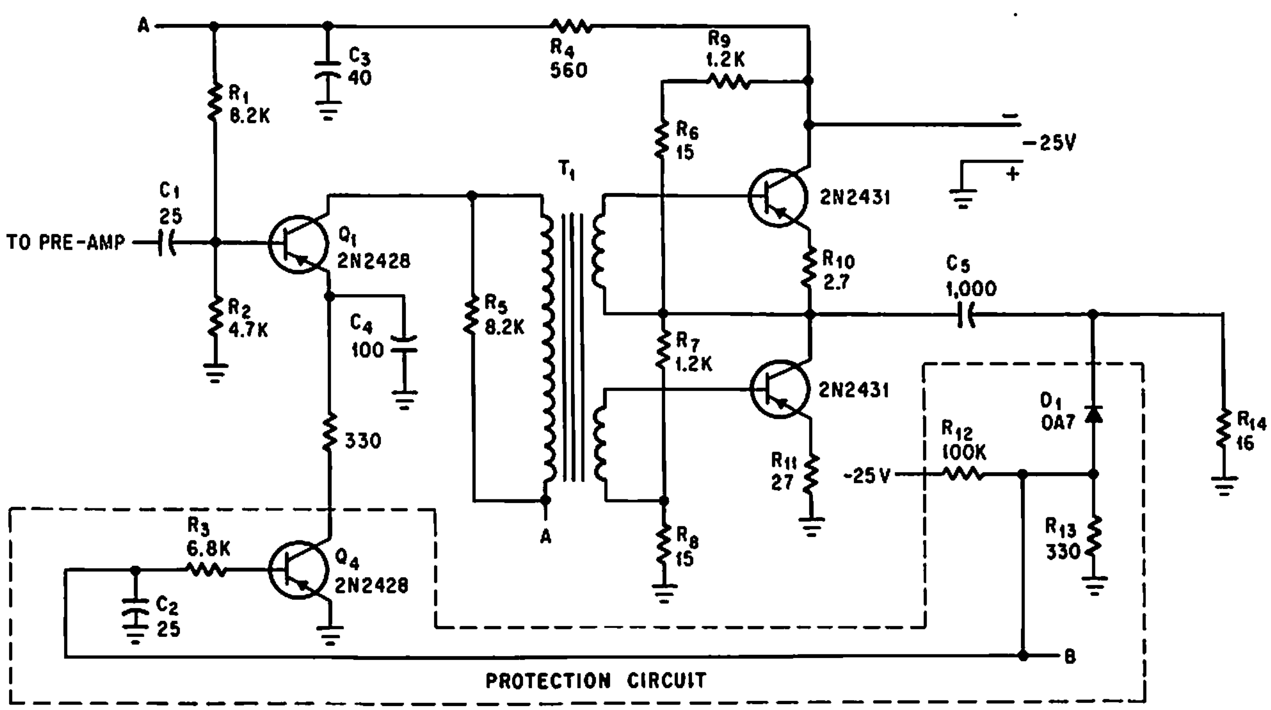
PREAMPLIFIER FOR DYNAMIC PICKUP—Accepts signal from variable-reluctance cartridge. Includes RIAA frequency-correcting network, variable bass and treble compensation, volume control, and loudness control that attenuates midfrequencies as loudness level is decreased, to emphasize lows and highs during soft musical passages.—R. Minton, Designing High-Quality A-F Transistor Amplifiers, *Electronics*, 32:24, p 60–61.



STABLE AUDIO AMPLIFIER—Provides low input and output impedances, along with stable gain for wide range of transistor parameters and thus for temperature and supply voltage variations, as required for sound level meter.—W. V. Richings and B. J. White, Transistorized Sound Level Meter, *Electronics*, 33:25, p 64–66.

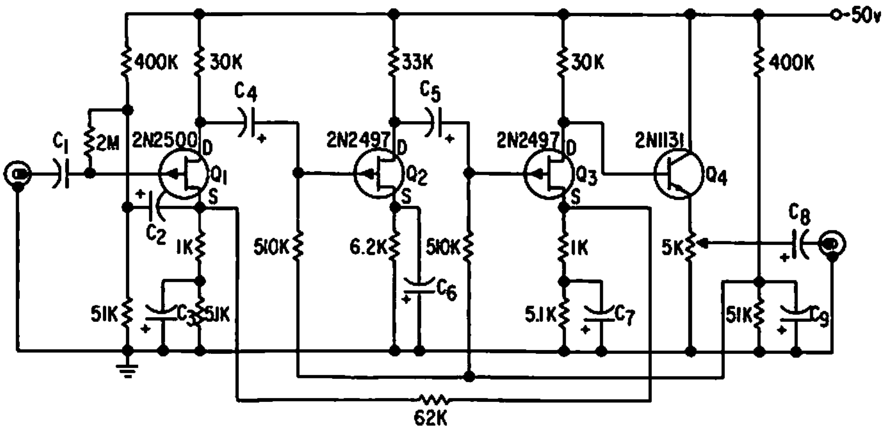


8-W SILICON-TRANSISTOR POWER AMPLIFIER—Output impedance is 0.5 ohm, for good speaker damping. Response is down only 3 db at 86 kc. Power response is flat within 0.33 db from 30 cps to 15 kc at 6 w output.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 263.

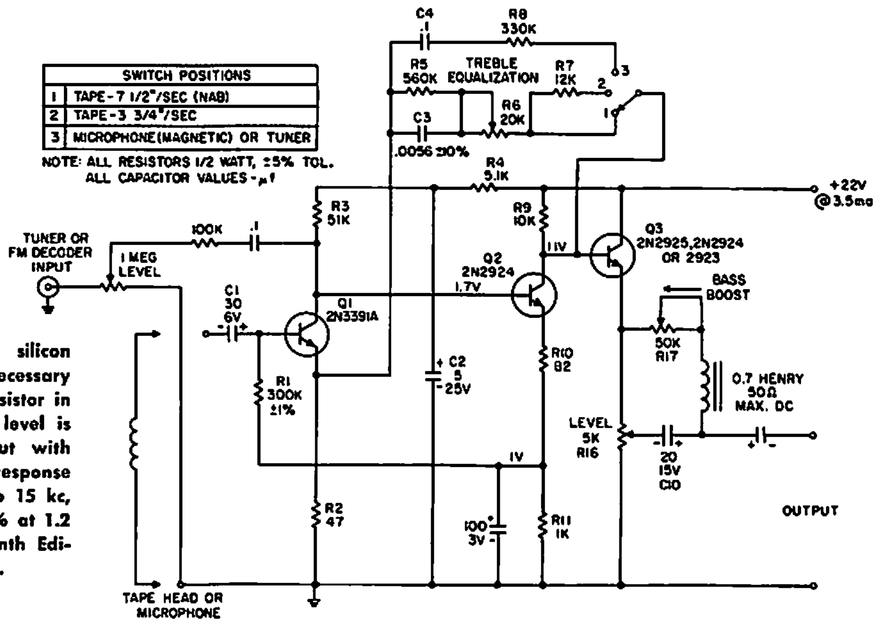


A-F OUTPUT TRANSISTOR PROTECTION—When output of 3-w audio amplifier is short-circuited, protection circuit reduces overall gain by 20 db.—E. Segatis, Circuit Protects Amplifier Against Short Circuit, *Electronics*, 37:23, p 61–62.

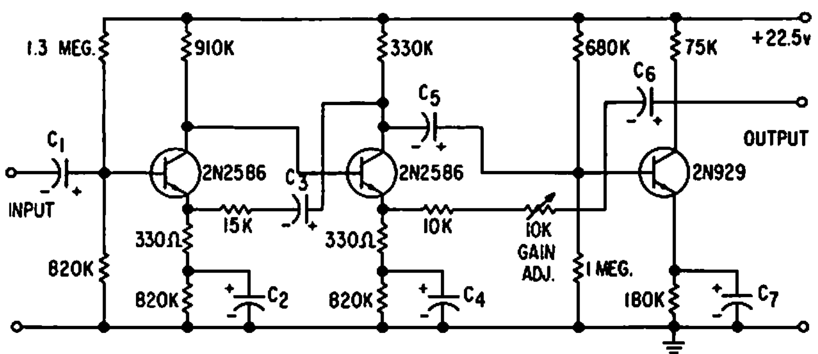
RESISTORS: All 1/2 watt, TI Type CD1/2MR
CAPACITORS:
C_1–0.1μf
C_2–5.6μf–TI Type SCM 565BP035C4
C_3, C_6, C_7–220μf–TI Type SCM 227HP010C4
C_4, C_5–1.0μf–TI Type SCM 105FP035C4
C_8–10μf–TI Type SCM 106BP020C4
C_9–68μf–TI Type SCM 686GP015C4



60-DB LOW-NOISE FET AMPLIFIER—Gives maximum voltage gain of 60 db, constant within 0.5 db from −55 to +125°C with built-in gain adjustment. Has good low-frequency response, along with extremely low noise, as little as 5 db at 10 cps. Used with low-level transducers, null detectors, recorders, oscilloscopes, and medical research equipment.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 293.

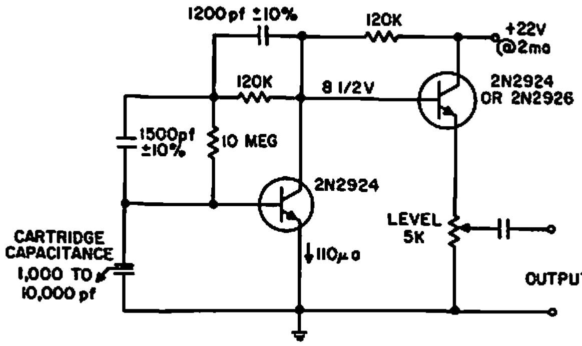


TAPE-MICROPHONE PREAMP—Uses silicon planar npn transistors, making it necessary to have temperature-compensating resistor in emitter circuit of first stage. Noise level is 66 db below reference level output with weighted measurement. Frequency response is flat within 0.25 db from 30 cps to 15 kc, and total harmonic distortion is 0.01% at 1.2 v output.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 256.

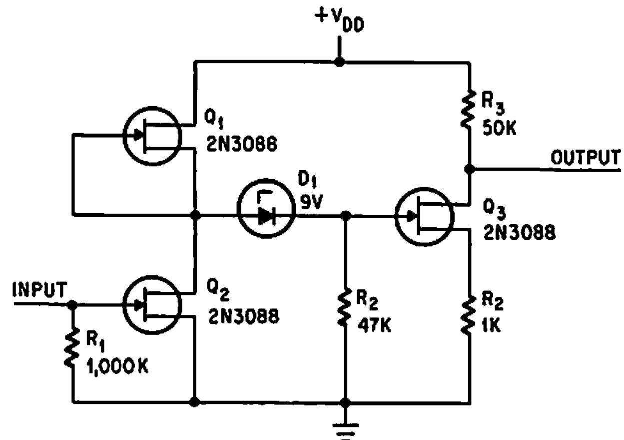


RESISTORS—ALL 1/2 watt, TI type CD1/2 MR
CAPACITORS
C_1, C_3, C_5, C_6 — 2μf, TI type SCM 225FP020C4
C_2, C_4 — 20μf, TI type SCM 226BP015C4
C_7 — 20μf, TI type SCM226GP035C4

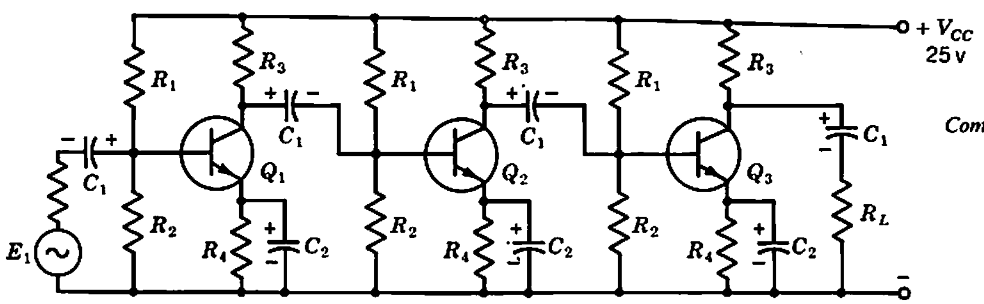
LOW-LEVEL LOW-NOISE HIGH-GAIN—Gives gains up to 1,000 (60 db) for high-impedance transducer applications, with typical noise figure of 1 db at emitter currents below 1 microamp and generator resistance above 1 meg. Such performance was previously available only with vacuum tubes and field-effect transistors. Ideal for space applications.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 291.



VELOCITY-RESPONSE PHONO PREAMP—Designed for use with wide range of ceramic cartridge capacitances. Input impedance, which is 30K at 40 cps, decreases with increasing frequency to give velocity response from cartridge, so that preamp frequency response is like that required for a magnetic cartridge. Output is equalized within 1.6 db from 40 cps to 12 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 258.



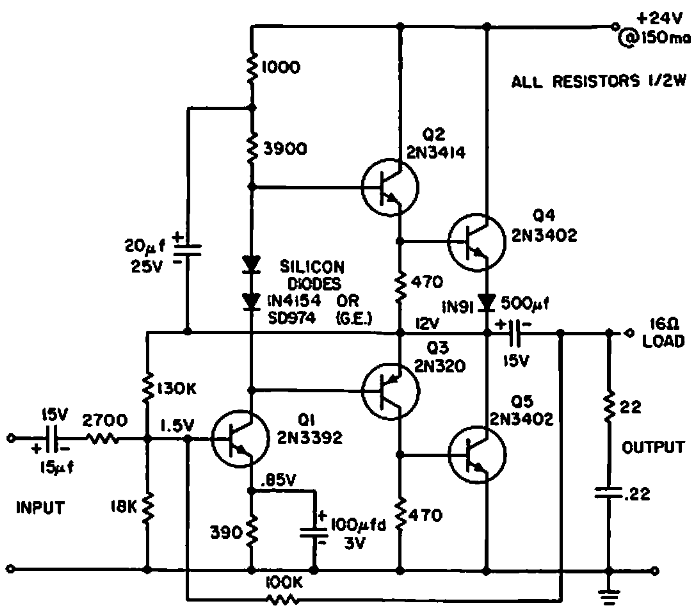
TWO-FET CASCODE—Gives high audio voltage gain (40 db), high impedance, low-noise operation, and good temperature stability with low supply voltage. Q3 serves as load resistance.—B. Smith, Low-Noise FETs Sound Good To Circuit Designers, *Electronics*, 37:31, p 58–62.



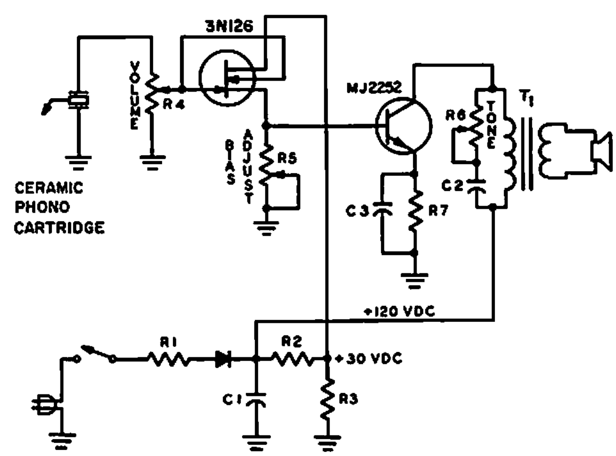
Component values:

R_L = 560 ohms
R_1 = 16 kilohms
R_2 = 6.2 kilohms
R_3 = 1.6 kilohms
R_4 = 1.0 kilohm

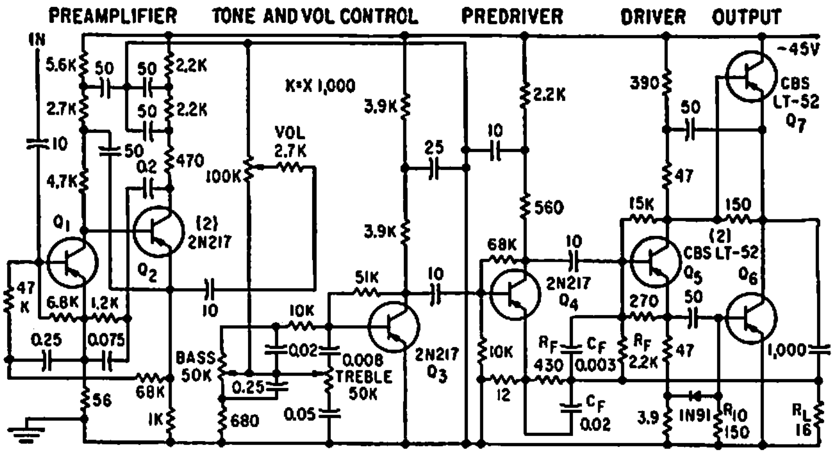
THREE-STAGE CASCADED COMMON-EMITTER—Gives current gain of 90 db at 1 kc. Output voltage swing is 2 v peak-to-peak. All transistors are 2N1565. Values of C1 and C2 depend upon frequency response desired; typical values are 10 and 100 mfd respectively.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 205.



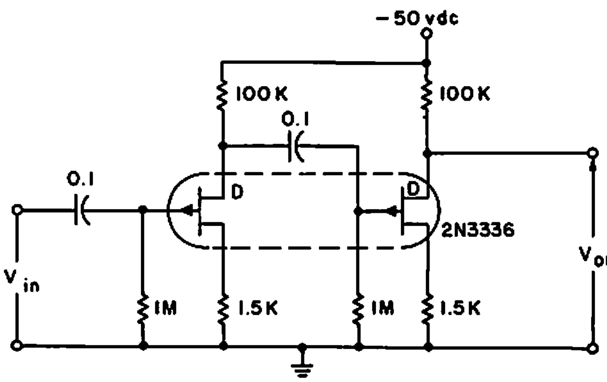
2.5-W TRANSFORMERLESS AMPLIFIER—Uses economical transistors and diodes. Requires 330 mv input for full output. Total harmonic distortion at 1 kc is less than 1% at full output.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 266.



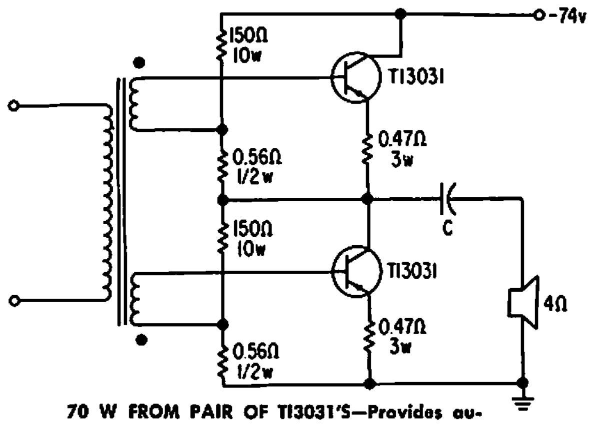
LOW-COST LINE-OPERATED PHONO—Provides 1 w output with only two transistors. High input impedance (above 10,000 meg) of fet permits direct drive by high-output cartridge, while MJ2252 npn silicon transistor operates directly from 120 v d-c output of simple power supply using Motorola 1N4004 surmetic silicon rectifier. Values are: C1—100 mfd; C2—0.1 mfd; C3—100 mfd, 3v; R1—330; R2—10K; R3—3K; R4—1 meg; R5—5K; R6—100K; R7—33.—D. L. Wollesen, "A Line Operated Solid State Phonograph Amplifier," Motorola Application Note AN-183, Feb. 1966.



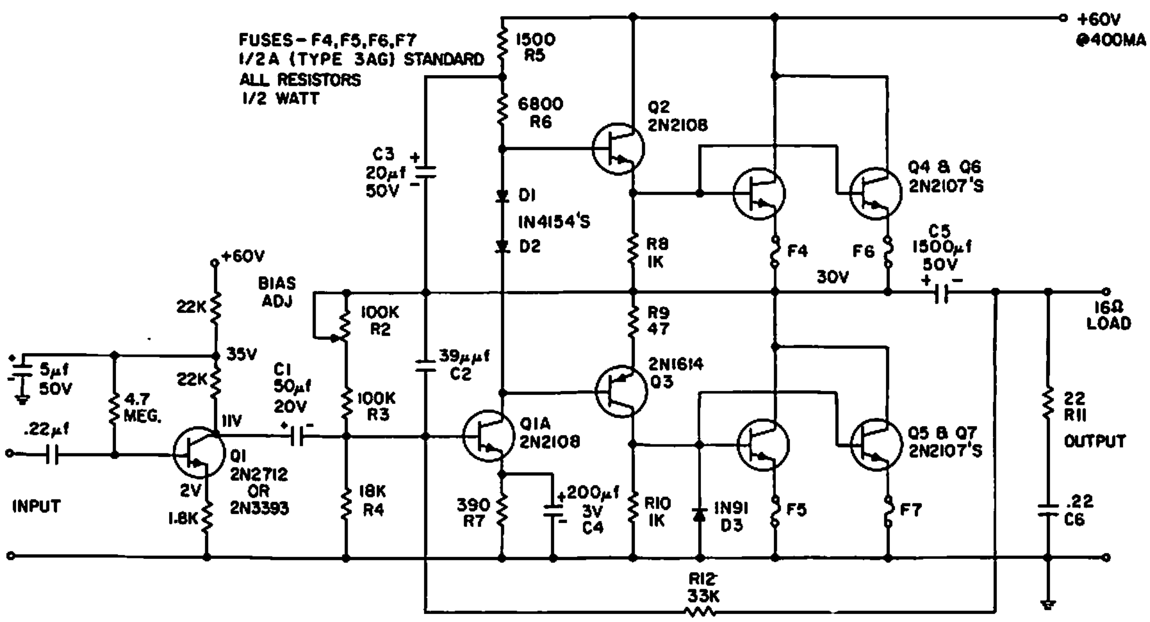
SINGLE-ENDED CLASS-B OUTPUT—High-fidelity 10-w amplifier uses capacitors and diodes to couple class A driver to single-ended class B output feeding 16-ohm speaker. Input stages are equalized for RIAA curve. Frequency response is flat within 1.5 db from 30 to 15,000 cps.—H. C. Lin and B. H. White, Single-Ended Amplifiers for Class B Operation, *Electronics*, 32:22, p 86–87.



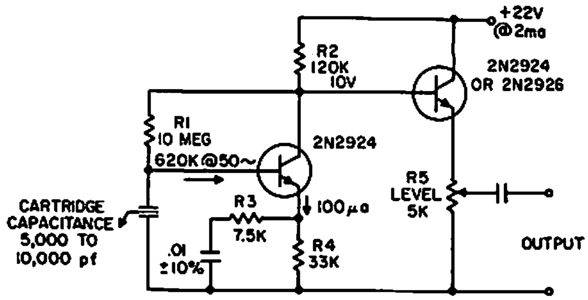
BUILDING-BLOCK AMPLIFIER—Has voltage gain of 1,000 and gain-bandwidth product of 15 Mc. High-fidelity audio preamp can be designed with two such packages, one with equalization network and one with tone control network.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 74.



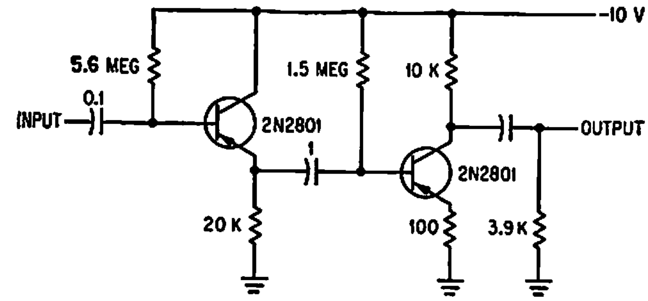
70 W FROM PAIR OF TI3031'S—Provides audio amplifier output stage with high power-to-cost ratio, with no need for transformer coupling to speaker coil.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 315.



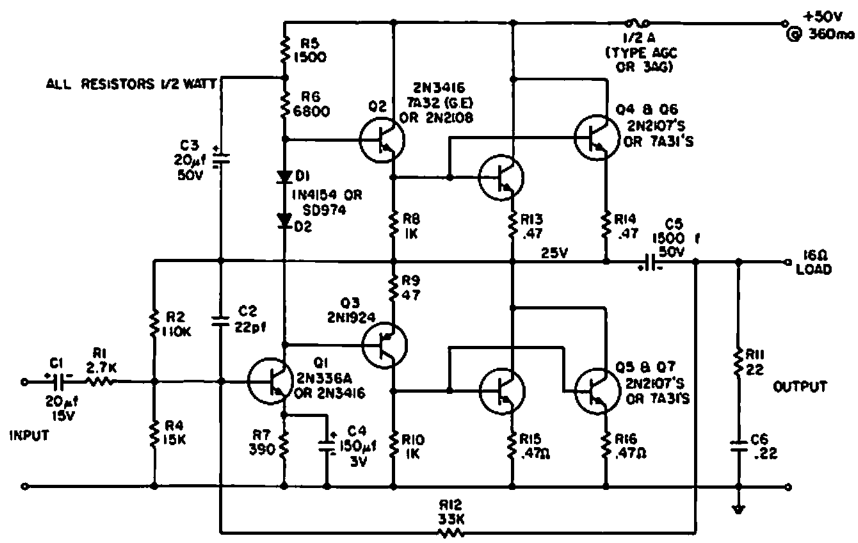
15-W TRANSFORMERLESS AMPLIFIER—Uses additional input stage to increase input impedance from 3K to over 200K. Power frequency response is flat within 0.5 db from 20 cps to 20 kc. Output impedance is less than 0.3 ohms, for good speaker damping, and harmonic distortion at full power is less than 0.25%.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 269.



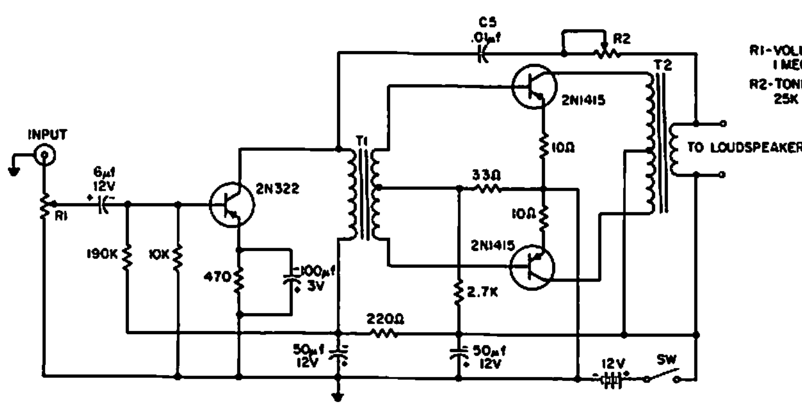
CERAMIC-CARTRIDGE PHONO PREAMP—Gives RIAA equalized output. With Astatic model 137 cartridge, output reference level of 1 v is 13 db below maximum output and 69 db above unweighted noise level.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 258.



LOW-NOISE AUDIO AMPLIFIER—Power gain is 44 db, input impedance 440,000 ohms, and hum and noise 57 db down for 3-db frequency response of 20 to 100,000 cps.—L. E. Clark, E. B. Mack, and R. C. Hajhall, Highlights of Small-Signal Circuit Design, *Electronics*, 36:49, p 46–50.

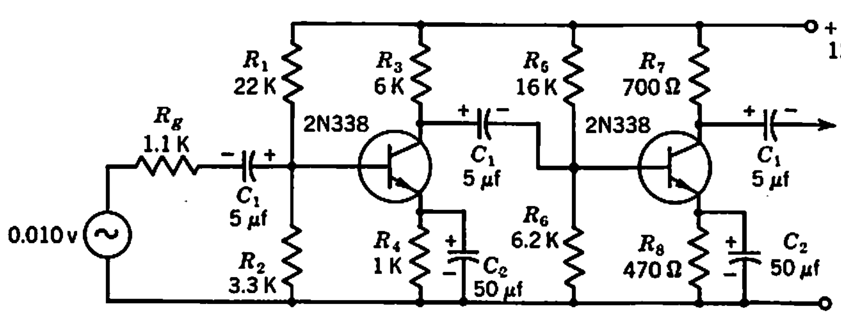


12-W TRANSFORMERLESS AMPLIFIER—Uses two transistors in parallel for each of the outputs, to cut saturation resistance in half and thereby increase power output. Parallel operation also serves to reduce distortion. Operating efficiency is 67% at 12 w.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 267.

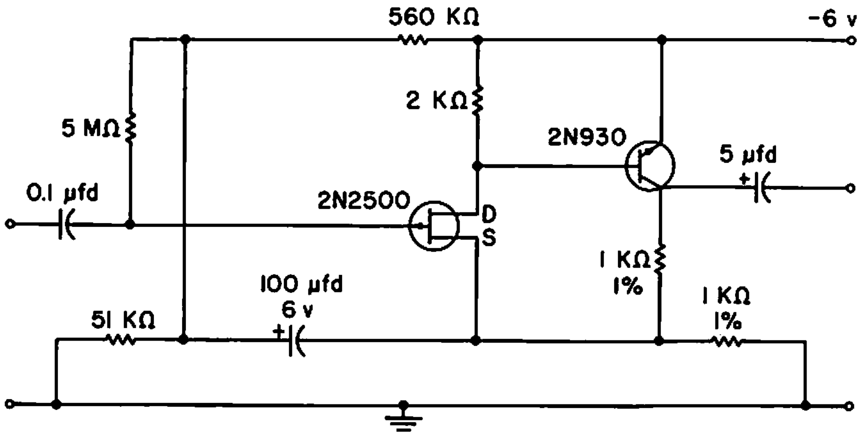


R1-VOLUME CONTROL 1 MEG AUDIO TAPER
R2-TONE CONTROL 25K LINEAR TAPER
T1-DRIVER TRANSFORMER PRI. 20K/SEC 2K CT
T2-OUTPUT TRANSFORMER PRI. 300Ω CT/SEC V.C.

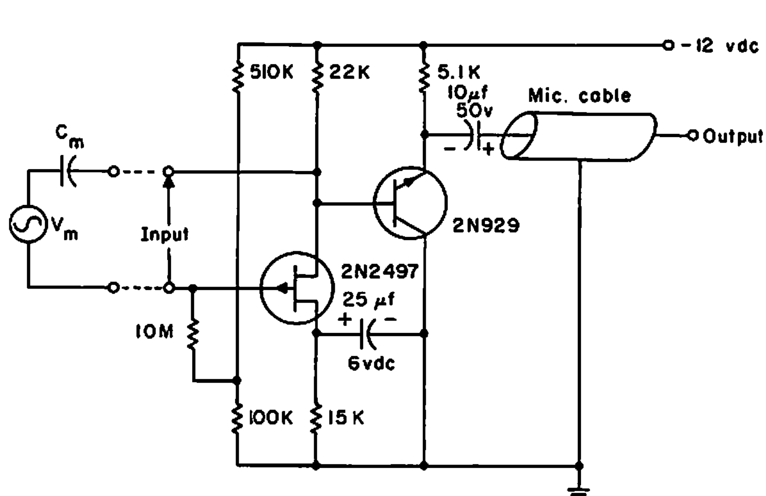
12-V AUDIO AMPLIFIER—Input sensitivity is 10 to 20 mv for 0.5 w output. Maximum power output at 10% harmonic distortion is 500 mw. Design calculations are given.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 246.



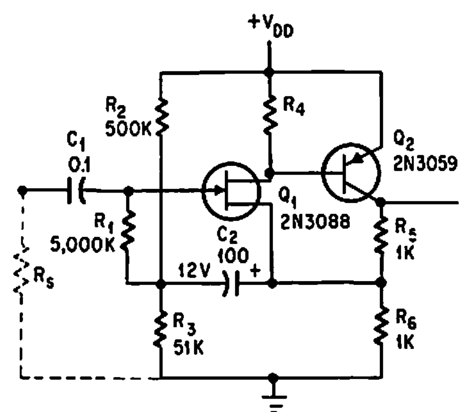
TWO-STAGE CASCADED COMMON-EMITTER—Design procedure is given for low-level amplifier that is one of the most-used circuits in all transistor applications, for boosting millivolt-range signals to workable level of several volts. Capacitance coupling is used for a-c operation along with d-c stability. Total power gain is 64 db. Voltage gain is 1,000. —Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 198.



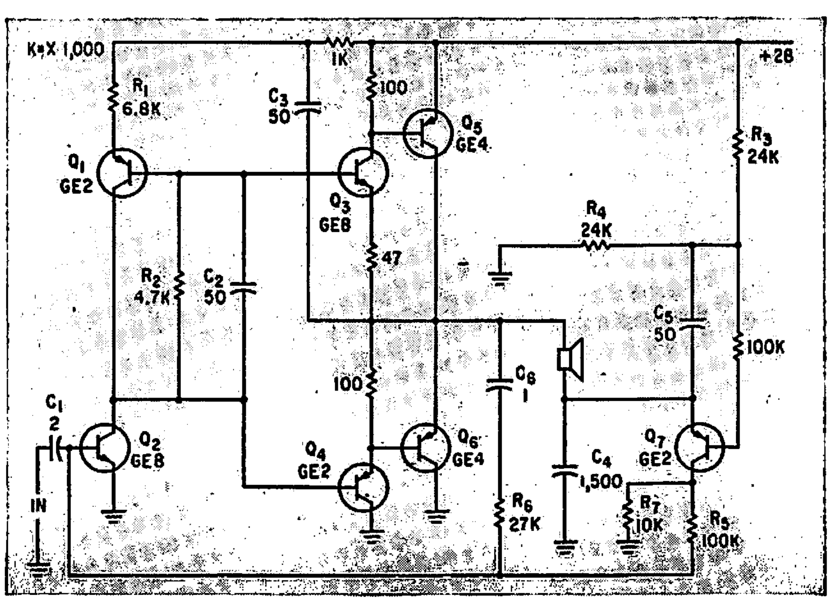
FET-PNP DARLINGTON—P-channel fet is combined with pnp transistor in equivalent to Darlington connection, for use with high-input-impedance low-frequency transducers. Spot noise figure is 7 db at 10 cps and 3 db at 100 cps. Broadband noise figure from 10 cps to 10 kc is 1.7 db with 200K generator resistance.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 136.



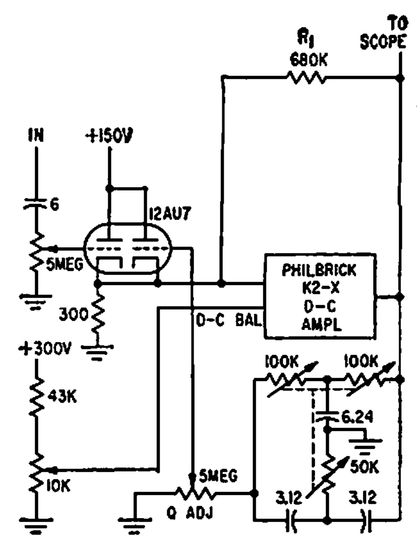
CAPACITOR MIKE PREAMP—Fet provides required high input impedance. Can easily be mounted in microphone. Emitter-follower with output impedance of about 100 ohms will drive 500 feet of microphone cable without appreciably affecting frequency response.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 75.



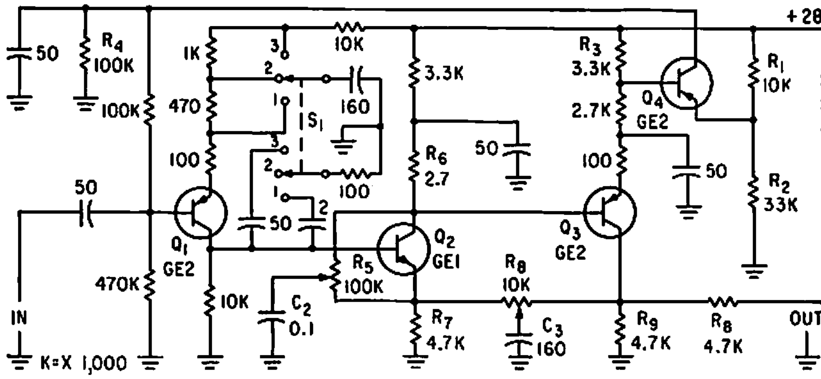
BOOTSTRAP FET—Input impedance is high at low frequencies (180 meg at 10 cps), but drops to 3 meg at 10 kc. High collector current contributes to high over-all noise level.—B. Smith, Low-Noise FETs Sound Good To Circuit Designers, *Electronics*, 37:31, p 58–62.



10-W POWER AMPLIFIER—Q1 provides bias current for low-power complementary-symmetry push-pull output stage Q3-Q4, which drives power transistors Q5-Q6. Q7 provides voltage bias for Q2.—H. W. Parmer, Two Easy Ways to Stabilize Power-Transistor Hi-fi Amplifiers, *Electronics*, 35:43, p 56–58.

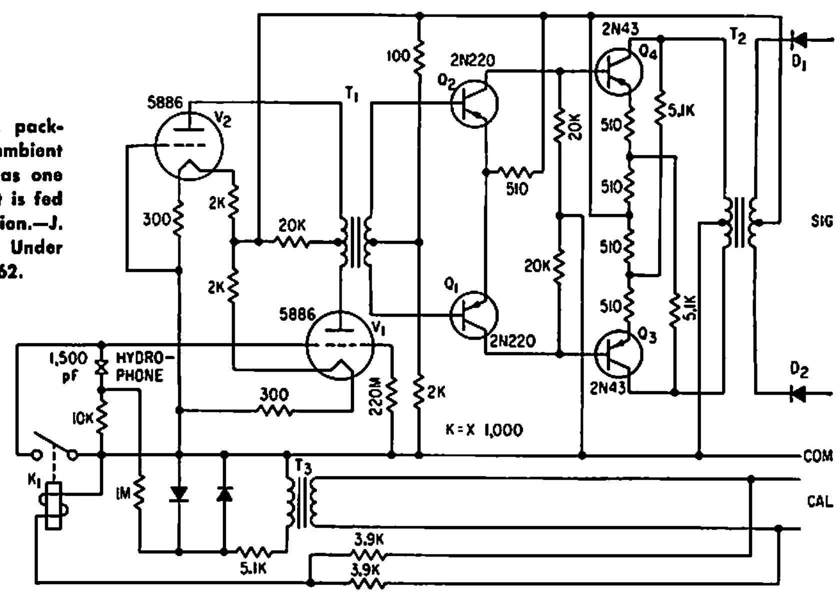


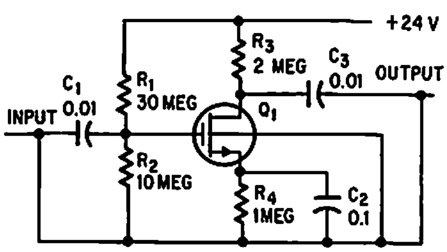
TUNABLE SUBAUDIO AMPLIFIER—Commercial d-c amplifier with twin-T feedback tuning element tunes from 0.5 to 100 cps, for analyzing low-frequency components of complex waveforms.—J. M. Reece, Subaudio Tunable Amplifier, *Electronics*, 32:45, p 72–74.



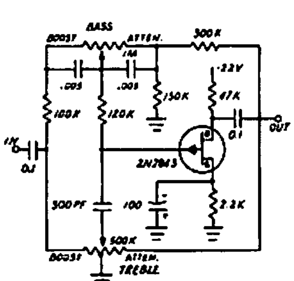
STABILIZED MULTI-INPUT AUDIO PREAMP—Switch gives choice of input impedance, frequency response, and level-compensation networks. R5 is tone control. Q4 provides bias current to base of Q1 for stabilization.—H. W. Parmer, Two Easy Ways to Stabilize Power-Transistor Hi-fi Amplifiers, *Electronics*, 35:43, p 56–58.

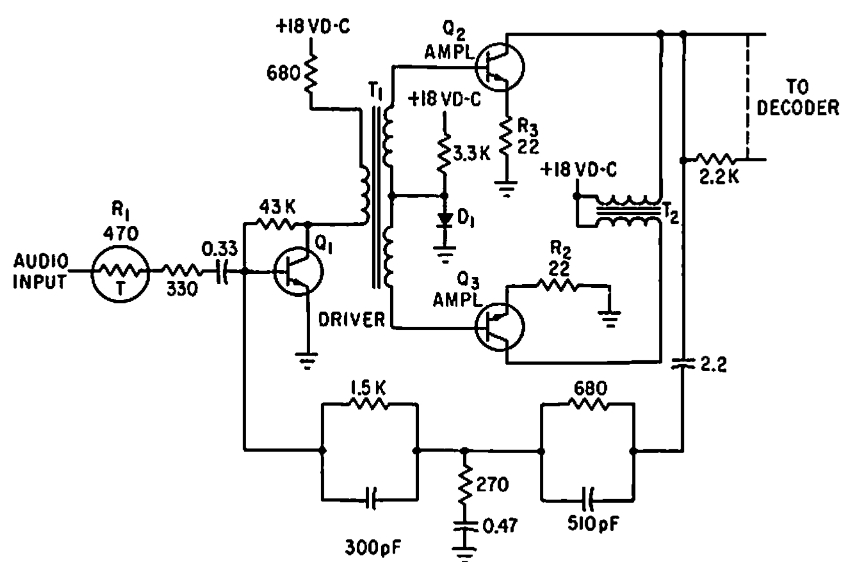
UNDERWATER PREAMPLIFIER—Used in package with hydrophone for measuring ambient ocean noise over periods of months, as one basis for sonar system design. Output is fed through cable pair to shore installation.—J. V. Schaefer, Remote Preamplifiers for Under Ocean Work, *Electronics*, 33:28, p 60–62.





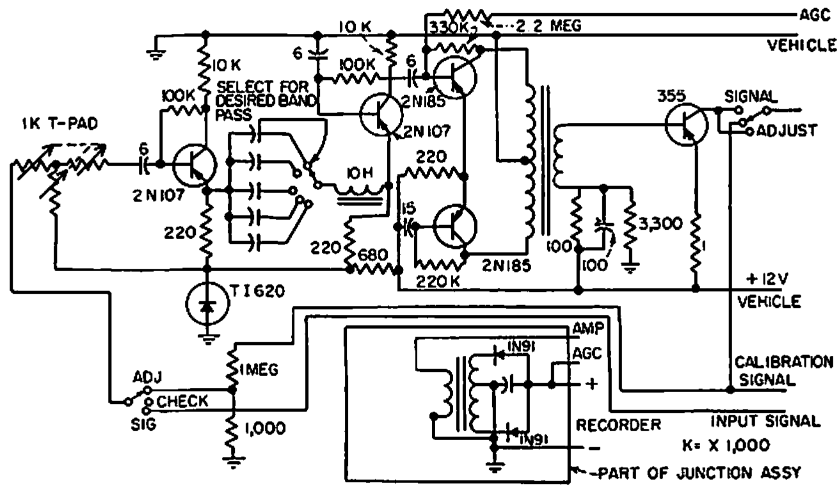
MOS FET AMPLIFIER—Circuit draws only 6 microamp while providing voltage gain over 200.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



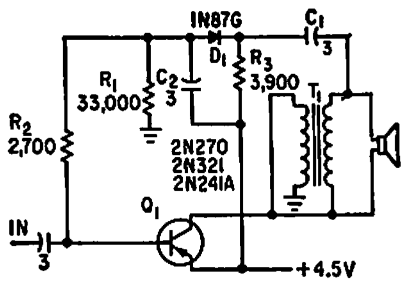


TONE CONTROL—Unlike bipolar transistor, fet maintains full dynamic range while loading R-C tone control network.—FET's and RC Networks (Siliconix ad), *Electronics*, 39:4, p 71.

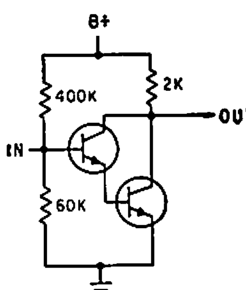
CLASS-AB PUSH-PULL AUDIO—Sensistor R1 in a-c coupled driver compensates for effects of temperature on amplifier gain. Negative feedback stabilizes frequency and phase response. Circuit drives 20 decoders in Mercury spacecraft command receiver.—R. Elliott, First Details on Mercury Spacecraft Command Receiver, *Electronics*, 36:5, p 32–35.



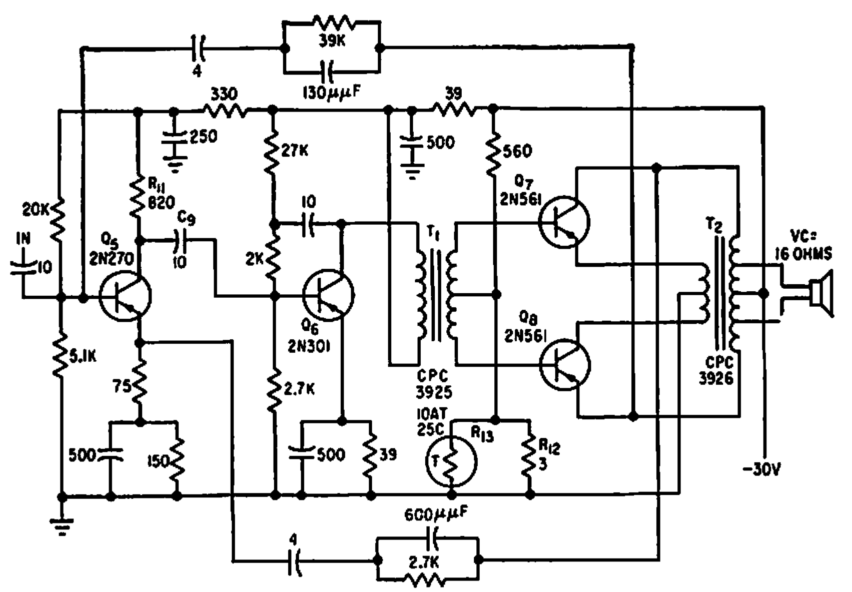
100-350 CPS RECEIVER—Input signal from electrodes of crevasse detector is attenuated to suitable level at constant impedance of 1,000 ohms by T-pad and passed to 2N107 preamplifier whose supply voltage is stabilized at 5.8 v by reversed TI620 silicon diode shunt operating at zener point. Signal is then fed through bandpass L-C filter to amplifier, driver, and final 355 class A stage that drives recorder pen motor and relaymeter.—H. P. Van Eckhardt, Crevasse Detector Blazes Glacial Trails, *Electronics*, 31:3, p 63–65.



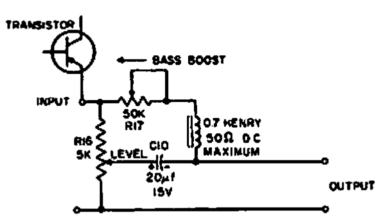
SYNTHETIC PUSH-PULL—Single transistor in sliding class-A output requires no input transformer, while approximating push-pull class-B output stage.—J. A. Worcester, One-Transistor "Push-Pull," *Electronics*, 32:24, p 74.



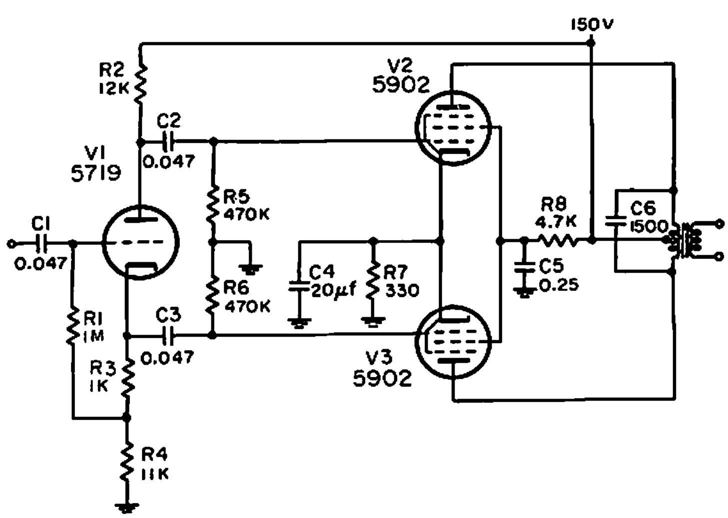
DARLINGTON AMPLIFIER—Useful up to 100 kc, but high input impedance makes it particularly desirable for audio preamps. Gives gain of two stages with dissipation of only one.—L. Pollock and R. Gutteridge, Latest Design Techniques for Linear Microcircuits, *Electronics*, 35:41, p 47–49.



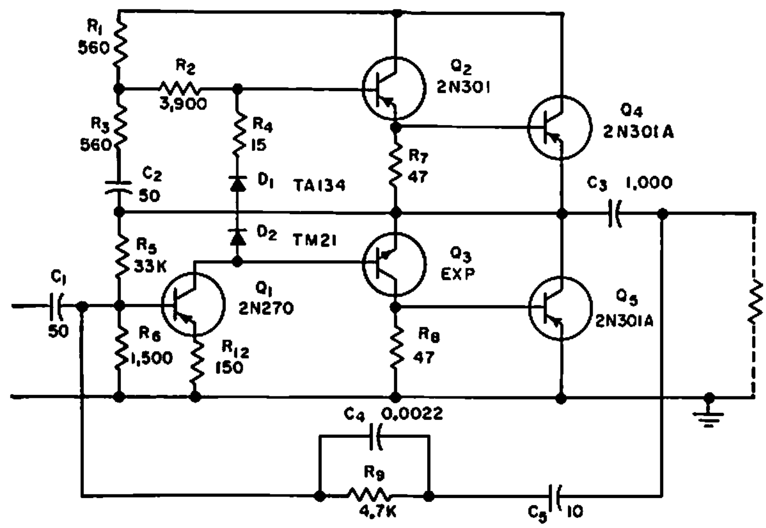
25-W CLASS-B POWER AMPLIFIER—Uses balanced negative feedback, with input Q5 and driver Q6 operating class A. Output stage is temperature-stabilized.—R. Minton, Designing High-Quality A-F Transistor Amplifiers, *Electronics*, 32:24, p 60–61.



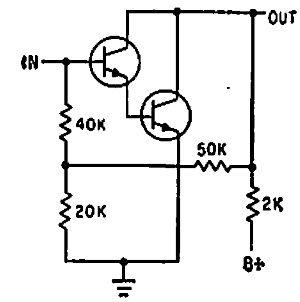
BASS BOOST OR LOUDNESS CONTROL—Operates on output of preamp. Gives operator independent control of level of bass or amount of bass boost desired. May also be used as loudness control.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 254.



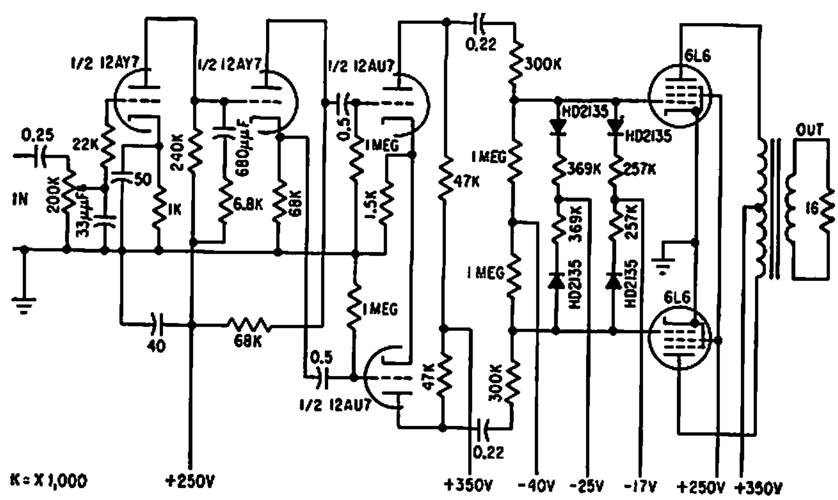
PREFERRED AUDIO POWER AMPLIFIER—Delivers 2 w with less than 5% distortion to suitably matched load. If push-pull tubes are dynamically matched, screen and cathode bypass capacitors C4 and C5 may be omitted. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 64, p 64–2.



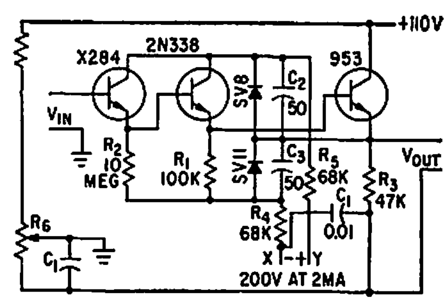
45-W A-F OUTPUT—Operates with convection cooling over temperature range of −10 to +50°C. Forward voltage drop of diodes decreases with increasing temperature, to hold emitter currents essentially constant. Uses quasicomplementary symmetry.—M. B. Herscher, Designing Transistor A-F Power Amplifiers, *Electronics*, 31:15, p 96–99.



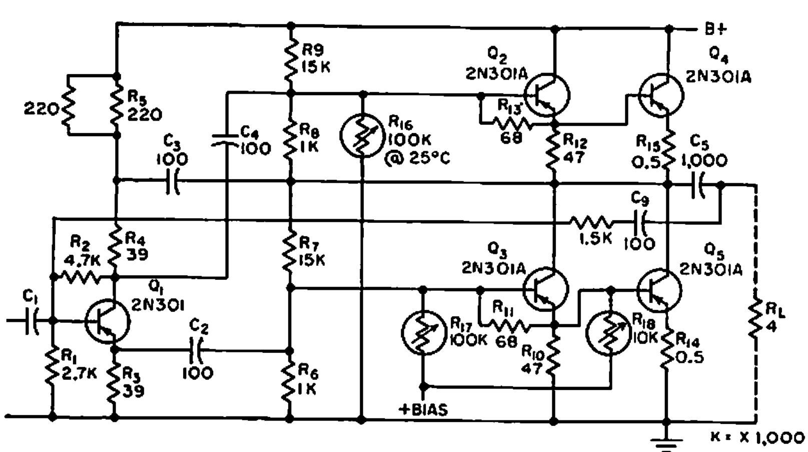
DARLINGTON WITH VOLTAGE DIVIDER—Additional resistors in voltage divider reduce bias voltage, to simplify manufacture as integrated circuit. Useful up to 100 kc.—L. Pollock and R. Gutteridge, Latest Design Techniques for Linear Microcircuits, *Electronics*, 35:41, p 47–49.



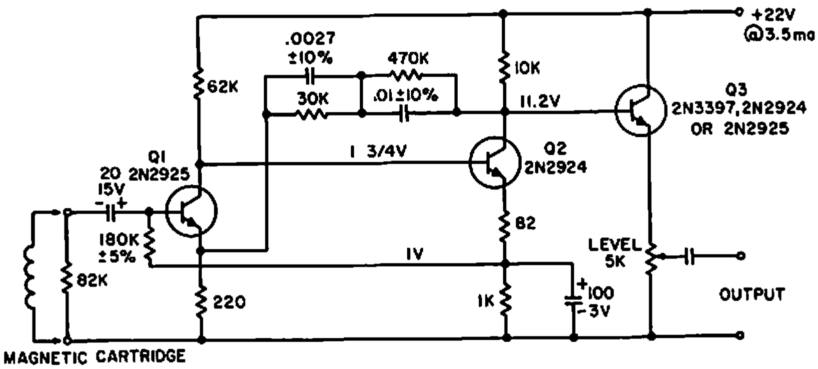
REDUCING ODD-HARMONIC DISTORTION—Grid-plate transfer characteristic of class-B amplifier is linearized to eliminate harsh odd-harmonic distortion, through use of compensation network having nonlinear transfer function. Distortion is cut to 2.6% at 16 w output.—B. Sklar, Reducing Distortion in Class-B Amplifiers, *Electronics*, 32:21, p 54–56.



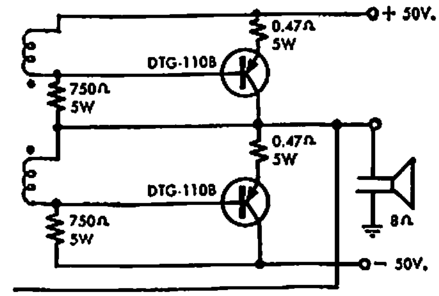
500-MEG D-C INPUT RESISTANCE—Bootstrap-collector circuit uses starved transistor to provide 500-meg d-c input resistance with 100-v input signal. A-c resistance is even higher, in the 1,000-megohm region at low audio frequencies.—B. M. Bramson, Starved Transistors Raise D-C Input Resistance, *Electronics*, 32:5, p 54–55.



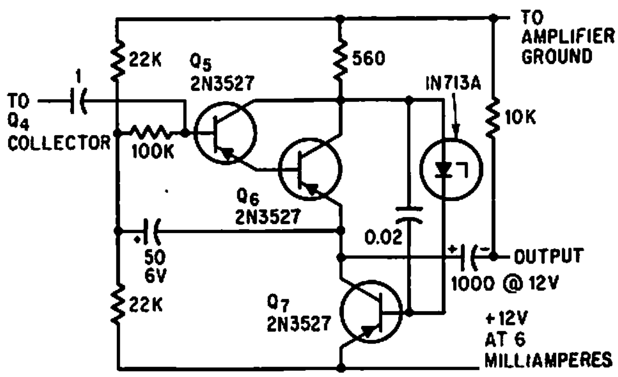
45-W SERIES-TYPE POWER AMPLIFIER—Uses split-load phase inverter, capacitance-coupled to common-collector class B driver, which in turn is direct-coupled to class-B common-emitter output stage. Driver and output stages are each in series for d-c collector supply. No transformers are required.—M. B. Herscher, Designing Transistor A-F Power Amplifiers, *Electronics*, 31:15, p 96–99.



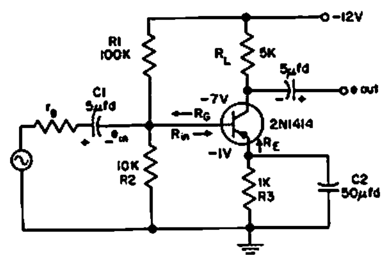
NPN PHONO PREAMP—Input of 6 mv at 1 kc from magnetic cartridge gives 1 v output, which is 15 db below clipping level and 72 db above unweighted noise level. RIAA equalized output is within 1 db from 40 cps to 12 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 257.



50-W TWO-STAGE OUTPUT—Produces over 50-w rms audio power and has simple drive requirements.—High-Power Nu-Base Germanium Transistors (Delco Radio ad), *Electronics*, 39:7, p 20–21.



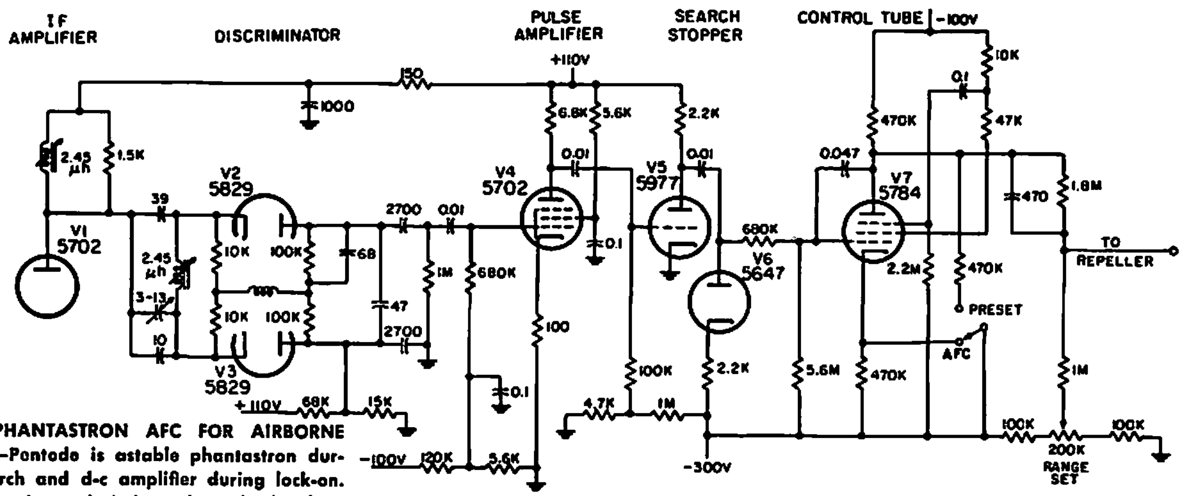
FET OUTPUT STAGE—Bootstrapped input, Darlington driver, and White follower give voltage gain of one, input impedance of 1 meg, and output impedance of 10 ohms.—B. Smith, Low-Noise FETs Sound Good To Circuit Designers, *Electronics*, 37:31, p 58–62.



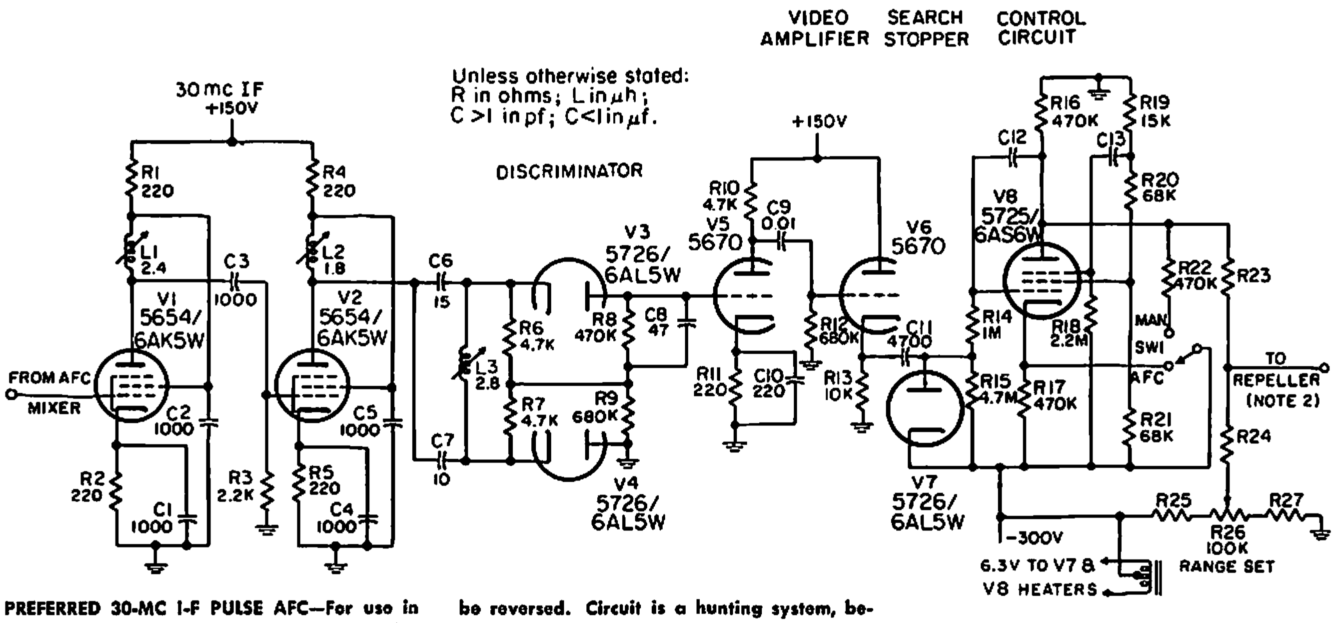
SINGLE-STAGE AUDIO AMPLIFIER—Design procedure is given for basic transistor stage.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 241.

CHAPTER 5

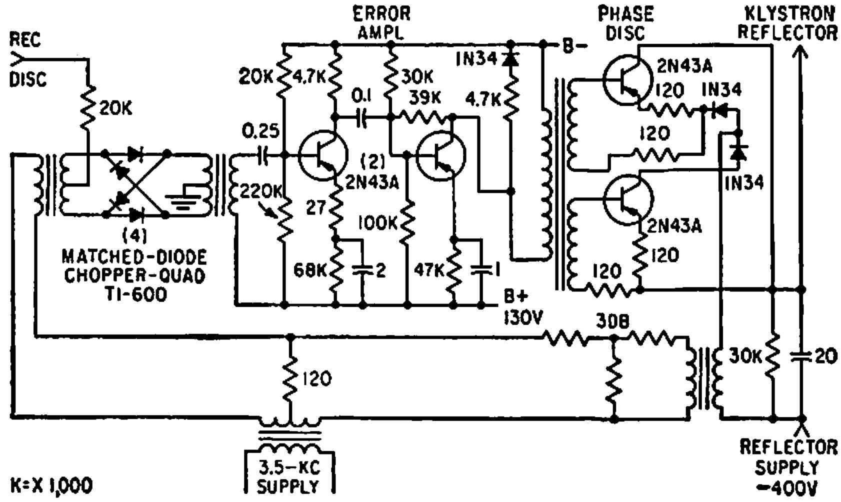
Automatic Frequency Control Circuits



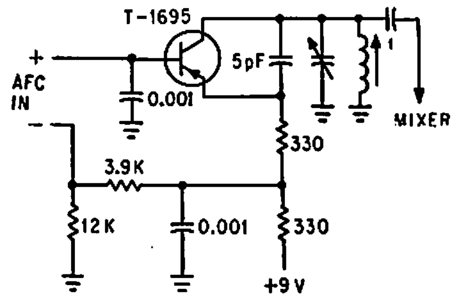
DIODE-PHANTASTRON AFC FOR AIRBORNE RADAR—Pentode is astable phantastron during search and d-c amplifier during lock-on. Operation is nearly independent of tube characteristics. Provides tight control of local oscillator frequency because during lock-on, pentode furnishes direct control of klystron repeller.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N13-6.



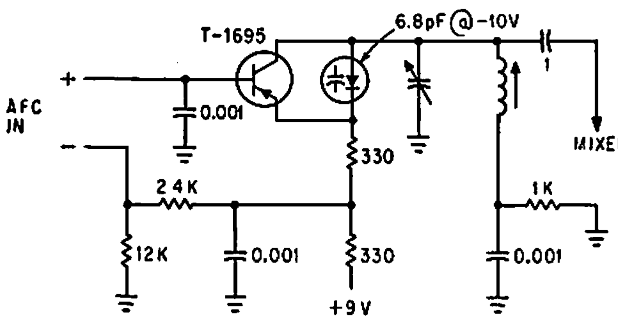
PREFERRED 30-MC I-F PULSE AFC—For use in pulse-modulated systems, to maintain a difference of 30 Mc between transmitter and local oscillator frequencies. If local oscillator is required to operate 30 Mc below transmitter, discriminator diodes V3 and V4 should be reversed. Circuit is a hunting system, because local oscillator is swept over band of frequencies to find correct operating point. During search, phantastron V8 acts as sawtooth generator to provide sweep voltage for control element of local oscillator (repeller of klystron).—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 53, p 53-2.



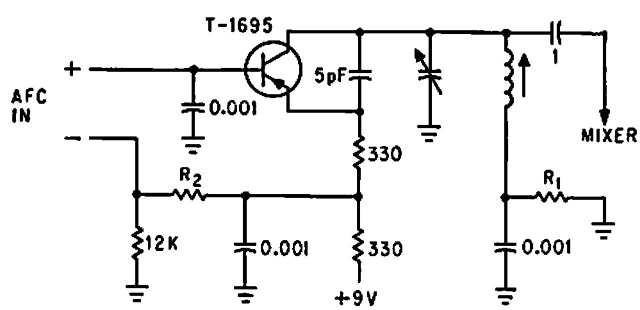
MICROWAVE KLYSTRON AFC—Uses signal from discriminator of 6,000-Mc microwave receiver to stabilize frequency of local-oscillator klystron. Balanced silicon-diode input chopper lattice is excited at 3.5 kc, but only error signal from discriminator will unbalance network and pass 3.5 kc on to error amplifier.—M. C. Harp, Nonvacuum Devices Control Klystrons, *Electronics*, 32:7, p 68–70.



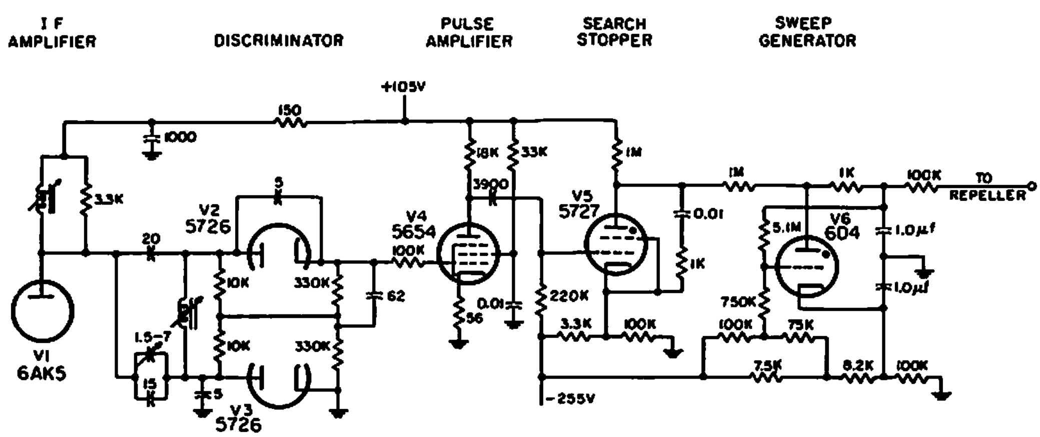
EMITTER-CURRENT-CONTROL 40-MC AFC OSCILLATOR—Error signal, usually derived from external discriminator, is applied in series with base bias network to give sensitivity of about 1.5 Mc per v and nearly straight voltage-frequency characteristic.—T. P. Prouty, Using Varactors to Extend Frequency-Control Range, *Electronics*, 36:45, p 48–49.



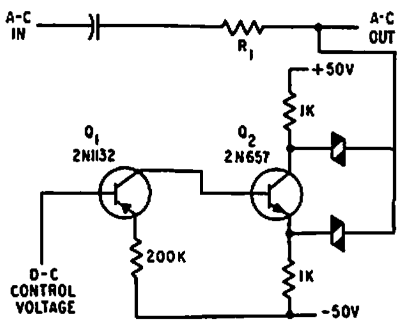
VARACTOR-CONTROLLED 40-MC OSCILLATOR—Oscillator transistor also acts as a d-c amplifier between afc input and varactor diode to give electronic tuning over range of 11 Mc with sensitivity of 5.8 Mc per v.—T. P. Prouty, Using Varactors to Extend Frequency-Control Range, *Electronics*, 36:45, p 48–49.



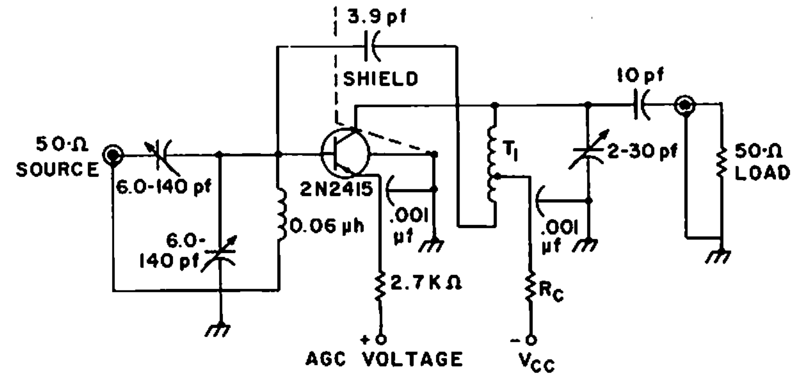
COLLECTOR-VOLTAGE-CONTROL AFC OSCILLATOR—Afc input signal acts through series resistor to vary collector voltage of 40-Mc oscillator. Sensitivity is 2.5 Mc per v. Bias network adjustment is critical.—T. P. Prouty, Using Varactors to Extend Frequency-Control Range, *Electronics*, 36:45, p 48–49.



THYRATRON AFC FOR AIRBORNE RADAR—Uses Weiss discriminator, which for large bandwidths is easier to adjust than Foster-Seeley, and requires no special i-f transformer. Employs two thyratrons to generate required control voltage for repeller of klystron.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N13-4.



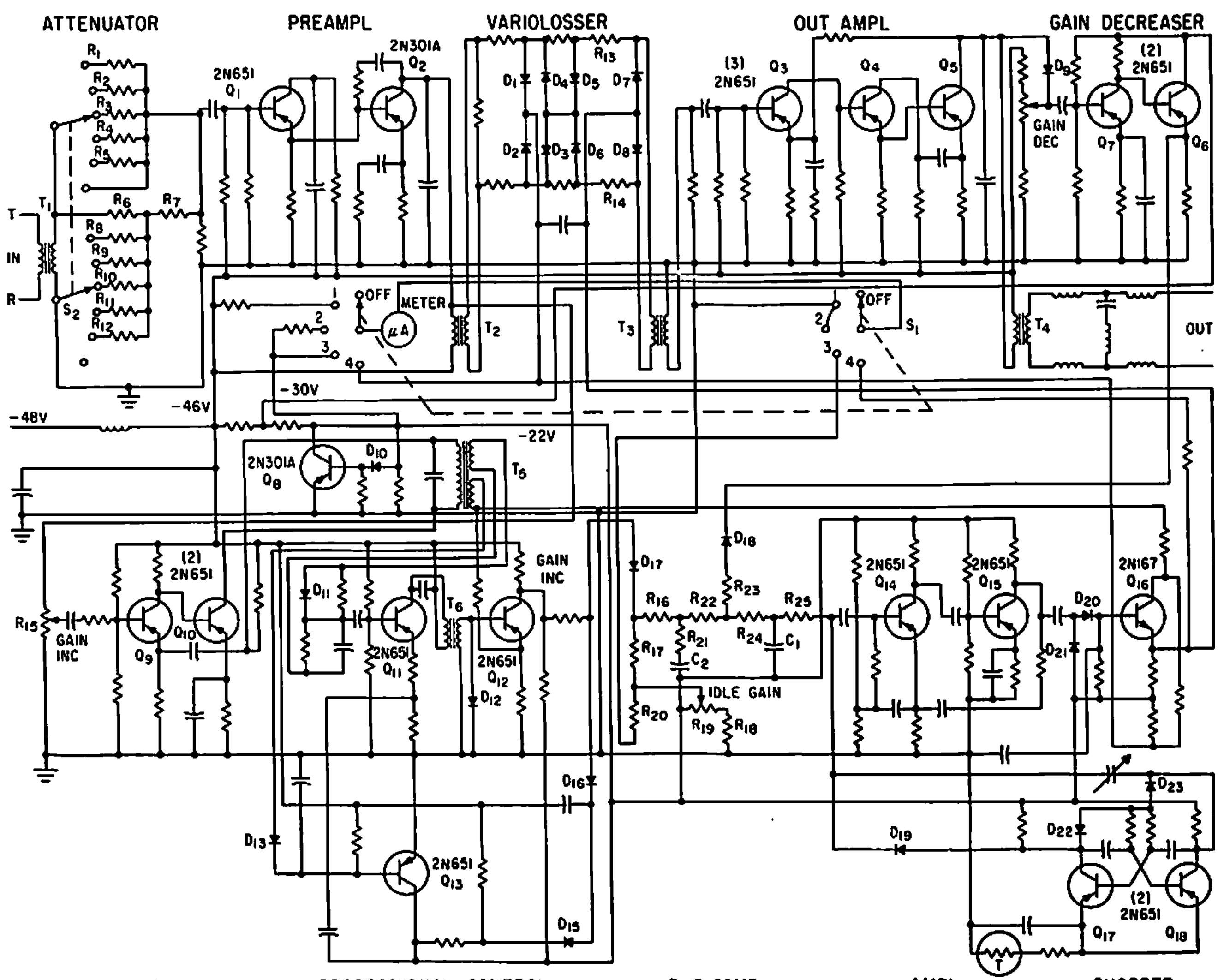
VOLTAGE-CONTROLLED GAIN—Response of two-transistor a-c amplifier, controlled by d-c voltage, can be made linear by adding suitable feedback. With no d-c control voltage on base of Q1, both transistors are saturated, and effective shunt resistance of circuit is about 500,000 ohms. When d-c control voltage is increased positively until Q1 is cut off, effective shunt resistance drops to 200,000 ohms.—L. C. Bowers, Attenuator Controls Amplifier Gain, *Electronics*, 34:39, p 150–153.



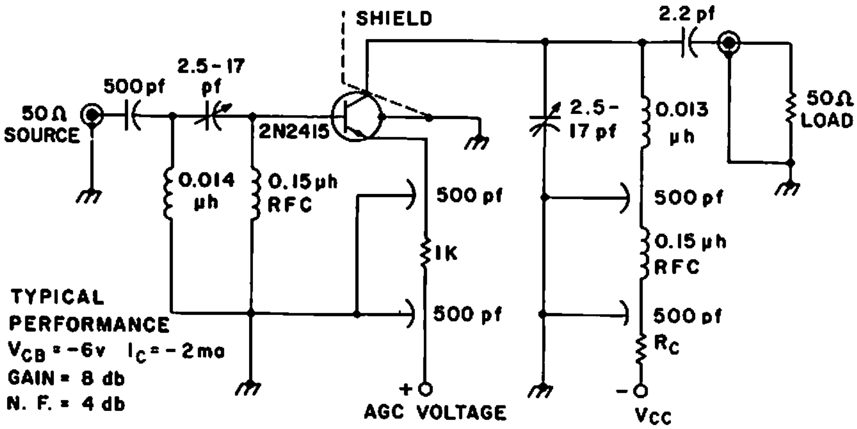
TYPICAL PERFORMANCE
$V_{CB} = -6$ v $I_C = -2$ ma
GAIN = 27 db
N.F. < 3 db

T_1 – 5t AIR DUX #516 TAPPED 4t FROM THE COLLECTOR

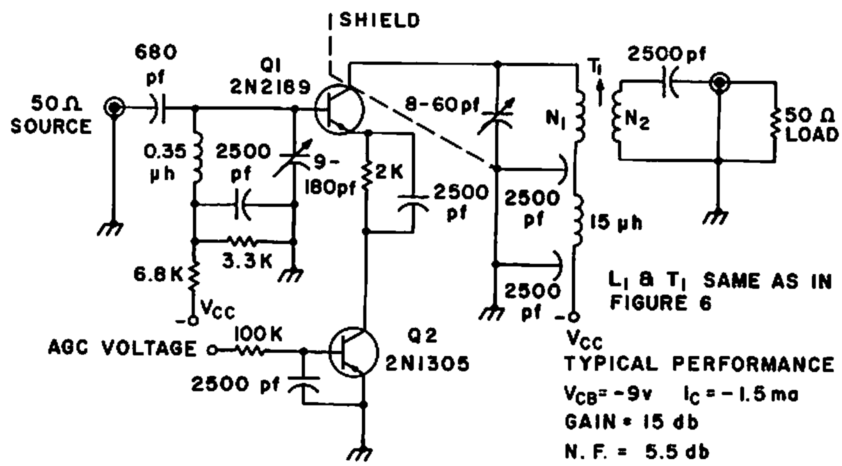
70-MC NEUTRALIZED GAIN-CONTROLLED AMPLIFIER—Gain is 27 db, with typical noise figure below 3 db. RC for reverse gain control is 0 ohms, and for forward gain control is 1,000 ohms. Reverse control range is 35 db, and forward gain control is 47 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 215.



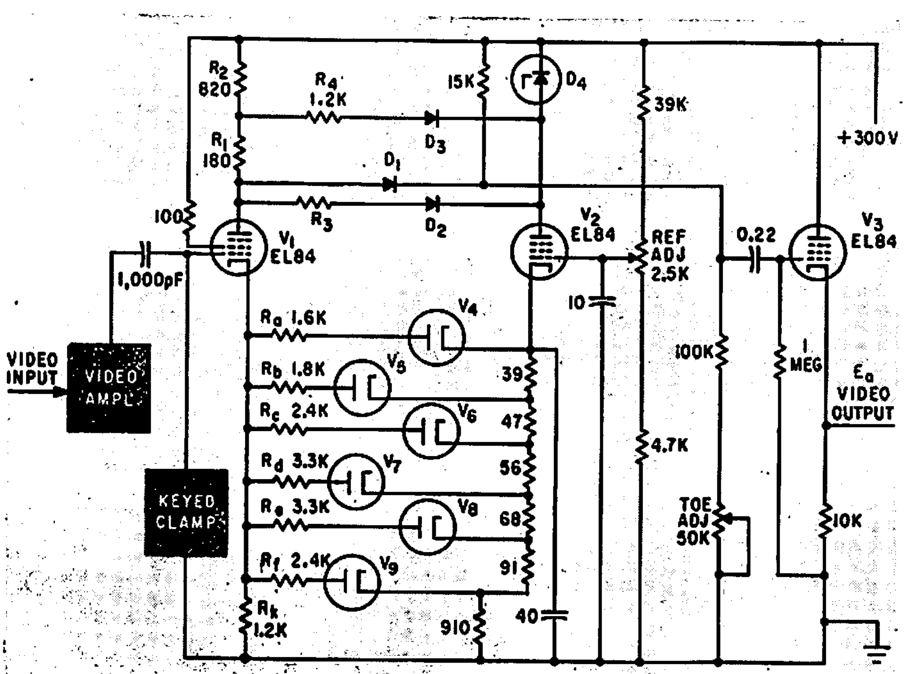
AUDIO AGC FOR 40-DB RANGE—Automatic gain-adjusting amplifier produces constant output for speech level variations up to 40 db. Intelligibility of speech is ensured by allowing instantaneous peaks to remain.—L. E. Getgen, Amplifier Compensates for Speech-Level Variations, *Electronics*, 33:31, p 103–106.



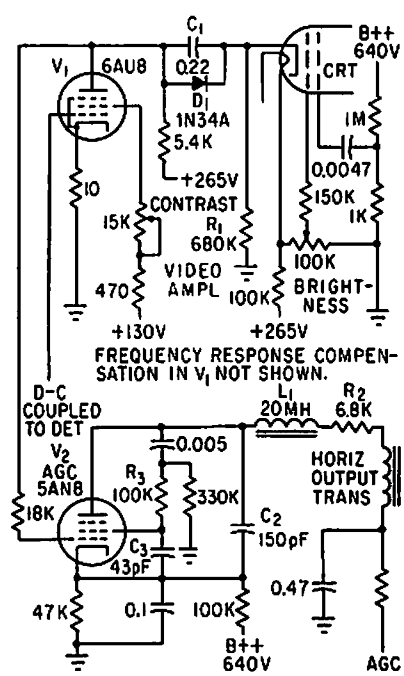
450-MC GAIN-CONTROLLED STAGE—Has gain of 8 db with typical noise figure of 4 db. Reverse gain control is 21 db for collector current of 20 microamp, and forward gain control is 26 db at 7 ma collector current.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 220.



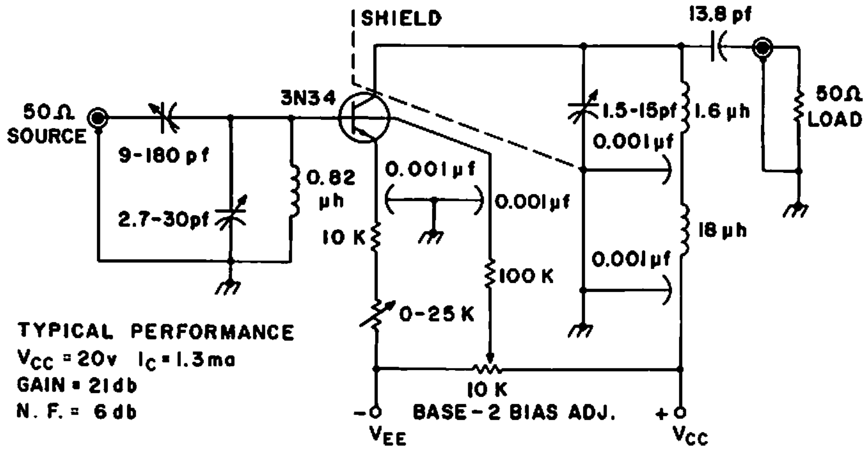
30-MC HYBRID GAIN CONTROL—Q2 acts as variable impedance to give emitter degeneration, which is a form of external gain control. Q2 also controls collector current of Q1 to give reverse gain control action, which is internal gain control. Gain control range is 33 db, with 2:1 change in bandwidth.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 222.



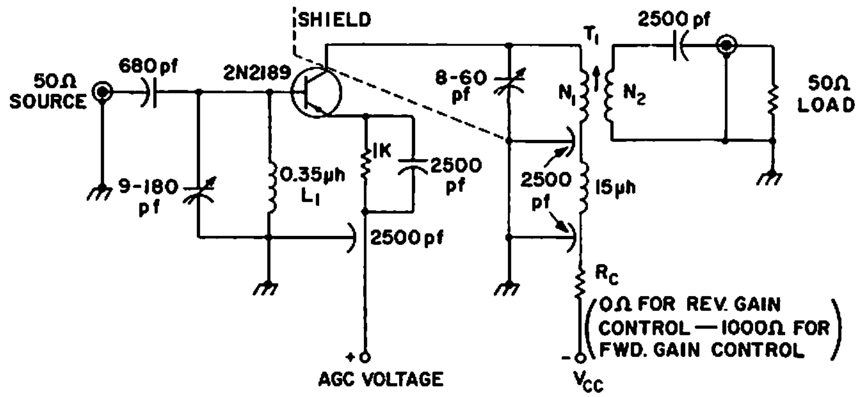
SIGNAL LEVEL CONTROLS GAIN—Amplifier is used with nonlinear circuit elements to get D-versus-log E characteristic approximating that of positive color film being scanned. When no signal is applied to grid of V1, all diodes in its cathode circuits are conducting, equivalent cathode resistance is lowest, and stage gain is highest. As signal level increases, diodes V4 through V9 successively stop conducting, with V9 turning off last to make stage gain a minimum.—R. M. Farber and K. M. St. John, Scanner Analyzes Color Content of Movie Film, *Electronics*, 34:48, p 38–41.



BACK-PORCH KEYED AGC—Composite of d-c coupling for dark scenes and a-c coupling for bright scenes, with agc referenced to back-porch (blanking level) rather than to sync tips, approaches ideal compromise for automatic control of tv picture.—L. Solomon, New Tubes and Circuits for Consumer Electronics, *Electronics*, 36:2, p 47–49.



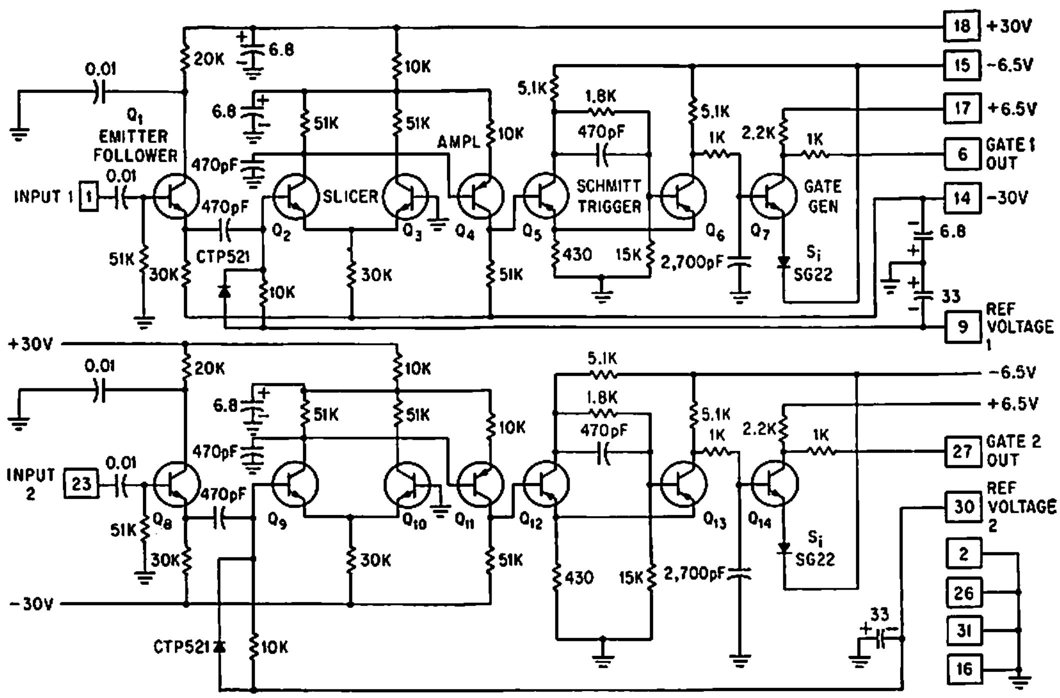
30-MC GAIN-CONTROLLED TETRODE—Collector voltage and current are kept constant and gain is changed in accordance with base-2 current. Gain is 21 db, and typical noise figure is 60 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 213.



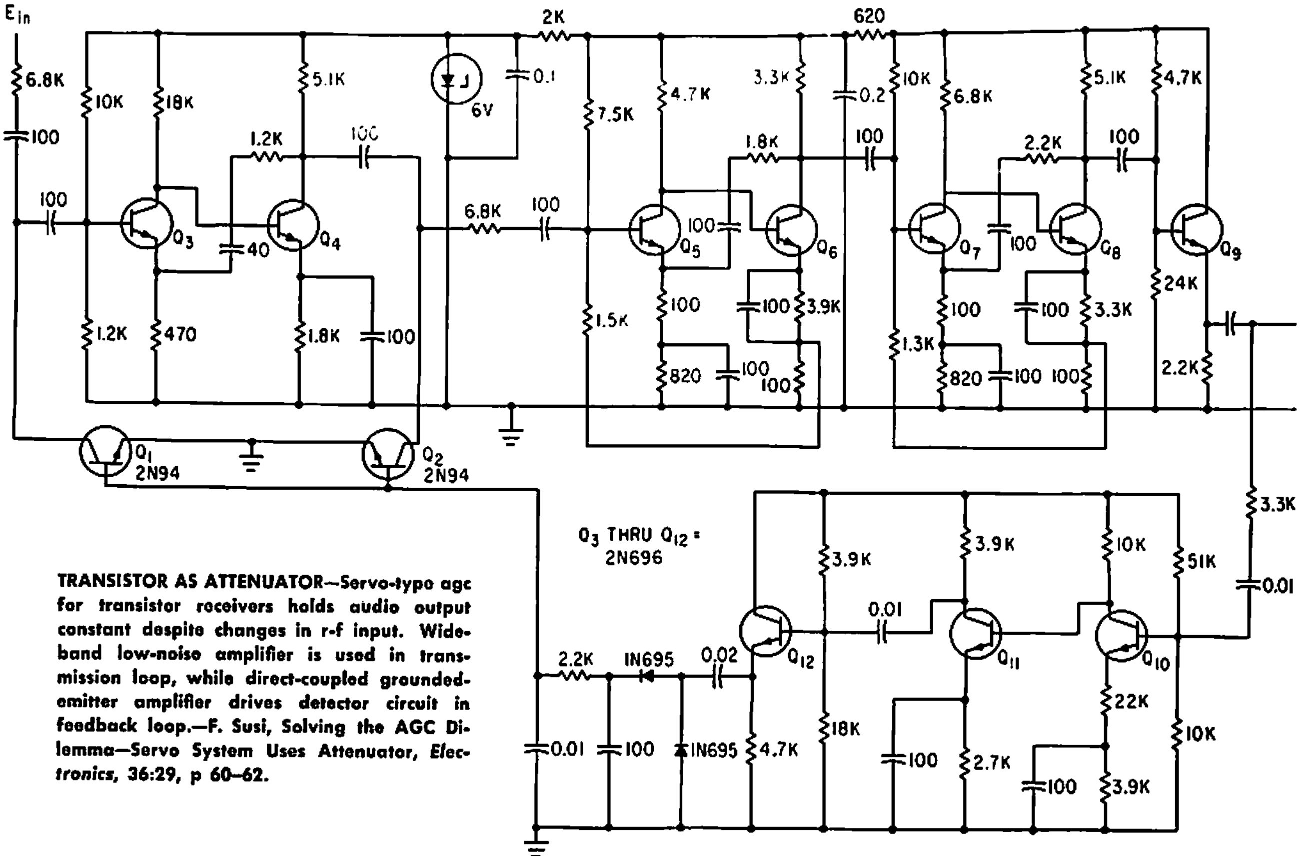
T_1 - N_1 = 10t #30 WIRE
N_2 = 3t #30 WIRE
BIFILAR WOUND ON
CTC# PLS62C4L/20063D
COIL FORM

L_1 - 6t AIR DUX# 408

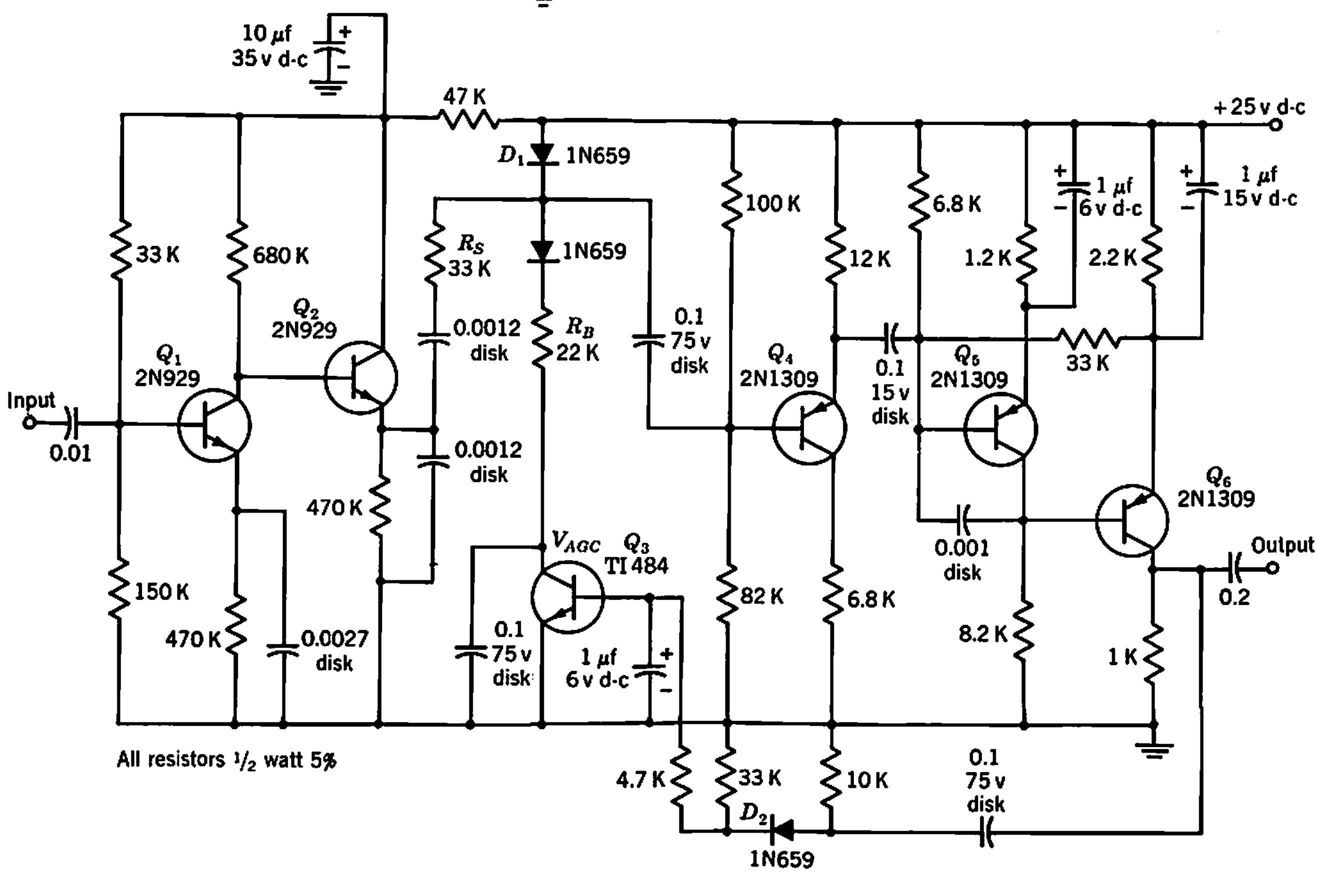
30-MC GAIN-CONTROLLED STAGE—Gain is 15 db. Typical noise figure is 5 db. Reverse gain control range is 25 db from collector current of 1.5 ma to 20 microamp. Provides 20 db of forward gain control.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 211.



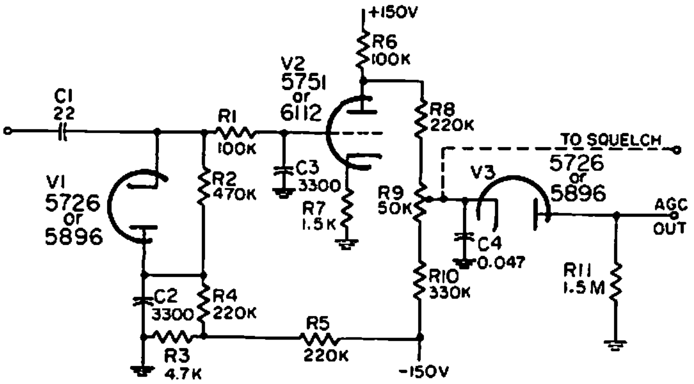
SLICER AND GATE FOR AGC—When peak-to-peak value of input signal exceeds preset reference voltage, slicer Q2 conducts, making Q4 apply amplified signal to Schmitt trigger for squaring. Q7 then delivers output gate that changes fixed-gain amplifier to unity gain to give effect of fast agc for monopulse radar amplifier.—W. W. Smith, Fast AGC Amplifier Locks Monopulse Radar on Target, *Electronics*, 36:39, p 34–36.



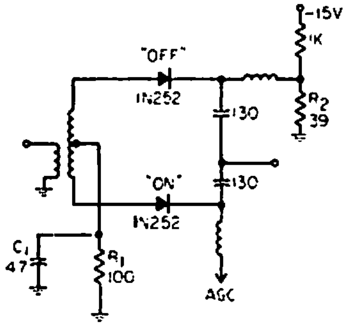
TRANSISTOR AS ATTENUATOR—Servo-type agc for transistor receivers holds audio output constant despite changes in r-f input. Wideband low-noise amplifier is used in transmission loop, while direct-coupled grounded-emitter amplifier drives detector circuit in feedback loop.—F. Susi, Solving the AGC Dilemma—Servo System Uses Attenuator, *Electronics*, 36:29, p 60–62.



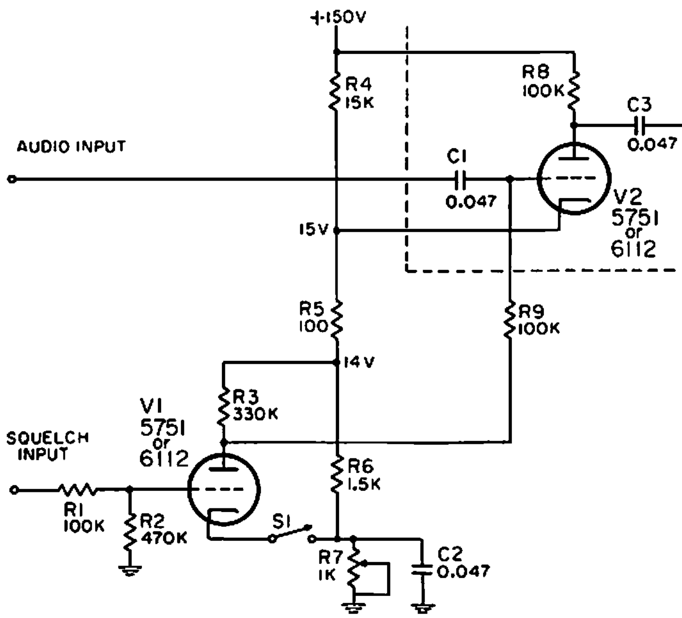
LOW-NOISE LOW-LEVEL AUDIO AGC—Q1 and Q2 are active amplifier elements. Agc range is 60 db, maximum output signal is 1 v, and maximum input signal is 2 mv. Noise figure is 6 db. Agc circuit here uses shunting diode D1.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 179.



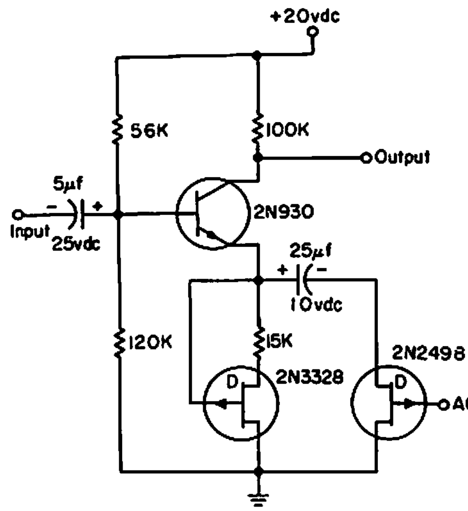
PREFERRED AGC AND SQUELCH CONTROL—Furnishes bias voltage for r-f and i-f stages of receiver, to minimize changes in output volume as input signal fades or as receiver is tuned to station having different signal strength. Additional output controls squelch tube that suppresses background noise in absence of input signal. Maximum i-f input is 7 v rms. Maximum d-c output level is −27 v for miniature tube and −35 v for subminiature.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 63, p 63–2.



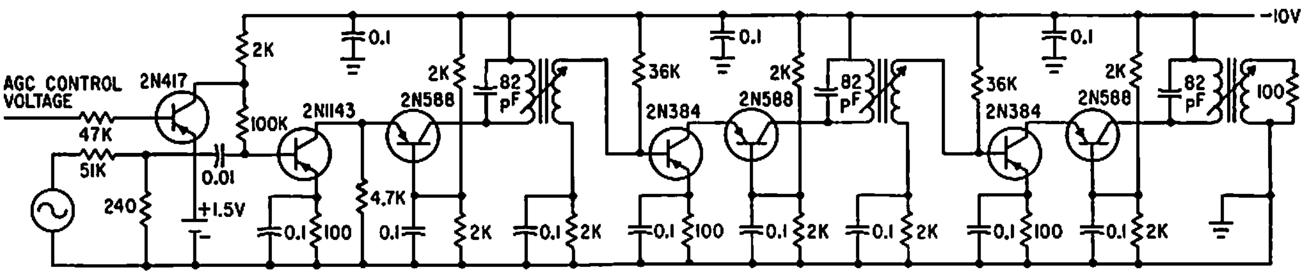
BRIDGE WITH AGC FOR ON DIODE—Input signal is applied in push-pull to two diodes, then combined by two capacitors. Reduction of agc bias increases attenuation of signal by bridge.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.



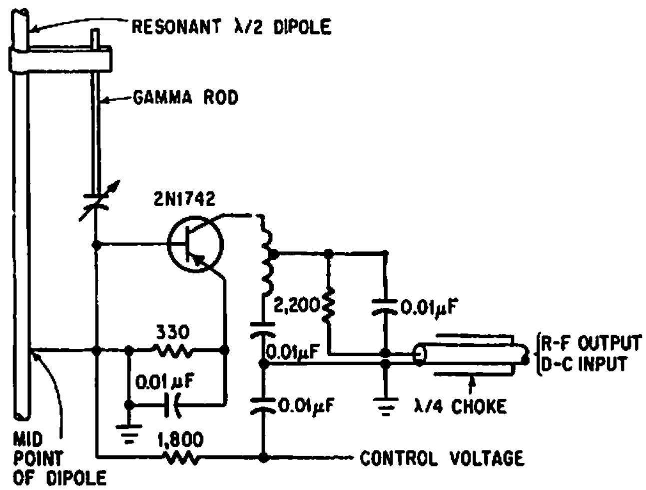
PREFERRED SQUELCH—Used in sensitive receivers having agc, to suppress objectionable increase in noise output when no signal is present, as when receiving intermittent transmissions. Uses d-c amplifier that is added to grid circuit of first audio stage to bias it beyond cutoff and thereby silence it until usable signal arrives.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 64, p 64–2.



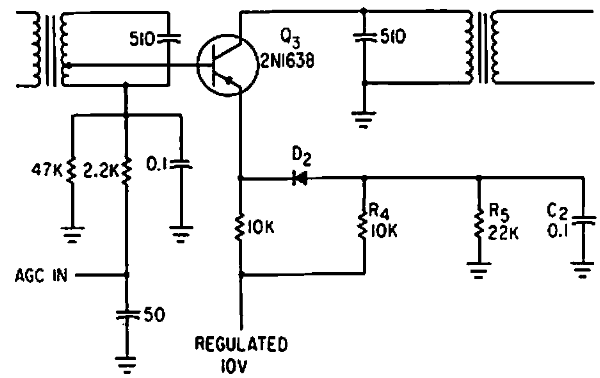
FET FOR AGC—Uses 2N2498 fet as variable-emitter resistor in common-emitter transistor amplifier. Low-current 2N3328 is used to supply constant emitter bias current and have very light dynamic loading on emitter for maximum agc range. Since variable resistor is capacitor-coupled to emitter of transistor, there is no change in bias current when strong agc voltage is suddenly applied. Absence of transient thump makes circuit desirable for broadcast speech compressors.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 78.



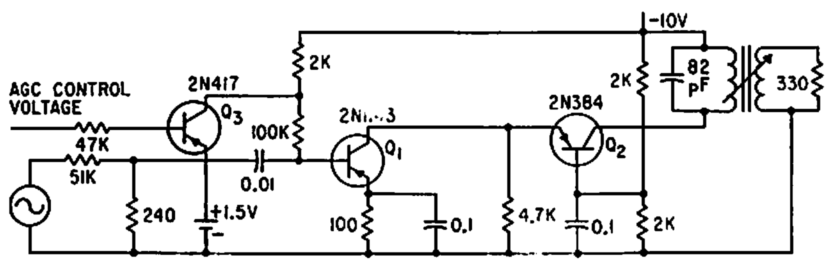
AGC FOR WIDE-BAND I-F—2N417 transistor is gain control element for 10-Mc tuned i-f amplifier using transistor cascode circuit. Bandwidth is 1.25 Mc and maximum gain is 91 db.—J. F. Perkins, Transistor Cascode Circuit Improves Automatic Gain Control in Amplifiers, *Electronics*, 34:22, p 49–51.



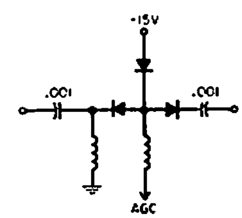
VARIABLE-GAIN ANTENNAFIER—Use of forward agc permits varying gain of amplifier mounted on dipole, as required for arrays.—J. F. Rippin, Making the Antenna an Active Partner, *Electronics*, 38:16, p 93–96.



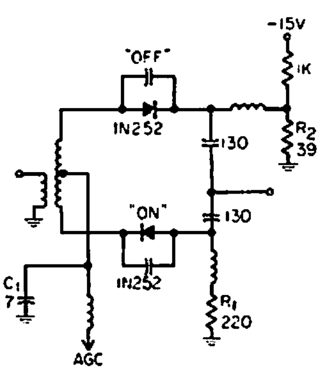
PREVENTING CLIPPING IN CONTROLLED STAGE—Agc bias controls negative current feedback in each controlled i-f stage. Diode D2 prevents clipping when forward bias falls below peak value of signal.—P. V. Sparks, Servo Filter and Gain Control Improve Automatic Direction Finder, *Electronics*, 34:23, p 110–113.



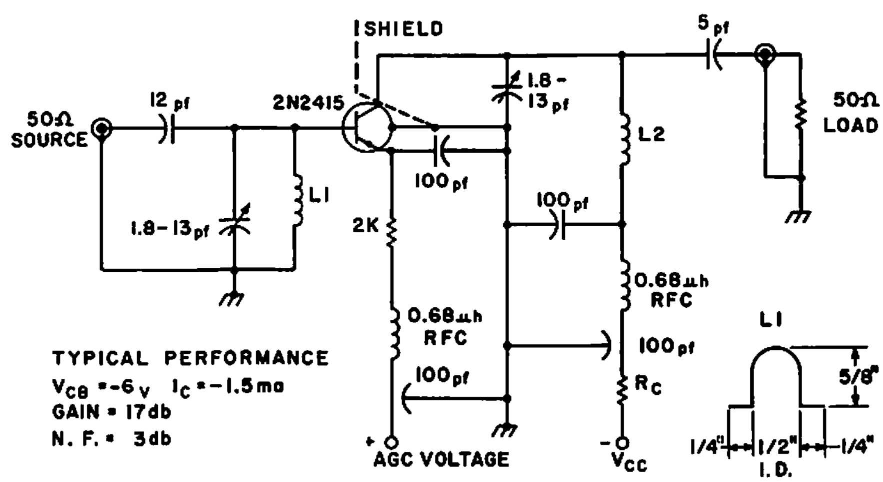
CASCODE I-F WITH AGC—Q3 is gain control element for cascode combination Q1-Q2 in 10-Mc i-f amplifier.—J. F. Perkins, Transistor Cascode Circuit Improves Automatic Gain Control in Amplifiers, *Electronics*, 34:22, p 49–51.



AGC WITH DIODE T-NETWORK VARICAP—Voltage-controlled capacitor circuit minimizes effect of shunt capacitance, thus reducing resonance peaks and preventing regeneration, but insertion loss is high (8 db).—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.

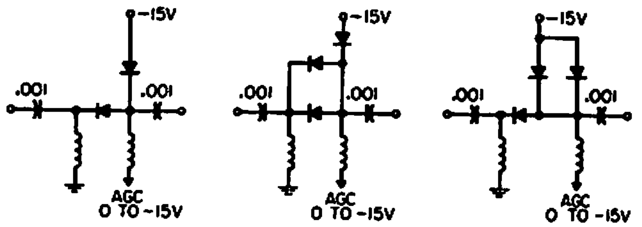


BRIDGE WITH AGC ON BOTH DIODES—Agc is applied to center tap of transformer, to turn one diode off while other is being turned on. Attenuation can be 40 db over bandwidth up to 250 Mc with agc bias of 0.5 to 3 v. Insertion loss is only a few db.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.

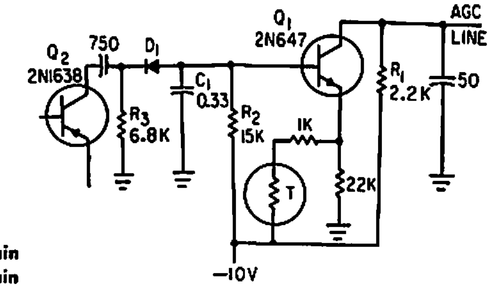


200-MC GAIN-CONTROLLED STAGE—Has gain of 17 db with typical noise figure of 3 db, 24 db of forward gain control, and 33 db of reverse gain control.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 218.

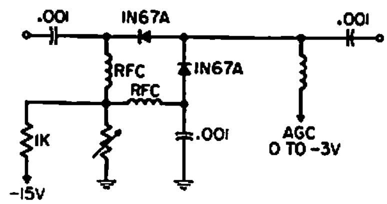
L1 = 1/4" X 1/32" COPPER STRAP BENT AS SHOWN ABOVE.
L2 = 2 t # 22 SOLDEREZE CLOSE WOUND ON C.T.C. PLS62C4L/200 63 NO SLUG.



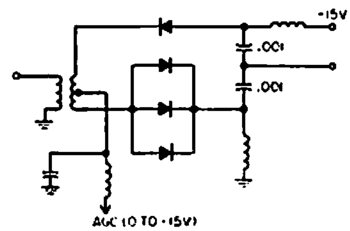
AGC WITH VARICAP—Basic voltage-controlled capacitor circuit uses capacitance variation with voltage of back-biased diode constructed to have large capacitance changes, such as Varicap. Circuits give different insertion losses and gain changes. Left: 5 db insertion loss and 16 db gain control range for agc bias of 15 v. Center: 2 db loss and 11 db gain range. Right: 7 db loss and 18 db gain range. All can be reasonably flat for 200-Mc bandwidth.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.



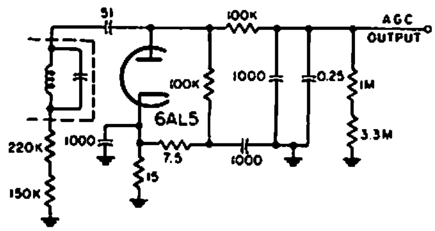
AGC FOR ADF—Gives uniform receiver response over wide dynamic range of input signal levels. Output of third i-f stage Q2 is applied across agc diode D1.—P. V. Sparks, Servo Filter and Gain Control Improve Automatic Direction Finder, *Electronics*, 34:23, p 110–113.



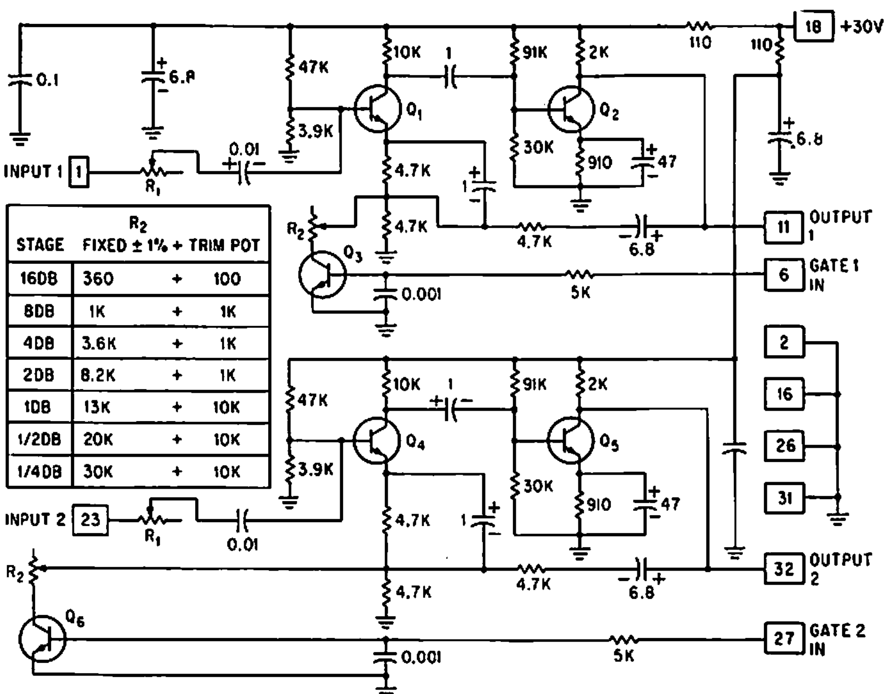
DIODE L-ATTENUATOR AGC—Two diodes provide maximum agc control. Circuit gives control range of about 15 db with agc voltages to 3 v. Above 200 Mc, frequency response changes irregularly with attenuation.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.



AGC WITH VARICAP DIODE BRIDGE—Uses voltage-controlled capacitors to provide very large gain control range, greater than 30 db.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.

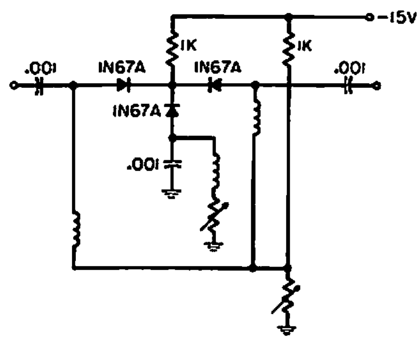


SIMPLE AGC—Used to keep output of communication receiver relatively constant with varying input signals.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12–4.

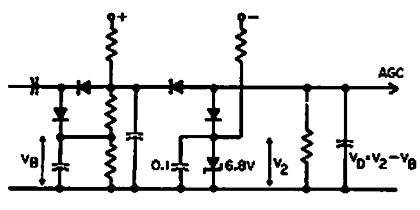


STAGE	R_2 FIXED ± 1%	+	TRIM POT
16DB	360	+	100
8DB	1K	+	1K
4DB	3.6K	+	1K
2DB	8.2K	+	1K
1DB	13K	+	10K
1/2DB	20K	+	10K
1/4DB	30K	+	10K

NINE FIXED-GAIN STAGES GIVE AGC—Monopulse radar amplifier stages are used in cascade, each with different fixed gain and a slicer that switches from that gain to unity gain if signal exceeds predetermined reference level. Give gain up to 80 db in 0.5-db steps, equivalent to fast agc, to give constant 10-v output for signals ranging from 1 mv to 10 mv.—W. W. Smith, Fast AGC Amplifier Locks Monopulse Radar on Target, *Electronics*, 36:39, p 34–36.

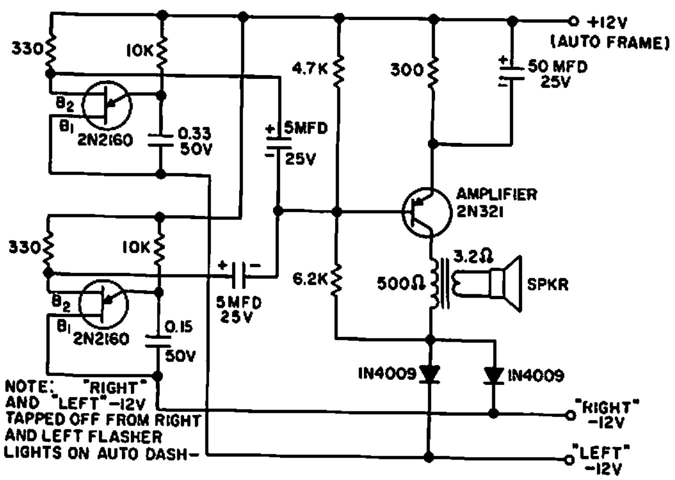


DIODE T-ATTENUATOR AGC—All three diodes are simultaneously controlled, to give excellent agc action over control range of 20 db, although insertion loss is high. Frequency response is excellent up to 150-Mc cutoff.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.

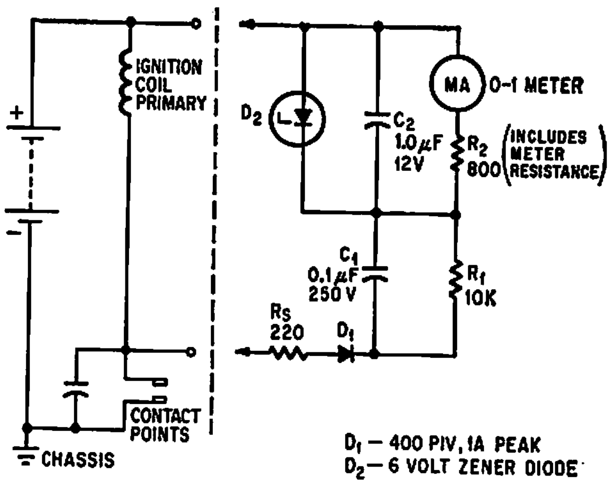


DOUBLE-GATED AGC—Uses zener diode to supply standing bias for agc bus.—W. A. Rheinfelder, Designing Automatic Gain Control Systems, *EEE*, 13:1, p 53–57.

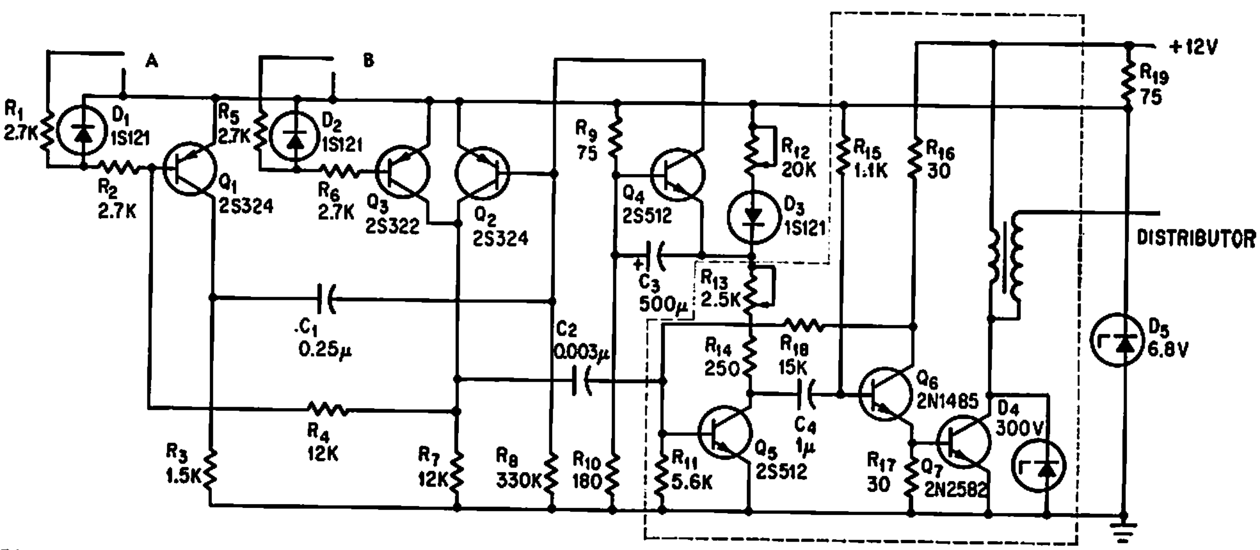
CHAPTER 7
Automotive Circuits



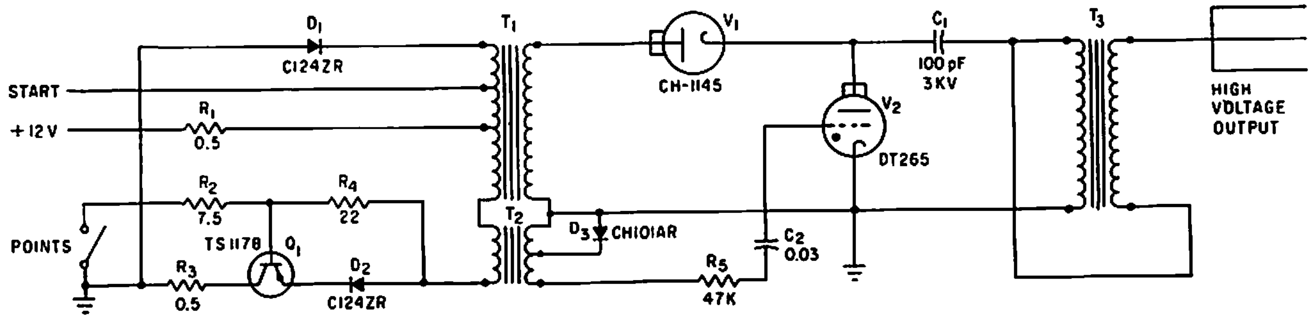
AUDIBLE TURN-SIGNAL INDICATOR—Produces two different tones in synchronism with turn-signal flashers. Diodes prevent short-circuit. For autos with positive ground.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 381.



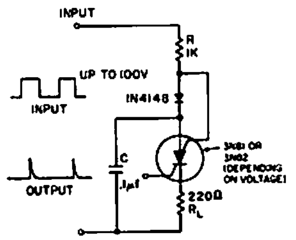
AUTO TACHOMETER—Connects to automobile circuit at battery and at distributor contact points. Zener diode D2 limits maximum charging voltage across C2.—J. A. Irvine, No Moving Parts in Auto Tachometer, *Electronics*, 39:9, p 77–78.



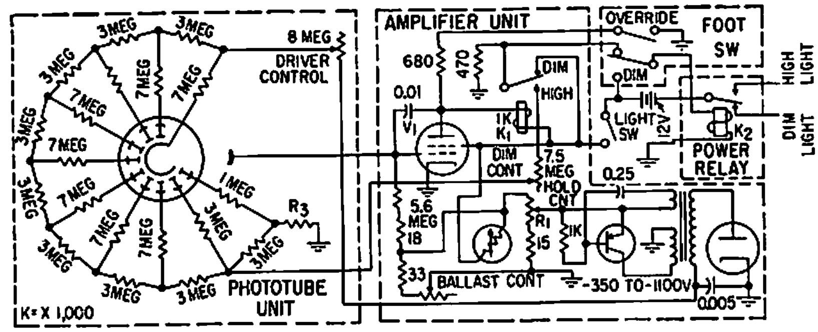
AUTOMATIC IGNITION ADVANCE—Inductive pickups on engine crankshaft feed to A and B, to make timing vary with engine speed by triggering monostable delay placed ahead of basic Delcotronic spark generator (dashed lines).—A. R. Hayes, Electronically Controlling Auto's Engine Spark, *Electronics*, 37:32, p 43–44.



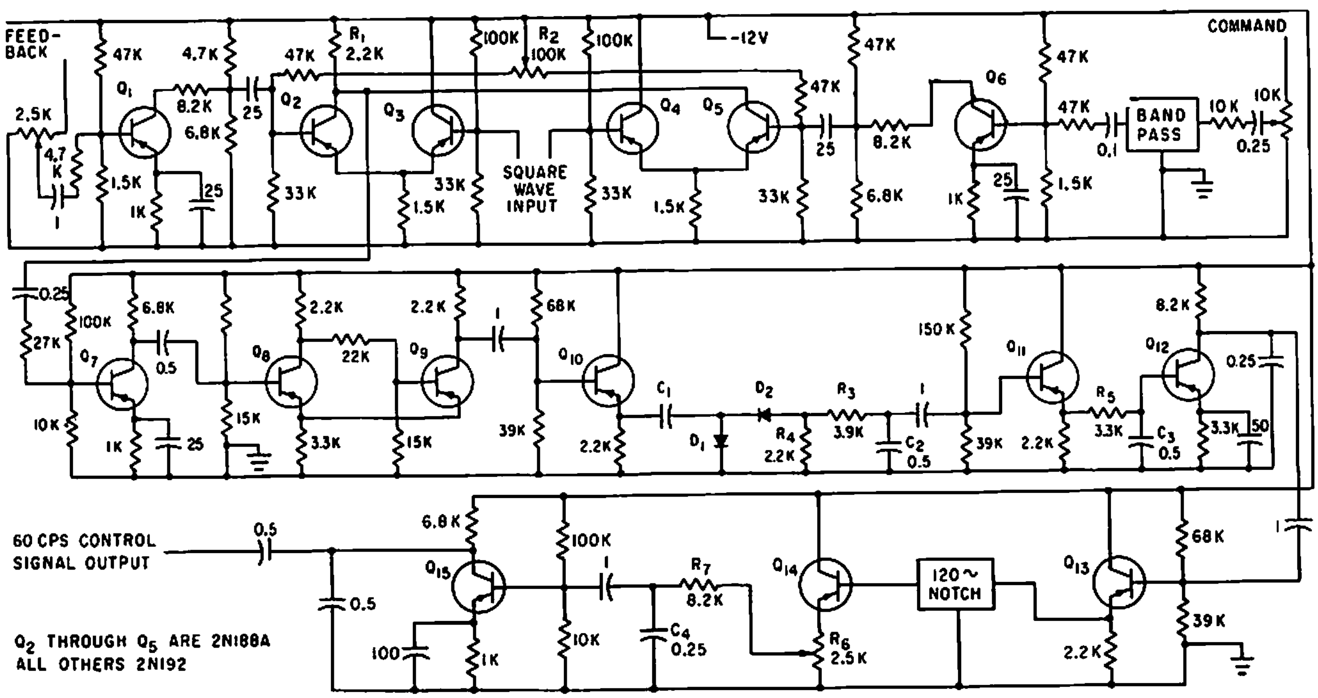
GAS-TUBE AUTO IGNITION—Thyratron V2 discharges C1 through spark coil T3 to provide ignition spark each time points open and magnetic field of trigger transformer T2 collapses. Field is built up in T1-T2 by power transistor Q1 when points close again.—H. P. Quinn, Gas Tubes and Transistor for Electronic Ignition, *Electronics*, 34:50, p 62–64.



SCS SINGLE-PULSE GENERATOR—Gives one output pulse for each positive-going input. Can be used as tachometer, power loss detector, or peak detector.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 434.

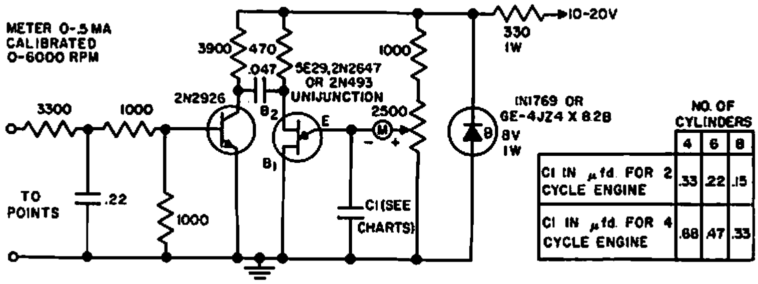


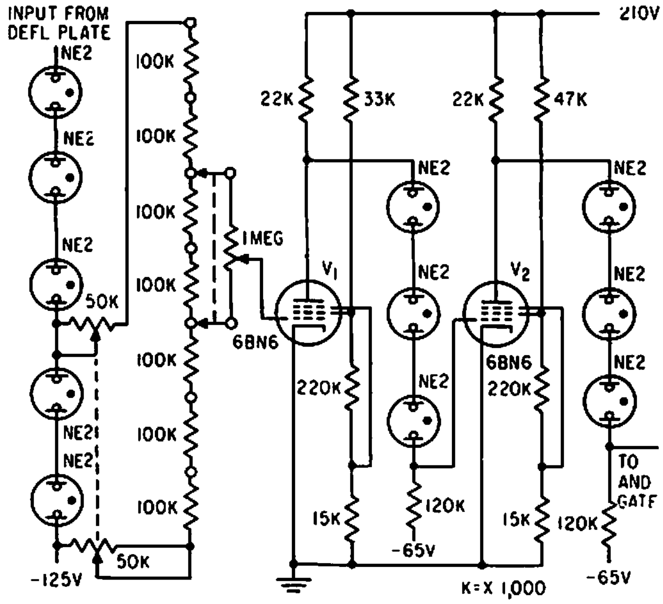
HEADLIGHT DIMMER—Will hold low beam setting even when approaching driver dims his headlights. Restores high beam only when light is completely removed from photocell. Street lights therefore keep system on a low beam. Used in Autronic Eye.—W. E. Bushor, Electronics and the American Automobile, *Electronics*, 31:47, p 73–79.



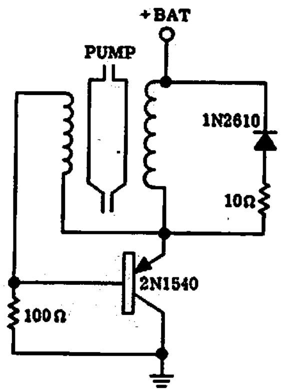
MAGNETIC-TAPE CONTROL OF ENGINE—Auto engine parameters are recorded during road tests, and tapes are then used to program laboratory engine to simulate further tests. Synchronous switches Q2-Q3 and Q4-Q5, driven by line-frequency square-wave generator, operate as line-synchronous spdt switch, to place tape signal and lab-engine feedback signal on line alternately and synchronously with line voltage. Frequency-measuring circuit develops d-c voltage proportional to input frequency. Output is used to drive two-phase motor that controls lab engine parameter.—V. C. Vanderbilt and C. L. Zimmer, Magnetic Tape Recorder Programs Engine Dynamometer Tests, *Electronics*, 33:51, p 74–77.

HIGH-PRECISION AUTO TACHOMETER—For auto ignition system having 12-v negative ground. Gives ultralinear readings on meter scale.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 380.

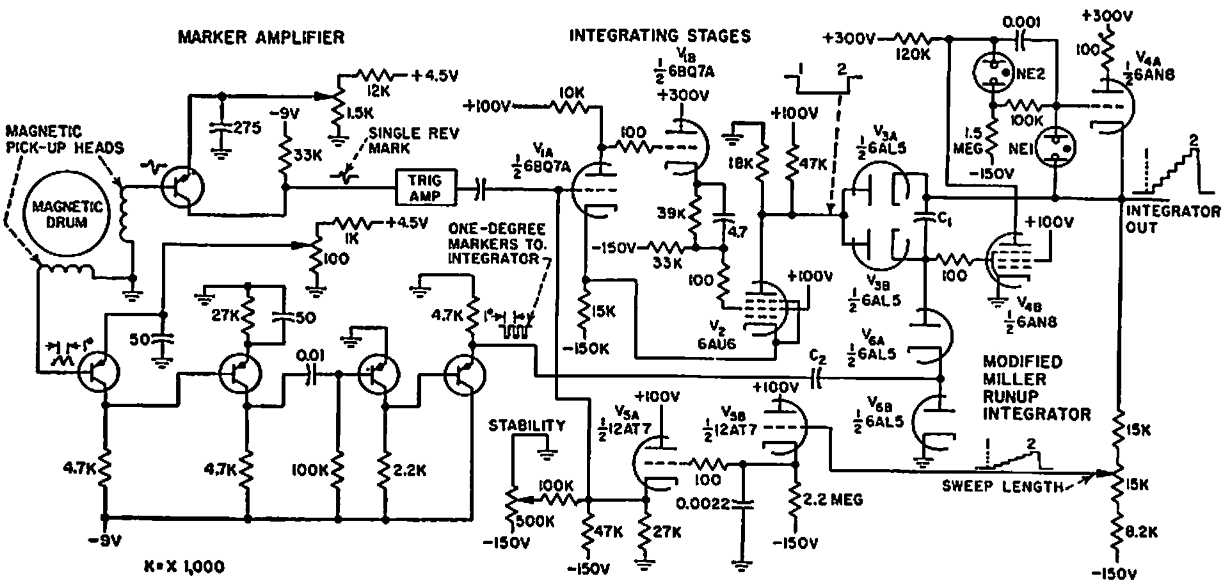




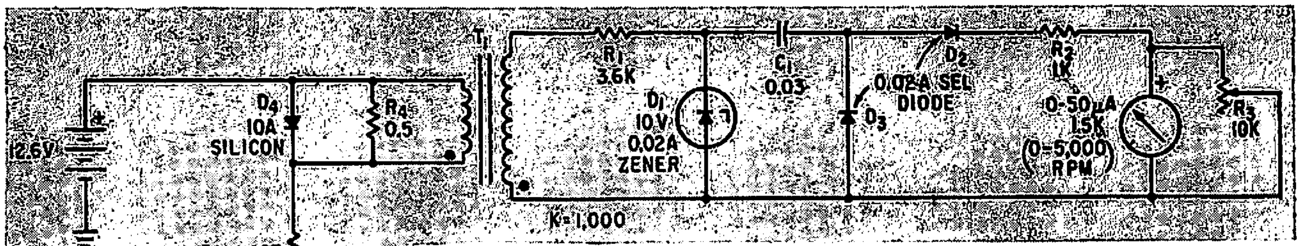
GATED AMPLITUDE RATIO INDICATOR—Accurately measures cylinder gas temperature as function of engine-cycle phase angle, by using amplitude discriminator to indicate ratio of two infrared radiation intensities emitted by gas at two known wavelengths. Discrimination is accomplished by amplifying 0.1% slice of radiation signal.—R. R. Bockemuehl, Gated Ratio Indicator Aids Engine Research, *Electronics*, 32:13, p 64–65.

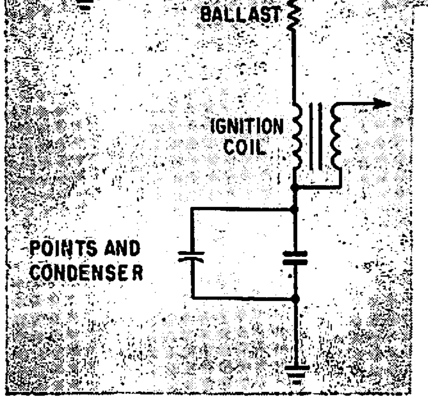


FUEL-PUMP OSCILLATOR—Silicon transistor serves as switch that eliminates arcing contacts, permitting use of pump in explosive atmosphere, even inside fuel tank. Power transistor is in blocking oscillator circuit for driving solenoid plunger assembly of commercial electric fuel pump. Feedback winding was added to drive coil. Ratio of solenoid coil turns to feedback turns should be 4 to 1 to insure proper starting in cold weather. —H. F. Weber, "Transistor Operated Fuel Pump Eliminates Arcing Contacts and Commutator Brushes," Motorola Application Note AN-175, Feb. 1966.

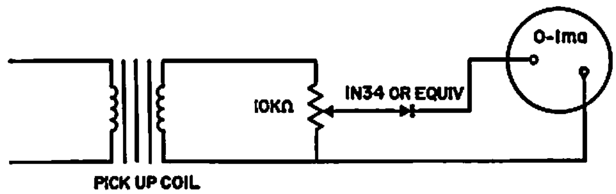


STAIRCASE INTEGRATOR FOR ROTATION ANALYZER—Used to observe relationship of crankshaft angle in gasoline engines to cylinder pressure and ignition timing. Parameters under study are indicated by angular displacement of rotating disk and are converted into signals for cro display. Magnetic drum is coupled to shaft under test. Ferrite-coated fiber disk with 1° magnetically recorded markers is source for pulses that are amplified for staircase integrating amplifier that feeds cro.—G. E. Edens, Stairstep Integrator Analyzes Rotation, *Electronics*, 31:13, p 41–43.

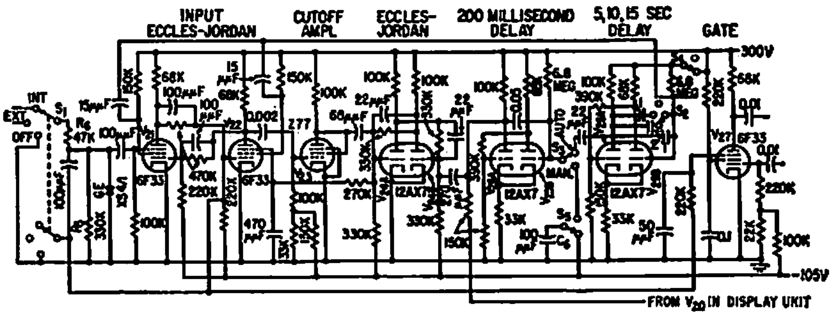




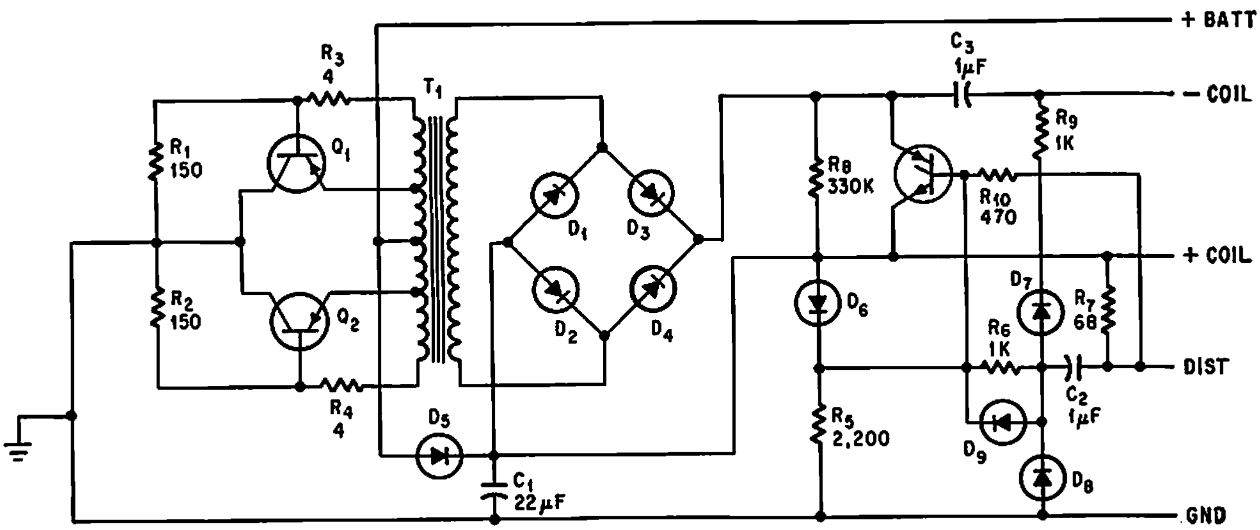
PASSIVE TACHOMETER—Circuit is placed in series with ignition coil to pick up ignition pulses and feed them to integrating ratemeter calibrated in rpm. Number of pulses per shaft revolution depends on number of cylinders.—F. Trainor, Unique Engine Tachometer Uses only Passive Components, *Electronics*, 35:30, p 40–41.



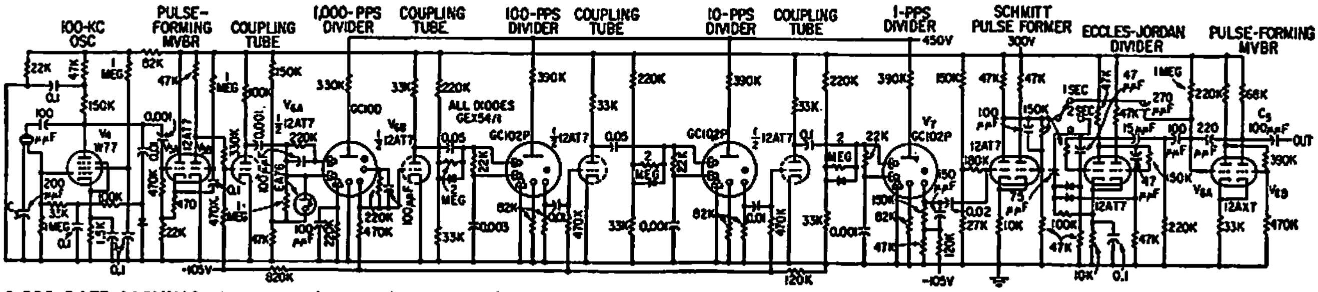
ZERO-POWER ENGINE TACHOMETER—Requires no battery or other power source. Coil from 10K relay serves as pickup for mounting near rotating magnets of flywheel of outboard motor or magneto. When rotating magnets are not available, as in most automotive engines, variable-reluctance pickup is used. This can be made from old loudspeaker, mounted so fan blades of generator pass between pickup coil and permanent magnet. Coil mounting should be aluminum to maintain calibration that is made with commercial tachometer.—K. M. Bronscome, Engine Tachometer, *EEE*, 10:9, p 27.



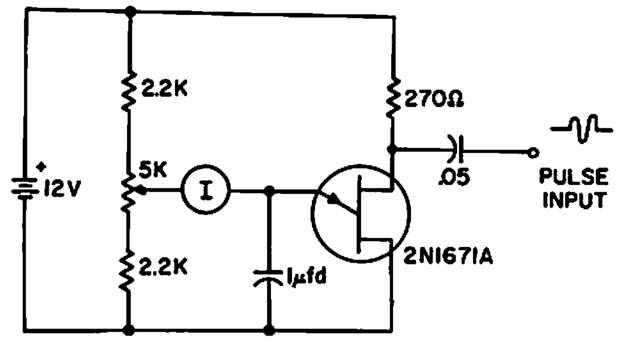
AUTO-LOCKING GATE FOR TACHOMETER DISPLAY—Permits pulses to pass to display unit during gating period. Display can be held for 5, 10, or 15 sec by switching different capacitors into delay mvbr. Additional 200-millisec delay gives time for counting tubes to return to zero.—J. K. Goodwin, Digital Tachometer Aids in Turbine Design, *Electronics*, 32:15, p 58–61.



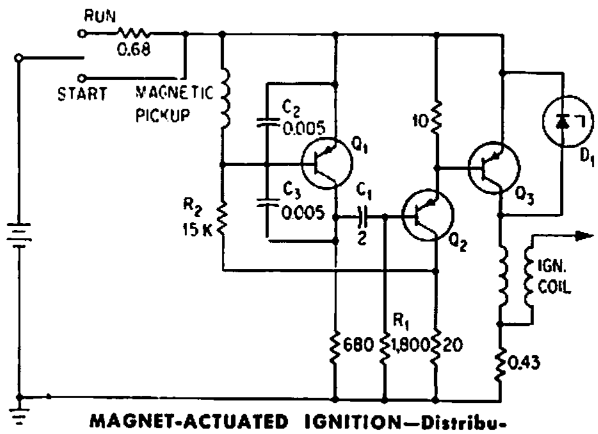
AUTO IGNITION—Capacitive-discharge ignition system uses scr as switch. Transistors serve as d-c to d-c converter.—R. Van Houten and J. C. Schweitzer, A New Ignition System For Cars, *Electronics*, 37:26, p 68–72.



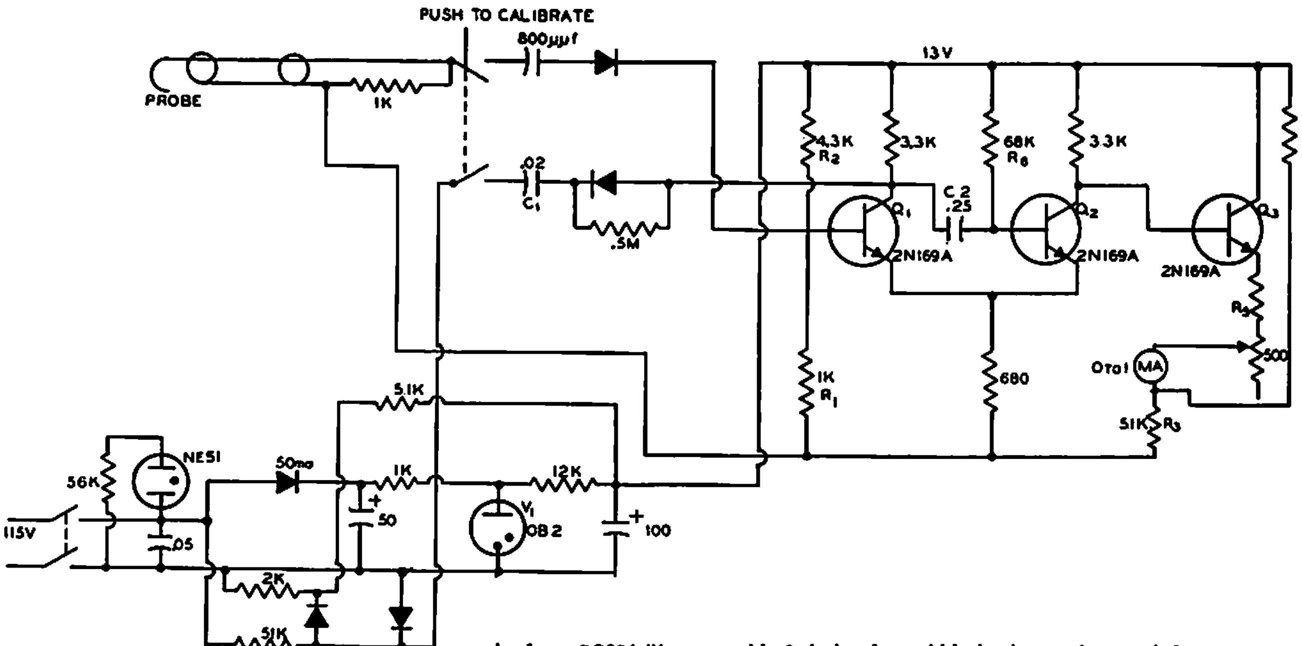
1-PPS GATE-OPENING TIMER—Produces pulses at 1-sec intervals to control gate of 400,000-rpm digital tachometer. Crystal oscillator produces 10-kc signal. Dekatrons are used to divide this to 1-pps output.—J. K. Goodwin, Digital Tachometer Aids in Turbine Design, *Electronics*, 32:15, p 58–61.



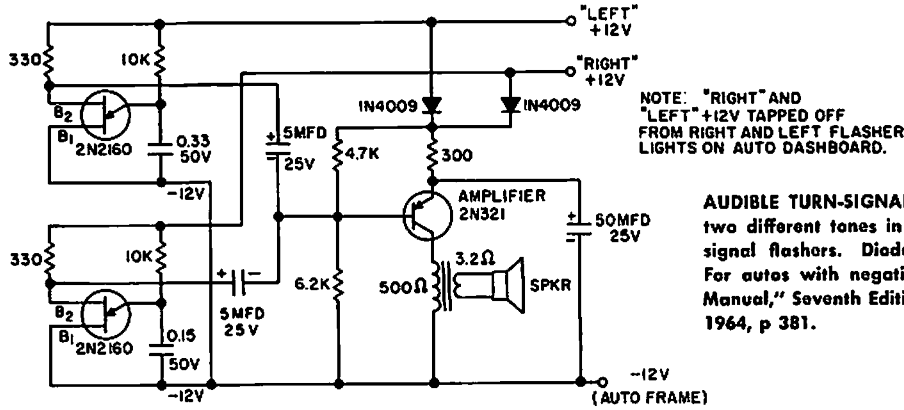
TACHOMETER AMPLIFIER—Unijunction transistor is basis of simple, inexpensive tachometer amplifier or frequency meter. Each negative input pulse of sufficient amplitude triggers ujt, so capacitor is discharged through ujt. Capacitor is then recharged through d-c ammeter by current having sawtooth waveform that minimizes flutter at low frequencies.—T. P. Sylvan, Frequency Meter-Tachometer Amplifier, *EEE*, 10:8, p 25–26.



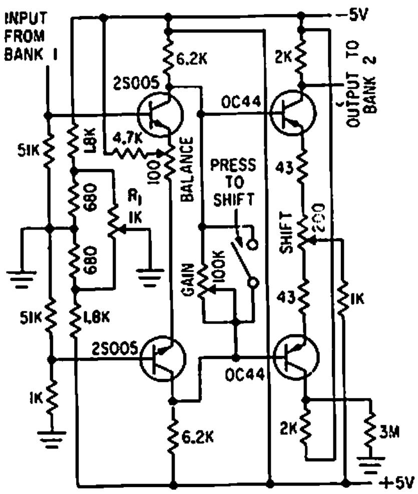
MAGNET-ACTUATED IGNITION—Distributor contact points are replaced by magnetic pickup that delivers timed pulses to trigger transistor Q1, driver Q2 and output transistor Q3, with latter controlling primary current through ignition coil. Zener diode D1 clips voltages exceeding voltage rating of Q3.—S. B. Gray, Home and Auto Controls, *Electronics*, 36:19, p 52–56.



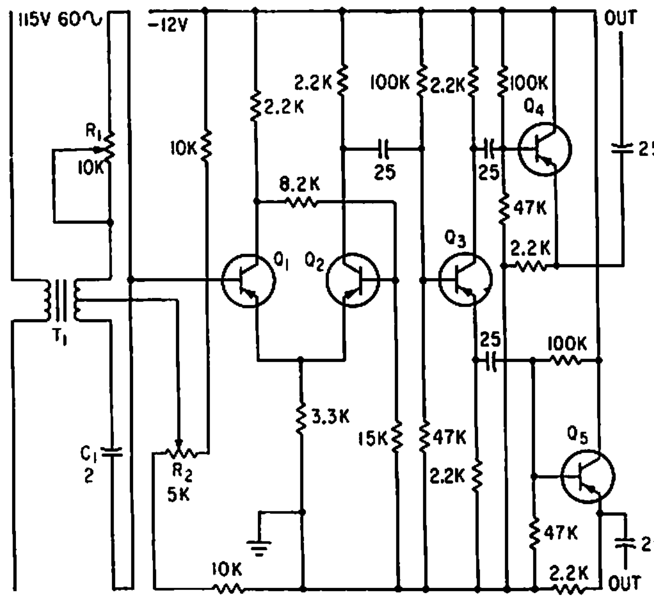
QUICK-DISCONNECT TACHOMETER—Can be connected and disconnected from engine fast enough for production-line speed adjustments. Pulse is picked up by curved probe that is hooked over ignition cable in use. Probe is made from RG58A/U coax with 1 inch of shield removed to provide coupling. Resulting pulse picked up is about 1 v, with width of about 20 microsec. Pulse is fed to first stage Q1 of monostable mvbr, which acts on Q2 to give pulse with constant height and width, having engine spark frequency. Meter gets current pulse through emitter-follower for each spark, so average meter current is proportional to rpm.—Transistorized Tachometer, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 154.



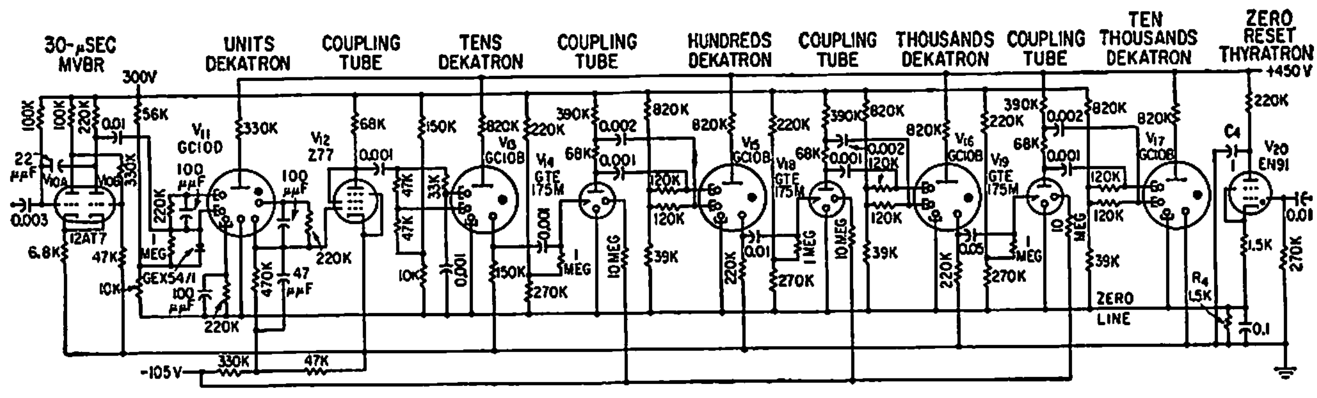
AUDIBLE TURN-SIGNAL INDICATOR—Produces two different tones in synchronism with turn-signal flashers. Diodes prevent short-circuit. For autos with negative ground.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 381.



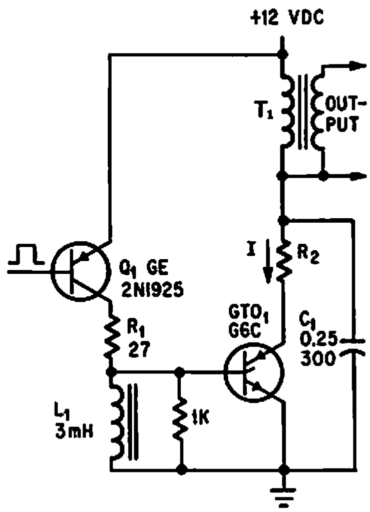
TRANSDUCER D-C AMPLIFIER—Bank 1 of 24-channel telemetry sampling switch feeds transducer outputs in sequence to heat-stabilized low-drift d-c amplifier. Output goes to bank 2, for feeding f-m subcarrier oscillator, which in turn amplitude-modulates uhf transmitter. —A. Potton, Telemetry System for Testing Automobiles, *Electronics*, 33:43, p 57–59.



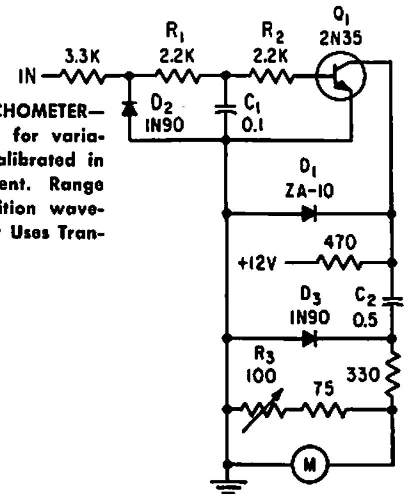
LINE-TRIGGERED SQUARE-WAVE GENERATOR—Bistable multivibrator Q1-Q2 is triggered by T1 through master phasing network R1-C1. R2 adjusts duty cycle. Output signal goes to frequency comparator that makes lab engine duplicate parameters recorded on magnetic tape during actual road run.—V. C. Vanderbilt and C. L. Zimmer, Magnetic Tape Recorder Programs Engine Dynamometer Tests, *Electronics*, 33:51, p 74–77.



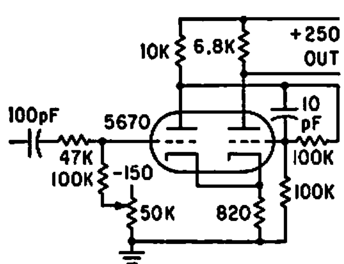
400,000-RPM TACHOMETER DISPLAY—Has five Dekatron tubes arranged in cascade. Negative-going pulses from plate of gating tube are fed to 30-microsec one-shot mvbr V10. Tetrode thyratron returns Dekatron to zero at end of counting period.—J. K. Goodwin, Digital Tachometer Aids in Turbine Design, *Electronics*, 32:15, p 58–61.



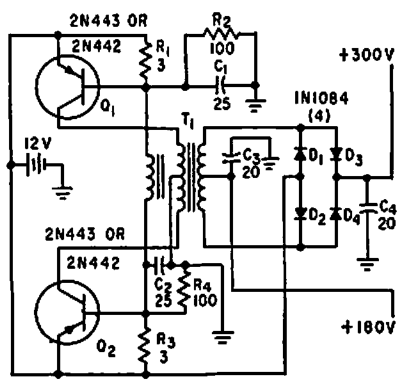
HIGH-VOLTAGE PULSE GENERATOR—Square-wave input to transistor Q1 triggers scr on and off, inducing high-voltage damped-oscillation pulse in secondary of T1. Used for auto ignition and other applications requiring up to 30 kv from 0 to 400 times per second. —D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.



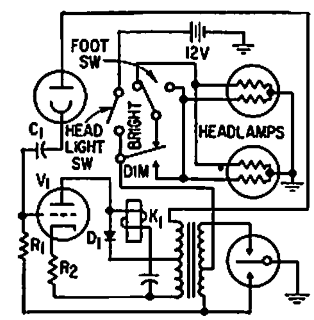
SINGLE-TRANSISTOR AUTO TACHOMETER—Uses zener diode to compensate for variations in 12-v supply. Meter is calibrated in rpm, using R3 for final adjustment. Range is 0 to 6,000 rpm. Input is ignition waveform.—J. Cowan, Auto Tachometer Uses Transistor, *Electronics*, 31:33, p 92–94.



AMPLITUDE DISCRIMINATOR—High-speed trigger with adjustable bias network and cathode-follower output serves as amplitude discriminator for tachometer that responds to pulses produced by gamma radiation sources on sealed-in rotating parts not directly coupled to input or output shafts of transmissions or turbines.—R. R. Bockemuehl and P. W. Wood, Unique Two-Channel Tachometer uses Radioisotopes, *Electronics*, 35:49, p 44–45.

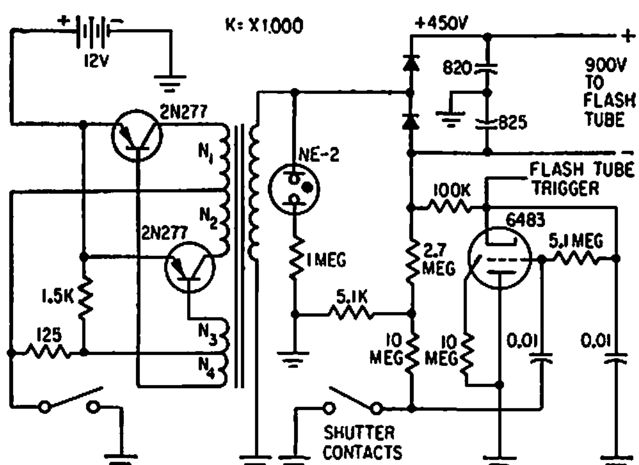


120-W, 300-V D-C AUTO CONVERTER—For 12-v auto systems. Develops square-wave voltage at 200 cps, for conversion to 300 v d-c by silicon-diode bridge rectifier. Each switching transistor requires 7-inch-square sheet of ⅛th-inch aluminum as heat sink.—W. E. Bushor, Electronics and the American Automobile, *Electronics*, 31:47, p 73–79.

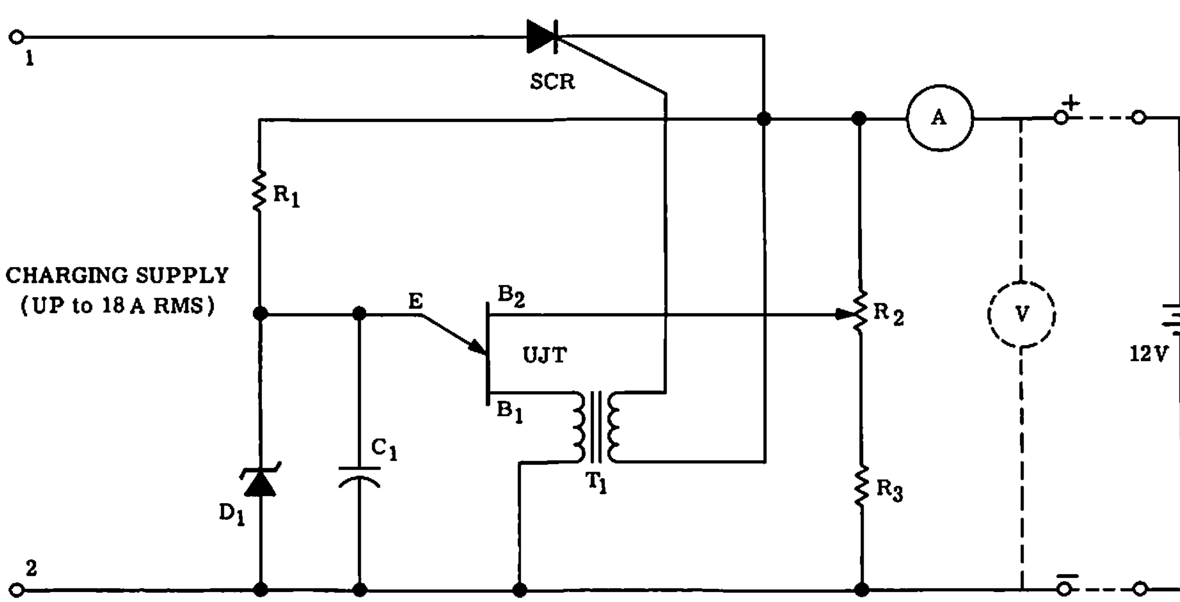


HEADLIGHT DIMMER—Automatically switches from high to low beam when oncoming headlight strikes photocell. Driver may dim lights manually at any time and leave them dim. When lights have been dimmed automatically, momentary reduction of light on photocell will not cause return to high beam.—W. E. Bushor, Electronics and the American Automobile, *Electronics*, 31:47, p 73–79.

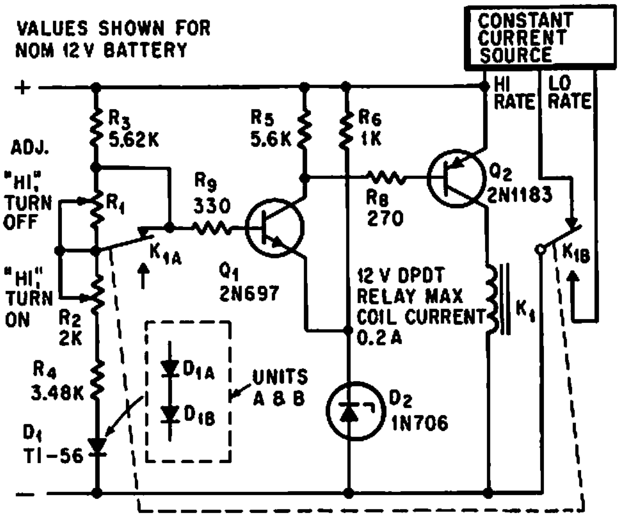
CHAPTER 8
Battery Charging Circuits



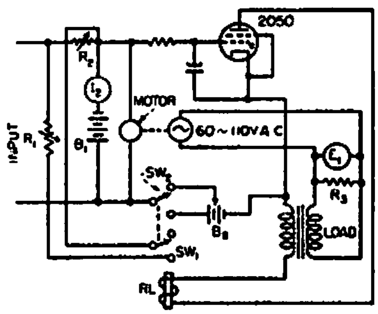
200 W-SEC SYMMETRICAL INVERTER—Designed for professional use. Thyratron trigger tube limits shutter contact current to 100 microamp. Converter charges storage capacitors to 90% of full charge in 8 sec. Peak current drain from nickel-cadmium battery during charging is only 5 amp, and idling current is 350 ma. 1,500-cps oscillator uses toroidal saturable-core transformer. 900-v full-wave voltage-doubling circuit has its center grounded, so maximum voltage above or below ground is 450 v.—H. A. Manoogian, Transistor Photoflash Power Converters, *Electronics*, 31: 35, p 29–31.



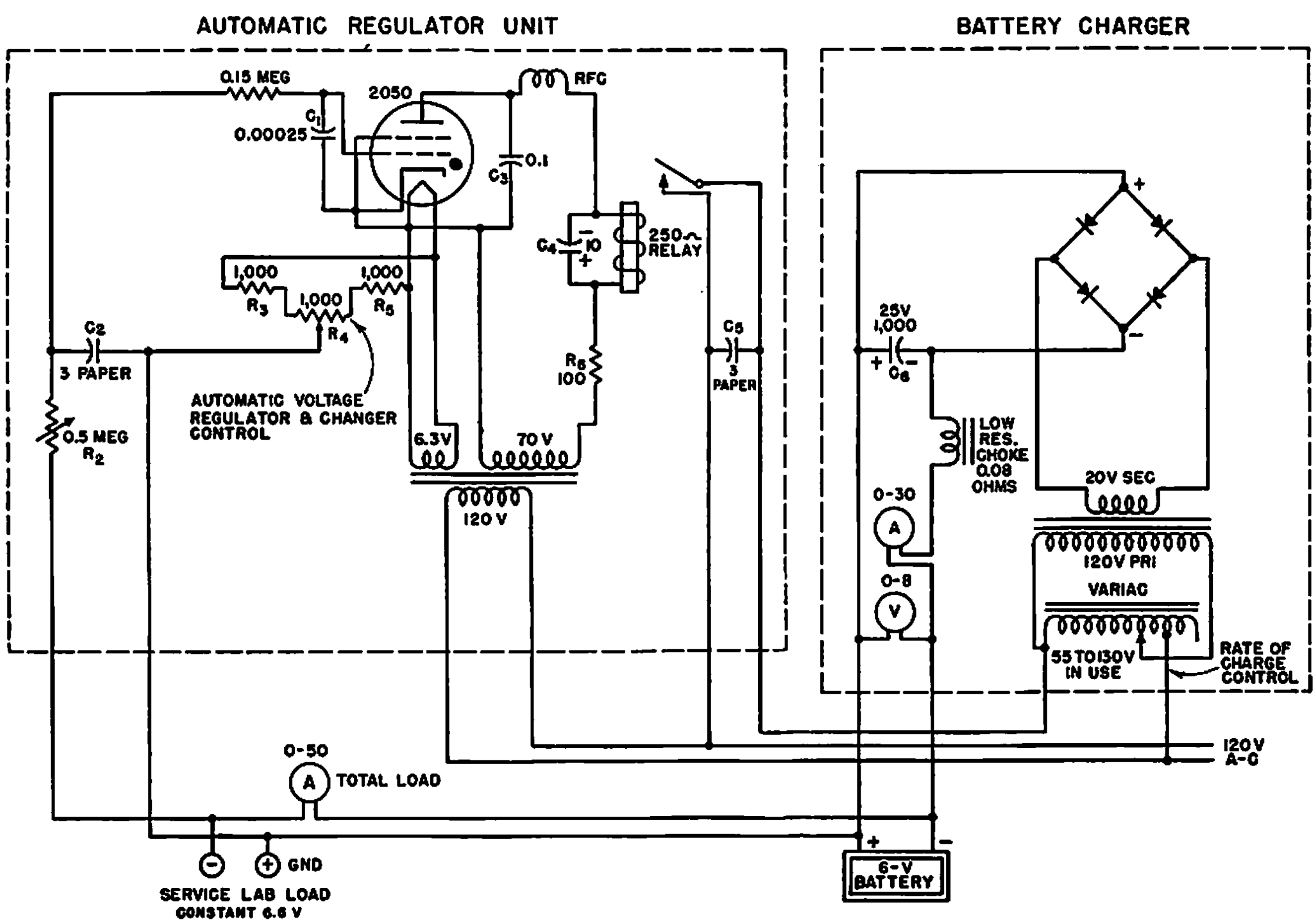
12-V BATTERY CHARGER CONTROL—Ujt with R1, R2, R3, and C1 form relaxation oscillator that gets power from battery being charged and serves to trigger scr through T1. When required firing voltage of unijunction, as determined by battery voltage, exceeds breakdown of zener D1, ujt can no longer oscillate, and charging ceases. R2 controls cutoff point. Charger is protected because scr cannot conduct under conditions of short-circuit, open-circuit, or reverse polarity connection to battery. Values are: R1—3.9K; R2—2.5K; R3—3.3K; C1—0.25 mfd; D1—1N753 zener, 6.2 v, 400 mw; SCR—MCR 808-3; UJT—2N2160.—R. Wechsler, "A Unique Battery Charger Control Circuit," Motorola Application Note AN-179, Feb. 1966.



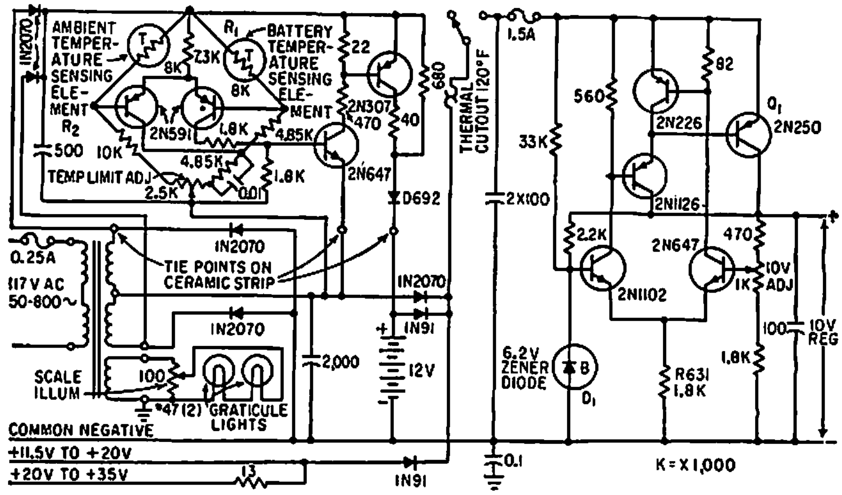
QUASI-CONSTANT-CURRENT BATTERY CHARGER—Circuit monitors state of charge of battery while charging at constant high rate, then transfers automatically to constant-current trickle charge when battery is fully charged. —A. Anton, Comparator Controls Battery Charging Rate, *Electronics*, 37:12, p 72.



CHARGER CONTROL WITH REFERENCE BATTERY—Developed to insure constant d-c supply for rotary converters if ship's power supply fails. Control circuit operates SW1 at proper time intervals. B2, in series with B1 with polarity opposing, supplies reference voltage. When storage battery needs charge, gas tube ignites to pull in RL and initiate charging cycle.—V. Zeluff and J. Markus, "Electronics Manual for Radio Engineers," McGraw-Hill, N.Y., 1949, p 545.

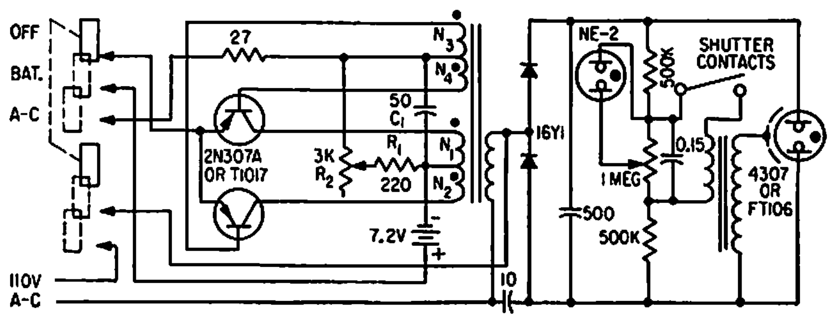


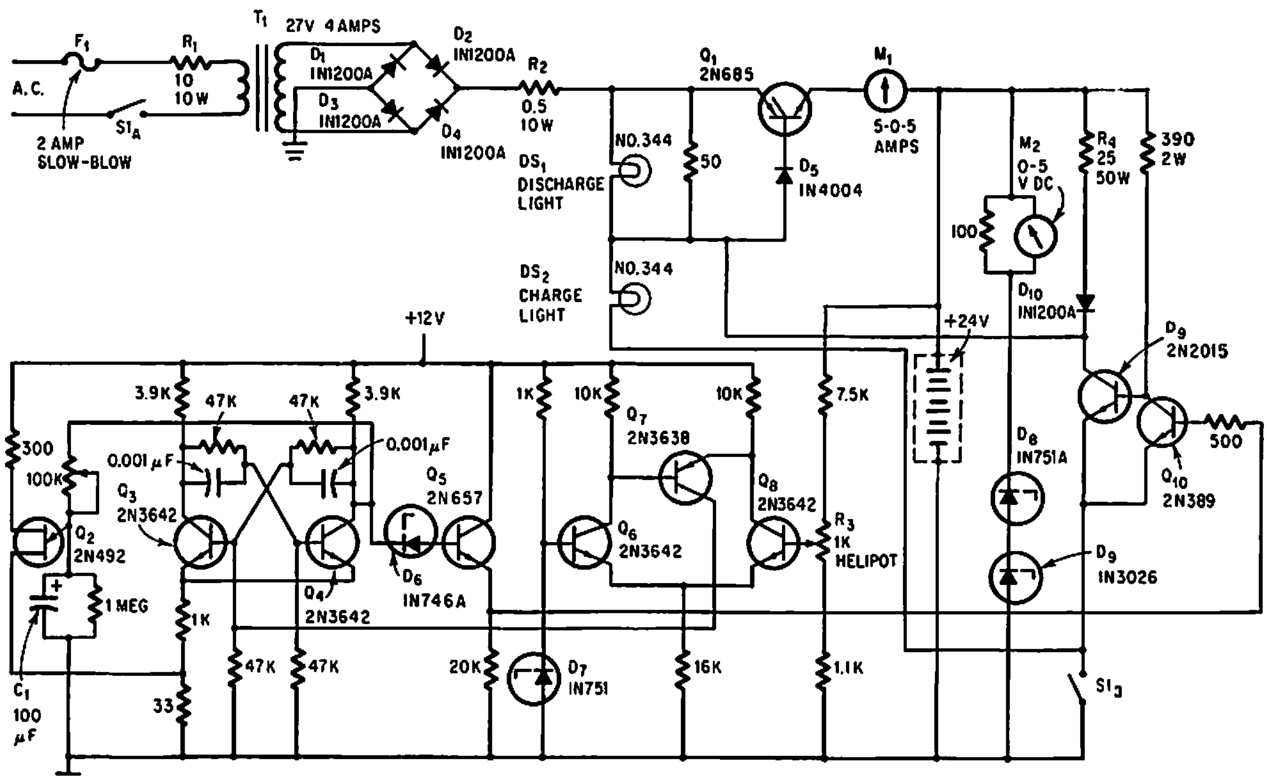
THYRATRON CONTROLS CHARGER RECTIFIER—Automatic regulator turns charger off when battery voltage exceeds predetermined value, and turns charger on again automatically at any desired lower voltage from 5 to 7.5 v. Line voltage changes do not affect adjustment.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Circuits," McGraw-Hill, N.Y., 1948, p 257.



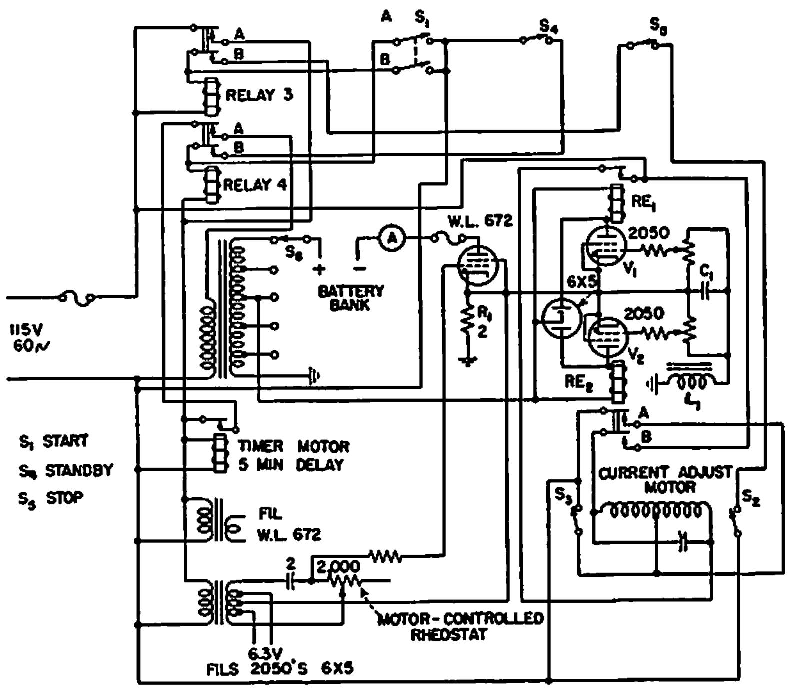
REGULATOR FOR PORTABLE CRO—Maintains constant 10-v output from 12-v nickel-cadmium battery, from external d-c voltages up to 35 v, or from 117-v a-c line. Includes battery-charging circuit, in which thermistor R1 senses rise in battery temperature and turns off charger when battery is fully charged. —O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.

30 W-SEC SUPPLY WITH CHARGER—Charges capacitor to 300 v in 8 to 12 sec through series-line voltage doubler. Battery drain is 750 ma peak and 150 ma idling. Uses transistor collector-base junction in full-wave rectifier circuit to charge nickel-cadmium battery from stepped-down a-c voltage across N1 and N2. Converter operates as 120-cps square-wave switch so same transformer may be used for 60-cps charging voltage. Battery provides up to 300 flashes.—H. A. Manoogian, Transistor Photoflash Power Converters, *Electronics*, 31:35, p 29–31.

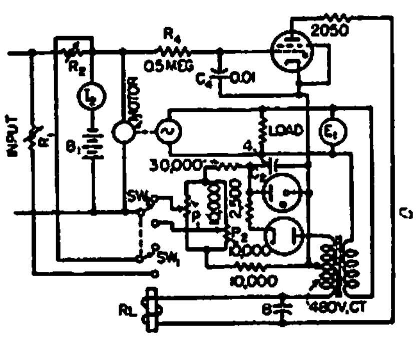




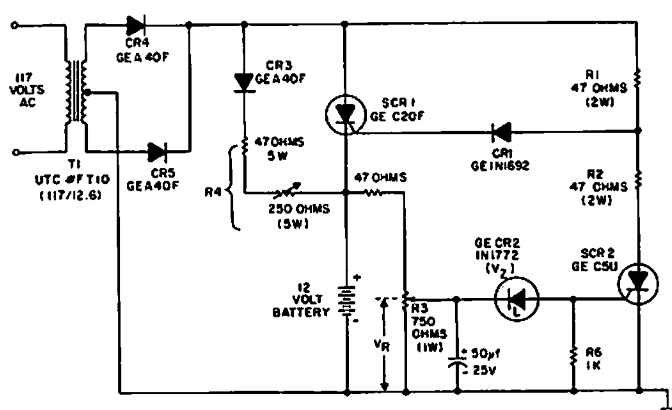
WELDER BATTERY CHARGER—During overnight charging of battery used to maintain equal-amplitude output current pulses for welder, circuit senses whether battery voltage is above or below required value for load current of 1 amp. If low, one-shot timer is actuated, to charge battery for preset interval. Voltage is then measured again, and charging repeated if necessary. If voltage is too high, load remains on until battery voltage drops to point where charger is actuated again.—F. T. Marcellino and A. A. Dargis, Circuit Keeps Voltage Constant for Welder Battery, *Electronics*, 38:21, p 88.



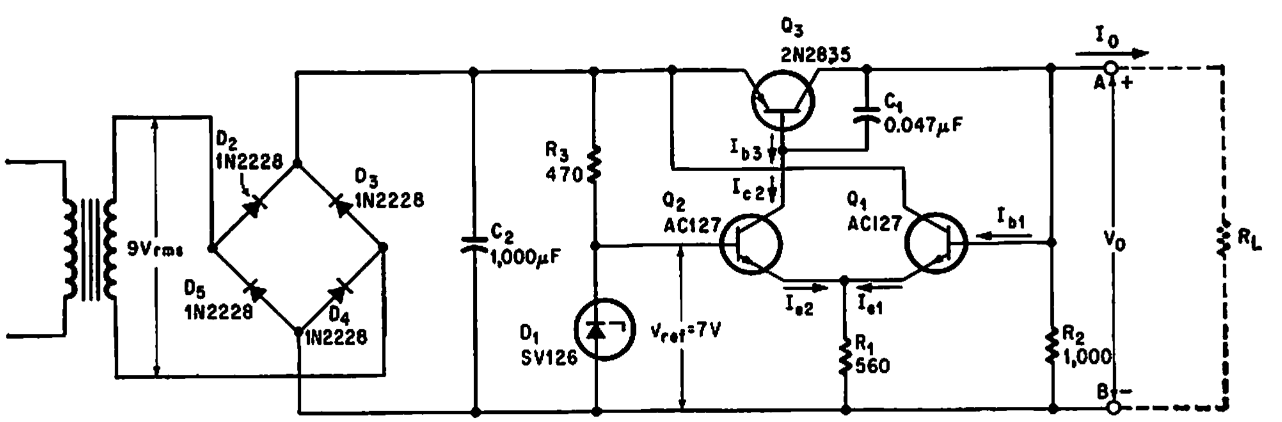
CONSTANT-CURRENT BATTERY CHARGER—Thyratron-controlled motor drives phasing control rheostat to give fully automatic charging of 50 2-v storage cells at constant rate of 2 amp.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 150.



CHARGER CONTROL WITH REGULATED D-C REFERENCE—Eliminates need for separate reference battery. Control fires thyratron to pull in or out and initiate charging cycle when battery voltage drops.—V. Zeluff and J. Markus, "Electronics Manual for Radio Engineers," McGraw-Hill, N.Y., 1949, p 545.

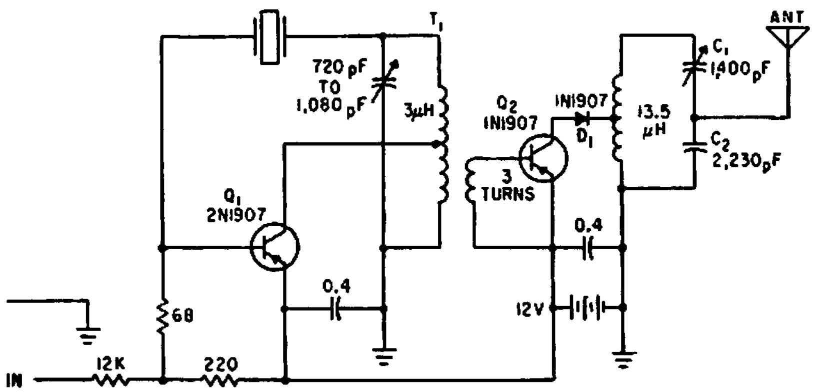


SCR BATTERY-CHARGING REGULATOR—Can charge 12-v battery at up to 6-amp rate. When battery voltage reaches charged level, charging scr shuts off, and trickle charge determined by R4 flows.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 109.

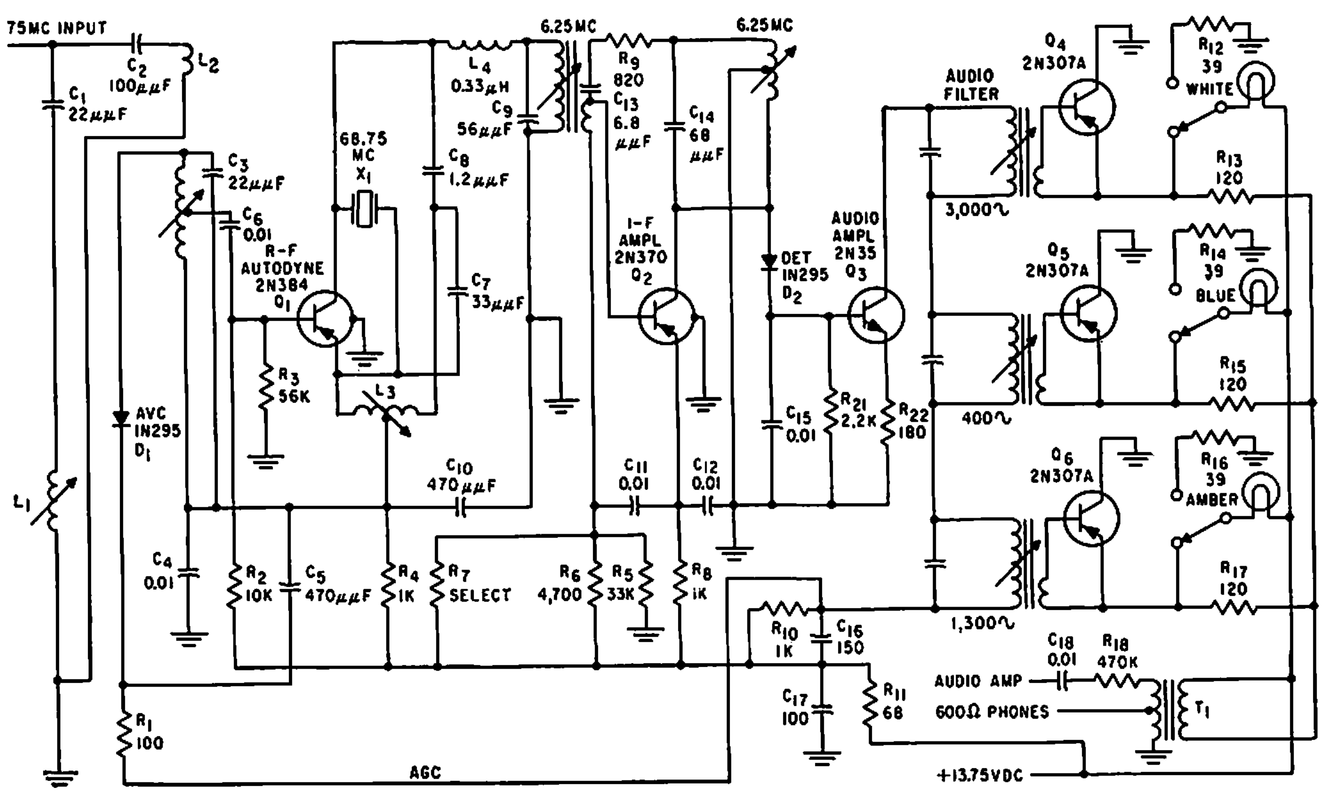


CHARGING CURRENT LIMITER—Series regulator transistor is driven by differential amplifier using npn transistors, to control charging of nickel-cadmium battery.—G. H. P. Kohnke, Simple Voltage Regulator Limits Load Current, *Electronics*, 37:28, p 63.

CHAPTER 9
Beacon Circuits

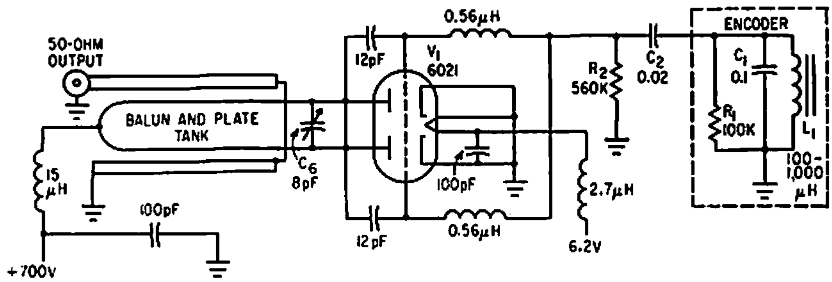


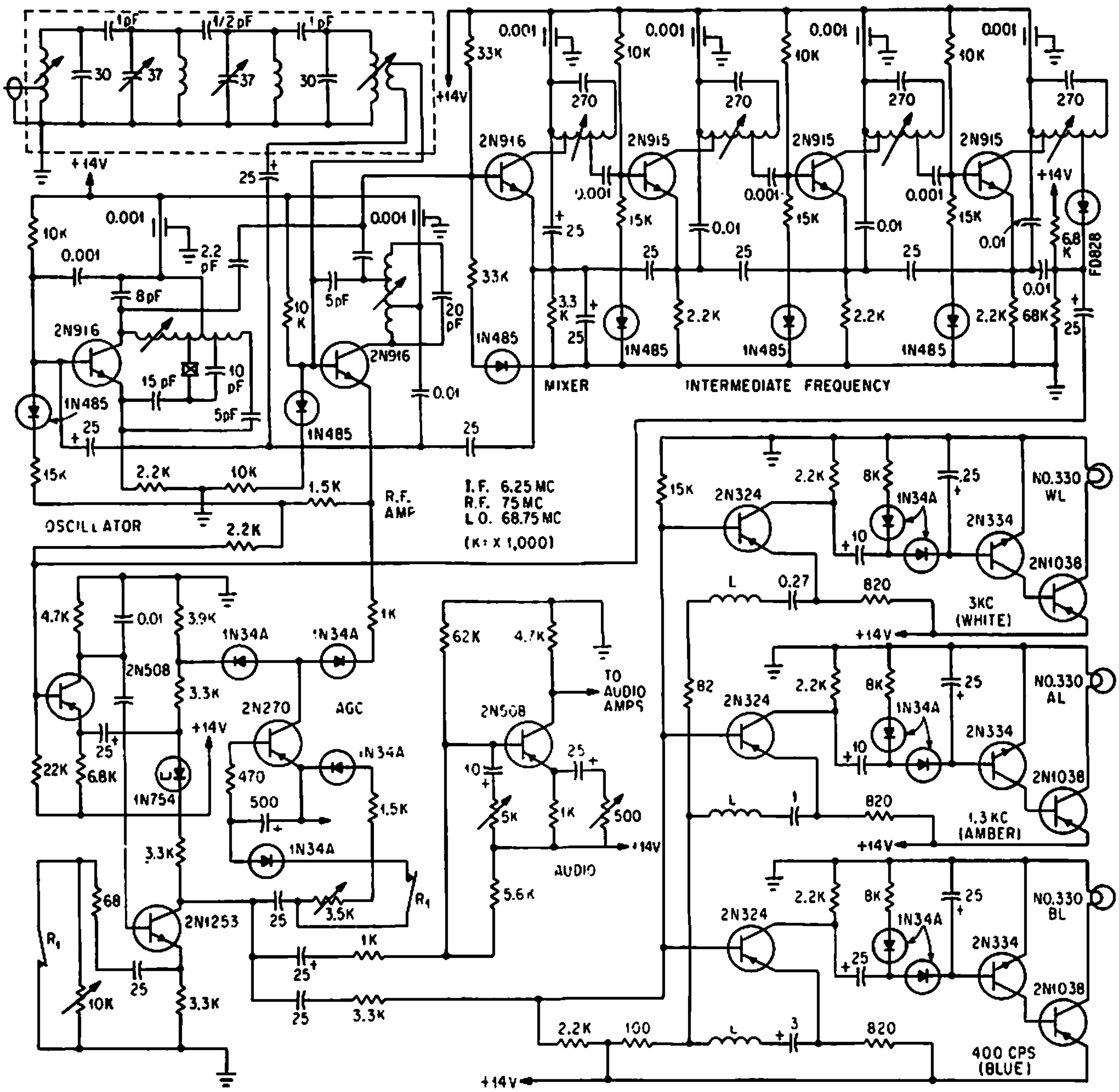
BALLOON TELEMETER AND BEACON—Delivers 10 w at 1,686 kc into 72 ohms at 60% efficiency. Can also operate at 7 Mc if crystal and tank are changed.—F. W. Frykman and A. R. Moore, Lightweight Transmitter Provides Flight Data and Beacon Signal, *Electronics*, 34:32, p 164.



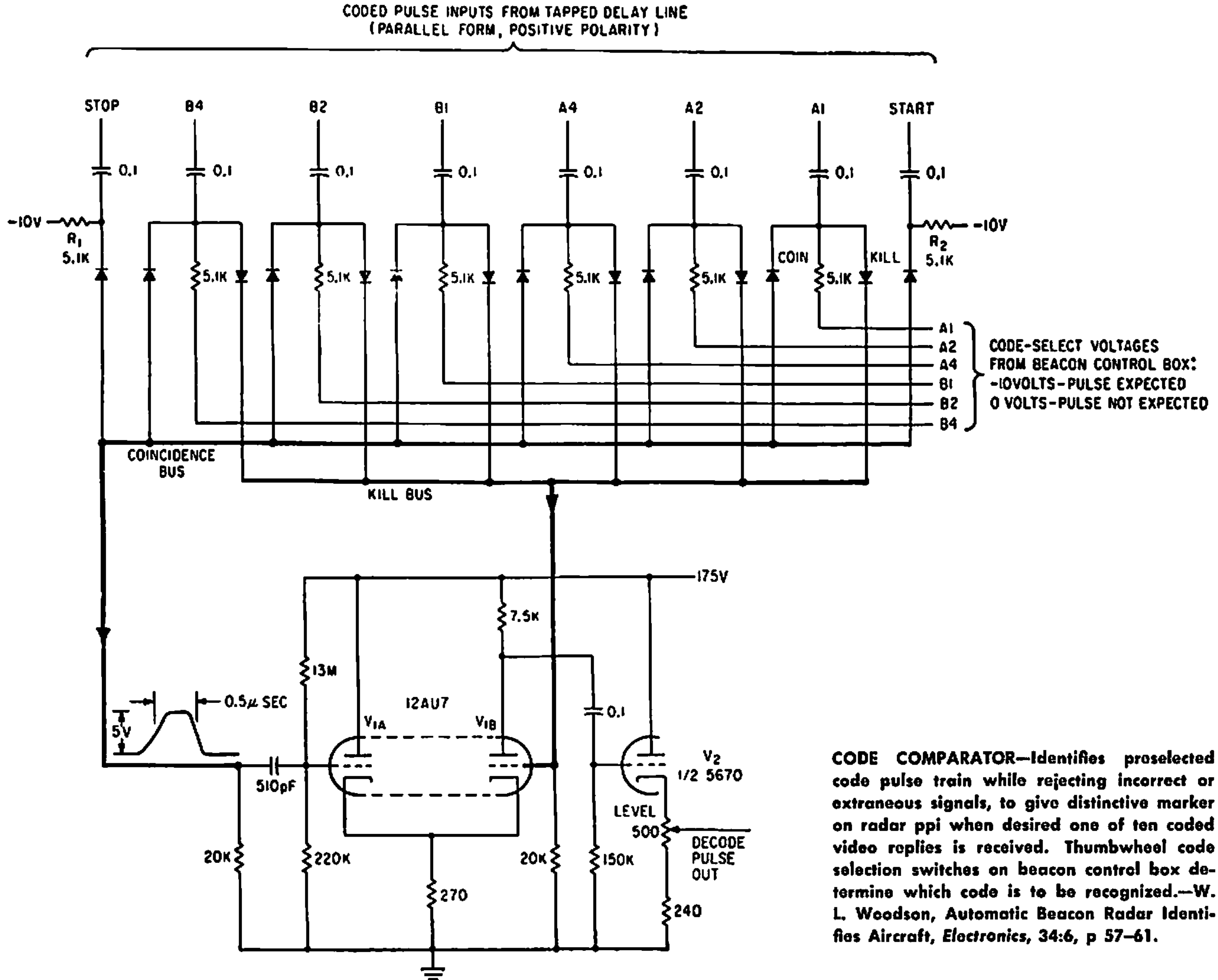
3-LIGHT SUPERHET MARKER BEACON—Gives audio output as well as colored-light presentation in aircraft. Superheterodyne provides immunity to spurious activation of lamps by tv stations.—F. P. Smith, Transistorized Receiver for Marker Beacon Use, *Electronics*, 32:46, p 76–78.

PULSE-CODED 100-WATT BEACON—Push-pull power oscillator with transmission-line tank gives good frequency stability at 220 to 260 Mc. Encoder uses capacitor charge and discharge to cut off V1 at intervals giving pairs of 10-microsec pulses to aid in recovery of spacecraft.—J. G. Richter, Redesigning Project Mercury Beacons, *Electronics*, 35:3, p 50–52.

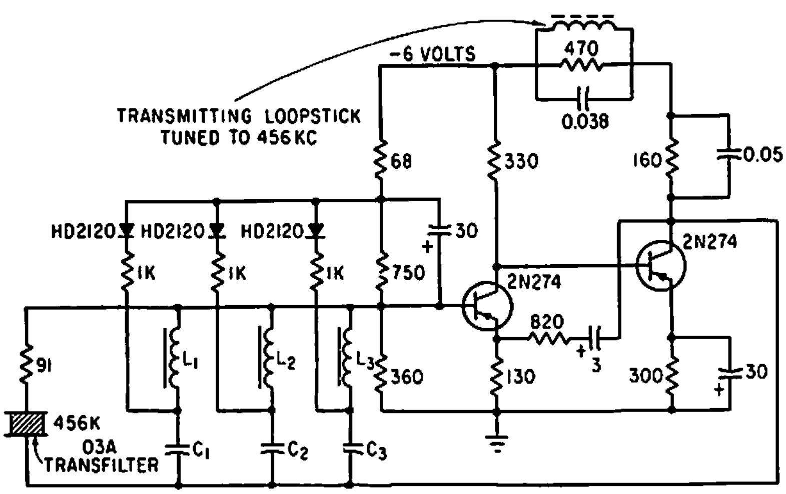




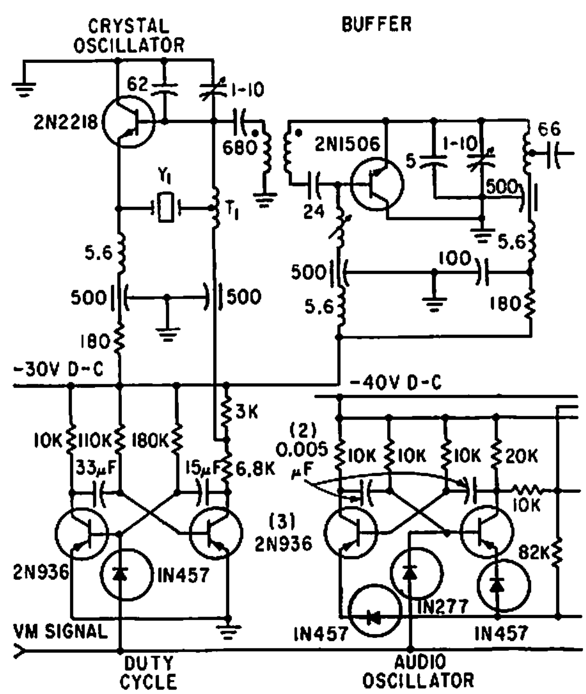
SOLID-STATE MARKER-BEACON RECEIVER—Three colored lamps glow in sequence during instrument landing system approach as 75-Mc receiver passes over three marker beacons modulated at 400, 1,300, and 3,000 cps respectively. Four-pole Butterworth filter ahead of first stage suppresses spurious response to 77.25-Mc carrier of television chanel 5. Single r-f stage isolates separate 68.75-Mc crystal controlled oscillator from antenna. Agc accomodates signals from 300 microvolts to 50 mv.—J. G. Robertson, Light-Airplane Marker-Beacon Receiver, *Electronics*, 37:3, p 33–35.

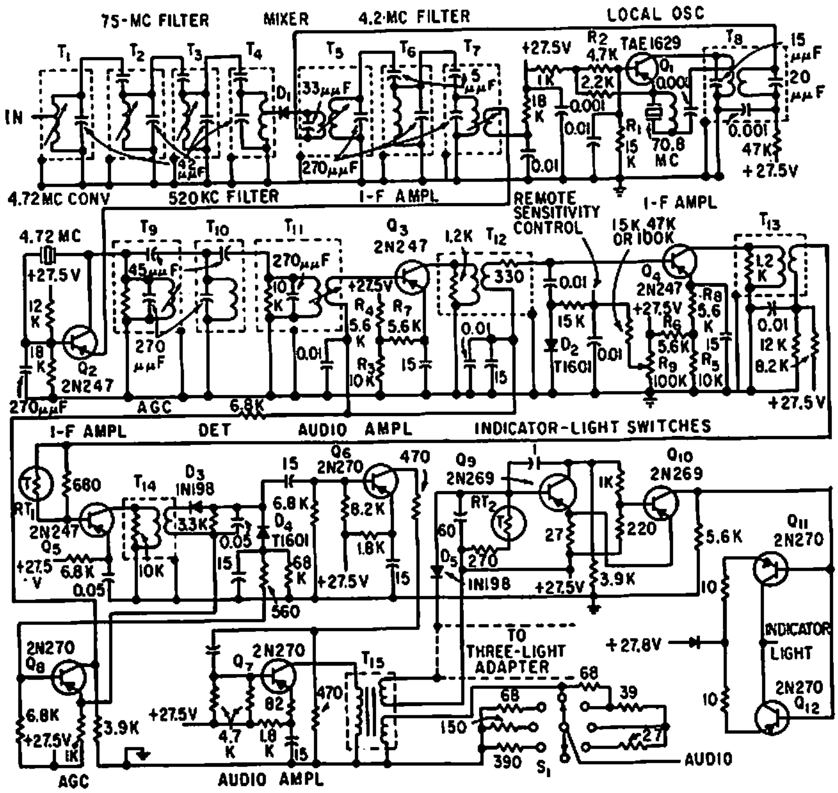


CODE COMPARATOR—Identifies preselected code pulse train while rejecting incorrect or extraneous signals, to give distinctive marker on radar ppi when desired one of ten coded video replies is received. Thumbwheel code selection switches on beacon control box determine which code is to be recognized.—W. L. Woodson, Automatic Beacon Radar Identifies Aircraft, *Electronics*, 34:6, p 57–61.

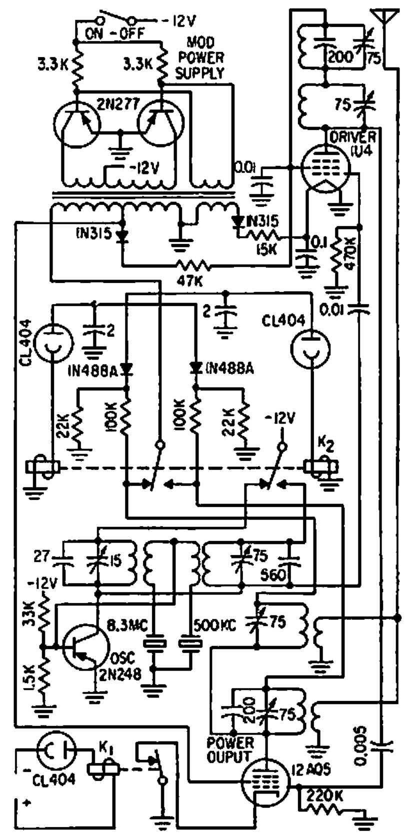


THREE-TONE VEHICLE BEACON—Multitone oscillator modulates 456-kc carrier with three different audio tones whose frequencies are determined by plug-in L-C tanks used in parallel with unstabilized BaTi Transfilter r-f tank circuit.—R. Stapelfeldt, Multitone Oscillators—New Source of Simultaneous Frequencies, *Electronics*, 36:1, p 86–87.

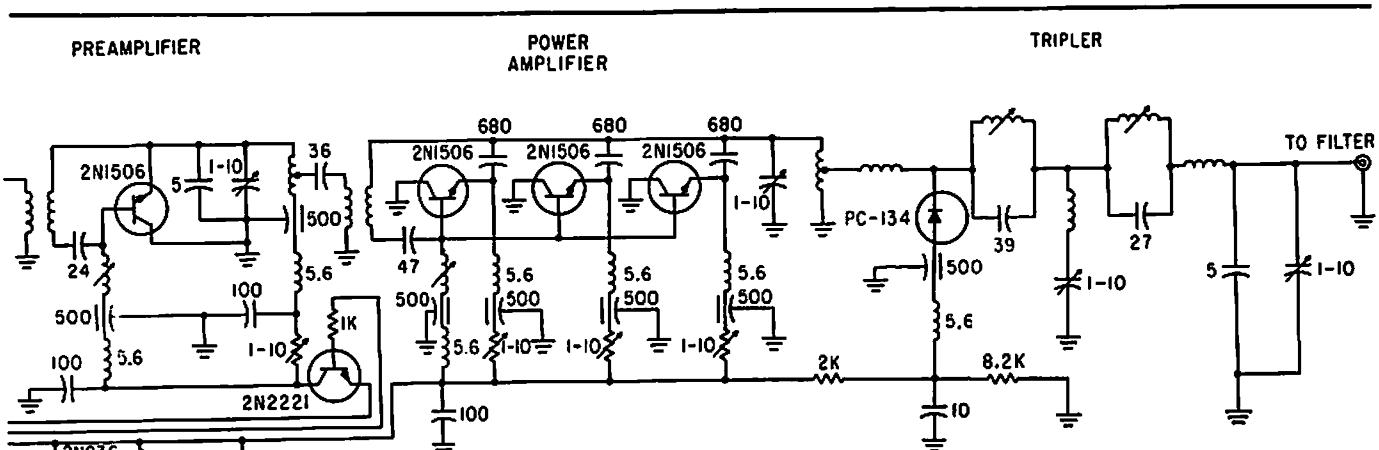


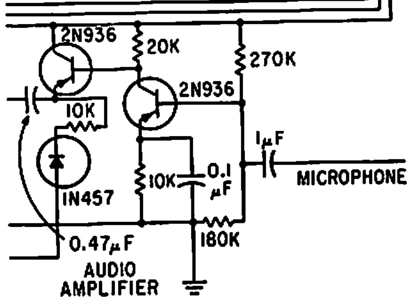


1-LIGHT AIRBORNE MARKER BEACON—Dual-conversion 75-Mc receiver has high first i-f for good image rejection and lower second i-f for stable gain. Responds to any of three modulating frequencies (3,000 cps airways, 400-cps outer runway, and 1,300-cps middle runway).—R. G. Erdmann, Transistor Dual Conversion for Marker-Beacon Receivers, *Electronics*, 32:19, p 59–61.



SOS ON TWO FREQUENCIES—Transistors and tubes are combined for maximum power efficiency at 5-w output. Operates on 500-kc and 8.326-Mc distress frequencies. Code-wheel-operated photoelectric flip-flop automatically switches bands and keys transmitter in SOS code.—H. B. Weisbecker, Distress Transmitter is Hybrid, *Electronics*, 31:31, p 98–100.

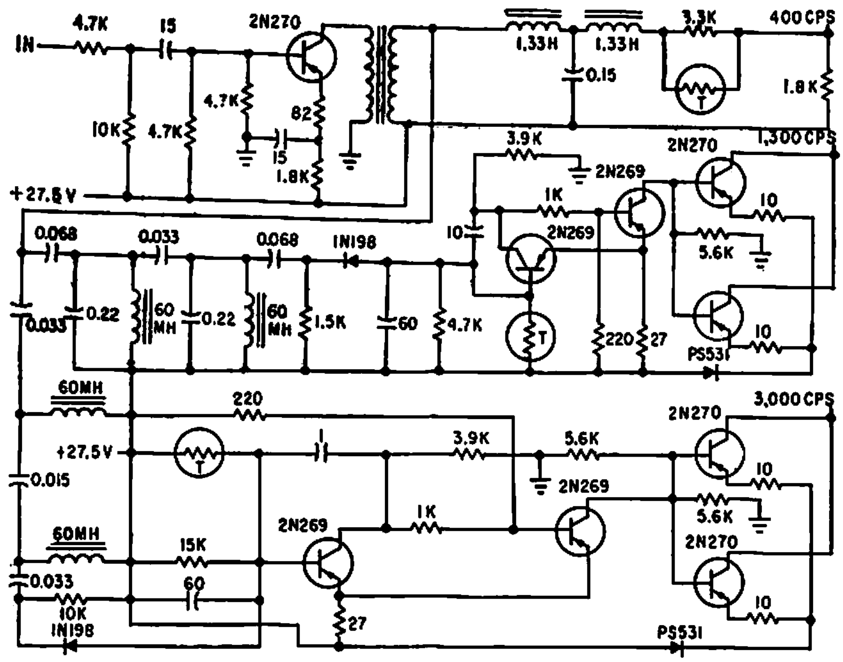




SOS BEACON—Gives 4 w output in 100-140 Mc or 220-260 Mc ranges. Uses class-C Hartley oscillator with crystal in feedback loop. Range is 100 miles for voice input and 200 miles for 1,000-cps tone of astable mvbr.—S. D. Czerwinski and F. S. Linn, Tiny Solid-State Transmitter May Save Your Life, *Electronics*, 35:48, p 90–91.

NOTES:

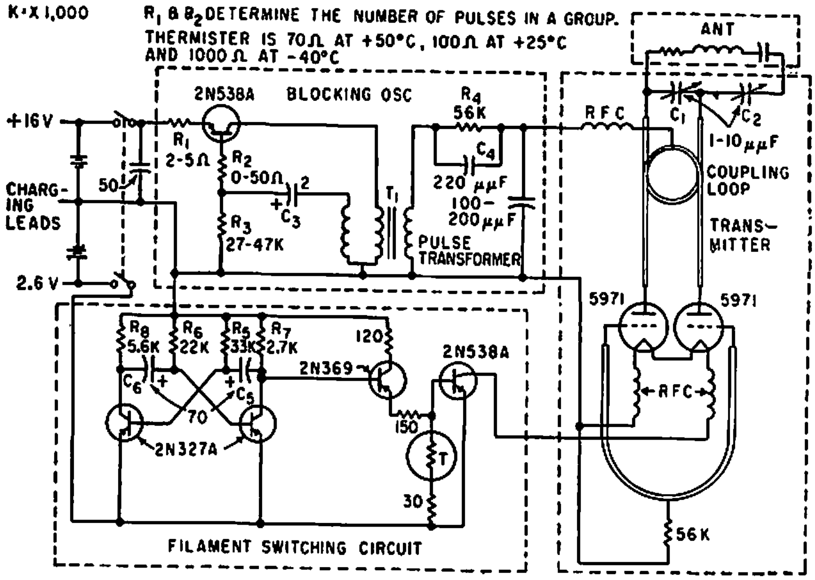
1. ALL CAPACITORS IN pF UNLESS SHOWN
2. ALL RFC'S IN μHys UNLESS SHOWN
3. TRANSFORMERS AND INDUCTANCES WOUND TO SPERRY DRAWINGS K=X 1,000



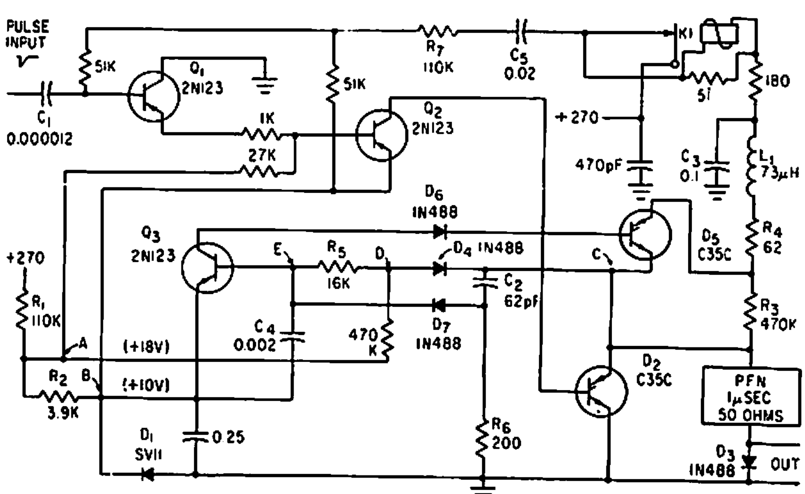
3-LIGHT MARKER-BEACON ADAPTER—Separates the three marker beacon modulating frequencies and converts them to voltages for operating three color-coded lights in aircraft. When added to one-light receiver, adapter requires only two more electronic switches, in addition to less amplifier and filters.—R. G. Erdmann, Transistor Dual Conversion for Marker-Beacon Receivers, *Electronics*, 32:19, p 59–61.

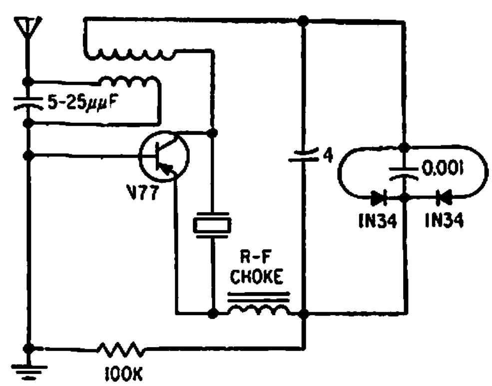
K=X 1,000

R_1 & R_2 DETERMINE THE NUMBER OF PULSES IN A GROUP.
THERMISTER IS 70Ω AT +50°C, 100Ω AT +25°C AND 1000Ω AT −40°C



CRASH-RESISTANT BEACON—Designed to withstand shocks up to 1,100 g and extreme environments, 5.7-lb beacon is thrown free of crashing aircraft and automatically starts transmitting pulse-modulated 243-Mc distress signal.—D. M. Makow, Radio Beacon Helps Locate Aircraft Crashes, *Electronics*, 33:4, p 54–56.

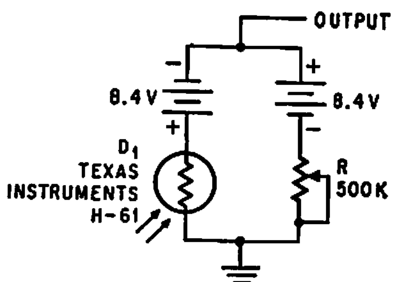




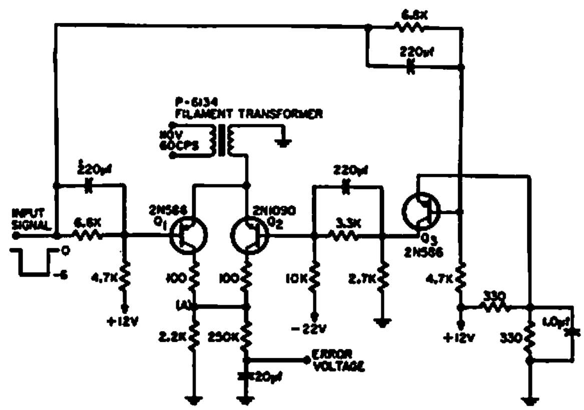
SIGNAL-POWERED TRANSPONDER—Power received at frequency of tuned antenna circuit energizes crystal transistor stage, to make it oscillate at a different frequency. Can be used in aircraft or vehicle to make it radiate position-determining signal when interrogated by powerful transmitter at base station.—L. R. Crump, Radio Waves Power Transistor Circuits, *Electronics*, 31:19, p 63–65.

GATED-DIODE BEACON MODULATOR—Replaces hydrogen-thyratron line-pulsing modulators formerly used to plate-pulse pencil triode in beacon transmitter. Maximum pulse rate is 5,000 pps.—W. H. Lob, Solid-State Pulse Modulator, *Electronics*, 33:30, p 72–74.

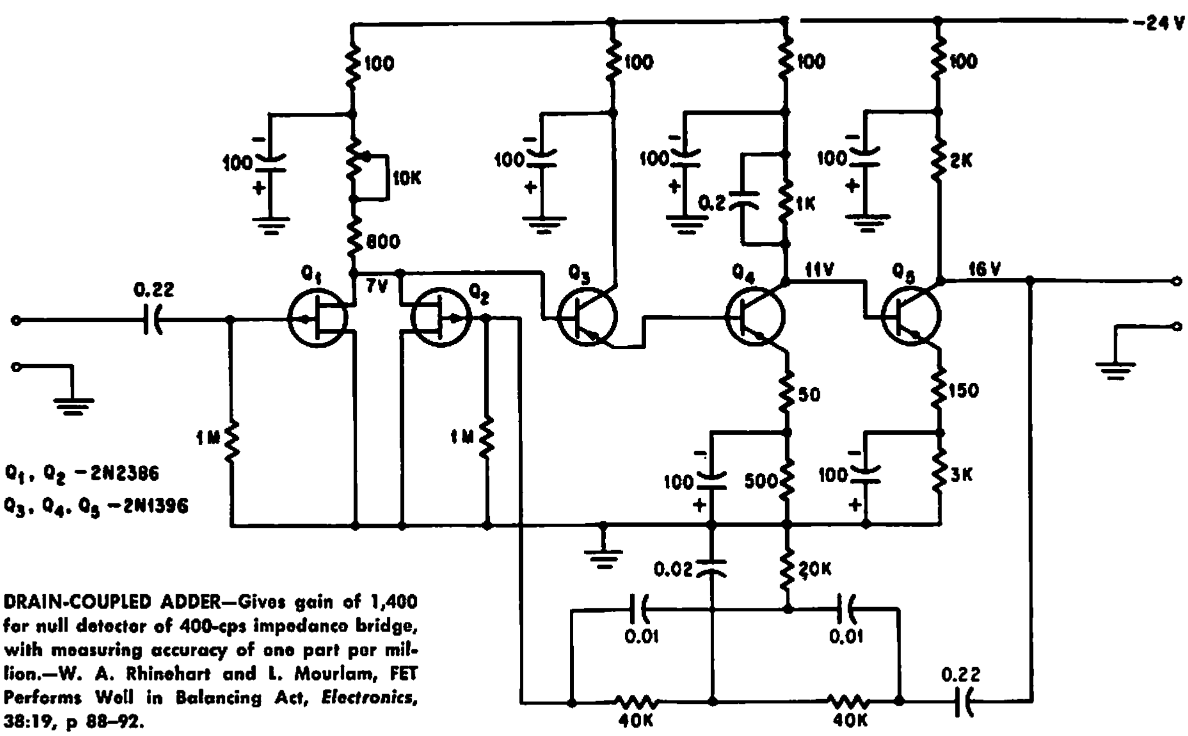
CHAPTER 10
Bridge Circuits



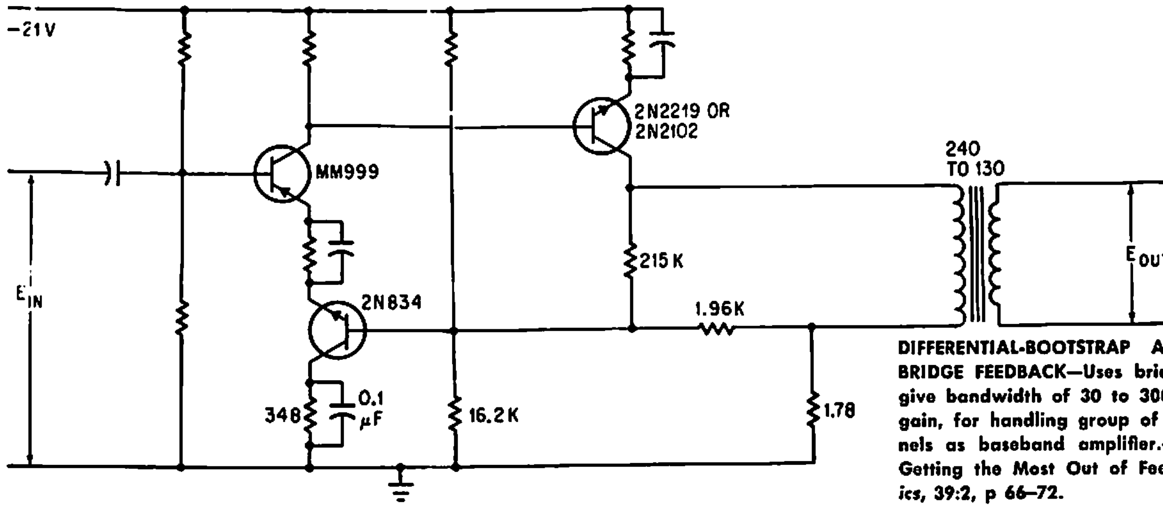
PULSE HEIGHT DETECTOR—Photodiode held against screen of scope unbalances bridge when illuminated by pulse on screen. Bridge output can control another scope for displaying and measuring pulses whose amplitude and period vary randomly.—I. Baird, Pulse Frequency Measured by Photoconductor and Scopes, *Electronics*, 38:13, p 77.



PHASE-DIFFERENCE BRIDGE—Develops d-c error voltage proportional to phase difference between two applied signals, one of which is 60-cps line-frequency reference. Can also correct oscillator outputs and serve as pulse-width discriminator.—D. P. Dorsey, Transistor Bridge Detector, *EEE*, 13:1, p 75.

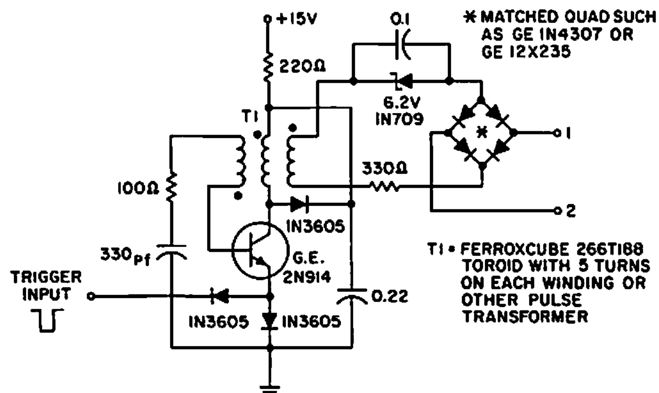


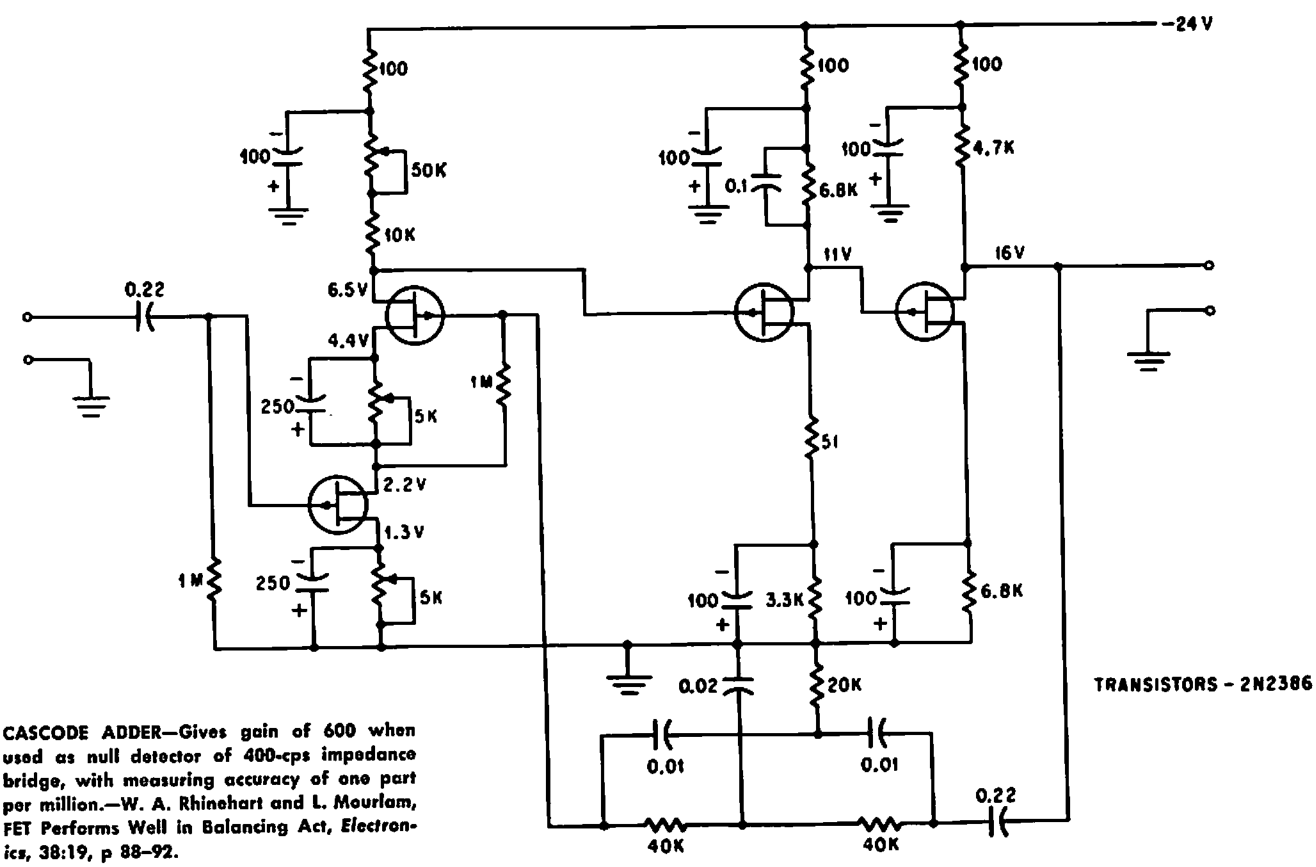
DRAIN-COUPLED ADDER—Gives gain of 1,400 for null detector of 400-cps impedance bridge, with measuring accuracy of one part per million.—W. A. Rhinehart and L. Mourlam, FET Performs Well in Balancing Act, *Electronics*, 38:19, p 88–92.



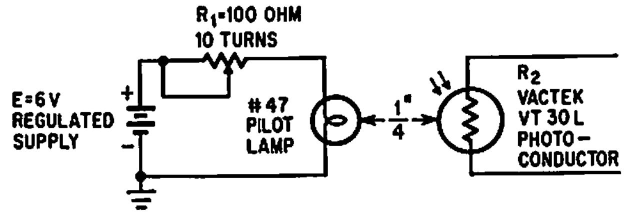
DIFFERENTIAL-BOOTSTRAP AMPLIFIER WITH BRIDGE FEEDBACK—Uses bridge feedback to give bandwidth of 30 to 300 kc with 40 db gain, for handling group of telephone channels as baseband amplifier.—N. A. Zellmer, Getting the Most Out of Feedback, *Electronics*, 39:2, p 66–72.

DIODE SAMPLING BRIDGE—Uses diode matched quad with blocking-oscillator driving circuit. Negative input pulse triggers oscillator, generating pulse about 100 nsec wide, to forward-bias bridge diodes and reduce impedance between terminals 1 and 2 to about 5 ohms. Between pulses, diodes are reverse-biased by capacitor charge and impedance between terminals rises to 1,000 meg.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 450.

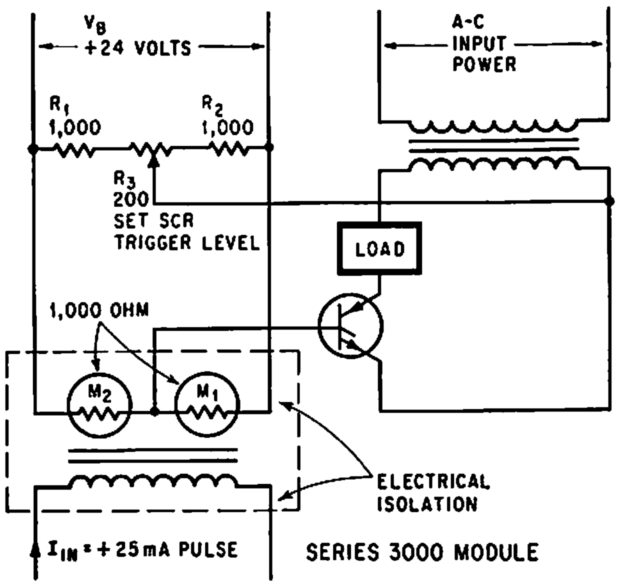




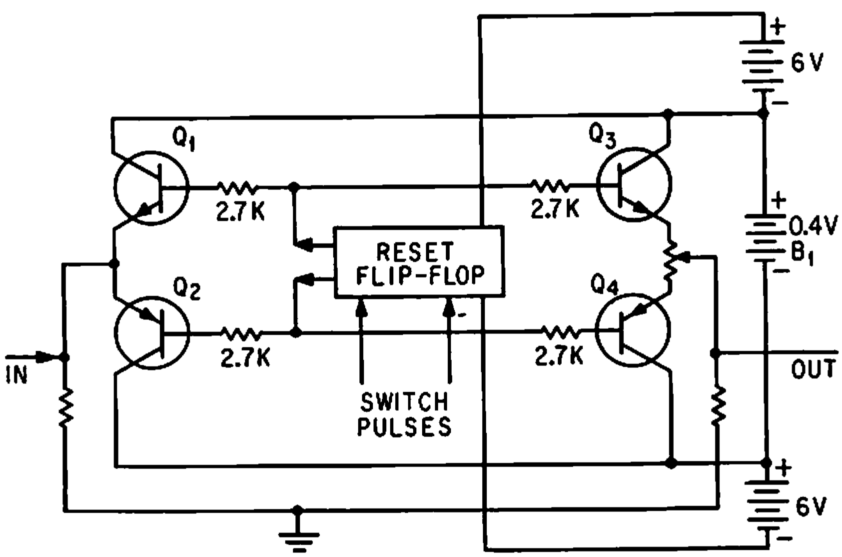
CASCODE ADDER—Gives gain of 600 when used as null detector of 400-cps impedance bridge, with measuring accuracy of one part per million.—W. A. Rhinehart and L. Mourlam, FET Performs Well in Balancing Act, *Electronics*, 38:19, p 88–92.



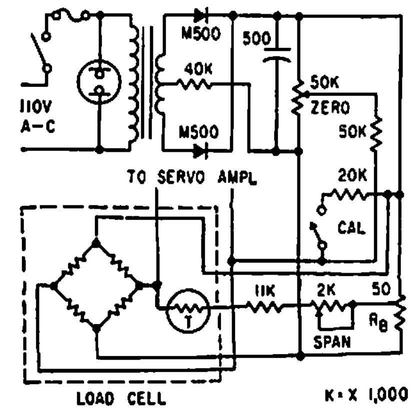
OPTOELECTRONIC BRIDGE ELEMENT—Lamp with rheostat varies resistance of photocell over range of 100 to 10,000 ohms to give stable nonreactive resistance element for r-f bridge.—R. H. Wagner, Variable R-F Resistor Attained With Photocell, *Electronics*, 37:26, p 67.



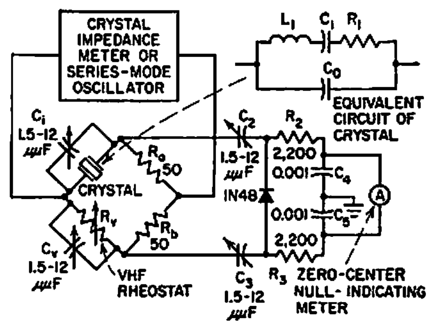
SCR CONTROL—Firing angle and trigger level are controlled by magnetoresistor bridge.—R. M. Gitlin, Magnetoresistors Isolate Load From Control Circuit, *Electronics*, 38:3, p 54–59.



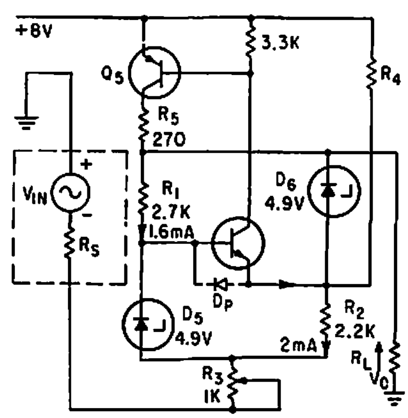
TRANSISTOR BRIDGE SWITCHES MICROVOLT SIGNALS—Circuit approaches infinite impedance during off condition by lowering emitter-to-collector conductance gap to zero. Conventional reset flip-flop controls on and off operation of series-connected npn and pnp bridge transistors.—M. V. Kalfaian, Transistor Bridge Switches Microvolts, *Electronics*, 37:1, p 60.



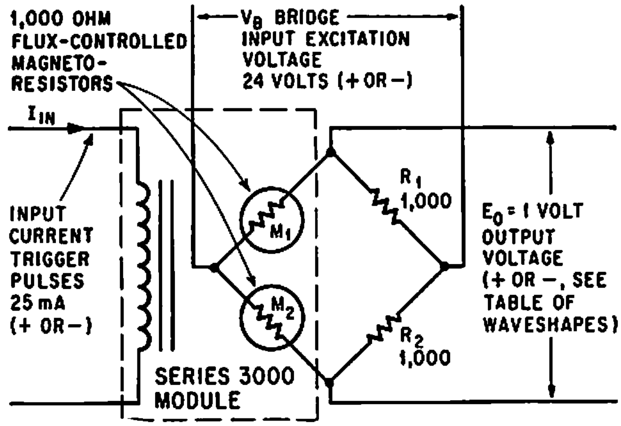
SELF-BALANCING TORQUE INDICATOR—Uses shunt bridge balancing technique. Amplifier and servo motor that drive 50-ohm balancing pot RB are standard commercial units. Highly stable power supply and reference voltage are not needed.—C. H. Haakana, Shunt Bridge Balancing in Strain-Gage Indicators, *Electronics*, 32:30, p 50–51.



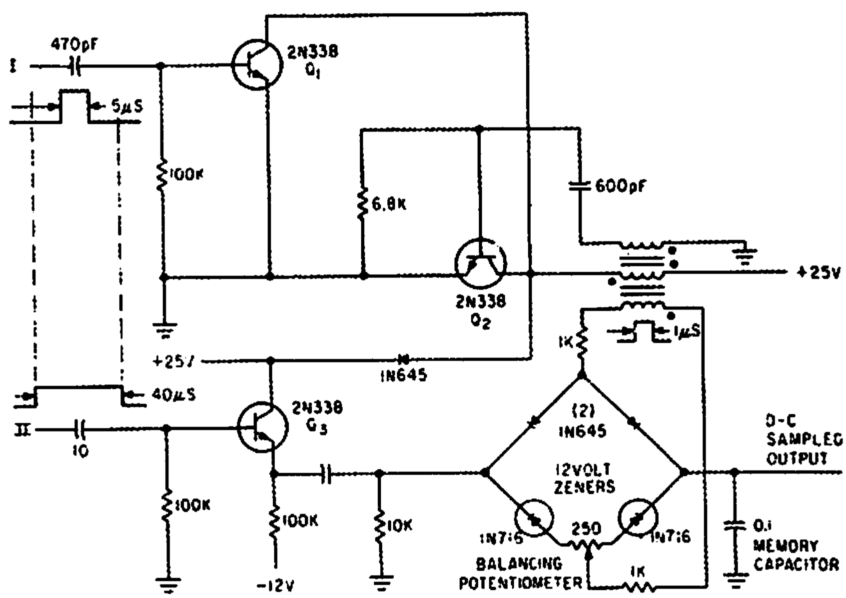
CRYSTAL-PARAMETER BRIDGE—Bridge plugs into crystal socket of standard crystal impedance meter, and crystal under test plugs into bridge. Only other instruments needed for measuring equivalent parameters of overtone crystals for 75 to 200 Mc are frequency meter and null-indicating meter.—D. W. Robertson, Plug-in Bridge Checks VHF Quartz Crystals, *Electronics*, 31:19, p 82–85.



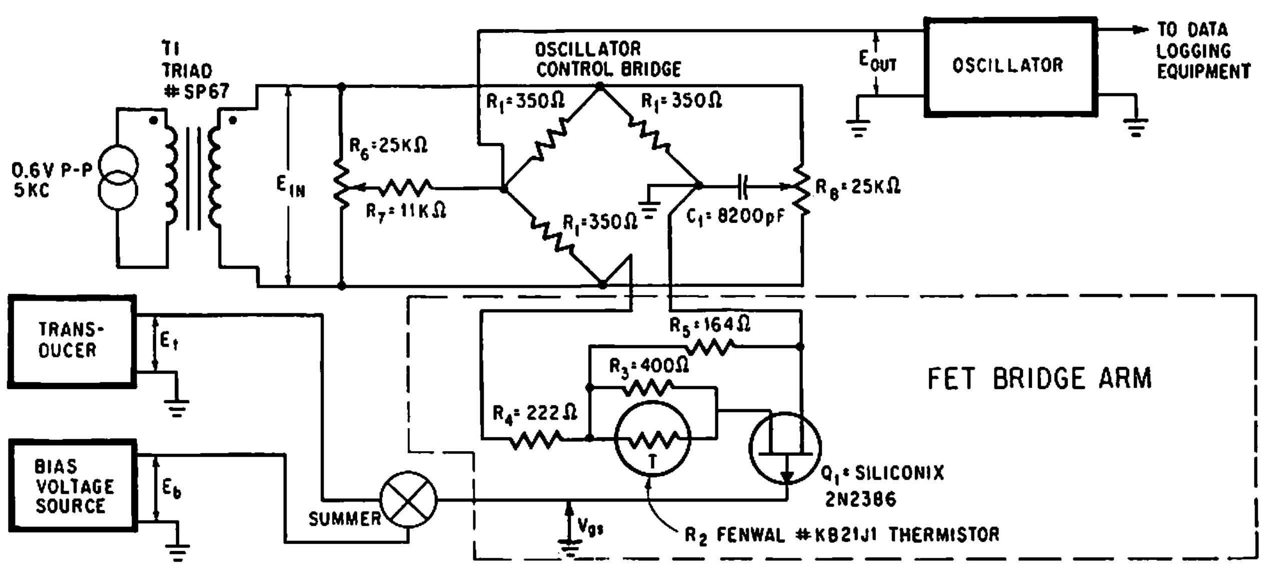
D-C LEVEL SHIFTER—Bridge R1D5R2D6 and two transistors in d-c negative-feedback loop deliver output signal that is replica of input but at lower impedance and shifted in d-c voltage level a predetermined amount.—J. Willis, High Precision D-C Level Shifter Reduces Output Impedance, *Electronics*, 36:18, p 65–68.



INPUT PULSE UNBALANCES BRIDGE—Trigger pulse causes opposite resistance variations in magnetoresistors M1 and M2, to give 1 v output for 25-ma pulse current.—R. M. Gitlin, Magnetoresistors Isolate Load From Control Circuit, *Electronics*, 38:3, p 60–61.

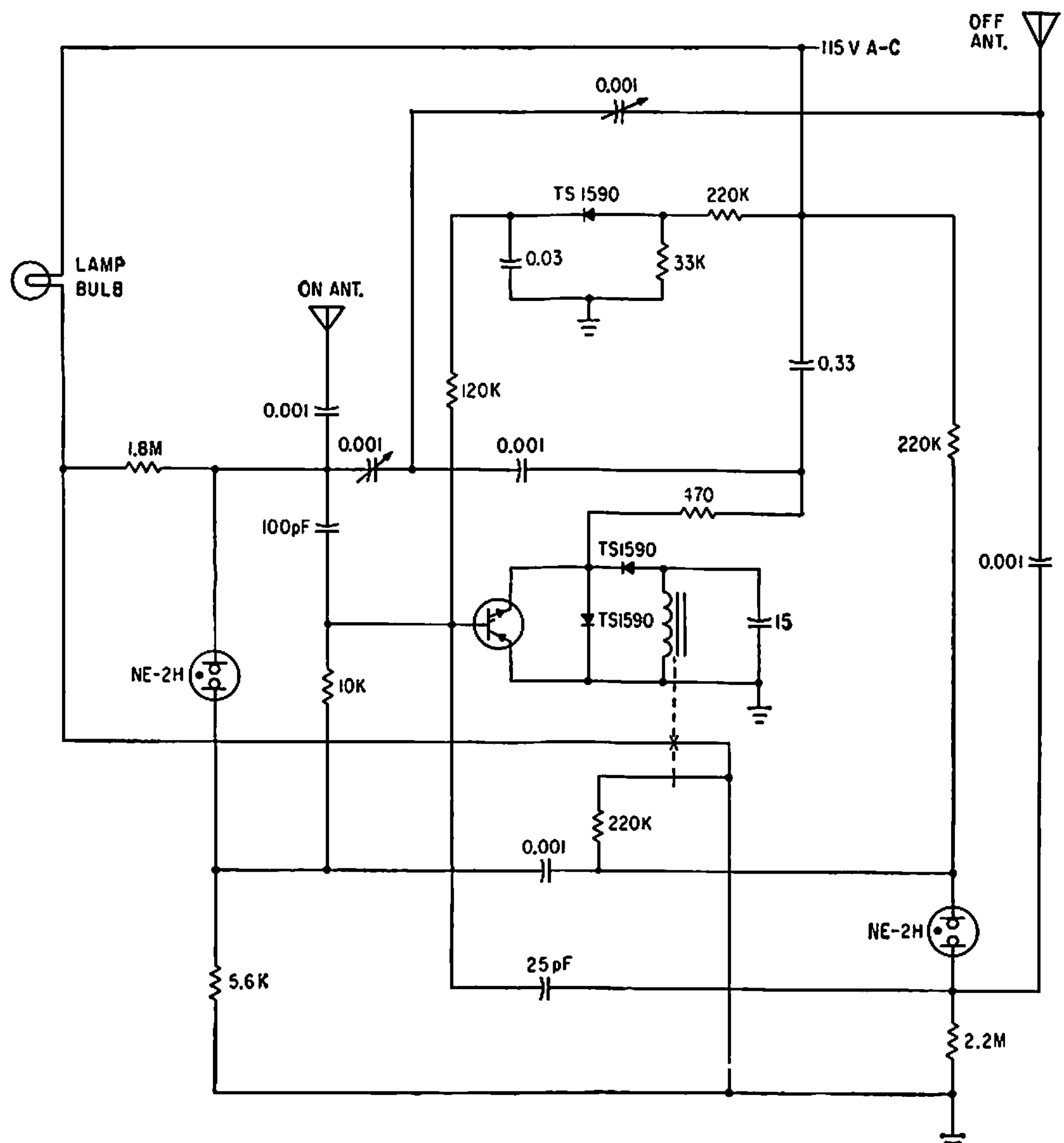


PULSE CLAMP—Clamps pulses in millivolt range to any d-c level even though pulses are below barrier potentials. Also used for sampling pulse amplitudes and for storing sampled amplitude in memory capacitor.—A. J. Koll, E. Bleckner, and O. C. Srygley, Semiconductor Clamp Handles Millivolt Signals, *Electronics*, 33:35, p 64–65.

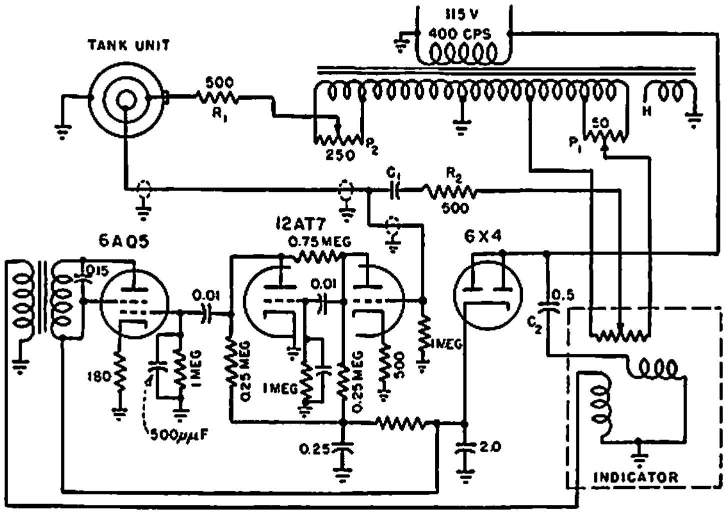


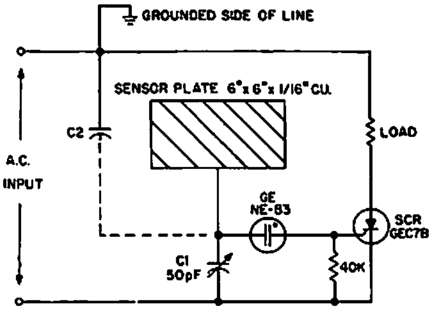
TRANSDUCER VOLTAGE-RESISTANCE CONVERTER—D-c voltage output of transducer is converted to a-c voltage by fet in one leg of bridge that controls f-m oscillator. Arrangement converts transducer in effect to variable resistor, simplifying measurement of many parameters in data acquisition system.—A. R. Greenfield and W. H. McCloskey, FET Converts Transducer for Use in A-C Bridge, *Electronics*, 39:3, p 84–85.

CHAPTER 11
Capacitance Control Circuits



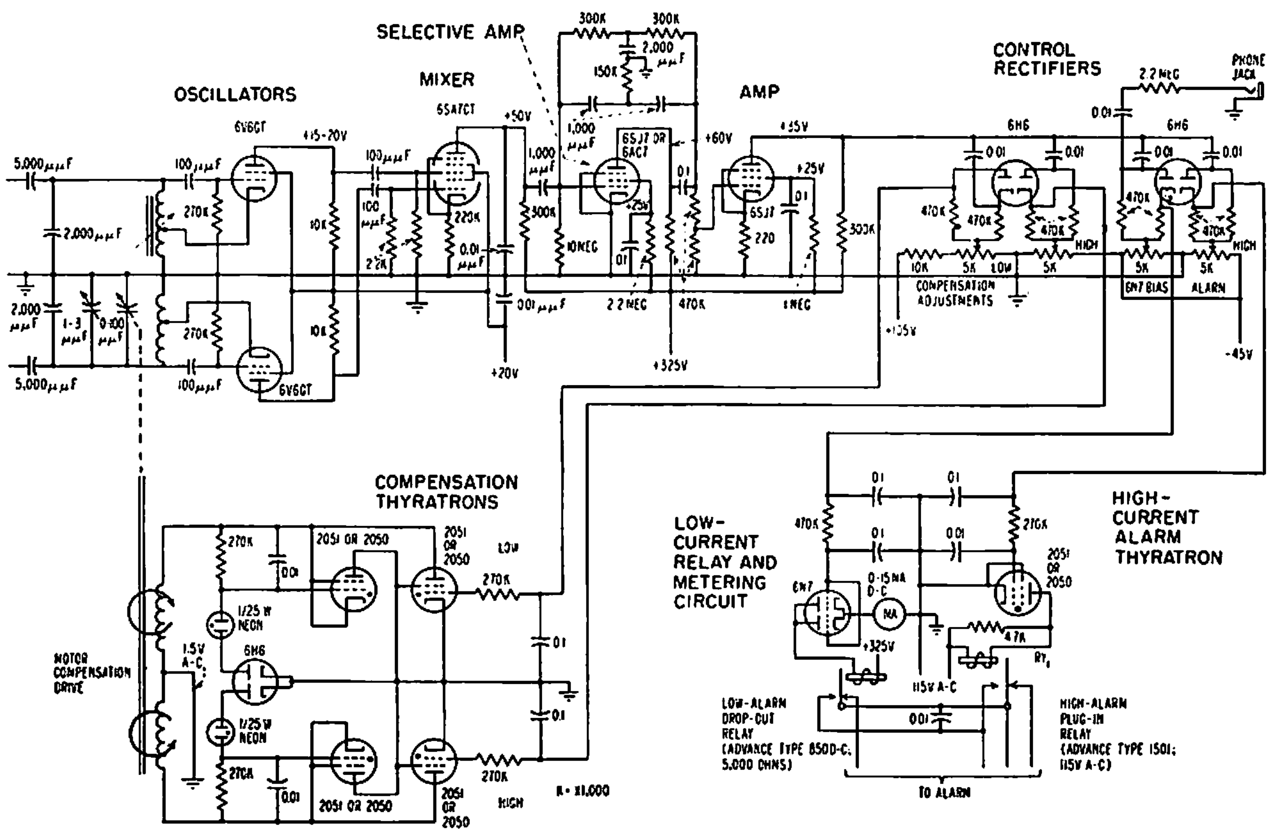
TOUCH-CONTROLLED SWITCH—Normal 30 to 100-pf capacitance of human body turns lamp on and off. Touching on antenna loads high-impedance network, reducing neon-lamp oscillator voltage below level required for firing four-layer pnpn germanium alloy transistor, and current that was shunted to ground through transistor now operates relay, turning on lamp. Touching off antenna reverses all conditions.—S. B. Gray, Home and Auto Controls, *Electronics*, 36:19, p 52–66.



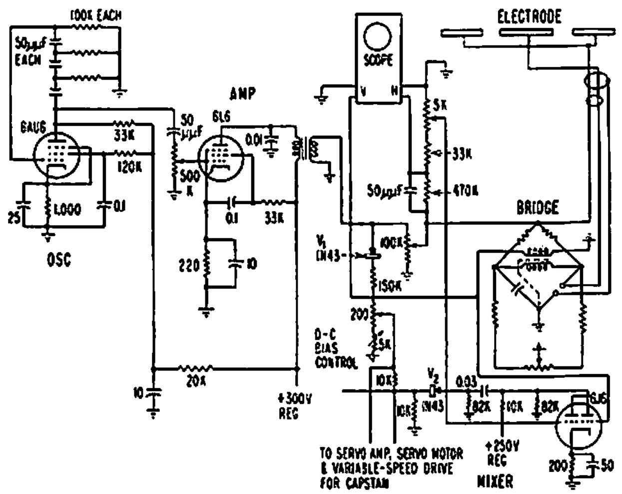


CAPACITANCE-TYPE AIRCRAFT FUEL GAGE—Indicates weight of fuel rather than volume. Uses self-balancing bridge, with concentric-tube capacitor mounted vertically in cell of tank to serve as one arm. With fuel in tank, servo drives bridge-rebalance potentiometer and indicator to new position corresponding to amount of fuel in tank.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 21.

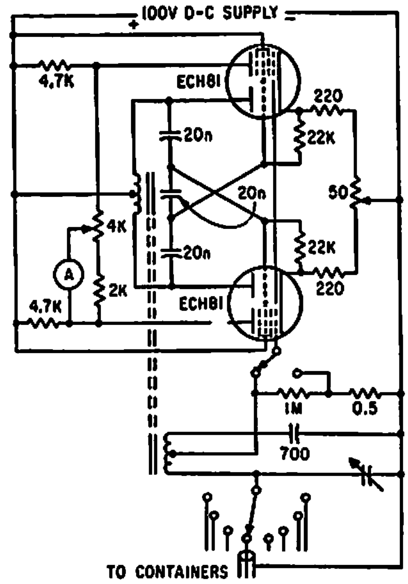
PROXIMITY SWITCH—Sensor plate and C2 form capacitive voltage divider across a-c supply. Value of C2 depends on proximity to sensor plate of human body, grounded object, or other reasonably conductive object. When voltage across C1 exceeds breakdown of neon, C1 and C2 discharge through scr gate, causing scr to trigger and energize load. Latching action is obtained by driving scr anode circuit with d-c, for such applications as elevator floor selector buttons and door safety controls.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 122.



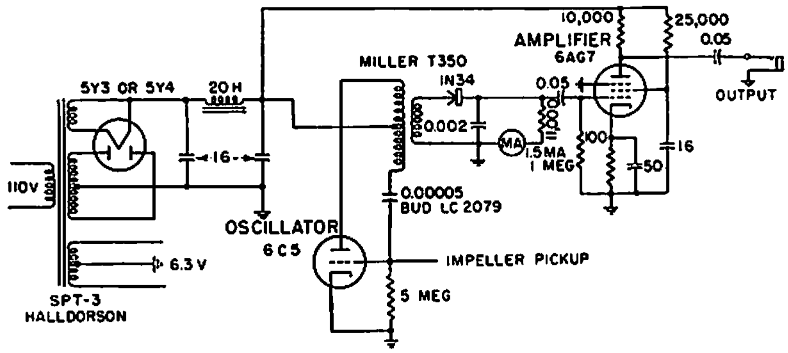
BALANCED-CAPACITANCE FENCE ALARM—Sets off alarm when anyone approaches barbed wire fence around power plant or substation. Automatically corrects for capacitance changes due to weed growth and changing weather conditions. Two separate antennas and two oscillators are used, with lines along fence serving as part of tuning capacitance of each oscillator. Mixer produces beats between harmonics. Frequency-selective network in low a-f range produces d-c voltages that trigger relay tubes and actuate alarm relays.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 1.



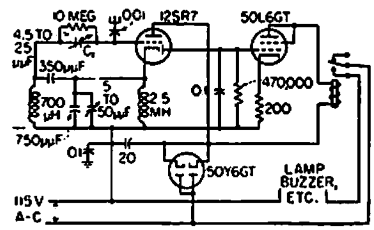
CONTROLLING EXTRUSION OF PLASTIC ON WIRE—Uses sensing probe as one arm of capacitance bridge that is normally balanced with respect to 10-kc phase-shift oscillator signal. Oscillator output is compared with bridge unbalance in mixer that determines directional error. Output of mixer is amplified to control servo-driven rheostat which in turn controls speed at which wire is pulled, to hold capacitance within desired limits. Sensing electrode is water trough, with water in contact with extruded insulation to form one side of unknown capacitor. Wire is grounded to form other side.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," Mc-Graw-Hill, N.Y., 1956, p 18.



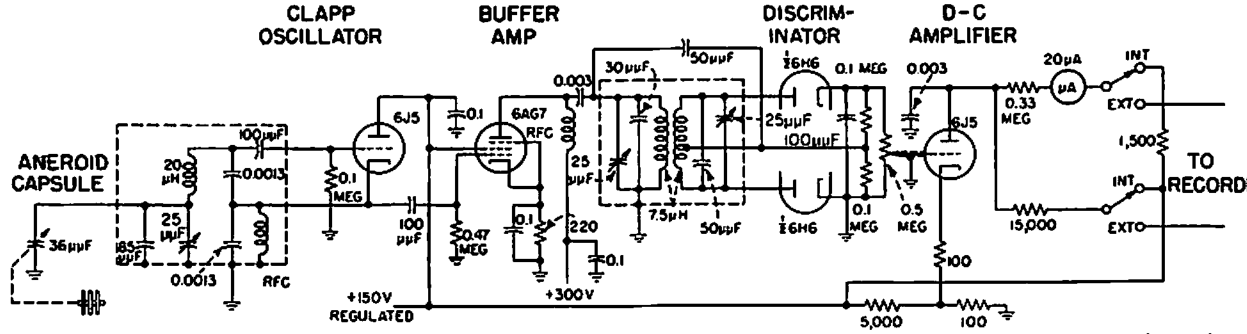
MONITORING ENAMEL THICKNESS ON WIRE—Wire is run through mercury-filled vessel. Bridge output goes to pair of mixer tubes (6AJ8 is U.S. equivalent) whose plate circuits form d-c vtvm, with milliammeter indicating amount of bridge unbalance. Bridge is formed by connecting mercury vessel, grounded wire, fixed capacitor, and variable capacitor to secondary coil of differential transformer.—Monitor Wire Enamel by Capacitance Bridge, *Electronics*, 33:44, p 92–97.



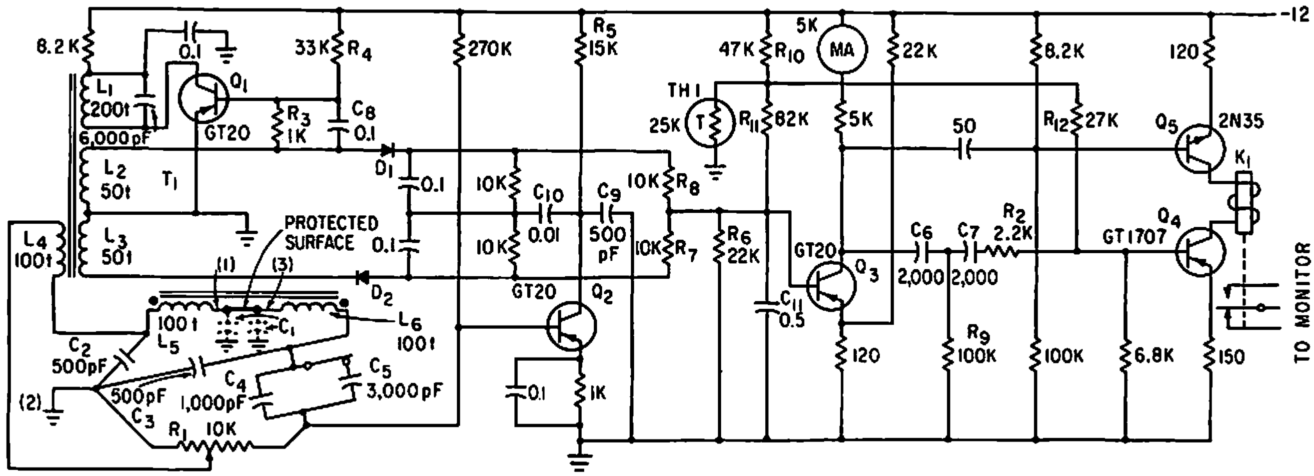
CAPACITANCE TRANSDUCER FOR 30,000-RPM TACHOMETER—R-f oscillator is adjusted to oscillate feebly anywhere between 500 and 2,000 kc. When pickup capacitance increases, it shunts oscillator feedback circuit more, reducing its r-f output voltage. Resulting drop in a-c component of rectified r-f carrier is amplified to drive tachometer or frequency meter. Pickup is mounted close to moving blades on shaft whose speed is being measured.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 17.



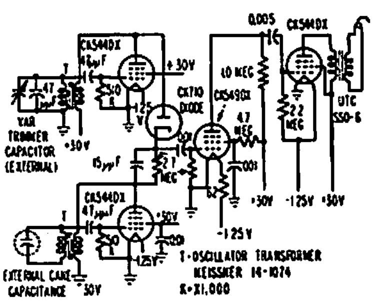
INTRUSION ALARM—Circuit stops oscillating when intruder approaches antenna surrounding area being protected. Uses weak oscillator with relay tube that is biased to cutoff by some of oscillator output. Additional capacitance caused by intruder stops oscillator, removing bias and making tube conduct and actuate relay to sound alarm.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits,"McGraw-Hill, N.Y.,1956, p 19.



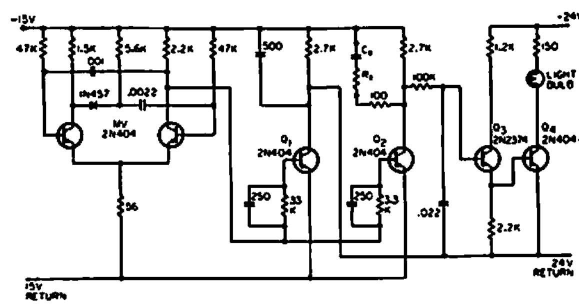
ANEROID-DRIVEN CAPACITOR—Datum stabilizer for radar-altimeter surveying uses oscillator to produce output current proportional to change in altitude. Resonant frequency of high-stability 3.5-Mc oscillator is varied by small capacitor plate driven by three-element aneroid. Discriminator and d-c amplifier transform resulting frequency changes to current variations proportional to changes in height.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 23.



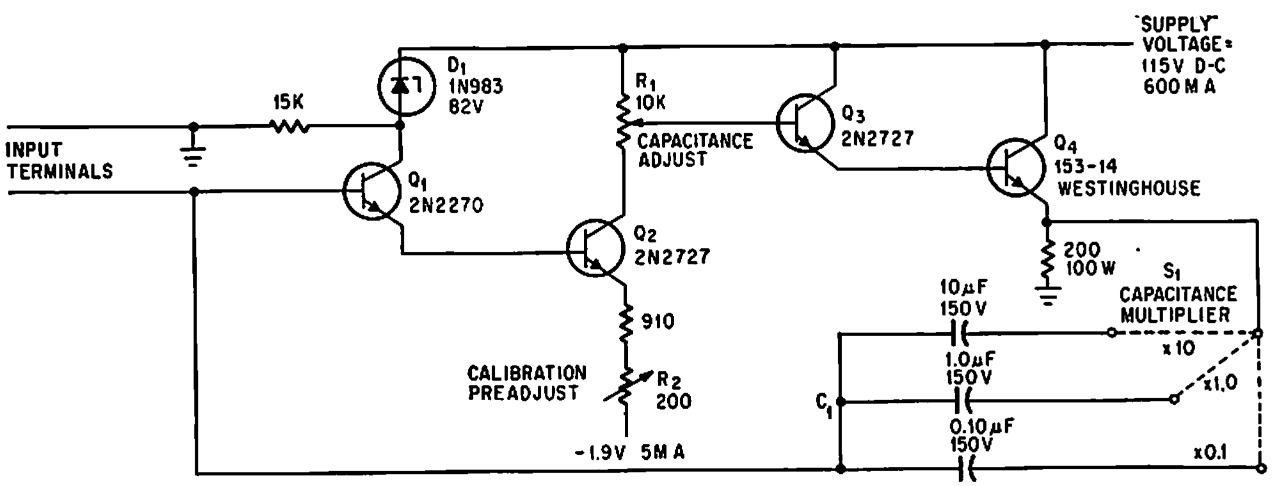
BODY-CAPACITANCE ALARM—Detects intruder by sensing body capacitance. Oscillator Q1 feeds 20 kc to capacitance bridge that contains C1, which is capacitance to ground of protected cabinet. When unbalanced, bridge feeds 20-kc signal to amplifier Q2, whose output goes to phase-sensitive detector D1-D2, which converts unbalance signal into d-c voltage for amplification by Q3. At balance, Q4 and Q5 send about 1 ma through relay K1 to keep it energized. When intruder approaches protected cabinet, output of phase-sensitive detector becomes more negative, causing K1 to drop out and sound an alarm. —S. M. Bagno, Sensitive Capacitance Intruder Alarm, *Electronics*, 33:38, p 65–67.



SENSING CANE FOR BLIND—Capacitance-sensing probe in tip of cane changes frequency of one oscillator in accordance with distance from ground, curb, or holes, to make beat-frequency oscillator produce audio tone in headset worn by blind person.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 24.

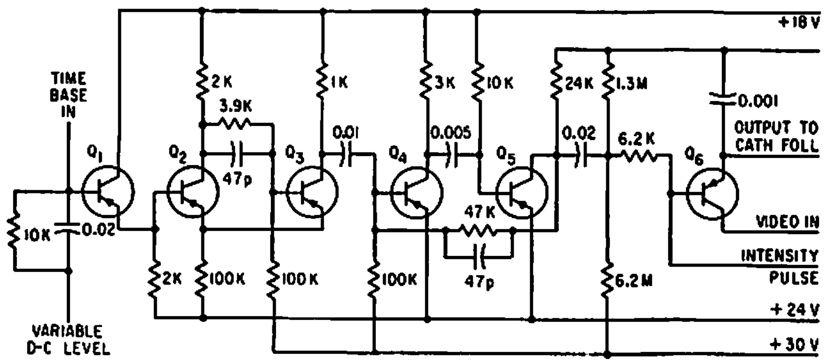


IN-CIRCUIT CAPACITOR TESTER—Permits checking capacitors dynamically for opens or shorts without disconnecting them. Indicator light is turned on for both faults.—E. L. Major, In-Circuit Capacitor Tester, *EEE*, 13:3, p 47.

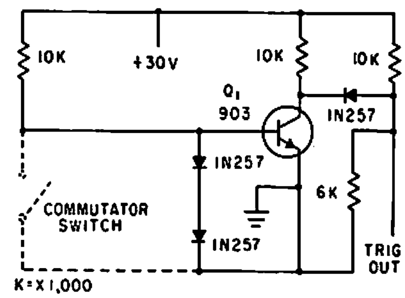


ELECTRONIC CAPACITOR—Two-terminal circuit provides capacitance values from 0.1 to 100 mfd, continuously variable in three ranges. Voltage rating is +10 v and frequency range is d-c to 45 cps. Used in low-pass RC filter with adjustable cutoff frequency, in waveform analyzer.—D. L. Bergman, Electronic Capacitor is Continuously Variable, *Electronics*, 3 21, p 89.

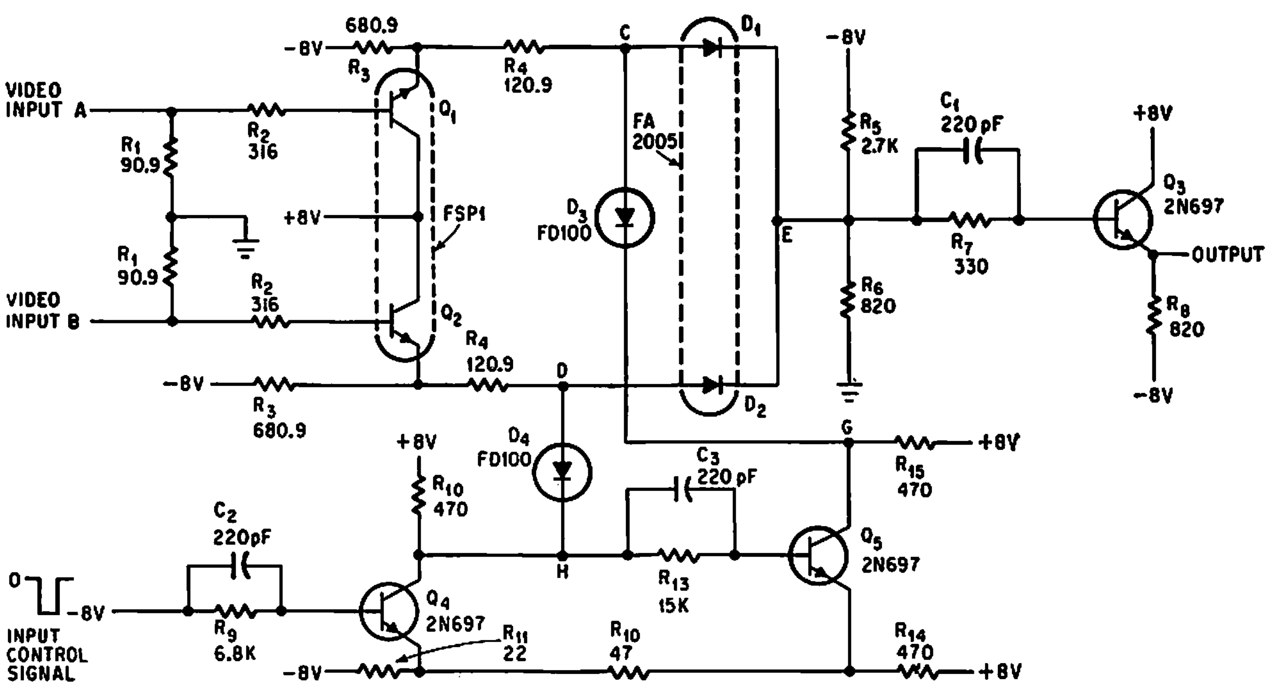
CHAPTER 12
Cathode Ray Circuits



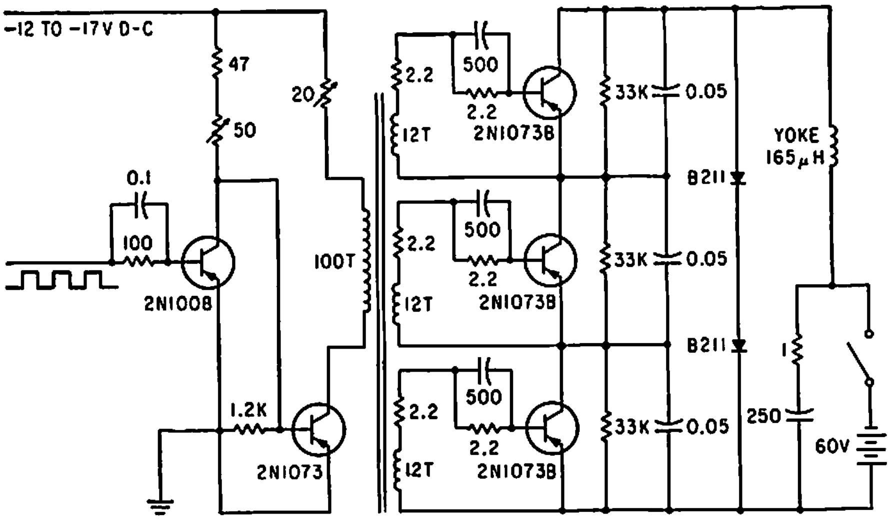
CRO LEVEL-CONTROLLED STROBE—Variable input level determines part of telemetry signal that is selected for cathode-ray display. Output of Schmitt trigger Q2-Q3 is square wave with repetition rate determined by time-base frequency, and mark-space ratio controlled by variable d-c level input.—A. D. Runnalis, Bluebird Racer's Telemetry System, *Electronics*, 33:44, p 70–72.



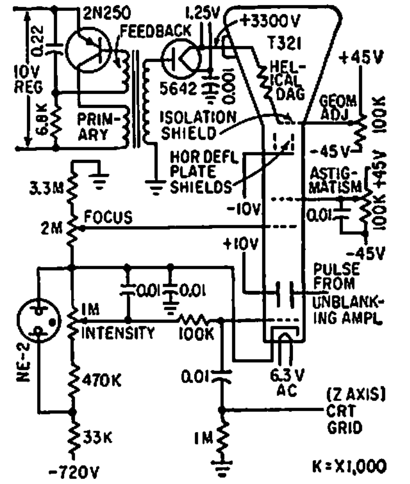
CRO SWEEP TRIGGER—Base of Q1 is grounded once during each revolution by commutator segment of gyro balancer, to make circuit produce sharp pulse that triggers oscilloscope sweep.—F. W. Kear, Electronic System for Balancing Gyro Wheels, *Electronics*, 33:43, p 82–85.



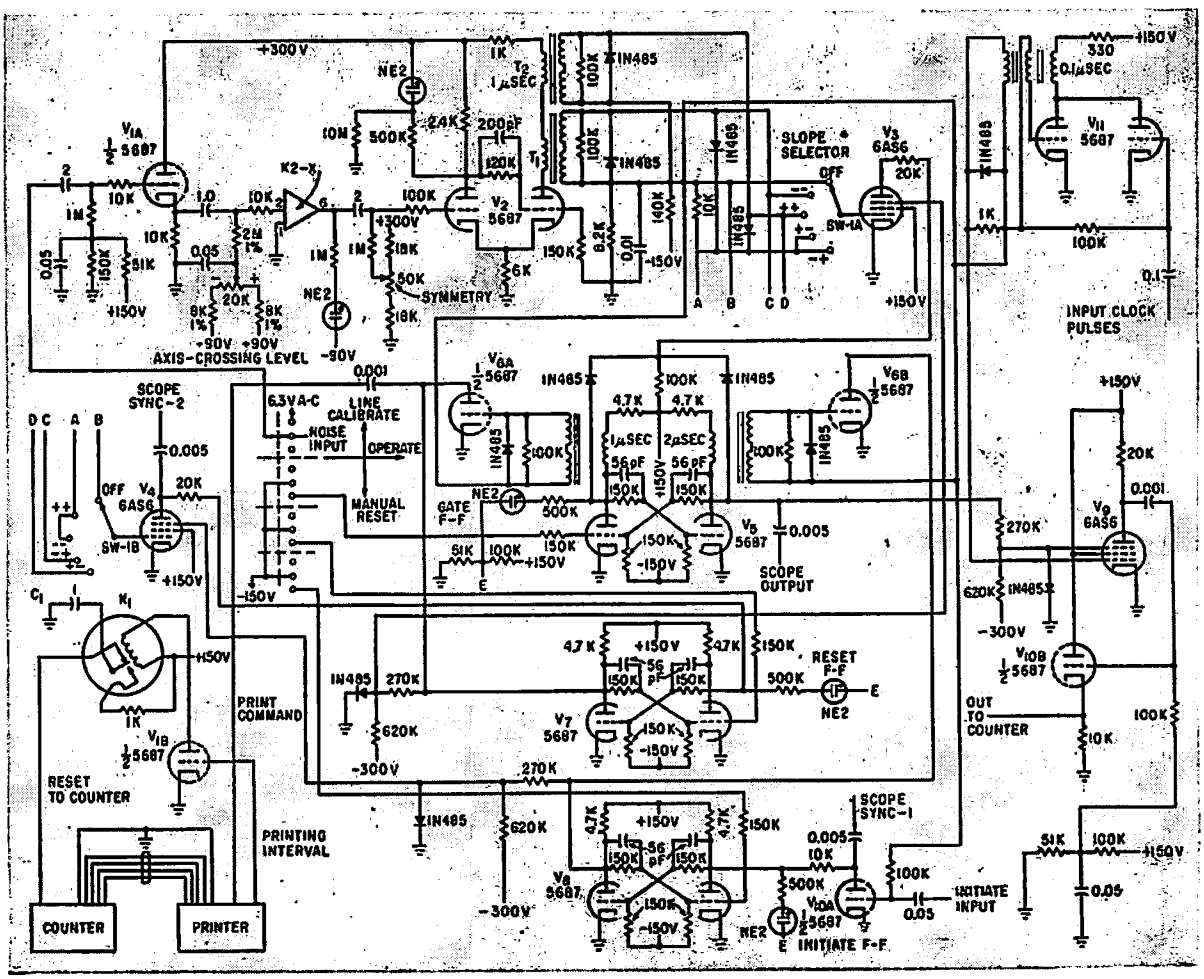
TWO-SIGNAL DISPLAY—Electronic switch samples two video signals and modulates crt beam so both waveforms appear simultaneously on screen. Matched diodes D1 and D2 serve as switches for the positive 2-v video signals.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.



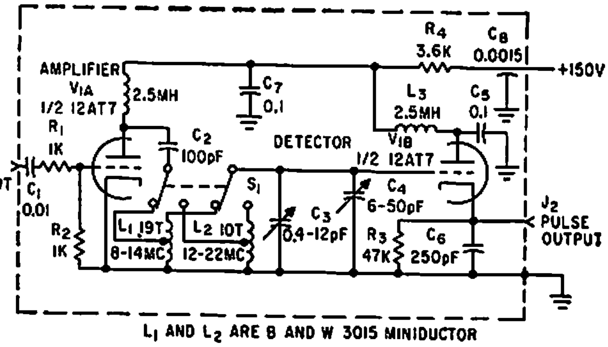
DEFLECTING 22-INCH CRT AT 50 KC—Circuit provides 5-amp peak-to-peak yoke current for full 70° deflection of analog computer display. Rapid collector turnoff minimizes retrace time. Two B-211 diodes, series-connected as dampers, must be matched for voltage division.—R. S. Hartz and R. C. Allen, Reliable Circuit Supplies High Peak Deflection Voltages, *Electronics*, 35:41, p 54–55.



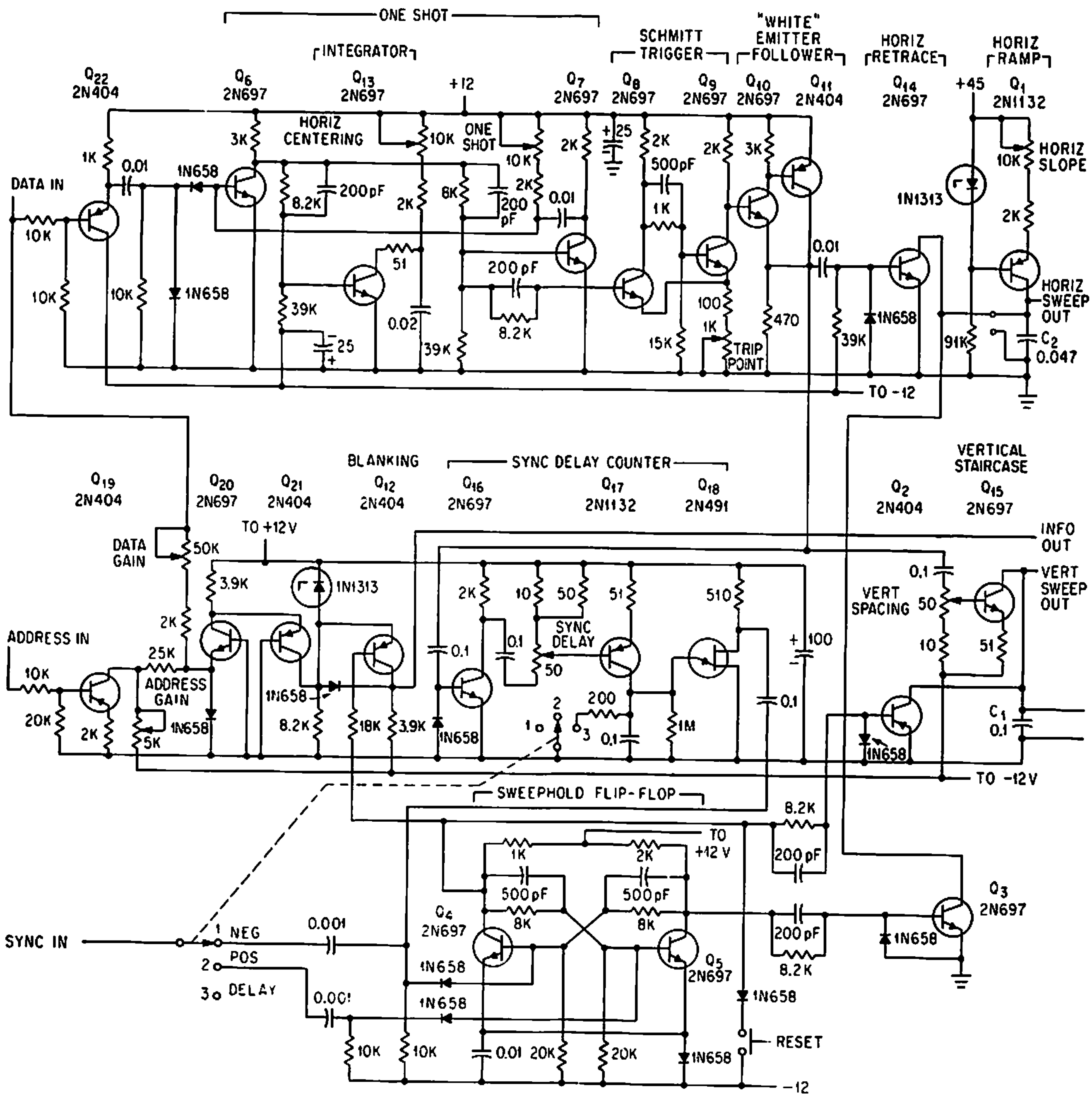
HIGH VOLTAGE FOR PORTABLE CRO—Derives 3.3 kv for post-accelerating anode from 20-kc high-voltage oscillator supply.—O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.



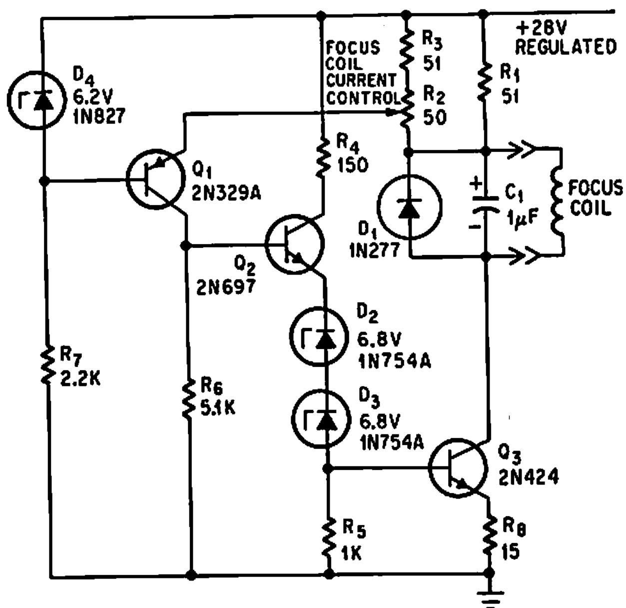
AXIS-CROSSING DETECTOR—Used in weak-signal detectors and in theoretical studies of noise. Samples time intervals between positive-going and negative-going zero crossings, to establish an interval gate whose width equals time interval of desired weak signal. Output goes to cro for viewing of interval gate.—A. J. Rainal, Digital Measurement of Axis-Crossing Intervals, *Electronics*, 33:23, p 88–91.



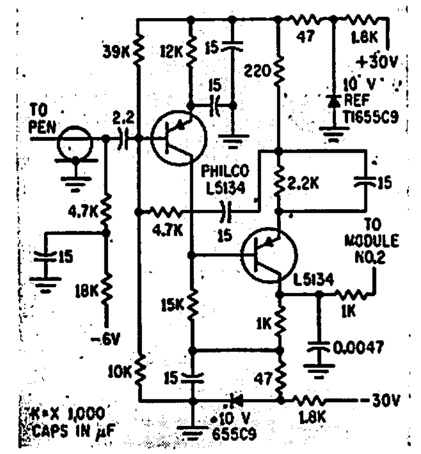
Z-AXIS MARKER GENERATOR—Circuit provides high-intensity dot marker on trace at any desired frequency in range from 8 to 22 Mc, in two overlapping ranges, with better than 1% long-term accuracy. Z-axis pulse is generated when external swept r-f oscillator passes through frequency to which tank circuit is tuned.—D. J. Odorizzi, Z-Axis Marker Generator for Bandpass Circuit Alignment, *Electronics*, 33:26, p 108–110.



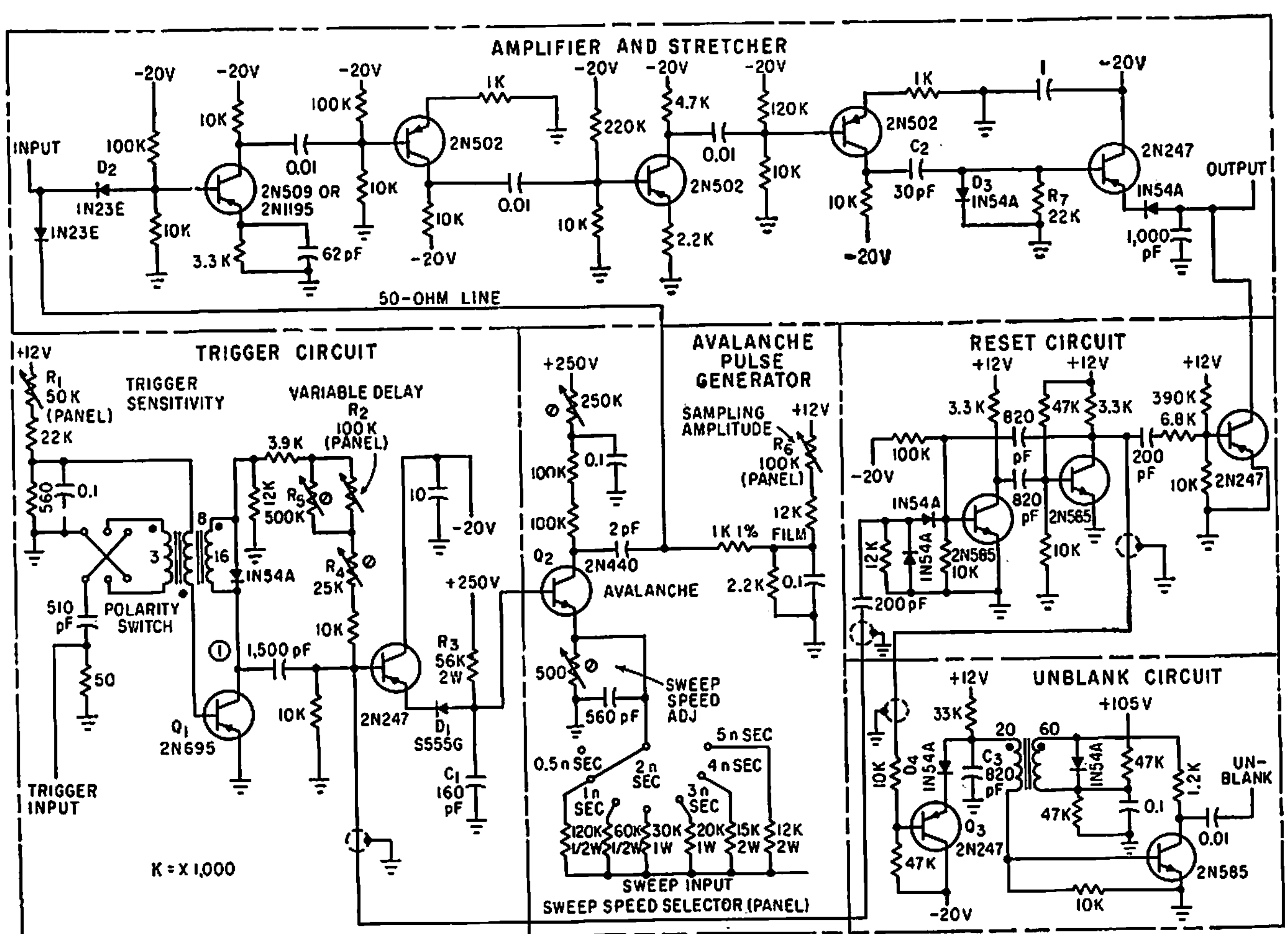
RASTER DISPLAY—Sixteen digital words can be displayed simultaneously on ordinary scope, for troubleshooting in data processors. Sweep generators are controlled by two-bit gap between words.—B. S. White, Circuit Converts One-Trace Scopes to Raster Display, *Electronics*, 36:48, p 33–35.



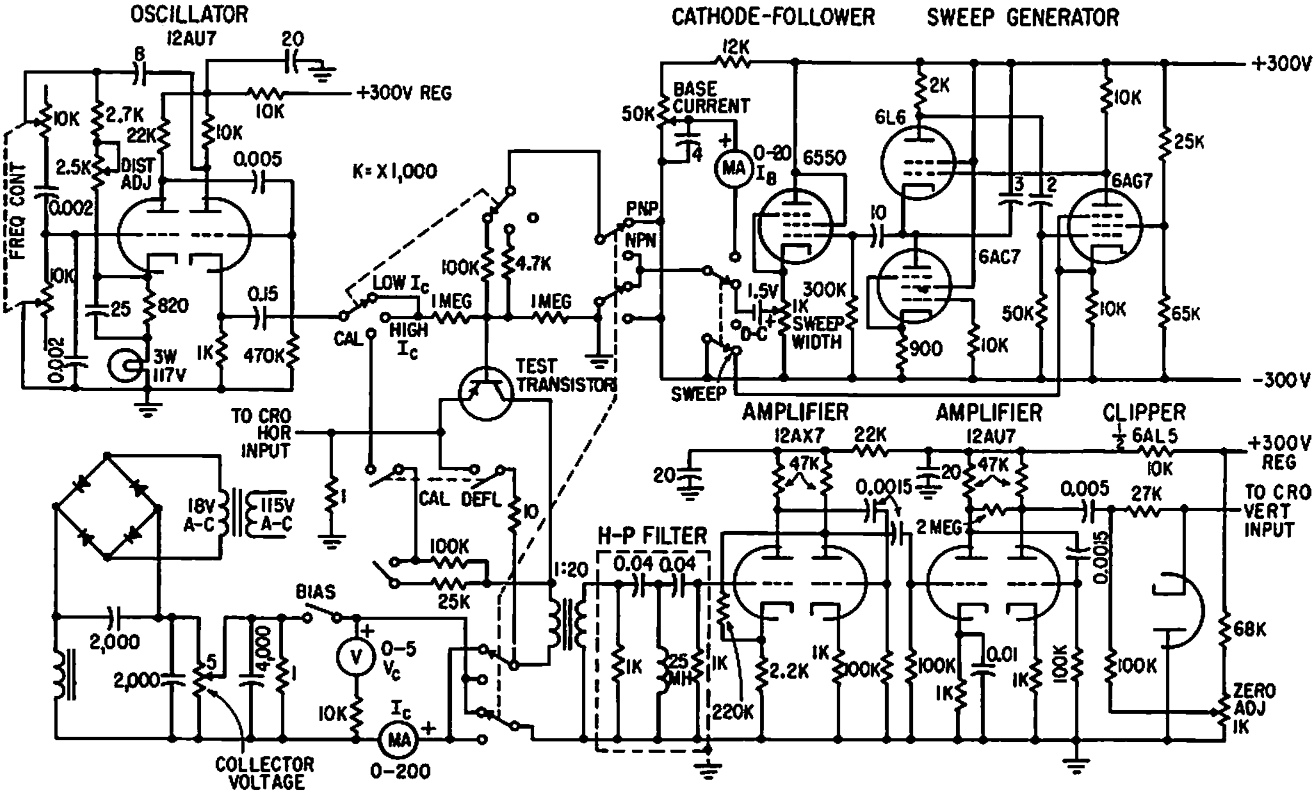
FOCUS-COIL REGULATOR—Regulation is 0.5% for current range of 220 to 270 ma, for magnetic focus coil of crt, between 25°C and 65°C.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.



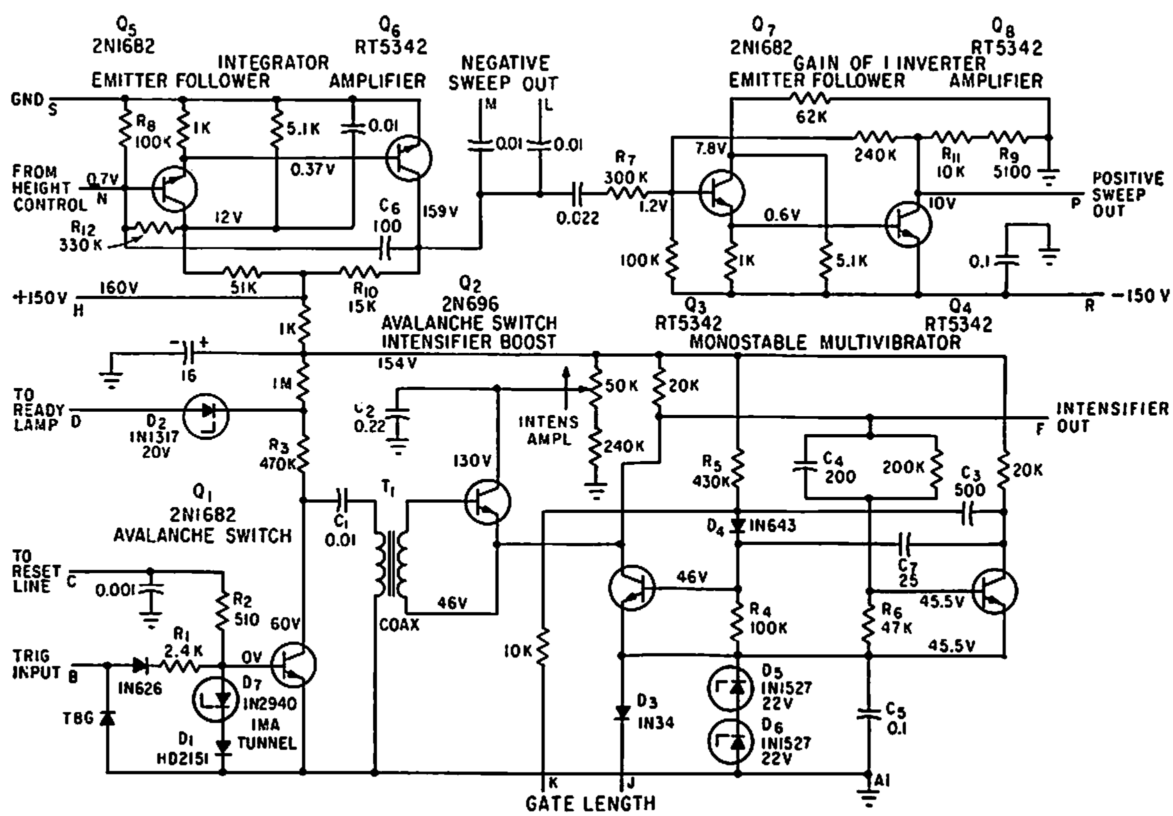
LIGHT-PEN AMPLIFIER—Consists of four two-transistor wideband-amplifier modules, each with inverse feedback to hold current gain at 21 with high stability. Interstage coupling networks raise lower cutoff frequency to 500 cps, to provide some rejection of 120-cps room light picked up by photodiode.—B. M. Gurley and C. E. Woodward, Light-Pen Links Computer to Operator, *Electronics*, 32:47, p 85–87.



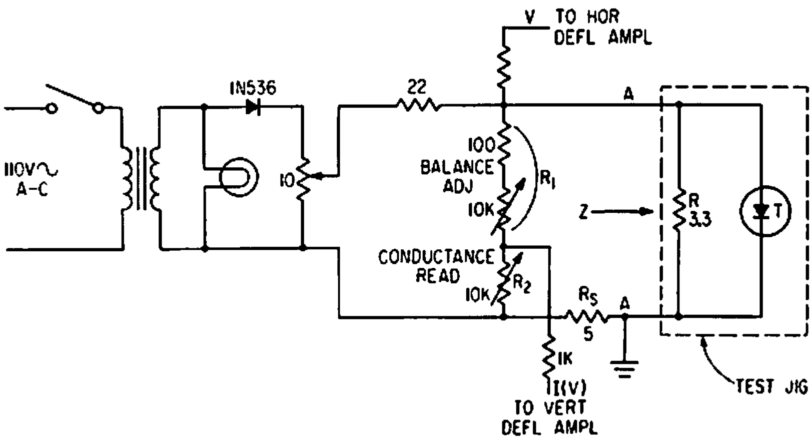
STRETCHING FAST PULSES BY SAMPLING—Attachment for conventional scope samples instantaneous amplitude of signals at different instants of time and reconstructs original shape by peak-detecting amplified and stretched samples. Permits resolving pulse rise times as short as ⅓ nanosecond with repetition rates up to 50 kc.—J. J. Amodei, Converting Oscilloscopes for Fast Rise Time Sampling, *Electronics*, 33:26, p 96–99.



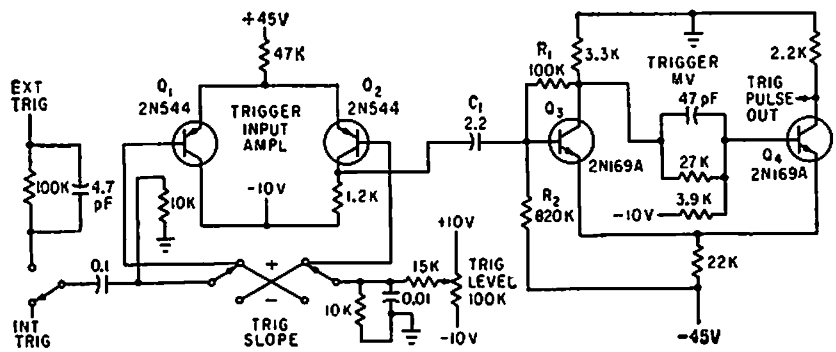
TRANSISTOR BETA DISPLAY—Falloff in beta with increasing collector current is displayed on auxiliary cro over range of 0 to 200 ma, for constant collector voltages up to 8 v.—R. Zuleeg and J. Lindmayer, Sweep Equipment Displays Transistor Beta, *Electronics*, 31:49, p 100–101.



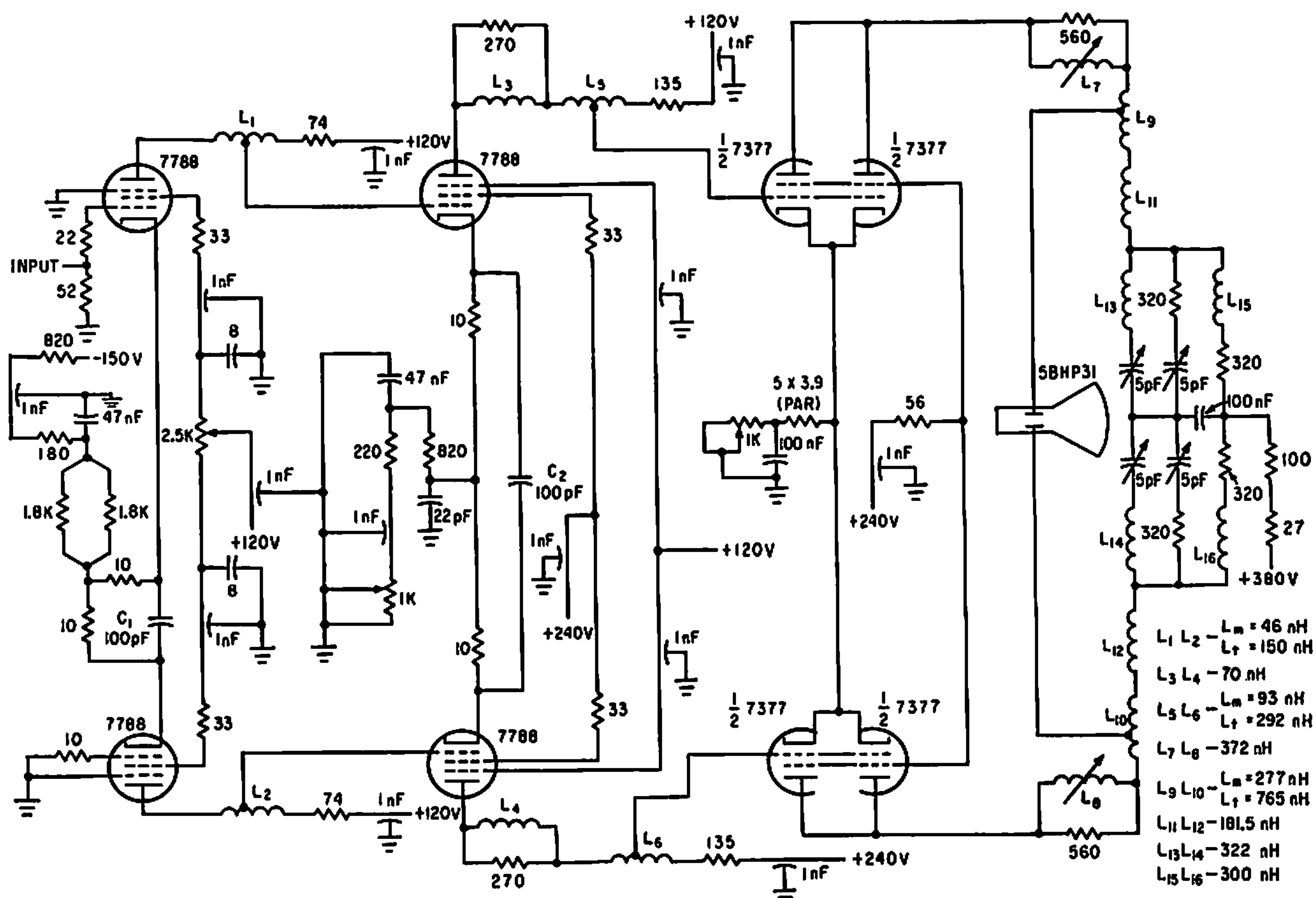
RASTER VERTICAL SWEEP—Q1 in shaper triggers intensifier pulse for test oscilloscope using tv-type scanning, while remainder of circuit generates vertical sweep for scope used to measure time intervals in range of 0.5 to 100 microsec with time resolution of 0.05 microsec.—R. P. Rufer and W. A. Karlotski, Use Raster Oscilloscopes for Faster Time Measurements, *Electronics*, 35:52, p 38–42.



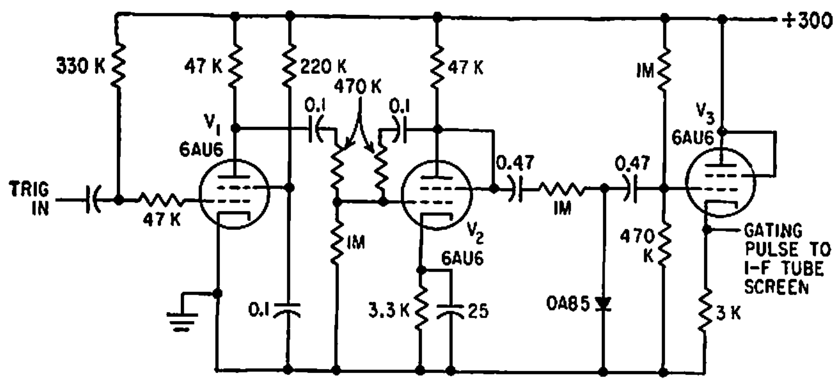
TUNNEL-DIODE CURVE-TRACER—Positive half of 60-cps a-c voltage is applied to tunnel diode and to horizontal deflection amplifier of cro, and voltage across RS, proportional to diode current, is applied to vertical input. Arrangement gives display of complete characteristic throughout negative-resistance region.—J. A. Narud and T. A. Fyfe, Tunnel Diode Curve-Tracer is Stable in Negative-Resistance Region, *Electronics*, 34:18, p 74–75.



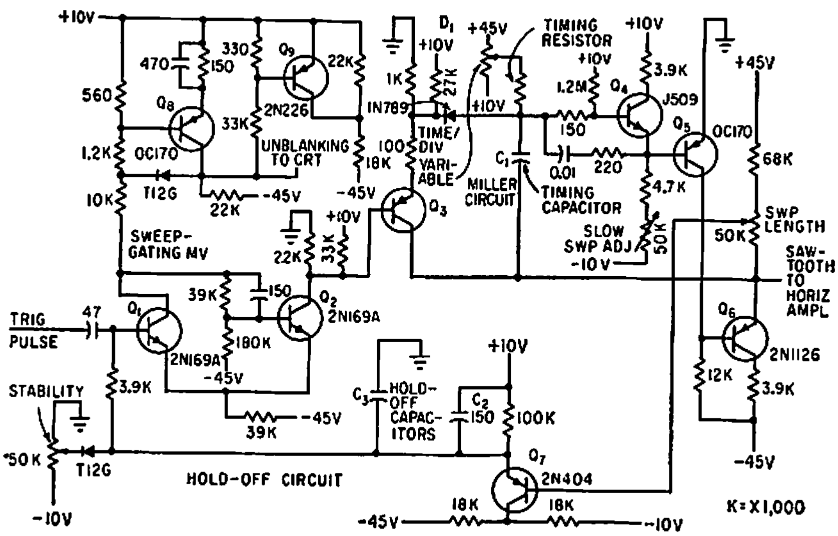
PORTABLE CRO TRIGGER INPUT AMPLIFIER—Schmitt trigger mvbr Q3-Q4 is modified by R1, R2, and C1 to give stable presentation at 2 Mc, with synchronization up to 4 Mc.—O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.



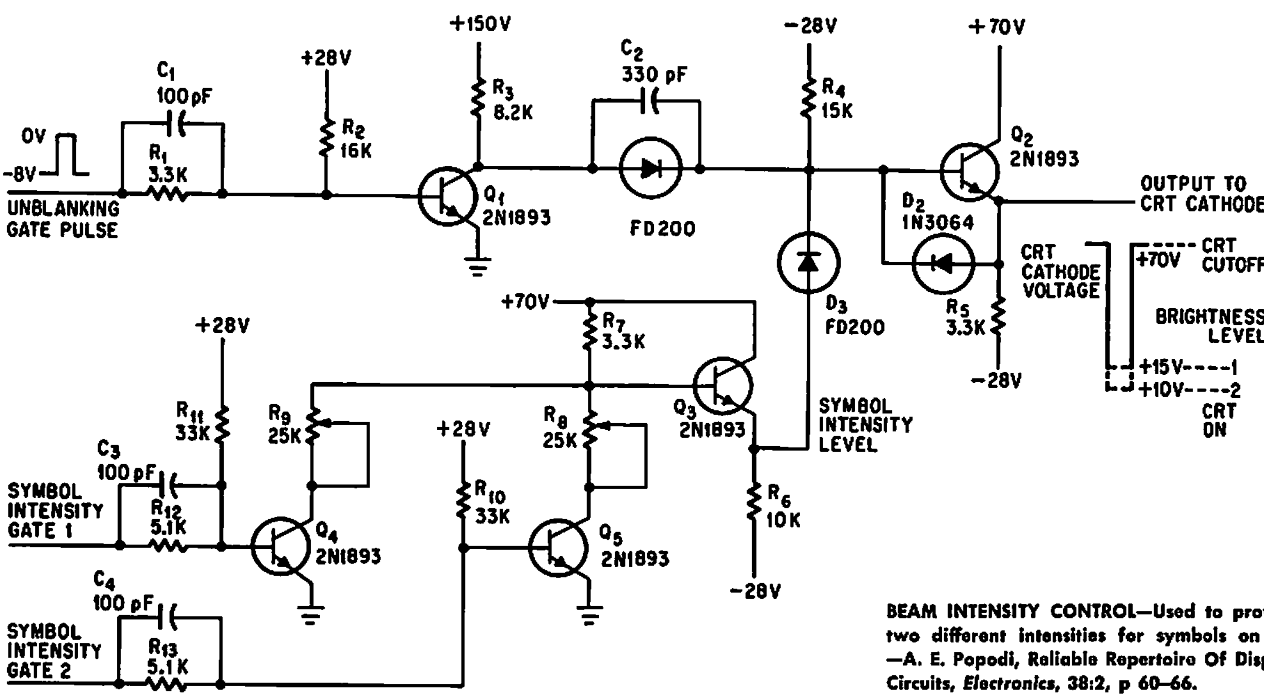
D-C TO 100-MC DEFLECTION AMPLIFIER—Gain is constant within 3 db of 40 db over entire 100-Mc bandwidth, for driving electrostatic deflection plates of oscilloscope.—L. L. Kossakowski, Designing a D-C to 100-MC Deflection Amplifier, *Electronics*, 35:17, p 64–66.



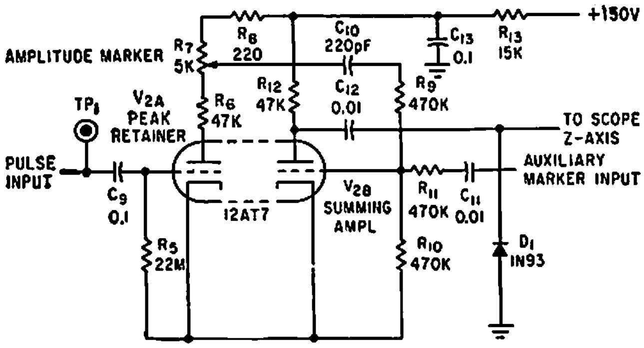
PPI GROUND PULSE BLANKER—Used in backscatter receiver to produce gating pulse that can be applied to screen grid of final i-f stage to remove bright ground pulse (occurring because receiver is fed from transmitting antenna by way of transmit-receive switch) from ppi screen.—K. Perry, Reducing Interference in Ionospheric Sounding, 33:22, *Electronics*, p 118–120.



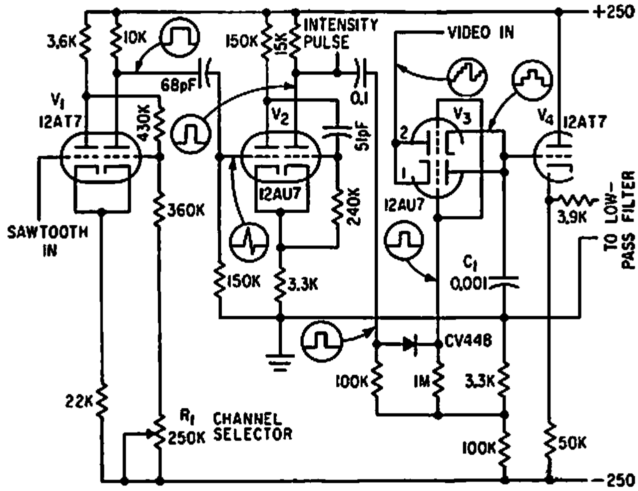
PORTABLE CRO UNBLANKING AMPLIFIER—Supplies signal to turn on crt during sweep. Hold-off circuit insures that trace starts from same point on every sweep.—O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.



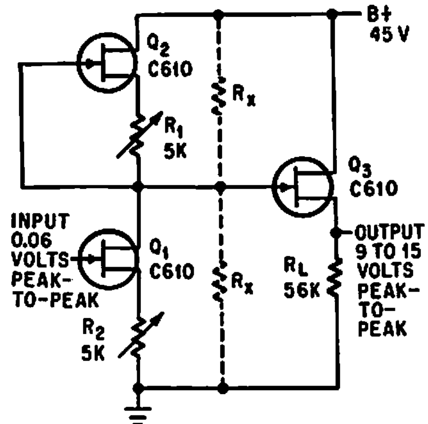
BEAM INTENSITY CONTROL—Used to provide two different intensities for symbols on crt. —A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.



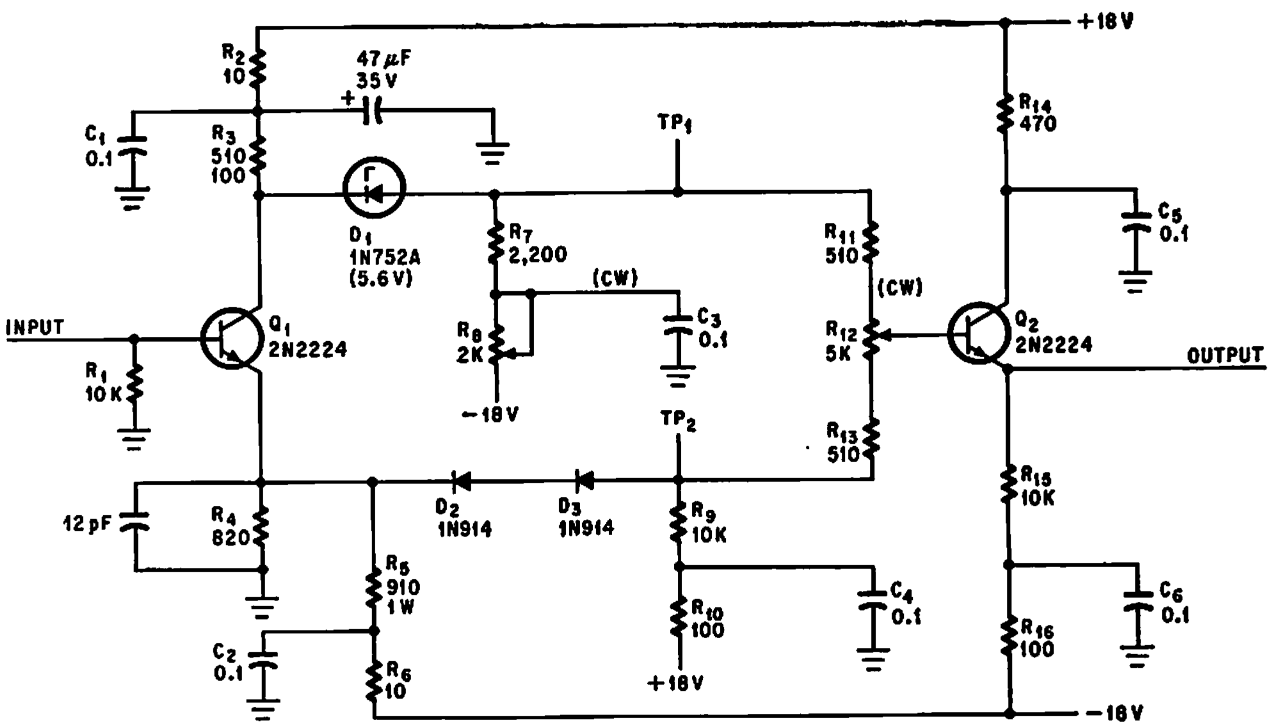
AMPLIFIER FOR MARKER GENERATOR—Triode V2A amplifies brightening pulse generated by marker circuit, and feeds amplified pulse to V2B for mixing with fixed or variable external marker pulse so both are applied to Z-axis of scope.—D. J. Oderizzi, Z-Axis Marker Generator for Bandpass Circuit Alignment, *Electronics*, 33:26, p 108–110.



STROBE PULSE GENERATOR—Constant-amplitude sawtooth from timebase of display unit is fed to one control grid of Schmitt trigger V1, whose output triggers one-shot mvbr to produce gating pulse 0.1 millisec wide that also identifies strobed channel on crt by brightening trace at that point.—A. Petton, Telemetry System for Testing Automobiles, *Electronics*, 33:43, p 57–59.

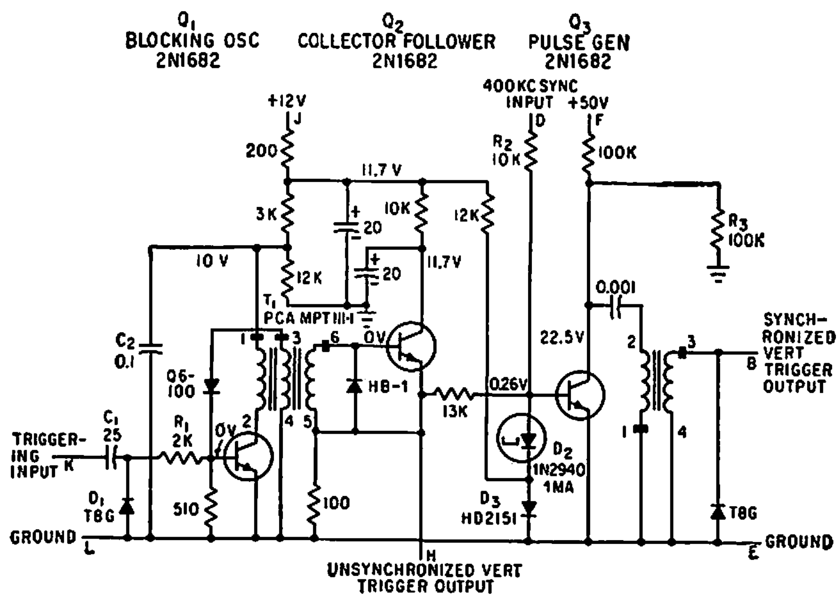


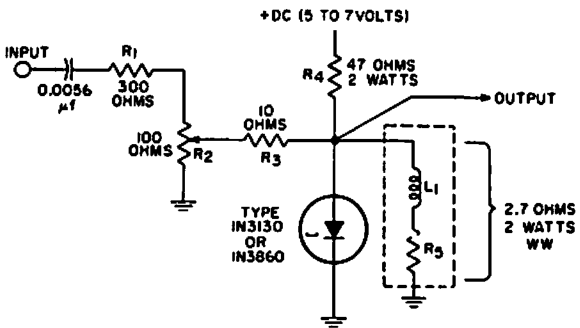
HORIZONTAL DRIVE—Three field-effect transistors give 45 db voltage gain for 1-cps triangular wave in horizontal deflection circuit of crt.—F. J. Murphree and J. H. Hammond Jr., High-gain D-C Amplifier Drives CRT Display, *Electronics*, 37:19, p 53.



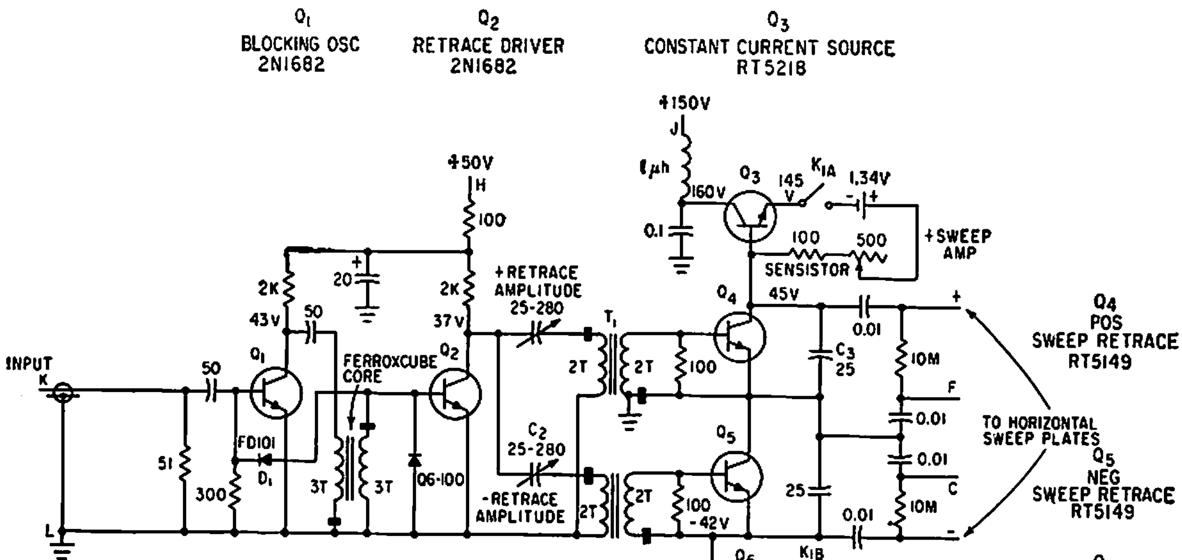
ALIGNMENT CORRECTION—Circuit developed for correcting alignment inaccuracies between electrostatic deflection plates and face of cathode-ray tube gives output varying from 0 to +3.5 v when input varies from 0 to −4 v.—F. E. Smith, Buffer Amplifier Supplies Bipolar Output, *Electronics*, 37:21, p 75.

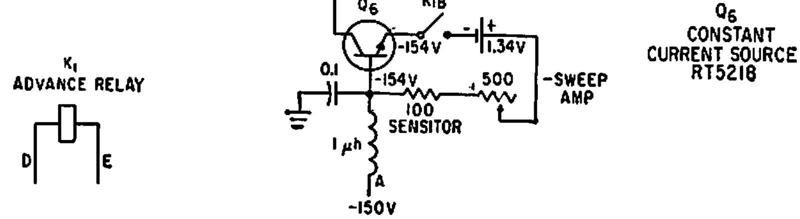
RASTER VERTICAL TRIGGERING GENERATOR—Output pulse width of blocking oscillator Q1 is over 3.5 microsec, determined by T1 and C2. Q2 couples this pulse to output H for use as unsynchronized output, while Q3 with 400-kc sync input serves with D2 as coincidence gate to give output only when both sync and gate pulses are present.—R. P. Rufer and W. A. Karlotski, Use Raster Oscilloscopes for Faster Time Measurements, *Electronics*, 35: 52, p 38–42.



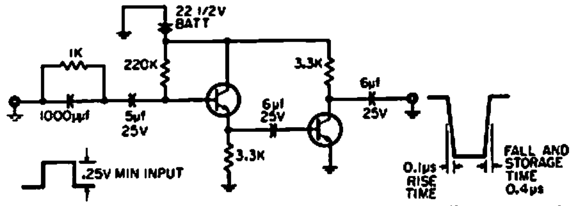


UHF SYNCHRONIZER—Simple tunnel-diode circuit can synchronize any scope to any constant frequency up to signal-bandwidth limits of scope, even though bandwidths are greater than cro sync circuits can handle. Upper frequency limit of circuit is at least 1.2 gc. Diode oscillates at frequency controlled primarily by L1, but will lock onto uhf input signal and deliver exact subharmonic of input. Can provide countdowns at ratios exceeding 100:1.—F. M. Carlson, Tunnel-Diode UHF Synchronizer, *EEE*, 12:2, p 109.

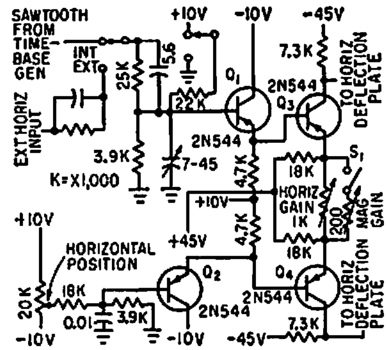




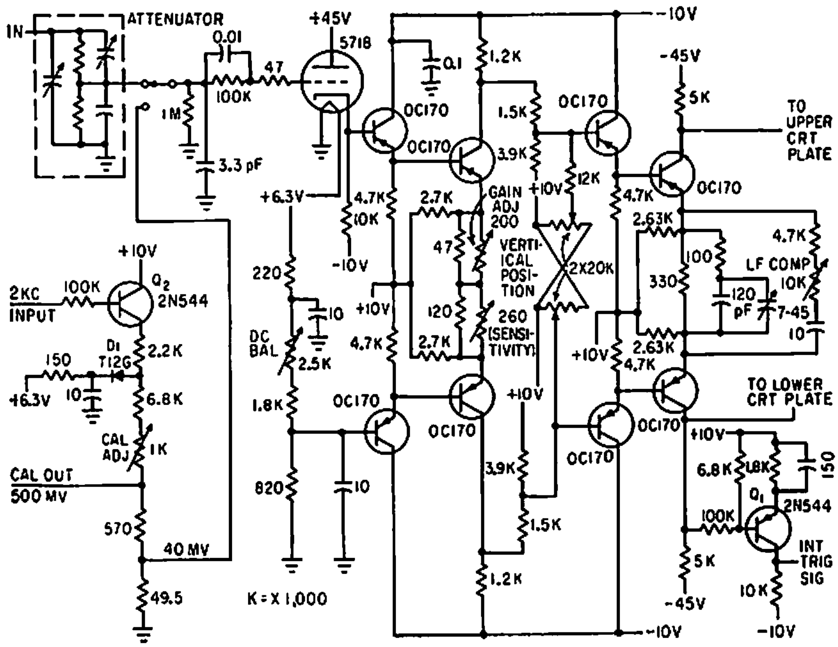
RASTER HORIZONTAL SWEEP GENERATOR—Input from 400-kc timing generator triggers Q4 through Q2 and T1, making C3 discharge to provide sweep retrace. Negative sweep is similar except that capacitor is charged from minus 150 v.—R. P. Rufer and W. A. Karlotski, Use Raster Oscilloscopes for Faster Time Measurements, *Electronics*, 35:52, p 38–42.



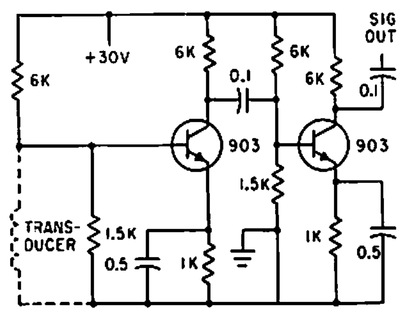
TRACE INTENSIFIER—Designed to convert weak positive-going pulse to negative-going pulse with 15 v minimum amplitude, as required on cathode of A-scope radar presentation on commercial oscilloscope. Minimum input amplitude is 250 mv.—L. J. Brocato, Scope-Trace Intensification Converter, *EEE*, 13:2, p 62–63.



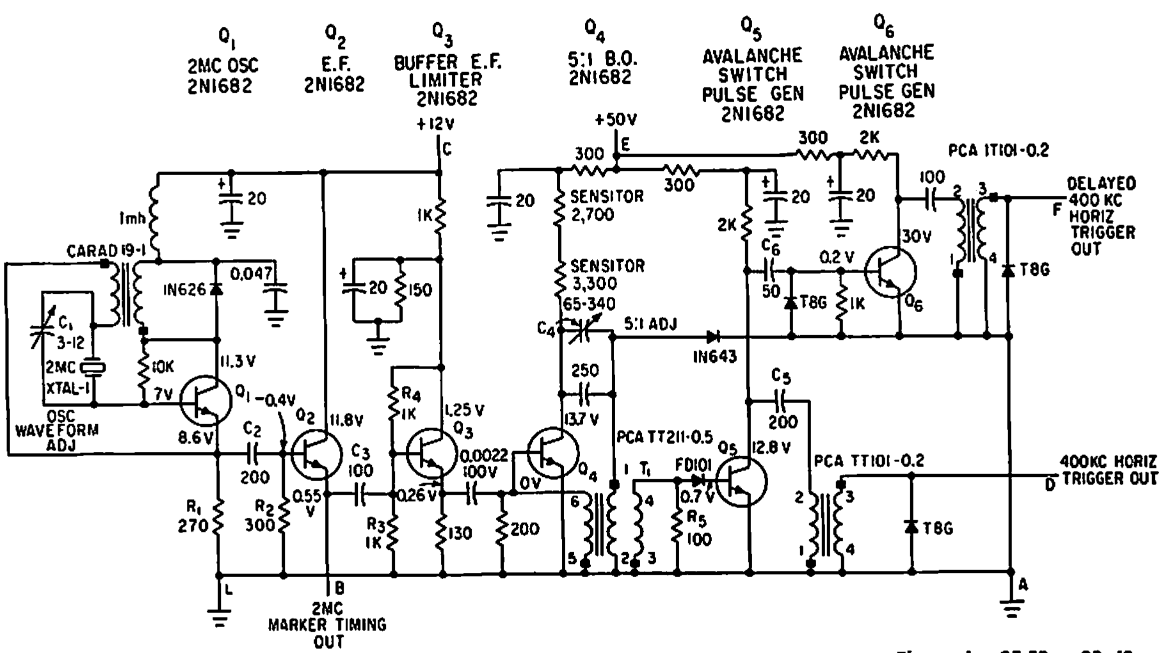
PORTABLE CRO HORIZONTAL AMPLIFIER—Balanced circuit includes temperature compensation. Closing S1 provides magnification of 5 on screen. Bandwidth is 1 Mc.—O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.



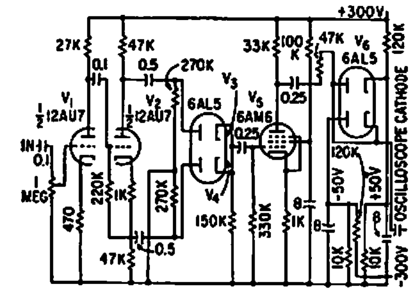
CALIBRATOR FOR PORTABLE CRO—Generates 40-mv square wave at 2 kc. Provides swing of 30 v at each crt deflection plate.—O. Svehaug and J. R. Kobbe, Battery-Operated Transistor Oscilloscope, *Electronics*, 33:12, p 80–83.



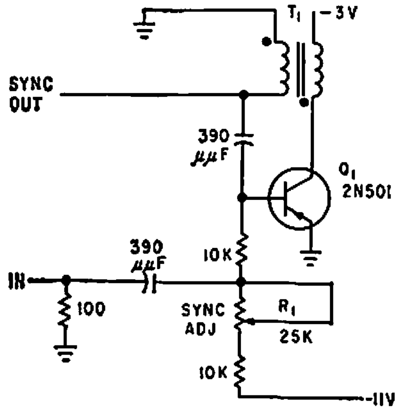
GYRO VIBRATION AMPLIFIER—Vibration resulting from imbalance is sensed by inductive transducer that produces sine wave which is amplified by circuit and displayed on cro.—F. W. Kear, Electronic System for Balancing Gyro Wheels, *Electronics*, 33:43, p 82–85.



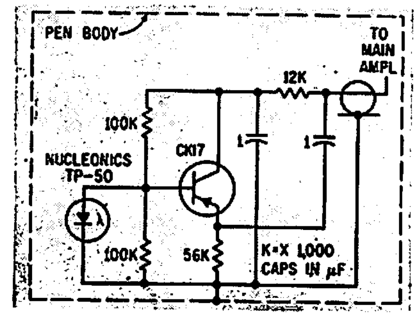
RASTER TIMING GENERATOR—Crystal oscillator (2 Mc) triggers blocking oscillator Q4 that counts down by 5 to produce 400-kc timing pulses for test oscilloscope using tv-type scanning.—R. P. Rufer and W. A. Karlotski, Use Raster Oscilloscopes for Faster Time Measurements, *Electronics*, 35:52, p 38–42.



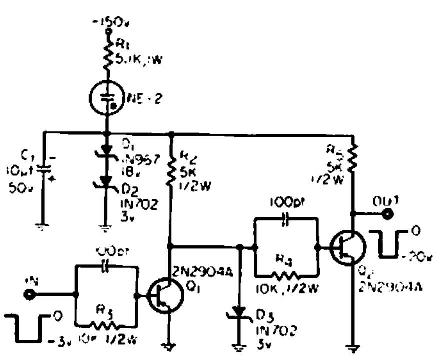
TRACE BRIGHTNESS EQUALIZER—Amplitude of signal to be displayed controls scope brightness by changing voltage on cathode of crt. Low-level signal and high-voltage pulses are automatically adjusted as to brightness, so both traces appear equally bright on photographic film.—J. K. Goodwin, Circuit Evens Scope Brightness, *Electronics*, 31:51, p 96–98.



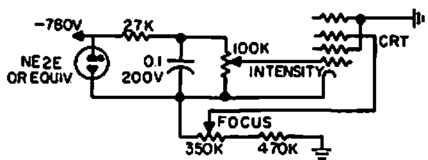
SYNC BLOCKING OSCILLATOR—Free-running period of grounded-emitter stage is made to lock in with frequency of pulse generator, to provide synchronizing signal for conventional oscilloscope during tests of high-speed computer circuits.—L. Neumann, Transistorized Generator for Pulse Circuit Design, *Electronics*, 32:14, p 47–49.



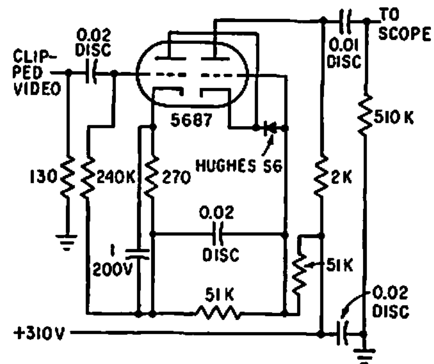
LIGHT-PEN PREAMP—Raises signal level of germanium photodiode before it is fed through coax to main amplifier. Special decoupling in collector circuit allows power and signal to be supplied simultaneously over single coaxial cable.—B. M. Gurley and C. E. Woodward, Light-Pen Links Computer to Operator, *Electronics*, 32:47, p 85–87.



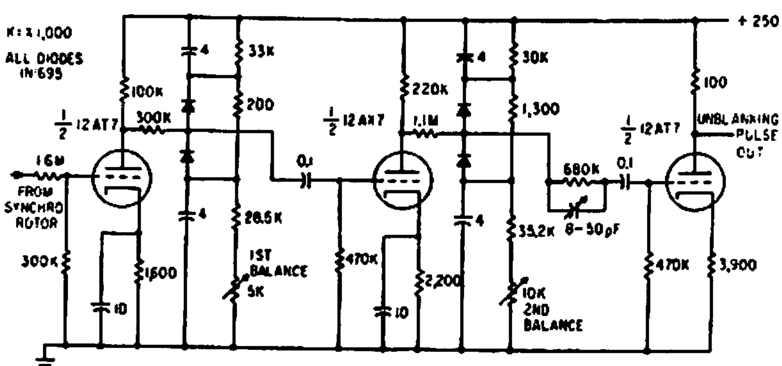
Z-AXIS MODULATION—Pulse amplifier allows crt beam-intensity modulation from 3-v logic levels. Requires only single −150 v supply. Intended as modification for Tektronix oscilloscope.—J. H. Cormack, Pulse Amplifier for Beam Intensity Modulation, *EEE*, 14:1, p 63.



NEON CRT BIAS REGULATOR—Neon lamp serves as bias regulator for grid 1 of oscilloscope crt and as pilot lamp.—More Glow-Lamp Circuits, *EEE*, 12:2, p 106–108.

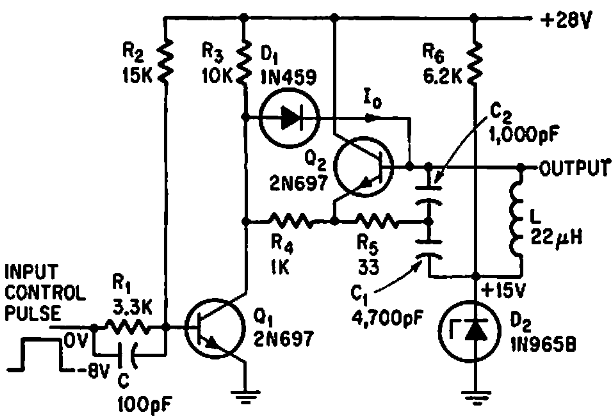


Z-AXIS AMPLIFIER—Accepts clipped video signal of microwave interferometer system and intensity-modulates electron beam of oscilloscope.—H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.

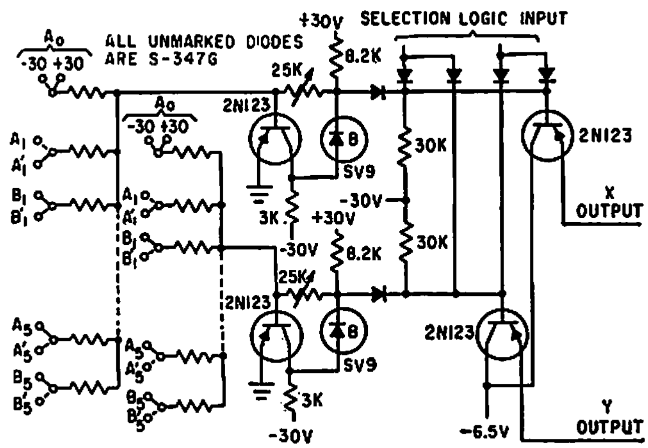


UNBLANKING PULSE GENERATOR—Unblanking signal is produced by repeated amplification and clipping of 500-cps signal from antenna synchro driver. Square-wave output is applied to control grid of display crt. Balancing controls are adjusted so unblanking strobe line starts from center.—R. T. Wolfram, Improved Communications Using Groundscatter Propagation, *Electronics*, 33:44, p 74–78.

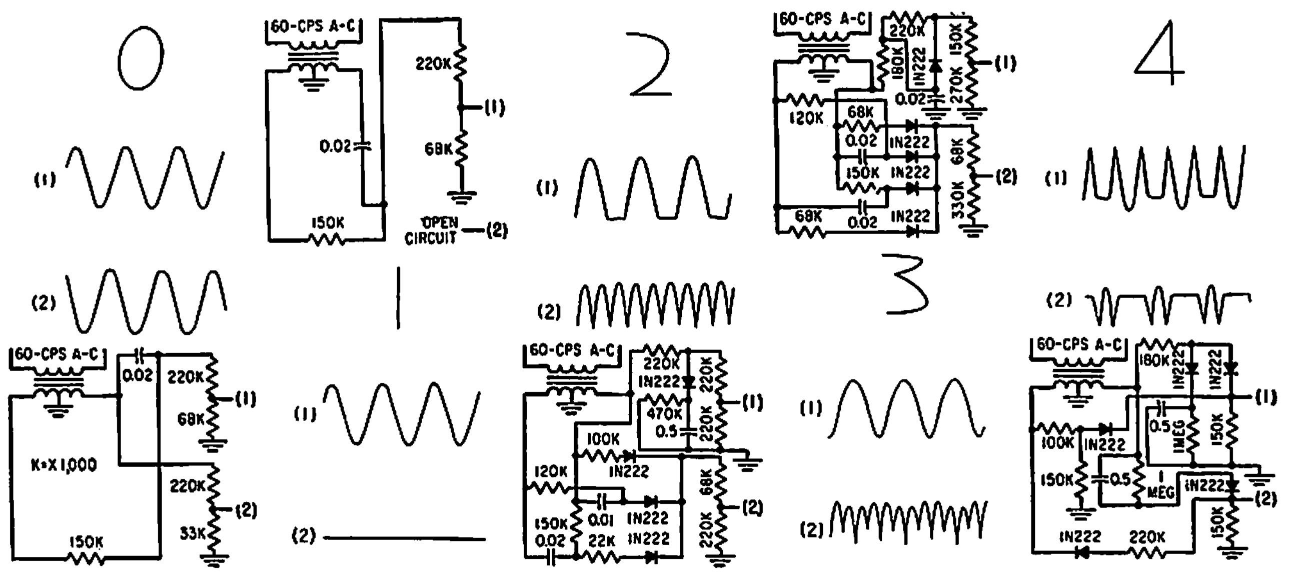
CHAPTER 13
Character Generator Circuits



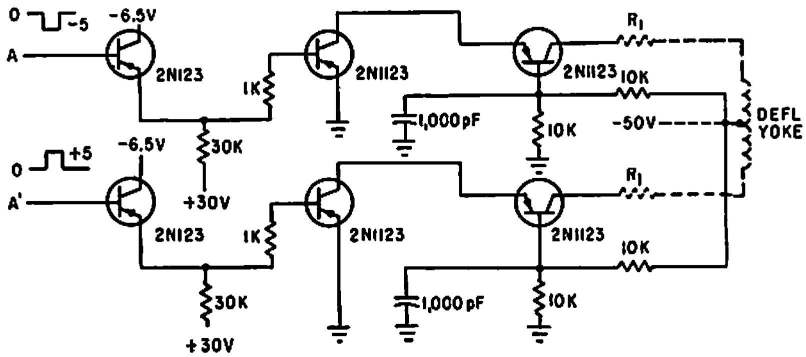
CHARACTER GENERATOR—Pulsed oscillator, used in producing alphanumeric display characters from combinations of circles, half-circles, and ellipses, is transient-free. Sinusoidal oscillator Q2 starts with full amplitude and stops in less than one cycle.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.



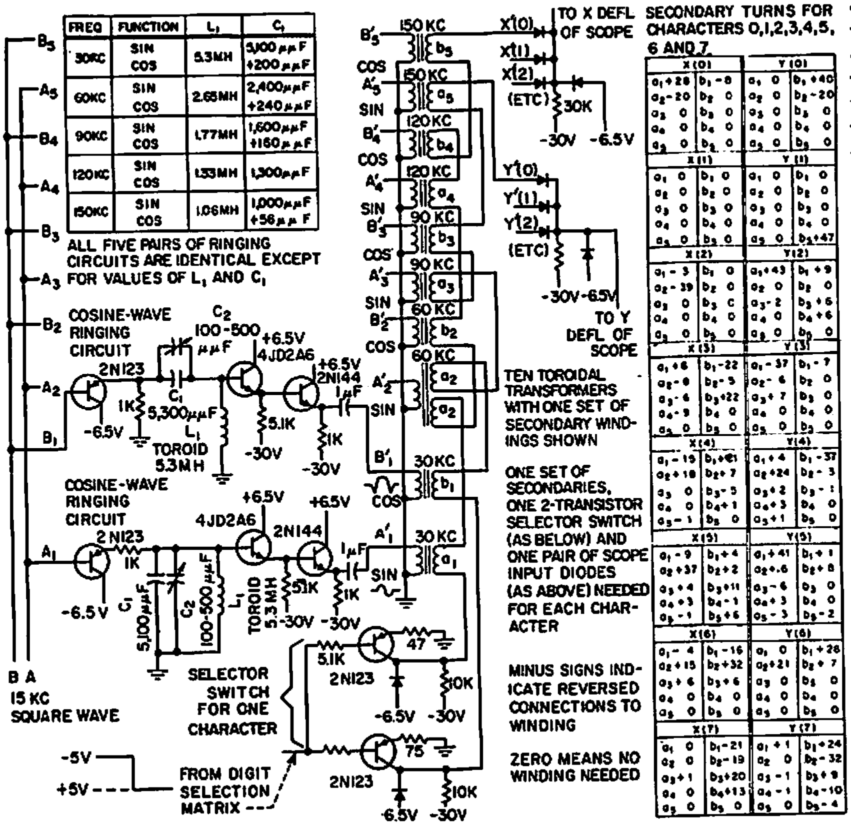
SYMBOL GENERATOR—Combines sine and cosine waves of ten harmonic generators to produce X and Y waveforms for alphanumeric character generator.—K. E. Perry and E. J. Aho, Radar-Computer Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.



CRT NUMBER GENERATOR—Lissajous patterns on crt form numerals 0 to 9 that appear to be handwritten. Vertical and horizontal waveshapes used to produce a number are continuously applied to pair of number gates. Gates open when excited by high-voltage r-f transformer, permitting waveforms to pass through to crt deflection plates and create pattern on screen. All waveshapes are de-



FINE-POSITIONING CHARACTER-GENERATOR SWITCH—Pairs of deflection switches operating push-pull into deflection yoke act with 16-point coarse positioning system to give 4,096 positions, generated in binary fashion. —K. E. Perry and E. J. Aho, Radar-Computer Display Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.



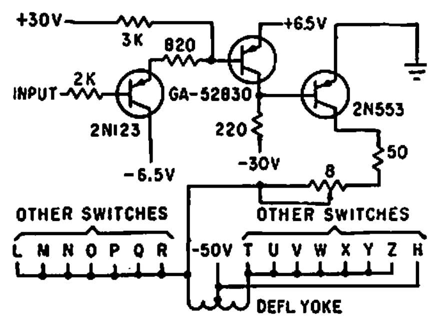
FREQ	FUNCTION	L_1	C_1
30KC	SIN / COS	5.3MH	5,100 μμF +200 μμF
60KC	SIN / COS	2.65MH	2,400 μμF +240 μμF
90KC	SIN / COS	1.77MH	1,600 μμF +160 μμF
120KC	SIN / COS	1.33MH	1,300 μμF
150KC	SIN / COS	1.06MH	1,000 μμF +56 μμF

ALL FIVE PAIRS OF RINGING CIRCUITS ARE IDENTICAL EXCEPT FOR VALUES OF L_1 AND C_1

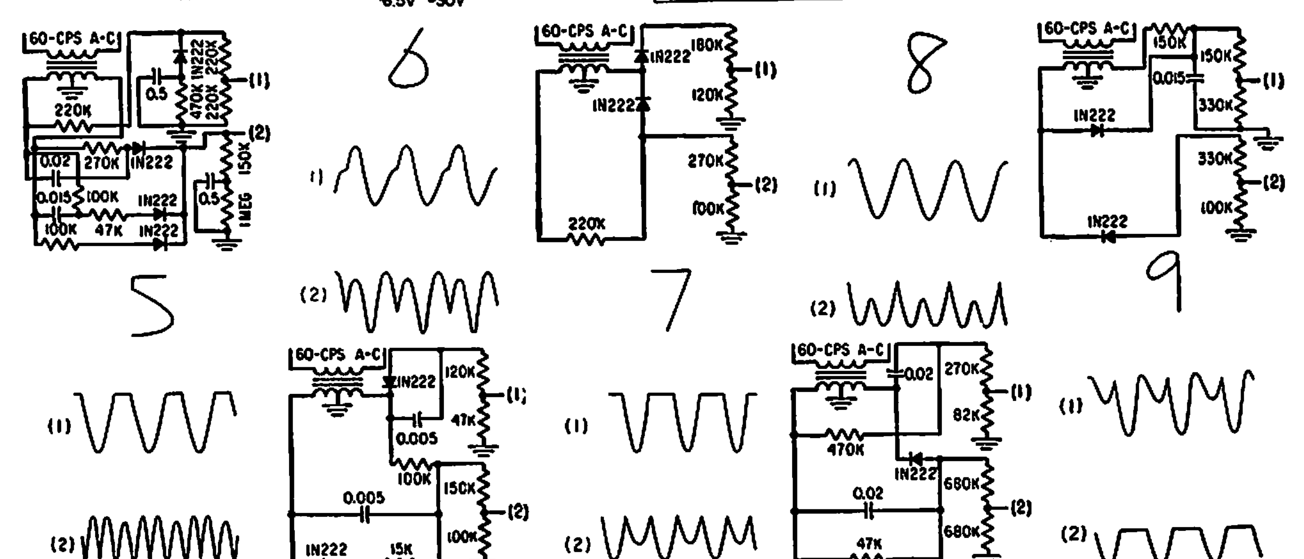
SECONDARY TURNS FOR CHARACTERS 0,1,2,3,4,5, 6 AND 7.

Character	X a	X b	Y a	Y b
0	a_1 +28	b_1 -8	a_1 0	b_1 +40
0	a_2 -20	b_2 0	a_2 0	b_2 -20
0	a_3 0	b_3 0	a_3 0	b_3 0
0	a_4 0	b_4 0	a_4 0	b_4 0
0	a_5 0	b_5 0	a_5 0	b_5 0
1	a_1 0	b_1 0	a_1 0	b_1 0
1	a_2 0	b_2 0	a_2 0	b_2 0
1	a_3 0	b_3 0	a_3 0	b_3 0
1	a_4 0	b_4 0	a_4 0	b_4 0
1	a_5 0	b_5 0	a_5 0	b_5 +47
2	a_1 -3	b_1 0	a_1 +43	b_1 +9
2	a_2 -39	b_2 0	a_2 0	b_2 0
2	a_3 0	b_3 C	a_3 -2	b_3 +6
2	a_4 0	b_4 0	a_4 0	b_4 +6
2	a_5 0	b_5 0	a_5 0	b_5 0
3	a_1 +6	b_1 -22	a_1 -37	b_1 -7
3	a_2 -8	b_2 -5	a_2 -6	b_2 0
3	a_3 -6	b_3 +22	a_3 +7	b_3 0
3	a_4 -9	b_4 0	a_4 0	b_4 0
3	a_5 0	b_5 0	a_5 0	b_5 0
4	a_1 -15	b_1 +21	a_1 +4	b_1 -37
4	a_2 +18	b_2 +7	a_2 +24	b_2 -3
4	a_3 0	b_3 -5	a_3 +2	b_3 -1
4	a_4 0	b_4 +1	a_4 +3	b_4 0
4	a_5 -1	b_5 0	a_5 +1	b_5 0
5	a_1 -9	b_1 +4	a_1 +41	b_1 +1
5	a_2 +37	b_2 +2	a_2 +.6	b_2 +8
5	a_3 +4	b_3 +11	a_3 -6	b_3 0
5	a_4 +3	b_4 -1	a_4 +3	b_4 0
5	a_5 -1	b_5 +6	a_5 -3	b_5 -2
6	a_1 -4	b_1 -16	a_1 0	b_1 +28
6	a_2 +15	b_2 +32	a_2 +21	b_2 +7
6	a_3 +6	b_3 +6	a_3 0	b_3 0
6	a_4 0	b_4 0	a_4 0	b_4 0
6	a_5 0	b_5 0	a_5 0	b_5 0
7	a_1 0	b_1 -21	a_1 +1	b_1 +24
7	a_2 0	b_2 -19	a_2 0	b_2 -32
7	a_3 +1	b_3 +20	a_3 -1	b_3 +9
7	a_4 0	b_4 +13	a_4 -1	b_4 -10
7	a_5 0	b_5 0	a_5 0	b_5 -4

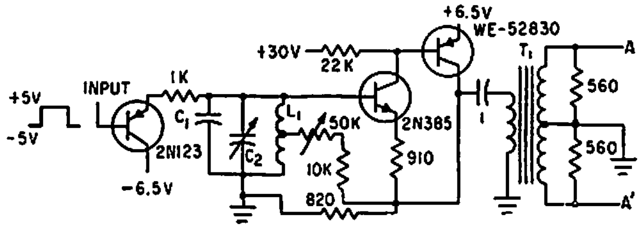
ANALOG CHARACTER GENERATOR—Displays numeric characters 1 through 7 on cathode-ray tube by deflecting spot to trace out each character continuously. X and Y deflection voltages are obtained by combining sine and cosine terms of first five harmonics of 30-kc fundamental. Transistorized gated oscillators, flip-flop serial counters, and emitter-followers feed 10 toroidal transformers having one set of secondary windings for each character.—K. E. Perry and E. J. Aho, Generating Characters for Cathode-Ray Readout, *Electronics*, 31:1, p 72–75.



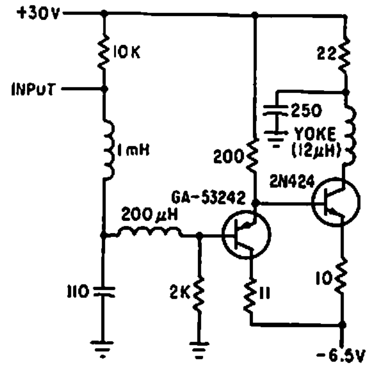
CHARACTER-GENERATOR DEFLECTION SWITCH—Coarse deflection system uses 32 identical power transistor circuits in switching configuration to drive low-inductance main deflection yoke. Half of these control X deflection to give 16 discrete positions, and the remainder serve for Y deflection.—K. E. Perry and E. J. Aho, Radar-Computer Display Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.



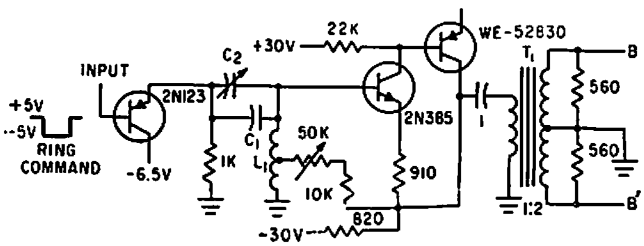
rived from 60-cps centertapped sine-wave source. Reliability is insured through use of passive elements (resistors, capacitors, and diodes) and standard techniques of clipping, limiting, and/or phase shifting to generate required waveshapes.—R. L. White, Forming Handwritten-Like Digits on CRT Display, *Electronics*, 32:11, p 138–140.



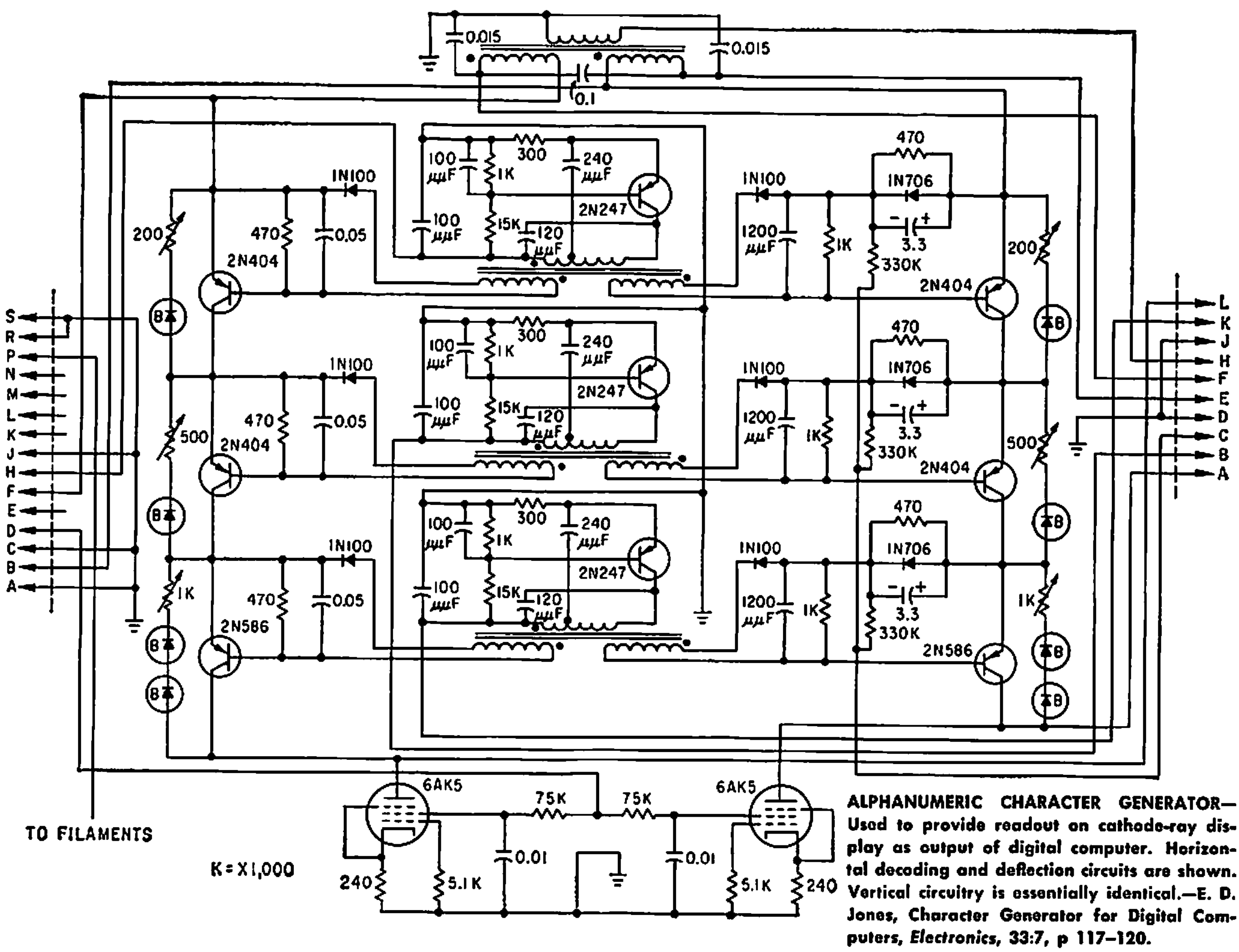
SHOCK-EXCITED SINE-WAVE OSCILLATOR—Rectangular pulse turns on five identical harmonic generators for alphanumeric character generator.—K. E. Perry and E. J. Aho, Radar-Computer Display Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.



CHARACTER DEFLECTION AMPLIFIER—Converts X or Y voltage waveform into equivalent current waveform of up to 0.5 amp peak to peak, to drive low-inductance deflection yoke of cathode-ray character generator.—K. E. Perry and E. J. Aho, Radar-Computer Display Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.

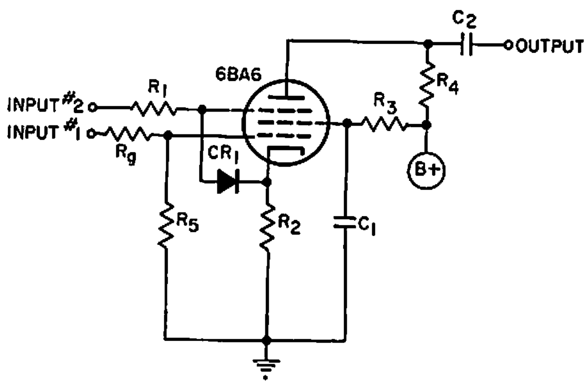


SHOCK-EXCITED COSINE-WAVE OSCILLATOR—Single 34.1-microsec ring command turns on five identical harmonic generators for alphanumeric character generator.—K. E. Perry and E. J. Aho, Radar-Computer Display Traces Alphanumeric Characters, *Electronics*, 34:26, p 75–79.

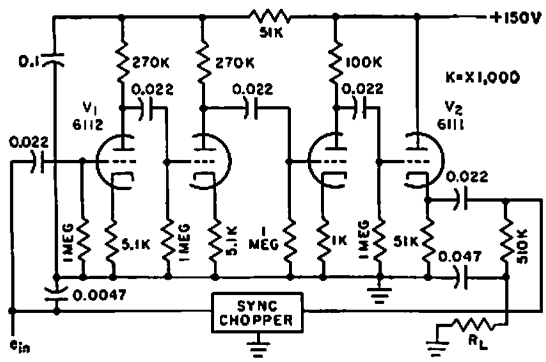


ALPHANUMERIC CHARACTER GENERATOR—Used to provide readout on cathode-ray display as output of digital computer. Horizontal decoding and deflection circuits are shown. Vertical circuitry is essentially identical.—E. D. Jones, Character Generator for Digital Computers, *Electronics*, 33:7, p 117–120.

CHAPTER 14
Chopper Circuits

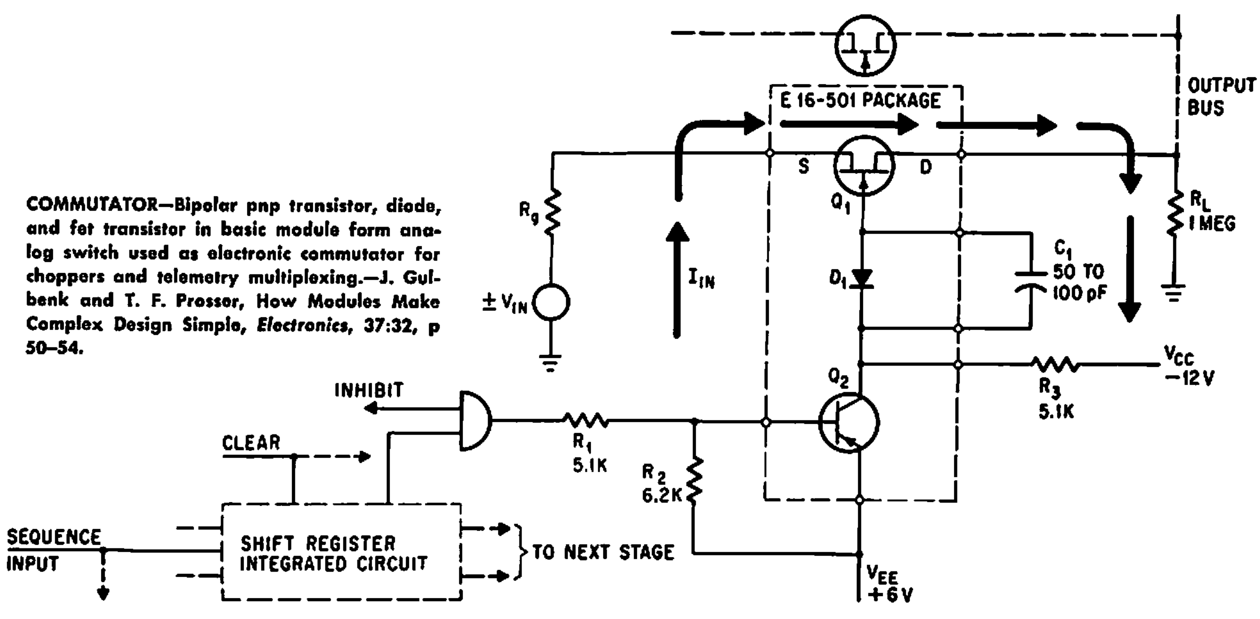


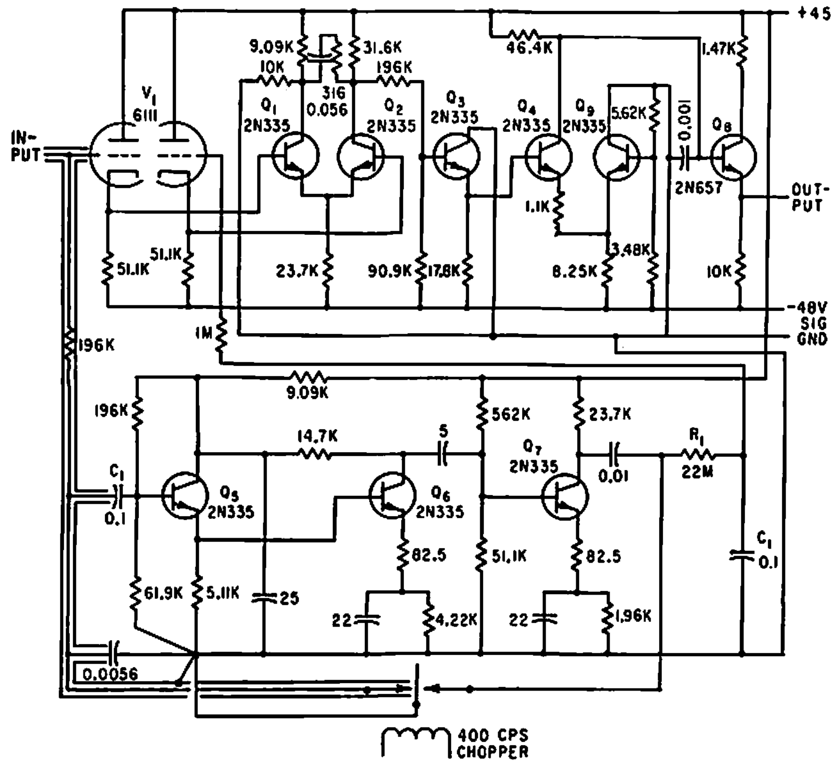
PENTODE CHOPPER—Designed for use as first stage of wide-band amplifier (d-c up to several kc). Design procedure is given. For 150-v plate supply, typical values are R2 = 100 ohms, R4 = 5K, R3 = 110K, R1 = 15K with 1N34A diode, R5 = 1 meg, Rg = 1K, and C1 depends on lowest frequency to be amplified. —D. G. Knox, Electronic Chopper, *EEE*, 10:11, p 27–28.



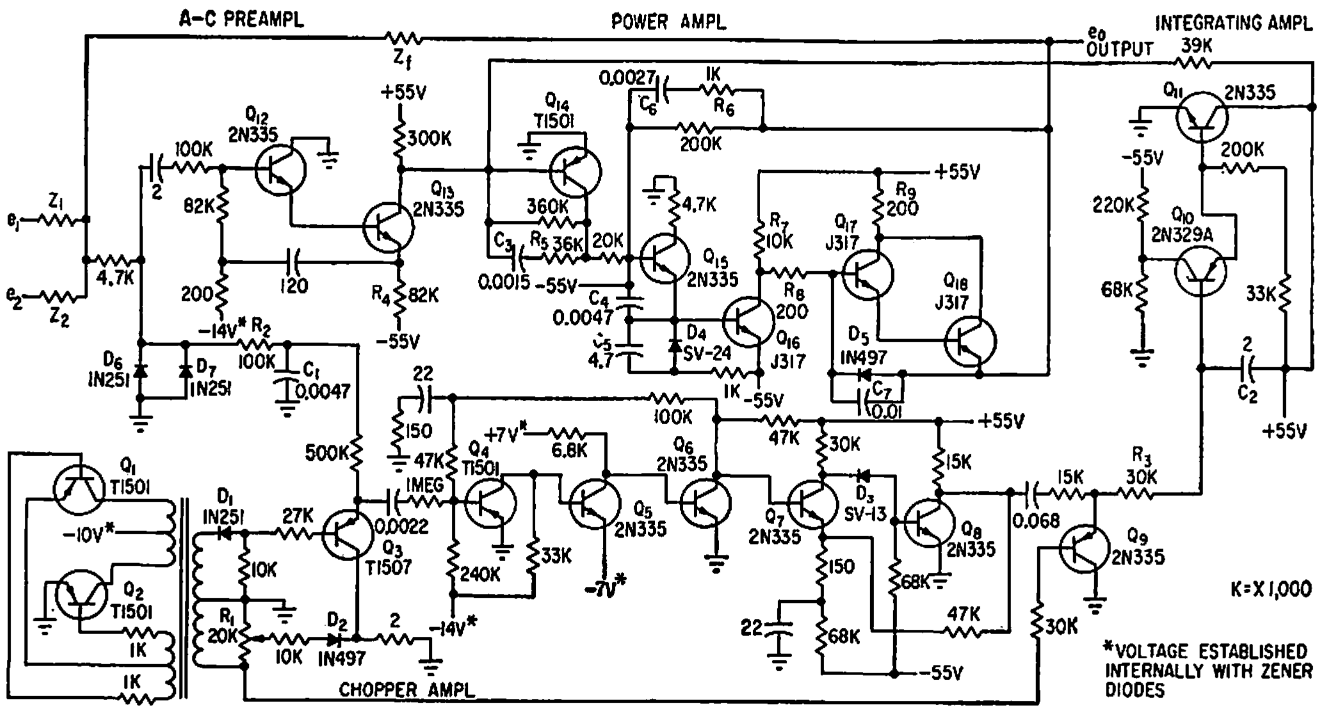
400-CPS MECHANICAL CHOPPER AMPLIFIER —Chopper modulates incoming d-c signal for a-c amplification, then demodulates output synchronously. Conversion gain is above 5,000. Suitable for high-gain low-level strain-gage thermocouple, and similar signals where amplifier drift must be minimized without using regulated power supply.—L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.

COMMUTATOR—Bipolar pnp transistor, diode, and fet transistor in basic module form analog switch used as electronic commutator for choppers and telemetry multiplexing.—J. Gulbenk and T. F. Prosser, How Modules Make Complex Design Simple, *Electronics*, 37:32, p 50–54.

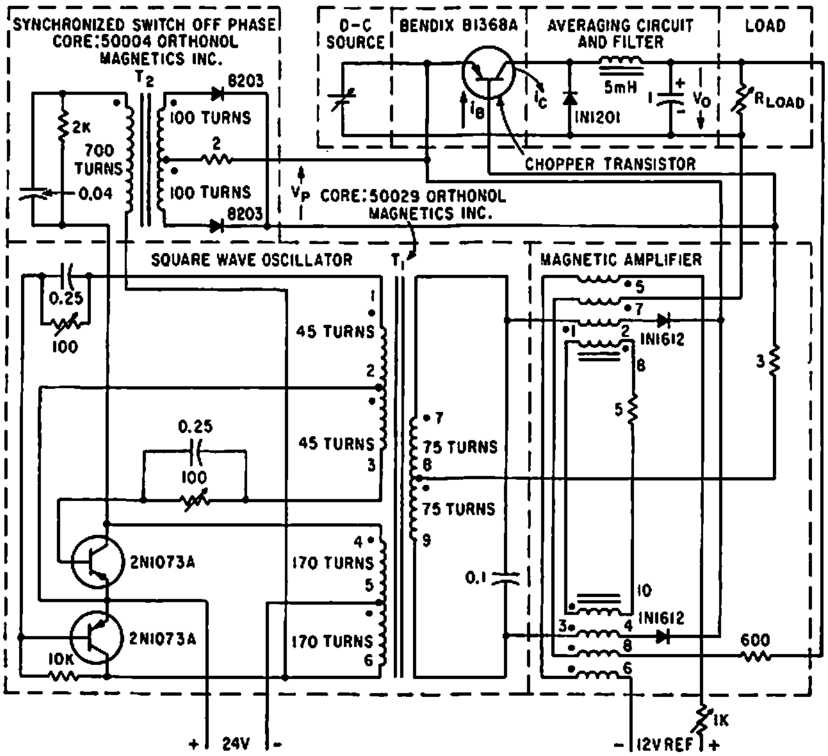




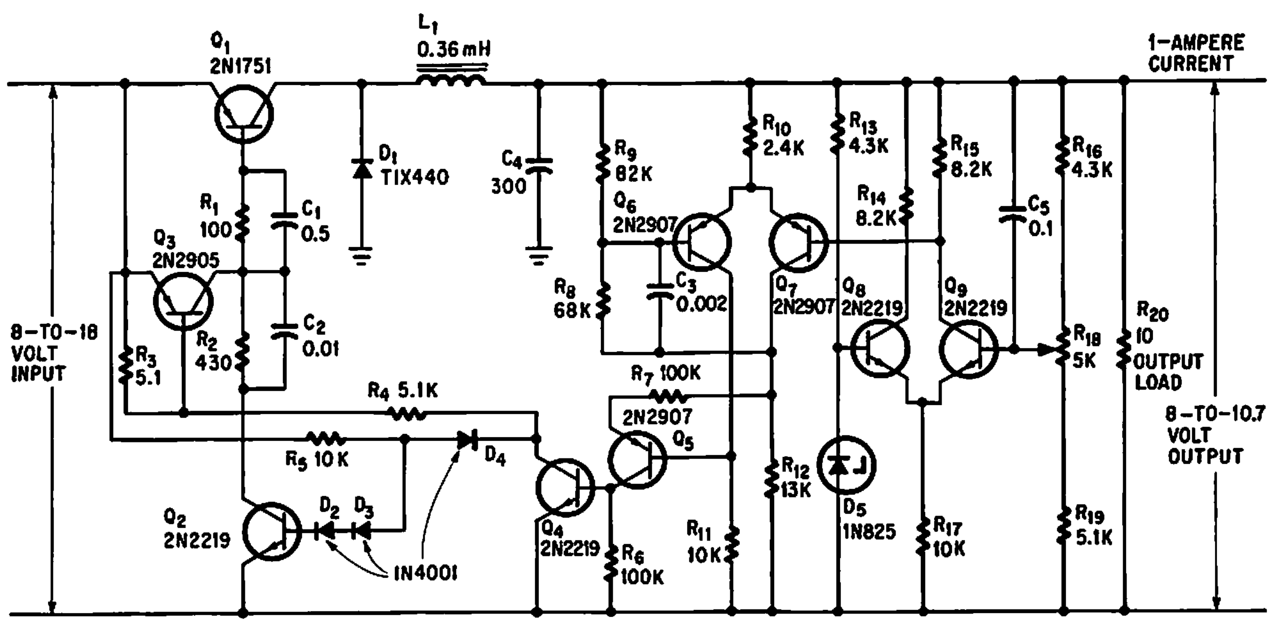
HYBRID D-C OPERATIONAL AMPLIFIER—Uses Goldberg chopper-stabilized principle for d-c drift correction. D-c gain is 900,000, input impedance 230,000 ohms, and output impedance 1,000 ohms. Generates −20 to +20 v across 10,000-ohm load at 0 to 800 cps.—R. L. Konigsberg, Designing Hybrid D-C Amplifiers to Withstand Missile Environments, *Electronics*, 34:32, p 157–159.



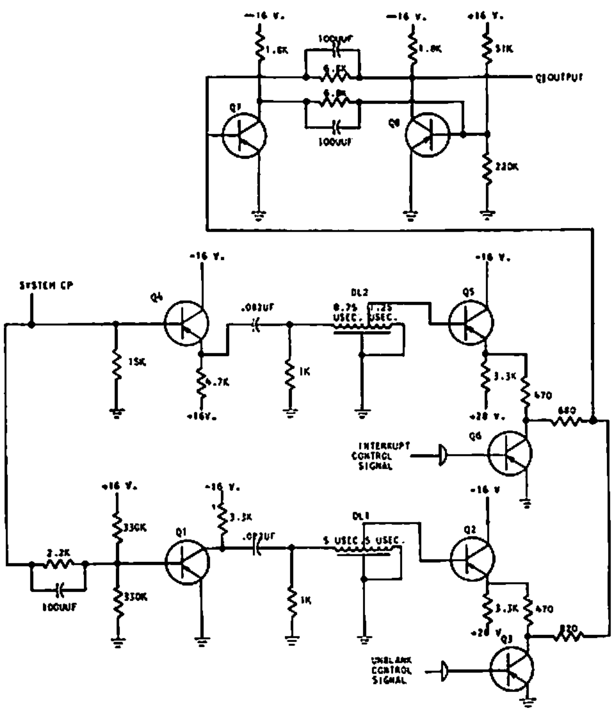
SUMMING CHOPPING AMPLIFIER—D-c operational amplifier is connected as summing amplifier with two inputs. Input-output relationship is independent of amplifier characteristics because amplifier gain is sufficiently high and effects of d-c drift in transistor circuits are sufficiently small. D-c and low-frequency components are amplified in chopper amplifier and integrating amplifier, while high-frequency a-c components go through preamplifier. The two signals are combined and further boosted by power amplifier. Integrating section has time constant of 12 sec, determined by C2-R3.—W. Hochwald and F. H. Gerhard, D-C Operational Amplifier With Transistor Chopper, *Electronics*, 32:17, p 94–96.



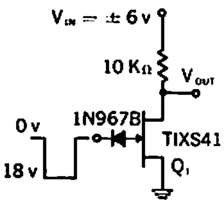
500-W VARIABLE PULSE WIDTH REGULATOR—Chopper transistor supplies pulse-width-modulated pulses to averaging circuit and filter. Filter output voltage is compared to external reference voltage by magnetic amplifier, which changes pulse width to decrease deviation. Chopper is driven by two-transistor square-wave oscillator modulated by magnetic amplifier.—P. Balthasar, New Transistor Regulator Handles 500-Watt Outputs, *Electronics*, 35:38, p 48–49.



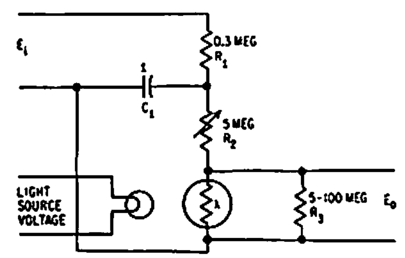
CHOPPER-TYPE REGULATOR—To obtain 10 v at 1 amp from satellite solar cell supply with 97% efficiency, differential amplifier in comparator stage produces error voltage to control Schmitt trigger, driver, and pass switch. This achieves regulation by chopping current flow into filter for discrete intervals.—C. Andren, High-Efficiency Voltage Regulator, *Electronics*, 37:23, p 64–5.



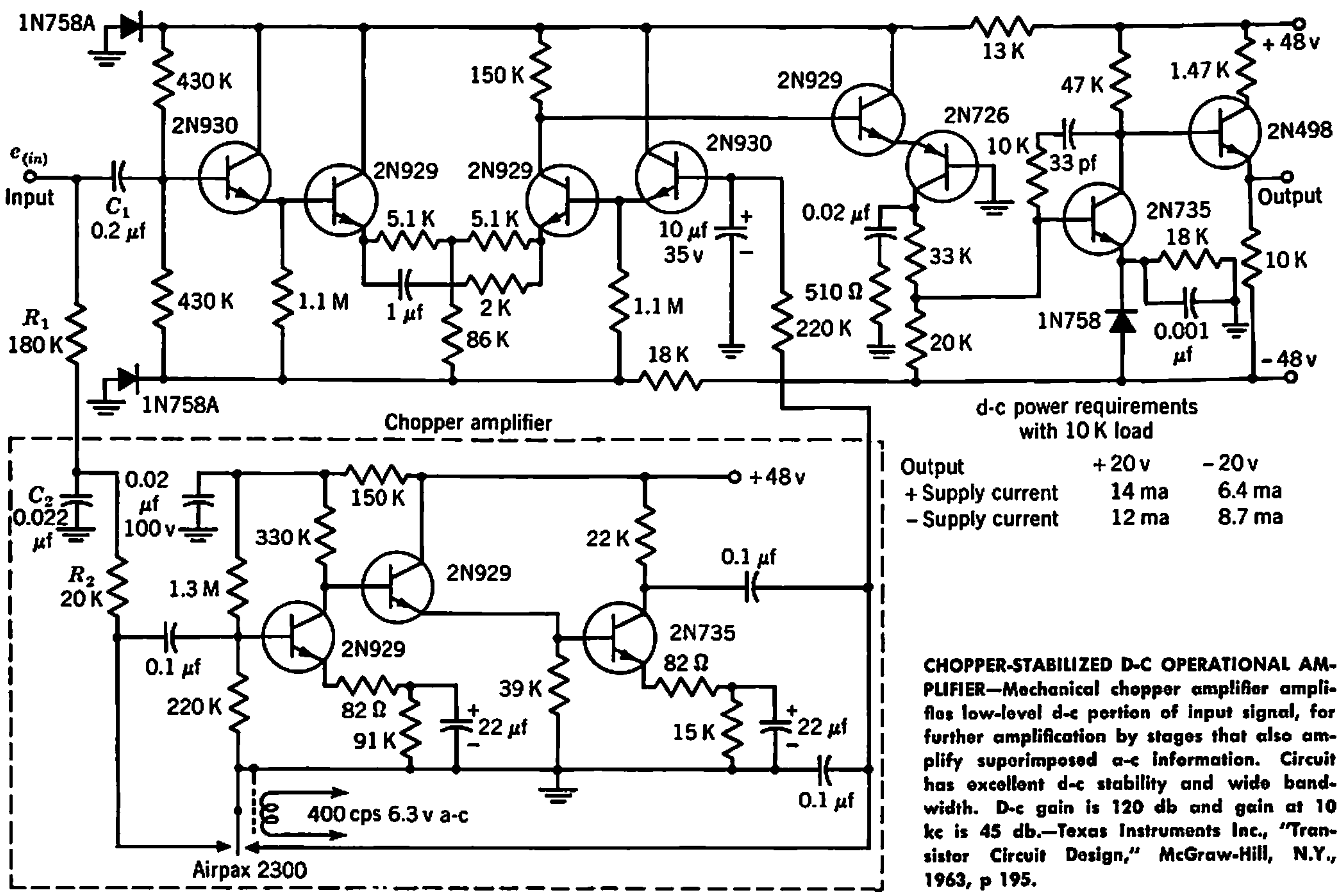
ASYNCHRONOUS SQUARE-WAVE CHOPPER—Used to interrupt or chop square wave generated with or in between regular system clock pulses, at specified times. Clock pulses are applied to bases of Q1 and Q4. Can be used to generate unblanking pulses without rise time deterioration, for intensifying sine and cosine waves on a radar display.—J. McGruder, Square Wave Chopper, *EEE*, 10:12, p 26–27.



SHUNT FET CHOPPER—Shunt connection of silicon fet gives excellent performance because on resistance is only 20 ohms and drain-gate leakage current is less than 0.1 nanoamp.—Six More Semiconductor Advances from TI, (Texas Instruments ad), *EEE*, 14:8, p 120–121.



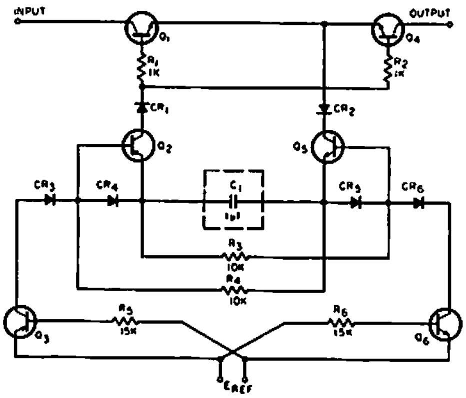
PHOTOCONDUCTIVE CHOPPER—Combines low noise level with resistance to vibration. R1 prevents burnup of photocell. R2 gives maximum conversion efficiency at setting of about 2.2 meg. C1 averages d-c input signal fluctuations so they do not exceed 120-cps chopping frequency of light source.—R. G. Seed, Chopper Uses New Photocells, *Electronics*, 31: 21, p 90–98.



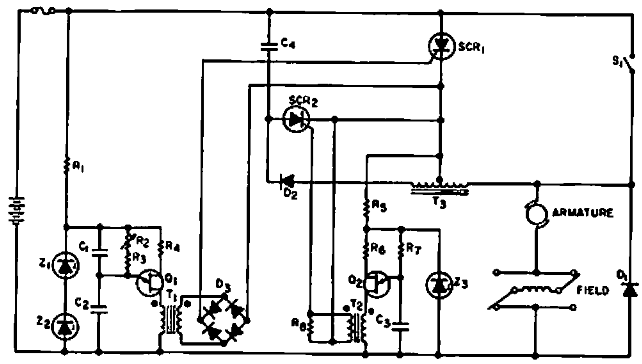
d-c power requirements with 10 K load

Output	+20 v	–20 v
+ Supply current	14 ma	6.4 ma
– Supply current	12 ma	8.7 ma

CHOPPER-STABILIZED D-C OPERATIONAL AMPLIFIER—Mechanical chopper amplifier amplifies low-level d-c portion of input signal, for further amplification by stages that also amplify superimposed a-c information. Circuit has excellent d-c stability and wide bandwidth. D-c gain is 120 db and gain at 10 kc is 45 db.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 195.

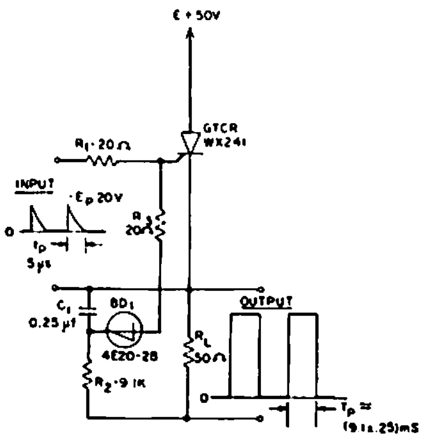


PRINTED-CIRCUIT CHOPPER—Uses conventional Bright chopper connected to reference supply through coupler, constructed on ceramic chip. Q1 and Q4 are 2N914 matched pairs, Q2 and Q3 are 2N2412, and Q5 and Q6 are 2N914. All diodes are 1N914.—D. D. Robinson, Application of Integrated Circuits: An Evolutionary Approach, *EEE*, 12:4, p 42–47.

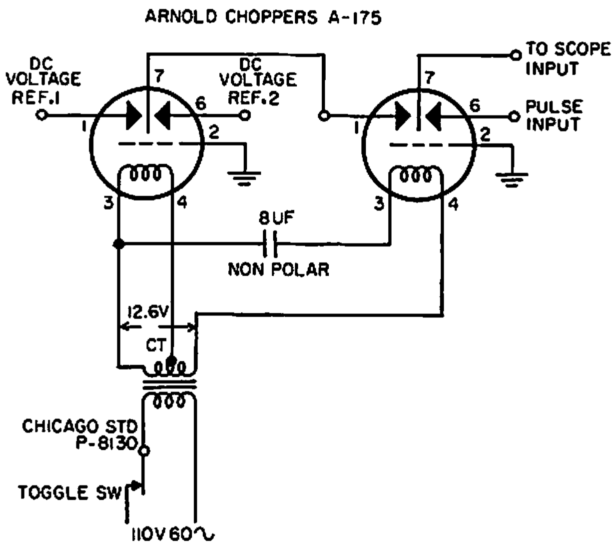


C1—0.1μf, 100V	R1—220Ω, 2W	SCR1—G-E C358
C2—0.1μf, 100V	R2—0 TO 100K POTENTIOMETER (TAPER Z)	SCR2—G-E C358
C3—0.22μf, 100V	R3—20K, 1/2W	T1—PE 2229
C4—100μf, 115VAC, G-E 28F1103	R4—330Ω, 1/2W	T2—PE 2229
D1—G-E 1N2155	R5—270Ω, 2W	T3—G-E 9T45Y7009
D2—G-E A27P	R6—330Ω, 1/2W	Z1—G-E 1N1771
D3—G-E 1N536(4)	R7—15K, 1/2W	Z2—G-E 1N1771
Q1—G-E 2N2646	R8—100Ω, 1/2W	Z3—G-E 1N1773
Q2—G-E 2N2647		

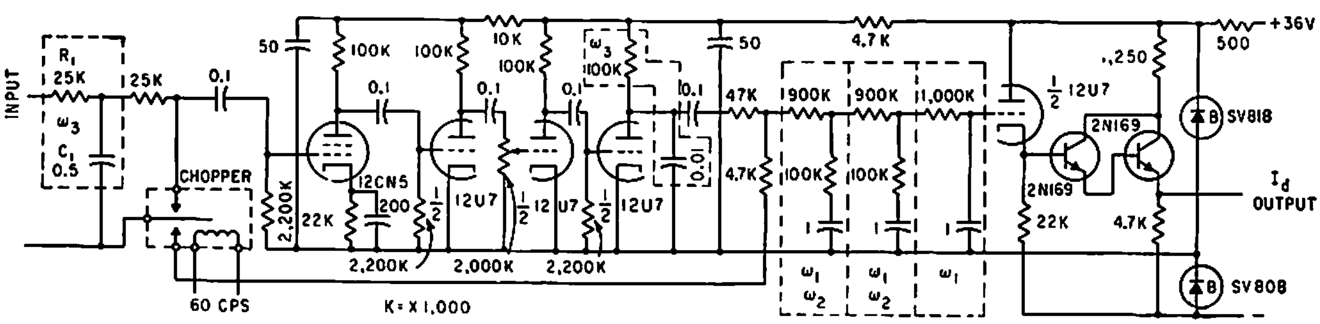
JONES CHOPPER FOR BATTERY-POWERED VEHICLE—Uses variable-frequency constant-pulse-width system that starts reliably and provides smooth acceleration. At low speeds, on time of chopper, in series with d-c series motor, is much less than off time so average motor voltage is low. Potentiometer R2 controls ratio of on to off times for speed control. —"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 173.



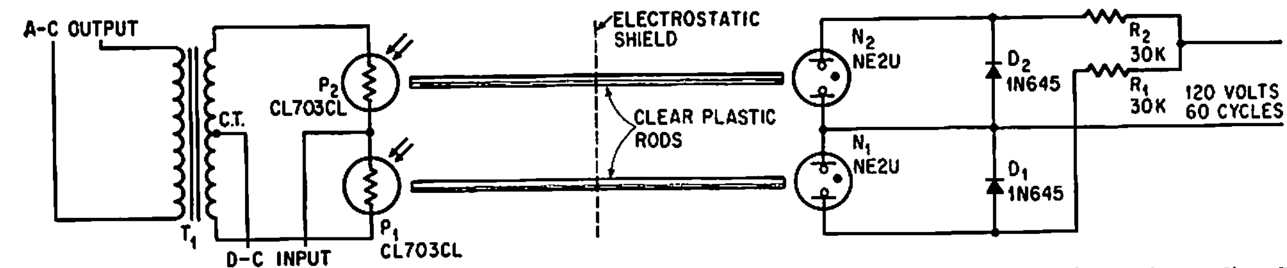
NORMALLY-OFF GTO CHOPPER—Small trigger at input generates high-power pulse with duration determined by time constant R2-C1. Gate-turnoff controlled rectifier in this circuit will chop 1 kw at 1 kc.—J. W. Motto, Jr., Switching Circuits Using the Gate Turnoff Controlled Rectifier, *EEE*, 11:3, p 52–55.



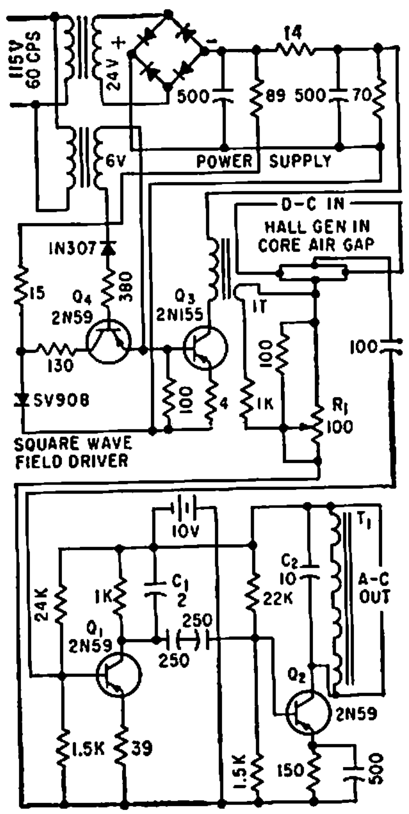
MULTITRACE CRO DISPLAY—Allows simultaneous presentation of desired pulse and of limit voltage levels. Choppers operate 45° out of phase, which provides approximately equal brightness for both parts of display.—D. F. Frost and R. M. Zilberstein, Multitrace Display Device, *EEE*, 10:8, p 27.



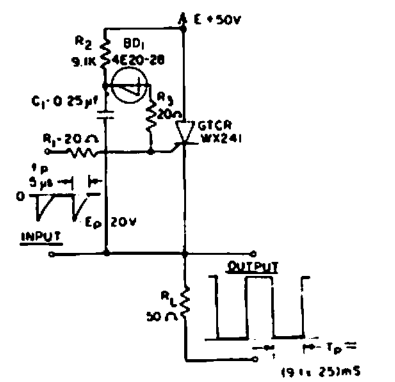
HYBRID D-C FEEDBACK AMPLIFIER—Used for calibrating a-c ammeters and voltmeters directly to standard cell. Use of tubes with chopper amplifier gives good temperature stability. Output to thermocouple is 7.5 ma.—E. A. Gilbert, Feedback Circuits for A-C Instrument Calibration, *Electronics*, 33:40, p 94–96.



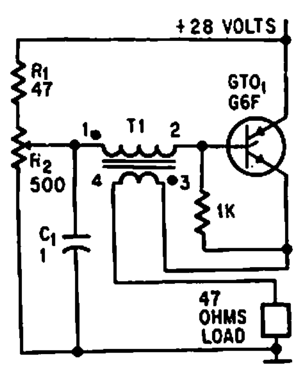
OPTOELECTRONIC CHOPPER WITH NEONS—Used with amplifier of sensitive potentiometer recorder. Diodes D1 and D2 short-circuit lamps on alternate half-cycles. Photoelectric chopping eliminates stray interference from a-c line and minimizes heat dissipation problems.—W. Moore, Photoconductors Chop D-C Signal Levels, *Electronics*, 38:9, p 61–62.



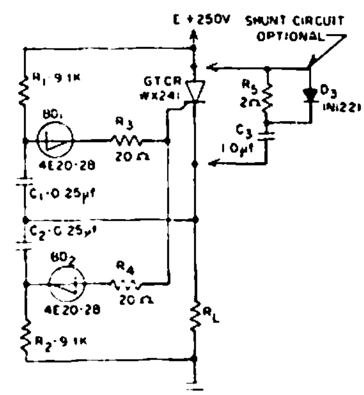
HALL-GENERATOR CHOPPER AMPLIFIER—D-c signal voltage to be chopped is applied as control current of Hall generator. Magnetic field for generator is pulsed at 60 cps by driver circuit. Output is pulsating d-c voltage that is product of the two inputs. Error in input d-c versus output a-c is 2.5% for temperature range of −20 to 50°C. Can be used as d-c, a-c, or r-f microammeter.—T. J. Marcus, Highly Sensitive Electronic Chopper, *Electronics*, 32:40, p 67–68.



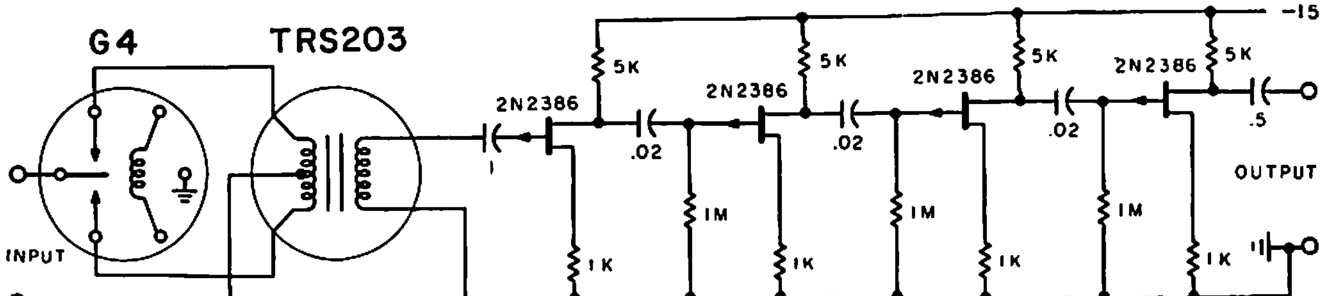
NORMALLY-ON GTO CHOPPER—Small trigger at input removes applied voltage from load for duration of time constant R2-C1. Handles 1 kw at 1 kc.—J. W. Motto, Jr., Switching Circuits Using the Gate Turnoff Controlled Rectifier, *EEE*, 11:3, p. 52–55.



GATE TURNOFF CHOPS 28 V AT 100 KC—Saturable transformer and gate turnoff scr give simple 100-kc chopper in which potentiometer R2 controls on-to-off timer.—D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.

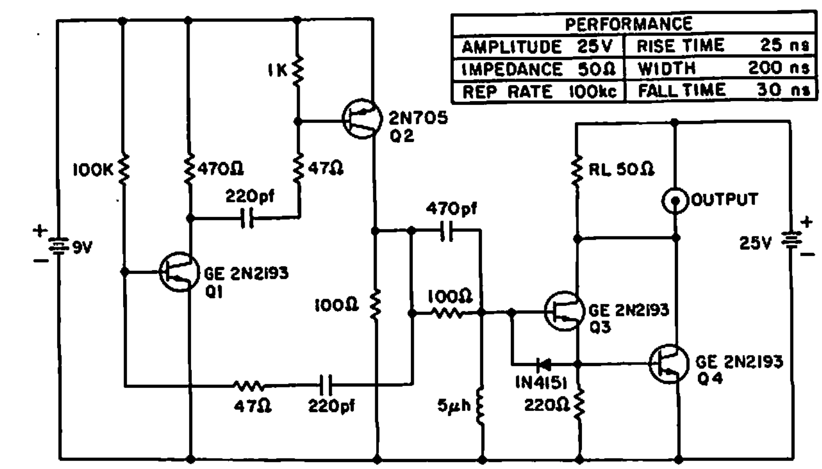


GATE-TURNOFF D-C CHOPPER—Will chop 1 kw at 1 kc. Ratio of on time to off time can be adjusted to control power, voltage, temperature, and other parameters. Shunt circuit allows larger currents to be chopped.—J. W. Motto, Jr., Switching Circuits Using the Gate Turnoff Controlled Rectifier, *EEE*, 11:3, p 52–55.

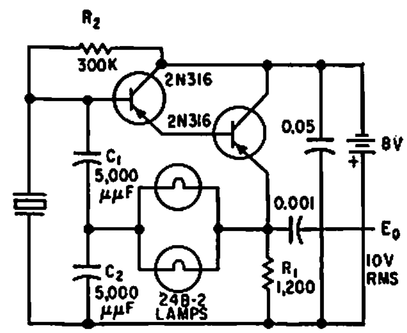


FET AMPLIFIER WITH MECHANICAL CHOPPER—Gives readings down to 10 nanovolts, with wideband response, because of remarkably low noise performance. Chopper frequency can be up to 1,500 cps.—Airpax Electronics (ad), *Electronics*, 39:15, p 170.

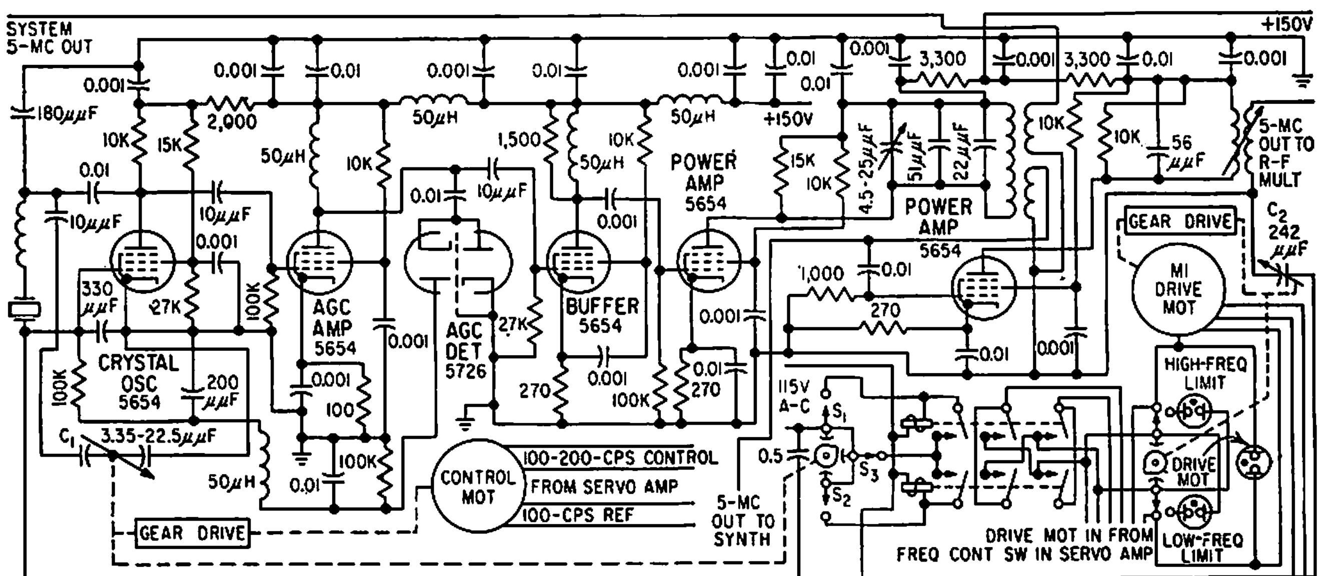
CHAPTER 15
Clock Circuits



25-NSEC 0.5-AMP CLOCK PULSE GENERATOR—Used in computer circuits to set timing for array of circuits. Mvbr Q1-Q2 triggers pulse generator Q3-Q4.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 202.

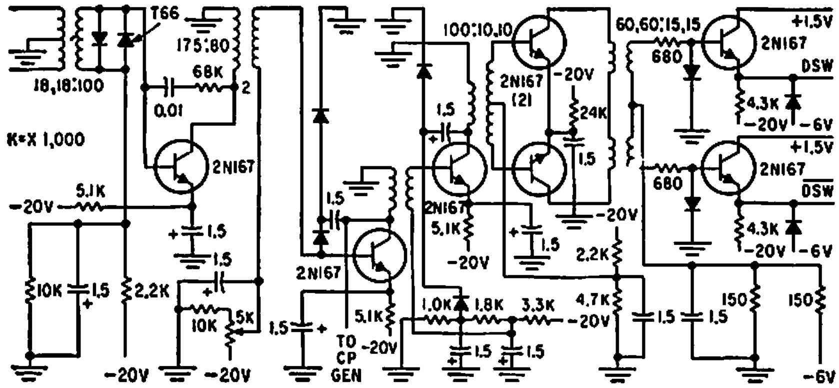


100-KC CLOCK FOR COUNTER—Stable fixed-frequency Pierce oscillator becomes transistorized Clapp oscillator when crystal is replaced by high-Q L-C tuner.—W. D. Fryer, How to Design Low Cost Audio Filters, *Electronics*, 32:15, p 68–70.

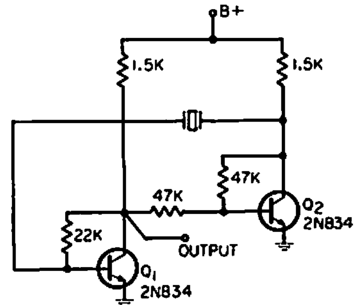


K=X 1,000

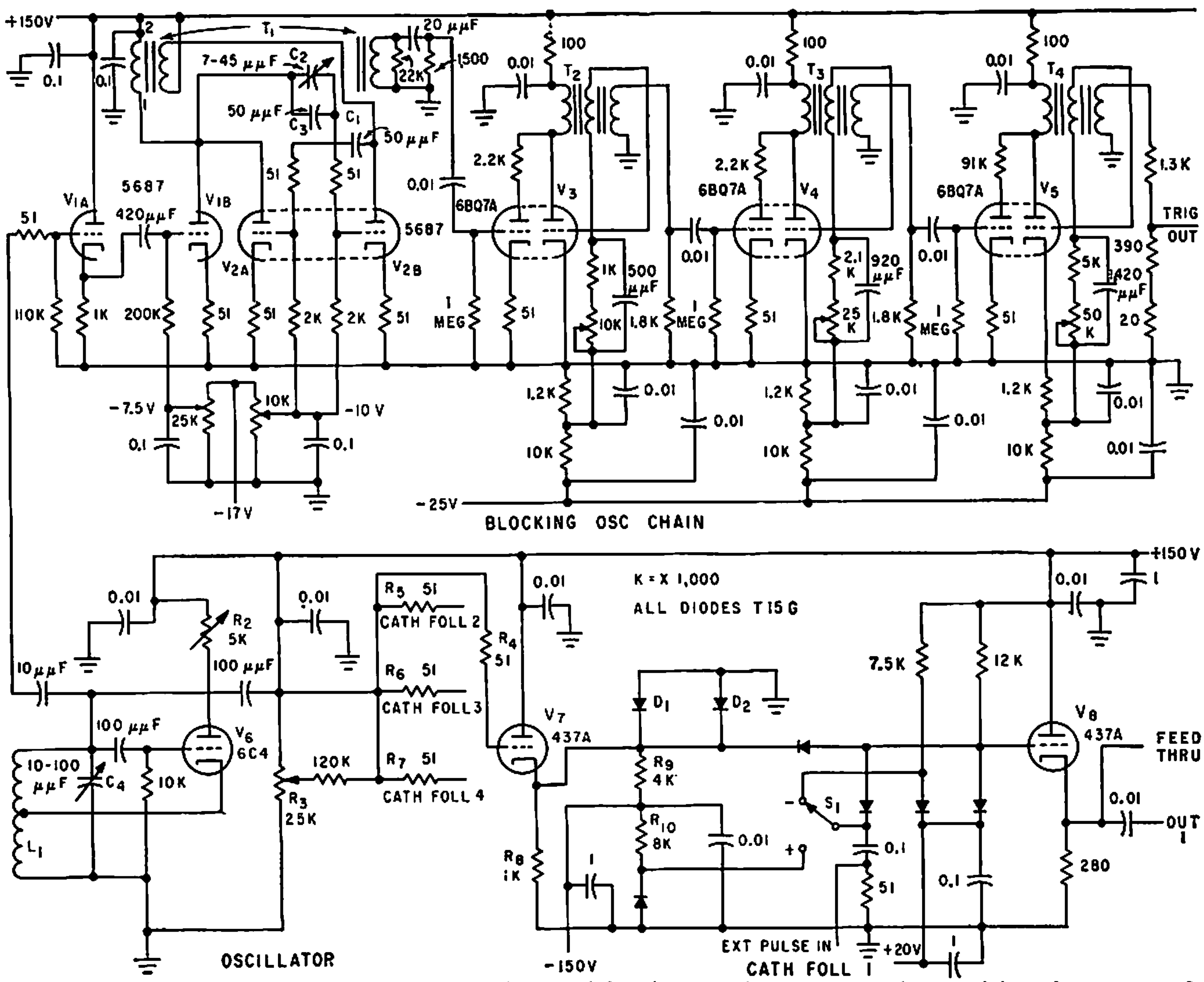
5-MC CRYSTAL FREQUENCY CONTROL—C1 provides fine frequency control of 5-Mc primary frequency standard, when driven by 100-cps control signal from cesium beam tube. This will change frequency up to 2.5 cps, sufficient for short-time drifts over several days. When C1 reaches either end of its range, cam closes S1 or S2 and energizes drive motor M1 for C2. Large capacitor is then driven in direction that will make small capacitor return to middle of its range.—W. A. Mainberger, Primary Frequency Standard Using Resonant Cesium, *Electronics*, 31:45, p 80–85.



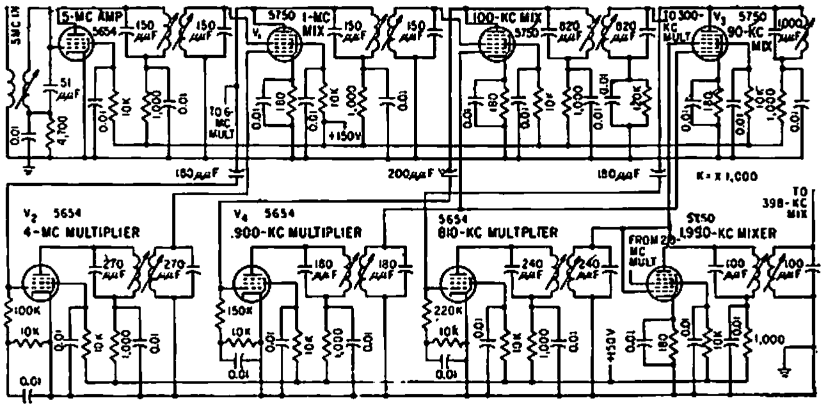
CLOCK PULSE AMPLIFIER—Generates clock pulses for driving all flip-flops in magnetic drum timing channel system, and generates digit square-wave signals used in Manchester conversion network of writing amplifier. External signal generator provides desired frequency for time track.—A. J. Strassman and R. E. Keeter, Clock Track Recorder For Memory Drum, *Electronics*, 32:41, p 74–76.



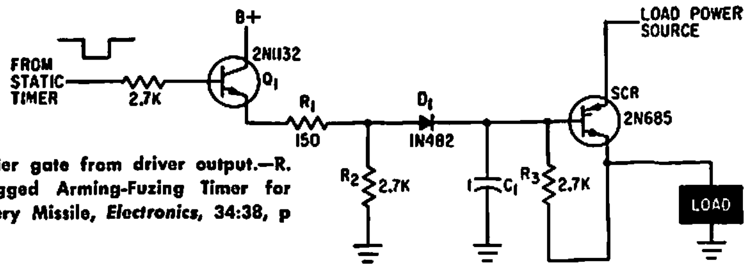
CRYSTAL-CONTROLLED MVBR—Simplicity and stability make circuit useful as system clock. Will oscillate at 1 Mc over supply voltage range of 2 to 30 v. Output is rounded square wave, at any frequency from 3 kc to 10 Mc depending on crystal used.—J. Freeman, Crystal Controlled Multivibrator, *EEE*, 13:6, p 65.



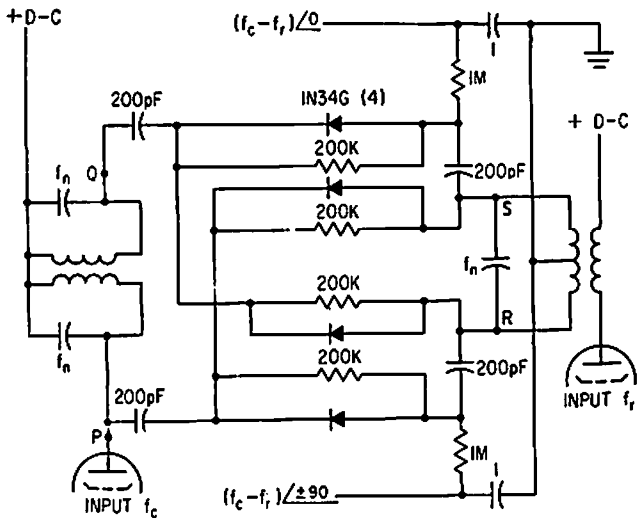
MEGAPULSE GENERATOR—Provides up to 18-Mc pulses for dynamic testing of high-speed digital computers. Can be used as clocking system. Major frequency changes in self-biased Hartley oscillator V6 are made with plug-in coils L1, and fine changes with C4. Positive output pulses, continuously variable between 0 and 20 v, are generated in four output channels, in 10-microsec bursts or with 0 to 10 microsec blanks between strings of pulses when gated by pulse generator.—R. W. Buchanan and B. Kautz, Dynamic Testing of Computer Building Blocks, *Electronics*, 32:33, p 66–68.



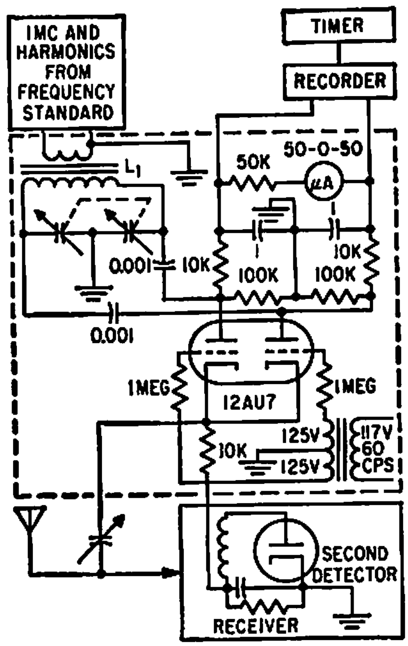
CESIUM CLOCK SYNTHESIZER—Crystal 5-Mc oscillator is monitored by natural resonance frequency of cesium (9,192.63184 Mc) to get primary frequency standard. Output signals are 100 kc and 1, 5, 10, and 100 Mc, with accuracy of one part in one billion. Starting with 5 Mc, 9,180 Mc is achieved as harmonic by direct multiplication. Remaining 12.631840 Mc is obtained from 5-Mc source by frequency multiplication, division, and mixing. Circuit shows input section of synthesizer used for this purpose.—W. A. Mainberger, Primary Frequency Standard Using Resonant Cesium, *Electronics*, 31:45, p 80–85.



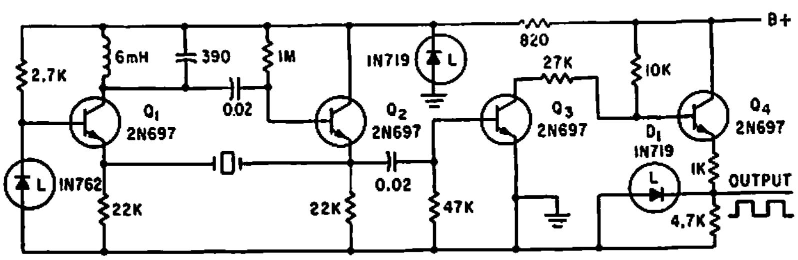
CLOCK OUTPUT DRIVER—Driver transistor Q1 is pulsed on at preset time, to supply drive current to gate of scr so it applies current to load. When scr fires, D1 is back-biased, removing rectifier gate from driver output.—R. S. Reed, Rugged Arming-Fuzing Timer for Atomic Artillery Missile, *Electronics*, 34:38, p 48–51.



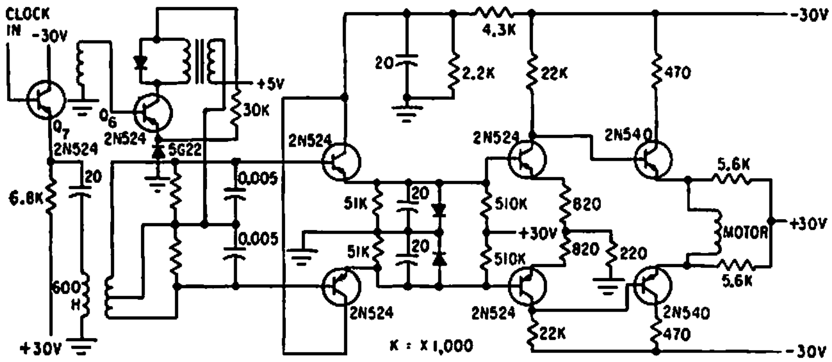
MOTOR-CONTROLLING MIXER—Used to lock crystal oscillator frequency to standard-frequency signals from WWV. Circuit mixes clock and WWV frequencies (fed to tubes at left and right) in Nygaard discriminator arrangement, which delivers two outputs, each equal to difference frequency but differing 90° in phase. These output signals are amplified for synchronous motor that drives trimmer capacitor of crystal oscillator in servo loop that brings difference frequency to zero.—K. Nygaard, Atomic Clock Accuracy for Crystal Oscillators, *Electronics*, 33:46, p 82–83.



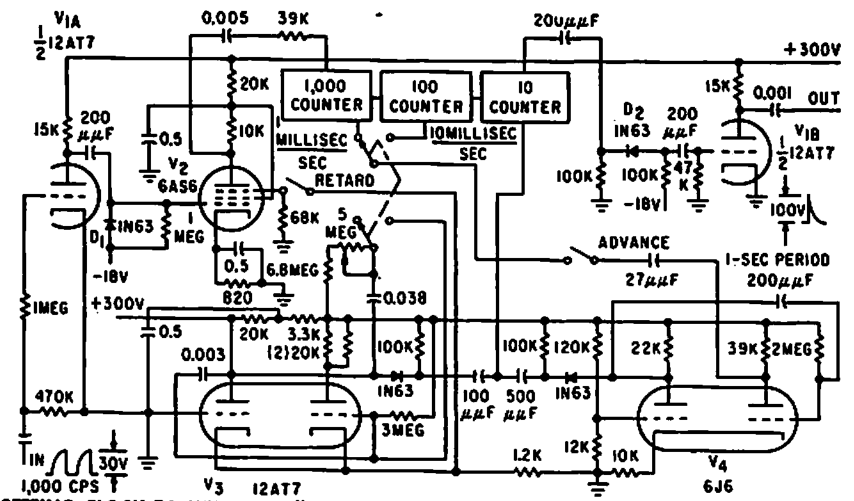
SIMPLE WWV CHECK—Permits making accurate check of local frequency standard quickly and easily by direct comparison with WWV signals. Uses one receiver. Two signals, at 0 and 180°, are obtained from local standard clock. Switch 12AU7 alternately connects one triode detector output and 0° signal simultaneously to antenna, and then other triode detector output simultaneously with 180° signal. Doppler error is minimized by averaging hourly 3-minute readings over 8-hour period. Accuracy is one part in 100,000,000.—J. F. Brumbach, Fast WWV Check of Frequency Standard, *Electronics*, 32:13, p 76–79.



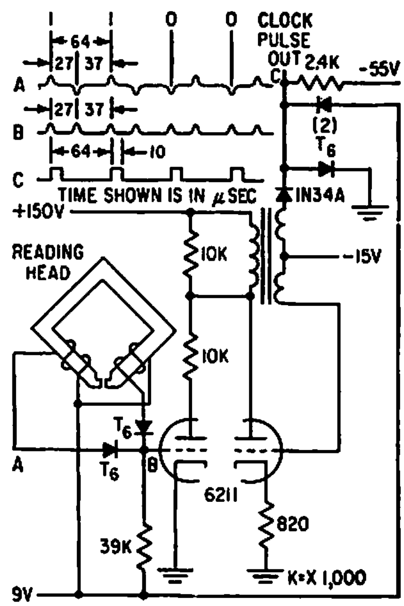
CLOCK OSCILLATOR—Q1 and Q2 form oscillator section of time-base generator, and Q3-Q4 serve as pulse shaper. Q1 is grounded-base voltage amplifier with tuned collector load. Q2 matches impedance of Q1 collector circuit to crystal. Output amplitude is limited by zener diode D1.—R. S. Reed, Rugged Arming-Fuzing Timer for Atomic Artillery Missile, *Electronics*, 34:38, p 48–51.



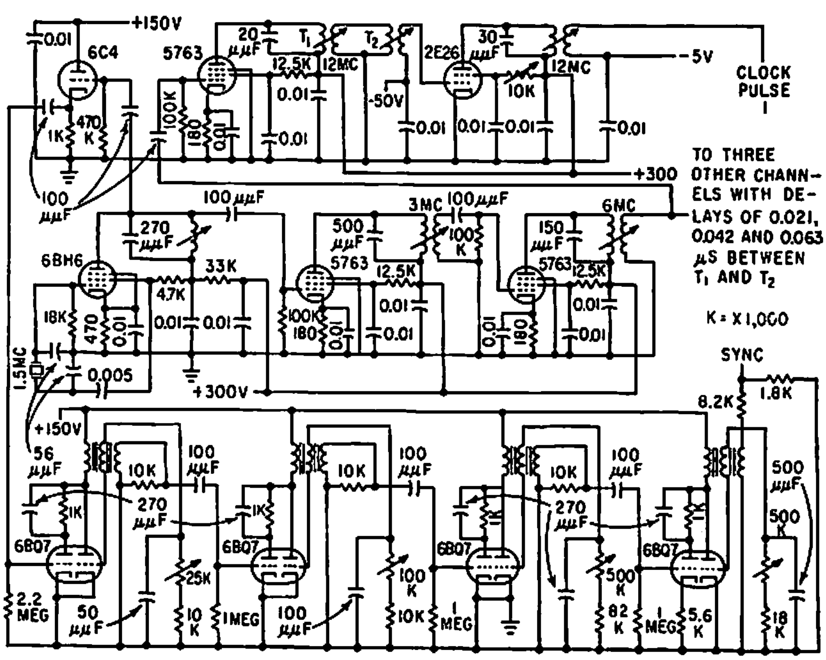
PHASE SYNCHRONIZER—Used to synchronize 2,500-cps local time standard with that of transmitting end of wire-line system. When zero crossings of pulses do not coincide, error signal is produced which, after amplification, is applied to motor that rotates phase shifter until there is phase synchronization between local clock and incoming information. This insures sampling of recovered information at middle of incoming bit.—J. L. Hollis, Sending Digital Data Over Narrow-Band Lines, *Electronics*, 32:23, p 72–74.



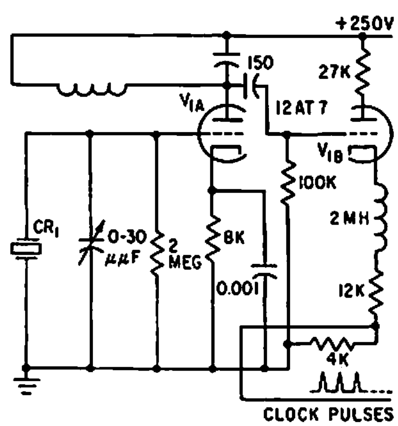
SETTING CLOCK TO WWV—Locally generated pulses can be easily synchronized with pulses from WWV to set clocks associated with frequency standard. Changes in period of pulses from counter-type frequency dividers are made with precision vernier. Any 10-stable divider can be used in counter circuit.—E. F. Wilson, Using Divider Vernier to Synchronize Pulses, *Electronics*, 32:27, p 44–45.



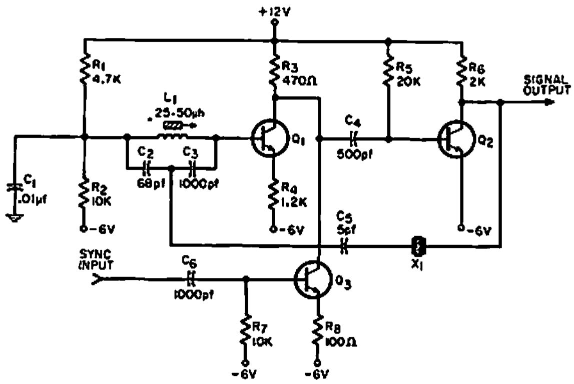
CLOCK PULSE GENERATOR—Derives pulse from reading head that scans data track of magnetic-spoke disk memory, eliminating need for separate timing track. Generates pulse for each magnetic spoke passing over gap of head, regardless of whether spoke is written with 1 or 0.—T. C. Chen and O. B. Stram, Digital Memory System Keeps Circuits Simple, *Electronics*, 32:11, p 130–133.



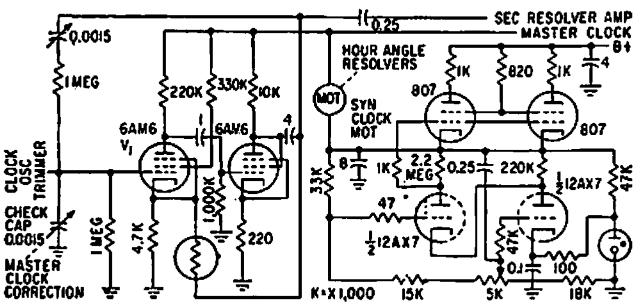
FOUR-PHASE 12-MC CLOCK—To minimize jitter of synchronizing signals, fundamental frequency is chosen at one-eighth of clock rate or 1.5 Mc. Oscillator output is fed through two doubler stages and split into three channels, each having additional doubler followed by power amplifier, to provide low output impedance at any reasonable power level.—G. O. Olson, Design of High-Frequency Clock Pulse Generators, *Electronics*, 32:35, p 56–57.



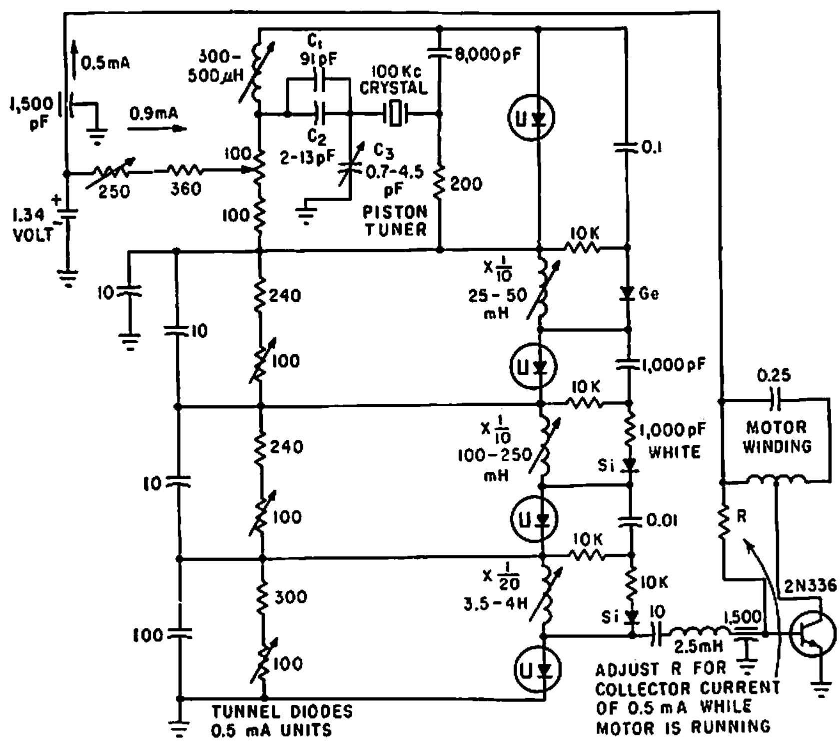
809.11-KC CLOCK OSCILLATOR—Crystal-controlled oscillator V1A and shaping circuit V1B produce pulses with repetition rate equal to frequency of crystal oscillator.—H. Vantine Jr. and E. C. Johnson, Modified Transceivers Compute Distance, *Electronics*, 31:37, p 94–98.



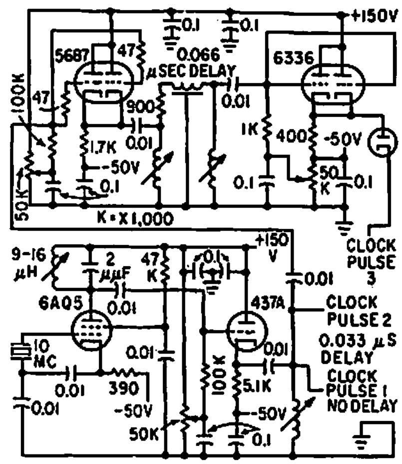
SYNCHRONIZING 3.3-MC CLOCK TO 300-PPS TRIGGER—Synchronizes crystal-controlled train of 3.3-Mc clock pulses to unrelated sync trigger having nominal repetition rate of 300 pulses per second, to provide constant delay between end of sync pulse and first clock pulse.—P. Danzer, Synchronized, Crystal-Controlled Oscillator, *EEE*, 12:5, p 90.



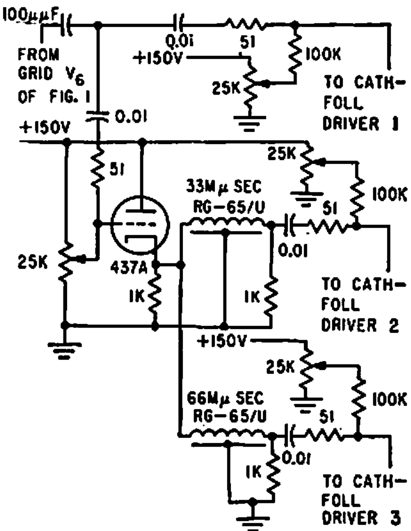
SIDEREAL REGENERATIVE OSCILLATOR—Compares synchronous clock motor speed at 30-sec intervals with pendulum-driven master sidereal-time clock. Motor runs slightly faster than sidereal time. If too fast at checking time, check capacitor at input of V1 is closed to reduce frequency of oscillation and speed of motor to bring it back into coincidence with master.—C. N. Kingston, Radio Telescope Sees 2 Billion Light Years, *Electronics*, 31:23, p 70–75.



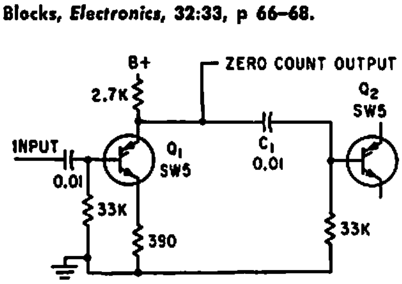
ELECTRONIC CHRONOMETER—Trimmers permit adjusting timing by a few seconds per year. Major error is due to aging of quartz crystal. Tunnel diodes divide 100-kc crystal frequency by 2,000 to give 50-cps output for driving motor of clock.—R. L. Watters, Tunnel Diodes Control Quartz-Crystal Chronometer, *Electronics*, 34:39, p 129–131.



10-MC CLOCK OSCILLATOR—Output through cathode follower is split into three channels (two are not shown) to get clock pulses at three phases.—G. O. Olson, Design of High-Frequency Clock Pulse Generators, *Electronics*, 32:35, p 56–57.

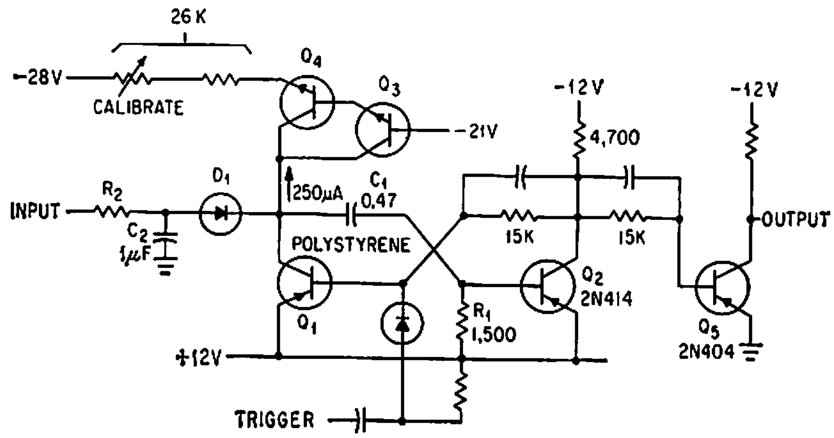


THREE-PHASE 10-MC CLOCK—Used in digital computer circuit testing when recirculation of pulses and pulse regeneration and shaping are required. Delay line provides required impedance match.—R. W. Buchanan and B. Kautz, Dynamic Testing of Computer Building Blocks, *Electronics*, 32:33, p 66–68.

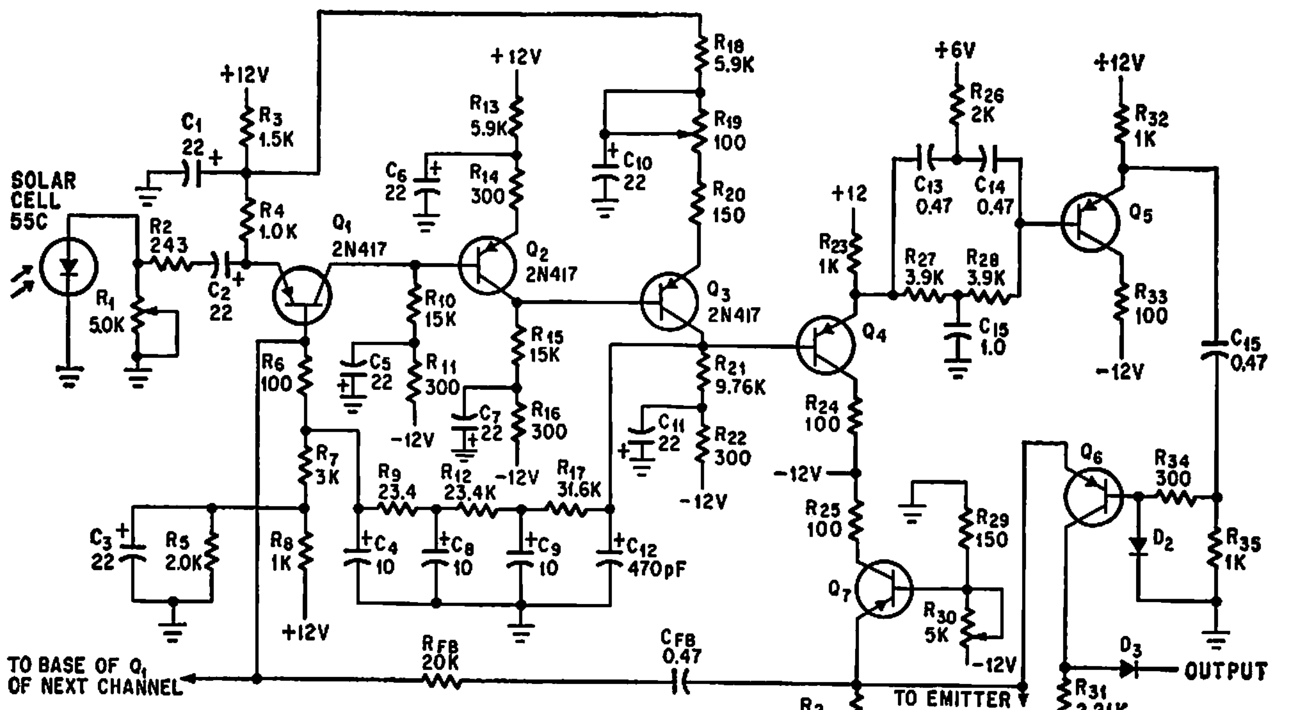


CLOCK RING COUNTER—Switching element is silicon controlled switch that approximates flip-flop, turning on when low-level positive pulse is applied to its base, and remaining on until turned off by negative pulse. Used as memory device to retain registered count until next input pulse makes bit transfer to following stage.—R. S. Reed, Rugged Arming-Fuzing Timer for Atomic Artillery Missile, *Electronics*, 34:38, p 48–51.

CHAPTER 16
Comparator Circuits

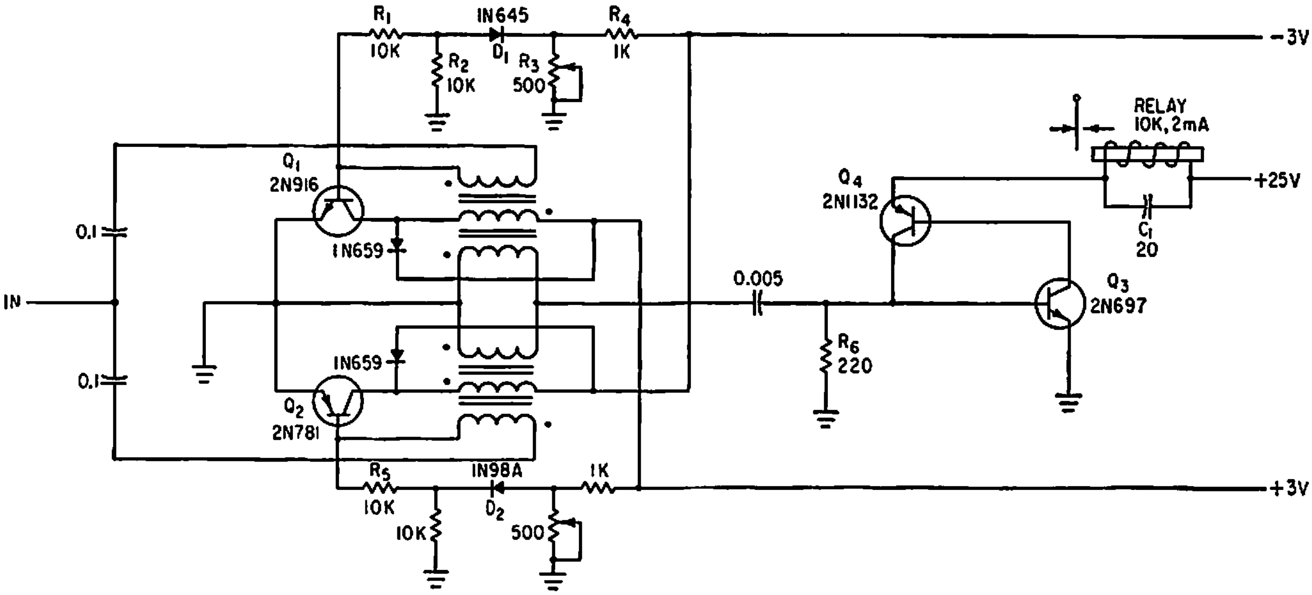


COMPARATOR FOR SOLID-STATE DIGITAL VOLTMETER—Circuit determines when output of ramp generator crosses 0 v and crosses unknown voltage. Transistor Q5 isolates mono Q1-Q2 from output logic. Transistors Q3 and Q4 provide constant current for charging C1 linearly to produce high-accuracy ramp.—R. C. Weinberg, Modified Ramp Generator Develops High D-C Input Impedance, *Electronics*, 37:8, p 33–35.

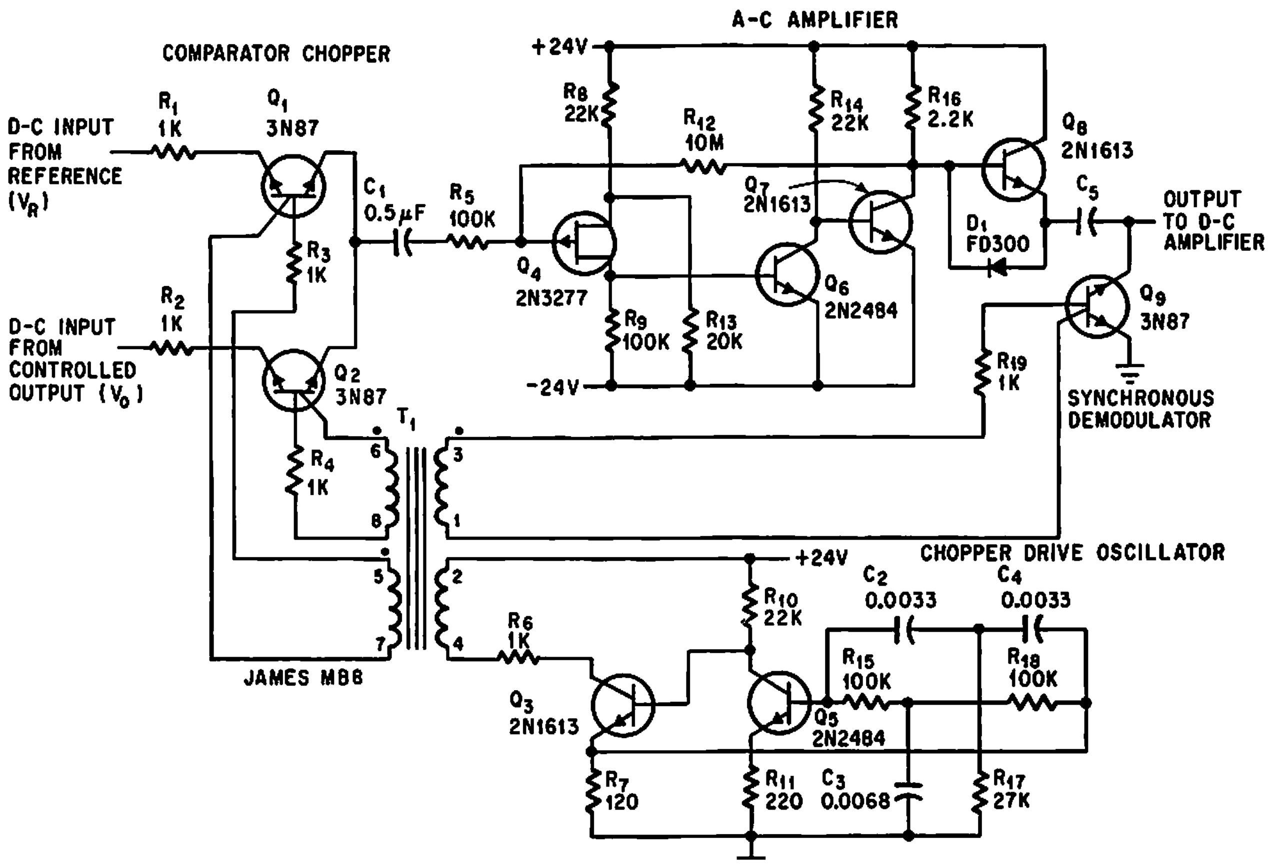


NOTE: UNLESS OTHERWISE NOTED, ALL RESISTANCE VALUES ARE IN OHMS, AND ALL CAPACITANCE VALUES ARE IN MICROFARADS

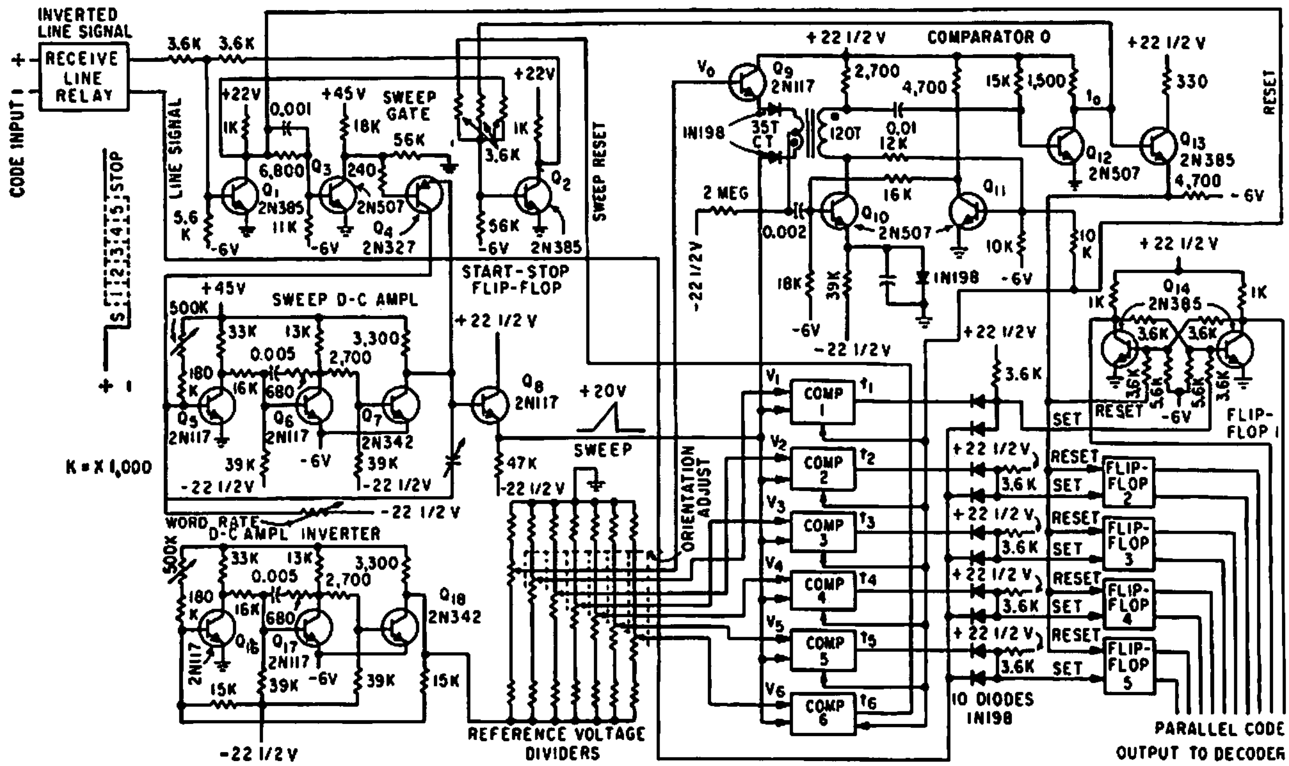
CHARACTER READER—Circuit shows one channel of solar-cell signal amplifier and section of switching block for experimental character recognition system.—P. H. Howard, Feedback System Detects 1% Amplitude Difference, *Electronics*, 38:10, p 68–70.



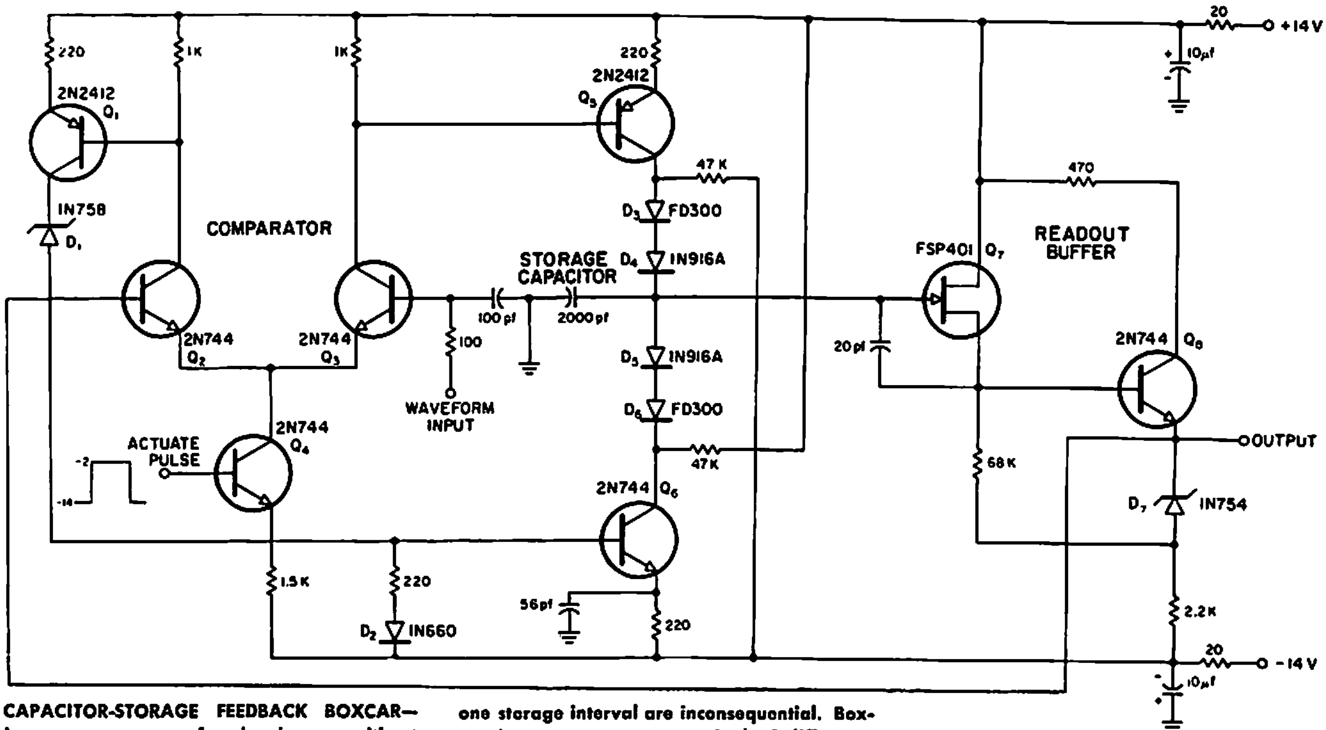
PULSE ANALYZER—Either positive or negative pulses equal to or greater than adjustable threshold voltage operate relay, thus measuring pulse height of either polarity. Responds to pulse widths as narrow as 50 nsec. Q1 responds to positive pulses, and Q2 to negative pulses.—O. B. Laug, Pulse Voltage Comparator Measures Height of Positive or Negative Pulses, *Electronics*, 34:36, p 70–71.



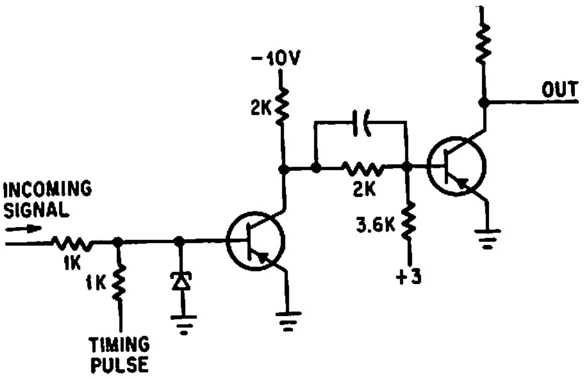
CHOPPER TRANSISTORS SIMULATE SPDT SWITCH—Comparator chopper senses difference between reference voltage and control signal while drawing very little current from reference. Sine-wave drive frequency is determined by C2 and C3, which should have 2 to 1 ratio.—J. S. Mac Dougall, Servo Comparator Amplifier Handles High Voltages, *Electronics*, 37:22, p 75–76.



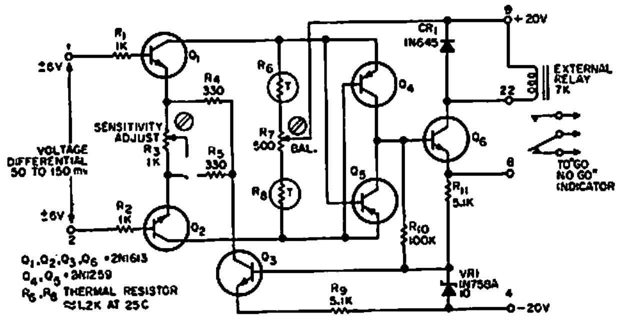
RECEIVING DISTRIBUTOR—Converts tape-code input to 5-bit parallel code at five conventional flip-flops. Rising sweep voltage successively triggers six comparator stages. If line signal is positive at triggering time, flip-flop corresponding to triggered comparator is set to its one state. Used in high-speed electrostatic printer in which each of 72 print heads has 35 print pins.—R. E. West, High-Speed Readout for Data Processing, *Electronics*, 32: 22, p 83–85.



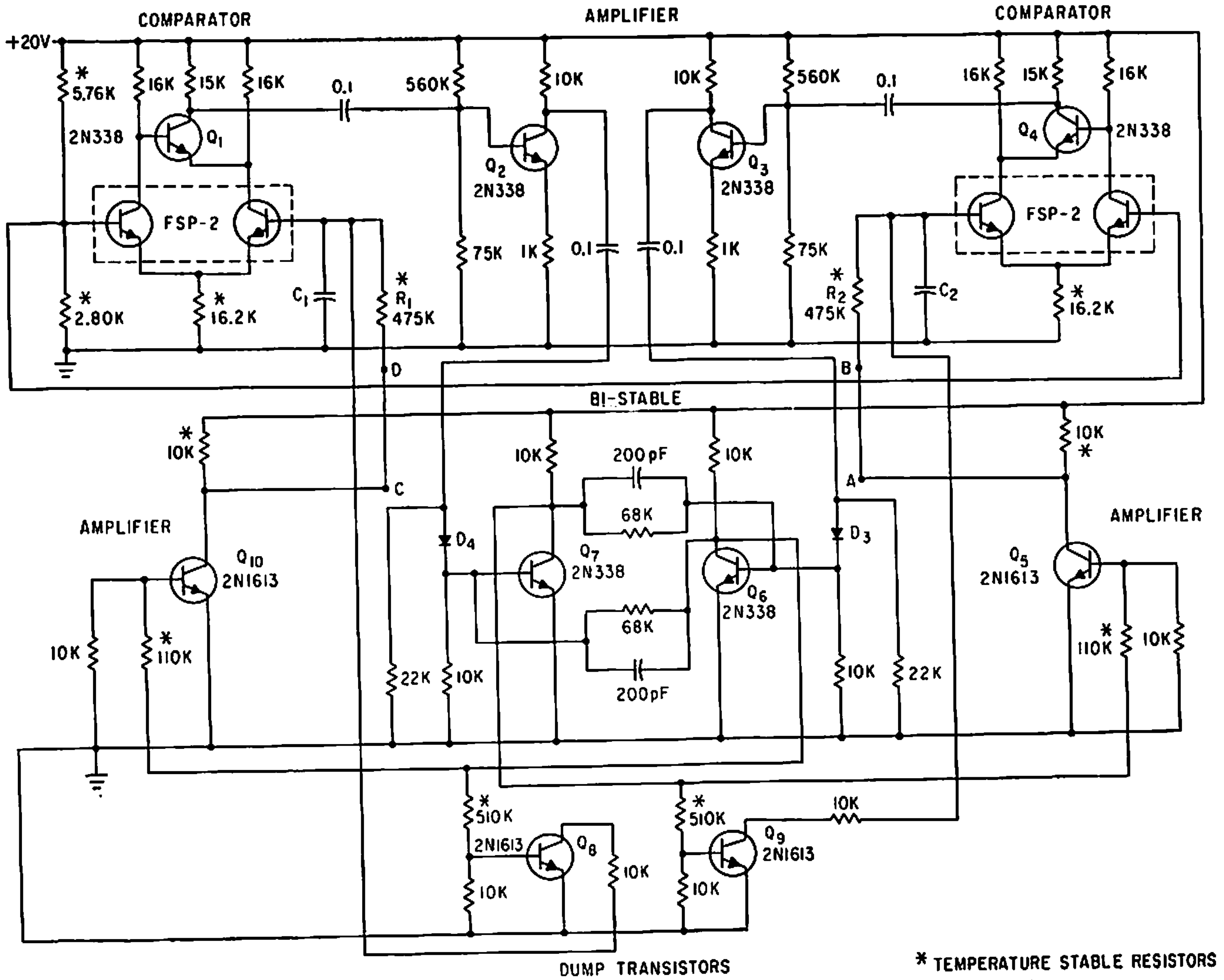
CAPACITOR-STORAGE FEEDBACK BOXCAR—Improves accuracy of radar boxcar without sacrifice in speed, by using feedback principles to overcome instabilities in d-c offset voltages. Feedback forces boxcar output to equal input voltage during sampling, so internal d-c offsets and instabilities longer than one storage interval are inconsequential. Boxcar input goes to one terminal of difference amplifier, and boxcar output goes to other terminal. Difference amplifier output is then used to control capacitor charge. By gating on difference amplifier during sampling interval, boxcar output is made equal to value of waveform at that time.—P. E. Harris and B. E. Simmons, DC Accuracy in a Fast Boxcar Circuit Via a Comparator, *IEEE Transactions on Electronic Computers*, June 1964, p 285–288.



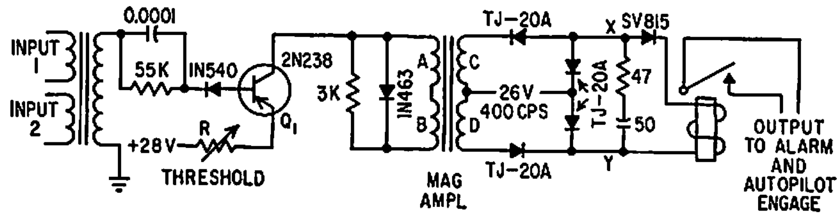
TUNNEL-DIODE VOLTAGE COMPARATOR—When incoming signal exceeds predetermined level, pulse with predetermined amplitude appears at output.—T. Kojima and M. Watanabe, When You're Second, You Try Harder, *Electronics*, 38:25, p 81–89.



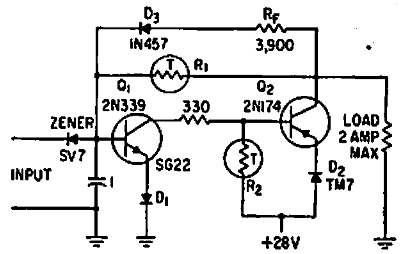
DIFFERENTIAL VOLTAGE COMPARATOR—If the two input signals are within preset differential voltage, relay is not actuated and GO indicator comes on. When the two signals differ too much, relay is actuated and NO-GO indication is provided. Used in comparing telemetered data received from satellite vehicle. —P. A. Walter, Differential Voltage Comparator, *EEE*, 10:8, p 24–25.



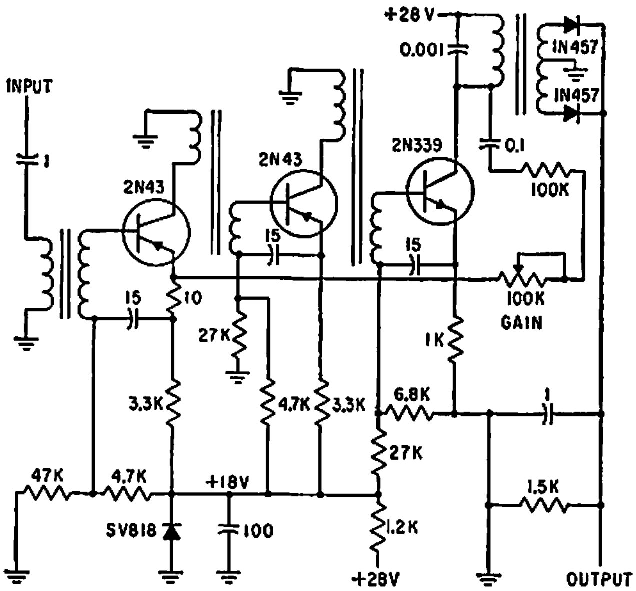
STABILIZED LOW-FREQUENCY OSCILLATOR—Transistors Q1 and Q4 compare charging voltages of mvbr timing capacitors C1 and C2 to fixed reference voltage. When a capacitor voltage is greater than reference voltage, its comparator switches its bistable mvbr to opposite state, so capacitor is discharged by dump transistor. Arrangement makes output frequency essentially independent of temperature from −25°C to +75°C, for frequency range of 0.01 to 100,000 cps.—J. D. Long, Novel Differential Amplifier Stabilizes Multivibrator, *Electronics*, 35:24, p 53–54.



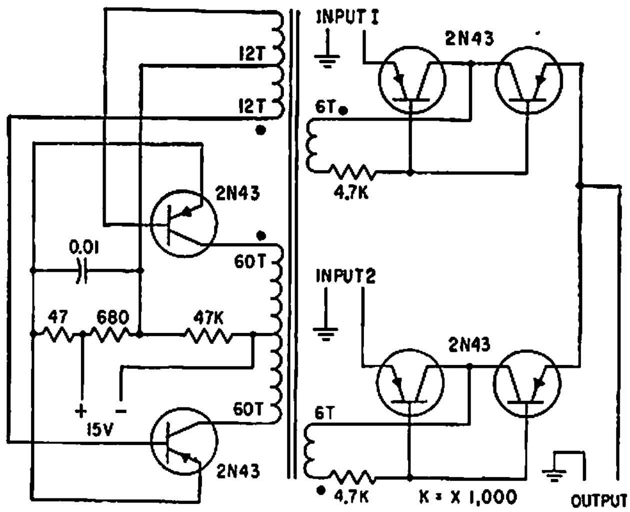
AUTOPILOT COMPARATOR-ALARM—Activates alarm or disengages autopilot when signals from dual accelerometers differ appreciably, indicating malfunction.—C. W. McWilliams, Designing Safety Into Automatic Pilot Systems, *Electronics*, 31:45, p 69–71.



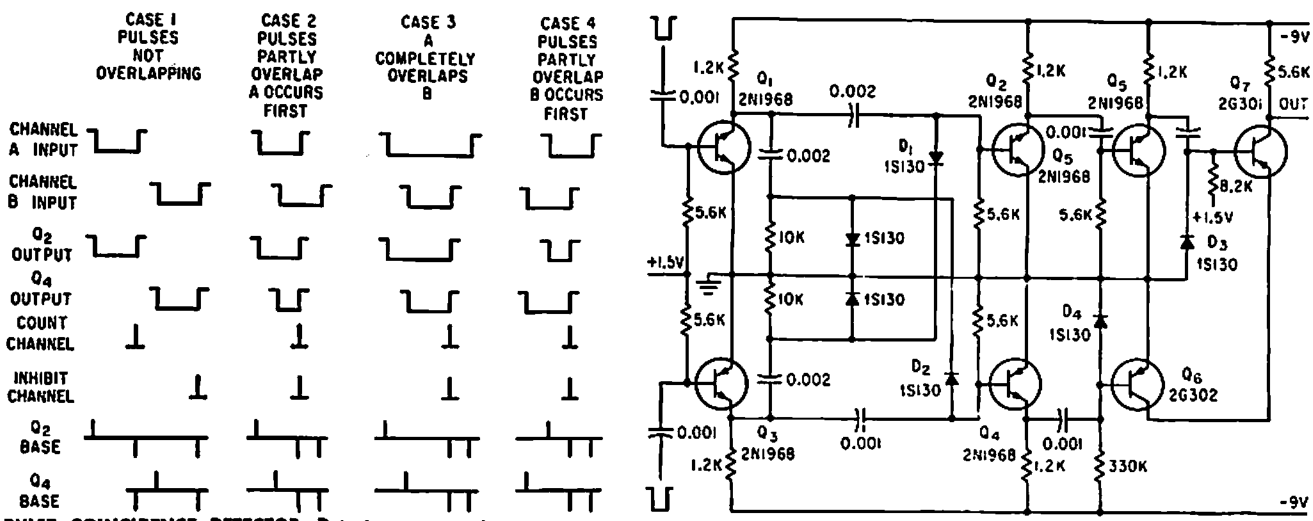
TWO-STAGE SWITCH—D-c output from carrier amplifier triggers switch consisting of two-stage complementary-coupled nonlinear amplifier, with zener diode in series with input to minimize drift, when difference between two d-c voltages exceeds preset threshold voltages of as little as 100 microvolts for only 300 microsec. Can handle 2 amp. R1 is 100,000 ohms and R2 is 100 ohms.—J. W. Higginbotham and H. H. Douglass, Voltage Comparator with High-Speed Switches, *Electronics*, 32:5, p 56–58.



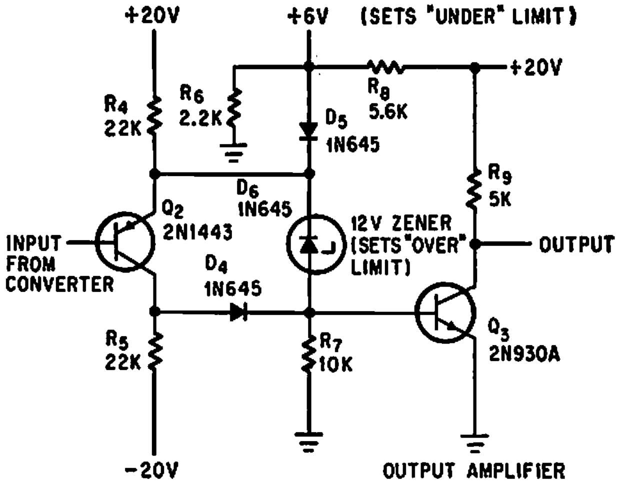
CONTROL AMPLIFIER—Converts output of 20-kc chopper to d-c error signal. Amplifier output is rectified by diodes rather than demodulated, since polarity of error is of no concern.—J. W. Higginbotham and H. H. Douglass, Voltage Comparator with High-Speed Switches, *Electronics*, 32:5, p 56–58.



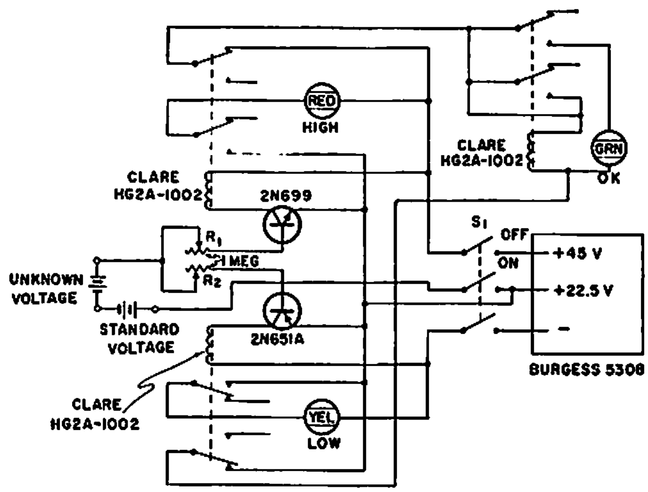
20-KC CHOPPER—Square-loop-core oscillator drives chopper at up to 20 kc for continuously monitoring two d-c voltages.—J. W. Higginbotham and H. H. Douglass, Voltage Comparator with High-Speed Switches, *Electronics*, 32:5, p 56–58.



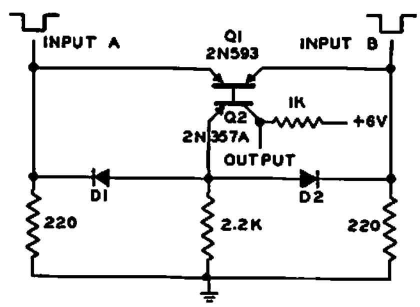
PULSE COINCIDENCE DETECTOR—Detects coincidences between pulses of random length and spacing occurring in two separate channels, to permit counting only pulses that do not overlap.—K. R. Whittington and G. Robson, Novel Anticoincidence Circuit Detects Pulse Overlap, *Electronics*, 35:26, p 82.



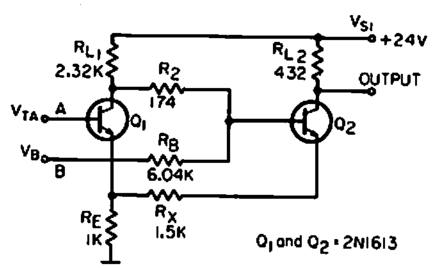
VOLTAGE-LEVEL MONITOR—Over-or-under circuit provides output signal when d-c input voltage is over 12 v or under 6 v, for monitoring or alarm purposes, with no output during desired on condition.—M. Merlon and D. Grossman, Interrogator Circuit Can Tell Good Data from Bad, *Electronics*, 37:20, p 58–59.



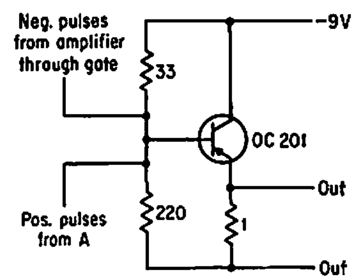
GO-NO-GO VOLTAGE COMPARATOR—Unknown voltage is compared to standard voltage within preset voltage limits. Circuit is sensitive enough to detect 0.5 v difference.—Transistor Go-No-Go Voltage Comparator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 87.



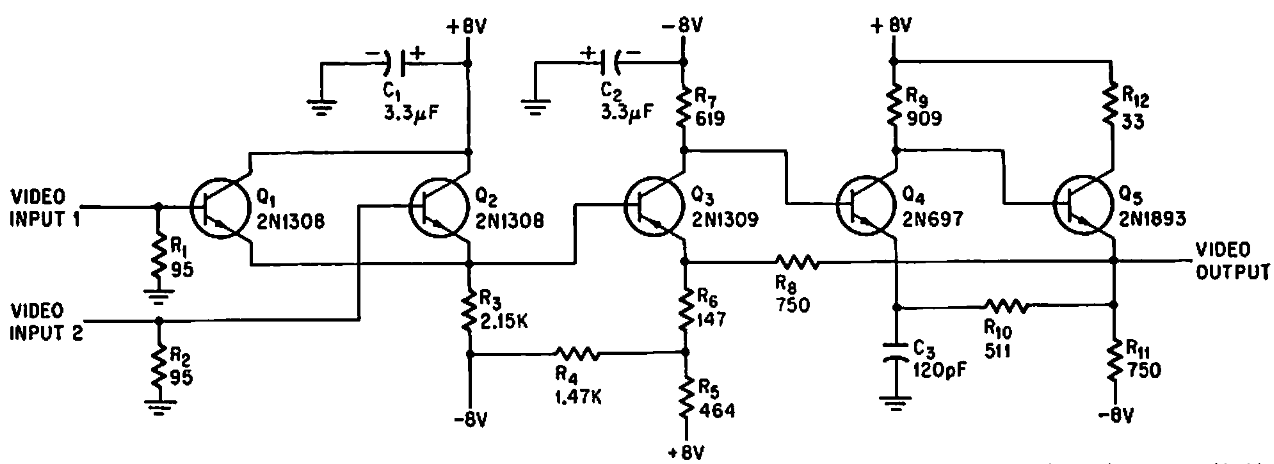
BILATERAL-TRANSISTOR COMPARATOR—Used as voltage comparator by connecting one input to some reference level and allowing second input to vary. Can also serve as digital comparator in digital computer, to ascertain when two numbers become equal. Output drops to zero when numbers in digital form are equal.—Comparator Uses Bilateral Transistor, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 91.



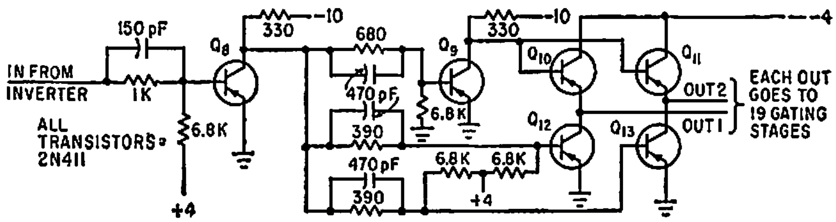
AMPLITUDE COMPARATOR—Uses minimum-hysteresis Schmitt trigger (30 mv hysteresis) to compare voltage at input B with that at input A. Can also be used as variable Schmitt trigger in which input B determines trigger voltage.—M. A. Smither and W. E. Zrubek, Variable Schmitt, Amplitude Comparator, *EEE*, 14:7, p 106.



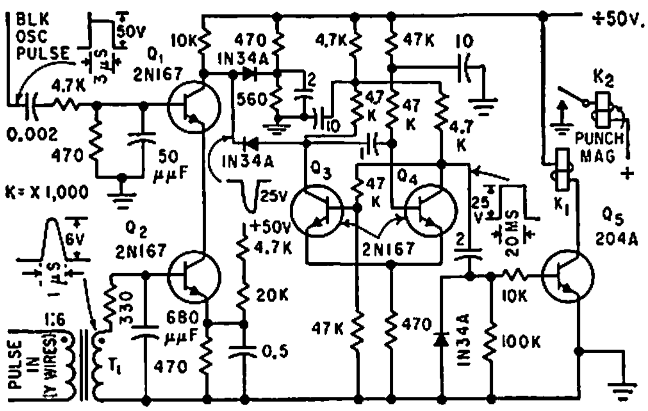
PULSE COMPARATOR FOR TAPE READER—With hole in front of photocell, negative pulse into comparator is much larger than positive drive pulse obtained from GaAs lamp circuit, and comparator delivers negative output pulse. With no hole and no negative pulse, comparator output is positive but same magnitude, because amplifier negative pulses are twice as large as positive input pulses.—R. F. Broom and C. Hilsum, Diode Lamp Makes Tape Readers Faster, *Electronics*, 36:20, p 44–45.



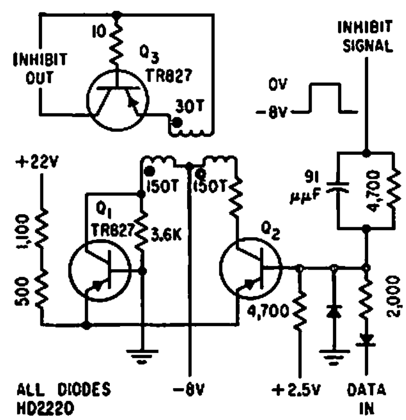
VIDEO SELECTOR—Selects largest of several positive-going video signals as positive-going output to 95-ohm load. Circuit gain is about 3 db.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.



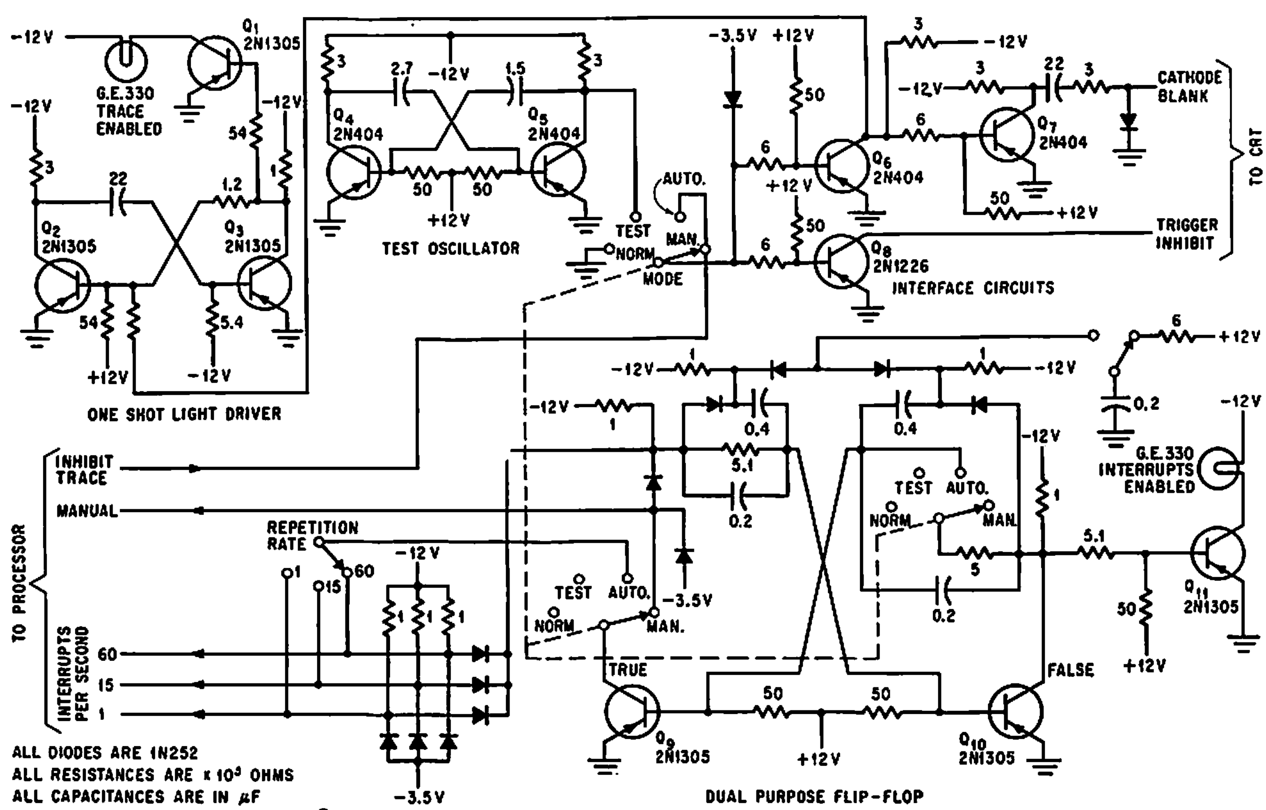
MEMORY STROBING-PULSE GATE—Used in generating precisely defined strobes for coincident-current memory. Uses drive-sampling core instead of clock signal to produce strobe at time when signal-to-noise ratio is highest. —A. H. Ashley and E. U. Cohler, Solving Noise Problems in Digital Computer Memories, *Electronics*, 33:13, p 72–74.



MATRIX READOUT—Used for data reduction in telephone traffic data recorder system to permit recording all information on a call as one entry. Coincidence circuit Q1-Q2 provides reliable sensing of matrix output in presence of noise generated by rotary switches and relays.—J. W. Blanchard, E. C. Bellee, and J. Smith, Ferrite Memories Simplify Telephone Data Analysis, *Electronics*, 32:41, p 68–70.

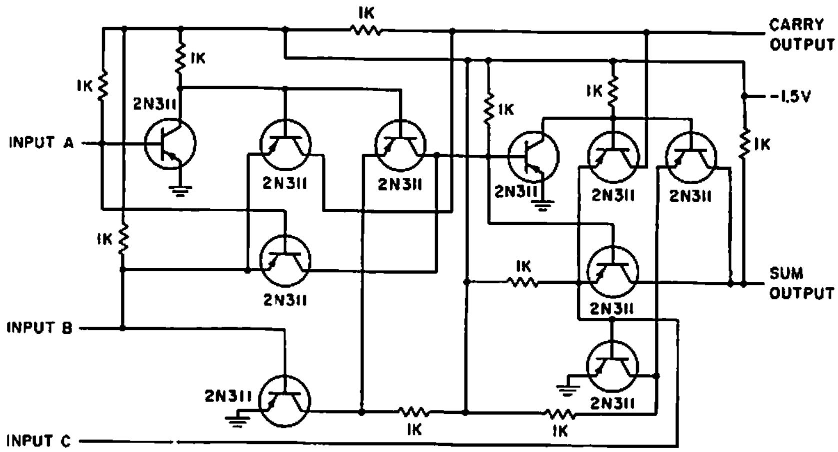


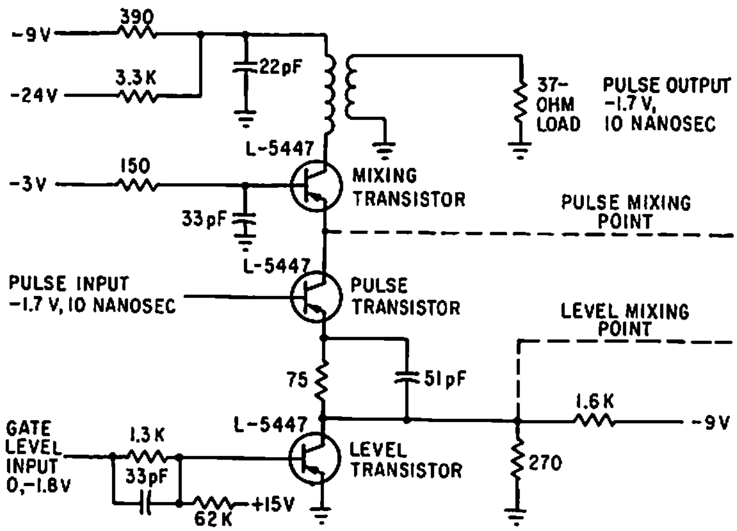
INHIBIT DRIVER—Used in coincident-current digital data buffer memory.—D. Haagens, Compact Memories Have Flexible Capacities, *Electronics*, 32:40, p 50–53.



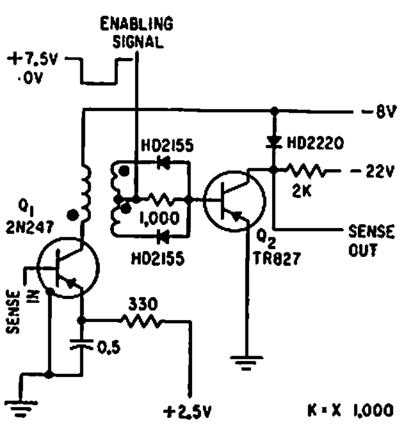
TIME-SHARED TROUBLESHOOTER SCOPE—Oscilloscope modifications shown permit computer to control crt display for diagnosing trouble in faulty section of time-sharing computer while users continue working with computer.—J. T. Quatse, Time-Shared Troubleshooter Repairs Computers On-Line, *Electronics*, 39:2, p 97–101.

FULL ADDER—Made by joining two half-adders. Push-pull inverting amplifiers serve as switches to provide completely automatic operation. Carry from full adder can derive from either half-section but never both. No inhibitor signal is required to suppress unwanted sum signal.—F. B. Maynard, Half-Adders Drive Simultaneous Computer, *Electronics*, 31:29, p 80–82.

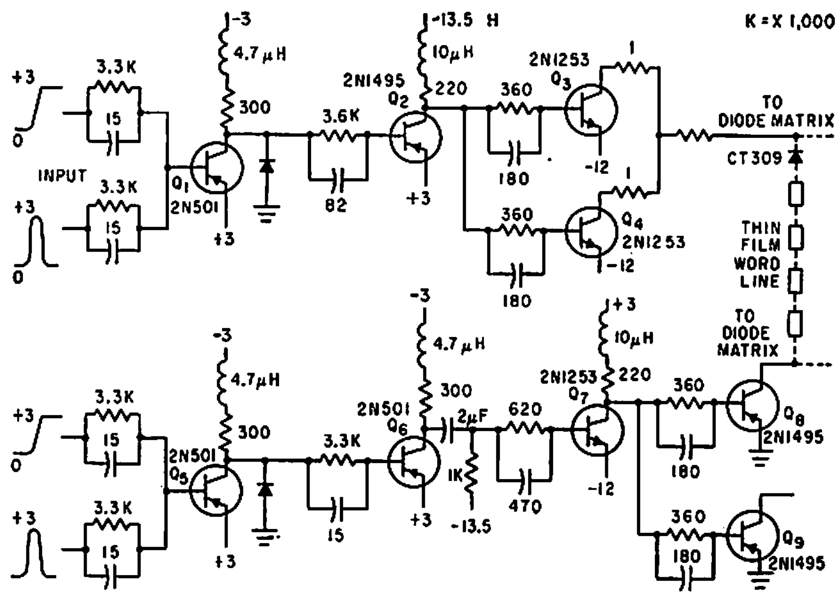




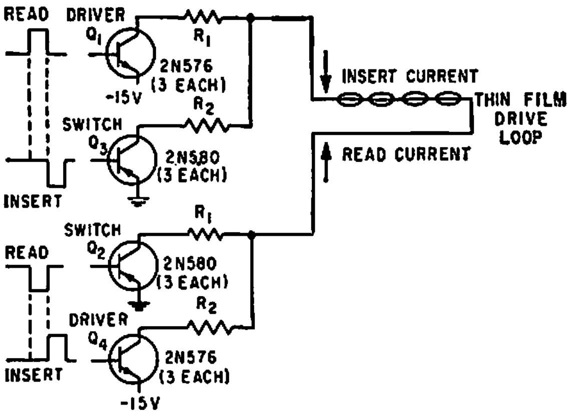
GATE AND MIXER FOR 10-NSEC PULSES—Used in 50-megapulse computer. Propagation delay time of circuit is only 4.5 nsec. Transistors may also be 2N769 or 2N976.—K. H. Konkle and J. E. Laynor, Key to Faster Computers: Ten-Nanosecond Amplifier, *Electronics*, 35:50, p 39–41.



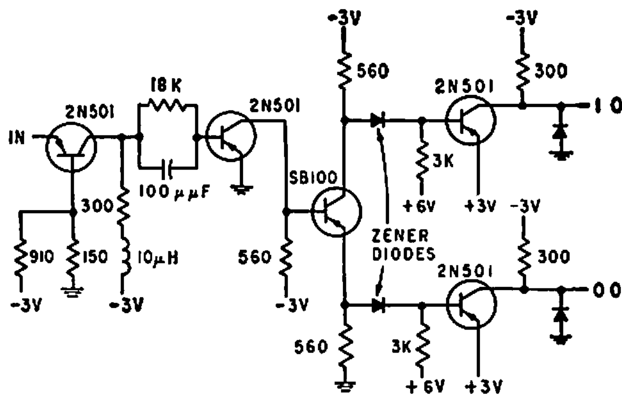
BUFFER MEMORY SENSE AMPLIFIER—Uses coincident-current technique. Full-wave rectifier is required at secondary of transformer because sense output can be of either polarity. Enabling signal turns on sense amplifier, to permit discrimination between memory core outputs during unload and load cycles.—D. Haagens, Compact Memories Have Flexible Capacities, *Electronics*, 32:40, p 50–53.



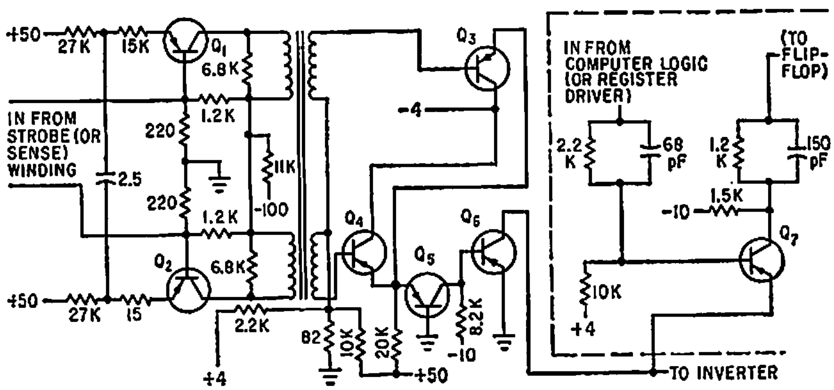
THIN-FILM MEMORY DRIVER—Generates 1-amp pulses with 35-nsec rise and fall times, at rates up to 1 Mc, for driving 2,560-bit memory plane using 2,000-angstrom nickel-iron films.—E. E. Bittmann, Thin Magnetic Film Memories for High-Speed Computers, *Electronics*, 34:9, p 39–41.



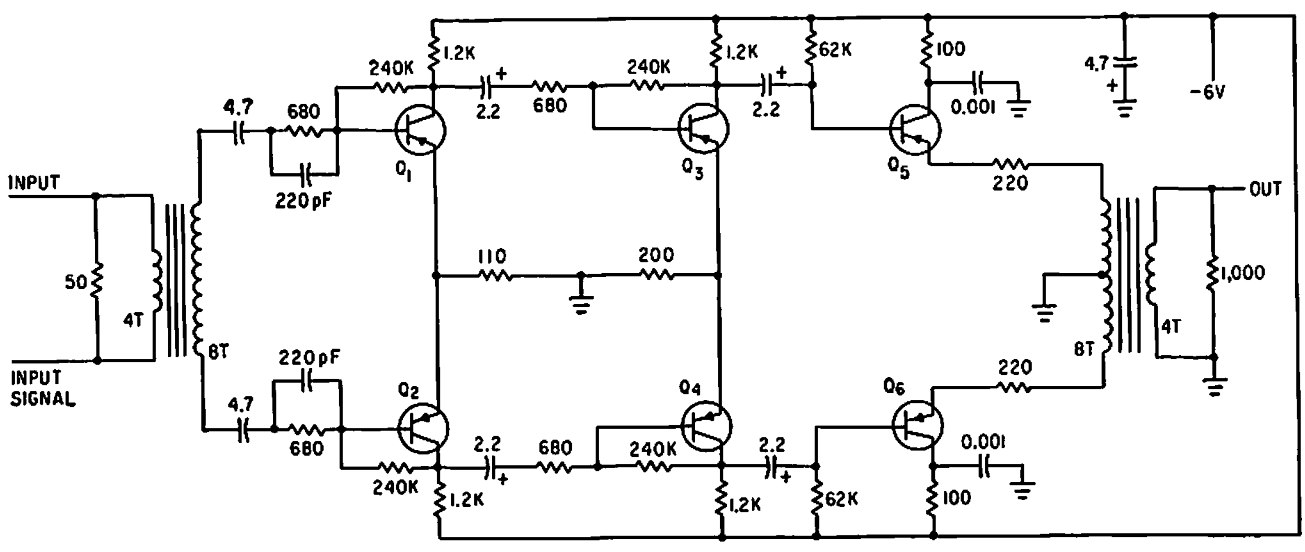
THIN-FILM CURRENT DRIVER—Three 2N576 driver transistors in parallel, each rated 400 ma, deliver 1-amp pulses with 0.15 microsec rise time. Three 2N580 pnp transistors in parallel serve as current switches.—E. E. Bittmann, Using Thin Films in High-Speed Memories, *Electronics*, 32:23, p 55–57.



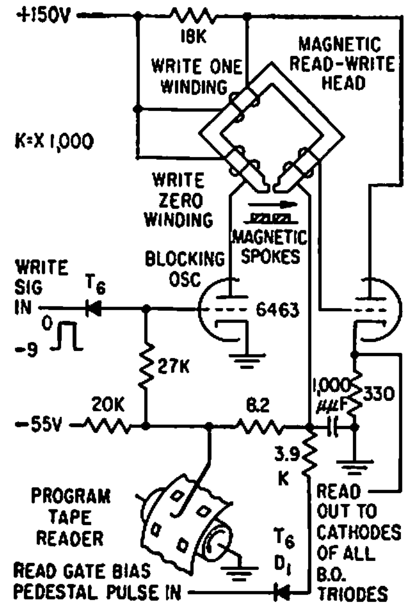
THIN-FILM SENSE AMPLIFIER—Common-base input stage matches low input impedance of sense winding. 5-mv input signal is boosted to 3-v level. Zener diodes shift d-c levels of output signal to desired 0 to +3 v level.—E. E. Bittmann, Using Thin Films in High-Speed Memories, *Electronics*, 32:23, p 55–57.



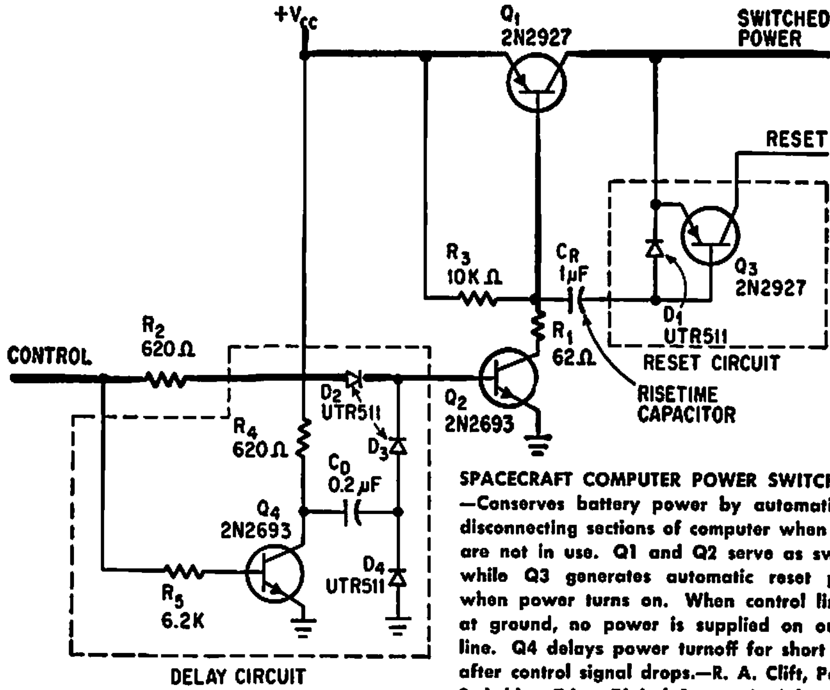
SENSE AMPLIFIER AND GATE—Uses drive-sampling core to generate precisely defined strobes for coincident-current memory.—A. H. Ashley and E. U. Cohler, Solving Noise Problems in Digital Computer Memories, *Electronics*, 33:13, p 72–74.



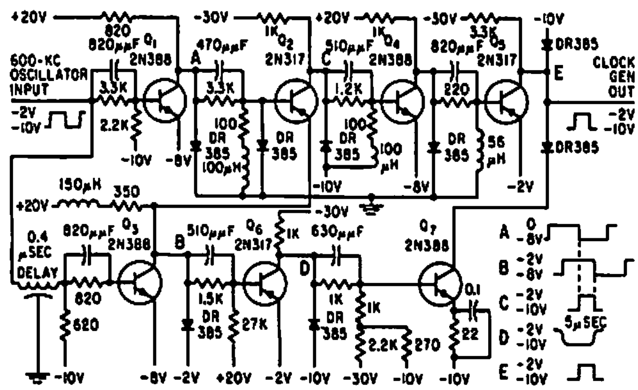
SENSE AMPLIFIER READS MEMORY DATA—Small signals stored in thin-film memory are amplified while rejecting noise from partially selected bits on same sense line. Circuit is completely isolated differential amplifier operating from low-impedance source.—A. A. Fleischer and E. Johnson, New Digital Conversion Method Provides Nanosecond Resolution, *Electronics*, 36:18, p 55–57.



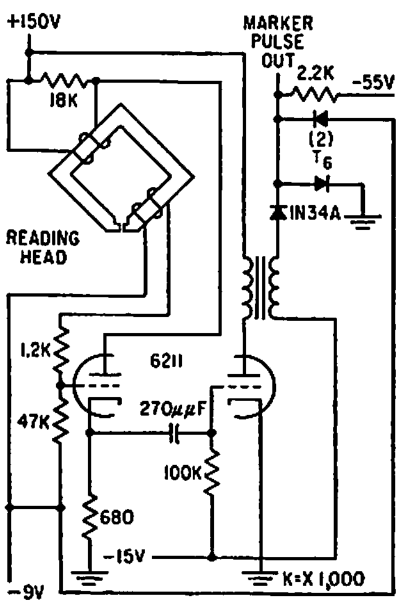
DISK READ-WRITE—Magnetic head is transformer of twin-triode blocking oscillator circuit used with aluminum disk having radial magnetic spokes that can store from 50 to 100 words.—T. C. Chen and O. B. Stram, Digital Memory System Keeps Circuits Simple, *Electronics*, 32:11, p 130–133.



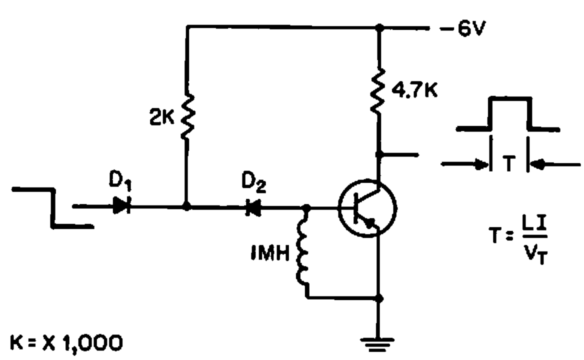
SPACECRAFT COMPUTER POWER SWITCHING—Conserves battery power by automatically disconnecting sections of computer when they are not in use. Q1 and Q2 serve as switch, while Q3 generates automatic reset pulse when power turns on. When control line is at ground, no power is supplied on output line. Q4 delays power turnoff for short time after control signal drops.—R. A. Clift, Power Switching Trims Digital System Weight, Cost, *Electronics*, 39:12, p 135–138.



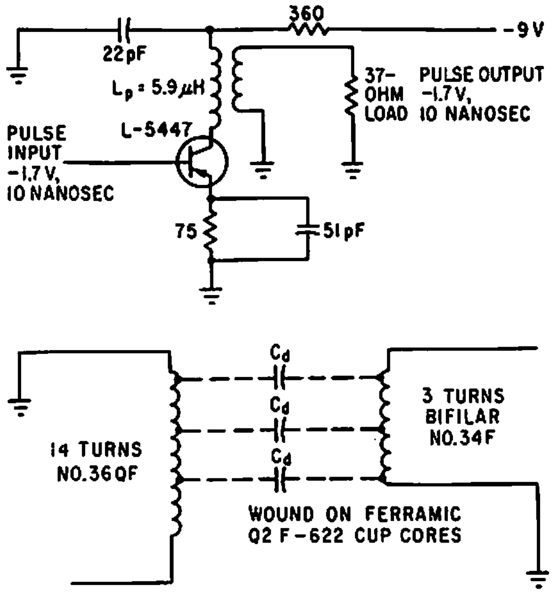
PULSE SHAPER FOR 600-KC CLOCK—Oscillator input through Q1 switches Q2 on, and same input through Q3 switches Q2 off after fixed delay, to produce desired rectangular clock pulse.—S. Schoen, Transistors Provide Computer Clock Signals, *Electronics*, 32:9, p 70–72.



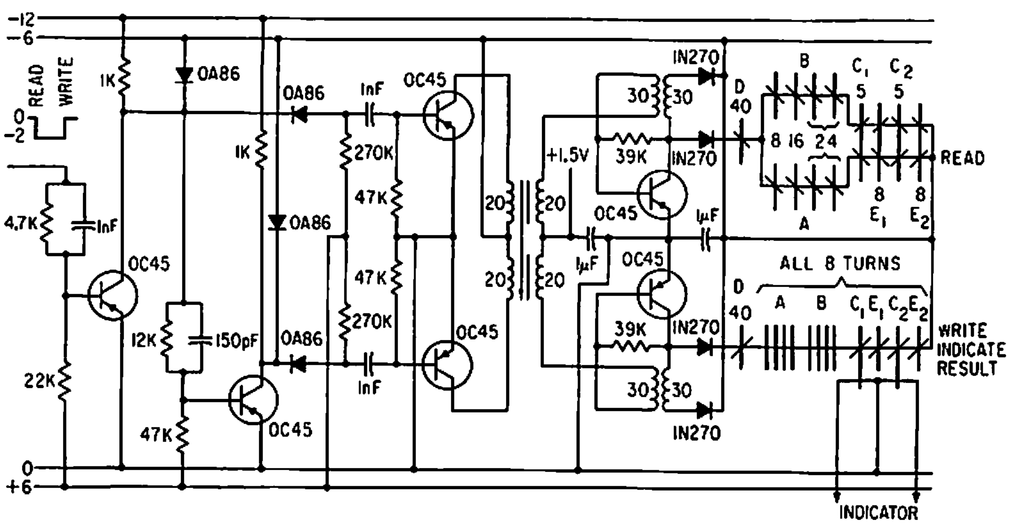
MARKER PULSE GENERATOR—Uses blocking oscillator to generate digit pulses of word being stored in magnetic-spoke disk memory, as well as for generation of index marker pulses.—T. C. Chen and O. B. Stram, Digital Memory System Keeps Circuits Simple, *Electronics*, 32:11, p 130–133.



CHOKE-CONTROLLED DIFFERENTIATOR—Uses inductance to control *on* time of transistor. Can also be used as straightforward pulse inverter. Input pulse is wider than output pulse.—W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.

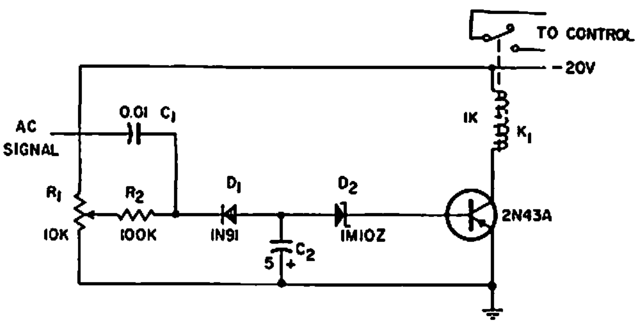


AMPLIFIER FOR 10-NSEC PULSES—Requires accurately wound pulse transformer in which secondary is close-wound over end of primary that is a-c ground, with accurate control of unsymmetrical distributed capacitance, to serve as building block of 50-megapulse computer. Commercial equivalent of L-5447 is 2N769 or 2N976.—K. H. Konkle and J. E. Laynor, Key to Faster Computers: Ten-Nanosecond Amplifier, *Electronics*, 35:50, p 39–41.

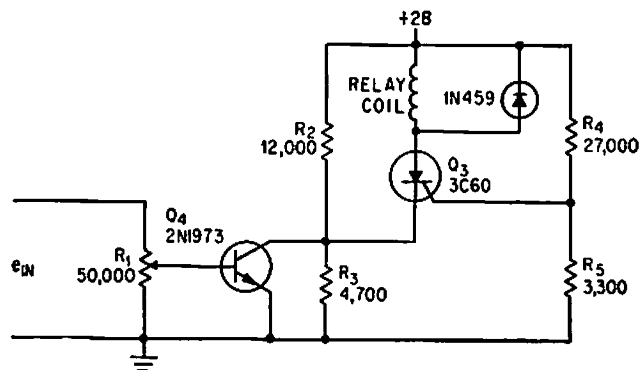


MAGNETIC REGISTER—Basis of storage is magnetization time. Four ferrite cores will store one decimal digit under control of one clock pulse.—A. A. Jaecklin, Storing Complete Decimal Digits with One Clock Pulse, *Electronics*, 34:11, p 50–53.

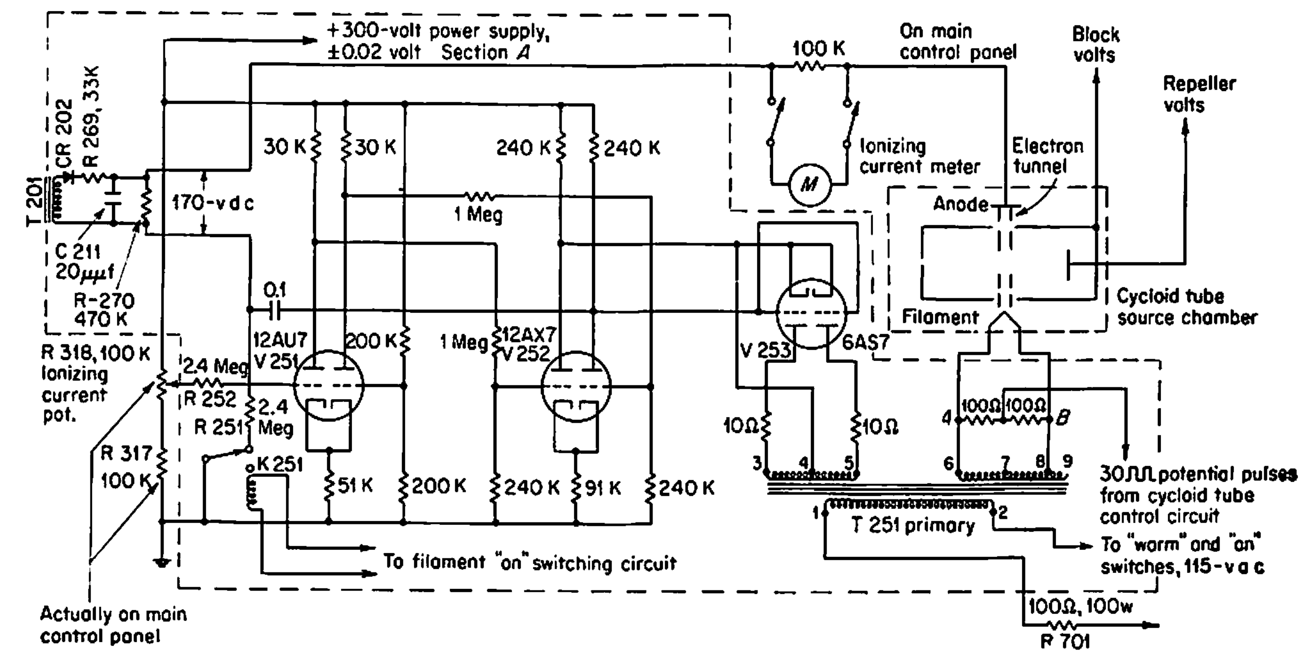
CHAPTER 18
Control Circuits



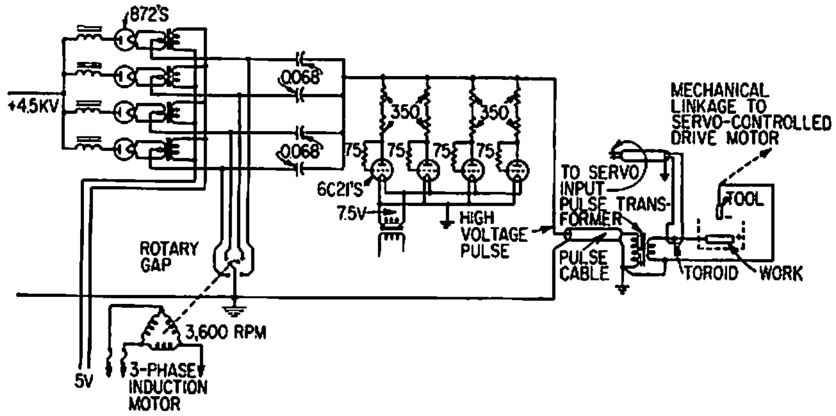
SNAP-ACTION A-F POWER LEVEL SWITCH—When integrated voltage reaches point where zener diode breaks from nonconduction to conduction, transistor goes from cutoff to saturation suddenly, to provide fast relay operation.—Snap Action Level Switch, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 30.



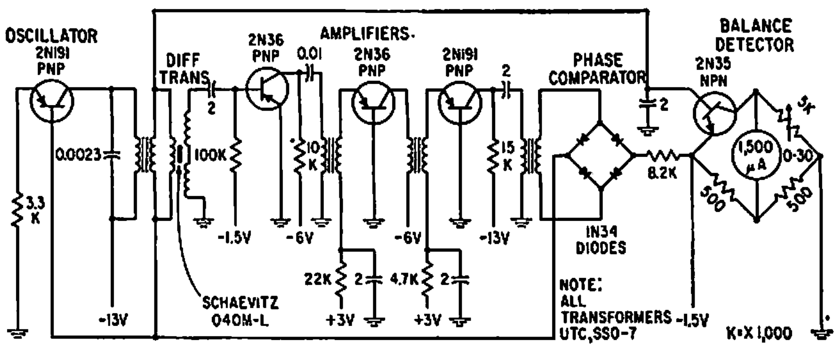
ACQUISITION RELAY DRIVER—Scr Q3 and transistor Q4 provide stable triggering point for acquisition signal used in aligning missile guidance systems, without hysteresis effect.—W. S. Zukowsky, Aligning Saturn Missile's Guidance System, *Electronics*, 37:8, p 26–27.



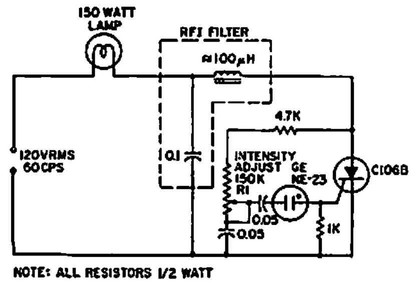
FILAMENT EMISSION REGULATOR—Used in Consolidated Electrodynamics gas analyzer to control ionizing current strength by regulating filament temperature of cycloid tube. Potentiometer used for control is in grid circuit of V251. Circuit maintains ionizing current automatically at desired level.—G. C. Carroll, "Industrial Instrument Servicing Handbook," McGraw-Hill, N.Y., 1960, p 8–122.



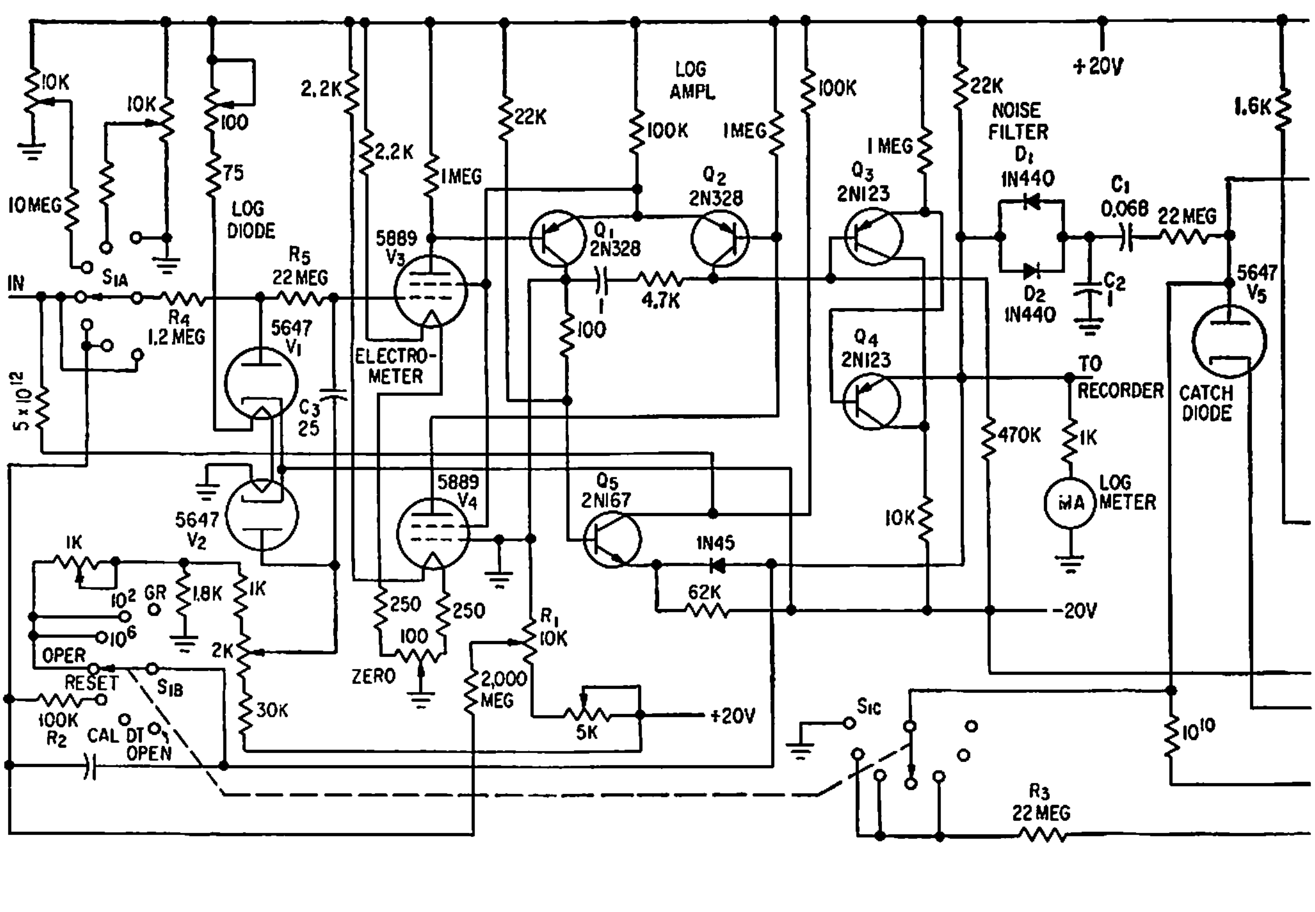
SPARK MACHINING CONTROL—Servo-controlled high-power electric spark machine produces repeated discharges between tool electrode and workpiece to cause erosion of metal to desired shape. Power source is 4.5-kv three-phase rectifier providing peak discharge current of 4,500 amp at pulse repetition rate of 2,880 pps. Rotary gap is used for pulse switching.—E. M. Williams and C. P. Porterfield, Spark Machine Tool has Servo Control, *Electronics*, 31:43, p 90–92.

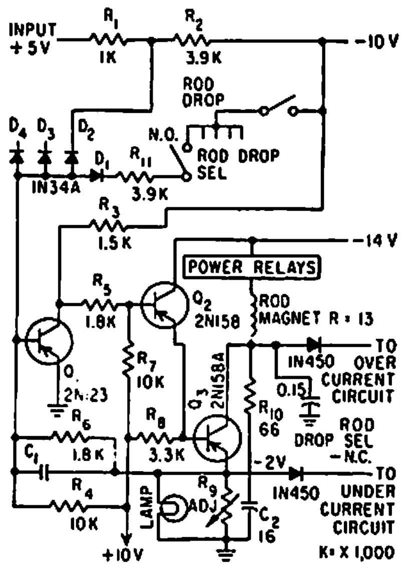


LIQUID-DENSITY GAGE—Peltier-effect semiconductor thermoelements maintain uniform cooling temperatures required for accurate specific gravity measurements. Null-position detecting circuit uses differential transformer to sense position of movable core at end of float.—C. W. Hargens, Semiconductors Cool and Control Density Gage, *Electronics*, 31:49, p 80–81.

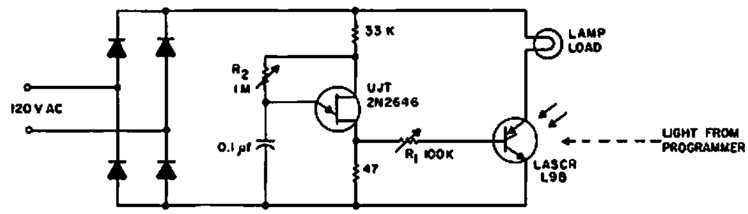


SCR LAMP BRIGHTNESS CONTROL—Will control up to 1.6 amp rms while operating directly from power line, yet is sufficiently compact to fit into base of common household lamp socket.—Low-Cost, Low-Power SCR's to Invade Commercial Market, *EEE*, 13:8, p 21-22.

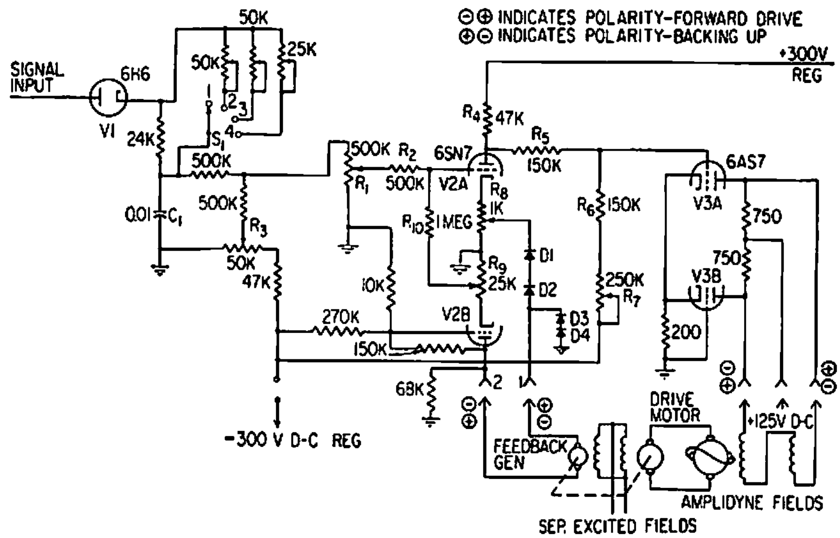




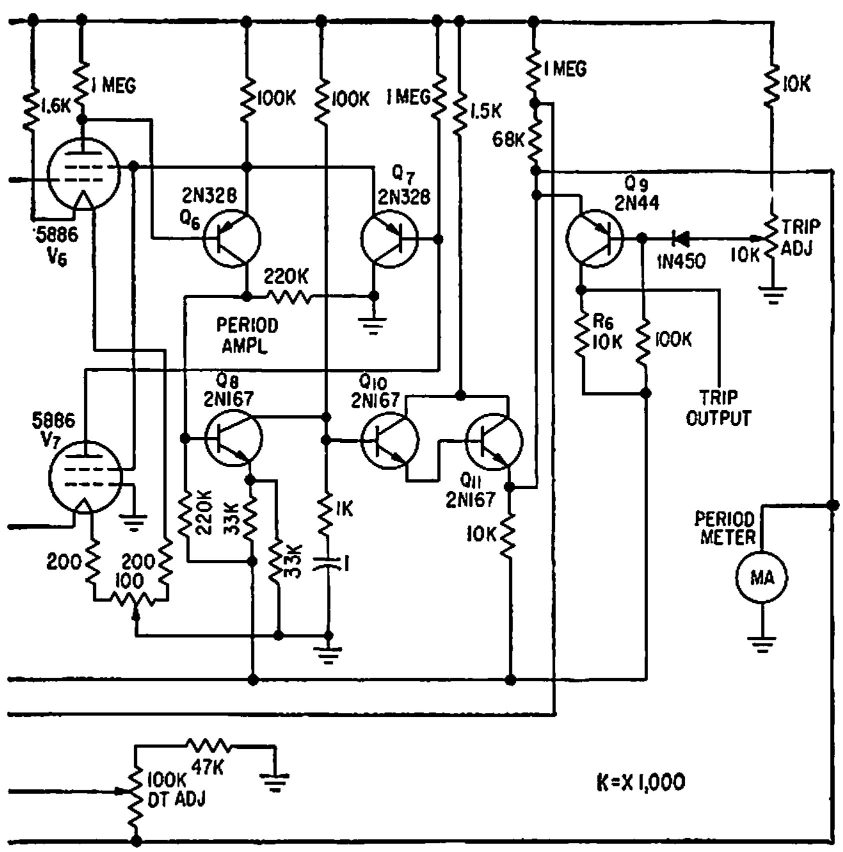
NUCLEAR REACTOR REGULATOR CONTROL—Feedback-type regulator holds magnet currents constant for control rods, at values set by R9 to 0.6 amp. When selected rods must be tripped for certain tests, regulator buses for these rods are connected to −10 v, to drop the rods. Amplifier uses +10 v supply as reference to hold output at −2 v.—E. J. Wade and D. S. Davidson, How Transistor Circuits Protect Atomic Reactors, *Electronics*, 31:29, p 73–75.



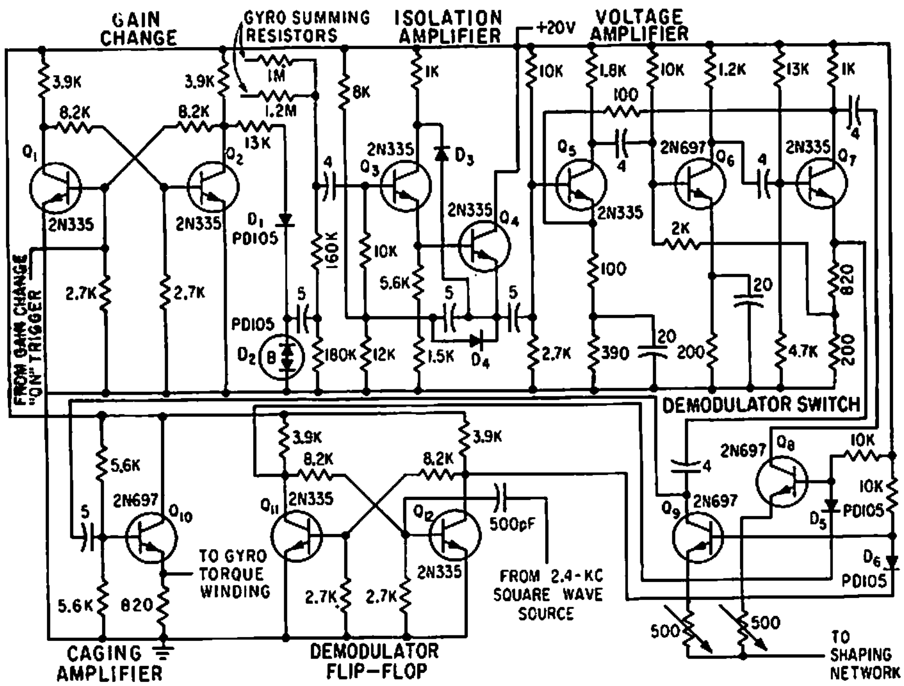
PREHEATING PROGRAMMED LAMPS—Minimizes thermal stresses on lamps and controls when programmed operation is repetitive for large number of cycles. Ujt control circuit provides preheating of lamp by triggering light-activated scr late in each half-cycle. Setting of R2 determines minimum lamp current to maintain filament temperature just below visible level.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 216.



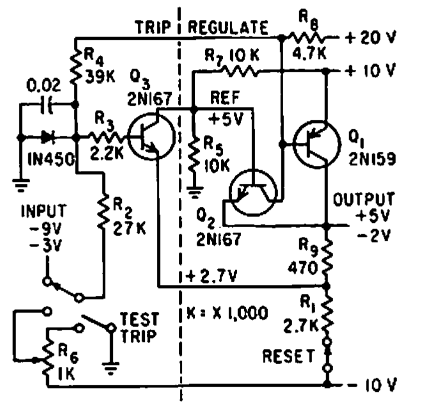
SPARK MACHINING SERVO DRIVE—Positioning information is derived from gap voltage, fed to integrating circuit through diode V1, and resulting output fed through V2 to cathode-coupled push-pull d-c amplifier that excites field of amplidyne generator to move tool electrode toward or away from workpiece, as required to permit sparkover at voltage selected for machining conditions desired. Used chiefly for work on high-temperature alloys and otherwise unmachinable materials.—E. M. Williams and C. P. Porterfield, Spark Machine Tool has Servo Control, *Electronics*, 31:43, p 90–92.



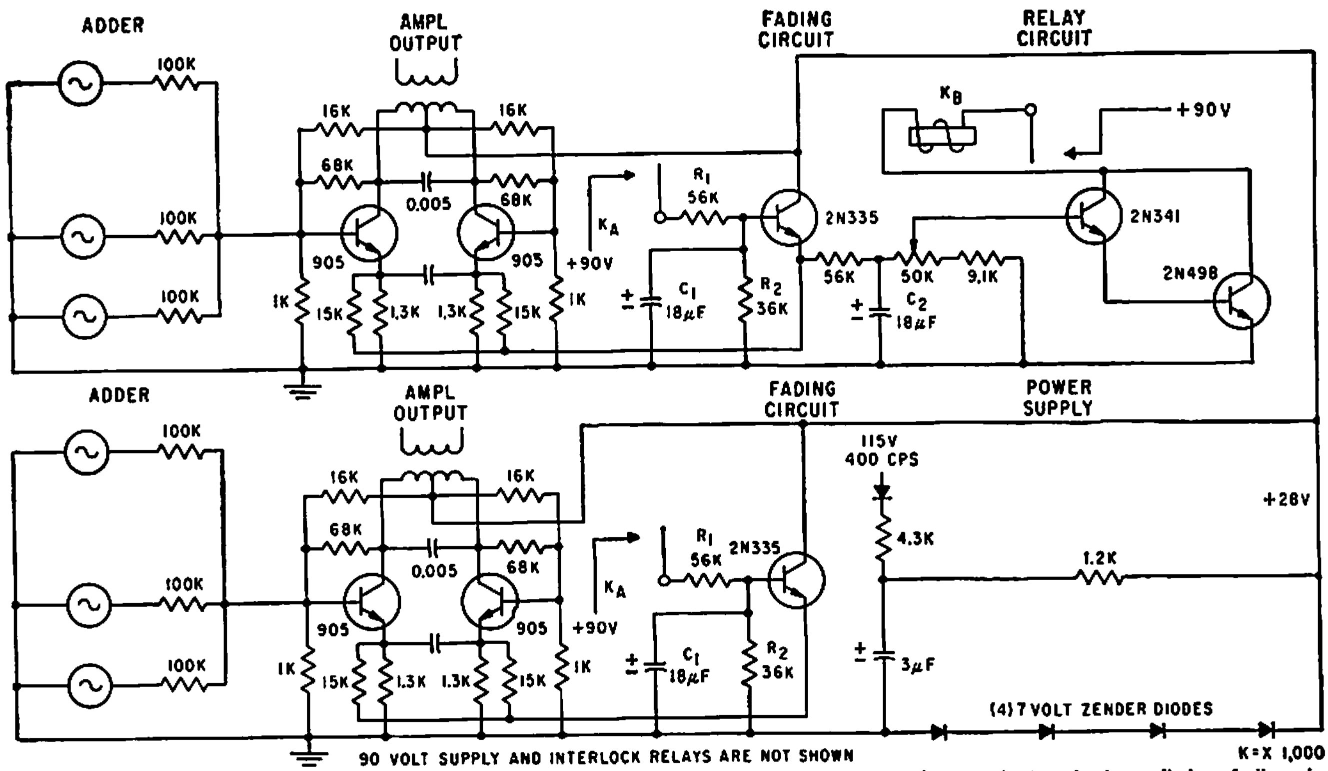
NUCLEAR REACTOR STARTUP CONTROL—Logarithmic and period amplifiers provide required wide indicating range without switching. Use of log diode V1 in series back to back with V2 provides nonlinear element in which effects of changes in cathode temperature and supply voltage are balanced out. V1 drives log amplifier consisting of balanced electrometer tubes V3 and V4, differential stage Q1-Q2, and cascaded emitter-followers Q3 and Q4. Period amplifier is a feedback-type differentiating circuit.—E. J. Wade and D. S. Davidson, Transistor Amplifiers for Reactor Controls, *Electronics*, 32:21, p 52–53.



AUTOPILOT GYRO CONTROL—Flip-flop Q1-Q2 controls breakdown of zener diode D2. At breakdown, D2 has low impedance, shunting 180,000-ohm trigger resistor and reducing input to five-stage d-c amplifier Q3-Q7. Overall voltage gain is 27. Demodulator is bistable flip-flop Q11-Q12 and series switching transistors Q8-Q9, giving no-signal d-c output of 9 v. This level is modulated 3 v for maximum in-phase or out-of-phase error signals from gyros.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33: 43, p 60–64.

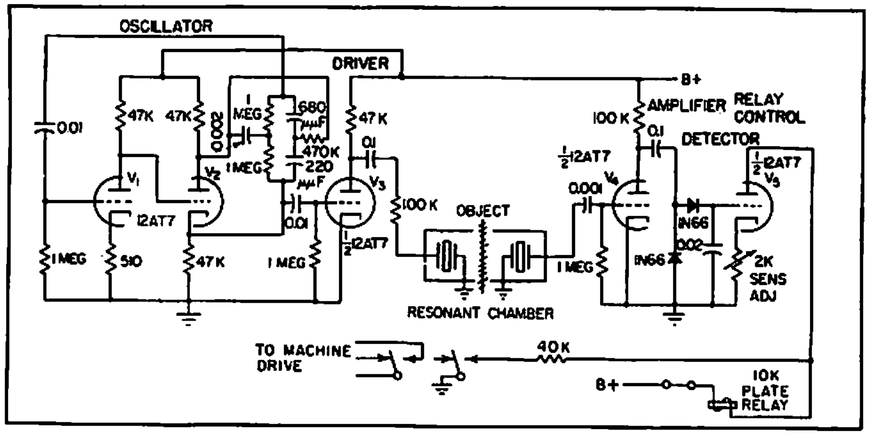


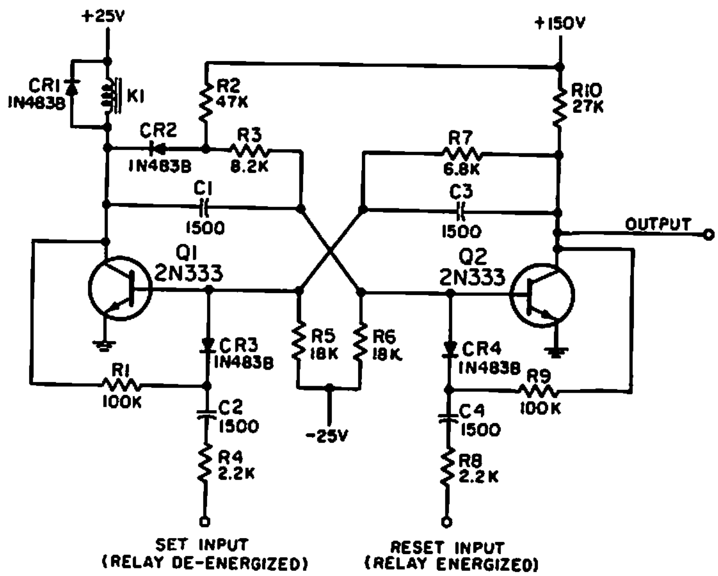
DUAL-FUNCTION BISTABLE SCRAM—Portion at right of dotted lines acts as regulator that holds constant voltage on output circuit until tripping of control rods is called for by nuclear radiation detector. Outputs of bistable circuits are connected through and gates so that, if desired, two input signals are necessary before trip signal is generated. Malfunction in ion chambers or failure of circuit component can make reactor exceed maximum critical assembly condition and generate trip signal that drops control rods.—E. J. Wade and D. S. Davidson, How Transistor Circuits Protect Atomic Reactors, *Electronics*, 31:29, 73–75.



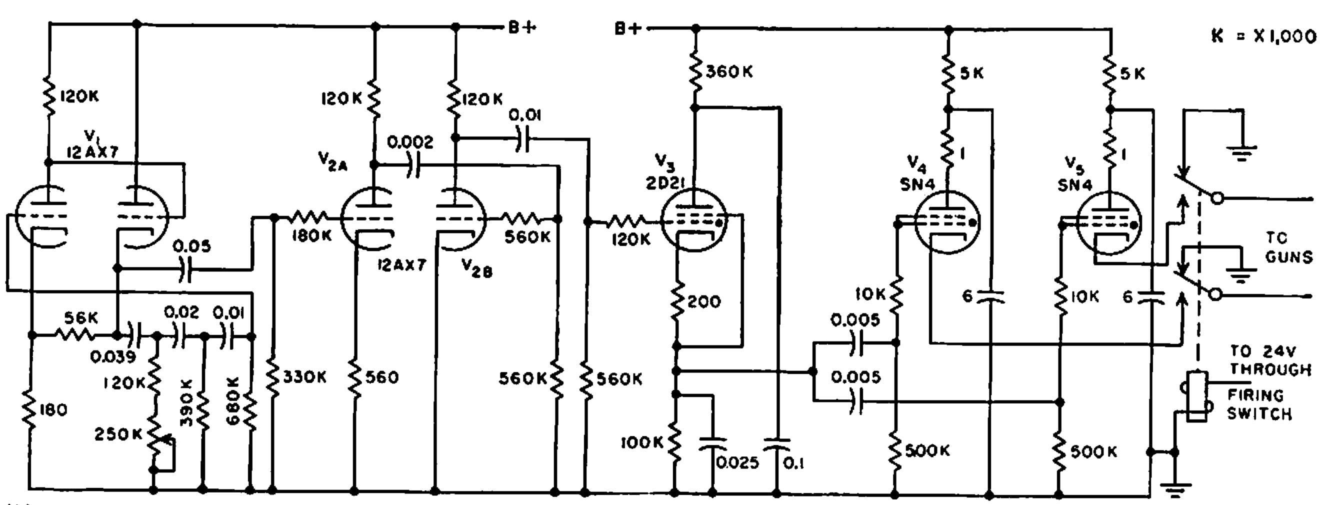
JET AUTOPILOT CONTROL—Adder-attenuator amplifier decreases gain slowly, allowing new control modes to be set up without undesirable aircraft motion or bumps, when jet pilot changes to different flight control mode, as from mach control to attitude control or altitude control. Relay KB allows new mode to be set up, and output then increases to normal. When pilot operates fading switch (not shown), relay contact KA closes and 90 v d-c is applied to fading circuit. Fadeout time constant is 0.5 sec and fade-in time constant 0.3 sec.—L. D. Fry, Taking the Bumps Out of Automatic Flight Control, *Electronics*, 32:32, p 106–109.

FILM-BREAK DETECTOR—Photographic film in processor is run through resonant acoustic chamber in which presence of film affects energy transfer between crystal transducers. Change in transducer output when film breaks is used to operate relay through amplifier and detector, to control automatic film processor and thereby minimize rethreading and film spoilage. Can also be used to detect bubbles in rubber tubing during blood transfusions, and detect similar changes in other films, liquids, and gases.—E. L. Withey and R. G. Seed, Acoustic Cavity Detects Breaks in Film, *Electronics*, 31:13, p 50–51.

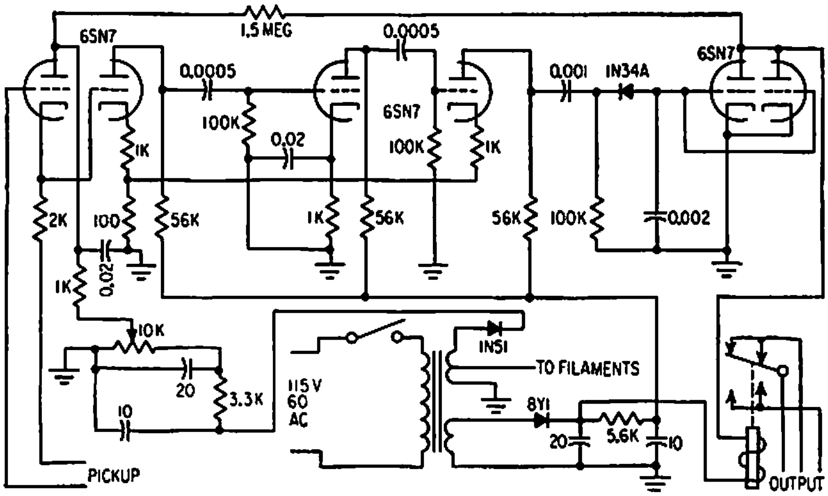




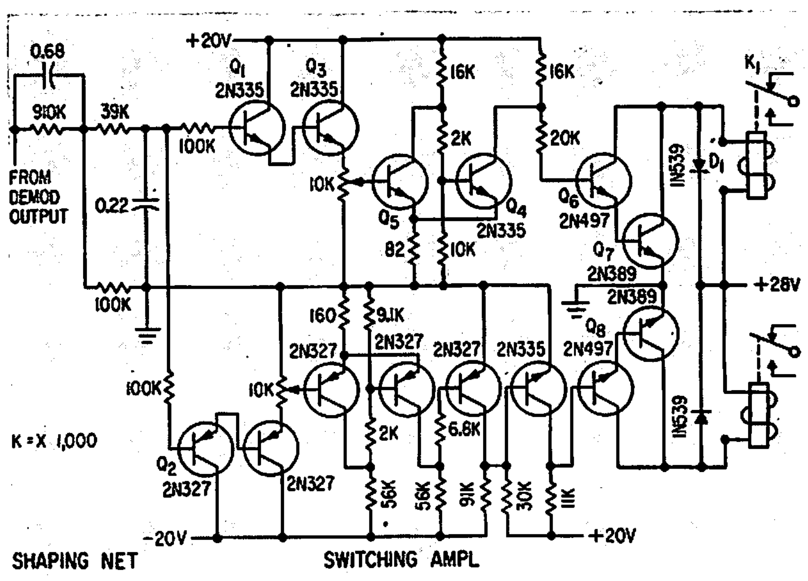
SATURATING-MVBR ON-OFF CONTROL—Used with relays and other electromechanical devices where current ratio must be 10 between on and off conditions. Operation is same as Eccles-Jordan, except that current drive for holding Q2 on is furnished through R2 and R3 rather than through Q1 collector load. Designed for relay that is energized by 8 ma and drops out at 0.5 ma. Trigger input should be between 14 and 20 v, with rise time of 10 microsec. Input circuit needs 5 millisec to recover from positive signal before next trigger is applied. 2N333 has been dropped from Preferred List, but 2N335 can be used if operating point is adjusted for its higher beta.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 17 (originally PC 251), p 17–2.



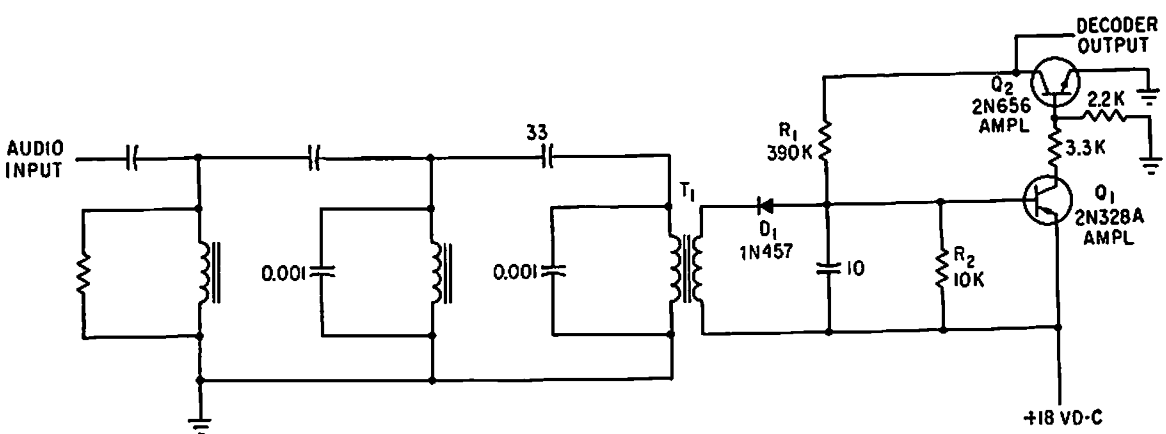
MACHINE-GUN CONTROL OSCILLATOR—Phase-shift oscillator firing circuit for airborne 20-mm guns permits operation anywhere in range of 600 to 900 rounds per minute. Accuracy is improved by adjusting firing rate away from natural gun-mount vibration frequency.—M. Halio, Firing Circuits Trigger Airborne Machine Guns, *Electronics*, 31:31, p 86–89.



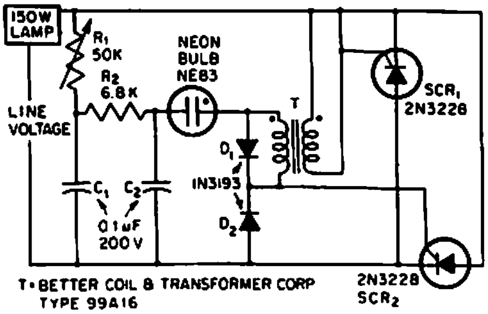
PROXIMITY CONTROL—Gain of Hartley oscillator is set so oscillation is maintained only when Q of resonant circuit is normal. When ferrous or nonferrous materials come near pickup coil, Q is reduced, oscillation stops, and output tube conducts, to pull in relay for counting or for controlling industrial machinery. Can be set for operating range of from 1/8th inch to 1 foot.—D. Elam, Proximity Transducer Uses Rapid Relay, *Electronics*, 31:25, p 73.



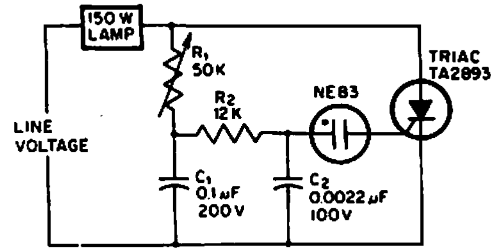
ROCKET ROLL CONTROL—Signal from roll-channel demodulator is shaped for two-section switching amplifier that energizes roll jet relays.—R. E. King and H. Low, Solid-State Guidance For Able-Series Rockets, *Electronics*, 33:5, p 60–63.



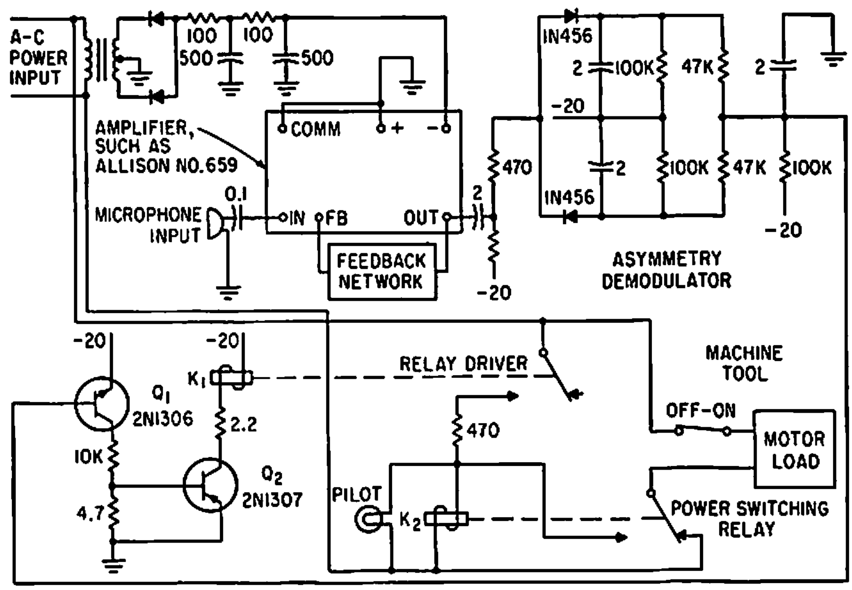
20-CHANNEL DECODER FOR AUDIO TONES—L-C filter in each decoder is tuned to channel tone, with 35-db adjacent-channel rejection. Rectified output of detector D1 drives two-stage d-c amplifier having relay load. Used in Mercury spacecraft command receiver.—R. Elliott, First Details on Mercury Spacecraft Command Receiver, *Electronics*, 36:5, p 32–35.



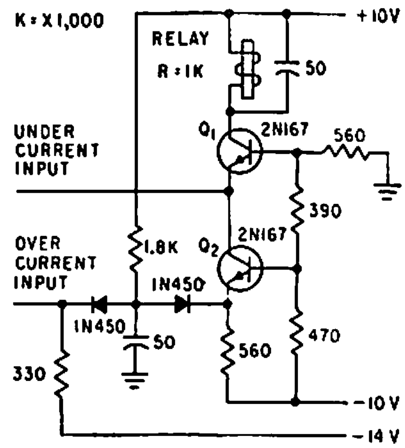
SCR LAMP DIMMER—Can easily be built into lamp socket or fixture.—J. Eimbinder, SCRs In The Consumer Market, *EEE*, 14:8, p 100-103.



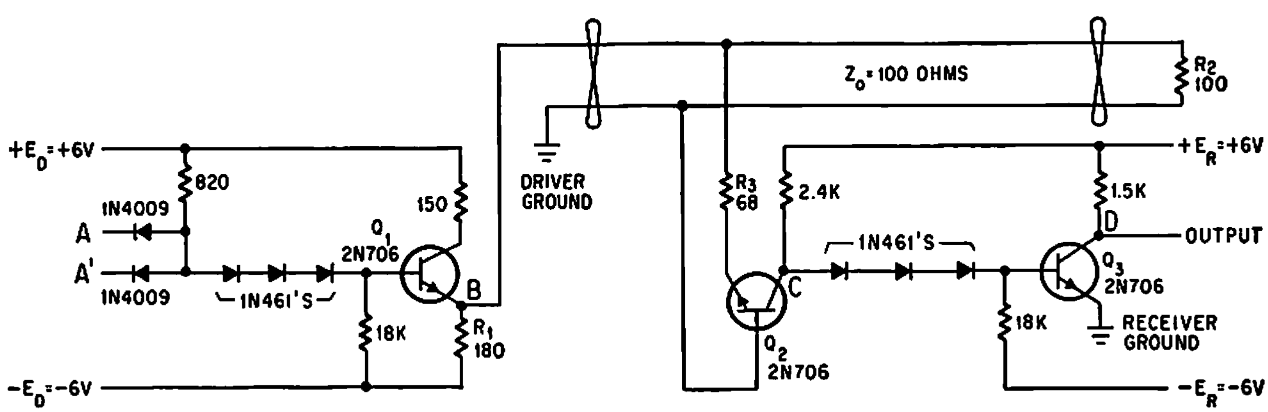
TRIAC LAMP DIMMER—Can easily be built into lamp socket or fixture. Uses minimum number of components.—J. Eimbinder, SCRs In the Consumer Market, *EEE*, 14:8, p 100–103.



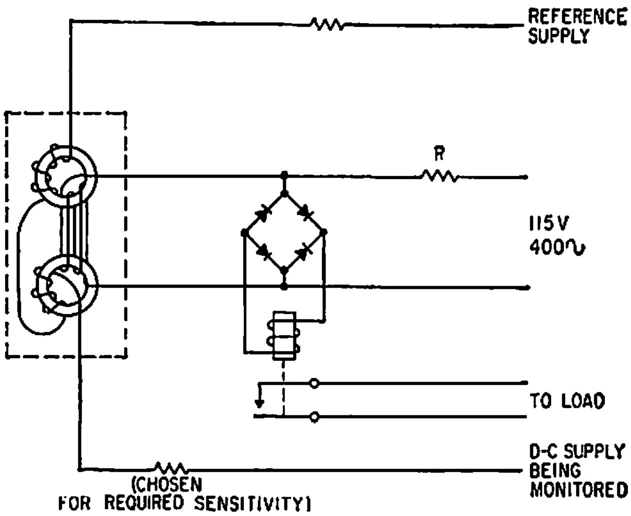
VOICE-OPERATED MACHINE CONTROL—Circuit rejects ambient noise or normal speech but responds to sharply spoken commands during emergency, to open motor circuit of machine tool. Asymmetry demodulator rejects symmetrical noise while accepting speech vowels having strong asymmetry.—W. C. Dersch, Speech Operates Safety Switch, *Electronics*, 36:25, p 78–82.



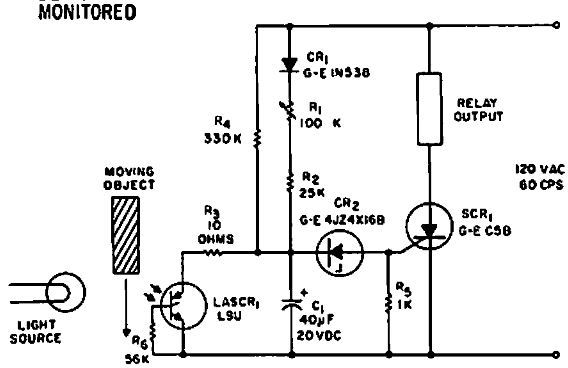
UNDERCURRENT-OVERCURRENT PROTECTION—Guards against improper operation of control amplifier in nuclear reactor scram system. If rod currents vary beyond predetermined limits, circuit initiates reactor scram. Either transistor may open relay coil circuit.—E. J. Wade and D. S. Davidson, How Transistor Circuits Protect Atomic Reactors, *Electronics*, 31:29, p 73–75.



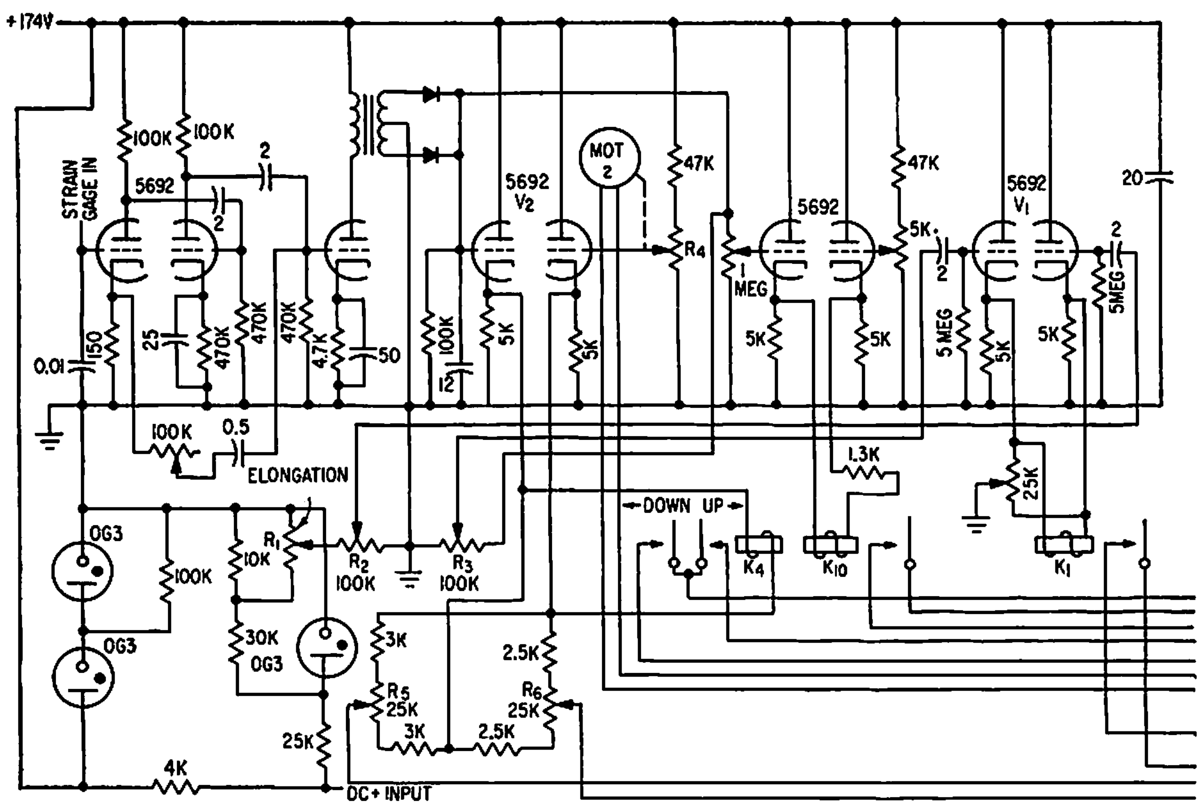
GROUNDED-LINE CABLE DRIVER—Twisted 100-ohm d-c coupled transmission line solves ground-differential problem between driving and receiving subsystems up to 120 feet apart, while eliminating costly transformer coupling. Holding line excursion to 1.5 v minimizes capacitive crosstalk. Up to four receivers can be used on one line.—R. C. Geravalia, Transmission Lines Couple Multiple-Driver Receivers, *Electronics*, 39:16, p 121–122.



CORES ACTUATE RELAY—When d-c supply voltage equals reference voltage, no direct current flows through the control windings of saturable reactors, reactance of 400-cps winding is high, and voltage across rectifier bridge is high enough to pull in relay. When supply voltage increases or decreases, difference voltage causes core saturation that reduces reactance, allowing relay to drop out. Neon indicator lamp may be used in place of rectifier bridge.—M. C. Herzig and D. C. Colbert, Voltage Monitor Needs Only Two Saturable Cores, *Electronics*, 36:23, p 50–51.

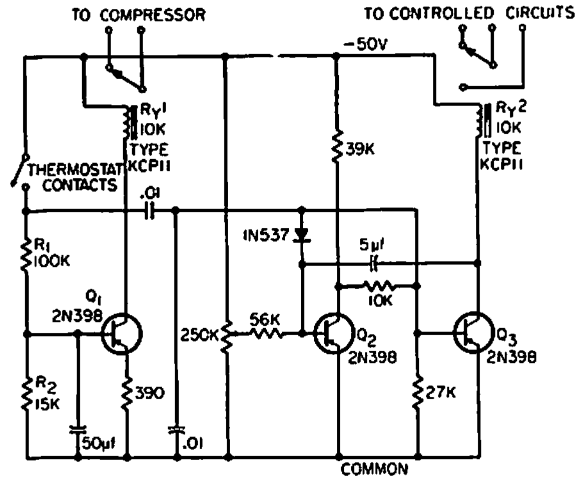


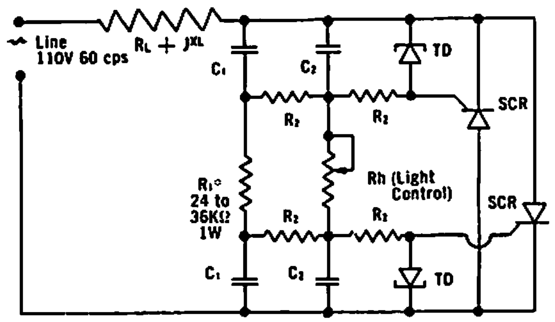
CONVEYOR MONITOR—Will shut down conveyor line rapidly to prevent catastrophic jam, while ignoring small self-clearing pile-ups. Each time light beam is interrupted, light-activated scr is briefly commutated by a-c line. C1 starts to charge but is shorted to zero as light is restored. If light path is blocked more than a few millisec, C1 continues to charge and fires SCR1 to stop conveyor.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 214.



METAL-FORMING CONTROL—Determines yield point by sensing when tension and elongation begin increasing at different rate during stretching and forming. Elongation signal comes from potentiometer R1, linked to ram of hydraulic relief valve. Tension signal comes from strain-gage bridge that delivers 0 to 10 mv at 60 cps. At yield point,

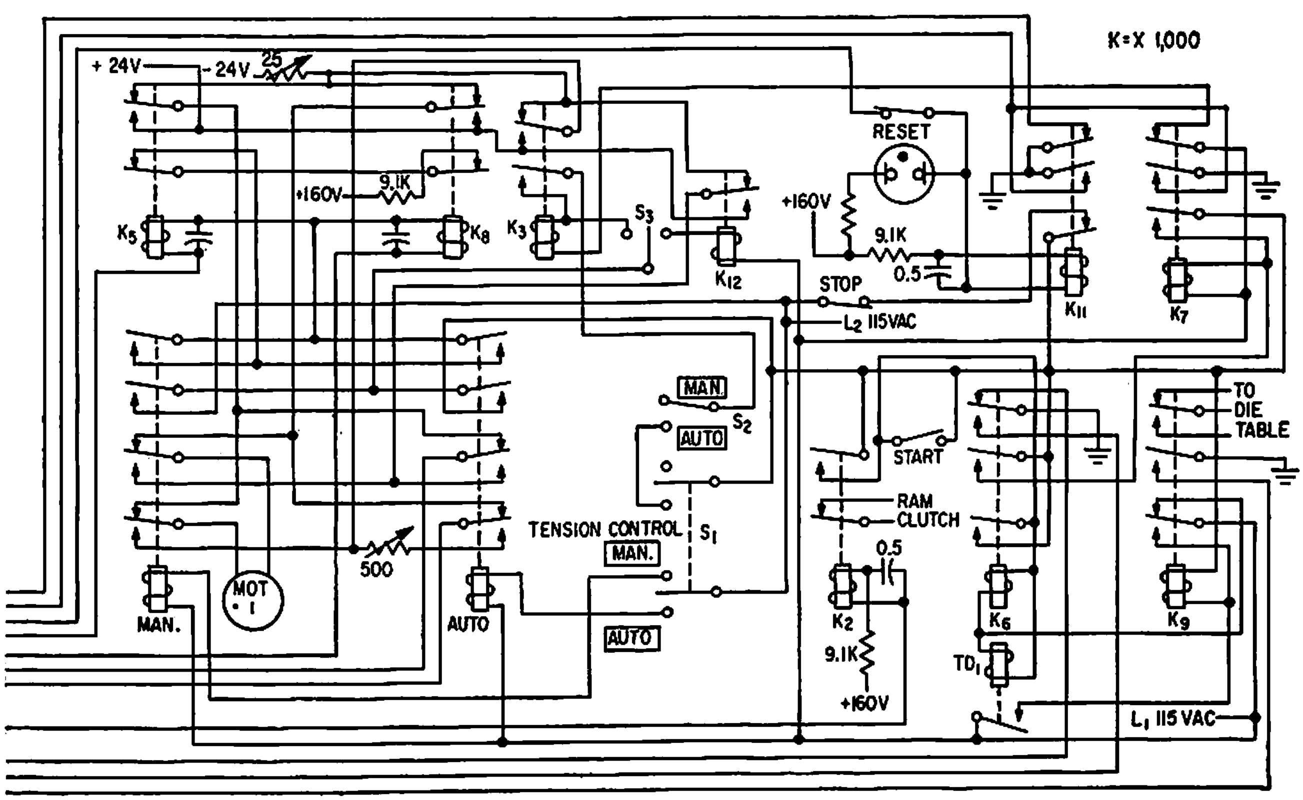
MOTOR TRANSIENT ANTICIPATOR—Disconnects battery supply of sensitive counters for preset interval during switching period of nearby air conditioner, to avoid extraneous counts by switching transients from compressor motor and control relays.—C. H. Harris, Motor Transient Anticipator, *EEE*, 13:5, p 45–46.



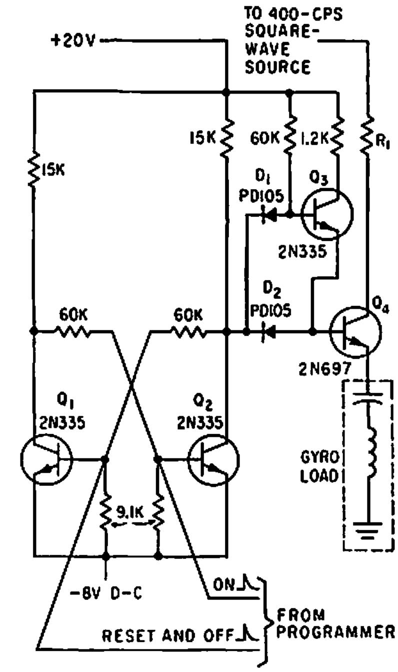


R1° = 24 to 36KΩ — Resistor adjusted for the Lowest Desired Level
C1 = .47µF, 30V, metallized paper ±20%
C2 = .47µF, 12V, metallized paper ±20%
R2 = 10KΩ, ¼W, ±10% SCR = K-1040, Hoffman
TD = T-1077, Hoffman Rh = 250KΩ linear rheostat, ½ watt

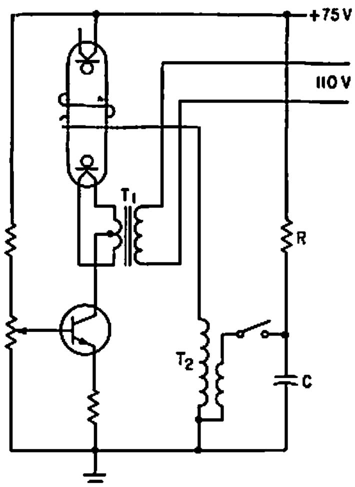
FULL-WAVE TD-SCR CONTROL—Use of tunnel diode between gate and cathode of each scr improves control performance of scr, to give triggering range of 10° to 175°. Input sensor Rh may be photocell or any other resistive transducer.—TD/SCR Combos for Sale, *EEE*, 12:3, p 62–64.



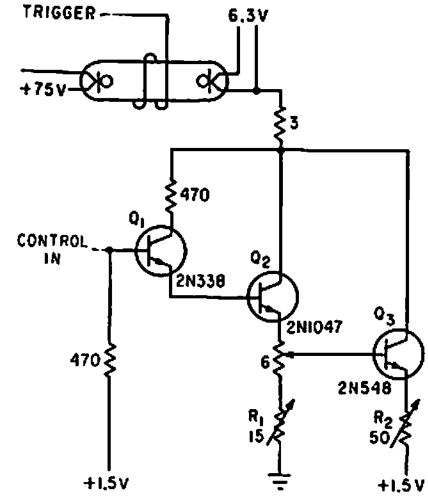
system lowers tension as dies are applied to metal. At end of cycle, operator opens stop switch, resetting relays that are energized by power line.—G. J. Crowdes, Automatic Controls for Metal Working Machines, *Electronics*, 32:10, p 41–43.



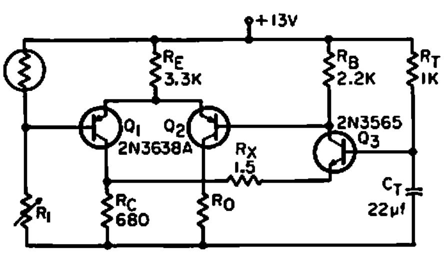
GYRO TORQUING SWITCH—Flip-flop Q1-Q2 controls Q3 driving switching transistor Q4. Trigger signals from telemetry receiver programmer control state of flip-flop. Can pass 400-cps square wave with 10-v peak.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33:43, p 60–64.



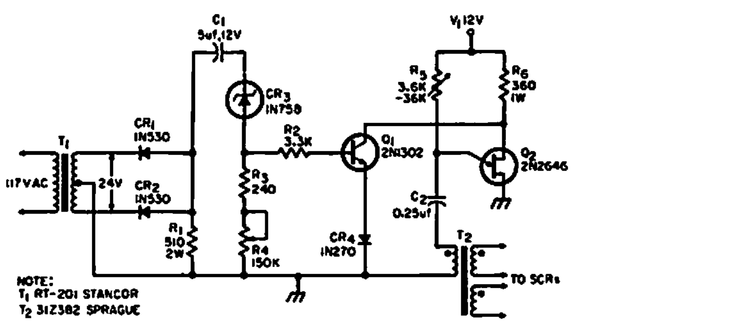
FLUORESCENT-LAMP DIMMER—Conventional photoflash trigger circuit R-C-T2 gives reliable starting for lamp currents down to 1 ma. High-voltage trigger pulse is applied to foil strip or wire loop going around lamp. Transistor can be 2N1047, with resistance values chosen to provide required d-c operating voltages.—L. L. Blackmer and A. T. Wright, Tandem-Transistor Circuit Regulates Fluorescent Lamp, *Electronics*, 34:17, p 114–116.



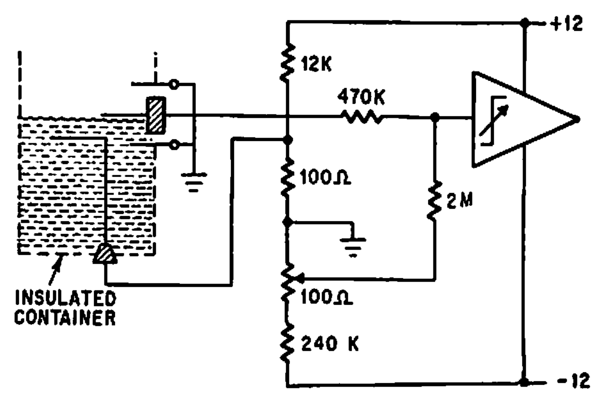
FLUORESCENT-LAMP DIMMER—Tandem circuit with amplifier stages requires only 0.4 ma at 8 v to drive 15-w fluorescent lamp at rated 300 ma while providing range of about 200 to 1 in luminance control. Conventional photoflash trigger gives reliable starting for lamp currents down to 1 ma.—L. L. Blackmer and A. T. Wright, Tandem-Transistor Circuit Regulates Fluorescent Lamp, *Electronics*, 34:17, p 114–116.



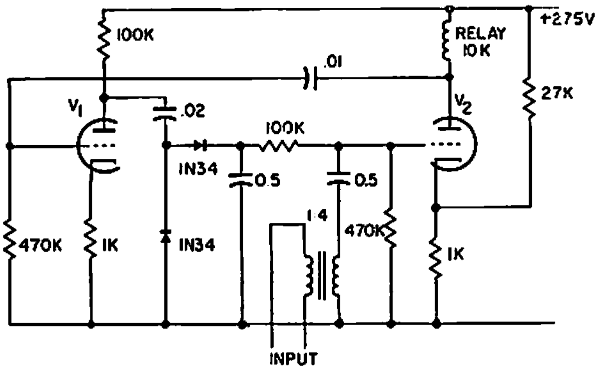
TIME-DELAYED SCHMITT AS SENSOR—Provides delay in sensor control until industrial process and system are started up and in normal operating mode. Delay is obtained with R-C network in additional transistor stage Q3. Photocell and R1 are interchangeable depending on polarity of control required from output.—L. T. Medveson, Time-Delayed Schmitt Sensor, *EEE*, 14:7, p 104.



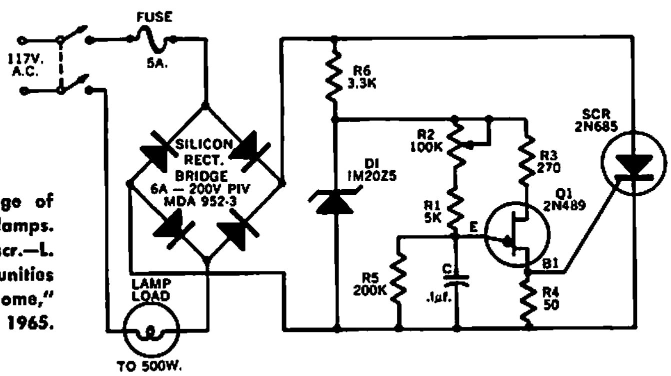
ZERO-CROSSING SYNCHRONIZER—Used to synchronize firing circuit of scr's with zero crossing points of sinusoidal a-c line voltage, to initiate new timing cycle at each zero crossing and thereby permit precise control of a-c power delivered to load. In temperature control system, circuit held liquid within 0.001°C of set point despite wide ambient temperature range.—J. D. Reed, Zero-Crossing Sync Circuit for SCR's, *EEE*, 12:8, p 74.



LIQUID LEVEL CONTROL—Operational trigger has sufficient sensitivity even for distilled water and alcohol, to control level within 1 mm.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.

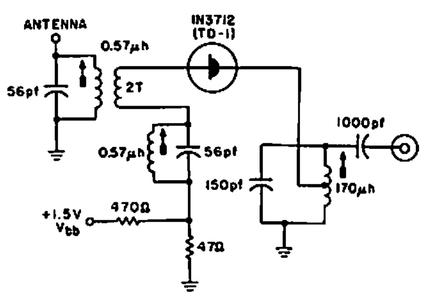


SENSITIVE RELAY CONTROL—Reflex circuit ensures full use of available gain of two-stage relay control amplifier using 12AT7 twin-triode. Tube V2 controls relay in its plate circuit and also serves as a-c amplifier, increasing over-all sensitivity by factor approximately equal to a-c gain. Performs best about 400 cps.—Sensitive Relay Control Amplifier, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., p 103.

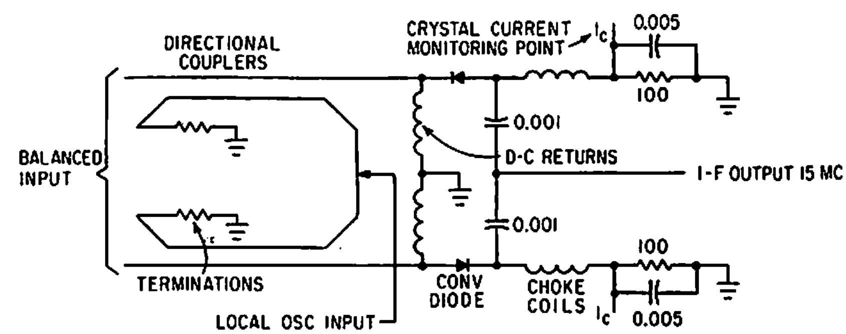


SCR LIGHT DIMMER—Provides full range of brightness control for up to 500 w of lamps. Ujt Q1 provides turn-on pulses for scr.—L. Stern, "Thyristors Provide New Opportunities for Electronic Applications in the Home," Motorola Application Note AN-141, Dec. 1965.

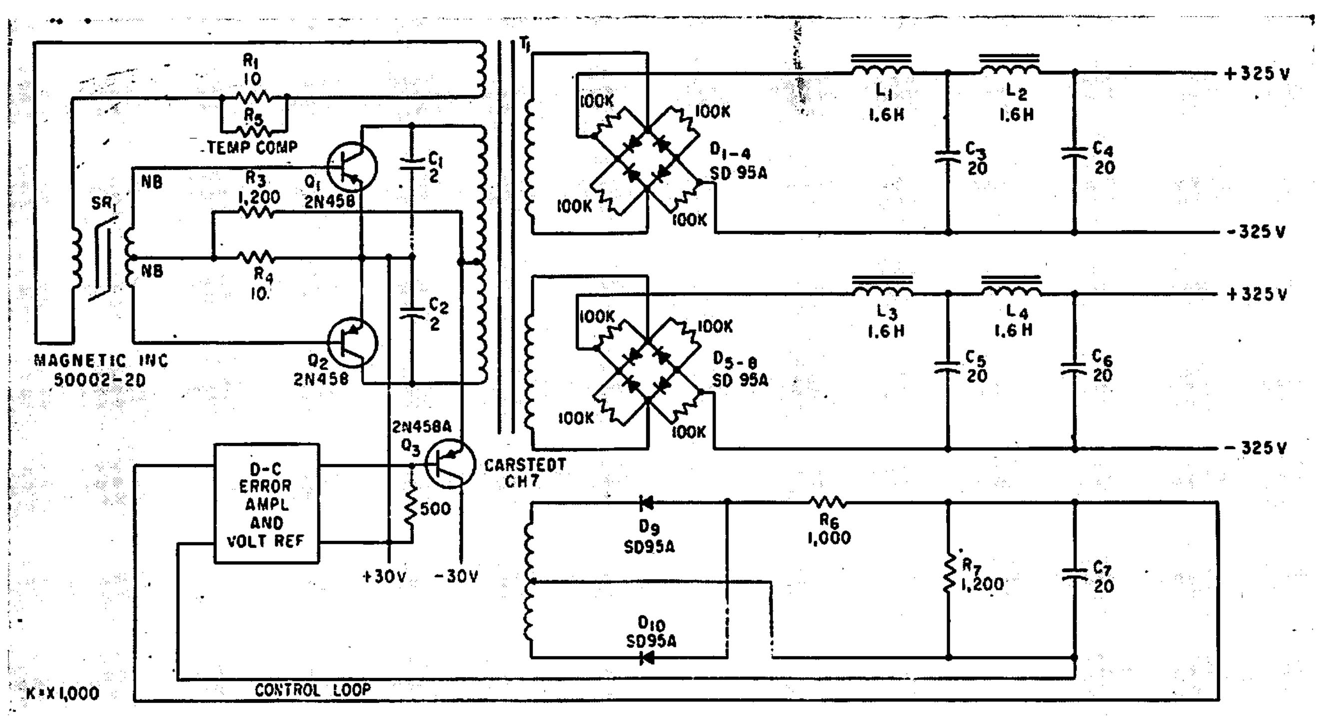
CHAPTER 19
Converter Circuits



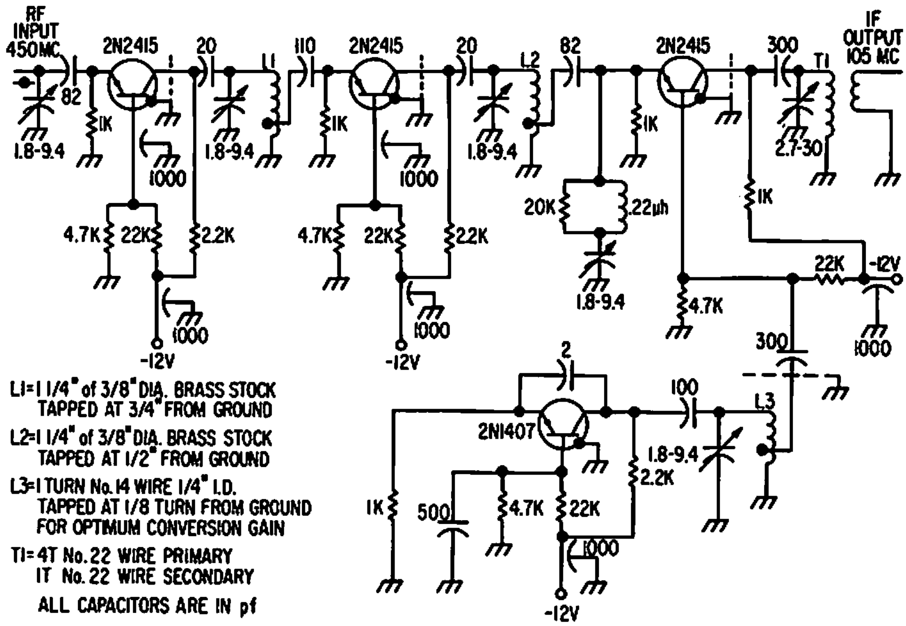
CB CONVERTER—Uses tunnel-diode oscillator. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 358.



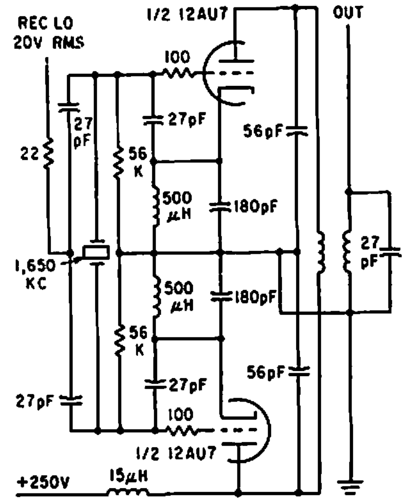
BALANCED-INPUT MIXER—Used with frequency-independent antennas to provide noise cancellation as balanced-input converter.—C. Strother, Jr. and C. R. Lundquist, Balinverter—Frequency-Insensitive Balanced Converter, *Electronics*, 35:44, p 46–47.



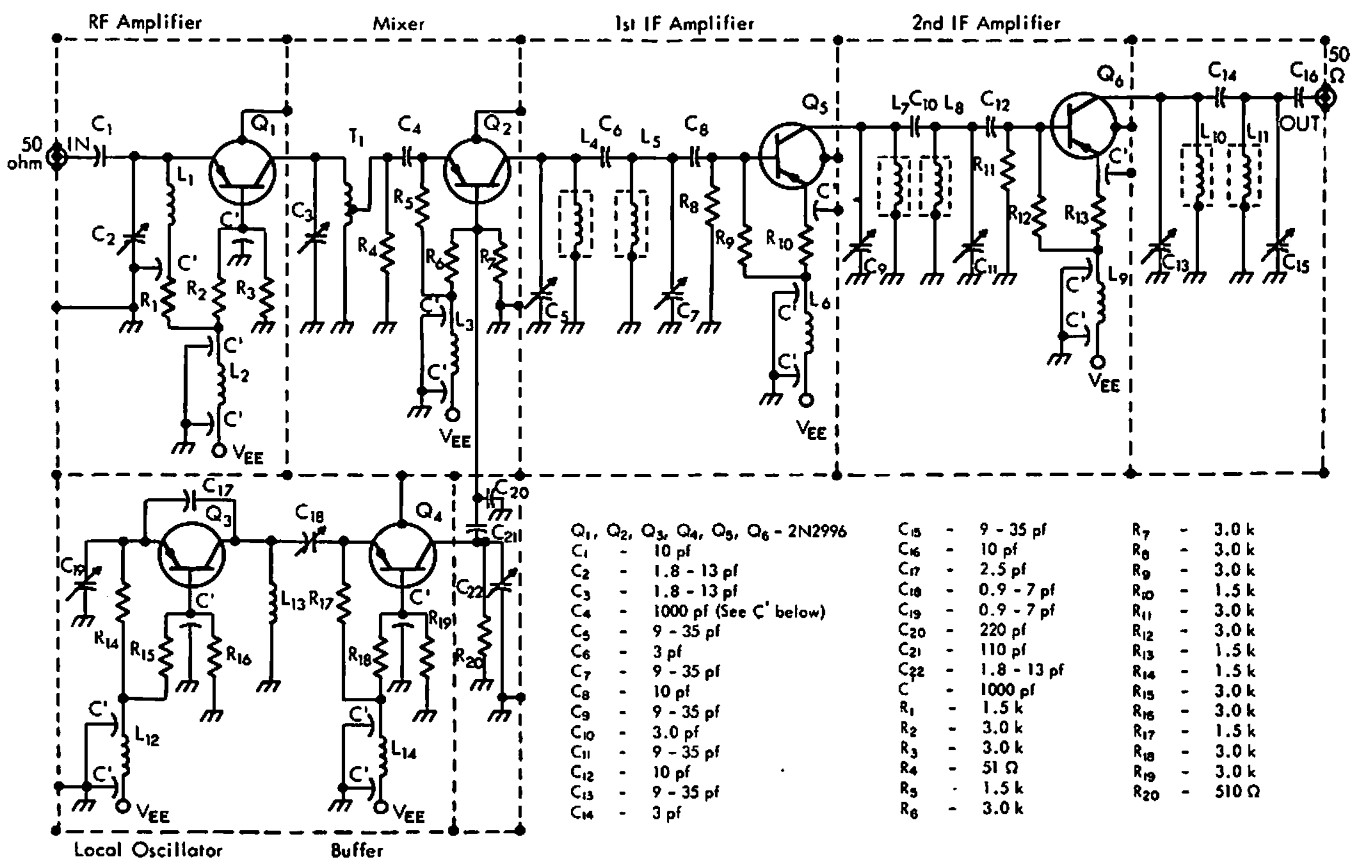
30 TO 325 V D-C—Use of transistors with high alpha cutoff frequency, along with loading networks across output bridge rectifiers, minimizes switching spikes in output. Control-loop amplifier provides overall regulation. —C. J. Biggerstaff, Reducing Spikes in D-C to D-C Converter Outputs, *Electronics*, 34:42, p 64–65.



450 MC TO 105 MC WITH 2N2415—Two-stage r-f amplifier has power gain of 20 db, noise figure of 4.5 db, and bandwidth of 10 Mc. 2N1407 local oscillator operates at 345 Mc. Conversion gain of mixer is 12 db. Total antenna to i-f conversion gain is 32 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 307.

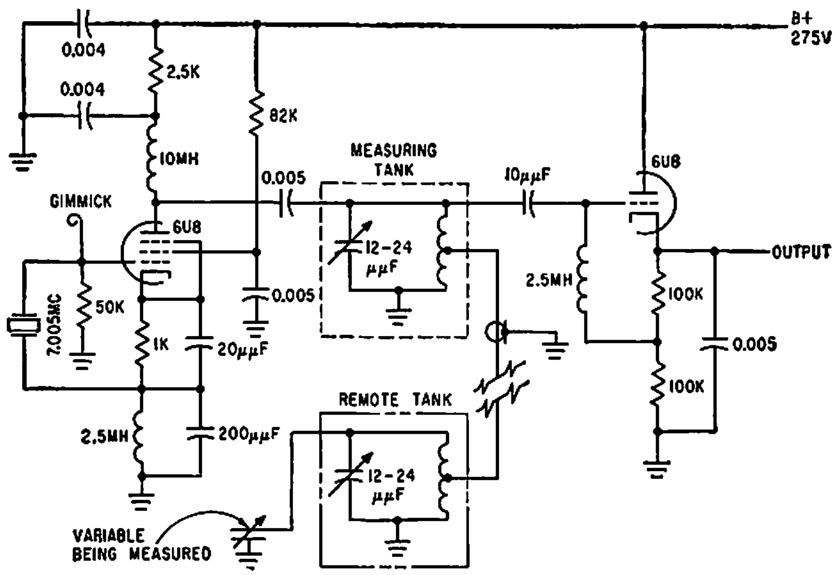


CB TRANSMITTER MIXER—Requires only one crystal per channel in 27-Mc citizens band radiotelephones, by combining beating oscillator with balanced mixer. Receiver local oscillator signal and even harmonics of beating oscillator frequency are cancelled in tuned symmetrical plate circuit.—M. E. Baird, Mixer Circuit Lowers Radiotelephone Costs, *Electronics*, 34:47, p 71.

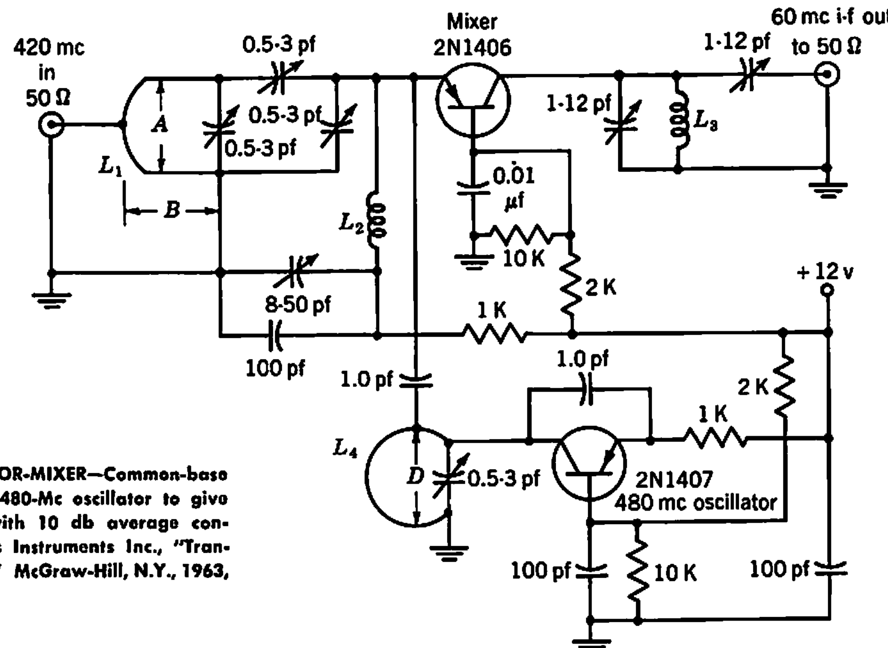


$Q_1, Q_2, Q_3, Q_4, Q_5, Q_6$	2N2996	C_{15}	9 - 35 pf	R_7	3.0 k
C_1	10 pf	C_{16}	10 pf	R_8	3.0 k
C_2	1.8 - 13 pf	C_{17}	2.5 pf	R_9	3.0 k
C_3	1.8 - 13 pf	C_{18}	0.9 - 7 pf	R_{10}	1.5 k
C_4	1000 pf (See C' below)	C_{19}	0.9 - 7 pf	R_{11}	3.0 k
C_5	9 - 35 pf	C_{20}	220 pf	R_{12}	3.0 k
C_6	3 pf	C_{21}	110 pf	R_{13}	1.5 k
C_7	9 - 35 pf	C_{22}	1.8 - 13 pf	R_{14}	1.5 k
C_8	10 pf	C'	1000 pf	R_{15}	3.0 k
C_9	9 - 35 pf	R_1	1.5 k	R_{16}	3.0 k
C_{10}	3.0 pf	R_2	3.0 k	R_{17}	1.5 k
C_{11}	9 - 35 pf	R_3	3.0 k	R_{18}	3.0 k
C_{12}	10 pf	R_4	51 Ω	R_{19}	3.0 k
C_{13}	9 - 35 pf	R_5	1.5 k	R_{20}	510 Ω
C_{14}	3 pf	R_6	3.0 k		

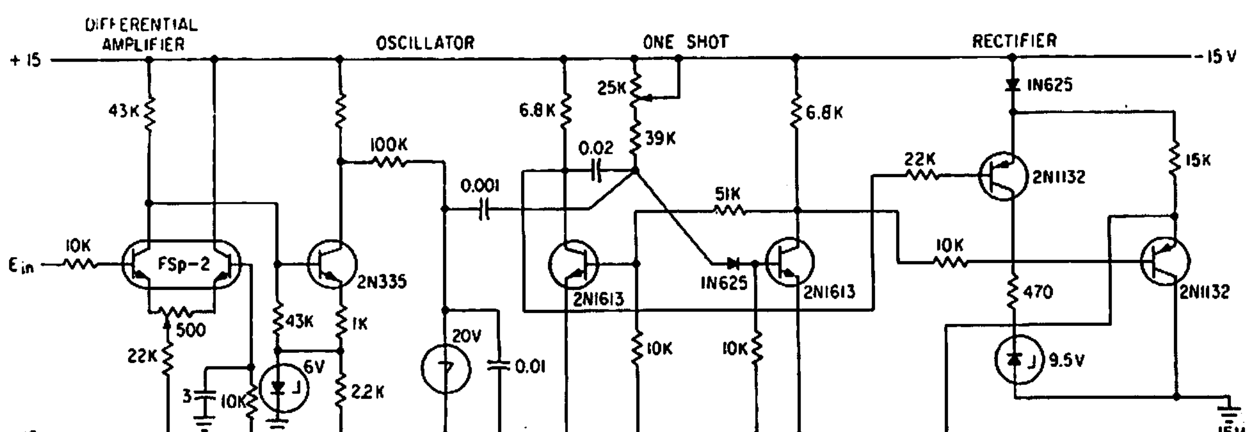
450 MC TO 105 MC WITH 2N2996—Local Colpitts oscillator operates at 345 Mc; it can deliver 5 mw, but only 1 mw is required by oscillator-stabilizing buffer for good mixing action. R-f stage ahead of converter provides power gain of 13 db at noise figure of only 5.9 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 305.



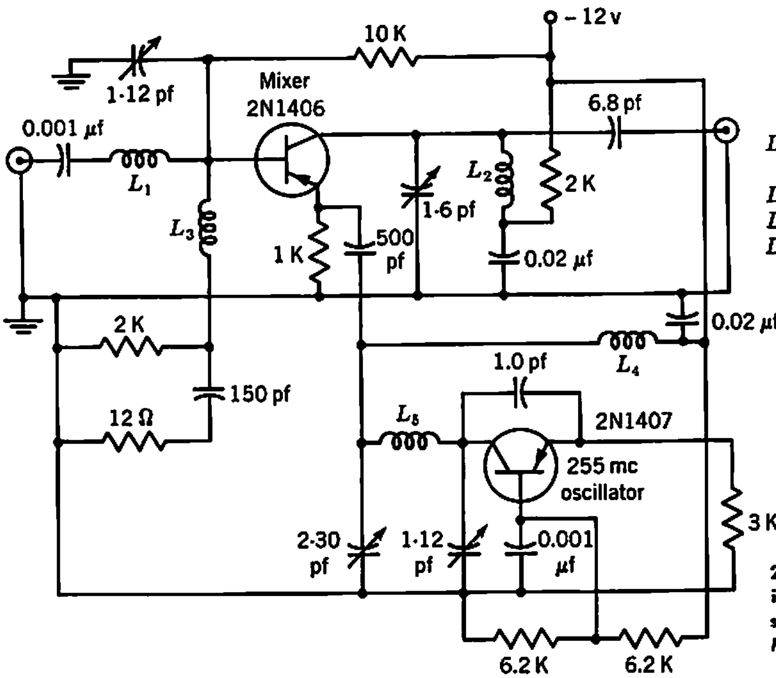
TRANSDUCER-DRIVEN CRYSTAL OSCILLATOR—Sensitive 70-Mc one-tube oscillator feeds local and remote tank circuits to which capacitive or inductive transducers may be connected, for conversion of displacement, temperature, pressure, and other variables to corresponding changes in d-c output voltage. Will give up to 250 v change per micromicrofarad of transducer capacitance change.—L. J. Rogers, Sensitive Transducers Use One-Tube Crystal Oscillator, *Electronics*, 32:40, p 48–49.



420-MC OSCILLATOR-MIXER—Common-base mixer is used with 480-Mc oscillator to give 60-Mc i-f output, with 10 db average conversion gain.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 327.

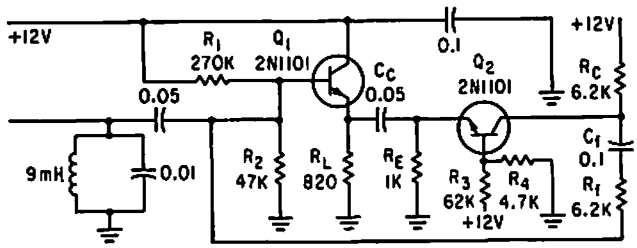


VOLTAGE-CONTROLLED OSCILLATOR—Simple circuit, using feedback to maintain accuracy, converts 0 to 3 v d-c linearly to 0 to 400 cps. Uses differential amplifier that amplifies difference between input and feedback signals and feeds frequency-determining output to Shockley four-layer diode oscillator.—J. D. Long, Feedback Linearizes Voltage-To-Frequency Converter, *Electronics*, 34:35, p 48.

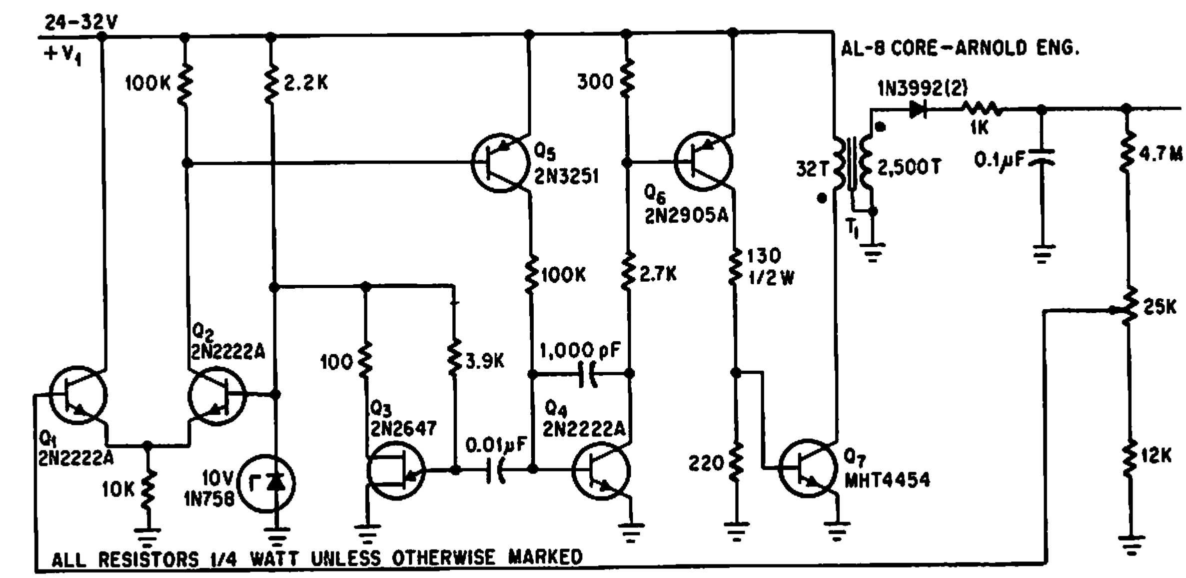


L_1, L_2	4 turns #18 tinned buss on 3/8" dia Teflon® rod Length 9/16"
L_3	25 turns #36 copper enamel on CTC LS 9
L_4	0.68 µh *RFC*
L_5	1 turn #18 tinned buss on 3/8" dia Teflon® rod Length 1/2"

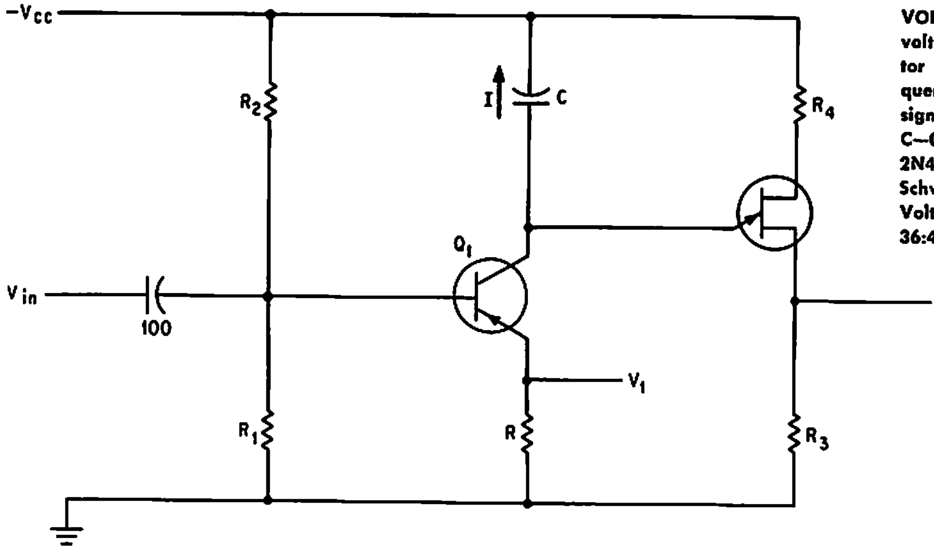
255-MC OSCILLATOR-MIXER—Conversion gain is 20 db and i-f output is 30 Mc.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 326.



NEGATIVE-IMPEDANCE CONVERTER—Increases circuit Q by factor of 4 or more in tuned audio circuits by reducing circuit losses.—W. P. Delaney, New Way to Multiply Q with Transistors, *Electronics*, 35:28, p 48–49.

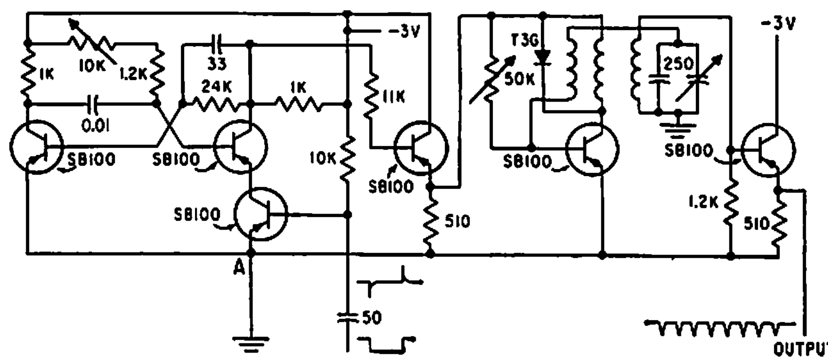


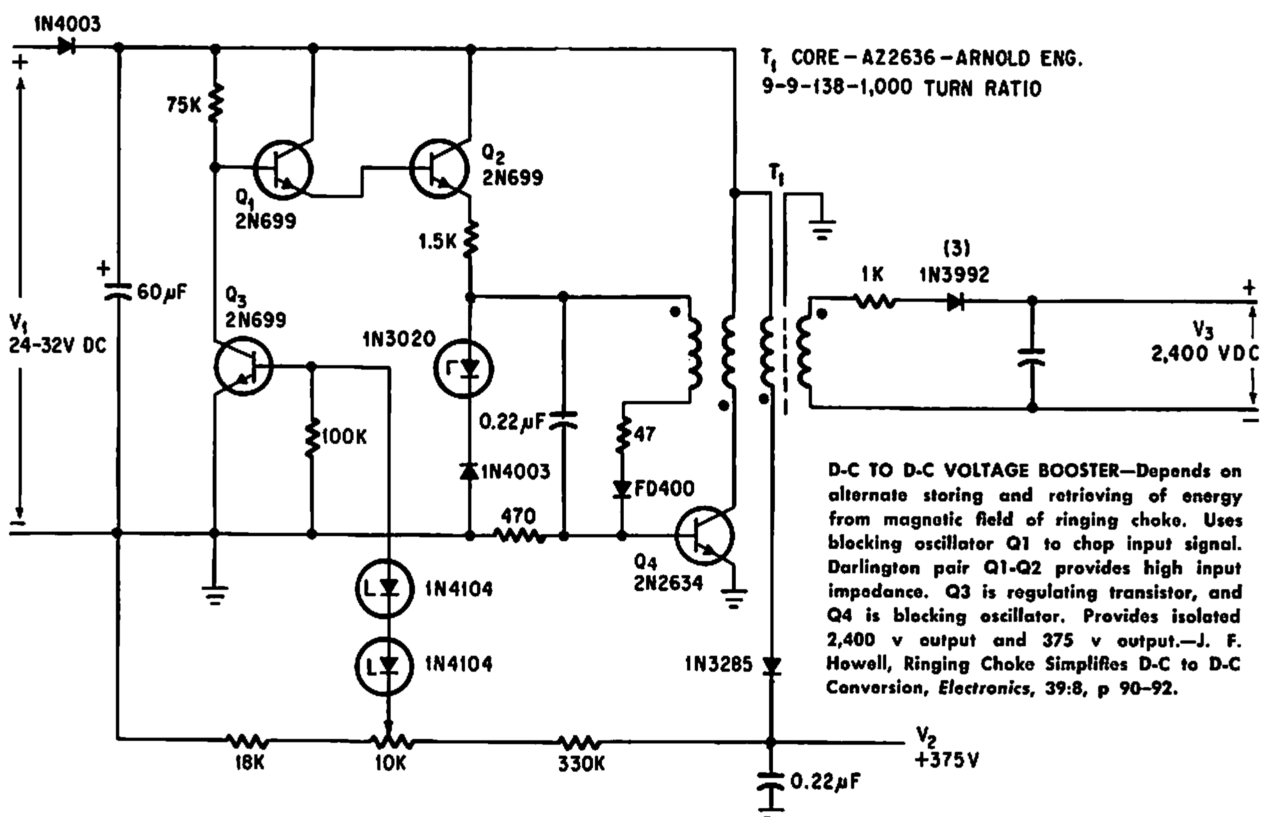
RINGING-CHOKE CONVERTER-REGULATOR—Steps up 32-v d-c pulses to 2,500-v d-c pulses, with regulation of 0.02%, achieved by sampling output and feeding it back to comparision circuit. Uses unijunction transistor Q3 with Q4 for pulse generation.—J. F. Howell, Ringing Choke Simplifies D-C to D-C Conversion, *Electronics*, 39:8, p 90–92.



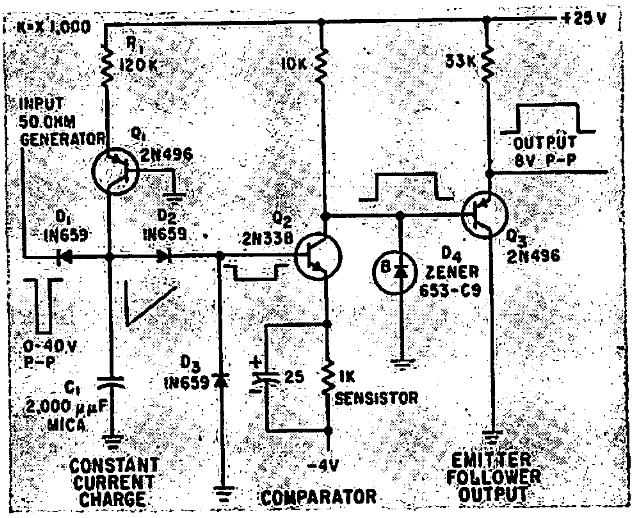
VOLTAGE-FREQUENCY CONVERTER—Linear voltage-controlled variable-frequency oscillator converts standard recorder to low-frequency f-m recorder for 0.1 to 1,000-cps signals. Values are: R1—18,000; R2—100,000; C—0.01 mfd; R—10,000; Q1—2N591; Q2—2N491; Vcc—20 v; R4—270; fo—2.5 kc.—J. Schwartz, Unijunction Transistor Simplifies Voltage-Frequency Converter, *Electronics*, 36:43, p 56.

EIGHT-PULSE GENERATOR—With 32-microsec gate following blocking oscillator, produces eight pulses at 4.5-microsec intervals at output of emitter-follower.—W. W. Grannemann et al., Pulse-Height-to-Digital Signal Converter, *Electronics*, 33:2, p 58–60.

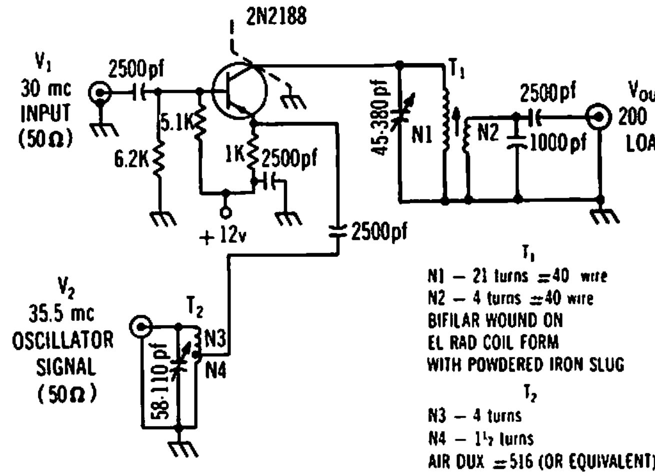




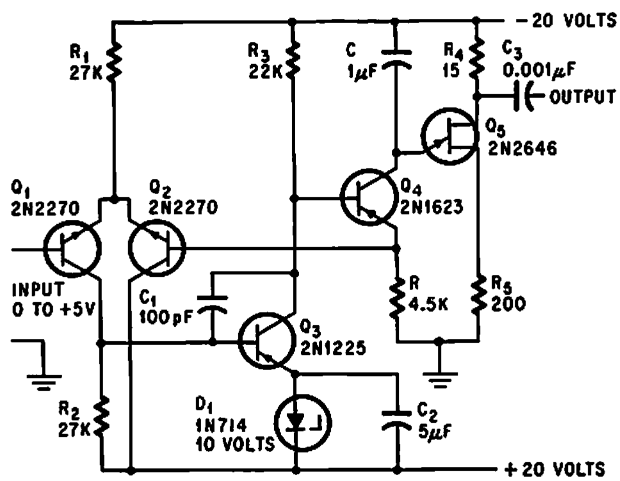
D-C TO D-C VOLTAGE BOOSTER—Depends on alternate storing and retrieving of energy from magnetic field of ringing choke. Uses blocking oscillator Q1 to chop input signal. Darlington pair Q1-Q2 provides high input impedance. Q3 is regulating transistor, and Q4 is blocking oscillator. Provides isolated 2,400 v output and 375 v output.—J. F. Howell, Ringing Choke Simplifies D-C to D-C Conversion, *Electronics*, 39:8, p 90–92.



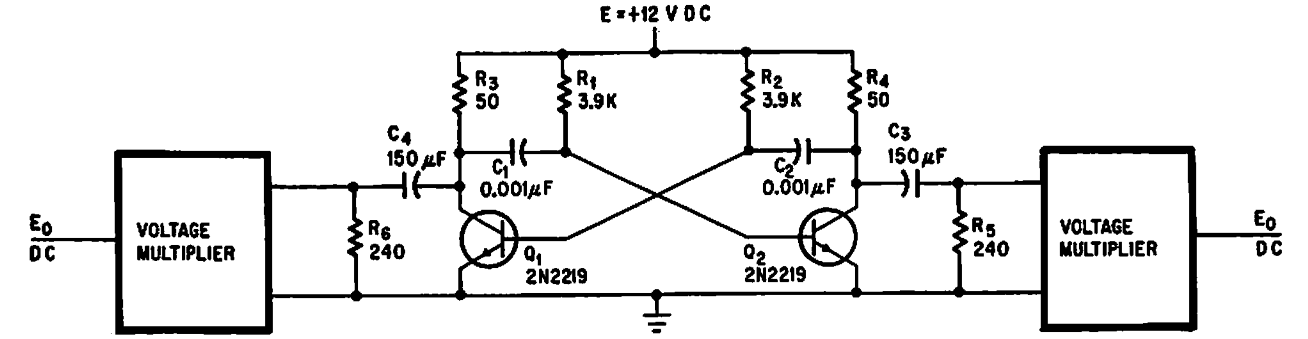
PULSE-HEIGHT-TO-TIME CONVERTER—Output width is proportional to input height. Last stage of constant-current charge circuit can be eliminated if output impedance can be high.—D. N. Carson and S. K. Dhawan, Data Conversion Circuits for Earth Satellite Telemetry, *Electronics*, 33:3, p 82–84.



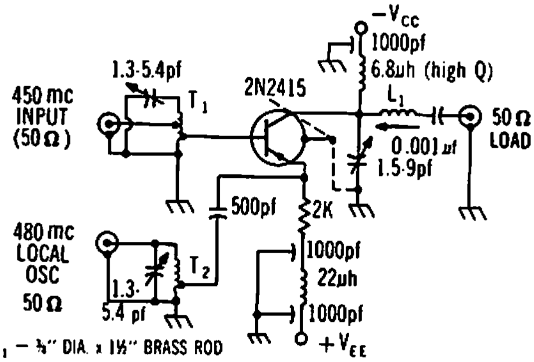
30 MC TO 5.5 MC—Single transistor serves as mixer to give 5.5-Mc i-f signal from 30-Mc signal input and 35.5-Mc oscillator input. Output is 100 mv for 10-mv signal input, with 630-mv oscillator signal.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 300.



VOLTAGE TO FREQUENCY CONVERTER—Q4 supplies charging current for C in relaxation oscillator Q5. Differential amplifier Q1-Q2 compares charging current with input voltage. Difference signal, amplified by Q3, controls charging current through Q4 and thus makes output frequency proportional to input voltage. For 0 to +5 v input, output is 0 to 100 cps with 0.1% linearity.—W. H. Voelker, Transistor Circuit Converts Voltage to Regulated Frequency, *Electronics*, 37:29, p 73–74.



D-C TO D-C—Free-running multivibrator (250 kc) generates unidirectional square waves having amplitude of d-c input voltage. R-C circuit at output blocks average value of unidirectional pulse, and standard diode-capacitor voltage multiplier boosts output voltage to desired new value.—A. J. Durocher, D-c Voltage Converter Needs No Transformer, *Electronics*, 37:28, p 64–65.

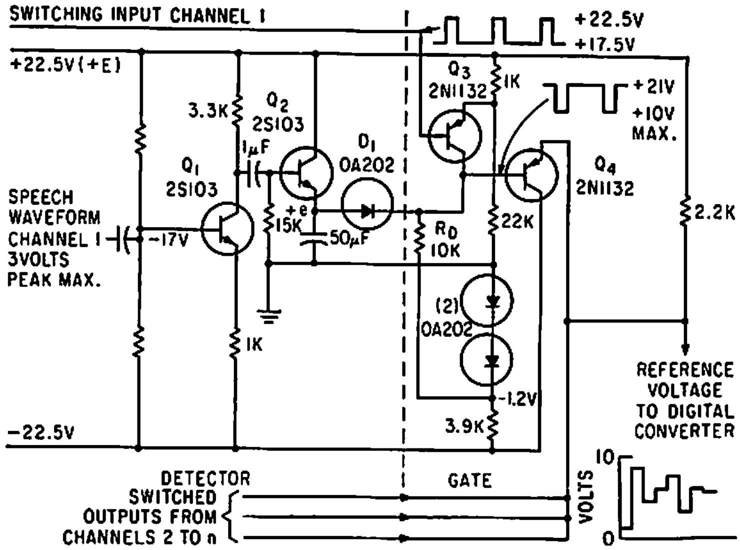


T1 – ⅜" DIA. x 1½" BRASS ROD TAPPED AT 0.75" and 0.375" FROM GROUND

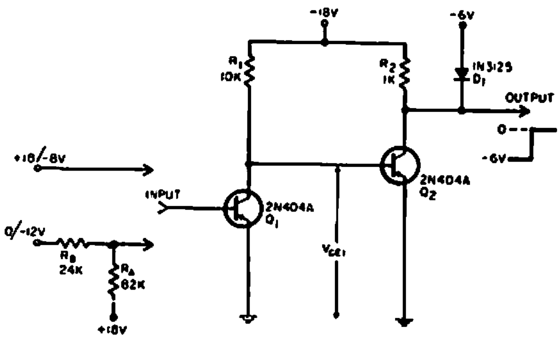
T2 – ⅜" DIA. x 1½" BRASS ROD TAPPED 0.375" FROM BOTTOM

L1 = 18 TURNS #30 WIRE ON CTL COIL FORM #PL562C4L/20063-0 CLOSE WOUND FROM BOTTOM. SLUG GROUNDED

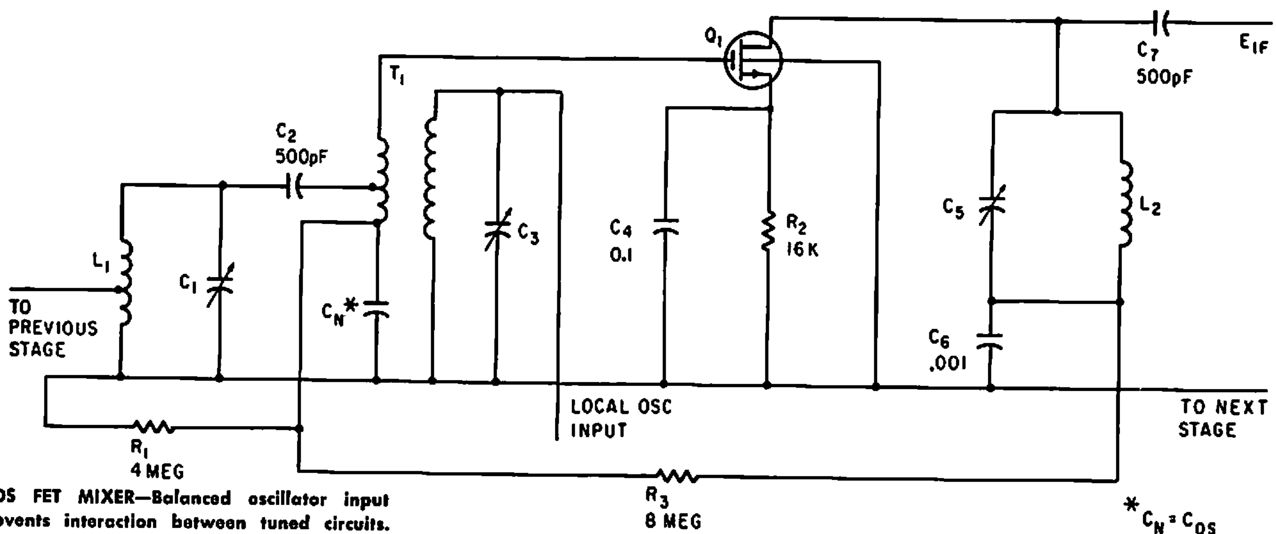
450 MC TO 30 MC—With local oscillator feeding 1 mw, conversion gain is 15 db and noise figure 10 db. With 2N2415 r-f stage ahead of mixer, combined power gain is 25 db and noise figure 6 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 302.



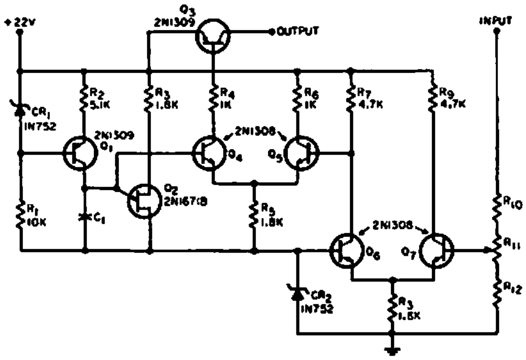
REFERENCE VOLTAGE FOR DIGITAL CONVERTER—Rectifies speech signals over 30-db range, and allows charge of memory capacitor to rise in millisec when speech input is applied, to form reference input voltage to digital converter for ratio quantizing unit.—J. D. Howells, Better Speech Quantizing for Pulse-Code Modulation, *Electronics*, 35:48, p 84–88.



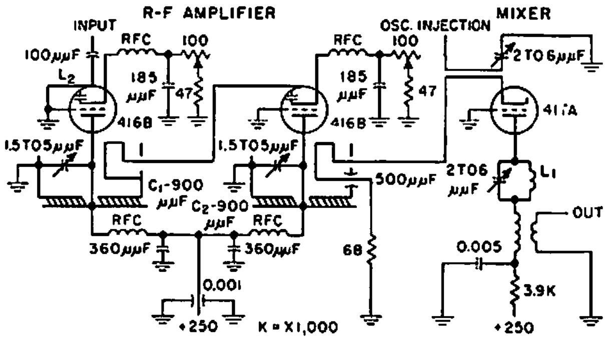
LOGIC-LEVEL CONVERTER—Converts from +18/−8 v logic levels of some frequency converters and other digital test equipment to commonly used 0/−6 v logic levels of data-logging system.—C. M. Jackson, Logic-Level Converter, *EEE*, 12:9, p 61.



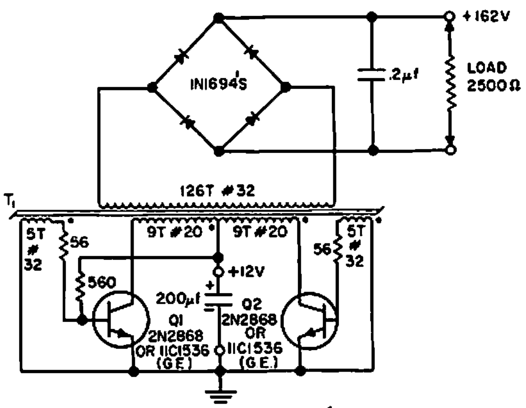
MOS FET MIXER—Balanced oscillator input prevents interaction between tuned circuits. Transconductance of mixer is directly proportional to oscillator voltage, permitting use for agc.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



VOLTAGE TO PULSE-WIDTH CONVERTER—Converts d-c level linearly to pulse width at preset frequency. Used as switching-type series d-c regulator. C1 is selected to give desired preset frequency, and R10, R11, and R12 are chosen for desired voltage division of input.—M. C. Ellis, Linear Voltage to Duty-Cycle Converter, *EEE*, 12:3, p 72.

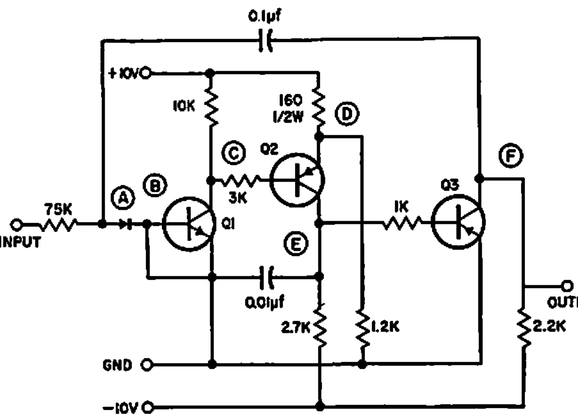


LOW-NOISE 400-MC CONVERTER—Voltage gain is 36 db, bandwidth 4 Mc, and noise figure only 2.5 db. Uses grounded-grid r-f and mixer stages. Applications include meteor, aurora, and forward scatter propagation studies.—L. F. Garrett, Low Noise Converter for IGY Propagation Study, *Electronics*, 31:5, p 52–54.

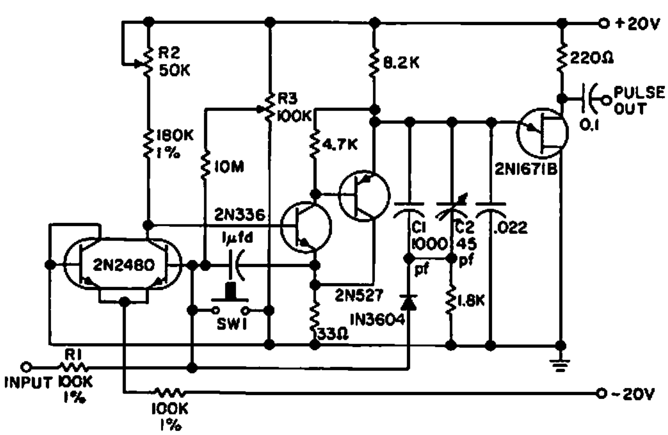


T1 -TWO #3C3 E CORE #206F440 } FERROXCUBE
BOBBIN # 595F425 } SAUGERTIES, N.Y.

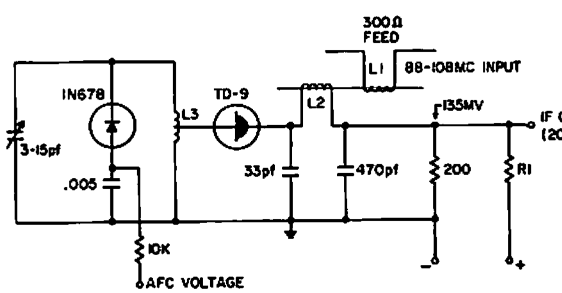
12 TO 162 V D-C CONVERTER—Simple and efficient saturating-core inverter provides 10 w output with efficiency of 80%, using operating frequency of about 8.5 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 237.



D-C TO AUDIO FREQUENCY CONVERTER—Response is nonlinear; 1.7 v input voltage gives 100 cps; 1.9 v gives 200 cps; 2.25 v gives 400 cps; 3.3 v gives 800 cps; 6.2 v gives 1,600 cps; 10 v gives 2,000 cps. Output waveform approximates rectangular shape.—D. Busby, Jr., DC to Frequency Converter, *EEE*, 10:11, p 31.

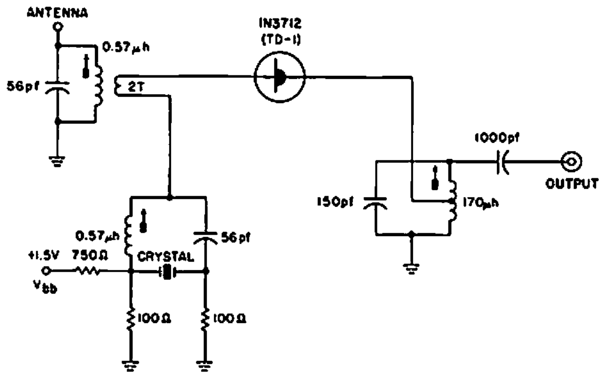


VOLTAGE-TO-FREQUENCY CONVERTER—Output frequency is proportional to input voltage, with 1 volt producing 1 kc. Linearity is better than 0.1%.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 346.

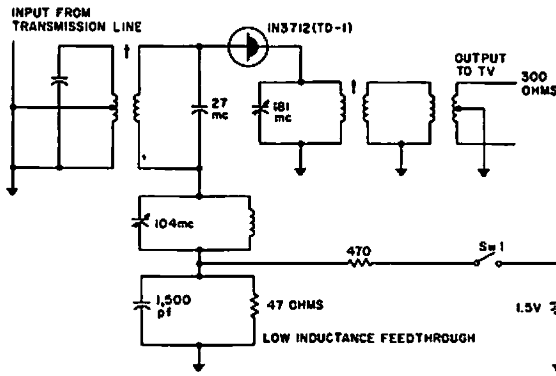


L1 - 4 TURNS #18-3/8" ID, APPROX. 1/2" LONG
L2 - 4 TURNS #18-3/8" ID, APPROX. 1/2" LONG
L3 - 8 1/2" TURNS #18-3/8" ID, APPROX. 3/4" LONG TAPPED AT 5 TURNS
L1L2 - COUPLED END TO END, SPACED ~ 1/8" APART
R1 - DEPENDS ON SUPPLY VOLTAGE. SELECT FOR BIAS OF APPROX. 135MV ACROSS 200Ω RESISTOR.

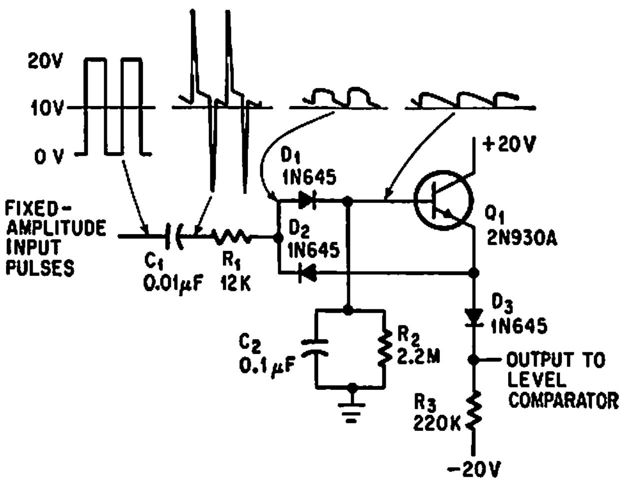
88-108 MC F-M CONVERTER WITH AFC—Variable-capacitance diode provides frequency control of tunnel-diode oscillator.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 361.



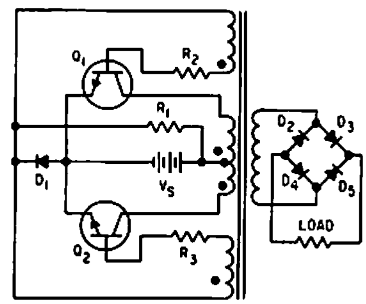
CRYSTAL-CONTROLLED CB CONVERTER—Uses tunnel-diode oscillator.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 358.



COMMUNITY-TV UP CONVERTER—Uses tunnel-diode oscillator.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 359.

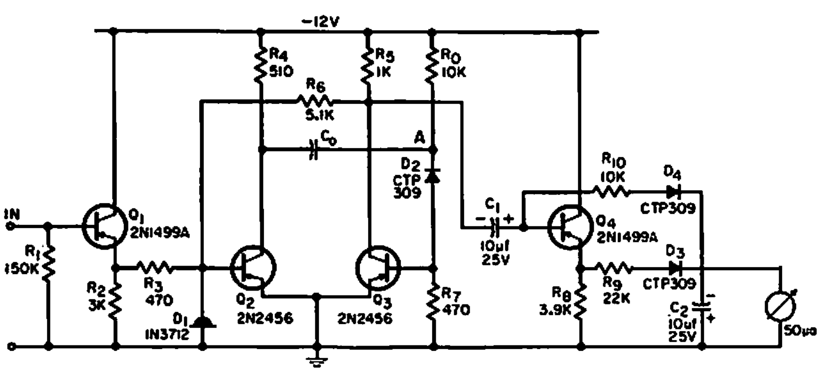


FREQUENCY-TO-VOLTAGE CONVERTER—Linear staircase generator delivers d-c output voltage proportional to repetition frequency of input pulses while rejecting short-duration spurious noise pulses.—M. Merlen and D. Grossman, Interrogator Circuit Can Tell Good Data from Bad, *Electronics*, 37:20, p 58–59.

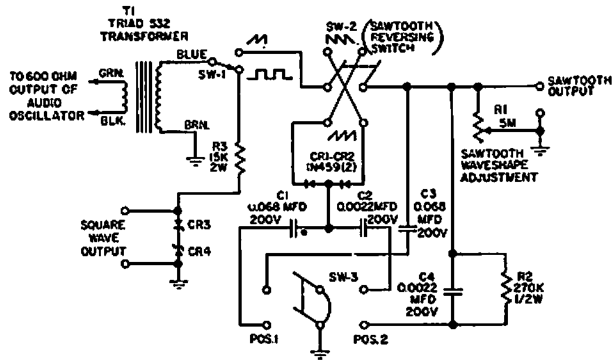


	SILICON	GERMANIUM
Q_1 Q_2	2N389	2N457
D_1	IN645	IN538
R_1	5,600	8,200
R_2,R_3	10	3.3
D_2,D_3,D_4,D_5	IN647	IN540

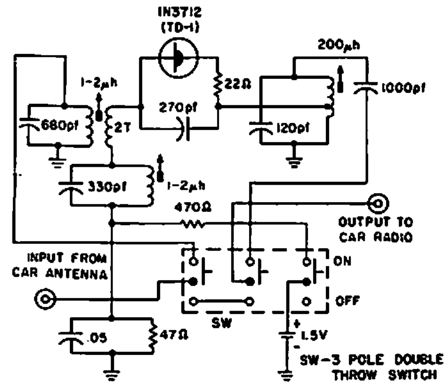
POWER CONVERTER—Silicon transistor version gives 15 w output from 24-v supply at 70% efficiency, while germanium version gives over 100 w at 90% efficiency. With germanium transistors, diode D1 and supply voltage must be reversed.—T. R. Pyo, Design of Transistor Power Converters, *Electronics*, 32:36, p 56–58.



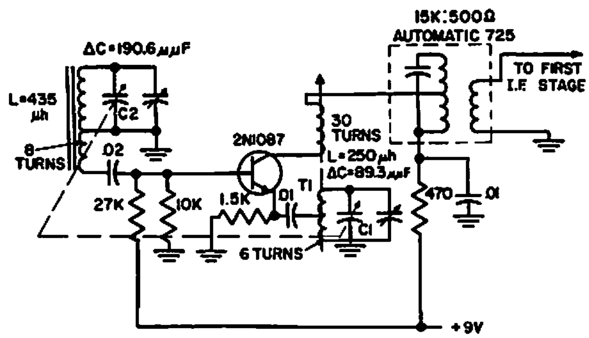
FREQUENCY TO D-C CONVERTER—Used in place of costly frequency meter for frequency measurements from 10 cps to 1 Mc, having almost any input waveform. Overall accuracy is 3%. Medium-power 12-v zener should be used to stabilize supply voltage.—T. Mollinga, Frequency-to-DC Converter for Lab Measurements, *EEE*, 12:8, p 84.



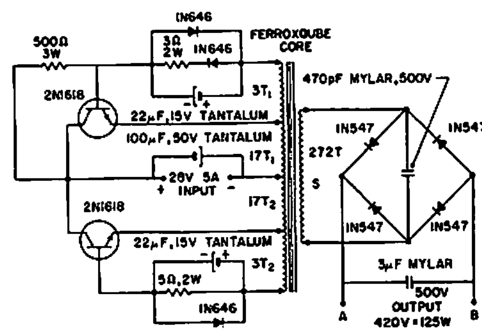
SINE TO SAWTOOTH OR SQUARE WAVES—Changes 50 to 17,000 cps sine waves to either waveform, using only power of signal itself. Sawtooth is obtained from sine wave by linear charging of capacitors. Switch position 1 covers 50 to 2,000 cps, and position 2 1,800 to 17,000 cps. CR3 and CR4 are IRC 60-1505 zener diodes (8 v - 0.1 v).—M. W. Raybin, Converts Sine Waves to Sawtooth or Square Waves, *EEE*, 10:11, p 28.



CIVIL AIR PATROL CONVERTER—Tunnel-diode oscillator in self-oscillating converter permits reception on aviation band with auto radio. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 358.

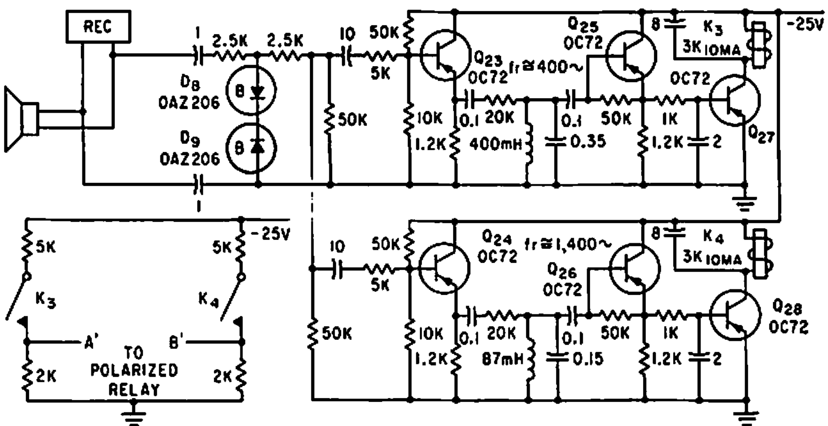


AUTODYNE CONVERTER—Single transistor stage serves as combination local oscillator, mixer, and i-f amplifier in transistor radio. Mixer operates in grounded-emitter configuration. I-f value is 455 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 284.

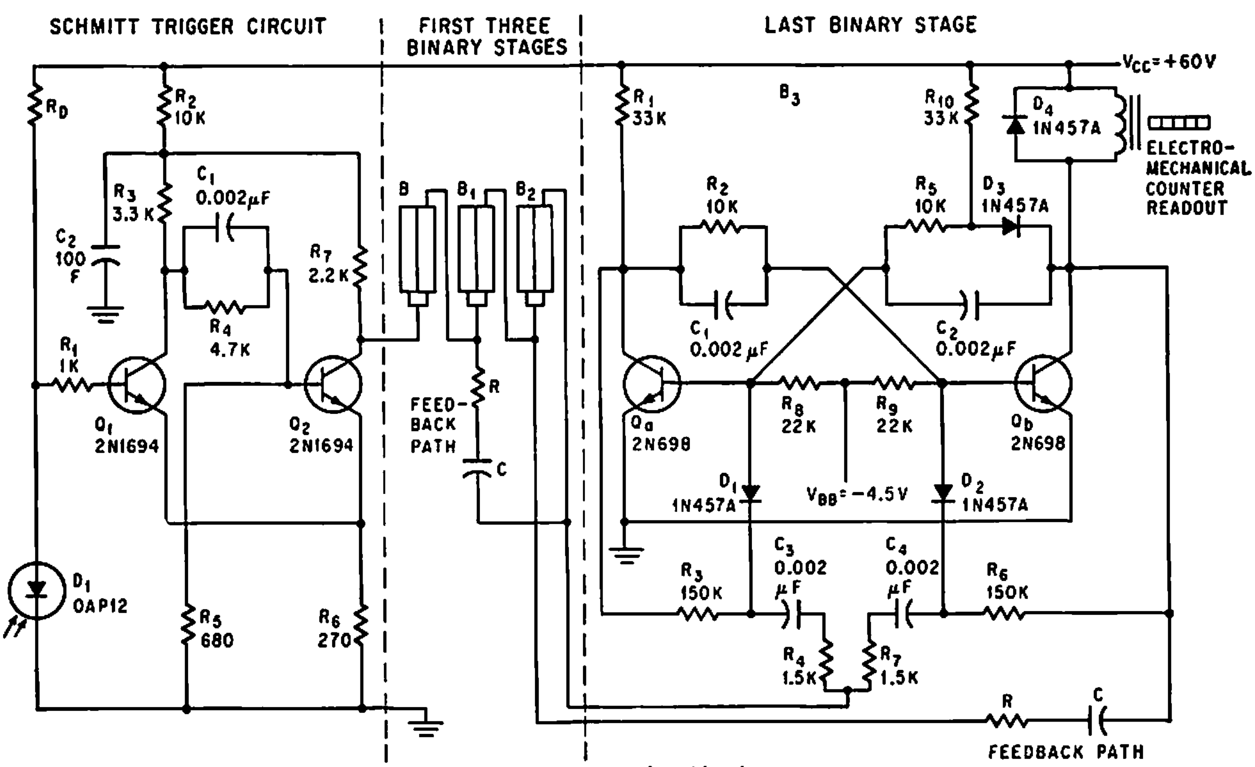


28 TO 420 V D-C CONVERTER—Efficiency is 87%, power output 125 w, output voltage ripple 0.7 v p-p, and operating frequency 10 kc. Ambient temperature range is —50 to 125°C. Transformer winding data is given. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 238.

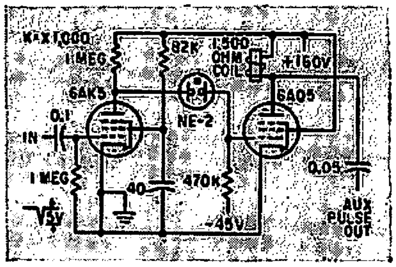
CHAPTER 20
Counter Circuits—Objects



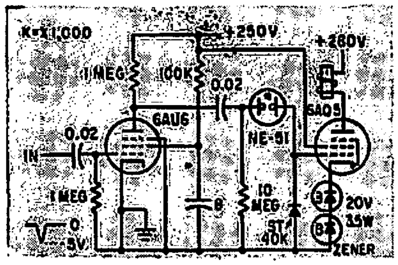
27-MC RECEIVER FOR TONE-MODULATED DATA—Two selective amplifiers, one tuned to 400 cps and other to 1,400 cps, drive relays K3 and K4 to control printing register for recording remote events such as passage of birds through infrared curtain.—P. A. Tove and J. Czekajewski, Infrared Curtain System Detects and Counts Moving Objects, *Electronics*, 34:31, p 40–43.



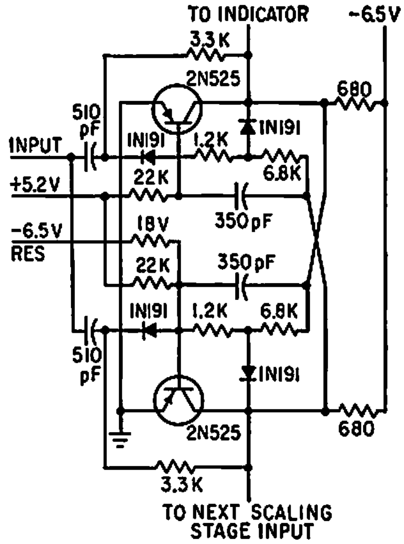
BUTTON AND BEAD COUNTER—Tiny objects passing before photodiode are counted by Schmitt trigger and four binary stages at up to 30 counts per second, with electromechanical counter readout.—E. J. Brach, Photocell Triggers Counting Circuit, *Electronics*, 38:13, p 74–75.

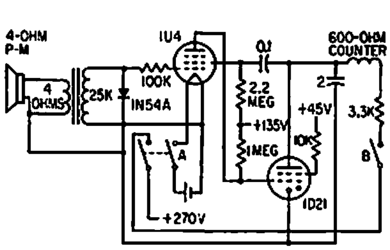


AMPLIFIER-DRIVER SPEEDS UP COUNTER—Arrangement using neon coupling between tubes can increase operating speed of well-designed electromechanical counter up to 2.5 times, by providing combination of pulsed and sliding overvolting.—R. L. Ives, Circuit Modifications for Boosting Counter Speed, *Electronics*, 33:7, p 112–114.



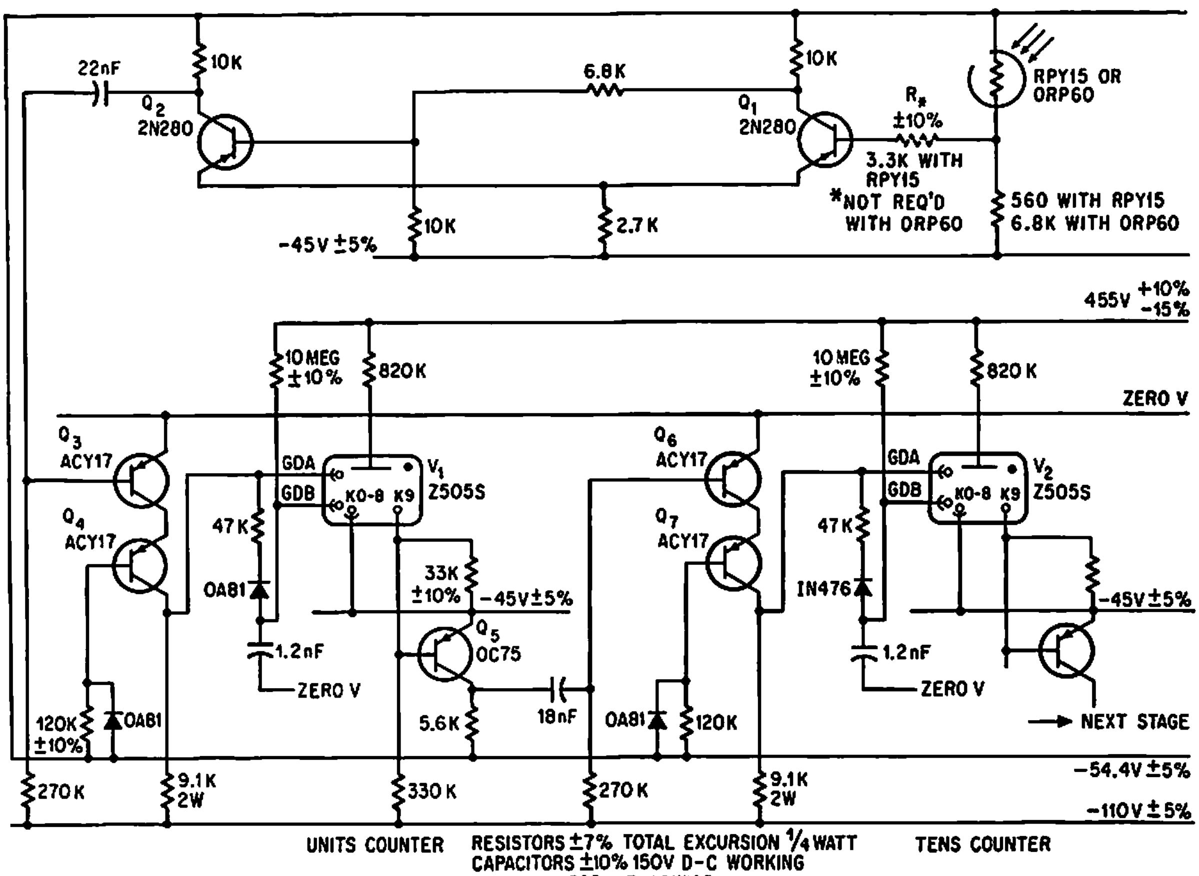
SPEED-TRIPLING COUNTER DRIVE—Increased speed of 25-cps electromechanical counter to 75 cps without affecting accuracy of count. Circuit arrangement simplifies power supply requirements. Zener diodes eliminate need for bias supply.—R. L. Ives, Circuit Modifications for Boosting Counter Speed, *Electronics*, 33:7, p 112–114.



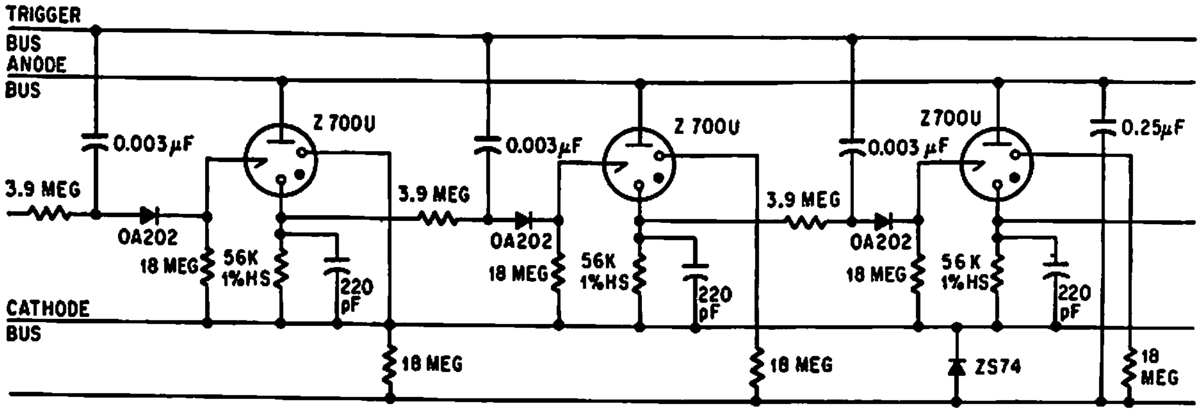


GUNSHOT COUNTER—Loudspeaker serves as microphone for picking up loud noises such as from blasts, noisy auto engines, and children on roller skates. Each input shock wave drives grid of 1U4 negative and fires 1D21 strobotron, thereby dumping charge on 2-mfd capacitor from plate to ground through counter. Operates at up to 40 shots per second, fast enough for most automatic weapons fire.—R. L. Ives, Shot Counter Uses Strobotron, *Electronics*, 31:33, p 94–96.

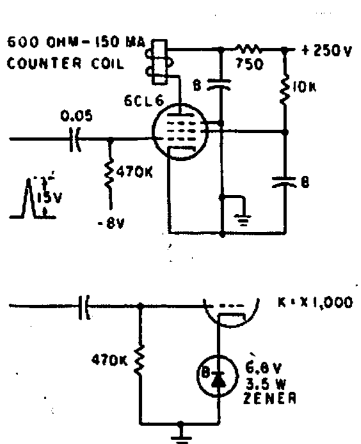
NEON INDICATOR SCALER—Battery-powered stage uses binary scaling circuit with nonsaturated temperature-compensated transistors, as elements of scale-of-64 circuit driving 4-digit mechanical register.—F. E. Armstrong, Battery Powered Portable Scaler, *Electronics*, 33:19, p 74–75.



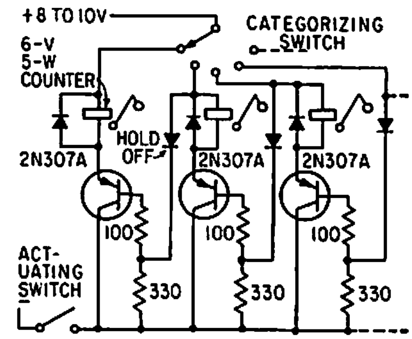
CONVEYOR COUNTER—Senses objects as small as 0.2 sq cm on moving conveyor at speeds up to 25 pps.—G. Jeynes, Using Cold-Cathode Tubes to Count and Store, *Electronics*, 38:8, p 80–89.



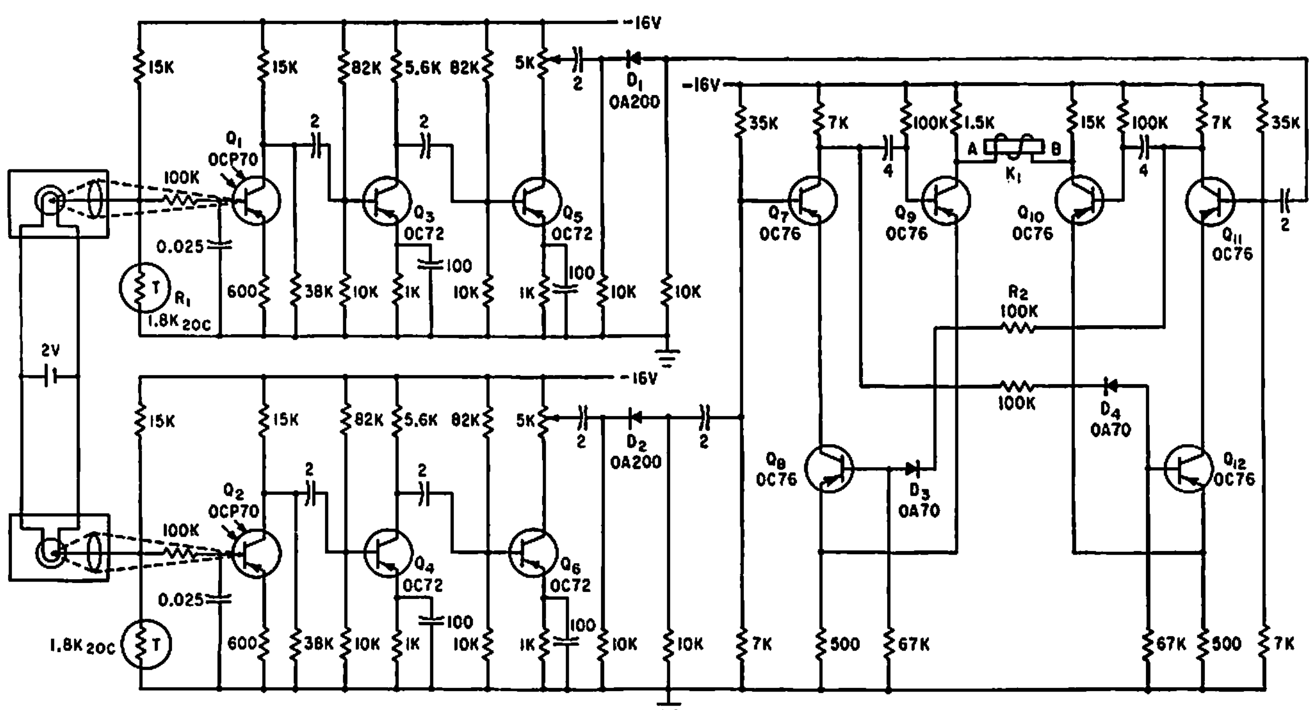
SHIFT REGISTER—Memory chain of 16 miniature logic tubes (three shown) serves as counter for weighing and batching.—M. E. Bond, Cold-Cathode Tubes as Triggers, *Electronics*, 38:7, p 76–85.



MECHANICAL COUNTER SPEEDUP—Vacuum-tube circuit doubles speed of counter, with minimum of overheating and other damage to counter coil and mechanism. Operation depends on pulsed overvolting for a limited time, along with some sliding overvolting wherein excess voltage is applied to coil when circuit is first completed, then reduced so it drops below normal operating voltage during pull-in time.—R. L. Ives, Circuit Modifications for Boosting Counter Speed, *Electronics*, 33:7, p 112–114.



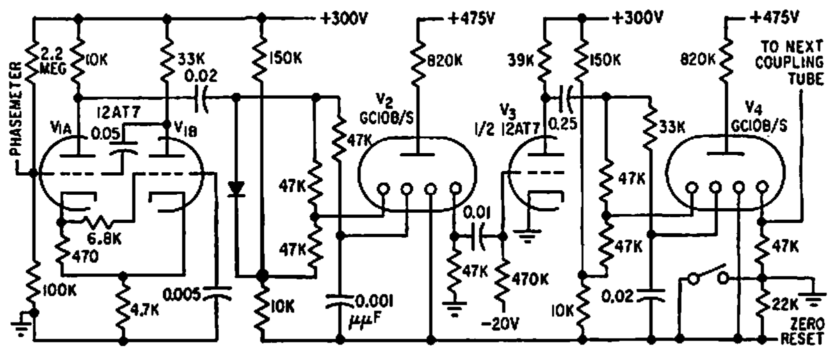
ANTIDUPLICATION CIRCUIT—Diodes absorb flyback and prevent duplicate counts when categorized information is fed to banks of electromechanical counters.—R. L. Ives, Reducing Errors in Category Counters, *Electronics*, 35:23, p 54–57.

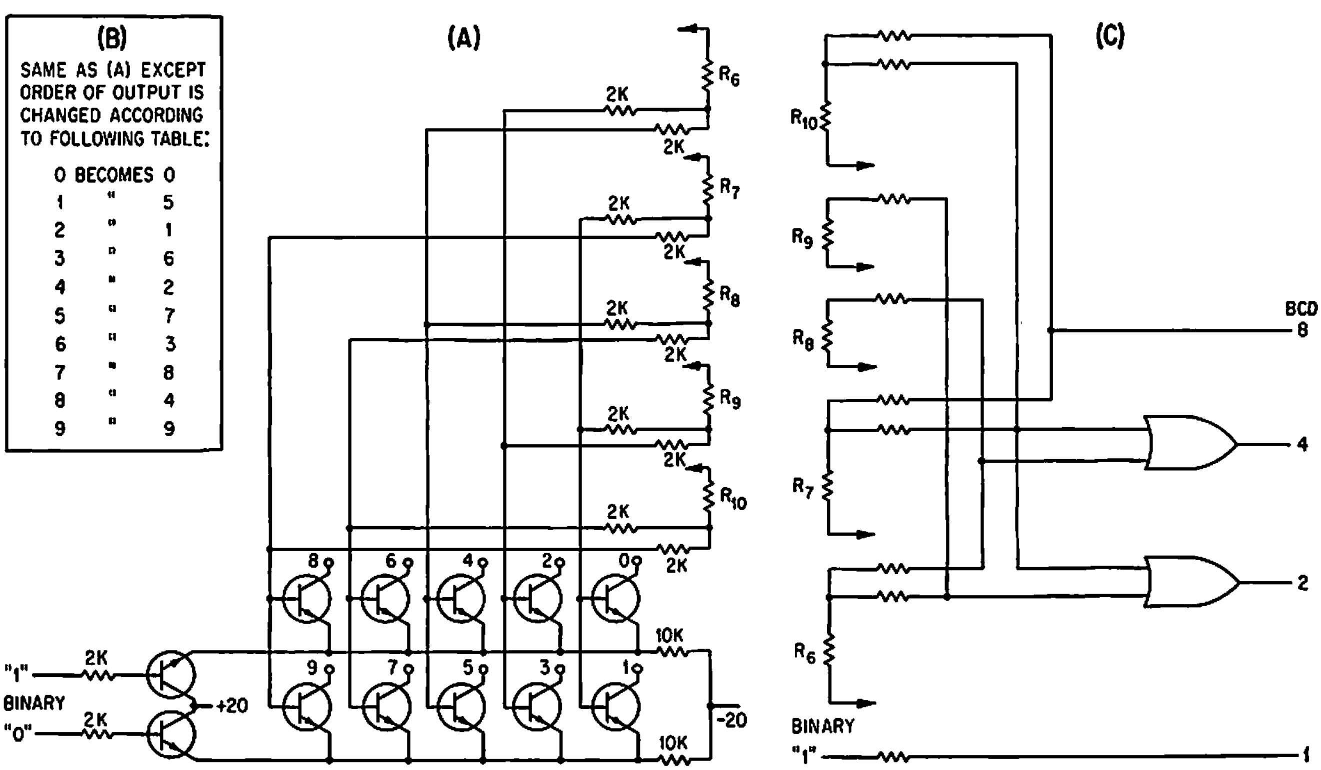


INFRARED-CURTAIN BIRD COUNTER—System registers appearance of bats and other moving objects moving through curtain of infrared light. Logic circuit determines direction of travel. Direction and pass time are automatically printed by mechanical register K1.—P. A. Tove and J. Czekajewski, Infrared Curtain System Detects and Counts Moving Objects, *Electronics*, 34:31, p 40–43.

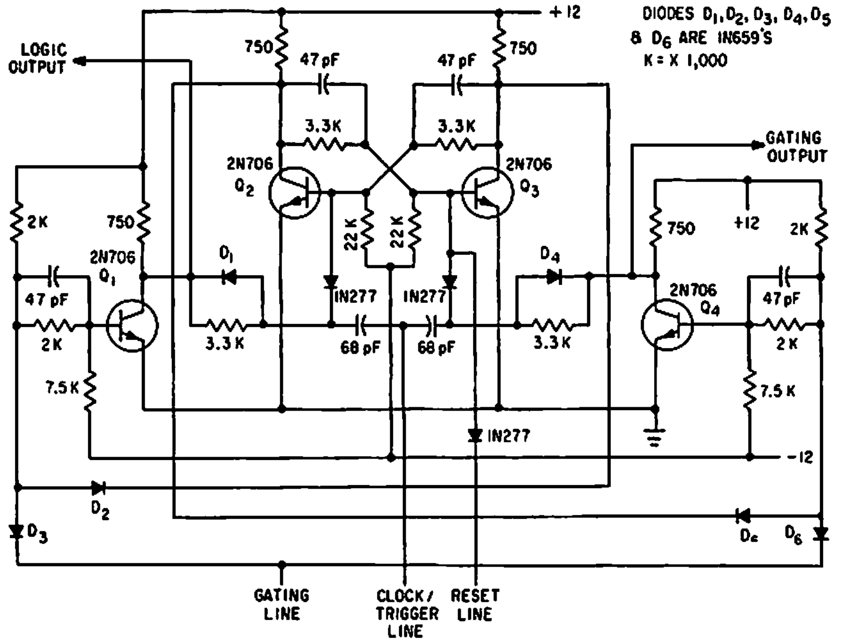
CHAPTER 21
Counter Circuits—Pulses

ADF DEGREE-INDICATING COUNTER—V1 is used in conventional pulse-forming circuit to drive counter V2. Each counter tube is connected to next by half of 12AT7. When first counter passes zero, pulse at its output is fed to next counter.—J. F. Hatch and D. W. G. Byatt, Direction Finder with Automatic Readout, *Electronics*, 32:16, p 62–64.

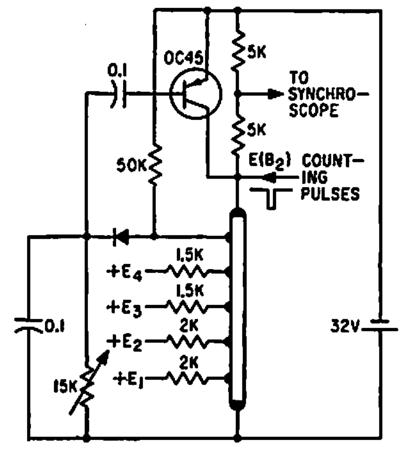




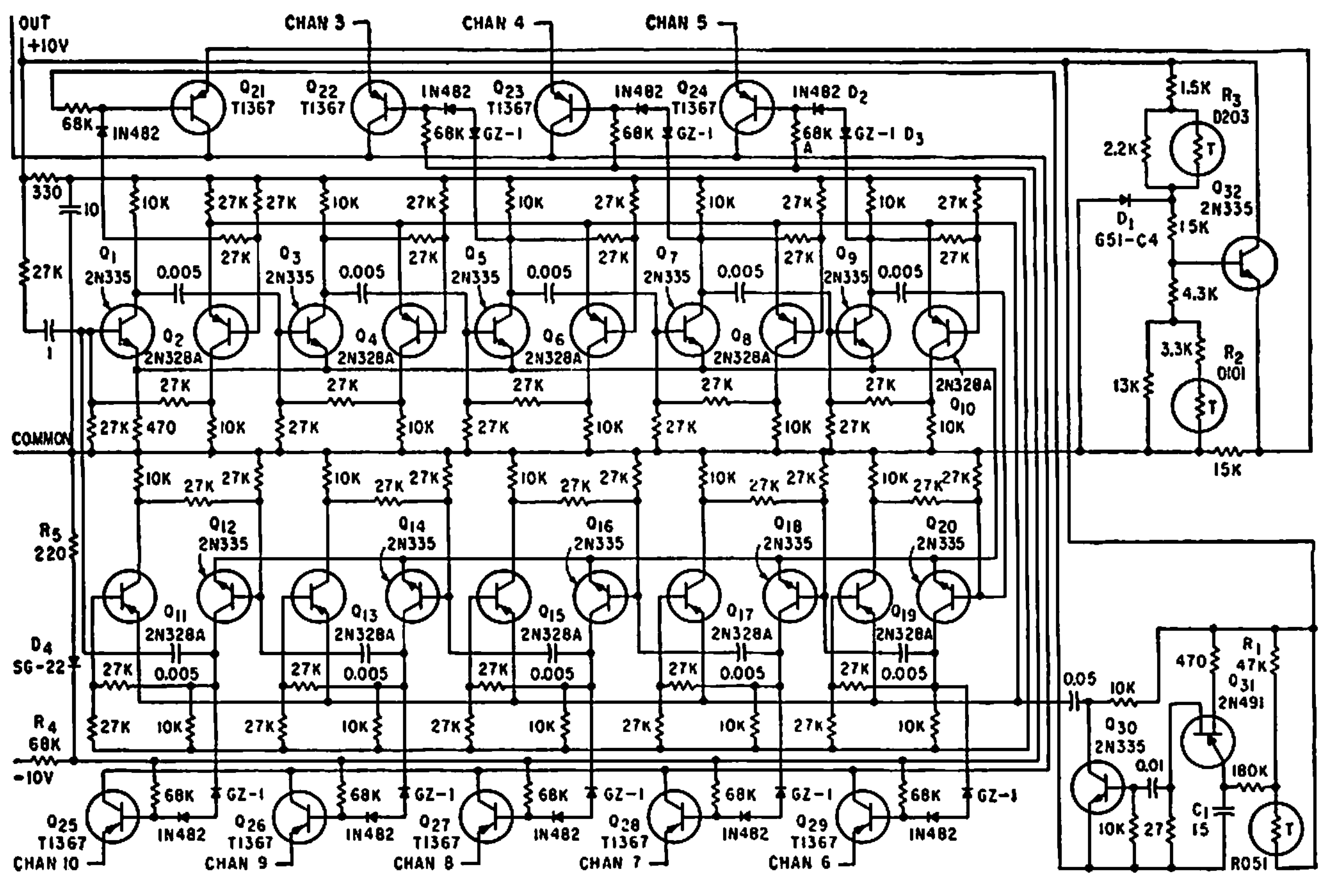
BIQUINARY DECADE WITH NIXIE INDICATORS—Transistor terminals 0 to 9 represent connections to Nixie indicator, which requires no buffers. Counting rate can exceed 500 Mc, using 2N2708 transistors. Bi-quinary decade connections, shown at right and in table, permit easy conversion to bcd.—R. Engelmann, B-Quinary Scaling: Accuracy and Simplicity at 500 Mc, *Electronics*, 36:46, p 34–36.



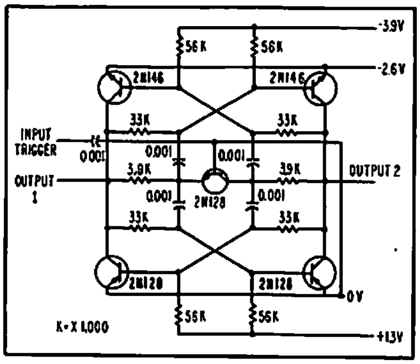
HIGH-SPEED BUFFERED FLIP-FLOP—Buffering increases load-handling capacity and insures accurate counting of 10-Mc clock frequencies.—D. L. Nepveux, Digital Circuits Achieve Automatic Control of Radar Range Tracking, *Electronics*, 34:52, p 46–50.



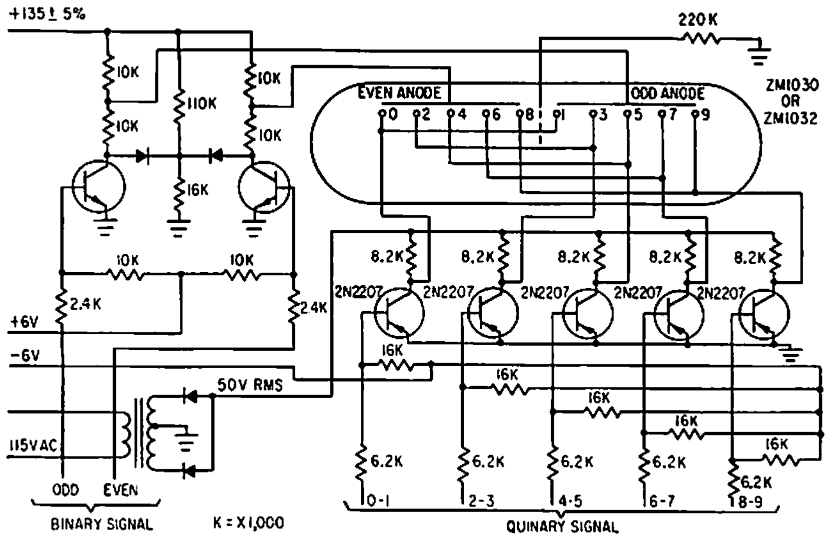
MULTIJUNCTION SEMICONDUCTOR AS DECADE COUNTER—Experimental equivalent of cold-cathode counter tube, developed in Poland, can serve also as staircase waveform generator. Although circuit shown, with five p-n junctions on one side of n-type semiconductor bar, gives only count of five before transistor restores initial state, decade counter would have ten junctions on bar.—A. Ambroziak, Semiconductor Analog of a Cold-Cathode Counter Tube, *Electronics*, 35:6, p 46–47.



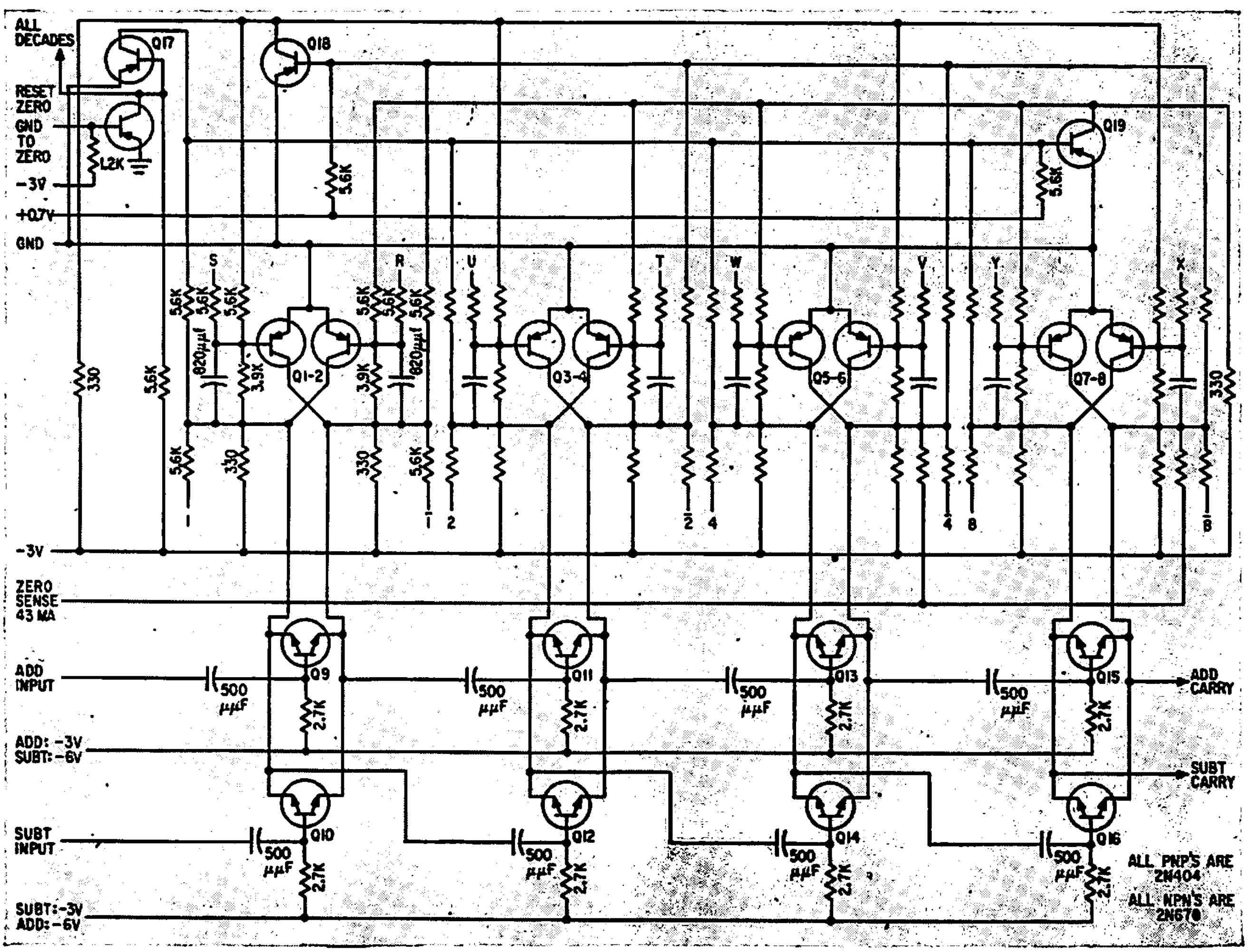
10-CHANNEL MULTIPLEXER—Basic counter consists of ten modified bistable mvbr stages, Q1 through Q20, coupled in usual ring manner and driven continuously by timing oscillator Q31. Used for multiplexing conventional or random pulse inputs from Explorer VII satellite. Eight channels serve for information inputs, and fixed levels of 0 and 110% are applied to other two channels for frame identification.—O. B. King, Multiplexing Techniques for Satellite Applications, *Electronics*, 32:44, p 58–62.



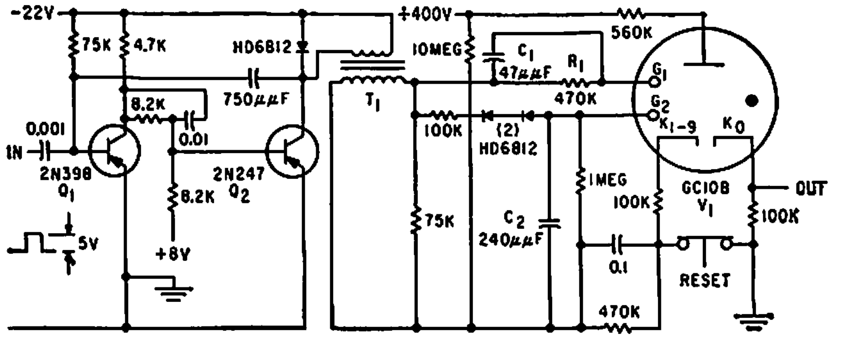
BINARY WITH STEERING-CIRCUIT TRANSISTOR—Input goes to steering transistor that replaces two back-to-back diodes normally used to drive bases of binary transistors through capacitive coupling. Four-transistor binary flip-flop reduces total quiescent drain on batteries.—R.W. Rochelle, Cyclops Cores Simplify Earth-Satellite Circuits, *Electronics*, 31:9, p 56–63.



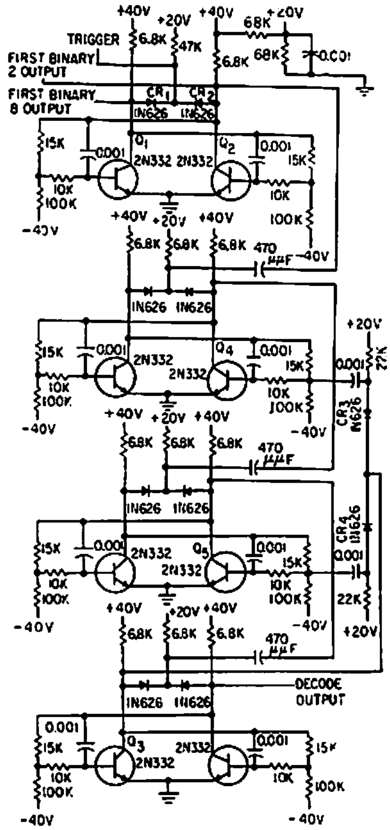
BIQUINARY COUNTER WITH READOUT—Simplified driver circuits require only seven transistors rather than ten, when used with special Amperex ZM1032 tube.—Biquinary Indicator Uses 7 Transistors, *Electronics*, 36:28, p 58.



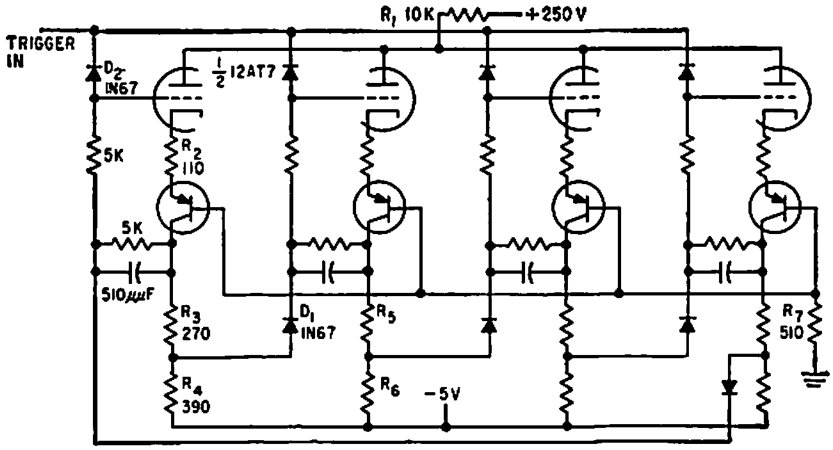
STEERING FOR REVERSIBLE DECADE COUNTER—Consists of four R-C coupled complementary saturated flip-flops Q1-Q8. Symmetrical npn steering transistors Q9 through Q16, coupled between collectors of flip-flops, are used as trigger current amplifiers and for steering when counting up or down.—R. D. Carlson, Steering Circuits Control Reversible Counters, *Electronics*, 33:1, p 86–88.



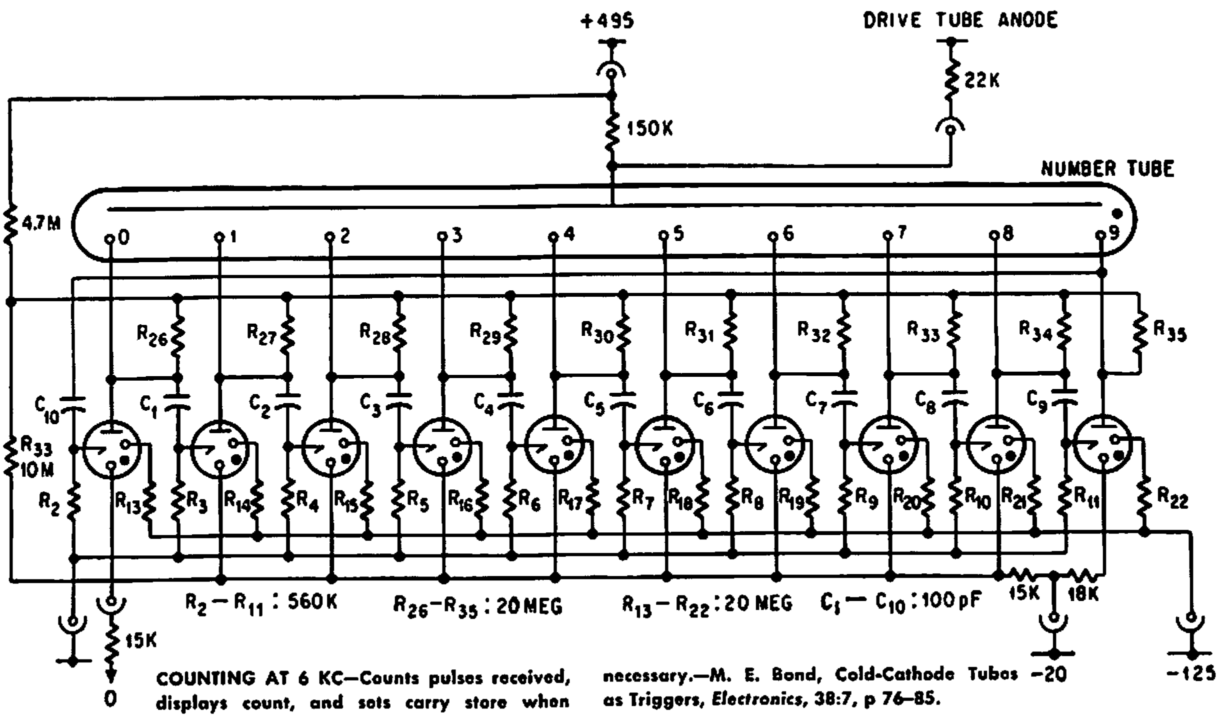
4-KC SCALER—Drives glow tube at maximum possible rate. Uses single-shot mvbr and step-up transformer Q1 to obtain 300-v pulses required to drive glow tube. Single drive pulse is fed simultaneously to both guides of tube.—H. A. Kampf, Increasing Counting System Reliability, *Electronics*, 32:37, p 112–113.



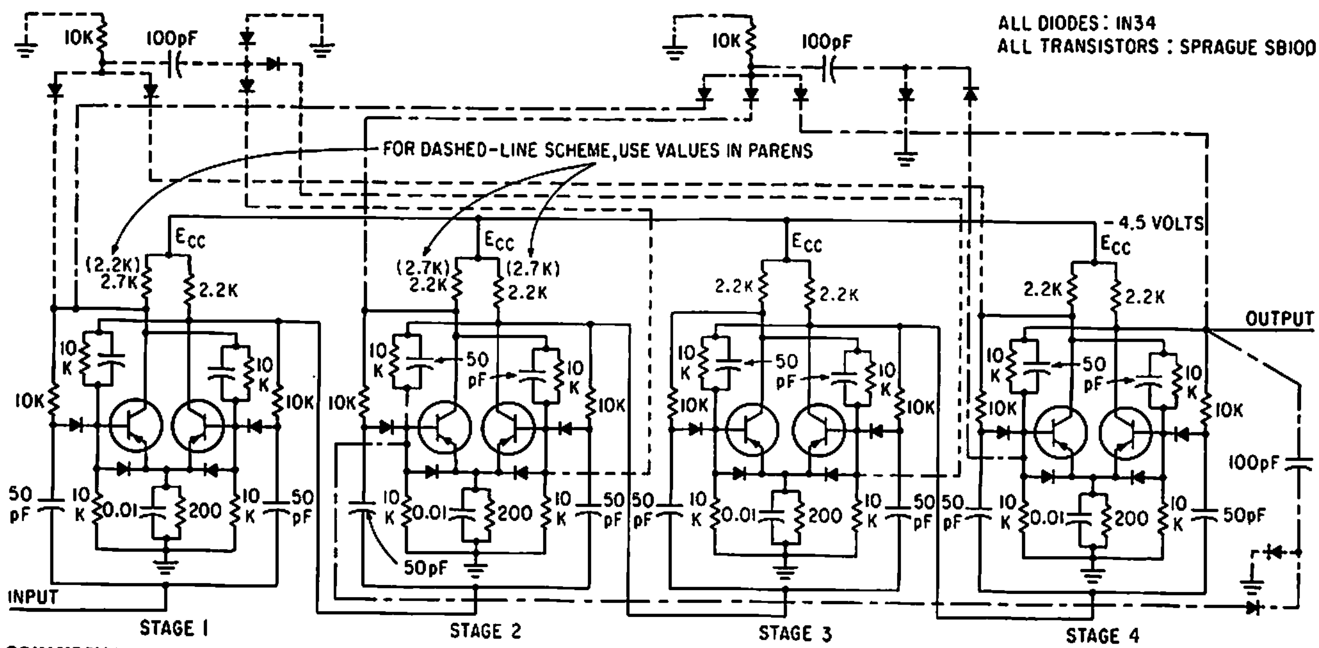
40,000-CPS DECADE COUNTER—Basic building block in counter is bistable mvbr which produces binary counts. Operates over wide range of operating voltages and temperatures.—Decade Counter is Flexible, Reliable, *Electronics*, 31:49, p 104-106.



HYBRID RING COUNTER—Counts reliably up to about 500 kc, with trigger amplitude of 4.5 v. All stages are identical.—G. A. Dunn and N. C. Hekimian, Tube-Transistor Hybrids Provide Design Economy, *Electronics*, 32:23, p 68–70.

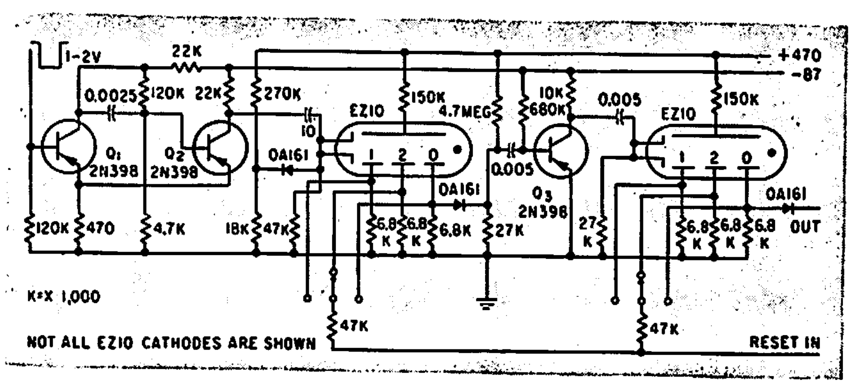


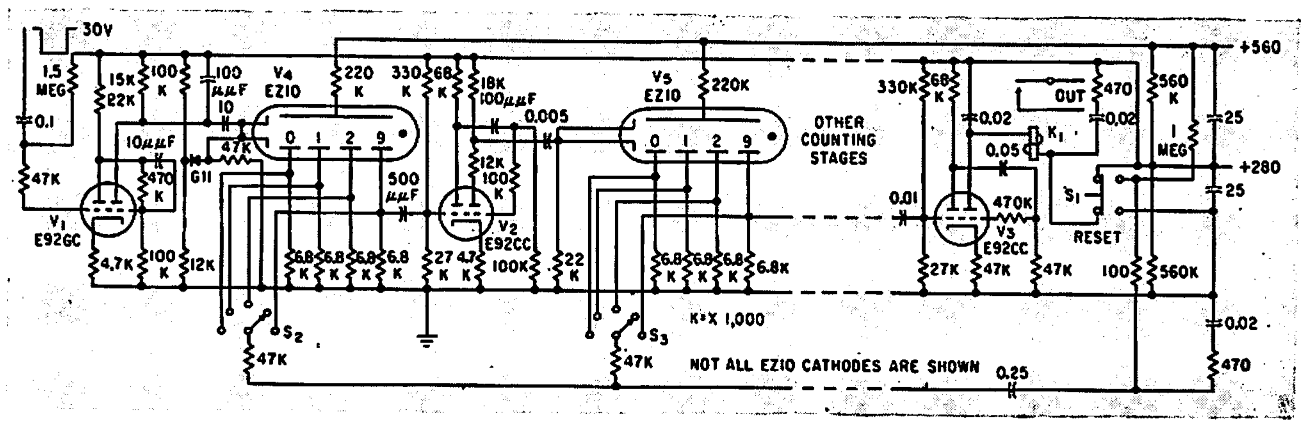
COUNTING AT 6 KC—Counts pulses received, displays count, and sets carry store when necessary.—M. E. Bond, Cold-Cathode Tubes as Triggers, *Electronics*, 38:7, p 76–85.



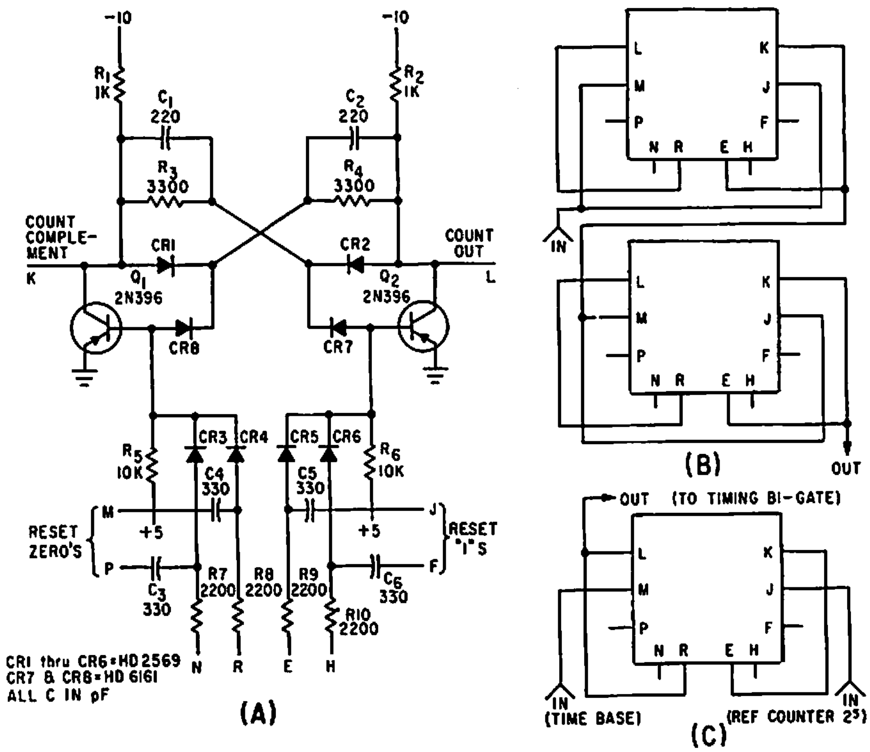
COINCIDENCE DECADE COUNTER—Circuit generates coincidence triggers for advancing count at any instant. Two decade schemes are shown by broken lines connected to basic counter stages. With dash-dash lines, counting proceeds in binary fashion until eighth count; at ninth count, stages 1 and 4 generate positive leading coincidence trigger and apply it to stages 2 and 3 to change them from 0 to 1, so all stages are at 1 on count 9. Next count then clears all stages to 0. Dash-dot lines show connections for advancing the counter six units for the fourth count.—P. K. Malhotra and R. Parshad, Novel Coincidence Technique for Transistor Decade Counter, *Electronics*, 36:7, p 71–72.

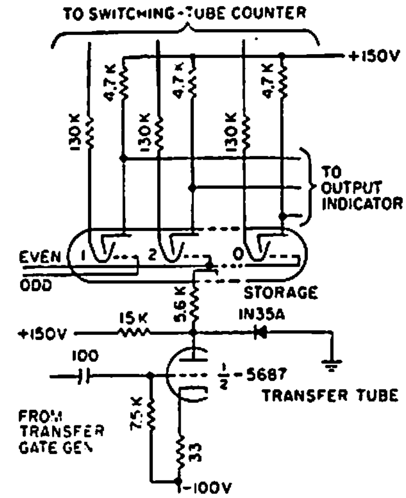
COUNTING UP TO 50 KC—Input stage is Schmitt trigger Q1-Q2. Diode at input of interstage transistor amplifier Q3 clips base of cathode pulse.—K. Apel and P. Berweger, Miniature Gas-Filled Tubes For High-Speed Counting, *Electronics*, 33:8, p 46–47.





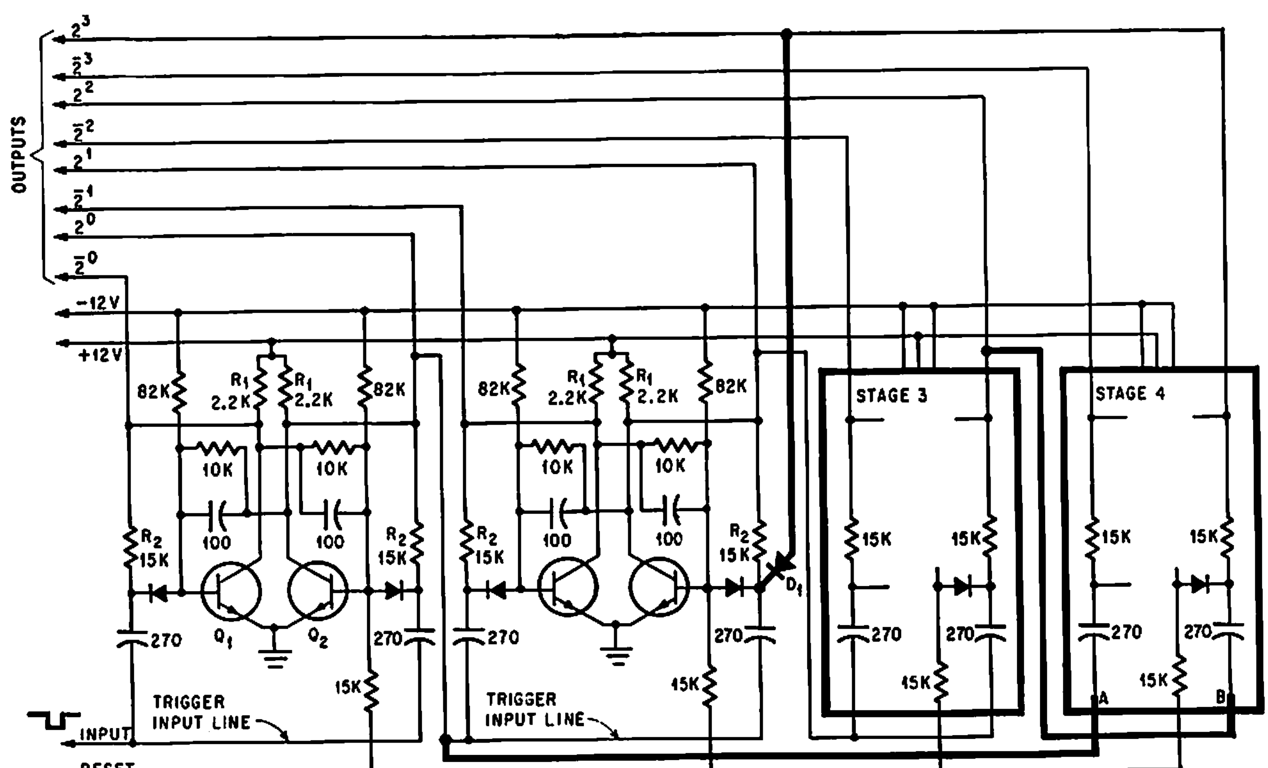
COUNTING UP TO 100 KC—Uses miniature gas-filled decade counters that provide visual indication of count along with high reliability. Schmitt-trigger input feeds mono between counter tubes. Can produce output after desired count if counter is initially reset to complement of the desired number.—K. Apel and P. Berweger, Miniature Gas-Filled Tubes For High-Speed Counting, *Electronics*, 33:8, p 46–47.





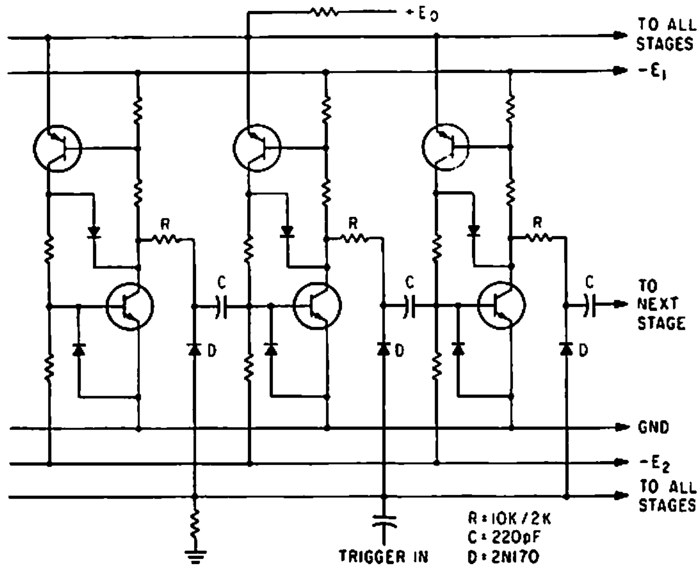
COUNT STORAGE—Magnetron beam-switching tube and transfer tube together serve to sample and store accumulated count and provide multioutput functions without stopping original count or losing input information during readout.—R. W. Wolfe, Decade Decimal Counter Speeds Printed Readout, *Electronics*, 31:3, p 88-90.

BINARY COUNTER—Basic binary circuit can be used alone as at A for counting up to 130 kc. Two circuits connected as at B give flip-flop operation, while one circuit with external connections as in C serves as bistable gate.—K. H. Brackney and D. R. Gosch, Pulse Comparator Circuit Measures Frequency Jitter, *Electronics*, 34:27, p 54–56.

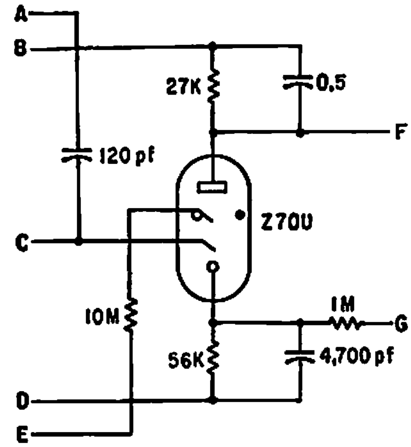


ALL DIODES 1N645 ALL TRANSISTORS 2N1304 ALL CAPACITORS IN PF ALL RESISTORS 1/2W ± 5%

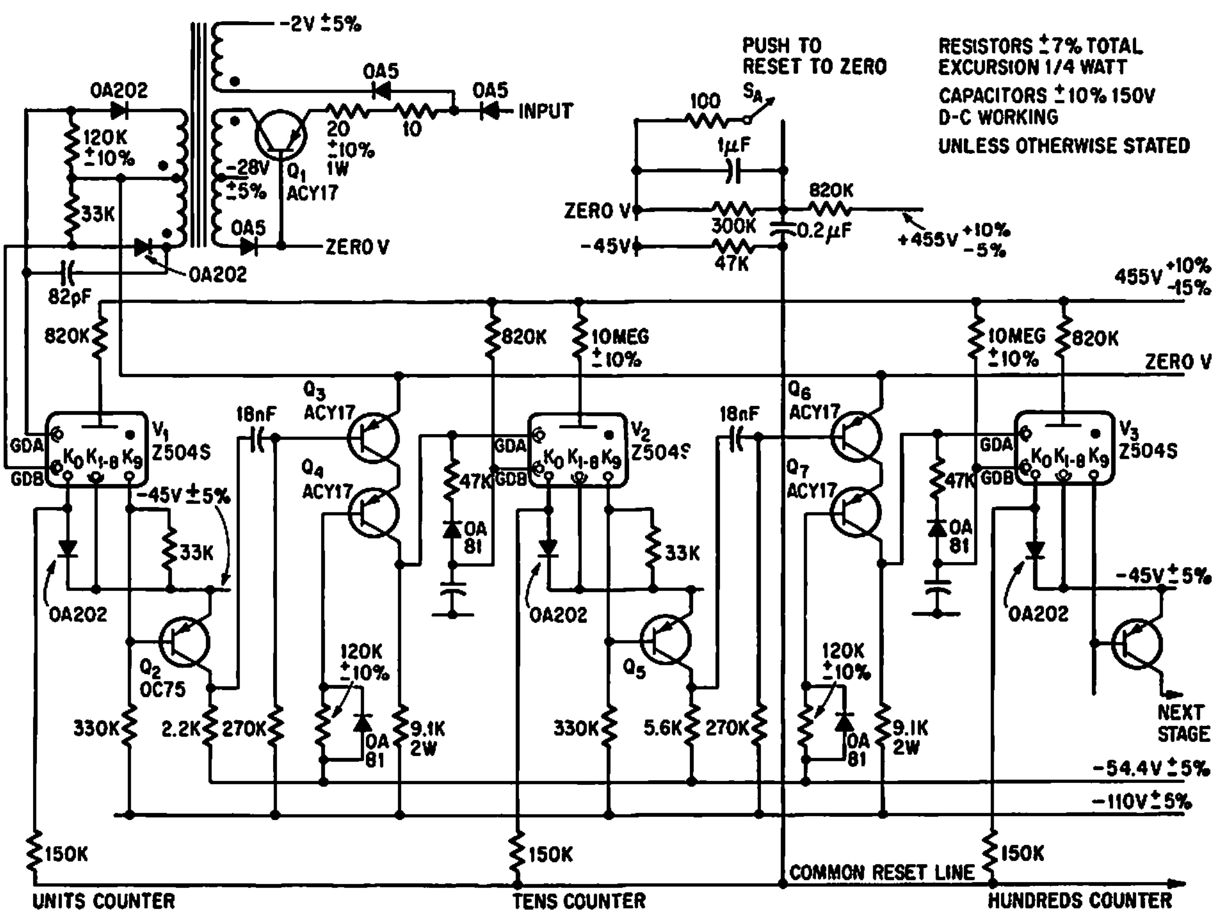
HIGH-SPEED BCD COUNTER—Elimination of capacitively coupled feedback increases operating speed to maximum repetition rate of flip-flop stages. By modifying circuit as shown in heavy lines and adding diode D1, circuit returns to initial state at count of 10 rather than 16.—P. Ward, Modified Decade Counter Eliminates Components, *Electronics*, 38:25, p 74–75.



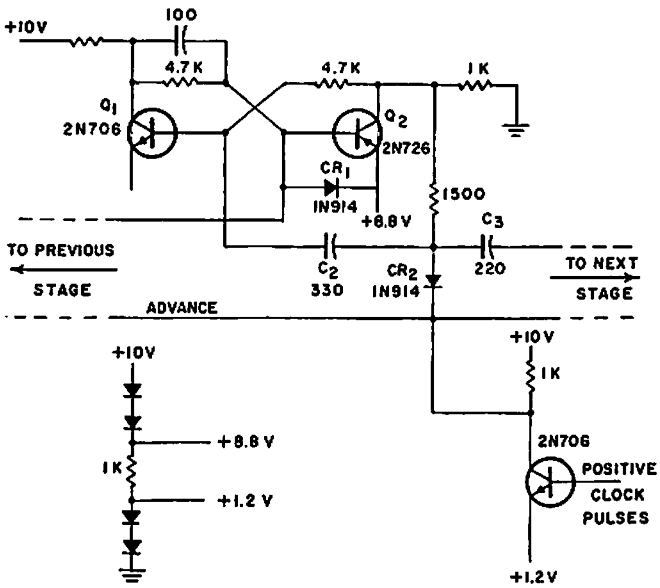
REVERSIBLE TEN-STAGE RING COUNTER—Can be operated above 100 kc. Reversible operation requires binary control, such as by bistable mvbr, to determine direction. Upper transistors are 2N414 and lower are 2N488. Other resistors are 1K.—N. C. Hekimian, PNP-NPN CIRCUITS: New Look at a Familiar Connection, *Electronics*, 35:47, p 42–46.



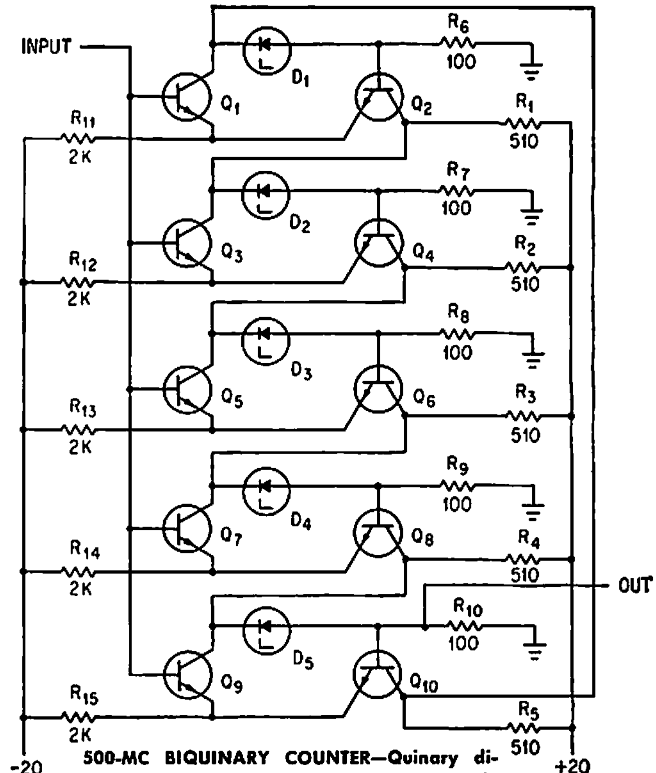
GAS-TUBE RING COUNTER—Uses Philips trigger tubes in decade counter having maximum speed of 2,500 pps. Bias developed at cathode is fed through G to prime following stage. Readout display can be Burroughs Nixie HB106 or other numerical indicator. —P. G. Hodgson, Cold-Cathode Ring-Counter Drives Numerical Indicator, *Electronics*, 33:14, p 80.



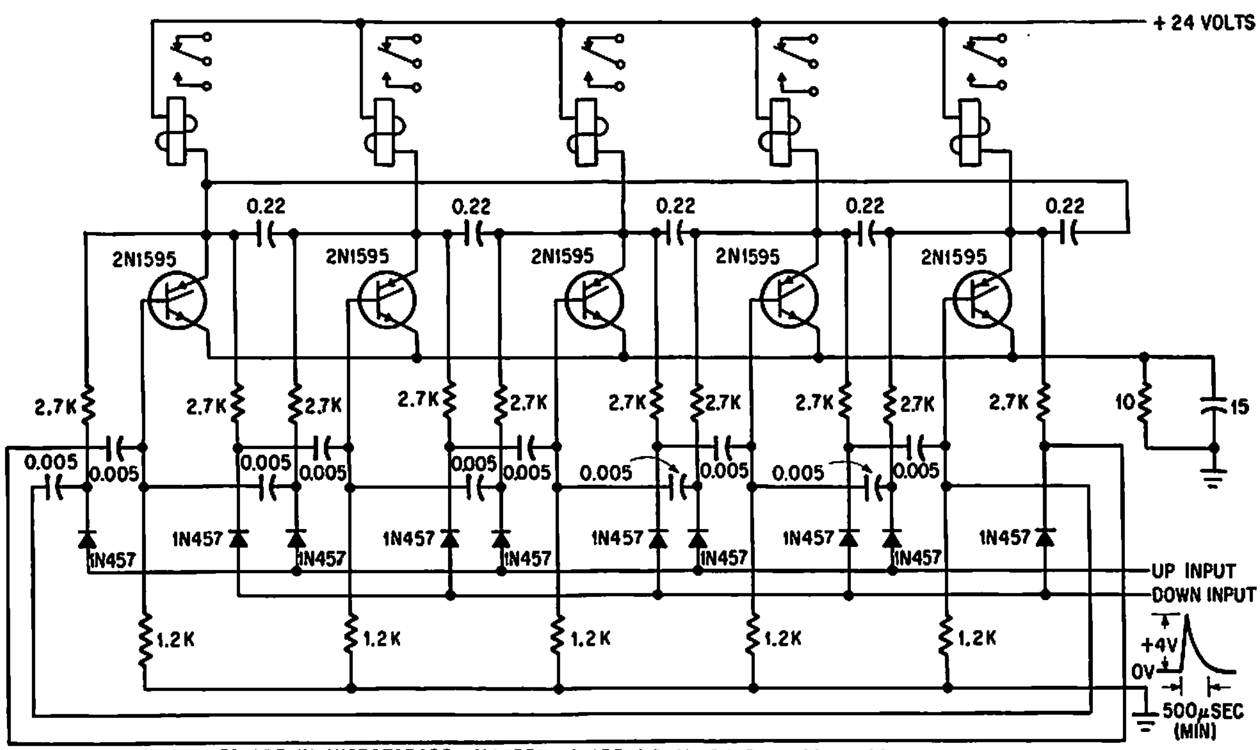
DECADE SCALER—For accurate timing applications up to 400 pps.—G. Jeynes, Using Cold-Cathode Tubes to Count and Store, *Electronics*, 38:8, p 80–89.



1-MC COMPLEMENTARY-TRANSISTOR COUNTER—Only one stage draws current from power supply, because *on* stage has both transistors conducting and *off* stages have both transistors cut off. Average power drawn is that of single conducting stage and is independent of number of stages. Circuit prefers *off* state at startup.—Counter Uses Complementary Transistors, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 129.

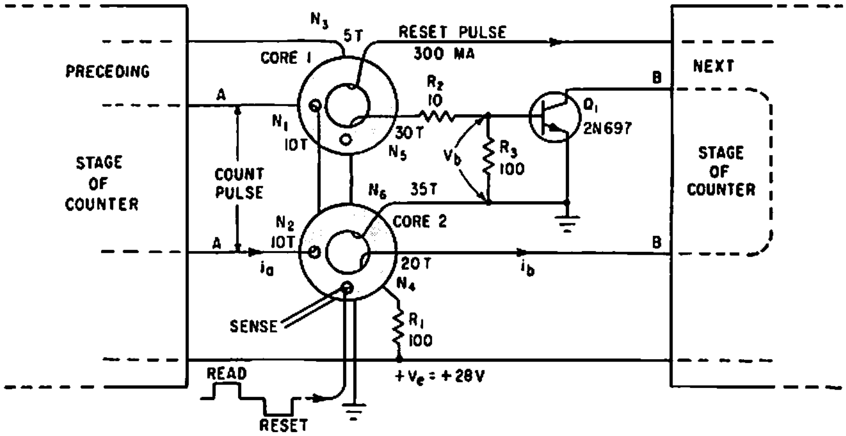


500-MC BIQUINARY COUNTER—Quinary divides input events by 5, using current-mode switches, and binary divides quinary output by 2 to give total division of 10. Chief drawback is difficulty of converting to bcd. All transistors are 2N2708.—R. Englemann, B-Quinary Scaling: Accuracy and Simplicity at 500 Mc, *Electronics*, 36:46, p 34–36.

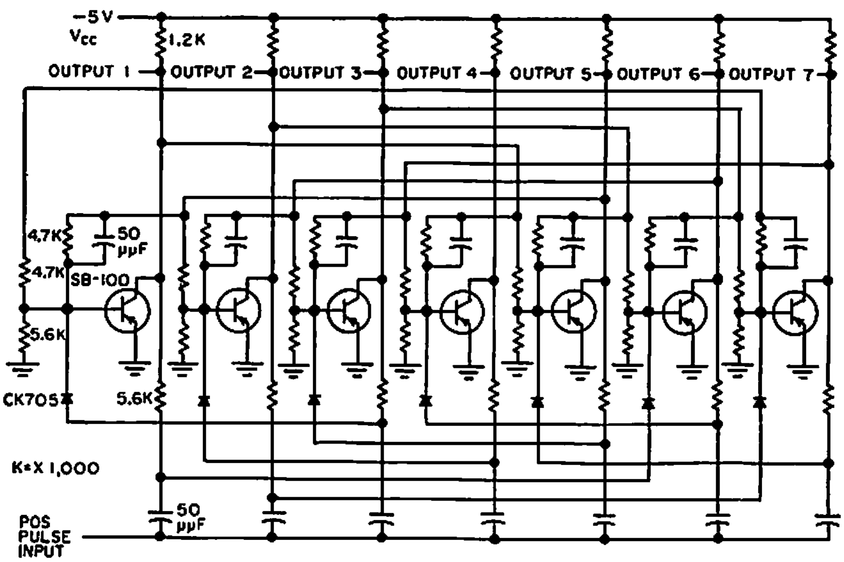


ALL CAPACITANCE VALUES ARE IN MICROFARADS ALL RELAYS ARE C.P. CLARE TYPE RP7641G2

UP OR DOWN—Scr ring counter shifts up or down in 3 millisec without missing count. Only conducting stage draws power.—J. G. Peddie, SCR Ring Counter Switches Up or Down, *Electronics*, 38:18, p 84–85.

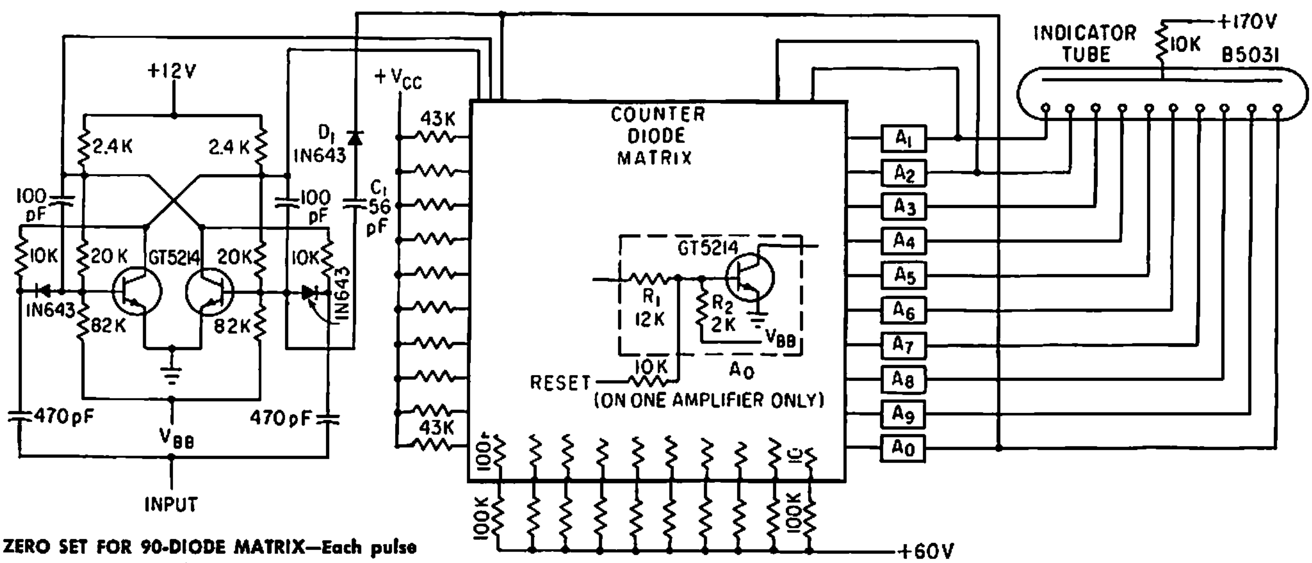


COMMAND TIME COUNTER—Used with time-logic matrix to store command times for missile-launching and guidance-control systems. —W. R. Johnston, Multiaperture-Core Counters Give Nondestructive Storage Readout, *Electronics*, 34:24, p 62–64.

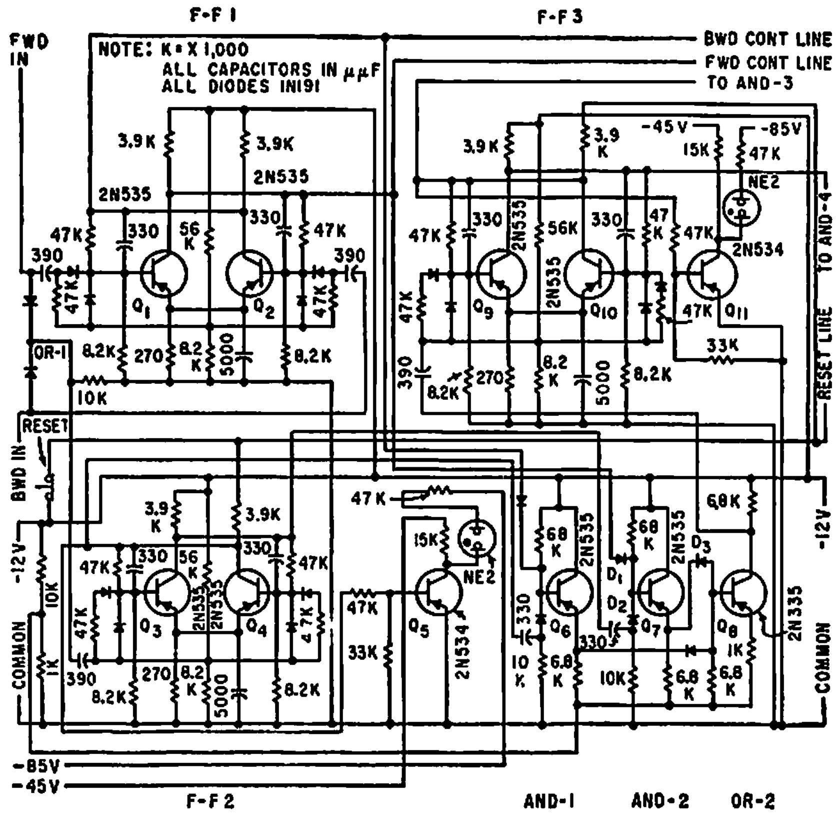


TRANSISTORS AND R AND C VALUES FOR EACH STAGE ARE IDENTICAL

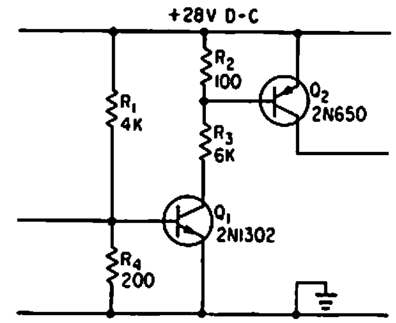
RING-OF-7 COUNTER—Uses surface-barrier transistors in arrangement wherein pattern of four on stages is stepped along ring, permitting maximum number of stages in ring to be much higher than in conventional rings. —W. Carlson, Ring Counter has Increased Count Capacity, *Electronics*, 31:15, p 89–91.



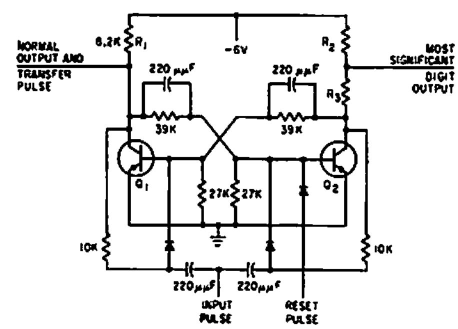
ZERO SET FOR 90-DIODE MATRIX—Each pulse input to flip-flop advances counter one position. Single-transistor amplifiers A1-A0 drive glow indicator tube serving as readout. For reset to zero, positive pulse is applied to base of transistor in zero amplifier, to turn its transistor on and turn all other amplifier transistors off.—R. W. Wolfe, Diode Matrix Shrinks Decimal Counter, *Electronics*, 35:13, p 50–52.



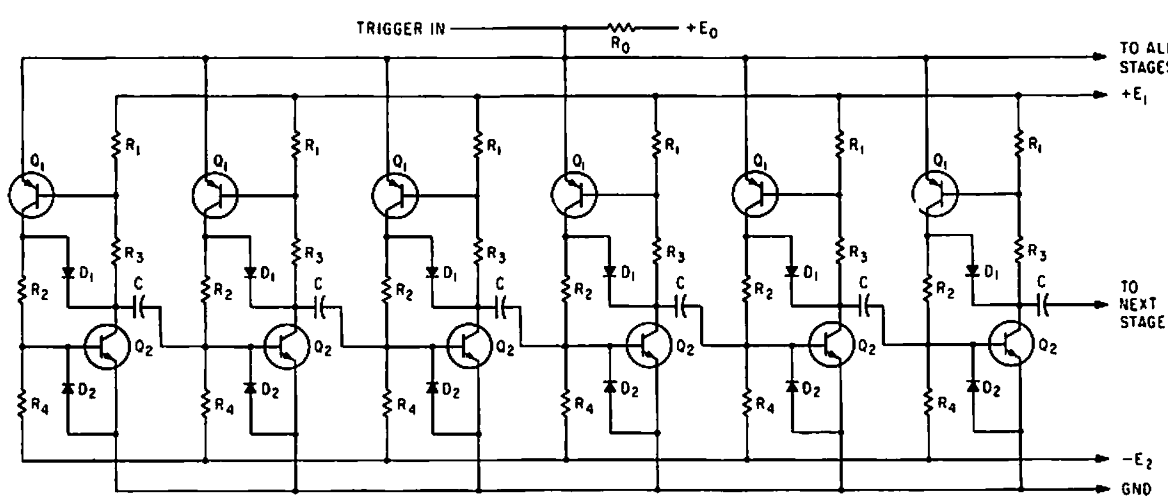
BACKWARD-OR-FORWARD COUNTER—Adds or subtracts pulses under control of appropriate logic circuits. All flip-flops are identical, operating in saturation mode for maximum stability.—H. J. Weber, Binary Circuits Count Backwards or Forwards, *Electronics*, 32:39, p 82–83.



BUFFER—Used between ring counters when readout number has several digits, to make final stage of one counter fire first stage of next counter while resetting first counter.—F. W. Kear, Digital Control Uses Unijunction Transistors, *Electronics*, 34:18, p 79–80.



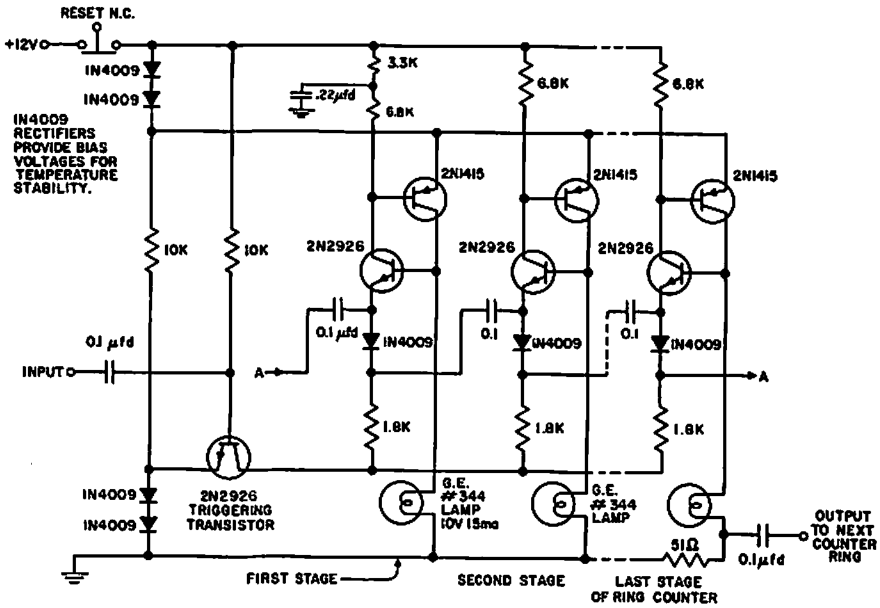
CURRENT-ECONOMIZING DESIGN—Used in 15-stage counter. Circuit is conventional, but to economize on current, only first three stages operate with relatively high collector currents; for these, R1 and R2 +R3 are 5,600 ohms and transistors are 2N496. Subsequent stages use 0C201 transistors and increasingly higher values of collector load, up to 22,000 ohms for 8th stage.—J. Ackroyd, Orbiting Spectrometer Plots Solar X-Rays, *Electronics*, 34:43, p 55–57.

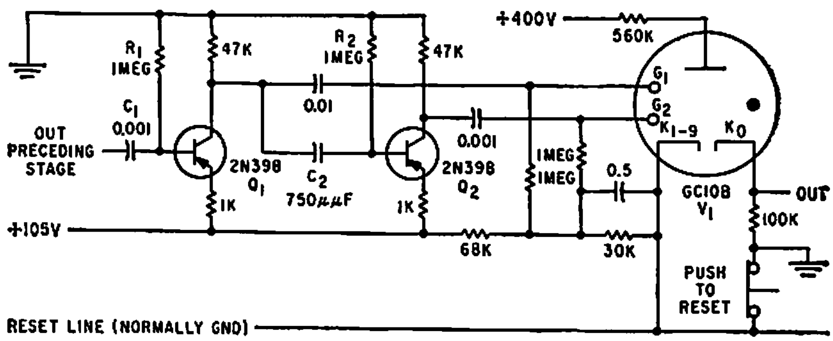


C = 800pF
R1 = 3K
R2 = 1K
R3 = 1K
R4 = 10K
R0 = 5.1K
D1, D2 = 1N270
Q1 = 2N414
Q2 = 2N488

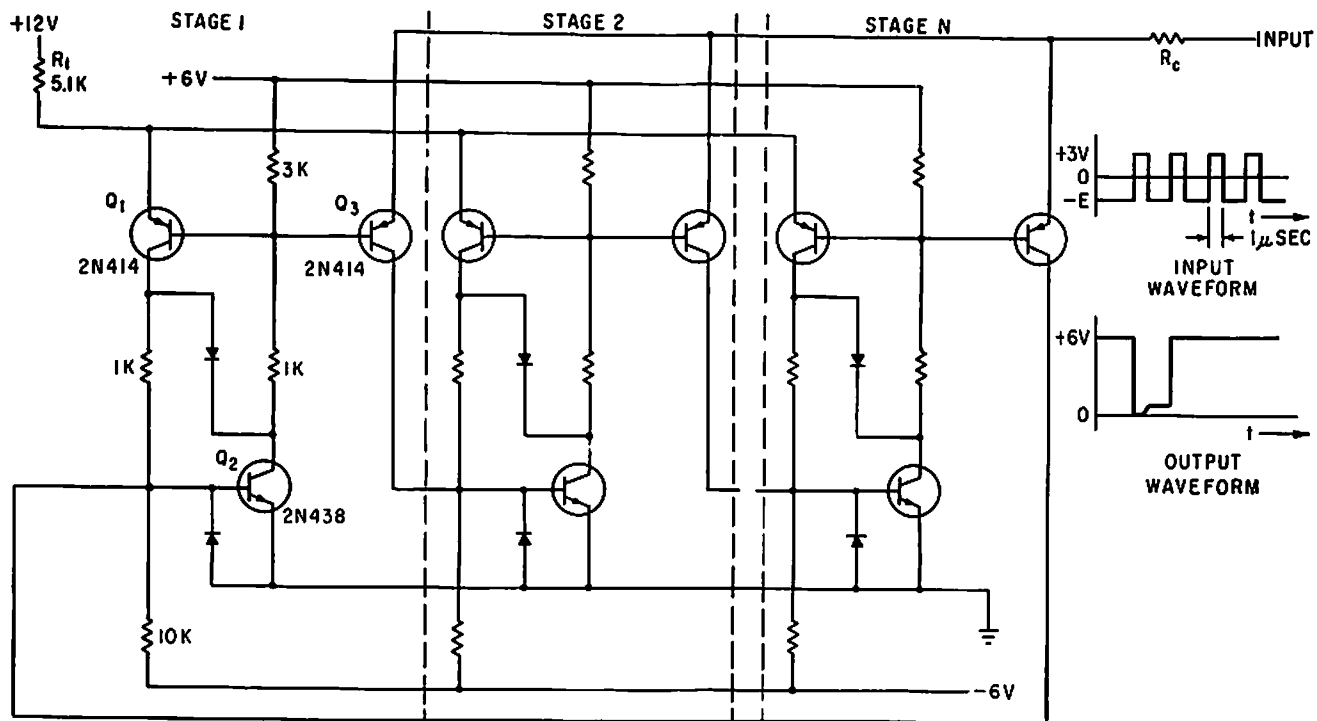
ANODE-TRIGGERED RING COUNTER—Triggered by coupling emitters of transistors Q1 to common bus, to permit both forward and reverse operation. Use of pnp-npn pairs reduces power requirements, improves load capacity, increases speed, and simplifies circuits.—N. C. Hekimian, PNP-NPN CIRCUITS: New Look at a Familiar Connection, *Electronics*, 35:47, p 42–46.

RING COUNTER WITH VISUAL READOUT—Uses only six components per stage. Combining of counter and indicator functions gives low battery drain. After reset button is released, 0.22-mfd capacitor insures that first stage turns on. Current is drawn by stage only when lamp is on. Any number of stages may be included in ring.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 203.



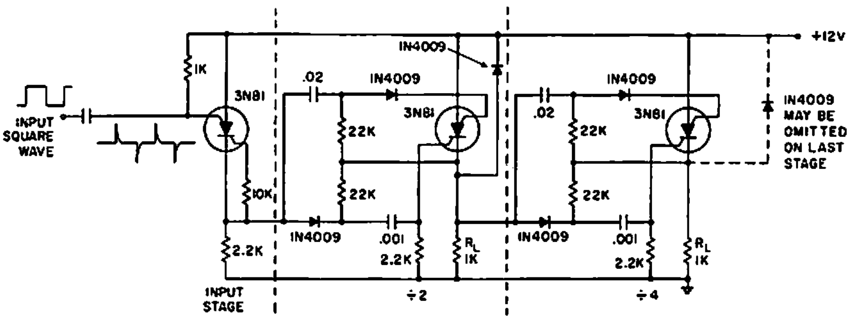


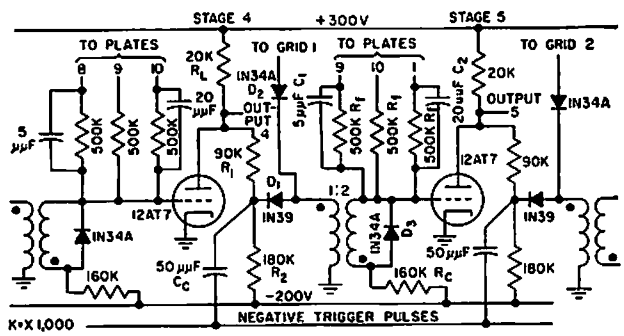
1-KC SCALER—Glow-tube counter provides driving pulses of about 100 v, using two amplifiers in cascade, both saturated when no signals are present.—H. A. Kampf, Increasing Counting System Reliability, *Electronics*, 32:37, p 112–113.



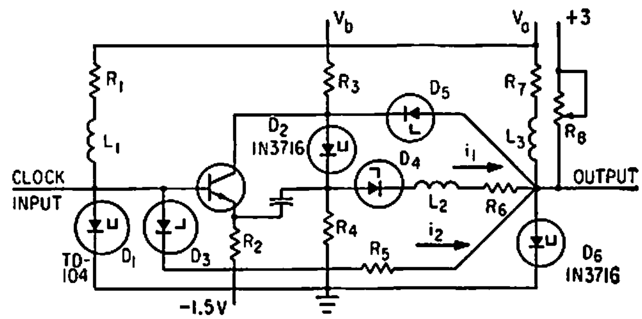
TRANSISTORIZED THYRATRON RING COUNTER—Each bistable circuit has two opposite-symmetry germanium transistors, two diodes, and four resistors. Additional transistor Q3 transfers conducting stage to next position when actuated by transfer pulse. Absence of capacitors gives high-speed operation. No bias current is required from ON stage to keep other stages cut off.—J. A. Pecar, Ring Counter Uses Transistors, *Electronics*, 34:4, p 49–51.

SCS BINARY COUNTER—Stages are triggered by positive-going edge of input. Silicon controlled switch is turned on at cathode gate, and turned off at anode gate.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 429.





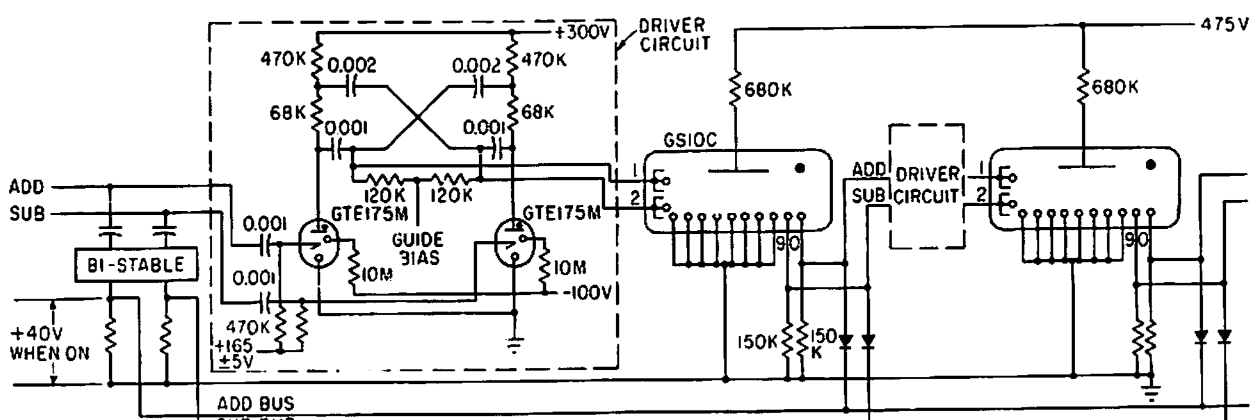
RING-OF-10 COUNTER—Based on stepping of recognizable sequence of on and off stages along ring at each count pulse, in contrast to conventional ring counters having only one *on* stage to hold off all other stages. Circuit gives partial diagram, and article gives wiring table for remaining stages. Four *on* stages are stepped along ring. Time constants of gating circuits limit count rate to 240 kc, but components with faster time constants permit operation up to 1 Mc. Ring of 13 is upper limit.—W. Carlson, Ring Counter has Increased Count Capacity, Capacity, *Electronics*, 31:15, p 89-91.



R_1 = 18 ohms
R_2 = 1.1K
R_3 = 68 ohms
R_4 = 68 ohms
R_5 = 470 ohms
R_6 = 130 ohms
R_7 = 51 ohms
R_8 = 10K

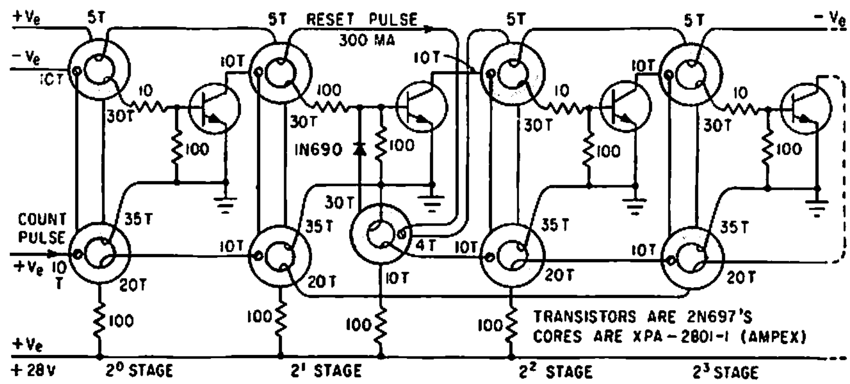
D_3, D_4, D_5 = $BD - 4\ (GE)$
L_1 = 0.68μh
L_2 = 62 μh
L_3 = 56 μh
V_a = 200 mv ± 10 percent
V_b = 500 mv ± 20 percent
C = 82 pf

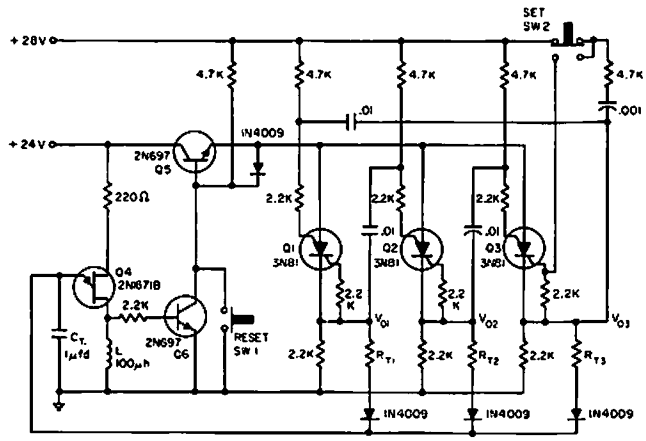
MULTI-SCALE COUNTER—Changing value of L2 changes scale factor in range of 2 to 8. Circuit operates to 10 Mc at scale of 5.—C. A. Budde, One-Stage Scaler Needs No Complex Feedback, *Electronics*, 36:39, p 32–33.



BIDIRECTIONAL MULTIDECADE COUNTER—Single sign-determining circuit ahead of input to tens stage provides gating signals for every decade, to handle rapid reversal of count direction.—L. C. Burnett, Reversible Decade Counter, *Electronics*, 35:9, p 46.

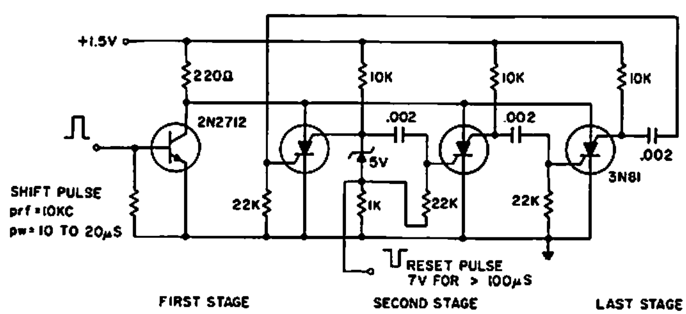
DECIMAL-CODED COUNTER—Addition of one core and one diode per decade converts straight-binary counter to decimal-coded counter.—W. R. Johnston, Multiaperture-Core Counters Give Nondestructive Storage Readout, *Electronics*, 34:24, p 62–64.

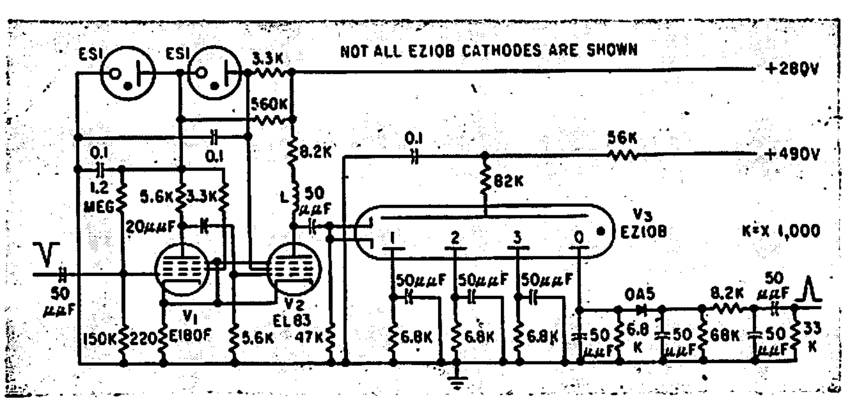




VARIABLE-TIMING RING COUNTER—Shift pulses are generated by unijunction transistors, with interval between pulses determined by CT and RT. RT can have different value for each stage of counter, as shown.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 430.

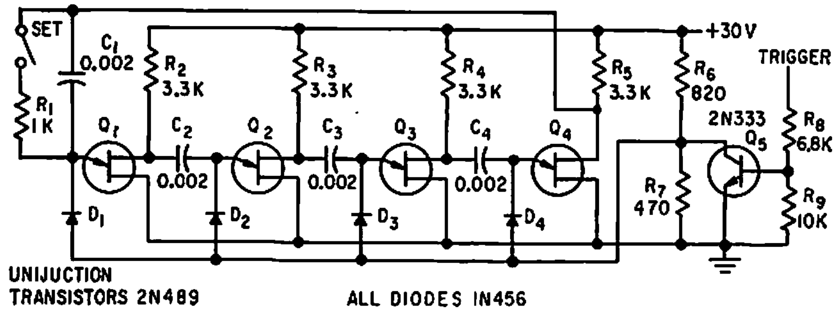
LOW-POWER RING COUNTER—Requires only 6 mw at 1.5 v. Reset pulse turns on first stage with its trailing edge.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 431.

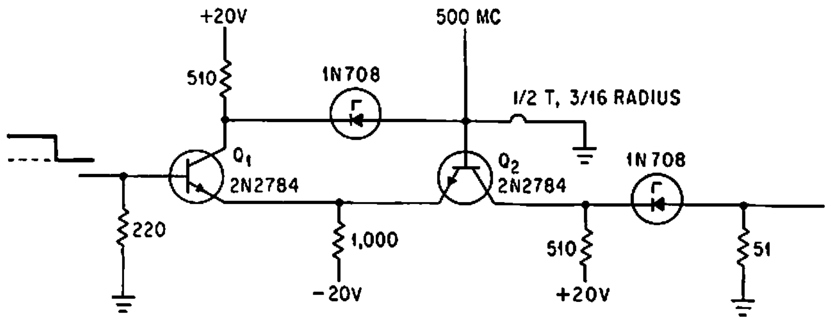




1-MC COUNTER—Increasing counting speed to this value requires special hydrogen gas in counter tubes and reduction of tube capacitances. Monostable mvbr V1-V2 is triggered by 5-v negative pulses. Cathode resistors of V3 are bridged by capacitors to reduce effects of capacitive coupling between main and auxiliary cathodes.—K. Apel and P. Berweger, Miniature Gas-Filled Tubes For High-Speed Counting, *Electronics*, 33:8, p 46–47.

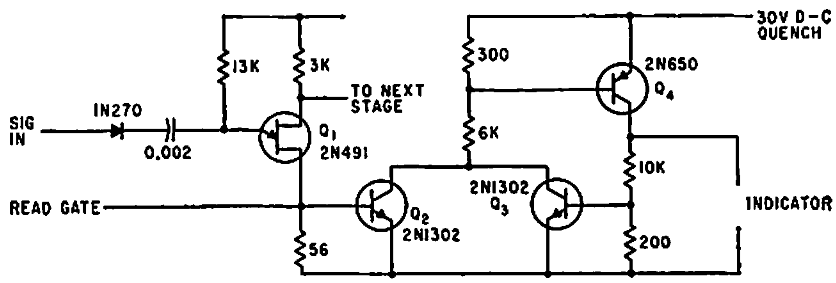
UJT BISTABLE RING COUNTER—Operates up to 40,000 cps, with trigger pulse widths between 6 and 9 microsec.—T. P. Sylvan, Bistable Circuits Using Unijunction Transistors, *Electronics*, 31:51, p 89–91.

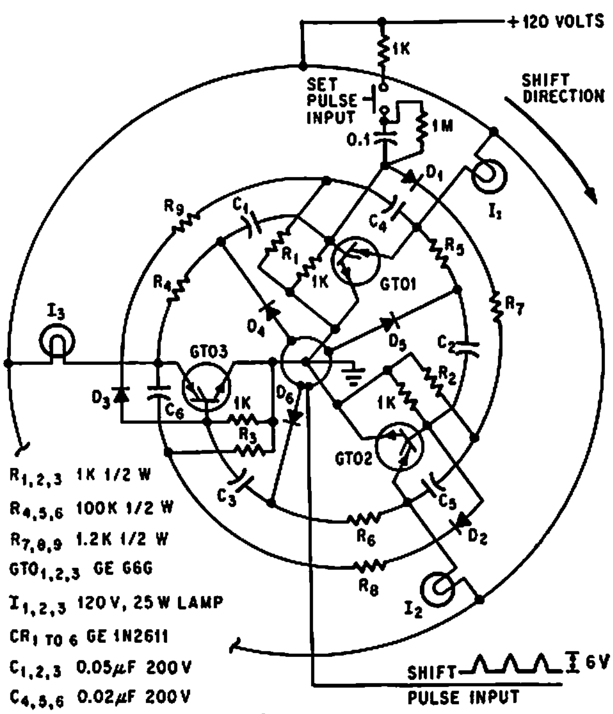


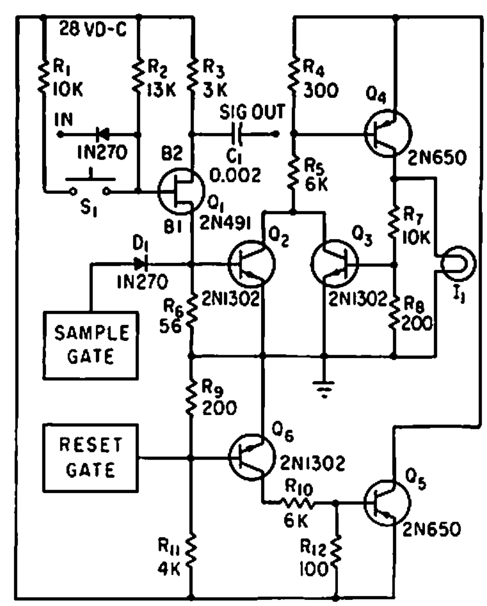


SYNC CIRCUIT FOR QUINARY SCALER—Timebase signal at 500 Mc turns Q1 on and Q2 off at timing rate. Negative 1-v start signal applied to base of Q1 makes 500-Mc signal appear at collector of Q2 to serve as output for one of quinary scalers. Two scalers in parallel can measure time accurately to within 1 nsec.—R. Englemann, Quinary Scalers: Measure Time Intervals Digitally, *Electronics*, 37:5, p 34–36.

PULSE COUNTER—Unijunction transistor Q1 serves as counter, with other counter stages being identical. Q3 and Q4 energize and lock readout circuit until quench pulse is applied after next counting cycle.—F. W. Kear, Unijunction Transistor Pulse-Circuit Design, Electronics, 35:21, p 58–60.

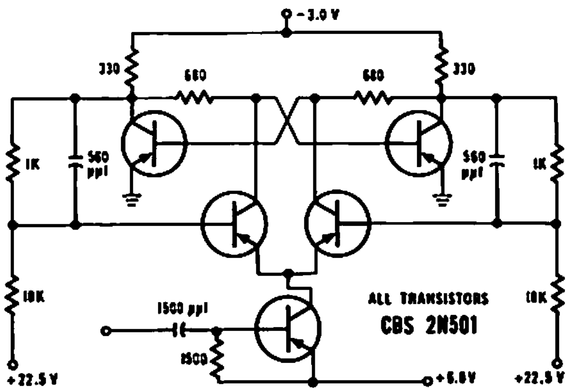




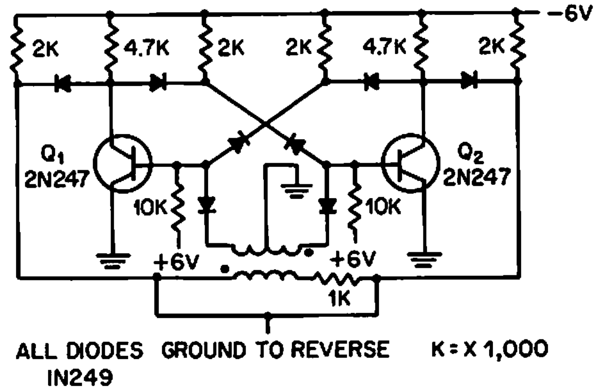


RING COUNTER USES GATE TURNOFFS—Closing of set pulse input switch turns on first gto, applying voltage to its lamp load. Each shift pulse input then transfers conduction to next gto and lamp.—D. R. Grafham, New the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.

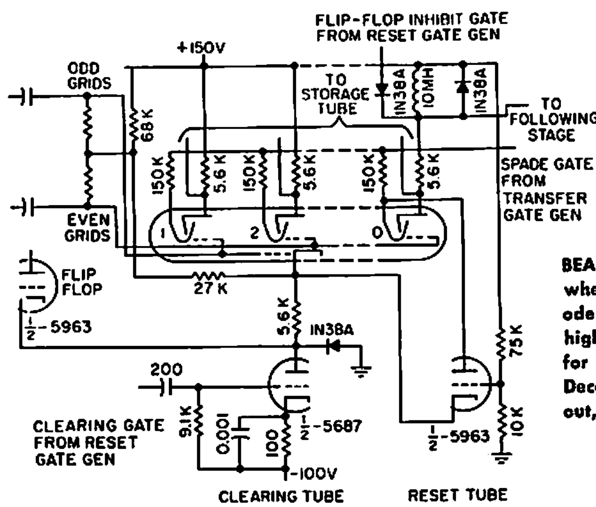
UNIJUNCTION RING COUNTER— Provides switching for readout and control applications, including data display for airborne digital instrumentation. Q5-Q6 provide resetting.—F. W. Kear, Digital Control Uses Unijunction Transistors, *Electronics*, 34:18, p 79–80.



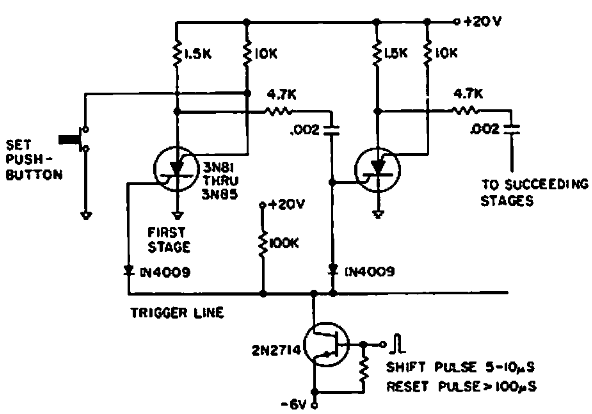
BASE-GATED BINARY—Input counting rate is up to 70 Mc. Saturating transistor gate minimizes turnoff and turnon delay. Flip-flop transition is completed in less than 16 millimicrosec.—High-Speed Switching Transistors (CBS Electronics ad), *Electronics*, 33:39, p 45.



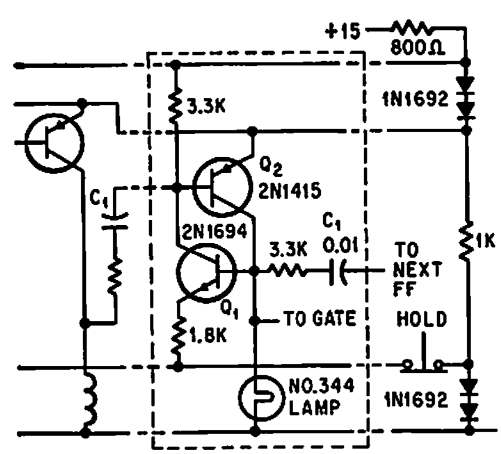
TRANSFORMER-CONTROLLED COUNTER—Uses conventional linear transformer in conventional bistable flip-flop to store information. —W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.



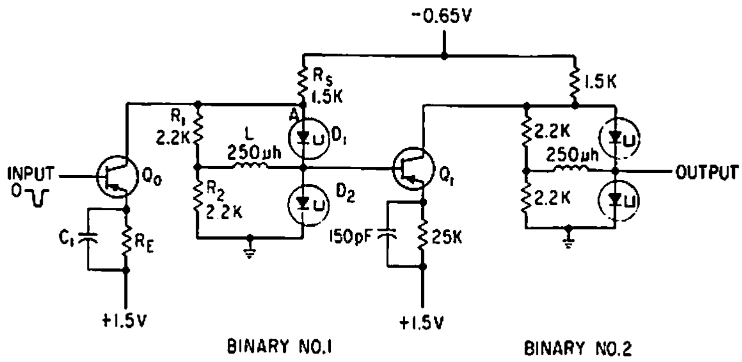
BEAM-SWITCHING DECADE—Counter is cleared when reset tube cuts off series triode in cathode of beam-switching tube. Circuit presents high impedance to initiating gate, as required for resetting several decades.—R. W. Wolfe, Decade Decimal Counter Speeds Printed Readout, *Electronics*, 31:3, p 88–90.



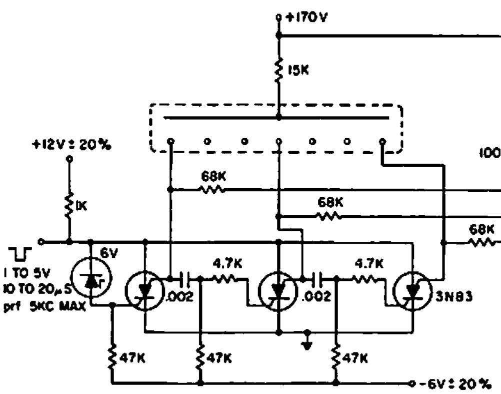
20-KC RING COUNTER—Shift pulses turns off conducting silicon controlled switch by reverse-biasing cathode gate. Charge stored on coupling capacitor then triggers next gate.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 431.



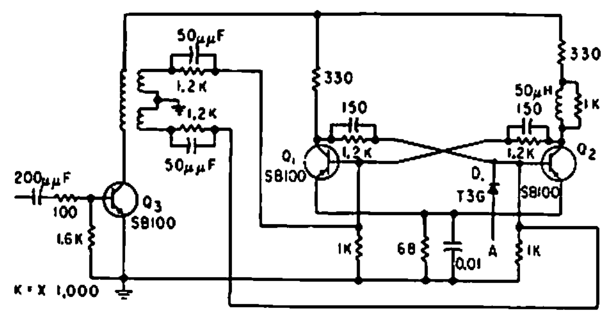
FLIP-FLIP RING COUNTER—Complementary mvbr, in which Q1 and Q2 are either both on or both off, gives low power drain. Strong negative pulse applied to base of Q2 of first stage gives reset.—J. E. Russell, Ten Signals at a Glance, *Electronics*, 37:19, p 54–57.



LOW-LEVEL 5-MC TUNNEL-DIODE—With 1N2933 germanium tunnel diode, power consumption is only 525 microwatts per transistor and binary stage. Circuit voltage and resistances are such that only one tunnel diode is in high-voltage state at a time. Silicon transistors, for coupling, can be pnp or npn.—E. Gottlieb and J. Giorgis, Tunnel-Diode Switching Circuits, *Electronics*, 36:27, p 26–31.

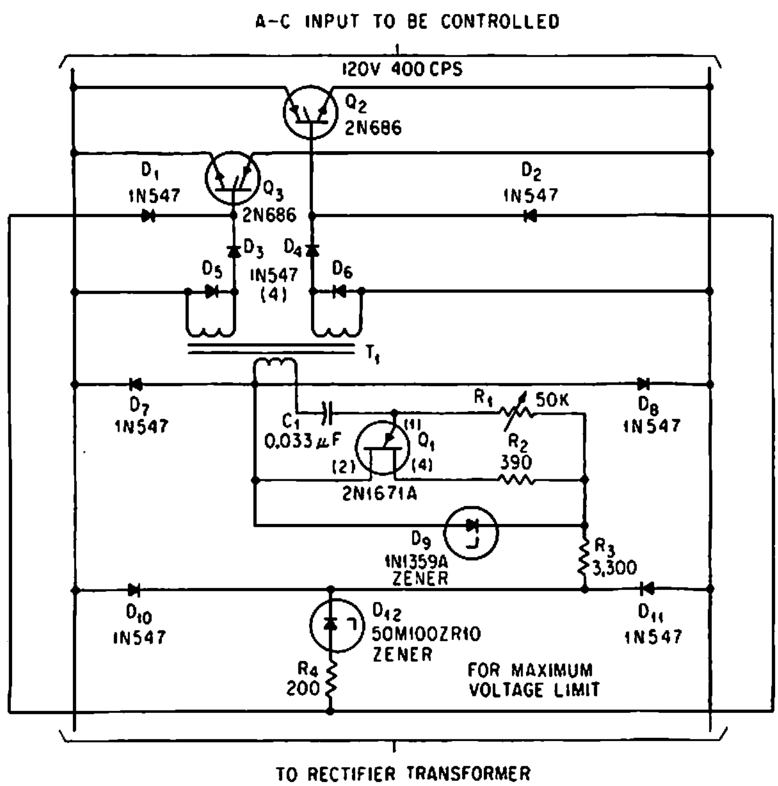


NIXIE-TUBE RING COUNTER—Uses silicon controlled switches.—"Transistor Manual," General Electric Co., 1964, p 430.

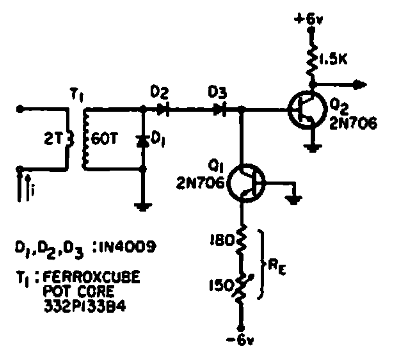


7-DIGIT BINARY COUNTER—Stores pulses received from oscillator gate. 128th pulse resets counter to zero. Complete binary counter consists of seven cascaded bistable multivibrators, transformer-triggered.—W. W. Grannemann et al, Pulse-Height-to-Digital Signal Converter, *Electronics*, 33:2, p 58–60.

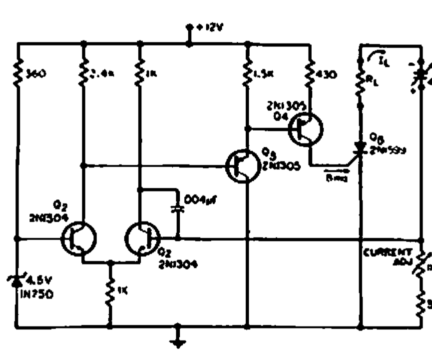
CHAPTER 22
Current Control Circuits



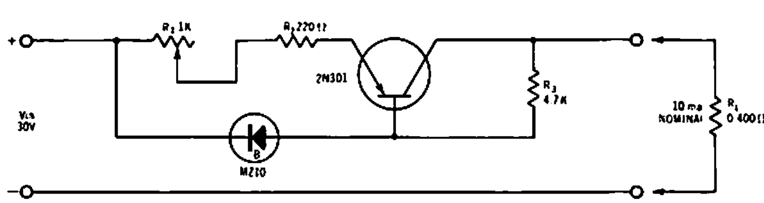
LASER MODULATOR CURRENT CONTROL—When modulator or pumping current for laser is lost, output voltage of pulse transformer T1 will rise to limit set by zener D12, which then conducts to make Q2 and Q3 absorb current not required by energy storage capacitors.—S. J. Grabowski, Pulse Power Supply Design for Laser Pumping, *Electronics*, 36:51, p 33–35.



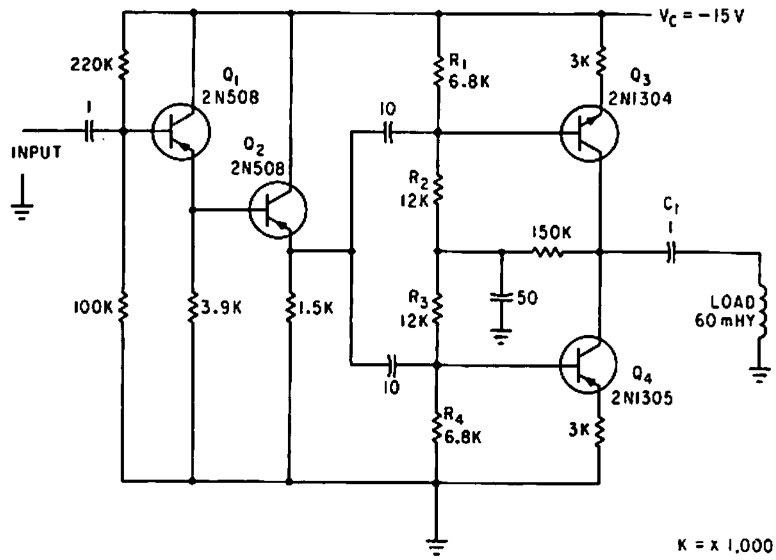
CURRENT AMPLITUDE DETECTOR—Used to indicate when pulsed drive currents for memory array exceed tolerance limits. Can detect current pulse deviation of 10 ma from 1.2-amp current level. RE is adjusted to vary current clamping level.—H. M. Winters and J. P. Shuba, Current Amplitude Detector, *EEE*, 12:11, p 68–70.



1-MA CONSTANT-CURRENT SCR SOURCE—Use of high-breakdown-voltage 2N1599 scr gives 0.25% regulation at 1 ma for input voltages of 10 to 400 v. Output current can be adjusted up to 10%. Differential amplifier Q1-Q2 compares sampled output current with voltage across reference zener.—R. H. Crawford, 400-Volt SCR Constant-Current Source, *EEE*, 12:3, p 74.

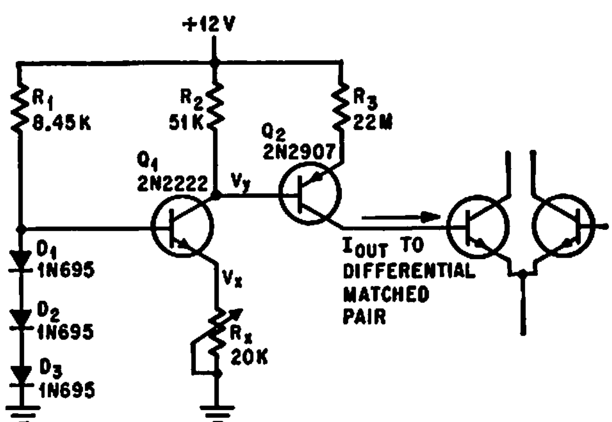


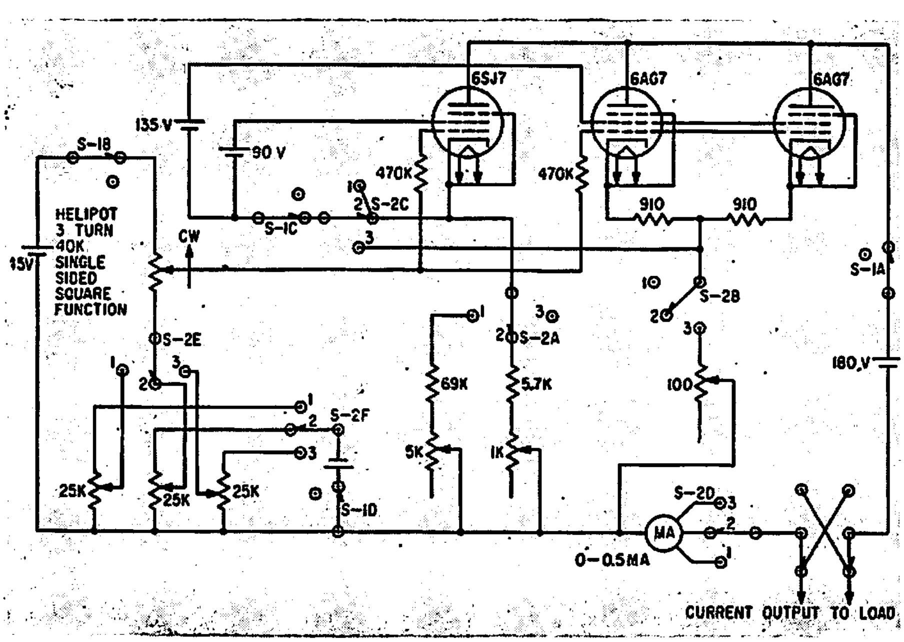
CONSTANT-CURRENT REGULATOR—Uses transistor as variable series resistor. Current will remain within 10% of 10 ma from short-circuit up to maximum load of 400 ohms. — "Zener Diode Handbook," International Rectifier Corp., 1960, p 59.



500 MICROAMP AT 30 TO 30,000 CPS—Used to drive 60-mh transducer at constant current without allowing d-c through transducer. Achieved by biasing Q3 and Q4 on all the time, so each acts as collector resistance for the other.—S. Sokol, Transistor Pair Provides Constant-Current Drive, *Electronics*, 35:38, p 56.

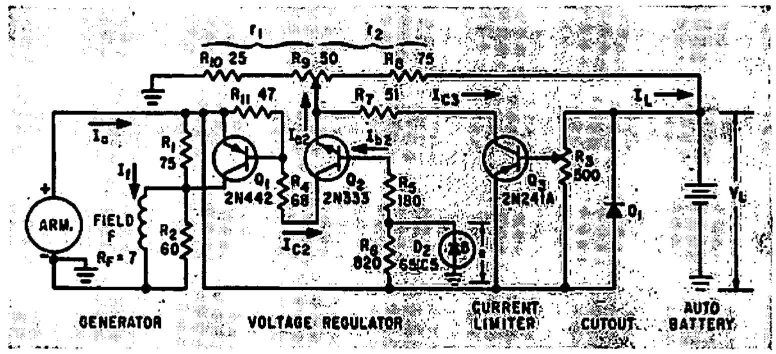
TEMPERATURE-COMPENSATED CURRENT SOURCE—Presents 1,000 meg of output impedance while supplying up to 200 na of temperature-compensated current. Germanium diodes serve as compensating network drawing 1.3 ma. Based on fact that matched transistor pairs have base-current temperature coefficients that are predictable as function of operating current.—C. C. Hanson, Low-Drift Current Generator Compensates for Temperature, *Electronics*, 39:12, p 108–109.



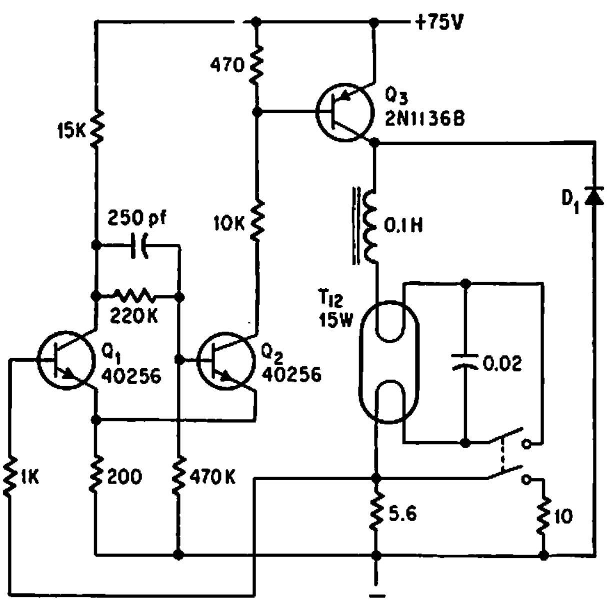


CONSTANT-CURRENT SUPPLY—Used to measure resistivity of semiconductors rapidly and accurately. Switch gives choice of 0.5, 5, and 50 ma. Values are read from dial settings rather than meters, to increase accuracy.—P. J. Olshofski, Constant-Current Generator Measures Semiconductor Resistance, *Electronics*, 34:47, p 63.

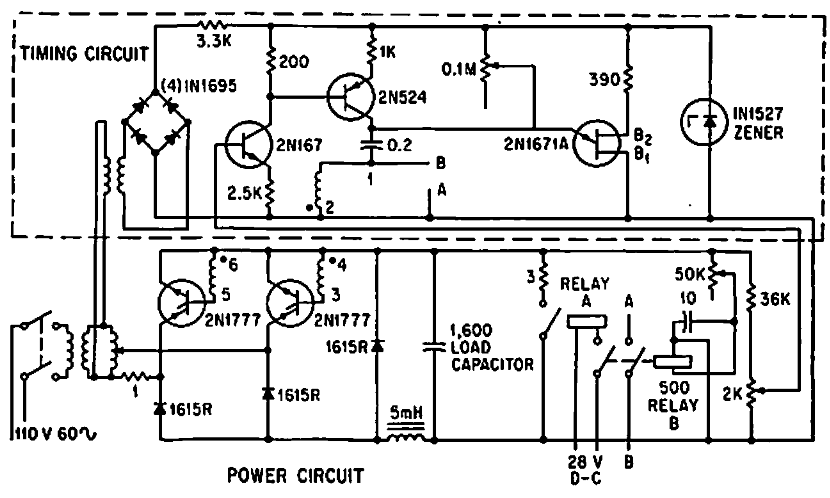
AUTO GENERATOR REGULATOR—Limits maximum generator current to safe value, prevents current flow from battery through generator when generator voltage falls below battery voltage, and regulates voltage.—L. D. Clements, Solid-State Generator Regulator for Autos, *Electronics*, 33:8, p 52–54.

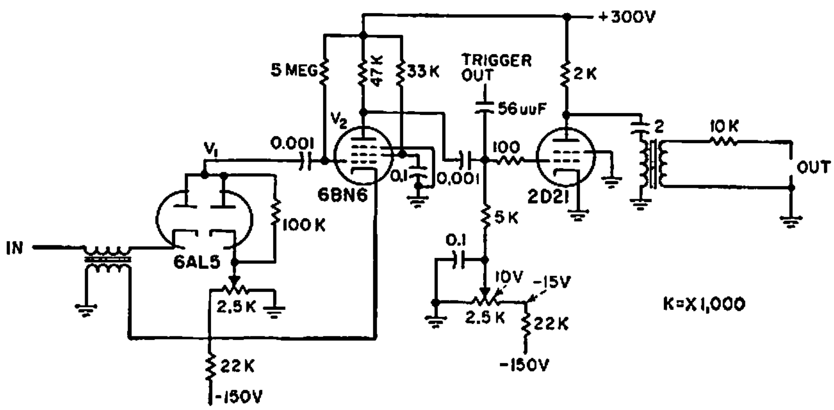


D-C SUPPLY FOR FLUOURESCENT LAMPS—Lamp operates directly from d-c supply, without a-c conversion. Transistors form constant-current source that controls lamp current. Q3 is controlled by Schmitt trigger Q1-Q2. When lamp current exceeds preset value, voltage drop across 5.6-ohm resistor turns on Q1, thereby turning off Q2 and Q3. When lamp current falls, Q3 comes on again. To start, pushbutton closes circuit through lamp heaters and shunts 5.6-ohm resistor to give faster heating. When button is released, voltage surge caused by series inductor ignites lamp. Control circuit then varies lamp current 25% above and below its average value at 1-kc rate. Regulator losses are only 3 w.—D. B. Hoisington, Direct Current Regulator Drives Fluorescent Lamps, *Electronics*, 39:17, p 94–95.

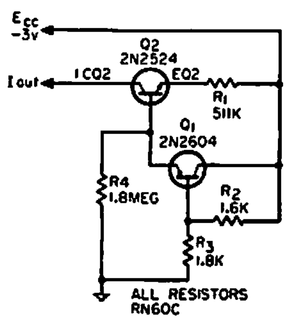


CONSTANT-CURRENT CAPACITOR CHARGER—Firing angle of a-c supply voltage is decreased in steps after each supply cycle, to match charging rate of 360-mfd capacitor for 30-kw plasma pinch space engine, so current pulses have identical average peak of 8.6 amp.—F. Ellern, Capacitance Chargers for Space Employ Controlled Rectifiers, *Electronics*, 36:41, p 32–33.

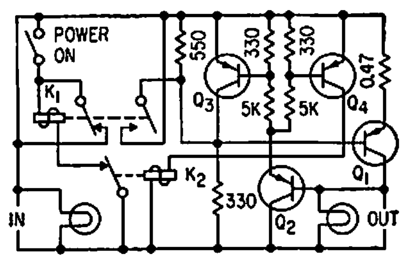




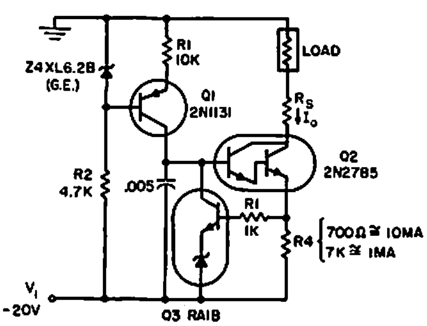
50,000-AMP SINGLE-PULSE CURRENT SWITCH—Simple triggered-gap switch operates at voltages down to 1 kv to control switching with time jitter of only 0.1 microsec between successive pulses. Can be used for magnetron testing, surge-current generator, and flash-lamp source. Output of trigger generator is damped sine wave having sufficient amplitude to break down gap in switch and initiate current pulse. V1 and V2 serve as sharpener for triggering pulse.—E. H. Cullington, W. G. Chace, and R. L. Morgan, Low-Voltage Trigger Controls High Currents, *Electronics*, 31:15, p 86–88.



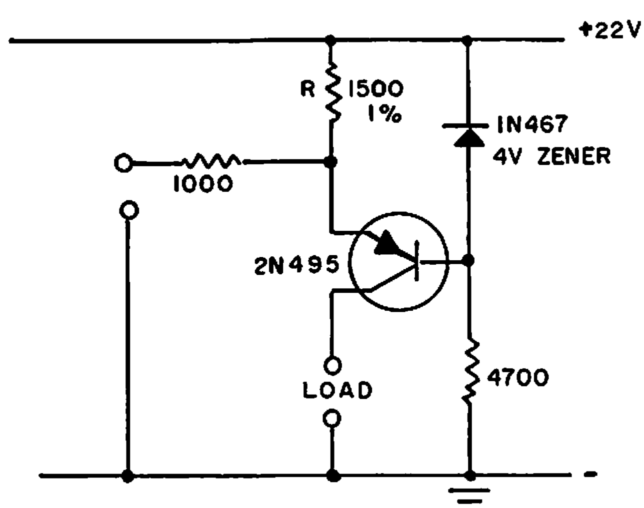
CONSTANT-CURRENT GENERATOR—Provides 2.8 microamp, regulated within 0.75% over range of −20 to +60°C, to feed emitters of low-level differential amplifier. Circuit compensates for base-emitter voltage change with temperature.—M. Wolpert and D. Spooner, Temperature-Compensated Constant-Current Generator, *EEE*, 12:12, p 58.



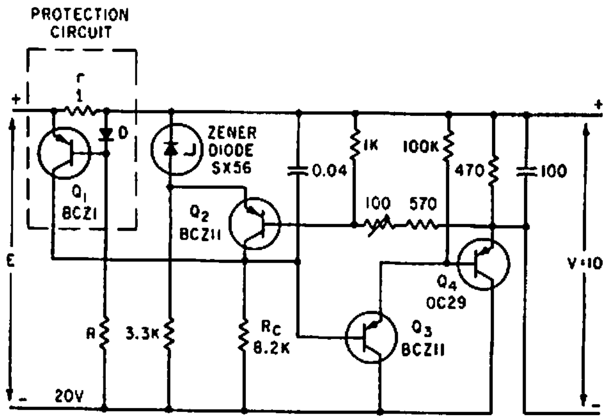
TRANSISTOR OVERLOAD PROTECTION—Current greater than 3 amp flowing through 0.47-ohm resistor in emitter of current-switching transistor Q1 drops voltage on base of Q2, causing Q2, Q3, and Q4 to saturate. Q3 opens circuit immediately and keeps it open for duration of overload. For complete short-circuits, Q4 latches K2 to provide positive protection.—F. W. Kear, Fast-Response Overload Protection, *Electronics*, 33:7, p 125.



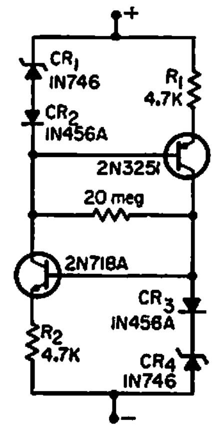
PRECISION CONSTANT-CURRENT SUPPLY—Reference amplifier, consisting of integrated zener diode and npn transistor, acts with Q2 to maintain constant reference voltage across R4. Current through R4 equals load current except for relatively small base currents of Q2 and Q3. Current drift over 15 hours is less than 0.01%.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 233.



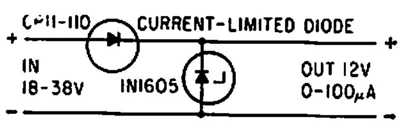
TEMPERATURE-COMPENSATED CONSTANT-CURRENT GENERATOR—Reverse voltage characteristic of zener, in conjunction with base-emitter characteristic of transistor, stabilizes collector current by maintaining constant voltage across R from −55 to +25°C.—Temperature-Compensated Constant Current Generator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 169.



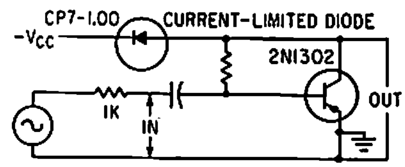
OVERLOAD PROTECTION—Protection circuit detects excessive load current and reduces output voltage proportionately. Values shown limit output current to 530 ma for short-circuit, while holding output voltage at 10 v during normal operation.—C. Yarker, Overload Protection Circuit Uses Low-Power Transistor, *Electronics*, 35:13, p 60.



CONSTANT-CURRENT CONTROL—Uses pnp and npn current sources connected to regulate each other's reference. Values shown are for 1 ma, but R1 and R2 can be changed to give other constant value of current. Applied voltage must be at least 8 v.—F. C. Allen, Two-Terminal Constant-Current Device, *EEE*, 13:10, p 71–72.

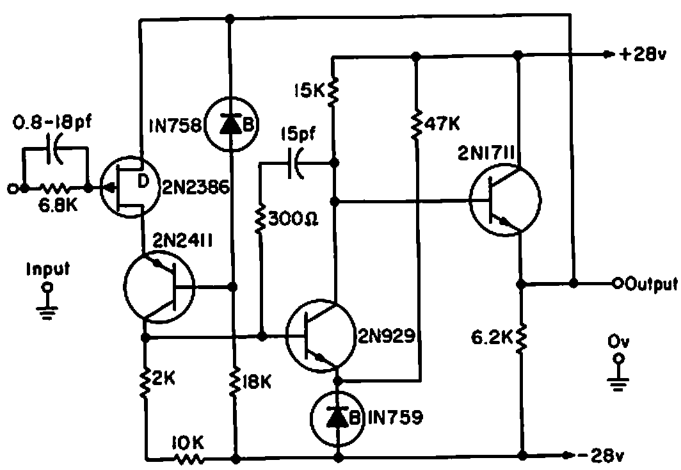


CURRENT REGULATOR FOR 0-100 MA—Constant-current Curractor diode and shunting zener diode together maintain constant current over extremes of input voltage for both normal and shorted loads.—N. Welsh, How Diodes Keep Current to Constant Value, *Electronics*, 36:4, p 74–78.

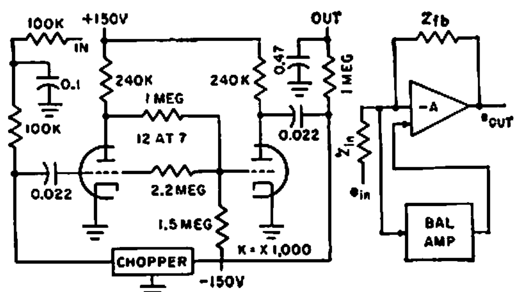


CONSTANT-CURRENT DIODE AS COLLECTOR LOAD—Current-limited Curractor diode isolates transistor amplifier output from changes in supply voltage and serves also as collector load impedance. Gain is over 60 db at 50 to 100 kc.—N. Welsh, How Diodes Keep Current to Constant Value, *Electronics*, 36:4, p 74–78.

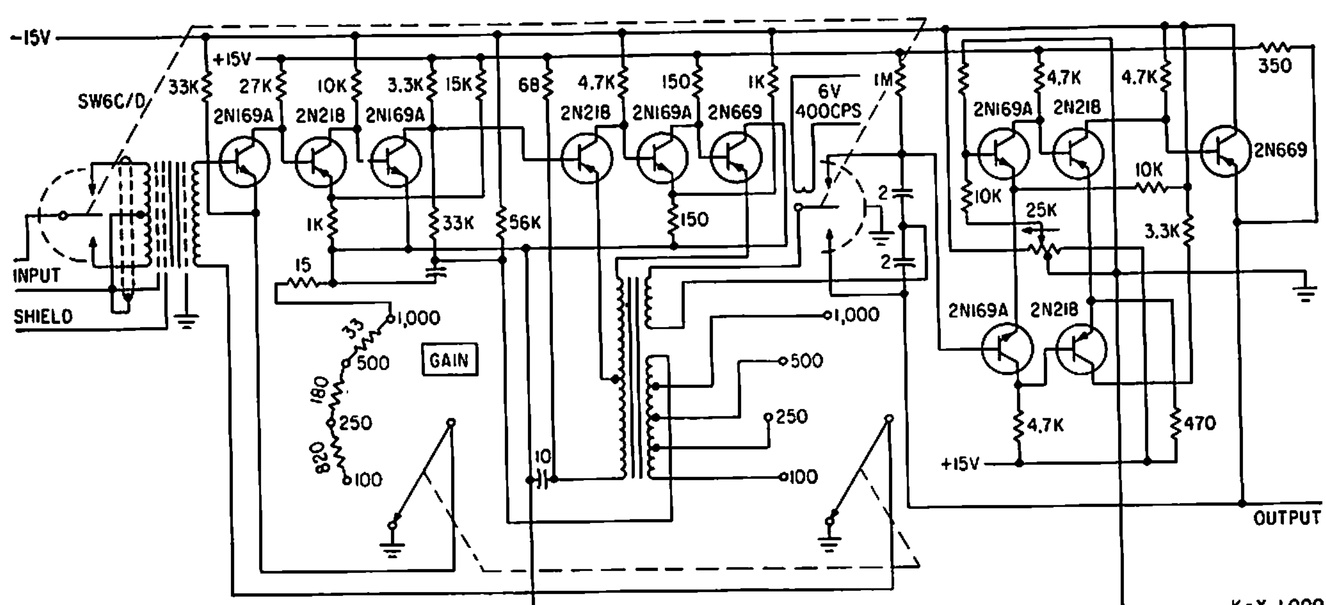
CHAPTER 23
D-C Amplifier Circuits



FET SAMPLE-HOLD D-C AMPLIFIER—Has low output impedance for rapid charging of sampling capacitor, unity gain, and no d-c offset adjustment period.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 114.

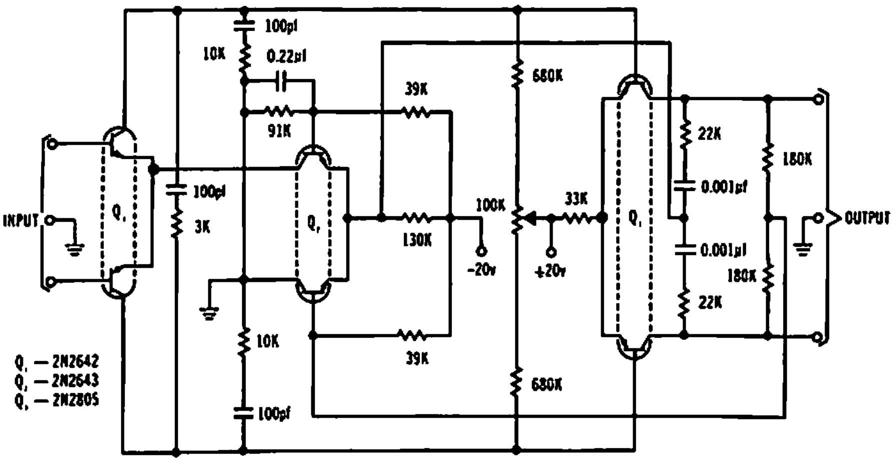


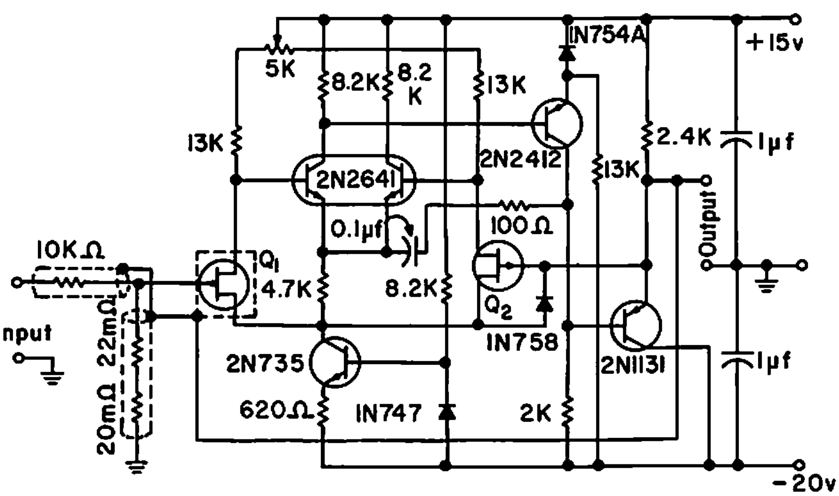
BALANCING D-C AMPLIFIER—Gain is 300. Detects slow changes at summing point of operational amplifier, amplifies drift voltage, and provides opposite-polarity output signal for second input grid of operational amplifier, much as in null-seeking servomechanism. —L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.



CHOPPER-TYPE DATA AMPLIFIER—Careful design of transistor circuits between chopper input and chopper output gives gain stability within 0.01% for long-term operation (1,000 hours) from 15 to 35° C. Linearity is equally precise for normal output range of plus or minus 10 v.—F. Offner, Transistorized Data Amplifier Has High Gain-Stability, *Electronics*, 33:27, p 55–57.

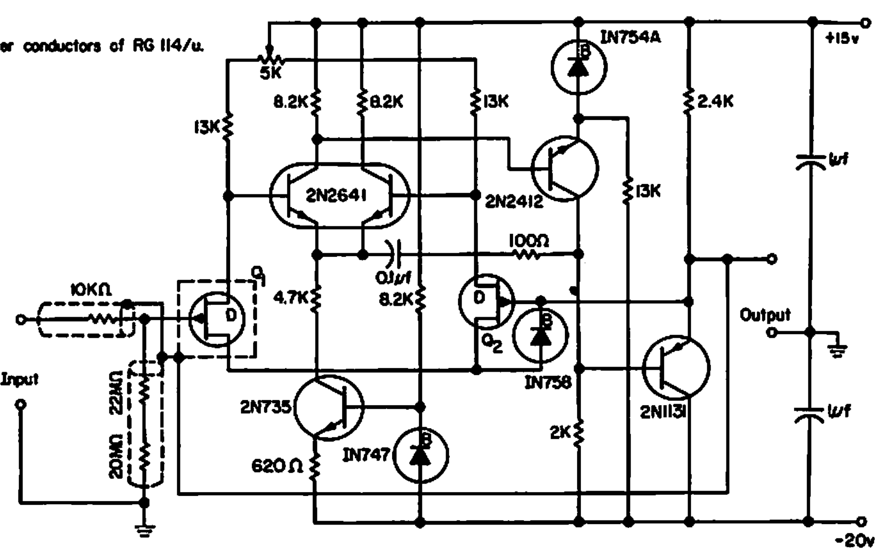
COMPLEMENTARY-PAIR LOW-LEVEL—Dual transistors provide extremely high gain, to give greater stability with fewer stages. Circuit has low drift and high common-mode rejection (120 db) for either differential or single-ended outputs. Differential input impedance is 500K minimum, gain-bandwidth product is 5 Mc, and low-frequency voltage gain is 68 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 290.



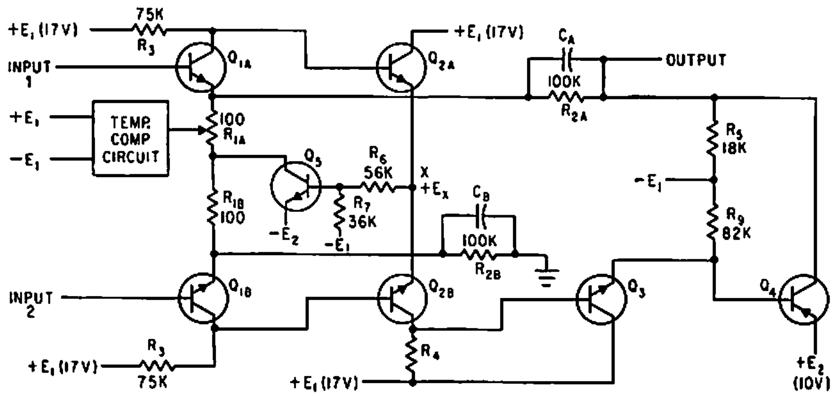


UNITY-GAIN TEMPERATURE-STABLE D-C AMPLIFIER—Two bootstrapped cathode followers are combined to form differential input stage, where one gate serves as feedback input and other as signal input. Field effect transistors Q1 and Q2 are matched.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 139.

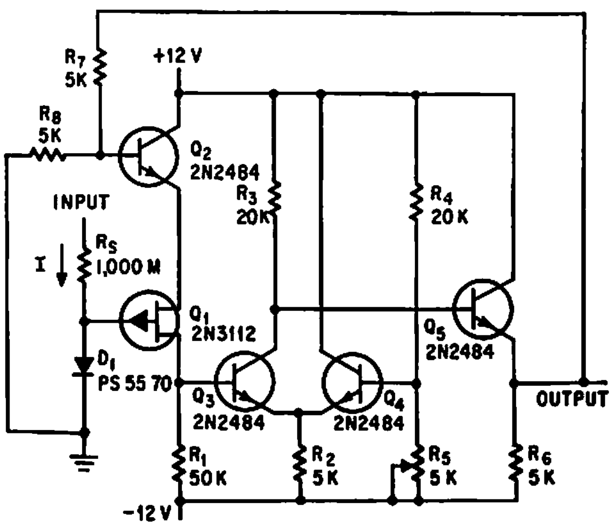
Notes: (1) Input shields are the outer conductors of RG 114/u.
(2) Q_1 and Q_2 are field-effect transistors matched for I_{DSS} between 2 and 6 ma, V_P < 6v, and I_{GSS} < 10na, all within 10%



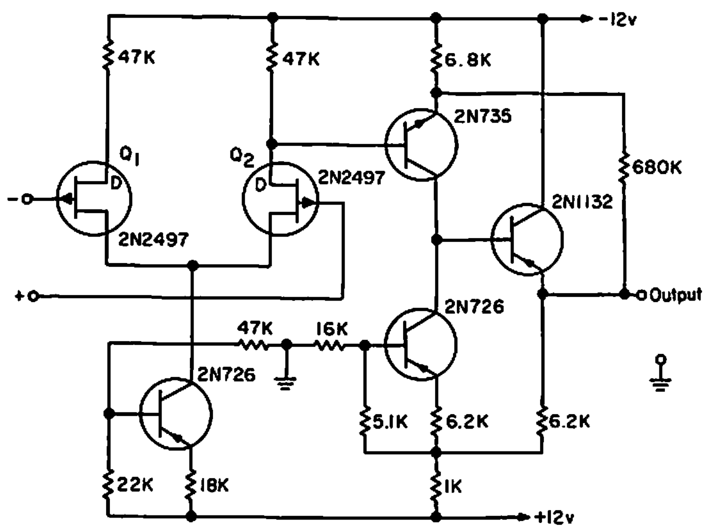
FET UNITY-GAIN D-C AMPLIFIER—Each base of 2N2641 dual transistor is driven by source-follower fet's Q1 and Q2. Q1 performs impedance transformation, while Q2 closes feedback loop and tends to cancel changes in parameters due to temperature variations. —L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 102.



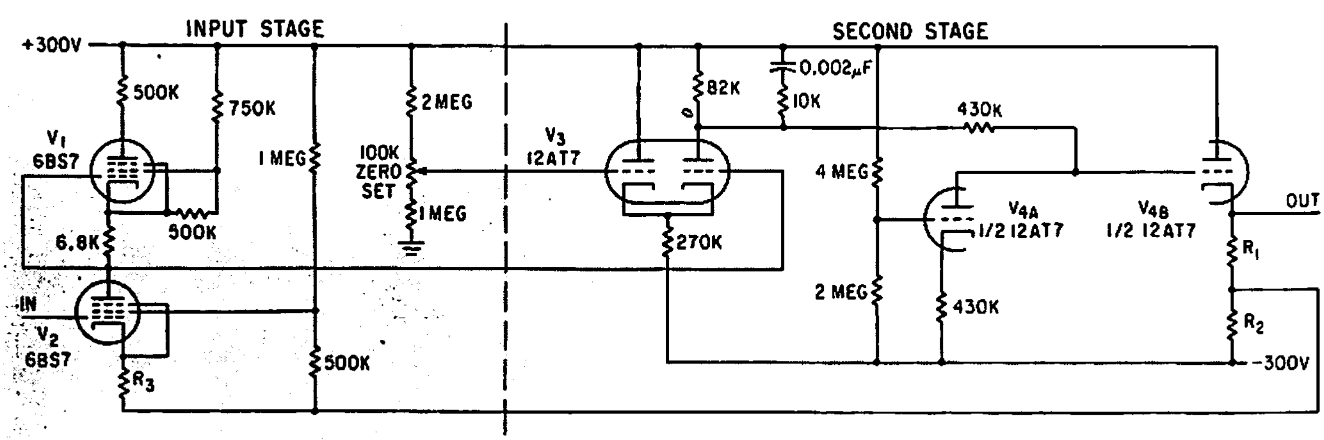
LOW DRIFT WITHOUT CHOPPER—Developed for airborne or missile telemetry. Gain is adjustable. Has wide frequency response, high common-mode rejection factor, and high input impedance, along with gain stability of 0.75% over wide temperature range.—R. D. Middlebrook and A. D. Taylor, Differential Amplifier with Regulator Achieves High Stability, Low Drift, *Electronics*, 34:30, p 56–59.



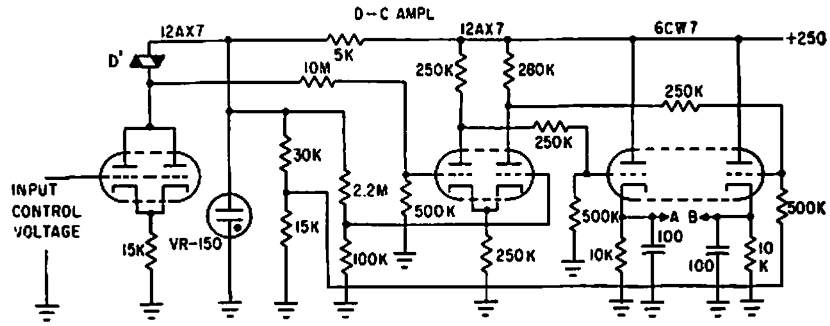
LOGARITHMIC INPUT CURRENT COMPRESSOR—Simple d-c logarithmic amplifier compresses positive input current into logarithmically related input voltage.—G. W. Candel, D-c Logarithmic Amplifier Compresses Input Current, *Electronics*, 39:10, p 91–92.



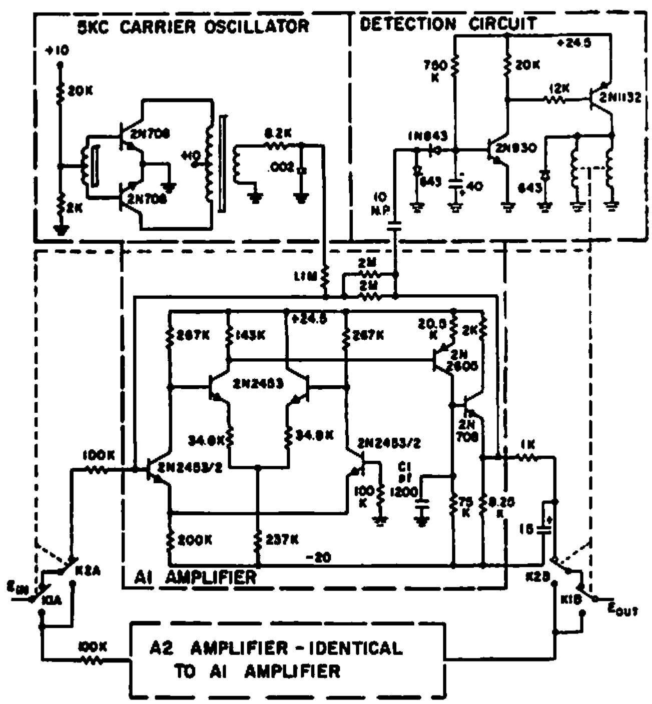
FET OPERATIONAL AMPLIFIER—Open-loop voltage gain at direct current is above 100,000. When operated open-loop, makes excellent voltage comparator having high resolution.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 107.



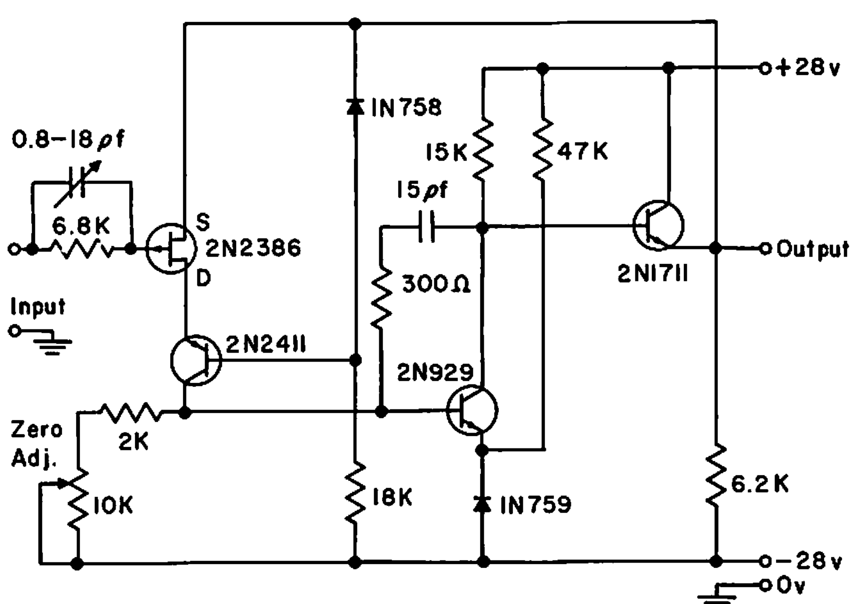
ULTRAHIGH-IMPEDANCE AMPLIFIER—Bridge-balanced series-compensated d-c amplifier using ordinary vacuum tubes gives input impedance of 250,000 meg, for precise voltage measurements without loading high-impedance circuits.—J. Morrison, For Precise Measurements An Ultrahigh Impedance Amplifier, *Electronics*, 35:40, p 49.



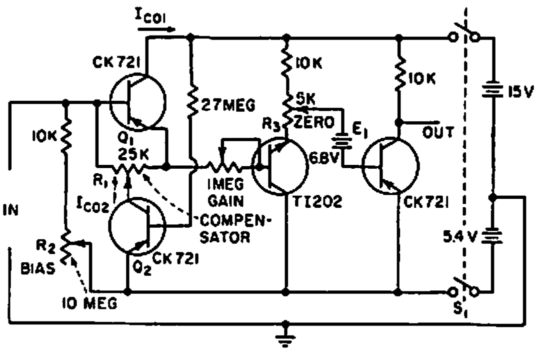
CONTROL FOR VOLTAGE-TUNED OSCILLATOR—Input d-c control voltage required by SiC varistors of voltage-tuned oscillator is boosted by d-c amplifier stages that produce two control voltages (at A and B) for SiC varistors of phase-shift oscillator circuit, changing their a-c resistance and thereby oscillator frequency.—M. Uno, Varistor Network Controls Voltage-Tuned Oscillator, *Electronics*, 34:30, p 44–47.



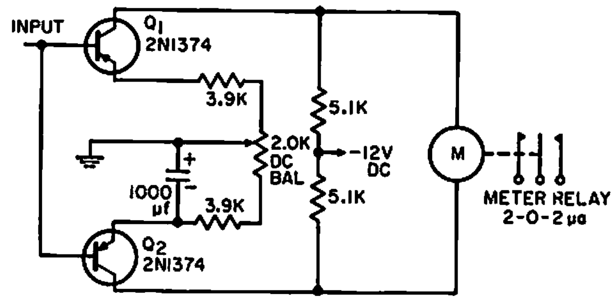
ACTIVE REDUNDANT D-C AMPLIFIER—Test carrier signal is added to input of normal amplifier A1. When failure occurs in A1, detector senses absence of test carrier and causes relay K to change over to amplifier A2. Both amplifiers are differential type, having open-loop gain of 1,000 and closed-loop gain of 10. Open-loop response is flat to about 2 kc, and closed-loop response extends beyond 5 kc.—T. B. Hooker, Designing Redundant Analog Amplifiers, *EEE*, 13:2, p 55–59.



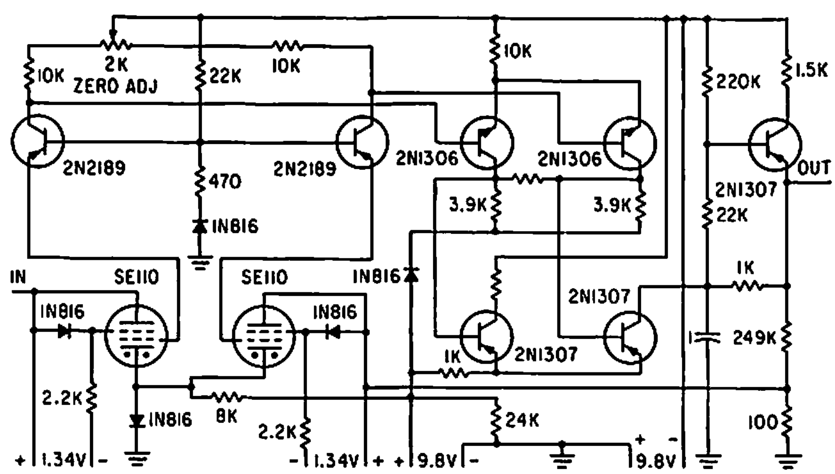
HIGH-INPUT-Z UNITY-GAIN—Source-output connection provides feedback. Cascode input stage has high gain, as required for good amplifier gain accuracy. Upper cutoff is 5,000 kc for 10,000-ohm generator resistance.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 141.



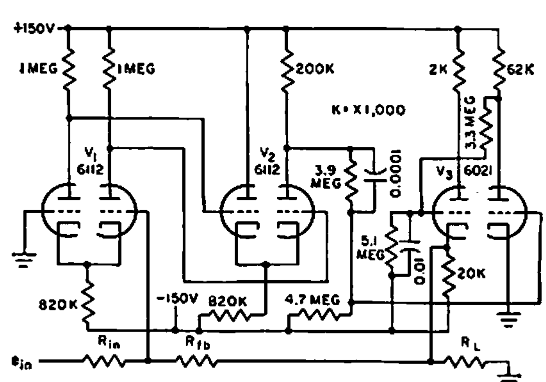
HIGH INPUT IMPEDANCE—Gives current gain of 1,000, voltage gain of 40, input impedance of 0.4 meg, and good short-term temperature stability. Output stage is battery-coupled.—D. Schuster, D-C Transistor Amplifier for High-Impedance Input, *Electronics*, 31:9, p 64–66.



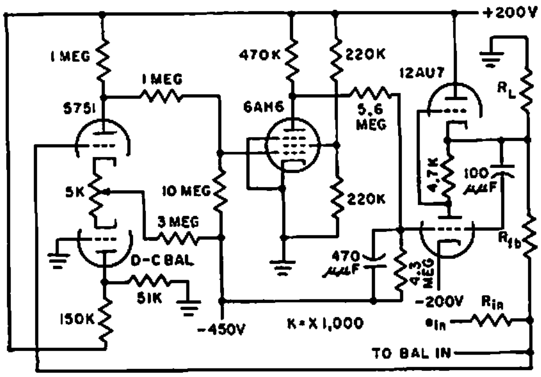
INPUT CHANGE RATE TRIGGERED RELAY—Sensitive and stable d-c amplifier operates relay only on rapid changes of input voltage, yet is immune to drift. Will also operate on a-c signal, which is the same as rapidly changing d-c signal.—Rate Circuit, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 239.



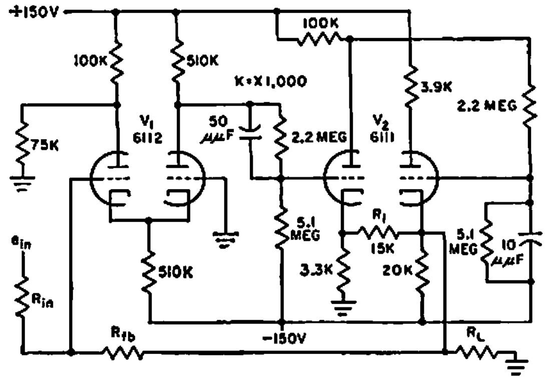
STRAIN-GAGE AMPLIFIER—Battery-powered circuit for low-impedance transducers has voltage gain up to 10,000 with low noise and low drift.—D-C Amplifier uses Solion Tetrodes, *Electronics*, 35:39, p 108.



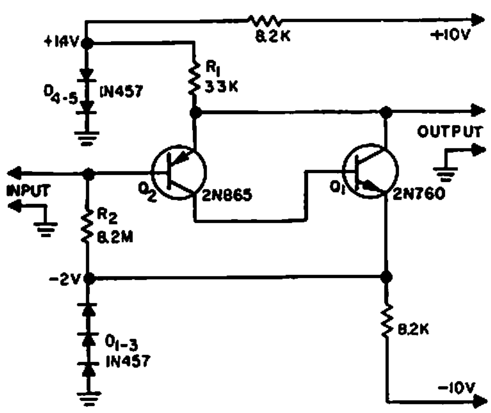
400-CPS SUMMING AND POWER AMPLIFIER—Used in either 60 or 400-cps control systems in which several signals must be summed and amplified in precise manner. Also used for broadband equalization when load impedance is below 25,000 ohms and phase lag must be minimum. Phase shift is less than 5° from d-c to 400 cps. Open-loop gain is above 5,000.—L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.



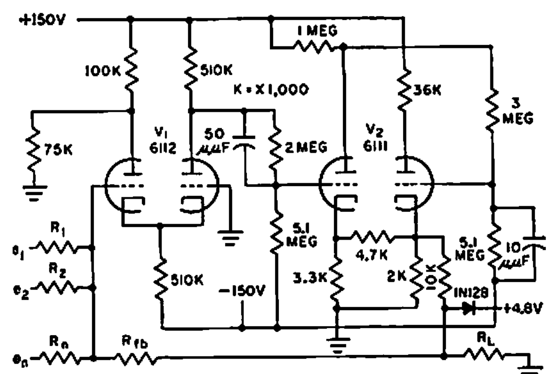
OPERATIONAL D-C AMPLIFIER—Ideal for control systems and analog computers because of broad passband and large control-system response characteristic. Open-loop gain above 15,000. Output swings 100 v into 20,000-ohm load. Can be used from d-c to 20 kc at unity closed-loop gain.—L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.



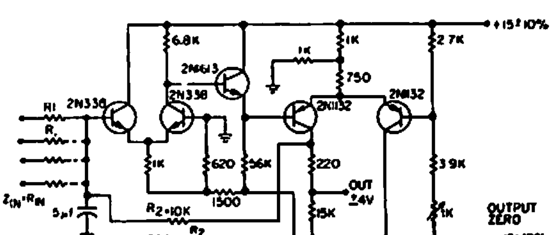
POWER-SUMMING D-C AMPLIFIER—Open-loop gain is 2,000 and maximum voltage swing is 10 v into 2,000-ohm load. Maximum closed-loop gain should be 50 for good stability. Used for straight resistance summing of several input signals.—L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.



STARVED D-C AMPLIFIER—Serves as wideband input stage for chopper-stabilized amplifier that resolves 10 microvolts. Bandwidth is 100 kc, equivalent input noise is less than 10 microvolts rms, and input current is only 8 nanoamperes.—Starved DC Amplifier Has Low Noise, High Z, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 108.

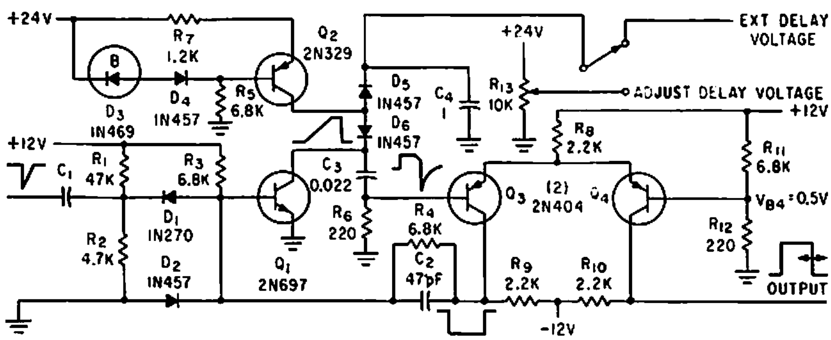


TELEMETRY SUMMING AMPLIFIER—Uses differential dual-triode first stage, voltage amplifier, and current and voltage-limited cathode follower to give output swing of 5 v above and below 0. Open-loop gain of 2,000 is obtained with positive feedback in last two stages. Used to isolate transducers and to amplify d-c or low-frequency signals in airborne or ground-based telemetry systems.—L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.

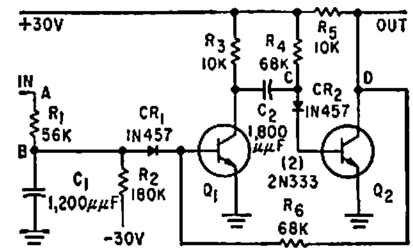


CURRENT-SUMMING OPERATIONAL AMPLIFIER—Uses current-summing to hold voltage at input node R1 at 0 v. With more than one input, there is exact summation of inputs, with no interaction. As sine-wave amplifier, gain is 1,000, and bandwidth for transistors shown is d-c to 20 kc.—C. J. Ulrick, Minimum-Interaction Summing Amplifier, *EEE*, 12:2, p 30.

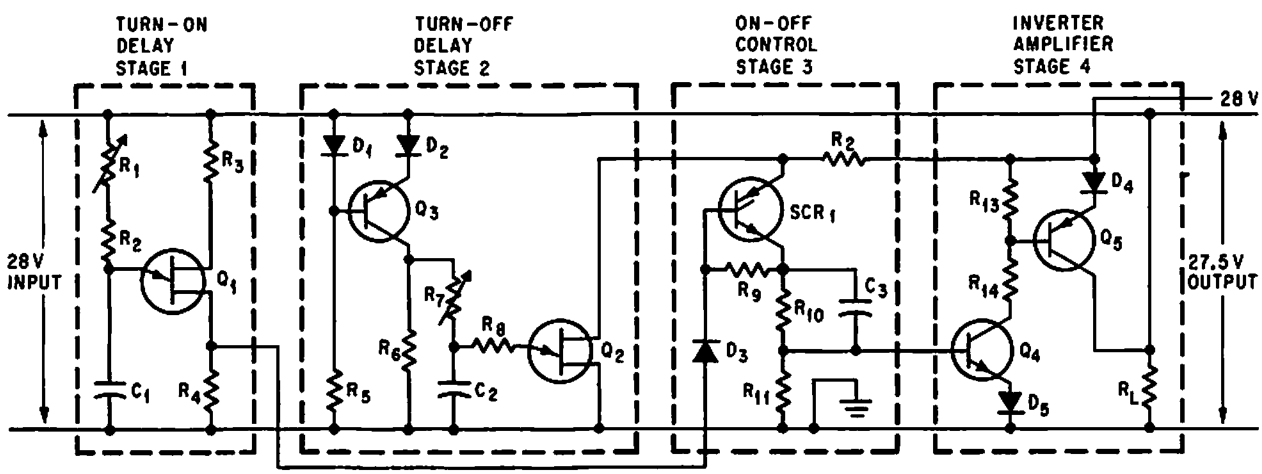
CHAPTER 24
Delay Circuits



VOLTAGE-CONTROLLED DELAY GENERATOR—Accuracy is 0.7%, with high stability. Used in radar range tracker, which requires accurate voltage analog of time between outgoing pulse and incoming echo.—C. K. Friend and S. Udalov, Stabilized Delay Circuit Provides High Accuracy, *Electronics*, 34:15, p 78–80.

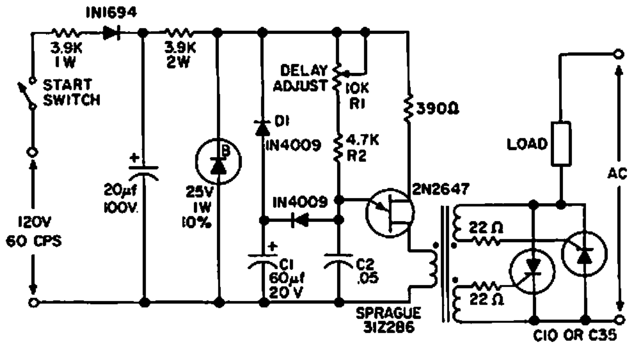


DUAL DELAY—Two-transistor circuit produces pulses of finite width that start finite time after reference pulse. Initial delay is determined by R1-R2-C1 and pulse width by C2-R4.—H. P. Brockman, Circuit Provides Dual Delay, *Electronics*, 32:18, p 62–65.

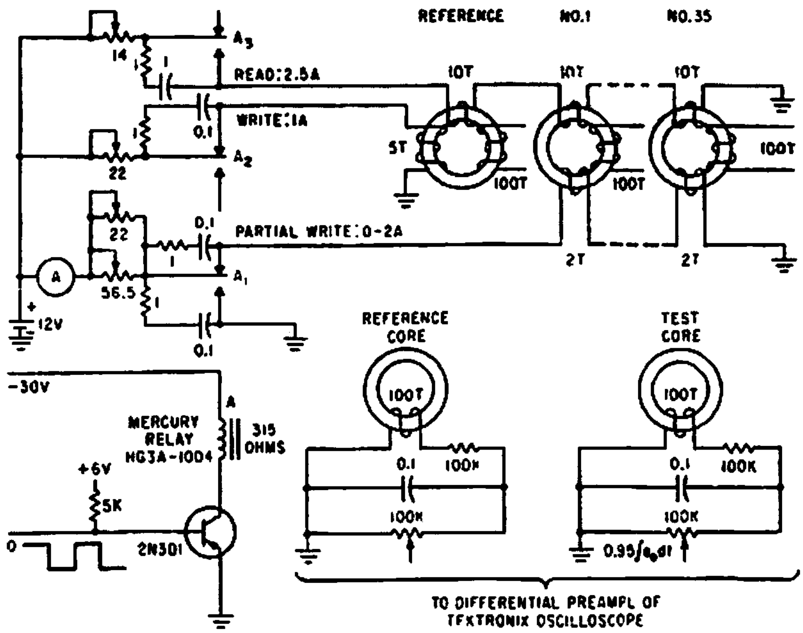


STAGE 1	STAGE 2		STAGE 3	STAGE 4
R_1—1M	R_5—82K	C_2—2.5μF	R_9—1K	R_{13}—390
R_2—680	R_6—22K	D_1—1N645	R_{10}—1.2K	R_{14}—3.3K
R_3—330	R_7—1M	D_2—1N645	R_{11}—220	R_L—LOAD RESISTOR
R_4—100	R_8—75	Q_2—2N1671A	R_{12}—470	D_4—1N645
C_1—2.5μF	Q_3—2N1132		C_3—0.056μF	D_5—1N645
Q_1—2N1671			D_3—1N645	Q_4—2N388
			SCR_1-2N1595	Q_5—2N1132

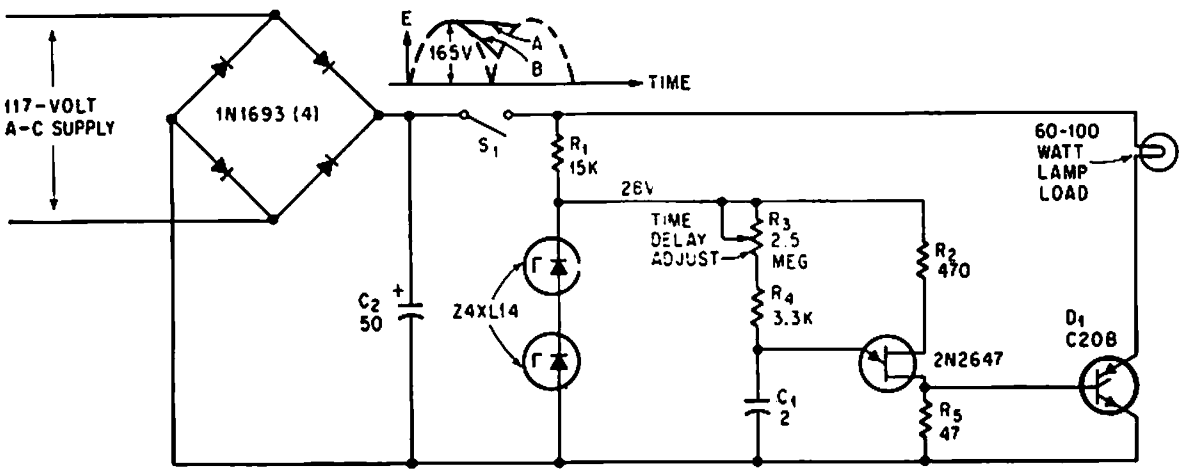
VARIABLE TURN-ON AND TURN-OFF—Both input and output delays are variable from 1.5 to 1,500 millisec. Maximum turn-on delay cannot exceed duration of input pulse. —C. R. Mora, Delay Circuit Varies Turn-on, Turn-off, *Electronics*, 39:7, p 92–93.



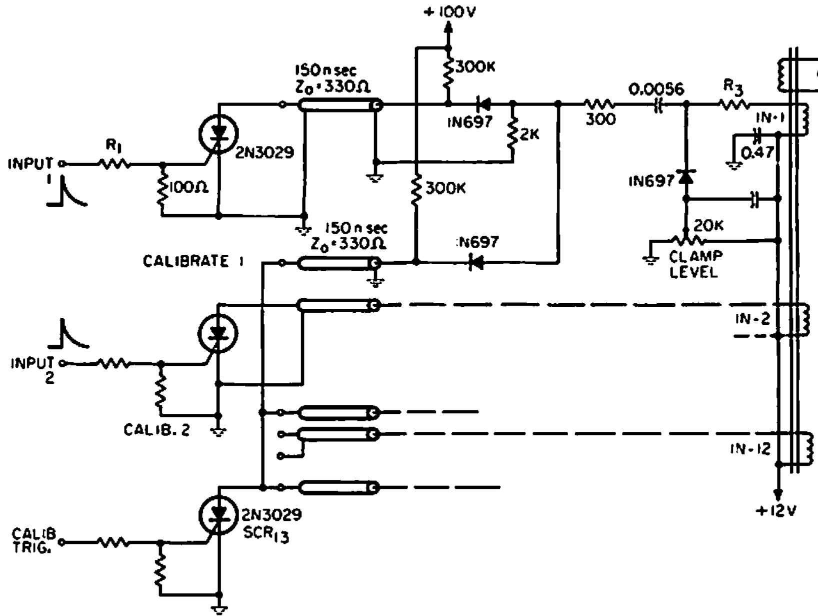
SOLID-STATE DELAY WITH A-C OUTPUT—Timing sequence is initiated by switch, which applies power to ujt circuit. When emitter voltage of ujt reaches peak point, C1 remains charged and ujt oscillates at high frequency. Resulting pulses turn on scr's through pulse transformer, applying voltage to load.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 322.



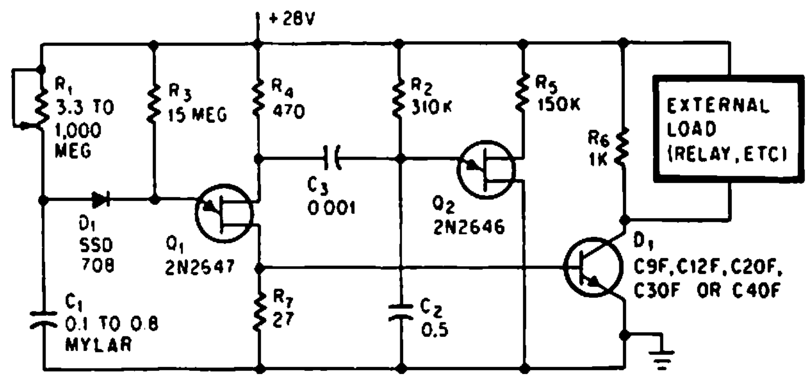
VARIABLE DELAY FOR ANALOG SIMULATION—Uses thick-walled ferrite cores to store voltage levels as flux levels.—W. C. Till and W. H. Ko, Versatile Analog Storage uses Ferrite Cores, *Electronics*, 35:39, p 60–63.



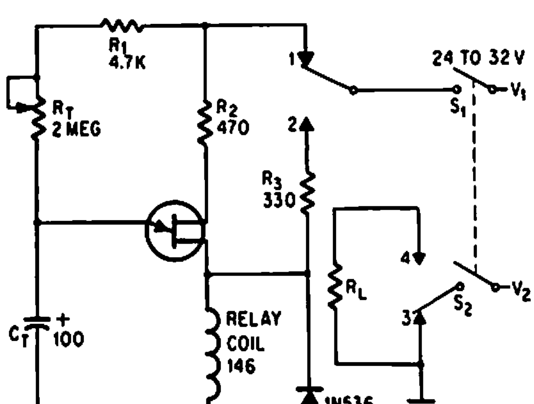
LINE-OPERATED DELAY—Operates directly from 117 v a-c line to provide time delays adjustable from 8 millisec to 5 sec for lamp loads up to 100 w.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.



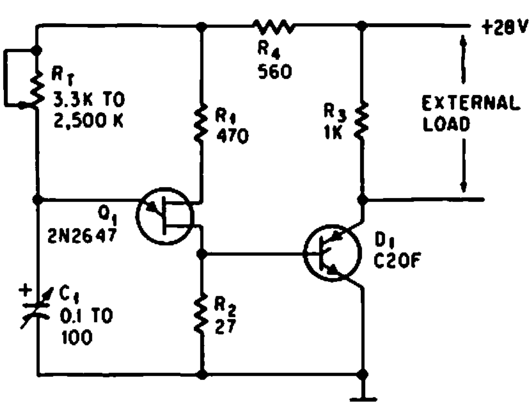
MEASURING NEARLY SIMULTANEOUS EVENTS—Used for measuring 12 events that can be as close together as 20 nsec and as far apart as 200 nsec. Twelve identical circuits, one for each trigger, drive magnetostrictive delay line for serializing events.—R. P. Rufre, How to Measure Simultaneous Events with Magnetostrictive Delay Lines, *EEE*, 14:5, p 44–49.



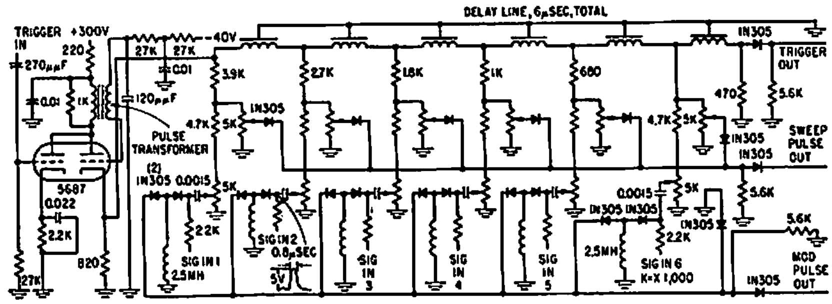
LONG DELAYS—Delays up to 2 hours are obtained, using unijunction transistor Q1 as trigger for scr and Q2 as free-running oscillator. Only 2 na through timing resistor R1 will provide triggering.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.



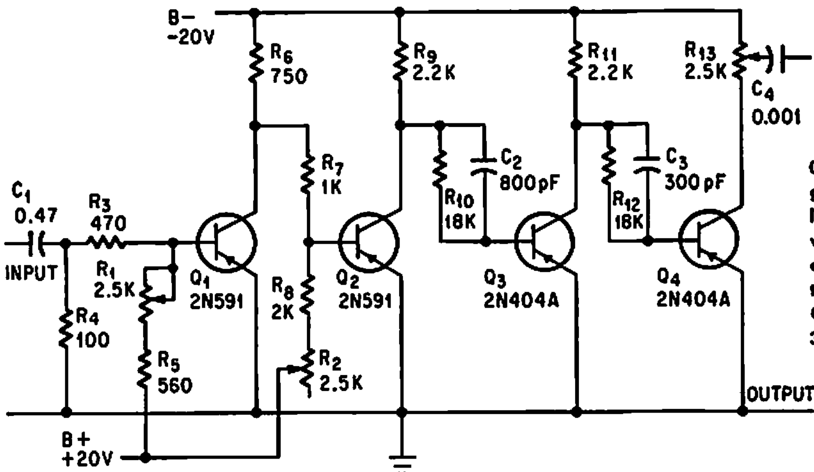
RELAY DELAY—Unijunction transistor is used to delay operation of relay from 0.5 sec to 3 minutes. CT-RT determine delay interval. —D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105-110.



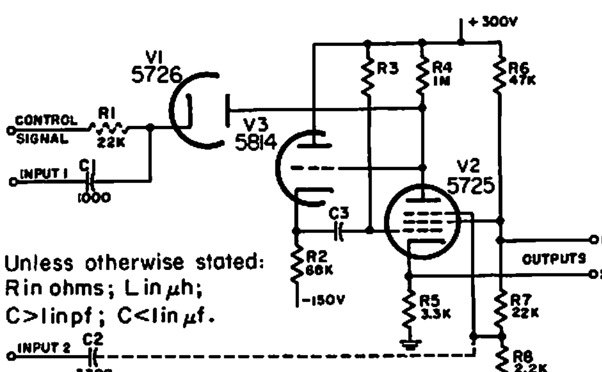
SCR TIME DELAY—Unijunction transistor Q1 and low-cost scr D1 give time delay of 0.4 millisec to 4 minutes, adjustable by CT-RT.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.



SIX-STEP RING DELAY—When double-triode blocking oscillator is fired by input trigger, it delivers 0.6-microsec pulse into 1-microsec delay line which, in turn, delivers pulse to next delay line. After sixth delay, pulse is used as trigger for next ring unit.—M. T. Nadir, Microsecond Sampler Handles 126 Channels, *Electronics*, 32:4, p 36–39.



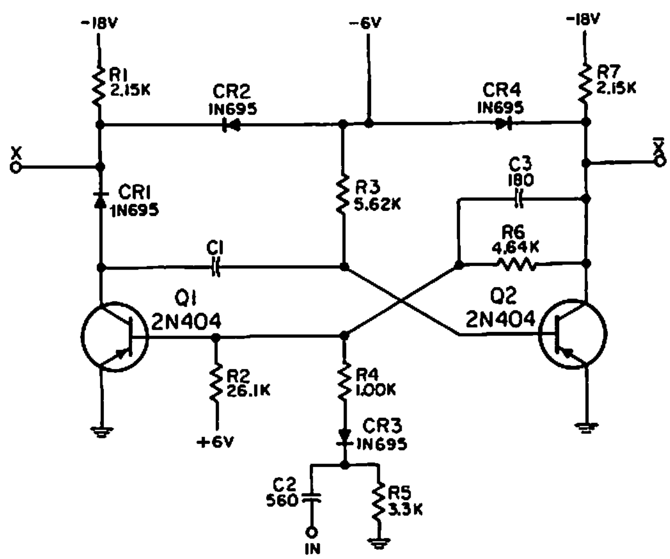
0.58 TO 4.65 MICROSEC DELAY—Saturated germanium transistors give variable time delay for 27-v input pulse having 2.75-microsec width, with R2 controlling delay time and R1 controlling output pulse width.—R. H. Blumenthal and F. E. Williams, Transistor's Stored Charge Controls Pulse Delay, *Electronics*, 37:19, p 52–53.



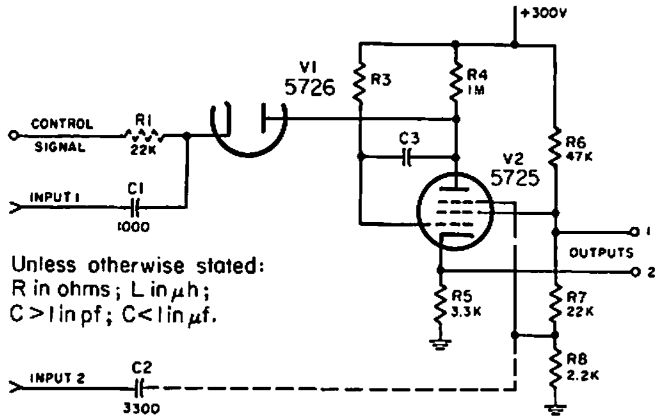
Components:

Maximum duration	R3	C3
<1000 μsec	1.0MΩ	100 to 1000 pf
1000 to 5000 μsec	3.3MΩ	330 to 2200 pf

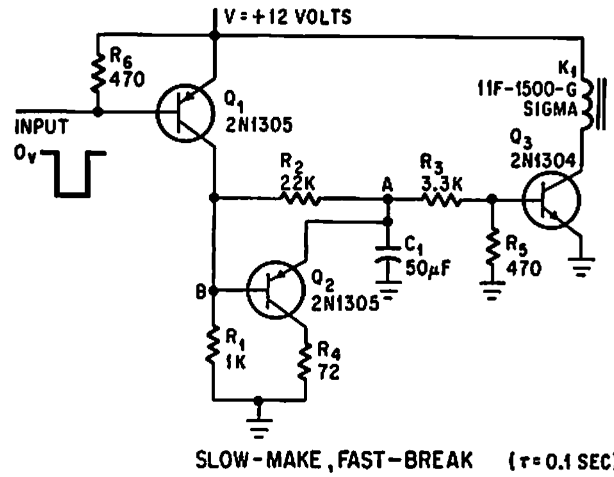
PREFERRED FAST-RECOVERY PHANTASTRON DELAY—Generates rectangular waveform whose duration is almost directly proportional to control signal. Used to produce movable markers on radar display and to time-modulate pulse in accordance with variable quantities such as antenna position. Maximum recovery time is 40 microsec. Control signal is 20 to 240 v, input 1 is −15 v, and input 2 is +20 v. Output 1 is +60 v and output 2 is −10 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 57, p 57-2.



MONOSTABLE DELAY—Designed to perform delay function in digital logic circuits for computer, control, and communication equipment. Choice of feedback capacitor C1 gives delay range from 2 microsec to 100 millisec. R3 may be made variable for further adjustment of time delay.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 10 (originally PC 213), p 10-2.

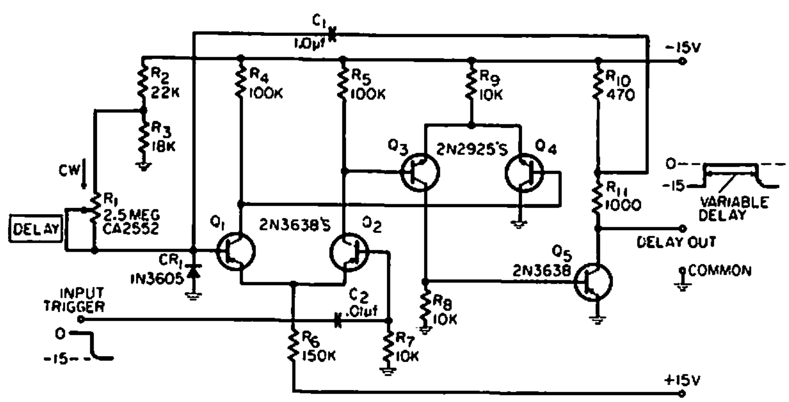


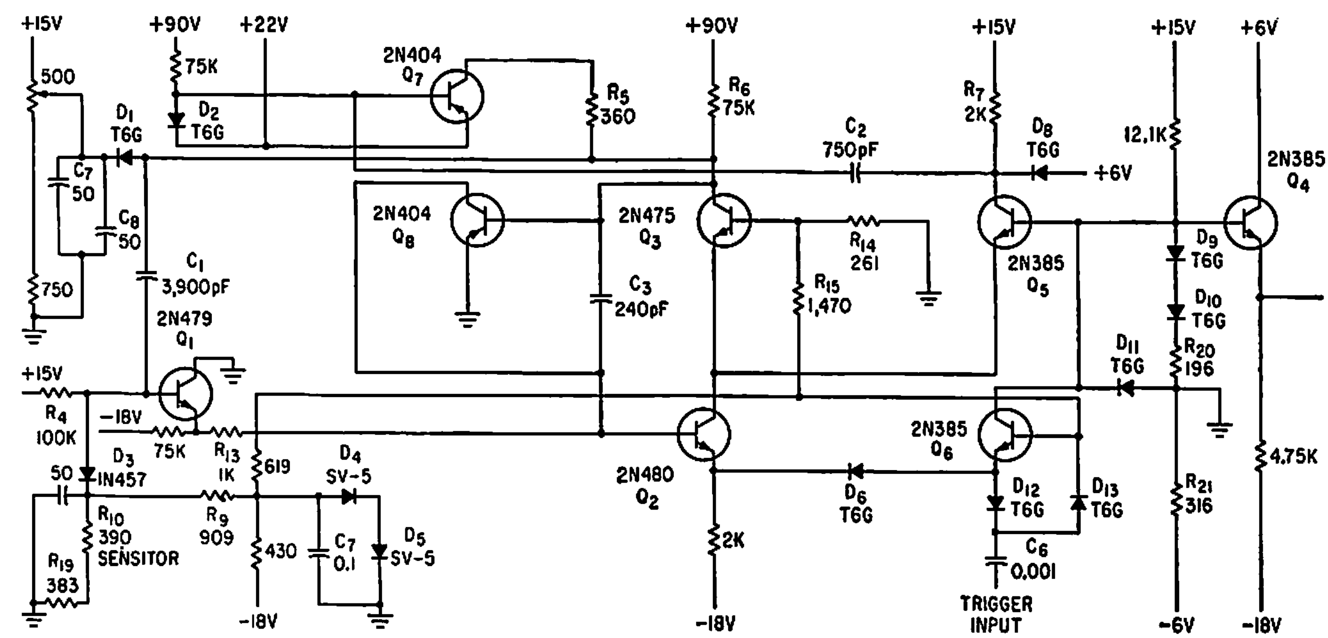
PREFERRED PHANTASTRON DELAY—Accepts 20 to 280 v control signal, 15-v negative pulse at input 1, and 20-v positive pulse at input 2. Output is +60 v, and output is −10 v. R3 can be 1 to 3.3 meg and C3 100 to 1,200 pf, depending on minimum and maximum duration desired.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 56, p 56–2.



SLOW-MAKE RELAY—Circuit energizes relay with delay controlled by R2-C1 after driving pulse is applied. Relay de-energizes the instant driving pulse is removed.—P. Haas, Timing Circuits Control Relays, *Electronics*, 38:6, p 85.

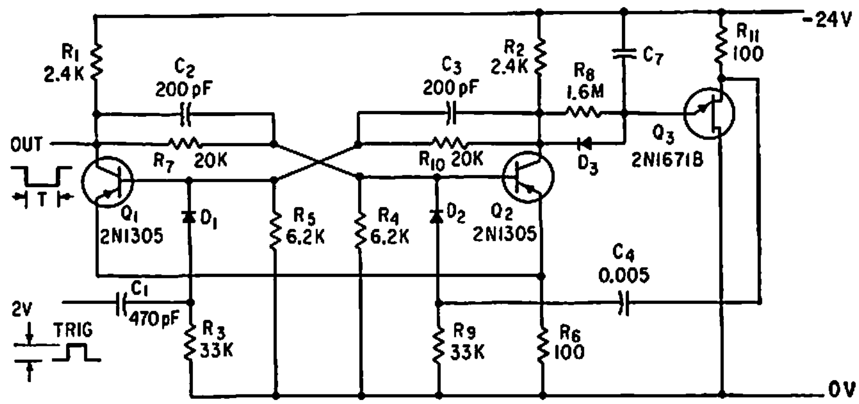
6 MSEC TO 1.5 SEC—Provides continuously variable delay having good settability over entire range due to use of single log-tapered pot R1.—S. G. Freshour, Wide-Range Variable Delay Circuit, *EEE*, 14:3, p 62.

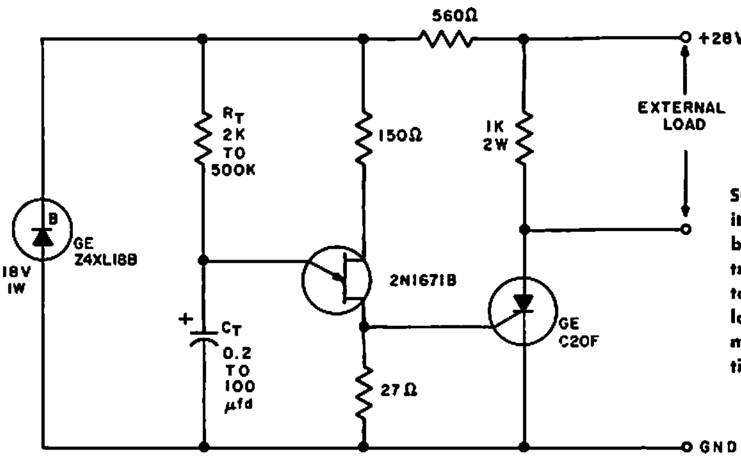




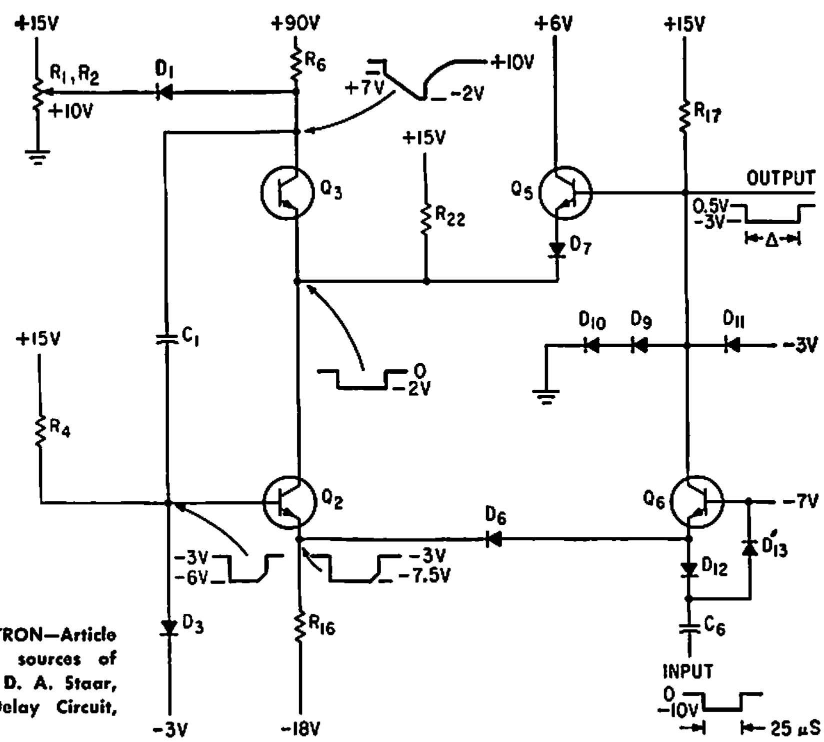
220-MICROSEC PHANTASTRON DELAY—Timing accuracy of 1% is achieved by adding temperature-correcting features to basic solid-state circuit.—S. R. Parris and D. A. Staar, Highly Accurate Phantastron Delay Circuit, *Electronics*, 33:43, p 72–74.

DELAY MULTIPLIER—Addition of silicon unijunction transistor Q3 to conventional monostable mvbr expands time delay two orders of magnitude.—M. P. Humblet, Unijunction Transistor Multiplies Monostable's Pulsewidth, *Electronics*, 35:26, p 74–75.

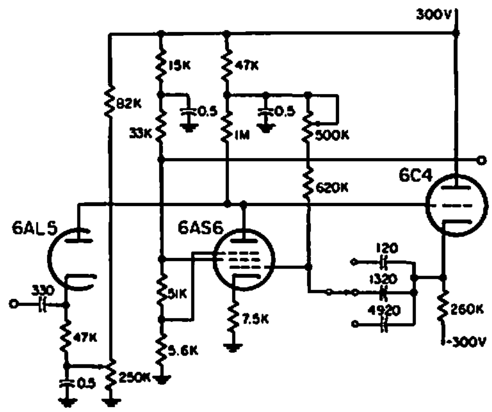




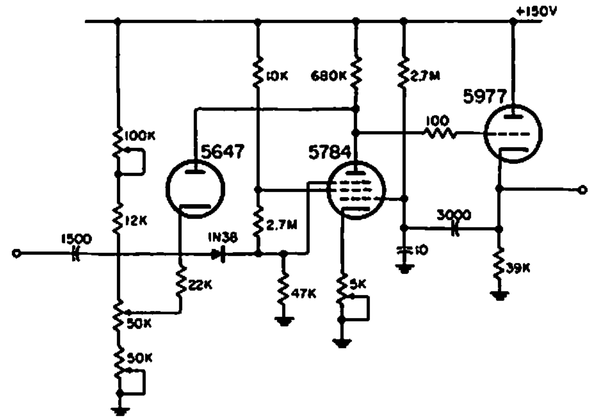
SCR-UJT TIME DELAY—Timing interval is initiated by applying power, and is determined by RT-CT. At end of interval, unijunction transistor triggers silicon controlled rectifier, to apply essentially full supply voltage to load. Delay range is from 0.4 millisec to 1 minute.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 321.



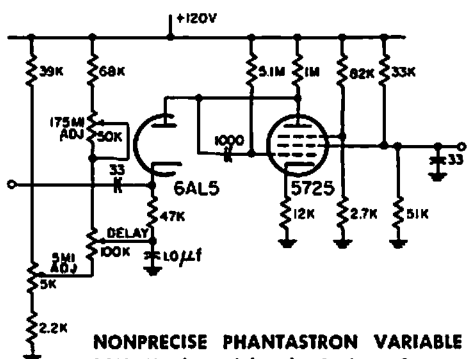
BASIC 4-TRANSISTOR PHANTASTRON—Article traces operation and analyzes sources of timing errors.—S. R. Parris and D. A. Staar, Highly Accurate Phantastron Delay Circuit, *Electronics*, 33:43, p 72–74.



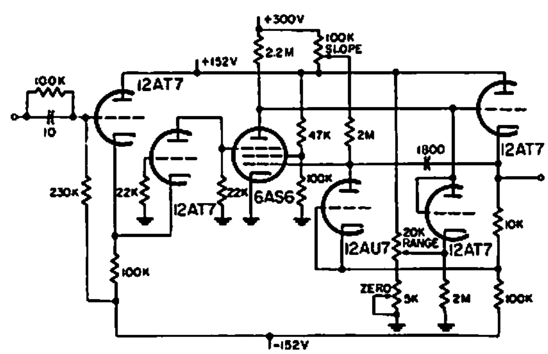
NONPRECISE PHANTASTRON VARIABLE DELAY—Used to delay beginning of crt sweep for expanded display. Provides three ranges: 0 to 5, 60, and 200 miles. Circuit is basically cathode-coupled phantastron, with additional coupling by returning suppressor and screen to same divider. Cathode follower reduces recovery time and provides low-impedance point for range switching.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–3.



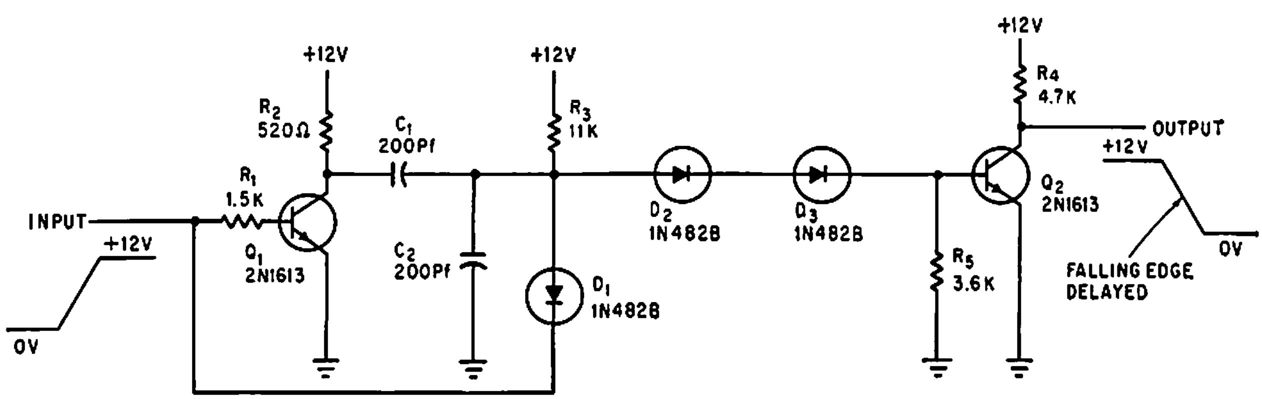
NONPRECISE PHANTASTRON VARIABLE DELAY—Is triggered by positive pulse on suppressor instead of negative pulse on plate. Crystal diode prevents interruption of phantastron operation by trailing edge of trigger. Used to delay beginning of crt sweep for expanded display. Delay range is 0 to 190 miles.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–3.



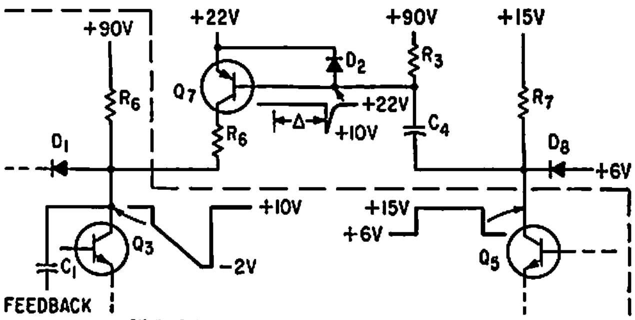
NONPRECISE PHANTASTRON VARIABLE DELAY—Used to delay beginning of crt sweep for expanded display. Range is 5 to 175 miles. Trailing edge of screen waveform is differentiated and used to trigger blocking oscillator through trigger amplifier.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–3.



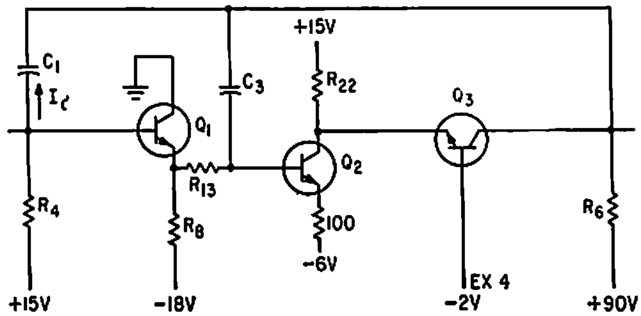
0 to 2,440-MICROSEC PHANTASTRON DELAY—Is triggered by gating mvbr. Receives control voltage from ten-turn potentiometer calibrated in distance units. Output drives blocking oscillator through transformer. Accuracy is about 1% of delay setting.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–2.



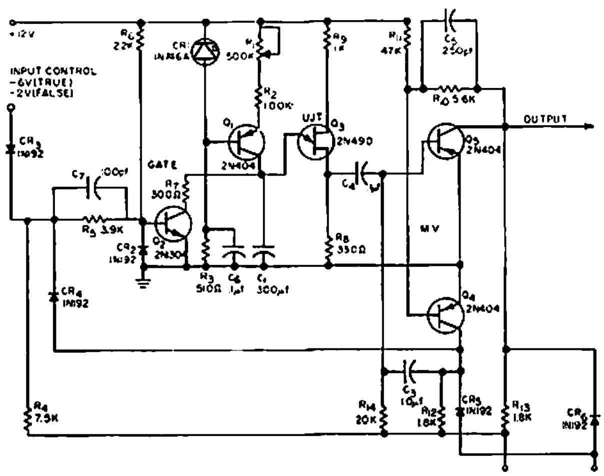
FAST RECOVERY—Addition of C2 to basic circuit reduced recovery time from 2 microsec to 0.5 microsec. Used in computers.—L. C. Radzik and J. J. Curtis, Adding A Component Reduces Recovery Time, *Electronics*, 38:2, p 78–79.



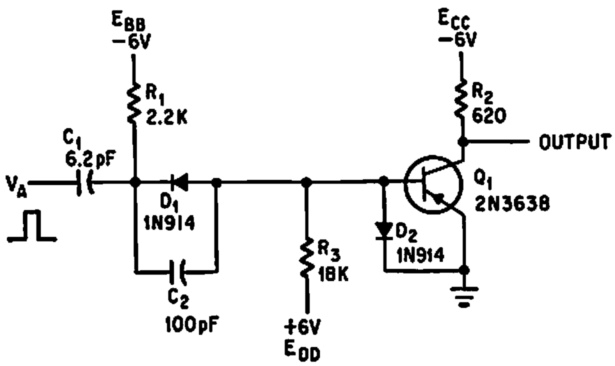
FAST-RECHARGING PHANTASTRON—Recharging of solid-state phantastron delay capacitor is reduced to 5 microsec by addition of Q7. Circuit of Q7 is inoperative during all other parts of cycle, including quiescent state. —S. R. Parris and D. A. Staar, Highly Accurate Phantastron Delay Circuit, *Electronics*, 33:43, p 72–74.



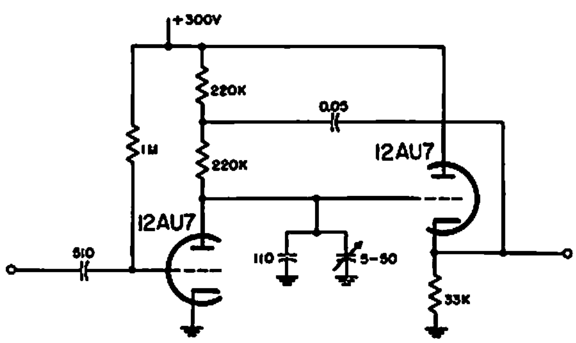
MODIFIED PHANTASTRON INTEGRATOR—Addition of input emitter-follower Q1 increases open-loop current gain of integrator and provides increased accuracy and linearity.—S. R. Parris and D. A. Staar, Highly Accurate Phantastron Delay Circuit, *Electronics*, 33:43, p 72–74.



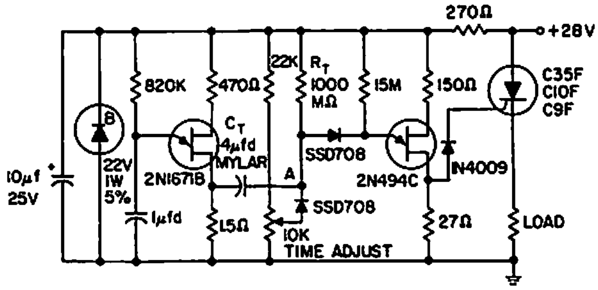
FOUR-MINUTE DELAY—Ujt switch gives accuracy of 1% for time delays in range of 1 to 4 minutes, over range of 10°C above and below 25°C. R1 controls amount of delay.—E. G. McCoy, Accurate Time Delays up to Four Minutes, *EEE*, 11:10, p 31.



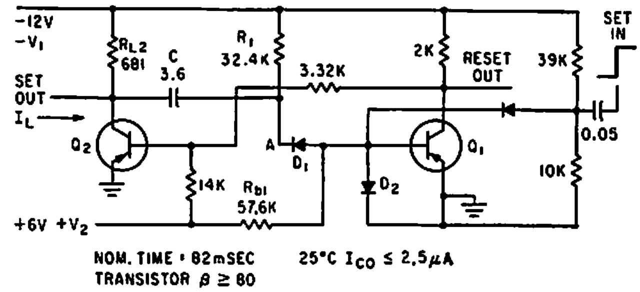
HIGH-VOLTAGE PULSE DELAY—Diode input network isolates base of Q1 from input when input pulse voltages exceed maximum rated emitter-to-base reverse voltage of input-inverting digital pulse delay circuit.—R. A. Karlin, One-Transistor Multi Delays Digital Pulses, *Electronics*, 38:17, p 85–86.



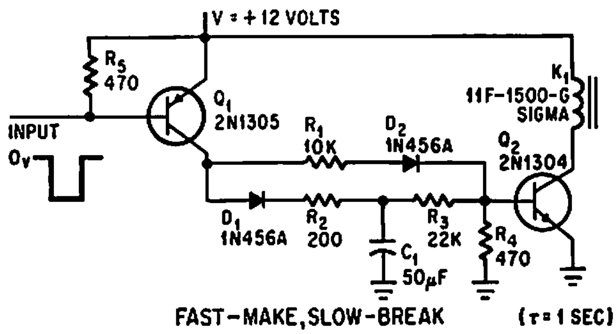
FIXED BOOTSTRAP DELAY—Used to provide buffer interval between sync and video information in radar relay transmitter. Requires gate at least as long as 30-microsec delay. Accuracy is only 10%.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–1.



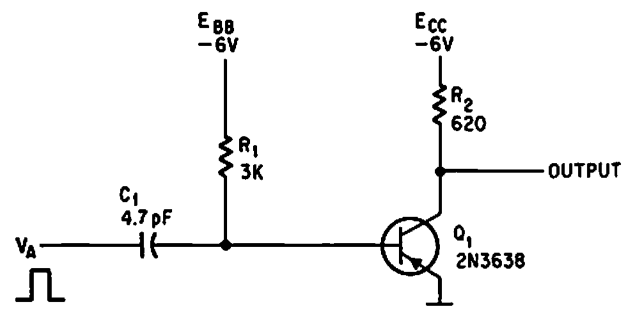
1-HR TIME DELAY—Achieved by periodically sampling voltage on timing capacitor, using sampling pulse generated by 2-cps ujt relaxation oscillator. Between samples, timing capacitor is isolated from emitter of ujt by low-leakage planar silicon diodes.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 321.



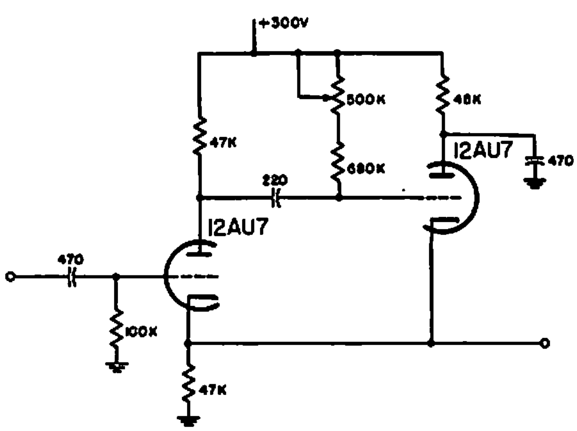
ISOLATING-DIODE MONO MVBR—Addition of diode D1 to conventional delay circuit reduces timing variations otherwise encountered in production runs. Supply voltage change of 10% causes timing change of only 1%—D. E. Haselwood, Monostable Multivibrators with Stable Delay Times, *Electronics*, 34:49, p 64–65.



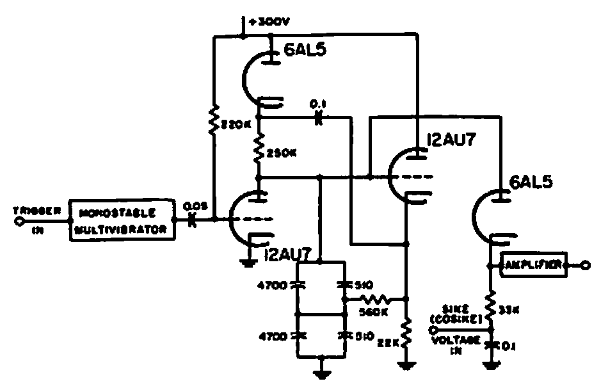
SLOW-BREAK RELAY—R3-C1 determine period that relay remains energized after input pulse is removed.—P. Haas, Timing Circuits Control Relays, *Electronics*, 38:6, p 85.



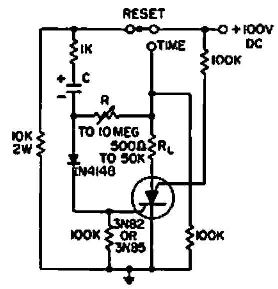
INPUT-INVERTING DELAY—Input voltage, supply voltage EBB, and R1-C1 determine delay time for digital pulses.—R. A. Karlin, One-Transistor Multi Delays Digital Pulses, *Electronics*, 38:17, p 85–86.



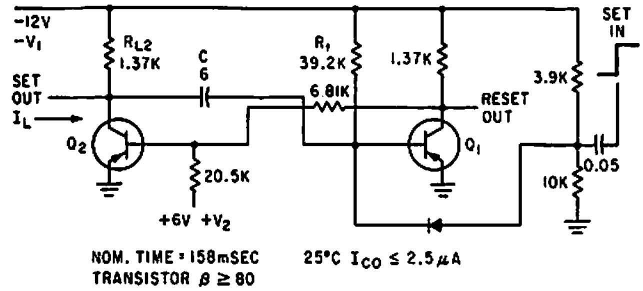
FIXED MVBR DELAY—Used to provide buffer interval between sync and video information in radar relay transmitter. Can be triggered by pulse. Accuracy of 30-microsec delay is only about 10%.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–1.



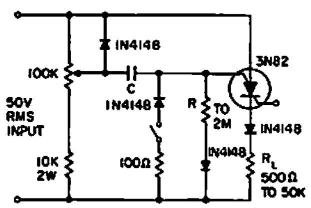
50-350 MICROSEC BOOTSTRAP DELAY—Provides continuously variable delay. Requires mvbr to generate necessary gate, and two amplifier stages following comparator diode to sharpen output waveform.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–2.



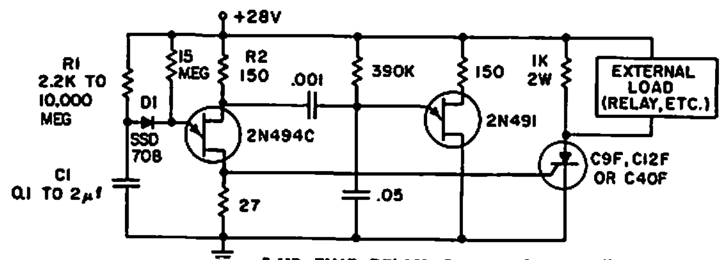
LOAD CURRENT DELAY—Silicon controlled switch circuit delays start of load current for interval of 0.5 RC after switch is thrown.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 435.



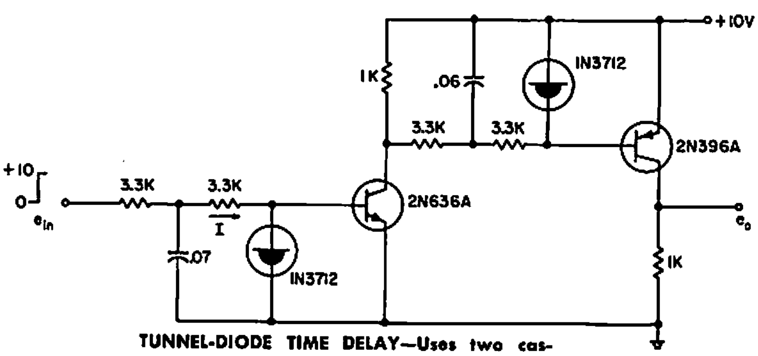
CONVENTIONAL MONO MVBR—Requires bulky capacitors and large timing resistors to get accurate delay times of 1 to 300 millisec. Ideal for laboratory use, but gives problems with mass production.—D. E. Haselwood, Monostable Multivibrators with Stable Delay Times, *Electronics*, 34:49, p 64–65.



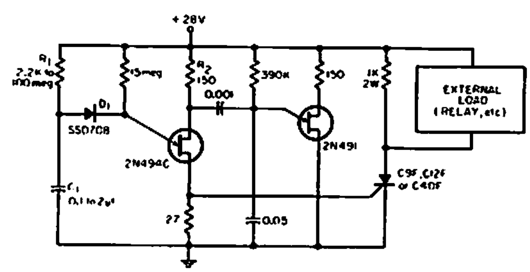
A-C OPERATED TIME DELAY—Switch is normally closed, charging C and blocking scs. Delay is initiated by opening switch. After delay interval, determined by R, C, and potentiometer, silicon controlled switch conducts on alternate half-cycles.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 435.



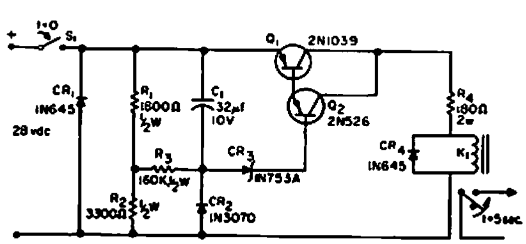
5-HR TIME DELAY—Range of 0.3 millisec to 5 hours is obtained without using electrolytic capacitor. At end of timing interval, initiated by applying power and determined by R1-C1, 2N494C triggers controlled rectifier.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 322.



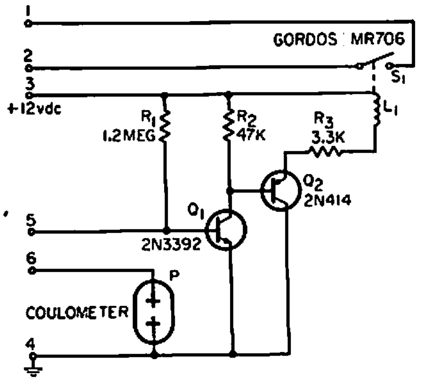
TUNNEL-DIODE TIME DELAY—Uses two cascaded complementary stages in which tunnel diodes are used with transistors. Takes +10 v input pulse.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 369.



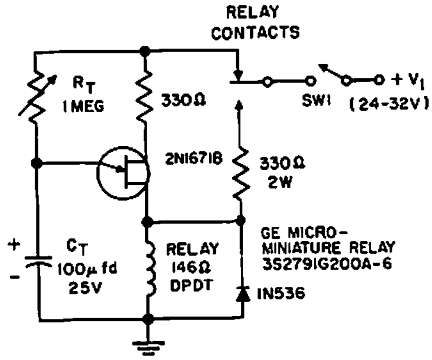
PRECISION SCR DELAY—Gives time delays over 3 minutes without need for tantalum or electrolytic capacitor. Timing capacitor C1 can be mylar unit. Application of power initiates timing of power, which is determined by R1-C1. At end of interval, 2N494C fires other scr, to place supply voltage across load.—D. V. Jones, Precision Solid-State Delay Circuit, *EEE*, 11:12, p 26–27.



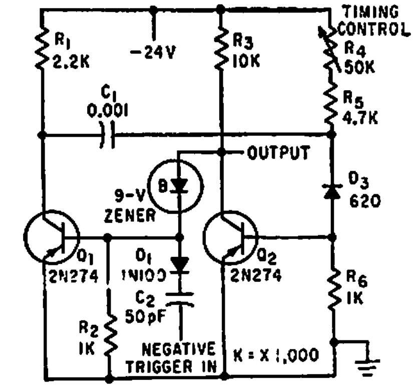
FAST-RECYCLING TIME-DELAY RELAY—Uses 28-v relay to give delay of 5 sec, with recycle time of 200 millisec.—R. W. Eubank, Fast Cycling Time-Delay Relay, *EEE*, 12:3, p 71.



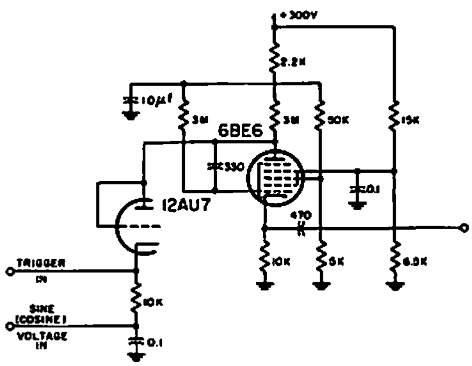
MICROCOULOMETER-CONTROLLED TIME DELAY—Gives delay accuracies of 1% for intervals from 30 sec to 350 hr. Delay interval ends when mercury in capillary glass tube is completely plated onto switching electrode of microcoulometer. With two delays in series, one can be reset while other is in timing mode, to give automatic reset.—Time-Delay Circuit Gives 1-Percent Accuracy, *EEE*, 13:9, p 94.



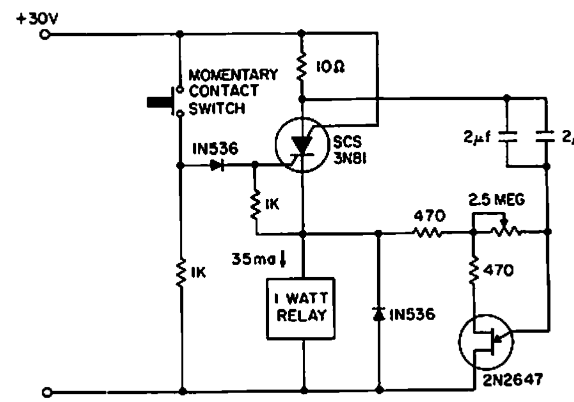
UJT RELAY-OPERATING DELAY—When switch is closed, capacitor charges to voltage at which unijunction triggers, then discharges through unijunction transistor and relay after time delay determined by RT, which is about 1 sec of delay for each 10K of resistance.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 320.



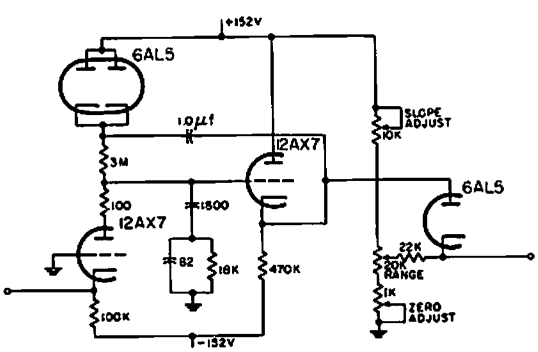
PRECISION TIME DELAY—Used as range gate delay in doppler radar boxcar circuit, as expanded-range indicator sweep, and for generation of gate waveforms. Output jitter is less than 4 nsec over delay range of 3 to 35 microsec. Negative-going output pulse is 9 v peak. Reliability is achieved chiefly through isolation of timing network R4-R5-C1 during timing interval.—P. E. Harris, Insuring Stability in Time Delay Multivibrators, *Electronics*, 33:15, p 73.



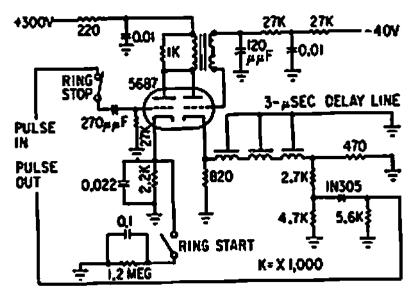
50–350 MICROSEC PHANTASTRON DELAY—Gives 0.5% accuracy. Phantastron furnishes own gate and does not require amplifier to trigger blocking oscillator at output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–2.



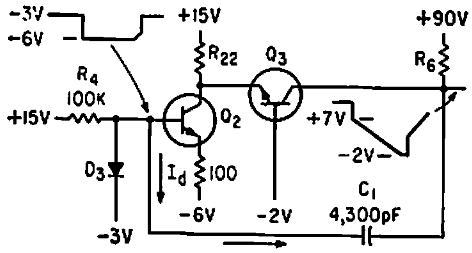
DELAYED-DROPOUT RELAY TIMER—Keeps relay energized for preset time of up to 10 sec after relay is pulled in by momentarily closing switch.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 324.



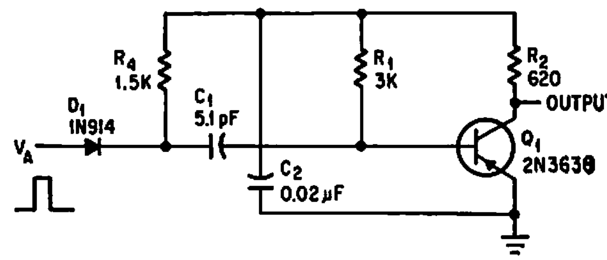
0 to 2,440-MICROSEC BOOTSTRAP DELAY—Is triggered by gating mvbr. Receives control voltage from ten-turn potentiometer calibrated in distance units. Output drives blocking oscillator through transformer. Accuracy is about 1% of delay setting.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N9–2.



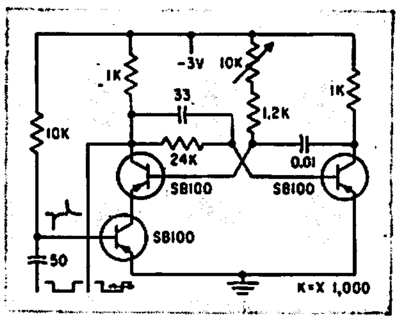
RING DELAY STARTING UNIT—Consists of blocking oscillator and 3-microsec delay line. Ring start switch fires blocking oscillator once and starts ring. Ring stop switch opens oscillator input to stop ring delay from oscillating.—M. T. Nadir, Microsecond Sampler Handles 126 Channels, *Electronics*, 32:4, p 36–39.



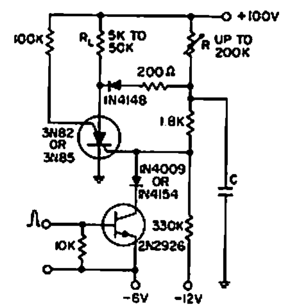
INTEGRATOR OF SOLID-STATE PHANTASTRON—Q2 and Q3 provide open-loop gain, while R4 and C1 are feedback elements.—S. R. Parris and D. A. Staar, Highly Accurate Phantastron Delay Circuit, *Electronics*, 33:43, p 72–74.



DECOUPLING FOR PULSE DELAY—Coupling circuit ahead of input-inverting digital pulse delay prevents C1 from loading driving collector and decreases noise sensitivity.—R. A. Karlin, One-Transistor Multi Delays Digital Pulses, *Electronics*, 38:17, p 85–86.

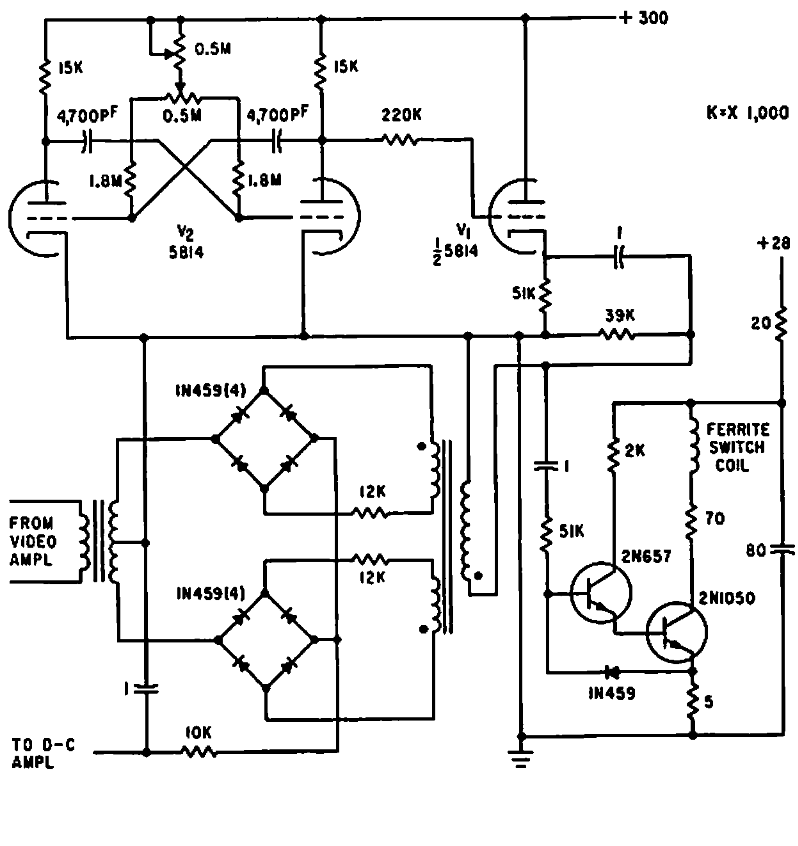


MONOSTABLE MVBR DELAY—Prevents certain circuits from operating until proper time and generates and shapes required output pulses. Is triggered by positive pulse produced by input differentiating circuit. Circuits are cascaded, and second stage starts its delay coincident with trailing edge of first delay output pulse.—W. W. Grannemann et al, Pulse-Height-to-Digital Signal Converter, *Electronics*, 33:2, p 58–60.

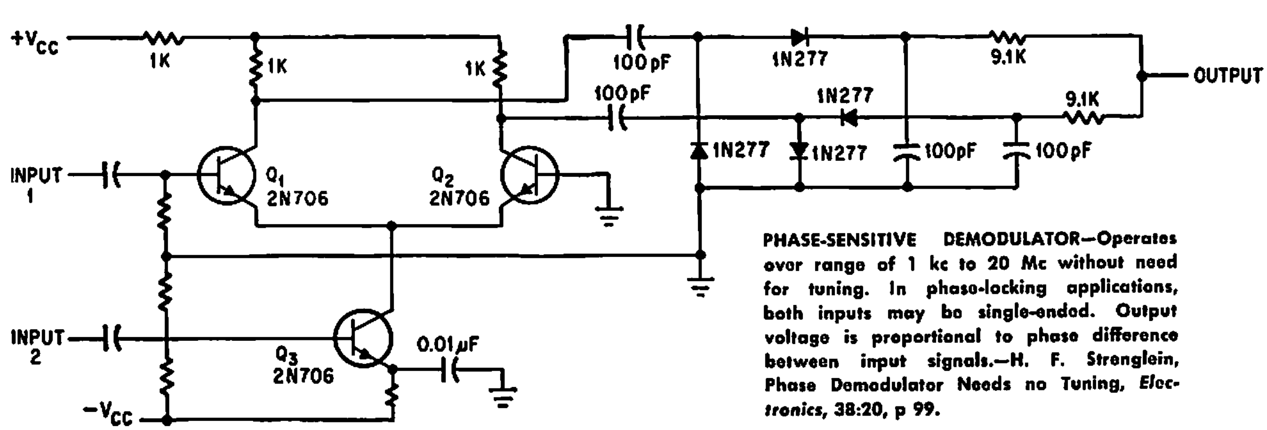


LOAD CURRENT TURNOFF DELAY—Input pulse turns off silicon controlled switch, which triggers after delay of approximately RC.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 435.

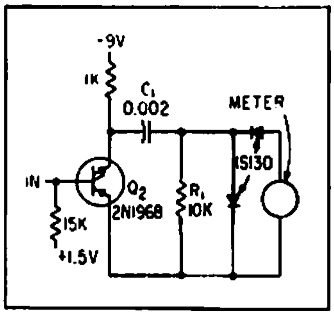
CHAPTER 25
Demodulator Circuits



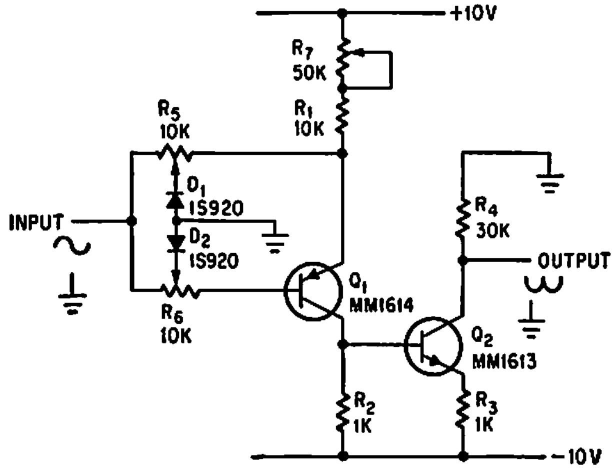
PHASE-SENSITIVE DEMODULATOR—Used in iceberg-detecting microwave radiometer. Faraday rotational ferrite switch alternately feeds calibrating noise source and ocean or iceberg signal through video amplifier to double-bridge demodulator. Output is d-c voltage proportional to change in antenna temperature, positive for warm signals from iceberg and negative for apparently colder sea water. Mvbr (125 cps) supplies reference voltage and ferrite drive signal.—T. V. Seling and D. K. Nance, Sensitive Microwave Radiometer Detects Small Icebergs, *Electronics*, 34:19, p 72–75.



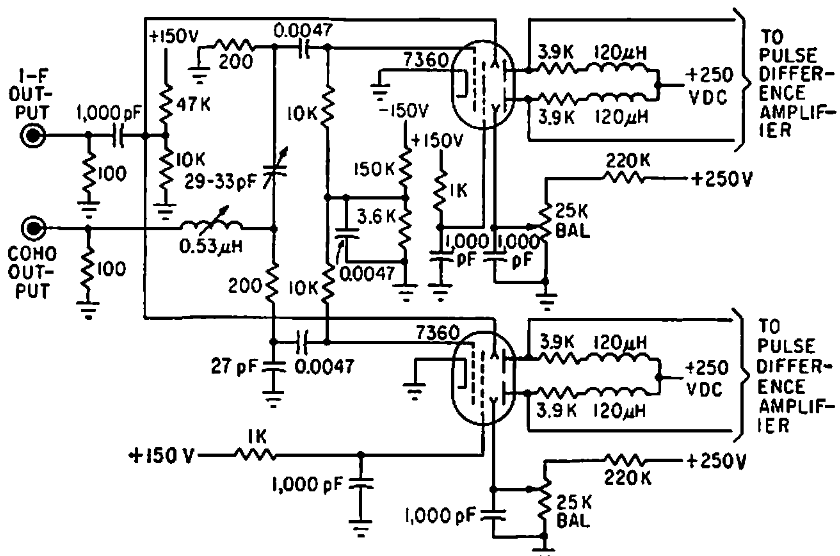
PHASE-SENSITIVE DEMODULATOR—Operates over range of 1 kc to 20 Mc without need for tuning. In phase-locking applications, both inputs may be single-ended. Output voltage is proportional to phase difference between input signals.—H. F. Stranglein, Phase Demodulator Needs no Tuning, *Electronics*, 38:20, p 99.



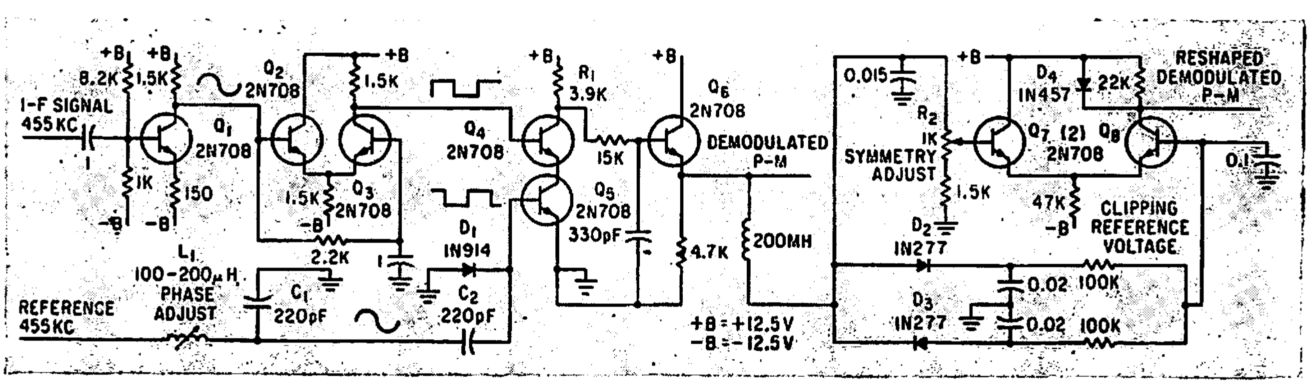
D-C FROM F-M—Mean d-c level, directly proportional to number of pulses per unit time, is read on meter for f-m data recorded on magnetic tape.—K. R. Whittington, Simple F-M Demodulator for Audio Frequencies, *Electronics*, 35:48, p 89.



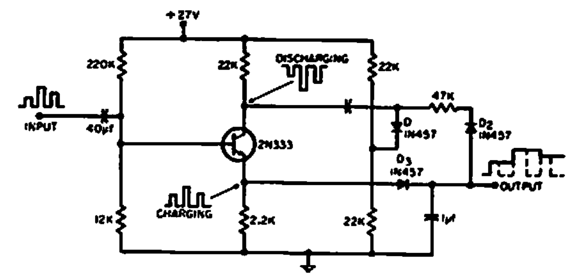
TRANSFORMERLESS FULL-WAVE DETECTOR—Each half-cycle of input sine wave produces negative half-cycle at output. Both input and output are referenced to ground. Operating range is from d-c to 10 Mc.—C. Yarker, Full-Wave Detector Without Transformer, *Electronics*, 39:15, p. 100-101.



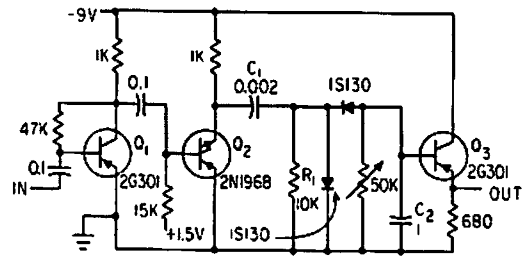
SYNCHRONOUS DEMODULATOR FOR COHERENT PULSE DOPPLER RADAR—C-w output of coherent oscillator is applied to control grid of one beam-deflection tube, and radar receiver i-f output is applied to control grid of other tube in push-pull, so i-f signal and modulation products are in push-pull at the two anodes while c-w signal components are in same phase and are hence cancelled in following pulse difference amplifiers.—J. B. Theiss, More Target Data with Sideband Coherent Radar, *Electronics*, 36:3, p 40–43.



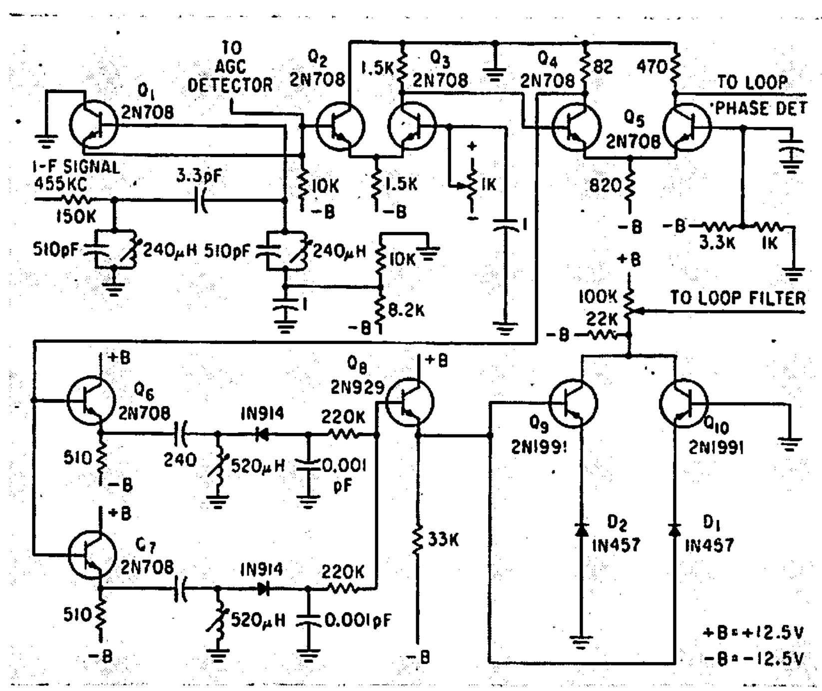
HIGH-LINEARITY PHASE DEMODULATOR—I-f signal is amplified by Q1, clipped by Q2-Q3, and resulting square wave phase-demodulated in coincidence circuit Q4-Q5 which also receives similarly clipped 455-kc reference signal. Demodulated output of Q6 is reshaped by clipper Q7-Q8, to give symmetrical output with linearity for deviations up to 85 deg.—W. H. Casson and C. C. Hall, New Phase-Tracking Demodulator Will Not Lock on Sidebands, *Electronics*, 36:6, p 52–55.



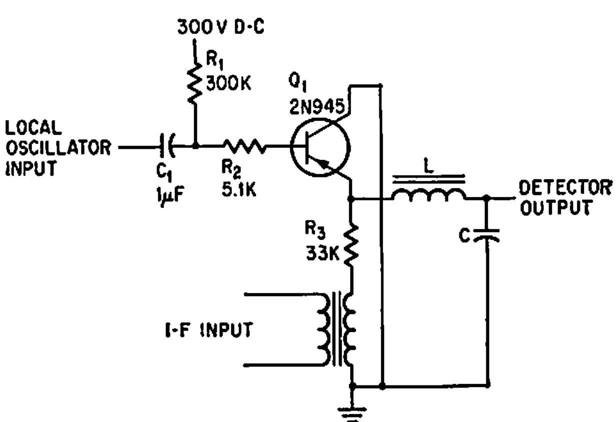
BOXCAR ENVELOPE DETECTOR—Gives accurate recovery of one-polarity modulation envelope by approximating envelope in level steps between successive peaks of wavetrain.—J. L. Markwalter, Boxcar Envelope Detector, *EEE*, 12:9, p 62–63.



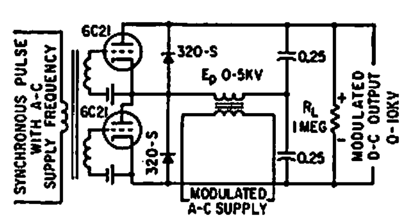
SMOOTHED D-C FROM F-M—Mean d-c level, derived from f-m data on magnetic tape, undergoes R-C smoothing in three-transistor pulse-counting demodulator circuit so output can be fed to cro.—K. R. Whittington, Simple F-M Demodulator for Audio Frequencies, *Electronics*, 35:48, p 89.



DUAL DETECTORS PREVENT LOCKING ON SIDEBANDS—Antisideband circuit rejects sideband locking while telemetry tracking loop is automatically searching for signals around i-f value. Circuit also provides both p-m and a-m demodulation. Emitter-follower Q1, receiving i-f signal, feeds discriminator Q6-Q7 through limiters Q2-Q3 and Q4-Q5. For 455-kc input, d-c outputs of diode detectors cancel at base of Q8. For lower or higher frequencies, difference voltage serves to apply antisideband error signal to loop filter through Q9 or Q10.—W. H. Casson and C. C. Hall, New Phase-Tracking Demodulator Will Not Lock on Sidebands, *Electronics*, 36:6, p 52–55.

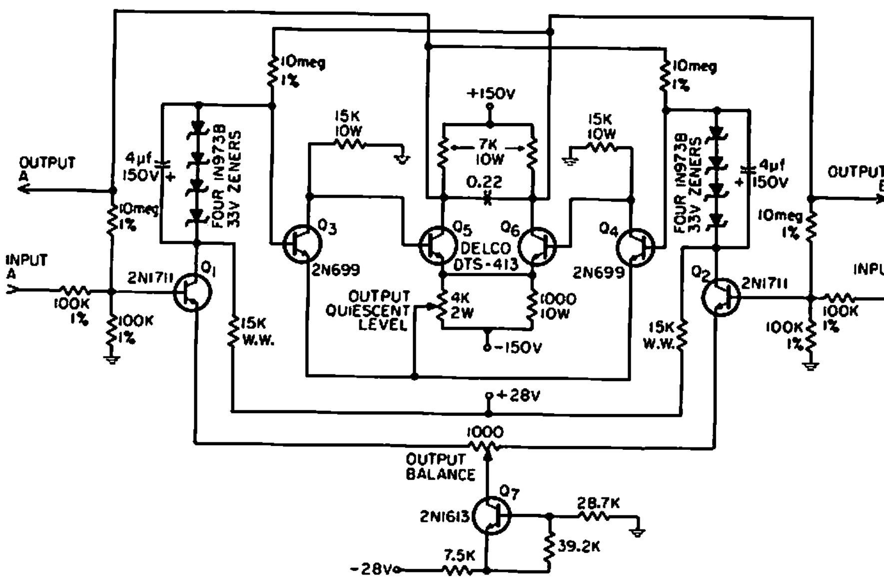


SYNCHRONOUS DETECTOR—Linear detection permits variation of bandwidth after detection in pcm receivers. Also used as a-m detector and for measuring phase and amplitude of unmodulated signals.—G. S. Parks, Detector Circuit Measures Phase and Amplitude, *Electronics*, 38:12, p 84-85.

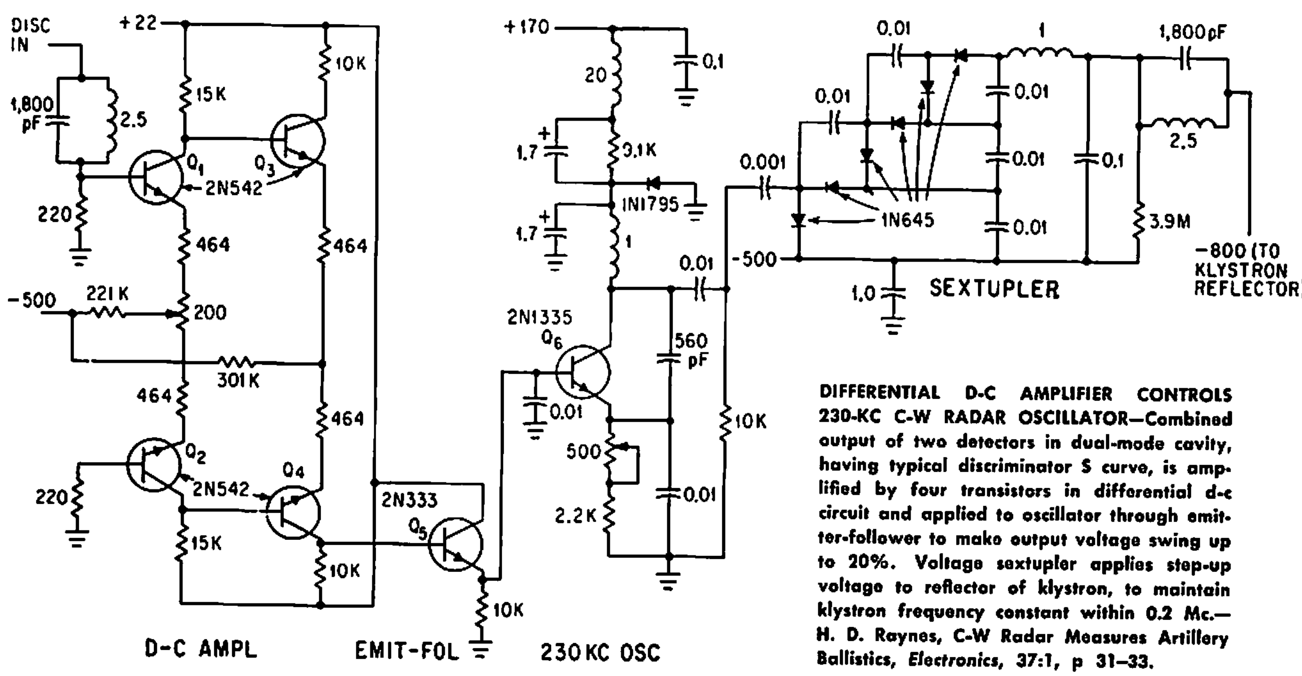


PULSED DEMODULATOR—Used to provide voltage to modulating anode of klystron power amplifier at control rates above 10 cps, in system that controls output power of uhf tropospheric communications links in accordance with received signal at opposite end of link, to compensate for fading.—L. P. Yeh, Loop Controls Scatter Power to Offset Fading, *Electronics*, 32:5, p 60–62.

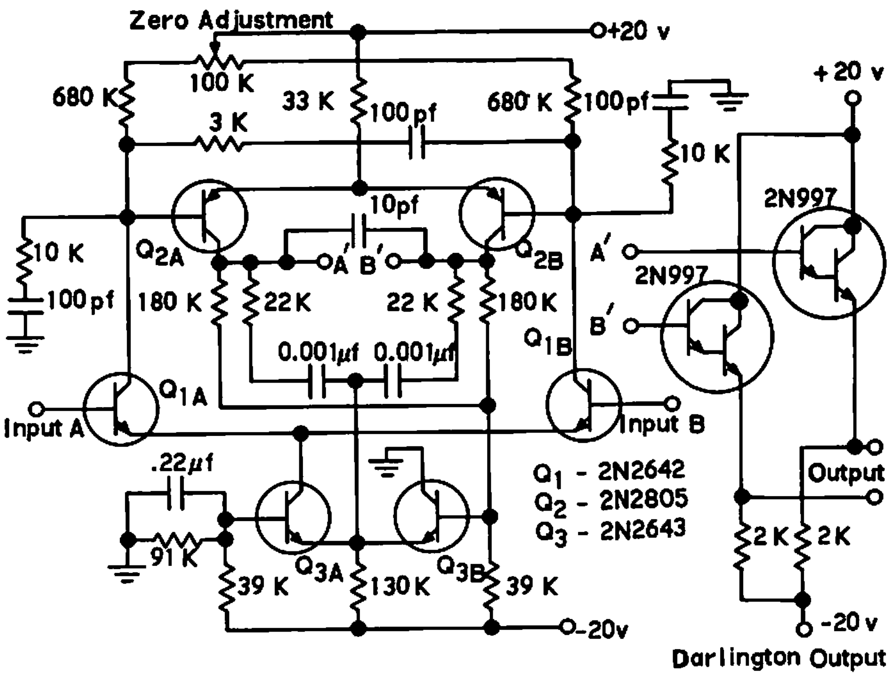
CHAPTER 26
Differential Amplifier Circuits



400-V OUTPUT SWING WITH TRANSISTORS—Direct-coupled differential voltage amplifier gives gain of 100 as low-frequency oscilloscope amplifier. Drift is less than 1 v over normal room temperature range. Output quiescent level is 0 v to ground, peak noise level is 3 v, and bandwidth is 5 kc. Amplifier is not damaged by shorted output, overdrive, or supply voltages applied in any sequence.—C. L. Benson, 400-Volt Output Transistor Amplifier, *EEE*, 14:8, p 168.

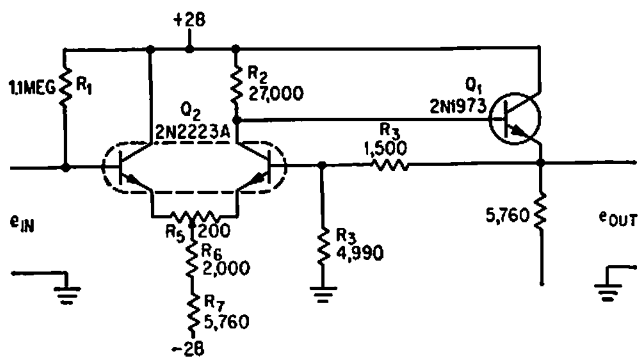


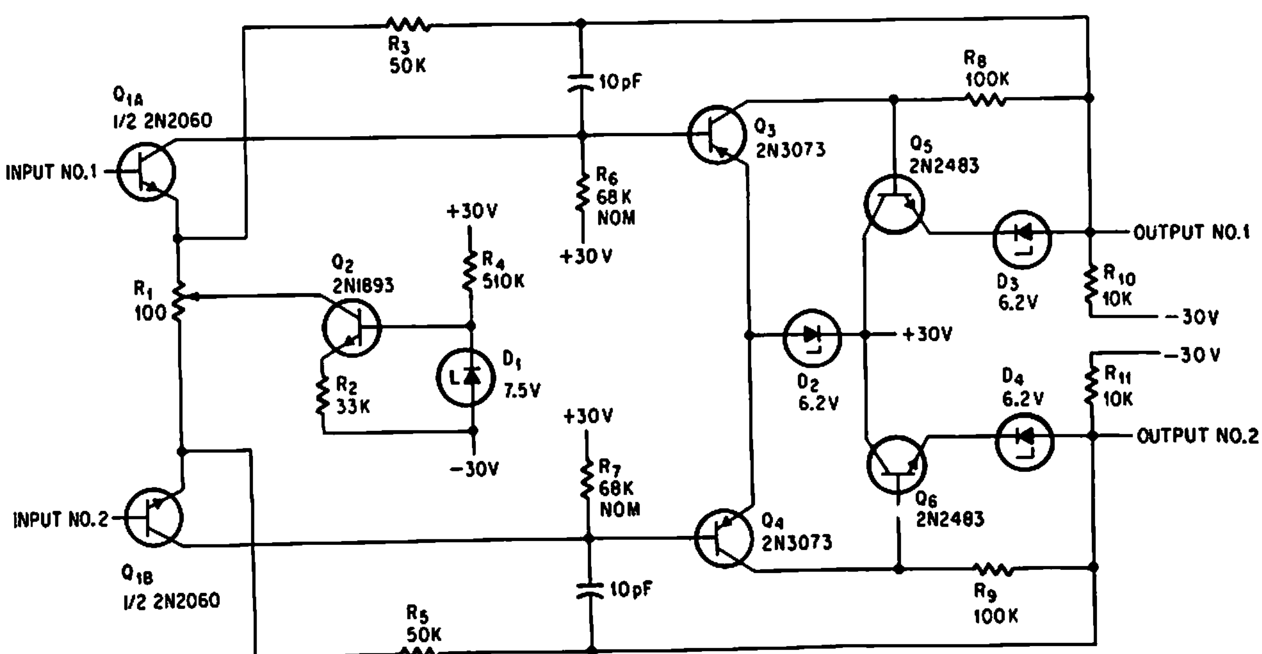
DIFFERENTIAL D-C AMPLIFIER CONTROLS 230-KC C-W RADAR OSCILLATOR—Combined output of two detectors in dual-mode cavity, having typical discriminator S curve, is amplified by four transistors in differential d-c circuit and applied to oscillator through emitter-follower to make output voltage swing up to 20%. Voltage sextupler applies step-up voltage to reflector of klystron, to maintain klystron frequency constant within 0.2 Mc.—H. D. Raynes, C-W Radar Measures Artillery Ballistics, *Electronics*, 37:1, p 31–33.



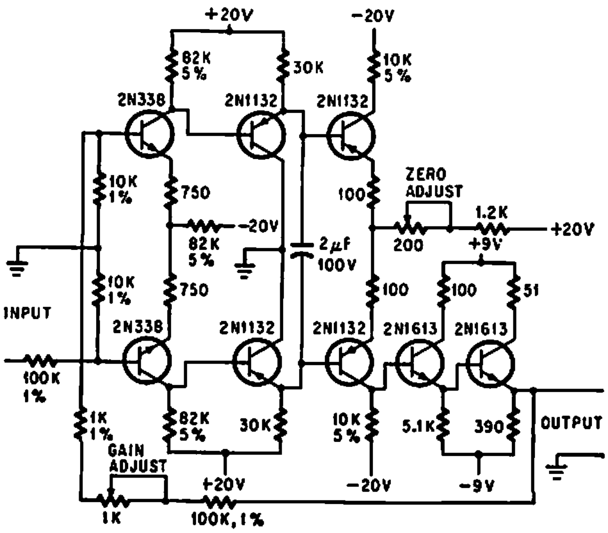
DIRECT-COUPLED DIFFERENTIAL AMPLIFIER—Designed for general use as complete amplifier with Darlington output stage, or as first two stages of low-drift high-gain amplifier without amplifier stage. Provides both low and high common-mode rejection for either differential or single-ended outputs. High common-mode rejection is achieved by use of common-mode feedback loop. Low drift is achieved by using dual transistor Q3 as first stage of common-mode feedback loop.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 161.

D-C AMPLIFIER SERVES AS VOLTAGE REGULATOR—Output voltage of series pass transistor Q1 is compared to input voltage serving as reference voltage by differential amplifier Q2 and variations are fed back to reduce difference. Feedback ratio of 0.67 gives overall gain of 1.3 and 10-ohm output impedance.—W. S. Zukowsky, Aligning Saturn Missile's Guidance System, *Electronics*, 37:8, p 26–27.

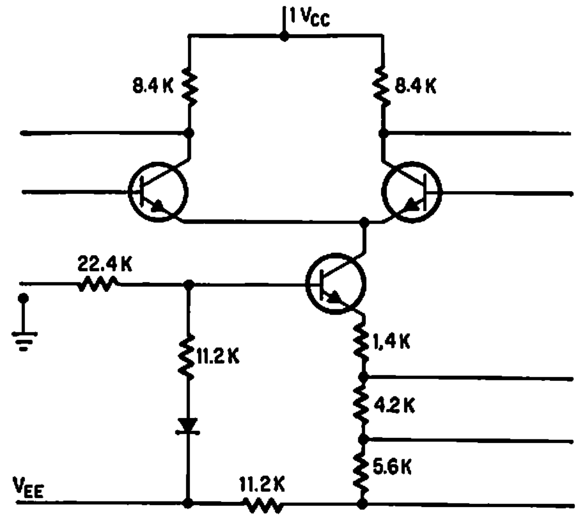




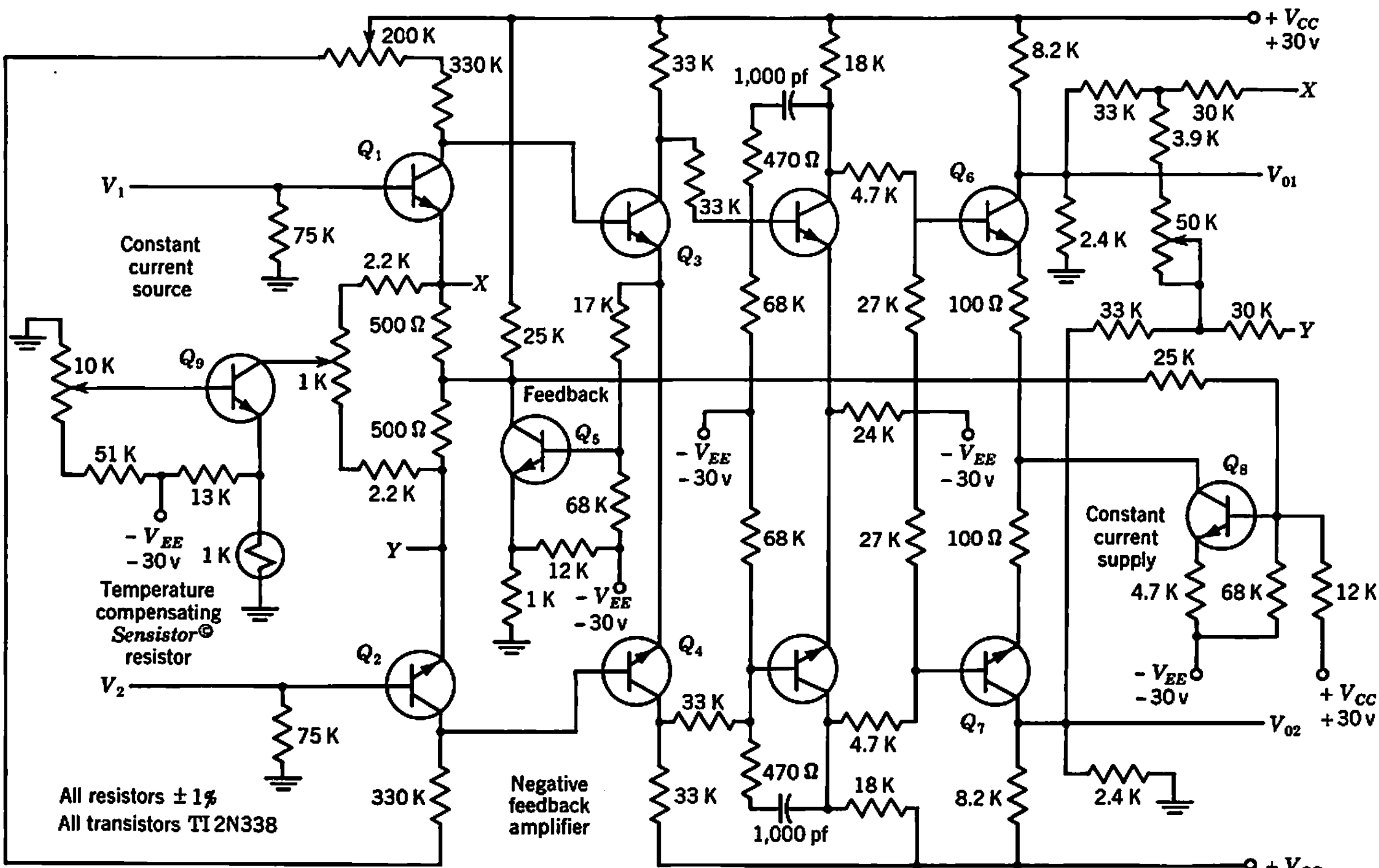
NO-CHOPPER DIFFERENTIAL AMPLIFIER—Stable voltage gain is 1,000. Current source Q2 provides bias for input stage. Amplification is linear within 10 microvolts over 100°C range.—D. F. Hilbiber, Stable Differential Amplifier Designed Without Choppers, *Electronics*, 38:2, p 73–75.



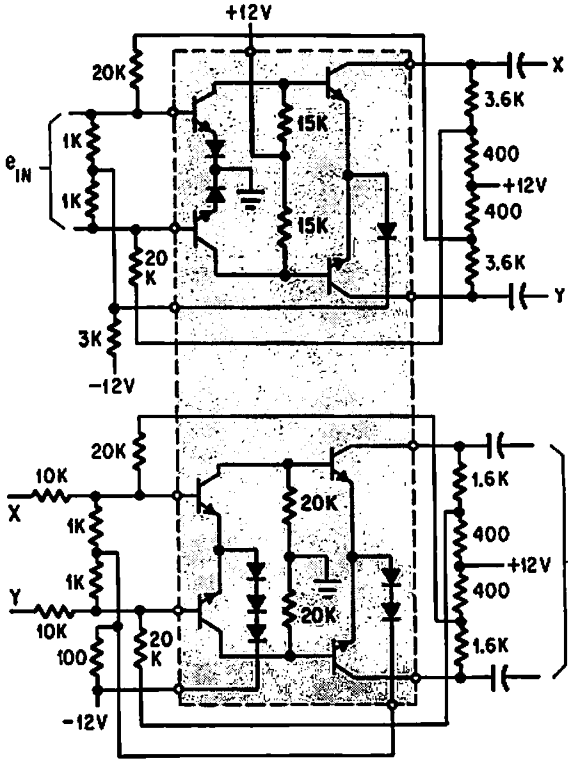
UNITY-GAIN DIFFERENTIAL D-C AMPLIFIER— Negative feedback with differential input and single-ended output give gain stability of 1.0000 for output of 1.2 v across 100-ohm load, for use in battery-powered transistor leakage-current tester.—A. T. Ashby, T. R. Shaifer, and H. R. Hagner, Testing Transistors In-Circuit, *Electronics*, 37:17, p 53–56.



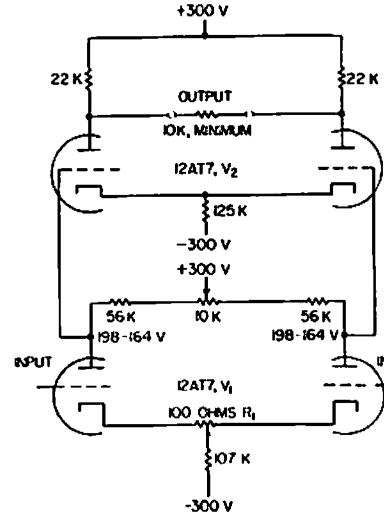
DIFFERENTIAL AMPLIFIER— Use of transistor in place of emitter resistor gives tenfold increase in impedance of emitter circuit, up to 200,000 ohms, while using only 1% of substrate area that would be needed by film resistor of this size.—R. Hirschfeld, IC's Improve Differential Amplifiers—and Vice Versa, *Electronics*, 38:16, p 75–79.



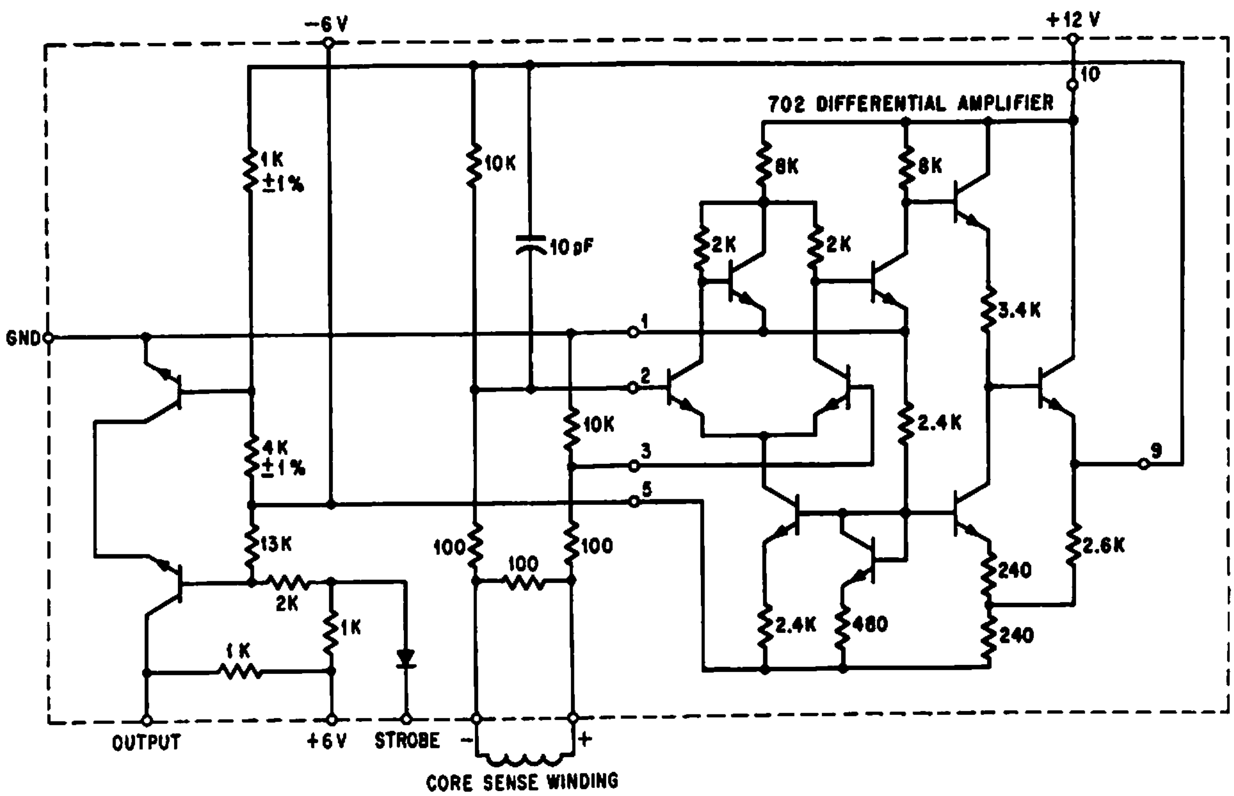
FOUR-STAGE DIFFERENTIAL AMPLIFIER— Designed for maximum open-loop amplification of differential signal. Series-shunt negative feedback provides high input impedance and low output impedance. Responds to differential signal of 25 microvolts superimposed on common level that varies from 0 to 5 v. Voltage gain is continuously variable from 100 to 500. Frequency response is flat within 1% from d-c to 1,000 cps. Ideal for telemetering systems.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N. Y., 1963, p 138.



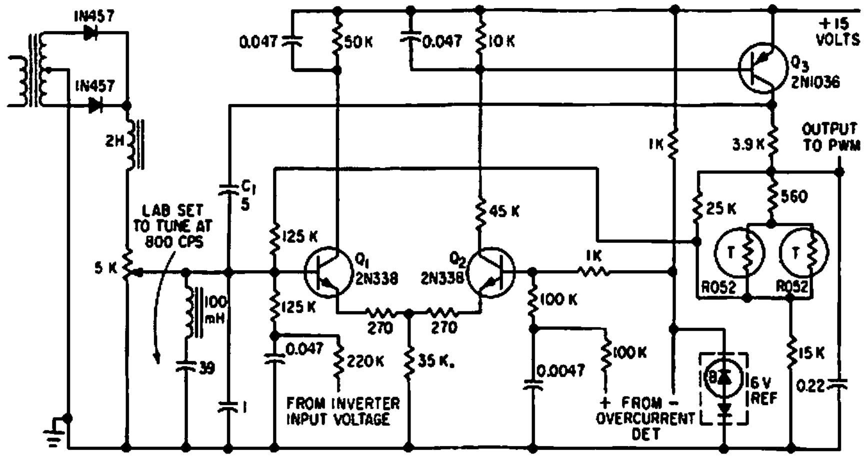
DIFFERENTIAL CURRENT AMPLIFIER—Uses eight npn transistors and eight diodes.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p. 58–64.



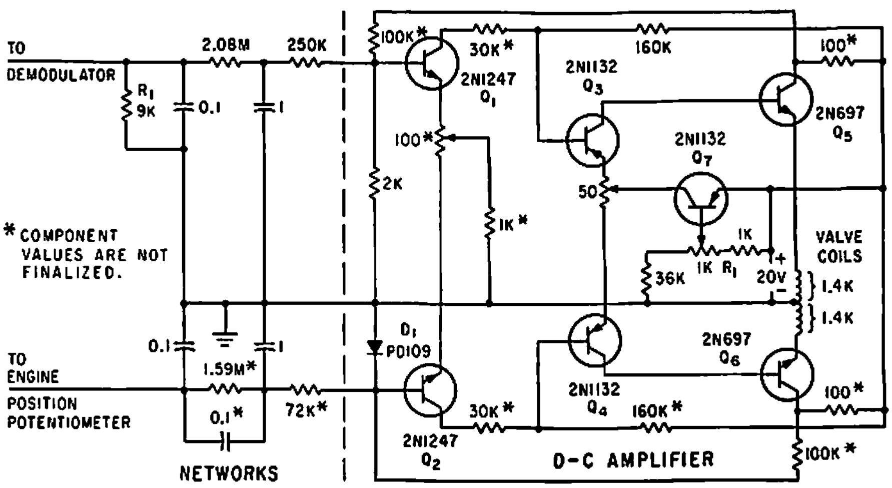
WIDE-DYNAMIC-RANGE DIFFERENTIAL AMPLIFIER—Used in amplifying and measuring small differences between two large voltages, either of which may be up to 100 v above ground. Amplification of difference voltage is 250. Frequency response is within 3 db from d-c to 250 kc.—D. D. Davis, High Dynamic Range Differential Amplifier, *Electronics*, 31:5, p 64–66.



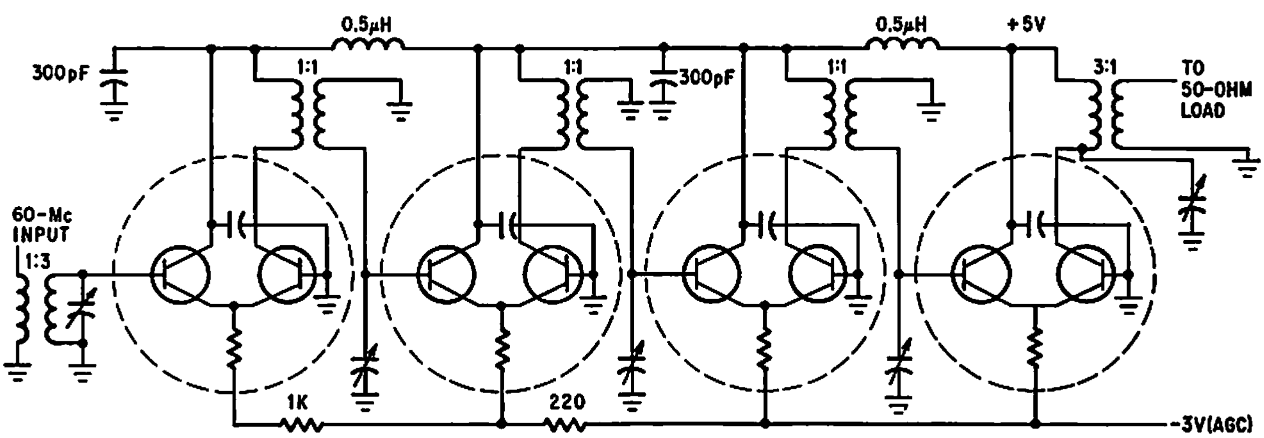
SENSE AMPLIFIER—Uses two flatpacks (shaded areas) attached to thick-film passive network. —F. A. Plemenos, The Packaging Revolution, Part VI: Converting to Microelectronics, *Electronics*, 39:4, p 103–109.



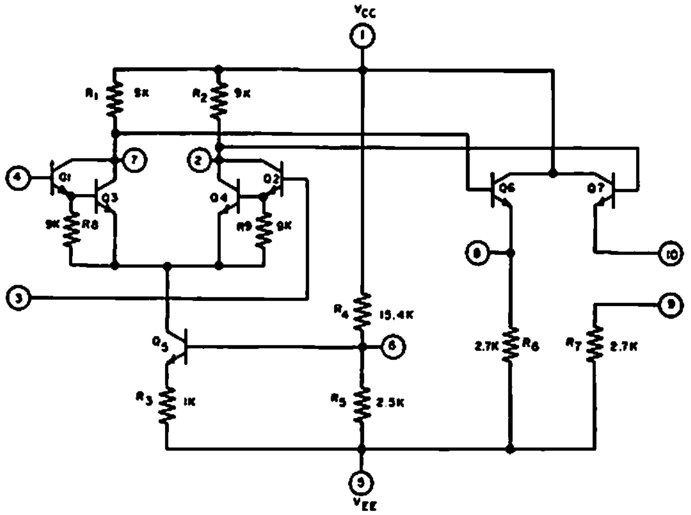
VOLTAGE REGULATOR—Portion of three-phase inverter output is filtered, rectified, and compared with temperature-compensated breakdown diode in differential amplifier Q1-Q2. Inverter load current and input battery voltage signals are also fed into differential amplifier, to further improve regulation.—R. J. Kearns and J. J. Rolfe, Three-Phase Static Inverters Power Space-Vehicle Equipment, *Electronics*, 34:18, p 70–73.



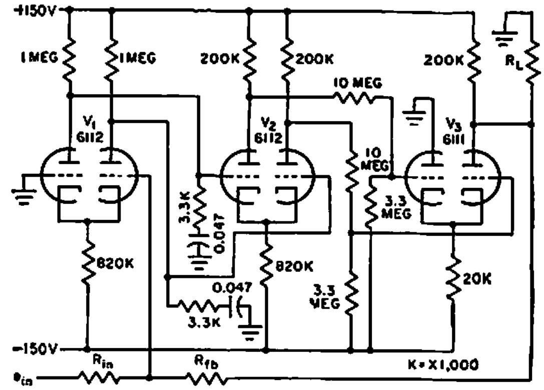
51-DB POWER GAIN FOR AUTOPILOT—Two differential stages, Q1-Q2 and Q3-Q4, drive two emitter-followers Q5 and Q6 which in turn drive valve coils in pitch and yaw channels of autopilot.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33:43, p 60–64.



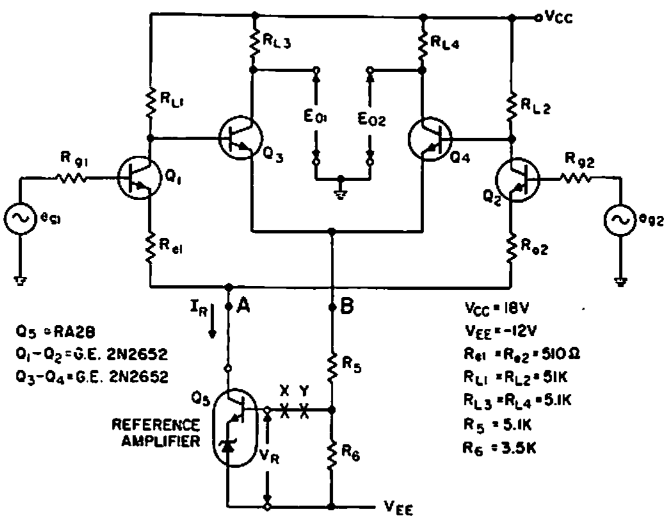
F-M LIMITER—Four differential-amplifier integrated circuits serve as 60-Mc i-f f-m limiter having 6-Mc bandwidth and 80 db power gain.—R. Hirschfeld, IC's Improve Differential Amplifiers—and Vice Versa, *Electronics*, 38:16, p 75–79.



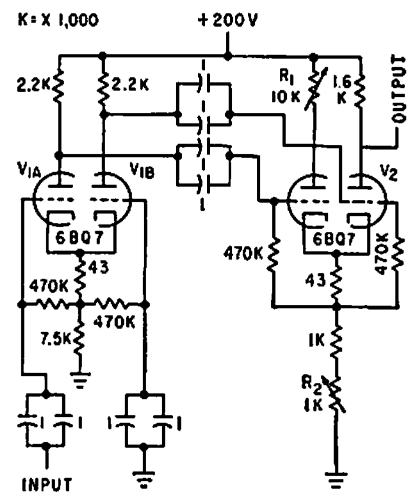
DIFFERENTIAL AMPLIFIER—Single-stage configuration for monolithic construction uses bleeder resistors with Darlington input transistors to increase bandwidth and gain. Current source is biased from separate bias resistor to increase output amplitude. Minimum differential voltage gain of Micronet 203 version is 100 and minimum bandwidth is 500 kc.—C. L. Heizman and D. G. Paterson, Circuit Analysis: A Monolithic Integrated Operational Amplifier, *EEE*, 13:5, p 80–84.



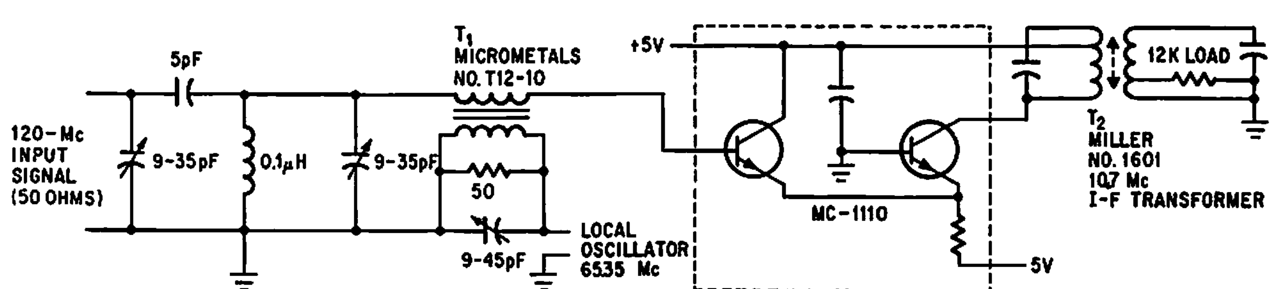
BALANCED DIFFERENTIAL OPERATIONAL AMPLIFIER—Open-loop gain is above 5,000 into 10,000-ohm load. Good stability and summing accuracy are obtained with closed-loop gains of 0.1 to 100. Provides 50-v output voltage swing for integrating or differentiating in control systems. Phase lag of 5° at 20 cps with closed-loop gain of 10 precludes use in high-frequency control systems. —L. S. Klivans, D-C Amplifiers for Control Systems, *Electronics*, 31:47, p 96–100.



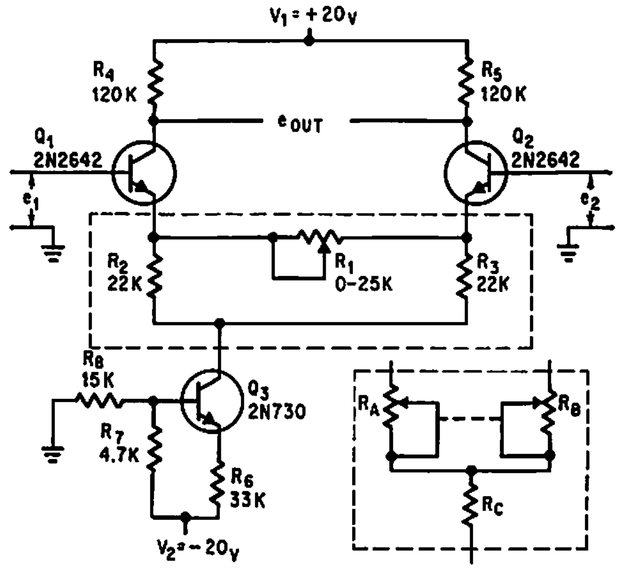
TWO-STAGE DIFFERENTIAL AMPLIFIER WITH COMMON-MODE FEEDBACK—Feedback arrangement provides significant reduction in temperature drift of bias circuits. Voltage gains of several thousand are possible.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 119.



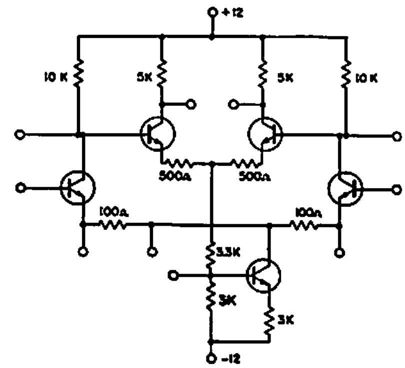
CANCELLING POWER SUPPLY VARIATIONS—Differential amplifiers in cascade cancel output error caused by supply fluctuations, to permit low-level signal amplification.—J. Holtzman, Reducing Errors Caused by Power-Supply Variations, *Electronics*, 32:29, p 54–55.



HARMONIC MIXER—MC-1110 differential-amplifier integrated circuit cancels odd-order harmonics while mixing. Local oscillator operates at half of mixing frequency. Conversion gain is 33 db from 120 Mc to 10.7 Mc.—R. Hirschfeld, IC's Improve Differential Amplifiers—and Vice Versa, *Electronics*, 38:16, p 75–79.

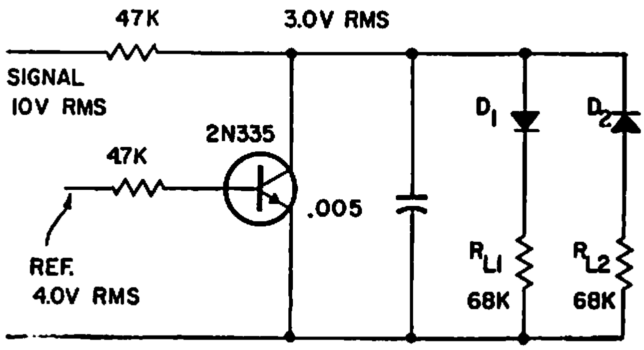


VARIABLE-GAIN DIFFERENTIAL AMPLIFIER—R1 controls gain. High dynamic impedance of constant-current source gives differential amplifier Q1-Q2 high common-mode rejection ratio.—G. Beene, Variable Resistor Controls Differential Amplifier Gain, *Electronics*, 37:29, p 74.

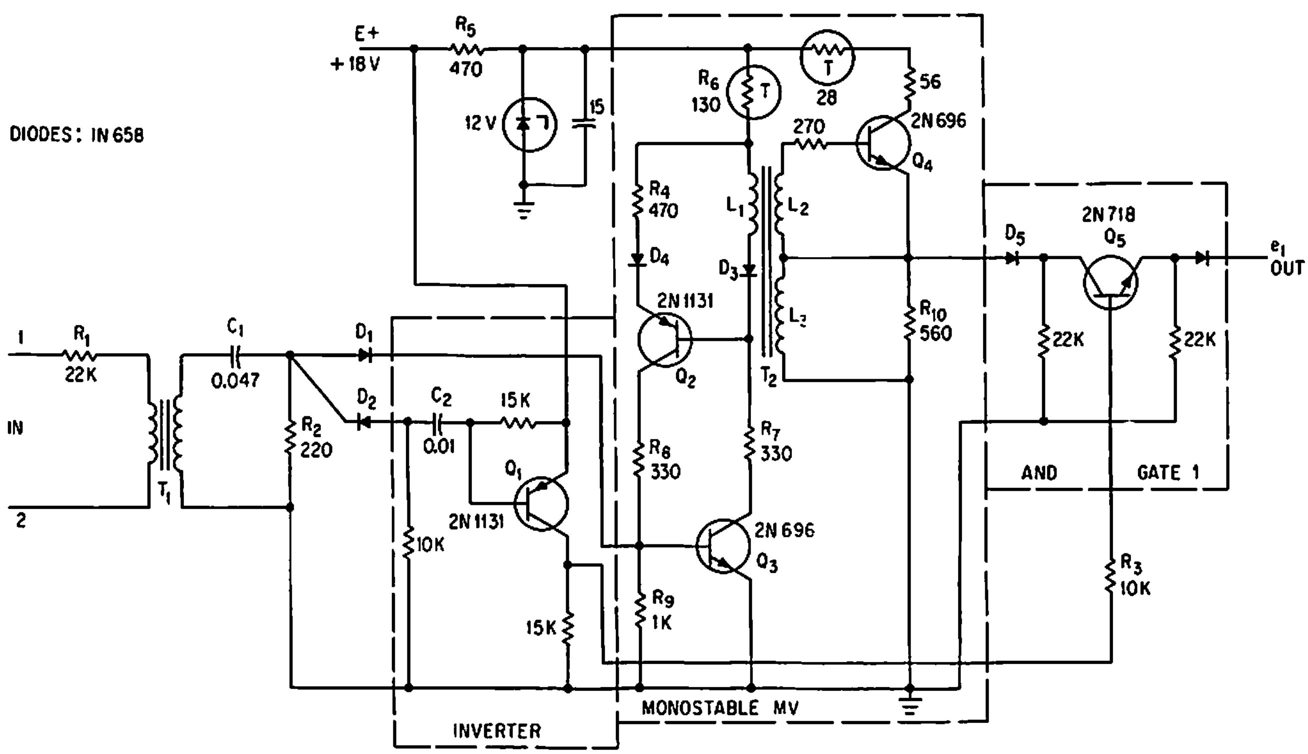


INTEGRATED-CIRCUIT DIFFERENTIAL AMPLIFIER—Common-mode output is 0.5 mv peak-to-peak, differential gain is 540, and common-mode rejection is 120 db at 60 cps in Amelco D13001 monolithic integrated circuit. —T. Prosser, How to Measure Differential-Amplifier Common-Mode Rejection, *EEE*, 12:7, p 74–75.

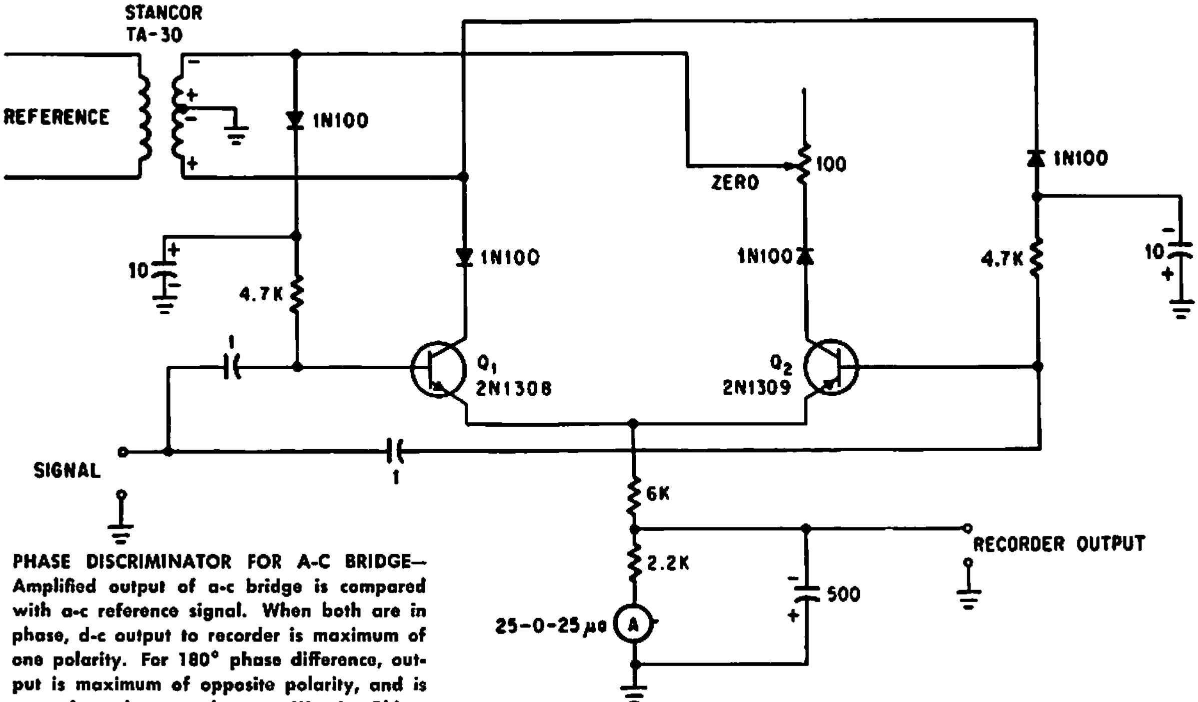
CHAPTER 27
Discriminator Circuits



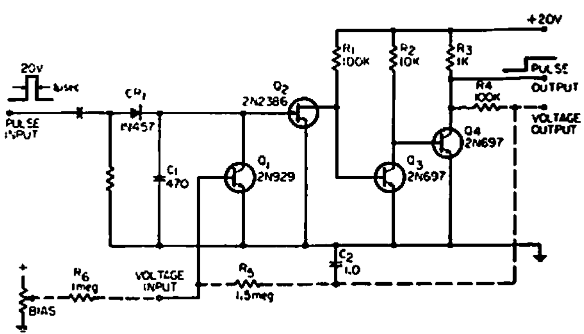
PHASE DISCRIMINATOR—Will deliver half-wave pulses to one of two loads, as determined by 0 or 180° difference between input signal and reference source. Useful where different devices, such as heating and cooling equipment, are to be actuated by change of signal phase.—A Phase Discriminator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 88.



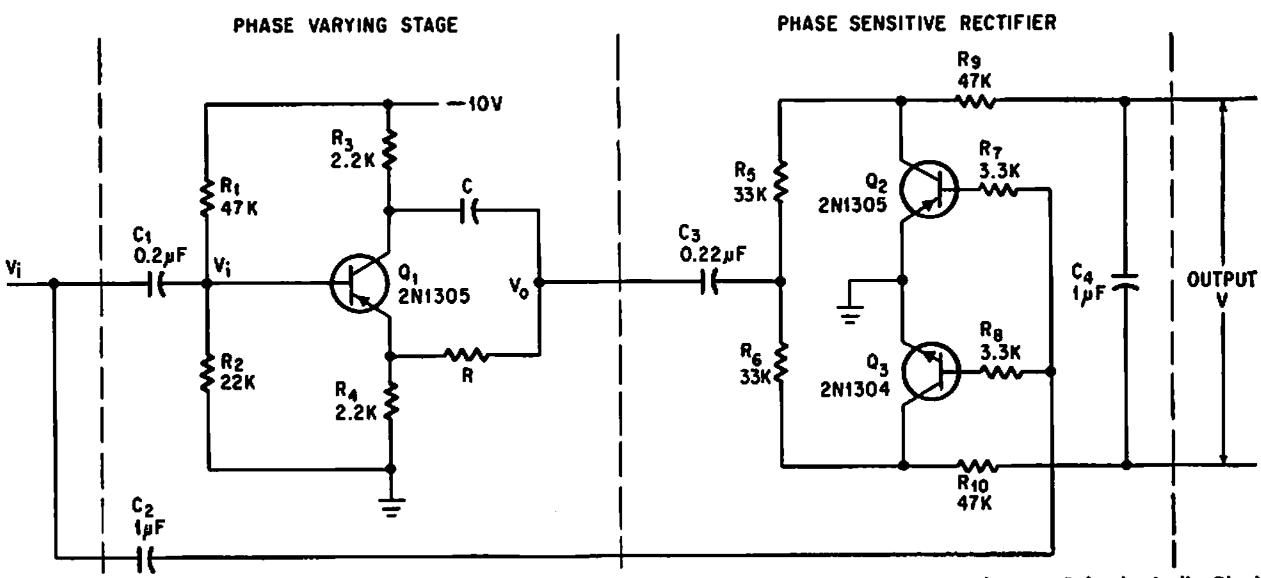
CHANNEL SELECTOR REPLACES TUNING DEVICES—By sensing leading edges of input signals, discriminator having two monostable multivibrators, inverter, and two *and* gates provides output for desired channel frequency in radio, television, telemetry, and digital control systems.—J. H. Firestone, Gated Pulses Yield Selected Frequency Outputs, *Electronics*, 36:51, p 38–40.



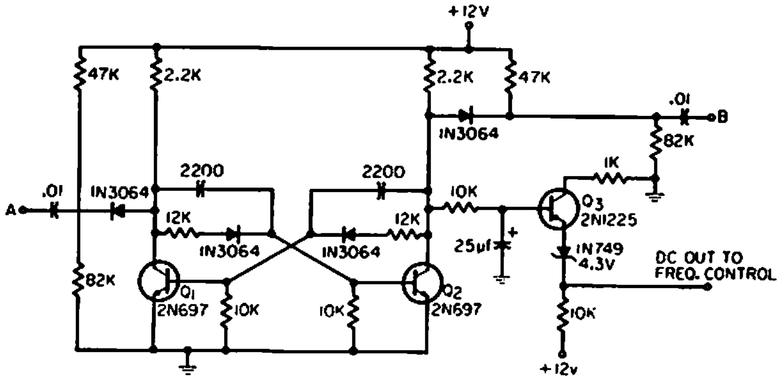
PHASE DISCRIMINATOR FOR A-C BRIDGE—Amplified output of a-c bridge is compared with a-c reference signal. When both are in phase, d-c output to recorder is maximum of one polarity. For 180° phase difference, output is maximum of opposite polarity, and is zero for phase-quadrature.—W. A. Rhinehart and L. Mourlam, FET Performs Well In Balancing Act, *Electronics*, 38:19, p 88–92.



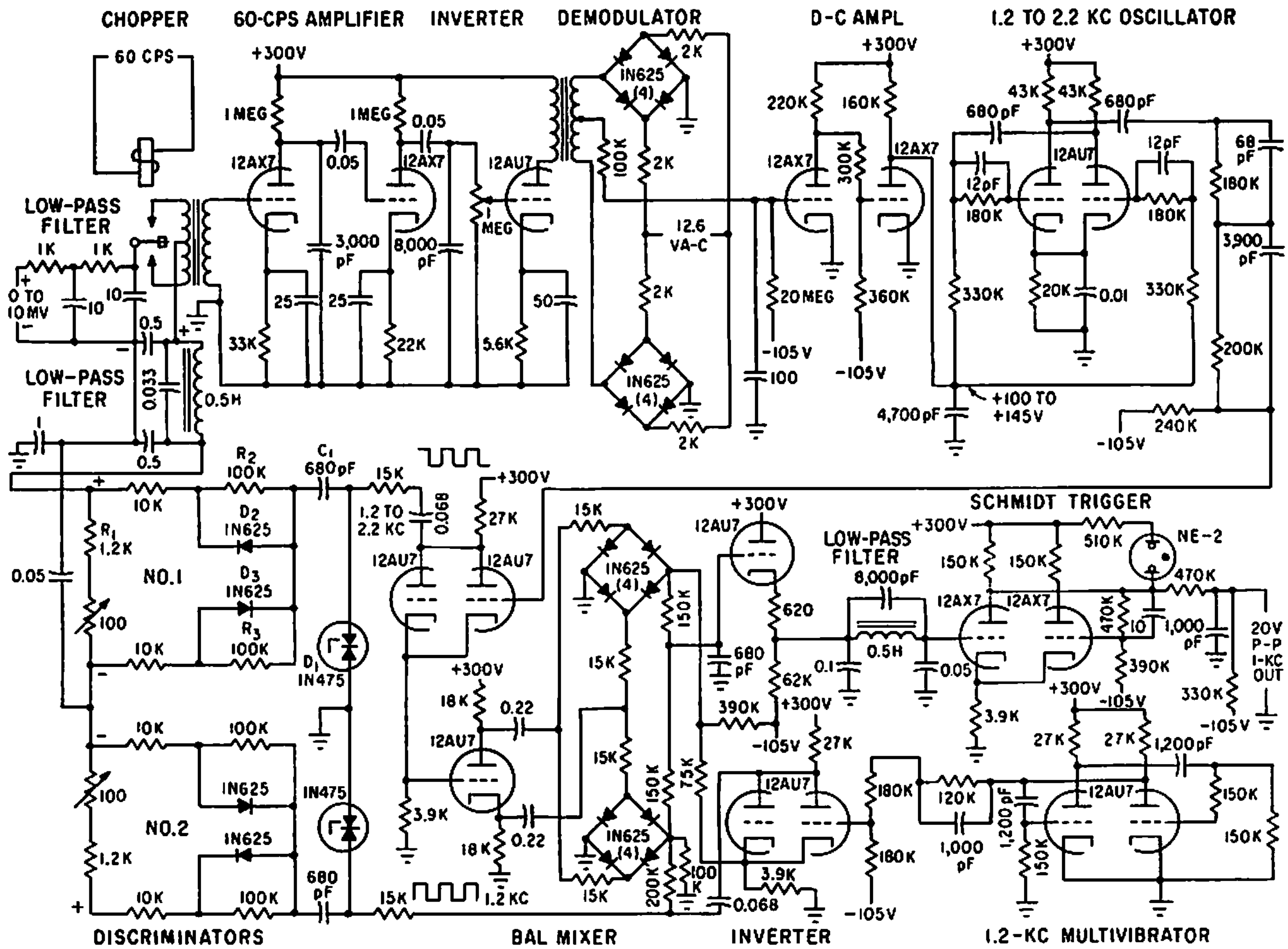
MONO AND PRF DISCRIMINATOR—Monostable multivibrator can be electronically adjusted to vary output pulse width over range of 0.2 microsec to several seconds. By adding feedback path shown in dashed lines, circuit also serves as pulse repetition frequency discriminator in which d-c output voltage is function of frequency from 3 cps to 300 kc.—G. Richwell, Wide-Range Monostable, PRF Discriminator, *EEE*, 13:8, p 67.



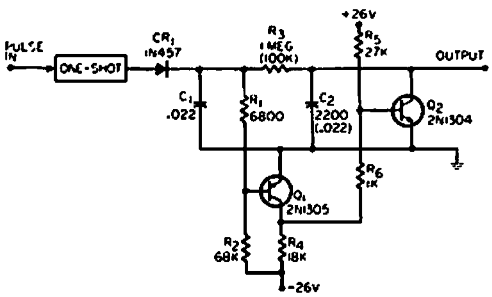
TWO-STAGE A-F DISCRIMINATOR—Circuit first shifts phase of incoming signal in proportion to its frequency deviation, then produces d-c voltage proportional to phase shift. Used to measure wow and flutter of disk and tape recorders having prerecorded audio signal.—J. F. Delpech, Audio Discriminator Measures Large Frequency Changes, *Electronics*, 39:9, p 76–77.



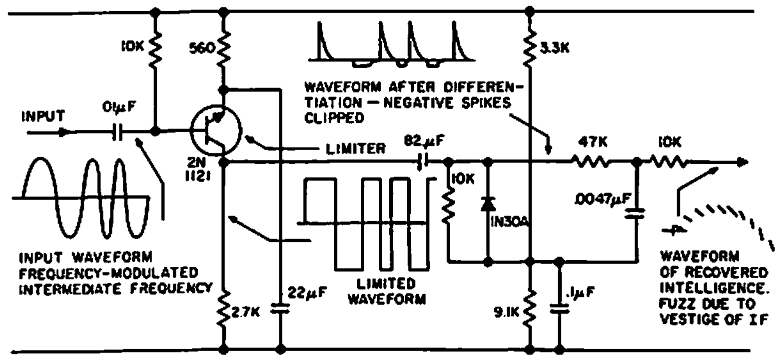
PHASE LOCK—Uses flip-flop, filter, and d-c level shift to phase-lock low-frequency oscillator to a desired frequency. Trigger from master frequency source is fed in at B, and trigger from phase-locked frequency is fed to A. Used to sync ujt sawtooth generator to operate at 10 times the 16-cps center frequency at B.—H. Anway, Phase-Locked Frequency Discriminator, *EEE*, 14:3, p 61.



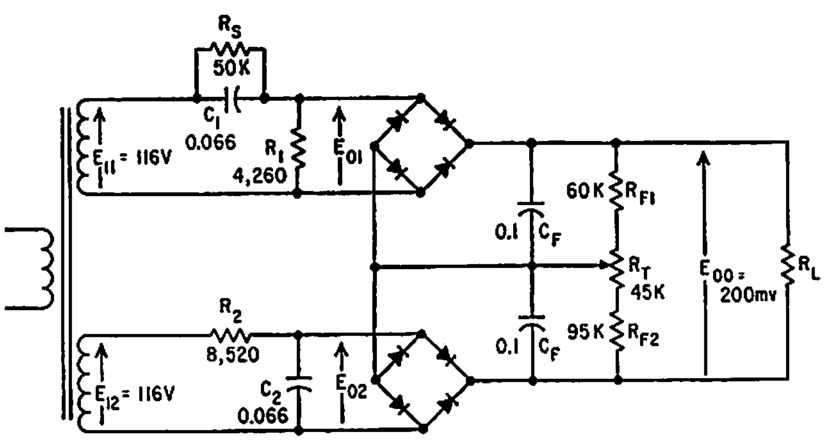
VOLTAGE-CONTROLLED 0-1 KC OSCILLATOR—Pulse-counting discriminator in feedback loop gives adequate linearity for computing applications. As input voltage rises from 0 to 10 mv, oscillator output frequency rises proportionally.—N. W. Bell and V. Chiunti, Voltage-Controlled Oscillator Uses Negative Feedback, *Electronics*, 35:11, p 64–65.



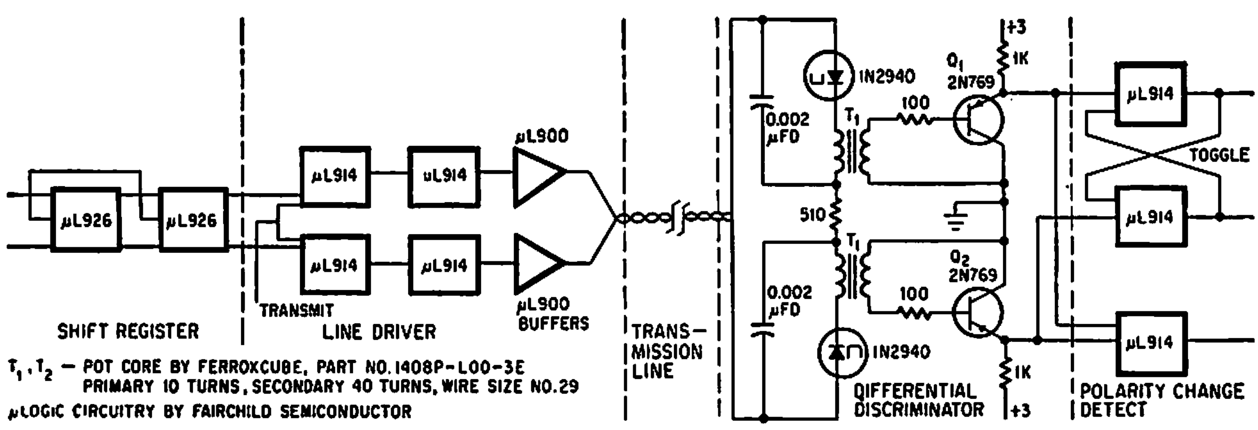
PRF DISCRIMINATOR—Requires pulse-train burst of only two successive pulses to determine prf above or below given limit. Two such circuits with *nand* gate can indicate presence of given prf within 0.1% or within 1 cps of 1 kc. Input pulses are first given standard width and amplitude by one-shot.—G. Richwell, PRF Discriminator, *EEE*, 13:7, p 41.



PULSE-COUNTING F-M DISCRIMINATOR—Based on inherent stability of tunnel diode as converter oscillator in f-m receiver for strong-signal locations. Uses 200-kc i-f center frequency as input.—D. Hubbard, Pulse-Counter FM Discriminator Design, *EEE*, 10:7, p 44–49.

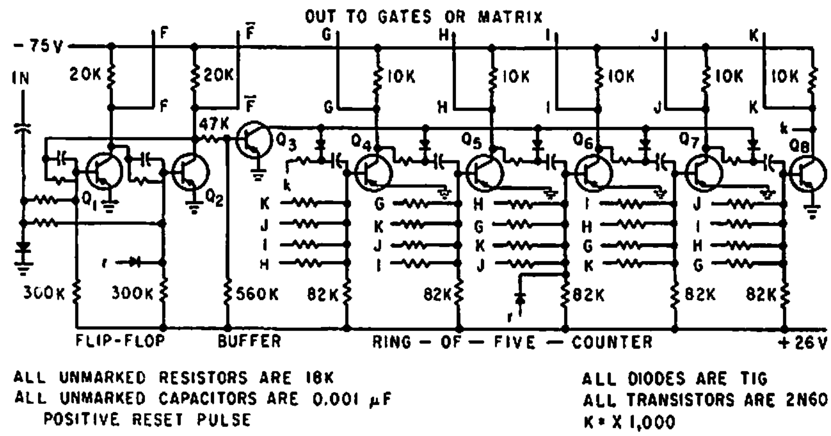


ALTERNATOR FREQUENCY CONTROL—Servo discriminator measures phase with respect to preadjusted components, making accuracy a function of initial setting. At 400 cps, d-c output is 100 mv for frequency deviation of 0.5 cps. Absolute accuracy is 0.125% between −55 and +100°C ambient. Used as error-sensing device with servo drive in feedback control loop of constant-speed transmission for aircraft alternators.—R. Hill, Discriminator Controls Aircraft Alternator, *Electronics*, 31:41, p 94–95.

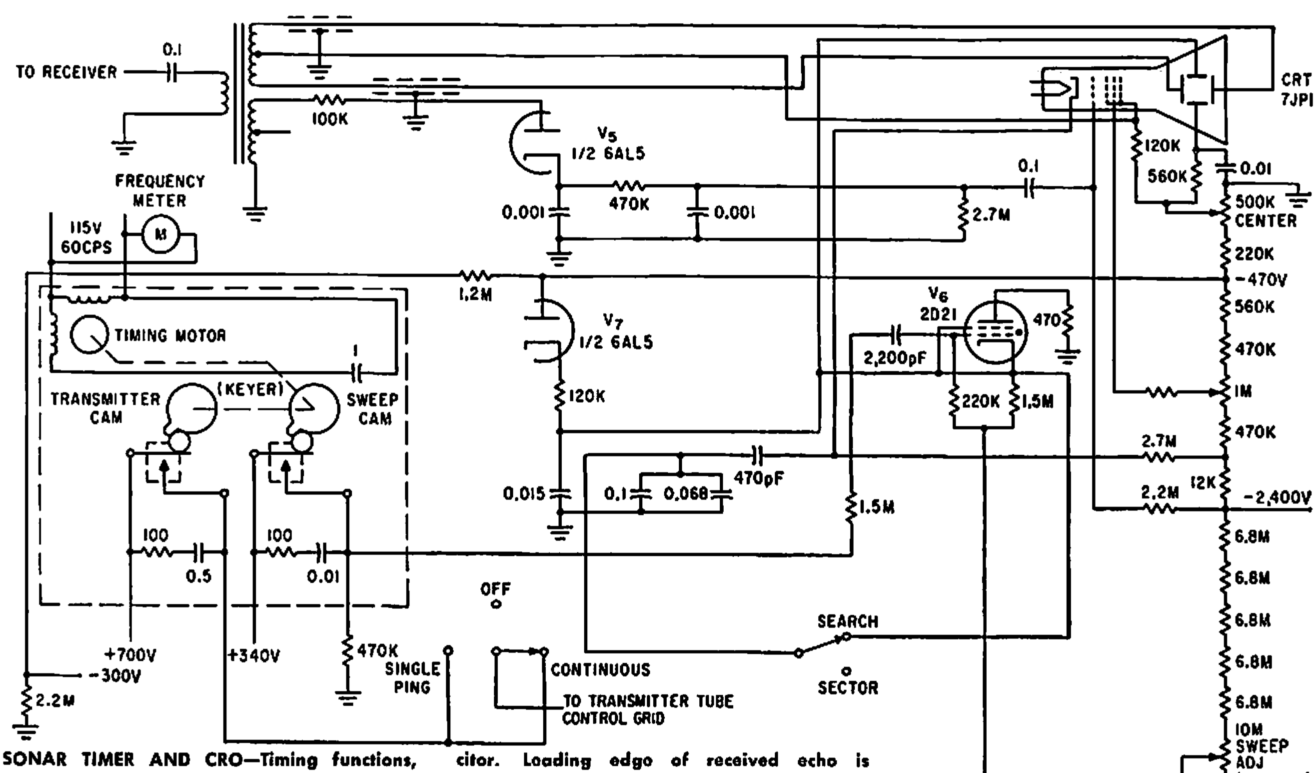


DIFFERENTIAL DISCRIMINATOR—Tunnel diodes serve as current level detectors, allowing detection of serial bit information while providing common-mode rejection of noise. Used in system for transmitting phase-modulated digital data over telephone line. Original pulse waveforms are restored by diodes. —F. Salter, Differential Discriminator Rejects Common-Mode Noise, *Electronics*, 39:15, p 101-102.

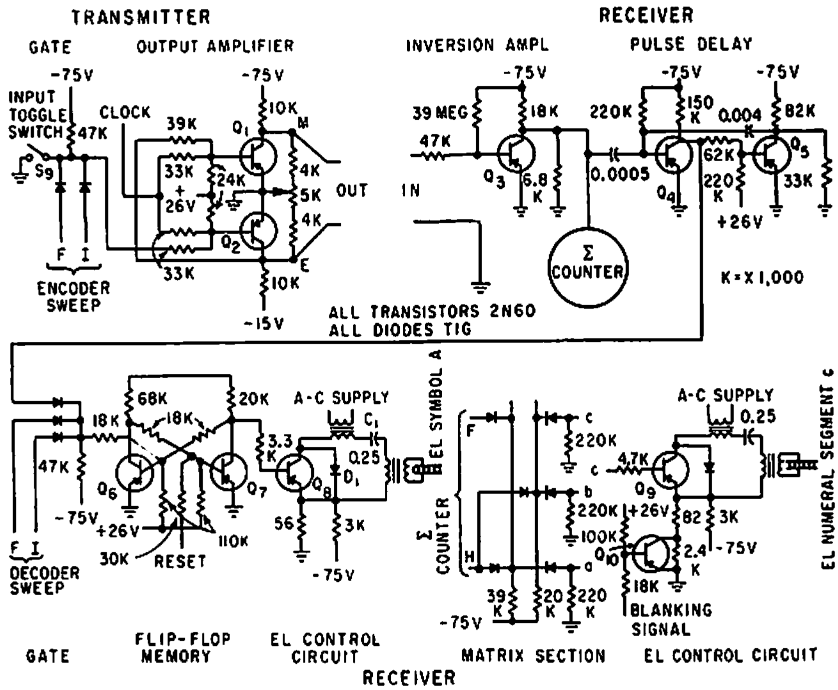
CHAPTER 28
Display Circuits



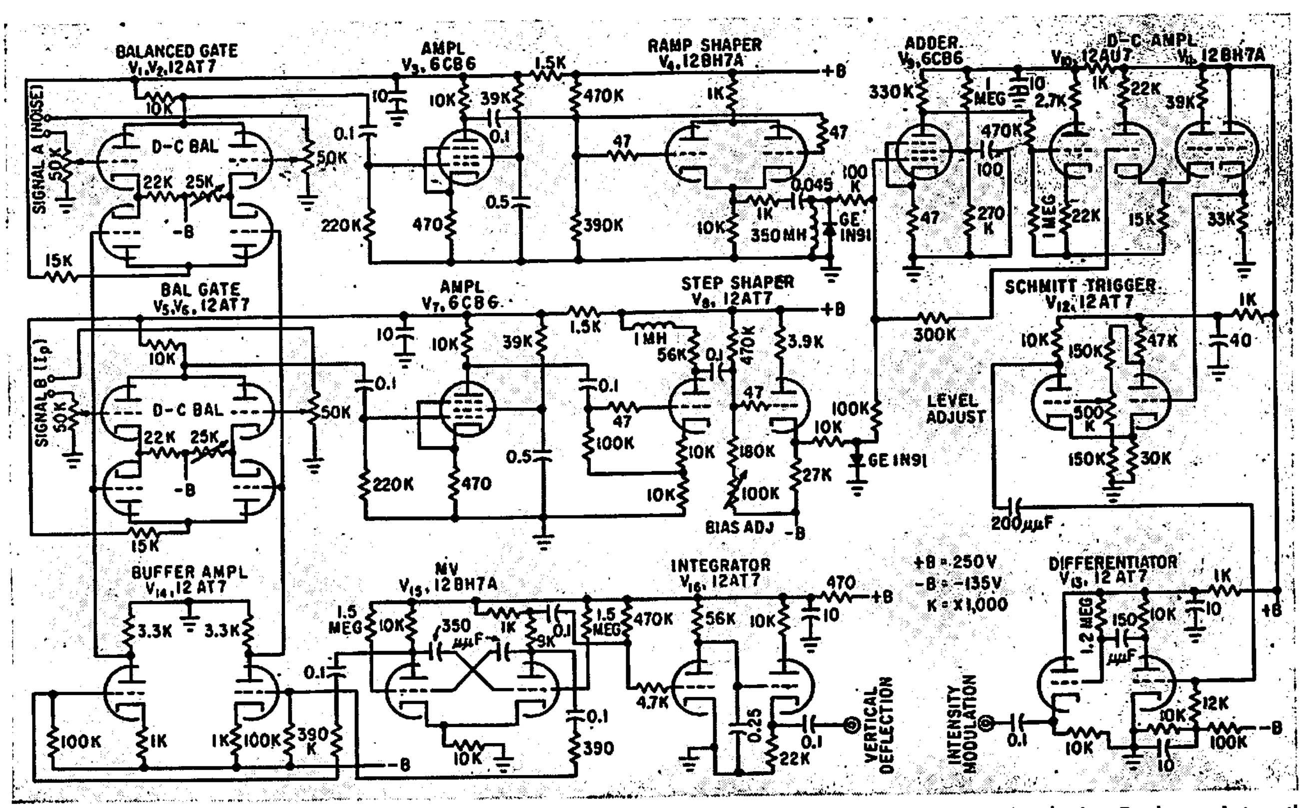
10-STATE RING COUNTER—Flip-flop drives ring-of-five stage that in turn drives diode matrix which translates each stored decimal number to electroluminescent display segment code.—R. C. Lyman and C. I. Jones, Electroluminescent Panels for Automatic Displays, *Electronics*, 32:28, p 44–47.



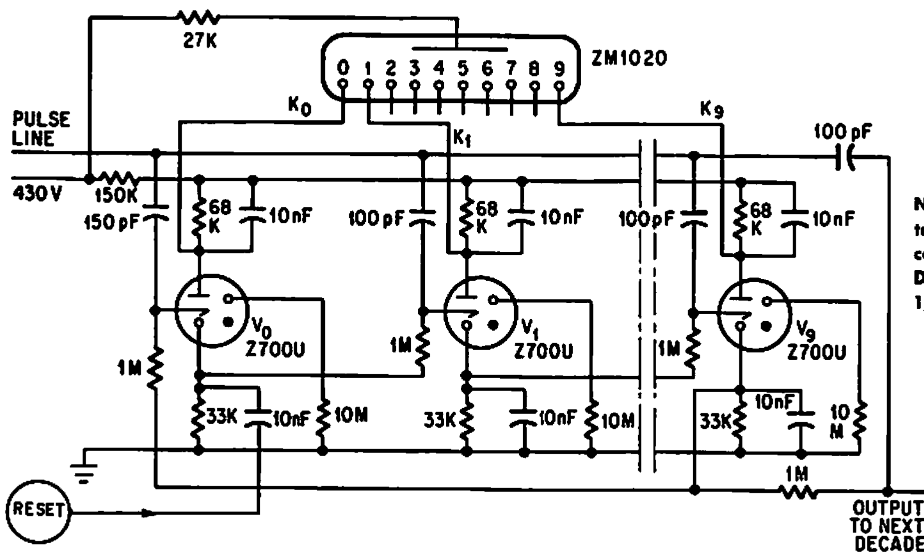
SONAR TIMER AND CRO—Timing functions, including display, are derived from cam-operated switches driven by synchronous motor. Thyratron V6 discharges sweep capacitor. Loading edge of received echo is aligned by delay control with crt reference line, and delay time in millisec is read directly from dial.—L. H. Dulberger, Sonar to Survey Arctic Ocean Shelf Transmits Through Ice and Water, *Electronics*, 34:31, p 44–45.



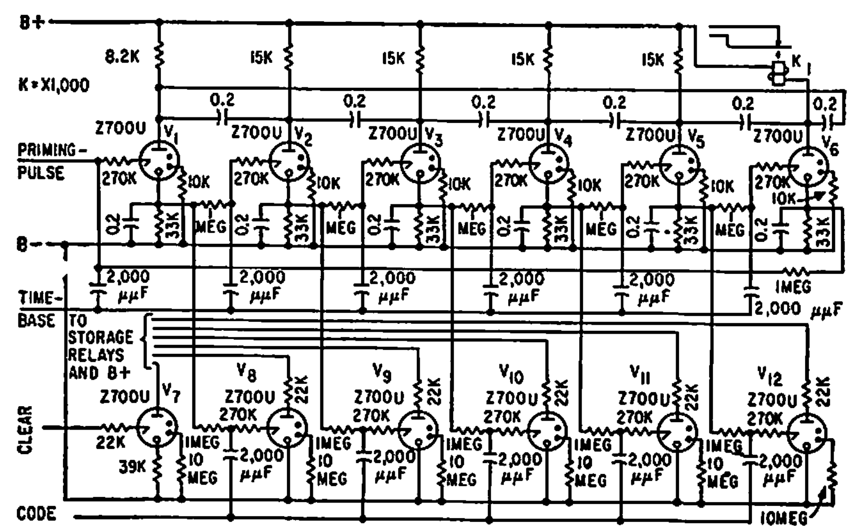
BINARY CHANNEL FOR EL DISPLAY—Information is transmitted to decoding unit and display board in series of pulse bursts, each containing entire information to be displayed, for rapid error correction if information is garbled during transmission. System can use pair of wires for transmission, having sufficient bandwidth to pass pulse burst. Information is introduced by opening S9 in transmitter.—R. C. Lyman and C. I. Jones, Electroluminescent Panels for Automatic Displays, *Electronics*, 32:28, p 44–47.



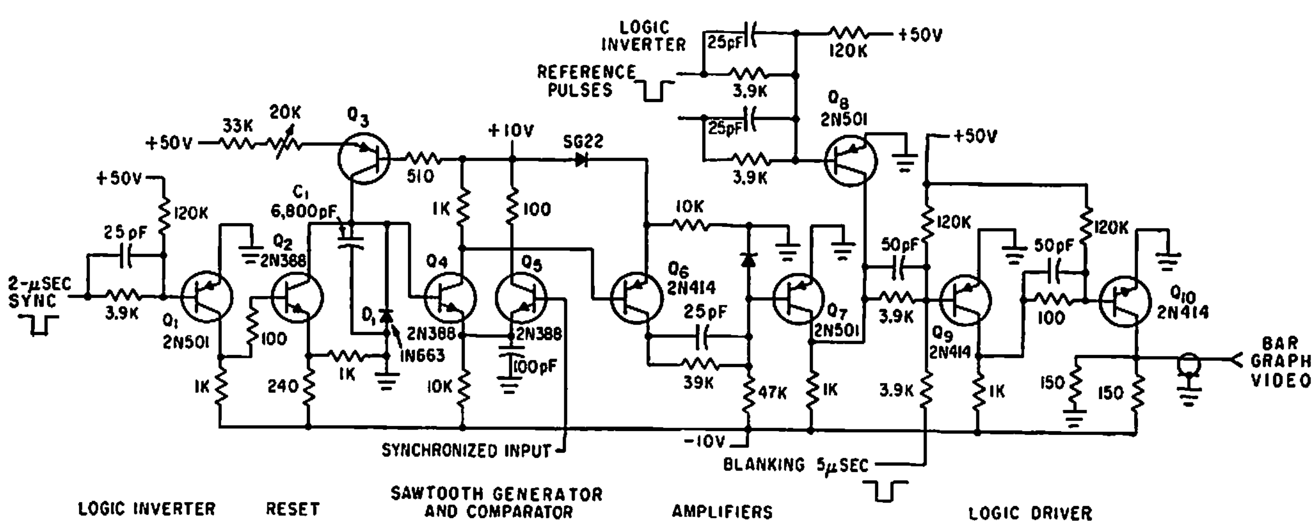
ANALOG-TYPE RATIO COMPUTER—Computes and automatically displays on oscilloscope the ratio of two time-varying quantities, such as noise suppression factor of tube shot noise. Five main parts are sampler, shaper of ramp or step in each channel, amplitude comparator, converter for final indicator, and timing unit that provides sampling signal.—J. Tamiya, Automatic Display of Noise Suppression Factor, *Electronics*, 33:6, p 55–57.



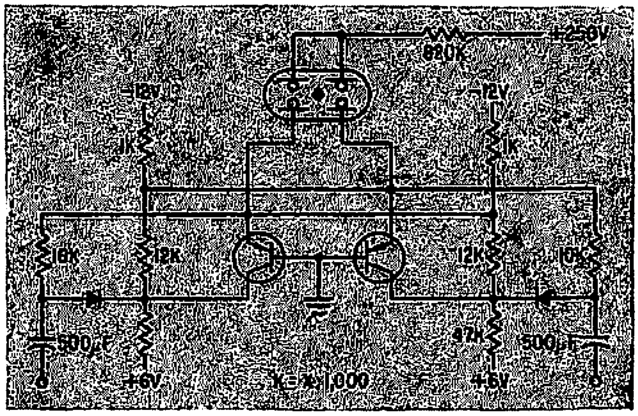
NUMERICAL DISPLAY—Either cold-cathode trigger tubes or transistors drive 10-digit cold-cathode indicator tube.—M. A. MacDougall, Using the Cold-Cathode Tube: Part 1, *Electronics*, 38:6, p 78–82.



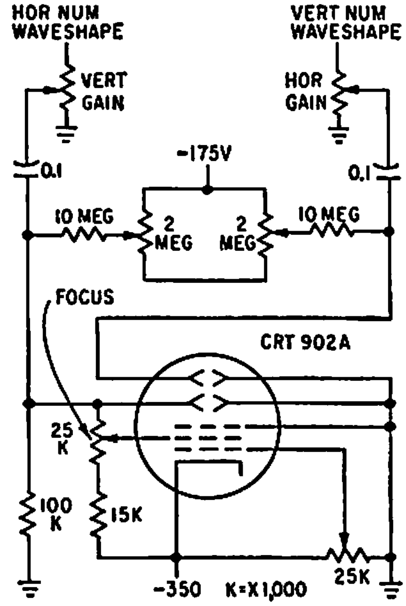
PULSE-COINCIDENCE CONTROL—Coincidence of incoming code with reference pulse causes cold-cathode code tubes to fire in accordance with binary number present, for driving display panel containing eight sections each having 30 miniature fluorescent lamps.—T. S. Pick and A. Readman, Photoelectric Scanners Control Bus Traffic, *Electronics*, 32:28, p 50–51.



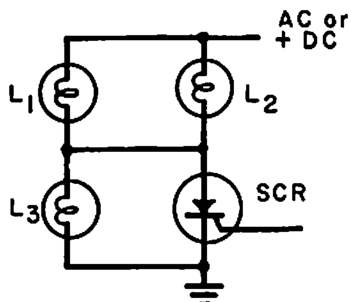
CCTV DISPLAYS VOLTAGES AS BAR GRAPHS—No change is necessary in closed-circuit television monitor. Switch gives choice of bar graph or picture display. Horizontal lines can be electronically positioned on screen as go and no-go limits. Display conversion system has counter that commutates up to 20 low-frequency analog voltages on to common bus feeding comparator input shown.—D. Cohen, Converter Produces Television Bar Display, *Electronics*, 34:44, p 45–47.



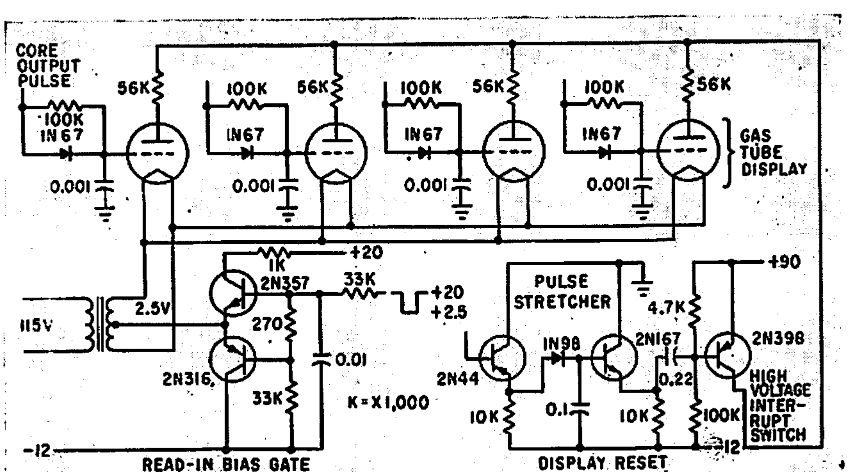
FOUR-ELECTRODE NEON—On-off indicator for transistorized flip-flop operates on voltage differential of 6 v.—A. Erikson, French Components Getting Smaller, *Electronics*, 34:11, p 24–25.



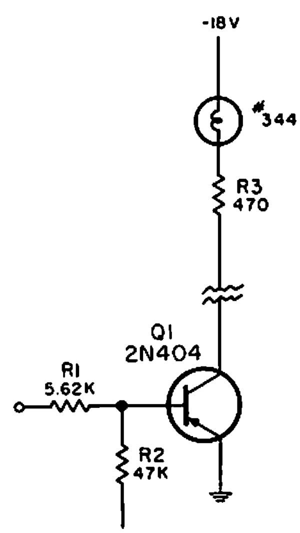
CRT CONTROL—Takes waveforms from gates and applies them to deflection electrodes of 2-inch crt to create numeral-forming Lissajous patterns.—R. L. White, Forming Handwritten-Like Digits on CRT Display, *Electronics*, 32:11, p 138-140.



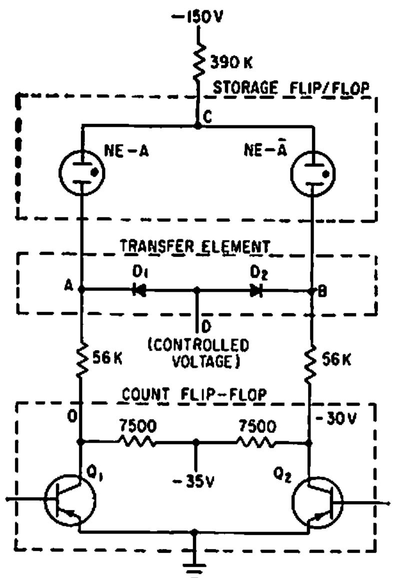
LAMP READOUT INVERSION—Used if lamp output is required with switch open, or if two lamp outputs are required (one lamp coming on for switch open and the other for switch closed). All lamps are type 39, rated 6.3 v at 0.36 amp. With scr off, voltage across L1 and L2 was 0.8 v with 6.3 v across L3, with no visible light from L1 and L2. With scr on, there is about 6.3 v across L1 and L2, with no visible output from L3.—Inversion Technique for Incandescent Lamp Readouts, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 208.



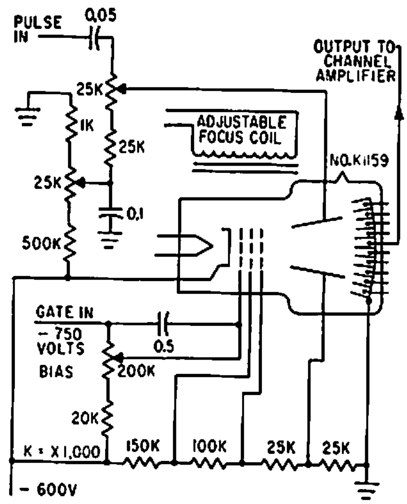
GAS-TUBE READOUT—Thyratron display tubes (Kip Memolites) remain on until next input sync pulse occurs. Static delay one-shot is then triggered, to extinguish display bulbs by dropping their plate voltage below ionization point. Bulbs are extinguished only when new input information is to be received. Used in converting up to 13 bits from Gray code to straight binary.—R. Wasserman and W. Nutting, Solid-State Digital Code-to-Code Converter, *Electronics*, 32:50, p 60–63.



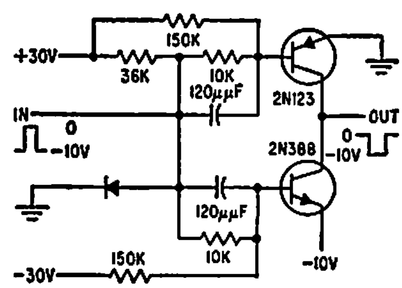
LAMP-TYPE INDICATOR—Used as indicator in digital logic circuits. Common-emitter amplifier drives type 344 lamp rated 18 ma at 12 v. Can also be used to drive electromechanical indicator having the same operating power requirements. Lamp may be remotely located.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 13 (originally PC 216), p 13–2.



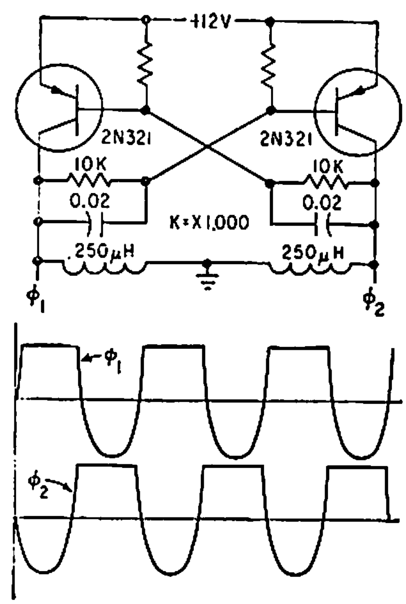
BINARY NEONS—Q1 and Q2 are active elements in transistor binaries, and lamps NE-A are pre-aged neons matched with respect to firing and running voltages. Voltage at D stores information in neon lamps.—B. H. Harrison, Photoconductive Matrix Simplifies Counter Display, *Electronics*, 34:51, p 28–30.



NANOSECOND PULSE DISPLAY—Magnetic-focus electrostatic-deflection beam-deflection tube permits pulse height analysis where pulse separation is of the order of microseconds.—J. Burns, Special Tubes for Nanosecond Display, *Electronics*, 33:49, p 82–85.



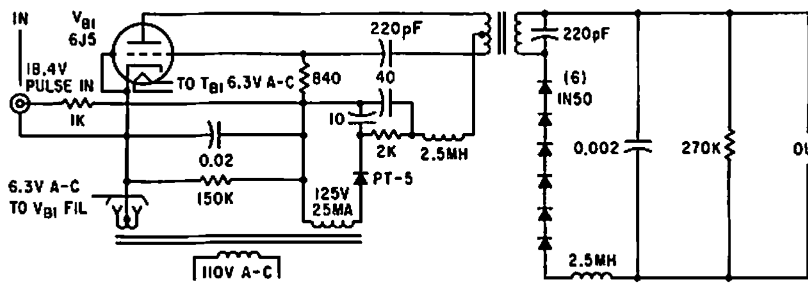
CHARACTER-FORMING DOT GENERATOR—Transistor switch, having drop of less than 50 mv when delivering 50 ma, is used in display that provides fast alphanumeric readout on crt by forming characters from series of overlapping dots.—S. C. Chao, Character Displays Using Analog Techniques, *Electronics*, 32:43, p 116–118.

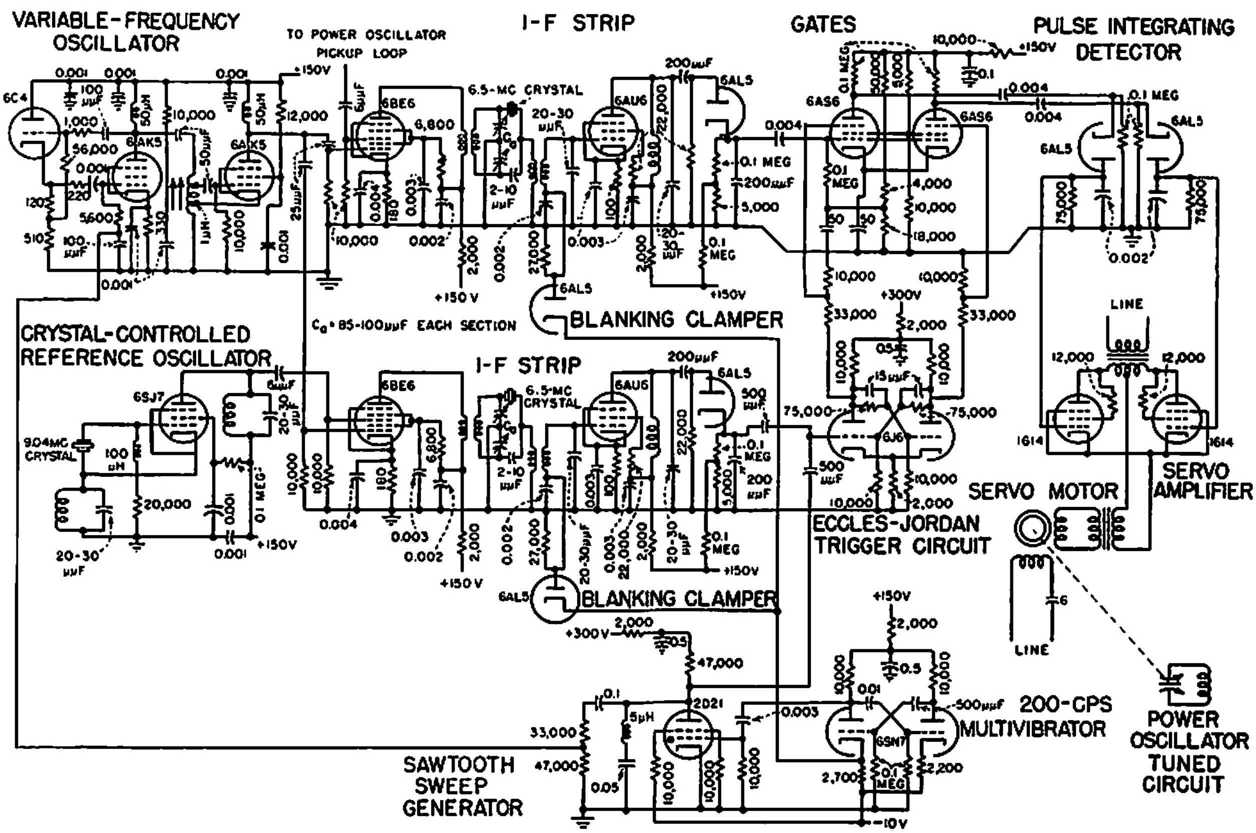


GATE-OPENING 100-KC OSCILLATOR—Output voltages are taken across r-f chokes in collector circuits, for controlling number gates of crt display that creates handwritten numerals.—R. L. White, Forming Handwritten-Like Digits on CRT display, *Electronics*, 32:11, p 138–140.

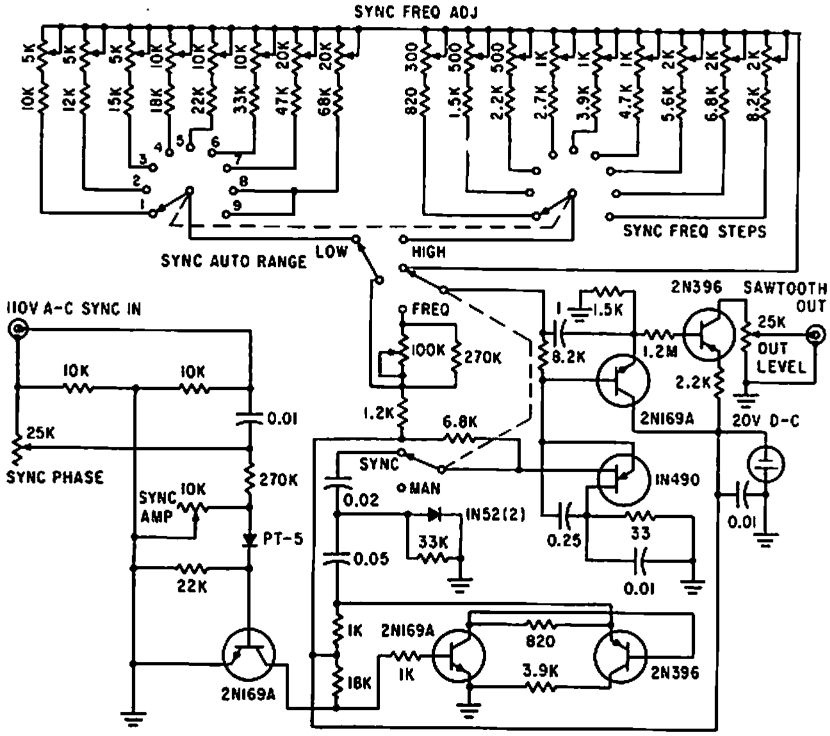
CHAPTER 29
Electronic Heating Circuits

ISOLATION OSCILLATOR—Used to isolate duty-cycle generator of induction heater control system from pulser of power oscillator.—R. E. Mathews and F. R. Sias, Jr., Testing Space Craft with Induction Heaters, *Electronics*, 35:34, p 38–41.

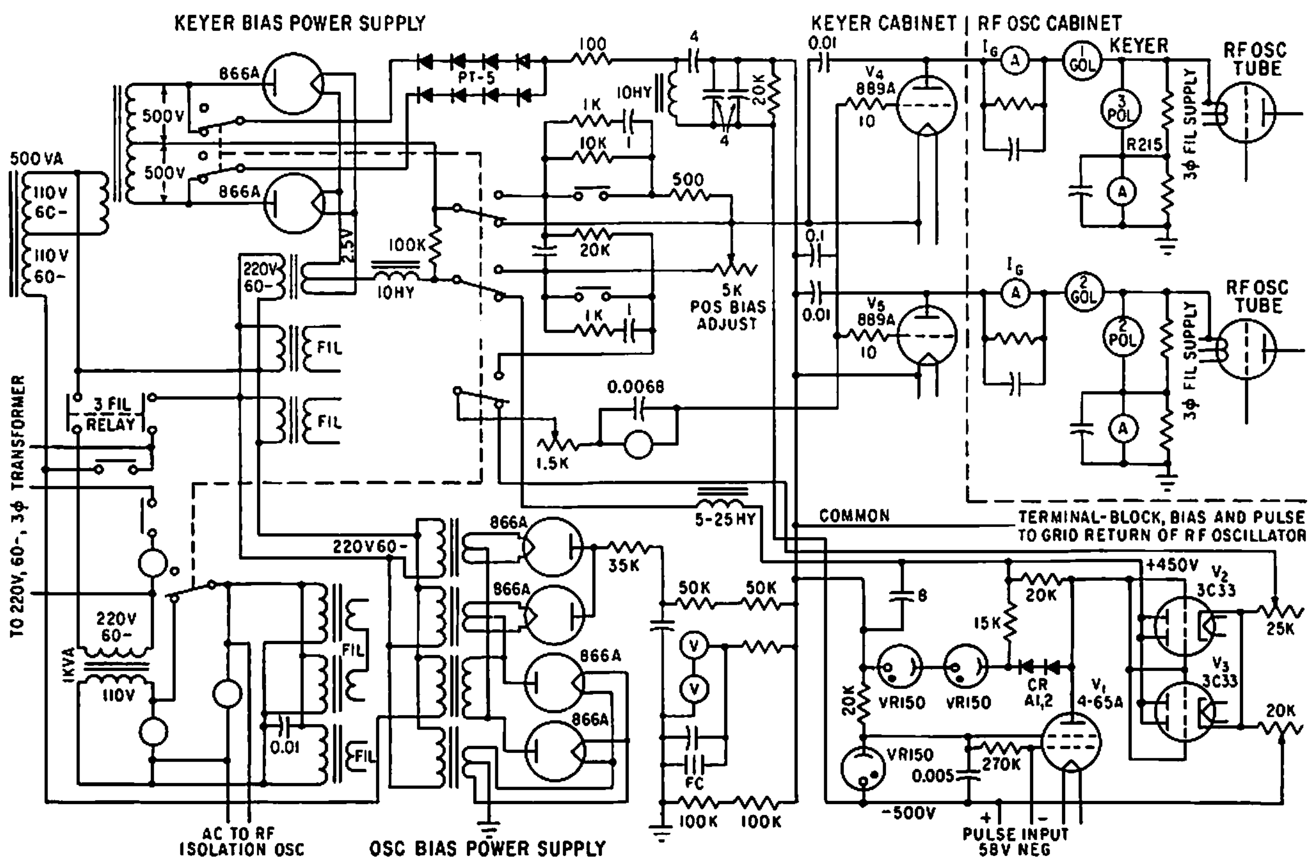




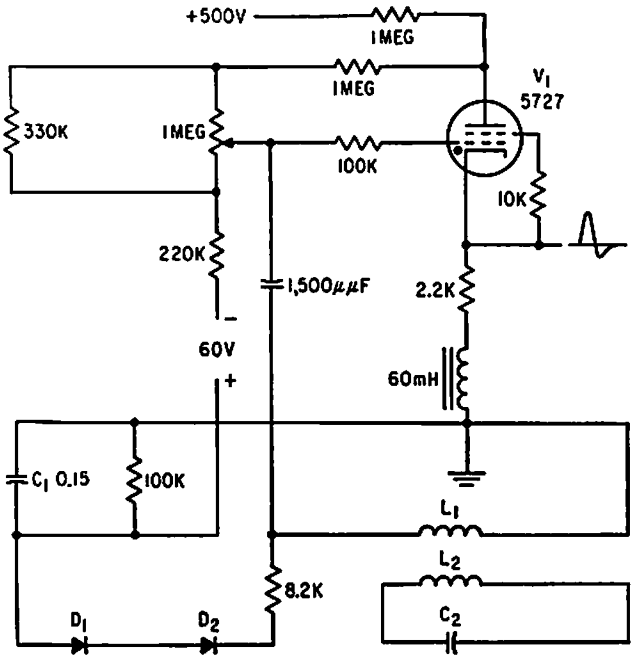
27.12-MC DIELECTRIC HEATER—Pulse-controlled frequency-stabilization servo mechanism retunes self-excited power oscillator continually, with 200-cps mvbr governing rate at which system compares oscillator frequency with that of crystal-controlled reference oscillator.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 173.



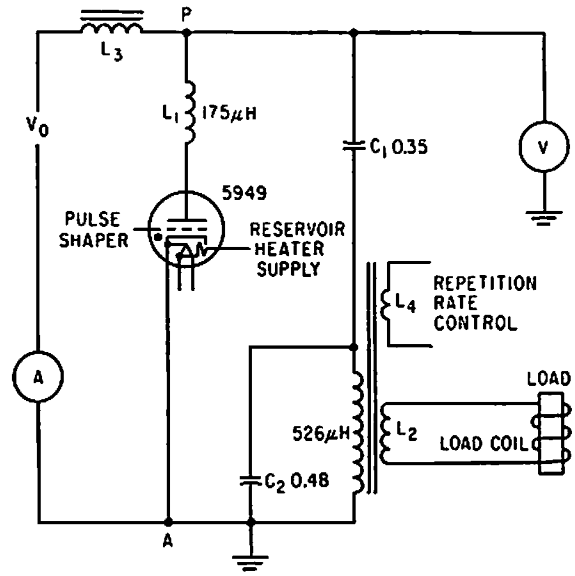
SAWTOOTH-SYNC GENERATOR—Provides sync and sawtooth signals for power oscillator control system of induction heater.—R. E. Mathews and F. R. Sias, Jr., Testing Space Craft with Induction Heaters, *Electronics*, 35:34, p 38–41.



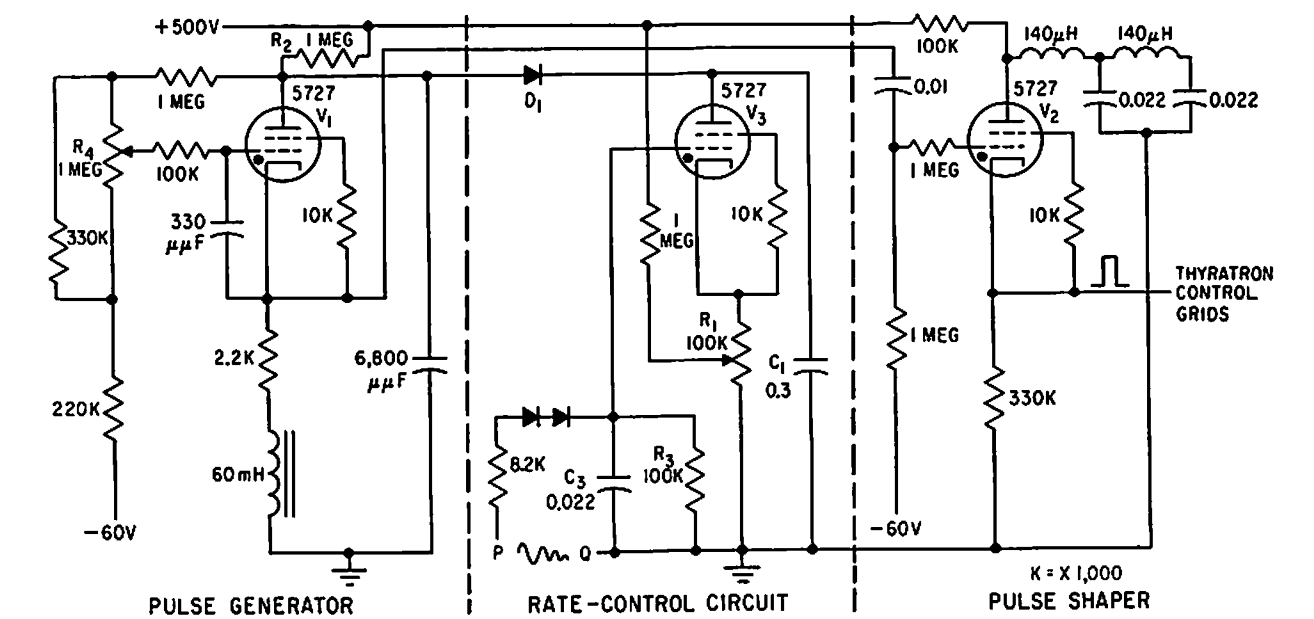
INDUCTION HEATER POWER OSCILLATOR—Circuit includes power supplies for oscillator and keyer bias.—R. E. Mathews and F. R. Sias, Jr., Testing Space Craft with Induction Heaters, *Electronics*, 35:34, p 38–41.



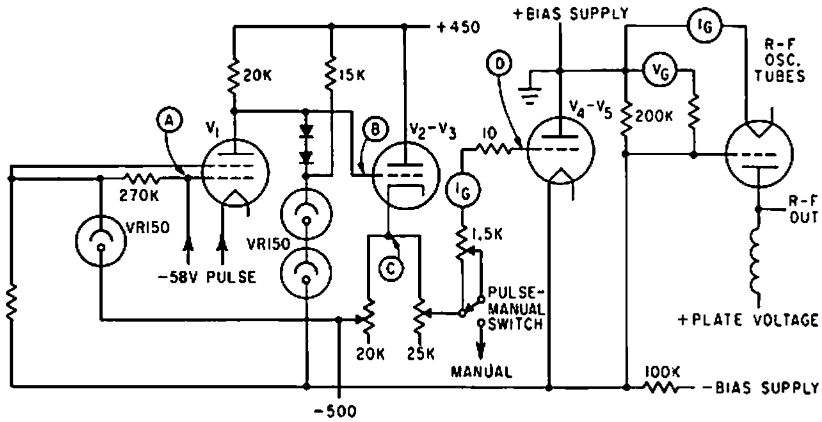
REPETITION RATE CONTROL—Compensates for fluctuations in repetition rate of hydrogen thyratron in induction heater. Ripple voltage induced in L1 acts on control grid of V1 to displace peaks at which ignition occurs in correct direction to maintain constant repetition rate in damped circuit.—H. L. Van Der Horst, How Radar Techniques Improve Induction Heating, *Electronics*, 32:7, p 51–55.



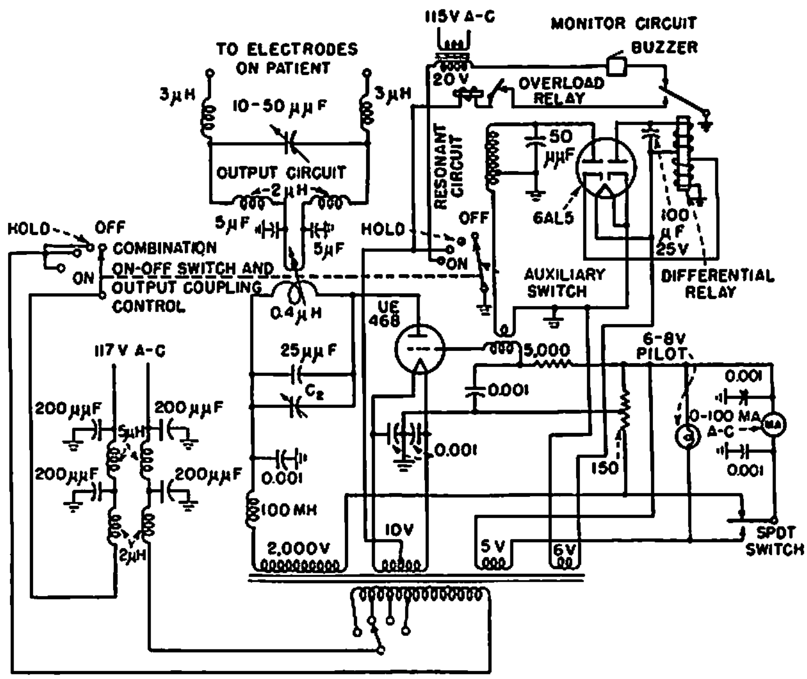
HYDROGEN-THYRATRON INDUCTION HEATER—Thyratron acts as high-speed switch, much like spark-gap oscillator, to produce damped oscillations in tank circuit L2-C2. Output frequency is 10 to 14 kc, depending on load. Peak thyratron current is about 340 amp when Vo is 10 kv. Repetition rate depends on maximum average current, and is 124 cps for 0.5 amp. L3 is 0.32 h.—H. L. Van Der Horst, How Radar Techniques Improve Induction Heating, *Electronics*, 32:7, p 51–55.



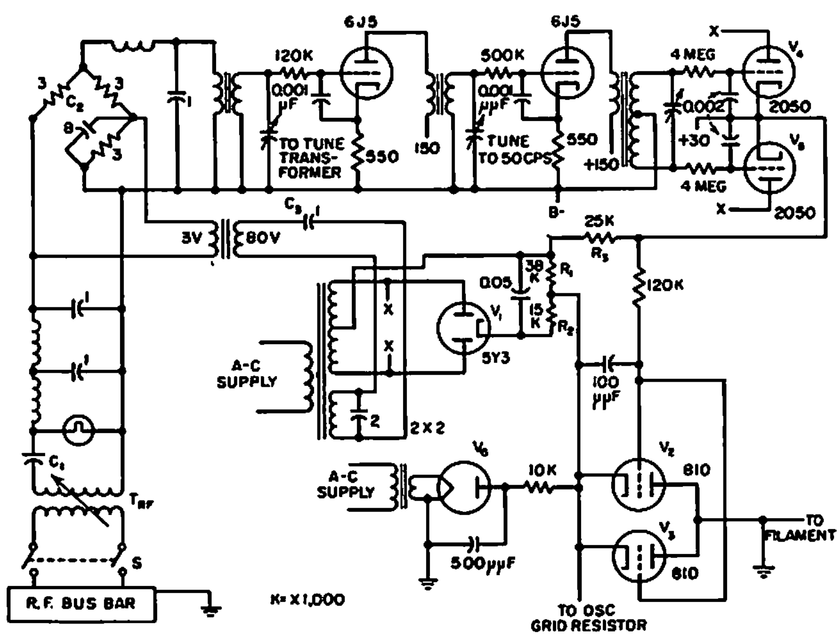
INDUCTION HEATER CONTROL—Thyratron pulse generator V1 produces voltage pulses of adjustable frequency for pulse shaper V2, which drives hydrogen thyratrons of high-power induction heater. V3 regulates repetition rate of pulses by acting as switch that, when conducting, allows C1 to discharge rapidly through R1.—H. L. Van Der Horst, How Radar Techniques Improve Induction Heating, *Electronics*, 32:7, p 51–55.



PULSER AND KEYER—Used to control power oscillator of induction heater at rates up to 800 pps.—R. E. Mathews and F. R. Sias, Jr., Testing Space Craft with Induction Heaters, *Electronics*, 35:34, p 38–41.

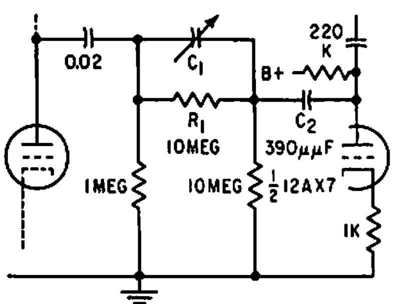


DIATHERMY FREQUENCY MONITOR AND CONTROL—Monitor circuit stops 27.12-Mc oscillator and sounds buzzer when frequency drifts beyond legal limits established by FCC. —J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 100.

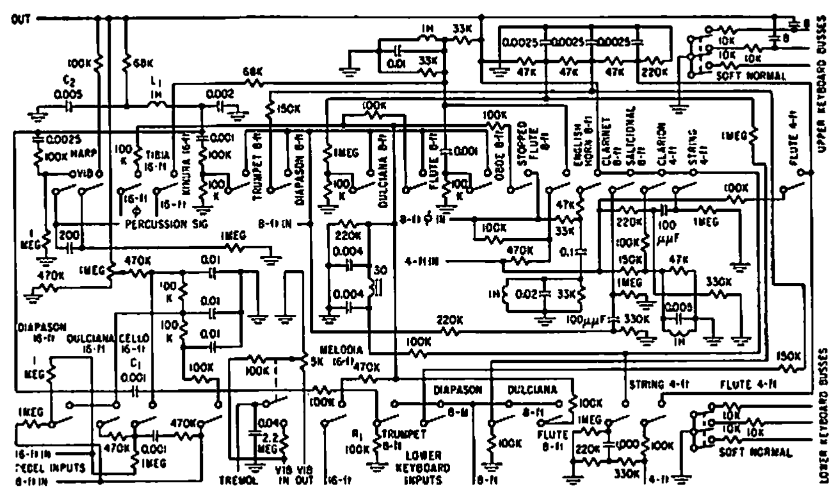


CLOSED-LOOP REGULATOR FOR INDUCTION HEATER—Switching action is performed by parallel triodes V2 and V3 that replace 5,000 ohms of oscillator grid resistance. Tungsten-lamp bridge serves as measuring circuit that produces phase-modulated supply-frequency error signal. Requires no components with heavy power rating because only low-power signal is required by switching triode.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 178.

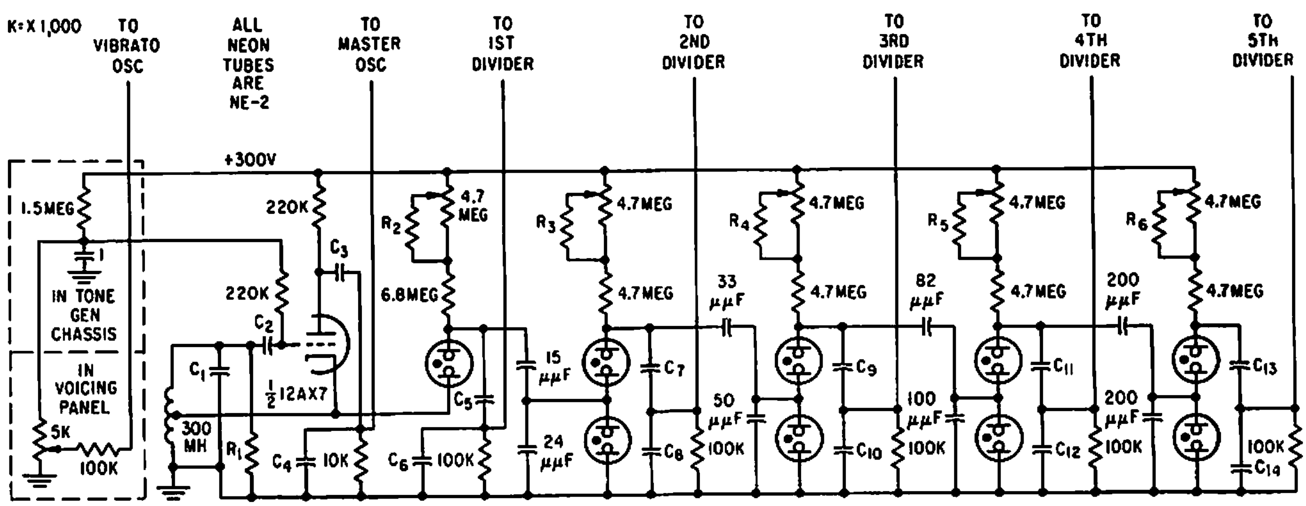
CHAPTER 30
Electronic Music Circuits



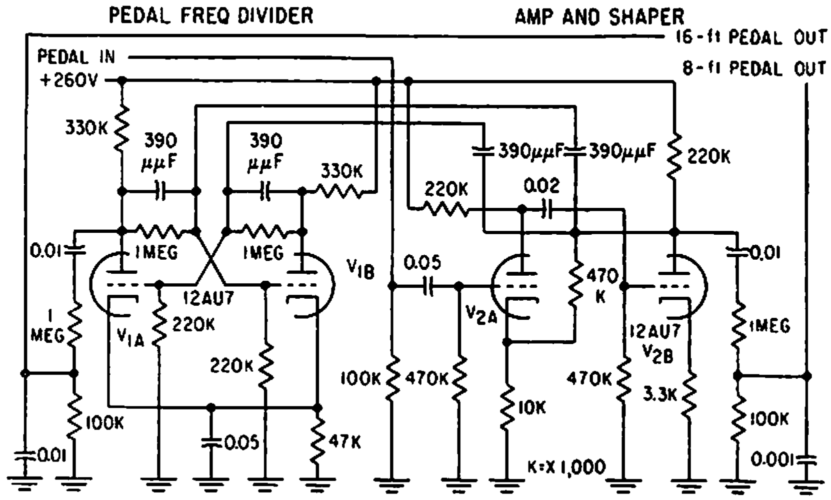
ORGAN SWELL SHOE—Uses capacitive volume control C1 to replace expensive industrial-type potentiometer. Operation of swell shoe varies value of C2 which consists of two hinged metal plates. C1 is series leg of capacitive voltage divider, shunt leg of which is dynamic capacitance of about 0.02 mfd across tube grid due to capacitive feedback from plate through C2. Attenuation range is great, and noise and hum are negligible. —R. H. Dorf, Electronic Organ Uses Neon Tone Generators, *Electronics*, 31:35, p 36–41.



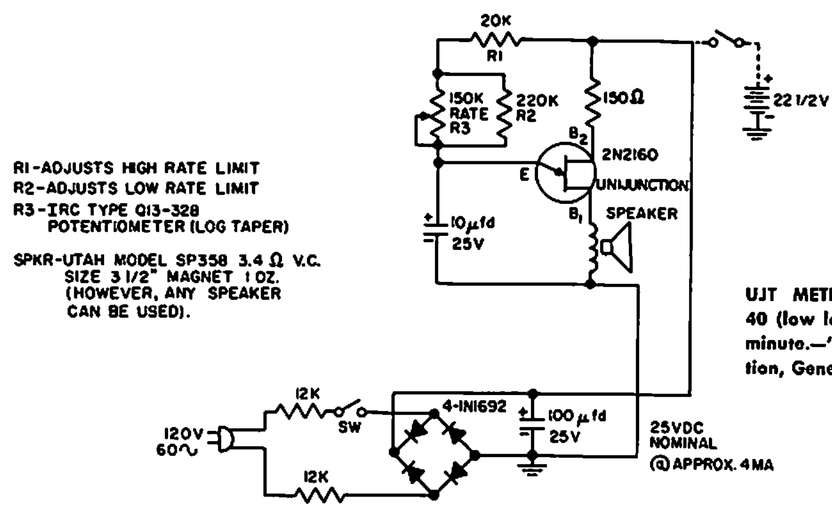
ORGAN VOICING PANEL—Contains formant filters that transform sawtooth generator signals into waveforms of various instruments. 19 different tone colors or timbres are available, ranging from sharp strings and reeds to bland flutes and pipelike diapasons. Filters are interlocked to produce composite effects.—R. H. Dorf, Electronic Organ Uses Neon Tone Generators, *Electronics*, 31:35, p 36–41.



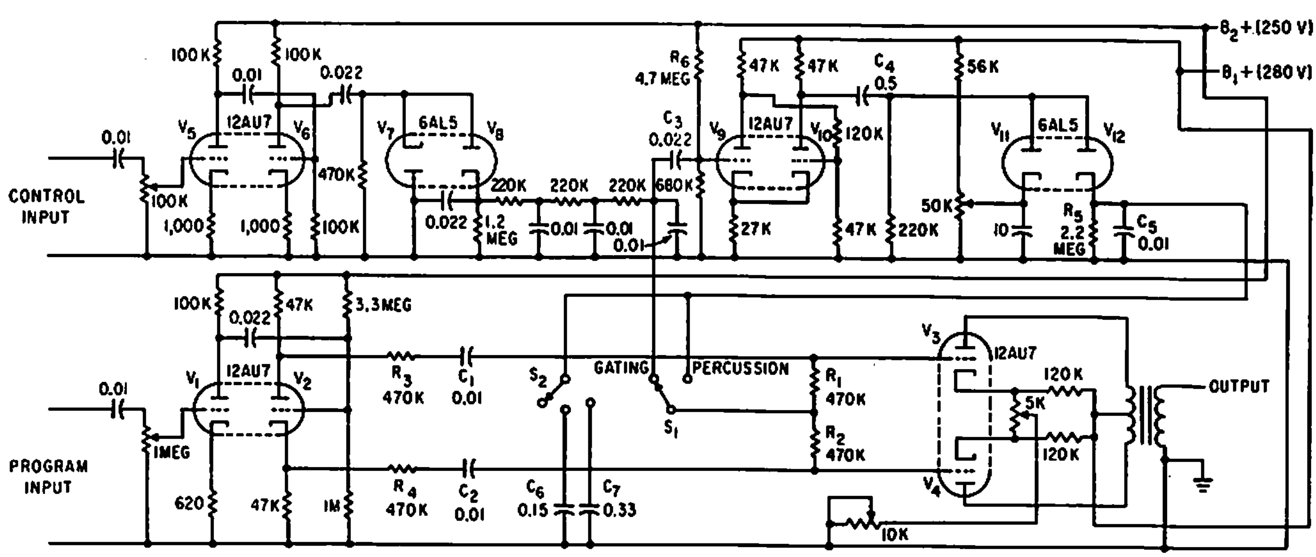
NEON TONE GENERATOR—Each of 12 organ tone generators has four pairs of neon tubes in series, each pair shunted by two series capacitors. With signal taken from common point between capacitors, sufficient insolation exists to prevent feedback and spurious tones in output. Master oscillator provides initial sync for neon-lamp divider chain. Article gives capacitor values for each musical note.—R. H. Dorf, Electronic Organ Uses Neon Tone Generators, *Electronics*, 31:35, p 36–41.



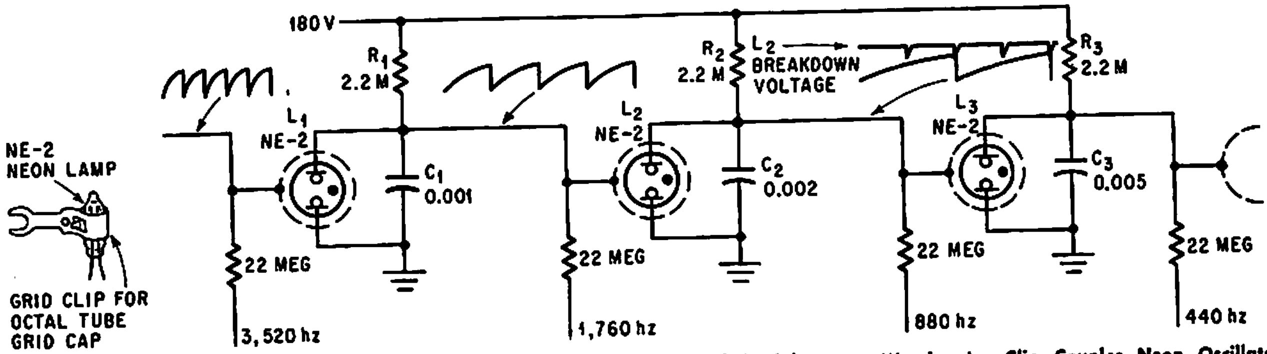
ORGAN PEDAL GENERATOR—Shaper V2 yields sawtooth wave with steeper flyback than from neon oscillator. Output of V2 feeds bistable mvbr V1 which changes state with each input trigger. Bistable output at V1A is half the input frequency (one octave lower), so 16-ft pedal tones are produced without low-frequency divider stage for each tone generator.—R. H. Dorf, Electronic Organ Uses Neon Tone Generators, *Electronics*, 31:35, p 36–41.



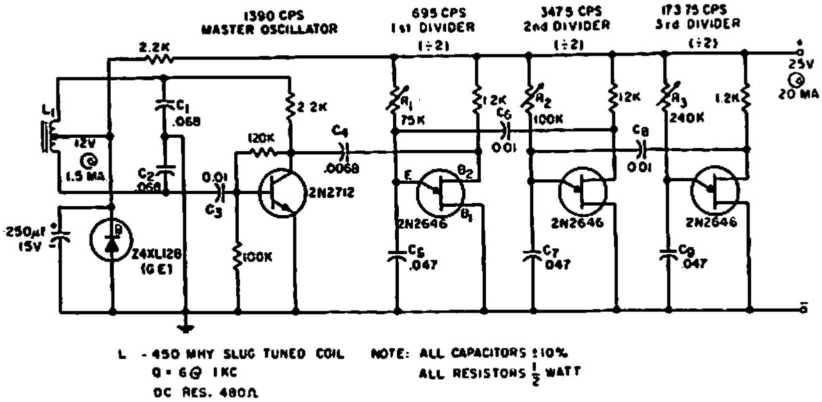
UJT METRONOME—Rate is adjustable from 40 (low largo) to 220 (high presto) beats per minute.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 379.



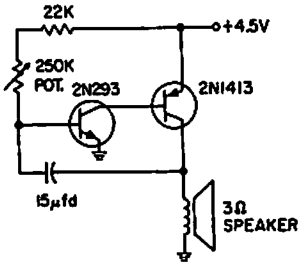
PERCUSSION OR ELECTRONIC MUSIC—Provides congruent envelope shaping and coincident percussive envelope shaping of synthesized program material. One input accepts control signal, while other accepts material requiring envelope shaping.—H. Bode, Sound Synthesizer Creates New Musical Effects, *Electronics*, 34:48, p 33–37.



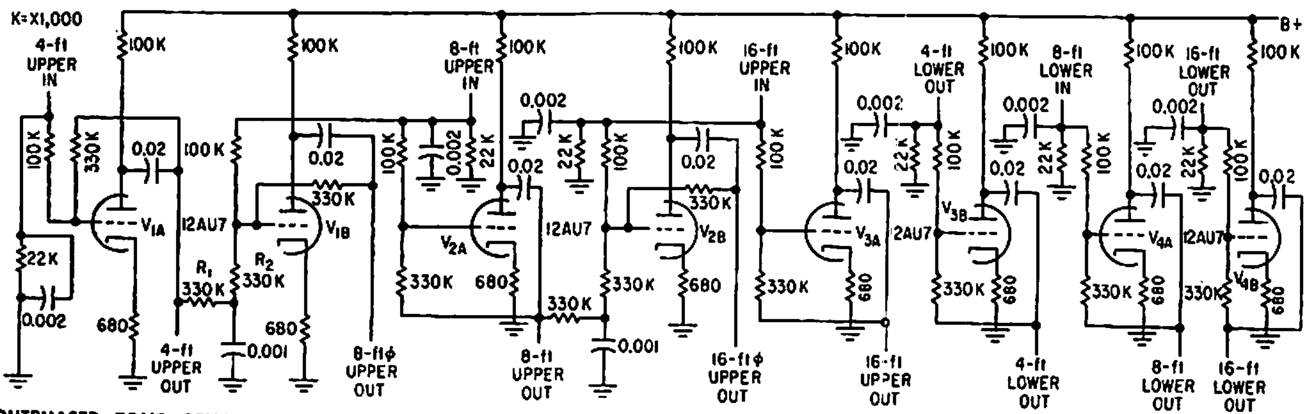
NEON-OSCILLATOR SYNCHRONIZER—Metal clips on neon lamps are used to synchronize successive stages of neon-lamp relaxation oscillators, overcoming their inherent instability. Used in frequency-division type of electronic organ tone generator.—R. F. Woody, Jr., Clip Couples Neon Oscillators, *Electronics*, 39:9, p 77.



ELECTRONIC ORGAN FREQUENCY DIVIDER—Ujt relaxation oscillator circuits reduce number of master oscillators needed and eliminate large inductors.— J. F. Cleary and D. V. Jones, A Unijunction Frequency Divider, *EEE*, 12:5, p 52–53.

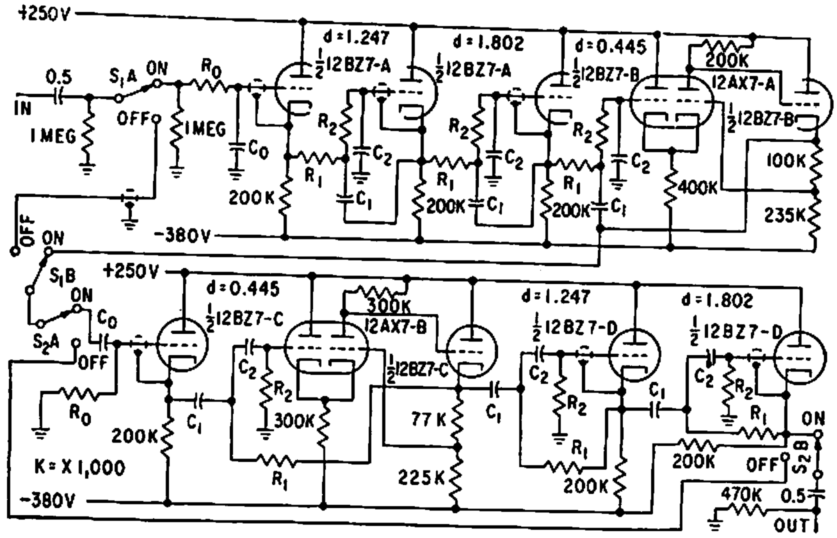


TWO-TRANSISTOR METRONOME—Rheostat provides rate adjustment.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 379.

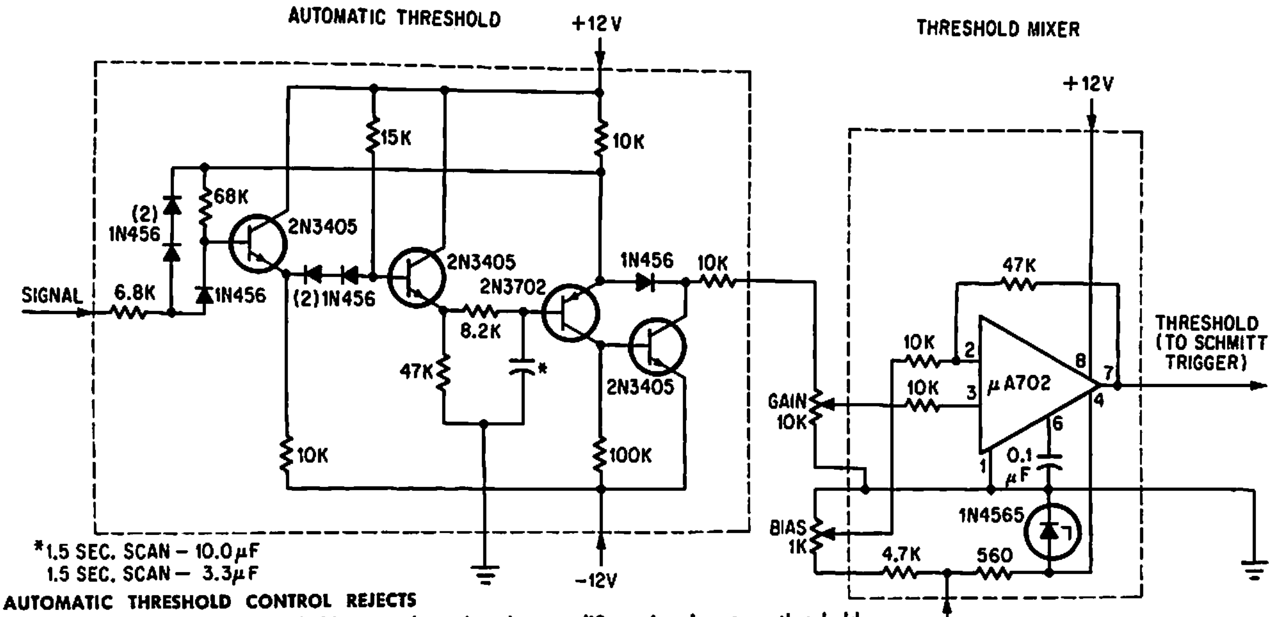


OUTPHASED TONE GENERATOR—Bus amplifiers located between keying-system outputs and formant filters provide outphased signals that lack even-harmonic content. Combinations of these produce organ tone colors called for by voicing panel.—R. H. Dorf, Electronic Organ Uses Neon Tone Generators, *Electronics*, 31:35, p 36–41.

CHAPTER 31
Filter Circuits

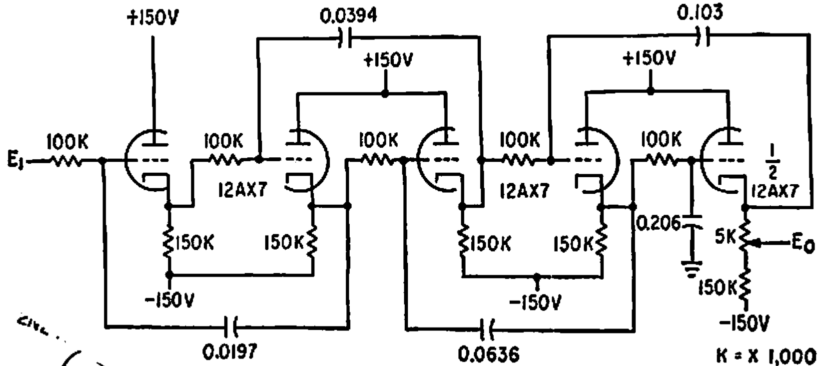


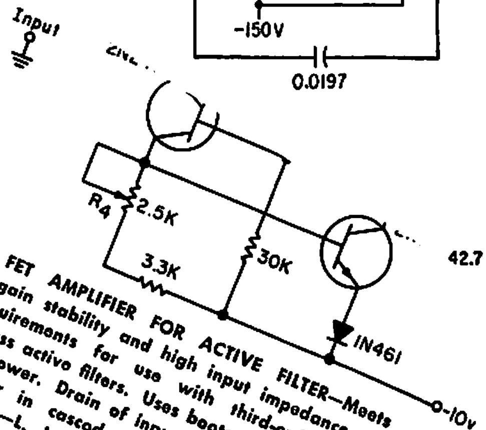
ACTIVE ADJUSTABLE-BANDPASS AUDIO FILTER—Has Butterworth attenuation characteristics and 42 db/octave cutoff slopes. Output is 50 v rms with low distortion, and dynamic range over 100 db. Second-order harmonic distortion is reduced by operating tube heaters at low voltage. Seven elements are varied simultaneously by switching different resistor and capacitor values to change cutoff frequencies. Article has three tables giving these values for high-pass cutoffs from 16 to 16,200 cps and low-pass cutoffs from 20 to 20,000 cps.—J. R. MacDonald, Active Bandpass Filter has Sharp Cutoff, *Electronics*, 31:33, p 84–87.



AUTOMATIC THRESHOLD CONTROL REJECTS NOISE—Provides varying threshold control voltage that causes detection threshold of celestial guidance system to operate at level slightly above background noise. After clipping by amplifier, signal enters threshold-shaping unit that operates as fast-rise, slow-fall agc.—R. L. Lillestrand, J. E. Carroll, and J. S. Newcomb, Automatic Celestial Guidance, Part 2: New Challenge to Designers' Ingenuity, *Electronics*, 39:7, p 94–105.

ACTIVE BUTTERWORTH R-C FILTER—Article gives design procedure for selecting R and C values for active filters characterized by zero output either at zero frequency or at infinite frequency. Symmetry of network transfer function allows choice of va[illegible]ues by coefficient matching technique. [illegible] low-pass filter, down 50 db at [illegible] shown.—R. E. Bach, Jr., Selecti[illegible] for Active Filters, *Electronics*





FET AMPLIFIER FOR ACTIVE FILTER—Meets gain stability and high input impedance requirements for use with third-order low-pass active filters. Uses bootstrapped source-follower. Drain of input fet drives pnp transistor in cascode to reduce input capacitance.—L. J. Sovin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 105.

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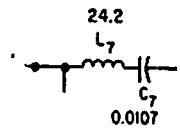
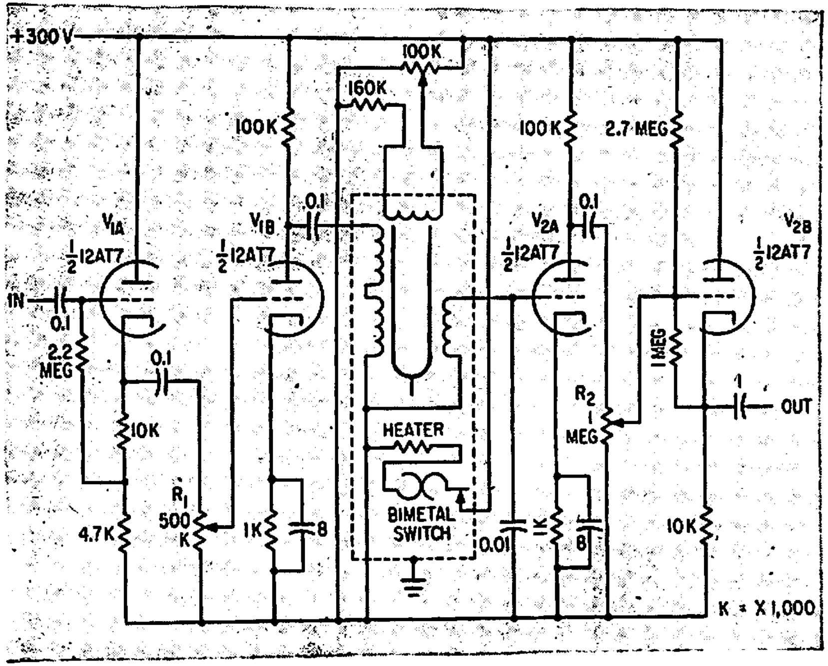


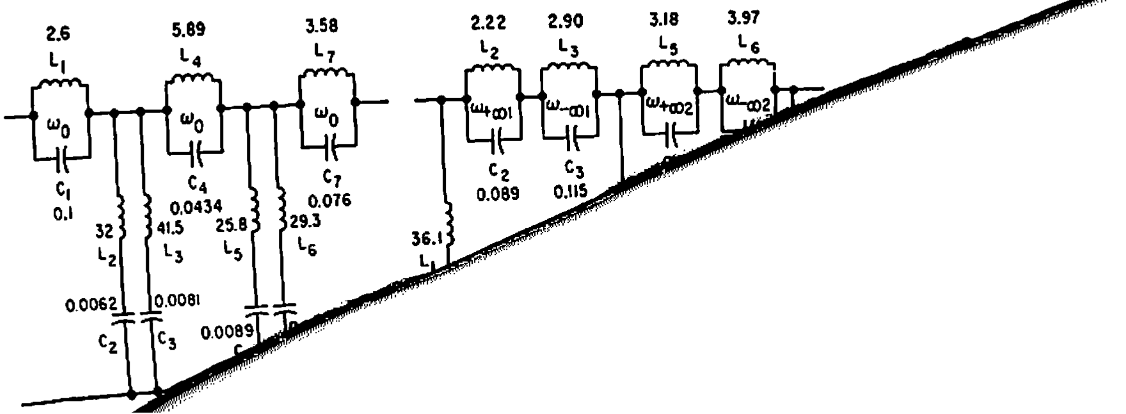
R1
100K

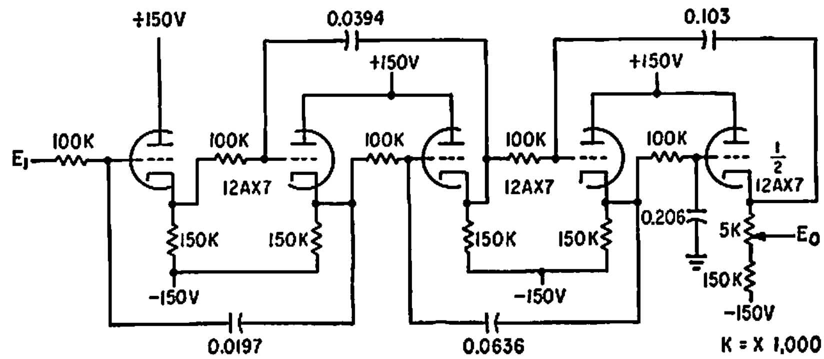
ADJUSTING [illegible]

CRYSTAL RADIOTELEGRAPH I-F FILTER—Voltage-controlled varactor diode D1 permits remote location of potentiometer used for phasing adjustment. Circuit can be use[illegible] for any i-f value from 100 kc to 1.6 M[illegible] selecting crystal with desired fre[illegible] H. Olson, Remotely Tuned Crystal [illegible] nates Tuned Transformer, Ele[illegible] 113.

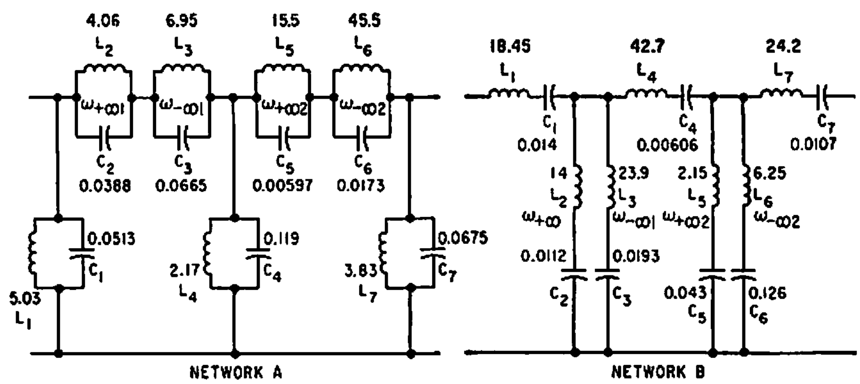


ADJUSTABLE 400-CPS TUNING-FORK FILTER—Tuning-fork frequency is adjusted by varying current in extra magnet coils facing ends of tines. Current change of 1 ma in frequency-adjust coils gives frequency change of 50 parts per million. Input and output cathode followers isolate filter from rest of circuit. Drive and pickup amplifiers cancel fork insertion loss.—J. J. O'Connor, Tuning-Fork Audio Filter Tunes Electrically, *Electronics*, 33:49, p 66–67.

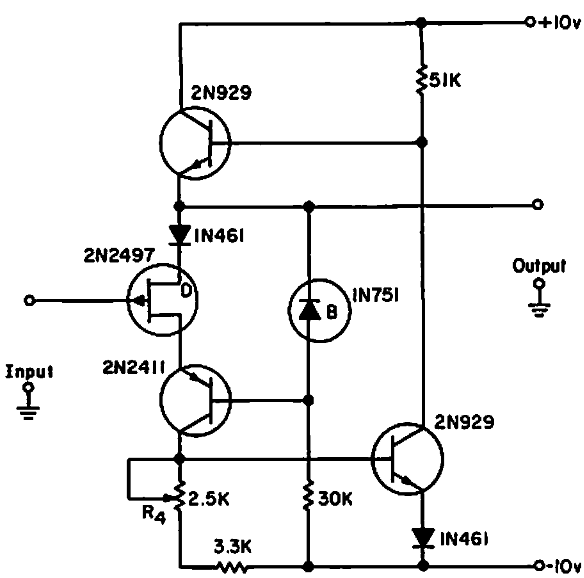




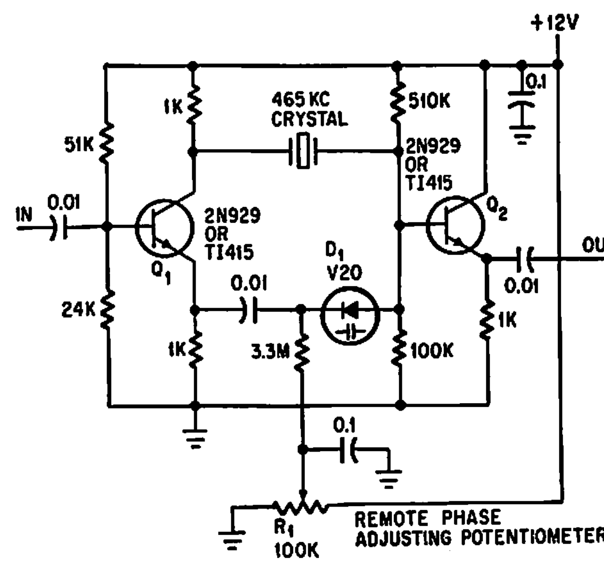
ACTIVE BUTTERWORTH R-C FILTER—Article gives design procedure for selecting R and C values for active filters characterized by zero output either at zero frequency or at infinite frequency. Symmetry of network transfer function allows choice of values by coefficient matching technique. Fifth-order low-pass filter, down 50 db at 70 cps, is shown.—R. E. Bach, Jr., Selecting R-C Values for Active Filters, *Electronics*, 33:20, p 82–85.



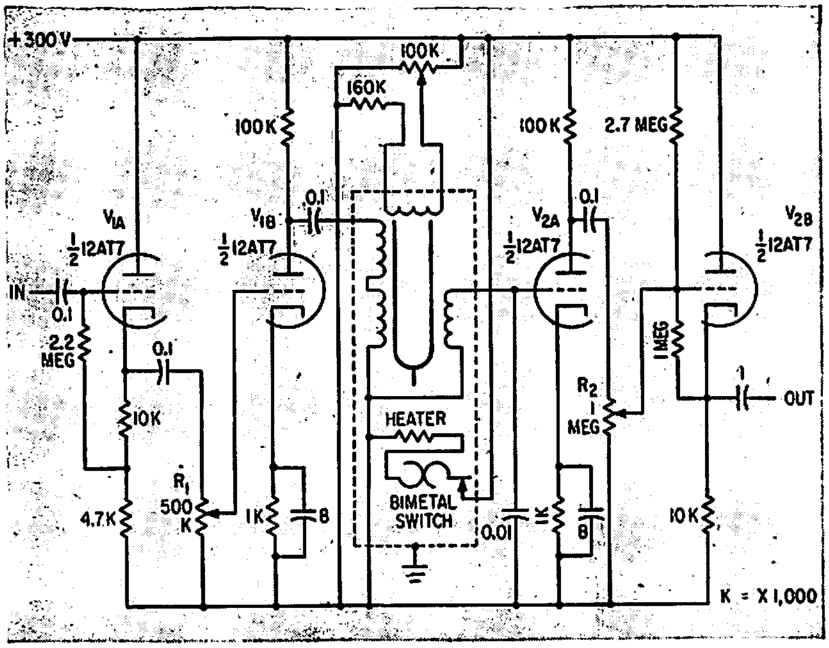
ZOBEL BAND-PASS FILTER—Both examples give at least 40 db attenuation below 7,500 cps and above 12,500 cps, for 600-ohm source and load resistances.—K. Lichtenfeld, Method for Simplifying Filter Design, *Electronics*, 33:21, p 96–99.



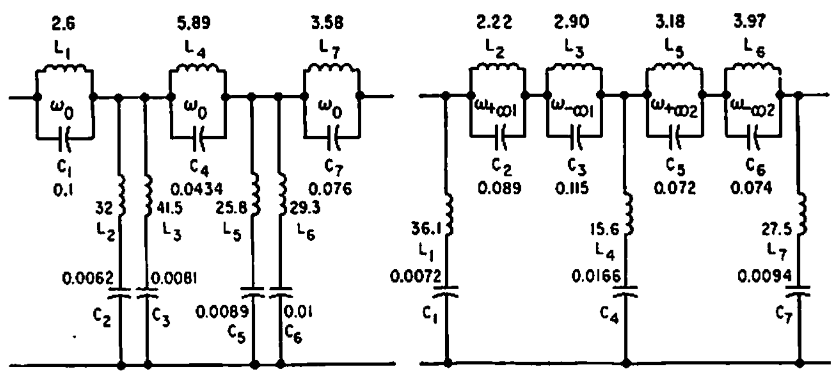
FET AMPLIFIER FOR ACTIVE FILTER—Meets gain stability and high input impedance requirements for use with third-order low-pass active filters. Uses bootstrapped source-follower. Drain of input fet drives pnp transistor in cascode to reduce input capacitance.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 105.



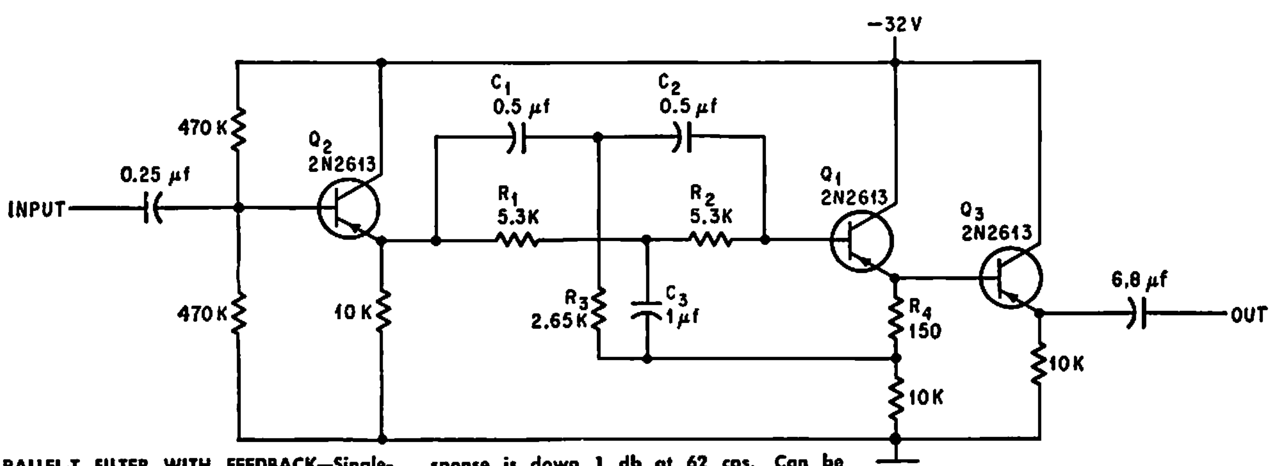
CRYSTAL RADIOTELEGRAPH I-F FILTER—Voltage-controlled varactor diode D1 permits remote location of potentiometer used for phasing adjustment. Circuit can be used for any i-f value from 100 kc to 1.6 Mc by selecting crystal with desired frequency.—H. Olson, Remotely Tuned Crystal Filter Eliminates Tuned Transformer, *Electronics*, 38:23, p 113.



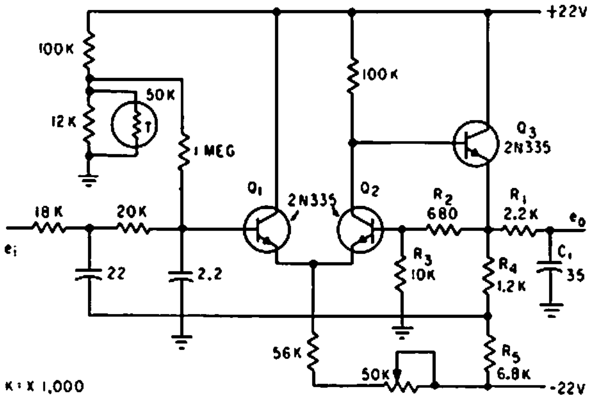
ADJUSTABLE 400-CPS TUNING-FORK FILTER—Tuning-fork frequency is adjusted by varying current in extra magnet coils facing ends of tines. Current change of 1 ma in frequency-adjust coils gives frequency change of 50 parts per million. Input and output cathode followers isolate filter from rest of circuit. Drive and pickup amplifiers cancel fork insertion loss.—J. J. O'Connor, Tuning-Fork Audio Filter Tunes Electrically, *Electronics*, 33:49, p 66–67.



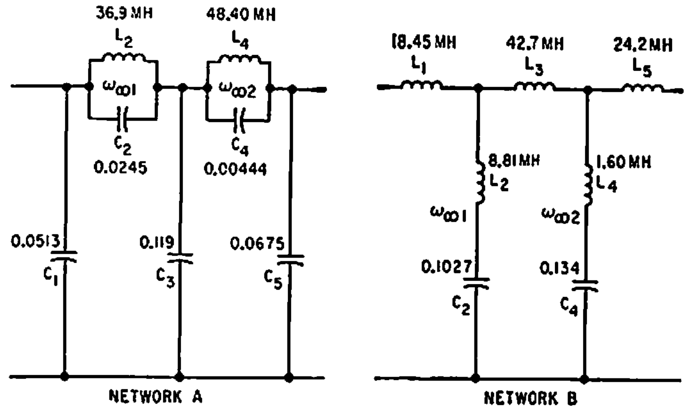
ZOBEL BAND-ELIMINATION FILTER—Both examples give at least 40 db attenuation between 8,410 cps and 11,150 cps, for 600-ohm source and load resistances.—K. Lichtenfeld, Method for Simplifying Filter Design, *Electronics*, 33:21, p 96–99.



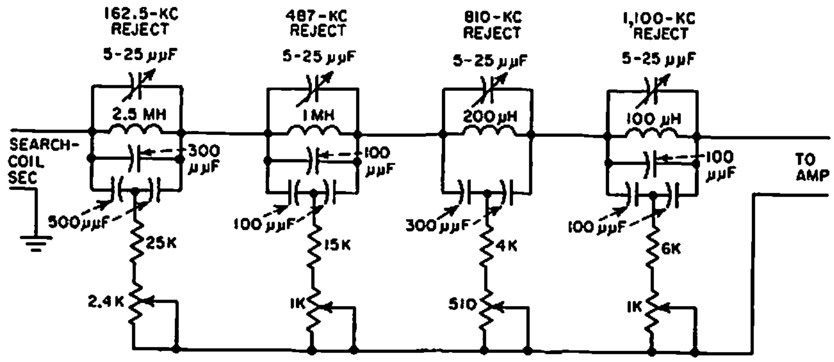
PARALLEL-T FILTER WITH FEEDBACK—Single-transistor feedback circuit Q2 reduces high attenuation in passband that severely limits conventional 60-cps T-notch filter. Filter response is down 1 db at 62 cps. Can be used in reproducing stereo tape, where it will salvage signals normally buried far below noise level of original tape recording. —J. Strattan, Feedback Improves Parallel-T Filter, *Electronics*, 39:18, p 99.



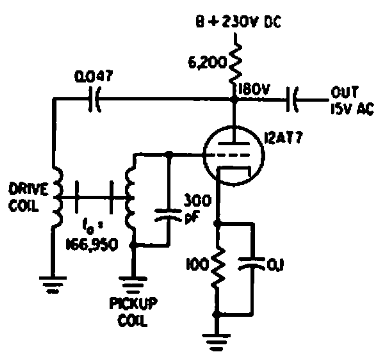
LOW-PASS SUBAUDIO FILTER—Gives flat frequency response from d-c to 1-cps cutoff, attenuation slope of 15 db per octave, near-zero insertion loss, and good temperature stability.—R. C. Onstad, Low-Pass Filter for Subaudio Frequencies, *Electronics,* 33:3, p 88–90.



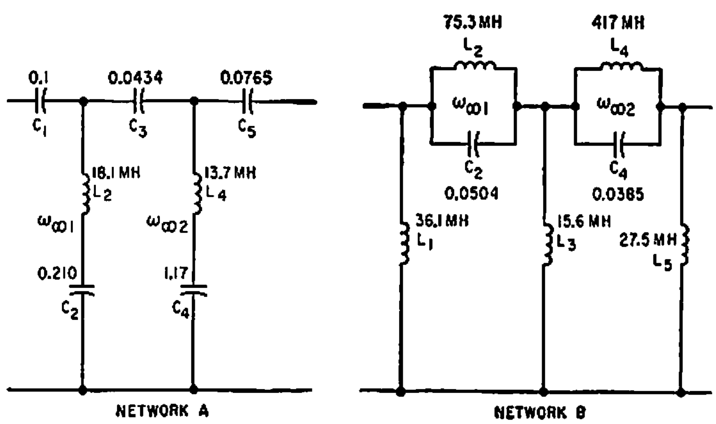
ZOBEL LOW-PASS FILTER—Article gives design procedure using Cauer parameters. Both examples give 40 db attenuation at 5,000 cps when inserted between 600-ohm source and load resistances.—K. Lichtenfeld, Method for Simplifying Filter Design, *Electronics,* 33:21, p 96–99.



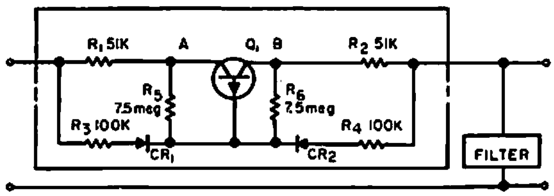
325-KC BRIDGED-T FILTER—Used in magnetometer having large amounts of odd harmonics and only feeble second harmonic at secondary of sensing probe. Permits amplifying only second harmonic, without excessive phase shift.—F. Voelker, Magnetometer Makes Continuous Measurements, *Electronics,* 31:11, p 152–154.



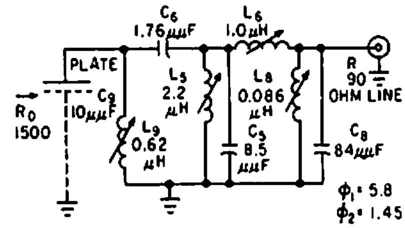
TRIODE MAGNETOSTRICTION BANDPASS FILTER—Practical range is from 45 to 300 kc. When filter is used with triode, it serves as stable fixed-frequency oscillator in telemetry command receiver.—E. J. Neville, Jr., Designing Magnetostriction Filters, *Electronics,* 33:51, p 88–89.



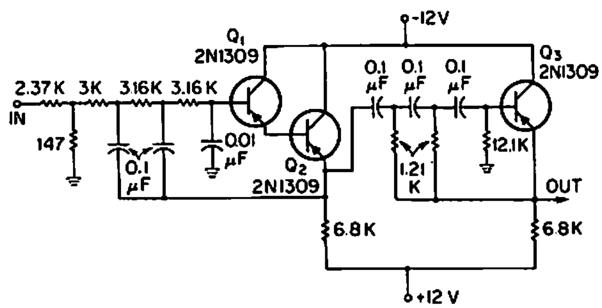
ZOBEL HIGH-PASS FILTER—Both examples give at least 40 db attenuation below 2,740 cps when inserted between 600-ohm source and load resistances.—K. Lichtenfeld, Method for Simplifying Filter Design, *Electronics,* 33:21, p 96–99.



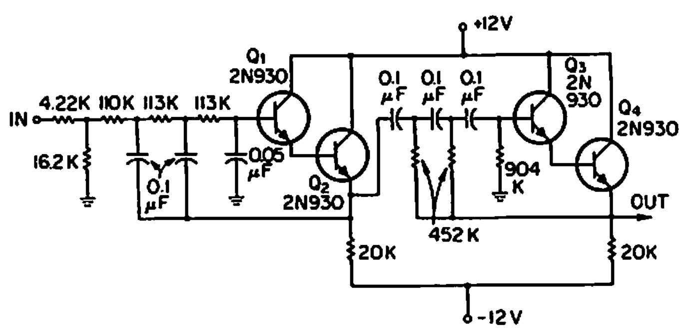
FET VOLTAGE-CONTROLLED RESISTOR—Field-effect transistor circuit (enclosed in dashed rectangle) serves as dropping resistor working into antiresonant a-f filter, to deliver constant voltage to filter despite input voltage variations. Uses 2N2386 fet as Q1.—H. H. Nord, the FET as a Voltage-Controlled Resistor, *EEE*, 13:1, p 65.



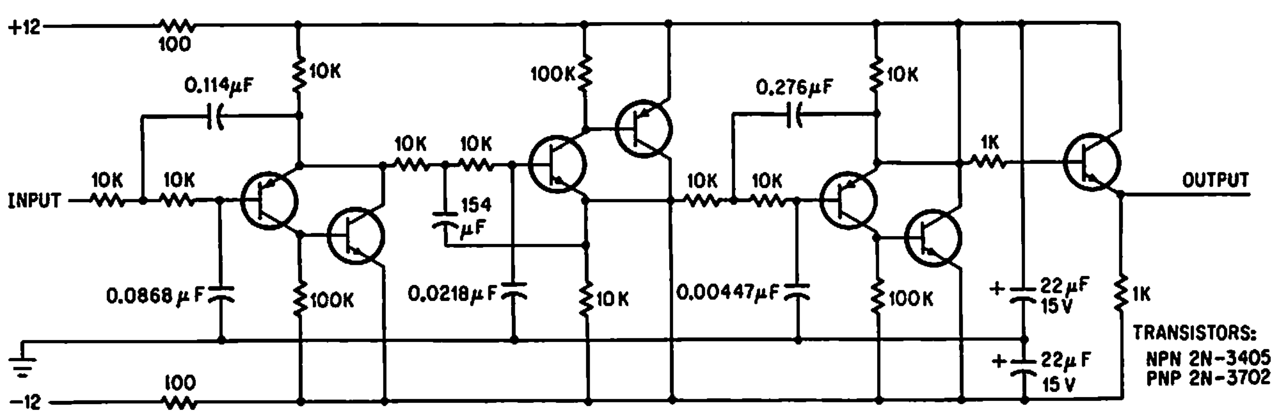
TRIPLE-TUNED 90-OHM OUTPUT—Used to provide bandpass between 55 and 65.5 Mc for signal from 10-mmfd plate capacitance.—R. B. Hirsch, How to Design Bandpass Triples, *Electronics*, 32:34, p 41–44.



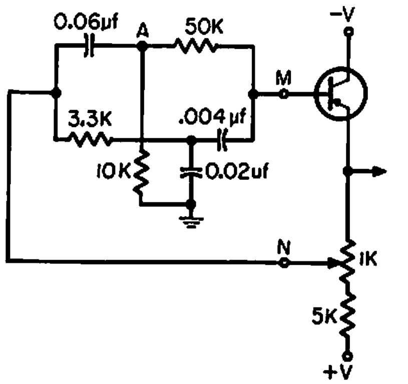
800-CPS ACTIVE BANDPASS—Provides bandwidth of 13 cps. Maximum gain is 24 db, and divider at input reduces this to 0 db. Selectivity at 3-db points is 72 db/octave.—T. Mollinga, Active Bandpass Filters, *EEE*, 14:8, p 115–119.



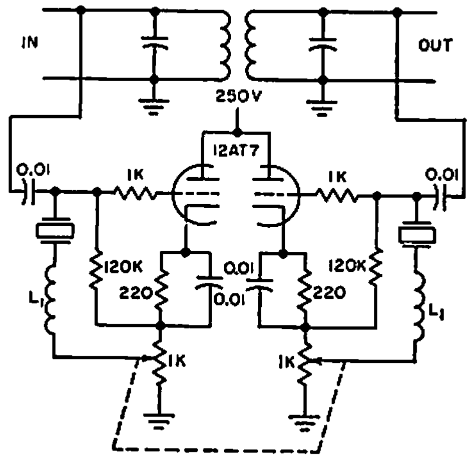
7-CPS ACTIVE BANDPASS—Band width is 1.6 cps for center frequency of 7 cps.—T. Mollinga, Active Bandpass Filters, *EEE*, 14:8, p 115–119.



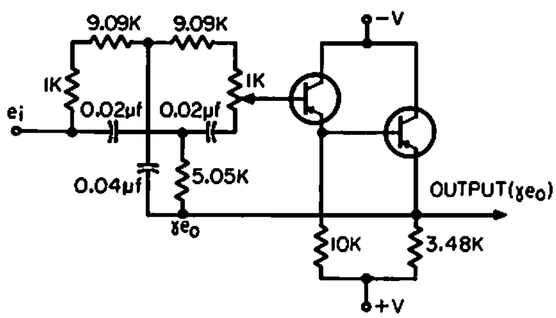
LOW-PASS FILTER—Unwanted short pulses from shot noise in celestial guidance photomultiplier are removed by active low-pass filter having constant phase shift over pass band. Active filter avoids bulky inductors and impedance-matching problems. Filter is modified 6th-order Bessel type, called a Paynter filter.—R. L. Lillestrand, J. E. Carroll, and J. S. Newcomb, Automatic Celestial Guidance, Part 2: New Challenge to Designers' Ingenuity, *Electronics*, 39:7, p 94–105.



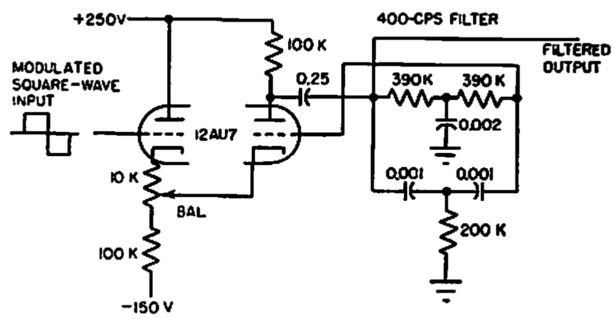
800-CPS OSCILLATOR WITH PARALLEL-T FILTER—R-C network in feedback loop determines frequency of oscillation.—T. Mollinga, Active Parallel-T Networks, *EEE*, 14:4, p 93–98.



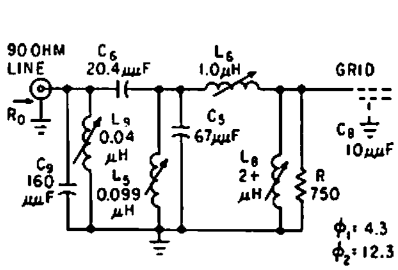
VARIABLE-BANDWIDTH 848-KC CRYSTAL FILTER—High-Q unbalanced crystal filter is easy to adjust over appreciable frequency range. Can be used in f-m oscillators, signal generators, and i-f amplifiers, as well as in variable-bandwidth filters.—J. C. Seddon, Stable Crystal Filter is Parallel Resonant, *Electronics*, 31:11, p 155–156.



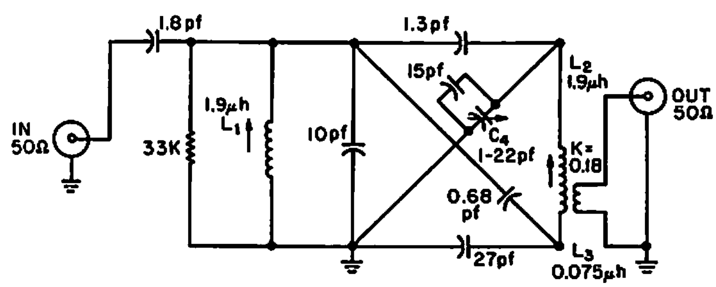
ACTIVE 800-CPS PARALLEL-T FILTER—Potentiometer adjusts amount of rejection to compensate for tolerances of components. Second emitter-follower provides lower output impedance so feedback to network is more effective in sharpening notch of filter characteristic and in decreasing phase shift around null frequency. Used in servo systems.—T. Mollinga, Active Parallel-T Networks, *EEE*, 14:4, p 93–98.



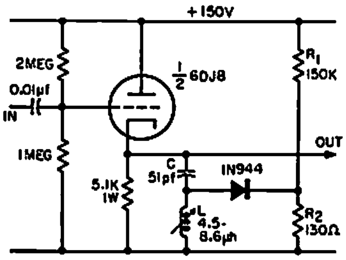
TWIN-T 400-CPS FILTER—Used with modulators to increase signal-noise ratio. Filter is tuned to 400 cps, and eliminates other frequencies by feeding them back. Q of filter is 6. Output is low-distortion sine wave in phase with input. Frequency regulation of carrier signal should be better than 1% or filter will introduce phase shift.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



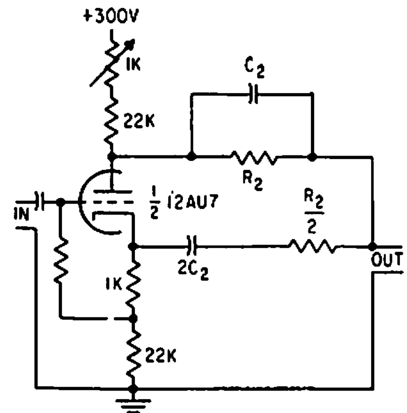
TRIPLE-TUNED 90-OHM INPUT—Article gives design procedure. Example shown passes signals between 55 and 65.5 Mc.—R. B. Hirsch, How to Design Bandpass Triples, *Electronics*, 32:34, p 41–44.



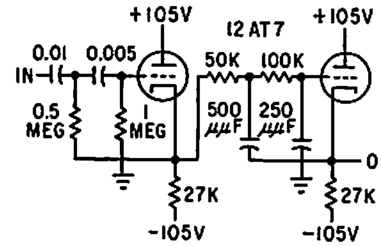
LATTICE COUPLING OF DOUBLE-TUNED FILTER—Permits adjusting coupling between input and output resonant circuits to compensate for stray reactances and variations in component values. Used in 30-Mc i-f amplifier requiring 1-Mc bandwidth. One side of variable capacitor is grounded, permitting convenient mechanical design.—J. R. Grindon, Lattice Coupling of Resonant Circuits, *EEE*, 13:6, p 53–55.



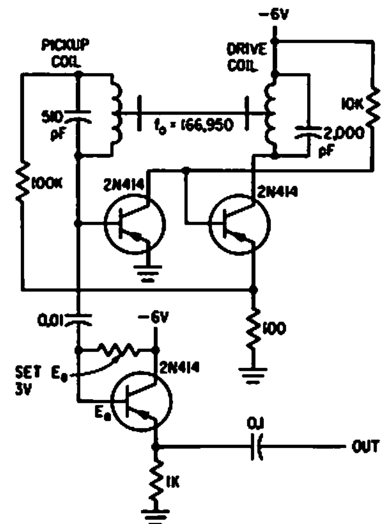
DYNAMIC NOTCH FILTER—Will trap out 10-Mc noise while passing 10-Mc signal in heterodyne frequency convertor used to extend measurement range of 10-Mc counter. Operation is based on difference in level of noise and desired signal. Dynamic action of filter nulls out low-level noise, but filter disappears in presence of desired high-level signal.—H. T. McAleer, Dynamic Notch Filter, *EEE*, 10:9, p 90-91.

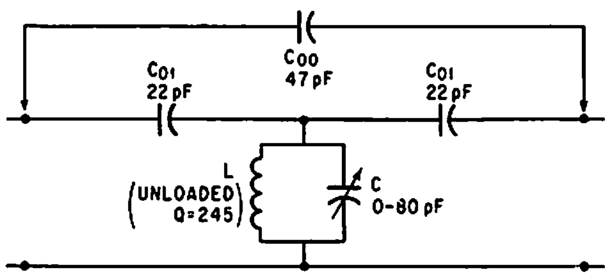


WIEN-BRIDGE FILTER—Does not have high Q, but provides good rejection (40 db attenuation with 1% tolerance components and 60 db with 0.1% tolerance components).—J. K. Goodwin, Wien Bridge Forms Rejection Filter, *Electronics*, 32:1, p 58–59.



CASCADED HIGH AND LOW-PASS A-F—Slope can be any desired multiple of 12 db per octave, with insertion loss less than 2 db. Corner frequencies are 200 radians per sec (32 cps) and 40,000 radians per sec (6,370 cps).—W. D. Fryer, How to Design Low Cost Audio Filters, *Electronics*, 32:15, p 68–70.

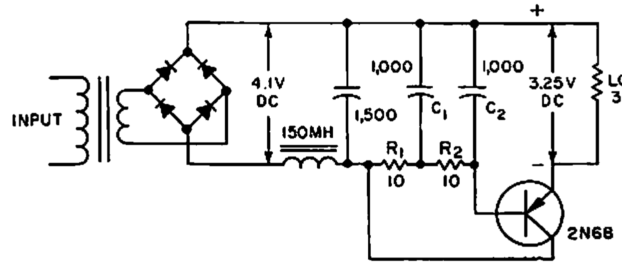




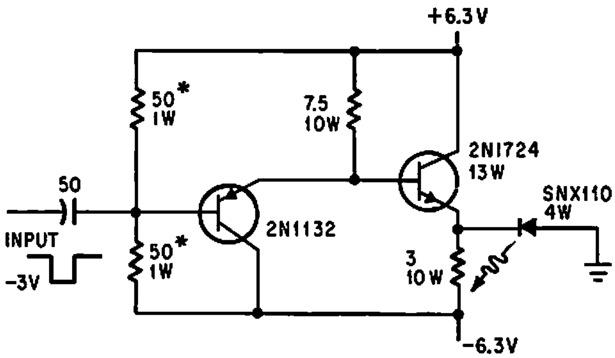
GENERAL FILTER—Bridging conventional bandpass filter with single capacitor C00 converts to general filter having both sharp pass and reject behavior at adjacent frequencies. For values shown, bandpass occurs at 20 Mc and peak rejection frequency is 19.15 Mc.—R. Kurzrok, Single Component Changes Bandpass into General Filter, *Electronics*, 39:8, p 95–96.

TRANSISTORIZED MAGNETOSTRICTION BANDPASS FILTER—Three transistors and filter give stable fixed-frequency oscillator, with overall gain of 20 db and maximum linear output of 1 v rms.—E. J. Neville, Jr., Designing Magnetostriction Filters, *Electronics*, 33:51, p 88–89.

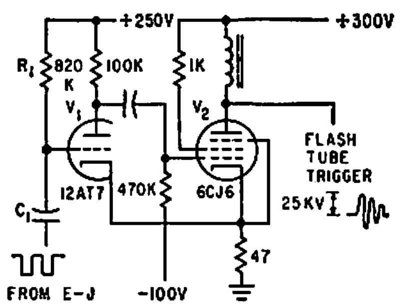
TRANSISTOR AS SMOOTHING FILTER—Single junction transistor in filter network of low-voltage power supply permits use of smaller filter capacitors and chokes. Used in calibrating d-c meters up to 1 amp, at which residual peak-to-peak ripple values are 0.0015 amp and 0.005 v.—F. Oakes and E. W. Lawson, Transistor Filters Ripple, *Electronics*, 31:15, p 95.



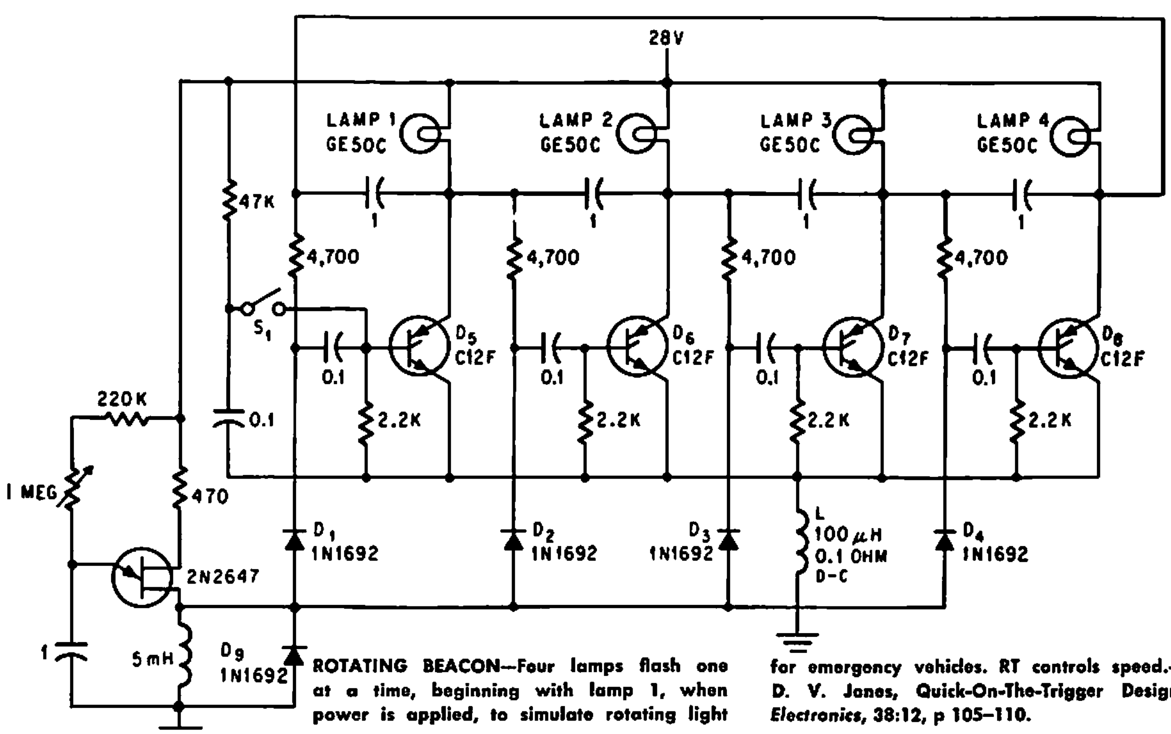
CHAPTER 32
Flash Circuits



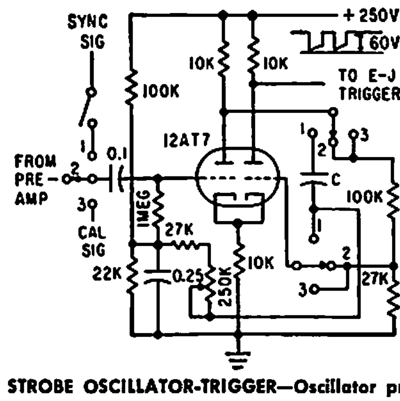
TWO-TRANSISTOR CURRENT-MODE SWITCH—With two separate voltage supplies, input pulse triggers transistors to give 2-amp pulses for driving light-emitting diode.—E. L. Bonin, Drivers for Optical Diodes, *Electronics*, 37:22, p 77–82.



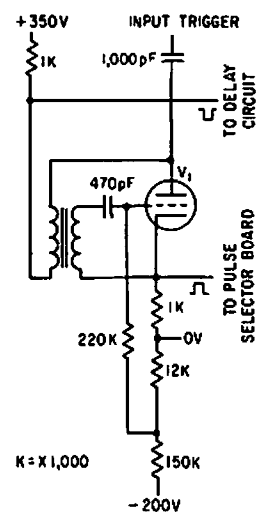
HIGH-VOLTAGE FLASH PULSER—Two identical pulse generators are used to fire two flash tubes alternately in high-speed strobe. One unit is coupled to each plate of an Eccles-Jordan trigger, to produce required alternating trigger sequence.—L. H. Barrett, New Circuit Improves Stroboscope Versatility, *Electronics*, 32:32, p 116–118.



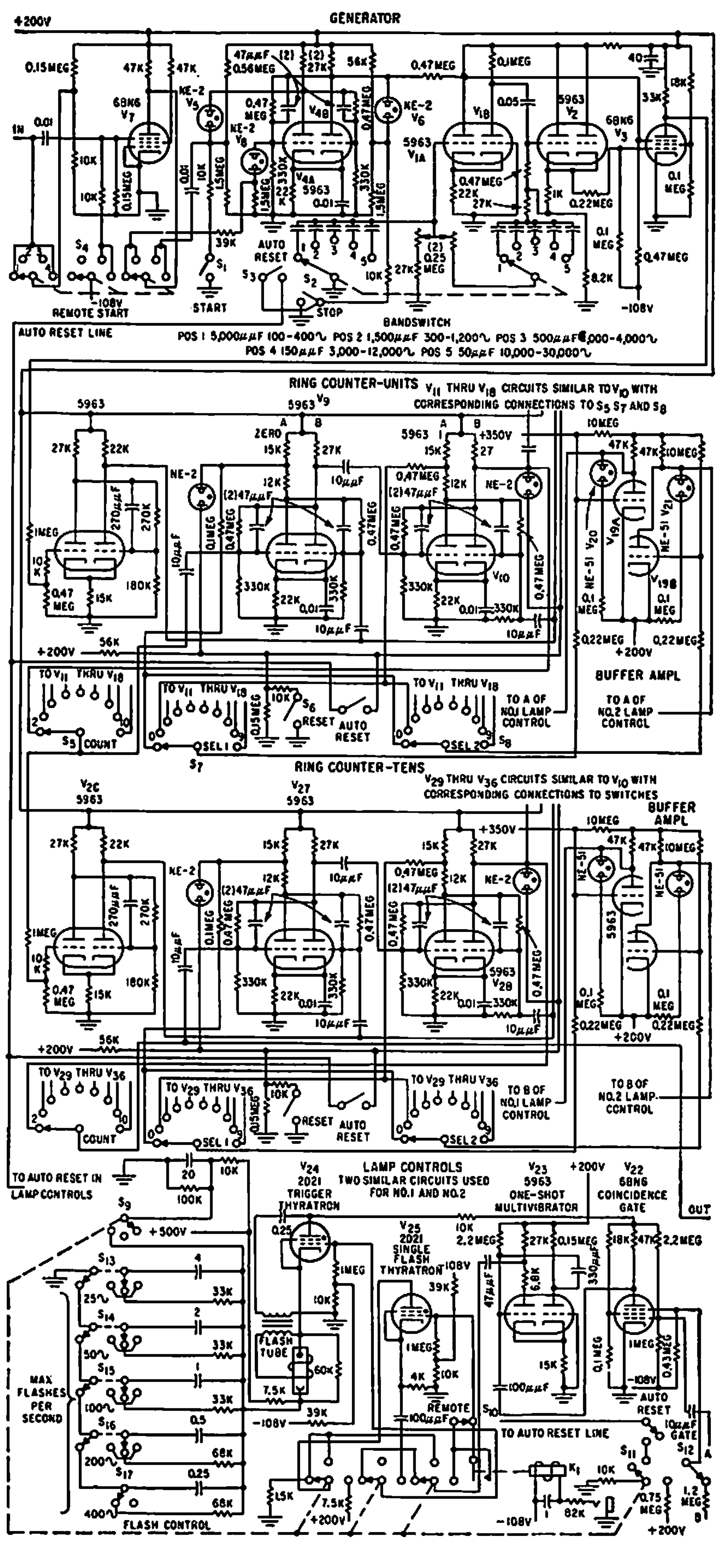
ROTATING BEACON—Four lamps flash one at a time, beginning with lamp 1, when power is applied, to simulate rotating light for emergency vehicles. RT controls speed.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.



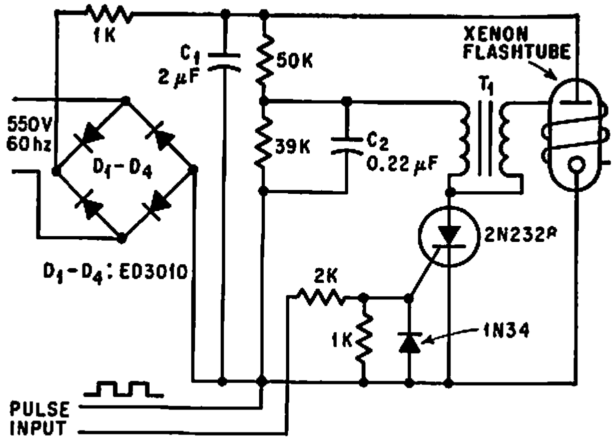
STROBE OSCILLATOR-TRIGGER—Oscillator produces square pulses having short rise time, over total frequency range of 200 to 1. Oscillator may also be sychronized to power line. Schmitt trigger provides additional means of getting output pulse to drive Eccles-Jordan trigger that provides alternate pulses for two shared-cycle strobe lamps.—L. H. Barrett, New Circuit Improves Stroboscope Versatility, *Electronics*, 32:32, p 116–118.



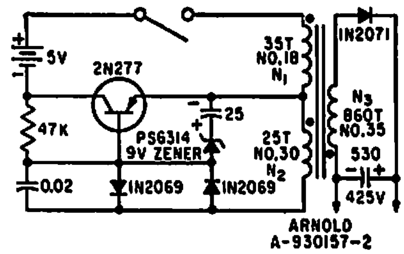
TRIGGERED BLOCKING OSCILLATOR—Gives pair of output pulses, with opposite polarity, for controlling timing and spacing of flashes. —P. Scott, Microflash and Pulse Stimulator Tests Human Optical Response, *Electronics*, 34:27, p 48–51.



ADJUSTABLE STROBE—Provides time-motion data not possible with ordinary strobe. Used in studying motions where velocity varies during cycle, as in sewing machines, switches, relays, motors, and vibrating parts. Viewer can change motion point being studied by turning switch that gives choice of 100 different viewing positions.—J. H. Blakeslee, Strobe Techniques Analyze Complex Mechanical Motion, *Electronics*, 32:23, p 62–64.

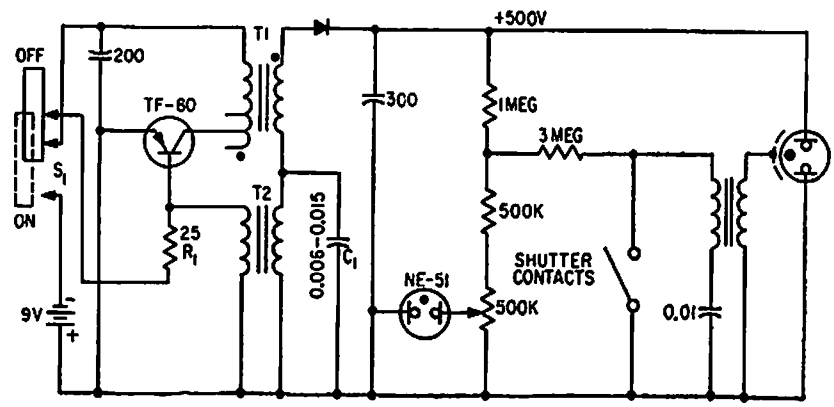


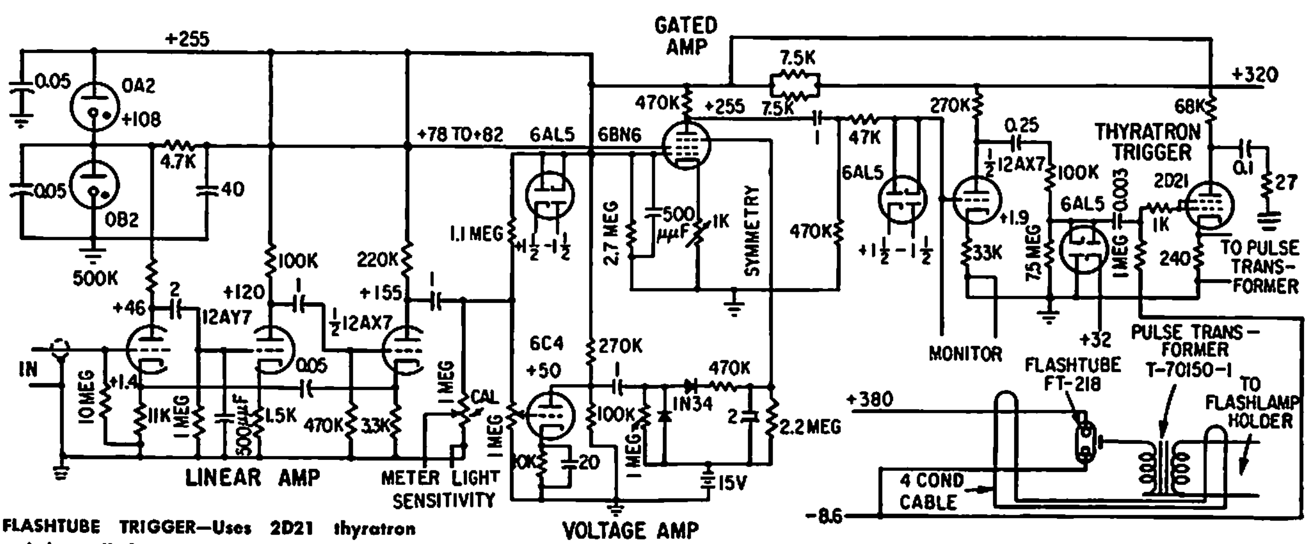
LOW-COST STROBE—Addition of silicon controlled rectifier in triggering circuit of $20 automobile engine-timing strobe gives low-cost general-purpose stroboscope. Modification is completed by wrapping ten turns of No. 18 bare copper wire around flashtube and connecting one end to photoflash transformer T1, with other end unconnected. Can be triggered by 10-microsec 3-v pulse at 5 ma, up to 25 times per second. Flash duration is 100 microsec.—A. C. Eberle, Low-Cost Strobe Built with SCR in Trigger, *Electronics*, 39:14, p 80-81.



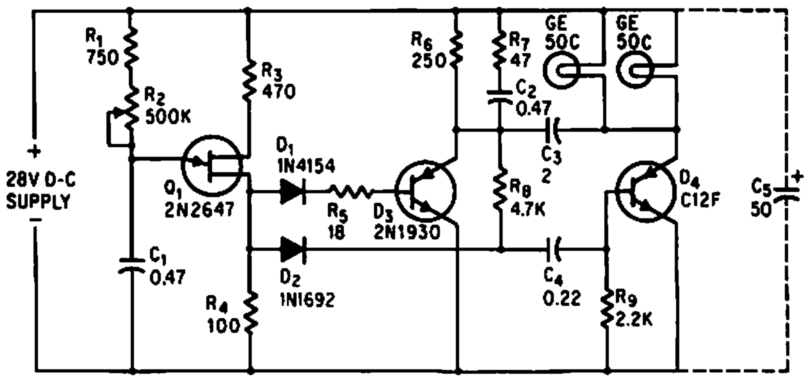
PHOTOFLASH SUPPLY—Flyback or ringing-choke oscillator is free-running when voltage on regulator capacitor C2 is less than zener voltage for reference diode D2, but converter action is halted when desired output voltage is reached. Circuit then periodically replaces charge lost by capacitor leakage. Energy conversion efficiency can therefore exceed 50% theoretical upper limit of most conventional photoflash circuits.—R. J. Sherin, Efficient Photoflash Power Converter, *Electronics*, 33:4, p 57.

BLOCKING-OSCILLATOR SUPPLY—Uses modified blocking oscillator to obtain square-wave switching at 4,200 cps. Charges 300-mfd capacitor to 500 v in 5 to 10 sec from 9-v dry cell that can deliver up to 700 flashes. To start oscillator, S1 momentarily connects R1 to negative side of battery.—H. A. Manoogian, Transistor Photoflash Power Converters, *Electronics*, 31:35, p 29-31.

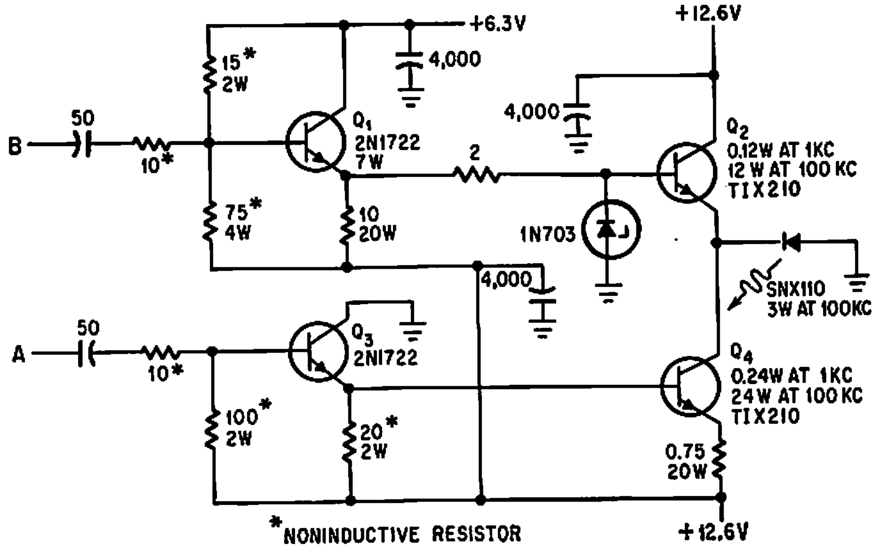




FLASHTUBE TRIGGER—Uses 2D21 thyratron switch to discharge capacitor across primary of high-voltage pulse transformer whenever thyratron is fired. Resulting pulse is applied to trigger electrode of flashtube. Fires reliably up to 60 times per second. Used to illuminate number on aluminum indexing wheel on spinning shaft of magnetic gage used to locate exact position of ferromagnetic barrier encapsulated in shaped-charge container.—P. Seward, Magnetic Gage Locates Encased Metal Parts, *Electronics*, 31:33, p 65-67.

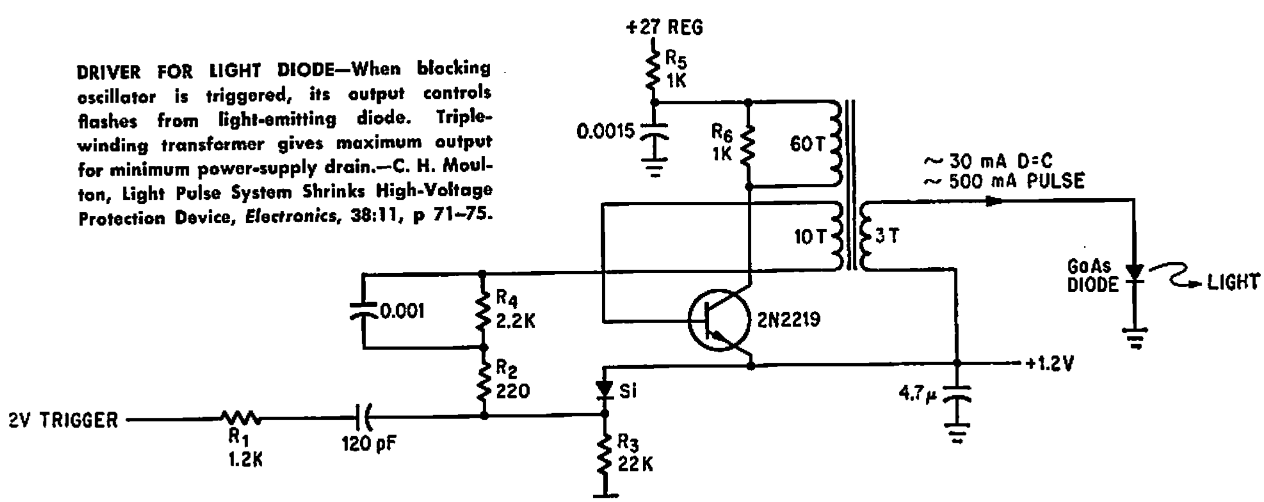


50% DUTY CYCLE—Provides 80 flashes per minute. Scr's conduct alternately in parallel inverter with capacitor commutation, and are triggered by free-running relaxation oscillator Q1. Flashing rate is determined by R1-R2-C1.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.

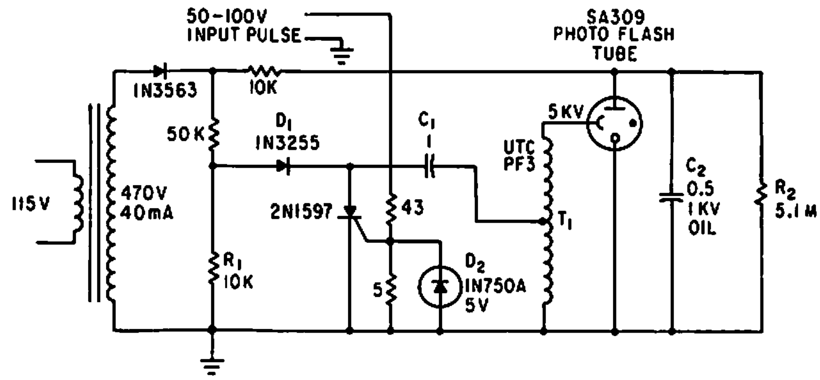


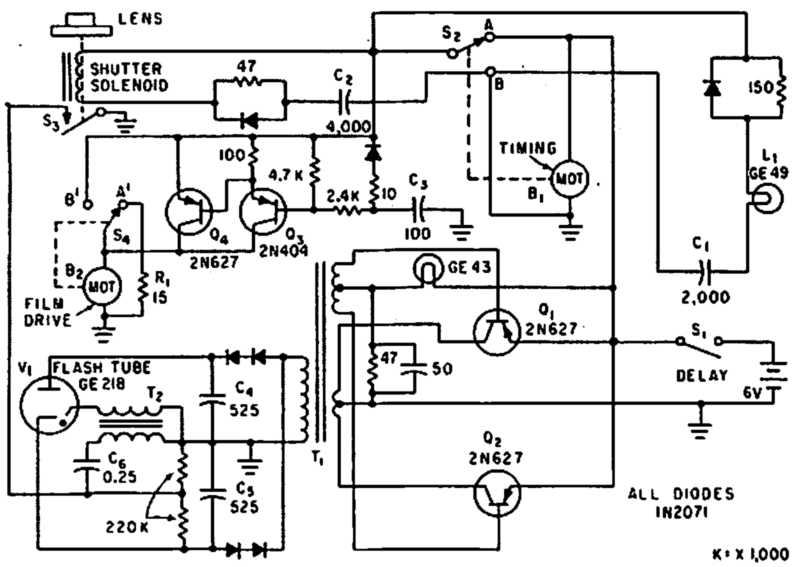
TRANSISTORS SWITCH 10-AMP PULSES FOR LIGHT-EMITTING DIODE—Input A must precede and follow B by 1 microsec to give 1-microsec width for 10-amp pulses driving light-emitting diodes at repetition rates up to 100 kc.—E. L. Bonin, Drivers for Optical Diodes, *Electronics*, 37:22, p 77–82.

DRIVER FOR LIGHT DIODE—When blocking oscillator is triggered, its output controls flashes from light-emitting diode. Triple-winding transformer gives maximum output for minimum power-supply drain.—C. H. Moulton, Light Pulse System Shrinks High-Voltage Protection Device, *Electronics*, 38:11, p 71–75.

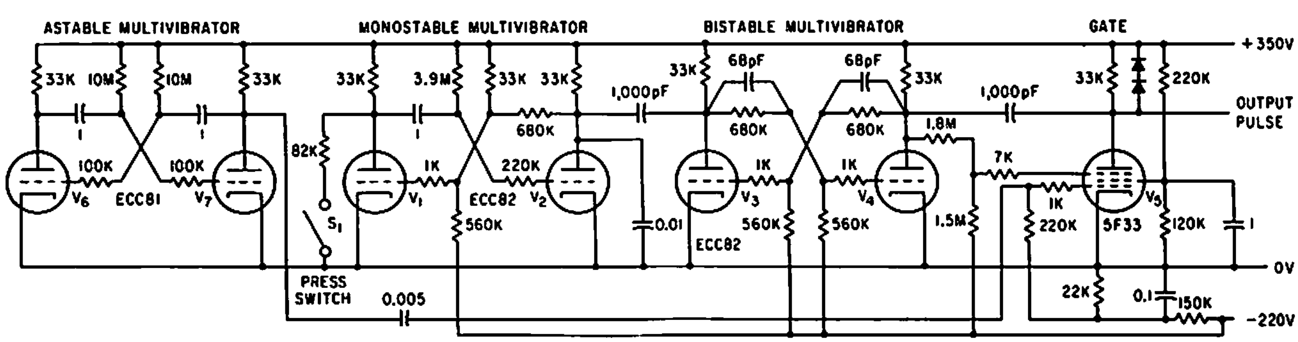


SCR CONTROLS PHOTOFLASH—C1 is charged to 100 v by a-c power supply. Input trigger pulse fires 2N1597 scr to make C1 discharge through primary of T1. Peak of 5 kv in secondary triggers photoflash. Maximum repetition rate is 20 flashes per second.—E. L. Harris, Jr., Solid-State Components Shrink Photoflash Control, *Electronics*, 36:15, p 70.

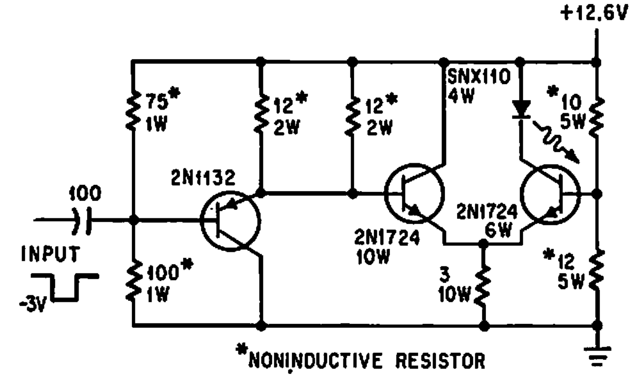




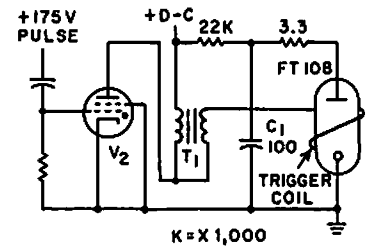
UNDERWATER CAMERA FLASH—Film drive motor and camera shutter are interlocked with electronic flash so camera can be operated blindly at depths up to 6 miles, with flash occurring only when shutter is open. Adjustable mechanical time-delay switch S1 delays start of operating cycle until camera is at operating depth. Timing switch S2 then takes picture every 12 sec for two hours. —H. E. Edgerton and S. O. Raymond, Instrumentation for Exploring the Oceans, *Electronics*, 33:15, p 62–63.



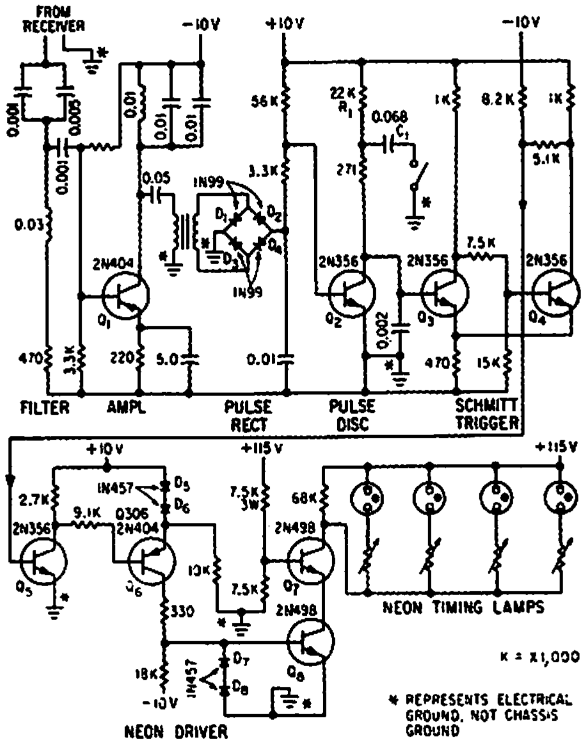
RANDOM-FLASH GENERATOR—Multivibrators generate single pulse to drive flash tube at unspecified time of from 2 to 10 seconds after switch is closed.—P. Scott, Microflash and Pulse Stimulator Tests Human Optical Response, *Electronics*, 34:27, p 48–51.



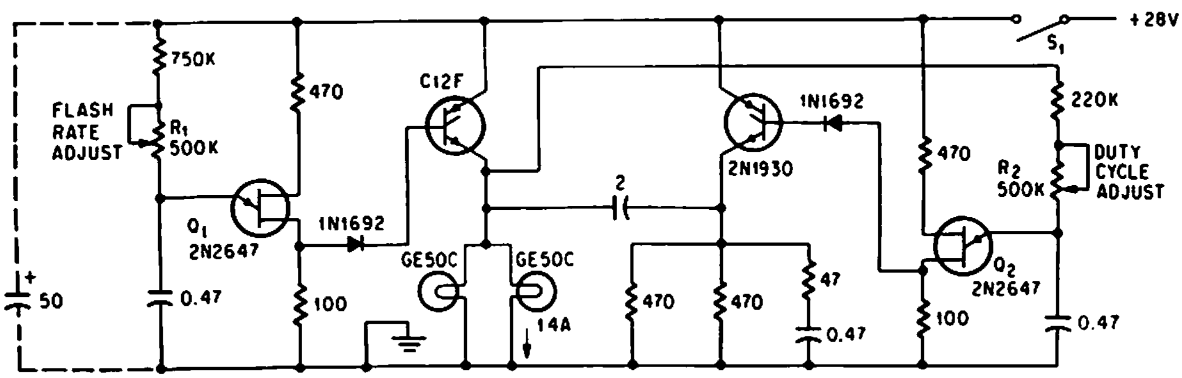
CURRENT-MODE SWITCH FOR LIGHT-EMITTING DIODE—Peak currents of 2 amp, with 50 nsec rise and fall, drive diode to give pulse-light communication.—E. L. Bonin, Drivers for Optical Diodes, *Electronics*, 37:22, p 77–82.



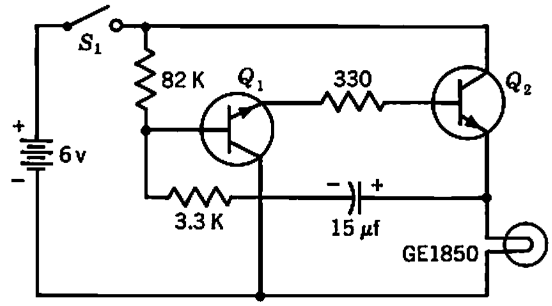
FILM TIMING-MARK GENERATOR—Instrumentation recorder for plasma studies uses discharge of capacitor at beginning of each plasma pinch discharge to trigger flash tube, light from which is chopped by glass disk driven at constant speed by synchronous motor.—J. J. Pearson, Instrumentation for Plasma Propulsion, *Electronics*, 33:24, p 66–69.



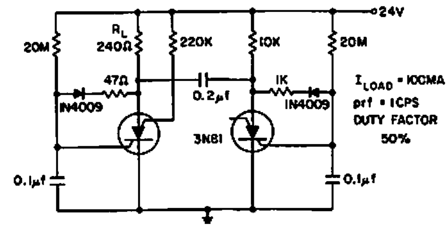
FLASH TIMER—Provides properly synchronized flash illumination for cameras in response to subcarrier pulse commands from uhf receiver.—F. M. Gardner and L. R. Hawn, Camera Control System for Rocket Sled Tests, *Electronics*, 33:14, p 63–65.



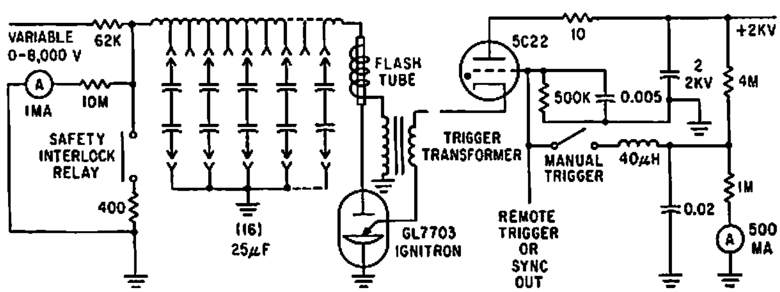
VARIABLE DUTY CYCLE—Unijunction transistor Q2 controls on time of lamp load.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105–110.



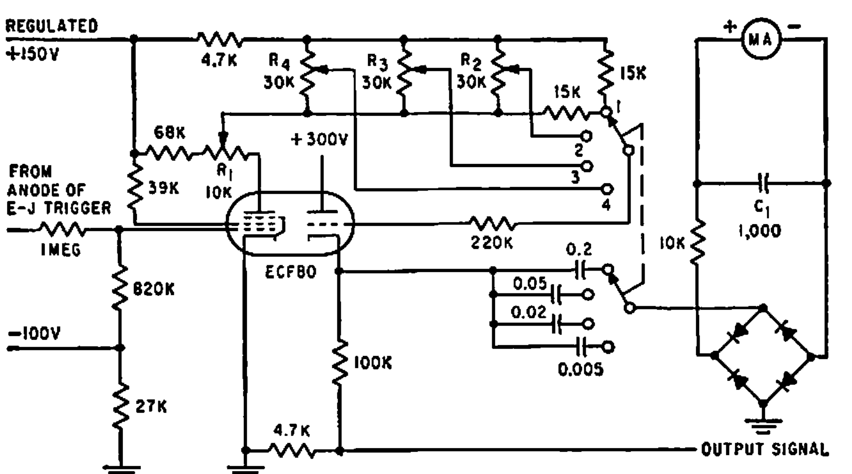
LOW-CURRENT FLASHER—Q1 is operated in inverted configuration for lower leakage current. Typical on time is 0.2 sec and off time 0.8 sec. Q1 is 2N1302 and Q2 is 2N1374. Can be used as construction barricade flasher, flashing single lamp at 1 cps for up to 60 days on single battery. Use of solar-cell switch for S1, to turn off flasher automatically in daytime, will roughly double battery life in unattended locations.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 425.



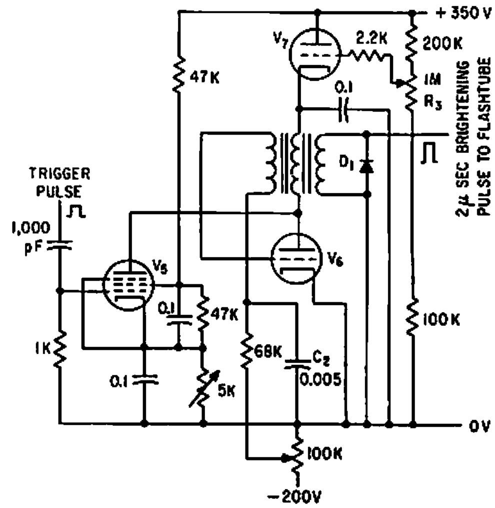
1-CPS FLASHER—When one scs triggers on, 0.2-mfd commutating capacitor turns off other scs and charges its gate capacitor to negative potential. At point in charging determined by 20-meg resistor, scs is retriggered. Battery power is delivered to load with 88% efficiency.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 434.



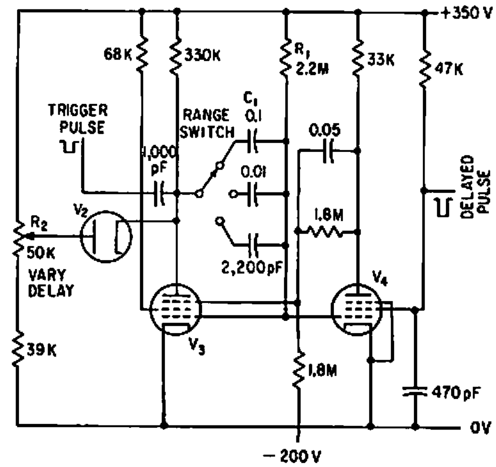
LASER FLASH TUBE SUPPLY—Variable pulse-forming network sends rectangular pulses of current through flash tube when network is discharged by ignitron used as switch. Resulting pump action on ruby crystal then produces laser beam for optical ranging up to 3 miles.—M. L. Stitch, E. J. Woodbury and J. H. Morse, Optical Ranging System Uses Laser Transmitter, *Electronics*, 34:16, p 51–53.



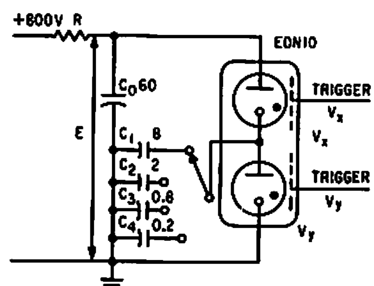
STROBE RATEMETER—Flash rate is metered by measuring mean charging current through capacitor supplied with constant-amplitude pulse voltage.—L. H. Barrett, New Circuit Improves Stroboscope Versatility, *Electronics*, 32:32, p 116–118.



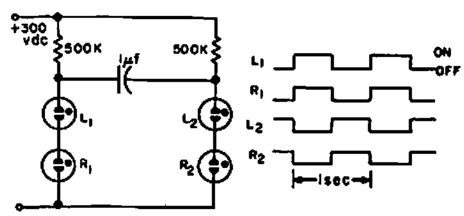
FLASH TUBE DRIVE—Generates low-impedance positive pulses having adjustable amplitude but constant duration, for driving flash tube to give same intensity-time characteristic as other flash tubes having different colors. —P. Scott, Microflash and Pulse Stimulator Tests Human Optical Response, *Electronics*, 34:27, p 48–51.



FLASH DELAY—Supressor-gated sanatron pentode provides adjustable delay for changing spacing of flashes.—P. Scott, Microflash and Pulse Stimulator Tests Human Optical Response, *Electronics*, 34:27, p 48–51.

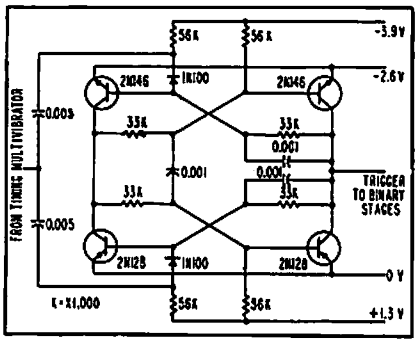


TWO-LAMP STROBE BOOSTS FLASH RATE—Two discharge tubes provide shared cycle of operation, to boost stroboscope firing rate to 1,000 flashes per second. Lamp circuit, with range-switched discharge capacitors, receives triggers in alternation.—L. H. Barrett, New Circuit Improves Stroboscope Versatility, *Electronics*, 32:32, p 116–118.

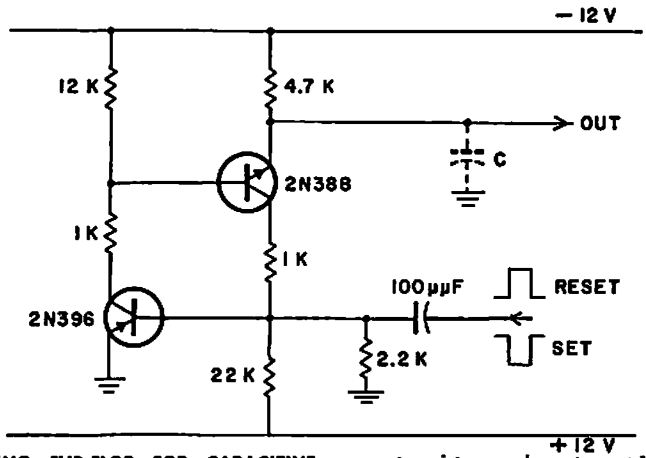


HALLOWEEN PUMPKIN BLINKER—Neon lamps blink alternately in eyes of pumpkin for 0.5-sec duration, with 0.5 sec between blinks. Will also serve as roadside blinker. Although NE2's can be used, LNE17's can be brighter and more effective.—More Glow-Lamp Circuits, *EEE*, 12:2, p 106–108.

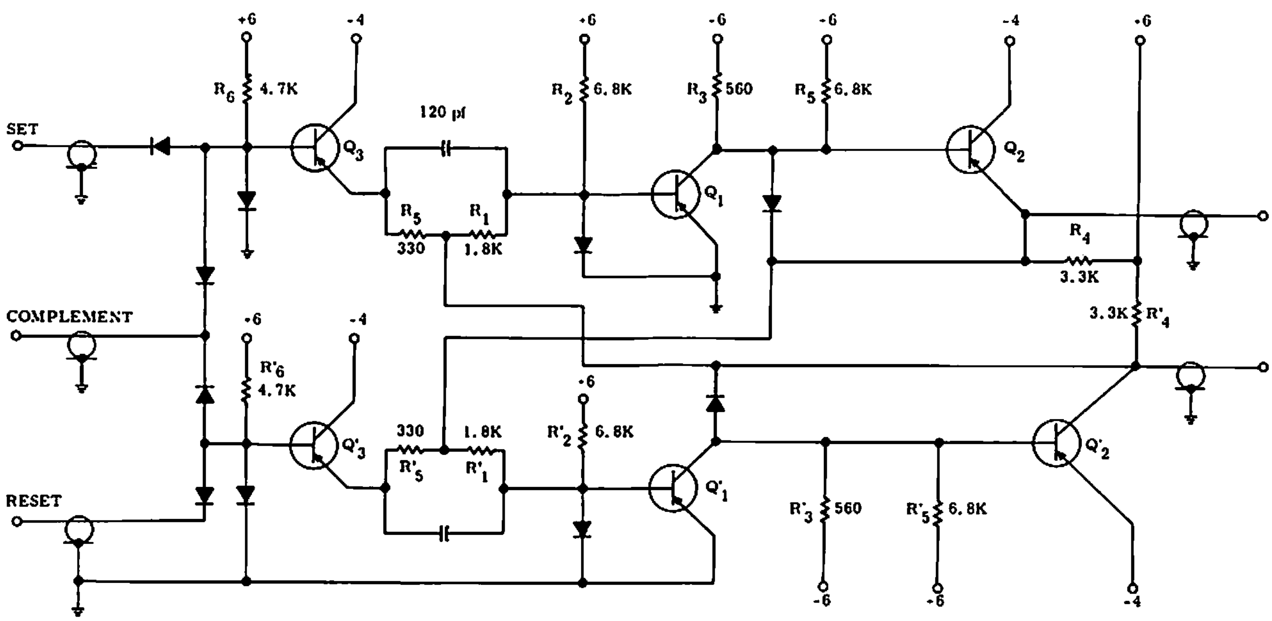
CHAPTER 33
Flip-Flop Circuits



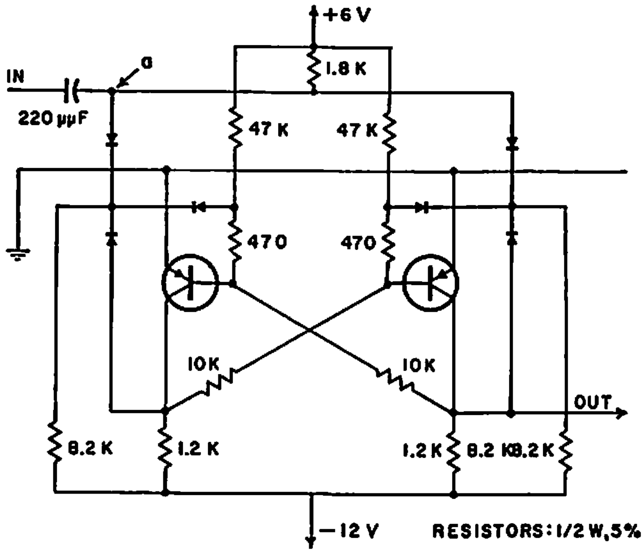
FLIP-FLOP FOLLOWER FOR COUNTER—Used to count down cycles of timing mvbr. Output of flip-flop follower is used in *and* circuit with matrix gates to turn on tone-burst oscillators or multivibrators during positive half-cycles only.—R. W. Rochelle, Cyclops Cores Simplify Earth-Satellite Circuits, *Electronics*, 31:9, 56–63.



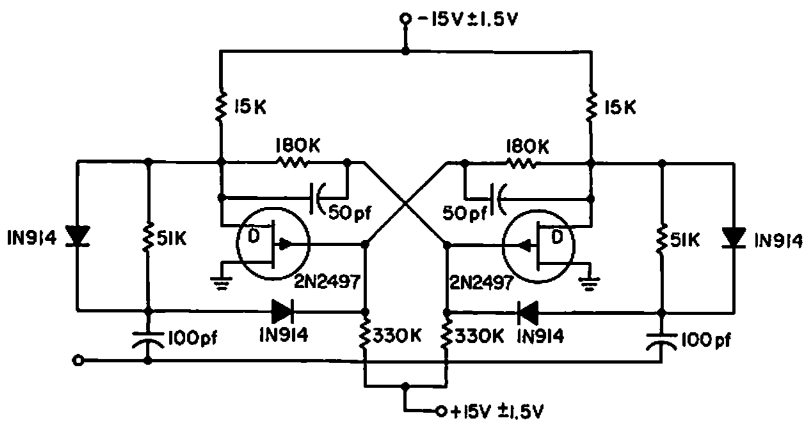
NONSTALLING FLIP-FLOP FOR CAPACITIVE LOAD—Used for transferring data into storage having heavy capacitive load, such as long connecting wires. Complementary configuration, with load in emitter circuit of one transistor, makes stage trigger reliably in fraction of microsecond.—Non-Stalling Flip-Flop for Capacitive Load, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 213.



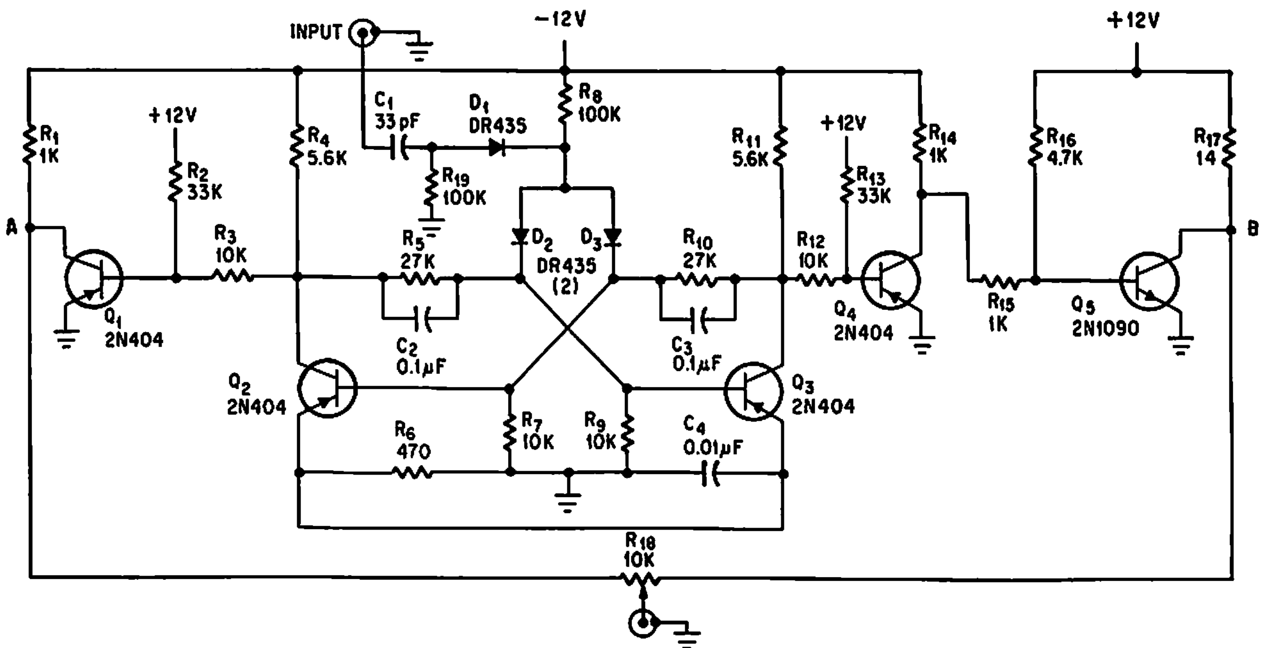
PAIRED INVERTERS—Cross-coupling of two basic inverters gives low-cost flip-flop using 2N711 germanium pnp mesa switching transistors. Flip-flop can be set and then reset, or run as counter using combined input. Close regulation is required for —4 v supply. —P. A. McInnis, "Low-Cost Computer Circuits," Motorola Application Note AN-130, Nov. 1965.



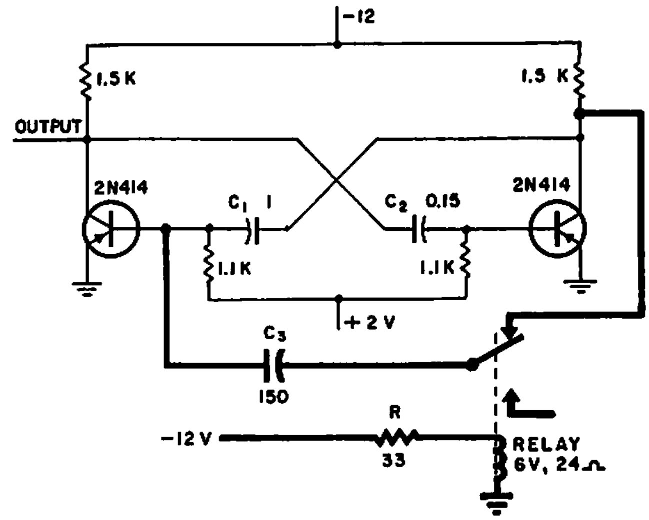
BINARY FLIP-FLOP TURNS ON—Triggering is accomplished by turning transistors on, whereas in most similar circuits the transistors are turned off. Trigger pulse merely has to lower point a below ground for fraction of microsecond. Almost any diode and transistor can be used. Speed can be up to 10 Mc with high-speed transistors. Output fall time is fast.—Binary Flip-Flop Turns On, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 214.



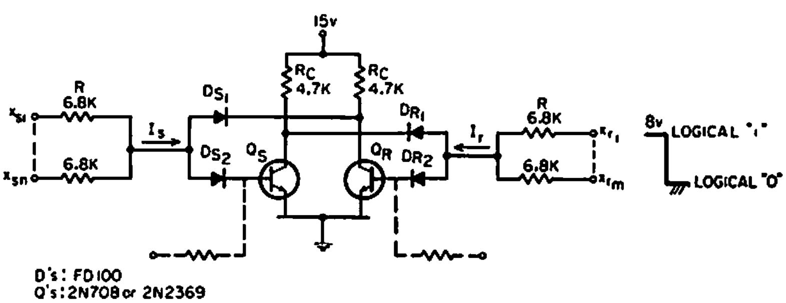
BASIC FET FLIP-FLOP—Connected as scale-of-two binary frequency divider, complete with steering diodes, speedup capacitors, and coupling capacitors. Used where speed is not primary consideration.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 89.



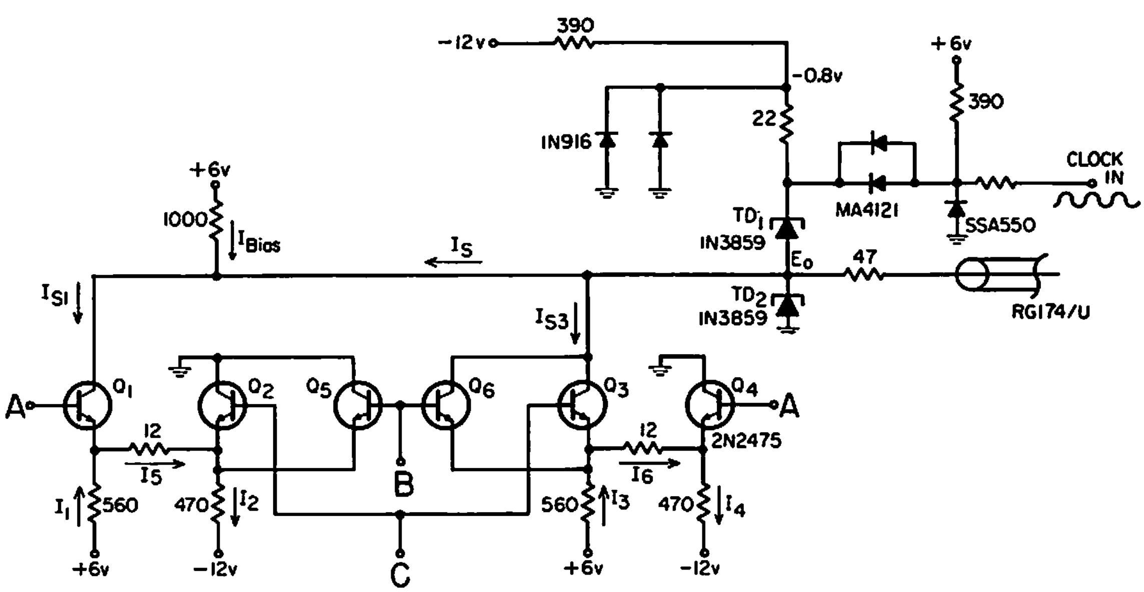
BIPOLAR OUTPUT—Output is clean square wave whose symmetry with respect to ground can be balanced by potentiometer R18. When input is fed by pulse generator, output can be used to test frequency response of transistor circuits.—F. C. Ruegg, Multivibrator Provides Bidirectional Output Pulses, *Electronics*, 38:17, p 87.



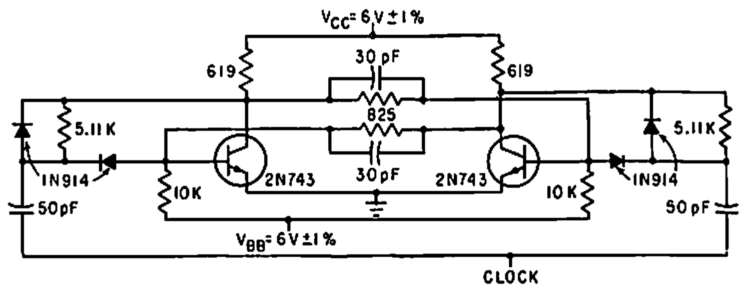
STARTER FOR FLIP-FLOP—Free-running flip-flop (thin lines) has several desired features but will not start oscillation by itself. Output impedance is less than 1,800 ohms, period is 1 millisec, and circuit is quite stable once in operation. Heavy lines show additions required for starting flip-flop when it is stalled. C3 (150 mfd) is in circuit for time period in which power supply voltage increases from 0 to 9 v after switch is closed. Relay pulls in at 9 v, to remove C3 from circuit after it has served its starting function.—Starter Circuit for Flip-Flop, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 229.



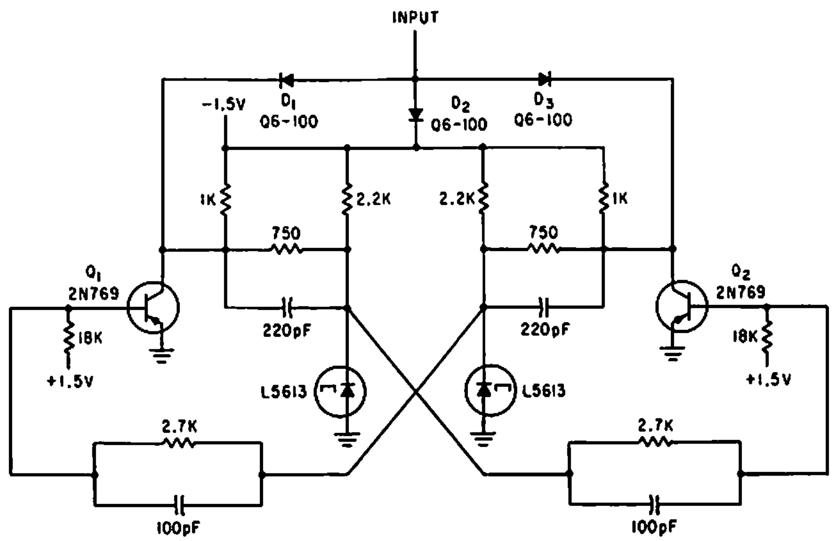
NOR-FUNCTION RESET—Modified flip-flop is set or reset when all input signals are low, corresponding to *nor*-function of input signals rather than the usual or function.—L. Mercurio, Flip-flop Operated by Input Signal NOR, *EEE*, 13:12, p 65.



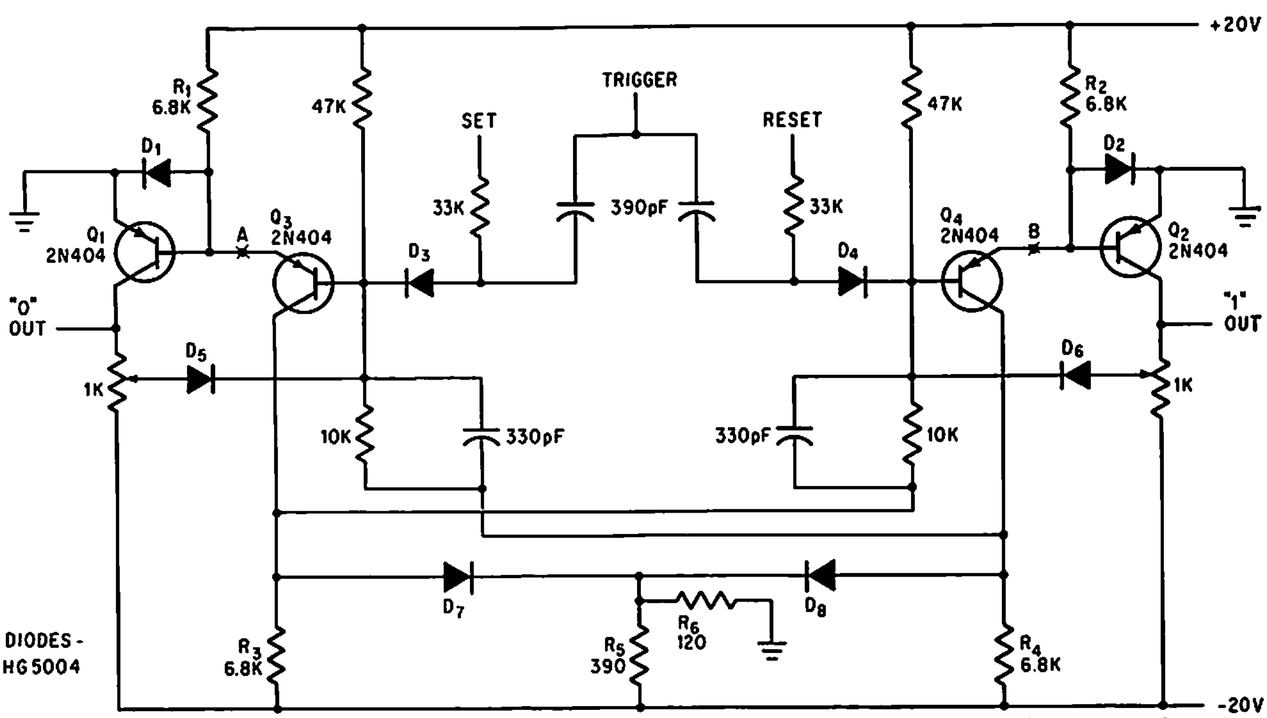
CURRENT MODE LOGIC FOR 500-MC GATED FLIP-FLOP—Uses 2N2475 transistors and 1N3859 tunnel diodes in current mode logic circuit having four inputs that can be energized to provide variety of desired logic functions. Supply of 0.8 v is obtained by passing current through two forward silicon diodes. Narrow 1-nsec clock pulse is generated by snap diode as close as possible to tunnel diode.—R. Glasgal, 500 MHz Transistor-TD Gated Flip Flop, *EEE*, 14:1, p 98–101.



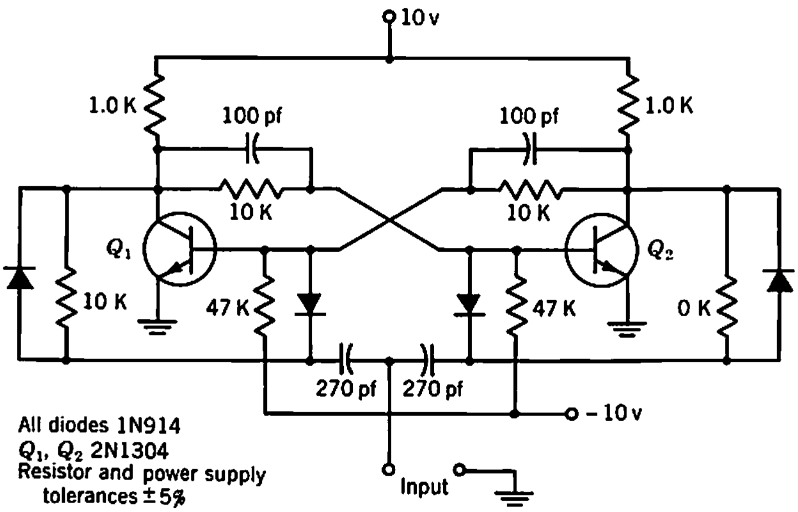
WIDE TEMPERATURE RANGE—Gives 10-Mc operation from −55°C to +125°C, with 3-v clock trigger. Addition of emitter-follower will improve wave form and extend operation to +150°C.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



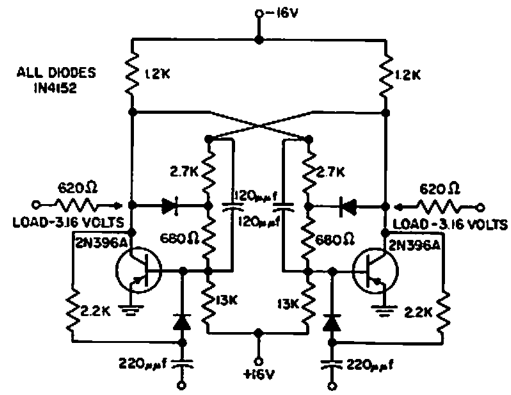
TUNNEL DIODE-COUPLED MICROENERGY FLIP-FLOP—Fan-in and fan-out capabilities per unit dissipation are improved up to ten times over existing types of logic. Use of tunnel diodes allows low supply voltages, resulting in low circuit dissipation.—T. Maguire, Electro-Optical Developments Highlight NEREM, *Electronics*, 34:45, p 73–77.



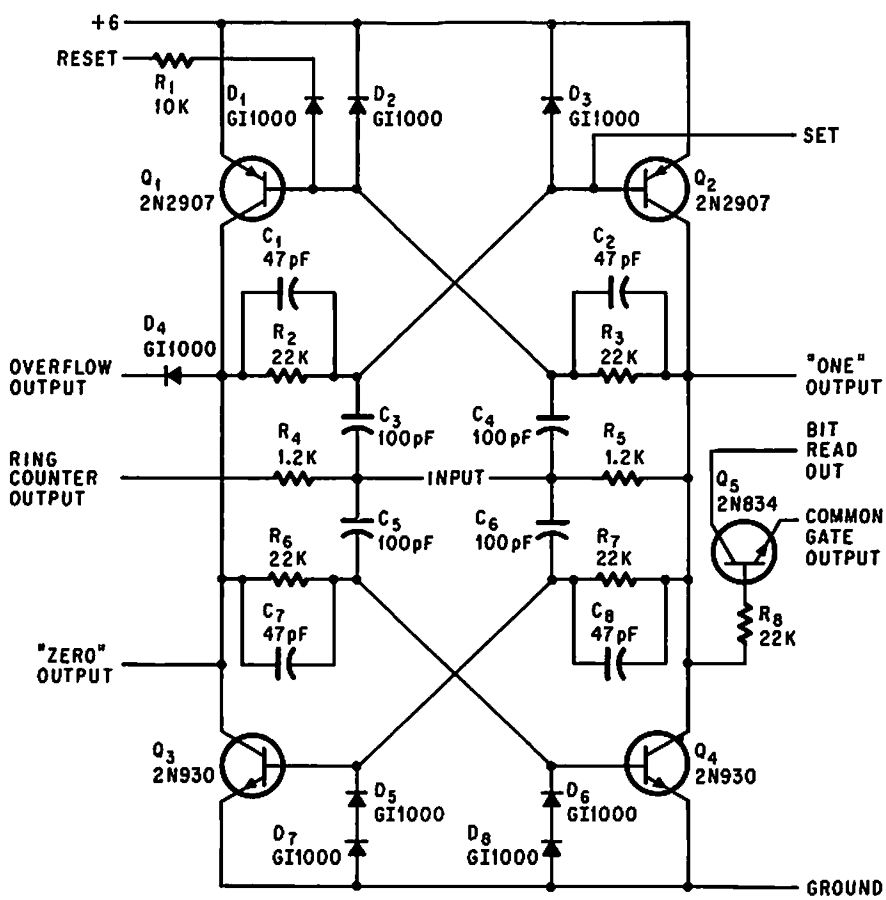
FAN-OUT TO 60—Fan-out of conventional flip-flop is quadrupled by driving bases of amplifiers Q1 and Q2 directly from emitters of Q3 and Q4.—D. J. Grover, Modified Flip-Flop Quadruples Fan-Out, *Electronics*, 38:26, p 67–68.



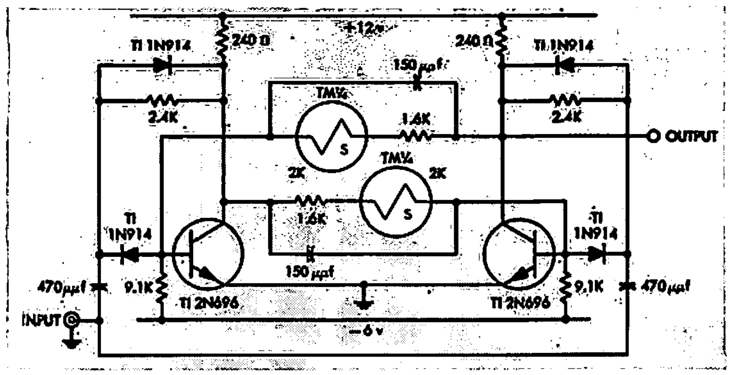
250-KC FLIP-FLOP—Basic design procedure is given. Circuit shown operates over temperature range of −55 to +55°C with input frequency of 250 kc.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 377.



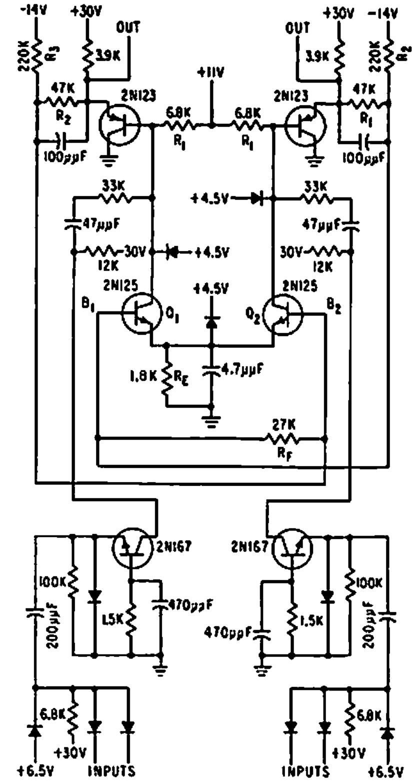
NONSATURATED FLIP-FLOP—Design procedure is given in 52 steps for manufacturability and long-term reliability, making full allowance for component tolerances, voltage fluctuation, and collector output loading.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 189.



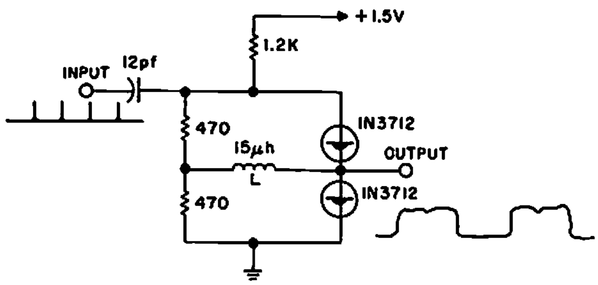
MULTICHIP COMPLEMENTARY FLIP-FLOP—Circuit for microelectronic application allows use of most suitable substrate for each component.—J. Eimbinder, Multichip Circuits Get Off The Ground, *Electronics*, 37:25, p 105–107.



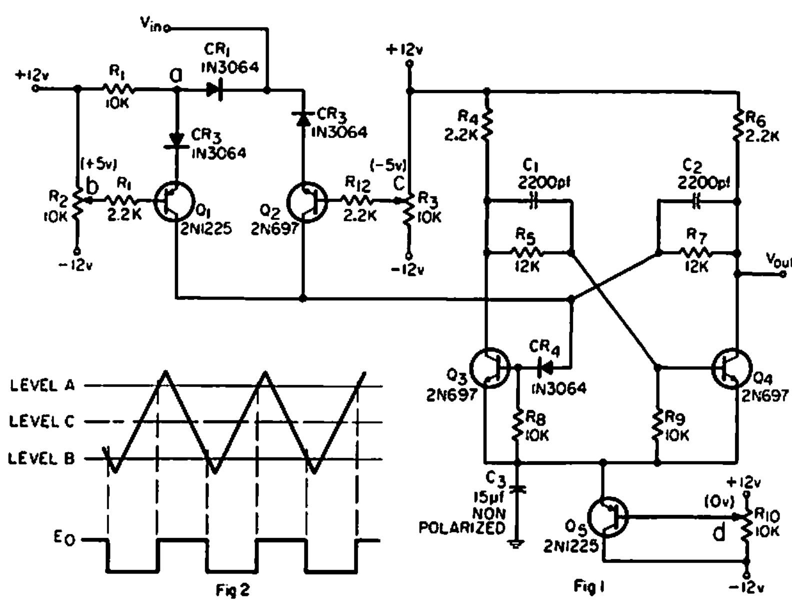
TEMPERATURE COMPENSATION—Sensistor silicon resistors in cross-coupling network compensate for temperature changes. Circuit operates at resolution rate above 5 Mc if input pulse is above 10 v when pulse width is decreased from 100 millimicrosec.—How to Compensate for Temperature Variation in a Transistorized Flip-flop (Texas Instruments ad), *Electronics*, 33:37, p 97.



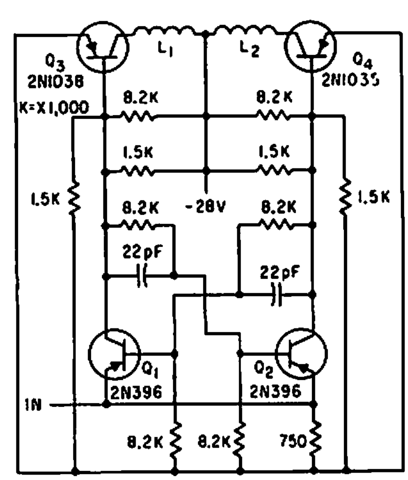
FEEDBACK PROVIDES STABILIZATION—Resistor Rf, connected between bases of Q1 and Q2, provides negative feedback to make flip-flop less sensitive to voltage variations and transistor unbalance. Will operate on 3-v pulses having 0.5-microsec fall time. Without feedback, higher voltage would be required for triggering.—P. Cheilik, Feedback Stabilizes Flip-Flop, *Electronics*, 31:19, p 92–96.



TUNNEL-DIODE FLIP-FLOP—Power consumption is very low. Takes advantage of fast switching speed (27 picosec) of tunnel diode. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 367.

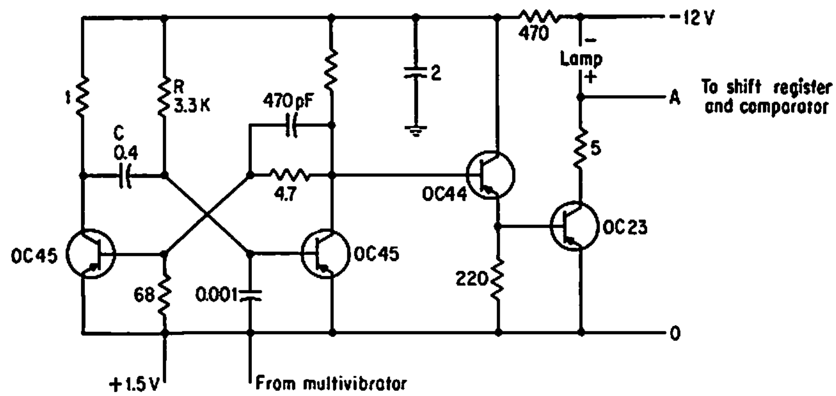


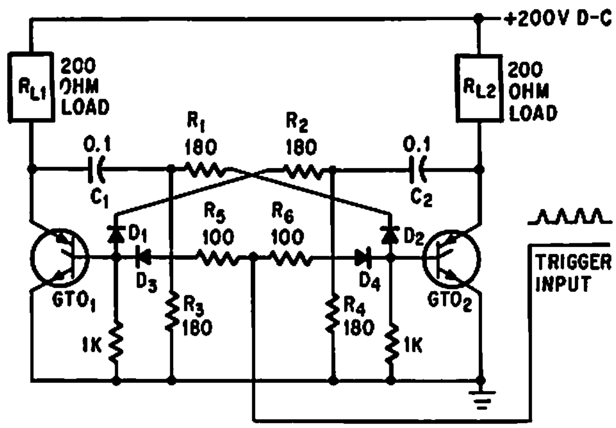
LEVEL DETECTOR—Used to provide switching function at two preset levels. R2 and Q1 determine highest level, while R3 and Q2 determine lowest level. Range of level adjustment is −10 to +8 v.—H. Anway, Level Detecting Flip Flop With Adjustable Hysteresis, *EEE*, 14:1, p 63–64.



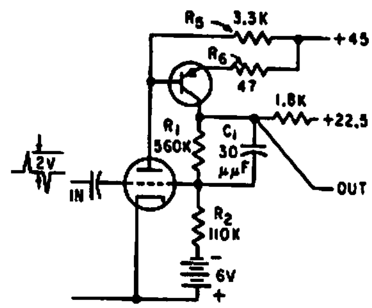
FLIP-FLOP SPEEDS MAGNETIC-DETENT STEPPING RELAY—Input signal goes to emitter of saturating flip-flop Q1-Q2, whose condition is sensed by driving transistors Q3-Q4. Stepping coils L1 and L2 are energized according to condition of flip-flop.—F. W. Kear, Coils Operate Stepping Relay at Higher Speed, *Electronics*, 35:6, p 60–63.

FLIP-FLOP DRIVES GALLIUM ARSENIDE LAMP—Pulses from mvbr (not shown) trigger flip-flop that feeds 1-amp current pulses to GaAs lamp through emitter-follower and power transistor. Used in high-speed punched tape reader.—R. F. Broom and C. Hilsum, Diode Lamp Makes Tape Readers Faster, *Electronics*, 36:20, p 44–45.

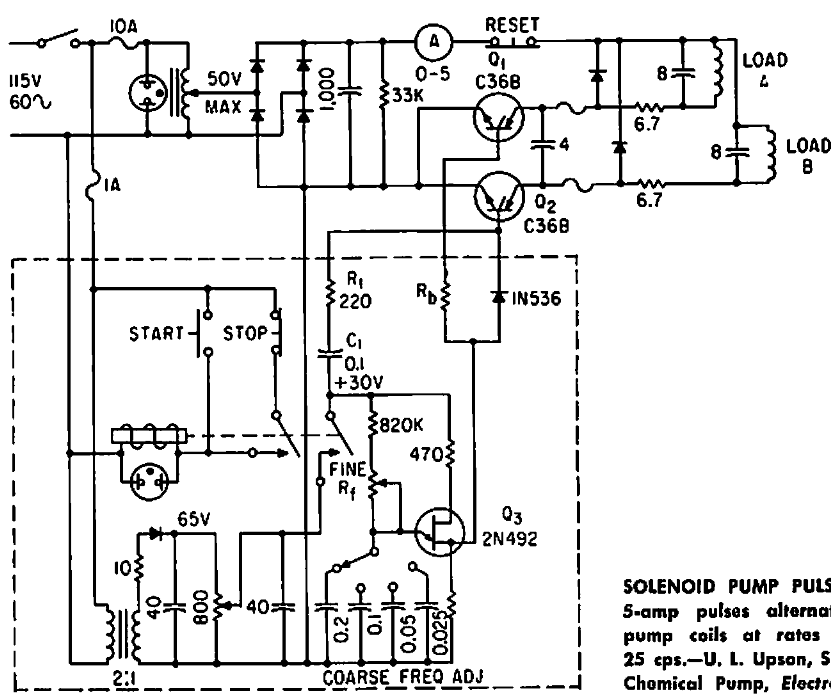




GATE-TURNOFF SCR FLIP-FLOP—Capacitor-commutated flip-flop transfers current from one load to other each time positive trigger pulse is applied to common input line, at rates up to 10 kc.—D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.

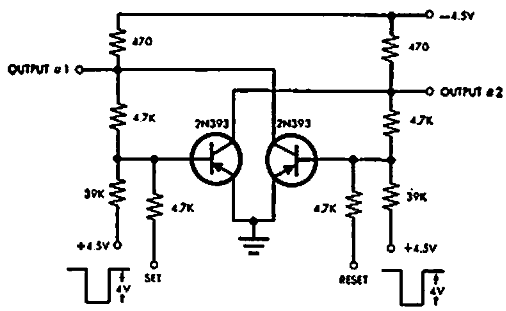


SELF-INDICATING FLIP-FLOP—Uses Amperex 6679 triode having fluorescent anode, to eliminate need for neons as indicators. Incorporates collector protection and stabilization against beta variation of transistor.—H. Rodriques deMiranda and I. Rudich, Indicator Triode for Direct Data Readout, *Electronics*, 33:6, p 52–54.

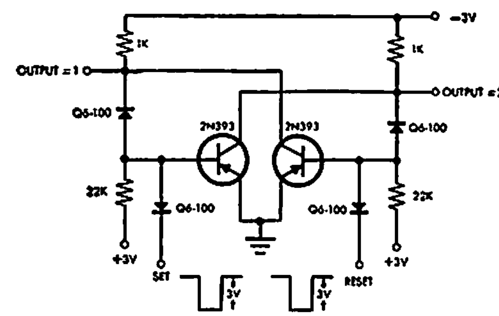


R_f = 0 TO 1M, VARIABLE
R_b = 0 TO 25 OHMS, SELECTED

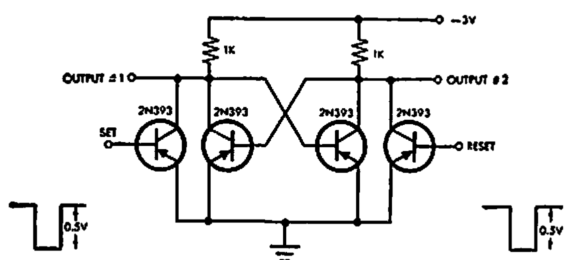
SOLENOID PUMP PULSER—Scr flip-flop feeds 5-amp pulses alternately to two solenoid pump coils at rates varying from 1.5 to 25 cps.—U. L. Upson, Solid-State Pulser Drives Chemical Pump, *Electronics*, 33:49, p 74–76.



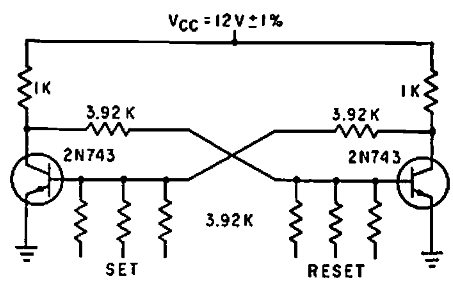
RESISTOR-COUPLED FLIP-FLOP—Typical switching times are 40 millimicrosec for tr and 110 millimicrosec for tf.—Philco MAT Transistors for Logic Circuits up to 5 Mc (Philco ad), *Electronics*, 33:17, p 50.



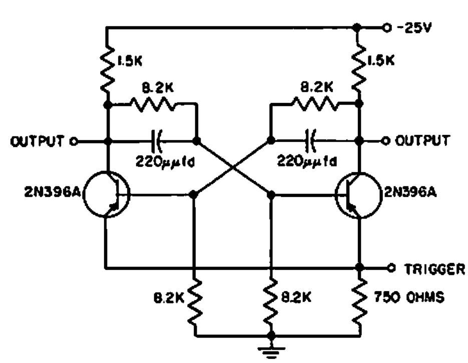
DIODE-COUPLED FLIP-FLOP—Typical switching times are 20 millimicrosec for tr and 60 millimicrosec for tf.—Philco MAT Transistors for Logic Circuits up to 5 Mc (Philco ad), *Electronics*, 33:17, p 50.



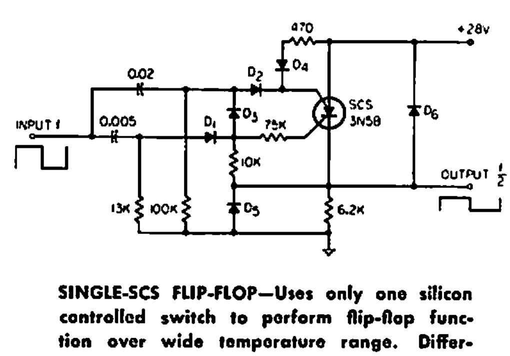
DIRECT-COUPLED FLIP-FLOP—Typical switching times are 12 millimicrosec for tr and 15 millimicrosec for tf.—Philco MAT Transistors for Logic Circuits up to 5 Mc (Philco ad), *Electronics*, 33:17, p 50.



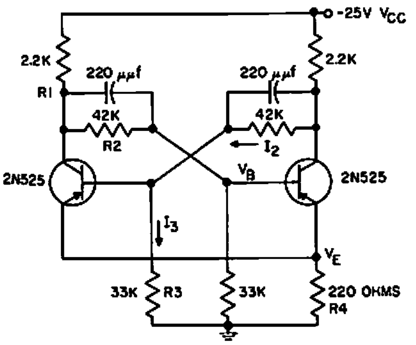
DIRECT-COUPLED *NOR* GATES—Consists of two epitaxial-transistor *nor* gates.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



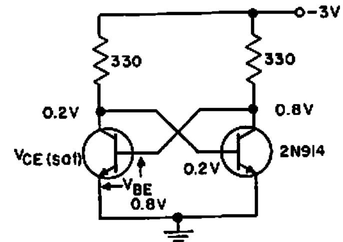
SATURATED FLIP-FLOP FOR 100°C—Increased temperature range is obtained at penalty of smaller voltage change at collector, more battery power consumed, and more trigger power required. Capacitor values depend on trigger characteristics and maximum trigger repetition rate.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 186.



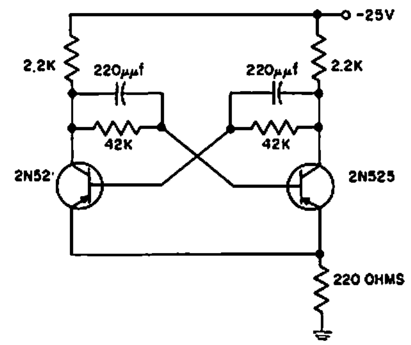
SINGLE-SCS FLIP-FLOP—Uses only one silicon controlled switch to perform flip-flop function over wide temperature range. Differentiated positive pulses are applied to cathode gate and anode gate alternately to turn scs on and off. If gate leads are brought out separately, circuit can be used as set-reset flip-flop.—E. Koda, Single-SCS Flip-Flop, *EEE*, 13:2, p 63.



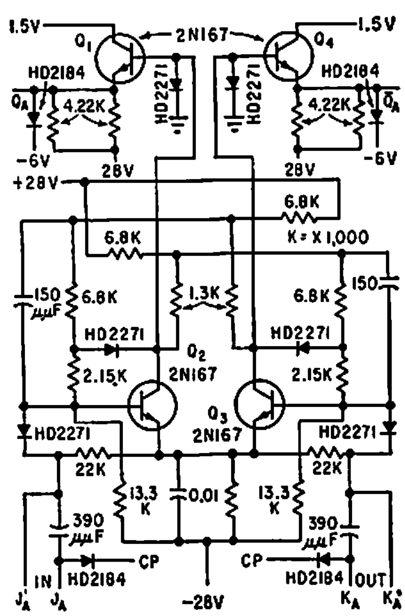
SATURATED FLIP-FLOP FOR 50°C—Addition of two 33,000-ohm resistors to basic saturated flip-flop boosts temperature range for stable operation above 50°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 186.



DCTL FLIP-FLOP—Direct-coupled transistor logic flip-flop utilizes saturation in circuit with extreme simplicity. With silicon transistors, operation up to 150°C is feasible. Saturation causes storage time delay that limits circuit speed. With germanium transistors, stray voltage signals of about 0.3 v can cause faulty performance.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 204.

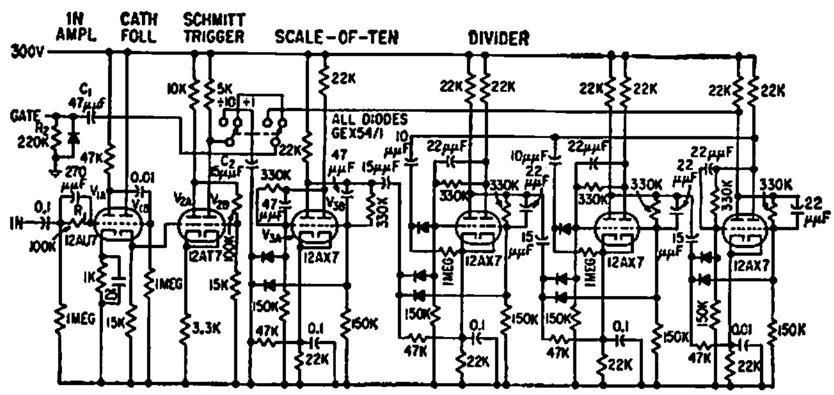


SATURATED FLIP-FLOP—Simple circuit shown is preferable at moderate operating temperatures. If emitter triggering is not used, 220-ohm emitter resistor can be removed.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 186.

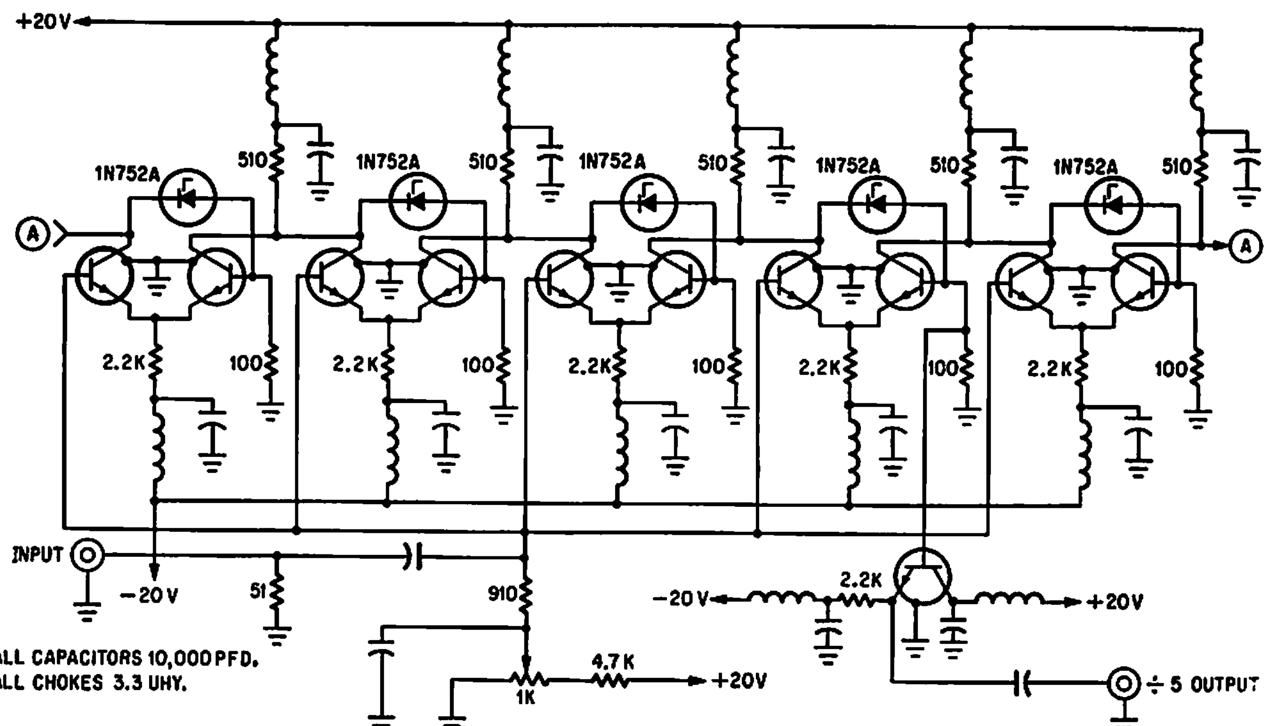


JK FLIP-FLOP—Consists of transistorized Eccles-Jordan switch, with collectors clamped with diodes to stabilize operating points. Used to provide current for driving gating circuits of voltage amplifiers for magnetic memory drum.—A. J. Strassman and R. E. Keeter, Clock Track Recorder For Memory Drum, *Electronics*, 32:41, p 74–76.

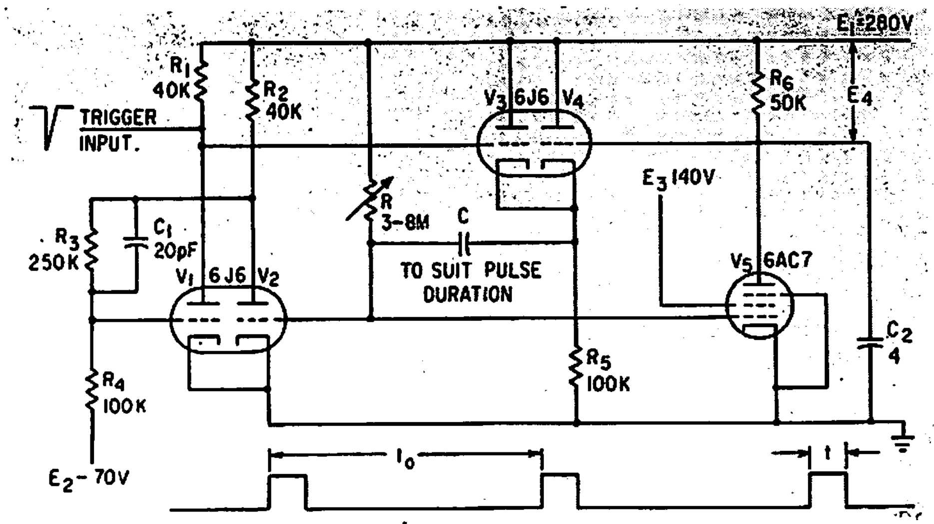
CHAPTER 34
Frequency Divider Circuits



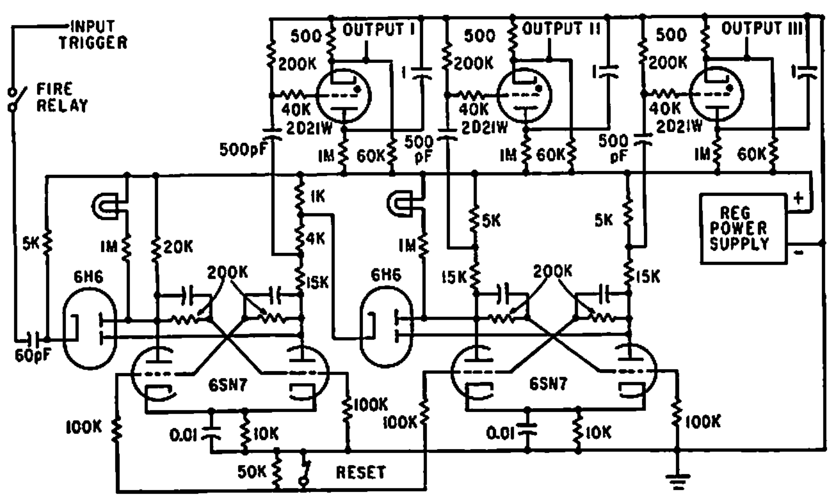
SCALE-OF-TEN DIVIDER—Consists of four cascaded Eccles-Jordan binary dividers with feedback loops, to recycle at 10. Operates up to 500 kc.—J. K. Goodwin, Digital Tachometer Aids in Turbine Design, *Electronics*, 32:15, p 58–61.



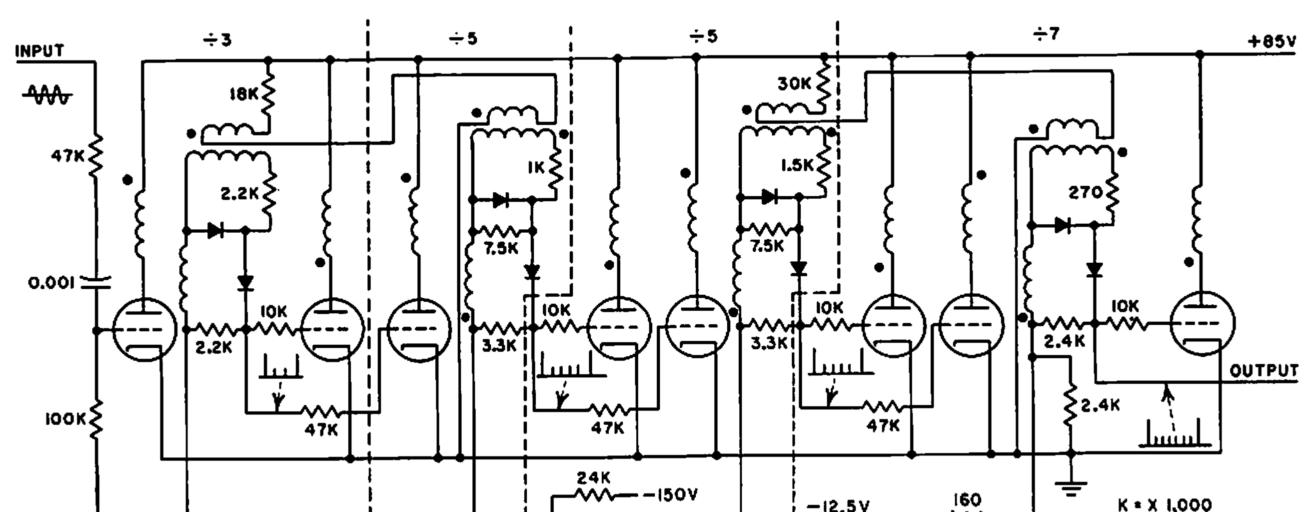
DIVIDE-BY-5 RING COUNTER—Each stage acts as nonsaturating current-mode switch. Two identical counters are cascaded in uhf prescaler of frequency synthesizer for military uhf transceiver.—L. F. Blachowicz, Dial any Channel to 500 Mhz, *Electronics*, 39:9, p 60–69.



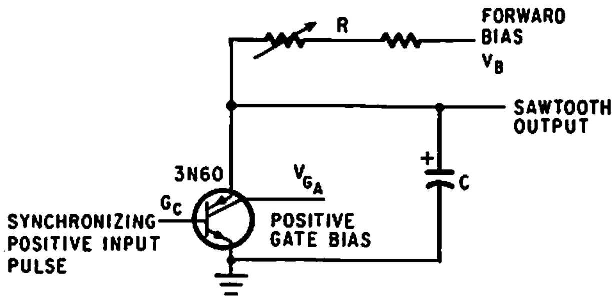
STABILIZED MONO—Operates as 10:1 divider at 1,000 pps. Division ratio of mvbr remains constant for supply variations of from 40 to 400 v. Average plate voltage of V5 is adjusted automatically to maintain optimum working conditions throughout operating range.—T. Hornak, Stabilizing Monostable Multivibrators, *Electronics*, 33:45, p 76.



CAPACITOR-BANK TRIGGER—Uses two bistable flip-flops in series as frequency divider for controlling firing of huge capacitor bank. Three outputs deliver pulses with times related to input frequencies.—R. Buser and P. Wolfert, Experimental 100,000 Joule Capacitor Bank for Plasma Research, *Electronics*, 33:32, p 58–61.

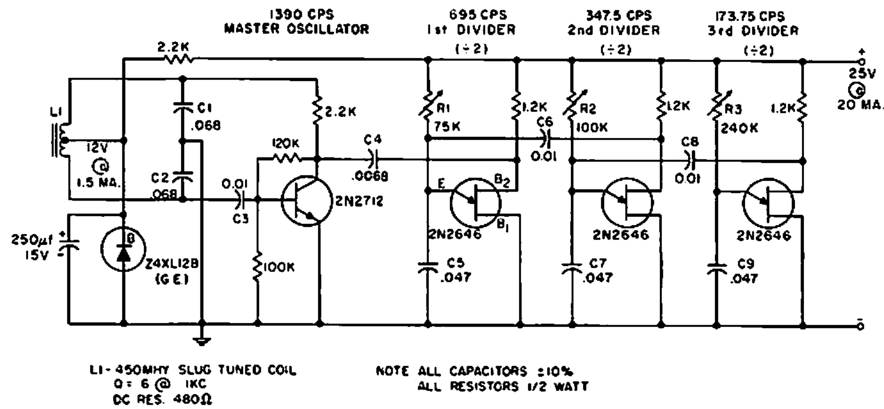


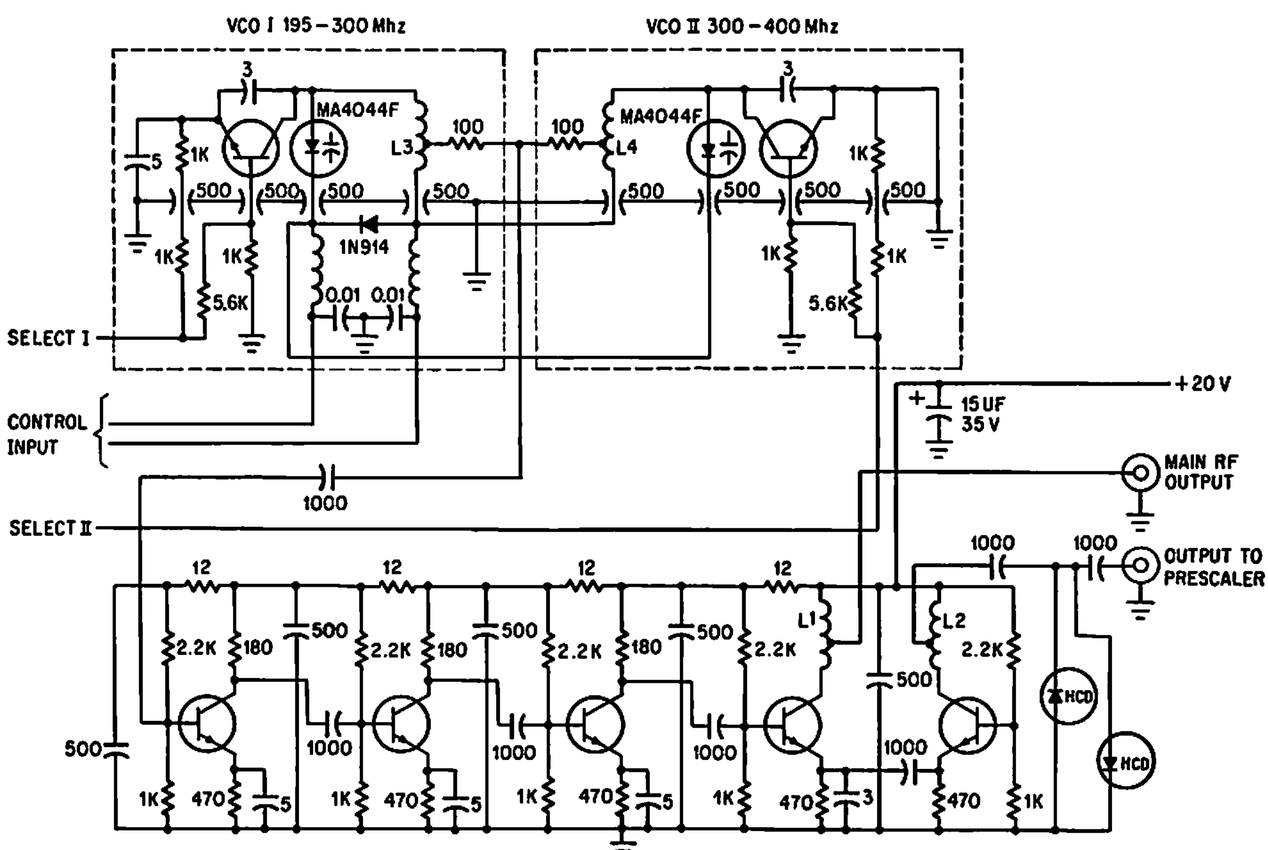
ITV DIVIDER CHAIN—Magnetic-core frequency divider counts 31.5-kc input signal down by 525 to produce 40-v 10-microsec output at 60 pps. Bias windings are series-connected in pairs to simplify circuit. Gives high accuracy and stability.—A. Rose, Magnetic-Core Divider for ITV Sync Generators, *Electronics*, 31:15, p 76–77.



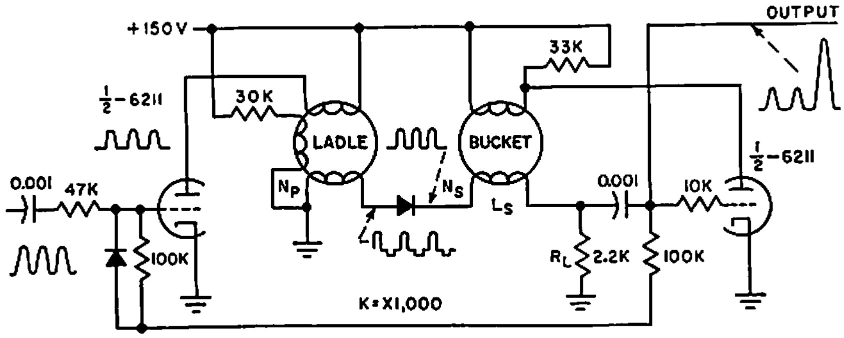
SILICON-CONTROLLED SWITCHES DIVIDE FREQUENCY BY 100—Each 3N60 stage divides input frequency by 10 while serving as relaxation oscillator, for frequencies from 250 kc down to fraction of cycle. Circuit can also be used as sawtooth generator.—R. J. Wold, 4-terminal Controlled Switch Divides Frequencies by 10, *Electronics*, 37:18, p 81–82.

CASCADED UJT RELAXATION-OSCILLATOR DIVIDER—Class C Hartley master oscillator serves for synchronizing three basic relaxation oscillators that would otherwise be free-running. Dividers remain locked over temperature range of 0 to 70°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 342.

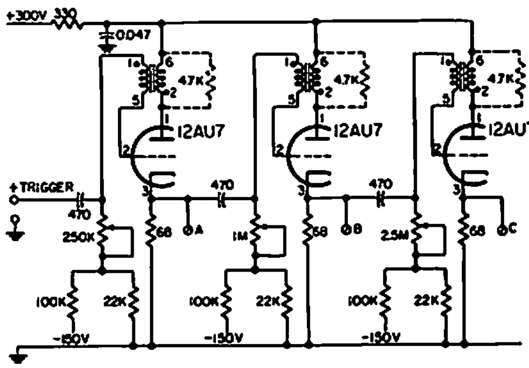




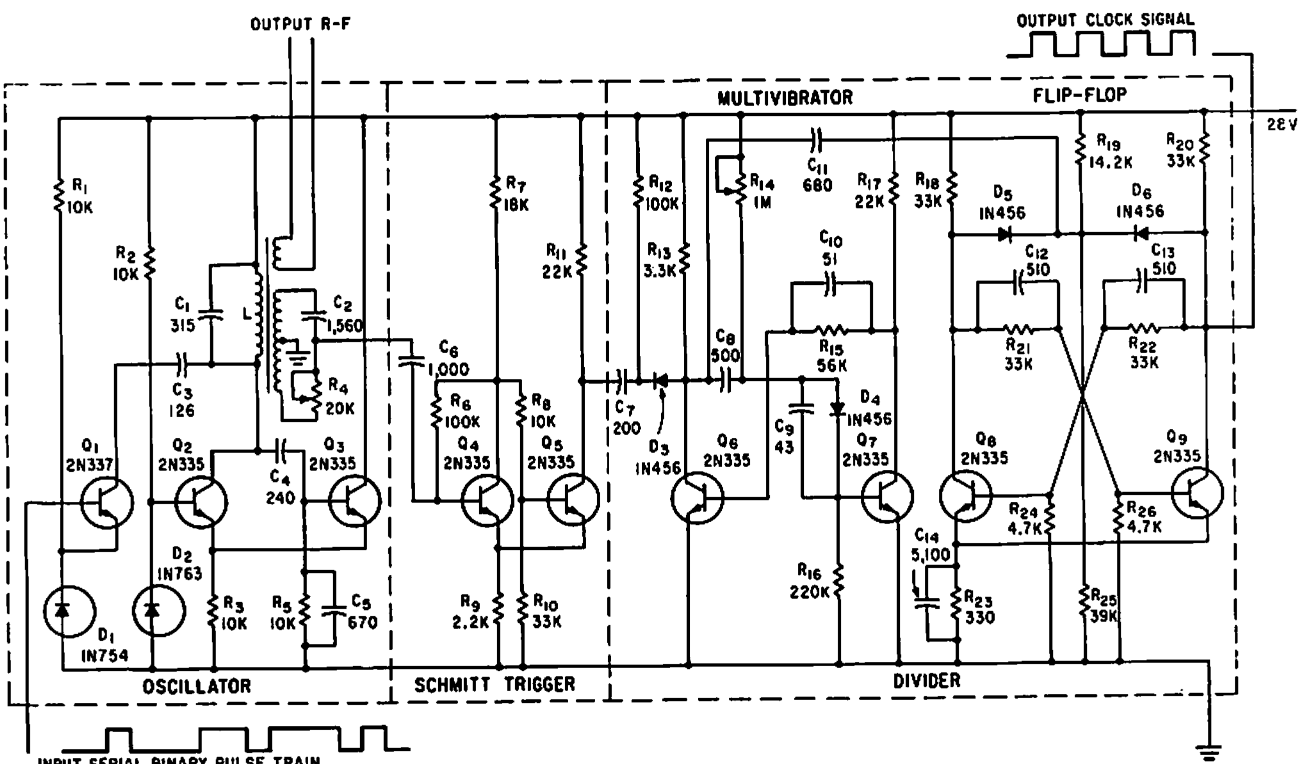
VCO FOR FREQUENCY SYNTHESIZER—Digital synthesizer uses two vco's to cover 190 to 400 Mc, giving choice of 3,500 channels for transceiver in military uhf band without tuning. Output to prescaler is limited with hot-carrier diodes. Control voltage acts on diffused-junction varactors.—L. F. Blachowicz, Dial any Channel to 500 Mhz, *Electronics*, 39:9, p. 60–69.



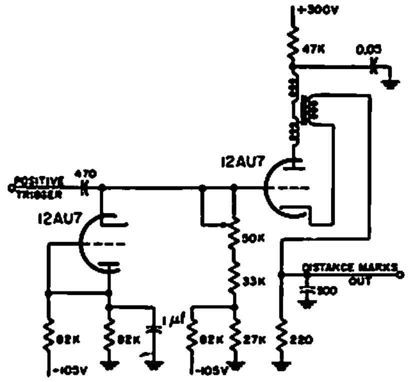
DIGITAL MAGNETIC-CORE DIVIDER—Frequency-divider chain uses pairs of rectangular hysteresis-loop magnetic cores as counting elements. Has high accuracy and stability. First core (ladle) is driven to saturation by each input pulse. Constant-voltage integral output from ladle core drives second bucket core. With appropriate turns ratios of windings, bucket core can be made to walk up its hysteresis loop in any number of predetermined steps. Successful single-stage dividers have been made up to scales of 17, with reliable operation from 10 to 50 kc.—A. Rose, Magnetic-Core Divider for ITV Sync Generators, *Electronics*, 31:15, p 76–77.



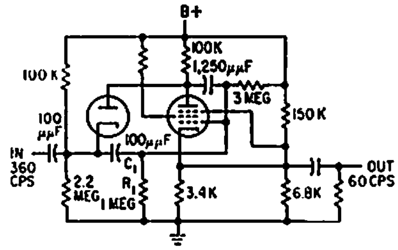
CASCADED DISTANCE-MARK DIVIDER—With 1-mile markers used as input trigger, outputs A, B, and C give 2 to 5, 10 to 25, and 20 to 50-mile distance marks, respectively. Grid potentiometers control exact mile mark obtained at each output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N7-5.



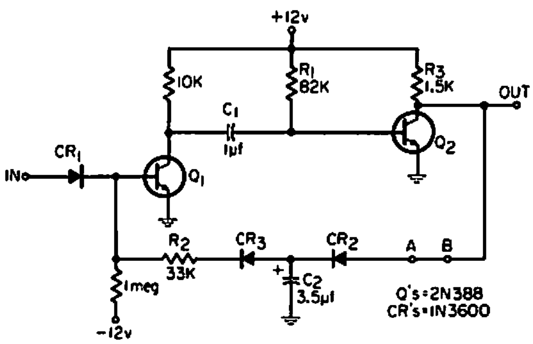
PCM FREQUENCY REFERENCE—Coherently switched oscillator, 90° phase shifter, Schmitt trigger, and frequency-dividing multivibrator and flip-flop together derive constant-frequency square-wave output clock signal from frequency-shifted subcarrier oscillator of f-m/f-m telemetry system.—R. C. Onstad, New Coherent Keyer Simplifies Pulse-Code Telemetry, *Electronics*, 35:26, p 71–73.



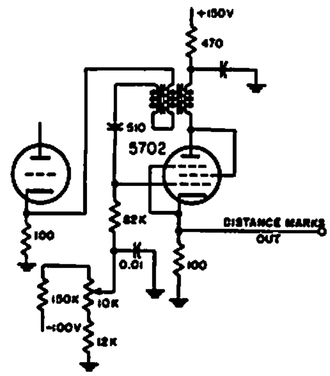
PULSE-FREQUENCY DIVIDER—Plate-to-cathode coupled blocking oscillator is used to divide from high to low pulse frequency, as required in radar distance-mark generator. Circuit is highly stable with respect to heater voltage variations.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N7-1.



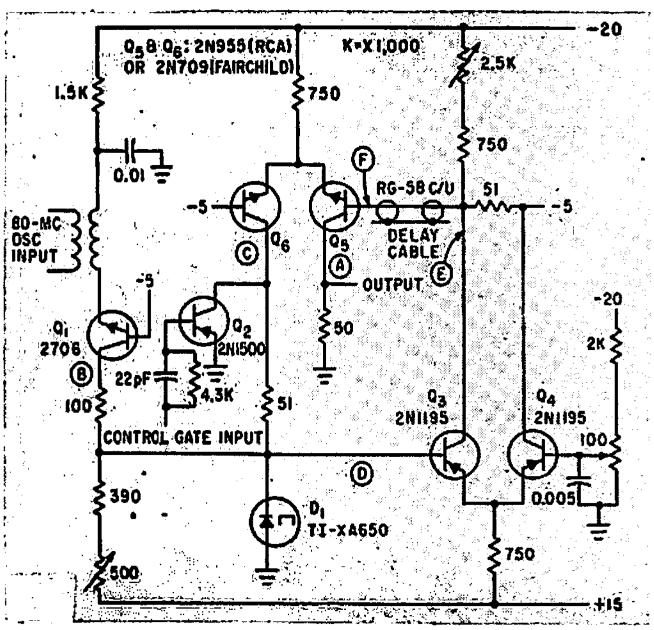
PHANTASTRON FREQUENCY DIVIDER—Will divide 360 cps to give 60 cps. Is triggered by pulse train with both positive and negative pulses.—K. M. Chen, Trigger Stabilizes Frequency Divider, *Electronics*, 31:47, p 104-107.



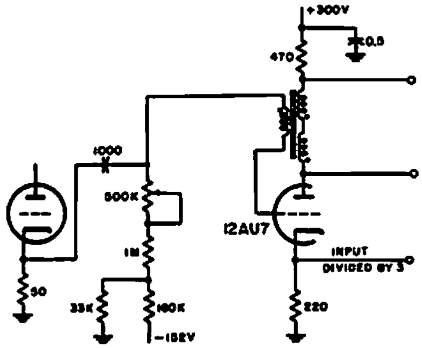
INDEPENDENT PULSE-WIDTH CONTROL—With components shown, circuit will divide 50-millisec pulses by 5 without changing pulse width. Other components give different widths along with division.—J. McGruder, Frequency Divider With Independent Pulse-Width Control, *EEE*, 14:2, p 69.



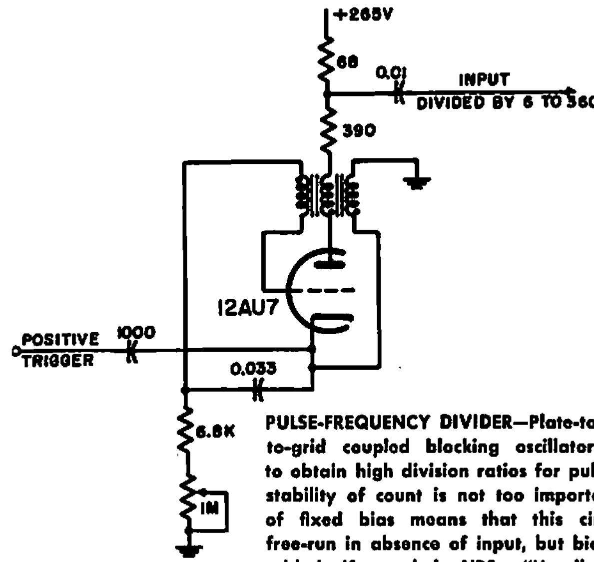
PULSE-FREQUENCY DIVIDER—Plate-to-grid coupled blocking oscillator, with voltage step-up to grid, is used to divide from high to low pulse frequency.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N7-1.



DIVIDER ELIMINATES COUNT-STARTING JITTER—Output of 80-Mc free-running crystal oscillator is divided by 8 to give 10-Mc time base that is almost perfect square wave.—W.O. LeCroy, Jr., Eliminating One-Count Uncertainty in Cycle-Counting Interval Timers, *Electronics*, 35:29, p 46-47.



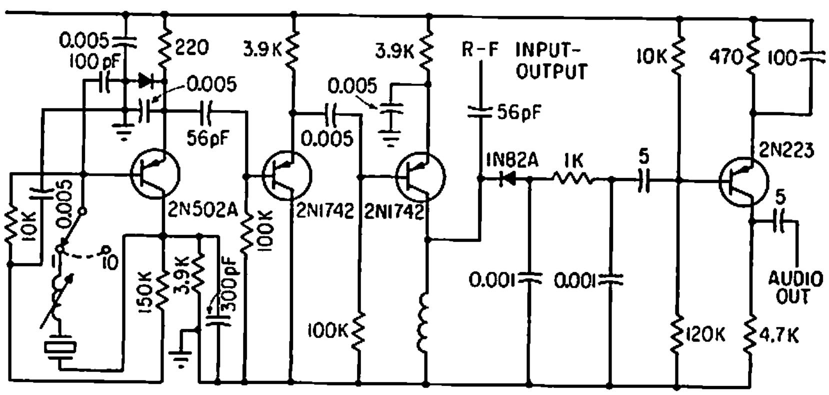
PULSE-FREQUENCY DIVIDER—Plate-to-grid coupled blocking oscillator, with voltage stepdown to grid, is used to divide from high to low pulse frequency. Stepdown yields maximum peak pulse voltage at plate and permits maximum pulse duration from given transformer.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N7-1.



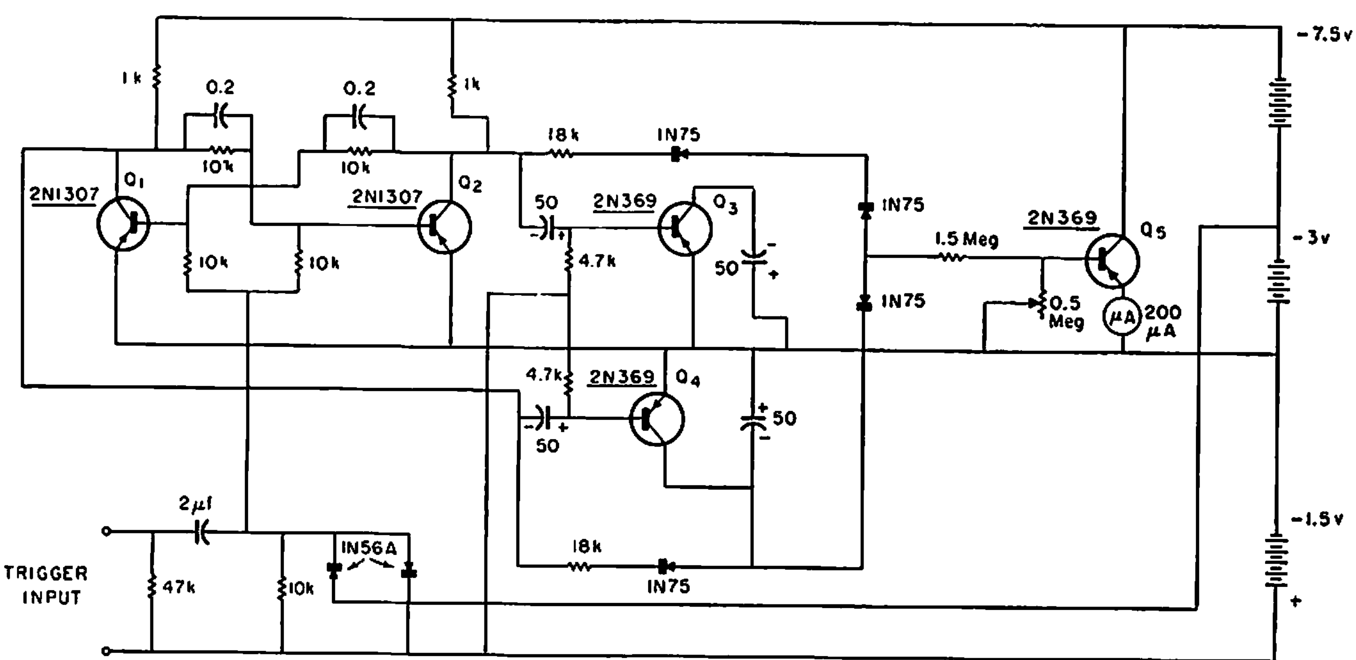
PULSE-FREQUENCY DIVIDER—Plate-to-cathode-to-grid coupled blocking oscillator is used to obtain high division ratios for pulses when stability of count is not too important. Lack of fixed bias means that this circuit will free-run in absence of input, but bias can be added if needed.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N7-1.

CHAPTER 35

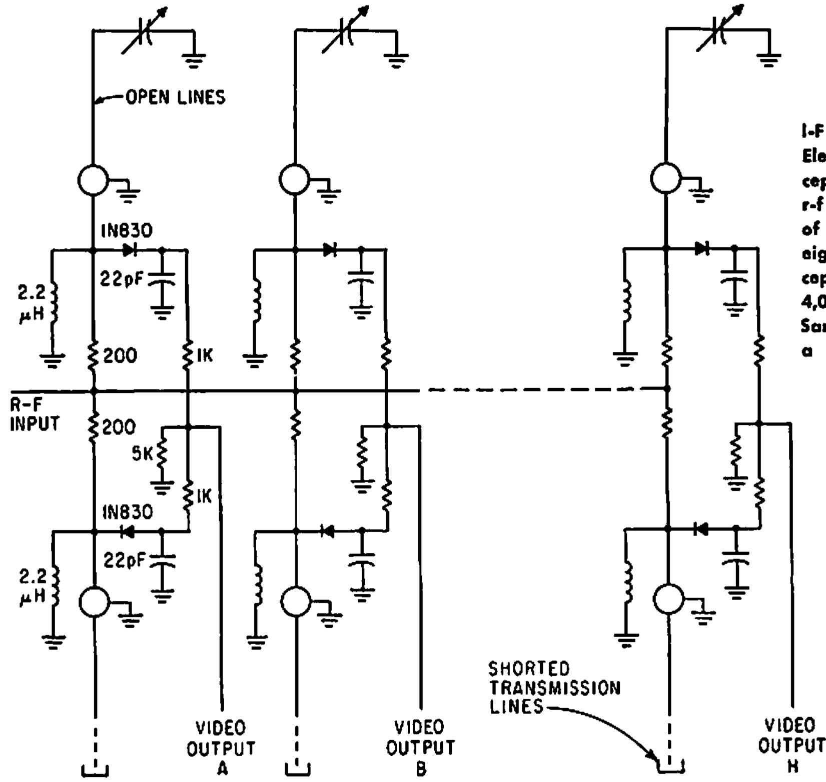
Frequency Measuring Circuits



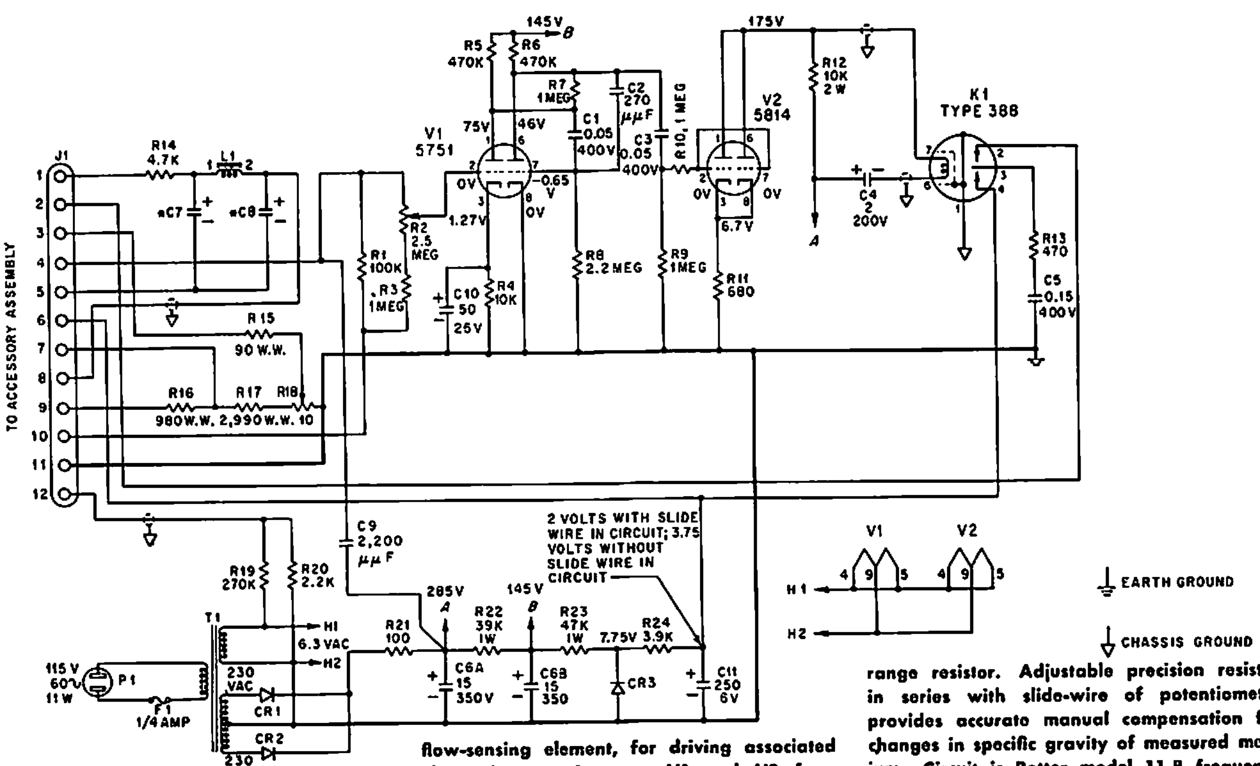
TEN-FREQUENCY STANDARD—Stable crystal switching oscillator, isolation amplifier, multiplier, mixer, and audio amplifier give choice of ten fundamental frequencies, between 10 and 20 Mc, with harmonic output from 20 to 480 Mc, for zero-beating with unknown input frequency being measured.—Portable Frequency Standard Between 10 and 480 Mc, *Electronics*, 35:18, p 64.



SUBAUDIO FREQUENCY METER—Provides meter indication of frequencies from 0.2 to 10 cps. Responds rapidly to changes in input frequency. Input signal is converted to square wave by limiting and differentiating network and bistable flip-flop, with period of square wave indicated on meter calibrated in pulses per minute. By alternately charging each one of pair of capacitors, steady voltage is maintained on capacitor connected to meter while other is charging.—Fast Acting Subaudio Frequency Meter, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 150.



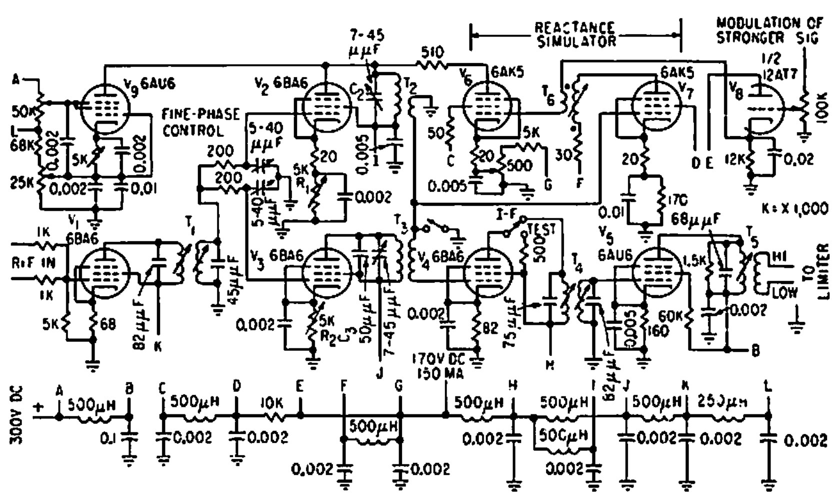
I-F BESS DIGITAL FREQUENCY METER—Binary Electromagnetic Signal Signature (bess) concept permits measuring frequency of single r-f pulse in range of 55 to 65 Mc. Eight pairs of transmission lines divide this band into eight equal segments of 1.25 Mc. Same concept can be applied to other ranges up to 4,000 Mc.—R. F. Morrison, Jr., and M. N. Sarachan, Binary Frequency Sensing Measures a Single Pulse, *Electronics*, 36:14, p 42–46.

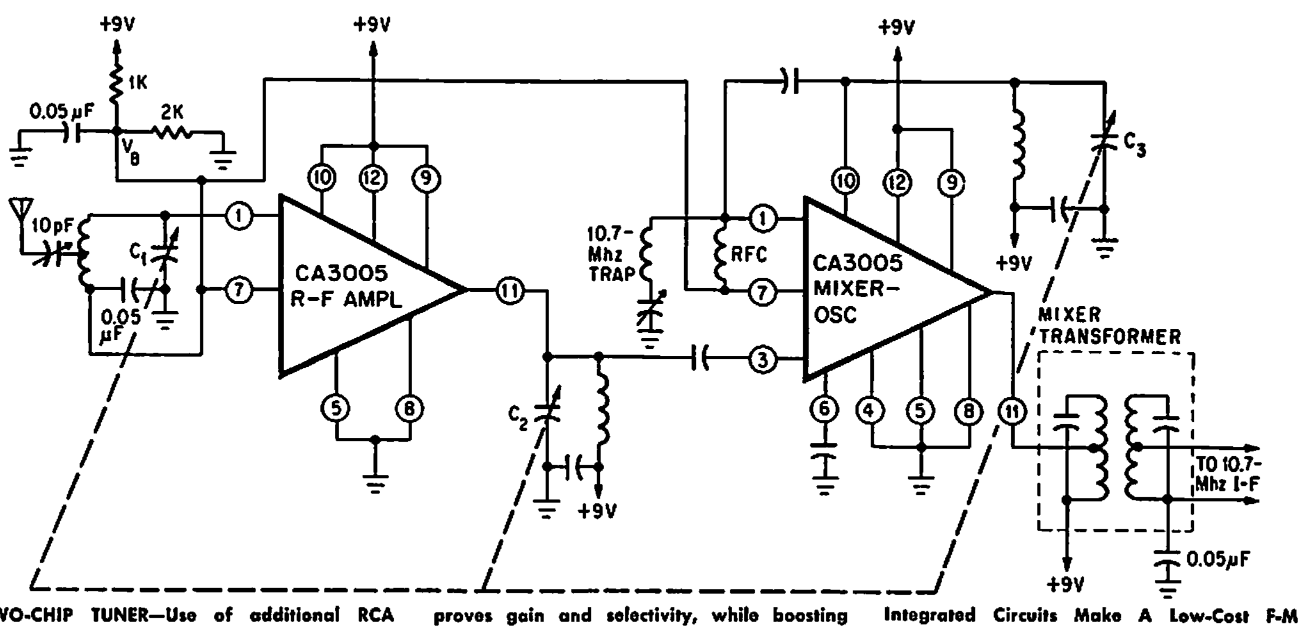


FLOWMETER FREQUENCY CONVERTER—Provides output signal that is directly proportional to frequency of input from turbine flow-sensing element, for driving associated electronic potentiometer. V1 and V2 form three-stage limiting amplifier. Capacitor tachometer circuit uses chopper K1 to discharge C5 repetitively through adjustable-range resistor. Adjustable precision resistor in series with slide-wire of potentiometer provides accurate manual compensation for changes in specific gravity of measured medium. Circuit is Potter model 11-B frequency converter.—G. C. Carrol, "Industrial Instrument Servicing Handbook," McGraw-Hill, N.Y., 1960, p 3–3.

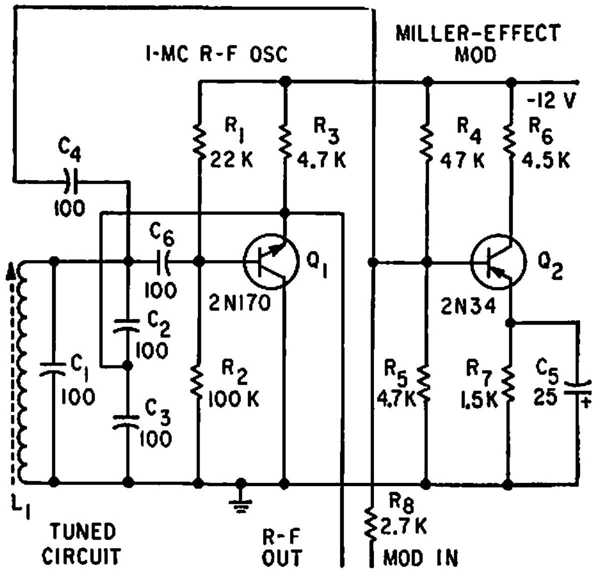
CHAPTER 36
Frequency Modulation Circuits

WEAK-SIGNAL CAPTURE—High-Q trap in reactance-tube circuit attenuates stronger of two signals, to permit capture of weaker of two cochannel f-m signals, as often required in police, military, and telemetering systems. Trap introduces depression in frequency response of third i-f stage, centered on frequency of stronger signal.—E. J. Baghdady and G. J. Rubissow, Dynamic Trap Captures Weak F-M Signals, *Electronics*, 32:2, p 64–66.

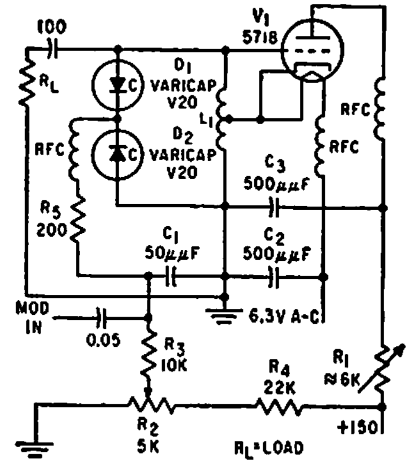




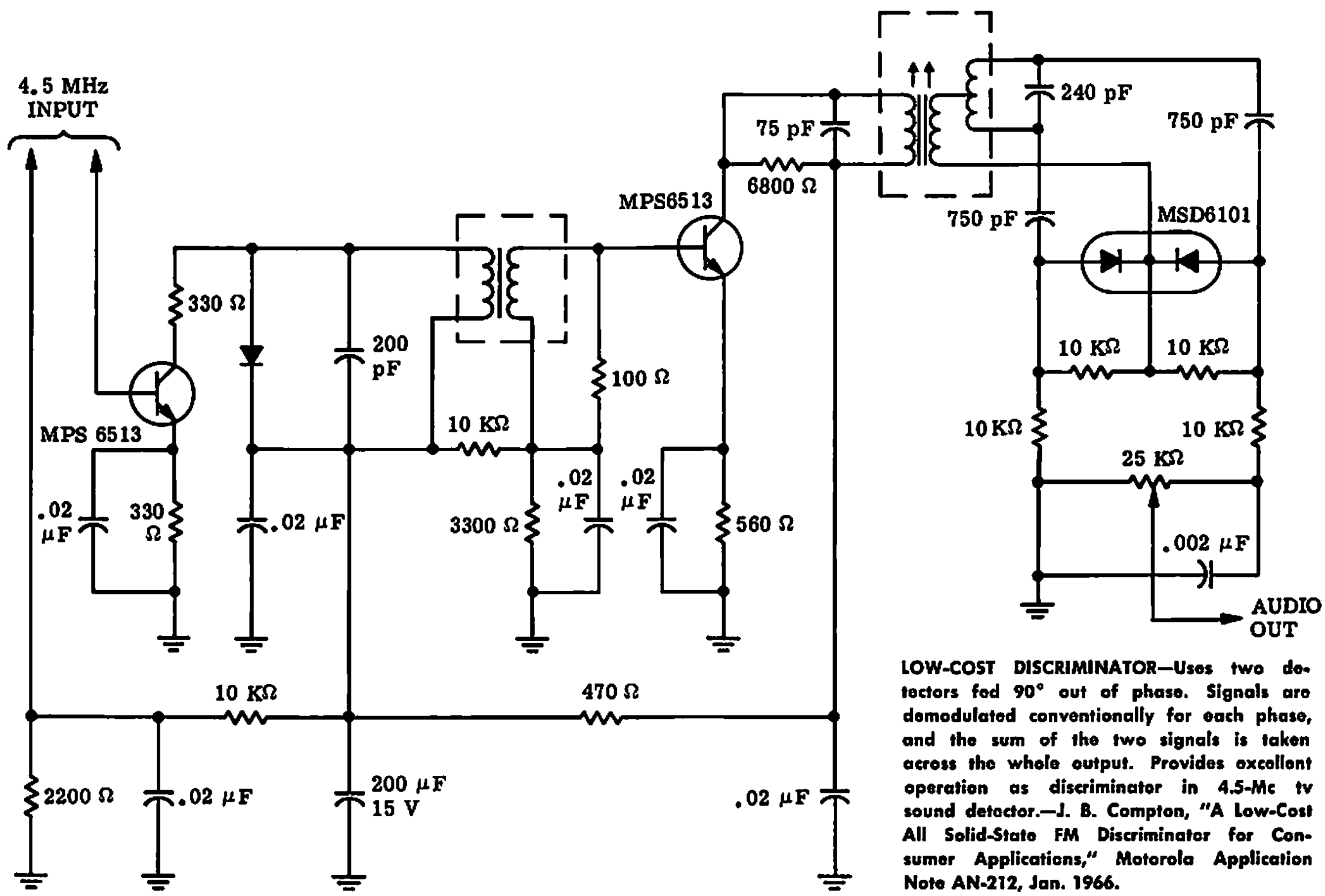
TWO-CHIP TUNER—Use of additional RCA integrated-circuit chip as r-f amplifier improves gain and selectivity, while boosting sensitivity to 3 microvolts.—R. L. Sanquini, Integrated Circuits Make A Low-Cost F-M Receiver, *Electronics*, 39:16, p 133–138.



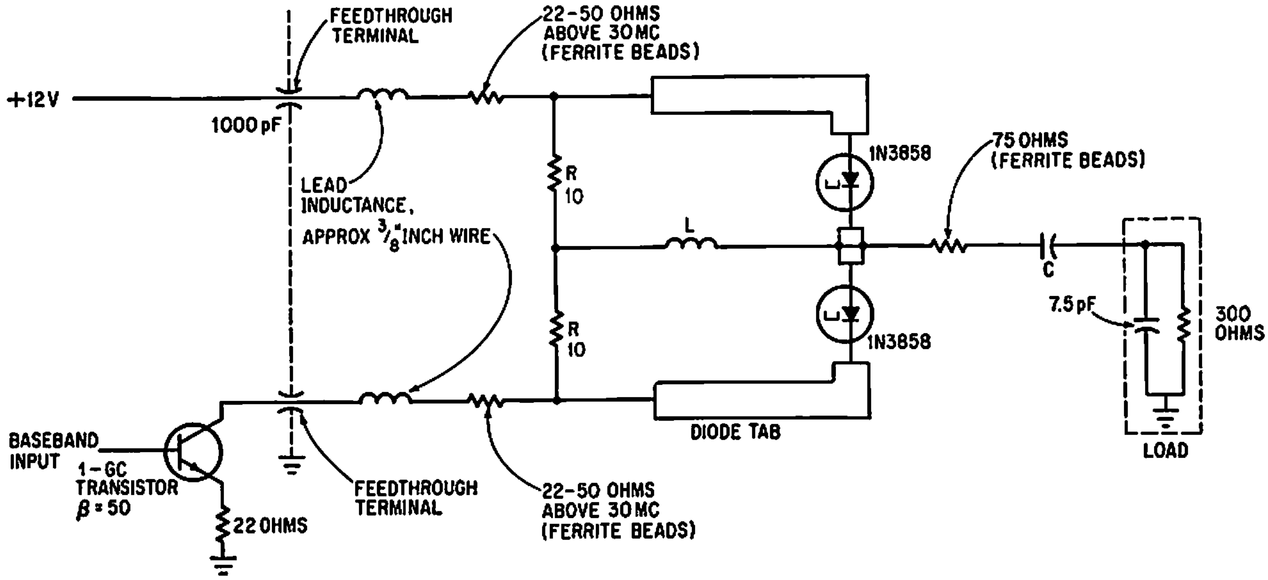
1-MC F-M OSCILLATOR—Combines Q multiplier with Miller effect to produce simple and stable f-m oscillator and modulator.—P. W. Wood, Transistorized F-M Oscillator, *Electronics*, 32:5, p 64.



100-MC VARICAP OSCILLATOR—Modulator consists of two variable-capacitance diodes in series to r-f and in parallel to audio modulating signals and d-c bias. Frequency deviation is 28 Mc peak-to-peak with modulating signals less than 28 v and negligible modulating power.—C. Arsem, Wideband F-M with Capacitance Diodes, *Electronics*, 32:49, p 112–113.

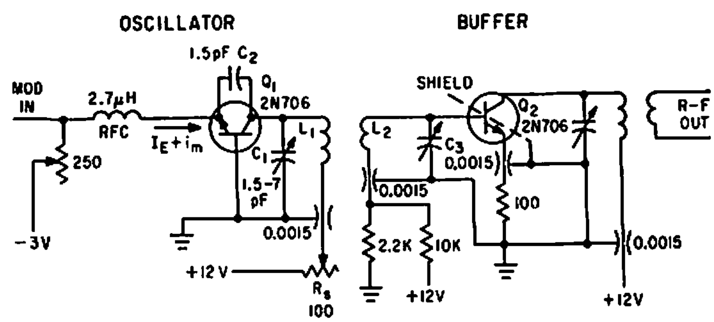


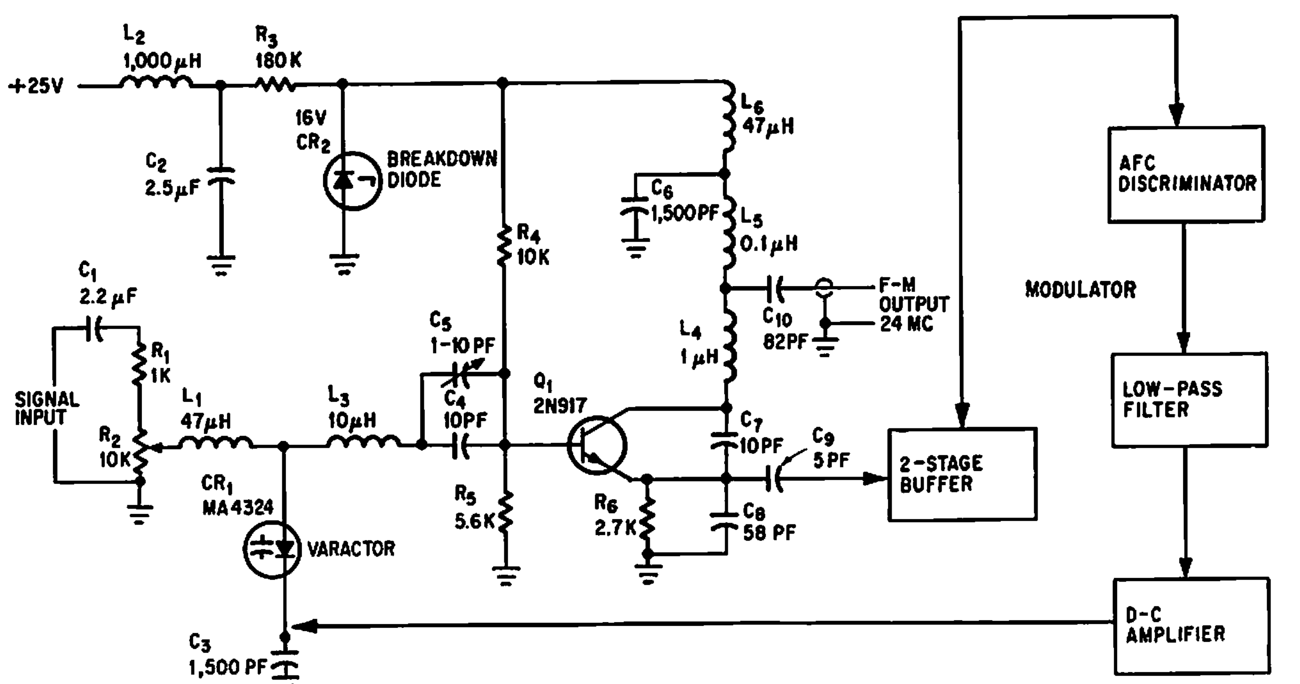
LOW-COST DISCRIMINATOR—Uses two detectors fed 90° out of phase. Signals are demodulated conventionally for each phase, and the sum of the two signals is taken across the whole output. Provides excellent operation as discriminator in 4.5-Mc tv sound detector.—J. B. Compton, "A Low-Cost All Solid-State FM Discriminator for Consumer Applications," Motorola Application Note AN-212, Jan. 1966.



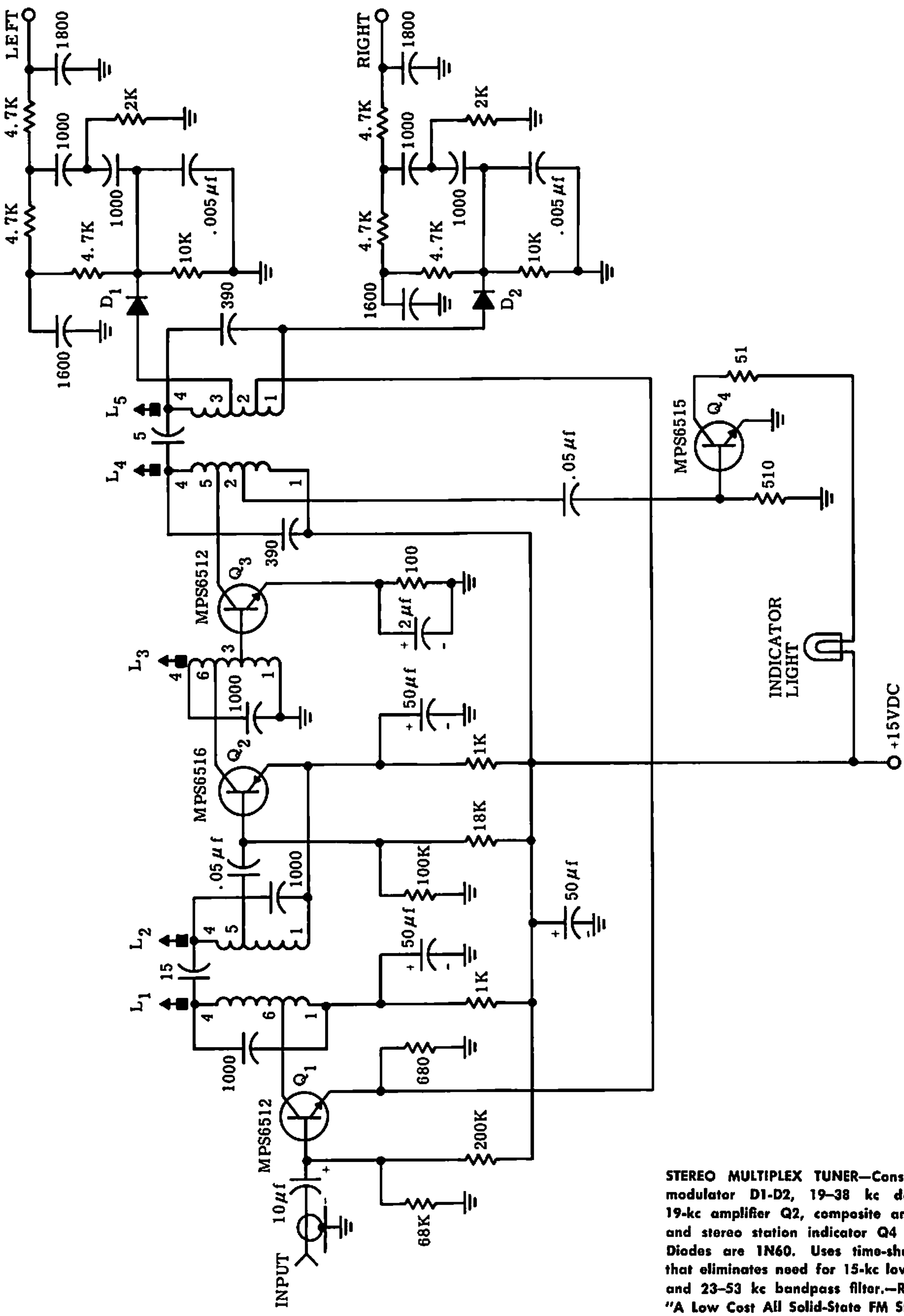
200-MC VOLTAGE-CONTROLLED OSCILLATOR—Uses two tunnel-diodes in astable mvbr to give symmetrical square-wave output. Used to produce wide frequency swing with respect to center frequency, linearly, when small control voltage is applied.—F. H. Lefrak, Tunnel-Diode Oscillator Expands F-M System's Channel Capacity, *Electronics*, 39:1, p 105–109.

SELF-REACTANCE MODULATION—Modulation current injected at emitter changes collector-base voltage, thus varying output capacitance, tank resonant frequency, and oscillator frequency for 230-Mc pam/f-m telemetery beacon.—T. M. Conrad, Self-Reactance Modulation in Telemetry Oscillators, *Electronics*, 35:9, p 35–37.

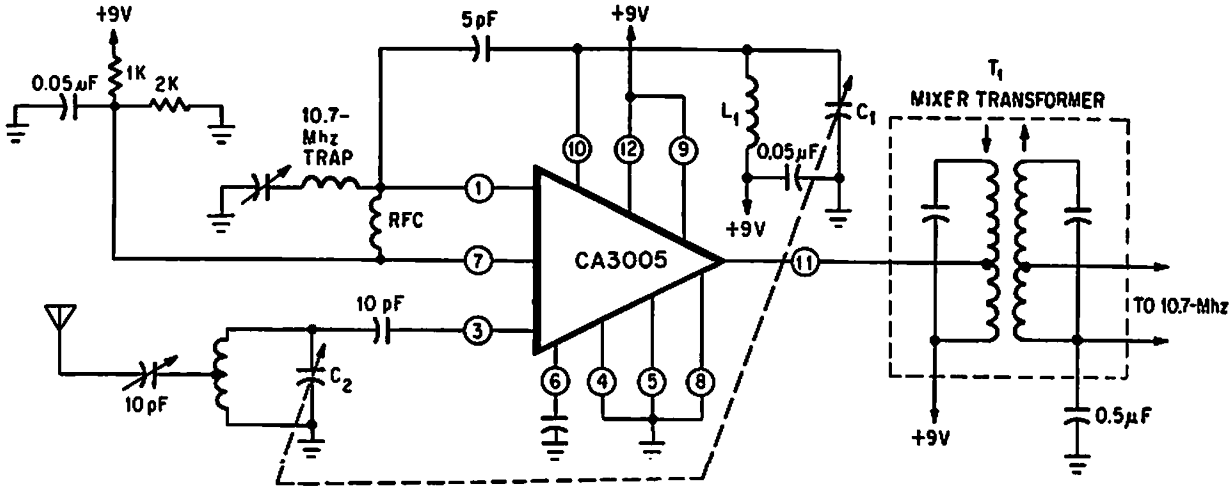




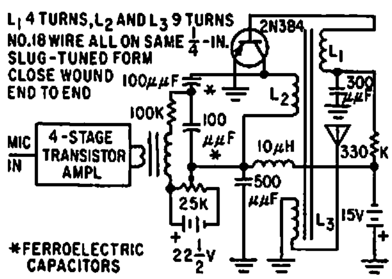
VARACTOR MODULATES 24-MC F-M OSCILLATOR—Modulating signal is applied to varactor diode in frequency-determining circuit of telemetering oscillator. Linearity is 2% for deviation of 60 kc.—N. Downs and B. van Sutphin, Solid-State Transmitter Ready for UHF Telemetry, *Electronics*, 37:17, p 76–80.



STEREO MULTIPLEX TUNER—Consists of demodulator D1-D2, 19–38 kc doubler Q3, 19-kc amplifier Q2, composite amplifier Q1, and stereo station indicator Q4 with lamp. Diodes are 1N60. Uses time-share method that eliminates need for 15-kc low-pass filter and 23–53 kc bandpass filter.—R. Brubaker, "A Low Cost All Solid-State FM Stereo Multiplex System," Motorola Application Note AN-207, Mar. 1966.



LOW-COST IC TUNER—Front end uses single RCA three-transistor two-diode chip with conventional tuning circuit. Ganged capacitors C1-C2 are 5–22 pf. Power gain is 15 db and sensitivity is 10 microvolts for 30 db of quieting. Performance is just adequate for low-cost commercial f-m tuner.—R. L. Sanquini, Integrated Circuits Make A Low-Cost F-M Receiver, *Electronics*, 39:16, p 133–138.



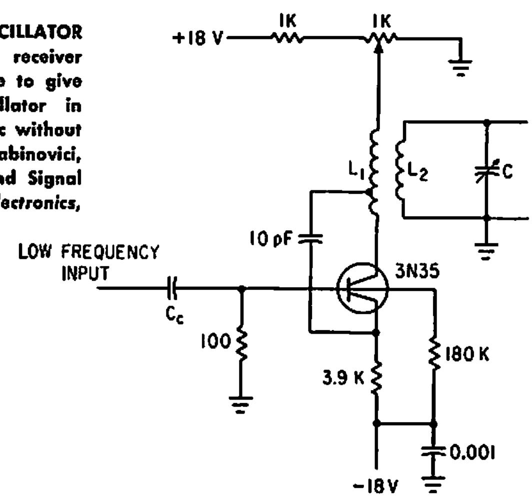
ELECTRIC TUNING FOR 50-MC F-M RANGE—Used two voltage-tunable ferroelectric capacitors. Can be built in pocket-size plastic case when powered with hearing-aid batteries. —T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.

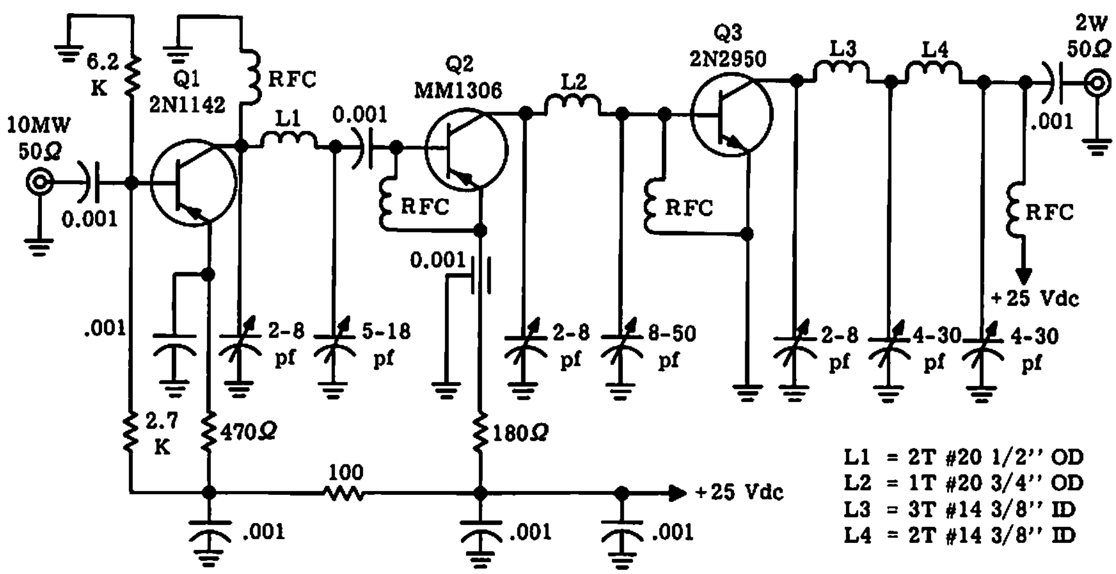
VOLTAGE-CONTROLLED 100-MC OSCILLATOR—Video voltage of wide-band f-m receiver is applied to base of silicon tetrode to give voltage-sensitive 100-Mc f-m oscillator in which deviations can be up to 1 Mc without excessive distortion.—S. Kallus, B. Rabinovici, and A. Newton, Fitting a Wide-Band Signal into a Narrow-Band Receiver, *Electronics*, 36:10, p 47–49.

L_1 – 4 TURNS NO. 18 WIRE 1/2" DIAM. TAPPED AT 1 1/4 TURNS

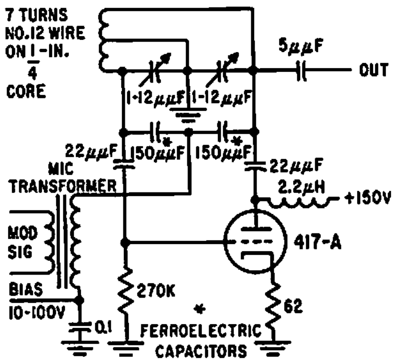
L_2 – 2 TURNS NO. 18 WIRE 1/2" DIAM.

C – TO RESONATE L_2 AT 100 MC.

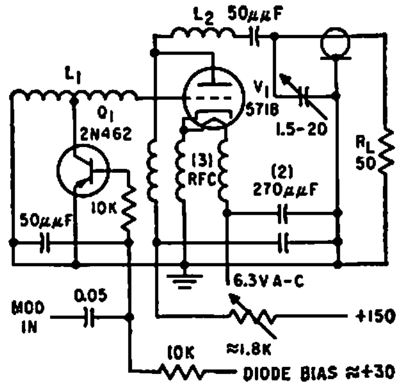




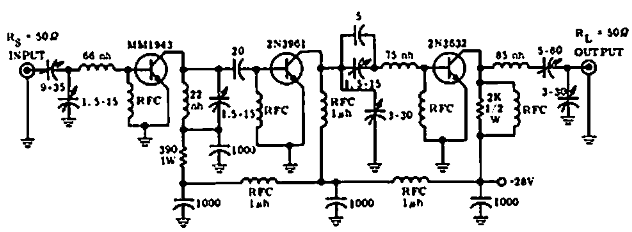
2-WATT POWER AMPLIFIER AT 160 MC—Uses 2N2950 npn silicon planar epitaxial transistor designed for medium-power high-frequency applications. Overall gain is 23 db. Intended for f-m or c-w applications only. For a-m, supply voltage on final stage must be reduced to 12 v to remain within voltage rating, and driver should also be 2N2950.—D. L. Adley, "Designing 160 Mc FM or CR Circuitry Using a Silicon High Frequency Transistor," Motorola Application Note AN-168, Aug. 1965.



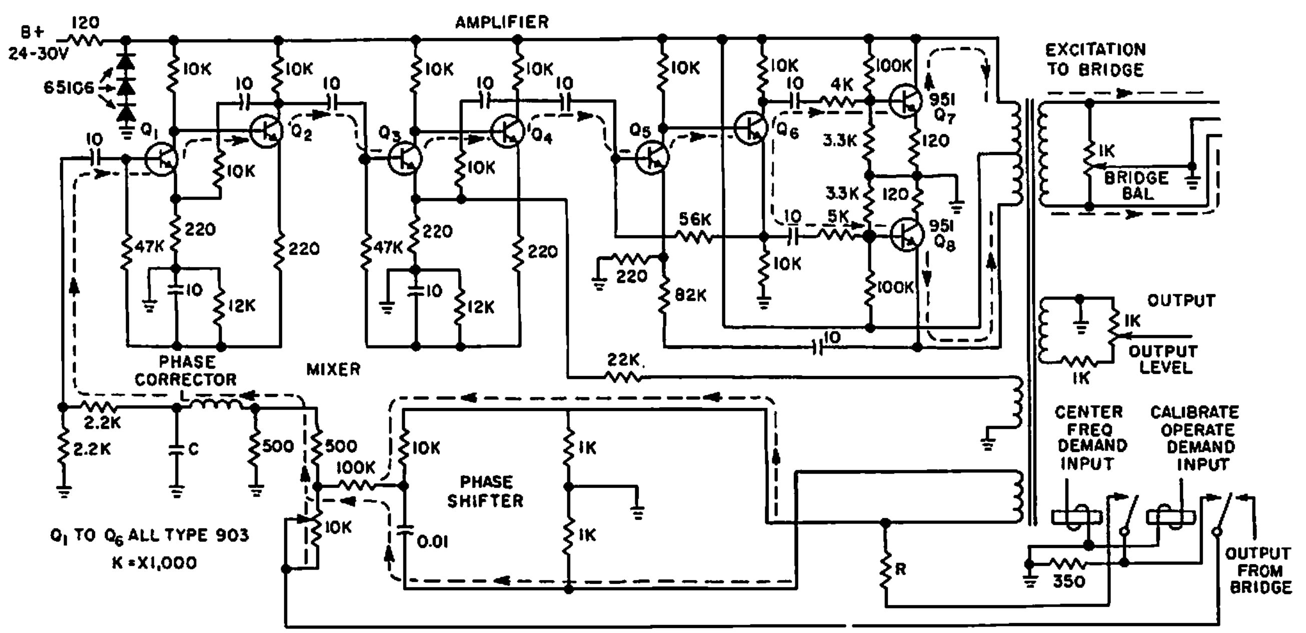
ELECTRIC TUNING FOR F-M OSCILLATOR—Voltage-tunable ferroelectric capacitors are used for tuning as well as for modulating.—T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.



400-MC VARICAP OSCILLATOR—Wideband frequency modulation of 400-Mc distributed-parameter Colpitts oscillator is obtained with symmetrical transistor in modulator. Q1 is equivalent to two reverse-biased diodes in series for r-f and in parallel with respect to modulating signals and d-c bias.—C. Arsem, Wideband F-M with Capacitance Diodes, *Electronics*, 32:49, p 112–113.



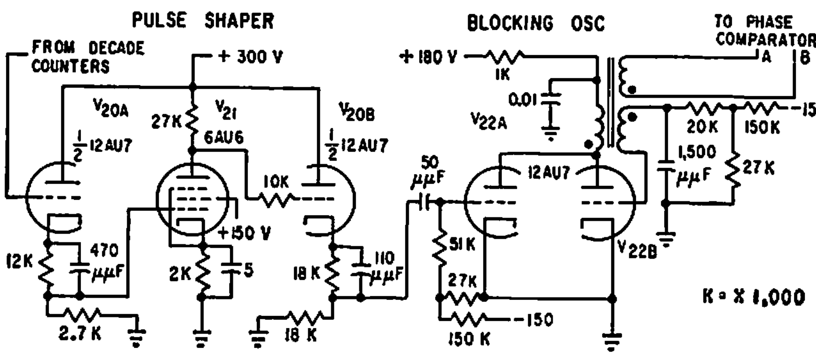
160-MC 15-W POWER AMPLIFIER—Performance of each of three stages is optimized by using input-output admittance data in network design, to give 30.5 db power gain from class-C operation. Circuit can be expanded to give complete f-m or c-w transmitter by adding appropriate oscillator-buffer-multiplier stages.—R. Hejhall, "A 160 MHz 15-Watt Solid-State Power Amplifier," Motorola Application Note AN-214, Nov. 1965.



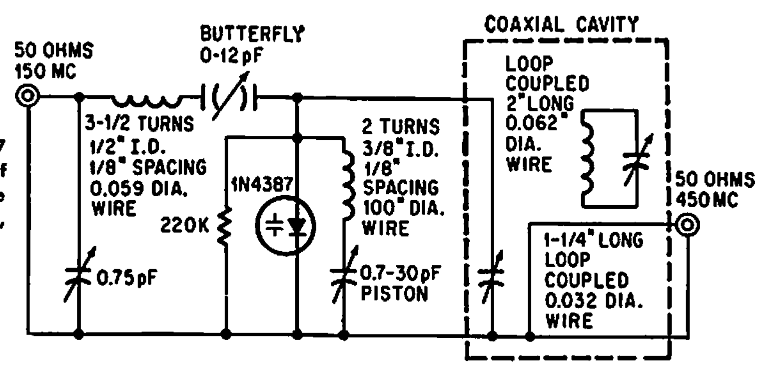
STRAIN-GAGE OSCILLATOR—Produces f-m signal output that is directly proportional to applied force, such as stress or pressure, on resistive-type gage. Operating and band-edge frequencies of oscillator are determined by values of R, L, and C.—W. H. Foster, Strain Gage Oscillator for Flight Testing, *Electronics*, 31:5, p 40–42.

CHAPTER 37

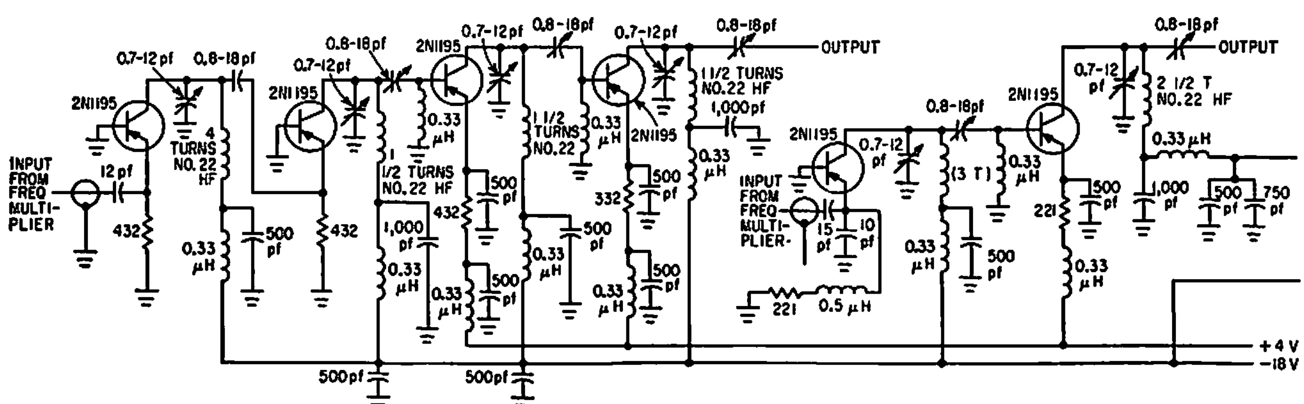
Frequency Multiplier Circuits



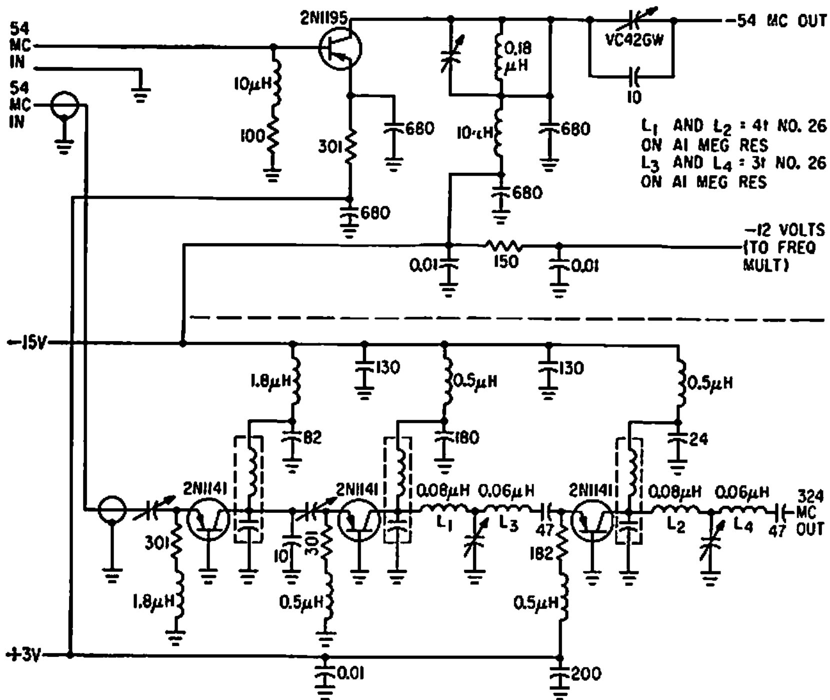
PULSE SHAPER FOR FREQUENCY MULTIPLIER—Combines clipping with cathode peaking to increase rise time to 1 microsec for 150-v pulses that drive blocking oscillator.—W. O. Brooks, Stepping up Frequency with Counter Circuits, *Electronics*, 32:29, p 60–62.



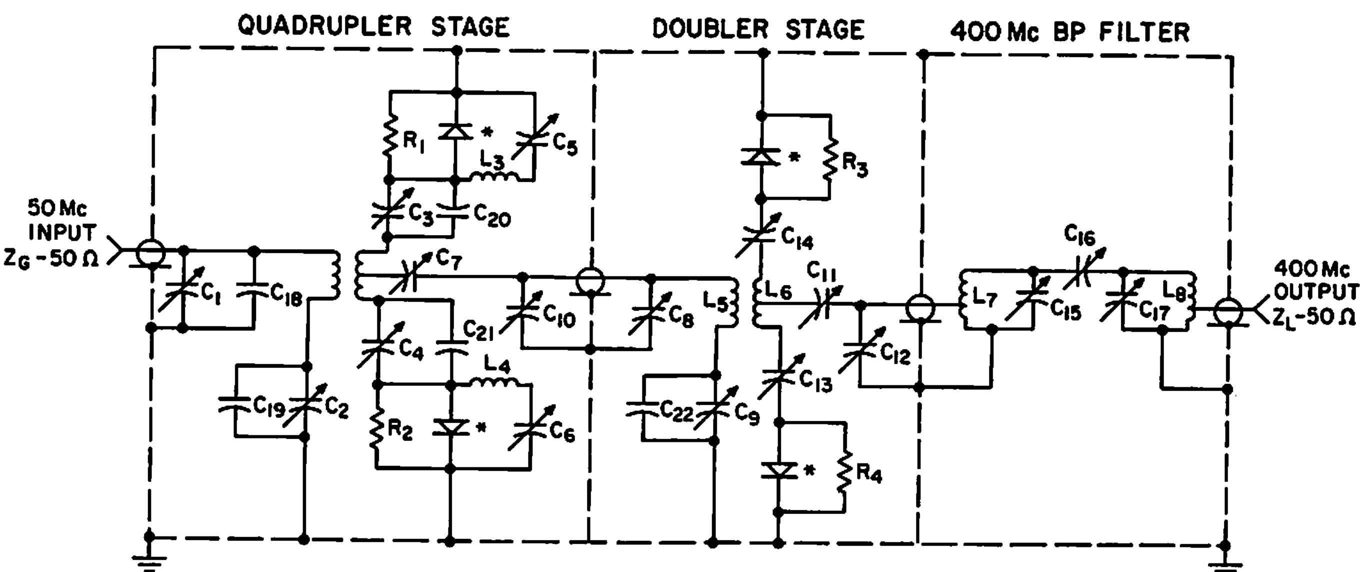
150-450 MC TRIPLER—Charge-storage 1N4387 varactor gives 20 w at 450 Mc for 40 w of 150-Mc input.—G. Schaffner, Charge Storage Varactors Boost Harmonic Power, *Electronics*, 37:20, p 42–47.



DOUBLERS AND TRIPLER—In left section, first two stages are class B common-base power doublers and last two are class AB common-emitter amplifiers. Output is 150 mw at 216 Mc, from 54-Mc input. In section at right, common-base class B power tripler drives common-emitter output amplifier to give 140 mw output at 162 Mc from 54-Mc input.—J. W. Hamblen and J. B. Oakes, Instrumentation and Telemetry of Transit Navigational Satellites, *Electronics*, 34:32, p 148–153.



MULTIPLIER GIVES 324 MC—Two class B common-base stages (one tripler and one doubler) drive class AB common-base output amplifier to give 50 mw at 324 Mc from 54-Mc input. Upper section, a 54-Mc transmitter, is simply a single class AB common emitter that gives 200 mw output from 25-mw input.—J. W. Hamblen and J. B. Oakes, Instrumentation and Telemetry of Transit Navigational Satellites, *Electronics*, 34:32, p 148–153.



C_1-HammarLund MAPC-75
C_2-HammarLund MAPC-75
C_3-HammarLund MAPC-75
C_4-HammarLund MAPC-75
C_5-HammarLund MAPC-50
C_6-HammarLund MAPC-50
C_7-HammarLund MAPC-25
C_8-E.F. Johnson Co.-Type "M"-160-110
C_9-E.F. Johnson Co.-Type "M"-160-110
C_{10}-HammarLund MAPC-25

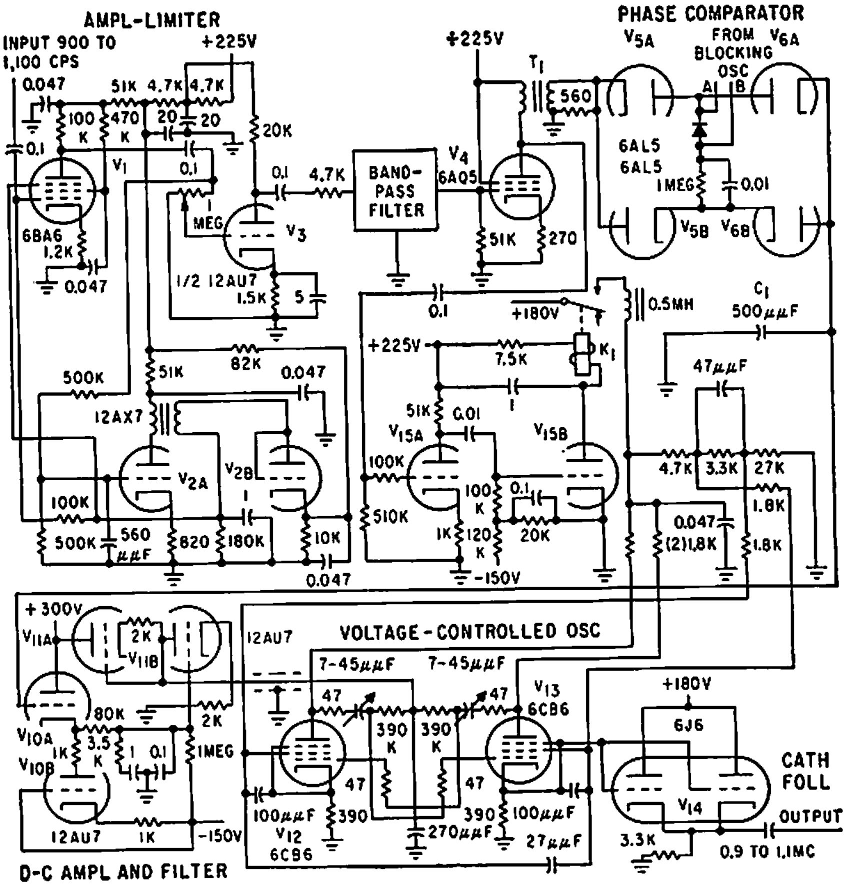
R_1 - 68KΩ
R_2 - 68KΩ
R_3 - 150KΩ
R_4 - 150KΩ

C_{11}-HammarLund MAPC-25
C_{12}-Johanson-JMC-1801
C_{13}-HammarLund MAPC-25
C_{14}-HammarLund MAPC-25
C_{15}-Johanson-JMC-1801
C_{16}-Johanson-JMC-2951
C_{17}-Johanson-JMC-1801
C_{18}-20 pf (Fixed)
C_{19}-32 pf (Fixed)
C_{20}-140 pf (Fixed)

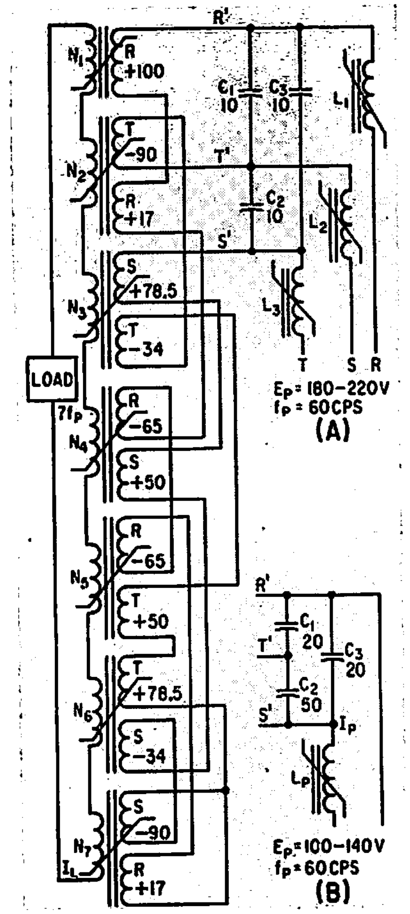
C_{21}-140 pf (Fixed)
C_{22}-15 pf (Fixed)

L_1-3 Turns 1" dia. 1/8 Tubing
L_2-6 Turns 5/8" dia. 1/8 Tubing
L_3-2 Turns 13/16" dia. 1/8 Tubing
L_4-2 Turns 13/16" dia. 1/8 Tubing
L_5-1 Turns 5/8" dia. 1/8 Tubing
L_6-2 Turns 5/8" dia. #8 Wire
L_7-3 Turns 1/4" dia. #8 Wire
L_8-3 Turns 1/4" dia. #8 Wire

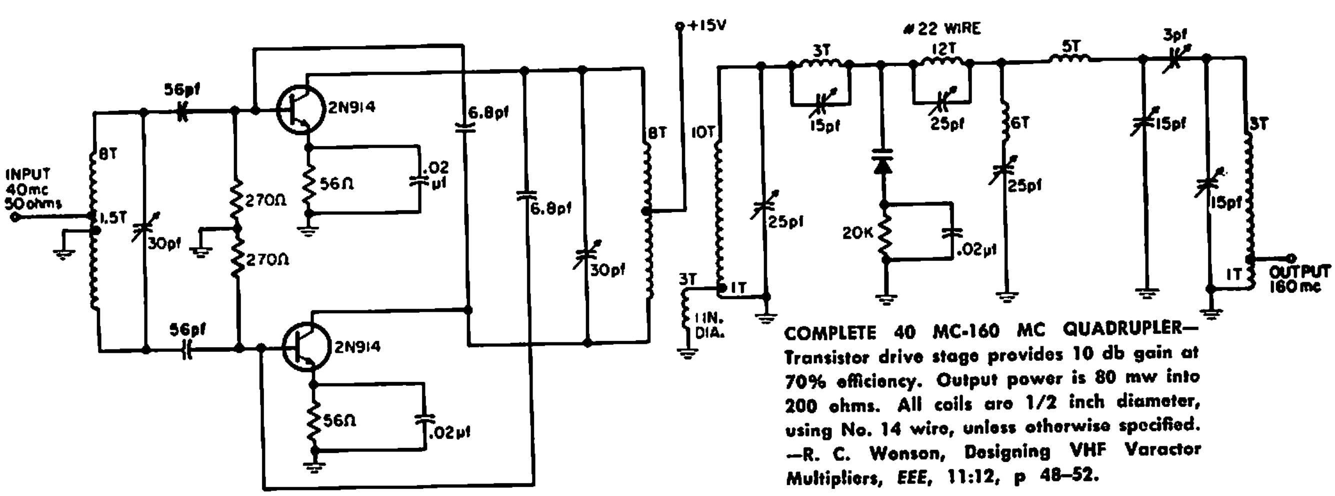
50 MC TO 400 MC VARACTOR MULTIPLIER—Consists of two push-push varactor circuits in cascade, with bandpass filter at output. Provides 40 w with 30% conversion efficiency. For pulse-modulated drive signals, will give 100 w peak pulse power at 0.0088 duty cycle. Uses Motorola 1N4386 varactors.—J. Cochran, "Two-State Varactor Multiplier Provides High Power at 400 Mc," Motorola Application Note AN-177, Aug. 1965.



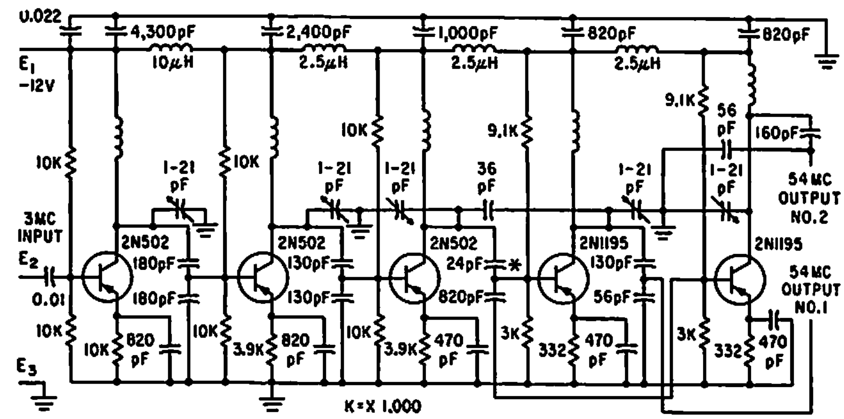
FREQUENCY MULTIPLIER—Phase comparator is combined with divider and digital feedback loop to give highly accurate frequency multiplication over wide band of inputs. Multiplying factor is 1,000, but technique is adaptable to other values. Amplified output of phase comparator is used to regulate voltage-controlled oscillator.—W. O. Brooks, Stepping up Frequency with Counter Circuits, *Electronics*, 32:29, p 60–62.



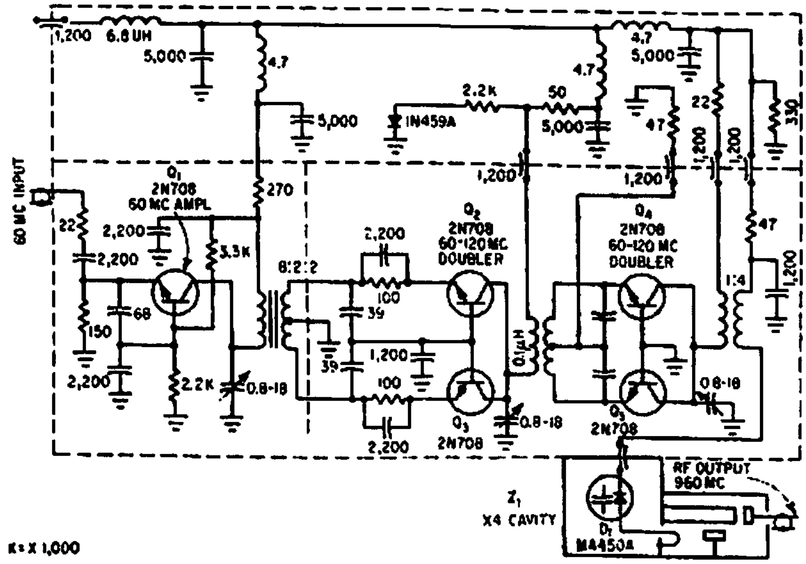
60-420 CPS FREQUENCY SEPTUPLER—Seven saturable-core transformers, with series-star connected multiple primary windings and series-aiding secondaries, serve as static frequency multipliers delivering 40 w at 420 cps. Input may be three-phase (A) or single phase (B).—W. A. Geyger, Frequency Septupler Provides Stable 420-Cps Voltage, *Electronics*, 36:18, p 58–61.



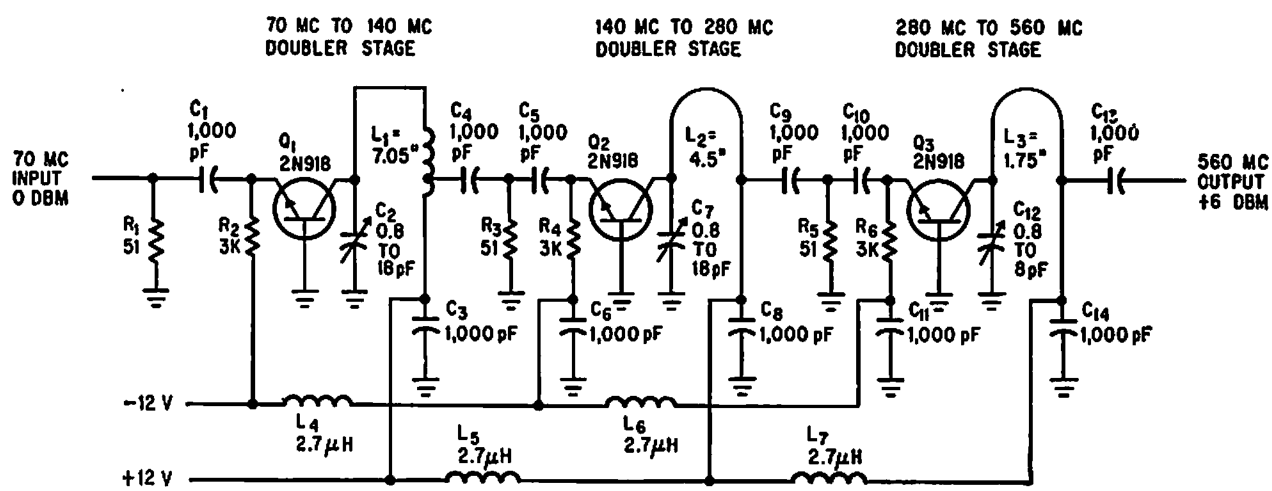
COMPLETE 40 MC-160 MC QUADRUPLER—Transistor drive stage provides 10 db gain at 70% efficiency. Output power is 80 mw into 200 ohms. All coils are 1/2 inch diameter, using No. 14 wire, unless otherwise specified. —R. C. Wenson, Designing VHF Varactor Multipliers, *EEE*, 11:12, p 48–52.



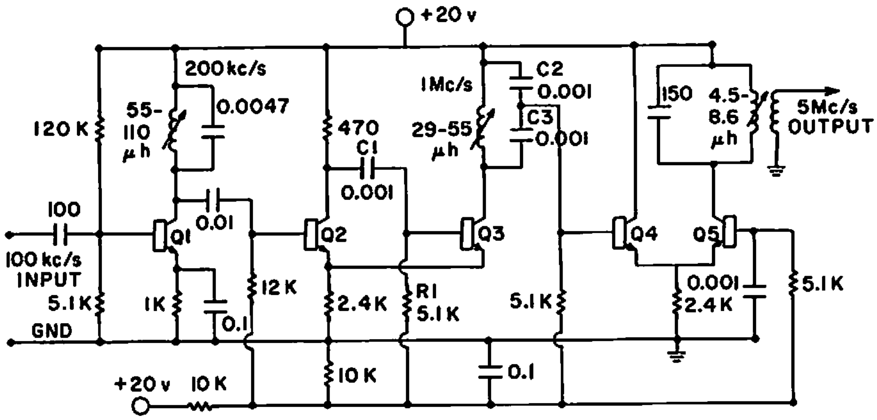
TWO 54-MC OUTPUTS FROM 3 MC—Uses three class AB common-emitter amplifiers. First two are triplers that multiply 3-Mc input to 27 Mc. Third doubles this to 54 Mc, and drives two parallel 54-Mc class AB output amplifiers providing 25 mw each.—J. W. Hamblen and J. B. Oakes, Instrumentation and Telemetry of Transit Navigational Satellites, *Electronics*, 34:32, p 148-153.



TWO DOUBLERS AND QUADRUPLER GIVE 960 MC—First two doublers are push-push class C with unity gain. Varactor D1 in final multiplier, feeding 960-Mc quarter-wave series-resonance coaxial cavity, acts as quadrupler.—W. E. Dahl, Communicating with Future Deep-Space Probes, *Electronics*, 36:22, p 28–32.

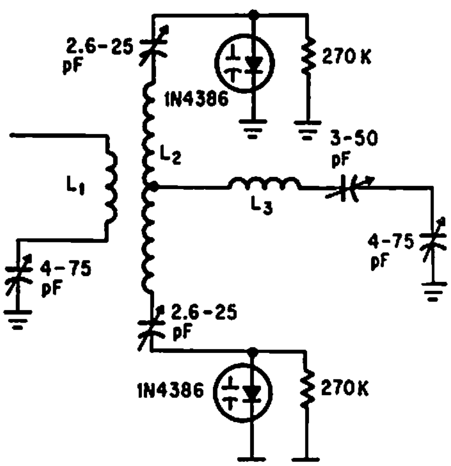


CASCADED UHF DOUBLERS—Common-base amplifier with tank circuit tuned to twice the input frequency is cascaded to give frequency multiplication in 40 to 1,000 Mc range, with power output per stage ranging from 50% of stage d-c supply at low frequencies to 25% at high frequencies.—A. E. Munich, Basic UHF Circuit Forms Amplifiers and Multipliers, *Electronics*, 37:20, p 59–60.

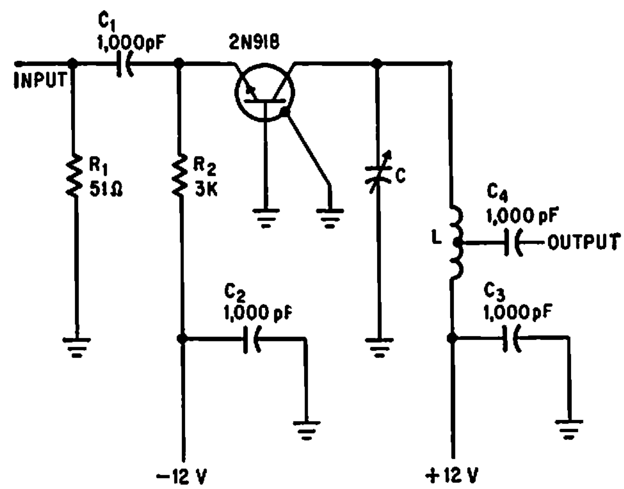


ALL TRANSISTORS 2N 2714 — ALL RESISTORS ±5%, 1/4 WATT

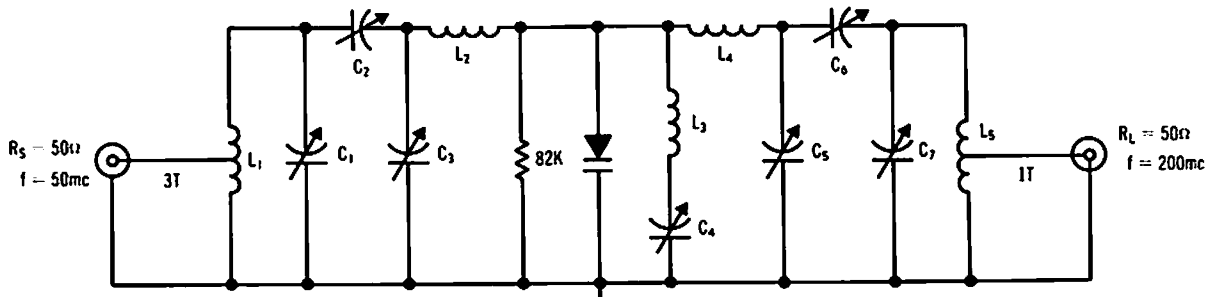
100 KC TO 5 MC—Simple transistor circuit converts 100-kc standard frequency of frequency counter to 5 Mc for use with 500-Mc frequency converter which requires 5-Mc reference frequency. Q1 is doubler. Q2 and Q3 form unique quintupler evolved from Schmitt trigger, in which square-wave symmetry is preserved by maintaining triggering point at zero crossings of input signal. Q4-Q5 is similar quintupler, but without cross-coupling feedback.—H. T. McAleer, Unique Frequency Multiplier, *Frequency*, May-June 1964, p 36–37.



50-100 MC PUSH-PUSH DOUBLER—Charge-storage 1N4386 varactors in push-push provide 180 w. output with 70% efficiency.—G. Schaffner, Charge Storage Varactors Boost Harmonic Power, *Electronics*, 37:20, p 42–47.



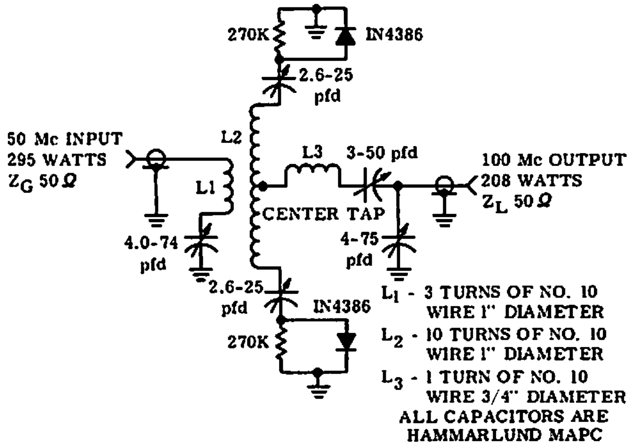
COMMON-BASE UHF AMPLIFIER OR DOUBLER—With output tank circuit tuned to frequency input, power gain ranges between 10 and 16 db for 40 to 1,000 Mc, with bandwidth varying from 10 to 40 Mc depending on temperature, frequency, and loading. Tuning tank to twice input frequency gives frequency doubler.—A. E. Munich, Basic UHF Circuit Forms Amplifiers and Multipliers, *Electronics*, 37:20, p 59–60.



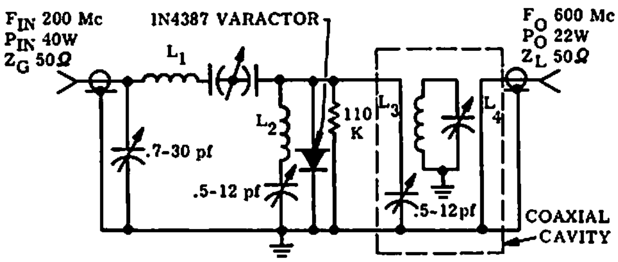
L_1, L_2: 11 Turns #14 Wire, 3/8" Dia. C_1, C_3: 1-30 pf; C_4: 0.5-12 pf

L_3: 3.5 Turns #14 Wire, 3/8" Dia. L_4, L_5: 4 Turns #14 Wire 3/8" Dia. C_2: 0.8-12 pf; C_5, C_6, C_7: 0.5-10 pf

50 MC TO 200 MC VARACTOR QUADRUPLER—Uses 1N4386 varactor capable of handling 50 w input power up to 300 Mc. Gives efficiencies up to 70%.—G. Schaffner, "High-Power Varactor Diodes," Motorola Application Note AN-147, Apr. 1964.

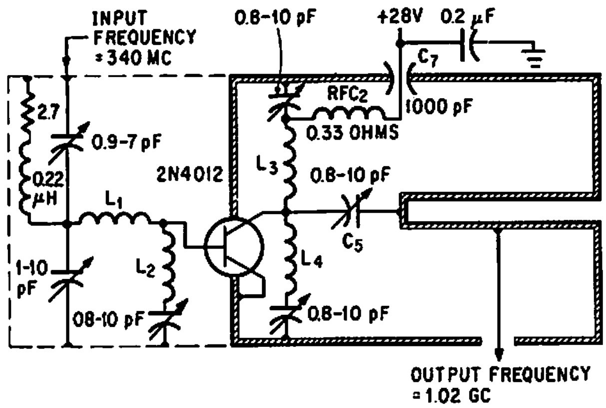


50 MC TO 100 MC PUSH-PUSH DOUBLER—Two 1N4386 varactors are connected in phase opposition to input signal and parallel to common load at even harmonic signal, to give action comparable to push-push circuit. Power-handling capacity is twice that of single varactor, with added benefit of odd-harmonic suppression.—G. Schaffner and J. Cochran, "Varactor Diodes and Circuits for High Power Output and Linear Response," Motorola Application Note AN-191, Aug. 1965.

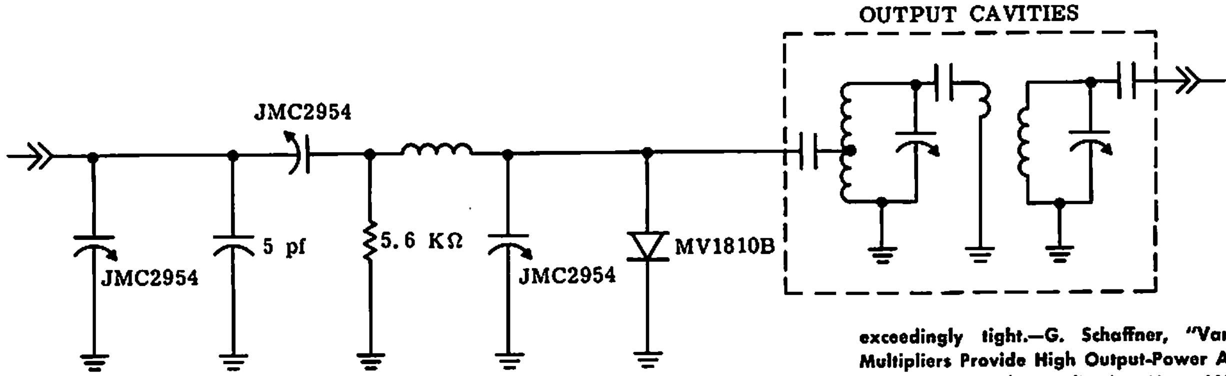


L_1 - 3 TURNS OF 1/16" WIRE 1/2" DIA. x 1" LONG.
L_2 - 1 TURN 1/8" TUBING 3/8" O.D.
L_3 - STRAIGHT COUPLING LOOP 1/8" TUBING 2" LONG SPACED APPROX. 1/8" FROM CENTER CONDUCTOR.
L_4 - STRAIGHT COUPLING LOOP 1/16" WIRE 1-1/2" LONG, SPACED APPROX. 1/16" FROM CENTER CONDUCTOR.

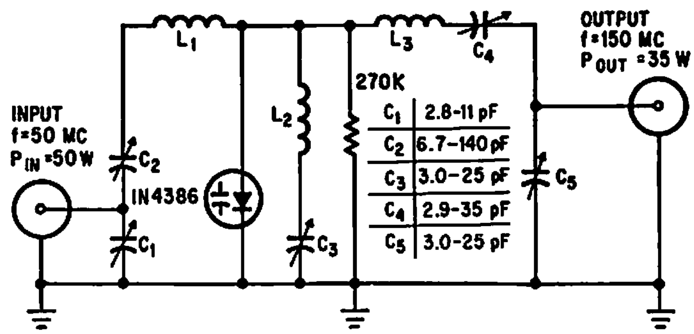
200 MC TO 600 MC HARMONIC TRIPLER—Uses single varactor to give 20 w output from 40 w input.—G. Schaffner and J. Cochran, "Varactor Diodes and Circuits for High Power Output and Linear Response," Motorola Application Note AN-191, Aug. 1965.



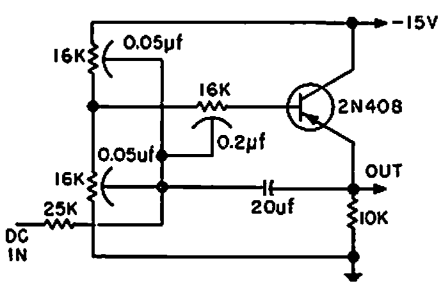
TRIPLER WITH OVERLAY TRANSISTOR GIVES 1.02 GC—Single overlay transistor eliminates conventional transistor amplifier and chain of varactor frequency multipliers. Output power is 3.5 w.—H. C. Lee and G. J. Gilbert, Overlay Transistors Move into Microwave Region, *Electronics*, 39:6, p 93–95.



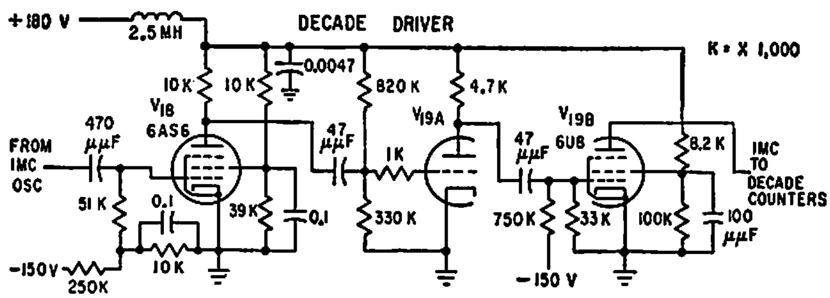
500 MC TO 4,000 MC 1-STEP MULTIPLIER—Combines both lumped and coaxial cavity techniques with varactor to serve as octupler. Coupling from varactor to first cavity must be exceedingly tight.—G. Schaffner, "Varactor Multipliers Provide High Output-Power Above 6 GHz," Motorola Application Note AN-213, Dec. 1965.



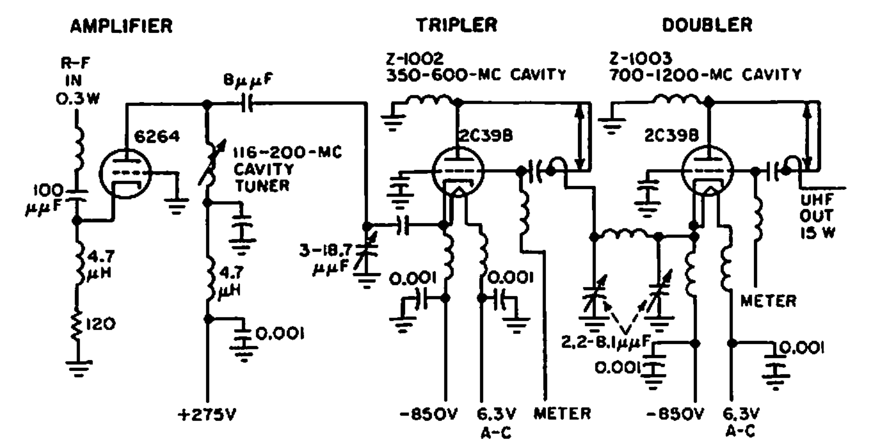
50-150 MC TRIPLER—Charge-storage 1N4386 varactor triples frequency with power efficiency of 70% for input of 50 watts.—G. Schaffner, Charge Storage Varactors Boost Harmonic Power, *Electronics*, 37:20, p 42–47.



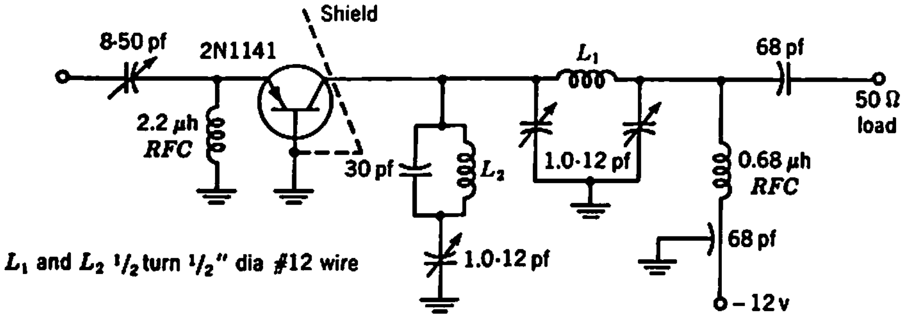
SIMPLE DOUBLER—Uses distributed R-C networks consisting of resistive and conductive layers on dielectric substrate, with d-c applied between electrodes at 65 v for doubling frequency of ceramic-dielectric 400-cps oscillator.—M. M. Perugini, Race to Reduce Capacitor Size, *EEE*, 10:7, p 61–64.



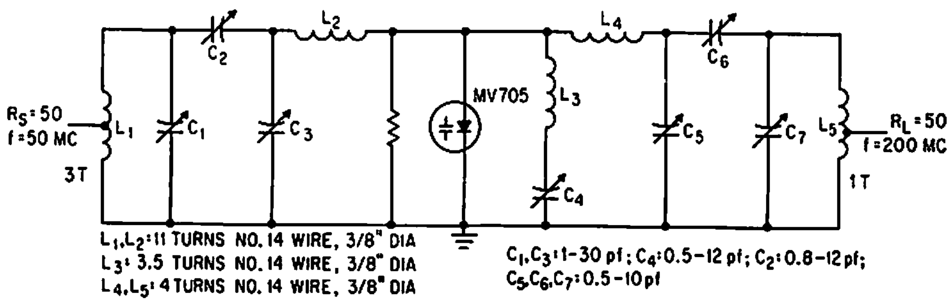
DECADE DRIVER FOR FREQUENCY MULTIPLIER—Input signal from frequency-multiplying oscillator is stepped up to 80 v peak-to-peak, with 1-microsec rise time, for accurate triggering of decade counter.—W. O. Brooks, Stepping up Frequency with Counter Circuits, *Electronics*, 32:29, p 60–62.



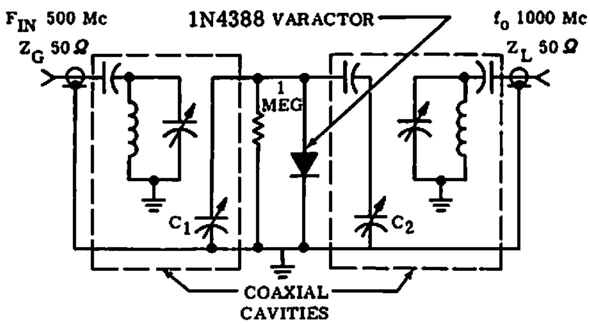
TRIPLER-DOUBLER GIVES 700-1,200 MC—First stage is grounded-grid amplifier, with plate tuned by 1-turn coil and variable capacitor. Common-grid tripler and doubler are tuned with coaxial resonators.—A. E. Anderson and H. D. Hern, F-M Exciter For Sight or Scatter Systems, *Electronics*, 31:11, p 148–151.



121.5 MC TO 243 MC DOUBLER—Input is tuned to fundamental and output to second harmonic. Combination series-parallel trap in collector circuit rejects fundamental.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 328.

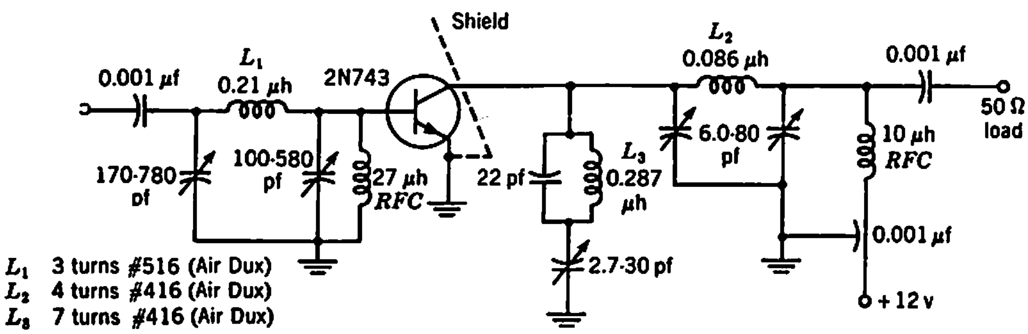


VARACTOR FREQUENCY QUADRUPLER—With 50-Mc input, output is 22 w at 200 Mc. Series-tuned idler circuit L3-C4 is omitted for frequency-doubling.—L. E. Clark, E. B. Mack, and R. C. Hojhall, Highlights of Small-Signal Circuit Design, *Electronics*, 36:49, p 46–50.

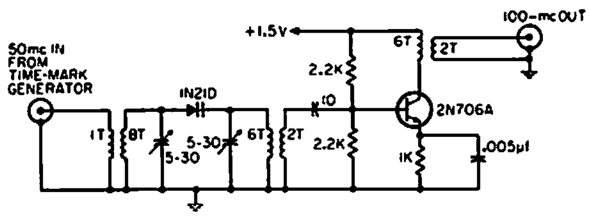


C_1, C_2, 1/2-12 pf JOHANSON JMC 1801

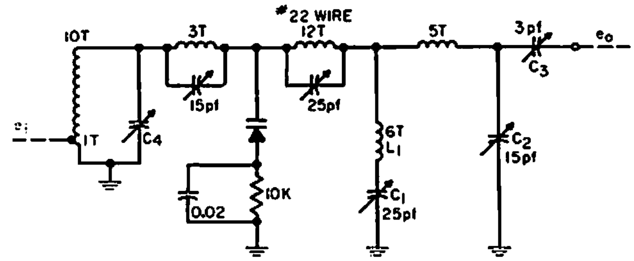
500 MC TO 1,000 MC DOUBLER—Single varactor gives up to 15 w output from 25 w input, with output linear up to 11 w. Conversion efficiency is 50%.—G. Schaffner and J. Cochran, "Varactor Diodes and Circuits for High Power Output and Linear Response," Motorola Application Note AN-191, Aug. 1965.



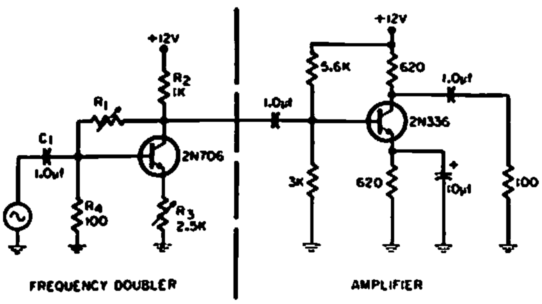
21 MC TO 42 MC DOUBLER—Combination series-parallel trap in collector circuit provides 50 db rejection of fundamental in output that is tuned to second harmonic.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 328.



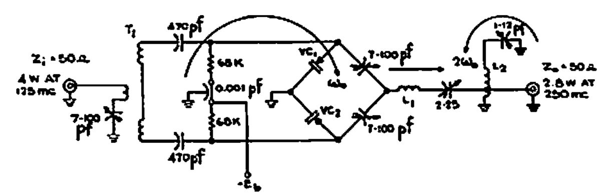
50 MC TO 100 MC VARACTOR DOUBLER—Used to extend usefulness of conventional time marker generator.—R. M. Zilberstein, Frequency Doubler and Amplifier, *EEE*, 12:12, p 57.



VHF VARACTOR QUADRUPLER—Supplies 160 Mc at up to 0.5 w. Output impedance is 50 ohms.—R. C. Wonson, Designing VHF Varactor Multipliers, *EEE*, 11:12, p 48–52.



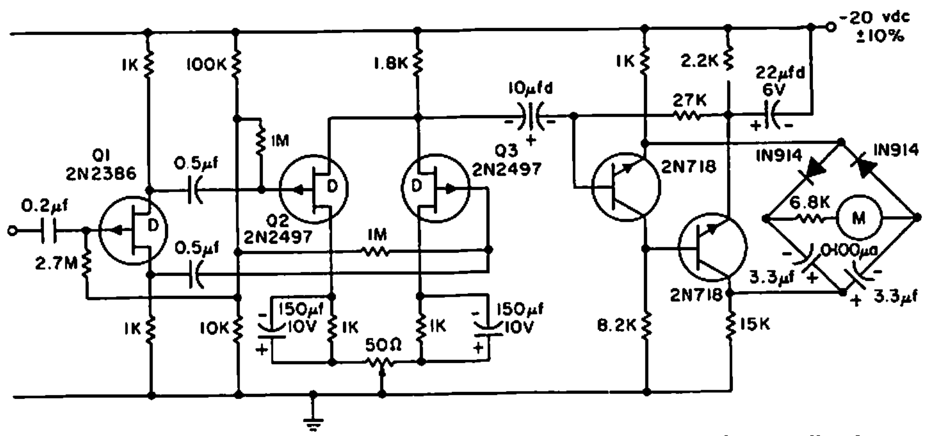
A-F DOUBLER—Frequency of sinusoidal signal is doubled with only one transistor, one coupling capacitor, and four resistors, by utilizing nonlinear characteristic of transistor for half-wave rectification. Purity of output waveform is adjusted with feedback control R1.—R. J. Miller, Jr., Audio Frequency Doubling Without Bulky Filters, *EEE*, 12:12, p 57.



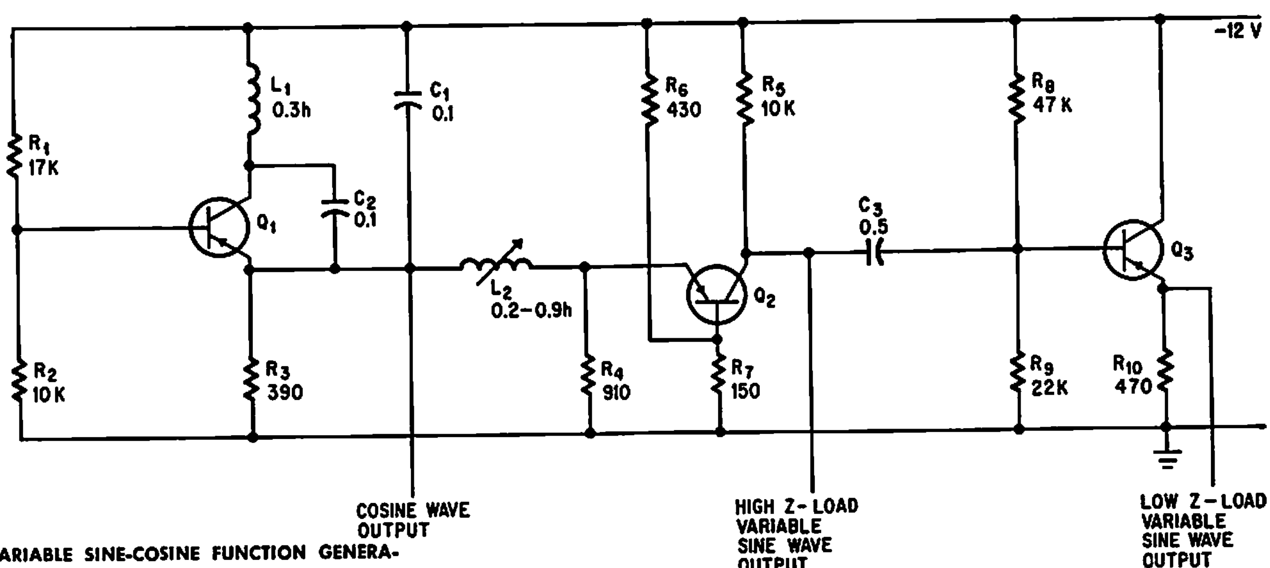
BALANCED PARAMETRIC DOUBLER—Handles twice the power of single-ended circuit using same varactor diode, while doubling 125-Mc input. Varactors VC are PSI type PC116. Efficiency is 70%. Transformer winding data is given in article.—R. D. Gromer, VHF Balanced Parametric Doubler, *EEE*, 11:8, p 30-31.

CHAPTER 38

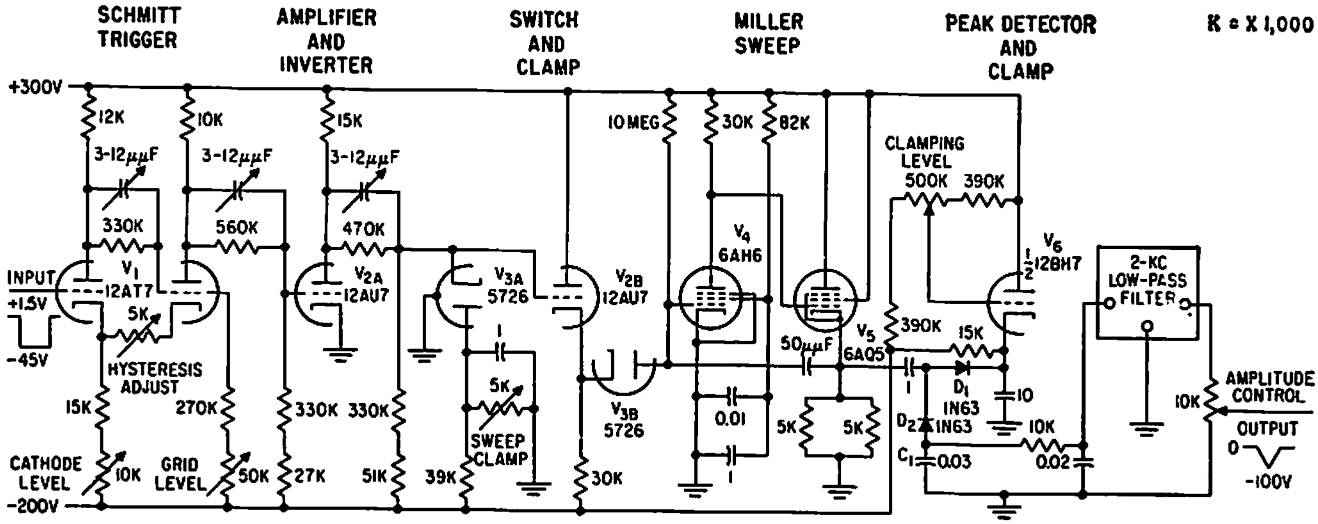
Function Generator Circuits



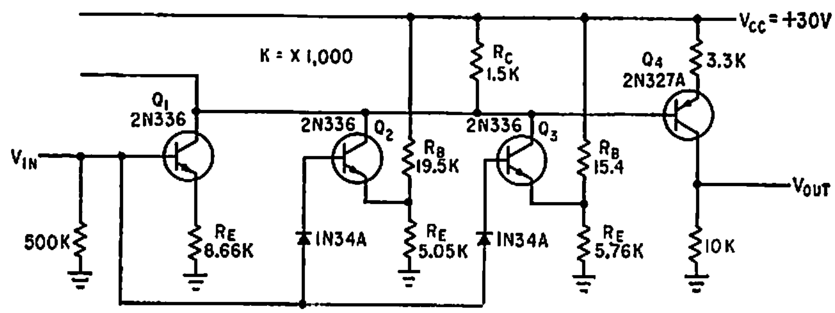
AUDIO FET SQUARING CIRCUIT—Used in noise investigation, analog computation, and measurement of power in complex waveforms, where squarer of high accuracy and wide bandwidth is required. First stage is phase divider whose outputs drive squaring fet's Q2 and Q3. Output of squarer is coupled through capacitor to meter rectifier whose reading is proportional to square of amplitude of input voltage.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 83.



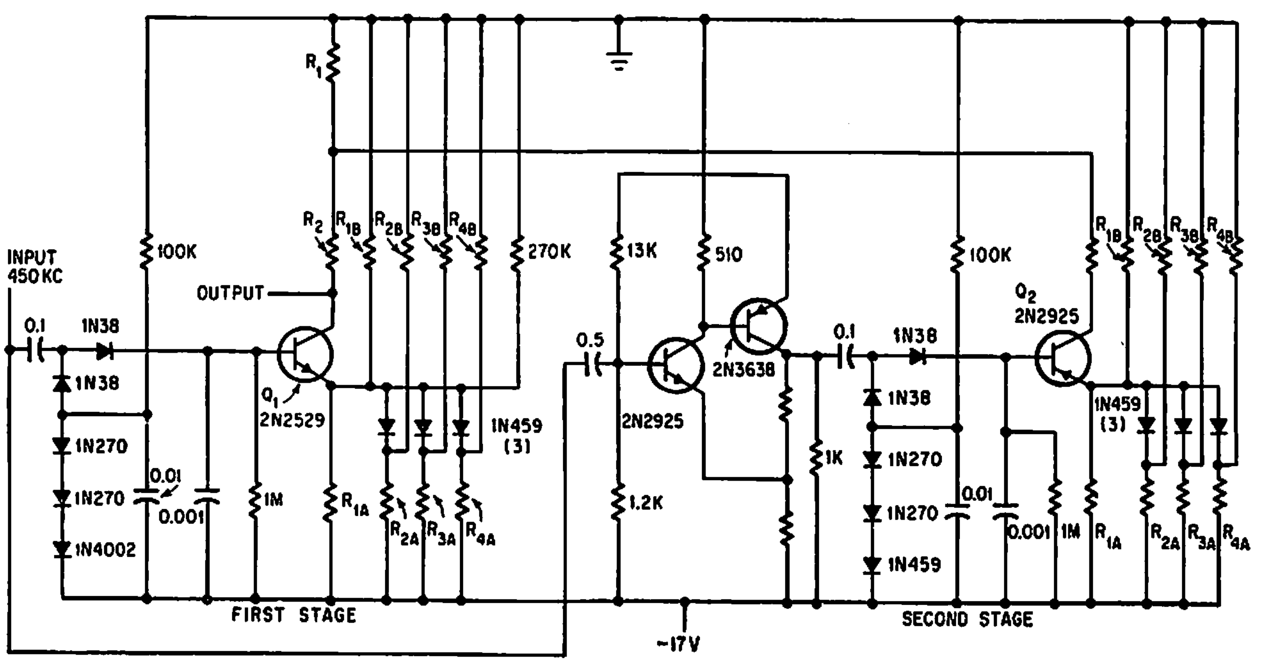
VARIABLE SINE-COSINE FUNCTION GENERATOR—For testing phase detector, one output gives reference cosine function and other gives waveform that can be varied in phase from sine to cosine function, with choice of high or low output impedance. Q1 is modified Colpitts. Frequency stability is 1% from 1 kc to 100 kc with regulated power supply. —J. G. Peddie, Oscillator Generates Sine, Cosine Waves Simultaneously, *Electronics*, 37:22, p 74.



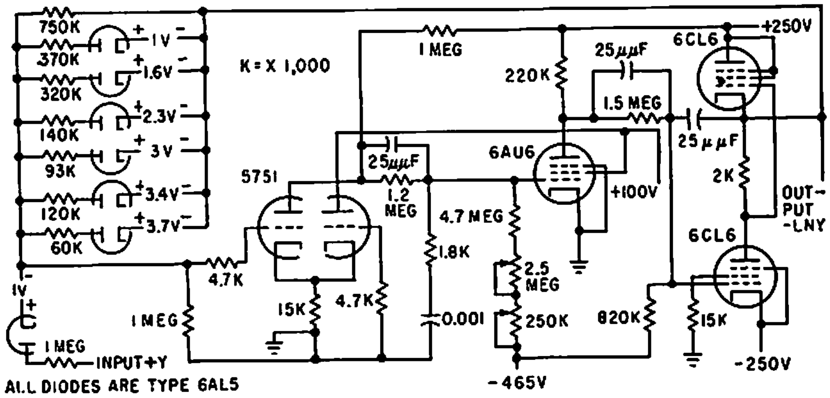
PHOTOELECTRIC FUNCTION GENERATOR—Open-loop photoelectric function generator generates any single-value function with 1% accuracy, as required for duplicating particular antenna patterns in radar simulator. Uses horizontal sweep of 10 millisec (100 cps) with 5-kc vertical sweep.—B. Silverberg, Function Generator for Radar Simulator, *Electronics*, 32:2, p 52–55.



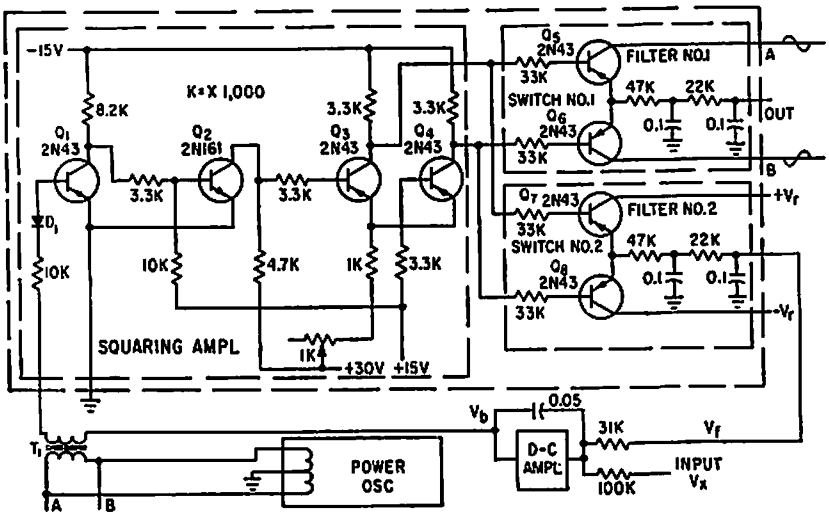
FUNCTION GENERATOR—Desired function of input voltage is developed across RC and inverted by Q4. One application is for computing ground range of radar target from slant range. Transistors eliminate need for d-c amplifier.—D. R. Chick, Boosting Function Generator Output with Transistors, *Electronics*, 33:13, p 75–76.



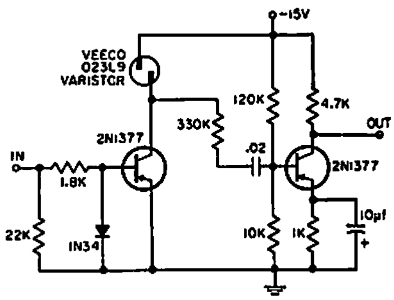
SQUARE-LAW OUTPUT—Diode network and detector provide output proportional to square of input voltage. Input range of 40 db is split into two 20-db segments. Each stage saturates and gives constant output for voltages above operating range. For voltages below operating range, stage is cut off and has zero output. Combination of two stages gives desired square-law characteristic. Resistor values are: R1A, R3A = 3.18K, R1B = 57.9K, R3B = 18.75K, R5 = 3K, R7 = 10, R2A, R4B = 5.06K, R4A = 1.86K, R2B = 64.2K, R6 = 300 and R8, R9 = 990.—R. J. Matheson, Square-Law Detector has 40-db Dynamic Range, *Electronics*, 39:18, p 95–97.



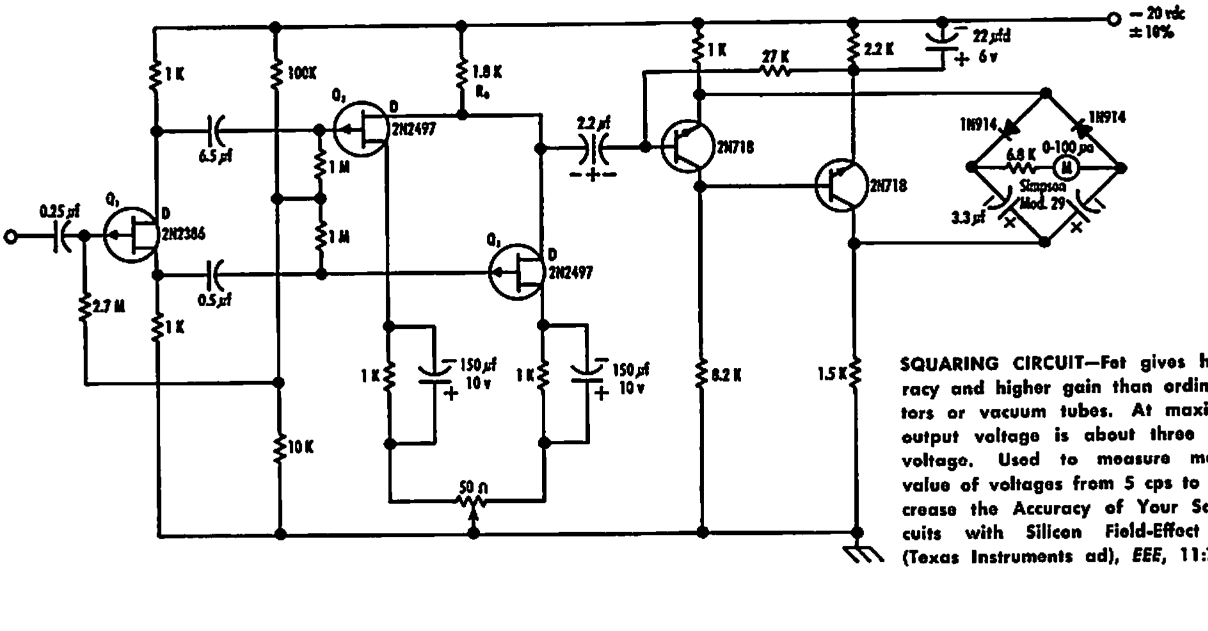
EXPONENTIAL FUNCTION GENERATOR—Output is exponentially decaying curve in which exponent is determined by other components of system. Used in analog computer to integrate curve of dye concentration in blood stream to obtain flow rate.—R. L. Skinner and D. K. Gehmlich, Analog Computer Aids Heart Ailment Diagnosis, *Electronics*, 32:40, p 56–59.



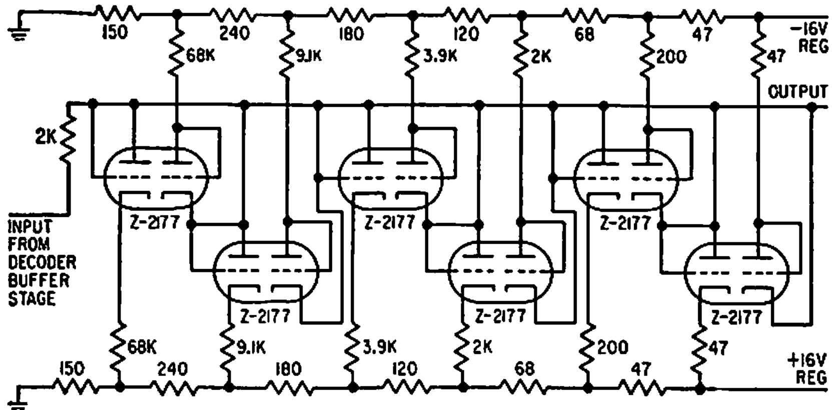
COSINE/SINE GENERATOR—Based on fact that area under sine curve varies as cosine function. Input voltage is converted into pulse width that controls electronic switch to cut off one portion of sine wave. Resulting rectangular pulses are symmetrical with respect to positive peak of sine wave.—H. Schmid, Function Generator for Sines or Cosines, *Electronics*, 32:4, p 48–50.



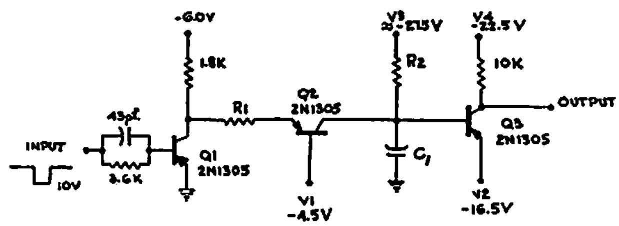
DYNAMIC RANGE COMPRESSOR—Transistorized version of vacuum-tube drawdown limiter or compressor amplifier limits dynamic range of any negative input signal without a threshold or saturation level. Output is approximately proportional to cube root of input, thus giving effective dynamic range compression. Good over audio range, yet can operate up to megacycle region if used with suitable high-frequency transistors and series inductance to varistor. Maximum input signal of 200 mv produces 3 v output, corresponding to gain of 15 at maximum permissible compression.—D. E. Lancaster, Dynamic Range Compressor, *EEE*, 11:2, p 25.



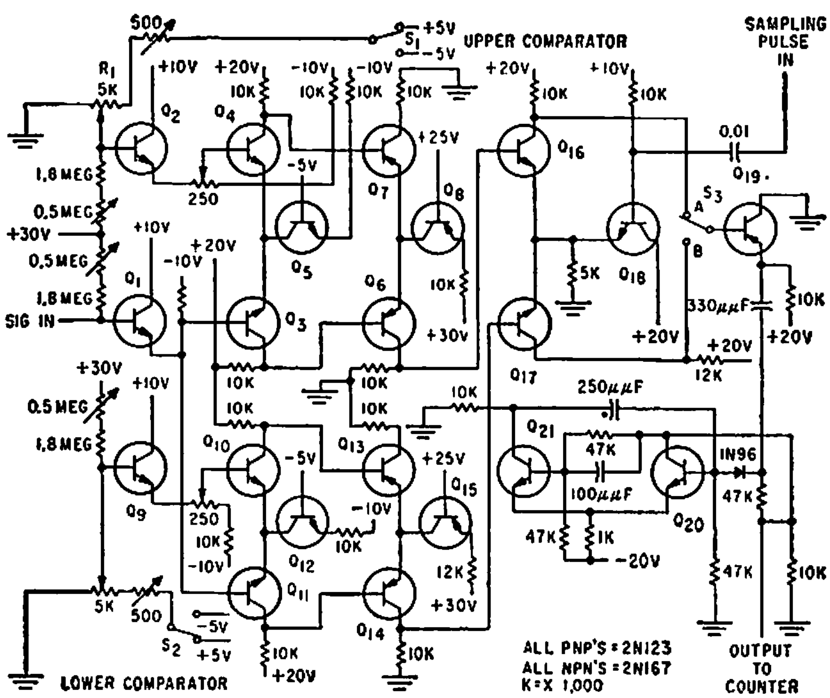
SQUARING CIRCUIT—Fet gives higher accuracy and higher gain than ordinary transistors or vacuum tubes. At maximum input, output voltage is about three times input voltage. Used to measure mean-squared value of voltages from 5 cps to 100 kc.—Increase the Accuracy of Your Squaring Circuits with Silicon Field-Effect Transistors (Texas Instruments ad), *EEE*, 11:7, p 6–7.



SINE-COSINE APPROXIMATOR—Converts triangular first approximation of sine and cosine of azimuth angle to accurate approximation of these functions by use of two diode-connected triodes as function generators, one for positive signals and the other for negative signals.—B. L. Bair, Logical Design of SAGE Input Monitor, *Electronics*, 31:33, p 78–81.

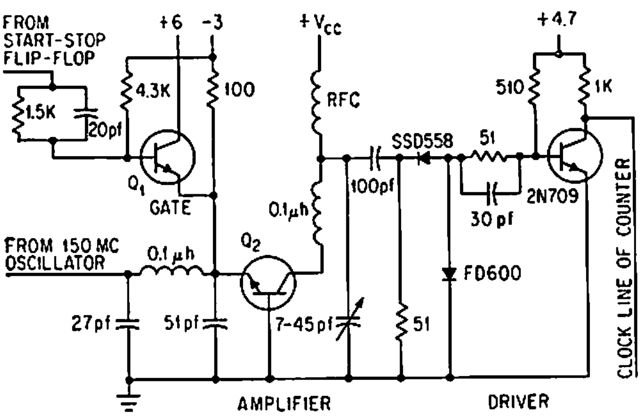


TIME AMPLIFIER—Output pulse width is linear function of input pulse width. With two stages, circuit can amplify nanosec pulse widths to seconds. Article gives design procedure for choosing values of R1, C1, and R2 for desired time amplification and input pulse range. For input of 0.1 — 1 microsec and time amplification of 1,000, R1 = 51, C1 = 8,200 mfd, and R2 = 3.2 meg. For 10 — 100 microsec input and amplification of 100, R1 is increased to 510 ohms. For 100 to 1,000 microsec input and amplification of 10, R1 = 510, C1 = 0.82 mfd, and R2 = 320K.—R. W. Fergus, Time Amplifier, *EEE*, 11:8, p 26–27.

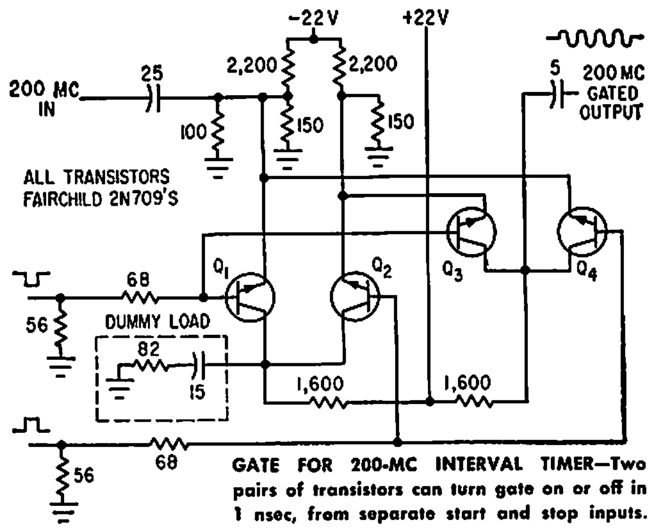


RANDOM-NOISE ANALYZER—Provides digital information from which amplitude probability distribution function and probability density function can be plotted. Consists of two amplitude comparators followed by logic circuits and sampling network.—D. Hoffman and E. Schutzman, Statistical Analysis of Noise-Signal Amplitudes, *Electronics*, 32:30, p 48–49.

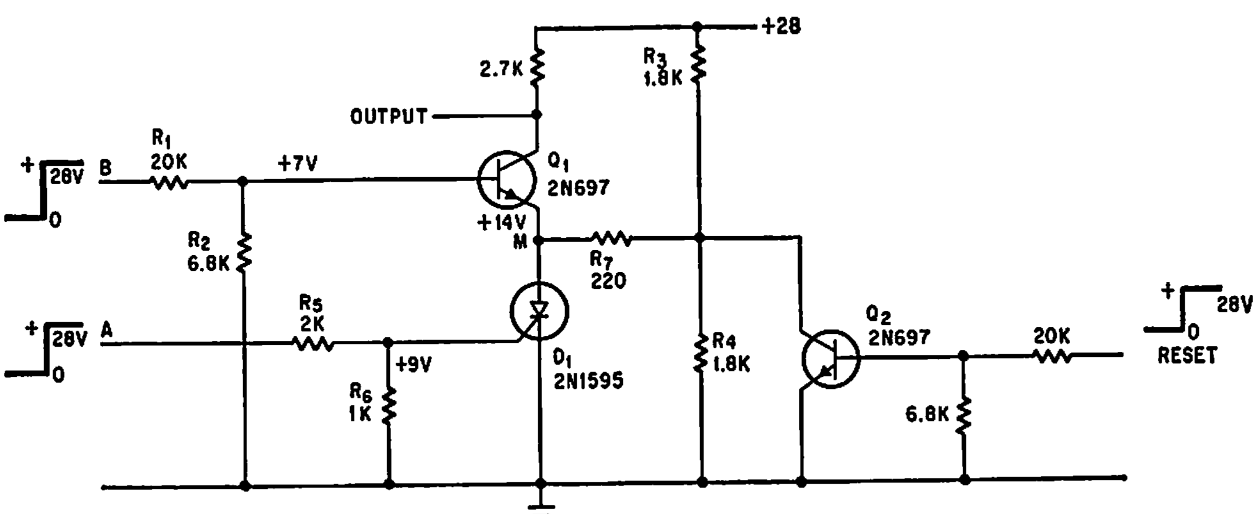
CHAPTER 39
Gate Circuits



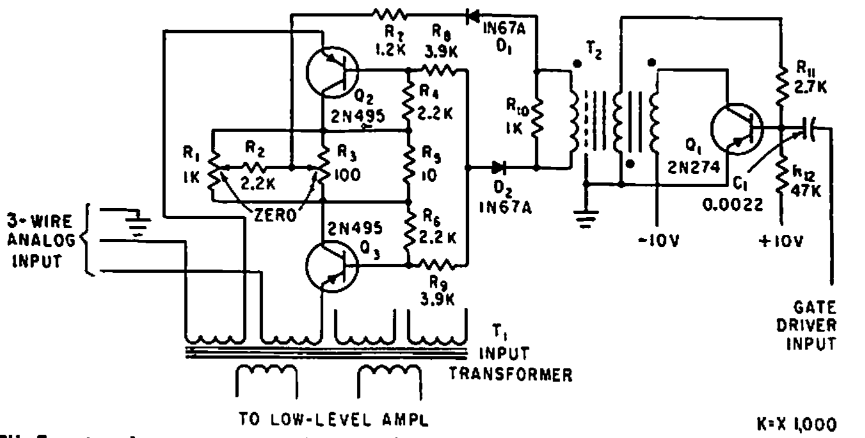
150-MC CLOCK GATE AND DRIVER—When gate transistor Q1 (2N2368) is turned on, 200-Mc bandwidth amplifier Q2 is off to provide isolation and permit switching within one cycle of clock. Driver output goes to decade counter.—L. C. Drew, Using Microcircuits in High-Resolution Range Counters, *Electronics*, 36:47, p 31–33.



GATE FOR 200-MC INTERVAL TIMER—Two pairs of transistors can turn gate on or off in 1 nsec, from separate start and stop inputs. Only one transistor per pair conducts at a time.—C. S. Coffey, VHF Counter Measures Time Intervals Precisely, *Electronics*, 36:34, p 27–29.

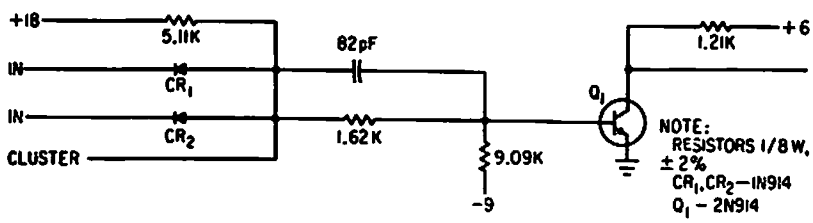


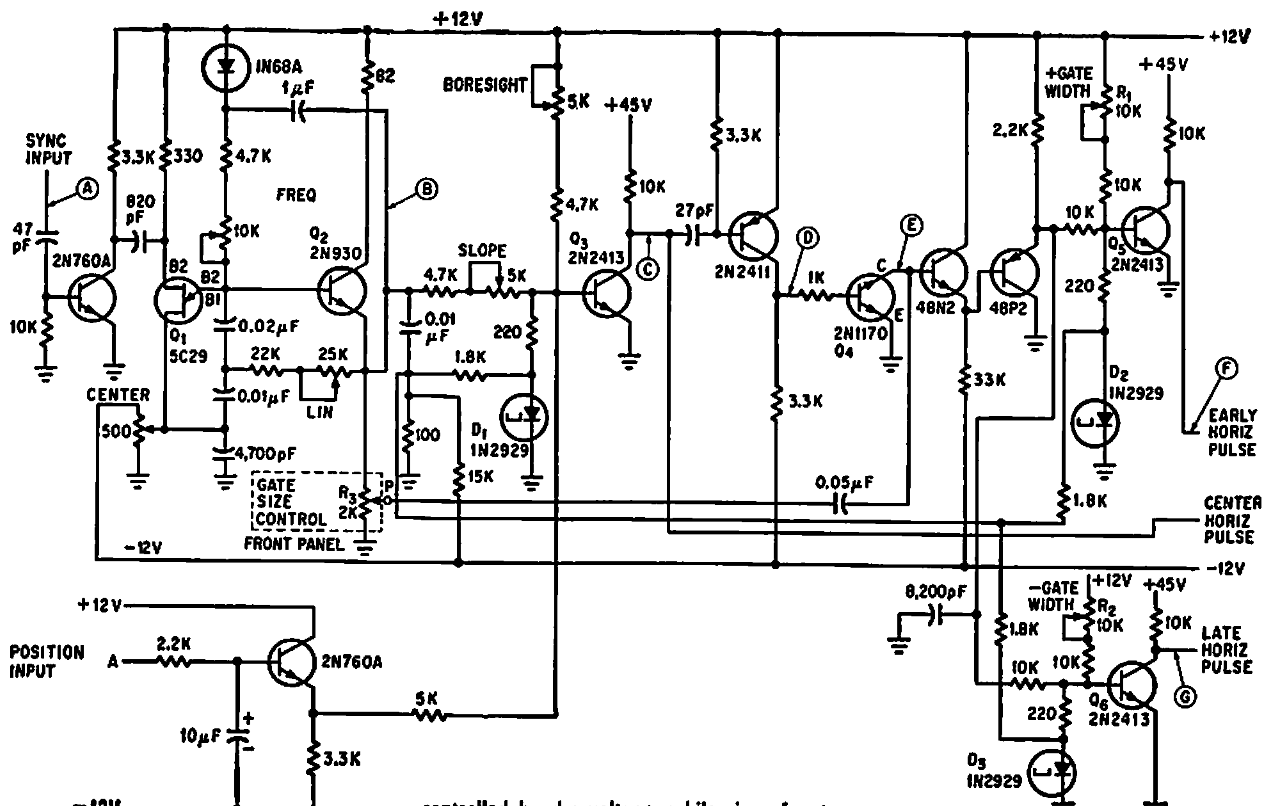
PULSE SEQUENCE DETECTOR—Output occurs only when event signal at A precedes event signal at B. Other sequences are ignored. —R. A. Wilson, Two Events, in Sequence, Produce Detector Output, *Electronics*, 39:16, p 120–121.



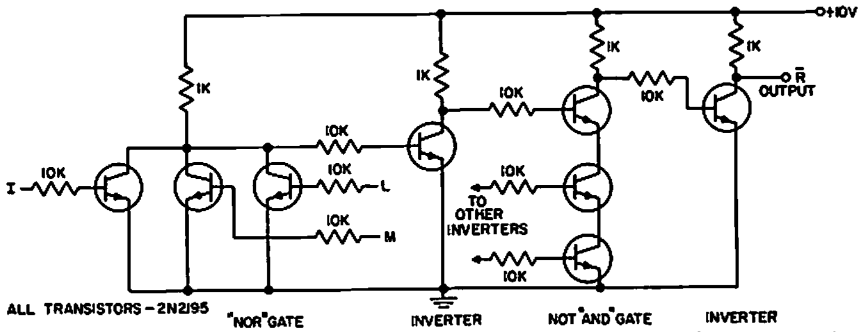
TRANSISTOR SERIES SWITCH—Two transistors back-to-back in inverted connection serve as *and* gate between analog input from instrumentation transducer and input transformer of multiplexer. Gate driver receives key pulse from timing matrix.—C. E. Griffin, J. P. Knight, and J. H. Searcy, Low-Level Multiplexing for Digital Instrumentation, *Electronics*, 33:41, p 64–66.

STANDARD MICROMODULE LOGIC GATE—Single-transistor gate can have maximum fan-in of 20 and maximum fan-out of 4. Power dissipation is 75 mw average, pair delay is 60 nsec, and rise time 30 nsec.—A. S. Rettig, Computers in the Front Lines: Micromodules Make it Possible, *Electronics*, 36:1, p 77–81.

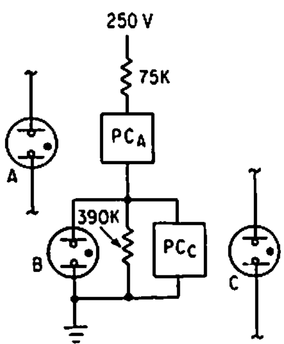




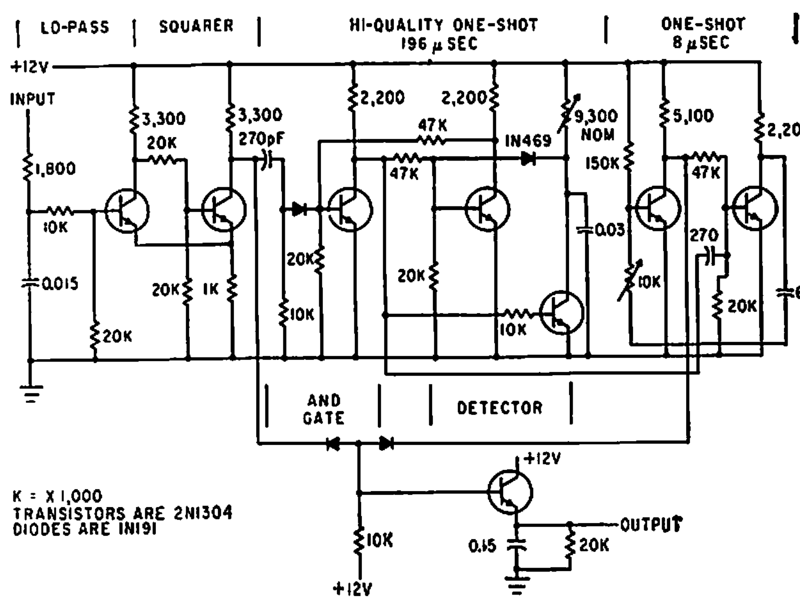
GATE GENERATOR FOR MISSILE TRACKER—Position of rectangular gate on tv display is controlled by d-c voltage, while size of gate can be adjusted manually without affecting its center position.—J. R. Kruse, Automatic Tv Tracker Keeps Eye on Missiles, *Electronics*, 34:13, p 82–87.



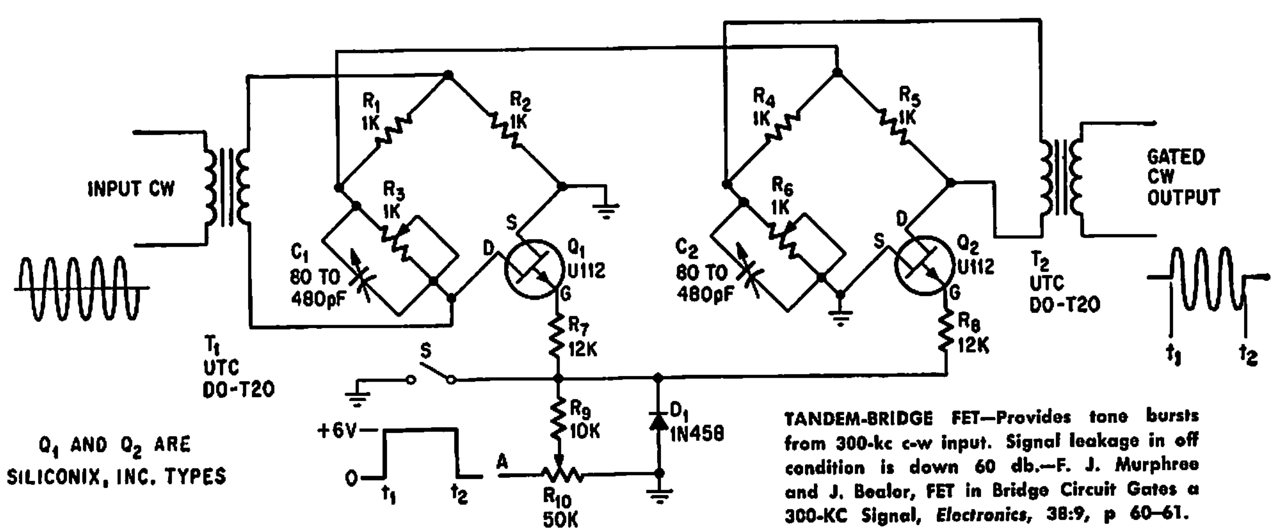
GATE OUTPUT INVERTER—Inverter stages compensate for phase inversion of three parallel-transistor *nor* gates and three series-transistor *not and* gates.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 177.



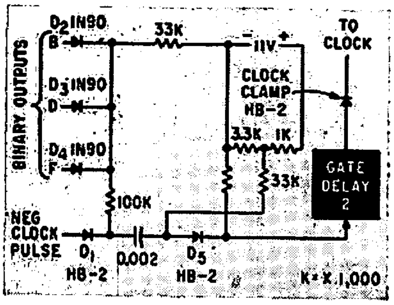
NEON PHOTOCONDUCTOR IN LOW-COST LOW-SPEED GATE—Cadmium selenide or cadmium sulfide photoconductors PC deposited on common substrate are used in pairs with Ne-2H miniature neon indicator lamps to replace electromechanical relays in low-speed digital gate. Firing time of neons is reduced and stabilized by applying 350-v, 60-cps voltage between one neon electrode and adjacent external electrode, to maintain ambient light that gives low level of ionization in lamp.—J. L. Patterson, Will Neon Photoconductors Replace Relays in Low-Speed Logic?, *Electronics*, 36:18, p 46–49.



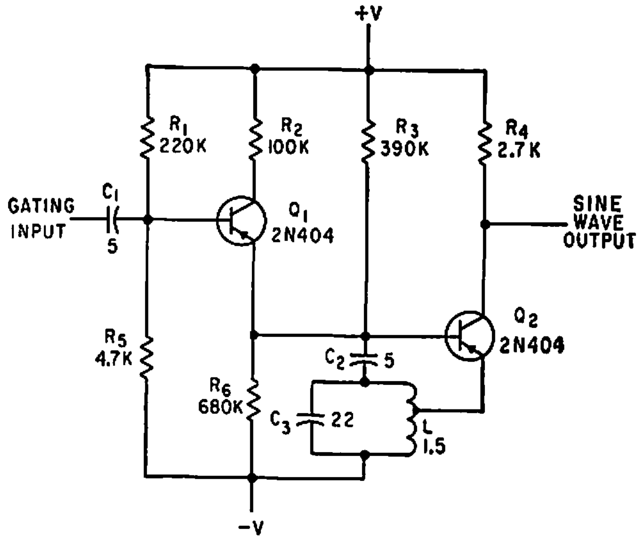
SLOT FILTER—Interval-sensitive gate will detect tone in range from 4,900 to 5,100 cps regardless of other frequencies present.—A. Corbin, Digital Tone Filter with Infinite Rejection Slope, *Electronics*, 34:5, p 58.



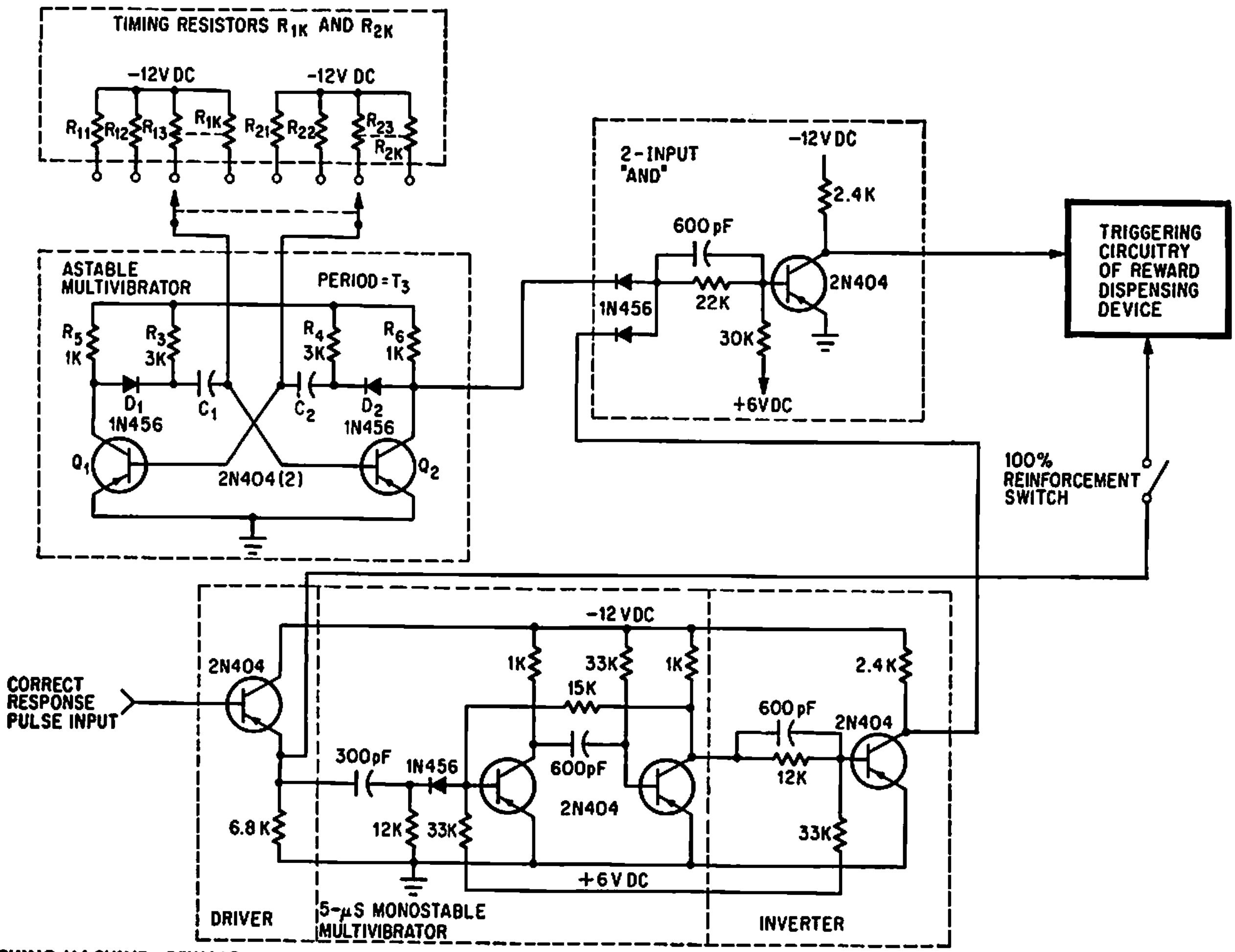
TANDEM-BRIDGE FET—Provides tone bursts from 300-kc c-w input. Signal leakage in off condition is down 60 db.—F. J. Murphree and J. Bealor, FET in Bridge Circuit Gates a 300-KC Signal, *Electronics*, 38:9, p 60–61.



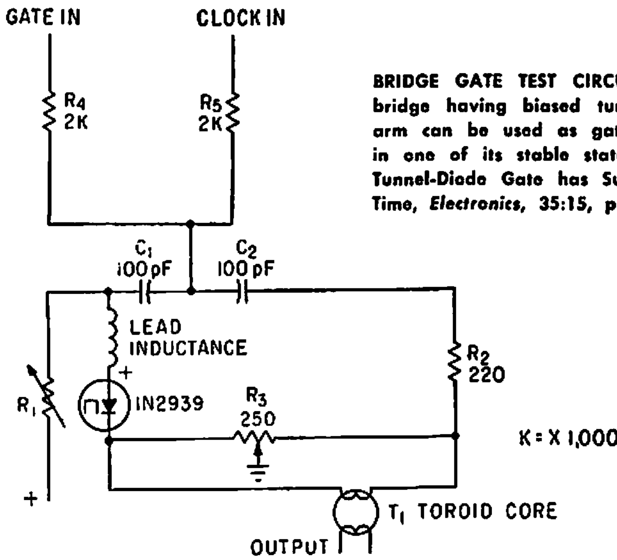
GATED DELAY—Negative-output clock pulses of 256-parameter microwave system checker are applied to gating diode D1, which ordinarily blocks signal to delay mvbr. During eighth pulse of code train, diodes D2-D3-D4 receive negative voltage from their binary outputs and make D1 trigger mvbr through D5. At end of mvbr delay, clamp is removed until eight more pulses arrive.—J. B. Bullock, Pulse-Coded Fault Alarm in Microwave Systems, *Electronics*, 33:1, p 82–84.



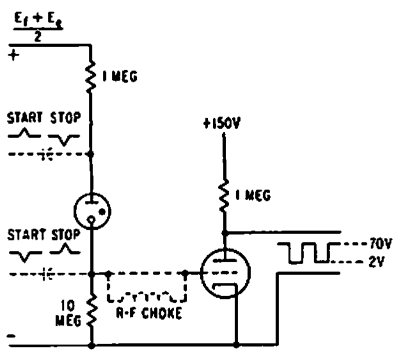
GATED OSCILLATOR—Drives pair of pulse generators for selective calling system.—A. I. Perlin, Selective Calling for Data Link Systems, *Electronics*, 33:18, p 108–110.



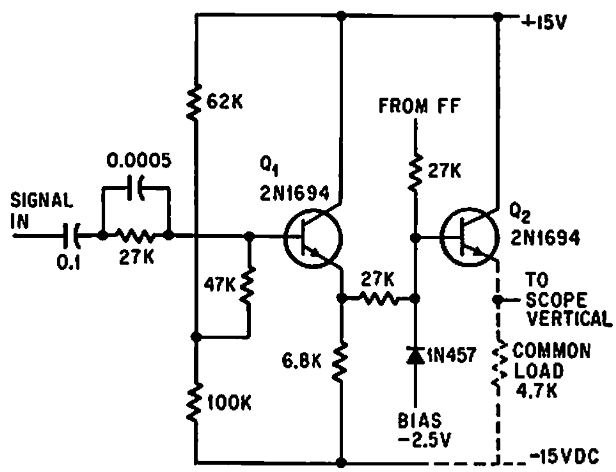
TEACHING-MACHINE REWARD GATE—Astable and monostable multivibrators feed *and* gate that triggers reward-dispensing device (such as candy dispenser) when number of correct answers exceeds preset percentage of random probability. Circuit may also give 100% reinforcement for correct response but with candy reward only at spaced intervals. —G. S. Pennington, Jr. and J. A. Boehm, III, Gate Varies Rewards from Teaching Machine, *Electronics*, 39:10, p 92–93.



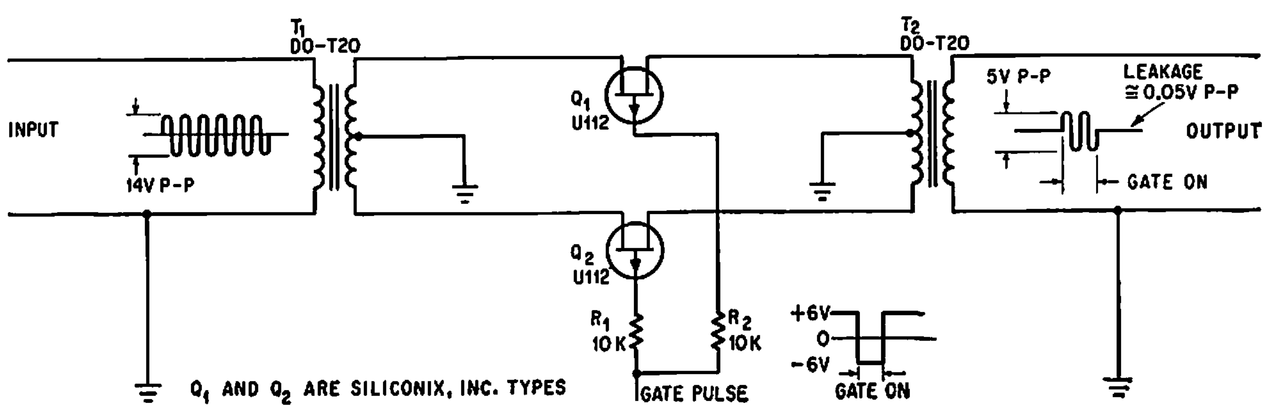
BRIDGE GATE TEST CIRCUIT—Two-state a-c bridge having biased tunnel-diode in one arm can be used as gate when balanced in one of its stable states.—F. W. Kantor, Tunnel-Diode Gate has Subnanosecond Rise Time, *Electronics*, 35:15, p 62–64.



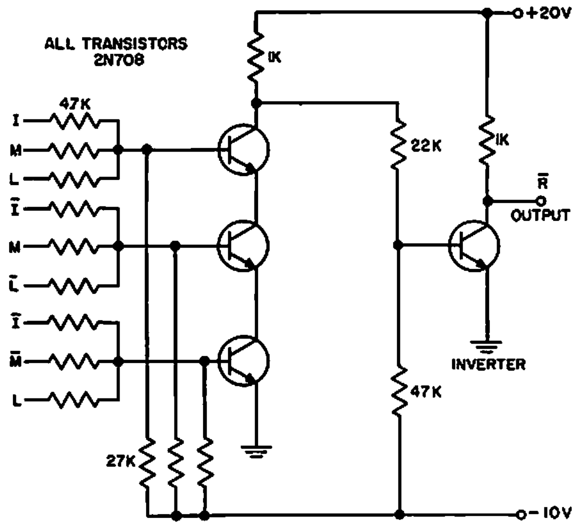
NEON-TRIODE OFF-ON GATE—Supply voltage is set midway between firing and extinction voltages of neon tube. Neon conducts when triggered by momentary increase in voltage, and continues conducting until supply voltage is momentarily lowered below extinction voltage. Can be used to produce low-repetition-rate pulses. Triode may be 6AV6 or ½ 12AX7.—R. L. Ives, Neon Triode Gives Low-Speed Gate, *Electronics*, 31:11, p 170–174.



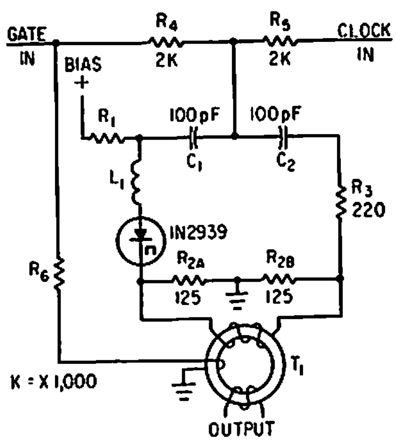
DIODE GATE—Input signal from ring counter applies reverse bias through isolating transistor Q1 to diode gate and base of Q2, which then supplies current to common load of multichannel scope display.—J. E. Russell, Ten Signals at a Glance, *Electronics*, 37:19, p 54–57.



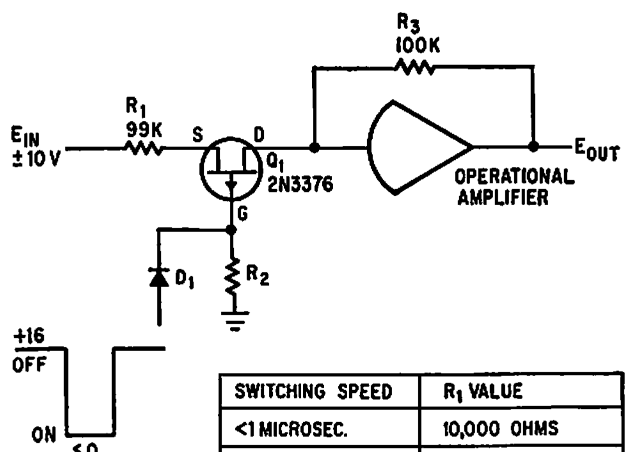
SIGNAL-BRIDGE FET—Provides pulsed c-w output from 300-kc c-w input. On-off ratio is 50 db. Insertion loss is 15 db with 510-ohm output load. Requires no adjustment. Used in sonar experiments.—F. J. Murphree and J. Bealer, FET in Bridge Circuit Gates a 300-KC Signal, *Electronics*, 38:9, p 60–61.



***NOR* LOGIC USING SERIES TRANSISTORS FOR *AND* GATE**—Requires inverter at output.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 179.

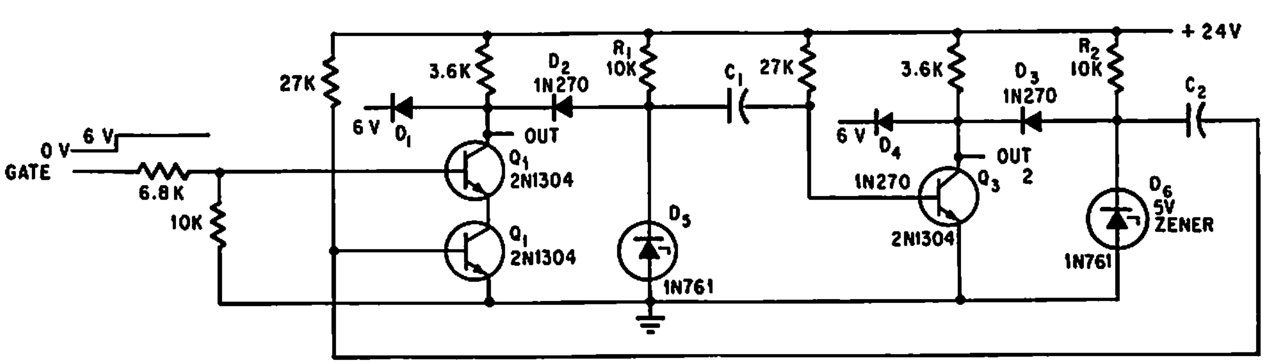


BRIDGE GATE WITH TOROID—Portion of gate input signal is fed to wire threading output toroid, to cancel output spike of a-c bridge.—F. W. Kantor, Tunnel-Diode Gate has Subnanosecond Rise Time, *Electronics*, 35:15, p 62–64.

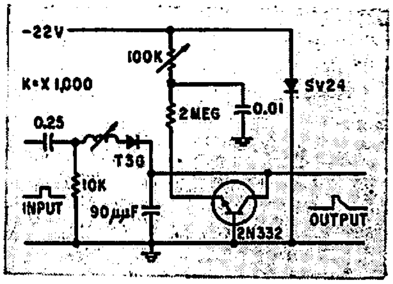


SWITCHING SPEED	R_1 VALUE
<1 MICROSEC.	10,000 OHMS
10 MICROSEC.	1.0 MEGOHM

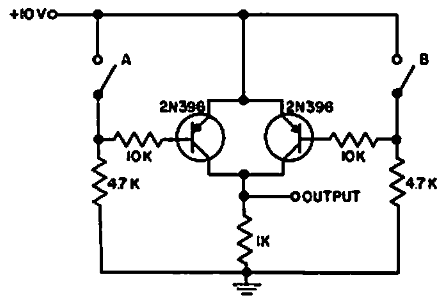
ANALOG GATE—Output is −10.0025 v for +10 v input, and +9.9975 v for −10 v input.—M. Shipley Sr., Analog Switching Circuits Use Field-Effect Devices, *Electronics*, 37:32, p 45–50.



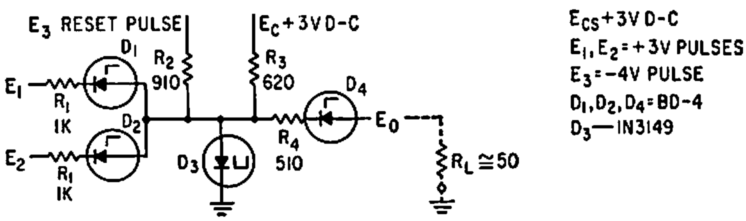
GATED MVBR—Complementary pulse trains appear at outputs 1 and 2 when gate is applied.—R. Newmeyer, Gated Multivibrator Output Provides Constant Pulse Width, *Electronics*, 38:26, p 69.



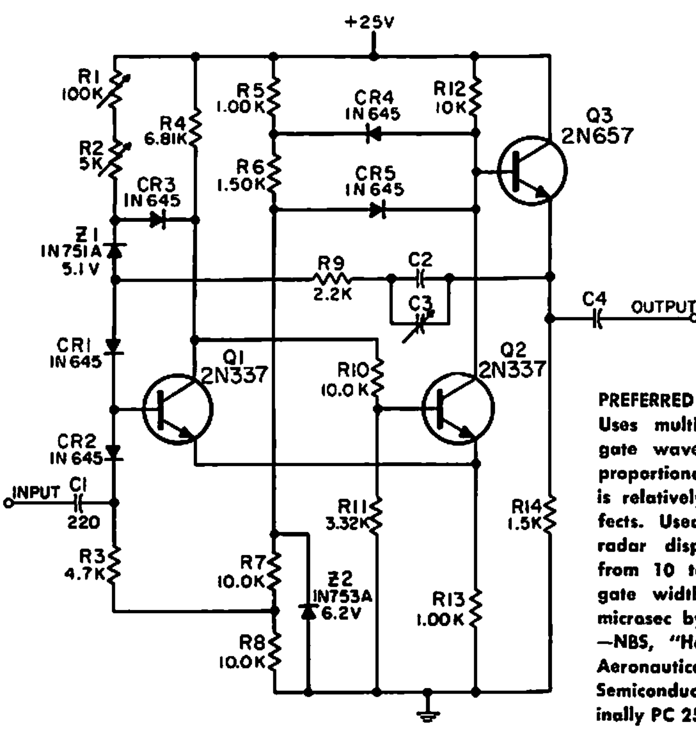
PULSE HEIGHT-TO-WIDTH CONVERTER—Converts 0 to 2-v pulse to gate for pulse height to pulse width conversion. Gate width, directly proportional to data pulse amplitude, is applied to clock circuits.—W. W. Grannemann et al., Pulse-Height-to-Digital Signal Converter, *Electronics*, 33:2, p 58–60.



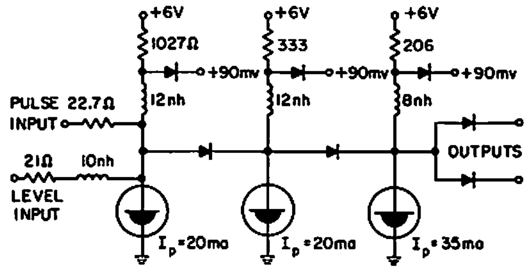
BASIC PNP GATE—Circuit is *and* gate if closing of switch is an input. Circuit is *or* gate if opening of switch is an input. Provides phase inversion of input without complicating overall circuitry.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 176.



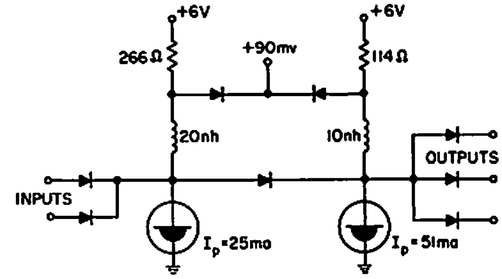
FAST TUNNEL-DIODE GATE—At coincidence between sampling pulse at one input and 100-Mc block pulse at other input, 11 ma current through D3 switches D3 to high level, making D4 pass current to load.—A. A. Fleischer and E. Johnson, New Digital Conversion Method Provides Nanosecond Resolution, *Electronics*, 36:18, p 55–57.



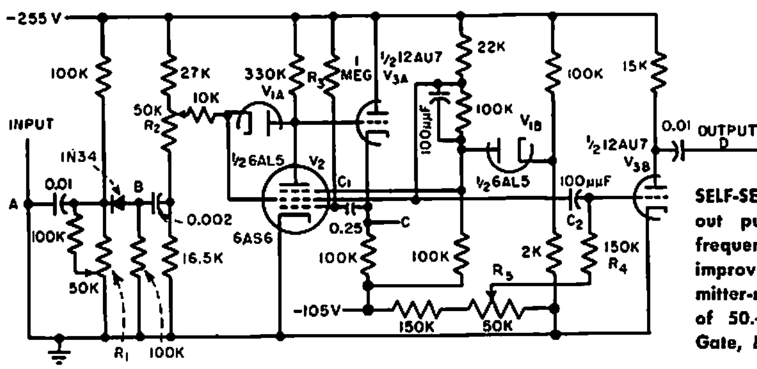
PREFERRED VARIABLE GATE GENERATOR—Uses multivibrator to generate rectangular gate waveform whose duration is directly proportional to setting of potentiometer and is relatively independent of temperature effects. Used to produce movable markers for radar displays. Input signal is negative, from 10 to 20 v. Output is 12.5 v, with gate width adjustable from 10 to 10,000 microsec by changing values of R1 and C2. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 16 (originally PC 252), p 16–2.



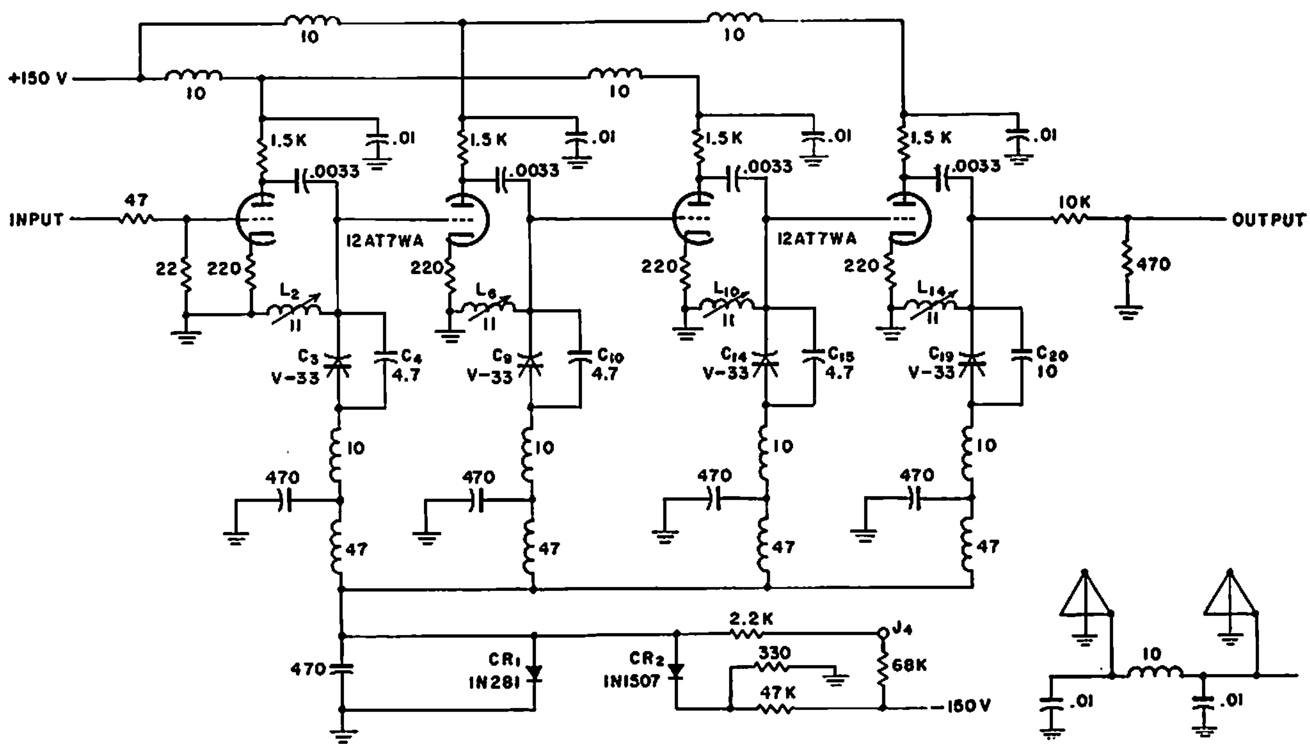
TUNNEL-DIODE *AND* GATE—Three cascaded monostables provide adequate gain for high-speed computer *and* logic.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 370.



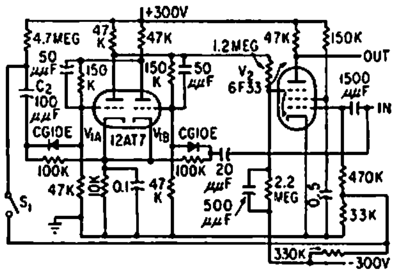
TUNNEL-DIODE *OR* GATE—Uses two cascaded monostables.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 370.



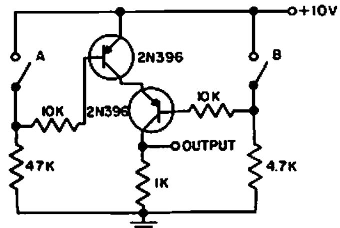
SELF-SETTING PULSE-PATTERN GATE—Picks out pulses transmitted at fixed repetition frequency, in presence of random noise, to improve reliability of ionospheric pulse transmitter-receiver synchronizing link by factor of 50.—E. R. Schmorling, Self-Setting Servo Gate, *Electronics*, 31:3, p 71.



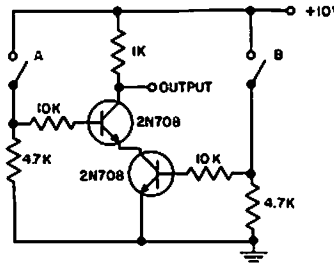
GATING WITH VARICAPS AND TRIODES—Gives 100-db on-off ratio of 5.5-Mc signal, using small-amplitude positive-pulse gate (about 4 v) with two dual triodes and four tuned circuits with varicaps in each. Tuned circuits are shifted from parallel to series resonance by gating signal.—Gating with Varicaps, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 211.



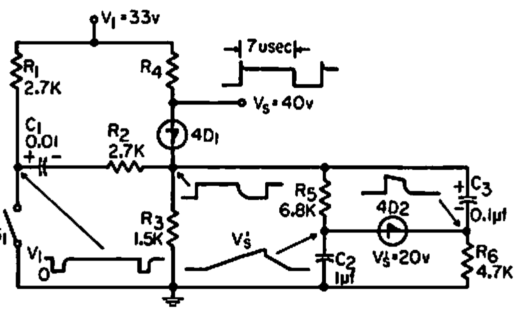
SYNCHRONIZED GATE—Continuous train of pulses is applied to control grid of gating tube. When S1 is closed, next pulse in train opens gate, then shuts gate after itself.—J. K. Goodwin, Time and Pulses Control Gates, *Electronics*, 32:3, p 72–73.



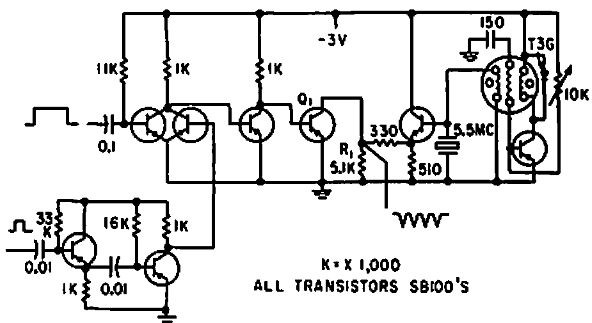
PNP SERIES-TRANSISTOR GATE—Circuit is *or* gate if closing of switch is an input. Circuit is *and* gate if opening of switch is an input. Provides phase inversion of input.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 176.



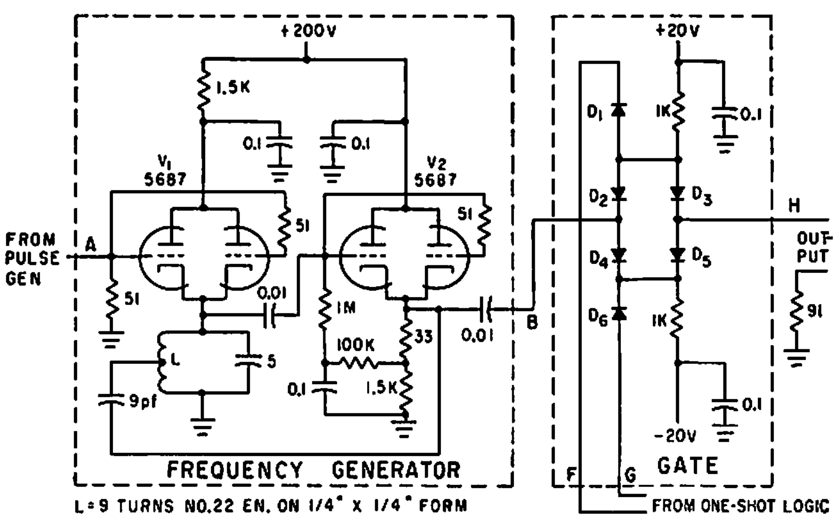
NPN SERIES-TRANSISTOR GATE—Circuit is *and* gate if closing of switch is an input. Circuit is *or* gate if opening of switch is an input. Provides phase inversion of input.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 176.



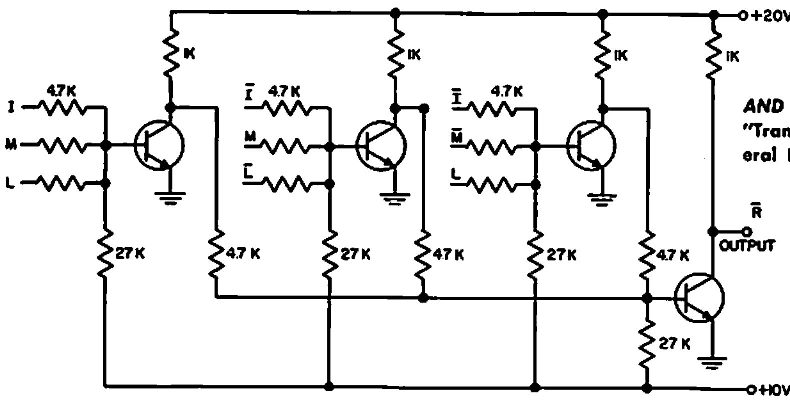
COMBINATION GATE AND ONE-SHOT—Uses two four-layer switching diodes, and draws no current from source except during gate pulse. Can also be used as one-shot. Width of pulse depends on supply voltage and R5-C2.—R. E. Amsterdam, Gate/One-Shot Uses Four-Layer Diodes, *EEE*, 12:12, p 58–60.



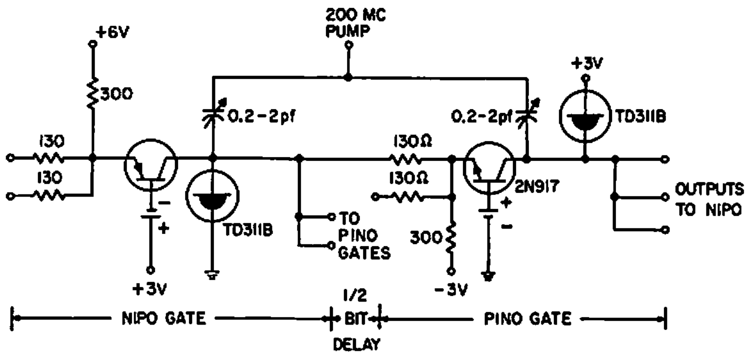
5.5-MC CRYSTAL OSCILLATOR GATE—Provides train of pulses to be read by 7-digit binary counter. Number of pulses in train depends on width of gate pulse received from gate amplifier, and is proportional to amplitude of data input pulse.—W. W. Grannemann et al, Pulse-Height-to-Digital Signal Converter, *Electronics*, 33:2, p 58–60.



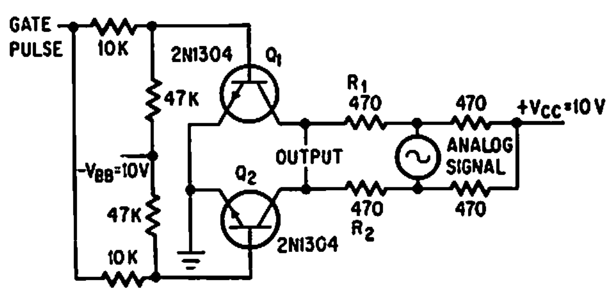
ONE-SHOT LOGIC CONTROLS TRANSMISSION GATE—Frequency generator, activated by negative pulse at A, generates 32-Mc burst in which number of cycles depends on input pulse width. Pushbutton-controlled one-shot logic allows diode transmission gate to pass first complete 32-Mc burst occurring after pushbutton is actuated, after which gate is closed. One-shot has sync connection to pulse generator.—V. Kann, One-Shot Gating Circuit Generates Sinewaves for Testing Counters, *Electronics*, 34:23, p 114–116.



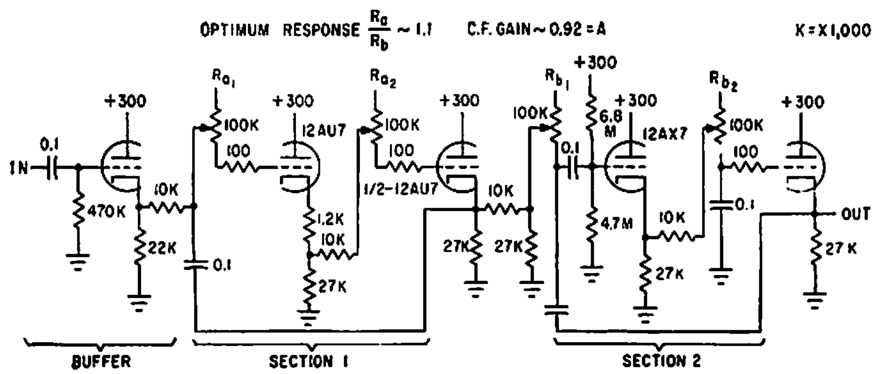
AND **GATE—Uses** ***nor*** **logic with inversion.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 179.**



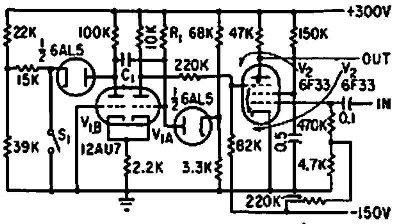
PUMPED TUNNEL-DIODE LOGIC GATES—Shows method of interconnecting negative-input positive-output gate with positive-input negative-output gate for high-speed computer logic.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 370.



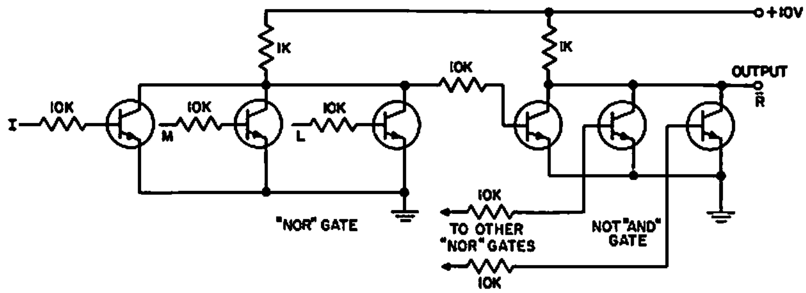
SINGLE POSITIVE PULSE GATES SINE WAVE SIGNAL—Two transistors act as balanced shorting switch, eliminating pedestal effects that normally necessitate dual-polarity gate pulses for analog signals. Positive 10-v pulse saturates both transistors, thereby grounding both output terminals to give isolation from input signal. Analog signal being gated can be as low as 5-mv rms.—L. E. Frenzel, Jr., Gate Circuit Eliminates Pedestal Effects, ***Electronics*****, 37:15, p 77.**



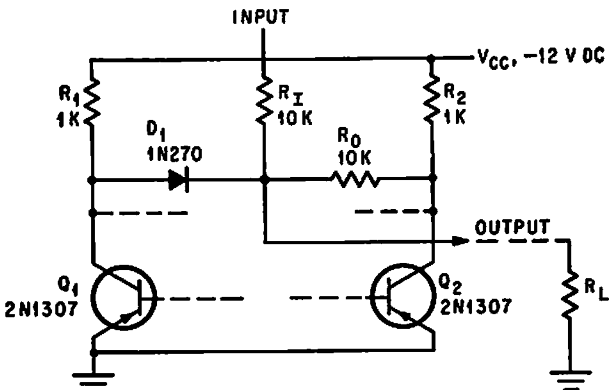
ZERO-CROSSING SWITCH FOR HEART SOUNDS—Active filter with three amplifiers provides output pulse for opening sliding gate at instant when heart sound being monitored is zero. Filter has sharp cutoff above highest-frequency heart sound (600 cps).—R. Weiss, Heart-Sound Discriminator Simplifies Medical Diagnosis, ***Electronics*****, 34:24, p 52–55.**



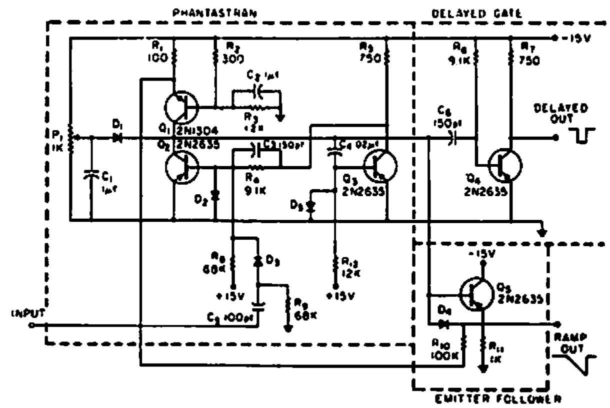
TIME-CONTROLLED GATE—Pentode gate is controlled by period of astable mvbr. Gate is closed when V1A is conducting; when S1 is closed, mvbr opens gate for period determined by C1-R1.—J. K. Goodwin, Time and Pulses Control Gates, *Electronics*, 32:3, p 72–73.



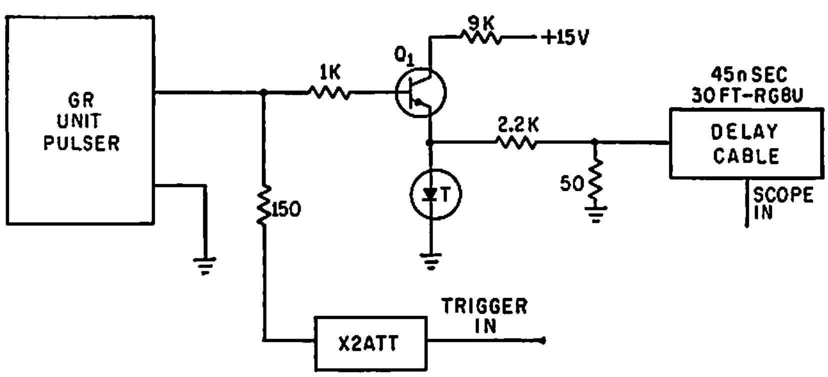
PHASE INVERSION WITHOUT INVERTERS—Used to achieve *and* and *or* functions from same circuit. Base resistors ease requirements for saturation voltage and base input voltage.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 177.



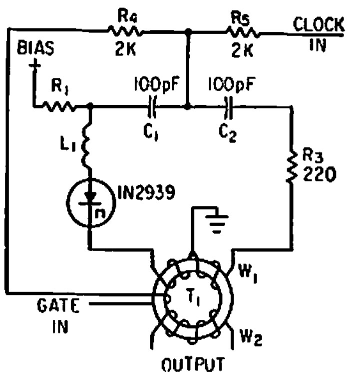
MVBR CONTROLS BILATERAL GATE—Q1 and Q2 are part of saturated multivibrator, and D1 with R0 form gate that permits output when Q2 turns on and blocks D1. When Q2 turns off, D1 and Q1 clamp output close to ground.—S. H. Tsao, Multivibrator Controls Single-Diode Gate, *Electronics*, 39:15, p 101.



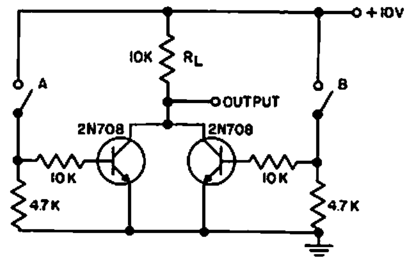
DELAYED GATE—Addition of four parts to phantastran (solid-state phantastron) gives gate at end of sweep for use as delayed signal. Width of delayed gate is function of maximum sweep amplitude, up to limit of 1 microsec width.—G. Marosi, Phantastran Delayed Gate, *EEE*, 13:7, p 42–44.



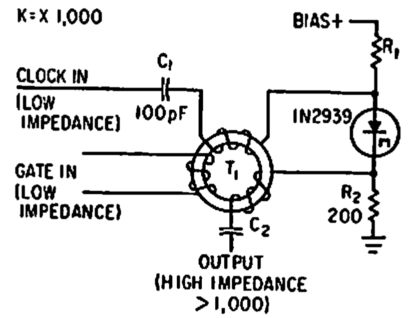
TUNNEL DIODE-TRANSISTOR GATE—Combines high switching speed of tunnel diode with isolation properties of transistor. Rise time of gate is 0.7 nsec. Clock rate can be at least 500 Mc.—R. W. Lade, Logic Combines Tunnel Diodes with Transistors, *Electronics*, 34:9, p 46–47.



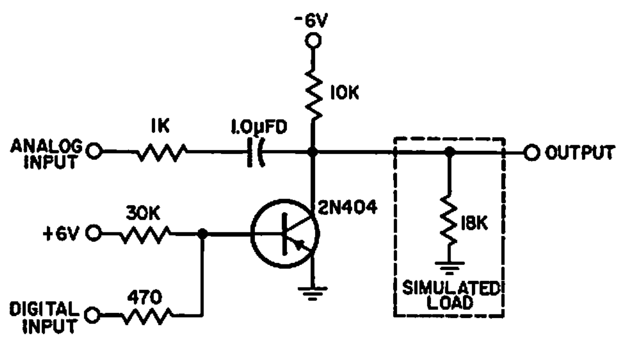
GATE WITH TAPPED TOROID—Arrangement of toroid windings minimizes number of components in a-c bridge used as computer gate, while keeping gating pulse out of output. R3 adjusts balance. Bias is adjusted for stable switching.—F. W. Kantor, Tunnel-Diode Gate has Subnanosecond Rise Time, *Electronics*, 35:15, p 62–64.



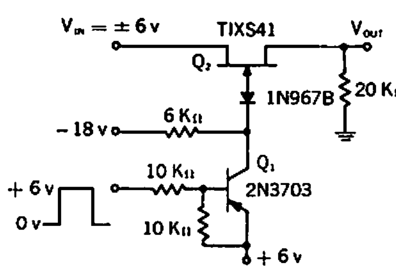
NPN *NOR* GATE—Circuit is *or* gate if closing of switch is an input. Circuit is *and* gate if opening of switch is an input. Provides phase inversion of input. If both switches are open, both transistors are nonconducting. When either switch is closed, output is negative, or *not* or, because of phase inversion, and circuit is therefore *nor* gate.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 176.



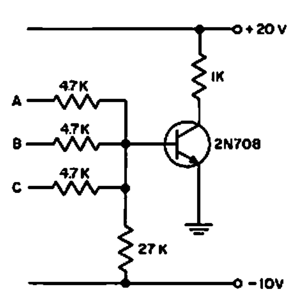
FAST-READOUT MEMORY—Voltage-divider version of tunnel-diode gate is used with toroid to give extremely fast readout, for use with computers having clock rates above 500 Mc. Tertiary winding cancels gating spike.—F. W. Kantor, Tunnel-Diode Gate has Subnanosecond Rise Time, *Electronics*, 35:15, p 62–64.



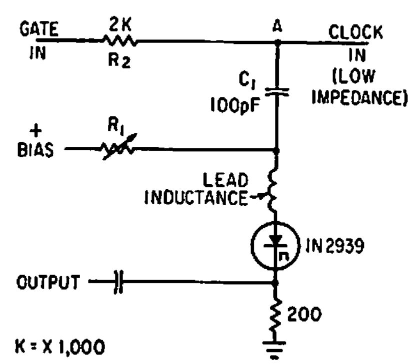
POSITIVE TRANSMISSION GATE—Is equivalent to digitally controlled analog switch, for frequency range of 8 to 650 kc. Output signal never passes through active device, hence is not attenuated, distorted, or delayed. Will pass a-c signal with zero average value. Ratio of on voltage to off voltage is 420:1 (4.2 v p-p to 10 mv p-p), for isolation of 54.5 db.—V. A. Bloom, Positive Transmission Gate, *EEE*, 10:9, p 26–27.



FET ANALOG GATE—Series connection of chopper-type fet permits high-accuracy analog switching. Resistance of Q2 when on is only about 20 ohms, and drain gate leakage current is less than 0.1 nanoamp.—Six More Semiconductor Advances From TI (Texas Instruments ad), *EEE*, 14:8, p 120–121.

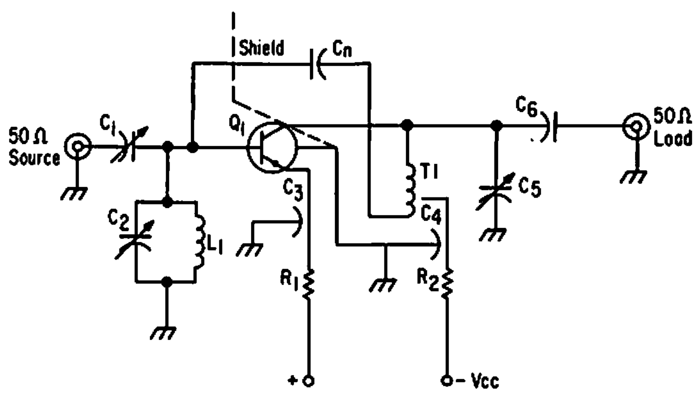


BASIC *NOR* GATE—Transistor conducts heavily if any of inputs is raised from 0 to +12 v. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 178.



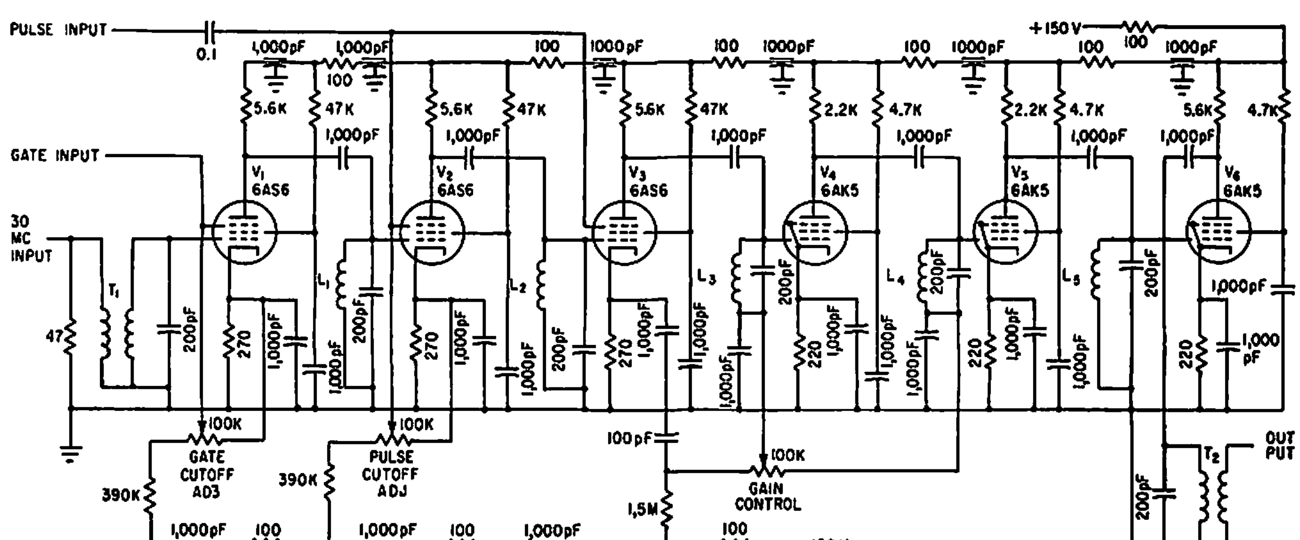
TUNNEL-DIODE GATE—Impedance of tunnel diode is part of voltage divider, eliminating need for a-c bridge in gate operating above 500 Mc.—F. W. Kantor, Tunnel-Diode Gate has Subnanosecond Rise Time, *Electronics*, 35:15, p 62–64.

CHAPTER 40
I-F Amplifier Circuits

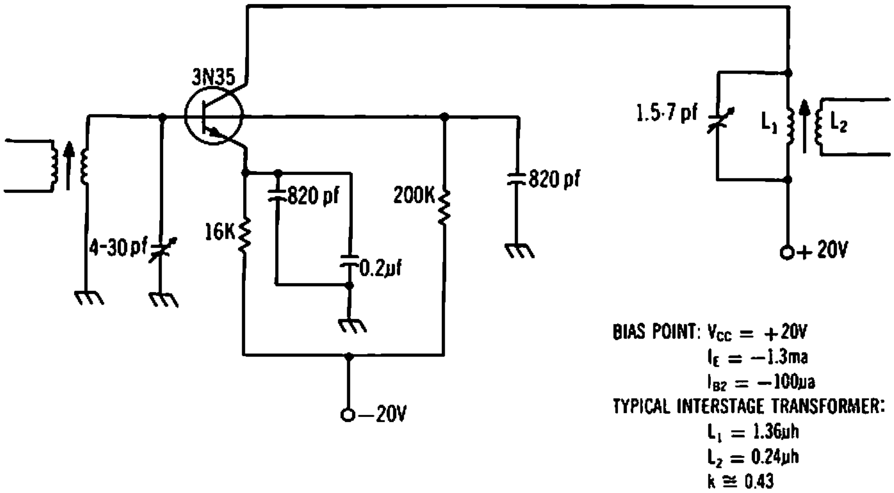


Q_1 = 2N2996
C_1,C_2 = 6.0-140pf
C_3,C_4 = .001μf
C_5 = 2-30pf
C_6 = 10pf
C_n = 3.9pf
R_1 = 2.7k
R_2 = 1.0k
L_1 = 0.06μh
T1 5 Turns No. 516 air dux tapped 4T from collector

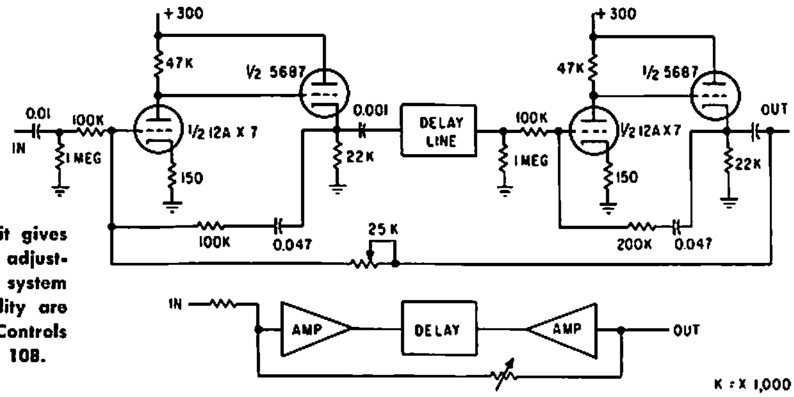
70-MC NEUTRALIZED—Designed to give maximum power gain in single stage while maintaining good stability. Noise figure is less than 3 db with power gain of 27 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 313.



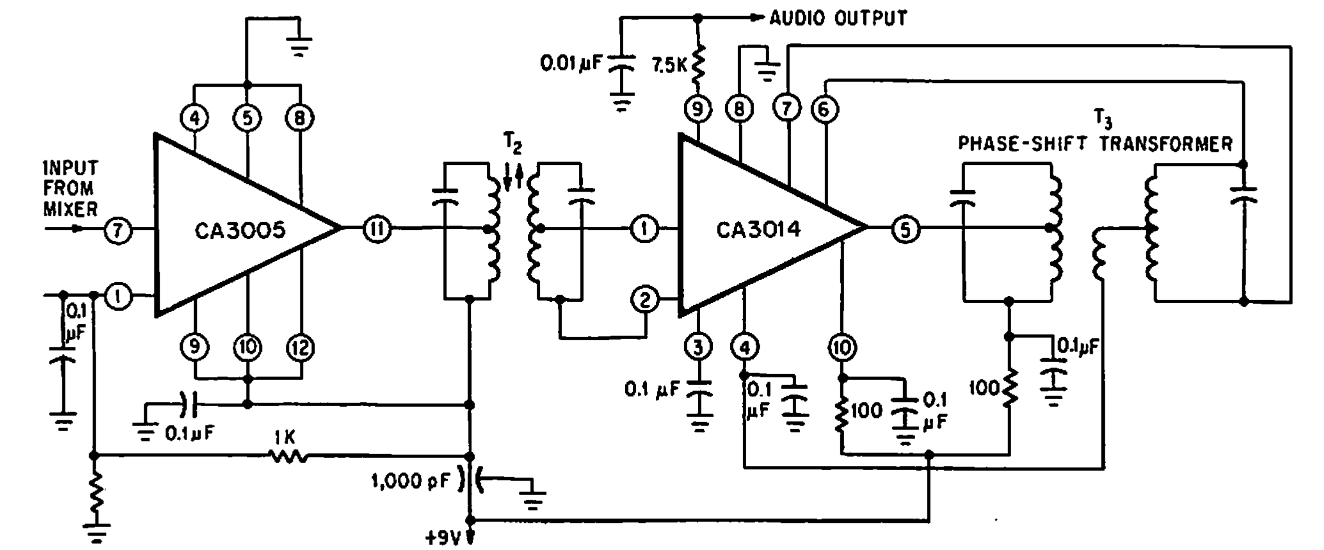
PULSED-GATED 30-MC I-F—Control signals are fed to suppressor grids of early amplifier stages, to generate groups of i-f pulses for simulating radar scanning or for testing transient response of i-f circuits. Bandwidth is 1.2 Mc.—C. D. Rasmussen, Suppressor Gating for I-F Amplifiers, *Electronics*, 34:34, p 62.



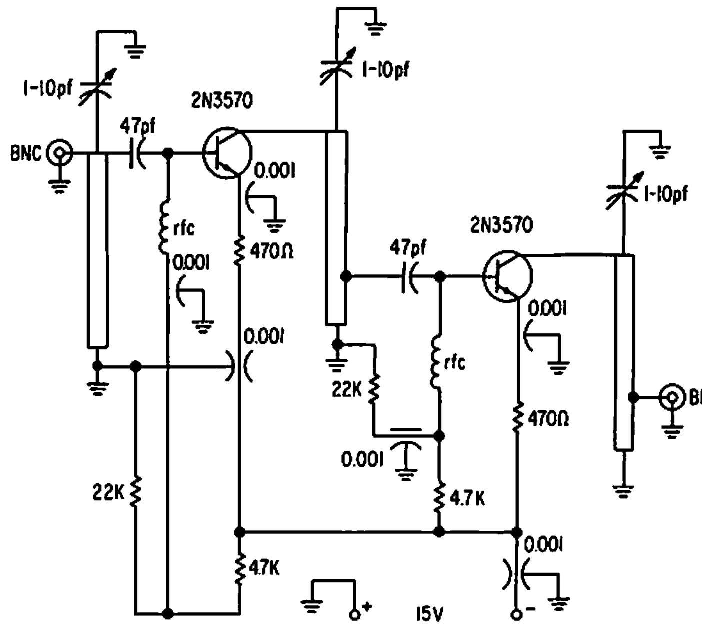
60-MC TETRODE I-F—Use of 3N35 gives excellent agc characteristics. Stage gain is 12 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 311.



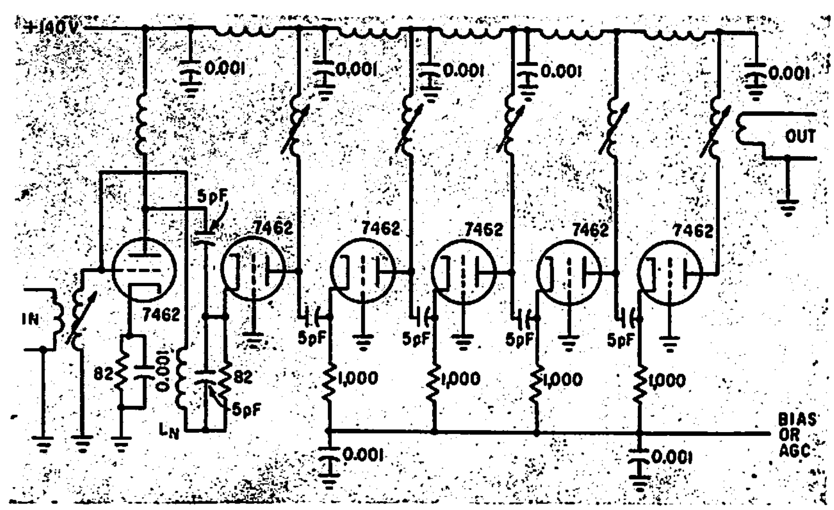
I-F TUNING WITH DELAY LINE—Circuit gives Q of 285 at 500 kc, and is tuned by adjusting delay time. Can be used in any system where high gain, high Q, and stability are needed.—I. F. Barditch, Delay-Line Controls Tuned Amplifier, *Electronics*, 33:31, p 108.



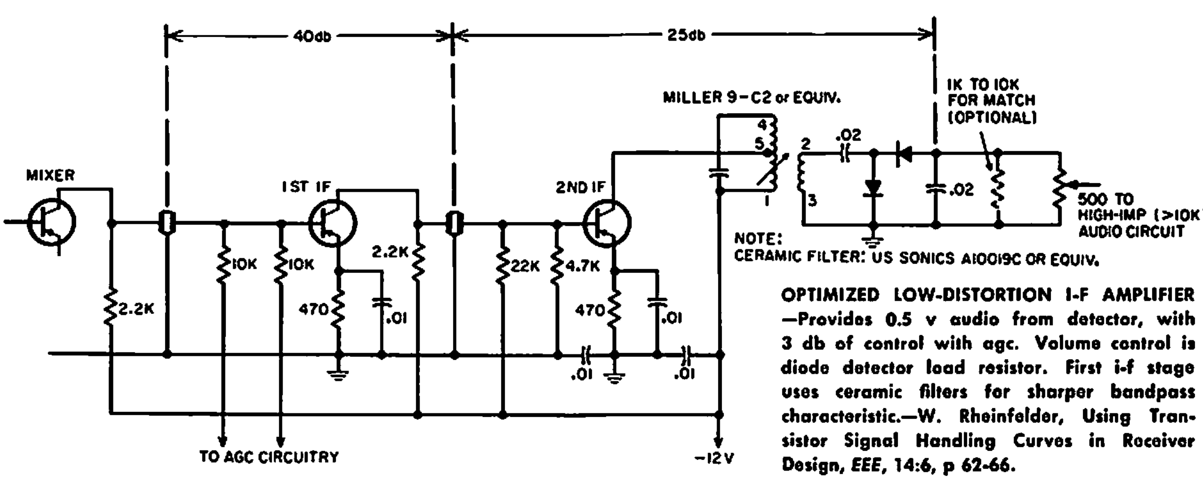
TWO-CHIP LOW-COST STRIP—Detector and 10.7-Mc i-f strip give 95 db gain. Differential amplifier in both RCA chips provides symmetrical limiting over wide input voltage range. Audio output is 220 mv.—R. L. Sanquini, Integrated Circuits Make A Low-Cost F-M Receiver, *Electronics*, 39:16, p 133-138.



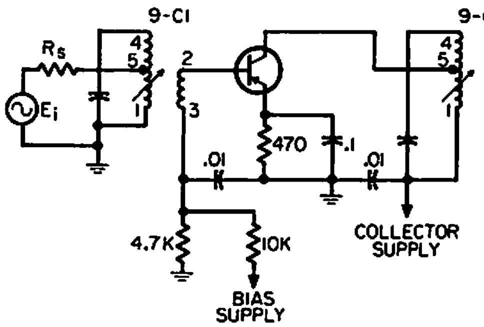
500-MC STAGGER-TUNED I-F—Slight staggering in two stages gives excellent stability, so circuit will not oscillate when either source or load is open. Bandwidth is 90 Mc for 1 db down and 110 Mc for 3 db down, with mid-band gain of 21 db. Draws only 7 ma at 15 v.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 315.



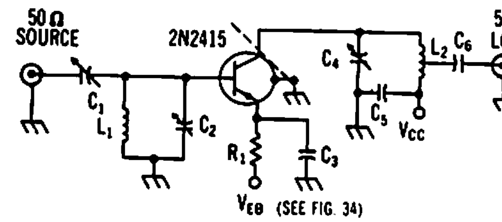
GROUNDED-GRID STRIP—Six-stage low-noise 60-Mc i-f strip amplifier, using microminiature ceramic triodes, gives 75-db overall gain, 1.7-db noise figure, and 6.5-Mc bandwidth. First stage is cascode and other five are grounded-grid triodes.—J. W. Rush, Designing Grounded-Grid Amplifiers with Controlled Gain, *Electronics*, 33:52, p 50–53.



OPTIMIZED LOW-DISTORTION I-F AMPLIFIER—Provides 0.5 v audio from detector, with 3 db of control with agc. Volume control is diode detector load resistor. First i-f stage uses ceramic filters for sharper bandpass characteristic.—W. Rheinfelder, Using Transistor Signal Handling Curves in Receiver Design, *EEE*, 14:6, p 62-66.



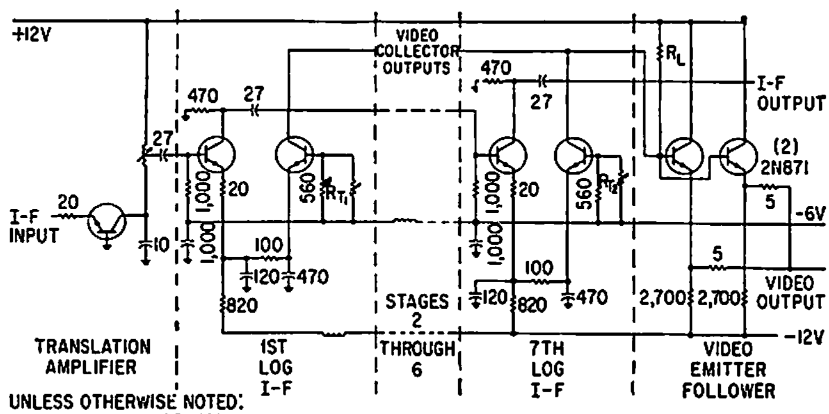
SINGLE-TUNED FINAL I-F—Circuit is example of optimum design based on use of transistor signal-handling curves. Transformers are single-tuned.—W. Rheinfelder, Using Transistor Signal Handling Curves in Receiver Design, *EEE*, 14:6, p 62–66.



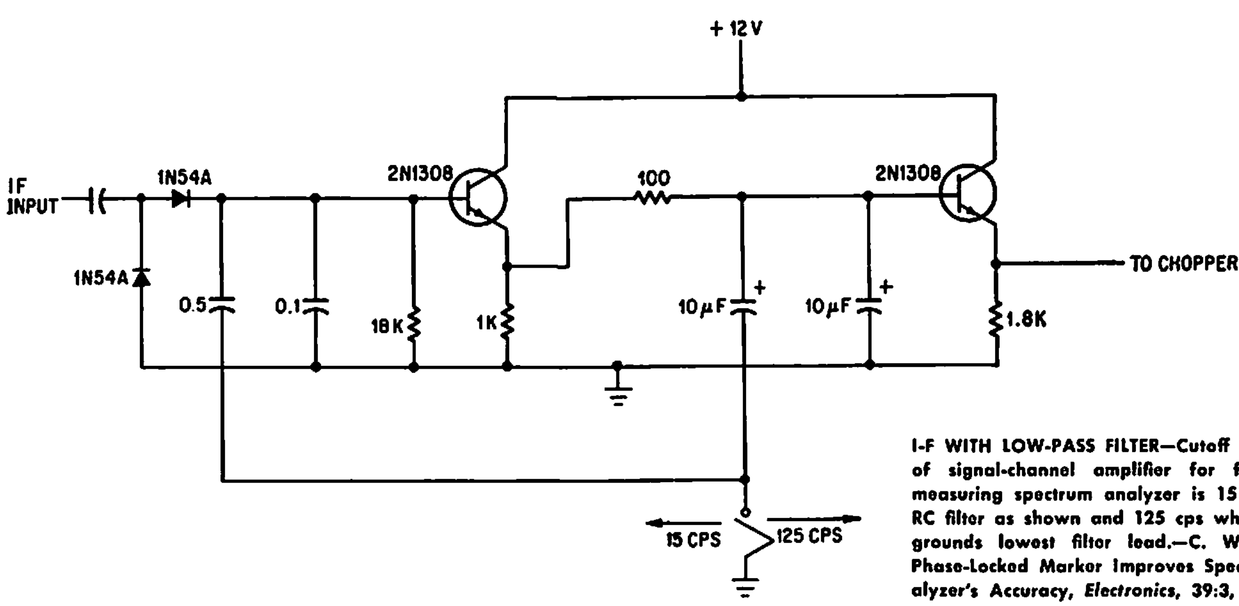
C_1=5.3 – 102 pf L_1 3T #14 WIRE ½" DIA; = 0.25 uh
C_2=3.7 – 52 pf L_2 4T #610 AIR DUX (OR EQUIV.); = 0.35 uh
C_3=0.01 µf TAPPED APPROX. 1 TURN UP FROM BOTTOM
C_4=3.7 – 52 pf C_1 IS ADJUSTED TO GIVE DESIRED VALUE OF R_g
C_5=0.01 µf *4th LEAD GROUNDED. R_1 = 1K ½ W
C_6=0.01 µf BIAS POINT: –6V. I_E (SEE FIG 34)

70-MC LOW-NOISE I-F—Noise figure ranges from 2 to 4 db depending on generator resistance and emitter current. Power gain is 24 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 312.

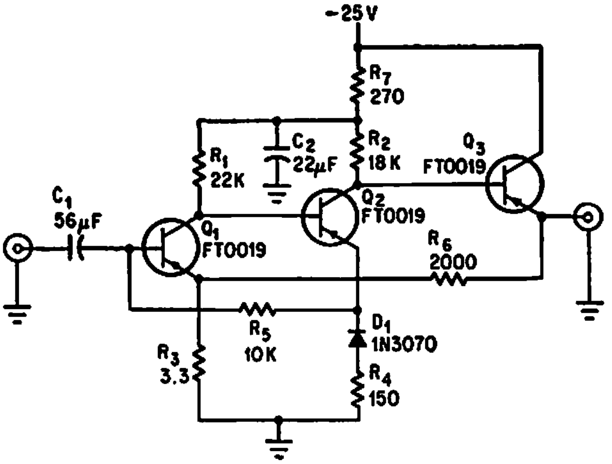
THIN-FILM LOG I-F AMPLIFIER—Translation amplifier limits bandwidth at input, while video emitter-follower matches 10-v output to load. All seven log i-f stages use thin-film circuits.—R. Leslie and T. Townsend, Inductors No Problem: New Thin-Film Amplifier, *Electronics*, 36:23, p 46–49.



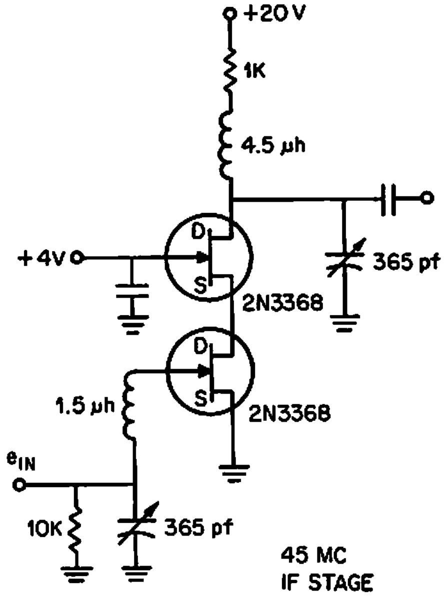
UNLESS OTHERWISE NOTED:
RESISTANCE VALUES IN OHMS, CAPACITANCE VALUES IN PF.



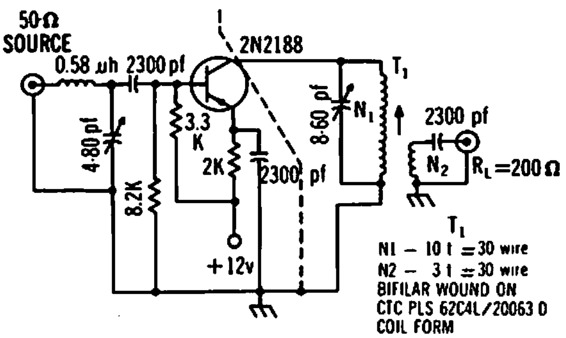
I-F WITH LOW-PASS FILTER—Cutoff frequency of signal-channel amplifier for frequency-measuring spectrum analyzer is 15 cps with RC filter as shown and 125 cps when switch grounds lowest filter lead.—C. W. Wilson, Phase-Locked Marker Improves Spectrum Analyzer's Accuracy, *Electronics*, 39:3, p 88–92.



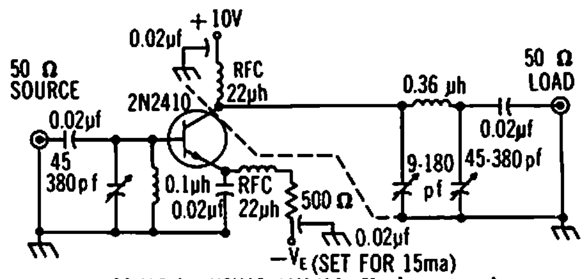
LOW-OUTPUT-IMPEDANCE I-F—Can provide impedances as low as 2 ohms and low noise figure, to take advantage of superior noise performance of backward diodes as mixers and detectors while overcoming their very low impedance at intermediate frequencies in range from 1 kc to 100 kc. Used in continuous-wave doppler radar systems.—R. O. Wright, New Twist for Backward Diode: Help from Low-Noise Amplifier, *Electronics*, 39:14, p 74-77.



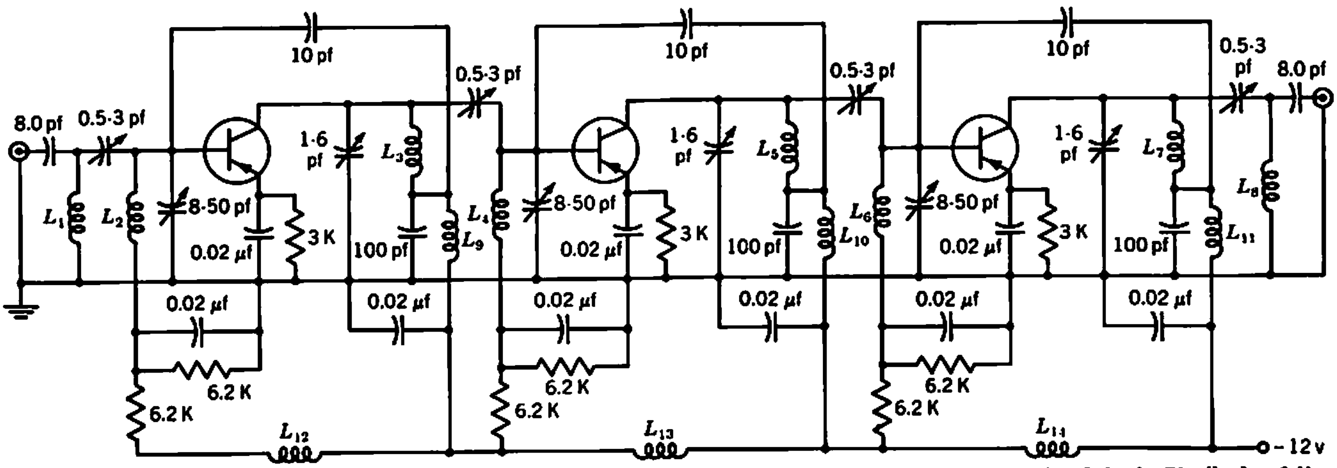
45-MC CASCODE FET—Operates without neutralization, giving 20 db power gain and 6-Mc bandwidth.—Cascode with FET's (Siliconix ad), *Electronics*, 39:2, p 109.



30-MC I-F USING 2N2188—Circuit includes L-section to give generator resistance of 350 ohms from 50-ohm source. Power gain is 13 db, noise figure 4 db, and bandwidth 5 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 309.

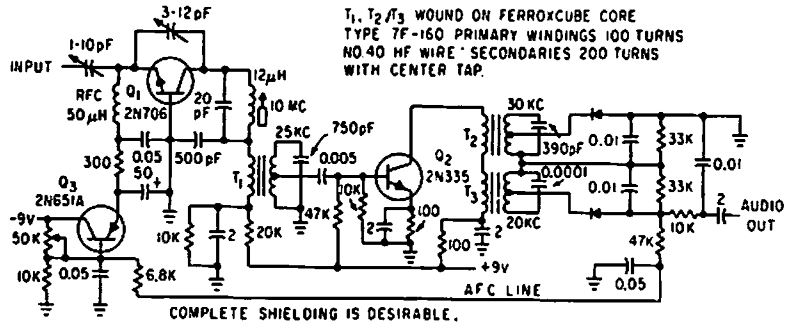


30-MC I-F USING 2N2410—Single stage gives power gain of 16 db, permitting use as final stage of i-f strip.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 308.

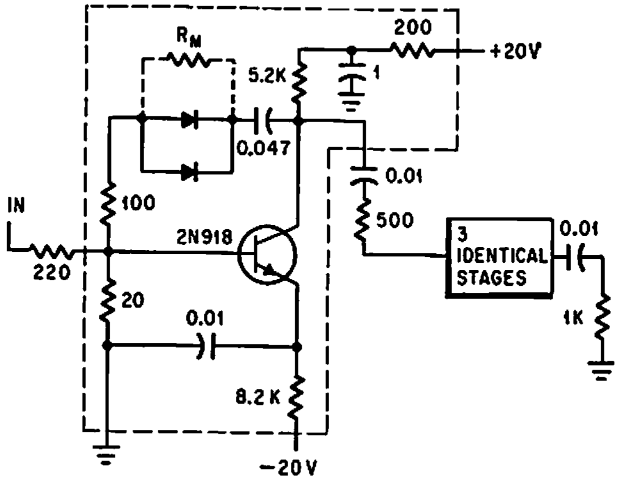


L_1, L_8 -3.5 μh 23 turns #36 heavy Formvar closewound on Cambion LS-9 form
L_2, L_4, L_6 -0.53 μh 9 turns #36 heavy Formvar space 1/62" apart on Cambion LS-9 form
L_3, L_5, L_7 -5.3 μh 29 turns #36 heavy Formvar closewound on Cambion LS-9 form
L_9-L_{14} -15 μh rfc

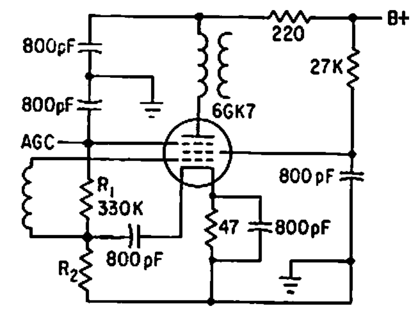
30-MC I-F STRIP—Gain is 70 db for 3-Mc bandwidth, using 2N1405 transistors. Design equations are given.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 276.



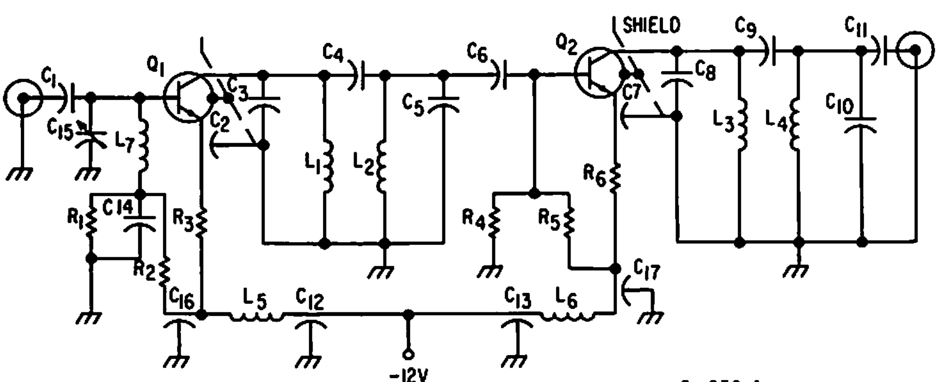
10-MC SUPERREGENERATIVE I-F—Grounded-base oscillator Q1 is self-quenched at 25 kc. Quench wave is amplified by Q2 and detected in modified Travis discriminator T2-T3. Afc voltage developed at discriminator is fed back to Q3 to maintain emitter current of Q1 at required value for quench rate.—N. H. Brown, Improved Superregenerator has Quench Converter, *Electronics*, 35:38, p 53



SYMMETRICAL LIMITING RADAR I-F AMPLIFIER—Four-stage i-f using silicon planar epitaxial transistors gives 35 db suppression of second harmonic for input of 0.3 to 30 mv. With one more stage and resistor RM across feedback diode, total phase shift is less than 25 deg.—R. F. Kirkpatrick and R. C. Stouffer, Symmetrical Limiting I-F Reduces Second Harmonic, *Electronics*, 37:12, p 72–73.



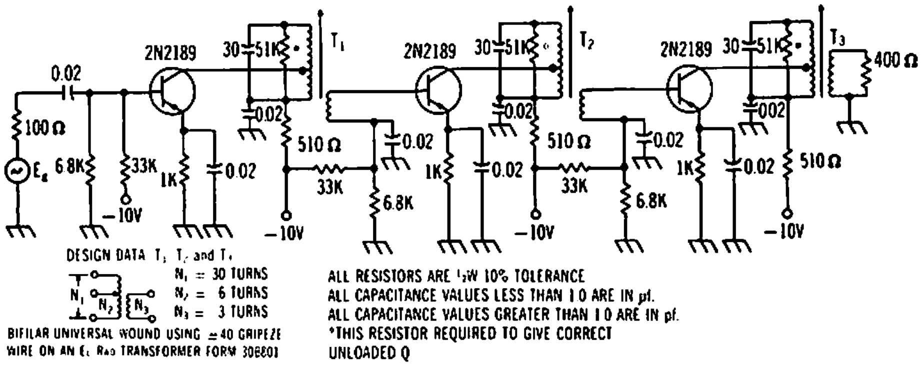
VIDEO I-F USES FRAME-GRID 6GK7—Negative voltage on suppressor controls gain of dual-control sharp-cutoff pentode. Cathode current is independent of agc, and control grid bias automatically adjusts to prevent modulation clipping.—L. Solomon, New Tubes and Circuits for Consumer Electronics, *Electronics*, 36:2, p 47–49.



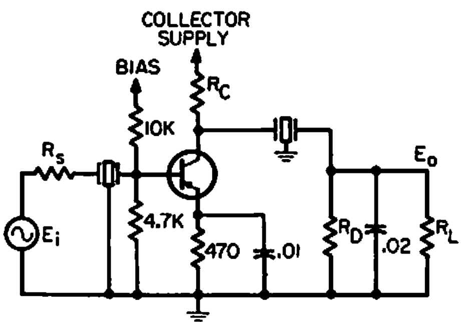
$Q_{1,2}$ = 2N2996
L_1, L_2, L_3, L_4 = 2 1/2 TURNS # 30 WIRE ON CAMBION
LS9 COIL FORM (ADJUSTED TO RESONATE WITH 31pf AT 105mc)
L_5, L_6 = 3.3μh
L_7 = 0.07μh
R_1, R_2, R_4, R_5 = 3K
R_3, R_6 = 1.5K

C_1 = 250pf
$C_2, C_7, C_{12}, C_{13}, C_{14}$ = 1000pf
C_3, C_5, C_8, C_{10} = 9-35pf
C_4, C_9 = 1.3-5.4pf
C_6 = 1.5-20pf
C_{11} = 10pf
C_{15} = 9-180pf
C_{16}, C_{17} = 1000pf

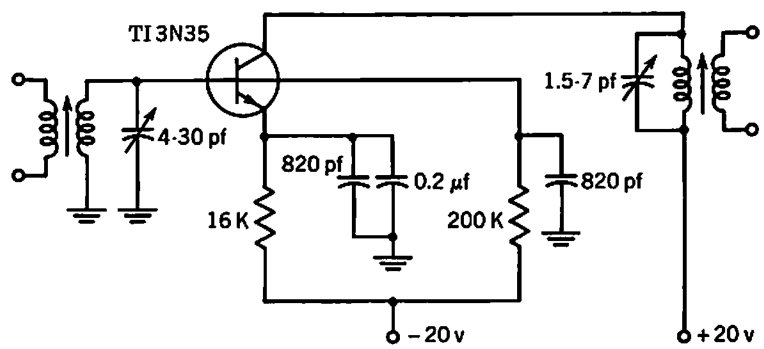
105-MC I-F WITH 2N2966—Proper loading gives good stability while providing 38 db power gain in two stages, with bandwidth of 8 Mc and noise figure of 2.5 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 314.



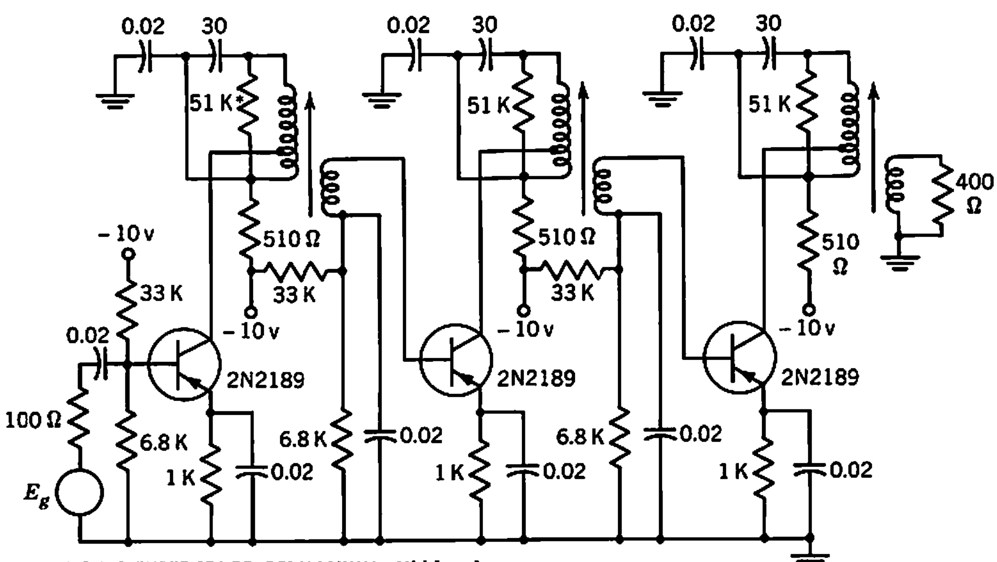
5.5-MC I-F—Three germanium transistors give power gain of 62 db with noise figure of only 4 db for bandwidth of 0.18 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 307.



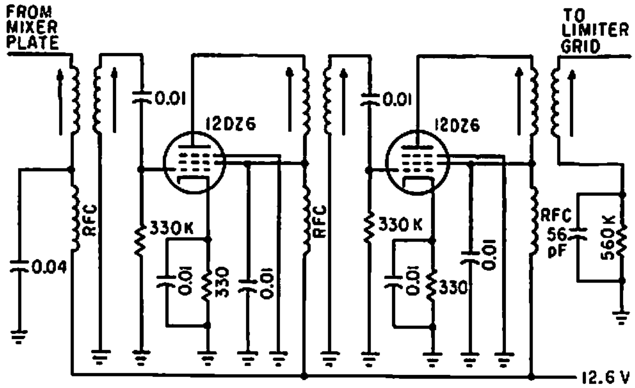
CERAMIC-FILTER I-F STAGE—Article covers design procedure using transistor signal handling curves. Collector resistance is used to minimize drift.—W. Rheinfelder, Using Transistor Signal Handling Curves in Receiver Design, *EEE*, 14:6, p 62–66.



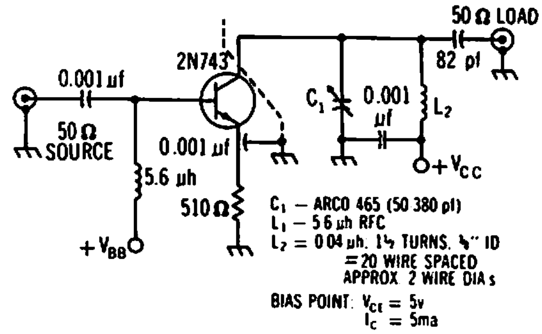
60-MC SILICON TETRODE STAGE—Used in eight-stage strip having identical stages except for input and output, whose transformers are designed for driving and load resistances. Transitionally coupled double-tuned interstages are used, with 5:1 mismatch providing stability and ease of alignment along with stage gain of 12.5 db.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 292.



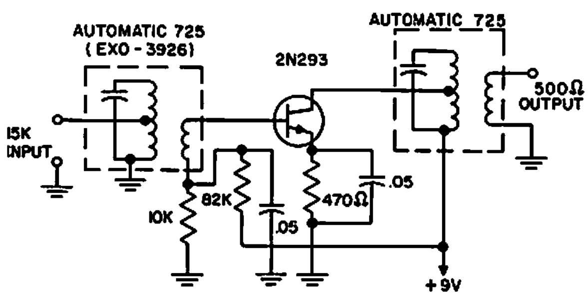
5.5-MC THREE-STAGE GERMANIUM—Mid-band gain is 60 db and 3-db bandwidth is 200 kc. Interstage networks consist of single-tuned transformers with collectors tapped down on primary.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 294.



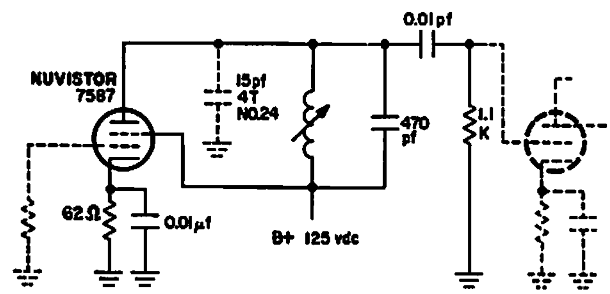
MOBILE I-F—Two 455-kc i-f stages provide gain of 20 per stage and average bandwidth of 12 kc.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



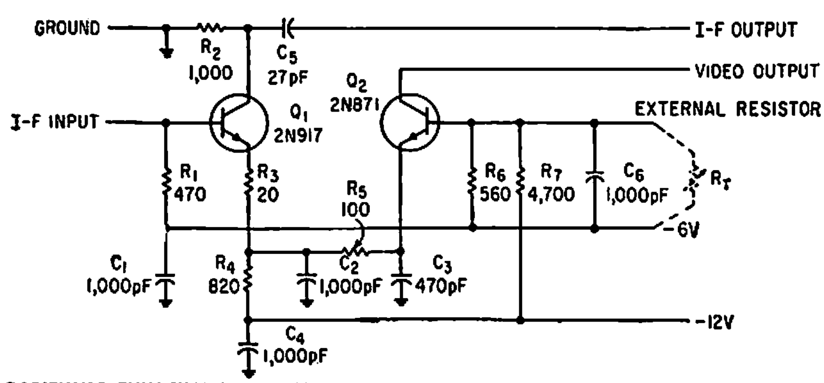
60-MC I-F WITH 2N743—Silicon epitaxial transistor has unconditional stability at this frequency, simplifying alignment. Gains up to 16 db per stage are possible with conjugate match at output. Noise figure is good. —Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 311.



SINGLE-TRANSISTOR I-F AMPLIFIER—Designed for broadcast-band transistor radio. Neutralization is unnecessary with 2N293 rate-grown npn transistor used.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 285.

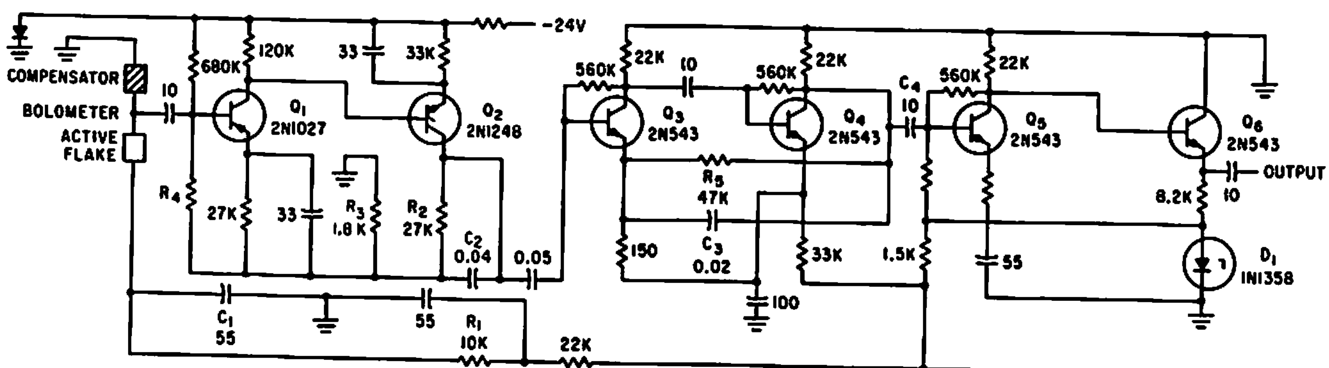


LOW-Q 22-MC I-F DESIGN—Article gives detailed design procedure, with example worked out for 480-kc bandwidth and gain of 92 db. For high-Q stage, 1.1K load resistor is changed to 12K.—J. F. Klarl, A Systematic Approach For Designing IF Amplifiers, *EEE*, 12:3, p 40–44.

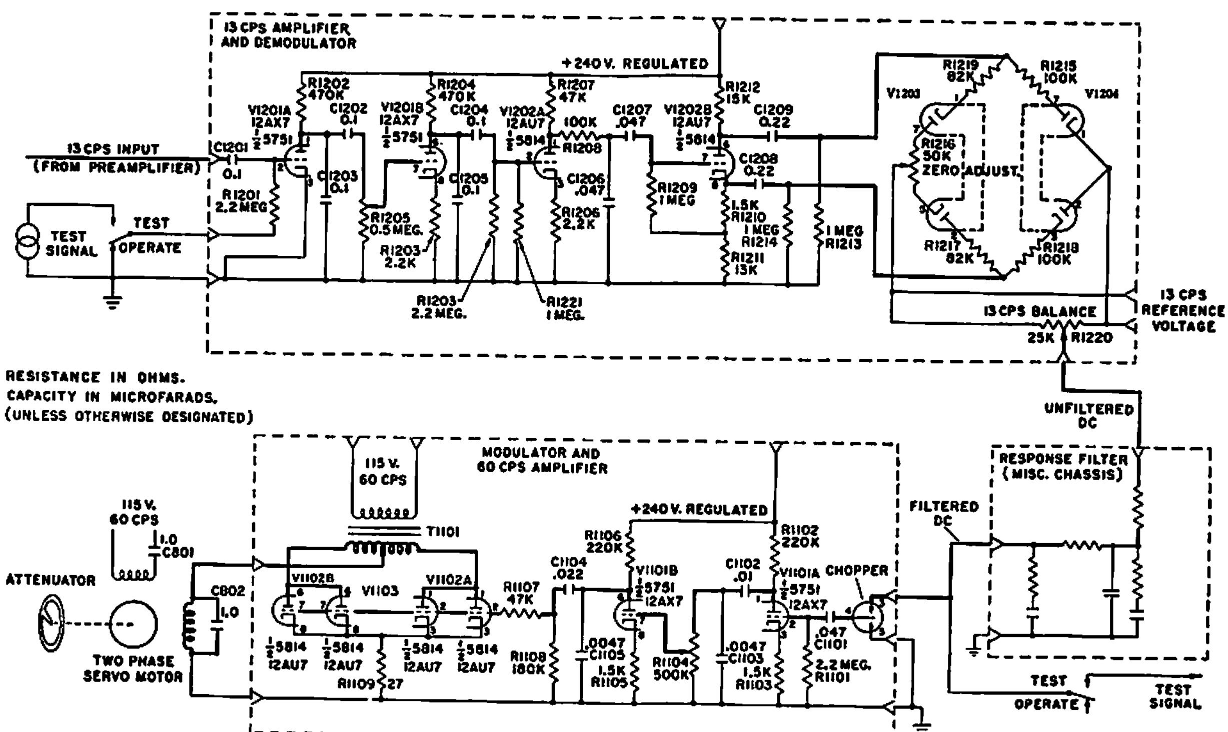


LOGARITHMIC THIN-FILM I-F AMPLIFIER—Untuned stages eliminate need for inductors in 60-Mc log i-f module while giving gain of 10 db.—R. Leslie and T. Townsend, Inductors No Problem: Now Thin-Film Amplifier, *Electronics*, 36:23, p 46–49.

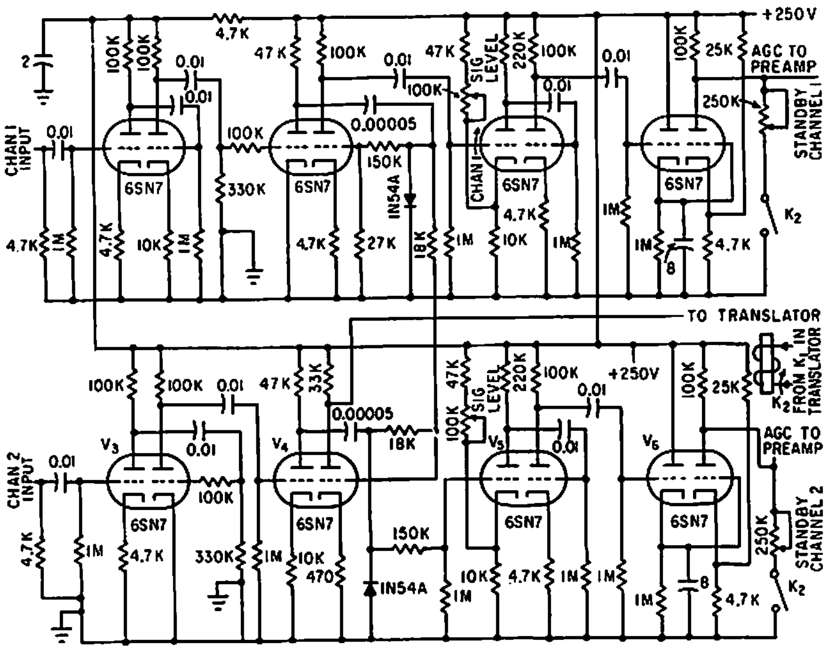
CHAPTER 41
Infrared Circuits



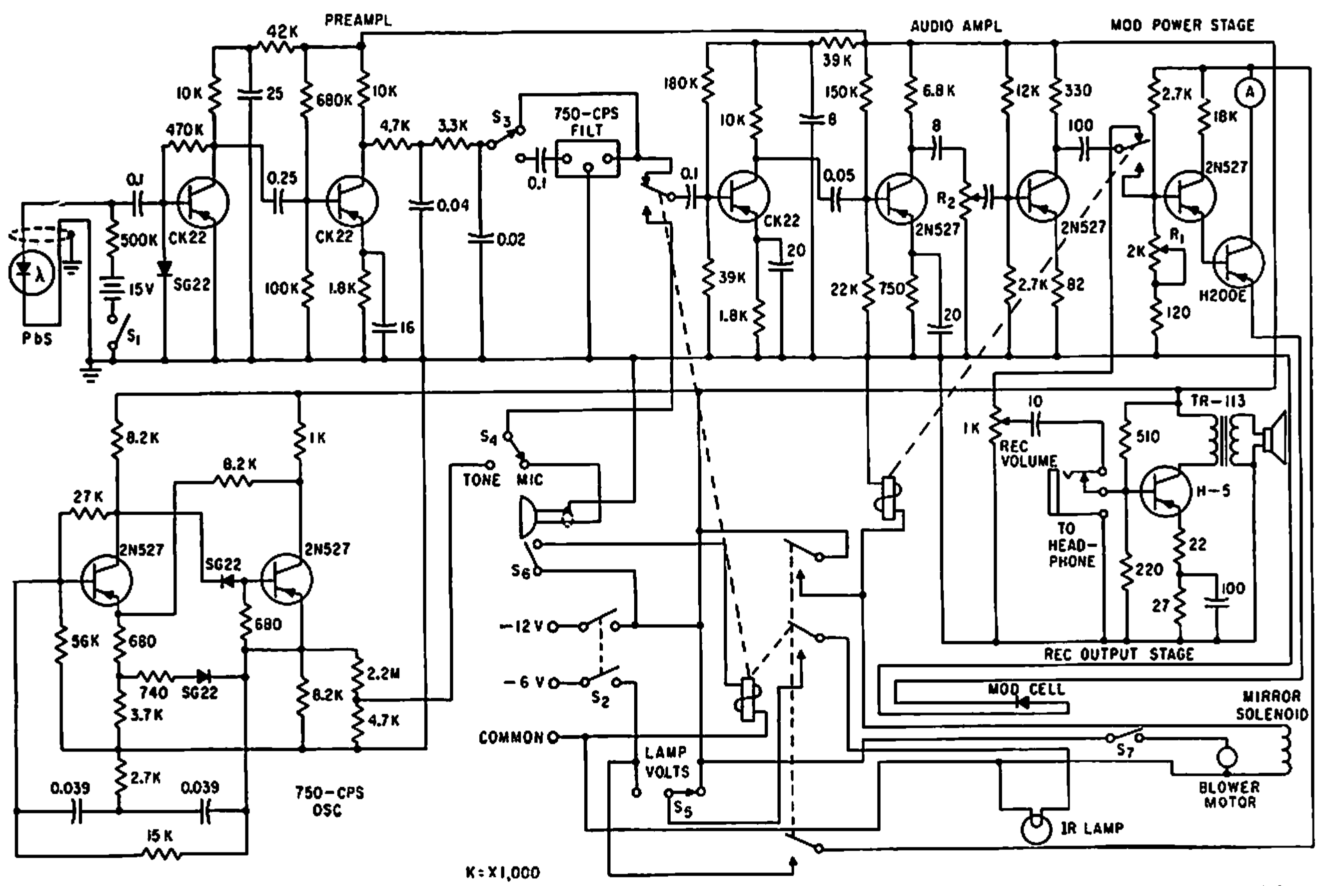
BOLOMETER AMPLIFIER AND DETECTOR—Used in infrared horizon sensor of meteorological satellite. Zener diode D1 provides low-impedance constant-voltage source of bias for detector.—F. Schwarz and W. Chou, Tiros Weather Satellites, *Electronics*, 34:39, p 136-137.



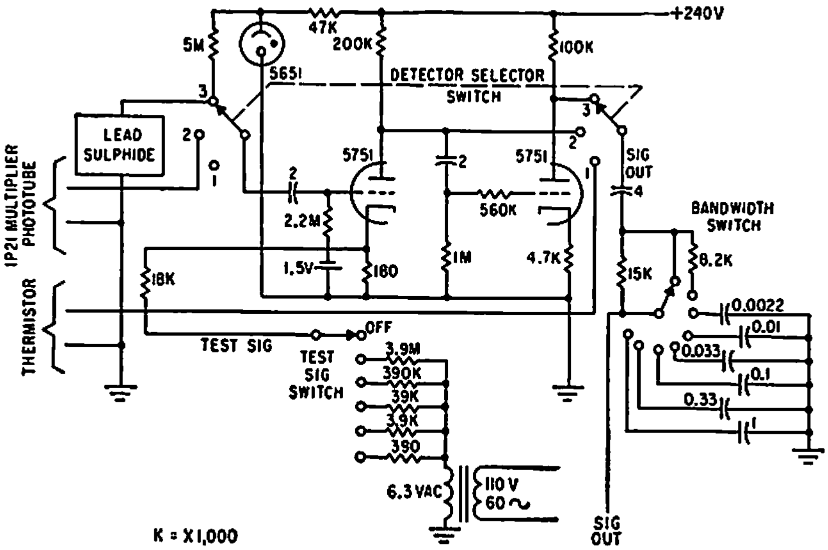
INFRARED ANALYZER—Circuit shows phase-sensitive demodulator, 13-cps amplifier, and modulator of servo system used in Perkin-Elmer Tri-Non triple-beam analyzer for measuring amount of infrared energy absorbed by component of interest in flowing sample of industrial process stream. Servo motor turns variable null-path attenuator to cancel radiation unbalance and restore null.—G. C. Carroll, Industrial Instrument Servicing Handbook, McGraw-Hill, N.Y., 1960, p 8-51.



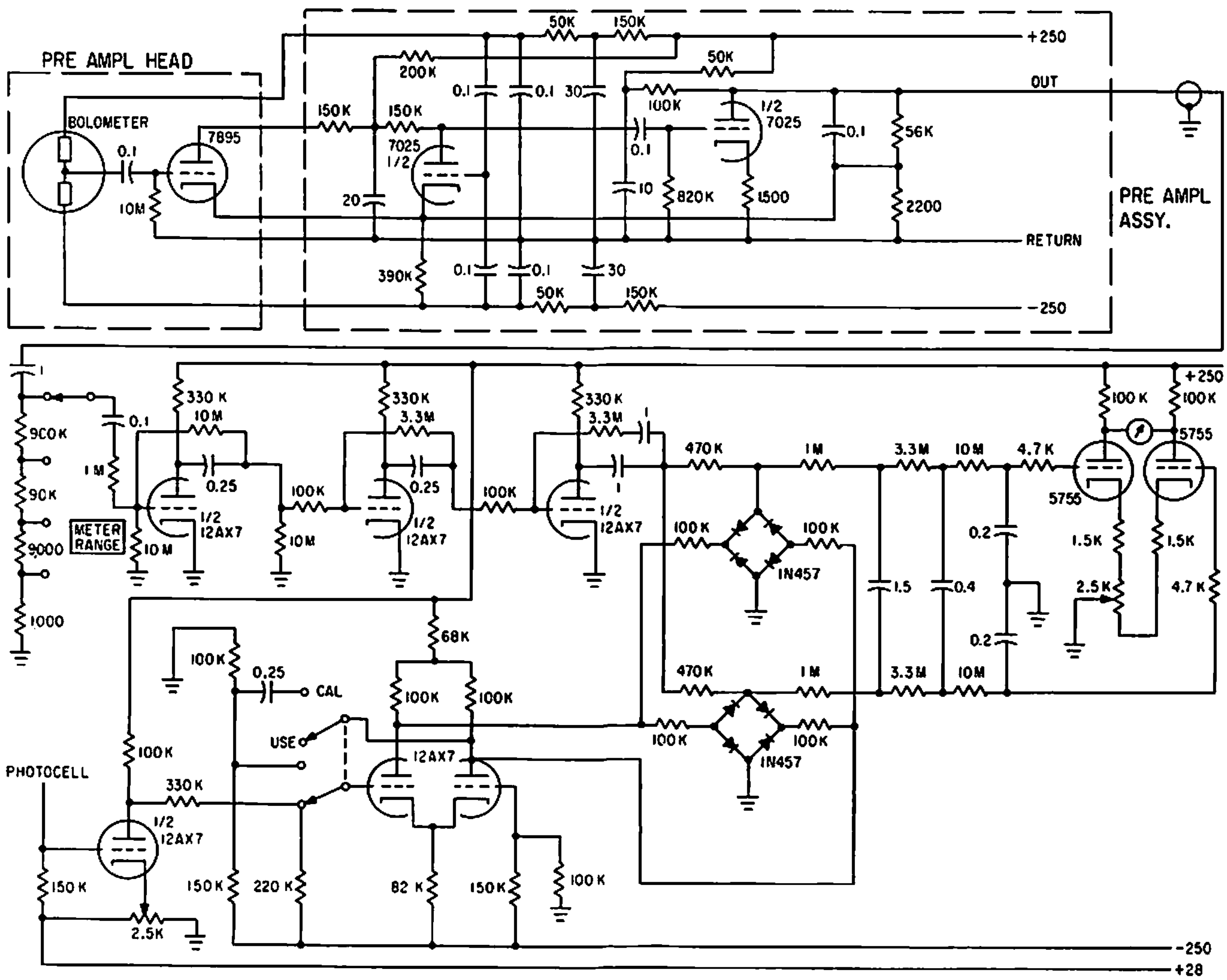
IR WIDTH GAGE AMPLIFIER—Amplifies signals from two amplifiers, and combines them at second triode of V4 for translator. Signal here consists of positive-going pulse from channel 1 and negative-going pulse from channel 2, with distance between pulses indicating strip width.—F. J. Danks, Infrared Gage Measures Hot Steel Strip Width, *Electronics*, 33:43, p 65–67.



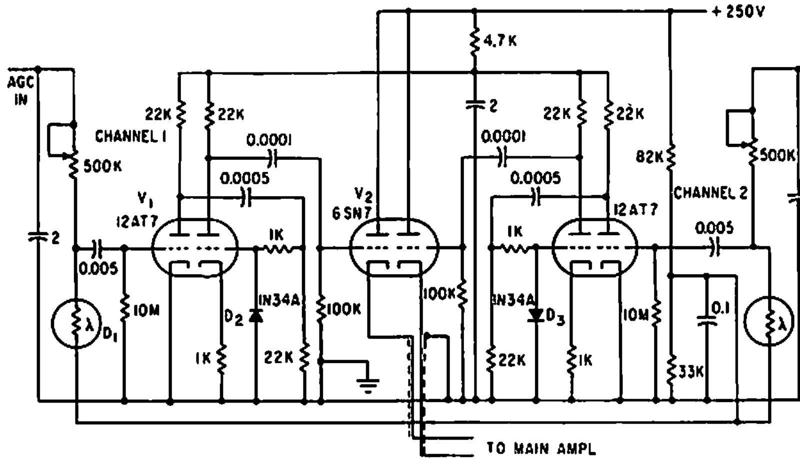
INFRARED COMMUNICATIONS TRANSCEIVER—When push-to talk switch S6 is closed, amplified microphone signal modulates infrared output of tungsten lamp. Lens gives 1° beam. When switch is released, lead sulfide cell picks up radiation from another transceiver, for driving speaker or phones through audio preamp and audio amp.—P W. Kruse and L. D. McGlauchlin, Solid-State Modulators for Infrared Communications, *Electronics*, 34:10, p 177–181.



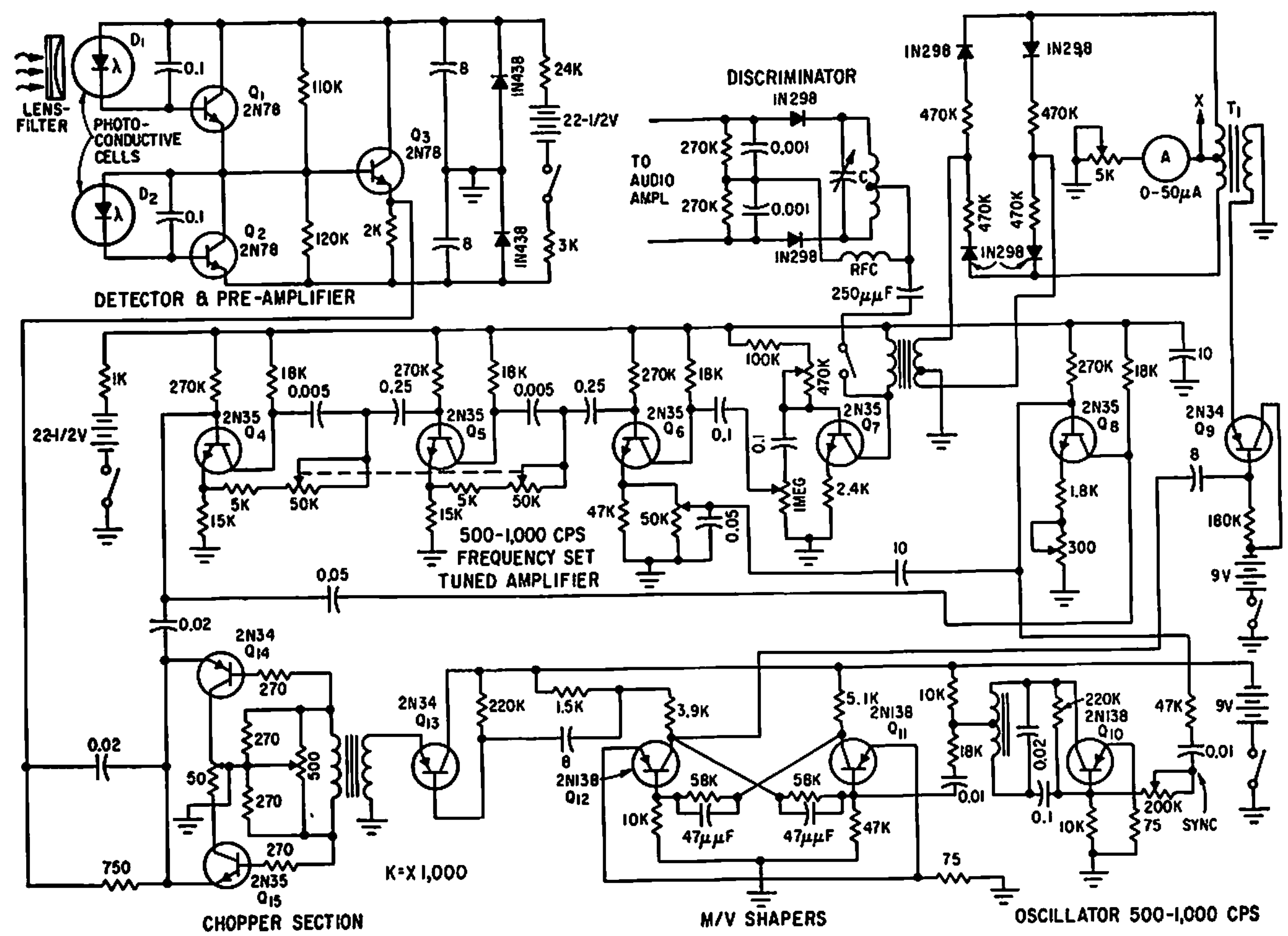
MONOCHROMATOR PREAMP—Used in scanning missile plumes to identify missile. Input may be either multiplier phototube or lead sulfide detector covering range from 0.35 micron in visible spectrum to 2.9 microns in infrared. Bias for lead sulfide detector is provided by 5651 regulator across plate supply. Test voltage is fed to cathode of first stage for gain calibration.—J. N. Day, Jr., Spectrometric Analysis of Missile Flights, *Electronics*, 33:21, p 86–88.



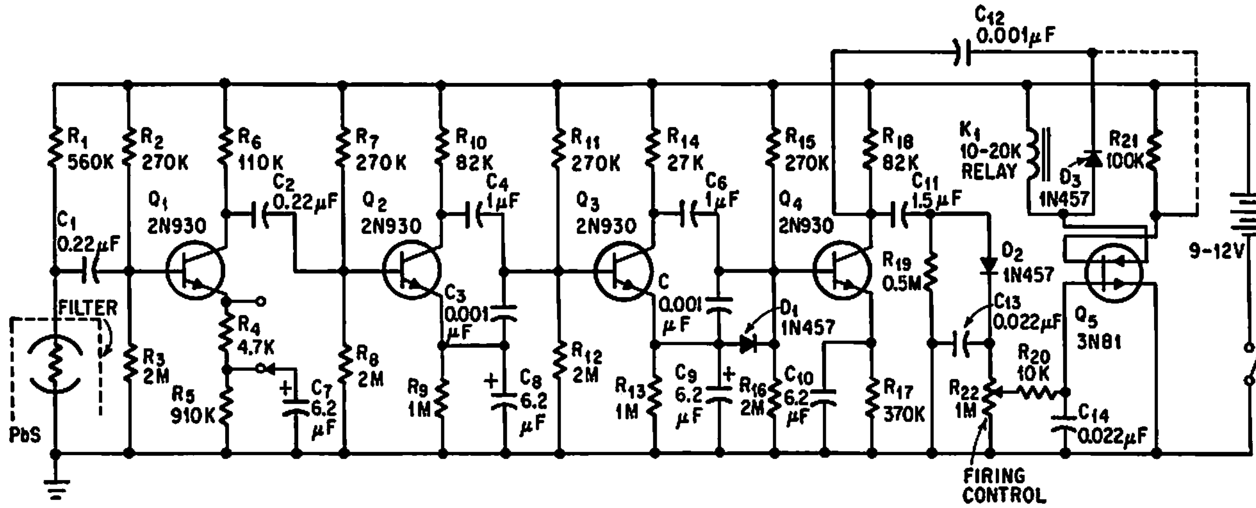
INFRARED POWER MONITOR—Output of infrared signal generator is monitored by two-thermistor bolometer, low-noise nuvistor preamp, and synchronous detector driving multirange meter, all operating from two highly regulated power supplies.—A. Glaser, Signal Generator for Infrared Region, *Electronics*, 35:8, p 40–43.



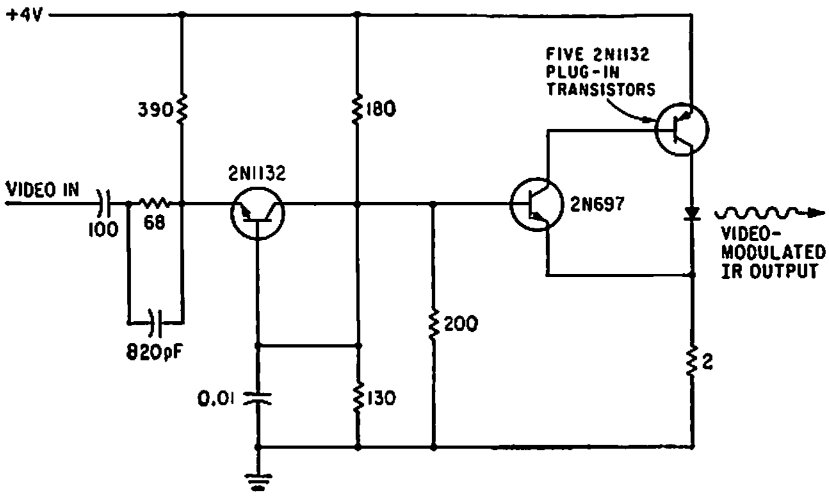
IR WIDTH GAGE PREAMP—Resistance of photocell D1 drops when hot steel strip passes, producing negative-going pulse that is amplified, differentiated, clipped, and differentiated again by D1. Signal through channel 2 is similar except that first pulse is unwanted. Second pulse, representing strip edge, is selected by reversed polarity of D3. Both signals are fed into cathode followers D2 to provide low-impedance drives for shielded cable to main amplifier.—F. J. Danks, Infrared Gage Measures Hot Steel Strip Width, *Electronics*, 33:43, p 65–67.



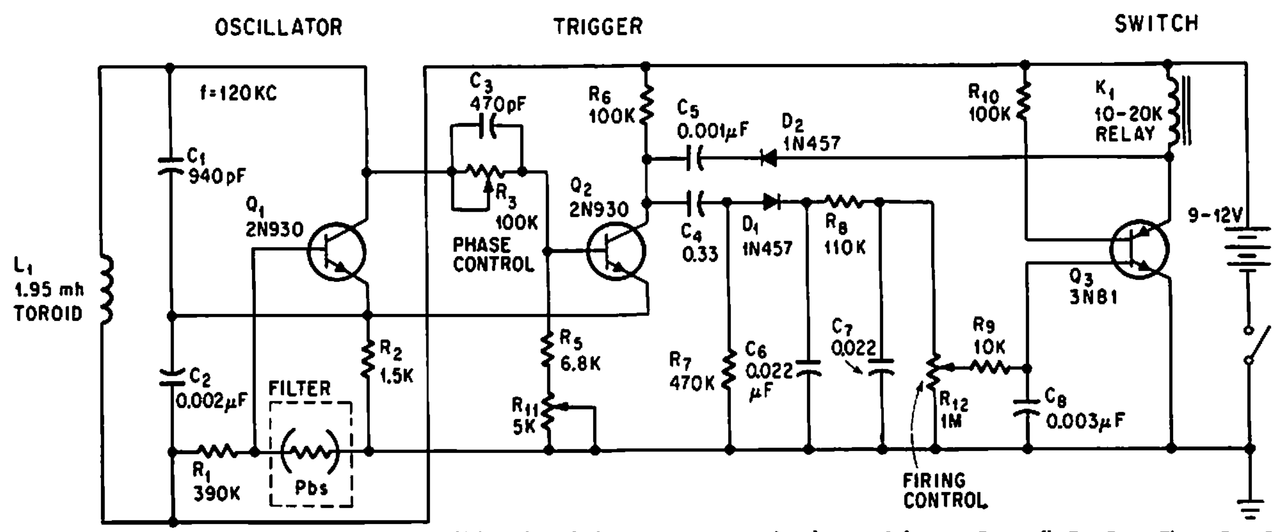
ALL-TRANSISTOR INFRARED RECEIVER—Addition of four-diode bridge and associated circuits converts communications receiver to radiation-measuring device. Normal modulation is taken from conventional diode discriminator. Applications include communication with space vehicles. Range in space is unlimited.—W. E. Osborne, Infrared Communications Receiver for Space Vehicles, *Electronics*, 32:38, p 38–39.



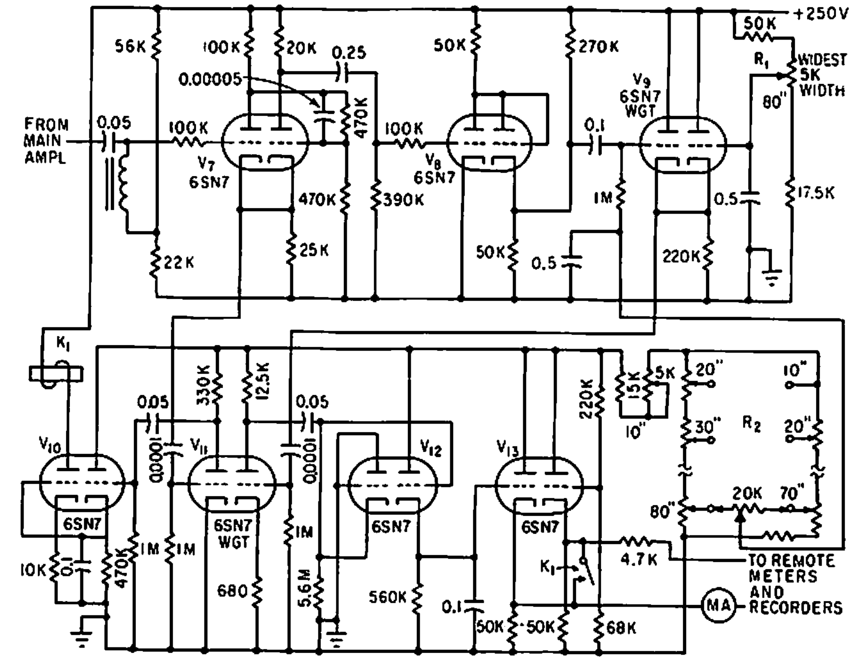
INFRARED HOT-ENGINE DETECTOR—Output relay resets parking meter to zero when lead sulfide detector senses heat of engine when parked car is started.—W. E. Osborne, Farewell To Free Time On City Parking Meters, *Electronics*, 37:32, p 72–74.



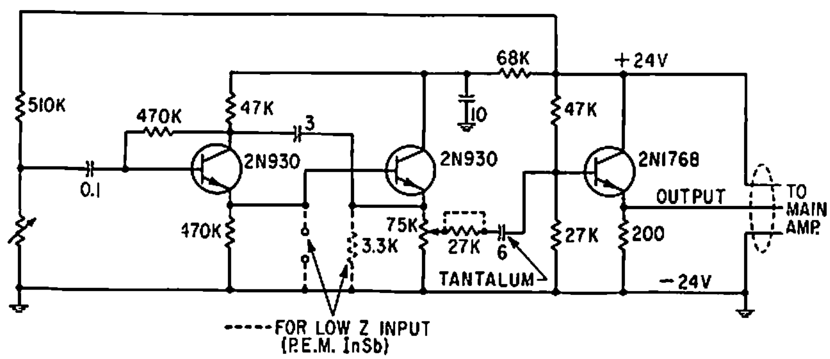
TV ON INFRARED BEAM—Forward-biased gallium arsenide diode converts video input signal to video-modulated infrared radiation with up to 85% efficiency.—R. H. Rediker et al., Gallium-Arsenide Diode Sends Television by Infrared Beam, *Electronics*, 35:40, p 44–45.



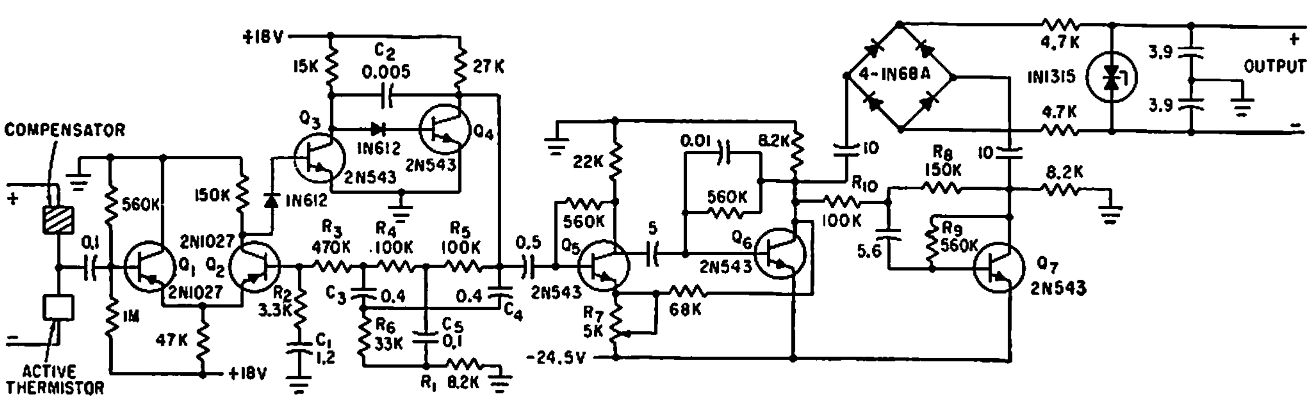
INFRARED HOT-ENGINE DETECTOR—Hot-engine alarm using only two transistors and an scr resets parking meter to zero when lead sulfide infrared detector senses engine heat as parked car starts. Circuit combines Colpitts oscillator with Schmitt trigger.—W. E. Osborne, Farewell To Free Time On City Parking Meters, *Electronics*, 37:32, p 72–74.



IR WIDTH GAGE TRANSLATOR—Combined signal output from main amplifier of infrared gage triggers bistable mvbr V7, output of which is rectangular pulse whose width is proportional to steel strip width. Pulse is clamped and amplified by V8 and passed to comparator V9, which provides output proportional in amplitude to width of input pulse.—F. J. Danks, Infrared Gage Measures Hot Steel Strip Width, *Electronics*, 33:43, p 65–67.

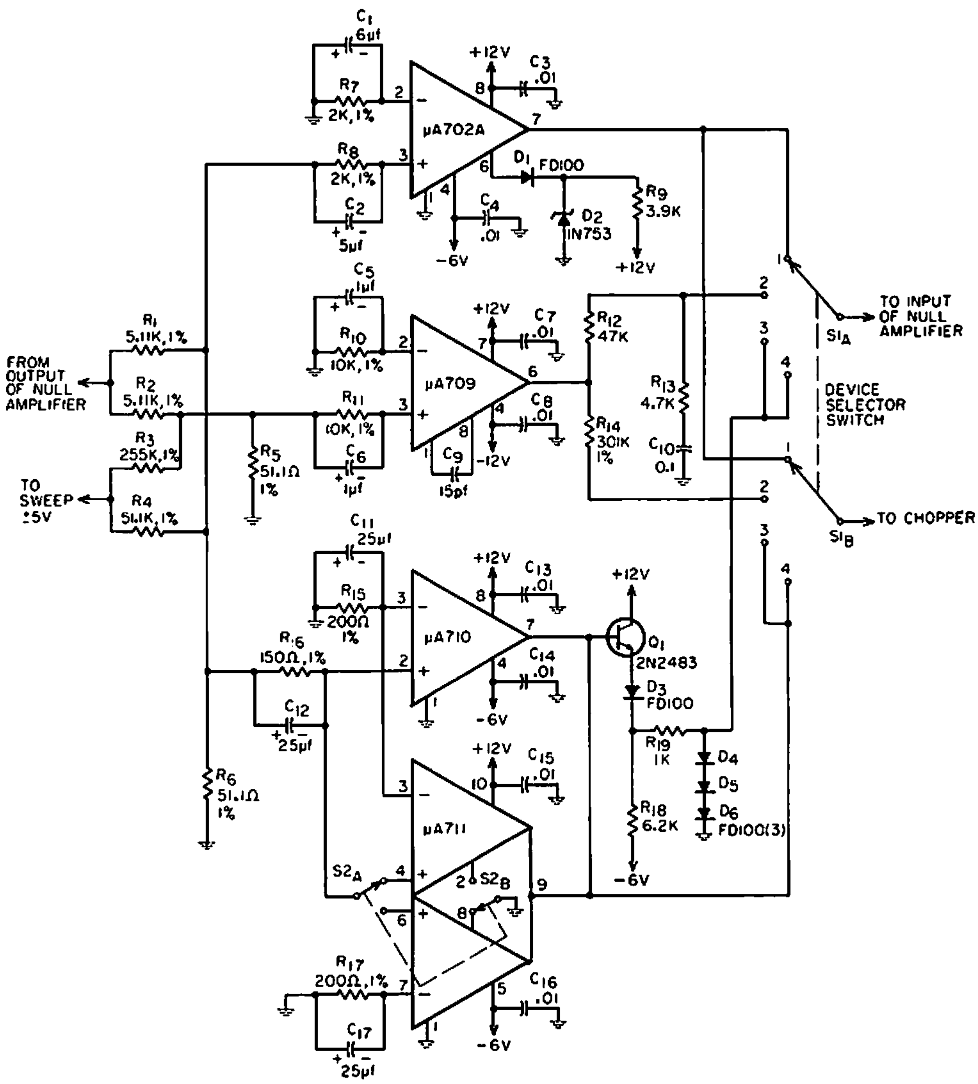


PREAMP FOR INFRARED MINE DETECTOR—Lead telluride cell cooled with dry ice, with infrared input chopped at 200 cps by fan motor, feeds three-transistor preamp that provides output at 200 ohms to remote R-C tuned main 200-cps amplifier.—W. E. Osborne, Infrared Mine Detector a Reality, *Electronics*, 36:31, p 54–58.

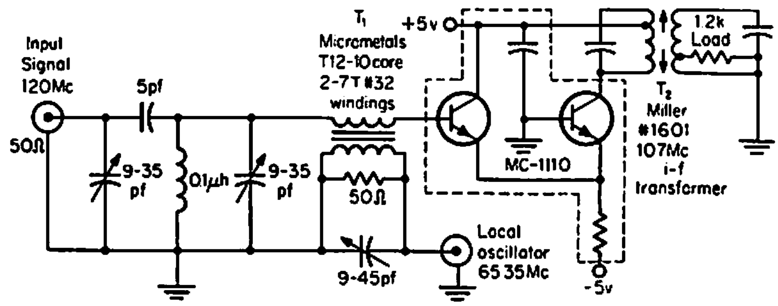


46-CPS AMPLIFIER WITH 8-CPS BANDPASS—Uses differential input amplifier Q1-Q2 as part of four-stage direct-coupled front end of optically chopped radiometer. Parallel-T filter provides desired frequency characteristic and d-c path for negative feedback around direct-coupled amplifier.—F. Schwarz, Infrared Circuits in Tiros Satellites, *Electronics*, 34:38, p 43–45.

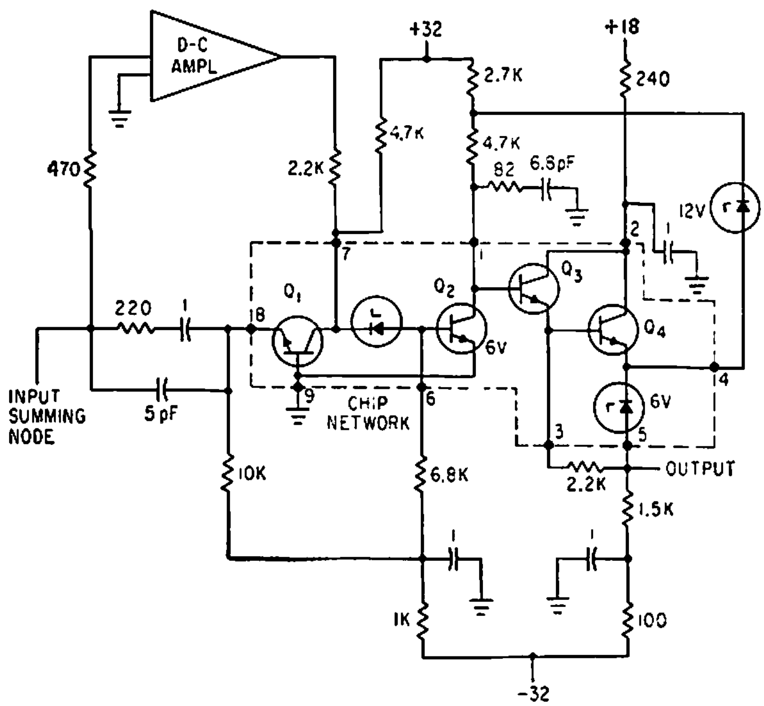
CHAPTER 42
Integrated Circuits



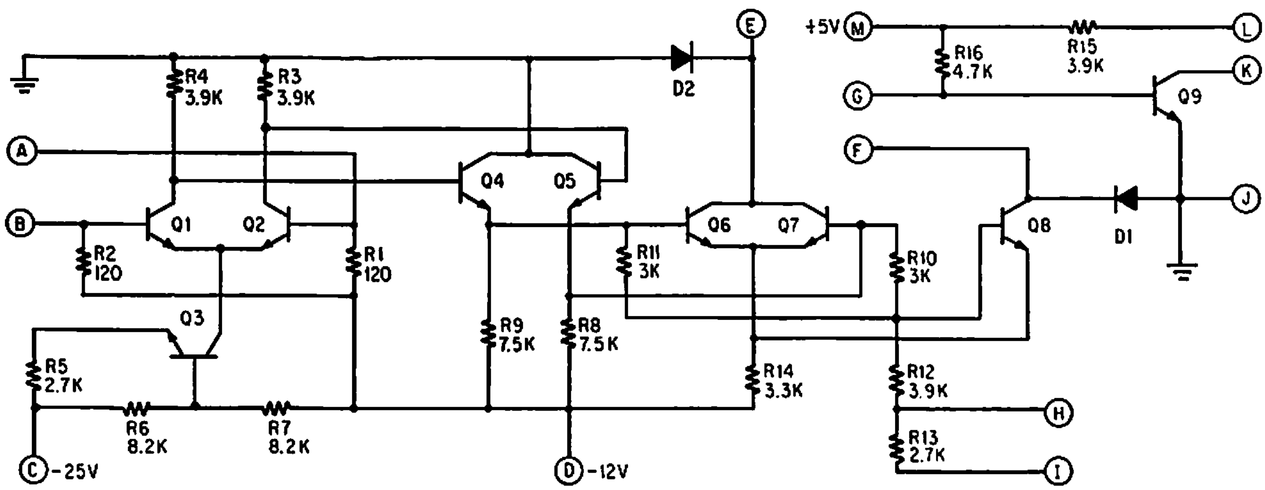
LINEAR IC TESTER—Basic lab tester circuit displays transfer function, offset voltage, gain, linearity, and output voltage swing on single scope trace. High-gain null operational amplifier (such as Fairchild 709 IC) is used in feedback loop around linear integrated-circuit amplifier under test, to hold output of amplifier under test at zero by adjusting its d-c input voltage to equal the offset. Chopper on vertical scope inputs allows simultaneous display of offset voltage and transfer function, by switching in synchronism with horizontal sweep. Separate TO-5 socket is provided for each type of integrated circuit to be tested.—J. N. Giles, How to Measure Linear-IC Performance, *EEE*, 14:8, p 62–68 and 161.



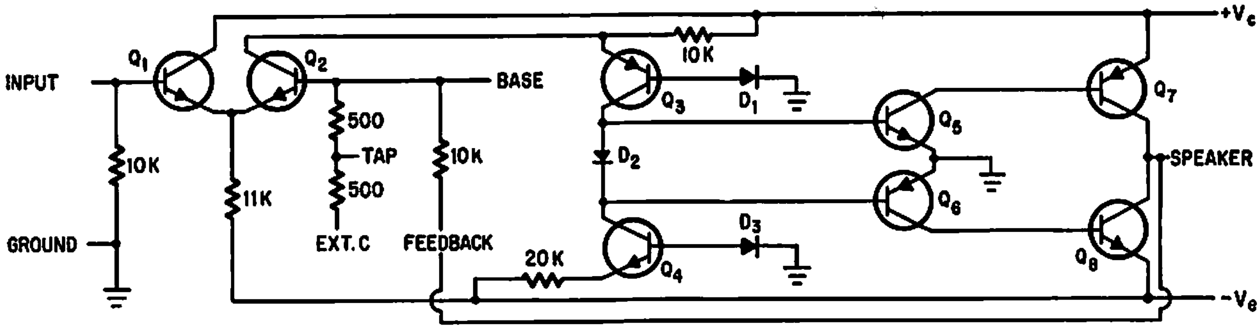
HARMONIC MIXER—Two-transistor integrated circuit is used in nonlinear mode for converting 120 Mc to 10.7 Mc with conversion of 29.4 db, noise figure of 11 db, and sensitivity of −105 dbm. Bandwidth, including i-f stages that follow mixer, is about 500 kc.—J. E. Thompson, "An Integrated Harmonic Mixer," Motorola Application Note AN-154, December, 1965.



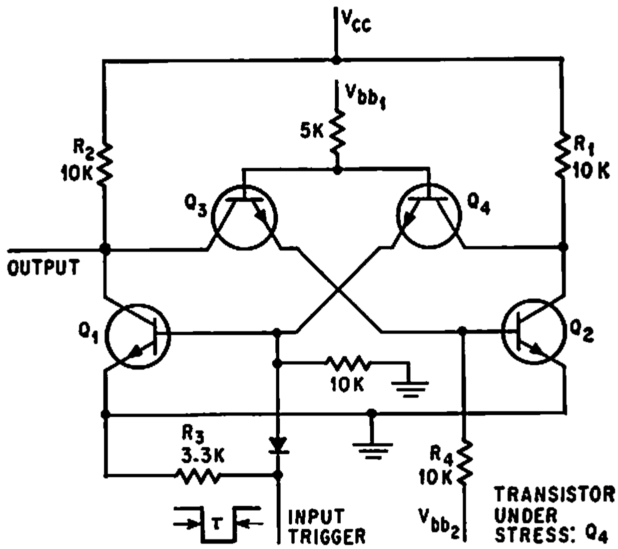
WIDEBAND ANALOG AMPLIFIER—D-C input summing mode signals are amplified in low-drift d-c amplifier and reinserted into amplifier signal path at input to common-emitter stage. Response of d-c amplifier in parallel with common-base stage is complementary to high-frequency amplifier Q2-Q3-Q4, maintaining unit slope down to 1 kc, where gain is 100 db. Loop delay is less than 0.1 nsec. —F. D. Waldhauer, Latest Approach to Integrated Amplifier Design, *Electronics*, 36:22, p 24–27.



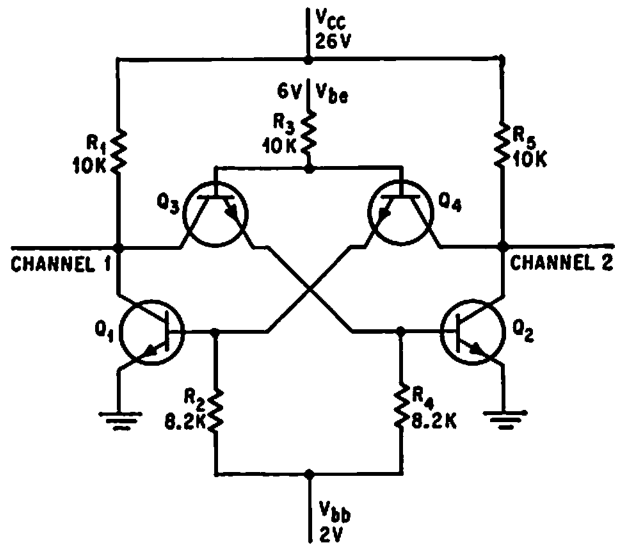
SENSE AMPLIFIER—General-purpose amplifier can be used with most coincident-current memories without redesign. Has adjustable threshold, good noise rejection, and drives any standard logic gate with positive or negative output. Bandwidth is 10 Mc. Drift is only 22 microvolts per °C. Circuit is differential amplifier whose inputs are connected to opposite ends of sense winding. Input accepts both polarities, but output is always same polarity. For negative output pulse, connect F to G; for positive output, connect E to G.—B. Johnson, Sense Amplifier Fits Any Memory, *Electronics*, 39:18, p 89–94.



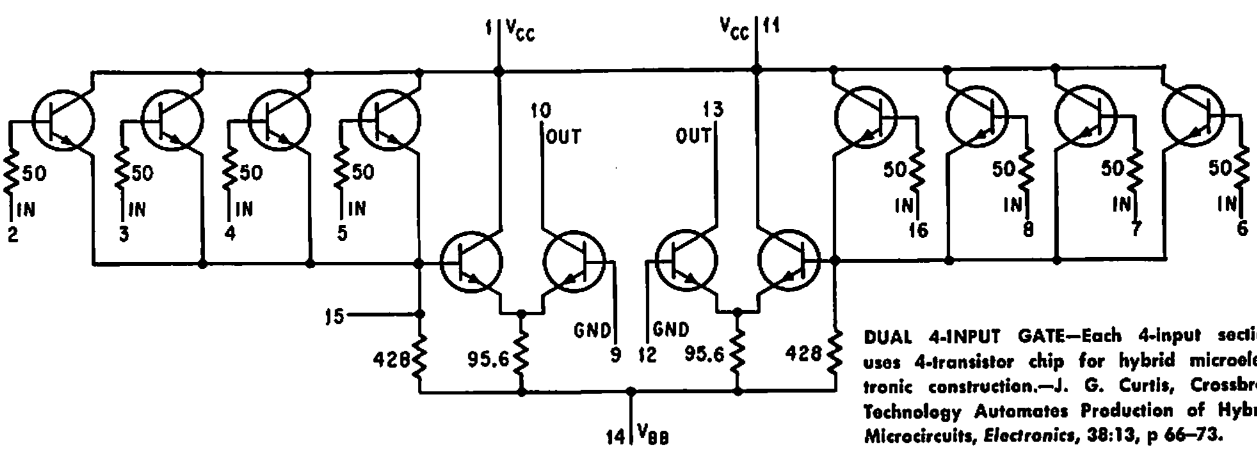
1-WATT AUDIO AMP—Negative d-c and a-c feedback is applied to one side of differential input stage and signal to other side. With balanced power supplies, d-c output is at ground, permitting direct drive of speaker without large d-c decoupling capacitor in MC1524 integrated circuit.—R. Hirschfeld, IC's Improve Differential Amplifiers—and Vice Versa, *Electronics*, 38:16, p 75–79.



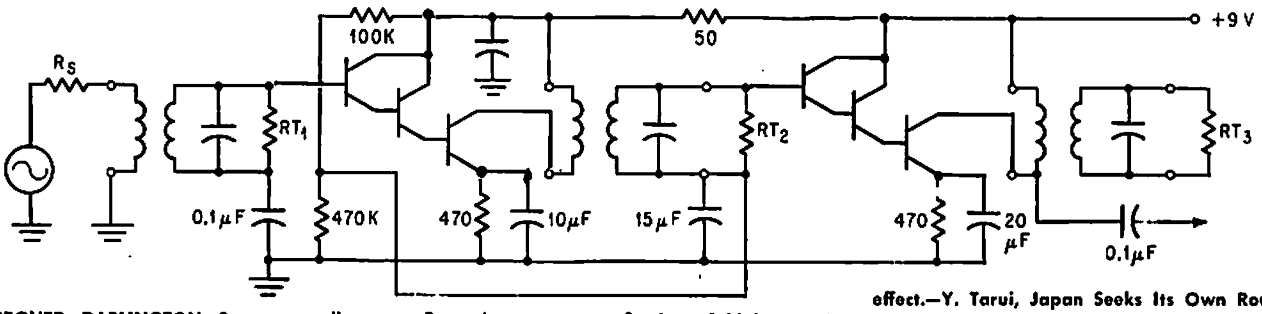
MONOSTABLE MVBR—Pulse width of stress-sensitive RC103 integrated circuit is reduced from 1.5 to 1.0 microsec when 7 grams of force is applied to one transistor.—R. C. Wonson, Stress-Sensitive Integrated Circuits, *Electronics*, 38:14, p 81–84.



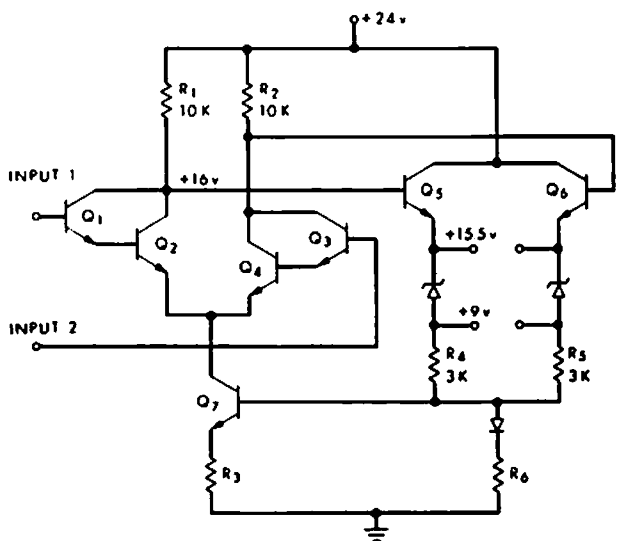
ASTABLE MVBR—Stress-sensitive RC103 integrated circuit shifts free-running frequency from 500 kc to 1 Mc when 7 grams of force is applied to one transistor.—R. C. Wonson, Stress-Sensitive Integrated Circuits, *Electronics*, 38:14, p 81–84.



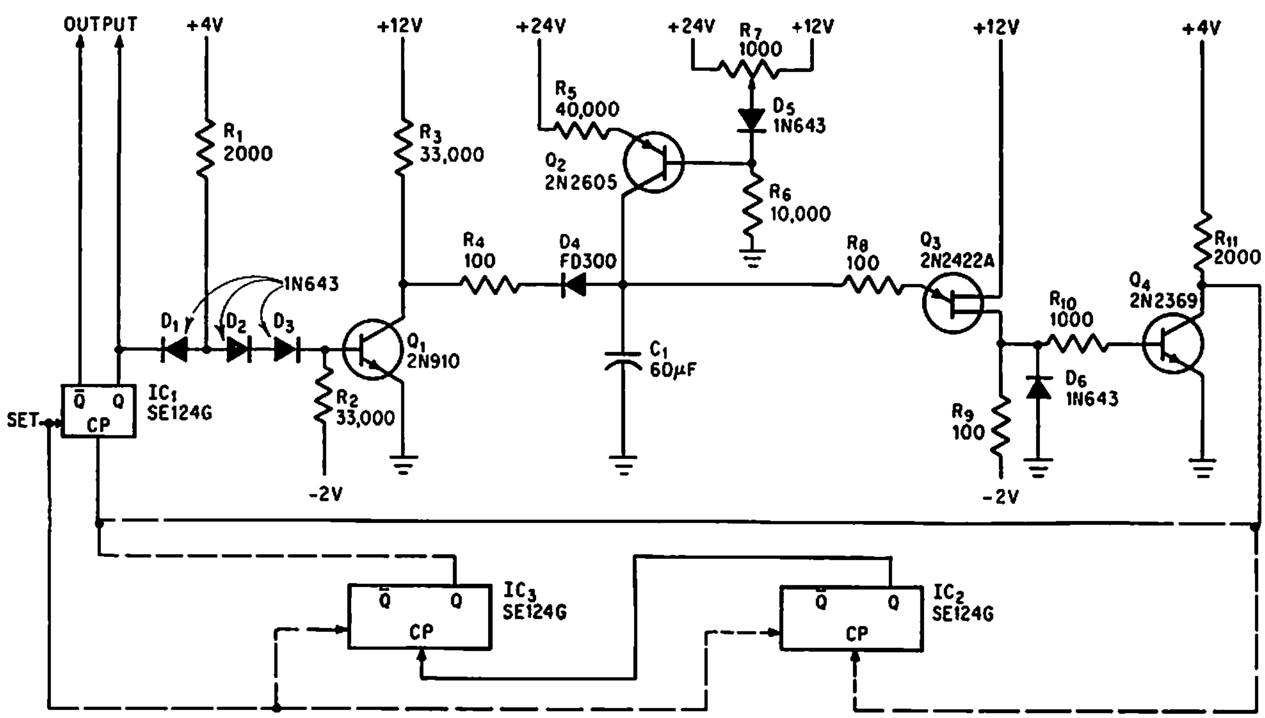
DUAL 4-INPUT GATE—Each 4-input section uses 4-transistor chip for hybrid microelectronic construction.—J. G. Curtis, Crossbred Technology Automates Production of Hybrid Microcircuits, *Electronics*, 38:13, p 66–73.



IMPROVED DARLINGTON—Separate collector circuit for third transistor of Darlington configuration prevents reflection of high capacitance back to input, thereby dissipating Miller effect.—Y. Tarui, Japan Seeks Its Own Route to Improved IC Techniques, *Electronics*, 38:25, p 90–98.

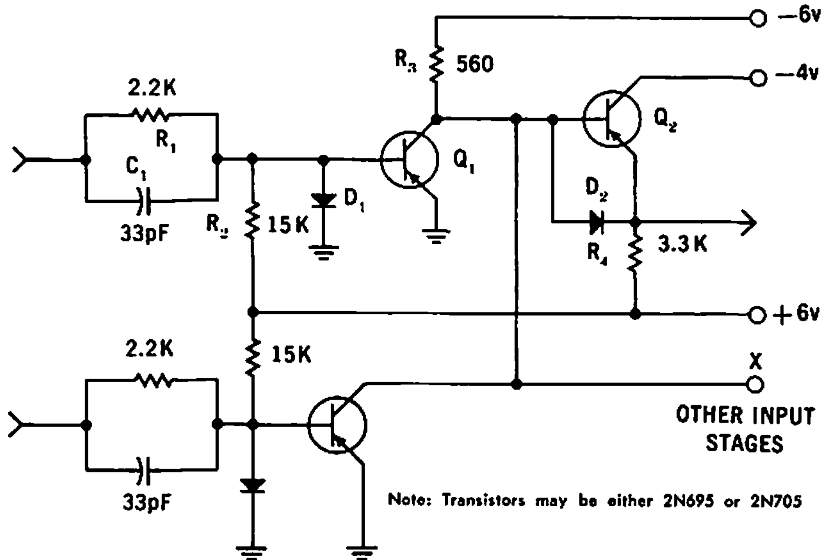


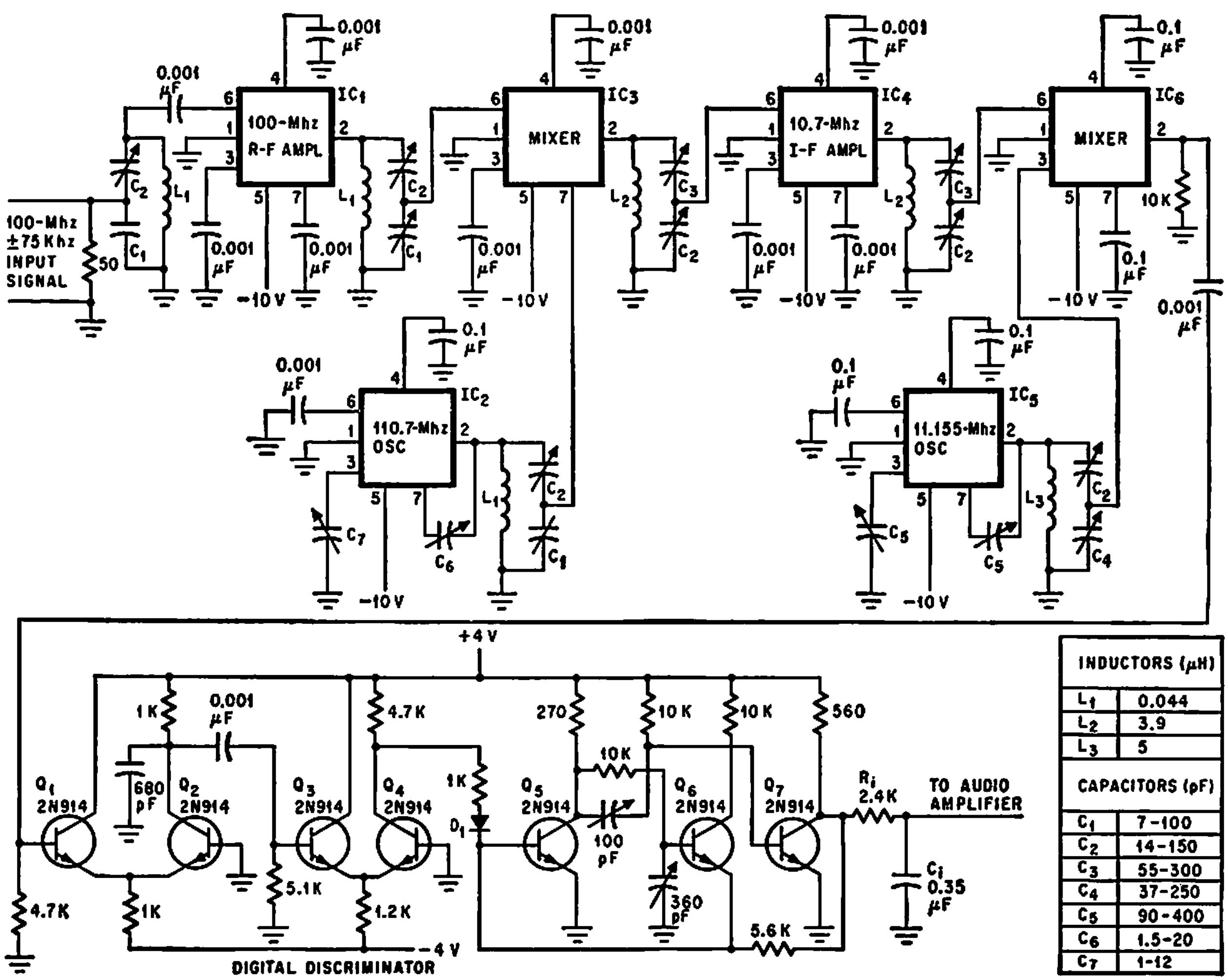
DARLINGTON-INPUT OPERATIONAL AMPLIFIER—Single-stage version uses emitter-follower output to lower impedance and shift d-c level of output. Q7 and R3 form constant-current source. Zeners, formed as base-emitter junctions of transistors, shift d-c level of outputs negative by 6 v to make them compatible with input voltages and permit cascading of monolithic integrated circuits directly.—C. L. Holzman and D. G. Paterson, Circuit Analysis: A Monolithic Integrated Operational Amplifier, *EEE*, 13:5, p 80–84.



2-SEC-TO-10-MIN TIMER—Number of monolithic diode-transistor logic circuits determines range of time delay provided by potentiometer R7. For shorter delays, one or both of integrated circuits connected with broken lines may be eliminated.—A. A. Lampell, Off-the-Shelf Integrated Circuits for Versatile and Accurate Timer, *Electronics*, 38:25, p 70–73.

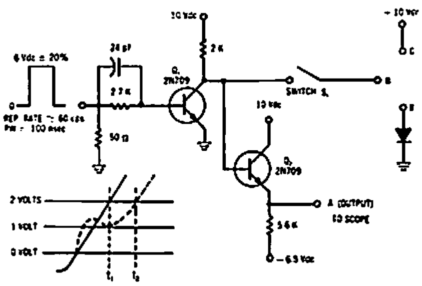
BASIC RCTL LOGIC—Transistors used provide ultrahigh switching speed for computers and have low stored charge along with gain-bandwidth product above 300 Mc. Circuit can readily be adapted as flip-flop, nor circuit, and Schmitt trigger.—W. D. Roehr, "For Computers . . . Basic RCTL Circuits," Motorola Application Note AN-129, Nov. 1965.



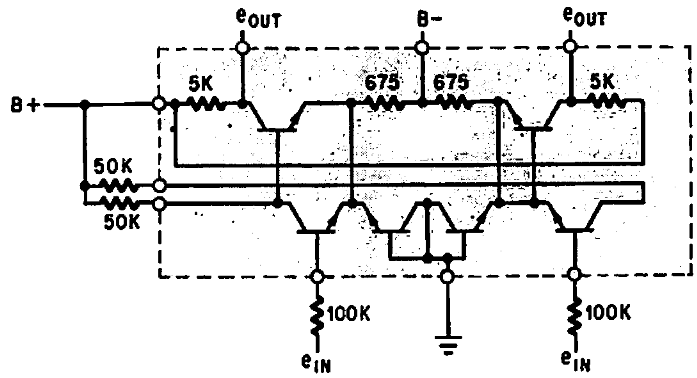


INDUCTORS (μH)	
L_1	0.044
L_2	3.9
L_3	5
CAPACITORS (pF)	
C_1	7-100
C_2	14-150
C_3	55-300
C_4	37-250
C_5	90-400
C_6	1.5-20
C_7	1-12

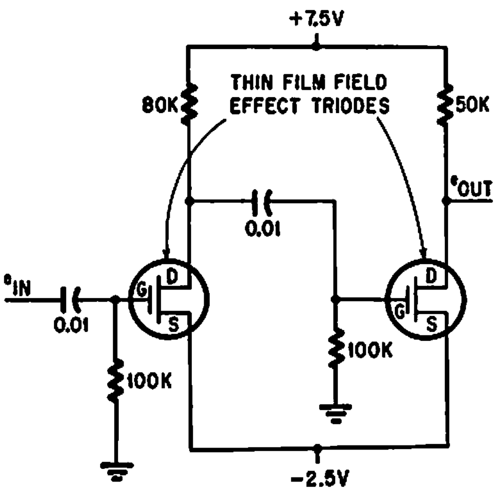
F-M RECEIVER—Multipurpose integrated-circuit chip consisting of six resistors and two identical transistors in cascode amplifier configuration serves three different functions in single-frequency 100-Mc f-m receiver. Although discrete components are used in digital discriminator, circuit requirements and component values here are compatible with monolithic techniques.—R. L. Sanquini, Multipurpose Chips Cut Costs of F-m Receiver, *Electronics*, 39:10, p 80–82.



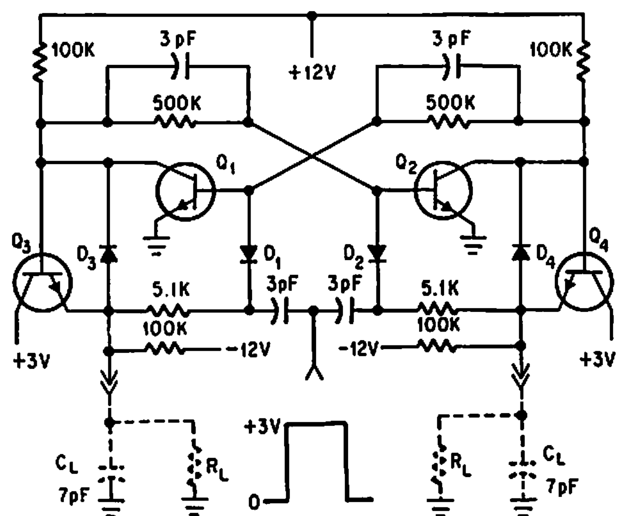
MEASURING SWITCHING TIME OF IC GATE—Used for *and* gates. To measure t1, S1 is opened, input pulse of Q1 is adjusted to give Q1 output fall time of 3 nsec/v slope for 2.5 v, and S1 is closed to measure t2.—Integrated Circuits, *EEE*, 12:3, p 78.



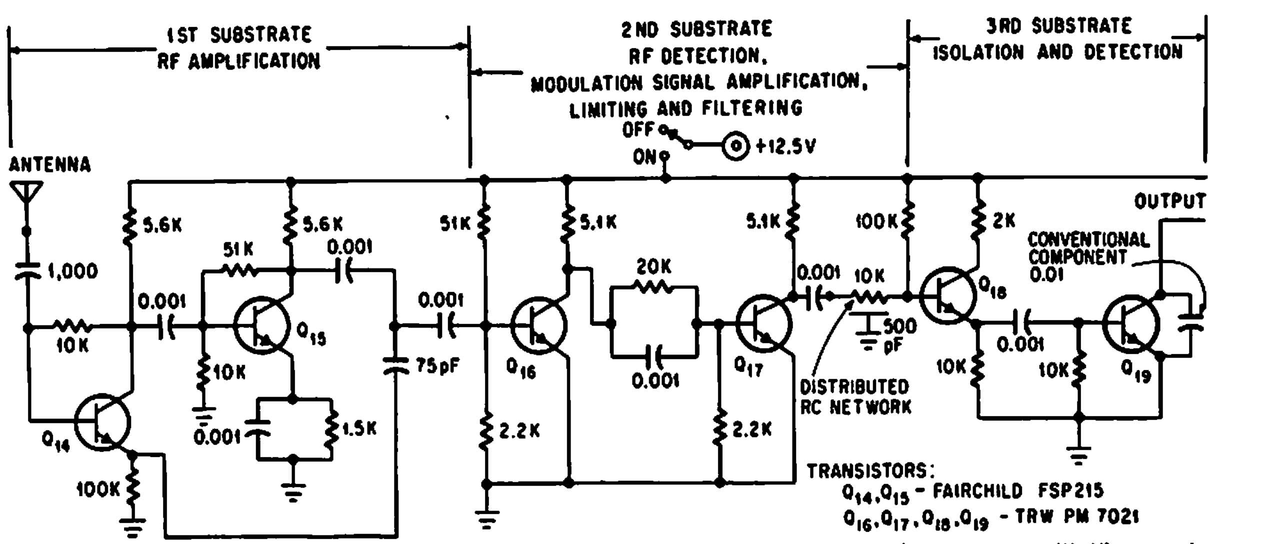
SCHMITT TRIGGER—Dual diode-coupled version for integrated construction uses eight resistors.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p 58–64.



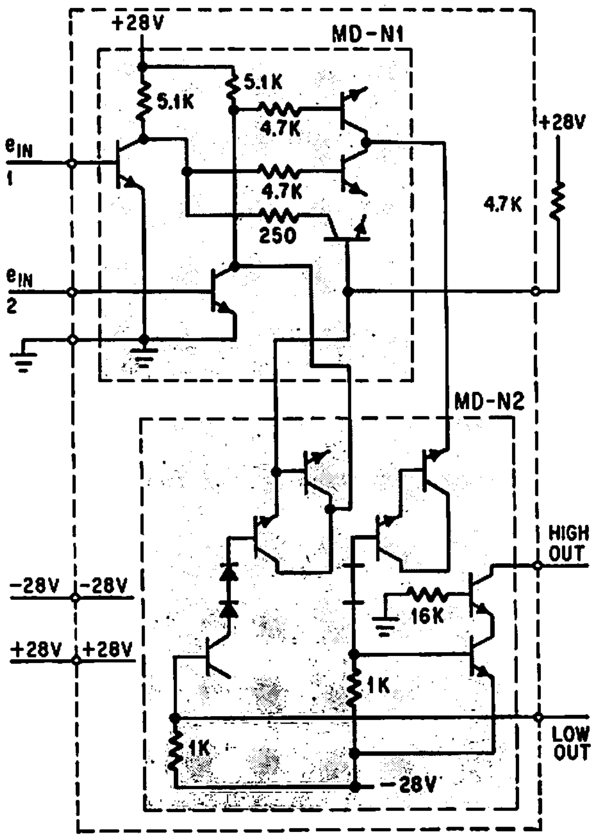
THIN-FILM AMPLIFIER—Pulse amplifier with evaporated connections uses two thin-film triodes, two silicon monoxide aluminum capacitors, and four chromium and rhenium resistors.—F. W. Schenkel, Thin-Film Capacitance Elements: Which Is Best For Your Purpose, *Electronics*, 38:2, p 67–72.



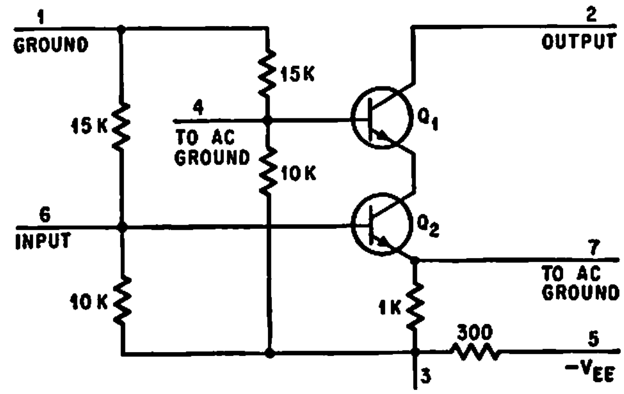
LOW-POWER FLIP-FLOP—2N3493 micropower transistors provide rapid switching with integrated construction. Power drain is only 6.6 mw.—R. W. McGinnis and W. D. Roehr, New Masking Techniques for Micropower Transistors, *Electronics*, 38:4, p 76–81.



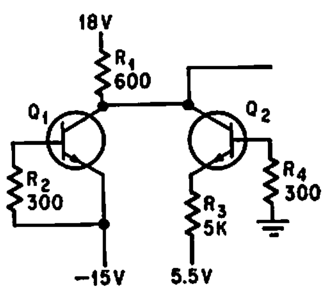
15-MC RECEIVER—Operates 150 hours on 9 mercury cells, for applying command signals directly to brain of monkey. Thin-film passive components on three substrates reduce weight to 7 ounces.—W. Libon, Monkeys and Microelectronics, *Electronics*, 38:4, p 90–93.



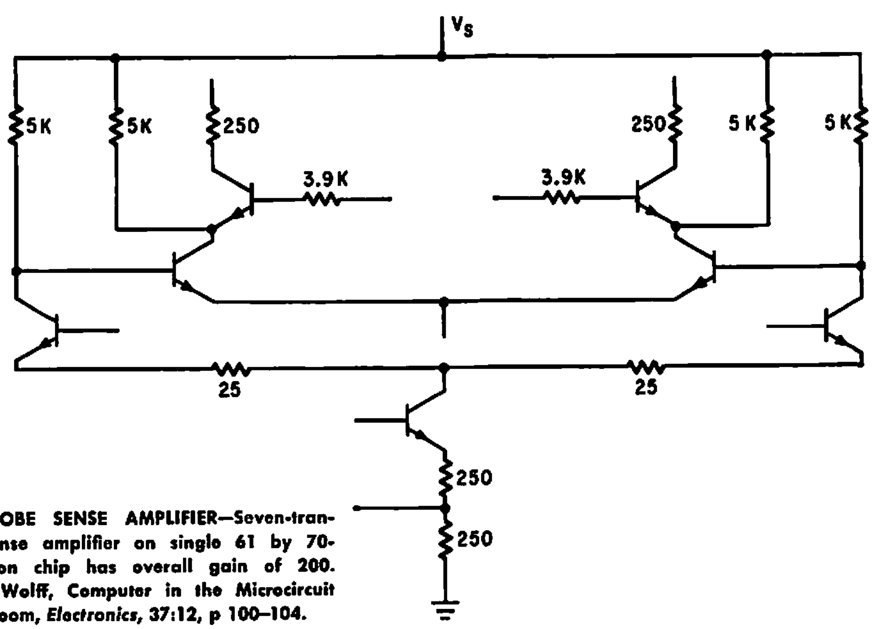
LOGIC AND BUFFER AMPLIFIER—Designed to be driven by dual Schmitt trigger.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p 58–64.



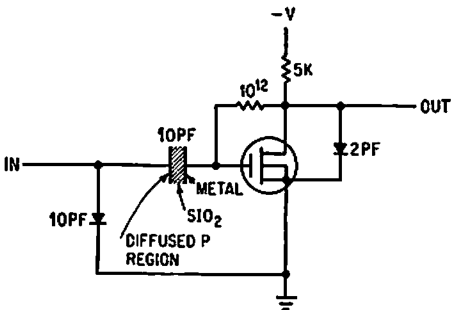
MULTIPURPOSE CHIP—Monolithic chip consisting of six resistors and two identical transistors serves three different functions in f-m receiver. Two transistors permit cascode amplifier configuration, giving low noise figure and good power gain at high frequencies.—R. L. Sanquini, Multipurpose Chips Cut Costs of F-m Receiver, *Electronics*, 39:10, p 80–82.



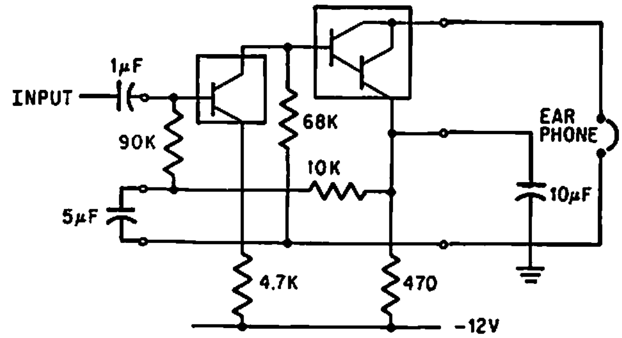
PRESSURE-CONTROLLED—Frequency of avalanche oscillator in integrated circuit using RC103 transistors varies linearly from 100 to 124 kc as stylus pressure on transistor Q2 is increased from zero to 7 grams. —R. C. Wonson, Stress-Sensitive Integrated Circuits, *Electronics*, 38:14, p 81–84.



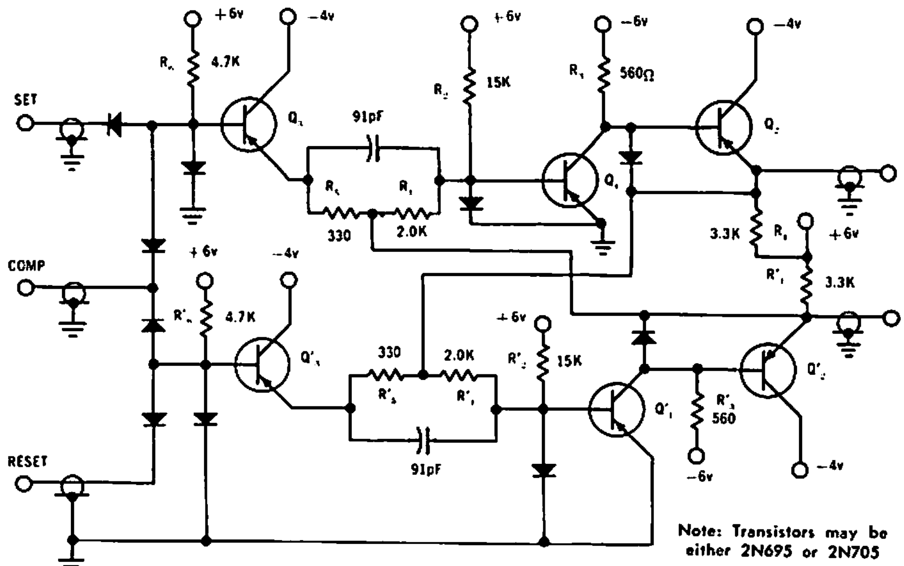
TWO-STROBE SENSE AMPLIFIER—Seven-transistor sense amplifier on single 61 by 70-mil silicon chip has overall gain of 200. —M. F. Wolff, Computer in the Microcircuit Design Room, *Electronics*, 37:12, p 100–104.



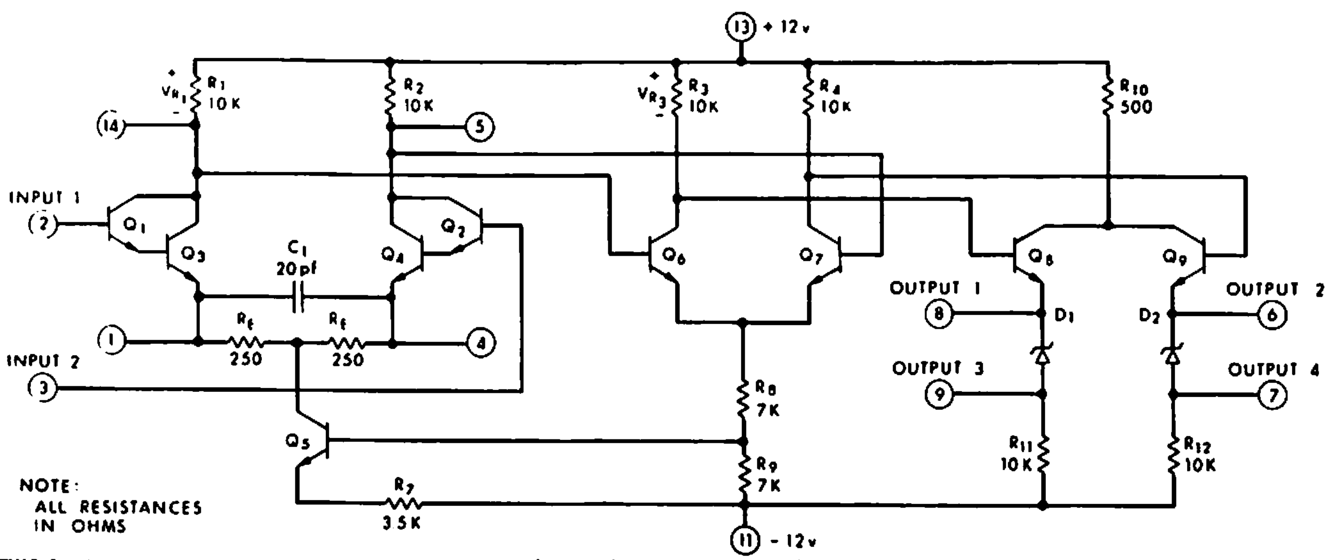
INTEGRATED p-MOST BROADBAND AMPLIFIER—Hole-conducting metal-oxide semiconductor transistor (p-most) and metal-oxide semiconductor capacitor give gain of 5 down to a few cps for integrated stage.—F. M. Wanlass, Novel Field-Effect Device Provides Broadband Gain, *Electronics*, 36:44, p 30–33.



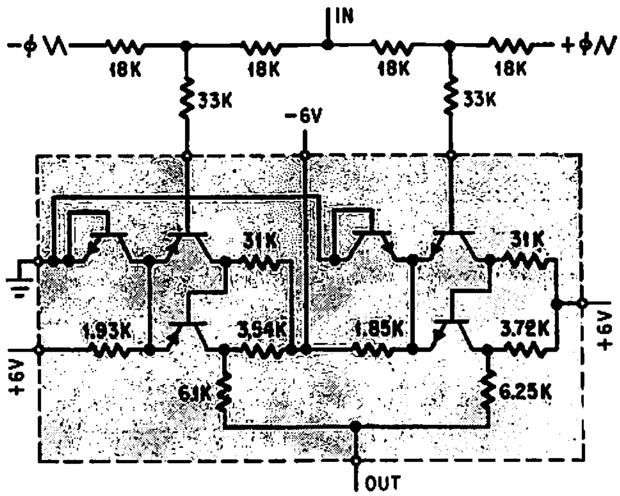
AUDIO AMPLIFIER—Uses Mitsubishi chromium-silicon and nickel-chromium thin-film resistors in hybrid arrangement with conventional transistors.—Y. Tarui, Japan Seeks Its Own Route to Improved IC Techniques, *Electronics*, 38:25, p 90–98.



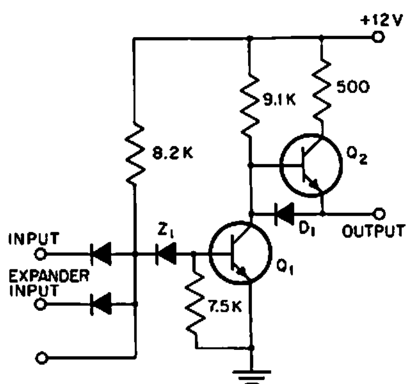
CROSS-CONNECTED INVERTERS AS FLIP-FLOP—Output levels are 0 and 3.5 v. Switching times are 20 to 34 nsec for resistive loads and 30 to 44 nsec for capacitive loads.—W. D. Roehr, "For Computers . . . Basic RCTL Circuits," Motorola Application Note AN-129, Nov. 1965.



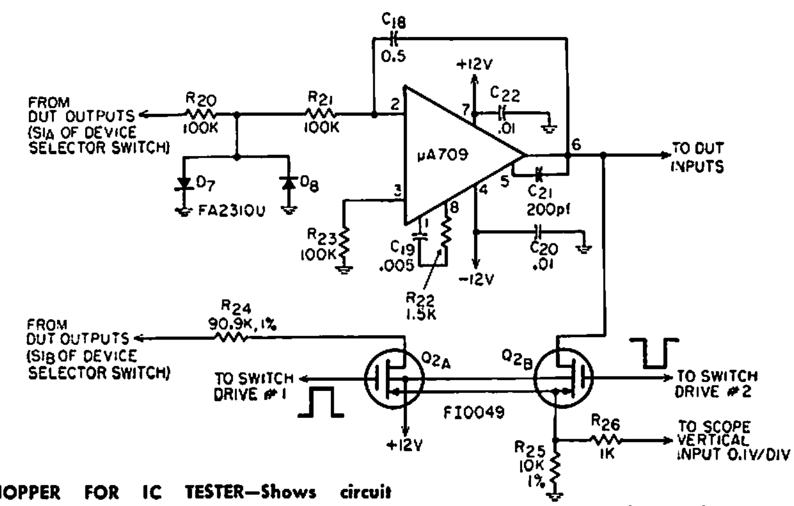
TWO-STAGE OPERATIONAL AMPLIFIER—Maximum gain at room temperature is 36,000. Emitter-follower output stages are used with zener diodes to shift d-c level. Input stage uses Darlington inputs. Input impedance is above 1 meg. Frequency rolloff of 6 db/octave begins at 50 kc.—C. L. Heizman and D. G. Paterson, Circuit Analysis: A Monolithic Integrated Operational Amplifier, *EEE*, 13:5, p 80–84.



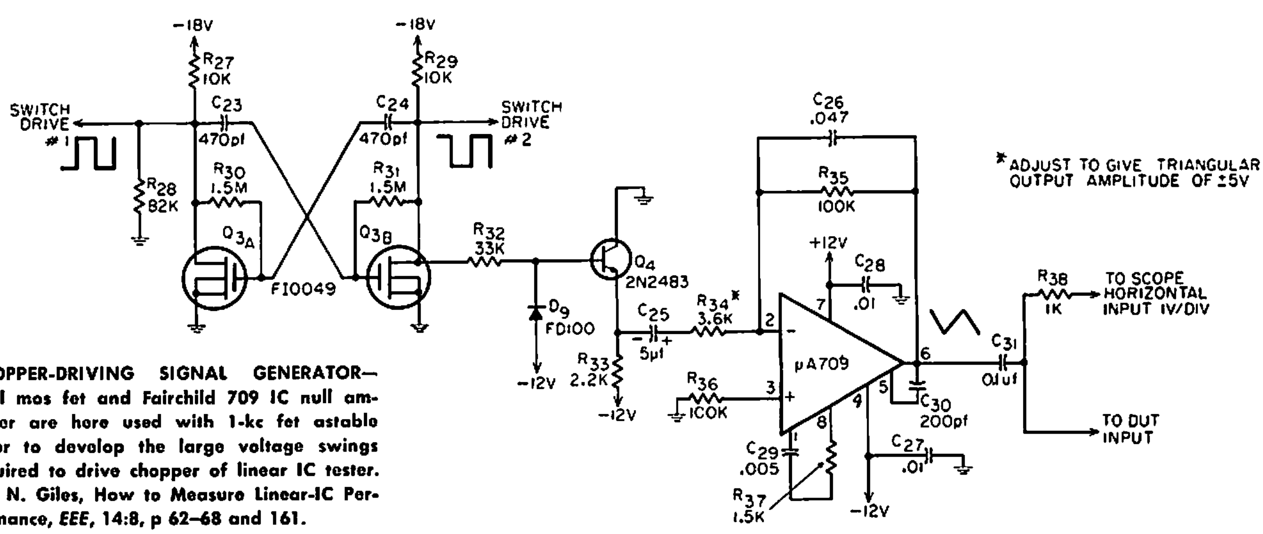
COMPLEMENTARY DUAL SCHMITT TRIGGER—Provides inverting and noninverting outputs for pulse-width modulation.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p 58–64.



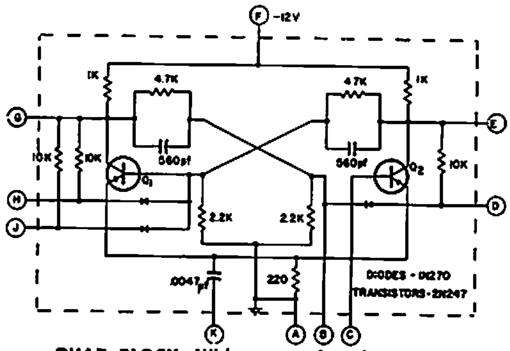
HIGH-NOISE-IMMUNITY LOGIC—Basic gate uses zener with 5.5-v breakdown to give high noise immunity for variety of logic circuits, at penalty of relatively high supply voltage. D1 prevents Q1 and Q2 from being on simultaneously, even during severe transients.—Higher-Voltage ICs Crack Noise Barrier, *EEE*, 14:8, p 40–42.



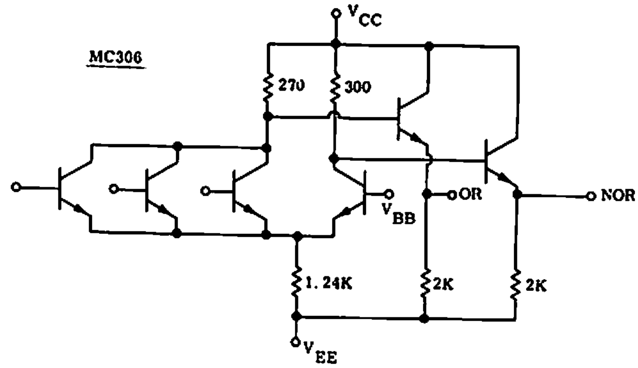
CHOPPER FOR IC TESTER—Shows circuit using Fairchild 709 IC null amplifier in feedback loop around linear integrated-circuit tester, and FI 0049 dual mos fet serving as chopper for displaying offset voltage and transfer function simultaneously on scope by switching in synchronism with horizontal sweep.—J. N. Giles, How to Measure Linear-IC Performance, *EEE*, 14:8, p 62–68 and 161.



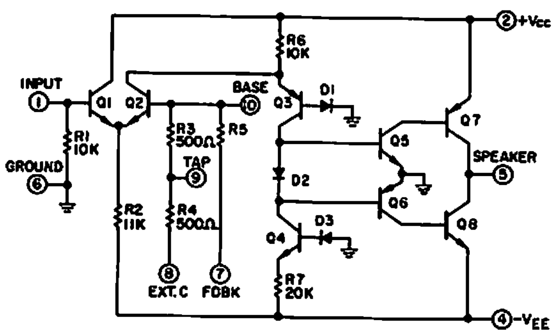
CHOPPER-DRIVING SIGNAL GENERATOR—Dual mos fet and Fairchild 709 IC null amplifier are here used with 1-kc fet astable mvbr to develop the large voltage swings required to drive chopper of linear IC tester.—J. N. Giles, How to Measure Linear-IC Performance, *EEE*, 14:8, p 62–68 and 161.



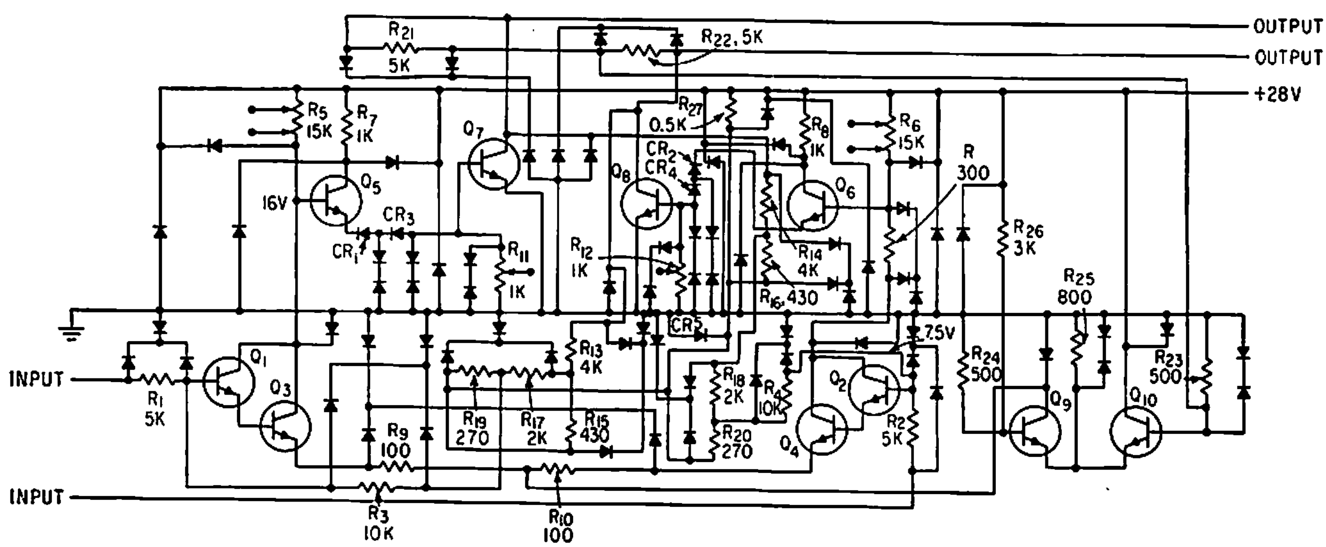
QUAD BLOCK—With appropriate interconnections of external terminals, can be used either as binary counter, monostable mvbr, Schmitt trigger, or selector. Although original design uses encapsulated construction, can readily be adapted for integrated circuit production techniques. Requires 10 ma for all applications, and gives output pulses with 0.1 microsec rise time and up to 0.4 microsec fall time.—F. K. Luteran, Four-Way "Quad" Circuit Building Block, *EEE*, 10:6, p 66–67.



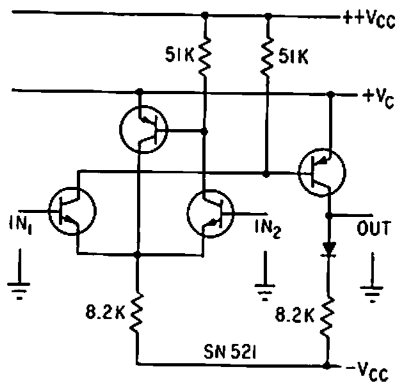
BASIC IC GATE—Circuit is basic element of current mode logic family. If reference voltage VBB is supplied to one side of gate, constant current that normally flows through 1.24 K emitter resistor can be switched from one side of gate to other by switching input signals above and below reference voltage. Complementary output is provided from single gate.—S. T. Robertson, "Integrated Circuit Line Driver," Motorola Application Note AN-187, Aug. 1965.



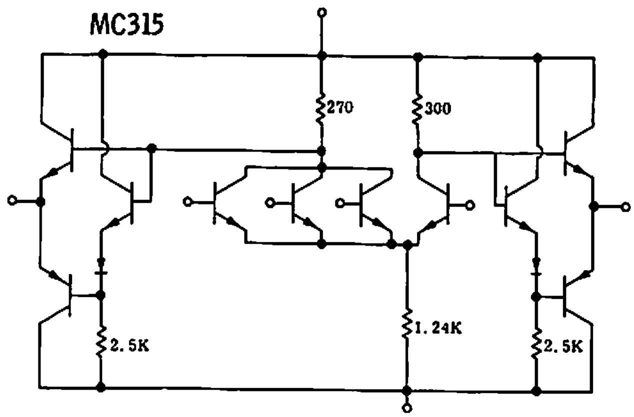
AUDIO POWER AMPLIFIER—MC1524 chip gives high efficiency, low distortion, and wide range along with highest output power permitted by dissipation of TO-5 case. Chip is combined with superior power-handling of standard bottom-collector output transistors to give monobrid amplifier providing 1 w to speaker. True class-B output circuitry gives low standby current, with crossover distortion of class B minimized by using current source Q3-Q4 for quad Q5-Q6-Q7-Q8. Diode D2 further reduces crossover distortion.—R. A. Hirschfeld, "Audio Power Applications Using Integrated Circuits," Motorola Application Note AN-162, Aug. 1965.



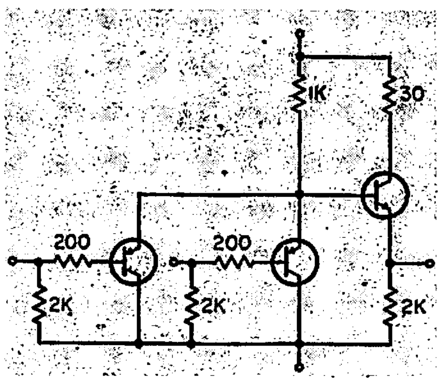
FINGERTIP-SIZE SERVO AMPLIFIER—Direct-coupled class A servo amplifier diffused into 0.75-inch-diameter silicon wafer gives power output of 1.5 w and overall closed-loop gain of 200. Distributed diode planes are introduced by substrate.—M. W. Aarons, Putting a Servo Amplifier on a Small Silicon Wafer, *Electronics*, 35:52, p 33–35.



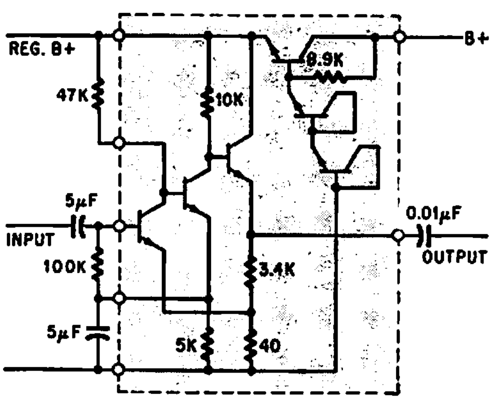
D-C OPERATIONAL AMPLIFIER—Open-loop voltage gain is 62 db, input impedance is 18,000 ohms differential and 10,000 ohms to ground, and output impedance is 8,000 ohms.—Operational Amplifiers are Getting Smaller, *Electronics*, 35:52, p 66.



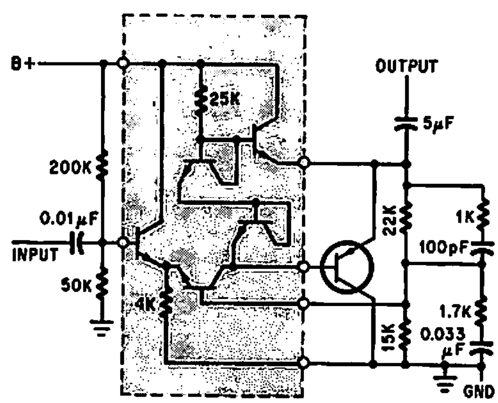
LINE DRIVER—Designed as line or capacitance driver, but is same as basic gate except for output stages. Pnp transistors are hybrid, while other parts are on monolithic chip.—S. T. Robertson, "Integrated Circuit Line Driver," Motorola Application Note AN-187, Aug. 1965.



COMPLEMENTARY-TRANSISTOR LOGIC—Uses both pnp and npn transistors, with pnp emitters tied together and returned through 1K resistor to positive voltage supply. Propagation delay is 3 to 5 nsec for fanouts of 1 to 10.—D. Christiansen, Logic Schemes Reviewed, *EEE*, 13:11, p 64–79.

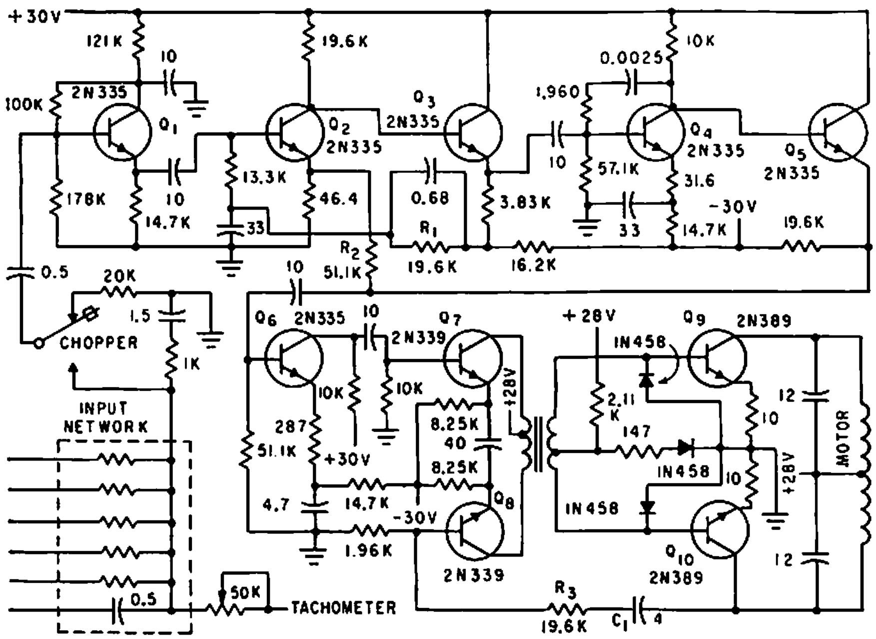


HIGH-GAIN AUDIOPREAMP—Has strong negative feedback and built-in power supply series regulator.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p 58–64.

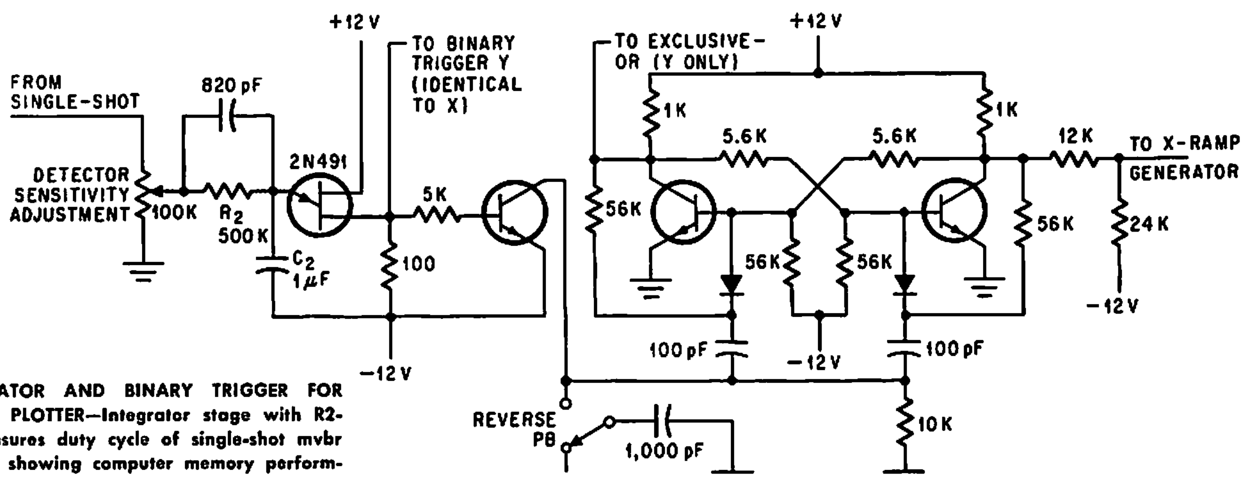


OUTPUT BUFFER AMPLIFIER—Integrated construction (shaded) is used with external pnp transistor.—D. D. Robinson, Linear Microcircuits Scarce? Now You Can Breadboard Your Own, *Electronics*, 37:27, p 58–64.

CHAPTER 43
Integrator Circuits

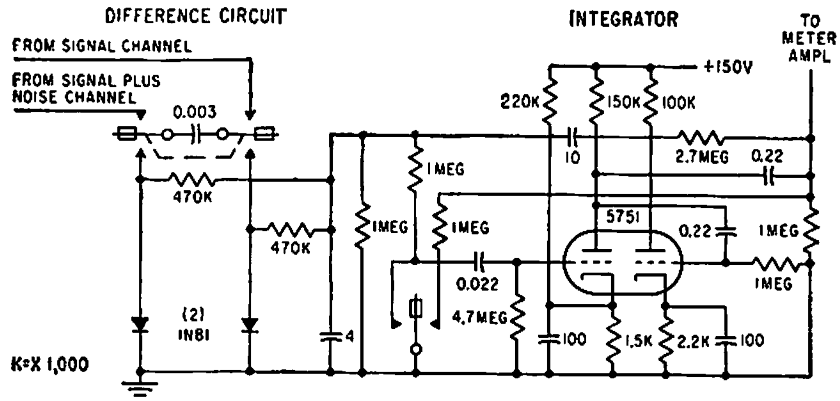


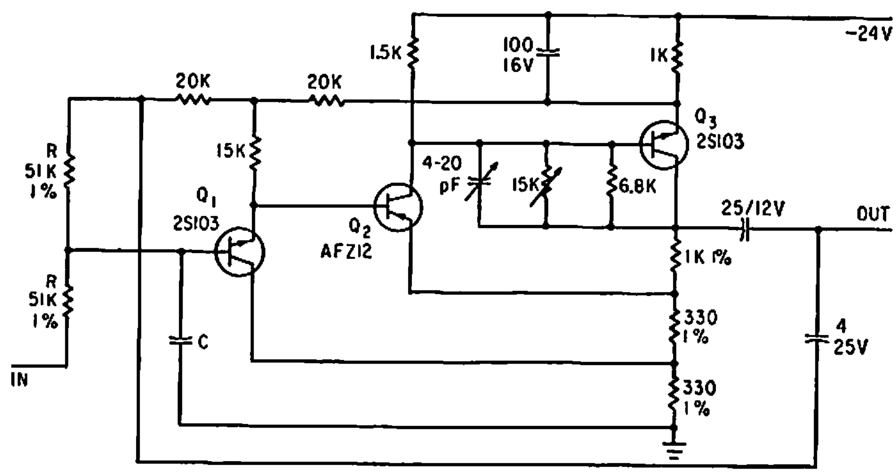
HIGH-GAIN AMPLIFIER—Integrator amplifier using ten silicon transistors in five voltage gain stages gives gain of 250,000. To prevent saturation by spurious microvolt signals, input network is shielded by Mu-metal can grounded to signal ground and overall steel can grounded to power ground. Power supply ripple must be below 0.01%. Amplifier drives 6-w a-c servomotor having d-c tachometer on same shaft.—S. T. Cap and N. P. White, Guidance Systems in Manned Space Flight, *Electronics*, 32:33, p 49–51.



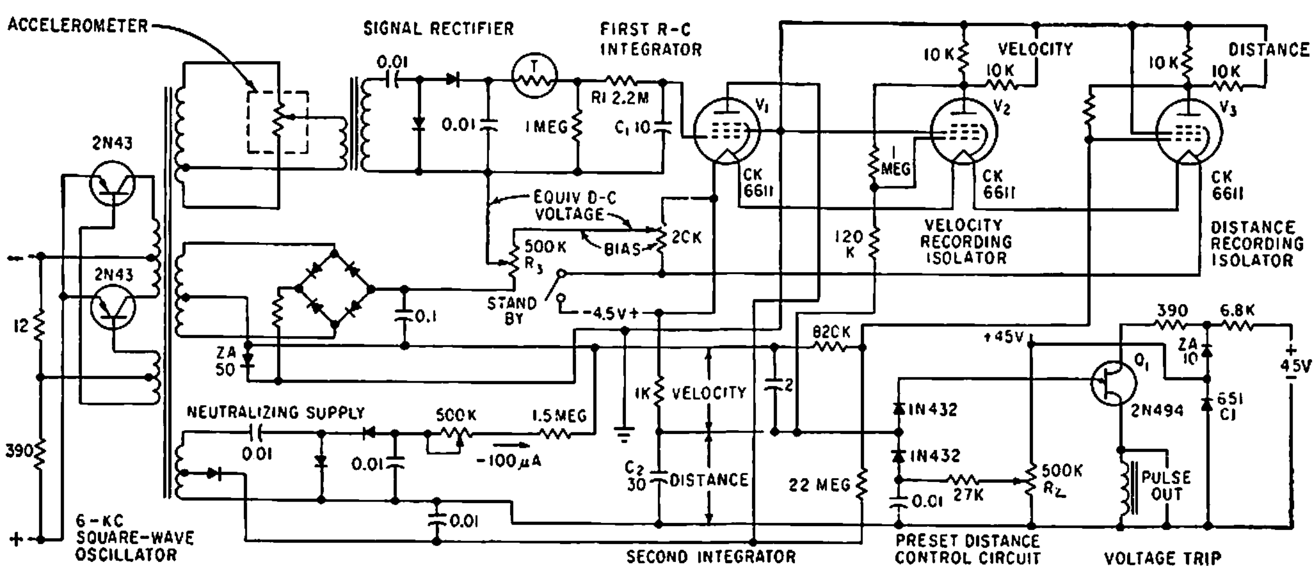
INTEGRATOR AND BINARY TRIGGER FOR SHMOO PLOTTER—Integrator stage with R2-C2 measures duty cycle of single-shot mvbr used in showing computer memory performance under marginal drive currents. Binary triggers control direction of ramp generators and increase or decrease memory drive current. Npn transistors are 2N706 and diodes are 1N921.—J. E. Gersbach, The Great Shmoo Plot: Testing Memories Automatically, *Electronics*, 39:15, p 127–134.

ABSOLUTE-DIFFERENCE INTEGRATOR—Uses two-pole chopper with capacitor connected between the two reeds. During half of chopper cycle, capacitor is charged to voltage difference between outputs of two signal-processing channels. During other half-cycle, charge is transferred to integrator circuit and positive side of capacitor is clamped to ground by one of the two diodes. Integrator is chopper-stabilized d-c amplifier with capacitive feedback, having gain of 200 and integration time constant of 1.5 hours.—H. Schwarzlander, Intelligibility Evaluation of Voice Communications, *Electronics*, 32:22, p 88–91.

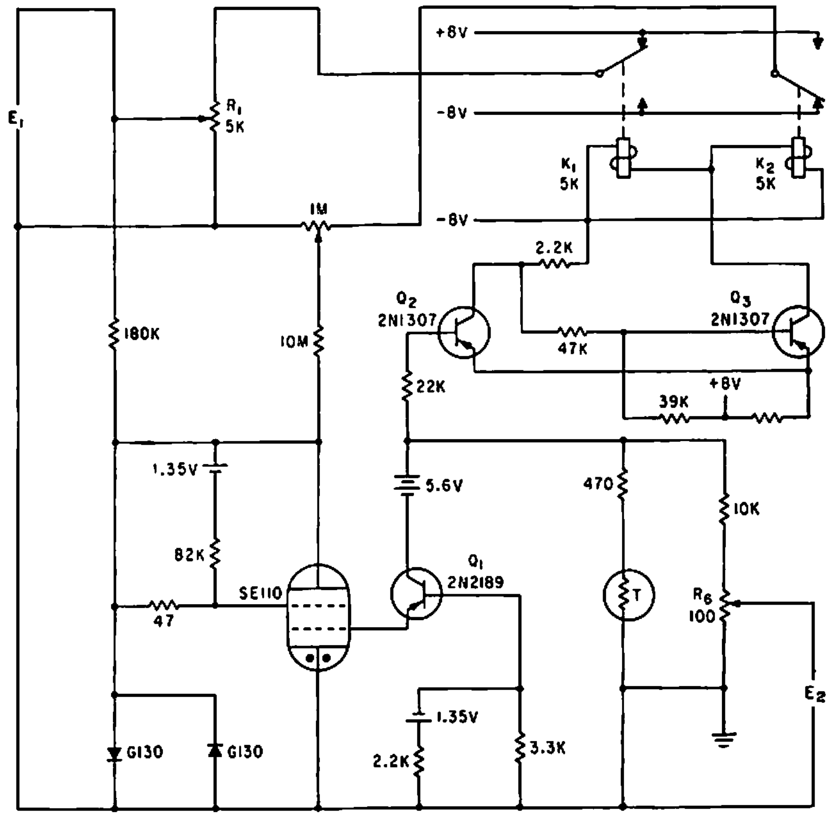




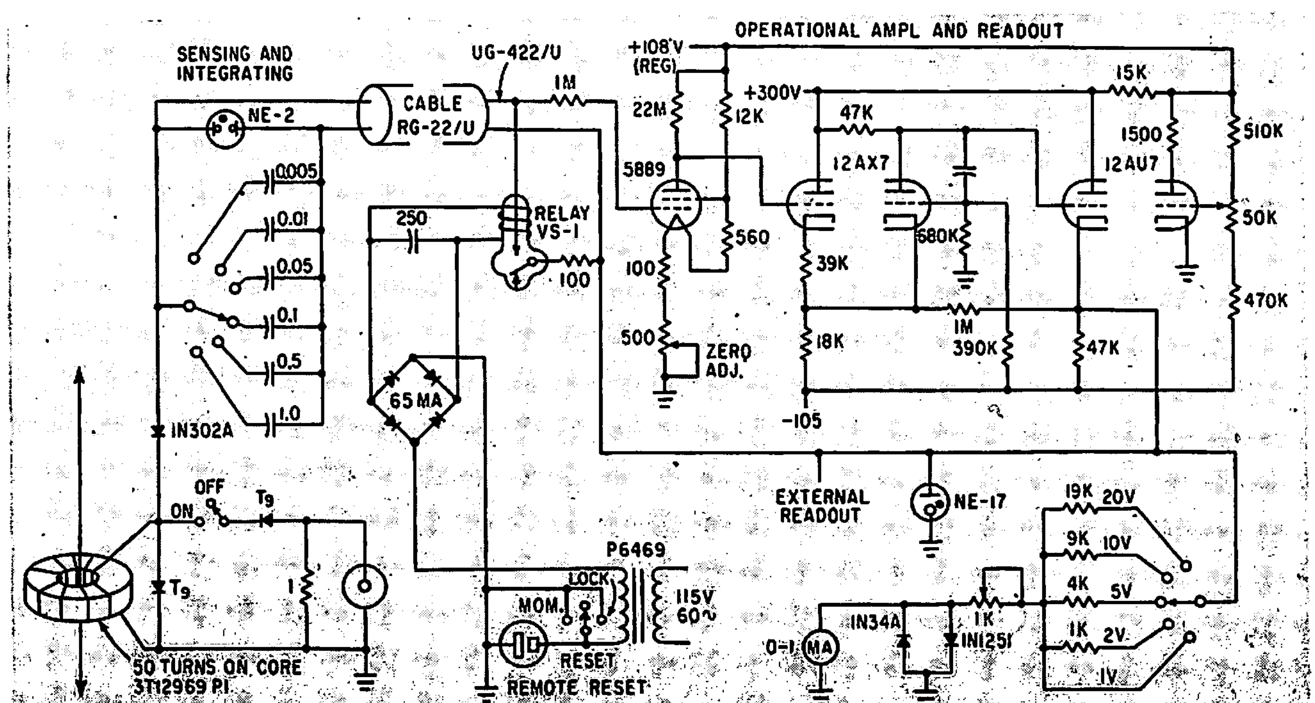
COMPENSATED R-C INTEGRATOR—Overshoot is less than 2% at 3 db down for bandwidth of 20 Mc.—S. Berglund and S. Westerlund, Probes for Plasma Research with Wideband Integrators, *Electronics*, 35:24, p 44–45.



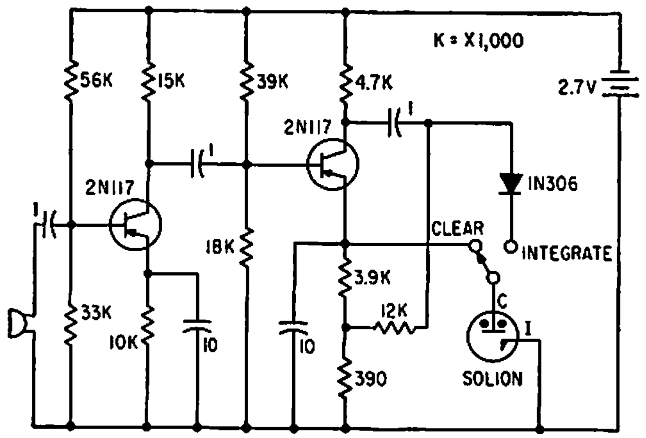
DOUBLE INTEGRATOR—Used to measures distances up to 150 feet, from information supplied by slide-wire accelerometer. Transistor operates as voltage trip, providing output pulse when distance reaches preset value. Two other tubes provide velocity and distance information for recorder.—T. R. Nisbet, Double Integrator Finds Distance, *Electronics*, 32:21, p 64–66.



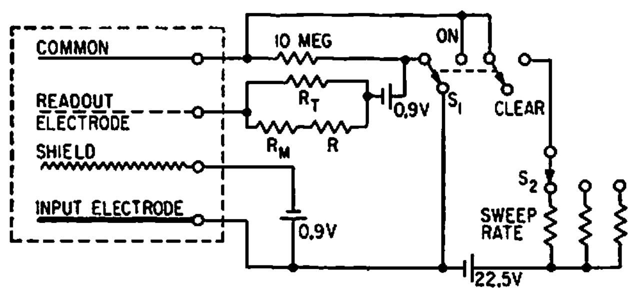
0-10 KC INTEGRATOR—Schmitt trigger Q2-Q3 drives relays K1-K2 to reverse polarity of input current to SE110 solion. Thermistor compensation T in output is accurate within 1% for battery operation, used in integrating long-period signals such as those proportional to sunlight and temperature changes.—J. W. Martin and J. R. Cox, Solion Tetrode Integrates Chromatograph Signals, *Electronics*, 35:12, p 46–47.



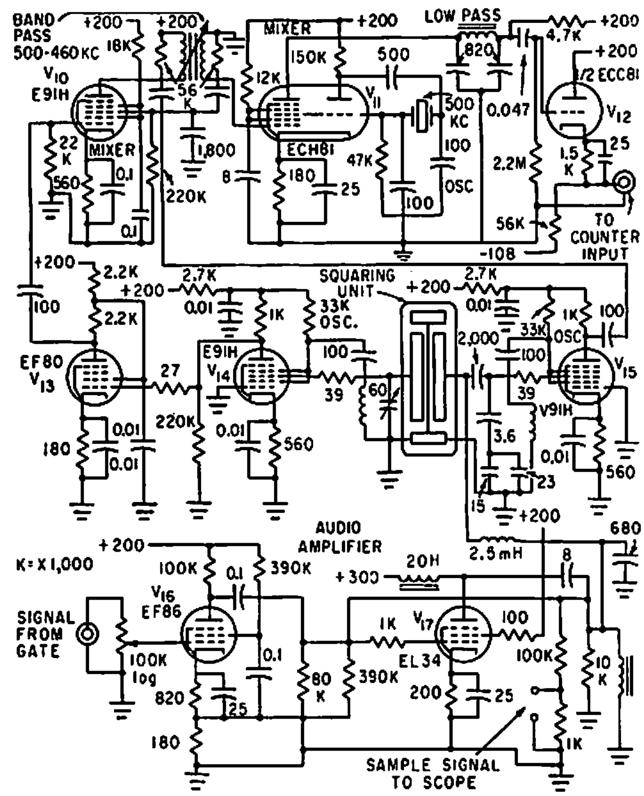
MEASURING INTEGRAL OF CURRENT PULSES—Gives current integral of one or more pulses, for measuring quantity of electricity in coulombs, regardless of pulse shape and independently of ground connection or circuit potential. Commercial d-c electrometer may be used in place of operational amplifier. Range switch is at pickup.—J. F. Howell, How to Measure Coulombs in Irregular Pulses, *Electronics*, 35:32, p 72–73.



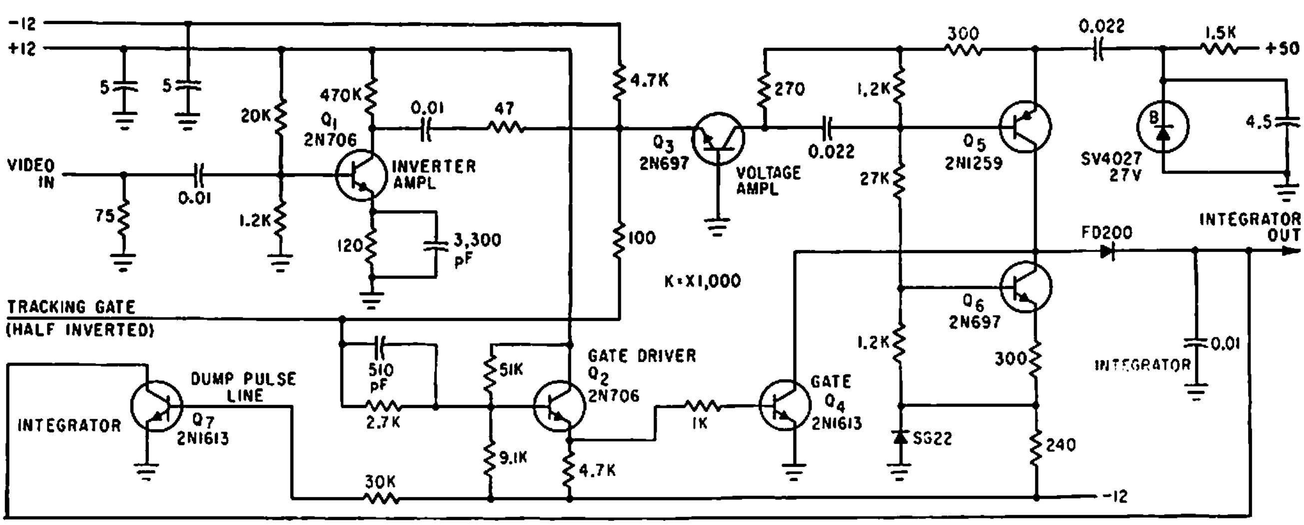
SOLION INTEGRATING NOISE METER—Audio amplifier for microphone feeds visual-readout solion integrator through rectifying diode. Used to measure extent of exposure of person to dangerously high levels of noise.—R. N. Lane and D. B. Cameron, Current Integration with Solion Liquid Diodes, *Electronics*, 32:9, p 53–55.



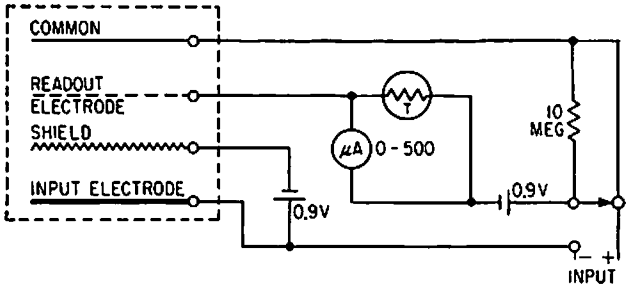
SOLION TIME BASE—Electrical readout integrator consisting of solion liquid diode provides readout current that increases linearly with time for constant current input, permitting use of input to axes of X-Y recorder. —R. N. Lane and D. B. Cameron, Current Integration with Solion Liquid Diodes, *Electronics*, 32:9, p 53–55.



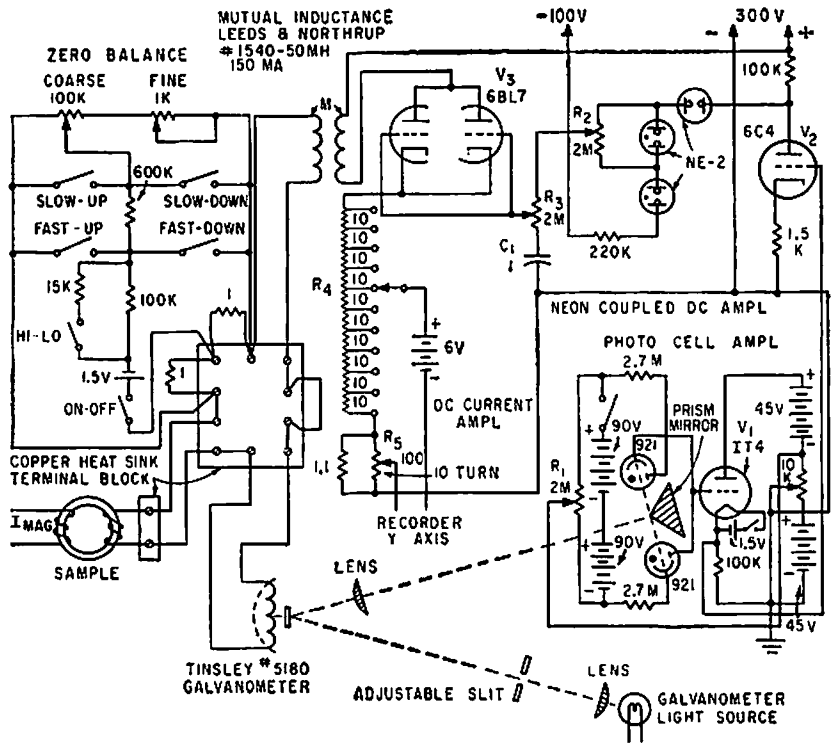
ELECTROSTATIC SQUARER—Used to obtain integrated reading of reflected sound patterns when measuring acoustic characteristics of auditoriums. Electrostatic squarer incorporates frequency-determining elements of two transitron negative-resistance oscillators (3.3 and 3.8 Mc). Amplified outputs are mixed to obtain 500-kc difference signal which in turn is mixed with 500-kc crystal oscillator output to give from 0 to 35 kc for feeding to counter.—J. P. A. Lochner and P. Meffert, Electrostatic Squarer for Acoustic Measurements, *Electronics*, 33:35, p 66–68.



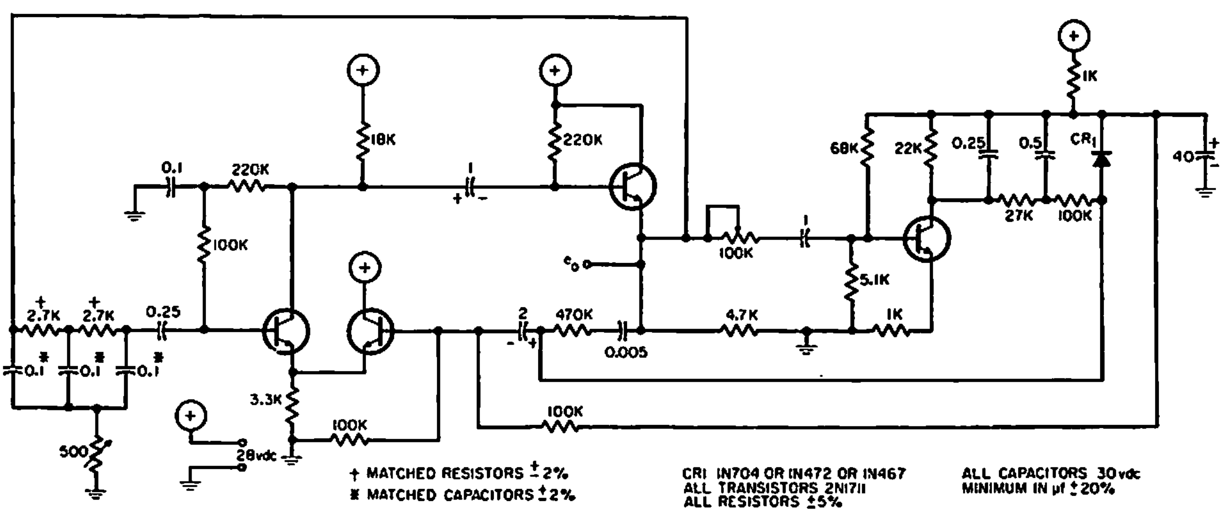
RADAR VIDEO INTEGRATOR—Accepts all video and noise signals within first half of tracking gate and performs voltage-time integration. Identical integrator performs similar function for second half. Results of integrations (integrator out) go to difference detector for comparison.—D. L. Nepveux, Digital Circuits Achieve Automatic Control of Radar Range Tracking, *Electronics*, 34:52, p 46–50.



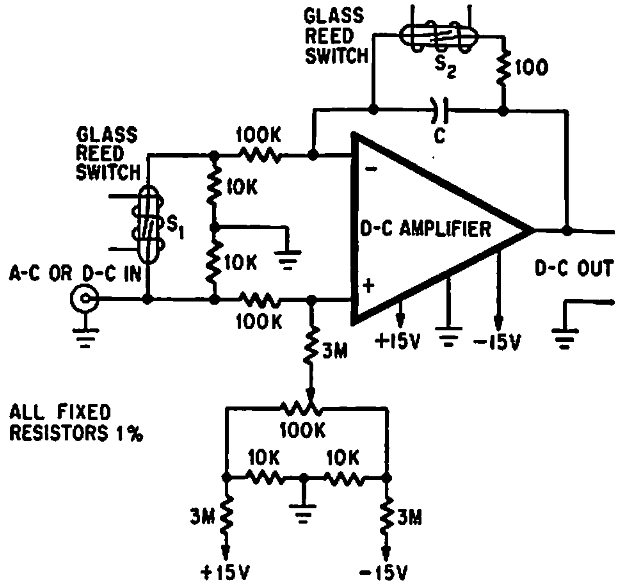
ELECTRICAL READOUT INTEGRATOR—Use of solion diode eliminates need for sensitive electrometer. Integral may be read continuously while integration is taking place, without affecting its value. Varistor is used in parallel with meter to compensate for temperature changes.—R. N. Lane and D. B. Cameron, Current Integration with Solion Liquid Diodes, *Electronics*, 32:9, p 53–55.



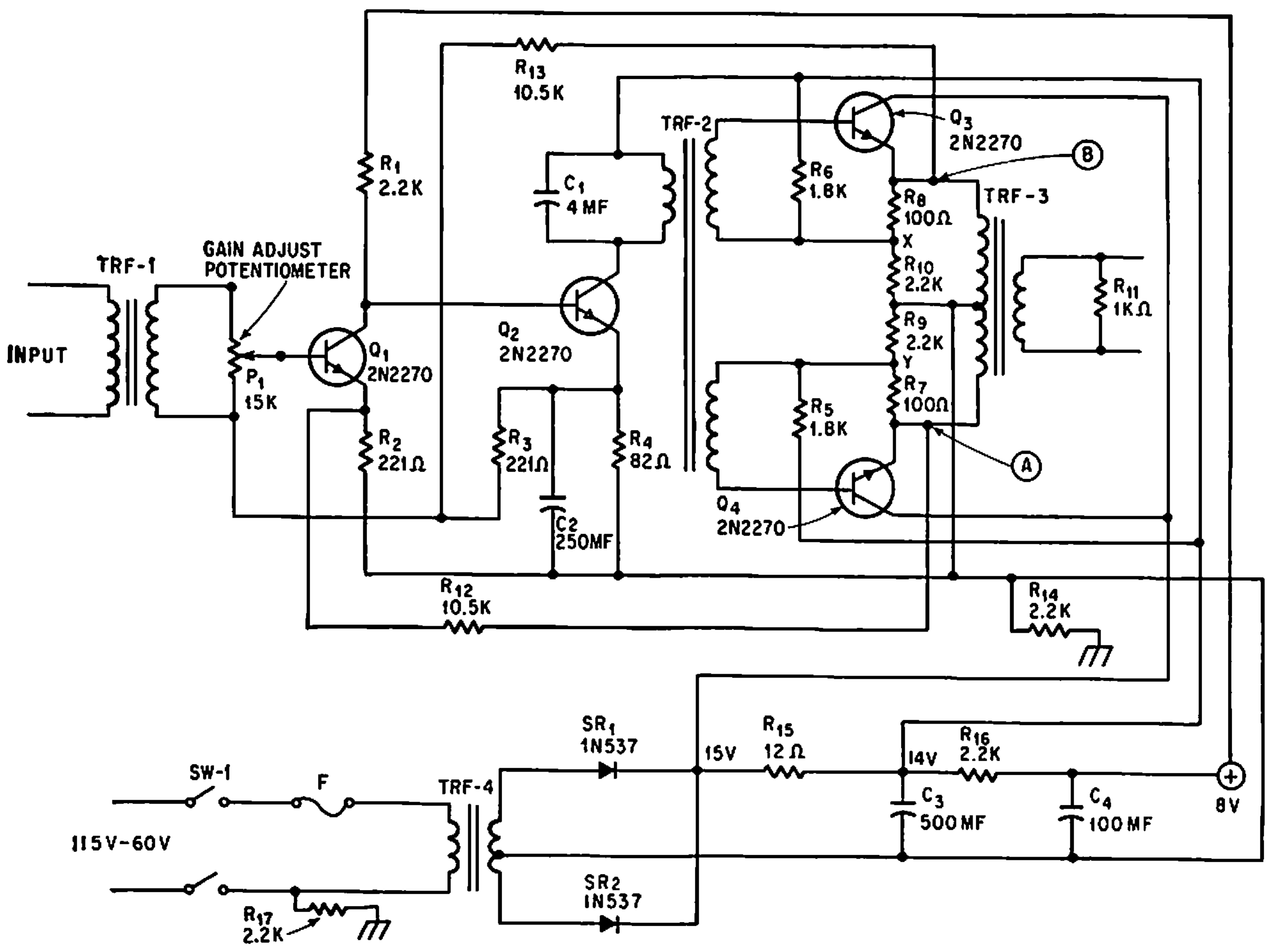
MEASURING MAGNETIC CHARACTERISTICS—Provides rapid and accurate record of d-c magnetization and hysteresis characteristics of materials.—R. R. Bockemuehl and P. W. Wood, Industrial Hysteresigraph Uses D-c Integration, *Electronics*, 33:13, p 70–71.



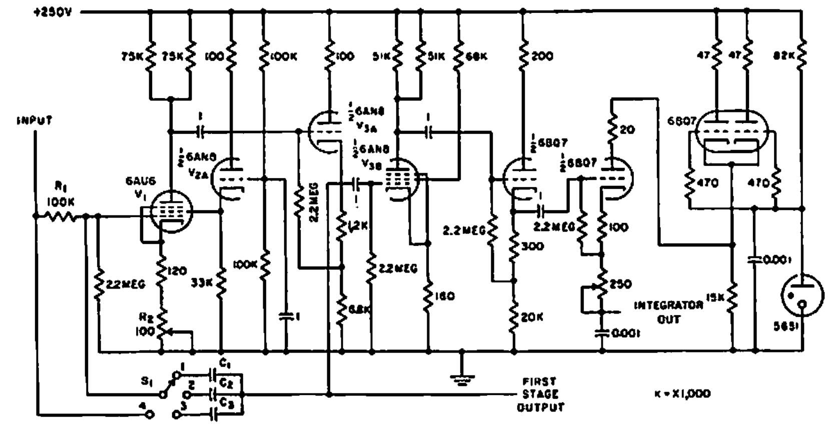
ISOLATED INTEGRATOR IN 100-CPS PHASE-SHIFT OSCILLATOR—Frequency can be adjusted over limited range with 500-ohm rheostat, which can easily be replaced with photocell or other resistive transducer to give frequency that varies with light intensity, temperature, voltage, current, or other parameter.—B. M. Van Emden, The Isolated-Integrator Network, *EEE*, 12:5, p 55–57.



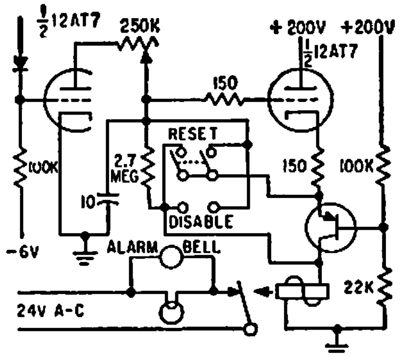
REED SWITCH CONTROLS OPERATIONAL AMPLIFIER—Circuit can gate out unwanted signals, maintain integrated output at specified level, or operate as synchronous detector. Maximum switching speed is 300 kc. Opening and closing S1 in synchronism with a-c input signal allows synchronous detection and integration of signal. Amplifier integrates only portion of signal present while switch is open.—H. Penfield, Glass Reed Switch Controls Operational Amplifier, *Electronics*, 39:17, p 97–98.



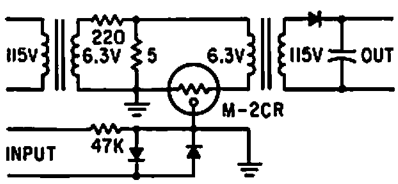
PROPORTIONAL AMPLIFIER FOR INTEGRATING CONTROL—Dual balanced feedback and form of bootstrapping give highly stable output of 35 v into 3,500 ohms, with voltage gain adjustable from 0 to 30 while output transformer return is to ground rather than B+.—C. H. Smoot and F. J. Karlov, Boiler Control: Simple Controller for a Complex Job, *Electronics*, 37:18, p 88–93.



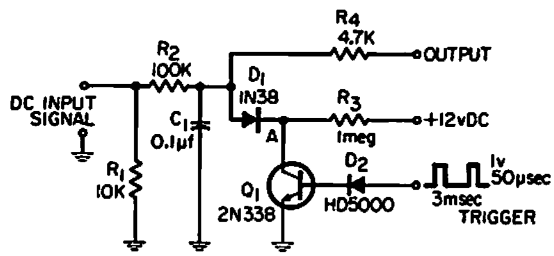
CORE FLUX INTEGRATOR—Speeds grading and matching of magnetic cores. Miller integrator measures instantaneous and peak flux in cores at 60, 400, and 1,600 cps. Design approaches ideal response throughout 480-kc bandwidth and provides closed-loop gain of 2 at fundamental excitation frequencies.—C. E. Goodell, Integrator-Amplifier for Core Measurements, *Electronics*, 31:7, p 110–113.



BOOTSTRAP INTEGRATOR AND SWITCH—Circuit is part of memory and alarm system that accumulates predetermined numbers of pulses, then switches off until reset.—G. A. Dunn and N. C. Hekimian, Tube-Transistor Hybrids Provides Design Economy, *Electronics*, 32:23, p 68–70.

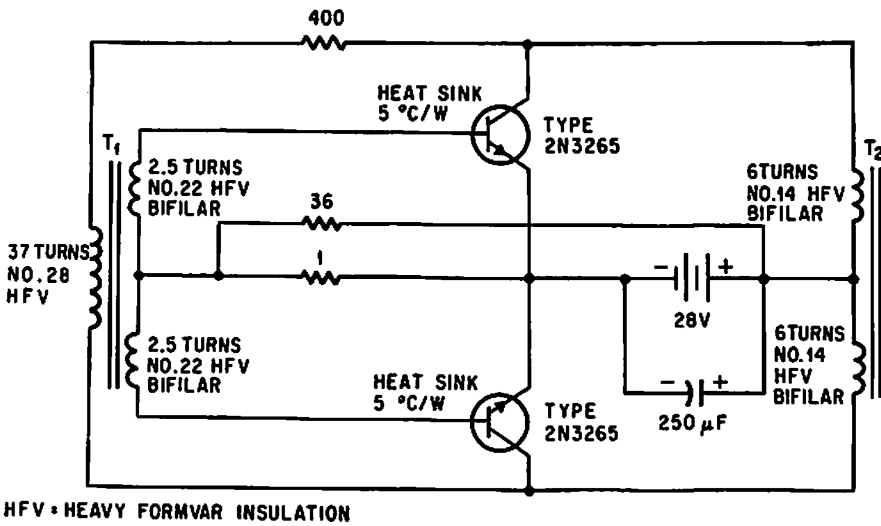


ELECTRONICALLY ADJUSTABLE RESISTOR—Uses Memistor in which rate of change of resistance is controlled by current applied to third electrode. Resistance range is from 2 to 30 ohms. Input pulses up to 10 v are integrated by plating action in sealed Memistor cell, to give d-c output of 0 to 3 v.—Adjustable Resistor Has Built-in Memory, *Electronics*, 35:51, p 76–77.

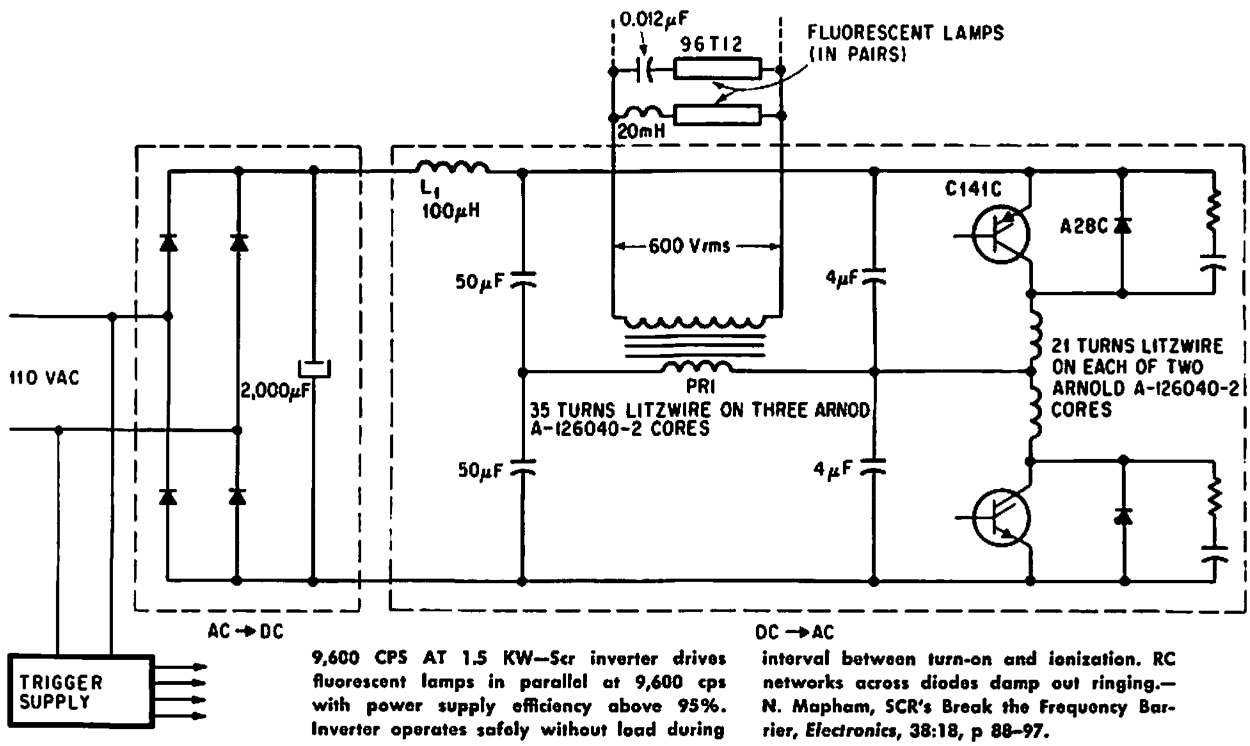


50-MICROSEC CLEARING—Will clear R2-C1 integrator in 50 microsec while providing isolation between integrator and switching network. Output is connected to differential amplifier for voltage level detection.—G. A. Herlich, Integrator Clearing Circuit, *EEE*, 14:2, p 69.

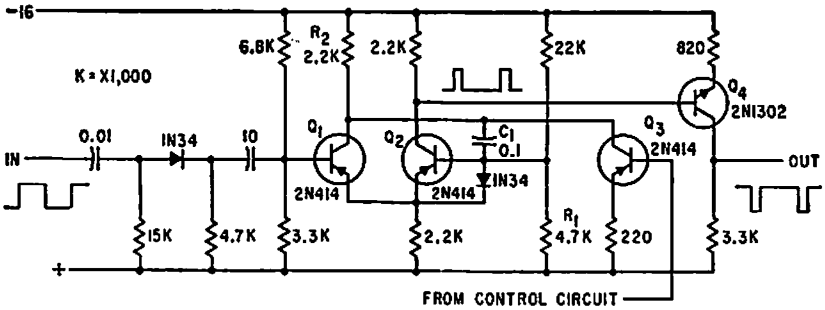
CHAPTER 44
Inverter Circuits



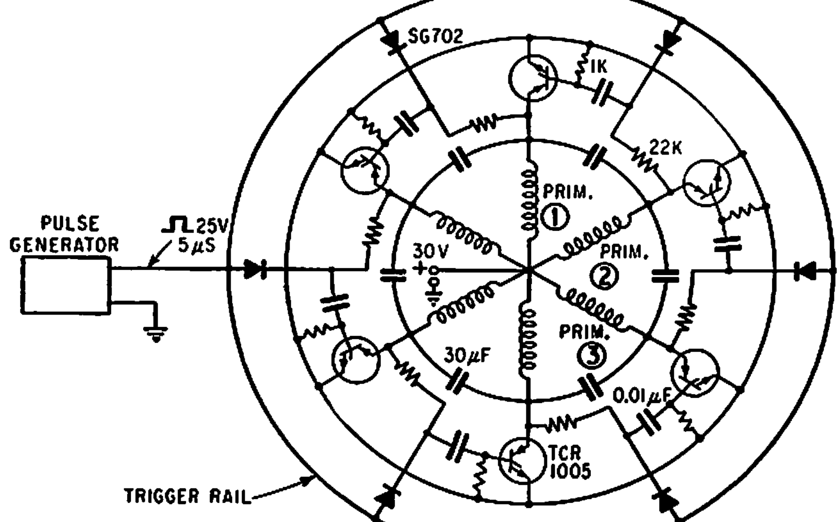
250-W, 50-KC INVERTER—Silicon power transistors in high-speed inverter circuit give conversion efficiency up to 90% in changing 28 v d-c to 50 kc at primary of output transformer. —H. T. Breece, Boosting D-C Voltage With Silicon Transistors, *Electronics*, 37:29, p 56–66.



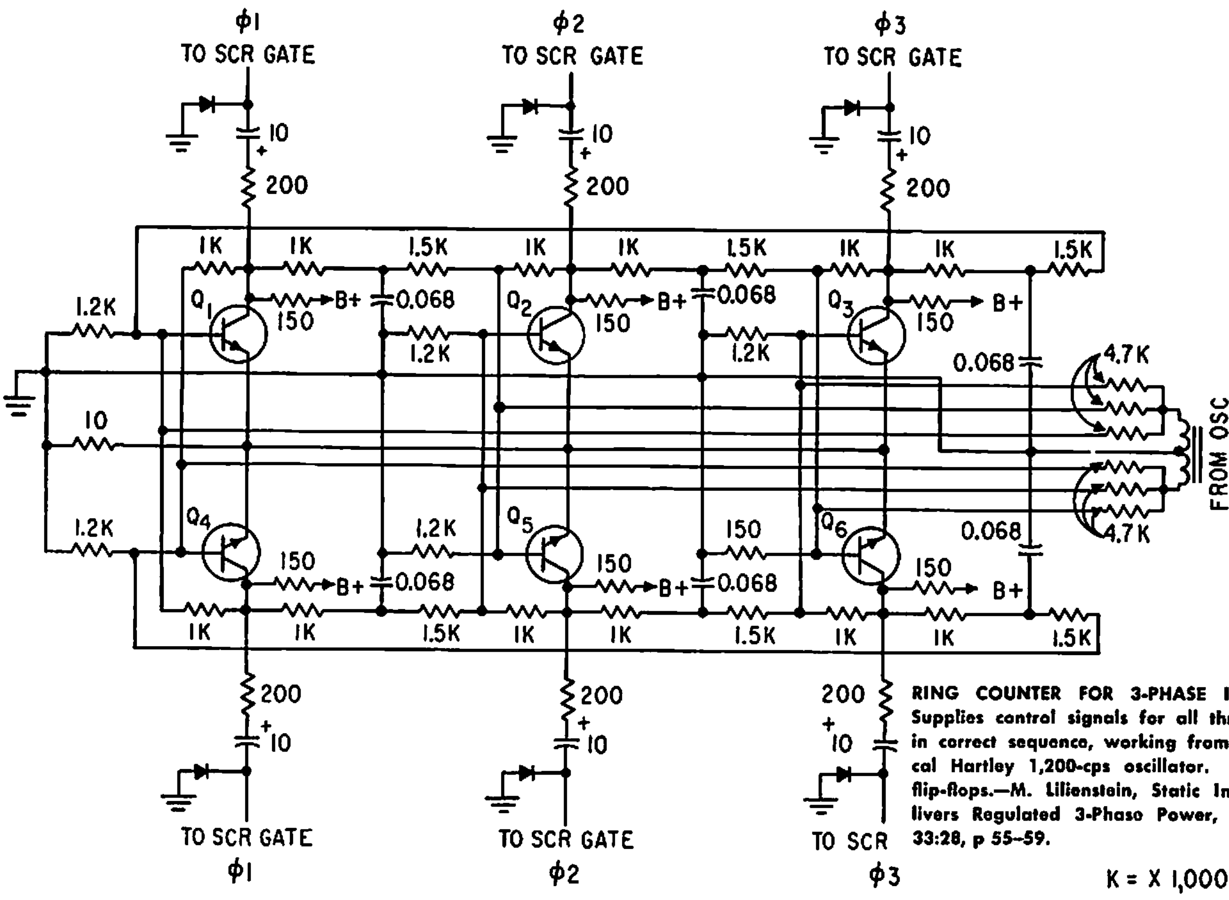
9,600 CPS AT 1.5 KW—Scr inverter drives fluorescent lamps in parallel at 9,600 cps with power supply efficiency above 95%. Inverter operates safely without load during interval between turn-on and ionization. RC networks across diodes damp out ringing.—N. Mapham, SCR's Break the Frequency Barrier, *Electronics*, 38:18, p 88–97.



400-CPS THREE-PHASE INVERTER DELAY CIRCUIT—One-shot mvbr Q1-Q2 triggered by input signal, and Q3 controlled by error-detecting signals at output of static inverter, together determine delay at output of Q4. Complete inverter uses six identical delay circuits together with solid-state servo loops to control output voltages and phase angles despite unbalanced loads.—T. J. Gilliam, Three-Phase Inverter with Feedback Loops, *Electronics*, 35:12, p 48–51.

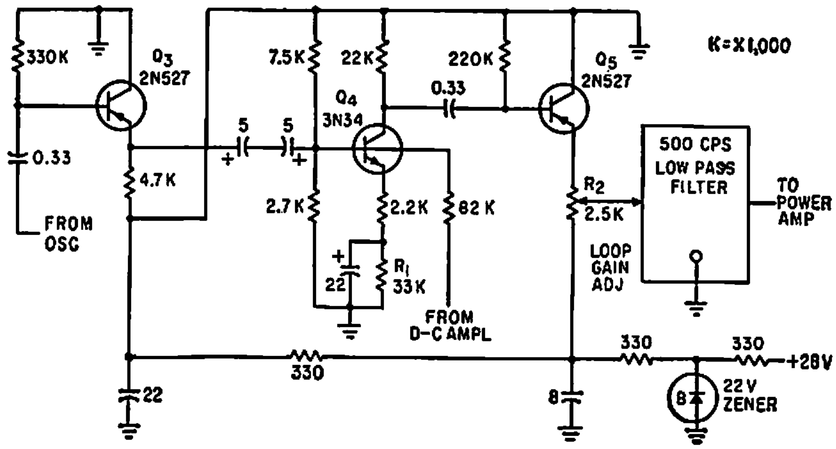


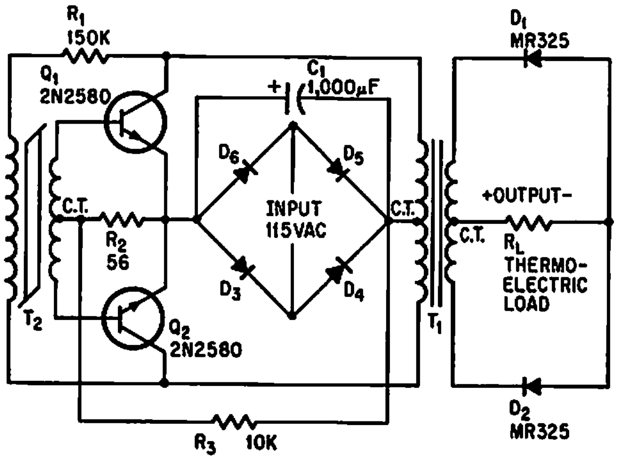
SCR STATIC ALTERNATOR—Silicon-controlled rectifiers serve as current-switching elements in ring-counter inverter that delivers three-phase a-c output requiring no filtering, without moving parts. With 2.4-kc pulse generator, output is 400-cps three-phase.—R. H. Murphy, Developing True Solid-State Static Alternators, *Electronics*, 36:21, p 58–61.



RING COUNTER FOR 3-PHASE INVERTER—Supplies control signals for all three phases in correct sequence, working from symmetrical Hartley 1,200-cps oscillator. Uses three flip-flops.—M. Lilienstein, Static Inverter Delivers Regulated 3-Phase Power, *Electronics*, 33:28, p 55–59.

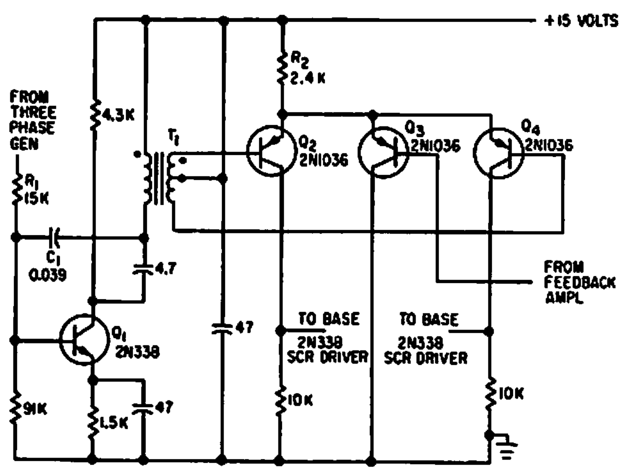
VARIABLE-GAIN INVERTER AMPLIFIER—Gives gain variations of up to 10 to 1, with less than 10% harmonic distortion at 1 v output through use of tetrode transistor, to provide precise voltage regulation of output of d-c to 400-cps a-c inverter. Error current from d-c amplifier of inverter is applied to base 2 of Q4, causing a-c voltage gain of stage to vary with magnitude of error current.—R. Wileman, Linear Circuits Regulate Solid-State Inverter, *Electronics*, 33:16, p 61–63.



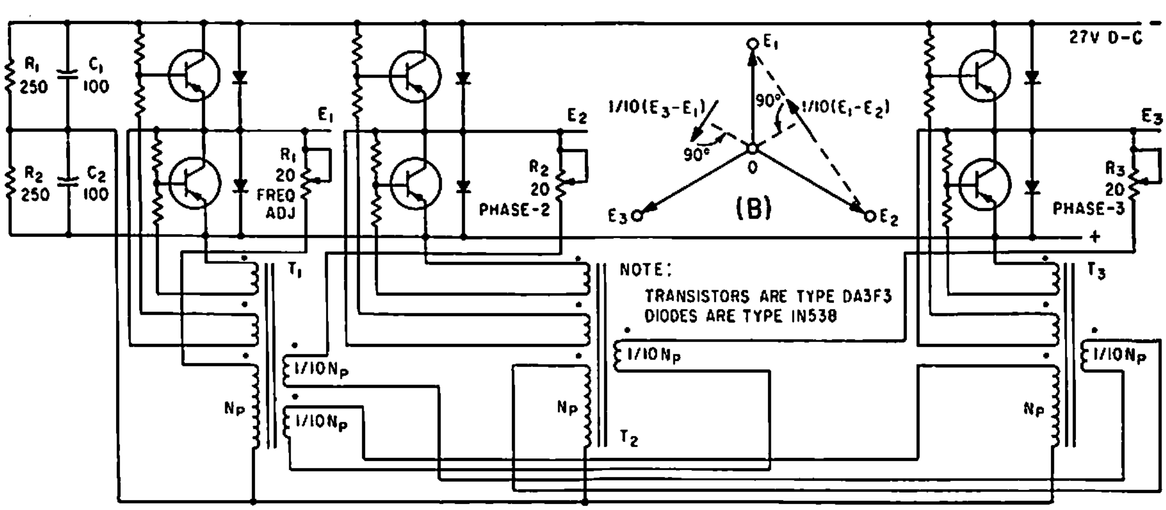


T_1 CENT TRAN W-23-104
T_2 CENT TRAN W-23-105
D_3–D_6 MDA952-5 (BRIDGE RECTIFIER ASS'Y)

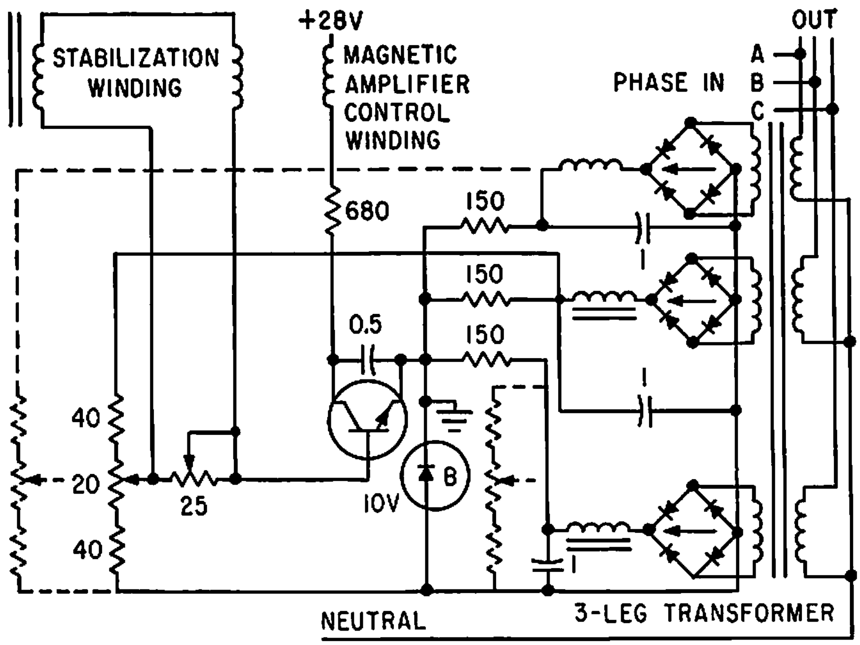
D-C/D-C—Line voltage is rectified, inverted at 18 kc, stepped down, and rectified to give 23 a at 6 v for thermoelectric heat-pump system.—A. L. Wennerberg and F. H. Schroeder, High-Current Converter is Small, Quiet, Low-Cost, *Electronics*, 37:30, p 41.



PULSE-WIDTH MODULATOR—Determines length of quasi-square waves used in connection with triggering of scr's in output stage of inverter.—R. J. Kearns and J. J. Rolfe, Three-Phase Static Inverters Power Space-Vehicle Equipment, *Electronics*, 34:18, p 70–73.

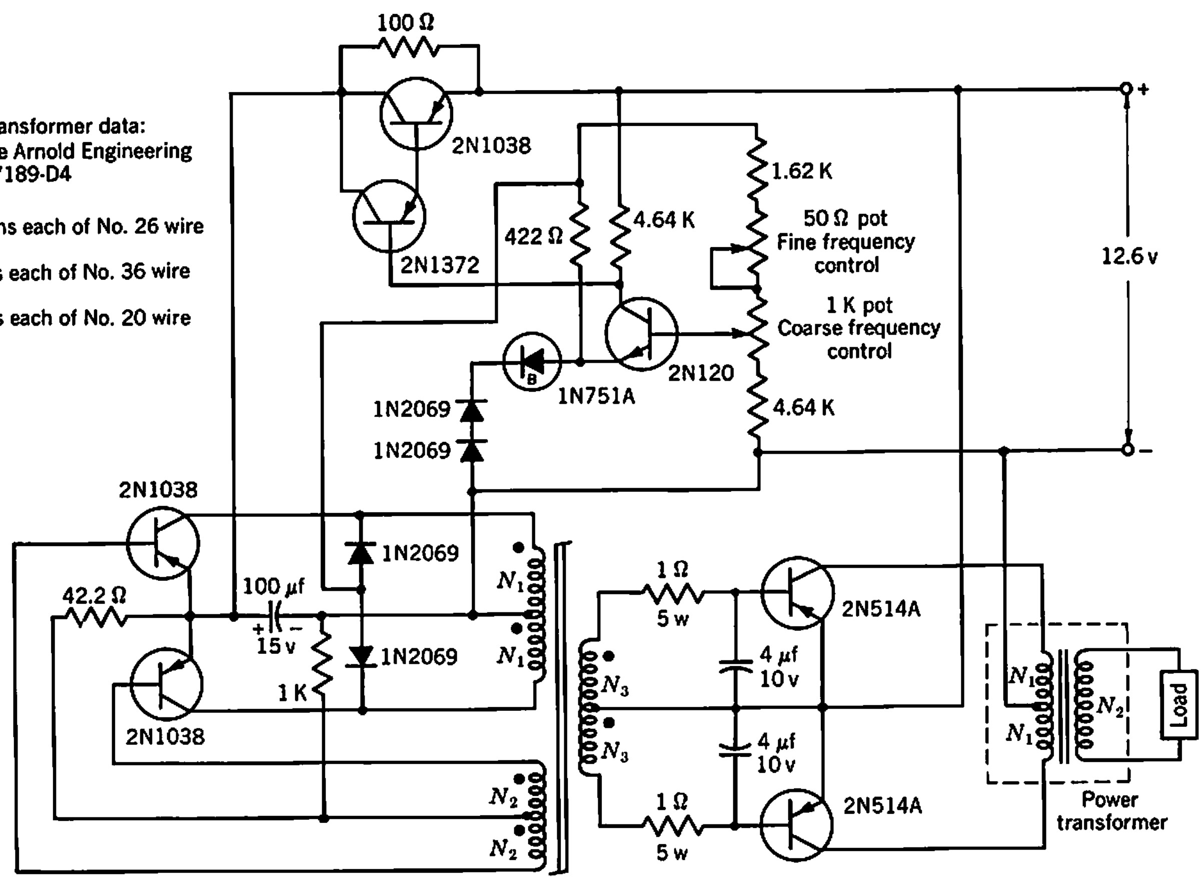


SELF-EXCITED 3-PHASE NON-PHASE-AMBIGUOUS BRIDGE—Each oscillating section is half-bridge converter operating in square-wave mode. Phase diagram shows derivation of synchronizing voltages.—A. G. Lloyd, Half-Bridge Inverter Provides Economical Three-Phase Power, *Electronics*, 34:37, p 62–65.

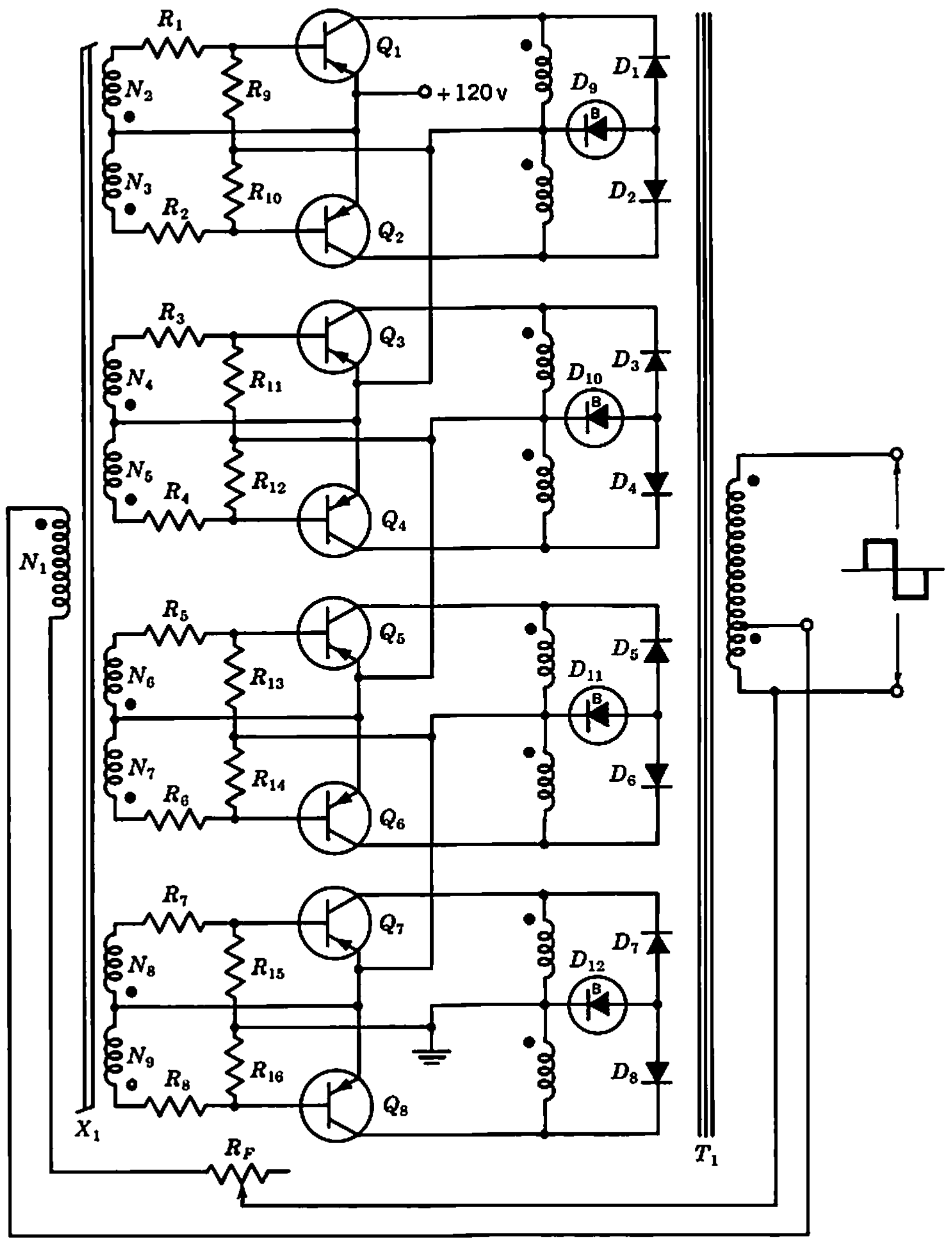


THREE-PHASE REGULATOR—When used with three-phase static inverter employing scr's and magnetic amplifiers, provides 25-millisec recovery time when load is switched from 2.5 amp to 0. The three bridges use one zener diode in common as non-linear element. Silicon transistor amplifies unbalance in each bridge.—M. Lilienstein, Static Inverter Delivers Regulated 3-Phase Power, *Electronics*, 33:28, p 55–59.

Saturating transformer data:
Core — The Arnold Engineering Co. 3T-7189-D4
Coil 1:
160 turns each of No. 26 wire
Coil 2:
20 turns each of No. 36 wire
Coil 3:
40 turns each of No. 20 wire



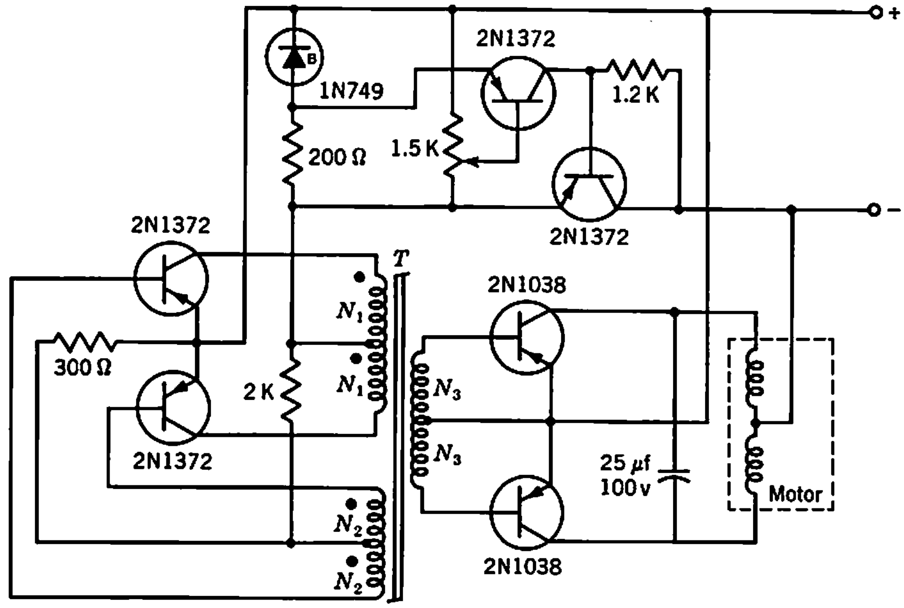
200-W 60-CPS 115-V POWER FROM 12 V—Uses saturating-core oscillator. Complete design procedure is given. Maximum frequency drift is below 0.5% for change from no load to full load and for input change from 11.5 to 13.5 v. Efficiency is about 86%. No-load input power is 8.5 w.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 451.



Parts List

Q_1 through Q_8—2N458A
D_1 through D_8—1N2069
D_9 through D_{12}—1N1825R
R_1 through R_8—5 ohms, 1 watt
R_9 through R_{16}—910 ohms, 1 watt
R_F—25-ohm 5-watt rheostat
T_1—Texas Instruments transformer #440220 or equivalent
X_1—Tapewound toroidal core, 51425-4A Magnetics Inc., or 5772-D4 Arnold Co.
N_1—448 turns, #22 heavy Formvar
N_2 through N_9—112 turns, #28 heavy Formvar

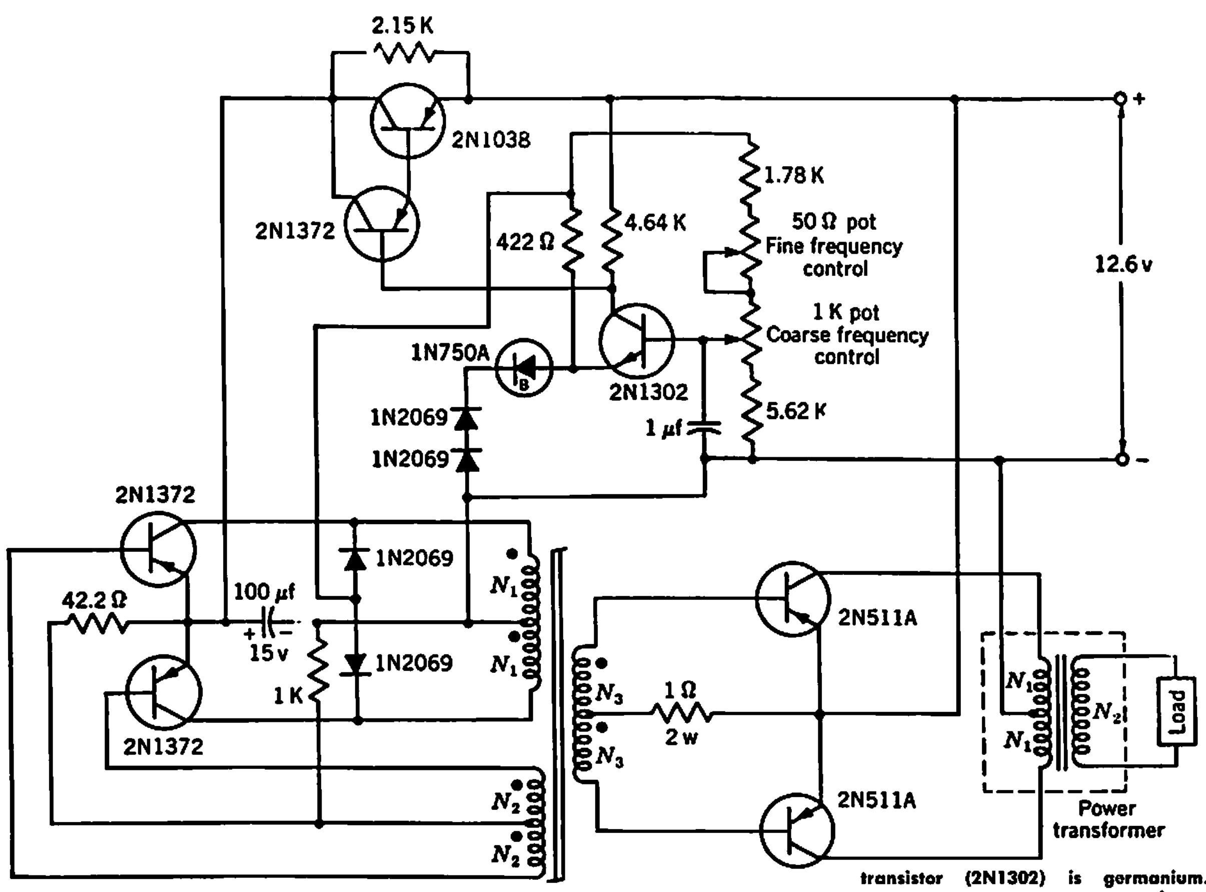
400-W 60-CPS DUAL-TRANSFORMER INVERTER—Input voltage is divided equally among four series primaries so each transistor is subjected only to 60 v when off. Output is 140-v square wave. Efficiency is 95% at full load. Use of dual-transformer configuration makes frequency of oscillation easy to adjust by changing setting of RF, to give exactly 60 cps for any value of load current.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 459.



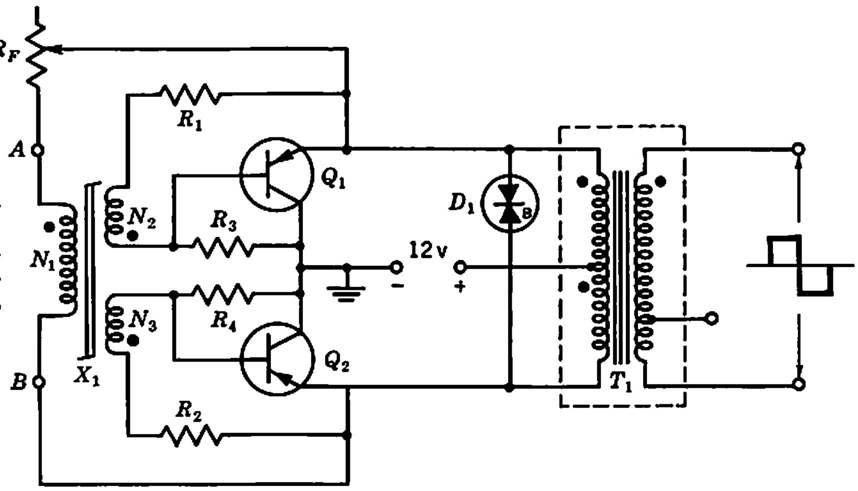
Transformer data:
Core—Magnetics, Inc., 50076-4A
Coil 1: 1,100 turns each of No. 36 wire
Coil 2: 130 turns each of No. 36 wire
Coil 3: 200 turns each of No. 36 wire

Note: All resistors are ½ watt

20-W 60-CPS INVERTER—Low-power version was designed to drive timer. Maximum frequency variation was only 1% for supply-voltage range of 11.5 to 14.5 v.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 458.



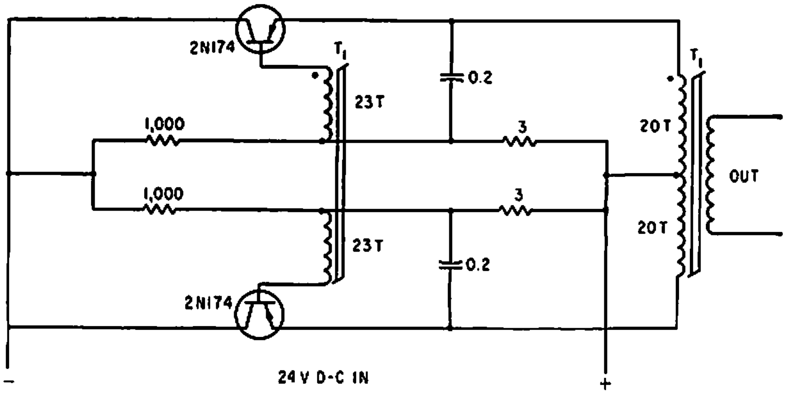
100-W 60-CPS INVERTER—Permits operation of small a-c appliances from auto or boat storage battery. Frequency changes somewhat with temperature because sensing-input transistor (2N1302) is germanium.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 457.



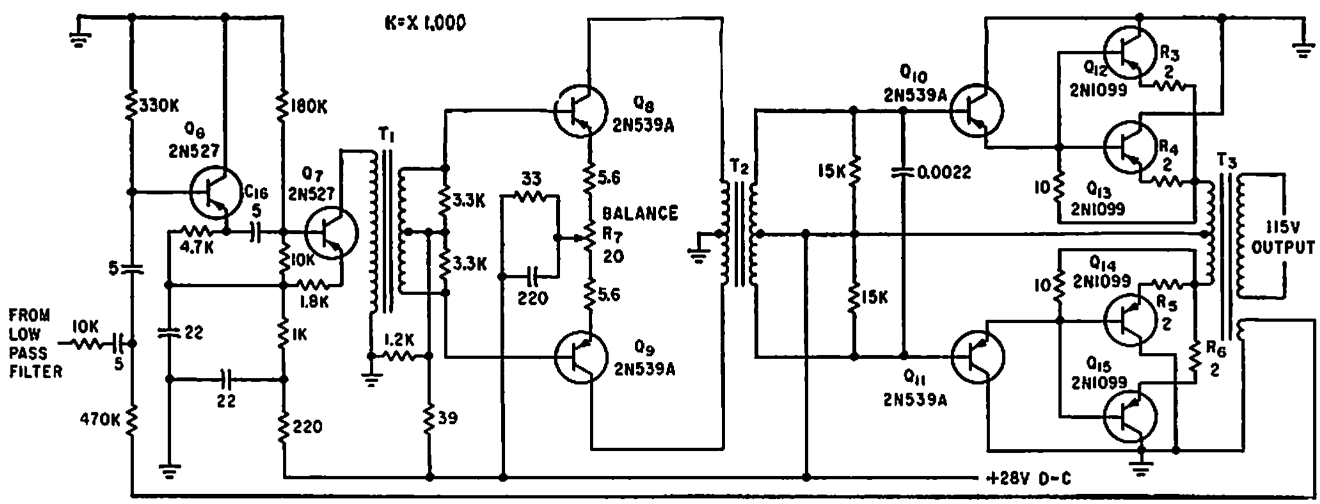
250-W 60-CPS DUAL-TRANSFORMER INVERTER—Provides square-wave output to load from 12-v d-c supply, at 130 v, with efficiency of 85%.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 458.

Parts List

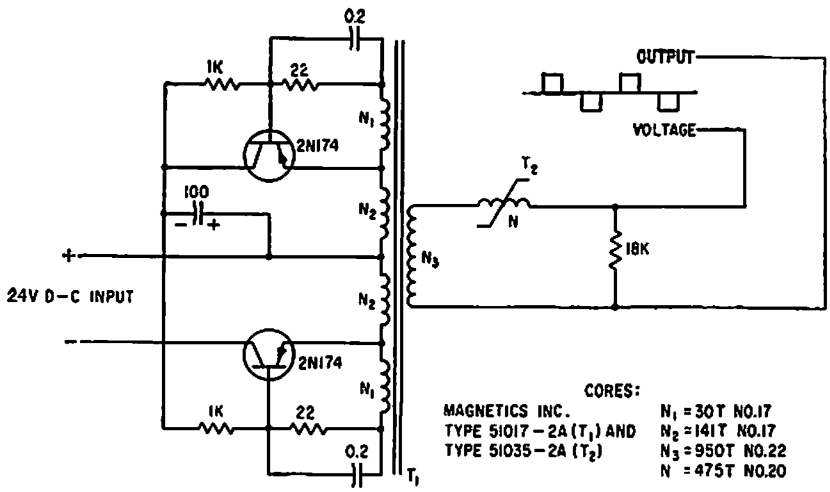
Q_1, Q_2—2N514
D_1—1N1823 (27-volt double-anode clipper)
R_F—20-ohm 5-watt rheostat
R_1, R_2—1 ohm, 5 watts
R_3, R_4—150 ohms, 1 watt
X_1—Tape-wound toroid, 5320-D4 Arnold Engineering Co., or 5000-4A Magnetics, Inc.
N_1—316 turns, #24 heavy Formvar
N_2, N_3—79 turns, #22 heavy Formvar
T_1—Texas Instruments transformer #440401 or equivalent



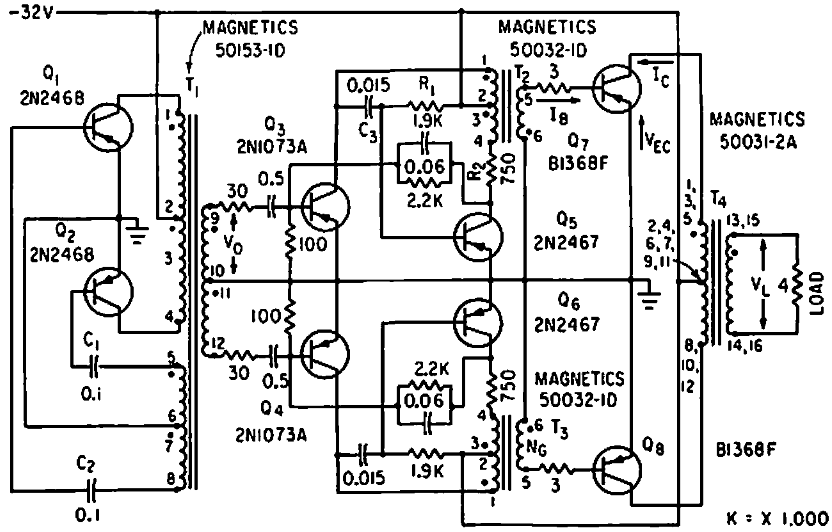
COLLECTOR CAPACITORS SPEED SWITCHING—Capacitors acting with 3-ohm resistors in collector circuits provide energy storage to increase switching speed.—A. G. Lloyd, Speed-Up Circuits Improve Switching of Transistor Inverters, *Electronics*, 34:45, p 92–94.



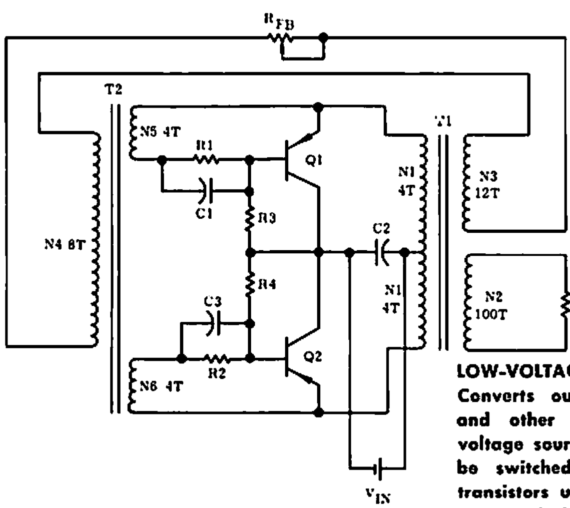
400-CPS INVERTER POWER AMPLIFIER—Has low internal impedance and low distortion, to provide good output voltage regulation for d-c to 400-cps a-c inverter. Uses compounded common-collector output stage. Delivers 55 w at 400-cps with only 2.4% total harmonic distortion.—R. Wileman, Linear Circuits Regulate Solid-State Inverter, *Electronics*, 33:16, p 61–63.



24 V D-C TO SQUARE-WAVE A-C—Will replace sine-wave source because square-wave output is modified by series saturable reactor to have same rms and average values as pure sine wave.—D. Levy, Replacing Sine Wave Sources with Solid-State Inverters, *Electronics*, 34:26, p 80–83.

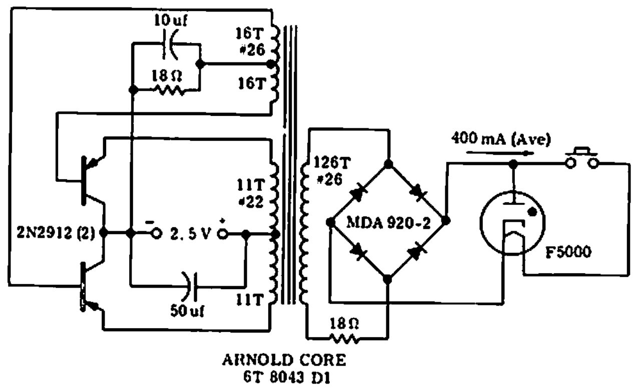


100 W AT 50 KC—Square-wave oscillator Q1-Q2 drives monostable gates Q3-Q5 and Q4-Q6 in parallel, and gates in turn drive push-pull amplifier using 25-amp transistors Q7-Q8 to deliver 100 w to load at 50 kc with overall efficiency of 70%.—S. L. Chin, New Circuit Design Raises Inverter Frequency Limits, *Electronics*, 35:43, p 59–60.

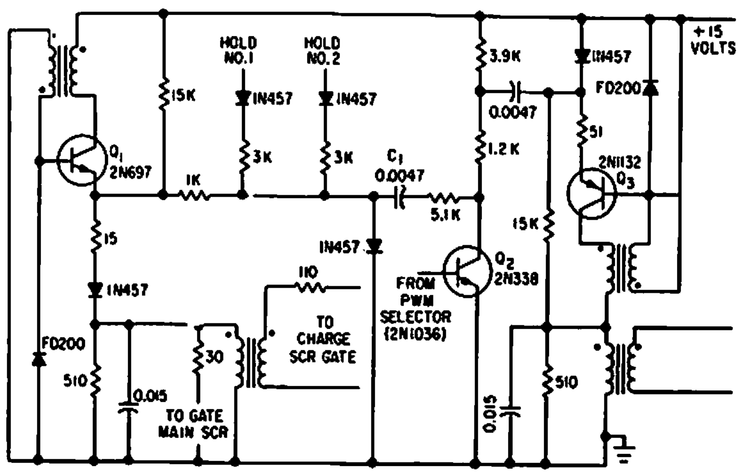


R_1	0.75Ω, 5 w
R_2	0.75Ω, 5 w
R_3	7.5Ω, 5 w
R_4	7.5Ω, 5 w
R_{FB}	1Ω, 5 w
C_1	20 μf, 6 v
C_2	10,000 μf, 6 v
C_3	20 μf, 6 v
T_1	Phoenix Transformer PX2127
T_2	Phoenix Transformer PX2126
Q_1, Q_2	2N2728
VIN	2V 50A

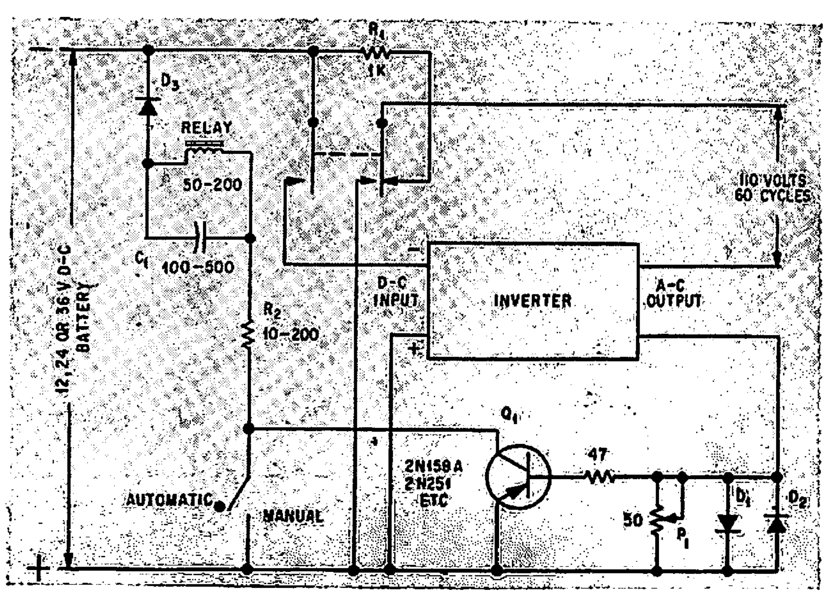
LOW-VOLTAGE HIGH-CURRENT INVERTER—Converts output of solar cells, fuel cells, and other low-voltage sources to higher voltage sources. Currents up to 50 amp can be switched efficiently by 2N2728 power transistors used. Circuit shown provides a-c output which can easily be changed to d-c at desired higher voltage by rectifying and filtering. Use of two transformers minimizes core losses when switching high collector currents. Efficiency is 70% at 60 w output.—J. Takesuye, "A Low Voltage High Current Converter," Motorola Application Note AN-169, Dec., 1965.



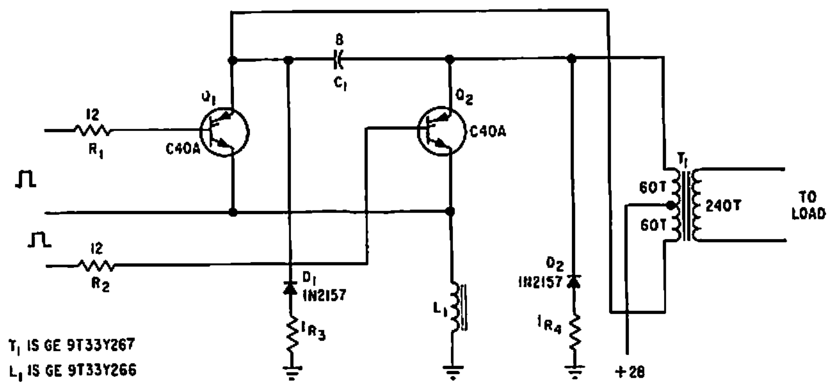
BLACK-LIGHT INVERTER—Operates from 2.5-v rechargeable battery and supplies 400 ma at 26 v to gas arc tube for portable ultraviolet lamp. Efficiency is 80%.—H. F. Weber, "Low Voltage Inverter Features High Frequency Operation with High Efficiency," Motorola Application Note AN-174, Feb. 1966.



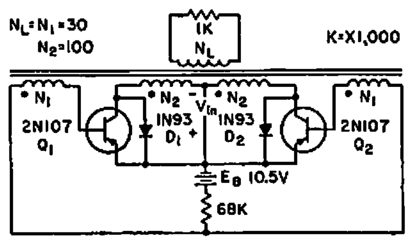
SCR DRIVER—Two types of blocking oscillators generate required turn-on and turn-off pulses for power-switching output stage of inverter.—R. J. Kearns and J. J. Rolfe, Three-Phase Static Inverters Power Space-Vehicle Equipment, *Electronics*, 34:18, p 70–73.



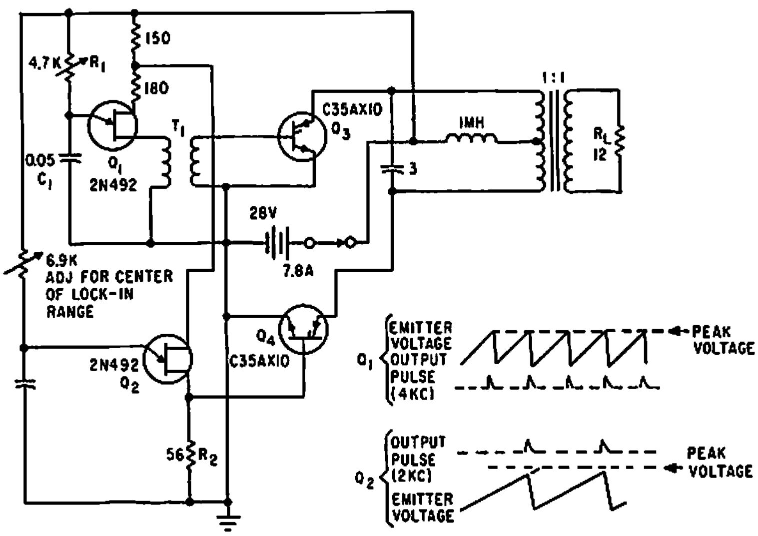
CONTROL CIRCUIT CUTS INVERTER IDLING CURRENT—Reduces standby current to less than 1 ma. Sensing element is pair of back-to-back silicon diodes, D1 and D2. Used when a-c power must be available on demand at many remote outlets even though actually used only few hours a day.—D. W. R. McKinley, Inverter Control Circuit Saves Power, *Electronics*, 34:31, p 56.



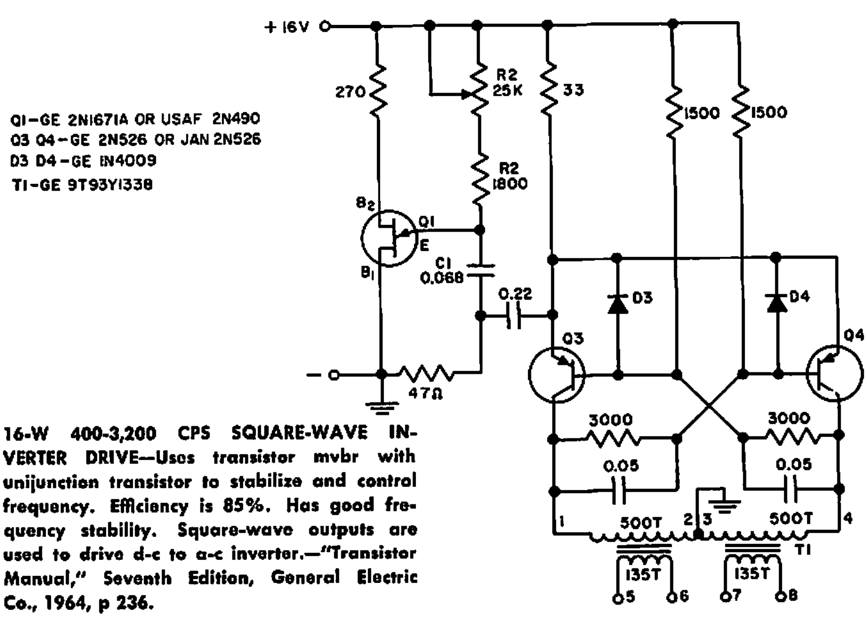
PARALLEL INVERTER FOR REACTIVE LOADS—Produces square-wave output under all load conditions, without creating high voltages across silicon controlled rectifiers during light loads.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.



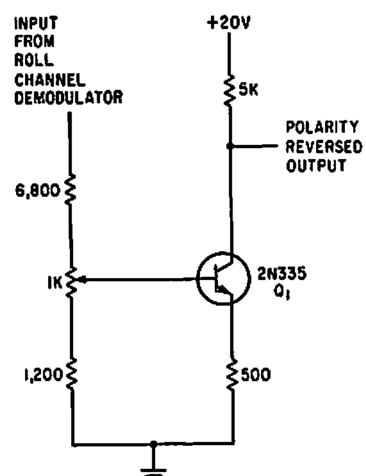
TRANSISTOR-MAGNETIC INVERTER—Signal conversion performance is comparable to that of electromechanical vibrator converters. For power conversion, can be substituted for dynamotor in producing high voltage from low-voltage d-c power source.—C. H. R. Campling, Magnetic Inverter Uses Tubes or Transistors, *Electronics*, 31:11, p 158–161.



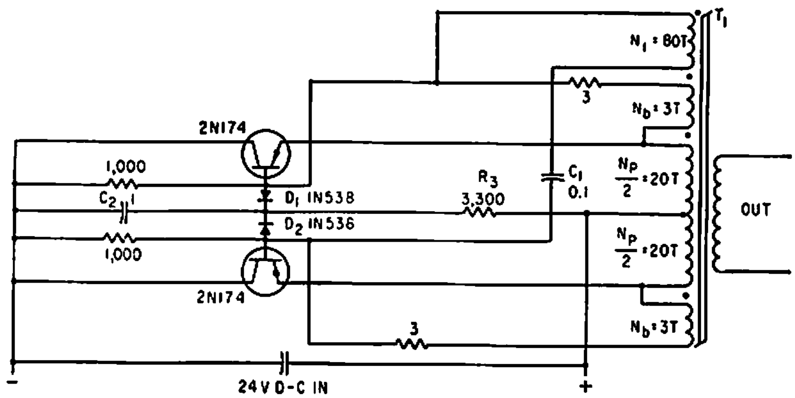
2-KC SCR INVERTER—Circuit shows parallel inverter, but unijunction relaxation oscillators Q1 and Q2 could also trigger series inverter, giving symmetrical operation. Q1 operates at twice the frequency of Q2.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.



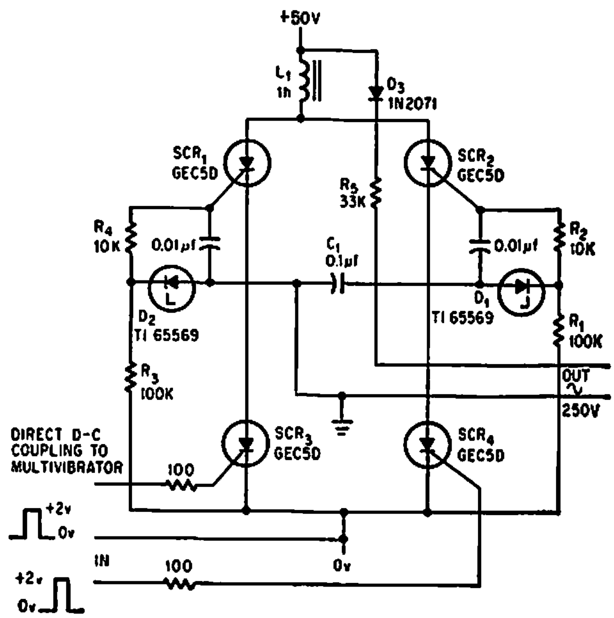
16-W 400-3,200 CPS SQUARE-WAVE INVERTER DRIVE—Uses transistor mvbr with unijunction transistor to stabilize and control frequency. Efficiency is 85%. Has good frequency stability. Square-wave outputs are used to drive d-c to a-c inverter.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 236.

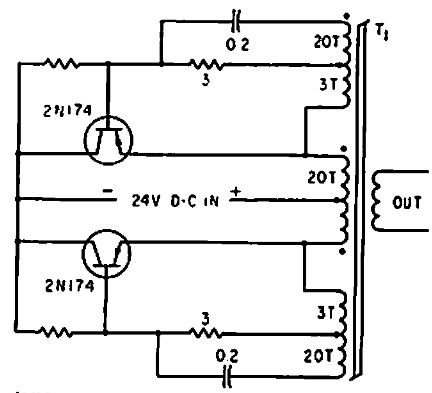


UNITY-GAIN INVERTER—Provides for differential roll motion of missile autopilot.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33:43, p 60–64.



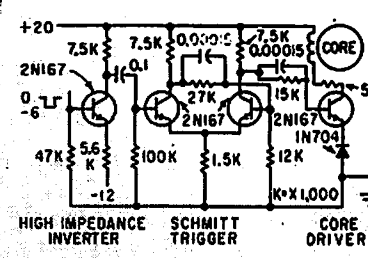
TRANSFORMER WINDING SPEEDS SWITCHING—Addition of speed-up winding N1 to conventional transformer arrangement of inverter, with C1 in series with N1, increases switching speed. Clipping of resulting base-collector voltage spikes is provided by network D1-D2-C2-R3.—A. G. Lloyd, Speed-Up Circuits Improve Switching of Transistor Inverters, *Electronics*, 34:45, p 92–94.



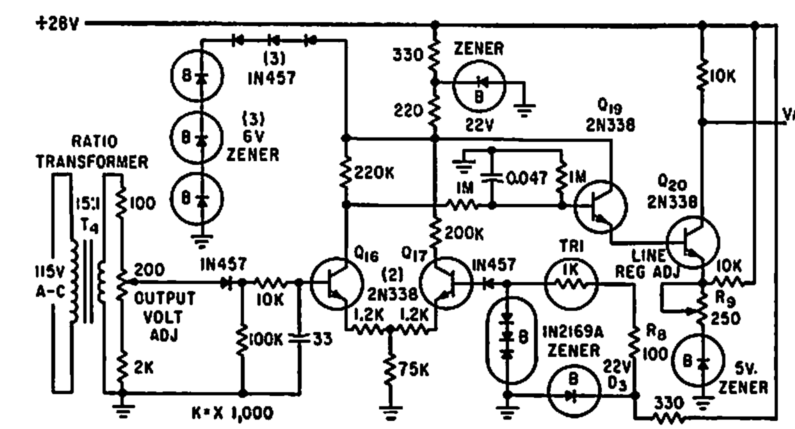


TRANSFORMERLESS SCR BRIDGE INVERTER—Slave-triggering of SCR1 and SCR2 with capacitive load cuts cost in half by eliminating costly gate transformers. Input of 800 pps (both half-cycles of 400-cps mvbr) gives 400-cps sine-wave output with peak amplitude of 350 v, because bridge switching inverts alternate pulses.—L. M. Tibbets, Scr Bridge Inverter Eliminates Transformers, *Electronics*, 39:18, p 98–99.

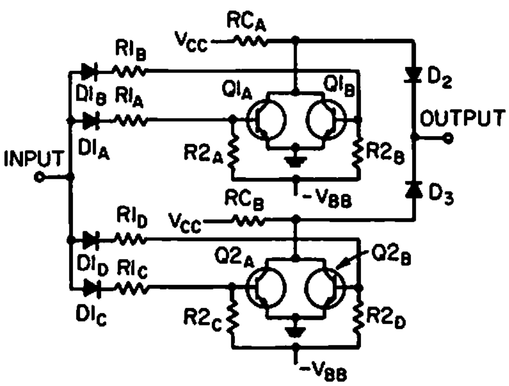
INVERTER BASE SPEED-UP WINDINGS—Individual speed-up windings and series capacitors for each transistor base reduce switching times to as little as 4 microsec for 2N174's and to 2 microsec for some germanium power transistors.—A. G. Lloyd, Speed-up Circuits Improve Switching of Transistor Inverters, *Electronics*, 34:45, p 92–94.



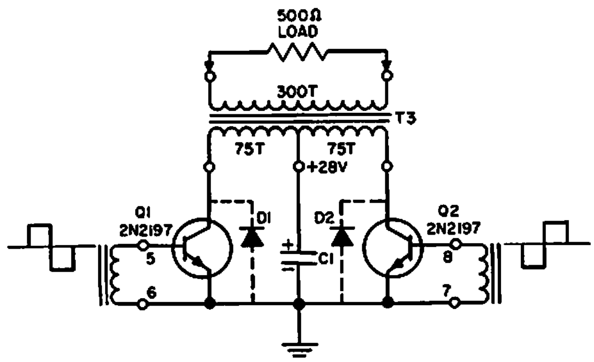
PHASE INVERTER FOR CODE CONVERTER—In addition to phase reversal of input signal, single npn transistor provides isolation between negative input pulse and core driver, which is Schmitt trigger having discrimination level within 10% of −4.5 v including phase inverters. Signals below that level are disregarded. Signal range from 6 to 12 v will cause pulse output from Schmitt, with duration dependent on duration of input signal. When Schmitt trigger emits pulse, 1N704 driver supplies 30-ma current pulse, writing a ONE into its associated core.—R. Wasserman and W. Nutting, Solid-State Digital Code-to-Code Converter, *Electronics*, 32:50, p 60–63.



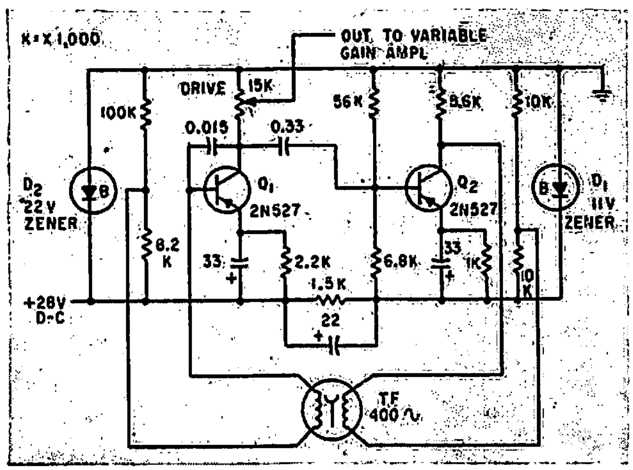
INVERTER REFERENCE ELEMENT—Accuracy and stability of d-c to 400-cps a-c inverter are achieved by temperature compensation of 1N2169A zener reference element. Silicon transistors are used where d-c levels are handled.—R. Wileman, Linear Circuits Regulate Solid-State Inverter, *Electronics*, 33:16, p 61–63.



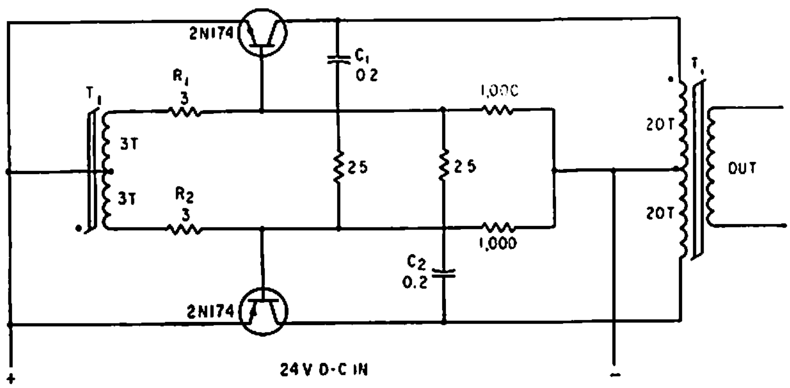
LOGICALLY REDUNDANT INVERTER—Symmetrical design with series-based diodes makes inverter independent of any single component failure.—T. Golstein, Reliable Circuits Through Redundancy, *EEE*, 11:3, p 56–59.



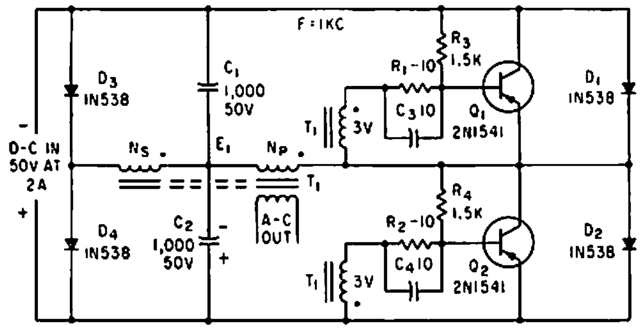
PARALLEL SQUARE-WAVE D-C TO A-C INVERTER—Receives square-wave inputs from separate drive circuit (not shown), causing Q1 to conduct half the time while Q2 is blocking, and vice-versa. Current from 28-v supply flows alternately through halves of transformer primary, to produce 400-cps a-c voltage across load.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 235.



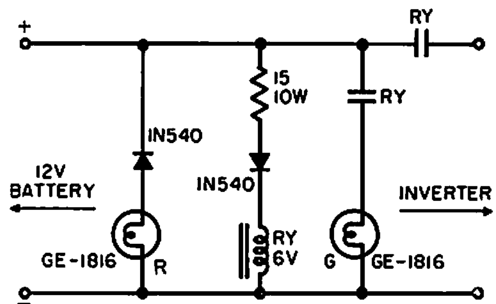
400-CPS FORK CONTROL—Tuning-fork oscillator gives frequency accuracy of 0.01% for d-c to a-c inverter. Consists essentially of two-stage amplifier, output of which is regeneratively coupled to input through tuning fork.—R. Wileman, Linear Circuits Regulate Solid-State Inverter, *Electronics*, 33:16, p 61–63.



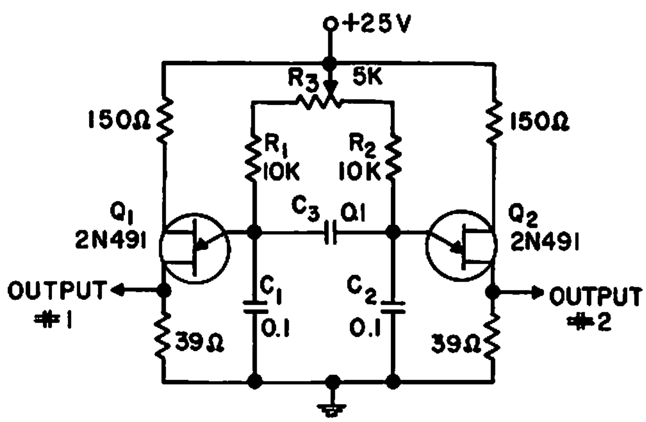
POSITIVE FEEDBACK BOOSTS SWITCHING SPEED—Base resistors R1 and R2 allow addition of cross-coupled positive-feedback capacitors C1 and C2 to increase high-frequency gain of feedback loop and provide energy storage to drive off transistor fully on when core saturates.—A. G. Lloyd, Speed-Up Circuits Improve Switching of Transistor Inverters, *Electronics*, 34:45, p 92–94.



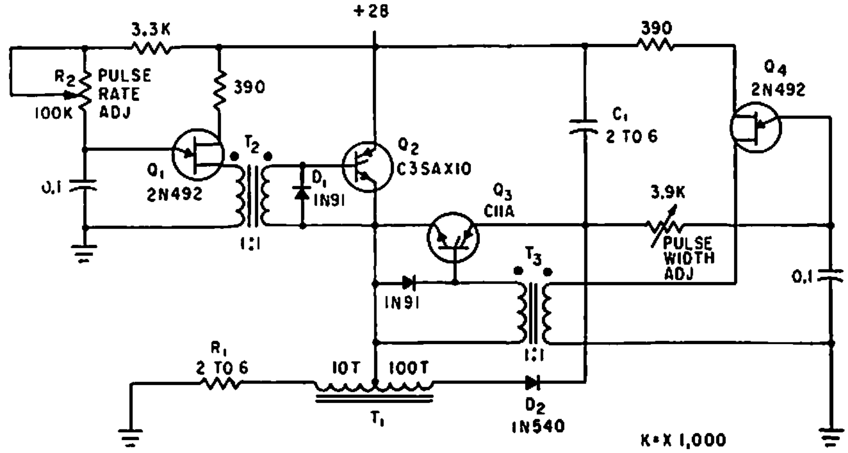
SELF-EXCITED HALF-BRIDGE—Uses only two transistors. Suitable for both two-phase and three-phase applications. Basic circuits can be connected in series for high-voltage operation. Maximum transistor off voltage equals input voltage of half-bridge, making 80-v inverter practical for germanium transistors and 150 v for silicon.—A. G. Lloyd, Half-Bridge Inverter Provides Economical Three-Phase Power, *Electronics*, 34:37, p 62–65.



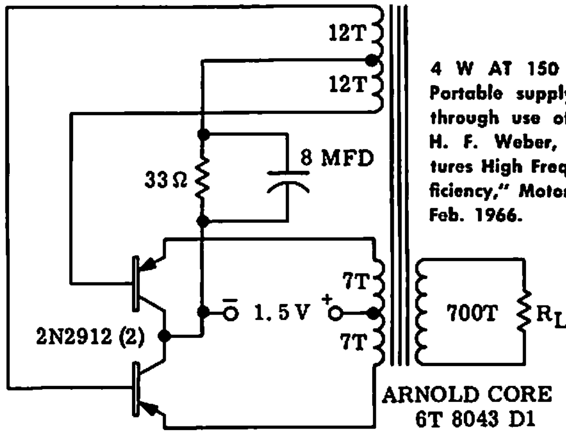
WRONG-POLARITY PROTECTION—Provides built-in protection of transistors in inverter from incorrect polarity of connection to 12-v battery. Used between inverter and battery. Green bulb G lights and relay operates for correct polarity. With wrong polarity, relay does not operate and red bulb R comes on to indicate error.—J. J. Pirch, Inverter Control, *EEE*, 11:3, p 44.



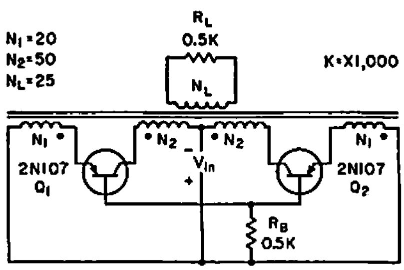
SYNC FOR SCR PARALLEL INVERTER—Double-output pulse generator uses two relaxation oscillators synchronized by C3 to produce high-energy pulses alternately from two separate sources, in correct timing sequence from instant that supply voltage is switched on. Synchronism is required to prevent inverter failure.—SCR Parallel Inverters in Correct Timing Sequence, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 66.



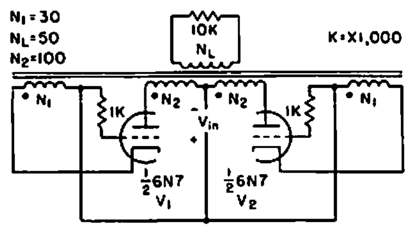
INVERTER WITH CAPACITOR TURNOFF—Load power factor variations do not affect turnoff time. Varying trigger rate of Q2 varies power delivered to R1. Trigger rate can be adjusted automatically for load regulation.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.



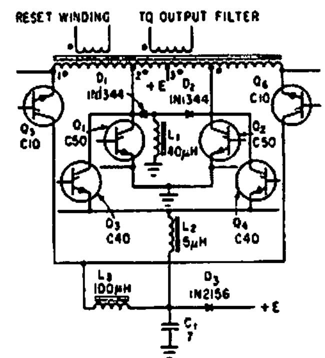
4 W AT 150 V FROM FLASHLIGHT CELL—Portable supply operates at 80% efficiency through use of rapid-switching transistors.—H. F. Weber, "Low Voltage Inverter Features High Frequency Operation with High Efficiency," Motorola Application Note AN-174, Feb. 1966.



DIFFERENTIAL-MVBR INVERTER—Magnetic inverter circuit with differentially connected windings oscillates reliably without use of current bias. Small spike in square-wave output can be eliminated by connecting small capacitor between collector and emitter of each transistor.—C. H. R. Campling, Magnetic Inverter Uses Tubes or Transistors, *Electronics*, 31:11, p 158–161.

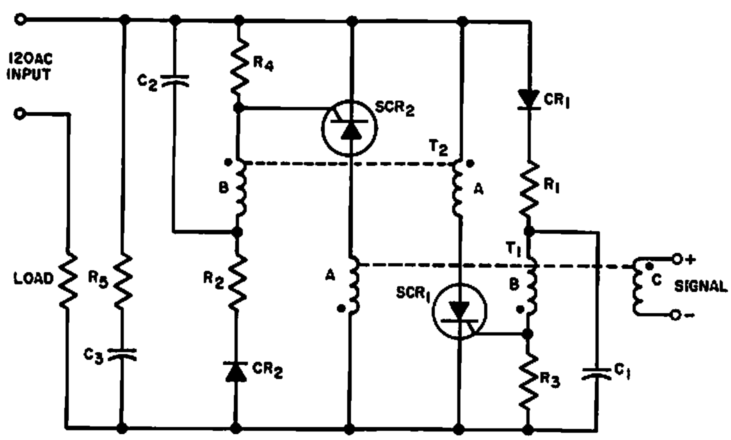


DUAL-TRIODE DIFFERENTIAL INVERTER—Uses electron tubes as switching elements in place of transistors. Although tubes are less efficient, availability of a suitable combination of voltage rating, current rating, and high-speed switching capacity may make tubes better than transistors in some signal or power converter applications.—C. H. R. Campling, Magnetic Inverter Uses Tubes or Transistors, *Electronics*, 31:11, p 158–161.



THREE-PHASE OUTPUT STAGE—Scr's provide power switching for static inverter designed to develop 500 w of three-phase 115-v 400-cps power from input of 22 to 29 v d-c.—R. J. Kearns and J. J. Rolfe, Three-Phase Static Inverters Power Space-Vehicle Equipment, *Electronics*, 34:18, p 70–73.

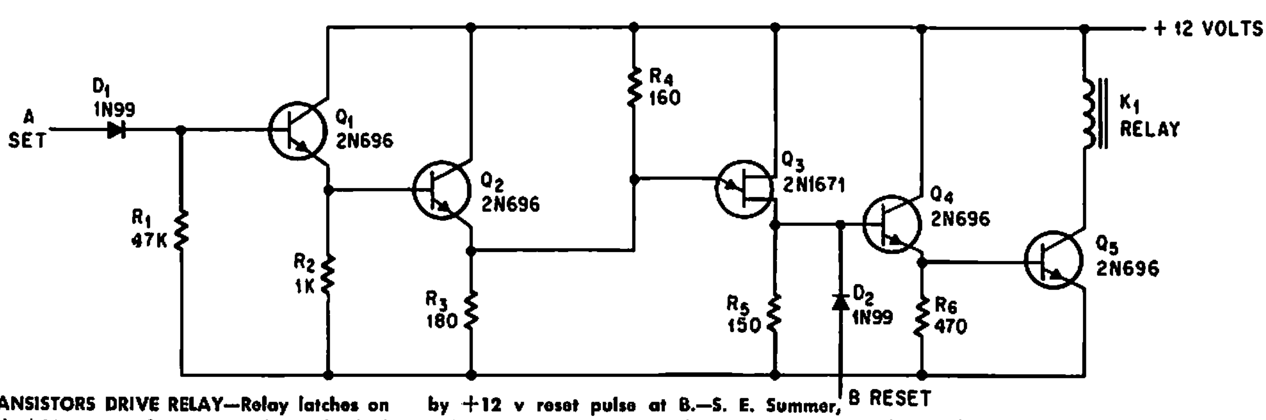
CHAPTER 45
Latching Circuits



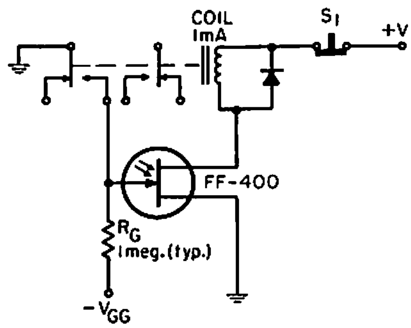
R1,R2 — 10K, 1 WATT
R3,R4 — 10 OHMS, 1/2 WATT
R5 — 15 OHMS, 1 WATT
C1,C2 — 0.25 MFD, 200 VOLTS
C3 — 0.5 MFD, 600 VOLTS
SCR1,SCR2 — G-E C35B OR C11B
CR1, CR2 — G-E 1N1695

T1 — MAGNETICS, INC ORTHONOL CORE #50007-1A
A 5 TURNS-#14 AWG
B 200 TURNS-#28 AWG
C 100 TURNS-#28 AWG
T2 — MAGNETICS, INC ORTHONOL CORE #50007-1A
A 5 TURNS-#14 AWG
B 200 TURNS-#28 AWG

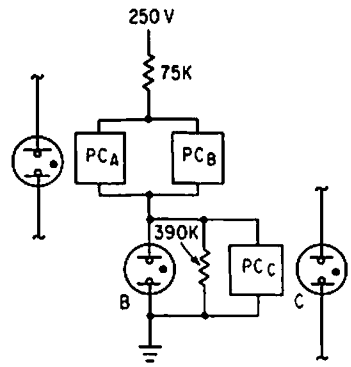
A-C STATIC LATCHING RELAY—Is equivalent to single-pole electromechanical latching relay with electrically isolated solenoid. Once turned on, circuit remains in conducting state even though line voltage is interrupted for long periods of time. Positive reset action requires that minimum load current of 1 amp flow whenever circuit is closed.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 106.



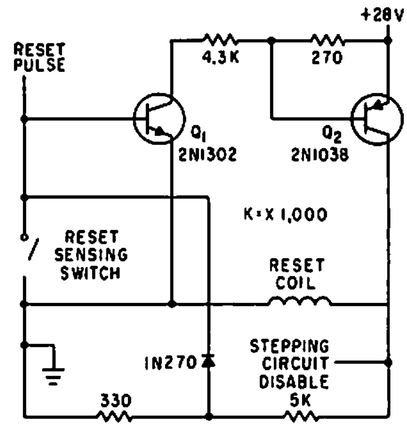
TRANSISTORS DRIVE RELAY—Relay latches on with +12 v set pulse at A, and is unlatched by +12 v reset pulse at B.—S. E. Summer, Unijunction Transistor Latches Relay With Short Pulses, *Electronics*, 38:9, p 62.



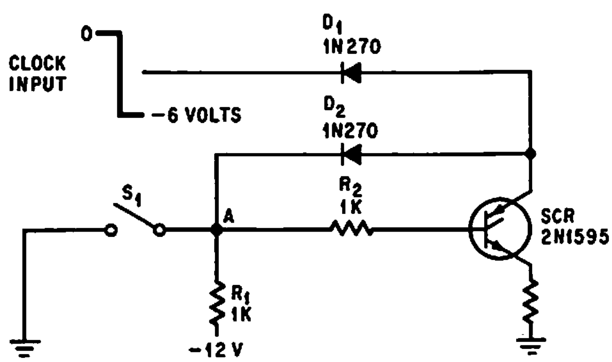
PHOTOELECTRIC LATCHING RELAY—Photosensitive fet serves as relay in light-activated smoke detectors, end-of-tape sensing in tape recorders, and light-activated alarms.—B. R. Smith, Light-Activated Latching Relay, *EEE*, 14:8, p 167.



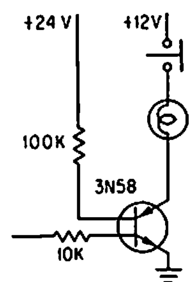
NEON-PHOTOCONDUCTOR LATCHING CIRCUIT—Cadmium sulfide photoconductor PC and Ne2H neon lamps give low-cost latch. When neon C is energized to provide input to PCA, neon B remains on, independent of input A, due to feedback from neon B to PCB. Latch is reset by input to PCC.—J. L. Paterson, Will Neon Photoconductors Replace Relays in Low-Speed Logic?, *Electronics*, 36:18, p 46–49.



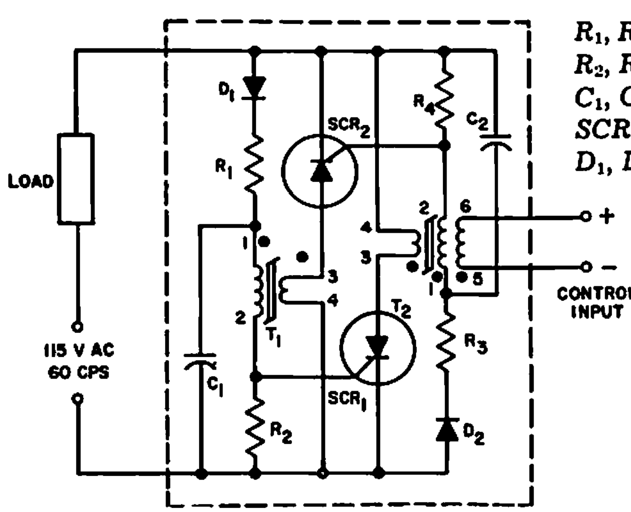
STEPPER RELAY RESET AND LATCH—Reset circuit deenergizes flip-flop that controls coils of stepper relay, and provides latching to keep reset coil energized until wiper senses reset contact.—F. W. Kear, Coils Operate Stepping Relay at Higher Speed, *Electronics*, 35:6, p 60–63.



POSITIVE GATING OF CLOCK PULSES—Adding scr latch to diode gate allows output to follow clock input when S1 is closed. When S1 is open, output will be fixed at existing clock level, without putting extra count into register.—R. A. Wilson, Latching Gate Removes Counter Ambiguity, *Electronics*, 39:7, p 91–92.

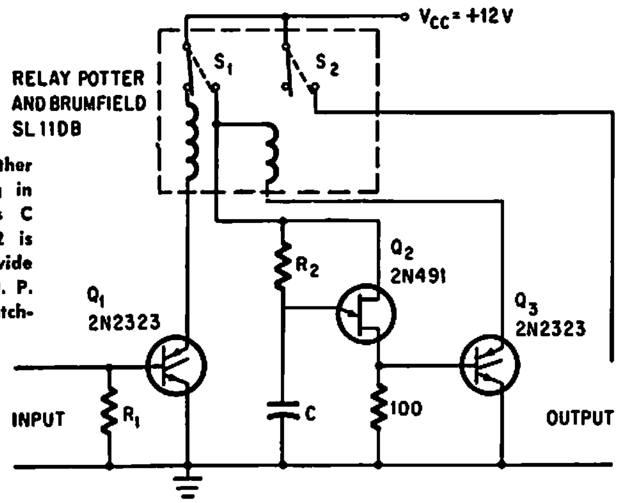


TRANSIENT-IMMUNE SCR LATCHING CIRCUIT—With 100,000-ohm resistor of silicon controlled switch returned to +24 v, latching circuit for lamp is immune to transient spikes of up to 12 v as well as to rate effect when turned off.—R. A. Stasior, How to Suppress Rate Effect in PNPN Devices, *Electronics*, 37:2, p 30–33.

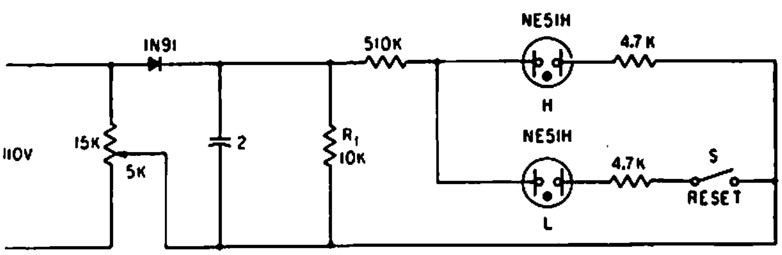


R_1, R_3 10 K, 1 W,	T_1, T_2 Magnetics Inc.
R_2, R_4, 10 ohms ½ W,	Orthonol #50007-1A
C_1, C_2, 0.25 μf,	1-2 200 turns #28 AWG
SCR_1, SCR_2 C10H or C35H	3-4 5 turns #14 AWG
D_1, D_2 1N1695	5-6 100 turns #28 AWG

SCR A-C LATCHING RELAY—Relay is activated by d-c or a-c control current in single electrically isolated control winding. Can switch load power up to 1.7 kw. Uses magnetic firing circuit in which saturable core is not required to sustain gate voltage for full half-cycle, thereby permitting use of smaller core. Load current must be above 1 amp for conduction to be maintained.—Solid State Latching Relay, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 226.



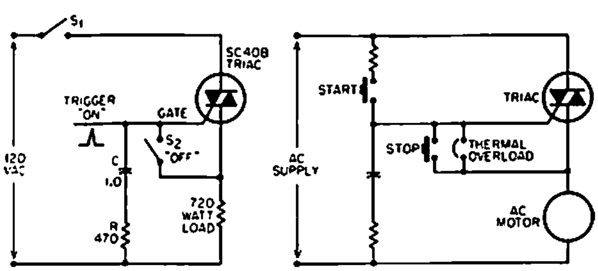
TRANSIENT DETECTOR—Transient or other pulse at input turns on scr Q1, pulling in dpdt latching relay. Q2 then charges C through R2 until emitter voltage of Q2 is high enough to make it conduct and provide trigger pulse for Q3 to unlatch relay.—D. P. Lynch, Unijunction Transistor Turns off Latching Relay, *Electronics*, 38:23, p 109.

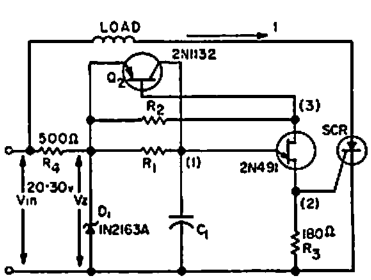


	EXTING. VOLTAGE	FIRE VOLTAGE
L	55	67
H	70	90

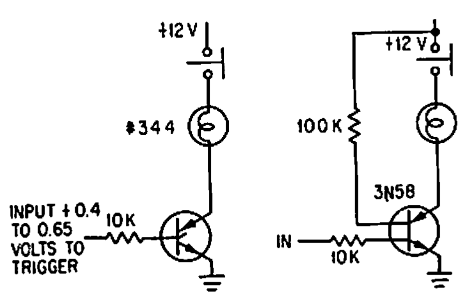
VOLTAGE DIP INDICATOR—Two neon lamps in parallel, with different striking voltages, form neon latch. After circuit is activated, next line voltage dip below preset level turns on lamp L. Circuit is then disabled until reset button is pressed.—T. D. Koranye, Thyratron Monitors Line-Voltage Dips, *Electronics*, 34:1, p 126.

120 V A-C LATCH—Bidirectional controlled rectifier (G.E. Triac) replaces more complicated scr or power transistor circuits for static switching of a-c power circuits. Can be adapted to simulate action of magnetic starter for a-c motor. Momentary closing of start switch (in circuit at right) latches Triac on and starts motor.—F. W. Gutzwiller, Simplified 120 VAC Latching Circuit, *EEE*, 13:8, p 77.



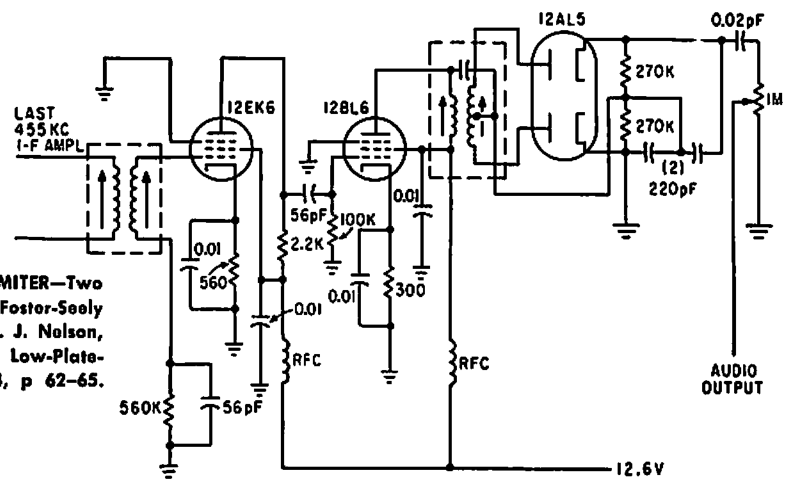


UJT LATCHUP FOR SCR's—Insures that scr will turn on properly when driving inductive load under control of unijunction transistor. Circuit action holds unijunction in saturation, causing scr gate voltage to be continuous rather than pulsating. Values of R1 and C1 are chosen to give desired time delay.—J. W. McAnally, Unijunction Latchup for SCR's Driving Inductive Loads, *EEE*, 11:7, p 31.

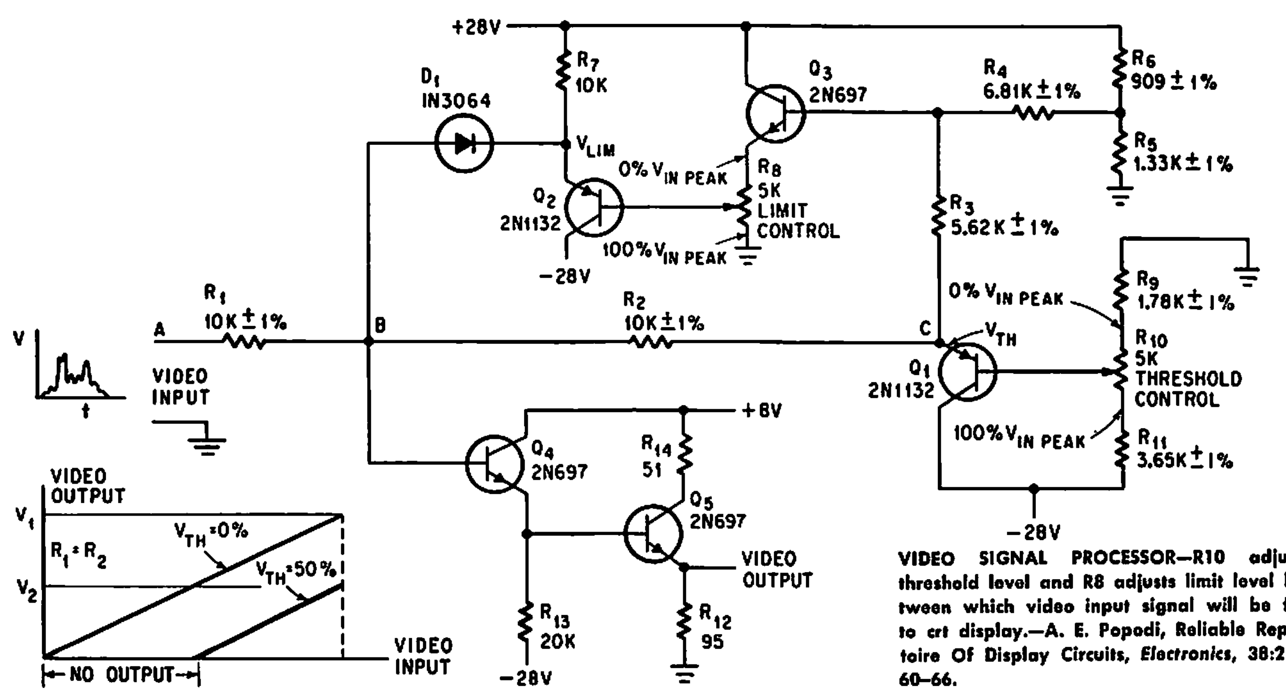


SCR LATCHING CIRCUIT WITH RATE-EFFECT SUPPRESSION—With basic scr latching circuit (at left) for latching on lamp when input voltage level is exceeded, resetting of circuit by opening supply lead exposes scr to fast transients and possible turn-on due to rate effect. Adding 100,000-ohm resistor and using four-terminal silicon controlled switch suppresses rate effect.—R. A. Stasior, How to Suppress Rate Effect in PNPN Devices, *Electronics*, 37:2, p 30–33.

CHAPTER 46
Limiter Circuits

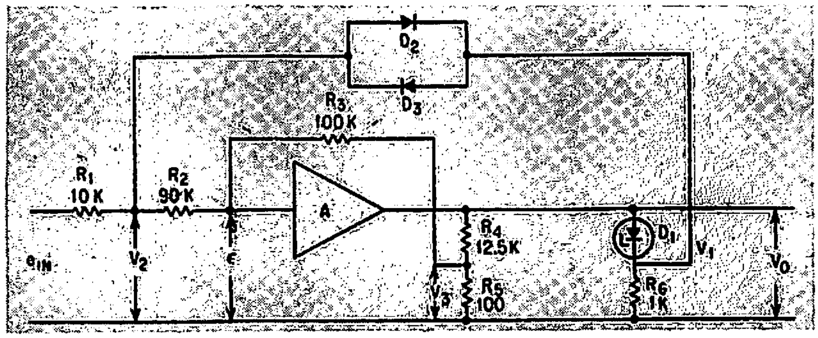


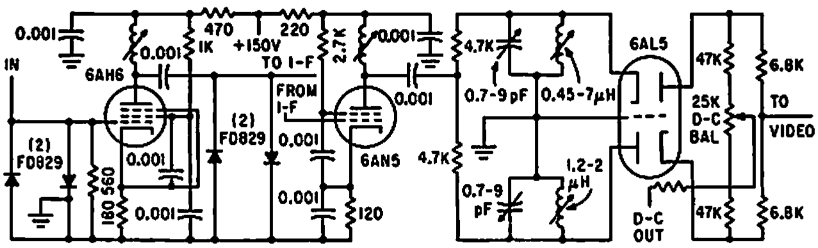
MOBILE DISCRIMINATOR AND LIMITER—Two limiter stages in cascade precede Foster-Seely discriminator.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



VIDEO SIGNAL PROCESSOR—R10 adjusts threshold level and R8 adjusts limit level between which video input signal will be fed to crt display.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.

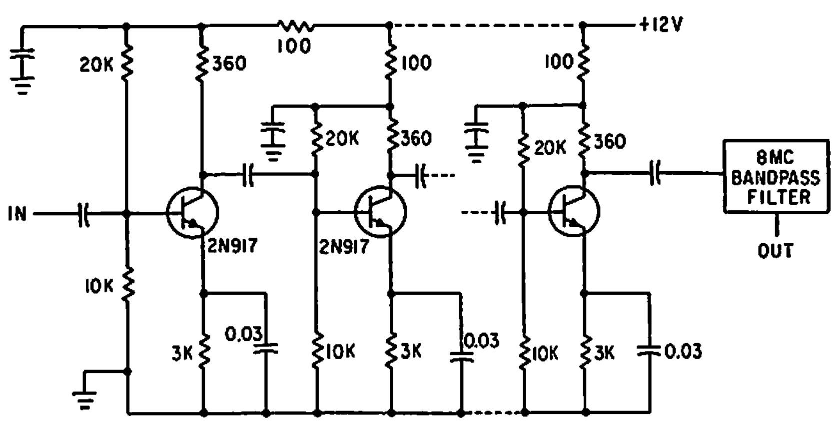
PREVENTS AMPLIFIER OVERLOAD—Zener 6.8-v diode shunts output while feedback diodes limit input. With input below 40 mv, output is below −5 v and diodes D1, D2, and D3 are biased off. When output exceeds −6.3 v, diodes act to clamp output at −6.8 v and maintain linear voltage relationships within the amplifier, preventing its saturation and allowing recovery from overloads.—J. V. Dirocco and J. W. Peghiny, Low-Level Encoding Approach: Latest Details of Titan II Telemetery, *Electronics*, 35:47, p 36–39.

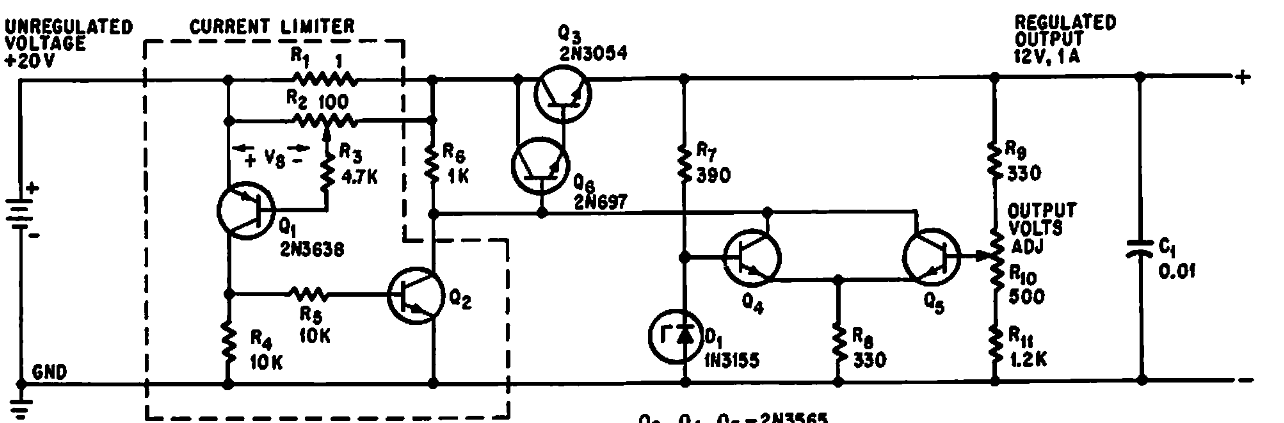




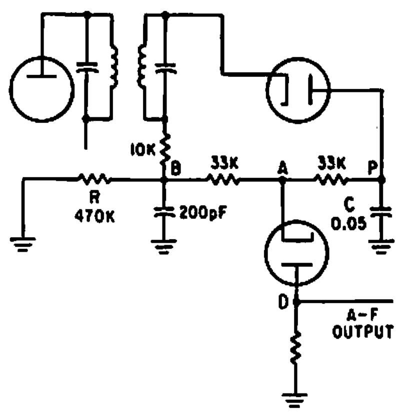
DIODE PAIRS—High-speed silicon diode pairs in two-stage limiter for telemetry, measuring, afc systems, and f-m systems give 5% linearity over 6-Mc bandwidth. Associated discriminator uses two single poles resistively coupled to driving tube.—High-Speed Diodes Make Limiting Smooth, *Electronics*, 35:27, p 80.

80 DB DYNAMIC RANGE AT 8 MC—Uses five identical cascaded stages with filter to restore sinusoidal waveform. Phase-shift variations are only 10°. Limits input signal by collector current cutoff only. Used in multichannel-tracking receiving system.—S. P. W. Stranddorf, High-Frequency Limiter Amplifier Solves Phase-Shift Problems, *Electronics*, 35:46, p 44–45.

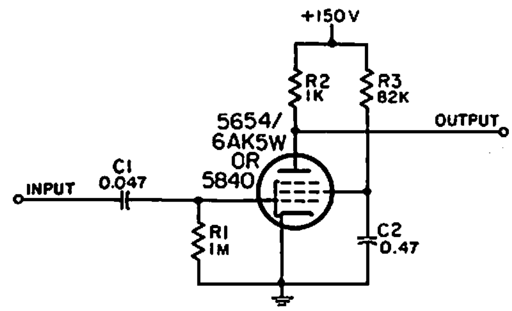




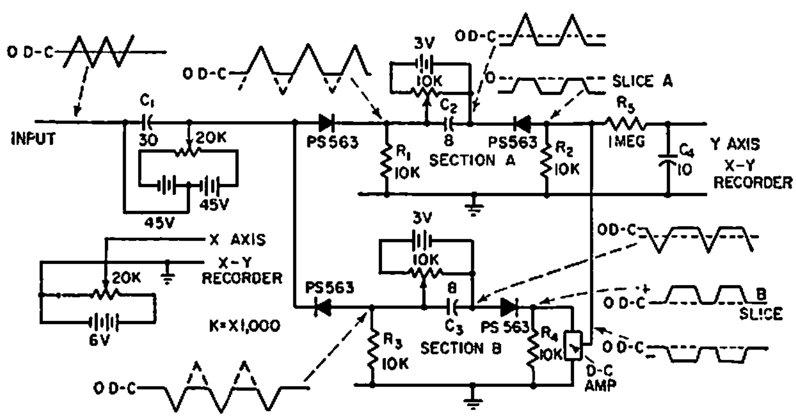
ADJUSTABLE CURRENT LIMITER—Q1 conducts when current exceeds limiting value determined by setting of R3, turning on Q2 and in effect grounding base of Q6, to prevent significant current flow in Q3. Circuit resets automatically when overload is removed.—P. Galluzzi, Adjustable Current Limiter for Regulated Power Supply, *Electronics*, 39:5, p 107.



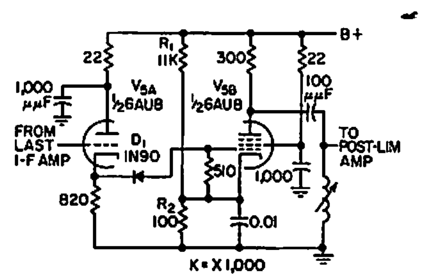
SUPPRESSING NOISES UP TO 1,000 TIMES SIGNAL LEVEL—Improved noise limiter for airborne transceiver uses large RC time constant. Plate of detecting diode is negatively charged by a-f signal, held steady by C. For noise impulses, point A swings positively and limiter diode blocks rectified noise signal. —K. Makino and T. Yamanaka, Servo-Tuned Transceiver for Airborne VHF Communications, *Electronics*, 35:1, p 82–85.



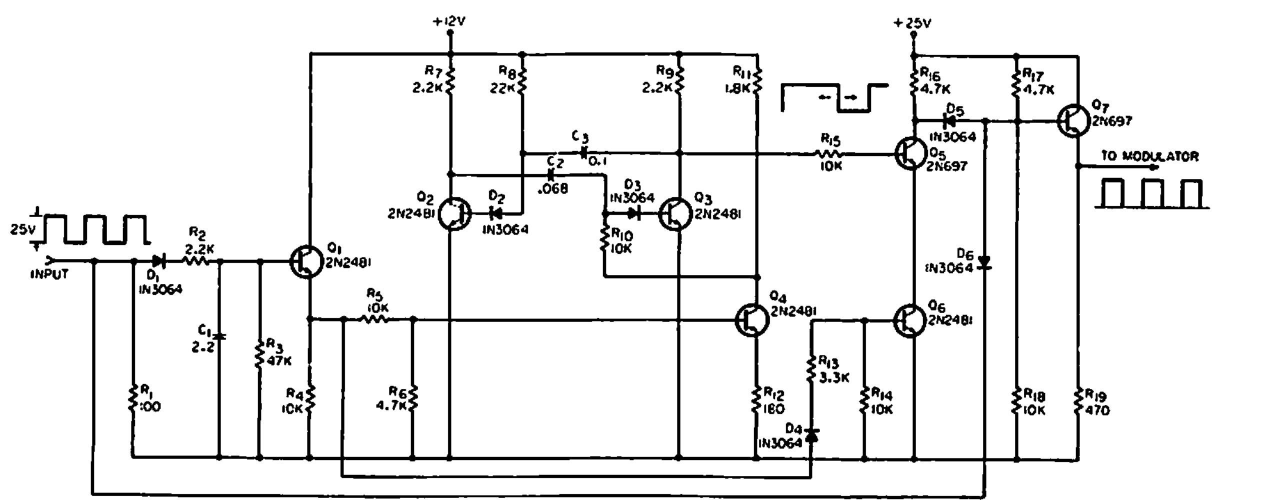
PREFERRED VIDEO LIMITER—Used to amplify and limit low-level video signals. Capable of handling very fast rise times. Maximum duty factor is 4%. Limiting level is within 35% of 4.8 v, depending on variations in tube and components.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, PC 21, p 21–2.



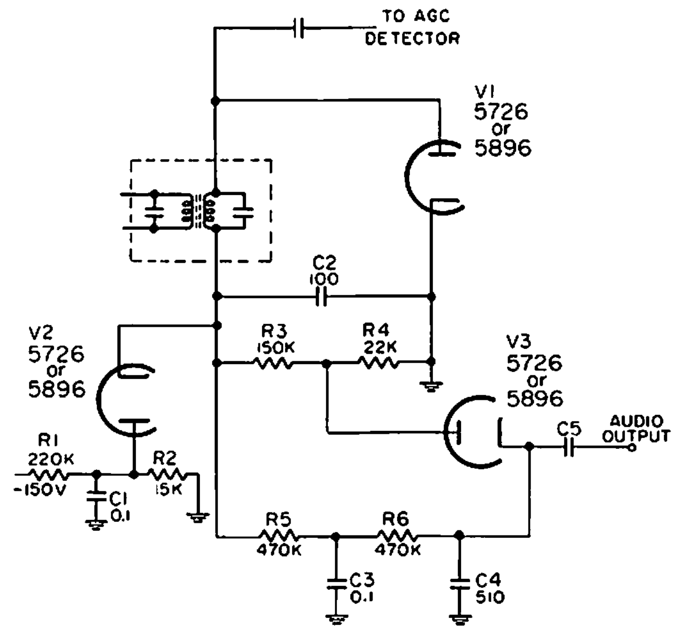
RADAR NOISE CLIPPER-LIMITER—Used in plotting amplitude-distribution density of noise and vibration signals over range of 1 to 10,000 cps. Section A samples d-c biased input signal between zero and positive half of slice width. Section B similarly handles negative half. Output of B is inverted and biased in d-c amplifier to produce positive square wave. Recorder plots average of combined outputs from A and B sections.—D. J. Zoll, Simple Plotter Analyzes Radar Noise Rapidly, *Electronics*, 31:11, p 162–164.



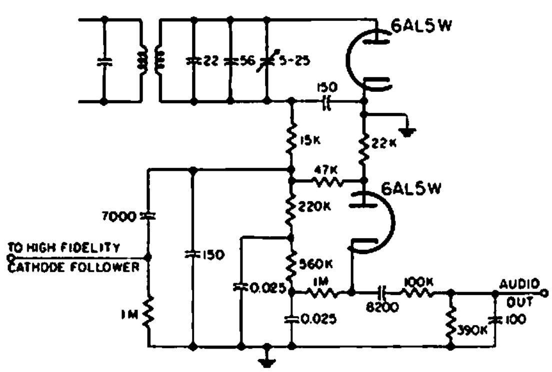
SYMMETRICAL LIMITER—Used in visual receiver of microwave relay. Signal is fed through triode cathode follower and diode-coupled to grid of pentode. D1 cuts off on positive r-f swing above d-c bias set by R1 and R2, to prevent grid of V5B from going positive and provide clipping on negative swing.—T. G. Custin and J. Smith, Relay System Diplexes Audio and Color Video, *Electronics*, 31:25, p 64–67.



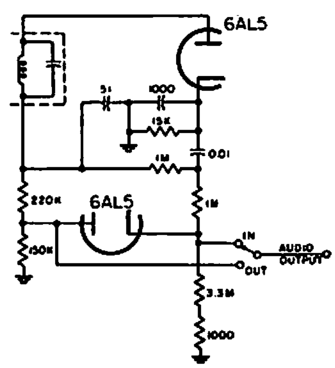
DUTY-CYCLE LIMITER—When duty cycle exceeds 1%, countdown begins and duty cycle is held at about 1%. Uses voltage-controlled astable mvbr consisting of Q2, Q3, and Q4, which runs unsynchronized with input prf.—C. Samocki, Duty-Cycle Limiter, *EEE*, 13:9, p 76.



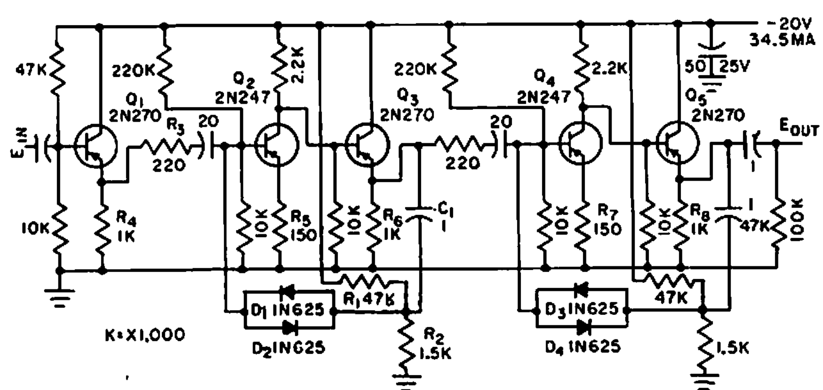
PREFERRED DETECTOR AND NOISE LIMITER—Used in a-m receivers to demodulate i-f output and reduce effect of short-duration electrical disturbances or impulse interference. Audio output is 20 to 150 mv rms, and upper 3-db frequency is 7,000 cps.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 62, p 62-2.



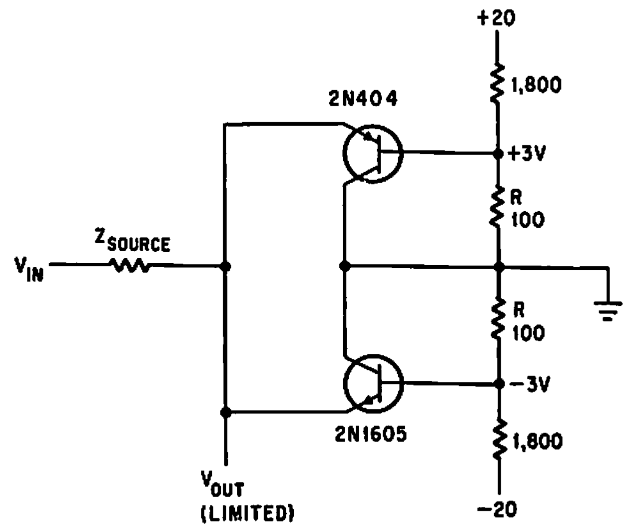
AUDIO DETECTOR WITH NOISE LIMITER—Conventional 6AL5 series noise limiter and diode detector are here augmented by elaborate tone control network.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12-1.



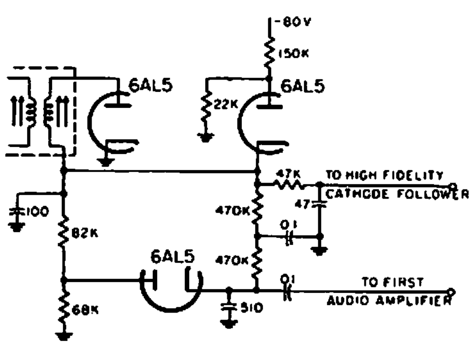
AUDIO DETECTOR WITH NOISE LIMITER—Uses conventional 6AL5 series noise limiter arrangement.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12-1.



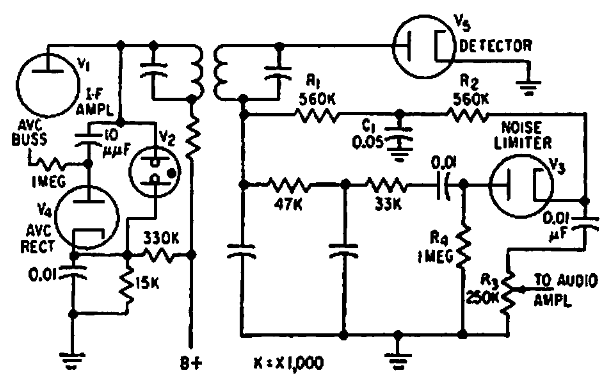
FAST-ACTING LIMITER—Provides compression of sine or square waves with minimum of phase distortion. Feedback paths in two direct-coupled transistor pairs improve limiting action of 100-kc pulse amplifier in which signals under 5 mv get 35 db of gain, with gain dropping to unity as signal strength increases to peak of 400 mv.—L. H. Dulberger, Pulse Amplifier with Nonlinear Feedback, *Electronics*, 31:45, p 86-87.



3-V BIPOLAR LIMITER—Upper transistor conducts when positive input pulse exceeds 3 v, and lower transistor shunts excess current to ground similarly for negative inputs above 3 v, to keep output at 3 v for both polarities. Circuit provides own reference voltage.—S. B. Gray, Bipolar Limiter Reduces D-C Loss, *Electronics*, 38:24, p 65.

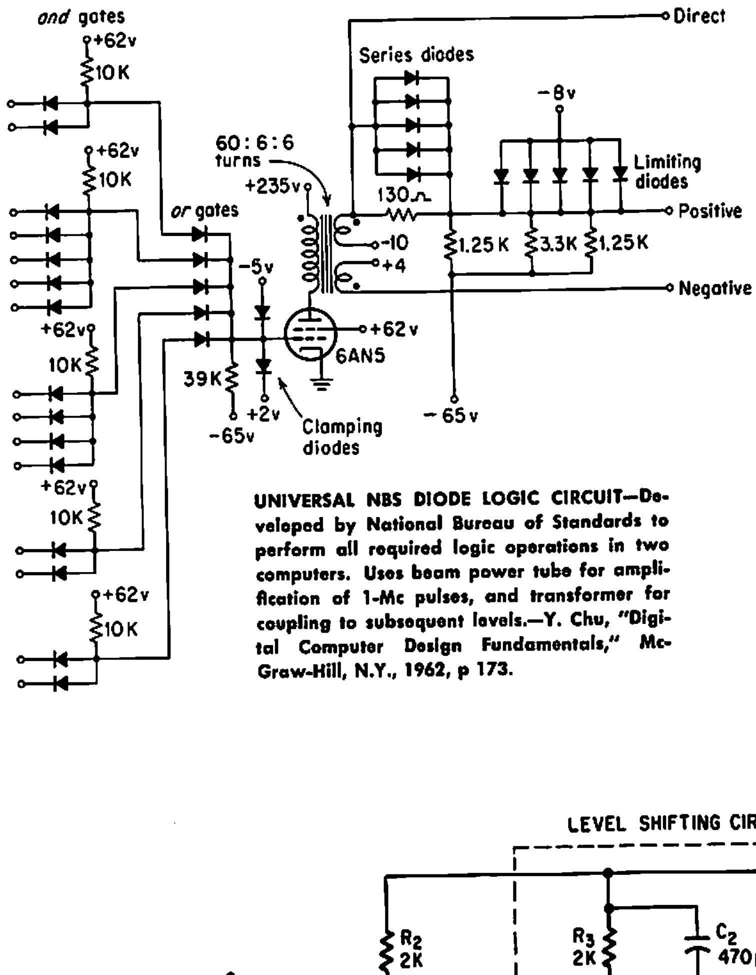


AUDIO DETECTOR WITH NOISE LIMITER—Uses shunt limiter in conjunction with series limiter, so noise pulses are prevented from operating agc circuit and thus desensitizing i-f amplifier of communication receiver. Broad-band cathode follower is connected to output of diode detector.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12–1.

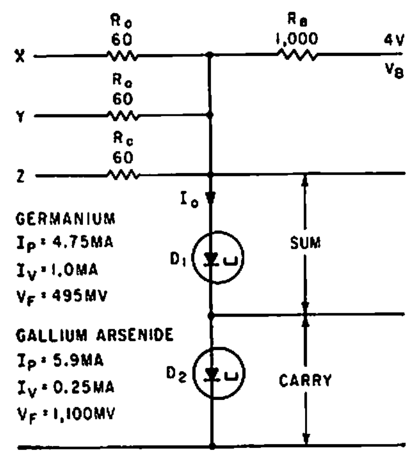


CLASS-D CB NOISE LIMITER—Two-step noise silencing system is almost essential for 27-Mc a-m receiver, because of ignition interference. Large noise pulse swings plate of V3 negative and cuts off diode V3, to prevent noise pulse and audio signal from reaching volume control R3. Circuit recovers quickly, allowing audio signals to pass.—L. G. Sands, Citizens Radio Revision Spurs Equipment Design, *Electronics*, 32:15, p 55–57.

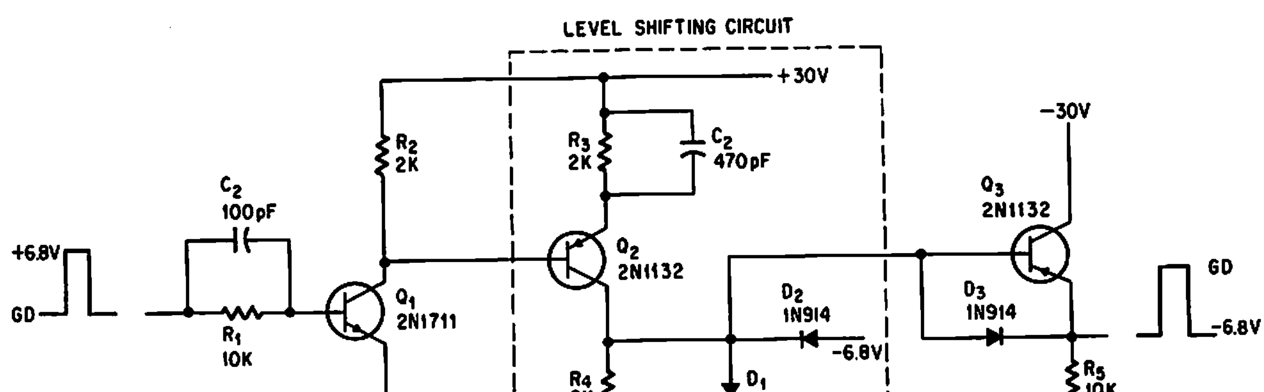
CHAPTER 47
Logic Circuits



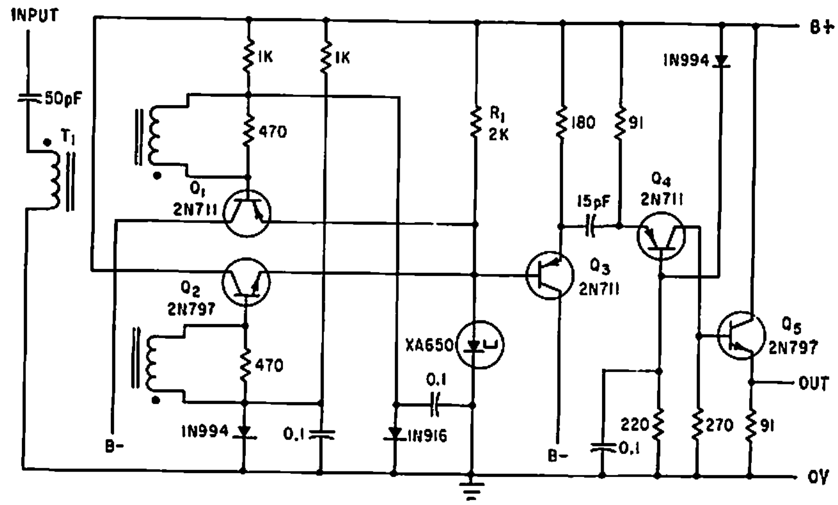
UNIVERSAL NBS DIODE LOGIC CIRCUIT—Developed by National Bureau of Standards to perform all required logic operations in two computers. Uses beam power tube for amplification of 1-Mc pulses, and transformer for coupling to subsequent levels.—Y. Chu, "Digital Computer Design Fundamentals," McGraw-Hill, N.Y., 1962, p 173.



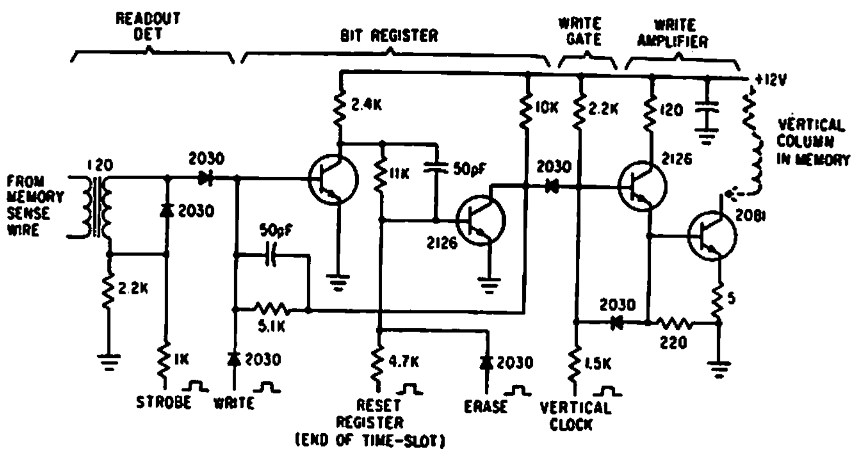
FULL BINARY ADDER—Two tunnel diodes in series perform arithmetic function of full addition.—B. Rabinovici and J. Klapper, Designing Tunnel-Diode Circuits Using Composite Characteristics, *Electronics*, 35:7, p 46–48.



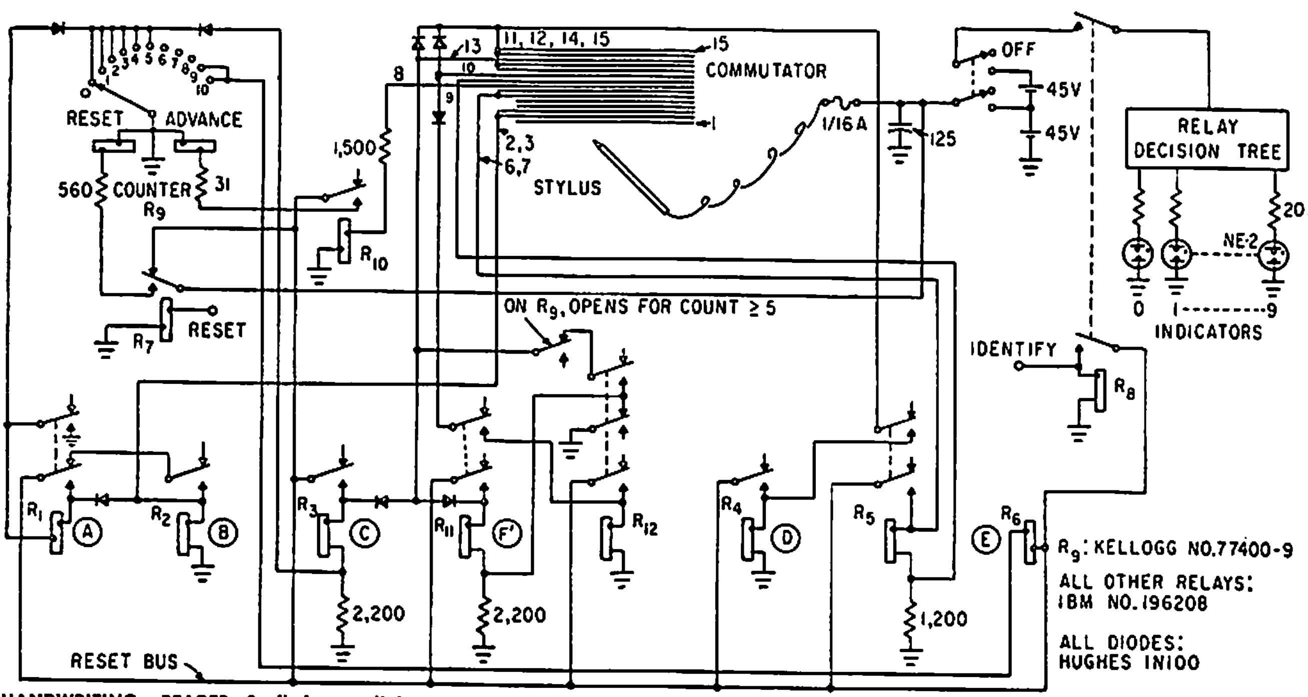
LOGIC LEVEL SHIFTER—Common-emitter circuit of Q2 shifts logic level from +6.8 v to −6.8 v, with rise and fall times of 60 nsec. Q3 is buffer.—G. Marosi, High-Speed Level Shifter, *Electronics*, 39:5, p 105.



HIGH-SPEED TUNNEL-DIODE BINARY—Tunnel diode with Q1-Q2, driven by series of positive or negative pulses at input repetition rates up to 140 Mc, can provide pulses capable of triggering successive pulse amplifier stages Q3, Q4, and Q5.—W. V. Harrison and R. S. Foote, Tunnel Diodes Increase Digital-Circuit Switching Speeds, *Electronics*, 34:32, p 154–156.

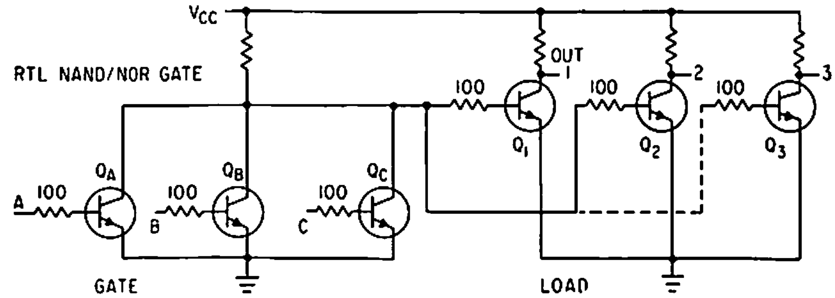


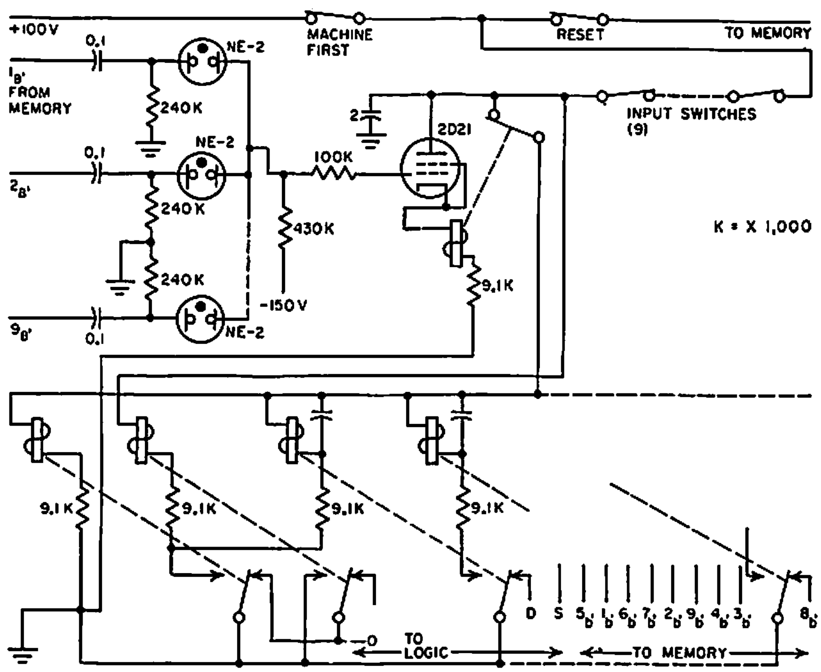
READ-WRITE AMPLIFIER—Each of 28 vertical circuits for coincident-flux memory consists of readout detector, bit register (flip-flop), write gate, and two-stage write amplifier.—H. F. Priebe, Jr., Three-Hole Cores for Coincident-Flux Memory, *Electronics*, 33:31, p 94–97.



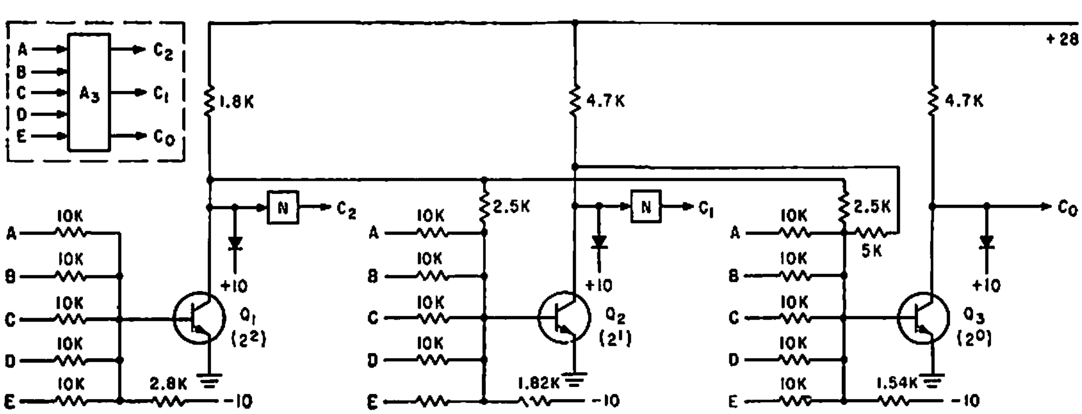
HANDWRITING READER—Spelled-out digits written with wire stylus on striated conductive surface are recognized by detecting risers, descenders, dots, word length, recrossings, and several other characteristics of spelled-out zero to nine, using only 12 relays, 8 diodes, and 10 neon indicator lamps. Accuracy is about 97% with the simple sequential logic used for recognition.—L. D. Harmon, Handwriting Reader Recognizes Whole Words, *Electronics*, 35:34, p 29–30.

RESISTOR-TRANSISTOR *NAND/NOR* GATE—For integrated circuits, 100-ohm resistor in base lead of each transistor reduces waste current, increases fan-out, and gives logic swing of 1 v.—A. E. Skoures, Choosing Logic for Microelectronics, *Electronics*, 36:40, p 23–26.

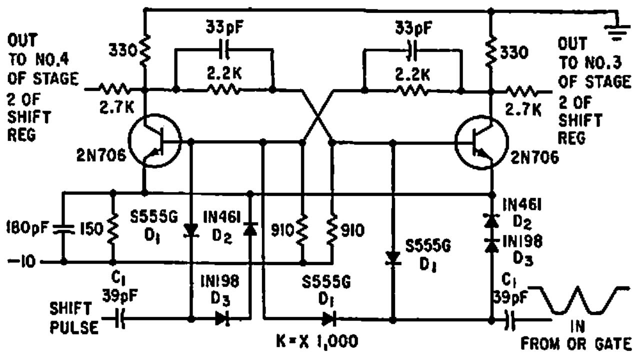




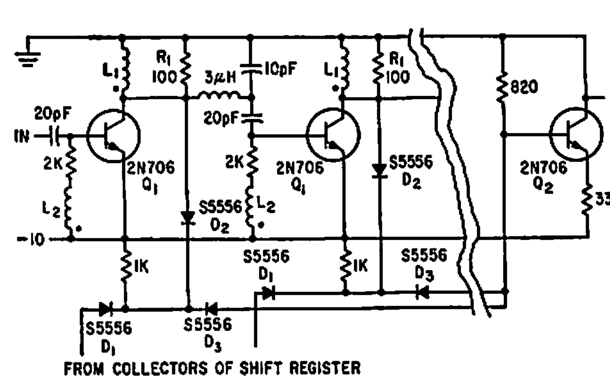
TICK-TACK-TOE LOGIC—Neon lamps serve as diode gates and indicate positions and moves on game board. Thyratron-relay combination serves as memory, while relays referee sequence to prevent two successive moves by either player.—C. E. Hendrix and R. B. Purcell, Neon Lamp Logic Gates Play Tick-Tack-Toe, *Electronics*, 31:25, p 68–69.



THREE-STAGE ENCODER—With 2N1499 transistors, settling time of encoder for simultaneous multiplier is less than 0.4 microsec, and maximum time to produce 8-bit product is about 1.2 microsec.—S. C. Chao, High Speed Encoding with Resistor-Transistor-Logic Circuits, *Electronics*, 35:6, p 48–51.

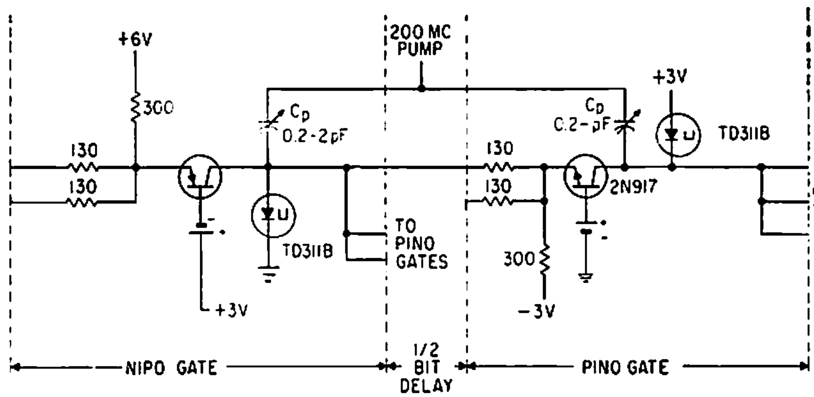


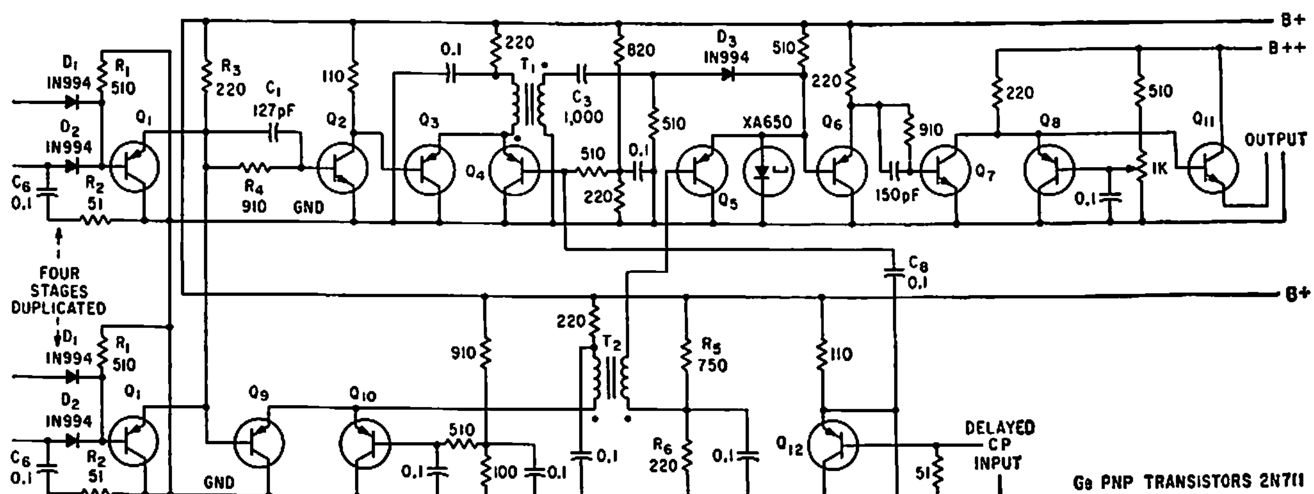
HIGH-SPEED FLIP-FLOP—Used in producing complex pulse sequences up to 4 billion bits in length. Drives n-stage shift generator that provides modulo-2 additions.—B. K. Ericksen and J. D. Schmidt, Random Pulse Generator Tests Circuits, Encodes Messages, *Electronics*, 34:25, p 56–59.



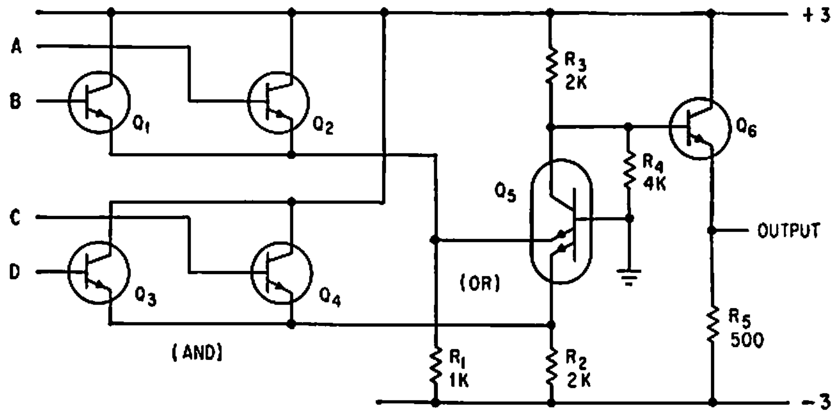
BLOCKING OSCILLATOR FOR SHIFT REGISTER—Used to generate series of ten pulses, 20 nsec wide and spaced 40 nsec apart. Each of the ten blocking oscillator stages Q1 is allowed to overshoot and trigger the following stage through an LC coupling network that provides additional delay.—B. K. Ericksen and J. D. Schmidt, Random Pulse Generator Tests Circuits, Encodes Messages, *Electronics*, 34:25, p 56–59.

PUMPED TUNNEL-DIODE TRANSISTOR LOGIC GATE—Nipo gate accepts negative inputs and provides positive outputs, while pino gate accepts positive inputs and provides negative outputs. With no inputs, 200-Mc pump or clock has sufficient amplitude to fire nipo stage tunnel-diode on positive half-cycle and pino stage tunnel-diode on negative half-cycle. When input signal is present, pump cannot fire that tunnel diode; this is basic *nor* gate action, with output pulse only when there is no input.—E. Gottlieb and J. Giorgis, Tunnel-Diode Switching Circuits, *Electronics*, 36:27, p. 26–31.

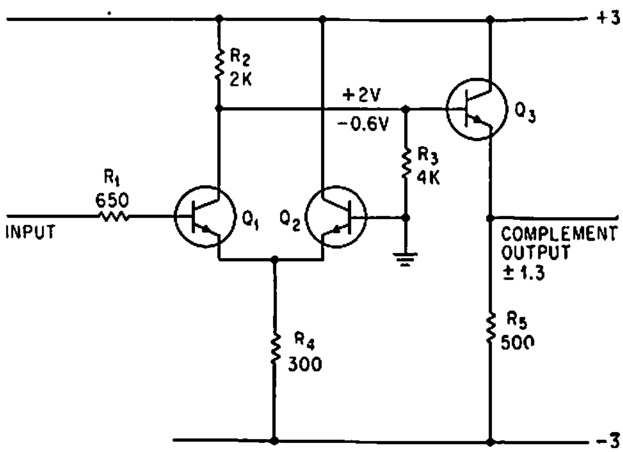




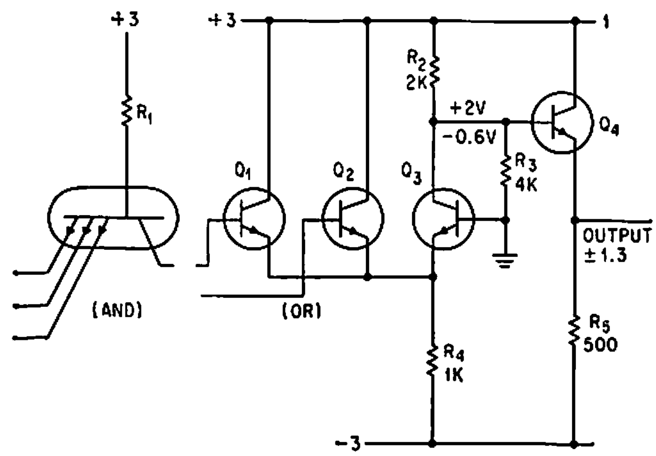
TUNNEL-DIODE OR CIRCUIT AND ENVELOPE GENERATOR—Used as part of program pulse generator incorporating ring of four stages, diode-matrixed with ring of three stages to provide twelve-bit words at 30-Mc clock rate. C6 and R2 are a-c terminations for coax from output of ring counter.—W. V. Harrison and R. S. Foote, Tunnel Diodes Increase Digital-Circuit Switching Speeds, *Electronics*, 34:32, p 154–156.



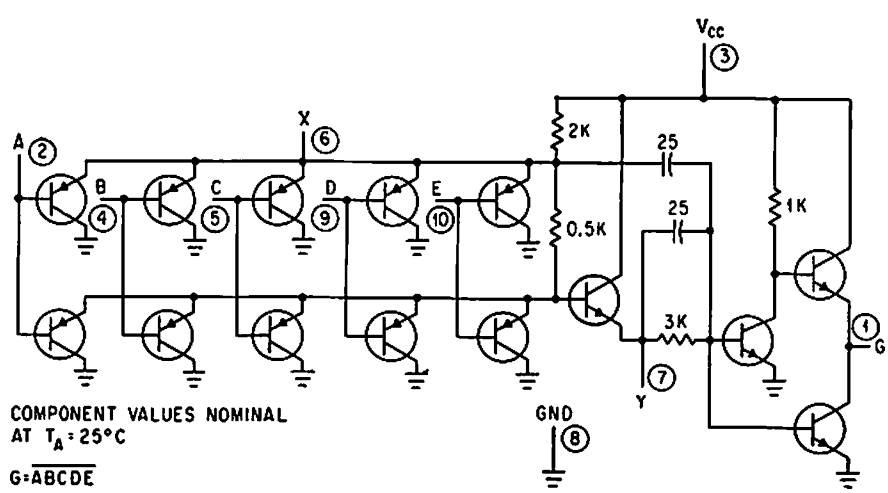
MULTIEMITTER TRANSISTOR ALTERNATES BETWEEN *AND/OR* LOGIC—Circuit performs *and* function first, then *or* function. For integrated-circuit construction, few isolated lands are needed.—P. M. Thompson, Logic Principles for Multi-emitter Transistors, *Electronics*, 36:37, p 25–29.



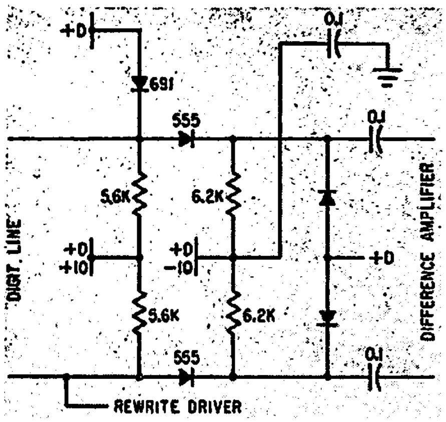
INVERTING AMPLIFIER GIVES COMPLEMENT OUTPUT—Only one transistor has isolated collector, so only three isolated lands are needed for integrated-circuit construction.—P. M. Thompson, Logic Principles for Multi-emitter Transistors, *Electronics*, 36:37, p 25–29.



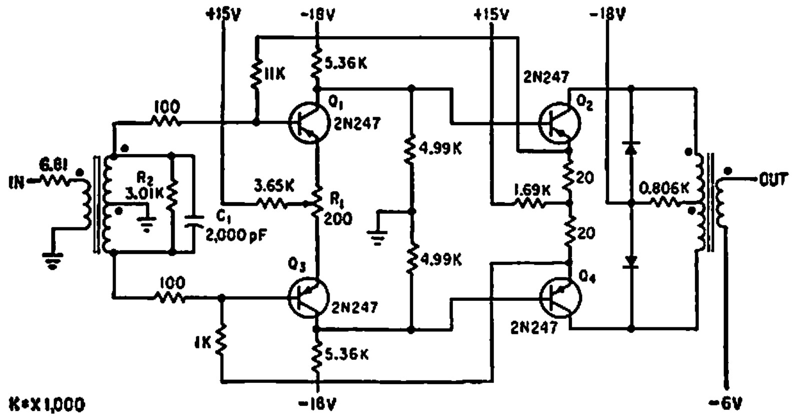
MULTIEMITTER-TRANSISTOR *AND/OR* LOGIC—Circuits may be coupled either directly or by multi-emitter transistor and gates. Components show promise for integrated circuits.—P. M. Thompson, Logic Principles for Multi-emitter Transistors, *Electronics*, 36:37, p 25–29.



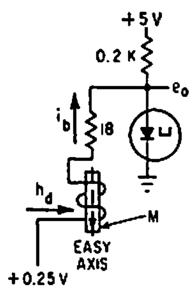
***NAND* LOGIC GATE**—*And/or* gate using pnp input transistors and npn output transistors is followed by three-transistor inverting output stage. Gate has fan-in of 5.—C. R. Cook, Jr., and B. M. Martin, New Semiconductor Networks Reduce System Complexity, *Electronics*, 37:2, p 25–29.



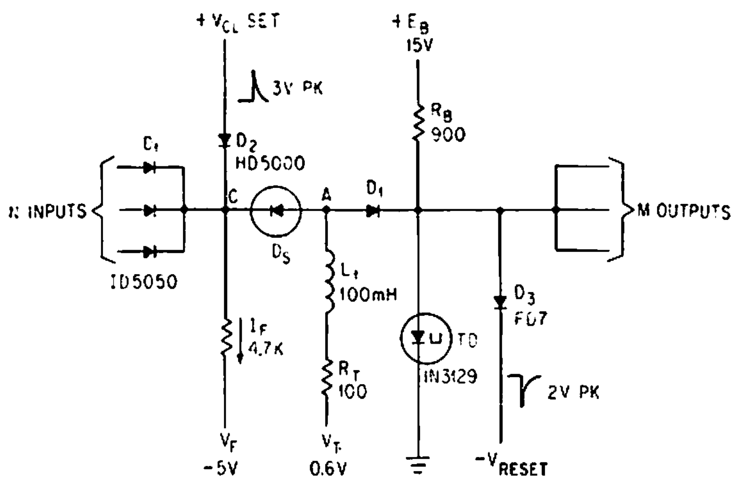
DIGIT LINE DECOUPLER—Diode switch and biasing network disconnect sense amplifier, allowing common-mode signal of about 1 v to reach difference amplifier. This signal is almost completely rejected at output, so amplifier is ready for next cycle 0.5 microsec after end of rewriting.—A. Melmed, R. Shevlin, and W. Orvedahl, Diode Steering Increases Speed of Magnetic Memories, *Electronics*, 34:37, p 68–70.



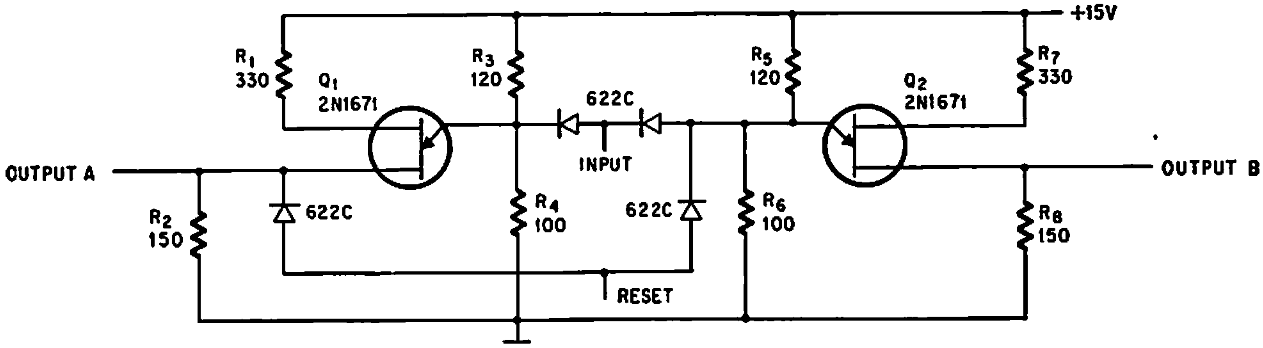
SENSE AMPLIFIER—Minimum input required from cores of random-access memory is 30 mv, and minimum output pulse is 6 v. Amplifier is balanced to reduce common-mode noise.—G. E. Lund and D. R. Faulis, Expandable Random Access Memories, *Electronics*, 33:11, p 164–166.



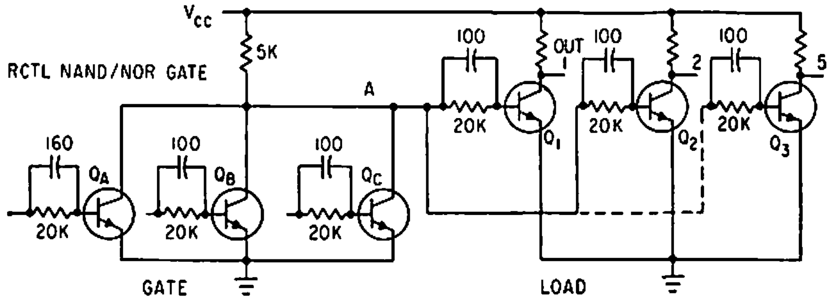
TUNNEL-DIODE THIN-FILM TOGGLING CIRCUIT—Supply biases film-diode combination at constant 5 v at 25 ma so two stable diode voltages are about 0.05 and 0.4 v. This means that bias current through film winding will flow in either of two directions, depending on state of diode.—T. A. Smay and A. V. Pohm, Design of Logic Circuits Using Thin Films and Tunnel Diodes, *Electronics*, 34:35, p 59–61.



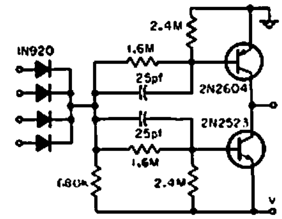
ENHANCED TUNNEL-DIODE *NOR* CIRCUIT—Clock pulse through D2 triggers tunnel diode to its high voltage state to produce an output only when there are no inputs. Hybrid circuit will operate above 100 Mc, at high fan-in and fan-out, and uses low-cost parts.—P. Chow and J. Cubert, A Key to Nanosecond Switching, *Electronics*, 36:42, p 42–45.



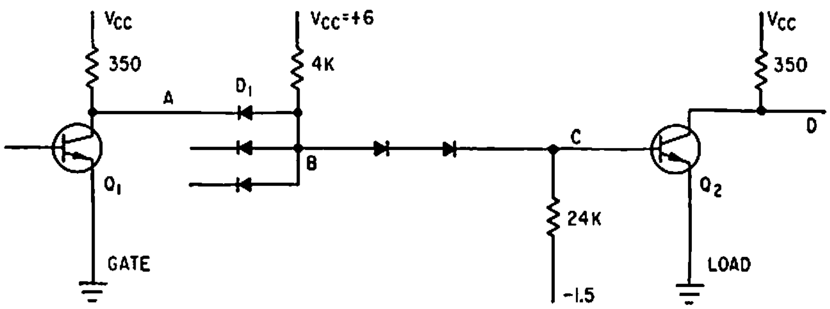
THREE-STATE LOGIC—With no input pulse (state 1), output A is zero and output B is 1.5 v. With a positive input pulse (state 2), A and B are both 1.5 v. With a negative input pulse (state 3), A and B are both zero. A 12-v positive pulse at the reset terminal restores state 1.—S. F. Summer, Two Unijunction Transistors Produce Three-State Circuit, *Electronics*, 39:1, p 100.



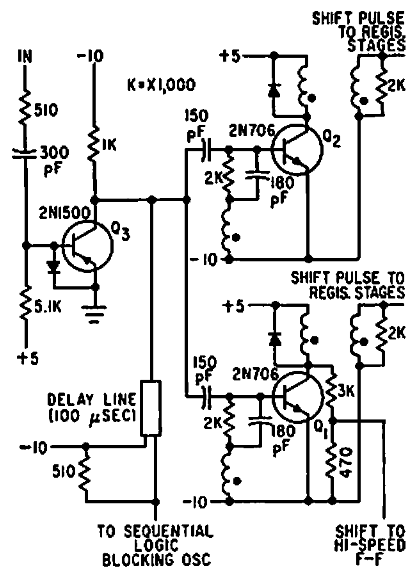
RCTL *NAND/NOR* GATE—Resistors and capacitors in base circuits permit higher fan-out and give logic swing of 2 v for high noise rejection in integrated-circuit logic.—A. E. Skouros, Choosing Logic for Microelectronics, *Electronics*, 36:40, p 23–26.



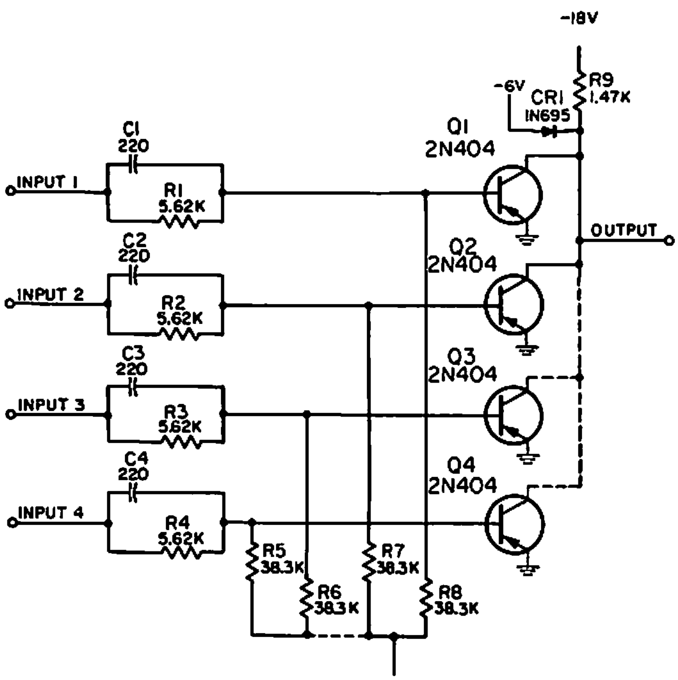
COMPLEMENTARY RDTL *NOR*—Alternately provides 500-na base current to pnp and npn transistors, thereby using transistor rise time at both edges of switching pulse to eliminate R-C time constant fall times of output waveform. Design reduces power drain and speeds up rise and fall times by factor of 15.—R. A. Tietsch, Complementary Microwatt Logic Circuits, *EEE*, 11:8, p 51–52.



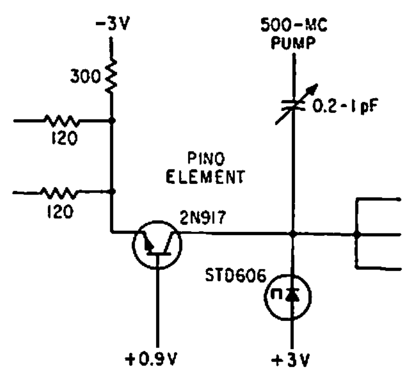
DIODE-COUPLED *NAND/NOR* GATE—Designed for integrated circuits, arrangement gives unlimited fan-in and high immunity to noise, with 1.7 v logic swing.—A. E. Skouros, Choosing Logic for Microelectronics, *Electronics*, 36:40, p 23–26.



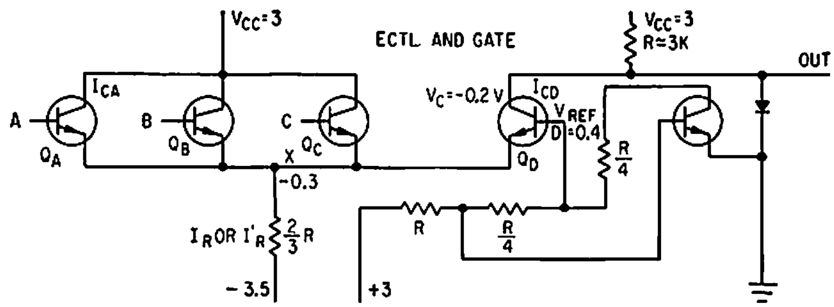
DRIVERS FOR SHIFT REGISTER—Inverter Q3 pulses 300-ma drivers Q1 and Q2 and feeds 100-nsec delay line that provides time for shift register stages to reach final values in new state.—B. K. Ericksen and J. D. Schmidt, Random Pulse Generator Tests Circuits, Encodes Messages, *Electronics*, 34:25, p 56–59.



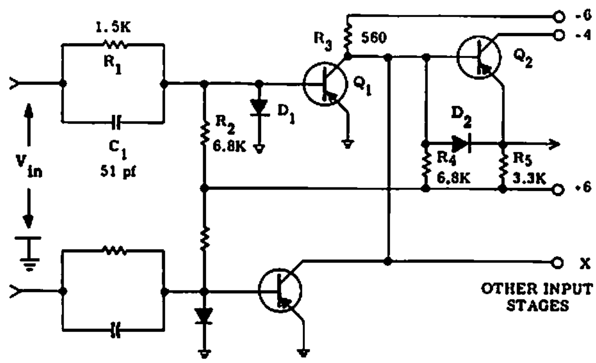
2 AND 4-INPUT-PULSE *NOR* GATE—Circuit is special-purpose nor gate for computer, control, and communication equipment. Used for the *and* operation when a general-purpose *nor* gate would be unsatisfactory because of possible spurious pulses in output. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 8 (originally PC 211), p 8–2.



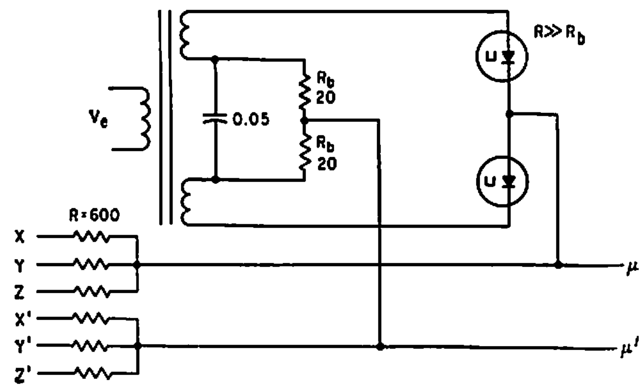
TWO-INPUT PINO *NOR* GATE—Pumped solid-state logic for uhf shift register using positive input-negative output gate gives 2-gc rate.—Tunnel Diode-Transistor Provides Fast Logic, *Electronics*, 35:11, p 72.



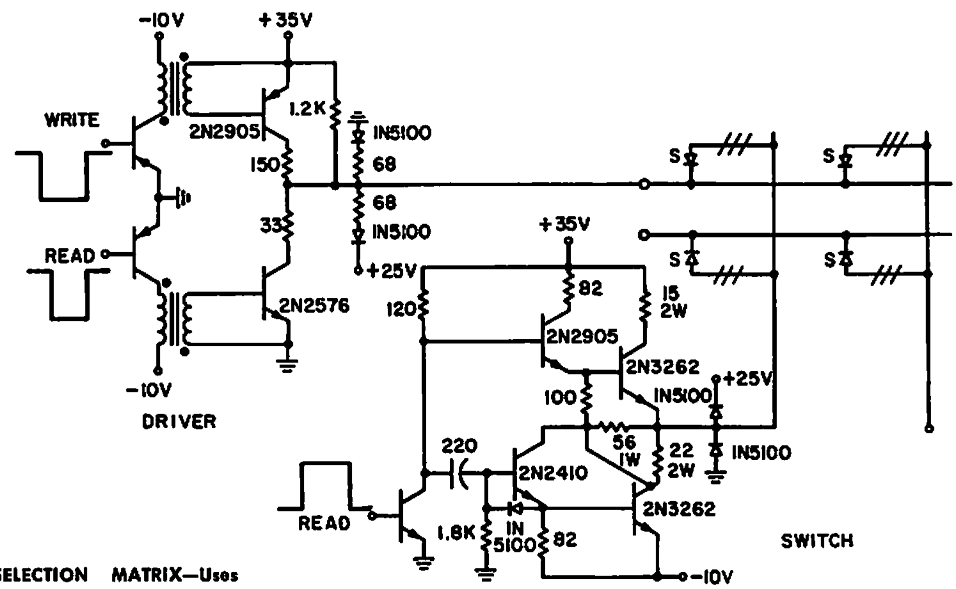
EMITTER-COUPLED TRANSISTOR *AND* GATE—Design gives manufacturing simplicity for integrated circuits without current hogging, but requires two power supplies. QD will conduct and QA, QB, and QC will be off when any of input A, B, or C are below 0.2 v.—A. E. Skoures, Choosing Logic for Microelectronics, *Electronics*, 36:40, p 23–26.



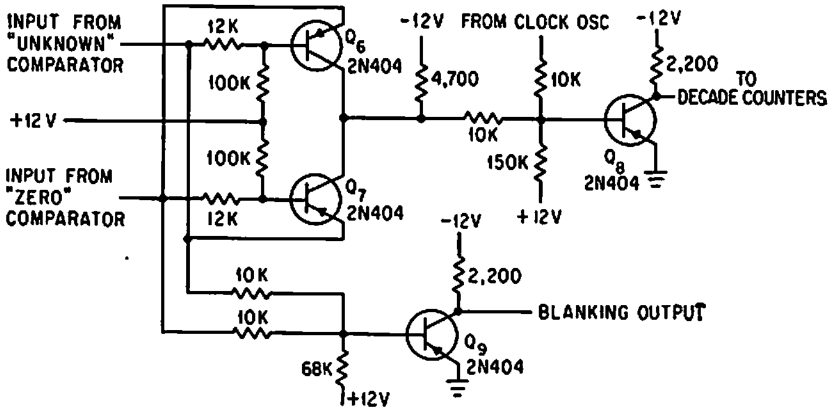
LOW-COST INVERTER AND *NOR* LOGIC—Inexpensive germanium pnp mesa switching transistor is used in basic inverter for high-speed computer circuits. *Nor* circuit is obtained by connecting other input stages to common collector load.—P. A. McInnis, "Low-Cost Computer Circuits," Motorola Application Note AN-130, Nov. 1965.



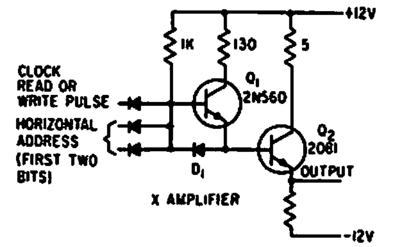
LOCKED PAIR—Ungrounded locked or Goto tunnel-diode pair permits logical inversion with no loss of speed or gain. Applications include converting analog television signals into pulse-code modulation.—C. L. Cohen, New Approach to Locked-Pair Tunnel-Diode Logic, *Electronics*, 35:31, p 46–47.



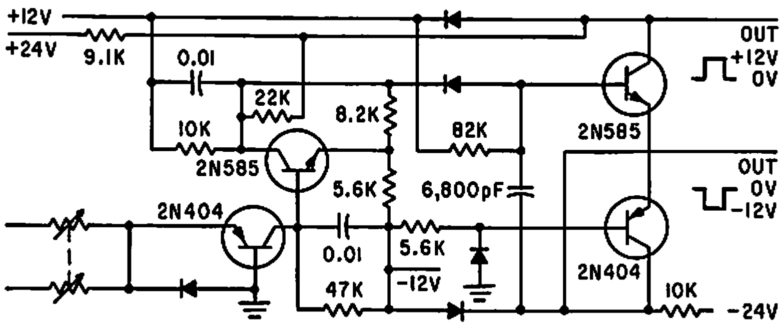
STORAGE-DIODE SELECTION MATRIX—Uses one diode per stored word. Four-word portion of 256-word matrix is shown. Activation of switch followed by driver drives selected diode sufficiently to permit flow of required read current. Write pulse is generated when read channel of both switch and driver are deactivated and write channel is activated.—I. Abeyta, M. M. Kaufman, and P. Lawrence, Monolithic Ferrite Memories, "1965 Fall Joint Computer Conference Preprints," Spartan Books, Washington, D. C., 1965.



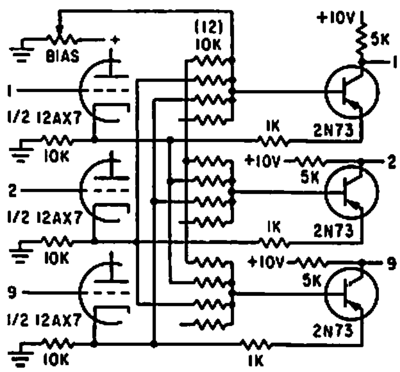
OR GATE FOR DIGITAL VOLTMETER—Ground-level signal output is produced only when inputs from the two comparators are in different states. Transistor Q8 gates continuously-running clock oscillator into decade counters of voltmeter.—R. C. Weinberg, Modified Ramp Generator Develops High D-C Input Impedance, *Electronics*, 37:8, p 33–35.



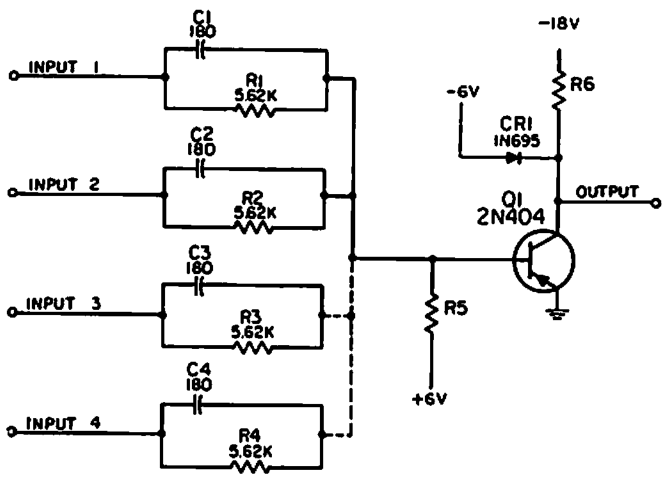
X AMPLIFIER FOR COINCIDENT-FLUX MEMORY—Inputs to *and* gate are clock read or write pulse and first two binary digits of horizontal address, forming one of the two translations for horizontal matrix of 1,120-bit memory.—H. F. Priebe, Jr., Three-Hole Cores for Coincident-Flux Memory, *Electronics*, 33:31, p 94–97.



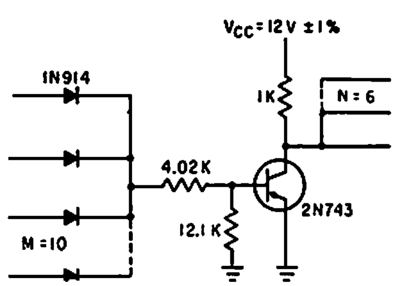
RECEPTOR-TYPE NEURON MODEL—Uses integrator quench circuit. Outputs of 100 or more such neuron circuits are combined so experiments can be repeated consistently, with minimal interaction.—C. M. Wiley, Bionics on Program at Midwest's NEC, *Electronics*, 34:40, p 61–67.



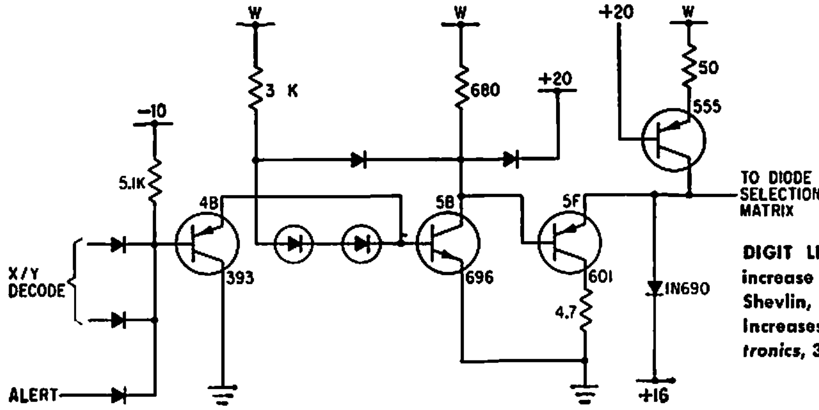
LARGEST-SIGNAL SELECTOR—Selects single channel that has greatest amplitude, using single nor-like transistor circuit per channel. Base mixer resistance network establishes signal bias level at greatest signal level encountered in all except designated channel. Channel transistor then conducts only when its signal at emitter is greater than all other signals.—L. R. Brown, Nonscanning Character Reader Uses Coded Wafer, *Electronics*, 33:48, p 115–117.



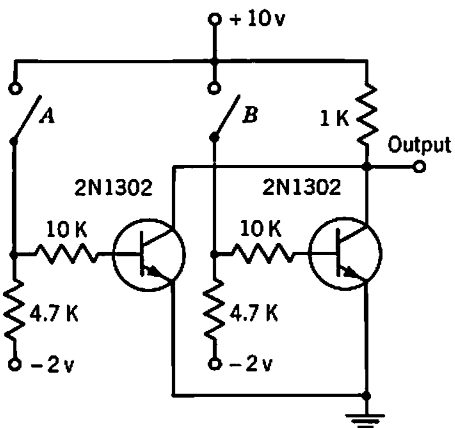
2 AND 4-INPUT *NOR* GATE—Performs general-purpose *and*, *or*, and inversion functions in compatible set of digital logic circuits for computer, control and communication equipment. Can be used as *and* gate for positive levels or positive-going pulses, as *or* gate for negative levels or negative-going pulses, and as inverter for both levels and pulses.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 7 (originally PC 210), p 7-2.



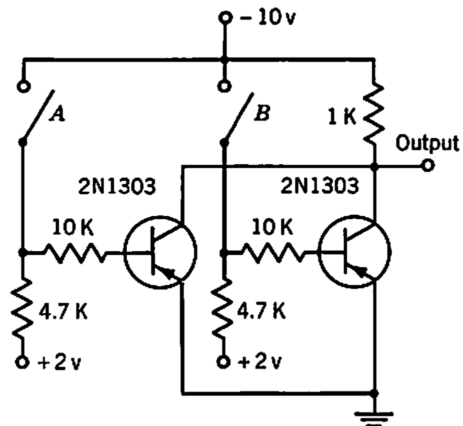
TRANSISTOR-DIODE *NOR* GATE—Low leakage and low storage time of silicon epitaxial transistor allow omission of base turn-off supply while giving medium-speed operation over wide temperature range, up to 2 Mc for two cascaded logic stages.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



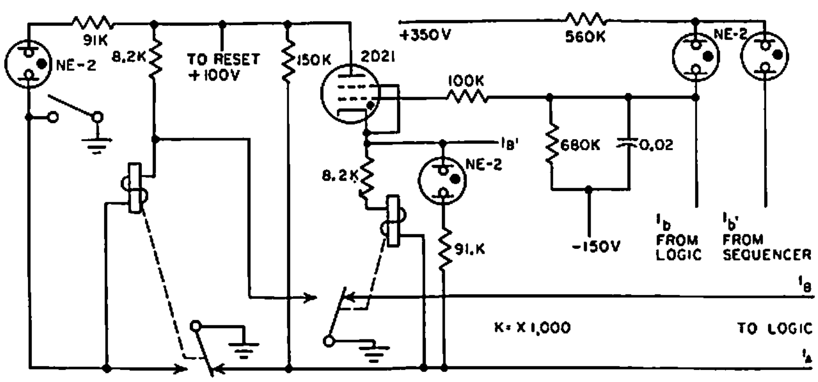
DIGIT LINE DRIVER—Uses diode steering to increase speed of memory.—A. Melmed, R. Shevlin, and W. Orvedahl, Diode Steering Increases Speed of Magnetic Memories, *Electronics*, 34:37, p 68–70.



PARALLEL NPN BASIC LOGIC—Serves as *or* gate for normally open switches and as *and* gate for normally closed switches. Provides phase inversion of input.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 388.

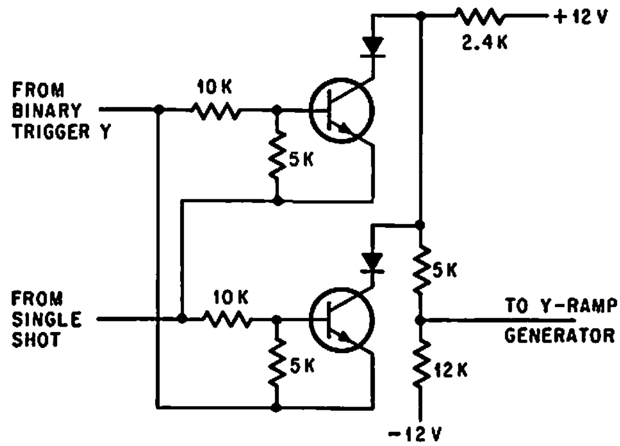


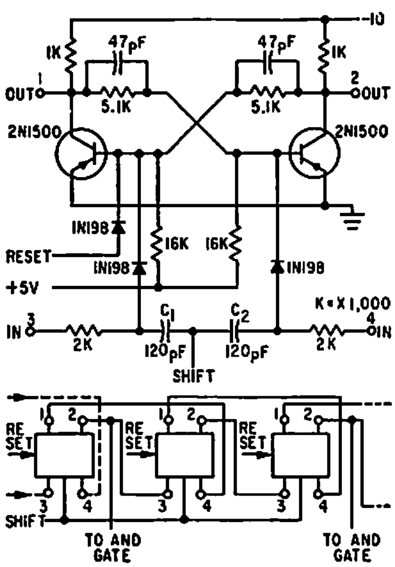
PARALLEL PNP BASIC LOGIC—Serves as *or* gate for normally open switches and as *and* gate for normally closed switches. Provides phase inversion of input.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 388.



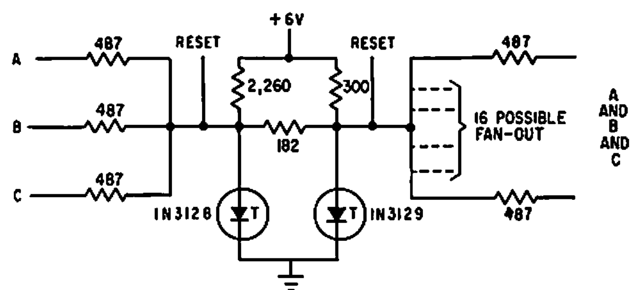
TICK-TACK-TOE MEMORY—Nine memory cells are used, one for each position on game board. Circuit shown is for position No. 1. Operator moves are entered into board by pushbuttons on display panel, energizing self-latching relays of memory. Board moves are determined by a separate logic section that triggers thyratron of memory and energizes relay. Neon lamps indicate when each position is filled, and by whom.—C. E. Hendrix and R. B. Purcell, Neon Lamp Logic Gates Play Tick-Tack-Toe, *Electronics*, 31:25, p 68–69.

EXCLUSIVE-OR CIRCUIT—Used in tester that shows computer memory performance under marginal drive currents by plotting shmoo curves. Memory error triggers single-shot and changes direction of Y generator from positive to negative along top of shmoo curve, and from negative to positive along bottom. Transistors are 2N706 and diodes are 1N921.—J. E. Gersbach, The Great Shmoo Plot: Testing Memories Automatically, *Electronics*, 39:15, p 127–134.

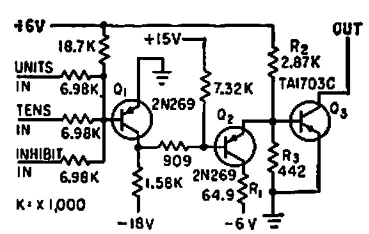




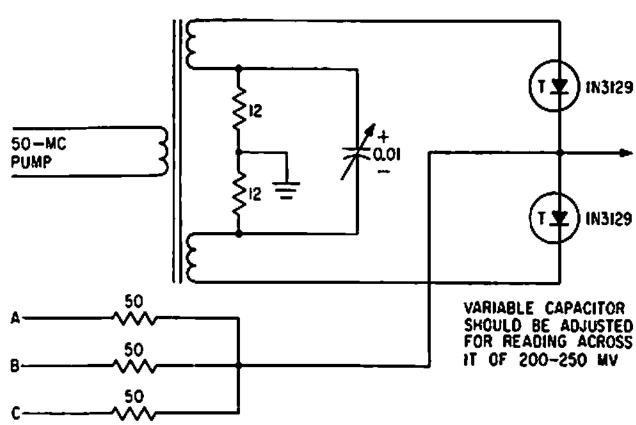
FLIP-FLOP FOR SHIFT REGISTER—Used to produce complex pulse sequences up to 4 billion bits in length, at frequencies up to 1.5 Mc. Each flip-flop provides 10 ma when turned on and draws 0.6 ma when off.—B. K. Ericksen and J. D. Schmidt, Random Pulse Generator Tests Circuits, Encodes Messages, *Electronics*, 34:25, p 56–59.



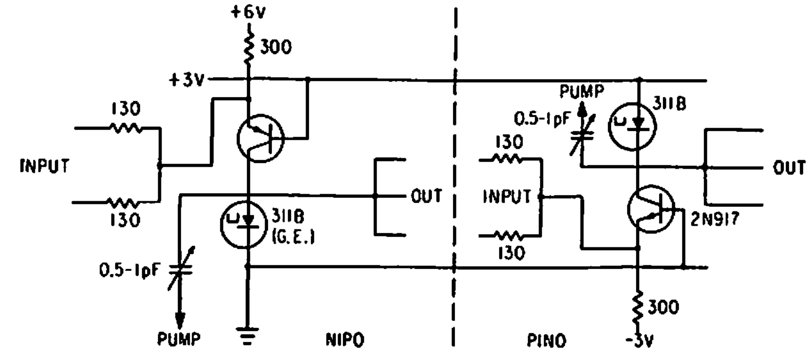
BISTABLE *AND* CIRCUIT WITH RESET—Uses resistance-coupled inputs to tunnel diodes. Gate is open when 1N3129 is on its negative-resistance slope, so reset pulse must be applied to close it.—F. Leary, Computers Today, *Electronics*, 34:17, p 64–94.



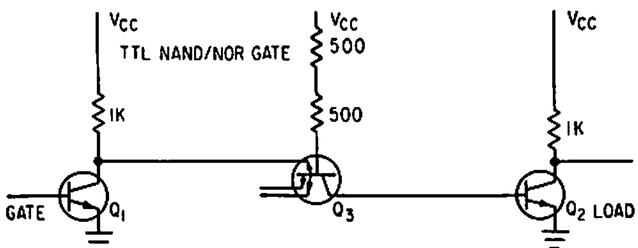
WORD SWITCH—Circuit is basically bilateral switch, which closes selected word circuit of memory used in Burroughs B-215 Visible Record Computer. Units and tens inputs are used to select particular word. Third input to gate is for special-purpose inhibit instruction.—G. E. Lund and D. R. Faulis, Expandable Random Access Memories, *Electronics*, 33:11, p 164–166.



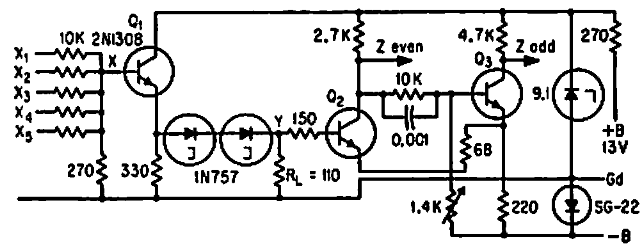
MAJORITY-DECISION—Balanced-pair tunnel-diode arrangement with phase-locked tank serves as gate operating on 50-Mc pump.—F. Leary, Computers Today, *Electronics*, 34:17, p 64–94.



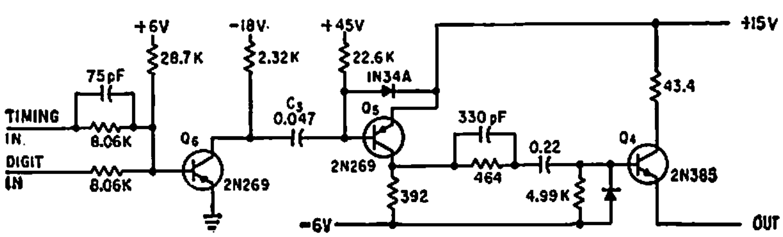
COMPUTER FOR SIX-BIT BINARY OUTPUT—Pumped tunnel-diode-transistor logic at 300 Mc converts outputs of converter subchannels into time series of six bits. In nipo element, one or more negative pulses at input inhibits positive-going pulse at output; other element operates at opposite half-cycles at pump source and gives opposite action.—H. R. Schindler, Semiconductor Circuits in a UHF Digital Converter, *Electronics*, 36:35, p 37–40.



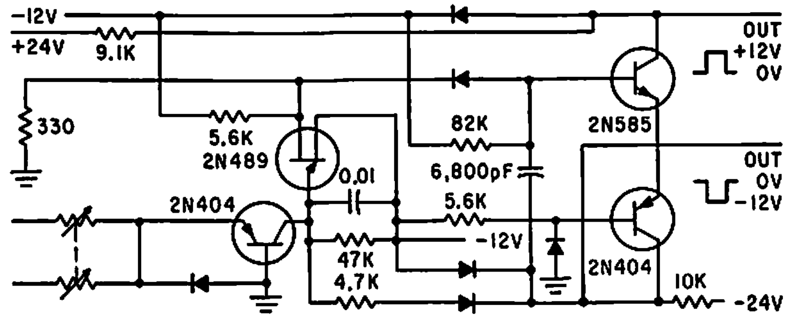
TRANSISTOR-COUPLED *NAND/NOR* GATE—Coupling transistor Q3 feeds its base current into base of inverting transistor Q2 when gate Q1 is cut off. When Q1 is saturated, coupling transistor Q3 clamps base of Q2 to low voltage. Logic swing of 0.4 v occurs at high speed.—A. E. Skouros, Choosing Logic for Microelectronics, Electronics, 36:40, p 23–26.



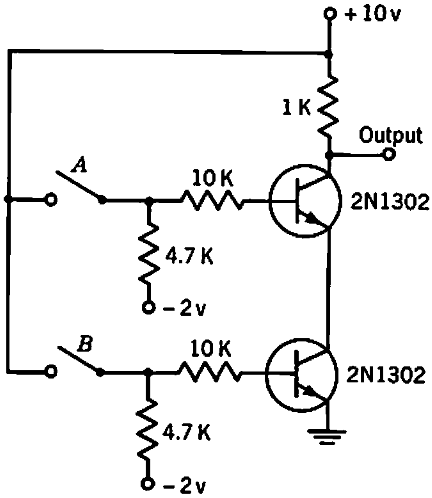
ODD-EVEN LOGIC—Accepts five binary inputs and produces signal at either of two outputs according to whether sum of inputs is even or odd. Schmitt trigger is used between tunnel diodes and load to boost output voltage to 9 v.—W. H. Ko, Unique Tunnel-Diode Circuit Performs Odd-and-Even Logic, *Electronics*, 35:42, p 61–62.



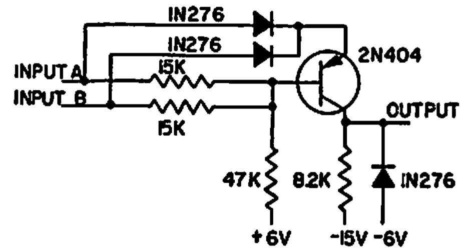
MEMORY INSERT DRIVER—Supplies current for inserting information in random-access memory.—G. E. Lund and D. R. Faulis, Expandable Random Access Memories, *Electronics*, 33:11, p 164–166.



NEURON MODEL WITHOUT INTEGRATOR—Gives rectangular output pulses of either polarity. Catastrophic failure is avoided even if outputs become grounded.—C. M. Wiley, Bionics on Program at Midwest's NEC, *Electronics*, 34:40, p 61–67.



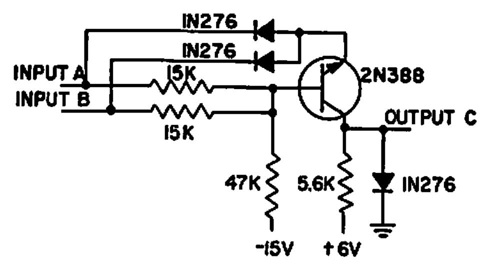
SERIES NPN BASIC LOGIC—Serves as *and* gate for normally open switches, and as *or* gate for normally closed switches. Provides phase inversion of input.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 388.



TRUTH TABLE

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

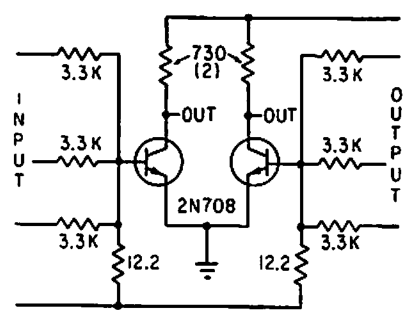
PNP *EXCLUSIVE-OR* LOGIC—For use with 0 (ground) and −6 v logic system. Can be adapted readily to most other logic levels. Produces logic 1 when inputs disagree.—Exclusive OR Uses One Transistor, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 213.



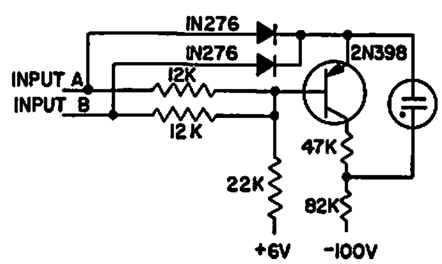
TRUTH TABLE

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

NPN *AND* GATE—Two diodes act as conventional *and* gate with transistor and its collector supply, using few components. Intended for 0 and −6 v logic.—Exclusive OR Uses One Transistor, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 213.



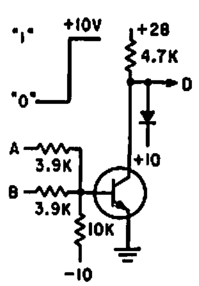
DOUBLE *NOR* GATE—Pulse repetition rate is 1 Mc, fan-in is 3, and fan-out is up to 6, with 30-mw dissipation for 7-v supply.—Double NOR Gate for Dense Packaging, *Electronics*, 36:12, p 100.



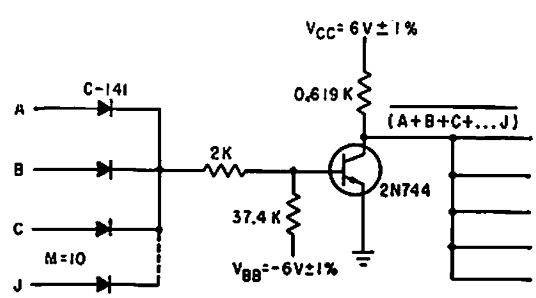
TRUTH TABLE

A	B	LAMP
0	0	ON
0	1	OFF
1	0	OFF
1	1	ON

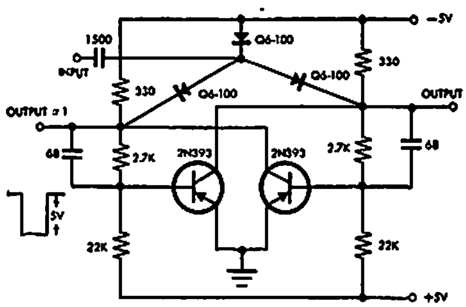
NEON WITH PNP *EXCLUSIVE-OR* LOGIC—Neon lamp glows when inputs are in agreement. Indicator will follow only one control level if other input is at fixed voltage such as logic 0; lamp will then turn off whenever control input is at logic 1. Similarly, if fixed voltage is logic 1, lamp will turn off when control input is at logic 0.—Exclusive OR Uses One Transistor, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 213.



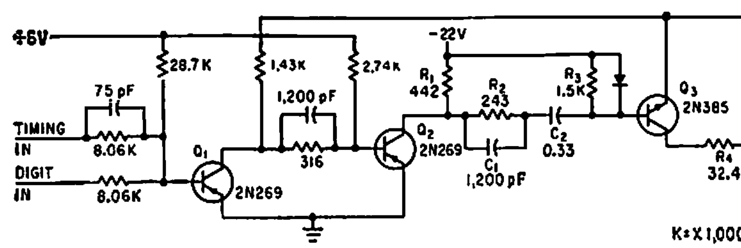
RESISTOR-TRANSISTOR *NOR* GATE—Circuit is basic building block of binary full adder for high speed encoding. Transistor is 2N1499.—S. C. Chao, High Speed Encoding with Resistor-Transistor-Logic Circuits, *Electronics*, 35–6, p 48–51.



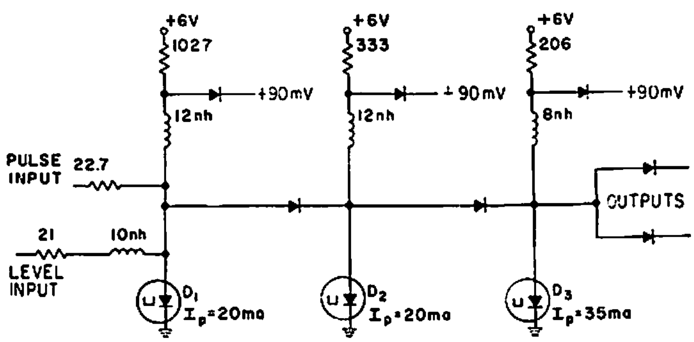
EPITAXIAL *NOR* GATE—Operates at up to 8 Mc from −55°C to +150°C.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.



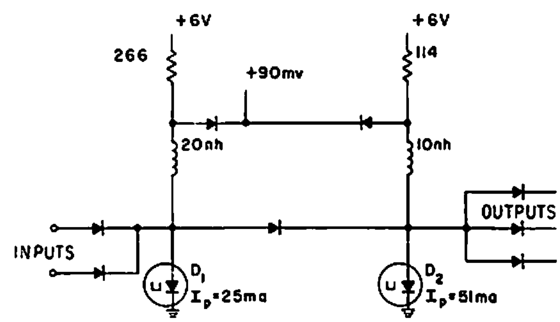
RC-COUPLED BINARY STAGE—Typical switching times are 30 and 44 millimicrosec.—Philco MAT Transistors for Logic Circuits up to 5 Mc (Philco ad), *Electronics*, 33:17, p 50.



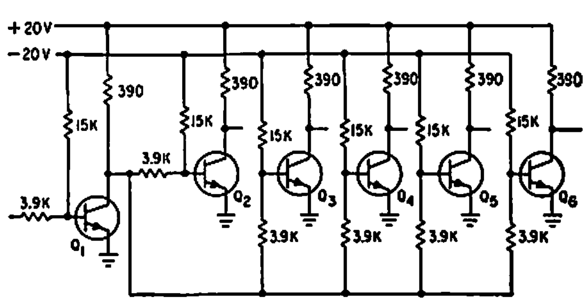
MEMORY DRIVER—Extract-driver circuit furnishes current to extract information from random-access memory of Burroughs B-251 Visible Record Computer.—G. E. Lund and D. R. Faulis, Expandable Random Access Memories, *Electronics*, 33:11, p 164–166.



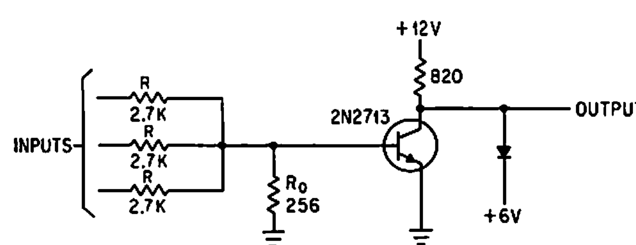
TUNNEL-DIODE *AND* GATE—Three cascaded monostable multivibrators provide required gain at 200 Mc.—E. Gottlieb and J. Giorgis, Tunnel-Diode Switching Circuits, *Electronics*, 36:27, p 26–31.



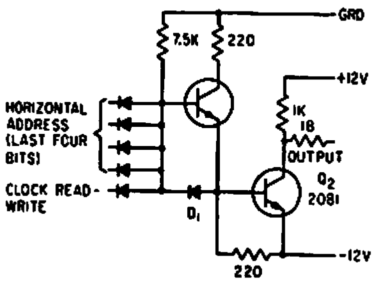
TUNNEL-DIODE *OR* GATE—Two monostable multivibrators are cascaded to provide current gain at 200 Mc. Output is obtained when either of input currents rises above 8 ma.—E. Gottlieb and J. Giorgis, Tunnel-Diode Switching Circuits, *Electronics*, 36:27, p 26–31.



***NOR* CIRCUIT**—With 2N834 epitaxial mesa transistors, turn-on time is 80 nsec, and turn-off 90 nsec, as compared to 111-nsec turn-on and 140-nsec turn-off for nonepitaxial 2N706 mesa transistors in same circuit.—W. D. Roehr, Epitaxial Process Improves Transistor Characteristics, *Electronics*, 34:9, p 52–53.

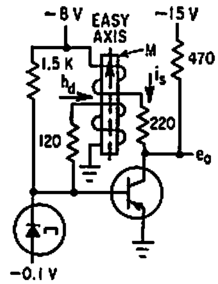


MAJORITY GATE—With odd number of inputs and resistor-summer, threshold logic transistor is virtually off up to 0.5 v base-emitter voltage and on at 0.7 v. Output is inverted. —W. A. Sauer, How to Achieve Majority and Threshold Logic with Semiconductors, *Electronics*, 36:48, p 23–25.

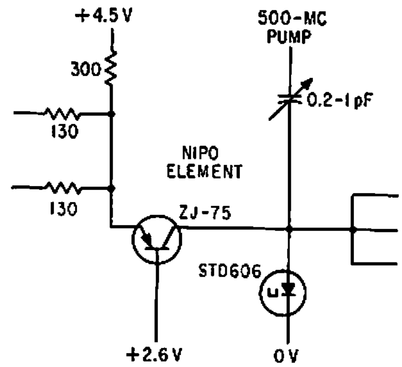


Y AMPLIFIER

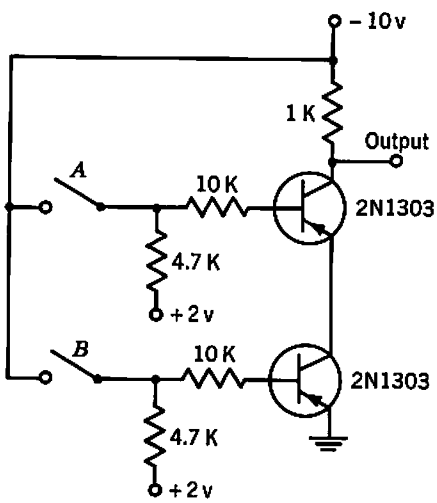
Y AMPLIFIER FOR COINCIDENT-FLUX MEMORY—Inputs to translator section of Y amplifier are last four bits of address, which perform one out of ten translations for horizontal matrix of 1,120-bit memory.—H. F. Priebe, Jr., Three-Hole Cores for Coincident-Flux Memory, *Electronics*, 33:31, p 94–97.



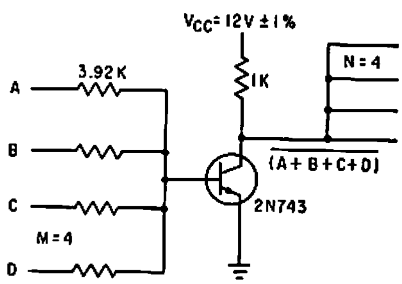
THIN-FILM TOGGLING WITH TRANSISTOR—Use of transistor stage permits cascading as for counters. Tunnel diode, which controls conducting state of transistor, is biased to have output voltages of 0.05 and 0.4 v. Additional film winding is needed because of phase reversal by transistor.—T. A. Smay and A. V. Pohm, Design of Logic Circuits Using Thin Films and Tunnel Diodes, *Electronics*, 34:35, p 59–61.



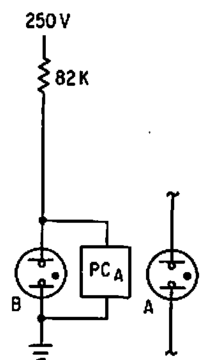
TWO-INPUT NIPO *NOR* GATE—Pumped tunnel diode-transistor logic gives 2-gc rate for uhf shift register using negative input-positive output gate having gain of 3 and 50-mw power drain.—Tunnel Diode-Transistor Provides Fast Logic, *Electronics*, 35:11, p 72.



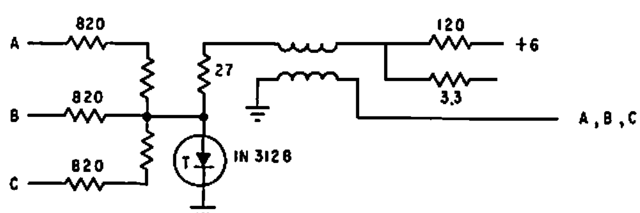
SERIES PNP BASIC LOGIC—Serves as *and* gate for normally open switches, and as *or* gate for normally closed switches. Provides phase inversion of input.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 388.



SINGLE-SUPPLY *NOR* GATE—Low storage time allows medium-speed operation without turn-off base bias supply. Maximum is 1 Mc for two cascaded logic stages.—D. Hall, Using Epitaxial Transistors in Switching and R-F Circuits, *Electronics*, 34:13, p 52–53.

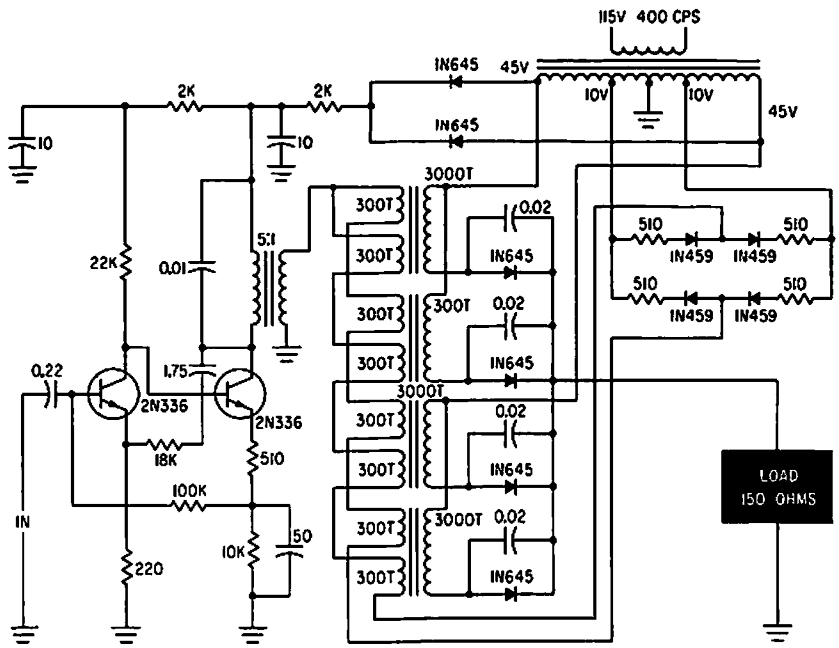


NEON PHOTOCONDUCTOR INVERTER—Cadmium selenide photoconductor PC and Ne2H neon lamps give low-speed inverter action for logic circuits at low cost. Neon B is on when there is no input. When neon A provides input, PC turns neon B off.—J. L. Patterson, Will Neon Photoconductors Replace Relays in Low-Speed Logic?, *Electronics*, 36:18, p 46–49.

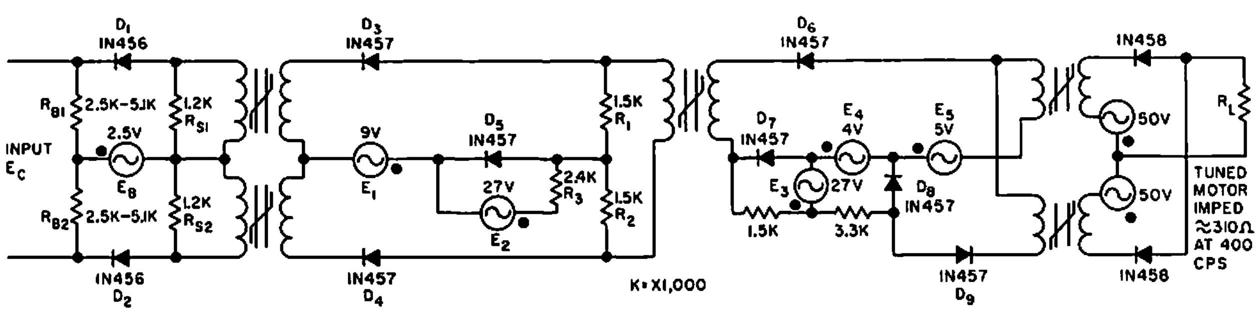


MONOSTABLE *OR* CIRCUIT—Uses resistance-coupled inputs to drive tunnel diode.—F. Leary, Computers Today, *Electronics*, 34:17, p 64–94.

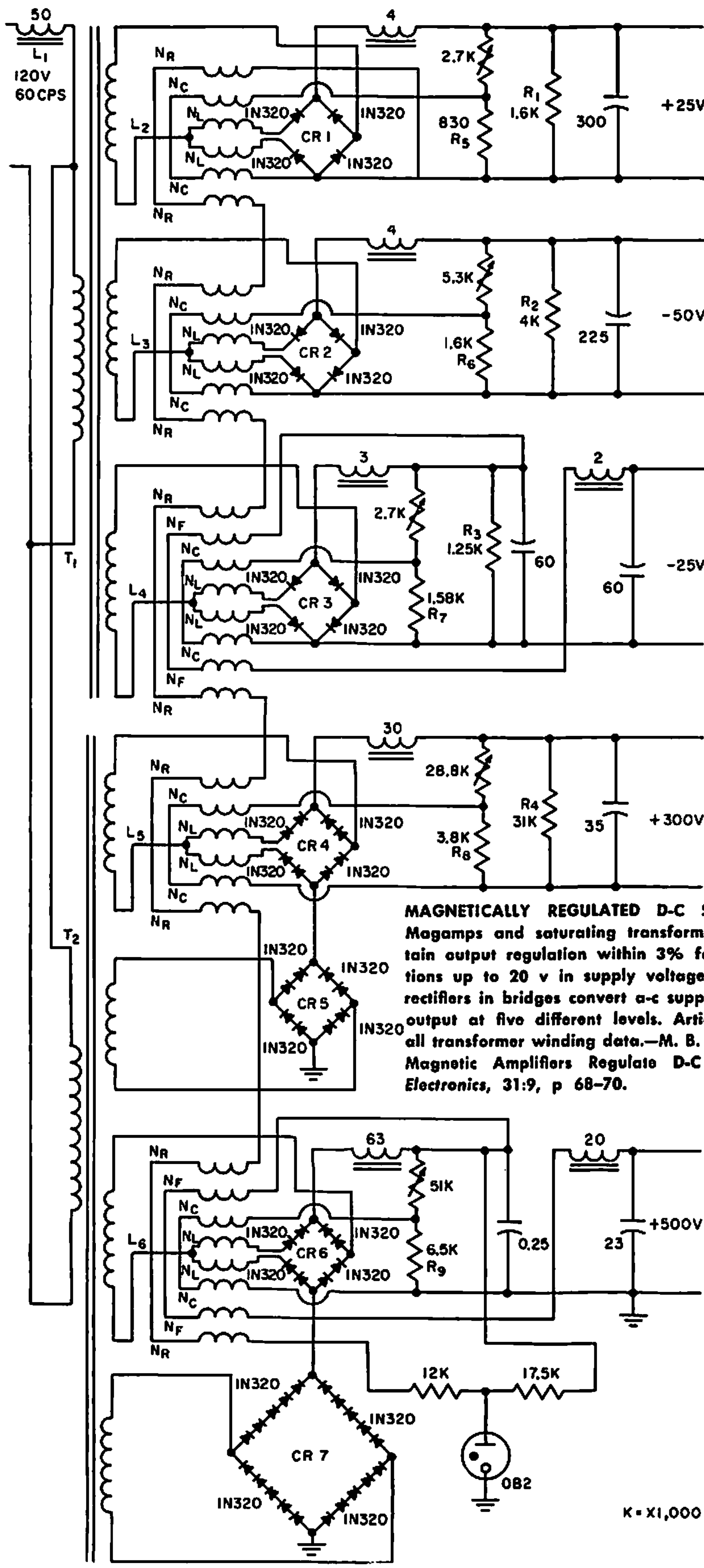
CHAPTER 48
Magnetic Amplifier Circuits



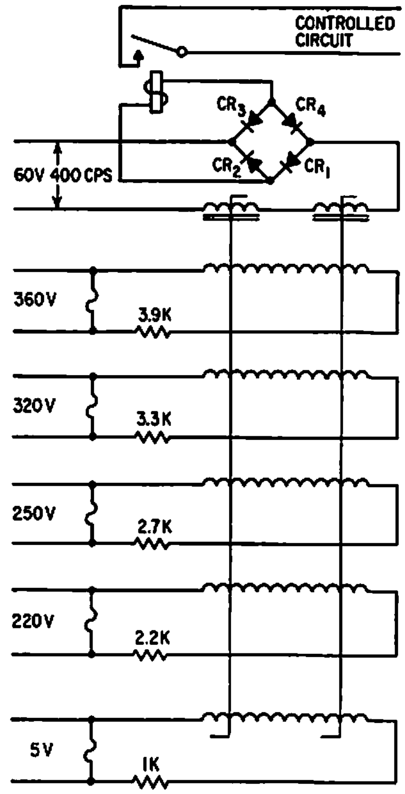
MAGNETIC AMPLIFIER—Used in aircraft fuel flow indicating system. Transistor preamp has stabilized gain of 350.—E. Van Winkle, A-C Controlled Half-Cycle Magnetic Amplifier, *Electronics*, 34:15, p 75–77.



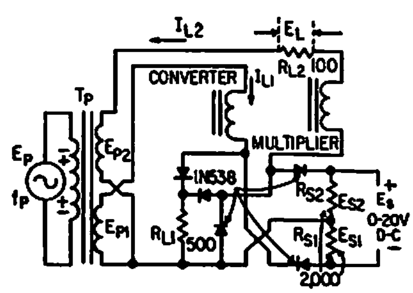
THREE-STAGE MAGNETIC SERVO—Has balanced two-core input, alternate-firing output stage, and synchronous interstage switches to eliminate interaction between stages. Power gain approaches 60 db. Zero drift is less than 0.25 deg, accuracy is within 0.5 deg, and follow-up rate is 300 deg per sec. —C. C. Voice, Magnetic Amplifier Drives Gyro Indicator, *Electronics*, 31:7, p 114–117.



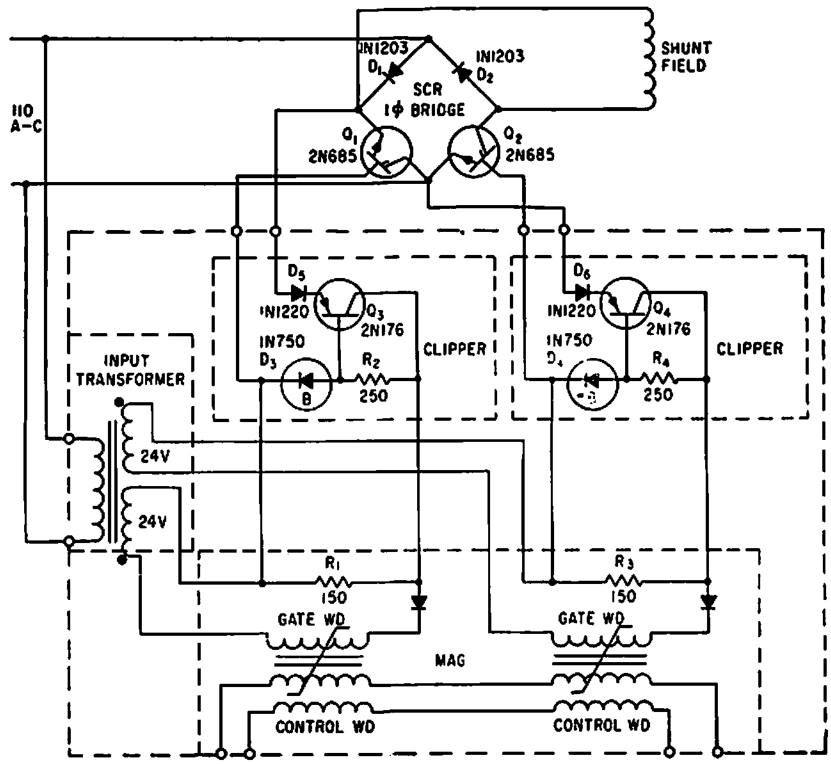
MAGNETICALLY REGULATED D-C SUPPLY—Magamps and saturating transformer maintain output regulation within 3% for variations up to 20 v in supply voltage. Silicon rectifiers in bridges convert a-c supply to d-c output at five different levels. Article gives all transformer winding data.—M. B. Meunier, Magnetic Amplifiers Regulate D-C Supply, *Electronics*, 31:9, p 68–70.



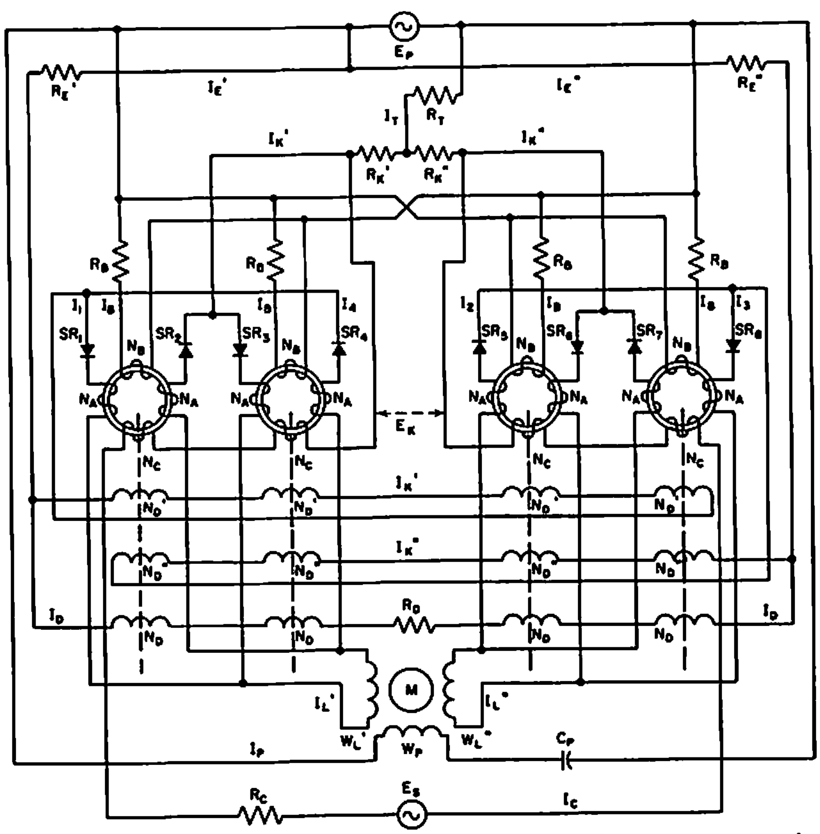
OPEN-FUSE DETECTOR—Magamp circuit uses bridge unbalance to operate control relay when protective fuse opens in digital computer, to remove d-c voltages from fused section. One of 15 control windings of series-connected magnetic amplifier is placed across each fuse, with appropriate current-limiting resistor in series with each winding. (Only representative control windings are shown.) —J. Maroz, Magnetic Amplifier Detects Open Fuses, *Electronics*, 31:29, p 86–92.



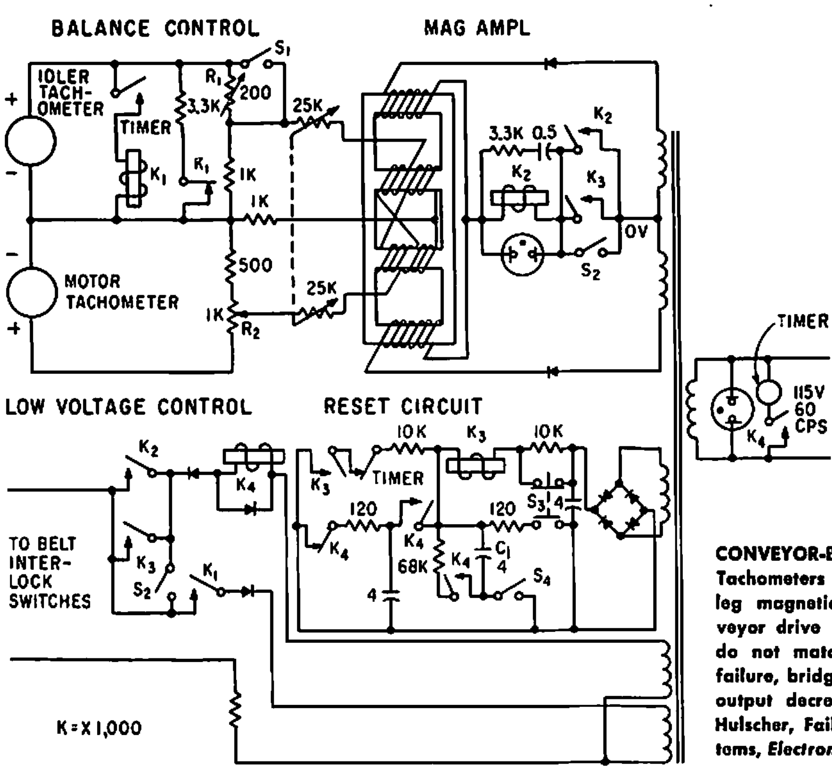
MODIFIED ANALOG MULTIPLIER—Input signal voltages are obtained from center-tapped 2,000-ohm input resistor so that each signal may change its polarity. Circuit then provides unidirectional output voltage EL which is equal to square of ES.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 103.



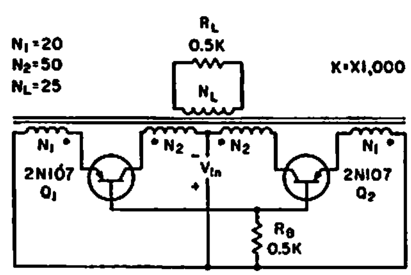
MAGAMPS CONTROL SCR BRIDGE—Single-phase bridge is controlled by two half-wave magnetic amplifiers each having a transistor emitter-follower used as clipper for each half-wave voltage output. Used for adjustable d-c field supply.—T. E. DeViney, Semiconductors Improve Reliability of Steel-Mill Control Equipment, *Electronics*, 34:23, p 104–107.



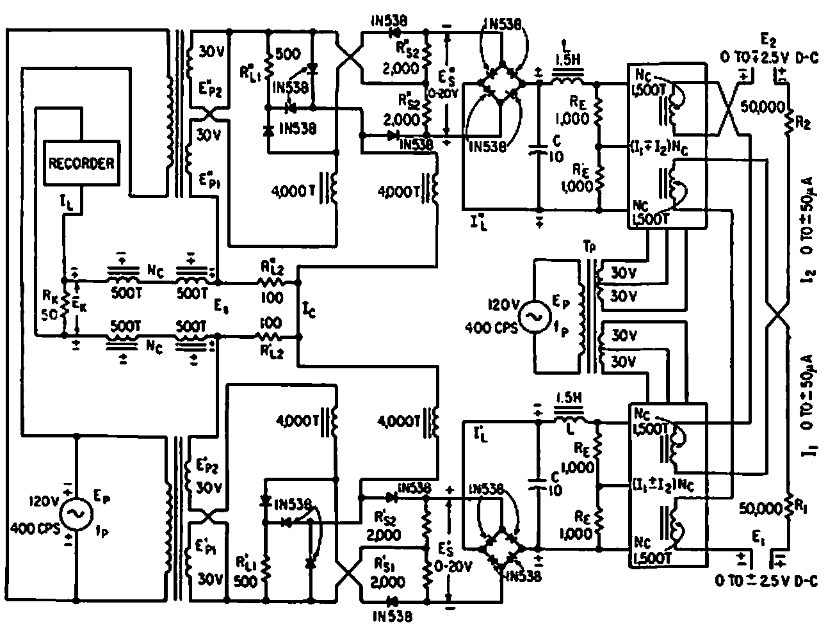
400-CPS SERVO MOTOR DRIVE—Self-balancing single-stage magnetic amplifier has high response speed, excellent stability, excellent linearity, and freedom from drift. Provides half-cycle response as operational amplifier. Article gives winding data for saturable reactors.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 107.



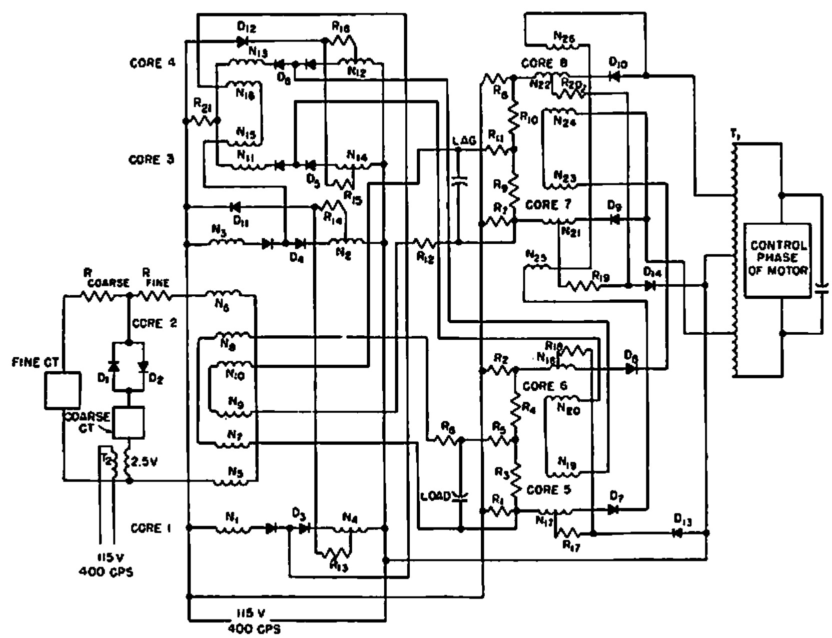
CONVEYOR-BELT OVERLOAD PROTECTION—Tachometers monitor belt slip and feed four-leg magnetic amplifier which controls conveyor drive relay K2. If tachometer outputs do not match because of belt slip or belt failure, bridge becomes unbalanced, magamp output decreases, and K2 drops out.—F. R. Hulscher, Fail-Safe Circuits for Conveyor Systems, *Electronics*, 32:28, p 60.



DIFFERENTIAL MAGNETIC INVERTER—Oscillates reliably without use of current bias. Excessive drive will not cause transistor overheating. Differential action of collector and emitter windings greatly improves performance as compared to conventional nondifferential inverter and eliminates need for clipping diodes.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 103.



FOUR-QUADRANT ANALOG MULTIPLIER—Uses two square-law multiplier circuits containing only magnetic cores, silicon diodes, and resistors, to provide first square term of algebraic sum of currents I1 and I2, and second square term of difference of these currents.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 104.



Core data: first and second stages
Cores 1, 2, 3 and 4 — Orthonol, 0.002-in. tape, 3/4 × 1 × 3/8 in.
Winding data

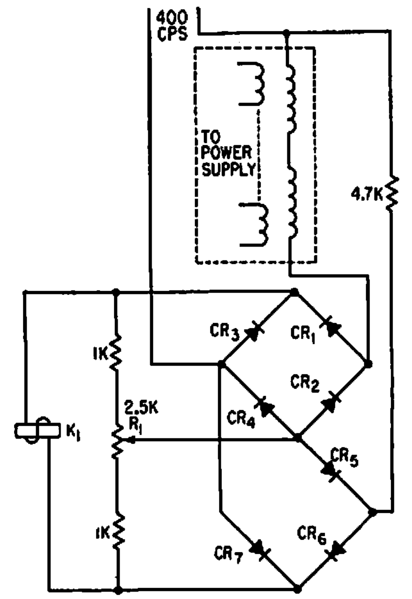
Core 1	Core 2	Core 3	Core 4	Turns	Wire Size
N_1	N_3	N_{11}	N_{13}	1,250	No. 34
N_2	N_4	N_{12}	N_{14}	1,250 Tapped at 650	No. 34
N_5	N_6			600	No. 37
N_7	N_8			300	No. 37
N_9	N_{10}			1,000	No. 37
		N_{15}	N_{16}	100	No. 34

Output stage
Cores 5, 6, 7 and 8 — Orthonol, 0.002-in. tape, 1 × 1 1/4 × 1/4 in.
Winding data

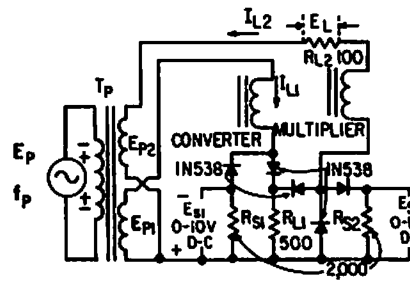
Core 5	Core 6	Core 7	Core 8	Turns	Wire Size
N_{17}	N_{18}	N_{21}	N_{22}	4,000 Tapped at 500	No. 32
N_{19}	N_{20}	N_{23}	N_{24}	7	No. 32
		N_{25}	N_{25}	7	No. 32

Rectifier data
D_3, D_4, D_5, D_6 — 6 plates, selenium, 1 in. square, doubler-connected
D_7, D_8, D_9, D_{10} — 6 plates, selenium, 1 in. square
D_1, D_2, D_{11}, D_{12}, D_{13}, D_{14} — 6 plates, selenium, 1/2 in. square
Resistor data
R_{13}, R_{14}, R_{17}, R_{18}, R_{19}, R_{20} — 56,000 ohms, 1/2 watt
R_{15}, R_{16} — 100,000 ohms, 1/2 watt
R_{21} — 150 ohms, 5 watt
R_1 through R_{12}, R_{fine} and R_{coarse} — vary depending on amount of compensation
Capacitor data
C_3 — 0.1 μf, 400 v, paper
C_1 and C_2 — vary depending on amount of compensation
Transformer data
T_1 — Westinghouse, Hypersil cut core, No. 6H
Windings 1,200 turns No. 30 wire
Tap at 400 turns
600 turns
800 turns
T_2 — 115/2.5-v transformer for stickoff voltage

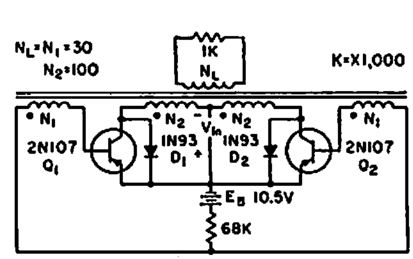
TWO-SPEED SERVO MOTOR DRIVE—Consists of two conventional half-wave bridge-type stages driving full-wave slave-type output stage. Designed to replace former electron-tube amplifier of two-phase servo system using fine and coarse control transformers.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 112.



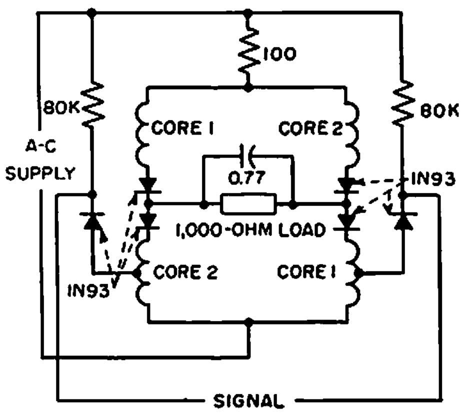
DOUBLE-BRIDGE OPEN-FUSE DETECTOR—Used with magnetic amplifier to disconnect d-c voltage from section protected by fuse that opens. Output of lower bridge is balanced against output of upper bridge by adjusting R1. Gives greatly increased sensitivity.—J. Maroz, Magnetic Amplifier Detects Open Fuses, *Electronics*, 31:29, p 86–92.



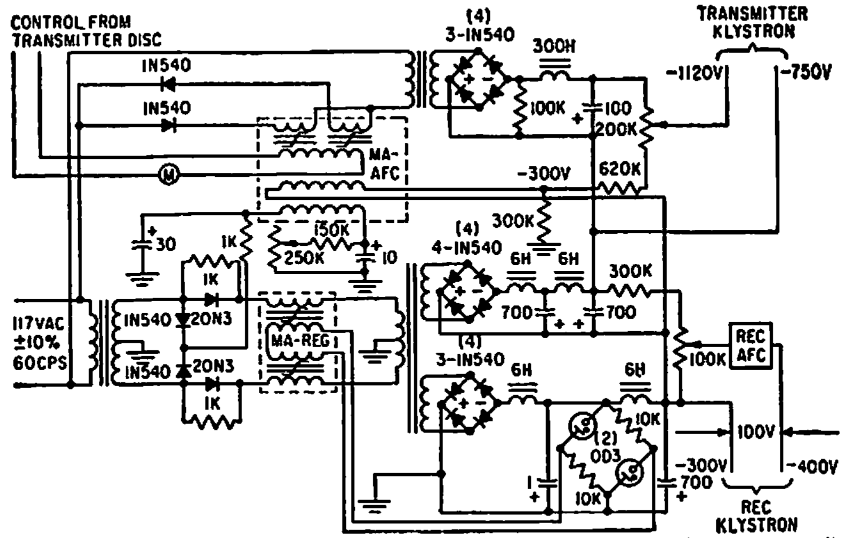
BASIC ANALOG MULTIPLIER—Multiplies d-c voltages ES1 and ES2 in two-stage arrangement in which converter is input stage controlled by one signal voltage and multiplier is output stage controlled by other signal voltage.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 103.



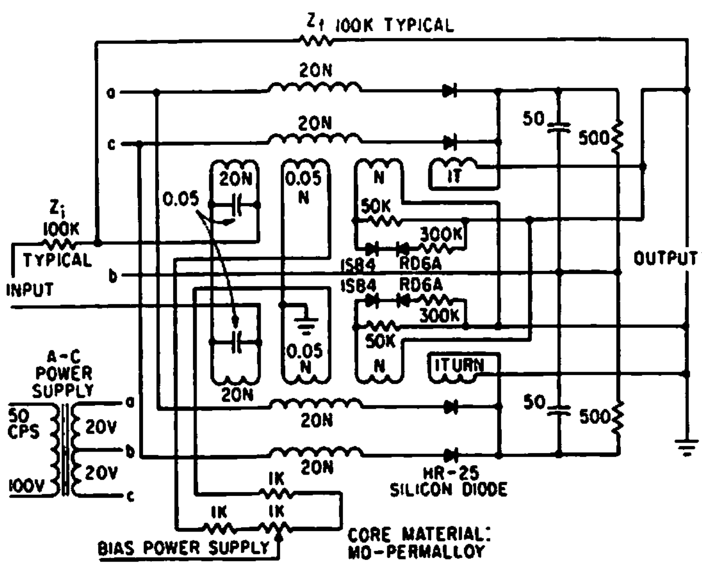
NONDIFFERENTIAL MAGNETIC INVERTER—Is analogous to free-running capacitor-coupled mvbr. Frequency and output amplitude are both directly proportional to input voltage. Chief drawback is need to increase input voltage to get higher frequency, which in turn increases all winding voltages.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 102.



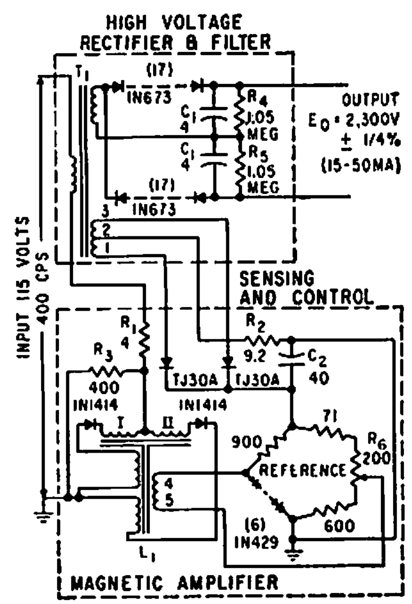
SYNCHRONOUS SWITCHING BOOSTS VOLTAGE GAIN—Synchronously switched biased diodes insert impedance in control circuit during power half-cycle. During reset half-cycle bias rectifiers conduct and signal is applied directly across control windings to increase gain by factor of four.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 115.



REFLEX KLYSTRON FREQUENCY AND VOLTAGE CONTROL—Consists of main regulation magnetic amplifier MA-REG for reflector of VA-222 power klystron in 6,000-Mc microwave link, and secondary magamp MA-AFC that provides further regulation for repeller voltage.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, N.Y., 1959, p 110.

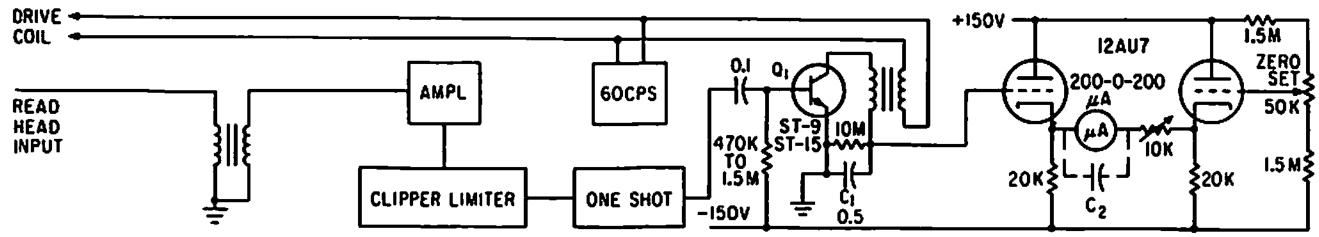


HALF-SQUARE MAGNETIC MULTIPLIER—Can be used as squaring function generator, quarter-wave multiplier, or two multipliers. Only one operational amplifier is required.—T. Miura and C. Hirano, Reliable Magnetic Amplifier Improves Multiplier, *Electronics*, 35:26, p 76–79.

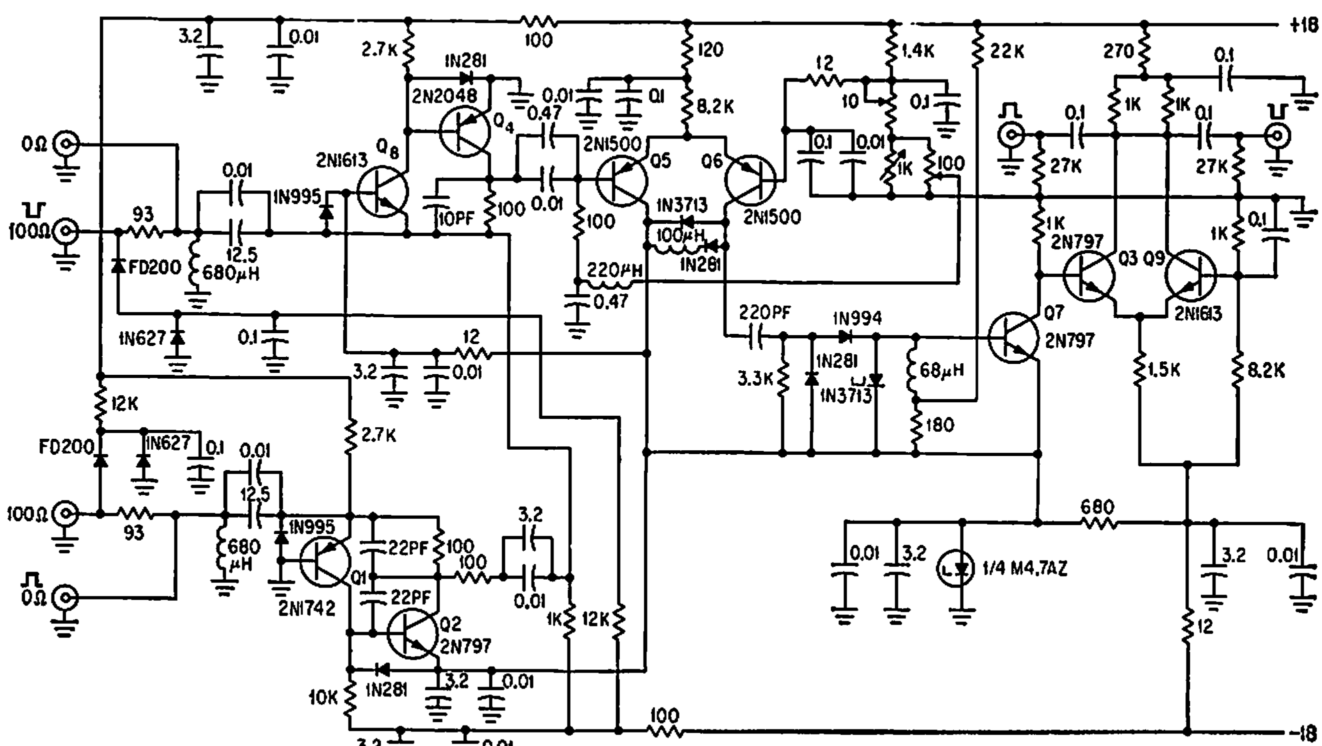


MAGAMP REGULATES 2,300-V SUPPLY—Self-saturating magnetic amplifier is placed on low-voltage input side of high-voltage 400-cps rectifier and auxiliary winding is added for output sensing, to isolate control and sensing functions from high-voltage circuit.—W. J. McDaniel and T. L. Tanner, Regulating High Voltage with Magnetic Amplifiers, *Electronics*, 32:29, p 64.

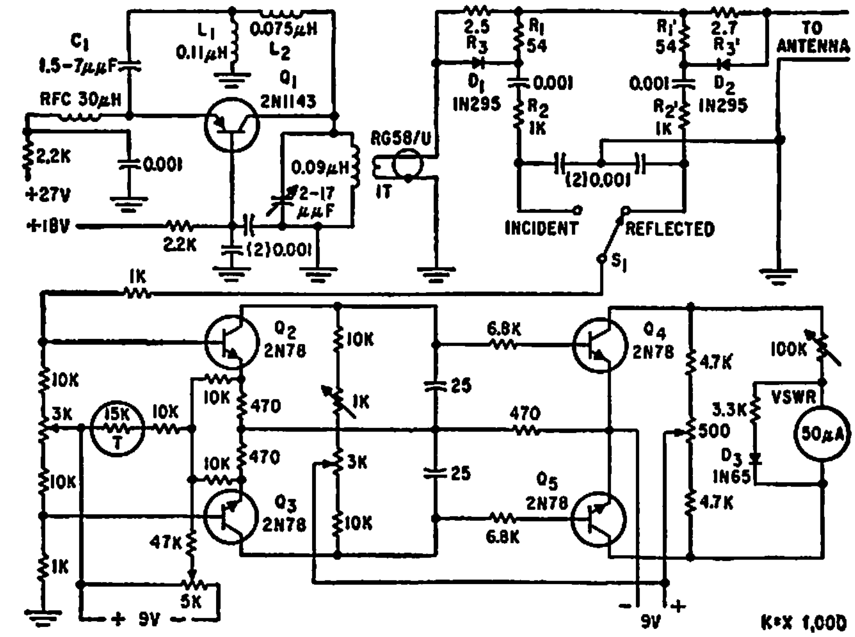
CHAPTER 49
Measuring Circuits



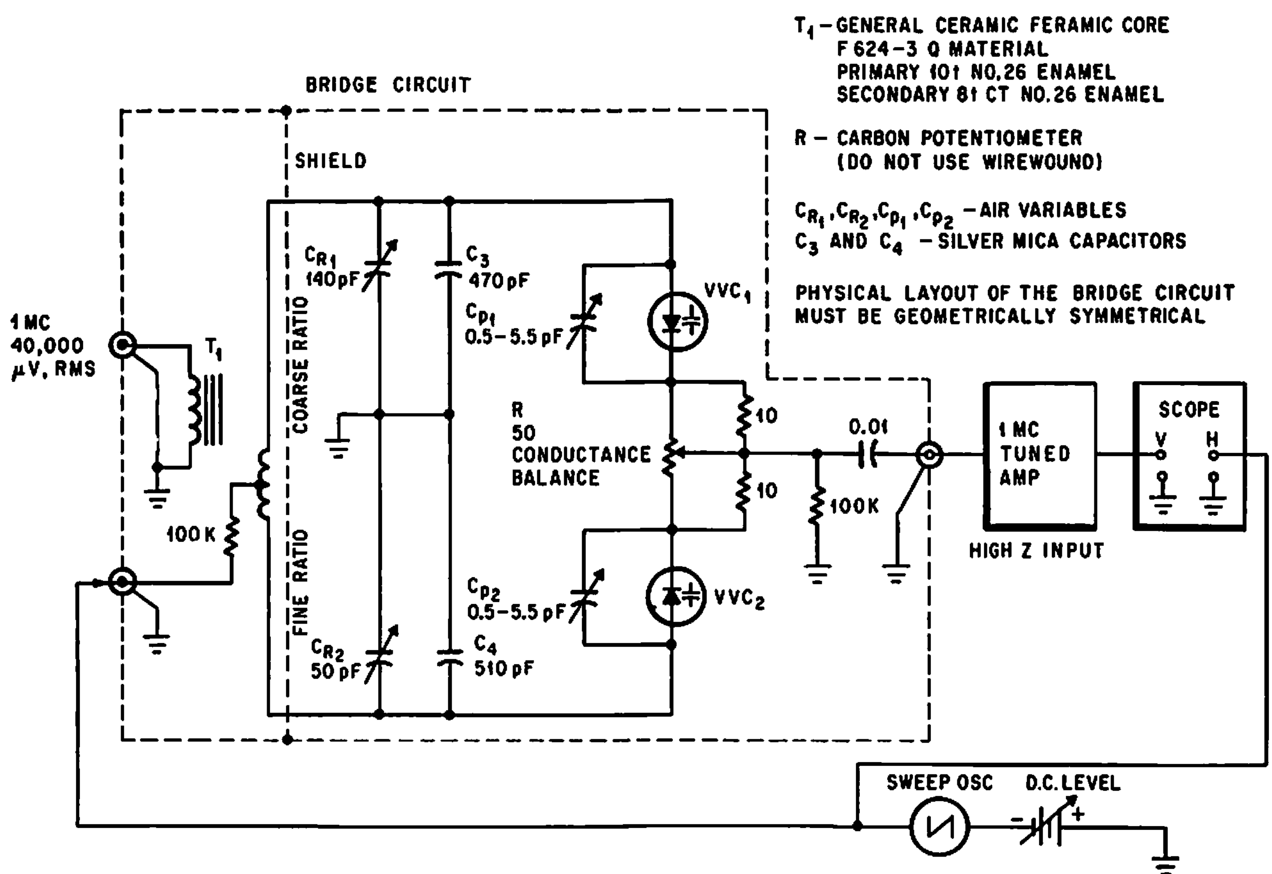
MAGNETIC TAPE SKEW MEASUREMENT—Magnetic strip recorded on tape is scanned transversely with ring-type play-back head, and periods between output pulses generated at crossover points are measured. C1 acquires positive charge for one direction of skew and negative charge for other. Output of detector of C1, which measures this charge, is fed to difference amplifier having microammeter connected between cathodes to read tracking error.—B. R. Gooch, Magnetic Strip Keeps Tape Running True, *Electronics*, 36:2, p 42–43.



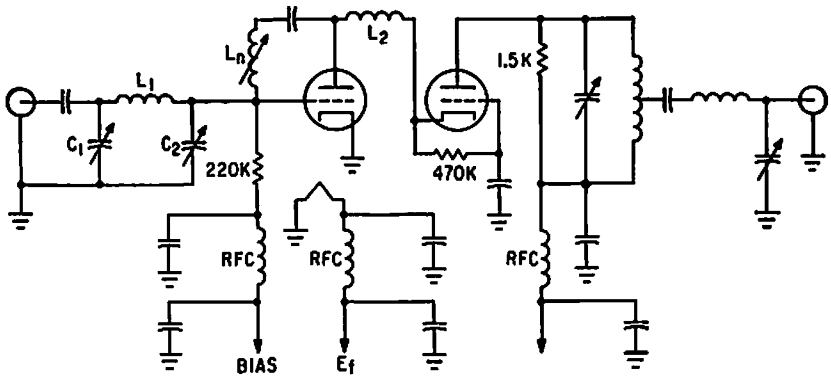
MOSSBAUER-EFFECT SPECTROMETER—Circuit makes effective use of transistors as current amplifiers.—W. W. MacDonald, Electronics in Israel, *Electronics*, 37:3, p 23–29.



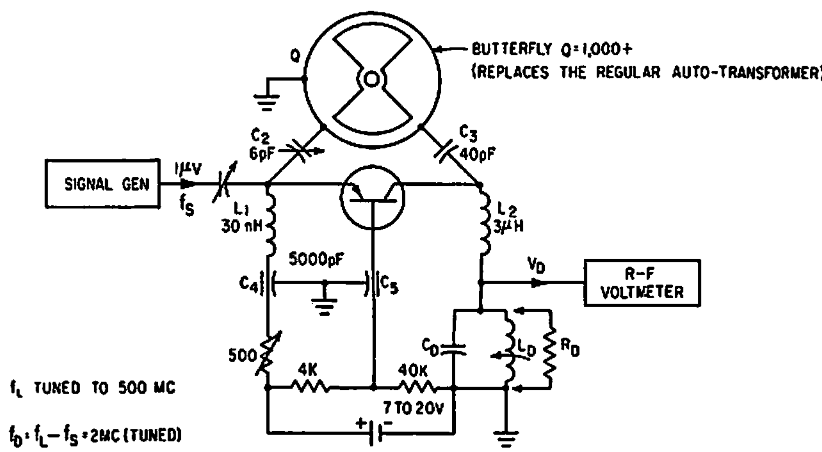
R-C DIRECTIONAL COUPLER—Couples variable-frequency 150–175 Mc oscillator to vhf antenna and furnishes incident and reflected power samples to d-c amplifier for measuring voltage-standing wave ratio.—J. Hanson, Unconventional Technique for Measuring VSWR, *Electronics*, 32:43, p 120–121.



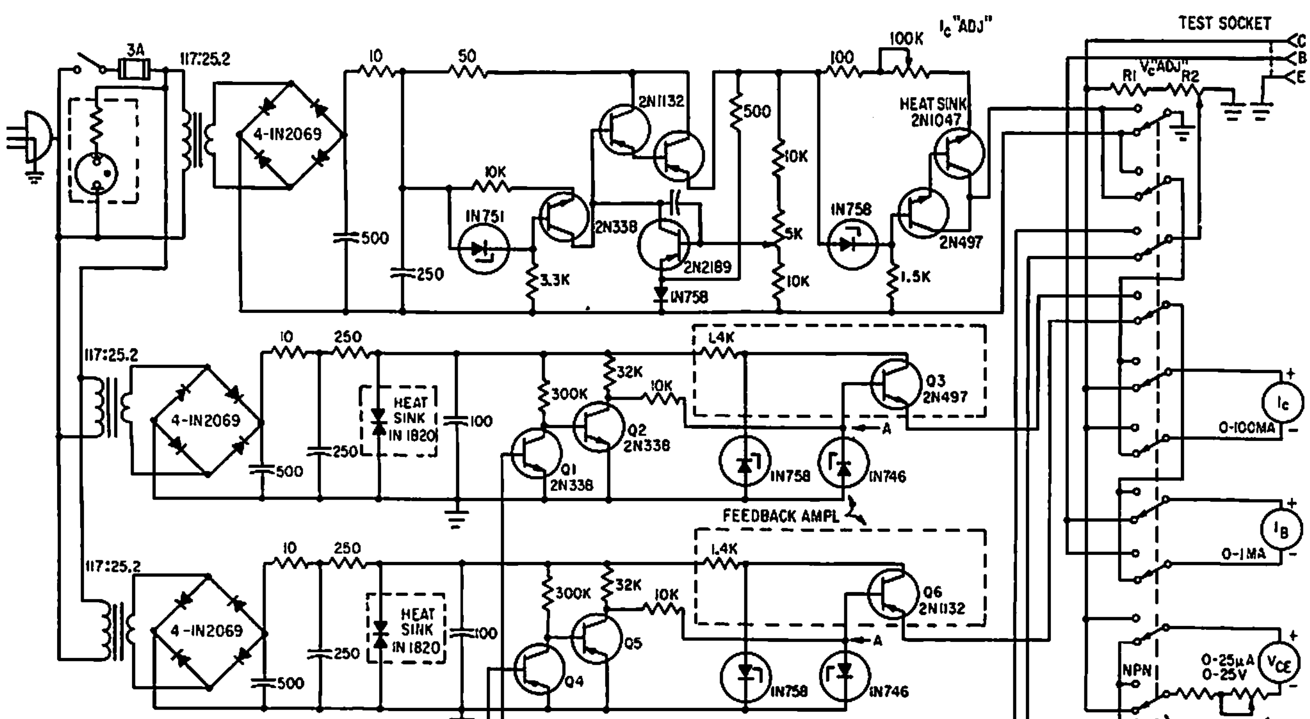
CAPACITANCE-TRACKING TEST SET—Output signal voltage of capacitance bridge, proportional to capacitance unbalance, is applied to vertical input of scope through 1-Mc preamp. Horizontal sweep voltage of scope is also applied as bias to voltage-variable capacitances VVC whose tracking is being measured, so scope display shows diode capacitance-tracking as function of bias voltage.—L. A. Weldon and R. L. Kopski, Boost for Electronic Tuning, *Electronics*, 37:14, p 61–63.



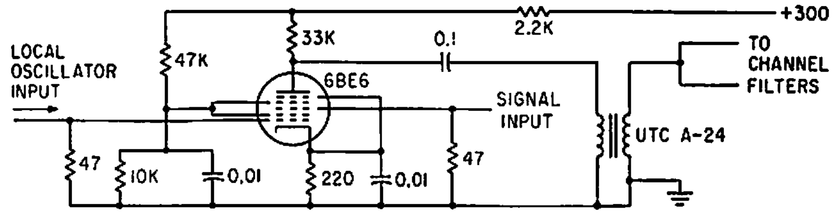
NOISE-FIGURE MEASUREMENT OF R-F TUBES—Standardized EIA Committee circuit measures noise-figure of cascode r-f amplifiers with 95% repeatability. Jig circuit for tube under test has 200-Mc center frequency and 10-Mc bandwidth.—T. E. Gausman, Standardizing Noise-Figure Measurement, *Electronics*, 36:1, p 124–129.



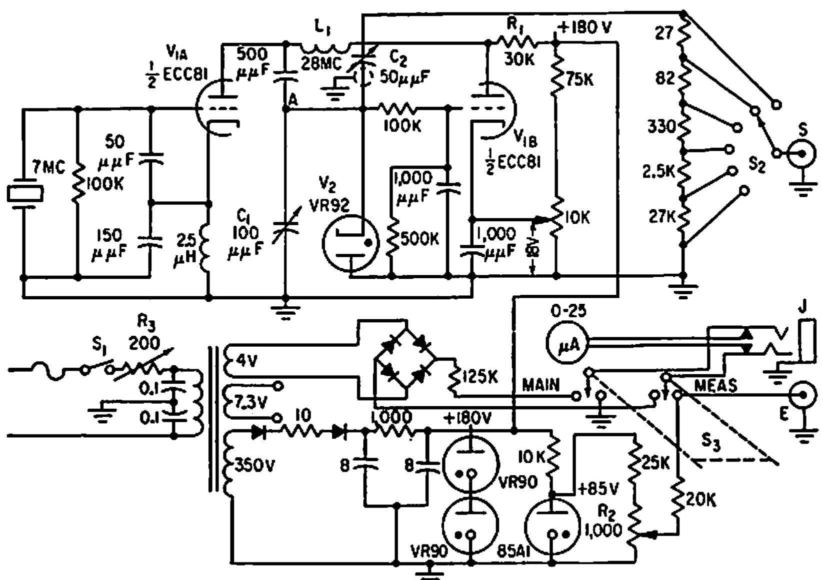
MEASURING CONVERSION GAIN—Used for measuring input impedance characteristics of high-frequency transistor for operation beyond cutoff in special converter circuits. —V. W. Vodicka and R. Zuleeg, Transistor Operation Beyond Cutoff Frequency, *Electronics*, 33:35, p 56–60.



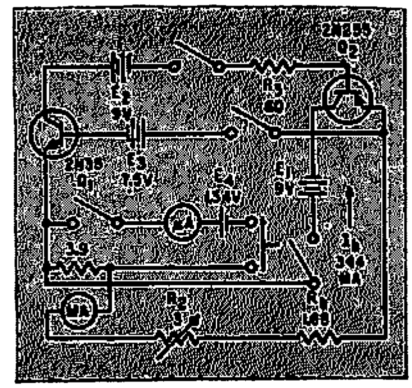
COMMON-EMITTER BETA TEST SET—Switch permits testing both npn and pnp transistors over wide current and voltage ranges. Two feedback amplifiers are used, one for npn and the other for pnp.—R. M. Mann, Fresh Approach to Measuring Transistor Beta, *Electronics*, 36:30, p 47–49.



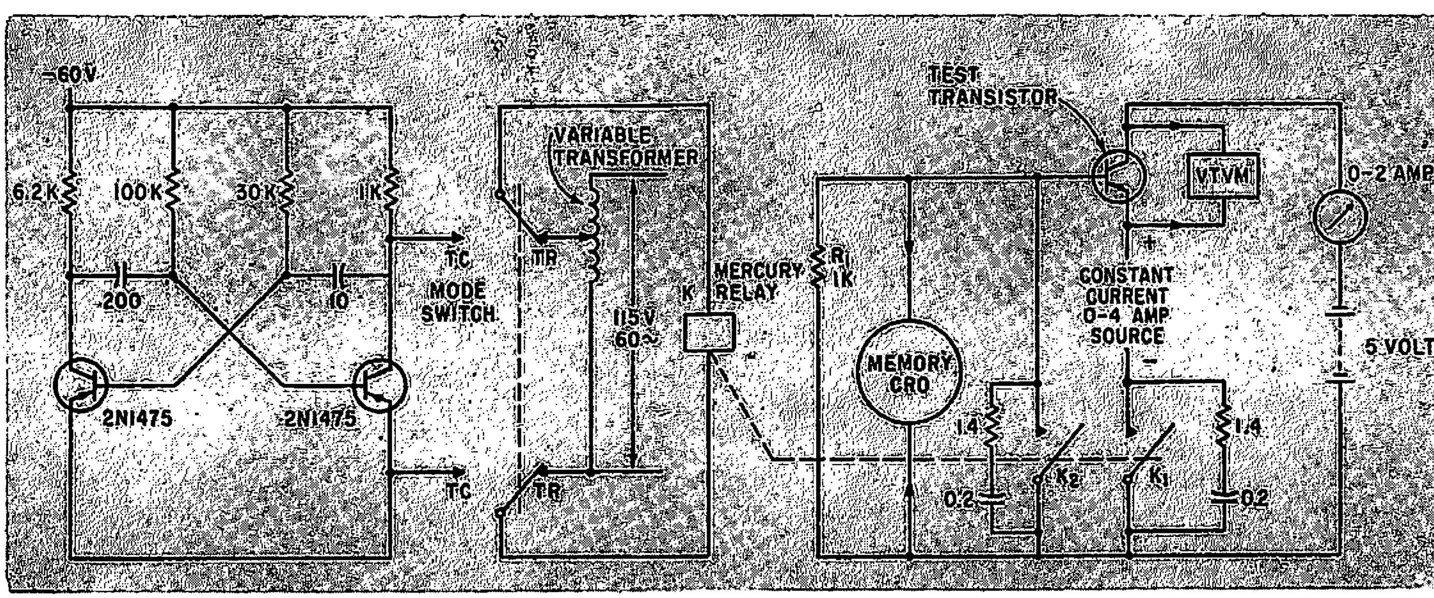
MIXER FOR DISTORTION MONITOR—Combines local oscillator signal with two input-frequency tones without introducing distortion, by using primarily grid-swamping techniques.—G. H. Smith, Distortion Monitor Checks Linear Amplifier Characteristics, *Electronics*, 34:27, p 57–59.



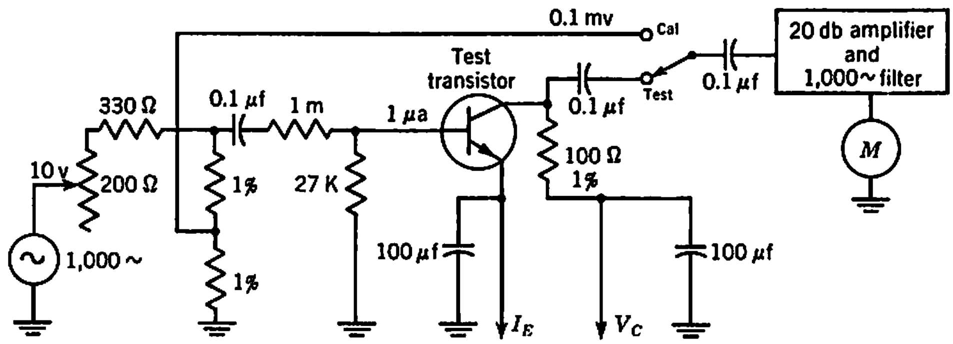
CEMENT-SETTING TIMER—Sample of cement is inserted as dielectric material in test-tube capacitor, and admittance readings are made every 15 minutes using 7-Mc crystal oscillator with anode circuit tuned to 28 Mc. Maximum admittance indicates end of setting process.—J. M. Tobio, Electronics Determines Cement Setting Time, *Electronics*, 31:41, p 88–90.



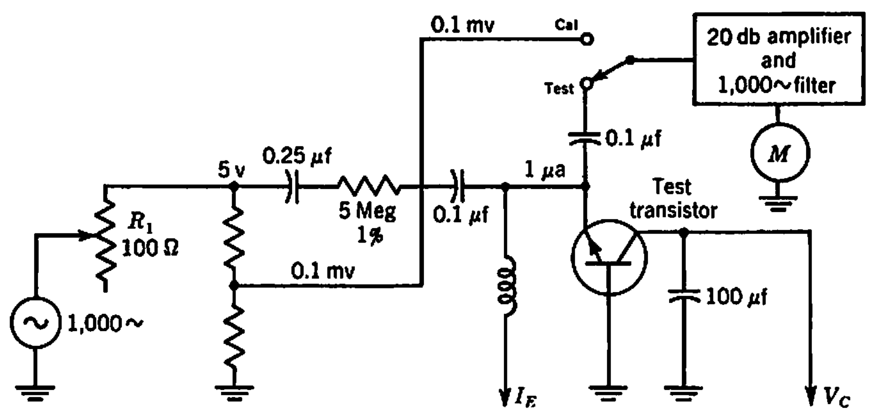
MOISTURE METER—Maintains constant current for 20 minutes of heavy loading of conventional zinc-carbon dry cells when measuring moisture in pulverized coal or other powders, through use of inverse voltage feedback in two-stage direct-coupled amplifier.—G. E. Fasching, Inverse Feedback Stabilizes Dry Cell Current Sources, *Electronics*, 32:41, p 78.



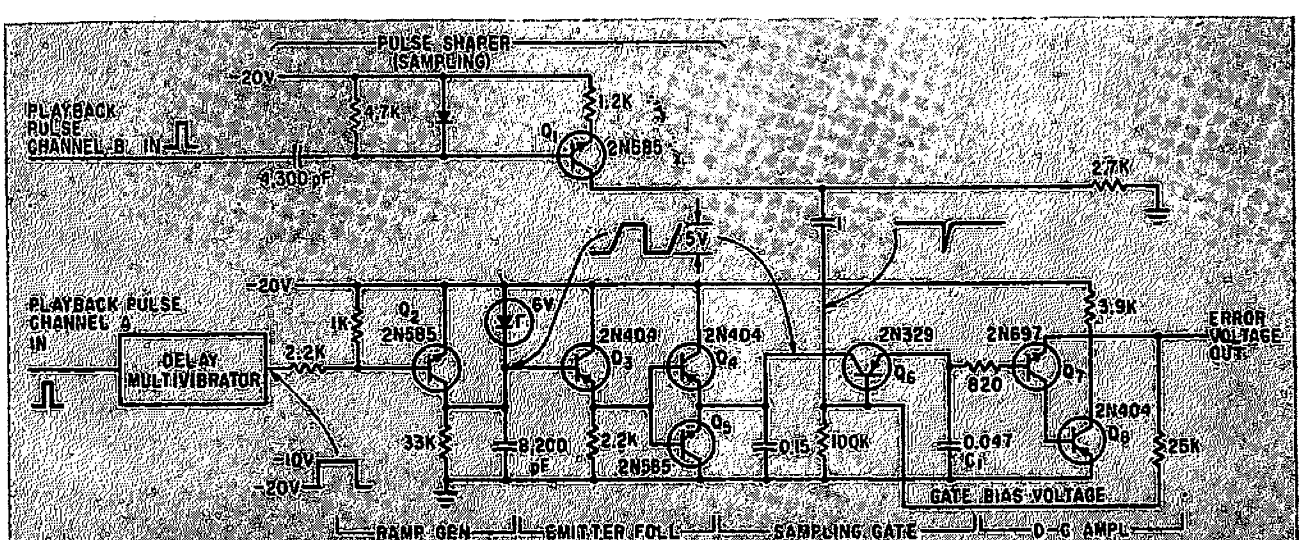
THERMAL CONSTANTS OF TRANSISTORS—Astable mvbr generates 0.3-sec pulse every 3 sec to drive mercury relay when mode switch is on TC contacts for measuring thermal time constant of transistor under test. Constant power is applied between pulses, using cro as guide for keeping power level near normal steady-state value of transistor. Thermal resistance data is obtained with mode switch on contact TR, where 60-cps supply drives relay.—H. Bauman, Practical Way to Measure Transistor Thermal Resistance, *Electronics*, 36:7, p 66–67.



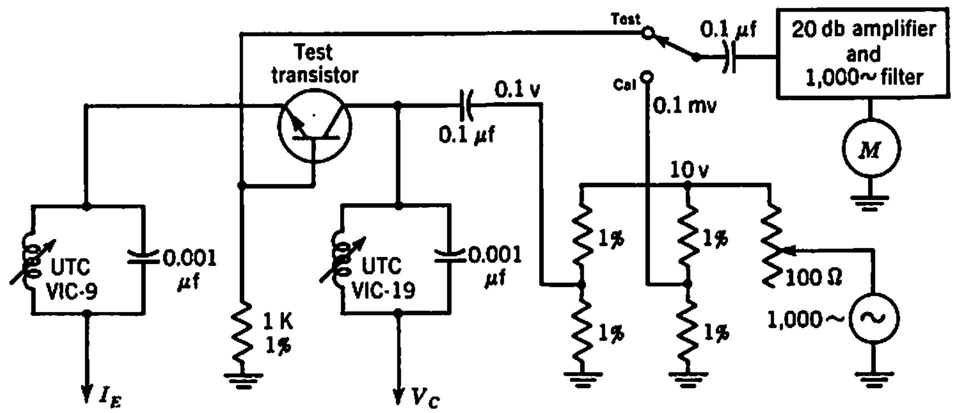
MEASURING TRANSISTOR TRANSFER RATIO—Basic test circuit shown measures small-signal short-circuit forward current transfer ratio of transistors. Gives direct reading of h-fe when base current is held at fixed value of 1 microamp.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 70.



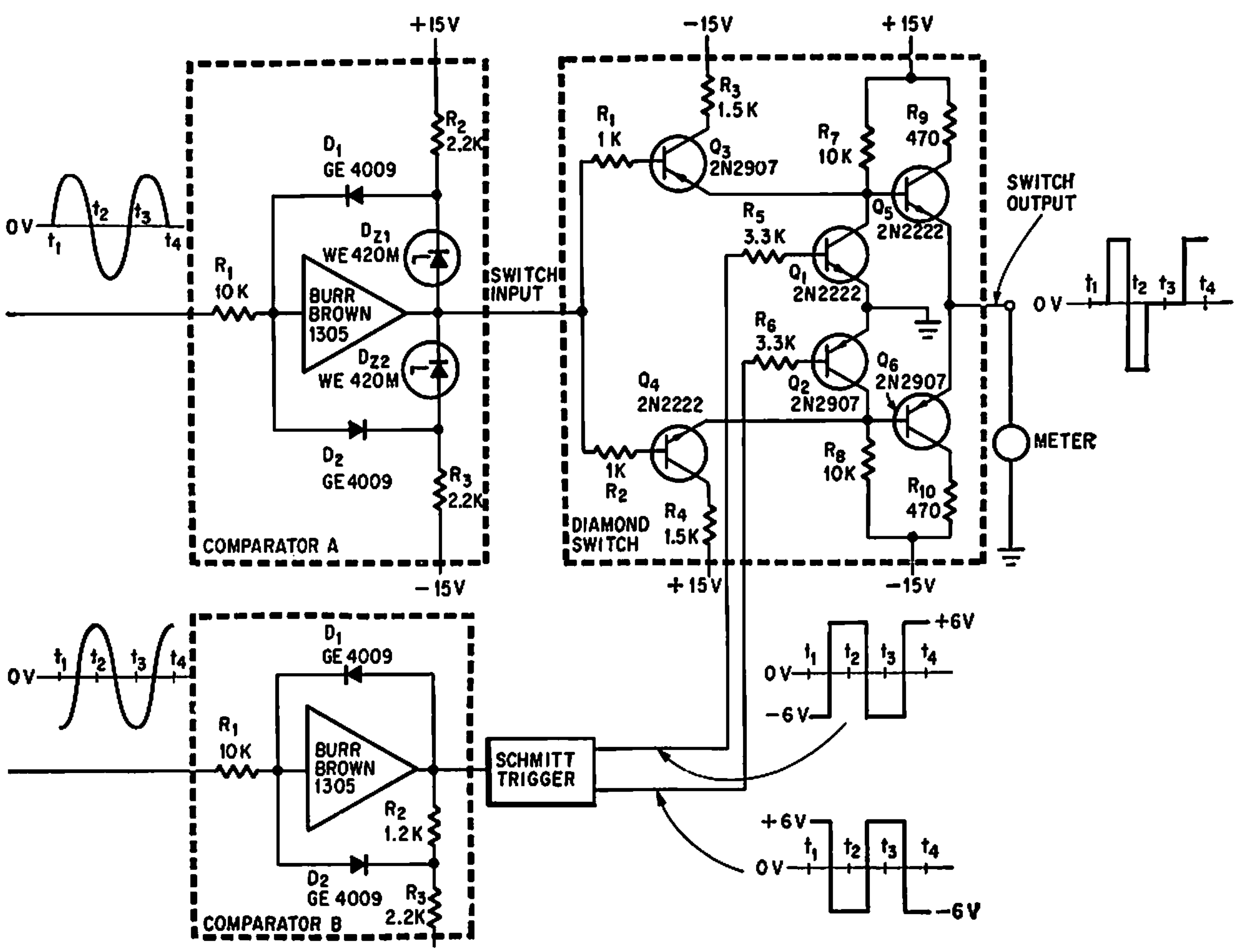
MEASURING TRANSISTOR SHORT-CIRCUIT INPUT RESISTANCE—Output meter gives direct reading of h-ib when input current is held at 1 microamp.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 70.



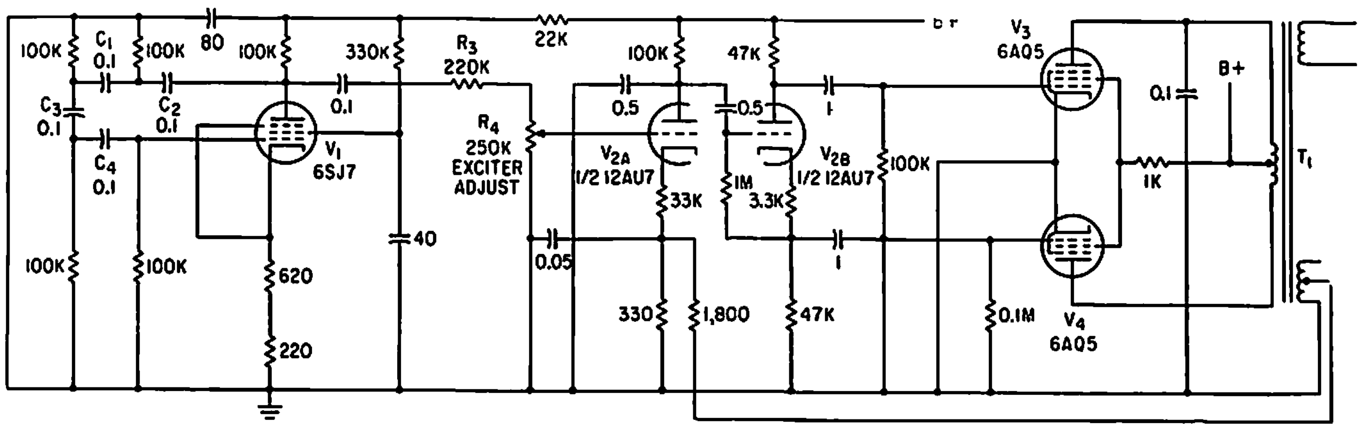
MAGNETIC TAPE FLUTTER—Time of travel of recorded pulse between two playback heads on tape recorder under test is converted to d-c voltage. Boxcar detection circuit, ramp generator, and sampling gate detect flutter components as small as 0.01% peak-to-peak.—A. Schulback, Instantaneous Measurement of Tape Flutter, *Electronics*, 35:19, p 93–94.



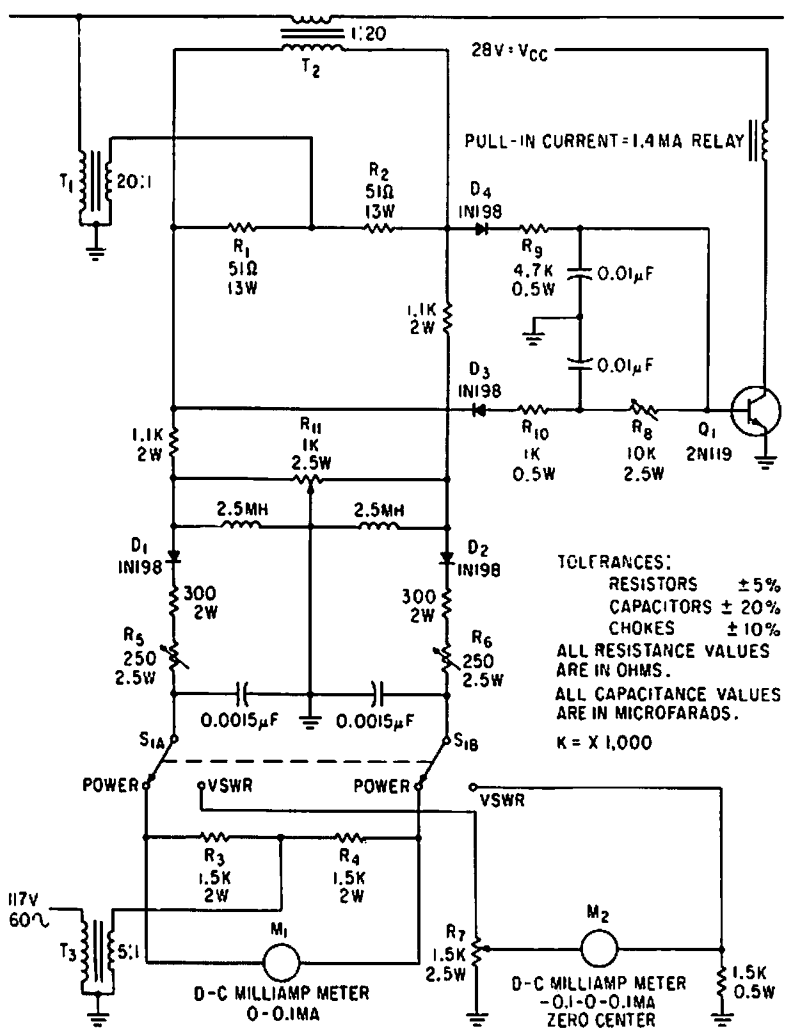
MEASURING TRANSISTOR OPEN-CIRCUIT OUTPUT ADMITTANCE—Test set gives small-signal value h-ob of open-circuit output admittance of transistor for common-base connection. Input voltage is held constant at 1 v and current is read as voltage drop across 1K resistor. Voltage in mv can then be read directly as admittance of 0.1 to 1 micromho on 10-mv scale of meter.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 71.



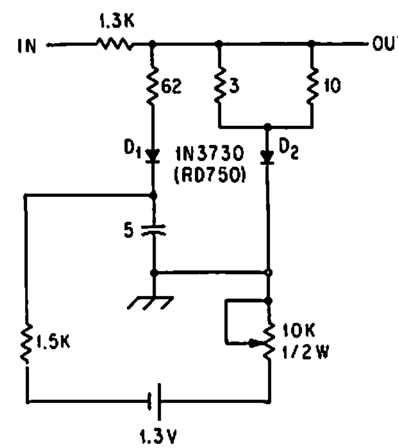
DIAMOND CIRCUIT MEASURES A-F PHASE SHIFT—Accuracy is 1% up to 2,000 cps. Used in computers and for high-speed analog instrumentation. Zero-center d-c ammeter indicates negative value for zero phase shift, zero for 90° phase shift, and some maximum value for 180° phase shift.—H. R. Deveraux, Diamond Circuit Measures Phase Shift, *Electronics*, 37:25, p 74–75.



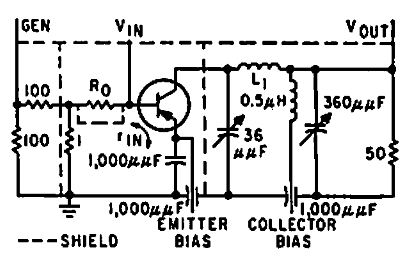
COATING THICKNESS GAGE—Oscillator V1 and amplifier V2-V3-V4 apply 10-cps signal to magnetic-reluctance transducer held over coating up to 0.040 inch thick, unbalancing transducer and giving output voltage proportional to thickness of coating.



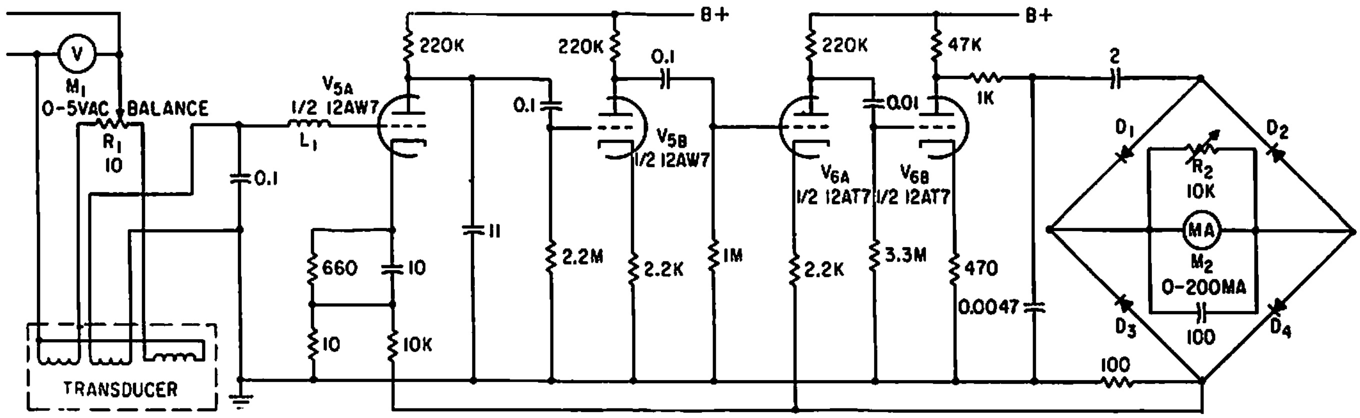
R-F TRANSMITTER POWER AND VSWR MONITOR—Standing-wave ratio is indicated by position of shaft of potentiometer R7 in bridge circuit, when switch is in vswr position. Diodes D3 and D4 act with Q1 as alarm circuit that interrupts power amplifier plate voltage when vswr exceeds preset limit. At other switch position, actual r-f output power in watts is indicated on d-c milliammeter.—L. F. Stein, Versatile R-F Monitor Shows Power and VSWR, *Electronics*, 36:13, p 44–46.



LOG ATTENUATOR FOR POSITIVE PULSES—Output is proportional to log of input voltages between 0.1 and 100 v.—C. D. Nail, Logarithmic Attenuator Spans Three Decades, *Electronics*, 36:46, p 47–48.

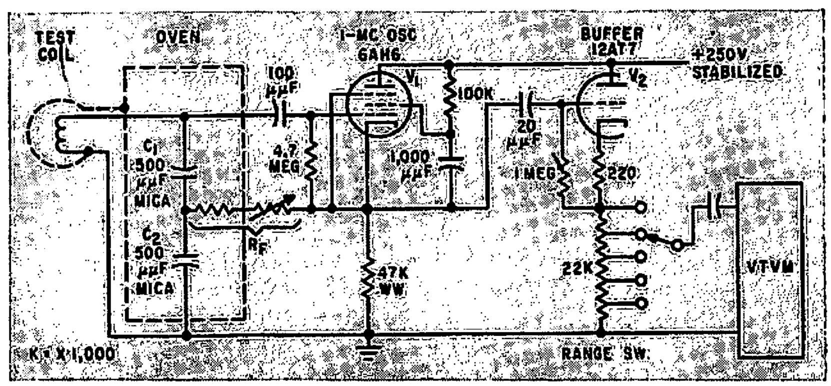


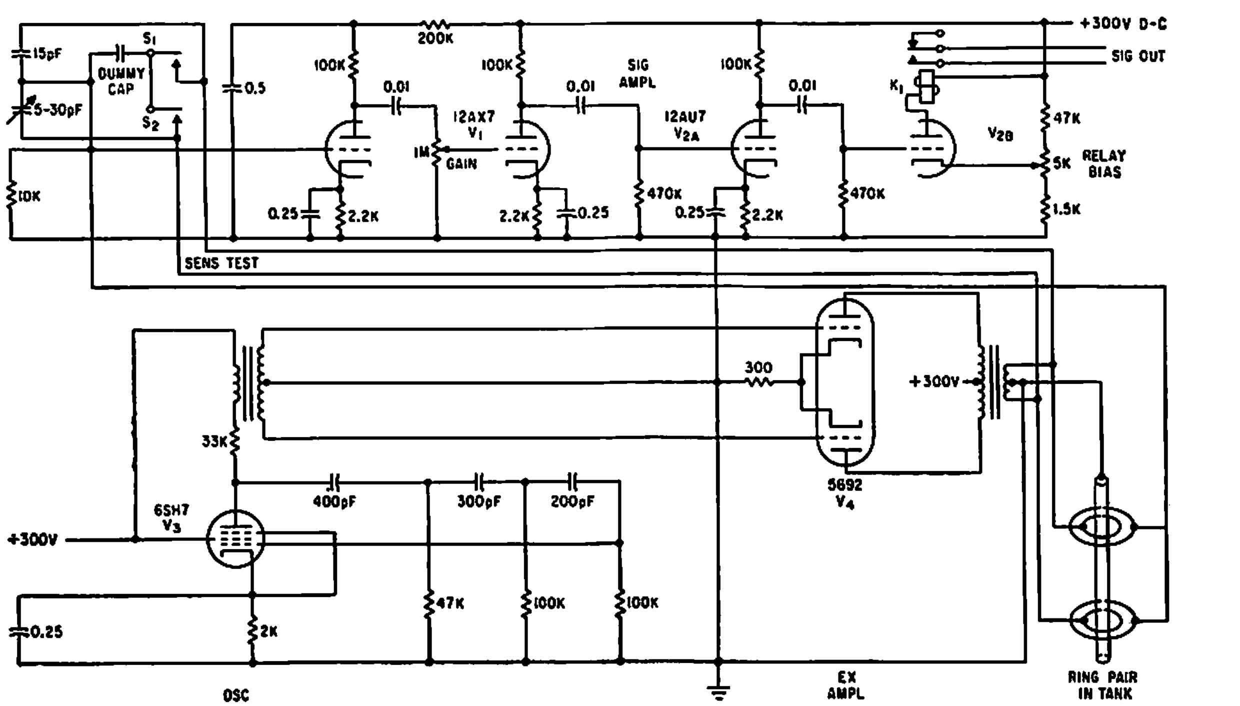
TRANSISTOR POWER GAIN—Measures power gain as a function of frequency. When maximum oscillation frequency is approached, unilateral gain drops at rate of 6 db per octave. Input generator has 1 ohm internal resistance. Pi network matches transistor output to load resistor.—J. Lindmayer and R. Zuleeg, Determining Transistor High-Frequency Limits, *Electronics*, 32:34, p 31–33.



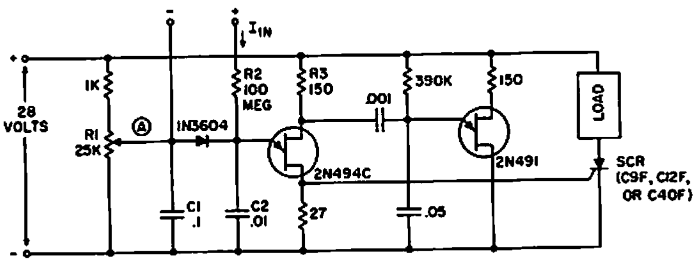
After amplification in V5-V6, this voltage is rectified for d-c milliammeter.—P. Dick, Measuring Thickness of Paramagnetic Coatings, *Electronics*, 34:8, p 48–50.

WIRE THICKNESS GAGE—Uses principle of proximity detectors for nondestructive measurement of moving copper wire thickness during drawing operation or on coil-winding machine. Wire passing through test coil acts like shorted turn of transformer, lowering Q of coil. Stable 1-Mc oscillator and buffer drive vtvm that indicates variations in wire diameter for sizes down to AWG 46. —K. H. Jaensch, Wire Gage Provides Continuous Measurement, *Electronics*, 33:7, p 109–111.

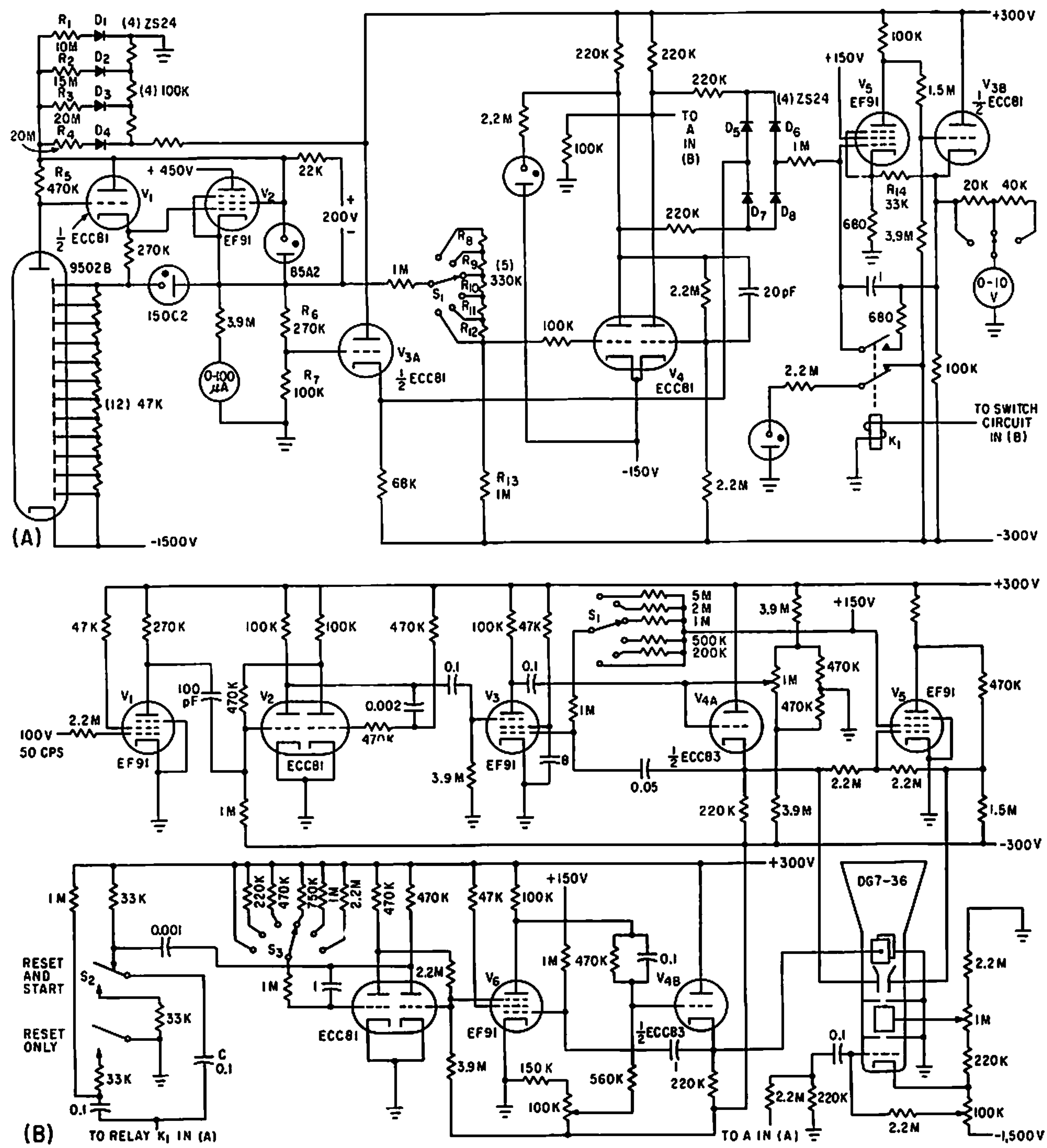




LIQUID LEVEL—Nonconducting liquids change electrostatic capacitance of ring electrodes in tank. Amplified error signal from electrode bridge operates recording galvanometer or indicator lamps to provide measurements of level accurate to 0.01 inch.—T. L. Greenwood, Capacitance Change Indicates Liquid Levels, *Electronics*, 33:34, p 66–67.

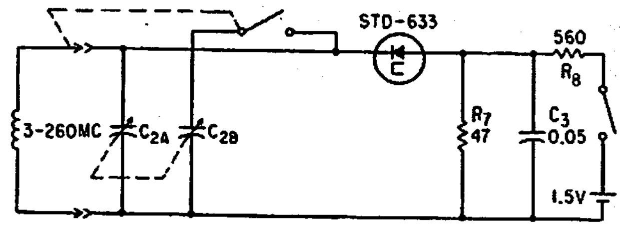


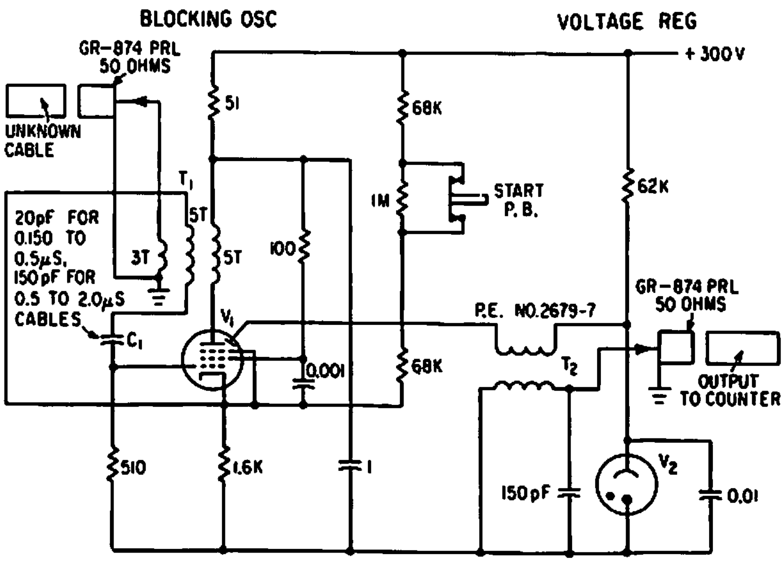
NANOAMPERE SENSING CIRCUIT—May be used as sensitive current detector or as voltage detector having high input impedance. Circuit input impedance is 100 meg. Input current of 40 nanoamperes charges C2 and raises emitter voltage of 2N494C to triggering level. C1 and C2 then discharge, and resulting positive pulse triggers scr or other pulse-sensitive circuitry.—Transistor Manual, Seventh Edition, General Electric Co., 1964, p 326.



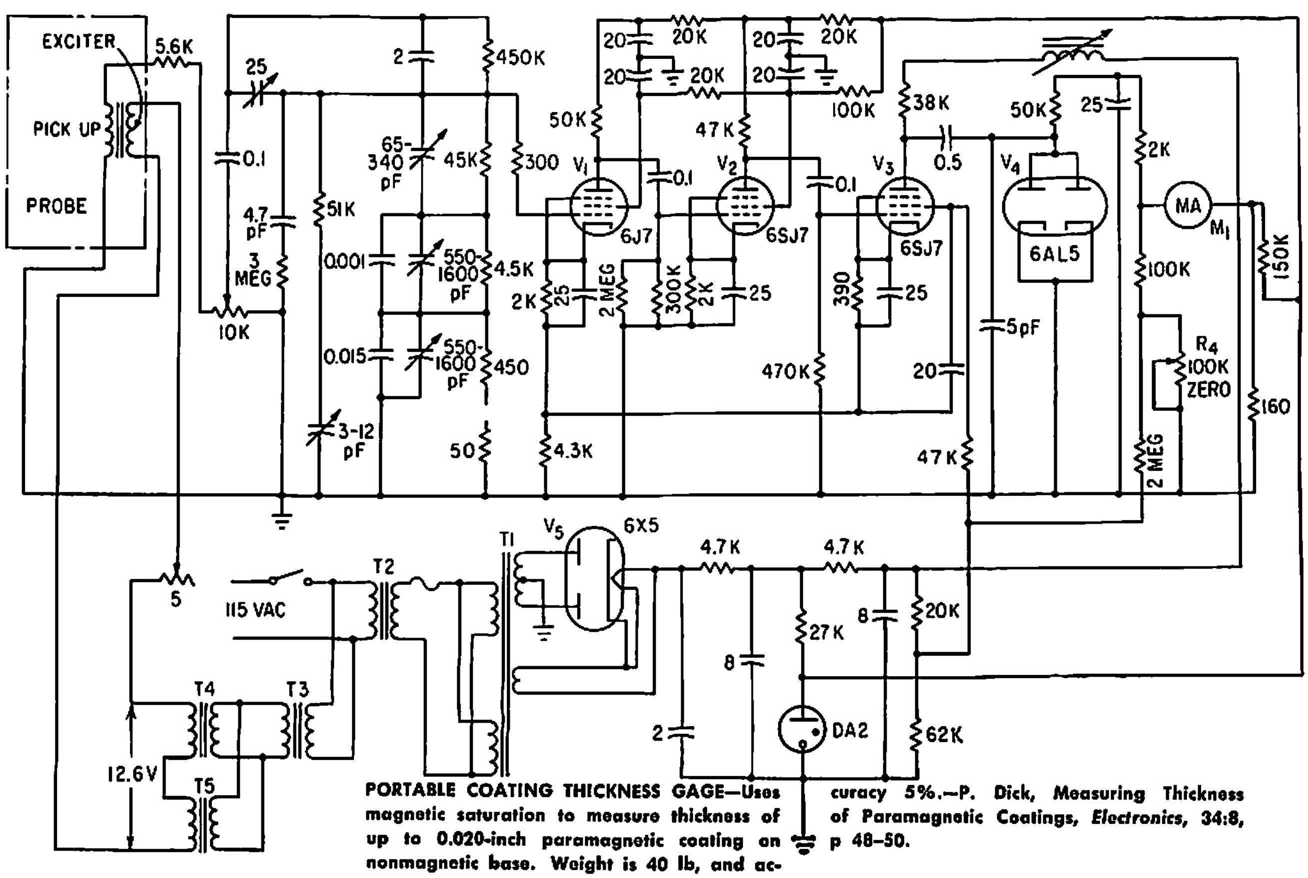
DENSITOMETER—Used in scanning X-ray diffraction photograph and measuring densities of hundreds of spots. Circuit integrates point-by-point values of optical extinction over the required area of the negative.—E. M. Deeley, Flying-Spot Integrating Densitometer, *Electronics*, 34:3, p 64–66.

3-260 MC TUNNEL-DIODE DIP METER—Oscillator is tunable in six ranges, using plug-in circuits.—E. Gottlieb and J. Giorgis, Tunnel Diodes—Using Them as Sinusoidal Generators, *Electronics*, 36:24, p 36–42.

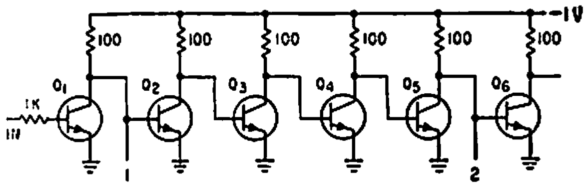




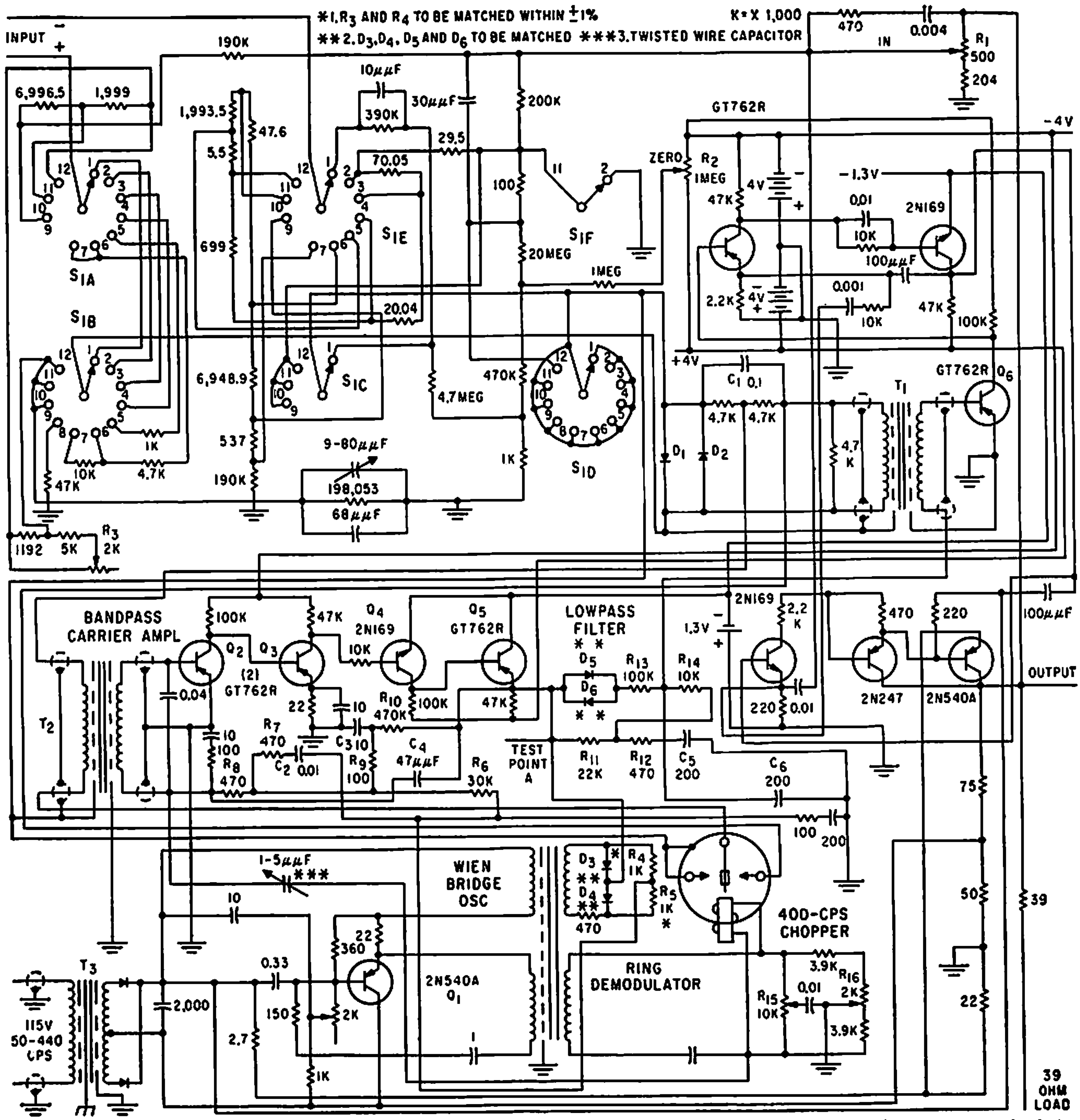
CHRONOTRON CIRCUIT MEASURES COAX DELAY—Secondary-emission tube V1 (EPP-60) in blocking oscillator generates millimicrosec pulses that are fed to unknown cable through anode transformer. Pulse reflected back from open-circuited end of cable is coupled into grid through same transformer to initiate new pulse. Resulting pulse repetition rate, proportional to cable delay, is measured with 10-Mc digital counter.—E. F. Laine, Getting Subnanosecond Precision in Coax Cable Delay Measurements, *Electronics*, 36:5, p 39–41.



PORTABLE COATING THICKNESS GAGE—Uses magnetic saturation to measure thickness of up to 0.020-inch paramagnetic coating on nonmagnetic base. Weight is 40 lb, and accuracy 5%.—P. Dick, Measuring Thickness of Paramagnetic Coatings, *Electronics*, 34:8, p 48–50.

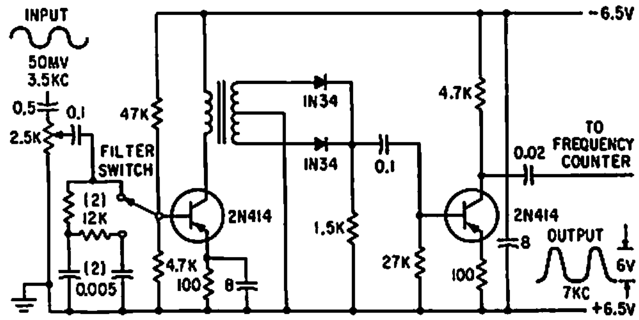


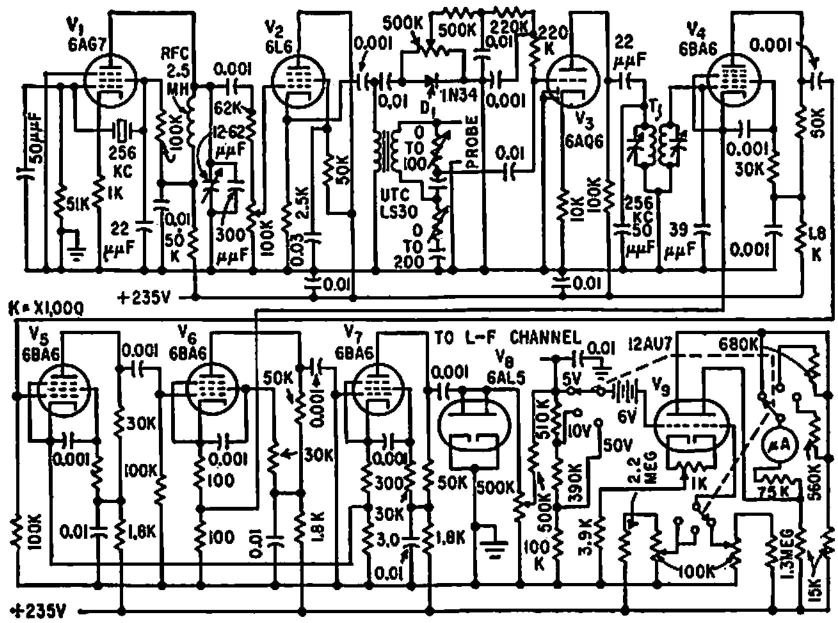
PROPAGATION TIME—Inverter circuit chain was developed to measure propagation time of 2N834 epitaxial mesa transistors. Pulse is applied to input, and outputs at 1 and 2 compared to get shift for four stages. Typical time measured was 4 nsec per stage.—W. D. Roehr, Epitaxial Process Improves Transistor Characteristics, *Electronics*, 34:9, p 52–53.



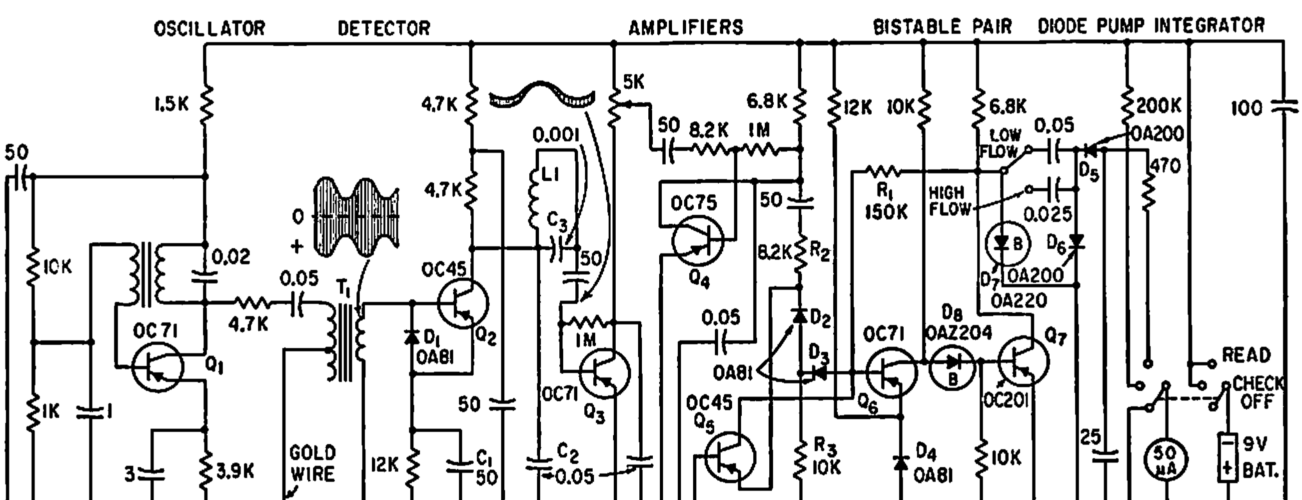
STRAIN-GAGE AMPLIFIER—Positive and negative feedback to bridge-type transformer-coupled input circuit provides high-impedance floating differential input in d-c to 25-kc amplifier. Bridge balances out common-mode signals that arise in data acquisition systems, where pre-amplifier ground may be hundreds of feet from transducer ground. Floating output delivers low voltage at high current for recorder or analog-to-digital converter. Linearity is within 15 microvolts from d-c to 25 kc. Chopper stabilization keeps input d-c drift below 0.5 microvolt during 40-hour run.—R. S. Burwen, Amplifiers for Strain Gages and Thermocouples, *Electronics*, 32:30, p 43–45.

CABLE TERMINATION FOR VELOCIMETER—Amplifier restores leading edge of sinusoidal signal that has travelled through up to 35,000 feet of cable from deep-sea velocimeter. Frequency is then doubled by diodes, for ease of counting.—L. Dulberger, Deep-Ocean Velocimeter Aids Sonar Systems Design, *Electronics*, 34:22, p 41–43.

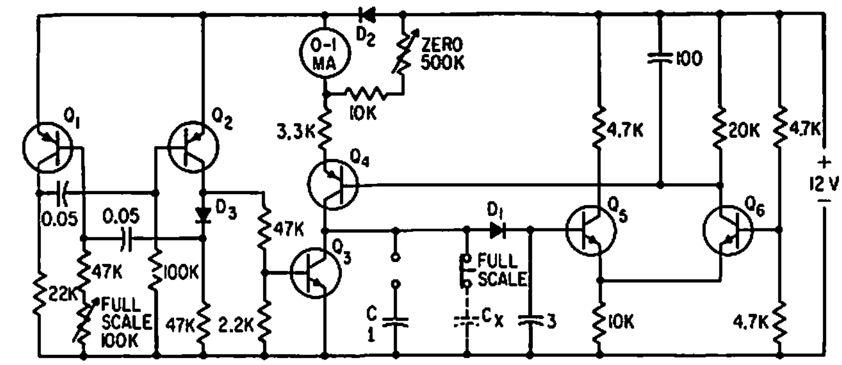




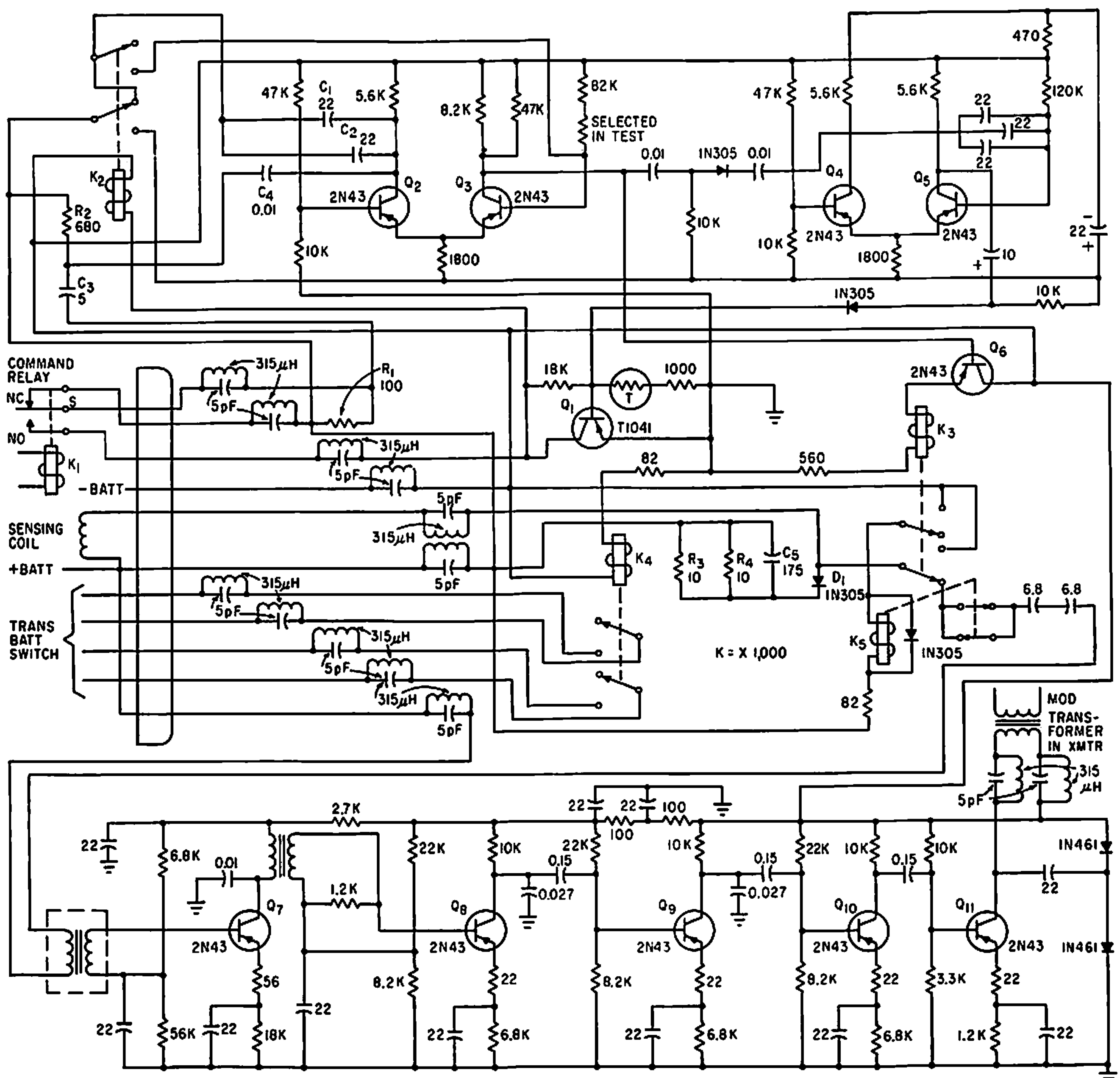
THICKNESS GAGE COMPENSATOR—High-frequency channel (256 kc) compensates for variation in probe-to-specimen spacing in eddy-current thickness gage for measuring cladding on reactor fuel elements.—W. J. McGonnagle, C. J. Renken, and R. G. Myers, Improved Nondestructive Testing by Eddy-Currents, *Electronics*, 32:35, p 42–43.



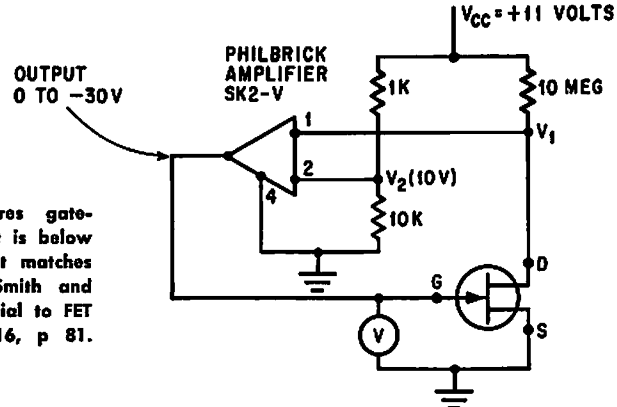
PORTABLE FLOWMETER—Impedance between gold wire and blades of water-driven propeller changes a small amount as each blade passes within 0.1 mm of wire tip, giving amplitude modulation of 15-kc carrier generated by Q1. After demodulation, signal at propeller frequency is amplified, rectified, and integrated to drive velocity-indicating meter.—L. Molyneux and J. M. Edington, Portable Propeller Flowmeter Determines Water Velocity, *Electronics*, 34:25, p 60–62.



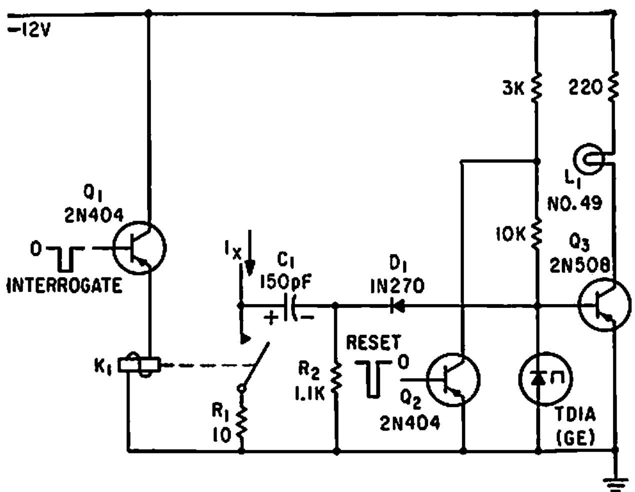
CAPACITANCE METER—Milliammeter indicates capacitance values over any desired range on linear scale having zero at right.—W. Mosinski, Capacitance Meter has Linear Scale, *Electronics*, 35:12, p 64.



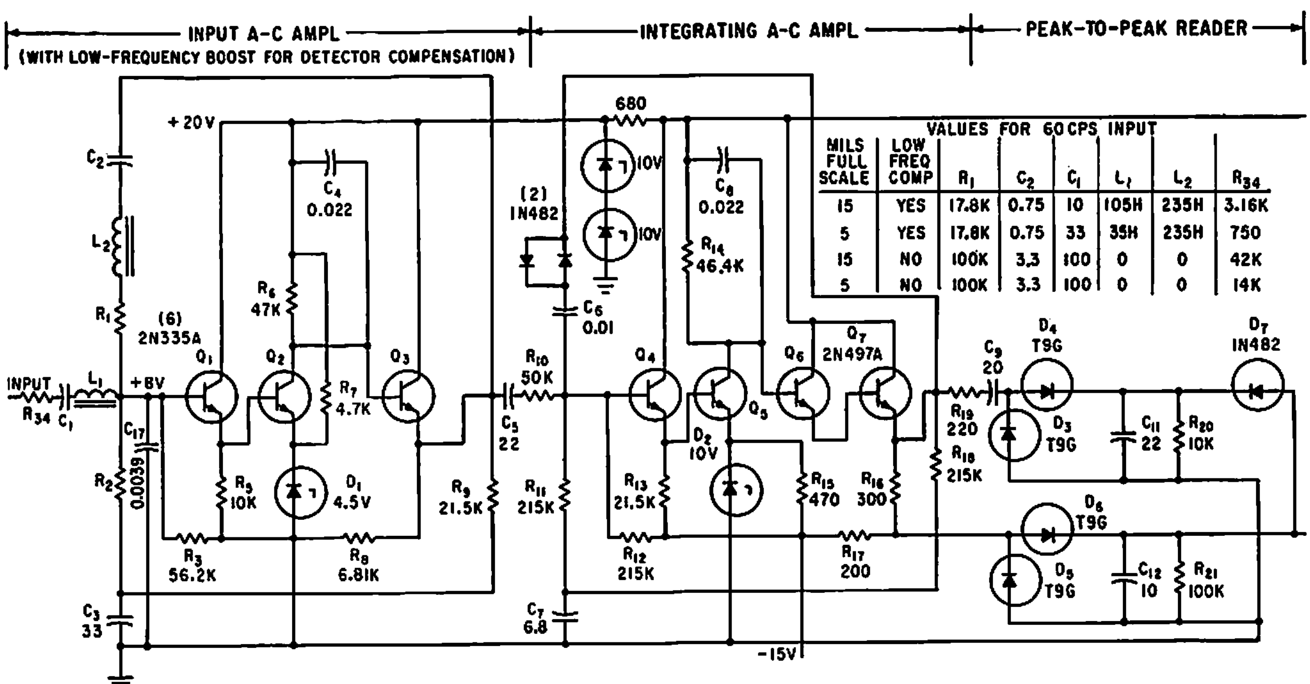
PROTON PRECESSION MAGNETOMETER—Used in Vanguard III satellite for magnetic field measurements at altitudes of 510 to 3,750 km.—D. Mansir, Magnetic Measurements in Space, *Electronics*, 33:32, p 47–51.



FET PINCHOFF VOLTAGE—Measures gate-source voltage while drain current is below 0.1 microamp, to give value that matches pinchoff voltage of fet.—B. R. Smith and I. C. Chase, Matching Gate Potential to FET Pinchoff Voltage, *Electronics*, 38:16, p 81.



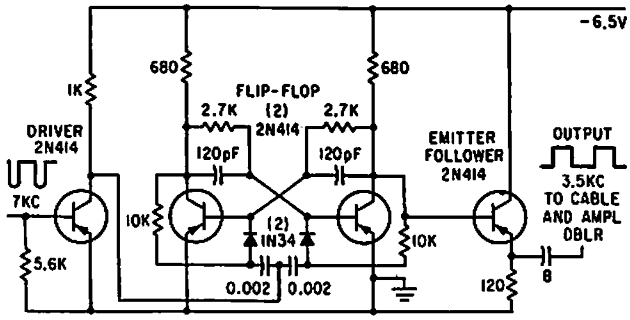
LOW-LEVEL CURRENT DETECTOR AND MEMORY—Unknown current Ix charges C1. Operation of relay K1 by interrogate pulse discharges C1 through tunnel diode, initiating switching of diode if in low-voltage state and unknown current is correct polarity. Lamp in transistor amplifier glows when tunnel diode is in high-voltage state. Currents of one picoampere can be measured.—C. D. Todd, Tunnel Diode Detects Currents Down to 100 Femtoamperes, *Electronics*, 36:14, p 33–37.



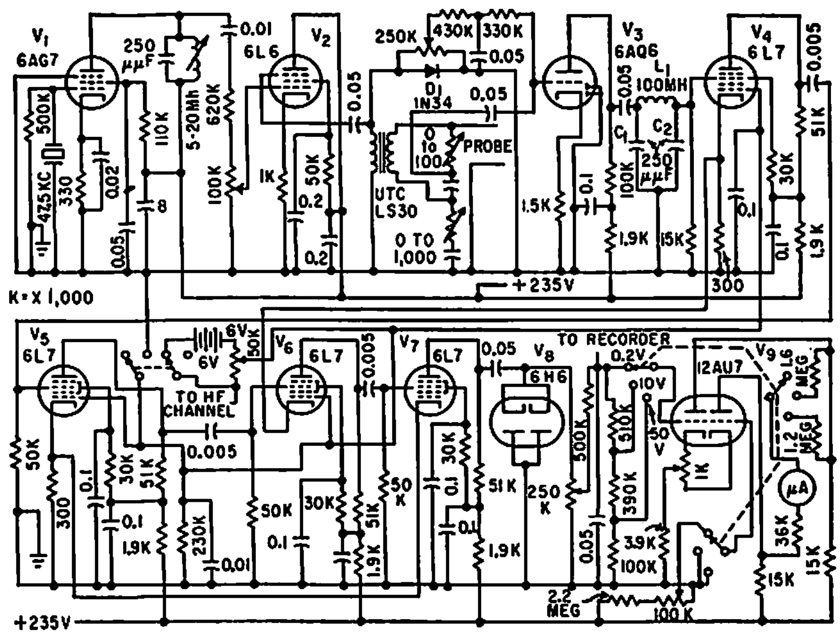
VALUES FOR 60 CPS INPUT

MILS FULL SCALE	LOW FREQ COMP	R_1	C_2	C_1	L_1	L_2	R_{34}
15	YES	17.8K	0.75	10	105H	235H	3.16K
5	YES	17.8K	0.75	33	35H	235H	750
15	NO	100K	3.3	100	0	0	42K
5	NO	100K	3.3	100	0	0	14K

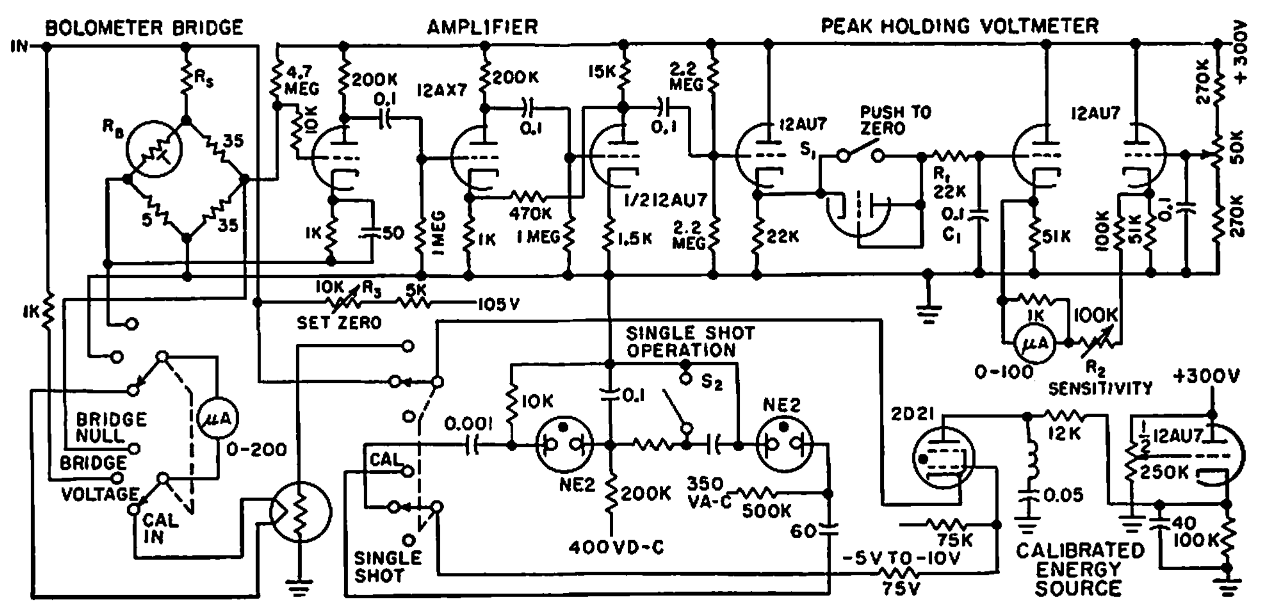
VIBRATION DETECTOR—Low-frequency boost compensates for characteristics of velocity-type vibration detector for turbines. Detector voltage is proportional to both displacement and frequency, so integrating action by capacitance feedback around high-gain amplifier stage makes output proportional to displacement only.—H. A. Harriman and W. M. Trenholm, Vibration Measurements with Peak-Reading Circuit, *Electronics*, 35:20, p 57–59.



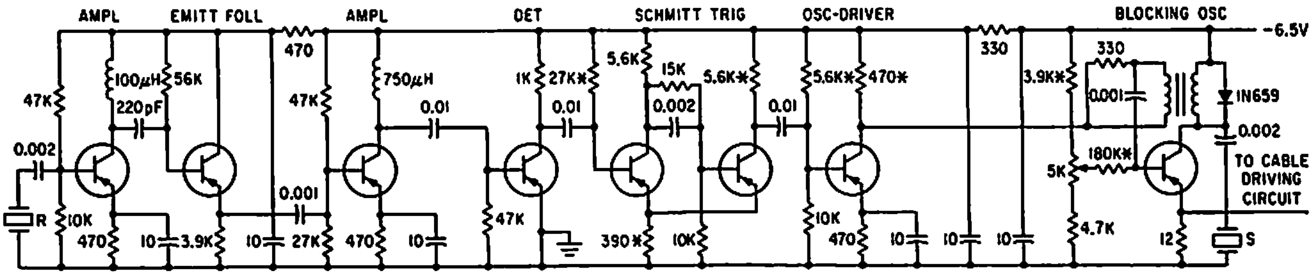
CABLE DRIVE FOR VELOCIMETER—Flip-flop frequency divider converts 7-kc pulse output of velocimeter to 3.5 kc while providing low impedance and sufficient driving power for sending pulses through up to 35,000 feet of cable to counter on surface vessel. —L. Dulberger, Deep-Ocean Velocimeter Aids Sonar Systems Design, *Electronics*, 34:22, p 41–43.



EDDY-CURRENT CLADDING THICKNESS GAGE—Low-frequency channel (47.5 kc) obtains thickness of cladding on reactor fuel elements. Probe is common element of each input bridge. Can also be used for measuring plating thickness or for detection of subsurface cracks and voids.—W. J. McGonnagle, C. J. Renken, and R. G. Myers, Improved Nondestructive Testing by Eddy-Currents, *Electronics*, 32:35, p 42–43.



PULSE-ENERGY ERGMETER—Bolometer bridge converts input signal to heat by integrating input power with respect to time. Heat upsets bridge balance, and resulting signal is amplified and applied to peak-holding voltmeter that indicates energy directly. Used to measure energy content of pulses. —L. A. Rosenthal, Ergmeter Measures Bursts of Energy, *Electronics*, 31:23, p 79–81.

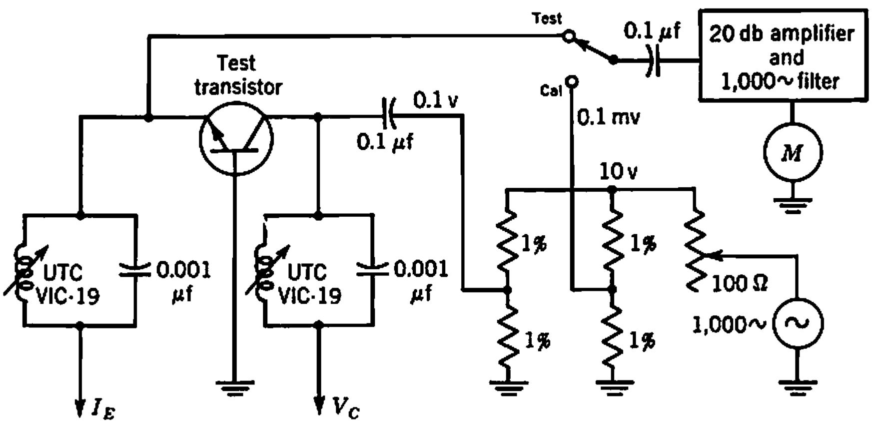


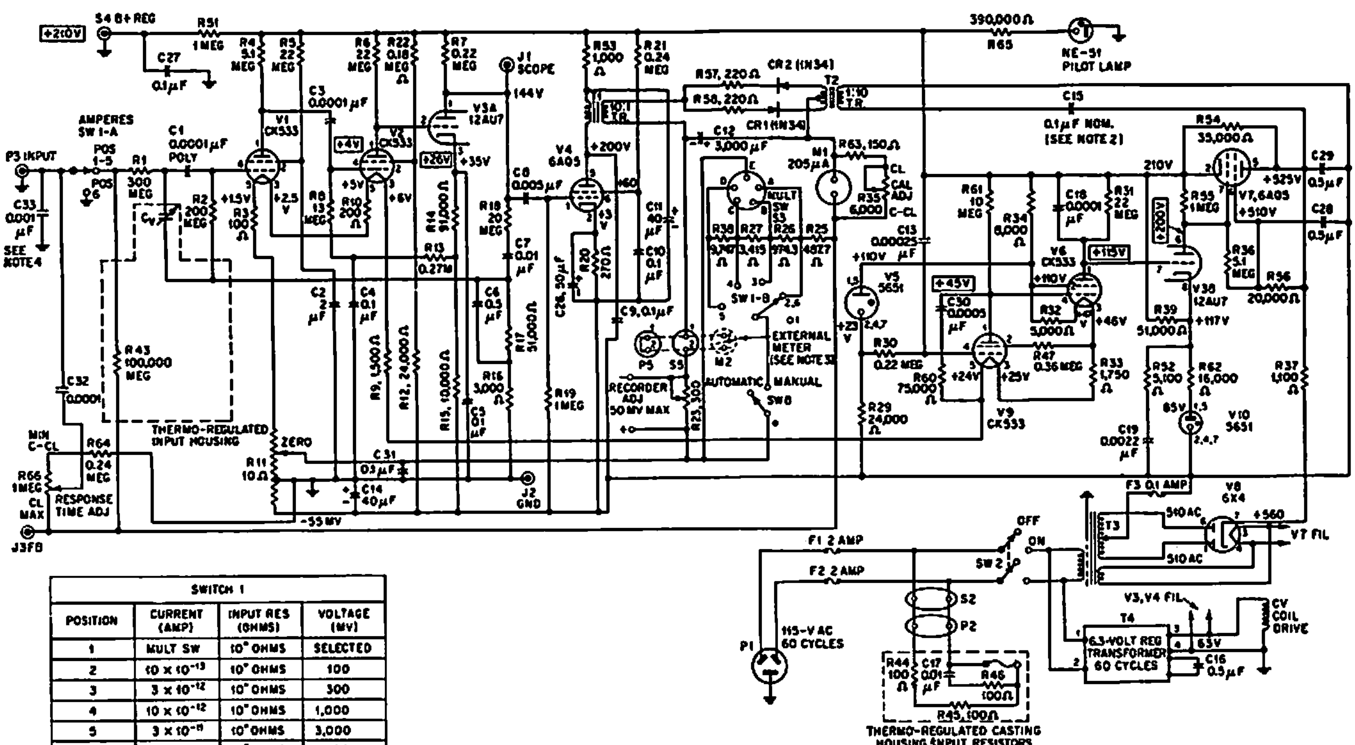
ALL TRANSISTORS TYPE 2N393

* VALUE DEPENDS UPON SOUND PATH

DEEP-OCEAN VELOCIMETER—Sonic pulse produced by transducer S is sent along fixed-length water path at any depth and picked up by receiving transducer R. Received signal is then amplified and fed back to blocking oscillator to synchronize it at repetition rate determined by delay time of pulse in water. Pulses then go to cable-driving circuit, and through cable to surface vessel for counting.—L. Dulberger, Deep-Ocean Velocimeter Aids Sonar Systems Design, *Electronics*, 34:22, p 41–43.

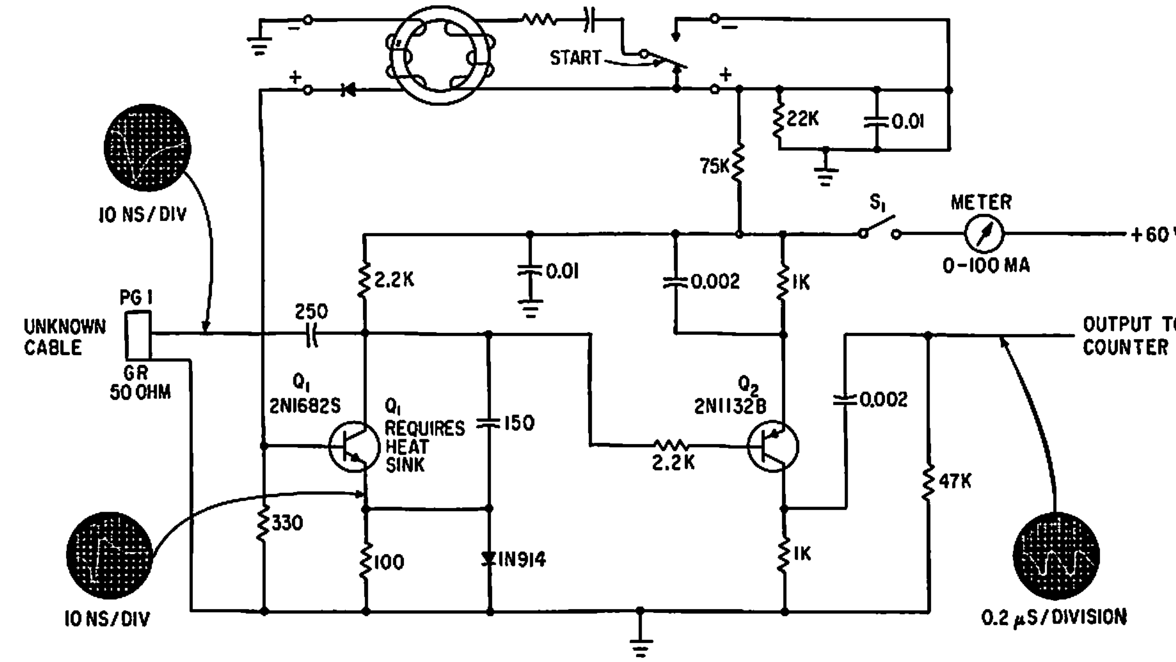
MEASURING TRANSISTOR REVERSE-VOLTAGE TRANSFER RATIO—When output voltage is held constant, 10-mv scale of output meter gives direct readings of small-signal value of open-circuit reverse-voltage transfer ratio h-rb over range of 0.0001 to 0.001.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 72.



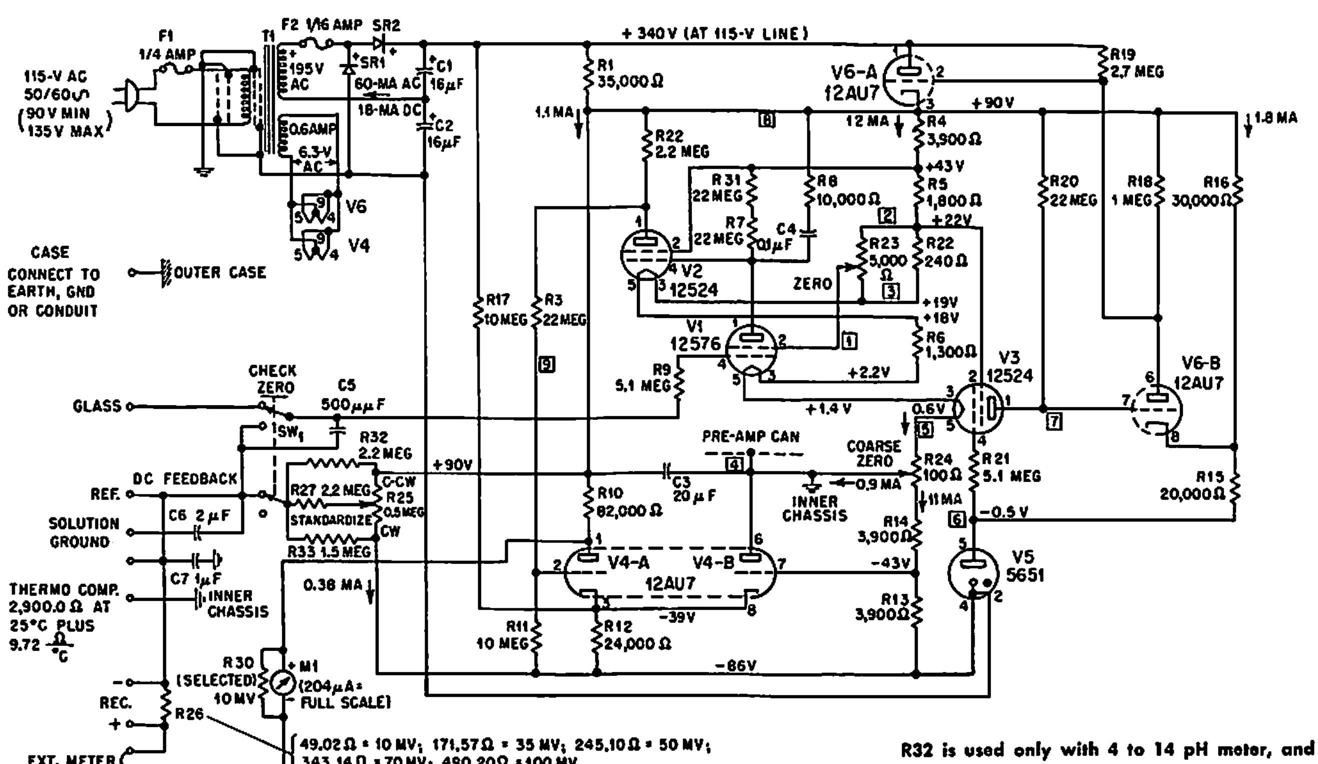


SWITCH 1			
POSITION	CURRENT (AMP)	INPUT RES (OHMS)	VOLTAGE (MV)
1	MULT SW	10[illegible] OHMS	SELECTED
2	10×10^{-13}	10[illegible] OHMS	100
3	3×10^{-12}	10[illegible] OHMS	300
4	10×10^{-12}	10[illegible] OHMS	1,000
5	3×10^{-11}	10[illegible] OHMS	3,000
6	ZERO	10[illegible] OHMS	100

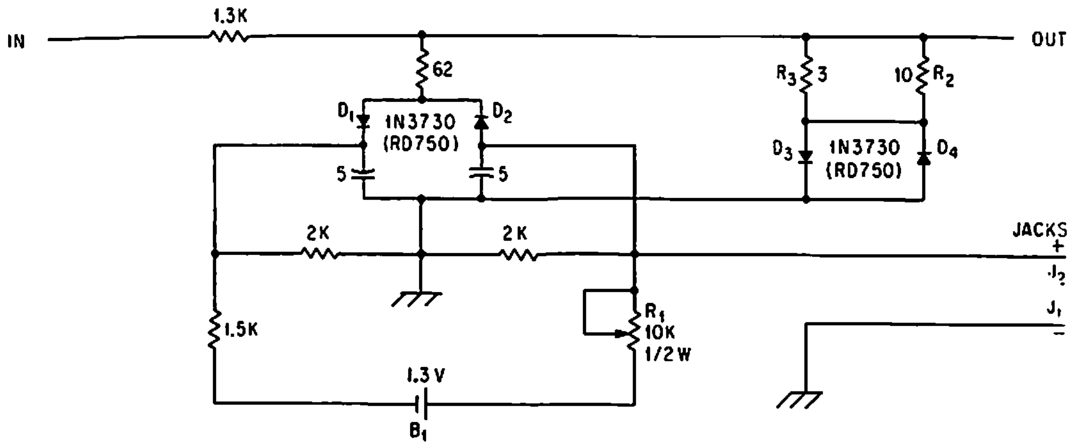
MICROMICROAMMETER—Uses vibrating capacitor, electrometer amplifier, and electronic servo in which amplifier attempts to maintain input at ground potential regardless of magnitude of voltage developed across input resistor by very small signal current being measured.—G. C. Carroll, "Industrial Instrument Servicing Handbook," McGraw-Hill, N.Y., 1960, p 6–6.



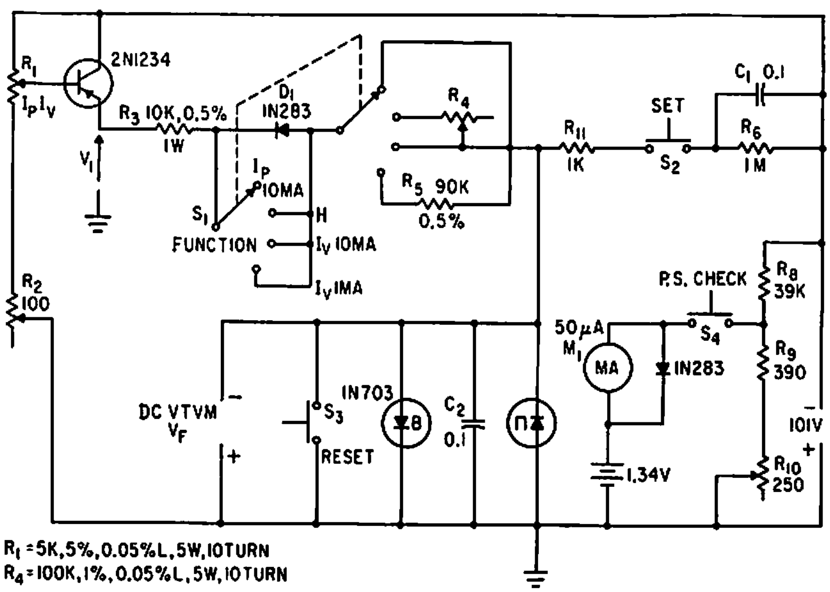
TRANSISTORIZED CHRONOTRON MEASURES COAX DELAY—Start switch triggers avalanche transistor Q1, generating millimicrosec pulse that travels down unknown cable and returns to trigger new pulse. Digital counter is used to measure prr, which is proportional to cable delay. Q2 shapes counter pulse.—E. F. Laine, Getting Subnanosecond Precision in Coax Cable Delay Measurements, *Electronics*, 36:5, p 39–41.



pH METER—Beckman model W industrial-type pH meter is d-c amplifier designed for measuring potentials generated by pH-sensitive electrodes. Output will drive most recorders. R32 is used only with 4 to 14 pH meter, and R33 only with −1 to 9 pH meter.—G. C. Carroll, "Industrial Instrument Servicing Handbook," McGraw-Hill, N.Y., 1960 p 7–4.

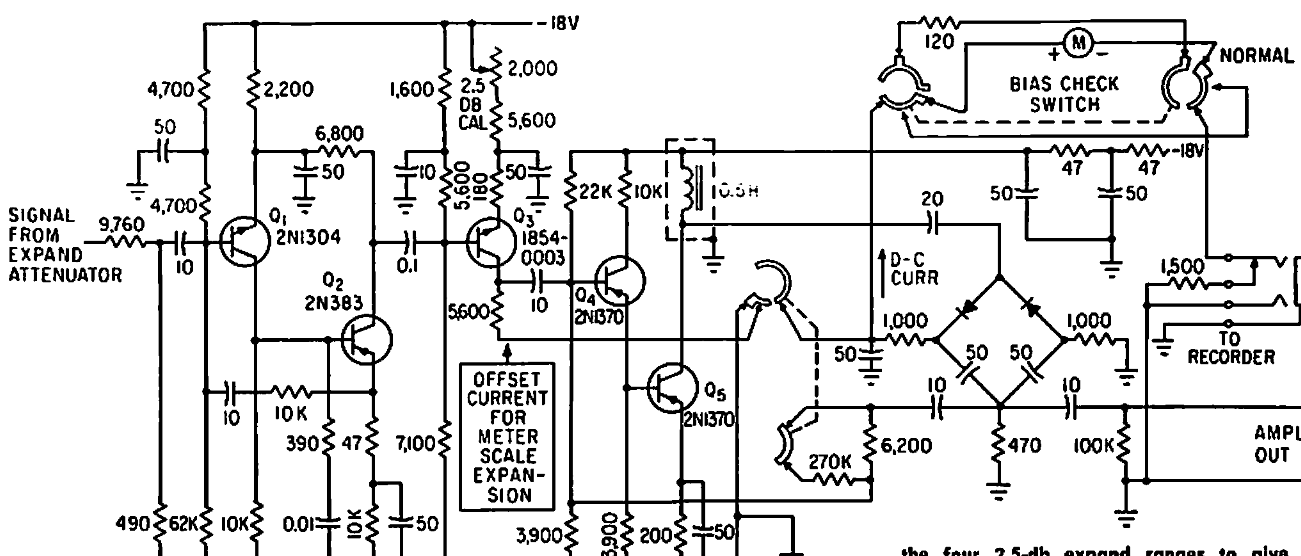


LOGARITHMIC ATTENUATOR—Output of passive circuit is proportional to log of input voltages between 0.1 and 100 v. Serves for either positive or negative pulses.—C. D. Nail, Logarithmic Attenuator Spans Three Decades, *Electronics*, 36:46, p 47–48.

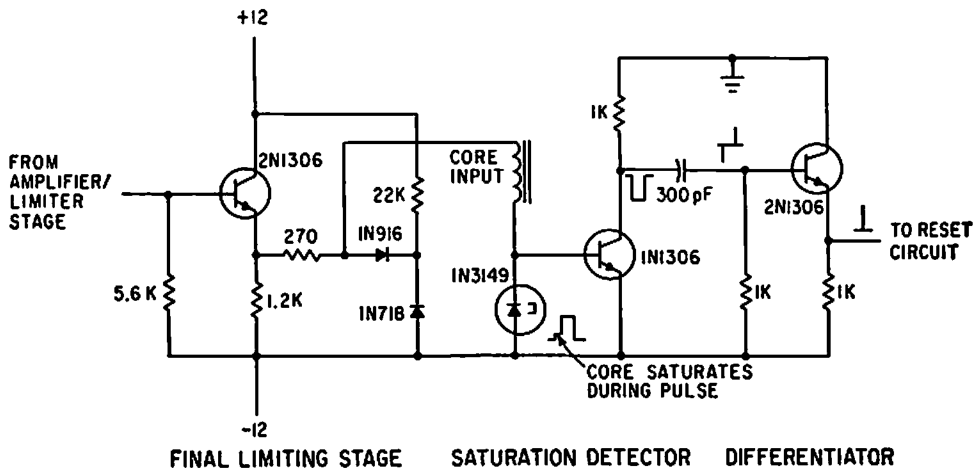


R1 =5K,5%,0.05%L,5W,10TURN
R4 =100K,1%,0.05%L,5W,10TURN

TUNNEL DIODE PARAMETERS—Provides quantitative measurement of all d-c parameters for the three regions of forward d-c characteristic curve for tunnel diodes.—C. D. Todd, Simple Test Sets Measure Tunnel-Diode Parameters, *Electronics*, 35:14, p 43–45.

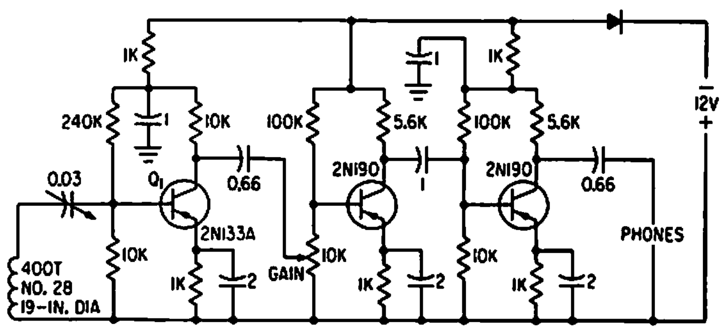


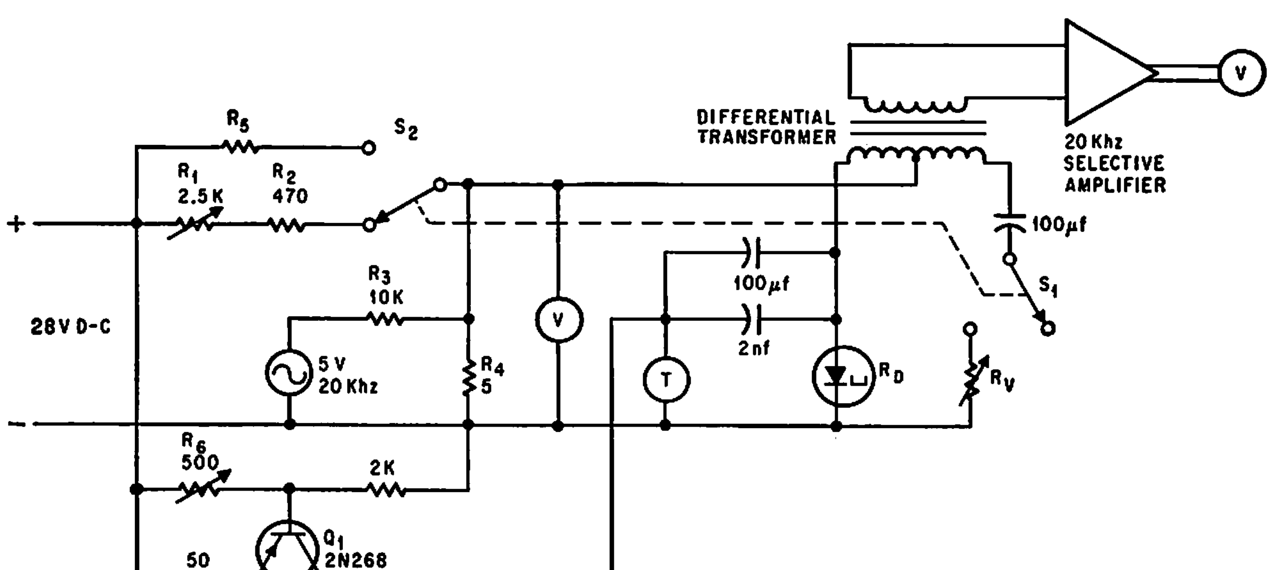
A-C AMPLIFIER FOR SWR METER—Collector of Q3 provides d-c offset current required for expanding a segment of the 10-db scale of the meter. Gain adjustment permits any of the four 2.5-db expand ranges to give a full-scale reading.—D. L. Howard, Drift Control Allows Expansion Scales for SWR Meter, *Electronics*, 35:21, p 45–47.



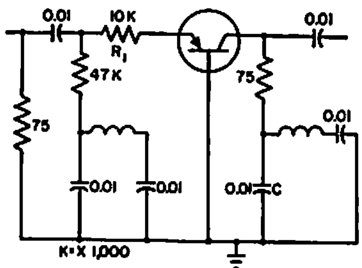
PULSE WIDTH ENCODER—Pulse widths in microsecond range are amplitude-limited and dumped into magnetic core. When core saturates, signal is recorded on magnetic tape and core is reset for next series of pulses. The number of changes of state between saturation points gives the number of pulses for core saturation, from which pulse width can be computed.—W. L. Carter and P. J. Knoke, Pulse-Width Measurements, *Electronics*, 35:43, p 51–53.

CAVE-MAPPING RECEIVER—Pickup loop feeds low-noise transistor Q1, followed by two-stage audio amplifier. Since low-frequency magnetic field (2 kc) is attenuated very little by rock, soil, or water, strength of received signal from transmitter in cave being mapped can be measured. When system is calibrated for distance on surface, depth can be measured.—E. R. Roeschlein, Mapping Caves Magnetically, *Electronics*, 33:39, p 61.

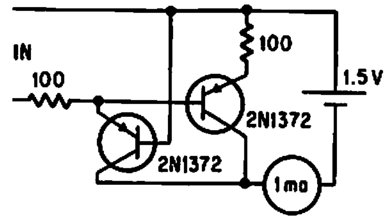




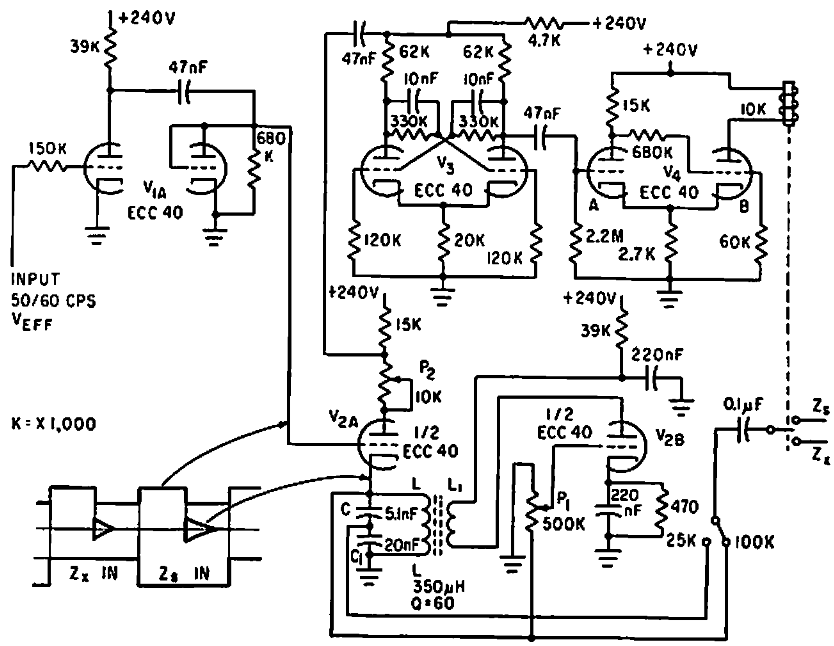
MEASURING NEGATIVE RESISTANCE OF TD—Thermistor cancels negative resistance of tunnel diode, and calibrated potentiometer that matches thermistor gives absolute value of td resistance at operating point. Q1 provides thermistor heating current, at level set by R6, while 5-v, 20-kc source provides a-c to modulate bias of tunnel diode.—A. Ambrozy, Thermistor Measures Negative Resistance of Tunnel Diode, *Electronics*, 39:17, p 95–96.



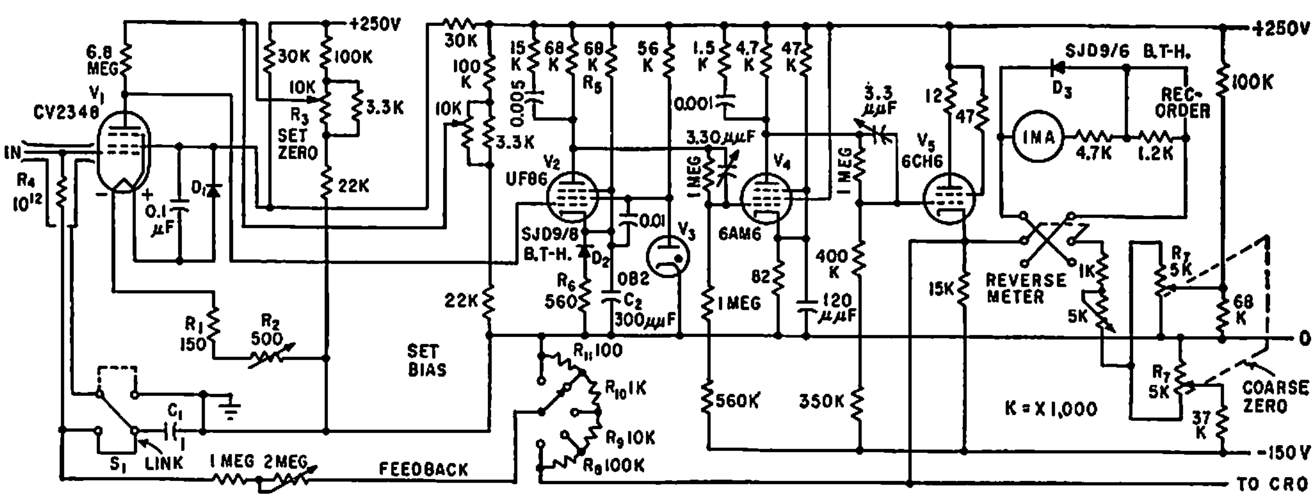
ALPHA CUTOFF—Measured with 3% accuracy up to 30 Mc and 5% up to 100 Mc. Method compares transistor to short-circuit. —G. I. Turner, Measuring Transistor Alpha Cutoff, *Electronics*, 32:1, p 54.



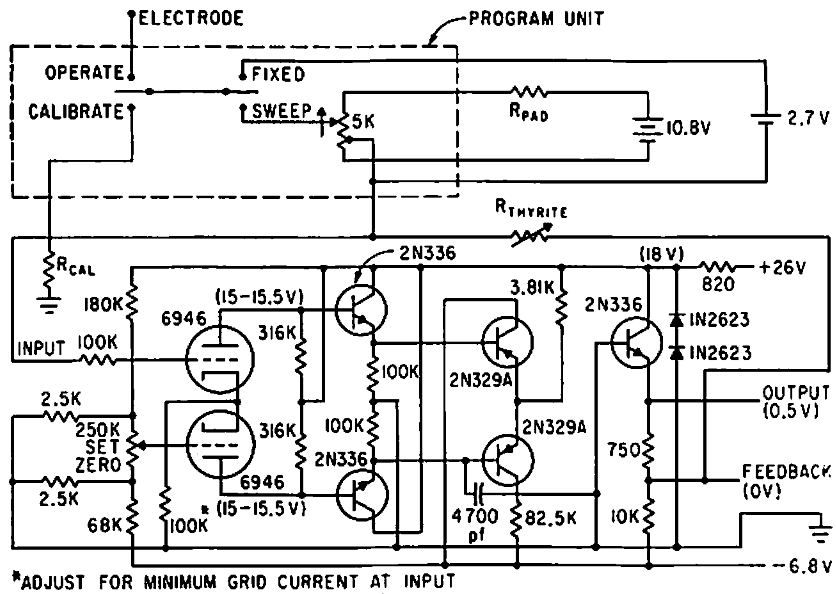
MILLIOHMMETER—Substitution of transistors for diodes in rectifier circuit of a-c milliohmmeter gives significant increase in sensitivity and linearity. Uses inexpensive milliammeter.—P. Lefferts, Transistors Replace Diodes in Milliohmmeter Circuit, *Electronics*, 39:18, p 97.



RESISTANCE COMPARATOR—Known and unknown resistances are connected alternately across shock-excited oscillator by flip-flop-driven relay, and damping effect is observed on cro.—A. Kislovsky, Comparing Resistances with Oscillator and Oscilloscope, *Electronics*, 34:23, p 118.



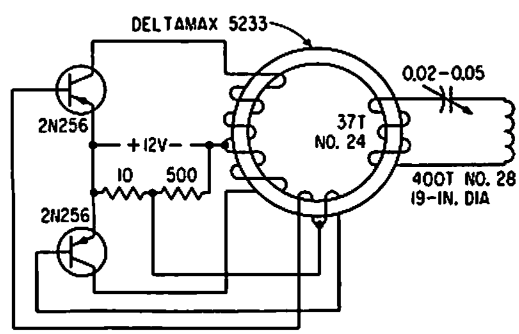
ELECTROMETER FEEDBACK AMPLIFIER—Measures currents in range of 10^{-11} to 10^{-15} amp by passing current through high-value precision resistor and amplifying voltage drop across resistor with direct-coupled amplifier of electrometer. British CV2348 is similar to CK5886. Bandwidth is 7.5 Mc. Zener diode D3 provides meter overload protection by clamping at about 20% overload.—D. Allenden, Using Feedback in Electrometer Design, *Electronics*, 32:41, p 71–73.

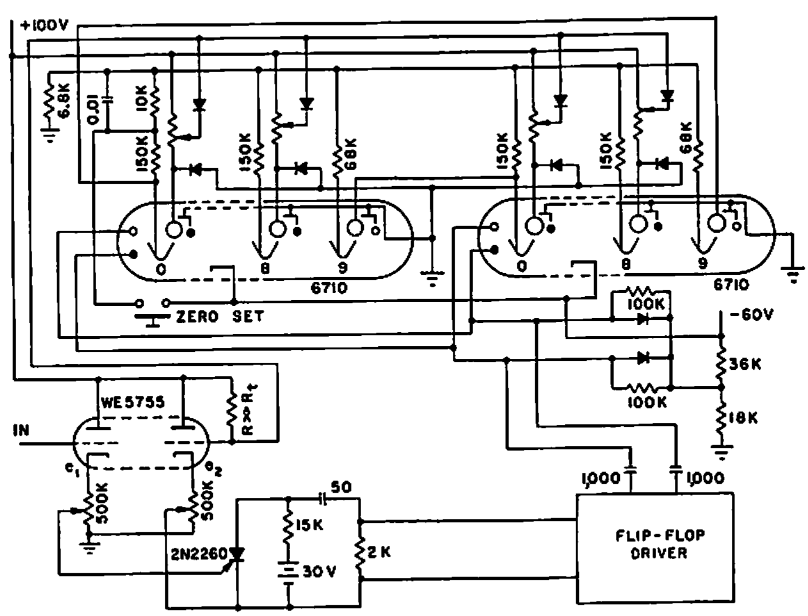


*ADJUST FOR MINIMUM GRID CURRENT AT INPUT

LANGMUIR ELECTRON-DENSITY PROBE—Used in Aerobee sounding rocket to measure daytime sporadic-E ionization of upper atmosphere. Electrometer uses 100% feedback and Thyrite resistor to produce compressed scale on telemetry record.—M. F. Wolff, Rockets Probe Sporadic-E, *Electronics*, 35:21, p 18–19.

CAVE-MAPPING TRANSMITTER—Transistorized 5-w, 2,000-cps generator of low-frequency magnetic induction field direction finder feeds tuned loop in cave being mapped. Detector at surface locates vertical flux line over cave and also receives Morse code for communication.—E. R. Roeschlein, Mapping Caves Magnetically, *Electronics*, 33:39, p 61.

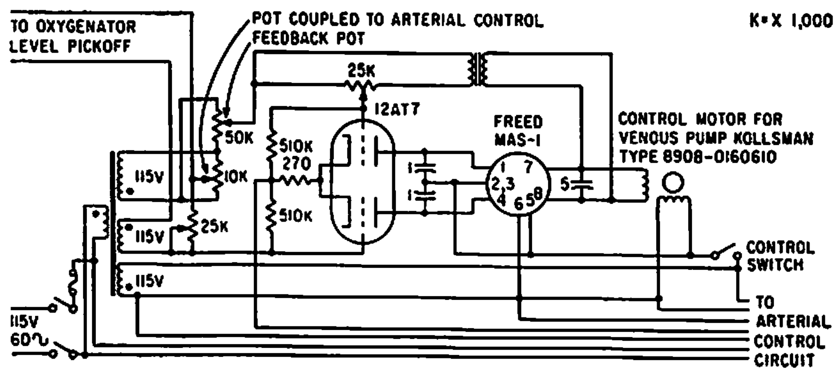


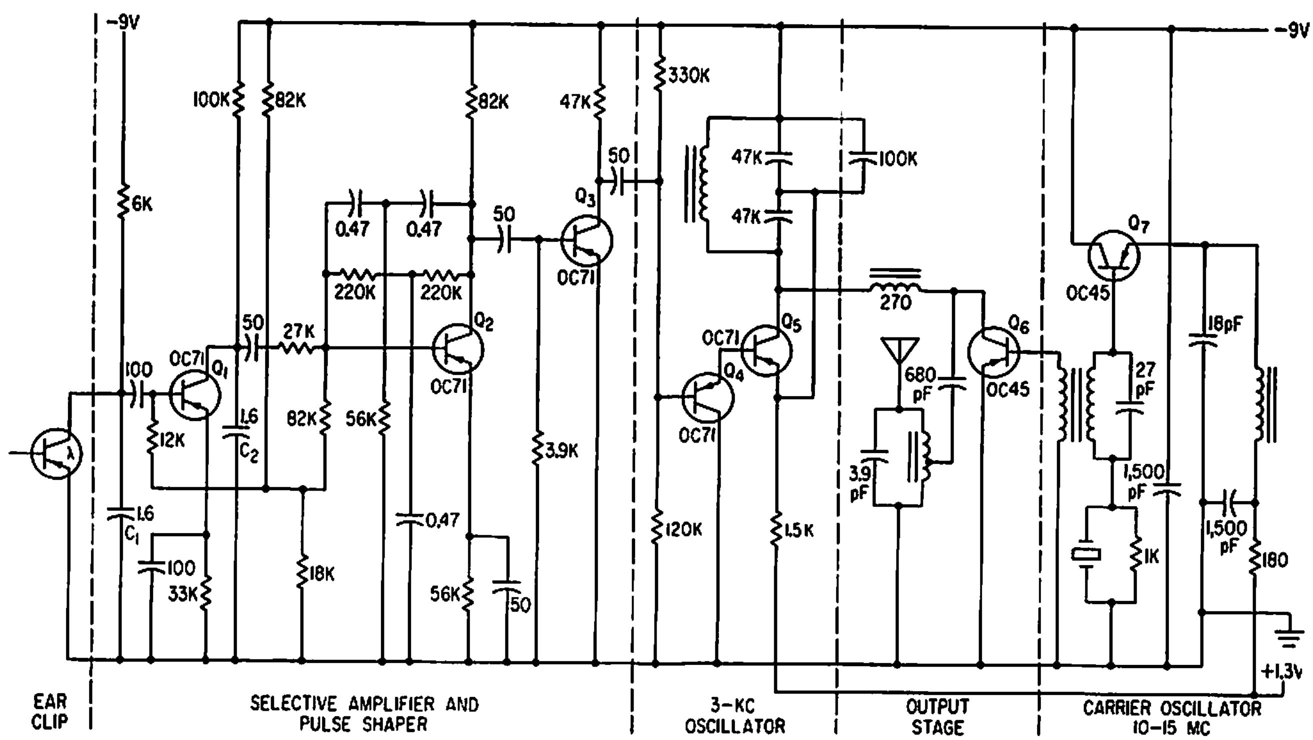


SHOCK SPECTRUM ANALYZER WITH PEAK VOLTAGE MEMORY—Each peak voltage-memory circuit has frequency-determining L-C filter. Shock spectrum of input pulse is defined by peak voltage across each filter capacitor. Memory is Burroughs Beam-X switching tube in which beam is advanced one position for each voltage increment. Output is d-c voltage suitable for automatic plotting.—Contest Produces Novel Circuit Designs, *Electronics*, 36:11, p 96–102.

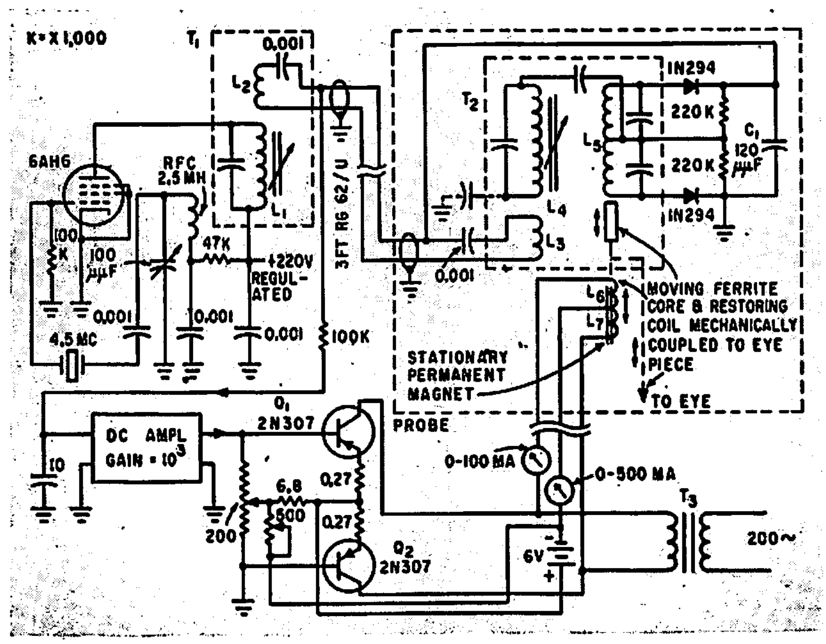
CHAPTER 50
Medical Circuits

BLOOD FLOW CONTROL—Used to correct long-term differences in flow rates of venous and arterial pumps. Venous control portion of heart-lung amplifier has two inputs, a signal derived from oxygenator level error and an input from potentiometer connected to arterial transmission control lever.—R. Roberts and J. Loeffler, Automatically Controlled Heart-Lung Machine, *Electronics*, 33:31, p 91–93.

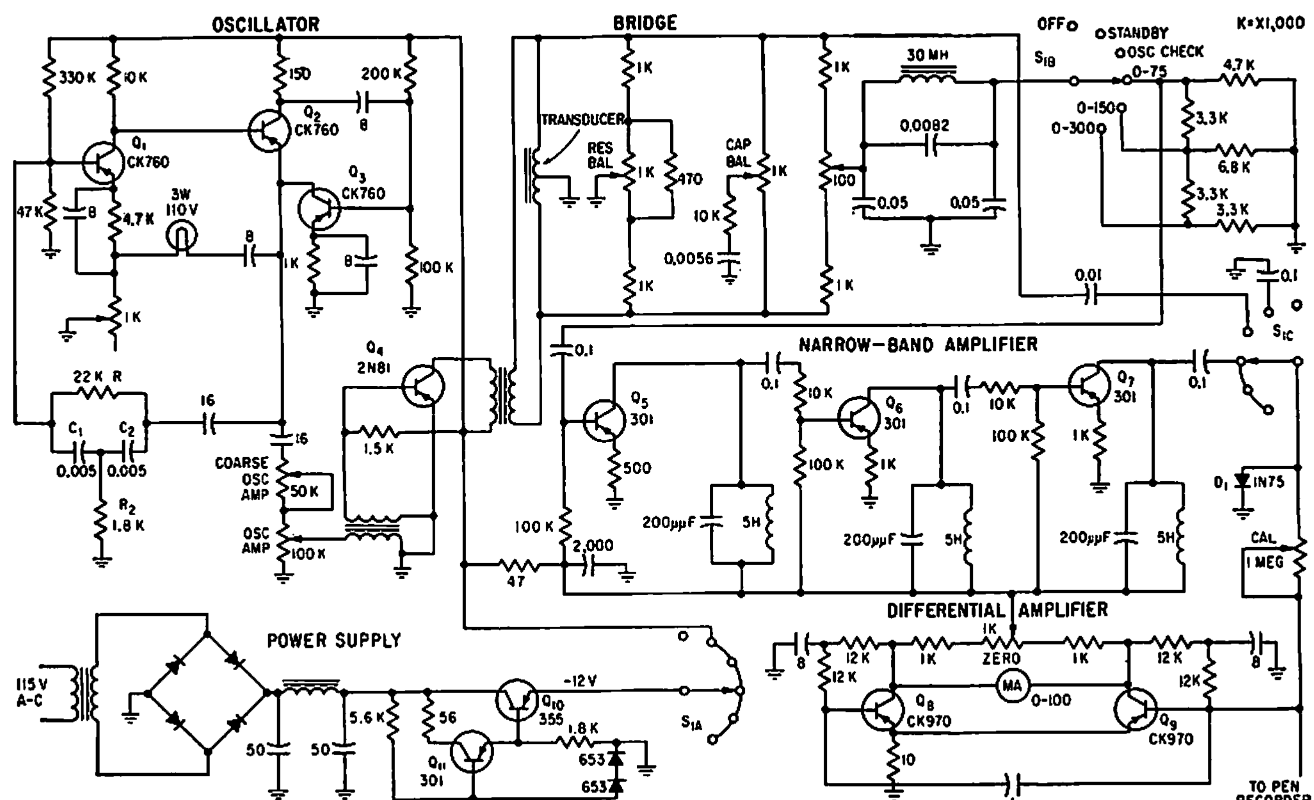




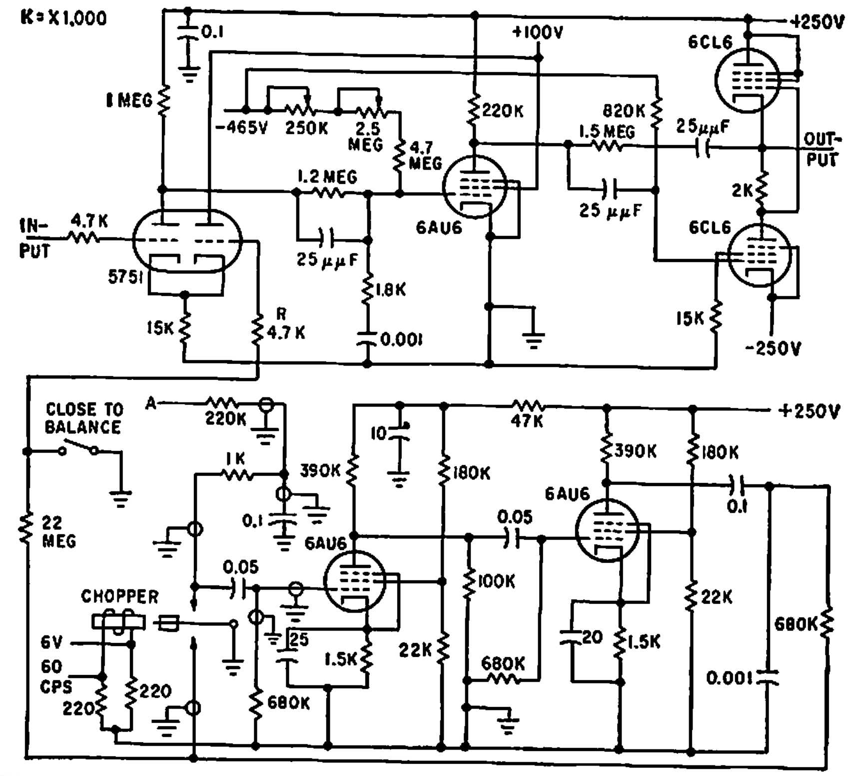
HEARTBEAT TRANSMITTER—Self-contained device worn by patient transmits his pulse to radio receiver for remote monitoring or recording. Photo-transistor, fed separately, measures changes in light transmitted through earlobe as heart pulses change blood density and volume of lobe.—G. A. Harten and A. K. Koroncai, Radio Transmitter for Remote Heartbeat Measurements, *Electronics*, 33:52, p 54–55.



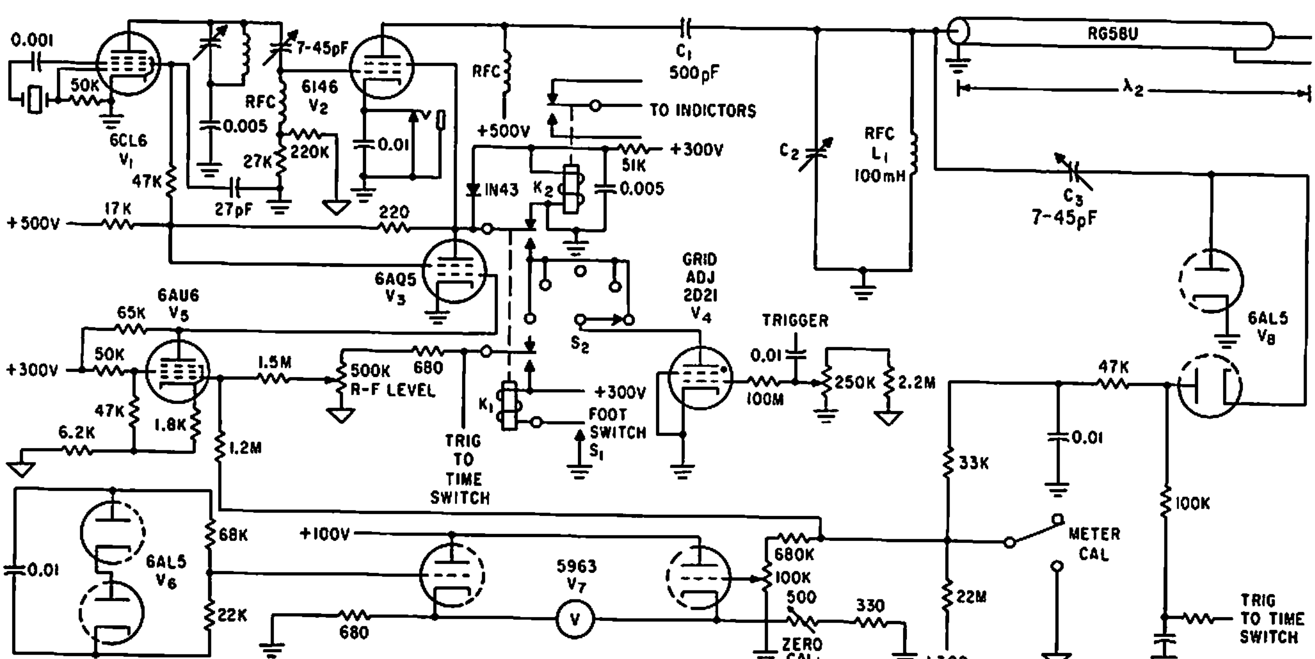
EYEBALL PRESSURE GAGE—Moving ferrite core in probe deflects in proportion to eyeball pressure and produces signal that is amplified to drive recorder. Plateau of recorded response represents true pressure, which can easily be read independently of peak caused by extra pressure of probe.—R. S. Mackay and E. Marg, Electronic Tonometer for Glaucoma Diagnosis, *Electronics*, 33:7, p 115–116.



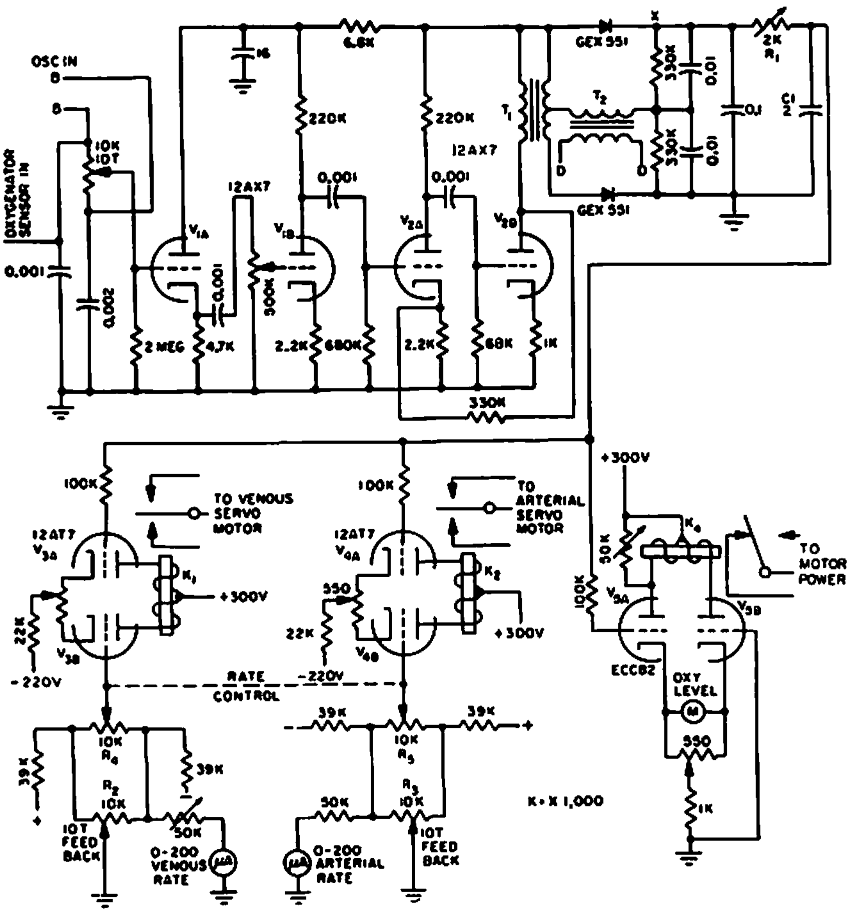
BLOOD-PRESSURE MONITOR—Continuous indication of blood pressure, with 3% full-scale accuracy, is obtained by mounting variable-reactance pressure transducer in 5-cc syringe inserted directly into patient's artery. Instrument has three ranges, for 0-75, 0-150, and 0-300 mm Hg. Transducer is excited by low-distortion sine wave generated by transistor counterpart of vacuum-tube Wien-bridge oscillator. Positive and negative feedback circuits generate 5-kc signal at 1 v rms.—O. Z. Roy and J. R. Charbonneau, Transistor Unit Monitors Blood Pressure, *Electronics*, 31:33, p 82–83.



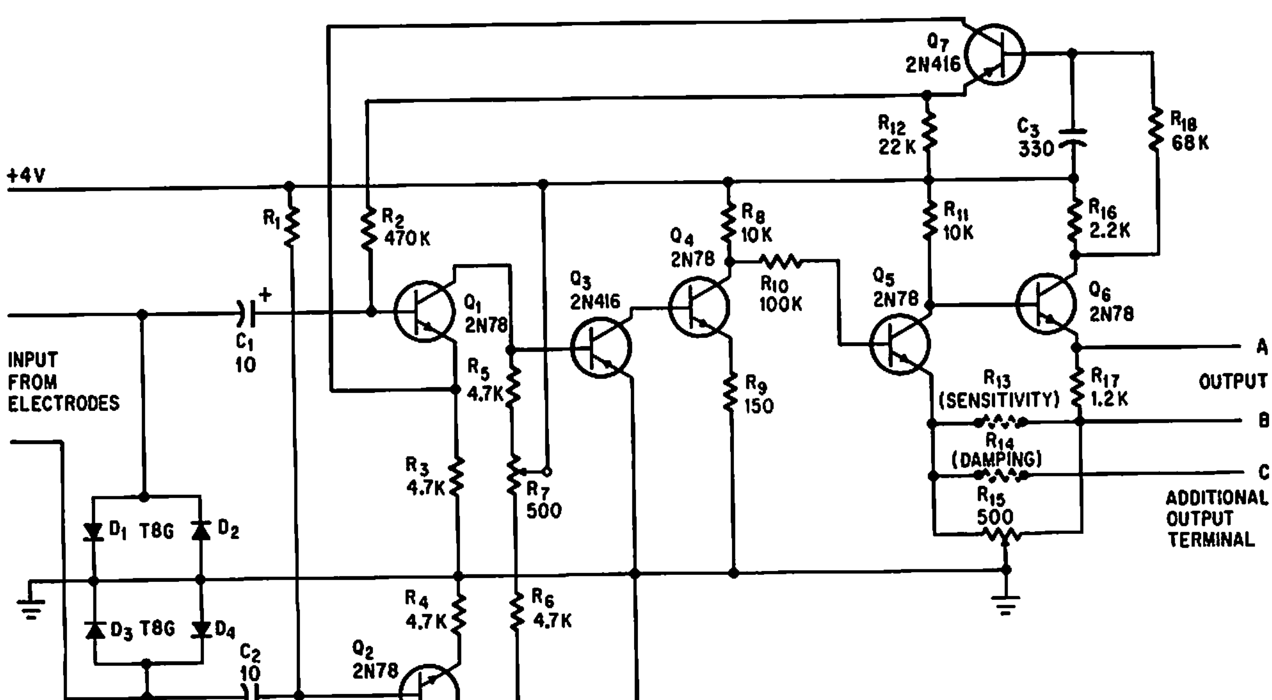
INTEGRATING OPERATIONAL AMPLIFIER—Analog-computer type of integrator uses stabilized chopper for integration of dye curve as function of time, in system for measuring dye concentration in blood stream to obtain flow rate.—R. L. Skinner and D. K. Gehmlich, Analog Computer Aids Heart Ailment Diagnosis, 32:40, *Electronics*, p 56–59.



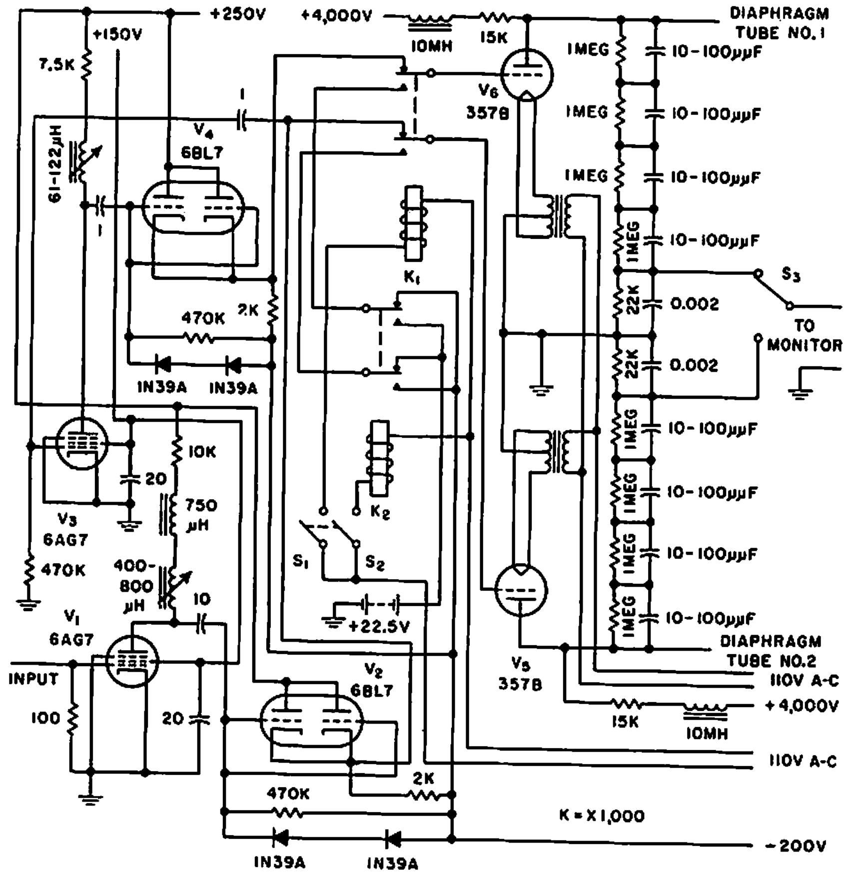
27.12-MC RETINA WELDER—Applies r-f energy to spot-weld retina back to original position by creating small burn scars. Crystal-controlled electron-coupled oscillator drives class C power amplifier V2. Sample of output is taken through C3, detected in V8, and applied to grid of V5, which amplifies output changes and applies them to grid of clamp tube V3 to restore output of V2 to desired level.—O. Rich, Jr. and R. V. Hill, R-F Spot Welder Reattaches Retina of Human Eye, *Electronics*, 34:32, p 160–163.



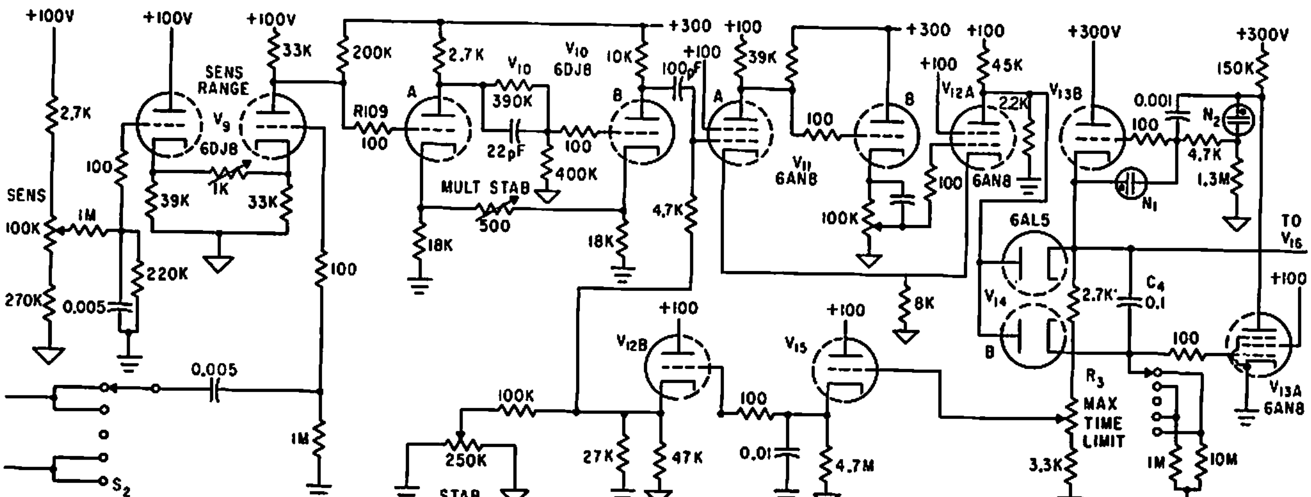
BLOOD-VOLUME SERVO—Servo-controlled pump with variable stroke drives blood from venous system of patient into artificial lung and after oxygenation returns it to arterial system. Control circuit insures that volume of blood is constant. Sensor is brass disk forming capacitance with pool of blood in oxygenator at spacing of 1 mm. Error signal derived from capacitance change unbalances bridge that is energized at 3 kc (points B-B). Amplified error signal is applied to phase-sensitive demodulator. Unbalance energizes center-stable relays K1 and K2 of arterial and venous servo motors, so stroke output of arterial pump is decreased while that of venous pump is increased, or vice versa, to restore preselected volume of blood.—R. Schild and N. Wesson, Servo Circuit Controls Artificial Heart, *Electronics*, 31:15, p 73–75.



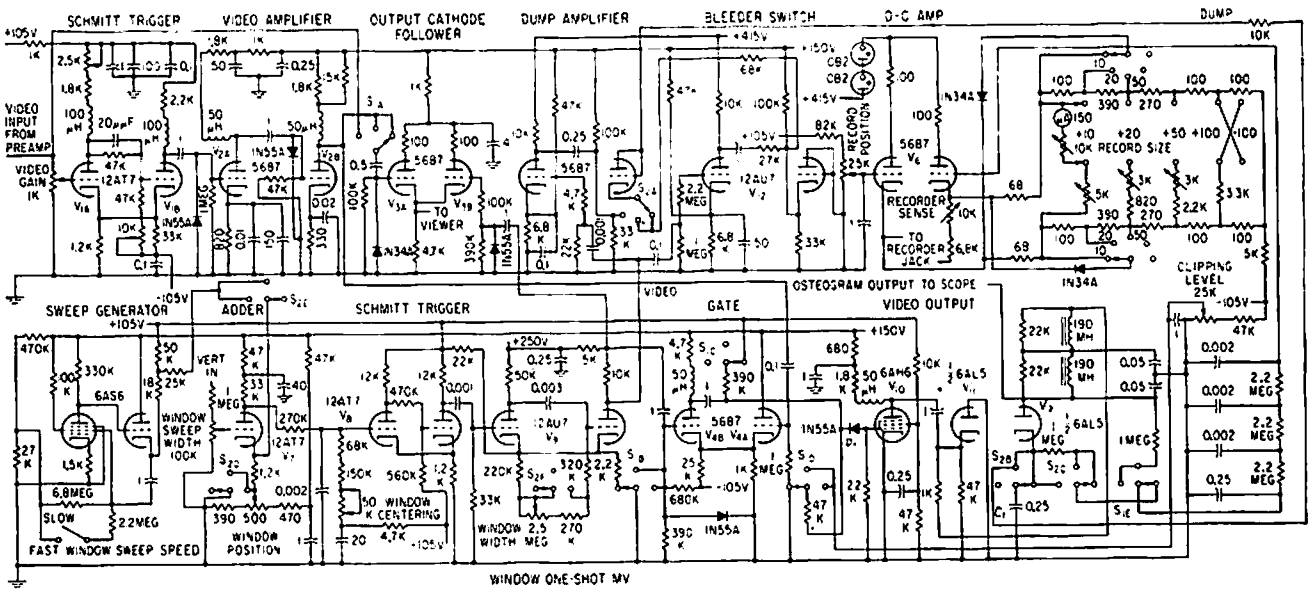
TEMPERATURE COMPENSATION IN ECG AMPLIFIER—Circuit has common-mode rejection ratio of 10,000, with adjustable cancellation of unbalanced noise at input, for electrocardiograph. For temperature compensation, C3 bypasses a-c signals from base of Q7, so only d-c signals are fed back through this transistor to Q1.—J. R. Smith, Jr., Amplifier Can be Adjusted to Cancel Unbalanced Noise, *Electronics*, 37:23, p 60–61.



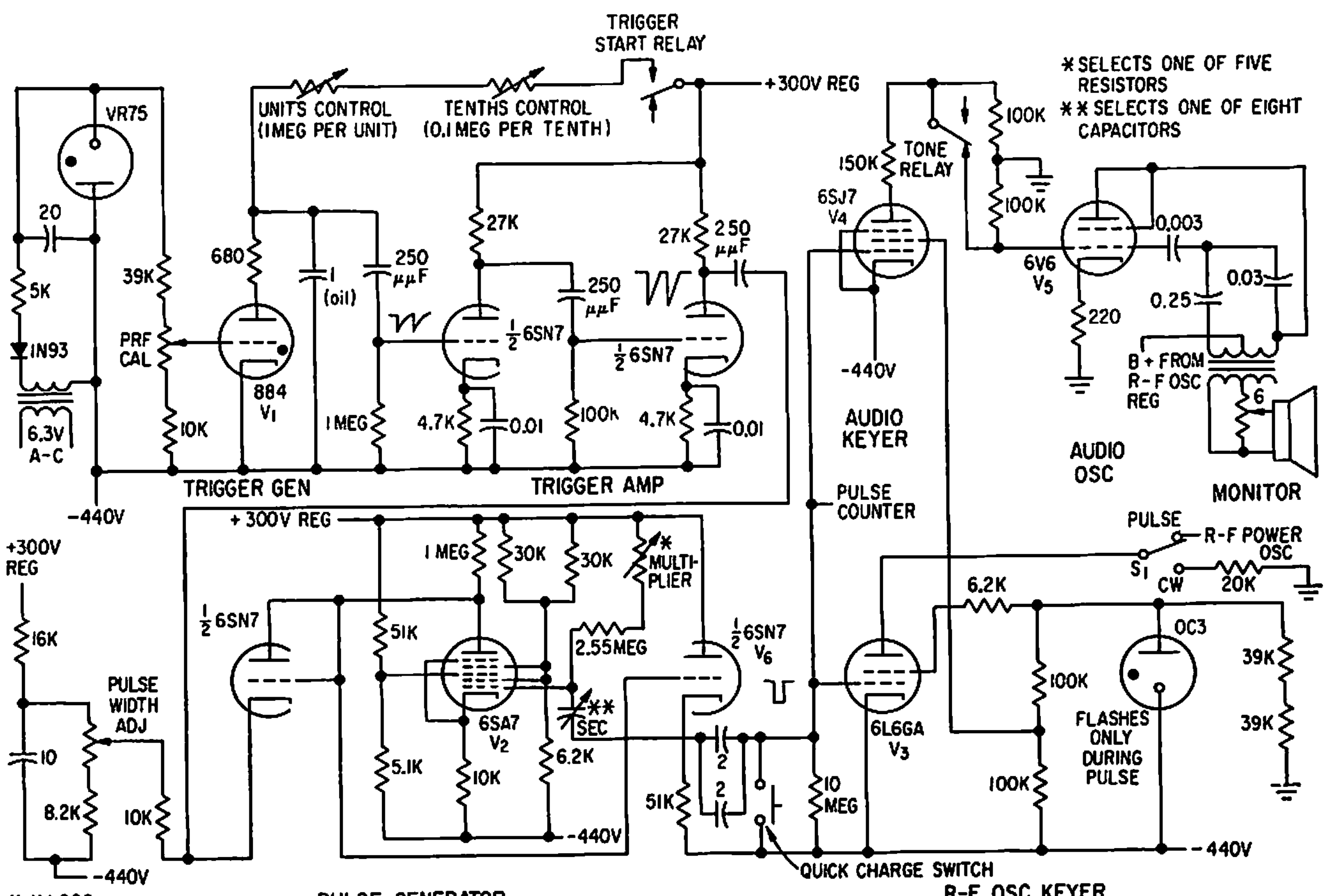
X-RAY TUBE PULSER—Supplies 3,600 v peak-to-peak pulses, swinging from 400 to 4,000 v. Input signal comes from square-wave generator having adjustable duty cycle of 10 to 90% from 35 to 100,000 cps. Uses two pulsating x-ray tubes, each controlled by applying low-voltage square-wave to special diaphragm element. Anode current is maintained constant by switching alternately between tubes. Used for delivering therapeutic dose levels.—E. F. Weller, Roof-Top-Target Tubes Pulse X-Rays, *Electronics*, 31:11, p 138–139.



TRIGGER SHAPING FOR RETINA WELDER—Trigger pulse, selected by S2, is compared to fixed bias on one half of comparator tube V9. Trigger shaping by V10 provides strong, sharp pulse for gating mvbr V11-V12A, which turns off diodes V14, allowing Miller integrator V13A and cathode follower V13B to start time base runup that drives C4 to 150 v. Circuit then reverts to normal.—O. Rich, Jr. and R. V. Hill, R-F Spot Welder Reattaches Retina of Human Eye, *Electronics*, 34:32, p 160–163.

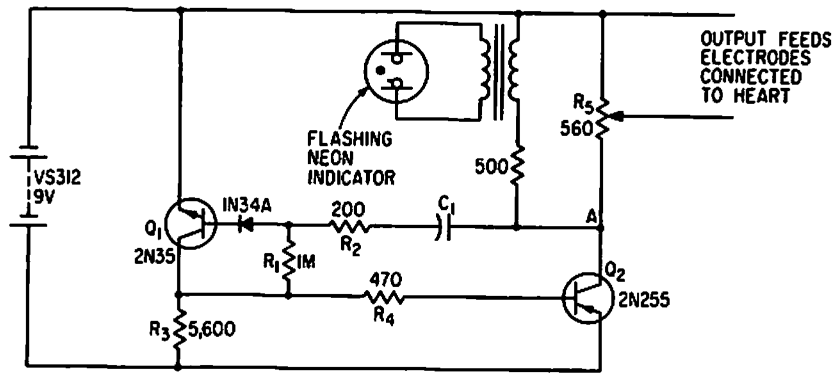


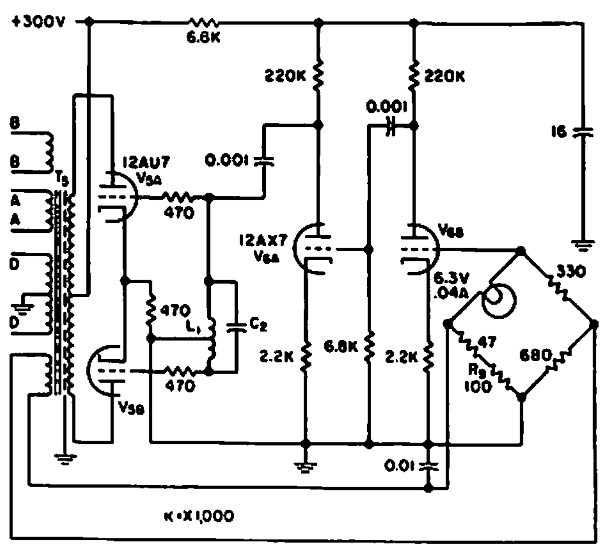
OSTEOGRAPH DETECTS BONE DISEASE—Electronic scanner using television flying-spot microscope measures irregular microscopic tissue areas of spongy bone, for early diagnosis of bone disease. Television monitor receiver shows enlarged picture of bone section as aid in centering area to be scanned. Recorder plots ratio between bone area and marrow area.—O. W. Jones III, R. V. Vreeland, and C. C. Collins, Video Microplanimeter Detects Bone Disease, *Electronics*, 31:43, p 85–87.



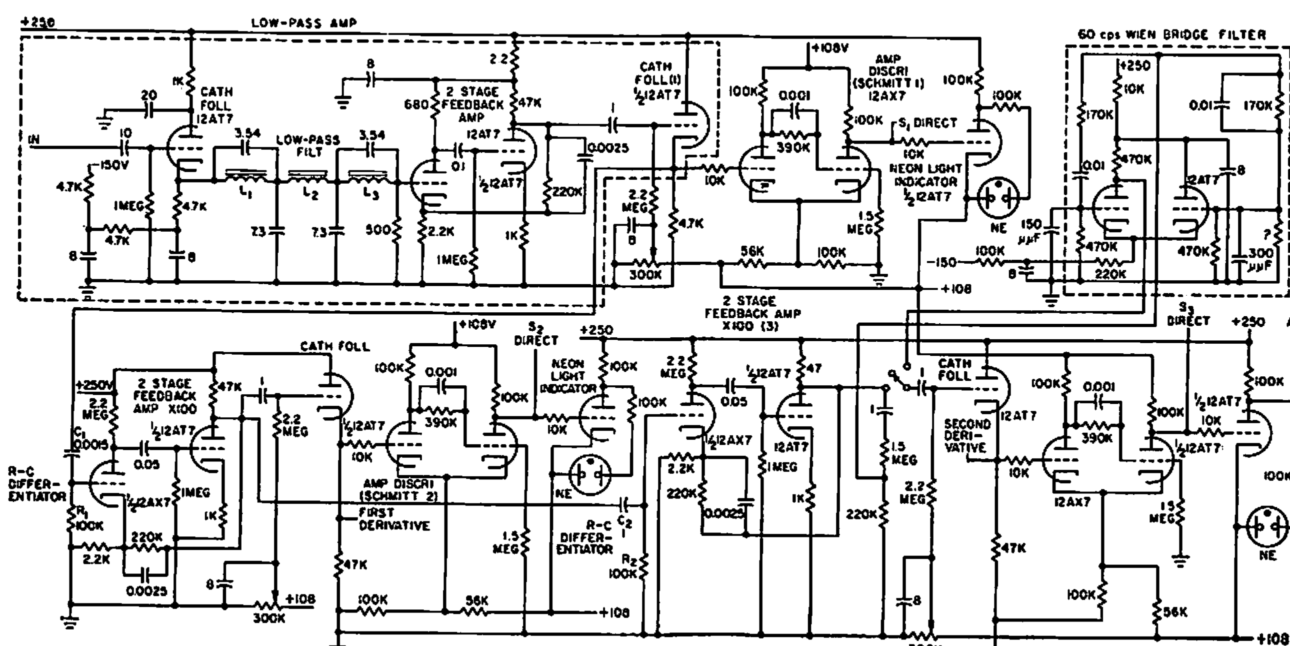
ULTRASONIC OSCILLATOR KEYER—Generates keying pulses up to 2 sec wide at prf down to 0.1 pps. Oscillator cutoff bias is gated off during pulse operation and switched off during c-w operation. Pulse repetition generator V1 is relaxation oscillator with trigger period variable in 0.1-sec steps from 0.1 to 10.9 sec. Fast-recovery phantastron pulse generator V2 allows precise pulsing up to 90% duty cycle, with pulse lengths from 0.005 to 2 sec.—B. J. Cosman and T. F. Hueter, Instrumentation for Ultrasonic Neurosurgery, *Electronics*, 32:20, p 53–57.

TWO-TRANSISTOR CARDIAC PACEMAKER—Produces triggering pulses that stimulate heartbeats during surgery. Repetition rate is determined by C1 and R1. Pulse duration is 4 millisec, with 8-v peak that sends 16 ma through 500-ohm load.—W. E. Gilson and H. F. Klinge, Cardiac Pacemaker Triggers Heartbeats, *Electronics*, 34:40, p 80.

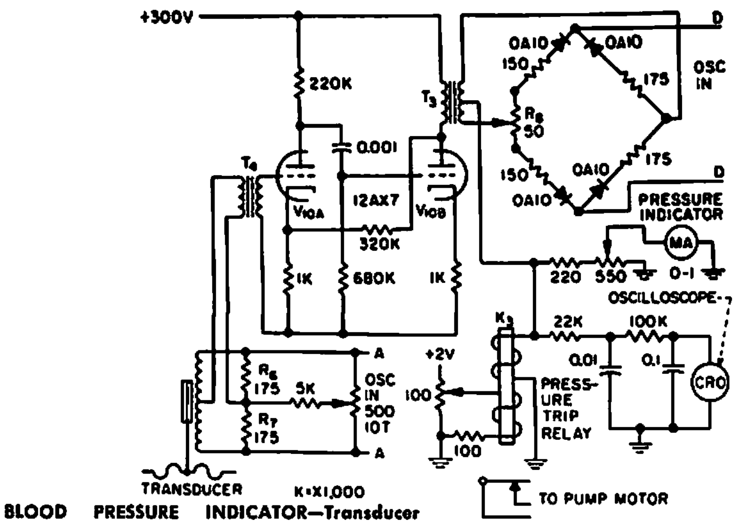




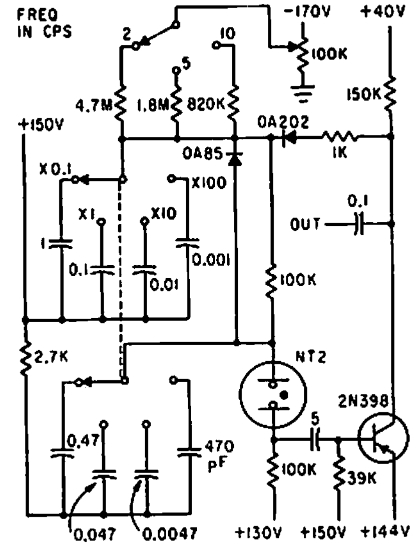
THREE-OUTPUT 3-KC OSCILLATOR—L-C oscillator provides carrier voltages of 4 v rms at 3 kc to blood-volume servo amplifier and to venous and arterial pressure indicator. Amplitude stabilization is achieved by bridge feedback network using filament-type lamp as nonlinear element in one bridge arm. —R. Schild and N. Wesson, Servo Circuit Controls Artificial Heart, *Electronics*, 31:15, p 73–75.



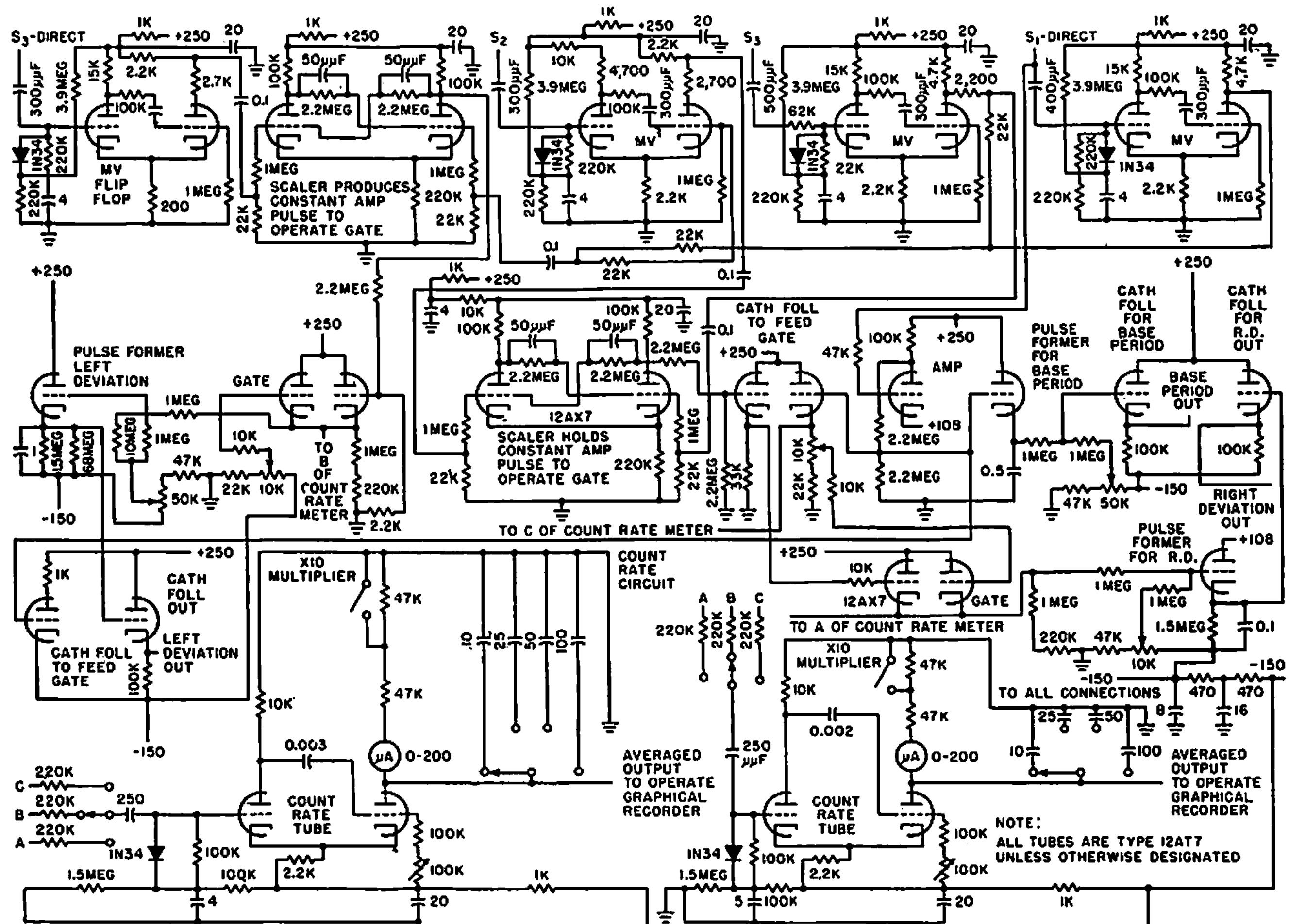
EEG WAVEFORM ZERO DETECTOR—Uses Schmitt triggers to produce output of one value when input signal exceeds preset reference, and produces output of one other value when input signal is less than reference value.—C. J. Zaander, Computer Analyzes Brain Waveforms, *Electronics*, 31:29, p 68–72.



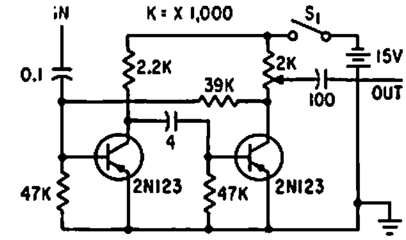
BLOOD PRESSURE INDICATOR—Transducer bridge is energized at points A-A by external 3-kc oscillator. Unbalance voltage is amplified by V10 and demodulated by second bridge that operates as rectifier with phase discrimination, while energized at D-D by separate 3-kc oscillator source. During unbalance, the only components reaching ring demodulator are those in phase or 180° out of phase with reference carrier voltage, giving positive or negative swing on meter.—R. Schild and N. Wesson, Servo Circuit Controls Artificial Heart, *Electronics*, 31:15, p 73–75.



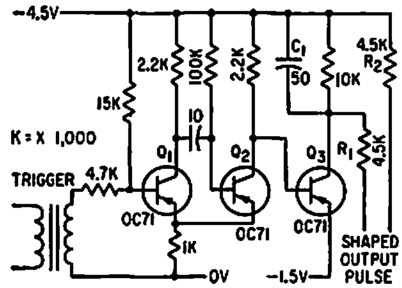
NERVE STIMULATOR—Neon relaxation oscillator and transistor give stable pulse generator covering range of 0.2 to 2,500 cps for neurophysiology research.—R. D. Ryan, Low-Cost Pulse Generator, *Electronics*, 35:15, p 70.



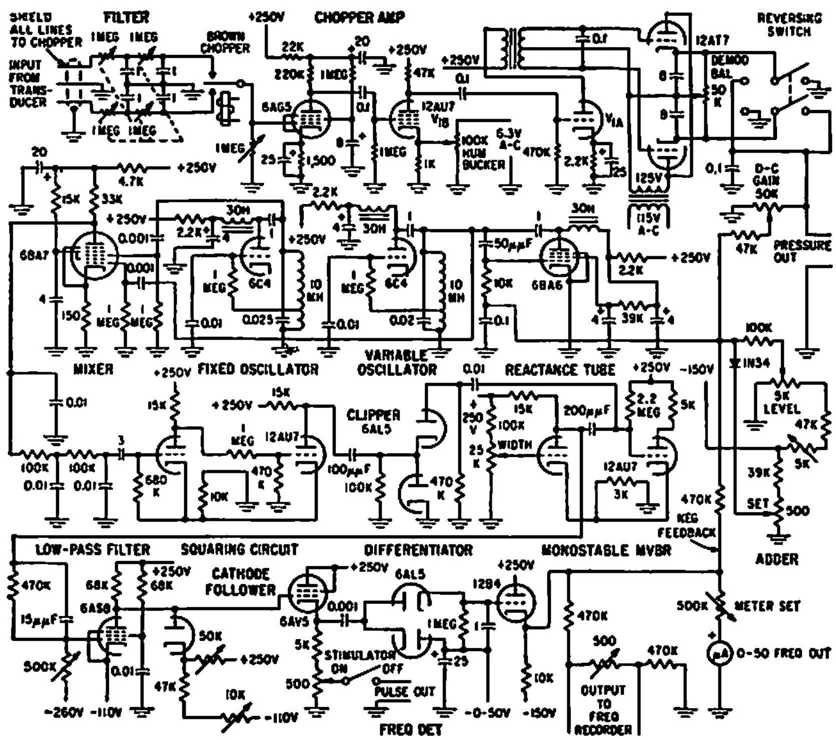
EEG WAVEFORM ANALYZER—Uses derivative curves of primary eeg signals to quantitatively describe waveshape deviations of irregular electrical waveforms emitted by brain, in terms of time and amplitude. Operates on zero-crossing detector measurements to produce analog voltages proportional to time between base periods and also proportional to time values of left and right deviation coefficients.—C. J. Zaander, Computer Analyzes Brain Waveforms, *Electronics*, 31:29, p 68–72.



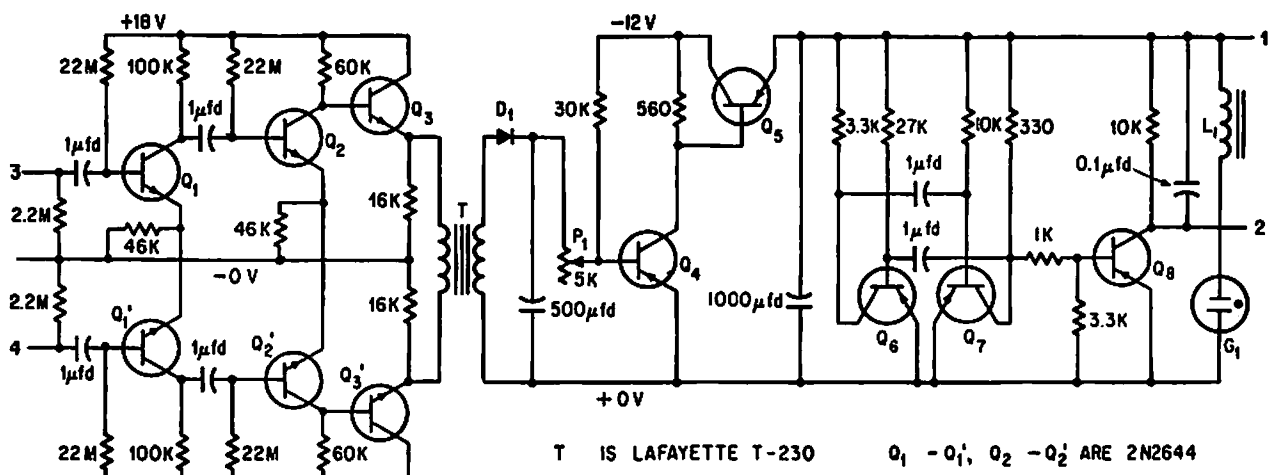
HEART-STIMULATING PULSE OUTPUT STAGE—Used in conjunction with pulse amplifier to increase stimulating voltage when scar tissue develops under electrodes sewn to auricle and ventricle of heart, introducing excessive load resistance. Produces constant-voltage positive-going pulse having maximum amplitude of 15 v and 0.1-sec duration, when triggered by positive pulse.—G. F. Vanderschmidt, Two-Transistor Amplifier Corrects Heart Block, *Electronics*, 31:47, p 80–81.



RETINA STIMULATOR—Generated pulse is applied to skin near eyes, to act on nerve cells of retina and give same effect as slight flash of extremely short duration.—P. Scott, Microflash and Pulse Stimulator Tests Human Optical Response, *Electronics*, 34:27, p 48–51.



BLOOD PRESSURE REGULATOR—Chopper amplifier delivers d-c voltage to adder that is proportional to mean blood pressure. Potentiometers in adder permit introducing negative voltages corresponding to desired blood pressure level and maximum safe level.—R. L. Skinner, D. K. Gehmlich, and F. W. Longson, Blood Pressure and Heart Regulator, *Electronics*, 32:1, p 38–41.

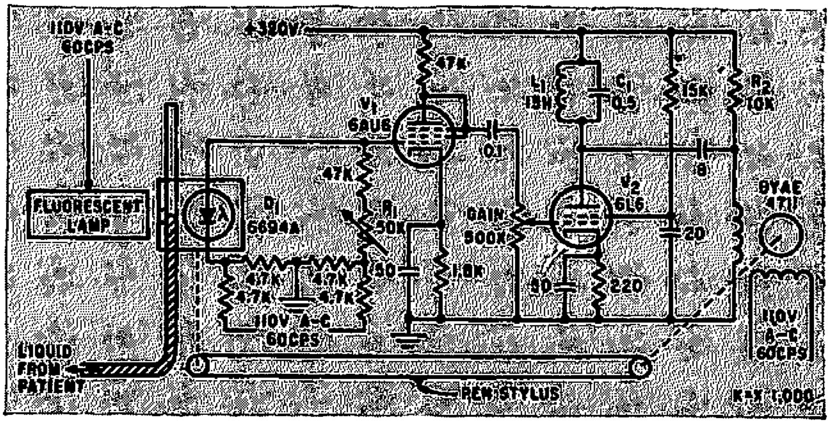


T IS LAFAYETTE T-230
D_1 IS IN34A

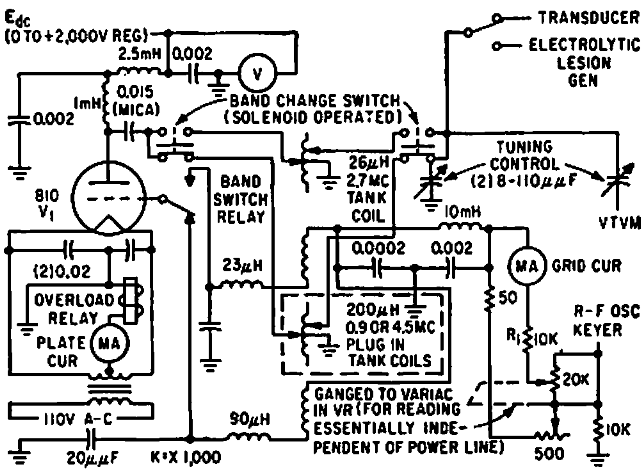
L_1 IS UTC-HQE-5 200 mH
G_1 IS NE-2

$Q_1 - Q_1'$, $Q_2 - Q_2'$ ARE 2N2644
$Q_3 - Q_3'$ IS 2N2223
Q_4 IS 2N1305
Q_5 IS 2N1038
Q_6, Q_7 ARE 2N404
Q_8 IS 2N398

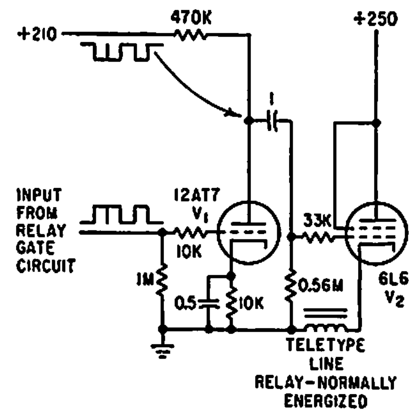
MYOELECTRIC STIMULATOR—Six-transistor amplifier having high-impedance differential input for commercial eeg or emg electrodes and gain of 10,000 from 5 to 10,000 cps drives modulator Q4-Q5 from decoupling transformer. Modulator makes stimulator (astable mvbr Q6-Q7) apply pulsating voltages to muscles of hand, to make hand open in response to signals picked up by electrodes over shoulder muscles, thereby bridging severed arm nerves.—L. Vodovnik and W. D. McLeod, Electronic Detours of Broken Nerve Paths, *Electronics*, 38:19, p 110–116.



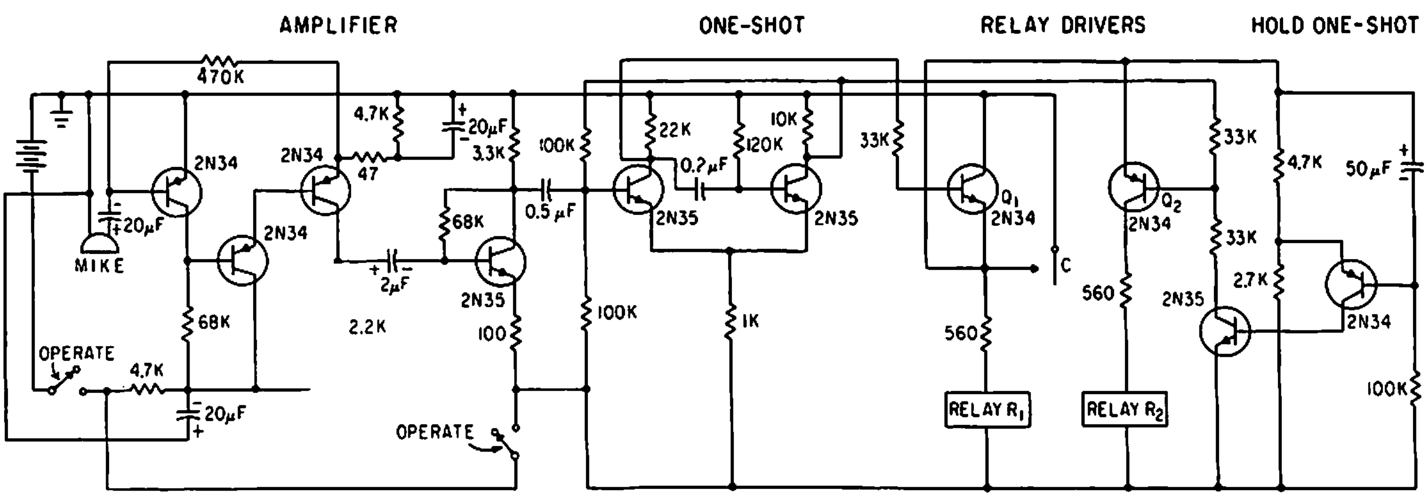
RECORDING MANOMETER—Pressure of blood or other body liquids is measured and recorded by photoelectric system. Mercury or other opaque fluids may also be measured. Servo loop maintains photocell at meniscus level of liquid. Mechanical linkage also drives recorder stylus.—W. E. Gilson and H. Ludwig, Recording Manometer, *Electronics*, 32:52, p 41.



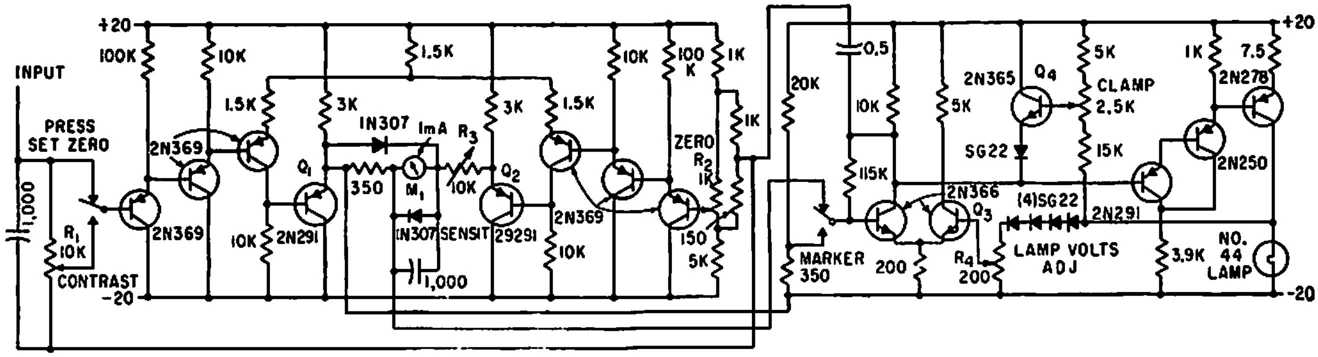
TUNED-PLATE TRIODE POWER OSCILLATOR—Drives ultrasonic transducer at odd harmonically related frequencies in 900 kc to 5 Mc optimum range, for neurosurgery, at power levels within 1 db of any prescribed level between 0.05 and 100 acoustic watts, without correction of amplitude after radiation has begun.—B. J. Cosman and T. F. Hueter, Instrumentation for Ultrasonic Neurosurgery, *Electronics*, 32:20, p 53–57.



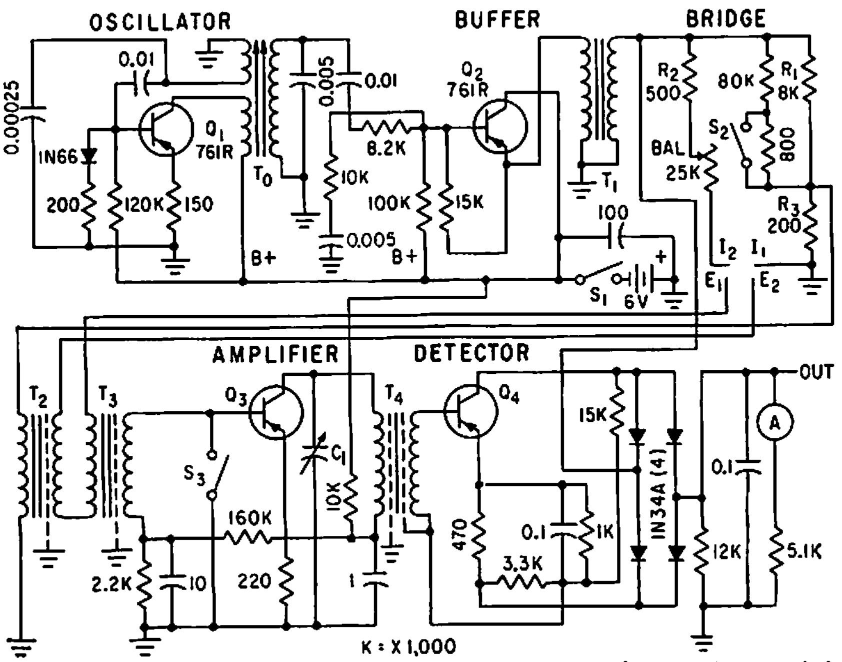
TELEPRINTER CONTROL—Coded pulse train controls teleprinter. When negative pulses are applied to grid of V2, line relays open in correspondence to pulse pattern.—R. L. Thomas, R. Howat, and N. H. Mackworth, Tv Tracker Records Eye Focus Points, *Electronics*, 33:17, p 57–59.



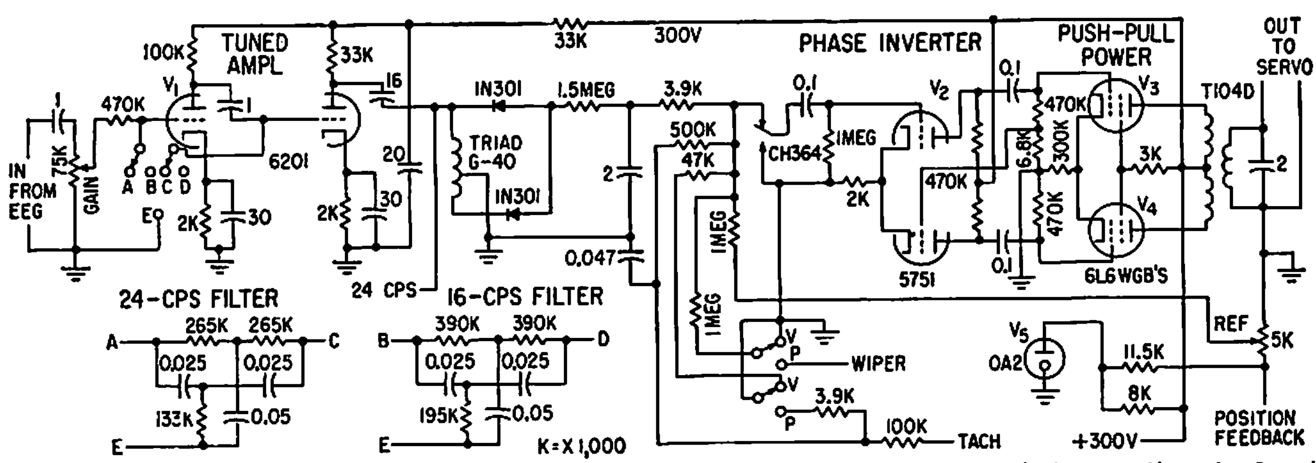
AUTOMATIC BLOOD-PRESSURE INDICATOR—High-gain amplifier-microphone combination detects pulse beats and feeds them through shaper circuit to hold-relays that lock pressure gages at systolic and diastolic blood-pressure readings.—R. J. Roy and M. Weiss, Inexpensive Monitor Reads Blood Pressure Automatically, *Electronics*, 35:47, p 40–41.



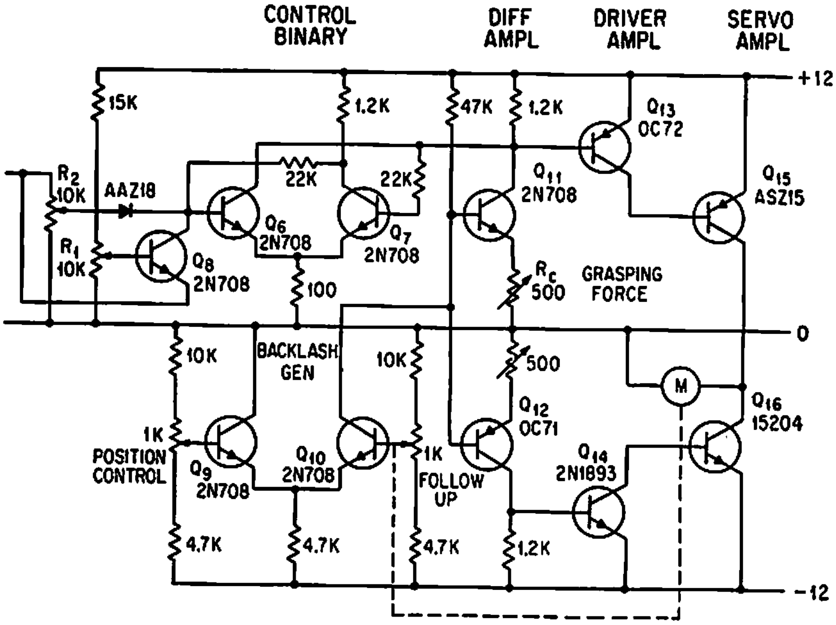
LAMP DRIVE—Count-rate meter of radiation-detecting tumor scanner provides input signal for d-c amplifier. Controls R1 and R2 in difference amplifier provides zero suppression and R3 provides scale expansion. Circuit drives lamp that exposes film in step with scanning motion of probe.—E. Gordy and G. Sieber, Sensitive Amplifier Helps Locate Tumors, *Electronics*, 34:1, p 123–124.



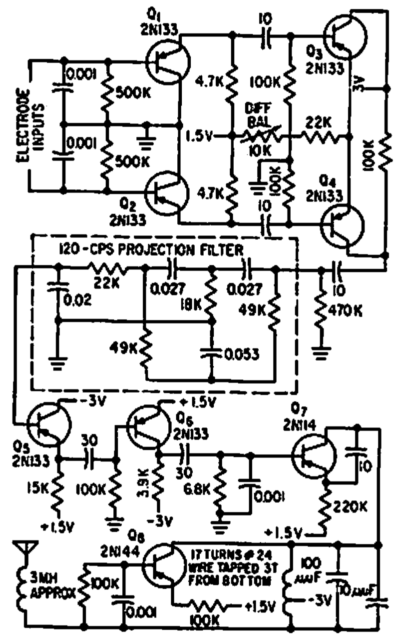
PLETHYSMOGRAPH—Transistorized unit measures change in impedance of living tissue resulting from nonrythmic fluctuations of blood content. Changes of 0.1% in total tissue impedance are detected by resistance bridge and phase-sensitive detector that scans bridge unbalance.—S. Bagno and F. M. Liebman, Impedance Measurements of Living Tissue, *Electronics*, 32:15, p 62–63.



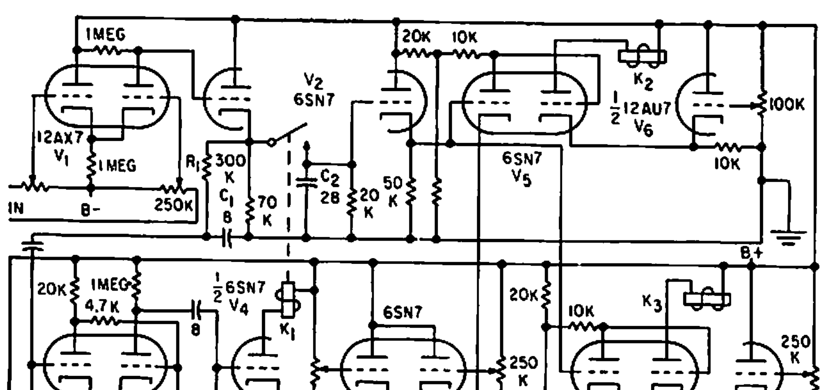
ANESTHESIA CONTROL—Drives anesthetic pump servomotor in response to signals from electroencephalograph that continuously monitors border of wakefulness of patient undergoing surgical operation. Anesthetic is supplied at fixed level, proportion to cortical activity of brain.—How Electronics Controls Depth of Anesthesia, *Electronics*, 32:5, p 43–45.



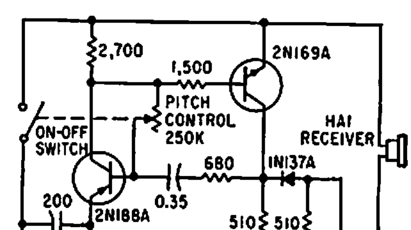
PRESSURE-SENSITIVE RESISTOR CONTROLS ARTIFICIAL HAND—Control binary Q6-Q7 is triggered on through diode AAZ18 and reset by Q8 whose conduction threshold is determined by R1. Settings of R1, R2, and RC control closing of artificial hand and strength of grip. Servo amplifier drives motor in hand and follow-up potentiometer.—G. W. Horn, Muscle Voltage Moves Artificial Hand, *Electronics*, 36:41, p 34–36.



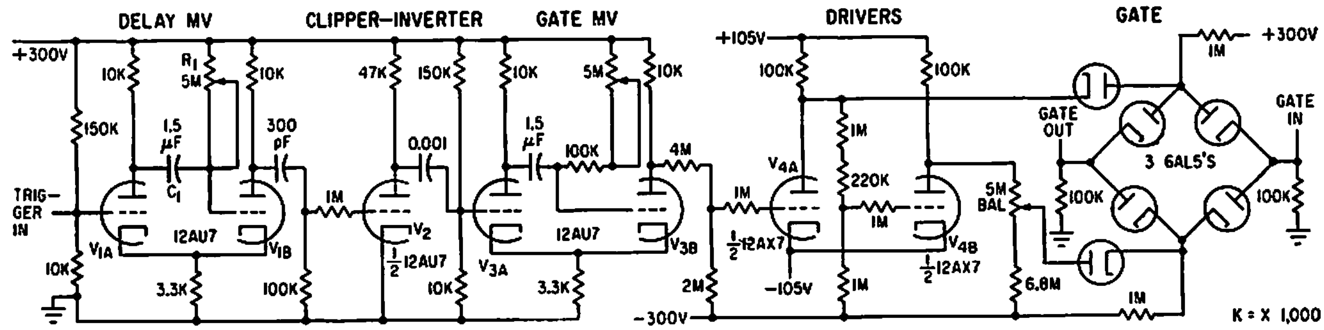
EEG TELEMETER—Amplifier, modulator, and oscillator produce 37.7-Mc signals frequency-modulated by scalp voltages of epileptics. Radiated signal may be picked up by antenna of receiver at distances up to 40 feet from patient in observation room.—C. L. Yeager and J. Henderson, Jr., Unit Telemeters Scalp Voltages, *Electronics*, 31:29, p 86.



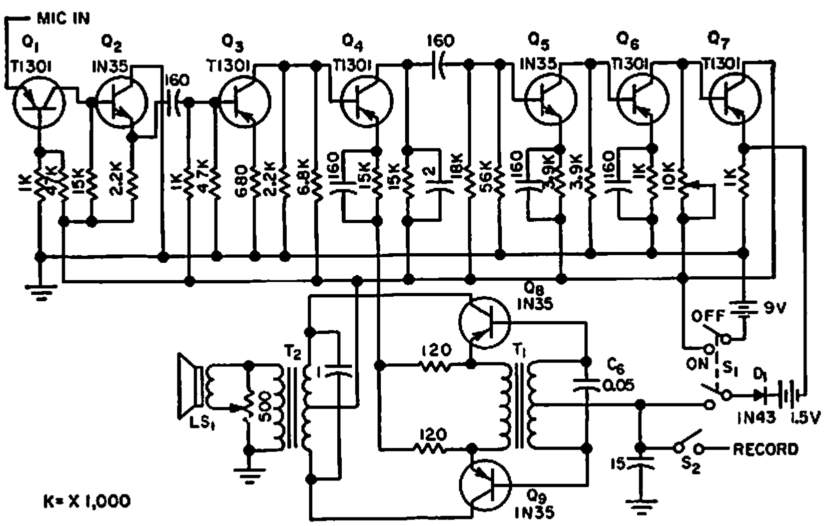
IRON-LUNG AIR INTAKE CONTROL—Air exhaled by patient is sampled and analyzed for carbon dioxide concentration by commercial infrared analyzer that provides electrical output proportional to amount of carbon dioxide. Analyzer output charges C2 to level dependent on carbon dioxide concentration. Comparison circuit controls relays K2 and K3 so iron lung bleeder valve keeps concentration within preset limits. V5, V6, and K2 establish upper limit; V7, other half of V6, and K3 establish lower limit.—Control Regulates Iron Lung, *Electronics*, 31:41, p 108.



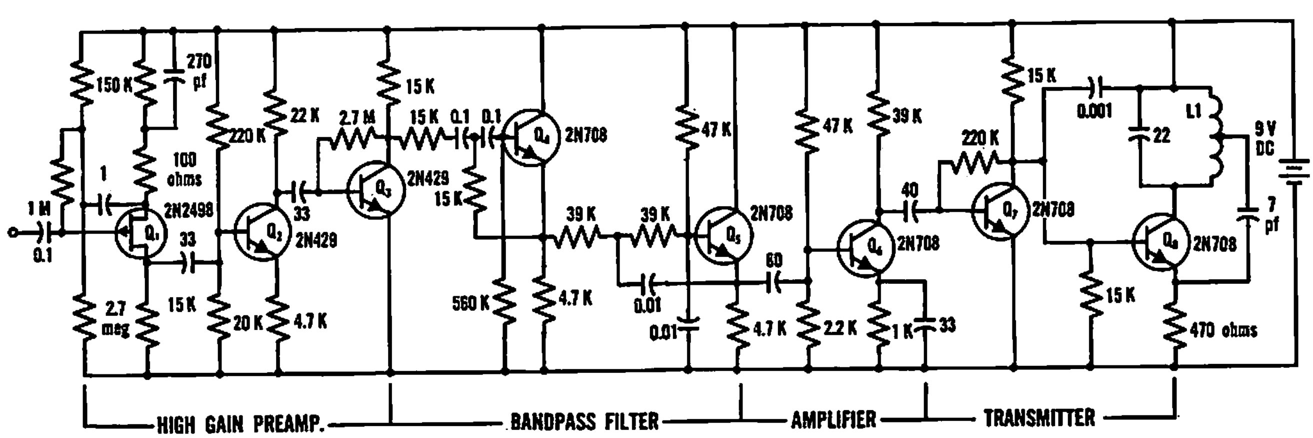
ARTIFICIAL LARYNX—Output is negative pulse whose repetition frequency is varied from 100 to 200 cps by rheostat to change pitch of voice while speaking. Modified telephone receiver serves as vibrator that is pressed against throat to transform generated vibrations into speech sounds by normalmal use of throat cavity, tongue, mouth, teeth, and lips. With practice, users can achieve sentence intelligibility above 97%.—Circuit Substitutes as Larynx, *Electronics*, 32:27, p 60–63.



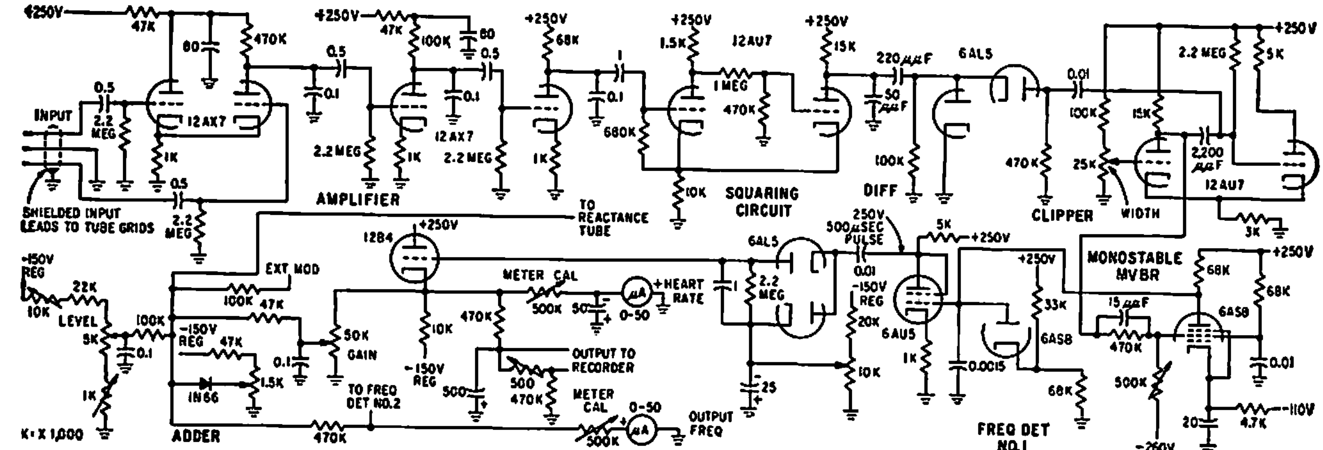
SLIDING GATE FOR HEART SOUNDS—Two multivibrators, synchronized with time reference, permit listening to selected portions of heart sound. Potentiometers permit adjusting width and position of gate.—R. Weiss, Heart-Sound Discriminator Simplifies Medical Diagnosis, *Electronics*, 34:24, p 52–55.



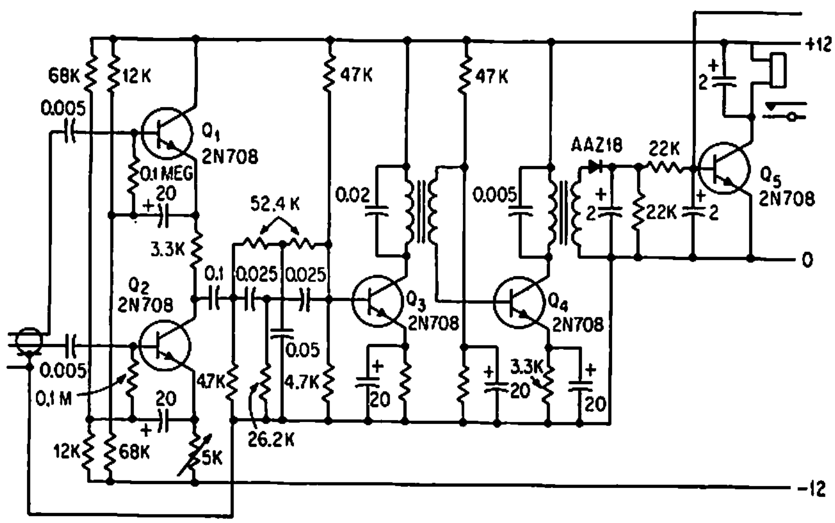
FOETAL HEART BEAT DETECTOR—Amplified 2- to 3-cps signal from foetal heart modulates transistor oscillator operating between 800 and 1,200 cps. Frequency modulation technique overcomes poor low-frequency response of human ear and loudspeaker. A-c coupled stages have large time constants, to give required low-frequency response.—T. I. Humphreys, Transistor Unit Detects Foetal Heart Sounds, *Electronics*, 31:17, p 52–54.



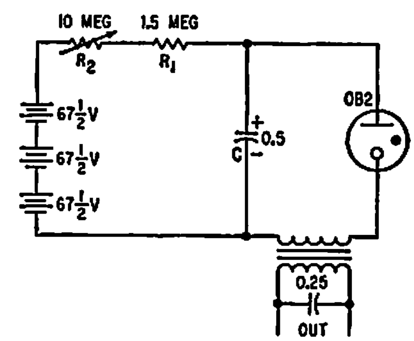
NERVE ACTION POTENTIAL TRANSMITTER—Used in telemetering bioelectric potentials from baroreceptors of blood pressure control system in active awake animals for several days after surgical implantation of electrodes in aorta and carotid arteries. System provides flat frequency response from 1 to 1,200 cps with input impedance of 2.5 meg and input sensitivity of 5 to 500 mv. Transmitting range is 25 feet.—P. Kezdi and W. S. Naylor, Telemetry System to Transmit Baroreceptor Nerve Action Potentials, *The American Journal of Medical Electronics*, 4:4, p 153–155.



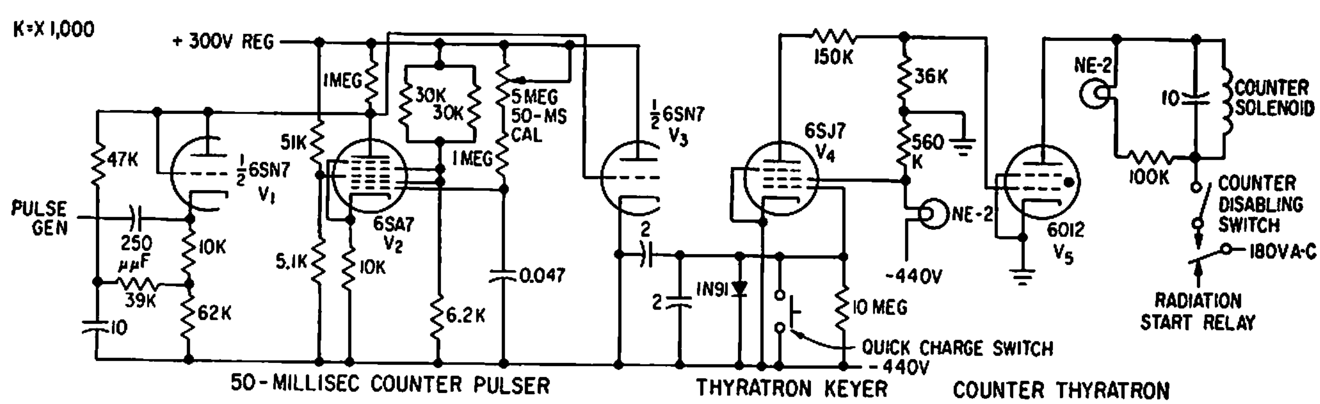
HEART RATE REGULATOR—Senses arterial pressure and differentiates pressure signal to eliminate mean pressure and produce required sharp spike at beginning of each pressure pulse. Spikes are used to control regulator that delivers pulses to vagus nerve that controls muscles of heart.—R. L. Skinner, D. K. Gehmlich, and F. W. Longson, Blood Pressure and Heart Rate Regulator, *Electronics*, 32:1, p 38–41.



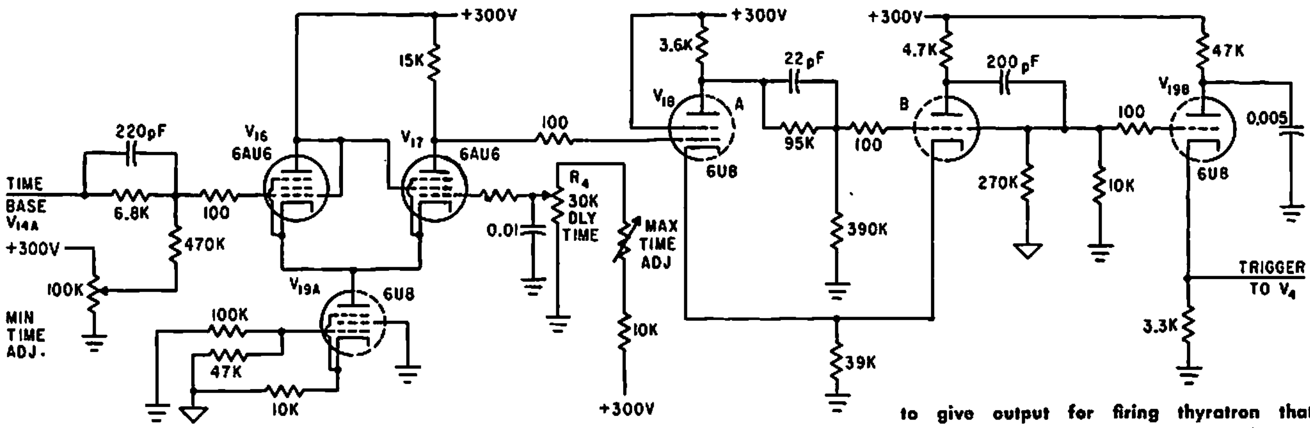
MUSCLE-SIGNAL AMPLIFIER—Differential input amplifier Q1-Q2 accepts myoelectric signals of 10 to 1,000 microvolts from stump muscles of amputee. Stagger-tuned interstage transformers for Q3-Q4 give bandwidth of 100 to 1,000 cps for main amplifier that drives integrating detector Q5 that operates relay to control servomotor for artificial hand.—G. W. Horn, Muscle Voltage Moves Artificial Hand, *Electronics*, 36:41, p 34–36.



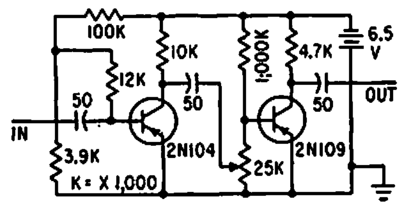
HEART PACER—Supplies pulses that drive heart at desired rate. Output is connected to heart muscles by small wires. Frequency of relaxation oscillator is controlled, between 50 and 200 ppm, by R2.—L. D. Trump and R. L. Skinner, Simple Heart Pacer is Highly Reliable, *Electronics*, 32:39, p 92–93.



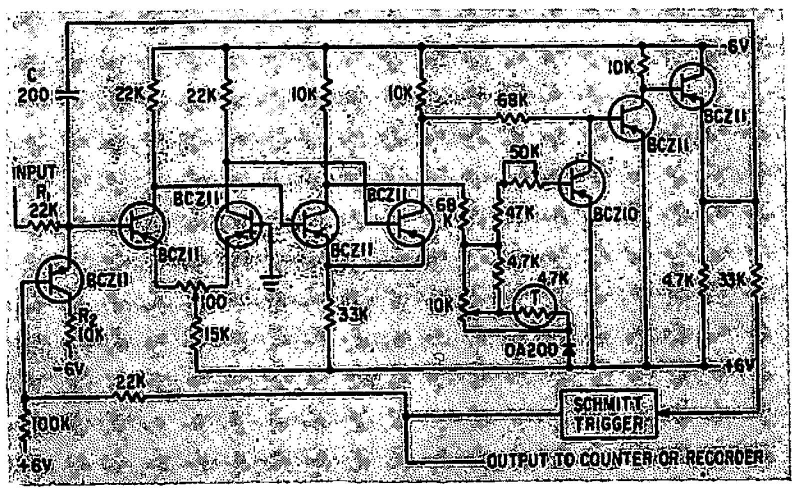
PRESET PULSE COUNTER—Automatically controls lesion-producing ultrasonic radiation by counting up to 99,999. Mechanical counter is actuated by thyratron V5, which is keyed on by 50-millisec counter pulser driven by leading edge of square-wave input pulse.—B. J. Cosman and T. F. Hueter, Instrumentation for Ultrasonic Neurosurgery, *Electronics*, 32:20, p 53–57.



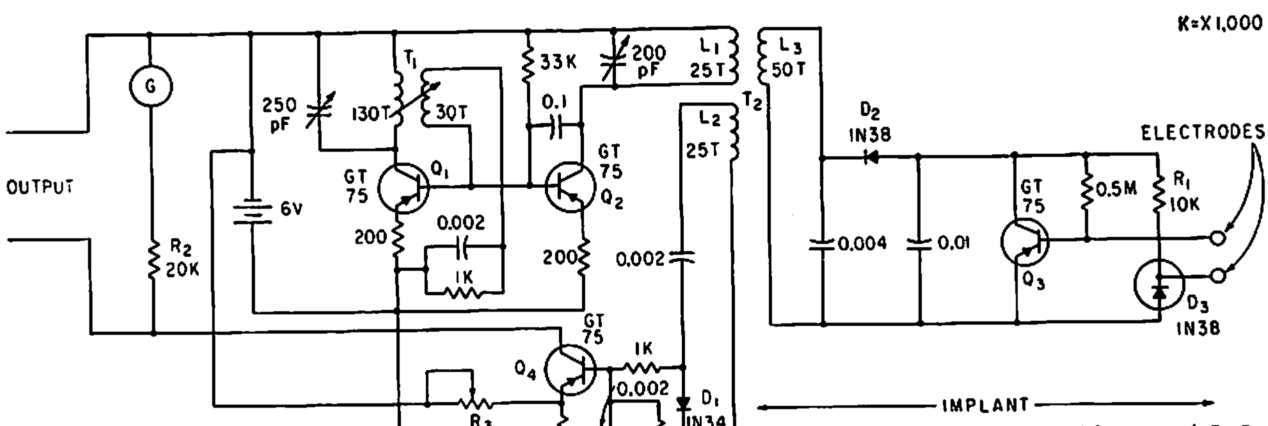
RETINA WELD TIMER—Time base ramp voltage is fed to trigger pickoff circuit V16-V17-V19A. Delay time potentiometer R4 determines voltage at which V17 conducts. Delayed pulse is fed to trigger-shaping mvbr V18 which feeds strong, fast pulse to V19B to give output for firing thyratron that turns off r-f power.—O. Rich, Jr. and R. V. Hill, R-F Spot Welder Reattaches Retina of Human Eye, *Electronics*, 34:32, p 160–163.



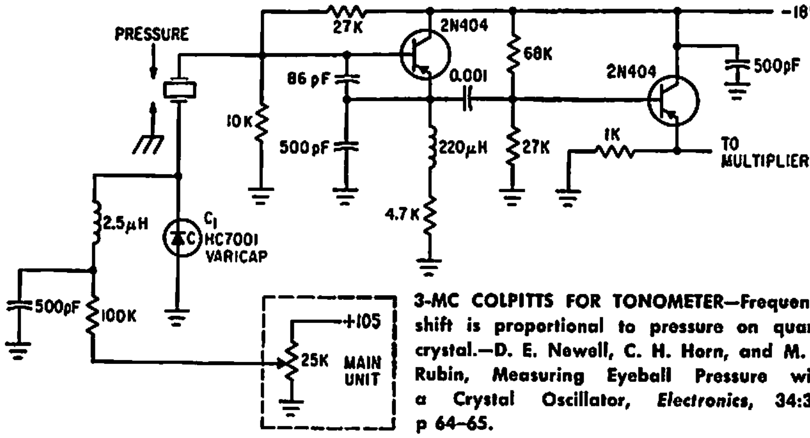
PULSE AMPLIFIER FOR HEART—Used to provide adequate stimulating voltage to electrode sewn on ventricle of heart to make it contract properly in heart-blocked patients. Command pulses from electrode on auricle are amplified 200 times by circuit, without waveform distortion, and applied to ventricle electrodes to produce normal pumping rhythm.—G. F. Vanderschmidt, Two-Transistor Amplifier Corrects Heart Block, *Electronics*, 31:47, p 80–81.



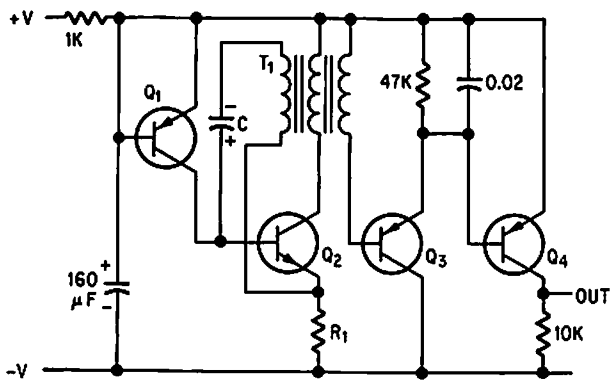
PILL-TRACING INTEGRATOR—Voltage proportional to speed of travel of pill-sized radio transmitter in human body is integrated in quantizing circuit that delivers number of pulses proportional to track length. Transistor differential amplifier charges C, and Schmitt trigger controls discharge of C through R2. Frequency of trigger pulses is proportional to input voltage within 1% over range of 2 to 200 mv.—B. Jacobson and B. Lindberg, Servo Tracks Pill in Human Body, *Electronics*, 36:12, p 58–60.



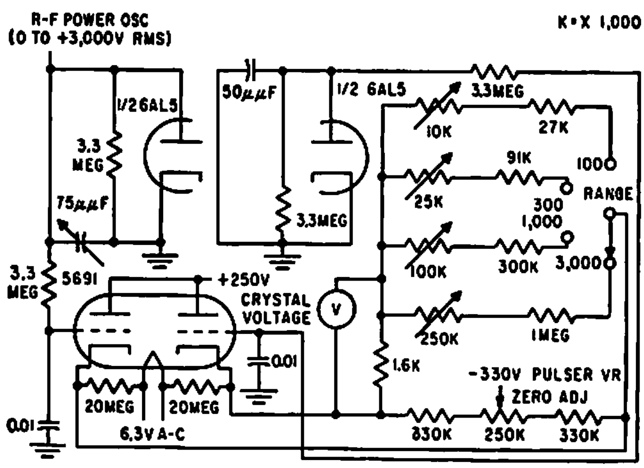
MUSCLE POTENTIAL TELEMETER—Implanted probe circuit receives power at 50 kc from external pickup coil driven by modified Hartley oscillator Q1. Signal is rectified by D2 to provide d-c power for Q3, to generate magnetic field that varies with muscle potential.—S. Bagno, F. Liebman, and F. Cosenza, Detecting Muscle Potentials in Unanesthetized Animals, *Electronics*, 33:41, p 58–59.



3-MC COLPITTS FOR TONOMETER—Frequency shift is proportional to pressure on quartz crystal.—D. E. Newell, C. H. Horn, and M. L. Rubin, Measuring Eyeball Pressure with a Crystal Oscillator, *Electronics*, 34:36, p 64–65.



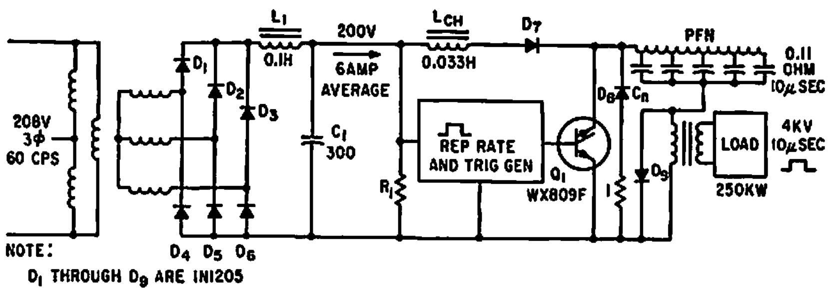
BATTERYLESS CARDIAC PACEMAKER—Body fluids are electrolyte for implanted silver and zinc electrodes that provide d-c power for four-transistor pacemaker. Secondary of T1 provides feedback for ringing-choke oscillator Q1, which charges C until Q2 is cut off. C then discharges until Q1 can again conduct.—O. Z. Roy and R. W. Wehnert, Keeping the Heart Alive with a Biological Battery, *Electronics*, 39:6, p 105–107.

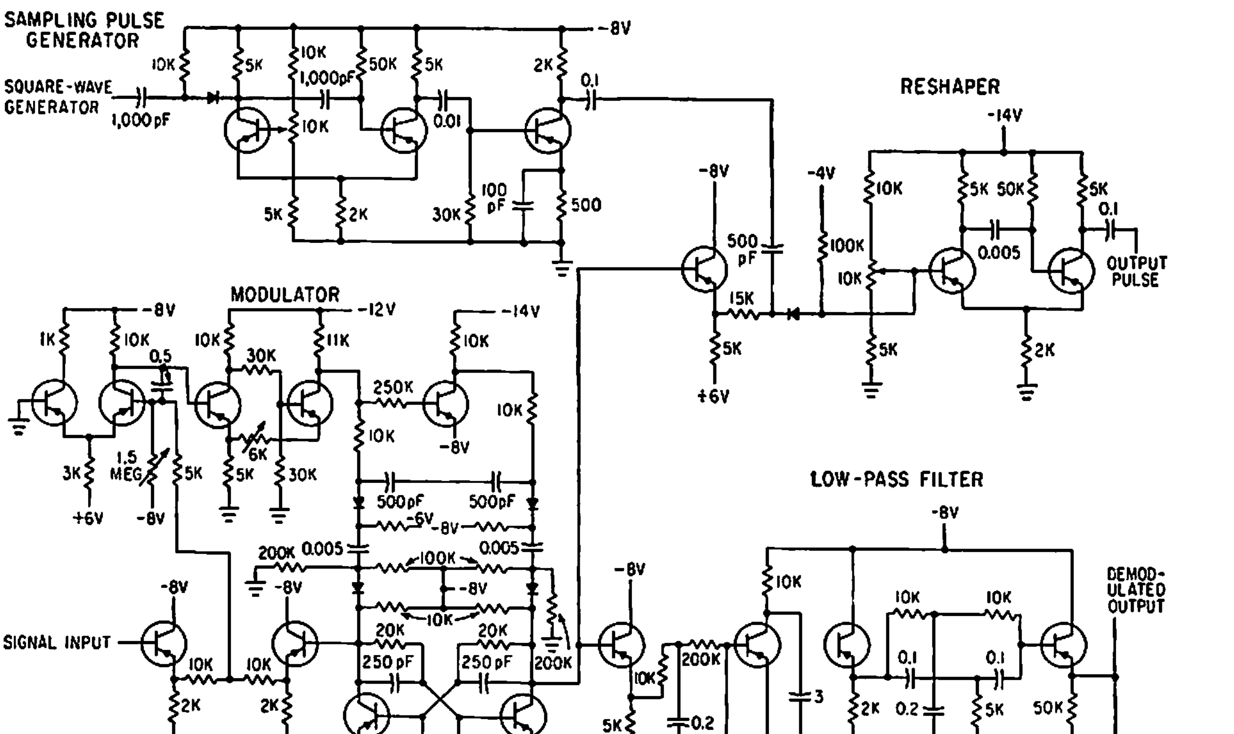


FOUR-RANGE VTVM—Measures r-f power oscillator output, for establishing irradiation and calibration procedures and positioning techniques when using focused ultrasound for therapeutic treatment of deep-seated brain structures.—B. J. Cosman and T. F. Hueter, Instrumentation for Ultrasonic Neurosurgery, *Electronics*, 32:20, p 53–57.

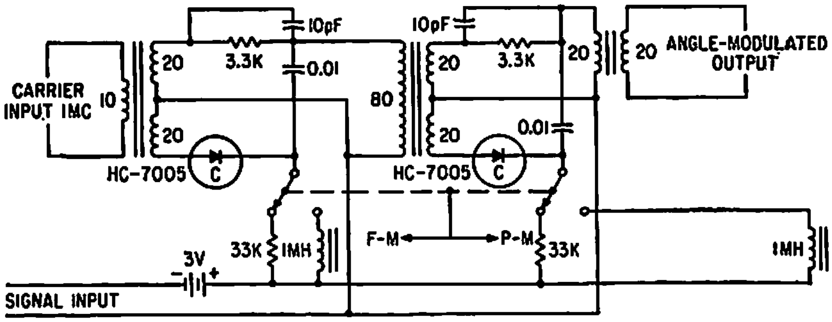
CHAPTER 51
Modulator Circuits

250 KW PEAK FROM SCR—Line-type modulator uses silicon diodes for high-voltage rectifiers, backswing, holdoff, and inverse-diode circuits. Trigger generator uses two-layer and four-layer diodes to provide pulse burst repetition rates up to 25 kc.—H. G. Heard, Controlled Rectifier Produces Quarter-Megawatt Pulse Power, *Electronics*, 34:25, p 54–55.

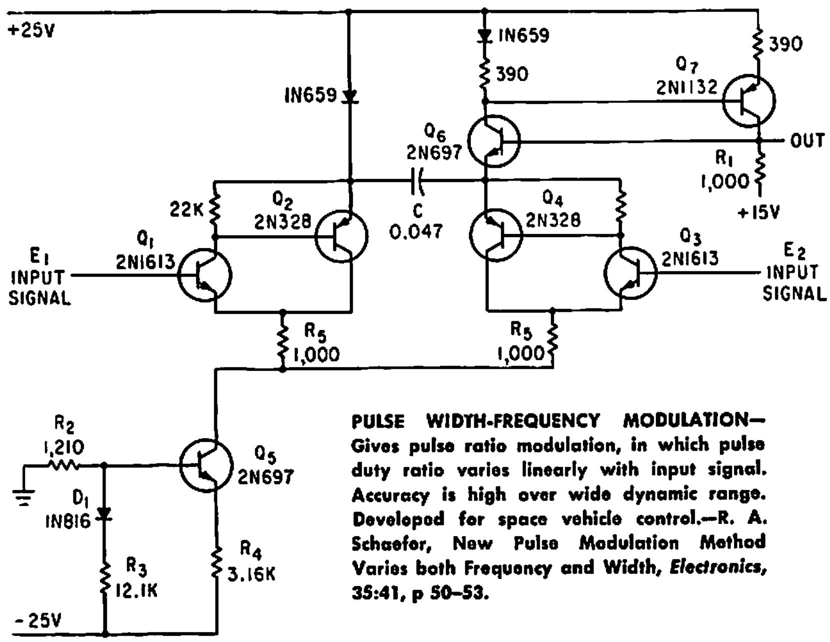




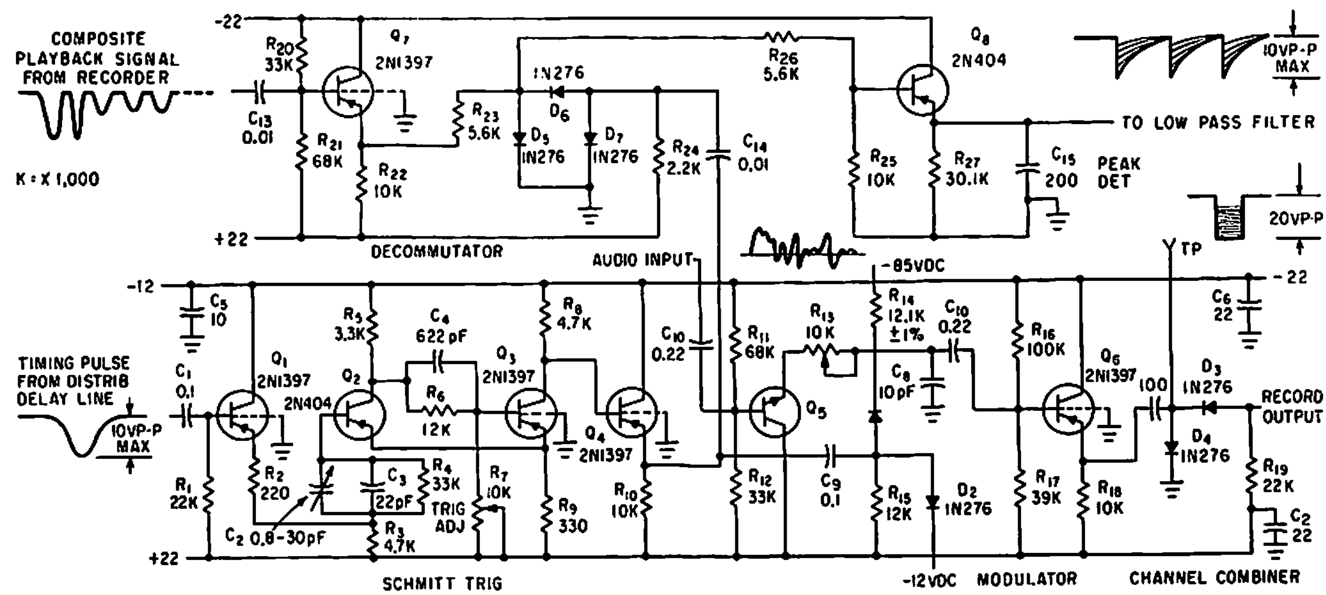
DELTA-SIGMA MODULATION FOR DIGITAL COMMUNICATIONS—Flip-flop sampling pulse generator supplies 5-microsec pulses at 3-kc prr to modulator that also has analog signal input. Integrated difference signal fires Schmitt trigger to provide positive output that opens gate, passing square-wave pulse that sets flip-flop. Output of flip-flop is fed to emitter-follower and demodulated by active low-pass filter having 50-cps cutoff.—H. Inose et al, New Modulation Technique Simplifies Circuits, *Electronics*, 36:4, p 52–55.



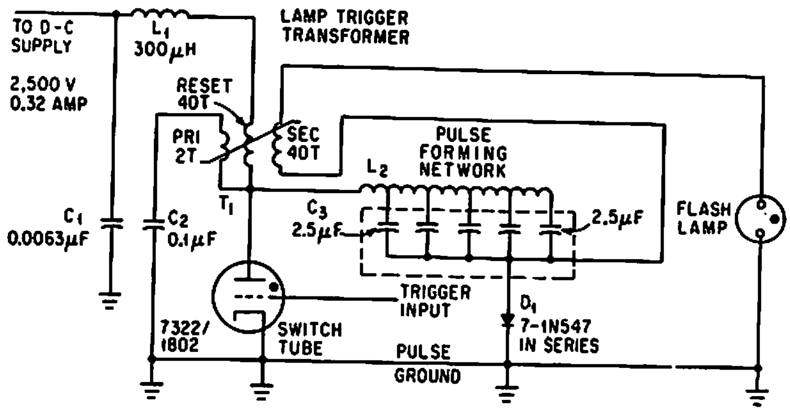
CASCADE ANGLE MODULATOR—Gives twice the modulation index for a particular signal, or 50° for the two sections.—A. C. Todd, P. Schuck, and H. M. Sachs, Using Voltage-Variable Capacitors in Modulator Design, *Electronics*, 34:3, p 56–59.



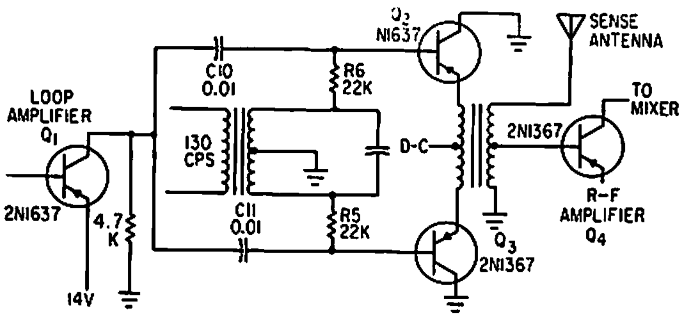
PULSE WIDTH-FREQUENCY MODULATION—Gives pulse ratio modulation, in which pulse duty ratio varies linearly with input signal. Accuracy is high over wide dynamic range. Developed for space vehicle control.—R. A. Schaefer, New Pulse Modulation Method Varies both Frequency and Width, *Electronics*, 35:41, p 50–53.



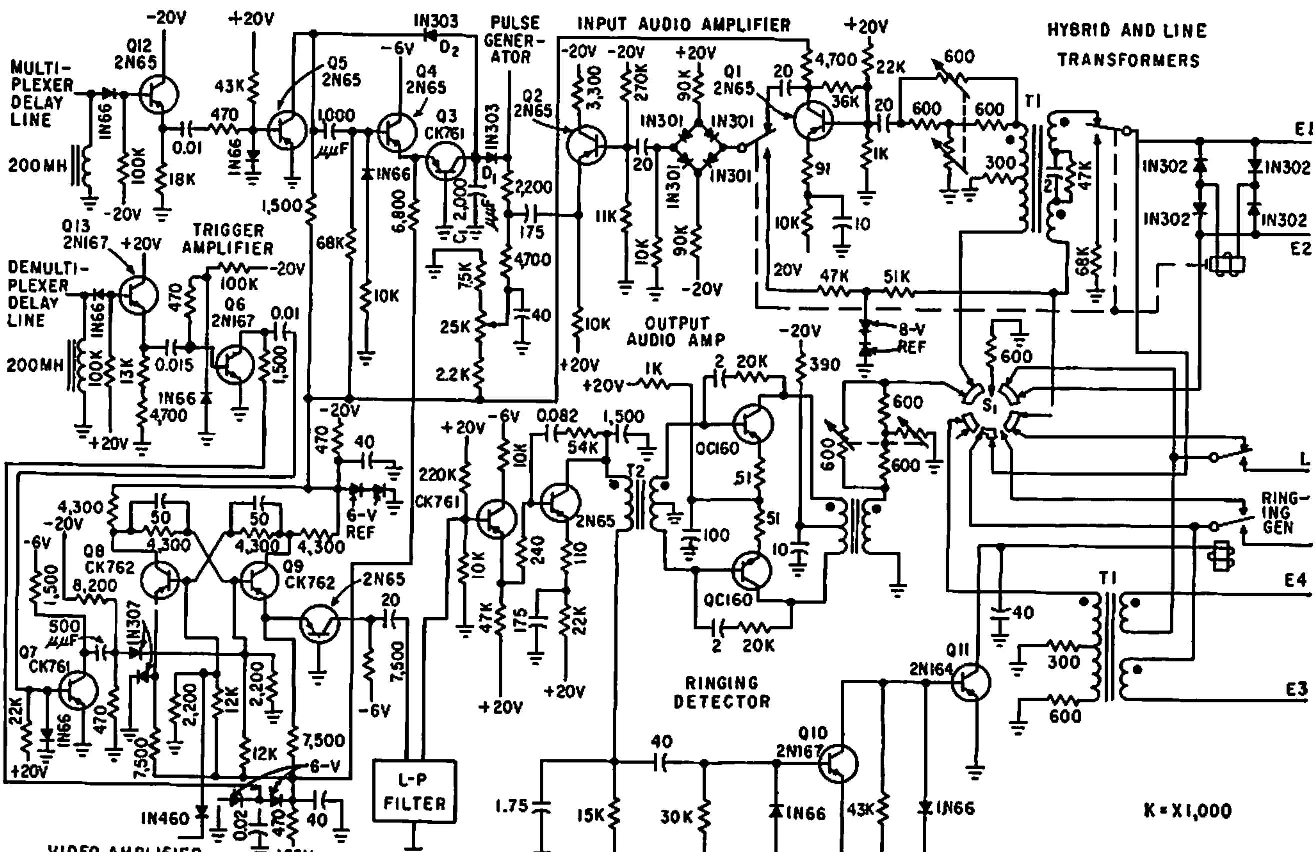
PAM MODULATOR-DECOMMUTATOR FOR VIDEO RECORDER—Schmitt trigger reshapes timing pulses from 52-channel distributing delay line. Modulator samples audio signal from one channel during record mode, while decommutator separates individual channels from composite signal during playback from time-division multiplexing on two-track video recorder.—M. H. Damon and F. J. Messina, High-Density Storage of Wideband Analog Data, *Electronics*, 35:13, p 45–49.



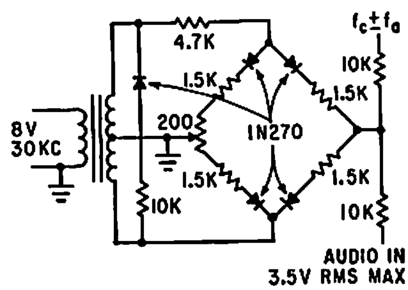
PULSE-FORMING MODULATOR FOR LASER FLASH LAMP—Saturating-core trigger transformer T1 responds to short high-voltage spike on leading edge of main pulse, generated by discharge of C2 through ceramic hydrogen thyratron switch tube when this tube is triggered on its grid.—S. J. Grabowski, Pulse Power Supply Design for Laser Pumping, *Electronics*, 36:51, p 33–35.



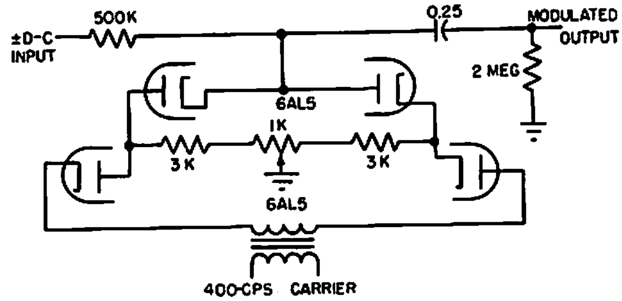
BALANCED MODULATOR FOR ADF—Combines signals from loop and sense antennas of automatic direction finder, to give 130-cps output having correct phase for driving rotor of resolver to null position.—P. V. Sparks, Servo Filter and Gain Control Improve Automatic Direction Finder, *Electronics*, 34:23, p 110–113.



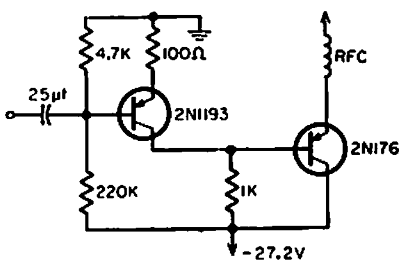
FOUR-CHANNEL PPM MODEM—Amplitude modulation of microwave radio system is pulse-position-modulated by multiplexer. Modulator-demodulator circuit handles 300 to 3,500-cps voice signals with amplitudes from −20 to +10 dbm.—P. W. Kiesling, Jr., Portable Multiplexer for Telephone Communications, *Electronics*, 32:2, p 60–62.



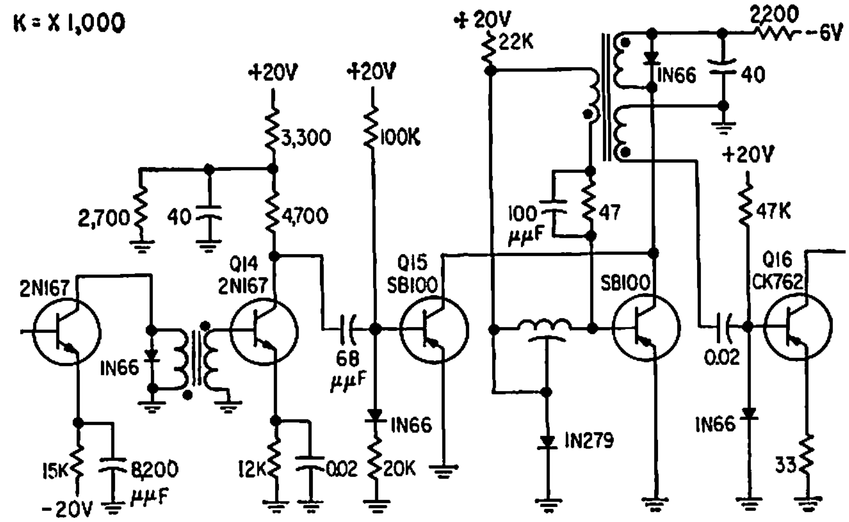
MODULATOR TRANSFORMER—Circuit provides best possible balance between halves of center-tapped secondary, as required for precise phase splitting, in Boynton-Scholt modulator shown.—Wide-Band Transformer Covers 3 Kc to 22 Mc, *Electronics*, 35:25, p 66.



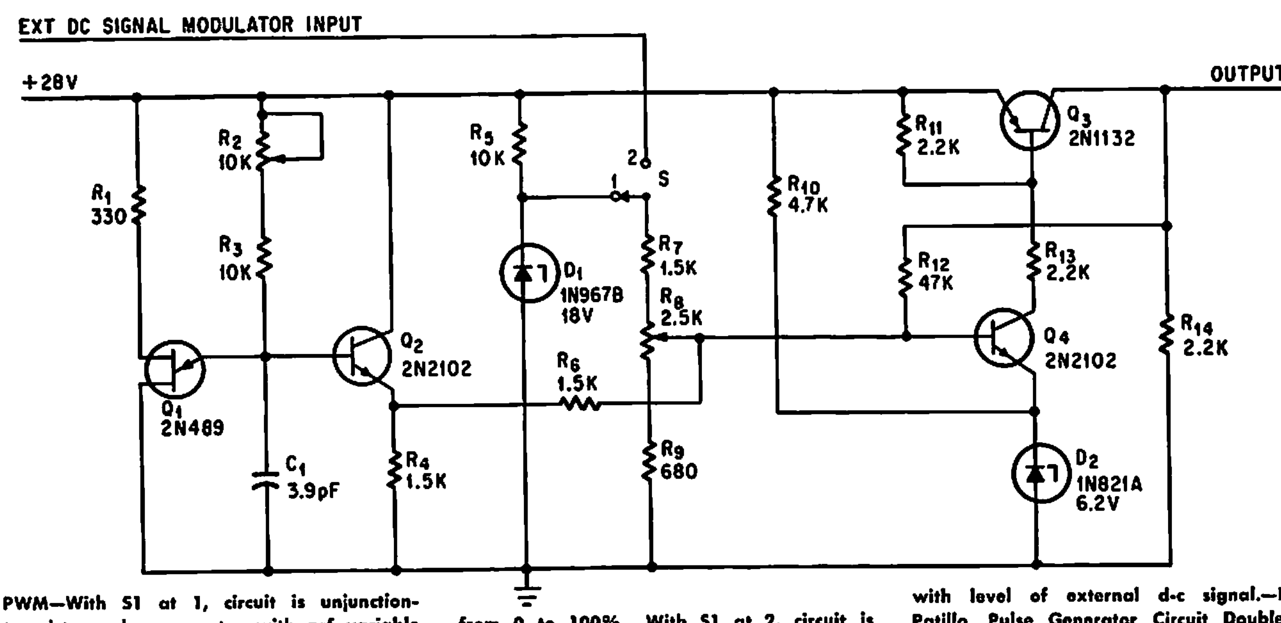
DIAMOND MODULATOR—Carrier signal turns electron tube or equivalent crystal diode on and off to modulate d-c input signal. Signal-noise ratio is about 1,500 to 1, with carrier voltage of 19 v rms. Output is linear up to 3 v rms for d-c inputs up to 10 v.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



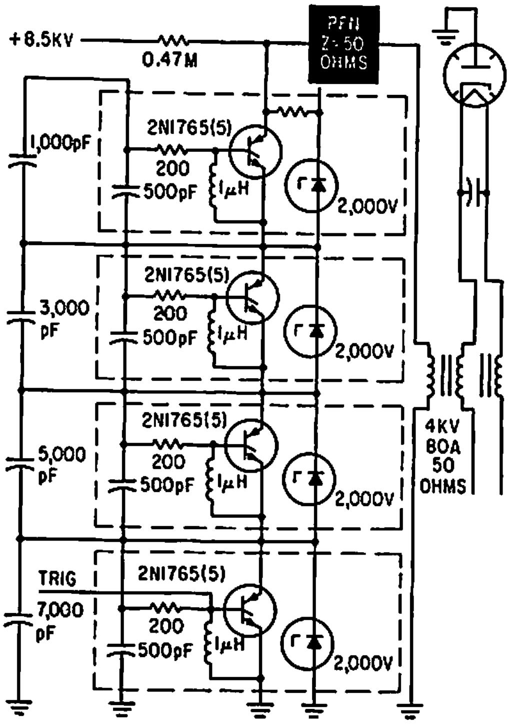
DIRECT R-C COUPLED COMMON-EMITTER MODULATOR—Performance is considerably better than that of conventional transformer-coupled collector-modulated 27-Mc CB modulator. Total current drain is 83 ma. 0.14 v gives full modulation. Power gain is nearly 20 db for 2N1193. Requires no audio transformers.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.



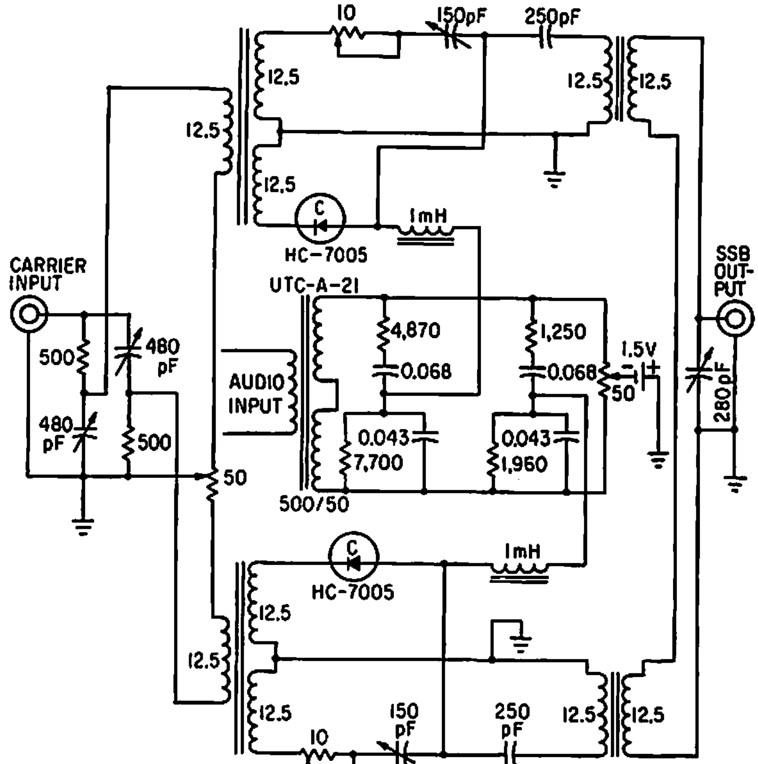
MODEM PULSE SHAPER—Removes audio component from modulator output to prevent crosstalk, and shapes pulse to required rise and fall time and width. Used in four-channel ppm microwave multiplex unit.—P. W. Kiesling, Jr., Portable Multiplexer for Telephone Communications, *Electronics*, 32:2, p 60–62.



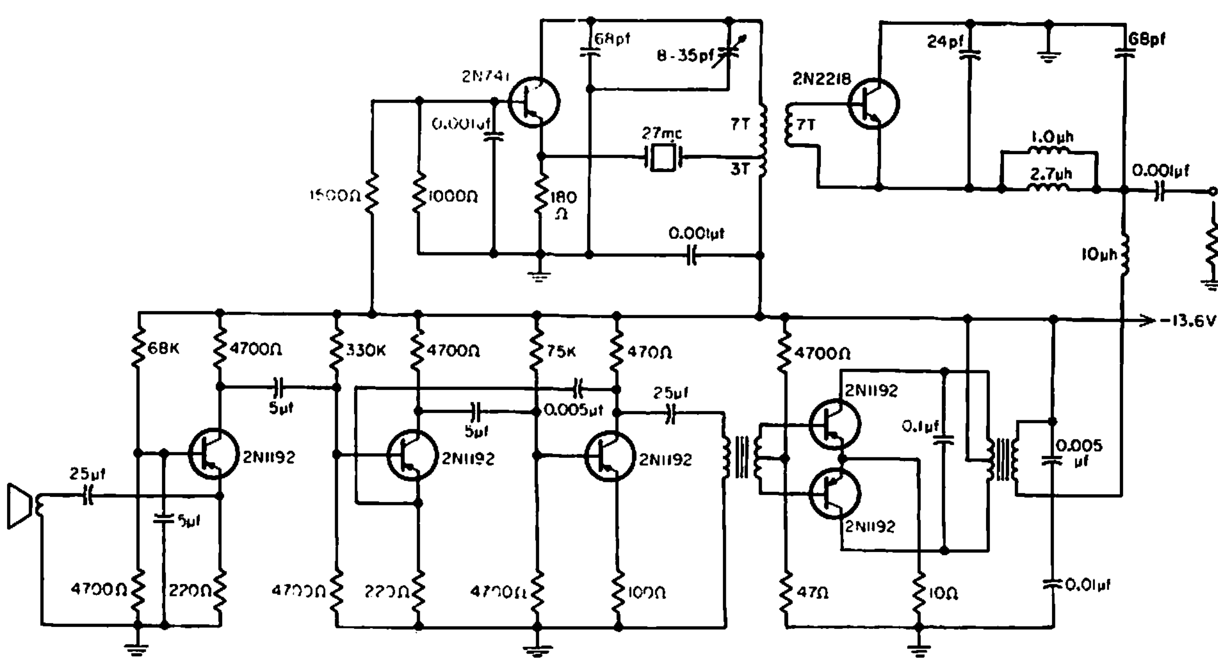
PWM—With S1 at 1, circuit is unijunction-transistor pulse generator with prf variable from 13 to 25 kc, and duty cycle variable from 0 to 100%. With S1 at 2, circuit is modulator whose output pulse width varies with level of external d-c signal.—D. L. Patillo, Pulse Generator Circuit Doubles as Modulator, *Electronics*, 38:8, p 91–92.



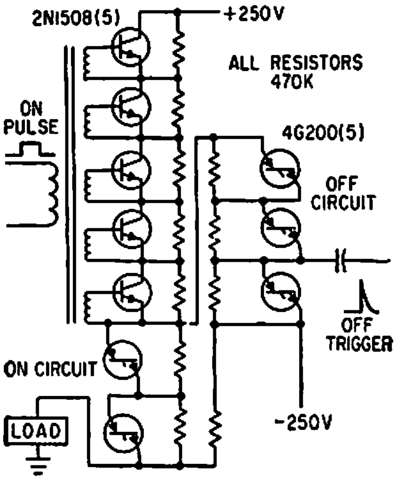
300-KW MAGNETRON MODULATOR—Trigger is applied to first of four 2-kv switch modules arranged in series, for simultaneous triggering of other modules to furnish 16-kv 20-amp pulse to type 7208 Ku-band coaxial magnetron through standard 50-ohm pulse-forming network PFN.—F. A. Gateka and M. L. Embree, Semiconductor Modulators for Modern Magnetrons, *Electronics*, 35:37, p 42–45.



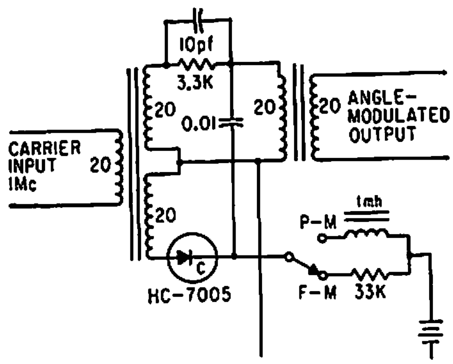
CAPACITOR-BALANCED SSB—Output varies linearly with input over signal range of 0 to 4.5 v. Undesired sideband is suppressed 26 db at balance.—A. C. Todd, R. P. Schuck, and H. M. Sachs, Using Voltage-Variable Capacitors in Modulator Design, *Electronics*, 34:3, p 56–59.



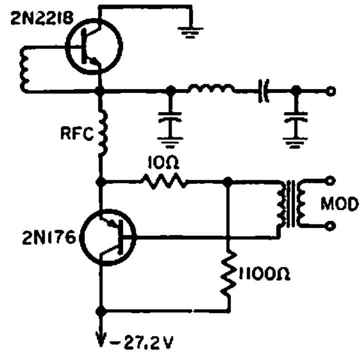
TRANSFORMER-COUPLED COLLECTOR-MODULATED TRANSMITTER—Widely used in a-m citizen's band (27-mc) transmitters. Modulation amplifier should be adjusted for clipping at 300-mw level, with passband from 300 to 3,000 cps. Input of 0.6 mv will provide rated output of 780 mw at 70 db gain. Large modulation transformer is required.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.



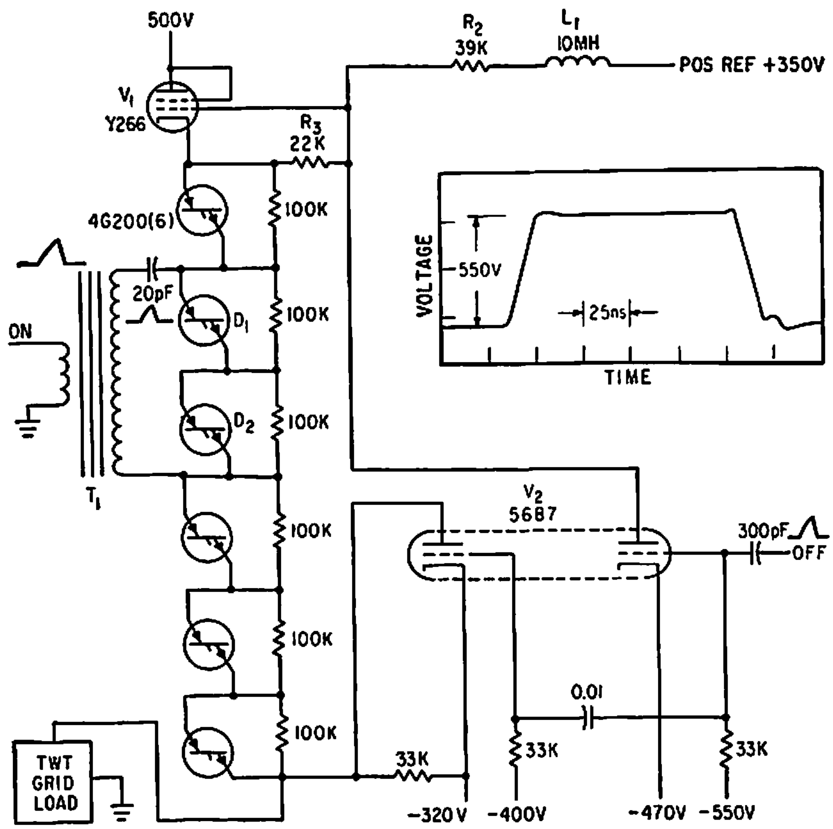
TRANSISTOR-DIODE PULSE MODULATOR—Four-layer diodes used in series give rise times faster than turn-on times of transistors, for pulse modulation of traveling-wave tubes and other devices at repetition rates up to 100 kc, with 5-microsec pulses and 3-microsec pulse spacings.—E. H. Hockman, Three New Approaches to Pulse Modulation, *Electronics*, 36:18, p 62–64.



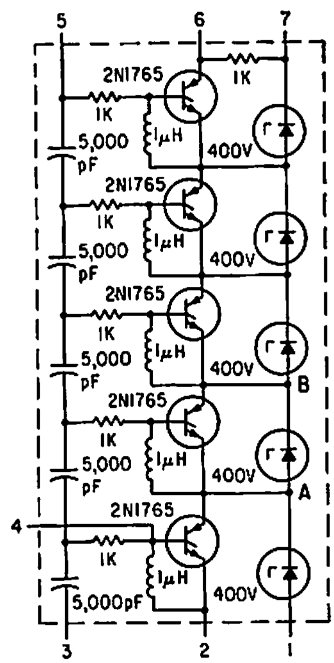
F-M/P-M—Angle modulator gives phase modulation below 500 cps and frequency modulation above. Voltage-variable capacitor HC-7005 gives phase angle change of up to 25° at 1 Mc.—A. C. Todd, P. Schuck, and H. M. Sachs, Using Voltage-Variable Capacitors in Modulator Design, *Electronics*, 34:3, p 56–59.



TRANSFORMER-COUPLED SERIES D-C MODULATION—Eliminates need for bulky modulation transformer and reduces envelope distortion when used in 27-Mc CB transmitter. Modulation power required is 0.35 mw. Chief disadvantage is that voltage source must be twice that of conventional collector-modulated transmitter.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.

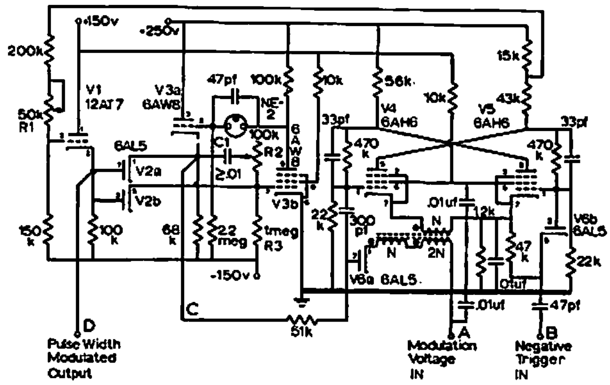


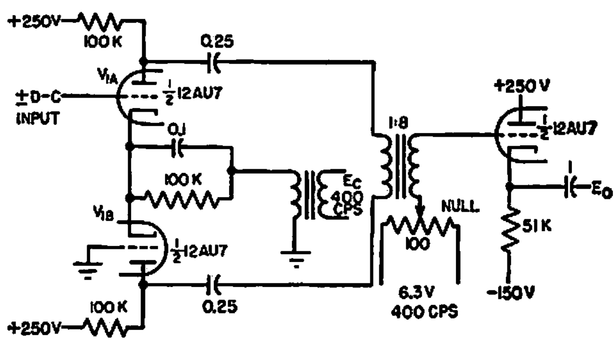
HYBRID DIODE-TUBE PULSE MODULATOR—Closely spaced pulses of any length, with 15-nsec rise and fall times at 550 v and 1.4 amp are produced for modulating traveling-wave tube by combining fast response of four-layer diodes with current-handling capabilities of tubes.—E. H. Hockman, Three New Approaches to Pulse Modulation, *Electronics*, 36:18, p 62–64.



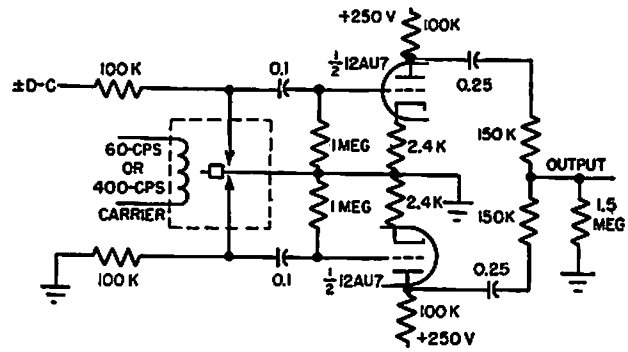
2-KV MODULE OF MAGNETRON MODULATOR
With terminal 6 at +2,000 v, voltage-regulator diodes maintain 400 v across each pnpn transistor. Lowest transistor receives 0.5-amp, 3-v trigger at its gate.—F. A. Gateka and M. L. Embree, Semiconductor Modulators for Modern Magnetrons, *Electronics*, 35:37, p 42–45.

LINEAR PWM FOR 0.5 TO 175 V—Tubes V4 and V5 form bistable mvbr that will accept modulation voltage range of 350:1, from 0.5 v to 175 v, at point A. V3 is Miller integrator. With 0.05 mfd for C1, pulse lengths are 61 and 173 millisec for limits of modulation voltage. Linearity is nearly perfect.—J. E. Frecker, A Pulse Width Modulator, *EEE*, 10:12, p 28–30.

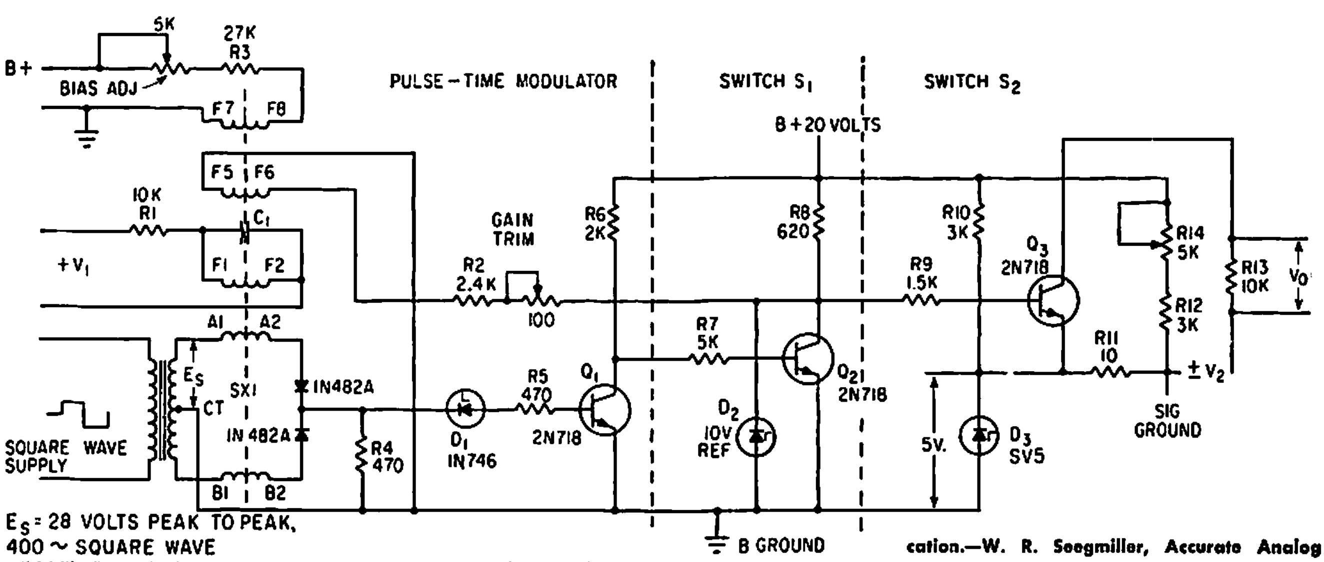




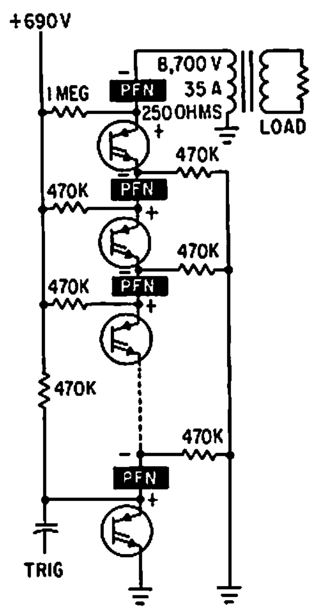
BALANCED-TRIODE SINE-WAVE MODULATOR—Gives sinusoidal output without filtering. Can be used for either open-loop or error-signal modulation when high input impedance and low-distortion sinusoidal output are required. Long-term drift stability is less than 1 mv per hour referred to output.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



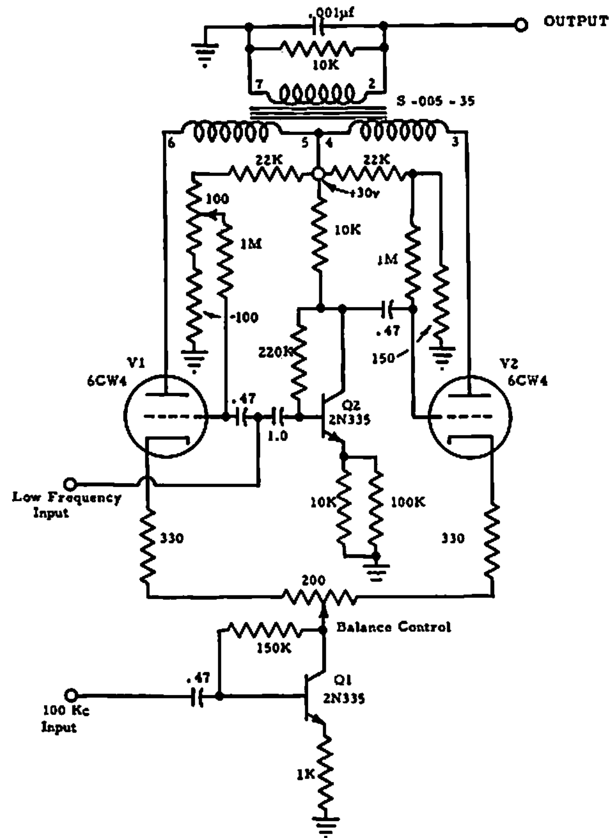
CHOPPER MODULATOR—Reduces output signal null level by balancing out zero input signal. Null levels can be maintained in microvolt region by proper shielding. Long-time drift stability is less than 1 mv referred to output. Used with strain gage and other low-level transducer signals.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



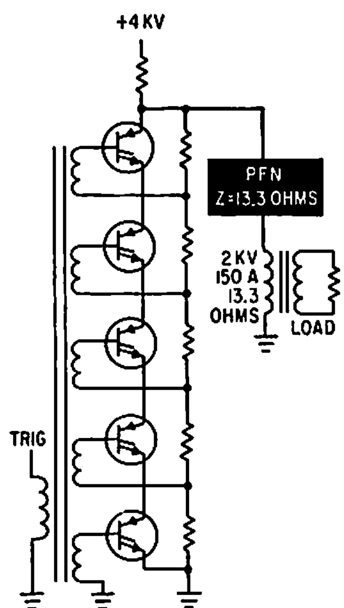
PULSE-TIME MODULATOR USES TWO-QUADRANT MULTIPLIER—Output transistor Q3 serves as series switch driven by Q2 and magnetic modulator to give accurate analog multiplication.—W. R. Seegmiller, Accurate Analog Computation with Pulse-Time Modulation, *Electronics*, 35:13, p 54–57.



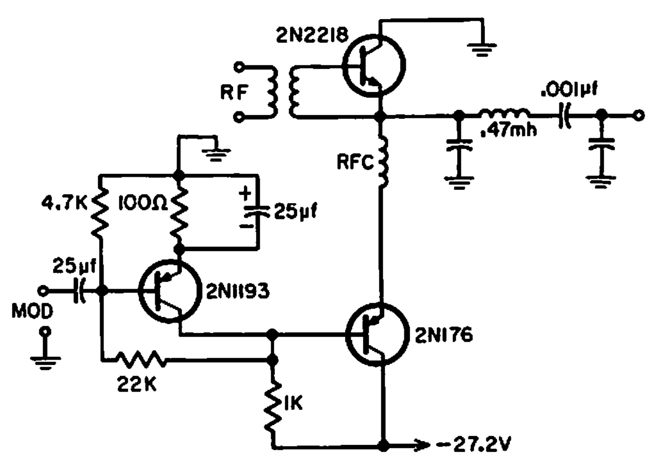
SERIES-DIODE MAGNETRON MODULATOR—In variation of spark-gap modulator, 25 pnpn diodes in series with pulse-forming networks (PFN) are switched by trigger and resulting voltage transient to supply 8,700 v at 35 amp to load. Success depends on availability of 700-v diodes.—F. A. Gateka and M. L. Embree, Semiconductor Modulators for Modern Magnetrons, *Electronics*, 35:37, p 42–45.



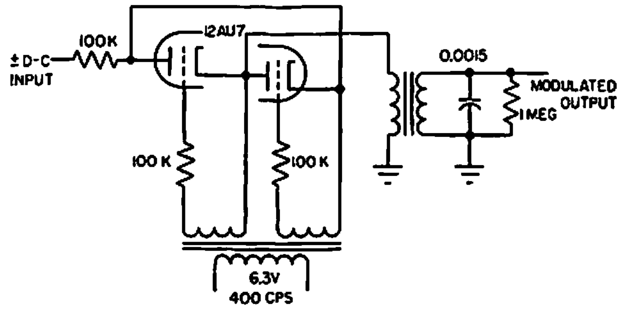
100-KC HYBRID BALANCED MODULATOR—Circuit is essentially balanced bridge, with carrier injected by Q1. Balance is maintained by balance control and by bias adjustment on V1. Modulation is achieved by unbalancing bridge in accordance with low-frequency input signal, using phase invertor Q2 to make both tubes unbalance bridge in same direction.—J. Chirnitch, Hybrid Balanced Modulator for 100 Kc, *EEE*, 10:10, p 30.



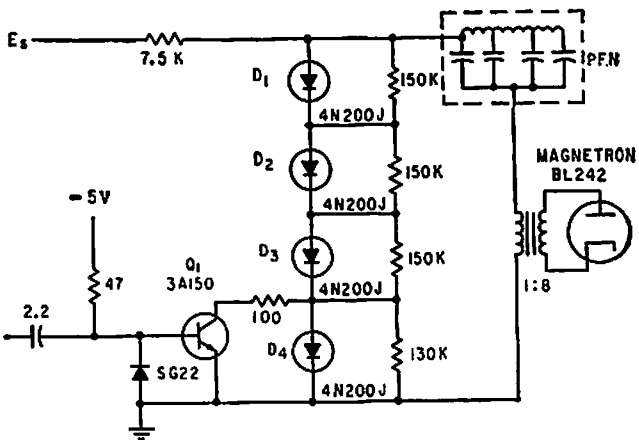
TRANSFORMER-TRIGGERED MAGNETRON MODULATOR—Success of circuit depends on availability of five pnpn transistors with breakover voltages of at least 800 v, in order to deliver 300-kw pulses to load through pulse-forming network PFN.—F. A. Gateka and M. L. Embree, Semiconductor Modulators for Modern Magnetrons, *Electronics*, 35:37, p 42–45.



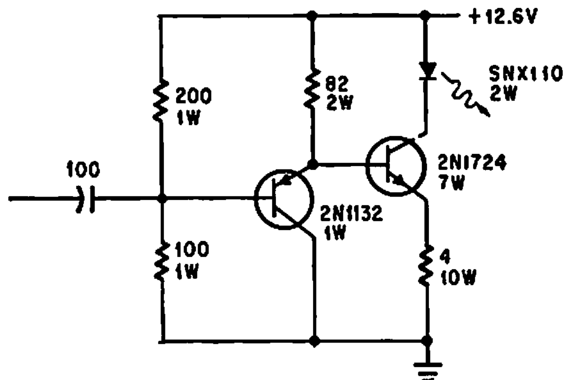
TRANSFORMERLESS-COLLECTOR MODULATOR—Provides 950 mw modulated power for CB transmitter, but 100% modulation can be reached only by using double modulation.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.



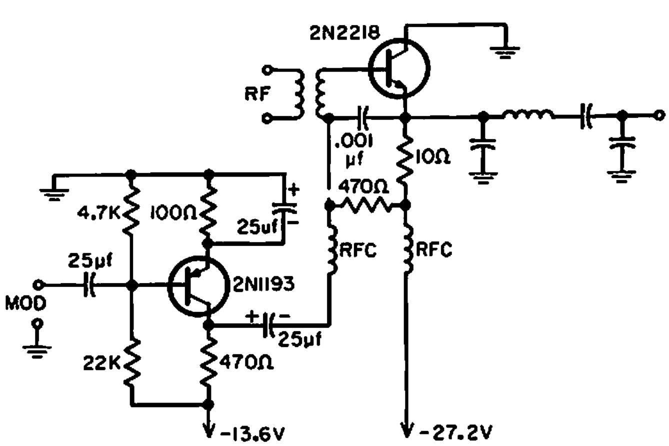
TRIODE CLAMP MODULATOR—Dual-triode performs chopper function. With 6.3 v rms carrier, output is linear to 2 v rms for d-c inputs up to 25 v. Null level is 100 mv, but can be reduced by filtering. Long-time drift stability is excellent. Output signal is normally square-wave, but tuned circuit shown converts this to sinusoidal signal.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



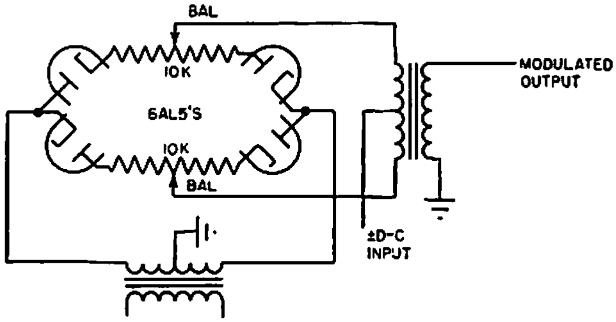
MAGNETRON MODULATOR—Uses four Shockley diodes in series, triggered by avalanche triode transistor, to give action similar to that of conventional line-type pulser using hydrogen thyratron, but requires no heater power or warmup.—L. Diven, Solid-State Modulator Feeds Subminiature Transponder, *Electronics*, 33:27, p 48–51.



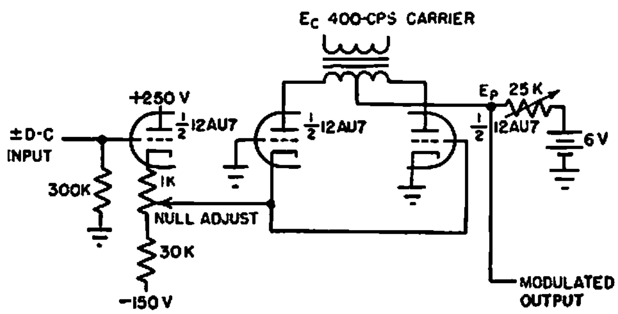
TWO-TRANSISTOR MODULATOR FOR LIGHT-EMITTING DIODE—Linear range of 80% modulation for bandwidth of 30 cps to 250 kc, with only 3% distortion at 1 kc, permits good voice transmission over light beams generated by SNX110 light-emitting diode. —E. L. Bonin, Drivers for Optical Diodes, *Electronics*, 37:22, p 77–82.



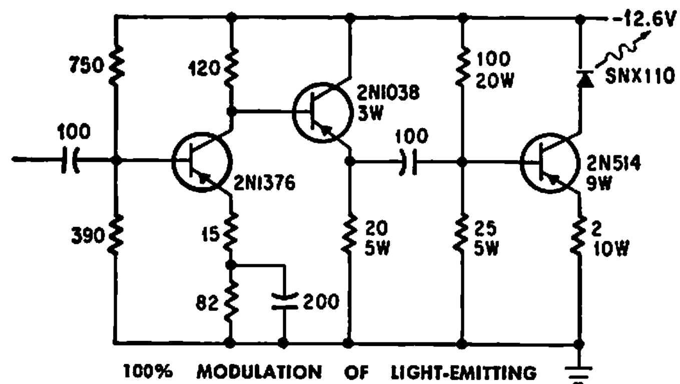
TRANSFORMERLESS BASE MODULATOR—Requires only one audio transistor, and readily provides 100% modulation. Modulated output power is 660 mw for CB transmitter. Audio quality is excellent.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.



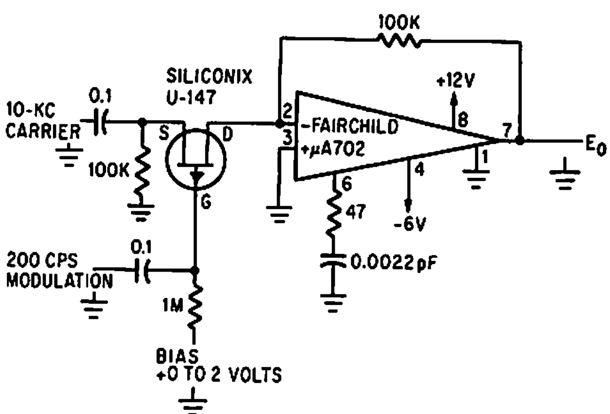
RING MODULATOR—Can be operated with either input or output ungrounded. With 100-v rms carrier and d-c input of 30 v, output is linear up to 0.2 v rms. Null level is less than 1 mv, but drift stability is poor and balance is critical. Used in applications where modulation of error signal is required.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



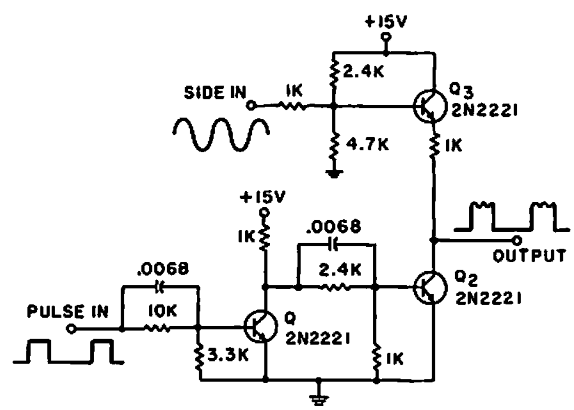
VARIABLE PLATE RESISTANCE MODULATOR—Increasing magnitude of carrier voltage increases modulated output. Used in amplification of d-c signals for automatic control systems.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



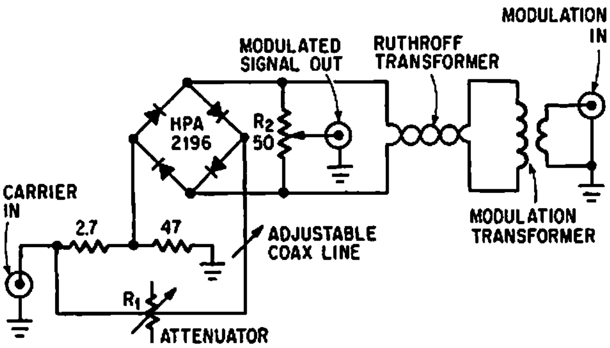
100% MODULATION OF LIGHT-EMITTING DIODE—Inpt of 0.35 v rms at 1 kc gives 100% modulation. Useful operating range of circuit is 30 cps to 25 kc for light-beam communication.—E. L. Bonin, Drivers for Optical Diodes, *Electronics*, 37:22, p 77–82.



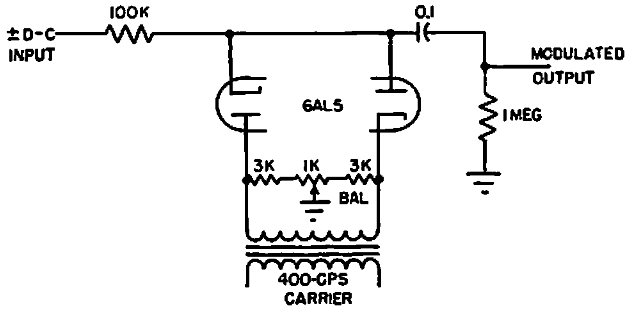
TRANSFORMERLESS LINEAR MODULATOR—Integrated-circuit operational amplifier and field effect transistor in single-ended linear configuration eliminate need for filter and transformer. Carrier level is adjusted by changing d-c bias, which sets gate midway between zero bias and pinchoff.—J. Althouse, Linear Amplifier Circuit Eliminates Transformers, *Electronics*, 39:6, p 99.



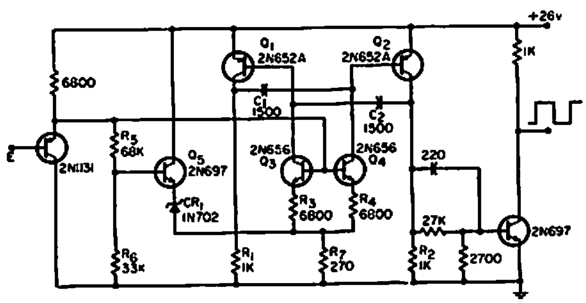
PULSE TRAIN AMPLITUDE MODULATOR—Provides amplitude modulation of pulse train with audio signal or other input, such as noise, over range of 0 to 200 kc with input pulses over 1 microsec wide. 80% modulation is available up to 3 kc, decreasing to 30% at input of 200 kc.—J. F. McCormick, Jr., Pulse Amplitude Modulator, *EEE*, 13:7, p 44.



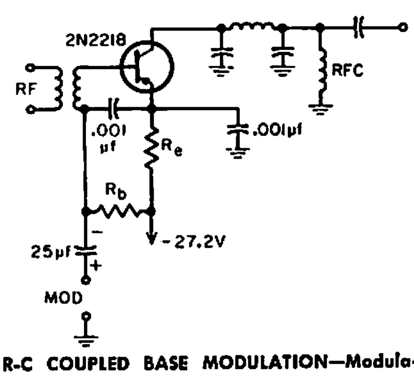
BALANCED MODULATOR-DEMODULATOR—Achieves high carrier and modulation suppression by using closely matched diodes and providing R1 for amplitude adjustment and coaxial line for phase adjustment. R2 provides slight amplitude adjustment.—W. H. Ellis, Diode Quad Modulator Suppresses Carrier 65 Db, *Electronics*, 39:8, p 97.



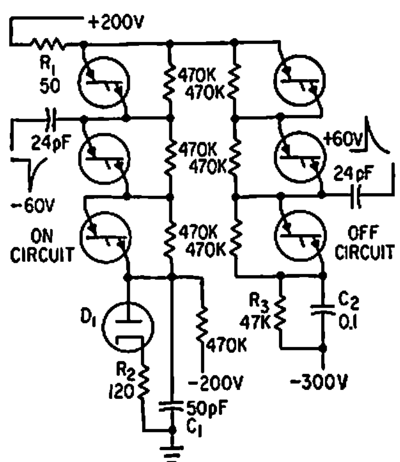
DUO-DIODE HALF-WAVE SWITCH MODULATOR—Tube serves in place of chopper. Carrier voltage turns diodes on and off, transferring d-c input signal to output when diodes are not conducting. With 10-v rms carrier voltage, output is linear up to 2 v for inputs up to 5 v d-c.—L. S. Klivans, Modulators for Automatic Control Systems, *Electronics*, 31:1, p 82–84.



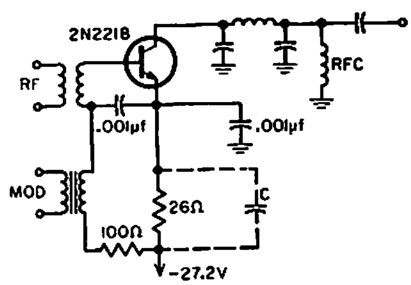
LINEAR F-M MODULATOR—Adding emitter-followers to astable mvbr makes output frequency linear function (within 0.01%) of input voltage for 50% modulation above and below center frequency.—G. Richwell, Linear FM Modulator, *EEE*, 12:10, p 59–60.



R-C COUPLED BASE MODULATION—Modulation signal is injected by using two resistors, values of which are determined by available r-f drive power; higher power is needed for larger resistance values. Excellent linearization of waveform is obtained with Re from 10 to 30 ohms. Rb should be in range from 100 to 2,000 ohms, with 470 as good compromise value. Modulation of 100% is easily achieved for CB transmitter.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.

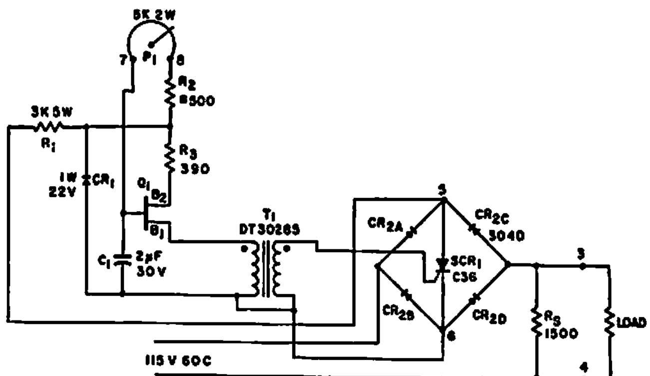


SERIES-RESISTOR PULSE MODULATOR—Four-layer diodes with series resistors reduce 350-v, 1-amp pulses to modulate twt and for other applications requiring fast-rise, variable-width, high-current flat-top pulses at repetition rates up to 200 pps.—E. H. Heckman, Three New Approaches to Pulse Modulation, *Electronics*, 36:18, p 62–64.

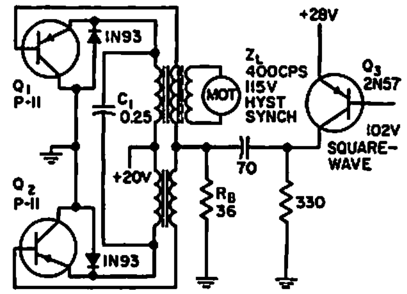


TRANSFORMER-COUPLED BASE MODULATION—Modulation is in series with r-f signal, so transistor operates in common-emitter configuration for both r-f and audio. Waveform is good, but modulation power is only 0.7 mw into 900 ohms when audio bypass C is used. Without bypass, modulation power is 1 mw into 200 ohms.—B. Rheinfelder, Modulation Techniques for Transistorized A-M Transmitters, *EEE*, 11:7, p 54–57.

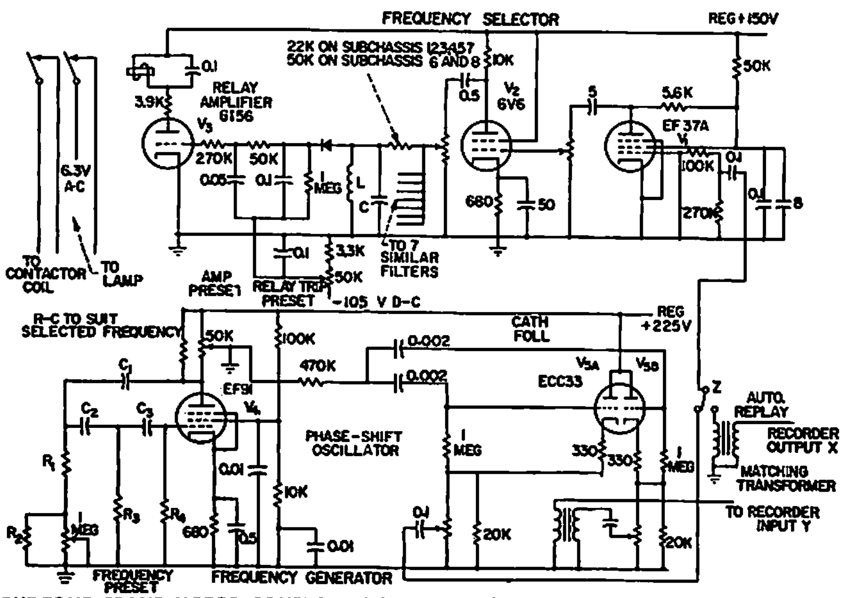
CHAPTER 52
Motor Control Circuits



FULL-WAVE CONTROL—Uses only one control rectifier and one single-ended trigger to obtain continuously variable a-c or d-c full-wave output. May be designed for any standard service power voltage. Trigger is always synchronized with power bridge because both obtain power from same source. Used to drive and adjust speed of single-phase induction motor, drive and adjust speed of universal motors in machine tools, and vary light output of high-power incandescent lamp.—Full-Wave Control with One Trigger and One Control Rectifier, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 187.

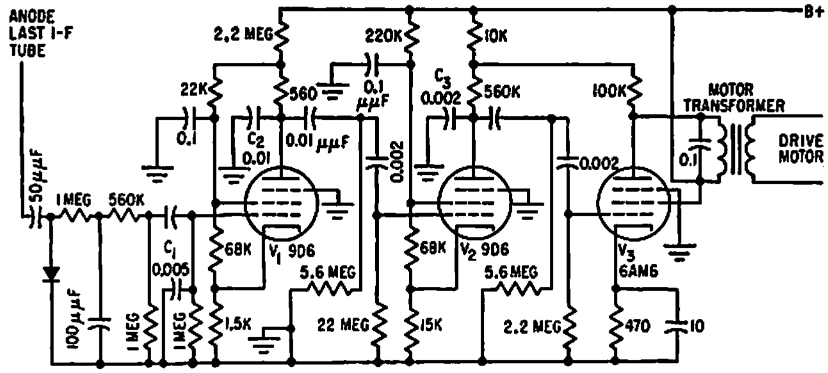


CONSTANT MOTOR SPEED—Precise control of instantaneous voltage and current for power transistors gives 90% operating efficiency in driving 400-cps synchronous motor of portable tape transport from 28 v d-c. Negative 800-cps synchronizing pulses from precision oscillator are applied to base of Q3 to produce positive pulses at bases of Q1 and Q2, cutting them off quickly.—J. W. Caldwell and T. C. G. Wagner, Boosting Power Transistor Efficiency, *Electronics*, 31:47, p 86–88.

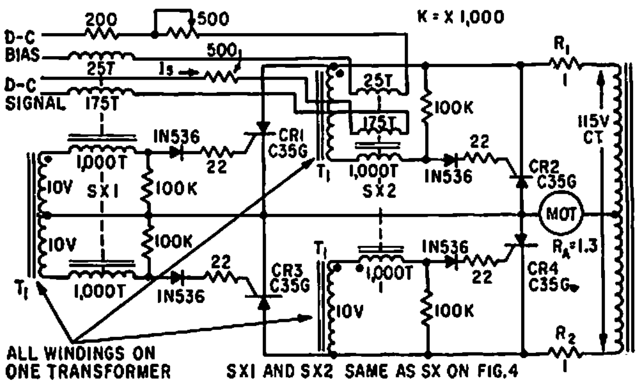


EIGHT-TONE CRANE MOTOR CONTROL—Eight preset frequencies or tones activate collector relays that operate crane motor contactors. Sequence of preselected operations, recorded on magnetic tape, is repeated by traveling crane during playback, to give positioning accuracies better than 1/8th inch. Table gives values of R-C network components in grid circuit of phase-shift oscillator to provide the eight tones.—G. V. Sadler, Taped Tones Control Overhead Crane, *Electronics*, 31:1, p 63–65.

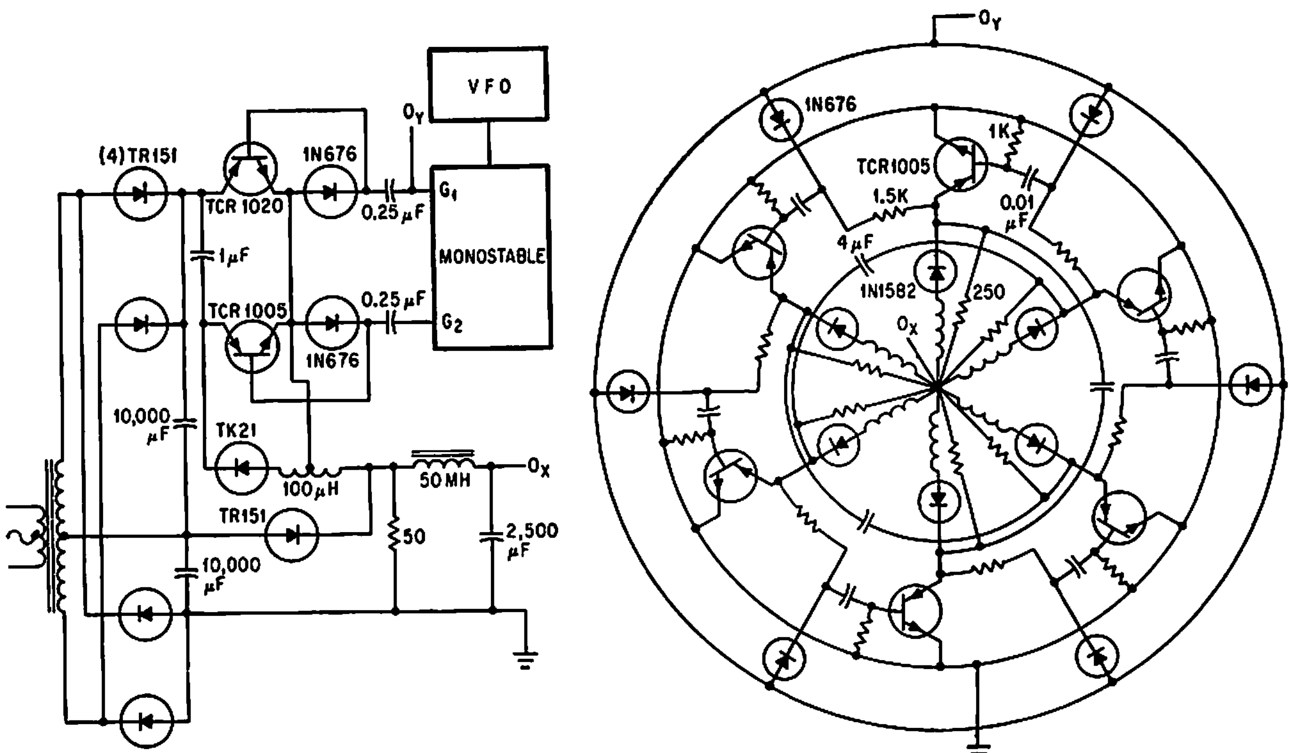
Chassis	Frequency	C_1	C_2	C_3	R_1	R_2	R_3	R_4
No	in cps	in $\mu\mu f$			×1,000 ohms			
1	270	460	460	390	135	270	560	1,000
2	1,600	220	220	100	135	100	270	270
3	450	390	303	270	195	560	560	1,000
4	2,600	127	100	68	135	100	270	270
5	700	460	290	330	135	270	270	270
6	3,800	68	68	78	100	100	270	270
7	1,080	330	270	270	100	270	270	270
8	4,500	100	68	25	100	47	270	270



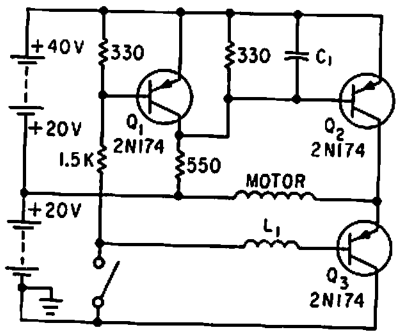
GONIOMETER MOTOR AMPLIFIER—Portion of adf receiver output is separately rectified and applied to selective amplifier V1-V2-V3. C1, C2, and C3 develop 90° phase shift required between two coils of goniometer drive motor and serve also as low-pass filter with sharp cutoff above 150 cps. Overall gain is high enough so motor will exert full torque when goniometer is only 3° off true null.—J. F. Hatch and D. W. G. Byatt, Direction Finder with Automatic Readout. *Electronics*, 32:16, p 62–64.



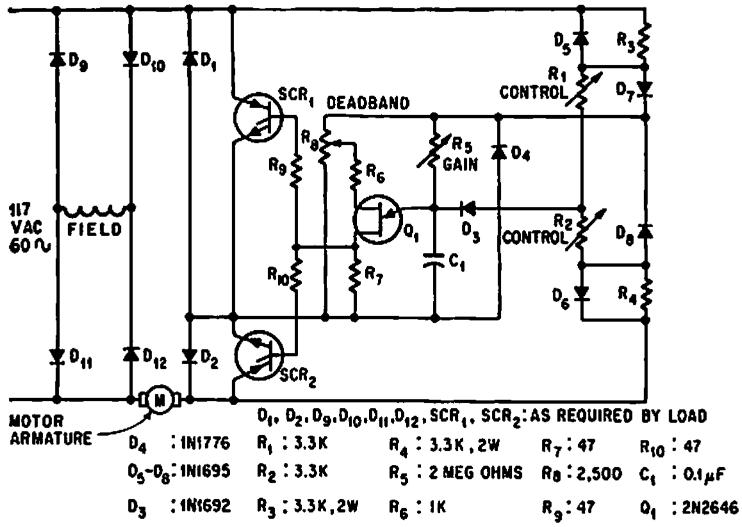
FULL-WAVE DRIVE FOR D-C MOTOR—Requires four controlled rectifiers and center-tapped transformer. Four magnetic cores are required for full-wave push-pull action.—W. R. Seegmiller, Controlled Rectifiers Drive A-C and D-C Motors, *Electronics*, 32:46, p 73–75.



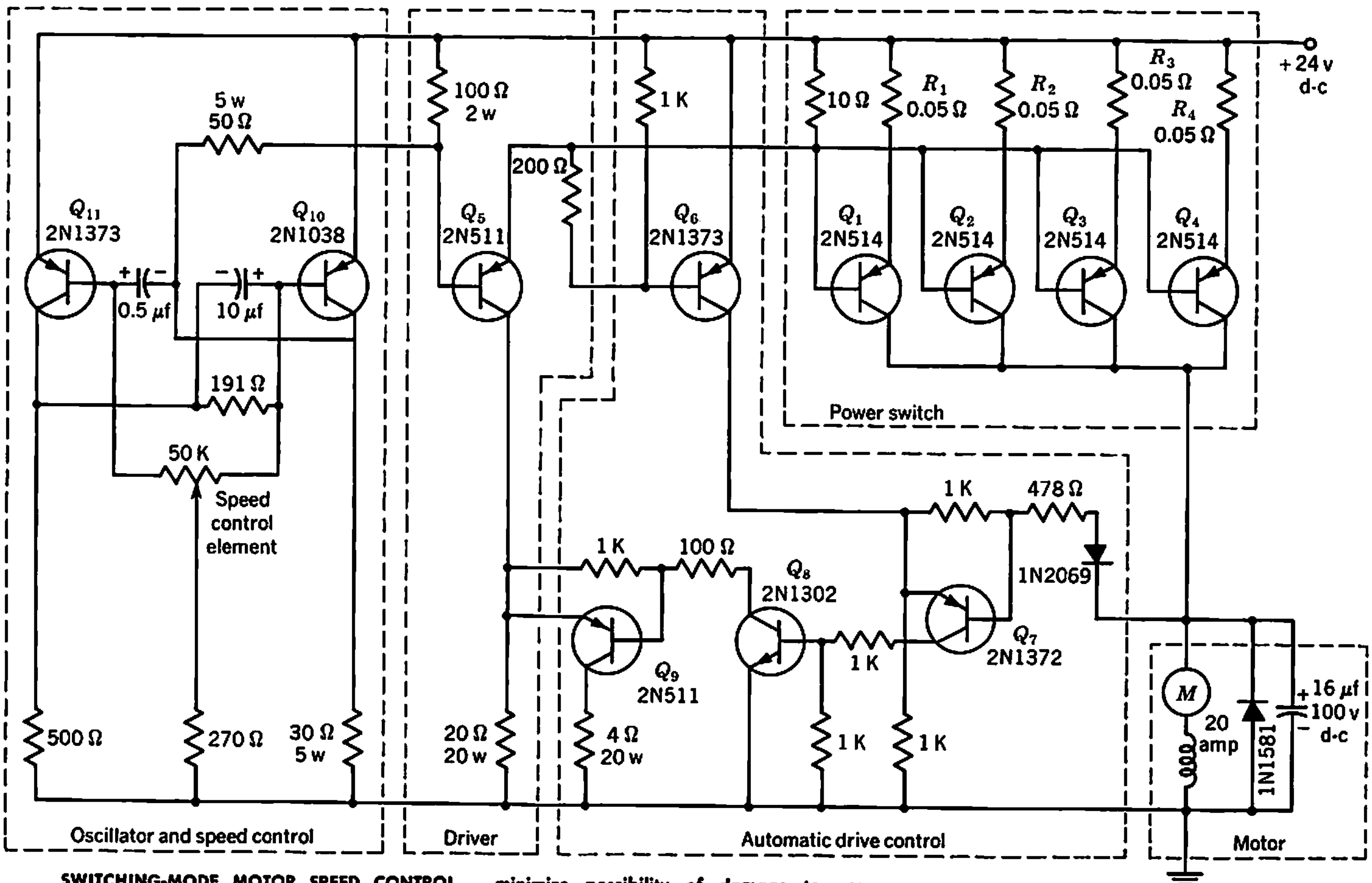
SCR RING COUNTER DRIVES HYSTERESIS MOTOR—Speed range of 1,200 to 18,000 rpm is obtained with 400-cps, six-pole fractional-hp hysteresis motor by modifying scr ring counter to work in switching mode. Series rectifiers prevent spurious modes during commutation. Output OX of circuit at left goes to center of circular configuration, and OY goes to outer circle.—R. H. Murphy, Static Alternator Controls Three-Phase Motor, *Electronics*, 37:5, p 30–33.



TWO-SOURCE CONTROL—Acts as bidirectional current switch that selects one of two oppositely polarized current sources for d-c motor of gyro or accelerometer. Switch is operated by opposing forces of motor torsion and acceleration. Motor torsion opens switch, reducing speed and therefore torsion of motor, and acceleration forces then close switch. Shaft speed is therefore proportional to acceleration.—F. W. Kear, D-C Motor Controls Improve System Accuracy, *Electronics*, 33:41, p 76.

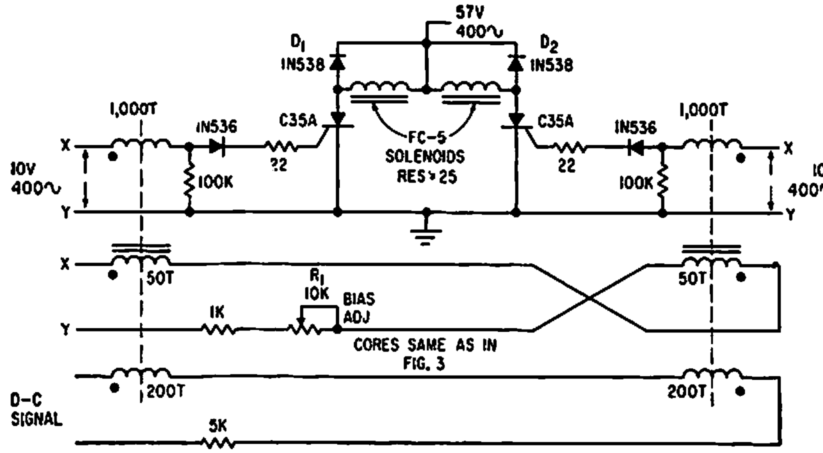


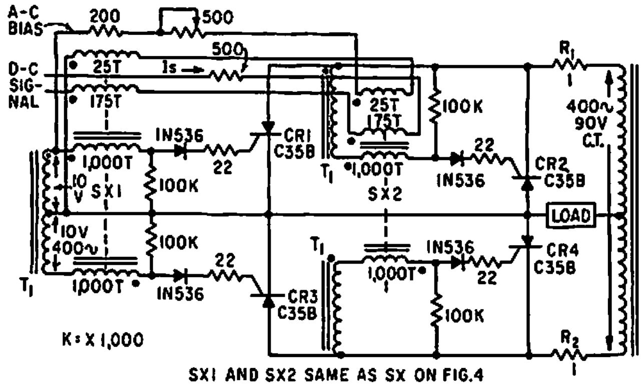
REVERSING DRIVE FOR SHUNT-WOUND MOTOR—Silicon controlled rectifiers in half-wave circuit act with unijunction transistor and two rheostats to adjust speed in either direction.—J. C. Hey, The Widening World of the SCR, *Electronics*, 37:25, p 78–85.



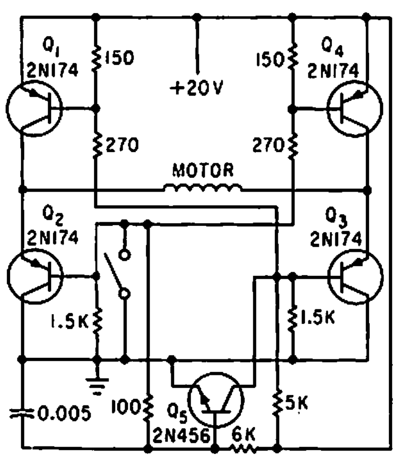
SWITCHING-MODE MOTOR SPEED CONTROL—Power-switch stage consists of four 2N514 transistors in parallel, to handle starting or stalled motor current approaching 100 amp. Rectifier and capacitor in parallel with motor minimize possibility of damage to power transistors when they switch off heavily inductive motor load. Variation of time duration of on and off portions of power transistor cycle, controlled by 50K potentiometer in mvbr, provides control of motor speed while giving high starting torque.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 477.

SERIES ACTUATOR SOLENOID DRIVE—Consists of controlled rectifier in series with each solenoid, and saturable magnetic core firing circuit. Each magnetic core has two control windings, one for adjustment and one for signal. Can also be used to drive d-c split-series motors. Windings of motor then replace solenoids.—W. R. Seegmiller, Controlled Rectifiers Drive A-C and D-C Motors, *Electronics*, 32:46, p 73–75.

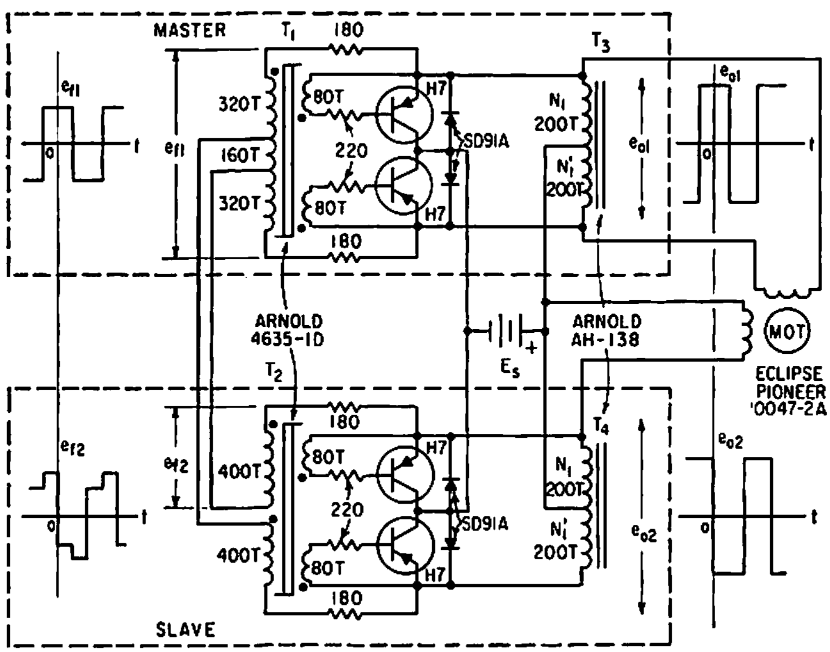




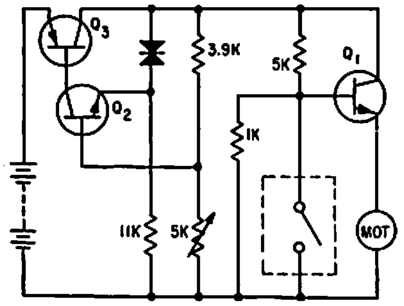
FULL-WAVE PUSH-PULL FOR A-C SERVOMOTOR—Circuit is identical to full-wave push-pull d-c shunt motor drive except for different arrangement of firing circuit. Limiting resistors R1 and R2 determine standby current.—W. R. Seegmiller, Controlled Rectifiers Drive A-C and D-C Motors, *Electronics*, 32:46, p 73–75.



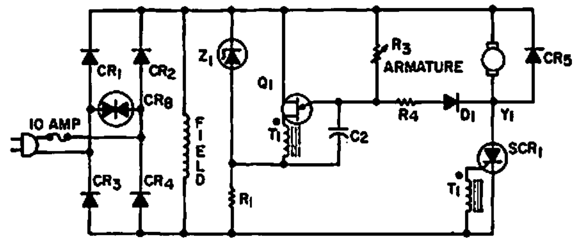
ONE-SOURCE CONTROL—Q5 determines direction of current flow through motor winding, which in turn depends on position of motor control switch. Motor torsion opens switch, and acceleration during slowdown closes switch, to make motor speed proportional to acceleration.—F. W. Kear, D-C Motor Controls Improve System Accuracy, *Electronics*, 33:41, p 76.



TWO-PHASE INDUCTION MOTOR DRIVE—Transistors used as controlled switches in inverter provide two-phase square-wave output from single d-c source. May also be used with hysteresis-synchronous motors to provide speed under load.—W. H. Card, Four Transistor Inverter Drives Induction Motor, *Electronics*, 32:8, p 60–61.



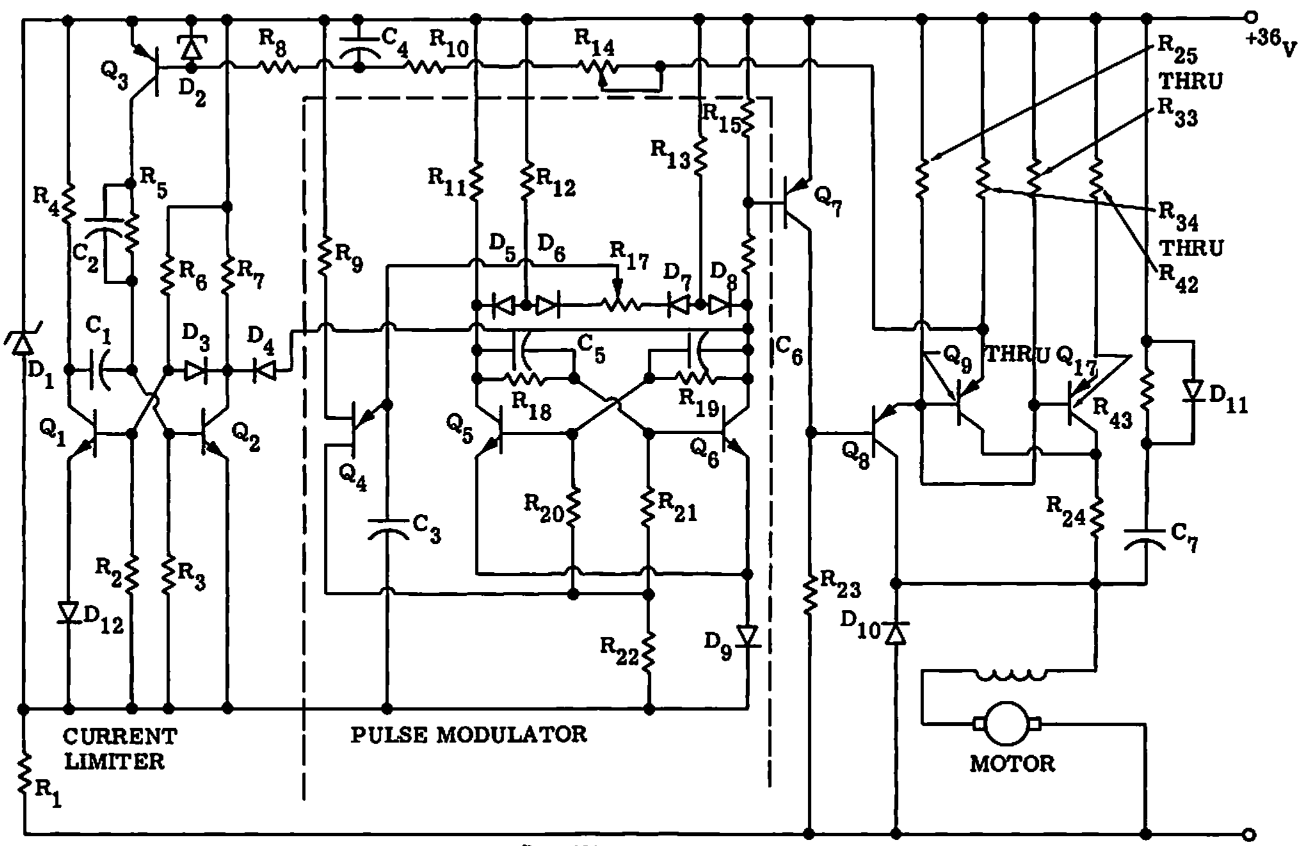
ACCELERATION-SENSING SWITCH—Sensing switch controls Q1, which provides power for accelerometer motor. Q2 and Q3 provide damping by current limiting, to increase accuracy by one order of magnitude.—F. W. Kear, Dynamic Fluid Switch Senses Acceleration, *Electronics*, 34:38, p 64–67.



R_1 – 4.7K, 10%
R_3 – 100K VARIABLE-SPEED CONTROL
R_4 – 100K, 1/2W, 10%
C_2 – 0.5µf, 50V
D_1 – G.E. 1N536
Z_1 – 25V ZENER DIODE, 1W
T_1 – PULSE TRANSFORMER, SPRAGUE 93Z20 OR EQUIVALENT

CR_1–CR_5 GE A40B
SCR_1–GE C35B
Q_1 –GE 2N2646
CR_8–GE 6RS21SA5D5 THYRECTOR (OPTIONAL–TRANSIENT PROTECTION)

FULL-WAVE SPEED REGULATOR—Features closed-loop feedback armature control to regulate speed of 0.5-hp shunt-wound d-c motor over 6:1 range.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 145.

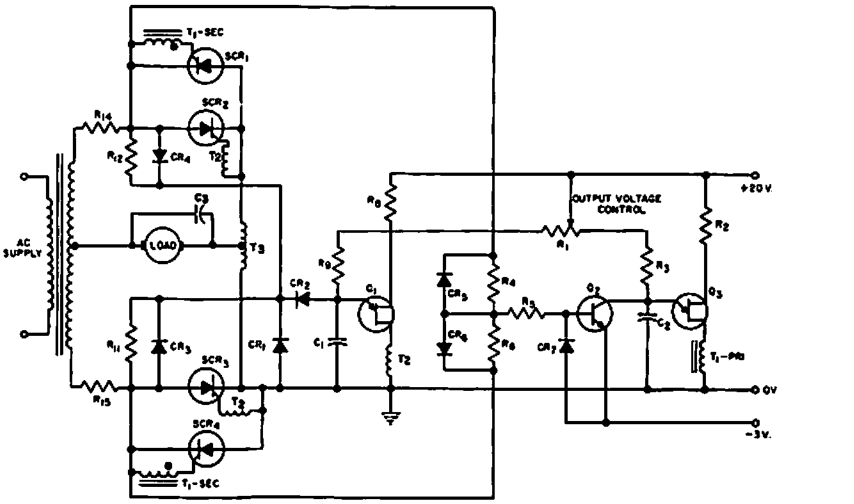


C_1 - 0.6
C_2 - 0.03
C_3 - 0.1
C_4 - 1.0
C_5 - 2200 µµF
C_6 - 470 µµF
C_7 - 1000 50V

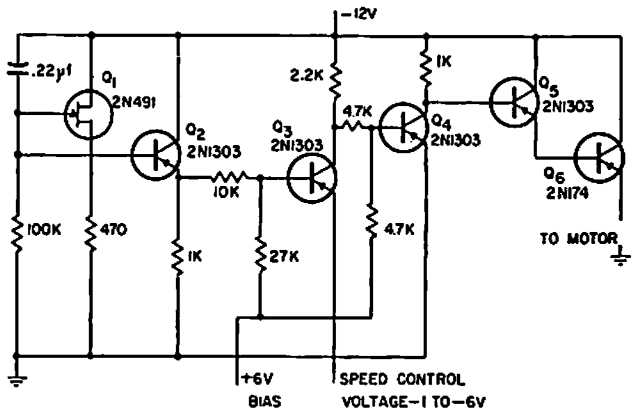
R_1 - 100 Ω. 10 W
R_2, R_4 - 5.1K
R_3 - 2.7 K
R_5 - 2 K
R_6 - 51K
R_7, R_{12}, R_{13}, R_{21} - 10 K
R_8 - 20 Ω
R_9 - 470 Ω
R_{10} - 51 Ω
R_{11} - 2.4 K
R_{14} - 100 Ω POT
R_{15}, R_{22} - 100 Ω
R_{16} - 510 Ω
R_{17} - 100 K POT
R_{18} - 6.8 K
R_{19} - 27 K
R_{20} - 39 K
R_{23} - 120 Ω, 20 W
R_{24} - 0.004 Ω, 50 W
R_{25} Thru R_{33} - 12 Ω
R_{34} Thru R_{42} - 0.03 Ω. 10 W
R_{43} - 0.5 Ω, 50 W
D_1 - IN2976
D_2 - 1N3128
D_3 Thru D_9 - 1N4001
D_{10}, D_{11} - MR1210
D_{12} - 1N4001
Q_1, Q_2, Q_5. Q6 - 2N2218
Q_3 - 2N1187
Q_4 - 2N2160
Q_7 - 2N1188
Q_8 - 2N1559
Q_9 Thru Q_{17} - MP506

GOLF CART TRACTION DRIVE—Pulse-width-modulating series motor control was designed to operate motor in Cushman golf cart from 36-v battery supply. Provides 200 amp for climbing steep inclines and up to 300 amp for starting. Eight MP506 transistors in parallel are used to switch peak motor load. Speed is changed by varying width of pulse that is applied to motor at constant rate, to vary average motor voltage.—H. F. Weber, "Solid-State DC Motor Control for Traction Drive Vehicles," Motorola Application Note AN-189, Mar. 1966.

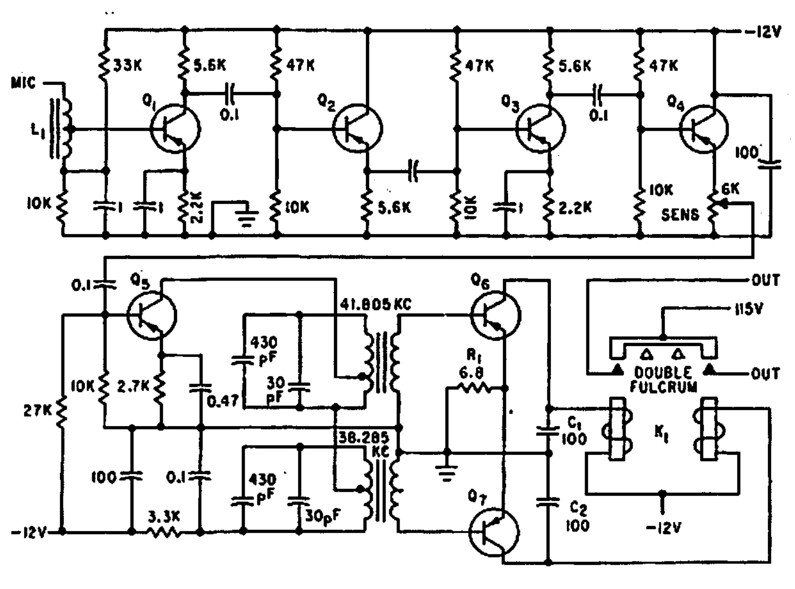
FULL-WAVE REVERSING D-C MOTOR DRIVE—Designed around two scr's with common cathode (SCR2 and SCR3) and two more with common anodes (SCR1 and SCR4). If load is d-c motor, plugging action occurs if R1 is reversed suddenly. R14 and R15 limit fault current if voltage transient should fire odd or even-numbered pair simultaneously.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 141.



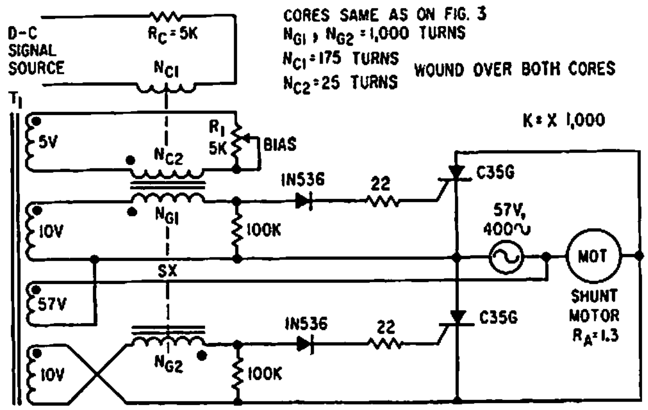
R_1—100K LINEAR POT
R_2,R_8—470 OHMS, 1/2 WATT
R_3,R_9—2700 OHMS, 1/2 WATT
R_4,R_6—10K, 2 WATTS
R_5—4700 OHMS, 1/2 WATT
R_{11},R_{12}—2200 OHMS, 2 WATTS
R_{14},R_{15}—2 OHMS, 900 WATTS OR LESS, DEPENDING ON RATING OF LOAD
C_1,C_2—0.2 MFD
SCR_1,SCR_2,SCR_3,SCR_4—G-E SCR (VOLTAGE RATING DEPENDENT ON SECONDARY TRANSFORMER VOLTAGE)
$CR_1,CR_2,CR_3,CR_4,CR_5,CR_6$—G-E 1N1695
CR_7—G-E 1N1692
Q_1,Q_3—G-E 2N1671A
Q_2—G-E 2N335
T_1,T_2—PE 2231, UTC H51, OR EQUIVALENT
T_3, C_3 } AS REQUIRED BY LOAD



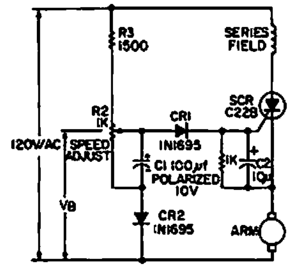
SMALL D-C MOTOR CONTROL—Will drive small permanent-magnet motor at speeds below 1 rpm up to full speed, in direct proportion to control voltage, without friction problems. Applies full voltage of 12 v to motor and provides speed regulation by interrupting voltage at about 50 cps and varying ratio of on time to off time.—Motor Speed Control, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 28.



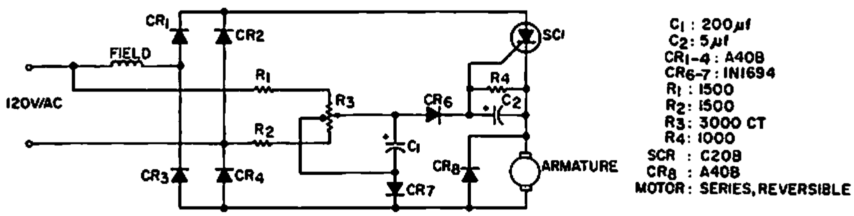
ULTRASONIC CONTROL RECEIVER—Five-stage amplifier Q1-5 amplifies both control signals, 38.285 kc and 41.805 kc, while Q6 and Q7 operate as class B detector-amplifiers to eliminate need for separate diode detectors. Desired control frequency energizes only one coil of double-fulcrum motor control relay, while noise acts on both coils and keeps relay balanced.—Transistor Amplifier Controls Remote Appliances, *Electronics*, 34:21, p 59.



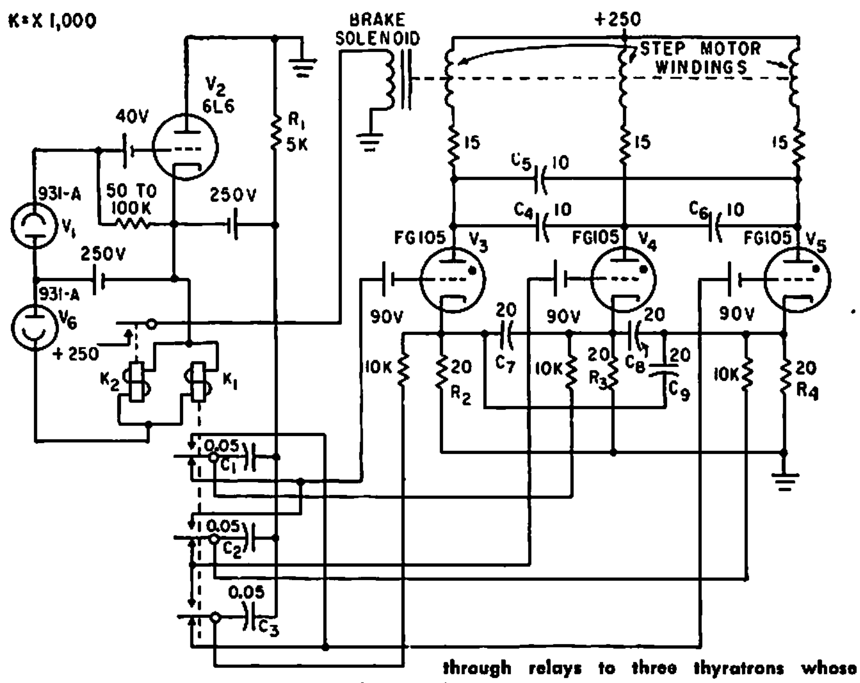
HALF-WAVE DRIVE FOR D-C MOTOR—Uses controlled rectifiers to control armature of d-c shunt motor or d-c torquer, for applications requiring push-pull output for reversible drive. Saturable reactor control windings are wound over both cores together. Maximum current during reversal from top speed in one direction to top speed in opposite direction is approximately 20 amp, with current dropping to 10 amp in 0.1 sec.—W. R. Seegmiller, Controlled Rectifiers Drive A-C and D-C Motors, *Electronics*, 32:46, p 73–75.



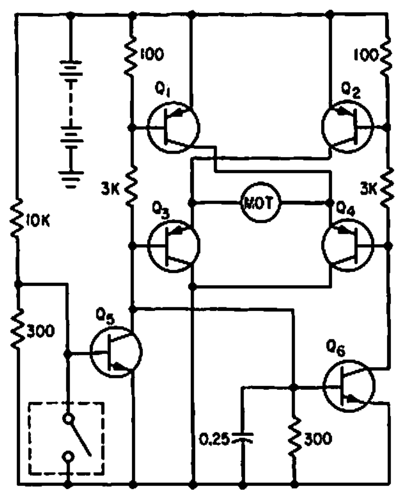
UNIVERSAL-MOTOR SPEED CONTROL—Regulated speed control is achieved by varying conduction angle of scr placed in series with armature and field of universal a-c/d-c motor. Makes use of motor residual field to induce counter emf in armature proportion to speed, for use as feedback signal. Provides stable operation at low speeds for sewing machines and small appliances.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 143.



REVERSIBLE HALF-WAVE SPEED CONTROL—Simple circuit is adequate for majority of universal series-wound motor drive applications. Direction of rotation depends on which half-cycle scr conducts, since series field is in a-c leg of bridge rectifier.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 144.

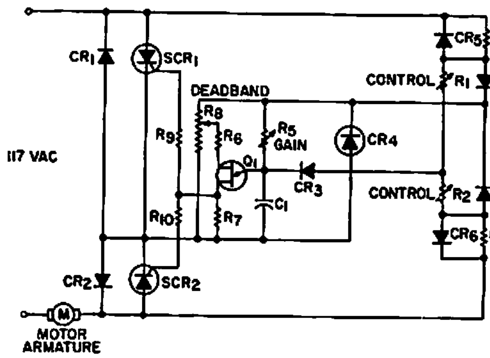


PUNCHED TAPE CONTROLS MOTOR—Phototubes sense holes punched in programmed tape and feed resulting command signals through relays to three thyratrons whose loads are windings of step motor for milling machine.—A. G. Thomas, Digital Control of Machine Tools, *Electronics*, 33:11, p 174–176.



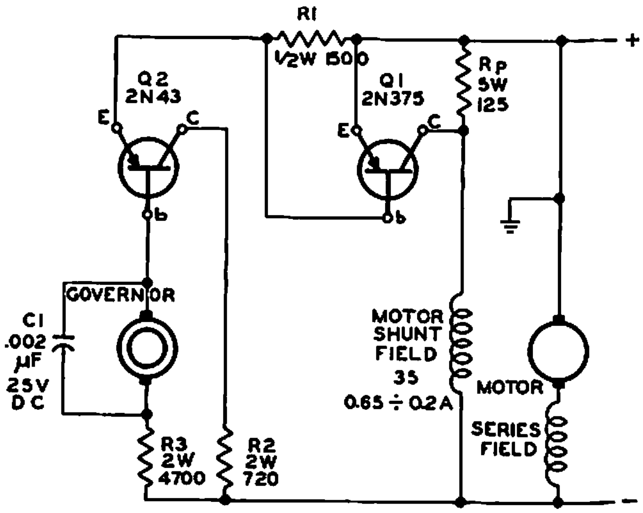
ACCELERATION-SENSING SWITCH WITHOUT OVERSHOOT—Provides null capture in indicated balance point for each level of acceleration, with bidirectional current switching for accelerometer motor.—F. W. Kear, Dynamic Fluid Switch Senses Acceleration, *Electronics*, 34:38, p 64–67.

BALANCED-BRIDGE REVERSING DRIVE—Phase-sensitive servo drive supplies reversible half-wave power to armature of small permanent magnet or to shunt motor. Power circuit consists of two half-wave circuits back-to-back (SCR1-CR1 and SCR2-CR2) fired by ujt Q1 on either positive or negative line half-cycle depending on direction of unbalance of reference bridge containing sensing element R1, which can be photoresistor, thermistor, potentiometer, or output from control amplifier.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 142.

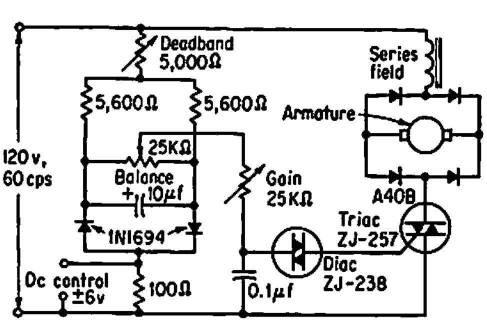


CR_1, CR_2, SCR_1, SCR_2 : AS REQUIRED BY LOAD

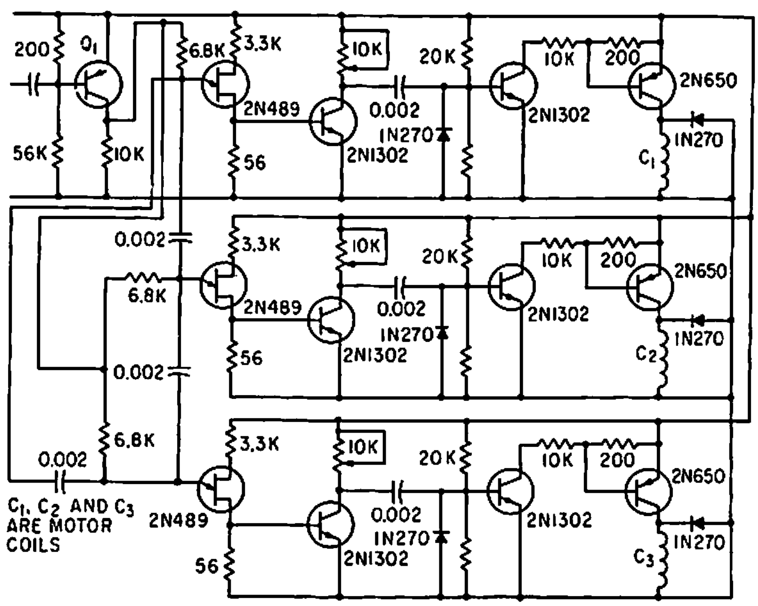
R_1 : 3.3K	R_6: 1K	C_1 : 0.1μf
R_2: 3.3K	R_7: 47Ω	Q_1 : 2N2646
R_3: 3.3K, 2W	R_8: 2500Ω	CR_4: 1N1776
R_4: 3.3K, 2W	R_9: 47Ω	CR_{5-8}: 1N1695
R_5: 2 MEGOHMS	R_{10}: 47Ω	CR_3: 1N1692



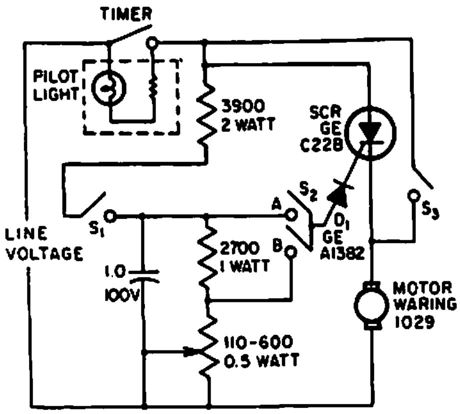
GOVERNOR-TRANSISTOR SPEED REGULATOR—Centrifugal governor is used as error detector, with contacts handling only a few microwatts. Two-transistor amplifier actuated by governor is connected across motor field resistor, with power being obtained from 24 v d-c motor bus. Maintains 0.5-hp motor speed at 6,000 rpm over input voltage range of 20 to 30 v.—Transistorized Speed Regulator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 30.



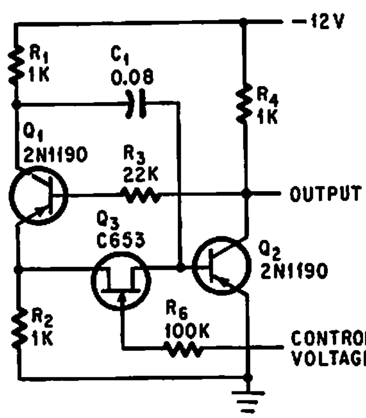
TRIAC-DIAC REVERSING SERVO CONTROL—Varies speed and direction of 5-amp reversible series a-c motor in accordance with d-c control signal. Polarity of control signal determines direction of rotation. Gain potentiometer adjusts slope of speed versus control voltage curve.—M. P. Southworth, Bidirectional Static Switch Simplifies Ac Control, *Control Engineering*, March 1964, p 75–76.



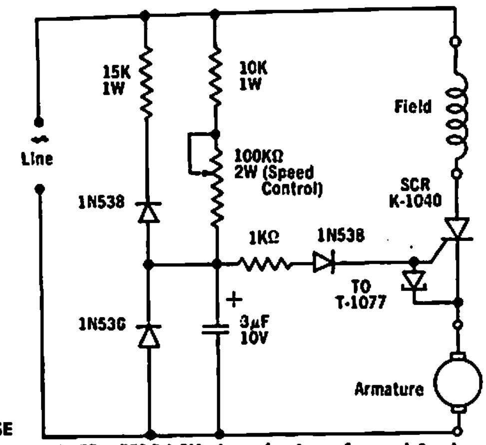
STEPPER-MOTOR PULSE GENERATOR—Unijunction ring counter energizes windings of stepper motor sequentially.—F. W. Kear, Digital Control Uses Unijunction Transistors, *Electronics*, 34:18, p 79–80.



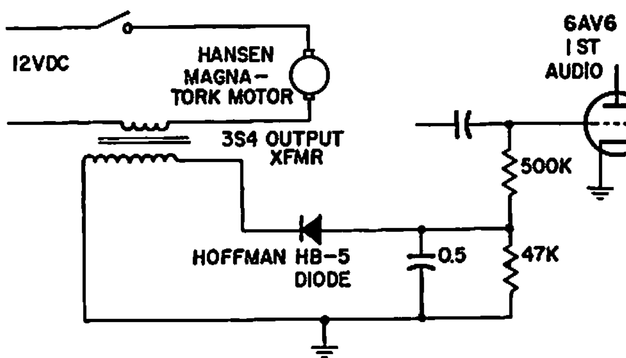
THREE-SPEED BLENDER CONTROL—Single scr safely handles 7.5-amp current of 1/2-hp motor. Feedback is used to change firing angle of scr as load increases, to maintain constant blending speed.—J. Eimbinder, SCRs In The Consumer Market, *EEE*, 14:8, p 100–103.



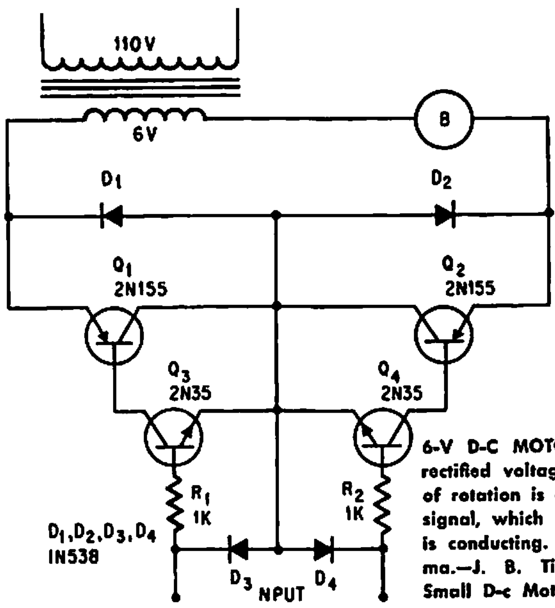
FIELD-EFFECT TRANSISTOR CONTROLS PULSE OSCILLATOR—C653 transistor serves as voltage-controlled nonlinear resistor that varies time constant of oscillator. Can generate narrow output pulses at rates up to several Mc, to drive stepping motor.—T. C. Ross, Field-effect Transistor Controls Pulse Oscillator, *Electronics*, 37:18, p 80–81.



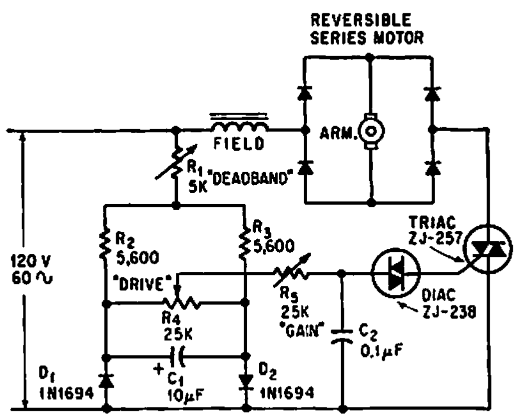
SPEED FEEDBACK—Introduction of speed feedback signal into firing circuit helps maintain constant torque regardless of speed. Tunnel diodes provide excellent stabilizing action at low speeds.—TD/SDR Combos for Sale, *EEE*, 12:3, p 62–64.



MOTOR NOISE ACTUATES MUTING SYSTEM—Noise pulses from commutator-type tuning motor in receiver are rectified and used to bias audio stage to cutoff for as long as tuning motor is running. Audio amplifier remains cut off for about 0.25 sec after motor stops.—Muting System for Motor-Tuned Receivers, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 51.

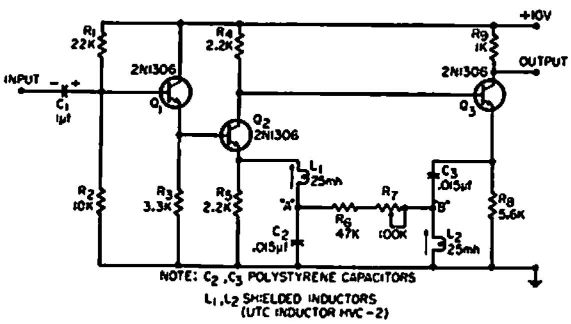


6-V D-C MOTOR—Motor B is energized by rectified voltage from transformer. Direction of rotation is controlled by polarity of input signal, which determines whether Q1 or Q2 is conducting. Motor draws several hundred ma.—J. B. Tiedemann, Transistors Control Small D-c Motor, *Electronics*, 39:7, p 93.

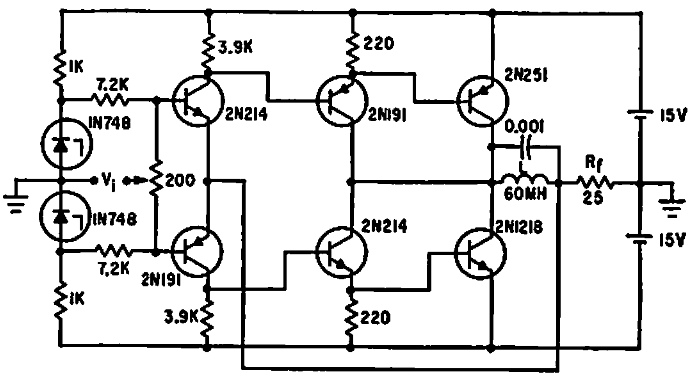


REVERSING DRIVE FOR SERIES D-C MOTOR—Triode and diode a-c switch components can be triggered into conducting in either direction by applying positive or negative gate current signal. Transducers can be used in place of potentiometer and rheostats to give automatic speed control.—J. C. Hey, The Widening World of the SCR, *Electronics*, 37:25, p 78–85.

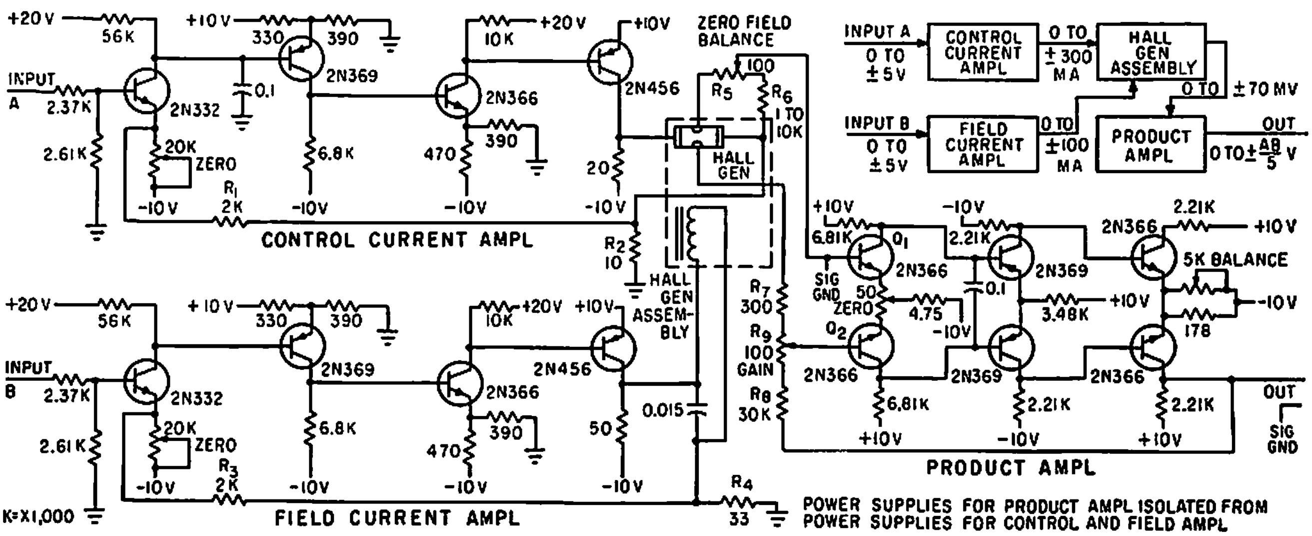
CHAPTER 53
Multiplier Circuits



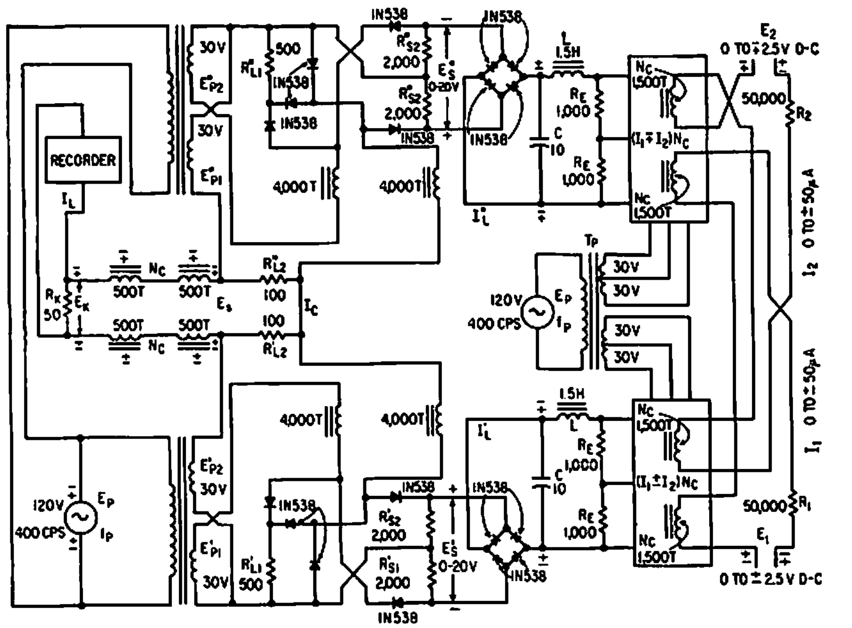
Q MULTIPLIER FOR TONE FILTER—Provides stable multiplication over wide temperature range, as required for high-selectivity single-frequency telemetry tone filter. Center frequency is 8 kc and bandwidth is 40 cps. Q is about 200.—W. New, Jr., Stable Q Multiplier, *EEE*, 13:4, p 41.



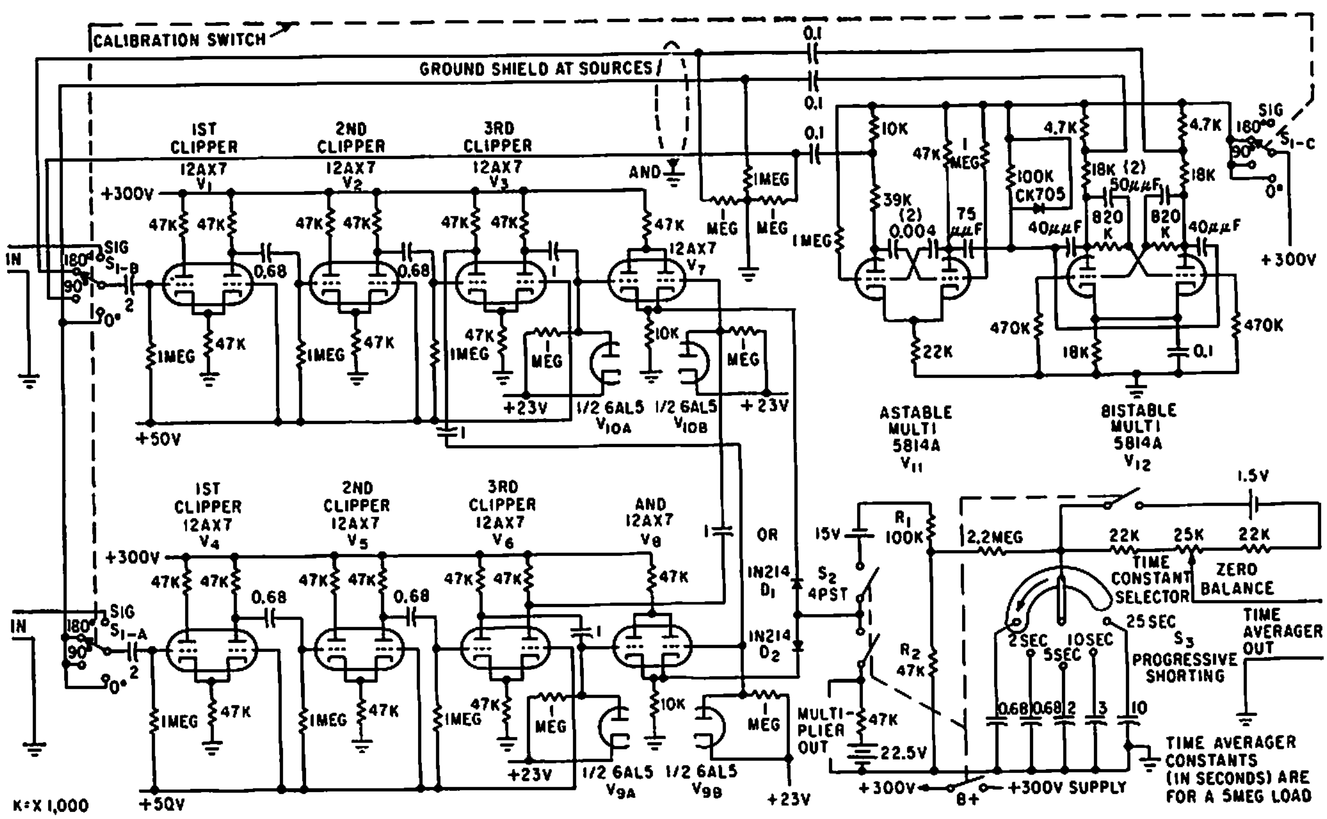
HALL-MULTIPLIER FIELD-COIL DRIVE—Feedback amplifier drives field coil current in phase with input signal over range of 0 cps to 7 kc, with less than 1.5% distortion.—R. A. Greiner, Feedback Amplification Improves Hall-Effect Multipliers, *Electronics*, 34:34, p 52–55.



HALL-EFFECT MULTIPLIER—Circuit gives algebraic product of two inputs. Accuracy is only 0.5%, but cost is low. Control current is applied through long dimension of Hall semiconductor element, to produce voltage across width of element that is proportional to product of control current and magnetic flux density.—W. A. Scanga, A. R. Hilbinger, and C. M. Barrack, Hall-Effect Multipliers, *Electronics*, 33:29, p 64–67.

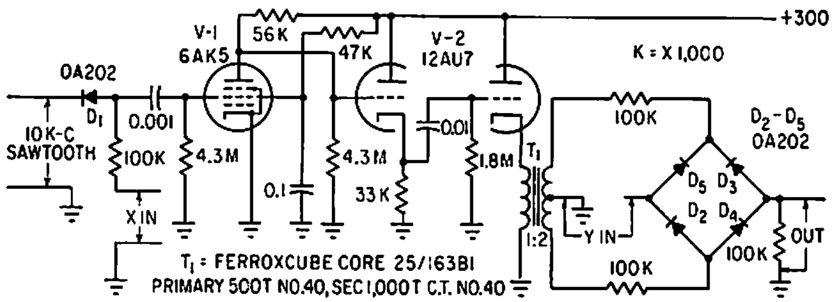


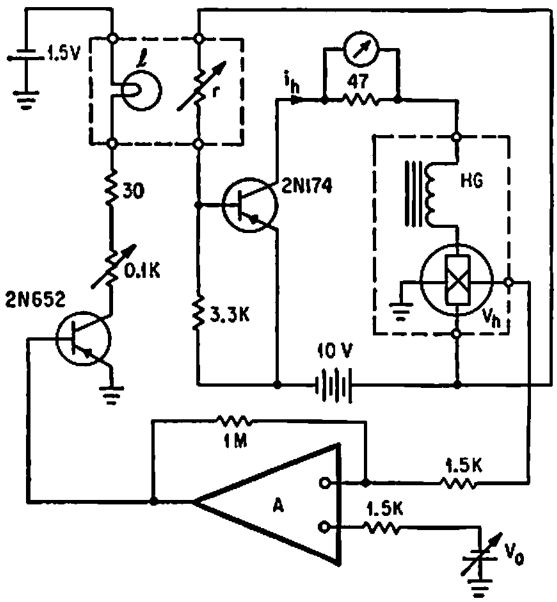
FOUR-QUADRANT SIGNAL MULTIPLIER—High-speed magnetic-amplifier square-law circuits with silicon diodes and resistors replace slow-response thermal converters in four-quadrant analog multiplying device. Polarity-reversible signal currents I1 and I2 are multiplied with two square-law and two push-pull magnetic amplifier circuits. Reversible-polarity output drives ink oscillograph.—W. A. Geyger, Multiplying Circuit Uses Magnetic Amplifiers, *Electronics*, 32:2, p 58–59.



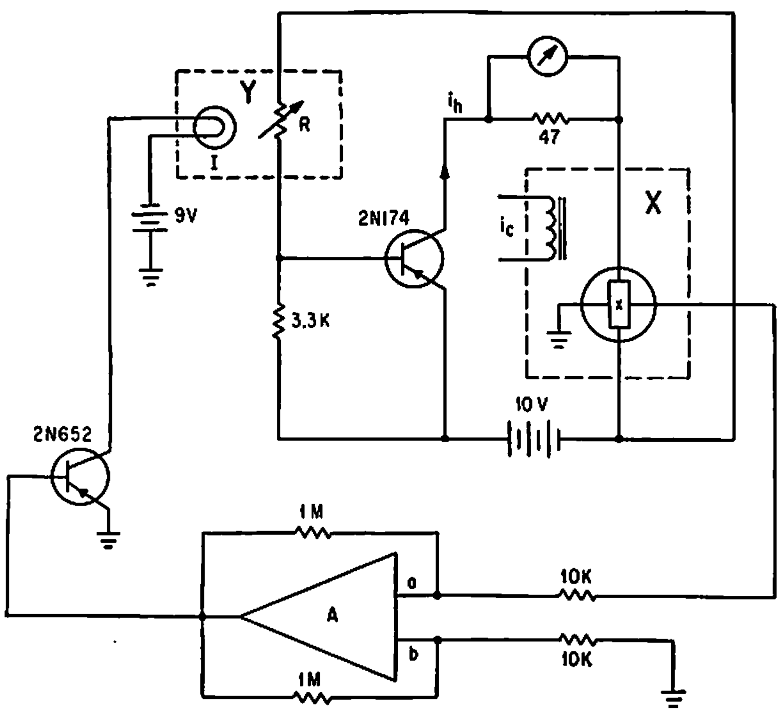
POLARITY-COINCIDENCE MULTIPLIER—Detects weak low-frequency signals in high-noise background, with output indicating presence and phase shift of signals received at dual inputs. Accuracy is within 1% for inputs of 1 to 500 cps.—B. M. Rosenheck, Detecting Signals by Polarity Coincidence, *Electronics*, 33:5, p 67–69.

ANALOG VOLTAGE MULTIPLIER—Pulse-width modulator and push-pull rectangular pulse generator driving diode-bridge switch give product of two input voltages X and Y, which must be in range of −10 v to +10 v. Input circuit of pulse-width modulator D1-V1 is supplied by 10-kc negative-slope sawtooth and input variable X.—J. Ash and Y. J. Fokkinga, Inexpensive Multiplier for Analog Computers, *Electronics*, 35:18, p 37.

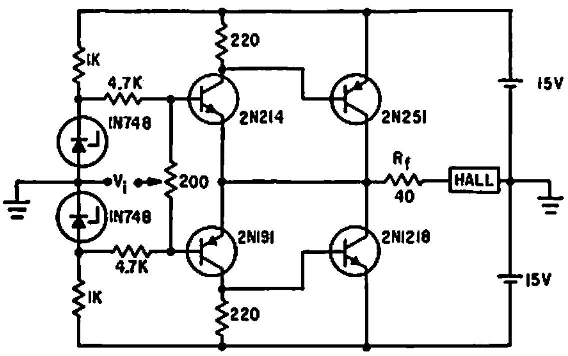




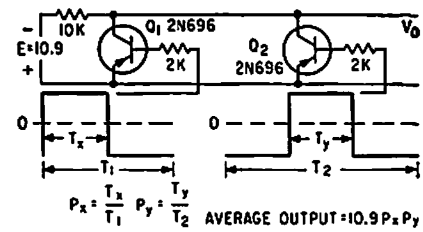
SQUARE ROOT OF SUM OF SQUARES OF THREE VARIABLES—Output signal of Hall-effect squaring multiplier HG is fed to differential amplifier A. Amplified difference controls current through lamp that determines resistance of photoresistor r which, with 2N174, controls Hall current derived from voltage source.—H. H. Wieder, Square-Root Computer Uses Hall Multiplier, *Electronics*, 37:4, p 30–31.



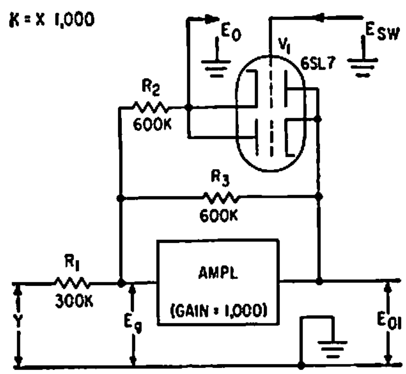
HALL MULTIPLIER FOR ANALOG RATIO COMPUTER—Indium arsenide Hall plate serves as analog multiplier in circuit with photoresistor R and 2N174 grounded-emitter power amplifier that controls drive current of Hall generator. Differential amplifier A in feedback loop including lamp I controls Hall current. —H. H. Wieder, Analog Ratio Computer Uses Hall Multiplier, *Electronics*, 36:45, p 46–47.



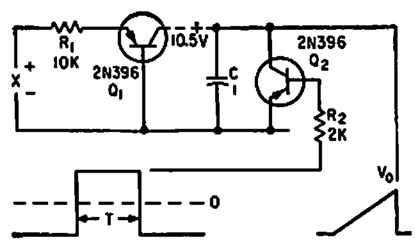
HALL-MULTIPLIER PLATE DRIVE—Current remains in phase with signal from 0 cps to over 20 kc. Distortion is less than 1% over entire range.—R. A. Greiner, Feedback Amplification Improves Hall-Effect Multipliers, *Electronics*, 34:34, p 52–55.



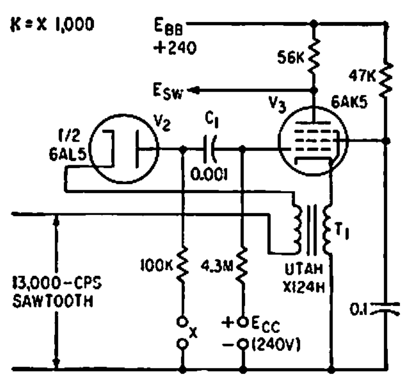
PROBABILITY MULTIPLIER—Based on converting two analog factors to duty cycles of pulse trains of uncorrelated repetition rate. Pulse-train control of *and* gate is such that there is no output unless both trains are simultaneously positive, and then average value of gate output is proportional to product.—T. R. Hoffman, Analog Multiplication Using Time as One Variable, *Electronics*, 33:33, p 136–138.



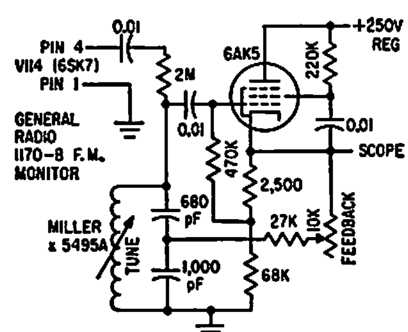
PULSE-AMPLITUDE MODULATOR—Used in multiplier that acts with one of operational amplifiers of analog computer. Double-triode V1 here provides pulse-amplitude modulation, for use with separate pulse-width modulator to form desired product of two input variables.—A. J. Ferraro, Multiplier for Analog Computers, *Electronics*, 33:45, p 73–74.



TRIANGLE MULTIPLIER—Electronic multiplication is achieved by making slope of sawtooth wave proportional to one factor and duration to other factor. Peak height of triangle will then be proportional to product. Triangle is generated by charging C with collector current of constant-current generator Q1 during time interval in which Q2 is cut off.—T. R. Hoffman, Analog Multiplication Using Time as One Variable, *Electronics*, 33:33, p 136–138.

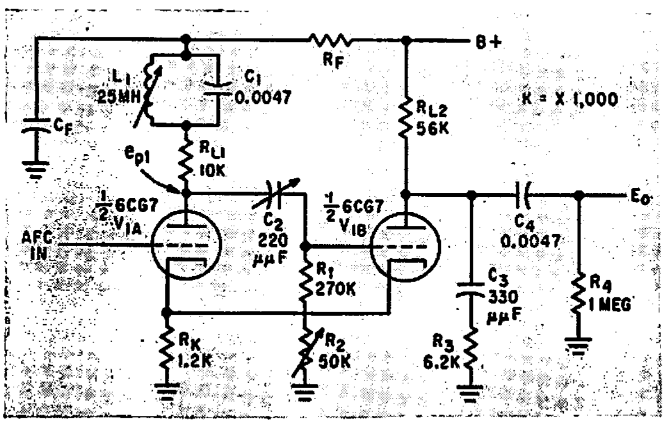


PULSE-WIDTH MODULATOR—Combines functions of rectangular pulse generator and width modulator for analog multiplier having error less than 2% of full-scale output—A. J. Ferraro, Multiplier for Analog Computers, *Electronics*, 33:45, p 73–74.

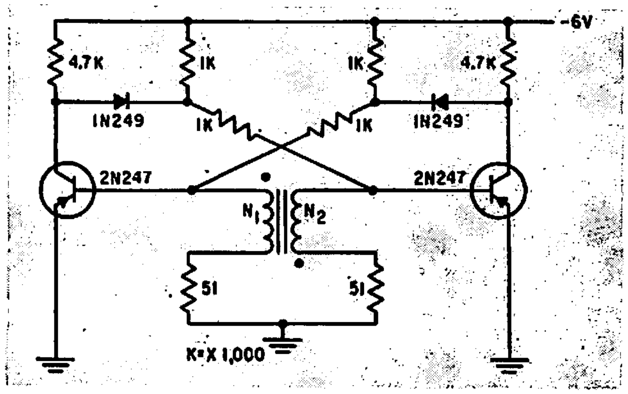


Q MULTIPLIER FOR F-M MONITOR—Checks calibration of f-m and television transmitter percentage-of-modulation monitors by using Q multiplier with monitor to make Bessel function measurements.—D. S. Henry, Calibrating Broadcast Modulation Meters, *Electronics*, 33:16, p 67.

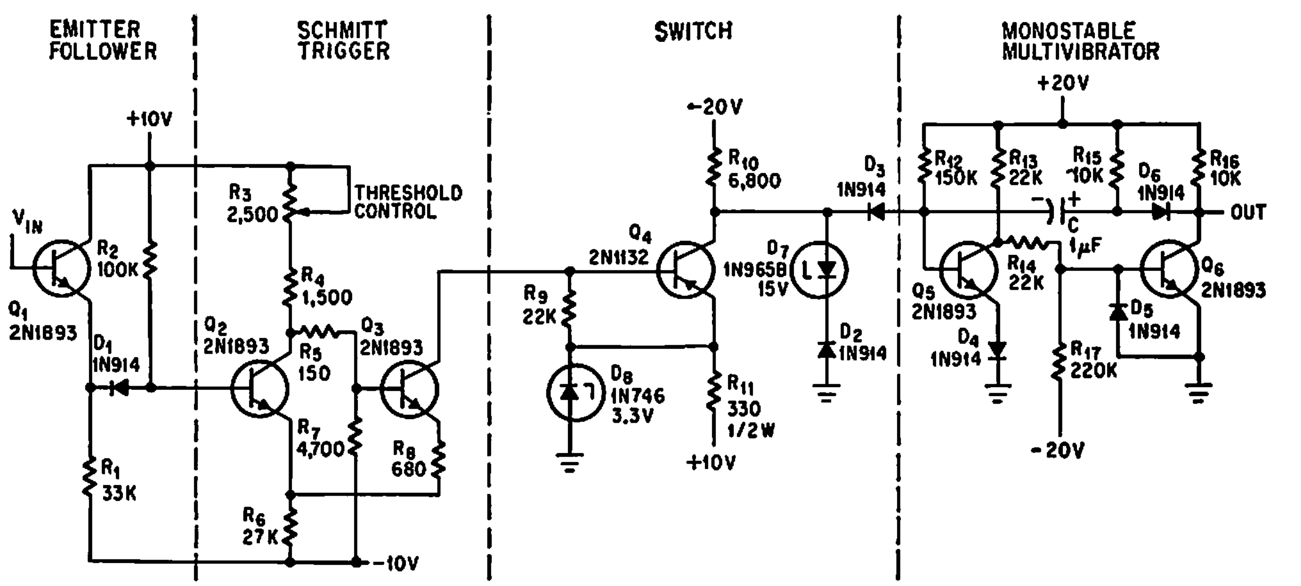
CHAPTER 54
Multivibrator Circuits



TV HORIZONTAL-SWEEP OSCILLATOR—Cathode-couped multivibrator includes noise-immunizing tuned circuit in plate circuit of triode.—C. L. Barsony, Graphical Checkout of Multivibrator Design, *Electronics*, 33:8, p 55–57.

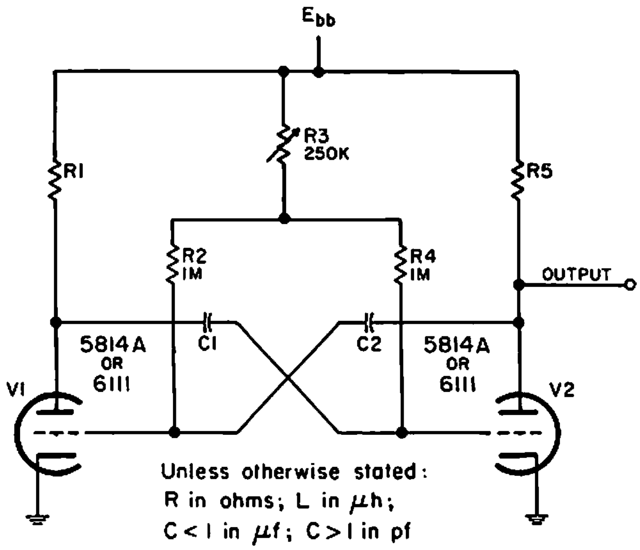


TRANSFORMER-CONTROLLED MVBR—Gives sharper trailing edges and tighter control over ratio of on times of the two sides, as compared to choke control for same free-running mvbr.—W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.

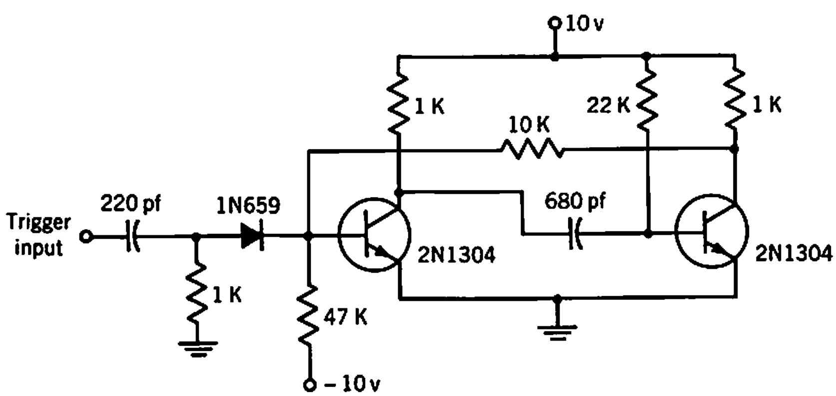


96-MILLISEC PULSE STRETCHER—Monostable multivibrator stays on for 96 millisec after Schmitt trigger goes off, while C discharges through R12.—J. R. Giroux, Multi's Output Duration Controlled by Input, *Electronics*, 38:4, p 88–89.

PREFERRED PRF GENERATOR—Astable plate-to-grid coupled mvbr serves as moderately stable repetition-rate generator having greater frequency stability than blocking oscillator and fewer components than Wien-bridge oscillator. One drawback is that output impedance for positive pulses equals plate load resistance, which must be relatively high for good frequency stability. Output is 260 v for 5814A and 125 v for 6111. Maximum prf is 8,000 pps.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 40, p 40–2.

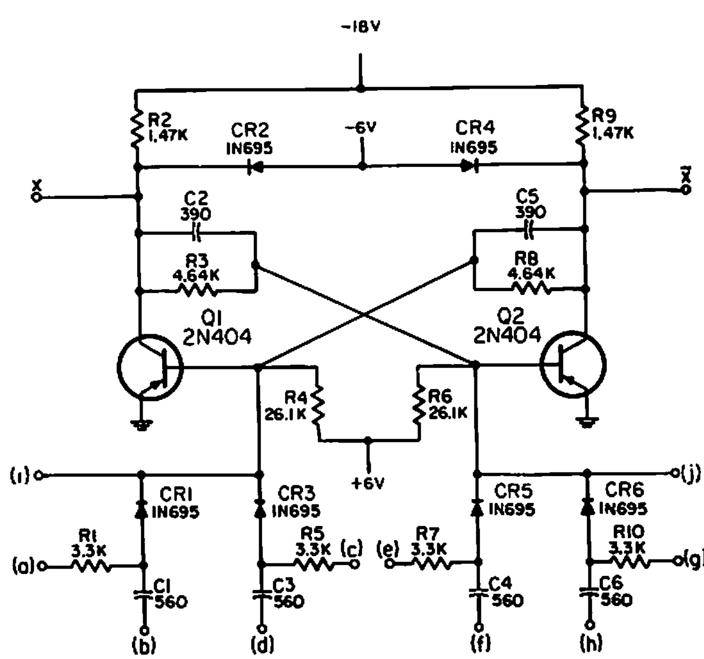


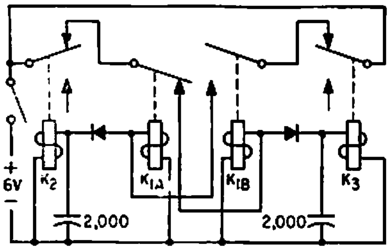
Components:
R1, R5: 68KΩ (5814A); 39KΩ (6111).
C1=C2= $\frac{0.79}{prf} \times 10^6$ pf, where prf=pulse repetition frequency in pulses per second.



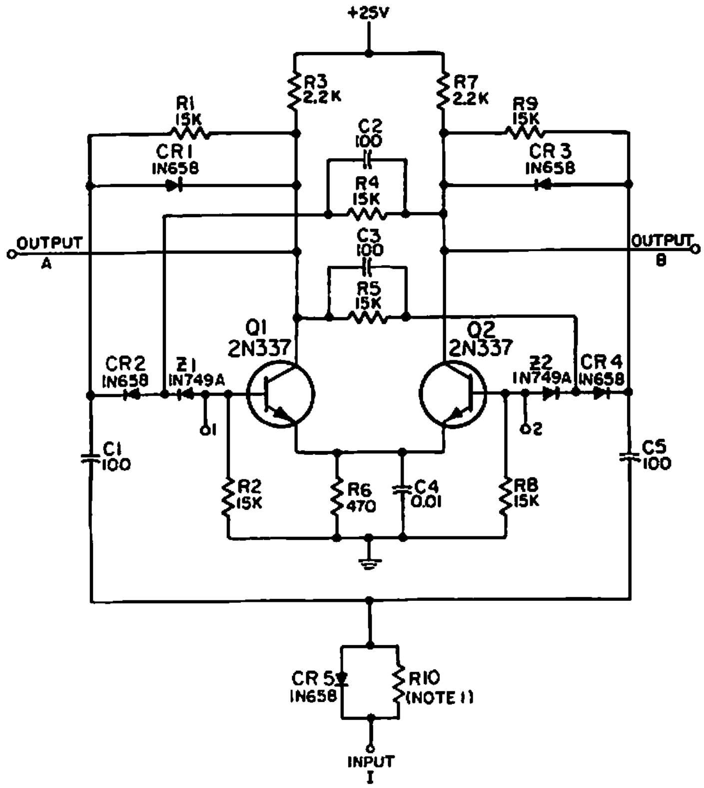
10-MICROSEC MONOSTABLE MVBR—Output pulse width is approximately 10 microsec with values shown for basic one-shot.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 381.

150-KC BISTABLE—Designed as storage element in digital logic circuits for computer, control, and communication equipment. Can be used as counter and as serial or parallel shift register at operating rates up to 150 kc under maximum load. Article gives connections of lettered terminals for various circuit functions and performance characteristics.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 9 (originally PC 212), p 9–2.

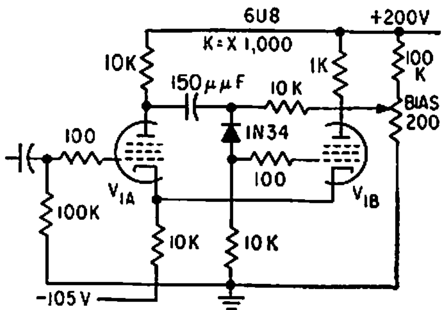




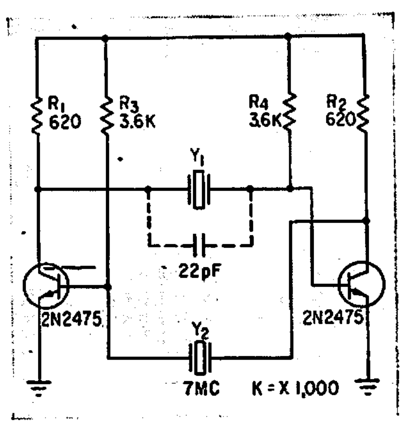
RELAY MVBR WITH ISOLATOR DIODES—Use of diodes to isolate capacitors reduces capacitance requirements for low frequencies. High-resistance relays for K2 and K3 cut costs.—R. L. Ives, Multivibrator for Low Frequencies Uses Relays, *Electronics*, 34:32, p 166–169.



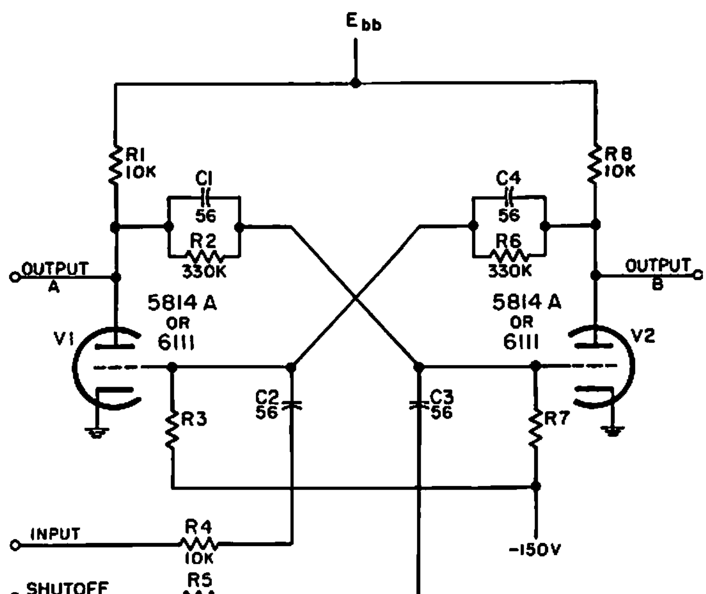
PREFERRED NONSATURATING BISTABLE—Used for frequency division of pulse trains when high stability is required. Cascade connection with appropriate feedback can provide any desired ratio. Also useful for coding, gating, and synchronizing. Maximum operating rate is up to 1 Mc.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 15 (originally PC 253), p 15–2.



CATHODE-COUPLED TRIGGER—Series diode improves sensitivity for cathode-coupled monostable mvbr while giving stability of 5% for threshold levels of several mv. Second tube can be triode, permitting use of 6U8 triode-pentode in compact assembly.—M. M. Vojinovic, Series Diode Increases Multivibrator Sensitivity, *Electronics*, 32:17, p 90–91.

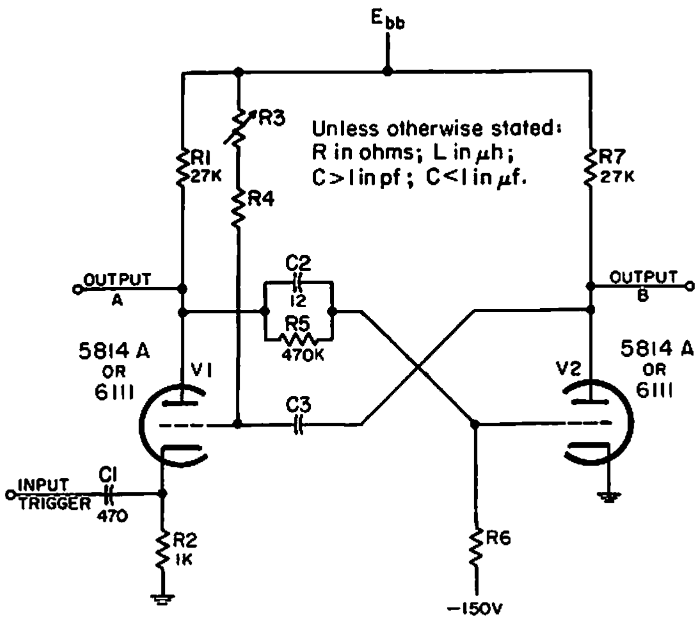


CRYSTAL CONTROL IMPROVES STABILITY—Use of 7-Mc crystal in place of feedback capacitors in conventional mvbr improves stability and waveform while still permitting operation down to 750 kc. Circuit also operates with one crystal; variable 7–47 pf capacitor in noncrystal-controlled side permits varying pulse width on this side over wide range.—H. R. Newhoff, Crystal-Controlled Multivibrator has Better Stability, *Electronics*, 36:15, p 60–61.



R3, R7: 270KΩ (5814A); 680KΩ (6111).

PREFERRED BISTABLE—In response to negative trigger, generates voltage steps of opposite polarity at the two outputs. Has no timing function, so second trigger is needed to restore circuit to initial state. Used as radar gate. Requires 150 v plate supply for 6111 and 300 v for 5814A.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 42, p 42–2.

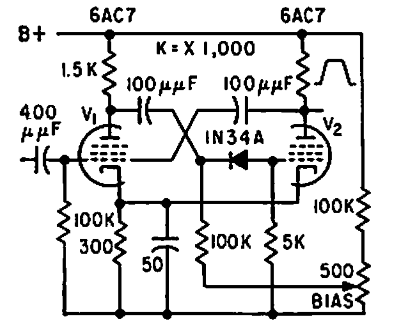


Components:

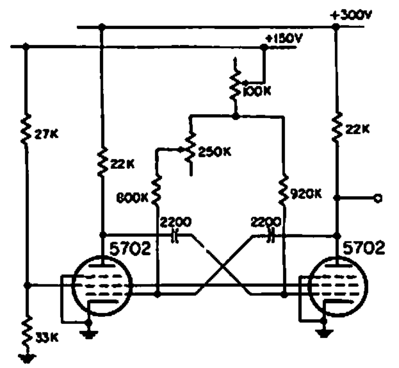
R6: 470KΩ (5814A); 680KΩ (6111).

	Gate duration (μsec)		
	25–100	*100–2500*	*>2500*
R3	250KΩ	500KΩ	1MΩ
R4	470KΩ	1MΩ	1.5MΩ
C3 (pf)	4000T	2000T	1000T

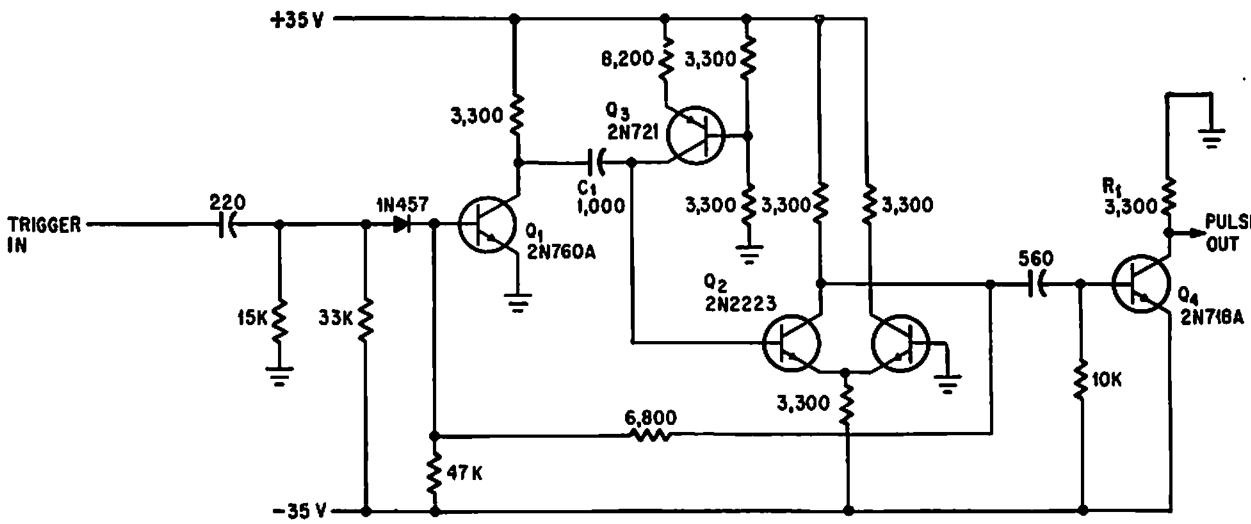
PREFERRED MONOSTABLE—Generates positive or negative rectangular gate in response to positive input trigger. Duration of gate will remain within 5% of initial preset value, and amplitude will be constant within 30%. Circuit is self-timing, with output gate duration determined by configuration and values of R3, R4, and C3. Used in radar to establish period during which main display sweep is presented, to provide crt unblanking gate, and to provide enabling gate for distance mark generator.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, PC 41, p 41–2.



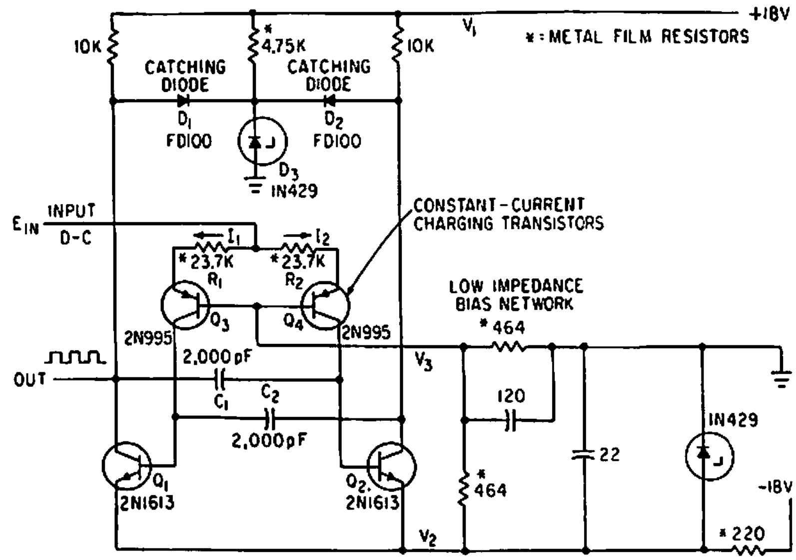
HIGH TRIGGERING SENSITIVITY—Semiconductor diode is used as series nonlinear element in feedback loop of monostable mvbr, to give good stability along with improved triggering sensitivity for nuclear event registration, pulse analysis, counting, and time modulation.—M. M. Vojinovic, Series Diode Increase Multivibrator Sensitivity, *Electronics,* 32:17, p 90–91.



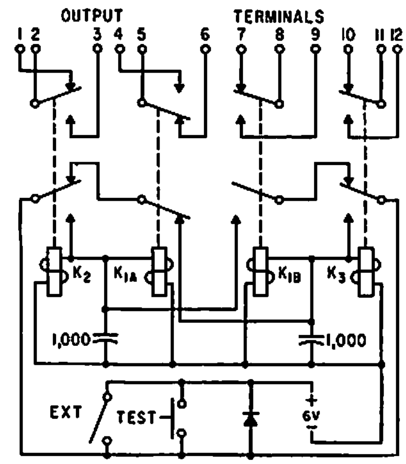
PRF GENERATOR—Provides frequency stability of 3% as repetition rate generator in airborne radar. Free-running connections are shown, but may also be triggered externally.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5–1.



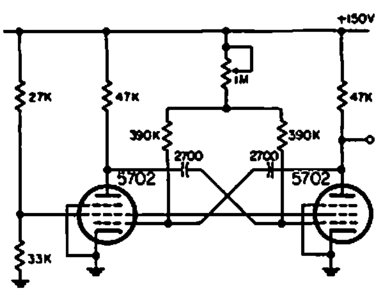
CONSTANT-PULSE-WIDTH ONE-SHOT—Monostable circuit holds pulse width constant within 0.5% from −65°C to 110°C. Stages Q1 and Q2 form conventional one-shot. Use of differential amplifier for Q2 stabilizes base voltage for turn-on of Q2 near ground. Constant-current transistor Q3 minimizes effects of small voltage variations, and switching transistor Q4 provides 35-v output pulse with base line at ground.—R. Stevens, One-Shot Multi Produces Constant Pulse Width, *Electronics,* 34:13, p 74–75.



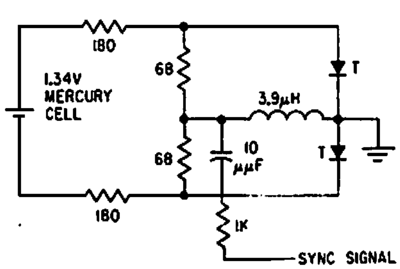
LINEAR VOLTAGE-FREQUENCY CONVERTER—Addition of two transistors to conventional astable mvbr gives constant-current charging of cross-coupling capacitors C1 and C2. Output frequency then varies linearly from 2,000 to 7,000 cps as d-c input rises from 0 to 5 v.—R. W. Biddlecomb, Latest Multivibrator Improvement: Linear Voltage-to-Frequency Converter, *Electronics*, 36:17, p 64–65.



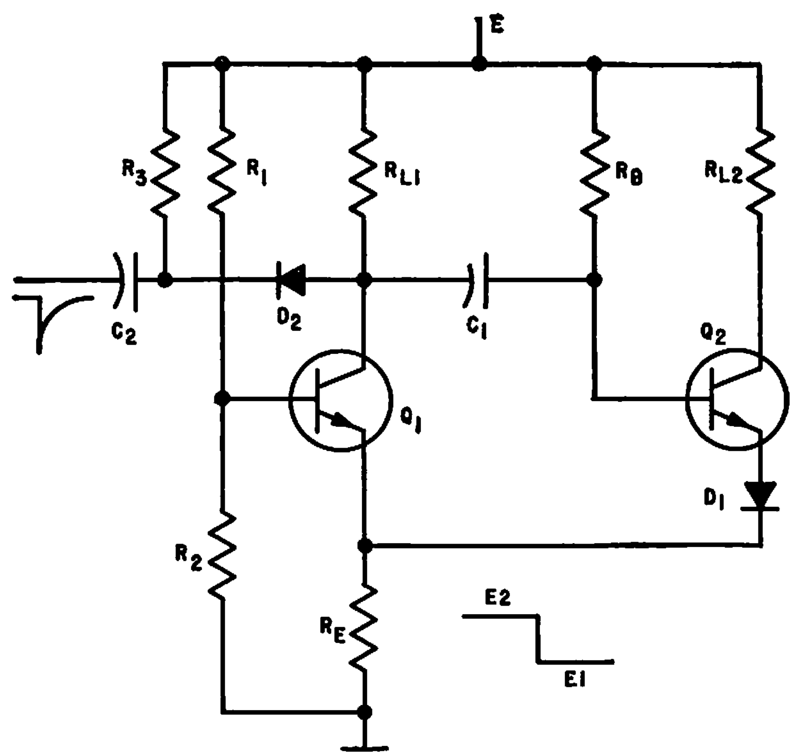
RELAY-ONLY MVBR—Consumes power only during switching. Can provide bistable, monostable, or astable operation at frequencies from a few operations per second to a few operations per hour.—R. L. Ives, Multivibrator for Low Frequencies Uses Relays, *Electronics*, 34:32, p 166–169.



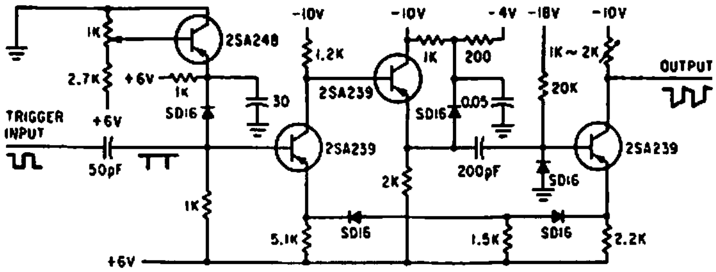
PRF GENERATOR—Used as repetition rate generator in airborne radar. Gives greater frequency stability than blocking oscillator and greater economy of components than Wien-bridge oscillator.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5–1.



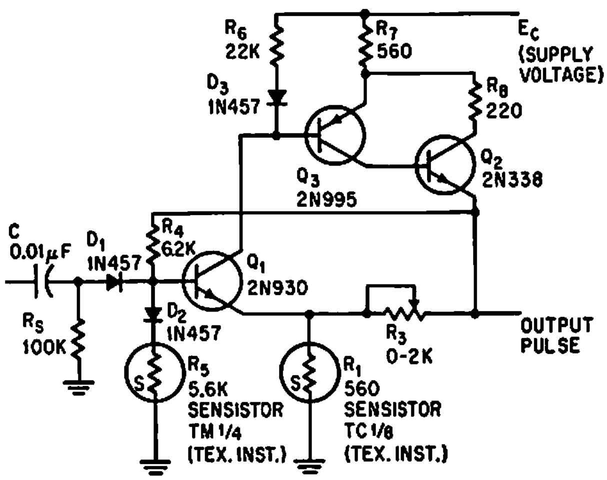
10-MC TD MVBR—Uses two 1-ma, 0.01-ohm tunnel diodes.—I. A. Lesk, N. Holonyak, Jr., and U. S. Davidsohn, The Tunnel Diode—Circuits and Applications, *Electronics*, 32:48, p 60–64.



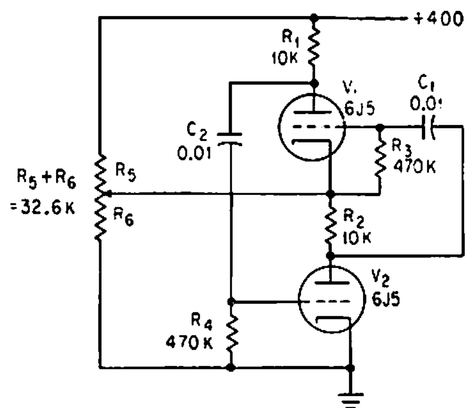
MONO DESIGN—Simplified equations are given for designing emitter-coupled monostable mvbr. With 20-v supply, component values for use with 2N388 transistors to provide 25-microsec pulse width, for E1 = 4 v and E2 = 7 v are RE = 1K, RL2 = 1,800 ohms, RL1 = 3,900 ohms, R1 = 56,000 units, R2 = 27,000 ohms, and C1 = 620 pf.—L. I. Kleinberg, Designing Emitter-Coupled Monostable Multivibrators, *Electronics*, 34:39, p 86.



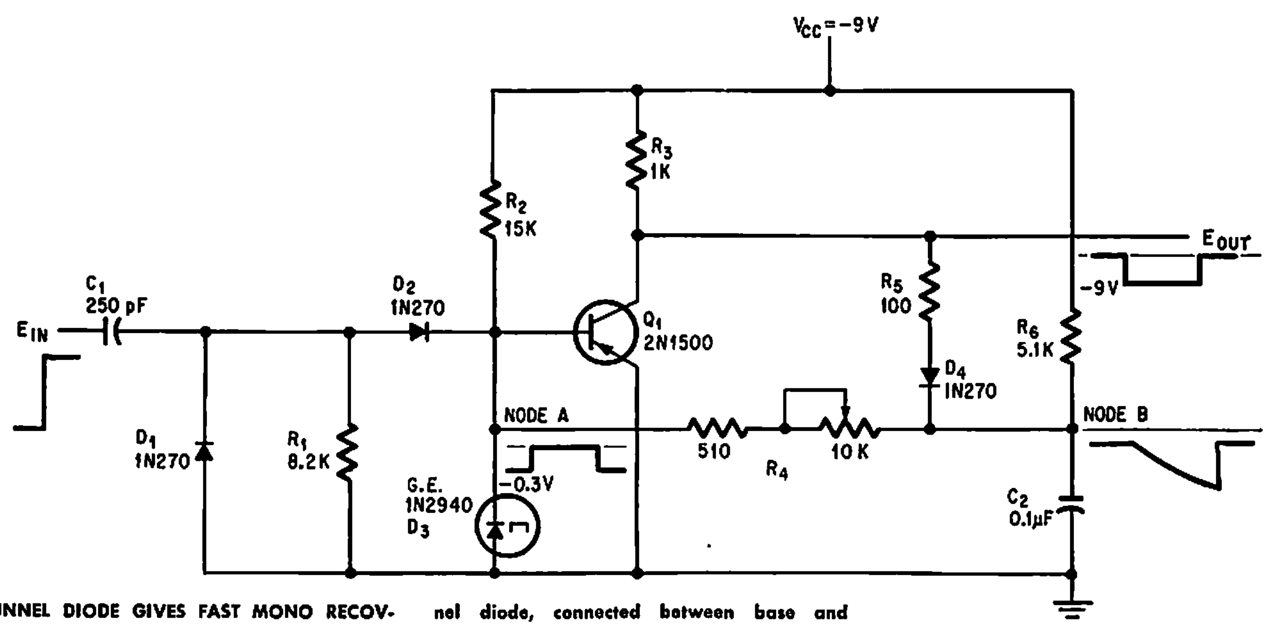
NONCUTOFF MONOSTABLE—Optimum operating conditions are achieved by keeping amplifiers connected to current sources continuously. With constant input voltage, triggering makes threshold level shift. Diodes in feedback loop improve switching speed. —H. Inose, Y. Yoshida, and H. Tada, Noncutoff Circuits Improve Trigger Switching, *Electronics*, 35:30, p. 36–39.



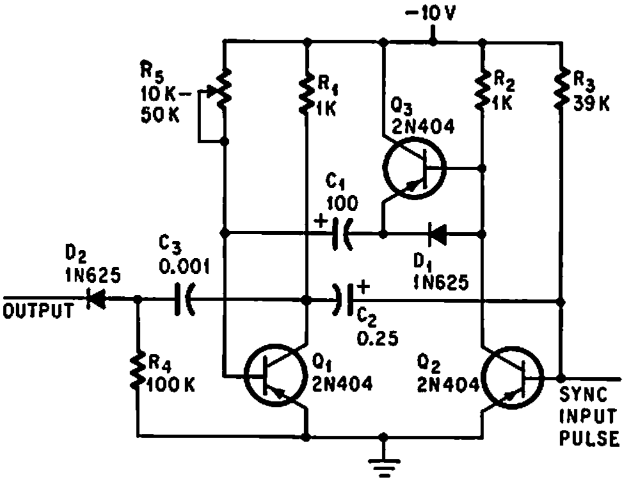
THERMAL MONO—Accurate pulse periods of 15 sec to 2 minutes are produced by thermal mono using silicon resistor (Sensistor) whose resistance varies with temperature, power, and time. Used as timer to turn on plate supply 30 sec after filament supply.—L. L. Kleinberg, Sensistor Produces Long, Reliable Pulses, *Electronics*, 37:31, p 51–52.



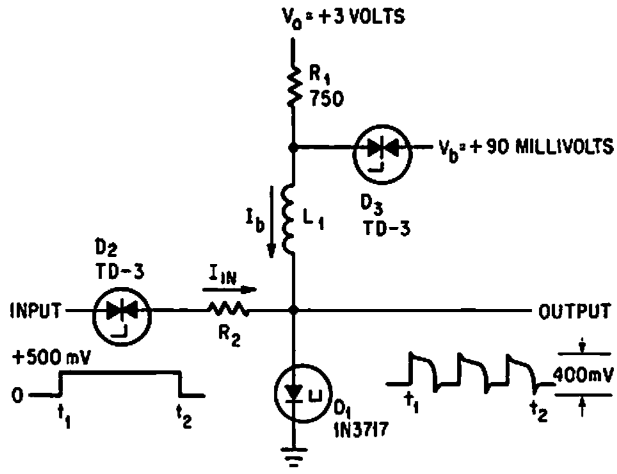
FREE-RUNNING CASCODE MULTIVIBRATOR—Output signal at cathode of V1 is nearly perfect square wave, either positive or negative depending on setting of potentiometer. —C. Sing, Advantages of Free-Running Cascode Multivibrators, *Electronics*, 37:5, p 28–29.



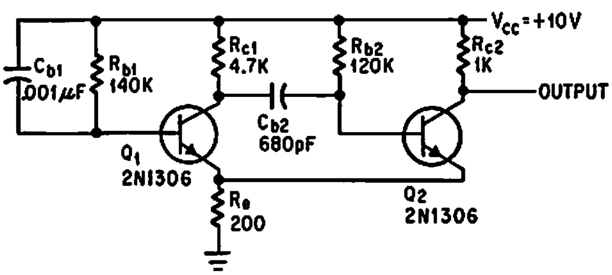
TUNNEL DIODE GIVES FAST MONO RECOVERY—Time delay can be varied continuously over 100-to-1 range. Duty cycle is 0.9. Tunnel diode, connected between base and emitter of transistor switch, acts as current-controlled threshold detector.—P. Heffner, Tunnel Diode Multi Recovers Quickly, *Electronics*, 37:25, p 75–77.



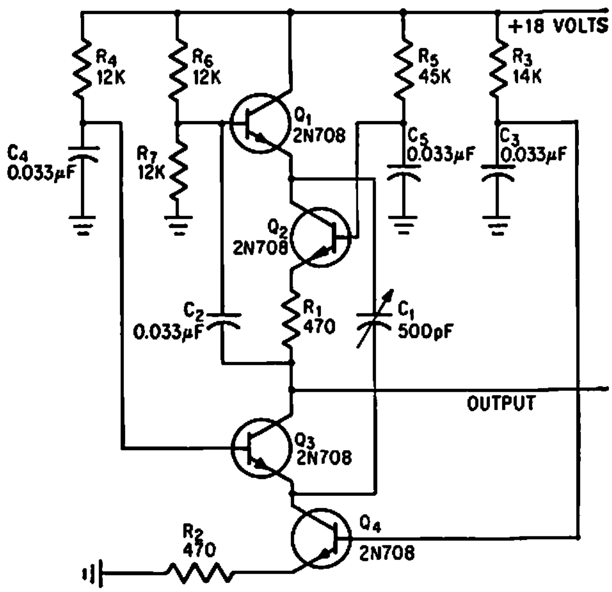
TRANSISTOR DECREASES RESET TIME—Time for recharging C1 is reduced by factor of 30 when Q3 is added to conventional astable mvbr.—S. A. Bell, Added Transistor Decreases Multivibrator Reset Time, *Electronics*, 37:21, p 72–73.



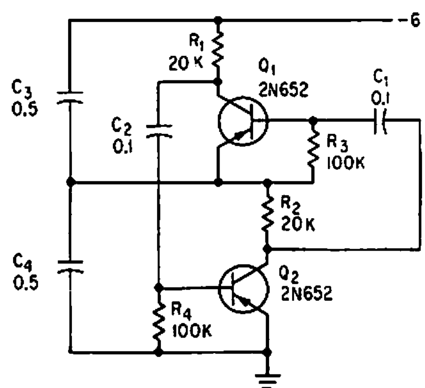
CLOCK PULSES—Tunnel-diode one-shot produces number of pulses in series, proportional to value of L1 and width of input pulse.—C. A. Budde, Pulse Width Converted to Pulse Sequence, *Electronics*, 38:4, p 86–87.



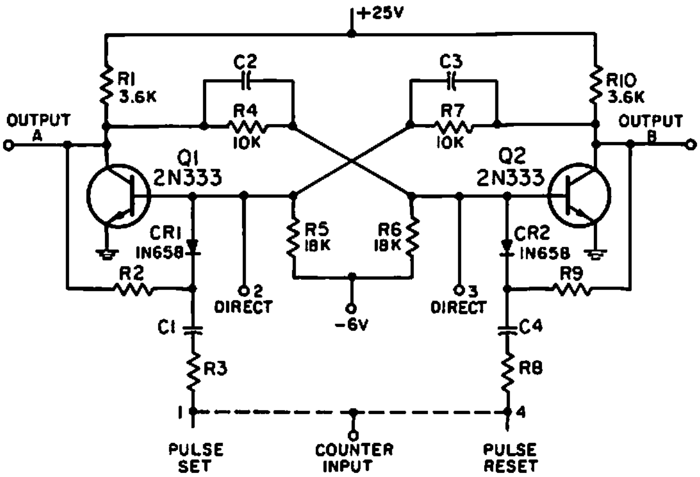
WIDE MARK-SPACE RATIO—Pulse width and interpulse period are independently adjustable from tenths of microsecond to several seconds by varying Cb1-Rb1.—S. Tesic, Pulses with Variable Mark-To-Space-Ratio, *Electronics*, 38:14, p 78–79.



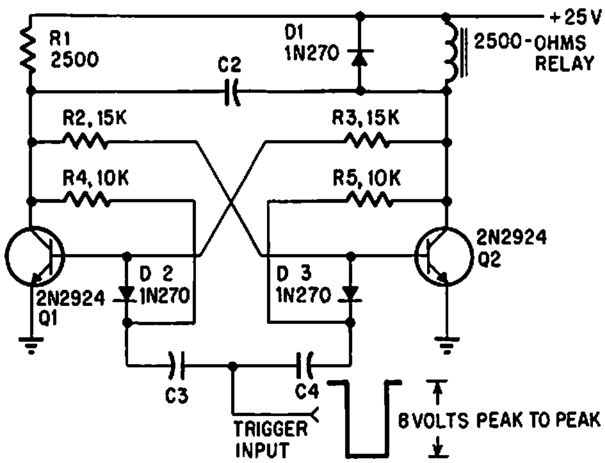
5-MC MVBR—Constant-current generators Q1 and Q2 conduct continuously. Timing capacitor C1 charges through Q1 and Q4 and discharges in next half-period through Q2 and Q3, all in saturated states. Output pulse amplitude is 4 v at up to 5 Mc.—V. M. Ristic, Simple Multivibrator Operates at 5 Mc, *Electronics*, 38:17, p 86–87.



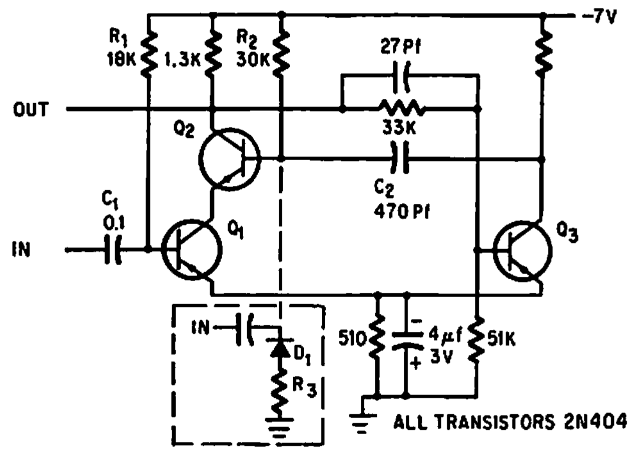
TWO-TRANSISTOR CASCODE MULTIVIBRATOR—Two capacitors in voltage-divider storage circuit control transistors to give choice of rectangular or sawtooth waveforms at output of Q1, depending on time constants C1-R3 and C2-R4.—C. Sing, Advantages of Free-Running Cascode Multivibrators, *Electronics*, 37:5, p 28–29.



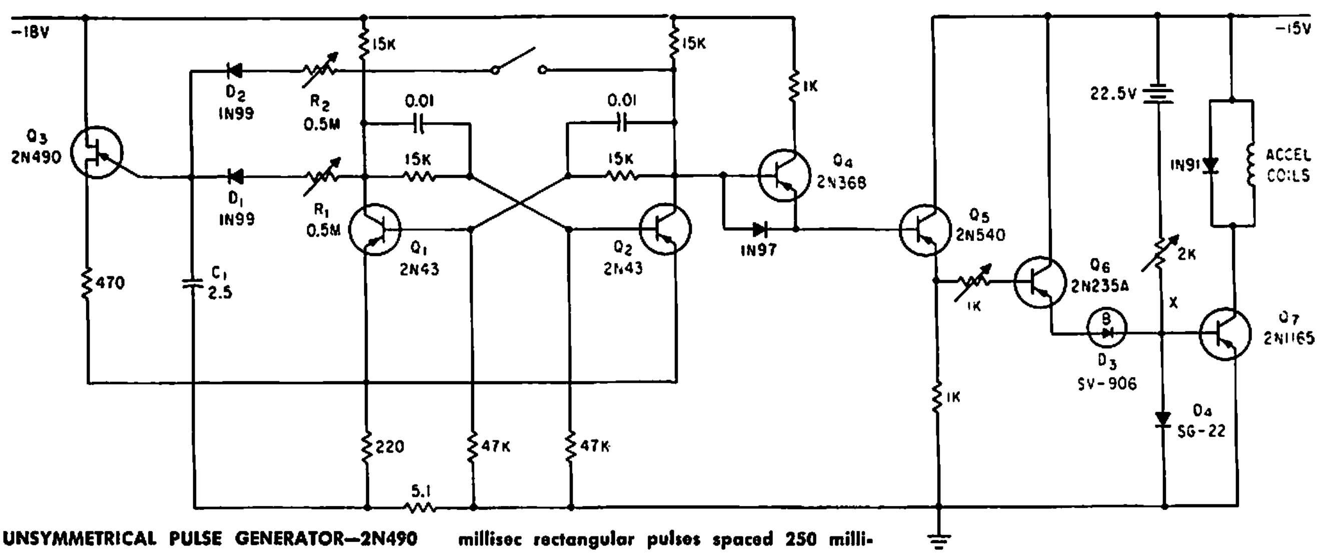
PREFERRED SATURATING BISTABLE—Slow-speed mvbr may be used as counter, shift register, gate, or switch. Provides transitional stages between electromechanical readout and higher-speed nonsaturating bistable counters. Maximum prf is 40 kc, delay time is 2 to 5 microsec, and output levels are both 18 v. 2N333 has been dropped from Preferred List, but 2N335 can be used if operating point is adjusted for its higher beta. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 14 (originally PC 250), p 14–2.



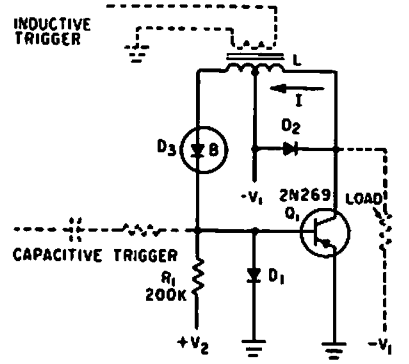
NOISE-IMMUNE BISTABLE—C2 gives immunity to accidental triggering by noise, though with some reduction in switching speed. When C2 is 0.1 mfd, upper frequency limit is 400 cps, and is 100 cps for 0.47 mfd.—R. W. Simister, Bistable Multivibrator Immune to Noise, *Electronics*, 39:6, p 97.



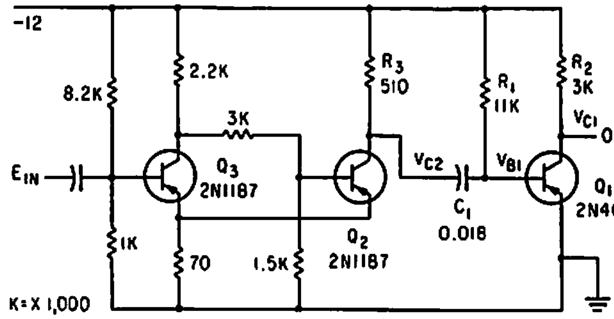
EXTRA TRANSISTOR STABILIZES ONE-SHOT—Q1 isolates triggering circuit from timing elements R2-C2, making duration of output pulse independent of input pulse amplitude and reducing minimum triggering voltage from 0.25 v to 0.1 v.—J. Kalisz, Isolating Transistor Improves One-Shot, *Electronics*, 38:25, p 76.



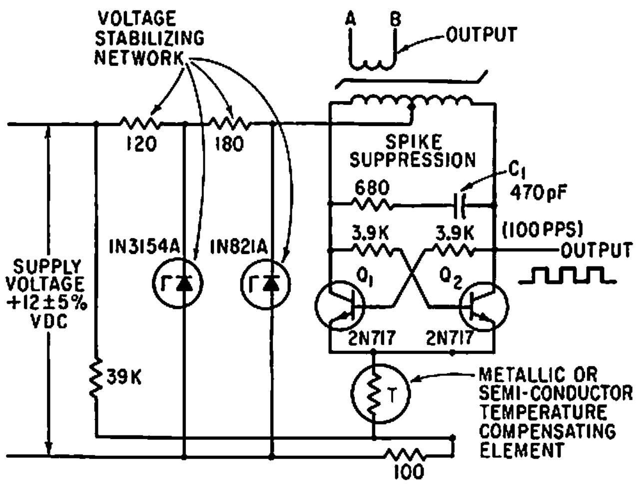
UNSYMMETRICAL PULSE GENERATOR—2N490 unijunction transistor serves as timer and trigger for flip-flop Q1-Q2, to provide 750-millisec rectangular pulses spaced 250 millisec apart, for energizing falling-sphere accelerometer.—C. H. Price, Jr., High-Current Solid-State Switches, *Electronics*, 33:38, p 72–73.



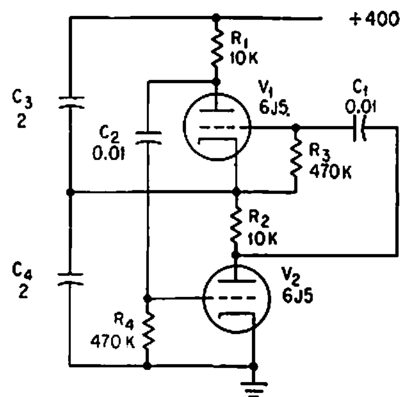
SINGLE-TRANSISTOR ONE-SHOT—Requires fewer components and gives higher reliability.—T. F. Heiting, One-Transistor Single-Shot, *Electronics*, 34:16, p 66.



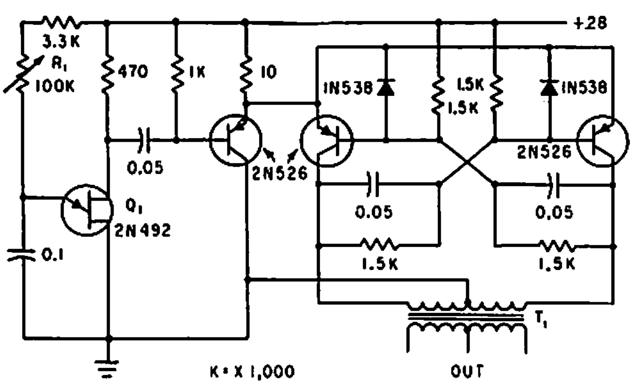
MONOSTABLE PULSE FORMER—Output stage of driver serves also as first stage of monostable multivibrator, with saving in components. Here Q2 is output of Schmitt trigger and first stage of monostable mvbr Q2-Q1. —R. L. Paul and A. S. Ottenstein, Eliminating the First State of a Monostable Multivibrator, *Electronics*, 35:36, p 54–55.



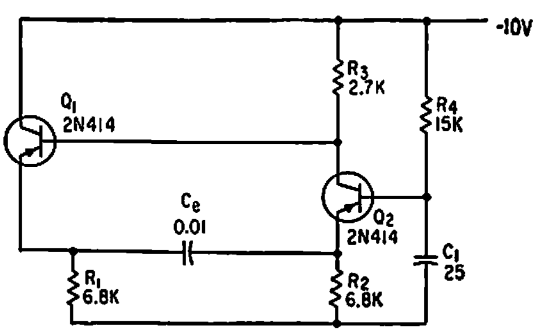
MAGNETICALLY COUPLED MVBR—Nonlinear element T in common-emitter lead stabilizes against temperature variation to within 0.1% over 150°C range. Output is 100 pps.—M. Ingenito, Magnetically Coupled Multivibrators, *Electronics*, 36:13, p 42–43.



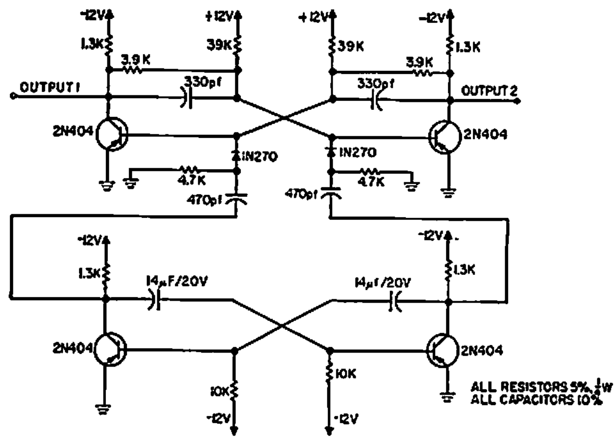
TWO-TRIODE CASCODE MULTIVIBRATOR—Two capacitors in voltage-divider storage circuit control dual-triode multivibrator to produce linear sawtooth waveform, square wave, sine wave, or pulse.—C. Sing, Advantages of Free-Running Cascode Multivibrators, *Electronics*, 37:5, p 28–29.



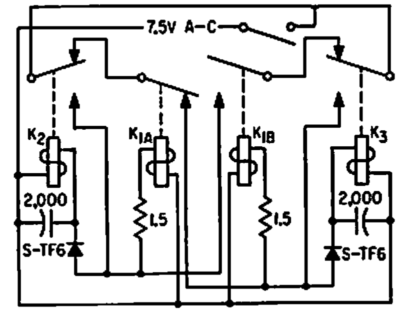
UNIJUNCTION CONTROL OF MVBR—Transistor mvbr trigger for scr inverter is controlled by unijunction relaxation oscillator Q1. Square-wave output of T1 is required for triggering some inverter circuits.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.



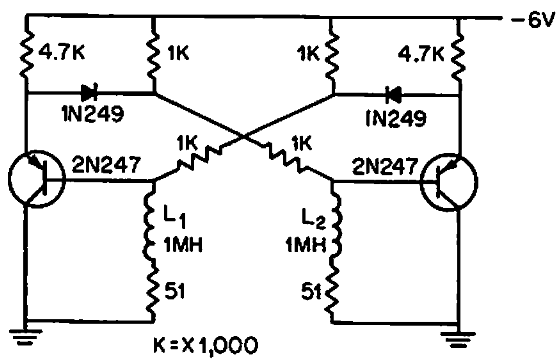
EMITTER-COUPLED MVBR—When Q1 conducts, Q2 is cut off and conversely. Duration of both quasi-stable states is controlled by Co. Q2 should saturate when conducting, to prevent distortion in flat tops of rectangular output pulses.—B. Rakovic, One More Transistor makes a Linear Sawtooth, *Electronics*, 35:49, p 50–51.



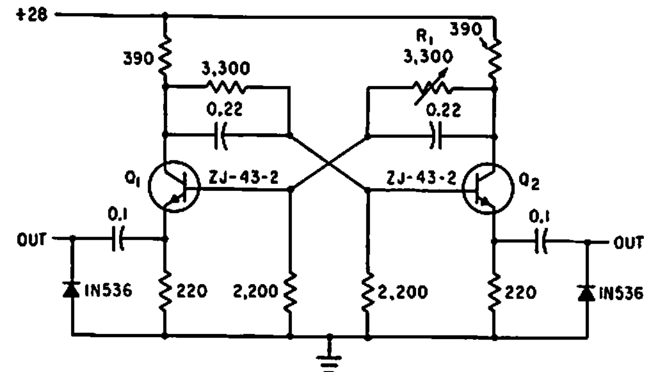
MICROSEC FALL TIME—Fast rise time of astable mvbr is used to set and reset bistable flip-flop, whose output waveform follows that of astable with important exception that now both rise and fall times are very fast, of the order of few microsec for 5-cps square wave.—M. I. Neidich, Astable Multi has Microsecond Fall, *EEE*, 11:7, p 28.



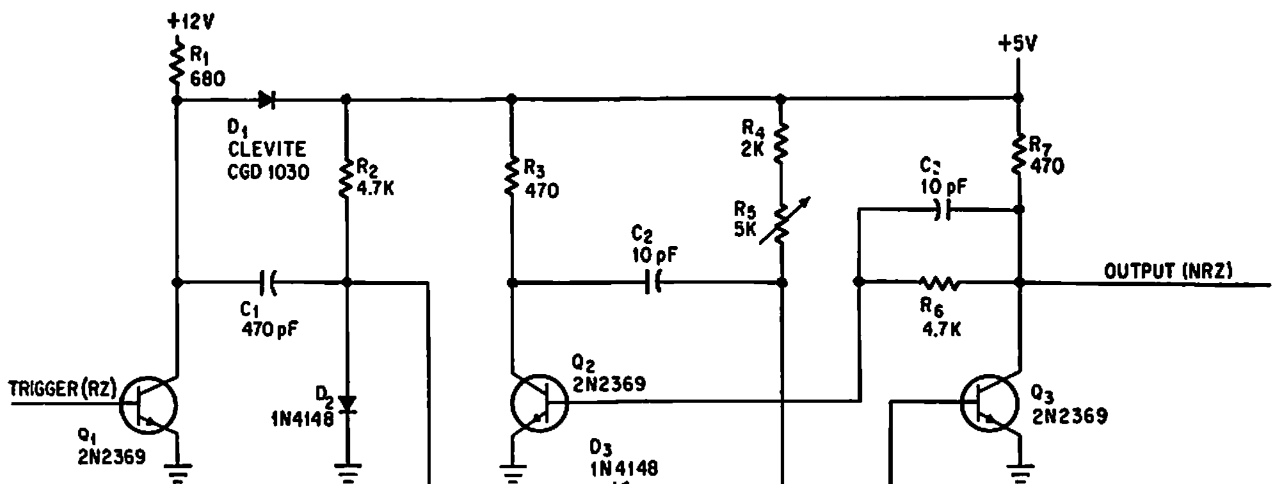
RELAY-ONLY MVBR FOR A-C—Use of a-c latching relay and rectifier diodes permits operation of low-frequency relay-type mvbr from a-c source.—R. L. Ives, Multivibrator for Low Frequencies Uses Relays, *Electronics*, 34:32, p 166–169.



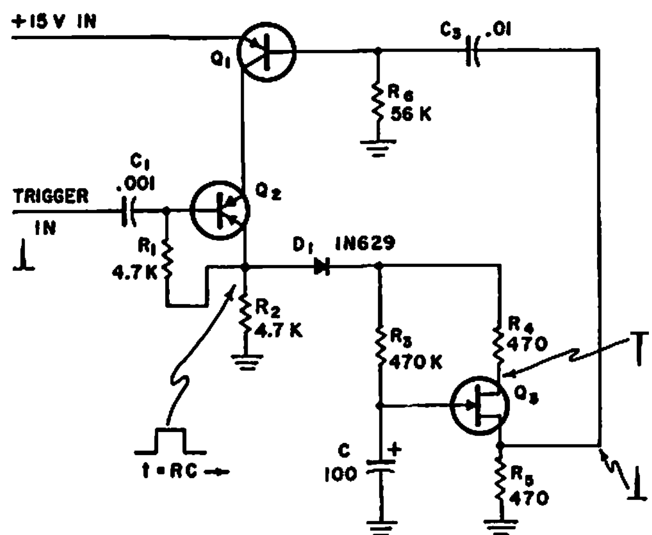
CHOKE-CONTROLLED FREE-RUNNING MVBR—Small resistors between chokes and ground bias transistors initially into active region to insure self-starting. Crossover resistors insure that chokes recover rapidly.—W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.



3-KC SCR TRIGGER—Two outputs from mvbr give alternating trigger pulses to each rectifier. R1 is adjusted for symmetrical operation.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.

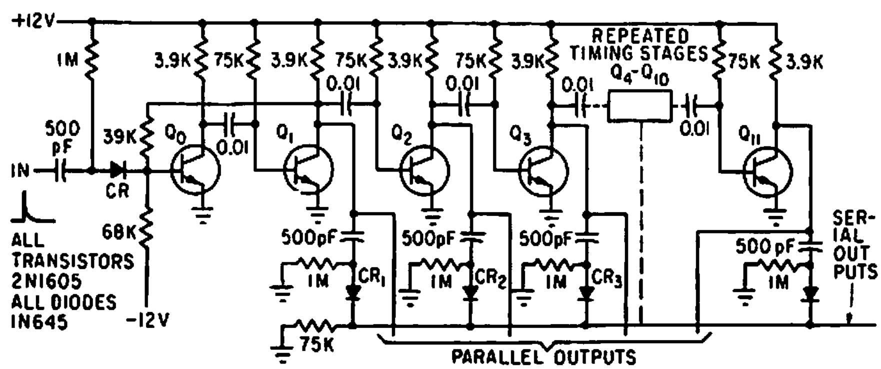


RZ TO NRZ ONE-SHOT—Zero recovery time of monostable multivibrator arrangement, achieved by using energy of input capacitor to recharge timing capacitor C2, makes circuit useful for converting digital data from return-to-zero format to non-return-to-zero.—P. T. Rux, One-Shot Multivibrator with Zero Recovery Time, *Electronics*, 39:2, p 75–76.



ULTRA-LONG MONO—Has quiescent power drain of zero. Generates step-function gate with good leading and trailing edges, and provides delayed pulse of either polarity for triggering cascaded circuits. Q1 is 2N1442, scr Q2 is 2N1595 or 3A31, and ujt Q3 is 2N489. Values for R3 and C2 give 50-sec pulse duration.—Ultra-Long Monostable Multivibrator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 66.

CASCADED ONE-SHOTS GENERATE PULSES IN BURST—Addition of redundant stages to timing portion of conventional monostable mvbr permits generating bursts of eleven 2-kc pulses every 0.1 sec. Used for testing decimal counters at high counting rates; each burst gives visible one-digit advance in readout because of 94.5-millisec time between bursts.—J. Gaon, Simple Counter Tester Uses Cascaded One-Shots, *Electronics*, 36:14, p 40–41.



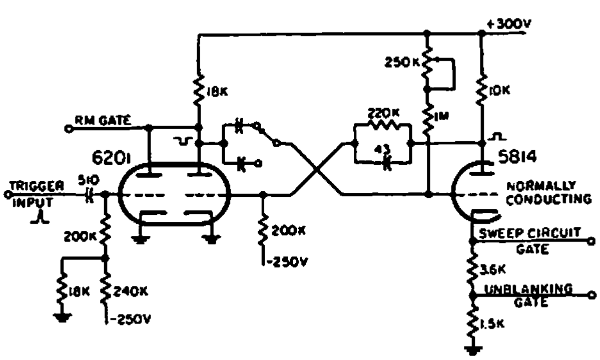
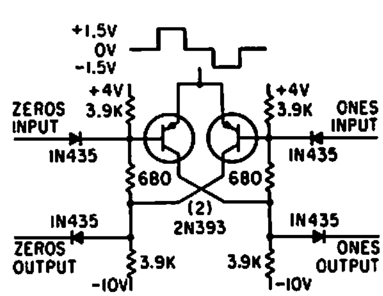
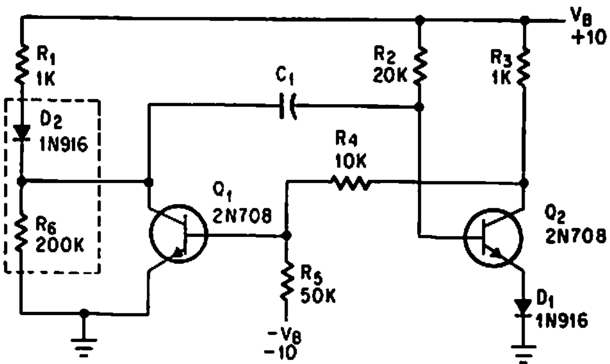


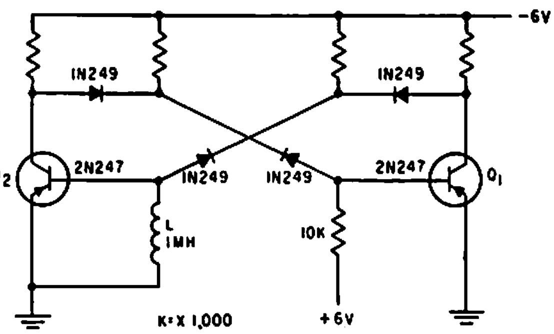
PLATE-TO-GRID COUPLED MAIN-GATE MVBR—Used in combination search and gun-laying radar. Triggered by connecting plate of trigger inverter or switch tube in parallel with plate of normally-off mvbr tube. Provides positive unblanking gate for crt. Different gate lengths are obtained by switching mvbr capacitors.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-2.



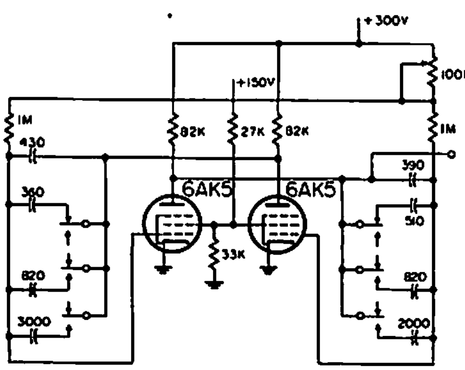
FLIP-FLOP FOR DATA REGISTER—Eccles-Jordan type circuit uses surface-barrier transistors with saturation biasing. Large registers for computers are assembled by using one flip-flop per digit.—W. Orvedahl and J. H. Shepherd, Designing Data Registers with Simple Diode Circuits, *Electronics*, 36:8, p 48–50.



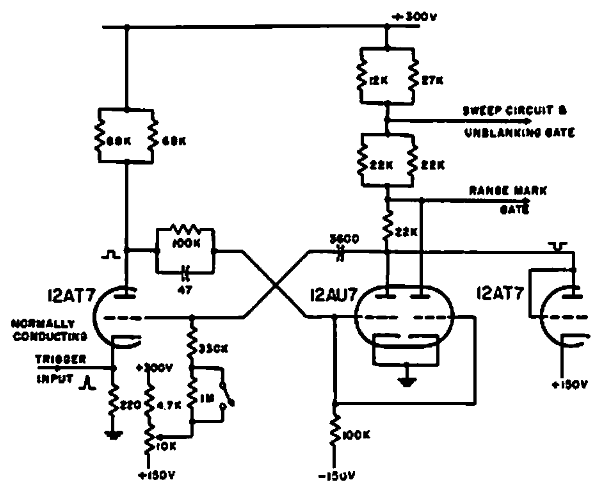
NOISE SUPPRESSION—Diode in collector circuit makes monstable mvbr immune to most noise pulses.—B. D. Simmonds, Diode Quiets Input to Monostable Multi, *Electronics*, 38:19, p 99–100.



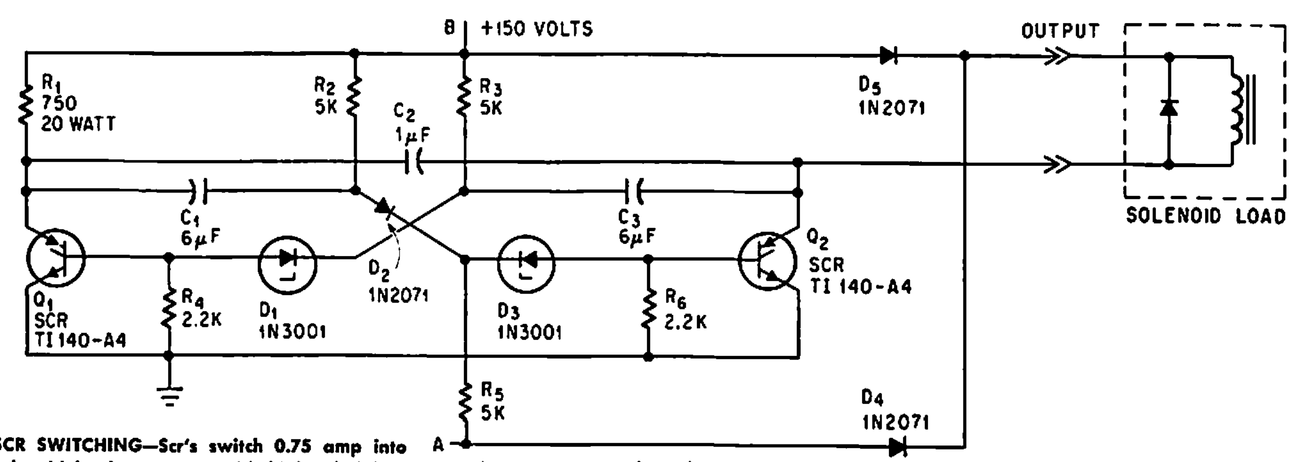
CHOKE-CONTROLLED ONE-SHOT—Provides output pulses longer in duration than input trigger. Can be triggered by either negative or positive pulse.—W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.



200, 400, AND 800 PPS PRF GENERATOR—Used in airborne radar. Frequency stability is 3% for 200 pps and 8% for higher frequencies. One drawback of mvbr here is that output impedance equals plate load resistance, which must be relatively high for good frequency stability.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5–1.

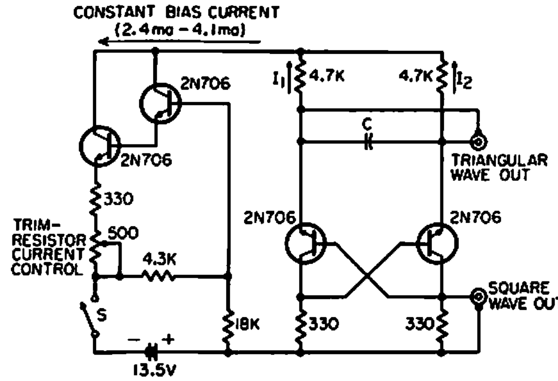


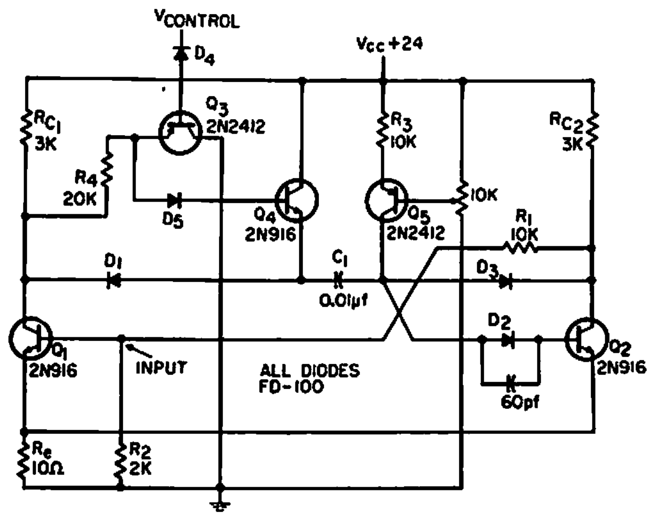
MAIN-GATE MVBR WITH DIODE LIMITER—Diode-connected triode in parallel with output tube plate limits positive swing at this point. Circuit is triggered by blocking-oscillator pulse through normally-on tube cathode resistor.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10–4.



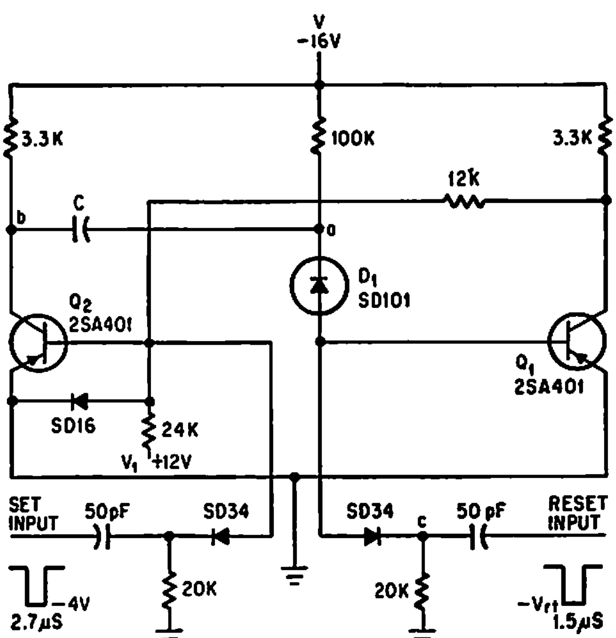
SCR SWITCHING—Scr's switch 0.75 amp into solenoid load at 20 cps with high reliability, simplicity, and low cost. For monostable mode, remove supply voltage from B and apply single +150-v pulse to A.—H. D. Valliant, Scr Multivibrator Switches Reliably, Electronics, 38:5, p 95.

CONTINUOUSLY VARIABLE PRR—When basic mvbr is biased from constant-current source, tops of square wave become flat across collector resistor, and triangular wave across capacitor becomes linear. Pulse repetition rate then varies directly with magnitude of constant biasing current, over range of 5.6 cps to 2.68 Mc, by using only seven different capacitance values for C (from 330 pf to 100 mfd).—J. H. Bayne, Jr., and R. J. Haislmaier, Improved Multi with Continuously Variable Rep Rate, *EEE*, 13:5, p 44–45.

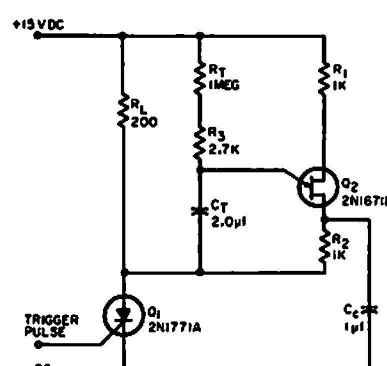




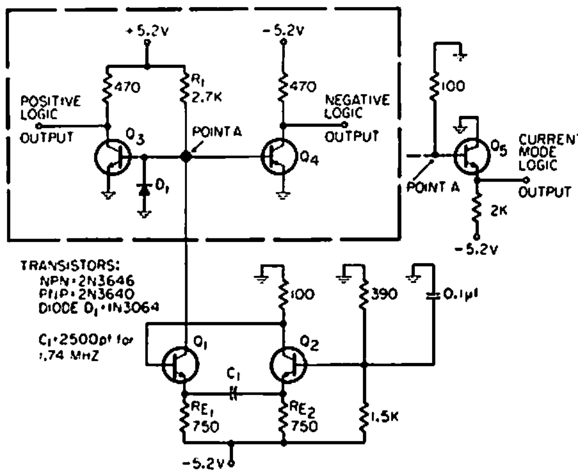
FAST-RECOVERY ONE-SHOT—Dynamic period can be varied linearly over range of 20 to 425 microsec. Retrigger time is only 3 microsec for short periods and 14 microsec for longest periods. Circuit is conventional except for d-c isolation diode D1 and drive resistor R4.—R. S. Hughes, A Linear, Voltage-Variable One-Shot With Fast Retrigger Time, *EEE*, 13:5, p 78–79.



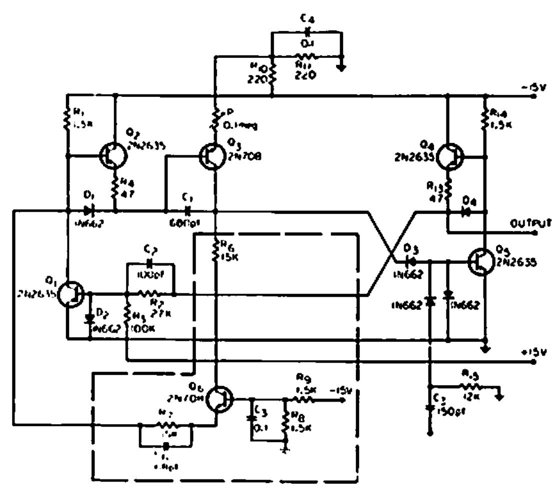
REDUCING RESET POWER LEVEL—Addition of diode D1 to conventional mvbr decreases required amplitude and duration of reset pulse. —H. Inose and T. Tomiyama, Diode Lowers Multi's Reset Power Level, *Electronics*, 39:13, p 76–77.



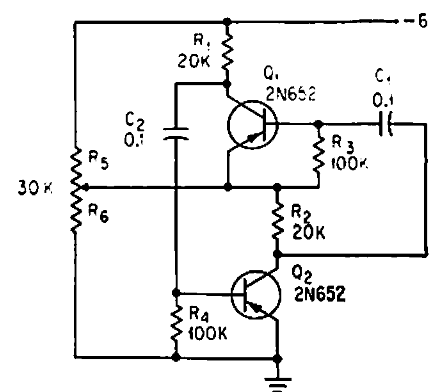
VARIABLE-POWER ONE-SHOT—Switches load currents from few ma to over 1 amp for precise time interval ranging from few millisec to one minute. Is excellent solid-state substitute for slug relays, dashpots, and thermal timers. Several stages can be cascaded to form sequence timer. With values shown, and RT at 680K, 1-v trigger pulse initiates 1-sec on period.—J. C. Rich and R. D. Turner, Variable Time, Power One-Shot Multivibrator, *EEE*, 12:7, p 25–26.



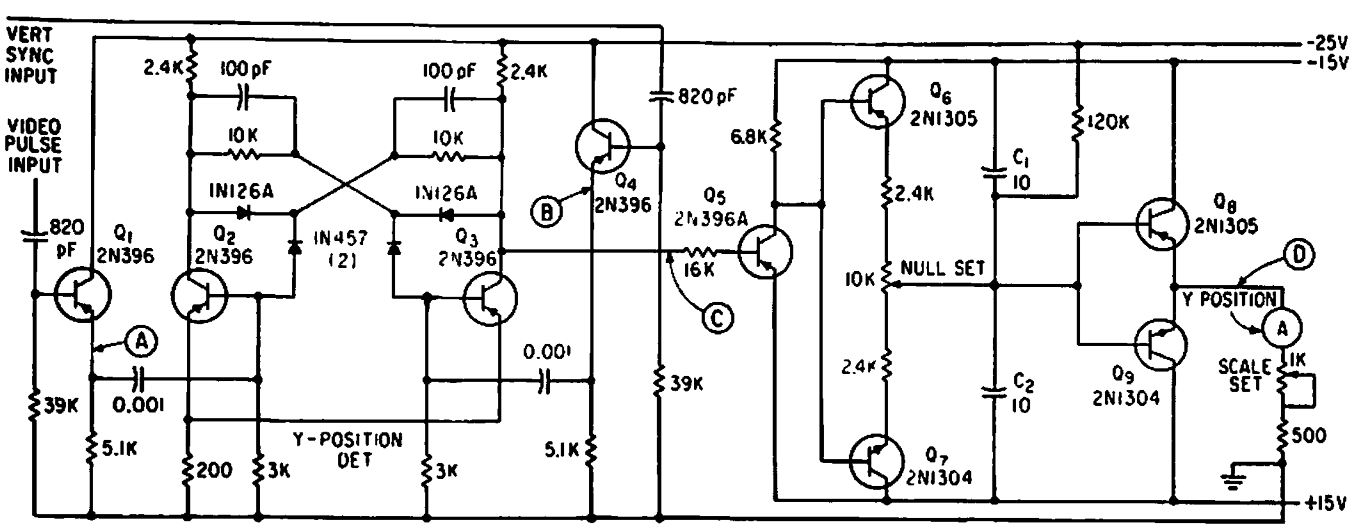
EMITTER-COUPLED ASTABLE LOGIC DRIVER—Self-starting design gives good frequency stability along with high-speed saturated positive and/or negative outputs. Current-mode logic output is optional, being obtained when circuit Q3-Q4 in dashed box is replaced by circuit of Q5. C1 determines operating frequency in range from 50 cps to 8.5 Mc.—D. R. Hoppe, Emitter-Coupled Astable With Saturated Output, *EEE*, 14:7, p 106.



WIDE-RANGE MONO—Adding one transistor (Q6) to linear one-shot increases frequency range 150 times.—G. Marosi, Wide Range Monostable Multivibrator, *EEE*, 13:9, p 76.

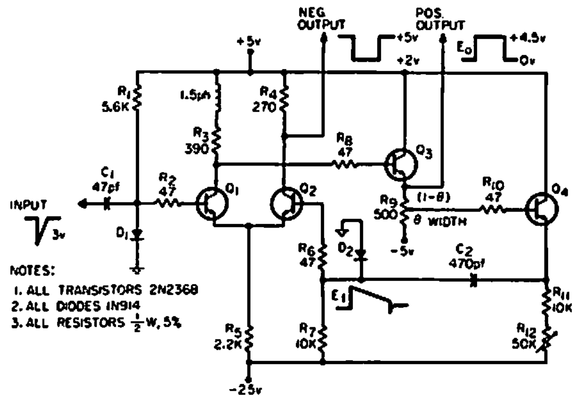


TRANSISTORIZED FREE-RUNNING CASCODE MULTIVIBRATOR—Output waveform can be rectangular or sawtooth, with polarity depending on setting of potentiometer.—C. Sing, Advantages of Free-Running Cascode Multivibrators, Electronics, 37:5, p 28–29.

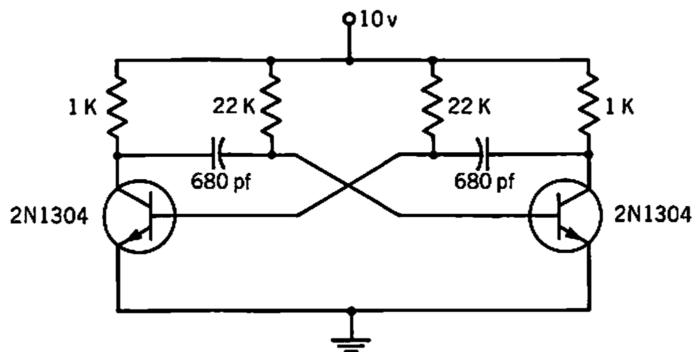


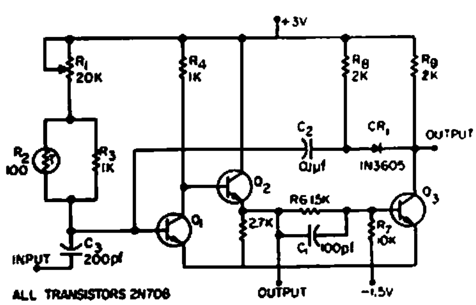
Y-POSITION DETECTOR FOR MISSILE TRACKER—Flip-flop Q2-Q3 is triggered by processed video pulse fed through Q1 and by delayed vertical sync pulse fed through Q4. Width of flip-flop output pulse, related to target position, is integrated by Q6-Q7 and amplified by Q8-Q9 to give d-c output voltage proportional to Y-position of target.—T. L. Poppelbaum, TV Camera Tracker: Can it Detect Missile Decoys? *Electronics*, 36:17, p 51–55.

ADJUSTABLE-DUTY-CYCLE MONO—When ratio of pulse width to pulse spacing exceeds value set by R12, width of output pulse is automatically reduced to maintain duty cycle at preset maximum. Used as pulse driver for high-power amplifier when duty cycle must be limited to prevent overheating. If duty cycle is set for 50% and frequency is increased, output will be square wave for all frequencies up to maximum frequency limit for circuit. R9 adjusts output pulse width from 0.7 to 7 microsec.—D. N. Lee, Monostable Multi With Adjustable Duty Cycle, *EEE,* 13:9, p 92–94.

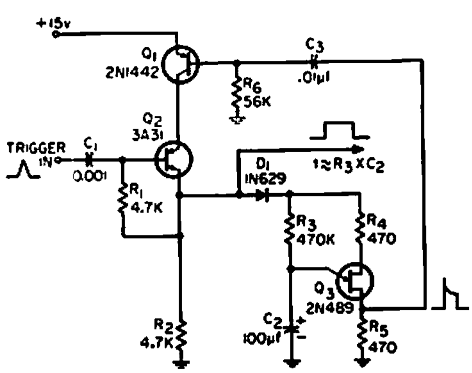


50-KC FREE-RUNNING MVBR—Uses 2N1304 transistors having base-emitter breakdown of −25 v, making emitter diodes unnecessary.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 380.

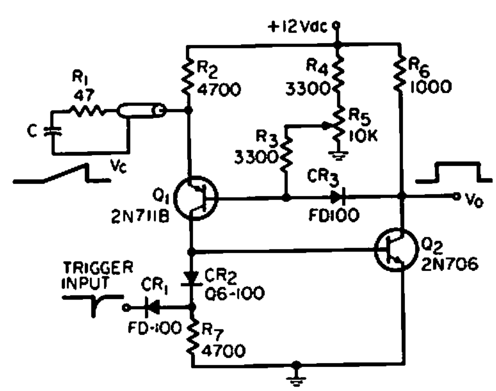




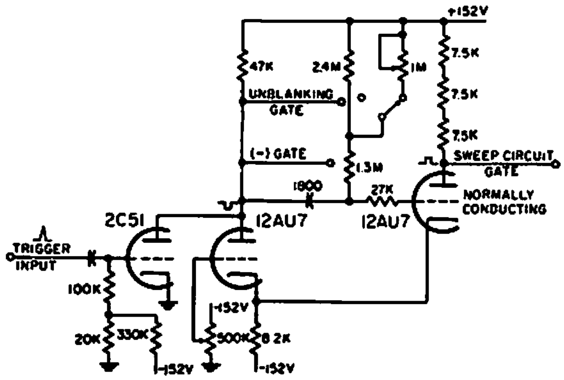
THERMISTOR COMPENSATED ONE-SHOT—Negative-temperature-coefficient thermistor in pulse width determining network keeps pulse width of mvbr constant within 0.6% over range of 25°C. Basic period with values shown is 357 microsec, increasing to 359 microsec at temperature extremes.—B. Hedin, Temperature-Compensated One-Shot, *EEE,* 12:5, p 75.



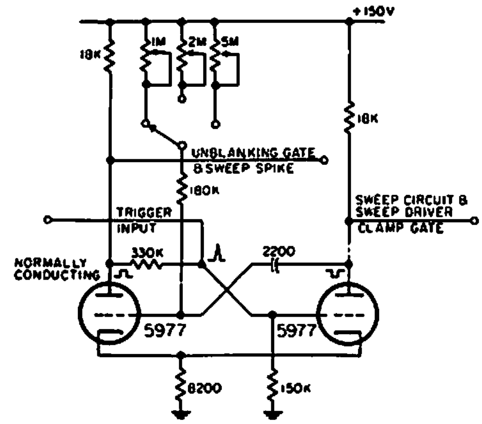
ULTRA-LONG MONO—For applications having only light loading. If required to drive heavy loads, standby efficiency is reduced, and C3 must be so large that circuit could be accidentally turned off by negative supply bus transients.—J. C. Schaeffert and N. F. Goldman, Improved Ultra-Long Monostable Multivibrator, *EEE,* 12:12, p 57–58.



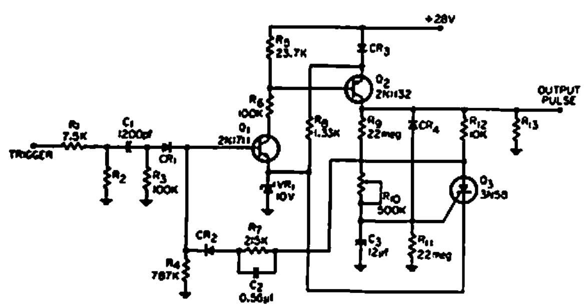
FAST-RECOVERY ONE-SHOT—Pulse width can be varied from 0.1 microsec to 10 millisec in decade ranges by changing timing capacitors. Used in commercial radar range unit and in pulse analyzer.—J. Rogers, Fast-Recovery One-Shot Multi Gives 10:1 Width Control, *EEE,* 14:4, p 44–45.



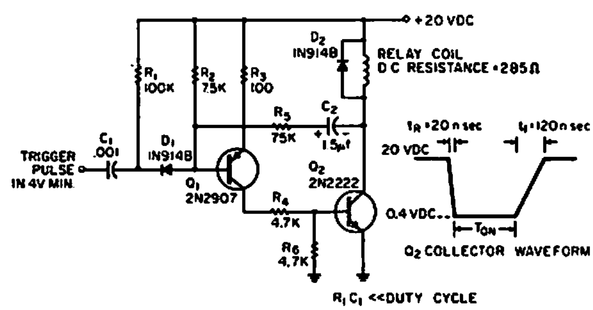
CATHODE-COUPLED MAIN-GATE MVBR—Positive gate is d-c coupled from plate of normally-on tube to cathode follower whose cathode resistor is common with diode clamp of main-gate mvbr. Negative gate for unblanking is taken from plate that is a-c coupled to opposite grid of mvbr.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-2.



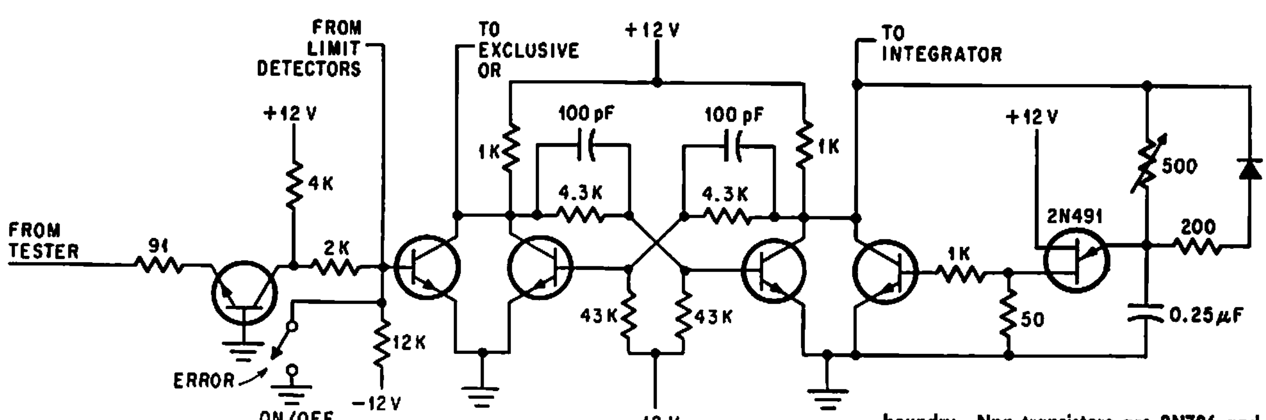
DOUBLE-COUPLED MAIN-GATE MVBR—Uses both cathode and plate-to-grid coupling, with gate length changed by switching of potentiometers. Used in radar to provide gate during which display sweep is generated, along with gates for waveforms that must be coincident with display sweep.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-3.



LONG-PULSE MONO—Advantages are high current gain, long pulse width with relatively small timing capacitance, and low dissipation when off. Pulse width is 11 sec. Drives 19.6K load.—J. M. Meuer, High-Gain, Long-Pulse Monostable, *EEE*, 14:4, p 41.

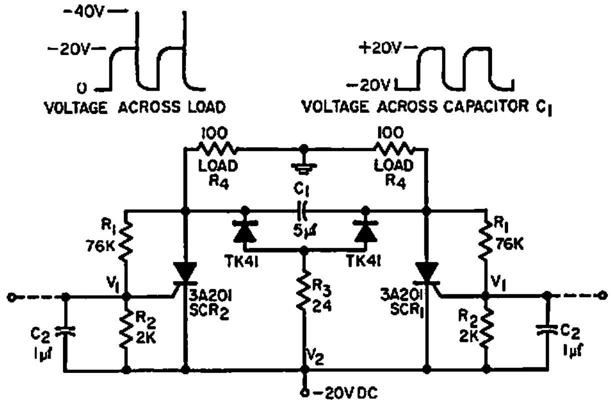


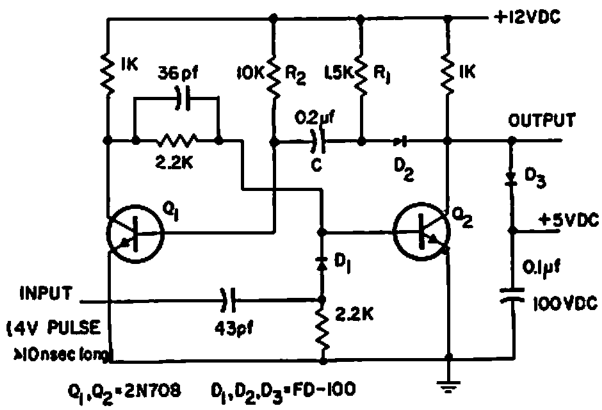
POWER ONE-SHOT—Complementary-symmetry one-shot supplies 1.4 w for 0.1 sec to relay coil on very low duty cycle, without drawing standby power. Used to discharge large 10-kv capacitor.—W. P. Mitchell, Power One-Shot, *EEE*, 13:6, p 68.



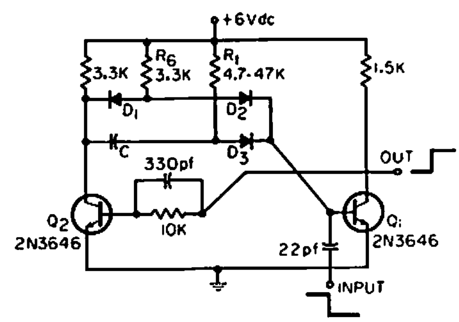
SINGLE-SHOT FOR SHMOO PLOTTER—Used for automatic testing of computer memories under marginal drive currents. Error in memory causes monostable mvbr to generate pulse half as long as complete pass through storage, to make system track along error boundry. Npn transistors are 2N706 and the diode is 1N921.—J. E. Gersbach, The Great Shmoo Plot: Testing Memories Automatically, *Electronics*, 39:15, p 127–134.

HIGH-POWER ASTABLE—Simple astable circuit design eliminates external trigger, minimizing number of components. Voltage dividers R1 and R2 provide gate voltage for scr's. Both dividers start charging associated capacitors C2 until one scr breaks down, initiating oscillation. Used in converter power supplies.—W. B. McCartney and E. O. Uhrig, Astable High Power Multivibrator, *EEE*, 10:12, p 30–31.

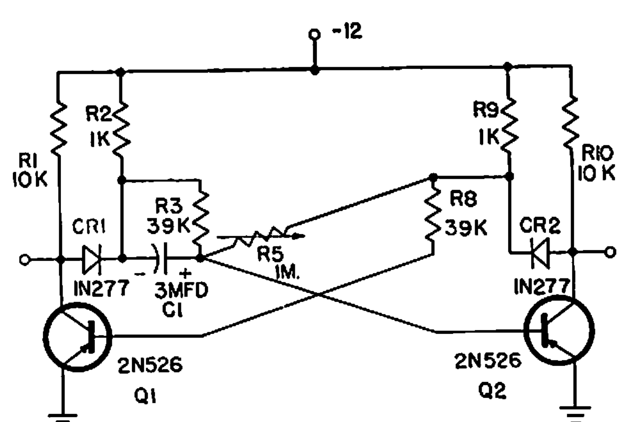




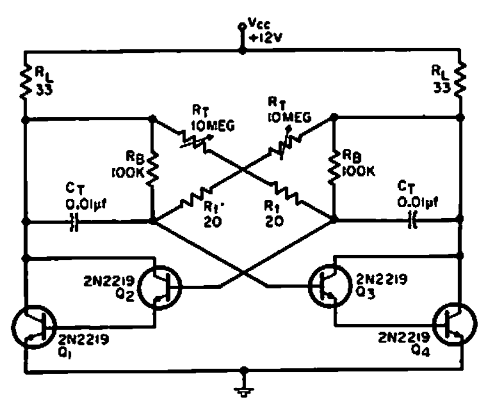
FAST-TURNOFF MONO—Has long delay time along with fast rise and fall times (each 30 nsec). Pulse amplitude is clamped at 5 v.—Fast Turnoff Monostable Multivibrator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 69.



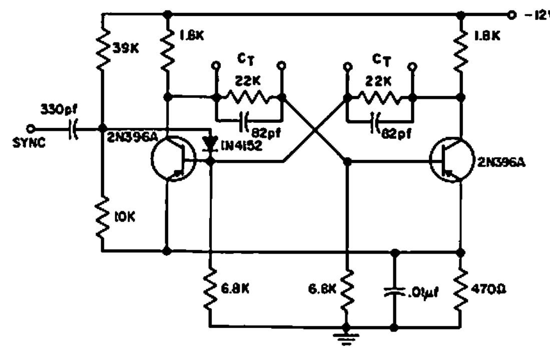
IMPROVED TRIGGERING OF MONO—Addition of three diodes and one resistor to conventional monstable mvbr permits increasing value of timing resistor Rt without making circuit susceptible to false triggering.—H. Cohen, Eliminating False Triggering in Monostable Multis, *EEE*, 14:8, p 168.



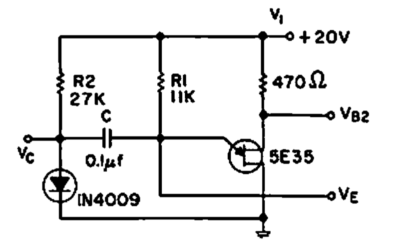
1,200:1 PULSE-WIDTH MONO—Output pulse width at collector of Q2 can be varied from 0.5 to 300 millisec. With suitable trigger, serves as one-shot for variety of uses.—Wide Range Variable Multivibrator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 110.



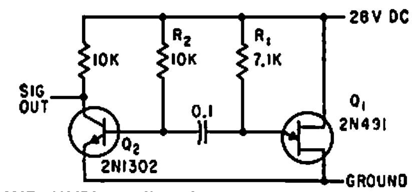
100 CPS TO 1 MC ASTABLE—Gives frequency change of 10,000 with reasonably good linearity over most of operating range. Two parts of timing cycle can be varied independently over wide range.—W. J. Mattox, A Versatile, Very-Wide Range Multivibrator, *EEE*, 13:7, p 59–61.



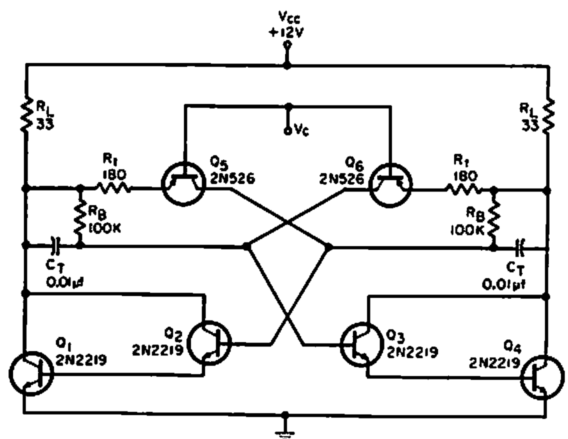
1 CPS-250 KC ASTABLE MVBR—Used as free-running oscillator for generating square waves and timing frequencies, and for frequency division. Synchronizing pulses permit generation of subharmonics. Sync pulse amplitude must exceed +1.5 v with rise time less than 1 microsec.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 201.



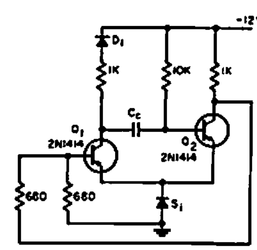
400-CPS UJT MVBR—Off time is determined primarily by R1, and on time primarily by R2. Frequency is inversely proportional to size of capacitor.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 340.



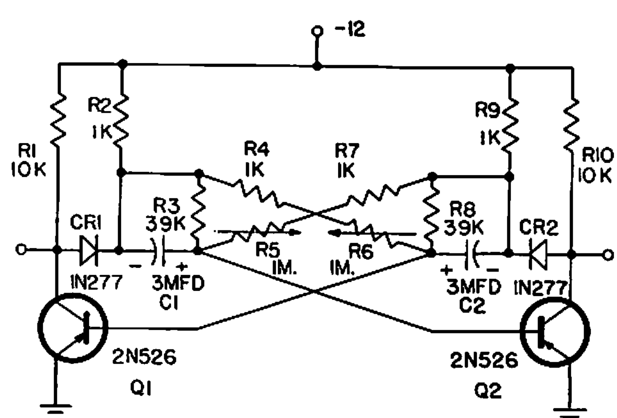
UJT MVBR—Unijunction transistor serves as multivibrator, with Q2 amplifying its output and providing isolation from load.—F. W. Kear, Unijunction Transistor Pulse-Circuit Design, *Electronics*, 35:21, p 58–60.



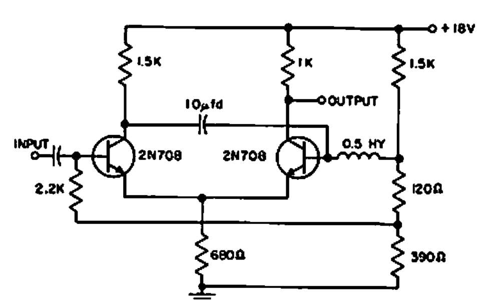
VOLTAGE CONTROL OF ASTABLE MVBR—Addition of two transistors to basic astable mvbr gives voltage-controlled constant-duty-cycle variable-frequency operation. Frequency range is 210 cps to 210 kc, ratio of 1,000 to 1, with less than 5% departure from linearity with change in control voltage.—W. J. Mattox, A Versatile, Very-Wide Range Multivibrator, *EEE*, 13:7, p 59–61.



TRANSIENT-IMMUNE MONO—Diode in series with cutoff collector load of Q1 provides protection against undesirable triggering by power supply transients.—W. B. Smith, Jr., Transient-Protection of Monostable Multivibrators, *EEE*, 11:3, p 38–39.

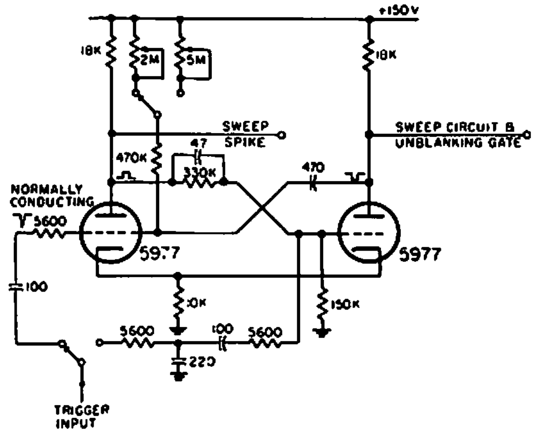


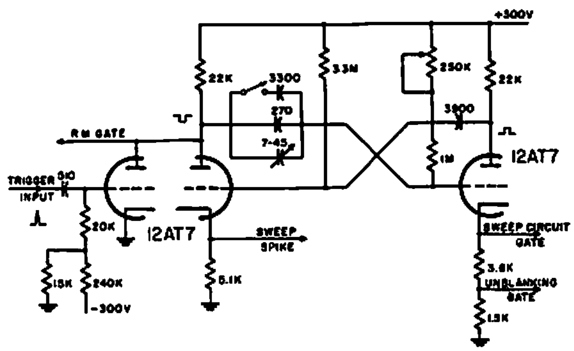
120:1 FREQUENCY-RANGE ASTABLE—Modified astable has frequency change of 5 to 600 millisec at 50% duty cycle, with symmetry variable by 97.5%. Can be used as pattern source for generating keyed d-c or keyed tone signals for testing digital communications and data processing equipment.—Wide Range Variable Multivibrator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 109.



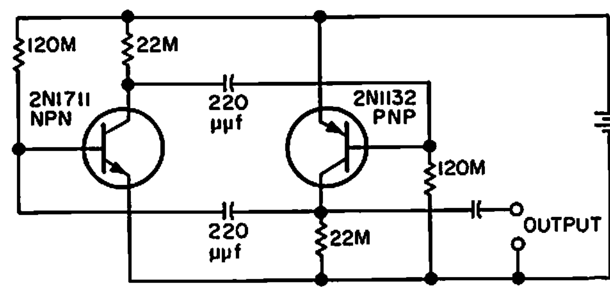
600-MICROSEC OUTPUT-PULSE MONO—Similar to flip-flop except that one cross-coupling network permits a-c coupling only. Flip-flop can therefore remain in its unstable state only until reactive components discharge. Use of inductor in place of capacitor for timing gives much better pulse width stability at high temperatures. Operating range is −55 to 71°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 201.

DOUBLE-COUPLED MAIN-GATE MVBR—Uses both cathode and plate-to-grid coupling, with gate length changed by switching of potentiometers. Differentiated negative gate from delay mvbr is applied as trigger to grid of normally conducting tube if undelayed range sweep is desired, or to grid of normally-off tube when delayed sweep is used.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-3.

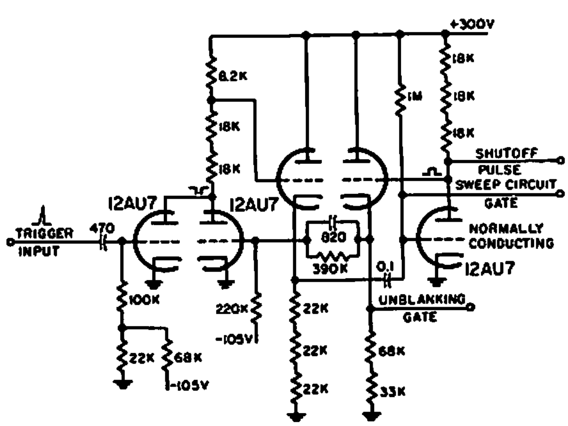




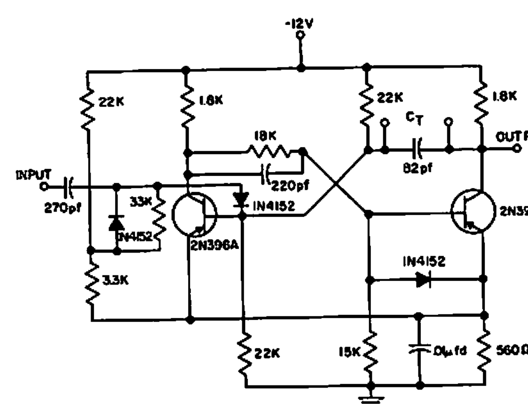
SYNCHRONIZED ASTABLE MAIN-GATE MVBR—Used in combination search and gun-laying radar. Different gate lengths are obtained by switching capacitors. Provides positive unblanking gate.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-4.



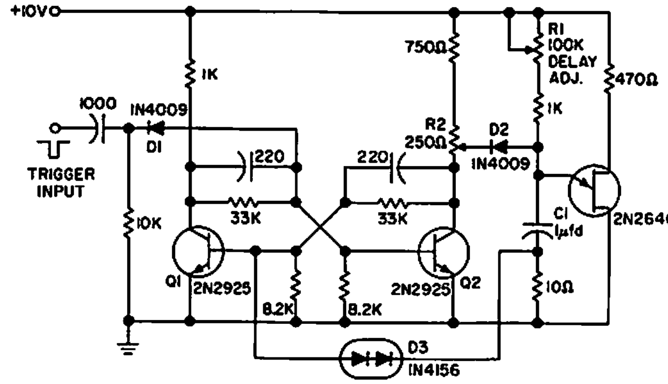
0.01-MICROWATT 40-CPS MVBR—Both npn and pnp transistors conduct at same time for part of cycle, and both are cut off for remainder of cycle, so average power consumed is much less than when one transistor always conducts. Frequency is 40 cps. With 0.6-v supply furnishing 0.015 microamp, total power consumption is 0.009 microwatt. —W. G. Shepard, A 0.01 Microwatt Multivibrator, *EEE*, 10:8, p 29.



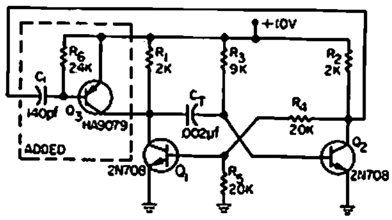
CATHODE-FOLLOWER COUPLING FOR MAIN-GATE MVBR—Triode cathode-followers provide coupling from plate to grid of radar main-gate mvbr. Provides positive unblanking gate.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-2.



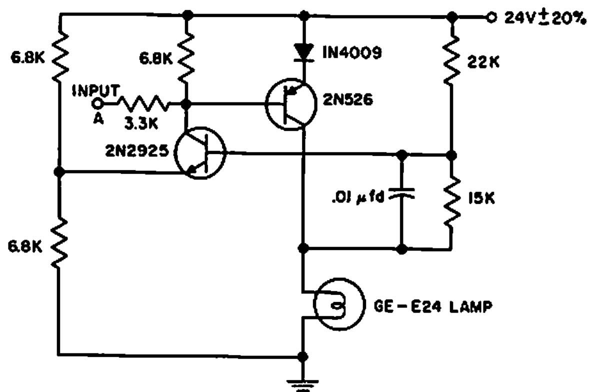
250-KC MONO—When triggered by input pulse up to 5 v, switches to unstable state and remains for predetermined time before returning to original stable state. Used for standardizing random-width pulses and generating time-delayed pulses. Output pulse duration range is 2 microsec to 1 sec. Maximum input frequency is 250 kc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 201.



FAST-RECOVERY HYBRID ONE-SHOT—Improved configuration provides wide timing range, good timing stability, and clean waveforms over extremely wide range of duty cycles. Can be retriggered immediately after completion of timing cycle without loss in overall timing accuracy.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 346.



SPEEDING ONE-SHOT RECOVERY—Additional transistor Q3 reduces charging time of timing capacitor, thereby increasing duty cycle. With values shown, circuit provides 10-microsec pulses with recovery time of 0.25 microsec, corresponding to repetition rate of almost 100,000 pps and 97.5% duty cycle.—W. A. Ross, Added Transistor Reduces One-Shot Recovery Time, *EEE*, 12:4, p 60.



BISTABLE INDICATOR LAMP DRIVER—Permits controlling lamp with short trigger pulses, for control panel of computer. Negative 2-v trigger at A turns on lamp, which then remains on due to regenerative feedback in circuit. Positive pulse at A turns out lamp. Use of complementary-type transistors minimizes standby power when lamp is out.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 202.

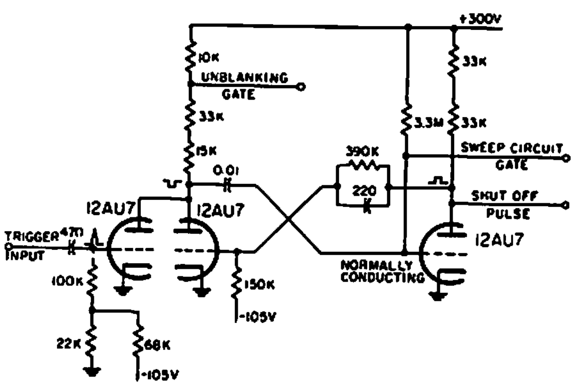
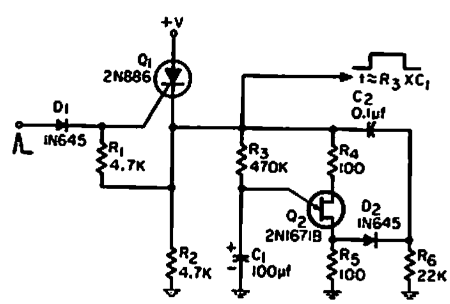
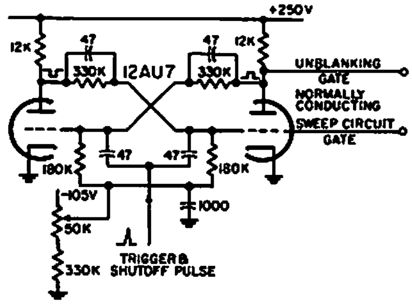


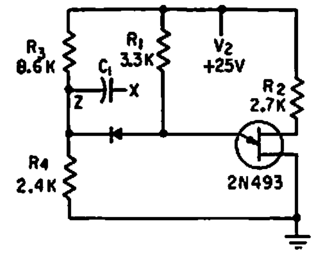
PLATE-TO-GRID COUPLED MAIN-GATE MVBR—Triggered by connecting plate of trigger inverter or switch tube in parallel with plate of normally-off mvbr tube. Unblanking gate is generated at mvbr as negative output. Used in radar to provide gate during which display sweep is generated, together with gates for generating waveforms that must be coincident with display sweep.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-2.



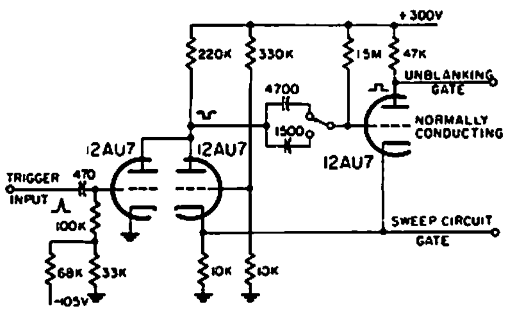
IMPROVED ULTRA-LONG MONO—Elimination of reset transistor and coupling diode makes circuit insensitive to supply bus transients, cuts standby current to essentially zero, and improves efficiency under heavy loading. Will handle loads above 150 ma.—J. C. Schaeffert and N. F. Goldman, Improved Ultra-Long Monostable Multivibrator, *EEE*, 12:12, p 57–58.



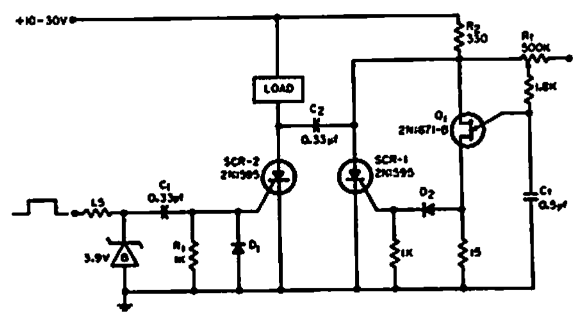
BISTABLE MAIN-GATE MVBR—Provides positive unblanking gate. Used in radar to provide gates during which displayed sweep is generated, along with gates for waveforms that must be coincident with display sweep, but monostable mvbr is generally preferred for this application.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-3.



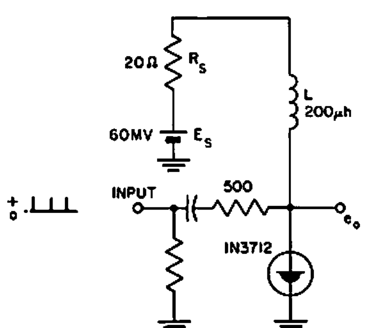
UJT BISTABLE WITH DIODE DECOUPLING—Needs only small negative trigger at X for turnoff.—T. P. Sylvan, Bistable Circuits Using Unijunction Transistors, *Electronics*, 31:51, p 89–91.



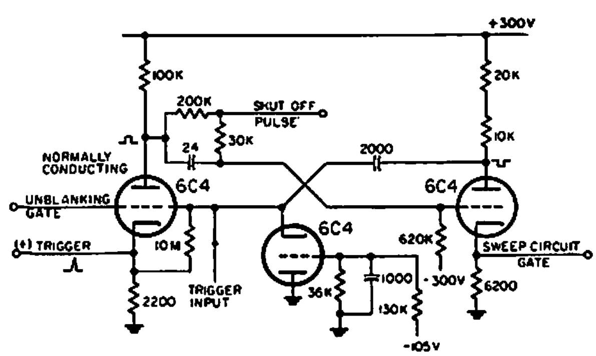
CATHODE-COUPLED MAIN-GATE MVBR—Provides positive unblanking gate. Used in radar to provide gate during which display sweep is generated. Capacitor switching provides choice of gate lengths.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-2.



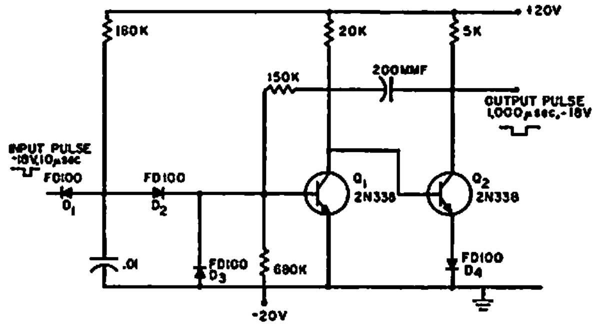
HIGH-POWER ONE-SHOT—Operates from random-amplitude (10 to 28 v) square-wave input having 1 to 6.5 sec random duration, and switches 20-w load for adjustable period of 5 to 200 millisec. Can easily be adapted for transient detection, pulse-width adjustment, and time delays.—G. T. Pennell, High-Power One-Shot Multi, *EEE*, 12:9, p 62.



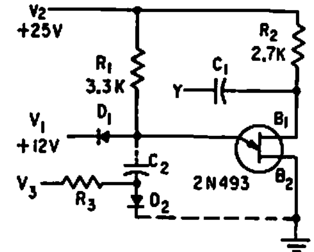
TUNNEL-DIODE MONOSTABLE—Used as pulse-controlled oscillator. Power consumption is very low.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 366.



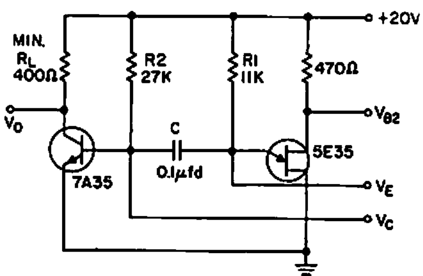
MAIN-GATE MVBR WITH TRIODE LIMITER—Triode connected to grid of normally-on tube limits swing of voltage. Plate of shutoff tube is tied to point in d-c coupling network between plate and grid, to give greater flexibility in setting plate voltage level of shutoff tube.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N10-5.



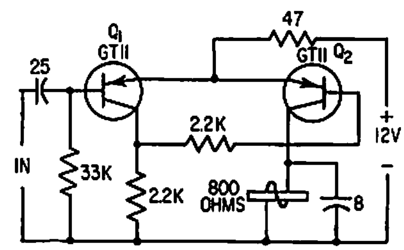
MONO WITH NEGATIVE RECOVERY TIME—Will respond to input pulses occurring even before end of output pulse, which in effect gives negative recovery time. If circuit begins normal 1,000-microsec cycle and another trigger pulse arrives in 500 microsec, output pulse will last 1,500 microsec, or 500 microsec longer than usual. In other words, output pulse continues for 100 microsec after last trigger pulse. Input pulses should be of standardized voltage and long enough to discharge 0.01-mfd capacitor.—Monostable Circuit with Negative Recovery Time, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 72.



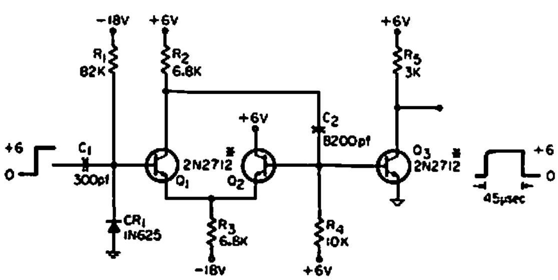
UJT BISTABLE WITH CLAMP—Clamping diode holds emitter voltage below peak-point voltage. When negative trigger at base B2 turns on transistor, D2 is back-biased and R1 becomes emitter load. Operation is stable if capacitance between emitter and base B1 is kept below critical value.—T. P. Sylvan, Bistable Circuits Using Unijunction Transistors, *Electronics*, 31:51, p 89–91.



TRANSISTOR-UJT MVBR—Uses low-cost 7A35 silicon mesa transistor.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 341.

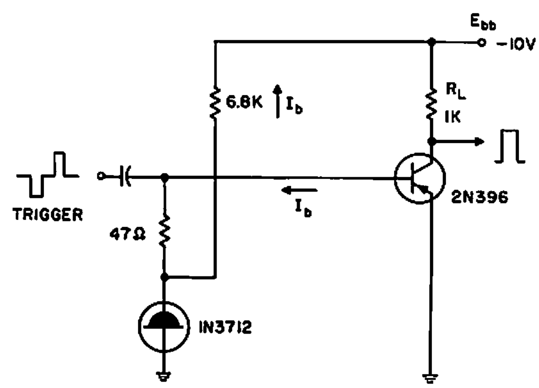


MULTIVIBRATOR-CONTROLLED RELAY—Control signal is used to trigger mvbr that operates relay when input signal is greater than predetermined level (about 10 mv), and releases relay immediately when signal falls below this level.—G. B. Miller, Multivibrator Operates Relay, *Electronics*, 31:49, p 106–112.



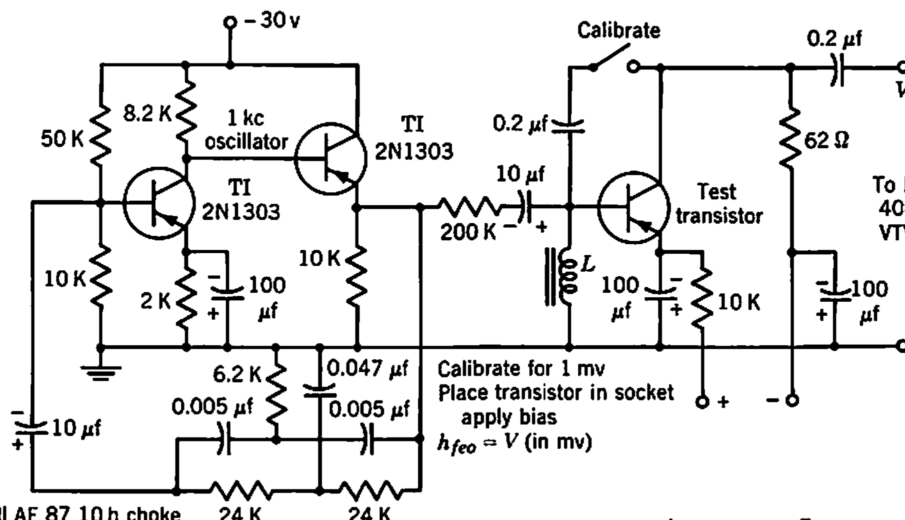
*Q_2, Q_3 $V_{BEO} > 8V$

IMPROVED ONE-SHOT—Improvement of basic circuit uses less power and fewer components, while providing higher timing accuracy.—T. G. Ellestad, Improved One-Shot Output Circuits, *EEE*, 13:8, p 67.

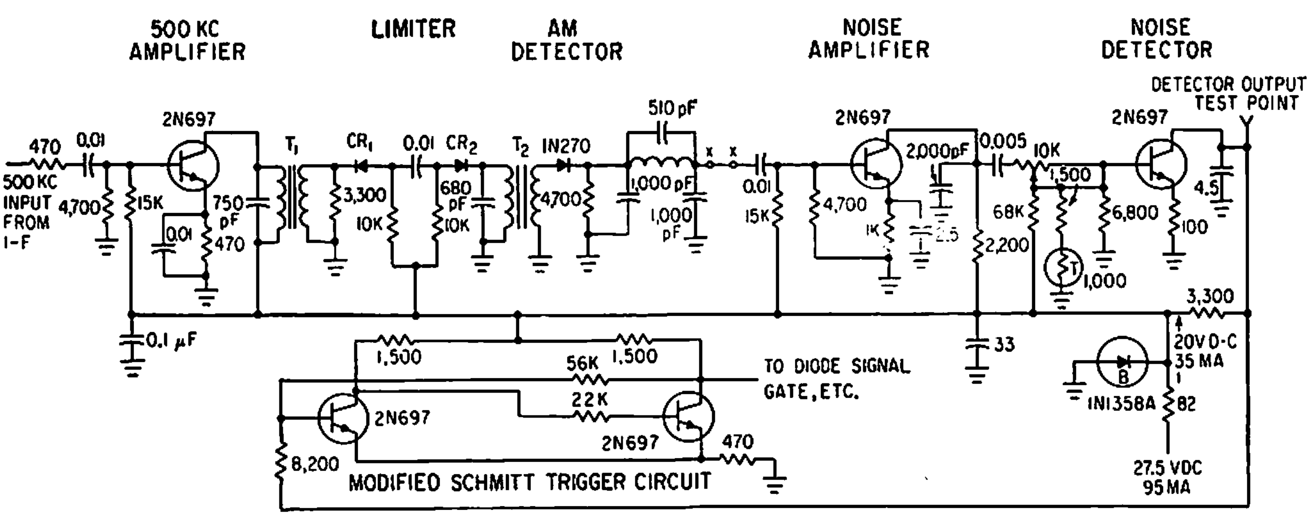


BISTABLE TD-TRANSISTOR—Fast switching speed of tunnel diode contributes to output waveform.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 367.

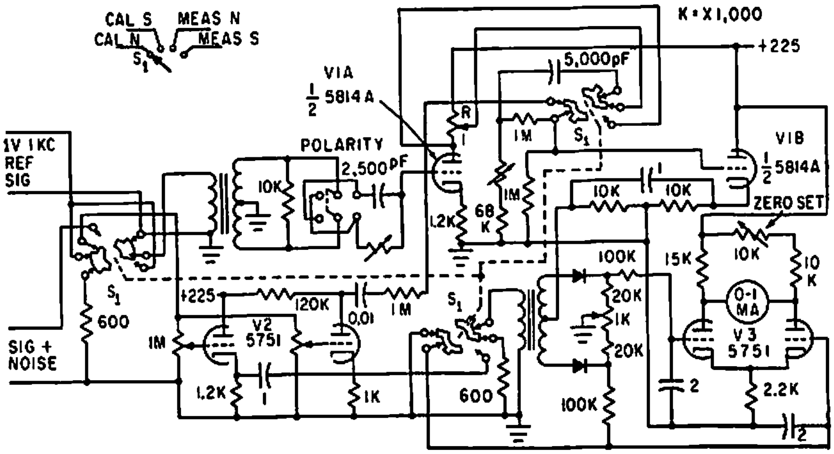
CHAPTER 55
Noise Circuits



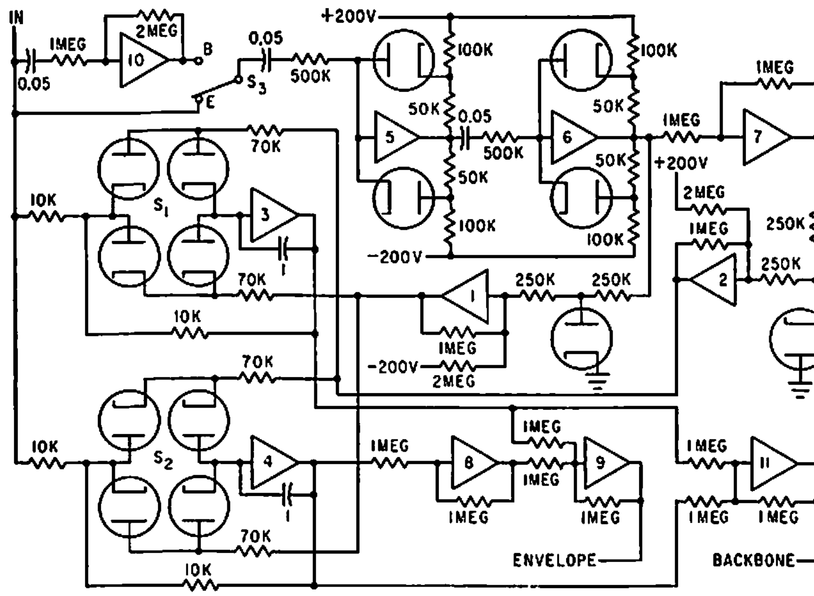
1-KC NOISE FIGURE TEST SET—Used in measuring low-frequency common-emitter short-circuit forward current transfer ratio h-feo, which is one of the parameters having greatest effect on transistor noise figure.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 304.



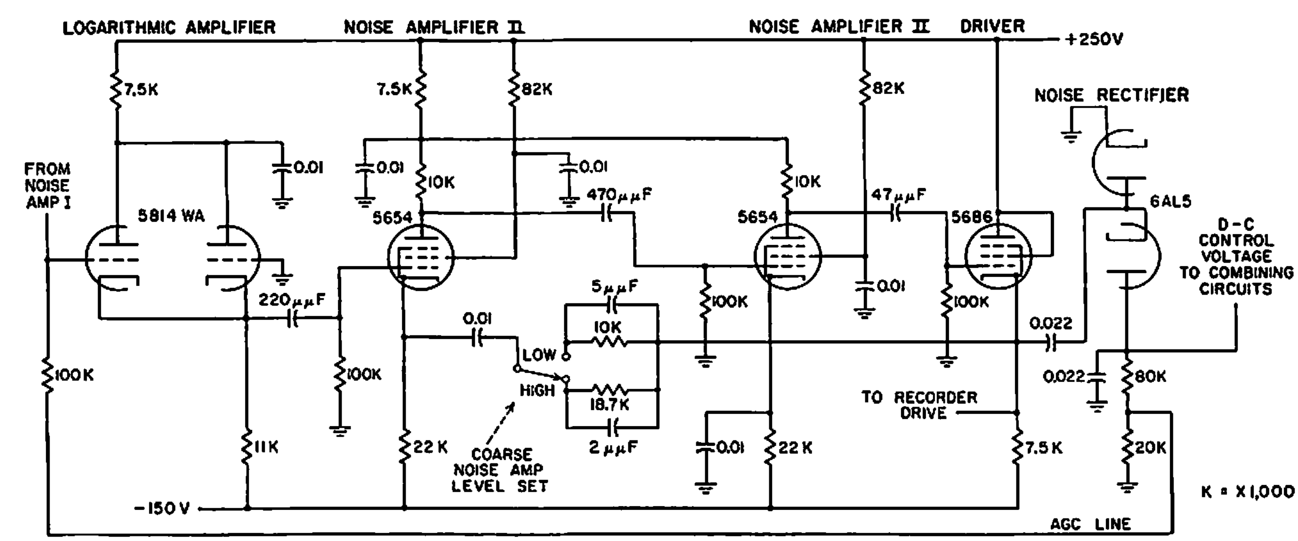
FAIL-SAFE COMMUNICATIONS SQUELCH CIRCUIT—Circuit adjusts automatically to changing noise levels in point-to-point vhf and uhf receivers while suppressing noise when no carrier is present, but stays open when receiver gain is below threshold level of 0.7 microvolt over range of 108.95 to 135.95 Mc. Schmitt trigger gives fast turn-on and turn-off of receiver audio output at predetermined carrier-to-noise ratios.—H. G. Michael, Fail-Safe Squelch Circuit Adapts to Changing Noise Levels, *Electronics*, 36:1, p 88–91.



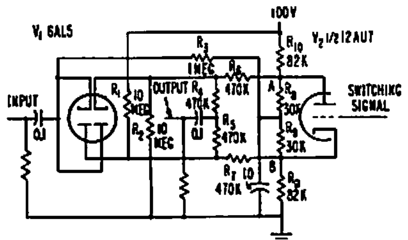
NOISE CORRELATOR—Requires two inputs, reference signal derived from modulating source and signal-pulse-noise input from receiver under test. Signal and noise components can then be measured separately.—B. T. Newman, Evaluating Radio Receiver Susceptibility to Interference, *Electronics*, 34:15, p 70–74.



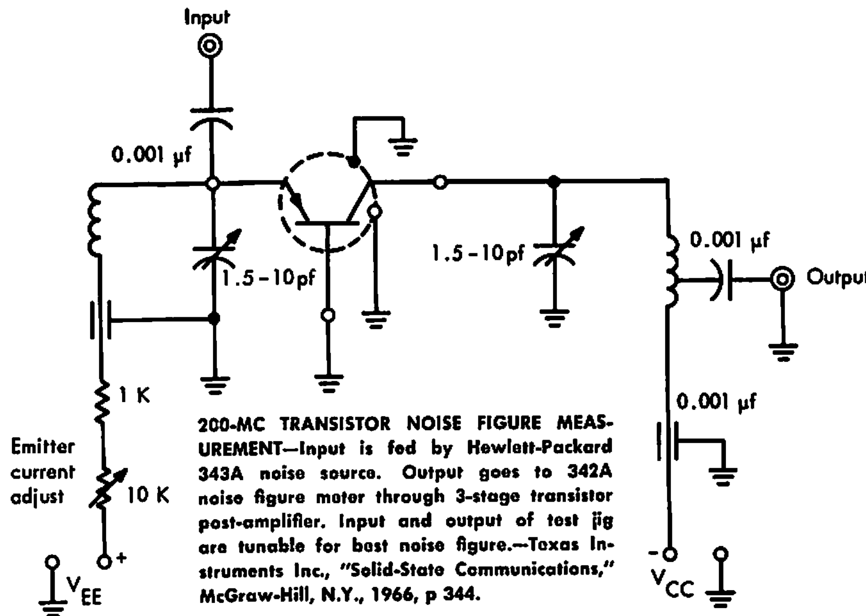
DETECTION IN NOISE—Time derivatives of noise-contaminated input signals control electronic switches which control sampling and holding unit. In mode for detection, signal is sampled at its peaks and troughs. In mode for backbone detection, involving additive noise, signal is sampled at its inflection points.—N. D. Diamantides, Nonlinear Filter Detects Envelope or Backbone, *Electronics*, 35:18, p 52–54.



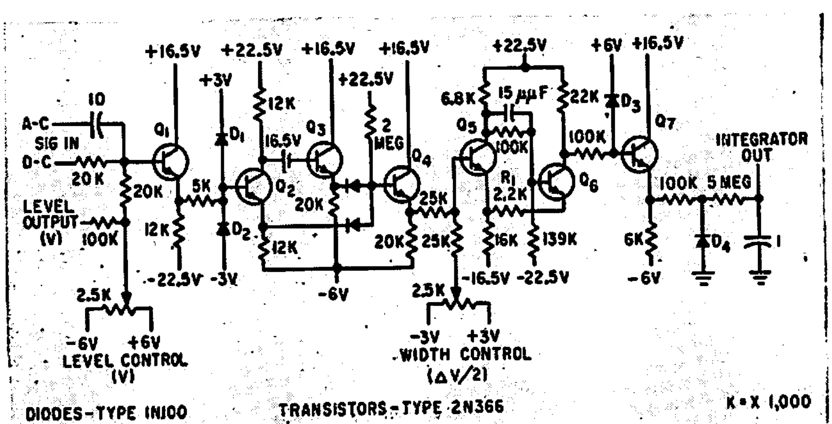
OUT-OF-BASEBAND NOISE AMPLIFIER—Provides transfer function that is essentially logarithmic, with slope of 5 to 7 db per octave, to serve as bias voltage for differential combiner of i-f amplifier in troposcatter f-m receiver. Amplifier control range extends 40 db above threshold. Signal-noise ratio of highest baseband channel is 70 db.—P. Gruber, Crystal Converter for Tropo-Scatter Receivers, *Electronics*, 31:15, p 78–82.



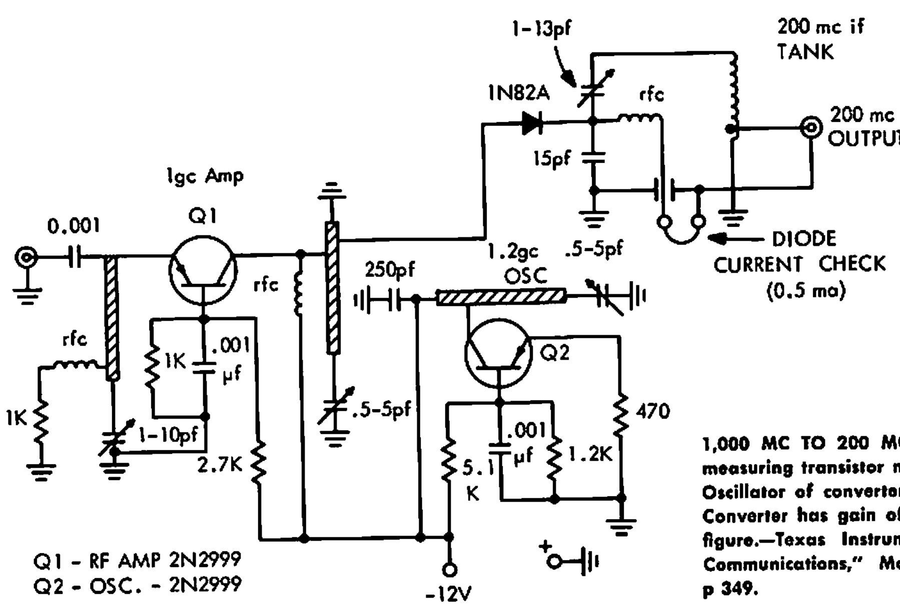
TRIODE VARIABLE-RESISTANCE THRESHOLD CONTROL SWITCH—Passes only signals above predetermined positive and negative threshold value, for suppression of audio background noise. When V2 is cut off, threshold is at highest value, corresponding to off position of switch. With V2 conducting, threshold will be low and practically all signals appear unclipped at output, corresponding to on position of switch. Provides stable, nontransient switching, independent of changes in tube characteristics.—W. E. Earle, A-C Threshold Converts to Switch, *Electronics*, 31:1, p 96–99.



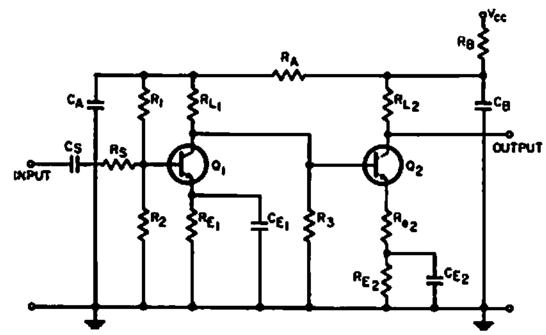
200-MC TRANSISTOR NOISE FIGURE MEASUREMENT—Input is fed by Hewlett-Packard 343A noise source. Output goes to 342A noise figure meter through 3-stage transistor post-amplifier. Input and output of test jig are tunable for best noise figure.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 344.



AMPLITUDE PROBABILITY DENSITY FUNCTION—Width of output pulse is proportional to time that input signal is between specified voltage levels. Used in statistical measurements of signals and noise.—B. M. Rosenheck, Detecting Signals By Polarity Coincidence, *Electronics*, 33:5, p 67–69.



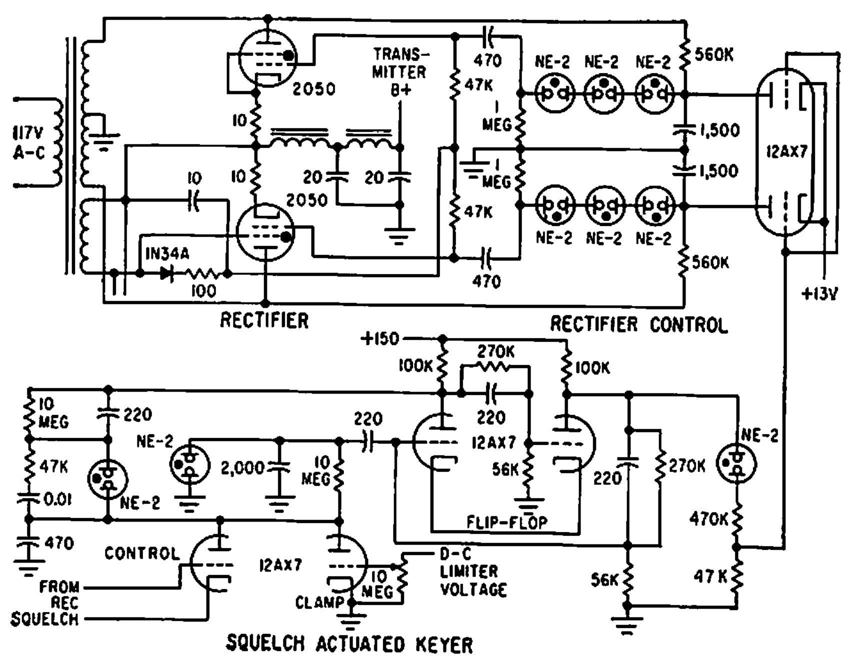
1,000 MC TO 200 MC CONVERTER—Used in measuring transistor noise figure at 1,000 Mc. Oscillator of converter operates at 1,200 Mc. Converter has gain of 10 db and 5 db noise figure.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 349.

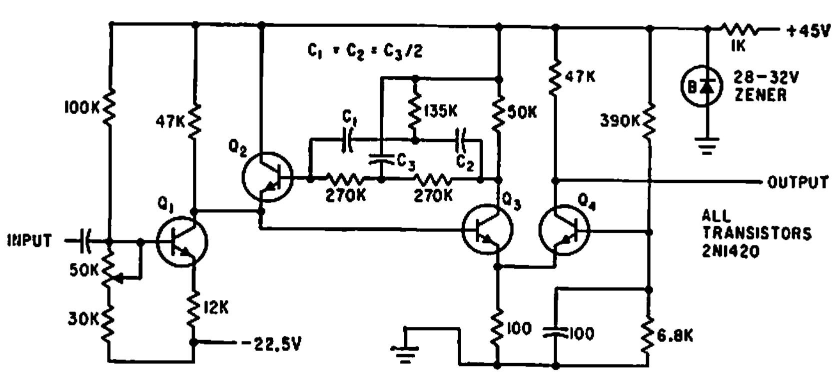


LOW-NOISE AMPLIFIER DESIGN—Article gives design procedure based on use of contour maps for 2N2524 at 100 cps, 1 kc, and 10 kc. Goal of design is to confine overall amplifier noise to that of transistor in first stage. Component values are given for three different low-noise amplifiers, each operating in a different range of collector current. —J. W. Baker, Jr., Designing Low Noise Amplifiers from Noise-Figure Contours, *EEE*, 11:10, p 56–59.

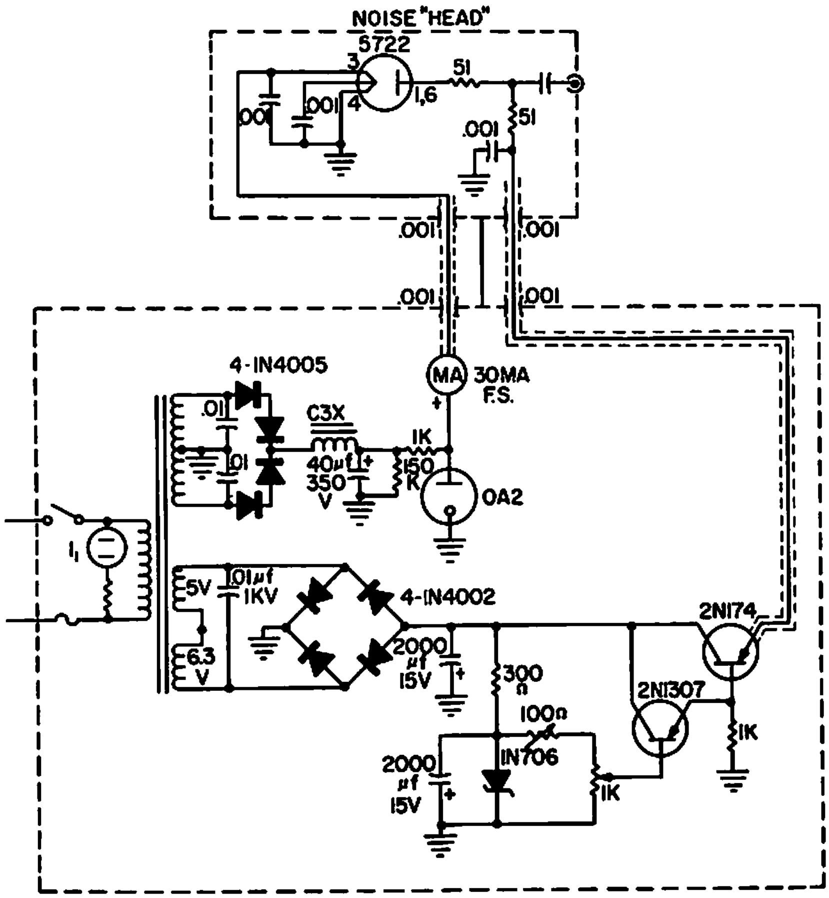
CKT	Range of I_C	C_A	R_1	R_2	R_{L1}	R_{E1}	C_{E1}	R_A	R_S	R_{L2}	R_{e2}	R_{E2}	C_{E2}	C_B	R_B
*1	50μa—500μa	10μf	130K	24K	3K	1K	220μf	7.5K	820K	24K	300	56K	25μf	4.7μf	5.1K
*2	10μa—100μa	.47μf	1.5M	240K	30K	10K	22μf	75K	6.2M	220K	3K	560K	5μf	.33μf	43K
*3	0.2μa— 20μa	.22μf	12M	2.4M	100K	100K	2.2μf	620K	10M	470K	6.2K	1.5M	2μf	.1μf	390K

SQUELCH-ACTUATED MOBILE REPEATER—Thyratrons serve as rectifiers in transmitter power supply to avoid repeater malfunctions caused by relays. When incoming signal opens receiver squelch, thyratrons conduct and provide d-c power for transmitter. Under standby conditions, flip-flop keeps thyratrons nonconducting. When relaxation oscillator is activated by squelch tube voltages, flip-flop reverses and applies pulses to thyratrons to make them conduct. This prevents transmitter from being activated by receiver failure.—L. G. Sands, Design Trends in Mobile Radio Repeaters, *Electronics*, 32:47, p 82–84.

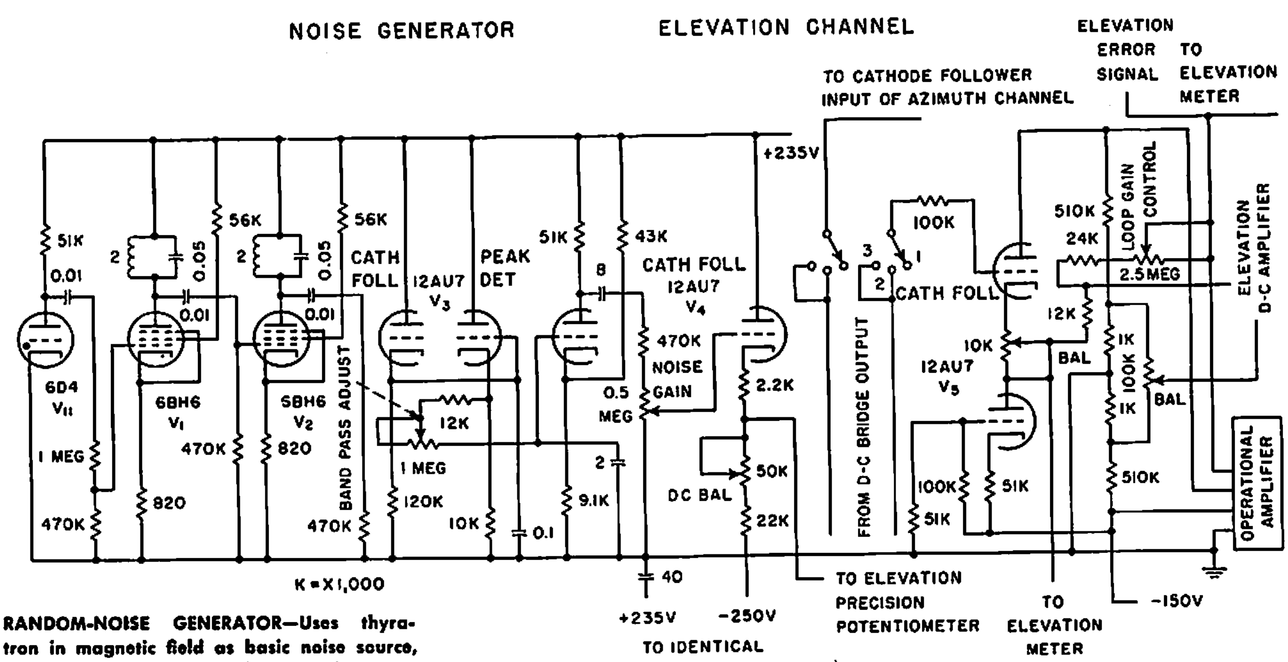




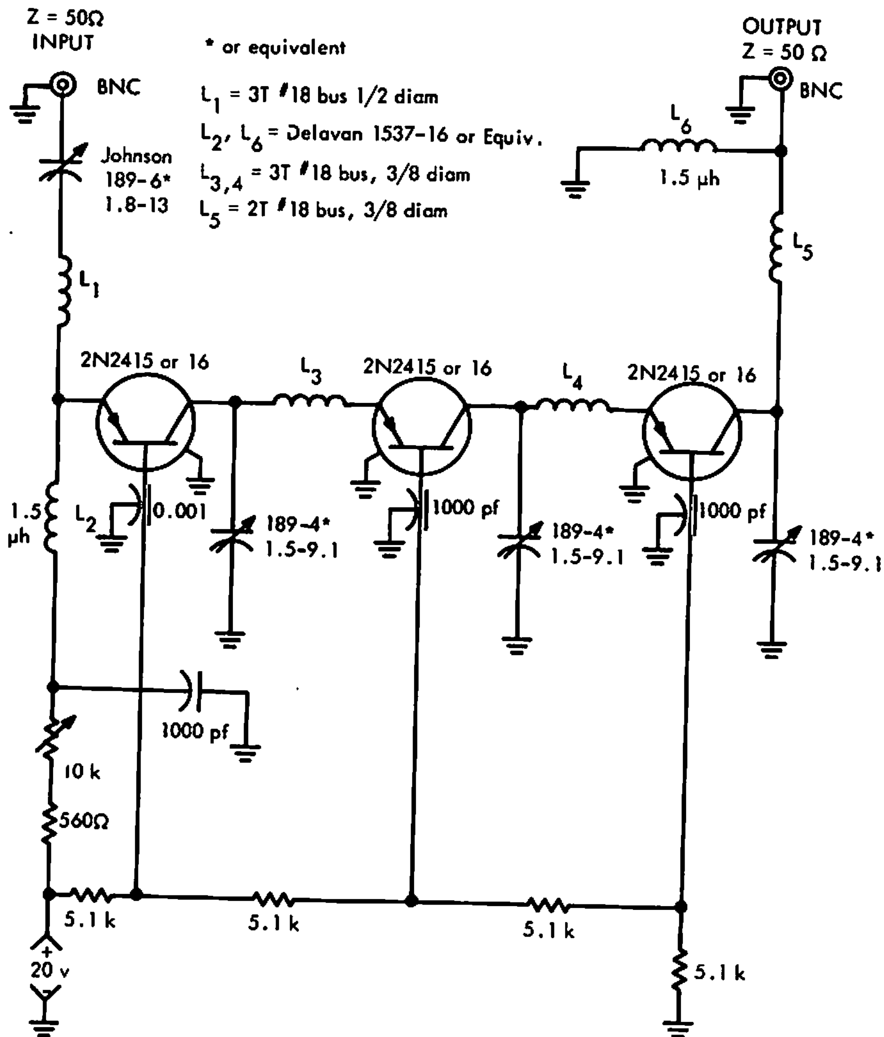
CONSTANT Q FROM 1 CPS TO 10 KC—Symmetrical parallel-T R-C rejection filter in negative feedback loop of amplifier gives Q of 28 over frequency range, for frequency-dependent noise measurements. Gain is about 5, and maximum output is about 5 v rms.—R. E. Hobson and L. Calcagno, Narrow Pass-Band Amplifier with Parallel-T Network, *Electronics*, 34:33, p 68.



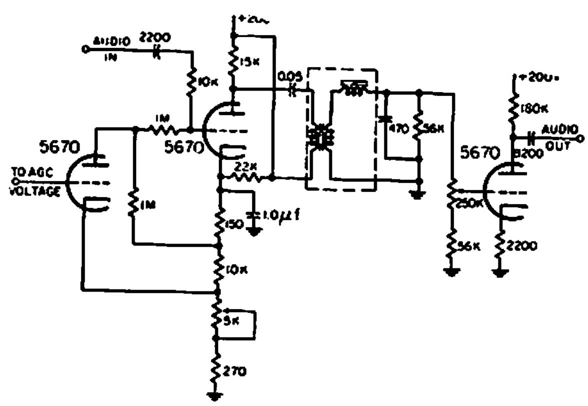
25 TO 450 MC NOISE GENERATOR—Uses conventional noise diode in shielded head. Transistor series regulator with zener diode improves performance when making noise figure measurements of communications receivers.—H. Olson and H. Howard, Noise Figure Measurement Fundamentals, *Electronic Technician*, November 1965, p 63–66 and 108.



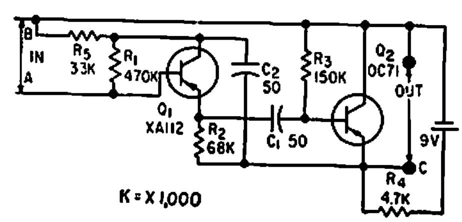
RANDOM-NOISE GENERATOR—Uses thyratron in magnetic field as basic noise source, to provide azimuth and elevation drive signals for missile radar that simulate actual tracking conditions. Eliminates need for expensive test drones in evaluating missile performance.—C. E. Hendrix, Target Simulator Tests Beam-Rider Missiles, *Electronics*, 31:5, p 32–35.



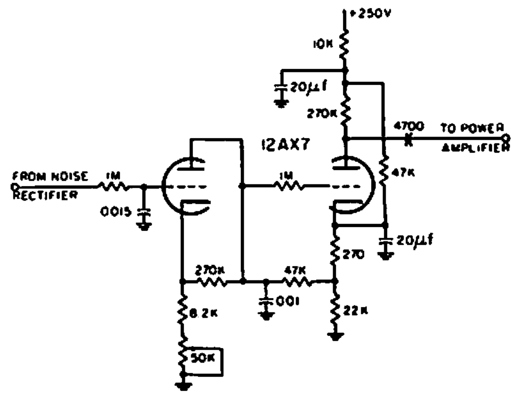
200-MC POST-AMPLIFIER FOR NOISE FIGURE METER—Cascaded common-base connection of germanium mesa transistors gives power gain of 40 db, bandwidth of 25 MC, and a noise figure of 3 db. Used between test jig and Hewlett-Packard 342A noise figure meter for measuring noise figure of transistors at 200 Mc.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 345.



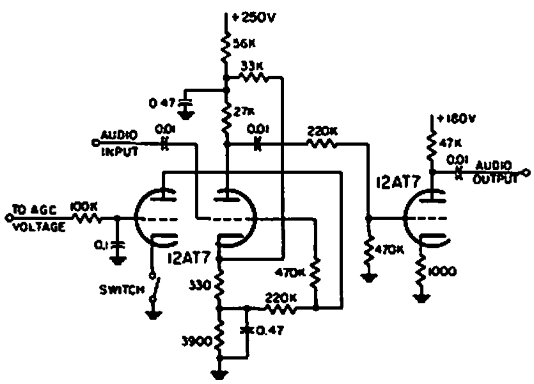
A-F AMPLIFIER WITH SQUELCH—Used to make first audio stage inoperative during no-signal condition in communication receiver.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12-2.



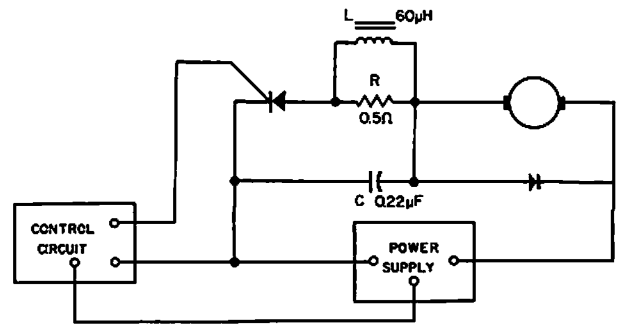
SOUND LEVEL METER—Two-transistor circuit takes high-impedance microphone feeding compound grounded-collector stage in which collector, emitter load, and biased resistor of Q1 are bootstrapped.—W. V. Richings and B. J. White, Transistorized Sound Level Meter, *Electronics*, 33:25, p 64–66.



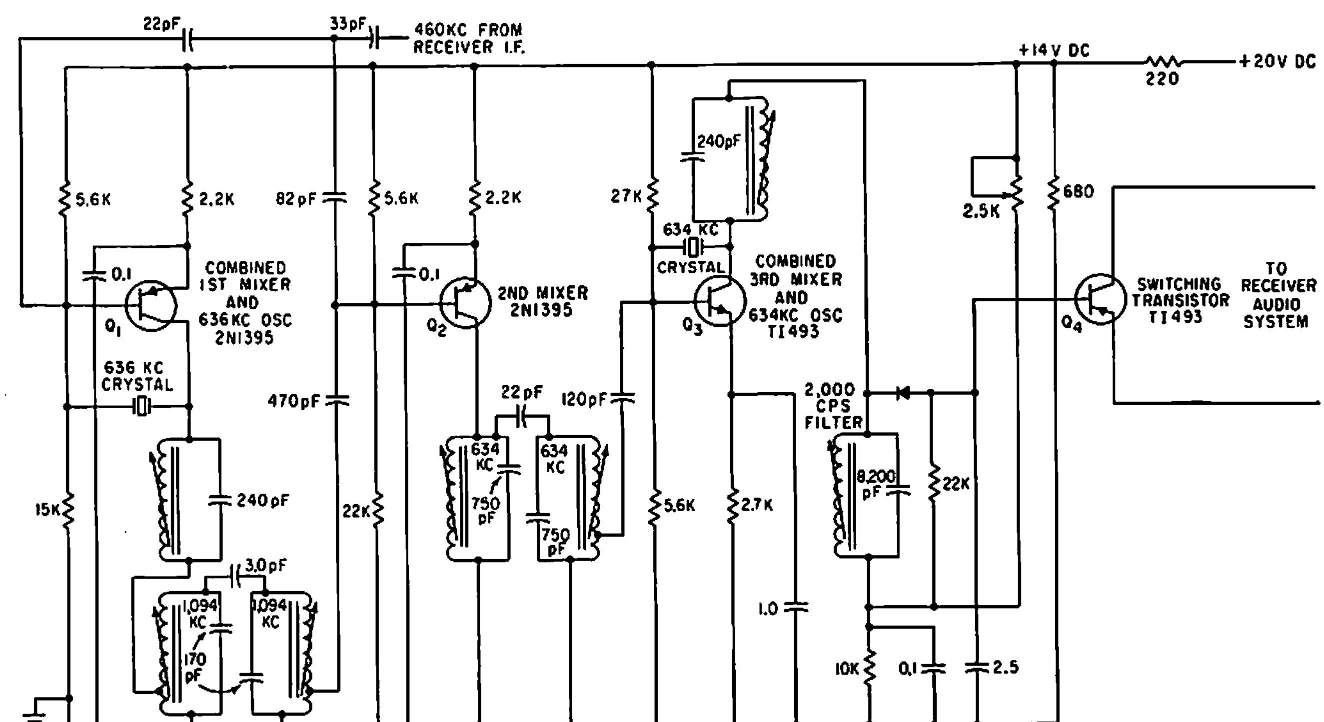
A-F AMPLIFIER WITH SQUELCH—Input is obtained from noise rectifier and amplifier of communication receiver. Squelch is used to make first audio stage inoperative during no-signal condition.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12-2.



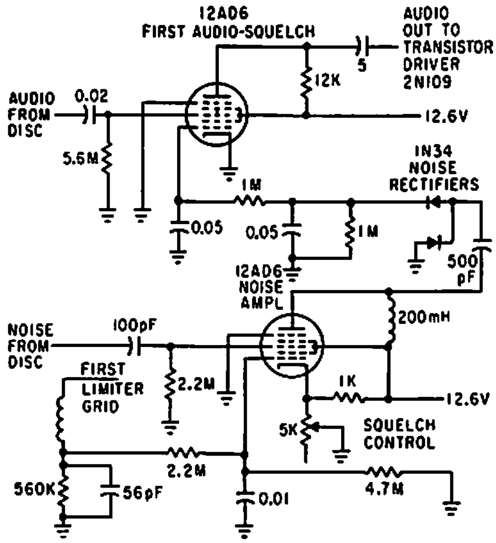
A-F AMPLIFIER WITH SQUELCH—Used to make first audio stage inoperative during no-signal condition in communication receiver.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N12-2.



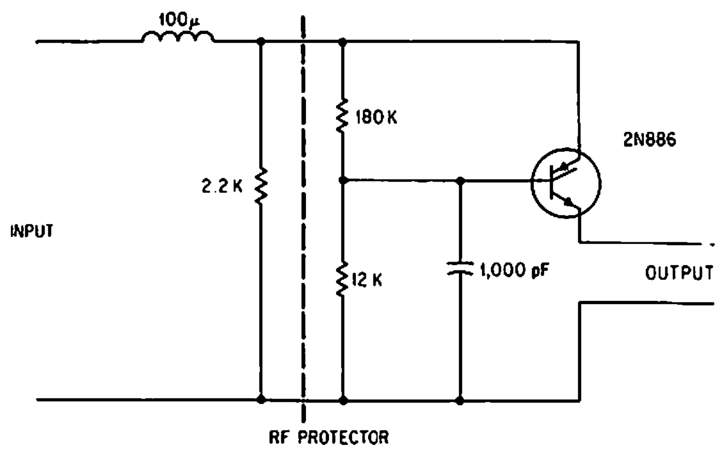
SCR NOISE SUPPRESSOR—Used to suppress circuit noise generated when scr is switched on, without materially affecting power-handling capacity or efficiency. Load shown is d-c series motor.—Noise Reducer for SCR, *EEE*, 10:10, p 94.



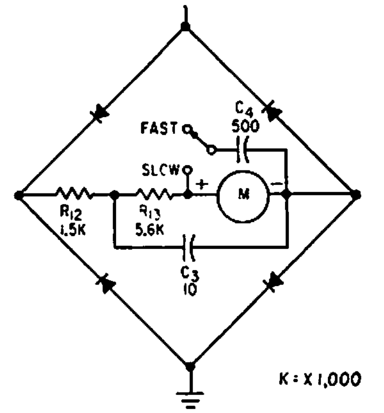
SQUELCH FOR DOUBLE SUPERHET—Carrier-operated squelch level is automatically adjusted to best compromise for incoming signal. Squelch can be adjusted to open on 0.5-microvolt input signal while remaining closed when subject to full output of noise generator.—J. M. Towksbury, Receiver Squelch Control Uses Double Superheterodyne, *Electronics*, 35:3, p 44–46.



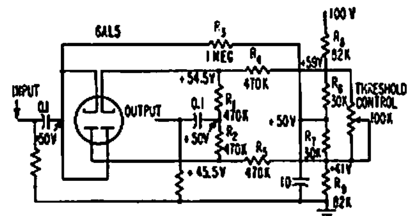
SQUELCH FOR MOBILE—Reduces background noise, to prevent operator fatigue during no-signal periods. Double-action squelch is obtained by using negative voltage at first limiter grid during signal periods to cut off 12AD6 noise amplifier.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



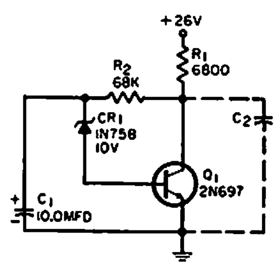
GATE CAPACITOR PROTECTS SCS AGAINST RFI—Capacitor between gate and cathode provides shunt path at higher frequencies to prevent firing of silicon controlled switch by r-f interference. Values in circuit will give protection from 32-v signals between 100 kc and 30 Mc.—R. J. Sanford, Can RFI Control Prevent Weapons Failures?, *Electronics*, 36:45, p 43–45.



SOUND METER RECTIFIER—Used with sound level meter to provide indication proportional to rms value of wideband noise, in two-segment linear approximation to required square-law characteristic.—W. V. Richings and B. J. White, Transistorized Sound Level Meter, *Electronics*, 33:25, p 64–66.

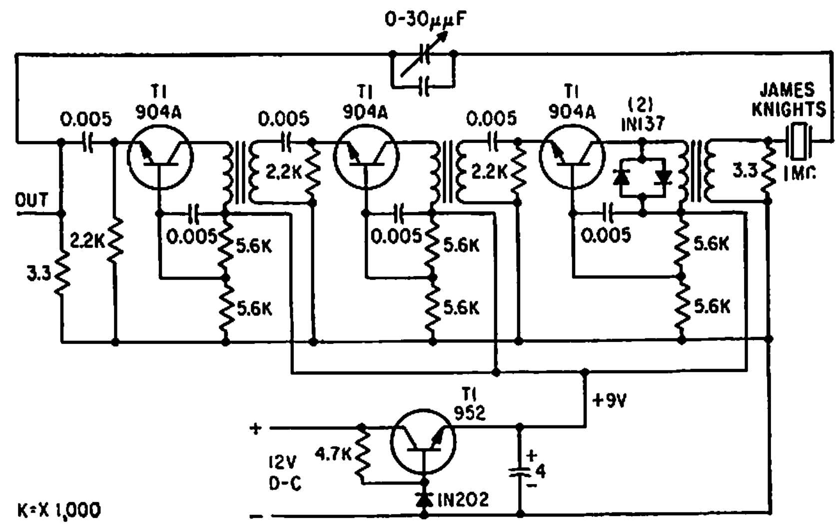


BACKGROUND NOISE SUPPRESSOR—With control set for maximum resistance, only desired a-c voltage peaks above 4.5 v are passed by diodes. Balanced variable-threshold circuit achieves this suppression of weak background noise without affecting a-c balance of signals.—W. E. Earle, A-C Threshold Converts to Switch, *Electronics*, 31:1, p 96–99.

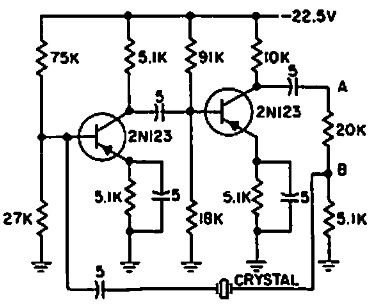


ZENER NOISE GENERATOR—Amplifies noise voltage developed across conducting zener diode. Zener current is fed to base of transistor, which has nominal current gain of 75.—G. Richwell, One-Stage Semiconductor Noise Generator, *EEE*, 12:7, p 26–28.

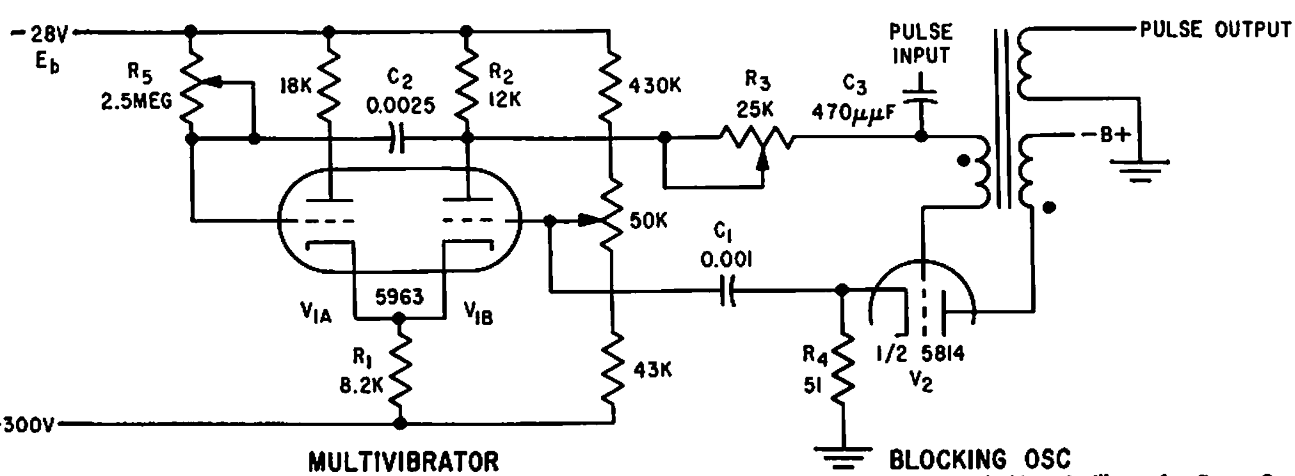
CHAPTER 56
Oscillator Circuits



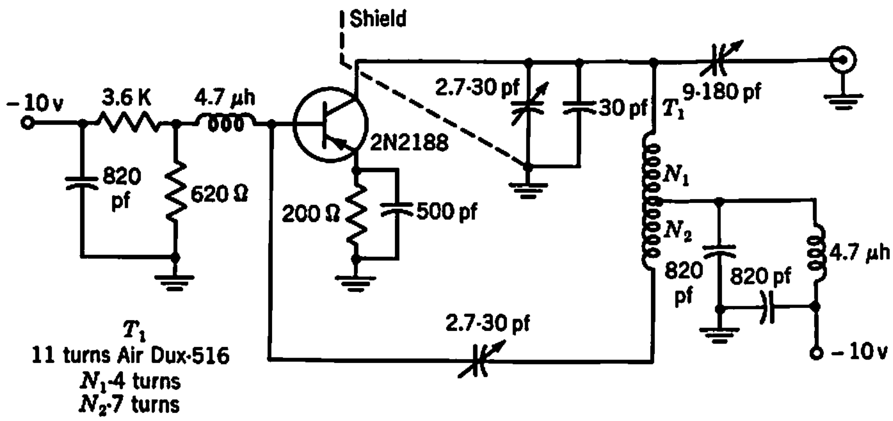
STABLE 1-MC OSCILLATOR—Gives frequency stability of one part in 1 billion per day at normal room temperature, at which a 12-lb, 45-v battery can furnish crystal oven and circuit power for 72 hours.—J. F. Mercurio, Jr., Stable, Low-Cost One-Mc Oscillator, *Electronics*, 32:6, p 50–51.



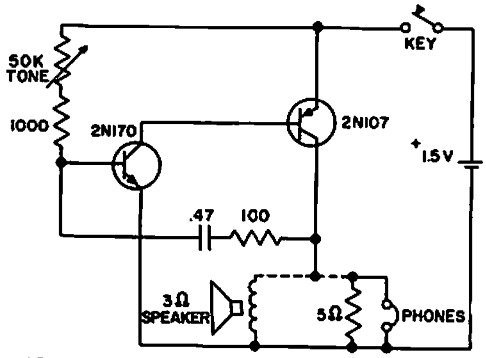
TWO-STAGE VARIABLE-FREQUENCY CRYSTAL OSCILLATOR—Operates at 9.1 kc with long-term frequency stability of a few parts per million. Frequency can be pulled up to 5 cps off resonance by adjusting trimmer capacitor in series with crystal. Used in analog and digital systems to achieve calibration by deviating carrier frequency a small but accurately known amount.—G. A. Gedney and G. M. Davidson, Crystal Oscillator has Variable Frequency, *Electronics*, 31:7, p 118–119.



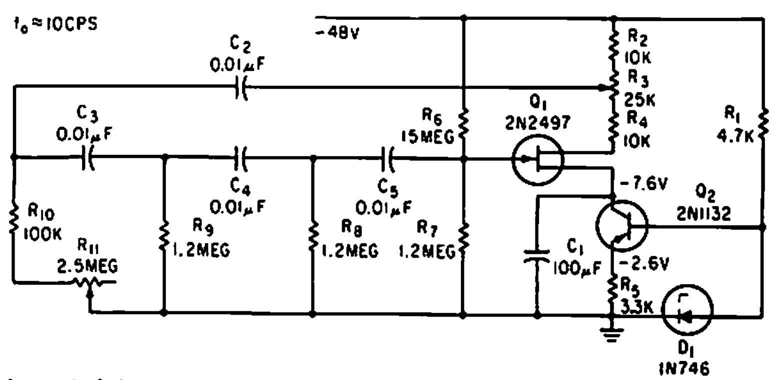
BLOCKING OSCILLATOR FOR 10:1 SYNC—Combines basic mvbr and blocking oscillator into self-gated oscillator that gives synchronization ratios of 10:1 or greater, with stability equal to that of conventional circuit having 1:1 synchronization.—W. W. Whatley, Blocking Oscillator for Ten-to-One Sychronization, *Electronics*, 32:48, p 58–59.



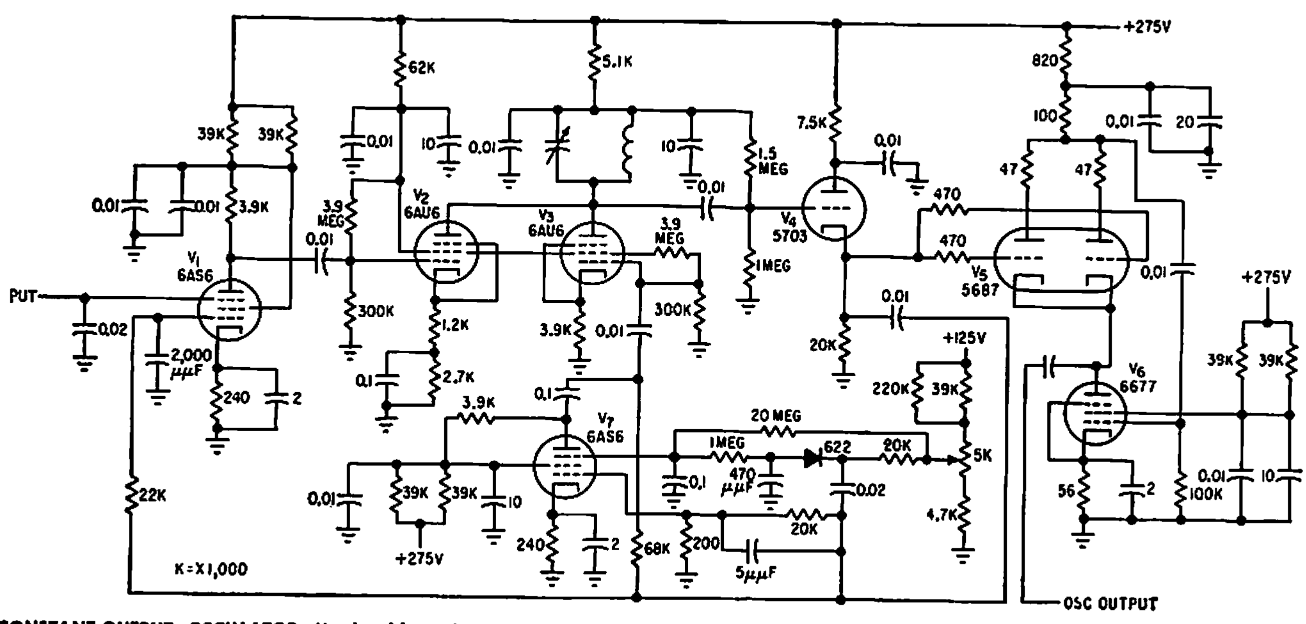
30-MC 2N2188—Delivers 23 mw over temperature range of −40 to +60°C. Typical collector efficiency is 30%.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 319.



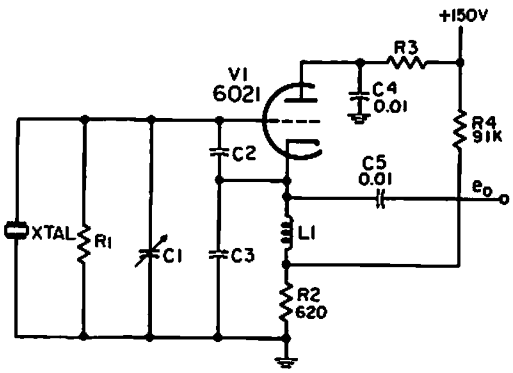
CODE PRACTICE OSCILLATOR—Requires only single flashlight cell and two transistors. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 378.



10-CPS PHASE-SHIFT FET OSCILLATOR—Uses four-mesh feedback network to provide attenuation of 18.36, without use of lamps.—V. Glover, Using a New Device: Field-Effect Transistor Oscillators, *Electronics*, 35:51, p 44–46.

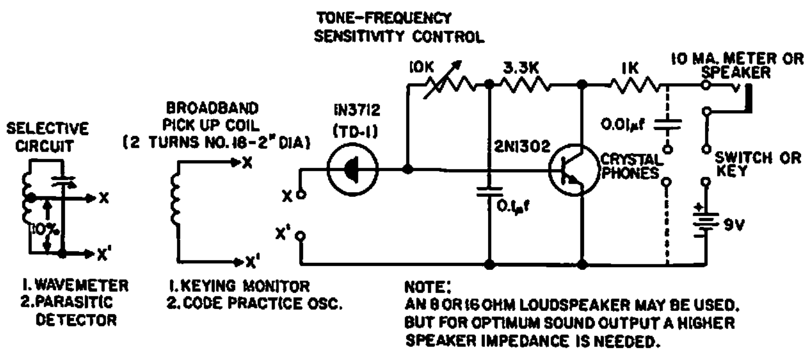


CONSTANT-OUTPUT OSCILLATOR—Used with automatic doppler cycle counter to determine position and velocity of missiles and satellites. Output signal amplitude is maintained constant over wide range of frequencies.—B. E. Keiser, Digital-Counter Techniques Increase Doppler Uses, *Electronics*, 32:21, p 46–50.

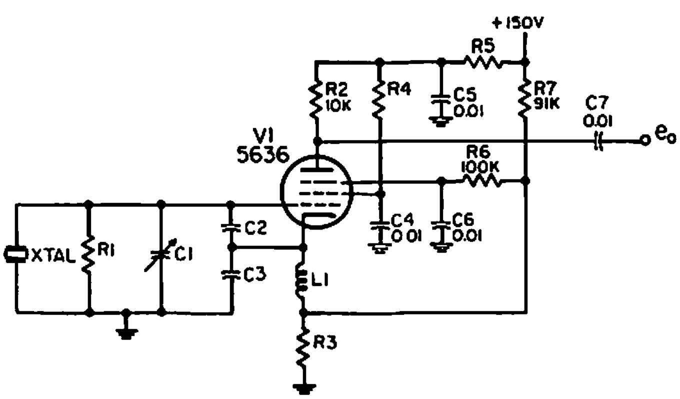


PREFERRED 0.8-20 MC COLPITTS CRYSTAL—Frequency is changed by substituting plug-in crystals. Component values depend on frequency range. Serves as simple and stable frequency source.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 101, p 101–2.

Frequency range mc	R1 Ω	R3 Ω	C1 pf	C2 pf	C3 pf	C1' (Distributed "C" pf)	C2'	C3'	L1 mh
0.8–5	560K	33K	10.7	15	100	6.3	2	12.5	7.0
3–11	47K	39K	12.4	15	33	6.3	2	12.5	0.9
5–20	33K	33K	*8.4	24	24	6.3	2	12.5	0.3

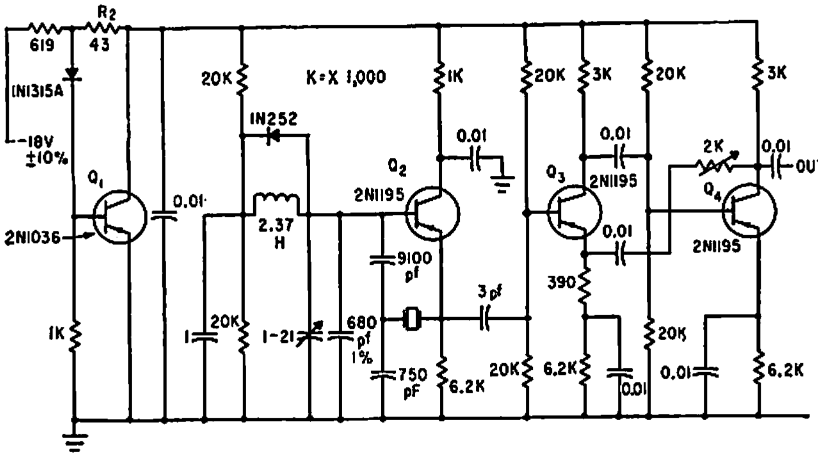


CODE PRACTICE OSCILLATOR—Basic tunnel-diode oscillator with single-transistor amplifier stage can be used as code practice oscillator, sensitive broadband c-w keying monitor, sensitive aural-visual parasitic detector, or as wavemeter.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 362.

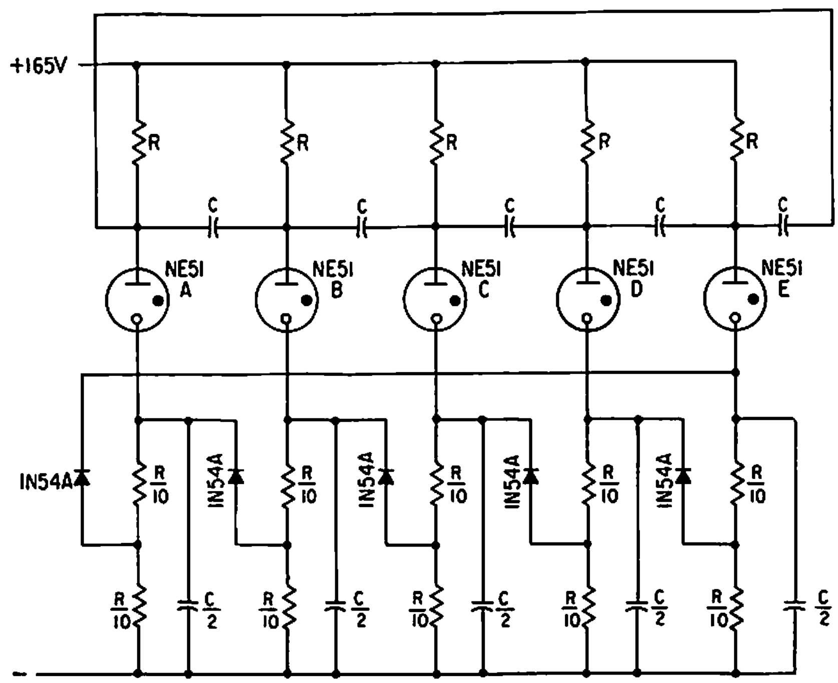


Frequency range mc	R1 Ω	R3 Ω	R4 Ω	R5 Ω	C1 pf	C2 pf	C3 pf	C1' (Distributed "C" pf)	C2'	C3'	L1 mh
0.8–5	330K	620	47K	12K	10.3	15	150	6.3	2	12.5	7.0
3–11	100K	620	68K	6.8K	8.7	18	100	6.3	2	12.5	0.8
5–20	47K	470	110K	150	8.6	22	47	6.3	2	12.5	0.3

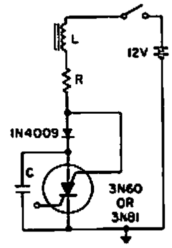
PREFERRED 0.8-20 MC ELECTRON-COUPLED COLPITTS CRYSTAL—Provides higher output, greater harmonic content, better frequency correlation, and more immunity from effects of load changes than simpler Colpitts version. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, PC 102, p 102–2.



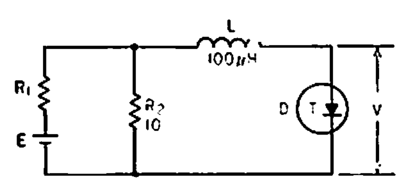
STABLE 3-MC CRYSTAL COLPITTS—Crystal operates at series resonance in feedback path between emitter of Q2 and tank tap. Q1 is shunt voltage regulator providing power-supply isolation. Two-stage feedback amplifier Q3-Q4 provides output impedance of about 150 ohms when R1 is adjusted for 0.5-v peak-to-peak output swing.—J. W. Hamblen and J. B. Oakes, Instrumentation and Telemetry of Transit Navigational Satellites, *Electronics*, 34:32, p 148–153.



RING-OF-FIVE NEON OSCILLATOR—Can be used for sequential switching, with operating cycles of various lengths at audio and sub-audio frequencies. When first turned on, one of lamps fires because of inequalities in lamp properties, and others then fire in sequence. Values of R and C determine cycle duration, according to formula given in article. Time is 1 sec for C=0.5 mfd and R=10 meg.—R. L. Ives, Neon Oscillator Rings, *Electronics*, 31:41, p 108–115.

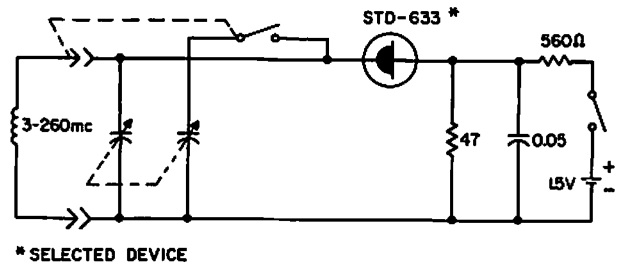


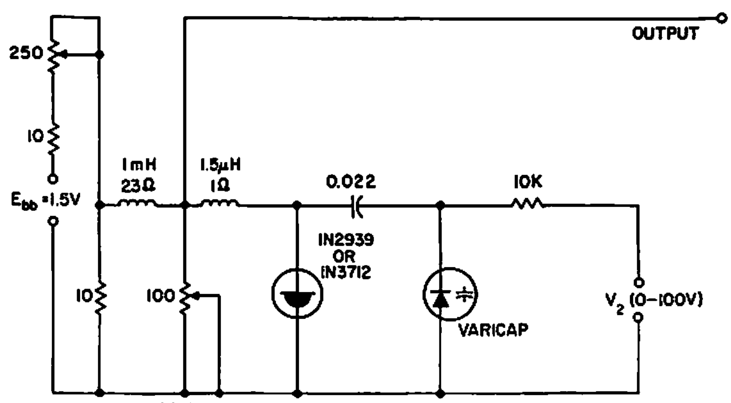
SCS RLC OSCILLATOR—Positive transient, such as closing of switch, charges C through L. When current reverses, diode blocks and triggers scs. When capacitor discharges, scs turns off and C charges to repeat cycle.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 434.



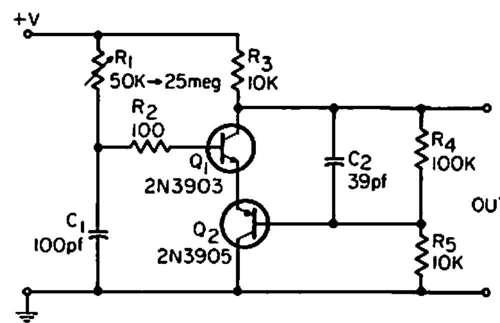
UNSTABILIZED TUNNEL DIODE—Simple but generally impractical because frequency varies greatly with supply voltage and waveform is poor. Frequency also varies with bias, from maximum of 2 Mc at 250 mv to 0.5 Mc at 80 mv and to 0.8 Mc at 400 mv.—Wen-Hsiung Ko, Designing Tunnel Diode Oscillators, *Electronics*, 34:6, p 68–72.

3-260 MC TUNNEL-DIODE OSCILLATOR—Uses plug-in coils to generate sine-wave output over wide frequency range.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 352.

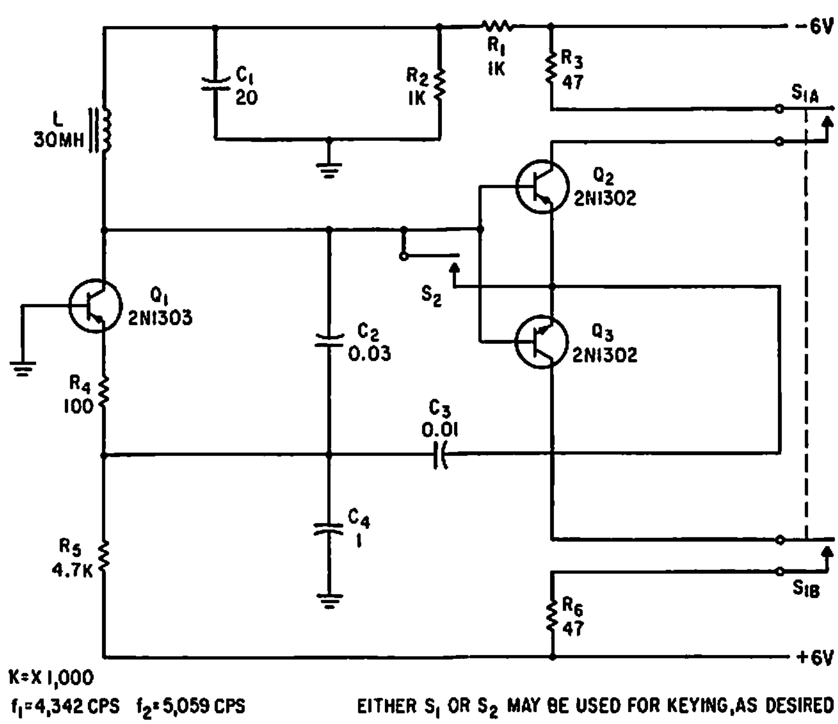




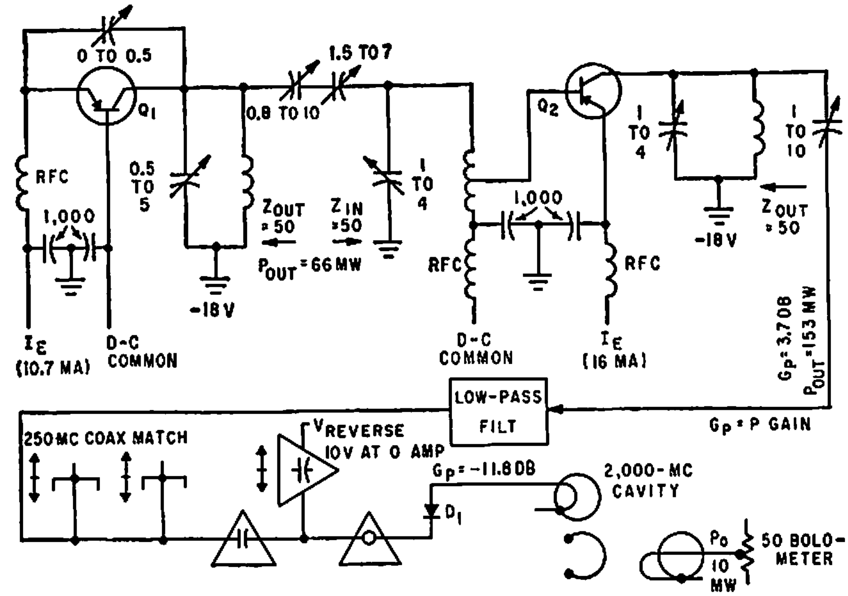
12-22 Mc VOLTAGE-CONTROLLED OSCILLATOR—Voltage-variable capacitor tunes tunnel-diode oscillator electronically.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 350.



RAMP GENERATOR DRIVES TRIGGER—Circuit is relaxation oscillator providing short, fast pulses for triggering mvbr. Upper operating frequency is about 1 Mc for values shown. Efficiency is high yet total component cost is under $2.—C. F. Andren, High Efficiency Relaxation Oscillator, *EEE*, 14:4, p 43.

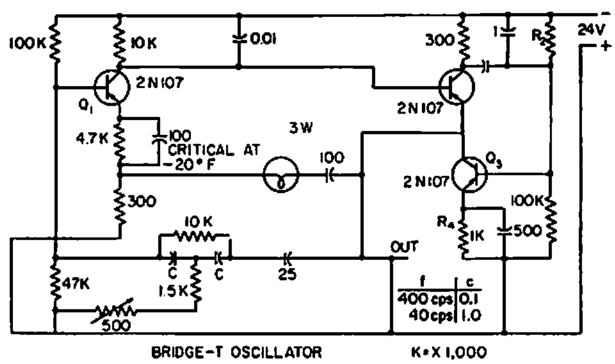


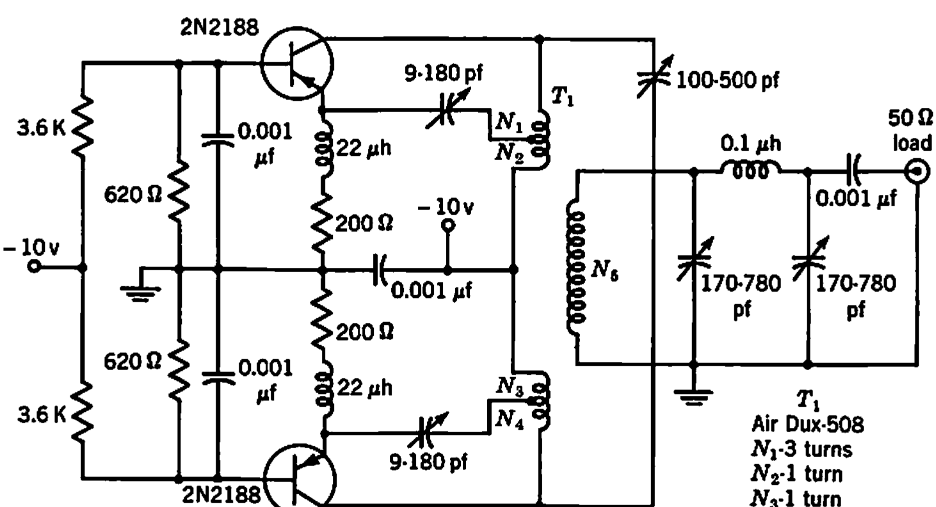
FREQUENCY-SHIFT-KEYED OSCILLATOR—Q1 is Colpitts oscillator at 5 kc and Q2-Q3 is push-pull complementary-emitter amplifier with unity voltage gain. Either switch shorts amplifier, thereby increasing tuning capacitance enough to shift frequency 1 kc.—N. C. Hekimian, Getting Rid of Transients in Frequency-Shift Keying, *Electronics*, 35:45, p 58–59.



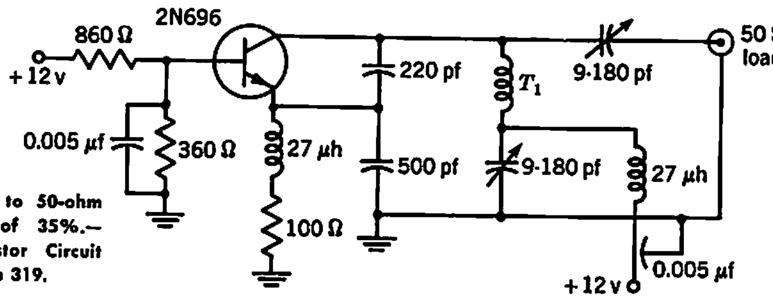
2,000-MC GENERATOR—Depends on harmonic frequency conversion. Oscillator Q1 and amplifier Q2 deliver 153 mw at 250 Mc to coaxial matching section. Despite conversion loss of 11.8 db in 8th-harmonic generator D1, output of 10 mw at 2,000 Mc appears across 50-ohm bolometer.—M. M. Fortini and J. Vilms, Solid-State Generator for Microwave Power, *Electronics*, 32:36, p 42–43.

BRIDGED-T AUDIO OSCILLATOR—Incorporates heavy degenerative feedback in which small lamp is nonlinear compensating resistance. Provides constant output frequency and voltage for any supply between 12 and 32 v, at temperatures down to −20°F. Frequency is determined by capacitors C and 500-ohm trimmer control, to give choice of 100, 150, 230, and 350 cps.—H. P. Van Eckhardt, Crevasse Detector Blazes Glacial Trails, *Electronics*, 31:3, p 63–65.



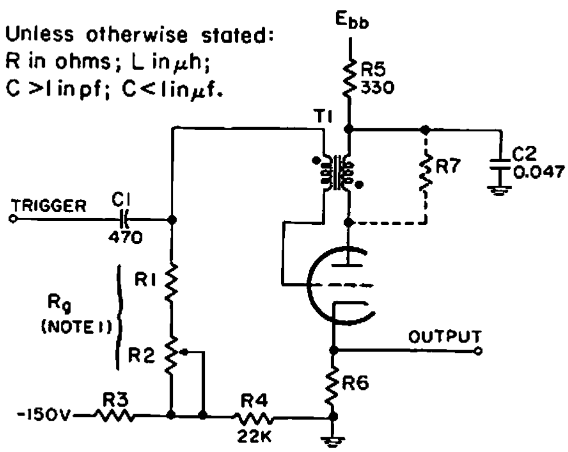


23-MC PUSH-PULL—Delivers 75 mw to 50-ohm load, through pi-matching network.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 318.



T_1-6 turns Air Dux-408

24-MC CLAPP—Delivers 300 mw to 50-ohm load, with collector efficiency of 35%.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 319.

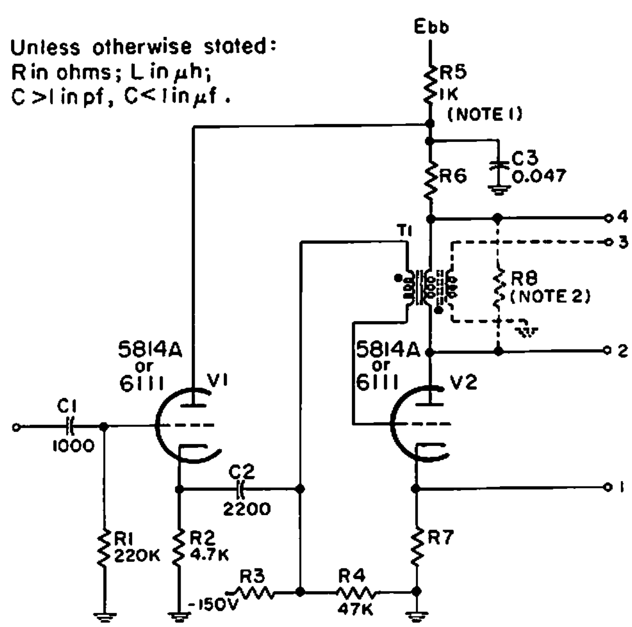


Components:

Input pulse spacing μsec	Division by	Output pulse spacing μsec	R_g ohms
12.2	5	61	250K
61	2	122	250K
61	5	305	1M
122	2	244	1M
122	5	610	2.5M

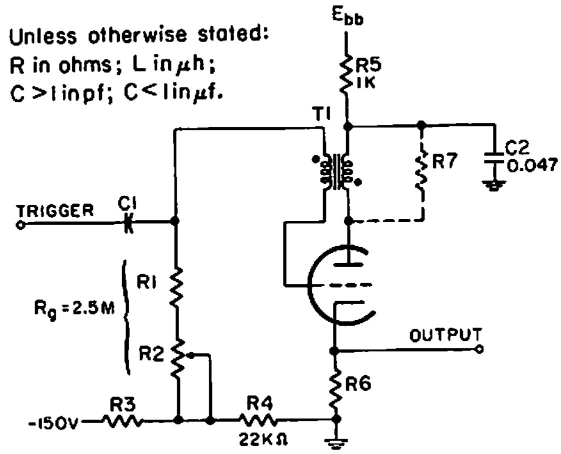
R2: 120KΩ (5814A); 270KΩ (6111).

PREFERRED DISTANCE-MARK DIVIDER—Used to generate distance marks when several must be displayed simultaneously. Maximum division factor is 5. For 5814A, R6 is 100 ohms and plate voltage is 300 v. For 6111, R6 is 150 ohms and plate voltage is 150 v. R7 should be maximum that will just suppress ringing.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 51, p 51–2.



PREFERRED SERIES-TRIGGERED BLOCKING OSCILLATOR—Responds to more slowly rising trigger than parallel-triggered version. Cathode follower V1 is included to provide required low driving impedance and minimize reaction of oscillator on trigger source. Designed for repetition rates up to 2,000 pps. Four terminals give choice of positive or negative output from positive input. Plate voltage is 300 v for 5814A and 150 v for 6111.—NBS, "Handbook Preferred Circuits, Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 49, p 49–2.

Components:
R3: 270KΩ (5814A); 560KΩ (6111).
R6, R7 (See Note 3): 100Ω maximum (5814A); 150Ω maximum (6111).
T1: 1:1 pulse transformer chosen to obtain desired pulse width.



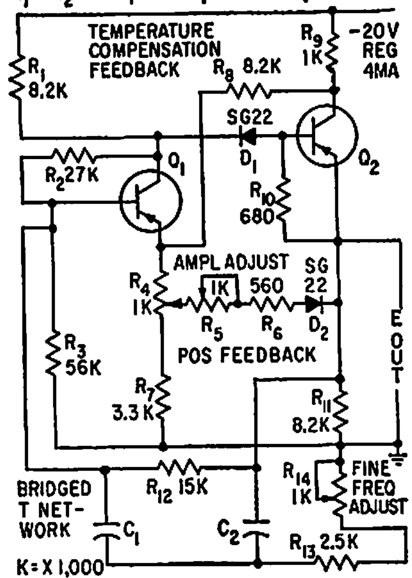
Components:

Output prf (pps)	200–600	600–1200	1200–2000
C1 (picofarads)	2200	1000	470

R3: 120KΩ (5814A); 270KΩ (6111).

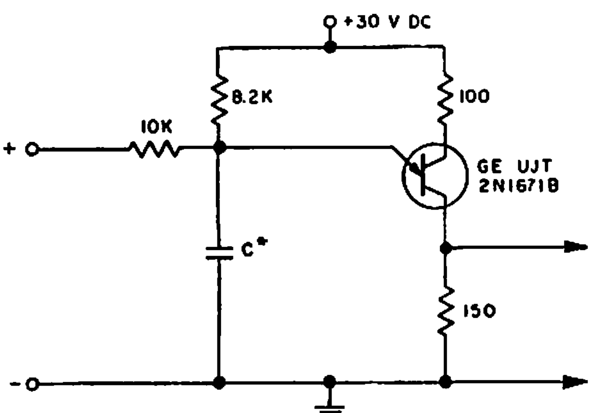
PERFERRED PULSE-FREQUENCY DIVIDER — Blocking oscillator design produces equally spaced pulses at submultiple of 2 to 5 of trigger frequency. Maximum prf is 2,000 pps. Input and output are both positive. Plate voltage is 300 v with 5814A tube and 150 v with 6111. R6 is 100 or 150 ohms depending on tube. R7 should be maximum that will just suppress ringing.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 50, p 50–2.

OSC FREQ	<10KC	TO 100 KC	AT 350 KC
Q_1 & Q_2 USED	2N270	2N247	2N384

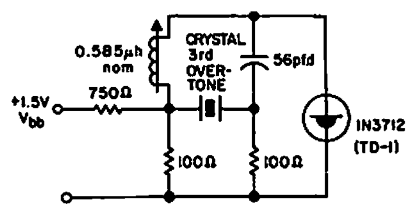


FREQ IN CPS	$C_1 = C_2$ VALUES	FREQ IN KC	$C_1 = C_2$ VALUES
4	6.8μF	1	0.025μF
100	0.25μF	10	2,300μμF
400	0.068μF	100	200μμF

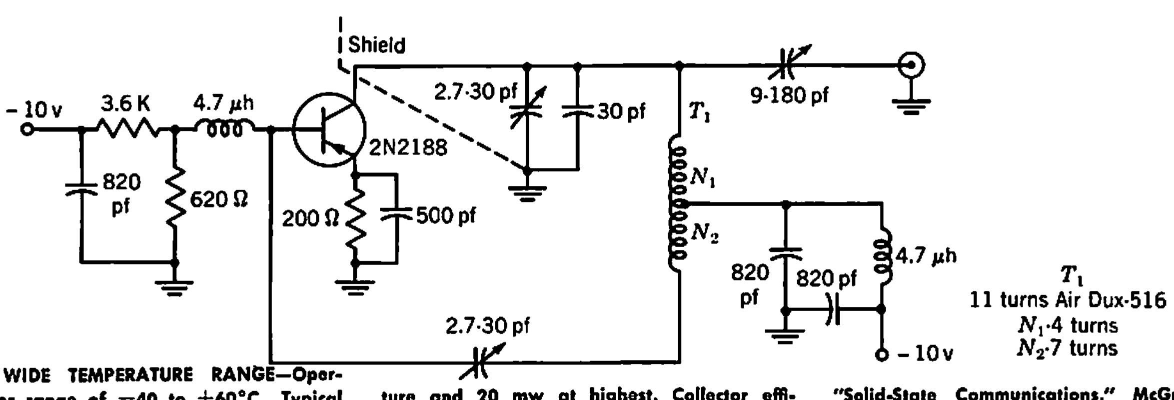
MULTIPLE-FEEDBACK R-C OSCILLATOR—Gives excellent amplitude stability and low distortion. Uses vibration and shockproof version of Sulzer bridged-T configuration to provide single-frequency operation in 4-cps to 350-kc range.—L. H. Dulberger, Improved R-C Oscillator, *Electronics*, 32:10, p 62.



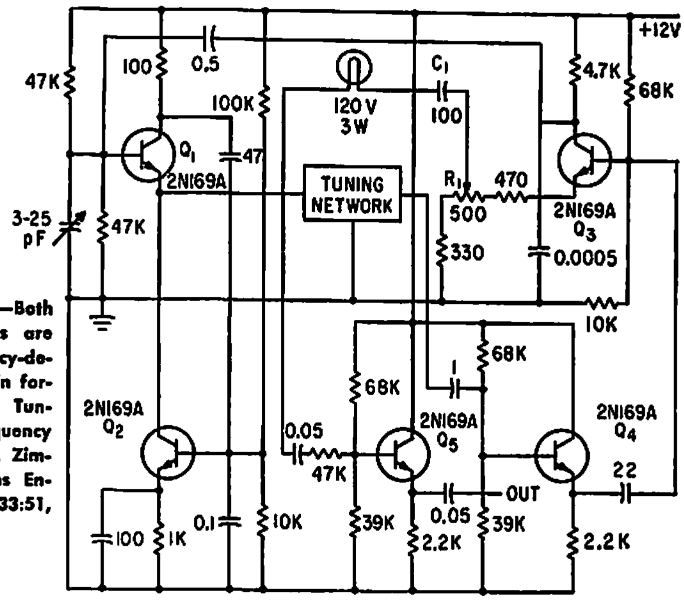
VOLTAGE-CONTROLLED VFO—Adding 10K resistor to basic ujt oscillator gives voltage-controlled variable-frequency oscillator. With 0.68 mfd for C, d-c input voltage range of 0 to 30 v gives 670 to 4,550 pps. With 0.2 mfd for C, same input range gives 220 to 1,400 pps. Not intended for use where linearity is important.—B. Strunk, Voltage-Controlled Variable-Frequency Oscillator, *EEE*, 10:12, p 28–30.



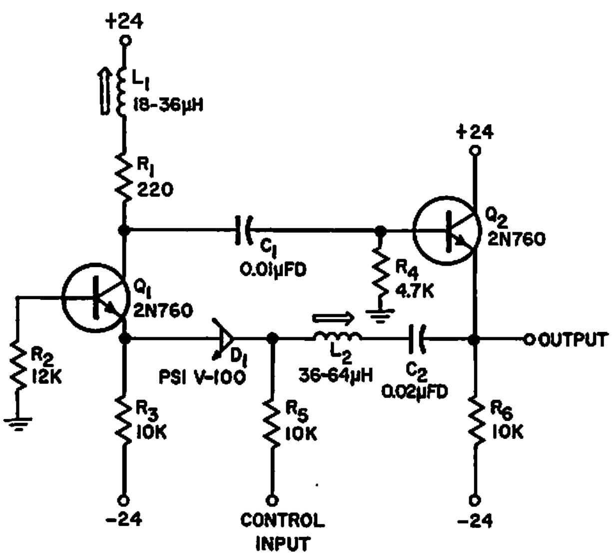
27.255-MC TUNNEL DIODE-CRYSTAL OSCILLATOR—Operates within tolerance of quartz crystal from −55 to + 85°C and bias range of 110 to 150 mv for Citizens Band service. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 353.



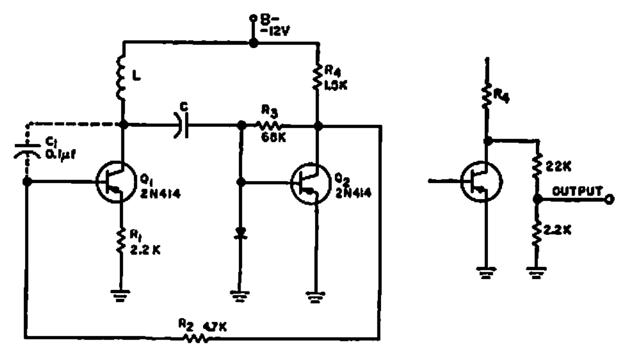
30-MC WIDE TEMPERATURE RANGE—Operates over range of −40 to +60°C. Typical power output is 23 mw at lowest temperature and 20 mw at highest. Collector efficiency is 30%.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 239.



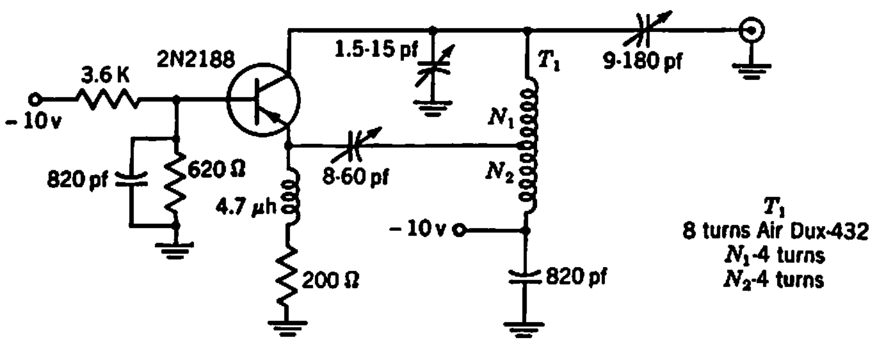
RESISTANCE-CONTROLLED OSCILLATOR—Both positive and negative feedback loops are used, with notch network as frequency-determining element. Incandescent lamp in forward loop give amplitude stabilization. Tuning network contains resistance-to-frequency tranducers.—V. C. Vanderbilt and C. L. Zimmer, Magnetic Tape Recorder Programs Engine Dynamometer Tests, *Electronics*, 33:51, p 74–77.



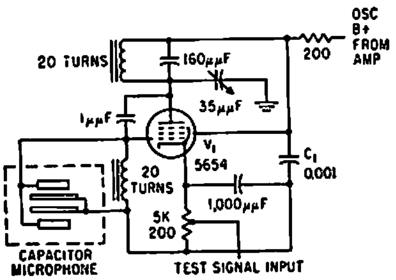
VOLTAGE-CONTROLLED BUTLER OSCILLATOR—Provides 70% frequency deviation. When tuned to 2 Mc, frequency deviation is −205 kc at 0 v control input and +1,289 kc at 20 v, though frequency deviation is not linearly proportional in lower half of voltage range. —C. F. Turner, Wide-Range, Voltage-Controlled Oscillator, *EEE*, 10:10, p 31.



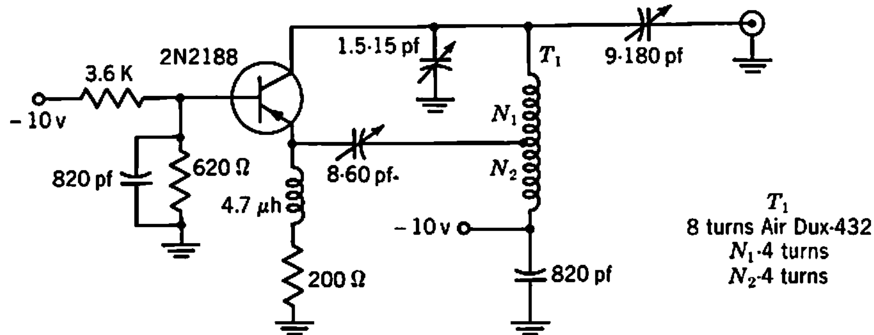
5 CPS TO 300 KC—Overcomes low-frequency problems of wide-range oscillators by using tank both for controlling frequency and coupling signal to next stage. Frequency is stable over wide variations in d-c voltage and temperature, yet circuit is inexpensive. Alternative output coupling shown is useful for driving varying loads.—J. Freeman, Low-Frequency C-Coupled Oscillator, *EEE*, 11:7, p 27–28.



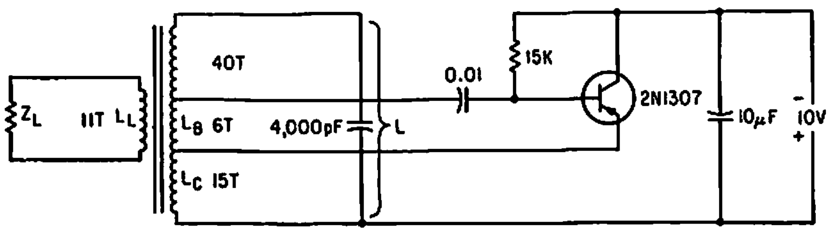
60-MC COMMON-BASE—Delivers 10 mw to 50-ohm load at 25°C. Collector efficiency is 10%.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 320.



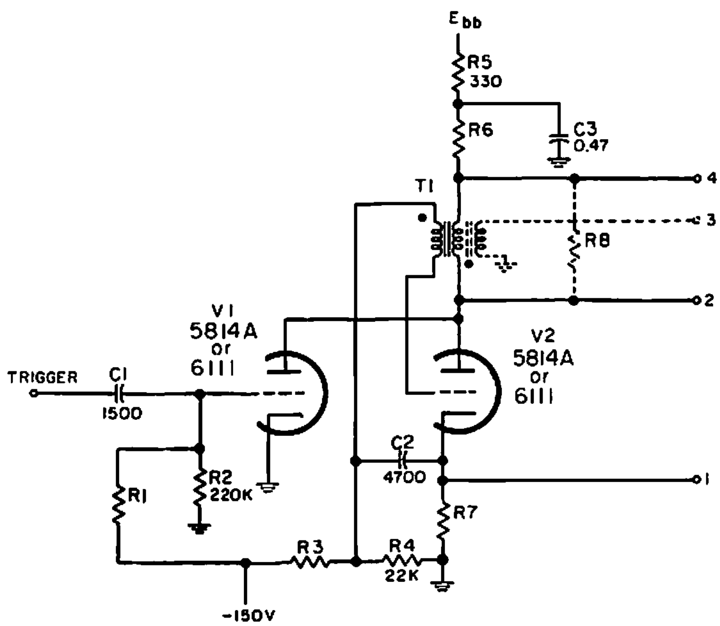
OSCILLATOR-DETECTOR—Capacitor microphones form part of grid tank circuit of 6-Mc tuned-plate tuned-grid r-f oscillator that also detects 6.5-cps modulation by class-C operation during oscillation. Used in infrared analyzer for detecting leaks in automobile air-suspension systems.—P. G. Balko, Infrared Finds Auto Suspension Leaks, *Electronics*, 31:49, p 82–85.



60-MC COMMON-BASE—Delivers 10 mw to 50-ohm load at 25°C. Collector efficiency is 10%.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 239.

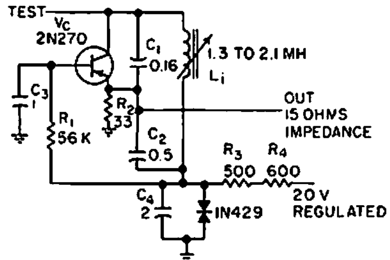


122-KC GROUNDED-COLLECTOR HARTLEY—Simple class-C L-C arrangement has many advantages for power oscillators and for d-c to a-c converters. One side of tank can be grounded.—P. Laakmann, Designing Class-C Transistor L-C Oscillators, *Electronics*, 35:30, p 42–45.

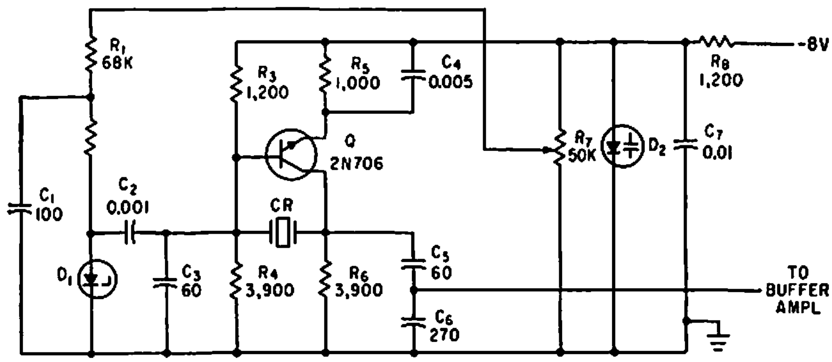


Components:
R1: 1MΩ (5814A); 2.2MΩ (6111).
R3: 100KΩ (5814A); 220KΩ (6111).

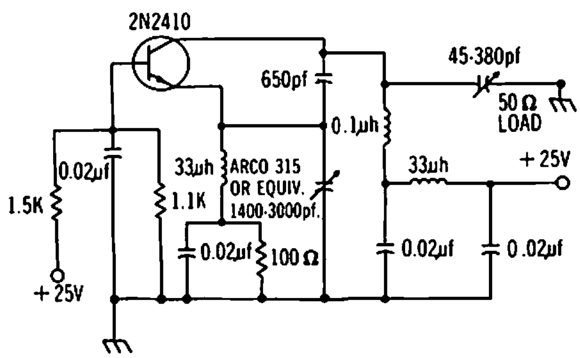
PREFERRED PARALLEL-TRIGGERED BLOCKING OSCILLATOR (BELOW 2,000 PPS)—Produces synchronizing impulses between 0.2 and 7 microsec wide at rates of 200 to 2,000 pps. One triode section is used as trigger amplifier to prevent triode blocking oscillator from reacting on trigger source. R6 and R7 are 100 ohms for 5814A and 150 ohms for 6111. R8 should be maximum that will just suppress ringing. Requires positive input trigger and gives choice of output polarities at the four output terminals.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 46, p 46–2.



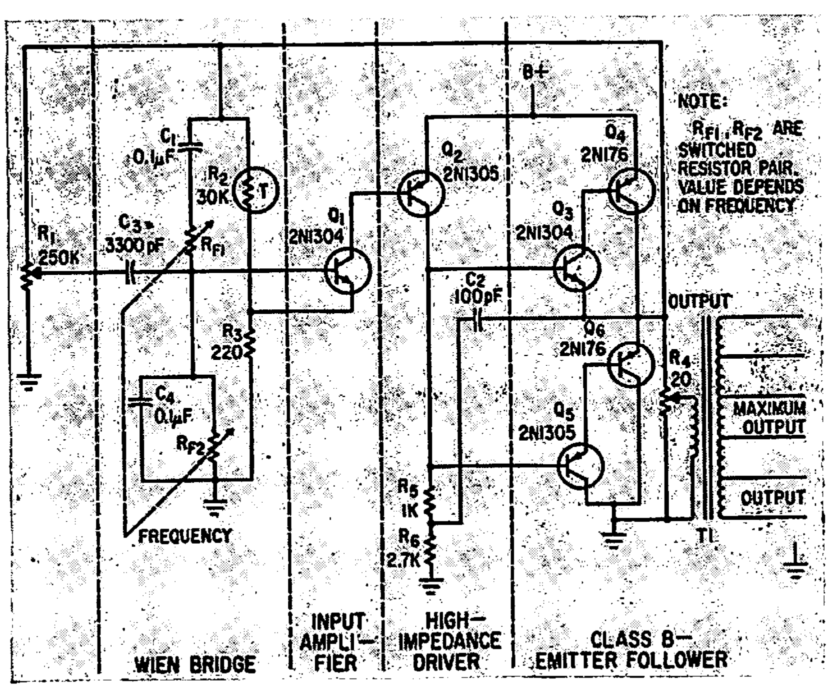
STABLE 10-KC COLPITTS—Provides constant-amplitude carrier for data reduction system, at 0.5 v rms with amplitude stability of 0.1% and frequency drift below 0.25% for temperature range of 30 to 50°C.—L. H. Dulberger, Transistor Oscillator Supplies Stable Signal, *Electronics*, 31:5, p 43.



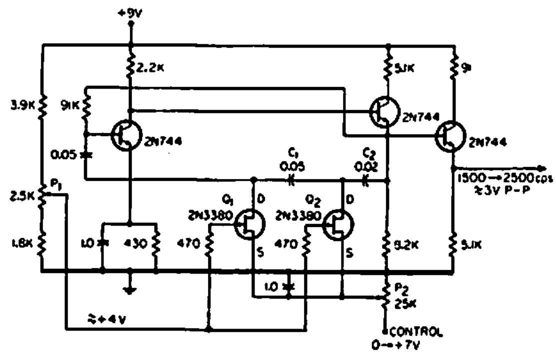
10-MC CRYSTAL—Collector voltage of transistor is kept low and is stabilized by zener diode D1 in microminiature oscillator using crystal in 10-Mc fundamental mode. Voltage-sensitive capacitor D2 and R7 serve for fine frequency adjustmets.—M. Lysobey, Microminiature Crystal Oscillator Using Wafer Modules, *Electronics*, 35:15, p 60–61.



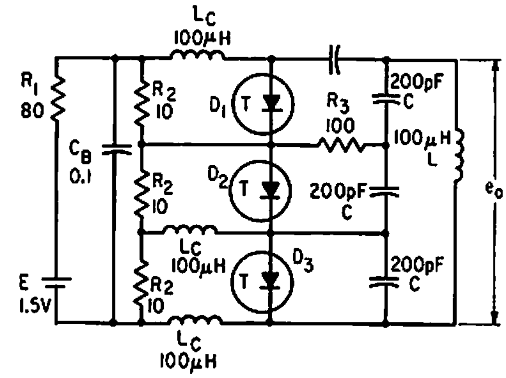
20-MC POWER OSCILLATOR—Colpitts-type common-base circuit gives power output of 500 mw to 50-ohm load, while dissipating 750 mw.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 300.



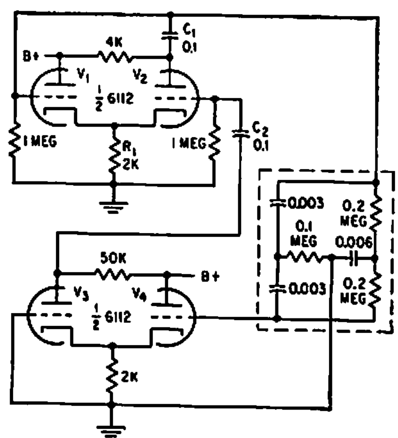
FEEDBACK LOOP STABILIZES A-F OSCILLATOR AMPLIFIER—Wien bridge determines frequency of oscillator, which is combined with amplifier stages to give single oscillator stage having sufficient output power to drive load directly. Thermistor R2 and resistor R3 provide negative feedback path around amplifier and oscillator, to make oscillator gain and frequency independent of load variations.—R. G. Fulks, Novel Feedback Loop Stabilizes Audio Oscillator, *Electronics*, 36:5, p 42–43.



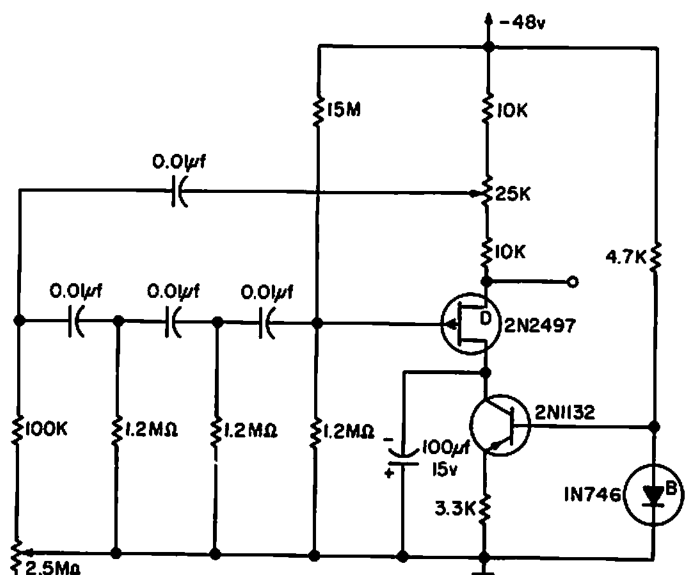
FET VOLTAGE-CONTROLLED OSCILLATOR—Produces excellent sine-wave output with good linearity over frequency range of 1,500 to 2,500 cps, for control voltage of 0 to 7 v d-c. Circuit is resistance-controlled three-section phase-shift oscillator.—R. Selleck, Voltage-Controlled Oscillators, *EEE*, 13:3, p 47.



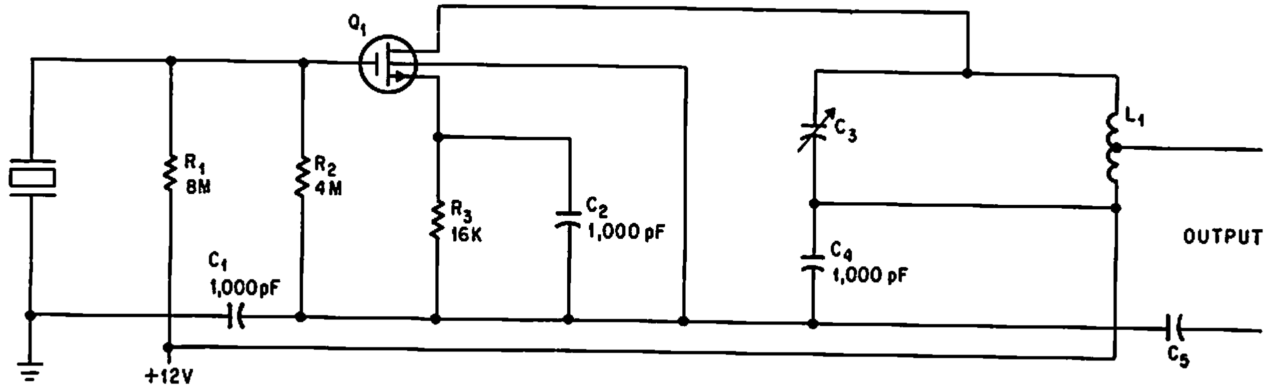
CASCADE TUNNEL DIODE—Voltage drops across resistors R2 serve as individual voltage sources in series for cascaded diodes that give three times sine-wave output voltage of single relaxation oscillator circuit.—Wen-Hsiung Ko, Designing Tunnel Diode Oscillators, *Electronics*, 34:6, p 68–72.



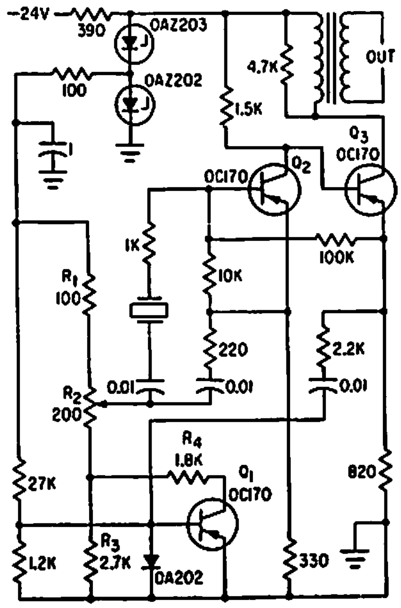
FEEDBACK OSCILLATOR—C1 provides positive feedback between amplifier V2 and cathode follower V1, causing oscillation at frequency and amplitude at which loop gain is unity. Twin-T network in negative feedback loop maintains pure sine wave, free of harmonics. Variable-gain negative-feedback amplifier V3-V4 stabilizes frequency and amplitude at prescribed values.—Oscillator Patent is Granted, *Electronics*, 31:37, p 108.



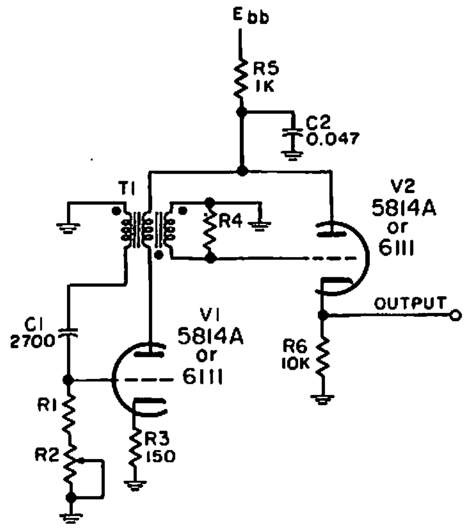
FET PHASE-SHIFT OSCILLATOR—Frequency of four-mesh phase-shift oscillator can be varied several cycles around 10 cps, using 2.5-meg pot. Attenuation of four-mesh feedback network is 18.36.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 111.



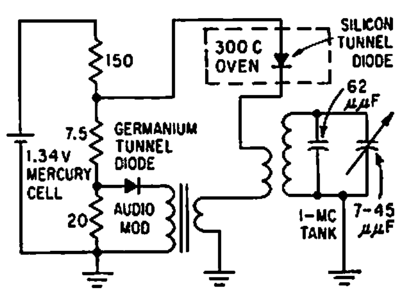
CRYSTAL MOS FET—Oscillation is maintained even with 100-microvolt oscillator output signal when using mos fet.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



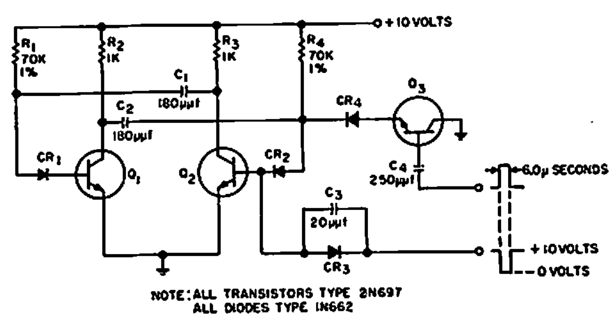
8 to 170 KC WITH PLUG-IN CRYSTALS—Oscillator frequency can be changed by replacing crystal and one capacitor in feedback loop. Stability is obtained from squaring transistor Q1 which feeds crystal.—R. Couvela, Oscillator Frequency is Changed by Plug-In Units, *Electronics*, 34:36, p 86–87.



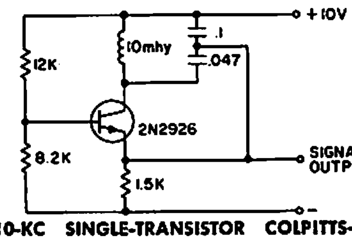
PREFERRED ASTABLE BLOCKING OSCILLATOR—Used as pulse generator when frequency stability is not important. Output can be used as trigger without further shaping. R4 should be maximum that will just suppress ringing. Design equations are given for R1 and R2, but final values must be determined experimentally. Range is 200 to 2,000 pps. Output is positive.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 48, p 48–2.



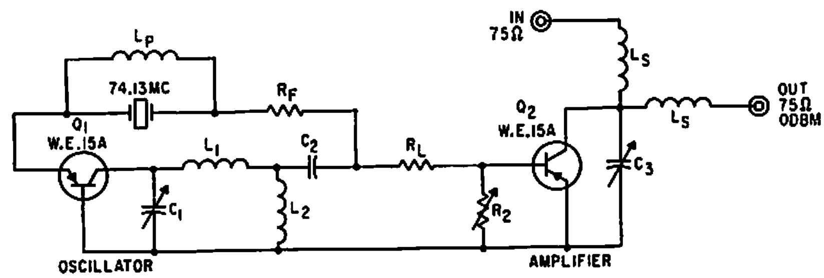
AUDIO-MODULATED 1-MC TUNED TD OSCILLATOR—Uses silicon tunnel diode that, with no surface protection, may be dipped in liquid nitrogen, placed in furnace, or immersed in acid, with only minor change in oscillator and modulation frequencies.—I. A. Lesk, N. Holonyak, Jr., and U. S. Davidsohn, The Tunnel Diode—Circuits and Applications, *Electronics*, 32:48, p 60–64.



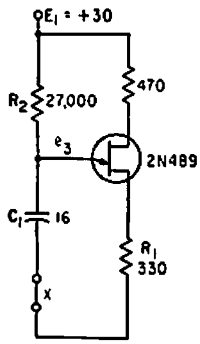
SYNCHRONIZED OSCILLATOR—Astable mvbr Q1-Q2 operating at 68.4 kc is synchronized by 400-cps signal having 6-microsec pulse width. Frequency stability can be one part in 4,000 if film resistors and other temperature-stable components are used. Synchronizing signal is variable, of the order of 1/170 of oscillator frequency but with no integral relationship between the signals.—G. Silverman, A Synchronized Oscillator Circuit, *EEE*, 10:7, p 29–30.



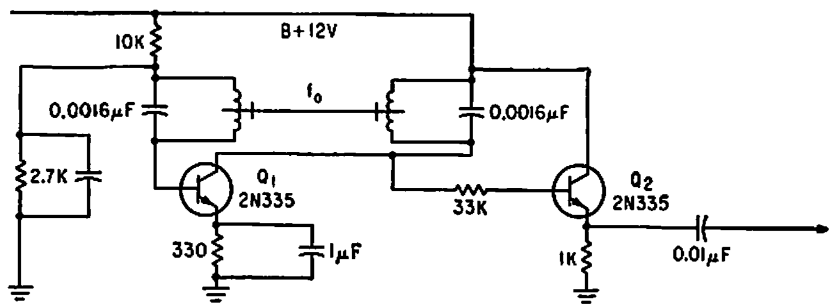
10-KC SINGLE-TRANSISTOR COLPITTS—Total temperature drift rate is only 0.035%/°C, determined by coil core material. For higher frequency stability, frequency-determining network should be buffered from amplifier.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 210.



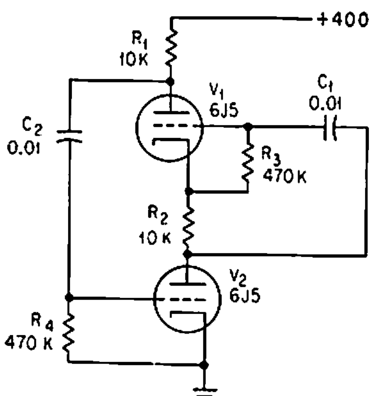
74.13-MC CRYSTAL REPLACES LOST MICROWAVE CARRIER—To prevent noise interference during signal losses due to fading, carrier resupplies oscillator, and amplifier replaces lost carrier, within 0.1 millisec. Q1 and Q2 are switched from cutoff when carrier is needed. Resistor RF in series with crystal lowers its Q to insure rapid starting.—Microwave Relay Designing with Traveling-Wave Tubes, *Electronics*, 35:3, p 40–43.



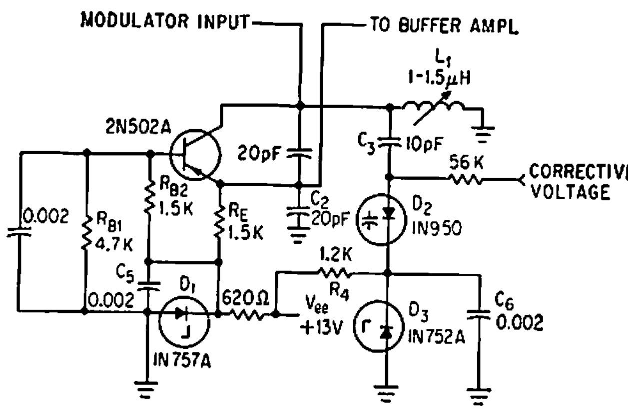
UNIJUNCTION-TRANSISTOR OSCILLATOR—If circuit is broken at X, discharge current of C1 can be used to shut off transistor stage.—A. G. Lloyd, Overload Protection for Transistor Voltage Regulators, *Electronics*, 33:52, p 56–59.



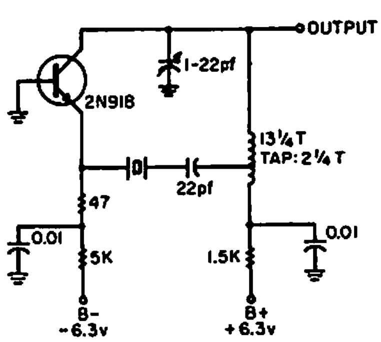
100-KC MAGNETOSTRICTIVE-ROD CONTROL—Oscillator Q1 can be adjusted to within 0.1 cps of desired frequency by adjusting length and center thickness of rod made from modified Elinvar constant-modulus material positioned between coils. Emitter-follower Q2 minimizes pulling by variable load.—T. A. O. Gross, New Magnetic Rods Simplify Circuits, *Electronics*, 35:28, p 62–66.



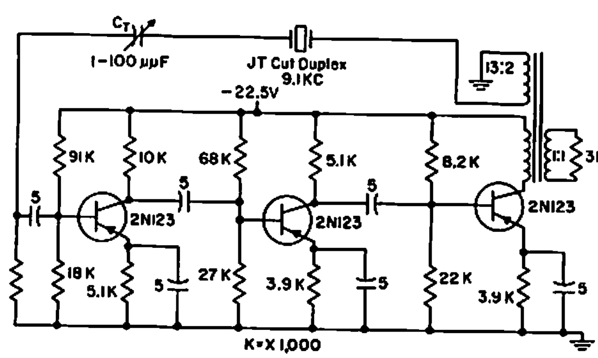
FREE-RUNNING CASCODE OSCILLATOR—Omission of voltage-divider capacitors from cascode multivibrator gives sine-wave oscillator if loop gain is equal to unity.—C. Sing, Advantages of Free-Running Cascode Multivibrators, *Electronics*, 37:5, p 28-29.



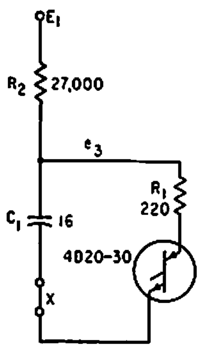
VOLTAGE-CONTROLLED 23-MC OSCILLATOR AND MODULATOR—Input signal voltage to transistor changes capacitance of tank circuit, to make oscillator frequency vary with input signal voltage. Variable-capacitance diode requires fewer parts than transistor modulator. Zener diodes provide constant bias for variable-capacitance diode D2.—F. L. Carroll, How to Achieve Stability in Space Telemetry, Electronics, 37:4, p 32–35.



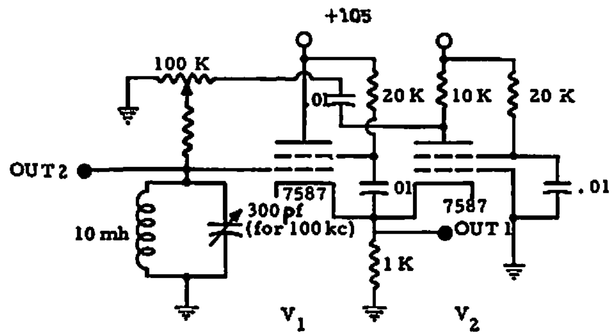
MEASURING OSCILLATOR STABILITY—Circuit is used as 90.3125-Mc reference oscillator in system for measuring short-term stability of 45-Mc stalo (stable local oscillator) of airborne radar under high vibration. Tape transformer in collector circuit of transistor controls crystal drive.—J. Coolican, How to Measure STALO Short-Term Stability Under Vibration, *EEE*, 13:5, p 96–98.



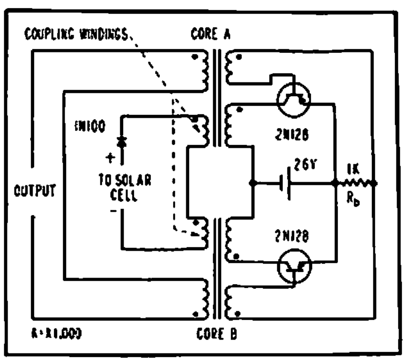
THREE-STAGE VARIABLE-FREQUENCY CRYSTAL OSCILLATOR—Provides loop transmission of 1, under maximum frequency pulloff of 5 cps from 9.1-kc crystal frequency, and has net phase shift around loop of 360° with crystal in circuit. Third stage provides extra circuit gain needed for larger power output or larger frequency deviations off resonance. Transformer provides phase reversal and reflects desired a-c load, to limit output swing of transistor.—G. A. Gedney and G. M. Davidson, Crystal Oscillator has Variable Frequency, *Electronics*, 31:7, p 118–119.



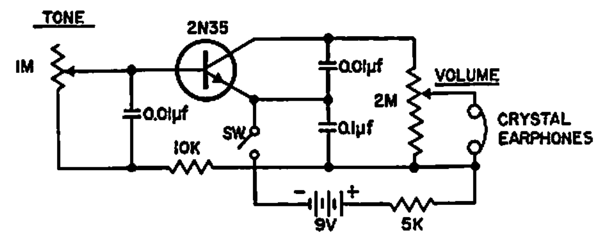
FOUR-LAYER DIODE OSCILLATOR—If circuit is broken at X, discharge current of C1 can be used to shut off transistor stage.—A. G. Lloyd, Overload Protection for Transistor Voltage Regulators, *Electronics*, 33:52, p 56–59.



STABLE OSCILLATOR—Excellent frequency and amplitude stability is accomplished by eliminating all grid current in tank circuit and by isolating tank from driving tube by means of resistive degeneration. If very pure sine wave is required, grid of V1 should be coupled to high-impedance load that is equivalent constant resistance, because either reactive or variable loads will impair stability.—J. C. Davis, Stable Oscillator Circuit, *EEE*, 11:2, p 26.

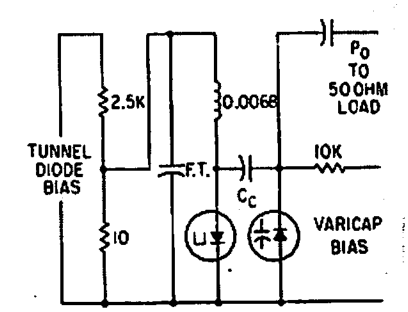


TONE-BURST OSCILLATOR—Consists of variable-frequency magnetically coupled mvbr, with two magnetic cores driven by battery-powered transistors. Injection of current or voltage from solar cell or other transducer affects mvbr reset, to give frequency change over range of 5 to 15 kc.—R. W. Rochelle, Cyclops Cores Simplify Earth-Satellite Circuits, *Electronics*, 31:9, 56–63.

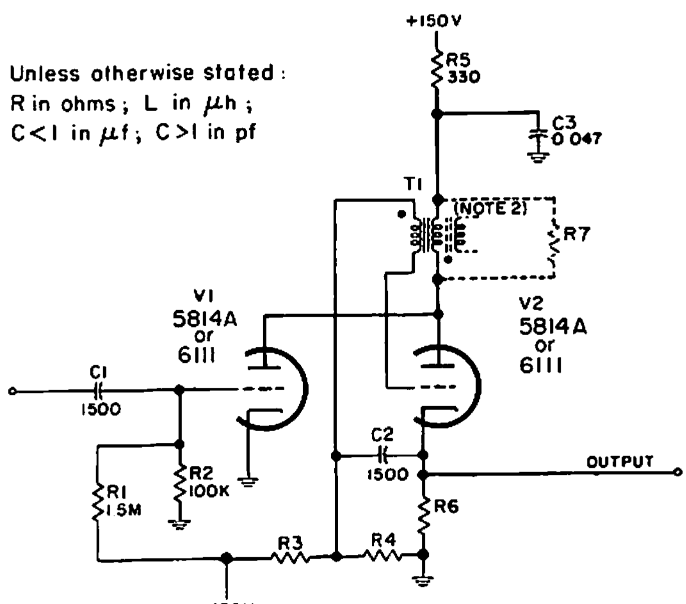


CHATTER JAMMER—Can be used to create pleasing tone at level that drowns out ambient noises, to permit concentration on problem while others are talking in vicinity.—J. Leeb, A Chatter Jammer Circuit, *EEE*, 10:11, p 31.

Unless otherwise stated:
R in ohms; L in µh;
C<1 in µf; C>1 in pf



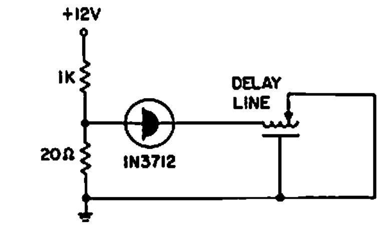
200-400 MC VARICAP-TUNED OSCILLATOR—Tuning range is achieved by adjusting Varicap bias voltage from 0.4 to 60 v.—E. Gottlieb and J. Giorgis, Tunnel Diodes—Using Them as Sinusoidal Generators, *Electronics*, 36:24, p 36–42.



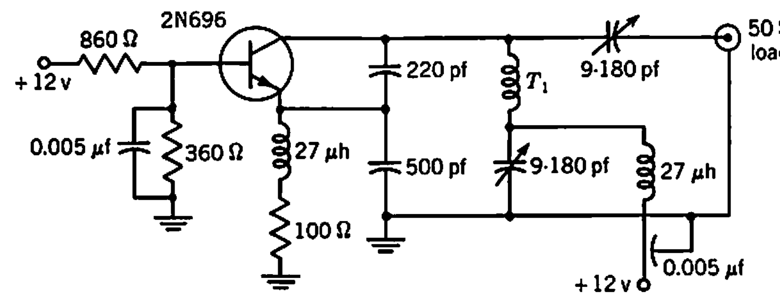
Components:

	Pulse spacing (µsec)	12 to 60	60 to 500
R3		47KΩ	150KΩ
R4		4.7KΩ	15KΩ

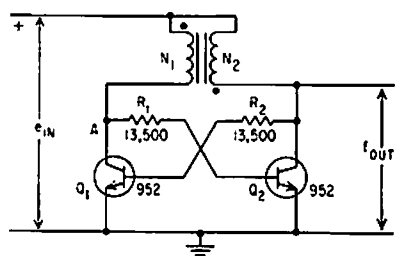
PREFERRED 2,000-83,000 PPS BLOCKING OSCILLATOR—Parallel-triggered circuit responds to trigger pulses separated by only few microsec, as required for distance-mark generators and pulse coding circuits. Input is positive, with minimum of 15 v, and output is positive. R6 is 220 ohms. R7 is maximum that will just suppress ringing.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 47, p 47–2.



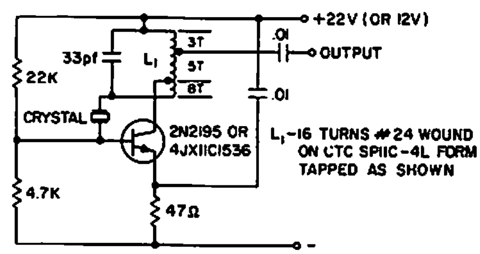
DELAY-LINE OSCILLATOR—Tunnel-diode oscillator with General Radio 314-S86 delay line produces square-wave output in range of 0.5 to 20 Mc.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 352.



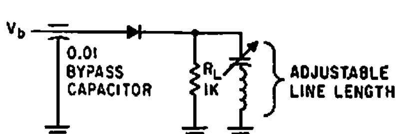
24-MC CLAPP—Delivers 300 mw into 50-ohm load. Typical collector efficiency is 35%. —Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 239.



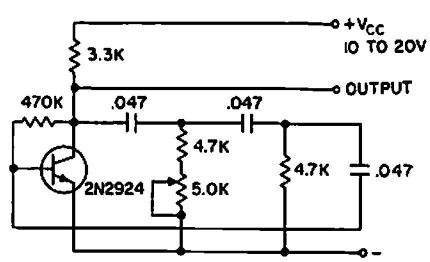
SATURABLE-REACTOR OSCILLATOR—Time-base integration of a variable is performed by counting cycles of saturable-reactor oscillator whose frequency is proportional to the variable. Linearity is within 1% of full scale.—L. W. Langley, Saturable-Core Oscillator Integrates Gas-Flow Data, *Electronics*, 32:4, p 42–43.



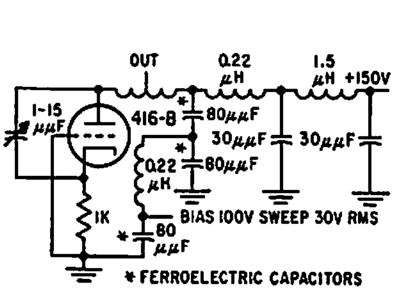
CB CRYSTAL OSCILLATOR—Uses low-cost crystal having high series resistance, up to 30 ohms. Provides adequate output to supply most master oscillator-power amplifier applications. Output tap is arranged to match directly a companion 2N2195 grounded-base amplifier. Crystal is 3rd overtone type.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 211.



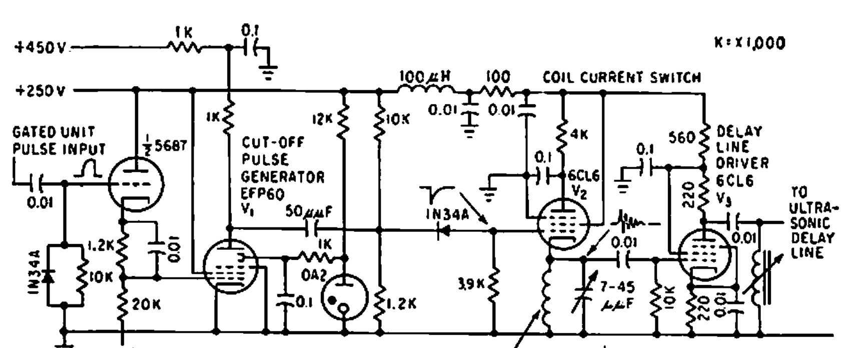
NR DIODE AS R-F OSCILLATOR—Simple negative-resistance diode circuit can develop several milliwatts at frequencies up to 300 Mc.—A. P. Schmid, Jr., Negative-Resistance Diode Handles High Power, *Electronics*, 34:34, p 44–46.



SIMPLE TRANSISTOR OSCILLATOR—Current gain is stabilized against transistor variation. Can be used over collector voltage range of 2 to 24 v. Oscillation occurs at frequency at which there is 360° total phase shift, 180° of which is furnished by grounded-emitter amplifier and 180° by high-pass network. 5K pot adjusts frequency from about 200 to 400 cps.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 206.

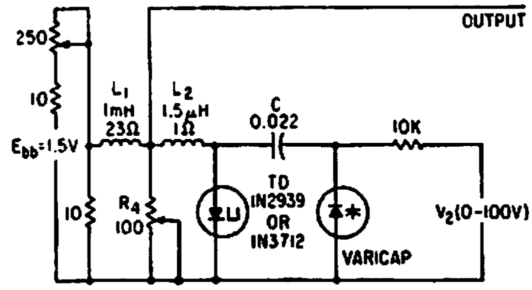


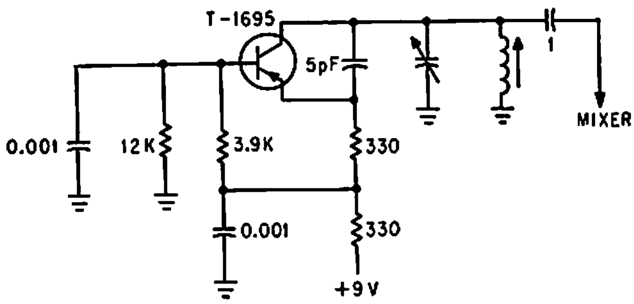
ELECTRIC TUNING FOR 600 to 1,200 MC—Lumped-constant technique is used with voltage-tunable ferroelectric capacitors to provide 10 mw into 50 ohms.—T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.



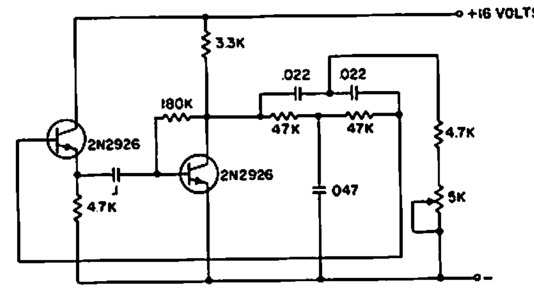
DAMPED 40-MC GENERATOR—Converts unit pulses, resulting from video screening in nuclear track scanner, to damped 40-Mc oscillations each 0.1 microsec long, which are inserted in quartz ultrasonic delay line that feeds counter.—P. V. C. Hough, J. A. Koenig, and W. Williams, Scanner Recognizes Atomic Particle Tracks, *Electronics*, 32:13, p 58–61.

VARICAP TUNES TUNNEL-DIODE OSCILLATOR—Series oscillator circuit tunes electrically over range of 12 to 22 Mc.—E. Gottlieb and J. Giorgis, Tunnel Diodes—Using Them as Sinusoidal Generators, *Electronics*, 36:24, p 36–42.

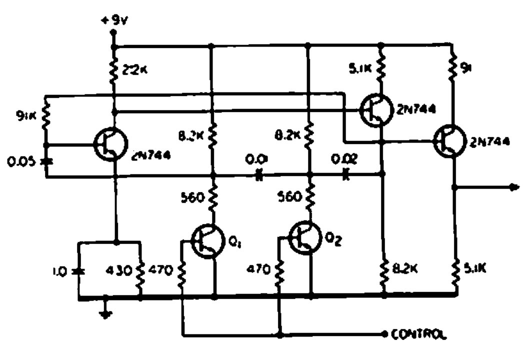




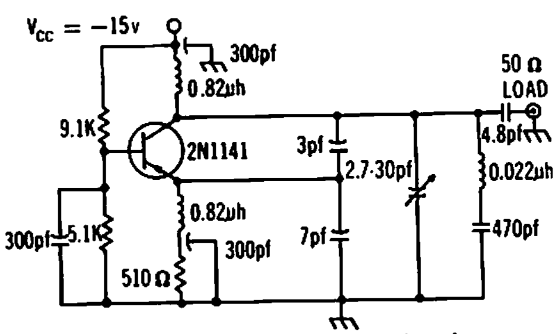
STABLE 40-MC OSCILLATOR—Frequency shifts less than 500 kc when supply voltage is changed from 5 to 12 v.—T. P. Prouty, Using Varactors to Extend Frequency-Control Range, *Electronics*, 36:45, p 48–49.



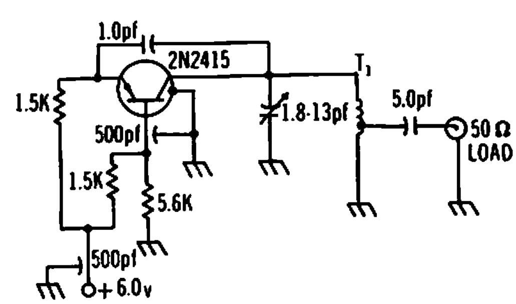
BRIDGED-T R-C PHASE-SHIFT OSCILLATOR—Emitter-follower eliminates loading variations, contributing to exceptional frequency stability (0.2%) over temperature range of −55 to 80°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 207.



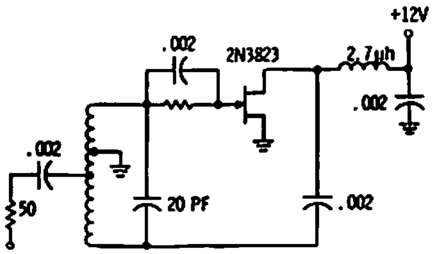
NONLINEAR VOLTAGE-CONTROLLED OSCILLATOR—Use of conventional transistors rather than fet's means that Q1 and Q2 operate in knee region, where frequency does not vary linearly with d-c control voltage. This is generally not a drawback when control voltage is servoed. Increasing the control voltage increases the frequency.—R. Selleck, Voltage-Controlled Oscillators, *EEE*, 13:3, p 47.



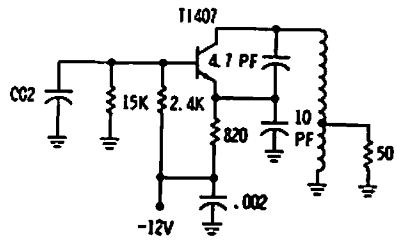
TEMPERATURE-STABLE 200-MC—Varies less than 2 Mc in frequency and less than 1.5 mw in power output over temperature range of 25 to 80°C. Normal power output is 22.5 mw.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 301.



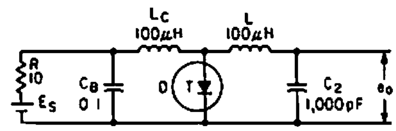
500-MC COLPITTS—Frequency varies less than 3 Mc from 25 to 75°C, and less than 1.5 Mc with bias change from 6 to 9 v. Output is 10 mw. T1 is 1.5" length of 3/8" brass rod with output tap 1/4" from bottom.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 301.



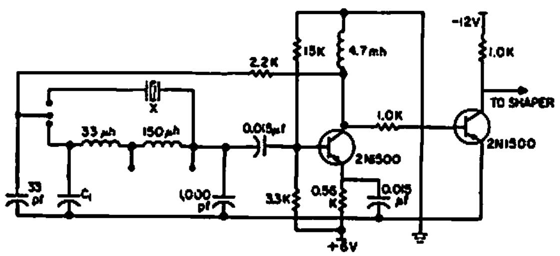
FET HARTLEY—Delivers 680 mv to 50-ohm load at 100 Mc. Coil is four 3/8-inch-diameter turns of No. 16 wire spaced to 0.5 inch.—Fets Come Alive: Clinic Unveils Practical Circuits, *EEE*, 14:4, p 16–18.



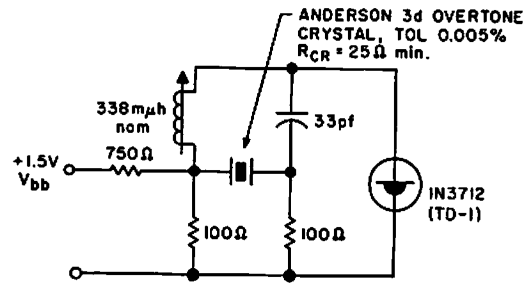
100-MC COLPITTS—Uses conventional bipolar transistor, which has low noise in operation from low-impedance voltage generator. Temperature drift is much greater than with fet. —Fets Come Alive: Clinic Unveils Practical Circuits, *EEE*, 14:4, p 16–18.



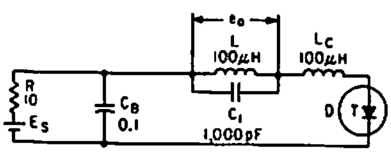
SINE-WAVE TUNNEL DIODE—Low-impedance capacitor in parallel with series-resonant circuit of tunnel-diode relaxation oscillator passes all frequencies except that for series resonance, giving sinusoidal voltage across output capacitor. Output frequency varies from 0.7 to 0.8 Mc over bias range of 100 to 400 mv.—Wen-Hsiung Ko, Designing Tunnel Diode Oscillators, *Electronics*, 34:6, p 68–72.



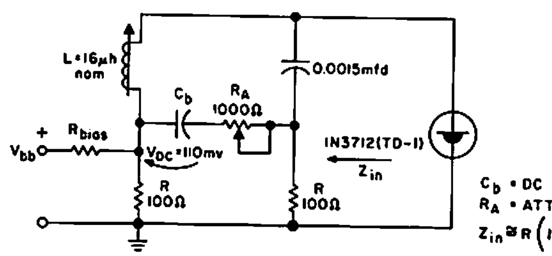
CRYSTAL-OR-CAPACITOR OSCILLATOR—Gives high stability from 800 kc to 3 Mc, from 0 to 65°C with either crystal or capacitor. Optimum operating frequency can be found and utilized by changing capacitor value C1 in range up to 500 pf, while awaiting delivery of CT-cut crystal at desired frequency. —T. Asai, Crystal-or-Capacitor Oscillator, *EEE*, 12:3, p 72.



47.1-MC TUNNEL DIODE-CRYSTAL OSCILLATOR—Used in Fire Department service. Operates within tolerance of quartz crystal from −55 to +85°C and bias range of 110 to 150 mv for Citizens Band service.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 353.

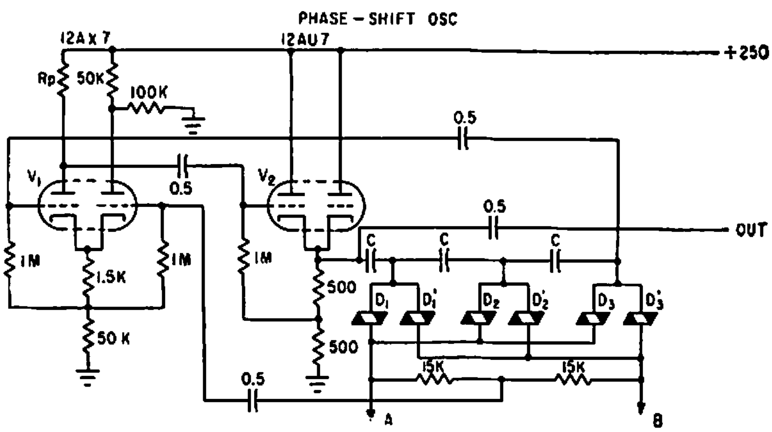


SINE-WAVE TUNNEL DIODE—Series filter selects desired frequency and rejects harmonics from pulse-shaped output of basic tunnel-diode relaxation oscillator. Values shown give 0.45 Mc, constant within 0.05 Mc over bias range of 100 to 400 mv.—Wen-Hsiung Ko, Designing Tunnel Diode Oscillators, *Electronics*, 34:6, p 68–72.

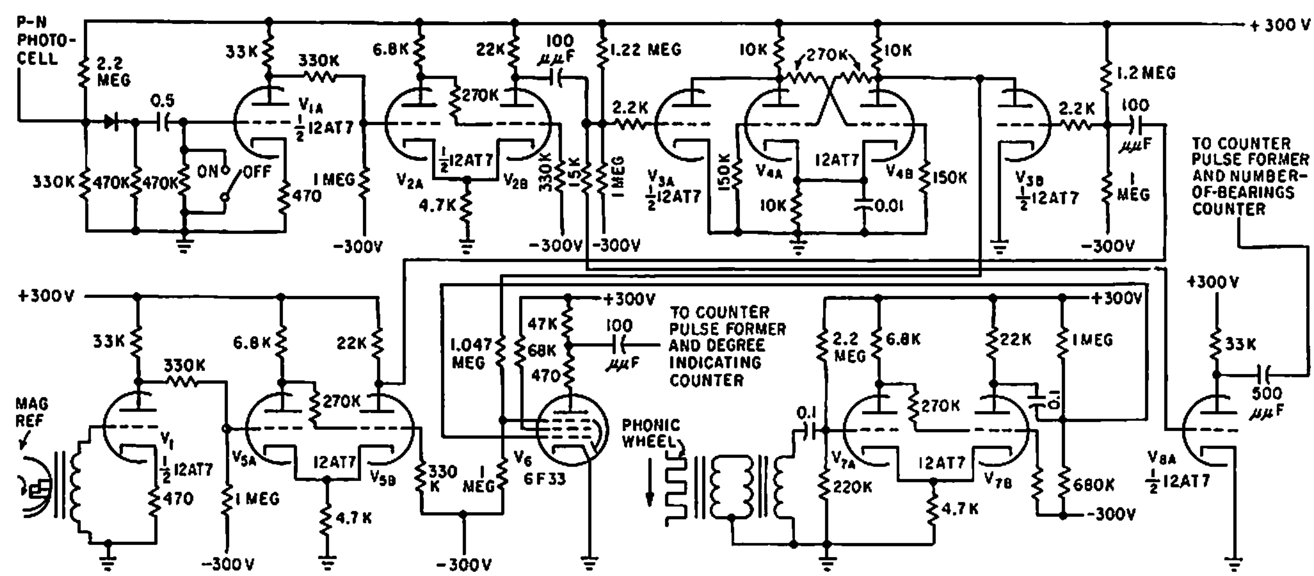


VARIABLE-AMPLITUDE TUNNEL-DIODE OSCILLATOR—Attenuating resistor RA varies magnitude of oscillator swing, so oscillator operates over limited highly linear portion of diode conductance curve.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 351.

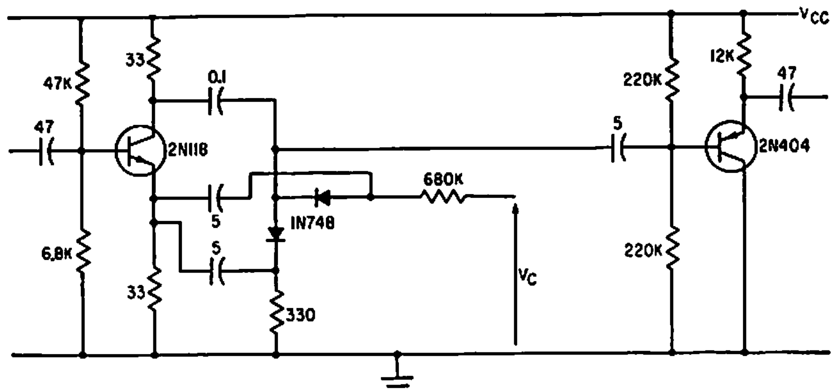
CHAPTER 57
Phase Control Circuits



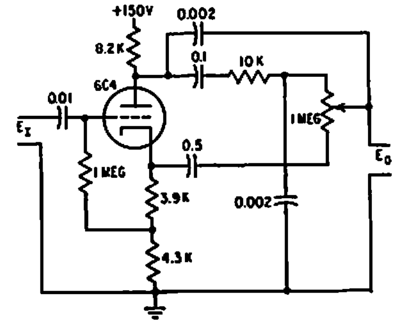
6-VARISTOR PHASE-SHIFT VTO—Range is ten times lowest frequency, with upper limit of several kc, depending on values of C. Triode differential amplifier V1 is first stage of oscillator. One input grid, for a-c amplification, goes to output of phase-shift circuit. Other grid goes to centertap across SiC varistors. —M. Uno, Varistor Network Controls Voltage-Tuned Oscillator, *Electronics*, 34:30, p 44–47.



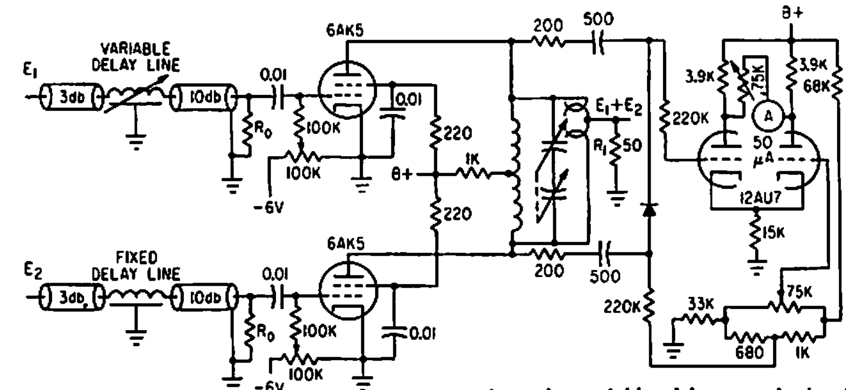
ADF PHASEMETER—Input signals are squared by Schmitt triggers, differentiated, and changed to unidirectional pulses that drive flip-flop V4 to produce pulse whose length is proportional to bearing of transmitter. 500-cps signal from phonic wheel is sharpened by Schmitt trigger V7 and used to indicate length of bearing pulse in degrees by modulating the pulse in V6. One output goes to decade counter chain that counts total number of degrees.—J. F. Hatch and D. W. G. Byatt, Direction Finder with Automatic Readout, *Electronics*, 32:16, p 62–64.



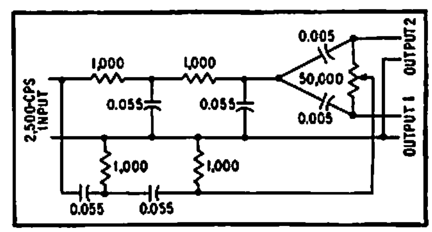
PHASE SHIFTER WITH LINEAR BIASING—Frequency range of more than two decades can be obtained from voltage-controlled oscillator when linear biasing is used for phase-shift circuit.—R. A. Greiner and S. K. Morgan, Voltage Controlled Wide-Range Oscillator, *Electronics*, 34:51, p 31–35.



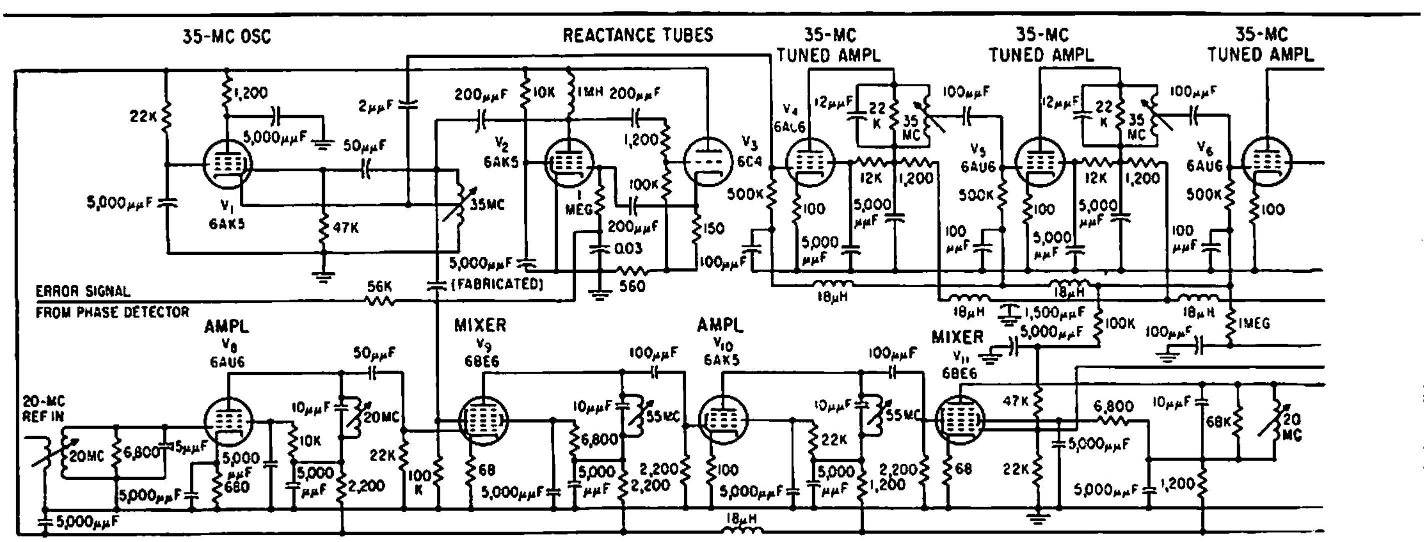
TUBE REPLACES 180° TRANSFORMER—Elimination of transformer resonance effects at higher frequencies permits phase shifter to handle wider band of frequencies, from 500 to 2,000 cps for component values shown.—W. G. Shepard, Phase Shifter Range Exceeds 180°, *Electronics*, 31:19, p 96–100.



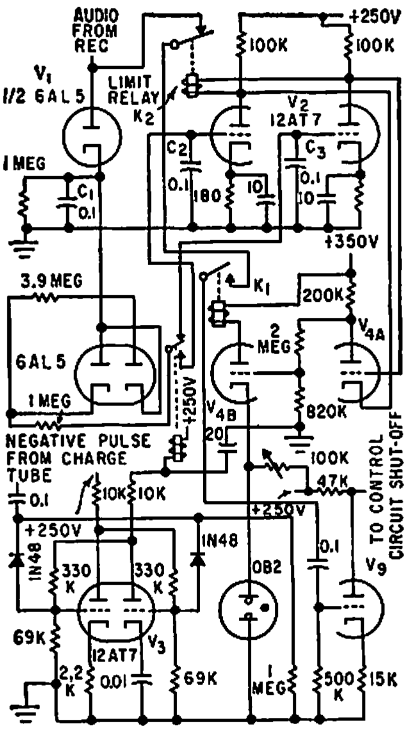
MEASURING PHASE UP TO 400 MC—Three plug-in tuning circuits cover range from 15 to 400 Mc. Phase delay is compared with continuously variable delay standard with accuracy of 1% or 0.1°.—Y. P. Yu, How to Measure Phase at High Frequencies, *Electronics*, 34:11, p 54–56.



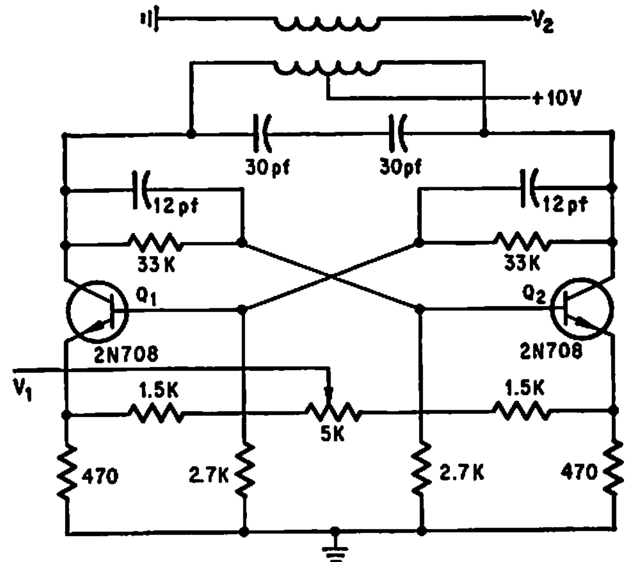
360-DEG SHIFTER—One variable component provides phase difference between outputs that is adjustable from −180 to +180 degrees without substantial change in magnitude, at fixed frequency of 2,500 cps.—W. Bacon, Circuit Shifts Phase 360 Degrees, *Electronics*, 31:23, p 94–97.



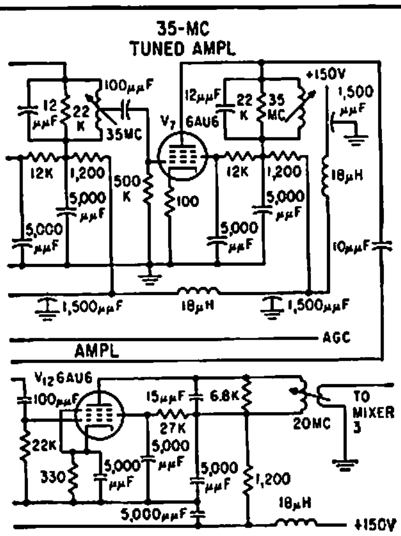
STEERABLE ANTENNA CONTROL—Phase-stabilized 35-Mc uhf amplifier controls directivity of multi-element stationary antenna array. Phase of amplifier output is compared with input reference signal in phase-sensitive detector. System keeps input-output error under 2°.—E. W. Markow, Servo Phase Control Shapes Antenna Pattern, *Electronics*, 32:1, p 50–52.

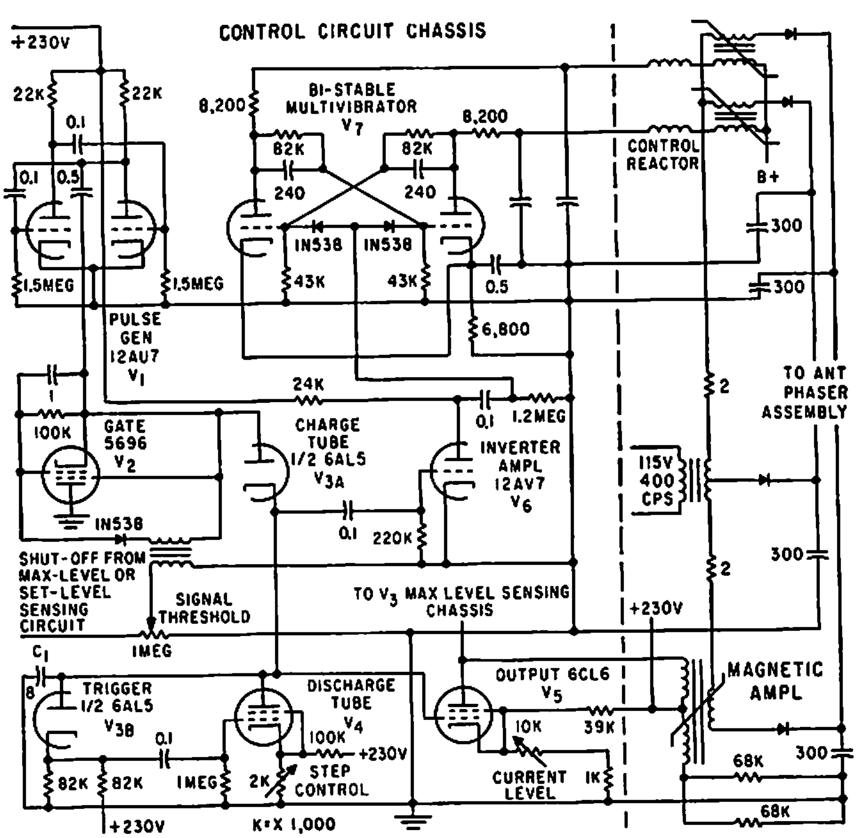


AUDIO CONTROL FOR ANTENNA PHASER—Rectified audio in multiple-antenna aircraft receiver alternately charges C2 and C3 at grids of V2. Bistable mvbr V3 performs switching in synchronism with pulse generator so each switch position corresponds to change in antenna phasing. When peak of signal is passed and phase is reversed, V4 pulls in K1 and sends control signal to control unit. K2 opens when difference in potentials of C2 and C3 becomes excessive, forcing system to resume cycling until output is again maximized.—I. Dlugatch, Optimizing Antenna Switches and Phasers, *Electronics*, 32:33, p 55–57.

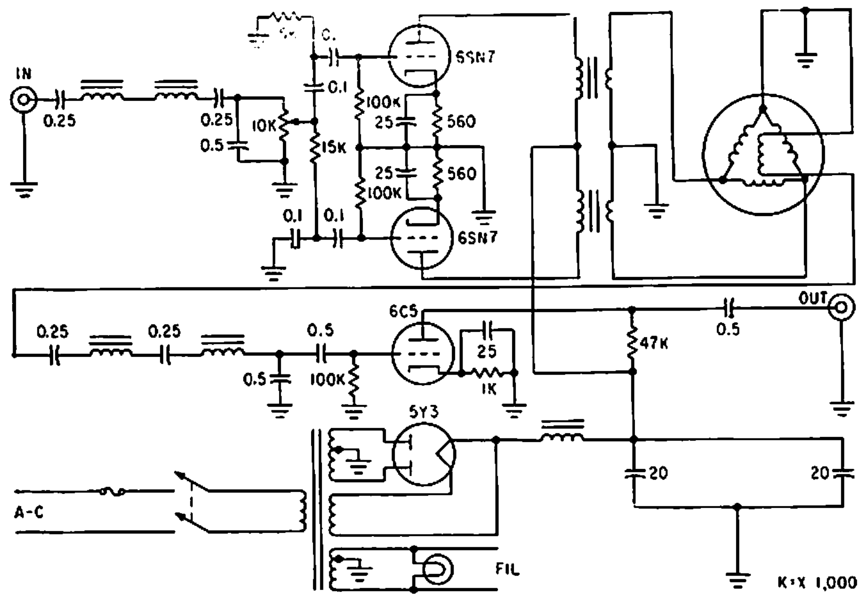


CONTINUOUS PHASE CONTROL—Potentiometer changes phase relationship between synchronizing voltage V1 and output voltage V2, without affecting amplitude of output from free-running mvbr.—S. Tesic, Multivibrator Provides Continuous Phase Control, *Electronics*, 39:15, p 102–103.

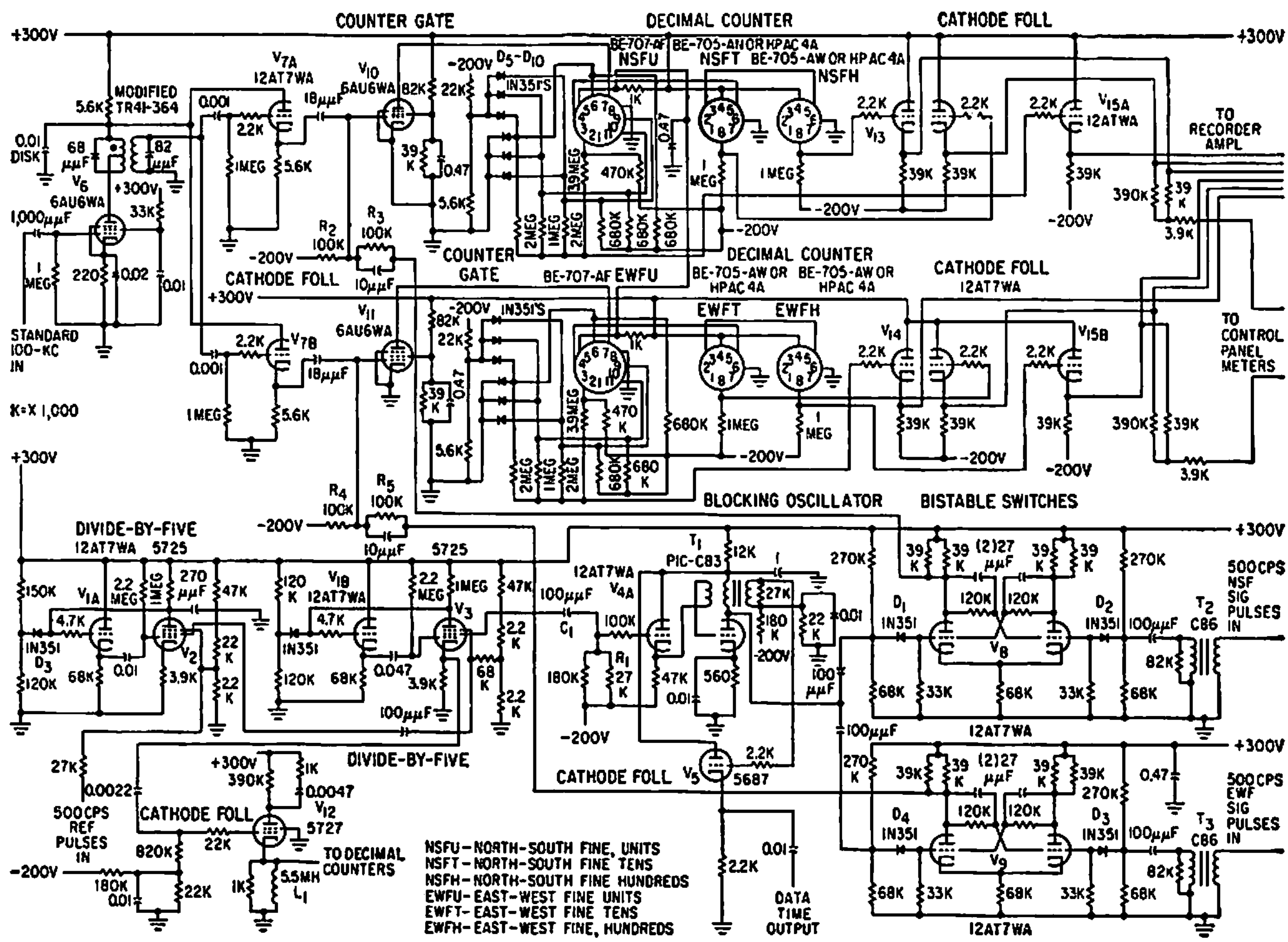




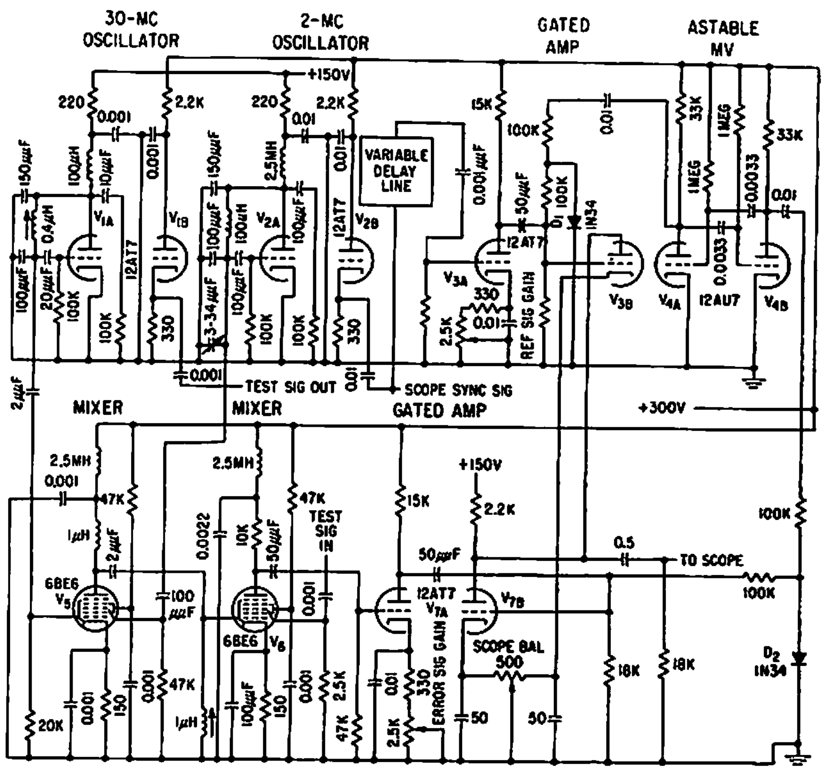
ANTENNA PHASING CONTROL—Used with two antennas on different parts of an aircraft to insert artificial delay in series with one antenna so signal addition will occur. Contains staircase generator that charges C1 in steps until receiver threshold cuts off V2. Charge on C1 biases V5 to change magnetization of reactor and thereby lock phaser automatically at optimum degree of delay.—I. Dlugatch, Optimizing Antenna Switches and Phasers, *Electronics*, 32:33, p 55–57.



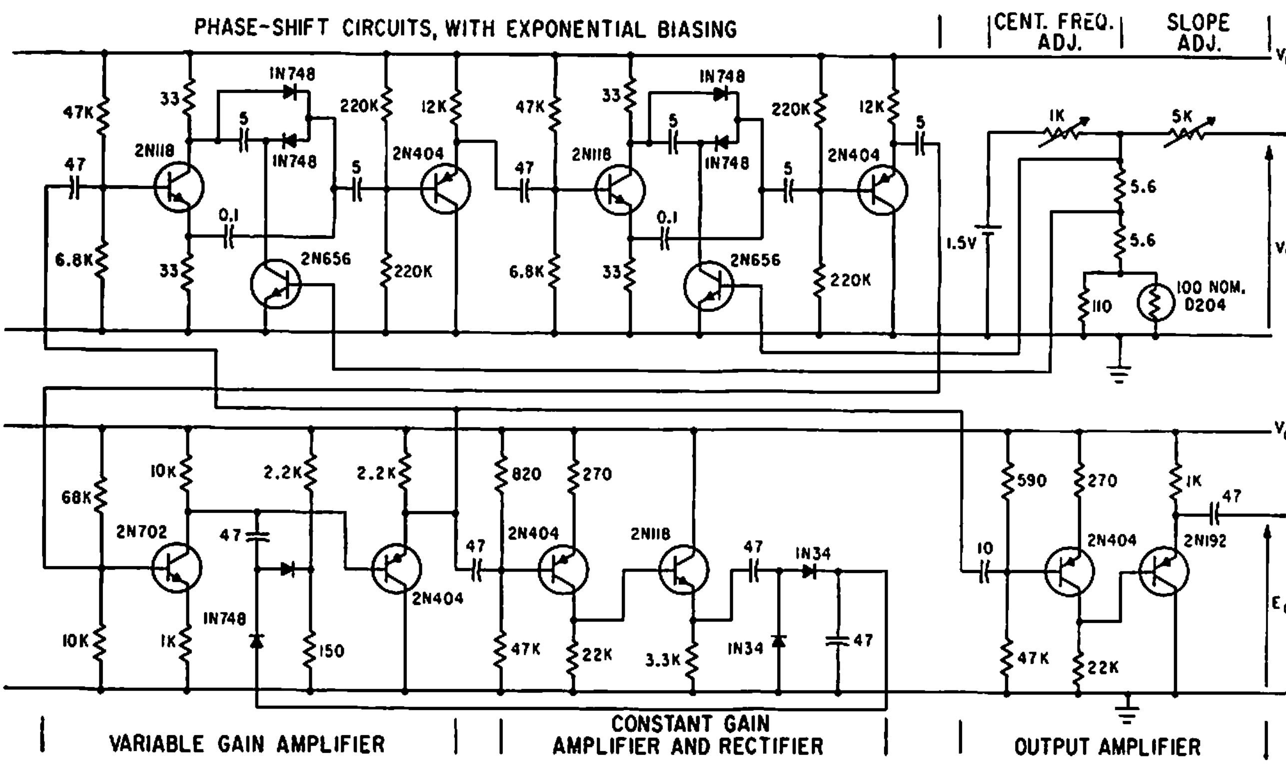
SELF-SYNCHRONIZED PHASE SHIFTER—Consists of power supply, inverter, phase-shifting Selsyn, 100-cps filter, and output amplifier, used to vary phase of 100-cps frequency standard output by synchronization with WWV for studies of low-frequency propagation over long distances.—M. M. Newman et al, Sea-Going Lightning Generator, *Electronics*, 33:30, p 53–55.



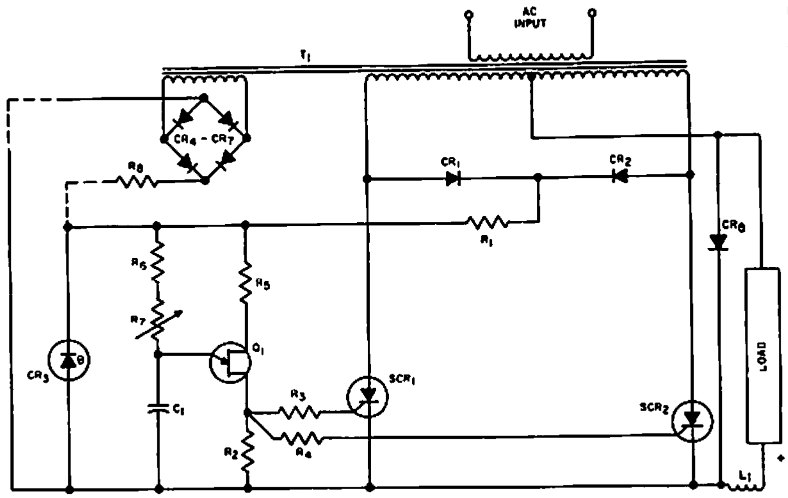
DIGITAL PHASE METER—Measures phase angle between satellite signal and reference pulse. Bistable switch operates as gate that connects 500-cps pulse train to 3-decade decimal counter during time between reference and signal pulses. Two channels measure phase angles of north-south and east-west fine signals.—C. A. Schroeder, C. H. Looney, Jr., and H. E. Carpenter, Jr., Tracking Orbits of Man-made Moons, *Electronics*, 32:1, p 33–37.



PHASE MEASURING AT 30 MC—Double mixing process linearly transposes phase shifts accumulated at 30 Mc down to 2 Mc, where they are accurately compared against calibrated 2-Mc reference signal. Samples of 30-Mc and 2-Mc signals are mixed in V5, and 32-Mc sum frequency is then mixed with phase-shifted 30-Mc signal from unit under test by V6. Difference frequency, equal to 2 Mc plus phase shift, is amplified in V7A, fed through gate V7B, and associated circuits then superimpose this signal and that of 2-Mc reference oscillator on cro to get display of phase shift.—A. Nirenburg, How to Measure Midfrequency Phase Shift, *Electronics*, 31:35, p 46–47.



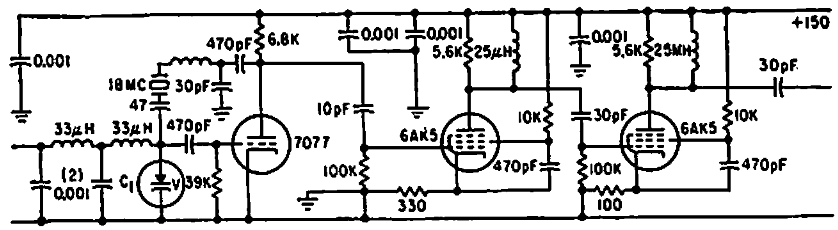
VOLTAGE-CONTROLLED PHASE-SHIFT OSCILLATOR—Small-signal a-c resistance of junction diode, related to reciprocal of junction current over two-decade range, is used in two-section R-C phase-shift network acting with amplifier and agc to give constant-amplitude voltage-controlled oscillator with frequency range of over two decades.—R. A. Greiner and S. K. Morgan, Voltage Controlled Wide-Range Oscillator, *Electronics*, 34:51, p 31–35.

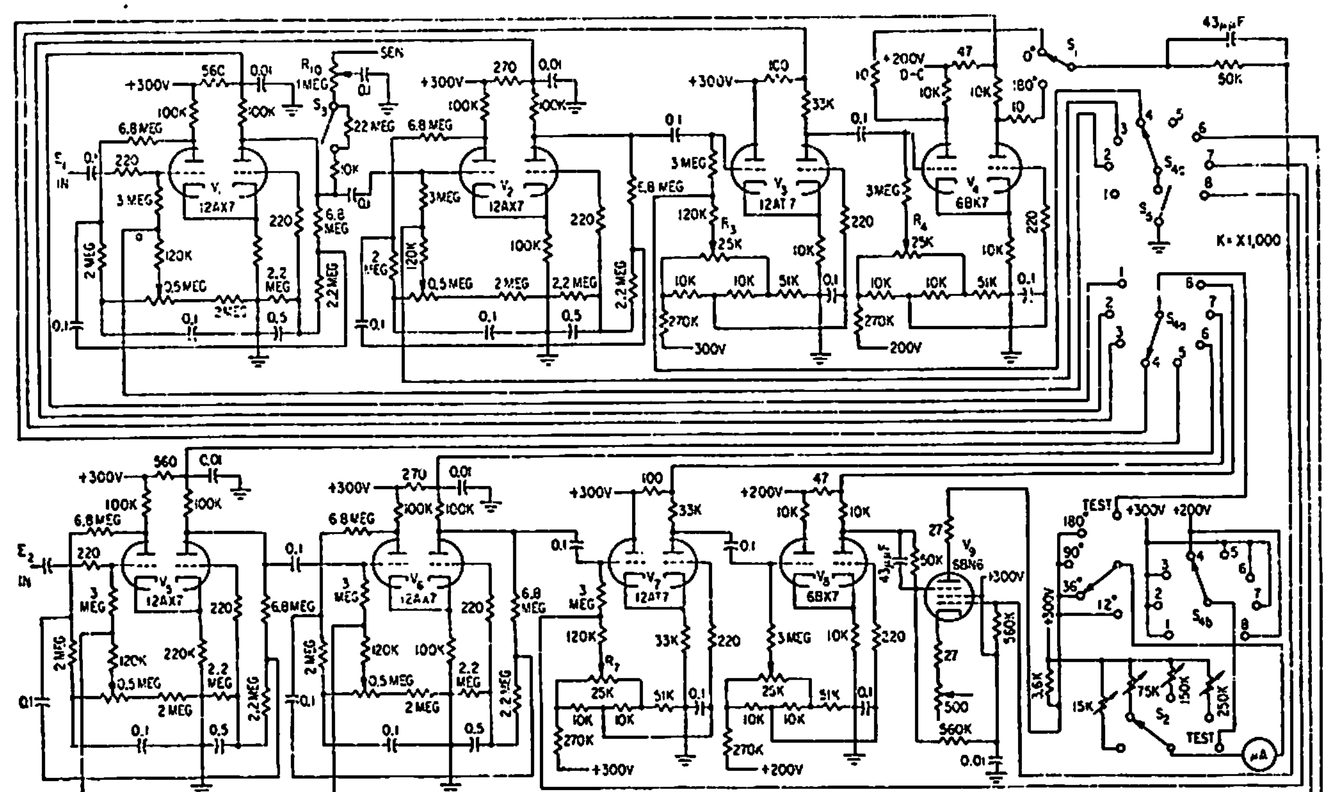


R1—3.3K, 5 WATT IF SEC VOLTAGE OF T1 IS 117 VOLTS EACH SIDE OF CENTERTAP
R2—47 Ω, 1/2 WATT
R3,R4—22 Ω, 1/2 WATT
R5—390 Ω, 1/2 WATT
R6—2.7K, 1/2 WATT
R7—50K LINEAR POT
R8—3.3K, 5 WATT
C1—0.2 MFD
SCR1, SCR2—AS REQUIRED BY LOAD
CR1,CR2,CR4,CR7—G-E 1N695
CR3—1N1776 REGULATING DIODE
Q1—G-E 2N2646
OPTIONAL CR8—AS REQUIRED BY LOAD CURRENT
L1—AS REQUIRED FOR FILTERING

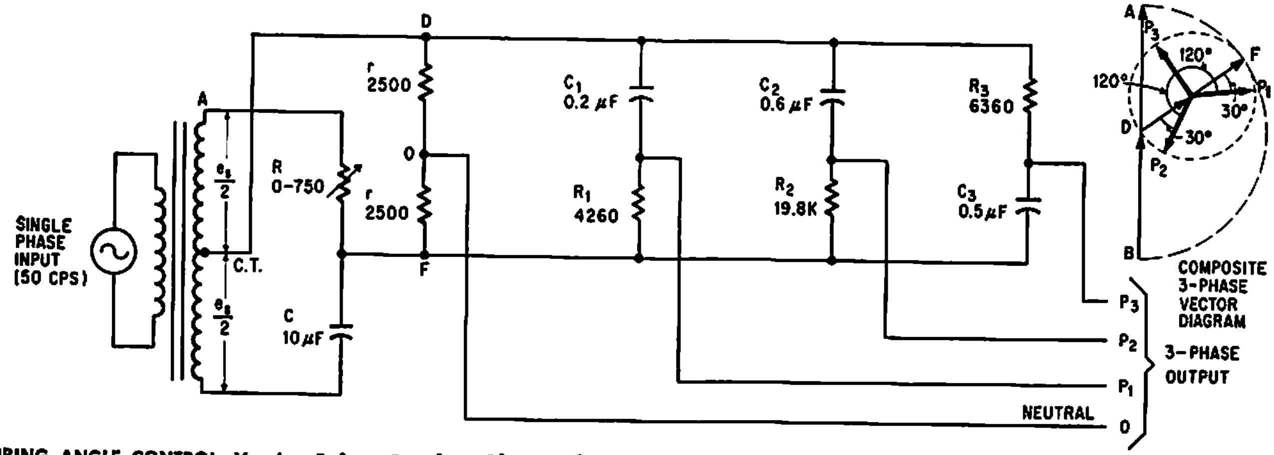
PHASE-CONTROLLED D-C SUPPLY—Uses scr's in single-phase center-tap phase-controlled rectifier. D-c voltage across load can be adjusted steplessly from zero to maximum with R7. Single ujt Q1 develops gate signal to fire both scr's on alternate half-cycles.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 140.

VOLTAGE-VARIABLE 90-MC OSCILLATOR—Ceramic triode in 18-Mc crystal stage has high short-term stability, yet can be pulled about 2 kc by voltage-variable capacitor C1. Fifth harmonic is amplified and buffered for use in measuring phase differences between two signals.—R. T. Stevens, Precision Phasemeter for CW or Pulsed UHF, *Electronics*, 33:10, p 54–57.



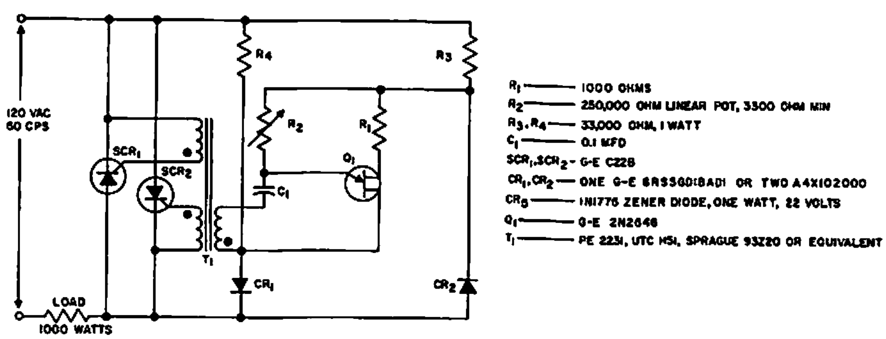


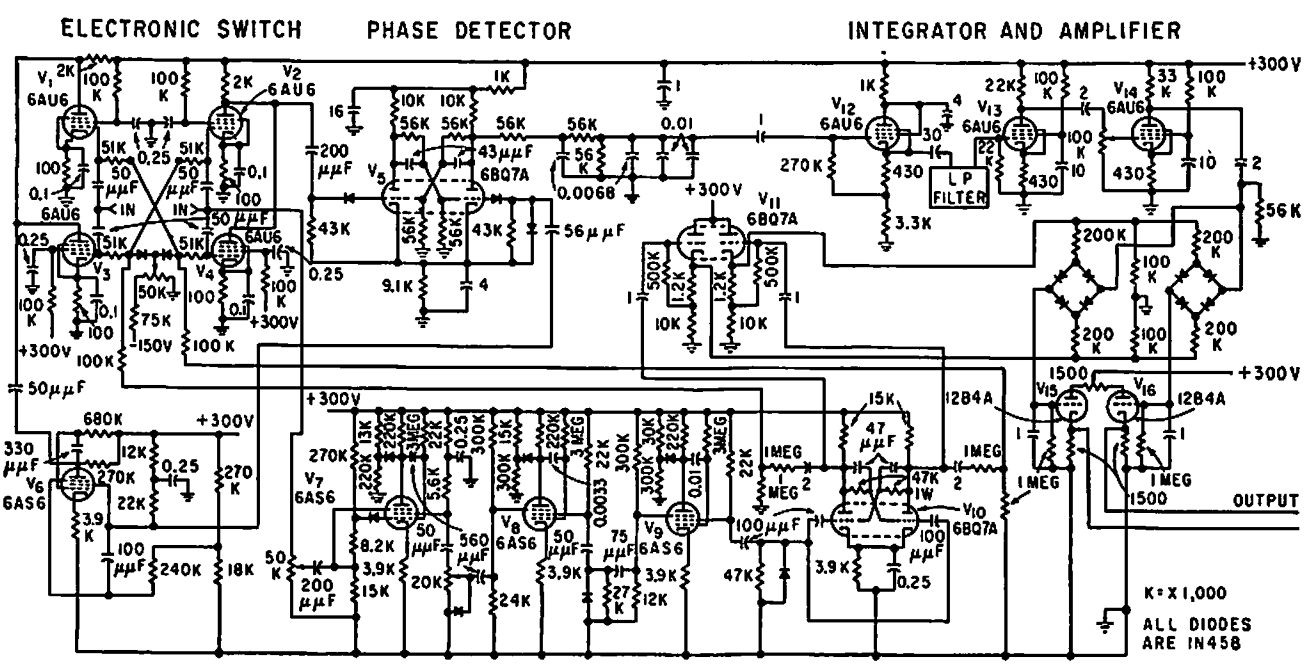
COINCIDENT-SLICER PHASEMETER—Cathode-coupled limiters convert input signals to square waves and feed them to coincident slicer. Self-adjustment of limiters and use of coincident slicer to drive direct-reading phasemeter give good accuracy and stability for input-signal fluctuations from 0.3 to 70 v and supply voltages from 94 to 135 v, with absolute accuracy of 1° and relative accuracy of 0.25°.—Y. P. Yu, Coincident Slicer Measures Phase Directly, *Electronics*, 31:37, p 99–101.



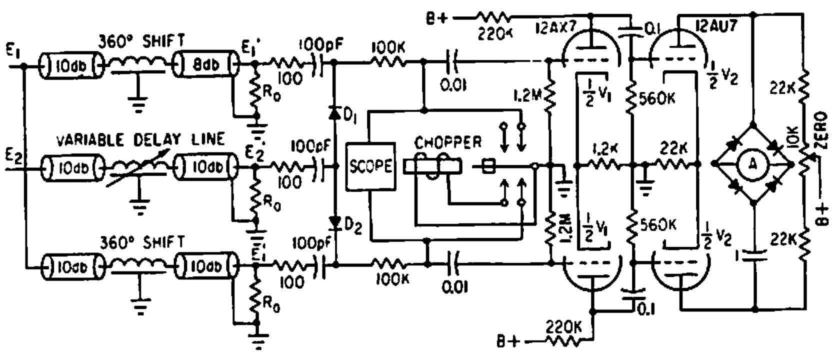
FIRING ANGLE CONTROL—Varying R from 0 to infinity shifts the three phase voltages from 0° to 180°.—J. J. Vithayathil, Variable-Phase, Polyphase From Single-Phase Supply, *Electronics*, 37:27, p 56–57.

1-KW A-C PHASE CONTROL—Inverse-parallel circuit is economical for manual control of lights, heaters, ovens, or fans.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 138.

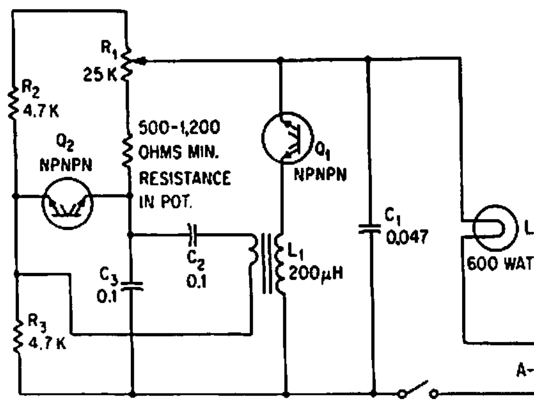




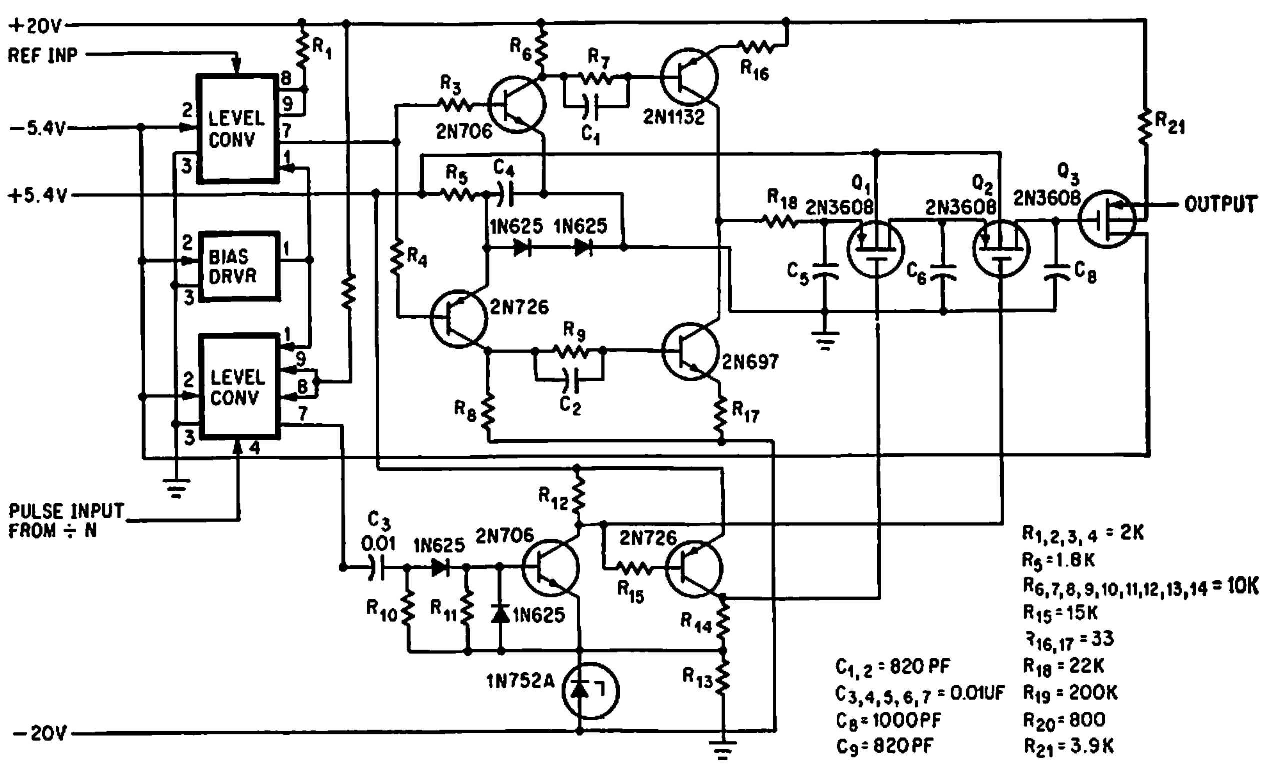
PULSE-CHAIN PHASEMETER—Measures phase difference as small as 0.005 deg between pulses of two nearly coincident pulse chains using electronic switch, mvbr phase detector, and diode synchronous detector. Output shows both sign and magnitude of phase angle between two corresponding pulses in pulse chains.—F. Vrataric, Jr., Electronic Switching in Phase Measurement, *Electronics*, 32:23, p 60–61.



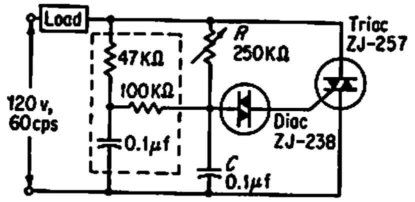
MEASURING PHASE UP TO 2,000 MC—Output is fed to cro having 100-kc bandwidth. In operation, time delay of both channels is equalized by applying identical signal to both inputs, then reference and unknown signals are applied to input terminals and variable delay line is adjusted again for null on chopper amplifier that drives d-c milliammeter.—Y. P. Yu, How to Measure Phase at High Frequencies, *Electronics*, 34:11, p 54–56.



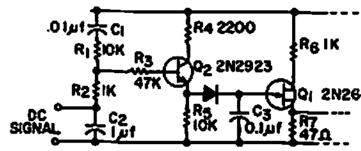
LAMP DIMMER—Silicon symmetrical switches Q1 and Q2 control phase angle at which current flows through 600-w fluorescent or incandescent lamp load. Q1 handles load current while Q2 serves as symmetrical relaxation oscillator, with setting of R1 determining point in each half-cycle at which Q2 fires. Since system is symmetrical, it cannot be damaged by transients or line surges.—S. B. Gray, Home and Auto Controls, *Electronics*, 36:19, p 52–56.



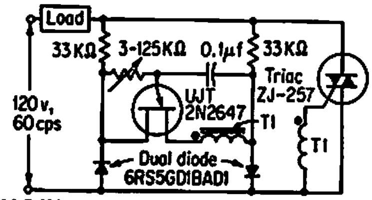
HOLD-SAMPLE-HOLD PHASE DETECTOR—Has two mos transistors as series switches and a third as impedance transformer. C5, C6, and C8 are charged to voltages proportional to phase difference between programmed divider's output and reference signal. Voltages are summed with pretuning voltage to control vco of frequency synthesizer for military uhf transceiver.—L. F. Blachowicz, Dial any Channel to 500 Mhz, *Electronics*, 39:9, p 60–69.



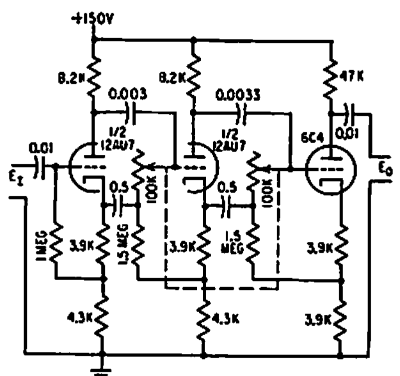
DIAC-TRIAC PHASE CONTROL OF 5-AMP LOAD—Uses two types of semiconductor switches together with R and C to give continuous control of power. Addition of second phase shift network (enclosed in dashed box) extends range of control to cover 5 to 95% of full power.—M. P. Southworth, Bidirectional Static Switch Simplifies Ac Control, *Control Engineering*, March 1964, p 75–76.



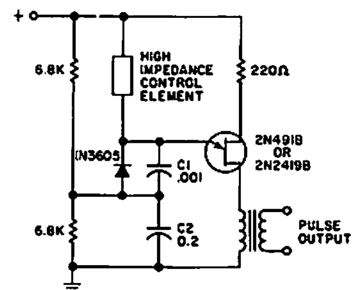
SNAP-ACTION A-C PHASE CONTROL—Provides snap-action switching of load in response to change in d-c signal, a-c signal, or variable resistance element, using small differentiating network R1-R2-C1 that peaks leading edge of pedestal. Triggering can occur only near beginning of each half-cycle, to give snap-on and snap-off action.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 135.



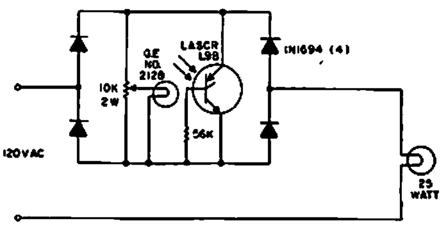
TRIAC-UJT PHASE CONTROL—Provides wide range of stable control without hysteresis at low outputs and without dependence on supply voltage. Triac eliminates need for transient suppression components that would be required with scr control and permits use of simple two-winding pulse transformer.—M. P. Southworth, Bidirectional Static Switch Simplifies A-C Control, *Control Engineering*, March 1964, p 75–76.



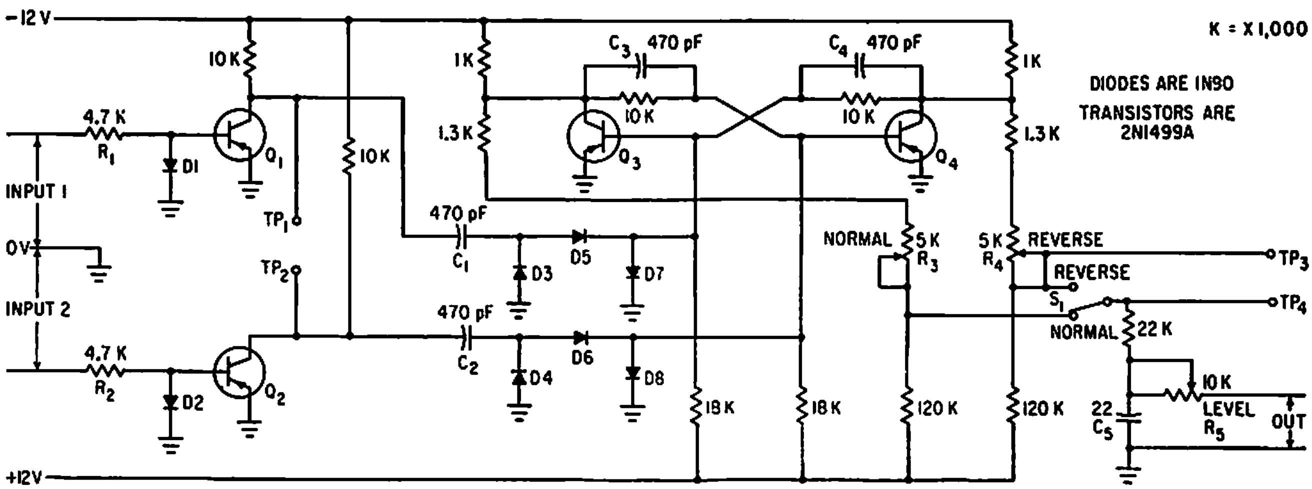
CASCADED TWO-TUBE PHASE SHIFTER—Provides phase shifts well over 180° with highly constant output voltage. Use of tubes in place of transformer gives wide-band operation, from 500 to 2,000 cps.—W. G. Shepard, Phase Shifter Range Exceeds 180°, *Electronics*, 31:19, p 96–100.



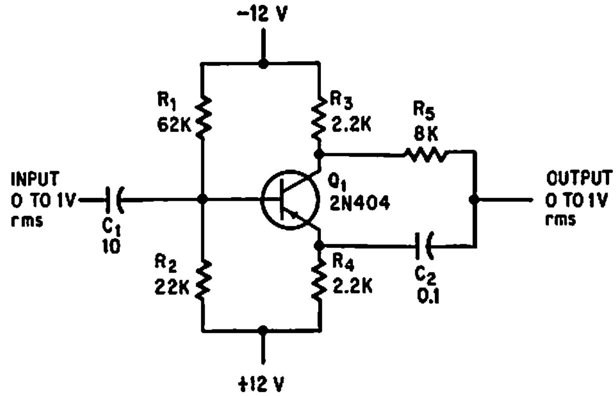
HIGH-GAIN PHASE CONTROL—Use of two different sizes of charging capacitors in series increases effective gain up to 10,000 times that of conventional ujt/scr phase-control circuit. Eliminates need for two or three stages of transistor amplification.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 332.



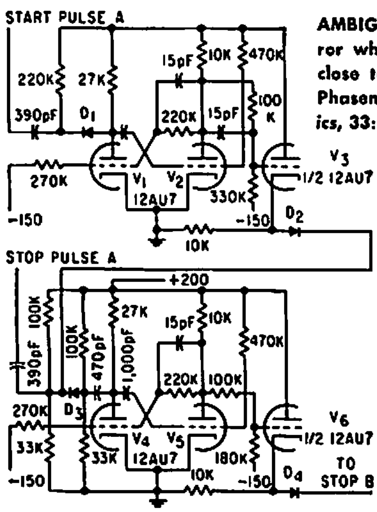
SMALLEST PHASE CONTROL—Miniature lamp No. 2128 with small, low-mass filament can reach firing level of light-activated scr in about three cycles with low applied voltage. As applied voltage is increased, this time is reduced to about 1 millisec when lamp is directed across LASCR terminals, thus providing phase control. Lamp voltage is removed when LASCR fires, protecting lamp and resetting it for next half-cycle. Useful for dimming 25-w lamp or for controlling temperature of small soldering iron.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 213.



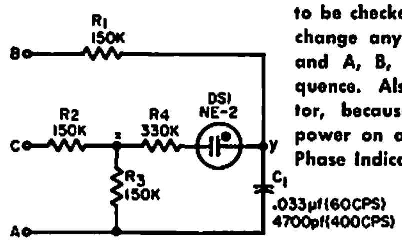
PHASE-DIFFERENCE METER FOR 0.2 TO 20 KC—Measures phase difference between two sinusoidal inputs. Each limiter (Q1 and Q2) drives one side of high-speed flip-flop Q3-Q4 through differentiating and clipping circuits, giving square wave that turns on when one input signal goes negative and turns off when other input goes negative. D-c value of output voltage is proportional to phase difference, with about 11 v corresponding to 360°.—J. R. Woodbury, Measuring Phase with Transistor Flip-Flops, *Electronics*, 34:38, p 56.



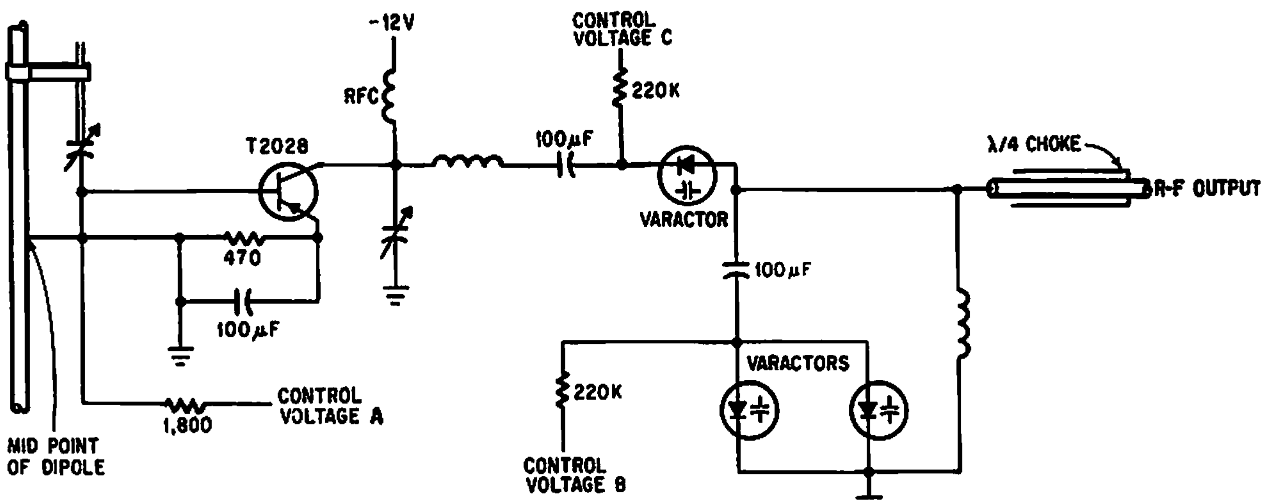
VARIABLE 0–180 DEG PHASE SHIFTER—Single low-cost pnp germanium transistor circuit gives any desired phase shift between 0 and 180 degrees, at constant amplitude, for frequencies up to 3 Mc, by varying values of C2 and R5. Values shown give 90° shift for 200 cps.—J. J. Collins, Single Transistor Provides Low-Cost Phase Shifter, *Electronics*, 37:16, p 92.



AMBIGUITY RESOLVER—Prevents counting error when phase shift between two signals is close to 0° or 360°.—R. T. Stevens, Precision Phasemeter for CW or Pulsed UHF, *Electronics*, 33:10, p 54–57.

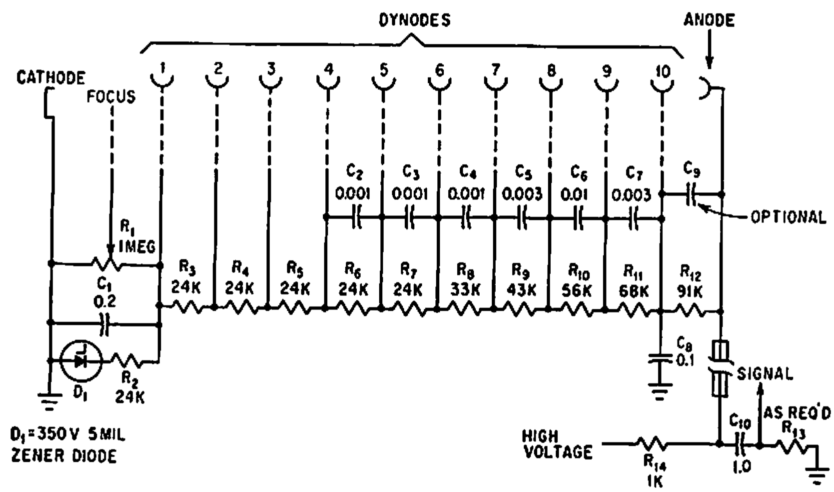


PHASE INDICATOR—Used to determine succession of phases of three-phase 120-v a-c source used in synchro work. Terminals A, B, and C are connected to terminals of source to be checked. If neon lamp comes on, interchange any two leads; light then goes out, and A, B, and C then indicate correct sequence. Also serves as phase failure monitor, because neon lamp will come on if power on any one line is lost.—G. Richwoll, Phase Indicator, *EEE*, 12:11, p 70.

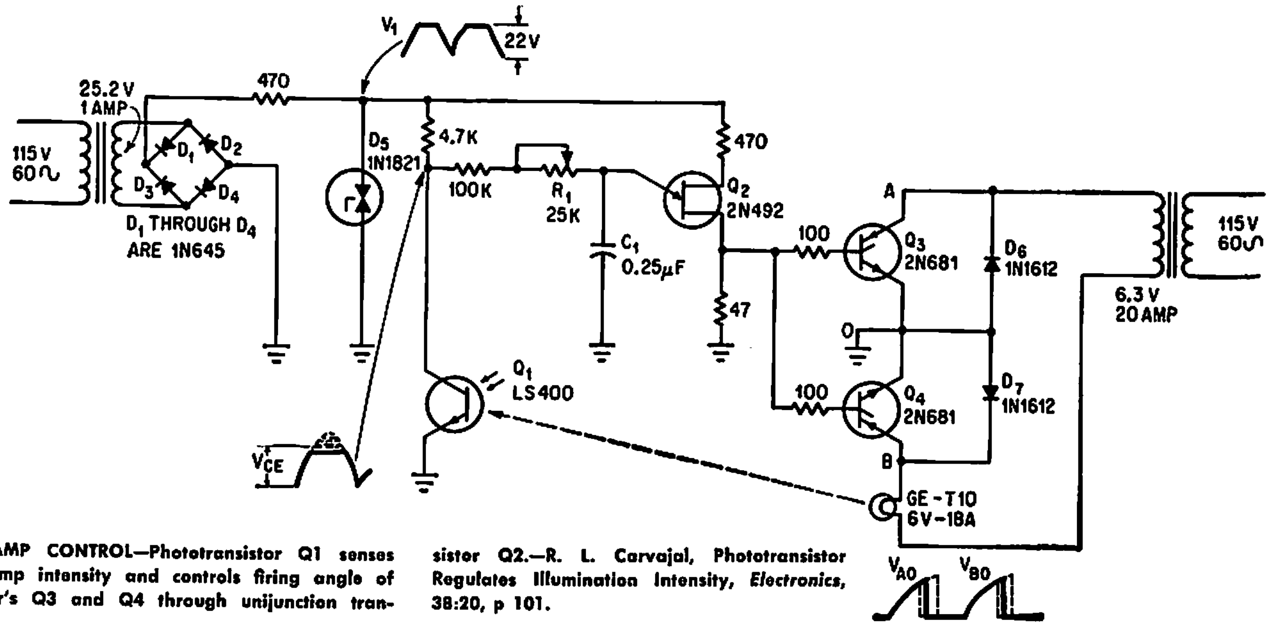


PHASE-SHIFTING ANTENNAFIER—Control voltages A, B, and C together produce up to 180° phase shift with adequate matching, for beam-steering arrays. Ganged potentiometers with appropriately tapered windings can provide the control voltages and relate beam position to shaft rotation.—J. F. Rippin, Making the Antenna an Active Partner, *Electronics*, 38:16, p 93–96.

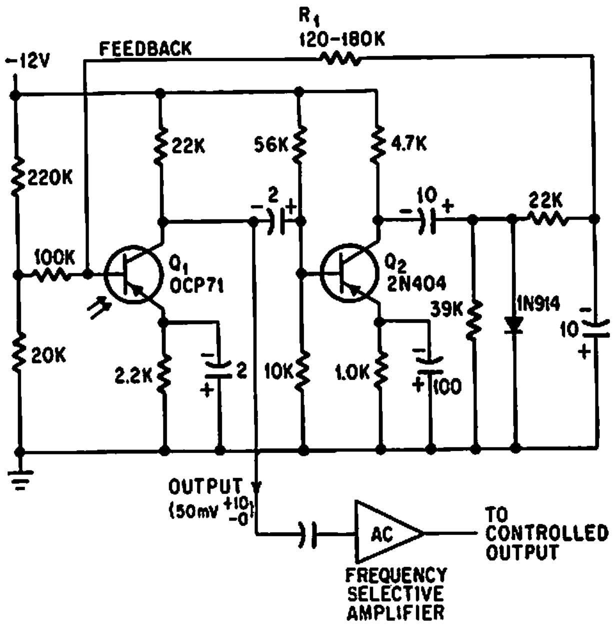
CHAPTER 58
Photoelectric Circuits



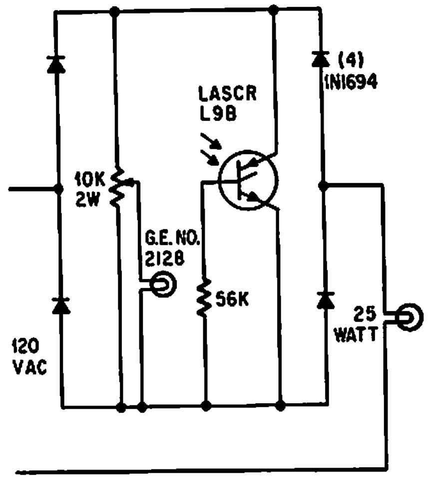
PHOTOMULTIPLIER FOR GAMMA-RAY SPECTROMETER—Flashes of light from scintillator crystal are picked up by EMI9579 photomultiplier to measure underwater gamma radiation, and amplified output of photomultiplier is fed to surface equipment through coaxial cable that also serves as 2,000-v high-voltage lead for anode.—G. K. Riel, New Underwater Gamma Spectrometer, *Electronics*, 36:10, p 56–8.



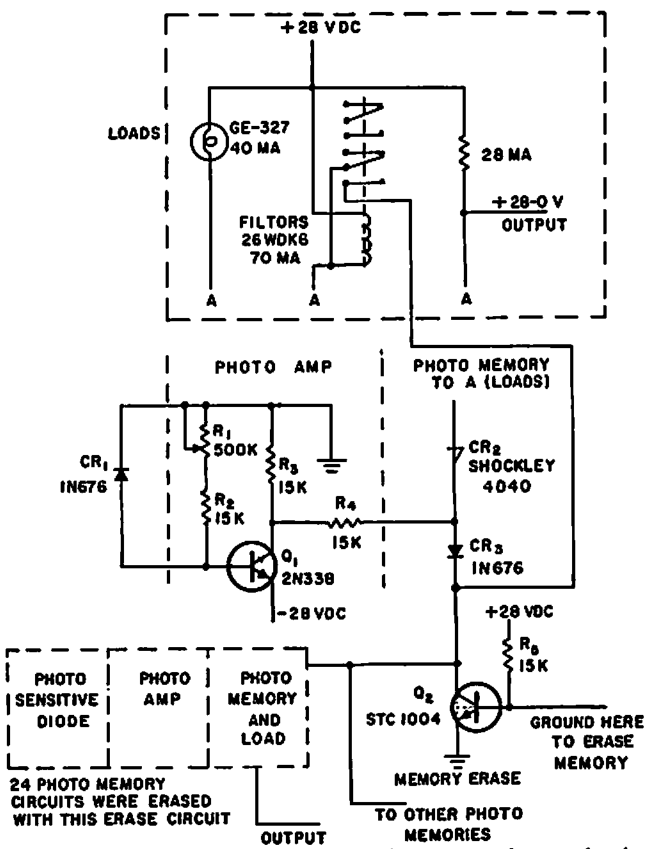
LAMP CONTROL—Phototransistor Q1 senses lamp intensity and controls firing angle of scr's Q3 and Q4 through unijunction transistor Q2.—R. L. Carvajal, Phototransistor Regulates Illumination Intensity, *Electronics*, 38:20, p 101.



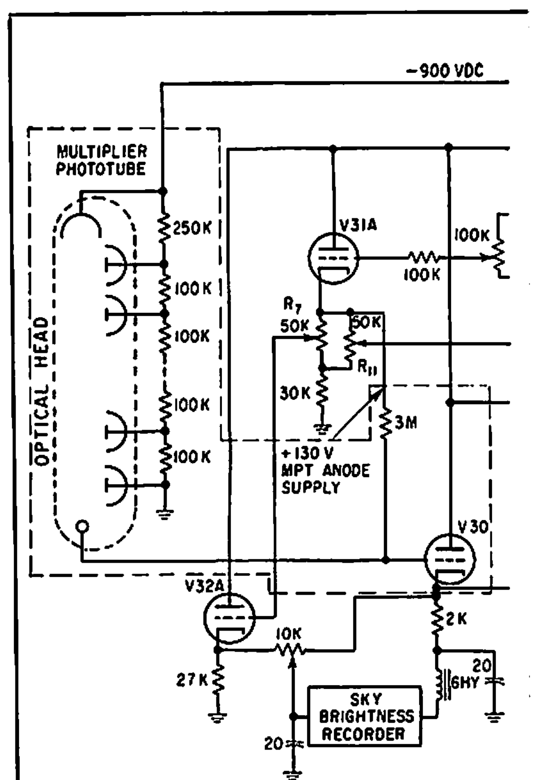
AGC FOR PHOTODETECTOR AMPLIFIER—Holds photodetector output signal constant within 2 db for 4-db variation in ambient light level.—P. H. Sydenham, Photodetector Gain Control Aids Signal Discrimination, *Electronics*, 38:23, p 111.



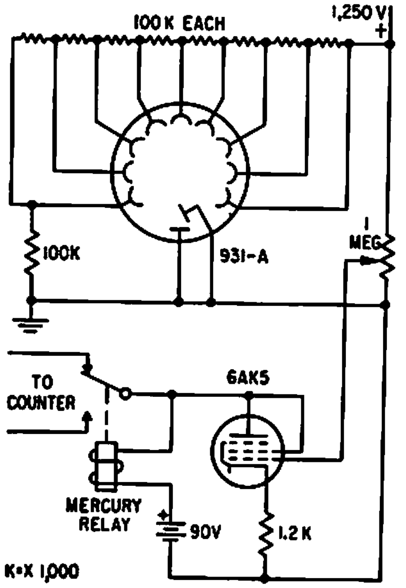
LAMP-TRIGGERED SCR GIVES VARIABLE PHASE CONTROL OF POWER—Miniature 2128 lamp with low-mass filament triggers light-activated scr in 1 millisec when lamp is across scr and in about 3 cycles at low a-c lamp voltage. Potentiometer thus provides phase control of scr for dimming 25-w lamp or equivalent-wattage load.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.



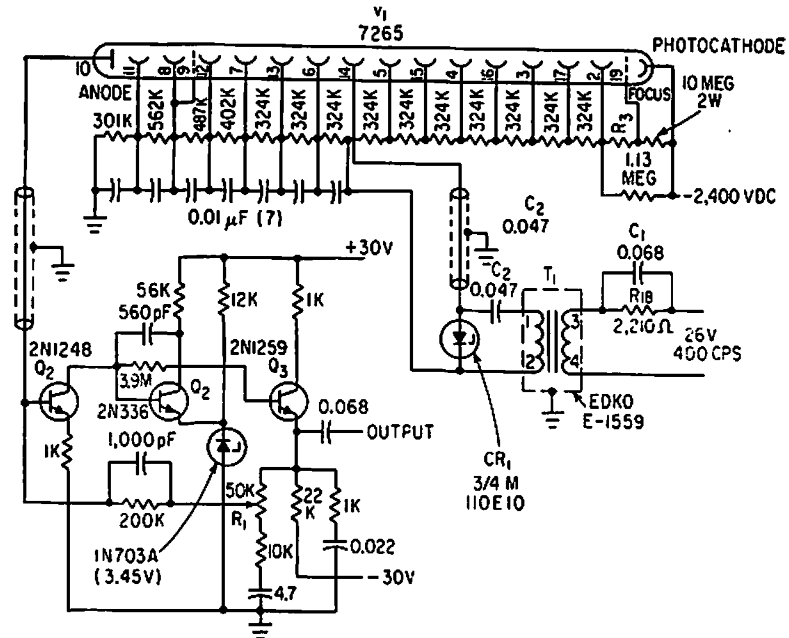
PUNCHED TAPE READER—Uses photo memory to drive loads, to keep signal applied to load until memory is erased. Lamp load can be used for verifying punched paper tape. Relay load controls circuit where it is necessary to handle large currents. Relay used exceeds continuous rating of CR2, so one set of relay contacts keeps relay latched. Resistive load is used to drive logic circuits. Sensor can be either photodiode or standard 1N676 diode with paint removed from glass case.—Photo Reader for Perforated Tape, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 207.



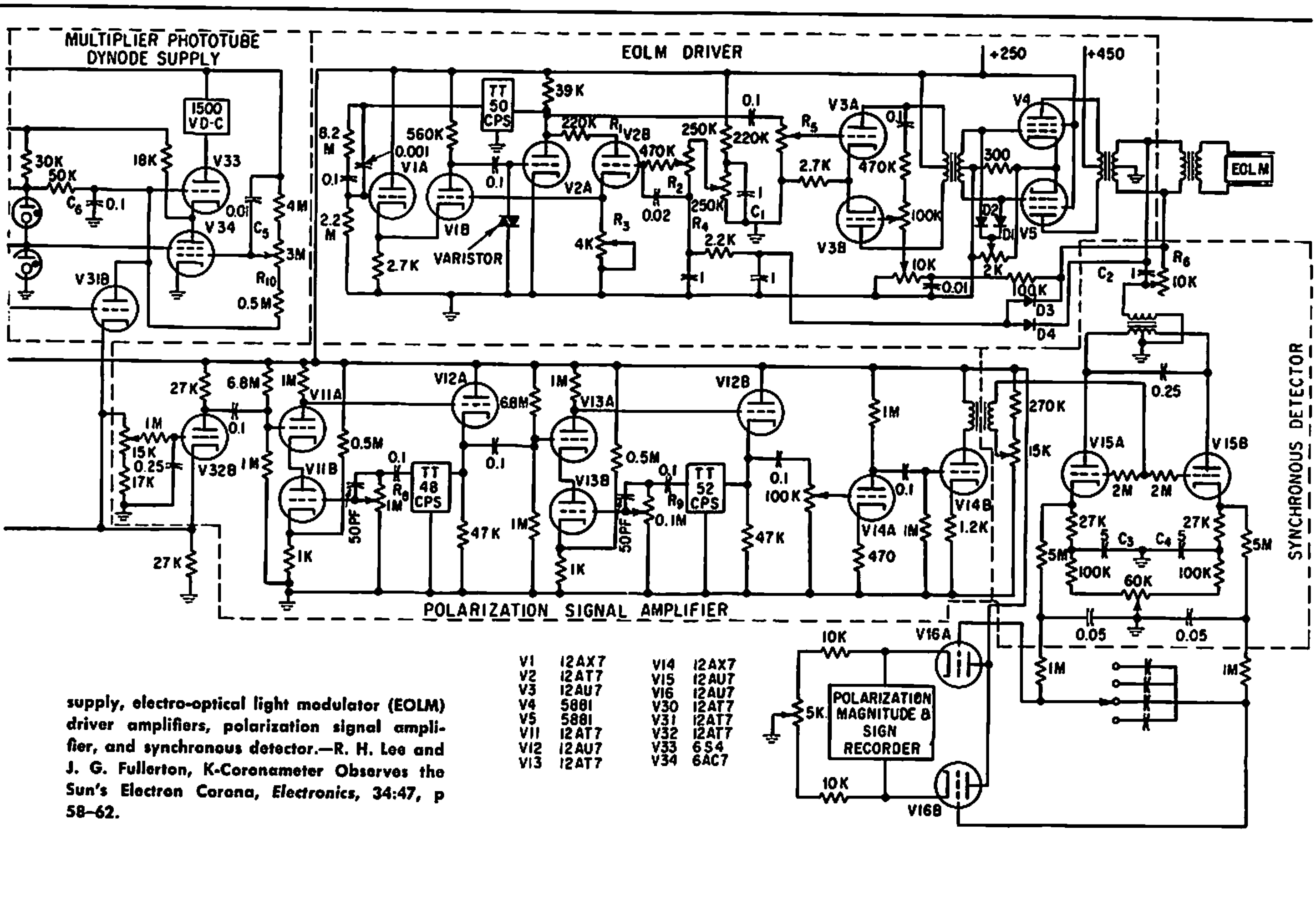
CORONAMETER—Uses polarized-light technique and closely controlled narrowband circuit to detect, observe, and measure otherwise invisible solar phenomenon. Circuit shows multiplier tube in optical head, with dynode



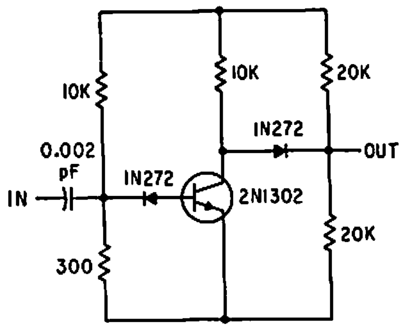
AUTOMATIC CALIPER—Photomultiplier and counter circuit on machine lathe feed recorder to give dimensions of printed circuits and photographic plates in increments of 0.0001 inch.—S. Isaacson, Electronic Caliper Checks Printed Circuits, *Electronics*, 32:1, p 44–45.



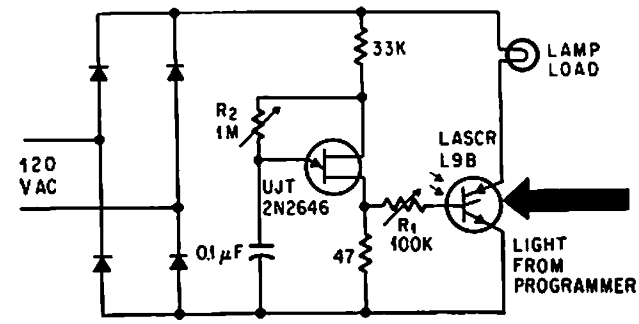
A-C MODULATOR FOR PHOTOMULTIPLIER—Output of star-tracking photomultiplier is converted to a-c by applying 400-cps modulating voltage to dynode 14, to make gain vary between nominal value and 1% of this in square wave fashion. Amplifier passband is then 130 to 800 cps.—E. R. Schlesinger, Aiming a 3-Ton Telescope Hanging from Balloon, *Electronics*, 36:6, p 47–51.



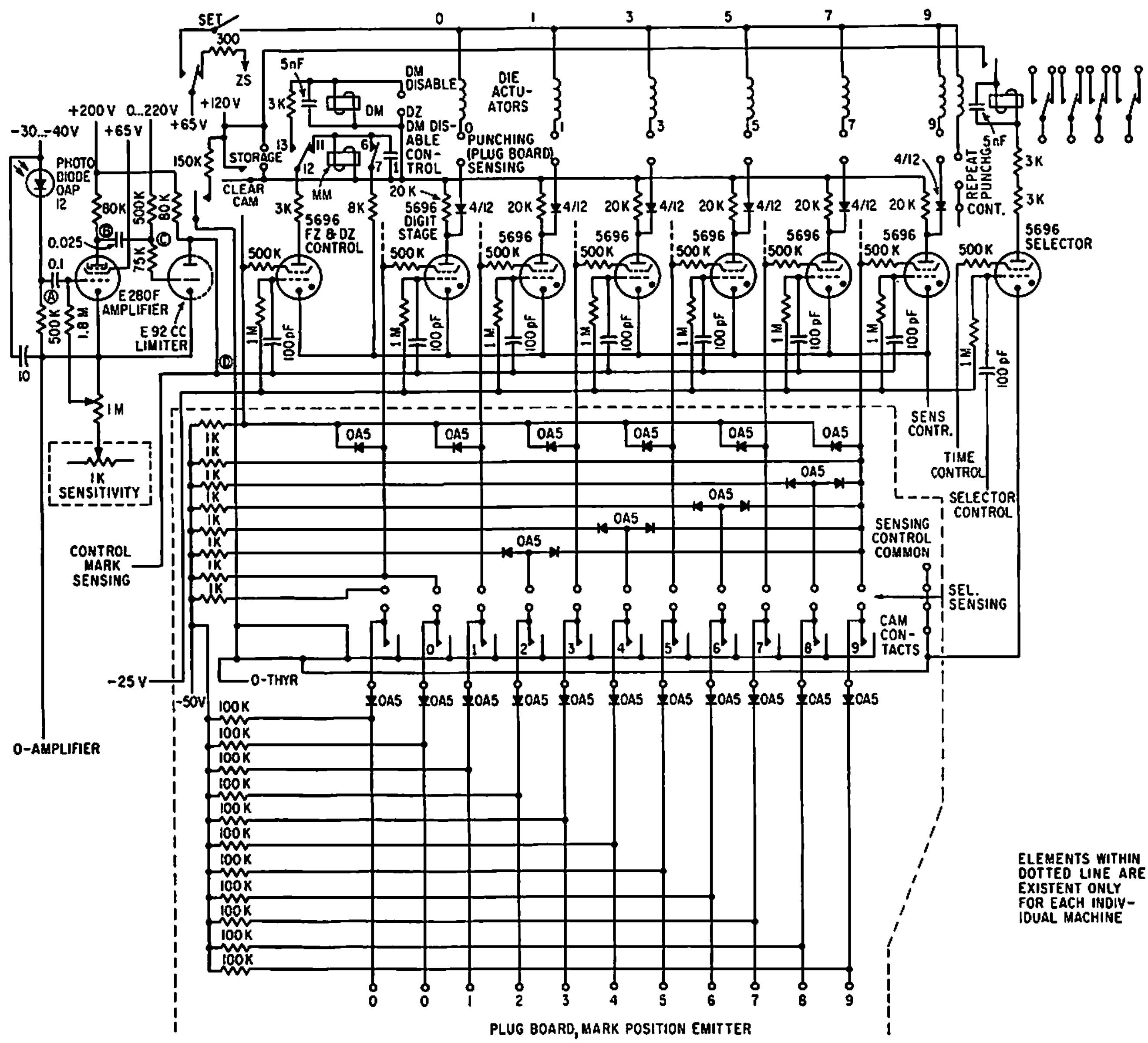
supply, electro-optical light modulator (EOLM) driver amplifiers, polarization signal amplifier, and synchronous detector.—R. H. Lee and J. G. Fullerton, K-Coronameter Observes the Sun's Electron Corona, *Electronics*, 34:47, p 58–62.



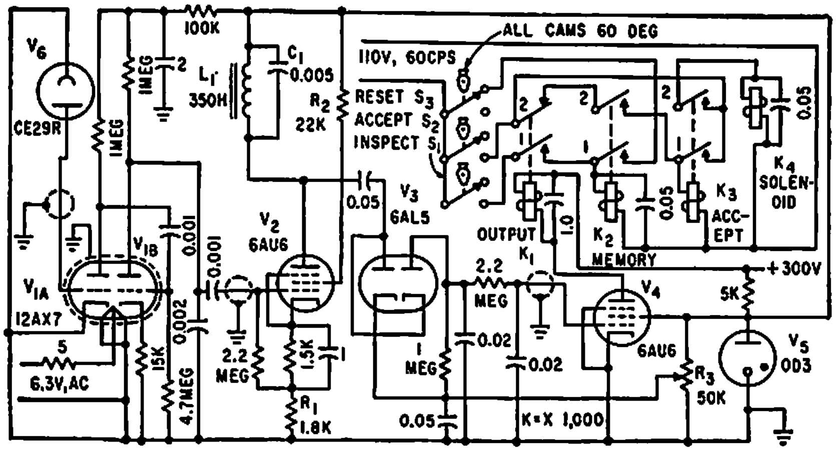
NOISE SUPPRESSOR—Removes noise from output of photodiode used in reflected-light shaft-position encoder.—F. W. Kear, How to Select Shaft-Position Encoders, *Electronics*, 35:35, p 48–51.



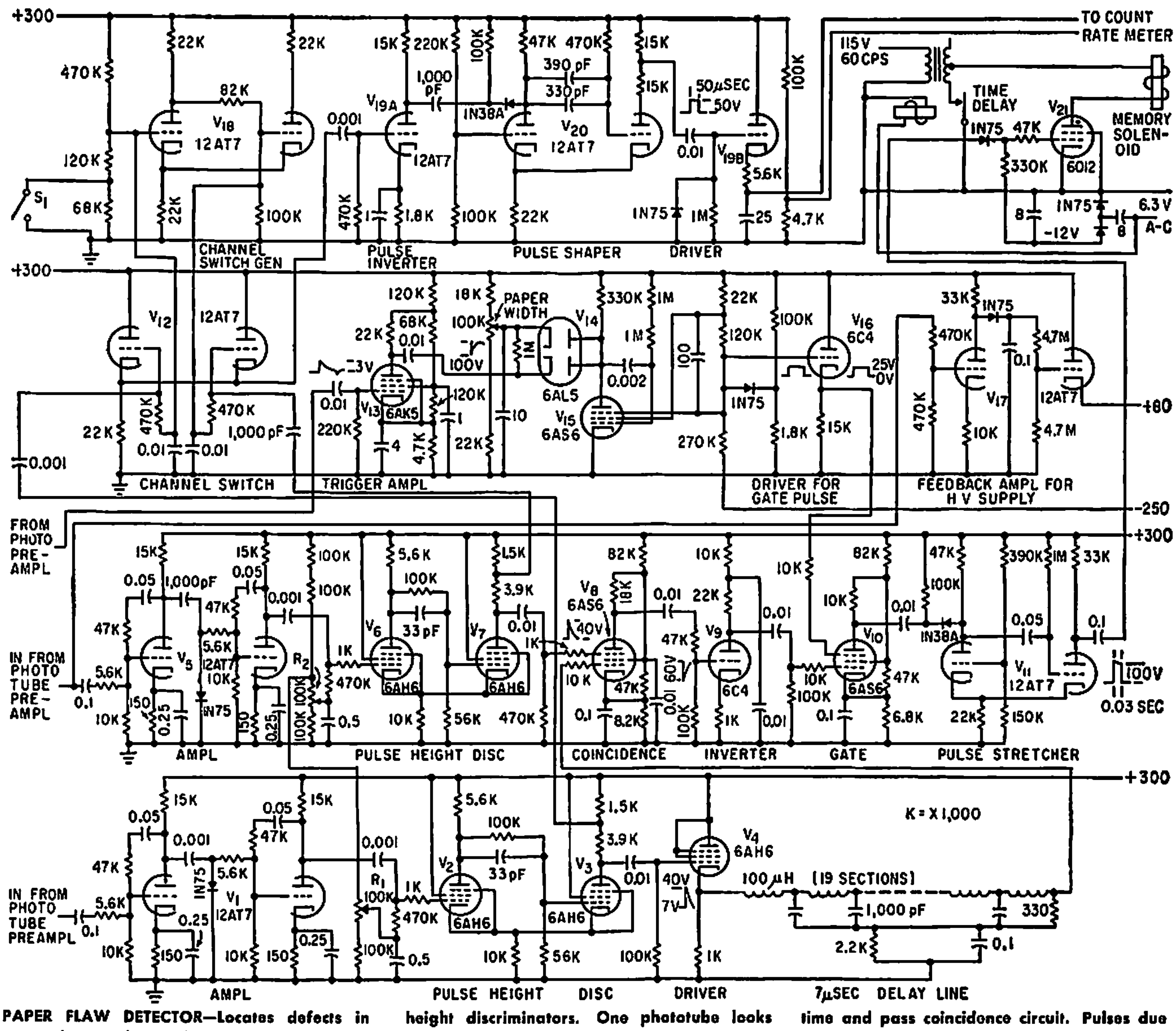
LAMP PREHEATER—Unijunction transistor triggers LASCR (light-activated scr) late in each half-cycle, with R2 determining lamp current so filament is heated but not visible. This preheating minimizes thermal stresses during programmed operation of lamps by control beam hitting LASCR, as for theaters or fountains.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.



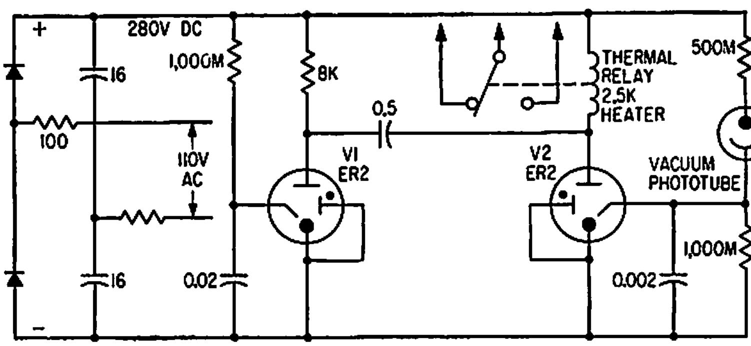
MARK SENSOR FOR CARDS—Automatically transcribes up to 40 pencil marks on specially printed 90-column cards into machine code and block-punches information into cards in any desired format at 150 cards per minute —F. A. Frankl, Transcribing Field Markings by Optical Scanning, *Electronics*, 34:31, p 49–51.



PHOTOELECTRIC GAGING—Checks dimensions of machine parts while they are rotating. Fail-safe circuit assures that only satisfactory pieces are accepted. Sorter is initially calibrated to desired sensitivity with go and no-go gages.—J. C. Frommer, Fail-Safe Photoelectric Inspection for Industry, *Electronics*, 32:31, p 74–75.

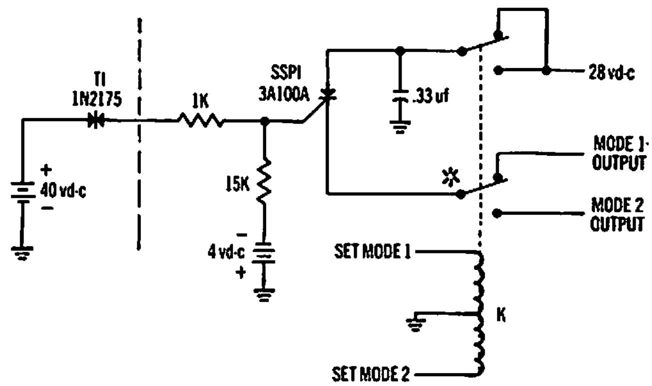


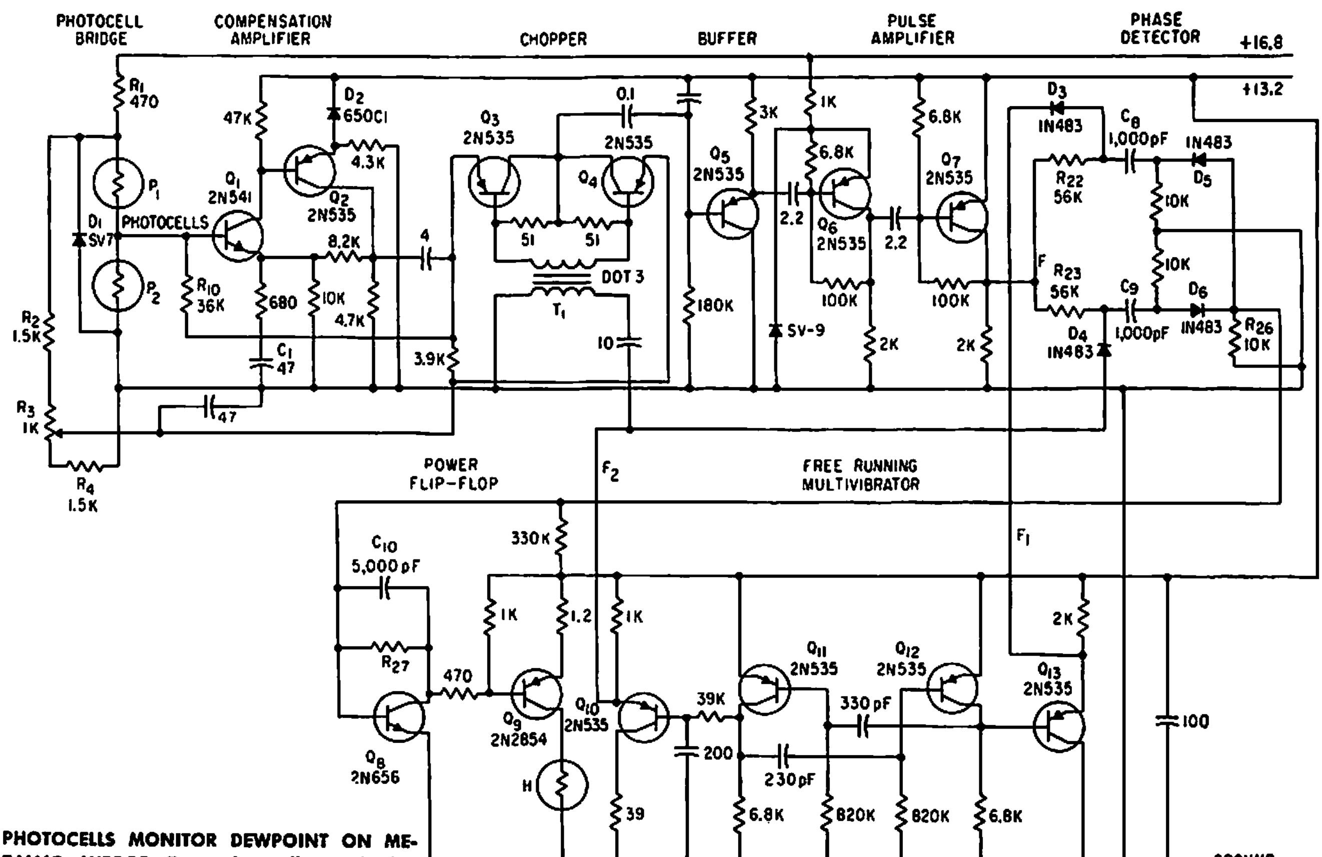
PAPER FLAW DETECTOR—Locates defects in paper despite photomultiplier noise amplitudes comparable to flaw-signal amplitudes. Two identical phototubes are used, each with identical preamplifiers, amplifiers, and pulse height discriminators. One phototube looks at paper ahead of other. Output of leading phototube is delayed to give same effect as if both looked at same area at same time. Pulses due to real defects then occur at same time and pass coincidence circuit. Pulses due to noise are random in time and do not pass.—M. P. MacMartin, Sensitive Flaw Detector Solves Noise Problems, *Electronics*, 33:16, p 64–66.



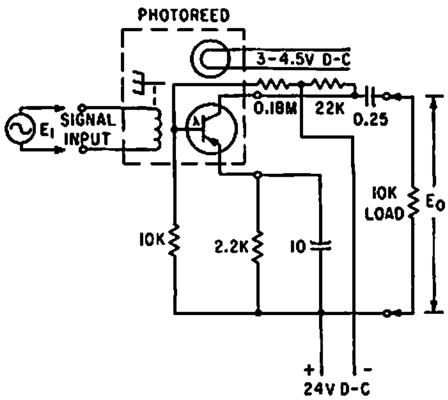
AUTOMATIC LIGHT CONTROL—High-sensitivity vacuum phototube responds to illumination by changing mark-space periods of cold-cathode mvbr so V2 is on most of the time when illumination is excessive. Thermal relay then gets heated sufficiently to switch off lights.—P. Bergweger, Photoelectric Control Using Cold Cathode Amplifiers, *Electronics*, 33:27, p 46–47.

TAPE READER—Simplified circuitry, few components, storage capability, and output power above 20 w are advantages of using silicon controlled switch in place of multistage amplifier for photoelectric paper-tape readers. Thyratron-like characteristics maintain output after photoelectric stimulus disappears, until cut off by control circuit. Asterisk on one pole of relay K indicates that similar pole is required for each bit in two-mode operation.—SCR Switch Eliminates Amplifier for Photoelectric Readers, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 222.

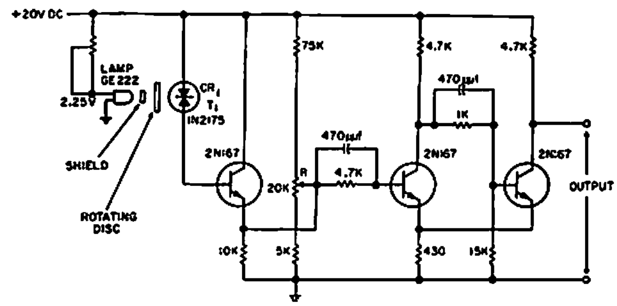




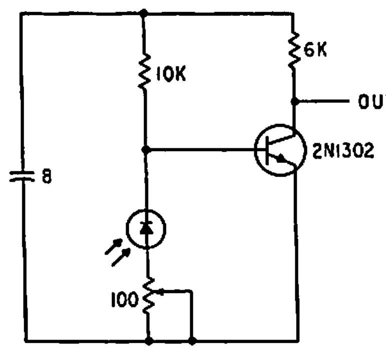
PHOTOCELLS MONITOR DEWPOINT ON METALLIC MIRROR—Two photocells in bridge circuit develop error signal for bang-bang servo that uses power flip-flop to turn heater H of metallic mirror on and off, to maintain constant-thickness film of dew or frost on mirror. Two-transistor chopper and a-c amplifier eliminate drift problems.—H. R. Farrah and P. E. Sherr, New Approach to Weather Data: Every Plane a Station, *Electronics*, 36:28, p 38–41.



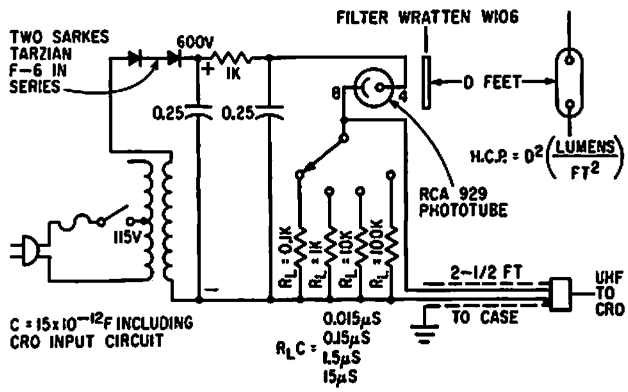
PHOTOELECTRIC BANDPASS FILTER—Output of phototransistor varies linearly with input signal at resonant frequency of photoreed, to give function of bandpass filter.—Frequency-Sensitive Control Uses Light, *Electronics*, 34:36, p 88–91.



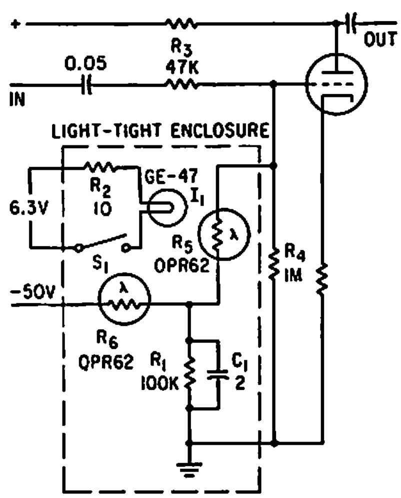
PHOTODIODE PICKOFF—Used in measuring servo system lag. Responds to slot milled near edge of rotating disk. Accuracy is 0.17° in either direction.—J. D. Habegger, Photo Diode Pickoff Gives Accurate Angular Reference, *EEE*, 10:6, p 37.



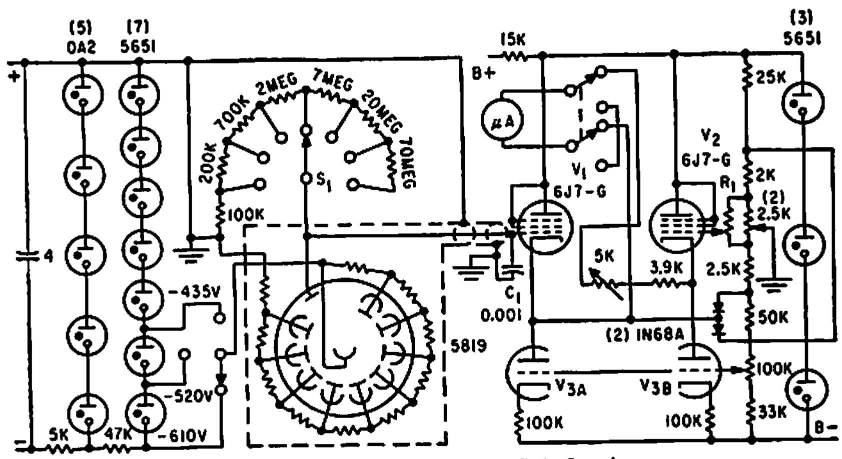
PHOTOSWITCHING CIRCUIT—Circuit provides amplification along with switching for photodiode mounted to pick up changes in light reflected by encoder disk.—F. W. Kear, How to Select Shaft-Position Encoders, *Electronics*, 35:35, p 48–51.



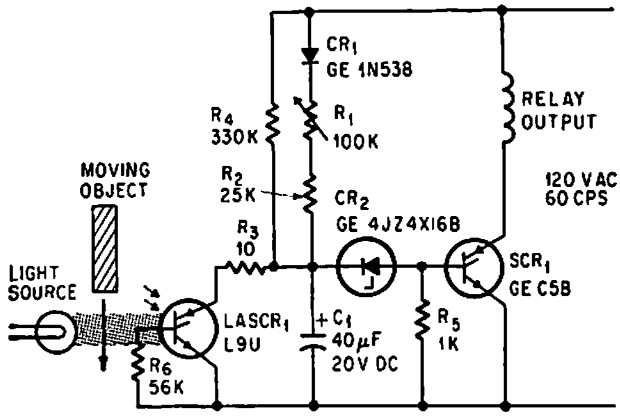
MEASURING TRANSIENT LIGHT—Used with cro for measuring rapidly changing light output of flashlamps.—H. E. Edgerton and R. O. Shaffner, Measuring Transient Light With Vacuum Phototubes, *Electronics*, 34:34, p 56–57.



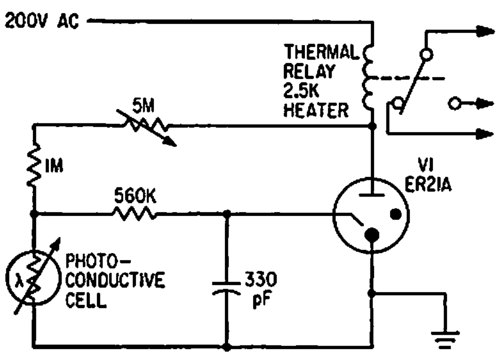
PHOTOCELLS PROVIDE NOISE-FREE AUDIO KEYING—Photoresistors R5 and R6 isolate control function from signal circuit to avoid switching transients. S1 may be replaced by automatic pulsing circuit.—A. Martens, Noise-Free Keying Circuit, *Electronics*, 35:13, p 53.



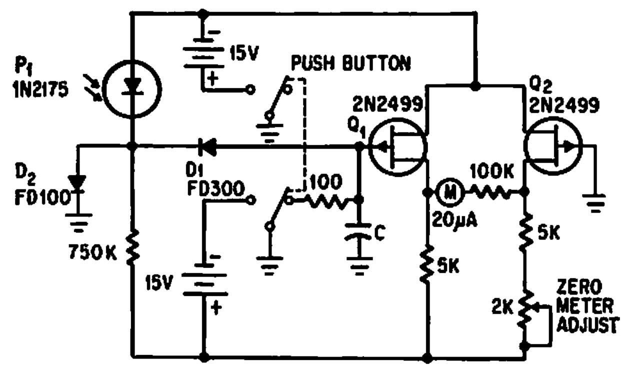
CELL-GROWTH MICROPHOTOMETER—Permits direct measurement of transmittance while stained cells are studied visually at magnification of 1,000 X. Beam-splitting mirror sends 90% of light to multiplier phototube. Maximum current sensitivity is 0.01 microamp full scale.—E. Gordy, Microphotometer Aids Biologists, *Electronics*, 32:28, p 62–64.



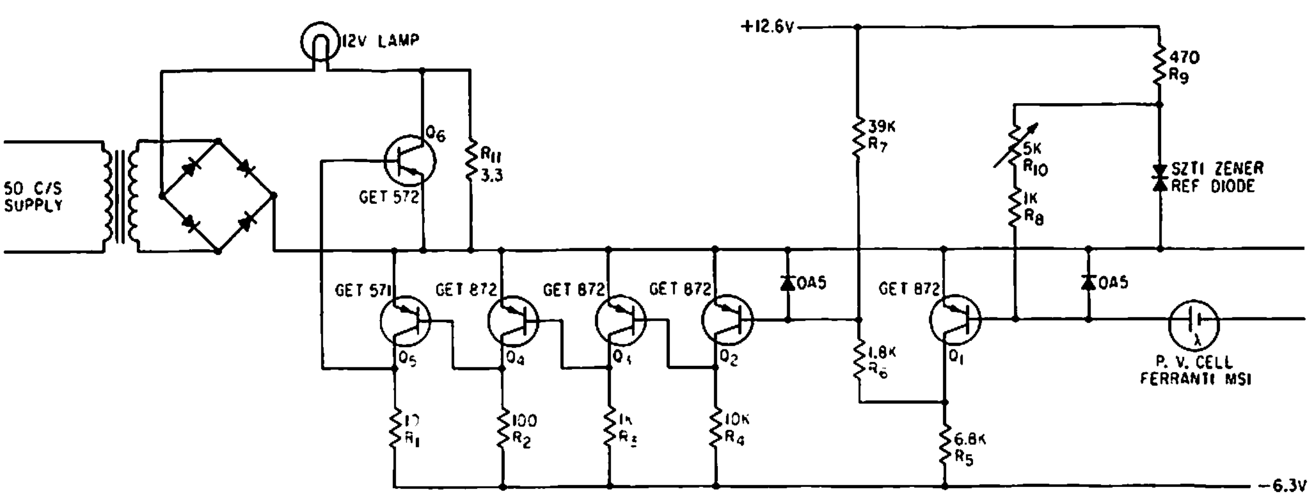
CONVEYOR-LINE JAM DETECTOR—Interruption of light beam to light-activated scr for more than few millisec fires SCR1, opening relay. Momentary interruptions by objects moving normally on conveyor have no effect. Circuit resets automatically when light is restored.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.



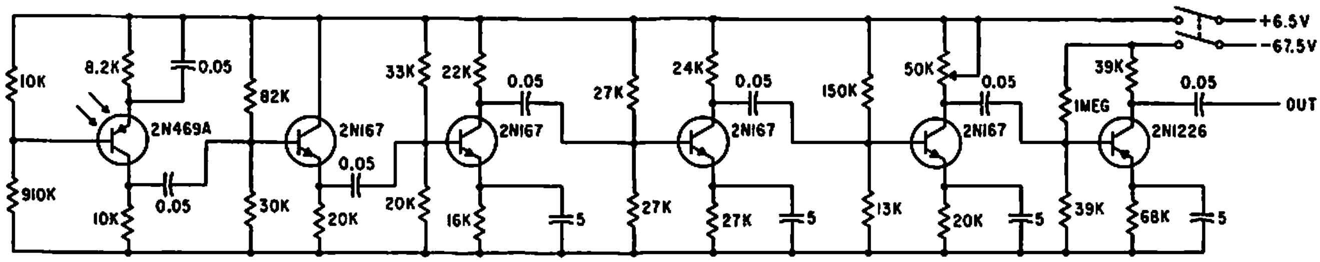
SINGLE COLD-CATHODE AMPLIFIER—Actuates thermal relay directly from photoconductive cell, for turning on lights at sunset.—P. Bergweger, Photoelectric Control Using Cold Cathode Amplifiers, *Electronics*, 33:27, p 46–47.



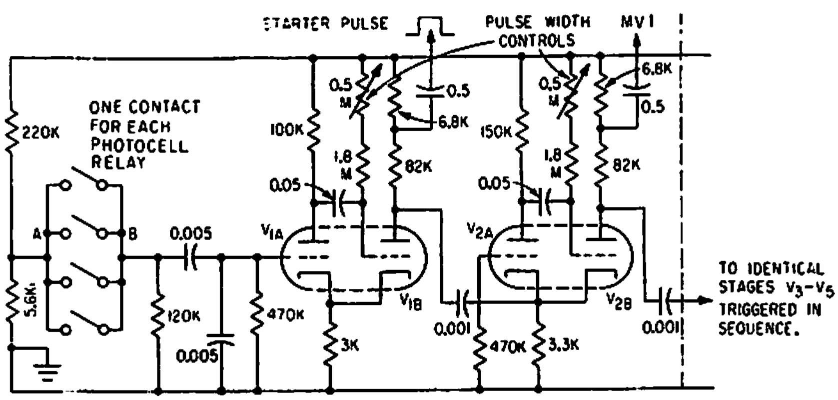
MEASURING FLASHES—Measures and holds intensity of single flash or total value of series of flashes.—C. R. Kerns, FET Circuit Stores Light Measurement, *Electronics*, 38:22, p 66.



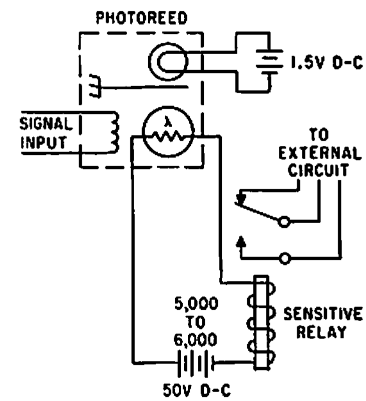
LIGHT-SOURCE STABILIZER—Feedback circuit generates precise pulses to control light level of photoelectric light source. Difference between reference current supplied by zener diode and current from photocell is amplified by transistor chain and applied to Q6 to adjust lamp current.—J. R. Dyke, Illumination Stabilizer for Photosensing System, *Electronics*, 34:52, p 44–45.



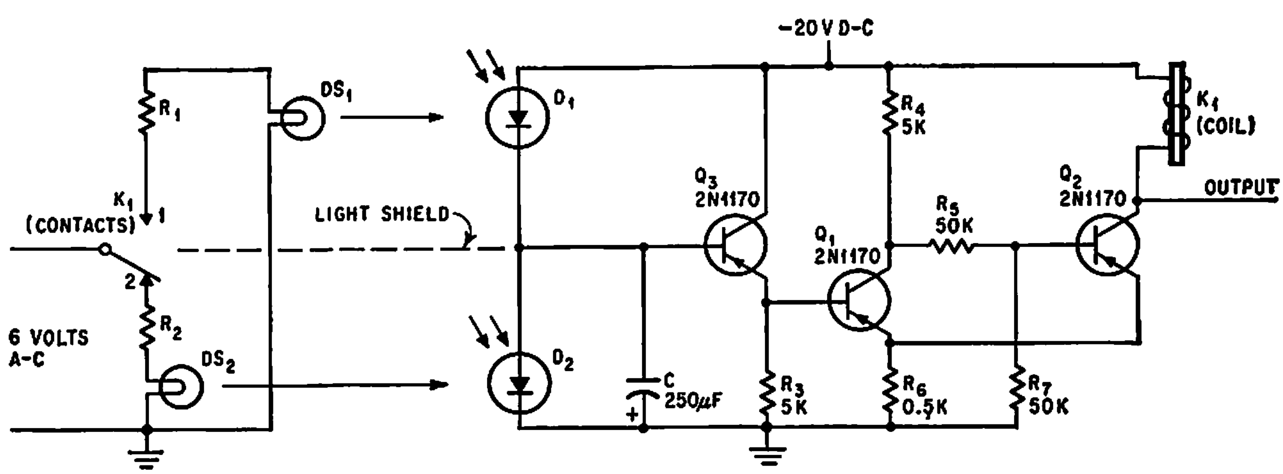
PROJECTILE GLOW DETECTOR—2N469A phototransistor detects brief low-intensity self-luminous shroud of projectile, and feeds high-gain pulse amplifier that elevates voltage enough to ionize thyratron that initiates discharge of spark-source capacitor for shadowgraph photography.—O. H. Bock and P. L. Clemens, Aerodynamic Measurements in a Hypervelocity Gun Range, *Electronics*, 34:44, p 33–37.



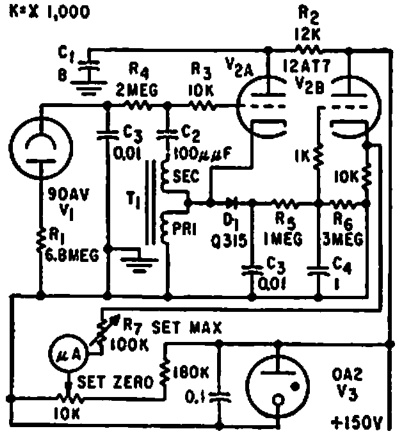
EYE-MOTION MVBR CHAIN—Illuminated photocell triggers mvbr chain. Starter-mvbr is triggered by positive pulse on grid of V1A, but remaining mvbr stages are triggered by negative pulse on cathode. Output pulses are taken from across 6,800-ohm resistor and a-c coupled to gate.—E. L. Thomas, R. Howat, and N. H. Mackworth, Tv Tracker Records Eye Focus Points, *Electronics*, 33:17, p 57–59.



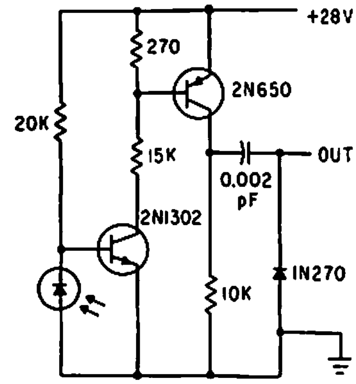
PHOTOREED—Combines resonant reed relay with photosensor to give frequency-sensitive control in which switching of contacts is accomplished by electro-optical techniques. Photosensor is exposed to intermittent light when reed vibrates like shutter between lamp and sensor.—Frequency-Sensitive Control Uses Light, *Electronics*, 34:36, p 88–91.



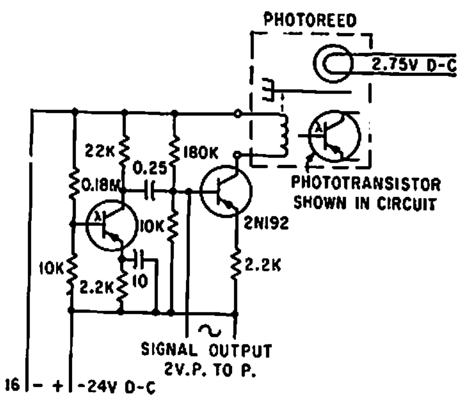
SQUARE-WAVE GENERATOR—Intensity of light sets pulse and interpulse periods in range from 0.2 to 300 sec, using Schmitt trigger Q1-Q2. Capacitor C is charged and discharged through diodes D1 and D2 consisting of collector-base junctions of 2N1393 phototransistors.—A. K. Horvath, Photodiodes Control Pulse Intervals, *Electronics*, 38:11, p 72.



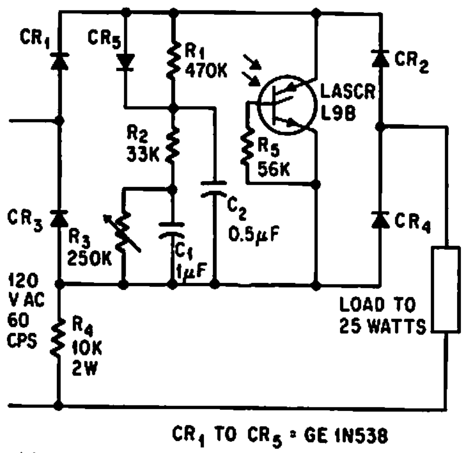
ILLUMINATION TELEMETER—Prf rate of blocking oscillator, controlled by photocell output, can be transmitted over telephone lines to give accurate remote indication of daylight or other light intensity. D1, V2B, and meter provide local indication. Maximum illumination gives highest prf.—E. F. Hasler and G. Spurr, Ways to Measure Light Intensity at a Distance, *Electronics*, 32:29, p 48–49.



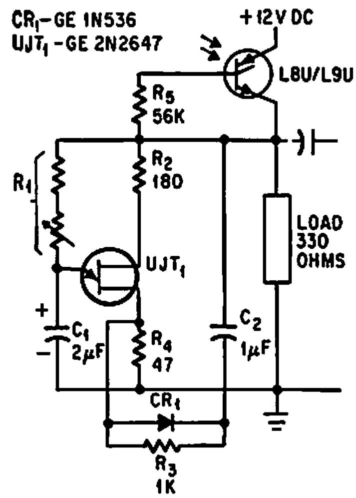
PHOTODIODE AMPLIFIER—Used with transmitted-light encoder disk to produce pulses with correct amplitude and rise time to drive logic circuit.—F. W. Kear, How to Select Shaft-Position Encoders, *Electronics*, 35:35, p 48–51.



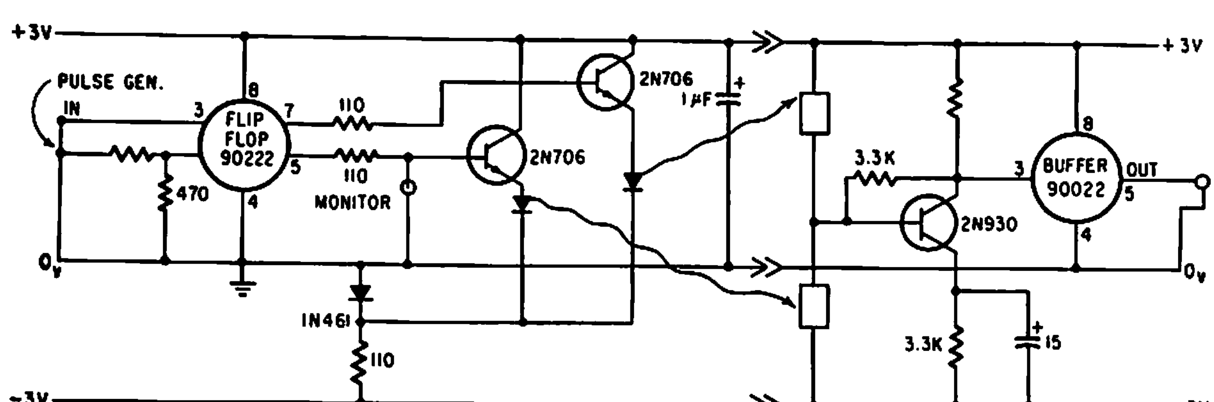
PHOTOREED OSCILLATOR—Gives good sine-wave output at reed frequency, using phototransistor to sense chopped light and transistor to boost output voltage. Can be used for remote control, telemetry, and logic functions. —Frequency-Sensitive Control Uses Light, *Electronics*, 34:36, p 88–91.



FLASH-ACTUATED SCR DELAY—Fractional-cycle light pulse fires glass-window scr at any phase angle, while values of circuit components determine number of cycles of conduction before turn off at zero current.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.



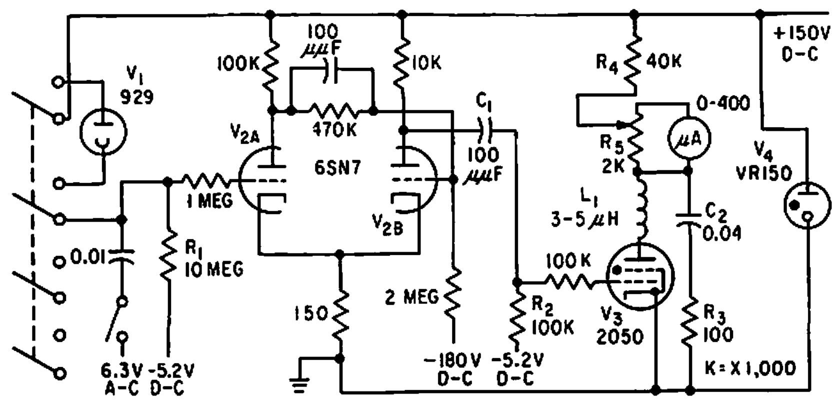
LIGHT-ACTIVATED SCR TIME DELAY—Bootstrapped unijunction transistor interrupts load current at desired delay interval (determined by R1 and C1) after short pulse of light hits glass-window scr L8U.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.

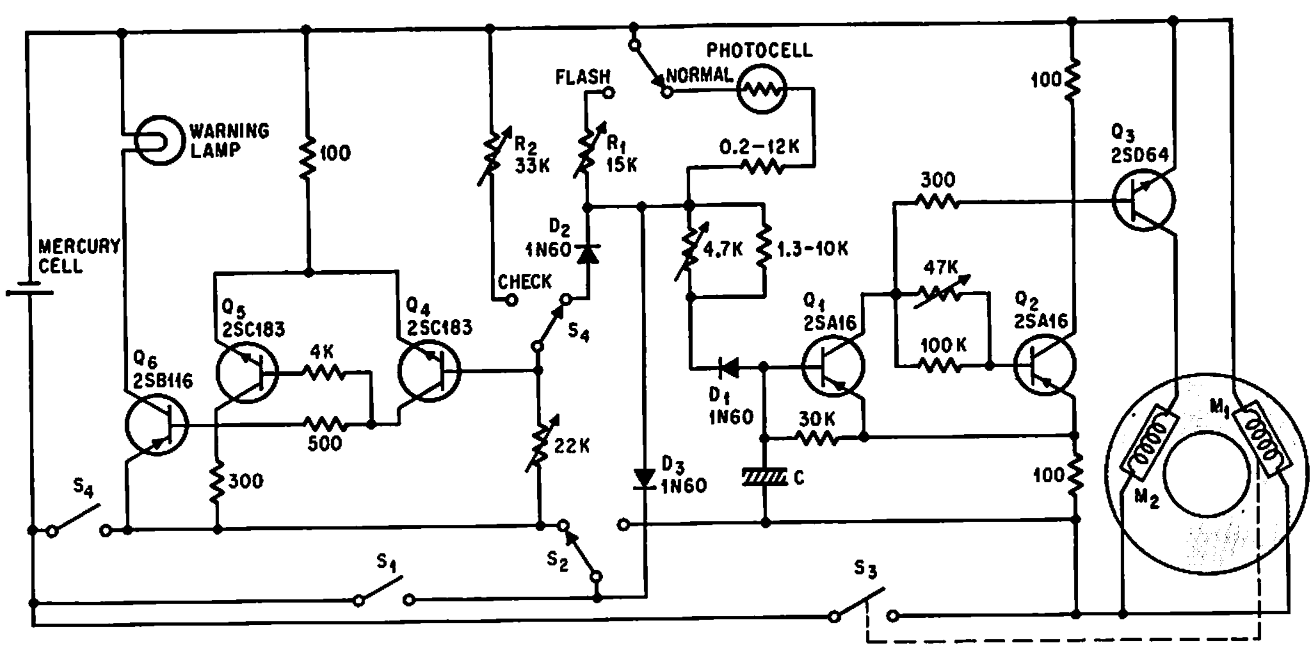


OPTICAL PUSH-PULL COUPLING—Two gallium arsenide light sources and two high-speed silicon photoconductors provide push-pull optical coupling between integrated-circuit flip-flop and buffer, with two transistors in push-pull amplifier overcoming losses of optical coupling.—T. E. Bray, Switching With Light, *Electronics*, 38:22, p 58–65.

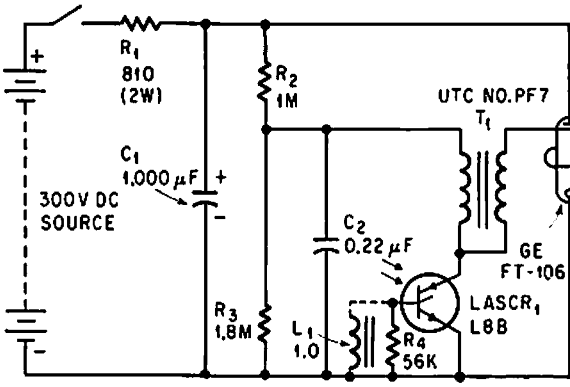
CHAPTER 59
Photography Circuits

MOVIE CAMERA FRAME-RATE CHECKER—Gives exact frame rate at each instant. Lens is removed for test. Light beam is projected into camera, and reflected back from pressure plate in film gate each time shutter opens. Reflected beam is deflected into phototube that feeds Schmitt trigger. Differentiated output goes to thyratron in circuit of meter that reads frame rates directly from 5 to 64 frames per second. May also be used for checking projectors.—C. Owlett, Frame-Rate Checker for Motion-Picture Cameras, *Electronics*, 31:37, p 88–89.

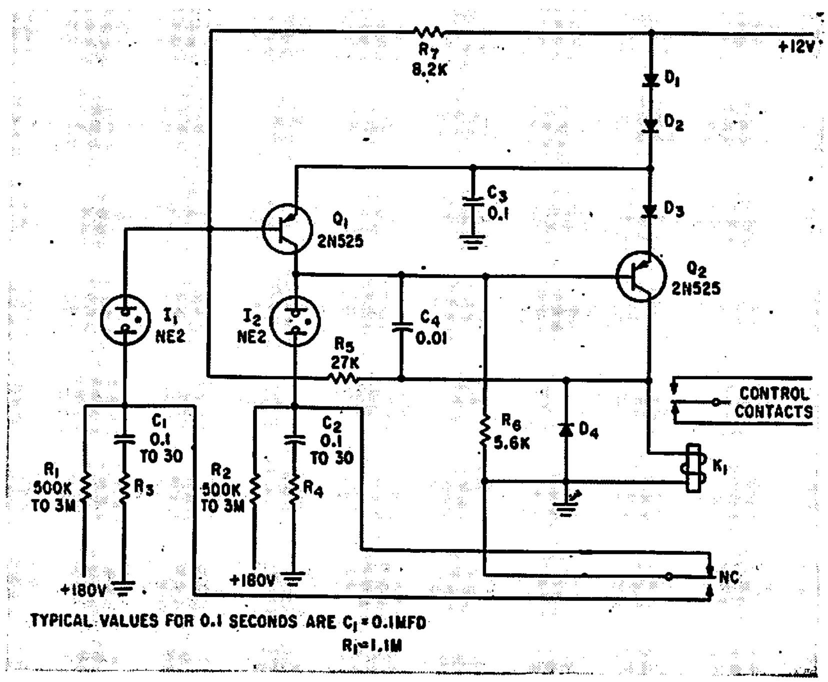




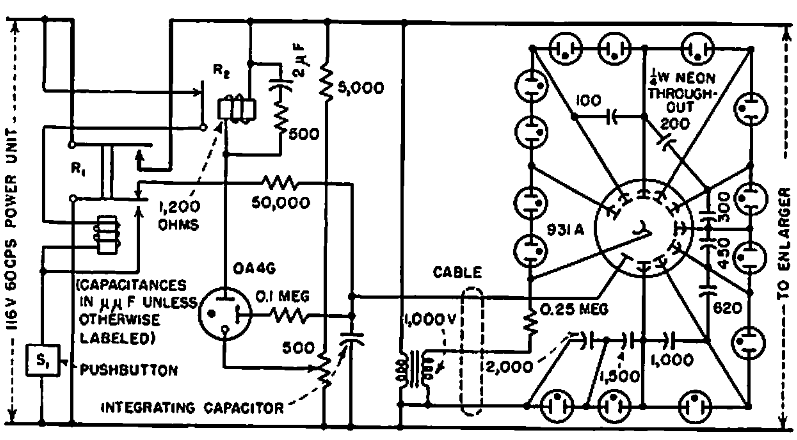
ELECTRONIC CAMERA SHUTTER—Uses six transistors and photocell to vary both aperture and exposure time automatically according to incident light, from range of 1/30 sec at f/2 to 1/500 sec at f/16. Transistors are split into two groups, each having a Schmitt trigger and output stage. One group warns photographer when light is insufficient, by turning on warning lamp, and other group drives solenoid that closes shutter at right instant. If light is adequate, depressing shutter button further moves S2 to timing position, and closes S3 to energize solenoid M1 and open shutter to smallest aperture. Mechanical governor then gradually opens camera's combination shutter-iris until M2 snaps it closed under control of Q3.—Open and Shut Case, *Electronics*, 39:17, p 153–155.



SLAVE FLASH—Addition of light-activated scr to ordinary flashgun gives fast-acting slave unit, with response speed of only few microsec to give perfect sync between master and slave. Use of L1 between gate and cathode of LASCR prevents triggering by high-level ambient light because L1 offers low impedance to ambient and high impedance to flash.—E. K. Howell, Light-Activated Switch Expands Uses of Silicon-Controlled Rectifiers, *Electronics*, 37:15, p 53–61.

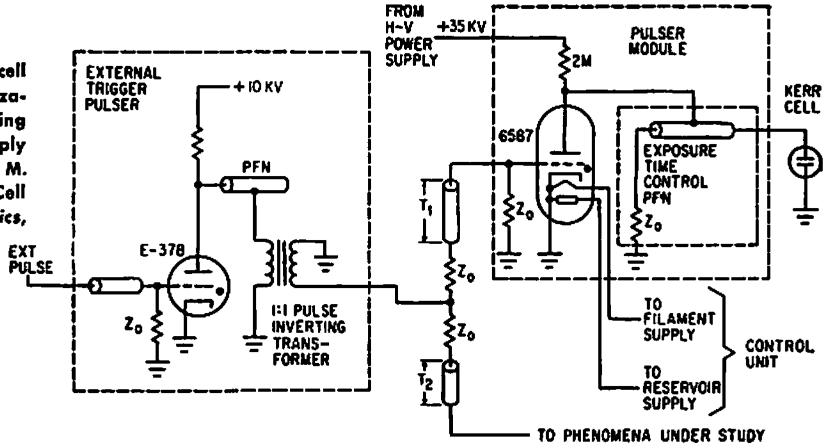


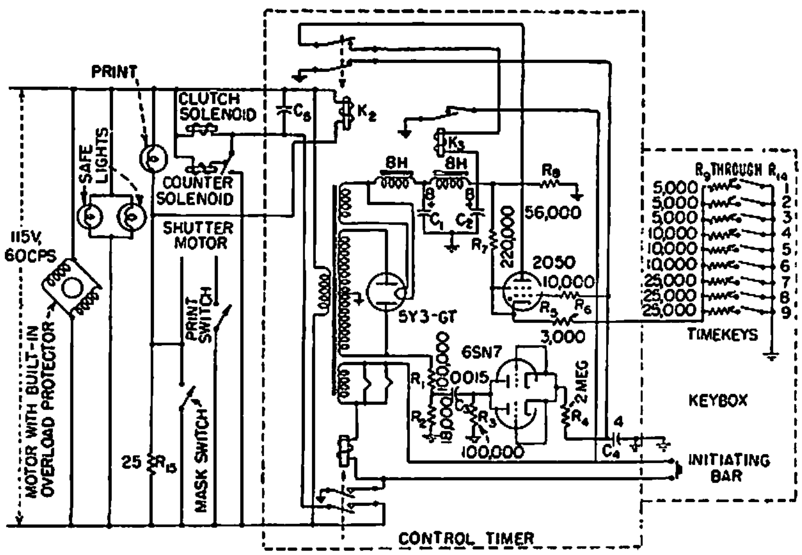
DATA RECORDING CAMERA TIMER—Controls exposure time and interval between exposures over ranges between 0.1 sec and 2 hours, independently of each other, by changing time constants with C1 and C2.—J. G. Fullerton, Bistable Circuit Times Camera Exposures, *Electronics*, 34:45, p 91.



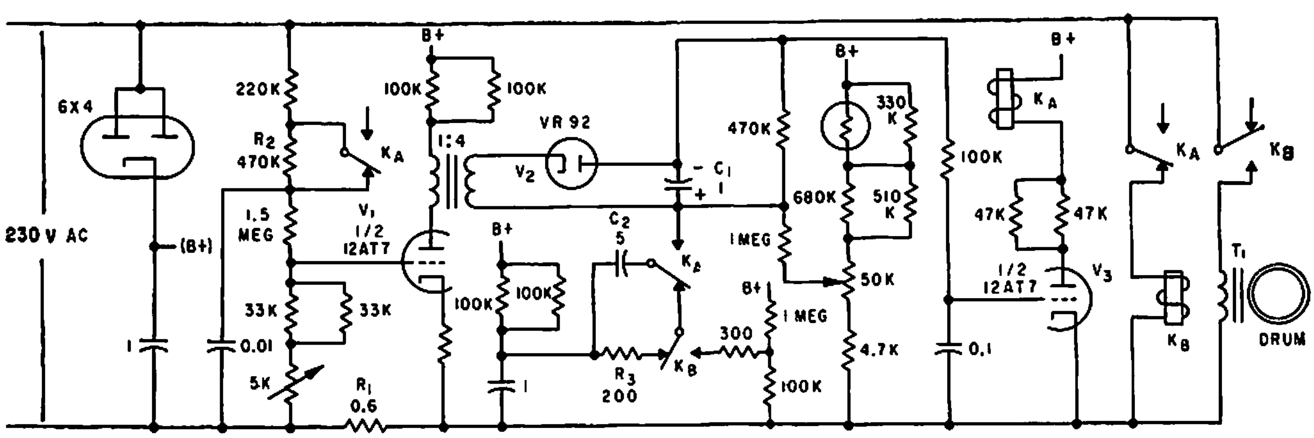
PHOTOMULTIPLIER TIMER FOR ENLARGER—Quarter-watt neon lamps regulate dynode potentials. Graded-capacitor voltage divider across string of neons makes them fire in sequence, to eliminate variations in firing times and increase timing accuracy.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 297.

KERR-CELL SHUTTER—High-voltage Kerr-cell pulser and parallel triggering synchronization give 5-nsec exposure, with triggering time jitter less than 1 nsec. Power supply must deliver 350-amp pulse as 35 kv.—S. M. Hauser and H. Quan, Applying the Kerr Cell to Nanosecond Photography, *Electronics*, 34:33, p 56–59.

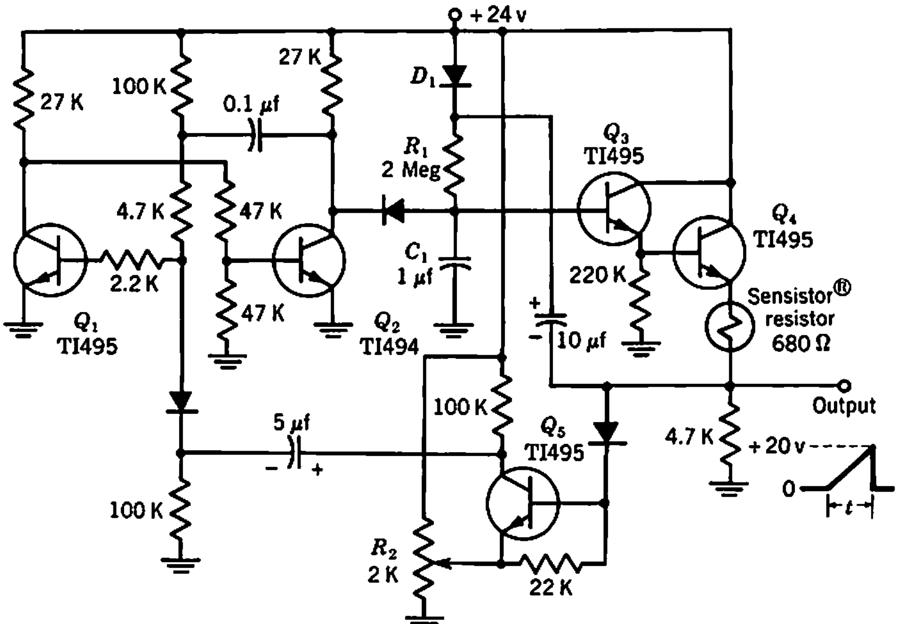




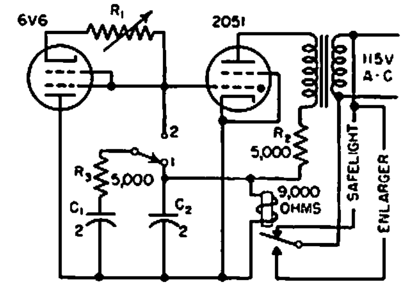
MAGNIFICATION-COMPENSATING DARKROOM TIMER—Pushbutton timer provides automatic compensation of exposure time with magnification of negative.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 296.



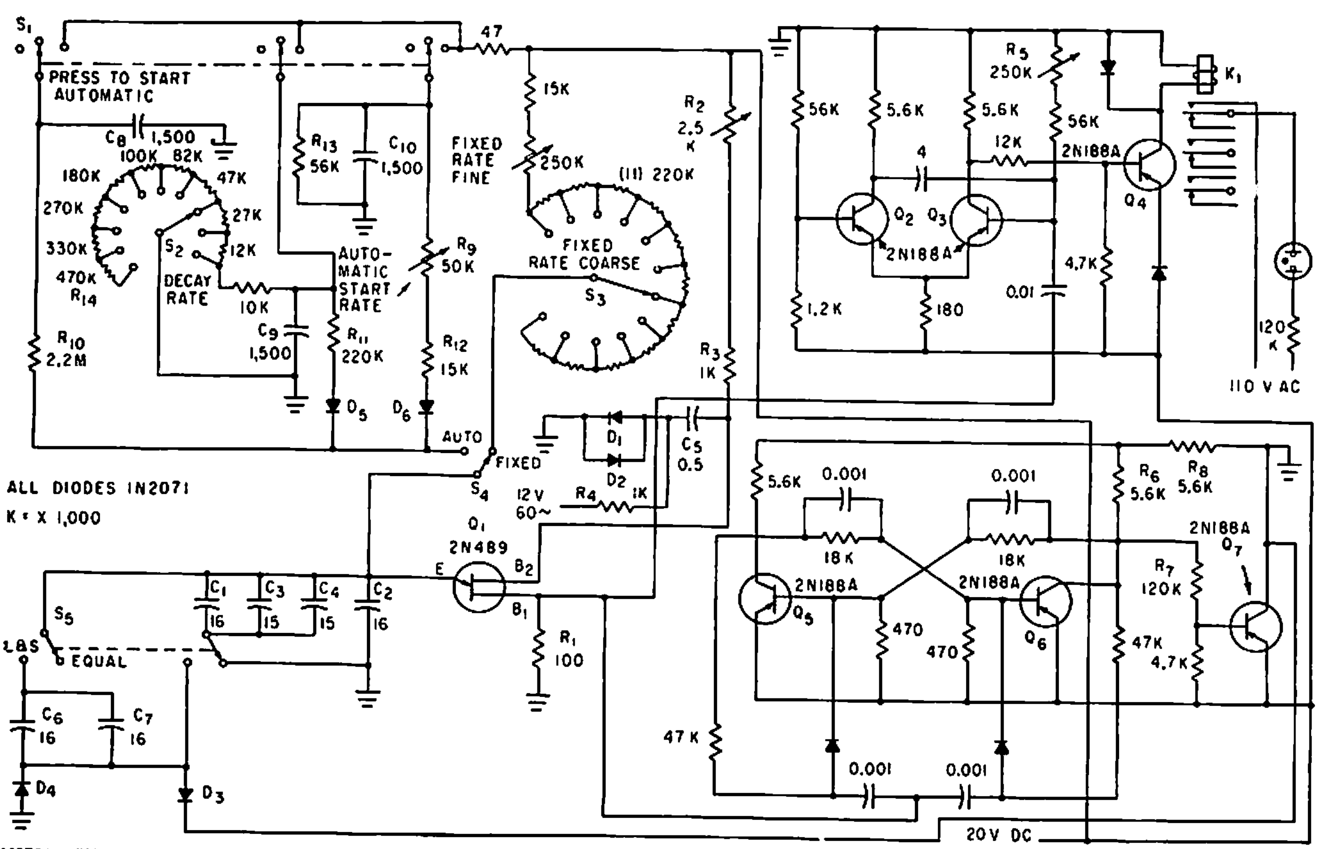
PHOTOGRAPHIC DRYER CONTROL—Copper drum, serving as single-turn shorted secondary of transformer, is heated by several thousand amperes of induced current. As drum heats up, transformer primary current decreases. When desired temperature is reached, KA energizes and T1 is disconnected by KB.—D. A. Senior, Temperature Control for Hot Rollers in Industry, *Electronics*, 32:30, p 40–42.



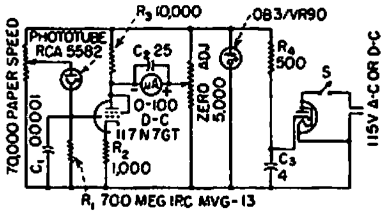
BOOTSTRAP TIMER—Q1 and Q2 form one-shot mvbr, with Q1 normally on. C1 charges toward 24 v through R1 and D1. Voltage on C1 is followed by Darlington circuit Q3-Q4. Feedback from Q4 to C1 gives nearly linear output voltage rise across emitter resistor of Q4, with length of time cycle varied by controlling emitter voltage of Q5. Overall accuracy of circuit, from −50 to +50°C, is 3%. Can give long time cycles for photographic and acid-bath control. All diodes are 1N2069. —Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 415.



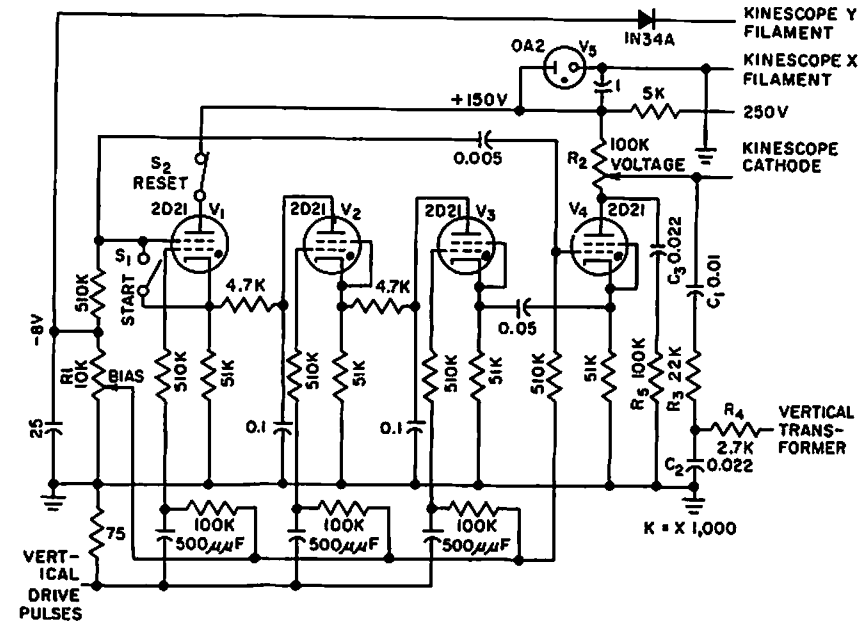
EXPOSURE TIMER—Uses thyratron to stop relay chatter. Gives long time delays with relatively small capacitance. Ordinary volume control covers complete timing range. Circuit is backwards relay, in which coil is energized except during timing interval. Relay pulls in at 10 ma and drops out at 6 ma.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 291.



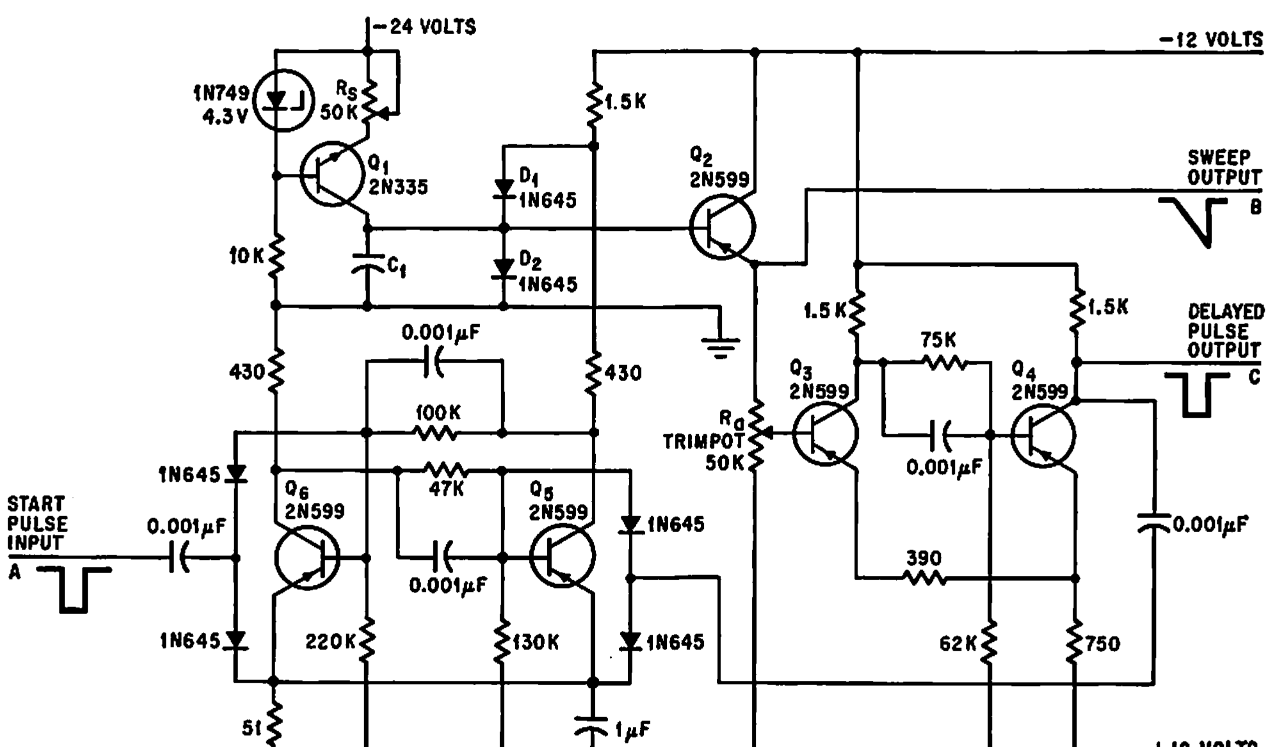
INSTRUMENTATION CAMERA TIMER—Varies camera exposure rates and durations automatically according to desired program. Triggering rate can be constant and adjustable or variable for selected period between predetermined initial and final rates. Monostable mvbr Q2-Q3 determines length of triggering pulse that operates relay K1.—B. E. Bourne, Variable-Program Triggering Source, *Electronics*, 33:37, p 76–77.



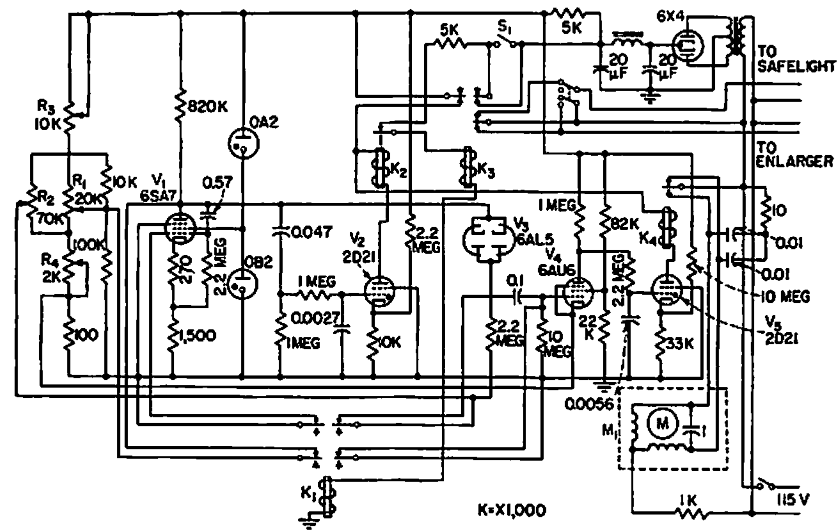
EXPOSURE INDICATOR FOR ENLARGER—One leg of Wheatstone bridge is unbalanced by light shining on phototube. Sensitivity of circuit is adjusted to match speed of enlarging paper with potentiometer that changes d-c voltage applied to phototube. Meter can be calibrated directly in seconds of exposure.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, N.Y., 1956, p 291.



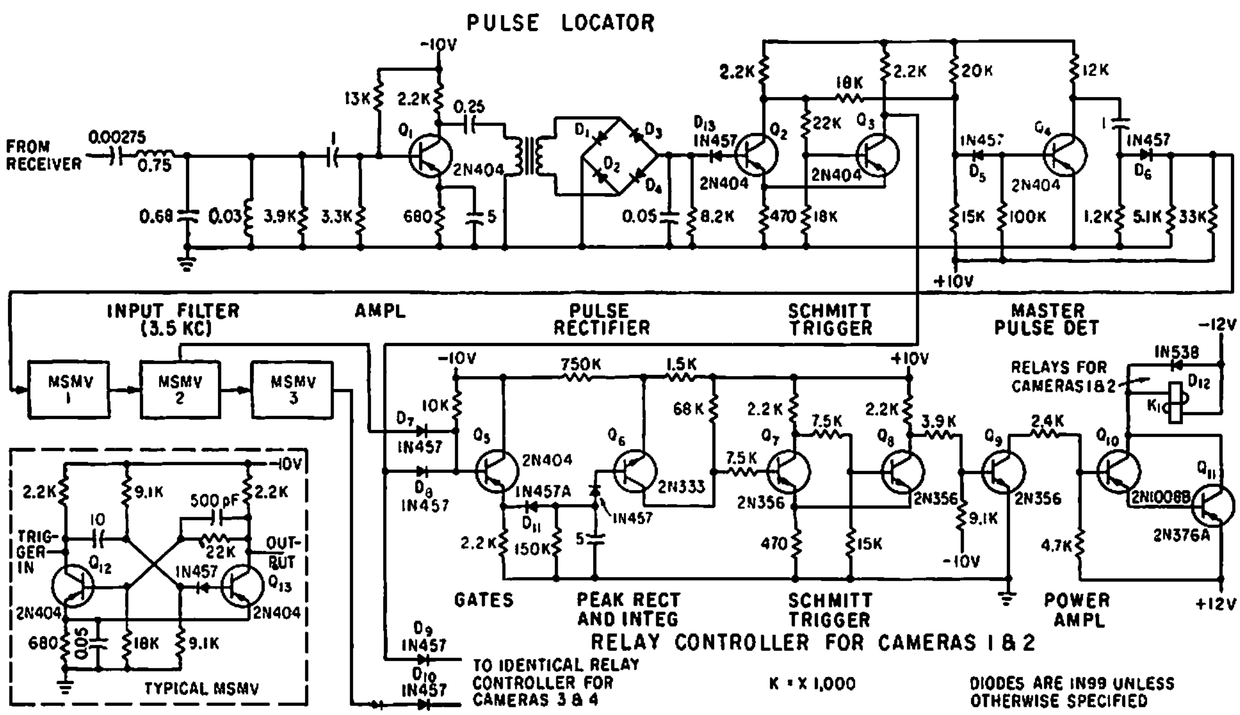
SINGLE-FRAME TV PHOTOGRAPHY TIMER—Uses four thyratrons to switch on picture tube for exact 1/30th-sec interval required to complete two interlaced fields and give clean photograph for open-shutter still camera. Vertical drive pulses from tv sync generator provide time-reference triggering. Stabilized high-voltage supply minimizes defocusing.—A. A. Tarnowski and K. G. Lisk, Timer Shutters CRT for Single Frame Photos, *Electronics*, 31:15, p 83–85.



CAMERA SHUTTER CONTROL—Keeps camera shutter open for predetermined time, to photograph scope as radiation pellet moves past a succession of radiation detector tubes facing conveyor belt. Pellet interrupts light beam to start sweep. RS and C1 control reset time of sweep.—R. L. Nuckolls, Slow Sweep Generator Controls Camera Shutter, *Electronics*, 38:16, p 82.

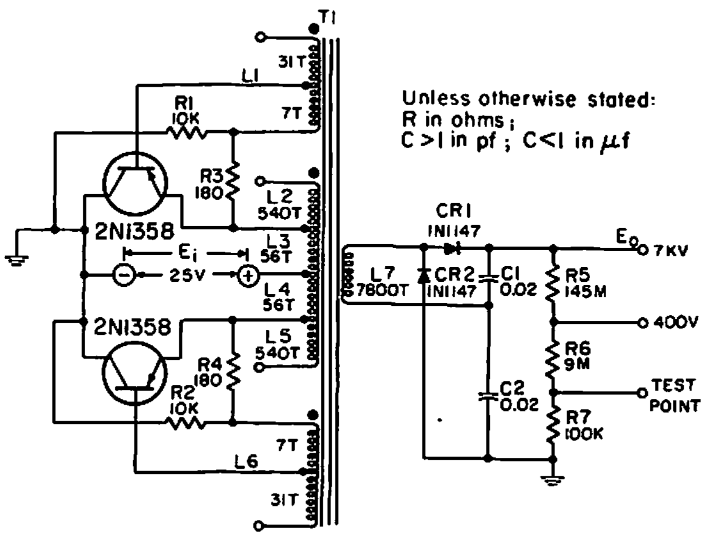


PRINT TIMER—Uses radar phantastron circuit to give correct combination of exposure time and color filter for desired contrast and density. R1 sets exposure time from 6 to 60 seconds and R2 regulates contrast.—J. D. Weir, Print Timer Controls Density and Contrast, *Electronics*, 31:7, p 108–109.

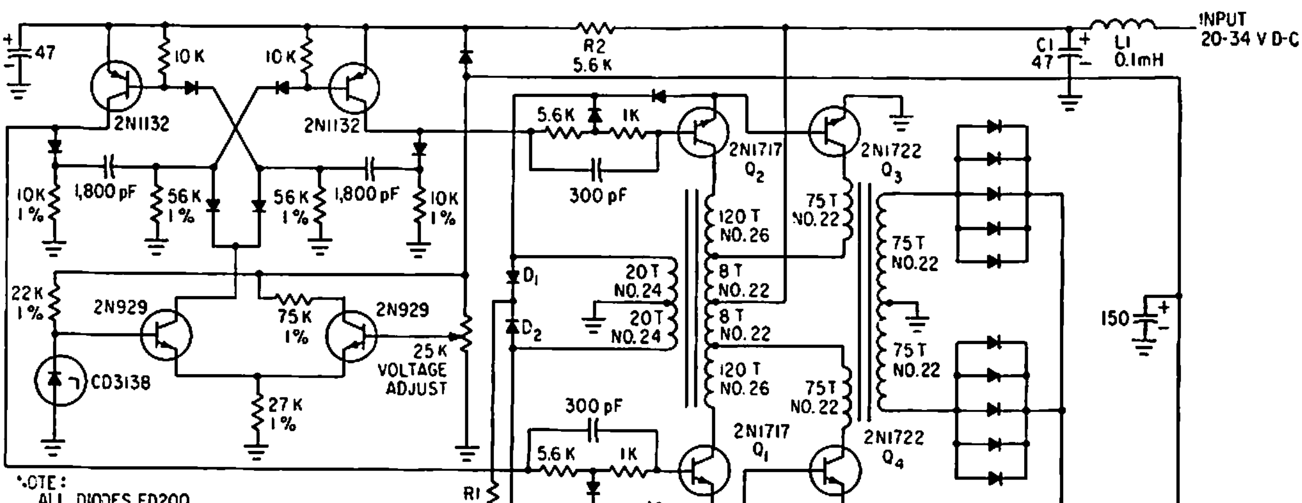


CAMERA CONTROL—Circuit separates 3.5-kc pulses from other subcarrier signals at input filter, then amplifies, rectifies pulses, and squares pulses at Schmitt trigger. Four cameras can be controlled by system from single 460-Mc radio link.—F. M. Gardner and L. R. Hawn, Camera Control System for Rocket Sled Tests, *Electronics*, 33:14, p 63–65.

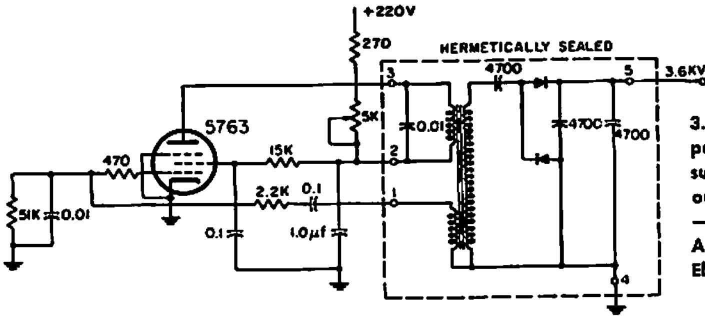
CHAPTER 60
Power Supply Circuits



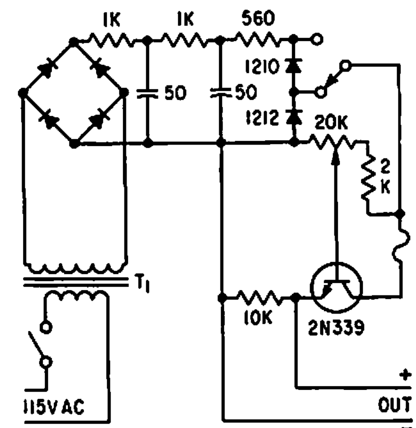
7-KV CRT SUPPLY—Provides high-voltage source for screen grid and final anode of 5 to 12-inch magnetic-deflection cathode-ray tubes in equipment having full or partial transistorization. Full-wave d-c to d-c converter, with transistor load connected between voltage source and emitter, permits attaching collectors to grounded or chassis-connected heat sink.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 6 (originally PC 202), p 6–2.



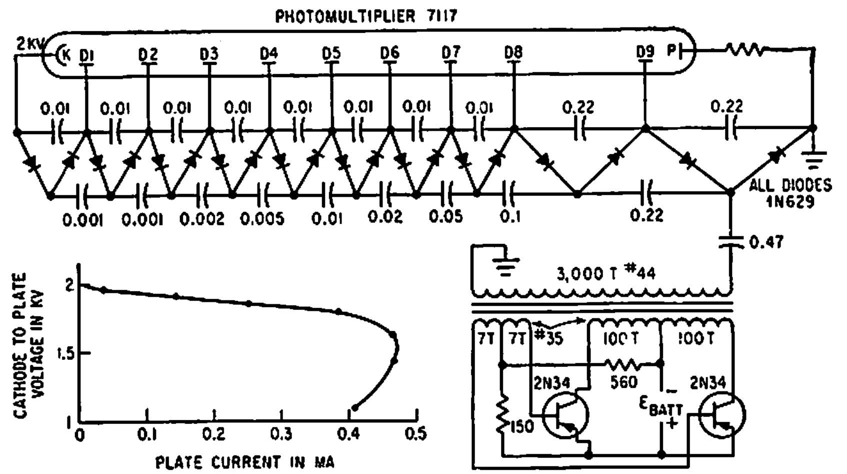
D-C/D-C CONVERTER USES 10-KC MVBR—Free-running mvbr and square-hysteresis-loop transformer together fire Q1 and Q2 alternately to give constant frequency independent of changes in input voltage, while varying pulse width to give voltage regulation. Short-circuits cannot damage power supply. —E. Josephson, Satellite Power Supply has Variable Pulse Width, *Electronics*, 35:8, p 47–49.



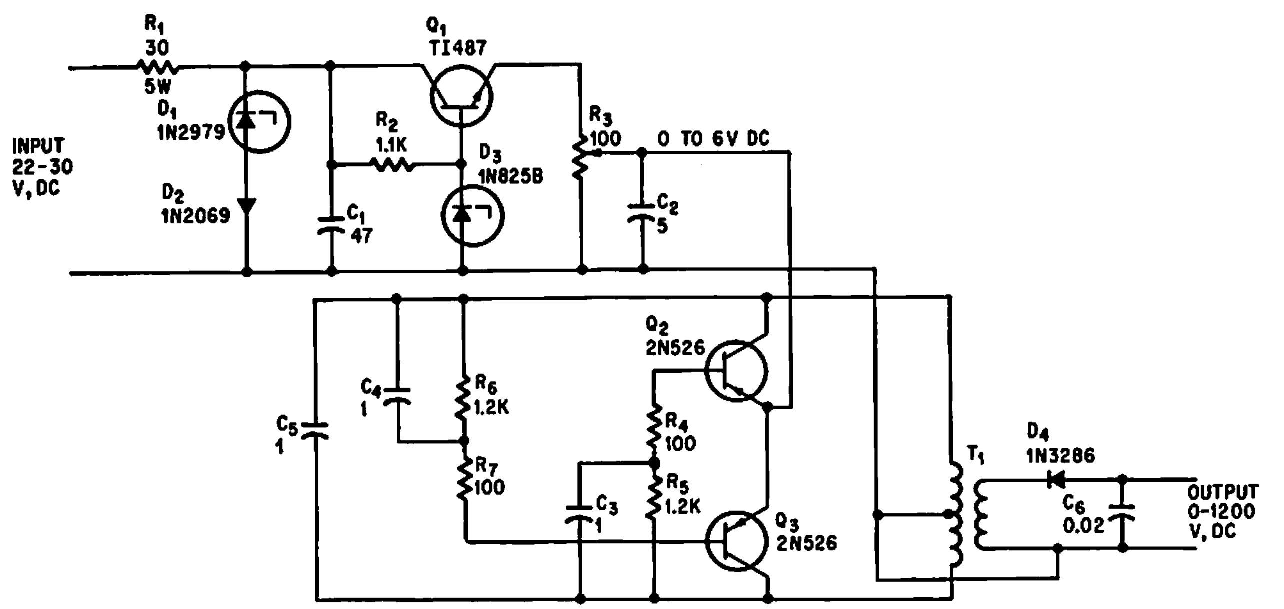
3.6-KV OSCILLATOR-TYPE SUPPLY—Single pentode in audio oscillator circuit provides sufficient power for step-up transformer and output rectifier filter. Used for dark-face crt. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–3.



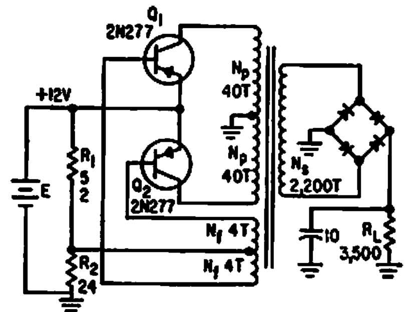
ANALOG VOLTAGE SOURCE—Consists of bridge-rectifier supply with R-C filtering and zener diode regulation, feeding control potentiometer that is isolated from load by grounded-collector transistor. Used as analog voltage source for computer circuits.—E. R. James, Semiconductors Provide Analog Voltage Source, *Electronics*, 31:33, p 96–100.



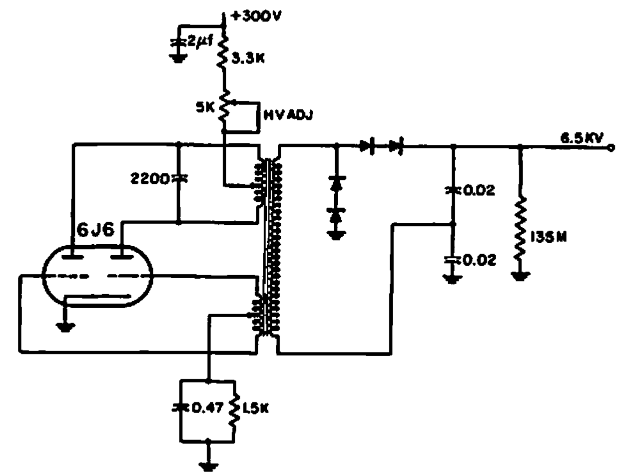
PHOTOMULTIPLIER SUPPLY—String of Cockcroft-Walton voltage doublers multiplies a-c output voltage of blocking oscillator to step up battery voltage to required 2 kv. Regulation is reasonably constant up to 0.4 ma plate current.—R. P. Rufer, Battery Powered Convertor Runs Multiplier Phototube, *Electronics*, 33:28, p 51.



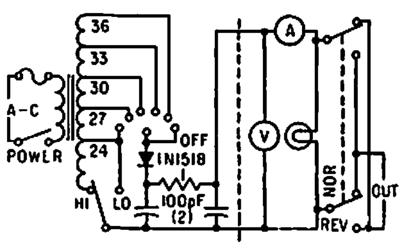
0-1,200 V REGULATED SUPPLY FOR PHOTOMULTIPLIER—Silicon diodes in R-C filter network gives 0.5% regulation over entire d-c output range, with temperature coefficient only 0.1% of output voltage per deg C, for photomultiplier stage in airborne equipment. —J. G. Peddie, Network Filters Stabilize d-c Supply Over Wide Range, *Electronics*, 37:18, p 83.



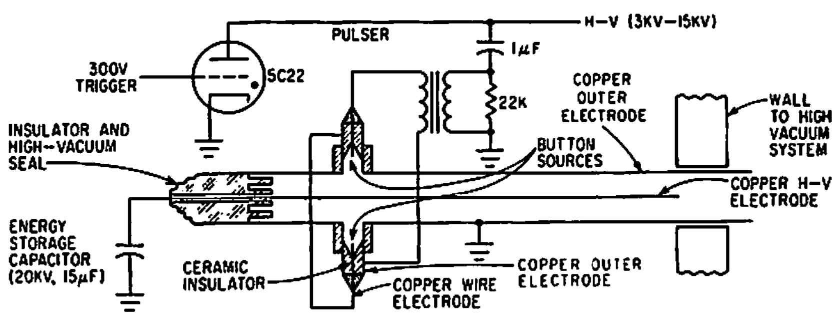
OSCILLATOR-TYPE SUPPLY—Article gives basic design equations for d-c to d-c power supply using power transistors. Efficiency is up to 90%. D-c output voltage is 590 v for 3,500-ohm load.—T. Hamm, Jr., Equations for Designing Transistor Power Supplies, *Electronics*, 32:43, p 122–124.



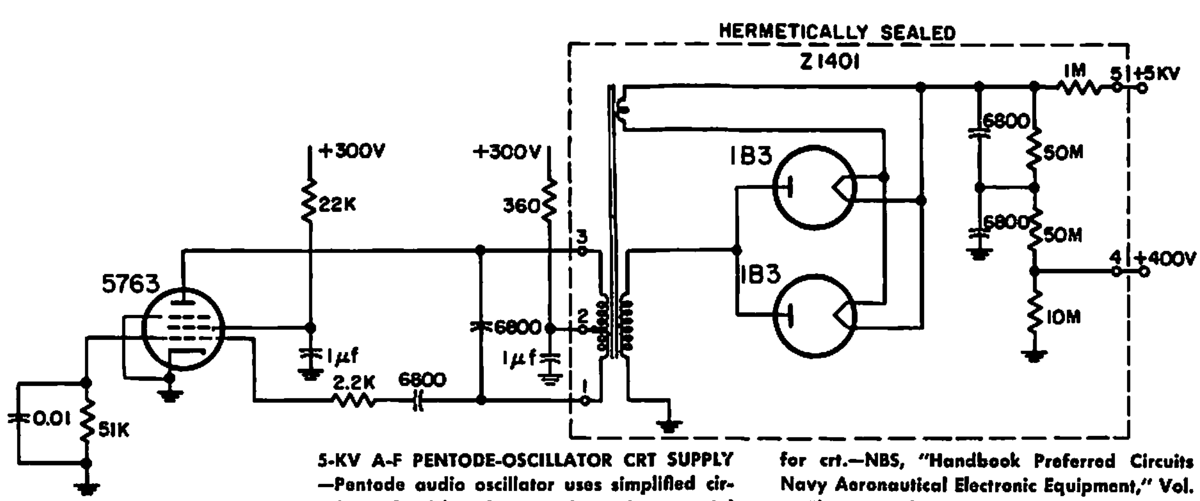
6.5-KV TWIN-TRIODE A-F OSCILLATOR CRT SUPPLY—Oscillator develops square wave because of saturable square-loop core material of transformer. Diodes eliminate extra load placed on oscillator by high-vacuum rectifier tube filaments.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14-5.



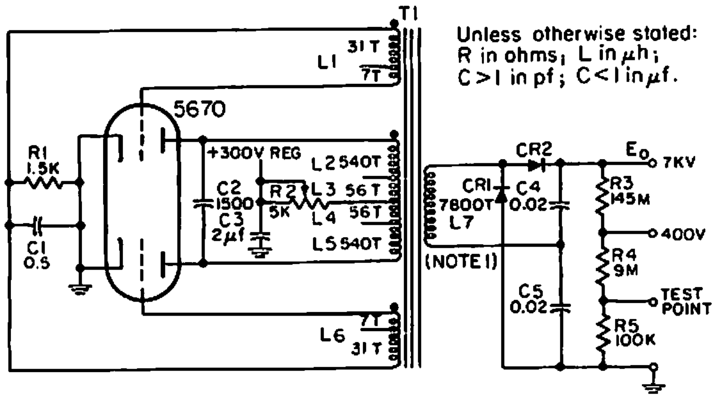
TRANSISTOR-TESTING SUPPLY—Six taps on transformer, plus range switch that transfers negative bus to 24-v tap, provide choice of nine constant outputs from 3 to 36 v d-c.—F. W. Kear, Laboratory Supply for Transistors, *Electronics*, 35:30, p 55–57.



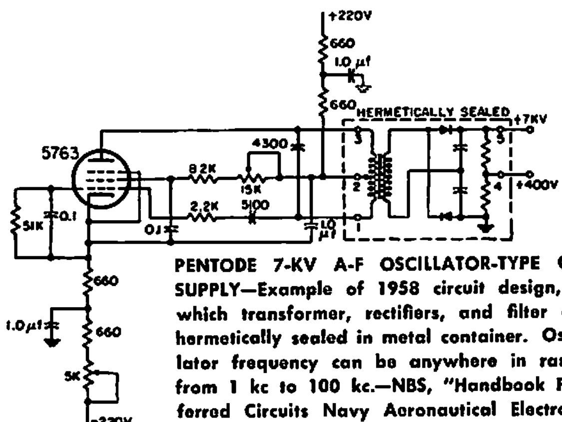
TRIGGERED THYRATRON PULSER—Coaxial rail gun generates high-velocity copper plasma when triggered by series-connected button guns energized through transformer by thyratron pulser. Vaporized copper from buttons shorts main 15-mfd capacitor, vaporizing inner copper high-voltage electrode.—M. F. Wolff, Plasma Engineering—Part 1: Generating and Heating Plasma, *Electronics*, 34:28, p 47–53.



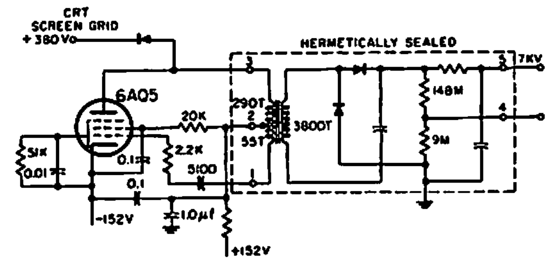
5-KV A-F PENTODE-OSCILLATOR CRT SUPPLY—Pentode audio oscillator uses simplified circuit to furnish only second anode potential for crt.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14-4.



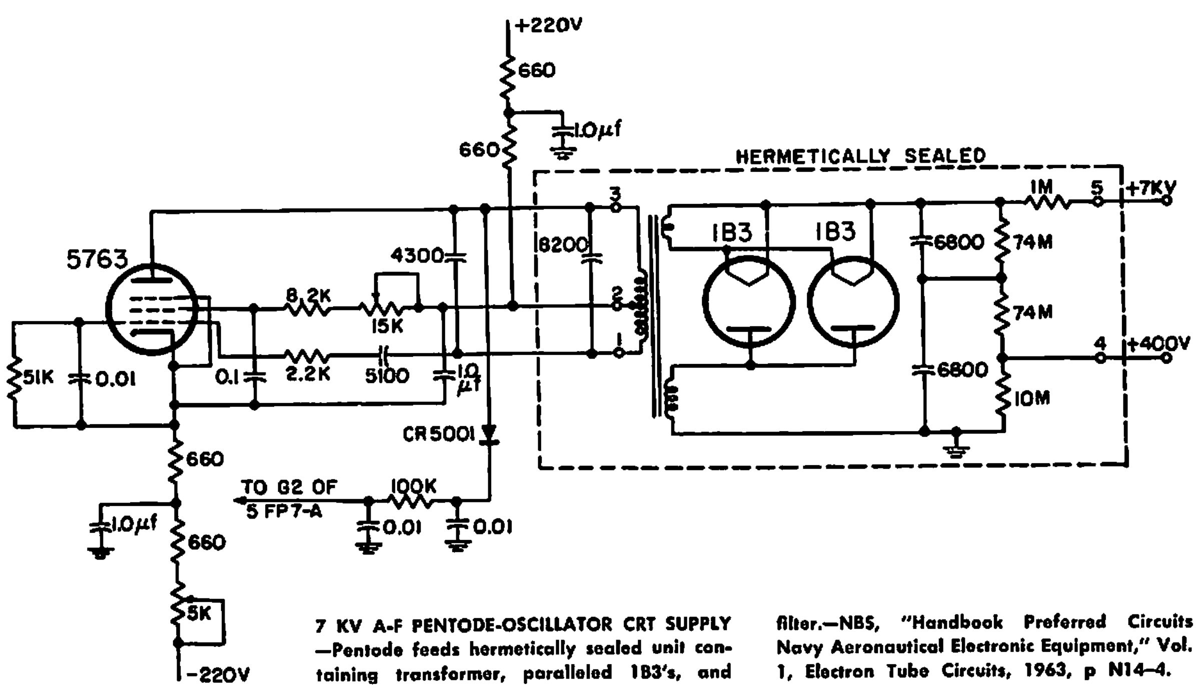
DUAL-TRIODE 7-KV CRT SUPPLY—Serves as high-voltage source for screen grid and final anode of 5 to 12-inch cathode-ray tubes. CR1 and CR2 are each six 1N588 silicon diodes in series. Operating frequency is about 450 cps for twin-triode tuned-plate oscillator having high L-C ratio.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, PC 6, p 6–2.



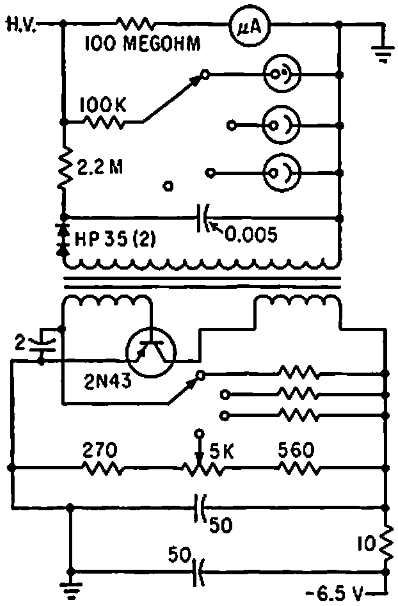
PENTODE 7-KV A-F OSCILLATOR-TYPE CRT SUPPLY—Example of 1958 circuit design, in which transformer, rectifiers, and filter are hermetically sealed in metal container. Oscillator frequency can be anywhere in range from 1 kc to 100 kc.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–2.



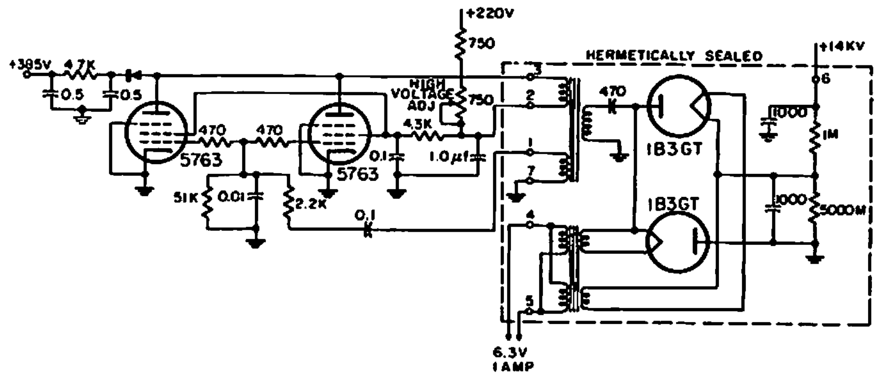
7-KV OSCILLATOR-TYPE CRT SUPPLY—Audio oscillator provides screen-grid voltage for crt directly and second-anode voltage through high-voltage transformer and rectifier-filter.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–2.



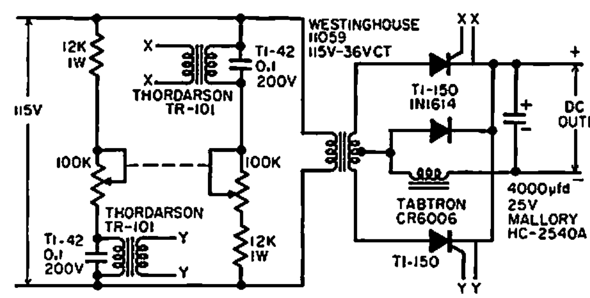
7 KV A-F PENTODE-OSCILLATOR CRT SUPPLY—Pentode feeds hermetically sealed unit containing transformer, paralleled 1B3's, and filter.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–4.



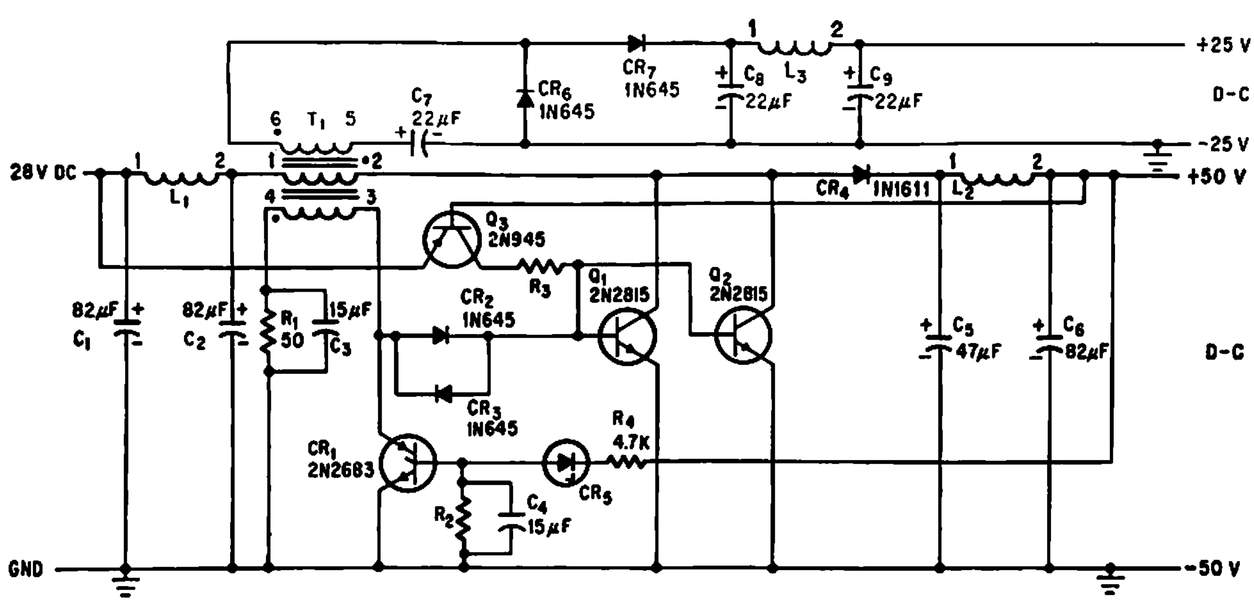
GEIGER-MULLER SUPPLY—Uses blocking oscillator to provide three stabilized levels of high voltage, at 900, 1,000, and 1,100 v, for G-M tube. Corona discharge tubes are switched in to provide regulation.—F. E. Armstrong, Battery Powered Portable Scaler, *Electronics*, 33:19, p 74–75.



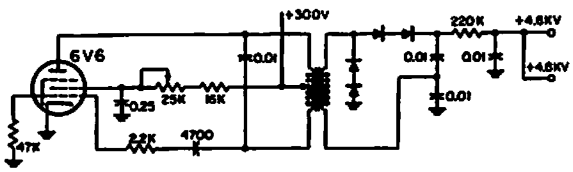
14 KV AND 385 V FOR DARK-FACE CRT—Uses two pentodes in parallel in a-f oscillator to provide sufficient power for final anode potential in oscillator-type supply.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–3.



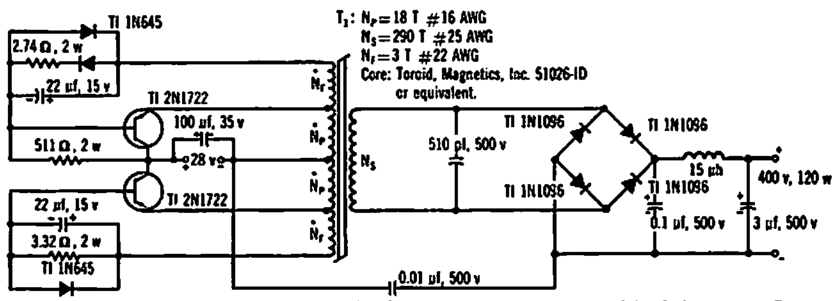
VARIABLE REMOTE POWER SUPPLY—Permits varying output d-c voltage of scr power supply without changing a-c input voltage. Conduction time of scr's during each half-cycle determines average power delivered to load. Conduction time is controlled with pulse gating circuit that is synchronized with a-c line and is phase-variable. Provides maximum output of 60 amp at 20 v.—B. F. Gilbreath, Variable High Current Remote Power Supply, *EEE*, 10:12, p 27–28.



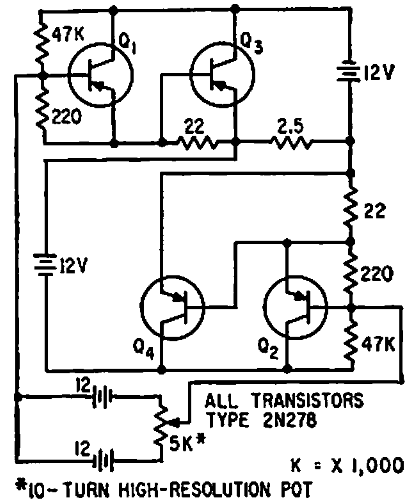
D-C/D-C REGULATED SUPPLY—Efficiency is 93% in converting 28 v d-c to 25 and 50 v d-c for telemetry transmitter. Regulation is achieved by storing energy in magnetic field of coil during half of each switching cycle created by transistors Q1 and Q2 after Q3 initiates switching cycle. SCR CR1 and diode CR5 control percentage of time switching transistors are on.—N. Downs and B. van Sutphin, Solid-State Transmitter Ready for UHF Telemetry, *Electronics*, 37:17, p 76–80.



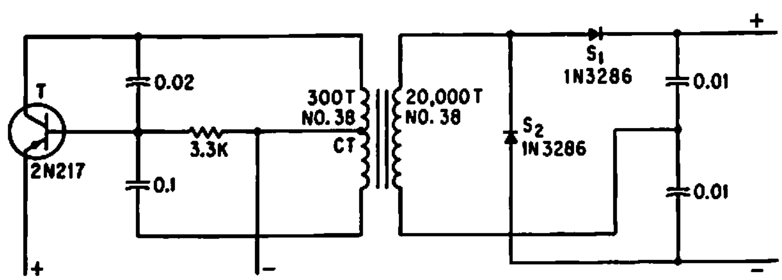
4.8-KV OSCILLATOR-TYPE CRT SUPPLY—One of earliest circuits in which a-f sine-wave oscillator was used as power source. Filter capacitors are significantly smaller than in conventional line-transformer supplies.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–2.



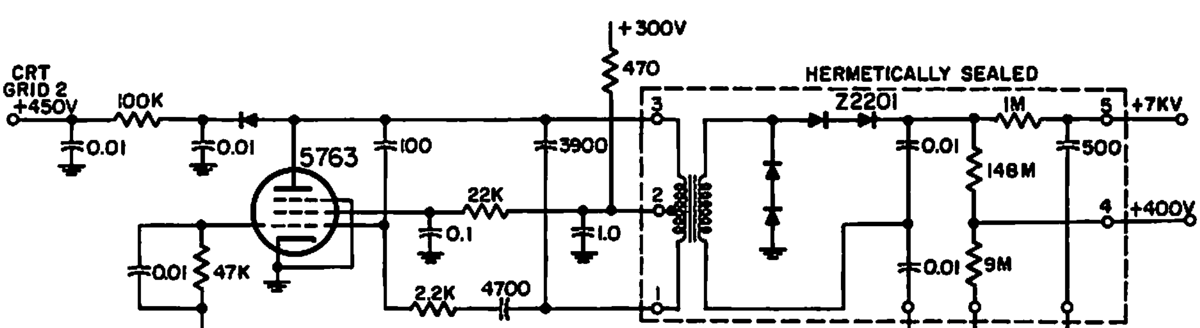
120-WATT D-C/D-C CONVERTER—Circuit boosts 28 v d-c input to 400 v d-c with 85% efficiency, drawing 5 amp and operating at 10 kc.—120-Watt D-C/D-C Converter Operates From −55° to +125°C, *Electronics*, 36:2, p 15.



DUAL-POLARITY VARIABLE D-C SUPPLY—Diagonally symmetrical power transistor circuit permits smooth load current variation over range of several amperes at either polarity. Rectifier supply can be used in place of storage batteries. Maximum current drain from two 12-v dry cells in 5K potentiometer control circuit is 7 ma.—R. R. Bockemuehl, Transistor Rectifier Gives D-C of Either Polarity, *Electronics*, 32:25, p 76.

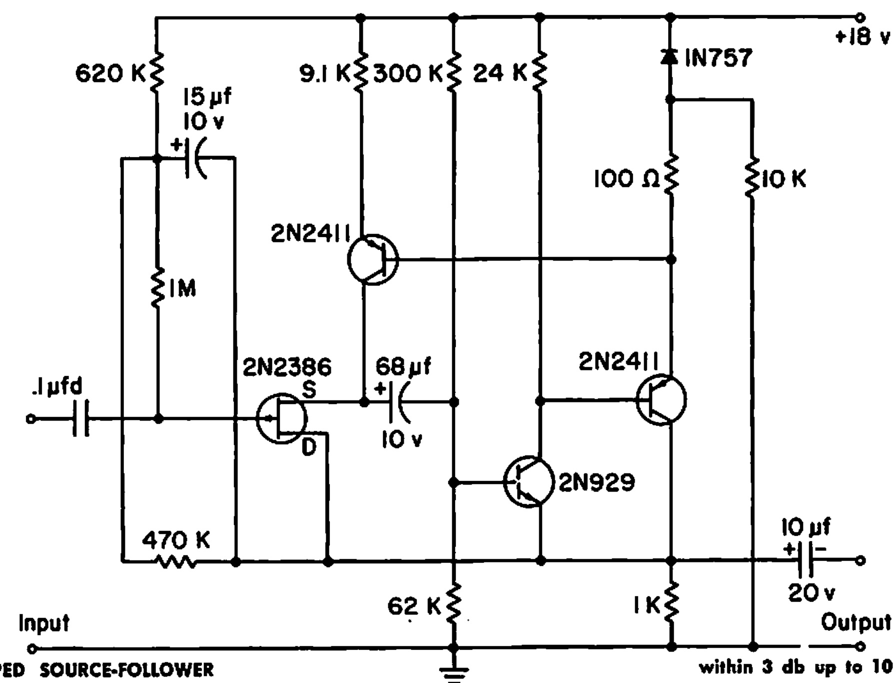


5,000 V D-C FROM 26 V D-C—Uses transistor as sinusoidal oscillator. Voltage-doubling capacitors keep ripple below 0.01%.—R. D. Morrow, Inexpensive Converter Gives 5,000 Volts D-C, *Electronics*, 35:28, p 54.

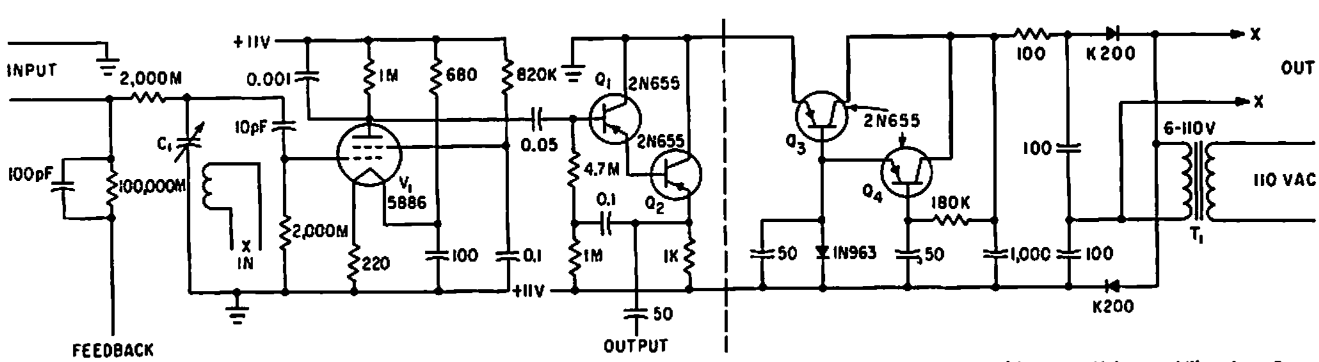


7 KV AND 450 V OSCILLATOR-TYPE CRT SUPPLY—Pentode audio oscillator feeds hermetically sealed transformer-rectifier-filter unit.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14–4.

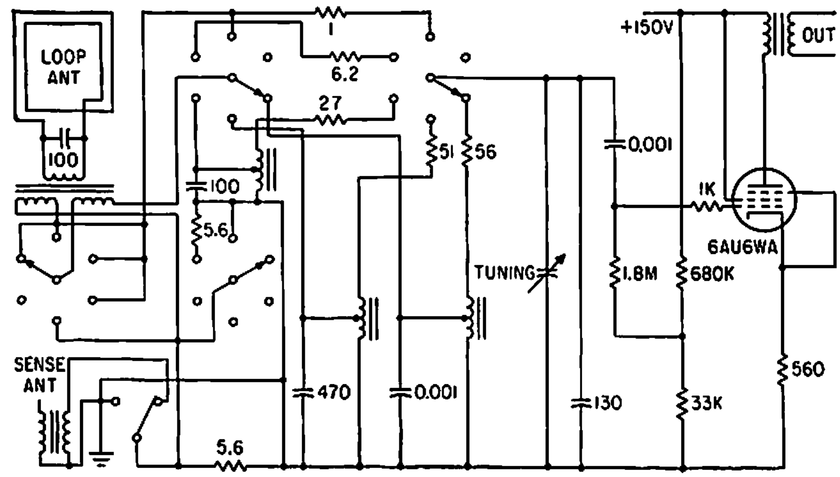
CHAPTER 61
Preamplifier Circuits



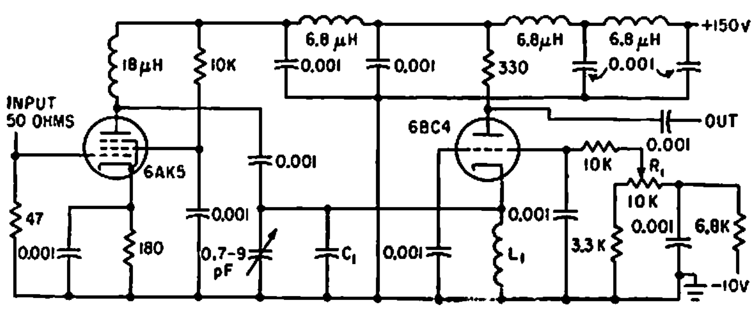
FET-PNP BOOTSTRAPPED SOURCE-FOLLOWER—Drain and gate divider are bootstrapped in phase with source, to reduce input capacitance of fet to minimum so only real part of input impedance is seen at high frequencies, in unity-gain high-input-impedance wideband preamplifier. Low-frequency input impedance is 100 meg. Frequency response is within 3 db up to 10 Mc for 50-ohm generator resistance, to 1 Mc for 100,000 ohms, and to 0.1 Mc for 1 meg.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 138.



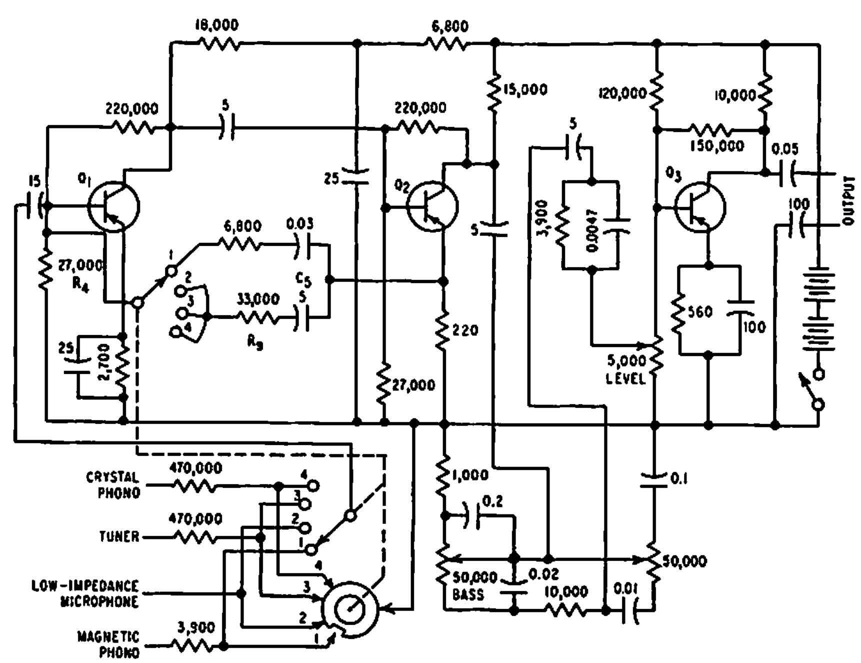
ELECTROMETER PREAMP—Transformer T1 feeds drive coil of vibrating capacitor C1 used in place of conventional chopper for measuring picoampere currents. Output of electrometer, taken from Q2 of preamp, goes to amplifier that is source of feedback signal. —V. J. Caldecourt, Using a Vibrating Capacitor as an Electrometer Input, *Electronics*, 35:14, p 48–50.



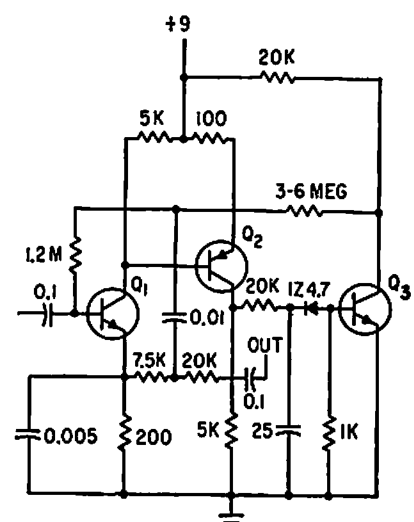
L-F D-F PREAMP—Negative feedback provides stability, yet gain is sufficient so noise contributions of preamplifier to 15-500 kc direction-finding receiver are negligible. Output of preamp feeds receiver through 100 feet of 100-ohm balanced transmission line.—L. E. Orsak and D. W. Martin, Direction Finding at Low Frequencies, *Electronics*, 33:38, p 74–77.



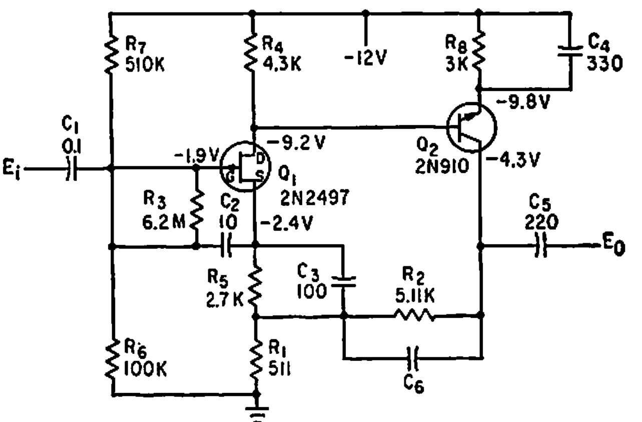
30-MC VARIABLE-BANDWIDTH RADAR PREAMP—Bias control R1 on grounded-grid 6BC4 triode provides continuous change of bandwidth from 200 kc to 15 Mc, for changing search range. Insertion loss is 0 db.—R. Hirsch, Voltage-Variable Bandwidth Filter, *Electronics*, 35:22, p 46–47.



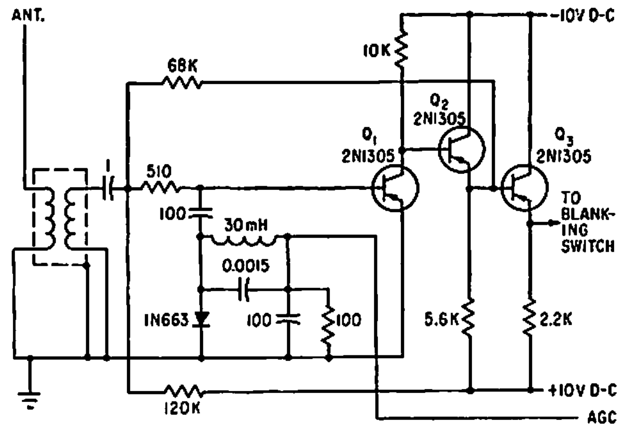
AUTOMATIC INPUT IMPEDANCE MATCHER—Uses controlled amounts of negative feedback to maintain practically constant voltage sensitivity for impedances from 10 ohms to over 10,000 ohms.—Preamp Matches Input Impedance, *Electronics*, 31:13, p 81.



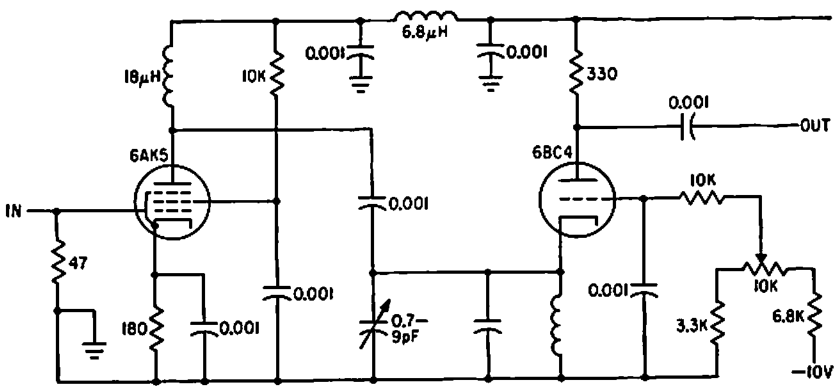
10 CPS TO 100 KC BANDPASS—Input impedance is over 1 meg. Can be used in microphone case to raise power level of signal above that of interference. Both positive and negative feedback are used. Q1 and Q3 are 2N1086A, and Q2 is 2N414.—J. J. Tiemann, Transistor Amplifier with Adjustable Impedance and Gain, *Electronics*, 35:15, p 68–69.



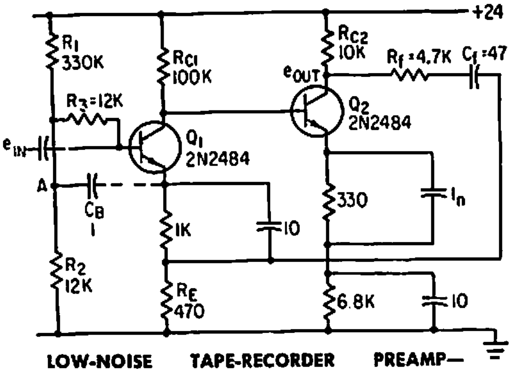
LOW-NOISE FET PREAMPLIFIER—For 600-ohm source, 3-db response is 0.5 cps to 700 kc, with voltage gain of 10.5, using common-emitter direct-coupled amplifier stage after fet stage, with 26 db of feedback. With 1-meg source, upper limit is 20 kc.—E. G. Fleenor, Low-Noise Preamplifier Uses Field-Effect Transistors, *Electronics*, 36:15, p 67–69.



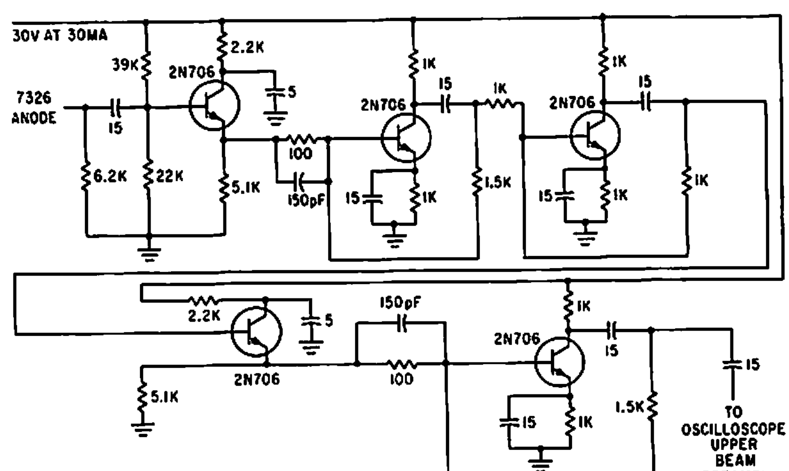
VLF PREAMP WITH AGC—Fast-recovery computer diode acts as pure variable resistance shunting base of Q1 to ground, for full agc control without phase shift in output signal. In frequency range of 13 to 24 kc, phase shift is less than 0.25 microsec over 40-db input signal range.—J. D. Echols, Calibrating Frequency Standards with VLF Transmissions, *Electronics*, 35:17, p 60–63.



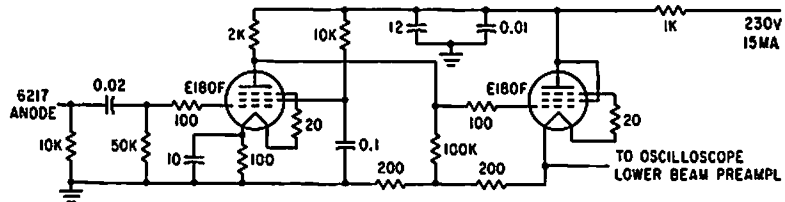
ELECTRONICALLY CONTROLLED BANDWIDTH—For search radar, potentiometer adjusts bias on 6BC4 tube of 30-Mc i-f preamp to vary bandwidth over range of 200 kc to 15 Mc.—Variable Bandwidth Preamplifier Electronically Varied Between 15 Mc and 200 Kc, *Electronics*, 35:2, p 102.



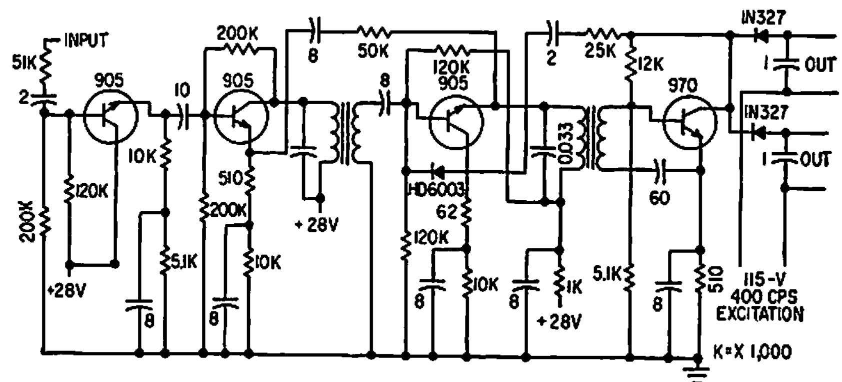
LOW-NOISE TAPE-RECORDER PREAMP—Closed-loop gain is 20 db from 100 cps to nearly 8 Mc for source impedance of 1,000 to 6,000 ohms.—J. J. Rado, Designing Input Circuits with Lowest Possible Noise, *Electronics*, 36:31, p 46–49.



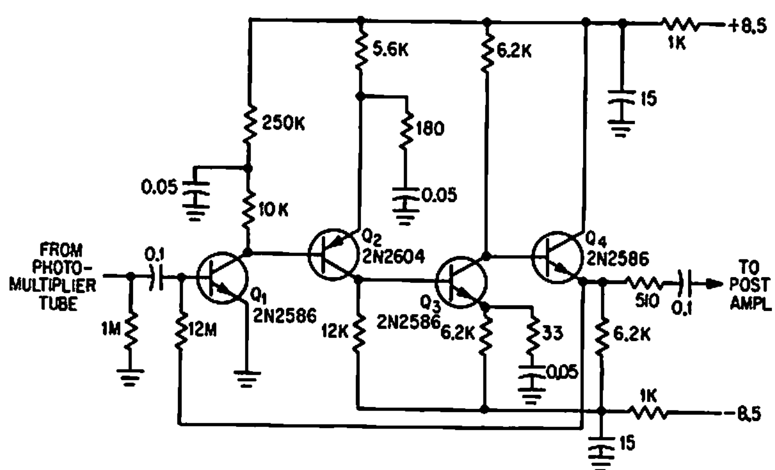
7326 PHOTOMULTIPLIER PREAMP—Used between type 7326 photomultiplier and dual-beam oscilloscope in receiver of optical ranging system. Voltage gain is 100 for output dynamic range of 1.5 v, but noise figure is only about 14 db.—M. L. Stitch, E. J. Woodbury and J. H. Morse, Optical Ranging System Uses Laser Transmitter, *Electronics*, 34:16, p 51–53.



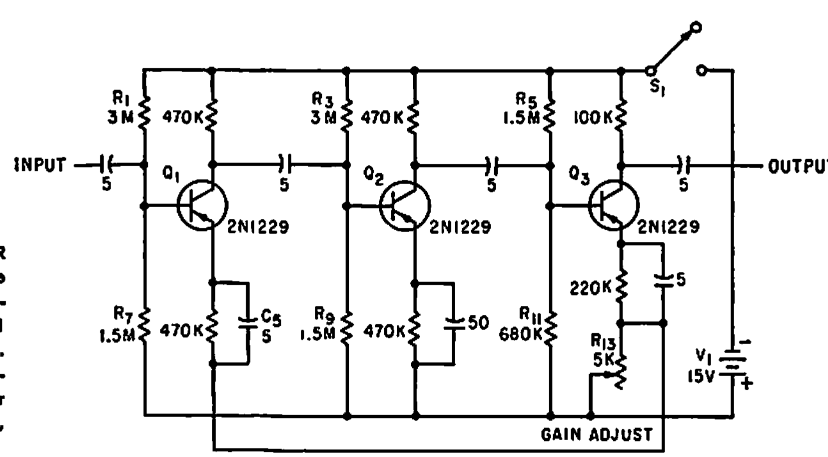
6217 PHOTOMULTIPLIER PREAMP—Used between photomultiplier and dual-beam oscilloscope to amplify signal pulse corresponding to transmitted laser signal in optical ranging system. Distance between transmitted and received pulses on cro corresponds to range. —M. L. Stitch, E. J. Woodbury and J. H. Morse, Optical Ranging System Uses Laser Transmitter, *Electronics*, 34:16, p 51–53.



AUTOPILOT PREAMP—Reliable pitch-axis channel uses four npn silicon transistors.—C. W. McWilliams, Designing Safety Into Automatic Pilot Systems, *Electronics*, 31:45, p 69–71.

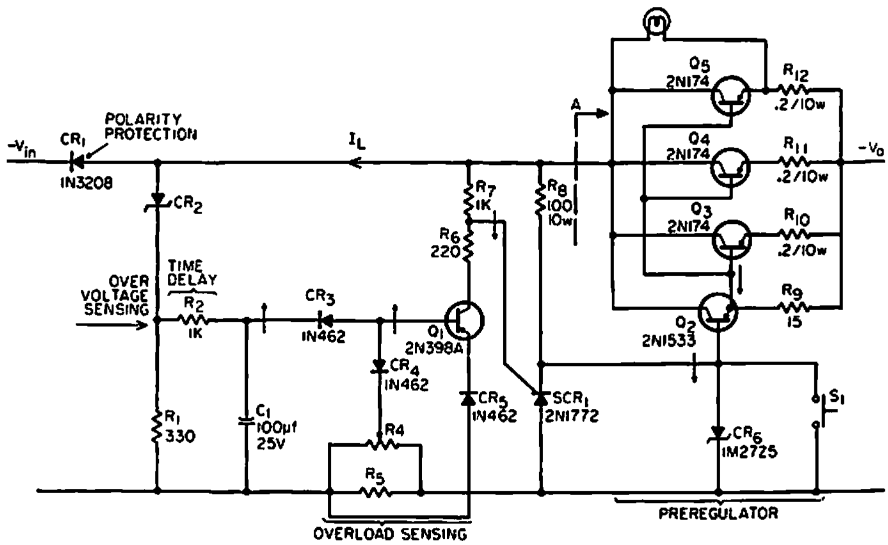


DIRECT-COUPLED PREAMPLIFIER—Output of multiplier phototube in orbiting astronomical observatory receives closed-loop amplification of 12 in current-sensing preamplifier over input dynamic current range of 3 to 500 ma. —R. Cuikay and T. Callahan, Orbiting Observatory to Measure Stars' Dim Light, *Electronics*, 37:9, p 28–31.

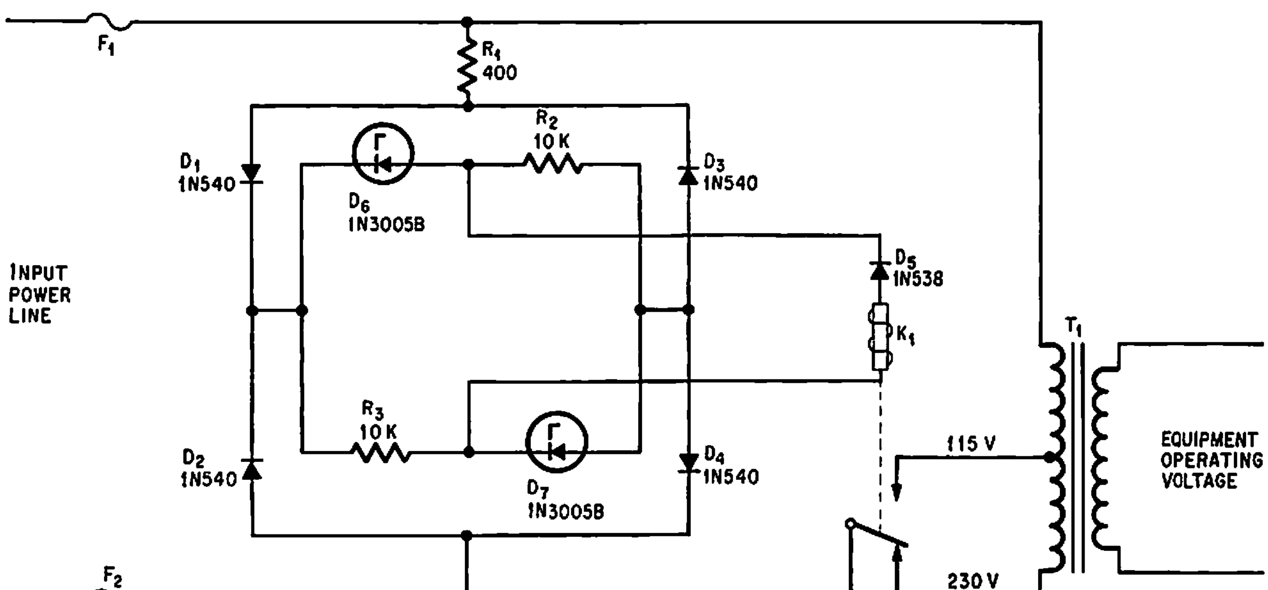


SILICON TRANSISTORS MINIMIZE POWER DRAIN—Used in conjunction with high-value circuit resistances to permit operation of preamplifier with battery drain of less than 1 nw. Gain is 100 for bandwidth of 18 kc. Intended primarily for use at room temperature.—C. D. Todd, Preamplifier Designed for Minimum Power Consumption, *Electronics*, 33:18, p 106–107.

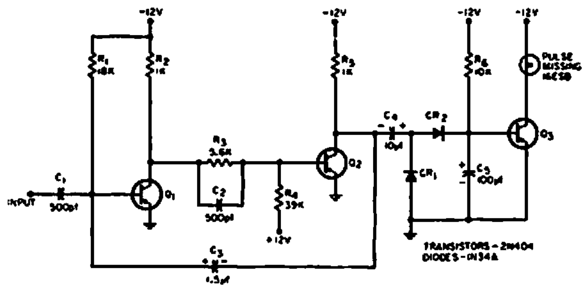
CHAPTER 62
Protection Circuits



SUPPLY OVERLOAD AND REVERSE-POLARITY PROTECTION—Uses signal from Q1 to trigger SCR1, which turns off series-pass transistor when overload reaches 15 amp. Will also provide limiting of output voltage at 25 v, input overvoltage protection at 32 v, and input reverse-polarity protection by CR1.—J. J. Rado, Versatile SCR Protection for Power Supplies, *EEE*, 13:8, p 56–62.

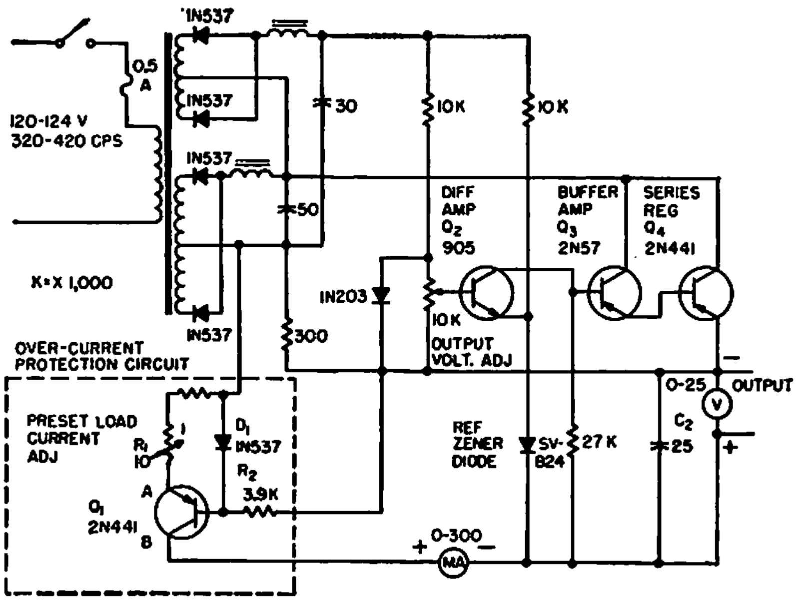


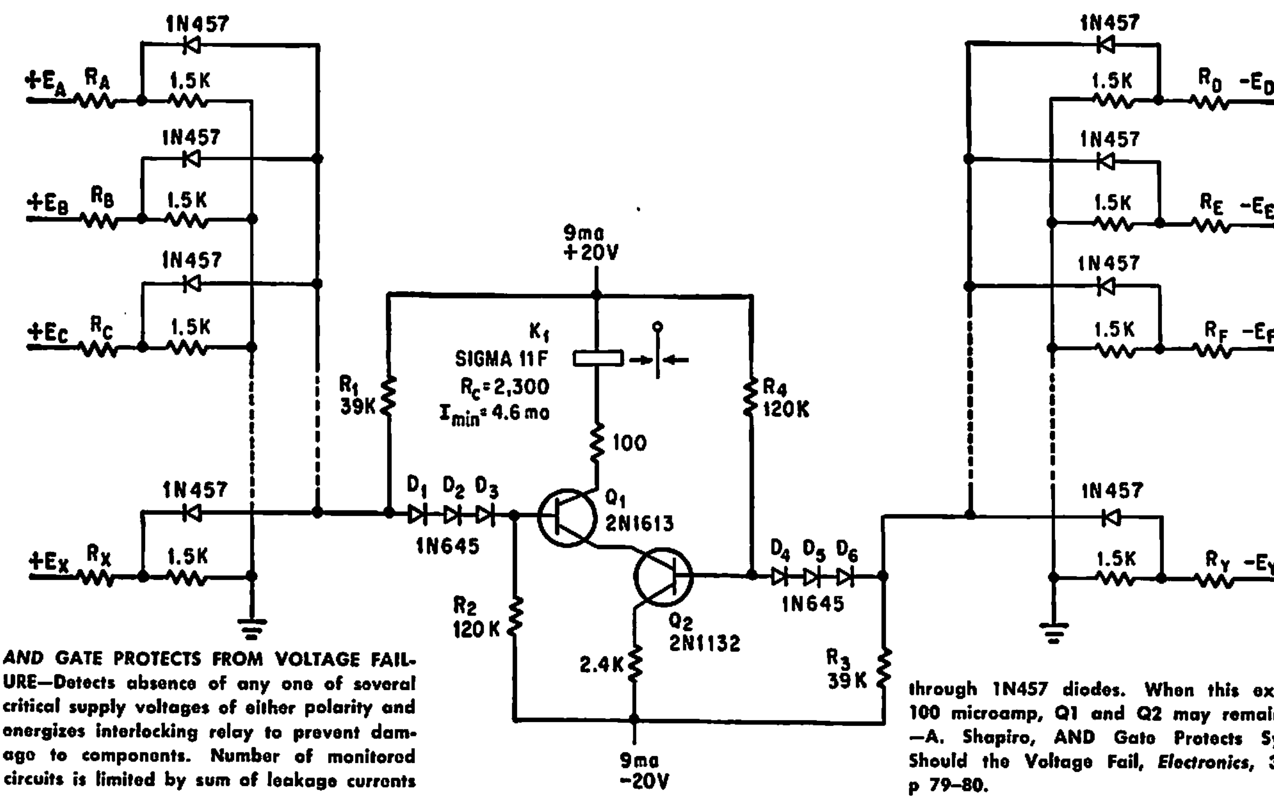
POWER TRANSFORMER SWITCHING RELAY SENSES LINE VOLTAGE—For 230-v line voltage, zener diodes back-bias diode D5, preventing energization of relay. For 115 v, diode conducts and relay closes, connecting line to 115-v tap of transformer.—L. K. Moyer, Circuit Always Applies Correct Operating Voltage, *Electronics*, 37:25, p 77.



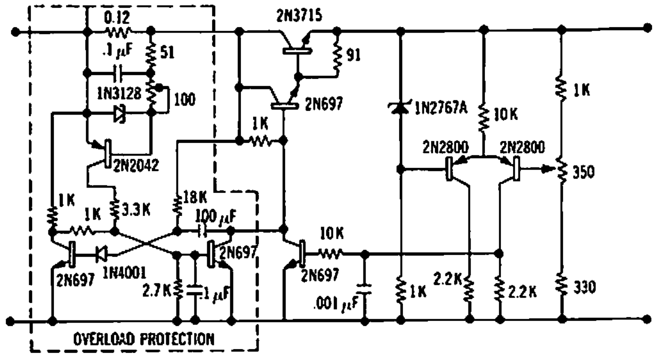
MISSING-PULSE DETECTOR—Turns on lamp if one of input pulses in continuous pulse input is missing. Pulses are very narrow (4 microsec wide) and 50 microsec apart for low duty cycle; Q1 and Q2 form pulse stretcher that increases width to about 40 microsec. In absence of stretched pulse, Q3 loses its bias and is turned on, making lamp light.—C. Gerston, Missing-Pulse Detector for Narrow Pulses, *EEE*, 12:8, p 72–74.

OVERLOAD PROTECTION—Transistor Q4 in conventional series regulated power supply is protected against charging current of load capacitance C2 by sharp current-limiting-characteristic protection circuit that operates statically, without need for resetting, in preset range of from 50 to 250 ma, and provides instantaneous response when regulator transistor is overloaded. Line regulation is 0.001% and load regulation is 0.002%.—H. D. Ervin, Transistor Power Supply has Overload Protection, *Electronics*, 31:25, p 74–75.

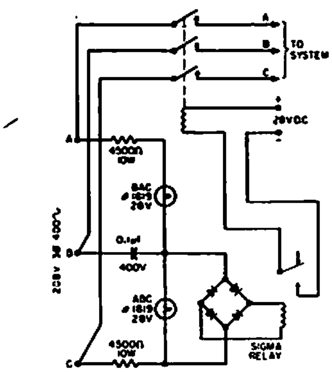




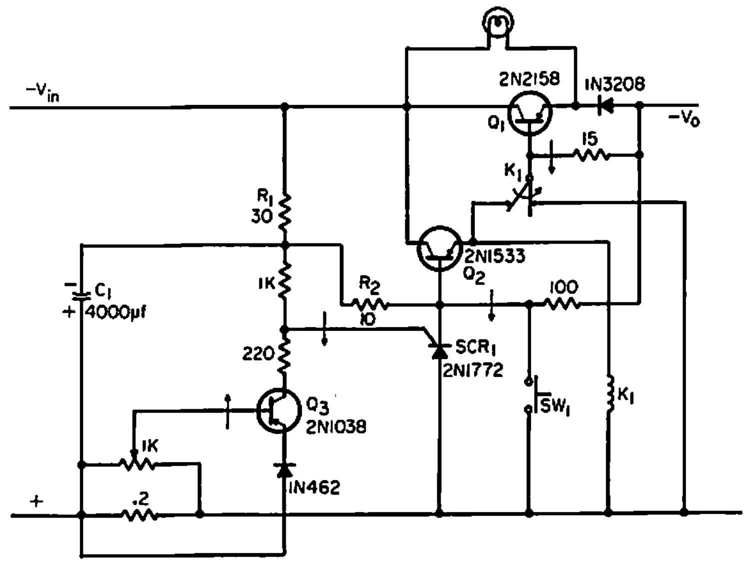
AND GATE PROTECTS FROM VOLTAGE FAILURE—Detects absence of any one of several critical supply voltages of either polarity and energizes interlocking relay to prevent damage to components. Number of monitored circuits is limited by sum of leakage currents through 1N457 diodes. When this exceeds 100 microamp, Q1 and Q2 may remain on. —A. Shapiro, AND Gate Protects System Should the Voltage Fail, *Electronics*, 39:14, p 79–80.



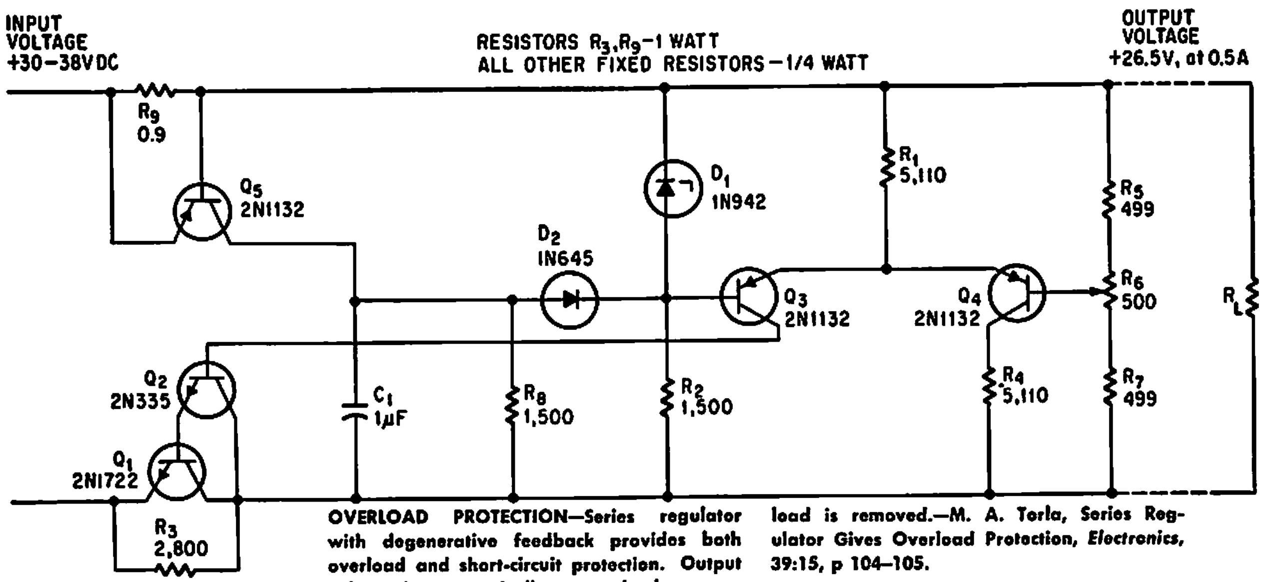
SERIES REGULATOR WITH OVERLOAD PROTECTION—Tunnel diode and transistor servo as overload sensing circuit used to trigger monostable mvbr, to protect series-pass transistors against overload. Circuit resets continuously after overload until trouble is cleared. Protection is adequate for resistive loads only.—J. Takesuye and H. Weber, "Silicon Power Transistors Provide New Solutions to Voltage Control Problems," Motorola Application Note AN-163, Aug. 1965.



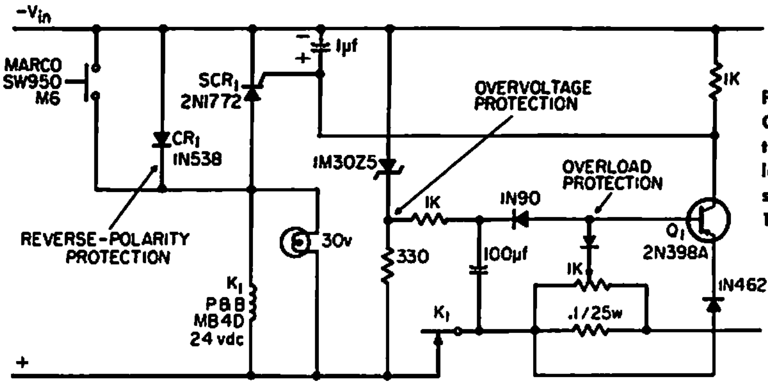
REVERSE-PHASE PROTECTION—Used to protect navigation system against damage if phase rotation is reversed by careless or accidental power transfers. With correct rotation, lamp ABC lights and relay closes control circuit to allow operation. With reverse phase rotation, lamp BAC lights and relay does not close.—J. J. Pirch, Simple Reverse-Phase Protection, *EEE*, 11:12, p 26.



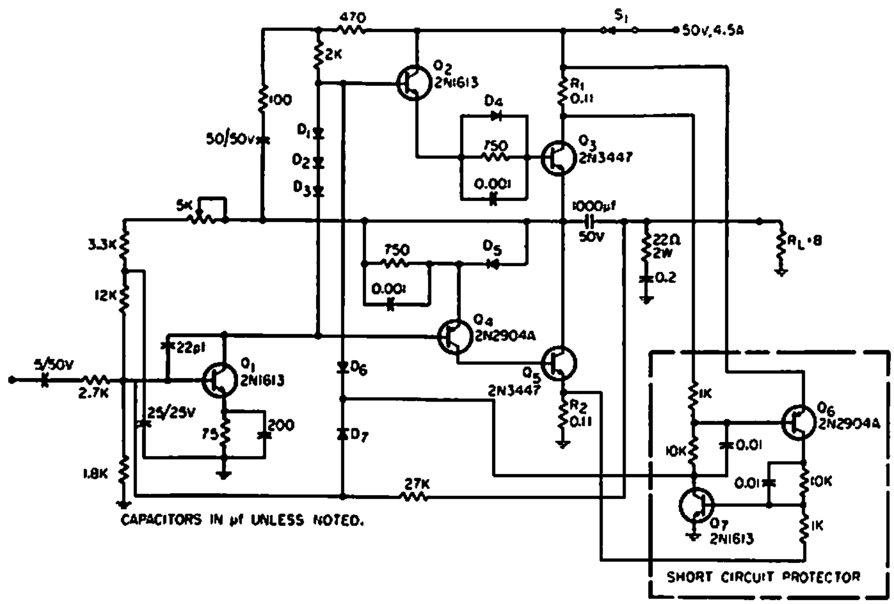
OVERLOAD PROTECTION WITH RIPPLE CLIPPING—Power transistor interrupts load when current exceeds safe limit, and also serves as part of ripple clipper.—J. J. Rado, Versatile SCR Protection for Power Supplies, *EEE*, 13:8, p 56–62.



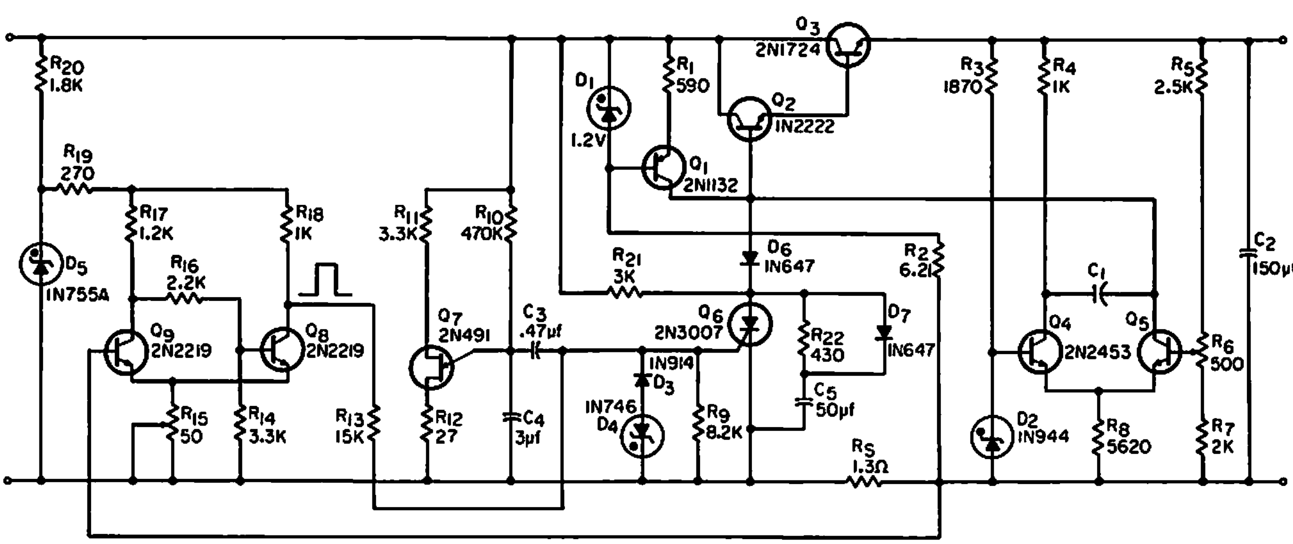
OVERLOAD PROTECTION—Series regulator with degenerative feedback provides both overload and short-circuit protection. Output voltage is automatically restored when overload is removed.—M. A. Torla, Series Regulator Gives Overload Protection, *Electronics*, 39:15, p 104–105.



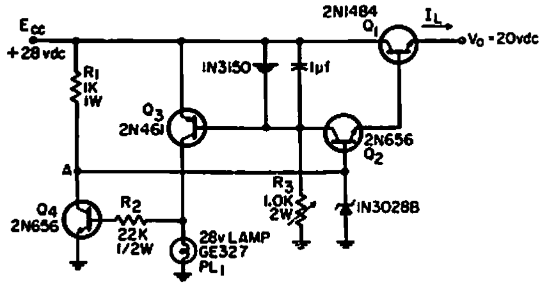
POWER SUPPLY OVERLOAD PROTECTION—Circuit uses simple relay instead of customary transistor to break load current when overload or overvoltage occurs.—J. J. Rado, Versatile SCR Protection for Power Supplies, *EEE*, 13:8, p 56–62.



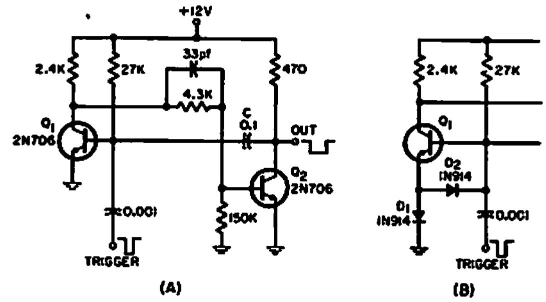
SHORT-CIRCUITABLE 30-W AUDIO AMPLIFIER—Utilizes practically entire supply voltage to produce usable power output, provides fail-safe overload protection, and stabilizes bias current. Any temporary overload or current surge will turn off drive to output stage. Circuit must be reset manually, by turning S1 off, removing cause of overload, and turning S1 on again. Circuit will limit peak current in output transistors Q3 and Q5 to about 5 amp.—W. O. Hamlin, Transformerless Amplifier with Overload Protection, *EEE*, 12:9, p 42–44.



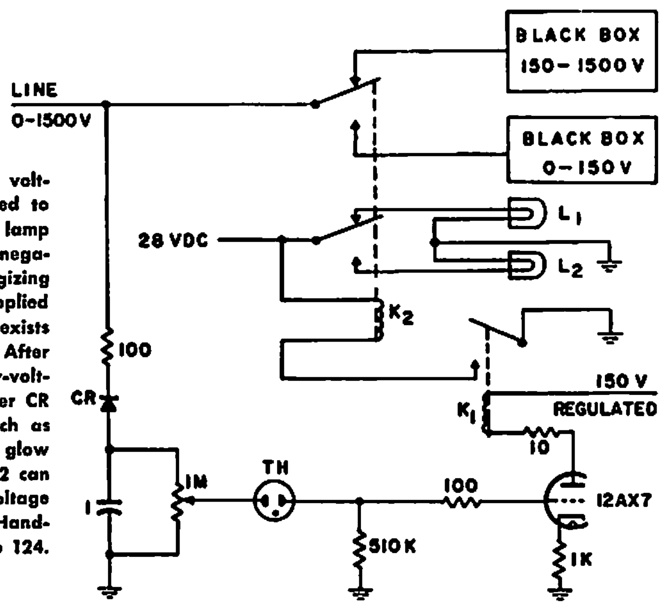
COMPLETE GTO PROTECTION FOR D-C SUPPLY—Circuit includes required recycle pulse generator and Schmitt trigger for driving gate-turnoff scr (gto) that switches off d-c power supply within 30 microsec of overload. Series regulator can deliver 125 v at 1 amp for input of 31 to 42 v. Overload trip point can be set anywhere between 0.75 and 1.2 amp.—W. C. Mosley, GTO Protection Circuitry for DC Supplies, *EEE*, 12:11, p 57–59.



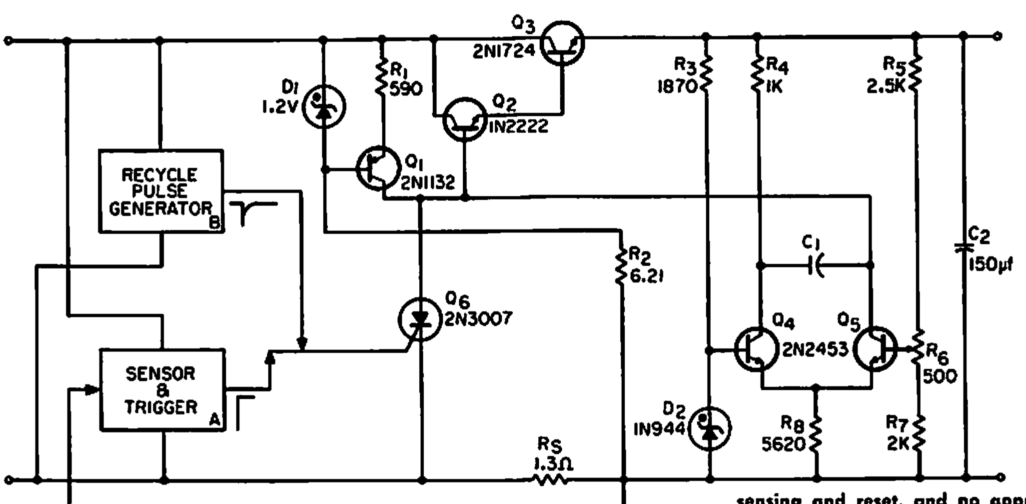
OVERLOAD PROTECTION WITH TD—Tunnel diode-transistor level detector reduces load current of series voltage regulator to zero when preset limit is exceeded. Protective circuitry consists of TD1, PL1, R2, R3, Q3, and Q4.—G. E. Bloom, Overload Protection with a Tunnel Diode, *EEE*, 12:10, p 60 and 75.



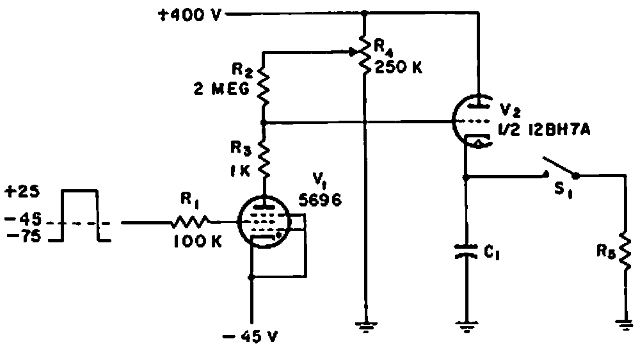
TRANSISTOR PROTECTION IN MONO—In typical transistor monostable mvbr (A), transient base-to-emitter voltage caused by discharging C often surpasses transistor rating. Two diodes alleviate trouble (B). Circuit produces width of 200 microsec.—J. S. Mikuckis, Base-Emitter Protection in Monostable Multivibrators, *EEE*, 12:9, p 63.



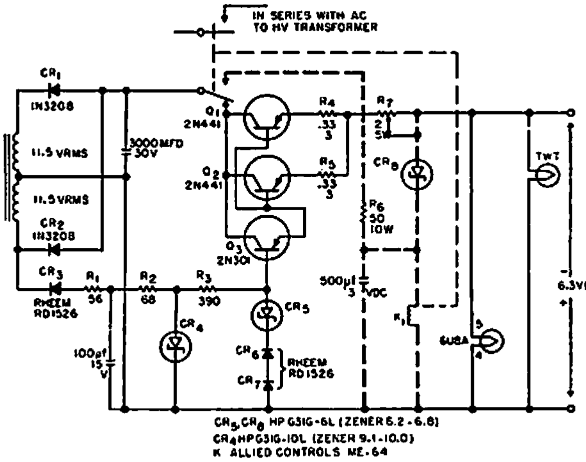
OVERVOLTAGE INDICATOR—Routes line voltage automatically to black box designed to handle it. Potentiometer is set so neon lamp TH fires at 152 v. This applies high negative voltage to grid of tube, deenergizing relays K1 and K2 so line voltage is applied to upper black box. This condition also exists when system is first connected to line. After tube is warmed up, it switches to low-voltage box if line is below 152 v. Rectifier CR is any 2,000-v low-current rectifier, such as Sarkes Tarzian 126-100-H-Q. NE68 glow lamp TH must be in lightproof box; NE2 can be used only if suitably aged.—Overvoltage Indicator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 124.



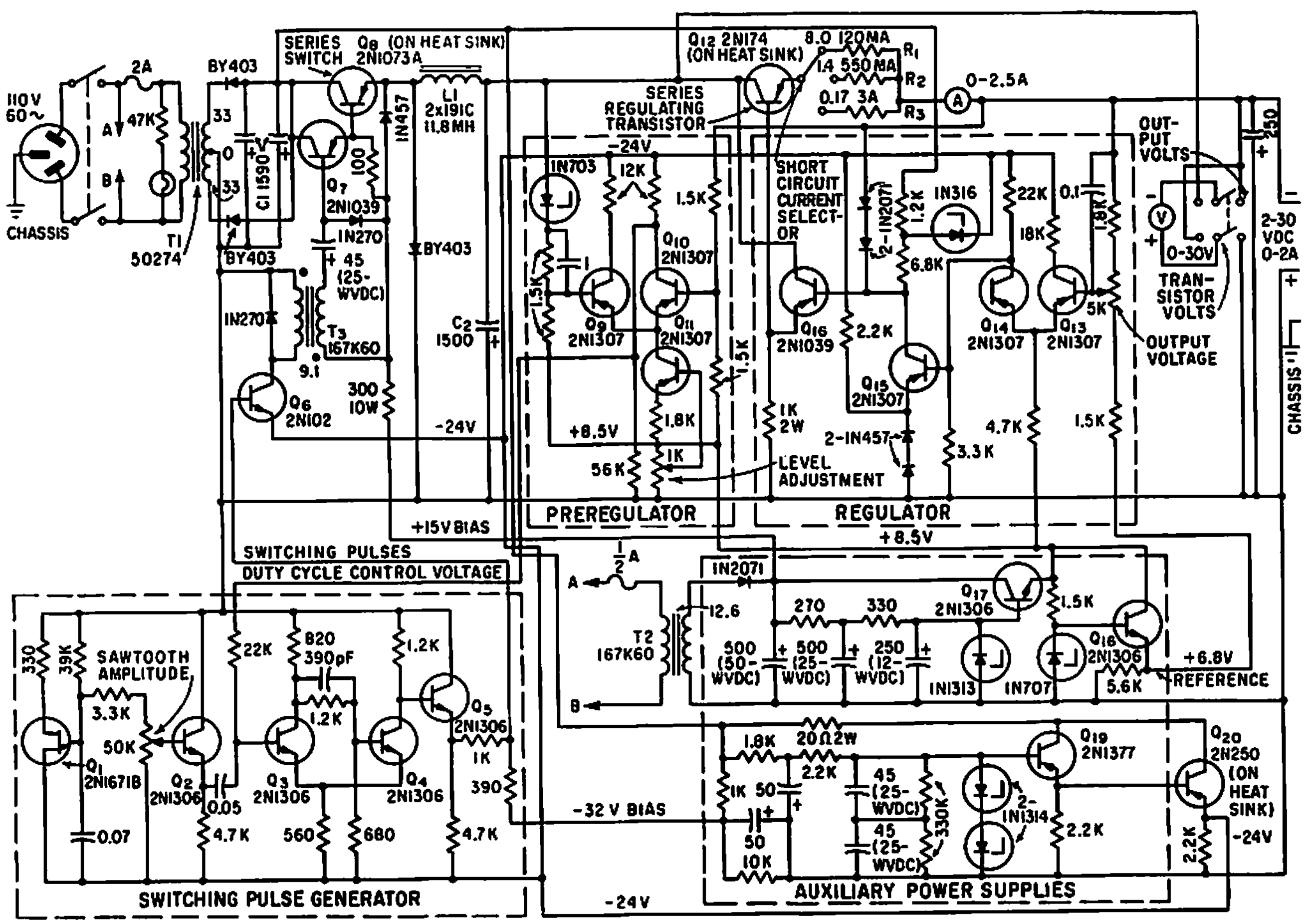
BASIC GTO FOR POWER SUPPLY OVERLOADS—Gate-turnoff scr (GTO) provides superior overload protection for d-c power supplies. Chief advantages are elimination of turn-on current surges, switching off within 30 microsec of overload, automatic load sensing, and reset, and no appreciable effect on power supply efficiency.—W. C. Mosley, GTO Protection Circuitry for DC Supplies, *EEE*, 12:11, p 57–59.



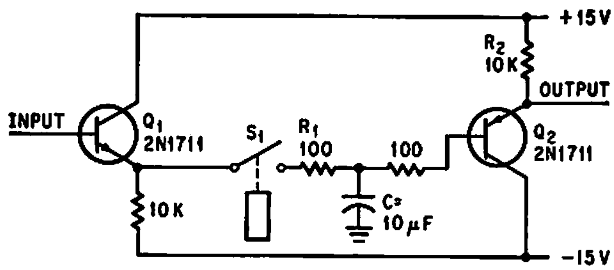
THYRATRON PROTECTION IN HIGH-VOLTAGE SWITCH—C1 is charged to some value up to 400 v, then discharged into load R5 by gas tube represented by S1. V2 acts as cathode follower to charge C1 as long as V1 does not conduct. When operation of S1 is desired, V2 is turned off by turning on V1 long enough for S1 to operate and recover, using square-wave input pulse. Circuit action prevents destruction of thyratron switch and load without sacrificing pulse rate. Tubes need separate filament transformers.—Voltage Controlled High Voltage Switch, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 233.



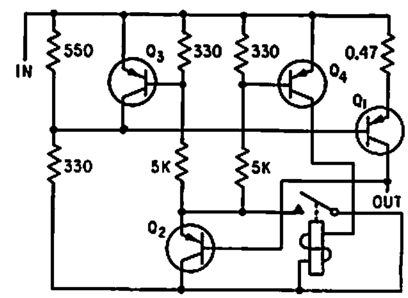
FAIL-SAFE TWT FILAMENT REGULATOR—Designed to supply well-regulated voltage of 6.3 v d-c at 2 amp to filament of travelling-wave tube, while providing temperature compensation and fail-safe capability. Protective circuit shown in heavy dotted lines operates if one of transistors shorts or if filament voltage rises for any other reason. —G. Stanley, Fail Safe DC Filament Regulator, *EEE*, 10–6, 32–33.



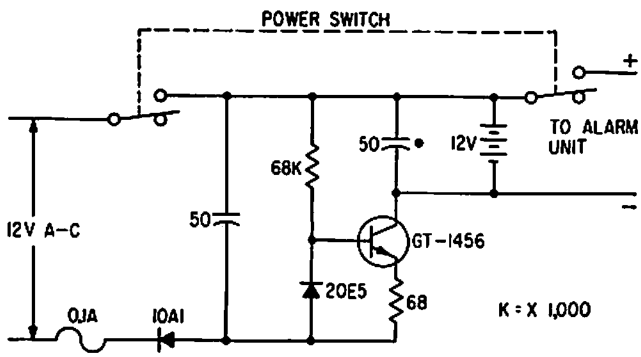
MINIMUM-DISSIPATION SERIES REGULATOR—Regulation of short-circuit-proof variable voltage-regulated supply is 0.1% for 2 to 30 v output and up to 2 amp. Dissipation in series regulating transistor is minimized by controlling on time of series switching transistor Q8. —J. S. Riordon, Power Supply Uses Switching Preregulation, *Electronics*, 35:10, p 62–64.



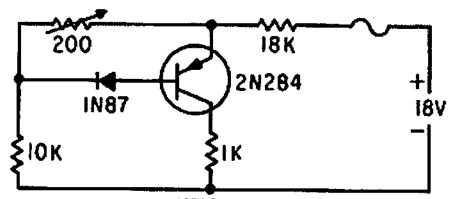
PULSED-TRANSDUCER METER PROTECTION—Circuit stores transducer output while transducer is momentarily disconnected during pulse period by relay drive circuit that operates coincidentally with transducer pulse drive. Meter voltage is stored by C during pulse period. No storage occurs when S1 is closed; meter then indicates voltage proportional to transducer current, as gain of circuit is 1.—C. Pittman and B. Birnbaum, Circuit Protects Meter from Periodic Current Spikes, *Electronics*, 39:12, p 108.



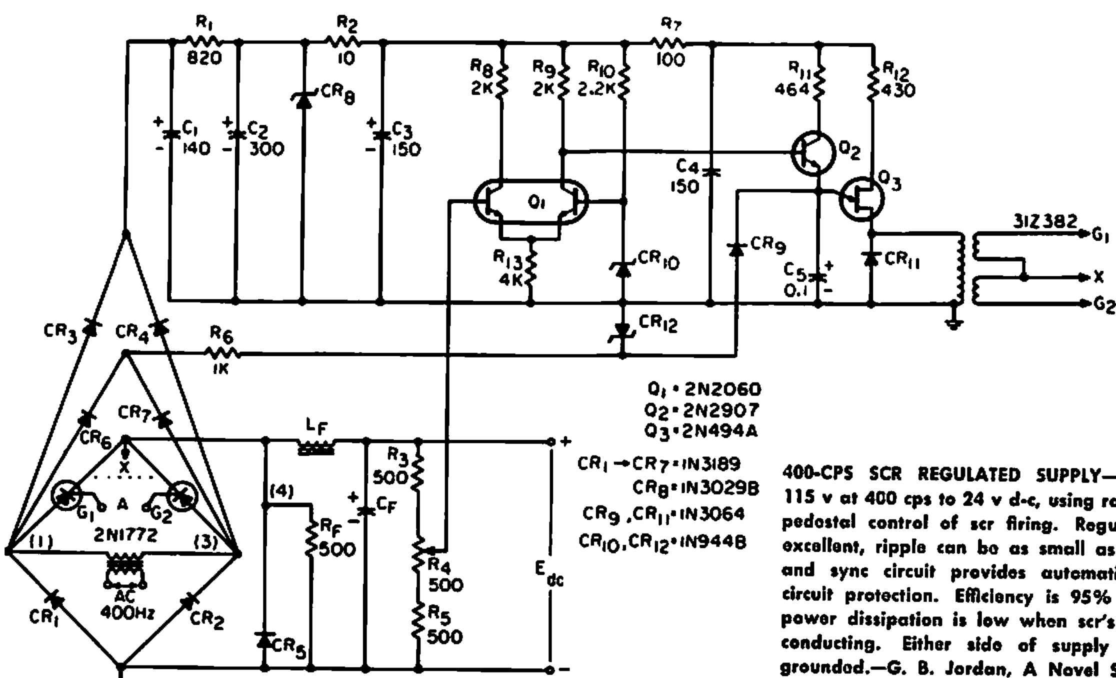
OVERLOAD PROTECTION—Switches power off rapidly to prevent current overloads from damaging transistors in breadboard circuits under test. Voltage drop across 0.47-ohm resistor and Q1 biases Q2 to saturation, causing Q3 and Q4 to open power relay.— F. W. Kear, Laboratory Supply for Transistors, *Electronics*, 35:30, p 55–57.



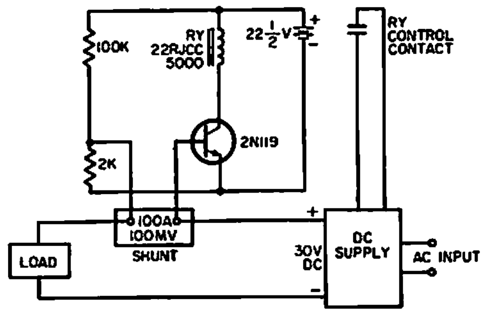
BATTERY STANDBY—Protects against false alarms caused by power failure of intruder detector.—S. M. Bagno, Sensitive Capacitance Intruder Alarm, *Electronics*, 33:38, p 65–67.



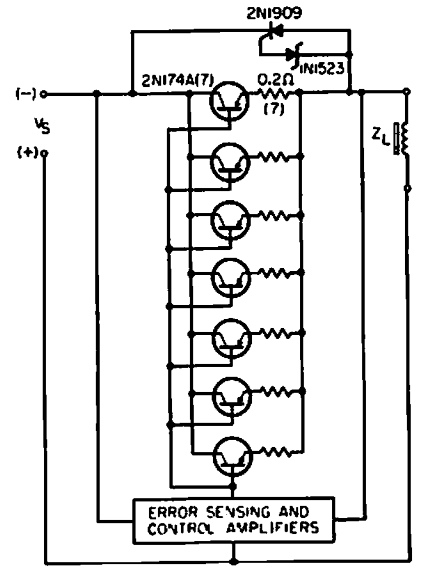
LOW-DISSIPATION TRANSISTOR OVERVOLTAGE FUSE—Series collector resistor lowers dissipation of fuse circuit during normal line voltages, and serves also as voltage regulator for transistors being protected (represented by 1K load).—K. Redmond, Low-Cost Transistor Overload Safety Circuit, *Electronics*, 33:42, p 102.



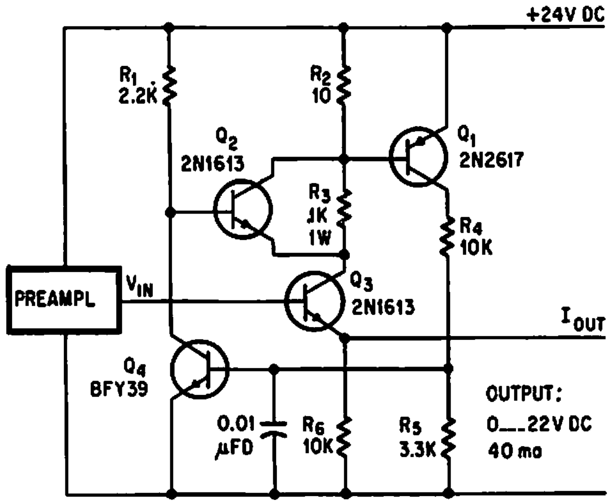
400-CPS SCR REGULATED SUPPLY—Converts 115 v at 400 cps to 24 v d-c, using ramp-and-pedestal control of scr firing. Regulation is excellent, ripple can be as small as desired, and sync circuit provides automatic short-circuit protection. Efficiency is 95% because power dissipation is low when scr's are not conducting. Either side of supply can be grounded.—G. B. Jordan, A Novel Sync Circuit for Scr Control, *EEE*, 14:7, p 58–61.



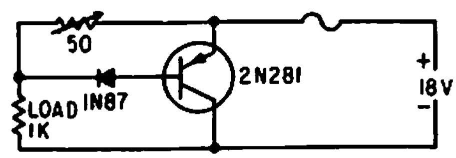
SHORT-CIRCUIT DETECTOR—Shunt used in d-c power circuit for metering also serves here to drive base of transistor that senses overloads. Relay in transistor circuit disconnects d-c power when drop across 100-mv shunt approaches 400 mv (4 times normal load current).—J. J. Pirch, Single-Transistor Short-Circuit Detector, *EEE*, 12:6, p 64.



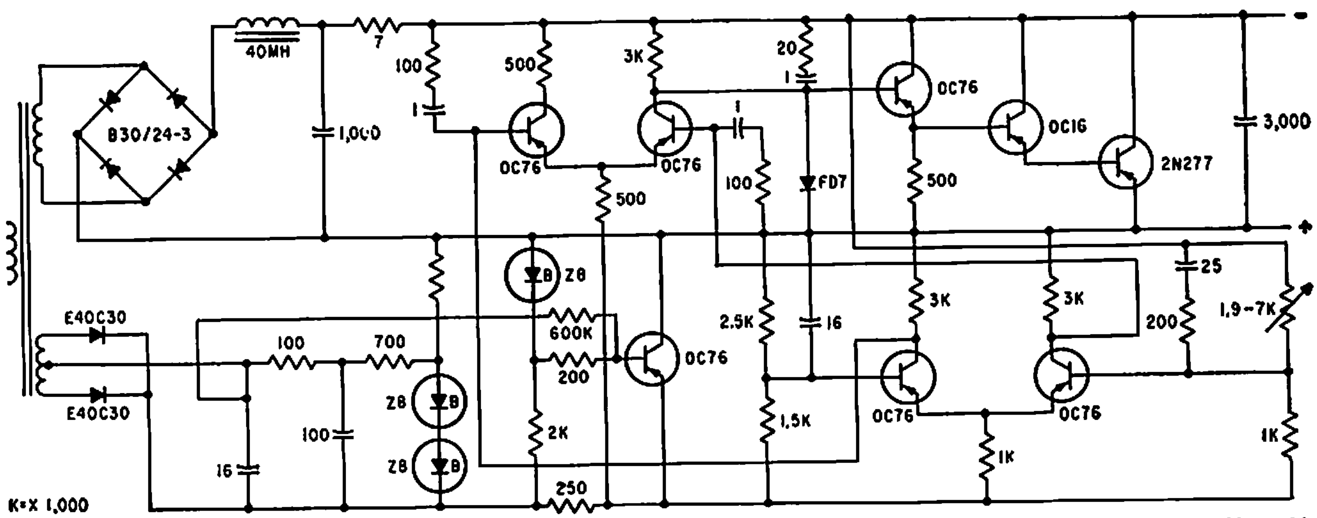
ZENER-GATED SCR PROTECTS POWER TRANSISTORS—Scr serves as controllable short-circuit across power transistors. Reaction time is about 2 microsec.—C. A. Blanchard, Zener-Gated SCR Protection for Power Transistors, *EEE*, 14:5, p 117–118.



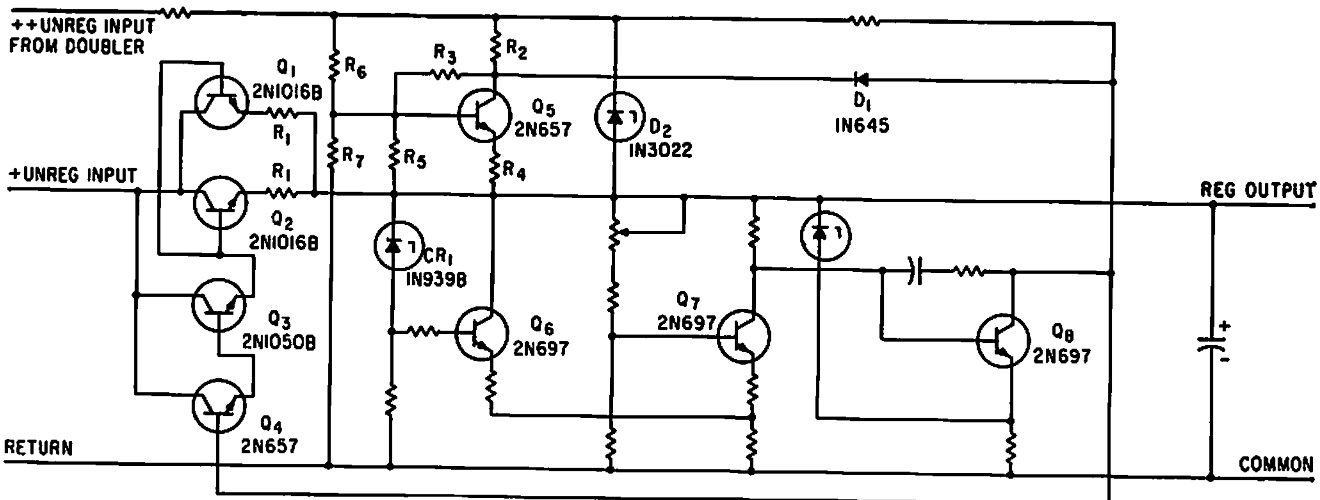
ELECTRONIC FUSE—Switches high series resistance R3 into circuit only when overload or short-circuit occurs. R3 is shunted out of load R2 by Q2.—L. Payerl, Overload Protection for D-C Amplifier, *Electronics*, 39:7, p 91.



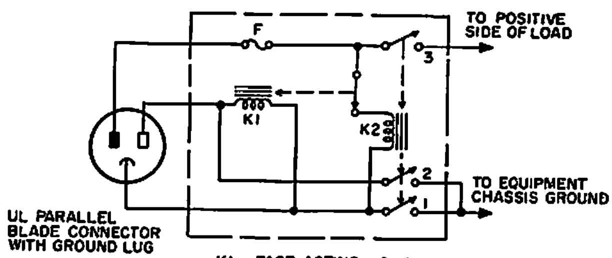
TRANSISTOR OVERVOLTAGE FUSE—Protective circuit uses one resistor, one diode, and one transistor. Transistor across supply line is cut off by 1N87 diode until overload occurs. When transistor conducts, fuse is open by current that would ordinarily destroy transistors being protected (represented here by 1K load).—K. Redmond, Low-Cost Transistor Overload Safety Circuit, *Electronics*, 33:42, p 102.



SHORT-CIRCUIT PROOF SHUNT-TYPE SUPPLY—Output is variable from 1 to 17 v, maximum ripple is 1 mv peak-to-peak, and maximum current is 2.5 amp at 1 v or 0.8 amp at 17 v. After two hours of warmup, output drift is negligible (fraction of mv).—E. Baldinger and W. Czaja, Designing Highly Stable Transistor Power Supplies, *Electronics*, 32:39, p 70–73.



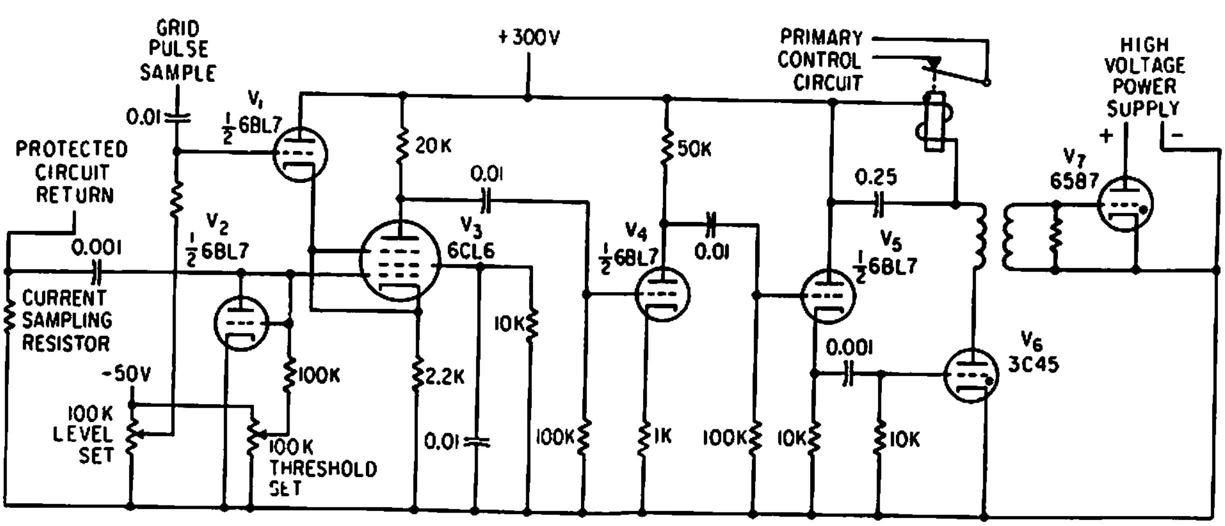
OVERLOAD PROTECTION FOR REGULATED POWER SUPPLY—When rated load current is exceeded in series-regulated power supply, D1 conducts and collector voltage of Q1 acts as clamp to prevent further increase in load current. At short-circuit, load current is only fraction of full value.—K. L. Burfeindt, Overload Protection Without High Power Dissipation, *Electronics*, 36:13, p 36–37.



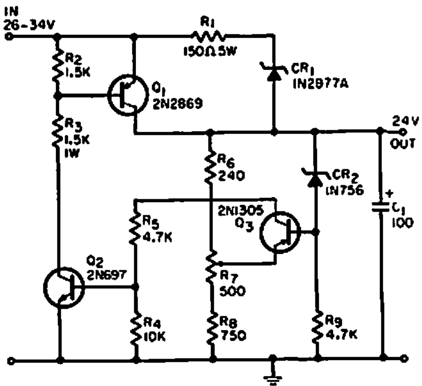
KI – FAST ACTING 115 VOLT AC RELAY

K2 – 115 VOLT AC RELAY WITH CONTACTS APPROPRIATE TO LOAD. CONTACTS AJUSTED TO CLOSE IN ORDER AND OPEN IN INVERSE ORDER OF CONTACT NUMBERS.

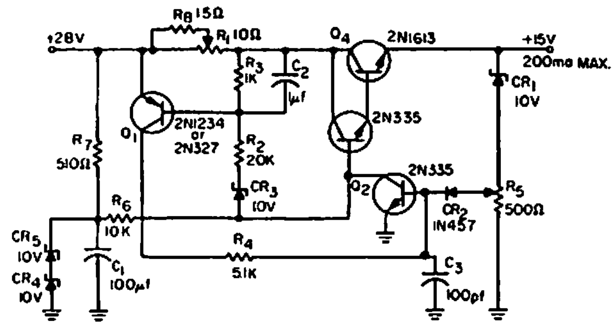
LIFESAVER—Used with transformerless line-operated equipment to minimize possibility of chassis being hot. Relays are so arranged that they automatically search for proper relationship of voltages between hot, neutral and ground terminals before power is applied to equipment. Only limitation is failure to protect against rare fault in which both neutral and conduit ground are at line potential with respect to earth ground.—R. E. Pafenberg, Lifesaver Circuit, *EEE*, 10:7, p 26–27.



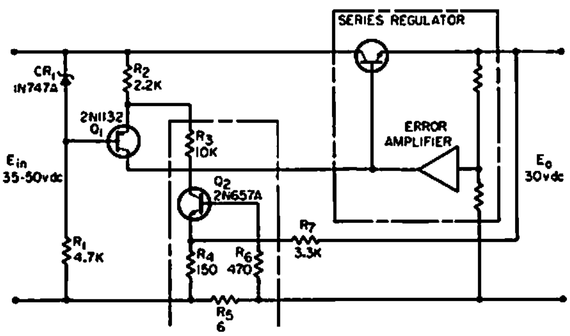
ARC-PROTECTION CIRCUIT—Circuit ignores desired peak pulse currents by sensing their coincidence with drive pulse, but fires trigger thyratron V6 and V7 in absence of drive pulse, to make thyratrons discharge power supply before breakdown and flashover of high-voltage electron device under test.—D. D. Mawhinney, Latest Thing in Arc-Protection Circuits, *Electronics*, 36:8, p 54–55.



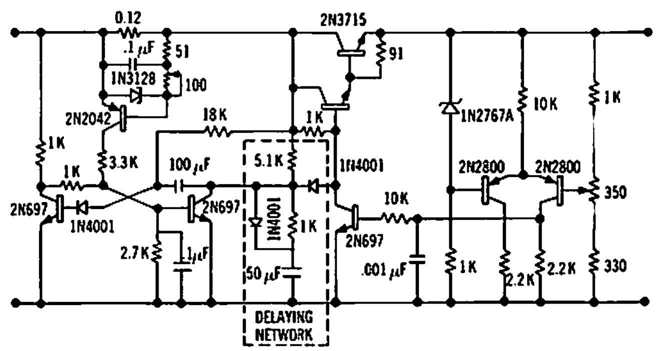
SHORT-PROOF REGULATOR—Provides constant 24 v at up to 500 ma and turns itself off when load is shorted. Restarts automatically when short is removed. Regulation is within 1% from no load to 500 ma and with input voltages from 26 to 34 v.—D. E. Wilson, Inexpensive Short-Proof Voltage Regulator, *EEE*, 12:6, p 64.



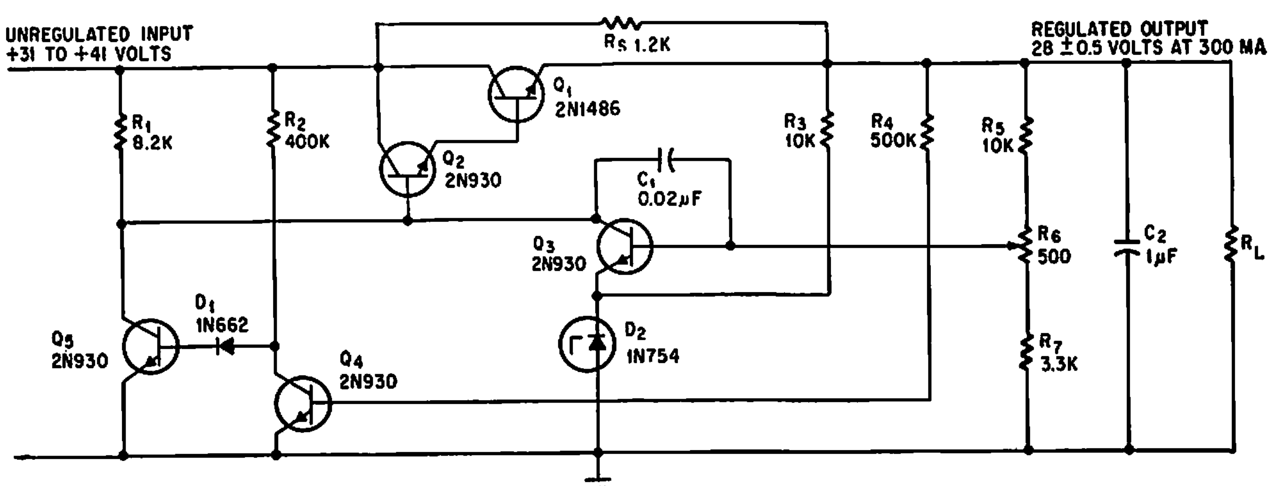
ADJUSTABLE OVERLOAD TRIP—Protection circuit, added to conventional regulator, consists of R1, R2, R3, R4, C2, CR2, CR3, and Q1. When load current reaches preset trip level, drop across R1 turns on Q1, which in turn saturates Q2 and cuts off regulator transistor Q3-Q4 to protect these transistors and reduce output voltage to zero. Turnoff is regenerative, hence fast. To reset, supply voltage is switched off and then back on.—W. A. O'Berry, Adjustable Overload Protection, *EEE*, 12:2, p 29.



REDUCED-POWER OVERLOAD PROTECTION—Circuit reduces power dissipation in series regulator transistors under overload or short-circuit conditions by making output current decrease as load resistance decreases. Values shown are for 30 v d-c supply delivering 0.25 amp, with current limiting starting at 0.31 amp.—R. A. Lewis, Reduced-Power Overload Protection, *EEE*, 12:11, p 67.

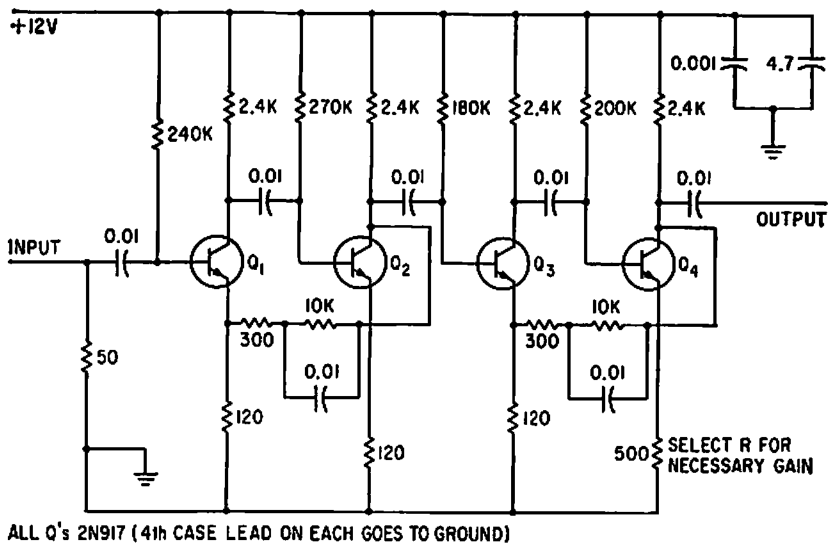


SERIES REGULATOR WITH CAPACITIVE OVERLOAD PROTECTION—R-C delaying network in dotted box applies drive slowly to series-pass transistor to prevent overload protective circuit from turning off regulator when surge current charges capacitive load. Network does not reduce response time.—J. Takesuye and H. Weber, "Silicon Power Transistors Provide New Solutions to Voltage Control Problems," Motorola Application Note AN-163, Aug. 1964.

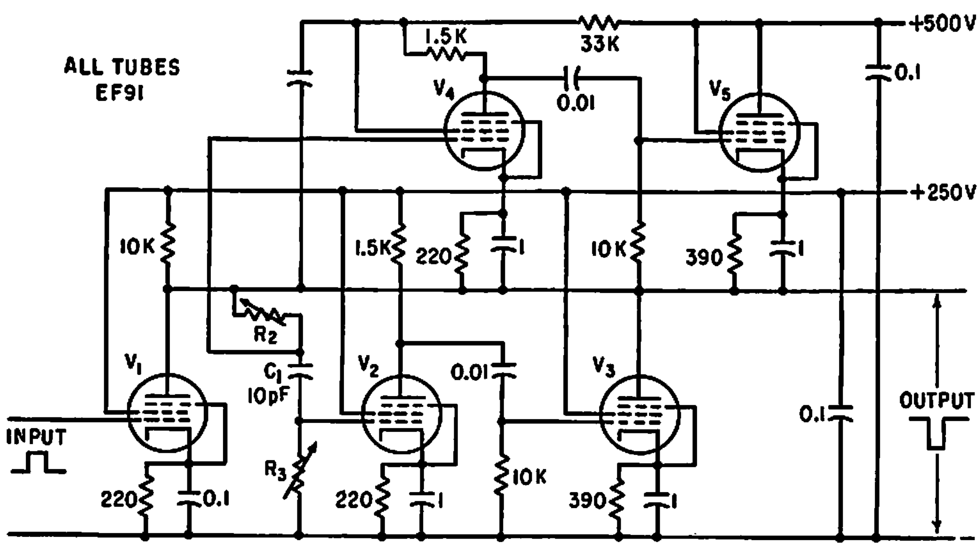


SHORT-CIRCUIT PROTECTION—Voltage-sensing short-circuit switch Q4-Q5 turns off series-regulating transistor Q1 when load R1 is short-circuited.—G. A. Chunn and G. D. Norton, Short-Circuit Protection Consumes Little Power, *Electronics*, 38:22, p 68.

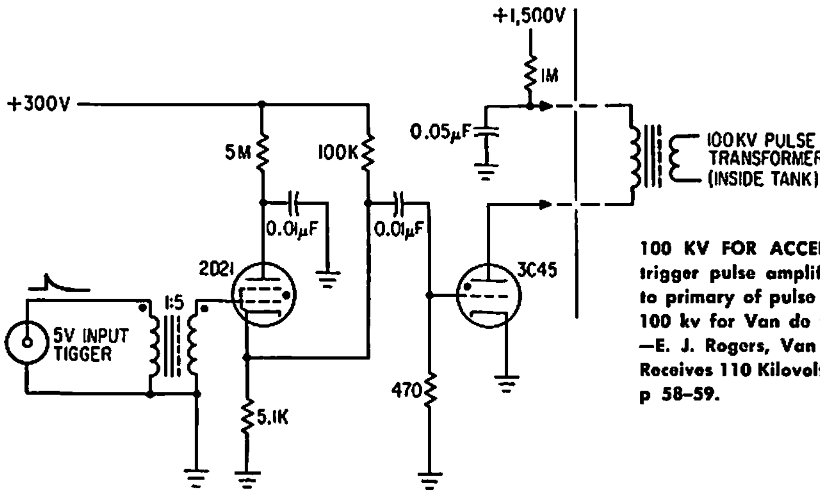
CHAPTER 63
Pulse Amplifier Circuits



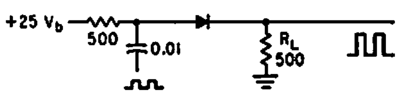
WIDEBAND DIGITAL PULSE AMPLIFIER—Common-emitter a-c coupled cascaded amplifiers, with negative feedback at every second stage, give voltage gain of 12, bandwidth of 100 Mc, rise time of 3 nsec, pulse pair resolution of 5 nsec, and s/n ratio of 100 to 1 for inputs from 0 to 200 mv.—A. A. Fleischer and E. Johnson, New Digital Conversion Method Provides Nanosecond Resolution, *Electronics*, 36:18, p 55–57.



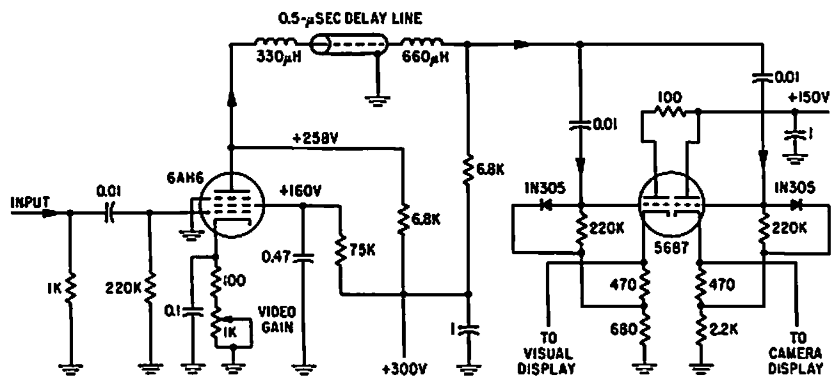
TWO AMPLIFIERS FOR BIPOLAR PULSES—Design procedure is based on fact that wide bandwidth is required only for leading and trailing edges of pulses. Auxiliary amplifier supplies current to charge load and stray capacitances, reducing standby current and improving gain. Auxiliary amplifier V4-V5 provides charging current for shunt capacitance during positive-going edge of output pulse.—J. F. Golding, Novel Approach to Pulse Amplifier Design, *Electronics*, 33:19, p 64–66.



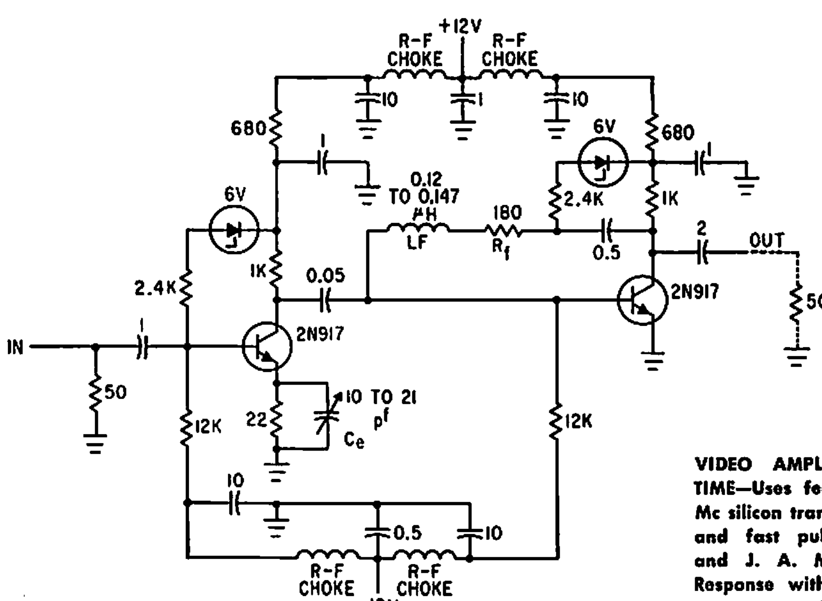
100 KV FOR ACCELERATOR—Two thyratrons trigger pulse amplifier to send 1,500-v pulse to primary of pulse transformer for stepup to 100 kv for Van de Graaff accelerator source.—E. J. Rogers, Van de Graaff Proton Source Receives 110 Kilovolt Boosts, *Electronics*, 35:13, p 58–59.



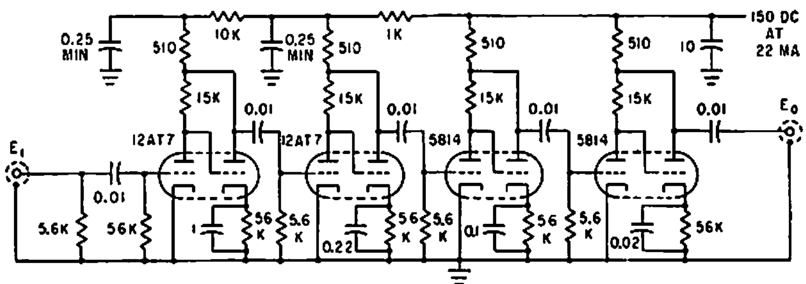
NEGATIVE-RESISTANCE DIODE—Input pulses as low as 0.01 ma are sufficient to hold negative-resistance diode in high-current region. When pulse is shut off, diode current decays to low-current state. Amplifier tends to square up input pulses.—A. P. Schmid, Jr., Negative-Resistance Diode Handles High Power, *Electronics*, 34:34, p 44–46.



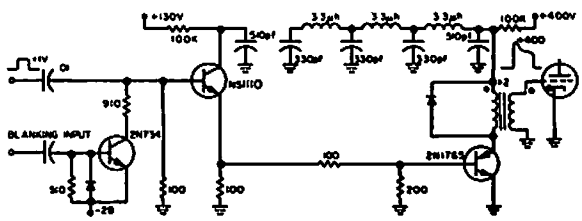
LINEAR PULSE AMPLIFIER—Simple linear amplifier drives two cathode followers through delay line. One output goes to one crt grid for intensity modulation. Other output goes to horizontal plates of another crt for bar presentation.—M. T. Nadir, Microsecond Sampler Handles 126 Channels, *Electronics*, 32:4, p 36–39.



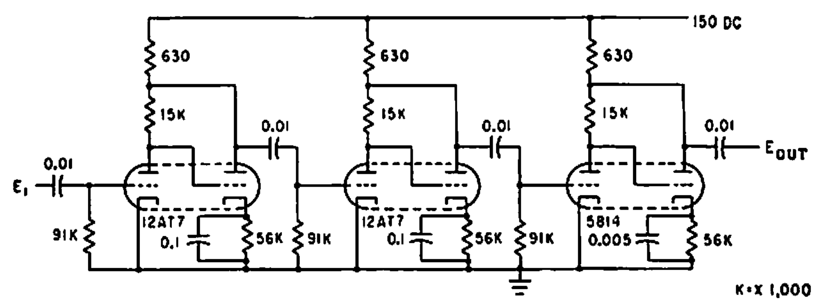
VIDEO AMPLIFIER WITH TWO-NSEC RISE TIME—Uses feedback techniques with 1,000-Mc silicon transistors to give wide bandwidth and fast pulse response.—P. J. Beneteau and J. A. MacIntosh, Getting Fast Pulse Response with Video Amplifiers, *Electronics*, 34:41, p 62–63.



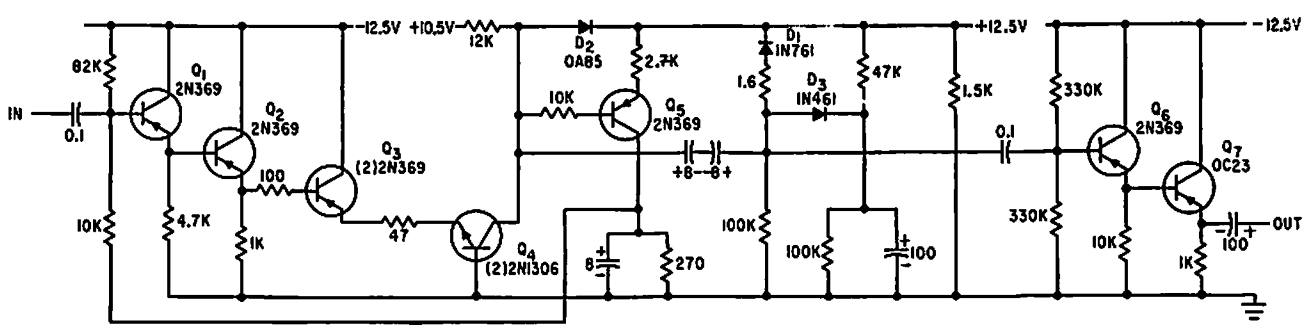
FOUR-STAGE NEGATIVE-PULSE AMPLIFIER—Gives gain of 87 db with over-all bandwidth of 0.9 Mc, using direct-coupled inverse-feedback pairs, for amplifying closely spaced pulse code groups coming from crystal detector of radar video receiver.—R. E. Koncen, Wide-Range Multiple-Pulse Amplifier, *Electronics*, 33:38, p 78–81.



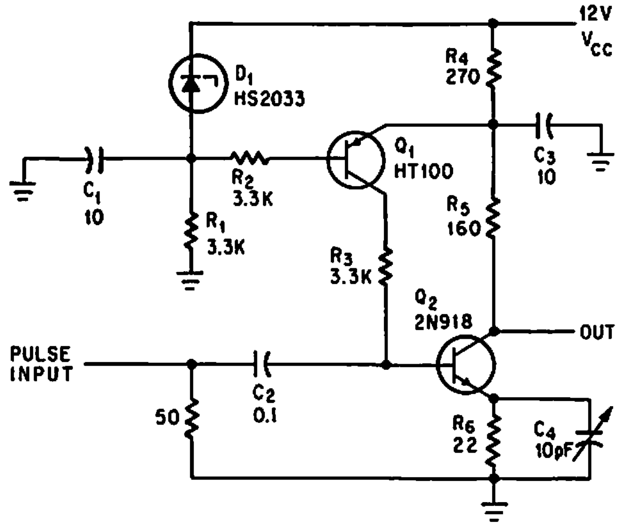
THYRATRON DRIVER—Input of 1 v makes solid-state circuit drive thyratron grid to 400 v within 60 nsec. Thyratron itself is fully on, and handling 100 amp at 6,000 v, in less than 100 nsec after input pulse. —W. D. Isreal and W. B. McCartney, Nanosecond Thyratron Driver, *EEE*, 11:12, p 66.



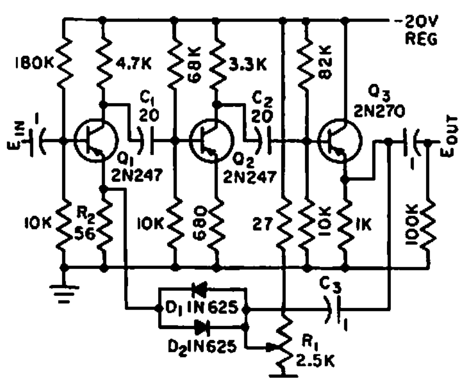
THREE-STAGE NEGATIVE-PULSE AMPLIFIER—Handles closely spaced negative pulses in radar beacon and similar applications, without distortion and recovery problems. Each amplifier stage is inverse-feedback pair of triodes with 360° total phase shift.—R. E. Koncen, Wide-Range Multiple-Pulse Amplifier, *Electronics*, 33:38, p 78–81.



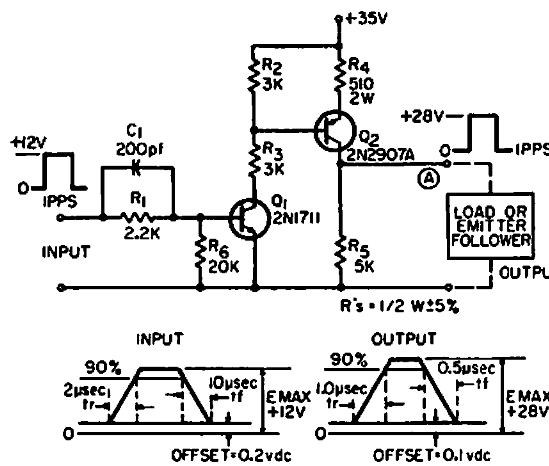
LOGARITHMIC PULSE AMPLIFIER—Selected zener diodes with breakdown voltages in range of 4 to 6 v, with 1.6 ohm-resistor in series with D1 for straightening curve, give close approximation to logarithmic amplification of pulses over three decades of current, from 0.1 to 100 ma.—D. Ophir and U. Galil, Zener Diode creates Logarithmic Pulse Amplifier, *Electronics*, 34:28, p 68–70.



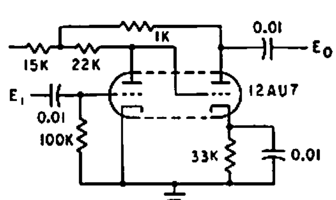
FAST RISE TIME—Achieved by precise bias control of Q2 without introducing parasitics in input signal line. Gives high gain-bandwidth product as pulse amplifier.—D. D. McLeod, Bias Control and Low Parasitics Shorten Amplifier Rise Time, *Electronics*, 39:2, p 73–74.



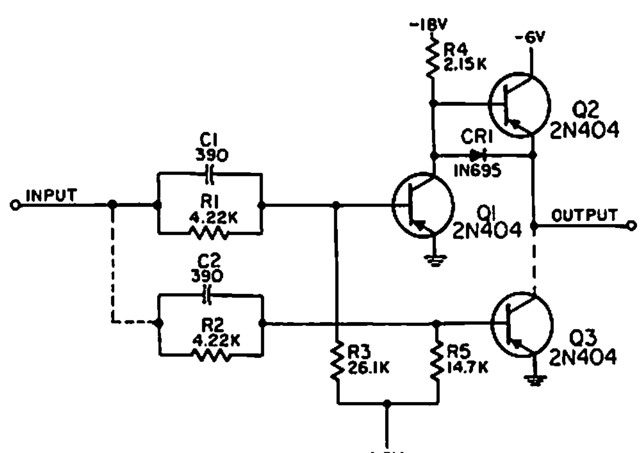
FAST-ACTING NONLINEAR FEEDBACK—Keeps output variation within 8 db for input level variation of 38 db. Amplifies 100-kc square waves and limits output amplitude without introducing phase distortion. Amplification is determined by input level. For signals below 5 mv peak, 38 db of gain is provided, automatically diminishing for higher-level input signals. With 400-mv peak input, gain is slightly over unity.—L. H. Dulberger, Pulse Amplifier with Nonlinear Feedback, *Electronics*, 31:45, p 86–87.



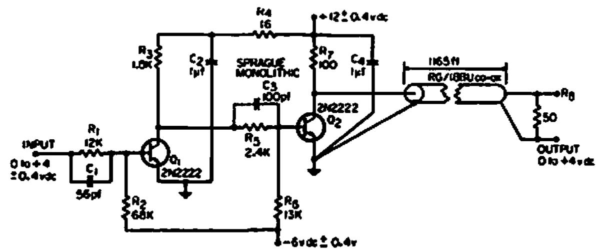
NONINVERTING AMPLIFIER—Increases amplitude of 1-pps pulses and decreases rise and fall times. For adjustable output amplitude, R5 can be potentiometer.—R. L. Sazpansky, Non-Inverting Pulse Amplifier Uses One Power Supply, *EEE*, 14:1, p 63.



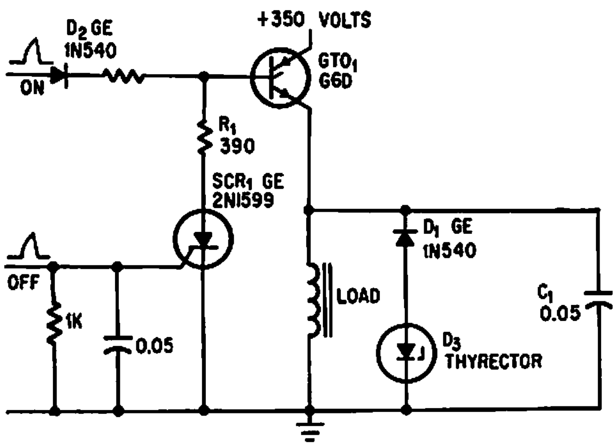
CRYSTAL VIDEO RECEIVER AMPLIFIER—Modified direct-coupled inverse-feedback pair of triodes handles negative pulse groups only if not too closely spaced. May be used in command guidance, radar beacon, and pulse communication applications.—R. E. Koncen, Wide-Range Multiple-Pulse Amplifier, *Electronics*, 33:38, p 78–81.



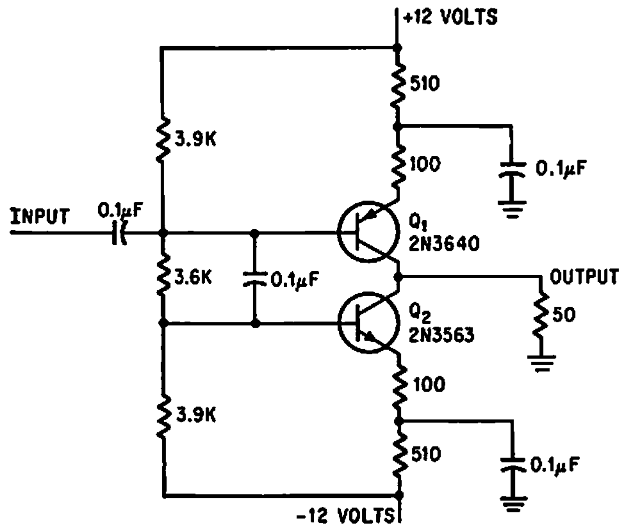
PULSE POWER AMPLIFIER—Operates as inverting power amplifier for either pulses or levels. Input levels are −6.2 v at 3.1 ma for logical 1 and −0.15 v for logical 0. Pulse polarity may be positive or negative 6 v. Third transistor is used for handling up to 40 flip-flop or gate loads. Two transistors will handle up to 12 such loads.—NBC, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 12 (originally PC 215), p 12-2.



COAXIAL CABLE DRIVER—Can drive digital information through long lengths of coaxial cable. Will send pulses with 30-nsec rise and fall time through 1,155 feet of 50-ohm RG/188U or through 650 feet of 93-ohm RG/62U.—B. Strunk, Coaxial Cable Driver Circuit, *EEE*, 13:5, p 43–44.

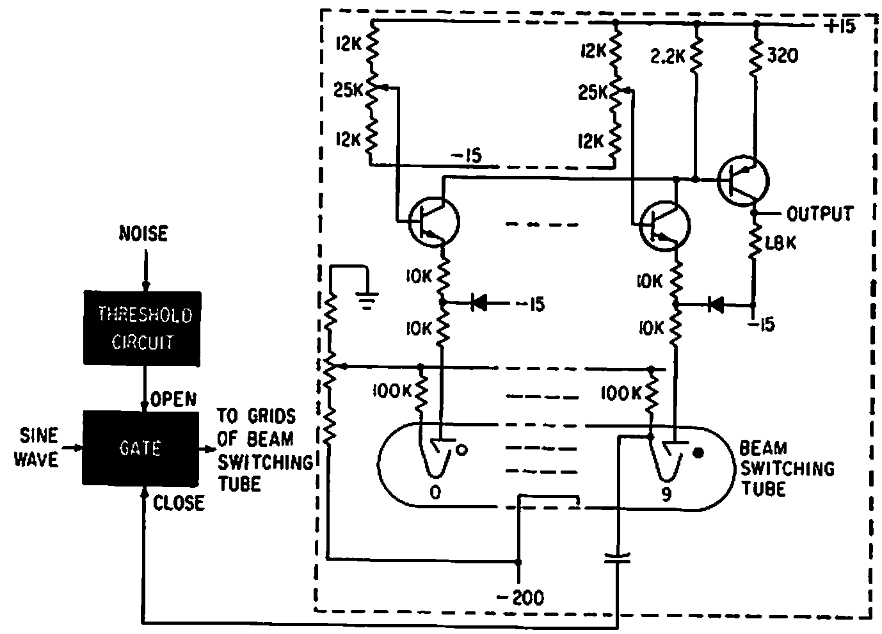


HAMMER-DRIVER FOR COMPUTER LINE PRINTER—Gate turnoff scr overdrives load solenoid momentarily by connecting it across 350-v bus and disconnecting before overheating occurs. Load current rise and fall times are less than one millisec.—D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, *37:12*, p 64–71.

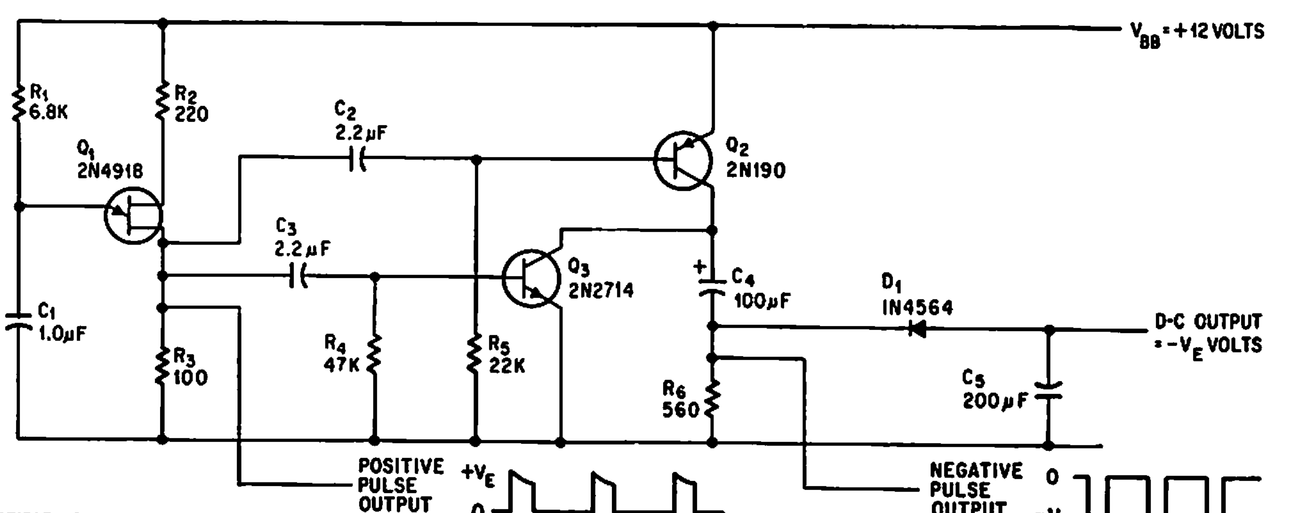


CURRENT DRIVER—Provides fast rise time and equal-amplitude positive and negative output pulses (equal-polarity drive) for 50-ohm load. —E. J. Kennedy, Fast-Pulse Amplifier Drives 50-Ohm Load, *Electronics*, 39:2, p 76.

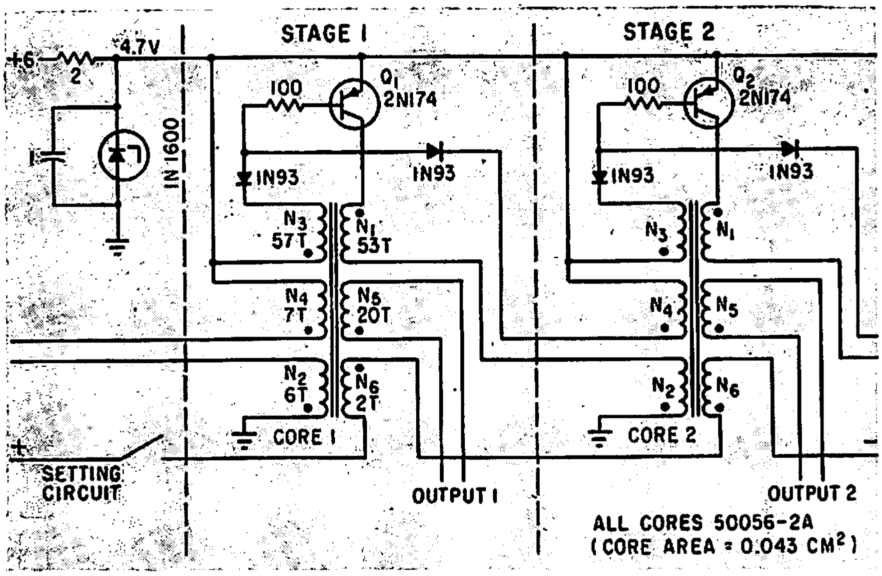
CHAPTER 64
Pulse Generator Circuits



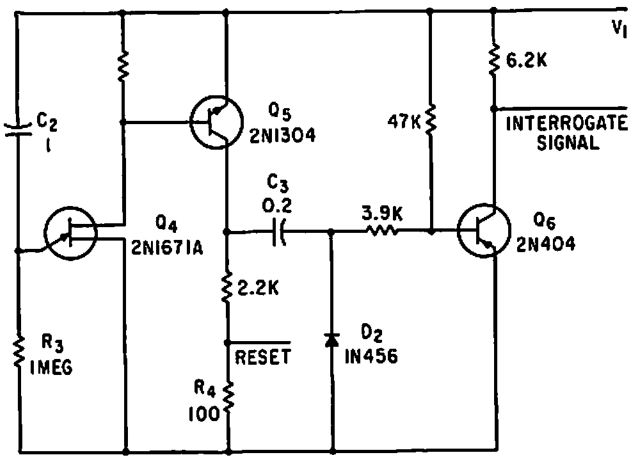
RANDOM-TIME PULSES—When gate is opened by noise, sine wave steps electron beam of Burroughs tube through its ten sections. Transistor connected to each target produces voltage pulse whose magnitude depends on potentiometer setting, giving sequence of different voltages in output. When beam reaches position 9, pulse is fed back to close the gate.—C. V. Jakowatz and G. M. White, Self-Adaptive Filter Finds Unknown Signal in Noise, *Electronics*, 34:7, p 117–119.



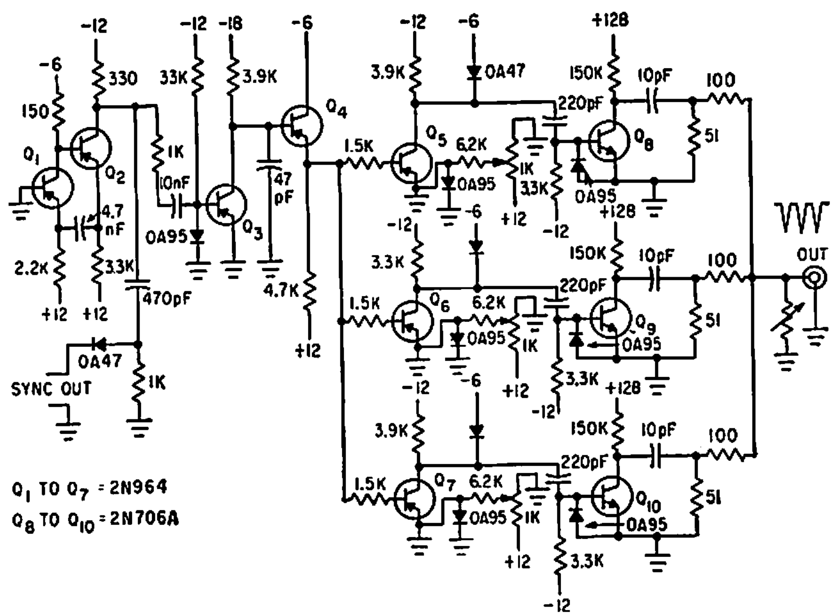
MULTIPLE OUTPUTS—Circuit provides negative d-c output voltage along with positive and negative output pulses, using only single d-c source. Unijunction-transistor oscillator Q1 provides positive pulses, while Q2 and Q3 together invert these and drive rectifier D1 that gives −5 v at 1 ma to drive low-power amplifier that may be used in same integrated circuit.—M. H. Hussain, Circuit Inverts D-C Voltage, *Electronics*, 38:19, p 100.



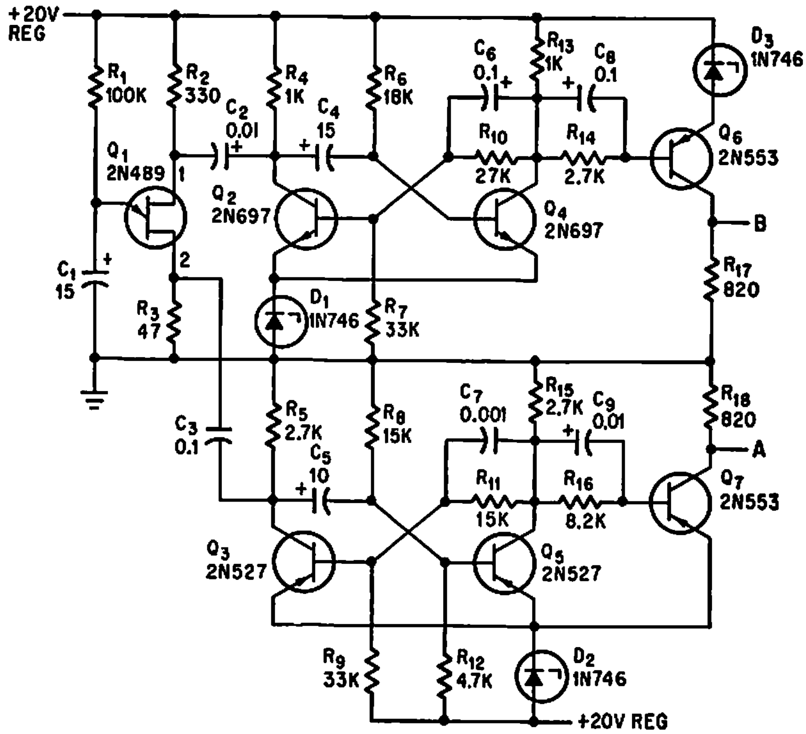
RING-TYPE OSCILLATOR—After core-setting current is removed, pulse output of Q1 is followed by output of Q2 after delay of 100 microsec to 3 sec, depending primarily on input voltage and core size. No separate drive oscillator is required when used as ring counter.—J. M. Marzolf, Magnetic-Core Ring Counter Needs No Drive, *Electronics*, 35:12, p 52–53.



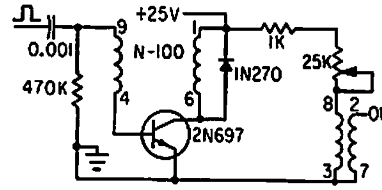
TWO-OUTPUT SQUARE-WAVE PULSE GENERATOR—Pairs of control pulses are provided in sequence by silicon unijunction transistor in relaxation oscillator. Interval between pulses is determined by R3-C2. When C2 charges enough to trigger Q4, pulse fed to base of Q5 makes it conduct heavily; C3 charges and reset pulse is then developed across R4. Next, Q5 switches off, thereby feeding negative pulse to base of Q6 to switch Q6 off and make its collector voltage rise rapidly to form negative second pulse of pair.—C. D. Todd, Tunnel Diode Detects Currents Down to 100 Femtoamperes, *Electronics*, 36:14, p 33–37.



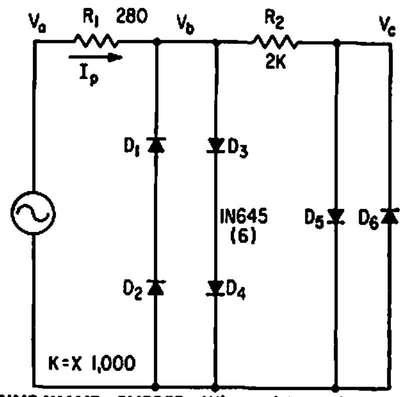
THREE-PULSE GROUPS TEST 10-NSEC DECADE COUNTERS—Free-running mvbr Q1-Q2 triggers sawtooth generator Q3, which in turn acts through emitter-follower Q4 to drive delay-adjusting amplifiers Q5, Q6 and Q7, each driving silicon transistor working in avalanche mode. Common output is group of three 10-v pulses having rise times below 1 nsec.—R. Charbonnier, Avalanche Transistors Test 10-Nsec Logic, *Electronics*, 36:28, p 46.



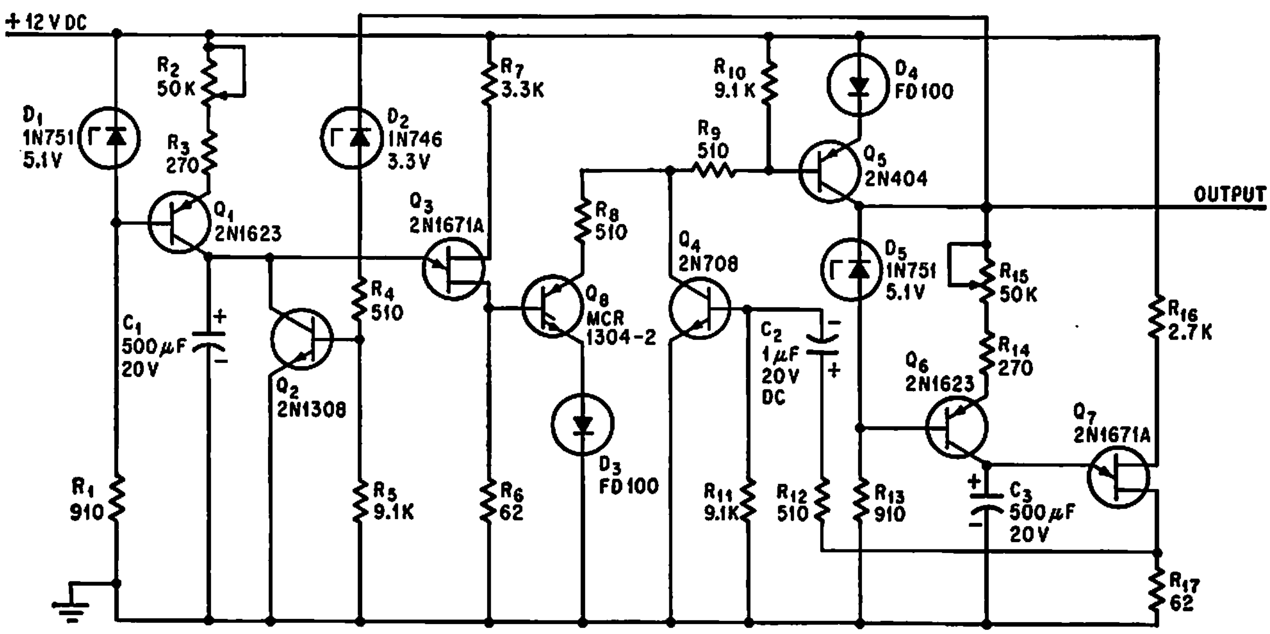
RECTANGULAR PULSES GENERATED IN PAIRS—Output A gives 50-millisec positive pulses and output B gives 120-millisec positive pulses, both square-wave and both at 0.5 cps, with rise and fall times under 2 microsec for 12-v pulses. Circuit uses one unijunction transistor, two npn transistors, and four pnp transistors.—R. W. Maine, Generating Two Rectangular Waves, *Electronics*, 37:18, p 82–83.



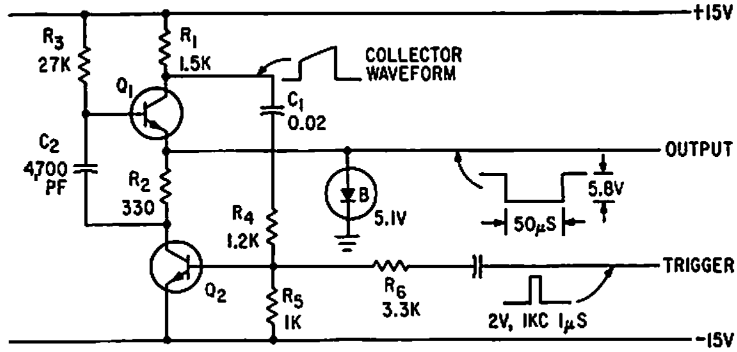
VARIABLE-WIDTH PULSE GENERATOR—Rheostat in series with pulse transformer primary winding controls bias current to adjust output pulse width over range of 0.06 to 5 microsec. Rise time is less than 40 nsec.—Blocking Oscillator Has Variable Width Output, *Electronics*, 36:11, p 156.



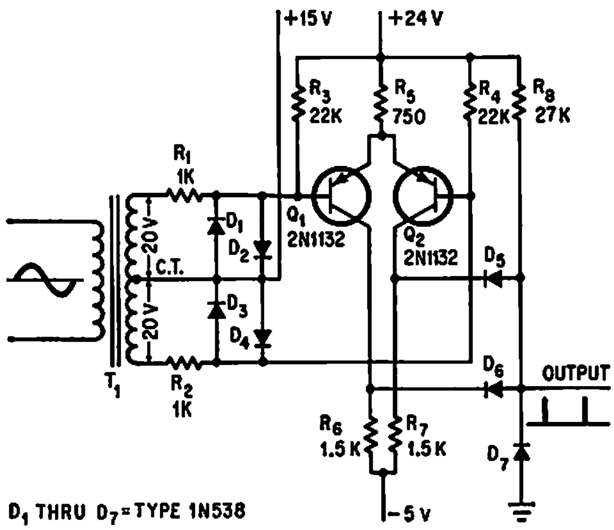
SINE-WAVE CLIPPER—When driven by sine waves, circuit gives high-quality square waves over wide frequency range. Output voltage is essentially constant at 1.5 v peak-to-peak if input voltage is high enough to saturate silicon diodes.—W. E. Nemeth, Two-State Sine-Wave Clipper, *Electronics*, 34:11, p 64.



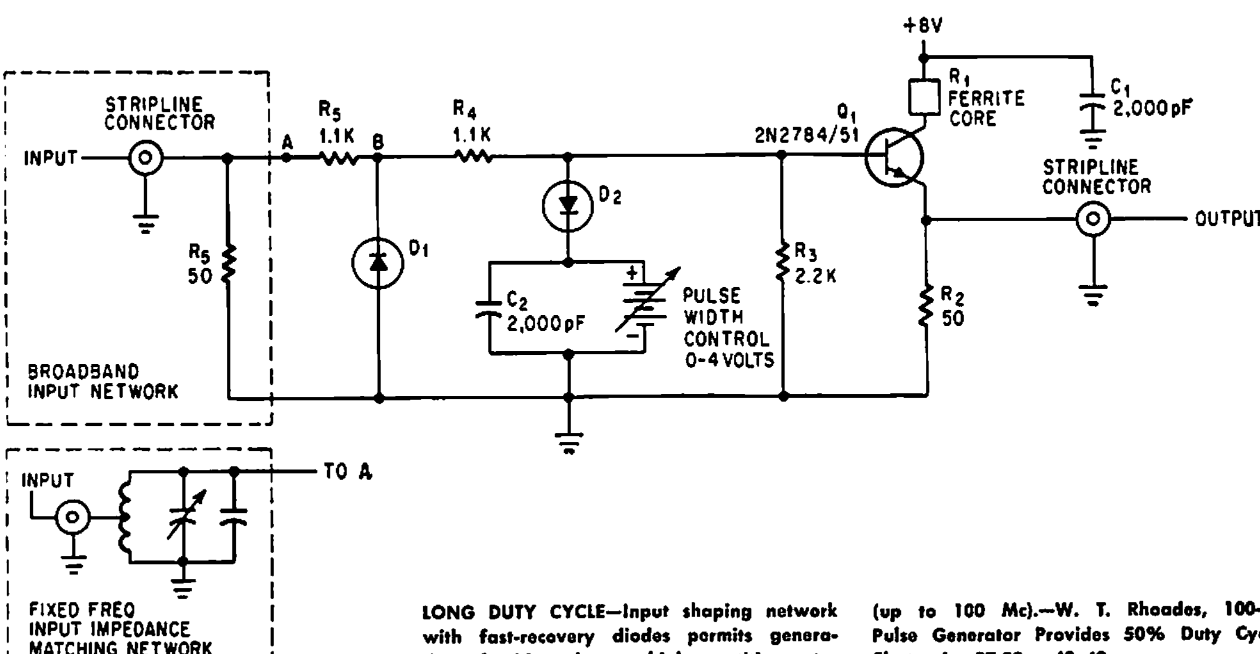
ADJUSTABLE DUTY CYCLE—R2 varies off time from 0.25 to 40 sec, while R15 provides variation of over 100 to 1 in ratio of on time to off time. Pulse width and interpulse time can thus be adjusted independently.—A. A. Dargis, On and Off Time Adjusted Independently, *Electronics*, 37:31, p 50–51.



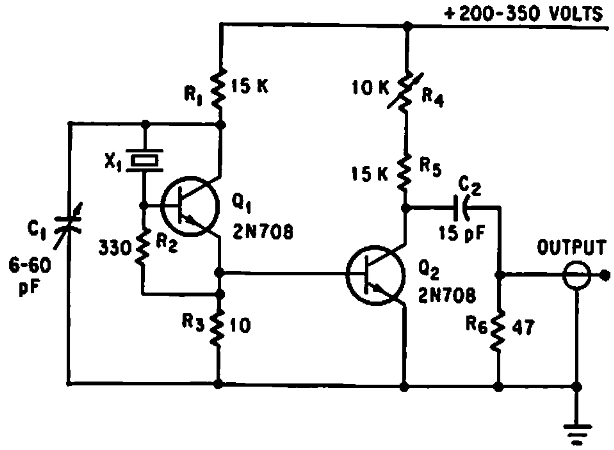
MONOSTABLE WITH ZENER CLAMP—Produces pulses of known length and amplitude when triggered by external pulse.—C. M. Stewart, Monostable Pulse Generator Employs Zener-Diode Clamp, *Electronics*, 34:19, p 76–77.



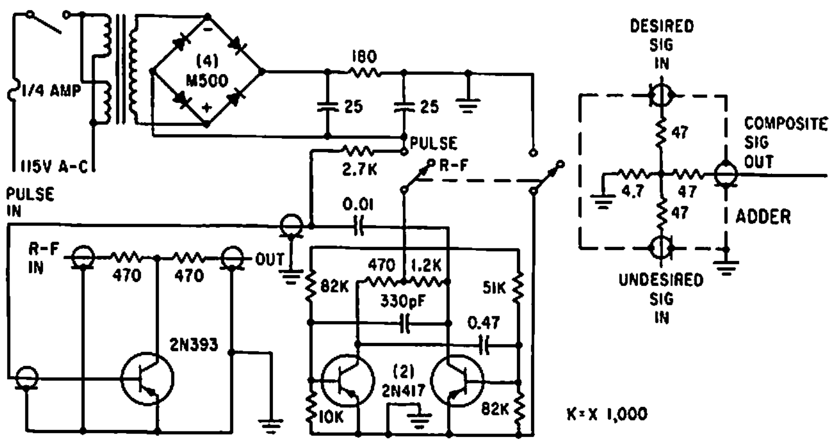
ZERO-CROSSING PULSES—Sharp pulse is produced at each zero crossing, for phase control of scr power supply. When instantaneous line voltage is zero, differential amplifier Q1-Q2 is balanced and collectors swing to +2.5 v, causing gate to produce 2-v, 20-microsec output pulse.—S. Prigozy, Zero-Crossing Detector Provides Fast Sync Pulses, *Electronics*, 38:8 p 91.



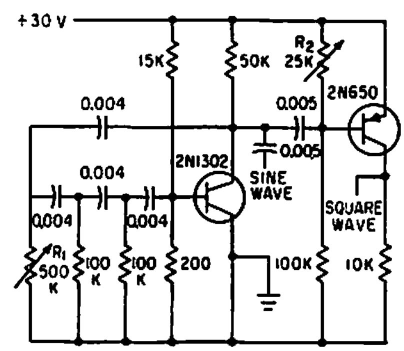
LONG DUTY CYCLE—Input shaping network with fast-recovery diodes permits generation of wide pulses at high repetition rates (up to 100 Mc).—W. T. Rhoades, 100-Mc Pulse Generator Provides 50% Duty Cycle, *Electronics*, 37:32, p 42–43.



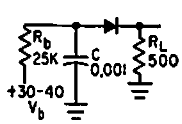
CRYSTAL-CONTROLLED PRR—Avalanche pulse generator used with 10-Mc AT-cut crystal supplies nanosecond pulses with high stability and high repetition rate, for phase-locking microwave oscillators and for generating vhf and uhf local oscillator signals.—J. N. Bridgeman, Crystal Accurately Controls Avalanche Pulse Generator, *Electronics*, 38:23, p 112–113.



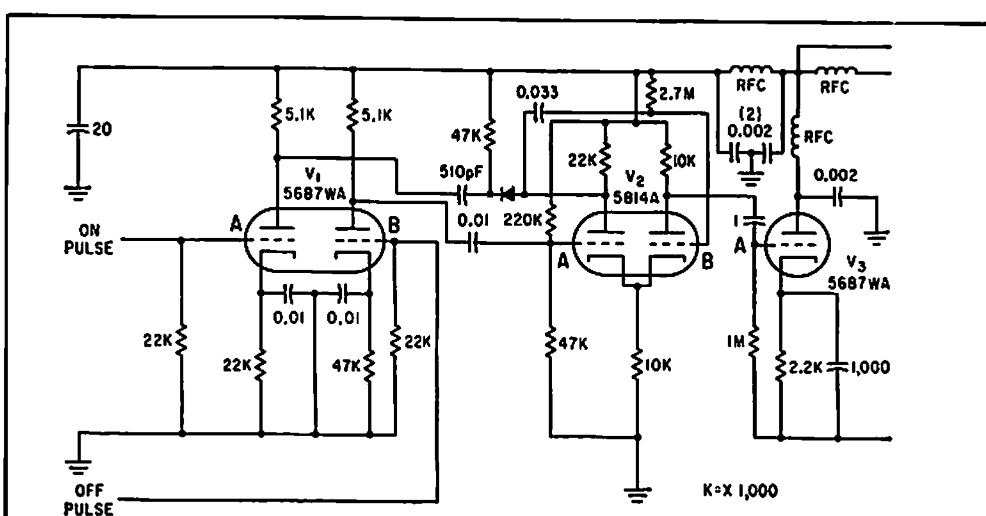
IMPULSE GENERATOR—Transistor electronic switch driven by mvbr provides 10-microsec pulses at 1,500 pps for modulating receiver close to 100% with pulsed interference.—B. T. Newman, Evaluating Radio Receiver Susceptibility to Interference, *Electronics*, 34:15, p 70–74.



SINE-SQUARE-WAVE PHASE-SHIFT OSCILLATOR—R1 controls oscillator frequency and R2 controls width of square wave having same frequency as sine-wave output.—F. W. Kear, Designing Transistor Phase-Shift Oscillators, *Electronics*, 35:11, p 72–74.

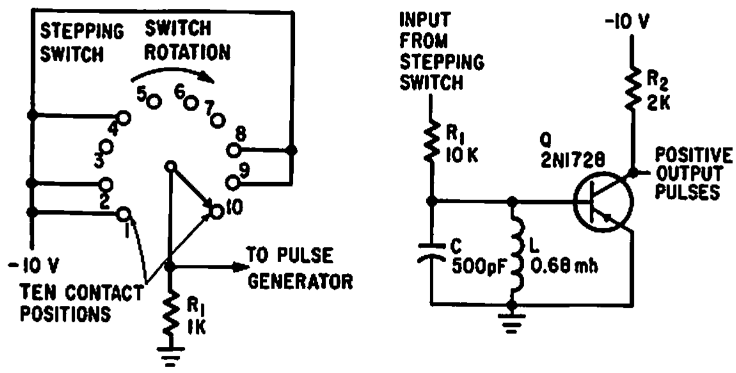


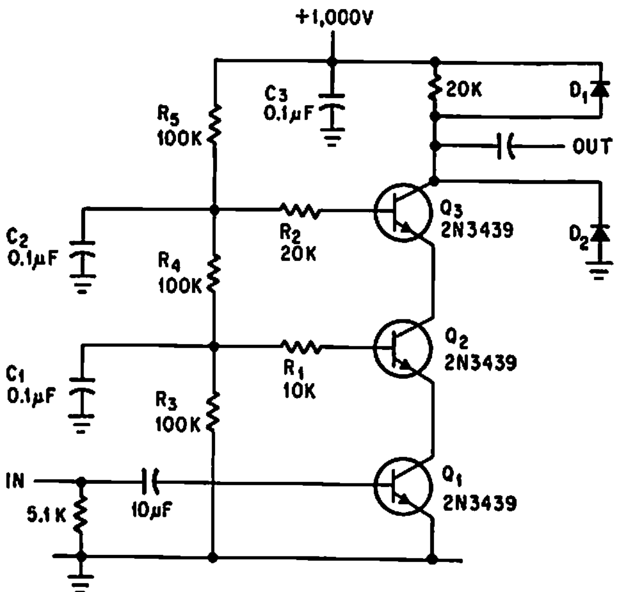
NEGATIVE-RESISTANCE DIODE—C discharges through negative-resistance diode and load after being charged by source, at rate determined by exponential function rather than by RC time constant.—A. P. Schmid, Jr., Negative-Resistance Diode Handles High Power, *Electronics*, 34:34, p 44–46.

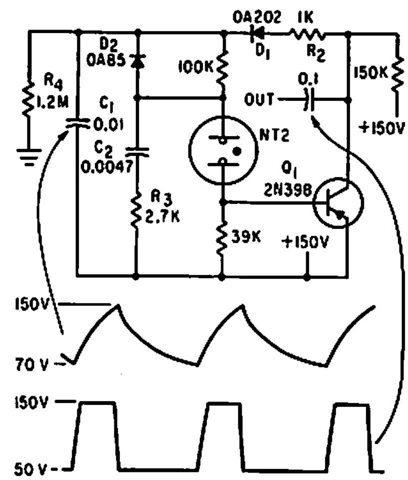


PULSE FORMER WITH GATED R-F OUTPUT—Used to drive power stage that delivers megawatt pulses in range from 16 to 24 Mc, under control from electronic timer of

STEPPING-SWITCH POSITION INDICATOR—Transistor Q generates positive output pulse when input pulse is applied or removed. To obtain such positive pulses when stepping switch of automatic test set reaches positions 1, 3, 4, 5, 8, and 10, contacts are connected to −10 v. Transfer for contact 1 to 2 then gives no output pulse, but moving from 2 to 3 removes input pulse and thus gives desired output pulse. Operation depends on underdamped oscillation in unloaded R-L-C circuit, with only one negative oscillation because saturated transistor shunts tuned network.—R. J. Bouchard, Positive-Pulse Generator, *Electronics*, 37:21, p 74–75.

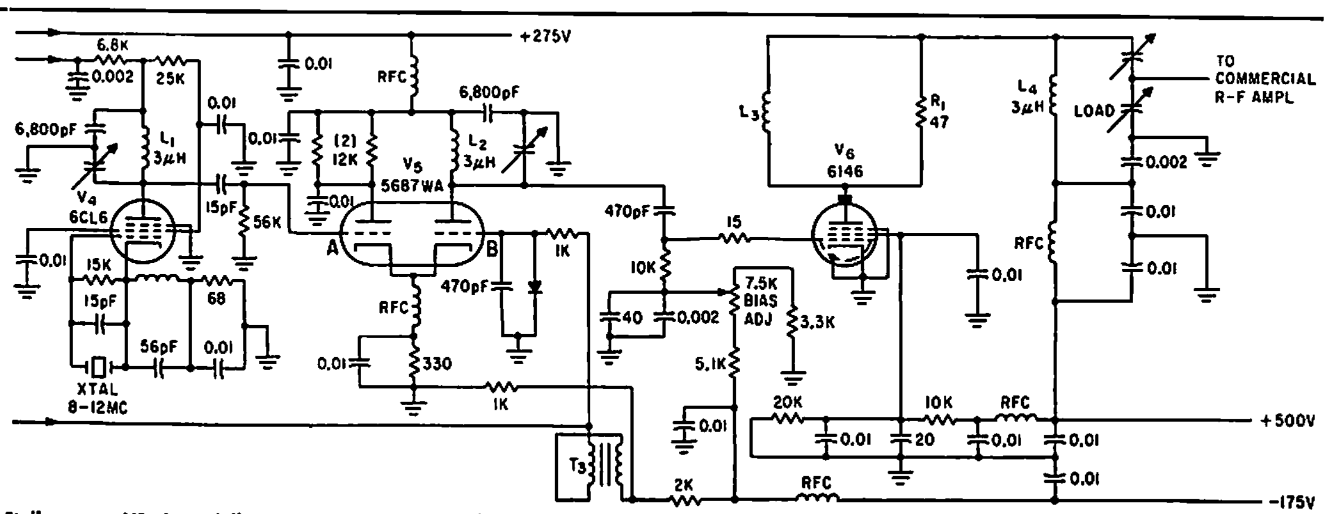




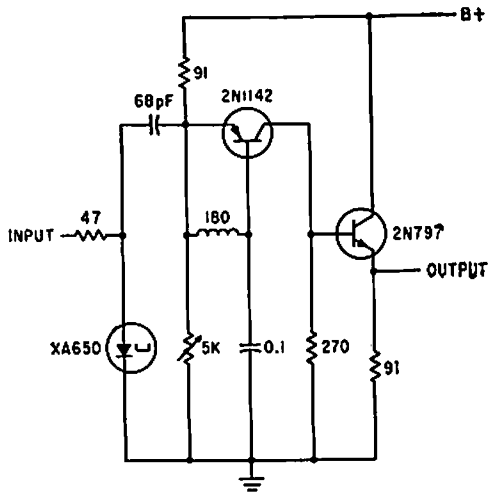


1,000-V PULSES—Positive 3-v input pulse switches Q1, Q2, and Q3 on in sequence, to produce 1,000-v pulse with short rise time for driving 20-kv pulse tube. High-voltage rectifier diodes protect transistor string from spurious high-voltage spikes.—D. O. Hansen, Transistor Circuit Pulses 1,000 Volts, *Electronics*, 38:18, p 86.

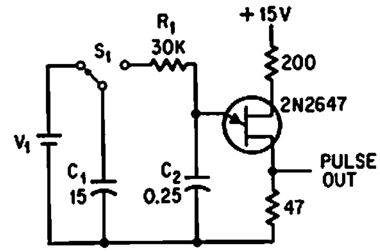
NEON-TRANSISTOR RELAXATION—Operates over range of 0.05 to 7,000 cps by adjusting values of C1, C2, and R4. Average supply current drawn is less than 1 ma.—R. D. Ryan, Low-Cost Pulse Generator, *Electronics*, 35:15, p 70.



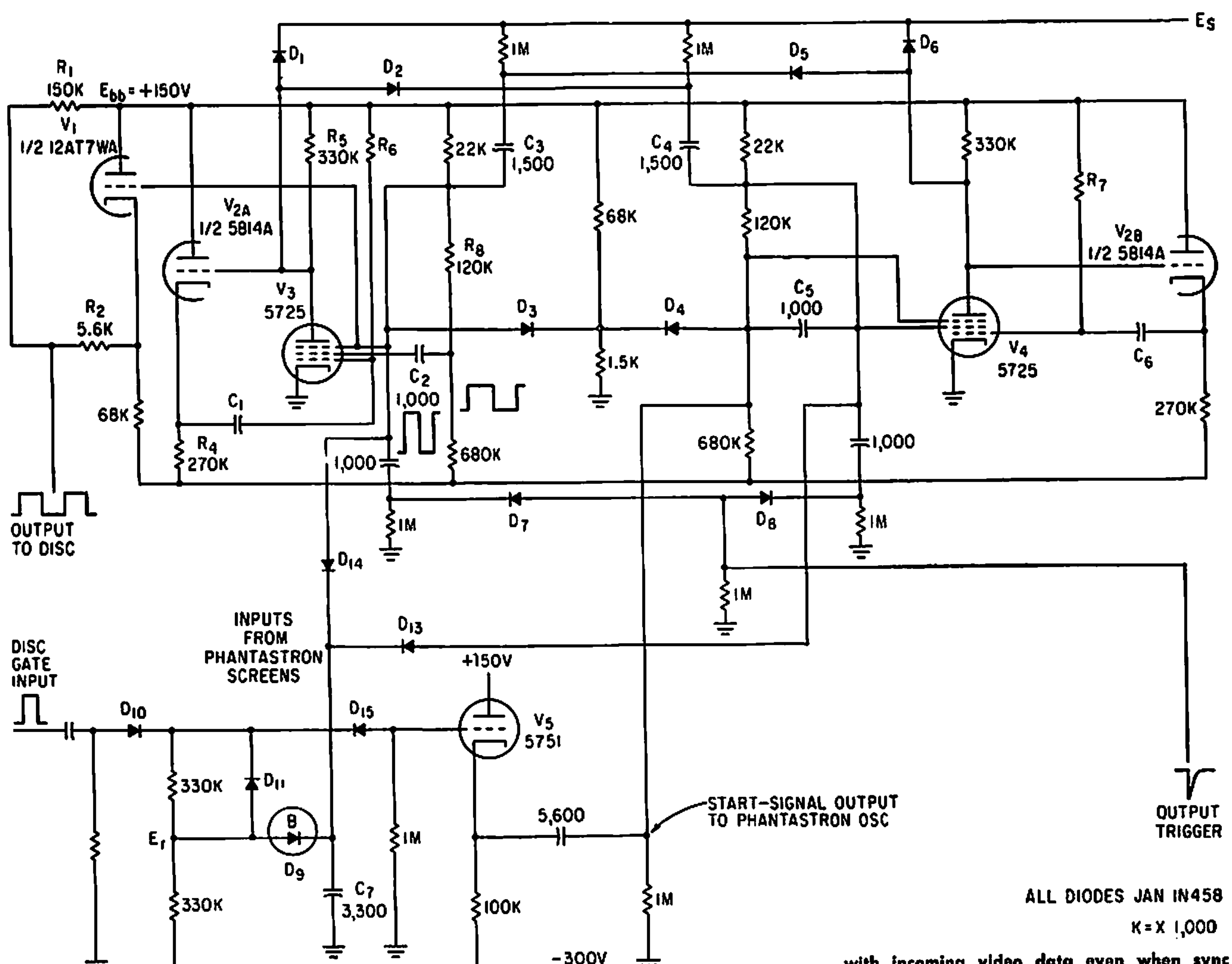
Stellarator. V2 is univibrator, and V4 is crystal-controlled oscillator-doubler.—H. M. Hill, Jr., Delivering Megawatt R-F Pulses for Resonant Heating of Plasma, *Electronics*, 34:29, p 70–73.



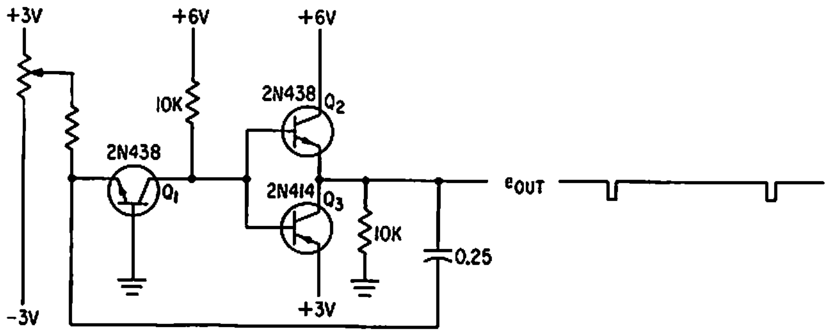
TUNNEL-DIODE PULSER—Switching voltage change of tunnel diode is differentiated and amplified by grounded-base amplifier. With 8-v supply, 5-v output pulses are obtained into 91 ohms at clock rates up to 140 Mc.—M. V. Harrison and R. S. Foote, Tunnel Diodes Increase Digital-Circuit Switching Speeds, *Electronics*, 34:32, p 154–156.



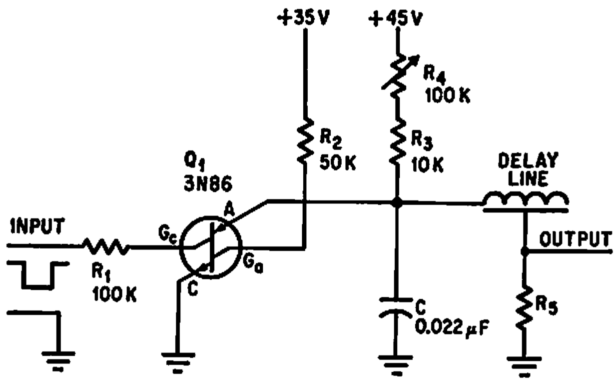
UNIJUNCTION TRANSISTOR GENERATES DESIRED NUMBER OF PULSES—Number of pulses generated each time switch S1 is operated increases linearly from 0 to 140 as battery voltage is increased from 11 to 35 v. Charge transferred from C1 to C2 fires transistor, discharging C2, with cycle repeating until C2 voltage drops below firing point.—R. Ferrie, Unijunction Circuit Generates Specific Number of Pulses, *Electronics*, 37:15, p 78.



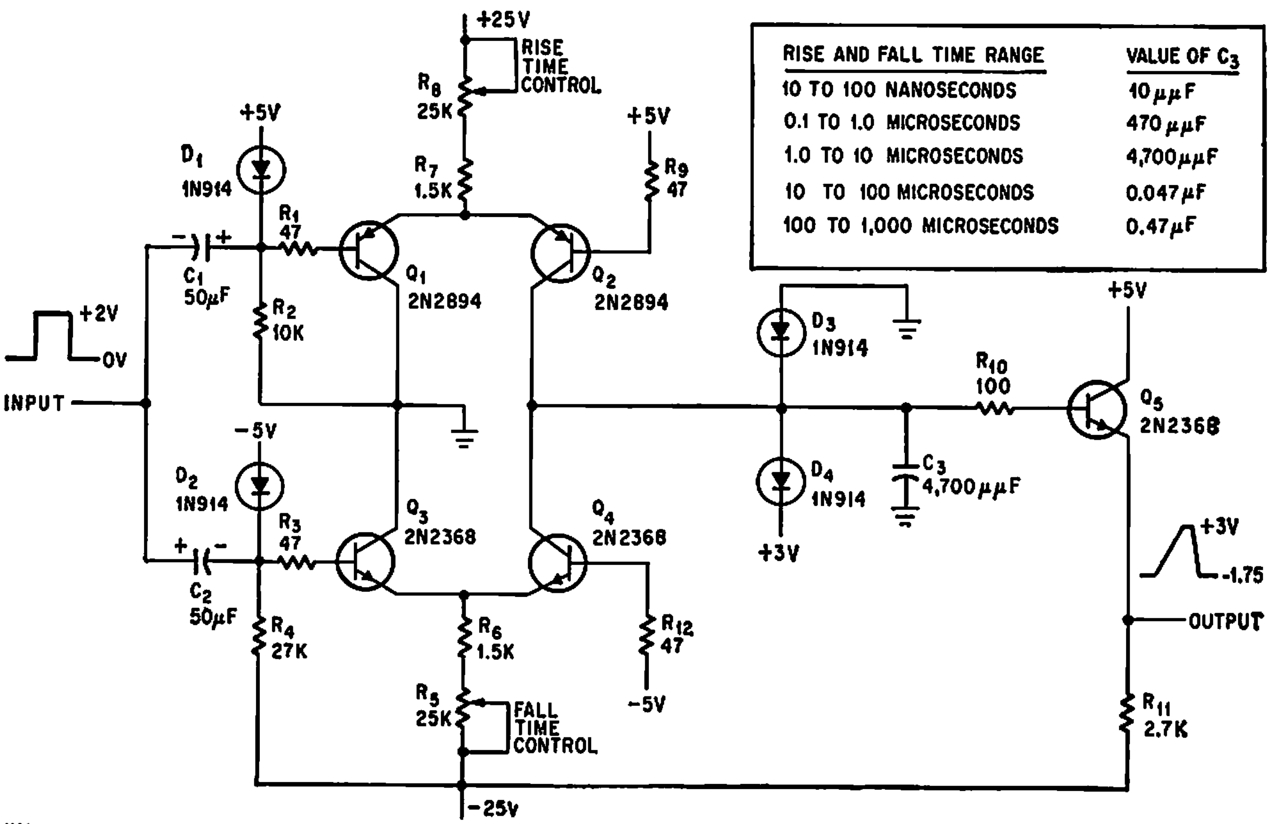
TWIN-PHANTASTRON—Frequency of free-running twin-phantastron oscillator V3-V4 varies with controlled voltage ES (upper right). V5 gates starting pulses to phantastron whenever it fails to oscillate. Used to generate train of pulses that continues in synchronism with incoming video data even when sync pulse is missing or below noise level.—W. C. Whitworth, Plate Voltage Control of Phantastron Frequency, *Electronics*, 34:6, p 73–74.



PHANTASTRON—Reversal of current and voltage functions of basic three-transistor phantastron sweep generator results in pulse output that is derivative of sawtooth sweep. —N. C. Hekimian, Phantastron Circuits Using Transistors, *Electronics*, 34:8, p 46–47.

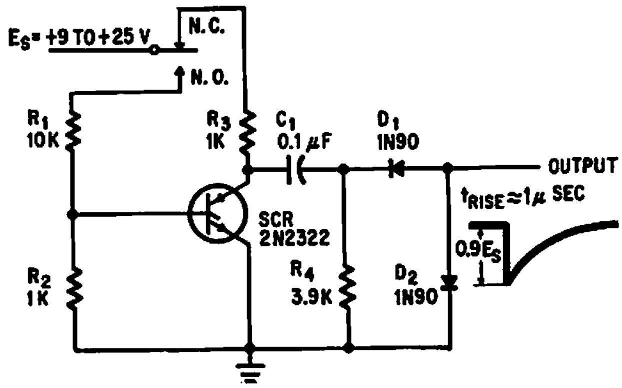


SINGLE SCS—R4 varies relaxation frequency of pnpn silicon controlled switch from 1 to 500 pps, independently of pulse duration and amplitude. For operation in gated mode, cathode gate pulse at input should be −1.5 v at 50 microamp.—H. H. Wieder, Silicon Controlled Switch Can Generate Pulses, *Electronics*, 38:2, p 79.

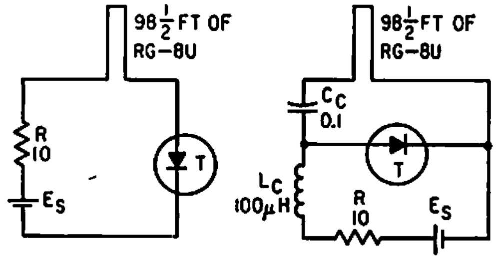


RISE AND FALL TIME RANGE	VALUE OF C_3
10 TO 100 NANOSECONDS	10 μμF
0.1 TO 1.0 MICROSECONDS	470 μμF
1.0 TO 10 MICROSECONDS	4,700μμF
10 TO 100 MICROSECONDS	0.047 μF
100 TO 1,000 MICROSECONDS	0.47 μF

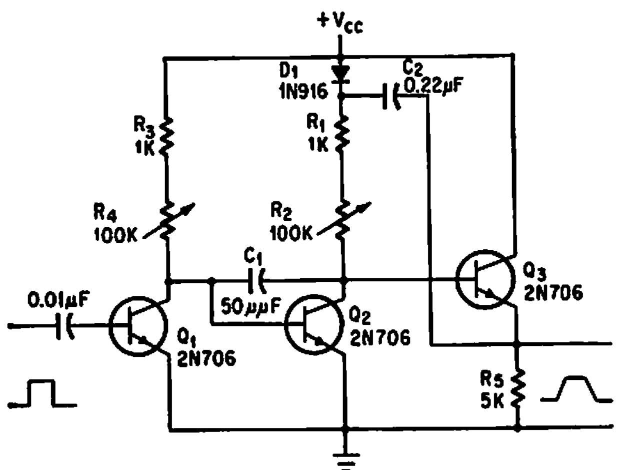
ADJUSTABLE RISE AND FALL TIMES—Constant-current source Q1-Q2 charges C3, while constant-current sink Q3-Q4 discharges C3. —D. N. Lee, Rise Time Adjustment Independent Of Fall Time, *Electronics*, 38:2, p 76–78.



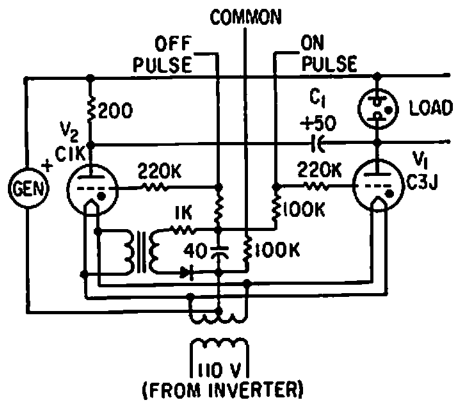
SINGLE PULSE—Push button fires scr to produce single pulse with rise time of 1 microsec.—R. W. Bailey, Push Button SCR Equals Fast Pulse, *Electronics*, 37:30, p 41–42.



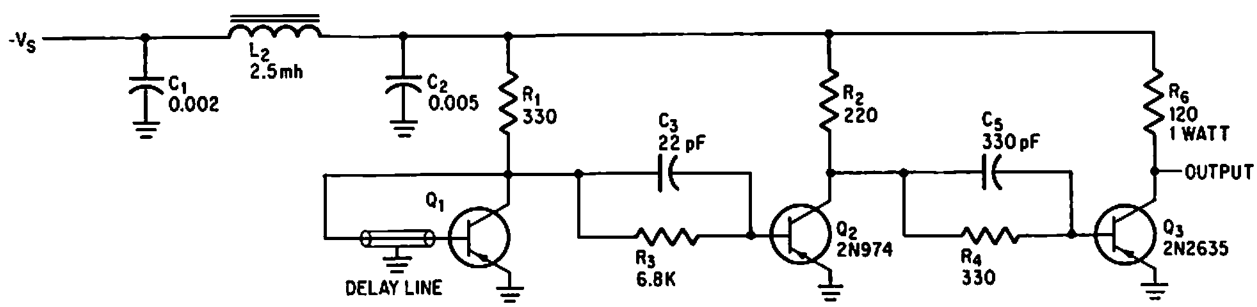
SQUARE-WAVE TUNNEL DIODE—Short-circuited coaxial cable may be connected either in series or in parallel with tunnel diode of basic relaxation oscillator, to get square-wave output with excellent frequency stability over entire bias range.—Wen-Hsiung Ko, Designing Tunnel Diode Oscillators, *Electronics*, 34:6, p 68–72.



RISE AND FALL CONTROL—C1 controls range of rise and fall times, from 10 nsec for 10pf, to 10 millisec for 0.1 mfd. Used for testing pulse networks.—D. G. Larsen, Pulse Generator Controls Rise, Fall Time Independently, *Electronics*, 38:19, p 98–99.

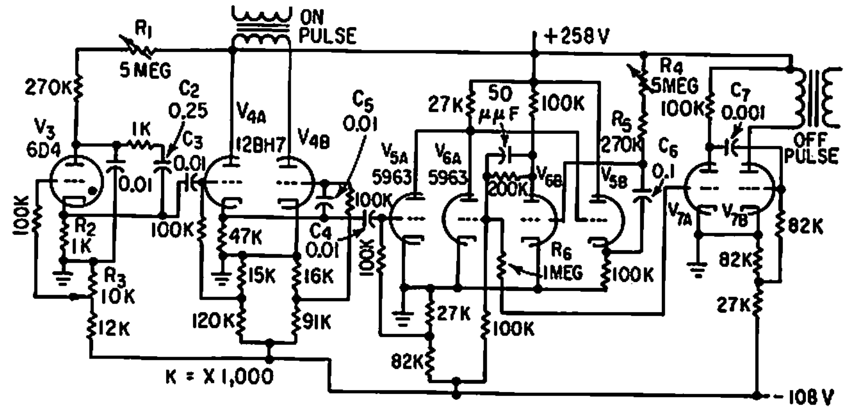


FISH SHOCKER—Two thyratrons serve as d-c interrupter that alternately connects and disconnects d-c generator from load consisting of fresh-water path between aluminum boat and aluminum grid 6 ft away. Fish swim toward positive electrode, receive shock, and are temporarily stunned. Timing circuits determines number and duration of pulses.—H. P. Dale, Electronic Fishing with Underwater Pulses, *Electronics*, 32:4, p 31–33.

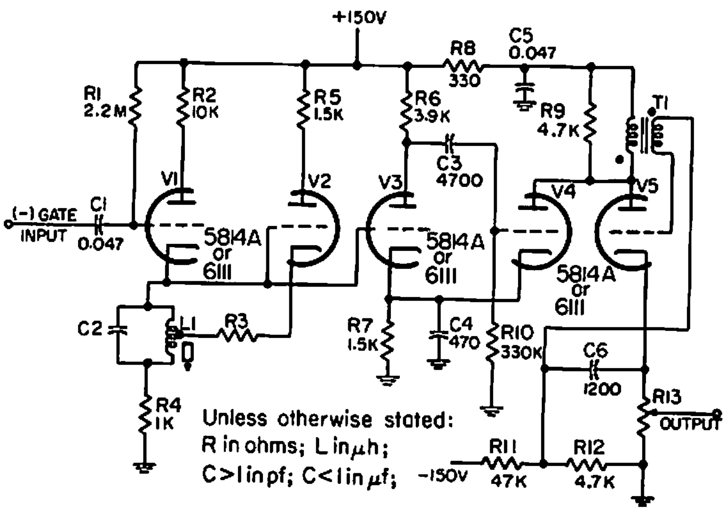


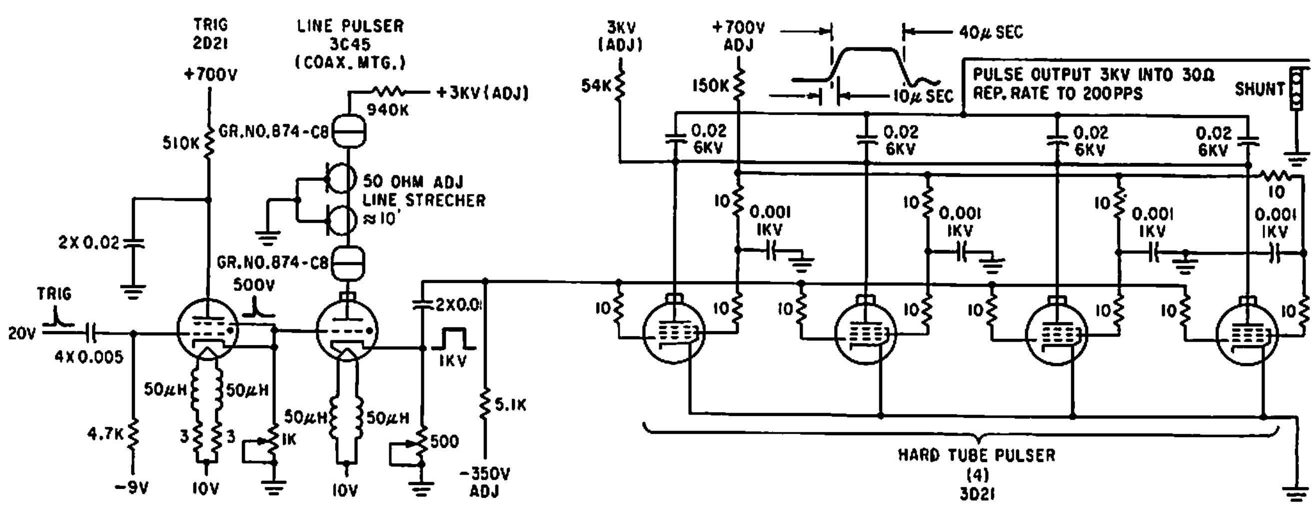
CONSTANT-WIDTH HIGH-CURRENT PULSES—Circuit generates negative pulses from −2 to −12 v with rise and fall times less than 30 nsec. Amplitude and spacing depend on supply voltage. For positive output pulses, use npn transistors and positive supply.—C. P. Hohberger, Fast Pulse Generator Tests Digital Circuit Delay, *Electronics*, 39:4, p 88–89.

CONTROL FOR FISH SHOCKER—Produces timing pulses that can be varied in range of 2 to 30 cps, with durations up to 250 millisec for square waves. R1 changes frequency of oscillator V3, while C6, R4, and R5 in delay mvbr V5-V6 determine width of pulse.—H. P. Dale, Electronic Fishing with Underwater Pulses, *Electronics*, 32:4, p 31–33.

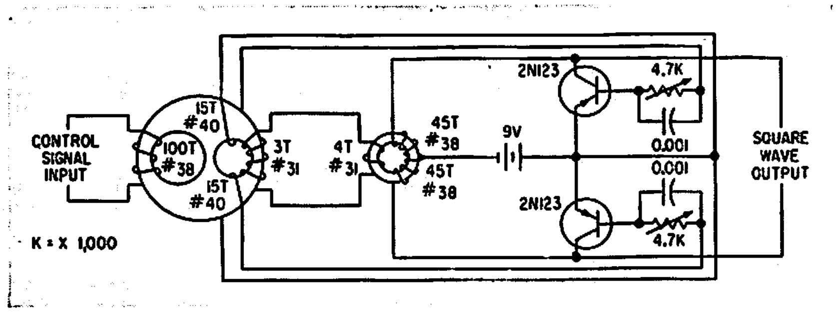


PREFERRED DISTANCE-MARK GENERATOR—Produces train of accurately spaced pulses. Number of pulses in train is determined by duration of input gate, and distance mark spacing is controlled by values of L1, C2, and R3. R13 is 250 ohms maximum. Output is 0 to 50 v positive, for distance mark spacings of 0.5 to 25 miles in search radar. V2 is switched Hartley oscillator, whose output is shaped by mvbr shaper V3-V4, for triggering blocking oscillator V5 to produce narrow marker pulses.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 55, p 55–2.

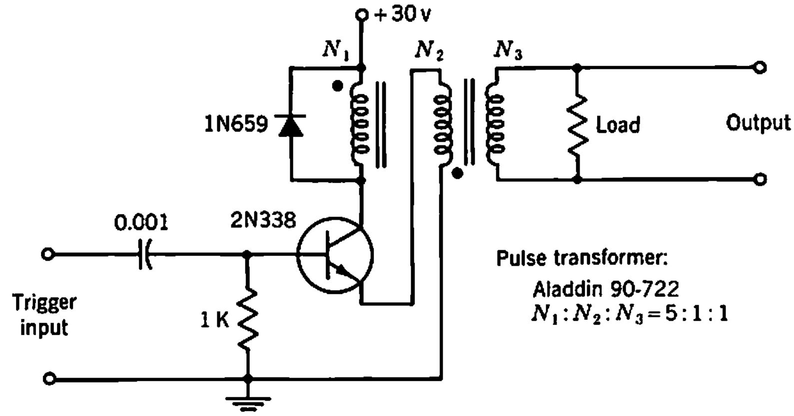




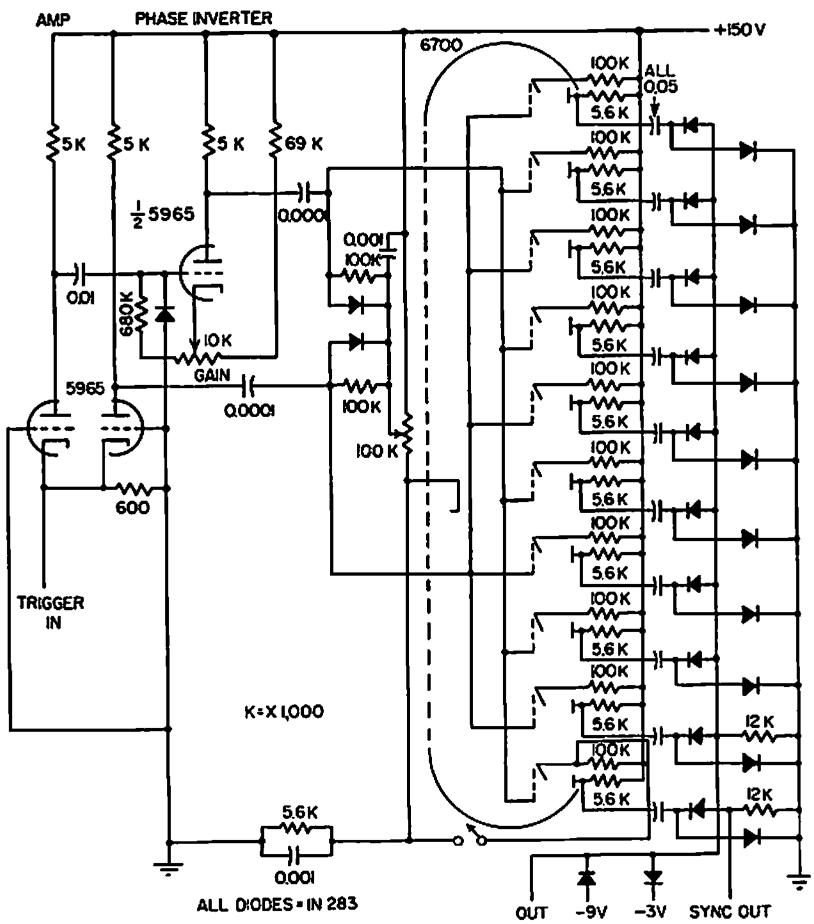
30-NSEC, 5,000-V, 30-AMP PULSES—Used for testing magnetic materials at narrow pulse widths. Four hard tubes in parallel drive test cores with 0.1 megawatt peak power and give some degree of regulation during pulsing.—G. A. Reeser, How Magnetic Materials Behave at Nanosecond Pulse Widths, *Electronics*, 34:36, p 72–75.

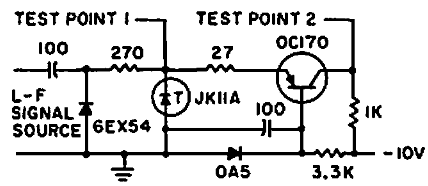


TRANSFLUXOR OSCILLATOR—Holds frequency setting for many hours after removal of control signal. Operates between 100 kc and 1 Mc. Gives square-wave output.—R. J. Sherin, Transfluxor Oscillator Gives Drift-Free Output, *Electronics*, 33:10, p 48–49.

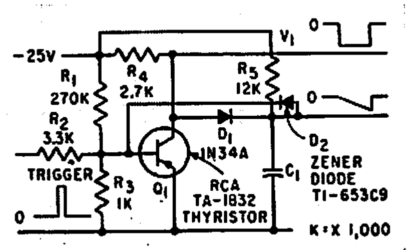


COMMON-BASE BLOCKING OSCILLATOR—Nonsaturating-type triggered blocking oscillator is used when fast response is desired. Often used as pulse generator when waveform requirements are not critical.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 430.





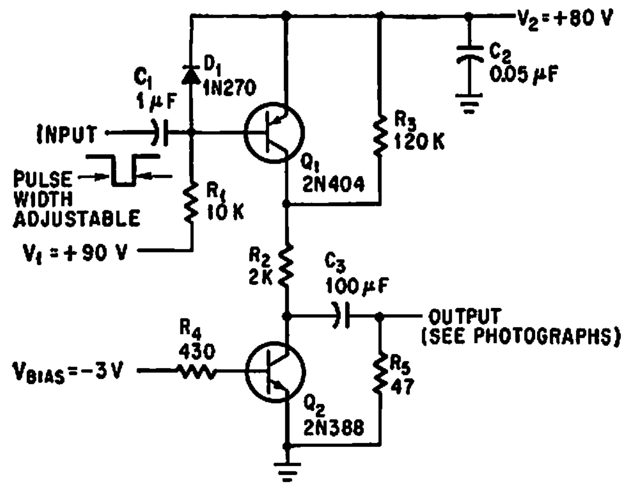
TUNNEL-DIODE PULSE GENERATOR—Negative-resistance characteristics of tunnel diode gives fast-rise-time rectangular pulses, independently of signal frequency. Used here with common-base transistor amplifier.—G. B. Smith, Tunnel Diode Generates Rectangular Pulses, *Electronics*, 33:48, p 124–125.

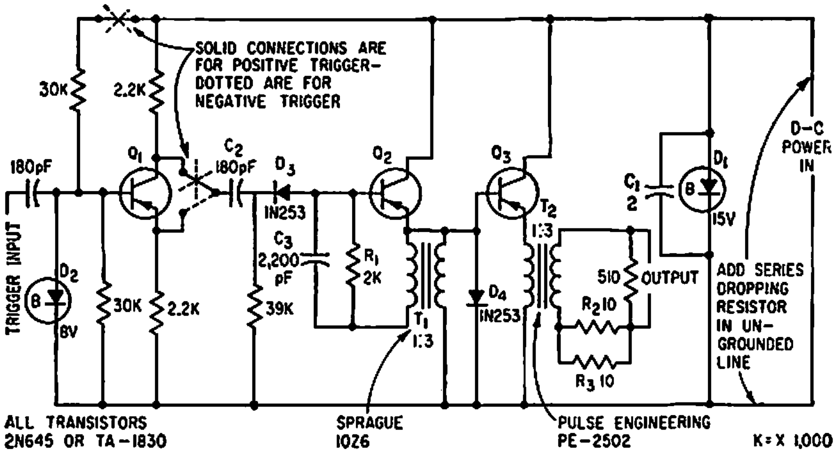


NINE-BIT WORD GENERATOR—Beam-switching tube provides arbitrary nine-bit words at pulse rates from few cps to 1 Mc, for testing digital systems. Output can be changed from spike to square wave by changing plug-in capacitors.—R. R. Hartel, Word Generator for Digital Testing, *Electronics*, 31:9, p 71.

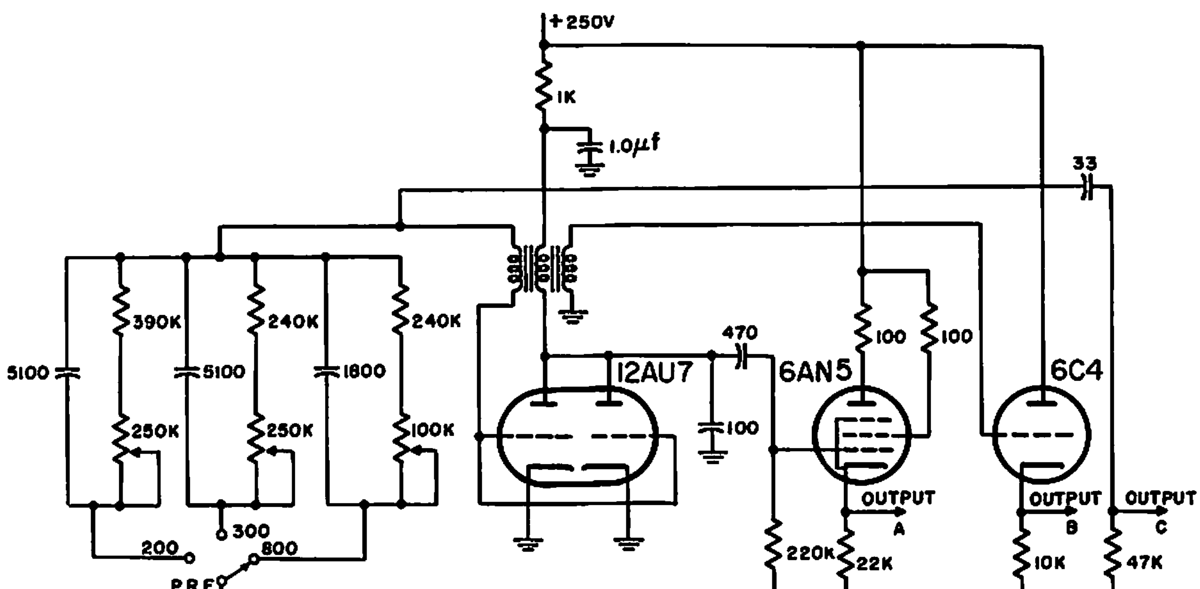
SIMPLE SQUARE-WAVE GENERATOR—Circuit performance is made independent of active elements by using transistor only as switch. For reliable operation, circuit requires extra 10% of output-pulse-width dead time between triggers.—C. A. Von Urff and R. W. Ahrons, How to Generate Accurate Sawtooth and Pulse Waves, *Electronics*, 32:50, p 64–66.

AVALANCHE SWITCH—Low-cost germanium transistors used in avalanche mode provide narrow pulses with fast rise times. Width of input pulse determines number of output pulses. For testing counter, collector voltage of Q2 was adjusted for ten pulses per input pulse, at input repetition rate of up to 100,000 pps.—B. S. Ahn, Germanium Transistor As Avalanche Switch, *Electronics*, 37:30, p 44.

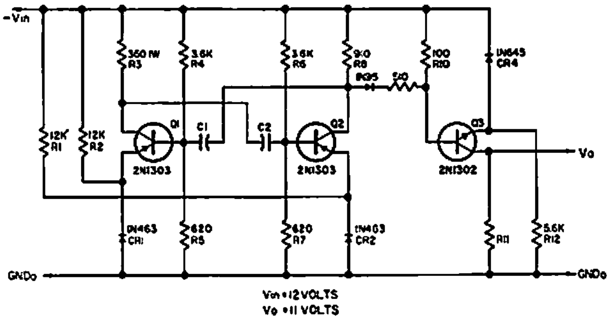




TRIGGERED SQUARE-WAVE GENERATOR—Synchronizing trigger signal drives phase splitter Q1, which in turn feeds blocking oscillator Q2. Output from emitter-follower Q3 is 1-microsec-wide pulse into 90-ohm load. Depending on connections for Q1, either positive or negative input pulse greater than 5 v will trigger generator. Maximum prr is 40 kc.—R. E. Daniels and C. Swoboda, Pulse Generator for Synchronizing Events, *Electronics*, 33:24, p 63.

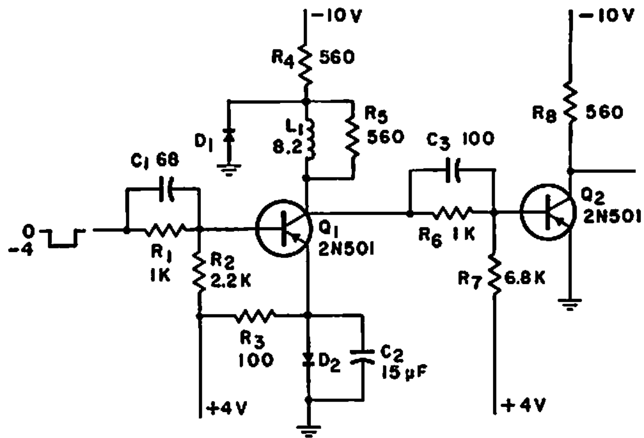


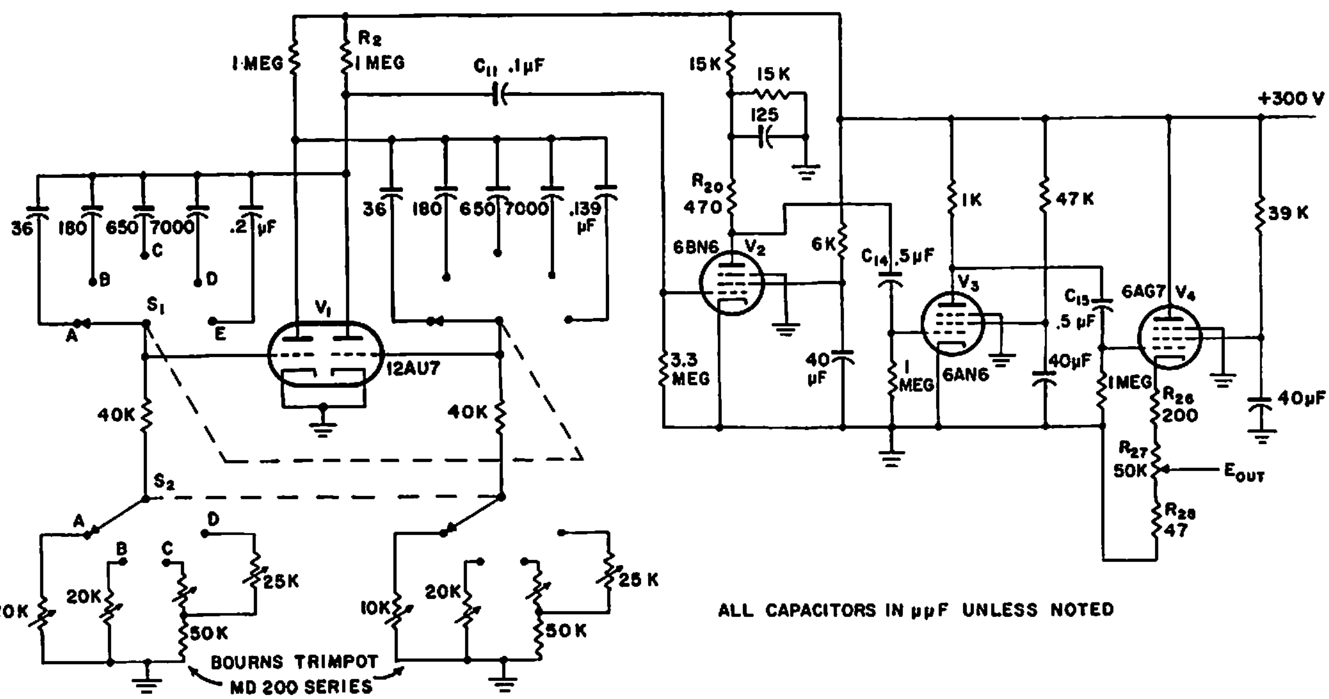
THREE-OUTPUT PRF GENERATOR—Switch gives choice of 200, 300, and 800 pps. Output C is negative, and other outputs are positive. Output B has positive overshoot to provide trigger that is delayed with respect to outputs A and C by width of pulse.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5–2.



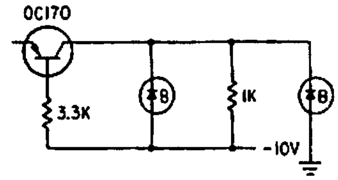
VARIABLE SQUARE WAVES—Output is adjustable from 0.5 cps to 60 kc at currents up to 150 ma, without appreciable corner rounding of waveform, with variable pulse width and variable interval between pulses, for driving flash lamps, relays, and computer gates.—J. D. Reed, Square Wave Generator with Variable On and Off Times, *EEE*, 10:10, p 27–28.

RINGING-TYPE PULSE GENERATOR—Used in some large high-speed computers to transmit pulses from central unit over long distances as d-c levels, then convert back to pulse forms. To convert level back to pulse, transistor switch is turned off by positive-going wavefront energizing ringing circuit. Input triggering of ringing stage is accomplished when definite threshold level is exceeded.—Pulse Generator for High-Speed Computers, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 75.

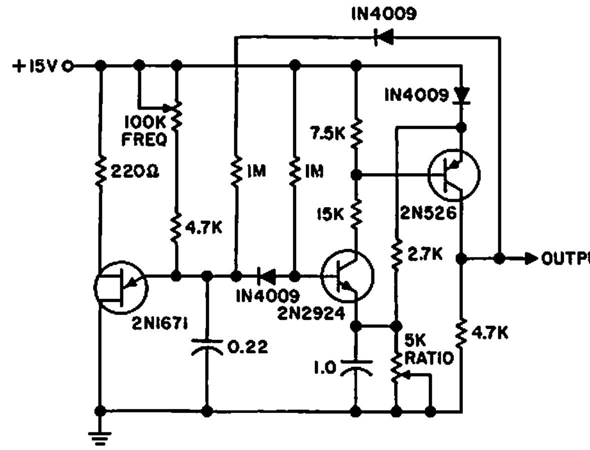




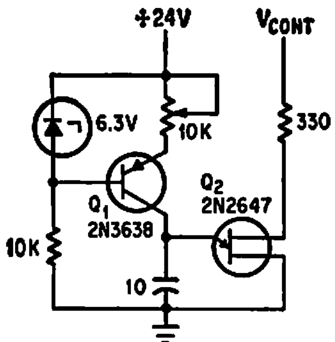
GATED-BEAM SQUARE-WAVE GENERATOR—Amplifies without attenuation up to tenth harmonic of square-wave fundamental, from which output of 50 to 500,000 pps can be adjusted over desirable range without waveform distortion. Uses twin-triode 12AU7 as symmetrical mvbr, 6BN6 as gated-beam tube, 6AN6 as wideband amplifier, and 6AG7 as cathode-follower output. Operating frequencies are changed by S1 and S2. R27 adjusts output signal level from 0.8 to 8 v peak to peak. Rise time for 500-kc signal is better than 0.07 microsec. Provides 5 distinct repetition rates (50, 1,000, 10,000, 100,000, and 500,000 pps) for checking amplifiers up to at least tenth harmonic of fundamental repetition ratio.—Gated-Beam Tube Square-Wave Generator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 175.



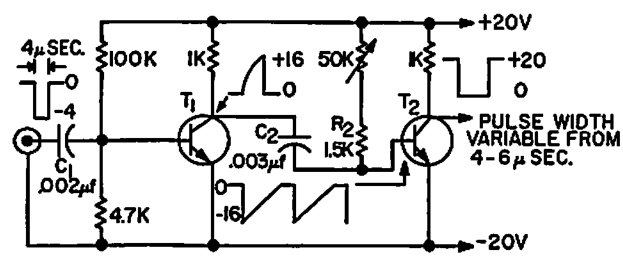
PULSE-SQUARING ZENERS—Addition of zener diodes to transistor amplifier fed by tunnel-diode pulse generator improves output waveform.—G. B. Smith, Tunnel Diode Generates Rectangular Pulses, *Electronics*, 33:48, p 124-125.



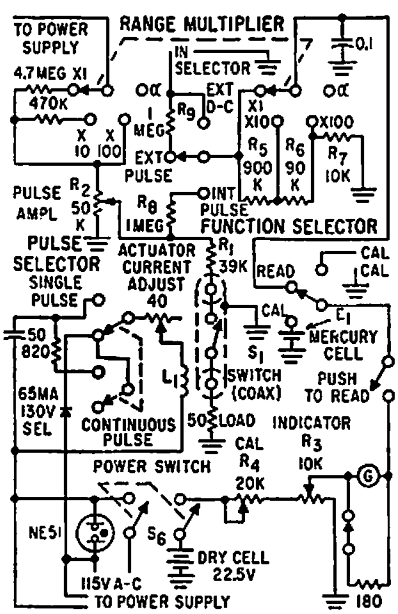
VARIABLE FREQUENCY AND VARIABLE DUTY CYCLE—Frequency and duty ratio can be varied independently to generate desired rectangular wave. Ujt is used in conventional sawtooth generator. Two transistors provide positive-going output when ujt emitter voltage exceeds npn emitter voltage. Frequency range is 60 to 1,000 cps.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 344.



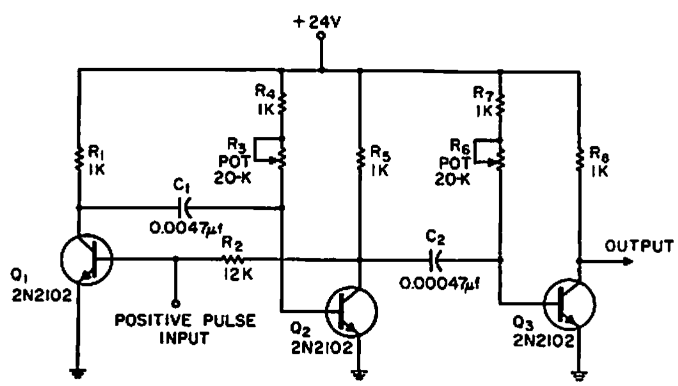
VOLTAGE-CONTROLLED PULSE SPACING—Unijunction transistor circuit generates train of pulses with constant pulse width but with spacing linearly adjustable over 20-to-1 range by voltage V, which varies trigger point of ujt Q2.—A. M. Ridenour and F. Turco, Unijunction Controls Spacing Between Pulses, *Electronics*, 39:14, p 82–83.



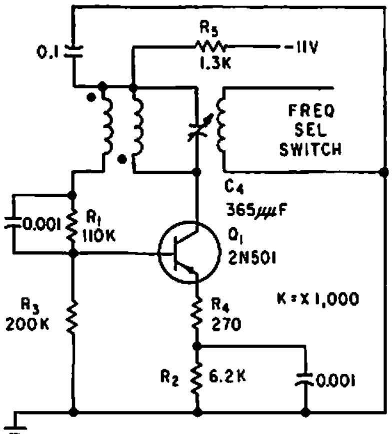
VARIABLE-PULSE-WIDTH GENERATOR—Converts fixed negative pulse-width input to variable and stable pulse width. Will accept positive inputs if T1 and T2 are changed from 2N1308 to 2N1309 and collector voltages reversed. Will operate at repetition rates from 30 cps to 2 Mc, with pulse widths from 600 microsec to 100 nsec. With values shown, maximum duty cycle is 92% with 63-microsec input rep rate.—H. D. Flagle, High-Duty-Cycle Pulse-Width Generator, *EEE*, 11:8, p 27–28.



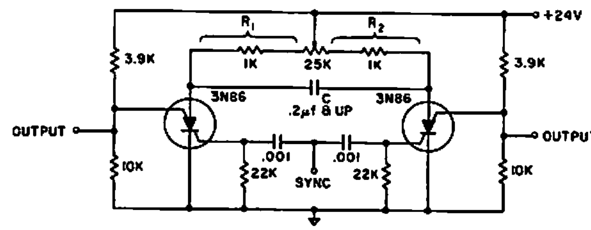
CALIBRATED MILLIMICROSECOND PULSER—Uses coaxial discharge line to produce precise short pulses on keyed single-shot basis or at constant repetition rate. Works into 50-ohm load.—E. J. Martin, Jr., Calibrated Source of Millimicrosecond Pulses, *Electronics*, 32:16, p 56–57.



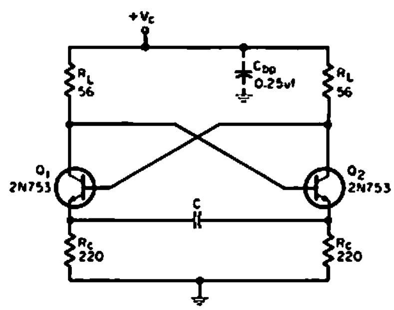
DELAYED OUTPUT PULSE—Only three transistors are required to generate output rectangular pulse that is delayed a predetermined time after arrival of input pulse. Delay time is determined by C1, R3, and R4, and is about 10 microsec for values shown. Output pulse width is also about 10 microsec. —T. R. Ferrara, Delayed Pulse Generator, *EEE*, 13:10, p 71.



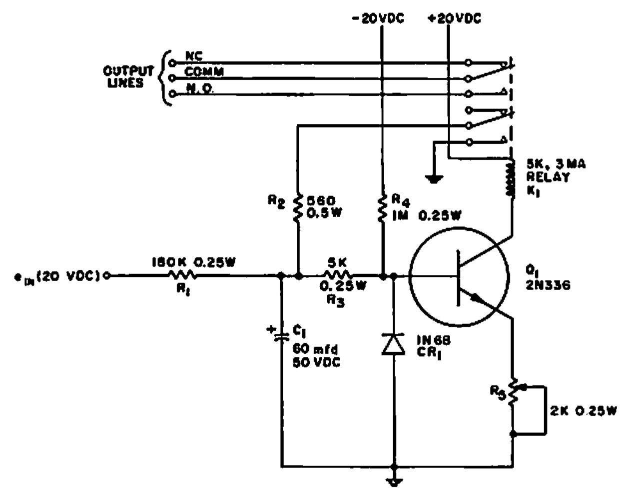
BASIC HARTLEY—Sine-wave oscillator, tunable over 3:1 frequency range by C4, uses switching transistor. Used in pulse generator for testing high-speed digital computers.—L. Neumann, Transistorized Generator for Pulse Circuit Design, *Electronics*, 32:14, p 47–49.



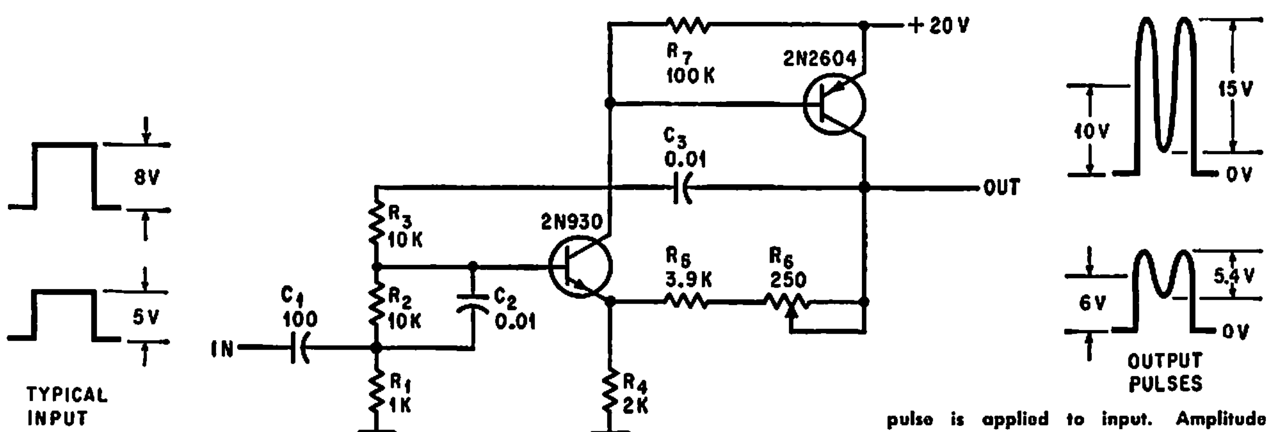
SCS SQUARE-WAVE GENERATOR—R1-C determines half the period, and R2-C the remainder. R1 should equal R2 for square-wave output. Potentiometer varies pulse width without affecting frequency. Outputs are equal and oppositely phased.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 434.



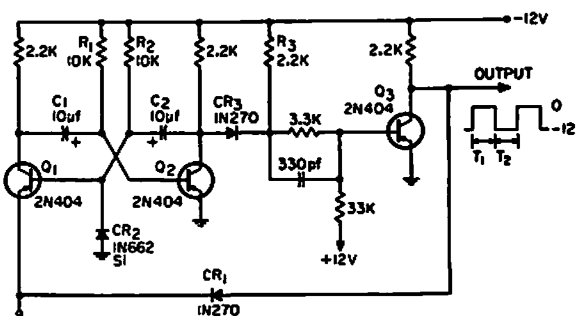
MULTI-WAVEFORM OSCILLATOR—By varying collector load, emitter resistors, and C, oscillator can produce triangular wave, square wave up to 30 Mc, microwatt audio signal, or serve as voltage-controlled oscillator. Values shown, with 6-v supply and 0.01 mfd for C, give 0.8 v peak-to-peak square wave at about 1 Mc.—P. Lefferts, Multi-Oscillator Gives Simple Waveforms, 30-Mc Output, *EEE*, 12:10, p 60.



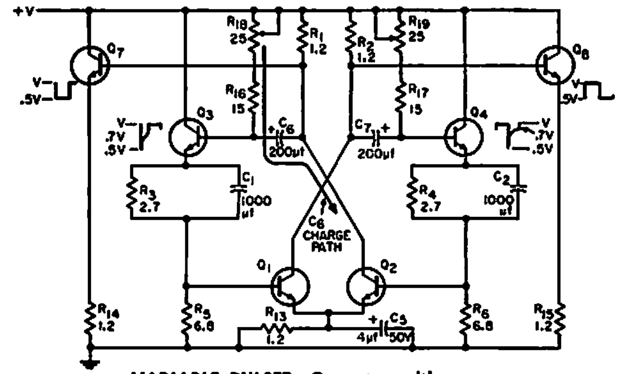
STEPPING SWITCH PULSER—Used to advance stepping switch automatically at predetermined rate, in automatic test equipment providing go-no-go indications. C1 controls output pulse width to give 80-msec *on* time, for reliable actuation of switch that normally requires 20 millisec. Range of *off* time, controlled by R5, is 20 millisec to 7 sec.—C. Wilson, Step Switch Pulser, *EEE*, 10:11, p 26–27.



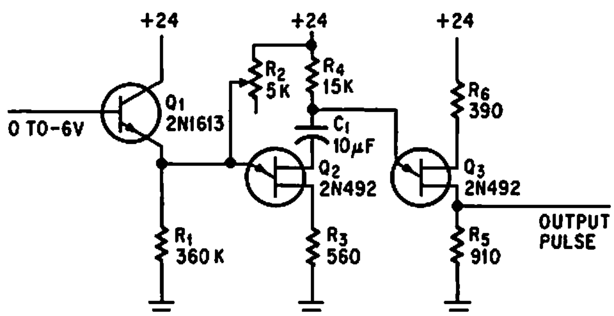
PULSED OSCILLATOR—Circuit is pulsed on only when required, as in tone generators where output is needed only occasionally and power must be conserved. Uses Wien-bridge oscillator having range of 100 cps to 100 kc, which operates only when gating pulse is applied to input. Amplitude of output oscillations varies with amplitude of gating pulse.—R. C. Lavigno and L. L. Kleinberg, Pulsed Oscillator Conserves Power, *Electronics*, 39:17, p 98–99.



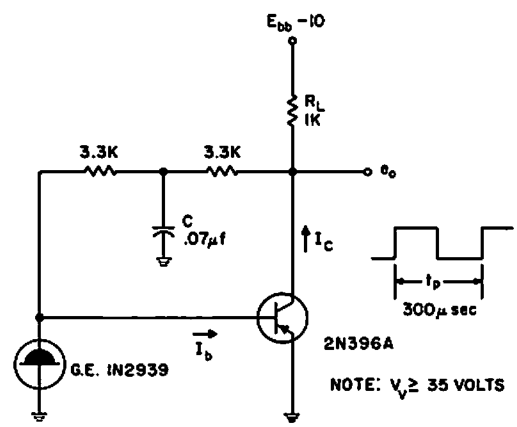
GATED ASTABLE PULSE TRAIN GENERATOR—Uses standard logic circuits with self-completing action to produce pulse train having any desired integral number of pulses. First pulse starts when S1 is closed, and last pulse is completed when S1 is open. Self-completing action is produced by *or* function of S1 and CR1.—M. Neidich, Self-Completing Gated Astable, *EEE*, 13:1, p 66 and 75.



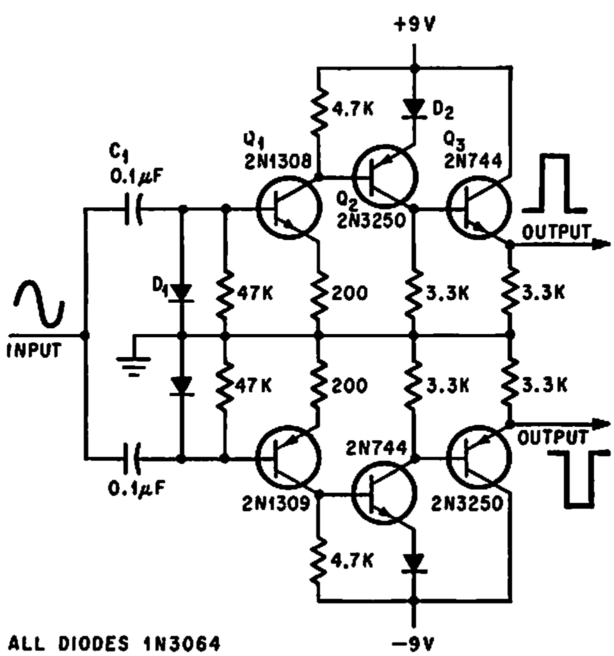
VARIABLE PULSER—Operates with any power supply voltage from 1.5 to 20 v, and generates symmetrical or nonsymmetrical low-impedance pulses from 0.5 ppm to above 200,000 pps. Used for controlling repetitive operation of certain analog computers, and as source for checkout of digital circuits. —J. V. Gaudiosi, Variable Pulse Generator, *EEE*, 11:2, p 27–28.



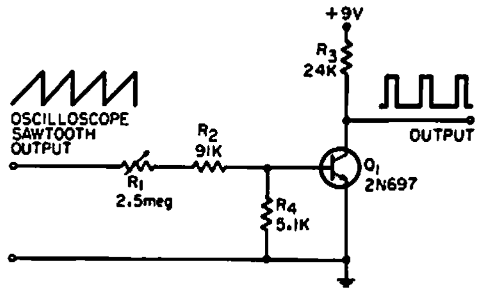
LEVEL DETECTOR—Provides constant-width pulses at fixed repetition rate whenever input signal exceeds predetermined level. Maximum current drawn from signal source is only 35 microamp.—J. G. Peddie, Two Unijunctions Form Low-Cost Level Detector, *Electronics*, 39:8, p 94.



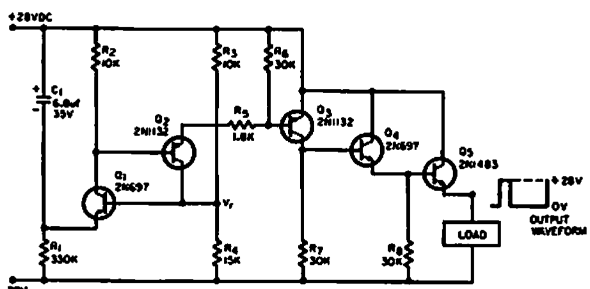
ASTABLE HYBRID TD-TRANSISTOR SQUARE-WAVE GENERATOR—Fast switching capability of tunnel diode contributes to clean output waveform of mvbr configuration.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 367.



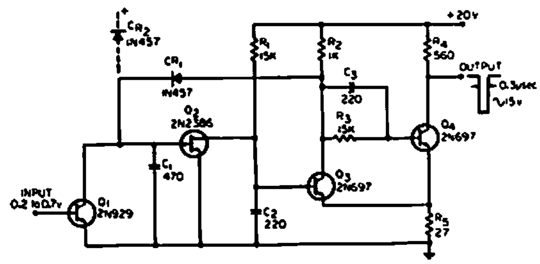
LOW-COST SQUARE WAVES—Conversion circuit coupled to sine-wave audio oscillator gives square-wave generator at half usual cost. Will shape sine waves up to 3 Mc before trailing edges of square-wave output begin to deteriorate. Can be triggered by input signals from 0.2 to 10 v. Positive input turns on D1 and Q1, driving amplitude-limiting pair Q2-D2 into conduction to square up waveform. Lower half of circuit generates negative square pulse in negative manner.—R. S. Selleck, Converting Audio Oscillators to Square-Wave Generators, *Electronics*, 39:16, p 123.



VARIABLE WIDTH AND VARIABLE PRR—Gives wide range of control over pulse width and pulse repetition rate, while maintaining synchronization with oscillosope. Can be constructed with banana plugs for sawtooth output jacks of scope.—R. G. Rakes, Simple Variable Width, PRR Pulse Generator, *EEE*, 13:11, p 45–46.

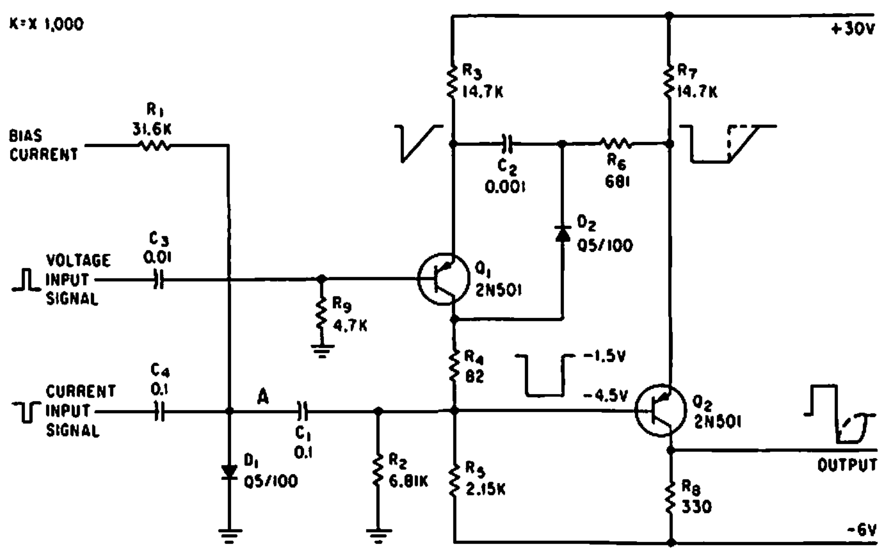


0.05 CPS TO 10 KC POSITIVE PULSES—Uses two-transistor equivalent circuit for double-base diode, to give better reliability and more uniform performance in recycling timers, indicator readouts, and switching regulators. With parameter values shown, frequency is about 1 cps and pulse width is 30 millisec.—G. B. Mahoney, Low-Frequency Pulse Generator, *EEE*, 12:6, p 63–64.

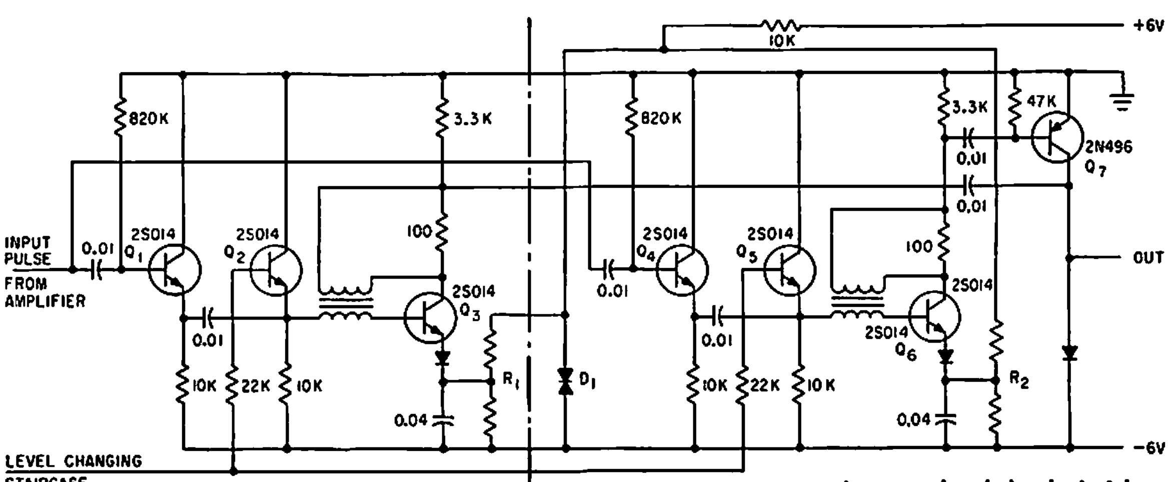


VOLTAGE-CONTROLLED PRR—Input change of only 0.5 v will change pulse repetition rate of generator by factor of more than 1 to 10,000,000. Output pulse is about 0.3 microsec wide, with rise and fall times of 20 nsec. Addition of back-biased diode CR2 extends low-frequency limit below 0.05 pps.—G. Richwell, Wide-Range Voltage-Controlled Pulse Generator, *EEE*, 13:10, p 72–77.

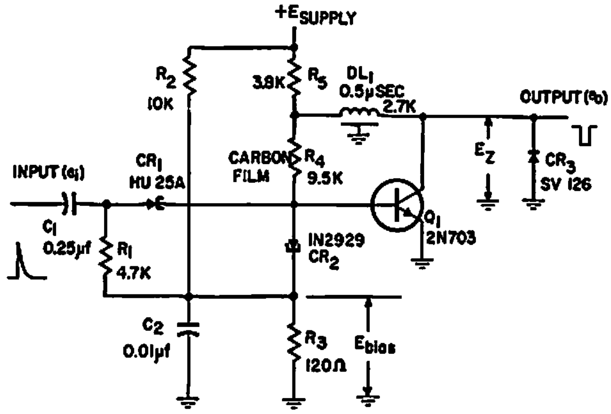
CHAPTER 65
Pulse Height Analyzer Circuits



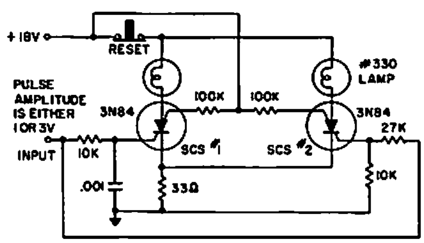
AMPLITUDE DISCRIMINATOR—Used in nuclear physics to determine whether voltage or current input pulse is above or below predetermined level. Triggering threshold is set by adjusting bias of diode D1. Accuracy is within 1 microamp at 50-microamp triggering level, or within 0.4 mv at 10-mv triggering level.—F. S. Goulding and L. B. Robinson, Achieving Discriminator Levels with a Biased Input Diode, *Electronics*, 33:21, p 89–91.



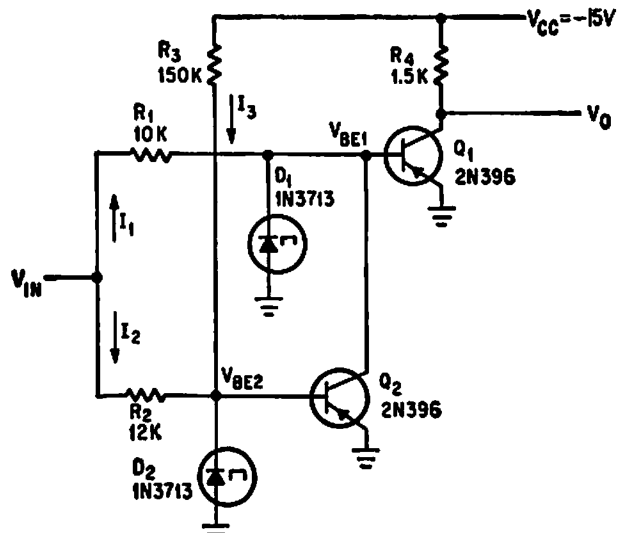
PULSE-HEIGHT DISCRIMINATOR—Selected pulses pass through timing gate Q7 (open for fixed time) to counter that registers average intensity of solar radiation falling in given wavelength band.—J. Ackroyd, Orbiting Spectrometer Plots Solar X-Rays, *Electronics*, 34:43, p 55–57.



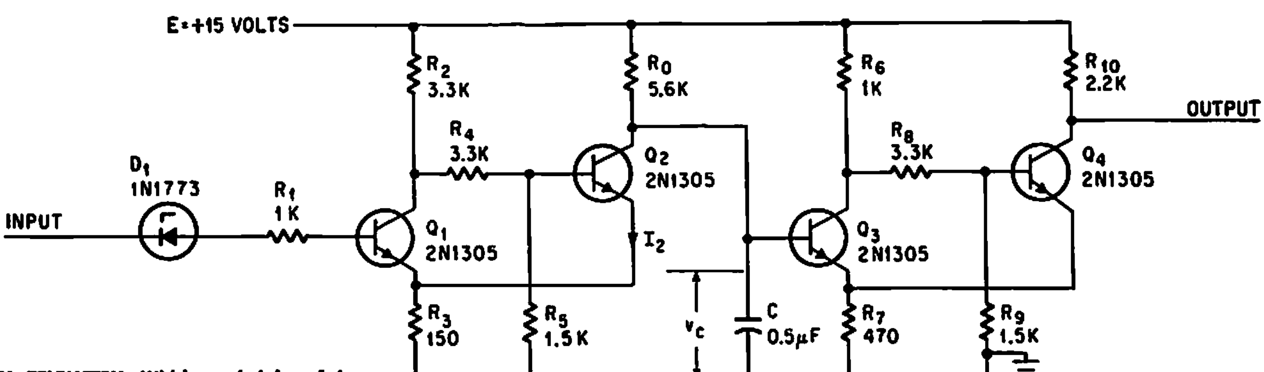
PULSE HEIGHT DISCRIMINATOR—Delivers trigger pulse when input signal reaches predetermined threshold. Used in nuclear counting experiments, in satellite and rocket applications where sensitivity and stability are essential.—R. H. Wagner, Stable, Sensitive Pulse Height Discriminator, *EEE*, 10:7, p 28–29.



PULSE AMPLITUDE DISCRIMINATOR—Input of 1 v triggers SCS1 but not SCS 2. Input of 3 v is delayed in reaching SCS1 by R-C integrating network and therefore triggers SCS2, which raises common-emitter voltage to prevent SCS1 from triggering.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.

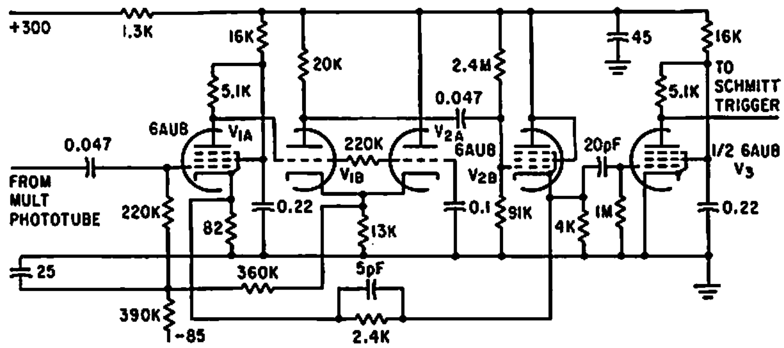


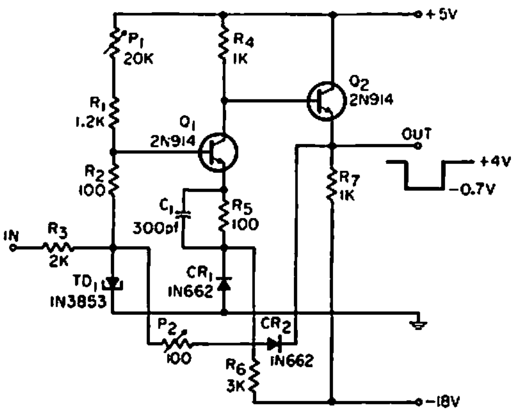
VOLTAGE DISCRIMINATOR—Output changes sharply when input signal rises above preset threshold such as −10 v, with circuit returning to initial state when input reaches still higher threshold such as −11 v. Width of resulting output pulse can be changed by varying R1, R2, or R3.—C. D. Todd, Sharp Discrimination of Voltage Differences, *Electronics*, 38:19, p 97–98.



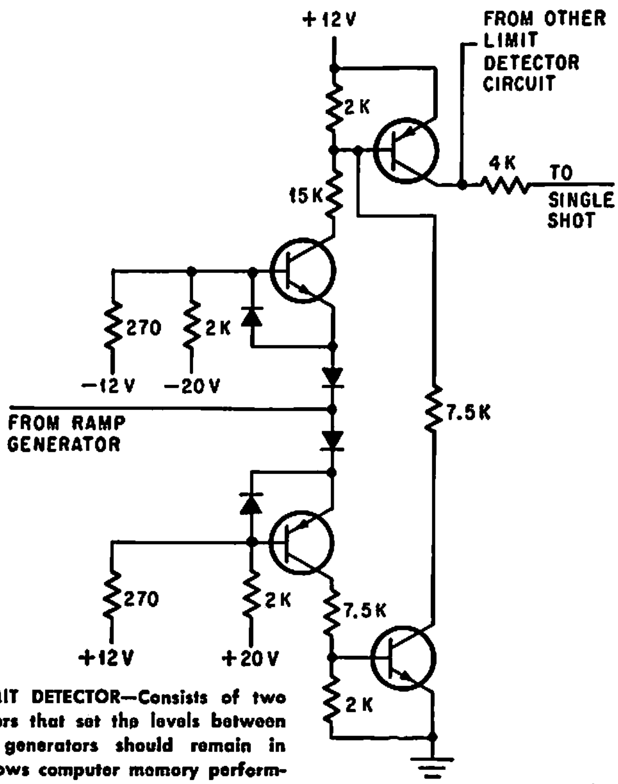
PWM TELEMETRY—Width or height of input pulse determines whether trigger Q1-Q2 will be on long enough for C to charge to voltage that will make trigger Q3-Q4 produce output pulse.—R. G. Ferrie, One Discriminator Senses Pulse Width and Height, *Electronics*, 38:8, p 90–91.

FAST AMPLIFIER FOR RANDOM TELEGRAPH WAVE—Amplifies small pulses above threshold value without being overloaded by large pulses derived from radioactive isotope and phosphor on envelope of multiplier phototube. Two feedback loops, similar to Oak Ridge-Fairstein and Brookhaven-Chase circuits, help to stabilize gain.—J. B. Manelis, Generating Random Noise with Radioactive Sources, *Electronics*, 34:36, p 66–69.

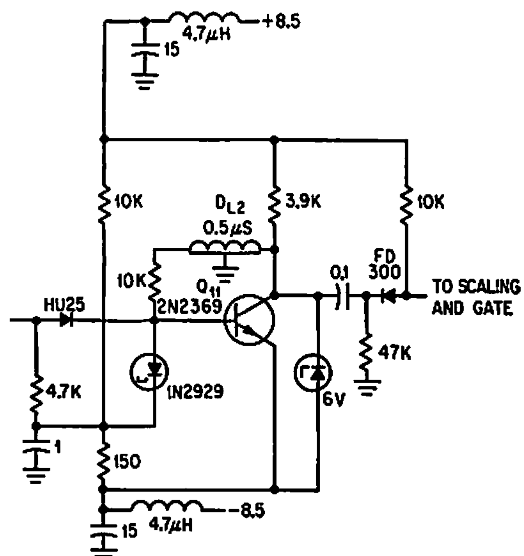




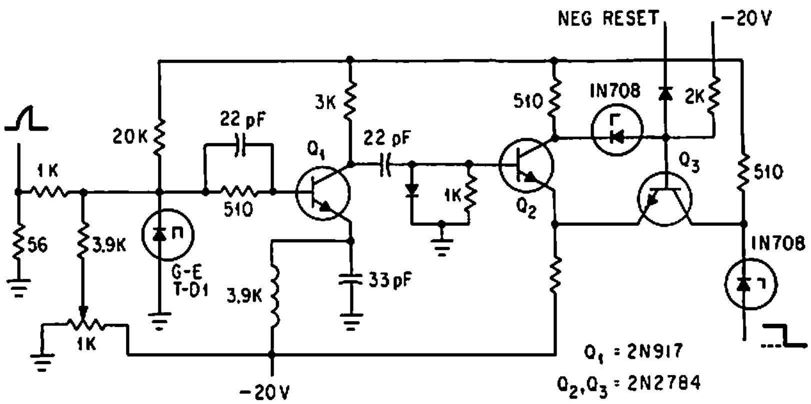
TUNNEL-DIODE DISCRIMINATOR—Td1, biased close to its peak current, is connected to d-c amplifier to overcome inherent limitations of tunnel diode. When input voltage makes current through R3 exceed diode peak current, diode switches to its high-voltage state of 0.5 v. Q1 amplifies this change by factor of 10, and Q2 initiates start of square-wave output. When input drops, circuit and diode revert to original state. Rise and fall times are about 10 nsec.—G. Marosi, Versatile Tunnel-Diode Discriminator, *EEE*, 14:5, p 120.



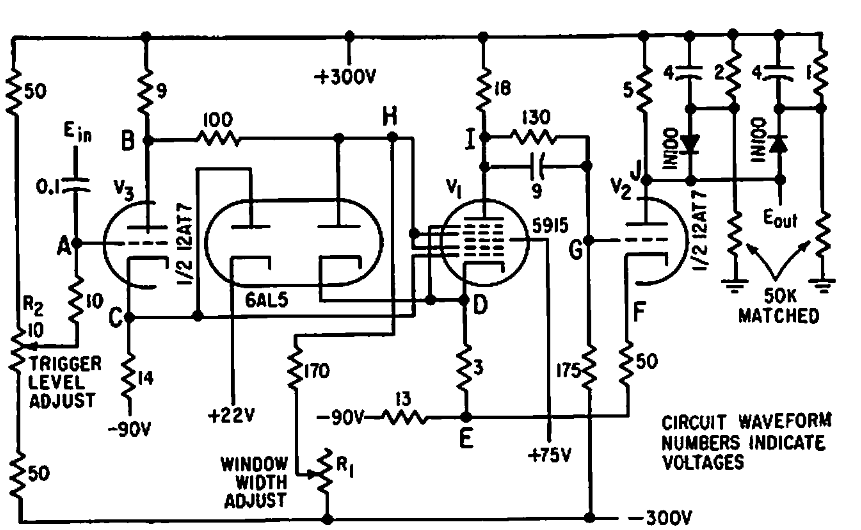
VOLTAGE LIMIT DETECTOR—Consists of two voltage dividers that set the levels between which ramp generators should remain in tester that shows computer memory performance under marginal drive currents by plotting schmoo curves. Npn transistors are 2N706, pnp transistors are 2N1132, and diodes are 1N921.—J. E. Gersbach, The Great Schmoo Plot: Testing Memories Automatically, *Electronics*, 39:15, p. 127–134.

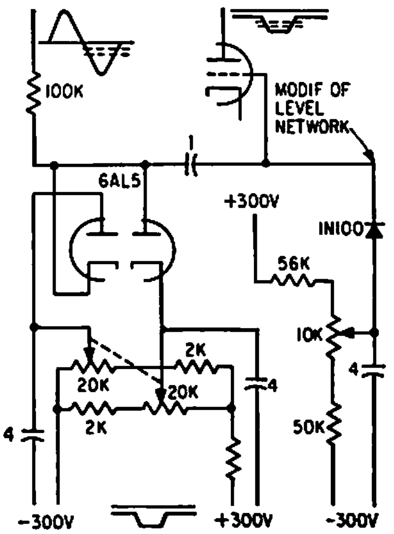


PULSE HEIGHT SENSOR FEEDS SCALER—Tunnel-diode 1N2929 senses pulse height through isolating unijunction diode HU25. Voltage input signals above preset threshold give negative output pulse for scaler.—R. Cuikay and T. Callhan, Orbiting Observatory to Measure Stars' Dim Light, *Electronics*, 37:9, p 28–31.



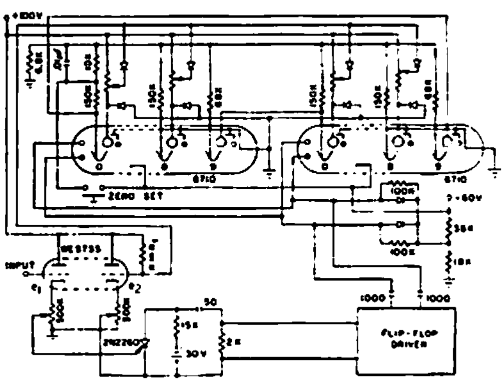
TUNNEL-DIODE LEVEL DISCRIMINATOR—Tunnel diode at input of high-gain amplifier stage gives highly accurate trigger action even for slowly rising input pulse. Used with quinary scalers to measure time intervals accurately to within 1 nsec.—R. Englemann, Quinary Scalers: Measure Time Intervals Digitally, *Electronics*, 37:5, p 34–36.



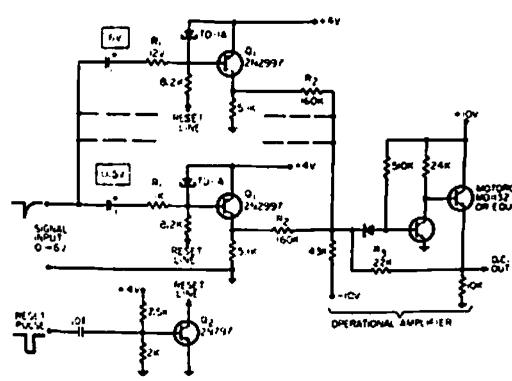


SIGNAL AMPLITUDE ANALYZER—Width of rectangular output pulse is proportional to time spent by signal between specified voltage levels. Used to determine probability amplitude density functions.—T. A. Bickart, Amplitude Slicer for Signal Analysis, *Electronics*, 32:9, p 64–65.

AMPLITUDE WINDOW—Provides trigger on negative portion of input signal or noise, for slicing portion out of input signal for use with amplitude analyzer in determining probability amplitude density functions.—T. A. Bickart, Amplitude Slicer for Signal Analysis, *Electronics*, 32:9, p 64–65.

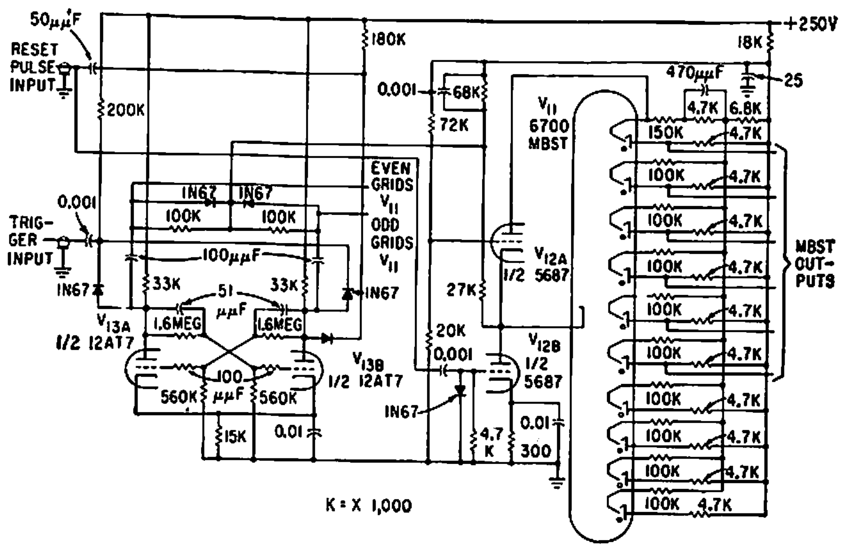


SHOCK SPECTRUM ANALYZER—Inexpensive peak memory unit has indefinitely long memory, to retain information long enough for all channels to be recorded. Shock spectrum of input pulse is then defined by peak voltages across capacitors in all memory units. Output is d-c level for automatic recording or plotting.—D. F. Palmer, Shock Spectrum Analyzer, *EEE*, 11:3, p 118–119.

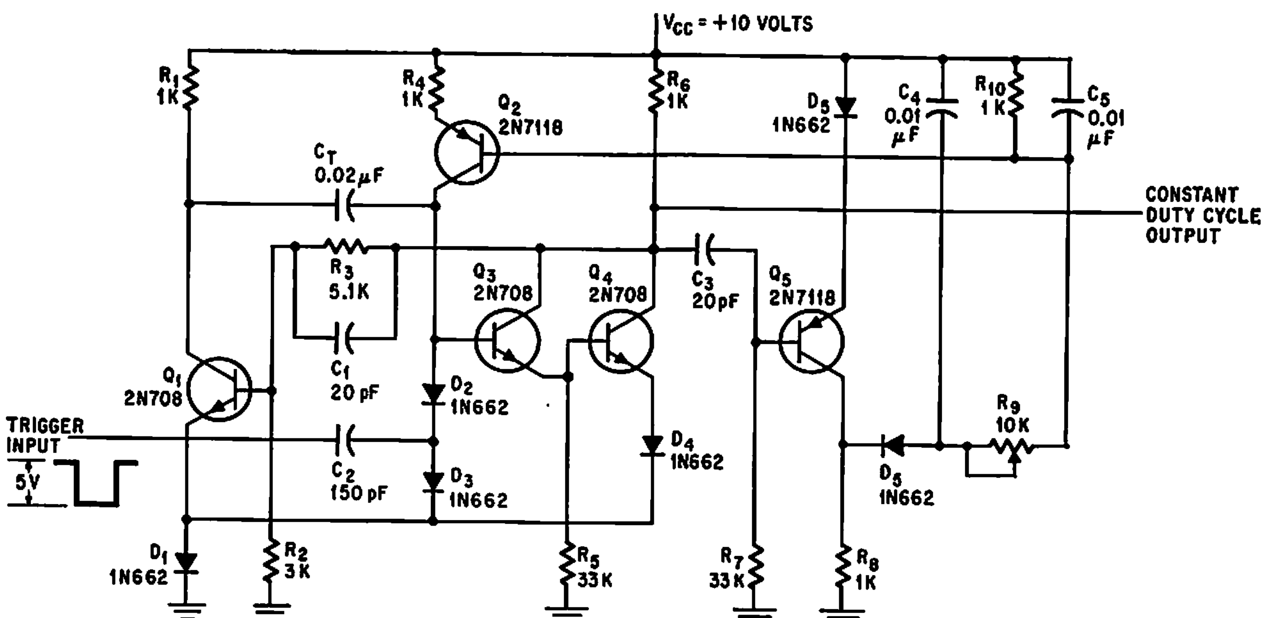


TUNNEL-DIODE PULSE-HEIGHT DISCRIMINATOR—Used to analyze 30-nsec pulses varying in height from 0 to 6 v peak, over temperature range of −20 to +60°C. Ten stages were connected in parallel and 0.5-v steps used for 0 to 5 v output range. When tunnel diode is triggered at its predetermined level, Q1 delivers fixed current to operational amplifier. As input pulse height increases, more and more tunnel diodes are triggered, and current to operational amplifier increases linearly.—J. D. Nickell, Tunnel-Diode Pulse-Height Discriminator, *EEE*, 13:9, p 75.

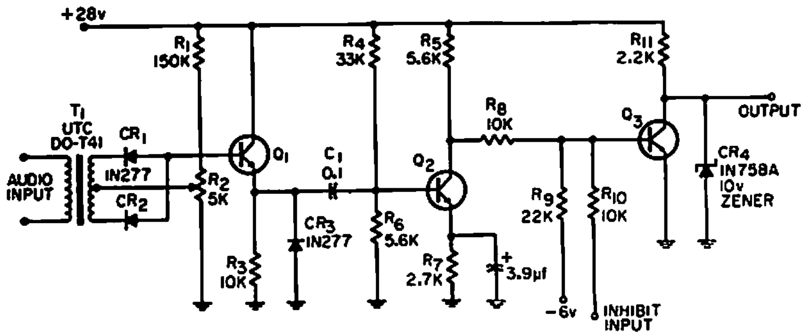
CHAPTER 66
Pulse Processing Circuits



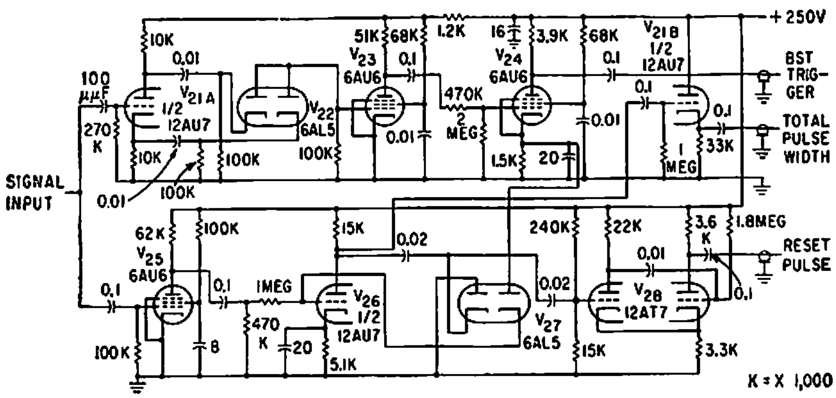
MAGNETRON BEAM SWITCHING—First trigger pulse switches beam to first position, and each succeeding trigger advances beam one position, until reset pulse zeroes V11 for repetition of switching sequence. Succeeding switching-circuit output pulses are thus time-coincident with succeeding amplitude portions of input signal, for pulse amplitude measurement.—J. F. Lyons, Jr., Analyzing Multipath Delay in Communications Studies, *Electronics*, 32:36, p 52–55.



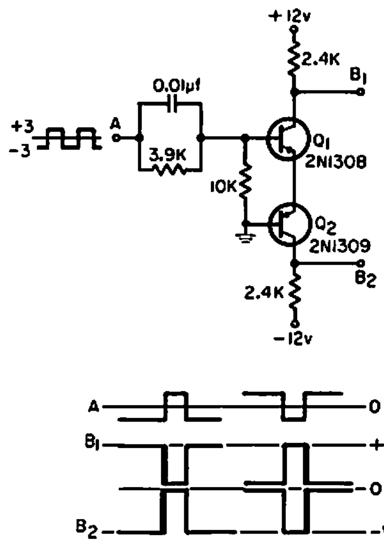
CONSTANT DUTY CYCLE—Width of output pulse varies with frequency to keep duty cycle constant at preadjusted value from 25% to 75%, over input trigger range of 100 to 5,000 pps. Q1, Q3, and Q4 form one mvbr, and Q5 is second mvbr. Q2 is voltage-to-current converter.—G. P. Klein, Duty Cycle is Constant at any Trigger Frequency, *Electronics*, 38:15, p 62–63.



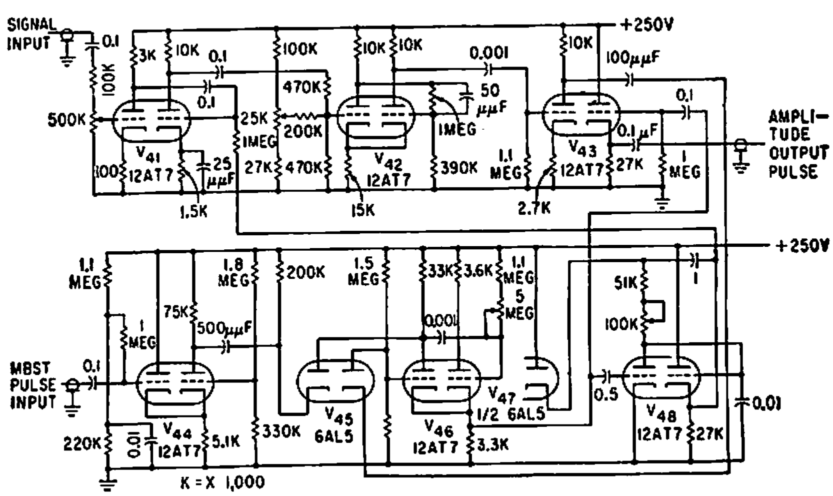
SINE-WAVE ZERO-CROSSING DETECTOR—Delivers 10-v pulse that coincides with zero crossings of sine-wave input for most of audio range. Output interval is adjustable. —F. Stevens, Jr., Sine-Wave Zero-Crossing Detector, *EEE, 13:11, p 45.*



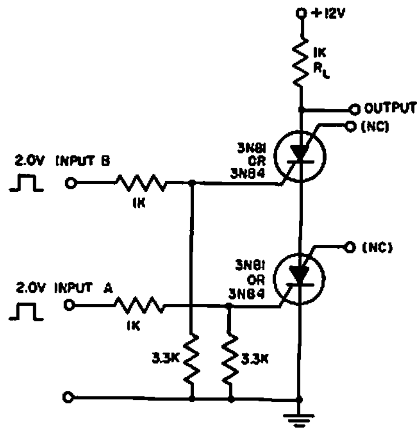
TRIGGER GENERATOR—Differentiating circuit provides triggers for each input signal amplitude discontinuity, and resultant positive and negative triggers are converted to uniform negative polarity in paraphase amplifier V21A. Second channel, composed of overdriven amplifiers V25 and V26 and cathode follower V21B, provides output pulse whose width corresponds to that of overall input signal. Lagging edge of pulse triggers one-shot V28 to generate delayed reset pulse for subsequent switching circuits.—J. F. Lyons, Jr., Analyzing Multipath Delay in Communications Studies, *Electronics*, 32:36, p 52–55.



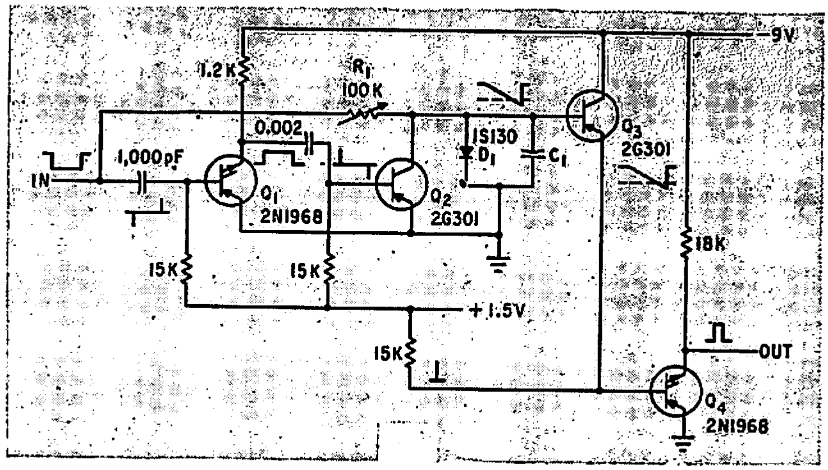
PULSE PHASE SPLITTER—Provides bipolar pulses 180° out of phase, with perfect coincidence of positive-going leading edges, same reference level, and drive capability for saturated inverters.—G. Wolff, Simple Pulse Phase-Splitter, *EEE*, 14:2, p 70–72.



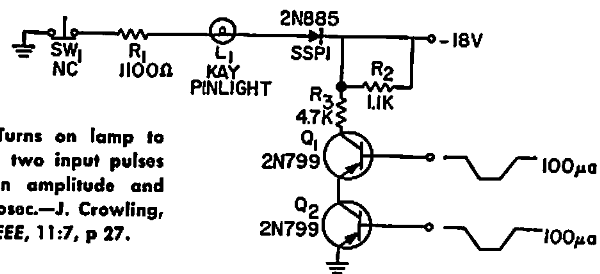
PULSE AMPLITUDE MEASUREMENT—Produces pulse whose width is linearly related to selected portion of input signal. V42 is Schmitt trigger. V46 is flip-flop controlled by output from magnetron-beam switching tube (MBST) for selecting desired sample of signal. Output pulse width is sampled and measured by counter.—J. F. Lyons, Jr., Analyzing Multipath Delay in Communications Studies, *Electronics*, 32:36, p 52–55.



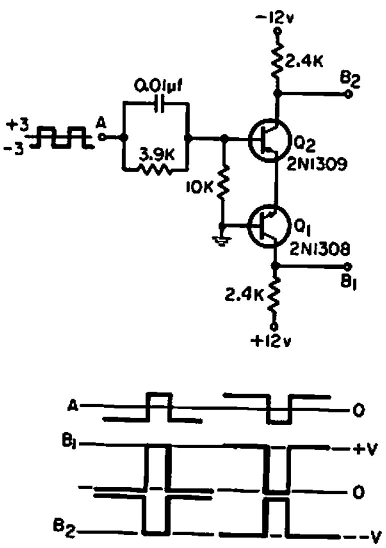
PULSE COINCIDENCE DETECTOR—Provides output from silicon controlled switches only when input pulses are applied simultaneously at A and B, with 2 to 3 v amplitude. Overlap of 1 microsec is sufficient for triggering.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 428.



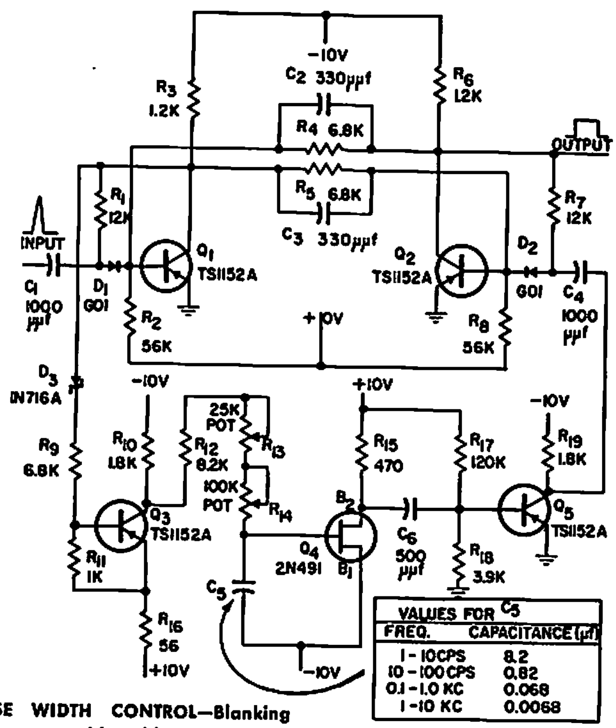
MEASURING PULSE LENGTH—Circuit delivers output pulse only when triggered by input pulse above preset width. Can be used for checking lengths of objects moving past photocell.—K. R. Whittington and G. Robson, Versatile Discriminator Measures Pulse Length, *Electronics*, 35:31, p 48.



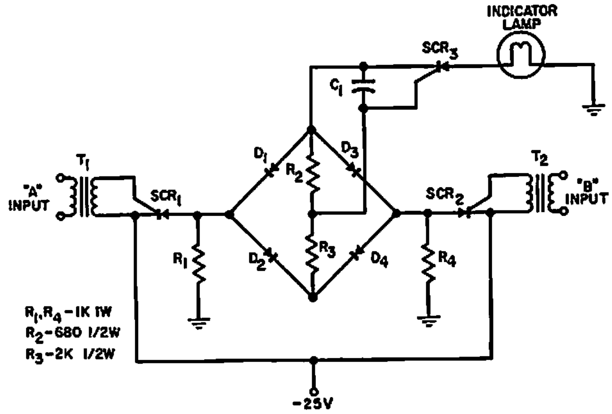
COINCIDENCE DETECTOR—Turns on lamp to indicate coincidence of any two input pulses that are 100 microamp in amplitude and coincide for at least 1 microsec.—J. Crowling, Pulse Coincidence Detector, *EEE*, 11:7, p 27.



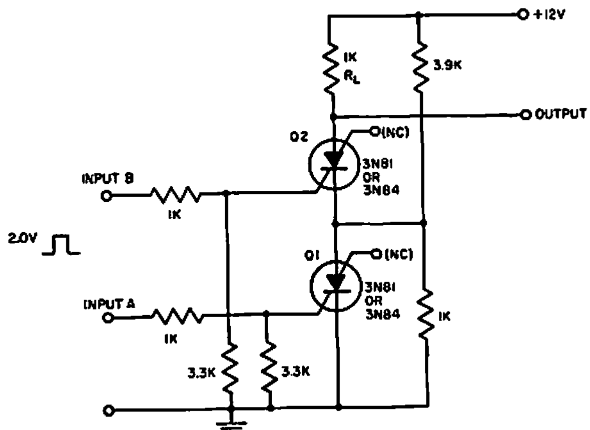
PULSE PHASE SPLITTER—Provides bipolar pulses 180° out of phase, with perfect coincidence of negative-going trailing edges, same reference level, and drive capability for saturated inverters. Used for switching sample-hold gates requiring opposite-going pulses with trailing-edge coincidence.—G. Wolff, Simple Pulse Phase-Splitter, *EEE*, 14:2, p 70–72.



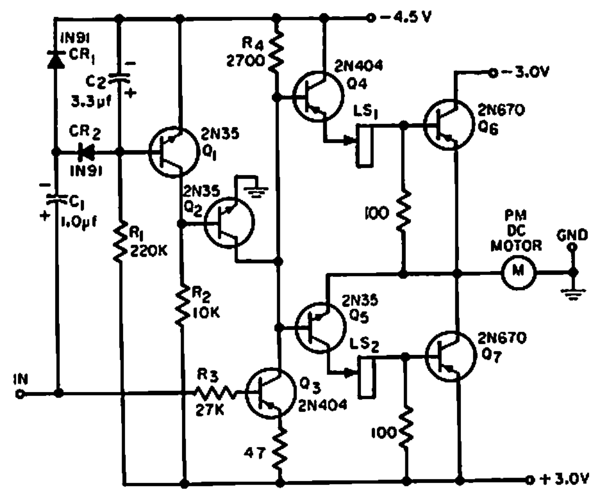
LINEAR PULSE WIDTH CONTROL—Blanking pulse generator provides blanking signal starting with input pulse and remaining on for some nominal portion of pulse, regardless of dropouts due to noise in triggering pulse.—Blanking Pulse Generator with Linear Pulse Width Control, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 78.



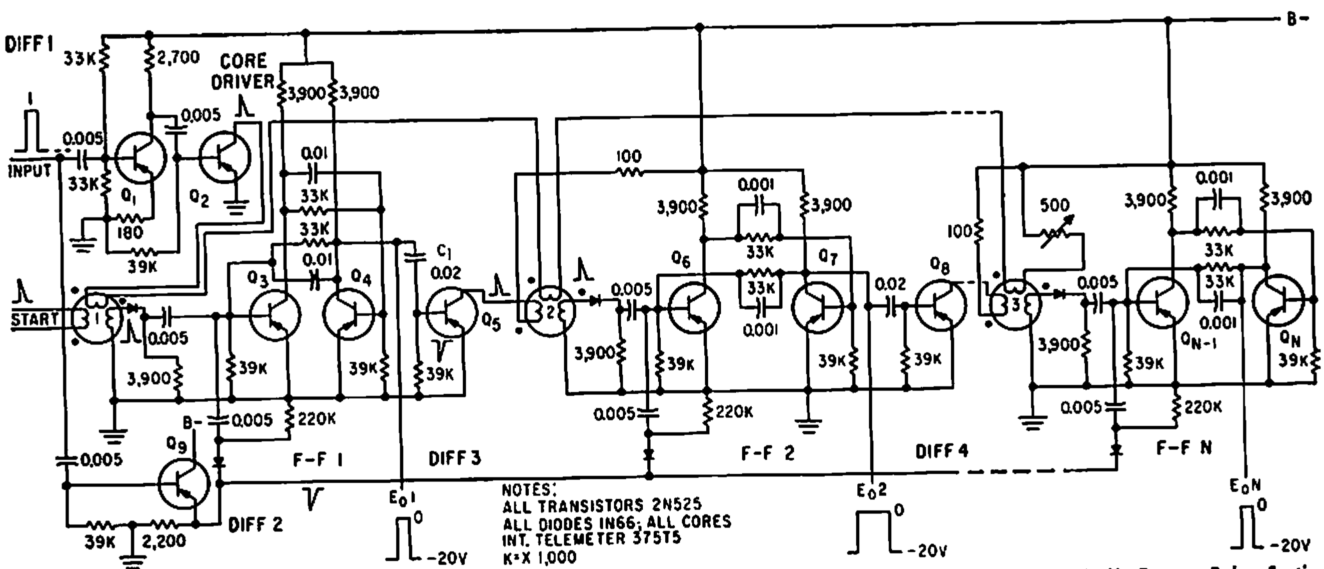
ANTICOINCIDENCE DETECTOR—Gives indication whenever two input pulses are not coincident. Limit on smallest degree of anticoincidence that is detectable is determined by turn-on time of SCR's, and is about 0.3 microsec for 2N1595 scr used, when C1 is omitted. Upper limit is set by C1, and can be several tenths of a second when C1 is 200 mfd. Circuit is reset by interrupting supply. Diodes are 1N691, and lamp is 1819. —J. T. Gatshall, Anti-Coincidence Detector, *EEE*, 10:9, p 28–29.



PULSE SEQUENCE DETECTOR—Resistor divider between Q1 and Q2 supplies current to silicon controlled switch Q1 after it is triggered by pulse at input A. Divider also prevents input B from triggering Q2 until after Q1 conducts.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 428.

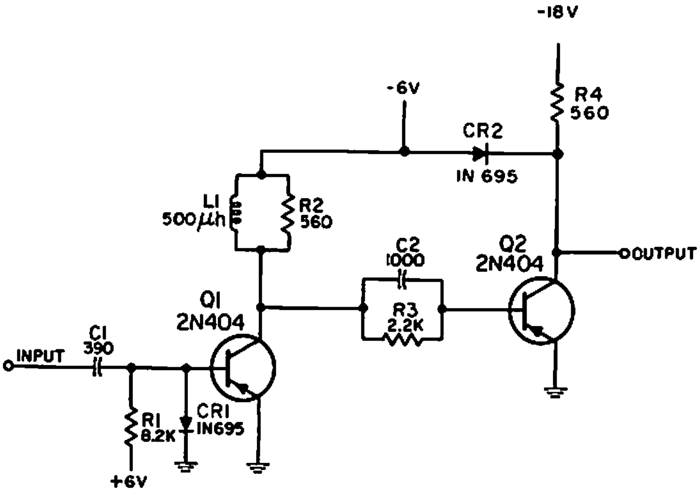


MISSING-PULSE DETECTOR—Detects presence or absence of pulse train and indicates whether level remains positive or negative after pulsing stops.—R. W. Allington, Pulse Absence Detector, *EEE*, 11:5, p 90–91.

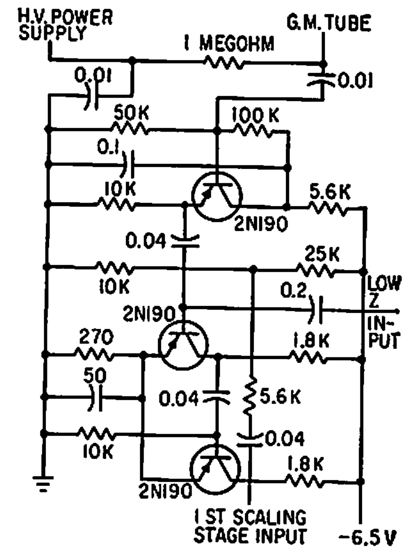


PULSE SORTER—Receives train of varying-width pulses and presents each pulse at output terminal corresponding to position of pulse in train, without changing pulse widths. Three transistors and one ferrite core are used for each sorted pulse. Can handle over 1,000 pps.—J. H. Porter, Pulse Sorting with Transistors and Ferrites, *Electronics*, 32:20, p 64–65.

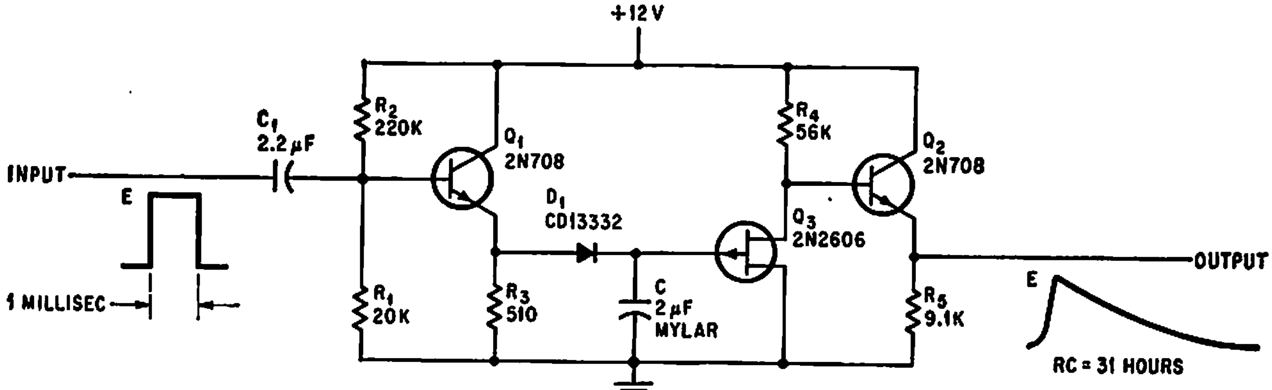
CHAPTER 67
Pulse Shaping Circuits



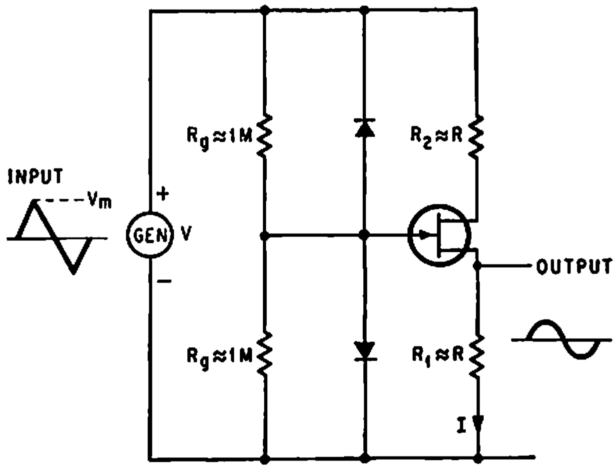
PREFERRED PULSE SHAPER—Generally used with monostable mvbr, to form 1-microsec pulse at end of delay period. Also used to reshape pulse that has suffered deterioration by passage through long chain of gates, or to produce 1-microsec pulse whose leading edge coincides with trailing edge of a positive pulse, for delaying output by width of input pulse.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 11 (originally PC 214), p 11-2.



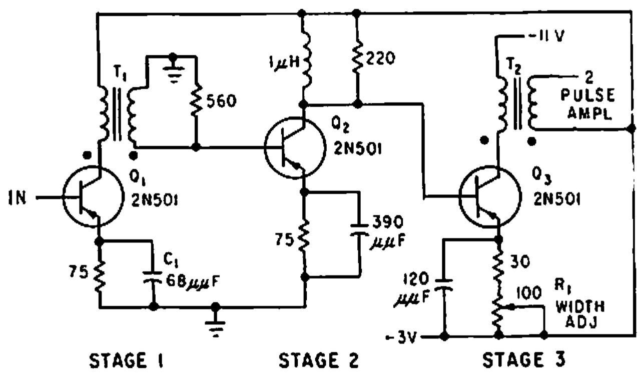
G-M DRIVE FOR SCALE-OF-64 COUNTER—Shapes pulses from Geiger-Muller tube and uses one-shot mvbr to drive first scaling stage.—F. E. Armstrong, Battery Powered Portable Scaler, *Electronics*, 33:19, p 74–75.



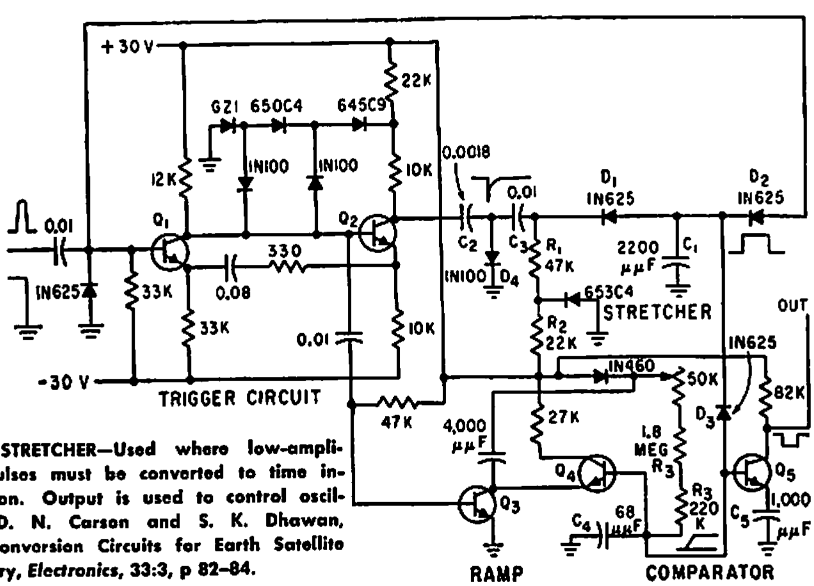
1 MILLISEC TO 30 HOURS—Input and output emitter-followers isolate fet. Extremely low leakage current through D1 and fet Q3 give circuit 30-hour time constant.—M. E. McGee, FET Circuit Stretches 1-MSEC Pulse to 30 Hours, *Electronics*, 38:7, p 87–88.



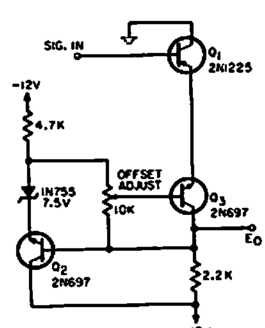
FET CONVERTS TRIANGULAR TO SINE—Eliminates need for signal rectification by using symmetrical properties of Fairchild FSB40 fet with respect to source and drain. For p-channel units, reverse the diodes.—R. D. Middlebrook and I. Richer, Nonreactive Filter Converts Triangular Waves to Sines, *Electronics*, 38:5, p 96–101.



PULSE FORMER AND SHAPER—Converts sine-wave input to 40 millimicrosec output. Used in versatile pulse generator for testing high-speed computer circuits. Input frequency range is 3 to 20 Mc.—L. Numann, Transistorized Generator for Pulse Circuit Design, *Electronics*, 32:14, p 47–49.

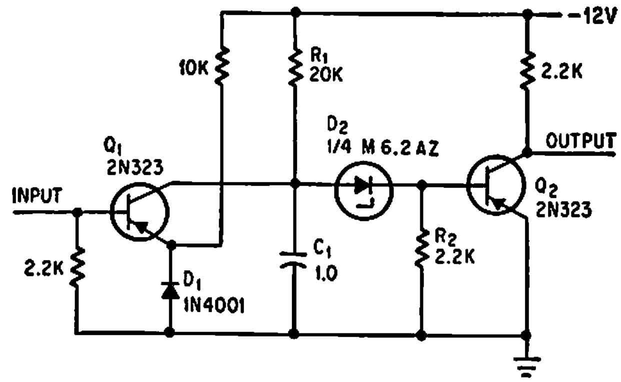


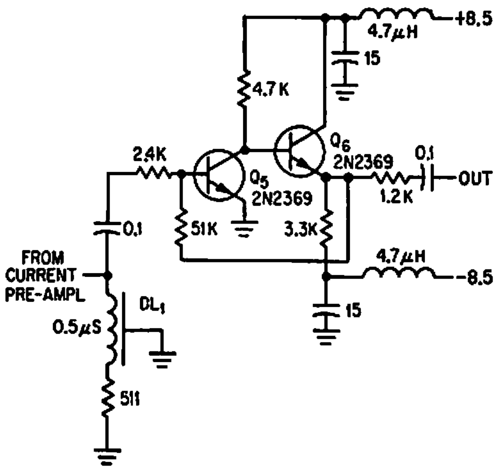
PULSE STRETCHER—Used where low-amplitude pulses must be converted to time information. Output is used to control oscillator.—D. N. Carson and S. K. Dhawan, Data Conversion Circuits for Earth Satellite Telemetry, *Electronics*, 33:3, p 82–84.



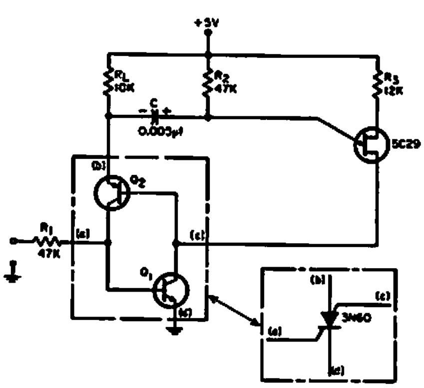
ADJUSTABLE D-C LEVEL SHIFTER—Shifts d-c level of signal accurately and continuously without affecting gain, from +4 v to +7 v d-c center-voltage output. Input a-c signal varies 2 v about +4 v d-c. Other offset voltages can also be obtained.—H. Anway, Continuously Adjustable DC Level Shifter, *EEE*, 12:10, p 59.

ZENER-DIODE PULSE STRETCHER—Gives delays up to 50 millisec without need for large capacitance values, by varying R1; delay is 10 millisec for 20K value shown. Input is negative 1-millisec pulse, which is stretched by amount of delay.—A. S. Robinson, Zener Diode Allows Delay Without Large Capacitors, *Electronics*, 39:11, p 93.

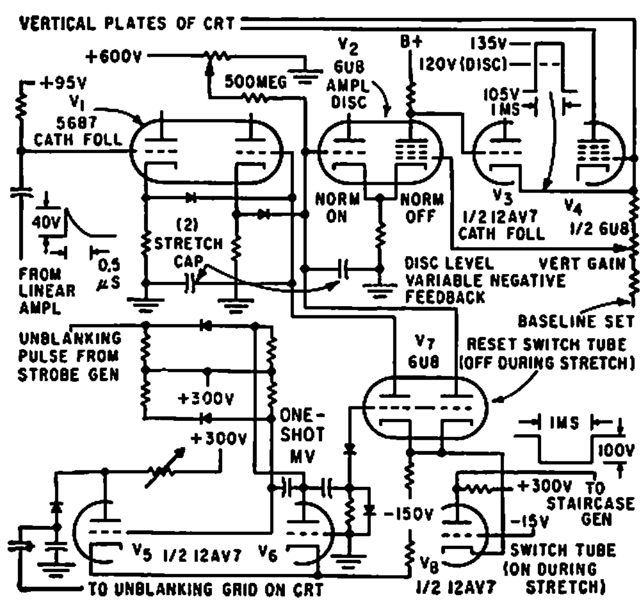




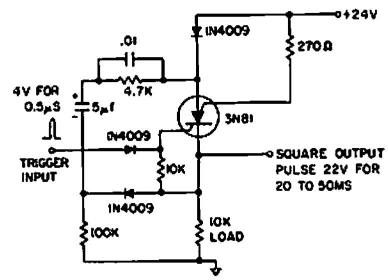
DELAY-LINE PULSE SHAPER—Voltage pulse from current preamplifier of multiplier phototube is shaped by DL1, which is shorted at one end and terminated at other end with its characteristic impedance, to normalize input pulse width at twice 0.5-microsec characteristic delay of line. First stage gives open-loop gain of 118. Second stage gives low-impedance drive for feedback and for following discriminator amplifier. Total loop gain is 17 for bandwidth of 1 Mc.—R. Cuikay and T. Callahan, Orbiting Observatory to Measure Stars' Dim Light, *Electronics*, 37:9, p 28–31.



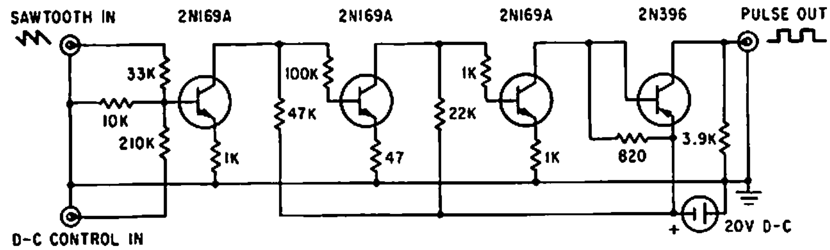
SELF-RESETTING PULSE STRETCHER—Produces output pulse that lasts for designated period of time after last of group of 20-microsec 5-v input pulses disappears. Circuit then resets, and draws no current while quiescent. Amount of stretching is determined by charging of C through R2, and is 55 microsec for values shown. Gate-turnoff scr can be used in place of transistors Q1 and Q2. —B. F. Smith, Self-Resetting Pulse Stretcher, *EEE*, 12:8, p 71–72.



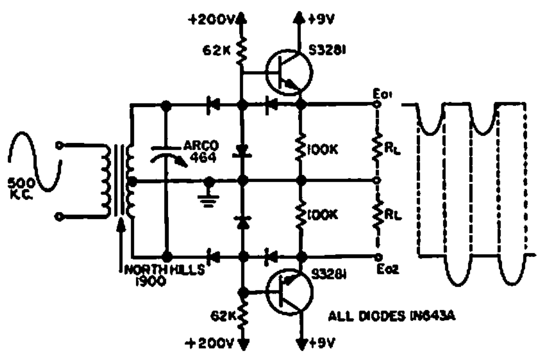
STRETCHER-EXPANDER—Produces dot pulse that unblanks crt screen and advances staircase. 0.5-microsec pulse from linear amplifier is stretched to 2-millisec pulse, amplified, and inverted for push-pull crt deflection.—W. E. Bushor, Sample Method Displays Millimicrosecond Pulses, 32:31, *Electronics*, p 69–71.



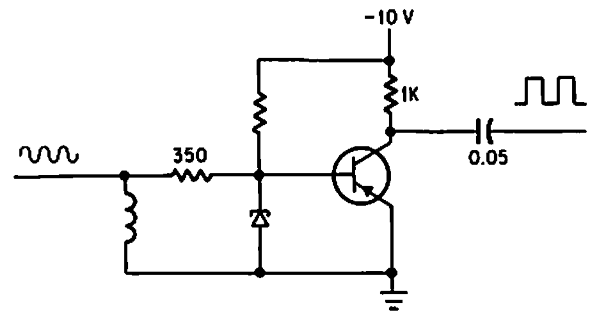
SCS PULSE STRETCHER—Stretch interval is determined by 5-mfd capacitor and 4.7K resistor.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 435.



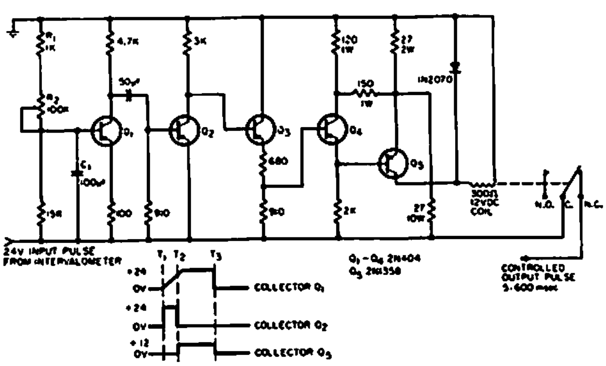
SAWTOOTH CLIPPER—High-gain amplifier converts sawtooth input to rectangular output pulse whose width is proportional to portion of sawtooth amplitude that is above threshold level.—B. E. Mathews and F. R. Sias, Jr., Testing Space Craft with Induction Heaters, *Electronics*, 35:34, p 38–41.



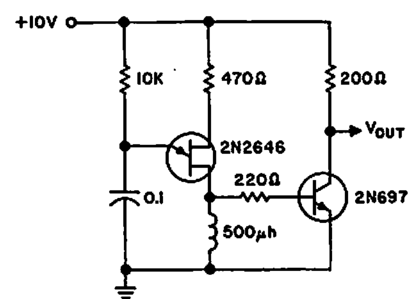
500 KC TO 1 MC D-C RESTORER—Modified clamp circuit is used with 500-kc sine-wave input to provide complete restoration of reference potential for 1-Mc half-wave output. —H. Kundrat, Jr., High Frequency DC Restoration with Gain, *EEE*, 11:10, p 26–27.



SINE TO SQUARE WAVES—Japanese Esaki or tunnel diode acts like Schmitt trigger in converting sine-wave input signal to square-wave pulse train.—T. Kojima and M. Watanabe, When You're Second, You Try Harder, *Electronics*, 28:25, p 81–89.



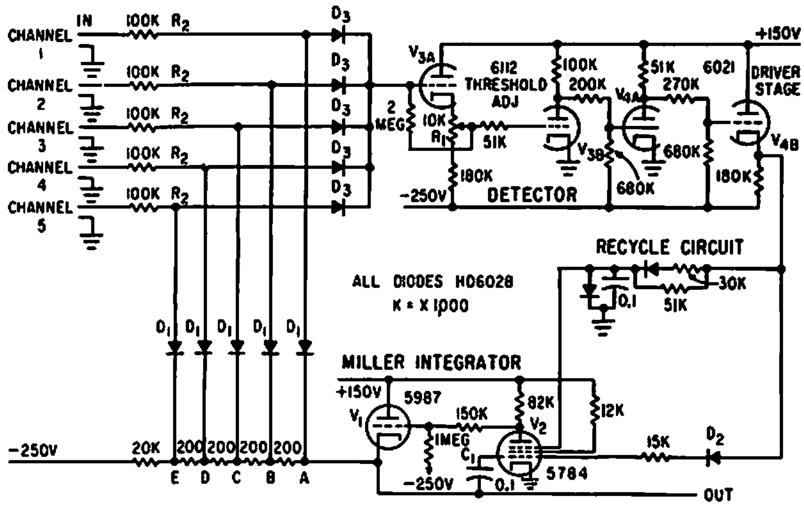
PULSE-LENGTH CONTROLLER—Reduces duration of intervalometer pulse from 400 millisec to 100 millisec without affecting intervalometer operation for other purposes. Used to control airborne strip-chart camera.—J. S. Peddo, Low-Cost Pulse-Length Controller, *EEE*, 12:7, p 26.

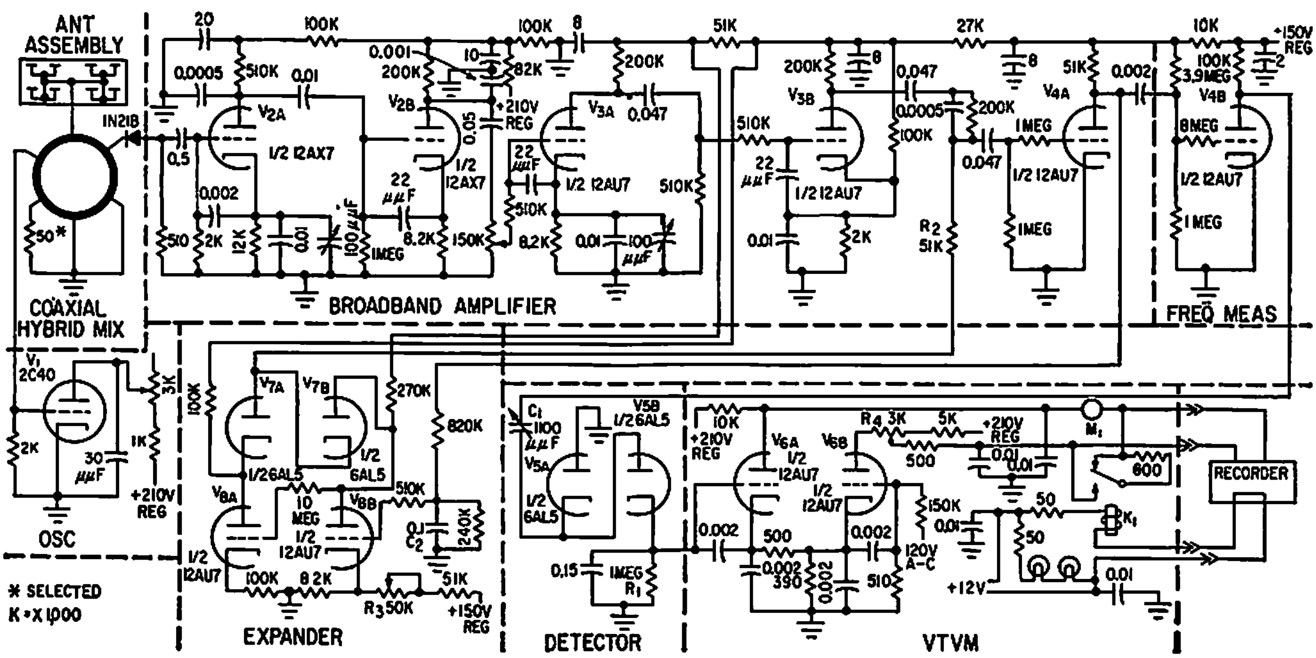


UJT PULSE SHAPER—Use of inductance in ujt relaxation oscillator gives significant improvement in output pulse shape over that of conventional resistance-coupled circuit. Pulse width for various transistors is between 11 and 12 microsec, and rise and fall times are typically 0.3 microsec. With 47-ohm resistor in place of inductance, fall time would be 3 microsec.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 316.

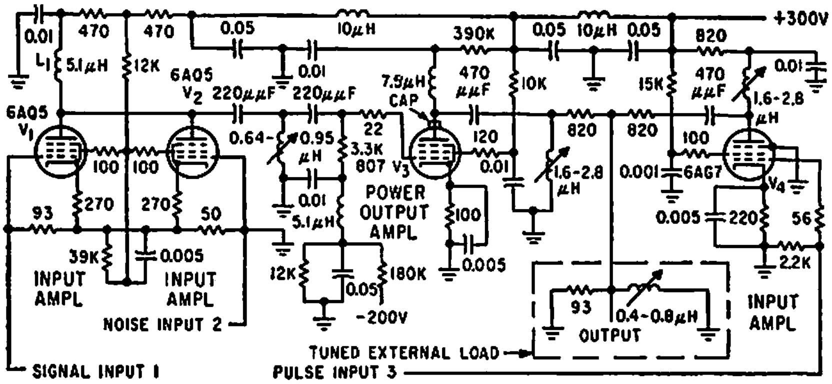
CHAPTER 68
Radar Circuits

MULTICHANNEL MONITOR—Automatically detects single signal coming from large number of separate sources and identifies source, as required in doppler radar sets that must search bank of sharp filters placed side by side, to detect target, while antenna scans field of search. Positive signal reaching detector is amplified to drive Miller integrator V1-V2. As V1 goes negative, it disconnects one channel at a time (by driving its disconnecting diode D1 below 0 v) until live channel is reached. Detector output is then cut off, and C1 stores level at which disconnect occurred.—R. Kronlage, Monitoring Multiple Inputs Simultaneously, *Electronics*, 32:35, p 50–51.

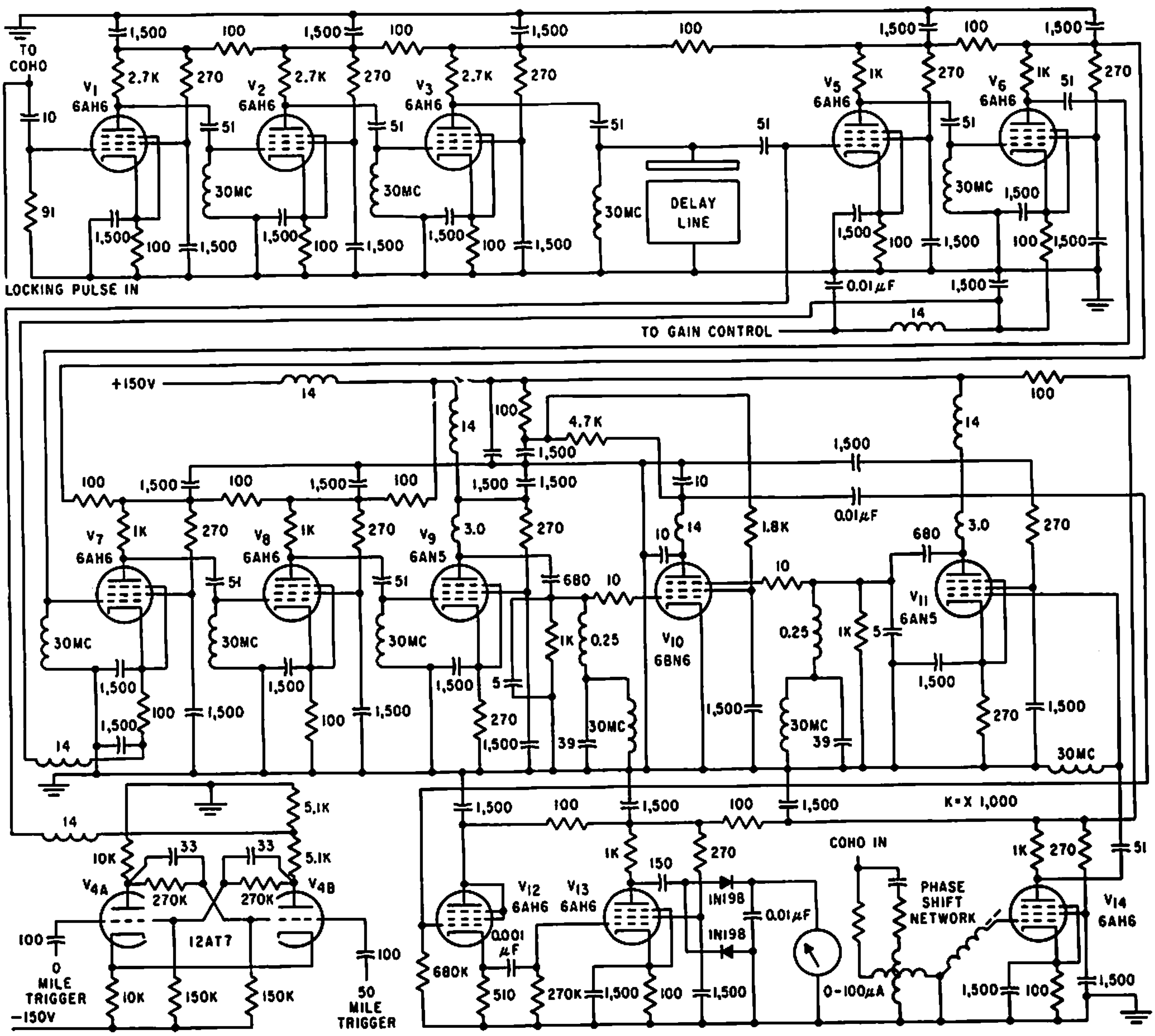




RADAR SPEED METER—Translates doppler or difference frequency between transmitted and received frequencies into mph and displays on meter or records on strip chart. Operates at 2,455 Mc and is accurate within 2 mph up to 100 mph.—J. Barker, Radar Meter Helps Enforce Traffic Laws, *Electronics*, 32:10, p 48–49.

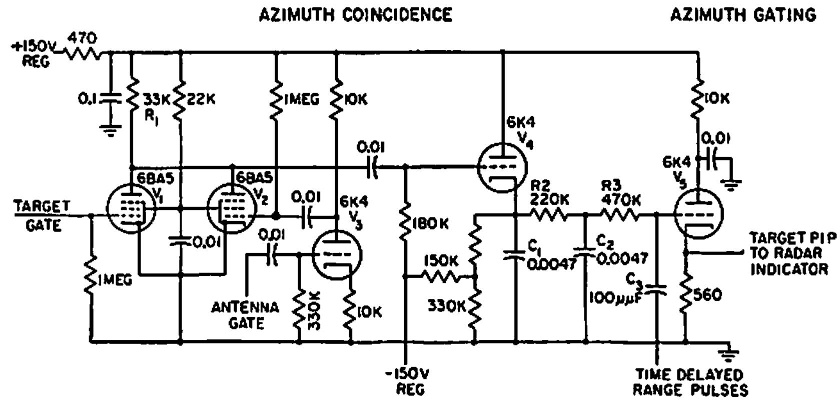


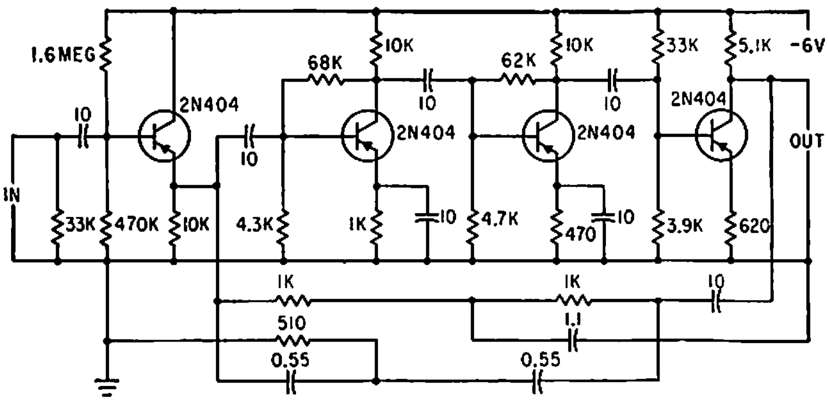
DELAY LINE AMPLIFIER FOR CLUTTER SIMULATOR—Used with ultrasonic delay line and 30-Mc Gaussian noise source to simulate actual clutter received during consecutive radar sweeps. Input 1 is amplified version of delay line output signal, which is added to noise input 2 in common plate load of V1 and V2, for amplification by V3. These three tubes together with tuned input to delay line form staggered Butterworth triple centered on 30 Mc, with half-power bandwidth of 2.75 Mc. Third input permits insertion of pulse for precise synchronizing to repetition frequency of clutter simulator. —J. Atkin, H. J. Bikel, and M. Weiss, Realistic Simulation of Radar Clutter, *Electronics*, 32:39, p 78–81.



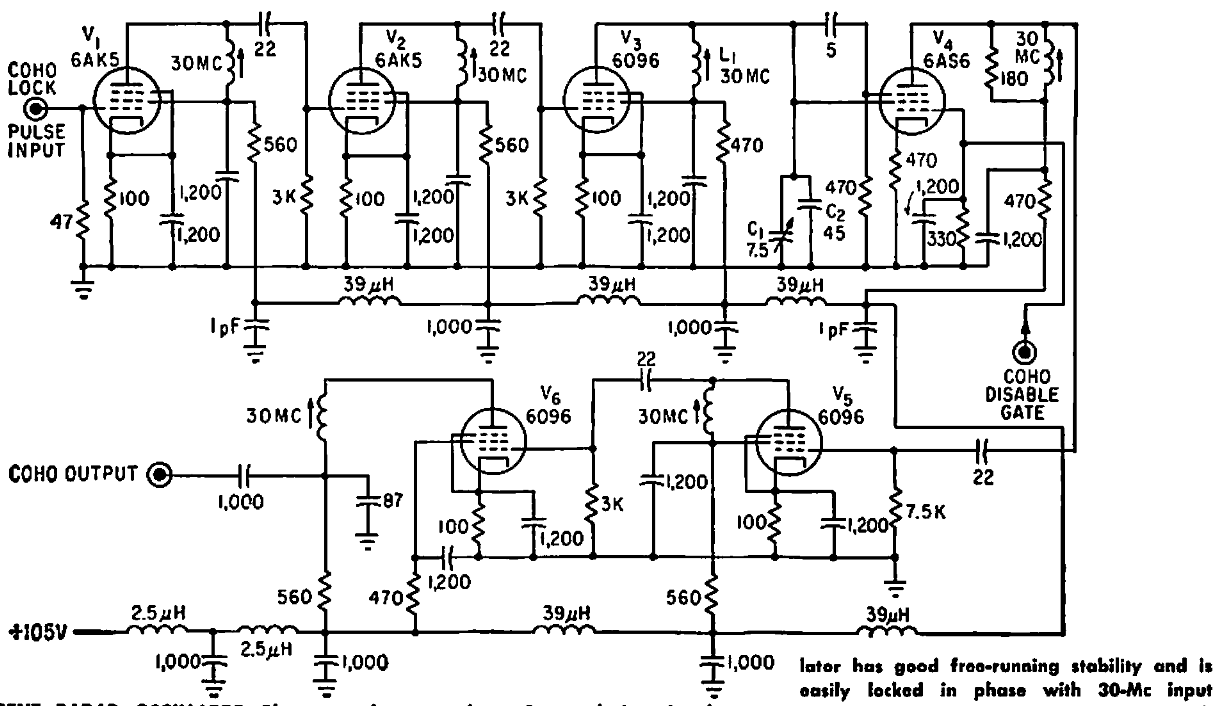
COHO JITTER MONITOR—Automatically monitors coherent oscillator frequency and provides visible indication of amount of jitter, as measure of mti system capability.—C. Clark, Checking Jitter in Moving Target Radar, *Electronics*, 32:29, p 56–58.

TWO-DIMENSIONAL TARGET SIMULATOR—Two signals, one representing angular position of target and the other angular position of radar antenna, are fed to azimuth coincidence circuit. When signals coincide, indicating that antenna is pointing at target, delayed pulses representing a target are passed to radar ppi by azimuth gating circuit.—J. I. Loskinen, Four Ways to Simulate Radar Targets, *Electronics*, 31:23, p 82–86.

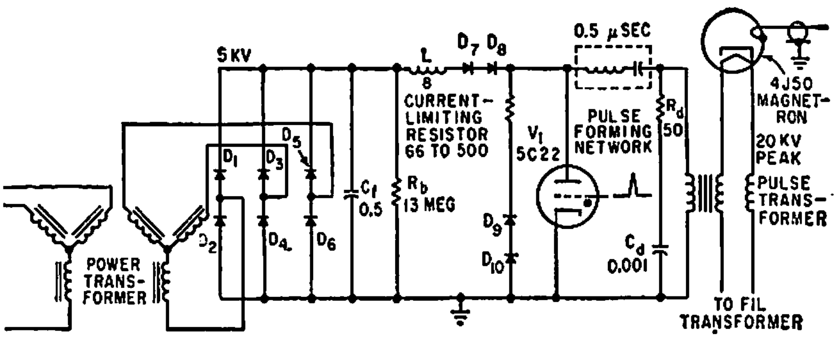




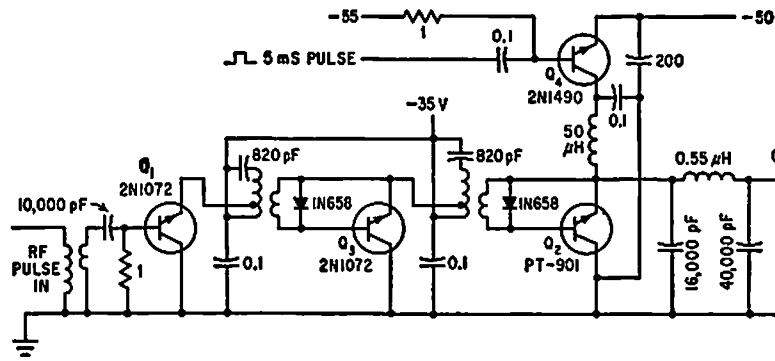
NARROW-BAND RADAR AMPLIFIER—Twin-tee feedback loop tuned to modulating frequency between 60 and 400 cps is used with video crystal and chopper of low-cost c-w radar receiver. Minimum detectable level is −55 dbm.—R. Fleming, Modulation Techniques Cut Radar Cost, *Electronics*, 35:35, p 56–58.



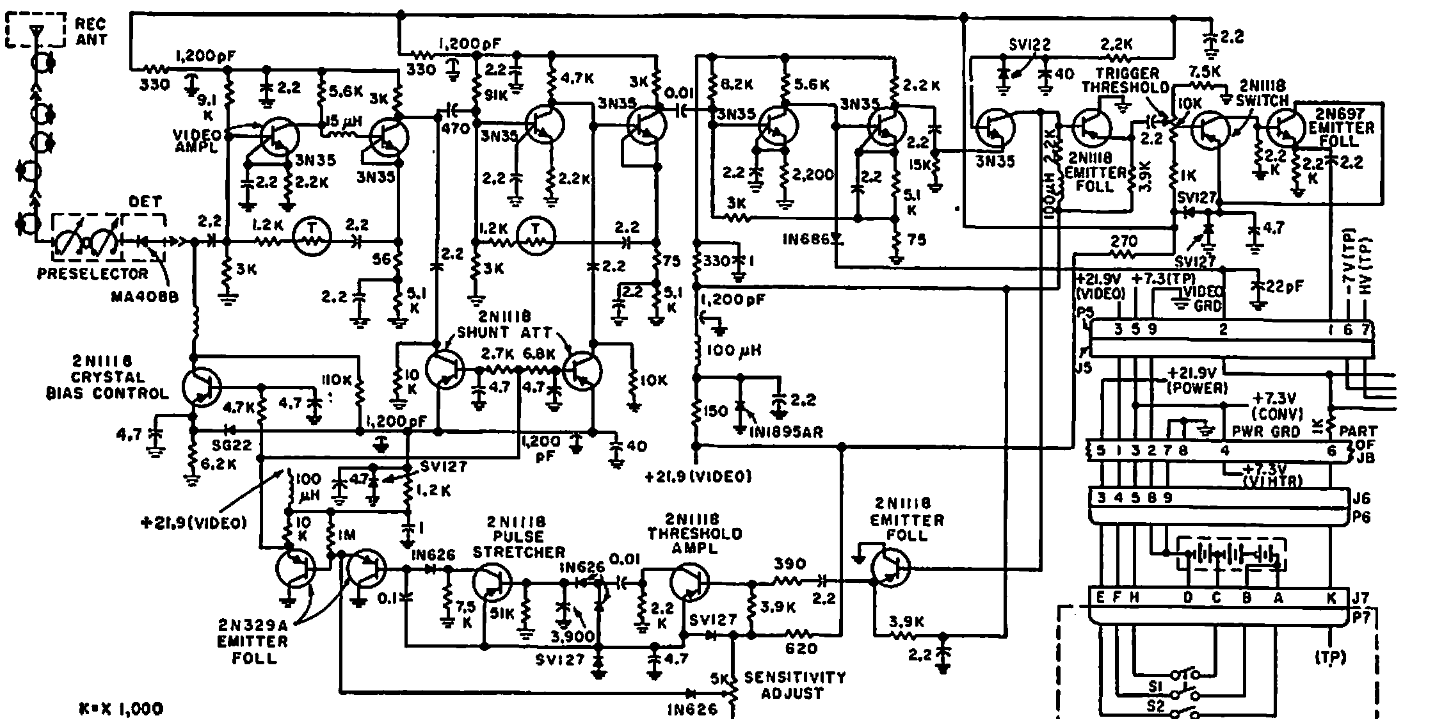
SSB COHERENT RADAR OSCILLATOR—Phase information of each transmitted pulse is stored in coherent oscillator V3 for use as reference voltage for analyzing doppler return from targets. Other stages are amplifiers. Oscillator tank is L1-C1-C2. This oscillator has good free-running stability and is easily locked in phase with 30-Mc input pulse.—J. B. Theiss, More Target Data with Sideband Coherent Radar, *Electronics*, 36:3, p 40–43.



250-KW MODULATOR—Ten silicon diodes replace five vacuum tubes in artificial line-type modulator for airborne radar operating at peak power of 250 kw.—M. G. Gray, Using Silicon Diodes in Radar Modulators, *Electronics*, 32:24, p 70–72.

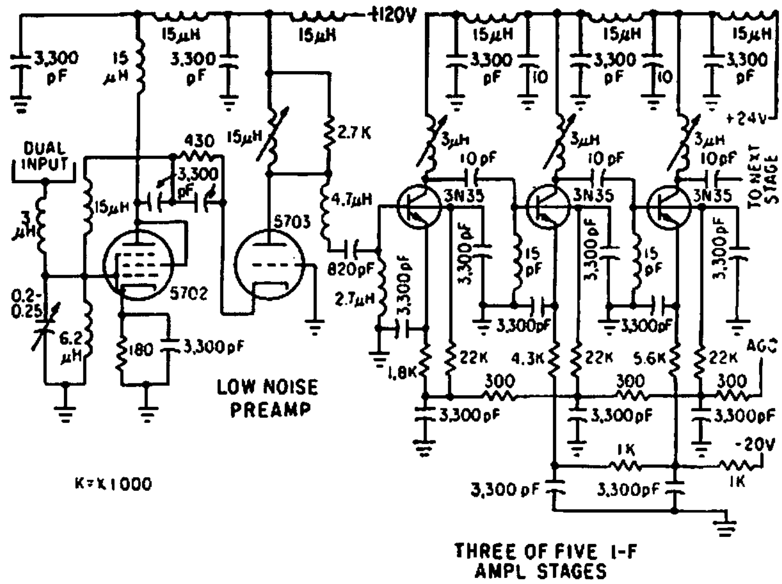


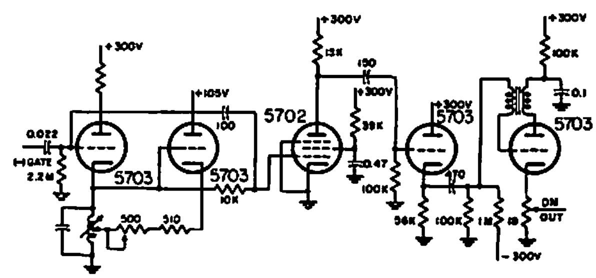
RADAR POWER AMPLIFIER—Handles pulses in range of 100 to 500 microsec at 2.2 Mc. Class B final stage Q2 delivers 105 w to pi loading network serving as 51-ohm load.—S. Horowitz and L. Humphrey, Satellite Sounder and Telemeter Chart Ionosphere Electron Density, *Electronics*, 34:25, p 50–53.



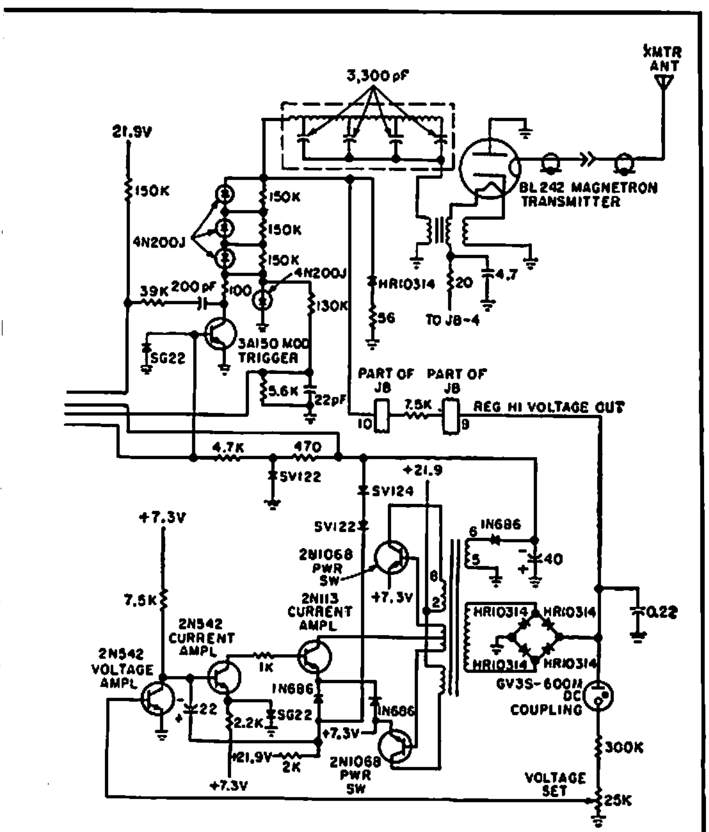
RADAR TRANSPONDER—Used in missiles for tracking during test firing on range. Semiconductor modulator minimizes power drain and thereby reduces heating in transponder, while providing r-f output pulse having extremely fast rise and fall times. Delay stability gives range accuracy of 1 yard.—L. Divon, Solid-Stage Modulator Feeds Subminiature Transponder, *Electronics*, 33:27, p 48–51.

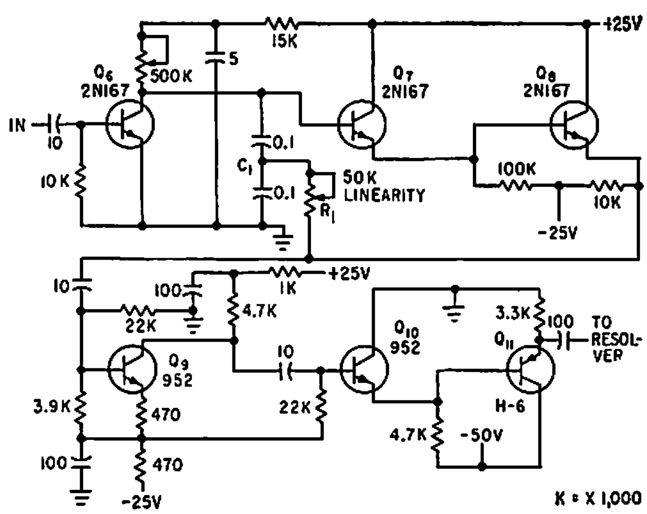
HYBRID 30-MC I-F—Bandwidth is 6 Mc, noise figure is below 2.5 db, and gain is enough to give 1 v peak-to-peak noise output into 1,000-ohm load when using two transistorized video stages following the five transistorized i-f gain stages.—J. Scott, D. Randise, and R. P. Lukacovic, Portable Radar Traces Battlefield Deployment, *Electronics*, 33:12, p 67–70.



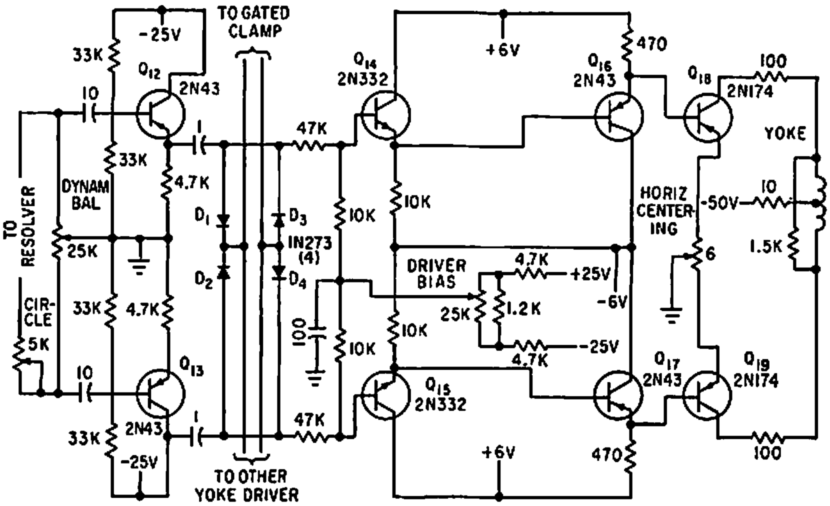


DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, pentode amplifier-shaper, and series-triggered blocking oscillator to generate 20-mile distance marks in airborne search radar.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8–2.

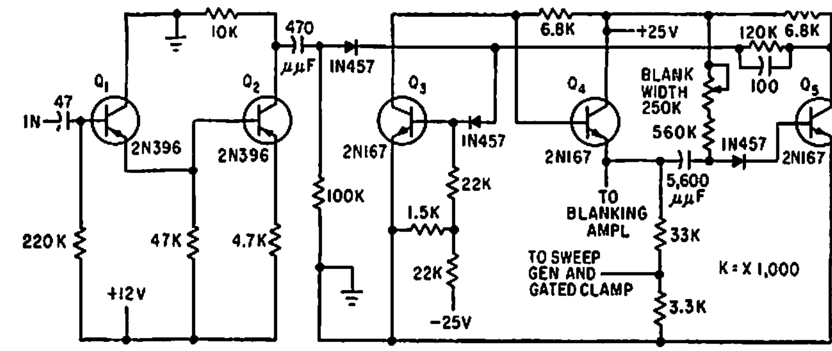




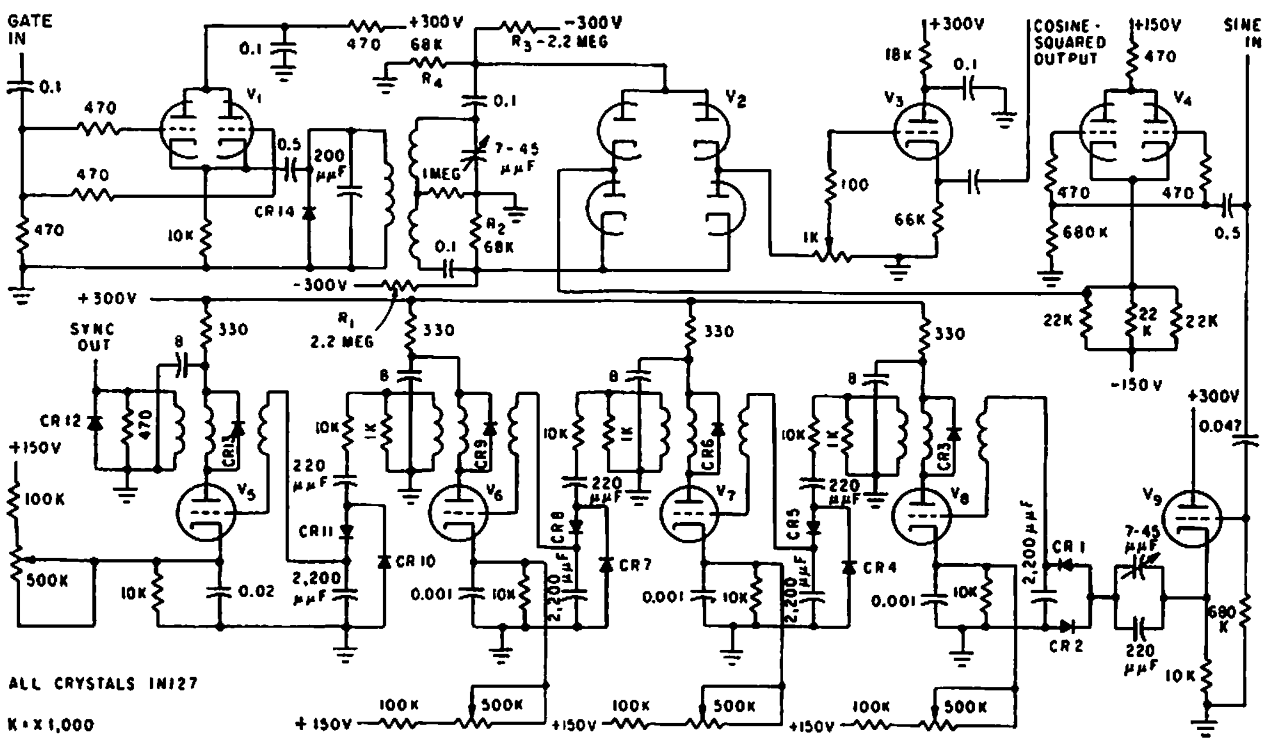
SWEEP GENERATOR—Accepts pulse from monostable mvbr and generates signal for sweep resolver of ppi radar. Voltage rises at constant rate during mono off time, and is held at zero during on time. Cascaded emitter-follower Q7-Q8 provides impedance match to output. Q9-Q10-Q11 provide required power for sweep resolver while preventing thermal runaway at normal temperatures.—C. E. Veazie, Transistorized Radar Sweeps Circuits Using Low Power, *Electronics*, 32:26, p 46–47.



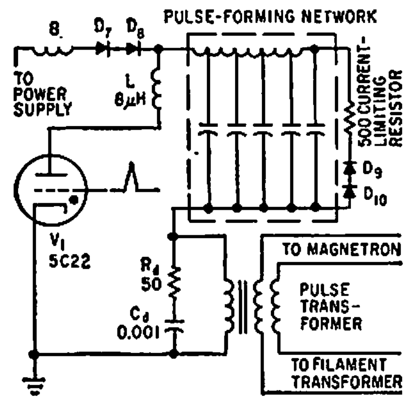
YOKE DRIVER—Used to clamp sweep signal voltage to reference voltage during clamping time at end of sweep, while removing clamp during sweep. Diodes D1-D2 and D3-D4, connected in opposite polarity to each signal line, serve as clamp circuit.—C. E. Veazie, Transistorized Radar Sweep Circuits Using Low Power, *Electronics*, 32:26, p 46–47.



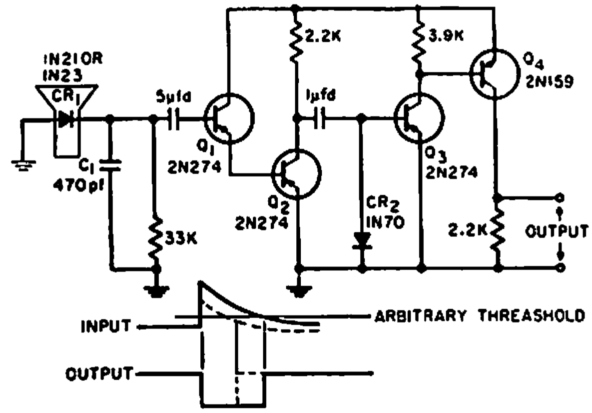
TIMING PULSE SHAPER—Monostable mvbr converts timing signal to narrow pulse whose width is accurately controlled by R-C network. Use of emitter-follower Q4 between triggered transistor Q3 and R-C network assures fast rise and fall times.—C. E. Veazie, Transistorized Radar Sweep Circuits Using Low Power, *Electronics*, 32:26, p 46–47.



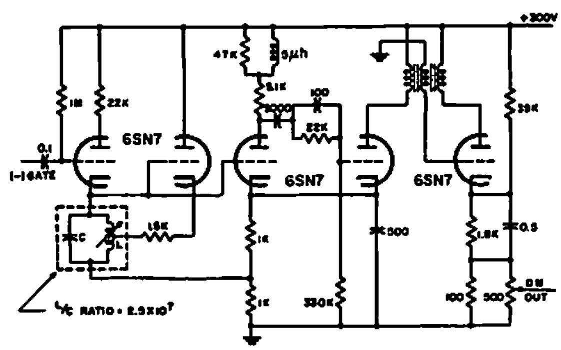
COSINE-SQUARED PULSE GENERATOR—Generates pulse whose width is half the duration of one input sine-wave cycle. Cosine-squared pulse output is fed into balanced modulator in conjunction with 30-Mc signal, and resulting burst is used as input to synchrodyne klystron.—K. H. Chase and J. L. Pierzga, Reducing Mutual Radar Interference, *Electronics*, 32:28, p 39–43.



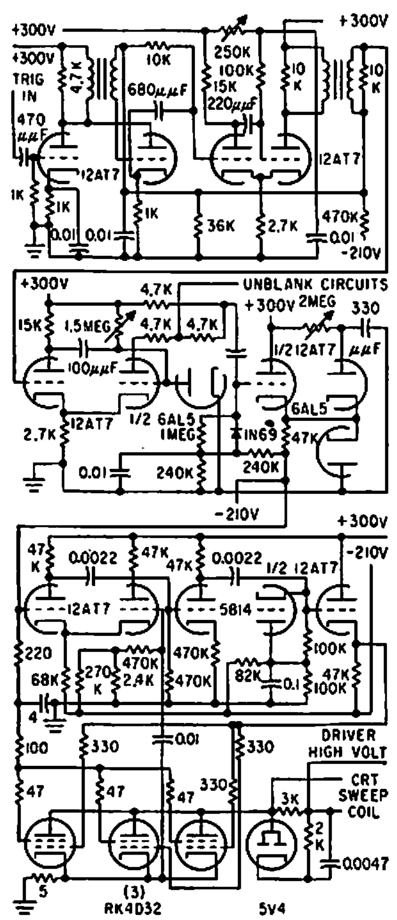
FAR-END-OF-LINE MODULATOR CLIPPER—In variation of diode modulator, clipper diodes D9 and D10 are connected to far end of pulse-forming network, for improved performance. Choke L in plate circuit of thyratron limits rate of rise of thyratron current.—M. G. Gray, Using Silicon Diodes in Radar Modulators, *Electronics*, 32:24, p 70–72.



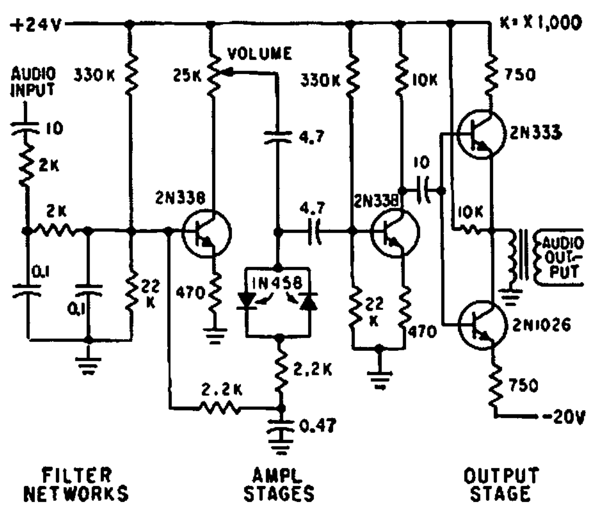
LOG AMPLIFIER—Has highly linear logarithmic output over 30-db dynamic range. Used in obtaining antenna patterns on operating radar system. Output current is directly proportional to pulse repetition frequency and log of peak r-f pulse power.—Logarithmic Amplifier for Radar Signals, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 107.



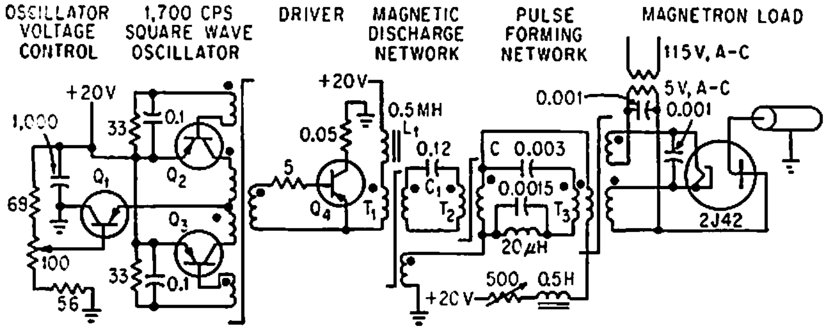
DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, mvbr-type trigger shaper, and parallel-triggered blocking oscillator to generate distance marks in airborne search radar. RLC unit is switched to change mark spacing.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8–1.



VARIABLE SWEEP LENGTH—Operates with sweep lengths varying by factor of 8 to 1. Supplies 1,100 v at 160 ma for 0.5-mile range and 400 v at 270 ma for 4-mile range.—R. F. P. Smith, Airport Radar Has High Resolution, *Electronics*, 32:14, p 64–69.

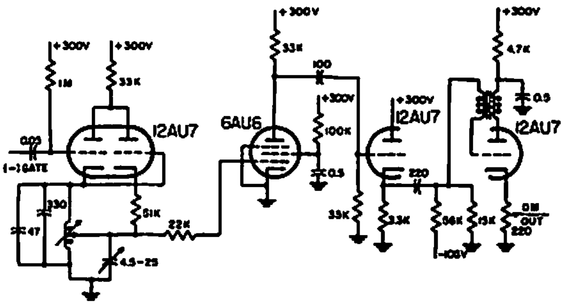


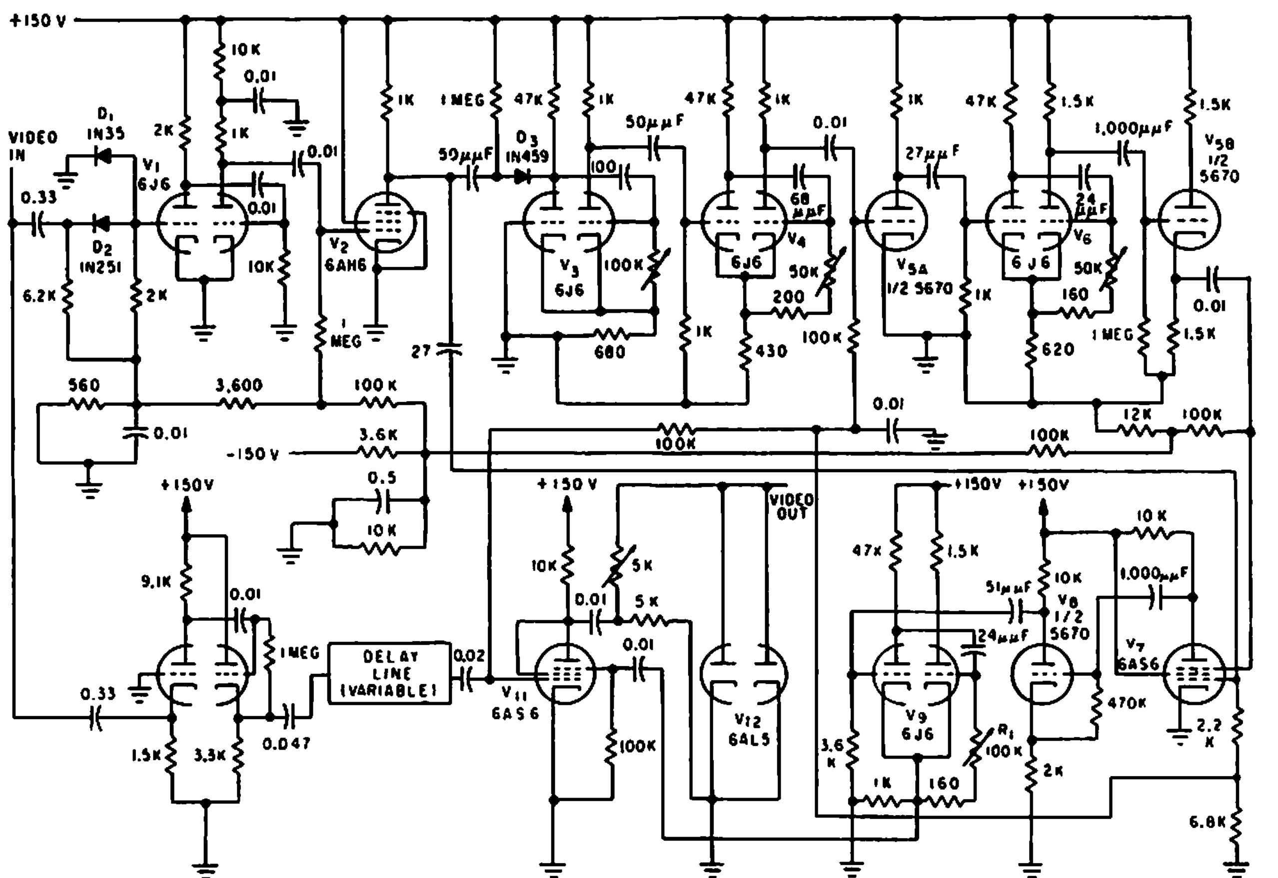
STRONG-NOISE-SUPPRESSING AUDIO AMPLIFIER—Feedback circuit limits amplitude of low-frequency signals such as those produced by wind-moved tree branches, to prevent masking vehicular target signals in portable doppler radar. Low-pass filtering compensates for poor bass response of human ear, permitting detection of slow-moving targets such as walking man.—J. Scott, D. Randise, and R. P. Lukacovic, Portable Radar Traces Battlefield Deployment, *Electronics*, 33:12, p 67–70.



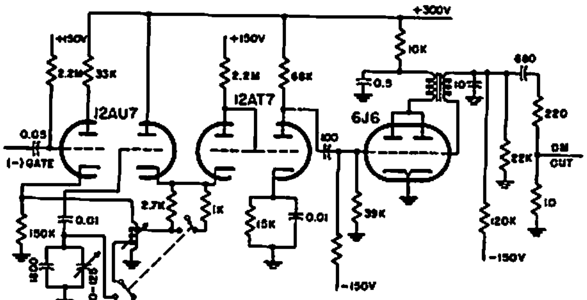
HIGH-POWER PULSE GENERATOR—Power transistors and saturable transformers serve in place of hydrogen thyratrons for generating pulses with 1-megawatt peak power for sonar and radar. Low-voltage capacitor is first charged to voltage that is regulated on pulse-to-pulse basis rather than from regulated supply. Capacitor is then discharged through saturable step-up transformer L1 to charge high-voltage capacitor, which in turn is discharged through magnetron load.—R. T. Maguire, SCR's to Pulse Radar, *Electronics*, 37:3, p 14–15.

DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, pentode amplifier-shaper, and series-triggered blocking oscillator to generate 1-mile distance marks in airborne search radar. Frequency dividers are used for 10- and 20-mile marks.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8–2.

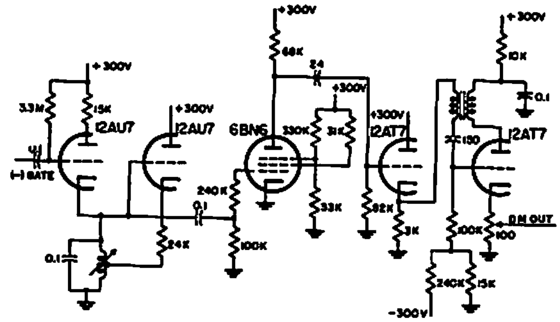




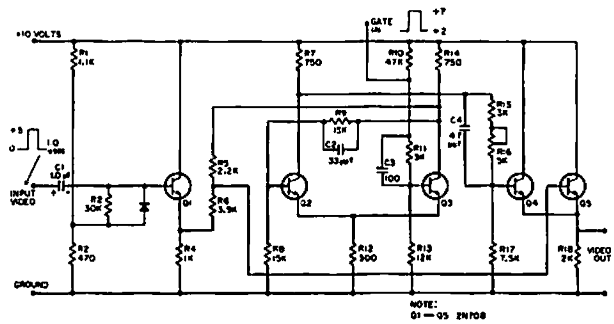
PULSE-WIDTH DISCRIMINATOR—Cuts scanning loss from interfering radars in half, by blanking video signal only if it falls within notch developed by gating circuits. Gives marked improvement in acquisition capability.—K. H. Chase and J. L. Pierzga, Reducing Mutual Radar Interference, *Electronics*, 32:28, p 39–43.



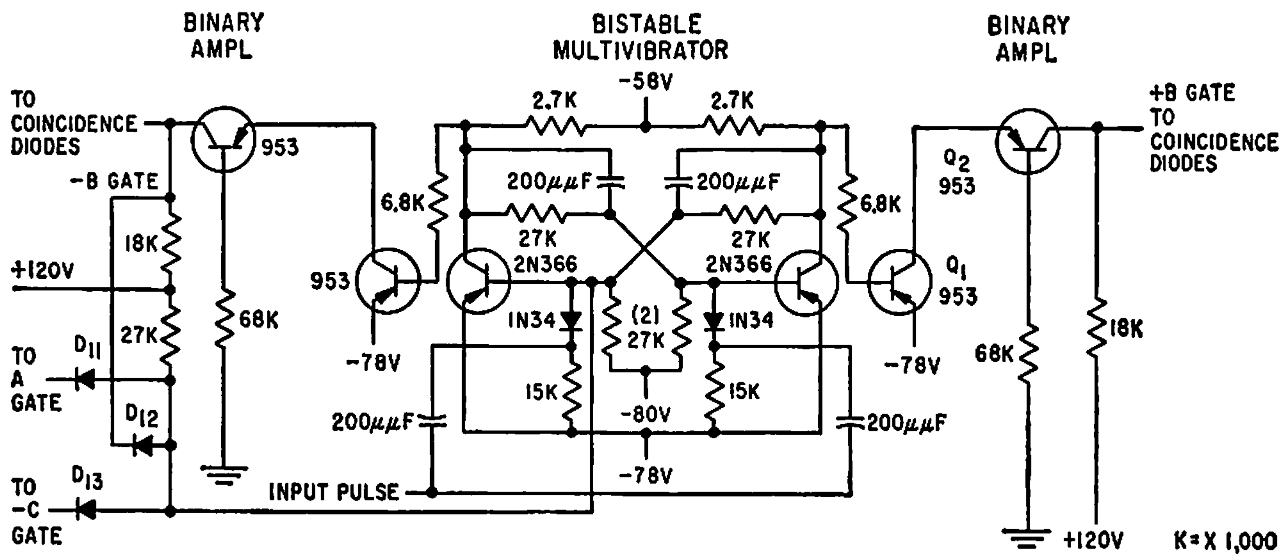
DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, amplifier-shaper, and parallel-triggered blocking oscillator to generate distance marks for 10 and 40 miles in airborne search radar.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8-3.



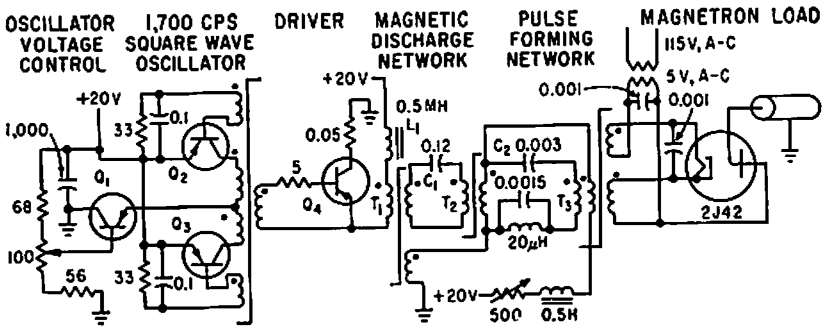
DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, gated-beam amplifier-shaper, and series-triggered blocking oscillator to generate distance marks for 2, 5, and 25 miles in airborne search radar.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8-3.



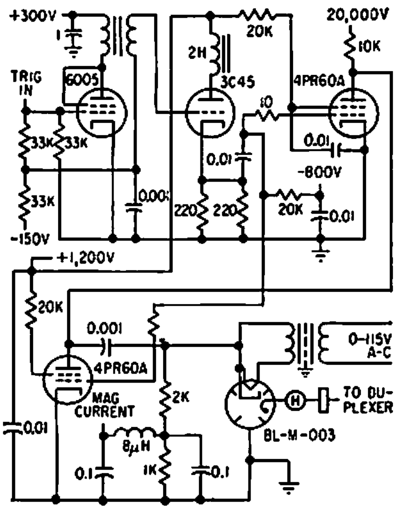
VIDEO SWITCH—Used to either pass or blank out video signals going to ppi visual display. Blanking gate input pulse is applied to switch if video fails to identify itself as signal from associated radar set.—L. Turf, Video Switch for Radar, *EEE*, 11:2, p 24–25.



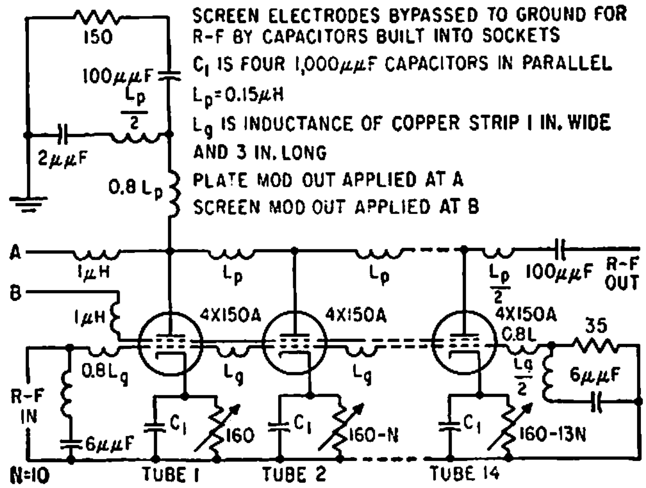
ELECTRONIC SWITCH FOR RADAR INDICATOR—Used to produce aircraft identification markers on ppi. Coincidence of binary voltages supplies gating signals for switch.—J. B. Beach, Coincidence Diodes Gate Electronic Switch, *Electronics*, 32:8, p 66–68.



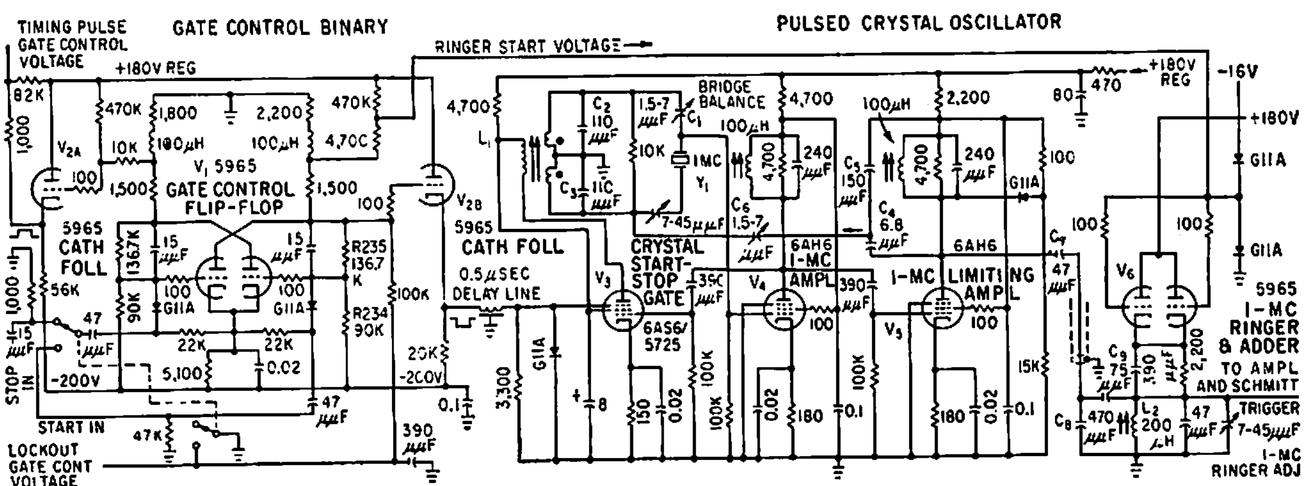
RADAR PULSER—Magnetic discharge and pulse shaping networks are used instead of thyratrons or vacuum-tube amplifiers to reduce size and weight while increasing reliability.—A. Krinitz, Using Magnetic Circuits to Pulse Radar Sets, *Electronics*, 32:27, p 42–43.



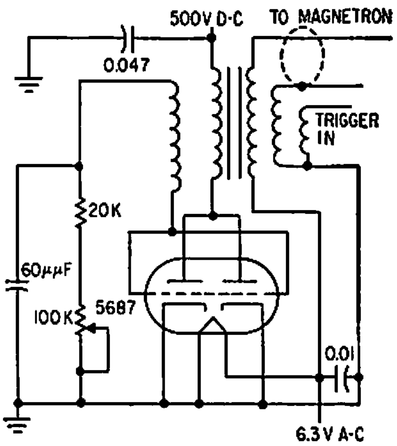
HARD-TUBE MODULATOR—Supplies 0.02-microsec 180-kw modulating pulses at prf of 14,400 pps. Hard tube is used because hydrogen thyratron of adequate power-handling capability would not deionize rapidly enough at this prf.—R. F. P. Smith, Airport Radar Has High Resolution, *Electronics*, 32:14, p 64–69.



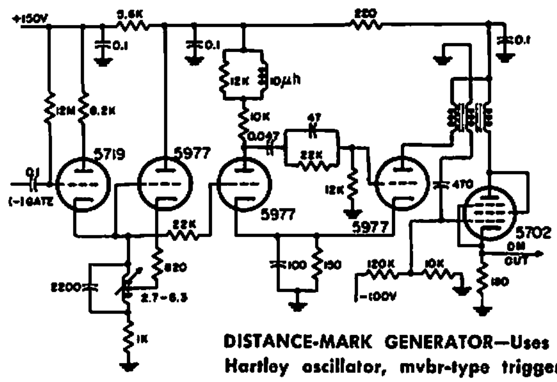
PULSED DISTRIBUTED AMPLIFIER—Gives 20% bandwidth centered on 200 Mc. Used as output stage of moderate-power radar, final drive of high-power drive, and for high-level pulse amplification.—S. K. Meads, How to Design Pulsed Distributed Amplifiers, *Electronics*, 32:12, p 56–58.



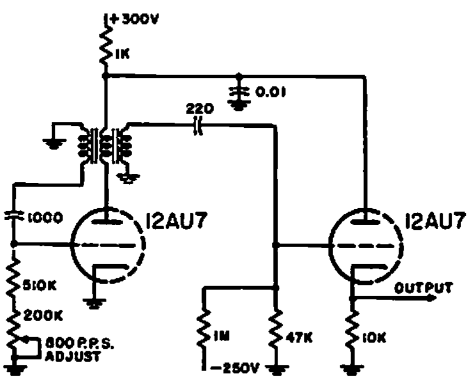
VARIABLE TIME-INTERVAL STANDARD—Produces two delayed pulses for establishing accurate time intervals from 1 to 10,000 microsec. Delays are adjustable in ¹ microsec increments, with continuous interpolation between steps. Crystal-controlled oscillator and fast preset counters reduce time-delay errors. Useful in calibrating radar and loran timing circuits, oscilloscopes, and marker generators, as well as for precision pulse code modulation and for calibrating delay lines.—D. Broderick, D. Hartke, and M. Willrodt, Precision Generator for Radar Range Calibration, *Electronics*, 32:14, p 58–60.



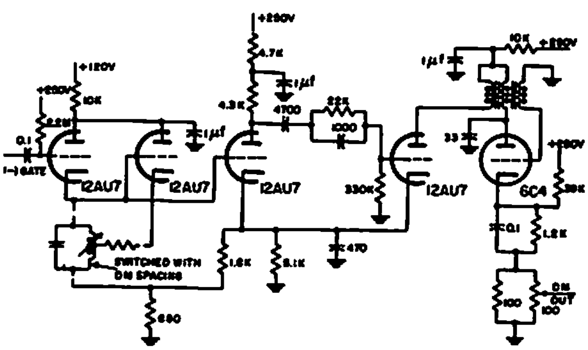
BLOCKING-OSCILLATOR MODULATOR—High permeability of ferrite-core transformer allows use of few coil turns, keeping capacitance at minimum so narrow pulses are produced.—C. D. Hardin and J. Salerno, Miniature X-Band Radar Has High Resolution, *Electronics*, 32:5, p 48–51.



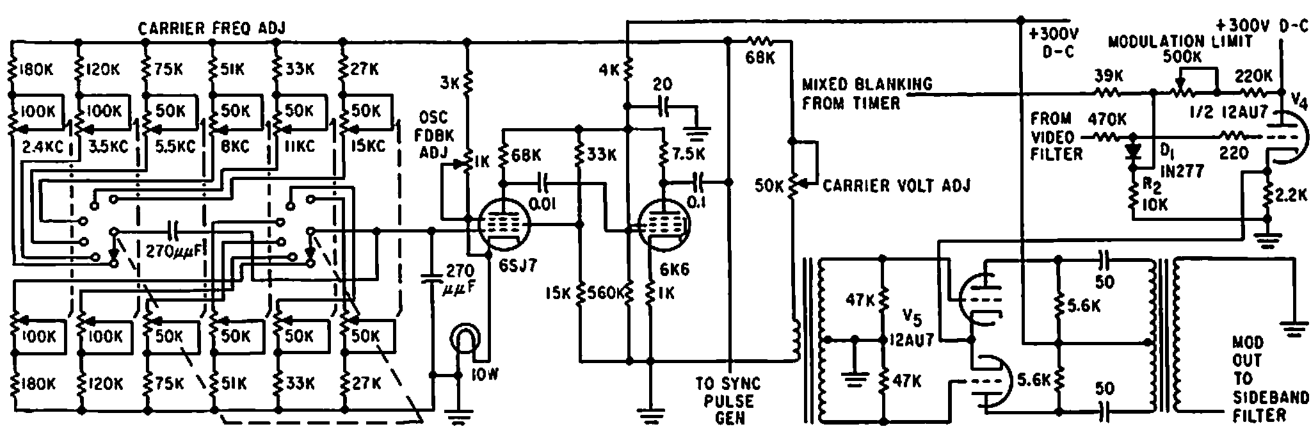
DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, mvbr-type trigger shaper, and parallel-triggered blocking oscillator to generate 1.67-mile distance marks in airborne search radar. Blocking-oscillator frequency dividers are used to get 5- and 10-mile marks.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8–2.



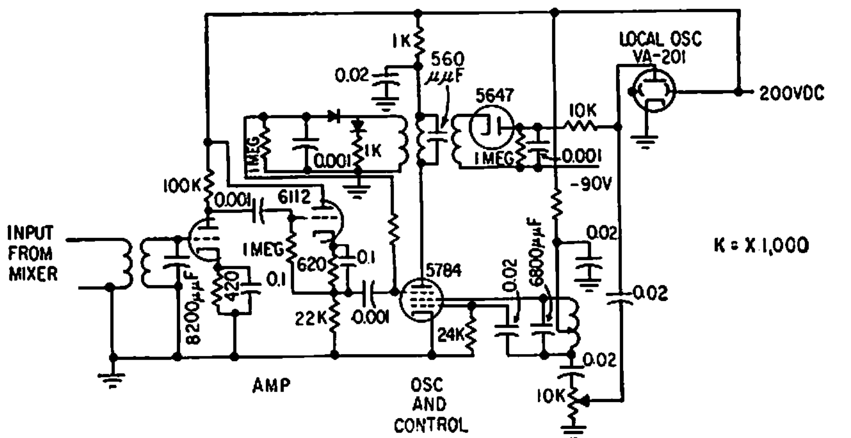
PRF GENERATOR—Blocking oscillator operates in range of 200 to 2,000 pps, as radar repetition-rate generator having frequency stability of about 5%.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5–2.



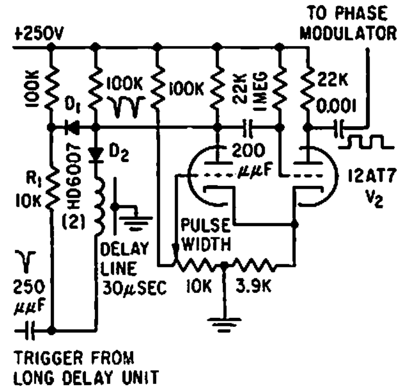
DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, monostable mvbr-type trigger shaper, and parallel-triggered blocking oscillator to generate distance marks for 2, 5, and 25 miles in airborne search radar. RLC unit is switched to change mark spacing. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8–1.



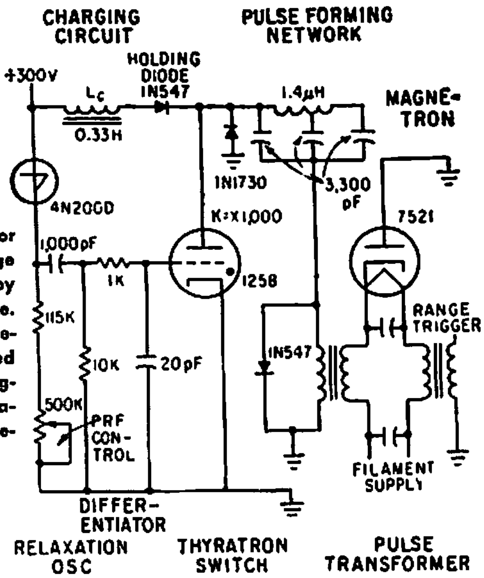
NARROW-BAND BALANCED MODULATOR—Yields two sidebands and carrier while balancing out original video signal. Gang switch permits use of six different carrier frequencies if sufficient telephone-line bandwidth is available. Sideband filters remove upper sideband and part of carrier to provide vestigial sideband operation.—H. W. Gates and A. G. Gatfield, Scan Converter Aids Phone-Line Radar Relay, *Electronics*, 32:16, p 48–51.



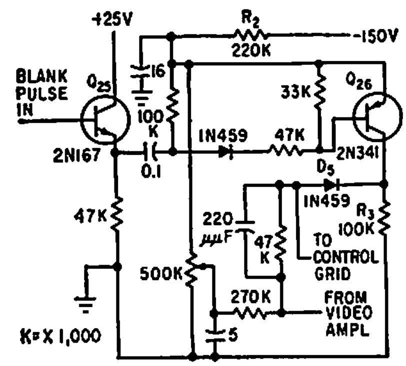
KLYSTRON SERVO—Simple three-tube mode-centering servo is only control required for local-oscillator klystron in wide-band receiver of short-pulse radar system.—C. D. Hardin and J. Salerno, Miniature X-Band Radar Has High Resolution, *Electronics*, 32:5, p 48–51.



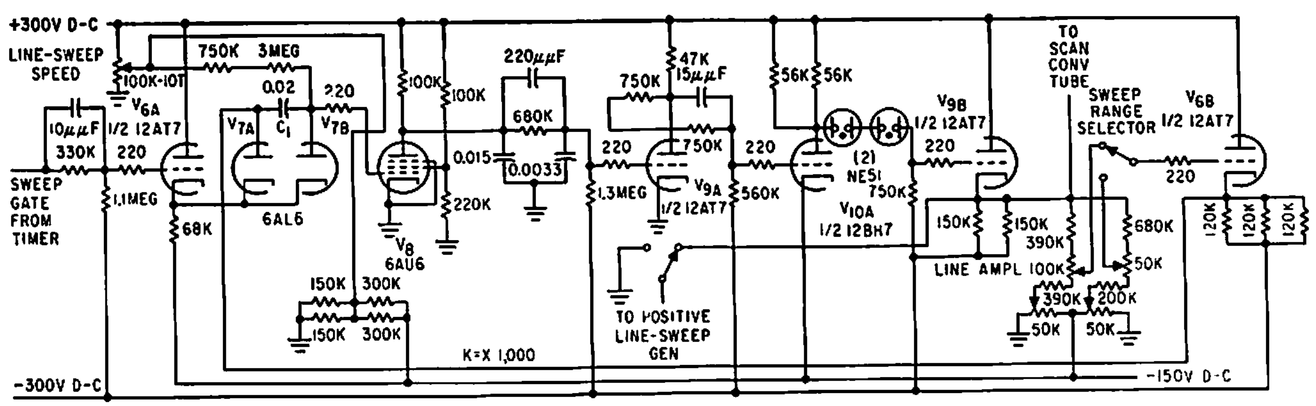
DOUBLE-PULSE GENERATOR—Used in responder-interrogator range computer to produce pair of 15-microsec-wide pulses spaced 30 microsec. Monostable mvbr receives two triggers, one through 30-microsec delay line, and produces 15-microsec pulse for each trigger received.—H. Vantine, Jr., and E. C. Johnson, Modified Transceivers Compute Distance, *Electronics*, 31:37, p 94–98.



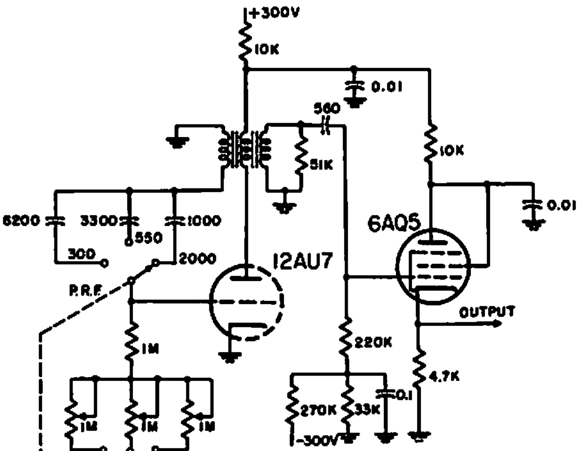
PULSED X-BAND MAGNETRON—Differentiator forms sharp 2-microsec pulse at trailing edge of each sawtooth waveform generated by R-C charging circuit and Shockley pnpn diode. Pulse triggers thyratron to discharge pulse-forming network, and new pulse is stepped up to 4,500 v by pulse transformer for magnetron.—J. Scott, D. Randise, and R. P. Lukacovic, Portable Radar Traces Battlefield Deployment, *Electronics*, 33:12, p 67–70.



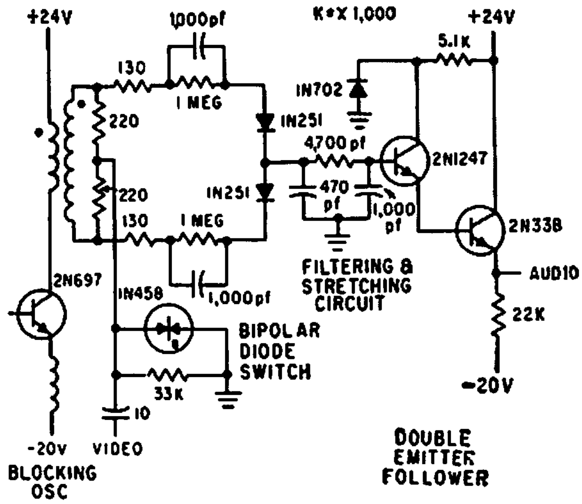
FLYBACK BLANKING—Amplifies blanking pulse from monostable mvbr sweep circuit to level required for blanking crt screen. Q26, normally nonconducting, is driven to saturation by blanking pulse, thereby applying high negative voltage to crt control grid.—C. E. Veazie, Transistorized Radar Sweep Circuits Using Low Power, *Electronics*, 32:26, p 46–47.



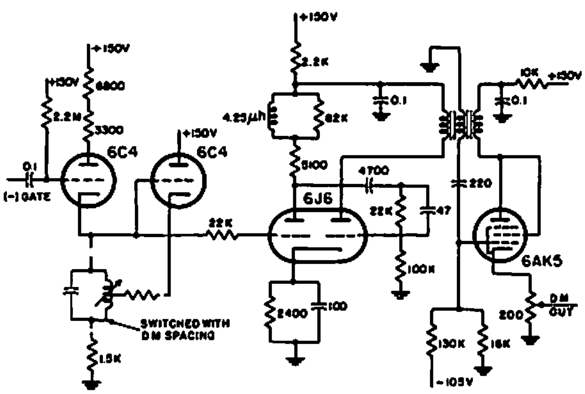
LINE SWEEP GENERATOR FOR ENCODER—Circuit is basically negative-feedback linearized R-C sawtooth generator in which charging voltage is held constant while negative end of sweep-forming capacitor is driven negative. Amplifier V8-V9A-V10A is direct-coupled throughout. Loop-stabilizing networks pass high-frequency components.—H. W. Gates and A. G. Gatfield, Scan Converter Aids Phone-Line Radar Relay, *Electronics*, 32:16, p 48–51.



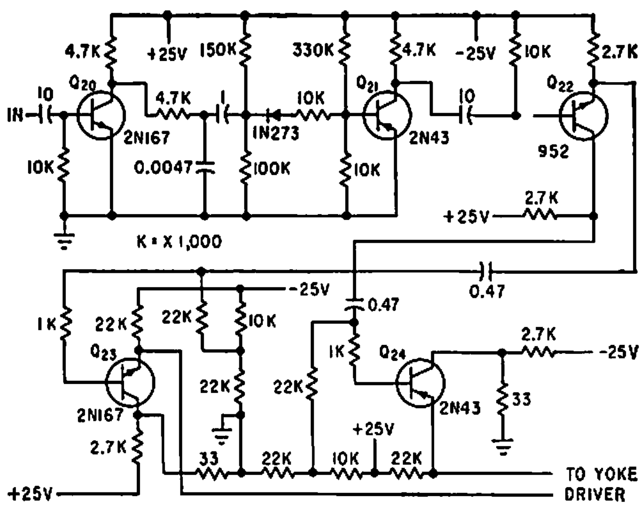
PRF GENERATOR—Blocking oscillator operates in range of 200 to 2,000 pps, as radar repetition-rate generator having frequency stability of about 5%. Has positive grid return, although this may decrease frequency stability if heater voltage drops below rated value. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N5-2.



BOXCAR DETECTOR—Diodes conduct during range gate interval of 0.2 microsec in portable doppler radar, to connect video signal to filter circuit.—J. Scott, D. Randise, and R. P. Lukacovic, Portable Radar Traces Battlefield Deployment, *Electronics*, 33:12, p 67-70.

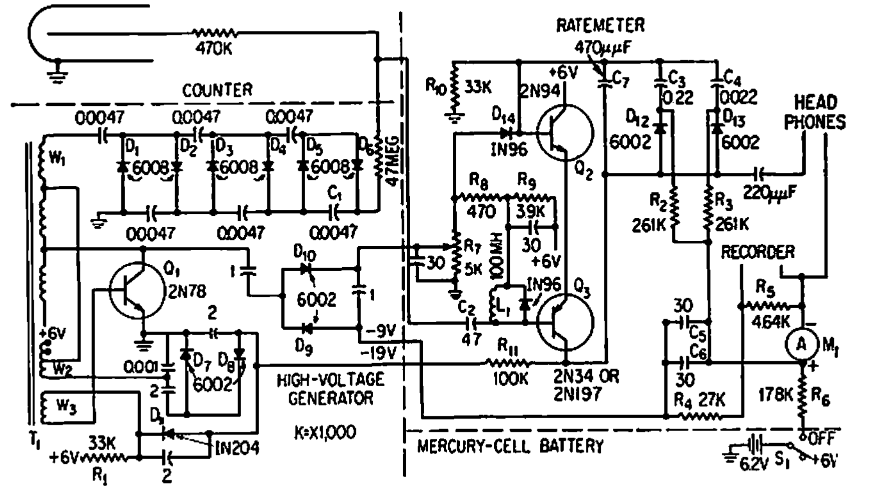


DISTANCE-MARK GENERATOR—Uses switched Hartley oscillator, mvbr-type trigger shaper, and parallel-triggered blocking oscillator to generate distance marks for 2, 5, and 25 miles in airborne search radar. RLC unit is switched to change mark spacing.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N8-2.

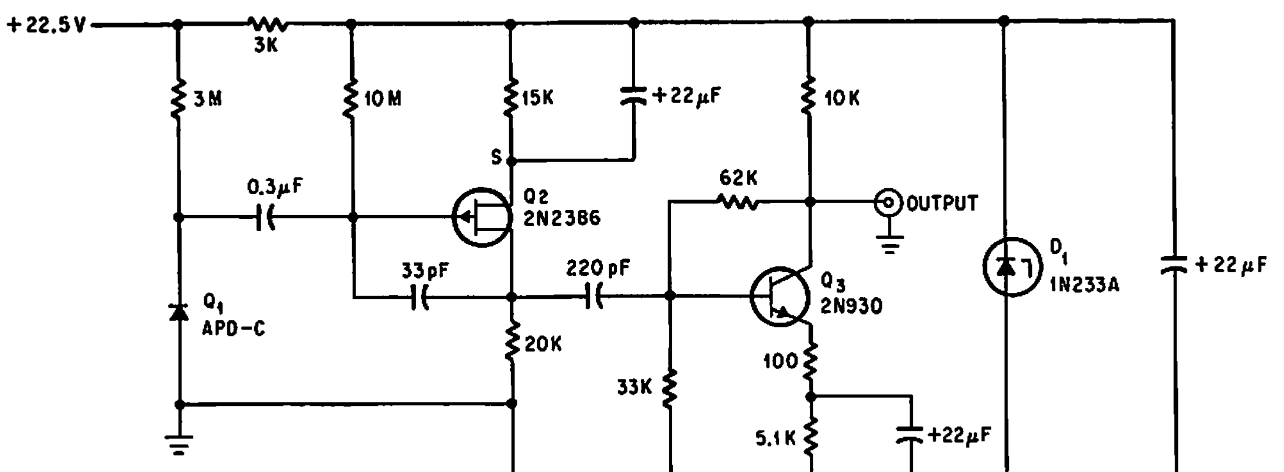


GATED CLAMP FOR PPI SWEEP—Uses monostable mvbr signal to generate reference level for yoke driver.—C. E. Veazie, Transistorized Radar Sweep Circuits Using Low Power, *Electronics*, 32:26, p 46-47.

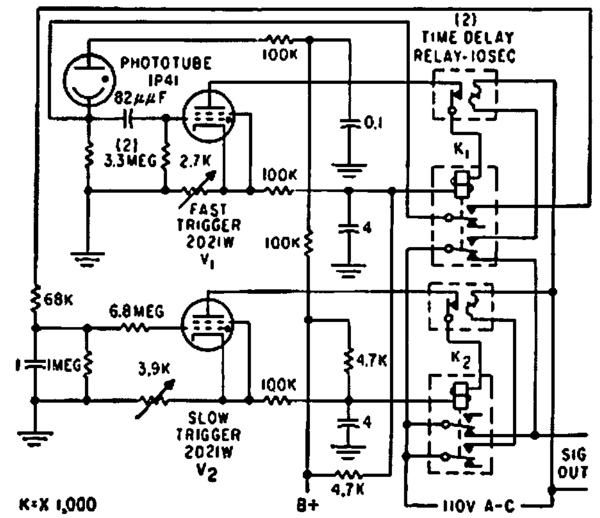
CHAPTER 69
Radiation Circuits



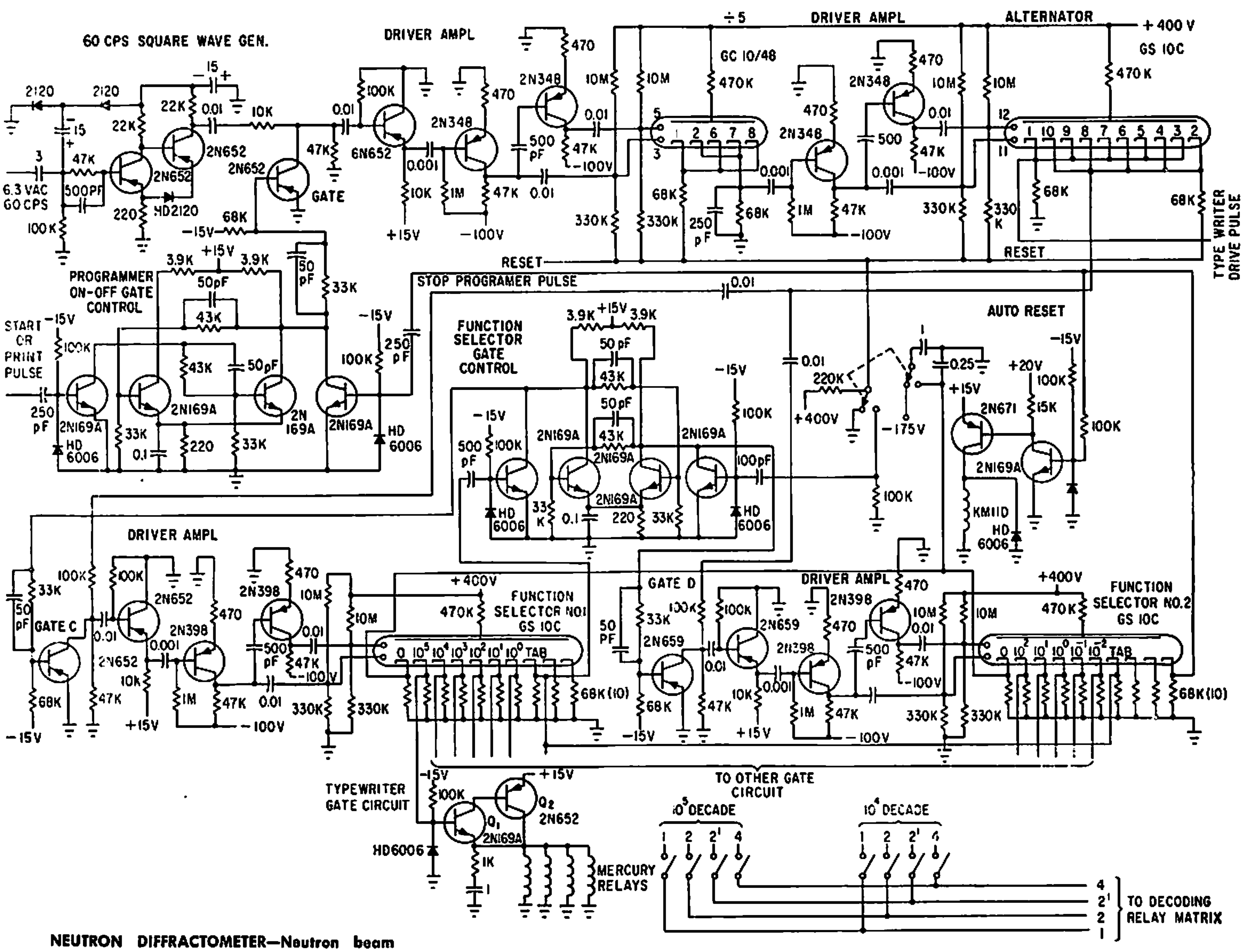
TRANSISTORIZED GEIGER COUNTER—Ratemeter circuit converts output of halogen-type counter directly into meter indication corresponding to radiation intensity. Counter triggers two-transistor switch to place low-impedance load across conventional dual-output diode pump. Two halves of pump current are summed in metering circuit.—F. S. Goulding, Transistorized Geiger Counter Fits in Probe, *Electronics*, 32:3, p 64–66.



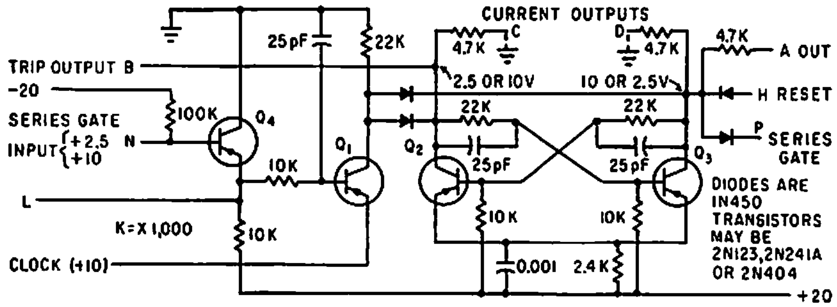
JUNCTION-DIODE ALPHA DETECTOR—Used for counting alpha particles at high altitudes in dew-point hygrometer. Signal-to-noise ratio is poor (about 4 to 1).—C. R. Seashore and C. D. O'Brien, FET Detects Alpha Particles Better and More Precisely, *Electronics*, 38:3, p 64–66.



THERMAL NUCLEAR RADIATION DETECTOR—Triggers only on light flash from nuclear explosion, consisting of initial fast-rising pulse lasting a few millisec, followed by pulse lasting over 1 sec. Discriminates against short flashes from lightning and shell bursts, and long slowly rising pulses caused by headlights and sunlight reflections.—J. C. Champeny, T. E. Petriken, and S. Siciliano, Nuclear Bomb Alarm Systems, *Electronics*, 32:19, p 53–55.

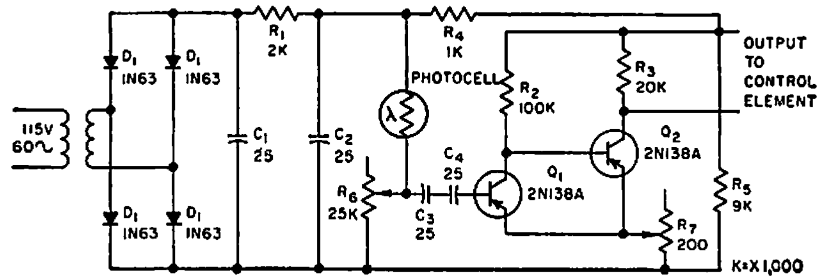


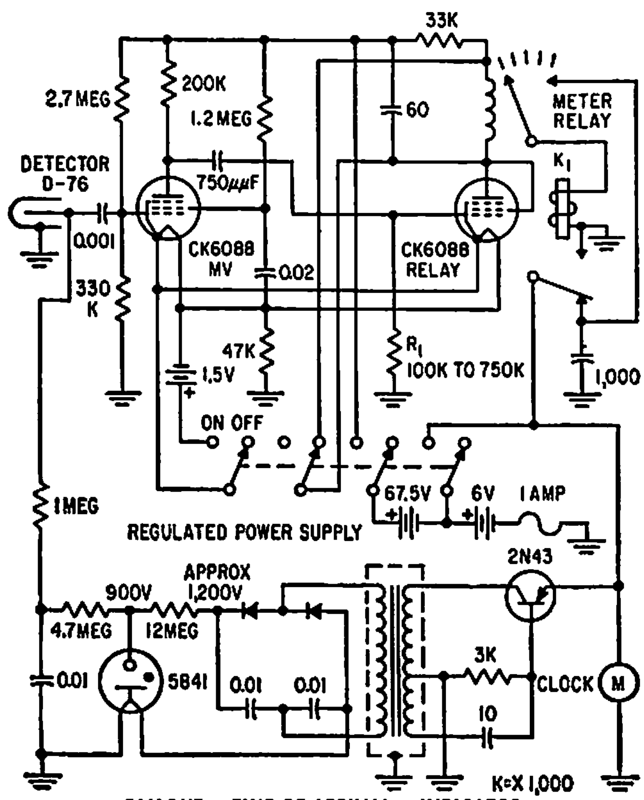
NEUTRON DIFFRACTOMETER—Neutron beam from reactor strikes sample, producing diffraction pattern. Multielement glow tubes control sequence of operation in which length of data accumulation time at each angle of diffraction is determined by counting neutrons in incident beam. This eliminates counting errors due to reactor level fluctuations. Circuit drives key solenoids of electric typewriter to give printout of results.—E. W. Johanson, Glow-Tube Programmer Controls Neutron Spectrometer Experiments, *Electronics*, 34:19, p 65–67.



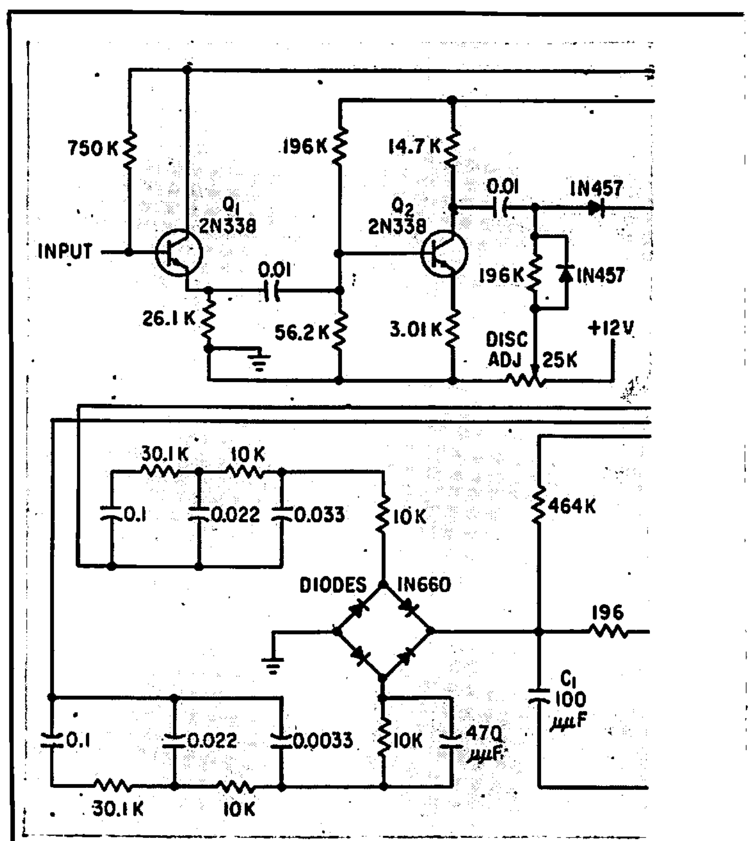
MULTI-OUTPUT BINARY—Basic binary circuit of 256-channel neutron analyzer is controlled by diode gates in coincidence with clock pulses derived from 200-kc crystal oscillator. Used in countdown, address overflow, memory cycle, sync, and gate stages.—E. J. Wade, Digital Instrumentation for Nuclear Research Tests, *Electronics*, 33:43, p 68–71.

PHOTO RELAY USES SR-90 SOURCE—Interruption of high-energy beam from strontium-90 radioactive source changes resistance of cadmium sulphide photocell. Transistor amplifier converts variation into signal that actuates relay or other control element. Source-detector separation must be less than 4 inches. Maximum counting rate is five pieces per second.—P. Weisman and S. L. Ruby, Solid-State Photocell Sees Through Haze, *Electronics*, 31:25, p 62–63.

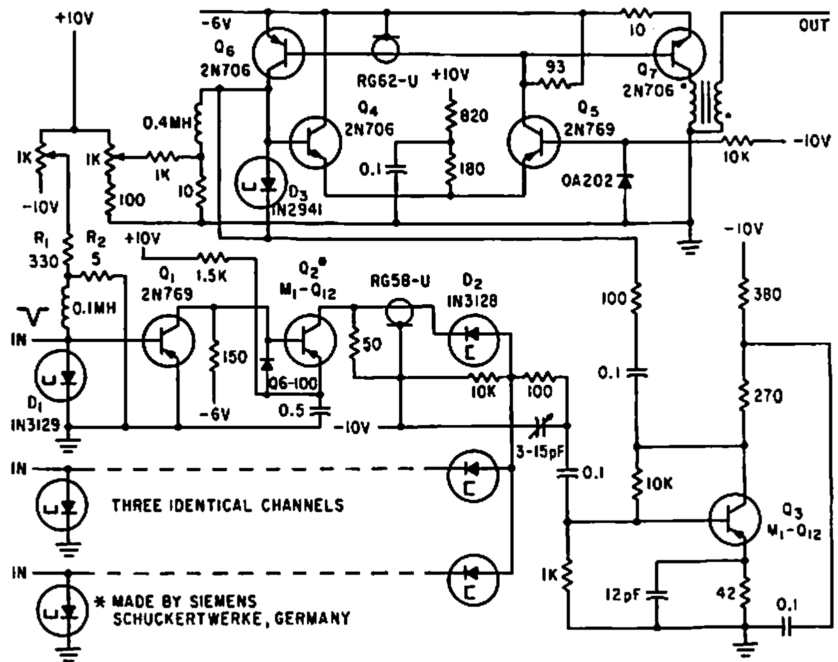




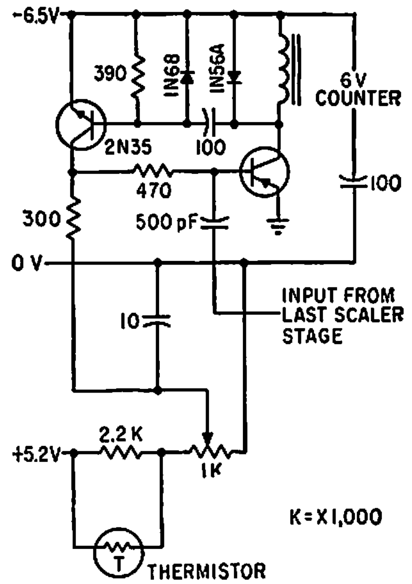
FALLOUT TIME-OF-ARRIVAL INDICATOR—Auto clock operates until fallout at level above 2 milliroentgens per hour arrives. Geiger-counter detection circuit then blows power-supply fuse, stopping clock with hands pointing to time of arrival.—R. W. Farmer and O. Reiner, Jr., Determining Arrival Time of Radioactive Fallout, *Electronics*, 31:31, p 69–71.



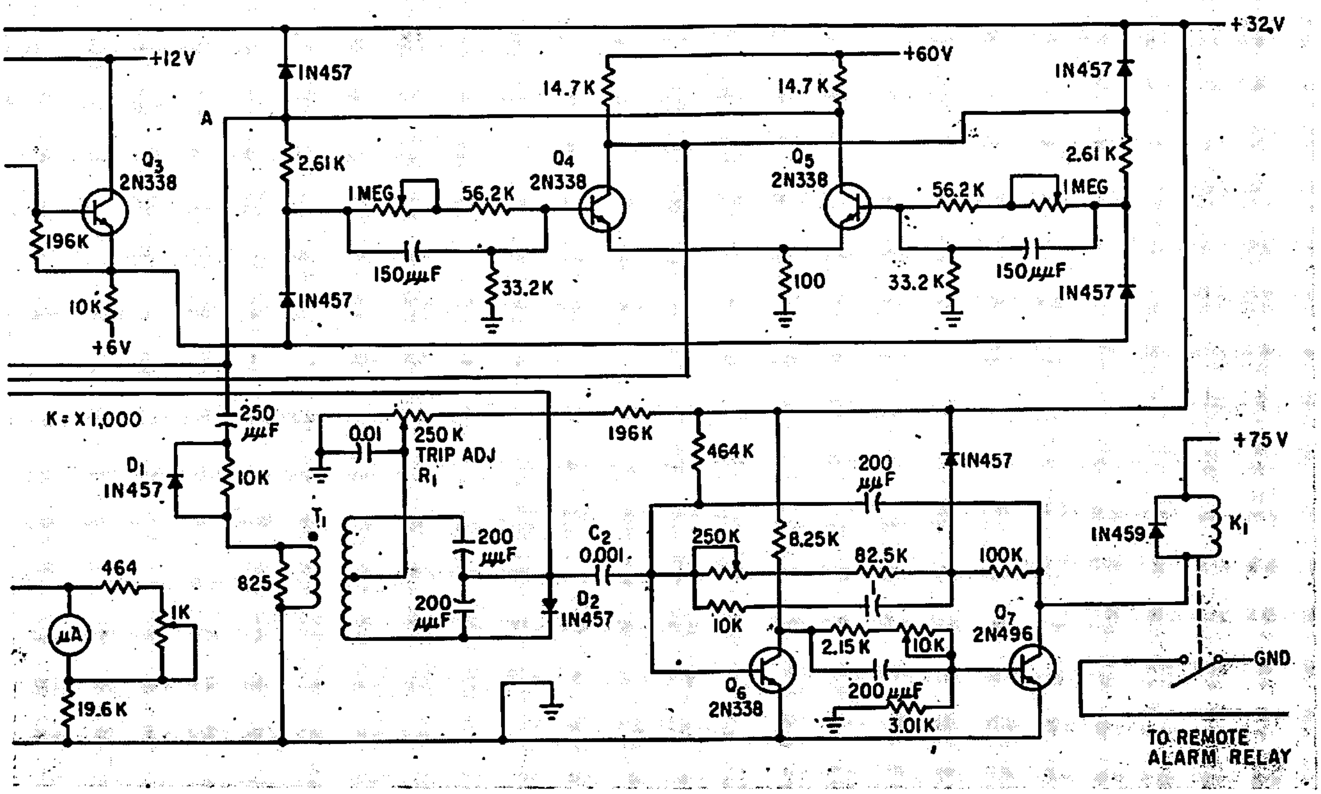
RADIATION ALARM—Input is from multiplier phototube having anthracene scintillation crystal on its window. Signals are amplified



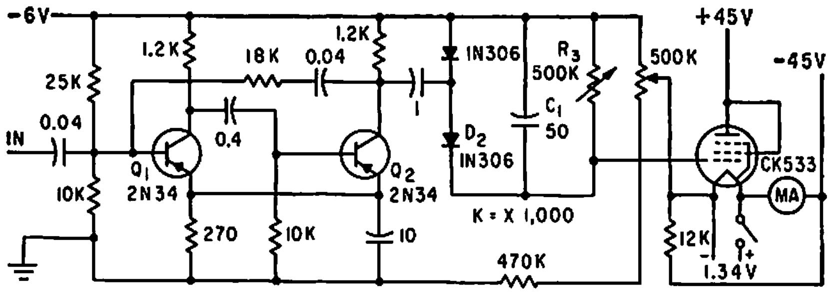
TUNNEL-DIODE COINCIDENCE CIRCUIT—Determines coincidence of pulses from scintillation counter within nanosecond limits, for high-energy physics experiments. Circuit has limited timing jitter, good temperature stability, and is insensitive to transistor parameters.—C. Infante and F. Pandarese, Tunnel Diodes Stabilize Coincidence Circuits, *Electronics*, 34:46, p 133–135.



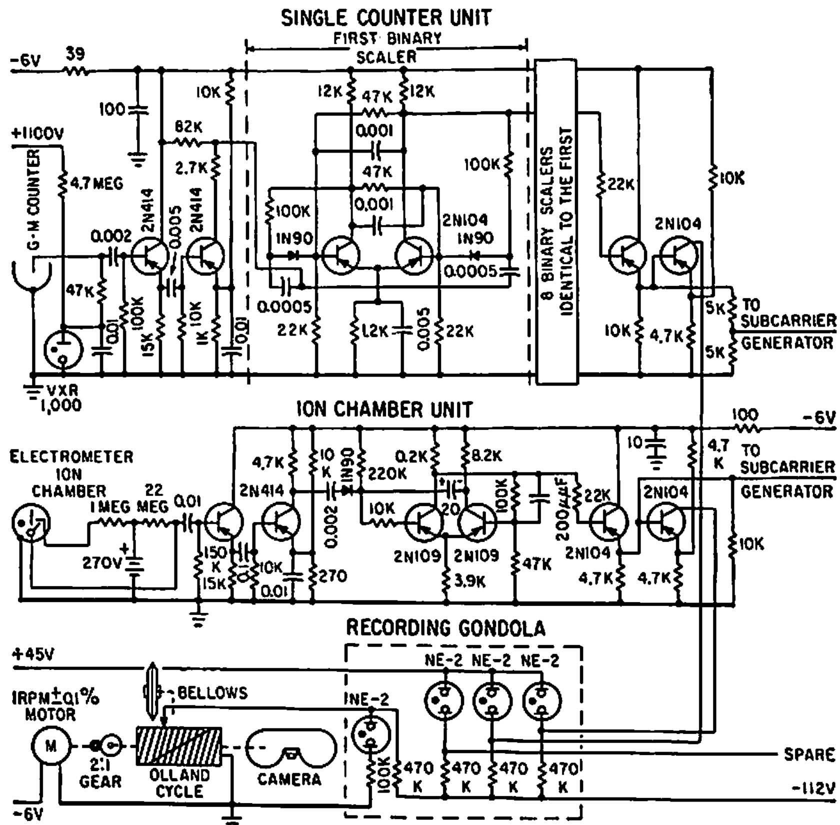
MECHANICAL COUNTER DRIVE—Takes output from scale-of-64 circuit and converts to 40-millisec square-wave pulse by means of complementary mvbr, to drive coil of mechanical register once for every 64 pulses from G-M tube.—F. E. Armstrong, Battery Powered Portable Scaler, *Electronics*, 33:19, p 74–75.



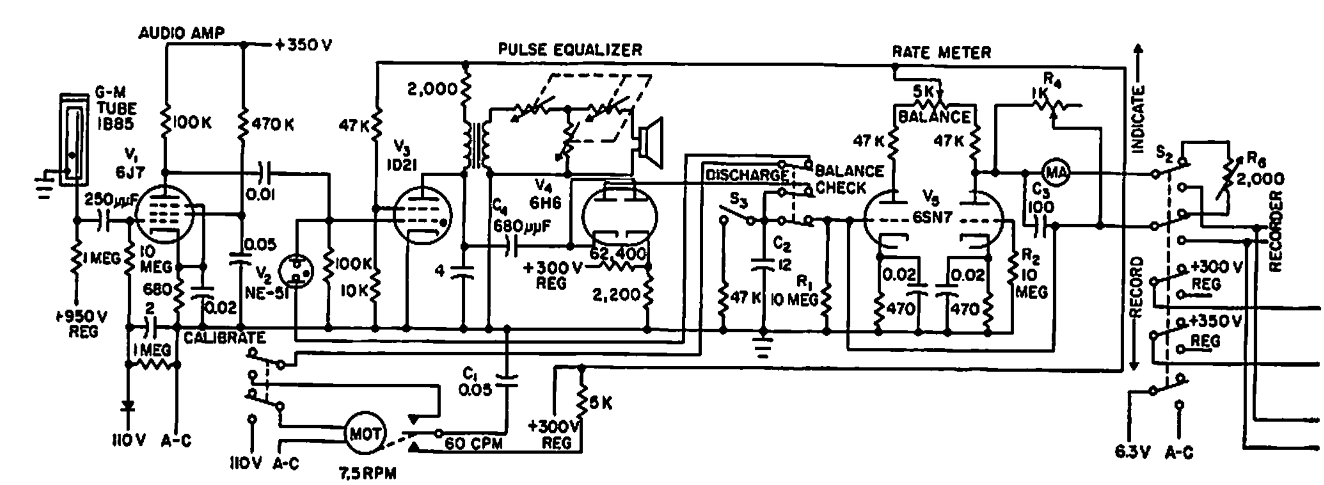
by Q1, Q2, and Q3, and fed to counter flip-flop Q4-Q5. Flip-flip output goes to logarithmic count circuit whose output level is indicated by microammeter. When output exceeds predetermined level, alarm circuit closes relay that actuates audible and visual alarms.—H. E. DeBolt, How Radiation Monitor Guards Nuclear Navy, *Electronics*, 33:4, p 43–45.



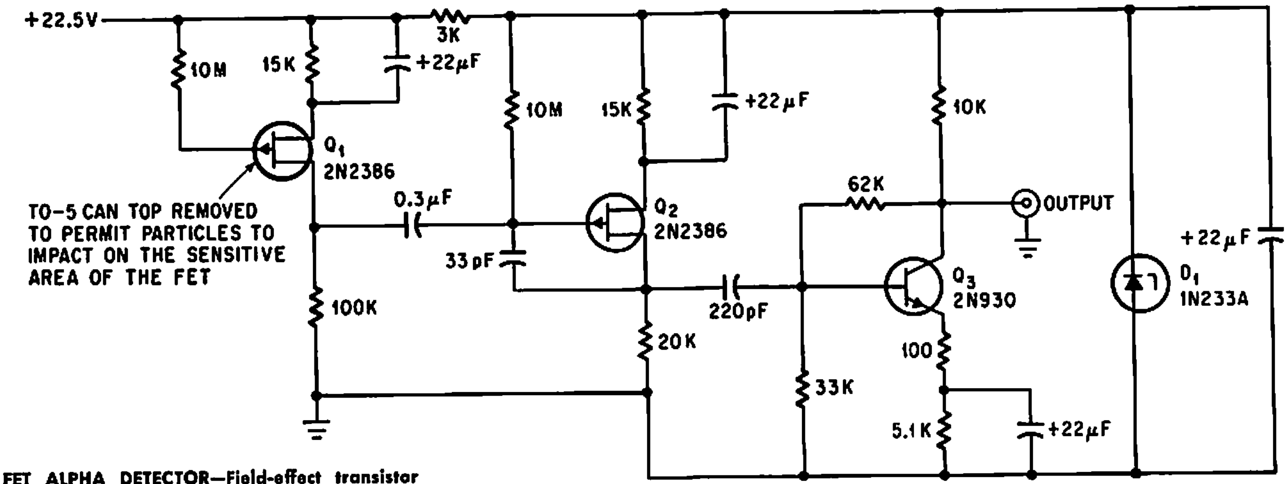
G-M COUNTING-RATE METER—Uses two transistors in integrating circuit and pentode recorder drive. Output of counting-rate mvbr Q1-Q2 is 4.5-v, 260-microsec square pulse that charges integrating capacitor C1 through D2.—F. E. Armstrong and E. A. Pavelka, Monitoring Radioisotope Tracers in Industry, *Electronics*, 32:26, p 42–43.



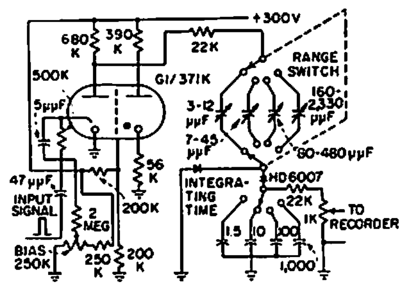
G-M COUNTER AND IONIZATION GAGE—Used to correlate cosmic radiation intensity with other ionospheric and geomagnetic phenomenom. G-M counter provides negative pulse that is differentiated, shaped, and amplified in circuits similar to that of ion chamber. Counter rate is scaled down by 9-stage binary scaler before square-wave output is fed to telemetering unit.—L. E. Peterson, R. L. Howard, and J. R. Winckler, Balloon Gas Monitors Cosmic Radiation, *Electronics*, 31:45, p 76–79.



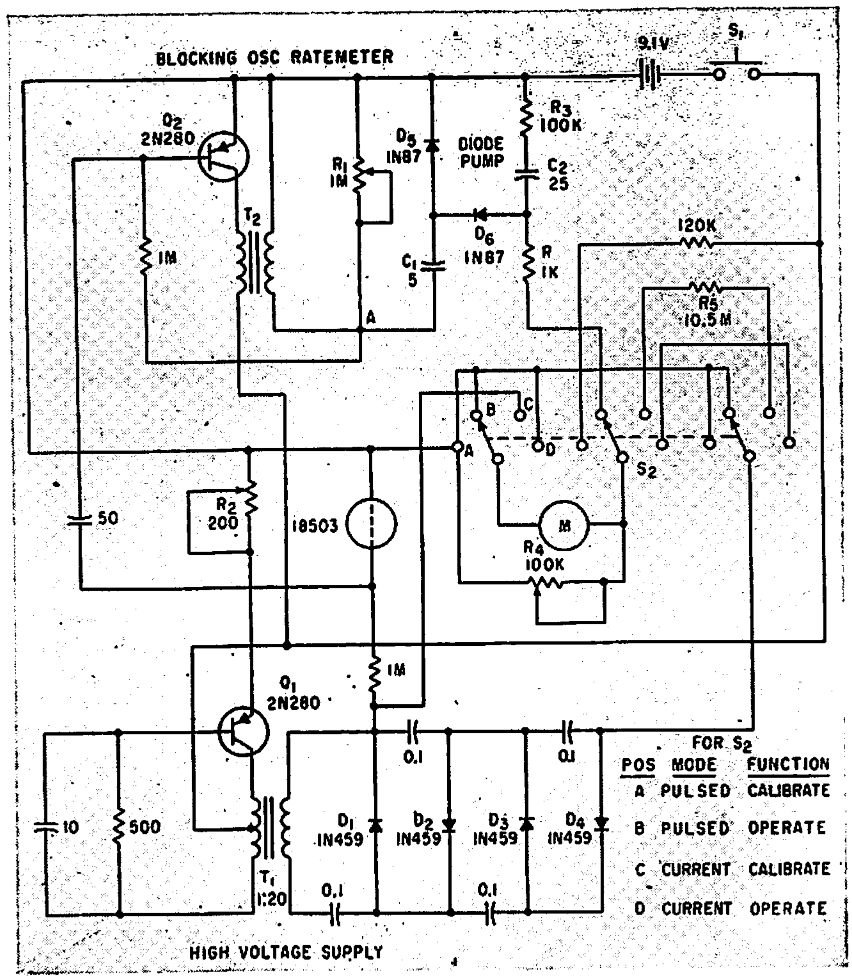
GEIGER COUNTER—Simple basic monitor provides continuous audio and visual indications of radioactive materials in industrial areas. If recording is required, four leads at right are connected to 10-cps keep-alive mvbr and triode output stage for driving recorder. Will handle count rates up to 10,000 per minute. Strobotron V3 in pulse equalizer provides visual indications.—R. L. Ives, Geiger Radiation



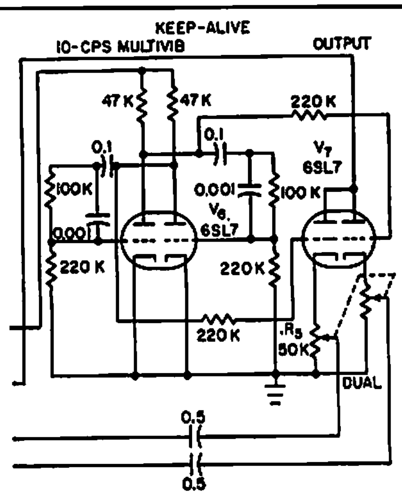
FET ALPHA DETECTOR—Field-effect transistor with cover removed serves as low-noise alpha-particle detector in high-altitude dew-point hygrometer. Signal-to-noise ratio is 67 to 1.—C. R. Seashore and C. D. O'Brien, FET Detects Alpha Particles Better And More Precisely, *Electronics*, 38:3, p 64–66.



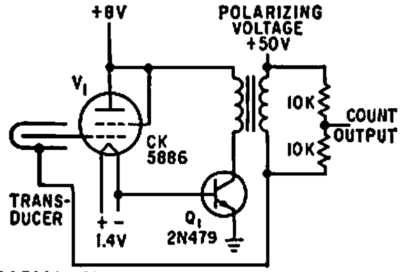
COLD-CATHODE COUNT RATE CIRCUIT—Four-element cold-cathode tube operates directly from output pulse of 6292 photomultiplier receiving light output of Zns screen of alpha particle detector. Maximum counting rate is 100 counts per second.—M. H. Goosey, Designing Cold-Cathode Tube Circuits, *Electronics*, 31:3, p 101-108.



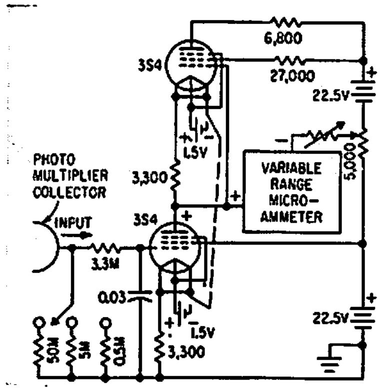
SURVEY METER HAS PULSED AND CURRENT MODES—High-voltage source for G-M counter uses 10-kc blocking oscillator and Cockcroft-Walton multiplier, to give 550 v stabilized by zener region of D1. Range for pulsed operation is 0.5 to 50 milliroentgen per hour. For current mode, same 18503 G-M tube is used, and current in range of 50 milliroentgen to 5 roentgen per hour is logarithmic function of radiation intensity.—R. W. Lehnert and J. M. McKenzie, Radiation Survey Meter, *Electronics*, 35:8, p 50.



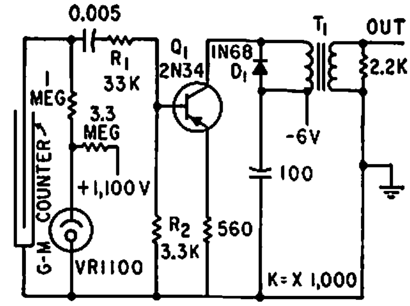
Monitor Indicates Continuously, *Electronics*, 31:43, p 93–95.



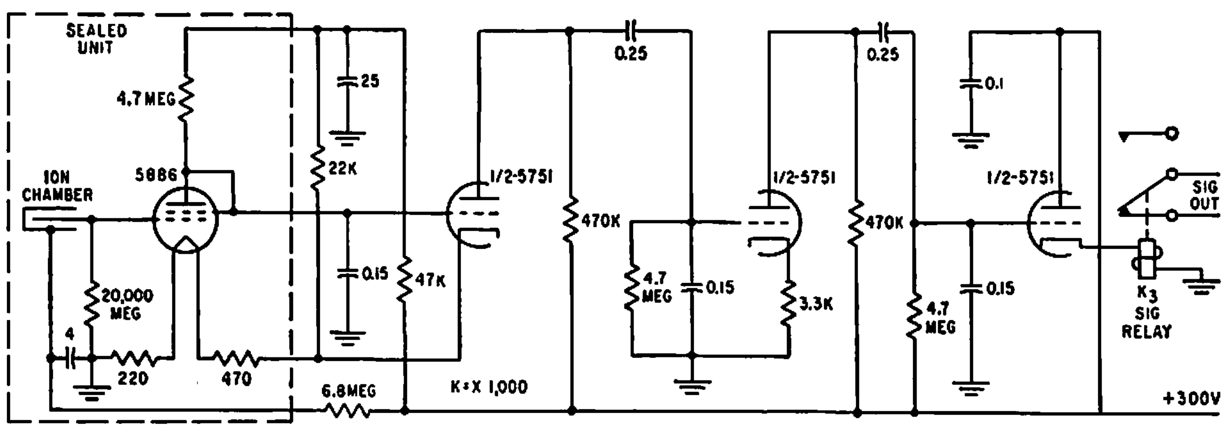
RADIOLOGICAL VACUUM GAGE—Permits measuring extremely low pressures in laboratory equipment and in high-altitude research. Provides digital output that can be used for storage for telemetry. Transformer is audio type with large step-up ratio. Polarizing voltage supplies less than 1 microamp. Transducer is small cylindrical tube lined with radioactive foil.—G. F. Vanderschmidt, Using Isotopes to Measure Low Pressures, *Electronics*, 32:25, p 60–61.



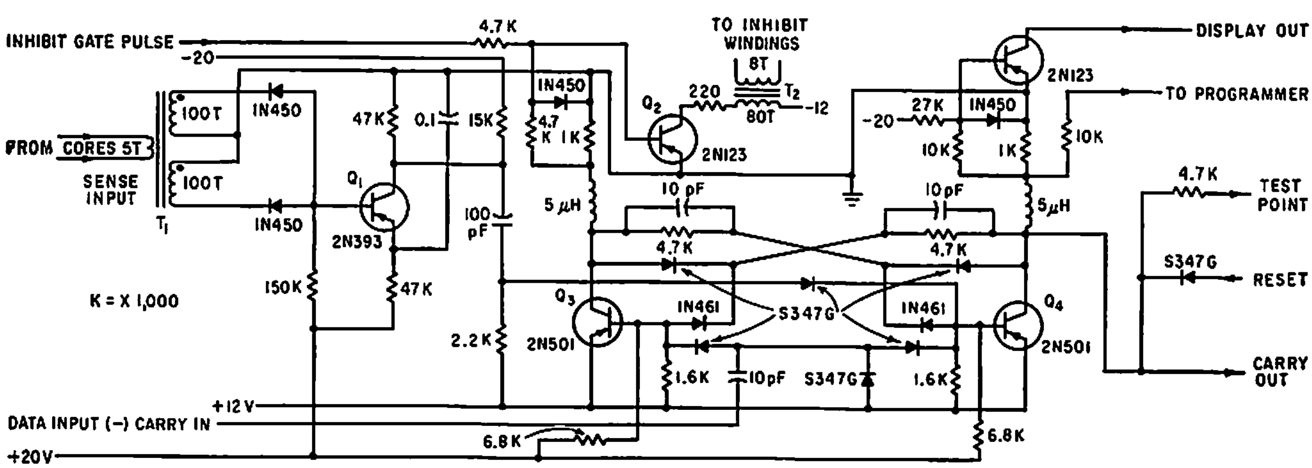
ELECTROMETER—Amplifies output of photomultiplier that responds to degree of fluorescence, which in turn is proportional to radiation received by glass dosimetry needle implanted in body of person undergoing radiation treatment.—S. J. Malsky et al, Measuring Radiation Within Human Body, *Electronics*, 33:12, p 74–75.



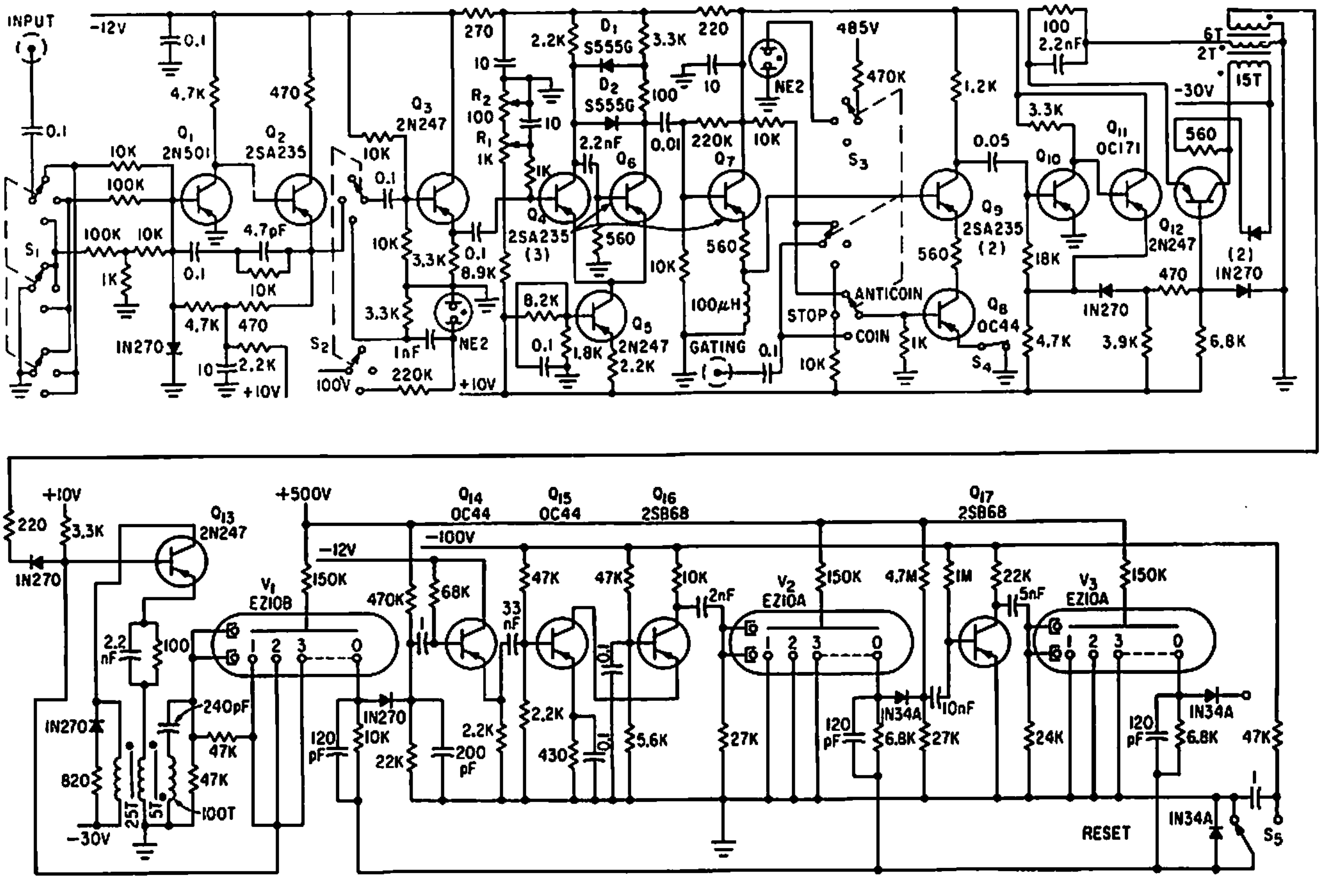
G-M COUNTER FOR TRACERS—Monitors radioactivity level of flowing liquids or gases for long periods of time. Concentration of 0.1 microcurie per liter of liquid gives counting rate of 200 cpm above 300-cpm background count when using iodine-131. Output pulse is 0.75 v in amplitude and 20 microsec wide.—F. E. Armstrong and E. A. Pavelka, Monitoring Radioisotope Tracers in Industry, *Electronics*, 32:26, p 42–43.



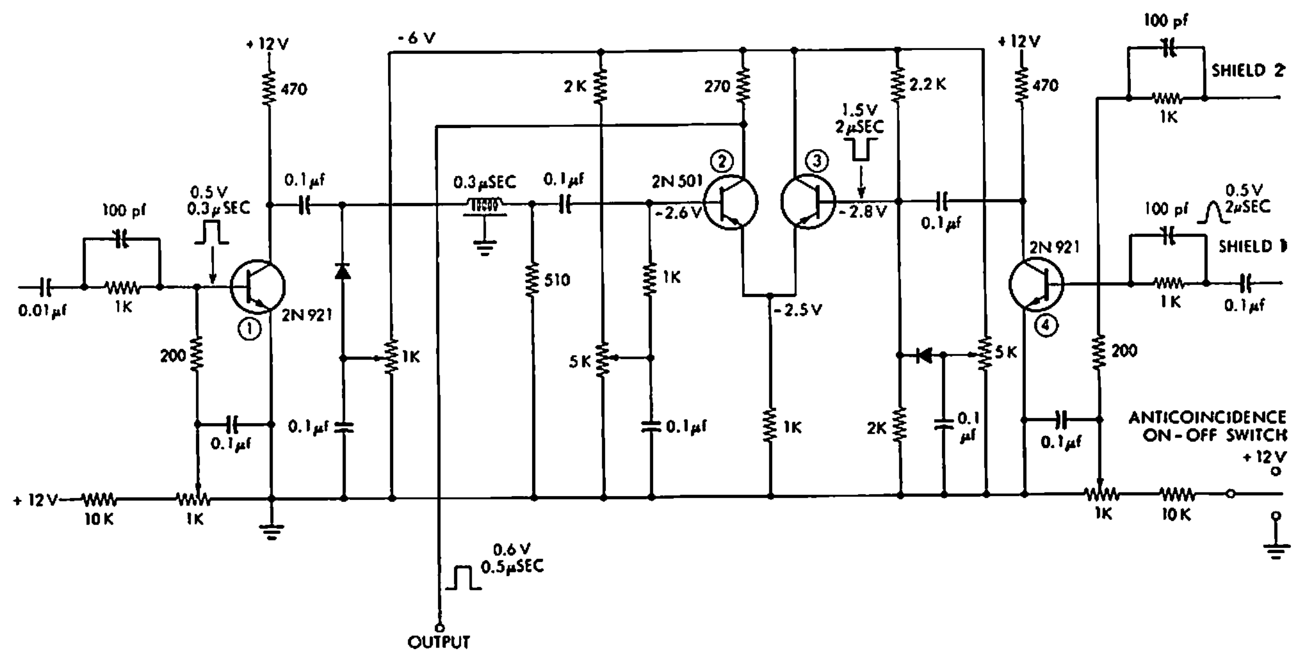
GAMMA-RAY DETECTOR—Triggers only on gamma-ray pulse produced by nuclear explosion. Uses a-c coupled ion chamber to detect pulses of gamma radiation.—J. C. Champeny, T. E. Petriken, and S. Siciliano, Nuclear Bomb Alarm Systems, *Electronics*, 32:19, p 53–55.



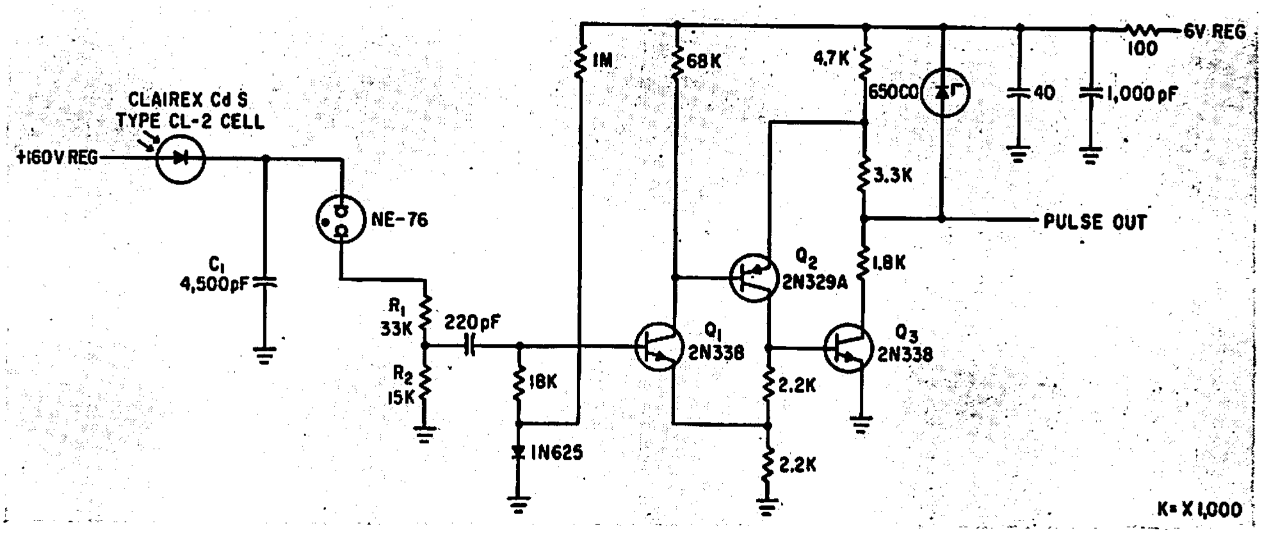
ARITHMETIC BINARY—Uses 2N501 series-triggered transistors, catching diodes, and peaking coils operating at data input rate of about 15 Mc, in neutron time-of-flight and pulsed-neutron measurements.—E. J. Wade, Digital Instrumentation for Nuclear Research Tests, *Electronics*, 33:43, p 68–71.



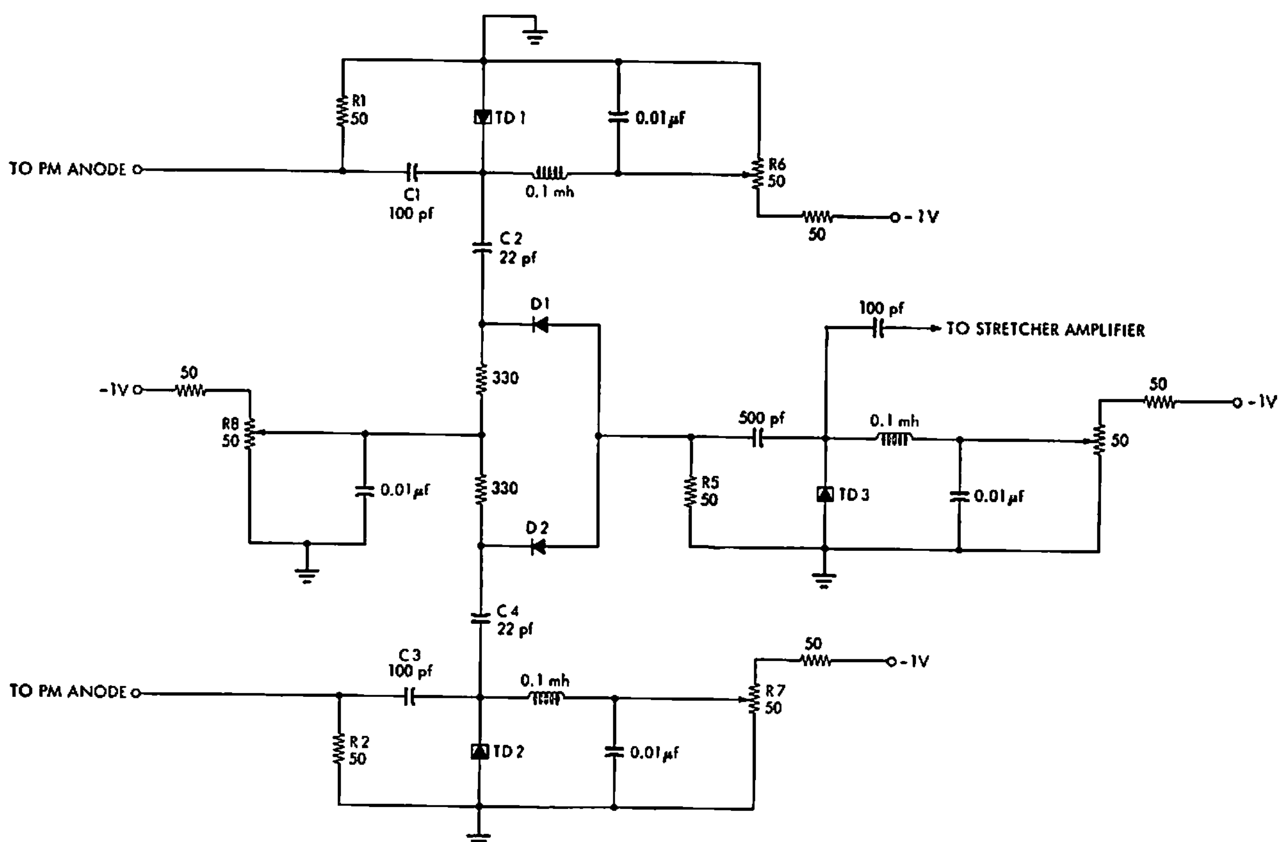
500,000-PPS SCALER—Uses seven fast gas-filled decade counter tubes driven by transistors, for counting pulses from nuclear radiation detector. Input channel, which can accept positive or negative pulses from 0.1 to 100 v, has amplitude discriminator and coincidence-anticoincidence gating.—M. Birk, H. Brafman, and J. Sokolowski, Transistors Drive Half-Megacycle Cold-Cathode Scaler, *Electronics*, 34:41, p 60–61.



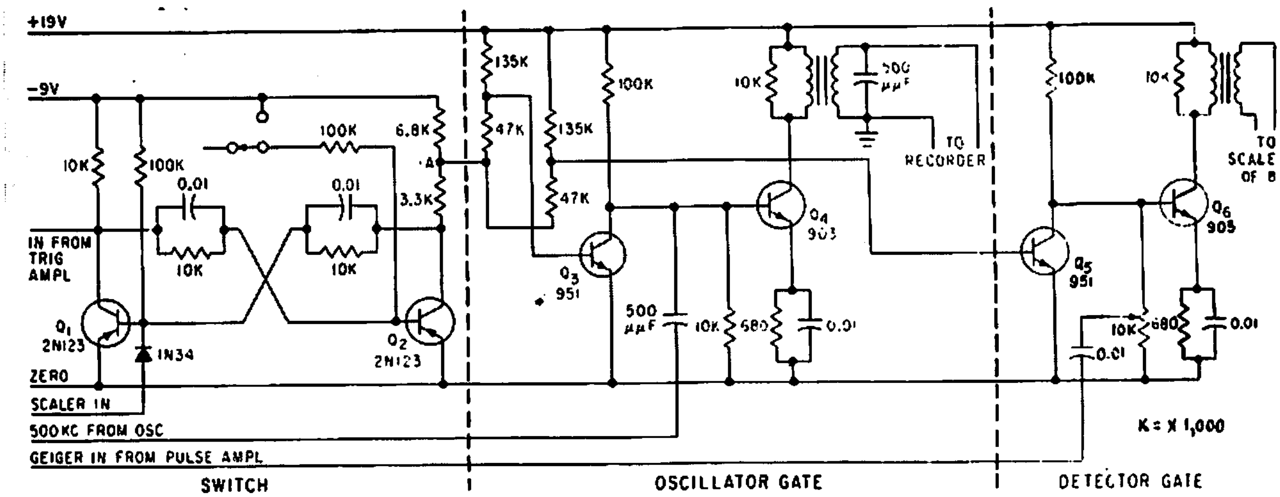
SCINTILLATION-COUNTER ANTICOINCIDENCE—Produces an output from a trigger at input 1 only if input 2 is not triggered at that time. Used in liquid scintillation counter where expected count rates are low.—G. J. Sprokel, A Liquid Scintillation Counter Using Anticoincidence Shielding, *IBM Journal of Research and Development*, 7:2, p 135–145.



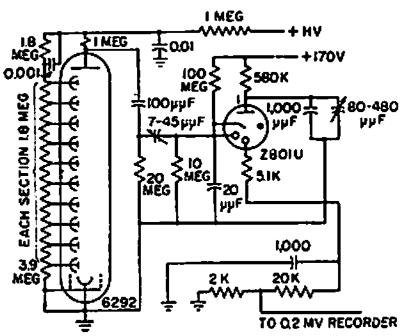
LOW-ENERGY PARTICLE DETECTOR—Change in conductivity of single-crystal photocell under irradiation is converted to pulse-code modulation by neon glow-tube relaxation oscillator whose firing rate is determined by charging of C1 through photocell. Saturating bootstrap amplifier Q2 inverts and shapes pulses to drive accumulation register.—J. W. Freeman, Energy Detector for Satellites, *Electronics*, 35:4, p 42–43.



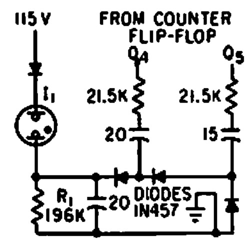
TUNNEL-DIODE COINCIDENCE—Used in liquid scintillation counter for carbon-14 and other radioactive solutions. Delivers output pulse to stretcher amplifier only for coinciding pulses from two photomultiplier inputs.—G. J. Sprokel, A Liquid Scintillation Counter Using Anticoincidence Shielding, *IBM Journal of Research and Development*, 7:2, p 135–145.



RADIOACTIVE FUEL-FLOW GAGE—Used in recording flow rate of jet fuel containing radioactive tracer.—J. D. Keys and G. E. Alexander, Radioactive Tracers Find Jet Fuel Flow Rates, *Electronics*, 33:8, 58–59.



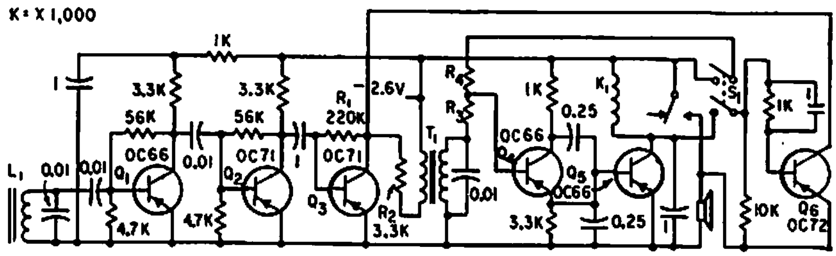
2-KC COLD-CATHODE COUNT RATE CIRCUIT—Uses triode having separate cold-cathode diode that produces glow discharge to eliminate trigger-cathode gap of triode section. This eliminates photosensitivity shown by most cold-cathode devices. Maximum operating speed is 2,000 counts per second.—M. H. Goosey, Designing Cold-Cathode Tube Circuits, *Electronics*, 31:3, p 101–108

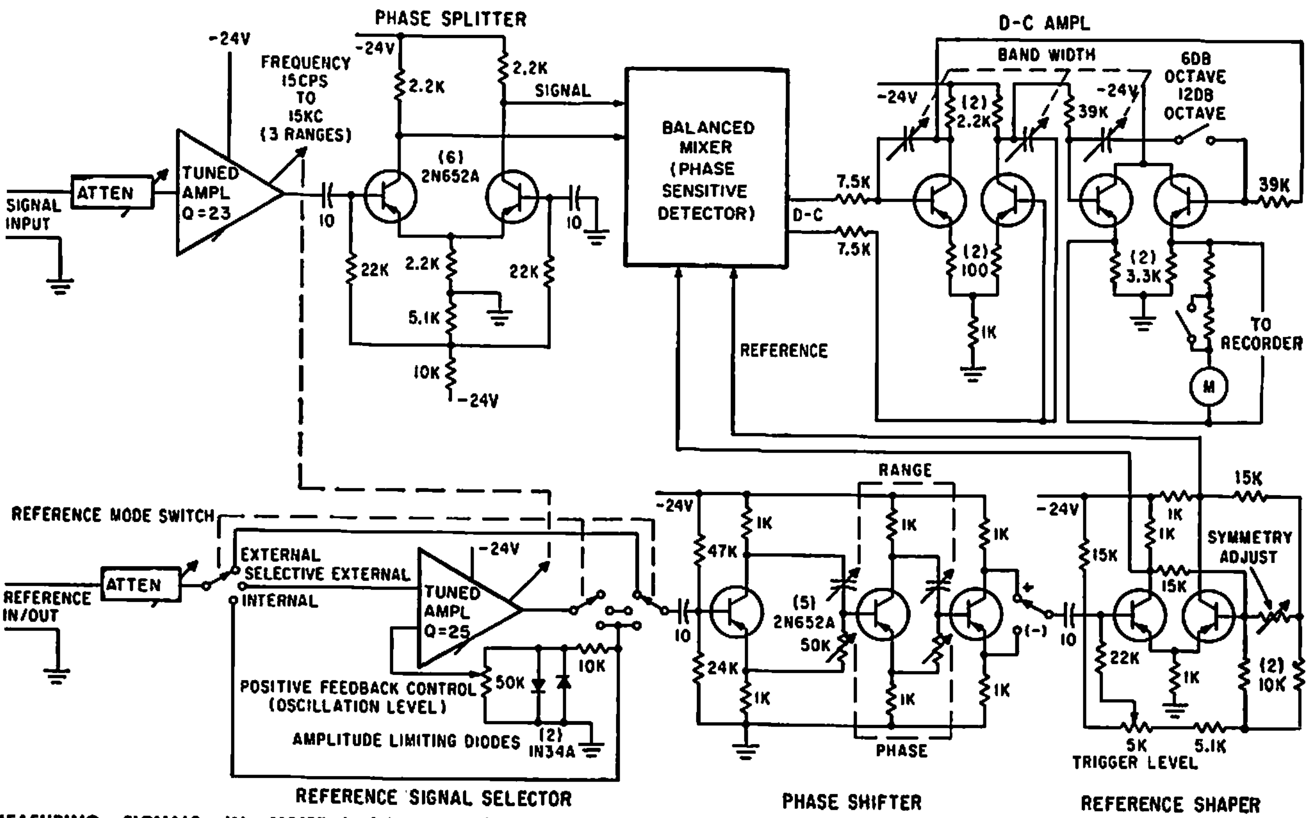


RADIATION ALARM FAILURE DETECTOR—Neon indicator lamp comes on when counter flip-flop of radioactive dust particle alarm stops. Flip-flop normally operates at minimum of 10 transitions per second due to slight leakage from radioactive test source built into detector.—H. E. DeBolt, How Radiation Monitor Guards Nuclear Navy, *Electronics*, 33:4, p 43–45.

CHAPTER 70
Receiver Circuits

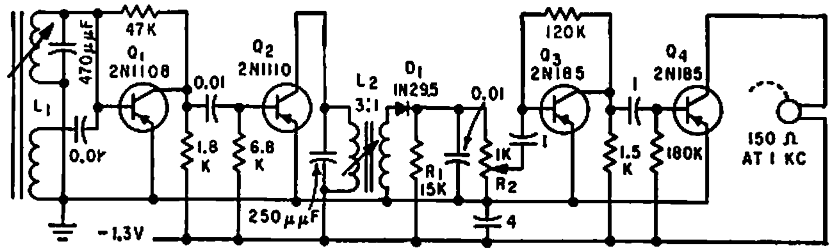
RESONANT-REED PAGING RECEIVER—Ferrite antenna L1 is tuned to one of up to 45 different carrier frequencies in range from 15 to 30 kc, keyed at various repetition rates. Resonant relay K1 in collector circuit of detector Q5 vibrates when excited at its natural keying rate, thereby interrupting loudspeaker current at audio rate to create paging tone. —J. G. DeGraaf, Selective Paging System Uses Coded Transmission, *Electronics*, 33:9, p 68–70.

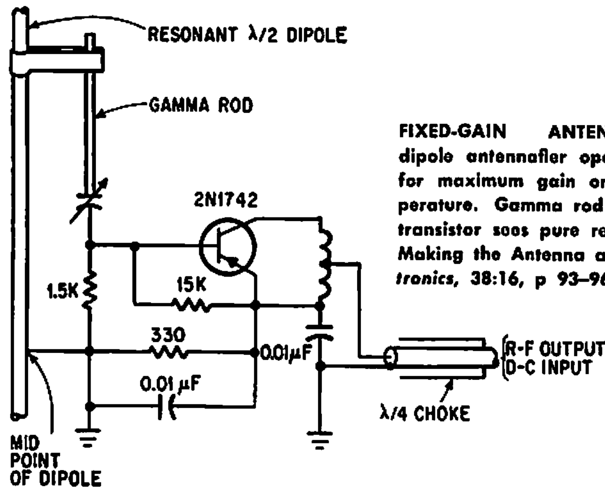




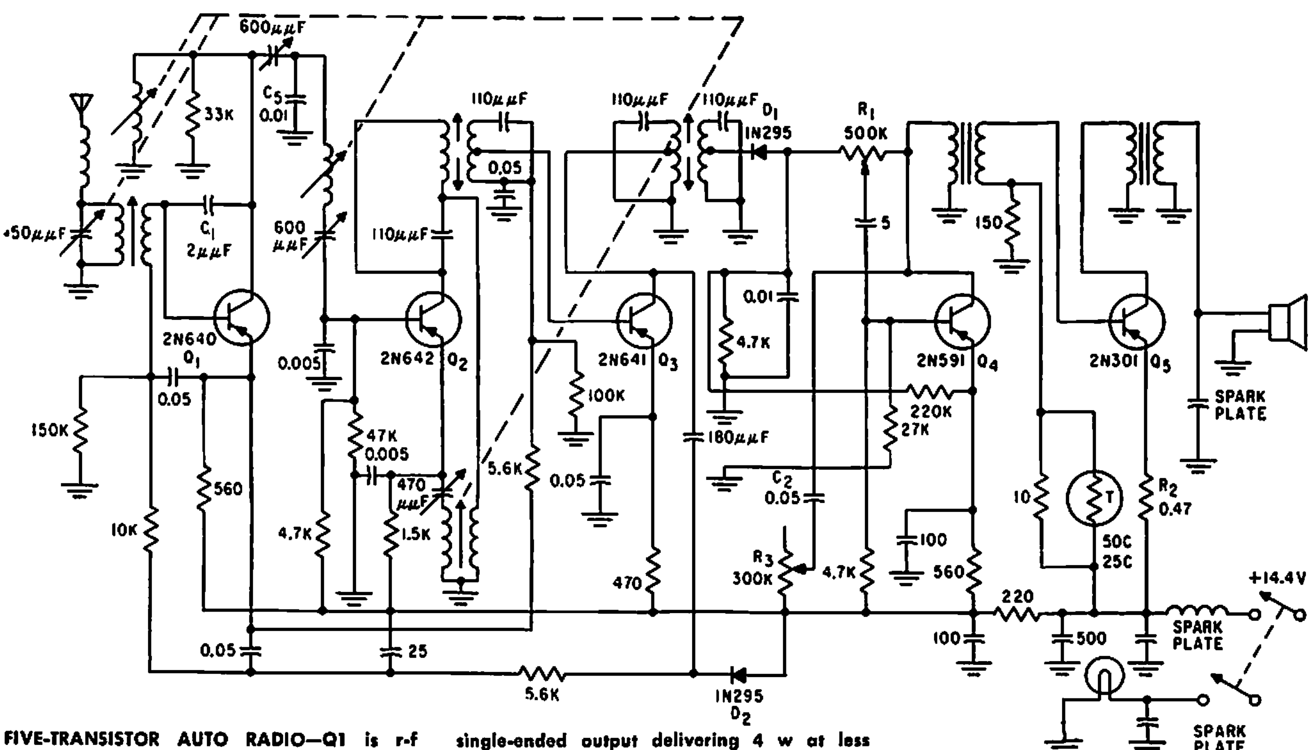
MEASURING SIGNALS IN NOISE—Lock-in amplifier beats desired weak signal (40 db below input noise level) with reference signal of same frequency, to give d-c output that can be measured or recorded, as required in radio astronomy. Bandwidth is variable down to 0.12 cps for tuning range of from 15 to 15,000 cps. Also used for checking oscillator frequency against WWV to one part in 10^{10}.—R. D. Moore, Lock-In Amplifier for Signals Buried in Noise, *Electronics*, 35:23, p 40–43.

FOUR-TRANSISTOR TRF—Single-channel receiver fits into one temple piece of eyeglass frame, with ferrite antenna in other piece, and separate miniature earphone.—H. F. Cooke, Transistor Eyeglass Radio, *Electronics*, 32:39, p 88.

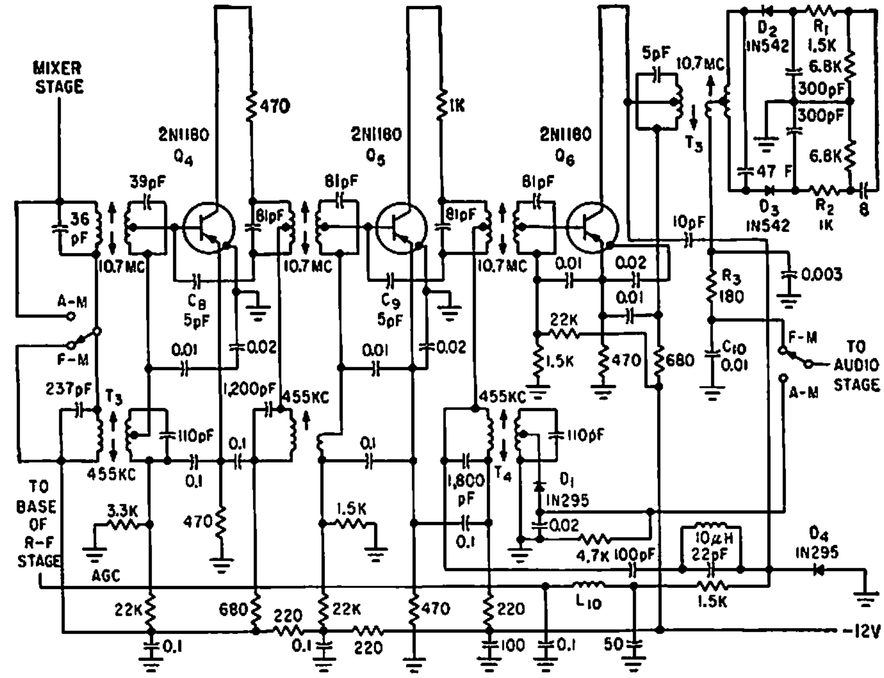




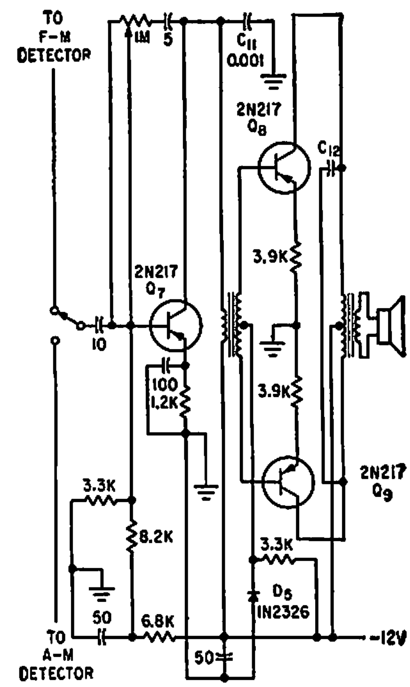
FIXED-GAIN ANTENNAFIER—Transistorized dipole antennafier operates with fixed bias for maximum gain or minimum noise temperature. Gamma rod provides matching so transistor sees pure resistance.—J. F. Rippin, Making the Antenna an Active Partner, *Electronics*, 38:16, p 93–96.



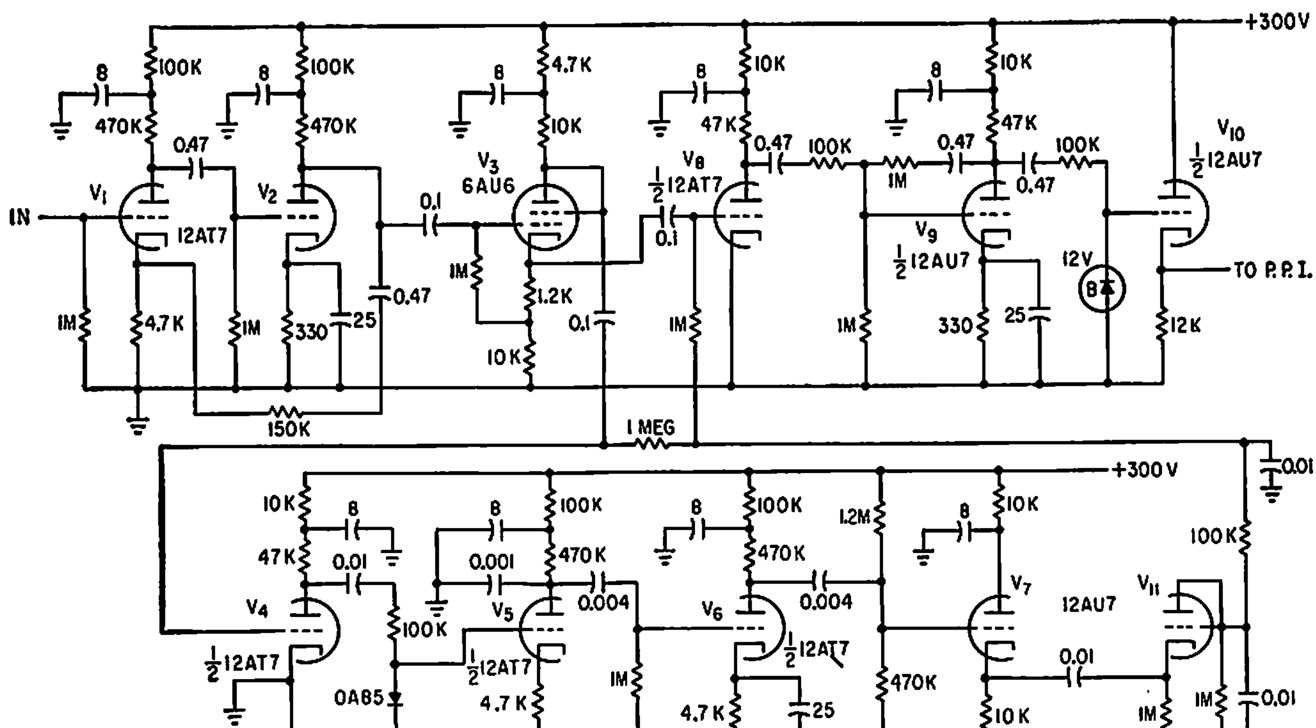
FIVE-TRANSISTOR AUTO RADIO—Q1 is r-f amplifier, Q2 is autodyne converter, Q3 is unneutralized 262-kc i-f amplifier, D1 is audio detector, Q4 is audio driver, and Q5 is single-ended output delivering 4 w at less than 10% total distortion. Sensitivity is 2 microvolts at 1 w audio output.—R. A. Santilli and C. F. Wheatley, Transistorizing Automobile Broadcast Receivers, *Electronics*, 32:38, p 42–45.



THREE-TRANSISTOR A-M/F-M I-F STRIP—Used in a-m/f-m portable radio. Only two stages operate on a-m.—R. A. Santilli and H. Thanos, Portable Radio Uses Drift-Field Transistors, *Electronics*, 33:28, p 48–50.

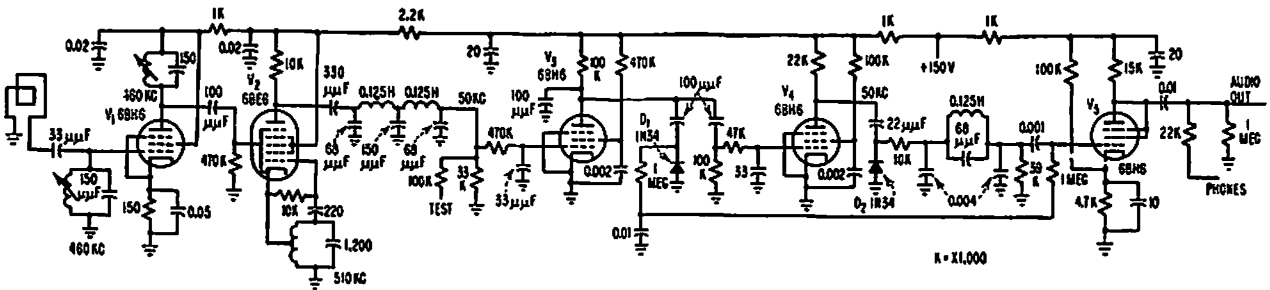


AUDIO FOR A-M/F-M PORTABLE—Overall power gain is 70 db, with audio output of 1 w at less than 10% distortion.—R. A. Santilli and H. Thanos, Portable Radio Uses Drift-Field Transistors, *Electronics*, 33:28, p 48–50.



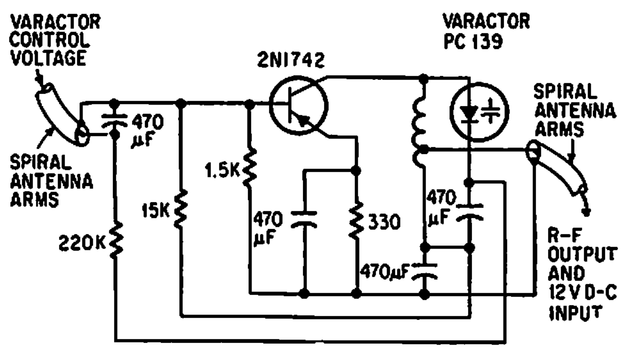
K = X 1,000

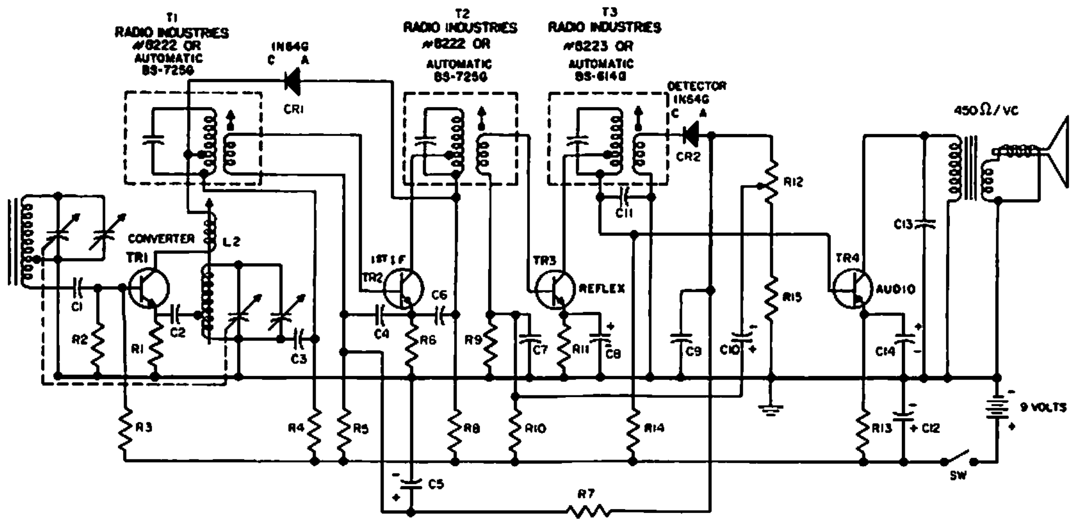
TONE SIGNAL REJECTOR—Used to separate desired backscatter pulses from unwanted tone signals of interfering stations on same frequency. Negative-going portion of tone signal is rectified and used as slicer level for passing desired pulse, which rides on top of interfering tone.—K. Perry, Reducing Interference in Ionospheric Sounding, 33:22, *Electronics*, p 118-120.



460-KC F-M RECEIVER FOR WIRELESS MICROPHONE—Loop 5 meters square picks up induction field of four-transistor transmitter and feeds r-f amplifier V1. Operating frequency is converted to 50 kc by V2 and amplified and limited by V3 and V4. Audio signal is recovered after passing through low-pass filter. Peak audio output is about 0.5 v, enough to feed p-a or speech preamplifier.—G. F. Montgomery, Wireless Microphone Uses F-M Modulation, *Electronics*, 31:1, p 54–55.

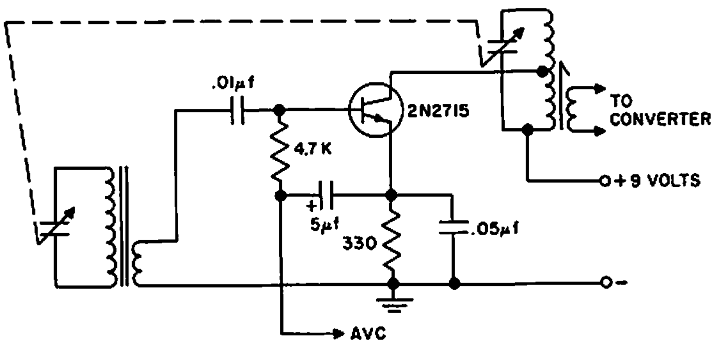
ANTENNAFIER—Varactor-tuned transistor amplifier built into tip of conical spiral antenna is tuned from 120 to 240 Mc by varying varactor voltage from 0 to 40 v d-c.—J. F. Rippin, Making the Antenna an Active Partner, *Electronics*, 38:16, p 93–96.



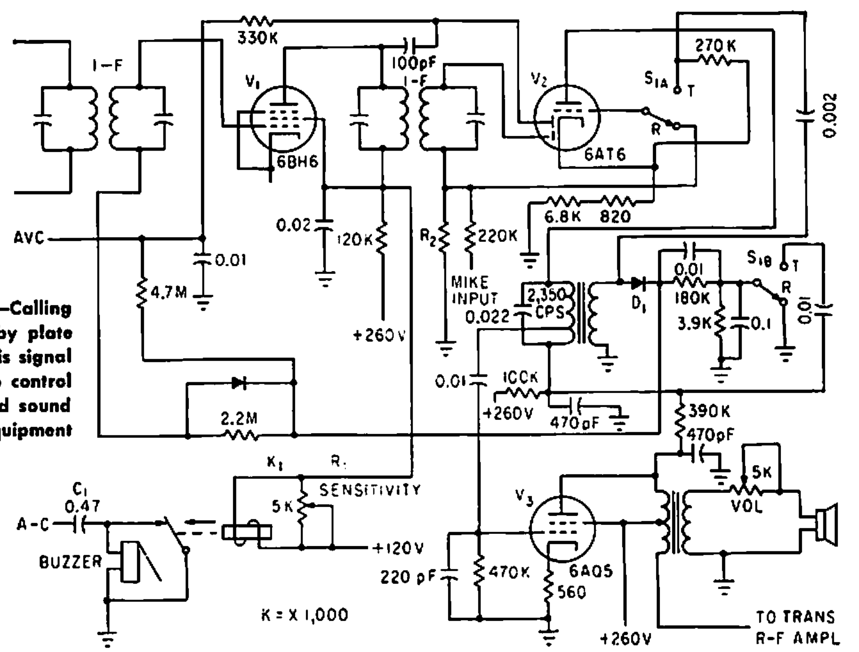


R1, R14	1500 OHM
R2	6800 OHM
R3	27,000 OHM
R4, R11	470 OHM
R5	82,000 OHM
R6	330 OHM
R7, R8	3300 OHM
R9	10,000 OHM
R10	91,000 OHM
R12	VOLUME CONTROL 10,000 OHM AUDIO TAPER
R13	100 OHM
R15	120 OHM
C1, C11	.02 µfd
C2, C3, C7	.01 µfd
C4, C6, C9, C13	.05 µfd
C5	15 µfd, 12V
C8	50 µfd, 3V
C10	6 µfd, 12V
C12	50 µfd, 12V
C14	100 µfd, 12V
TR1	GE 2N1086, 2N1086A OR 2N1087 CONVERTOR
TR2	2N292 1ST I.F.
TR3	GE 2N169 OR 2N1121 REFLEX
TR4	2N1415 AUDIO
L1	435 µh ± 10%
L2	250 µh ± 10%
CR1, CR2	IN64G OR EQUIV.
ΔC1	190.6 } R/C MODEL 242
ΔC2	89.5 } R/C MODEL 242

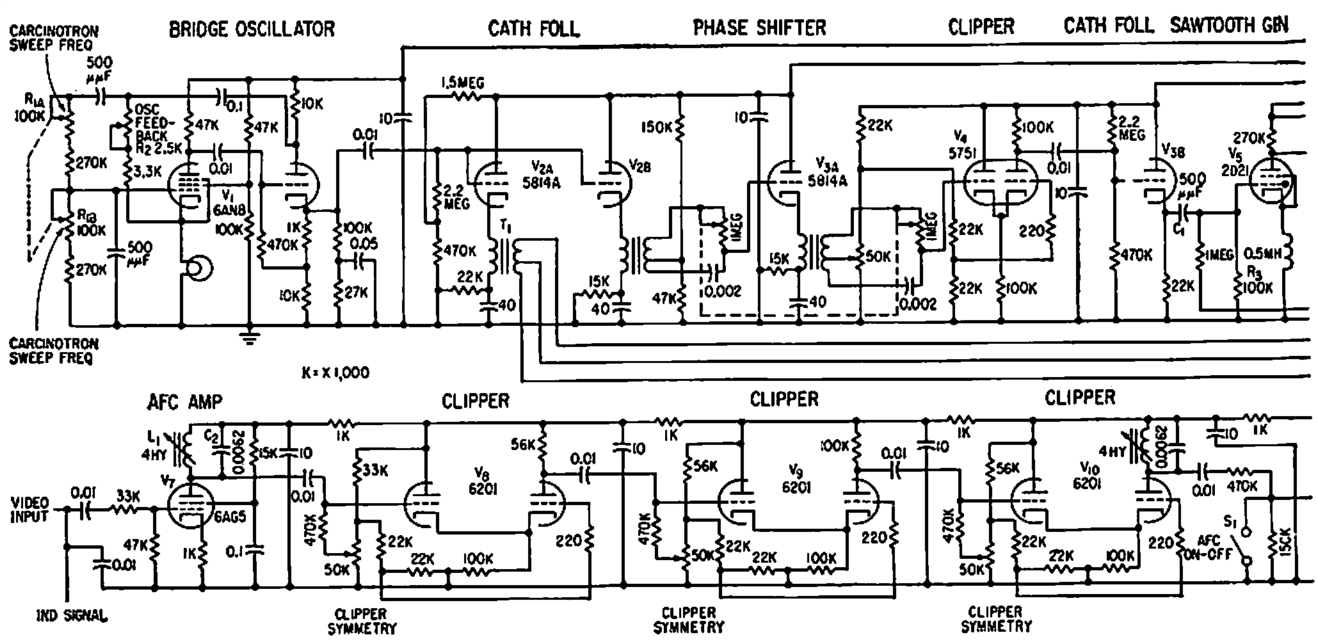
FOUR-TRANSISTOR REFLEX—Nominal sensitivity is 200 microvolts per meter at 5 mw reference power output. Maximum power output is 75 mw, and total battery drain is 17 ma.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 291.



TUNED R-F STAGE—Improves sensitivity, selectivity, and signal-to-noise ratio when used at input of radio receiver.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 283.

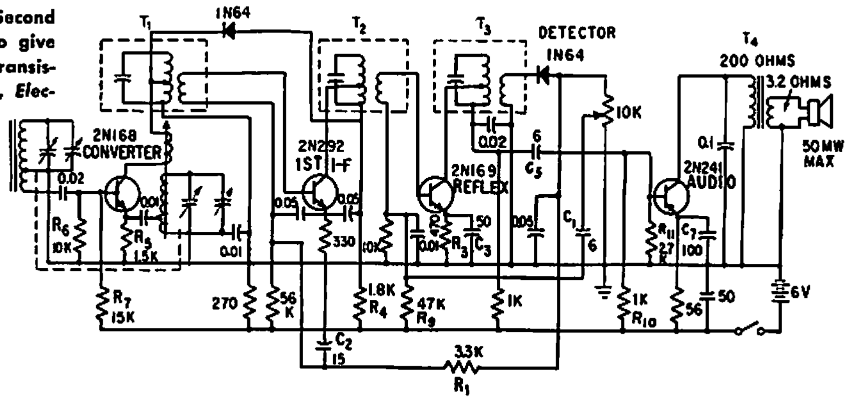


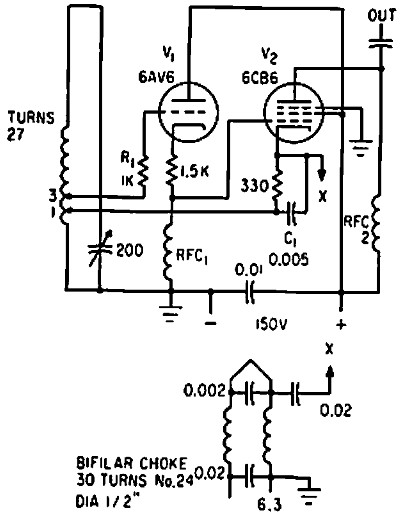
TONE-OPERATED CALLING SYSTEM—Calling frequency of 2,350 cps is amplified by plate resonant circuit of V2. D1 rectifies this signal and applies positive-going voltage to control grid of last i-f V1, to operate K1 and sound buzzer.—L. Solomon, Citizens Band Equipment Design, *Electronics*, 33:45, p 70–72.



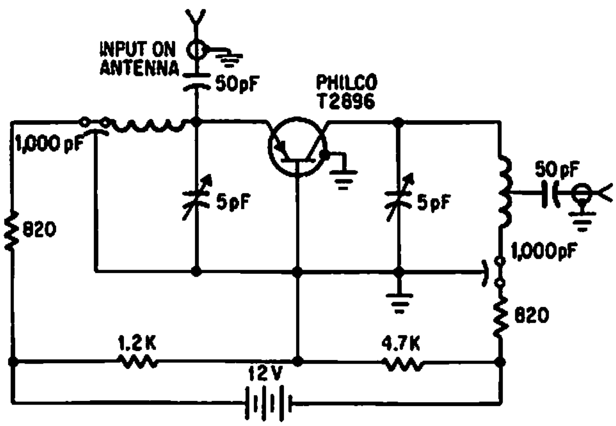
VOLTAGE-TUNABLE CARCINOTRON CONTROL—Used with superheterodyne receiver to provide continuous frequency coverage from 30 Mc to 75,000 Mc by means of harmonic mixing.—C. H. Currie, Carcinotron Harmonics Boost Receiver Range, *Electronics*, 32:9, p 58–61.

FOUR-TRANSISTOR REFLEX PORTABLE—Second i-f stage doubles as audio amplifier to give five-stage performance.—E. Gottlieb, Transistor Reflex Circuit Trims Receiver Costs, *Electronics*, 31:1, p 66–68.

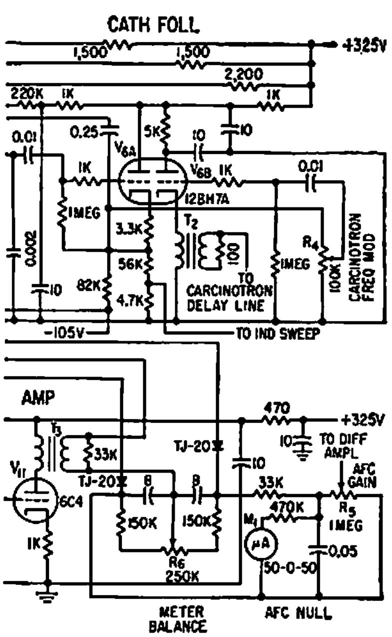


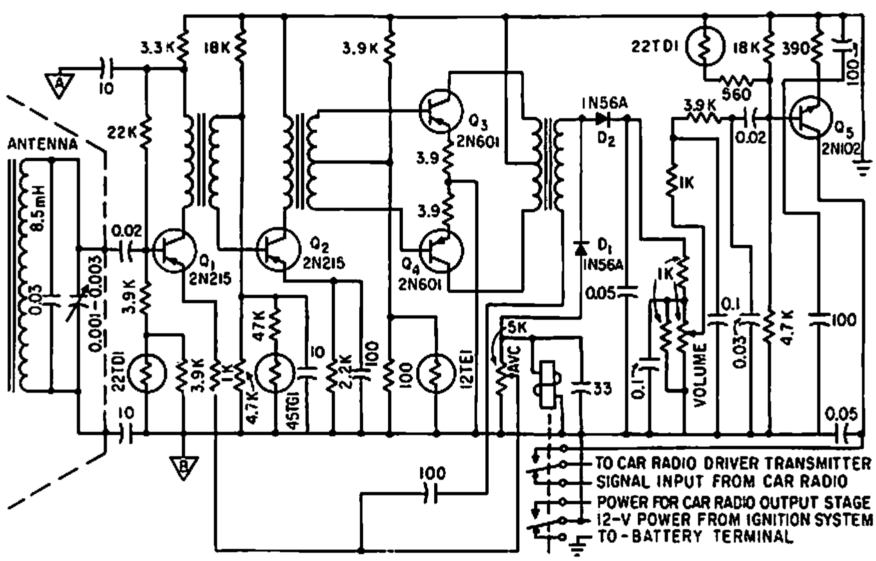


LOAD-ISOLATING 3-3.5 MC OSCILLATOR—Refined version of Lampkin variable r-f oscillator for dual-conversion receiver gives uniform output over band and sufficient stability for single-sideband reception after 30-sec warmup.—E. Robberson, R-F Oscillator has Improved Stability, *Electronics*, 36:32, p 62–63.

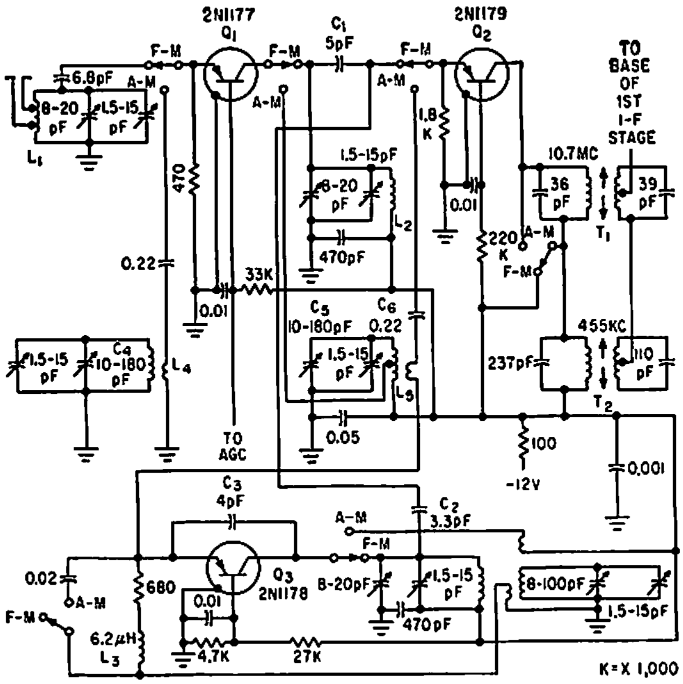


SLOT ANTENNAFIER—T-bar-fed 420-Mc slot antennafier for space vehicles has gain of 10 db, 100-Mc bandwidth, and 7.8 db noise figure.—J. F. Rippin, Making the Antenna an Active Partner, *Electronics*, 38:16, p 93–96.

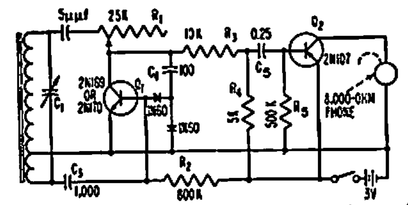




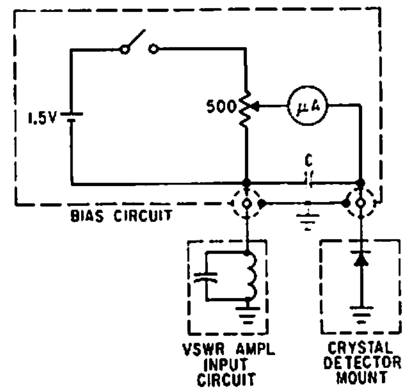
9-KC INDUCTION RECEIVER—Thermistor network in base circuits of transistors provide thermal compensation between −30 and +140°F, for picking up messages broadcast from roadside telephone-line loops.—E. A. Hanysz, J. E. Stevens, and A. Meduvsky, Communication System for Highway Traffic Control, *Electronics*, 33:42, p 81–83.



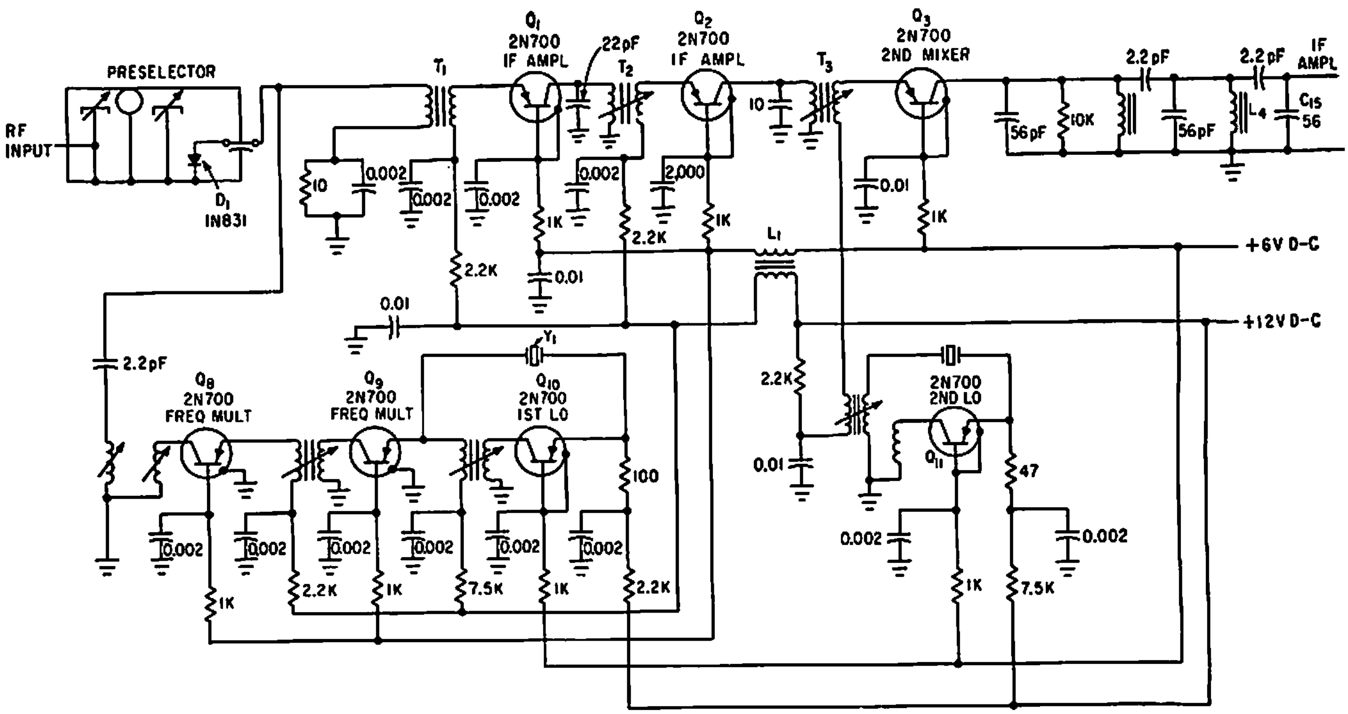
TUNER FOR A-M/F-M PORTABLE—R-f amplifier Q1, mixer Q2, and local oscillator Q3 are all switched to perform same functions on f-m as on a-m. Grounded-base oscillator Q3 requires careful design to compensate for transconductance phase shift at highest frequency of oscillation (118.7 Mc). Overall gain of tuner is 25.5 db at 88 Mc and 22.5 db at 108 Mc.—R. A. Santilli and H. Thanos, Portable Radio Uses Drift-Field Transistors, *Electronics*, 33:28, p 48–50.



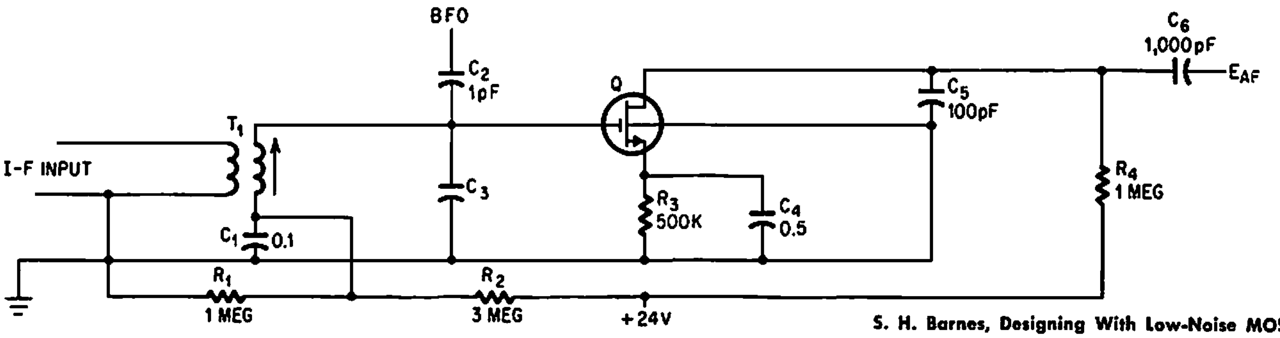
TWO-TRANSISTOR REFLEX RADIO—Q1 is used regeneratively as r-f amplifier and reflexively as first a-f amplifier, while Q2 serves as power amplifier.—S. A. Sullivan, Transistor Radio Uses Few Parts, *Electronics*, 31:1, p 90–92.



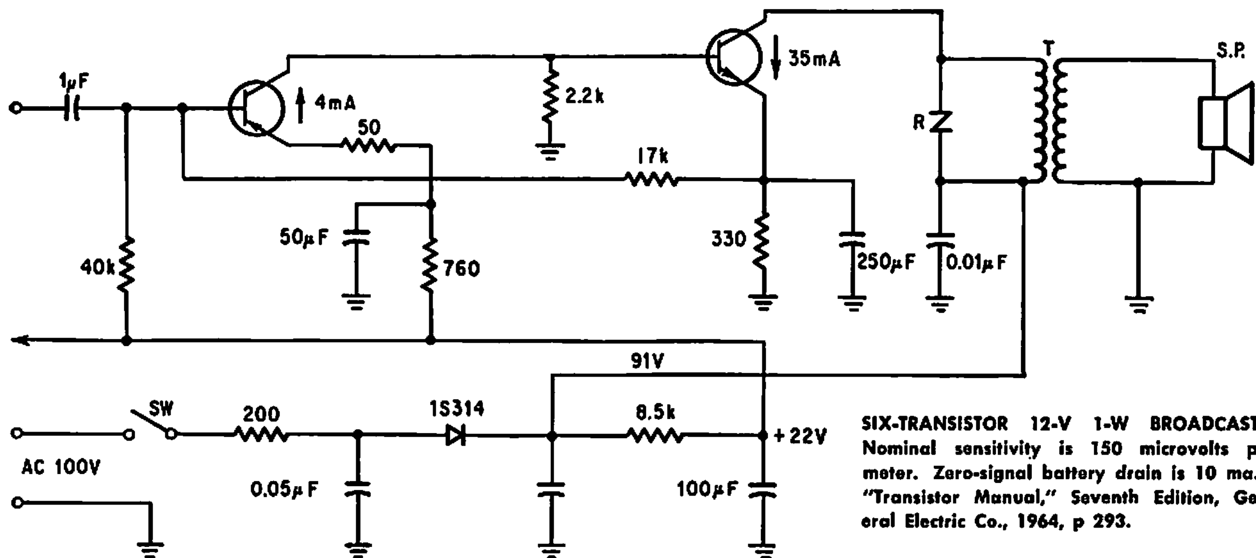
MILLIMETER-WAVE DETECTOR—Biasing with 1N53 crystal detector increases gain 20 db at 73 Mc.—K. Ishii and A. L. Brault, Crystal Biasing Improves Millimeter-Wave Detector, *Electronics*, 34:24, p 65.



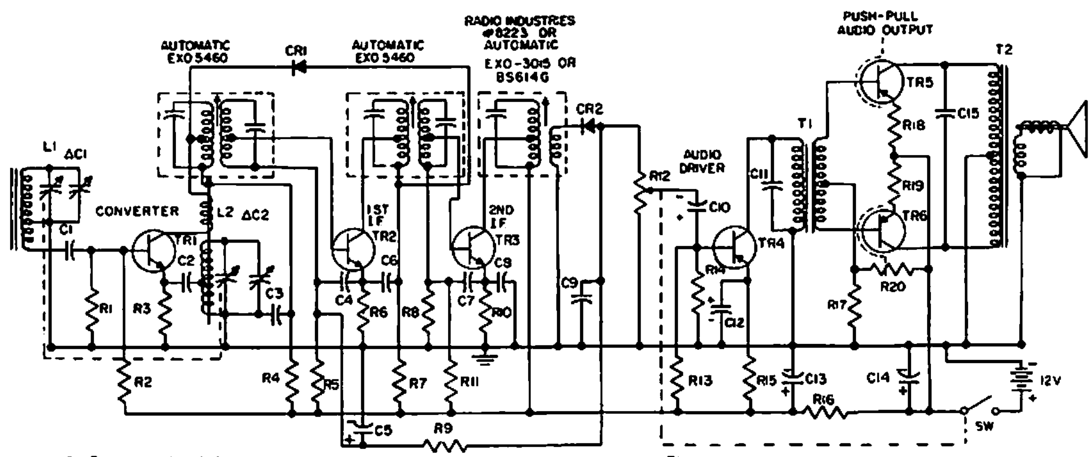
DOUBLE-CONVERSION F-M SUPERHETERODYNE—Common-base connections in local oscillators Q10 and Q11 give stability with minimum components in 20-channel Mercury spacecraft command receiver. Each frequency multiplier doubles frequency of first local oscillator. I-f output is 10.7 Mc.—R. Elliott, First Details on Mercury Spacecraft Command Receiver, *Electronics*, 36:5, p 32–35.



SSB PRODUCT DETECTOR—Square-law relationship between transconductance and drain current makes mos fet ideal for product detector in ssb receivers.—G. G. Luettgenau and S. H. Barnes, Designing With Low-Noise MOS FETs: A Little Different But No Harder, *Electronics*, 37:31, p 53–58.



SIX-TRANSISTOR 12-V 1-W BROADCAST—Nominal sensitivity is 150 microvolts per meter. Zero-signal battery drain is 10 ma.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 293.

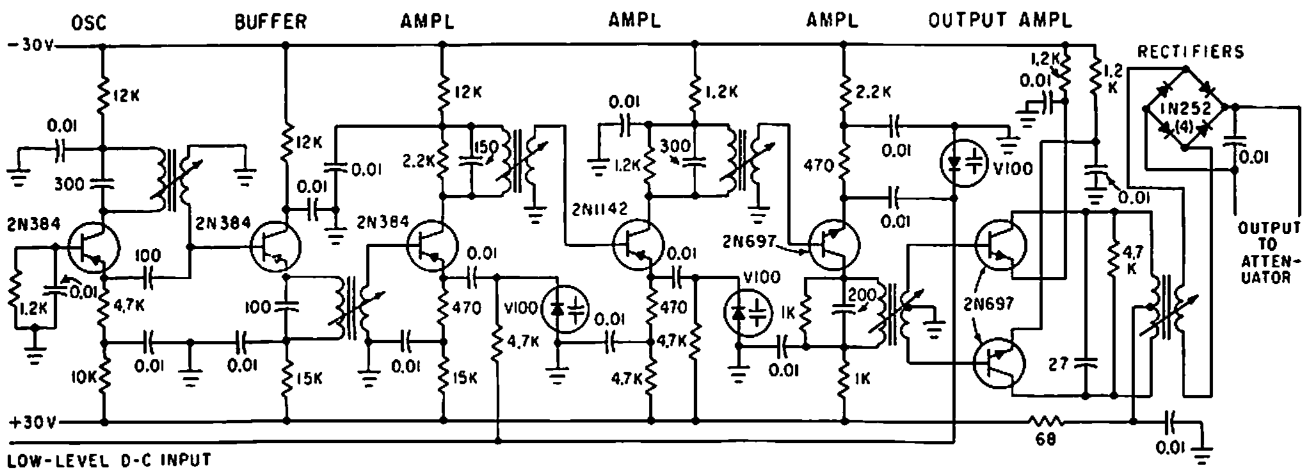


R1, R11, —— 6800 OHM
R2, —— 33,000 OHM
R3, —— 1500 OHM
R4, R10, R15, — 470 OHM
R5, —— 100,000 OHM
R6, —— 330 OHM
R7, R13, —— 4700 CHM
R8, —— 2200 OHM
R9, —— 2,700 OHM
R12, —— VOLUME CONTROL 10,000 OHM 1/2W AUDIO TAPER
R14, —— 15,000 OHM
R16, —— 220 OHM
R17, —— 2700 OHM
R18, R19, —— 10 OHM
R20, —— 33 OHM

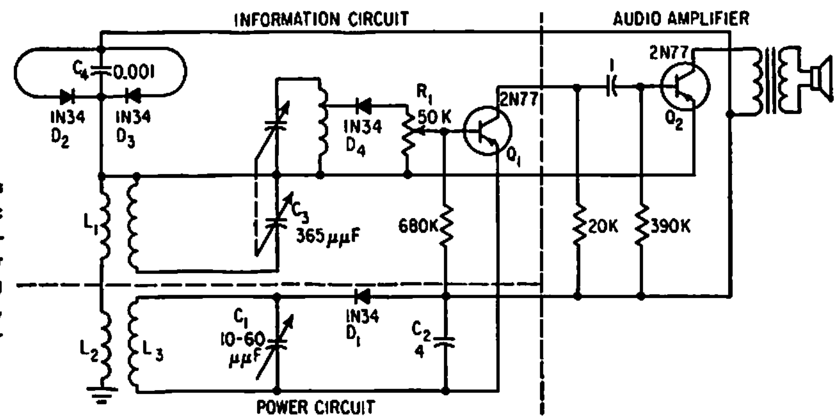
C1, —— .02μfd
C2, C3, —— .01μfd
C4, C6, C7, C8, — .1μfd
C5, —— 6μfd, 12V
C9, —— .05μfd
C10, —— 6μfd, 6V
C11, —— .003μfd
C12, C13, C14, — 50μfd, 12V
C15, —— .2μfd
TR1, —— G.E. 2N1087 CONVERTER
TR2, —— G.E 2N293 1ST I.F.
TR3, —— G.E. 2N169 OR 2N1121 2ND I.F.
TR4, —— G.E. 2N324 DRIVER
TR5, TR6, —— G.E. 2N1415 AUDIO WITH CLIP-ON HEAT SINK (BIRCHER 3AL635-2R OR EQUIV)

T1, —— 2000/2600 CT
T2, —— 200Ω CT/VC
L1, —— 435μh±10%
L2, —— 250μh±10%
ΔC1, — 190.6 } R/C MODEL 242
ΔC2, — 89.3 }
CR1, CR2, —— 1N64 OR 1N295 OR EQUIV

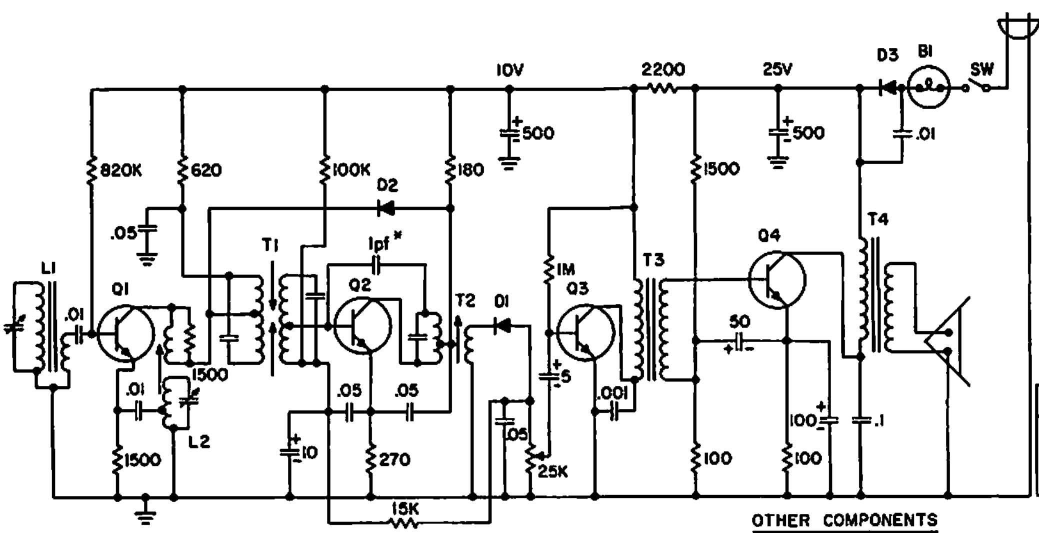
PROTECTED OUTPUT STAGE—High-voltage passivated mesa transistor in output stage of Japanese home radio is protected by silicon varistor R.—T. Kojima and M. Watanabe, When You're Second, You Try Harder, *Electronics*, 38:25, p 81–89.



AUTOMATIC LEVEL CONTROL FOR PARAMETRIC AMPLIFIER—Varactor diode in pump feed line feeds so-called magnified d-c amplifier that in turn drives ferrite variable attenuator, to hold troposcatter receiver signal level constant over entire klystron mode.—W. L. Smott and H. C. Leahy, Parametric Amplifier Improves Tropo-Scatter System, *Electronics*, 35:9, p 38–40.



SIGNAL-POWERED RECEIVER—Circuit receives and rectifies r-f radiation, stores resultant d-c energy in C2, and releases energy to transistors as required. Unique dipole rectifier provides efficient antenna-to-receiver coupling for frequencies of above 50 Mc.—L. R. Crump, Radio Waves Power Transistor Circuits, *Electronics*, 31:19, p 63–65.



PERFORMANCE	
NOMINAL SENSITIVITY	40μv/m
RATED OUTPUT POWER	750 MW
TOTAL POWER DRAIN	10 W

GENERAL ELECTRIC CO.

Q1 2N2926 (RED) OR 2N2715 OR 2N3394
Q2, Q3 2N2926 (ORANGE) OR 2N2716 OR 2N3393
Q4 2N2196 OR 2N2107 (ATTACH TO HEAT SINK)
D1 1N4009 (SILICON)
D2 1N60 (GERMANIUM)
D3 1N1692

RADIO INDUSTRIES, INC.

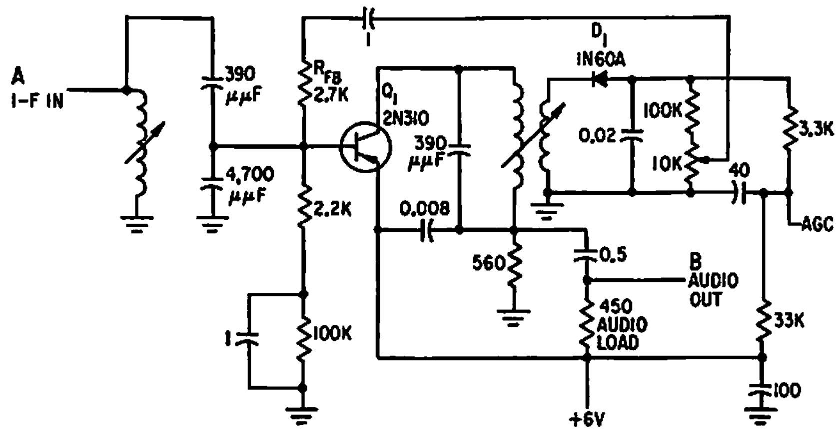
T1 16414
T2 13964
L1 16413
L2 16411
ΔC MODEL 42-2A

OTHER COMPONENTS

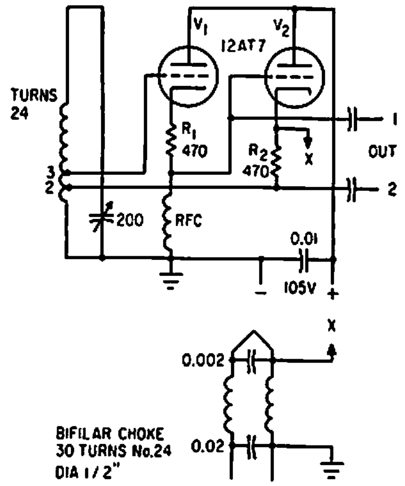
T3 35K/100Ω
T4 250/VC
B1 110V, 25W LIGHT BULB

* USE 1.0pf WITH 2N2926 AND 2N3391 SERIES TRANSISTORS, 0.5pf WITH 2N2715 SERIES.

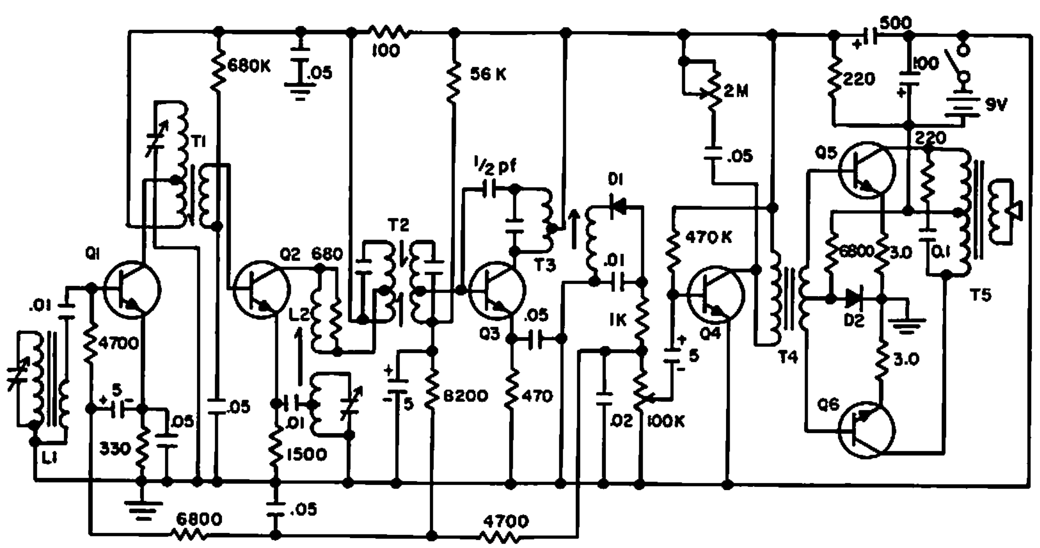
FOUR-TRANSISTOR A-C LINE SET—Nominal sensitivity is 40 microvolts per meter, power output 750 mw, and total power drain 10 w.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 297.



I-F/A-F REFLEX—Single transistor gives simultaneous amplification at intermediate and audio frequencies in economy radio. Careful design provides high gain and sufficient undistorted output power to drive audio output transistor at full rating without motorboating. —J. Waring, How To Design Reflexed Transistor Receivers, *Electronics*, 32:19, p 70–72.



HIGH-STABILITY 3-3.5 MC OSCILLATOR—Modification of Lampkin circuit uses pair of cathode followers in cascade, with tube circuits being tapped across part of coil and excited from resonator through high impedance. Bifilar choke minimizes variations in heater-cathode capacitance of driver V2.—E. Robberson, R-F Oscillator has Improved Stability, *Electronics*, 36:32, p 62–63.



GENERAL ELECTRIC CO.

Q1	2N2715
Q2, Q3	2N2716
Q4	2N2924 OR 2N3392
Q5, Q6	2N2714 (WITH HEAT SINK)
D1, D2	IN4009

RADIO INDUSTRIES, INC.

T1	16412
T2	16414
T3	13964
L1	16413
L2	16411

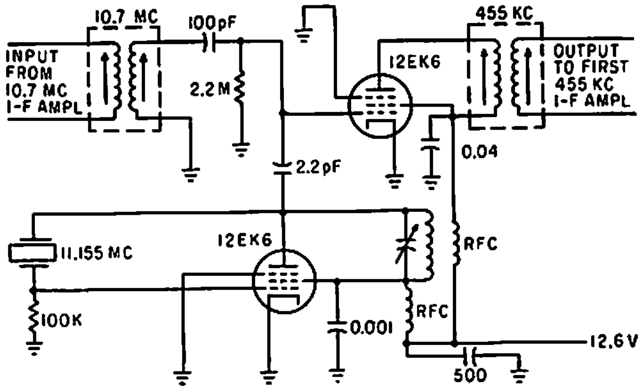
RADIO CONDENSER CORP.
TUNING CONDENSER
MODEL 42-3A (CN 909991)

PERFORMANCE	
NOMINAL SENSITIVITY	30μv/m
RATED OUTPUT POWER	500 MW
BATTERY DRAIN	12.5 MA

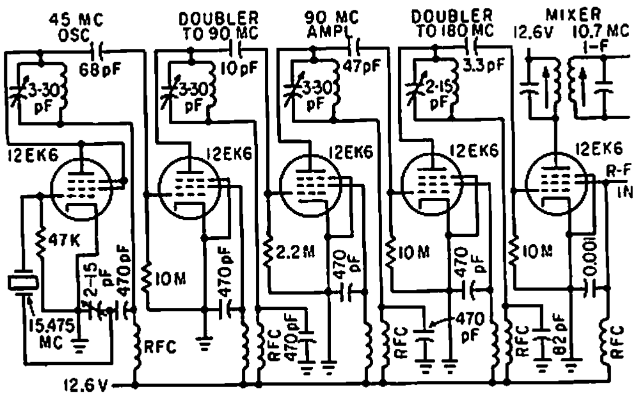
OTHER COMPONENTS

T4 5K/2K CT
T5 250 CT/VC

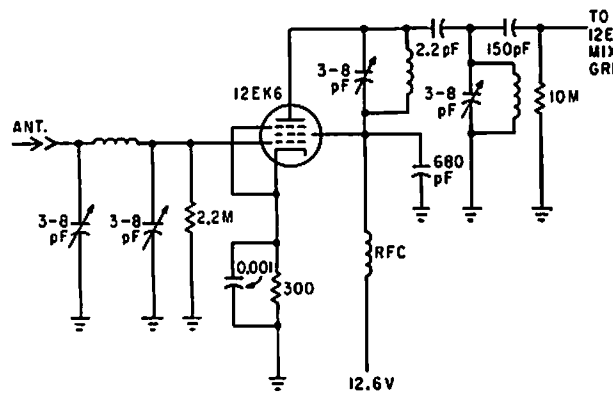
SIX-TRANSISTOR 9-V BROADCAST WITH TUNED R-F STAGE—Nominal sensitivity is 30 microvolts per meter, power output 500 mw, and battery drain 12.5 ma.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 296.



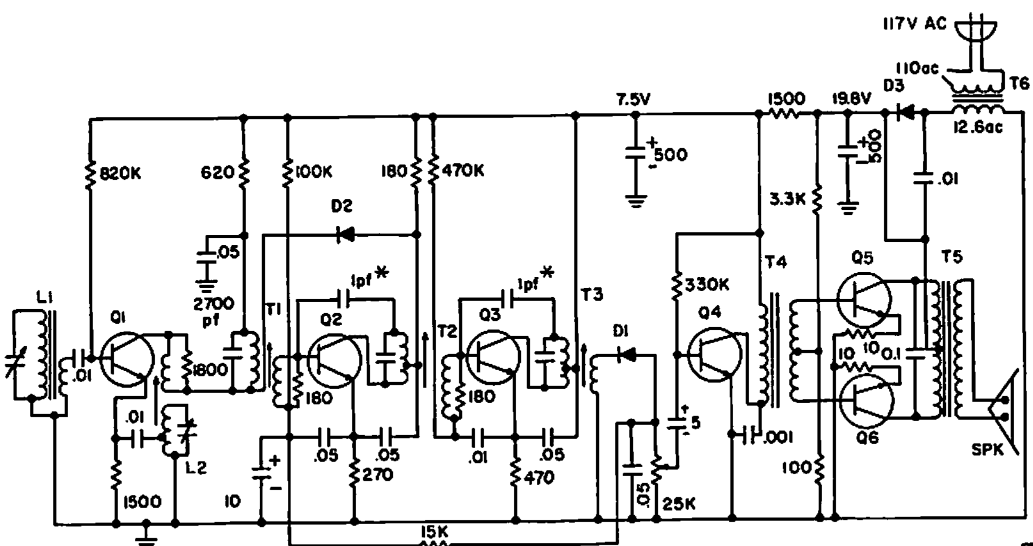
COLPITTS CRYSTAL—Oscillator uses 11.155-Mc tuned plate circuit for operation at crystal fundamental frequency. Other 12EK6 has no cathode bias and provides conversion gain of 10.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



HIGH-FREQUENCY MOBILE OSCILLATOR—Uses third-overtone crystal oscillator with two doubler stages. To get adequate drive for doubler to 180 Mc, stage of straight-through amplification at 90 Mc is used.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



175-MC R-F STAGE—Pi network in grid circuit couples energy from antenna. Double-tuned capacitance-coupled transformer is used in plate circuit.—C. Gonzalez and R. J. Nelson, Design of Mobile Receivers with Low-Plate-Potential Tubes, *Electronics*, 33:34, p 62–65.



RADIO INDUSTRIES, INC.

T1	13964-R1
T2, T3	13964
L1	16413
L2	16411
AC	MODEL 42-2A

GENERAL ELECTRIC CO.

Q1, Q3	2N2926 (RED) OR 2N2715 OR 2N3394
Q2, Q4	2N2926 (ORANGE) OR 2N2716 OR 2N3393
Q5, Q6	2N2714 (WITH HEAT SINK) OR 4JX1IC1536
D1	1N4009 (SILICON)
D2	1N60 (GERMANIUM)
D3	1N1692

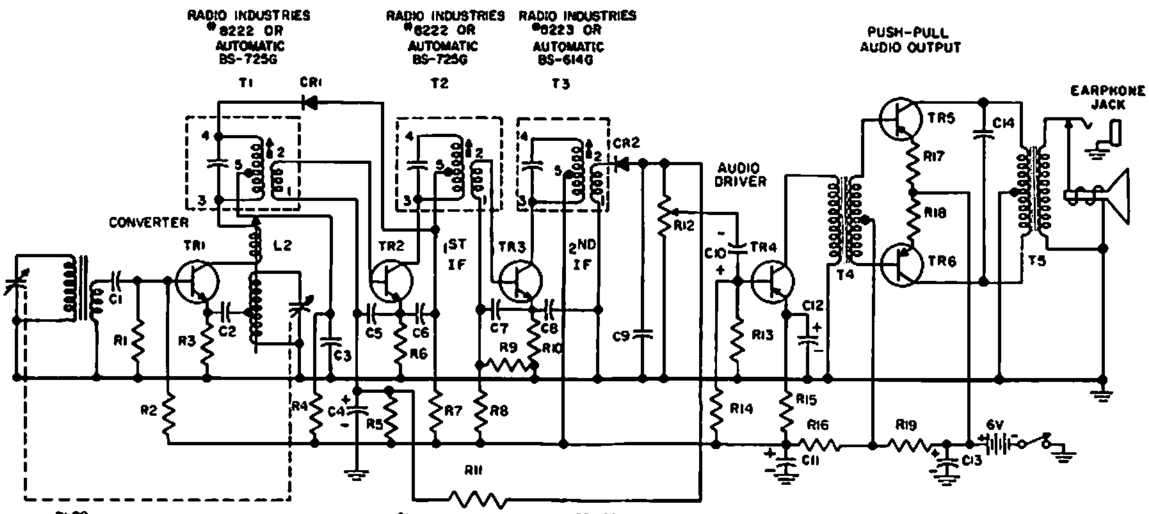
*USE 1.0pf WITH 2N2926 AND 2N3391 SERIES TRANSISTOR, 0.5 pf WITH 2N2715 SERIES

PERFORMANCE	
NOMINAL SENSITIVITY	30μv/m
RATED OUTPUT POWER	940 MW
TOTAL POWER DRAIN	4 W

OTHER COMPONENTS

T4 4K/2.5K CT
T5 450 CT/VC
T6 12.6V FILAMENT TRANSFORMER

SIX-TRANSISTOR A-C LINE SET—Nominal sensitivity is 30 microvolts per meter, power output 940 mw, and total power drain 4 w.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 298.

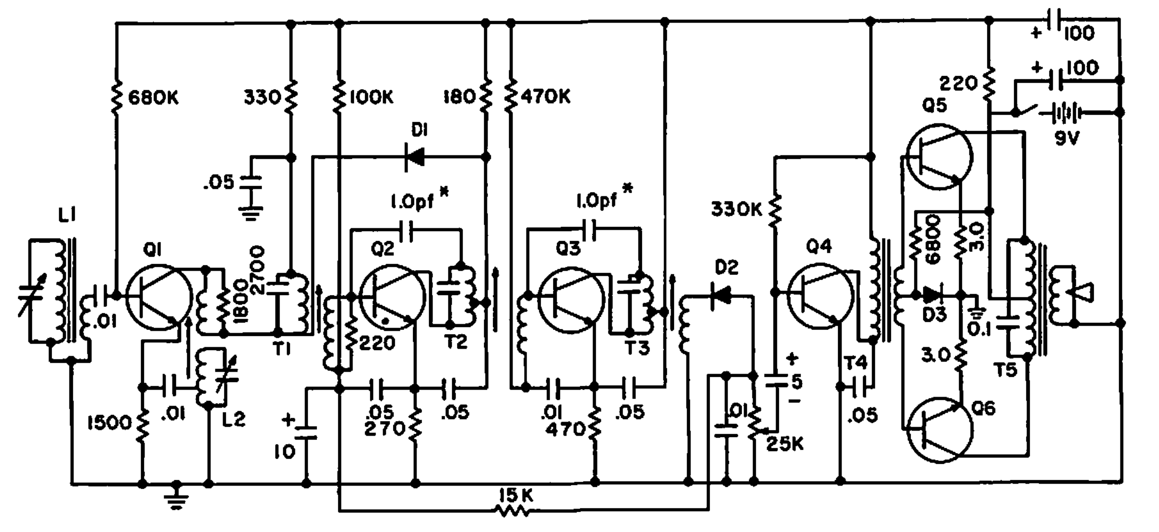


R1, R8,	10,000 OHM
R2,	15,000 OHM
R3,	1500 OHM
R4,	270 OHM
R5,	47,000 OHM
R6,	220 OHM
R7, R9,	2200 OHM
R10,	1000 OHM
R11, R14,	4700 OHM
R12,	VOLUME CONTROL 10,000 OHM 1/2W AUDIO TAPER
R13,	68,000 OHM
R15,	470 OHM
R16,	100 OHM
R17, R18,	8.2 OHM
R19,	33 OHM

C1,	.02 μfd.
C2, C3, C5, C6, C7, C8,	.01 μfd.
C4, C10,	6 μfd. – 6V
C9,	.05 μfd.
C11, C12, C13,	50 μfd. – 12 V
C14,	.2 μfd.
CR1, CR2,	1N64G OR EQUIV
TR1,	G.E. 2N1087
TR2,	G.E. 2N293
TR3,	G.E. 2N169 OR 2N1121
TR4,	G.E. 2N324
TR5, TR6,	G.E. 2N1415

*T4 = 3600Ω/2000Ω CT
*T5 = 360Ω CT/VC

SIX-TRANSISTOR 6-V BROADCAST RECEIVER—Nominal sensitivity is 200 microvolts per meter, maximum power output is 200 mw, and zero-signal battery drain is 8 ma.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 292.



GENERAL ELECTRIC CO.

Q1,Q3 2N2926 (RED) OR 2N2715 OR 2N3394
Q2,Q4 2N2926 (ORANGE) OR 2N2716 OR 2N3393
Q5,Q6 2N2714 (WITH HEAT SINK)
D1 1N60 (GERMANIUM)
D2,D3 1N4009 (SILICON)

RADIO INDUSTRIES, INC.

T1 – 13964 – R1
T2,T3 – 13964
L1 16413
L2 16411
ΔC MODEL 42-2A

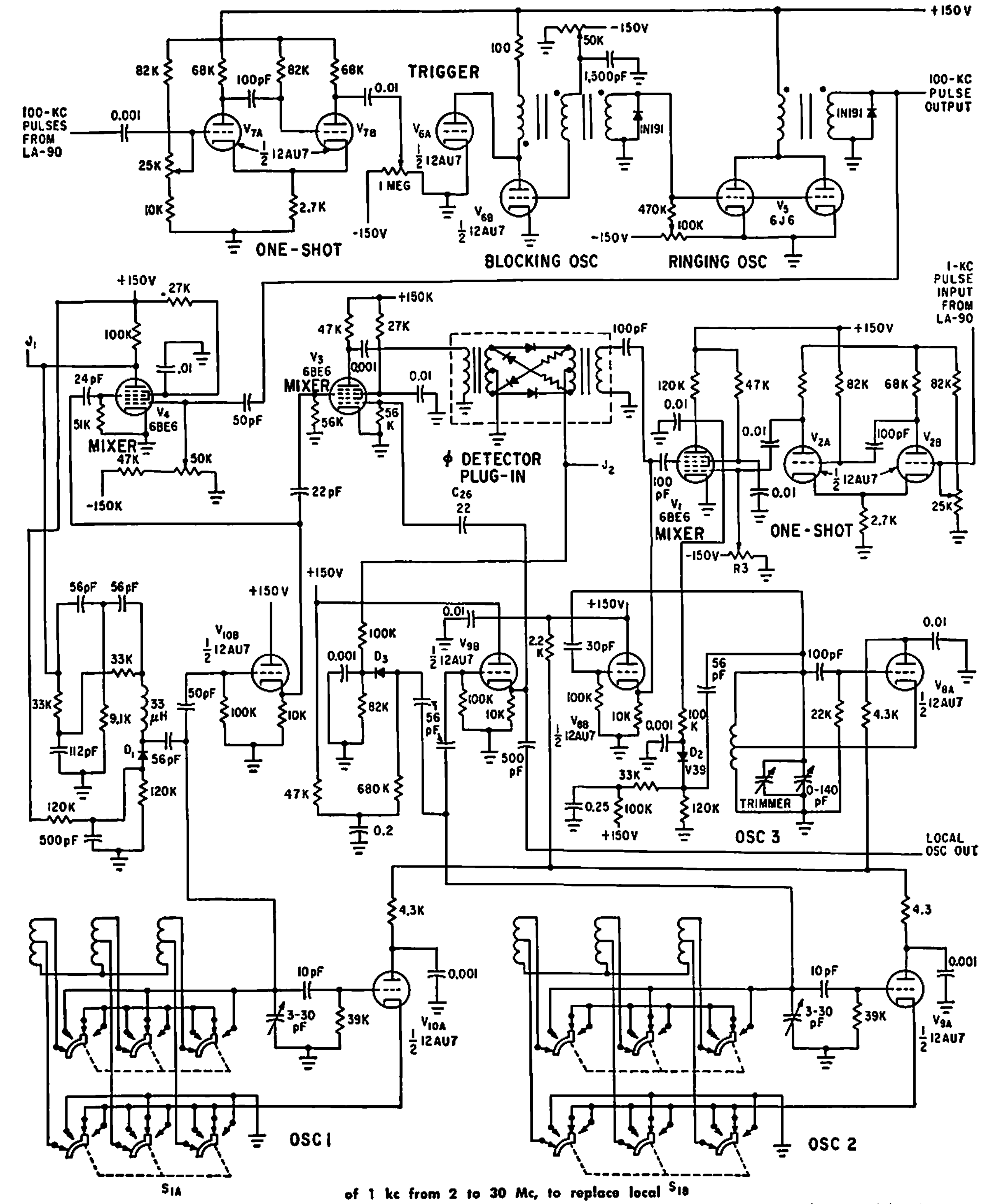
PERFORMANCE	
NOMINAL SENSITIVITY	20 μv/m
RATED OUTPUT POWER	500 MW
BATTERY DRAIN	10MA

OTHER COMPONENTS

T4 – 5K/2K CT
T5 – 250 Ω CT/VC

*USE 1.0pf WITH 2N2926 AND 2N3391 SERIES TRANSISTORS, 0.5 pf WITH 2N2715 SERIES.

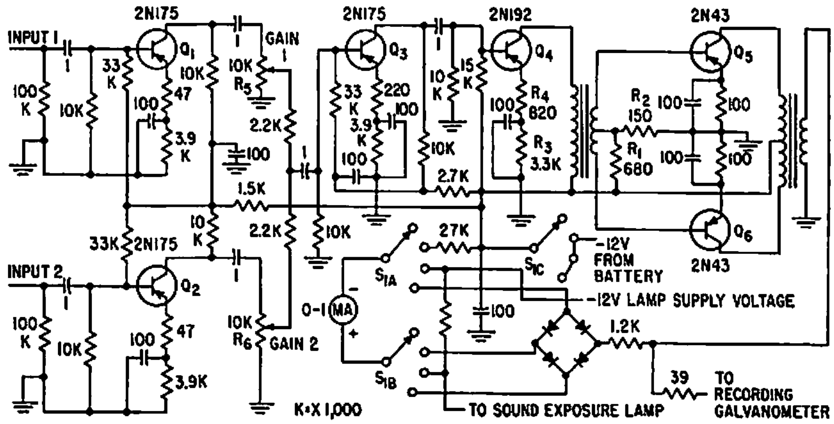
SIX-TRANSISTOR 9-V BROADCAST—Nominal sensitivity is 20 microvolts per meter, rated power output 500 mw, and battery drain 10 ma.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 295.

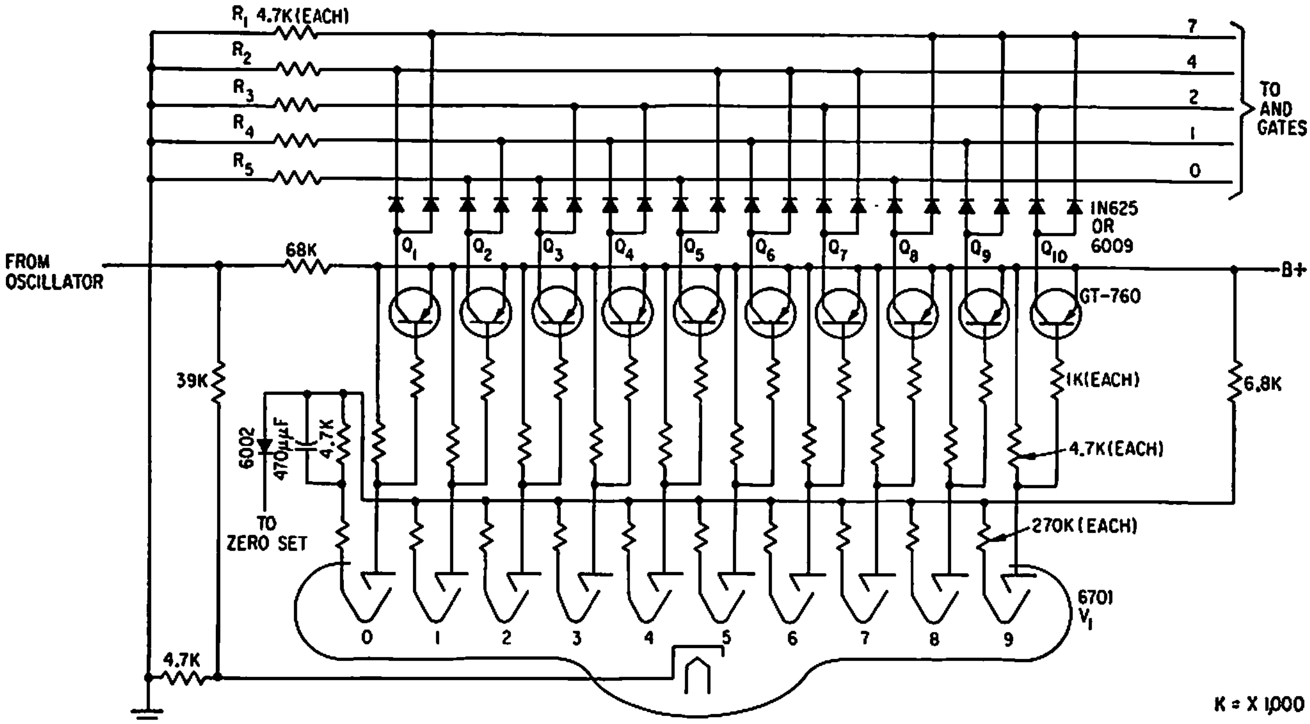


FREQUENCY SYNTHESIZER—Three oscillators in synthesizer provide frequency increments of 1 kc from 2 to 30 Mc, to replace local oscillator operation in double-conversion ssb receiver.—J. E. MacDowell, Stable Frequency Synthesizer Replaces Sideband Converter, *Electronics*, 35:25, p 41–43.

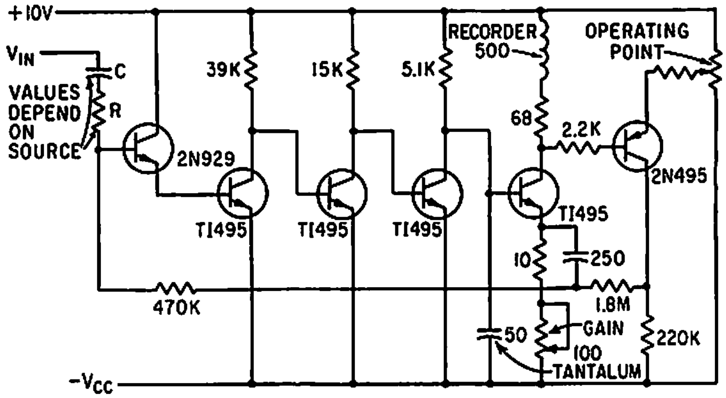
CHAPTER 71
Recorder Circuits

SOUND TRACK DRIVE—Dual-input amplifier drives 10-ohm recording galvanometer for variable-area optical sound track of 16-mm sound-on-film camera. Can be mounted directly on camera. Requires only two 6-v nickel-cadmium cells.—E. M. Tink, Transistorizing 16-Mm Tv Remote Film Camera, *Electronics*, 32:3, p 58–59.

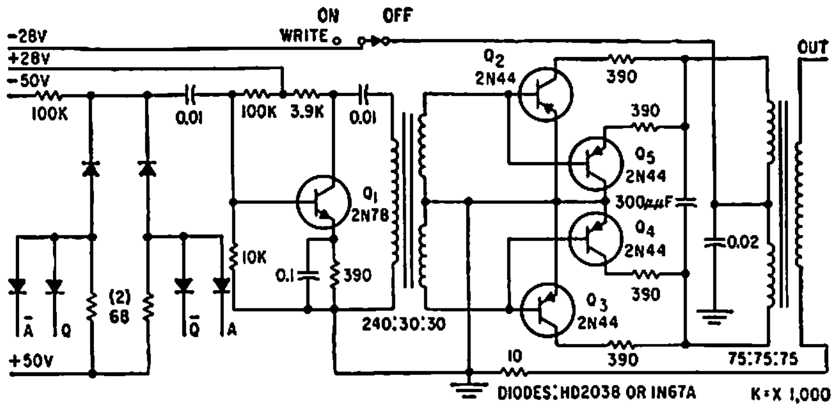




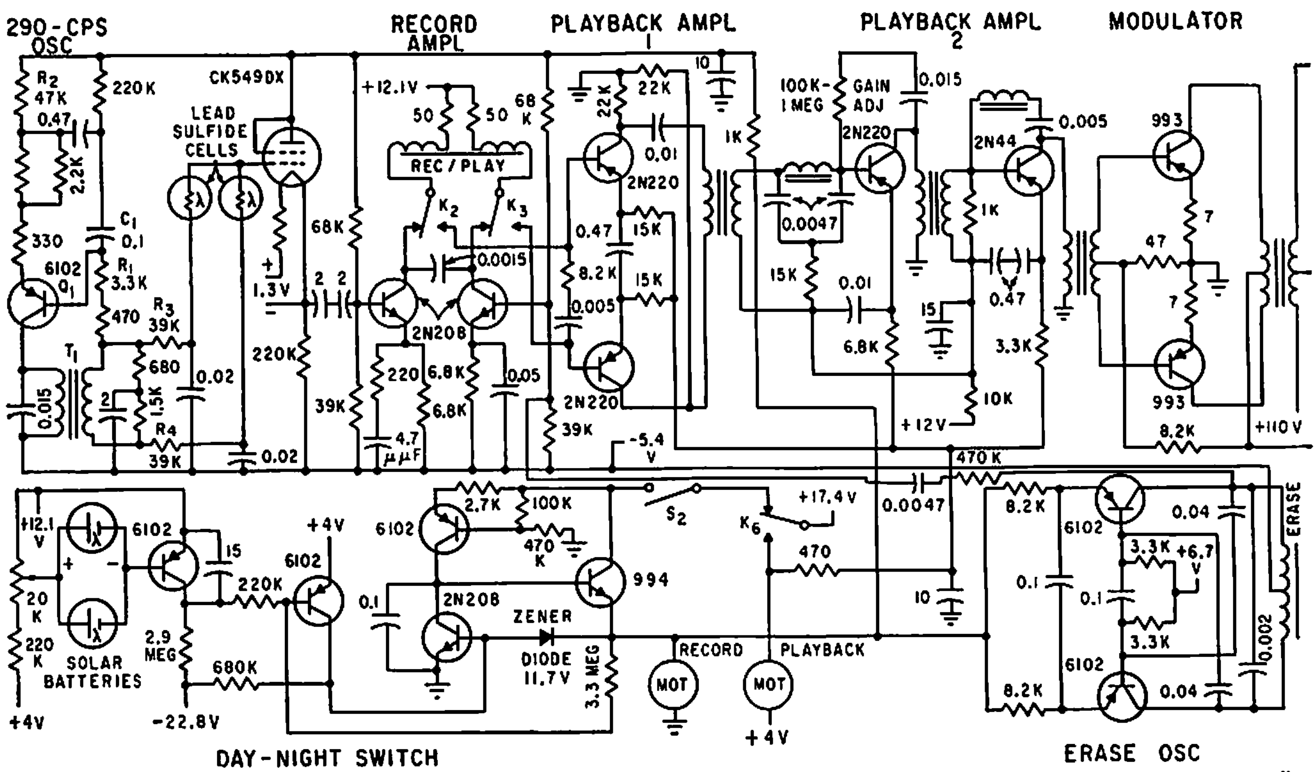
SHOCKPROOF FERRITE-CORE RECORDER—Cores retain stored data even after 6,000-g shock. Each transistor encodes decimal digit into two binary digits. Beam-switching decade counter makes Q1 to Q10 count in succession, to energize the five outputs that pulse cores through gated amplifiers.—C. P. Hedges, Digital Recorder Holds Data After Shock, *Electronics*, 32:12, p 60–62.



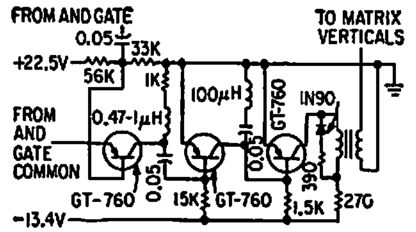
BANDPASS AMPLIFIER DRIVES RECORDER—Feedback from final stage to input sets bias level of direct-coupled a-c amplifier having current-derived stabilization, for driving recorder over range of 0.2 to 5 cps, with no bulky capacitors.—P. Laakmann, Direct Coupling Shrinks Amplifier Size and Cost, *Electronics*, 36:12, p 66–68.



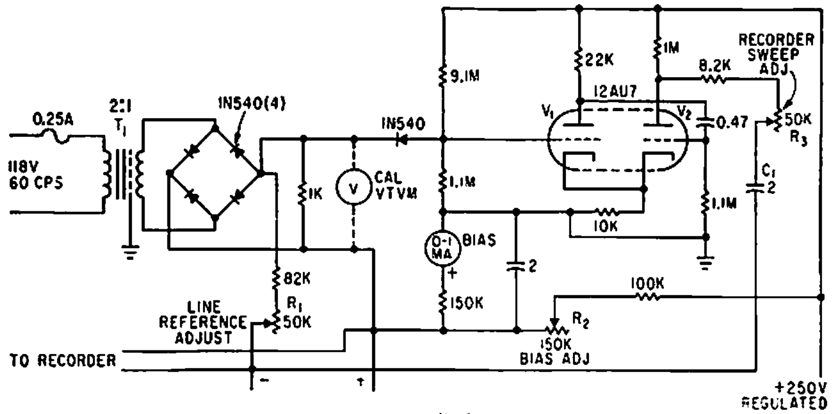
MAGNETIC DRUM WRITE AMPLIFIER—Power amplifier is followed by impedance-changing device that converts voltage waveform at output of flip-flop into corresponding current waveform for low-impedance recording head of magnetic memory drum, for Manchester recording with 220 ma peak-to-peak.—A. J. Strassman and R. E. Keeter, Clock Track Recorder For Memory Drum, *Electronics*, 32:41, p 74–76.



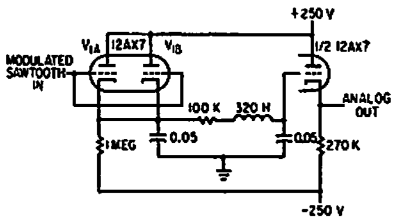
SATELLITE RECORDER AND TRANSMITTER—Primary video signal bandwidth is 0 to 240 cps. Direct-record system uses 290-cps subcarrier for reproducing d-c component of signal, giving 50-cps lower sideband. Upper sideband (530 cps) is suppressed. Transmitter uses crystal-controlled 108-Mc Hartley oscillator, feeding 1 w to antenna.—R. Hanel et al, Tracking Earth's Weather with Cloud-



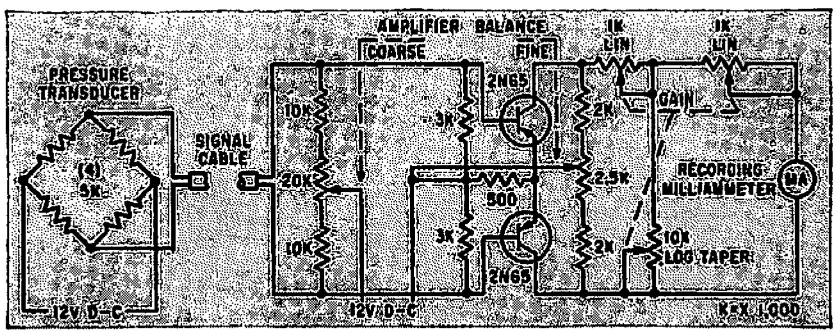
GATED AMPLIFIER DRIVES FERRITE CORES—Used in shockproof recorder in which each amplifier drives a line of six cores. Interrogation of cores releases stored information for processing.—C. P. Hedges, Digital Recorder Holds Data After Shock, *Electronics*, 32:12, p 60–62.



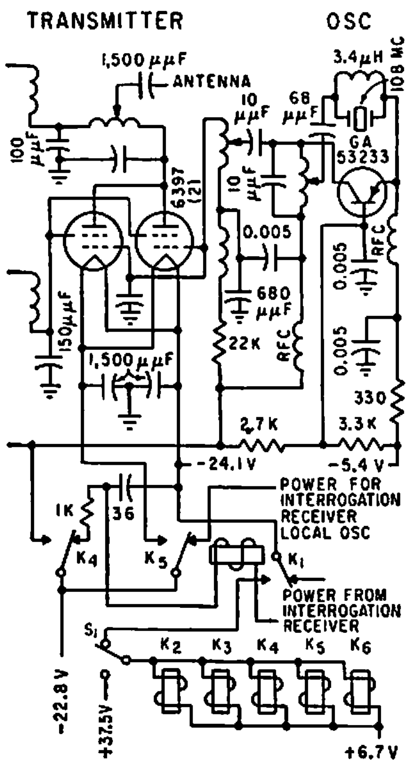
TRACING CAUSES OF LAB LINE TRANSIENTS—Circuit responds to single pulse having rise time as short as 1 microsec, and records average value of line voltage. Transients greater than preset trigger level pass through diode gate and trip mono, giving current pluse that drives chart recorder pin.—F. Trainor, Transient Recorder Monitors Power Lines to Protect Circuits, *Electronics*, 34:29, p 74–75.



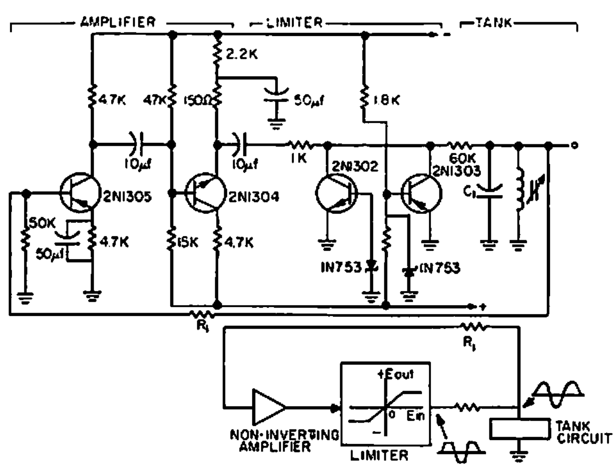
PEAK-READING CIRCUIT—Recovers analog voltage from modulated sawtooth waveform of magnetic-drum recorder.—H. L. Daniels and D. K. Sampson, Magnetic Drum Provides Analog Time Delay, *Electronics*, 32:6, p 44–47.



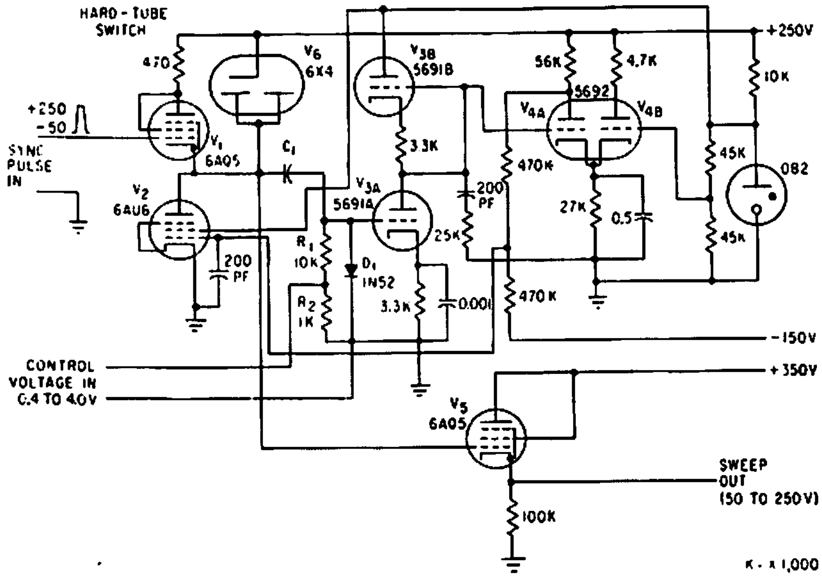
RUGGED DESIGN FOR OCEANOGRAPHY—Can drive low-impedance recording galvanometer for long periods without auxiliary power. Bilateral symmetry of push-pull circuit using matched 2N65 transistors optimizes linearity and thermal stability. Although designed for d-c operation, response is flat within 2 db up to 50 kc.—W. G. Van Dorn, Transistor D-C Amplifier for Rugged Use in Field, *Electronics*, 33:1, p 85.



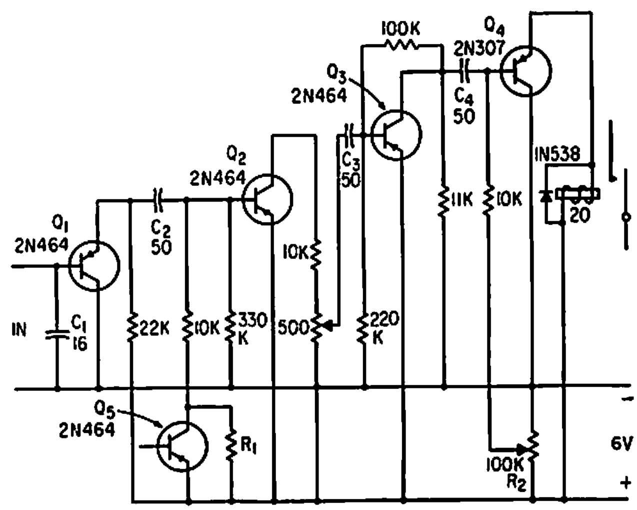
Cover Satellites, *Electronics*, 32:18, p 44–49.



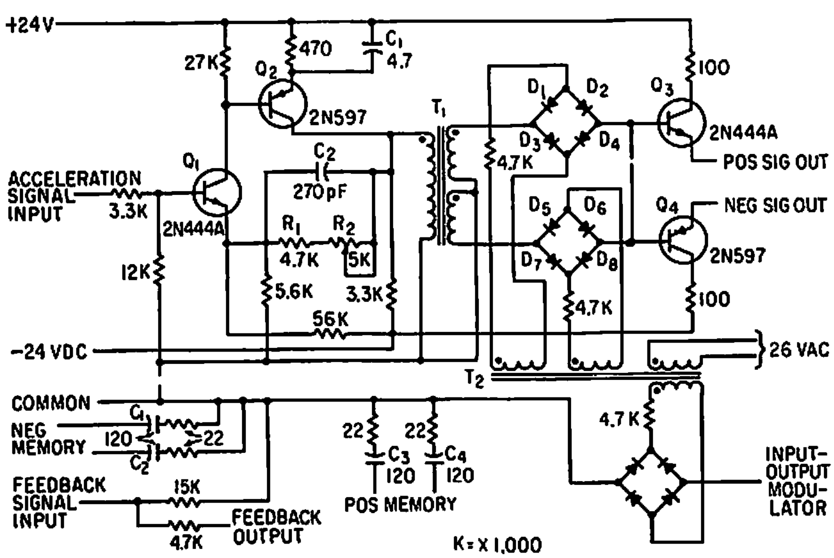
TRANSDUCER EXCITER—Used in carrier amplifier of strip-chart recorder to provide amplitude-stable fixed excitation frequency for transducer. Two-stage amplifier with 360° phase shift oscillates when output is fed to input, at frequency depending on loop parameters. Amplitude variation is held to 0.2% for 25°C change in ambient by simple zener and transistor limiter.—Amplitude-Stable Audio Oscillator, *EEE*, 11:8, p 87.



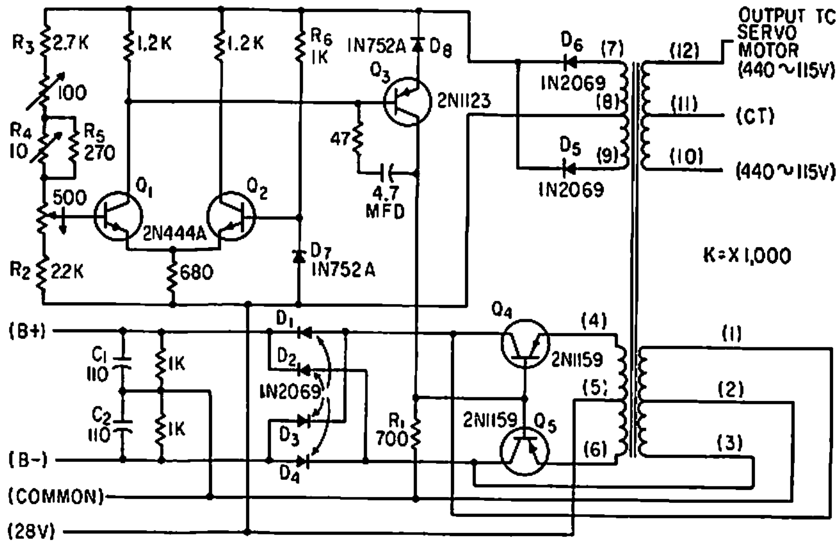
FACSIMILE SWEEP—Maximum variation in sweep length is less than 1 part in 1,000. Uses modified Miller feedback circuit. Sweep rate can be controlled over 10:1 ratio.—E. W. VanWinkle, High-Precision Sweep Generator, *Electronics*, 33:50, p 88–90.



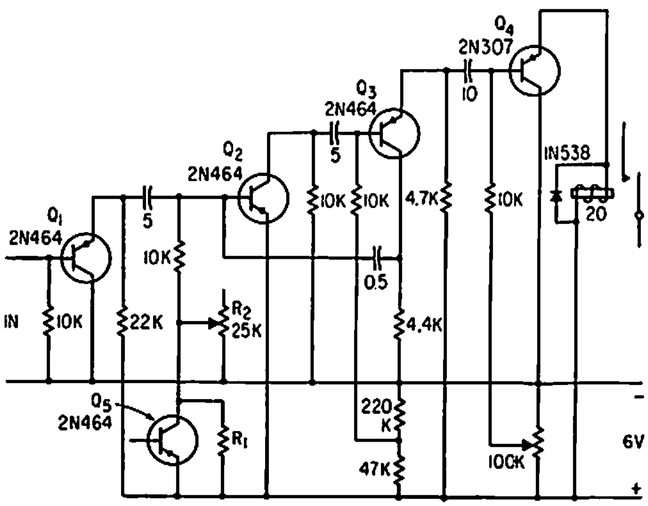
1-CPS RAIL FLAW AMPLIFIER—Used to amplify extremely low-frequency signals produced by longitudinal defects in rails, to drive pen recorder. C1 bypasses high-frequency signals.—H. W. Keevil, Transistor Pulse Amplifiers Detect Rail Faults, *Electronics*, 35:21, p 53–54.



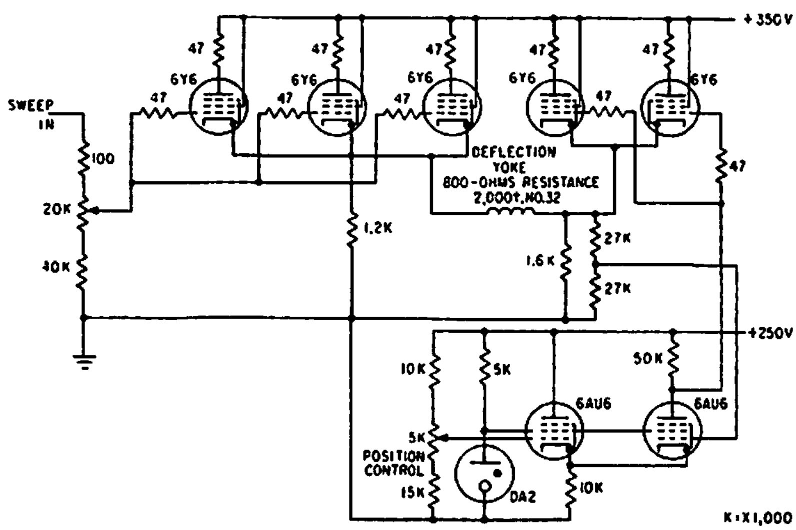
VERTICAL ACCELERATION RECORDER—Accepts phase-reversible 400-cps signal from vertical accelerometer, which is in phase with reference voltage for positive accelerations and 180° out of phase for negative. After amplification by Q1-Q2, synchronous demodulator diodes D1 to D8 separate positive and negative signals for output transistors Q3 and Q4, which feed servo of engraved-foil flight recorder.—H. E. Schauwecker, Data Recorder for Airplane Flight Analysis, *Electronics*, 33:48, p 118–120.



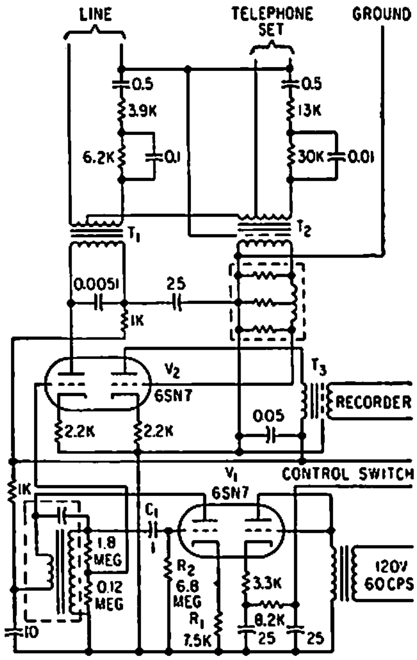
PRECISION FREQUENCY GENERATOR—Provides 440 cps at 115 v for timing motor of engraved-foil flight recorder. Uses saturating-transformer oscillator and auxiliary regulating circuits to maintain precise voltage and frequency.—H. E. Schauwecker, Data Recorder for Airplane Flight Analysis, *Electronics*, 33:48, p 118–120.



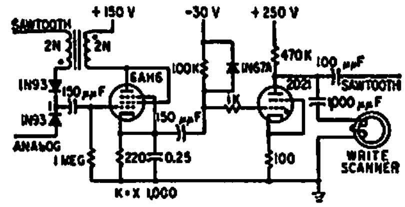
RAIL FAULT-DETECTING AMPLIFIER—Signals from inductive pickup near rail are amplified enough to drive sensitive relay of pen recorder. Amplifier does not block after being overloaded when pickup passes over rail joint.—H. W. Keevil, Transistor Pulse Amplifiers Detect Rail Faults, *Electronics*, 35:21, p 53–54.



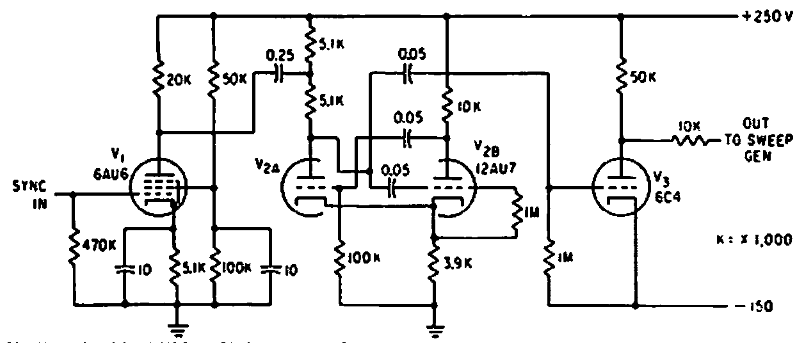
FACSIMILE SWEEP AMPLIFIER—Provides power amplification for driving electronic high-definition facsimile recorder. Sweep input voltage is high enough to eliminate need for voltage gain in power amplifier stages.—E. W. VanWinkle, High-Precision Sweep Generator, *Electronics*, 33:50, p 88–90.



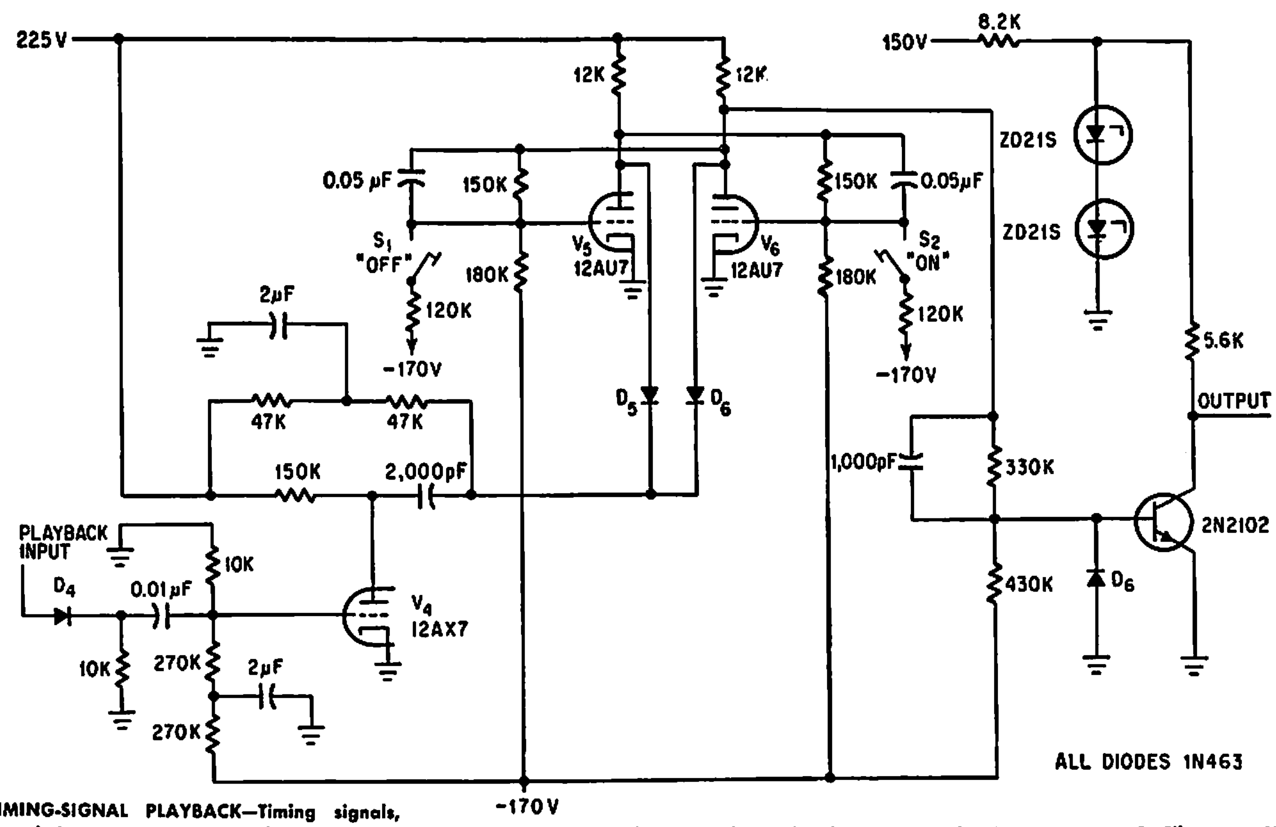
BEEPER FOR TELEPHONE RECORDING—Generates periodic 1,400-cps tone or beep having 0.2 sec duration, at intervals of about 15 sec, as required by Federal law when recording or broadcasting telephone conversations.—J. Zelle, Phone Calls for Broadcast, *Electronics*, 31:45, p 96–101.



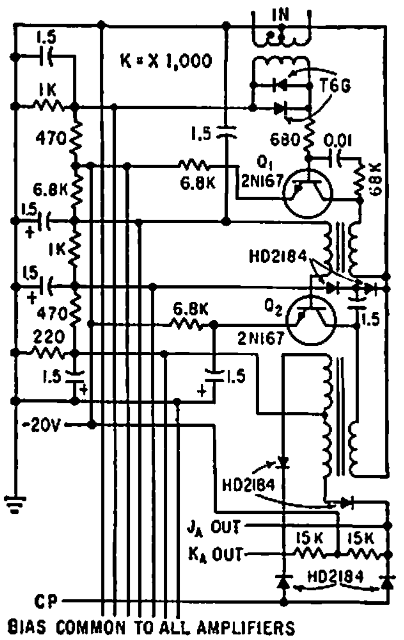
ANALOG VOLTAGE COMPARATOR—When sawtooth amplitude exceeds analog voltage, positive feedback loop of blocking oscillator is completed through conducting diode and oscillator conducts, triggering thyratron writing circuit for magnetic drum.—H. L. Daniels and D. K. Sampson, Magnetic Drum Provides Analog Time Delay, *Electronics*, 32:6, p 44–47.



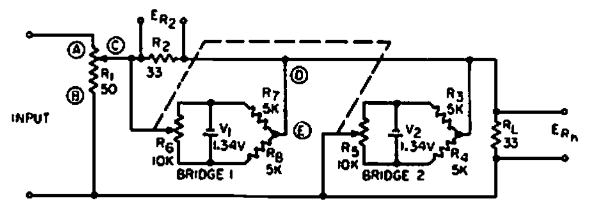
FACSIMILE SYNC PULSE SHAPER—Used to change shape of high-precision sync pulse for facsimile recorder in order to change time of return trace. Amplifier V1 is coupled to plate-driven one-shot mvbr whose time constants determine return trace time.—E. W. VanWinkle, High-Precision Sweep Generator, *Electronics*, 33:50, p 88–90.



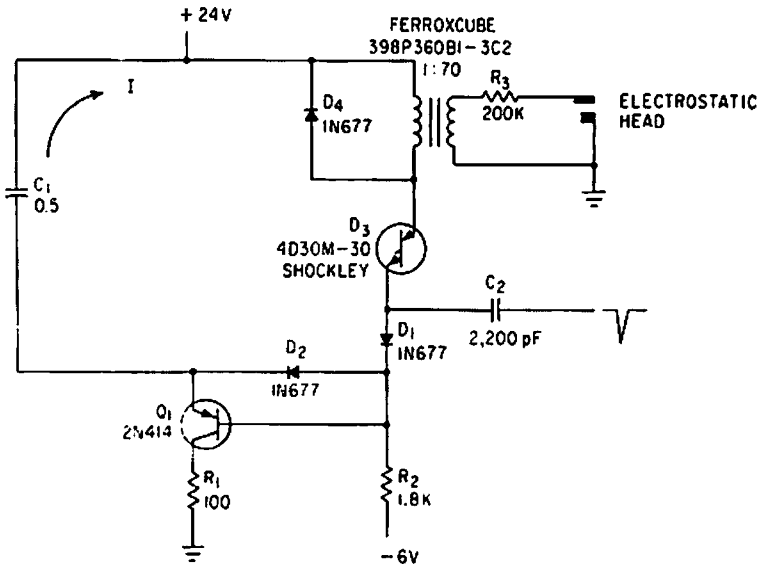
TIMING-SIGNAL PLAYBACK—Timing signals, recorded as 50-v negative pulses, each corresponding to an edge of original interval-timing pulse in biomedical experiments, are converted to original rectangular pulse by pulse amplifier and bistable circuit. Negative pulses change state of bistable, to reproduce original pulse at output.—G. Silverman, Modified Tape Recorder Stores Timing Signals, *Electronics*, 39:13, p 75–76.



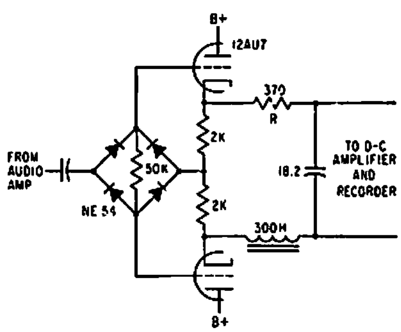
MAGNETIC DRUM READ AMPLIFIER—Amplifies phase-modulated step-modulated Manchester signal from magnetic drum read head and provides phase detection for recovery of stored information. Also used for synchronization.—A. J. Strassman and R. E. Keeter, Clock Track Recorder For Memory Drum, *Electronics*, 32:41, p 74–76.



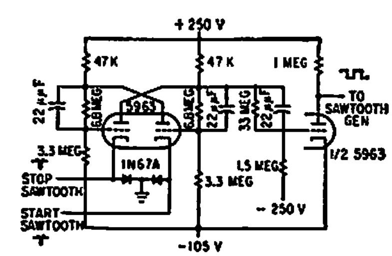
POSITIONING AND ATTENUATING CONTROL—Adds d-c positioning voltage to input signal of recording galvanometer. Magnitudes of input and positioning voltages can be varied independently without interaction. Circuit also has attenuating control for signal voltage.—N. Kassowitz, Non-Interacting Positioning and Attenuating Controls, *EEE*, 13:3, p 47.



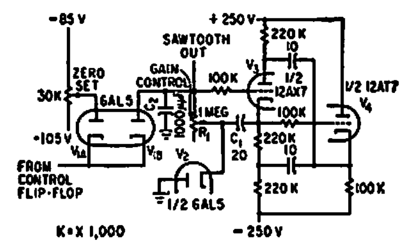
10,000 1-KV PULSES PER SECOND—Four-layer diode D3 discharges C1 through pulse transformer and transistor Q1 prevents diode from remaining in conducting state. Used in electrographic recorder.—N. C. Hokimian and P. M. Schmitz, Four-Layer Diode Triggers High-Voltage Pulse Generator, *Electronics*, 34:26, p 84–85.



VU RECORDER—Used to provide permanent records of broadcast speech levels and for checking audio network circuits. Circuit has same rise time, overshoot, frequency response, and rectifier characteristics as standard vu meter.—D. H. McRae, Vu Recorder Has Standard Response, *Electronics*, 31:17, p 78–82.

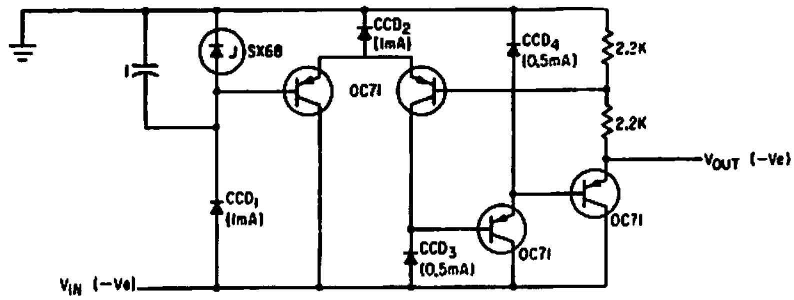


RECORDING SAWTOOTH-CONTROLLING FLIP-FLOP—Used for sawtooth generator of magnetic drum recording system.—H. L. Daniels and D. K. Sampson, Magnetic Drum Provides Analog Time Delay, *Electronics*, 32:6, p 44–47.

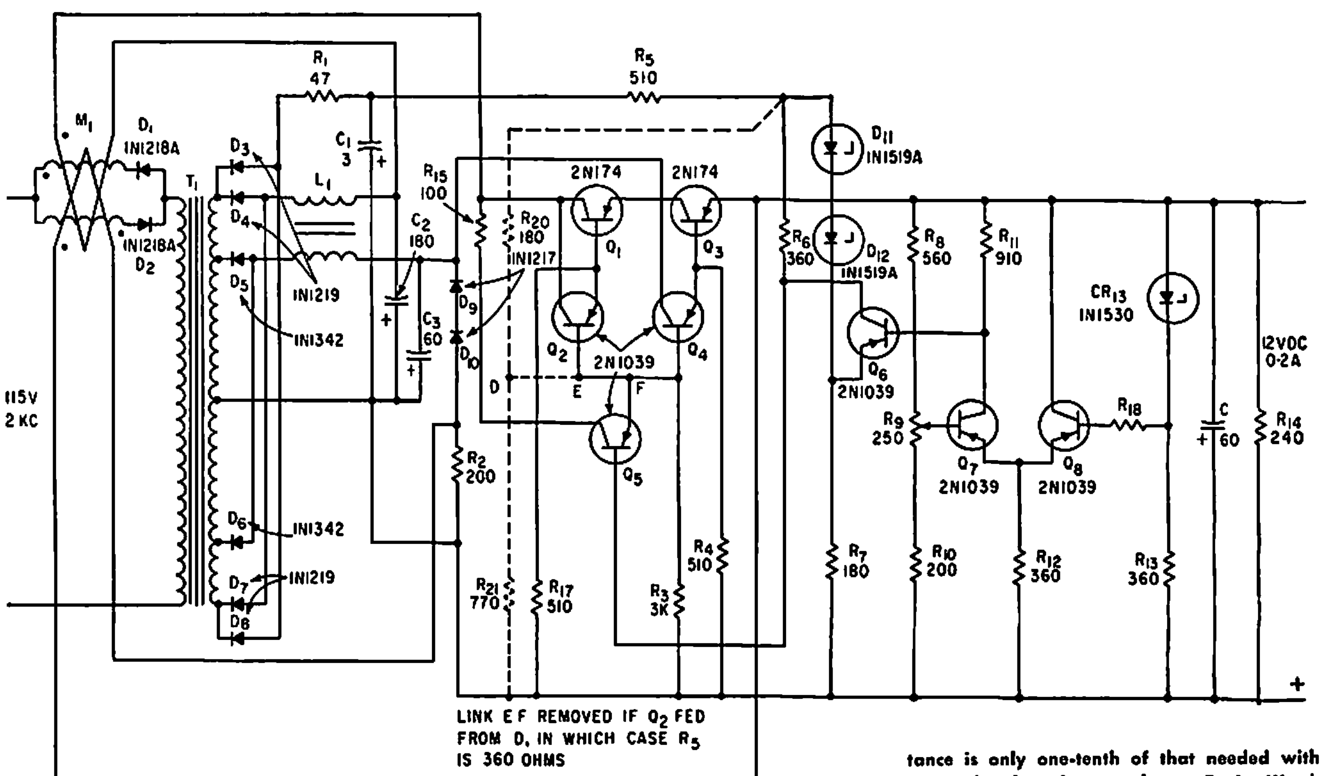


READING SAWTOOTH-CONTROLLING FLIP-FLOP—When flip-flop output is negative with respect to zero-set reference voltage, sawtooth output is dropped through diode gate to reference voltage. Start-sawtooth pulse makes output of flip-flop positive.—H. L. Daniels and D. K. Sampson, Magnetic Drum Provides Analog Time Delay, *Electronics*, 32:6, p 44–47.

CHAPTER 72
Regulated Power Supply Circuits

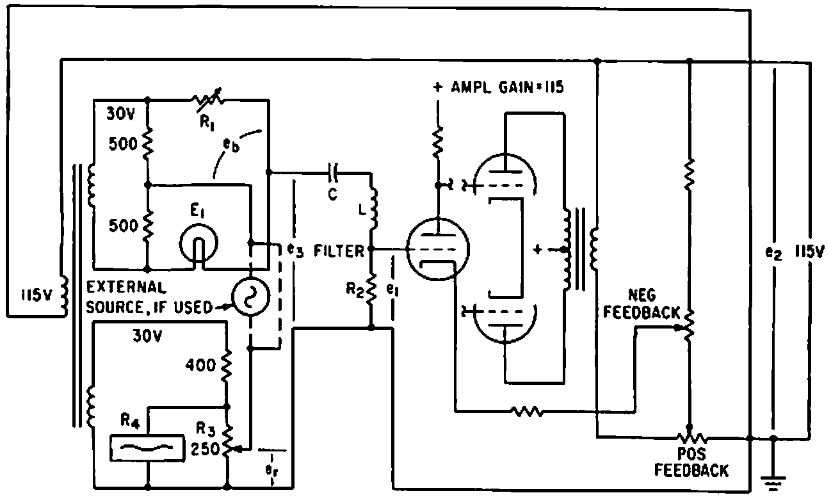


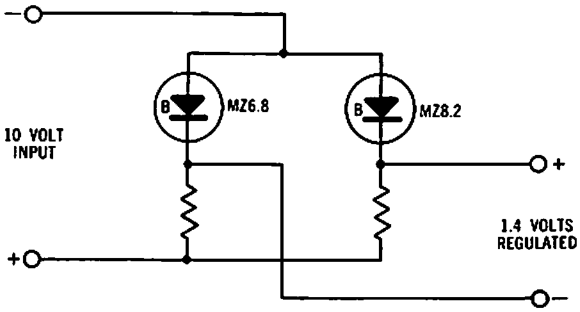
VOLTAGE STABILIZER USING FOUR CONSTANT-CURRENT DIODES—Value of stabilized output voltage can be adjusted by placing potentiometer in parallel with SX68 zener diode and connecting base of Q1 to slider. With this arrangement, magnitude and phase angle of output impedance are not affected by output voltage setting.—T. K. Hemingway, Applications of the Constant-Current Diode, *Electronics*, 34:42, p 60–63.



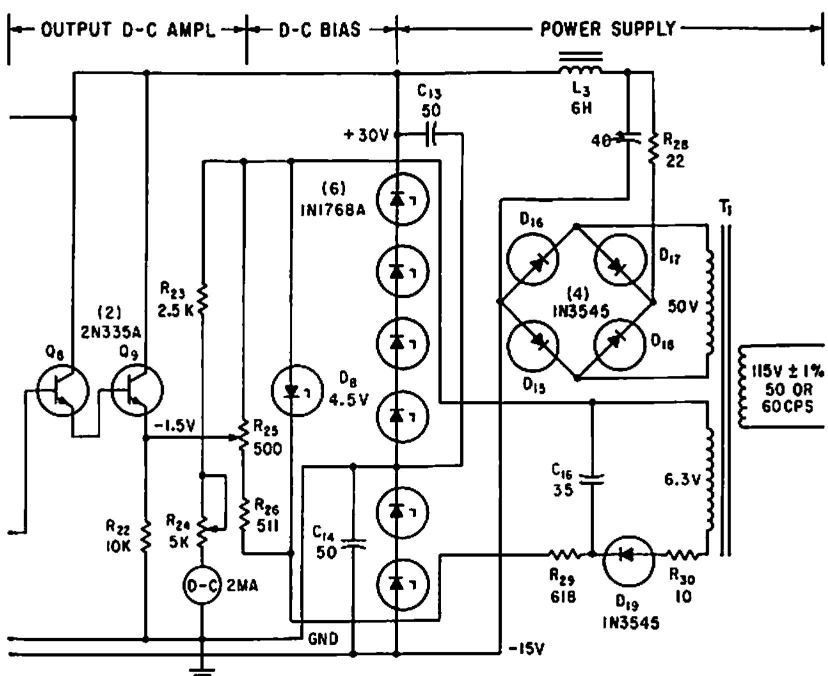
TWO-LEVEL REGULATION FOR 12 V AT 0.2 A—Transformer provides two voltages, one for normal operation and the other to supply current during transients. Storage capacitance is only one-tenth of that needed with conventional series regulator.—F. L. Ward, Novel Bi-Level Regulator Reduces Storage Capacitance, *Electronics*, 35:32, p 74–75.

VARIABLE-FREQUENCY A-C REGULATOR—Commercial ballast tube in thermal regulating bridge is used with feedback-stabilized amplifier and filter to regulate a-c voltage source to 0.1%. Used for instrument calibration. Triode oscillator circuit oscillates at series resonant frequency of LC filter, which can be tuned from 50 to 2,000 cps.—E. A. Gilbert, Precision Variable Frequency Power Supply, *Electronics*, 34:2, p 99–100.

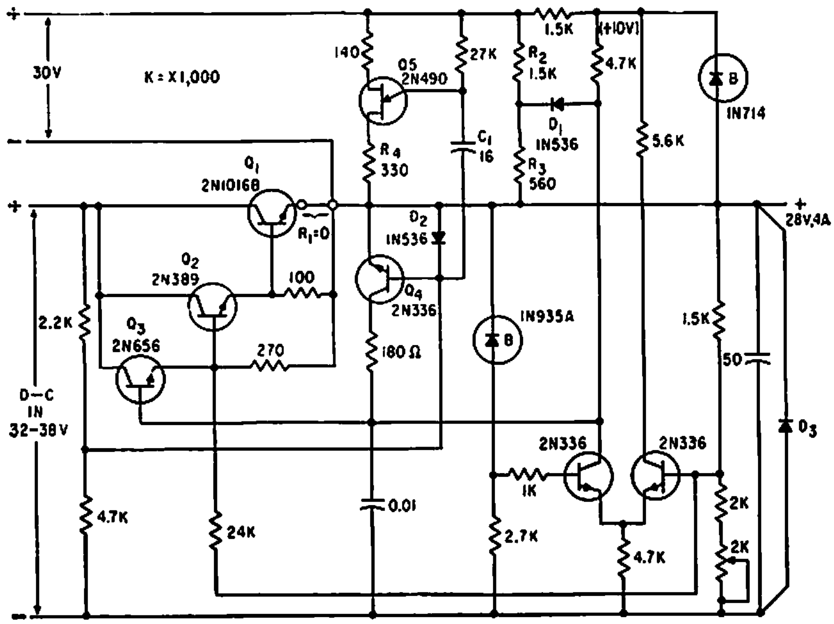




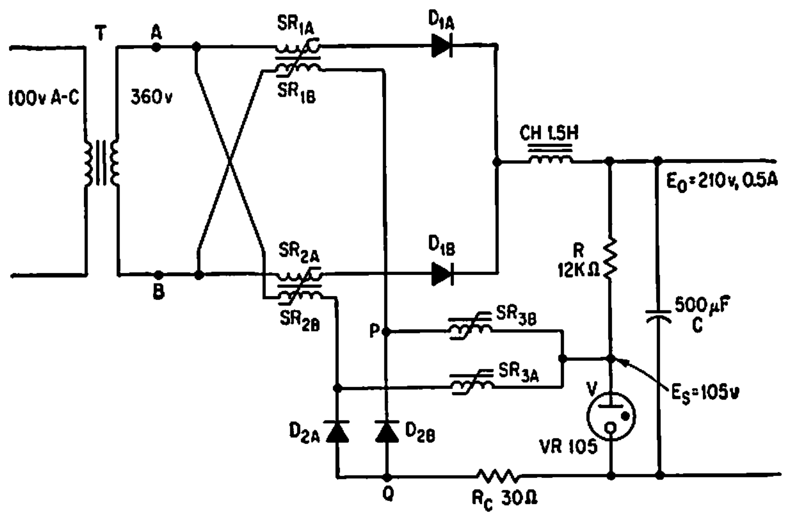
1.4 V TWO-ZENER REGULATOR—Used to deliver regulated voltage lower than is normally available with zener diodes. Difference voltage is used for output. Gives excellent temperature compensation because both diodes tend to drift in same direction.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 54.



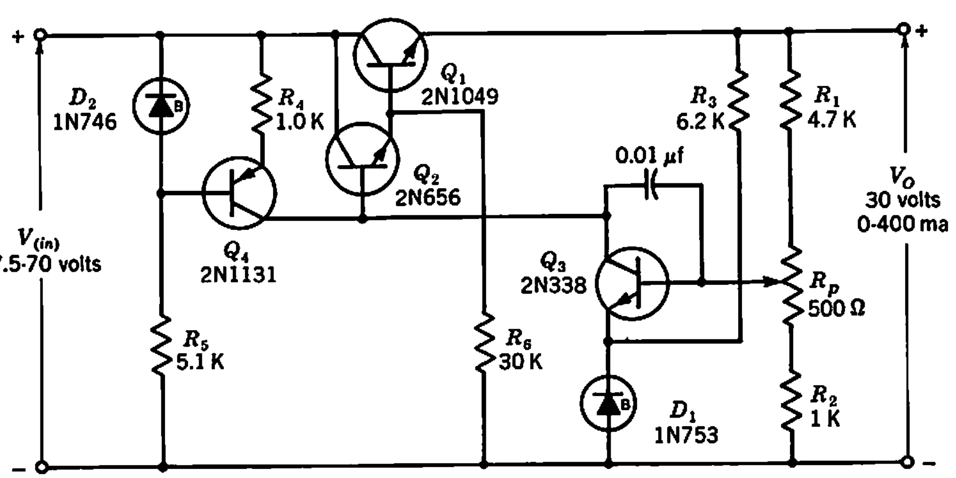
REGULATOR DIODE STRING—Six 5% silicon regulator diodes operated at 65 ma give +30 v at 90 ma and −15 v at 95 ma. Used with vibration-measuring circuit whose peak-reading output drives d-c amplifier Q8-Q9 to give required output current of 2 ma for d-c meter or recorder.—H. A. Harriman and W. M. Trenholm, Vibration Measurements with Peak-Reading Circuit, *Electronics*, 35:20, p 57–59.



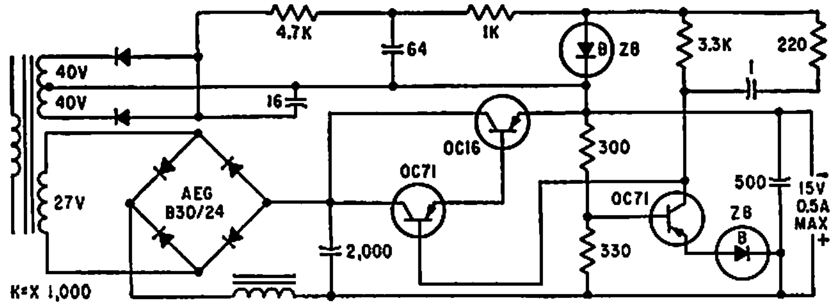
SHORT-CIRCUIT PROTECTION—Series regulator has automatic pulsing-type short-circuit protection. D1, R2, and R3 form constant-current prelimiting circuit, and Q4 is shutoff transistor. Unijunction transistor Q5 pulses continuously. D2 completes discharge path of C1 through R4 when Q5 fires.—A. G. Lloyd, Overload Protection for Transistor Voltage Regulators, *Electronics*, 33:52, p 56–59.



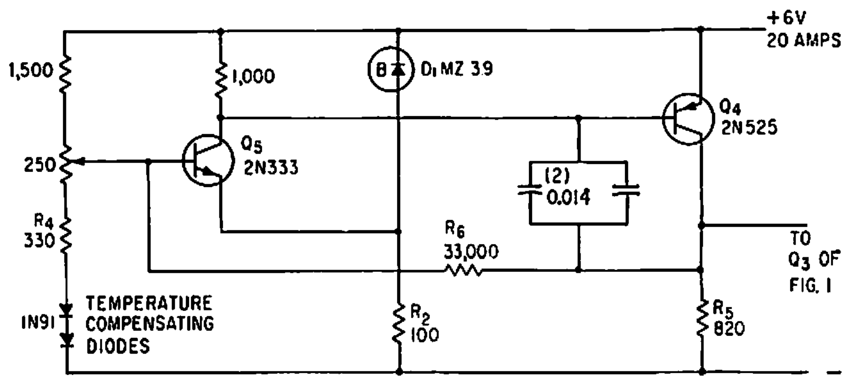
TRANSDUCTORS STABILIZE HIGH-POWER RECTIFIER—Rectangular-loop saturable reactors SR in single-phase power supply hold output voltage constant within 1% at load currents of 0 to 20 amp and line voltage variations of 50%. Choice of components dedetermines power capacity.—T. Kurimura and K. Yamamura, New Way to Use Saturable Reactors: Stabilizing High-Power Rectifiers, *Electronics*, 36:21, p 62–66.



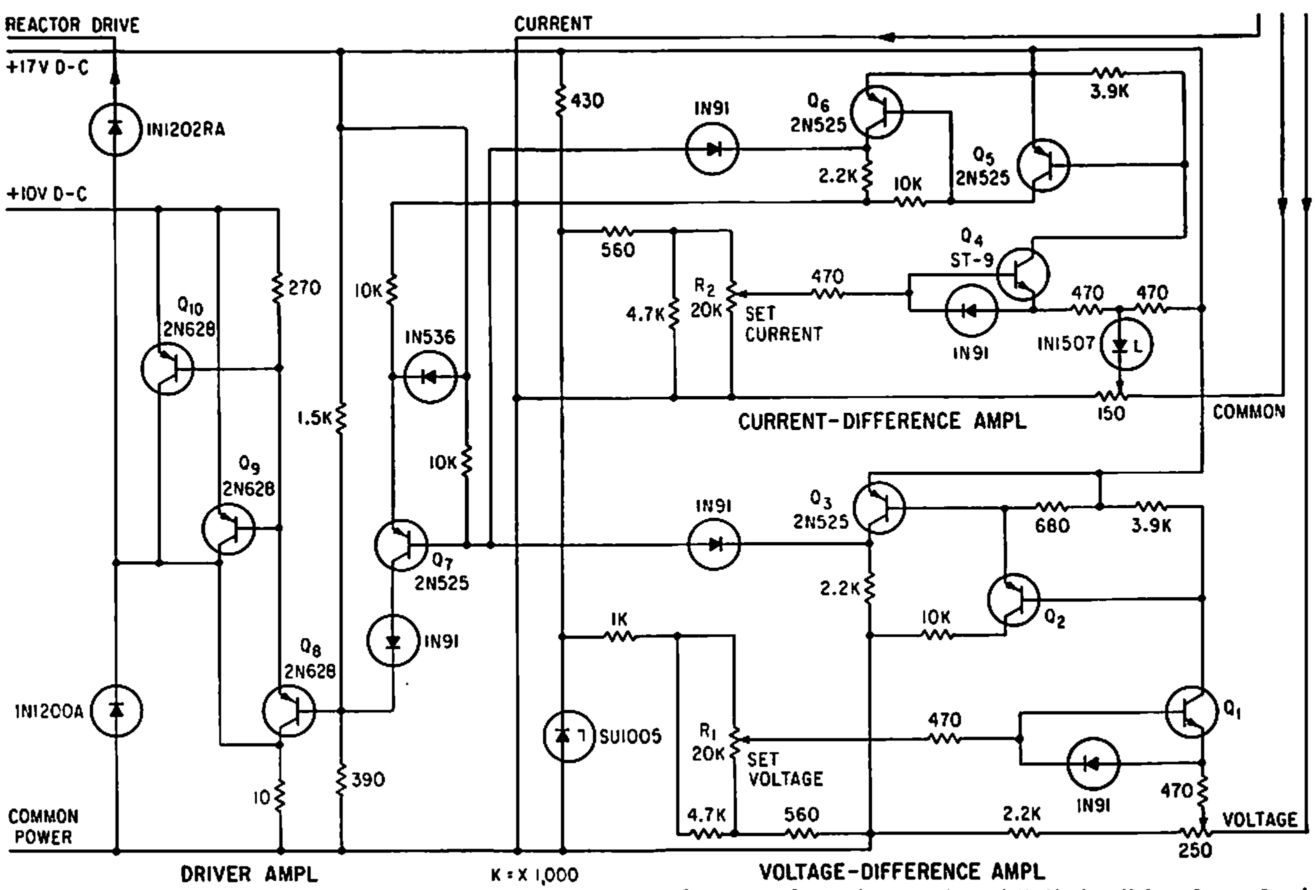
SERIES REGULATOR WITH TRANSISTOR PREREGULATOR—Design procedure is given to meet specification that regulation factor F range from 0.001 for no load to 0.00145 for full load when input voltage varies over range specified. Output varies from 30.7 v to 31.1 over temperature range of −50 to +125°C.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 160.



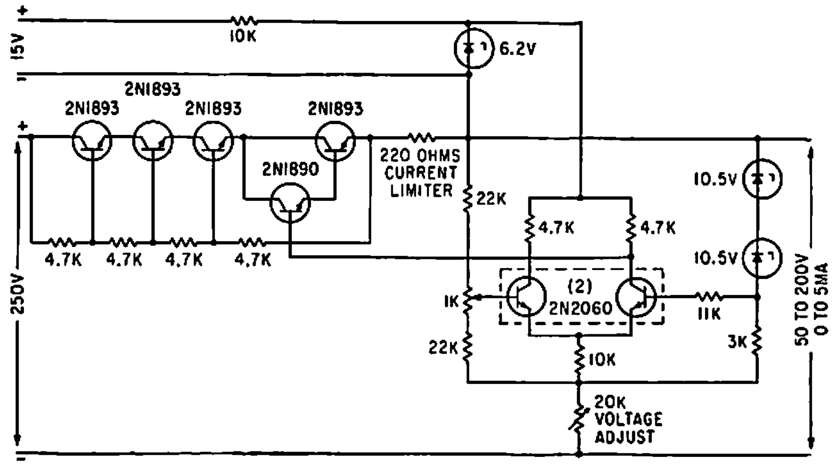
MIDDLEBROOCK SERIES-STABILIZED SUPPLY—Provides constant 15 v for moderately variable load, with temperature coefficient of 1 mv per degree C, 4 mv peak-to-peak ripple, and 0.5 amp maximum current.—E. Baldinger and W. Czaja, Designing Highly Stable Transistor Power Supplies, *Electronics*, 32:39, p 70–73.



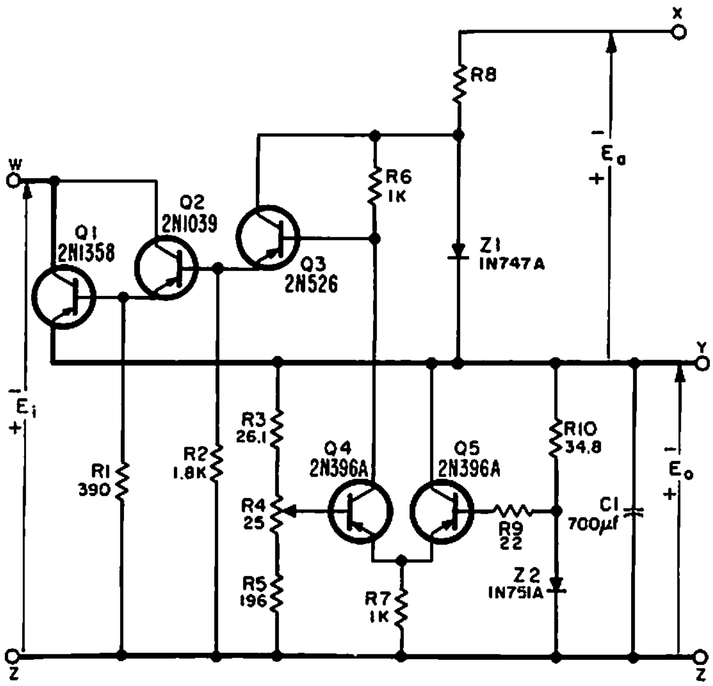
ZENER REFERENCE—Sensing circuit for 6-v constant-voltage transformer-regulated power supply develops error signal for controlling shunt transistors.—J. T. Keefe, Transformer and Shunt Transistors Regulate D-C Power Supply, *Electronics*, 34:20, p 99–101.



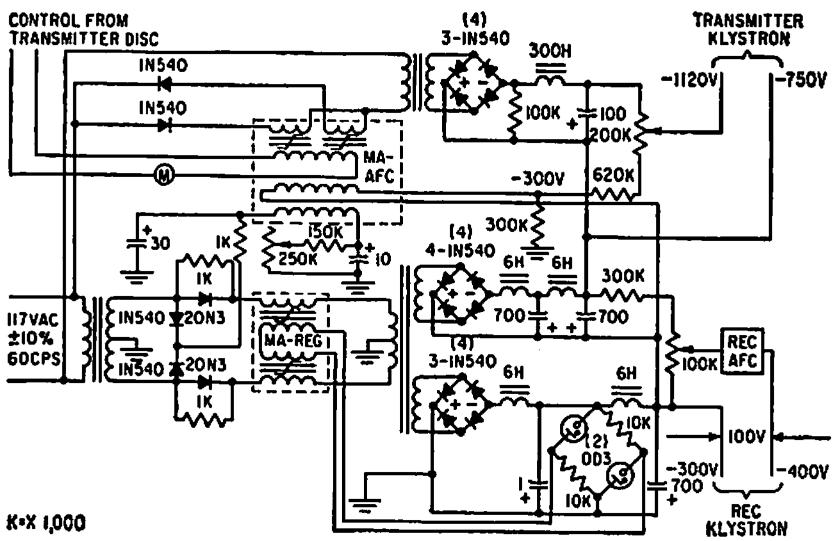
FORMING ELECTROLYTICS—Current-difference amplifier delivers constant current during initial forming of electrolytic capacitors, and voltage-difference amplifier holds voltage constant when final forming voltage is reached. Values of current and voltage can be adjusted over wide range of preset values for different sizes of capacitors.—J. W. Martin and H. Liepins, Unique Power Supply Delivers Constant Voltage and Current, *Electronics*, 35:31, p 40–41.



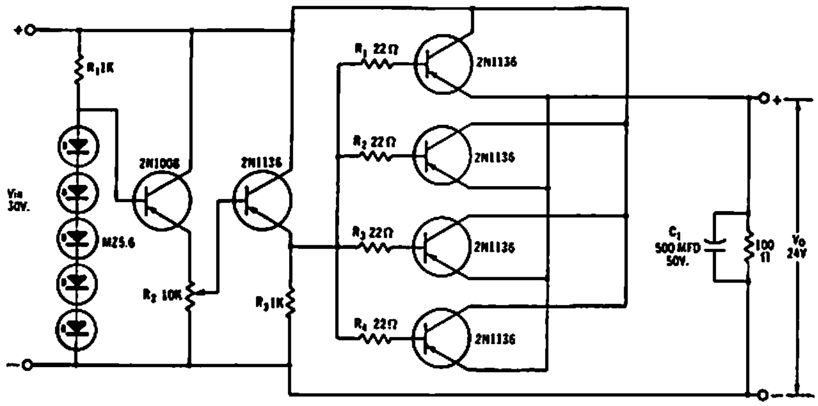
MAGNETRON INJECTION ELECTRODE SUPPLY—Constant-voltage bridge floating on variable resistor feeds differential amplifier and series regulator. Rheostat setting determines value of regulated output voltage.—S. Prigozy, Designing Special Power Supplies for Voltage-Tunable Oscillators, *Electronics*, 35:44, p 48–50.



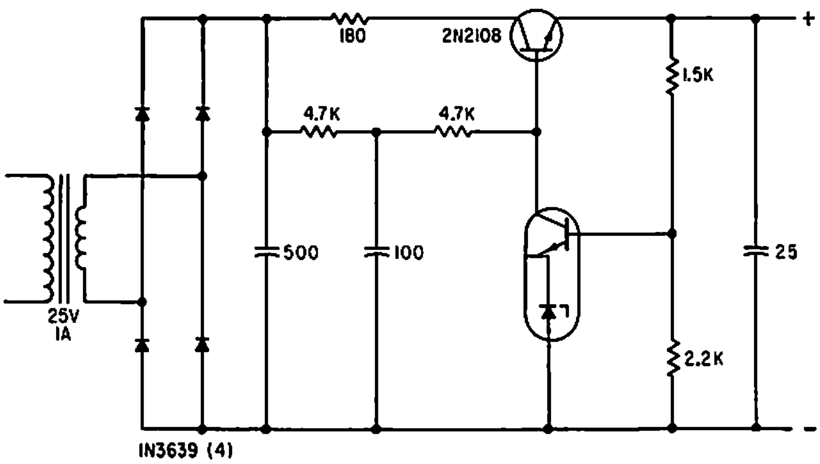
6-V D-C REGULATOR—Provides 4 amp at 6 v with 1% regulation for inputs of 7 to 50 v from unregulated source. Auxiliary source Ea must be minimum of 5 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 1, p 1-2.

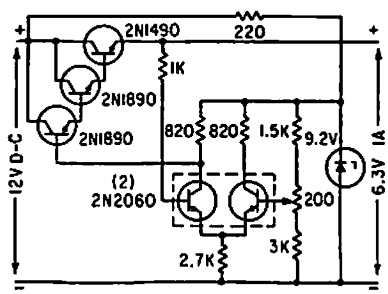


MAGNETIC-AMPLIFIER REGULATOR—Provides stable operating voltages for transmitter and receiver local-oscillator klystrons in 6,000-Mc microwave link.—M. C. Harp, Nonvacuum Devices Control Klystrons, *Electronics*, 32:7, p 68–70.



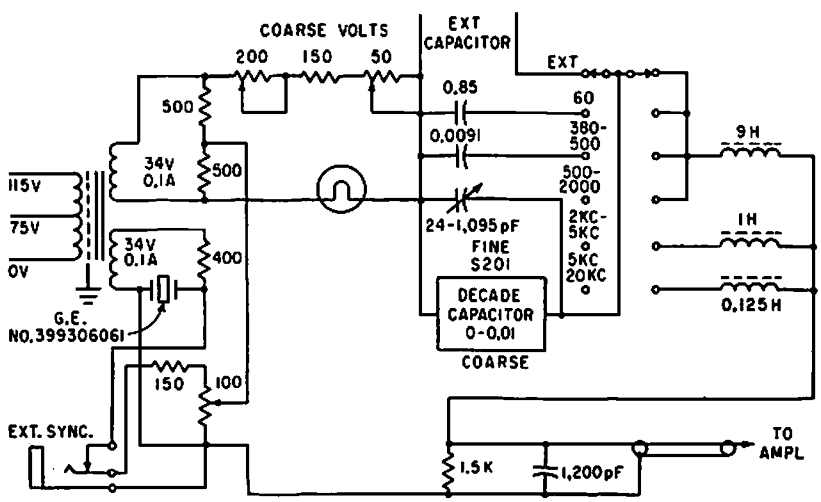
HIGH-CURRENT REGULATOR—Four parallel-connected transistors handle up to 240 w if mounted with heat sink. If output voltage is reduced, separate power supply must be provided for zener regulator to protect transistors.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 57.



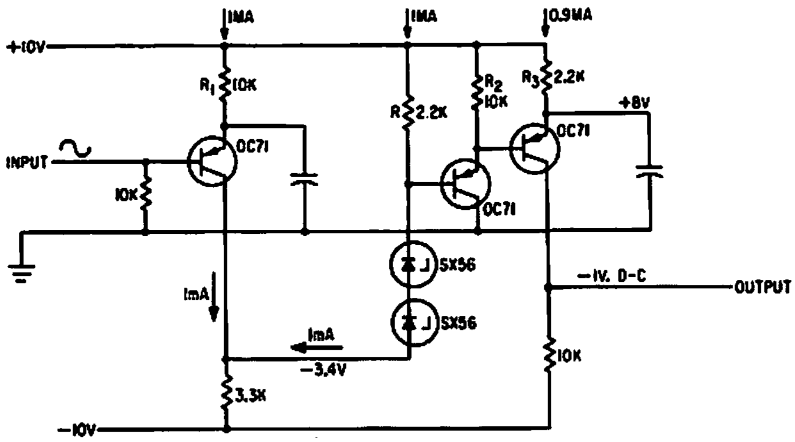


12-V REGULATED SUPPLY WITH REFERENCE AMPLIFIER—Integrated transistor and zener diode in reference amplifier act with transistor 2N2108 to hold 12-v d-c output voltage within 0.3% over a-c line voltage variations of 10% for load currents up to 100 ma. —T. P. Sylvan, New Device Simplifies Power Supply Design, *Electronics*, 36:20, p 39–43.

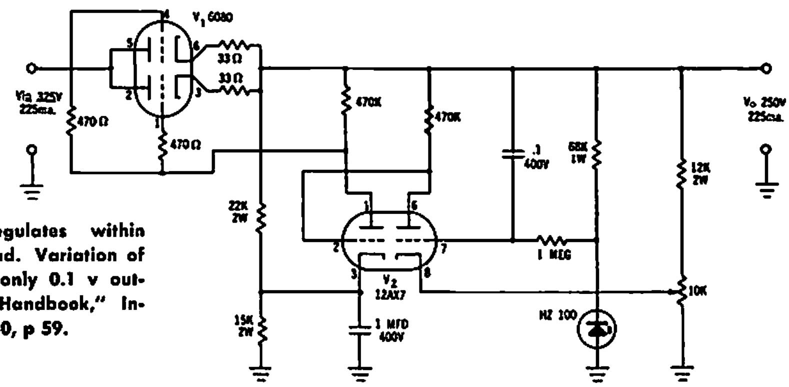
BACKWARD-WAVE OSCILLATOR FILAMENT SUPPLY—Provides constant voltage for filament of backward-wave oscillator. Output voltage is compared with fixed reference in d-c amplifier, and difference is used to control series pass element.—S. Prigozy, Designing Special Power Supplies for Voltage-Tunable Oscillators, *Electronics*, 35:44, p 48–50.



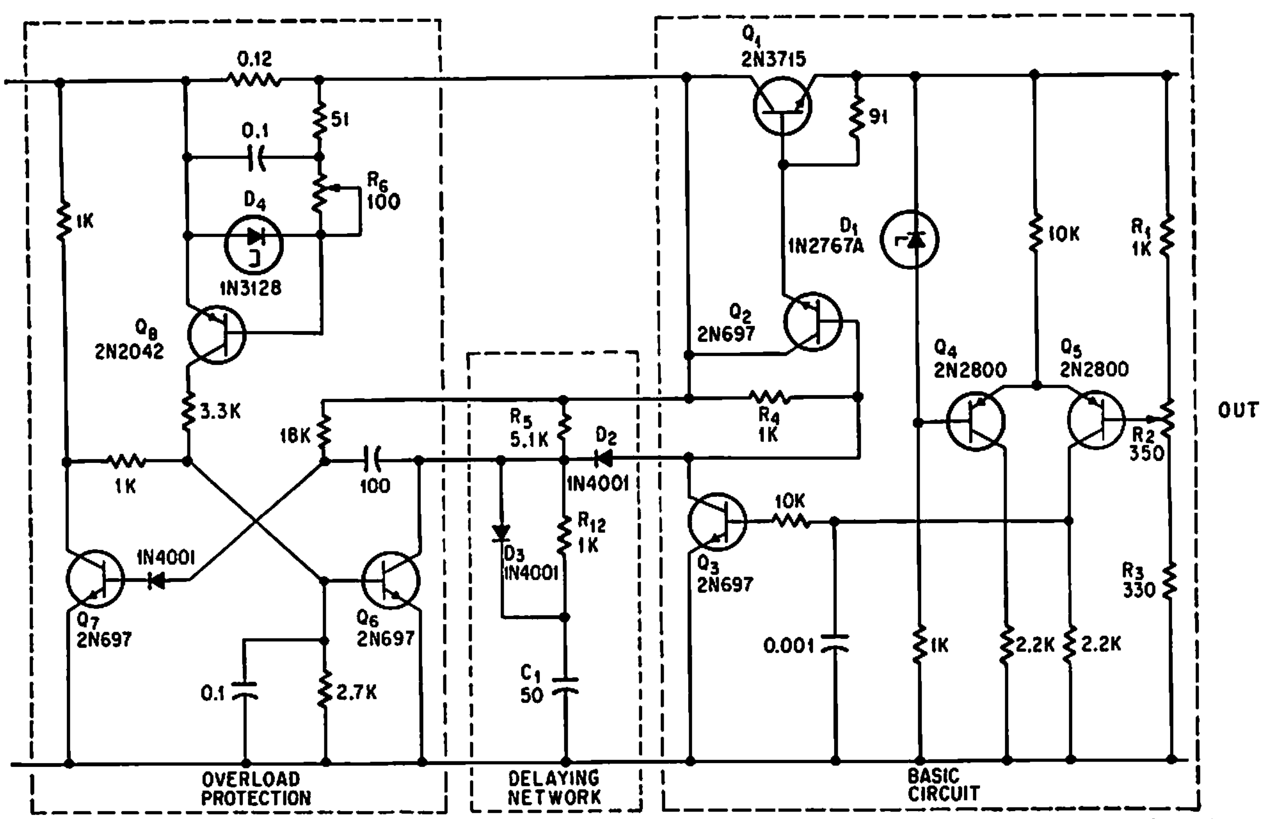
50 CPS-2 KC REGULATOR—Thermal bridge using ordinary iron-wire ballast tube is used with tunable filter of 200 v-a variable-frequency power supply for instrument calibration. Output stage (not shown) uses two 7378 pentodes in push-pull class AB1, with positive feedback.—E. A. Gilbert, Precision Variable Frequency Power Supply, *Electronics*, 34:2, p 99–100.



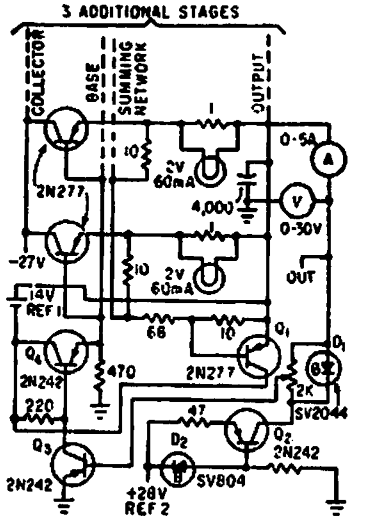
LARGE VOLTAGE SWING WITH LIMITED SUPPLY VOLTAGES—Circuit shows usual solution to problem, wherein final transistor is operated near positive supply voltage and zener diode provides coupling. Drop in gain caused by R can be eliminated by using constant-current diode in place of R. If R1, R2, and R3 are similarly replaced with these diodes, circuit becomes independent of positive line, eliminating spurious feedback through this line.—T. K. Hemingway, Applications of the Constant-Current Diode, *Electronics*, 34:42, p 60–63.



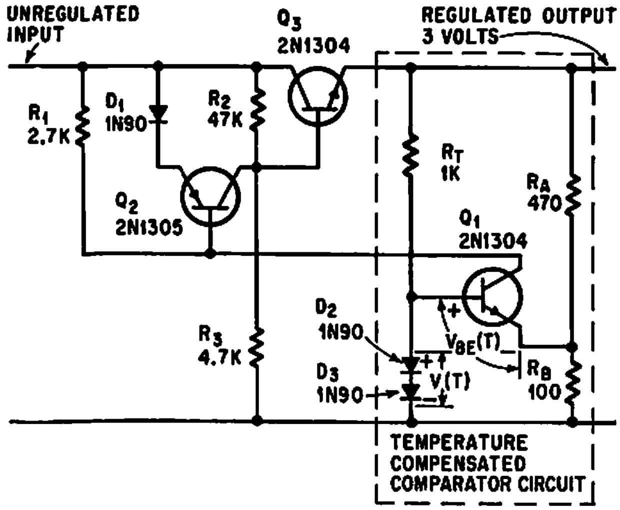
TUBE-ZENER REGULATOR—Regulates within 0.2 v from no load to full load. Variation of 10% in line voltage causes only 0.1 v output change.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 59.



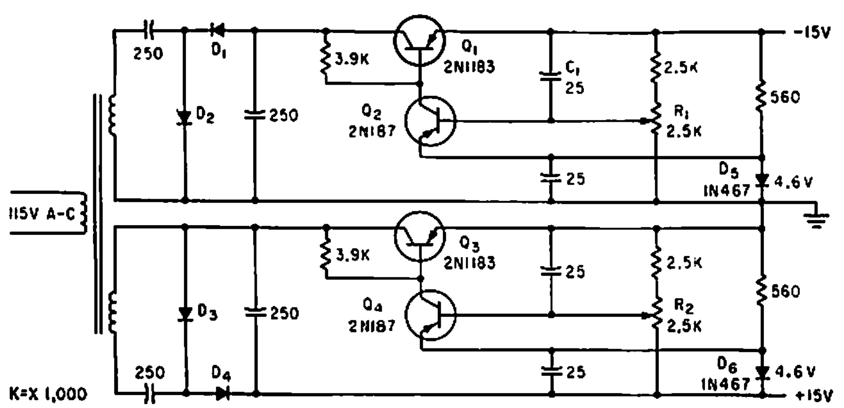
OVERLOAD PROTECTION FOR SERIES REGULATOR—For input voltage of 30 to 40 v d-c, output at full load of 3 amp will be held within 99.09% of 28 v. Tunnel diode D4 and transistor Q8 in overload-sensing circuit trigger monostable mvbr Q6-Q7 to remove drive from Q1 until mvbr resets.—J. Takesuye, Tunnel-Diode Sensor Protects Regulator from Short Circuit, *Electronics*, 38:25, p 75–76.



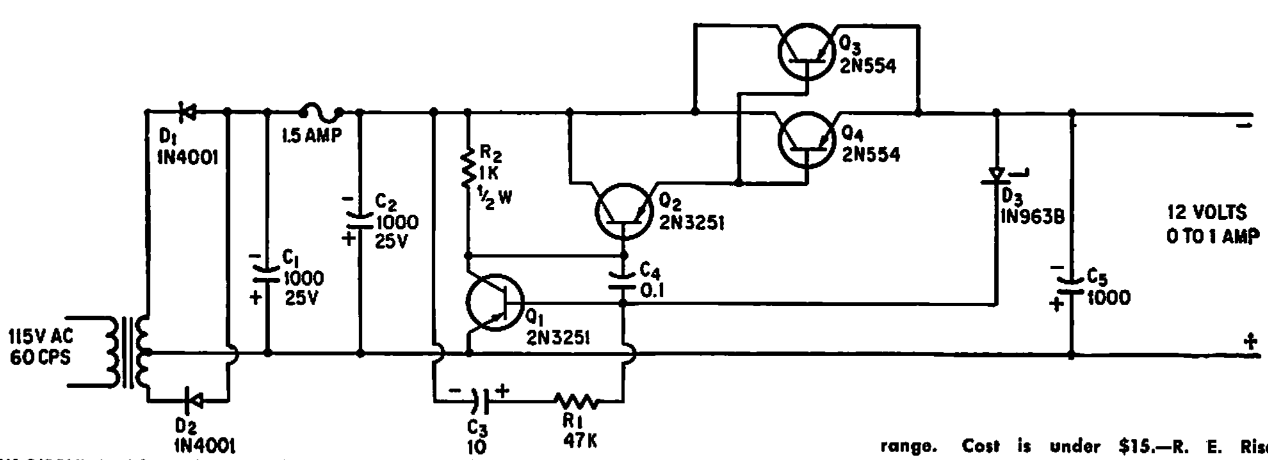
5 AMP AT 0 TO 20 V—Five regulator transistors in 5-amp power supply have indicator lamps at their emitters. Regulation is better than 0.1% at 20 v, and ripple is below 1 mv rms.—J. A. Wheeler and E. J. Currence, Fault-Indicating Series Regulator, *Electronics*, 34:4, p 60.



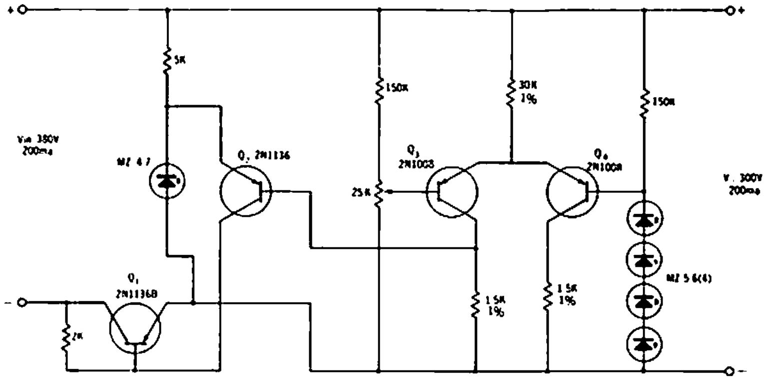
REGULATED 3-V SUPPLY—Junction diode D1 provides nonlinear voltage-current characteristic of zener diode, as required for reference level below 2 v. Poor temperature characteristics of junction diode are offset by base-emitter voltage variation of transistor Q1 with temperature. Regulated output of 3 v within 2%, at 5 to 100 ma, is obtained from unregulated 4.8-v source over range of −16°C to +50°C.—A. K. Scidmore, Junction Diode Regulates Low-Voltage Supply, *Electronics*, 37:27, p 55–56.



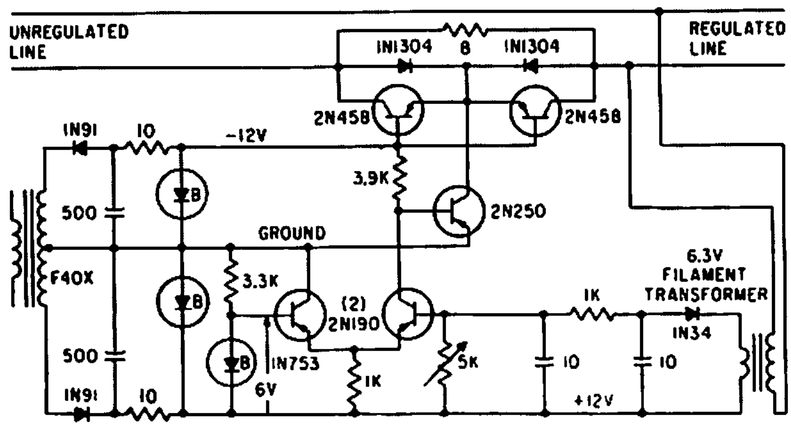
DUAL-POLARITY 15-V SUPPLY—Output voltage is adjustable from 11 to 15 v d-c and nearly constant from no load to 300 ma, or from 90 to 140 v a-c line voltage.—D. T. Birch and K. E. Chellis, Regulated Positive-Negative Supply Delivers Low-Voltage Direct Current, *Electronics*, 34:30, p 62.



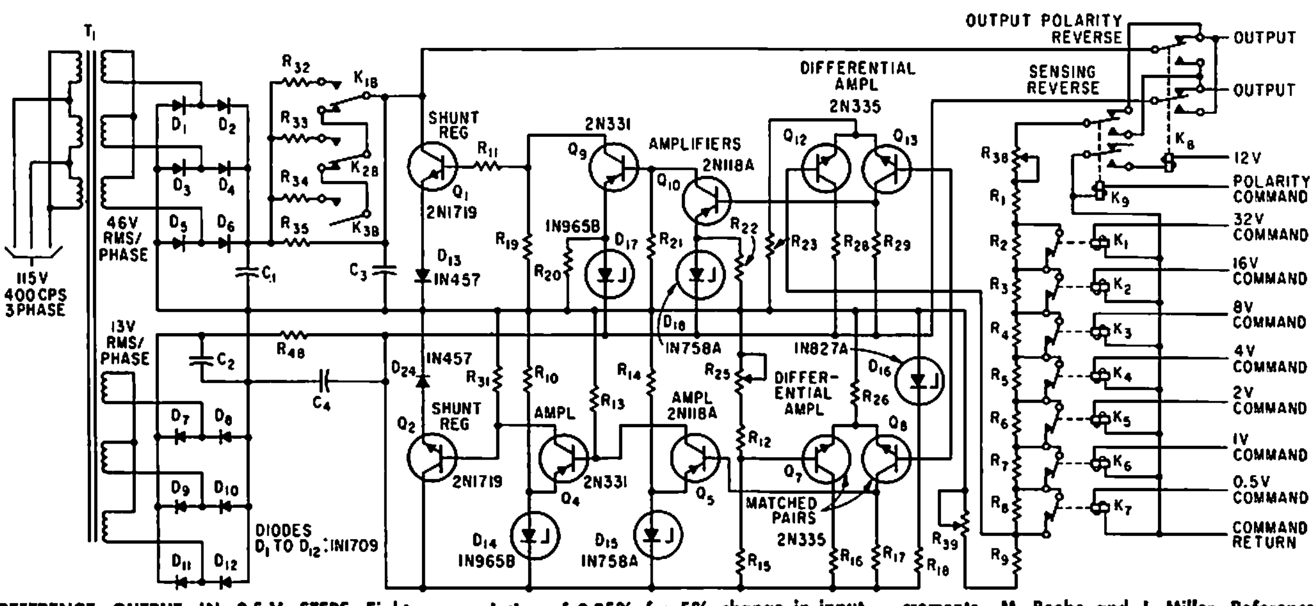
LOW RIPPLE AT LOW COST—Ripple at output is used to control d-c resistance of series regulator transistors Q3-Q4, to keep ripple below 10 mv rms over wide temperature range. Cost is under $15.—R. E. Risely, Power Supply Reduces Ripple by Varying Series Resistance, *Electronics*, 39:2, p 74–75.



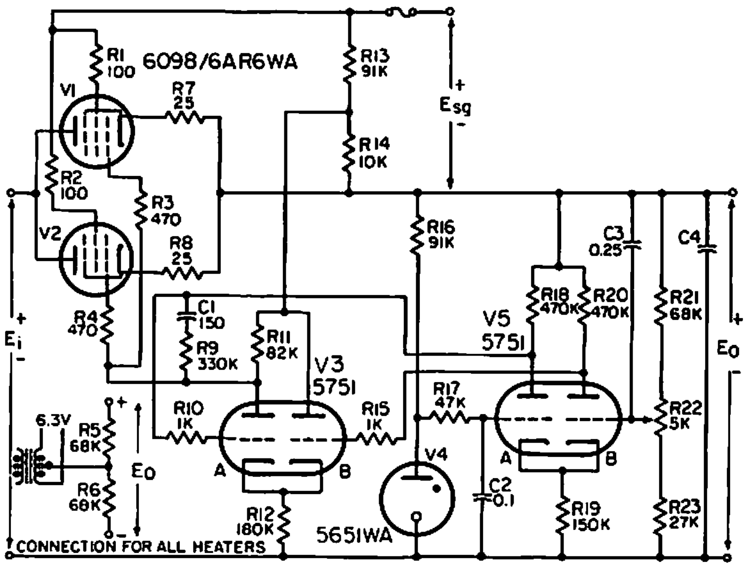
300-V 200-MA REGULATOR—Transistor Q1 serves as series element in negative lead of high-voltage regulated supply, dissipating less than 16 w.— "Zener Diode Handbook," International Rectifier Corp., 1960, p 58.



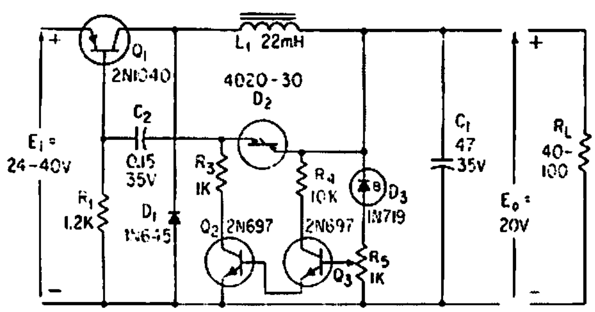
A-C LINE REGULATOR—Five-transistor circuit uses breakdown diodes to regulate voltage inputs between 113 v and 140 v to within 0.5 v of 110 v for 2-amp load.—R. A. Greiner, Line Voltage Control Uses Zener Diodes, *Electronics*, 33:6, p 64.



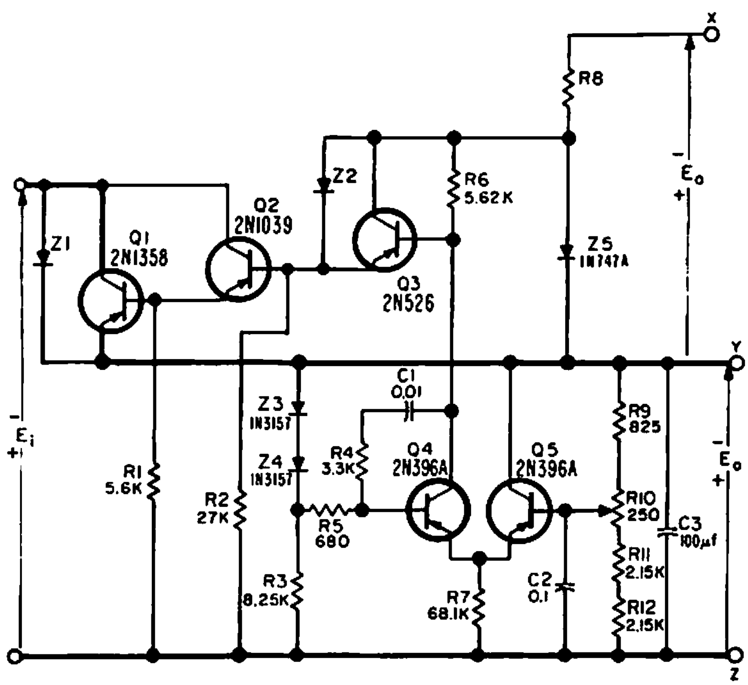
REFERENCE OUTPUT IN 0.5-V STEPS—Eight command signals combined in a binary manner provide stable reference output voltage from −63.5 v to +63.5 v in 0.5-v steps, with regulation of 0.05% for 5% change in input voltage. System uses two independent d-c power supplies, one delivering fixed 20 v and the other from 20 to 83.5 v in 0.5-v increments.—M. Beebe and J. Miller, Reference Supply Delivers Half-Volt Increments, *Electronics*, 35:18, p 41–43.



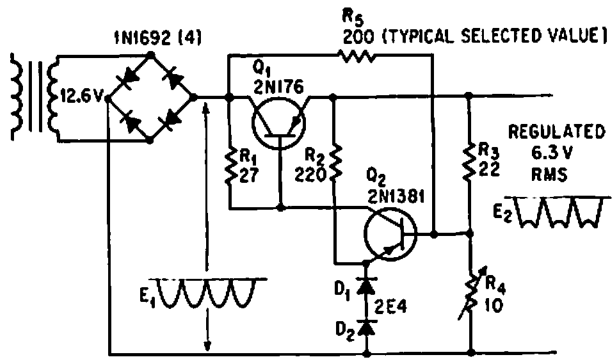
PREFERRED 0.1% REGULATION 300-V D-C—Provides either polarity, for applications requiring superior regulation and long-time stability. Minimum input is 340 v d-c, and minimum Esg is 150 v. Maximum load current is 100 ma per series tube. C4 is minimum of 4 mfd.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 5, p 5-2.



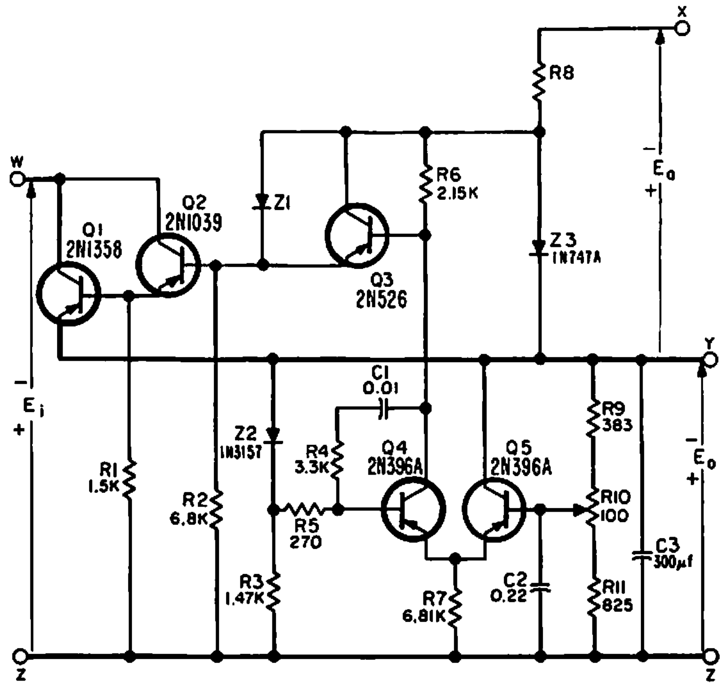
D-C SWITCHED REGULATOR—Gives 0.5% regulation for input voltage range from −15% to +30%. Efficiency is 95%. Transistor is near-ideal switch, having low leakage when open and low voltage when closed.—A. A. Sorenson, Solid-State D-C Switched Regulators, *Electronics*, 33:48, p 121–123.



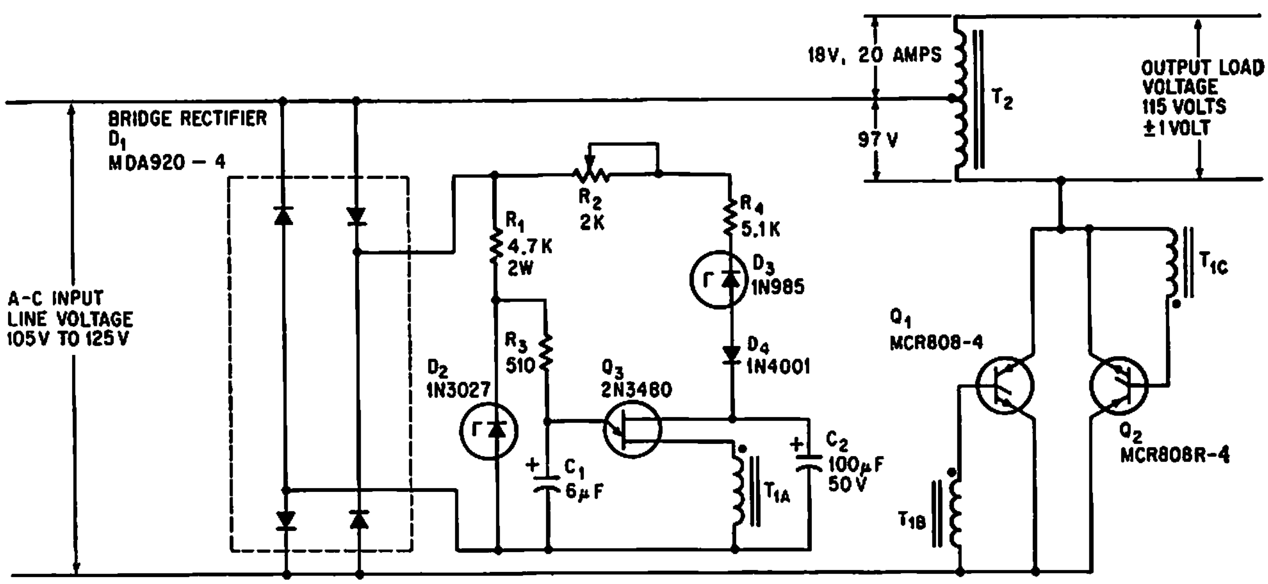
100-V D-C REGULATOR—Provides up to 400 ma at 100 v with 1% regulation for inputs of 101 to 150 v from unregulated source. Auxiliary source Ea must be minimum of 5 v. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 5, p 5-2.



HEATER VOLTAGE REGULATOR—Clipping action is combined with depression of flat-top portion of output waveform in proportion to input voltage change, to hold rms output voltage constant within 0.2% of voltage determined by value of R5.—J. D. Wells, Low-Cost Adjustable Regulator Consumes Little Power, *Electronics*, 38:23, p 109–110.



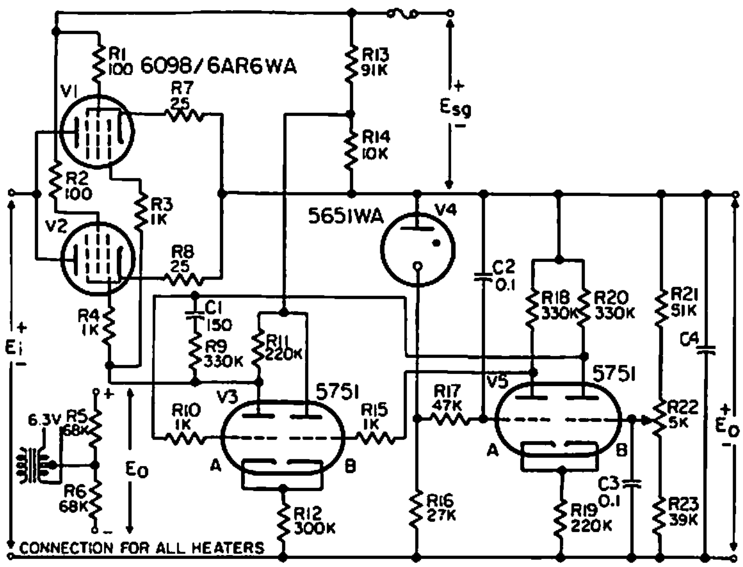
25-V D-C REGULATOR—Provides up to 1.5 amp at 25 v with 1% regulation for inputs of 26 to 50 v from unregulated source. Auxiliary source Ea must be minimum of 5 v. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 3, p 3-2.



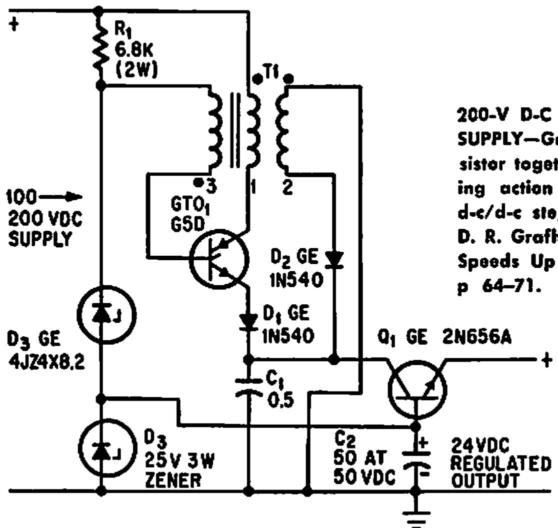
T_{1A} – 30 TURNS OF AWG NO. 22

T_{1B} & T_{1C} – 45 TURNS OF AWG NO. 22 T_1 CORE – FERROXCUBE 203F181 – 3C, OR EQUIVALENT

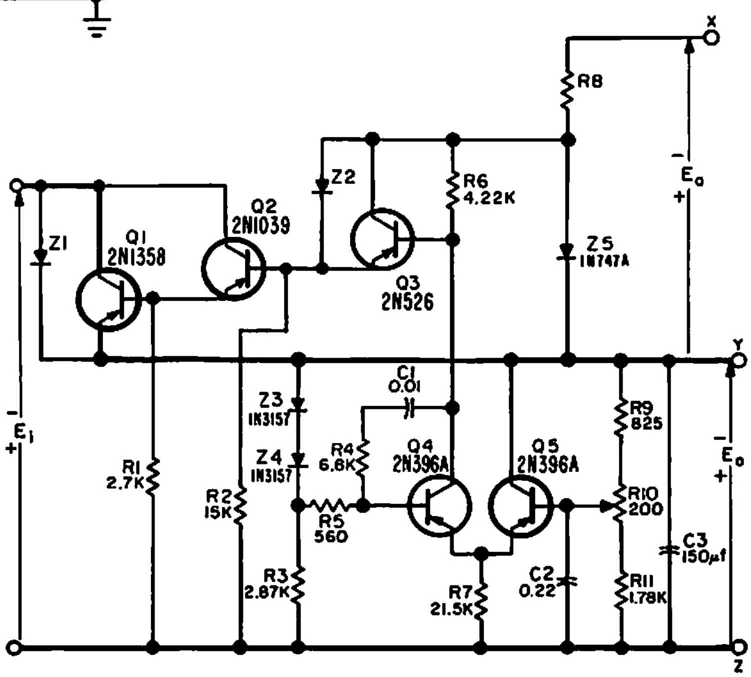
LINE VOLTAGE REGULATOR—Line voltage controls frequency of relaxation oscillator Q3, which in turn changes triggering of scr's to keep load voltage essentially constant.—R. Wechsler, Scr's Regulate A-C Line Voltage, *Electronics*, 38:3, p 61–62.



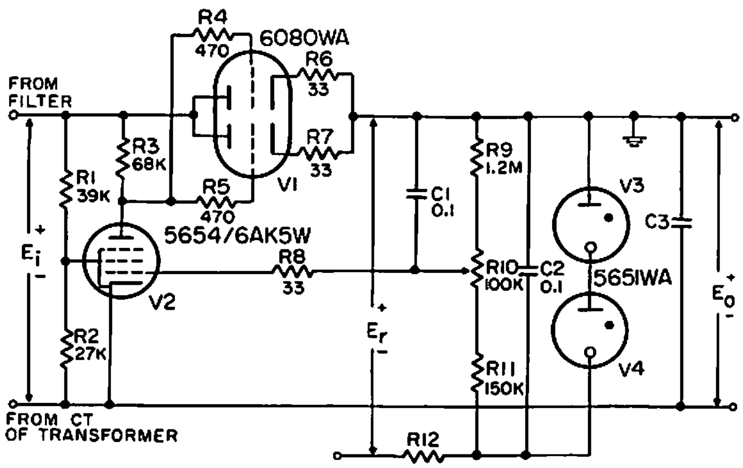
PREFERRED 150-V D-C REGULATOR—Provides either polarity of output with 1% regulation, from minimum of 190 v d-c input. Maximum load current is 100 ma per series tube. C4 is minimum of 4 mfd.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 4, p 4-2.



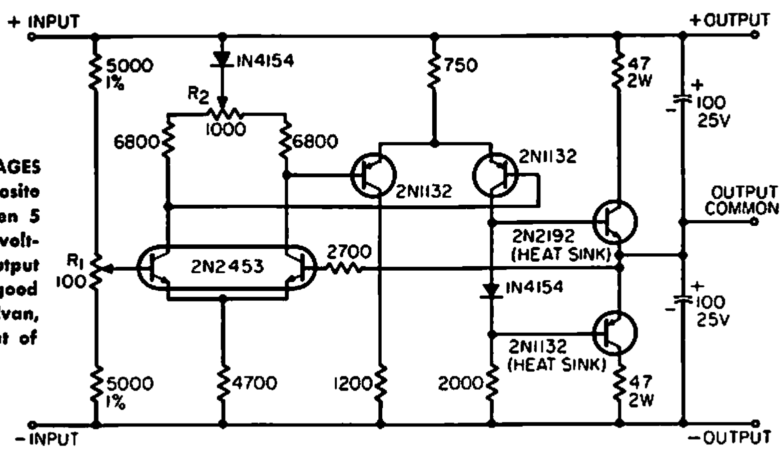
200-V D-C TO 24-V D-C REGULATED POWER SUPPLY—Gate turnoff and silicon power transistor together provide switching and regulating action efficiently at high frequency for d-c/d-c stepdown transformer applications.—D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.



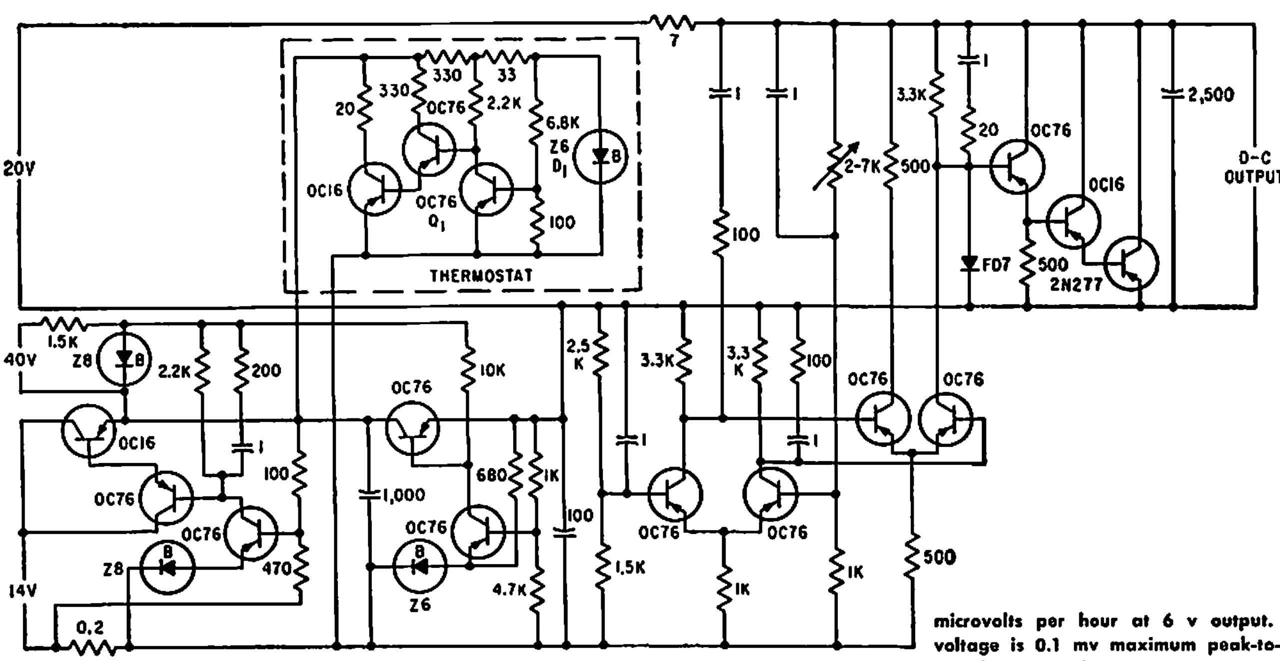
50-V D-C REGULATOR—Provides up to 750 ma at 50 v with 1% regulation for inputs of 59 to 100 v from unregulated source. Auxiliary source Ea must be minimum of 5 v. —NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 4, p 4-2.



PREFERRED —150-V D-C REGULATOR—Provides 1% output voltage regulation under normal line and load variations of military equipment. Minimum value of C3 is 2 mfd. Value of R12 depends on reference voltage Er, which should be minimum of —300 v d-c. Two reference tubes, V3 and V4, are used in series so negative bias for V2 can be obtained with grounded reference supply. Minimum input voltage is 200 v d-c.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 2, p 2-2.

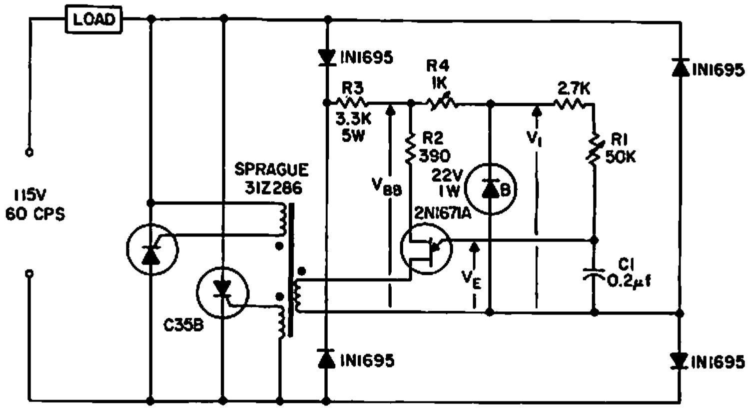


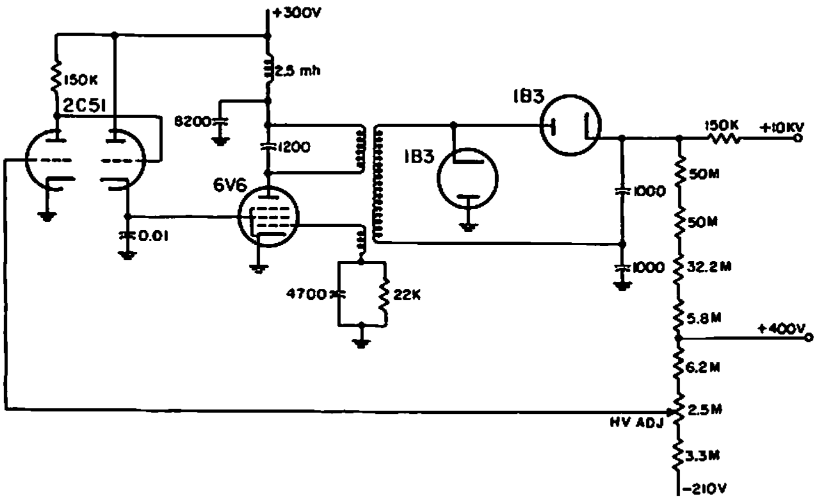
EQUAL POSITIVE AND NEGATIVE VOLTAGES—Single supply provides equal and opposite output voltages at desired value between 5 and 25 v, at up to 100 ma, for input voltages from 10 to 50 v. R1 balances output voltage, while R2 is adjusted to give good tracking of output voltage.—T. P. Sylvan, Regulator Makes Two Power Supplies Out of One, *EEE*, 14:5, p 117.



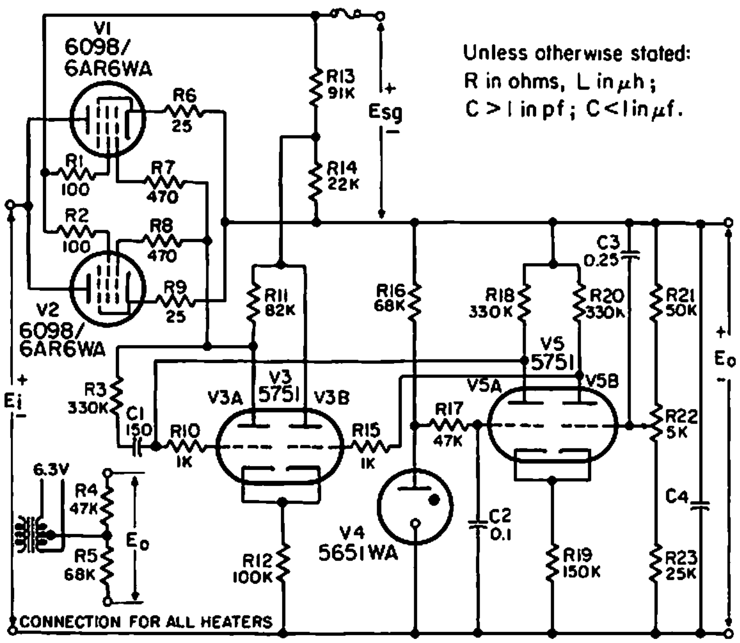
TEMPERATURE-STABILIZED 1 TO 17 V—Shunt-type supply uses prestabilizer to control temperature controller and stabiilzing circuit that serves as voltage reference. After reaching equilibrium temperature in 5 hours, overall drift over 15-hour period is only 36 microvolts per hour at 6 v output. Ripple voltage is 0.1 mv maximum peak-to-peak.—E. Baldinger and W. Czaja, Designing Highly Stable Transistor Power Supplies, *Electronics*, 32:39, p 70-73.

UJT-SCR REGULATED A-C SUPPLY—Component values shown give optimum regulation at 25 v rms output, with less than 0.1 v variation for change in line voltage from 115 v to 100 v. For wider range of output voltage than 10 to 30 v, R1 and R4 can be ganged pot.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 334.

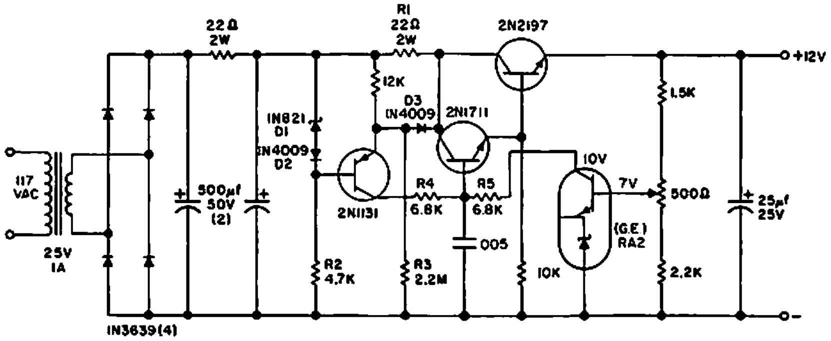




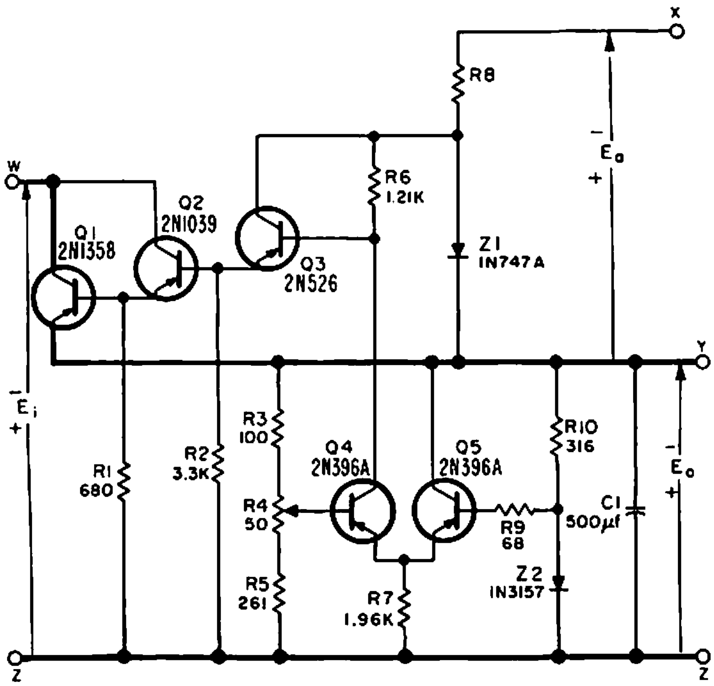
10-KV R-F OSCILLATOR-TYPE CRT SUPPLY—Associated regulator controls oscillator output. Considered less desirable than a-f oscillator supplies, which have no r-f radiation problem.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14-3.



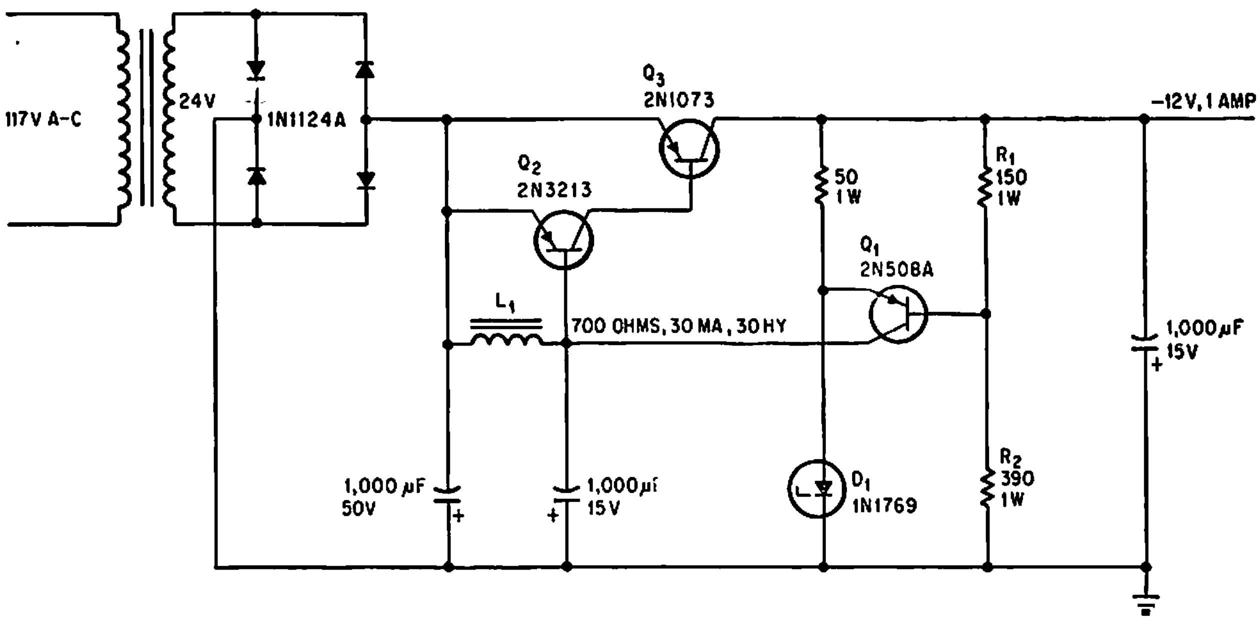
PREFERRED 0.1% REGULATION 250-V D-C—Provides either polarity, for applications requiring superior regulation and stability. Minimum input is 290 v d-c, and minimum Esg is 150 v d-c. Maximum output is 100 ma per series tube. C4 is minimum of 4 mfd.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 8, p 8-2.



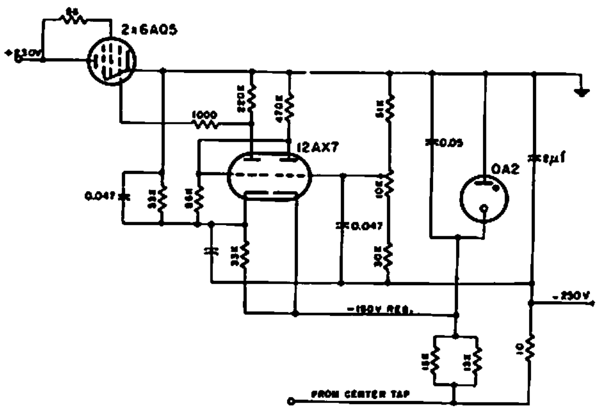
PRECISION 12-V 200-MA SUPPLY—Regulation is less than 0.001% for 10% change in line voltage. Sharp current limiting at 300 ma is provided by R1 and D3. Darlington connection for series regulator gives current gain of 10,000 at 100 ma, so normal variation of reference amplifier collector current is only 10 microamp over full range of output current.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 232.



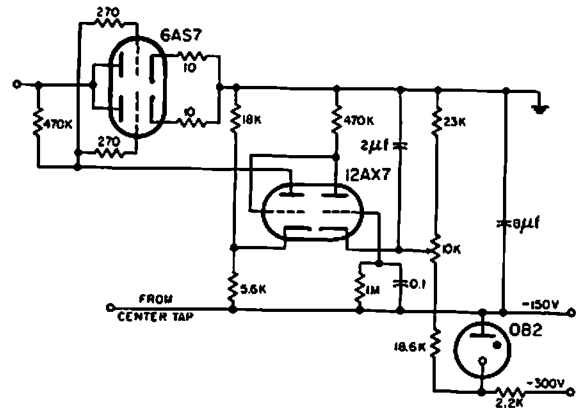
12-V D-C REGULATOR—Provides up to 3 amp at 12 v with 1% regulation for inputs of 13 to 50 v from unregulated source. Auxiliary source Ea must be minimum of 5 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 2, p 2–4.



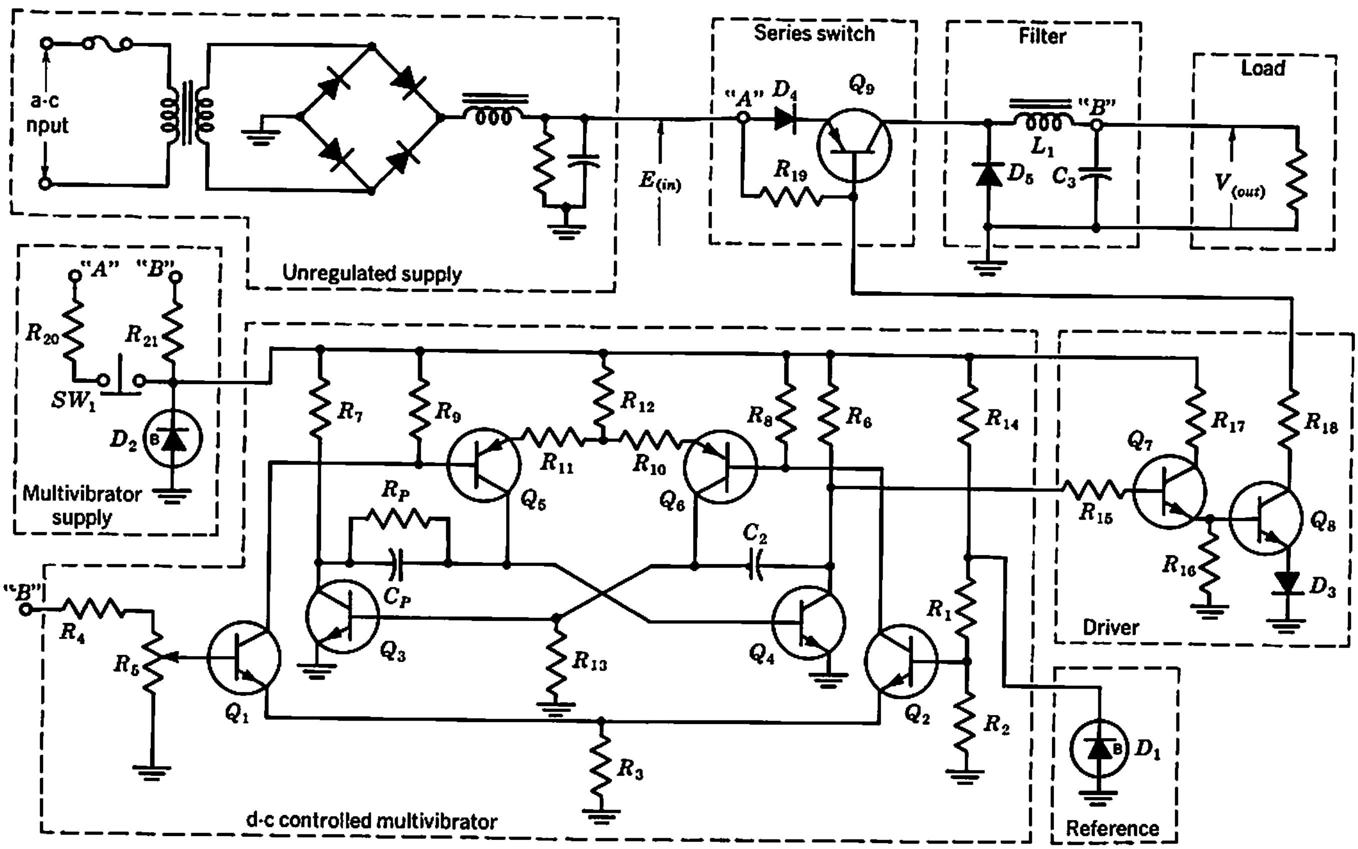
FEEDBACK CHOKE CUTS RIPPLE—Choke L1, placed in feedback path from Q1 to Q2, holds down ripple in current supplied to load through Darlington amplifier Q2–Q3. Choke acts as if it were in series with load even though carrying only a fraction of load current.—J. T. Quatse, Feedback Choke Reduces Power Supply Ripple, *Electronics*, 39:13, p 74.



NEGATIVE-OUTPUT 250-V REGULATOR—Operation is comparable to corresponding positive-output circuit.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-5.



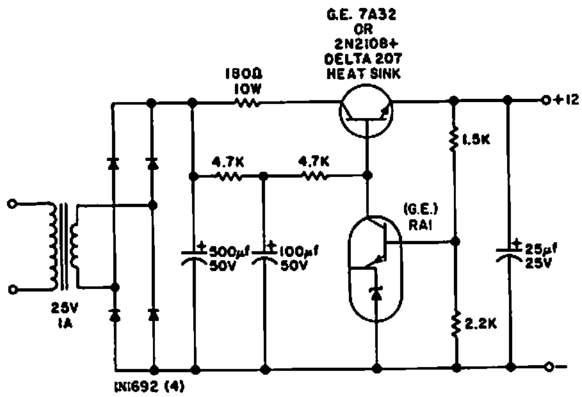
NEGATIVE-OUTPUT 150 AND 300-V REGULATOR—Operation is comparable to corresponding positive-output circuit.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-5.



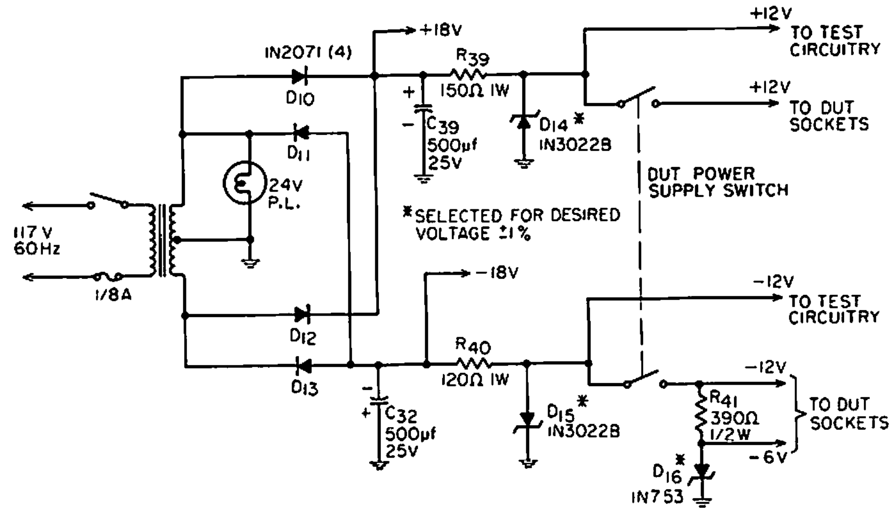
Parts List

Resistors*	Kilohms	Resistors*	Kilohms	Resistors*	Kilohms	Transistors		Capacitors	μf	Diodes and rectifiers	
R_p	4.7	R_8, R_9	10	R_{17}	270 ohms	Q_1, Q_2, Q_3, Q_4	2N1304	C_p	0.02	D_1	1N751
R_1	1.8	R_{10}, R_{11}	2.2	R_{18}	110 ohms, 20 watts	Q_5, Q_6	2N1305	C_2	0.001	D_2	1N2499
R_2, R_3	3.3	R_{12}	4.7	R_{19}	33 ohms	Q_7	2N1302	C_3	1,000	D_3	1N2069
R_4	3.0	R_{13}	47	R_{20}	200 ohms, 10 watts	Q_8	2N1720	*Inductor*		D_4	1N1581
R_5	1.0	R_{14}	680 ohms	R_{21}	82 ohms, 2 watts	Q_9	2N1907	L_1	10 mh	D_5	XR-78
R_6	470 ohms	R_{15}	2.0								
R_7	2.2	R_{16}	680 ohms								

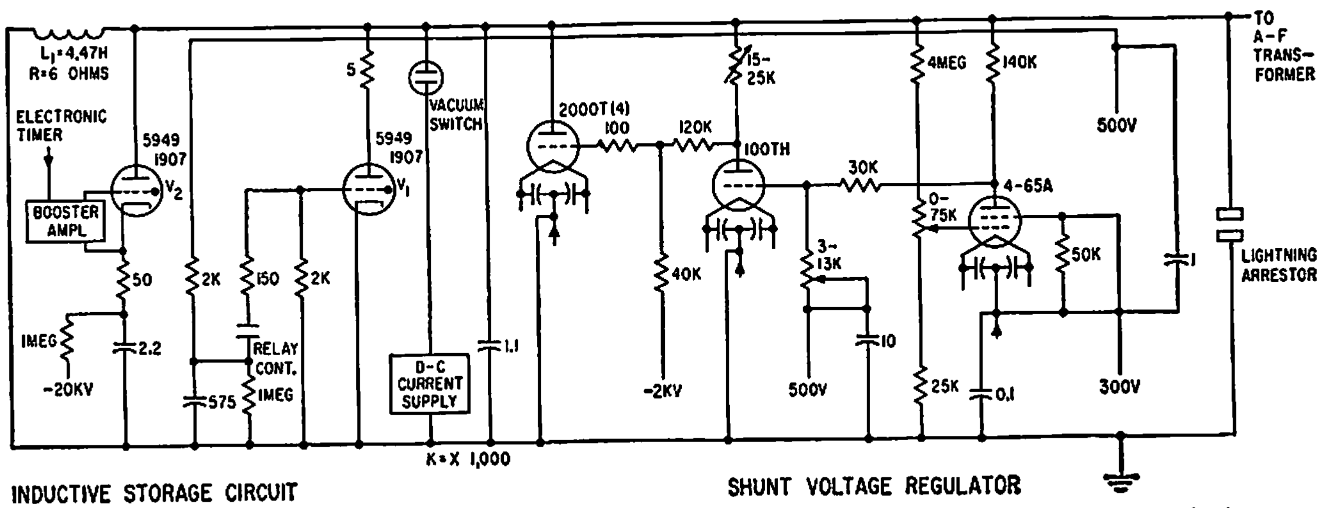
100-W SWITCHING REGULATOR—Chief advantage of switching-mode regulator is relatively low power dissipated in series regulating transistor. Circuit provides 20 v d-c output, constant within 0.2 v, for loads up to 5 amp. Input 60-cps voltage may vary 10 v above and below 40 v. Operating temperature range is −25 to +50°C. Driver transistors Q7 and Q8 operate as switches that are saturated when driven with positive pulses from mvbr.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 468.



REFERENCE-AMPLIFIER 12-V REGULATED SUPPLY—Uses integrated device consisting of zener diode and npn transistor in single pellet, to serve dual function of voltage reference element and error voltage amplifier. Provides up to 100 ma. 180-ohm series resistor provides short-circuit protection by limiting output current to less than 200 ma. Output regulation is better than 0.3% for line voltage variations of 10%.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 231.

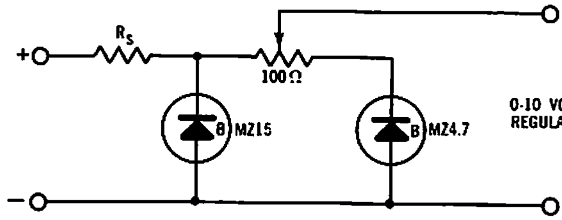


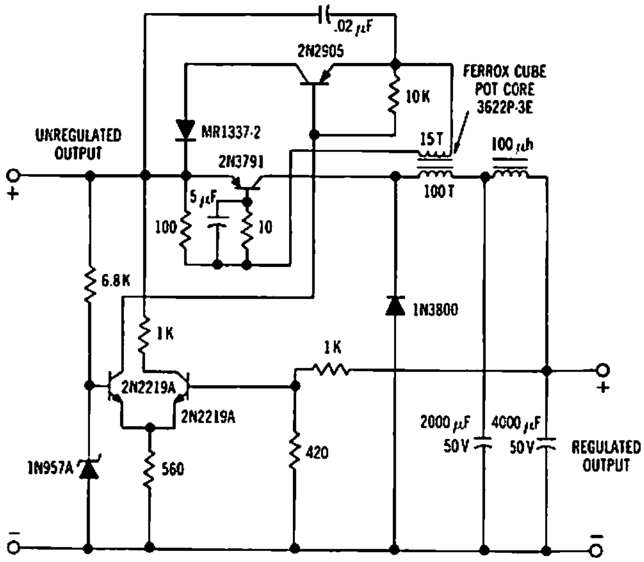
SIMPLE 5-VOLTAGE SUPPLY—Provides −6 v and both positive and negative 12 and 18 v outputs, each regulated by zeners, for linear integrated-circuit tester and for integrated circuits under test. Transformer has center-tapped 24-v secondary. Lamp across half of secondary operates at 12 v to extend life.—J. N. Giles, How to Measure Linear-IC Performance, *EEE*, 14:8, p 62–68 and 161.



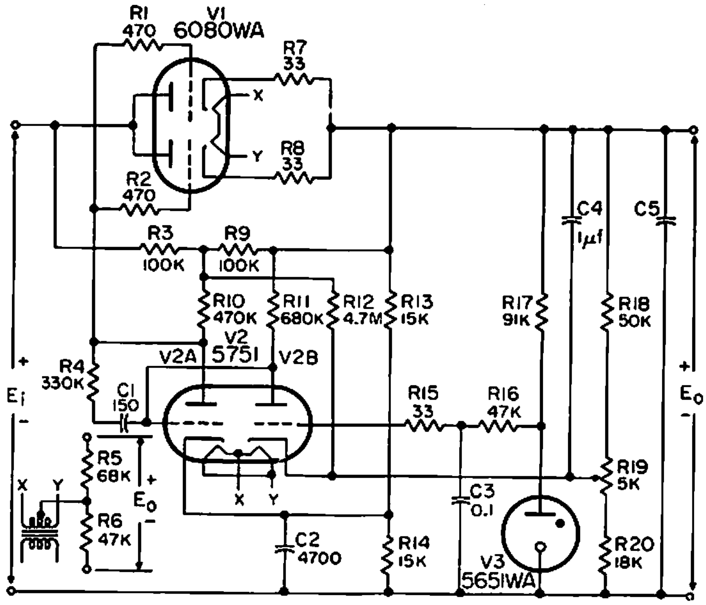
20,000-V INDUCTIVE-STORAGE SUPPLY—Consists of shunt-regulated electronically switched inductive energy storage system in which coil L1 is charged through vacuum switch. When high voltage is needed, V2 is fired to deionize V1. Cathode capacitor of V2 is then charged to 20,000 v by coil current, at which time electronic feedback regulator in shunt with L1 draws current to maintain constant output voltage.—R. L. Gamblin, Ohmic Heating Circuits for Plasma Physics, *Electronics*, 32:41, p 57–59.

0-10 V TWO-ZENER—Simple arrangement provides source of well-regulated adjustable voltage. First zener diode tends to act as pre-regulator, improving dynamic regulation. —"Zener Diode Handbook," International Rectifier Corp., 1960, p 54.



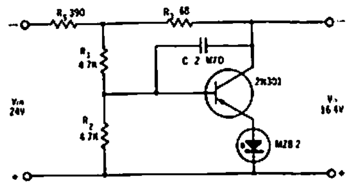


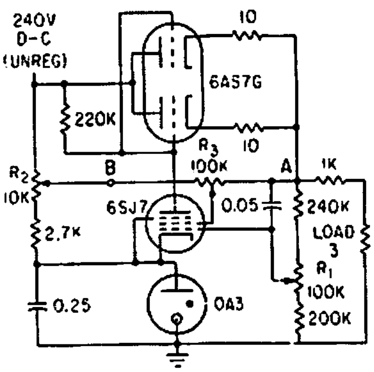
BLOCKING-OSCILLATOR SWITCHING VOLTAGE REGULATOR—Efficiency is improved greatly by having current of 2N3791 transistor flow through load. Differential-amplifier voltage-sensing arrangement controls action of oscillator to maintain constant output voltage. Will regulate 24-v output to within 1% over load range of 100 ma to 2 amp. Oscillator frequency is 6 kc.—H. Weber, "Two Unique Switching Voltage Regulators Using Blocking Oscillators," Motorola Application Note AN-163, Aug. 1965.



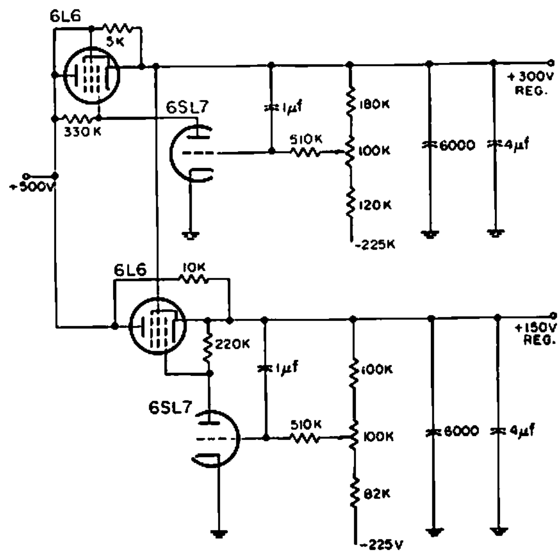
PREFERRED 300-V D-C REGULATOR—Provides either polarity of output with 1% regulation, from minimum of 350 v d-c input. Maximum output current is 125 ma for single series tube section and 100 ma per triode section when two or more are paralleled. Minimum value of C5 is 4 mfd.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 3, p 3-2.

SHUNT REGULATOR—Used when output voltage must be higher than zener voltage. Ripple is less than 10 mv when regulator is supplied by full-wave rectifier having 20 mfd capacitance.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 55.

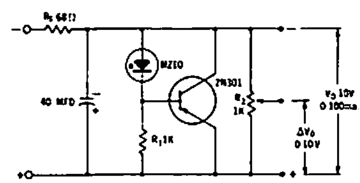




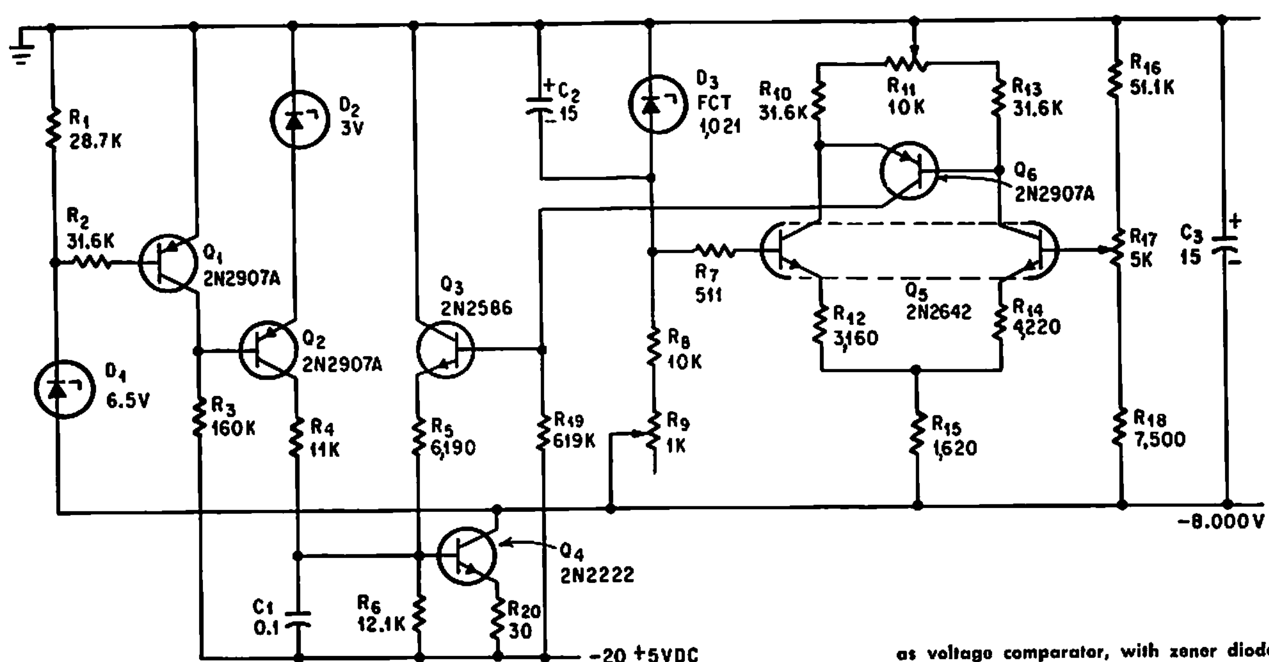
THERMOCOUPLE VACUUM-GAGE HEATER—Simple regulator for 240-v d-c supply provides 140 ma with 0.1% regulation. Uses regulator triode, pentode-connected d-c amplifier, and series-connected reference regulator tube.—W. V. Loebenstein, Regulated Power Supply for Instruments, *Electronics*, 33:48, p 132.



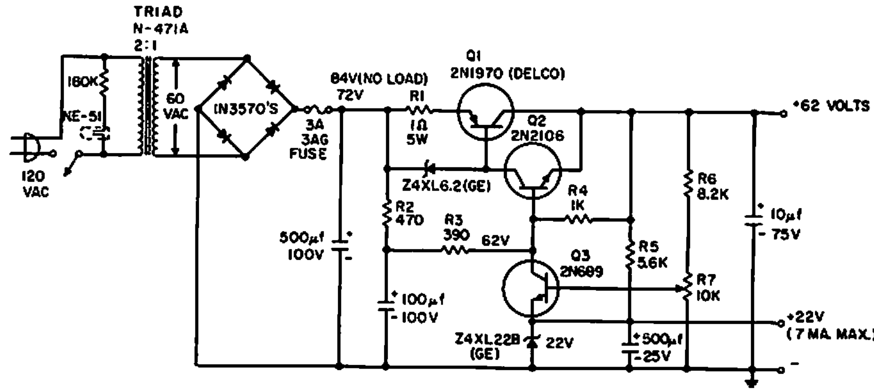
150 AND 300 V SERIES-TUBE REGULATOR—Uses simple triode as regulator amplifier. Series tube for 300-v supply is conventional triode-connected pentode, but series tube that regulates 150 v has its screen fed from output of 300-v regulated supply, for pentode operation.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-11.



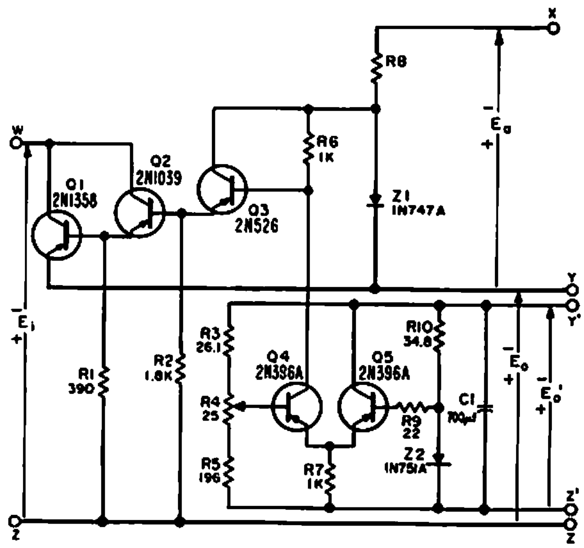
SHUNT REGULATOR—Used when output can be less than zener voltage.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 55.



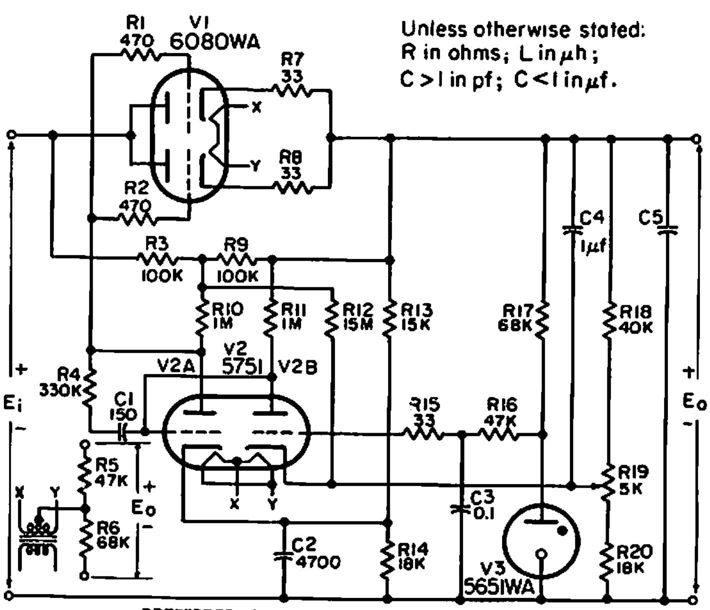
8-V VOLTAGE REGULATOR—Output voltage is held within 0.1% despite 5-v variations in 20-v input to regulator that itself consumes only 1.5 ma. Differential amplifier Q5 acts as voltage comparator, with zener diode D3 as reference.—A. Dargis, A High Performance Voltage Regulator, *Electronics*, 37:13, p 75.



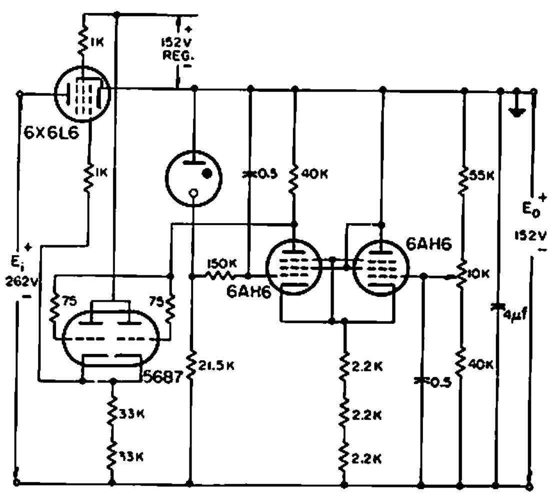
DARLINGTON-CONNECTED SERIES REGULATOR—Designed for output currents up to 2 amp average or 3.5 amp peak. Output voltage can be adjusted from 45 to 65 v by R7. Ripple is less than 1 mv rms at no load, increasing to 60 mv peak-to-peak at 2 amp. Regulation is 2.1% at 2 amp and 0.72% at 1 amp.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 228.



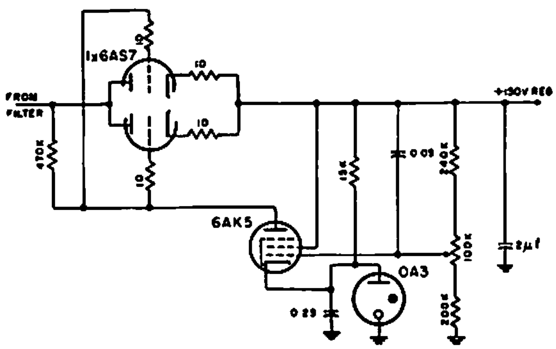
REMOTE-SENSING 6-V REGULATOR—Used when small lead resistance between regulator and load is physically impossible. Voltage Eo' is essentially voltage that appears directly across load. Differential amplifier senses and corrects for changes in this voltage rather than for changes in Eo at regulator output terminals.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 1, p 1–11.



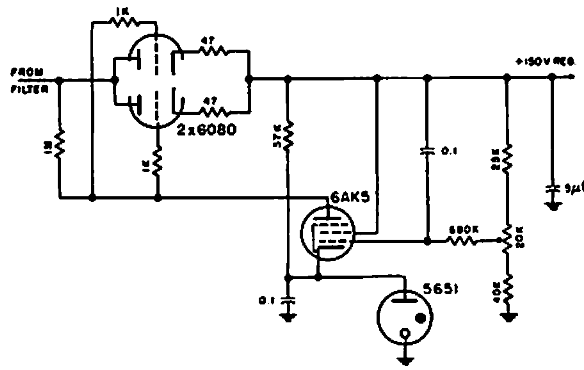
PREFERRED 250-V D-C REGULATOR—Provides either polarity of output with 1% regulation, from minimum of 300 v d-c. C5 is minimum of 4 mfd.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 7, p 7–2.



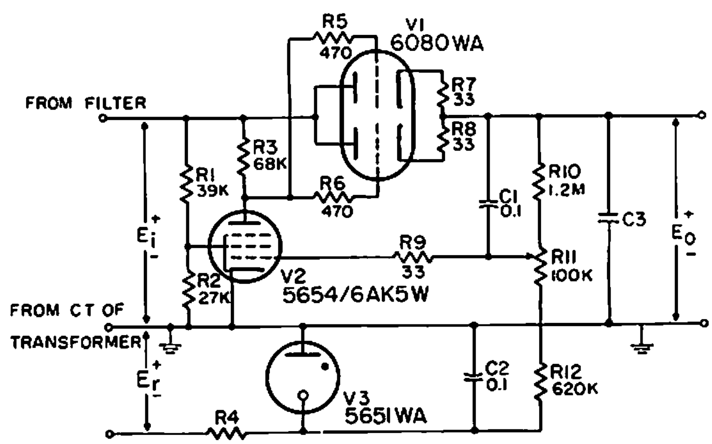
152-V PENTODE SERIES-TUBE REGULATOR—Has excellent frequency response, but this performance could also be obtained if cathode follower were amplifier using negative feedback for frequency compensation, along with better regulation and lower d-c resistance.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–11.



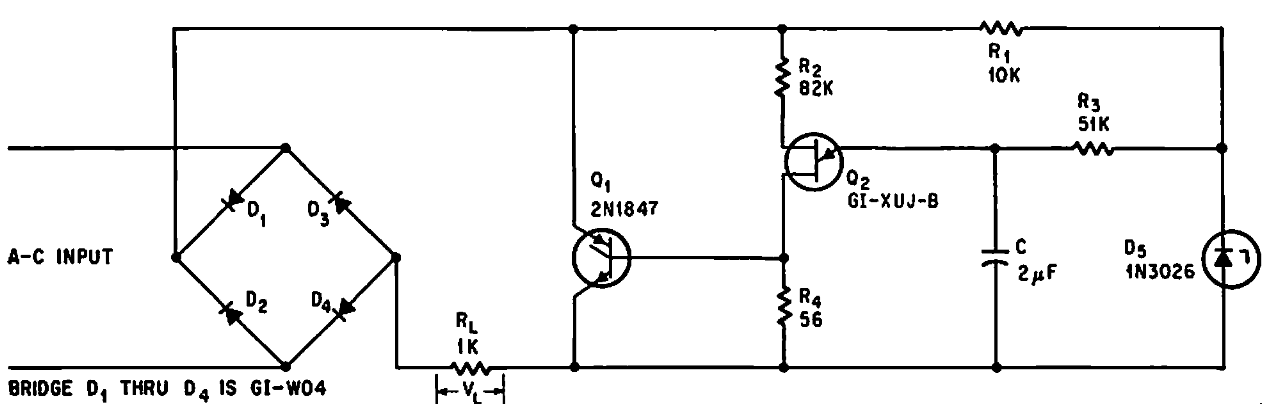
POSITIVE-REFERENCE REGULATOR—Has self-contained 150-v positive reference potential for pentode regulator, but gives only marginal operation.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–4.



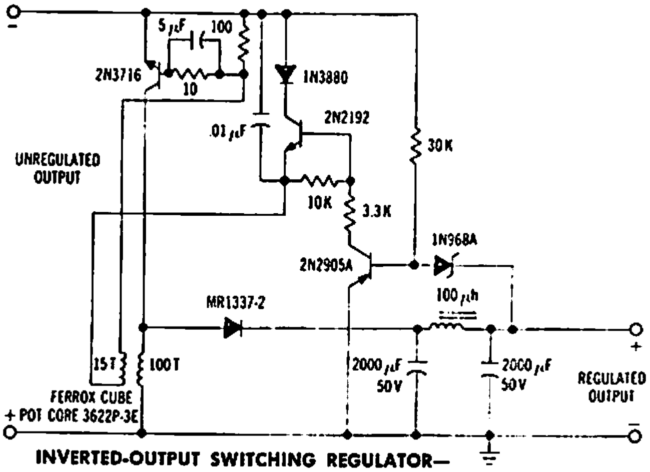
POSITIVE-REFERENCE REGULATOR—Has self-contained 150-v positive reference potential for pentode regulator, but gives only marginal operation.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–4.



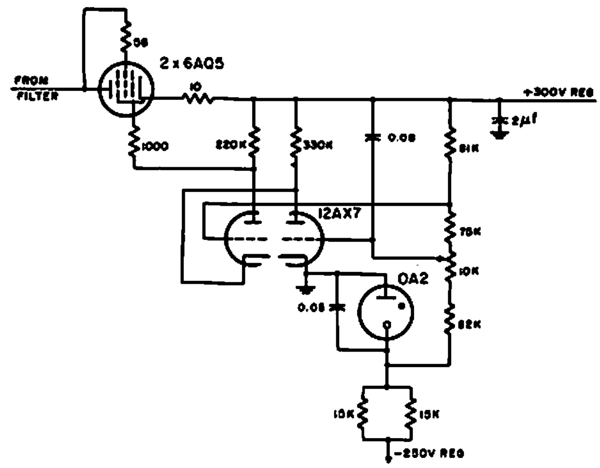
PREFERRED +150-V D-C REGULATOR—Provides 1% output voltage regulation under normal line and load variations of military equipment. Minimum value of C3 is 2 mfd. Value of R4 depends on reference voltage Er, which should be minimum of −150 v d-c. Minimum input voltage is 200 v d-c.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 1, p 1–2.



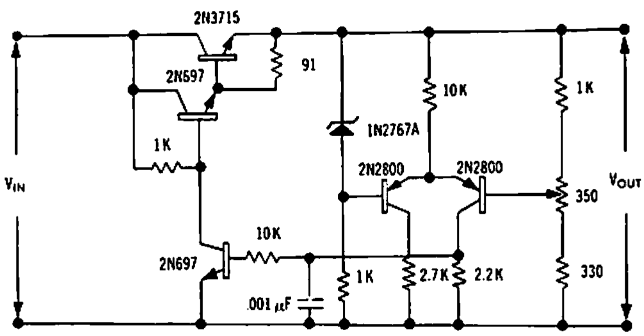
SCR FIRING-ANGLE CONTROL—Unijunction transistor trigger circuit fires scr at specific time in each half-cycle of a-c input to keep average load voltage constant over line voltage range of 100 to 200 v a-c.—R. S. Krechmal and W. Weber, Controlling SCR Firing Angle Regulates D-C Load Voltage, *Electronics*, 38:16, p 80–81.



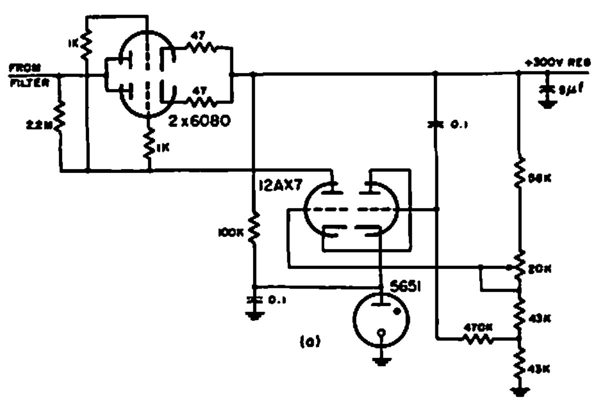
INVERTED-OUTPUT SWITCHING REGULATOR—Simple 6-kc blocking oscillator circuit serves both for sensing and duty cycle control. Arrangement is more efficient than conventional series-pass regulators. Inverted polarity is added feature. Will regulate 20-v output within 1% overload range of 50 ma to 1 amp. —H. Weber, "Two Unique Switching Voltage Regulators Using Blocking Oscillators," Motorola Application Note AN-163, Aug. 1965.



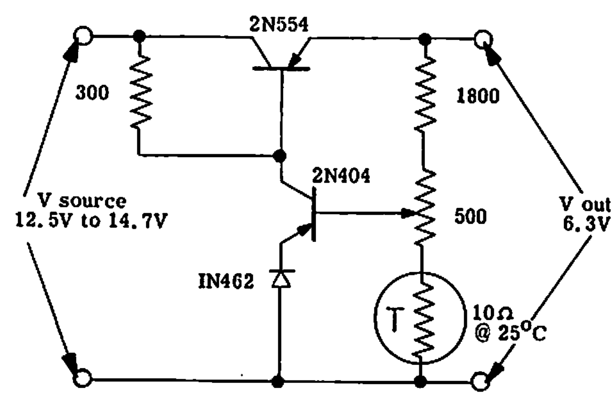
MODIFIED TWIN-TRIODE CASCODE—Plate resistor for lower-potential triode parallels top triode, which is plate load for true cascode. This increases gain of circuit by increasing average plate current and thereby transconductance of bottom triode.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-2.



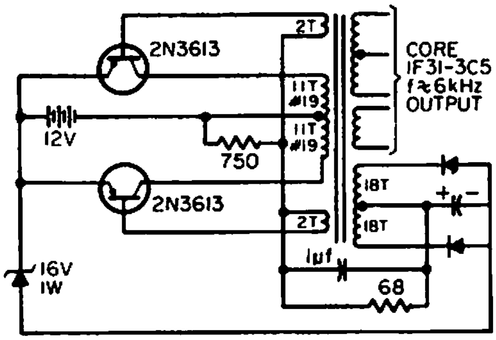
BASIC SERIES-PASS REGULATOR—Output voltage is regulated by 2N3715 series-pass silicon power transistor having rise and fall times below 0.5 microsec at 5 amp. Transistor has wide safe-area range, but circuit otherwise has no overload protection.—J. Takesuye and H. Weber, "Silicon Power Transistors Provide New Solutions to Voltage Control Problems," Motorola Application Note AN-163, Aug. 1965.



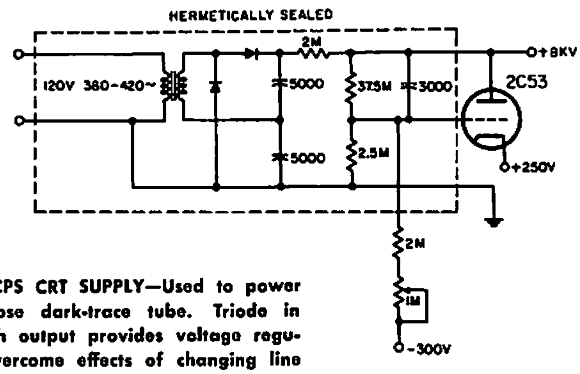
TRUE TWIN-TRIODE CASCODE—Use of 5-mfd capacitor across regulated output reduces adverse effect of 2.2-meg plate load resistor on frequency response. Cascode circuit is used when required gain is too high for single triode, because it avoids need for second d-c supply that would be required for screen if pentode were used.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-2.



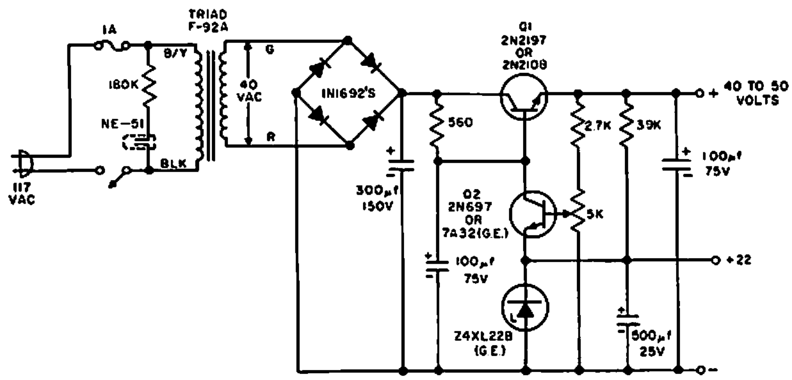
LOW-COST VOLTAGE REGULATOR—Costs 5 to 7 times less than zener regulator having same power rating. Can be set at precise voltage value required, whereas zener has 5 or 10% tolerance. Uses 1N462 silicon diode for reference. Total cost (in quantity) is less than two dollars. Thermistor makes circuit perform from −55 to 71°C. Input voltage source is sea-water-activated battery.—M. E. Gavin, Low Cost Transistor Voltage Regulator, *EEE*, 10:8, p 28–29.



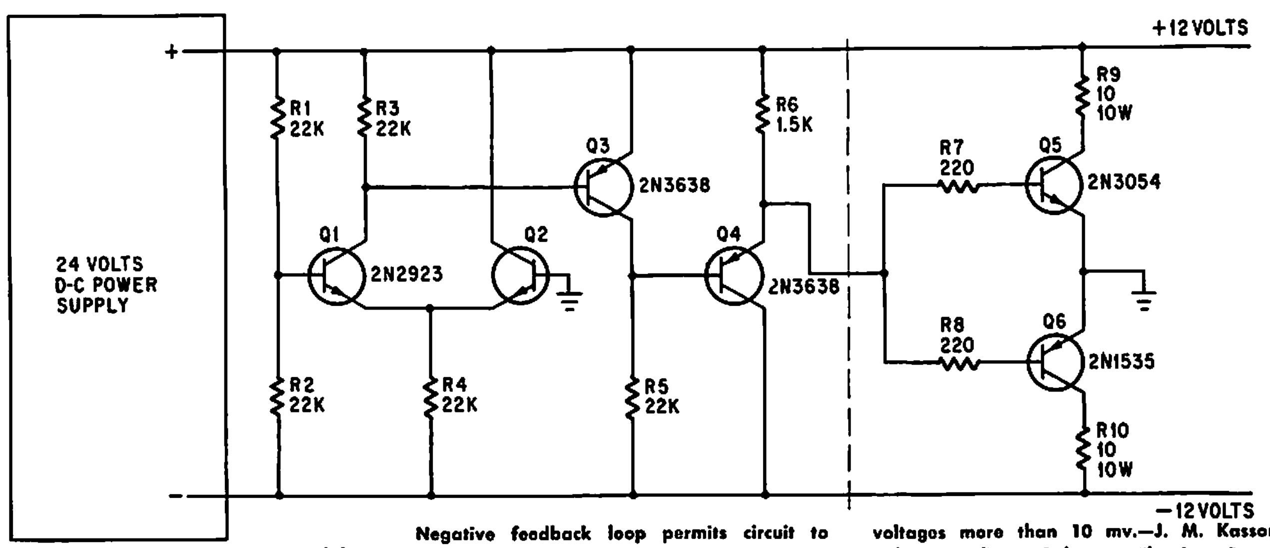
BATTERY VOLTAGE REGULATOR—Used in battery-powered instruments to compensate for wide range of battery voltages. Converter serves to provide required variety of operating voltages and isolate equipment from supply. Will hold output within 0.5 v of 16 v for input range of 11.5 to 19 v.—C. D. Lindsay, Combined Battery Converter-Regulator Power Source, *EEE*, 14:3, p 61.



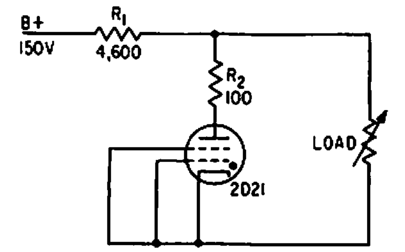
14-KV 400-CPS CRT SUPPLY—Used to power special-purpose dark-trace tube. Triode in parallel with output provides voltage regulation to overcome effects of changing line voltage, improve output ripple, and improve output impedance characteristics.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N14-1.



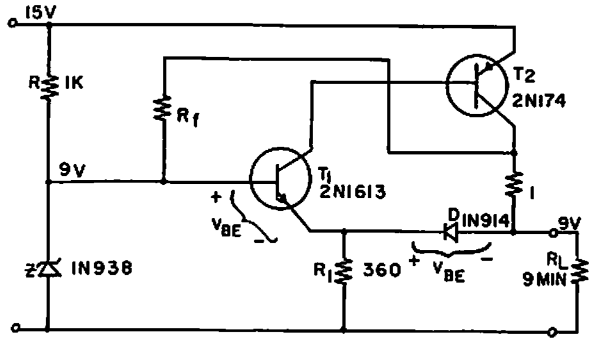
BASIC SERIES REGULATOR—Provides voltage regulation within 2% at 400 ma, with peak-to-peak output ripple below 0.3 v. Output impedance is less than 2 ohms from d-c to 20 cps.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 227.



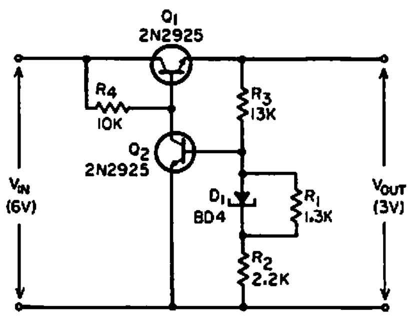
VOLTAGE SPLITTER-REGULATOR—Provides regulated +12 and −12 v from 24-v supply. Negative feedback loop permits circuit to furnish unbalanced currents up to 700 ma in either direction without changing output voltages more than 10 mv.—J. M. Kasson, Voltage Splitter Balances Floating Power Supply, *Electronics*, 39:6, p 96.



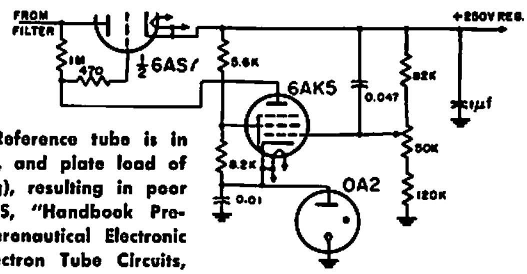
THYRATRON REGULATOR—Output of 12 to 16 v is regulated within 1% for loads of 6 to 22 ma. Since 2D21 can handle 100 ma continuously, circuit is easily modified to regulate higher current values.—W. D. Fryer, Thyratron Regulates Supply, *Electronics*, 31: 25, p 88.



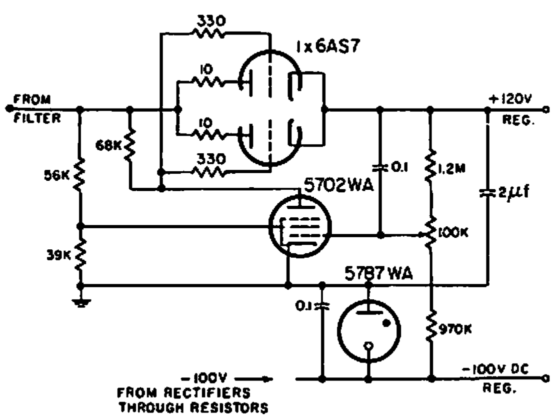
ZERO-IMPEDANCE VOLTAGE REGULATOR—Uses two transistors and controlled positive feedback along with temperature compensation to reduce output resistance to zero while holding output voltage constant. Also gives some current overload protection. Values shown provide 1 amp at 9 v.—G. Duggan, Zero Impedance Voltage Regulator, *EEE*, 11:5, p 91–92.



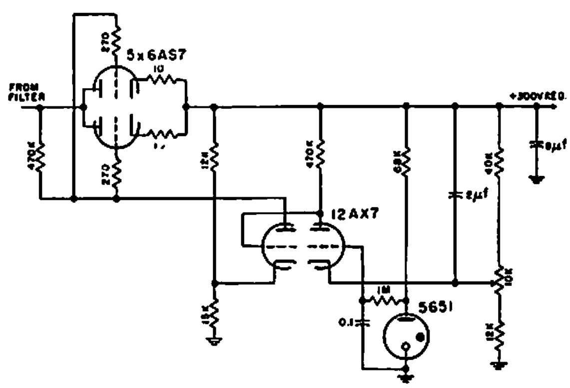
SERIES REGULATION at 3 V—Combination of backward diode and resistor network serves as reference for regulated outputs below 6 v, for which temperature-compensated zener diodes are not available. Provides input regulation of 100:1 over 10% change in input voltage, with output impedance of 0.04 ohm. —T. P. Sylvan, Backward-Diode Power-Supply Reference Elements, *EEE*, 13:11, p 46–48.



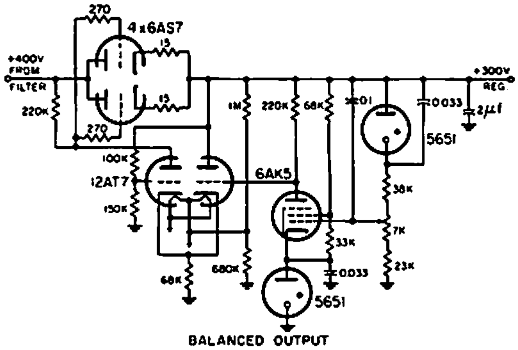
PENTODE REGULATOR—Reference tube is in cathode circuit of 6AK5, and plate load of pentode is high (1 meg), resulting in poor frequency response.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-2.



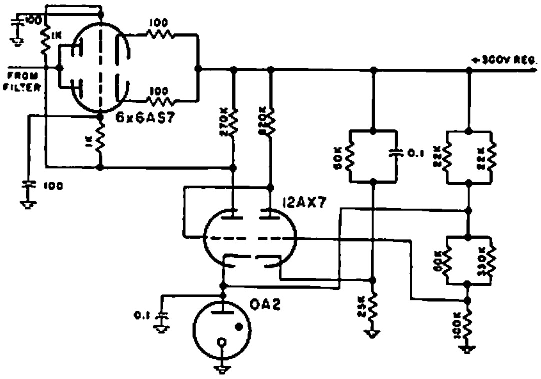
150-V REGULATOR WITH EXTERNAL REFERENCE—Permits wider supply voltage range and better operation than arrangements using self-contained reference.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-4.



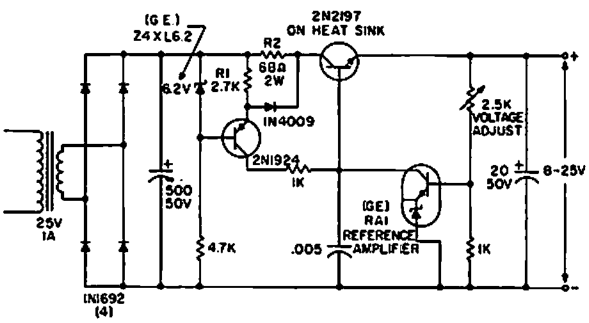
TWIN-TRIODE CASCADE—Has self-contained reference voltage, and does not load reference tube. Is theoretically capable of highest possible gain obtainable with single-envelope d-c amplifiers.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-3.



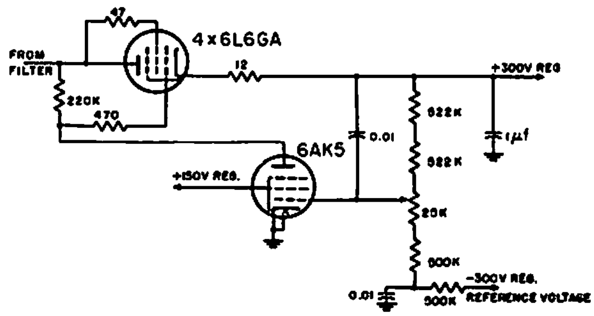
BALANCED-OUTPUT PENTODE TWIN-TRIODE—Arrangement gives high gain, approaching 10,000, along with more ripple reduction than is generally required.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–4.



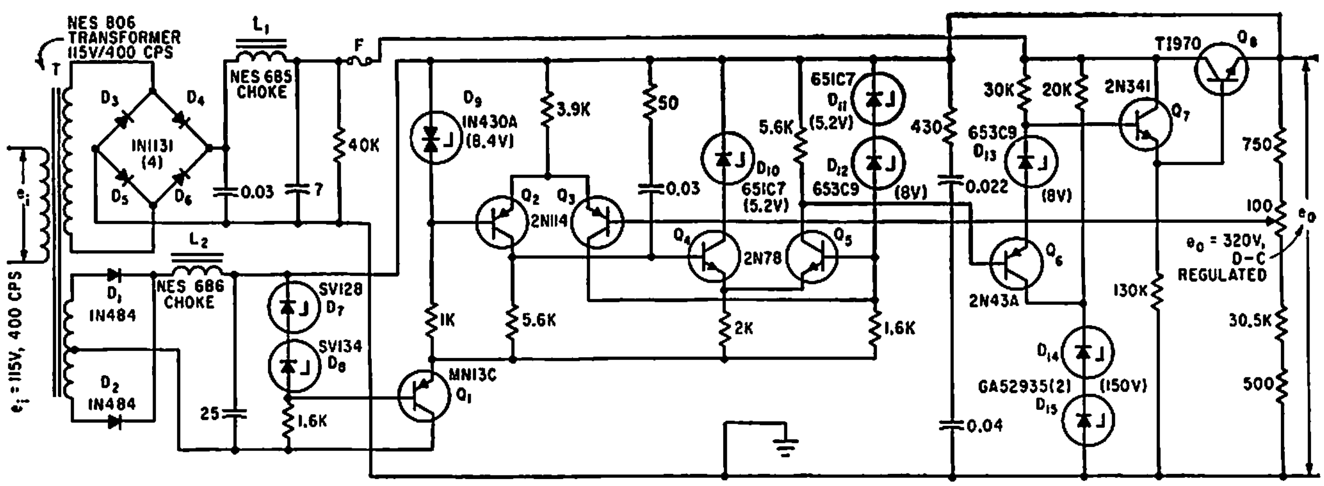
TWIN-TRIODE CASCADE—Smaller load resistor improves frequency response. Both reference tube and comparison divider are loaded.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–3.



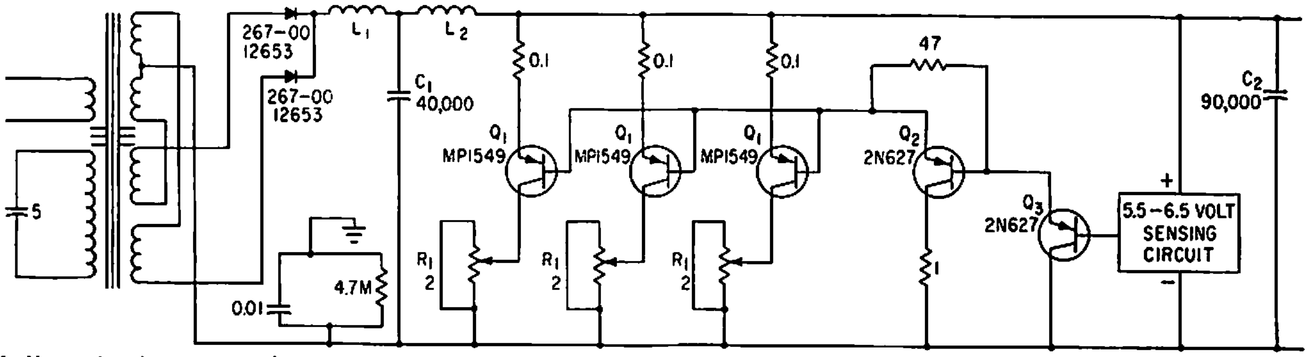
CURRENT-LIMITING SUPPLY WITH REFERENCE AMPLIFIER—Variable 8 to 25-v supply limits output to 100 ma for protection against short-circuits. Regulation is 0.02% for line voltages from 105 to 130 v.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 232.



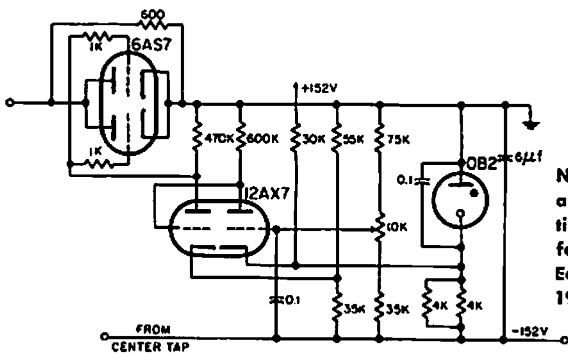
PENTODE WITH CONSTANT REFERENCE CURRENT—Screen is fed directly from regulated voltage of shunt-regulating supply using VR-105 and VR-150 reference tubes to give −300 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–2.



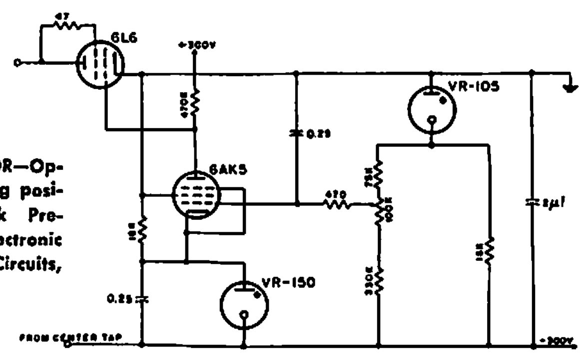
320 V AT 60 MA—Silicon diodes in full-wave bridge feed seven-transistor regulator. Temperature-compensated silicon-junction zener diode is basic reference element. Output is constant within 50 mv, for use with digital-analog converter.—N. Aron, Precise Converter takes Current Analog of Digital Voltage Pulses, *Electronics*, 35:32, p 68–71.



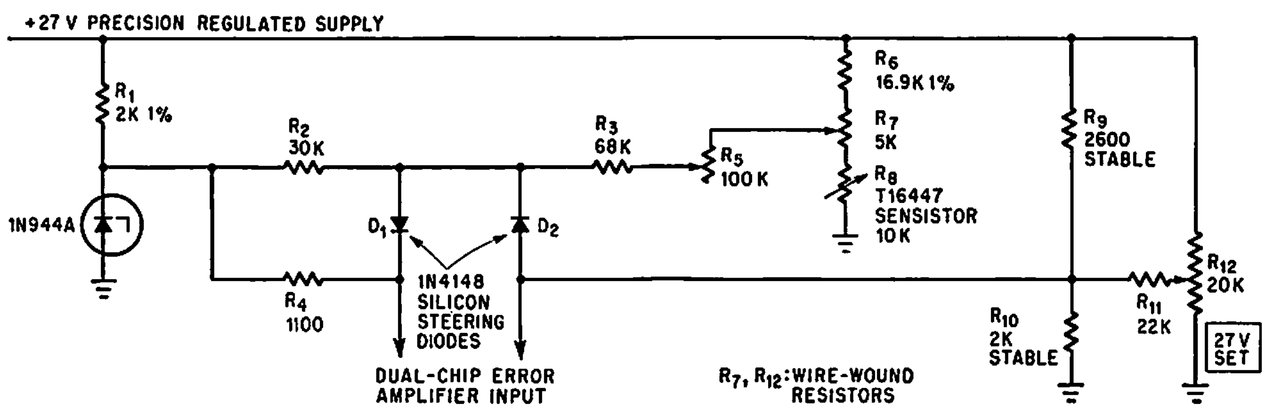
6 V at 20 A—Constant-voltage ferroresonant transformer with full-wave silicon rectifiers is supplemented by shunt transistors driven by error signal from zener-reference sensing circuit.—J. T. Keefe, Transformer and Shunt Transistors Regulate D-C Power Supply, *Electronics*, 34:20, p 99–101.



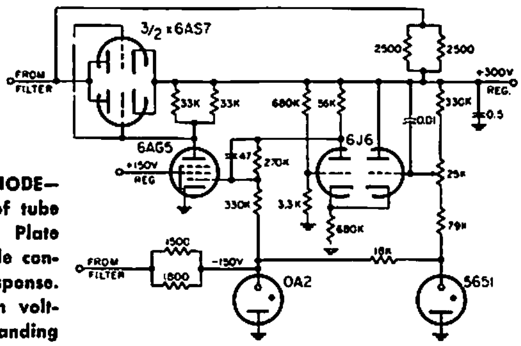
NEGATIVE-OUTPUT 152-V REGULATOR—Operation is comparable to corresponding positive-output circuit.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-5.



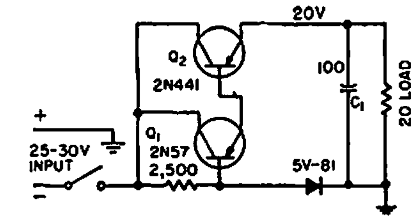
NEGATIVE-OUTPUT 300-V REGULATOR—Operation is comparable to corresponding positive-output circuit.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2-5.



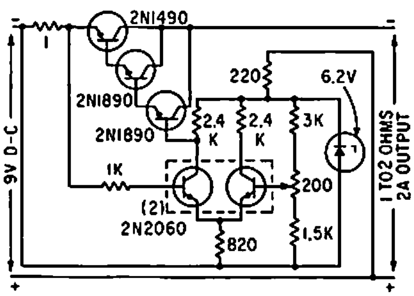
TEMPERATURE-COMPENSATED ZENER—Reference voltage is compared to 27-v output by dual-chip transistor serving as error amplifier. Unique end-compensation circuit using sensistor generates voltage that rises with temperature.—C. H. Moulton, Light Pulse System Shrinks High-Voltage Protection Device, *Electronics*, 38:11, p 71–75.



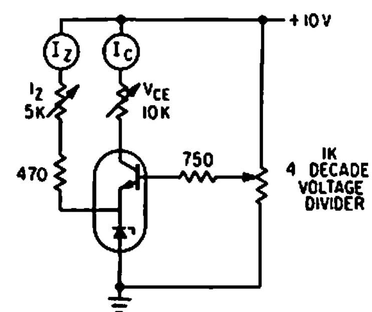
BALANCED-INPUT PENTODE TWIN-TRIODE—Balanced input stage reduces effects of tube aging and heater voltage change. Plate load of 16,500 ohms on output pentode contributes to excellent frequency response. Neither reference tube nor comparison voltage divider are loaded. Gives outstanding over-all performance.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–4.



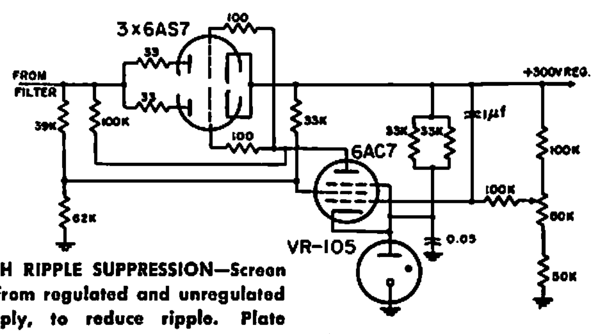
SIMPLE SERIES REGULATOR—Satisfactory for power supplies that are not subjected to shorted, capacitive, or suddenly increased loads. Any capacitance C1 at load must be charged through Q2, so entire supply voltage appears across Q2 before C1 starts charging. If initial charging current exceeds limits of Q2, it will be damaged immediately or become unstable.—H. D. Ervin, Transistor Power Supply has Overload Protection, *Electronics*, 31:25, p 74–75.



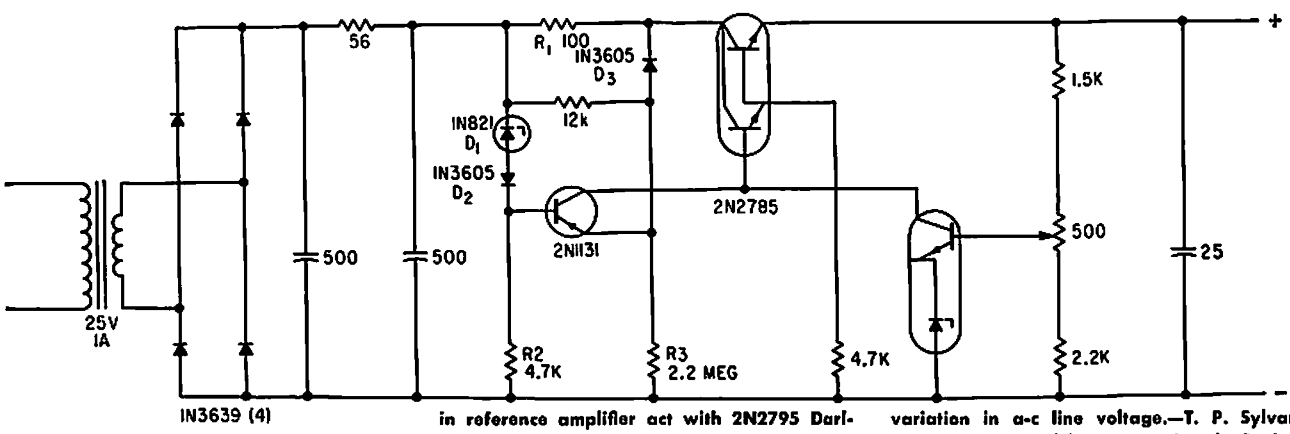
VOLTAGE-TUNABLE MAGNETRON FILAMENT SUPPLY—Voltage drop across 1-ohm resistor, proportional to output current, is compared with fixed reference and held constant by series pass element.—S. Prigozy, Designing Special Power Supplies for Voltage-Tunable Oscillators, *Electronics*, 35:44, p 48–50.



REFERENCE AMPLIFIER TESTS POWER SUPPLY STABILITY—Integrated transistor and zener diode serve as reference amplifier for testing effects of temperature on output voltage. After amplifier is heated or cooled, voltage divider is adjusted to restore initial collector current, and change in reference voltage is read from voltage divider scale to within 1 mv.—T. P. Sylvan, New Device Simplifies Power Supply Design, *Electronics*, 36:20, p 39–43.



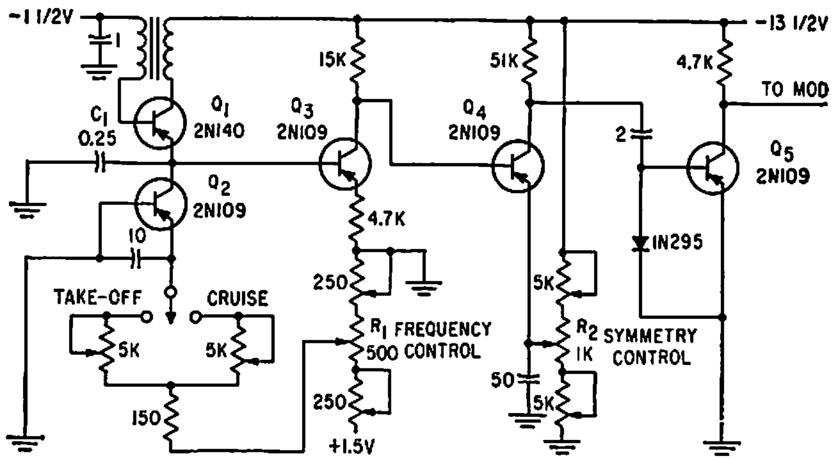
PENTODE WITH RIPPLE SUPPRESSION—Screen is fed jointly from regulated and unregulated sides of supply, to reduce ripple. Plate load is low (100,000 ohms), providing good frequency response but increasing current fluctuations in VR-105.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N2–2.

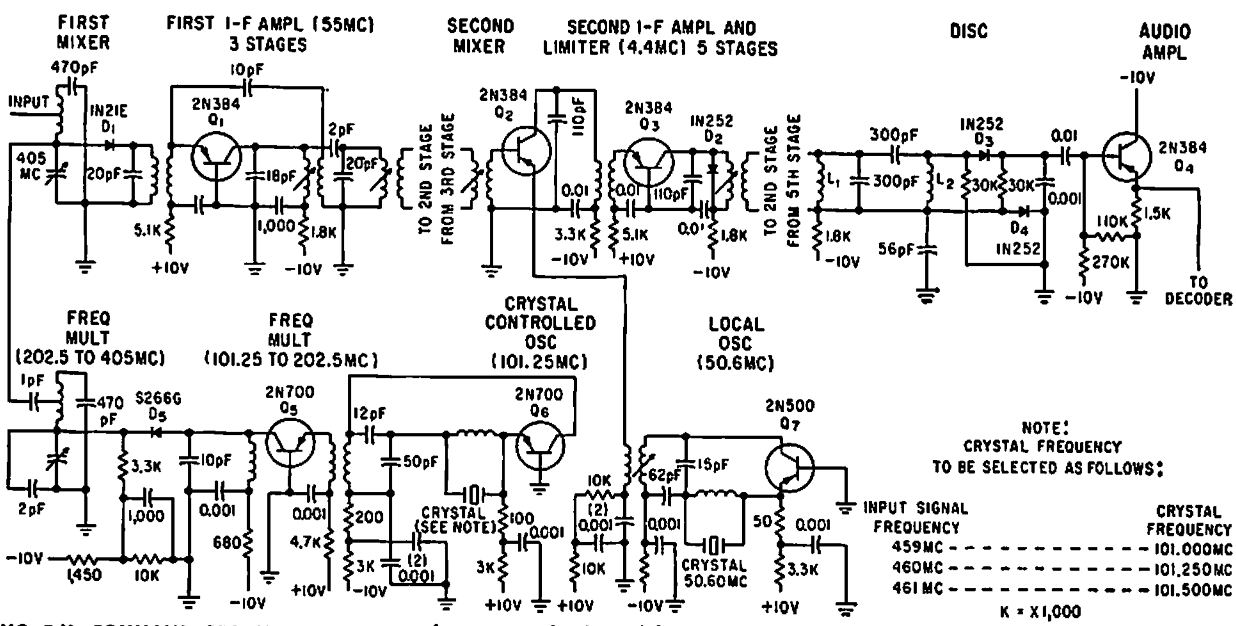


DARLINGTON-TRANSISTOR SERIES REGULATOR—Integrated transistor and zener diode in reference amplifier act with 2N2795 Darlington transistor to hold 50-ma output to within less than 0.001% of 12 v over 10% variation in a-c line voltage.—T. P. Sylvan, New Device Simplifies Power Supply Design, *Electronics*, 36:20, p 39–43.

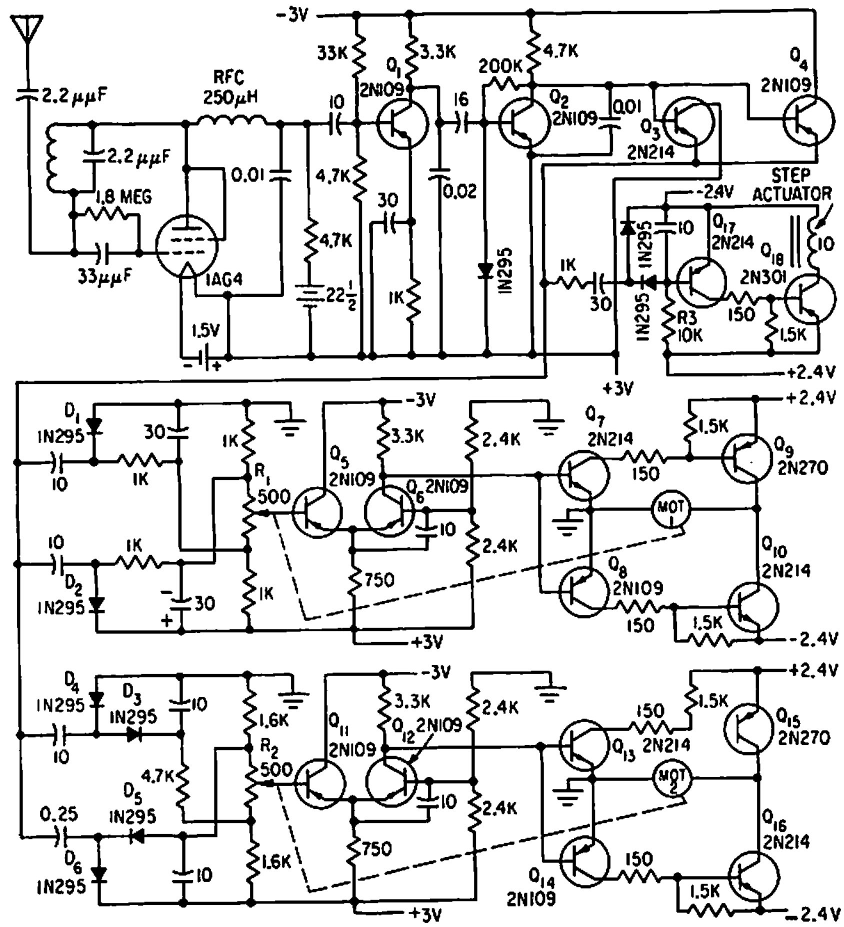
CHAPTER 73
Remote Control Circuits

TRANSMITTER CONTROL FOR DRONE—Pulse repetition rate and pulse symmetry control servos that drive rudder and elevator. Pulses modulate transmitter carrier, which is picked up and detected by superregenerative receiver in target drone.—G. B. Herzog, Transistors Simplify Control of Target Drone, *Electronics*, 32:18, p 52–54.

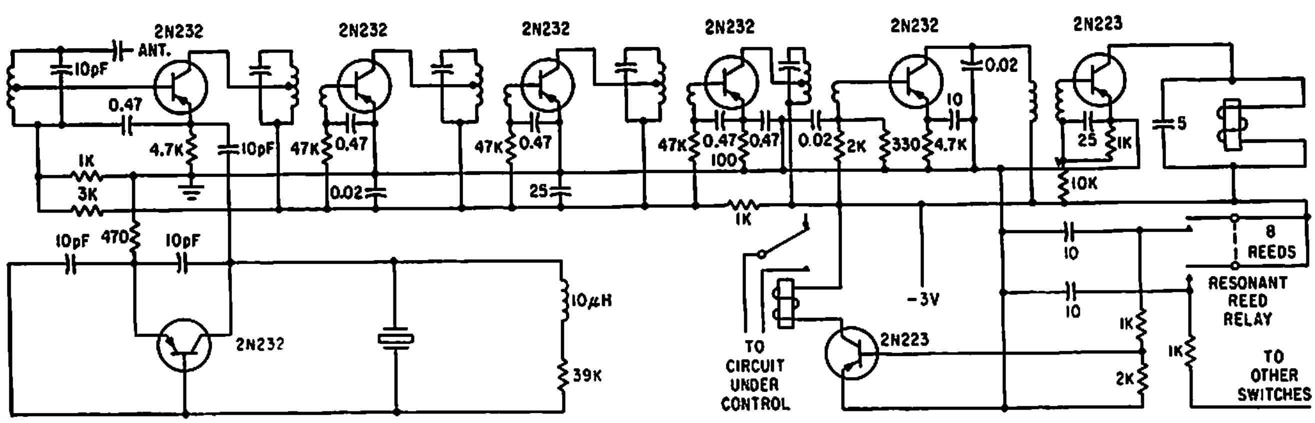




460-MC F-M COMMAND RECEIVER—Transistorized double-conversion f-m superhet, tunable by crystal substitution in 457–462-Mc band, has 6-microvolt sensitivity for 20 db of noise quieting. Camera start and timing pulses are amplitude-modulated onto 3.5 and 12-kc carriers. After signal is detected, subcarriers are separated and pulses are reconstituted by decoder. Start pulses operate camera relays, and timing pulses flash neon lamps.—F. M. Gardner and L. R. Hawn, Camera Control System for Rocket Sled Tests, *Electronics*, 33:14, p 63–65.

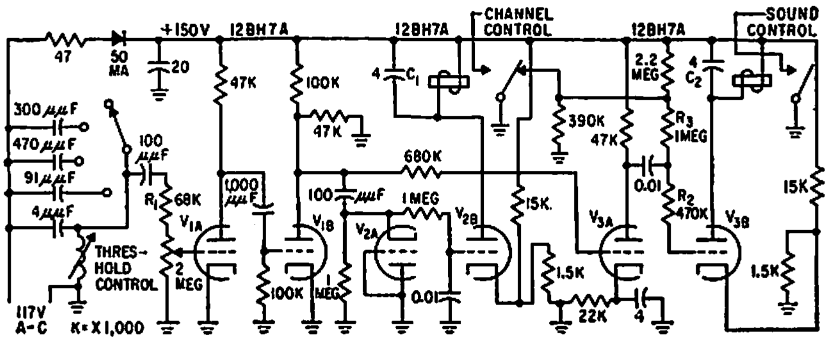


DRONE RECEIVER—Signal from ground transmitter is received by logarithmic mode (self-quenching) superregenerative receiver. Clipper Q2 limits signal to constant level. Combinations of prr and pulse symmetry alter positions of rudder and elevator motors. Engine speed, transmitted by momentarily interrupted modulation, acts on Q17-Q18.—G. B. Herzog, Transistors Simplify Control of Target Drone, *Electronics*, 32:18, p 52–54.

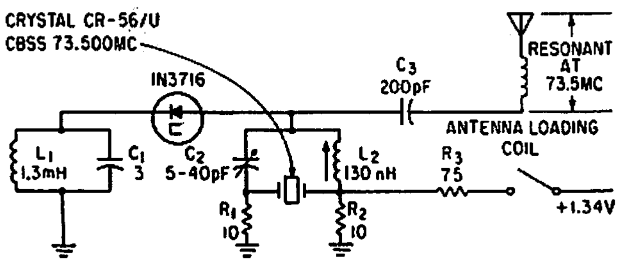


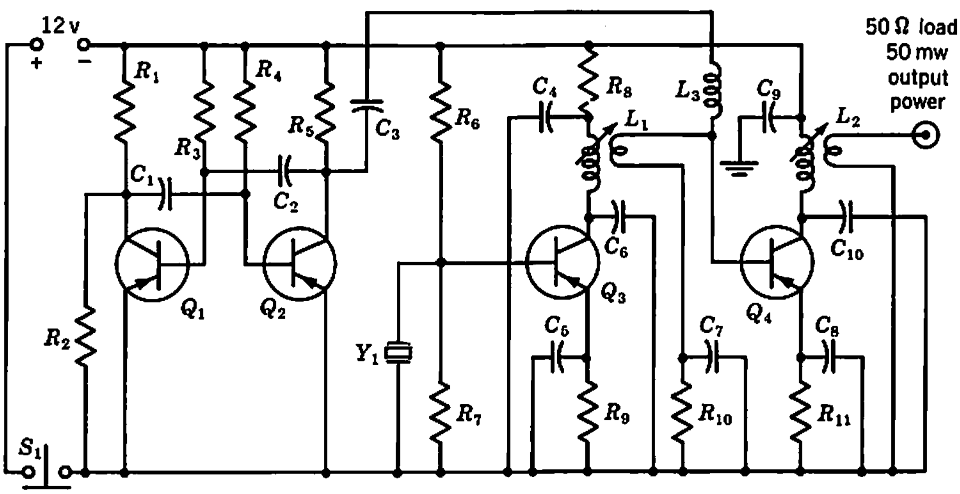
EIGHT-COMMAND RECEIVER—Transistorized superheterodyne with crystal-controlled local oscillator energizes eight-reed relay, with each reed activating own transistor switch. Reeds are tuned to different frequencies between 250 and 500 cps.—R. A. Baker, Radio-Controlled Tank for Realistic Combat Training, *Electronics*, 33:45, p 55–57.

LINE-CURRENT TV CONTROL RECEIVER—Can be considered as two separate receivers, one detecting unmodulated power-line carrier for channel selection, the other detecting both modulated and unmodulated carriers for sound-muting relay. Four individually tuned frequencies (52.5, 57.5, 67.5, and 73.5 kc) are selectable by switching additional capacitors across that for highest frequency.—J. R. Banker and C. H. Wood, Jr., Line Current Controls Remote Tv Receiver, *Electronics*, 31:33, p 68–69.



73.5-MC CRYSTAL-CONTROLLED TUNNEL-DIODE TRANSMITTER—Self-modulated low-power oscillator for remote-controlled toys, trains, and garage doors can also be voice-modulated. Range is about 200 yards, and battery drain is 18 ma.—E. Gottlieb and J. Giorgis, Tunnel Diodes—Using Them as Sinusoidal Generators, *Electronics*, 36:24, p 36–42.





Parts List

Resistors	*Kilohms*	*Watt*
R_1	6.8	½
R_2	20	½
R_3, R_4	100	½
R_5	6.8	½
R_6	47	½
R_7	4.7	½
R_8, R_9	150 ohms	½
R_{10}	1	½
R_{11}	47 ohms	½

Miscellaneous

S_1 Push-button switch (normally open)

Y_1 27.255-mc crystal

Capacitors	
C_1, C_2	0.01-μf disk
C_3	0.1-μf disk
C_4, C_7, C_8, C_9	0.05-μf disk
C_5	56-pf disk
C_6, C_{10}	33-pf disk

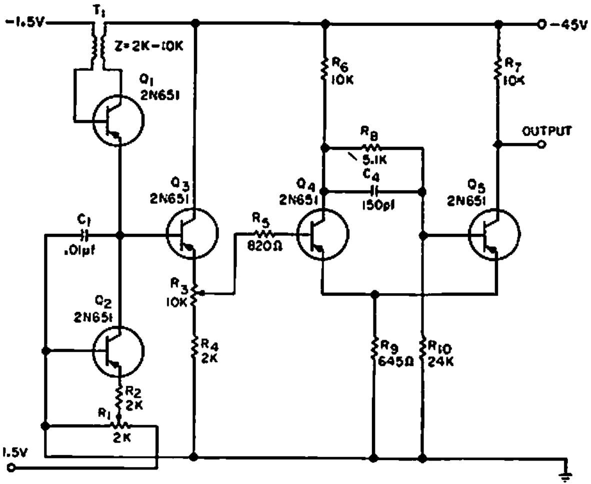
Inductors

L_1, L_2 Adjustable RF coil (J. W. Miller 4403 or equivalent). Add 2 turns of No. 24 enameled wire on cold end.

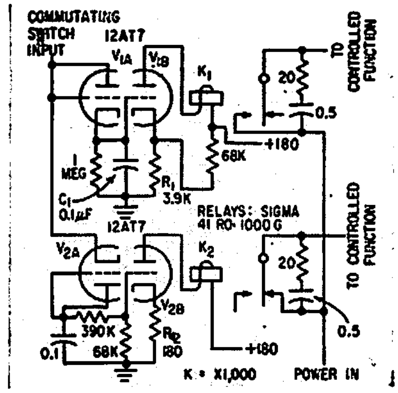
L_3 RF coil, 15 μh (Delevan 1537–40 or equivalent).

Transistors	
Q_1, Q_2	2N1274
Q_3, Q_4	TI 395

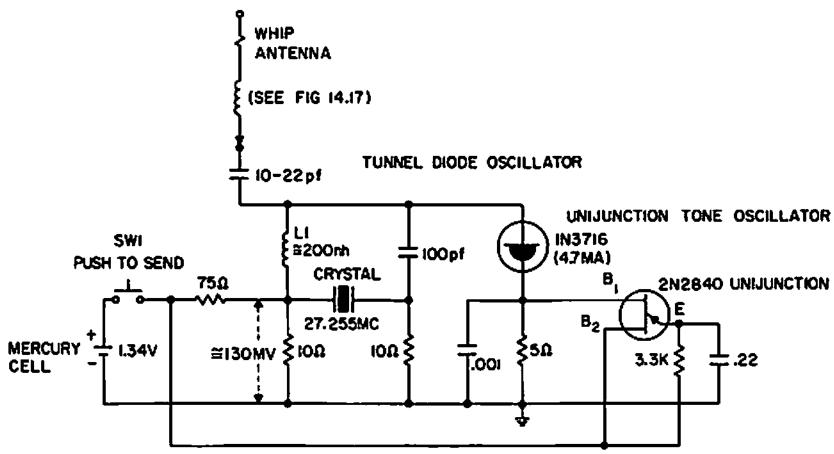
27.255-MC CONTROL TRANSMITTER—Free-running multivibrator keys power amplifier Q4 at audio rate. Range is about 1 mile. C6 tunes collector of oscillator to crystal frequency.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 361.



RECTANGULAR WAVEFORM GENERATOR—Povides variable frequency and symmetry without interaction of functions. Supply voltage can be −15 to −45 v. Frequency range is variable from 60 cps to 7 kc. Can be used to modulate small transmitter for remote control purposes.—L. E. Spadt, Rectangular Waveform Generator, *EEE*, 10:6, p 33–34.

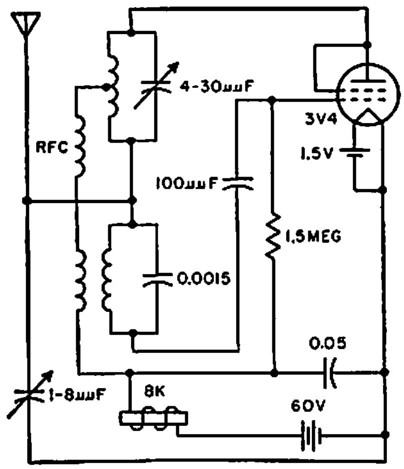


POLARITY-SENSING ON-OFF CONTROL—Remote switching circuits are sensitive to positive and negative inputs, thereby doubling number of control channels available from commutating switches of remote control system for robot that performs jobs in dangerous radioactive areas. All functions requiring independent operation are connected to positive input circuits only.—D. A. Campbell, Multiplex Circuits for Control of a Robot, *Electronics*, 33:4, p 46–48.

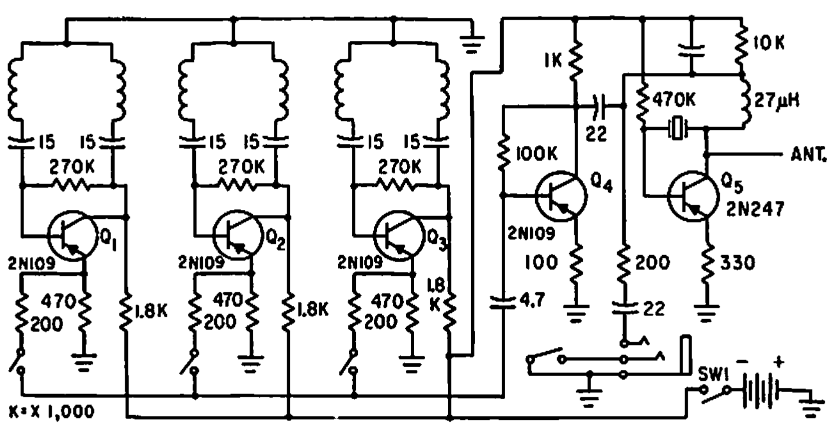


L1- 6 TURNS #16 (1/2" LONG, 3/8" I.D., TURNS SPACED 1/32")

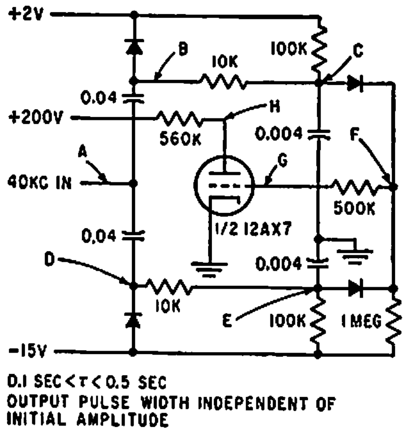
UJT-TD GARAGE-DOOR CONTROL TRANSMITTER—Unijunction tone oscillator modulates 27.255-Mc crystal-controlled tunnel-diode oscillator. Has adequate range for remote control of toys, window displays, garage doors, etc. When voice-modulated, can be used for short-range communication, as in shopping centers and bowling alleys.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 355



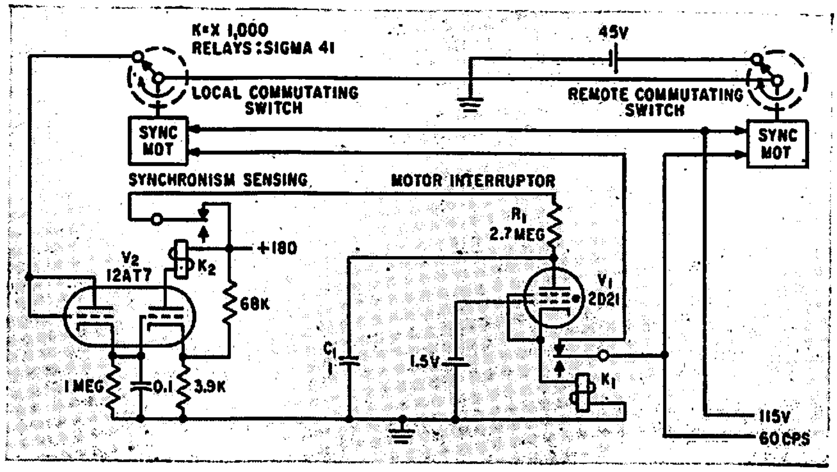
MILLER SUPERREGENERATIVE RECEIVER—Well-known in model-control field for its reliability. With self-quenching, optimum performance is obtained when receiver is in weak oscillatory state and incoming signal causes oscillation every third quench cycle. Provides large decrease in plate current when signal arrives.—S. J. Neshyba and F. E. Brooks, Jr., Stable Receiving Circuits for Remote Control, *Electronics*, 31:31, p 74–76.



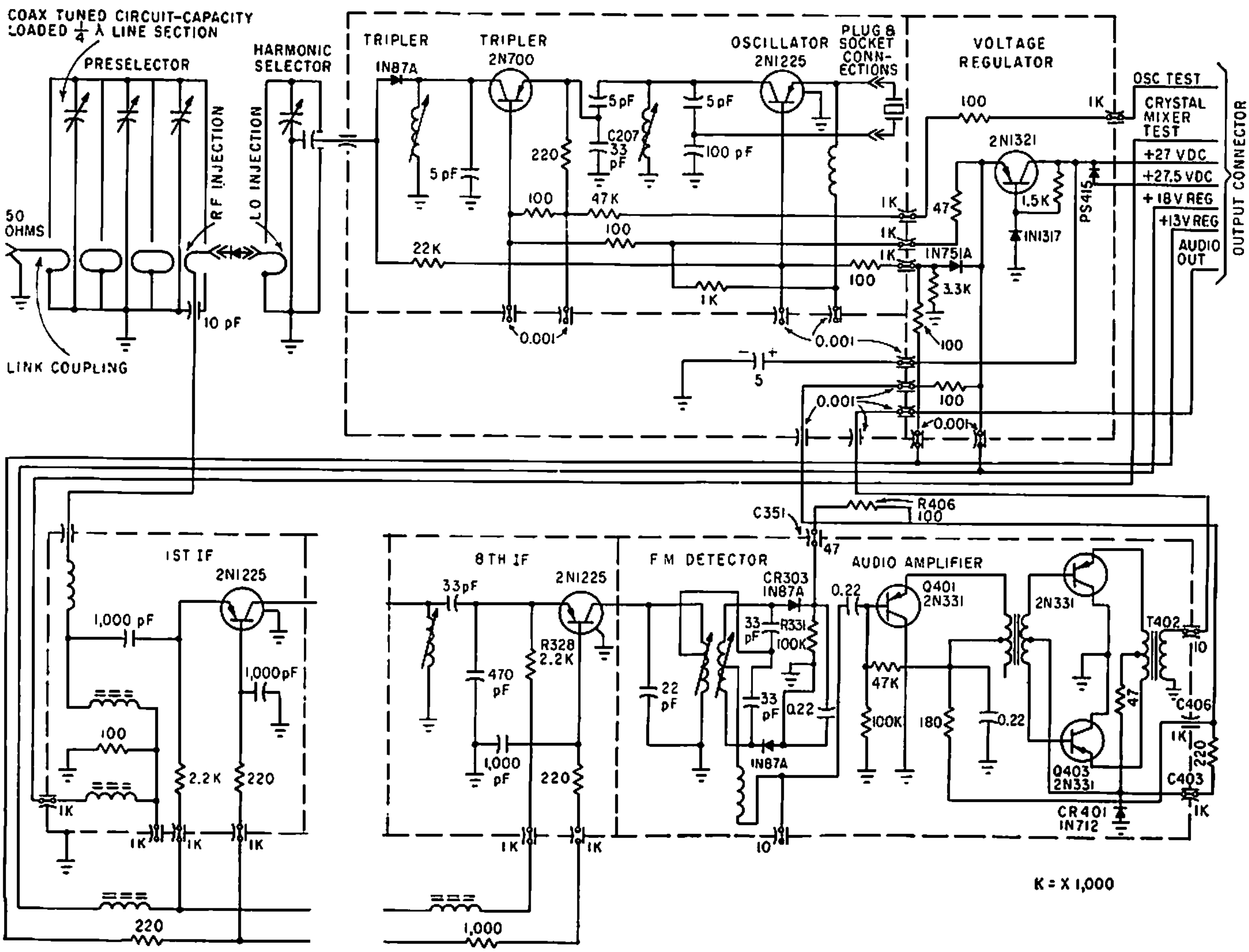
THREE-TONE H-F CONTROLS TRANSMITTER—Tone-modulated ground transmitter can be tone-modulated by three different tones, each corresponding to a particular reed of receiving relay and balloon. Consists of three stable audio oscillators (between 200 and 500 cps) and low-power crystal-controlled transmitter in h-f band between 3 and 18 Mc.—R. W. Frykman, Radio Command Set for High-Altitude Balloons, *Electronics*, 33:35, p 54–55.



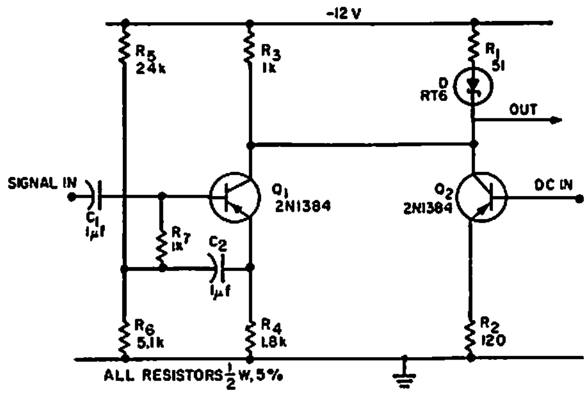
TIME-CONSTANT DETECTOR FOR TV CONTROL—Produces output pulse whose width is proportional to time constant of exponentially damped ultrasonic signal, in range of 0.1 to 0.5 sec, independent of input amplitude.—K. R. Cross and R. O. Whitaker, Time-Constant Detectors Control Tv Sets, *Electronics*, 32:36, p 62–67.



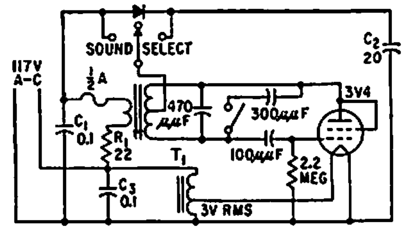
COMMUTATOR SYNCHRONIZER—Automatic synchronizing circuit consists of motor interrupter and synchronism-sensing circuit. Commutator drive motor at control transmitter is interrupted until it syncs with commutator drive motor in robot that performs jobs in dangerous radioactive areas. Each interrupt makes motor drop back 90°, so that only up to three interruptions are required to achieve synchronism.—D. A. Campbell, Multiplex Circuits for Control of a Robot, *Electronics*, 33:4, p 46–48.



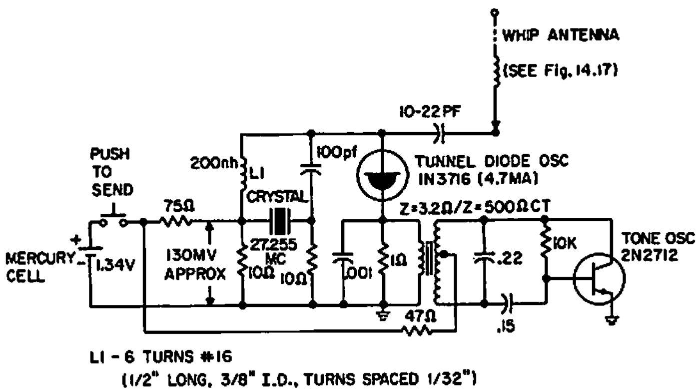
WIDEBAND F-M RADIO CONTROL LINK—Covers 406 to 549 Mc. Used in missiles and missile-target aircraft to receive up to 20 tone channels and provide demodulated audio output to decoding equipment. Second through seventh i-f channels are essentially same as eighth.—T. L. Fischer, Wideband F-M Receiver for Remote Aircraft Control, *Electronics*, 33:40, p 85–87.



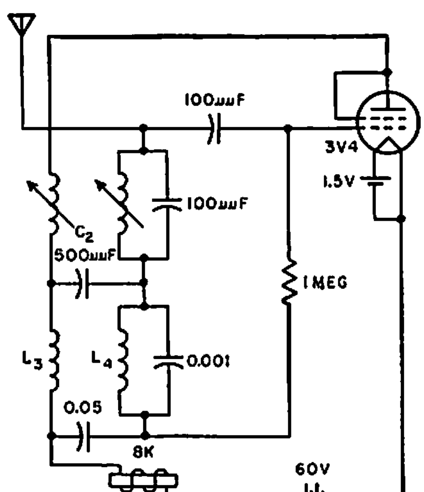
REMOTE CONTROL OF AMPLIFIER GAIN—Permits control of gain of small signal amplifier by means of d-c voltage. Adjustment potentiometer does not carry signal current. D-c control voltage acts on 6-v zener diode which in turn controls amplifier gain. Control voltage is limited to −4 v, which makes gain adjustable between 0.04 and 0.7 for range of 1 to 18. Input signal is 1 v p-p sine wave.—T. Molligna, Amplifier with DC Controlled Gain, *EEE*, 11:5, p 94–96.



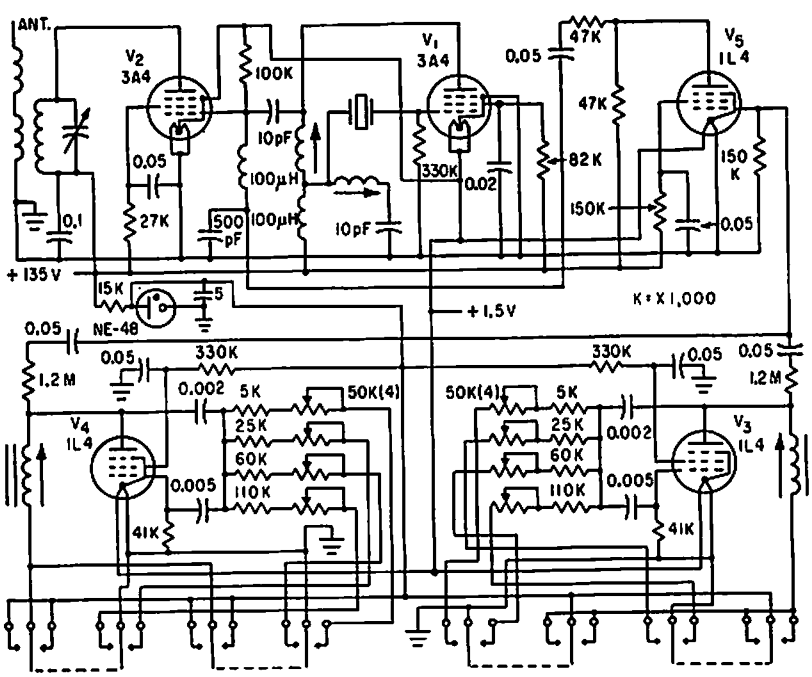
CARRIER-CURRENT TV CONTROL—Low-power oscillator provides both unmodulated and 60-cps modulated signals for power-line carrier-current transmission to control receiver in tv set. Unmodulated carrier having preset duration controls channel selection, while modulated carrier controls sound level. System operates on one of four nonadjacent frequencies (52.5, 57.5, 67.5, and 73.5 kc) to avoid interaction between nearby systems.—J. R. Banker and C. H. Wood, Jr., Line Current Controls Remote Tv Receiver, *Electronics*, 31:33, p 68–69.



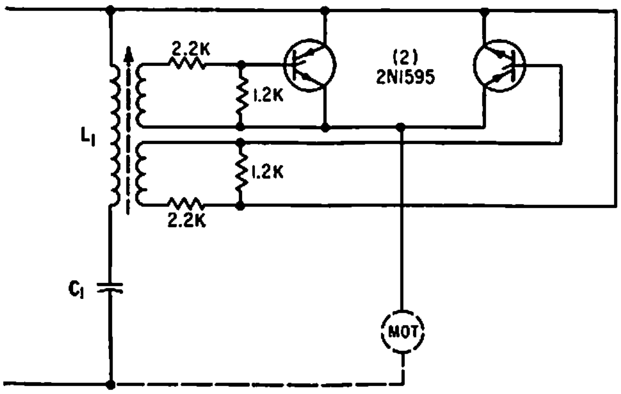
27.255-MC TD-CRYSTAL TRANSMITTER—Silicon-transistor Hartley oscillator modulates tunnel-diode oscillator in remote-control transmitter.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 356.



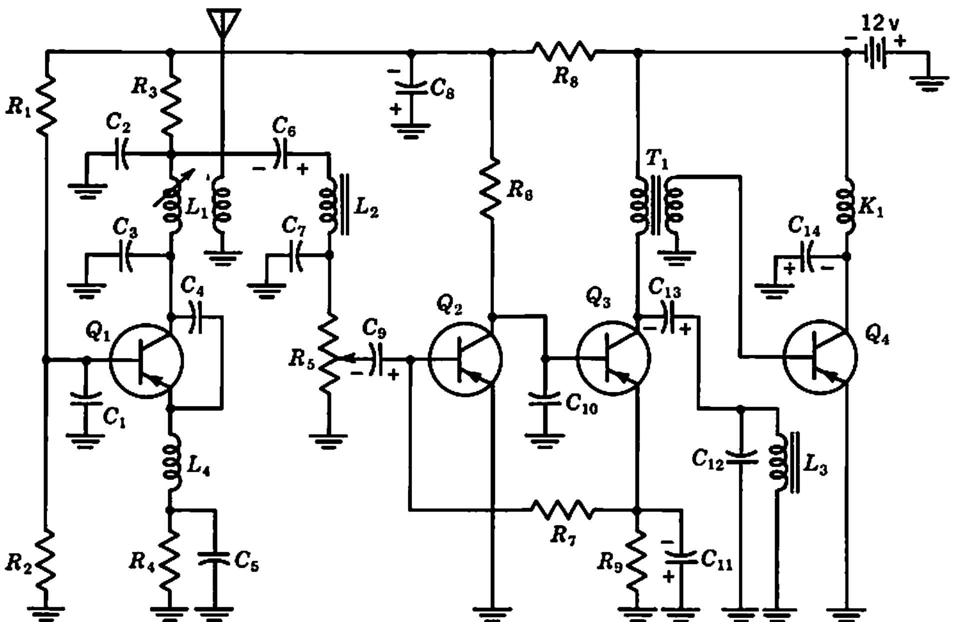
FRANKLIN SUPERREGENERATIVE RECEIVER—Has low sensitivity to impulse noise, wide dynamic range, high gain, and flexibility, since quench oscillator components are at r-f potential and feedback adjustments more easily made. Oscillates at 27 Mc as modified Hartley with interelectrode capacitances tuned by L1, and also oscillates at 25-kc quench frequency. Provides large decrease in plate current when signal arrives.—S. J. Neshyba and F. E. Brooks, Jr., Stable Receiving Circuits for Remote Control, *Electronics*, 31:31, p 74–76.



EIGHT-COMMAND TRANSMITTER—Two tone channels can be transmitted simultaneously. Operates at 27 Mc with 0.25-w output, for controlling model tank.—R. A. Baker, Radio-Controlled Tank for Realistic Combat Training, *Electronics*, 33:45, p 55–57.



TOY TRAIN CONTROL—With L1-C1 tuned to one of five r-f channels (100, 140, 180, 220 and 255 kc), pair of scr's drives train either forward or in reverse, depending on polarity of r-f signal pulse applied to rails by control station. Five-channel transmitter permits simultaneous control of five different trains, each having receiver tuned to different frequencies. Scr characteristics eliminate jackrabbit starts. —S. B. Gray, Appliances and Housewares, *Electronics*, 36:20, p 46–49.



Parts List

Resistors	*Kilohms*	*Watt*
R_1	22	½
R_2	2.2	½
R_3, R_4	1	½
R_5	10	Potentiometer
R_6	2.7	½
R_7	10	½
R_8	270 ohms	½
R_9	150 ohms	½

Transistors

Q_1	2N2188
Q_2, Q_3, Q_4	2N1274

Miscellaneous

K_1 Typical: Sigma 11F-2300-G/SIL or equivalent

Transformer

T_1 10-2 kilohms (Thordorson TR7 or equivalent)

Capacitors	
C_1	0.001-μf disk
C_2, C_7, C_{10}	0.05-μf disk
C_3	15-μf disk
C_4	18-pf disk
C_5, C_{12}	0.002-μf disk
C_6, C_9, C_{13}	5-μf electrolytic
C_8, C_{14}	100-μf electrolytic
C_{11}	40-μf electrolytic

Inductors

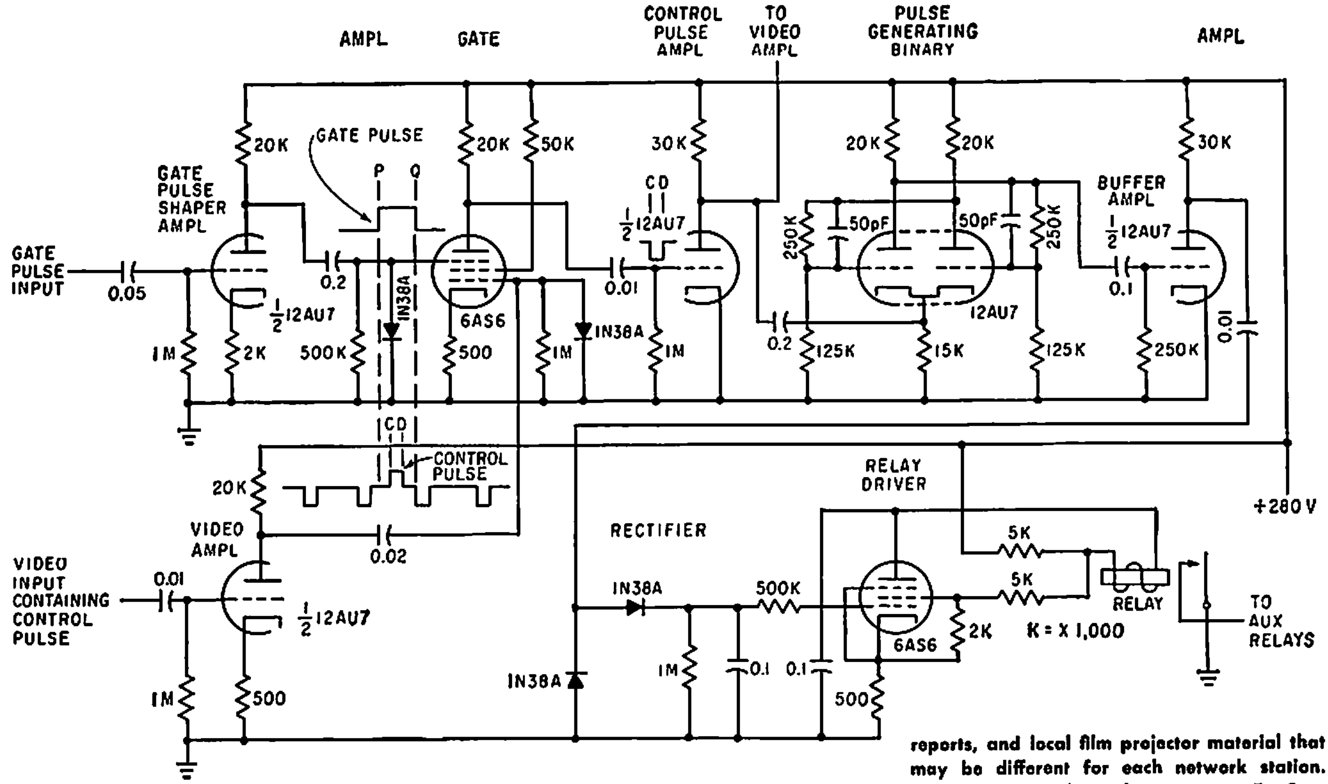
L_1 Adjustable RF coil (J. W. Miller 4403 or equivalent). Add 2 turns of No. 24 enameled wire on cold end.

L_2 30-mh choke (Bud CH 1227 or equivalent).

L_3 8.5 henrys (Stancor C1279 or equivalent).

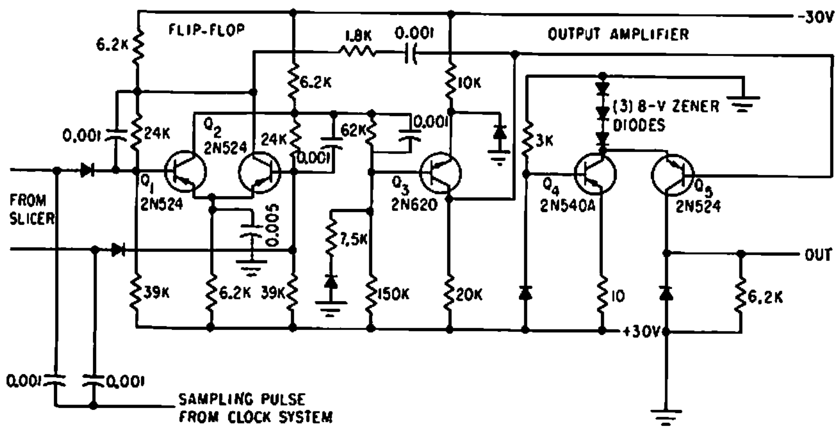
L_4 RF coil, 15 μh (Delevan 1537-44 or equivalent).

27.255-MC REMOTE-CONTROL RECEIVER—Output of superregenerative detector consists of 200-kc quench signal and 1,000-cps tone modulation from incoming signal. Quench filter passes only audio signal to amplifier. Amplified audio is detected and resulting direct current used to operate relay K1.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 363.

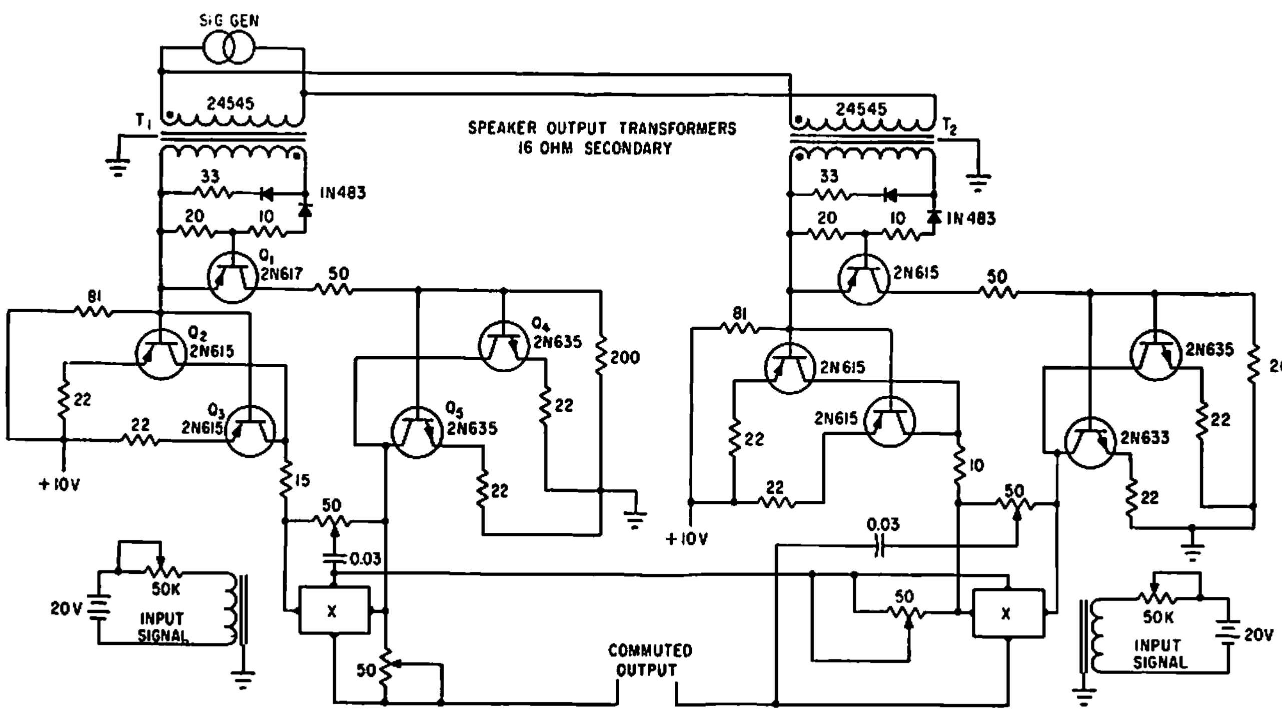


TV STATION CONTROL—Control pulses transmitted in blanking interval by tv network transmitter are decoded by receiver circuits shown and translated into six different switching actions used to introduce special program matter such as commercials, weather reports, and local film projector material that may be different for each network station. —K. Kazama and T. Ishino, Remote Tv Control by Blanking-Interval Pulses, *Electronics*, 33:20, p 79–81.

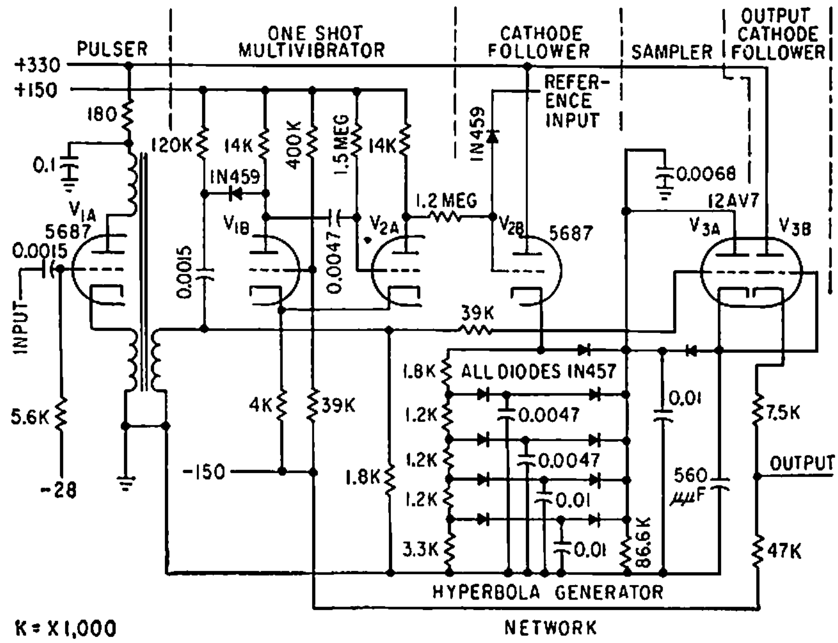
CHAPTER 74
Sampling Circuits



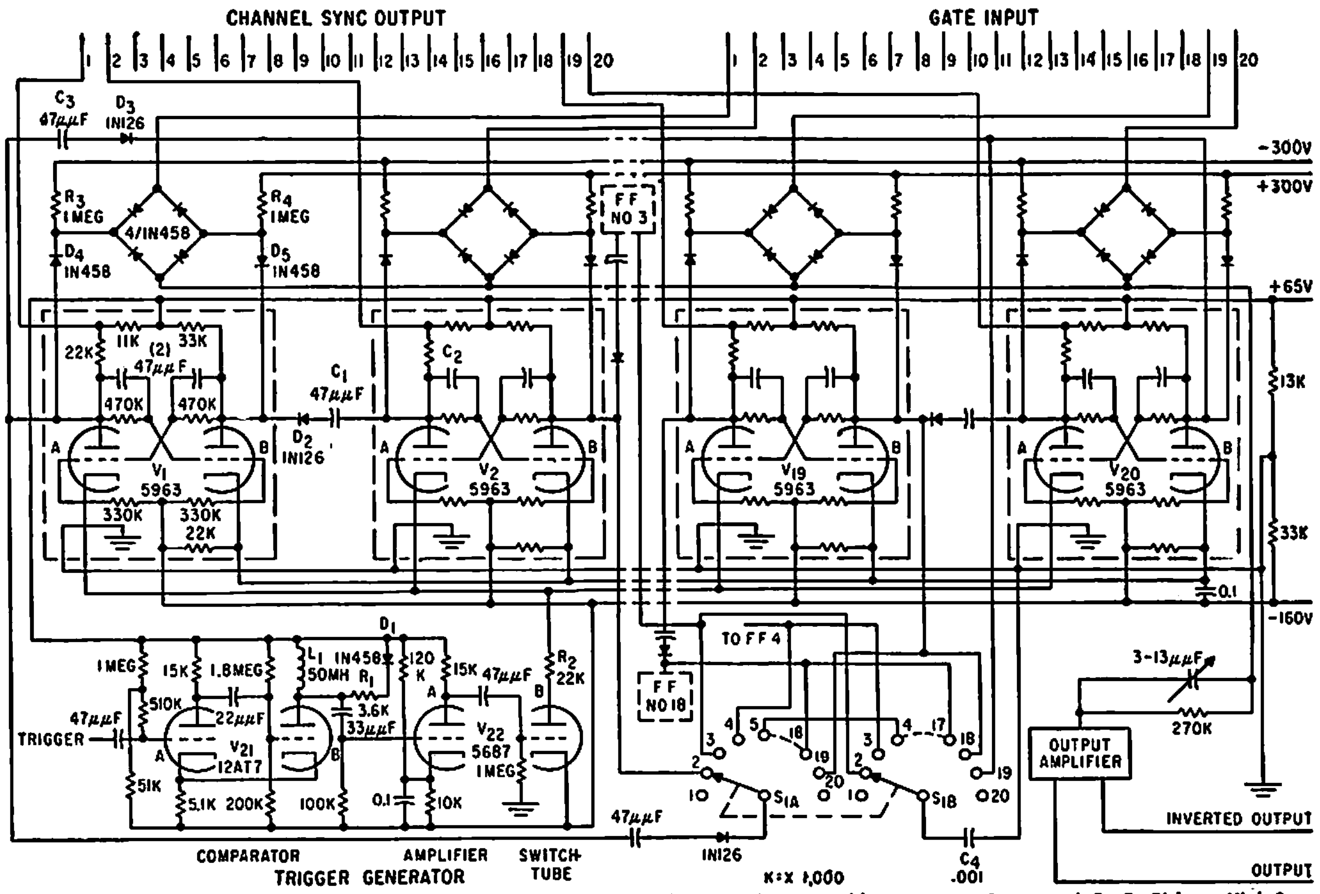
SYNCHRONOUS SAMPLER—Time jitter of digital receiver output pulse is eliminated by synchronous sampling of detected signal. Each bit is sampled by local clock pulses that trigger flip-flop Q1-Q2. Two outputs of slicer, 180° out of phase, are applied to bases of Q1 and Q2. Output of flip-flop is regenerated information, free of jitter.—J. L. Hollis, Sending Digital Data Over Narrow-Band Lines, *Electronics*, 32:23, p 72–74.



30-KC HALL-GENERATOR SAMPLING SWITCHES—Control current circuits of series-connected Hall generators X are pulsed alternately for switching d-c input signal. Triggering for identical circuit at right occurs on opposite half-cycles of signal generators.—T. J. Marcus, Using Hall Generators as Contactless Commutators, *Electronics*, 35:4, p 43–45.

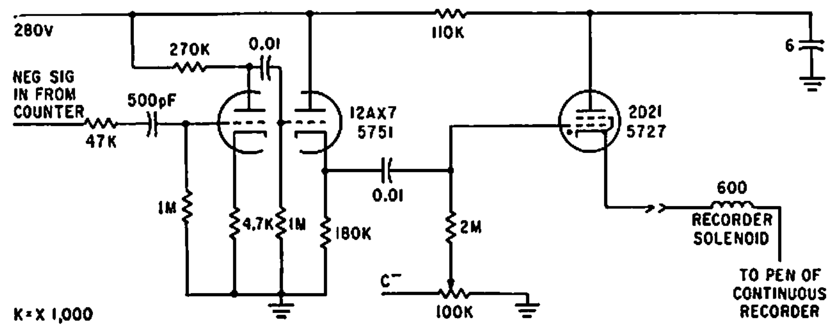


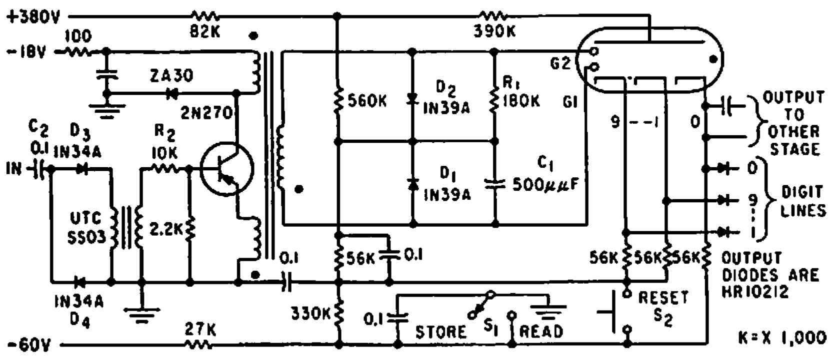
MAGNETIC-TAPE DATA SAMPLER—Used in playback system for discrimination of f-m signal from magnetic tape. Compares data channel signals with recorded reference frequency, to make output independent of tape speed. Tube V2B is cathode follower with hyperbola generator network as cathode impedance, to create curve for average area of voltage block at any time during data period for a given blockwidth (1.4 millisec).—P. S. Bengston, Sampling Discriminators for Data Reduction, *Electronics*, 32:13, p 70–72.



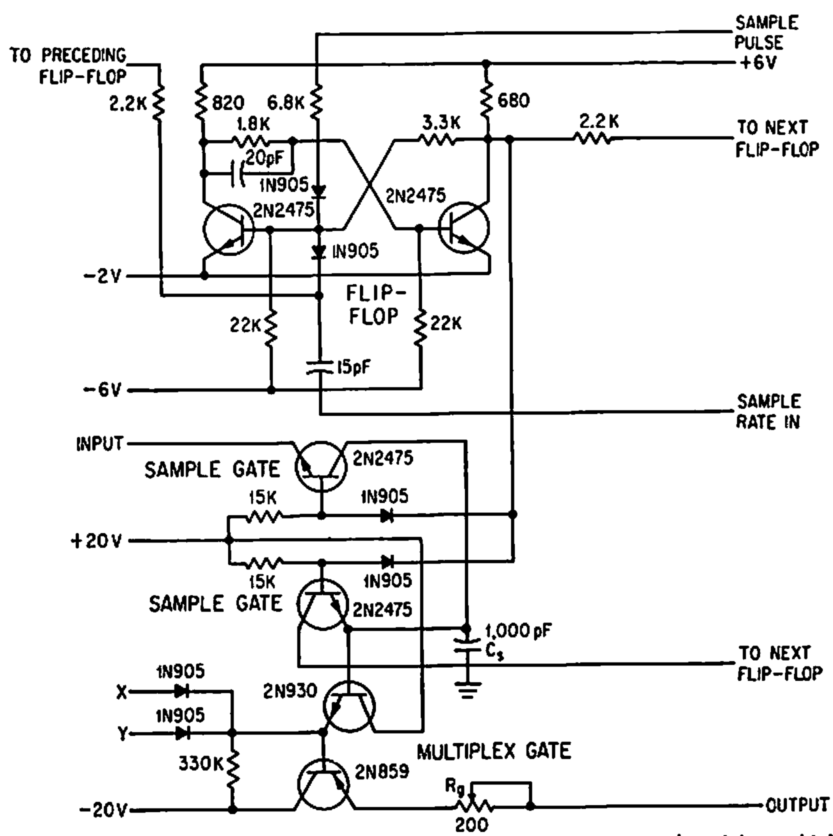
CLOSED-RING COUNTER—Serves as 20-channel electronic switch for sampling voltage sources at rates of up to 50,000 cps. Flip-flop ring actuates diode gates in step with trigger pulses. Output can be used to drive recorders or feed data processing equipment.—K. L. Berns and B. E. Bishop, High-Speed Multiplexing With Closed-Ring Counters, *Electronics*, 32-26, p 48–50.

PULSE-COUNT SAMPLE-TIME RECORDER—Amplifier and thyratron trigger feed pulse to solenoid pen of recorder, to record time of end of counting period, corresponding to instant at which counter delivers negative pulse.—C. F. Miller, New Phototransistor Tachometers Measure Missile Spin, *Electronics*, 35:25, p 33–35.

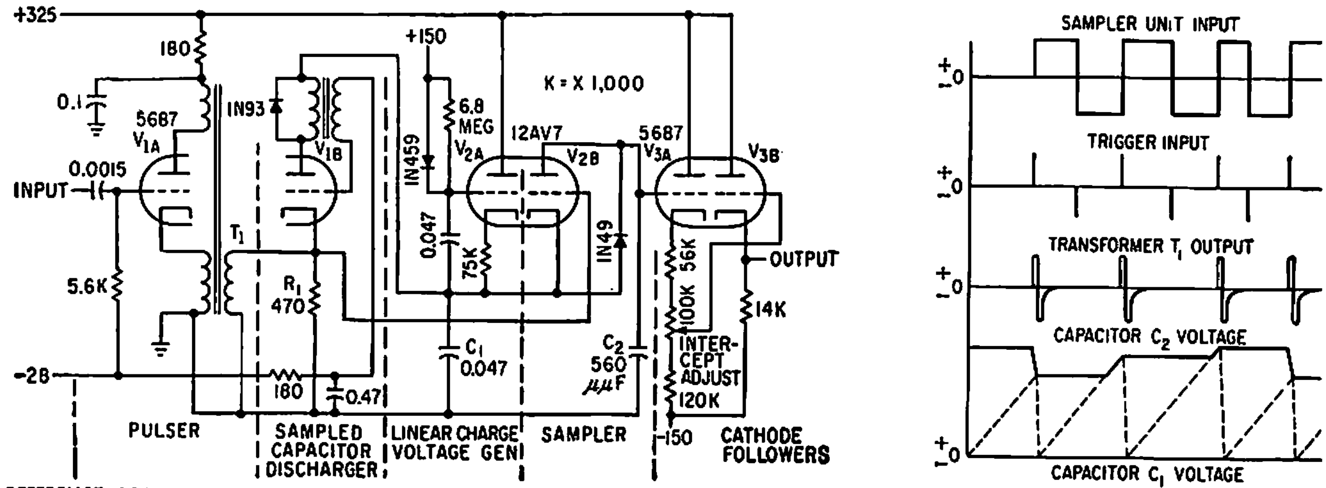




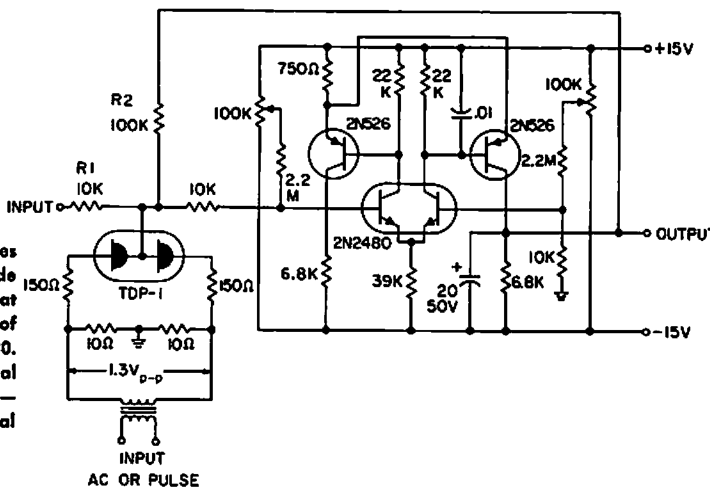
COLD-CATHODE SAMPLING COUNTER—Transistor-blocking oscillator drives cold-cathode counter tube to give long-life decade counter having low power consumption. Used in automatic recorder for data from several hundred radioactive samples per day. Maximum repetition rate is 200 pps.—H. Sadowski and M. E. Cassidy, How Transistor Drives Cold-Cathode Counter, *Electronics*, 32:38, p 46–47.



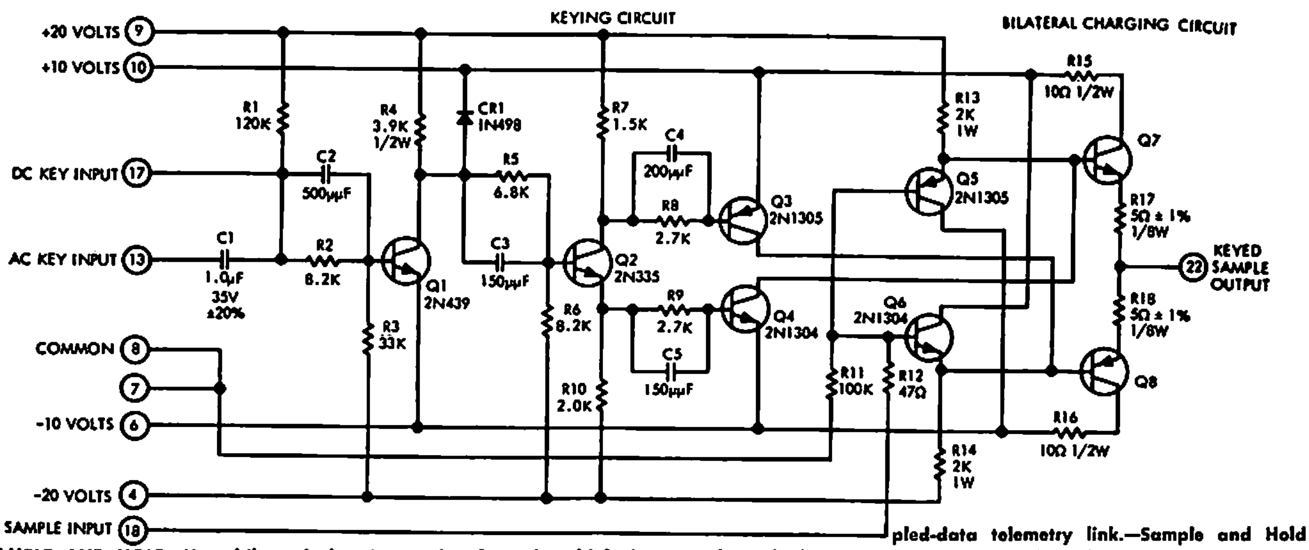
FLIP-FLOPS CONTROL SAMPLE-AND-HOLD—Sampled slices of incoming radar pulse are converted to binary digital form at 10-Mc rate, using flip-flops to connect sample-and-hold capacitor Cs to signal amplifiers. Effective aperture time of sample gate is 20 nsec. Multiplex gate feeds sampled signal values to analog-digital converter at proper time as selected by multiplex counter of system.—A. Hakimoglu and R. D. Kulvin, Sampling Ten Million Words a Second, *Electronics*, 37:8, p 52–57.



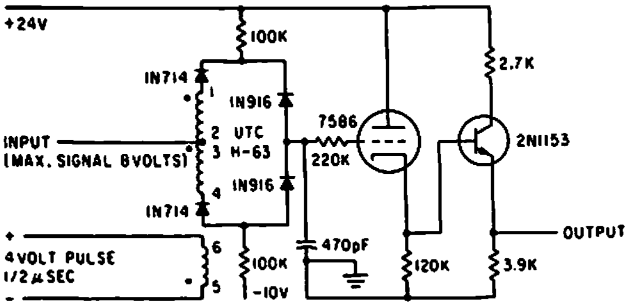
REFERENCE-FREQUENCY SAMPLER—Improves discrimination of f-m signals from magnetic tape, with fastest possible response to wide-deviation frequency-modulated transients. Constant reference frequency is recorded on one tape channel. When playback output voltage is made proportional to quotient of data and reference frequencies, output is independent of tape speed, and wow and flutter components are cancelled. Reference discriminator shown provides voltage output proportional to period of preceding cycle. —P. S. Bengston, Sampling Discriminators for Data Reduction, *Electronics*, 32:13, p 70–72.



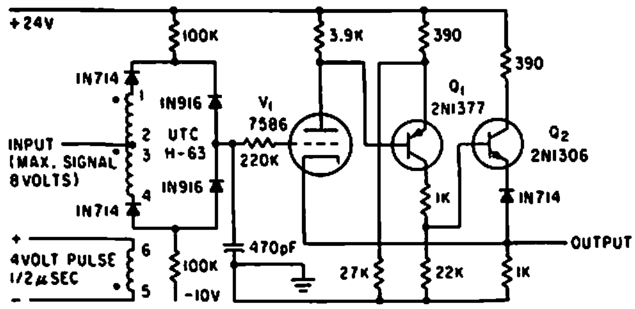
OPERATIONAL-AMPLIFIER SAMPLER—Uses tunnel-diode pair with amplifier to provide output that is proportional to input signal at instant corresponding to leading edge of sampling pulse. Voltage gain of circuit is 100. Can also be used to measure differential peak point current of tunnel diode pairs.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 372.



SAMPLE AND HOLD—Uses bilateral charging to increase energy content of series of low-duty-cycle amplitude-modulated pulses resulting from demultiplexing one channel of pam pulse train. Designed for sampling and holding 0 to 5 v information received via sampled-data telemetry link.—Sample and Hold Circuit with Bilateral Charging, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 131.

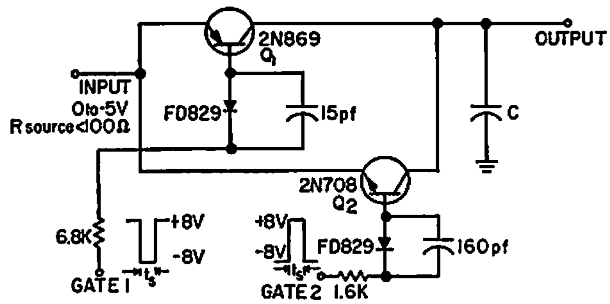


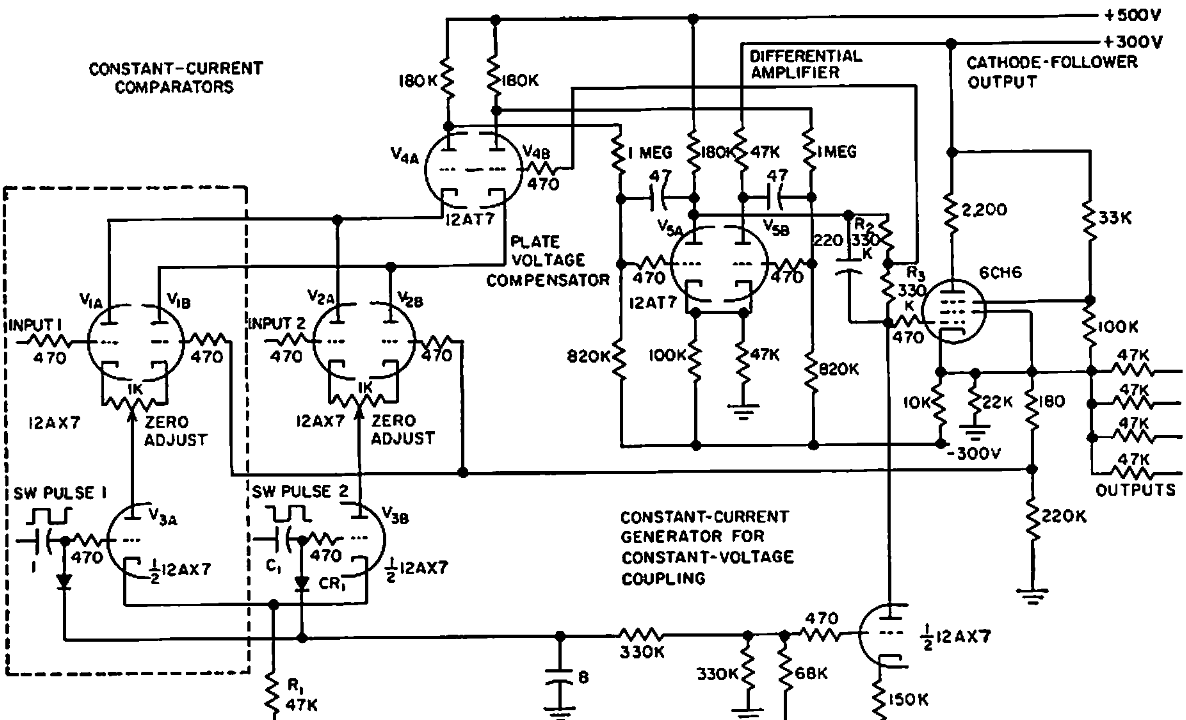
HYBRID SILICON BOXCAR—Signal-to-noise ratio of silicon hybrid is up to 2 db better than germanium at all temperatures. Only one transistor is needed for high-temperature stability. Input to boxcar should be from 150-ohm source.—A. G. Lloyd, Half-Bridge Inverter Provides Economical Three-Phase Power, *Electronics*, 34:37, p 62–65.



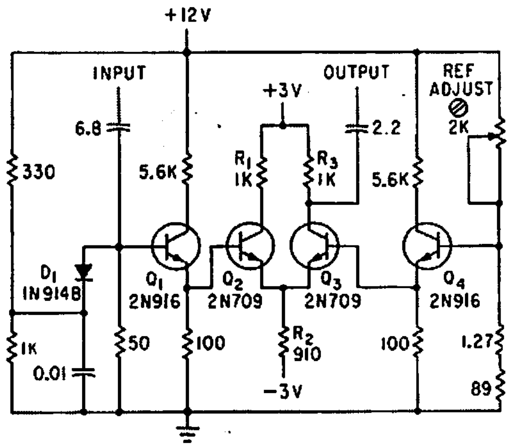
HYBRID GERMANIUM BOXCAR—Provides time selection and storage of waveforms, as required for radar mti, sensing elements of tracking radars, and gated agc. Power drain is negligible except for 7586 nuvistor filament power of about 1 w.—A. G. Lloyd, Half-Bridge Inverter Provides Economical Three-Phase Power, *Electronics*, 34:37, p 62–65.

ZERO-ORDER DATA HOLD—Samples analog signal and holds sample value for period much longer than sampling aperture, as required in some sampled data systems and analog-to-digital converters. Used to sample inputs to accuracy of 0.1% of full scale, using sampling aperture greater than 1.25 microsec. Value of C is equal to sampling aperture divided by resistance in charge and discharge path.—E. Nelson, Zero-Order Data Hold, *EEE*, 11:7, p 26–27.

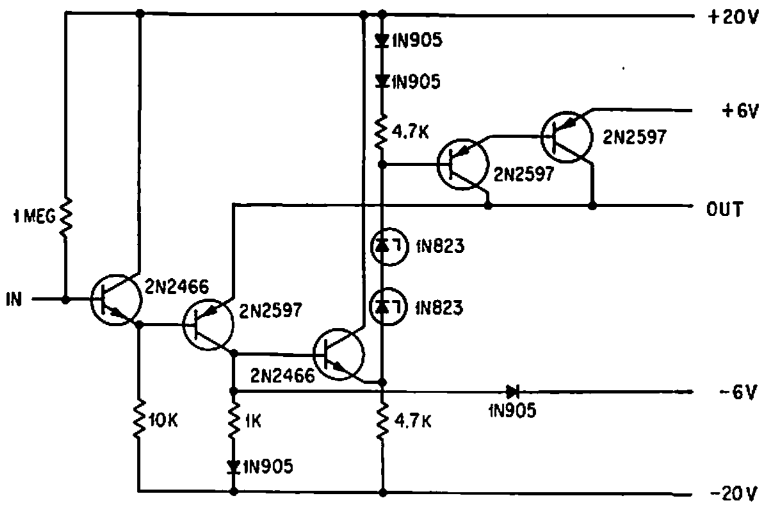




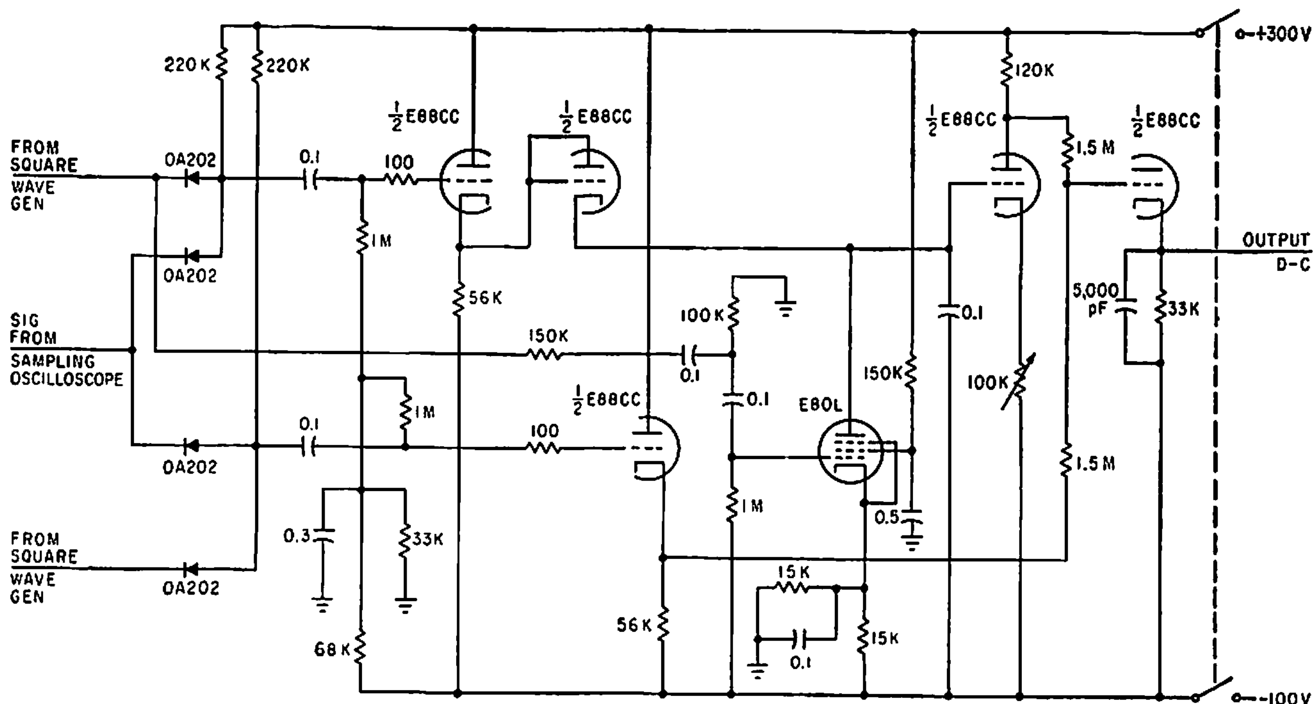
TWO-WAY SAMPLING SWITCH—Uses two compensated comparators V1 and V2 whose currents are maintained constant by V3A and V3B, while V4 maintains constant plate voltage on these tubes. May be expanded to multi-way unit by adding input selector circuits, or may be used as precision cathode follower by eliminating selector. Circuit has near-infinite input impedance and near-zero output impedance. Comparator compensation permits accuracy of 0.1% over range of −100 to +100 v.—R. Benjamin, Electronic Switch Doubles as Cathode Follower, *Electronics*, 31:3, p 81–83.



HEIGHT SAMPLING GIVES NANOSECOND RESOLUTION—Eight identical four-transistor difference amplifiers in parallel divide input signal into eight levels for sampling. In each, input signal is compared to reference signal in Q2-Q3.—A. A. Fleischer and E. Johnson, New Digital Conversion Method Provides Nanosecond Resolution, *Electronics*, 36:18, p 55–57.

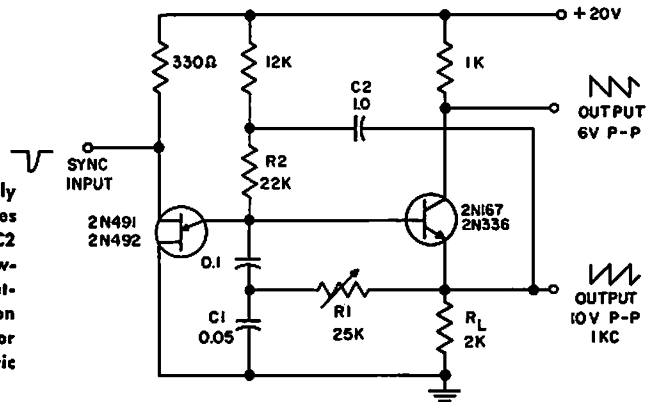


UNITY-GAIN VIDEO SAMPLING AMPLIFIER—Five-transistor amplifier delivers high bidirectional current, with bandwidth of 10 Mc, for amplifying incoming radar or other pulse prior to binary conversion.—A. Hakimoglu and R. D. Kulvin, Sampling Ten Million Words a Second, *Electronics*, 37:6, p 52–57.

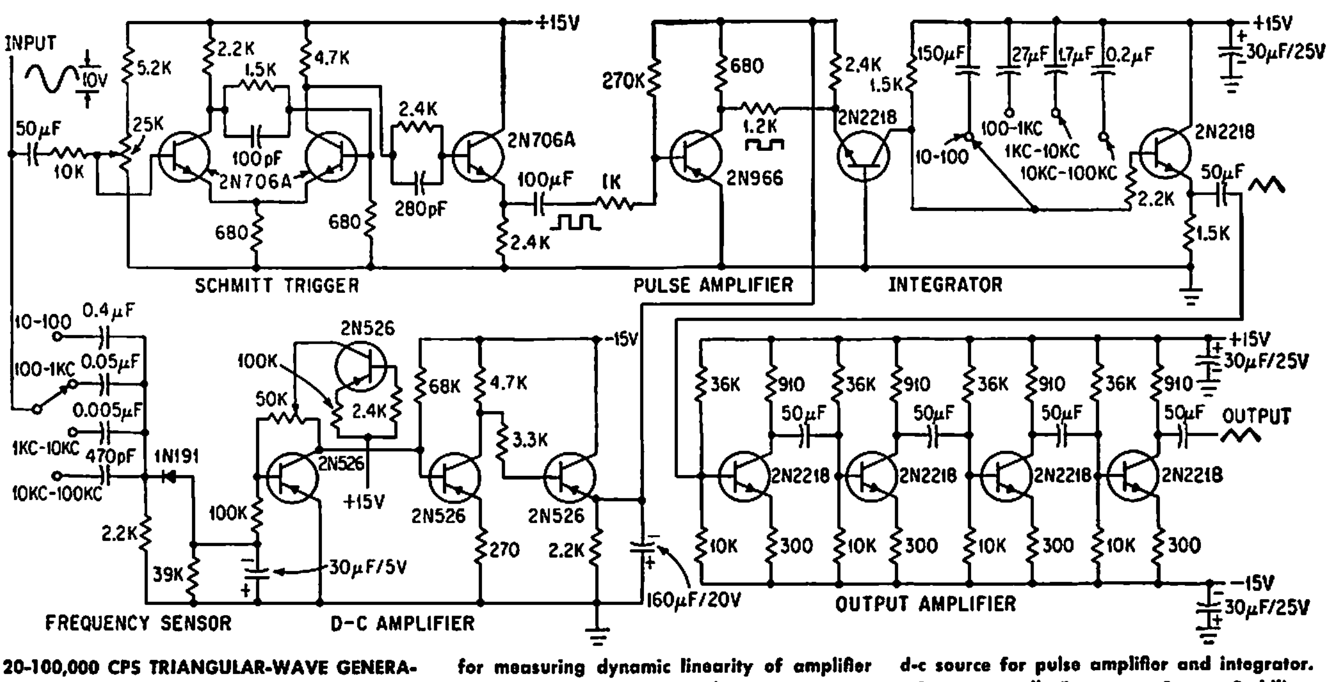


MAGNETIC FILM—Circuit subtracts one sampled waveform from the next, to reduce noise disturbances by factor of 10 in equipment using strip transmission line for determining polarity reversal time of thin magnetic films to be used as switching elements in computers.—W. Dietrich and W. E. Proebster, Measuring Switching Speed of Magnetic Films, *Electronics*, 33:23, p 79–81.

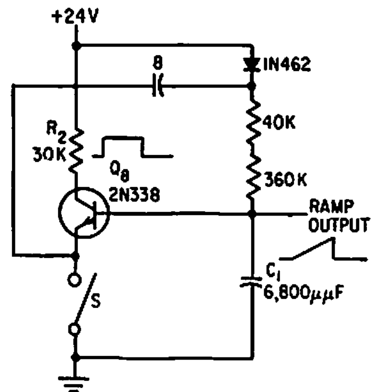
CHAPTER 75
Sawtooth Generator Circuits



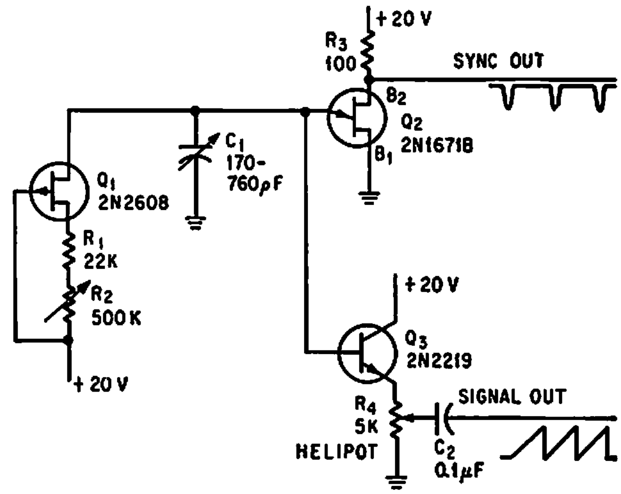
HIGH-LINEARITY SAWTOOTH—Requires only single positive supply. Npn transistor serves as output buffer amplifier, while R2 and C2 in bootstrap circuit improve linearity of sawtooth. R1 and C1 act as integrating network to provide second-order compensation for nonlinearity of waveform.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 319.



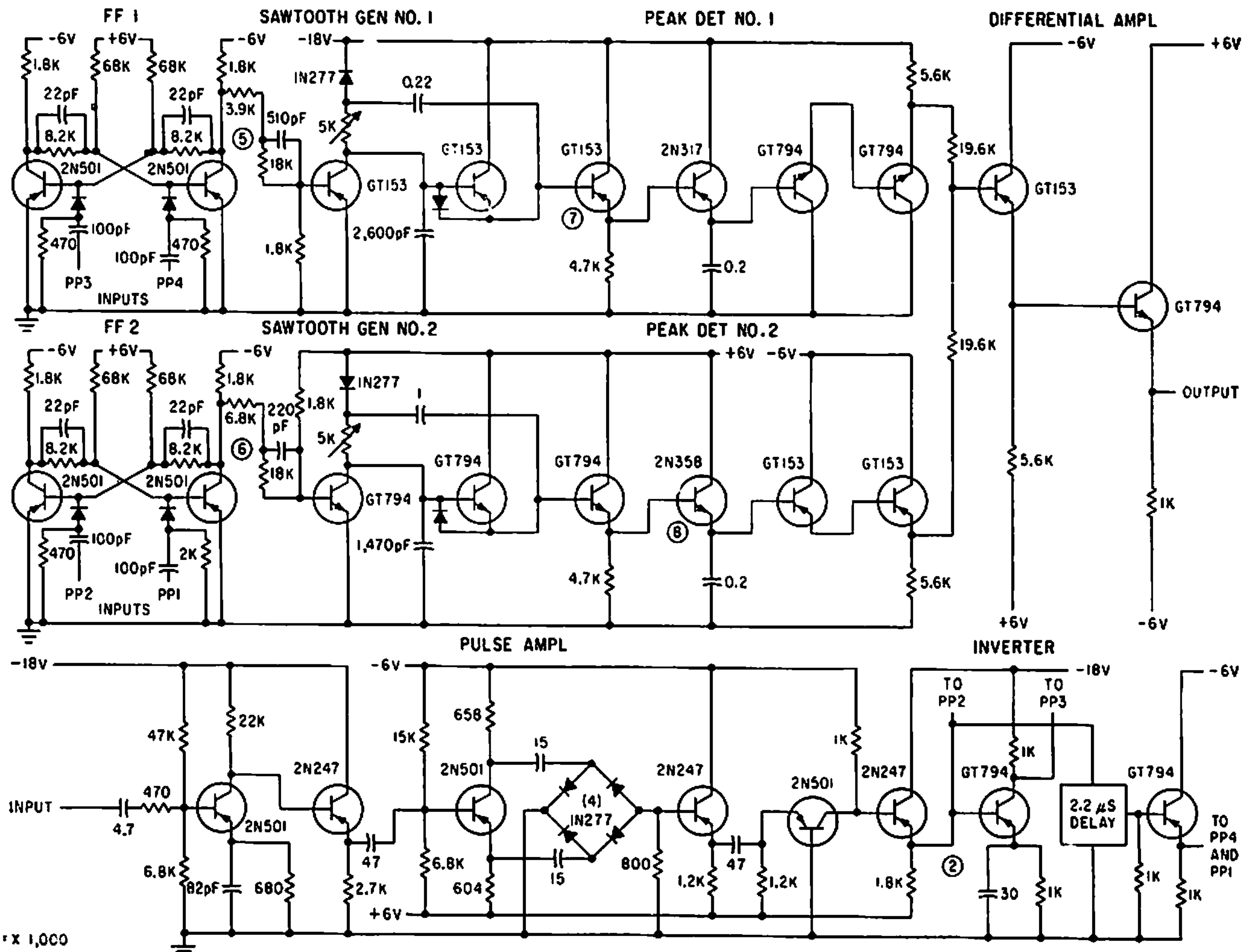
20-100,000 CPS TRIANGULAR-WAVE GENERATOR—Sinusoidal frequency changes are converted into proportional d-c voltage and fed into pulse amplifier and integrator to generate constant-amplitude triangular waveform for measuring dynamic linearity of amplifier as function of frequency. Schmitt trigger converts input sine wave to constant-amplitude square wave. Frequency sensor produces d-c voltage proportional to frequency to serve as d-c source for pulse amplifier and integrator. —D. E. Cottrell, Frequency Sensor Stabilizes Triangular-Wave Generator, *Electronics*, 37:9, p 38–40.



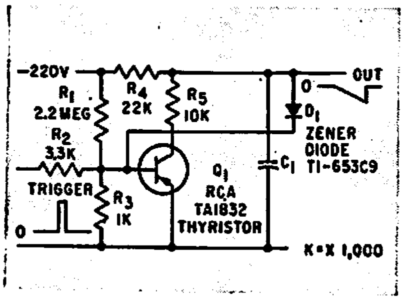
LINEAR BOOTSTRAP—Charging current of C1 is kept constant, resulting in high linearity of ramp output. Positive-going square wave is on collector of Q8 while ramp is being generated.—D. A. Williams Jr., Transistors Ruggedize Airborne Telemetry Keyer, *Electronics*, 31:37, p 81–83.



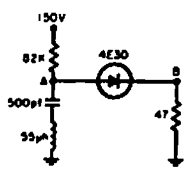
FET SUPPLIES CONSTANT CURRENT—Utilizes near-zero temperature drift of fet at bias point, to make performance independent of battery or line voltage fluctuations.—E. Elad, FET Insures Stable Sawtooth Wave, *Electronics*, 39:16, p 122–123.



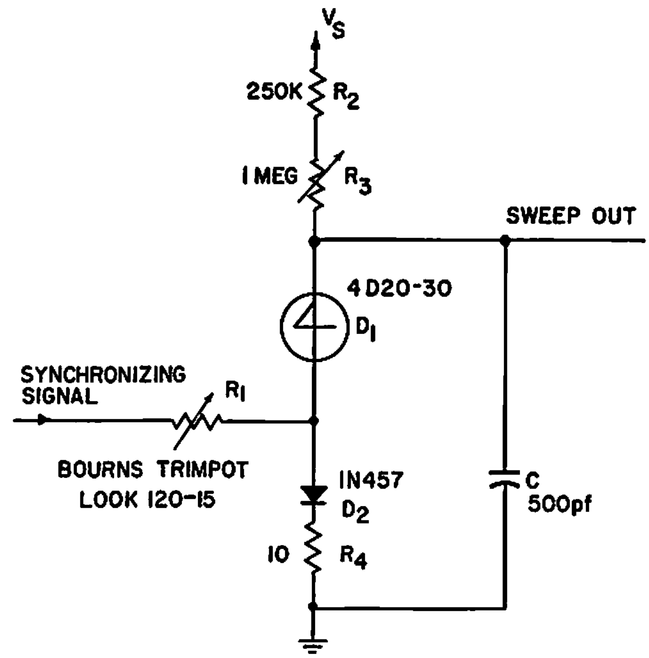
PULSE WIDTH MEASUREMENT—Develops two sawtooth waveforms of equal slope, one delayed relative to other by width of pulse to be measured. Control flip-flops turn both sawtooth generators off simultaneously, so difference in sawtooth peak amplitudes is proportional to pulse width being measured.—D. B. Dobson and L. L. Wolff, Automatic Test Equipment Checks Missile Systems, *Electronics*, 33:29, p 74–78.



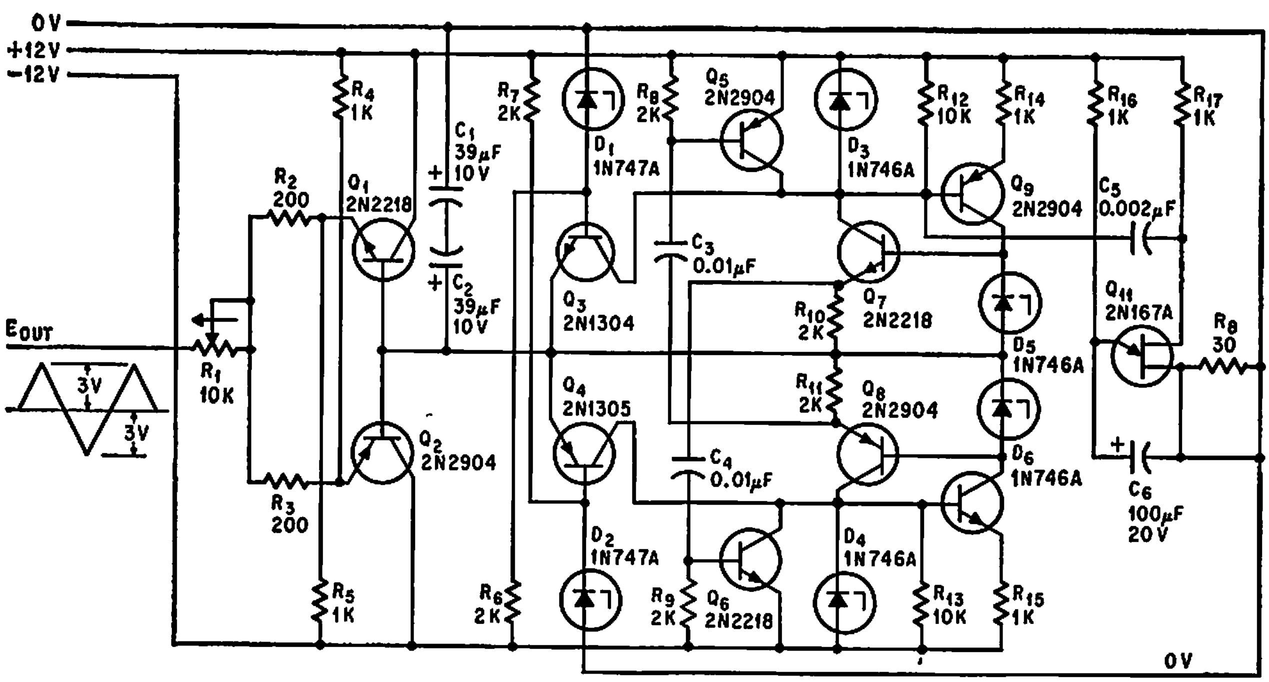
SIMPLE SAWTOOTH—Uses semiconductor switch Q1, whose amplitude is controlled by zener diode D1. Operation on only small part of R-C charging curve helps make output pulse widths, amplitudes, and waveform timing independent of active elements in circuit.—C. A. Von Urff and R. W. Ahrons, How to Generate Accurate Sawtooth and Pulse Waves, *Electronics*, 32:50, p 64–66.



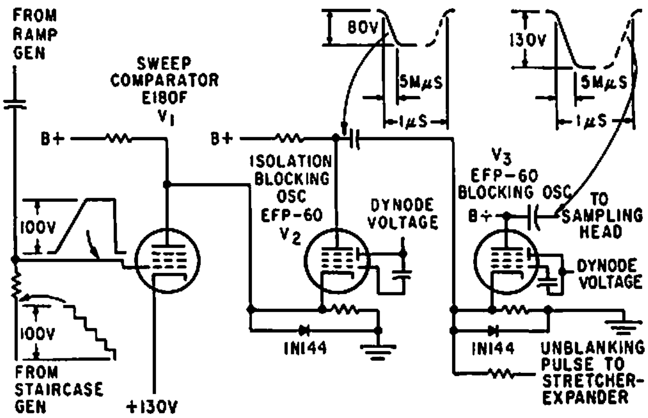
BOOSTING SAWTOOTH FREQUENCY—Inductor causes ringing and thereby extends operating frequency of sawtooth oscillator using four-layer diode. Will operate well above 100 kc.—P. Emile, Jr., Inductor Raises Useful Sawtooth Frequency, *EEE*, 12:7, p 28.



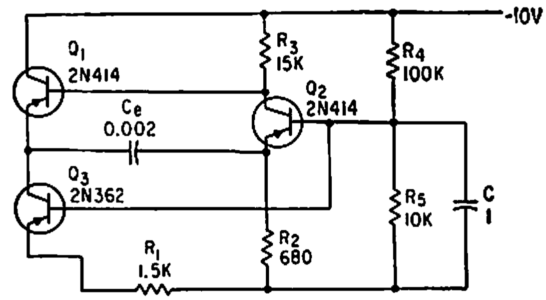
SYNCHRONOUS SWEEP—Produces linear 20-v sawtooth with four-layer diode and six other components. Maximum sweep rate can reach 100 kc. Provides synchronous operation with good linearity and sufficiently fast retrace to eliminate need for blanking in oscilloscope applications.—4-Layer Diode Sweep (Synchronous), "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 173.



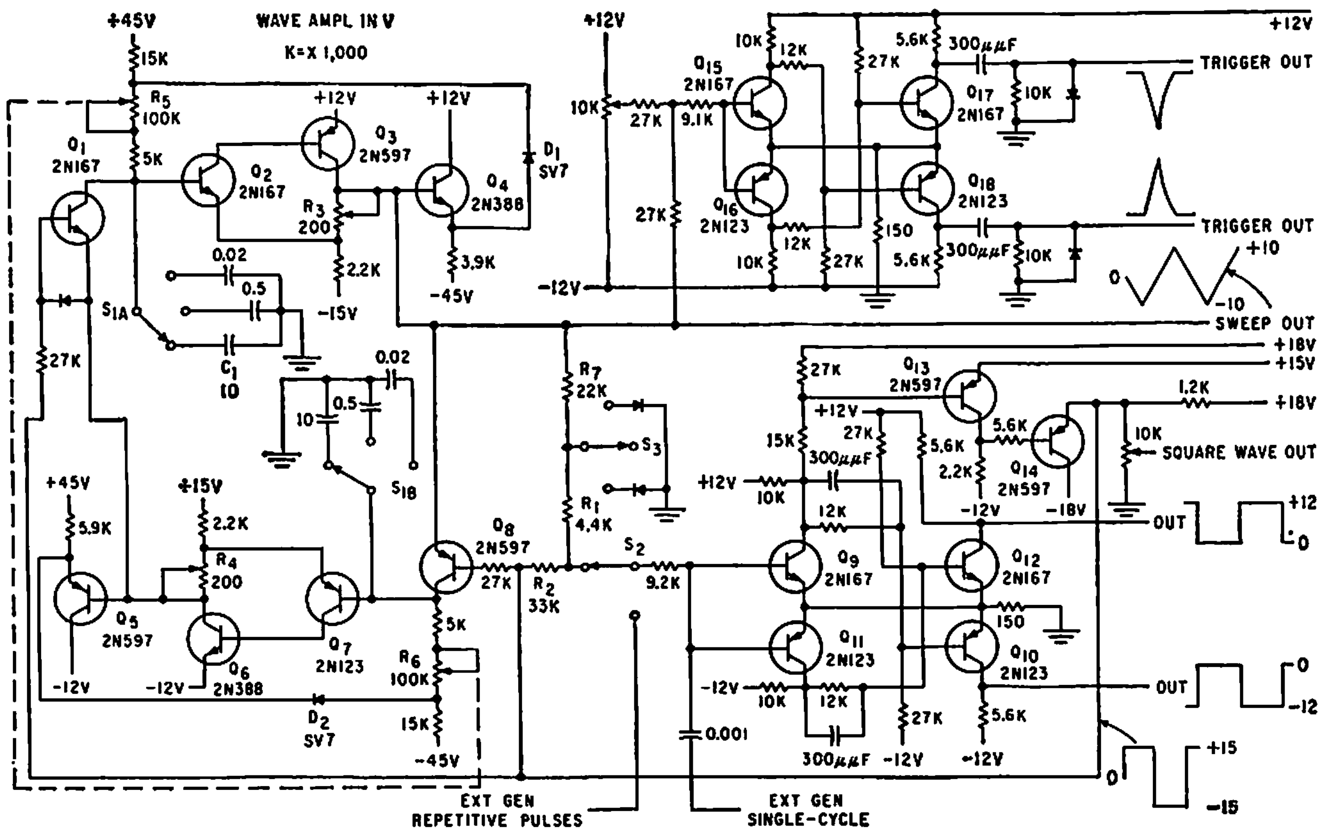
TRIANGLES—Peaks, slopes, and frequency of triangular waves can be varied independently. R10-R11 control positive slope, R11-R15 negative slope, and C1-C2 both slopes. Zener voltages of D1-D2 determine peaks.—R. Zano, Triangle Generator Adjusts Output Slopes and Peaks, *Electronics*, 38:12, p 85–86.



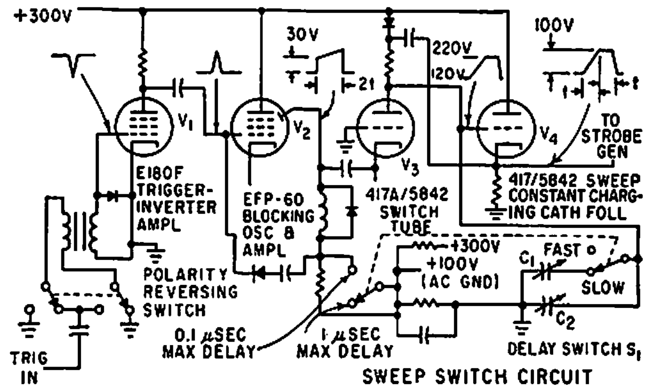
STROBE GENERATOR—Sweep comparator V1 mixes output of ramp generator and staircase generator to give sampling or strobe pulse. Instantaneous d-c level of ramp, corresponding to a step, fixes time at which strobe signal is generated.—W. E. Bushor, Sample Method Displays Millimicrosecond Pulses, *Electronics*, 32:31, p 69–71.



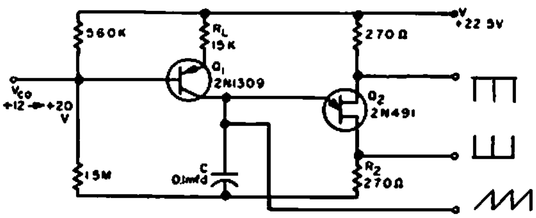
LINEAR SAWTOOTH—Q1 and Q2 in emitter-coupled mvbr and constant-current generator Q3 produce sweep having linearity comparable to that of vacuum-tube circuits.—B. Rakovic, One More Transistor Makes a Linear Sawtooth, *Electronics*, 35:49, p 50–51.



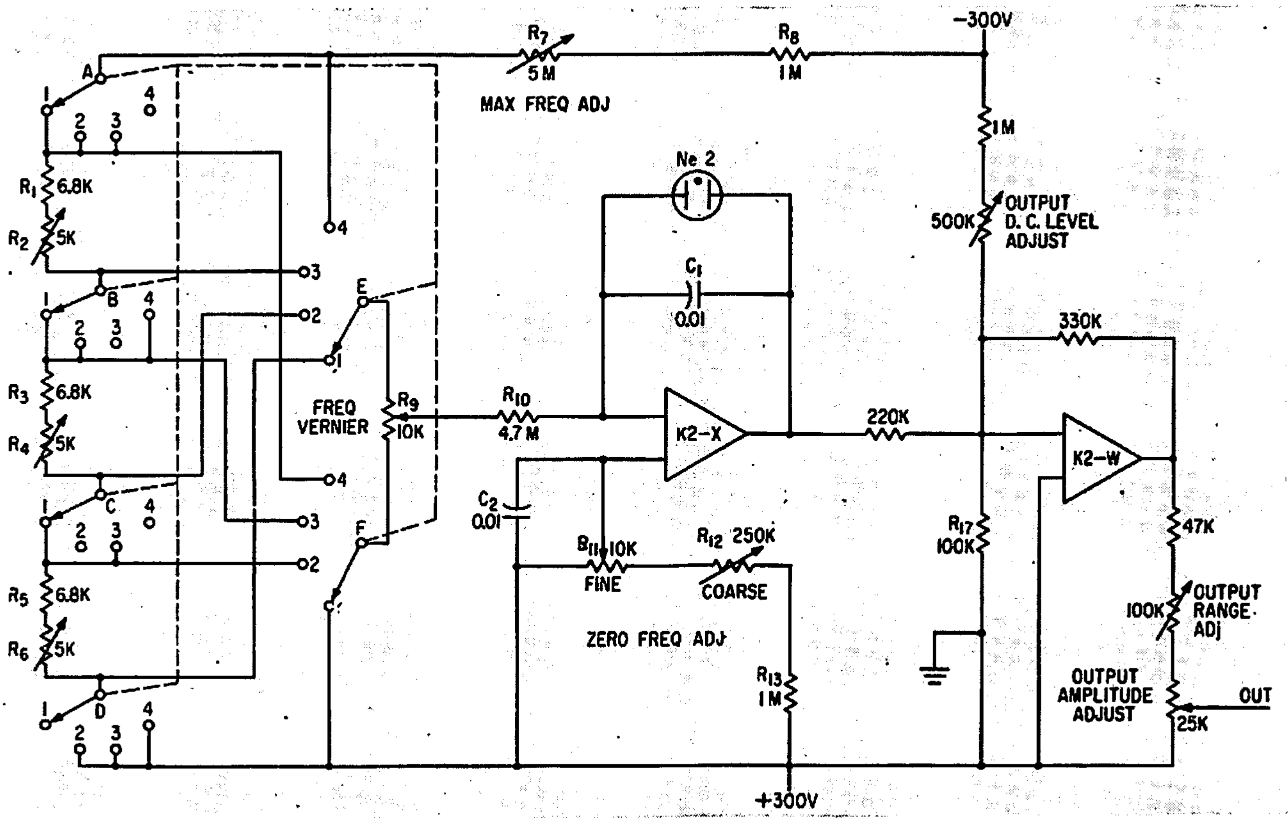
MULTI-WAVEFORM GENERATOR—Uses double-bootstrap sweeps to generate triangular wave. Can be free-running or driven by external generator. Polarity-sensitive trigger circuit controls sweeps.—J. E. Curry, Multi-Waveform Generator, *Electronics*, 32:46, p 83.



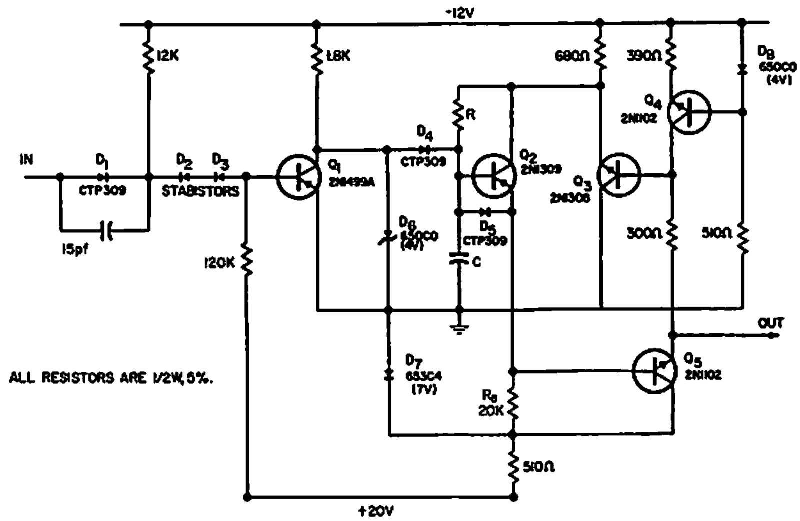
RAMP GENERATOR—Produces positive-going ramp with 100-v amplitude when input trigger pulse is applied. Time duration of ramp can be set at 0.1 or 1 microsec. Time stability is better than 0.1 millimicrosec for long time intervals.—W. E. Bushor, Sample Method Displays Millimicrosecond Pulses, *Electronics*, 32:31, p 69–71.



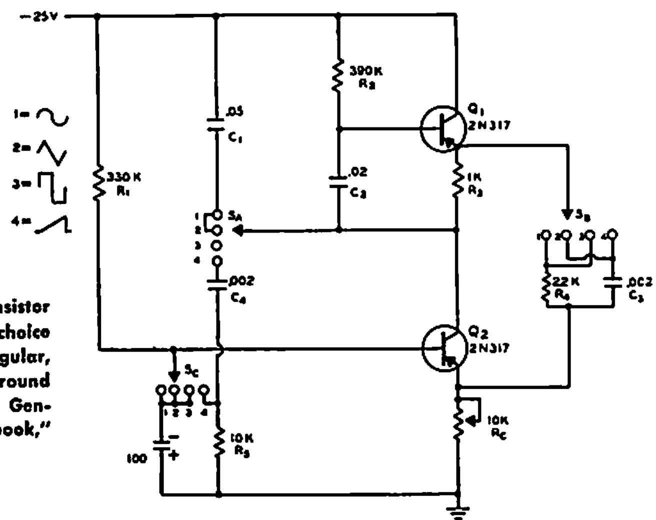
VOLTAGE-CONTROLLED RAMP/TRIGGER—Provides ramp output with or without positive and negative trigger pulses over 6:1 linear range of frequency control. For values of C from 0.001 to 10 mfd, frequency range is 10 cps to 20 kc.—M. S. Tatch, Voltage-Controlled Ramp/Trigger Generator, *EEE*, 12:3, p 71.



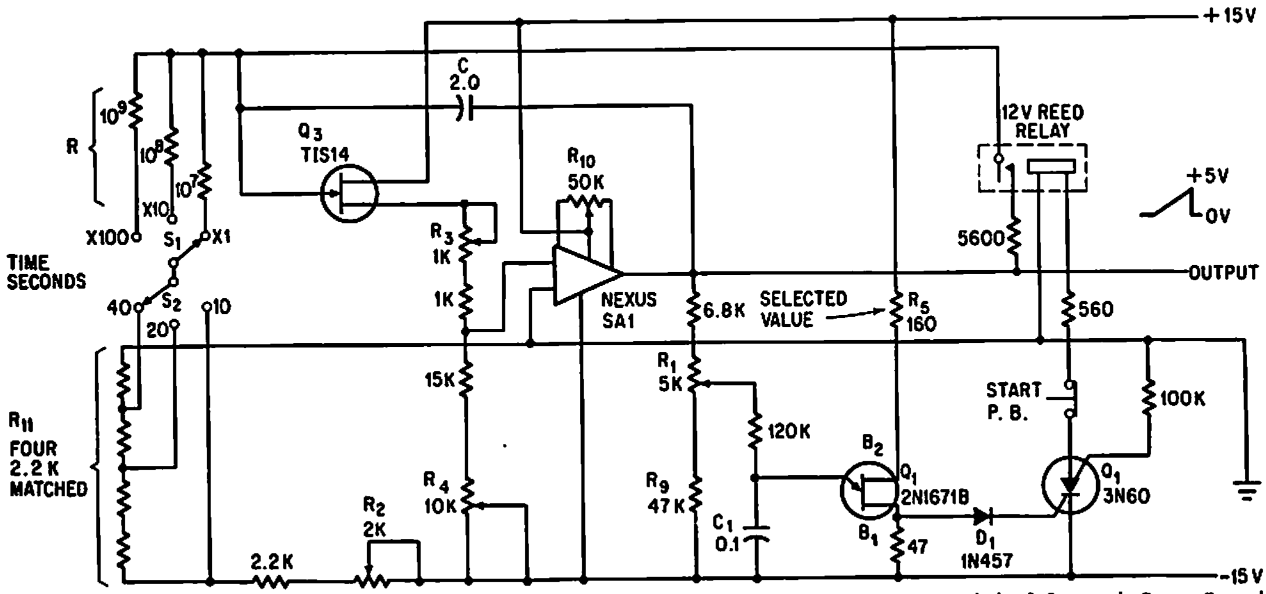
0.2 TO 18 CPS—Provides low-frequency 5-v sweeps of high linearity, to complement conventional signal generators having maximum accuracy at higher sweeps.—A. Angelone, Subaudio Sawtooth Generator Gives One-Percent Linearity, *Electronics*, 34:48, p 42–43.



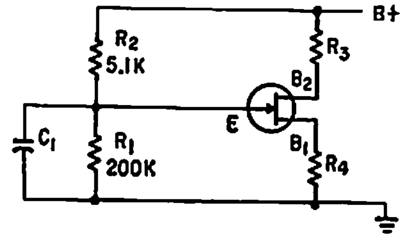
WIDE-RANGE LINEAR BOOTSTRAP TIME BASE —Delivers highly linear ramps at repetition rates up to 5 Mc, for input pulses from 0.1 microsec to several seconds wide. Nonlinearity is 5% for slow ramps, and improves to 0.05% for fast ramp. Measures pulse width accurately when used in combination with voltage comparator. Can also be used for sampling and for testing amplitude response of linear amplifiers.—T. Mollinga, A Wide-Range, Linear Time Base, *EEE*, 10:8, p 56–59.



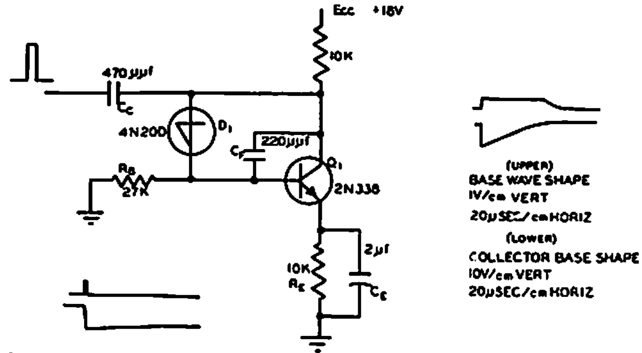
ALL-WAVEFORM GENERATOR—Two-transistor circuit with function switch provides choice of four different waveforms: sine, triangular, square, and sawtooth. Frequency is around 450 cps.—Transistorized All-Waveform Generator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 168.



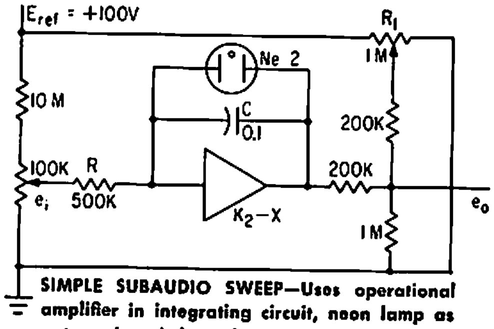
5-HOUR RAMP—Switches S1 and S2 give ramp periods of 100 to 4,000 sec. Changing C to 10 mfd increases period to 20,000 sec. For 5-hour period, C must be 10-mfd low-leakage capacitor. R1 calibrates ramp amplitude and R2 calibrates period.—R. Chapman, Period of Sawtooth Ramp Extends to 5 Hours, *Electronics*, 39:13, p 78.



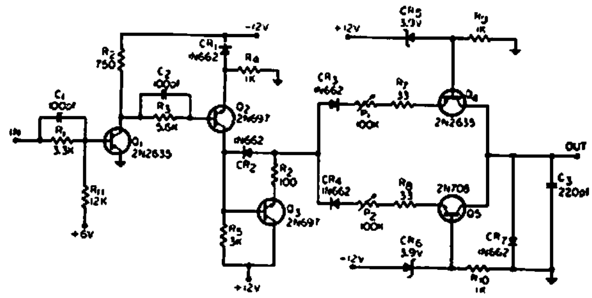
UNIJUNCTION SAWTOOTH—Uses ZJ14 unijunction transistor. R1 represents input impedance of conventional emitter-follower having nominal 5,000-ohm impedance in emitter circuit. R3 is 3K and R4 is 330 ohms. —M. Rosen, Subaudio Swept Signal Generator, *Electronics*, 33:17, p 67–68.



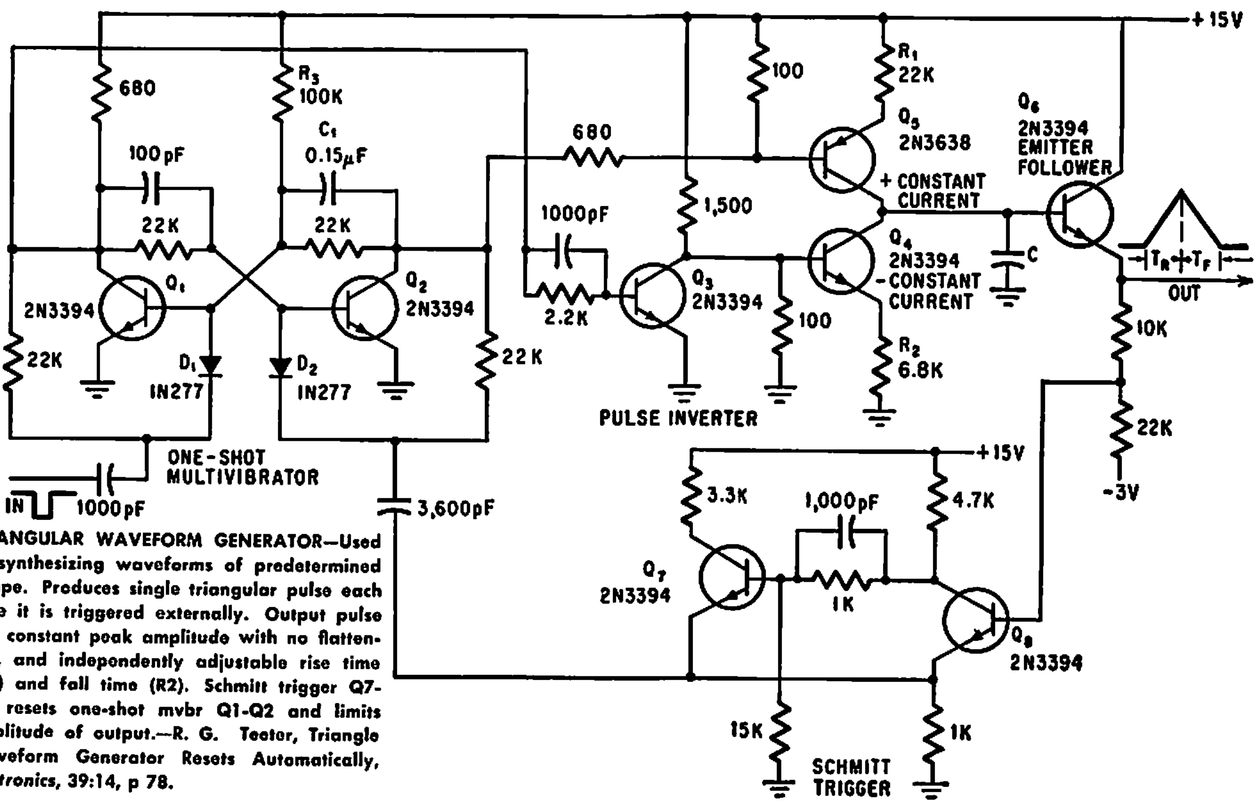
TRIGGERED SAWTOOTH—Uses Shockley four-layer diode and transistorized integrating circuit. Ramp starts with quick drop, then rises back to steady-state condition. Pulse width is 0.2 microsec at 400 pps.—Triggered Sawtooth Generator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 169.



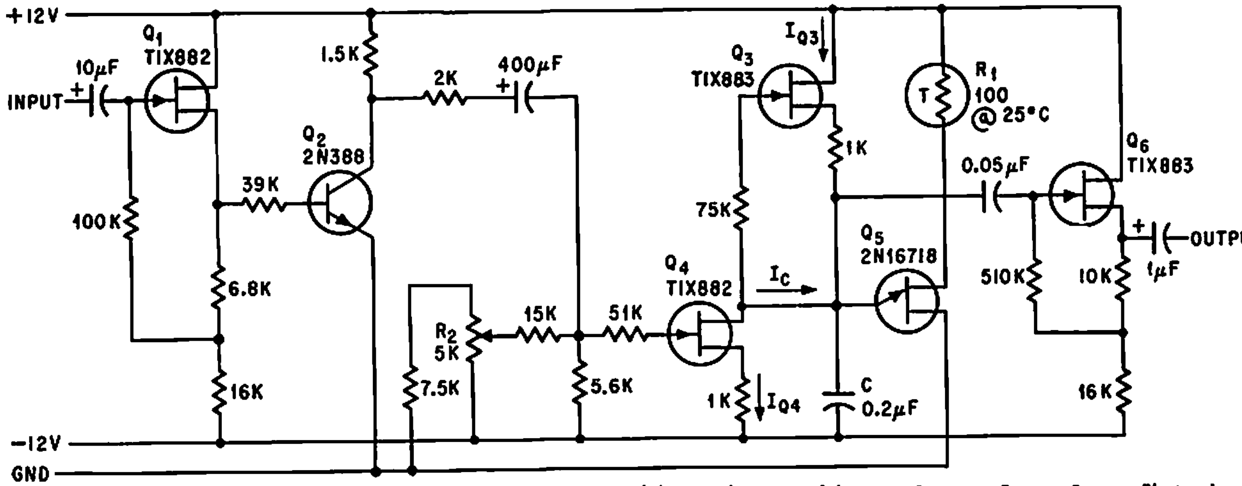
SIMPLE SUBAUDIO SWEEP—Uses operational amplifier in integrating circuit, neon lamp as automatic switch, and resistance network that allows output to be varied around level set by R1. Used to generate sweeps with high linearity up to 18 cps.—A. Angelone, Subaudio Sawtooth Generator Gives One-Percent Linearity, *Electronics*, 34:48, p 42–43.



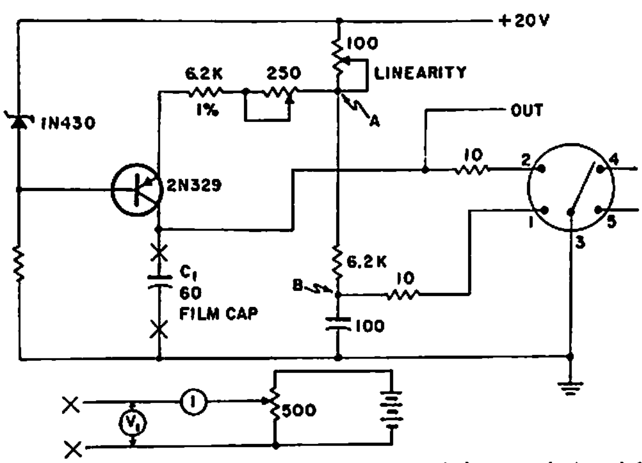
POSITIVE OR NEGATIVE SLOPE—Generates linear ramps, either negative or positive, by switching two current sources on and off during charging of C3.—G. Marosi, Positive or Negative Slope Generator, *EEE*, 13:5, p 43.



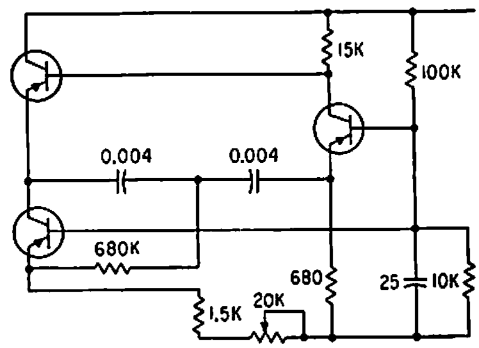
TRIANGULAR WAVEFORM GENERATOR—Used in synthesizing waveforms of predetermined shape. Produces single triangular pulse each time it is triggered externally. Output pulse has constant peak amplitude with no flattening, and independently adjustable rise time (R1) and fall time (R2). Schmitt trigger Q7-Q8 resets one-shot mvbr Q1-Q2 and limits amplitude of output.—R. G. Teeter, Triangle Waveform Generator Resets Automatically, *Electronics*, 39:14, p 78.



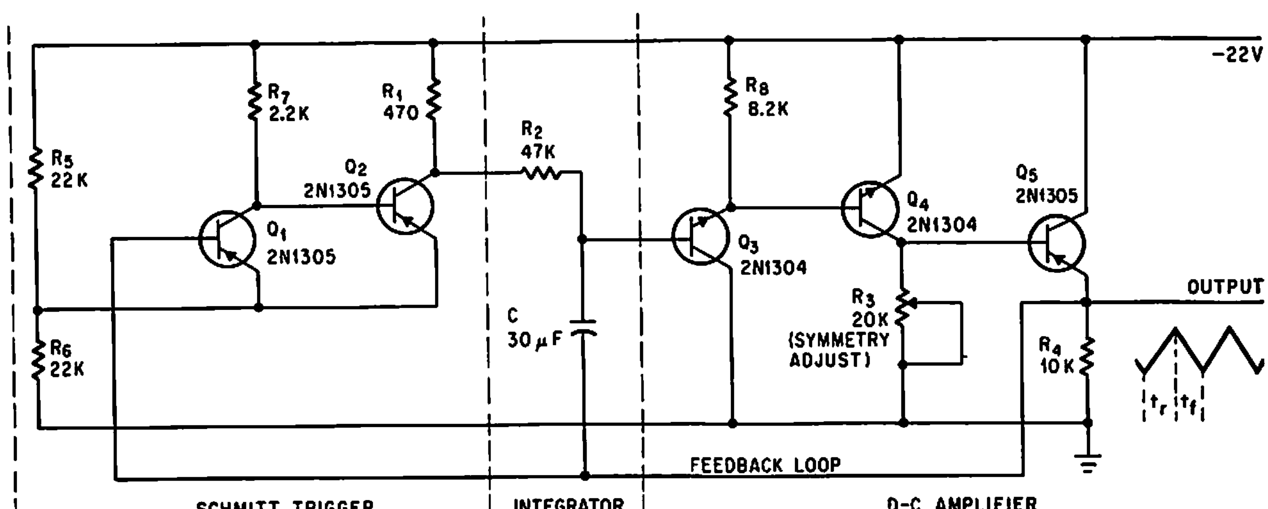
LINEAR RAMP—Output voltage varies linearly with frequency within 98%, while peak voltage is constant at 0.6 v. Thermistor R1 provides temperature stability and source follower Q6 reduces loading.—D. D. Brooks and C. F. Johnson, Sawtooth Generator Uses FET as Constant Current Source, *Electronics*, 38:18, p 87.



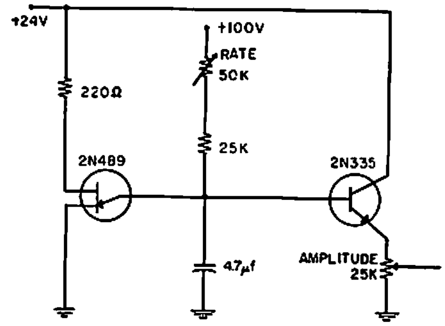
ULTRALINEAR RAMP GENERATOR—Used in high-accuracy low-speed voltage- to pulse width converter. Linearity is better than 0.02% between 10 and 90% points of ramp. Test circuit below is substituted for C1 when adjusting linearity control.—Ultra Linear Ramp Generator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 166.



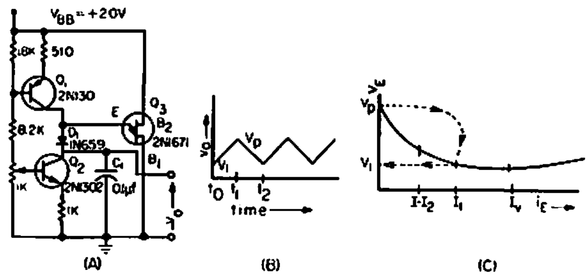
LINEAR SAWTOOTH WITH SPLIT TIMING CAPACITOR—To compensate for linearity deterioration, timing capacitor of emitter-coupled mvbr is split into two equal parts, and feedback resistor is connected between center point and emitter of constant-current generator Q3.—B. Rakovic, One More Transistor Makes a Linear Sawtooth, *Electronics*, 35:49, p 50–51.



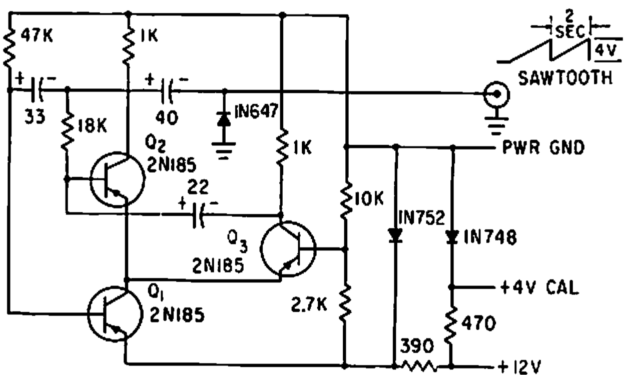
TRIANGULAR—Deviation is less than 1% from linearity at any frequency from 400 cps to 1 cycle per hour. Frequency is changed by varying R1, R2 or C; values shown give 20-second period. Used to sweep magnetic field across air gap of electromagnet and for testing servos and vlf amplifiers.—J. F. Delpech, Triangular Waveforms Have 1% Linearity, *Electronics*, 38:7, p 86–87.



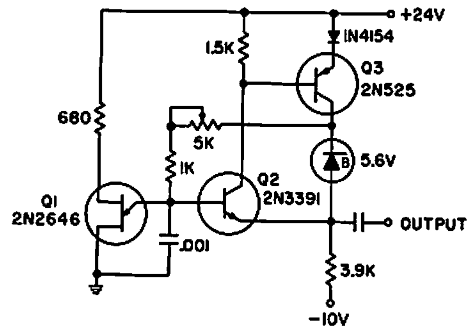
SIMPLE UJT SWEEP—Generates variable-frequency sawtooth directly, with emitter-follower 2N335 serving only for isolation. Sawtooth frequency can be varied without affecting output amplitude.—Unijunction Sweep, *EEE*, 11:7, p 86.



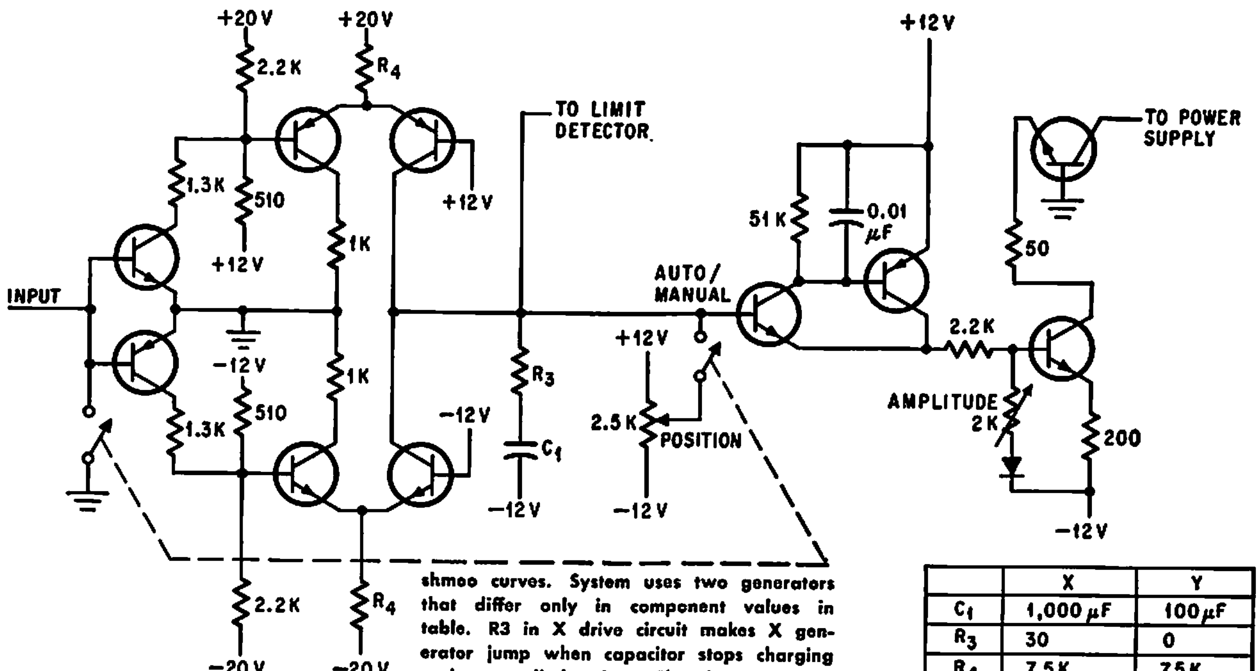
UJT TRIANGULAR-WAVE GENERATOR—Two current generators produce triangular wave by alternately charging and discharging C1. Ujt and diode serve as switch to reverse slope of ramp.—R. Dean, Unijunction Triangular Wave Generator, *EEE*, 12:4, p 59.



LINEAR SAWTOOTH—Develops signal with 4-v amplitude and 2-sec period.—O. C. Haycock and K. D. Baker, Measuring Antenna Impedance in the Ionosphere, *Electronics*, 34:2, p 88–92.

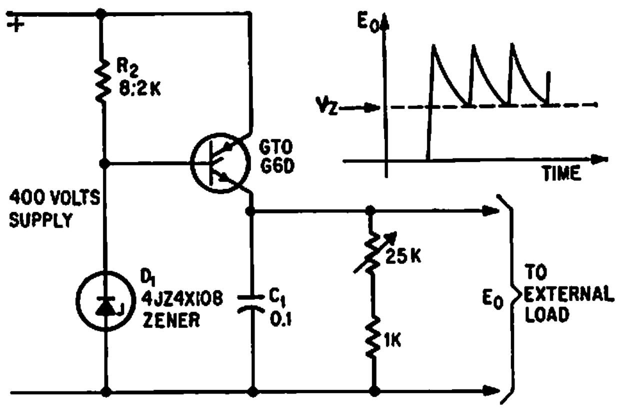


50-KC SAWTOOTH—Uses bootstrap charging circuit, with constant voltage maintained across charging resistor by zener diode and emitter-follower amplifier Q3, so capacitor charging current is constant over complete cycle.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 319.

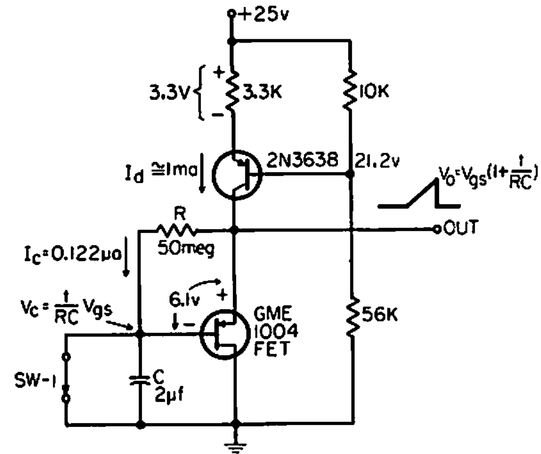


	X	Y
C_1	1,000 μF	100 μF
R_3	30	0
R_4	7.5 K	7.5 K

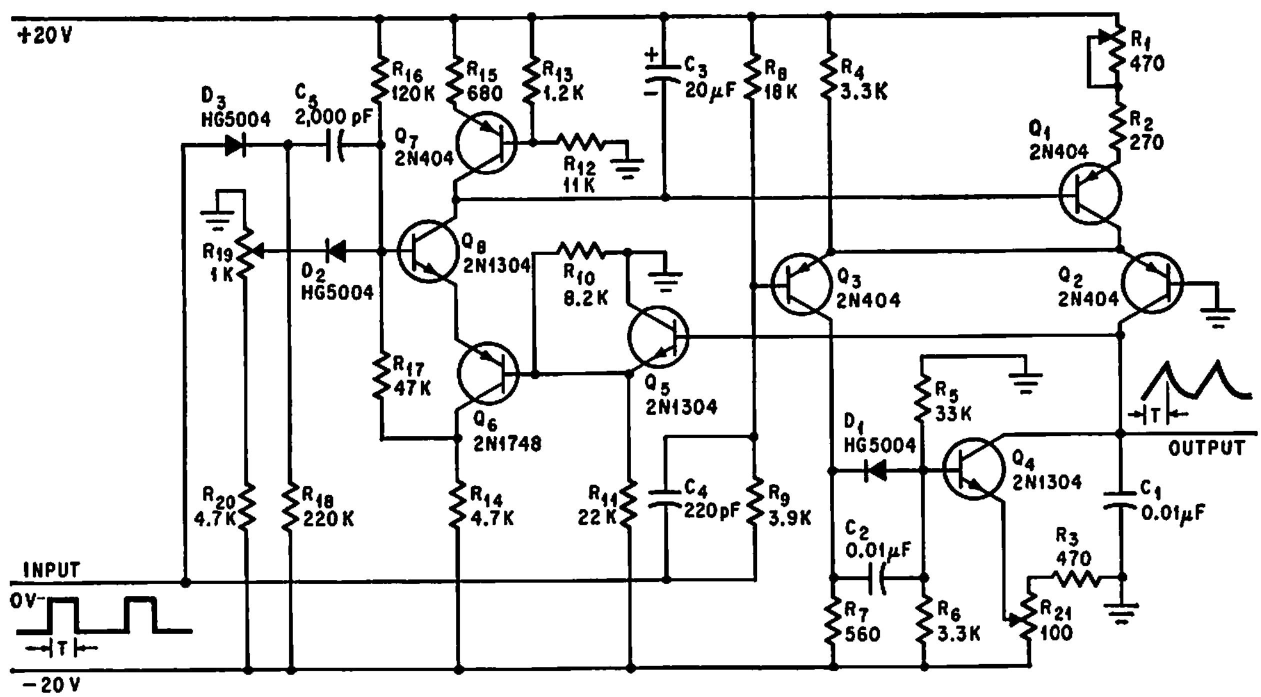
LINEAR RAMP GENERATOR—Used in tester that shows computer memory performance under marginal drive currents by plotting shmoo curves. System uses two generators that differ only in component values in table. R3 in X drive circuit makes X generator jump when capacitor stops charging and starts discharging. Charging current is positive or negative depending on input voltage polarity. Npn transistors are 2N706, pnp transistors are 2N1132, and diodes are 1N921.—J. E. Gersbach, The Great Shmoo Plot: Testing Memories Automatically, *Electronics*, 39:15, p 127–134.



FREE-RUNNING HIGH-VOLTAGE SAWTOOTH GENERATOR—When power is applied, gate-turnoff scr triggers and applies 400 v to C1. When voltage across C1 rises above avalanche voltage of D1, GTO turns off and C1 discharges until scr conducts again.—D. R. Grafham, Now the Gate Turnoff Switch Speeds Up D-C Switching, *Electronics*, 37:12, p 64–71.

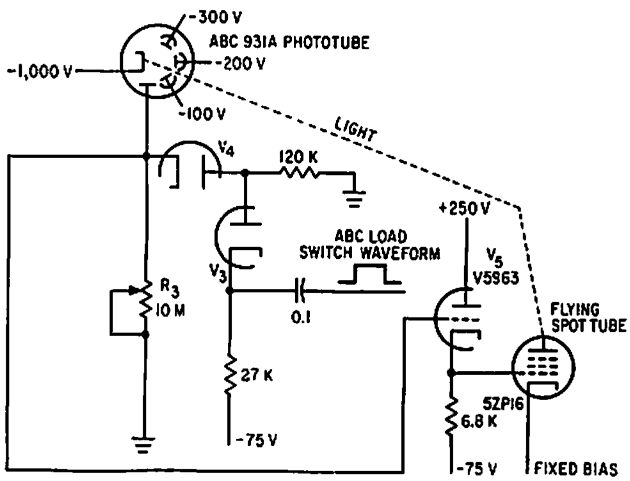


FET RAMP GENERATOR—Use of mos fet gives very slow rate-of-rise linear ramp generator (less than 0.1 v/sec). Longer durations can be obtained by using larger values for R and C. —J. M. Phalan, MOS FETs Give Long Time-Constant Ramps, *EEE*, 14:4, p 46.

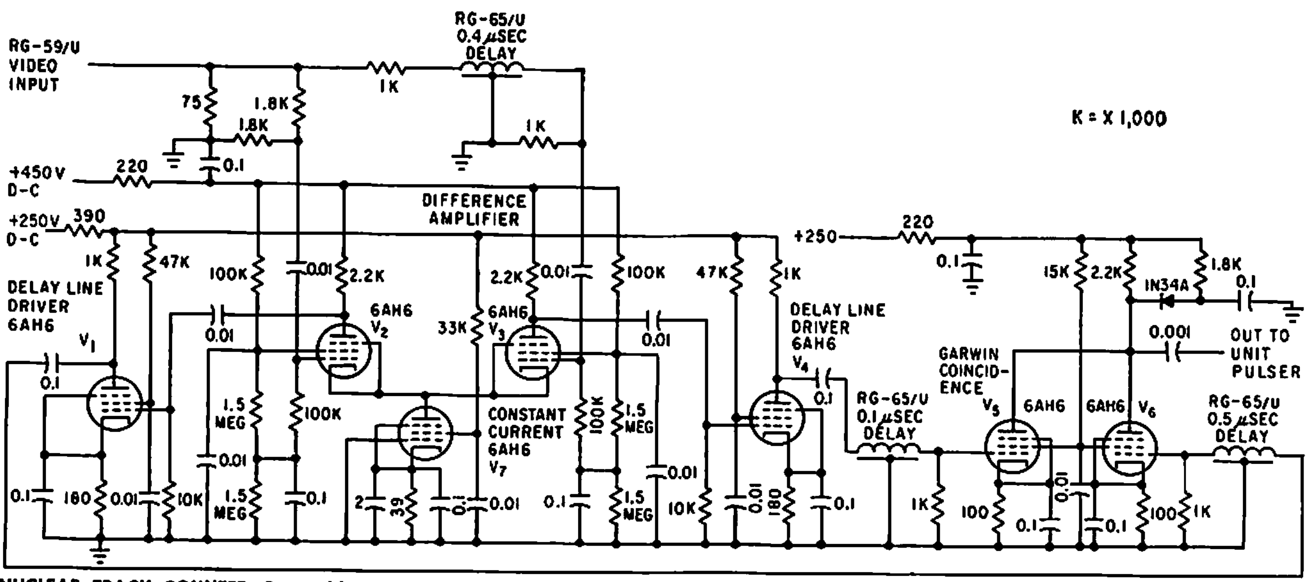


VARIABLE-SLOPE RAMP GENERATOR—Slope is determined by rate at which C1 is charged by constant-current generator Q1-R4 through Q2. Peak of ramp is determined by R19. Circuit will synchronize over 3:1 frequency range centered on 70 kc.—D. J. Grover, Capacitor Charging Controls Variable Ramp Generator, *Electronics*, 39:11, p 91–92.

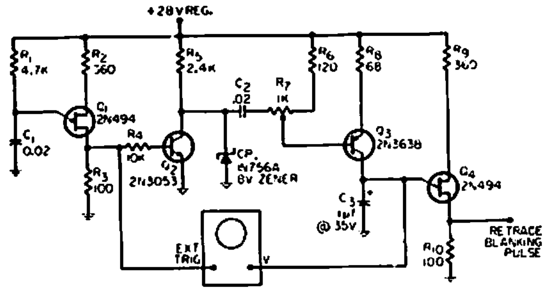
CHAPTER 76
Scanner Circuits



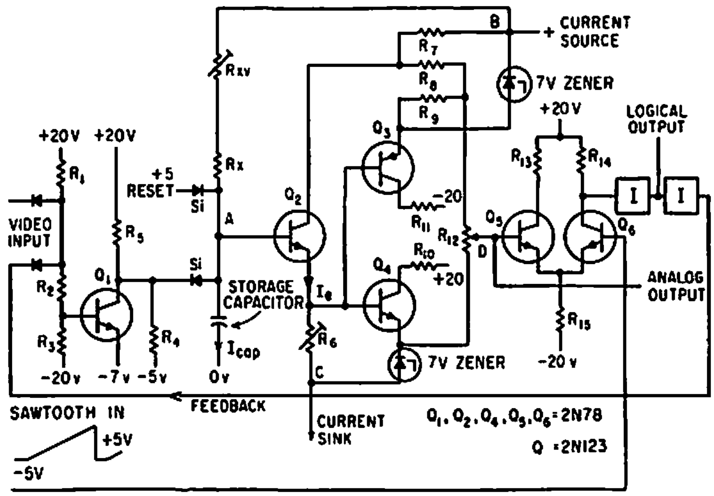
AUTOMATIC BRIGHTNESS CONTROL—Automatic brightness control circuit intensifies scanning spot when sweep is triggered, and holds intensity constant. When spot is quiescent, output of 931A is applied to cathode follower that determines bias on 5ZP16. Phototube then sees only 10-meg load because V4 is cut off. When mark is sensed by scanner, load switching action makes V4 conduct to reduce phototube load to 120,000 ohms.—A. C. L. Brown, Flying Spot Inspects TV Rating Records, *Electronics*, 35:9, p 31–34.



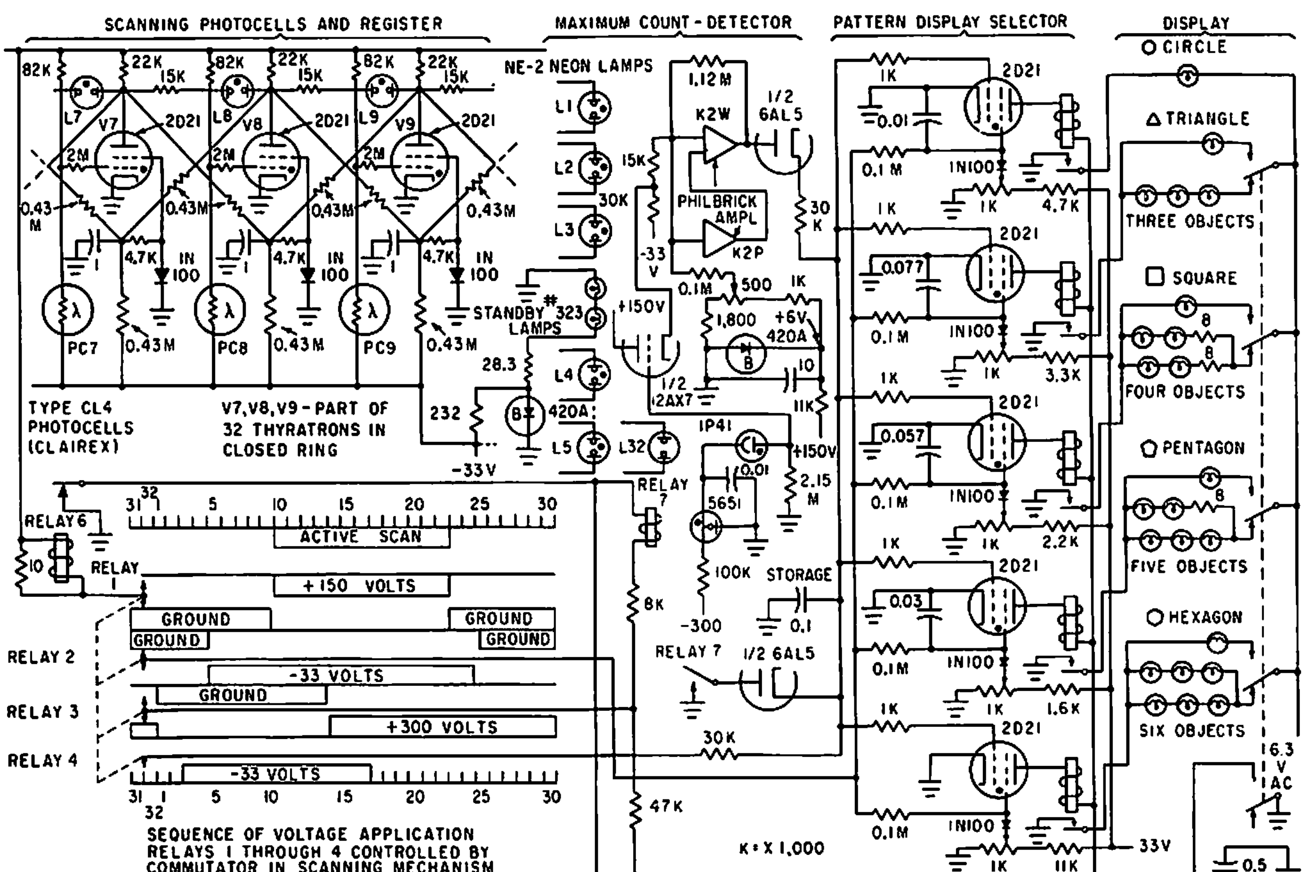
NUCLEAR TRACK COUNTER—Recognition system scans nuclear emulsion strips coated on glass, using image orthicon with microscope. Straight or moderately curved tracks in emulsion, produced by nuclear particles, are recognized and counted by scanner that used video screening circuit shown. Opaque emulsion regions that meet narrowness criteria produce output pulses.—P. V. C. Hough, J. A. Koenig, and W. Williams, Scanner Recognizes Atomic Particle Tracks, *Electronics*, 32:13, p 58–61.



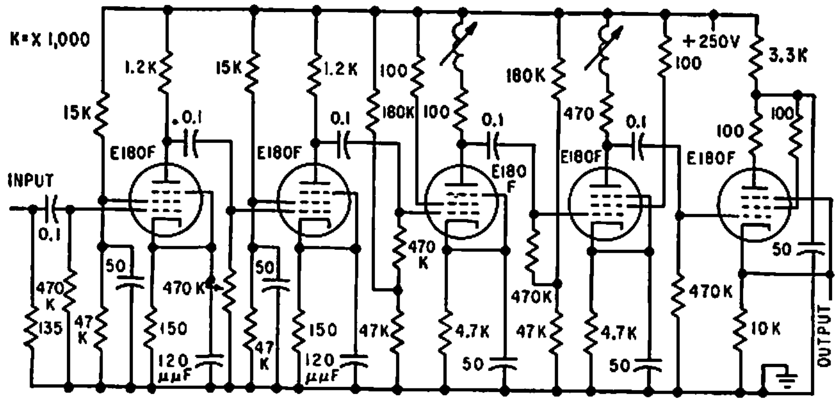
UJT RASTER GENERATOR—Developed for use in low-cost transistorized flying-spot scanner. Can also be adapted for closed-circuit tv cameras and monitors. Ujt Q1 is relaxation oscillator at desired horizontal sweep rate of 10 kc. Interlaced scanning is easily obtained.—F. Stevens, Low-Cost UJT Raster Generator, *EEE*, 13:12, p 65–66.



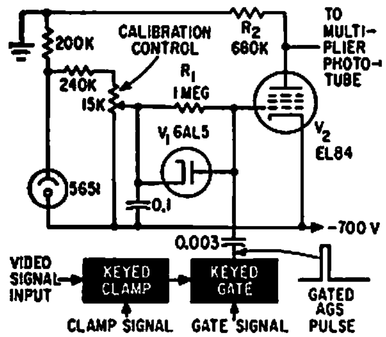
VERTICAL LOCATOR FOR CHARACTER READER—Sawtooth input is compared with earliest video of each vertical sweep of typed character being scanned, to charge capacitor and derive logical output related to bottom of typed line.—J. Bauldreay and E. Milbradt, Solving Registration Problems in Optical Character Recognition, *Electronics*, 35:1, p 77–81.



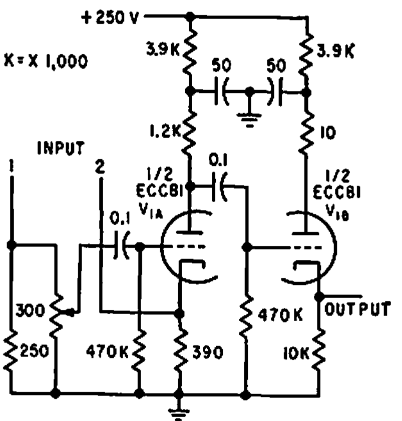
SHAPE RECOGNITION—Use of dilating circular scan resolves some of problems for general-purpose reading machine. Technique can be applied to automatic recognition of letters and numbers in variety of styles.—L. D. Harmon, Line-Drawing Pattern Recognizer, *Electronics*, 33:36, p 39–43.



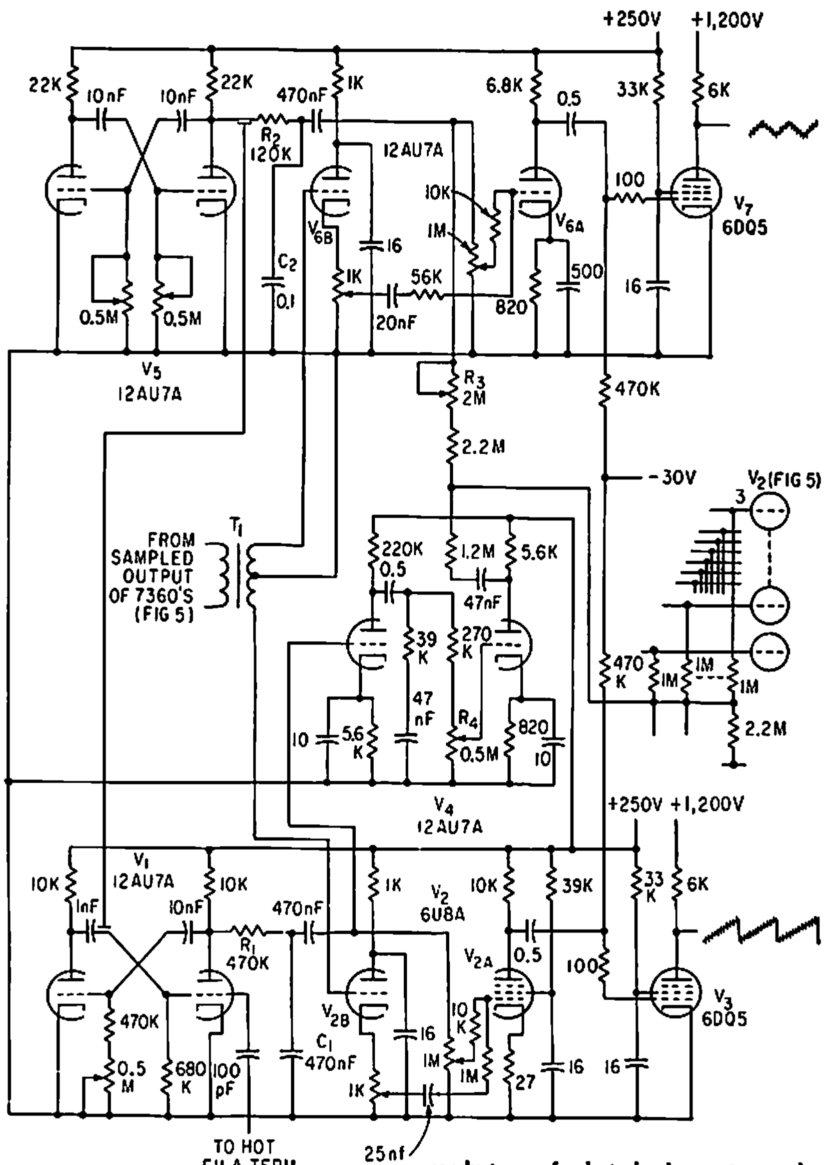
WIDEBAND VIDEO AMPLIFIER—Has gain of 1,000, bringing 1-mv input up to 1 v. First two stages are cathode-bypassed, and next two use inductive compensation for high-frequency peaking, to compensate for non-infinitesimal short persistence of screen of flying-spot scanner. Used in comparing two sky photographs to detect variable stars.—J. Borgman, Using Tv Techniques in Astronomy, *Electronics*, 32:19, p 66–68.



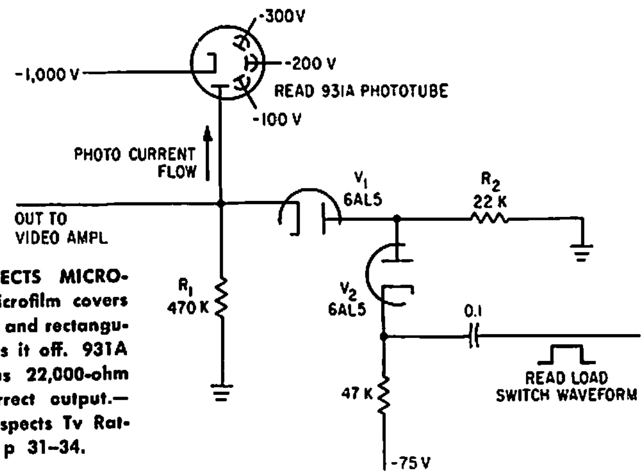
STABILIZING PHOTOMULTIPLIER GAIN—Feedback loop provides automatic gain stabilization for color film scanner.—R. M. Farber and K. M. St. John, Scanner Analyzes Color Content of Movie Film, *Electronics*, 34:48, p 38–41.



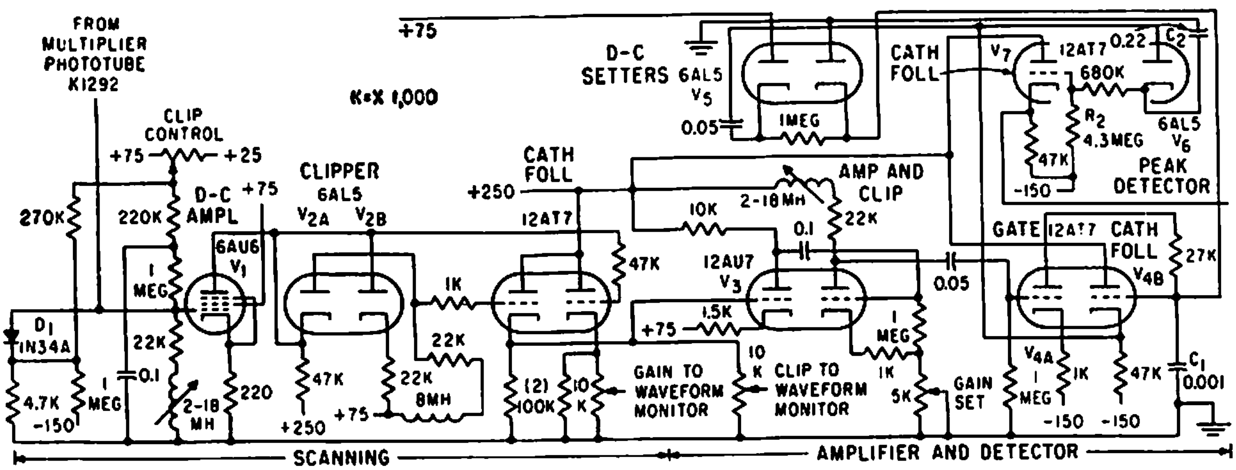
TWO-PHOTOMULTIPLIER SUBTRACTION CIRCUIT—Flying-spot closed-circuit tv system compares two photographs and displays only differences between them, for automatic identification of variable stars. Both photomultiplier signals are coupled to subtraction tube V1A. Difference signal is fed by cathode follower to video amplifier of 14-inch tv monitor.—J. Borgman, Using Tv Techniques in Astronomy, *Electronics*, 32:19, p 66–68.



FLAT-TUBE SCANNER—V1 thru V3 generate sawtooth wave and V5 thru V7 triangular wave for driving horizontal and vertical conductors of electroluminescent panel.—B. Binggeli and E. Fatuzzo, Solid-State Panels: Will They Bring Flat-Display TV? *Electronics*, 35:26, p 67–70.

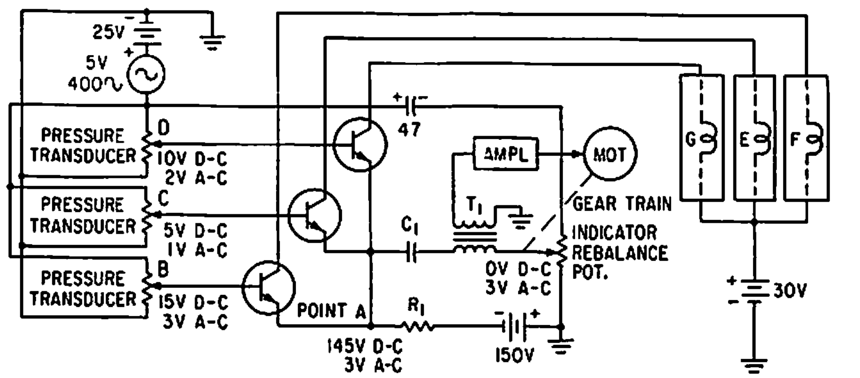


FLYING-SPOT SCANNER PROTECTS MICROFILM—When black mark on microfilm covers quiescent spot, sweep is tripped and rectangular pulse on cathode of V2 cuts it off. 931A multiplier phototube then sees 22,000-ohm load through V1 to give correct output.—A. C. L. Brown, Flying Spot Inspects Tv Rating Records, *Electronics*, 35:9, p 31–34.

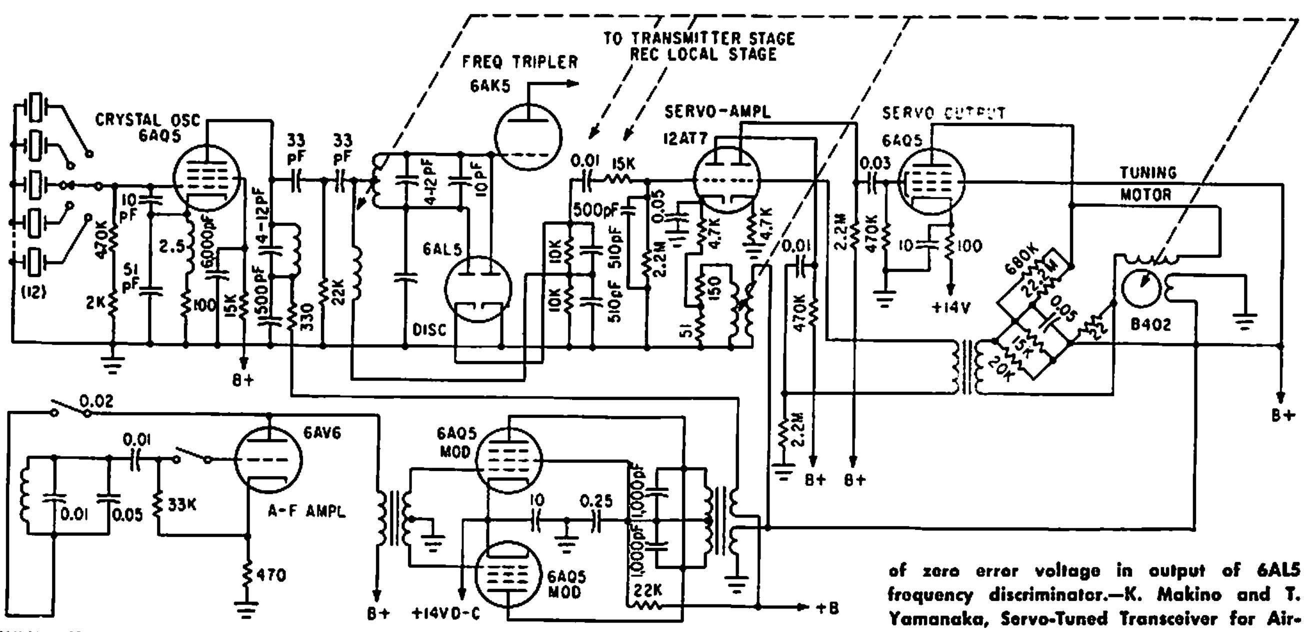


PUPILLOGRAPH—Measures movements of pupil of eye, using flying-spot scanning unit with multiplier phototube, amplifier-detector, and recorder.—G. W. King, Recording Pupil Changes For Clinical Diagnosis, *Electronics*, 32:39, p 67–69.

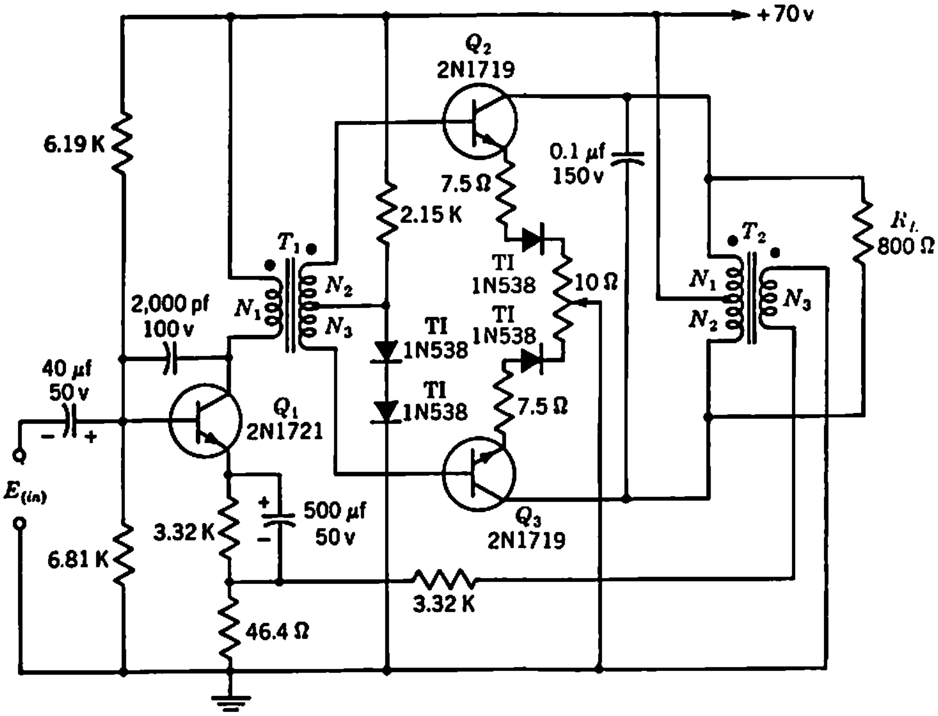
CHAPTER 77
Servo Circuits



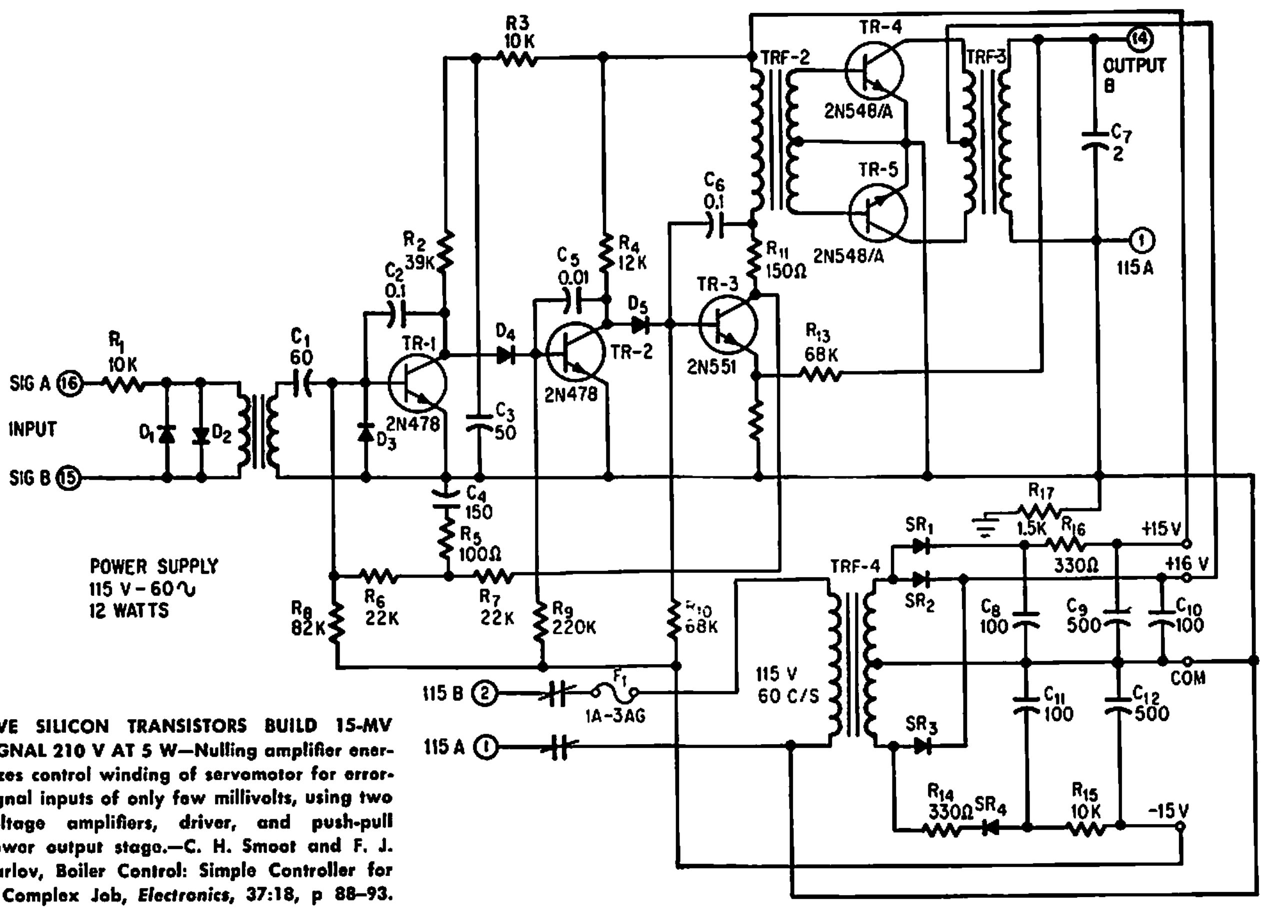
TRANSDUCER SCANNER WITH INDICATORS—Transducers monitored in parallel mode actuate a-c servo when any one goes beyond predetermined range. Transistor then turns on lamp to identify transducer whose output has actuated the servo.—S. Thaler, Solid-State Parallel-Mode Scanner Reads System Physical Parameters, *Electronics*, 34:19, p 78–80.



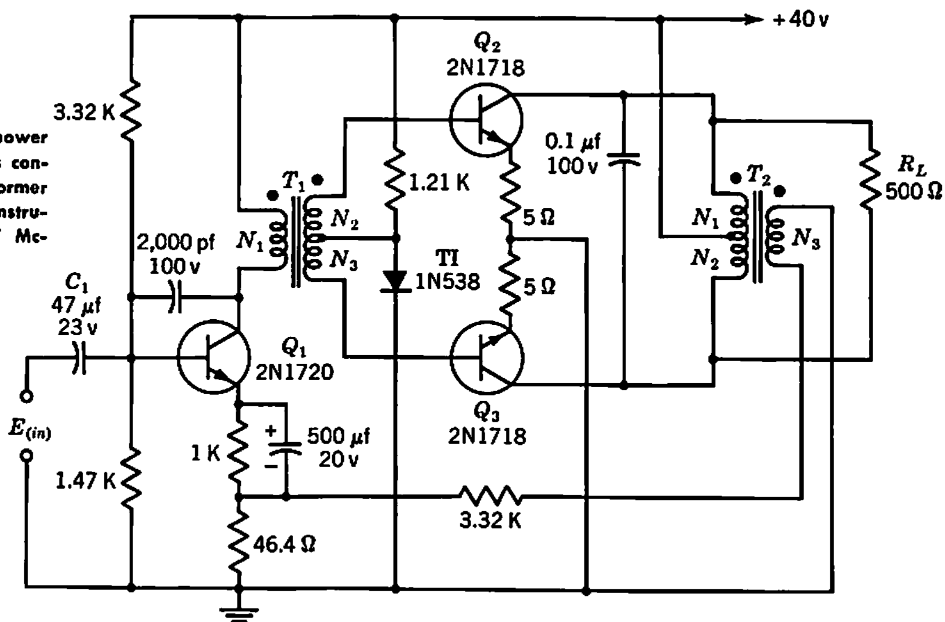
TWELVE-FREQUENCY SERVO TUNER—Negative feedback voltage proportional to servo speed is picked off winding of servomotor to improve stability in stopping at point of zero error voltage in output of 6AL5 frequency discriminator.—K. Makino and T. Yamanaka, Servo-Tuned Transceiver for Airborne VHF Communications, *Electronics*, 35:1, p 82–85.



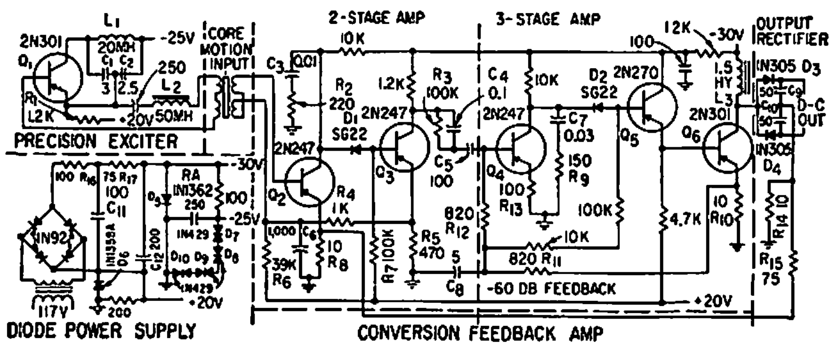
7.5-W CLASS B SERVO AMPLIFIER—Gives power gain of 45 db. Voltage amplification is constant within 2 db of 44 db. Transformer data is for 400-cps operation.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 242.



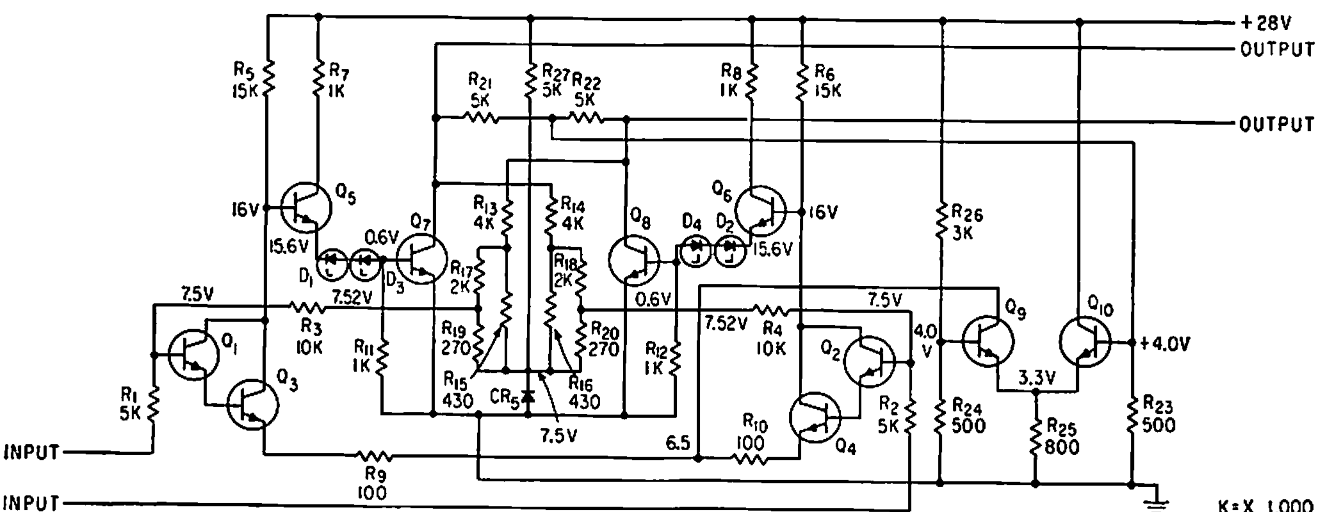
FIVE SILICON TRANSISTORS BUILD 15-MV SIGNAL 210 V AT 5 W—Nulling amplifier energizes control winding of servomotor for error-signal inputs of only few millivolts, using two voltage amplifiers, driver, and push-pull power output stage.—C. H. Smoot and F. J. Karlov, Boiler Control: Simple Controller for a Complex Job, *Electronics*, 37:18, p 88–93.



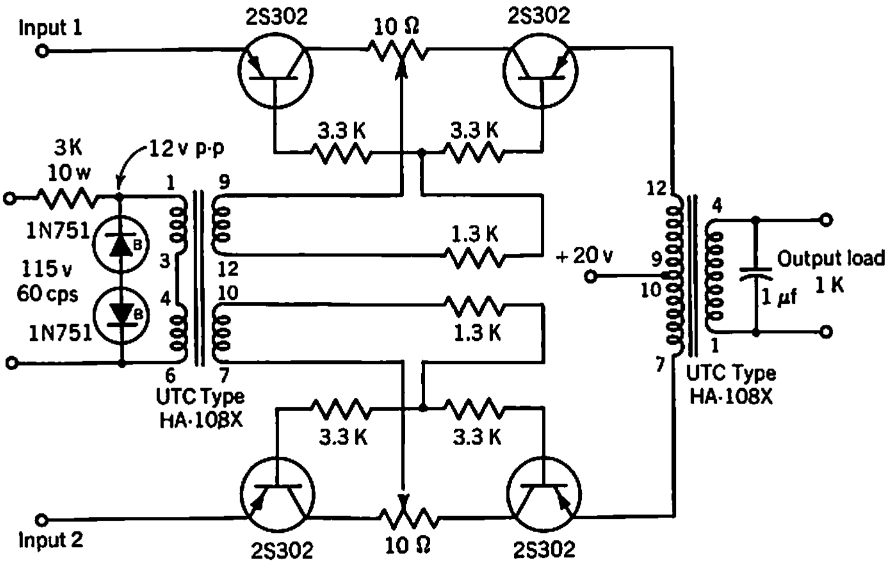
4-W CLASS B SERVO AMPLIFIER—Gives power gain of 42 db. Voltage amplification is constant within 2.5 db of 42.5 db. Transformer data is for 400-cps operation.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 241.



DIFFERENTIAL-TRANSFORMER TRANSDUCER—Detects and responds with 0.1% linearity to core displacement. Low-level a-c transformer output is converted to 10 to 50 ma d-c transmission signal with 1 w maximum power by high-input-impedance feedback amplifier. Precision exciter consists of constant-voltage 1-kc oscillator and high-Q swamping choke. Gain is stabilized by using separate d-c feedback loop for each group of d-c coupled transistors.—L. H. Dulberger, Constant-Current Technique Cuts Servo Response Time, *Electronics*, 32:28, p 52–54.

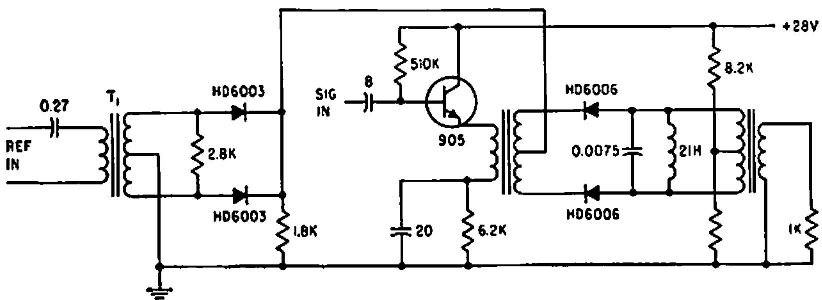


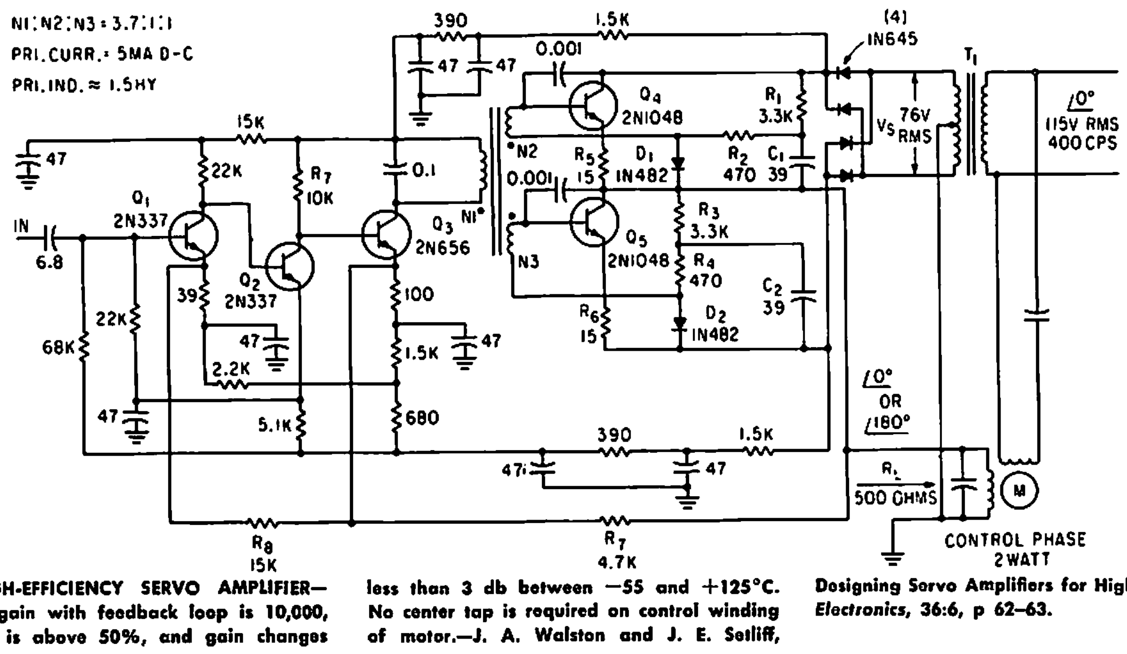
DARLINGTON-PAIR SERVO AMPLIFIER—Open-loop gain of differential forward amplifier Q1 through Q8 is over 2,000 and closed-loop gain is 200. Signal across output of common-mode feedback amplifier Q9-Q10 is differentially summed by R21-R22 to cancel a-c components, while d-c component is amplified and applied to emitters of differential-input Darlington pair.—M. W. Aarons, Putting a Servo Amplifier on a Small Silicon Wafer, *Electronics*, 35:52, p 33–35.



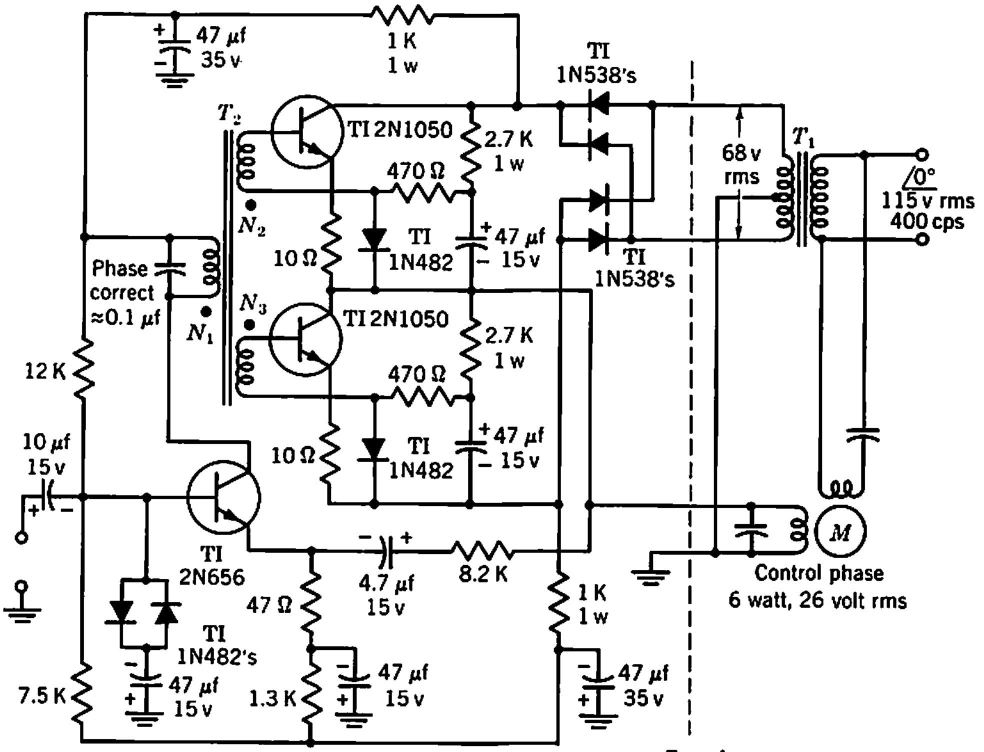
DIGITAL SERVO MODULATOR—Used to subtract two analog currents of digital-to-analog converter, giving phase-sensitive 60-cps square-wave output signal. Modulator is driven from 60-cps line to maintain precise phase relationship with two-phase servo motor. Modulator gives 2.4-mv p-p output signal for 2-microamp input signal on one side, and 1.1 v p-p for 1-ma input signal on one side. First output corresponds to least significant digit error in Gray-to-binary converter, and latter to most significant digit error.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 492.

QUADRATURE VOLTAGE REJECTION—Suppresses quadrature voltages in servo loops while delivering in-phase a-c signal. Phase reference voltage controls two unmatched diodes so they conduct only when in-phase signal component is passing through maximum and quadrature is passing through minimum. Prevents overload of amplifier.—B. Fennick, Phase-Selective Gate Rejects Quadrature, *Electronics*, 31:51, p 89–91.





2-W HIGH-EFFICIENCY SERVO AMPLIFIER—Voltage gain with feedback loop is 10,000, efficiency is above 50%, and gain changes less than 3 db between −55 and +125°C. No center tap is required on control winding of motor.—J. A. Walston and J. E. Setliff, Designing Servo Amplifiers for High Efficiency, *Electronics*, 36:6, p 62–63.



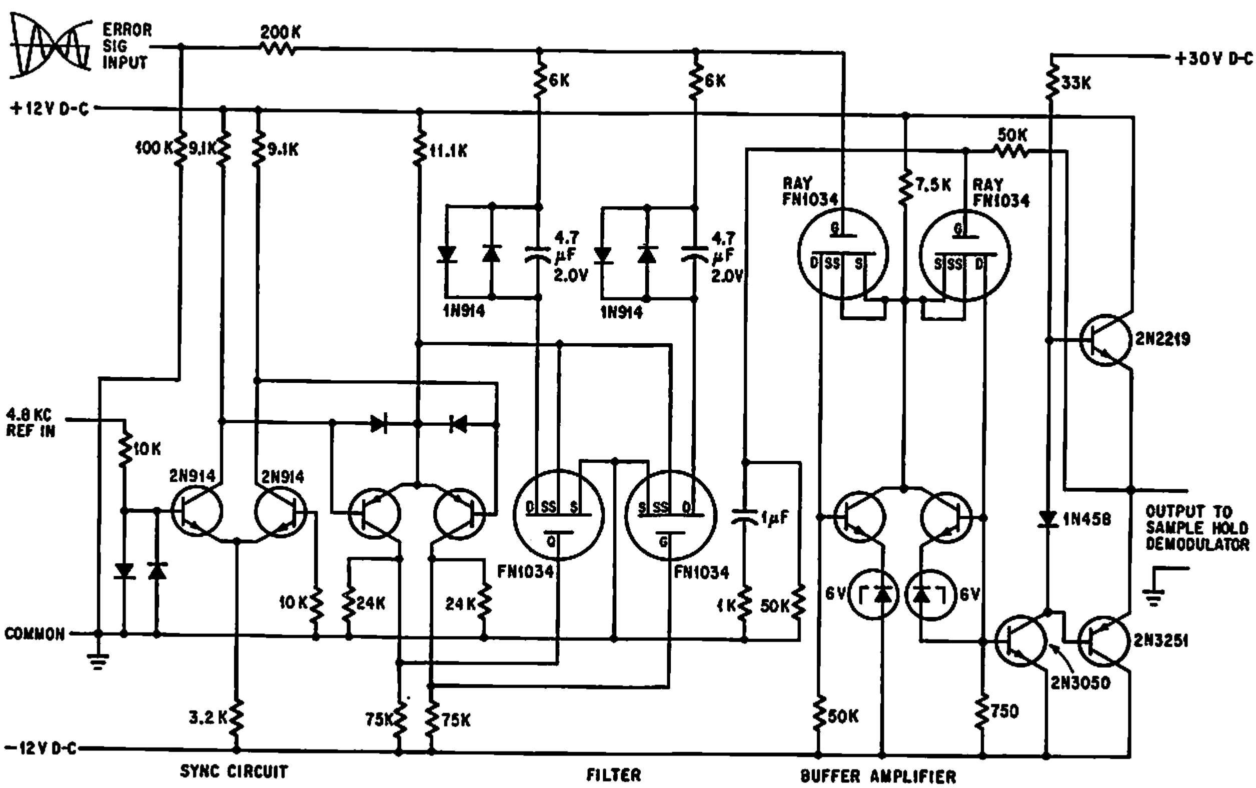
6-W HIGH-EFFICIENCY AMPLIFIER—Overall efficiency is 55%. Design equations are given.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 249.

Transformers

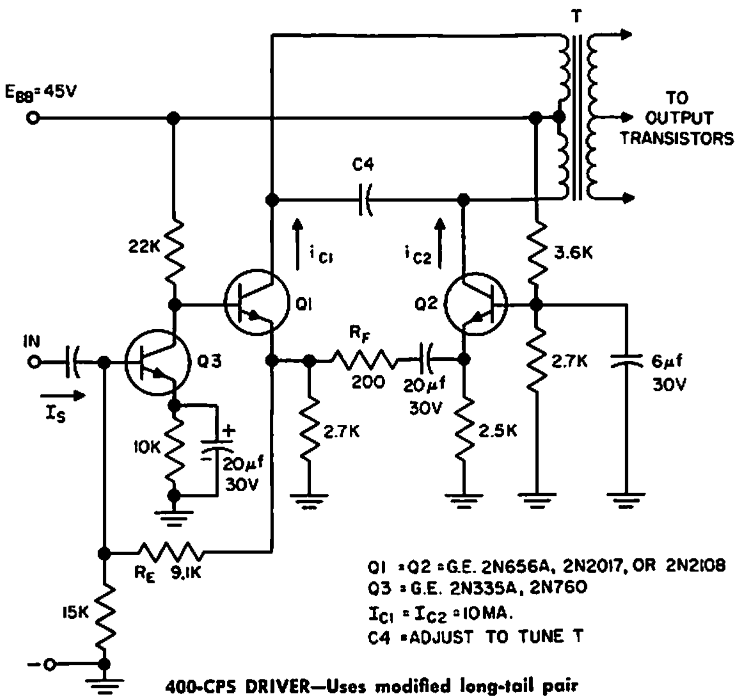
T_1 400 cps 12-watt power transformer step-down 115 volt to 68 volt c.t.

T_2 400 cps 65-mw driver transformer. Turns ratio $N_1 : N_2 : N_3 = 2 : 1 : 1$

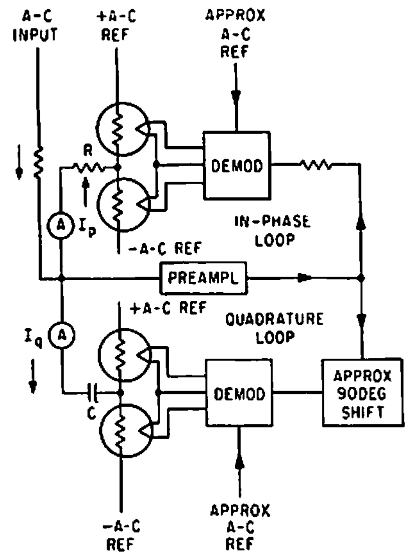
Primary current = 10 ma d-c. Primary inductance = 1.5 hy.



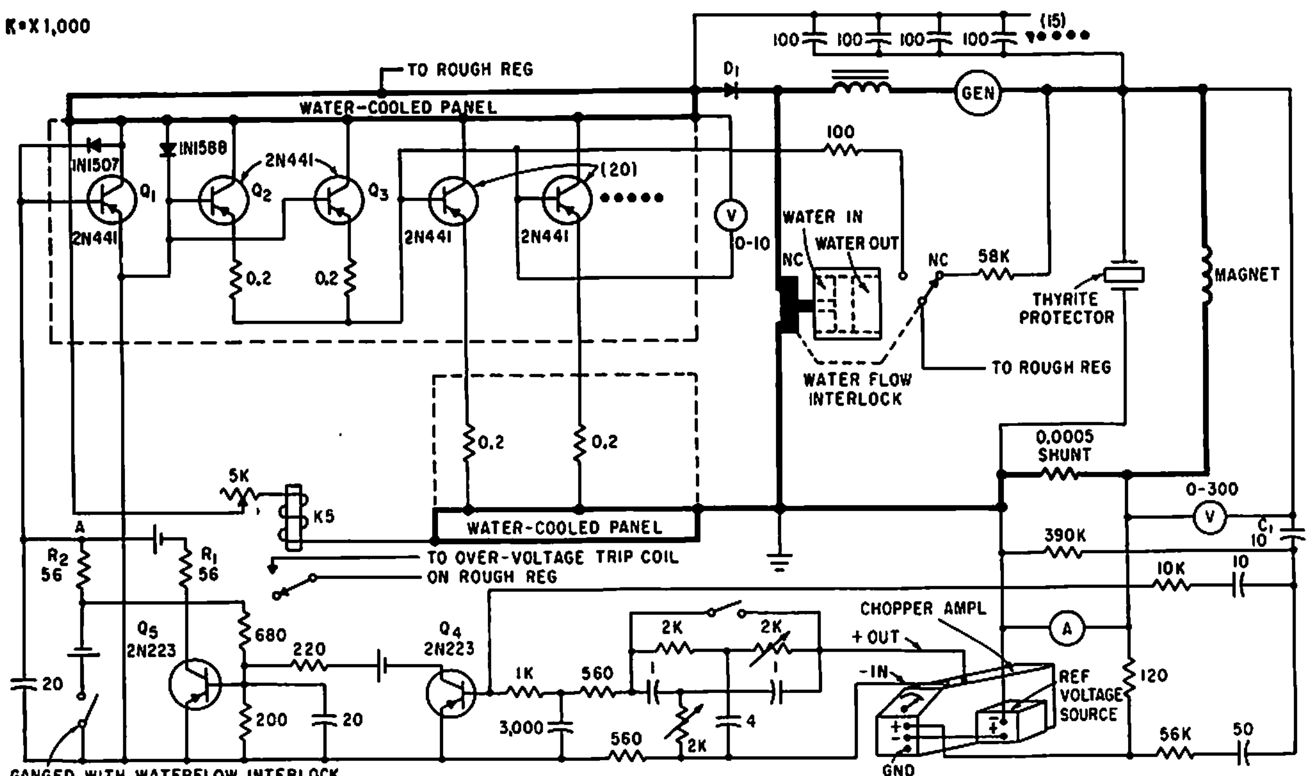
SERVO FREQUENCY COMPENSATION—Performs frequency compensation in servo system by operating on modulation envelope of amplitude-modulated suppressed-carrier signal. Hybrid construction, replacement of linear circuits with switching circuits, and substitution of active filters for large L-C filters reduce size and weight.—F. A. Plemenos, The Packaging Revolution, Part VI: Converting to Microelectronics, *Electronics*, 39:4, p 103–109.



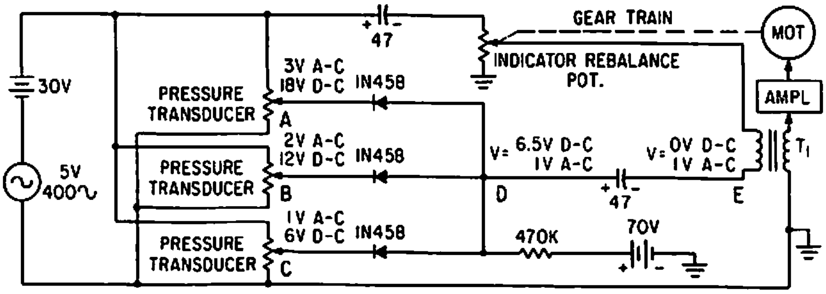
400-CPS DRIVER—Uses modified long-tail pair to give highly stable gain. Separate emitter resistors improve bias stability. Provides push-pull operation.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 222.



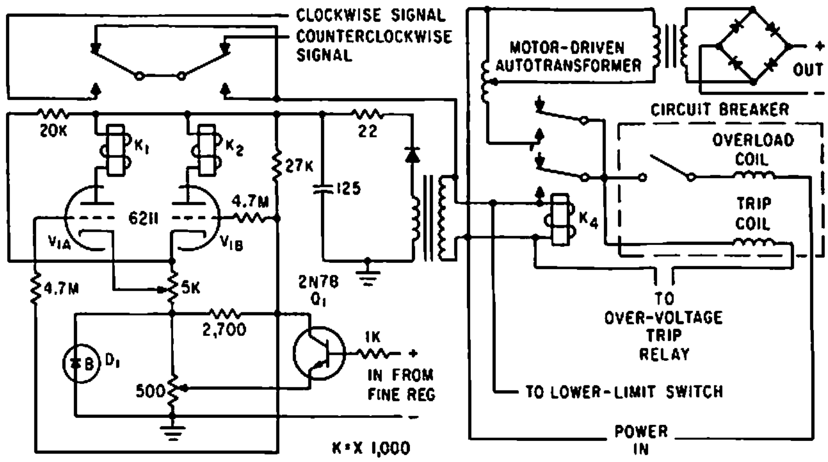
QUADRATURE SUPPRESSION—Two pairs of thermistor potentiometers balance the in-phase and quadrature components of input current, which are in phase and in quadrature with a-c reference of the same frequency, to permit displaying components simultaneously on two a-c meters. Circuit and values for demodulators and preamplifier are same as for THERMISTOR CONTROL circuit.—I. C. Hutcheon, Using Thermistors as Servo Elements, *Electronics*, 34:5, p 52–55.



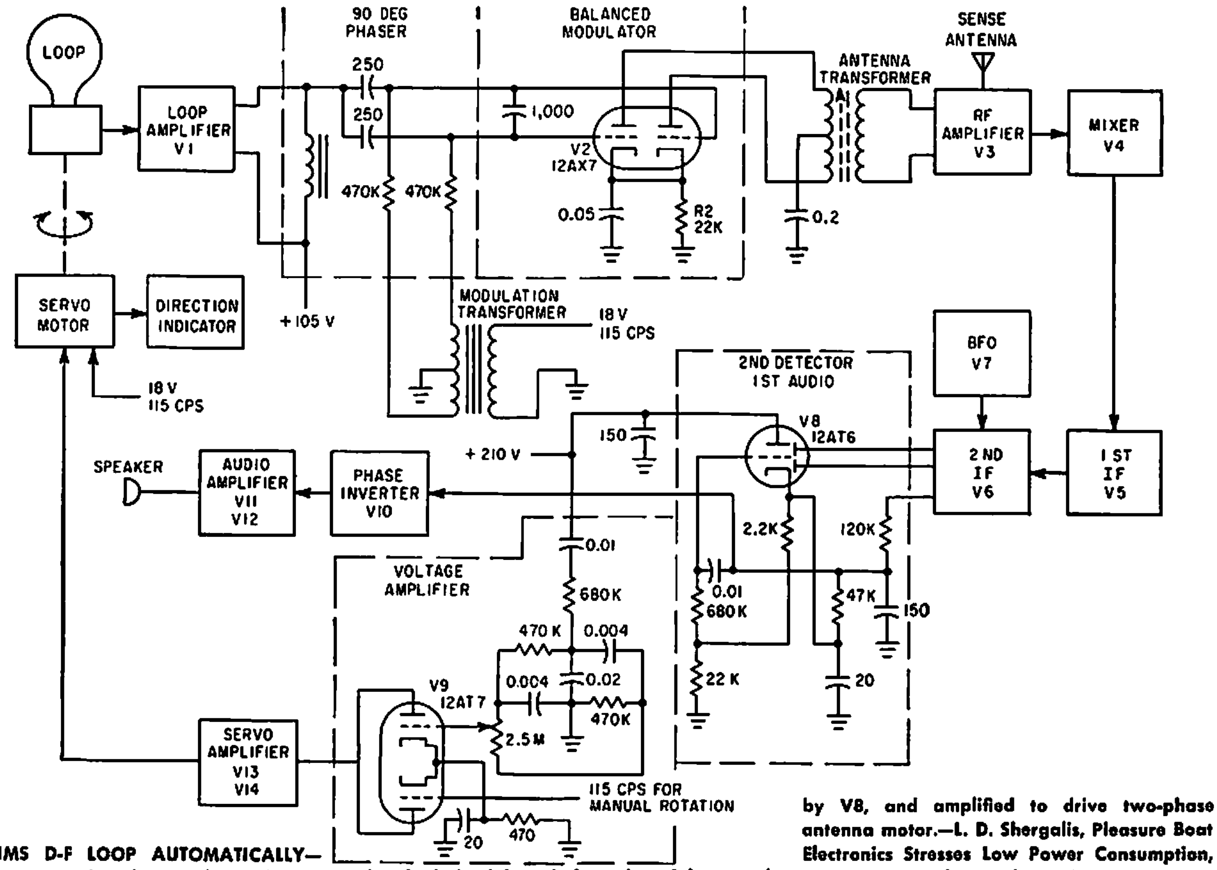
FINE SERVO REGULATOR—Used in double-loop servo system that holds field of large electromagnet constant to one part in 15,000,000. Primary loop or rough regulator establishes small region over which fine regulator operates. Uses 20 paralleled transistors in output stage to regulate by dissipating some of available power.—A. M. Patlach, Precision Servo Regulator Controls High-Power Magnetic Field, *Electronics*, 33:45, p 66–69.



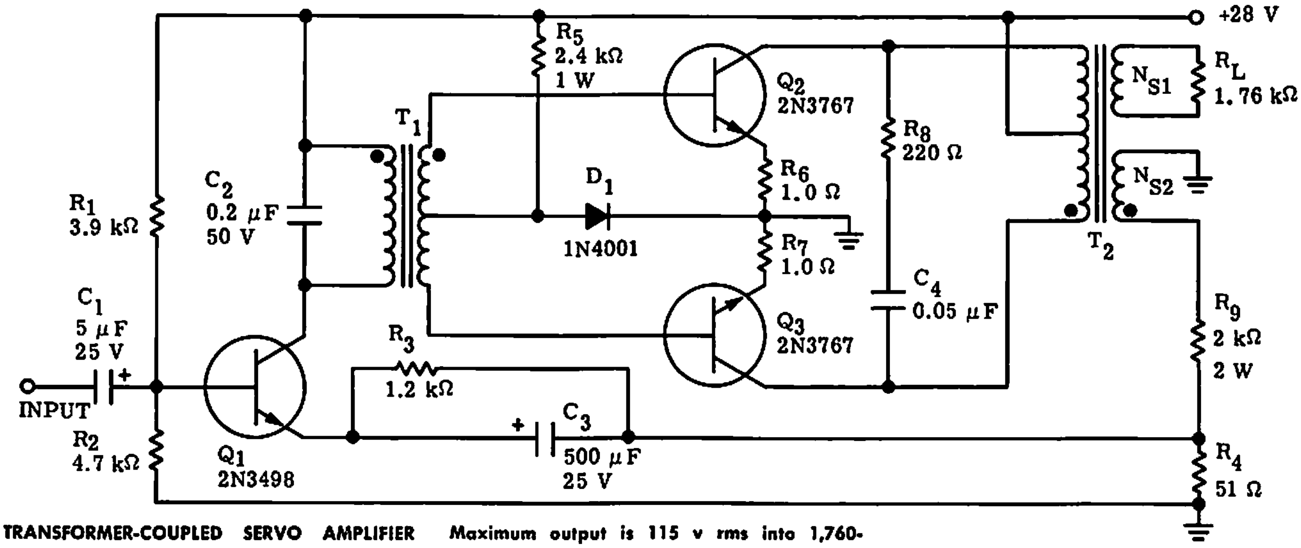
TRANSDUCER SCANNER—Monitors transducer outputs in parallel mode and reports when any one of measured parameters exceeds or falls below predetermined limit. Superimposing a-c signal on d-c control voltage permits use of a-c servo as indicator.—S. Thaler, Solid-State Parallel-Mode Scanner Reads System Physical Parameters, *Electronics*, 34:19, p 78–80.



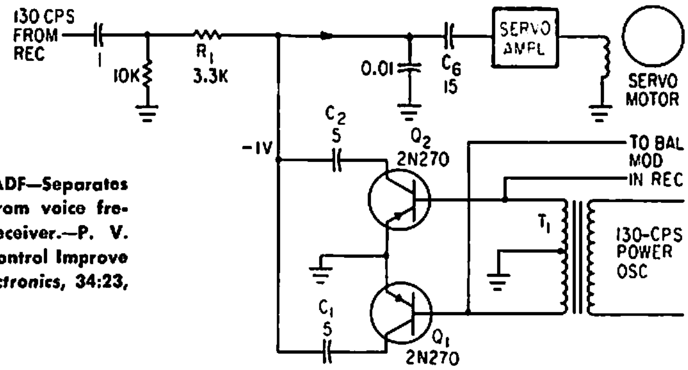
ROUGH SERVO REGULATOR—Drives autotransformer to establish narrow range of fine regulator for close control of field of large electromagnet having 50-kw excitation. —A. M. Patlach, Precision Servo Regulator Controls High-Power Magnetic Field, *Electronics*, 33:45, p 66–69.



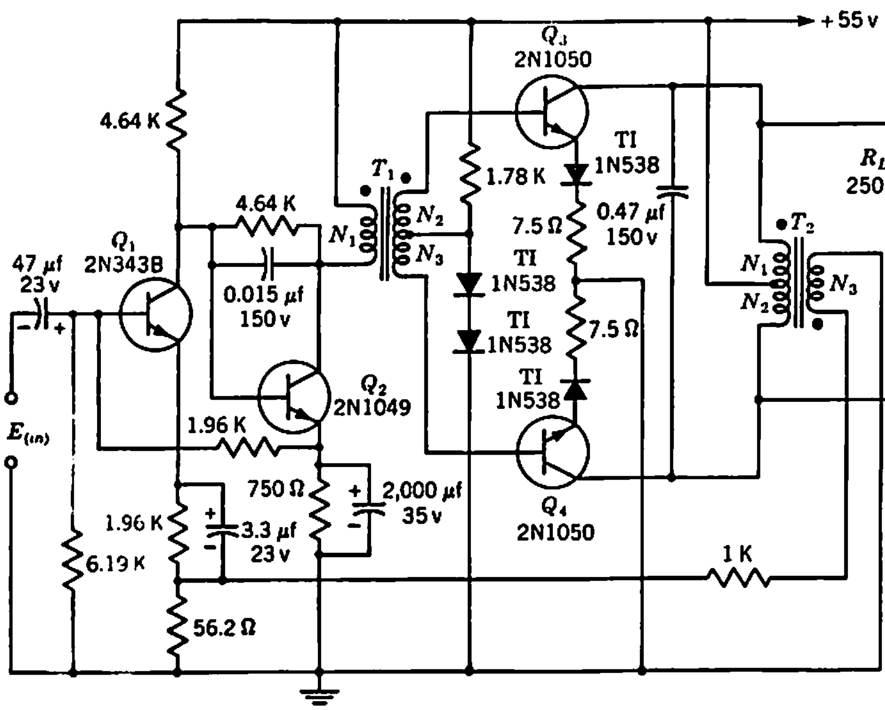
SERVO AIMS D-F LOOP AUTOMATICALLY—Bearing accuracy of 3 deg is obtained over frequency range of 190 kc to 2.8 Mc. Error signals derived from balanced modulator and sense antenna are mixed, amplified, detected by V8, and amplified to drive two-phase antenna motor.—L. D. Shergalis, Pleasure Boat Electronics Stresses Low Power Consumption, Operating Simplicity, *Electronics*, 35:4, p 20–21.



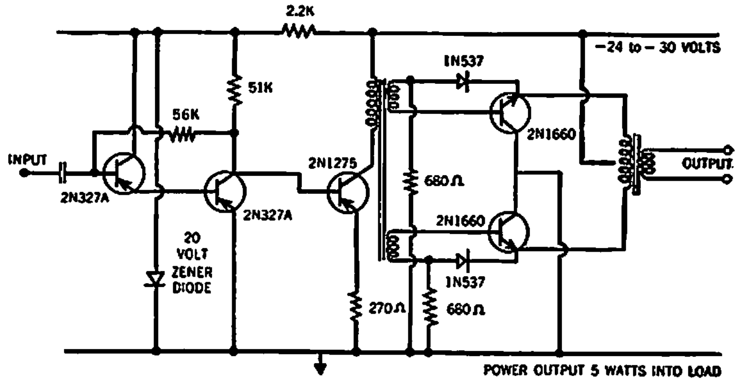
TRANSFORMER-COUPLED SERVO AMPLIFIER—Three transistors provide stable voltage gain of 40 db and power gain of 37 db. Maximum output is 115 v rms into 1,760-ohm load, for 7.5 w.—N. Freyling, "High Performance All Solid-State Servo Amplifiers," Motorola Application Note AN-225, Jan. 1966.



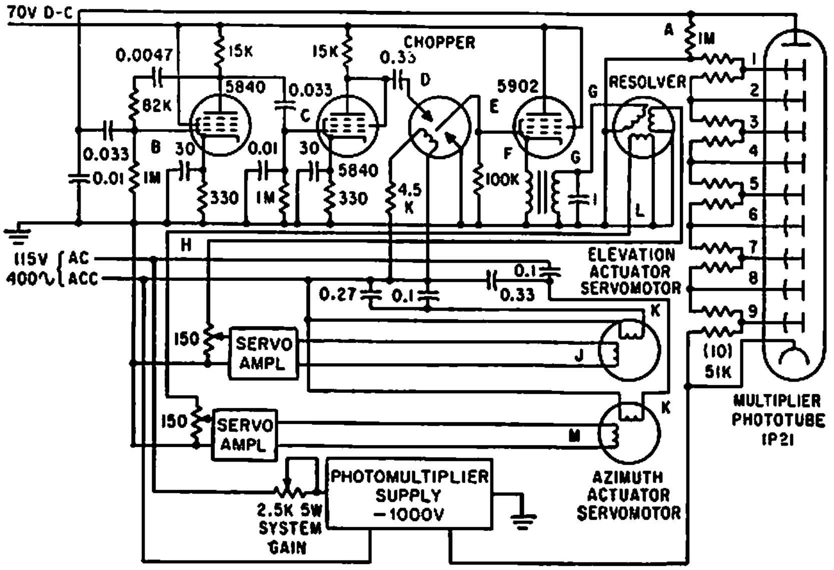
SYNCHRONOUS FILTER FOR ADF—Separates 130-cps motor drive voltage from voice frequencies in output of adf receiver.—P. V. Sparks, Servo Filter and Gain Control Improve Automatic Direction Finder, *Electronics*, 34:23, p 110–113.



10-W CLASS B SERVO AMPLIFIER—Gives power gain of 39 db. Voltage amplification is constant within 1 db of 32.5 db. Transformer data is for 400-cps operation.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 243.



LOW-POWER DRIVER—Pair of high-voltage, high-gain silicon power transistors gives 5 w output from −55 to +125°C when driven by 250-mw 2N1275 transistor.—New High Voltage, High Gain Transistors (Raytheon Ad), *Electronics*, 33:35, p 42.

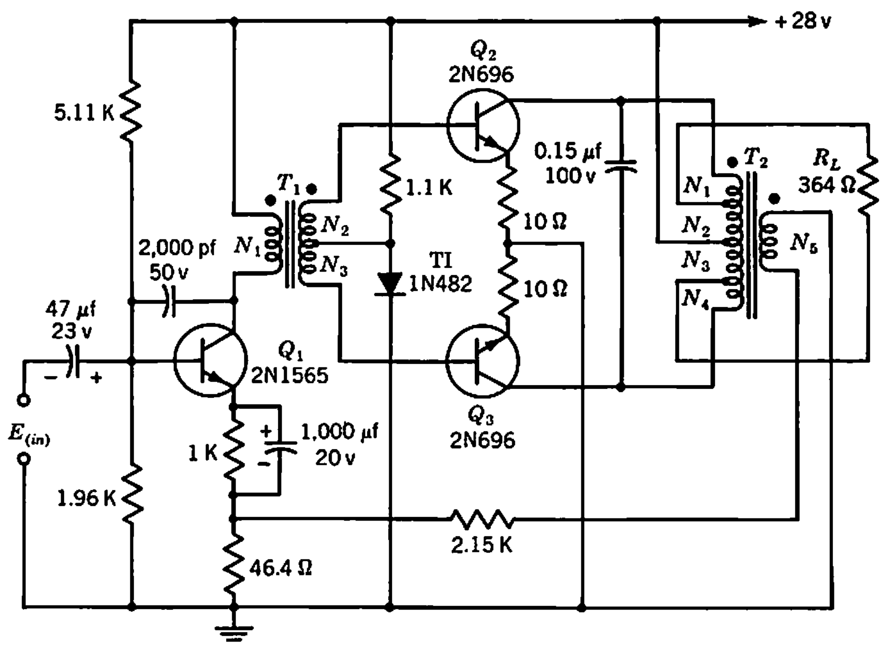


SERVO-CONTROLLED GAIN—Gain is controlled by varying photomultiplier input voltage, permitting photoelectric system to track brightness range from remote stars to moon.—W. J. Wichman and M. M. Birnbaum, Servo System Design for Balloon-Borne Star Trackers, *Electronics*, 34:35, p 43–46.

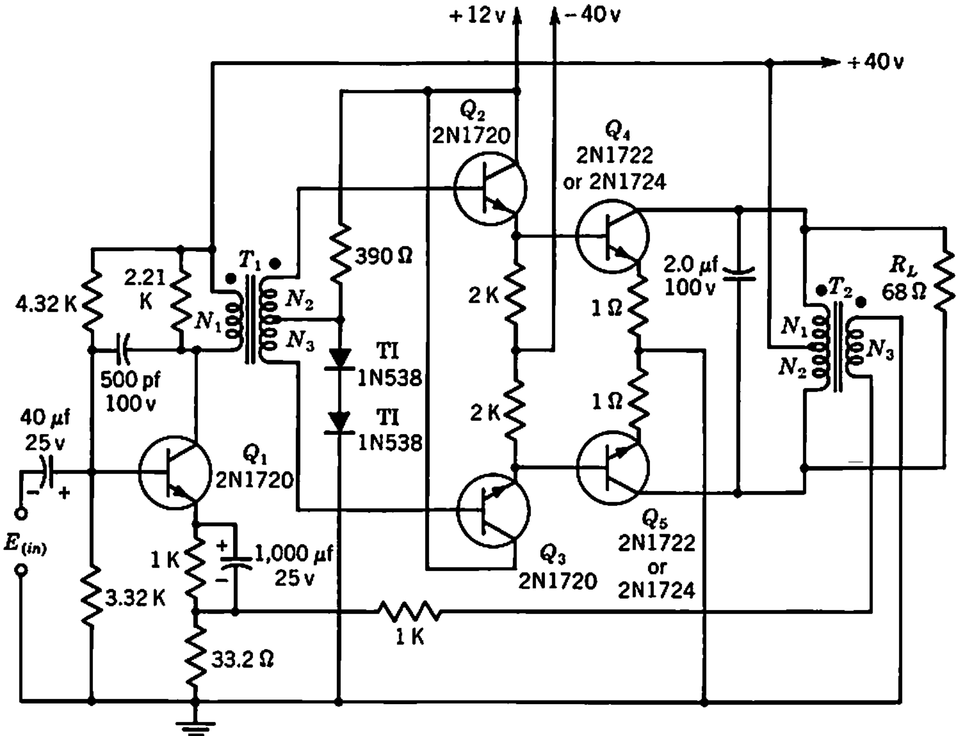
Transformer data

T_1—N_1 = 2050 turns No. 35 AWG. $N_2 = N_3$ = 466 turns No. 29 AWG, bifilar wound. Core: Magnetic Metals 75 EI, SL-14, or equivalent, butt-jointed.

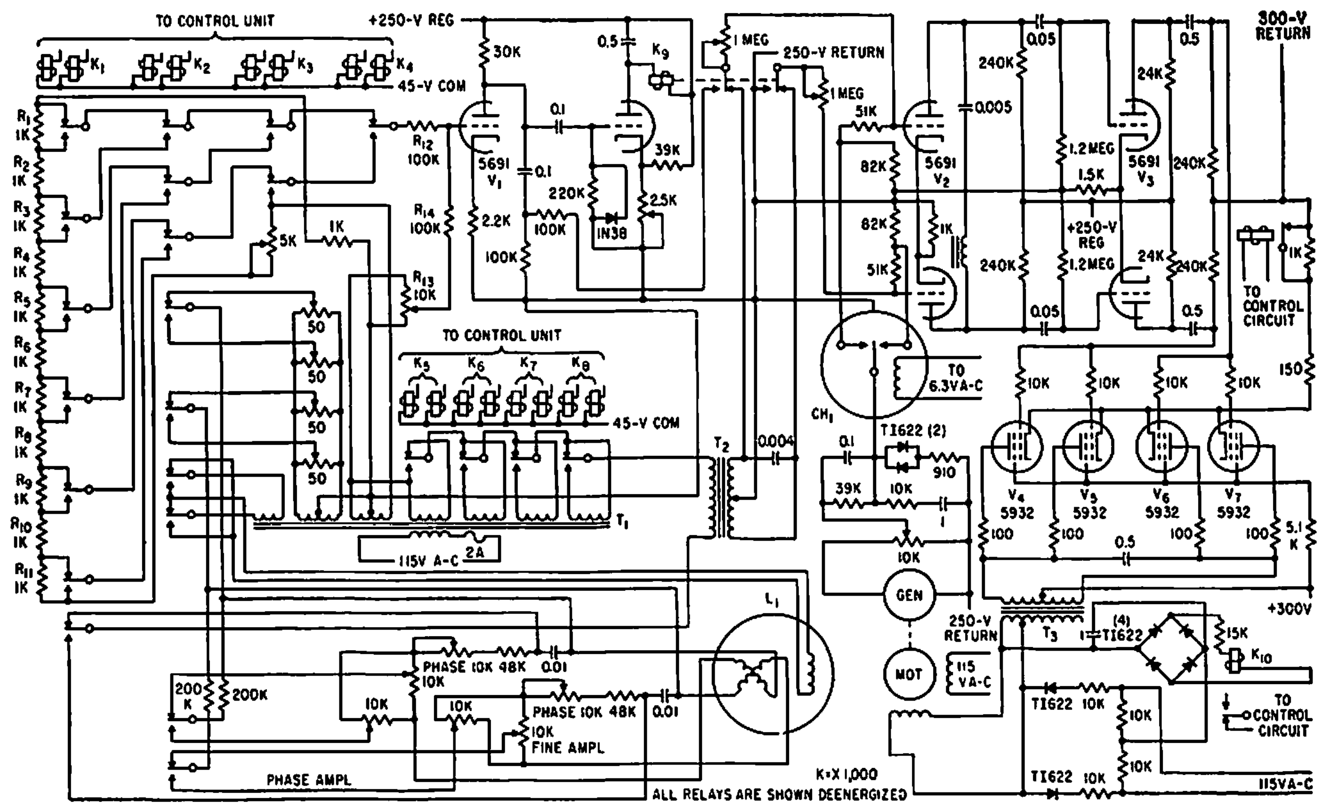
T_2—$N_1 = N_4$ = 90 turns No. 29 AWG. $N_2 = N_3$ = 433 turns No. 29 AWG, bifilar wound. N_5 = 303 turns No. 38 AWG. Core: Magnetic Metals Carpenter 49, 0.006-in. 375 EI or equivalent, 8 × 8 interleaved.



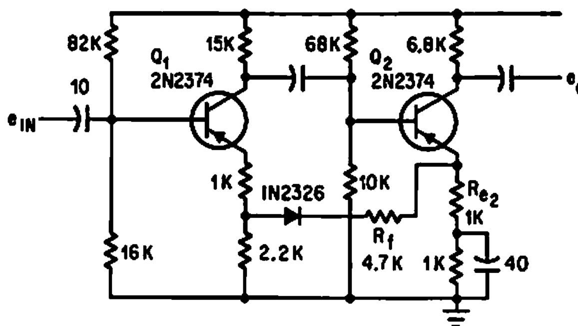
1.5-W CLASS B SERVO AMPLIFIER—Gives power gain of 38 db. Voltage amplification is constant within 1.5 db of 40.5 db. Transformer data is for 400-cps operation.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 240.



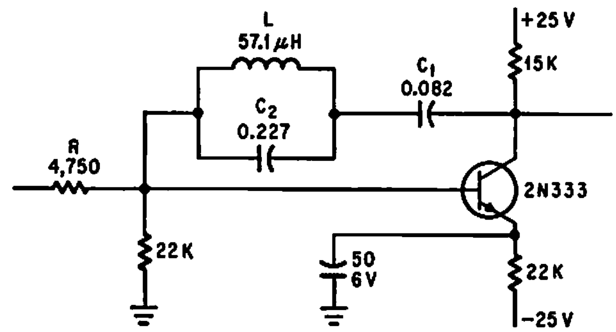
35-W CLASS B SERVO AMPLIFIER—Gives power gain of 45 db. Voltage amplification is constant within 1.5 db of 36.5 db. Transformer data is for 400-cps operation.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 244.



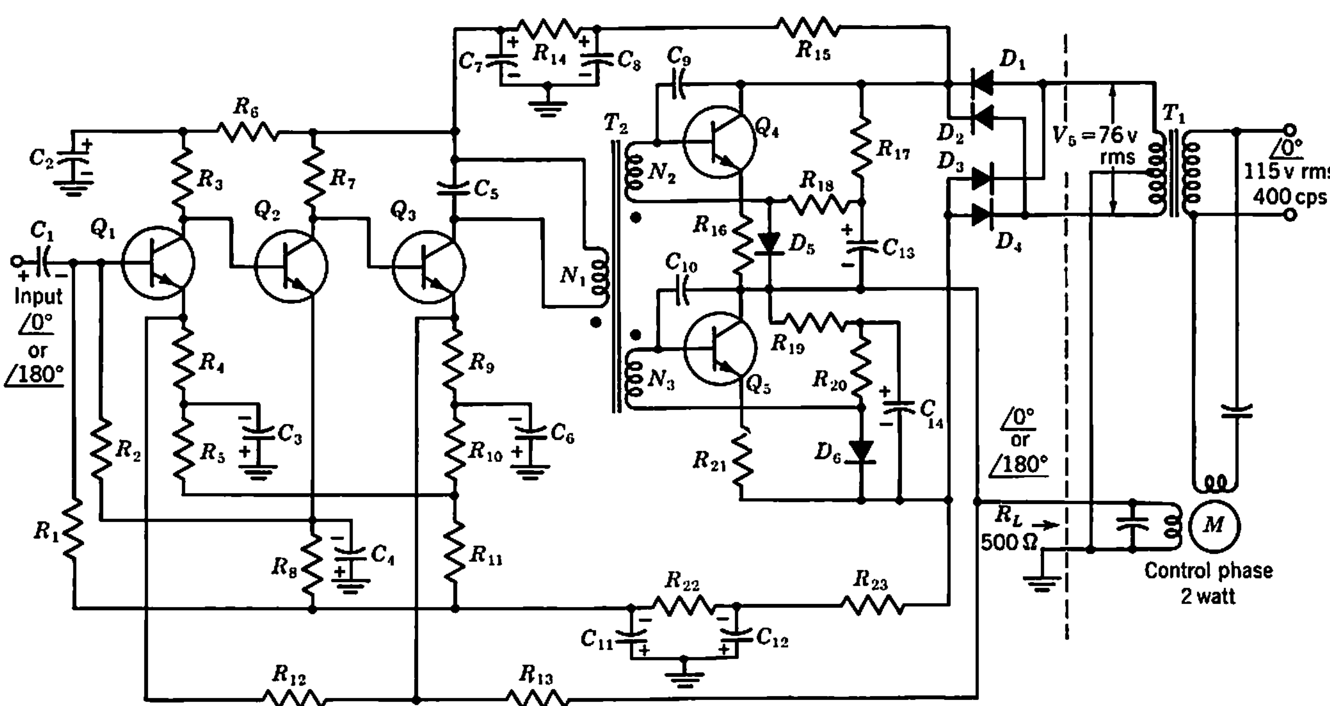
PROGRAMMED SERVO—Positions printed-circuit board in response to controller commands. Component selection and insertion are also directed by controller. Relays apply fine and coarse voltages to servo positioner as required.—S. B. Korin and F. B. Spencer, Programmed Servo Speeds Short-Run Production, *Electronics*, 32:10, p 54–56.



COMBINED NEGATIVE-POSITIVE FEEDBACK—Two-stage common-emitter amplifier permits use of positive feedback to Rf along with negative feedback, to give stability factor of 5 and overall gain of 47 db with input impedance of 10,000 ohms for small-pulse amplification in servo system.—N. A. Wade, Combined Feedback Stabilizes Amplifier, *Electronics*, 37:15, p 76.



400-CPS SERVO AMPLIFIER SUPPRESSES THIRD HARMONIC—Single-transistor operational amplifier for 400-cps servosystems gives accurate 90-deg phase shift at carrier frequency and open-loop gain of 34 db. Circuit resonance at 1,200 cps keeps third harmonic 20 db down.—M. Schmidt, Operational Amplifier Suppresses Third Harmonic, *Electronics*, 35:13, p 74.



Parts List

Resistors	Ohms	Watts	Resistors	Ohms	Watts
R_1	68 K	¼	R_{10}, R_{15}, R_{23}	1.5 K	½
R_2, R_3	22 K	¼	R_{11}	680	¼
R_4	39	¼	R_{13}	4.7 K	¼
R_5	2.2 K	¼	R_{14}, R_{22}	390	¼
R_6, R_{12}	15 K	¼	R_{16}, R_{21}	15	¼
R_7	10 K	¼	R_{17}, R_{19}	3.3 K	2
R_8	5.1 K	¼	R_{18}, R_{20}	470	¼
R_9	100	¼			

Transistors

Q_1, Q_2	2N337
Q_3	2N656
Q_4, Q_5	2N1048

Capacitors	μf	Volts
C_1	6.8	20
C_2, C_3, C_4, C_6	47	20
C_5*	0.1	
C_7, C_8, C_{11}, C_{12}	47	35
C_9, C_{10}	0.001	
C_{13}, C_{14}	39	10

Transformers

T_1 400-cps 4-watt power transformer. Step-down 115–76-volt center-tapped.

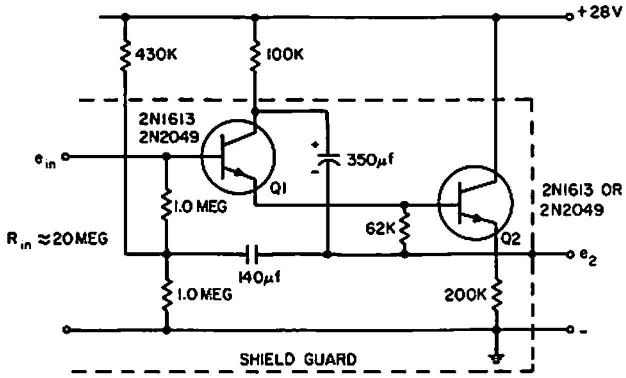
T_2 400-cps 50-mw driver transformer: Turns ratio: $N_1 : N_2 : N_3 = 3.7:1:1$. Primary current = 5 ma d-c. Primary inductance ≅ 1.5 henrys.

Diodes

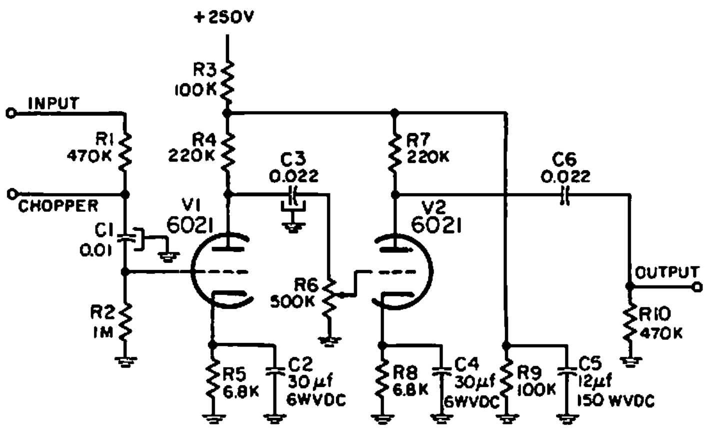
D_1, D_2, D_3, D_4	1N645
D_5, D_6	1N482

* Value depends on primary inductance of T_2.

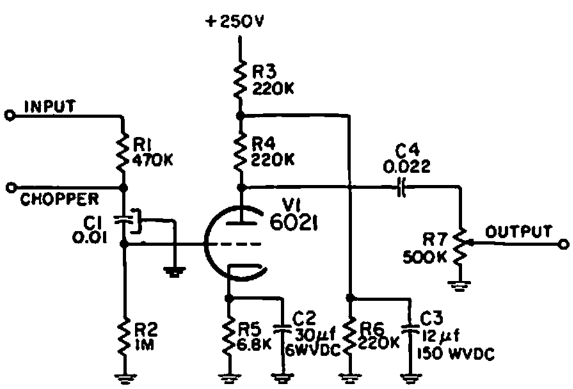
COMPLETE 2-W SERVO AMPLIFIER—Includes direct-coupled preamplifier and driver stages, with considerable d-c feedback to stabilize bias conditions. Voltage gain of amplifier with feedback loop closed is 10,000. Overall efficiency is 50%. Input impedance is 10,000 ohms and output impedance is 150 ohms.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 247.



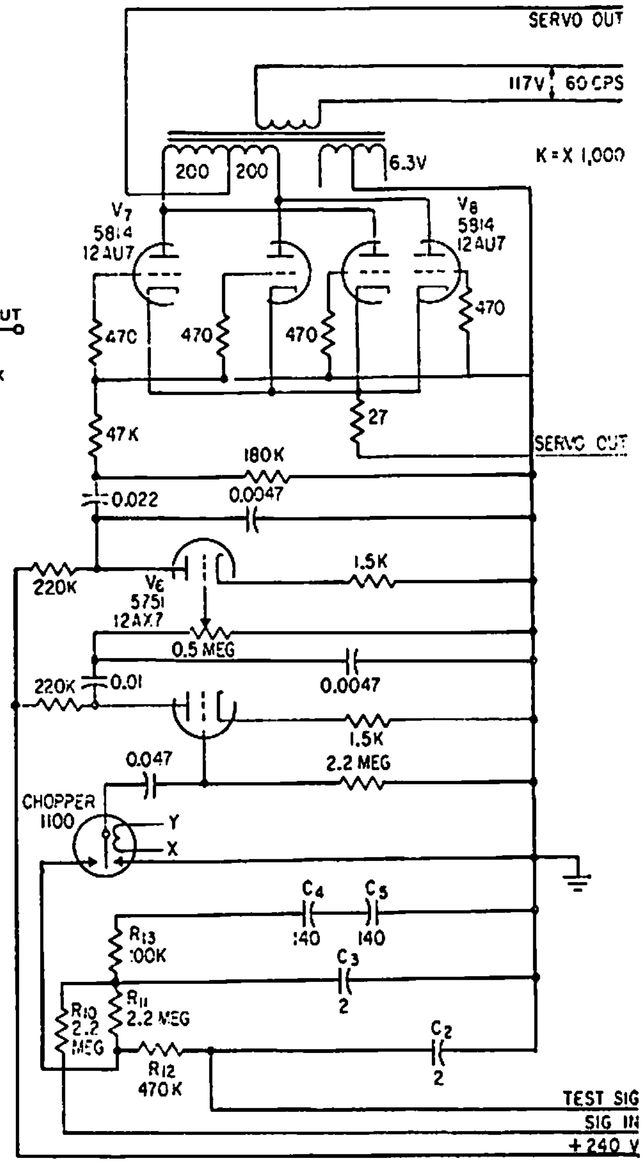
BOOTSTRAPPED EMITTER-FOLLOWER—Bandwidth is 1 cps to 5 kc. Gives stable operation in servo systems even with positive feedback, because loop gain is less than unity. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 217.



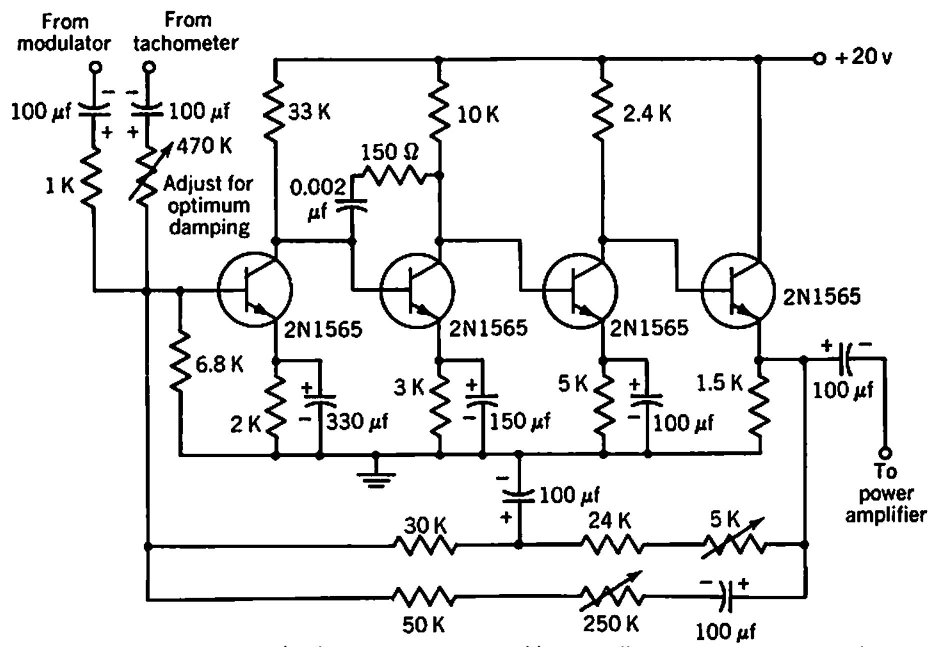
PREFERRED AMPLIFICATION-300 PREAMPLIFIER—Used with instrument servo motor controller to increase available gain. Chopper is used with d-c inputs only.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 73, p 73-2.



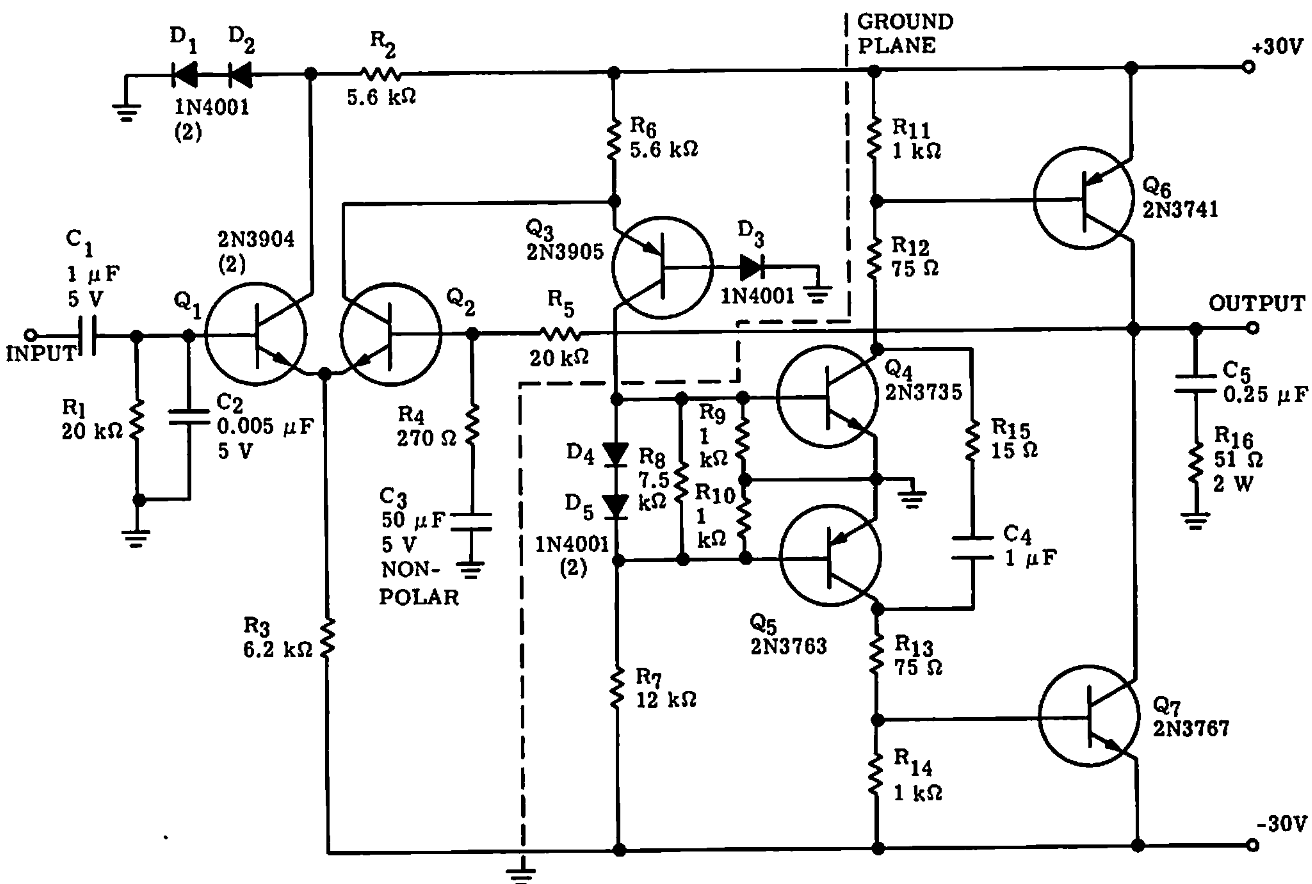
PREFERRED AMPLIFICATION-15 PREAMPLIFIER—Used with instrument servo motor controller to increase available gain. Choice of preamplifier depends on error voltage per degree error available. Chopper is used with d-c inputs only.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 71, p 71-2.



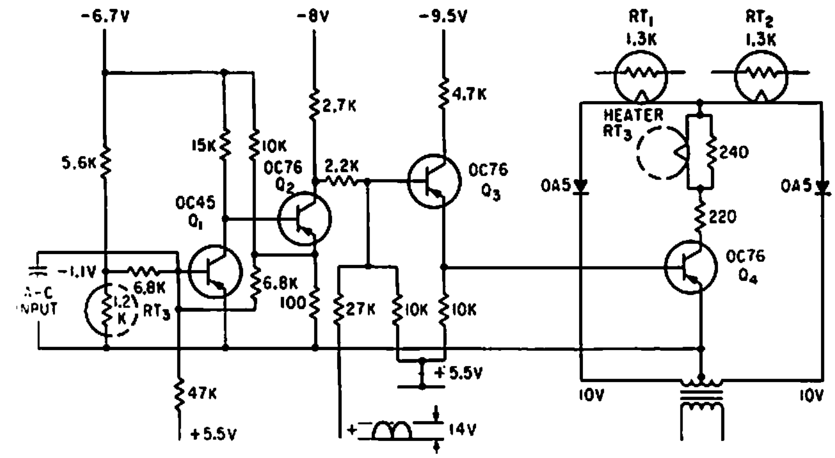
60-CPS SERVO AMPLIFIER—Consists of 60-cps d-c chopper, two stages of 60-cps voltage amplification V6, and 4-w power output stage V7-V8 that drives control winding of two-phase servo motor. Over-all power gain is 80 db.—P. G. Balko, Infrared Finds Audio Suspension Leaks, *Electronics*, 31:49, p 82-85.



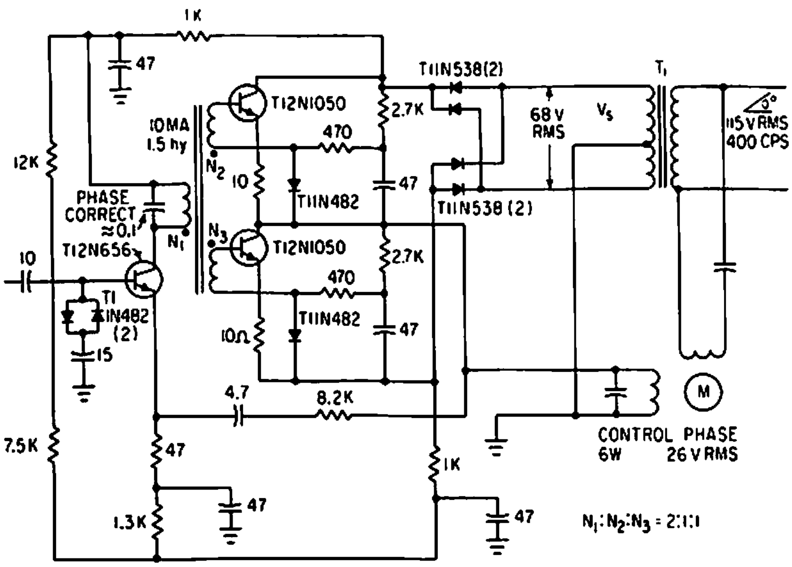
OPERATIONAL PREAMPLIFIER—Used to sum modulator and tachometer outputs and provide signal for power amplifier that drives split-phase motor. Adjustable overall d-c feedback insures equal clipping when amplifier is overloaded, so squared output will have equal mark-space ratio.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 493.



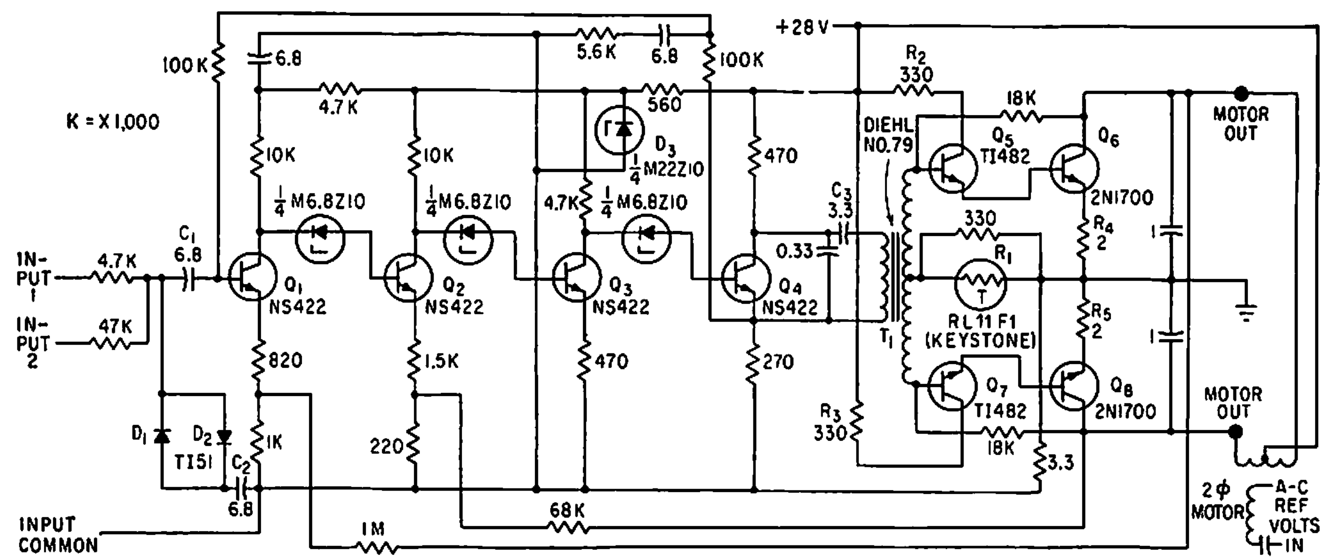
COMPLEMENTARY-TRANSISTOR SERVO AMPLIFIER—Use of direct coupling eliminates transformers. For d-c loads, C1 and C3 must be shorted. Will drive 20 v rms into 40-ohm load, giving 10 w. Voltage gain is 37 db and power gain is 60 db.—N. Freyling, "High Performance All Solid-State Servo Amplifiers," Motorola Application Note AN-225, Jan. 1966.



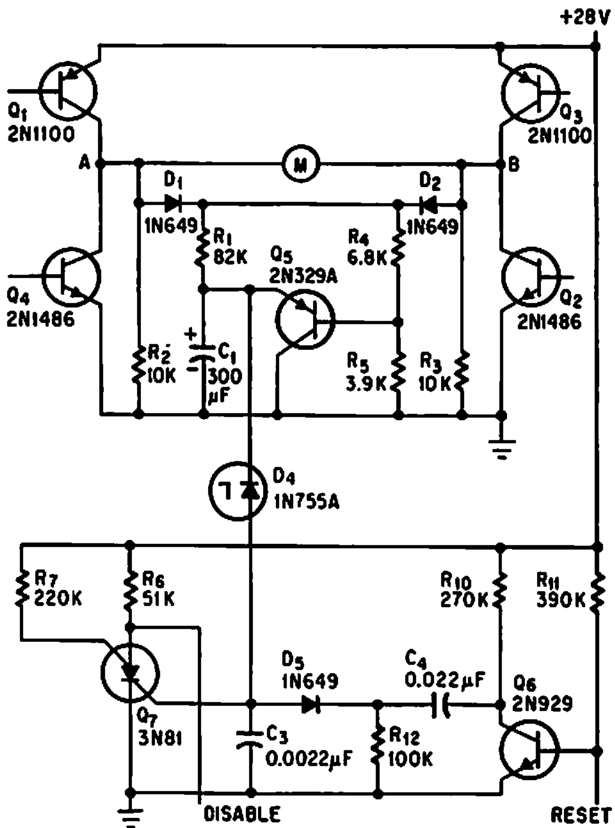
THERMISTOR CONTROL—Thermistors RT1 and RT2 in series are heated equally under no signal. Applying a-c signal increases resistance of one and lowers that of other, depending on phase. Q1 and Q2 form a-c preamp. Q3 and Q4 operate in switched mode as demodulator. Circuit can be used in place of mechanical servo.—I. C. Hutcheon, Using Thermistors as Servo Elements, *Electronics*, 34:5, p 52–55.



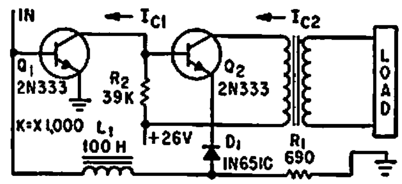
6-WATT SERVO AMPLIFIER—Unconventional output stage eliminates need for center tap on servomotor for controlled winding, gives 55% overall efficiency.—J. A. Walston and J. E. Setliff, Designing Servo Amplifiers for High Efficiency, *Electronics*, 36:6, p 62–63.



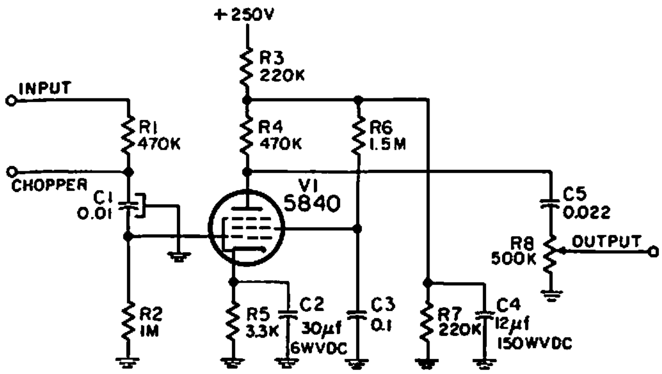
50, 60, and 400-CPS SERVO AMPLIFIER—Solid-state 10-w amplifier handles all three power frequencies, operates from 28v d-c, and uses four-transistor Darlington output stages to drive two-phase servo motor. Preamplifier and drive stages Q1-Q4 are all d-c coupled through zener diodes, with d-c feedback around all four stages to stabilize bias against temperature changes.—M. Bodnar, Versatile Servo Amplifier for 50, 60 or 400-Cycle Operation, *Electronics*, 36:3, p 44–45.



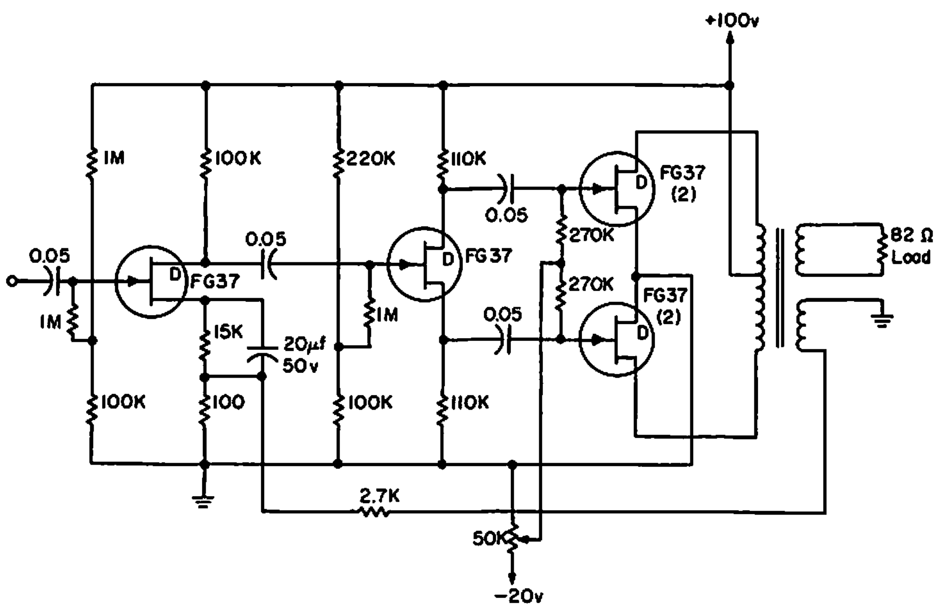
STALLED SERVO MOTOR SHUTOFF—Silicon controlled switch Q7 in timing circuit turns on each time servo motor is actuated, and removes power from motor if it remains on more than 15 sec, indicating a stall.—D. Perlman, Silicon Switch Turns Off Stalled Servomotors, *Electronics*, 39:10, p 90–91.



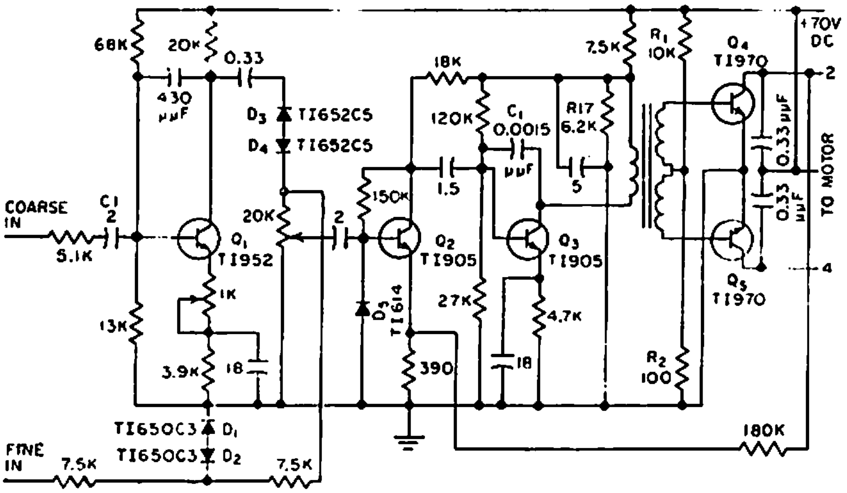
DIRECT-COUPLED PREAMP—Direct-coupled silicon-transistor amplifier uses zener diode to provide constant voltage, and has adequate d-c stability even with transistors having beta range of 3:1.—A. N. Desautels, Servo Preamplifiers Using Direct-Coupled Transistors, *Electronics*, 32:20, p 74.



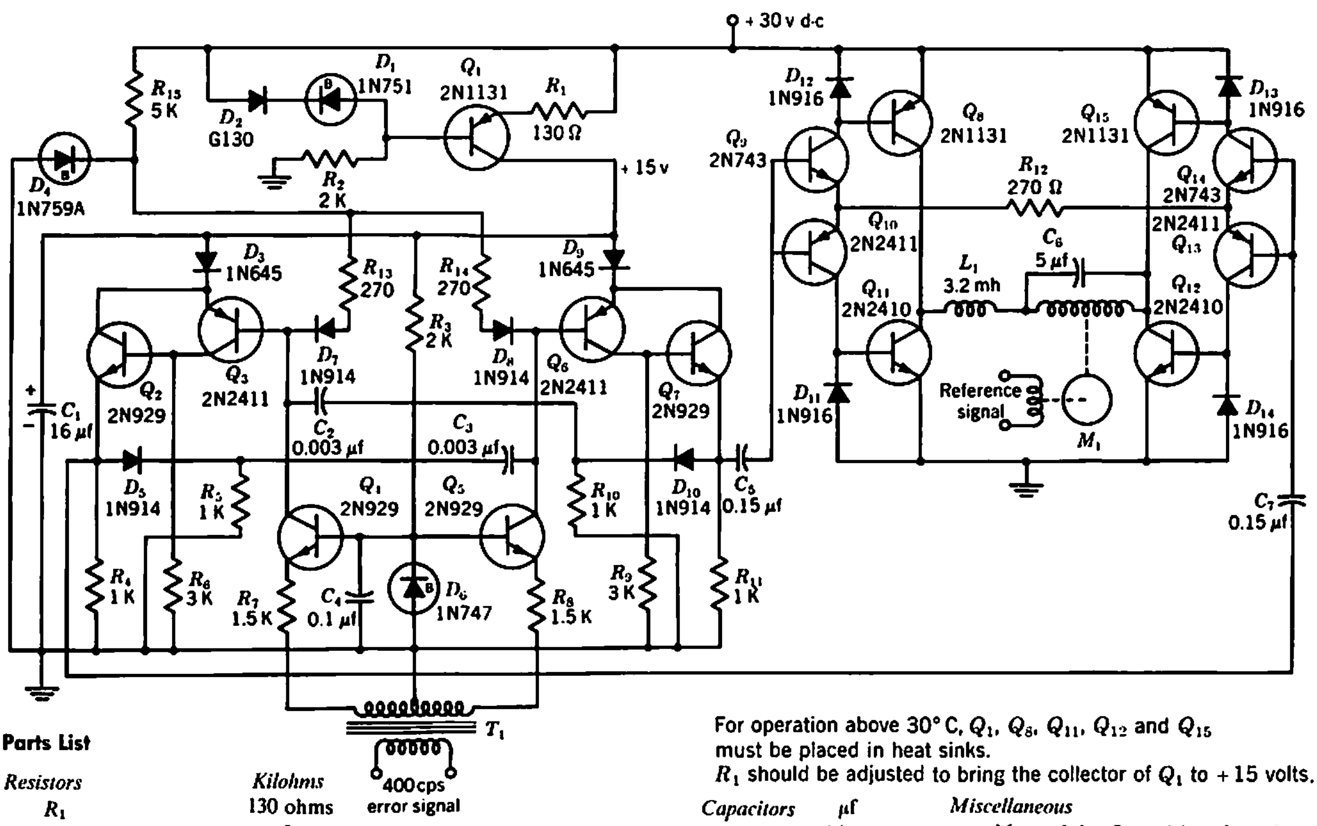
PREFERRED AMPLIFICATION-70 PREAMPLIFIER—Used with instrument servo motor controller to increase available gain. Chopper is used with d-c inputs only. Frequency range is 380 to 420 cps.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 72, p 72–2.



FET SERVO AMPLIFIER—Servo amplifier uses medium-power fet's for 1.5 w output. Circuit has no driver transformer for power stage, and only one electrolytic. Power gain is 70 db, voltage amplification 30 db, input resistance 1 meg, and maximum efficiency 56%.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 100.



TWO-SPEED SERVO—Directly drives size 11 motor, eliminating need for output transformer. Zener diodes provide switching between fine and coarse signals for two speeds. Maximum coarse and fine signal input is 26 v rms at 400 cps. Voltage gain of coarse amplifier Q1 is 25, and gain of feedback amplifier Q2-Q3-Q4-Q5 is 460.—B. E. Orr, Direct Drive Amplifier for Two-Speed Servos, *Electronics*, 31:11, p 146–147.



For operation above 30° C, Q_1, Q_8, Q_{11}, Q_{12} and Q_{15} must be placed in heat sinks.

R_1 should be adjusted to bring the collector of Q_1 to +15 volts.

Parts List

Resistors	*Kilohms*
R_1	130 ohms
R_2, R_3	2
R_4, R_5, R_{10}, R_{11}	1
R_6, R_9	3
R_7, R_8	1.5
R_{12}, R_{13}, R_{14}	270 ohms
R_{15}	5

Transistors	
Q_1, Q_8, Q_{15}	2N1131
Q_2, Q_4, Q_5, Q_7	2N929
Q_3, Q_6, Q_{10}, Q_{13}	2N2411
Q_9, Q_{14}	2N743
Q_{11}, Q_{12}	2N2410

Diodes	
D_1	1N751
D_2	G130
D_3, D_9	1N645
D_4	1N759A
D_5, D_7, D_8, D_{10}	1N914
D_6	1N747
D_{11}, D_{12}, D_{13}, D_{14}	1N916

Transformer	
T_1	Step-down 117-12.6-volt

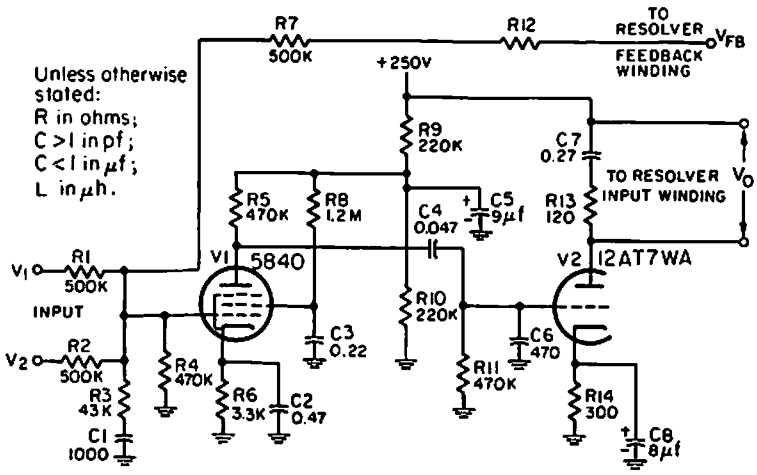
Capacitors	μf
C_1	16
C_2, C_3	0.003
C_4	0.1
C_5, C_7	0.15
C_6	5

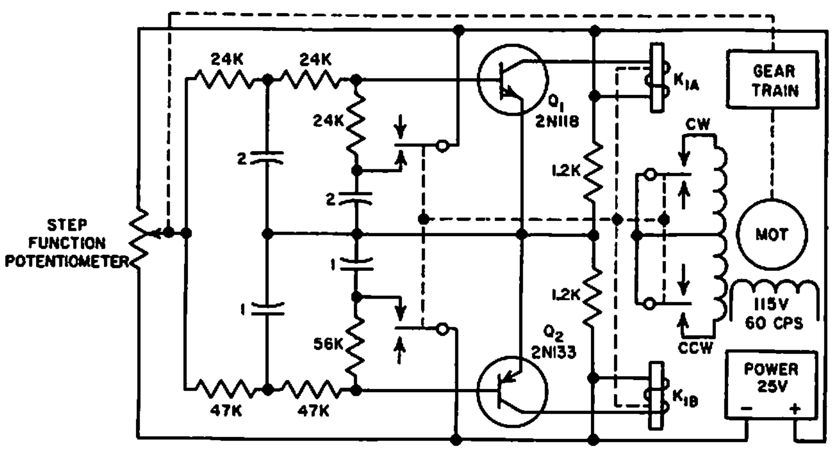
Inductor	
L_1	3.2 mh

Miscellaneous	
M_1	John Oster Manufacturing Co. type 11-5101-03

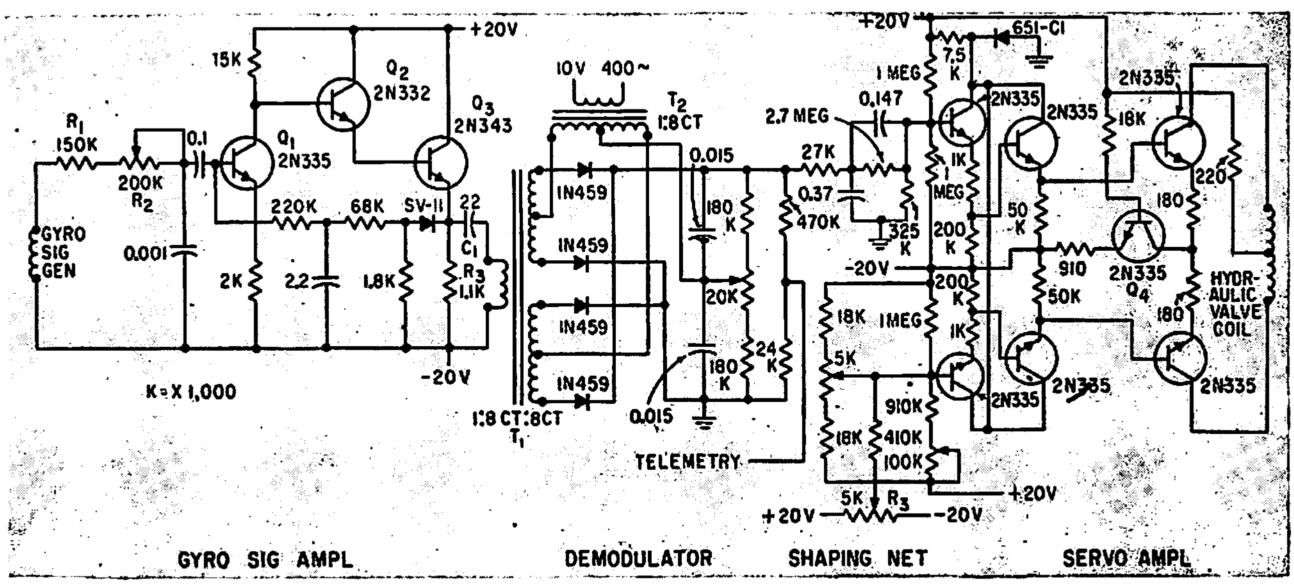
SWITCHING-MODE SERVO AMPLIFIER—Input signal is used to control duration of relatively constant repetition-rate pulse signal, to give pulse-duration modulation. Repetition rate is 10 kc. Switching-mode output stage supplies power to control winding of two-phase servo motor.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 483.

PREFERRED RESOLVER DRIVER—A-c operational amplifier is used as isolation amplifier, employing feedback that includes compensating winding of a-c resolver being driven. Useful as computing element for coordinate conversion, coordinate rotation, and resolution of vectors when accuracy of 0.5% is sufficient. Component values given are for 500 cps, with Mark 4 Mod 0 resolver.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 79, p 79-2.

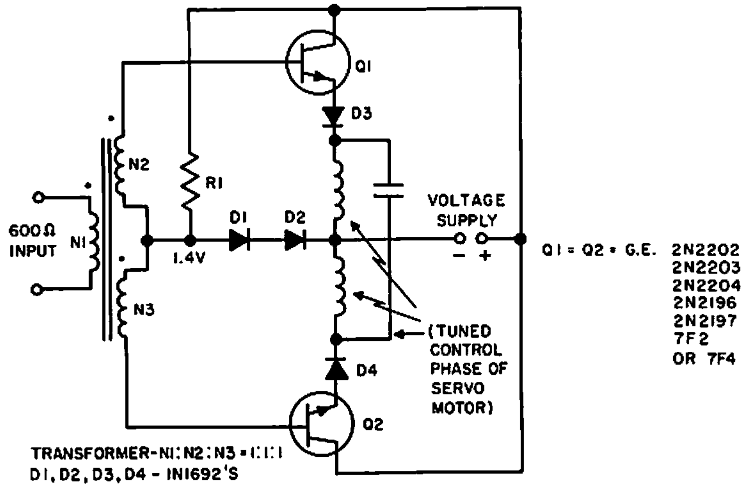




ON-OFF RELAY SERVO—Step-function potentiometer provides on-off characteristic of null detector. Easily adjusted damping is applied through differential relay contacts to eliminate oscillations. Fast response to small angular displacements assures close following. Tapping positive voltage off step-function potentiometer causes current flow through Q1, operation of relay K1A, and upward movement of arms. Negative voltage moves arms downward, reversing motor travel.—S. Shenfeld, Transistors Reduce Relay Servo Size, *Electronics*, 31:33, p 74–77.

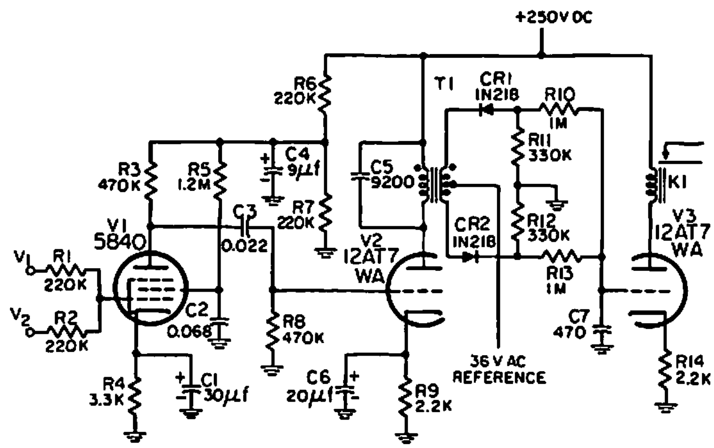


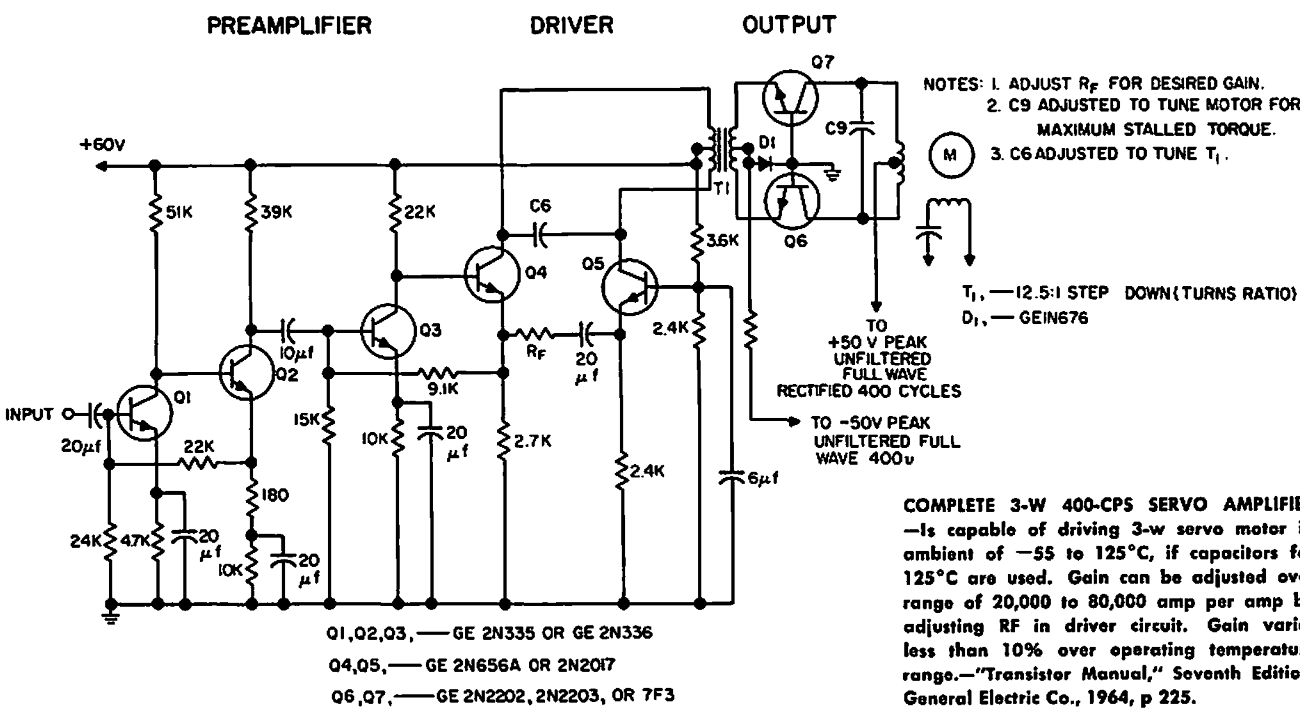
PITCH AND YAW CHANNELS—Identical channels amplify, demodulate, and shape gyro signal to feed direct-coupled differential servo amplifier whose output differential current goes to dual-coil hydraulic control valve in rocket.—R. E. King and H. Low, Solid-State Guidance For Able-Series Rockets, *Electronics*, 33:5, p 60–63.



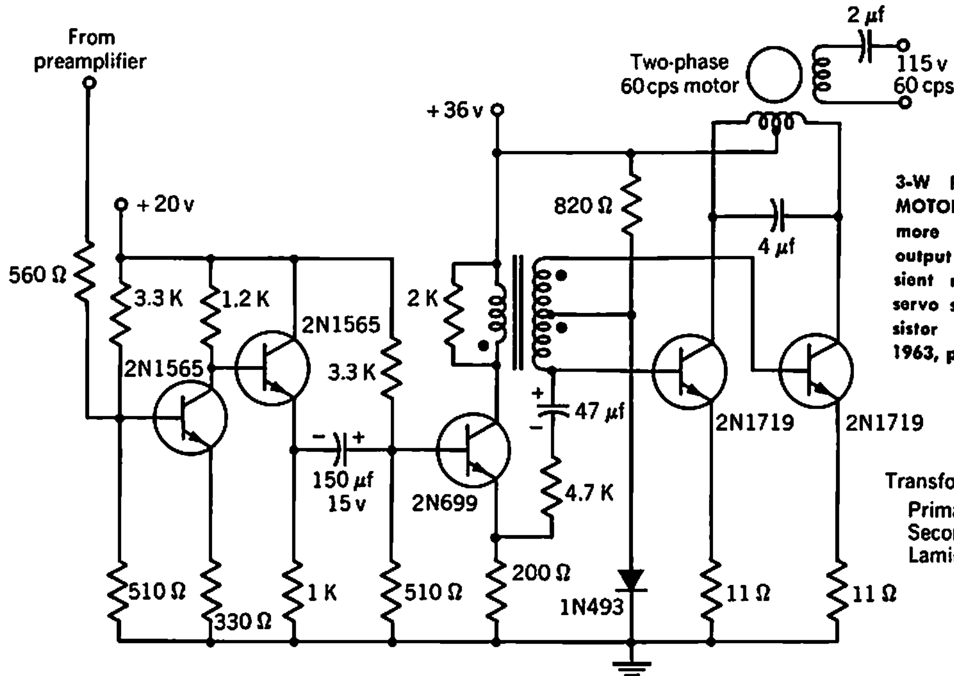
4-W SERVO MOTOR DRIVE—Emitter-follower (common collector) push-pull amplifier gives stable output stage gain along with low-impedance drive for 1 to 4-w servo motors. Forward bias of 1.4 v is developed across D1 and D2, while D3 and D4 protect transistors from inductive load generated voltages that exceed emitter-base breakdown. Efficiency is better than 60%.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 223.

PREFERRED PHASE-SENSITIVE NULL DETECTOR—Operates d-c relay when sum of input currents is zero. Circuit can be adjusted for any operating frequency from 300 to 1,000 cps by selection of C5 and C7; values given are for 500 cps. Consists of a-c amplifier, phase-sensitive detector, and relay control tube.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, PC 78, p 78-2.



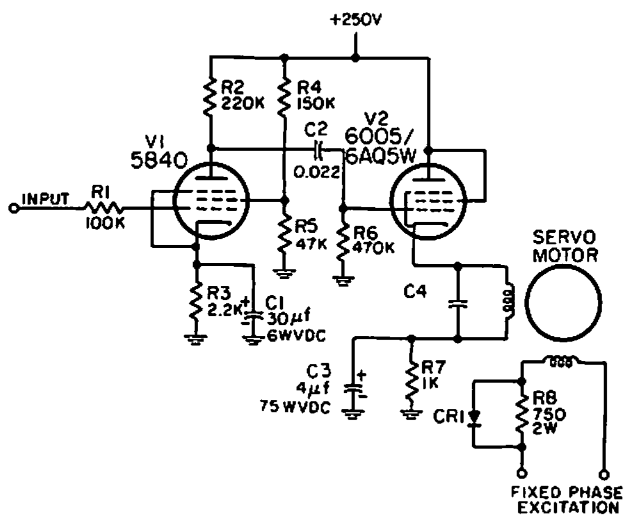


COMPLETE 3-W 400-CPS SERVO AMPLIFIER—Is capable of driving 3-w servo motor in ambient of −55 to 125°C, if capacitors for 125°C are used. Gain can be adjusted over range of 20,000 to 80,000 amp per amp by adjusting RF in driver circuit. Gain varies less than 10% over operating temperature range.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 225.

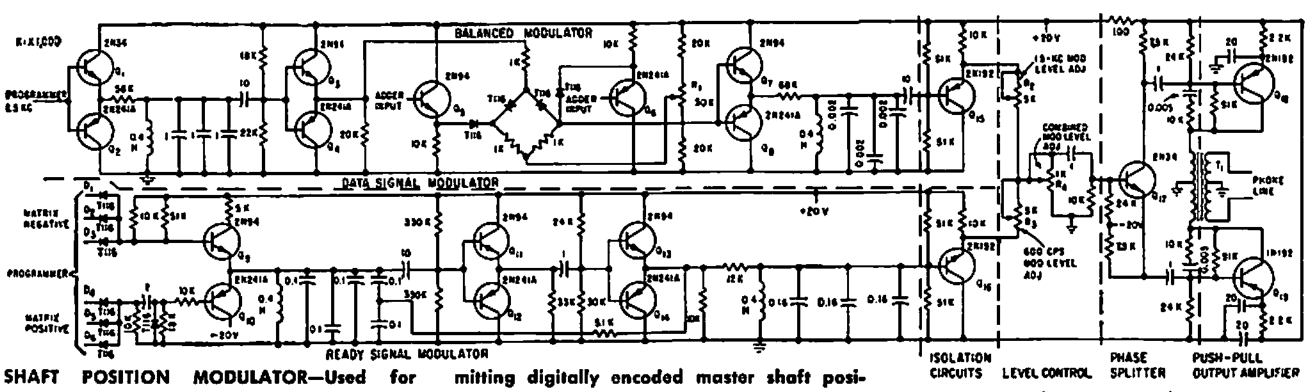


3-W POWER AMPLIFIER FOR SPLIT-PHASE MOTOR—Capacitor tunes motor to make load more resistive. Feedback is used to lower output impedance and thereby improve transient response of motor. Used in digital servo system.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 493.

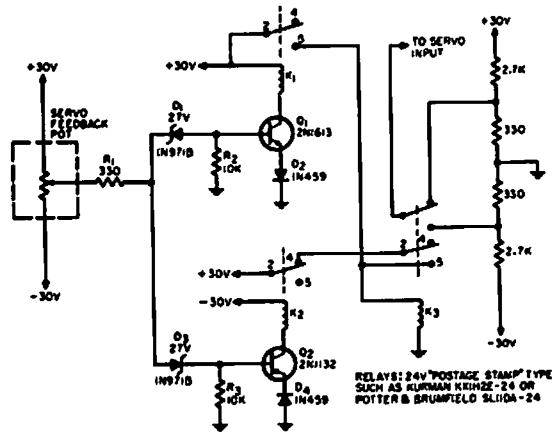
Transformer:
Primary 1630 T #35
Secondary 1020 T #29 Bifilar wound
Laminations EI 75 SL14 5 x 5 interleaved



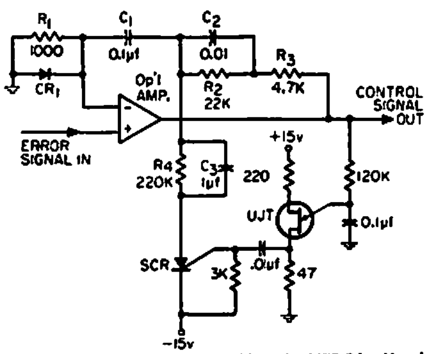
PREFERRED INSTRUMENT SERVO MOTOR CONTROLLER—Used to excite control winding of 2-phase Mark 7 Mod 1 and Mark 14 Mod 0 servo motors. Delivers nominal output of 1 w to loads with effective resistance between 2,000 and 4,000 ohms. Maximum output is 50 v. CR1 is 75-ma silicon rectifier with 70-v reverse working voltage.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 70, p 70–2.



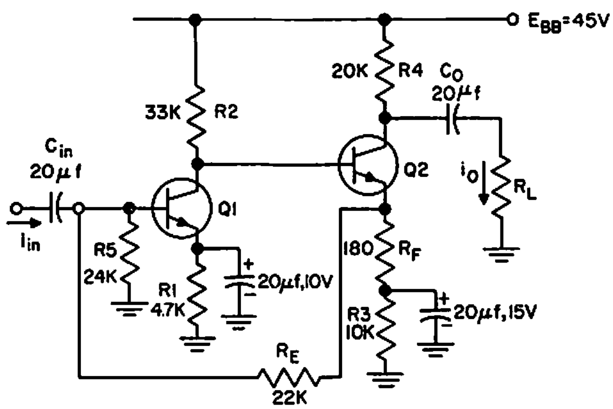
SHAFT POSITION MODULATOR—Used for modulating and mixing 1.5-kc data carrier and 600-cps ready signal in system for transmitting digitally encoded master shaft positions over phone line at 750 bits per second.—R. B. Palmiter, Digital System Positions Shafts Over Phone Line, *Electronics*, 32:7, p 62–66.



INSTRUMENT SERVO CYCLING—Used to cycle instrument servo units from stop to stop for extended periods of time, as for determining wear characteristics and friction level changes. Motor drive is applied so servo pot arm is driven toward +30 v. When 27-v breakdown of D1 is exceeded, it conducts and turns on Q1; K1 pulls in, energizing K3, and motor drive reverses. As pot arm approaches −30 v, reversing action occurs again. —P. J. Stein, Instrument Servo Cycling Circuit, *EEE*, 12:9, p 61.

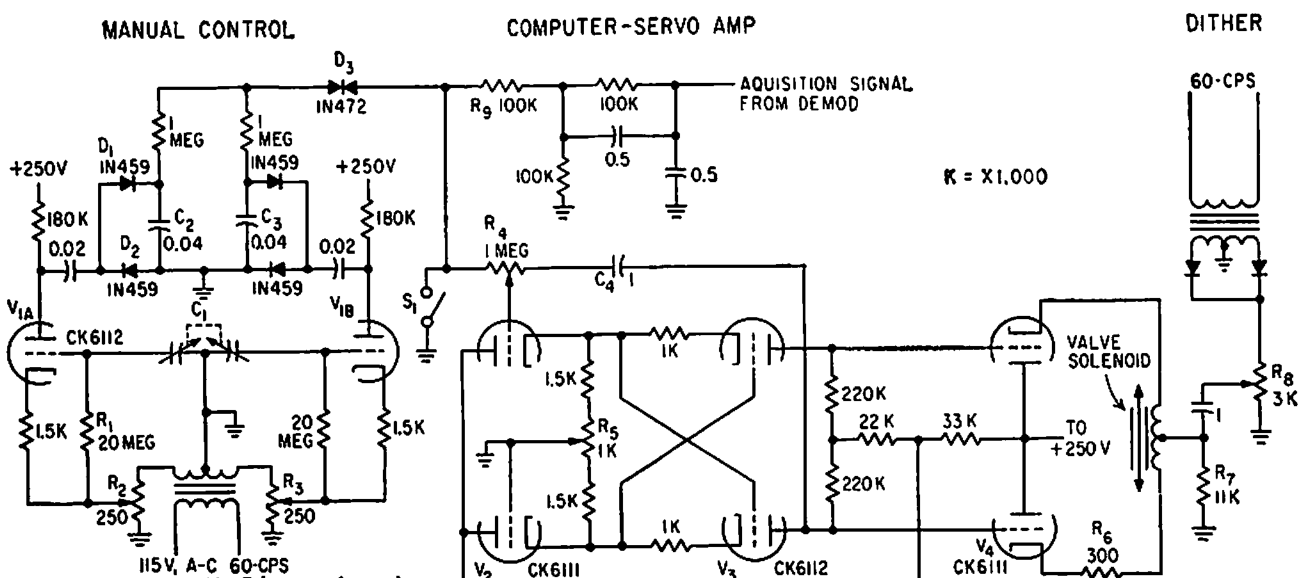


AUTOMATIC SEARCH AND CONTROL—Used in servo control systems when automatic acquisition and linear search are desired, as in afc and phase-lock controls. Basic circuit was used in phase-lock microwave systems having 300-kc bandwidth. Active integrator is used as linear search generator as well as control system integrator.—W. H. Schuette, Automatic Search and Control Circuit for Servo Loop, *EEE*, 12:11, p 67–68.

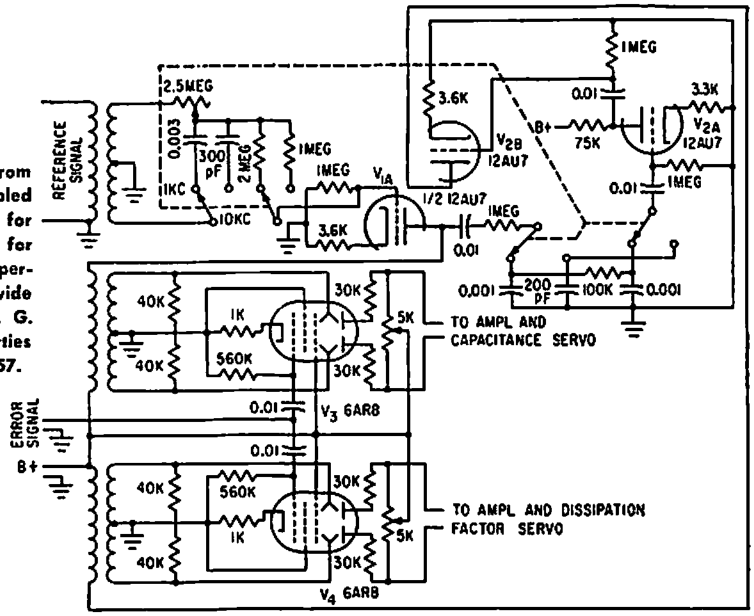


Q1 = Q2 = G.E. 2N335, 4C30, 4C31, OR 2N336

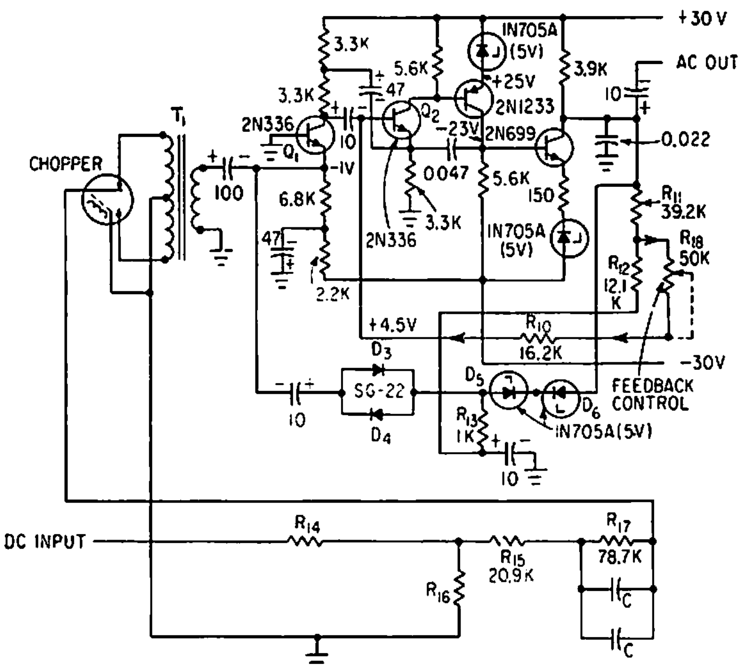
400-CPS PREAMP FOR TWO-PHASE SERVO MOTOR—Bias point and gain are stable over wide temperature range, from −55 to 125°C. No selection of transistors is required. Bias design procedure and design equations are given.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 218.



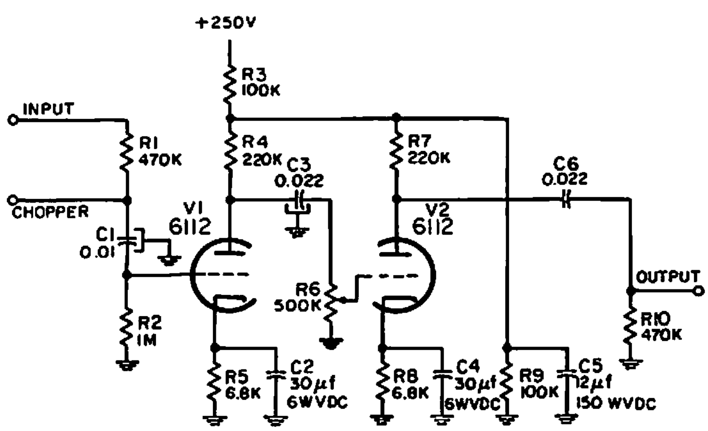
AIDED-TRACKING SERVO—Telescope is positioned on remote object by radar and then directed by operator, who adds corrections to tracking vector only if tracking rate changes. —R. L. Schaum and D. W. Savage, Joy-Stick Control Aids Telescope Tracking, *Electronics*, 32:17, p 87–89.



BRIDGE BALANCER—Reference signal from capacitance bridge is transformer-coupled into phase-shifting circuit to compensate for phase shifts in bridge and amplifier used for automatic measurement of dielectric properties. Sheet beam tubes V3 and V4 provide gating action for rebalancing servos.—P. G. Frischmann, Measuring Dielectric Properties Automatically, *Electronics*, 33:32, p 56–57.

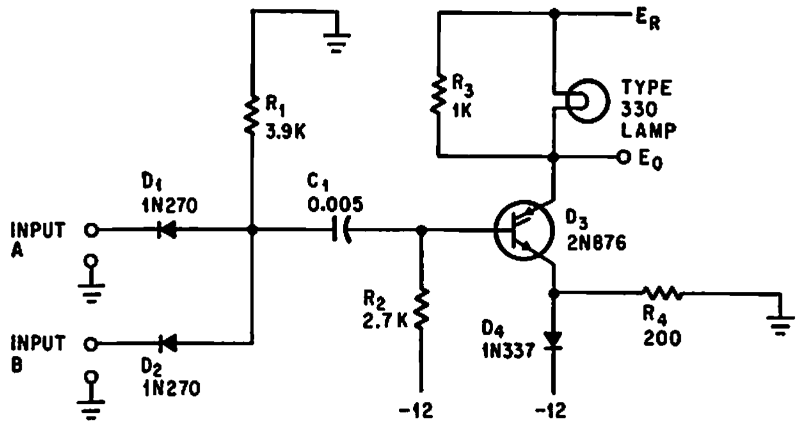


ERROR-RATE COMPENSATION AMPLIFIER—Chopped d-c input is fed to Q2 through T1 and Q1. Base of Q2 is amplifier summing point and receives feedback signals. Gain is 2.73 v rms per volt d-c.—E. R. Schlesinger, Aiming a 3-Ton Telescope Hanging from Balloon, *Electronics*, 36:6, p 47–51.

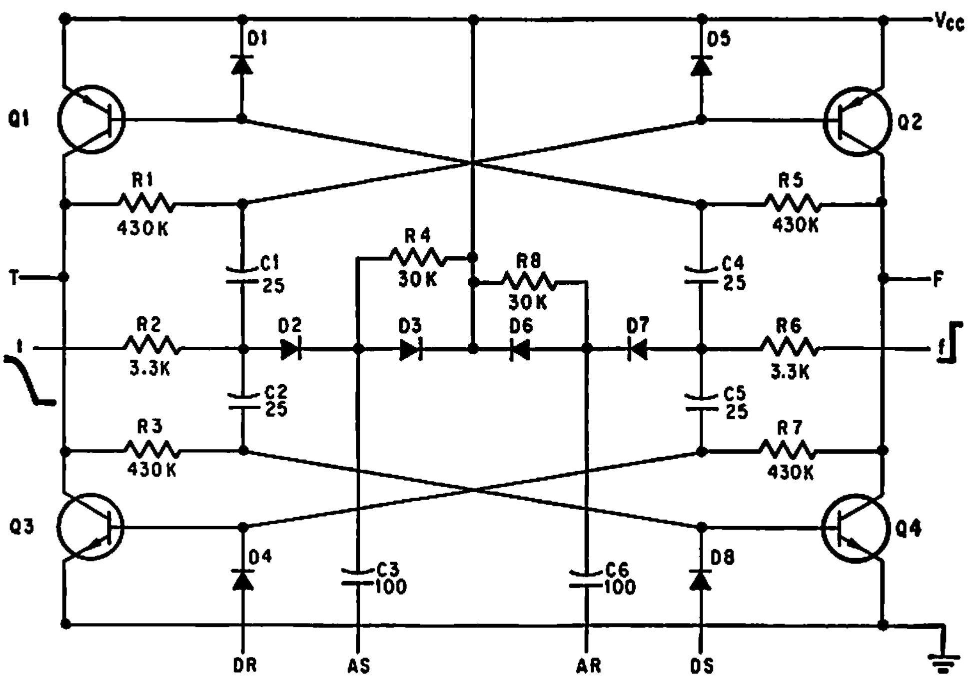


PREFERRED AMPLIFICATION-1,200 PREAMPLIFIER—Used with instrument servo motor controller to increase available gain. Chopper is used with d-c outputs only.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 74, p 74–2.

CHAPTER 78
Shift Register Circuits



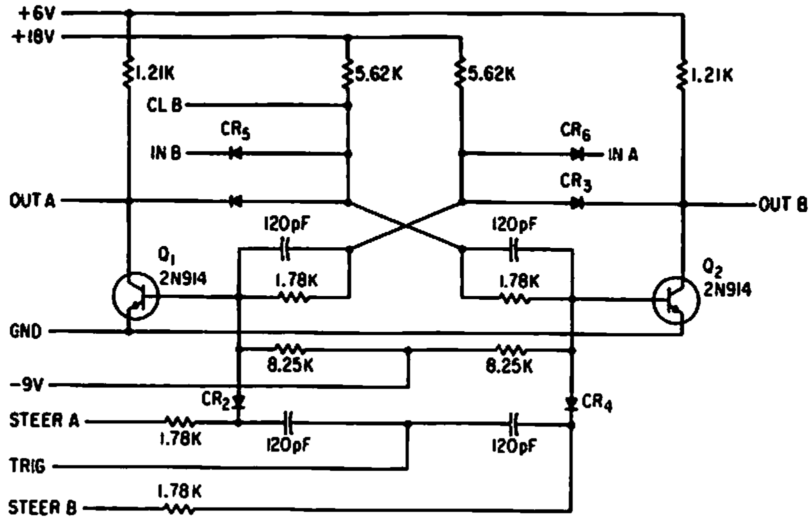
SCR AND LAMP DISPLAY CONTENTS OF REGISTER—Computer register to be sampled is connected to input A, and input B is fed with 10-microsec, 12-v positive pulse. When output of register is at its low level of —12 v, diode D1 conducts but D2 does not, so scr D3 is nonconducting and lamp is off. When register output is high level (ground potential), coincident positive voltages applied to base of scr make it conduct and turn lamp on.—J. J. Collins, Displaying the Contents of a Computer Register, *Electronics*, 37:21, p 72.



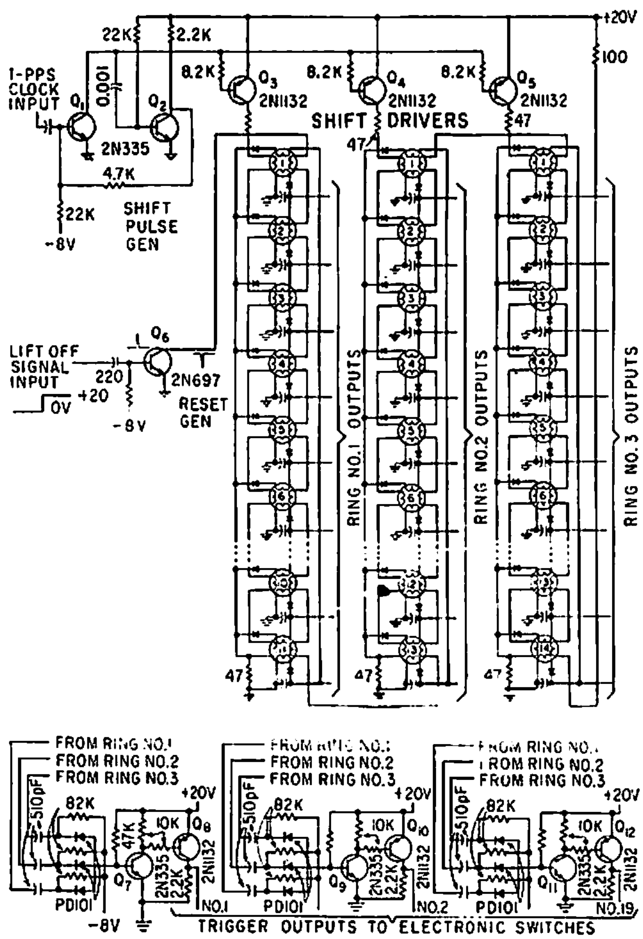
POINT	FUNCTION
Vcc	6V
T & F	OUTPUT
t & f	CONNECT TO T AND F FOR BINARY OPERATION
DS	DC SET
DR	DC RESET
DS & DR	CONNECT TO GROUND FOR BINARY OPERATION
AS	AC SET
AR	AC RESET

1. Q1 & Q2: SELECTED 2N3251.
2. Q3 & Q4: COMPLEMENT TO 2N3251
3. D1-D8: IN3206 OR IN914

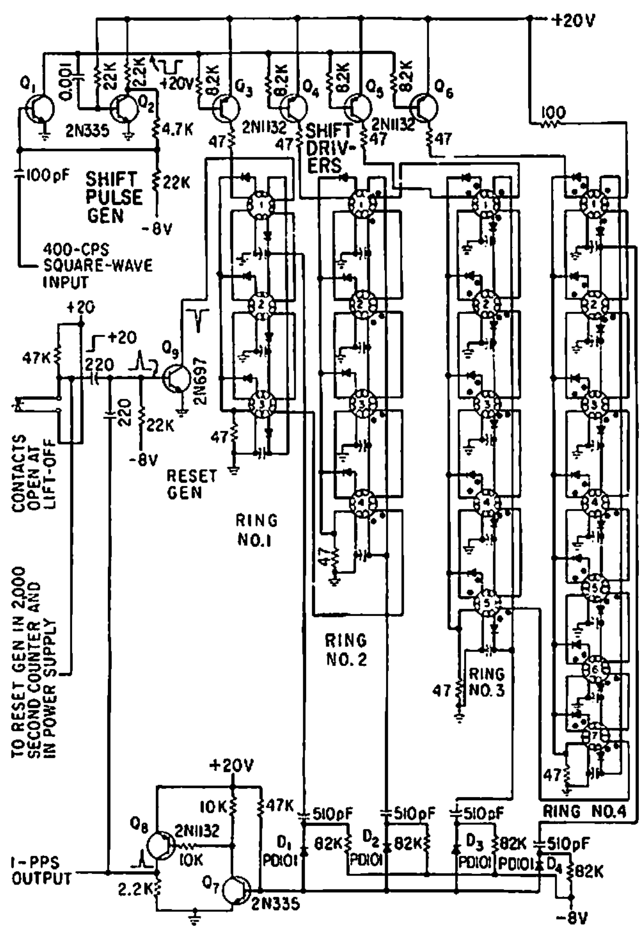
LOW-DISSIPATION 1-MC FLIP-FLOP—Complementary-pair circuit keeps power dissipation below 2 mw, with standby power of only 150 microwatts. Consists of two interconnected flip-flops, sharing common diode steering network at input. Diodes D1, D4, D5, and D8 protect emitter-based junctions from breakdown and also increase switching speed by clamping back bias levels at base of transistor. May be used for binary operation, as scaler, or as shift register.—M. E. McGee and J. H. Wujek Jr., One-Megahertz Flip-Flop Saves Standby Power, *Electronics*, 39:12, p 106–107.



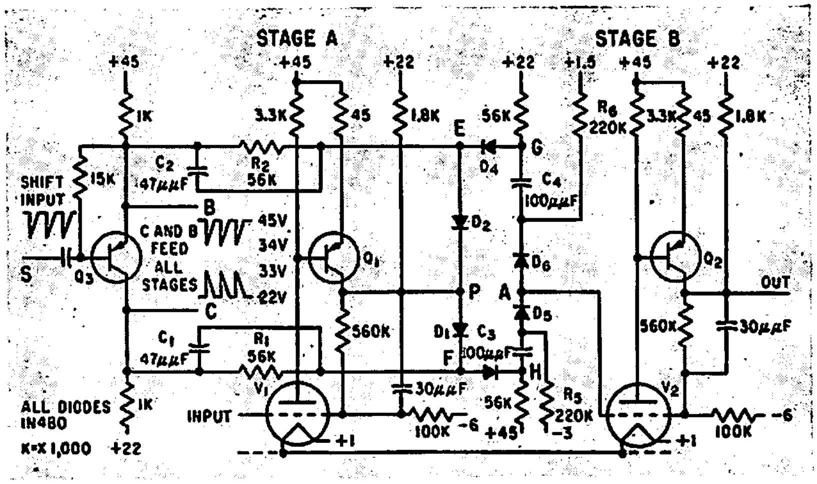
MICROMODULE FOR 1.6-MC CLOCK RATE—Flip-flop arrangement of two standard gates, with capacitor-resistor-diode gates tied to bases for trigger input, operates under worst-case temperature conditions with two standard gate loads.—A. S. Rettig, Computers in the Front Lines: Micromodules Make it Possible, *Electronics*, 36:1, p 77–81.



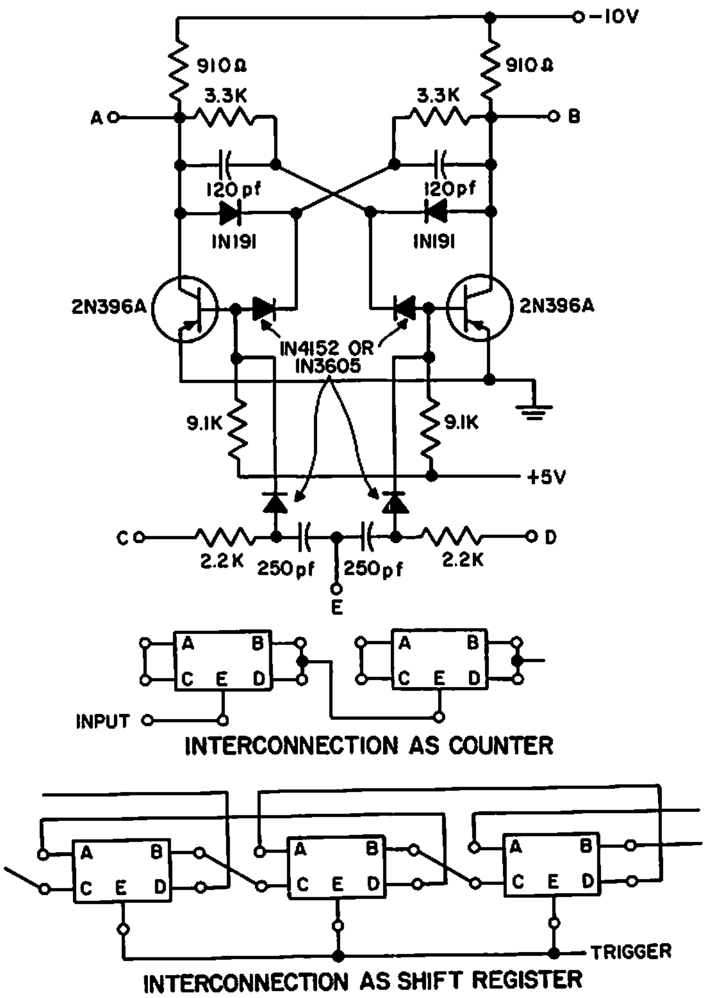
2,000-SEC COUNTER—Up to 20 *and* gate inputs can be supplied by each closed ring element. 1-pps clock triggers operate 2,000-sec counter pulse generator using unique magnetic shift register elements.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33:43, p 60–64.



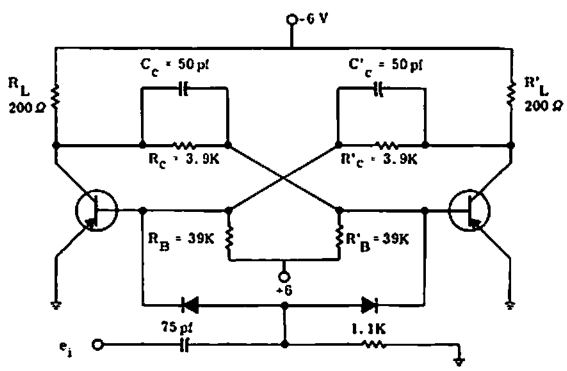
1-PPS CLOCK GENERATOR—Uses unique magnetic shift register in which elements are connected in rings, with output of last element connected to input of first. Each ring has own driver, all operated from same 400-cps pulse generator.—J. H. Porter, Miniaturized Autopilot System for Missiles, *Electronics*, 33:43, p 60–64.



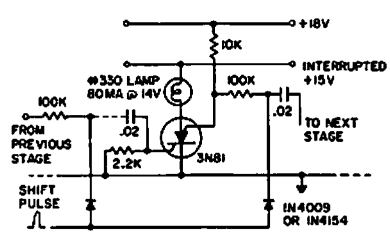
SELF-INDICATING REGISTER—Combines two self-indicating flip-flops with phase splitter that converts single-polarity shift pulses to positive and negative-going pulses for all stages. Indicator triodes are Amperex 6977.—H. Rodriques de Miranda and I. Rudich, Indicator Triode for Direct Data Readout, *Electronics*, 33:6, p 52–54.



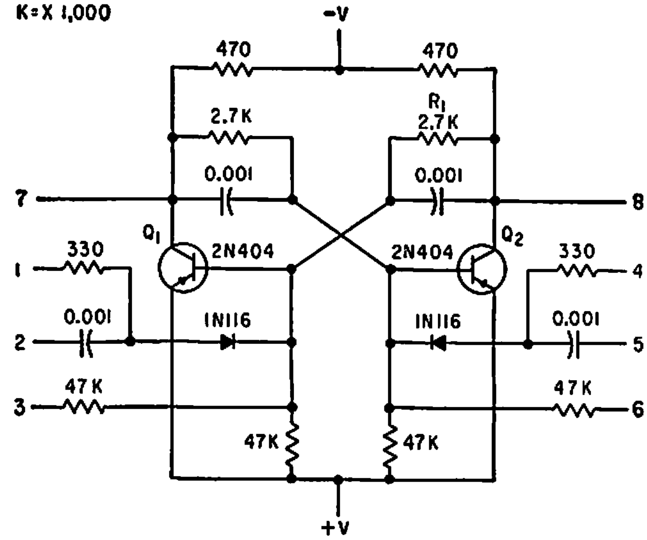
500-KC SHIFT REGISTER—Basic nonsaturated flip-flop, using 52-step design procedure given, serves as building block for 500-kc counter and shift register.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 190.



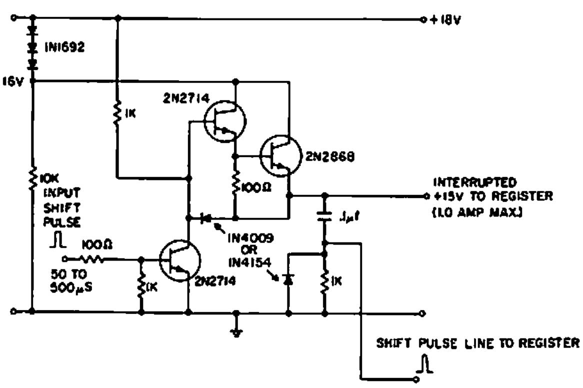
SYMMETRICAL SATURATED FLIP-FLOP—Developed for inexpensive 2N711 germanium pnp mesa switching transistors, to serve as building block for high-speed computer applications. Two or more flip-flops can be cascaded to form counter, or used as shift register by separating inputs. Close regulation is required for −6 v supply.—P. A. McInnis, "Low-Cost Computer Circuits," Motorola Application Note AN-130, Nov. 1965.



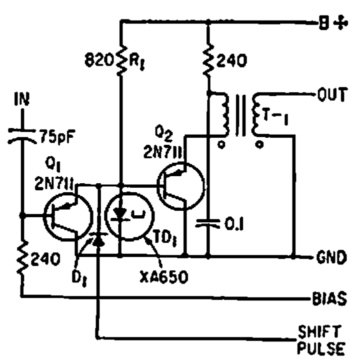
BASIC SHIFT-REGISTER STAGE—If silicon controlled switch stage is off, shift pulse (less than 15 v) will not be coupled to next stage. Anode supply is interrupted just before shift pulse, to turn off all stages. Stored capacitor charge then determines which stages will be retriggered.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 432.



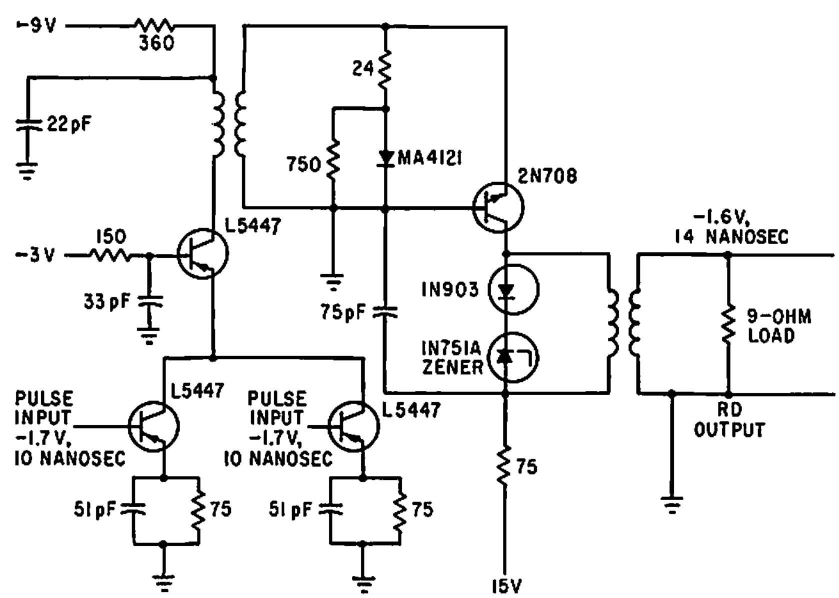
BASIC BISTABLE MODULE—Can be used as flip-flop by connecting 1 to 7 and 4 to 8, than using 2 and 5 as inputs and 7 and 8 as outputs. Becomes binary counter stage when 2 and 5 are tied together for same arrangement. Other combinations of connections give one-shot mvbr, pulse generator, shift register, square-wave generator, or flip-flop. —A. I. Perlin, Selective Calling for Data Link Systems, *Electronics*, 33:18, p 108–110.



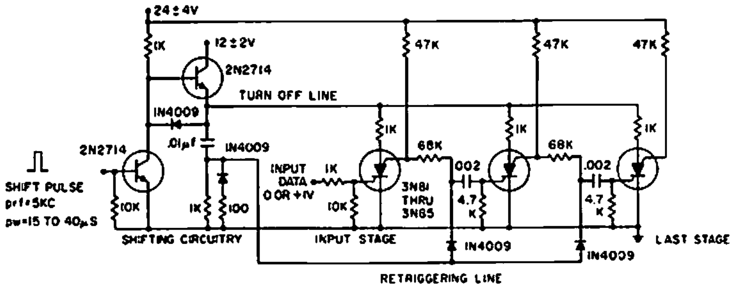
SHIFT REGISTER DRIVER—Shift pulse input saturates 2N2714, depriving Darlington combination of base drive. Resulting negative pulse generated on 15-v line is differentiated to produce positive trigger pulse at its trailing edge.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 432.



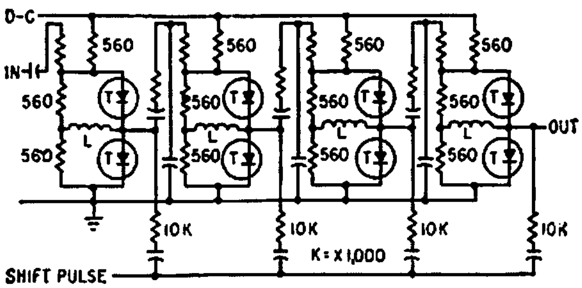
TUNNEL-DIODE SHIFT REGISTER—Incorporates tunnel-diode steering by Q1 and D1. T1 provides necessary phase reversal.—W. V. Harrison and R. S. Foote, Tunnel Diodes Increase Digital-Circuit Switching Speeds, *Electronics*, 34:32, p 154–156.



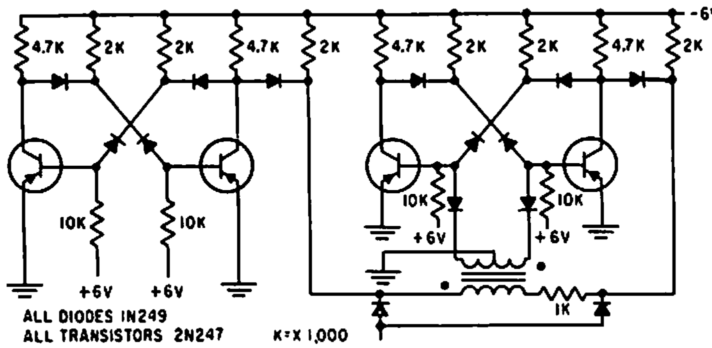
REGISTER-DRIVER—Handles 10-nsec pulses for 50-megapulse computer. Can drive eight 75-ohm lines.—K. H. Konkle and J. E. Laynor, Key to Faster Computers: Ten-Nanosecond Amplifier, *Electronics*, 35:50, p 39–41.



SCS SHIFT REGISTER—Shift pulse turns off all silicon controlled switches. Trailing edge of turnoff pulse is differentiated for turning on appropriate stages. 2N2714 will easily drive ten scs stages.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 432.

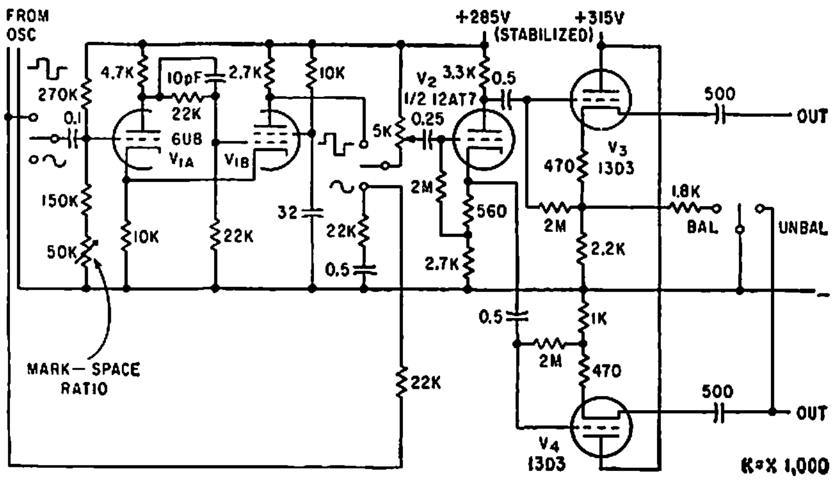


FLIP-FLOP BUILDING BLOCKS—Inductively coupled flip-flops are put together to form shift register. Both signal and shift pulses are positive. Operates reliably over wide ranges of input pulse amplitude and circuit parameters.—M. M. Perugini and N. Lindgren, Recent Progress in Solid State Technology, *Electronics*, 33:10, p 39–43.

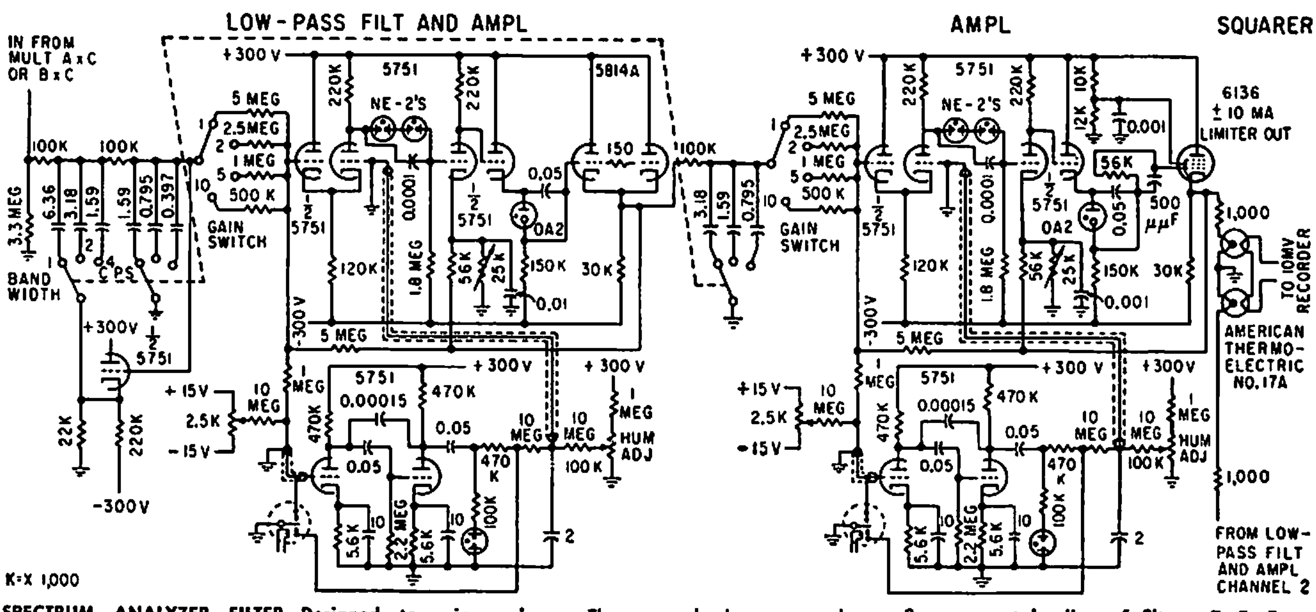


TRANSFORMER-CONTROLLED SHIFT REGISTER—Can be built to shift forward, backward, or in *n* dimensions. With series of flip-flops, stored information can be rearranged arbitrarily, in single pulse.—W. M. Carey, Using Inductive Control in Computer Circuits, *Electronics*, 32:38, p 31–33.

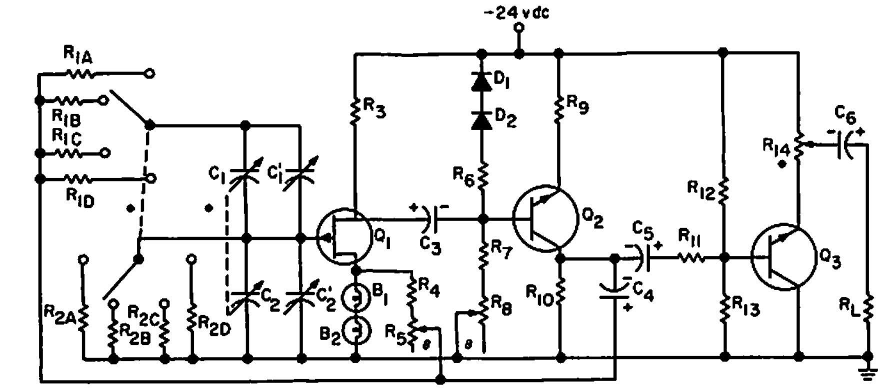
CHAPTER 79
Signal Generator Circuits



OSCILLATOR OUTPUT STAGE—Used with incremental-tuning precision R-C oscillator for testing and aligning equipment having sharp resonances. Oscillator signal is fed through phase splitter V2 to cathode followers V3 and V4 in push-pull, to provide symmetrical output when required. Will feed either 600-ohm unbalanced load or two 300-ohm outputs balanced with respect to ground, with 10 mw maximum output.—J. H. Reyner, Precision Oscillator with Incremental Tuning, *Electronics*, 33:16, p 76–78.



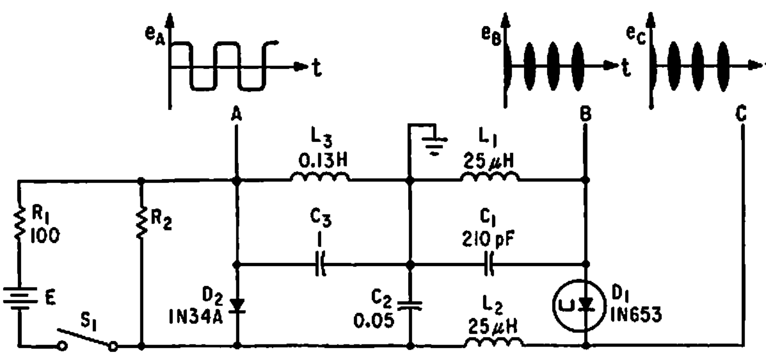
SPECTRUM ANALYZER FILTER—Designed to study dynamic data recorded as frequency-modulated signals on magnetic tape. Filter circuit values give 1, 2, and 4-cps bandwidth in analyzer. Thermocouple in squarer has time constant of 1 sec so output is filtered as well as squared. Outputs of thermocouples are in series to provide summing. D-c amplifiers prevent loading of filters.—T. B. Fryer, Frequency Analyzer Uses Two Reference Signals, *Electronics*, 32:18, p 56–57.



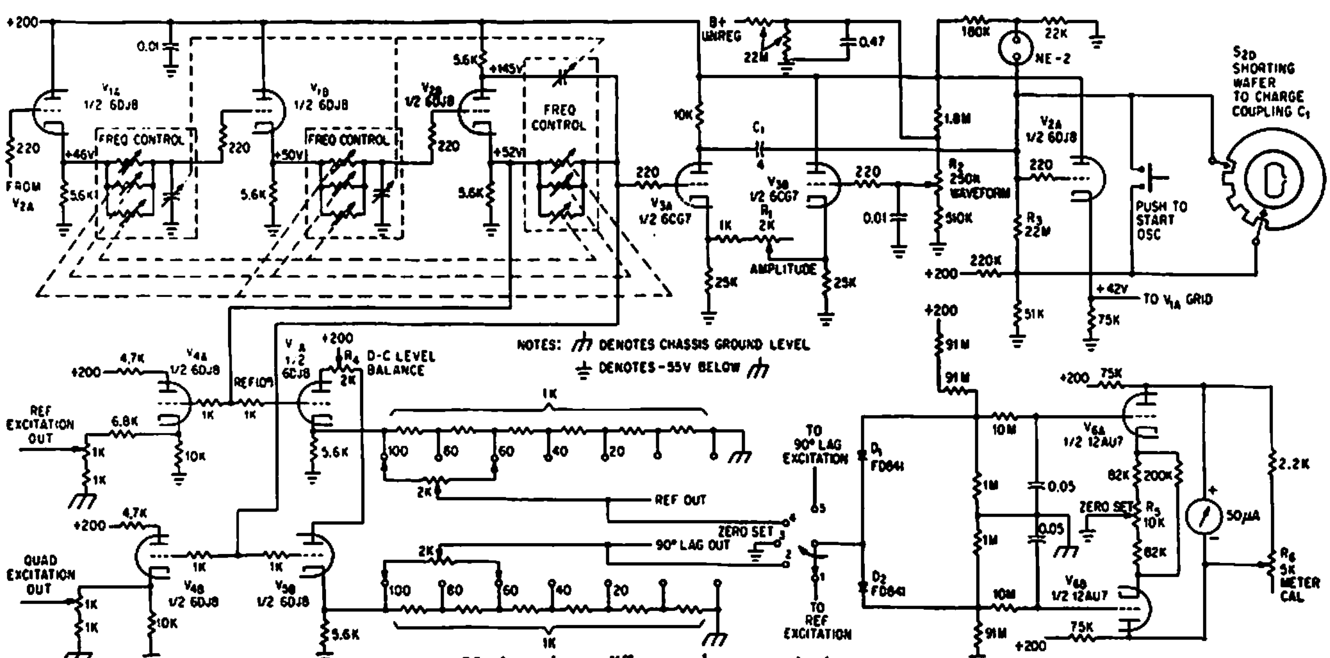
Q_1 = 2N2498
Q_2, Q_3 = 2N736
B_1, B_2 = 120v, 3w lamps
R_3 = 11K
R_4 = 3.9K
R_5 = 1.5K rheostat
R_6 = 33K
R_7 = 100K
R_8 = 250K rheostat
R_9 = 1K
R_{10} = 5.1K
R_{11} = 10K
R_{12} = 150K
R_{13} = 56K
R_{14} = 4K potentiometer
R_L > 2K
C_3, C_4, C_5 = 20 μf, 15v
C_6 = 50 μf, 15v
C_1 and C_2 are a 4-section ganged variable air capacitor, each section variable from 19 pf to 425 pf.
C_1 and C_2 each consist of two paralleled sections.
C_1' = adjustable trimmer, 9–180 pf; ARCO 463
C_2' = 15 μμf
R_{1A} = R_{2A} = 44.3K
R_{1B} = R_{2B} = 90K
R_{1C} = R_{2C} = 900K
R_{1D} = 9 MΩ
R_{2D} = 9.3 MΩ
D_1, D_2 = G129 stabistors

θ A screwdriver adjustment which needs adjustment only during periodic calibration. • A panel control.

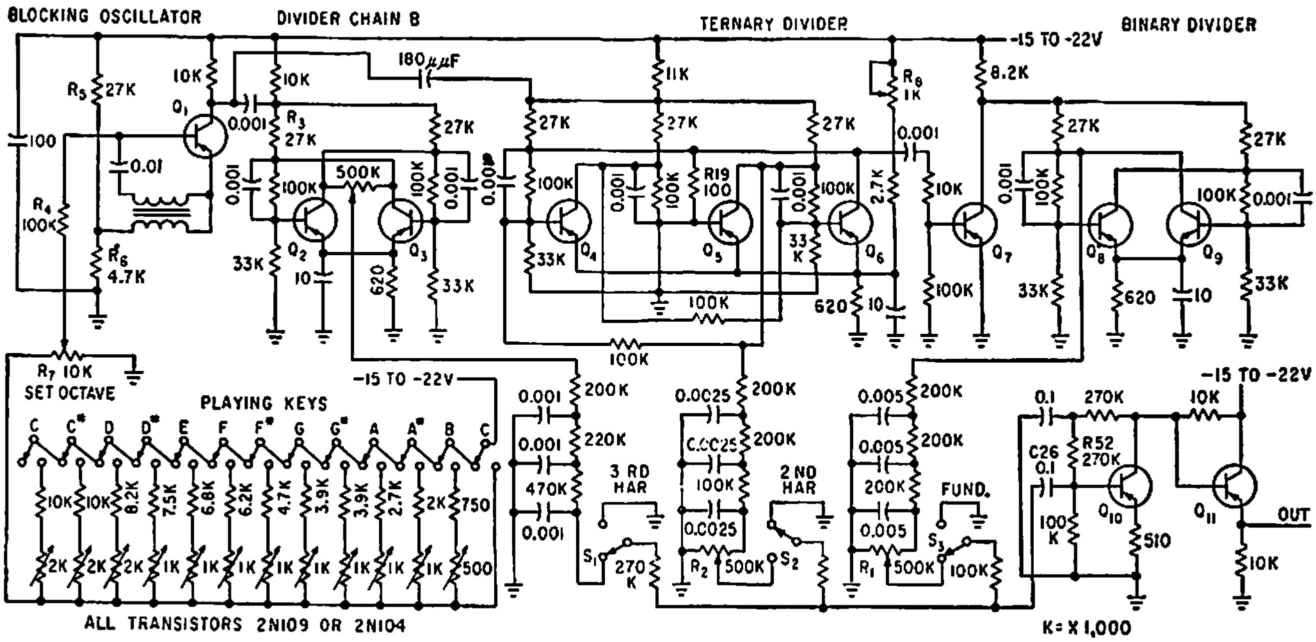
FET WIEN-BRIDGE OSCILLATOR—Used where good amplitude stability is required for wide frequency variations. Two-stage R-C coupled class A amplifier has positive feedback loop that causes oscillation, and negative feedback loop that stabilizes amplitude of oscillation. Frequency ranges are 20 to 200 cps, 200 cps to 2 kc, 2 to 20 kc, and 4 to 40 kc. —L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 113.



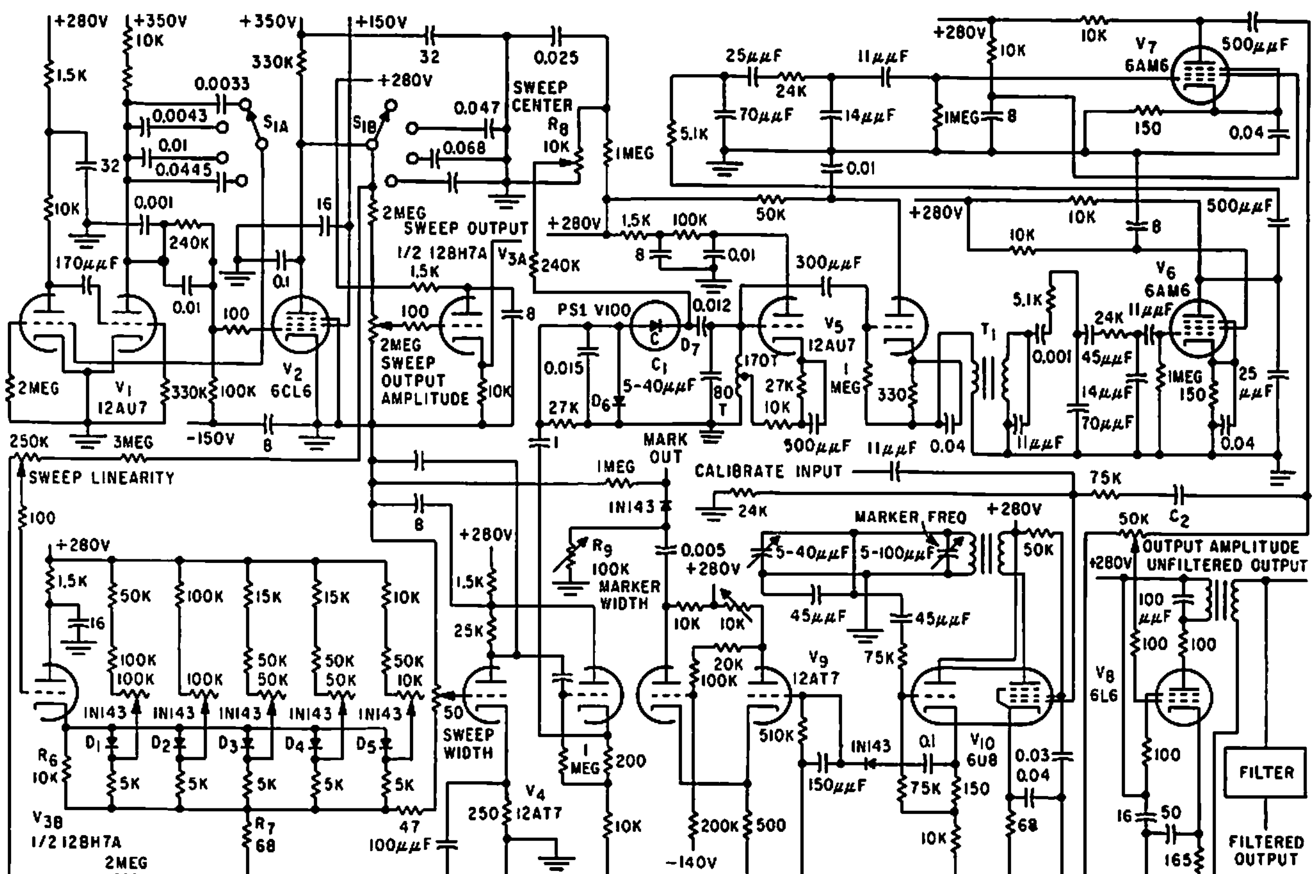
COMBINED R-F AND A-F OSCILLATOR—Used for checking a-m receivers. Generates r-f at 0.6 Mc, determined by L1-C1, and relaxation-type audio output of 400 cps at A.—W. H. Ko, Tunnel-Diode Oscillator Delivers R-F and Audio, *Electronics*, 35:41, p 56.



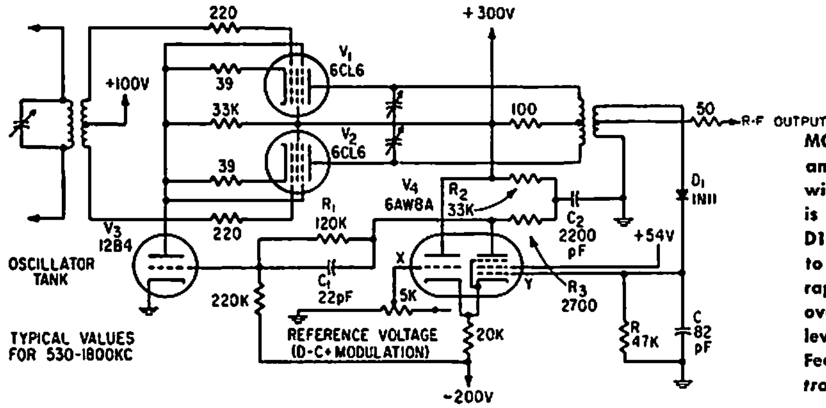
0.1-1,000 CPS DECADE-SWITCHING TWO-PHASE OSCILLATOR—Simultaneous outputs at 90 deg phase difference have constant amplitudes over entire range. Direct coupling between stages avoids phase error.—Y. P. Yu, Two-Phase Oscillator Covers 0.1 to 1,000-CPS, *Electronics*, 36:40, p 27–29.



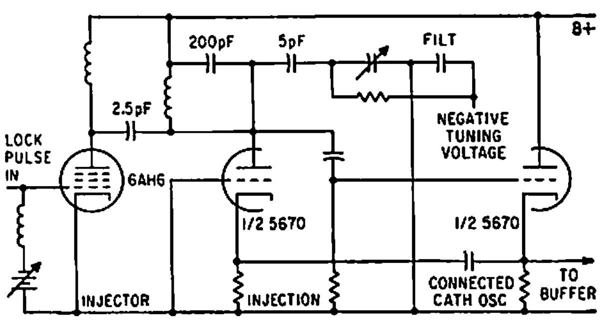
TONE TIMBRE DEMONSTRATOR—Demonstrates principles of Fourier synthesis of musical tone, for one octave. Lowest fundamental is 250 cps. Switches S1, S2, and S3 add or remove third harmonic, second harmonic, or fundamental components from output signal to change tone quality. Master oscillator has range of 1.5 to 3 kc. Blocking oscillator Q1 is tuned through one octave by varying voltage to which R4 is returned, by switching resistors in series with playing keys.—W. S. Pike and C. N. Hoyler, Synthesizing Timbre for Electronic Musical Tones, *Electronics*, 32:22, p 92–94.



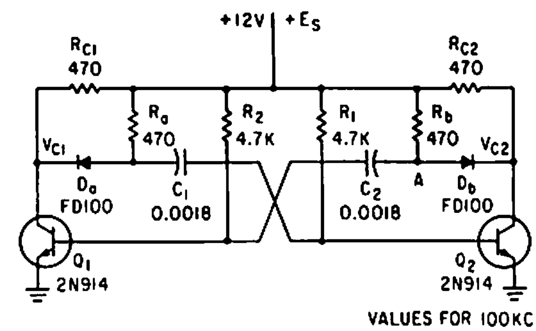
LINEAR-FREQUENCY SWEEP GENERATOR—Frequency is swept from 400 to 600 kc electronically by using reverse-biased pn junction diode C as variable capacitor in oscillator V5. Frequency markers are provided. Output is amplified and filtered to give 6 w into 150 ohms with high purity of waveform.—M. M. Brady, Oscillator Design Using Voltage-Variable Capacitors, *Electronics*, 32:34, p 38–40.



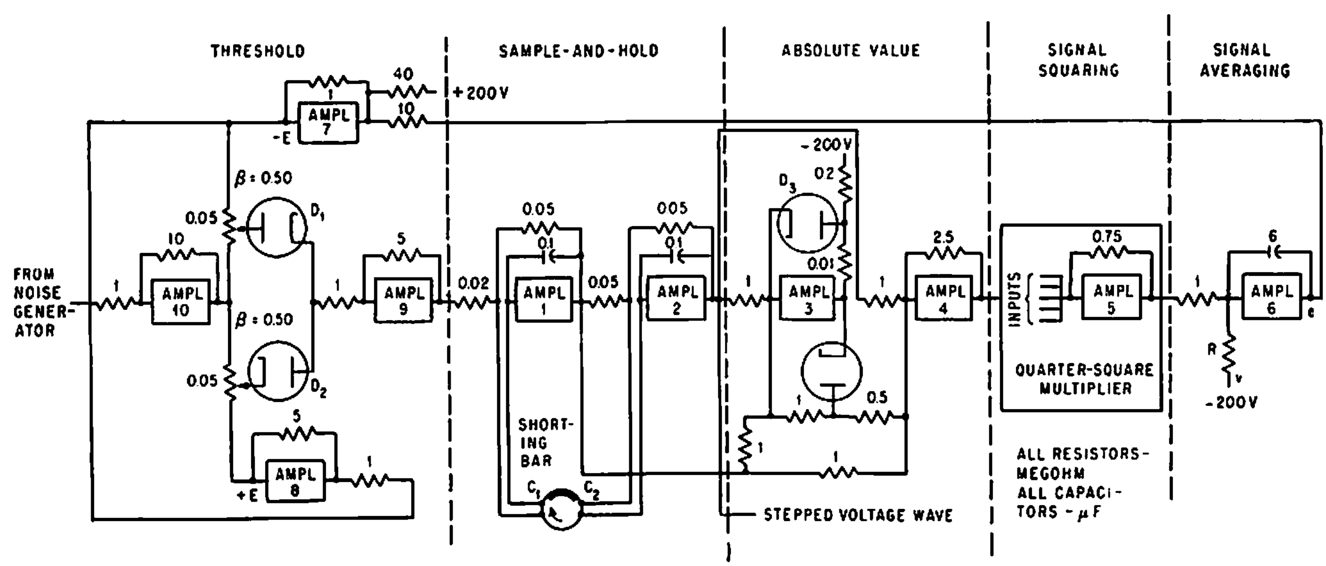
MODULATOR WITH FEEDBACK—Automatic amplitude stabilization of r-f test signals, within 1 db over 1,300 to 1 frequency range, is achieved by demodulating r-f output with D1 and feeding demodulated voltage back to grid Y of differential amplifier V4. Permits rapid and accurate response measurements over wide range without resetting signal level to input of device under test.—A. Fong, Feedback Stabilizes Signal Generator, *Electronics*, 33:29, p 71–73.



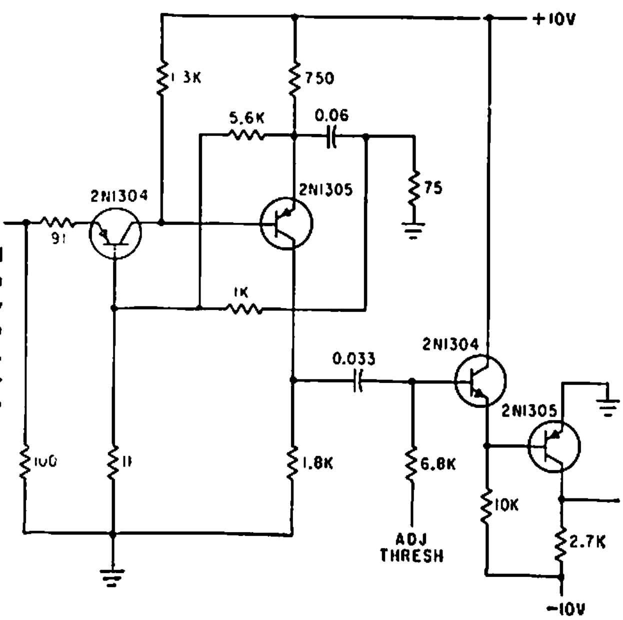
COHO—Connected-cathode coherent oscillator has compromise between good short-term frequency stability and good locking ability, as required for measuring pulse-to-pulse phase variation in pulsed r-f systems. —R. H. Holman and R. B. Shields, Measuring Frequency Stability of Pulsed Signals, *Electronics*, 34:16, p 61–65.



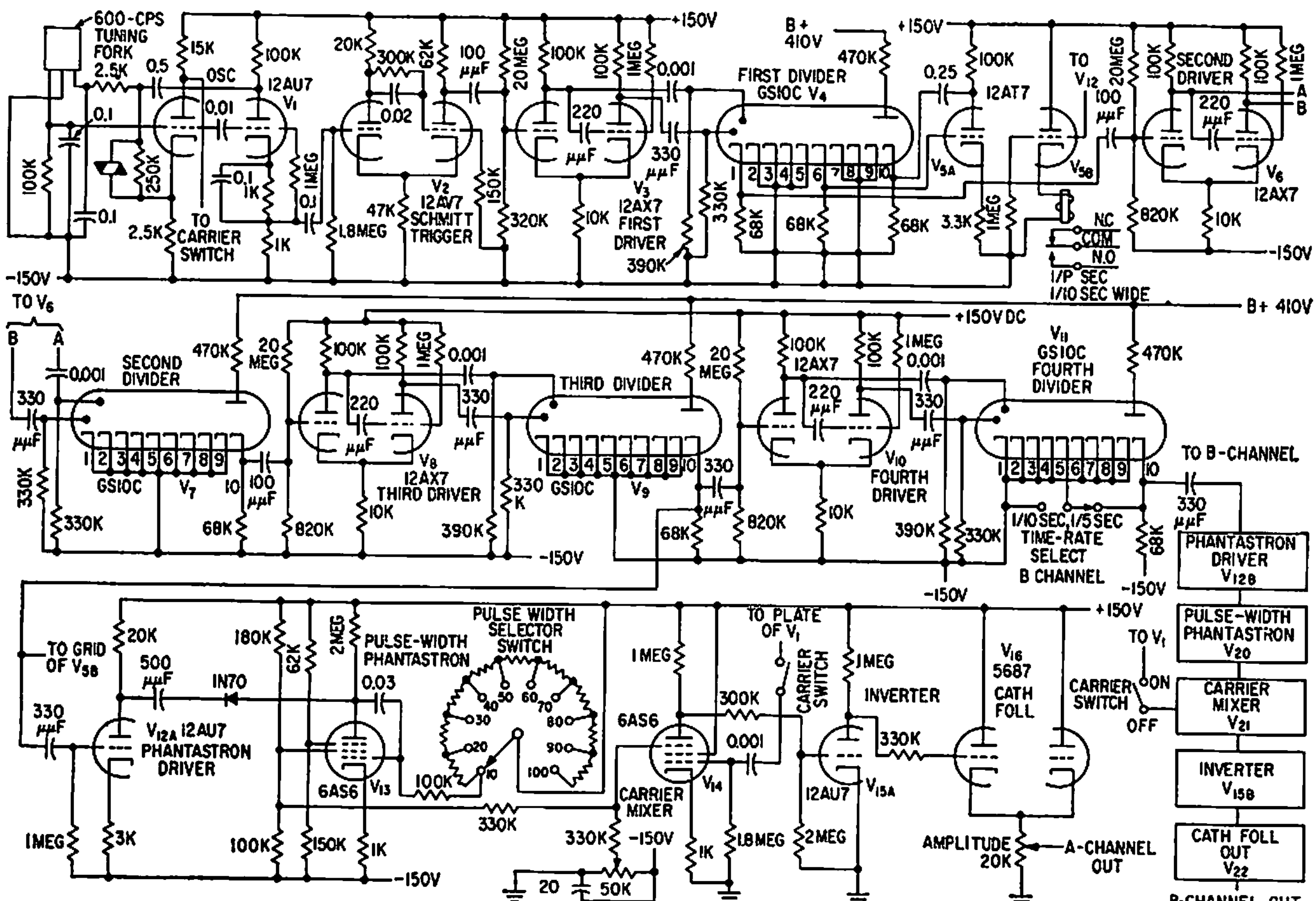
SQUARE WAVES FROM MVBR—Use of four additional components (two resistors and two diodes) with basic free-running mvbr changes its output to clean square wave. Operating range is from several cps to several Mc.—R. O. Gregory and J. C. Bowers, Simple Square-Wave Generator, *Electronics*, 35:51, p 47.



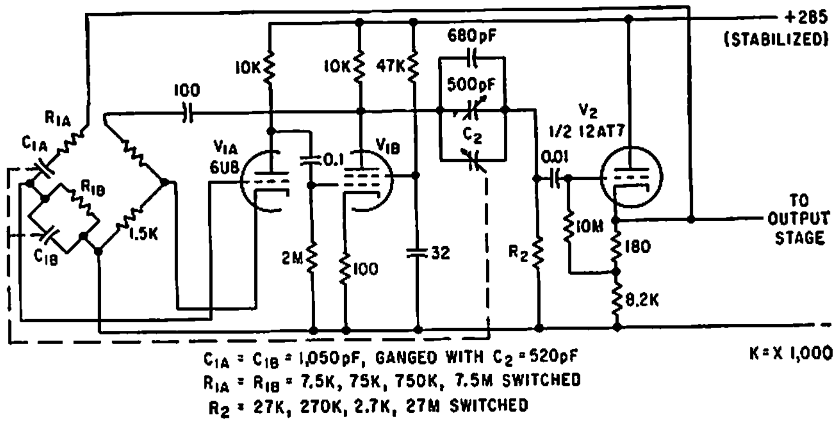
SPECTRUM-INVARIANT RANDOM FUNCTION GENERATOR—Operational amplifiers of analog computer produce periodically stepped waves by clipping and sampling raw noise signal. Feedback maintains desired power density spectrum.—N. D. Diamantides and C. E. McCray, Generating Random Forcing Functions for Control-Systems Simulation, *Electronics*, 34:33, p 60–63.



CORE SENSE AMPLIFIER—Used in programmed digital signal generator in which plug-in magnets set up program. Input, nominally 100 mv, is amplified and clipped before it is gated with strobing pulse.—W. D. Woo, Novel Digital Signal Generator Uses Magnetic-Core Pegboard, *Electronics*, 35:27, p 46–49.

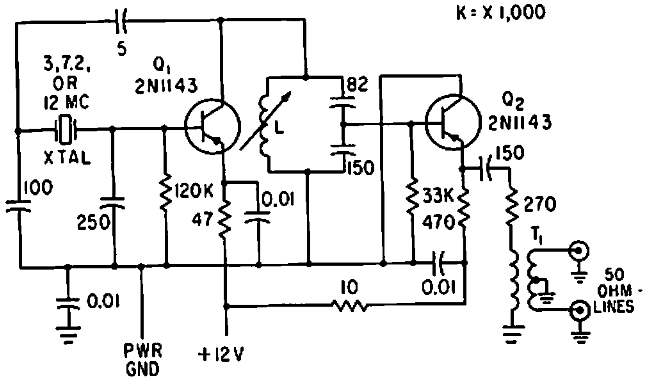


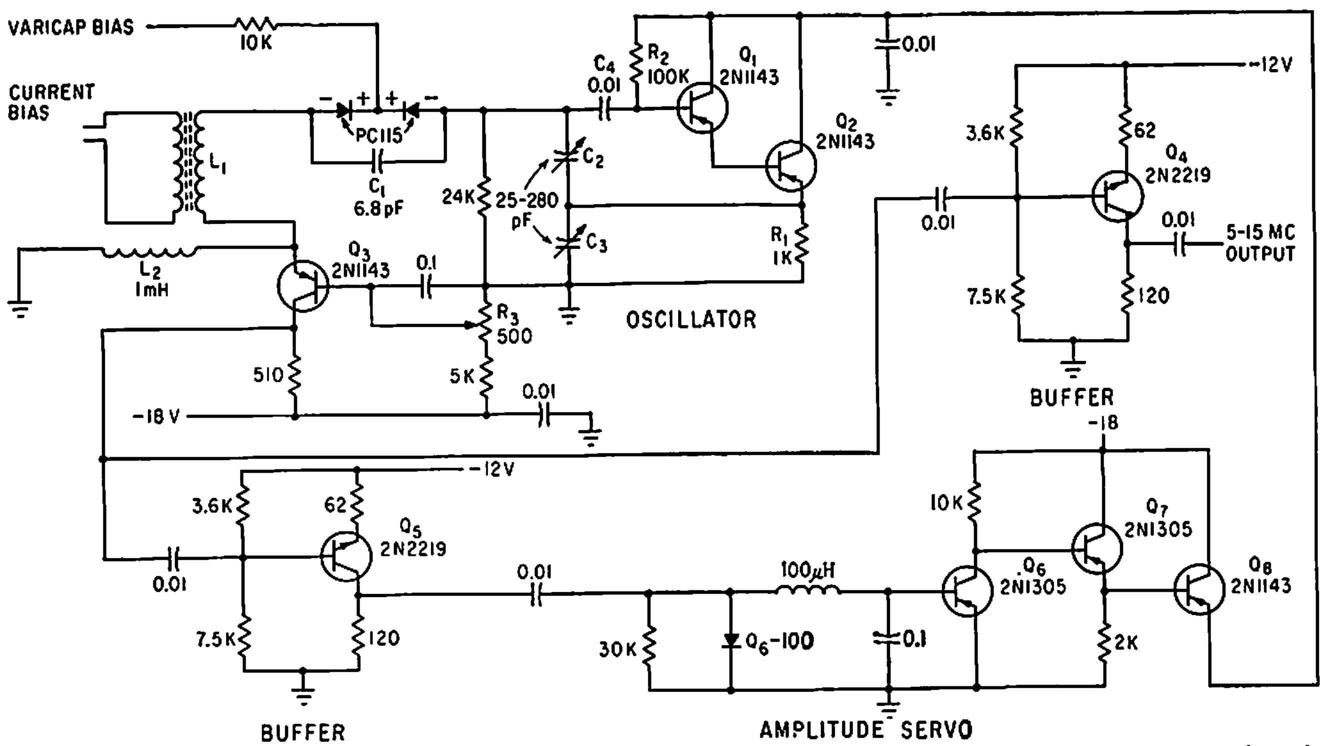
TIMING SIGNAL GENERATOR—Delivers pulses of controlled duration, amplitude, and carrier content at 1 pps in channel A and either 1 per 5 sec or 1 per 10 sec in channel B. Any decimal frequency multiple of 1, 2, or 5 from 100 to 0.1 cps may be obtained. Timed pulse signals can be controlled both in amplitude and width, and turned on or off at will.—D. E. Minow, Timed-Signal Generator With Flexible Output, *Electronics*, 32:10, p 52–53.



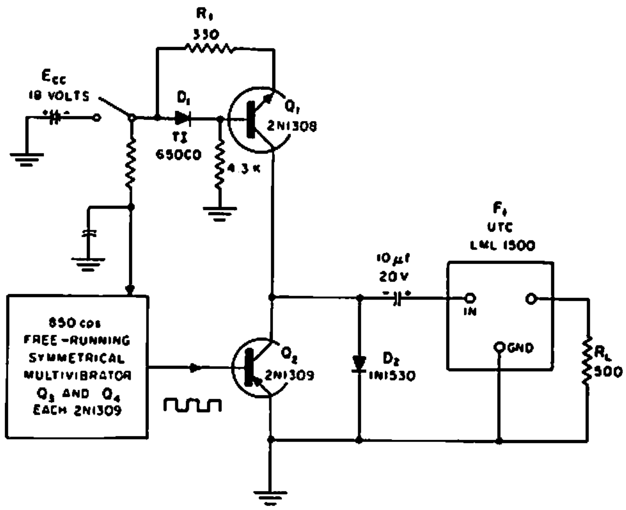
PRECISION R-C OSCILLATOR—Used in signal generator for testing systems by varying frequency over very small limits, as in aligning filters having sharp resonance curves. Cathode follower V2 is included in feedback loop to reduce loading on bridge network. Covers 25 cps to 250 kc in four ranges, with incremental control giving increment of 2% of maximum frequency in each range.—J. H. Reyner, Precision Oscillator with Incremental Tuning, *Electronics*, 33:16, p 76–78.

12-MC CRYSTAL STANDING-WAVE DETECTOR—Transistorized crystal oscillator Q1 and emitter-follower Q2 feed 1 v rms into two balanced transmission lines going to standing-wave detector.—O. C. Haycock, and K. D. Baker, Measuring Antenna Impedance in the Ionosphere, *Electronics*, 34:2, p 88–92.

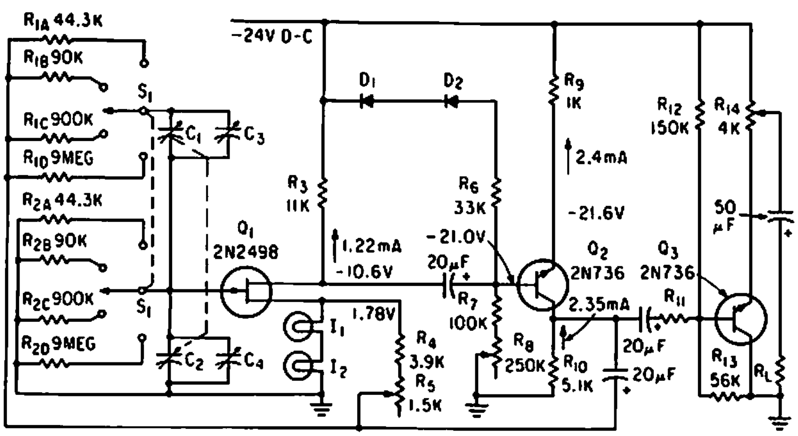




SWEEP-FREQUENCY CLAPP OSCILLATOR—Tank circuit L1-C1-C2-C3 sweeps frequency of transistor Clapp oscillator over range of 5 to 15 Mc when current through bias winding of L1 is varied from zero to 800 ma. Collector voltage is servoed to maintain constant output amplitude.—R. E. Daniels and A. D. Cook, Advanced Clapp Oscillator Features 3-to-1 Dynamic Range, *Electronics*, 36:8, p 60–61.

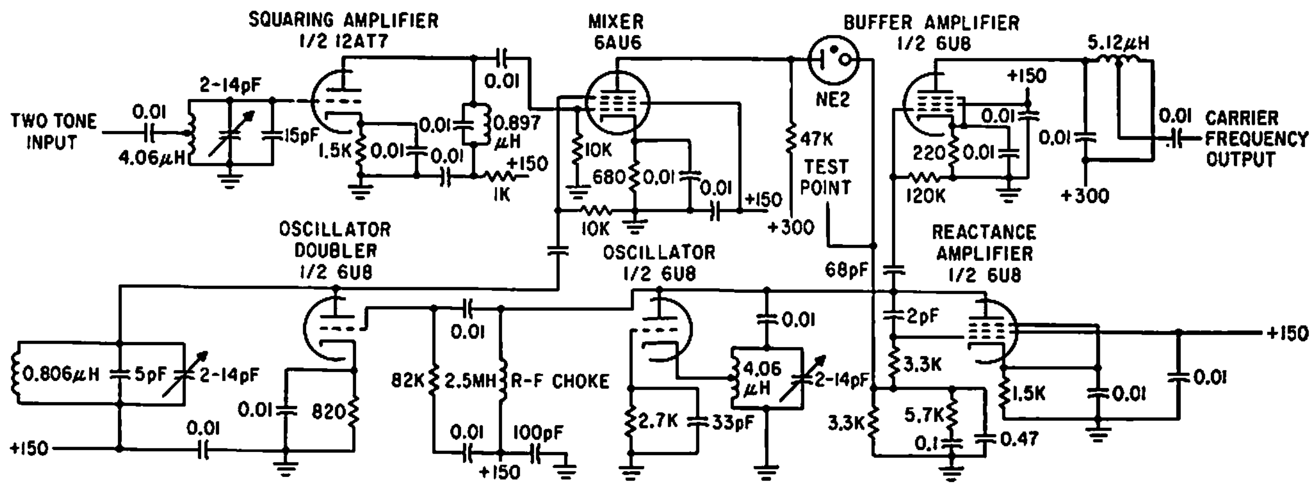


CONSTANT-AMPLITUDE SINE-WAVE SOURCE—Battery-operated fixed-frequency calibration source gives constant amplitude within 1% between 0 and 70°C, with less than 1% harmonic distortion. Circuit generates square wave, then converts it to sine wave in low-pass filter network. Frequency remains constant at around 850 cps within 4% over operating temperature range.—Constant-Amplitude Sine-Wave Source, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 166.

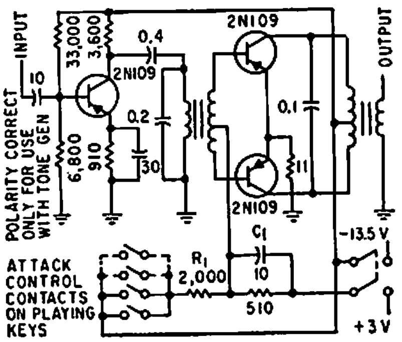


C1 AND C2 ARE GANGED 4-SECTION AIR CAPACITORS, VARIABLE FROM 19pF TO 425pF EACH.

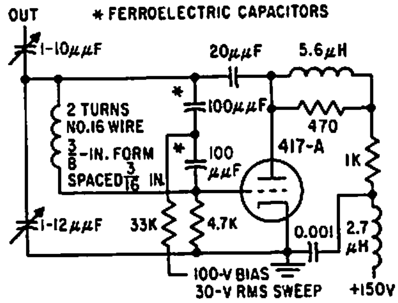
20 CPS TO 40 KC WITH WIEN BRIDGE—Range is covered in four steps. Two-stage oscillator is followed by buffer that delivers 3.5 v to 2,000-ohm load.—V. Glover, Using a New Device: Field-Effect Transistor Oscillators, *Electronics*, 35:51, p 44–46.



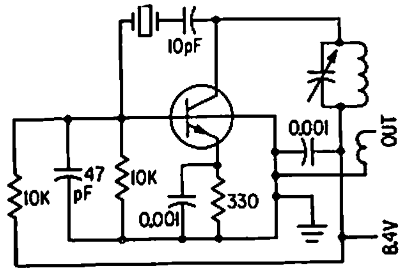
CARRIER SYNTHESIZER—Generates signal midway in frequency between two input frequency tones, for mixing with output of linear amplifier under test.—G. H. Smith, Distortion Monitor Checks Linear Amplifier Characteristics, *Electronics*, 34:27, p 57–59.



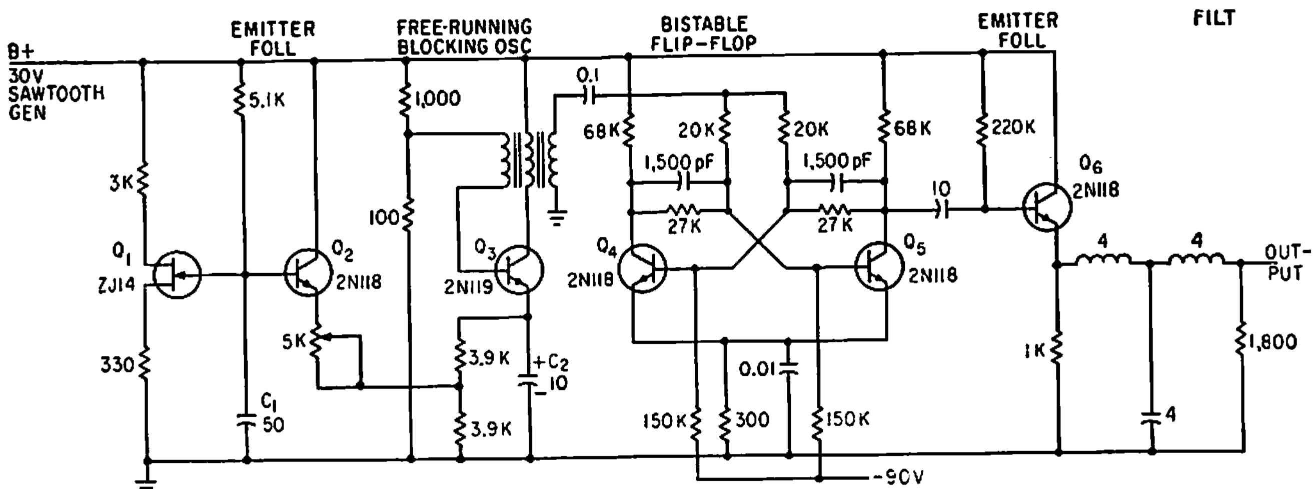
ATTACK CONTROL AMPLIFIER—Used with tone timbre generator to provide gradual attack for electronic music demonstration.—W. S. Pike and C. N. Hoyler, Synthesizing Timbre for Electronic Musical Tones, *Electronics*, 32:22, p 92–94.



VHF SWEPT OSCILLATOR—Voltage-tunable ferroelectric capacitors give tuning ratio of about 2 to 1 from 20 to 250 Mc and 1.5 to 1 from 250 to 400 Mc.—T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.

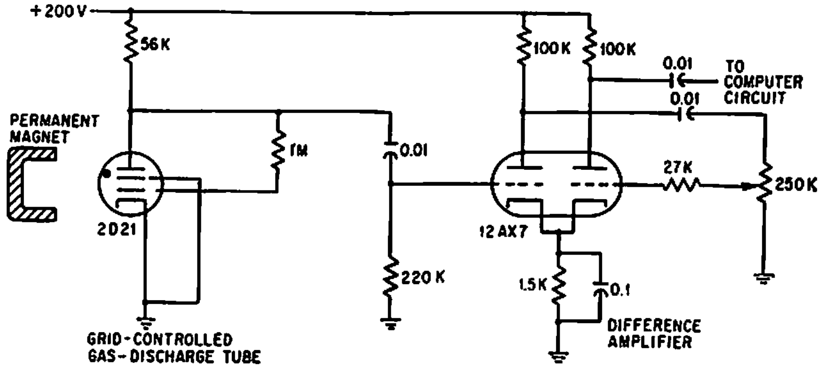


PIERCE TETRODE-TRANSISTOR—Tuned to third overtone of crystal fundamental. Fifth harmonic of oscillator is used as calibration frequency for c-w receiver of radio direction finder.—A. T. Lloyd, Direction Finder Helps Recover Discoverer Capsule, *Electronics*, 34:9, p 42–45.



20-40 CPS VARIABLE SWEEP—Used to test servos and related equipment. Sawtooth waveform developed by unijunction transistor circuit is used to key blocking oscillator.—M. Rosen, Subaudio Swept Signal Generator, *Electronics*, 33:17, p 67–68.

CHAPTER 80
Simulator Circuits

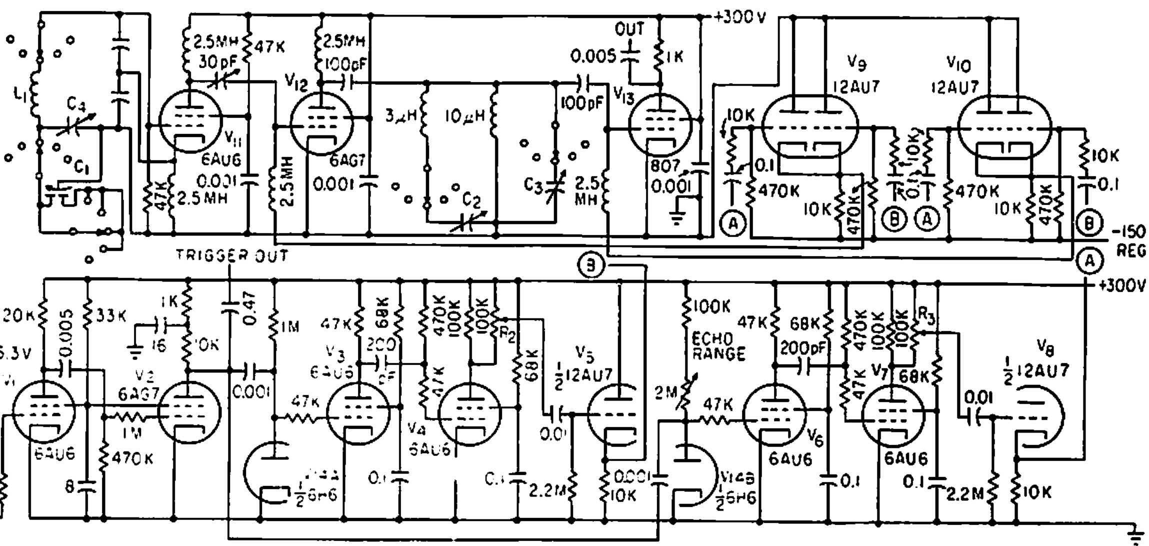


RANDOM-SIGNAL GENERATOR—Signals arise from fluctuations in dense layer of positive ions near cathode of 2D21 grid-controlled gas-discharge tube. Used with computers to simulate random action, such as effect of wind gusts on controls of airplane.—N. D. Diamantides and C. E. McCray, Generating Random Forcing Functions for Control-System Simulation, *Electronics*, 34:33, p 60–63.

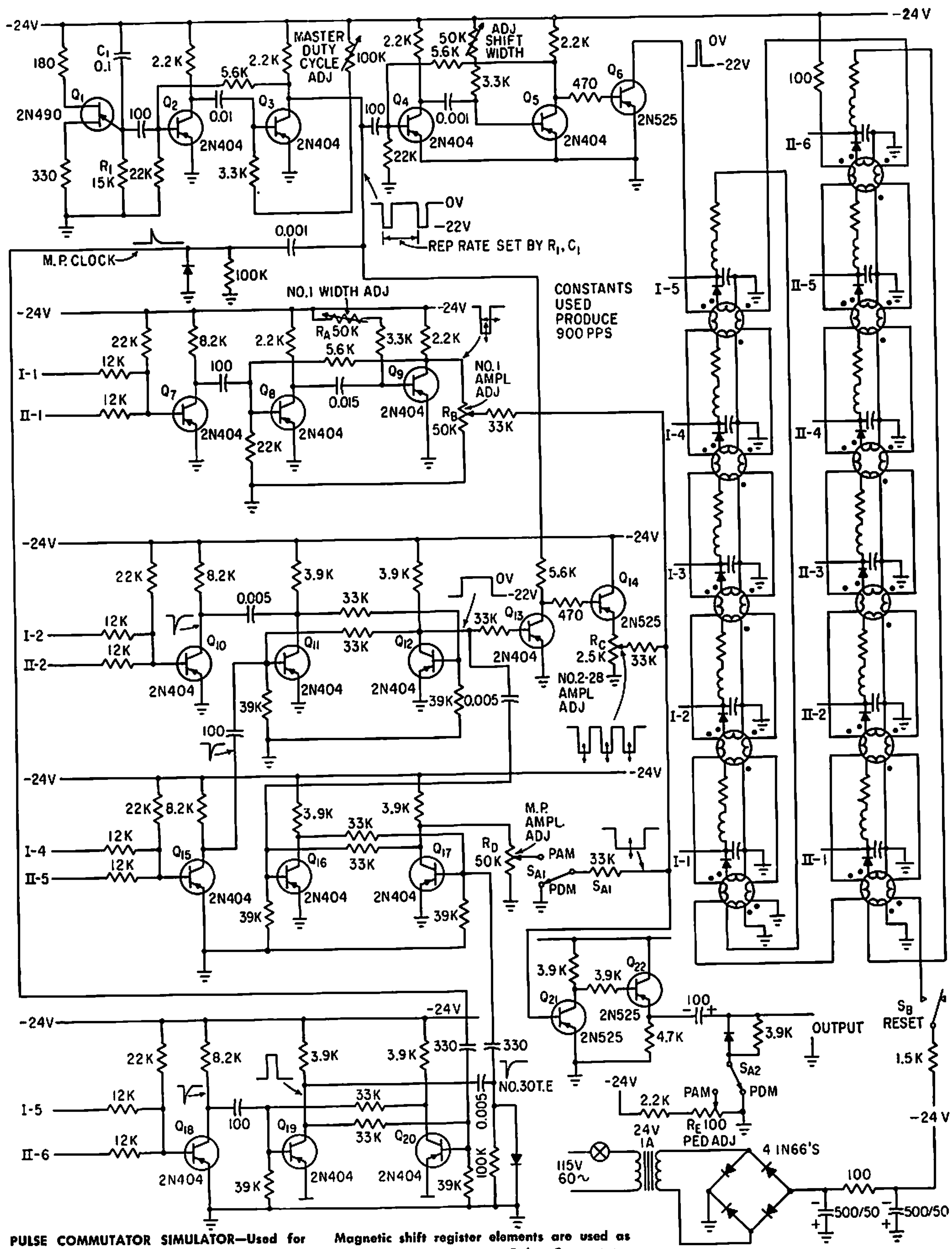
COIL DATA

OSC FREQ MC	L_1 μH	C_4 pF
1.14	150	150
1.92	80	80
2.9	50	50
3.82	40	40
8	20	20

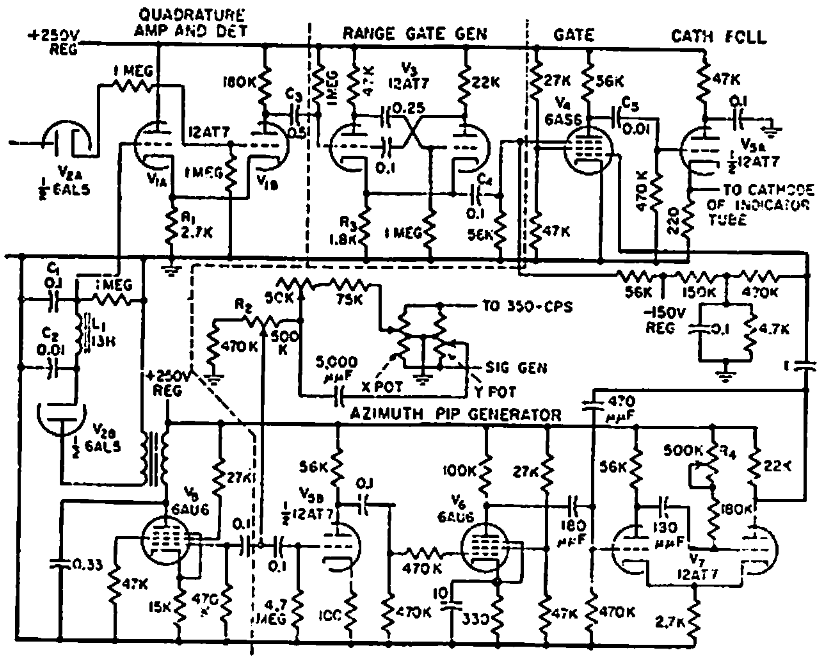
K = X 1,000



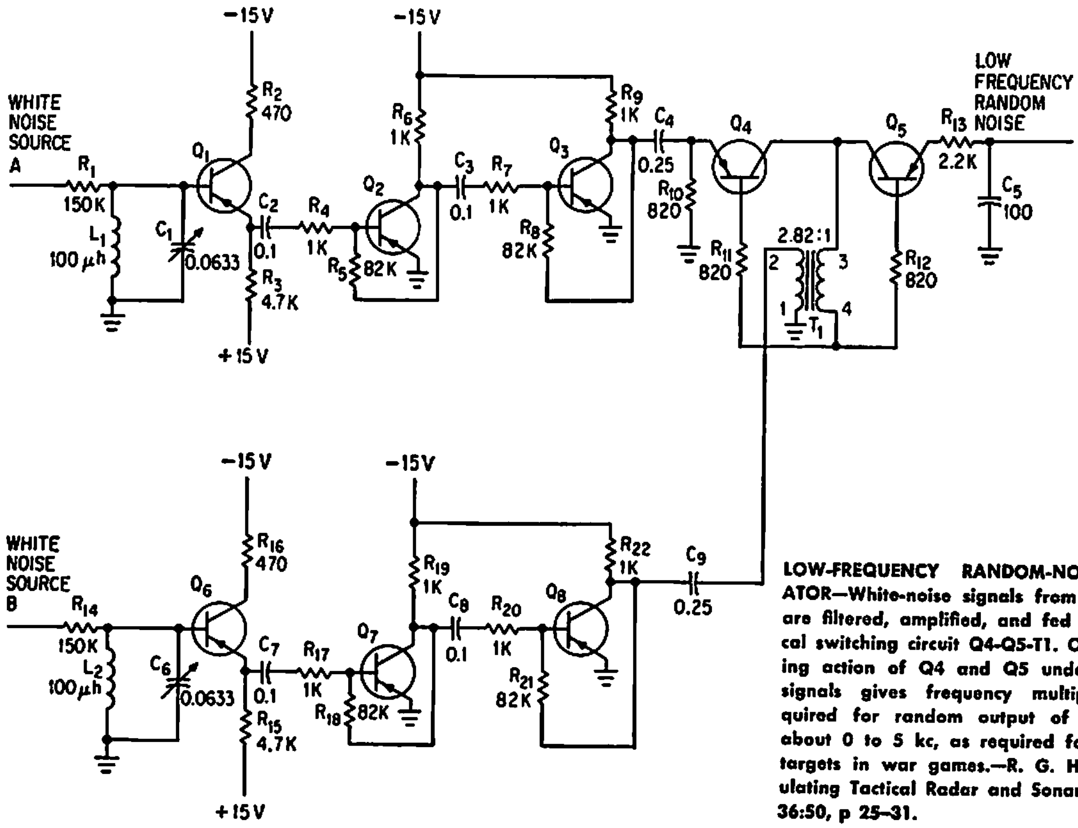
PULSE RECEIVER TESTER—Simulates field conditions encountered by pulse receivers use in ionospheric soundings, by supplying powerful pulse followed by weak pulse, with variable time separation. Weak pulse can be moved through fixed strong pulse without addition of pulse amplitudes. Uses cathode-follower mixer pulser and c-w oscillator pulsing a buffer.—K. Perry, Transmitter Simulator Tests Pulse and Phase-Path Receivers, *Electronics*, 33:41, p 67.



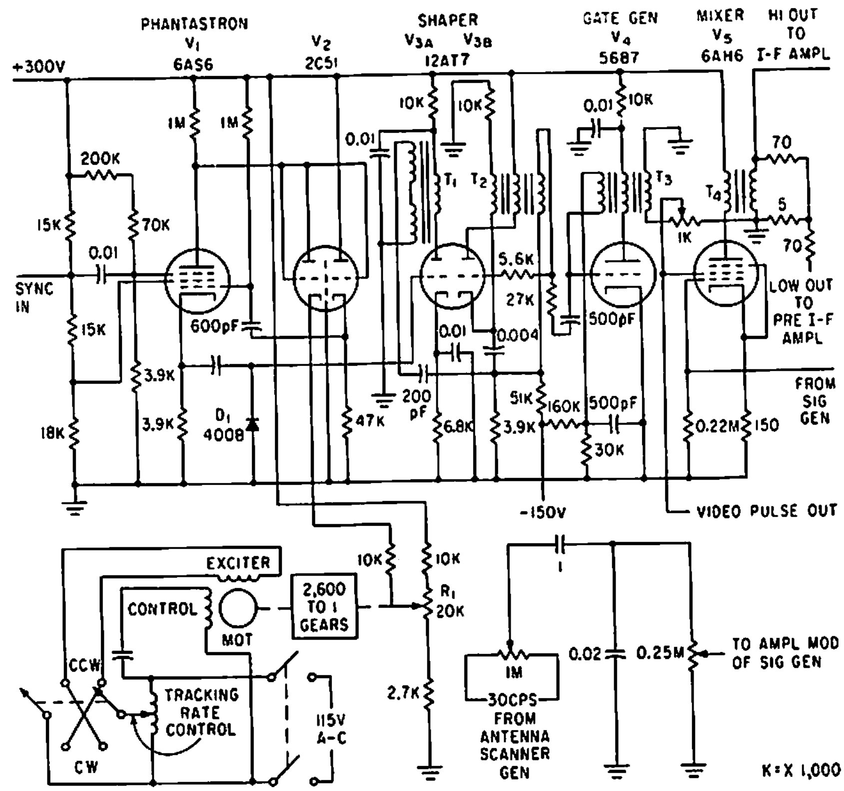
PULSE COMMUTATOR SIMULATOR—Used for checking telemetry ground station equipment without wearing out commutator of telemeter. Magnetic shift register elements are used as ring counters.—J. Porter, Pulse Commutator Simulator Uses Magnetic Logic Elements, *Electronics*, 34:12, p 43–45.



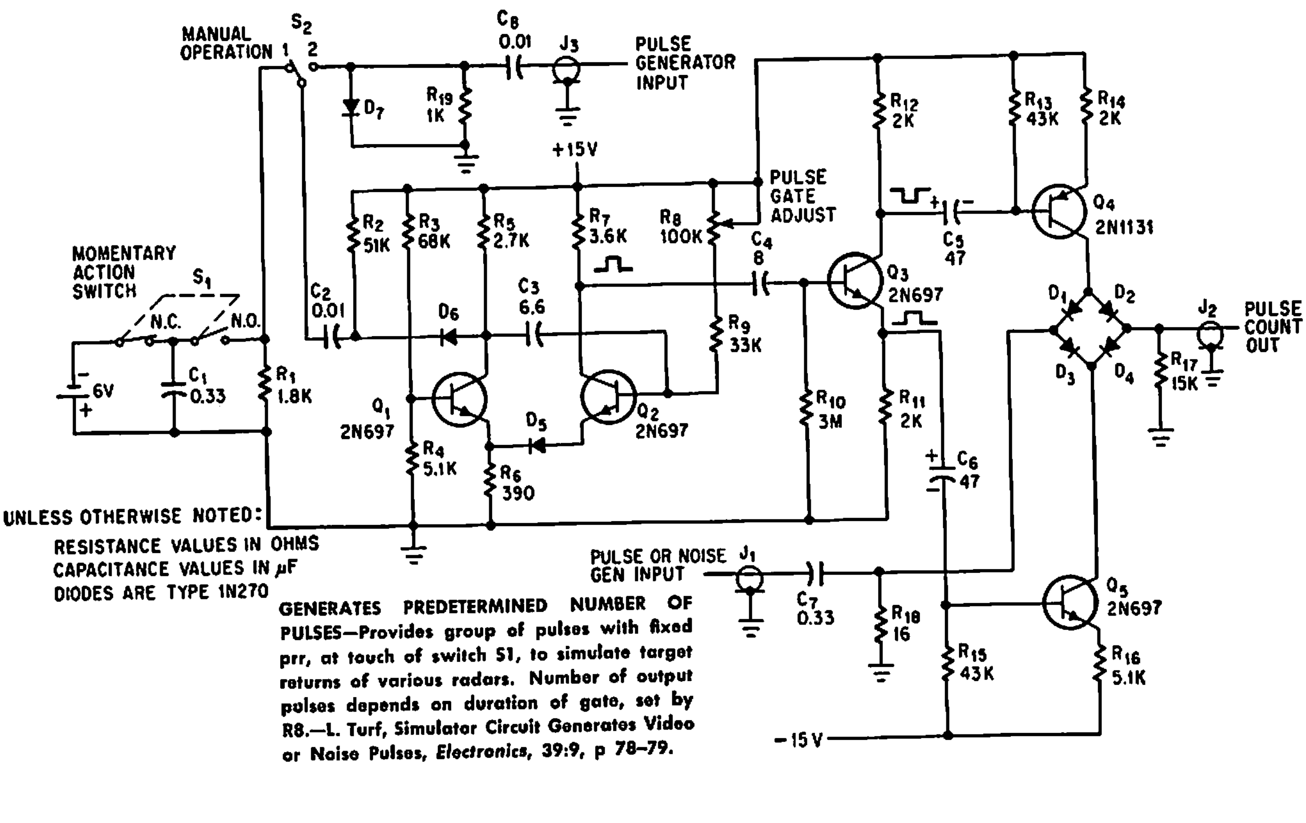
SPIRAL SWEEP SIMULATOR—Does not require operational radar equipment. Antenna signal is obtained from phase shifter and sweep amplitude potentiometer that provides spiral sweep for target on oscillosope. Range is indicated by gating target to correct radius of spiral sweep. Azimuth is indicated by another gate that limits target appearance to correct angle on spiral sweep. —J. I. Loskinen, Four Ways to Simulate Radar Targets, *Electronics*, 31:23, p 82–86.



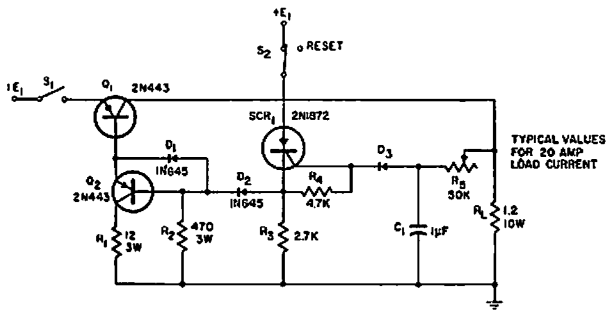
LOW-FREQUENCY RANDOM-NOISE GENERATOR—White-noise signals from two sources are filtered, amplified, and fed to symmetrical switching circuit Q4-Q5-T1. On-off switching action of Q4 and Q5 under control of signals gives frequency multiplication required for random output of pulses from about 0 to 5 kc, as required for simulating targets in war games.—R. G. Hundley, Simulating Tactical Radar and Sonar, *Electronics*, 36:50, p 25–31.



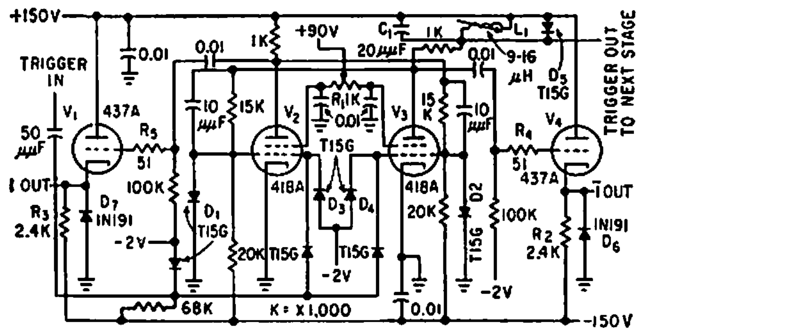
RADAR MOVING-TARGET SIMULATOR—Supplies signal having all characteristics of radar echo, for testing automatic tracking radars under normal and extreme conditions. Phantastron, dual-diode V2, and two-phase motor serve as variable time-delay.—K. L. Chapman, Moving-Target Simulator Tests Tracking Radars, *Electronics*, 34:13, p 58–60.



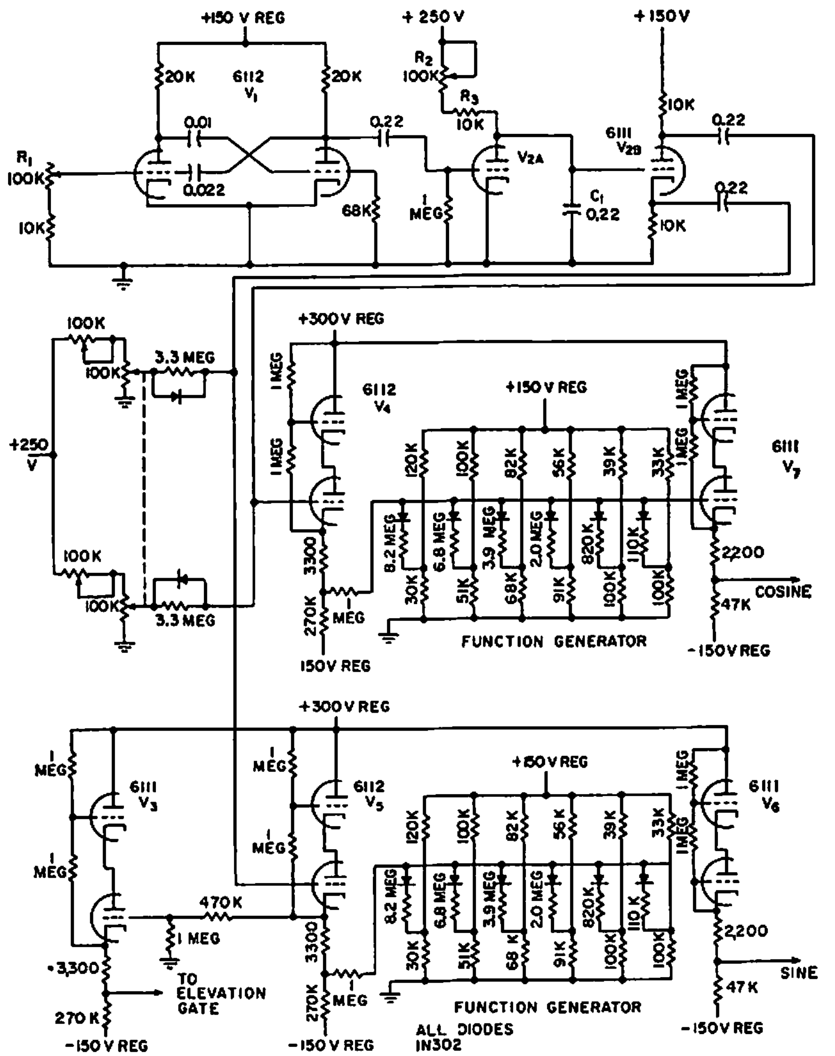
GENERATES PREDETERMINED NUMBER OF PULSES—Provides group of pulses with fixed prr, at touch of switch S1, to simulate target returns of various radars. Number of output pulses depends on duration of gate, set by R8.—L. Turf, Simulator Circuit Generates Video or Noise Pulses, *Electronics*, 39:9, p 78–79.



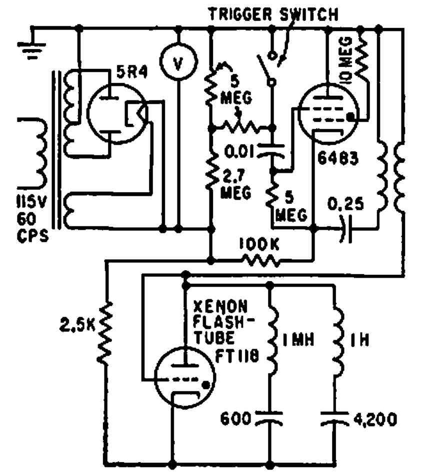
SQUIB SIMULATOR—Simulates electrical characteristics of primer or squib of propellant-actuated fastener used in missiles and space systems for vehicle separation. Has very low impedance prior to firing, and infinite impedance after firing. Useful for testing firing circuits in laboratory where firing of actual squib would create disturbing sound.—C. S. Lewis, Electronic Squib Simulator, *EEE*, 10:9, p 24–25.



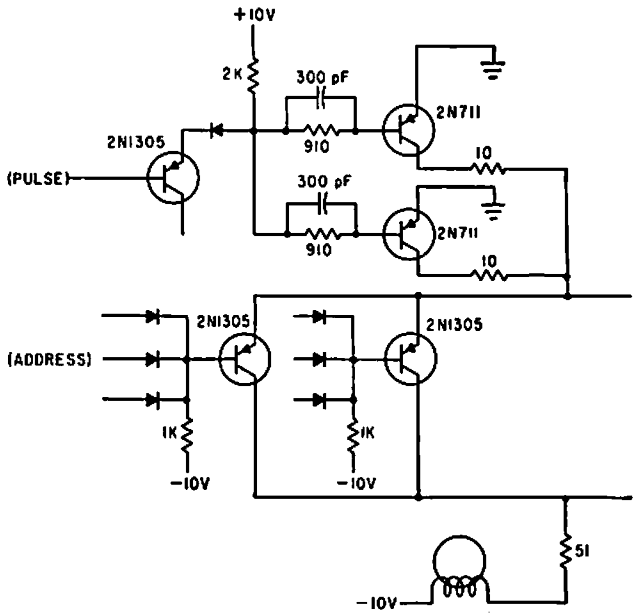
16-BIT WORD GENERATOR—Provides all possible 16-bit serial binary words at 10-Mc rate, to simulate expected input of high-speed computer circuits. Four identical binary stages are used in word generator. Speed is derived from high-transconductance tetrodes.—R. G. Norquist, Testing High-Speed Digital Computer Circuits, *Electronics*, 32:29, p 50–51.



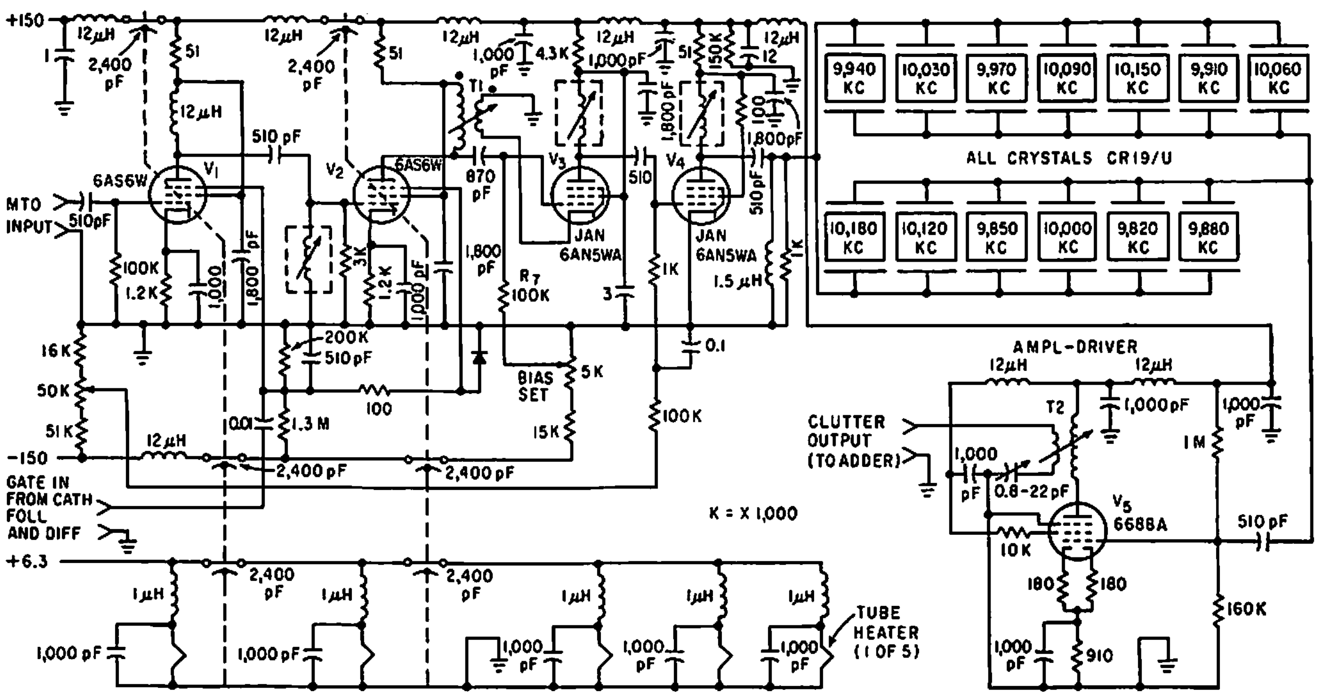
THREE-DIMENSIONAL TARGET SIMULATOR—Trigger generator supplies zero time reference for ppi and rhi scopes and circuits of radar simulator. Course generator provides voltages proportional to X, Y, and Z target coordinates. Transformation computer with function generators converts these into polar coordinates. Range voltage from computer is compared with linear sawtooth to obtain time delay proportional to target range.—J. I. Leskinen, Four Ways to Simulate Radar Targets, *Electronics*, 31:23, p 82–86.



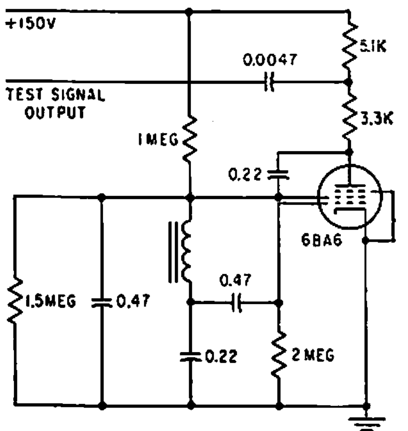
NUCLEAR BLAST SIMULATOR—Uses xenon flashtube in double-discharge circuit to simulate thermal radiation pulse of nuclear explosion within atmosphere, which rises rapidly to first maximum, declines to minimum, rises to second maximum, then decreases gradually to zero. Used to evaluate atomic bomb alarm systems.—D. J. Baker and D. E. Thomas, Nuclear Thermal Pulse Simulator, *Electronics*, 32:44, p 66–69.



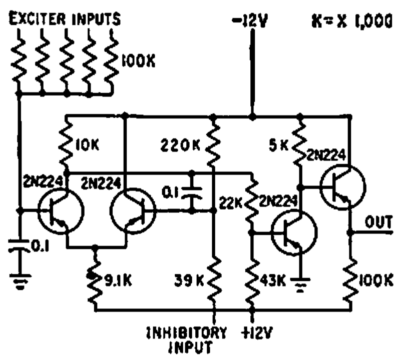
CORE DRIVER—Causes current with fast rise and fall time to flow through steering driver that has been actuated by outputs of address counter used in generating programmed digital signals for simulation or test purposes. —W. D. Woo, Novel Digital Signal Generator Uses Magnetic-Core Pegboard, *Electronics*, 35:27, p 46–49.



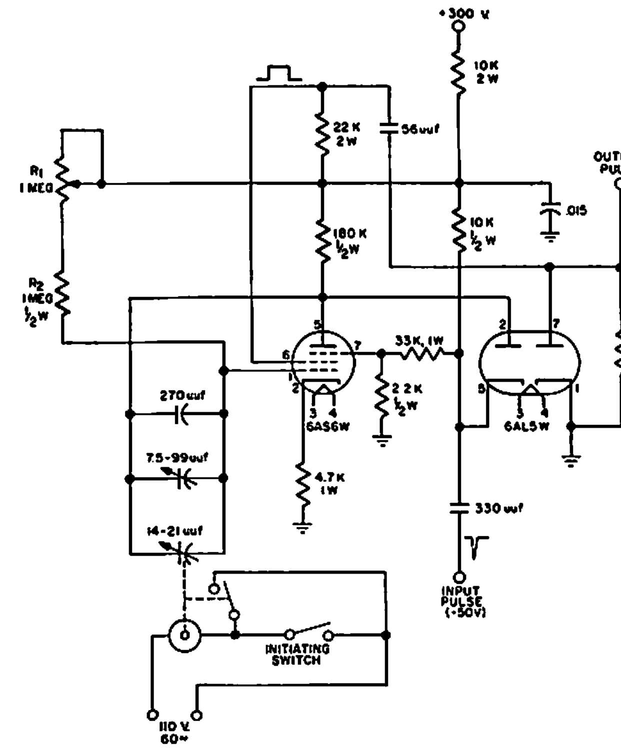
CLUTTER GENERATOR—Simulates radar clutter received by rotating antenna on 550-mph aircraft, for checking airborne moving-target indicator on ground. Clutter is produced by ringing bank of closely spaced crystals and allowing resulting frequencies to beat together to produce jagged clutter return that decays with range.—H. Lobenstein and A. R. Dial, Radar-Return Simulator Tests Moving-Target Indicators, *Electronics*, 33:49, p 58–60.



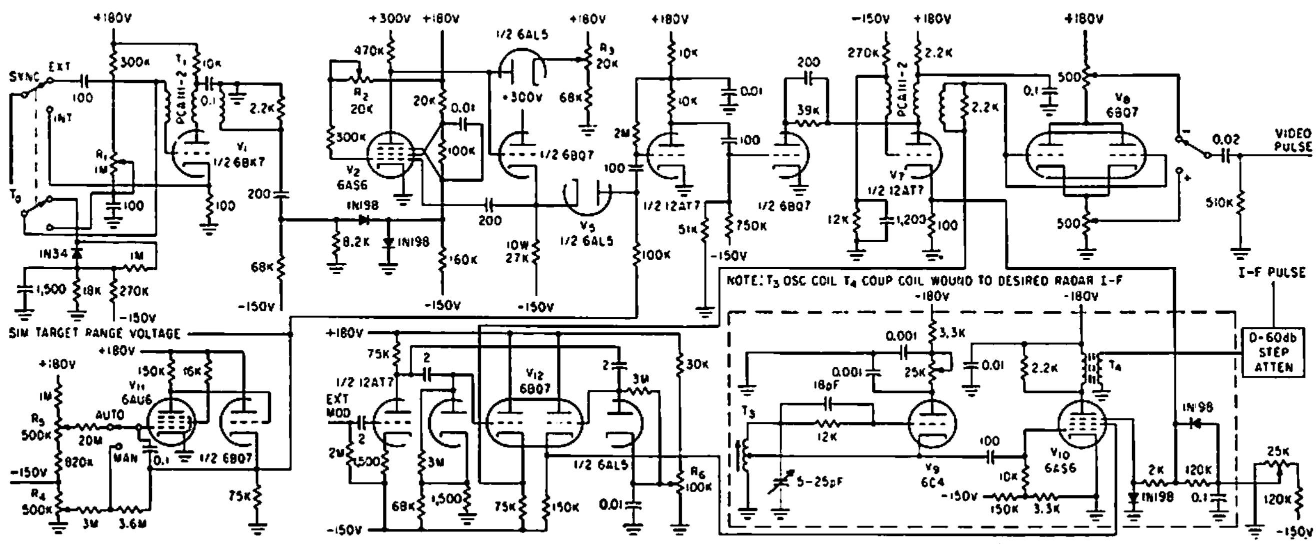
SPEECH SIMULATOR—Electron-coupled 1-kc Colpitts oscillator is modified to hunt at approximately 10 cps. Serves as source of fluctuating-amplitude audio tone, to simulate speech in narrow spectrum region.—H. Schwarzlander, Intelligibility Evaluation of Voice Communications, *Electronics*, 32:22, p 88–91.



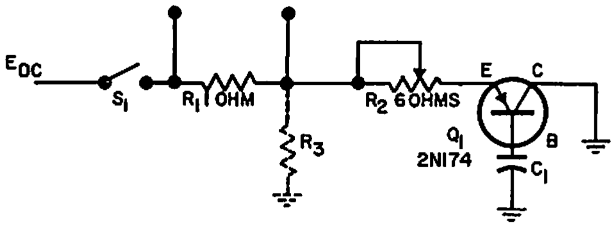
NEURON SIMULATOR—Simulates many of functions of eye and ear nerve cells. Output consists of 6-Mc pulses.—Artificial Neuron Uses Transistors, *Electronics*, 32:7, p 74.



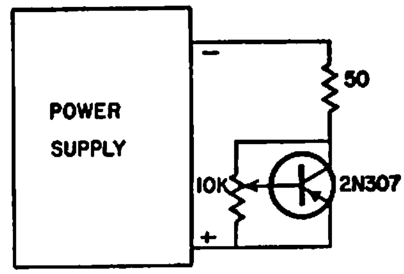
RADAR TARGET ACCELERATION SIMULATOR—Used for testing radar range tracking systems. Uses phantastron delay modified by adding synchronous-motor-driven capacitor in feedback loop to provide target with controlled acceleration. Pulse used to trigger phantastron corresponds to radar transmitted pulse; second pulse, triggered by trailing edge of phantastron square-wave, represents radar echo. Time between pulses, representing range, can be set to desired values by changing resistance between positive supply and grid and changing capacitance between plate and grid of phantastron tube.—Radar Target Acceleration Simulator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 171.



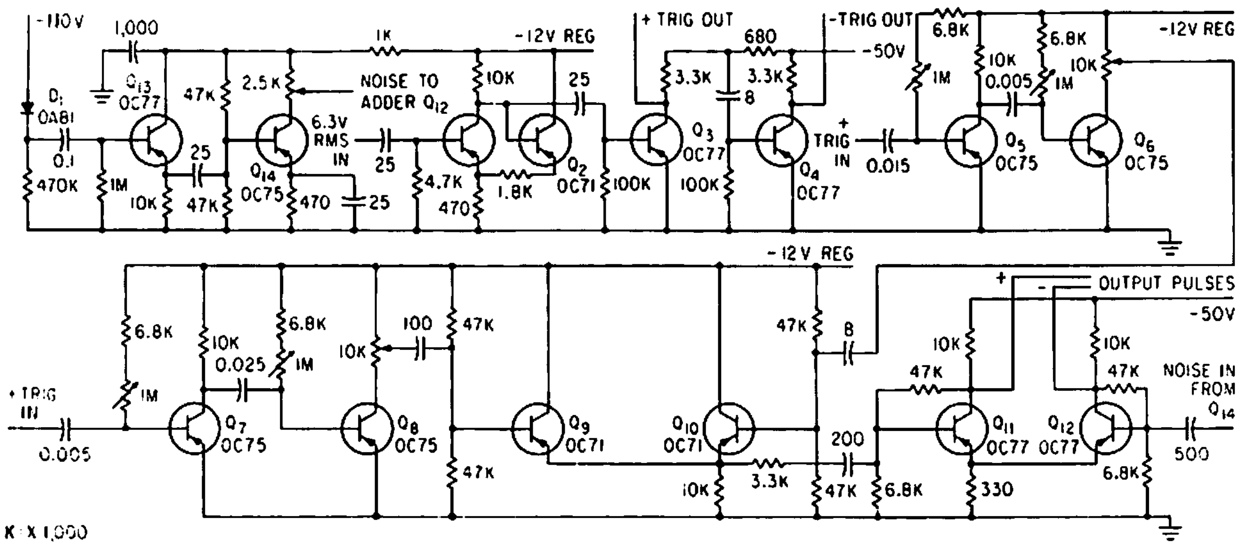
RADAR RANGE TESTER—Dynamic target simulator independently generates time-delayed fixed or moving target pulses for target rates above mach 3, for testing range accuracy of airborne automatic-tracking radar.—O. B. Mitchell, Simulator Tests Radar Tracking Systems, *Electronics*, 34:8, p 51–53.



EXPONENTIAL-DECAY LOAD—Used in place of a capacitor when large load with exponential decay is required. R1 provides means for monitoring current on cro. Article gives component values for wide range of decay times, from 50 millisec to 1 sec, with initial discharge currents of 6.3 to 21.5 amp. Source voltage is 28 v.—B. Bever and L. Snyder, Transient Load With Exponential Decay, *EEE*, 10:10, p 31.

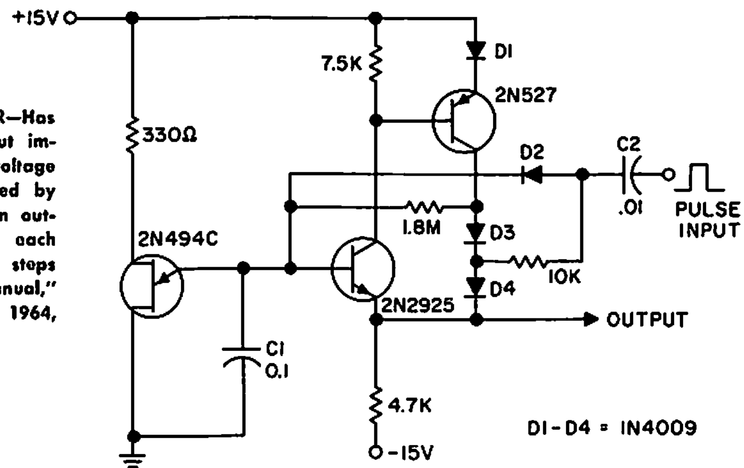


LOAD SIMULATOR—Is more economical than large rheostat when testing semiconductor power supplies for ripple attenuation and output impedance at different values of load current. Presents variable load to 30-v supply rated at 0.6 amp.—Inexpensive Load Simulator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 165.

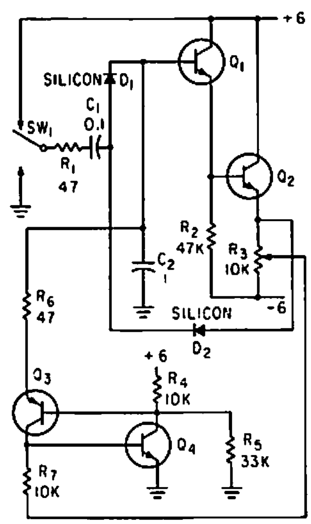


IONOSPHERIC SOUNDER PULSE SIMULATOR—Generates long and short output pulses with positive and negative polarities, each adjustable in duration and amplitude. Small pulse can be moved through large pulse. Simulator is triggered at power-line frequency.—K. Perry, Back-Scatter Simulator Checks Ionospheric Sounder Displays, *Electronics*, 35:25, p 50.

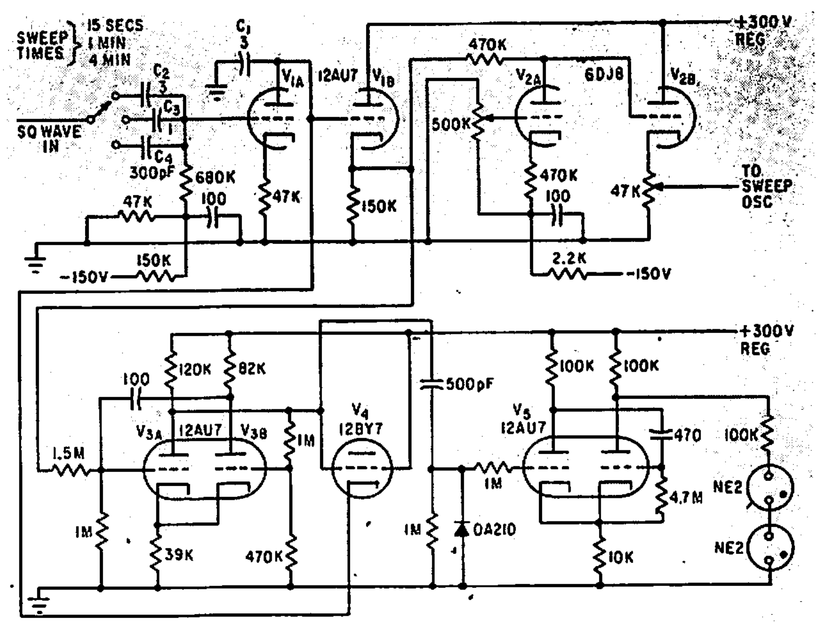
CHAPTER 81
Staircase Generator Circuits



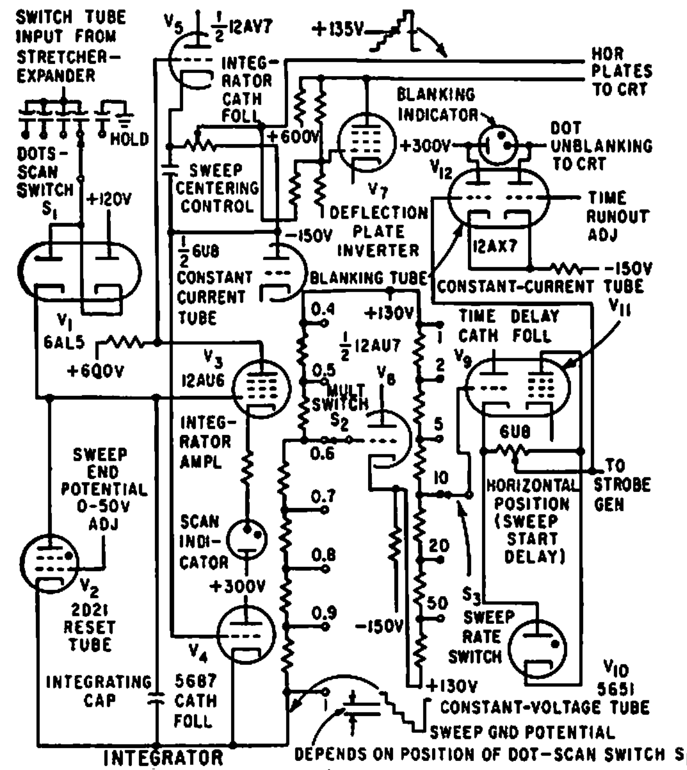
WIDE-RANGE STAIRCASE GENERATOR—Has high input impedance and low output impedance, to reduce droop in output voltage between pulses. Staircase is generated by pump D2-C2, which is boostrapped on output to maintain equal amplitude on each step. Circuit values shown give 10 steps with 12-v input pulse.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 345.



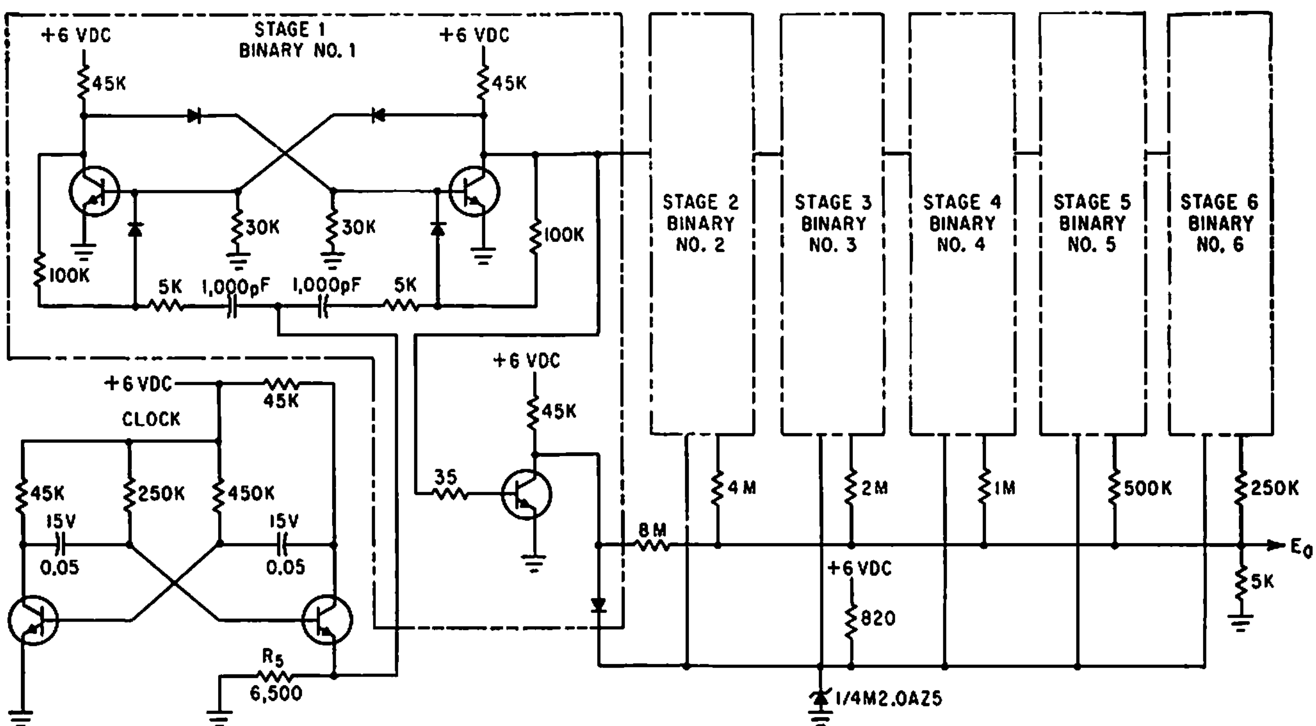
STAIRCASE COUNTER—Q1-Q2 serve as bootstrap amplifier for voltage on storage capacitor C2. Each incoming pulse transfers charge increment from C1 to C2. Reliable counts as large as ten are easily obtained.—N. C. Hekimian, PNP-NPN CIRCUITS: New Look at a Familiar Connection, *Electronics*, 35:47, p 42–46.



10-MINUTE STEPPED SWEEP—Provides long stepped sweeps required for swept-frequency ionosondes, with 100-v amplitude. Schmitt trigger V3 detects end of rundown and initiates recharging of C1.—K. Perry, Long Staircase Generator, *Electronics*, 35:35, p 54.

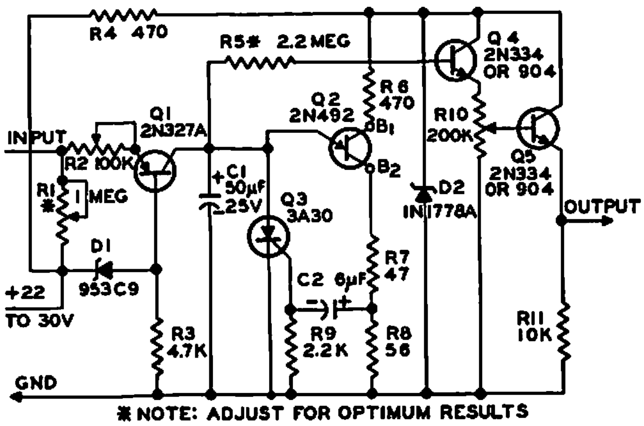


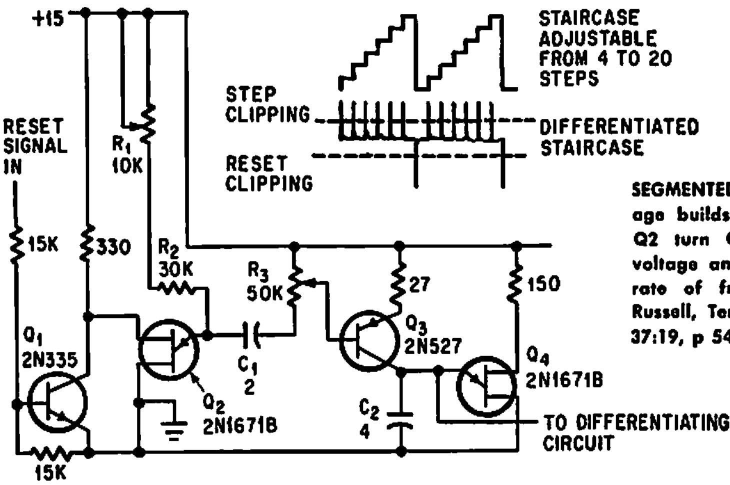
SAMPLING STAIRCASE—Provides horizontal deflection voltage for crt and time advance information for comparator tube in strobe generator. Increase of d-c bias superimposed on staircase advances start of sampling with respect to start of ramp, decreasing apparent time delay in start of d-c trace. Blanking indicator in staircase generator is on when screen is blanked. Scan indicator flashes when staircase is sweeping. Staircase advances one step for each displayed sample.—W. E. Bushor, Sample Method Displays Millimicrosecond Pulses, *Electronics*, 32:31, p 69–71.



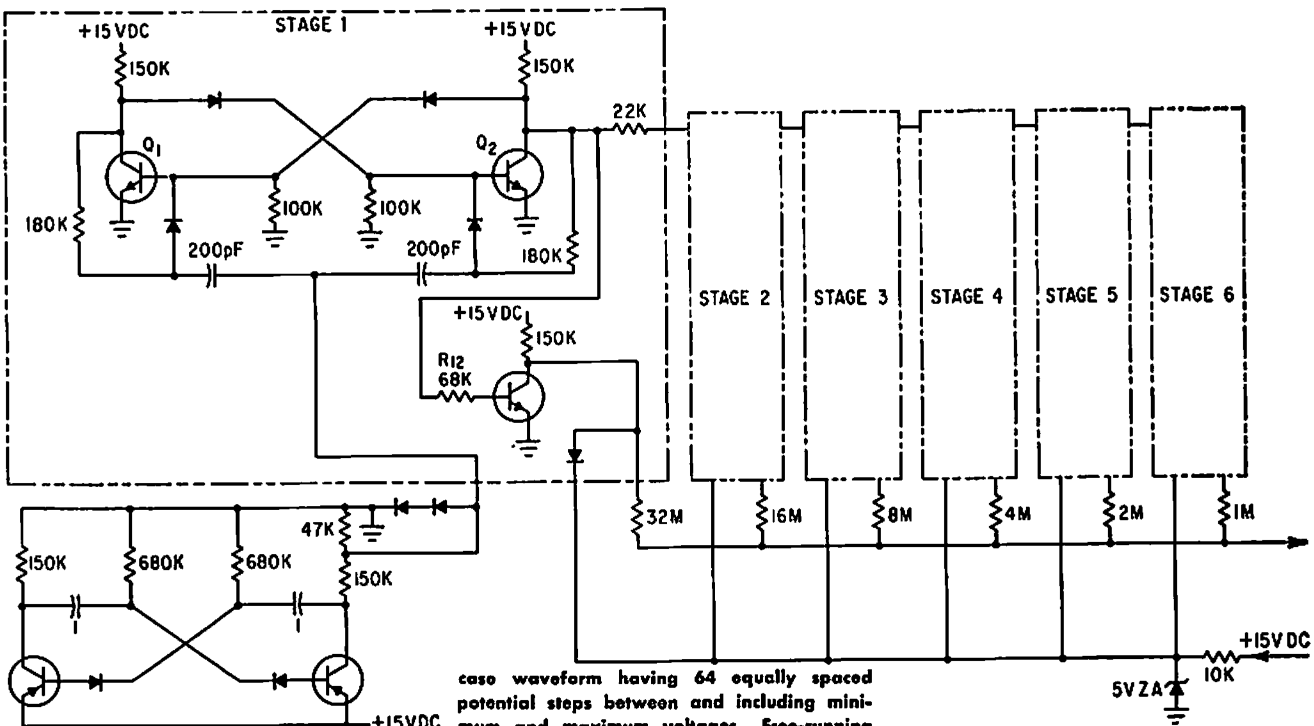
STAIRCASE GENERATOR—Major modification of conventional 64-step voltage staircase generator for integrated-circuit construction involved dropping supply voltage from 15 v to 6 v, to cut power drain in half and reduce summing resistor network values. Circuit uses Pacific Semiconductor PD101 microdiodes and uncased Fairchild FSP-42-1 transistors.—E. E. Eberhard, Latest Thin-Film Circuit Techniques, *Electronics*, 35:24, p 37–39.

LOW-FREQUENCY STAIRSTEP—Accepts pulse input, either random or evenly spaced, and produces output after fixed number of inputs. Useful in measuring and recording low-frequency data. Pulse widths may be 1 millisec to several hundred millisec. Output may have anywhere from 2 to 1,000 steps. By making R1 smaller and eliminating R2, output becomes sawtooth with 1% linearity, variable from 10 millisec to 15 minutes depending on values of C1 and R1.—Low-Frequency Stairstep Generator and Timing Circuit, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 144.

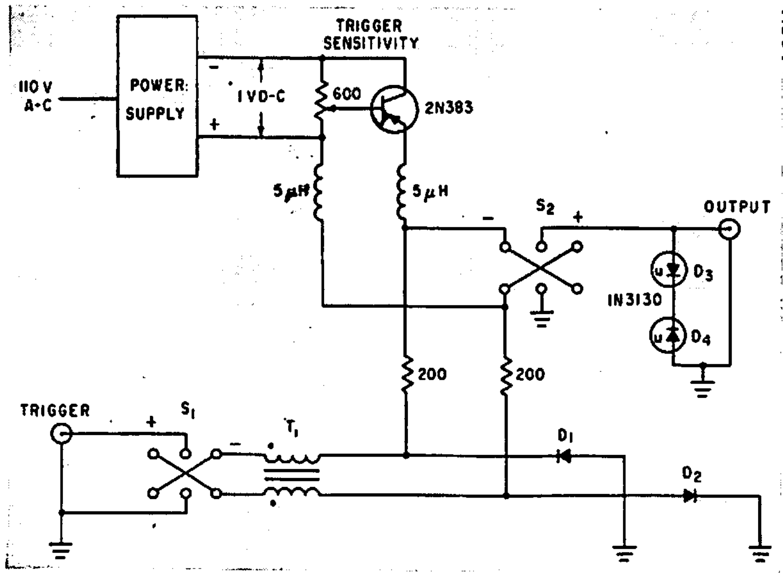




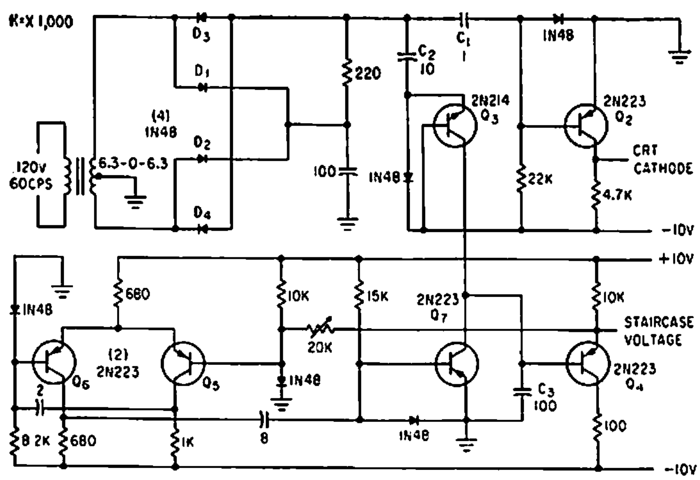
SEGMENTED-SWEEP DISPLAY—Staircase voltage builds up across C2 when pulses from Q2 turn Q3 on momentarily. R3 controls voltage amplitude of each step. R1 controls rate of free-running oscillator tube.—J. E. Russell, Ten Signals at a Glance, *Electronics*, 37:19, p 54–57.



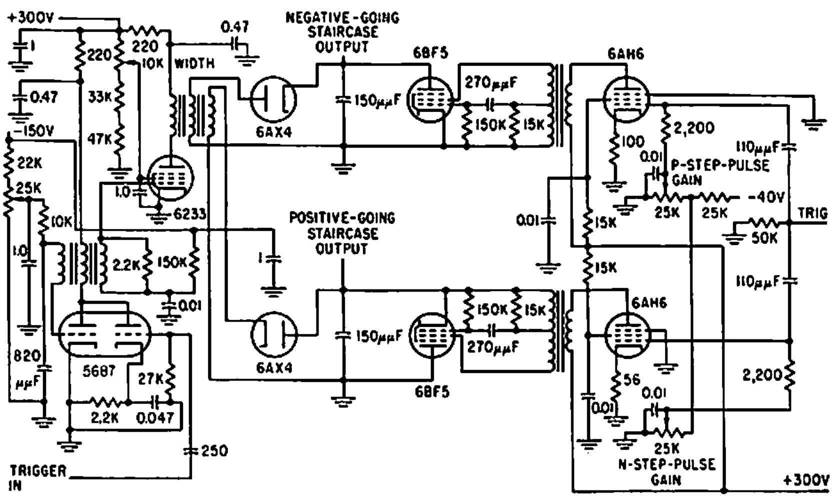
64 STEPS—R-C clock, six binary counters, and summing network give repetitive staircase waveform having 64 equally spaced potential steps between and including minimum and maximum voltages. Free-running astable mvbr (lower left) generates 40-cps clock signal. Transistors can be 2N697.—E. E. Eberhard, Latest Thin-Film Circuit Techniques, *Electronics*, 35:24, p 37–39.



SINGLE STEPS AT 100 KC—Tunnel-diode step generator provides single 400-mv steps that are fast and free from overshoot, for testing wideband systems. Flat top of step, used for tests, is 2 microsec long. Step can be triggered with 0.5-v signal at repetition rates to 100 kc, or can free-run at about 100 kc.—R. Carlson, Tunnel-Diode Fast-Step Generator Produces Positive or Negative Steps, *Electronics*, 34:30, p 48–49.

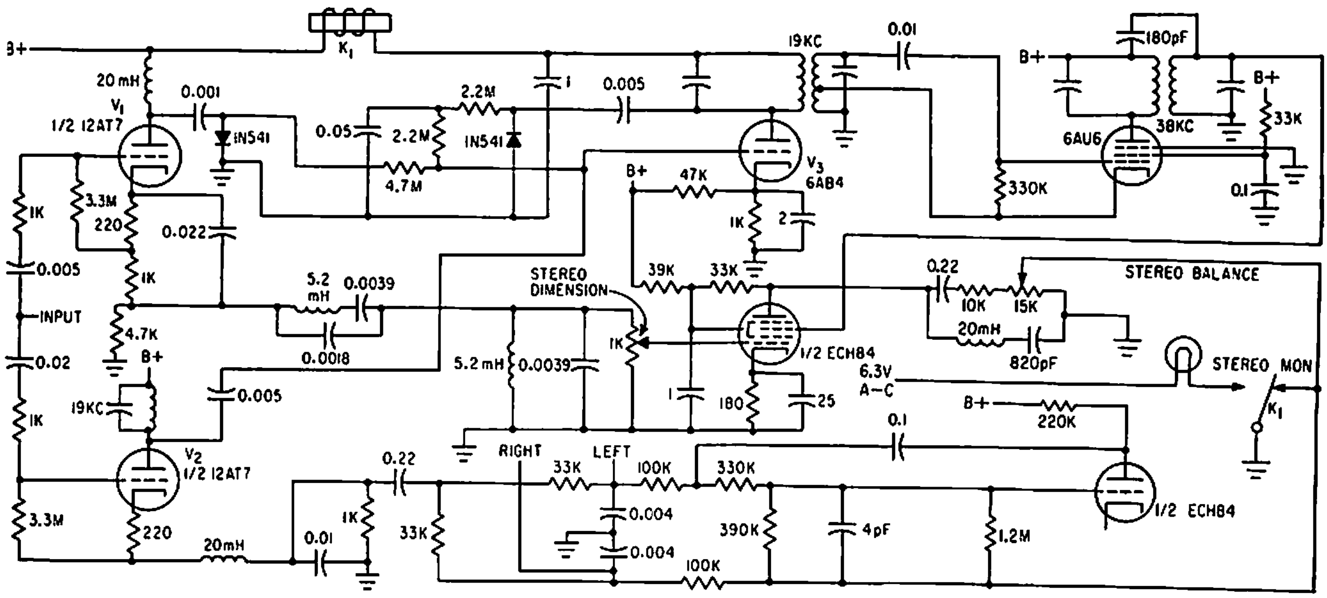


WAVEFORM GENERATOR FOR CURVE TRACER—Generates blanking signal at collector of Q2 and staircase waveform at emitter of Q4 by charge transfer from C2 to C3. —C. J. Candy, Simplified Curve Tracer for Transistors and Diodes, *Electronics*, 33:34, p 68–70.

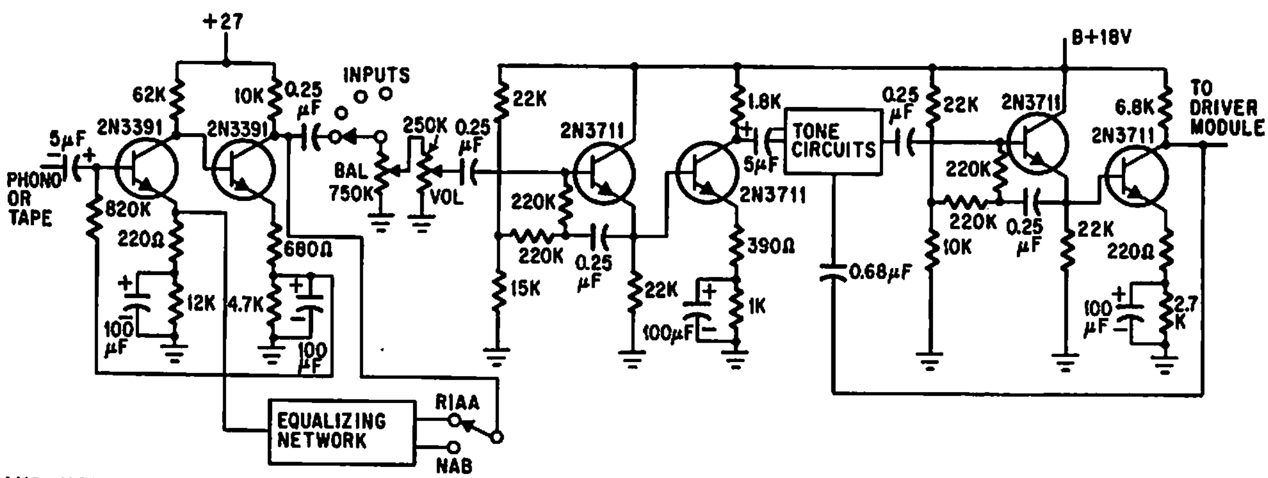


TWO-SECTION STAIRCASE—Negative-going staircase is developed from positive potential, and positive-going staircase from negative potential. Output voltage across 150-mmfd capacitors is 800 v peak-to-peak, enough to drive crt directly.—M. T. Nadir, Microsecond Sampler Handles 126 Channels, *Electronics*, 32:4, p 36–39.

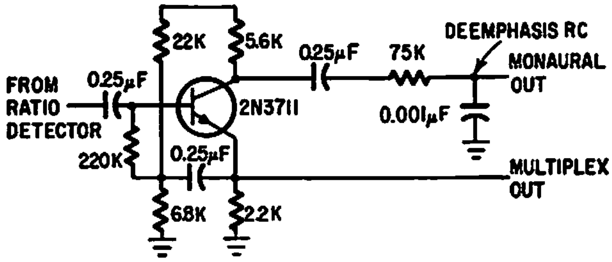
CHAPTER 82
Stereo Circuits



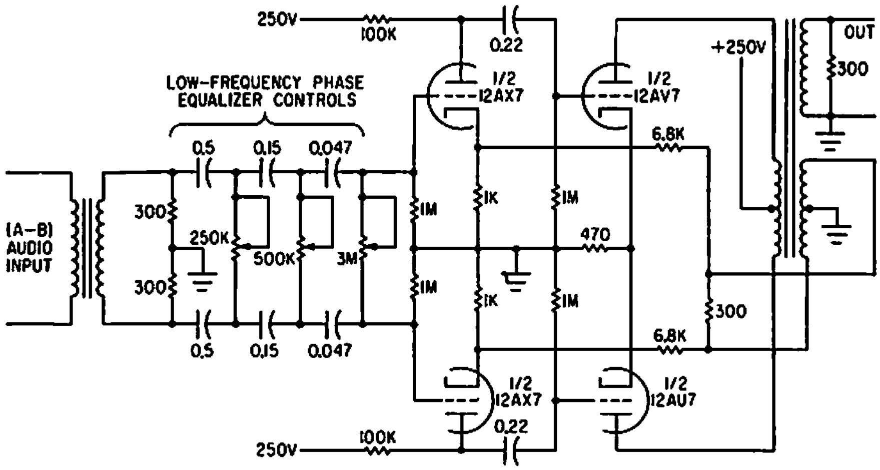
AUTOMATIC STEREO SWITCH—Switches f-m tuner into stereo mode and turns on indicator lamp when f-m tuner is tuned to station broadcasting stereo subcarrier or when subcarrier comes on during normal f-m broadcast.—L. Solomon, Audio Show Features Automatic Stereo, Hi-Fi Earphones, *Electronics*, 34:39, p 34–35.



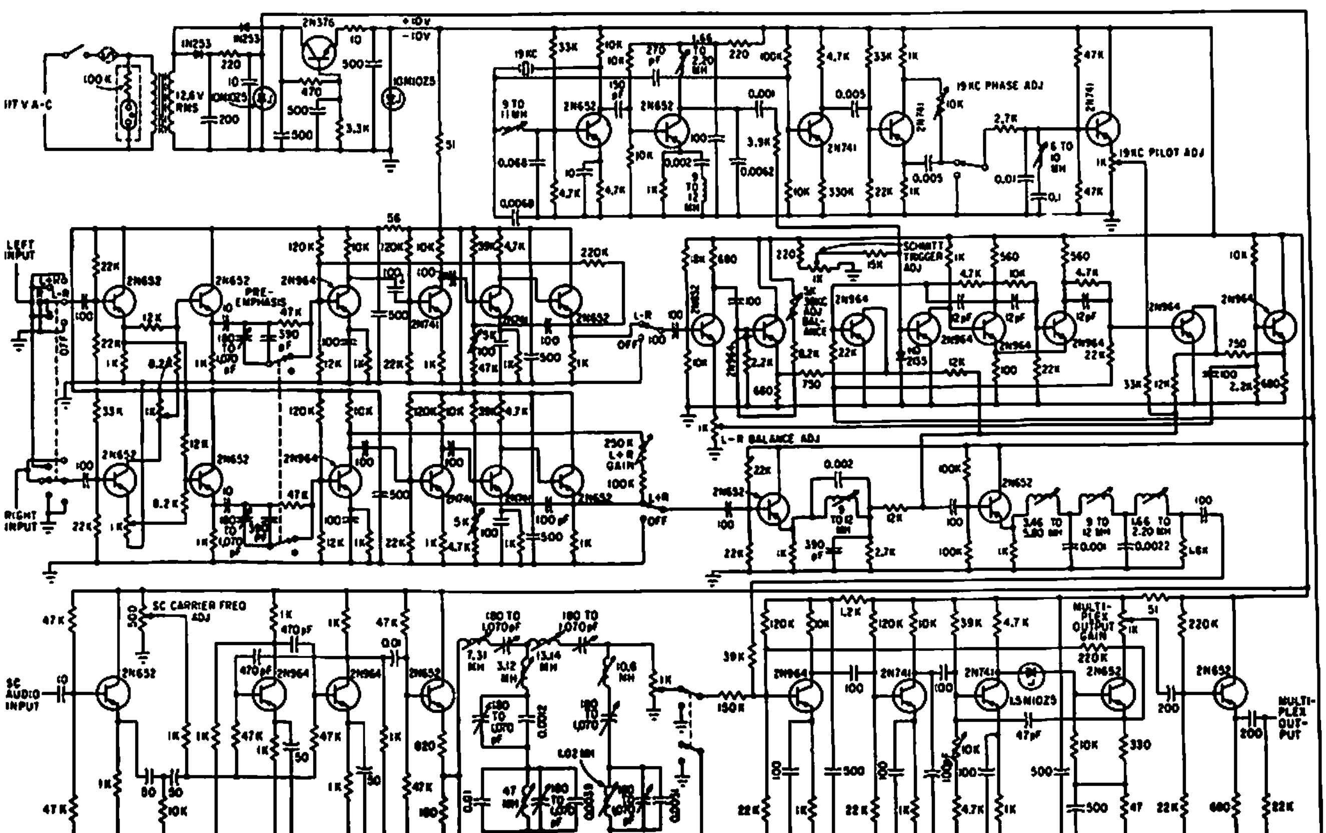
PREAMP MODULE—Bootstrapped emitter-followers accept high-impedance input signals and minimize loading of equalizing and tone circuits.—S. Messin and T. E. Nawalinski, A Solid State Stereo Set Built in Modules, *Electronics*, 38:16, p 88–92.



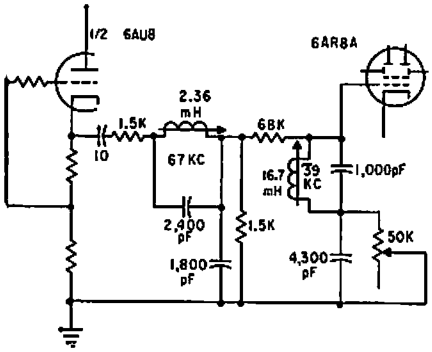
DUAL-OUTPUT I-F—Final i-f stage of stereo f-m set has two outputs, to permit independent feed of monaural f-m.—S. Messin and T. E. Nawalinski, A Solid State Stereo Set Built in Modules, *Electronics*, 38:16, p 88–92.



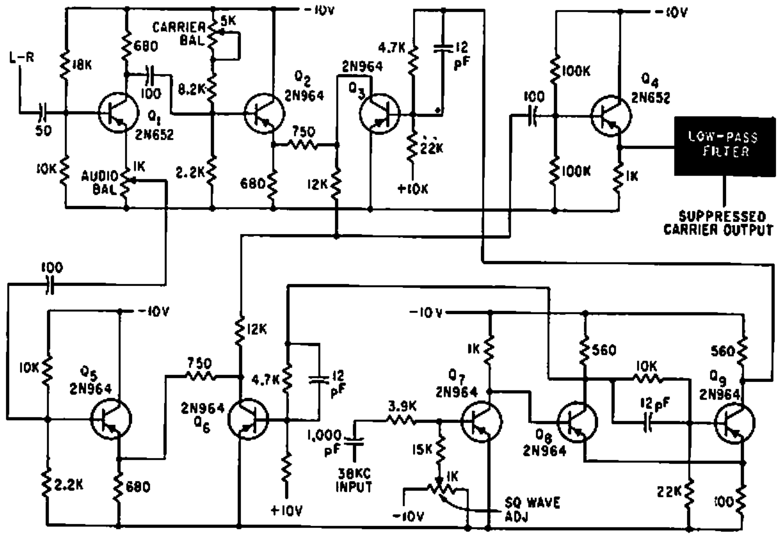
STEREO MULTIPLEX A-F AMPLIFIER—Provides low-frequency phase equalization for the A-B channel, using variable R-C high-pass filter sections that can be adjusted for cutoff between 5 and 25 cps.—Modifying an F-M Transmitter for Compatible Stereo Multiplex, *Electronics*, 34:28, p 60–62.



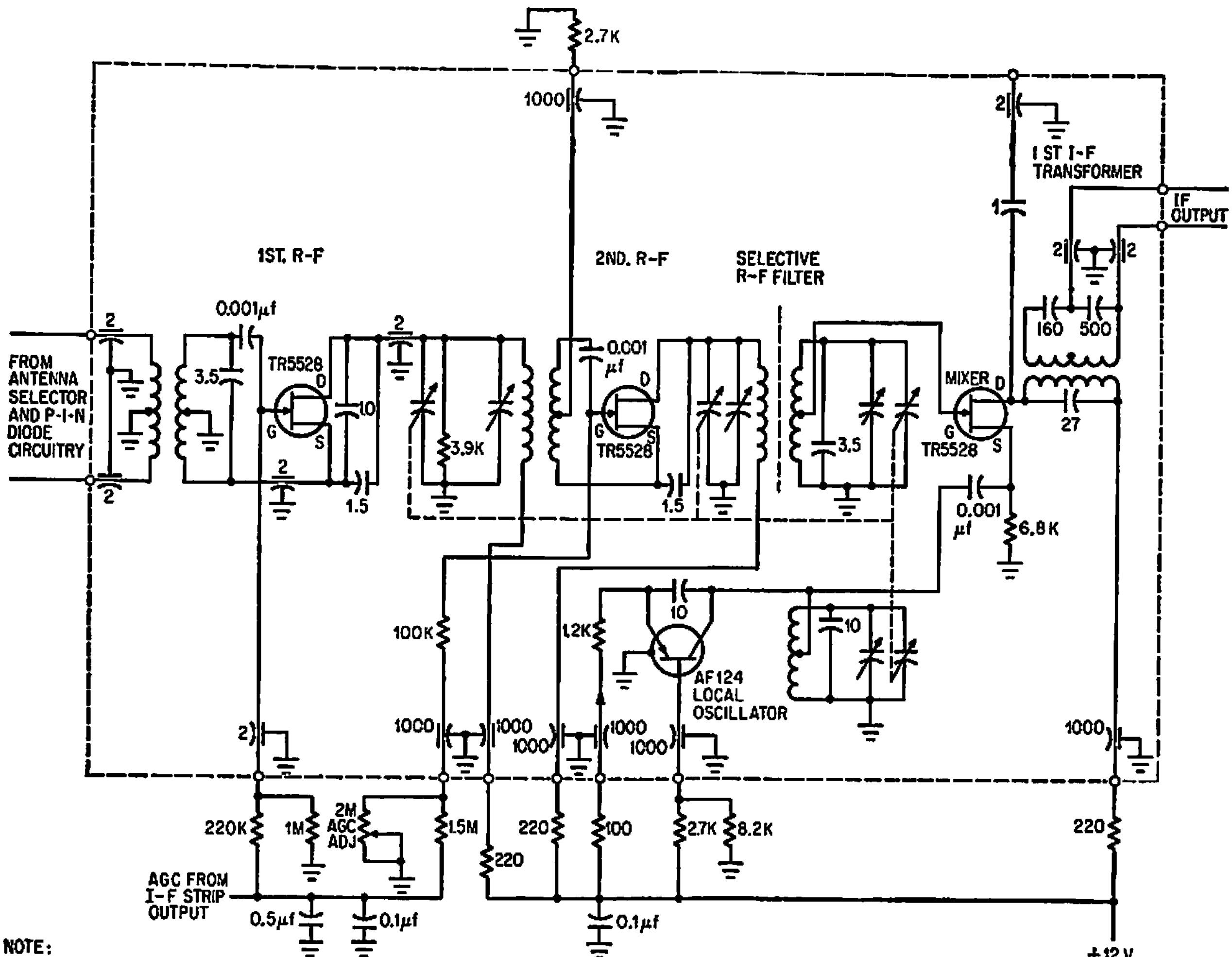
STEREO MULTIPLEX F-M SIGNAL GENERATOR—Used for testing and aligning multiplex receivers and adapters. Switches permit generating L+R or L−R separately with or without preemphasis and inserting or removing SCA 67-kc signal.—S. Feldman, Stereo F-M Multiplex Alignment Signal Generator, *Electronics*, 35:3, p 37–39.



F-M STEREO MATRIXING—Matrixing is completely accomplished before detection. Can be substituted for 67-kc rejection filter of stereo demodulator. Also provides deemphasis.—L. Solomon, Multiplex Adaptors for Compatible F-M Stereo Reception, *Electronics*, 34:33, p 45–47.

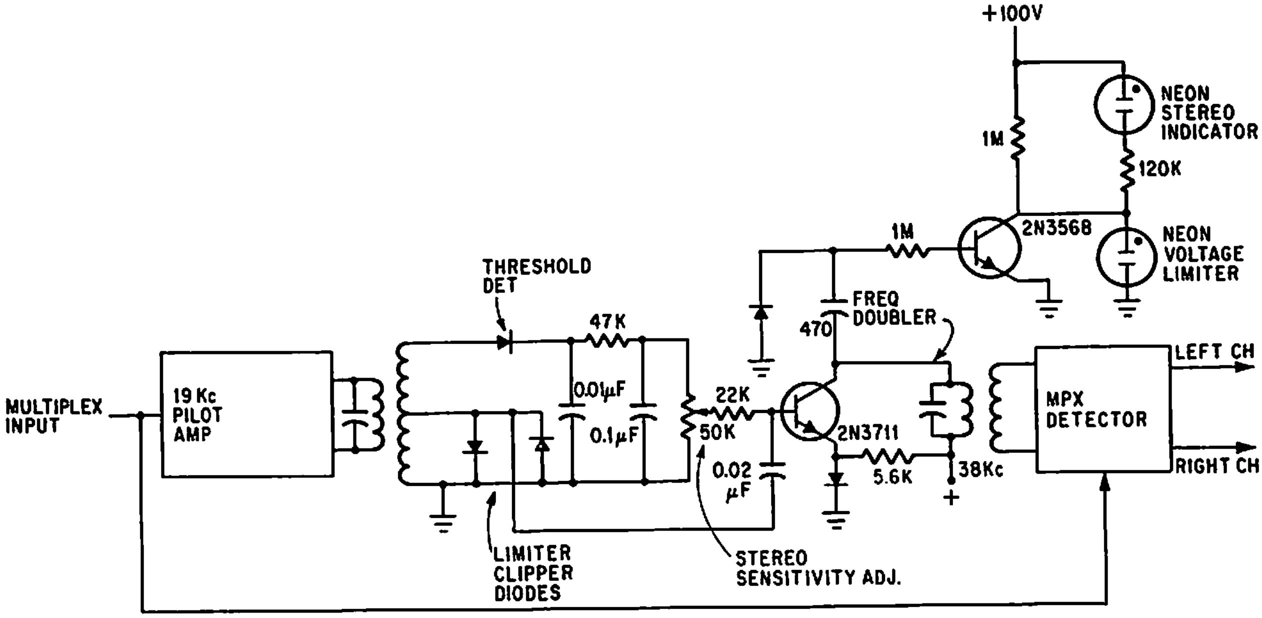


SUPPRESSED-CARRIER SIGNAL GENERATOR—Output of 38 kc, modulated by L-R signal, is obtained by bias-modulating symmetrical stable multivibrator. Carrier will remain suppressed 46 db below maximum signal level for days.—S. Feldman, Stereo F-M Multiplex Alignment Signal Generator, *Electronics*, 35:3, p 37–39.

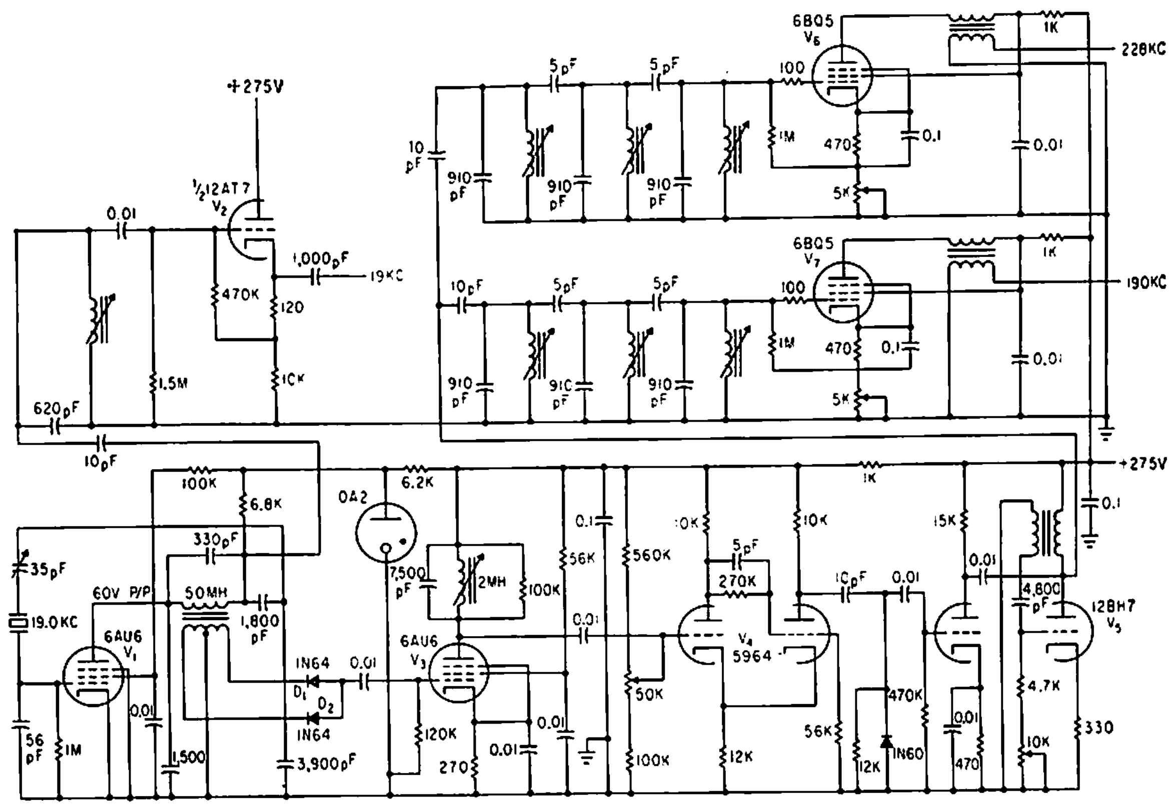


NOTE:
ALL CAPACITORS ARE pf UNLESS DESIGNATED ON DRAWING

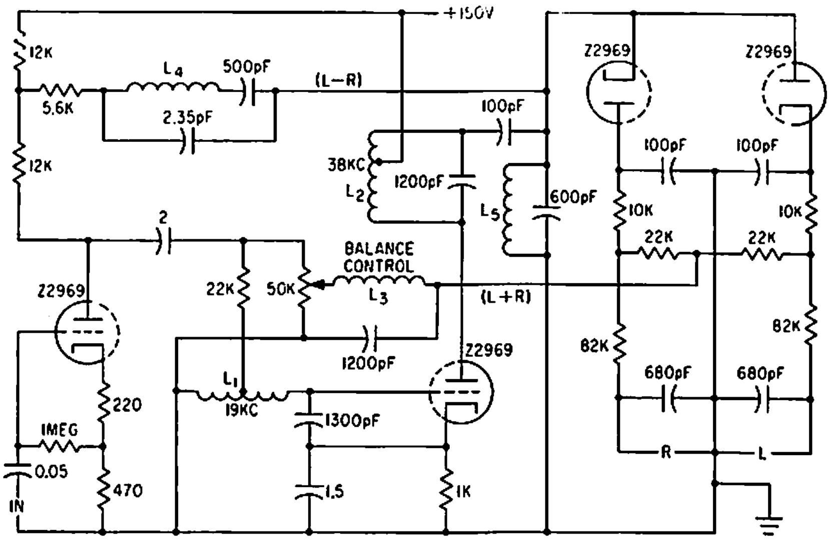
FET STEREO-FM TUNER—Uses four tuned r-f circuits, two in high-Q highly selective band-pass filter, plus two fet r-f stages in addition to fet mixer and local oscillator. Agc voltage for the two gain-controlled fet r-f stages is derived from fourth i-f stage, which also drives narrow-band meter amplifier.—F. L. Mergner, P-i-n Diode and FET's Improve F-M Reception, *Electronics*, 39:17, p 114–118.



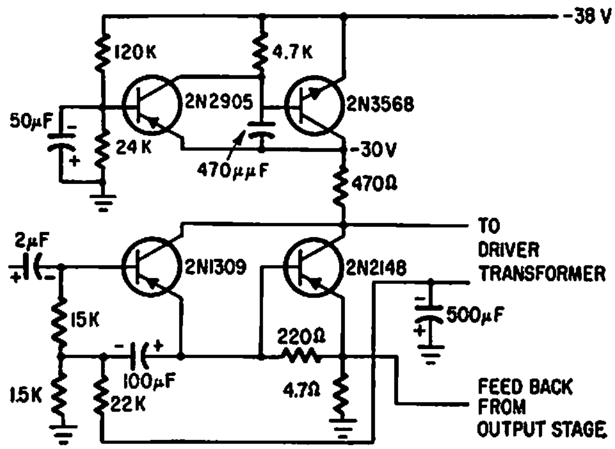
STEREO MULTIPLEXER—F-m reception is monaural when 19-kc multiplex input is absent or below acceptable power level. Rectification of 19-kc signal provides turn-on voltage to frequency doubler, for stereo.—S. Messin and T. E. Nowalinski, A Solid State Stereo Set Built in Modules, *Electronics*, 38:16, p 88–92.



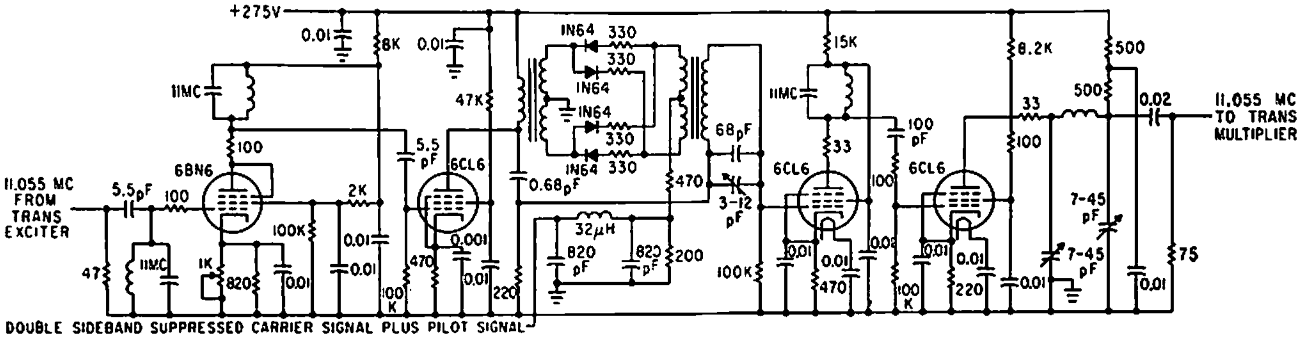
STEREO MULTIPLEX OSCILLATOR—Output of 19-kc crystal oscillator is amplified by V2 for pilot subcarrier. Same frequency is doubled by D1-D2, amplified by V3, and shaped by monostable mvbr V4 to provide trigger pulses for blocking oscillator V5, from which fifth and sixth harmonics (190 and 228 kc) are taken and amplified by V6 and V7 for use as carrier signals.—Modifying an F-M Transmitter for Compatible Stereo Multiplex, *Electronics*, 34:28, p 60–62.



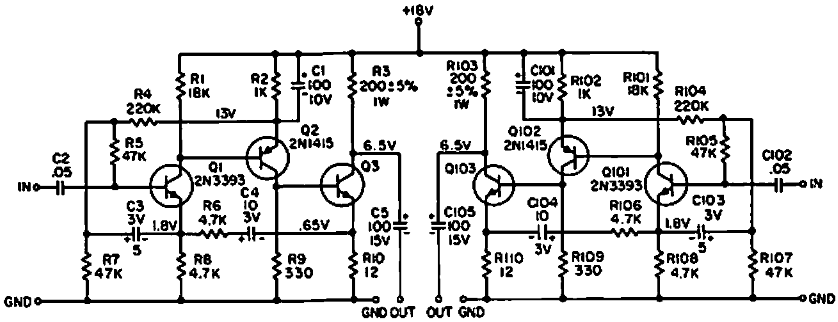
COMPACTRON FOR STEREO—Z2969 compactron performs functions of two triodes and two diodes in circuit for adapting f-m receivers to stereo.—L. Dillon, Single Compactron Adapts Receiver for Stereo, *Electronics*, 34:43, p 62–64.



DRIVER—Upper pair of transistors provides voltage regulation, filtering, turn-on time delay, and decoupling for audio driver transistors below.—S. Messin and T. E. Nawalinski, A Solid State Stereo Set Built in Modules, *Electronics*, 38:16, p 88–92.

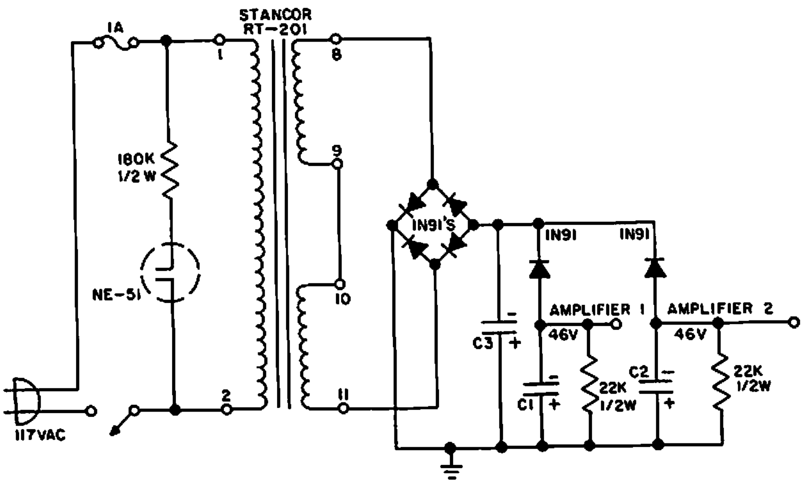


STEREO MULTIPLEX PHASE MODULATOR—Circuit serves for frequency-modulating main carrier signal by stereophonic subcarrier in four-diode ring modulator to which 19-kc pilot subcarrier is also applied. Resultant signal is phase-modulated at same 11.055-Mc carrier frequency as input signal.—Modifying and F-M Transmitter for Compatible Stereo Multiplex, *Electronics*, 34:28, p 60–62.



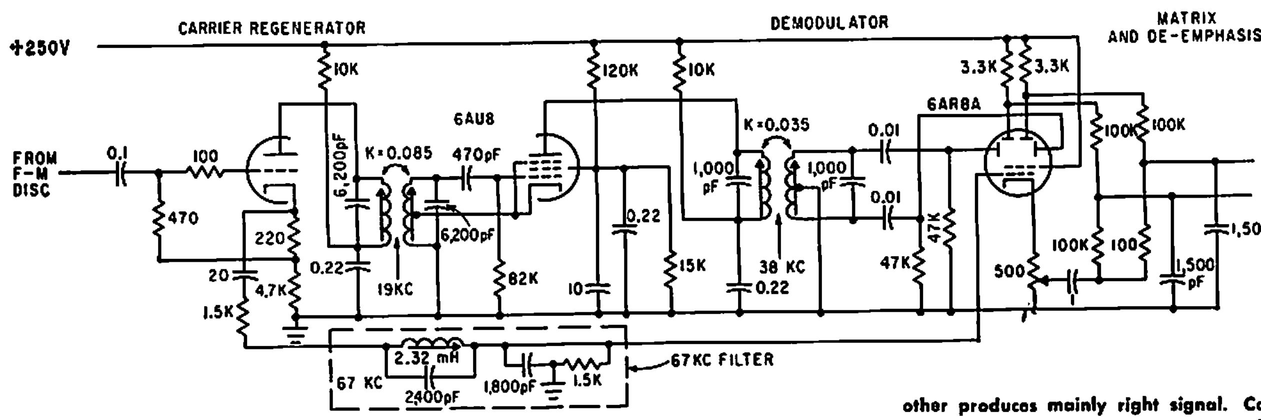
NOTE: SELECT R4 AND R104 TO GIVE 13 VOLTS AT EMITTER OF Q2 AND Q102.
Q3 AND Q103-2N2868 OR 11C1536(G.E.)

STEREO HEADPHONE AMPLIFIER—Will drive dyanamic headphones of 75 to 400 ohms impedance to power level of 60 mw. Program source may be tuner or ceramic cartridge. Frequency response is flat within 0.33 db from 20 cps to 20 kc. High input impedance, 1 meg up to 2.5 kc and decreasing to 400K at 15 kc, is obtained by using bootstrapped bias network for Q1 along with negative feedback.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 272.

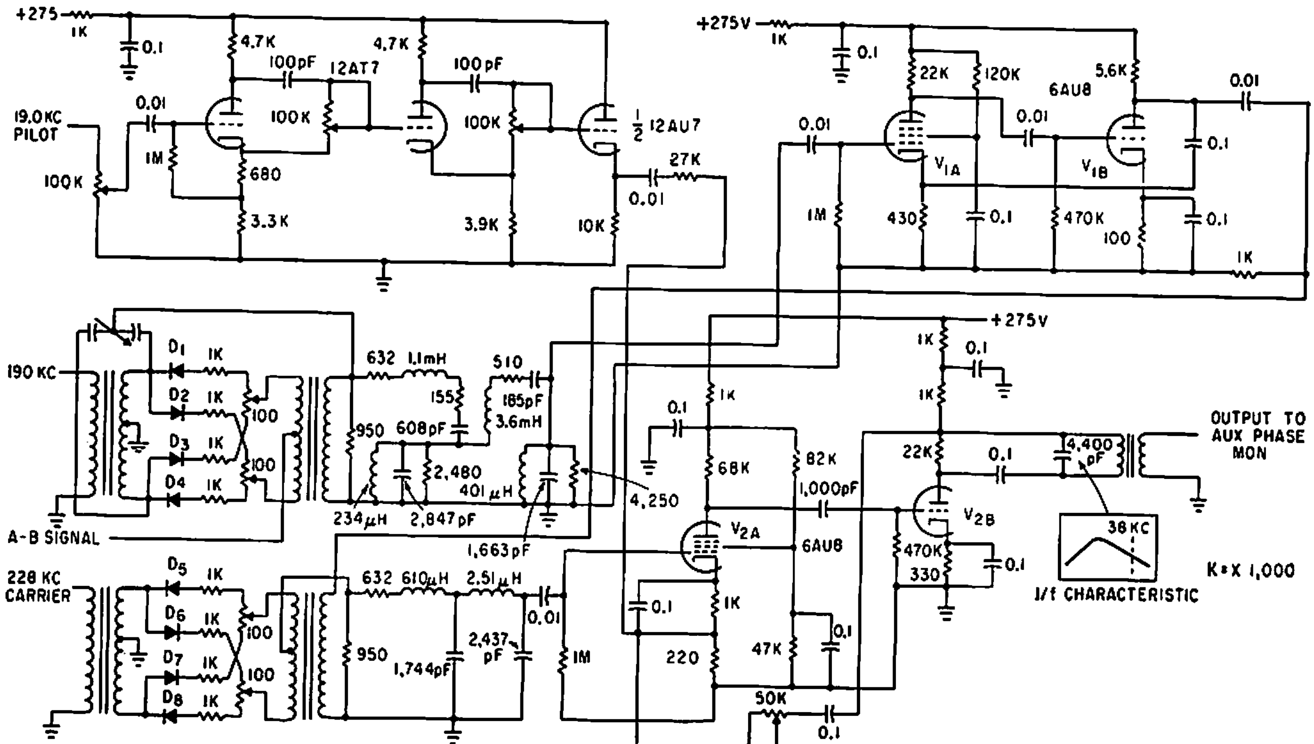


C1, C2, & C3—1500μf, 50V.

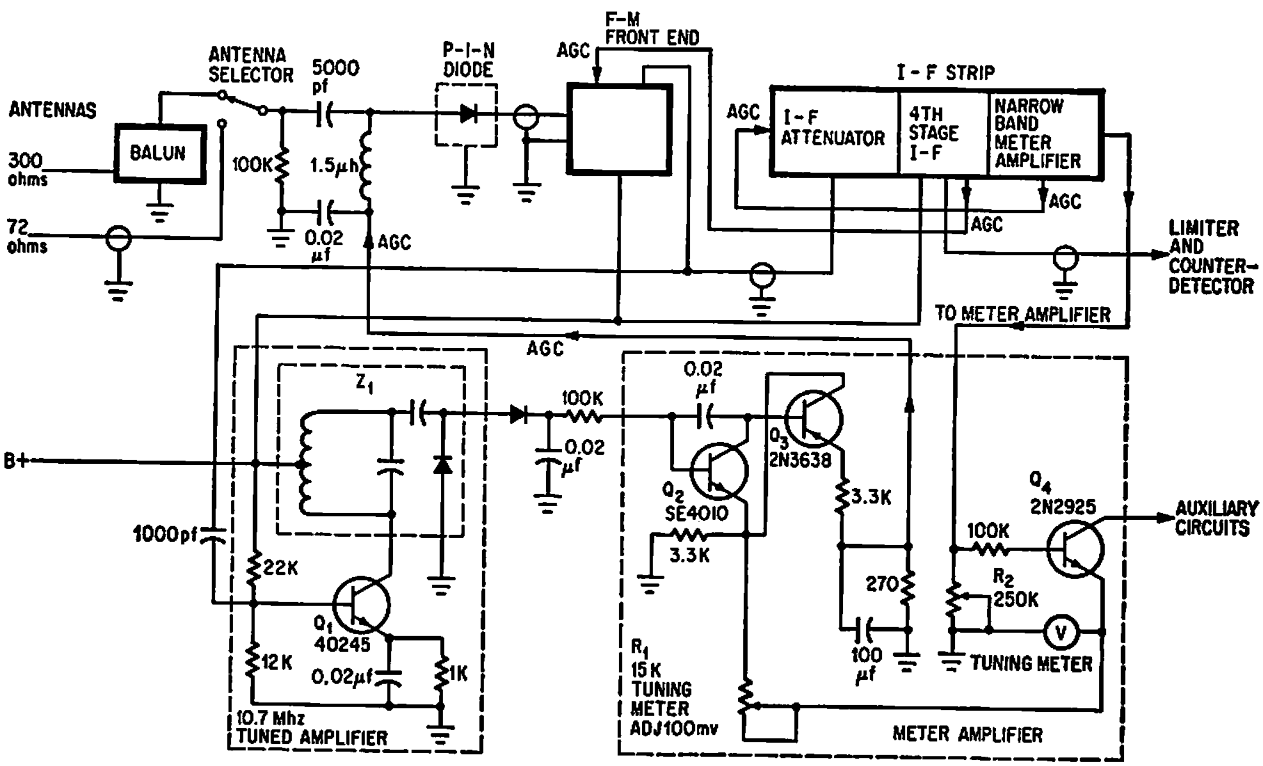
STEREO AMPLIFIER POWER SUPPLY—Diode decoupling provides 80 db of separation between two stereo amplifier channels. Designed for use with 10-w power amplifiers. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 261.



F-M STEREO DEMODULATOR—Signal from f-m discriminator is passed through 67-kc rejection filter to control grid of 6AR8A as electronic switch, while high-amplitude 38-kc sine wave is applied to its deflection plates. One plate produces mainly left signal, and other produces mainly right signal. Cathode gives balanced L+R signal.—L. Solomon, Multiplex Adaptors for Compatible F-M Stereo Reception, *Electronics*, 34:33, p 45–47.

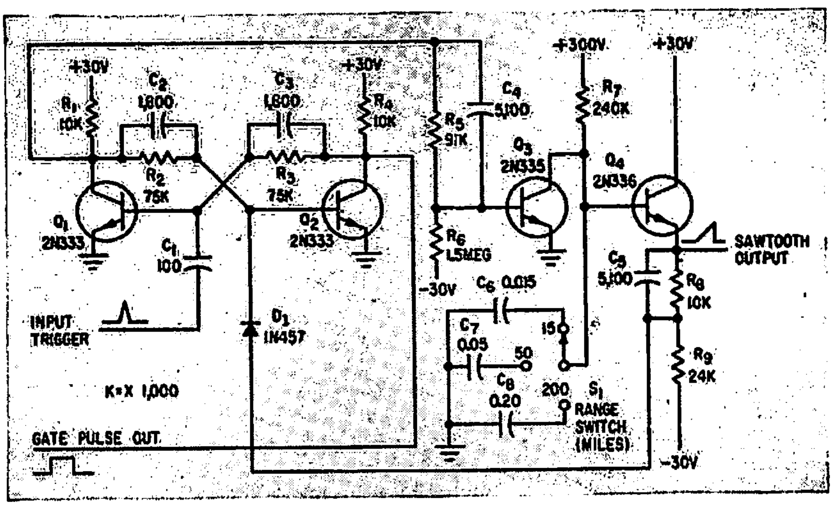


STEREO MULTIPLEX SUBCARRIER GENERATOR—Double-sideband suppressed-carrier a-m subcarrier generator uses inverse feedback for low distortion. Double-modulation system is used.—Modifying an F-M Transmitter for Compatible Stereo Multiplex, *Electronics*, 34:28, p 60–62.

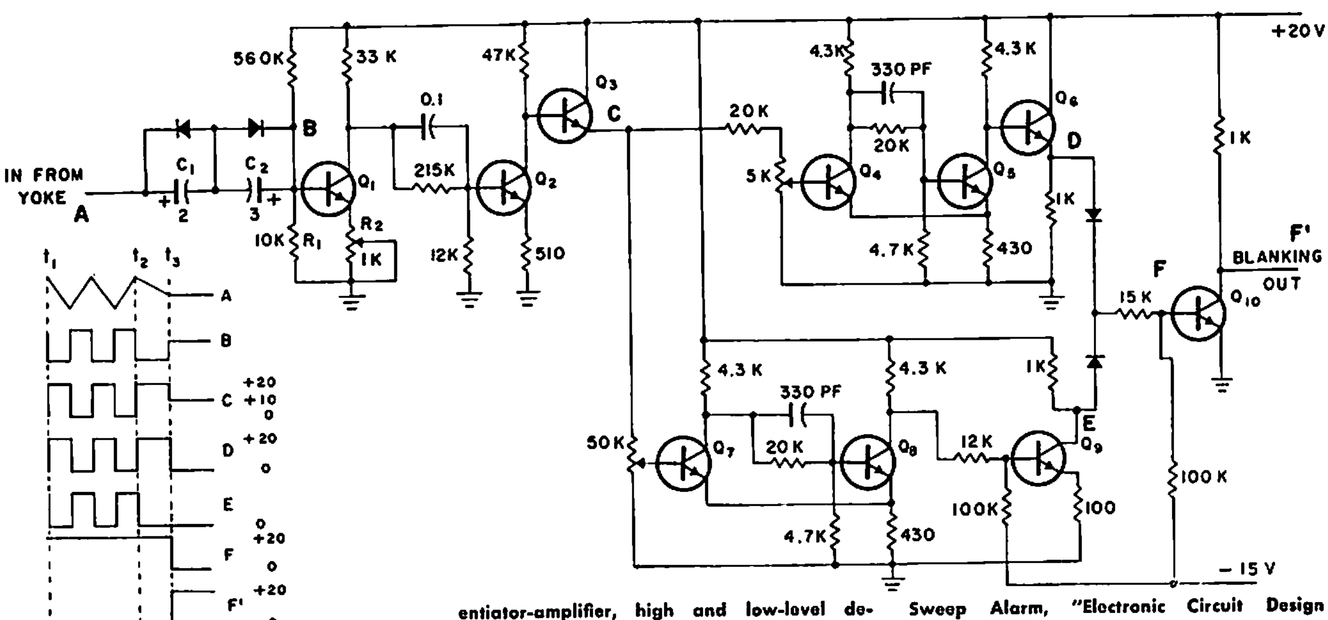


PIN DIODE PROVIDES 120 DB AGC RANGE—Dynamic signal range exceeds 120 db in fully transistorized Fisher TFM-1000 stereo set. Will receive signals as low as 1.5 microvolts without distortion, yet 0.5-v signals can be handled without overload or spurious response. Solid-state pin diode serves as gain-controlled attenuator. Separate 10.7-Mc tuned amplifier delivers agc voltage that, along with d-c amplifier, controls pin diode. Action of tuned amplifier is delayed until antenna signal is 1 mv.—F. L. Mergner, P-i-n Diode and FET's Improve F-M Reception, *Electronics*, 39:17, p 114–118.

CHAPTER 83
Sweep Circuits

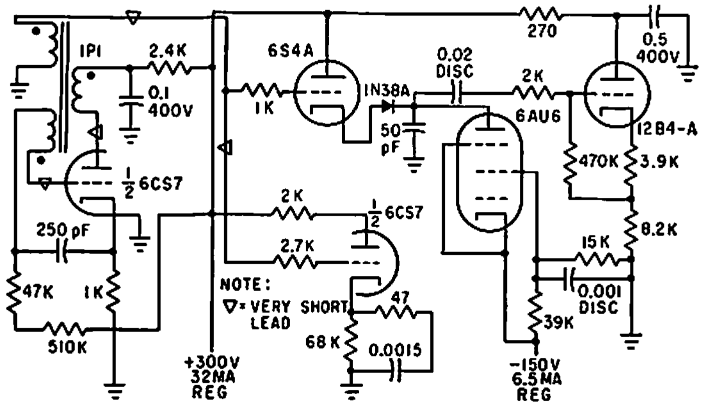


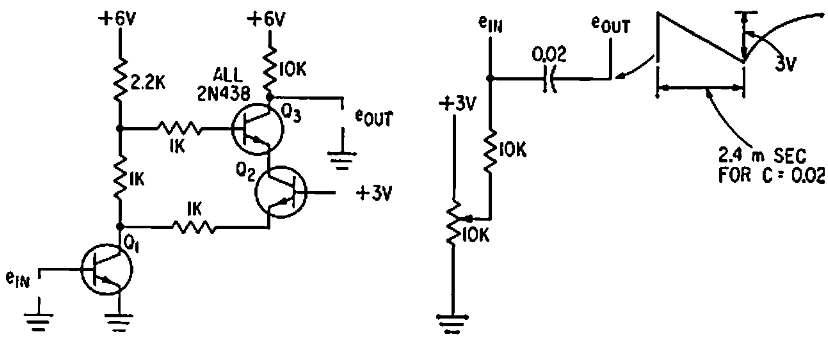
CONSTANT AMPLITUDE FOR THREE RANGES—Multiple-range sweep generator for airborne radar provides constant-amplitude output sawtooth, along with fast-rising gate pulse or pedestal having duration of sawtooth. Linearity is kept within 1% without using bootstrap.—H. P. Brockman, Sweep Generator Design: How to Keep It Simple, *Electronics*, 33:3, p 92.



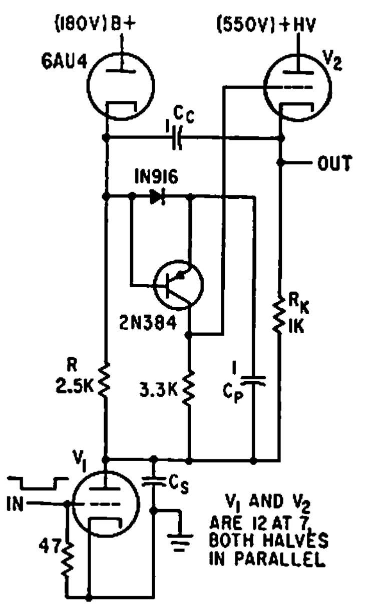
SCANNER SWEEP FAILURE ALARM—Prevents burning of phosphor on face of flying-spot scanner if sweep is lost. Consists of differentiator-amplifier, high and low-level detector, inverter, and summing and blanking generator. All transistors are 2N1302, and all diodes are 1N497.—Flying Spot Scanner Sweep Alarm, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 125.

KLYSTRON SWEEP—Provides sweep voltage for klystron in microwave interferometer system, plus vertical sweep and trigger for oscilloscope.—H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.

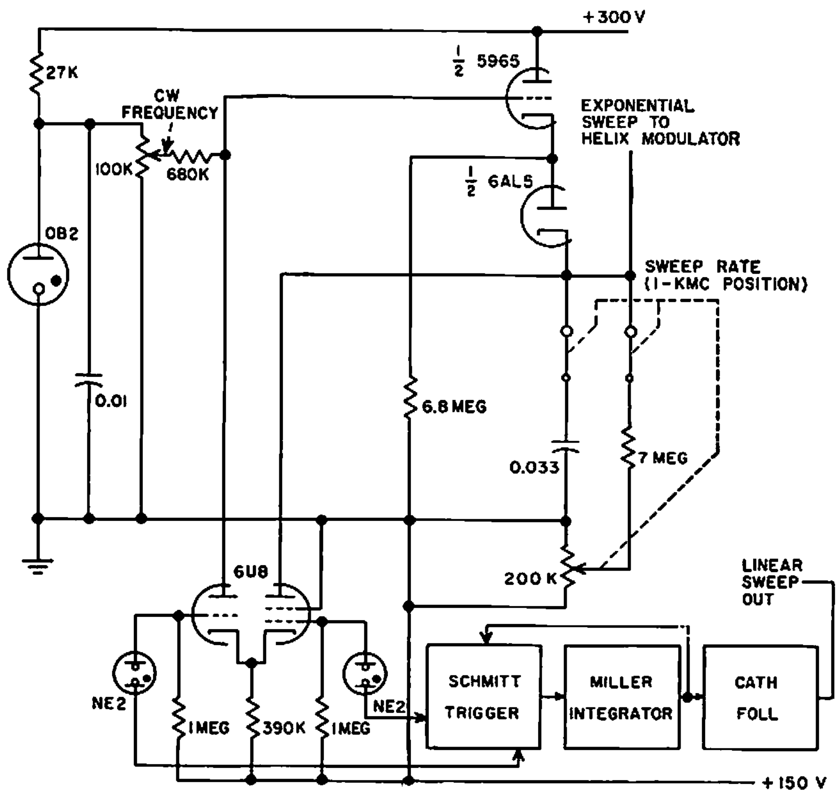




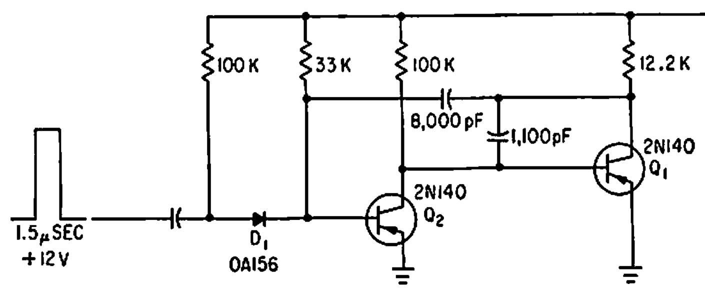
TRANSISTORS SIMULATE PHANTASTRON—Three transistors simulate current-partitioning action of pentode vacuum-tube phantastron sawtooth sweep generator. Potentiometer in bias and feedback circuit can be adjusted for either triggered or free-running phantastron sweep.—N. C. Hekimian, Phantastron Circuits Using Transistors, *Electronics*, 34:8, p 46–47.



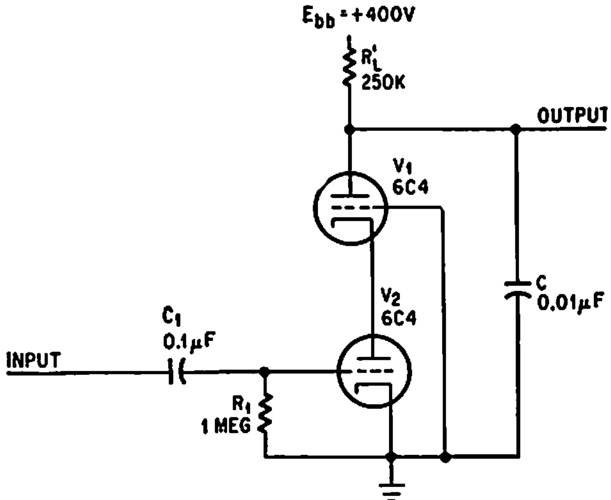
HIGH-SPEED HYBRID BOOTSTRAP—Speed is increased because Cc does not have to supply charging current for Cs, but only current required by grid leak resistor; this is small, so Cc can be small and easily recharged during quiescent period.—F. C. Creed, Hybrid Bootstrap Circuits Increase Sweep Linearity, *Electronics*, 34:31, p 46–48.



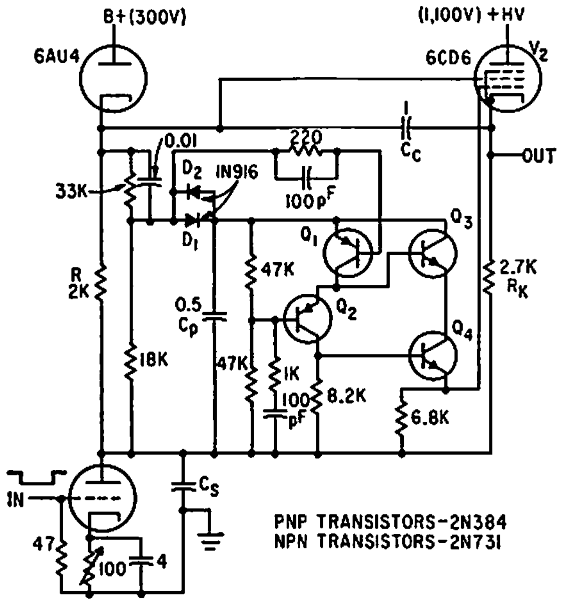
SHF SWEEP GENERATOR—Swept-frequency signal source using backward-wave oscillator tube offers variable sweep rate in microwave region between 8,200 and 12,400 Mc. Sweep width is continually adjustable from 3 Mc to 4,200 Mc. May be modulated with either f-m or a-m.—D. E. Wheeler and P. D. Lacy, SHF Frequency Sweeper Uses Backward-Wave Tube, *Electronics*, 31:1, p 76–78.



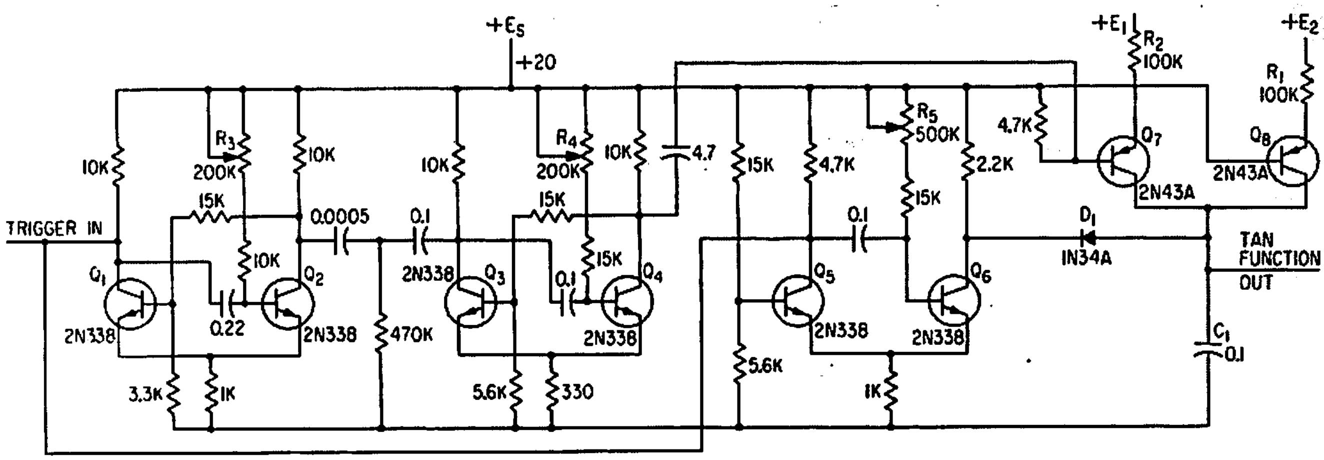
TWO-TRANSISTOR PHANTASTRON SWEEP—Combined positive and negative feedback loops in two-transistor circuit give phantastron effect of single pentode with good sweep linearity.—A. S. Kislovsky, Sweep Circuits Using Two Three-Terminal Active Elements, *Electronics*, 35:12, p 54–55.



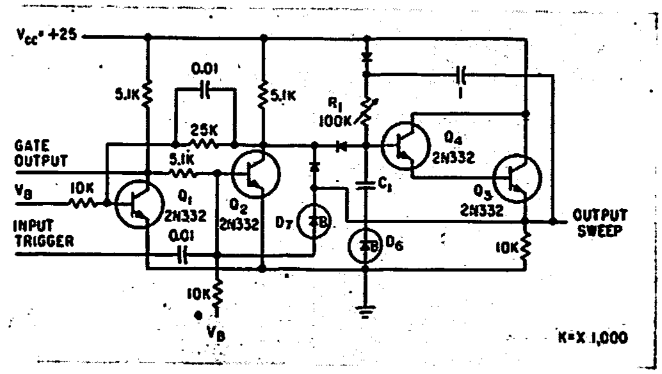
TRIGGERED GROUNDED GRID—Triggered linear sawtooth generator uses grounded-grid amplifier, eliminating initial step voltage that usually occurs in Miller sweep.—C. Sing, Grounded-Grid Circuit Sweeps Better Than Miller or Bootstrap, *Electronics*, 38:6, p 83–84.



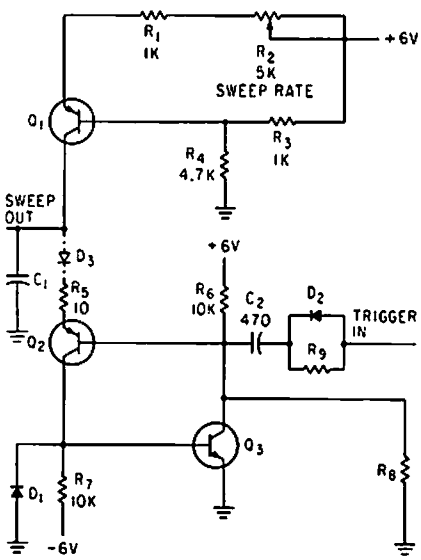
FAST 800-V SWEEP—Hybrid bootstrap arrangement with transistors in cascade generates 800-v sweeps in either polarity with 0.15 microsec duration.—F. C. Creed, Hybrid Bootstrap Circuits Increase Sweep Linearity, *Electronics*, 34:31, p 46–48.



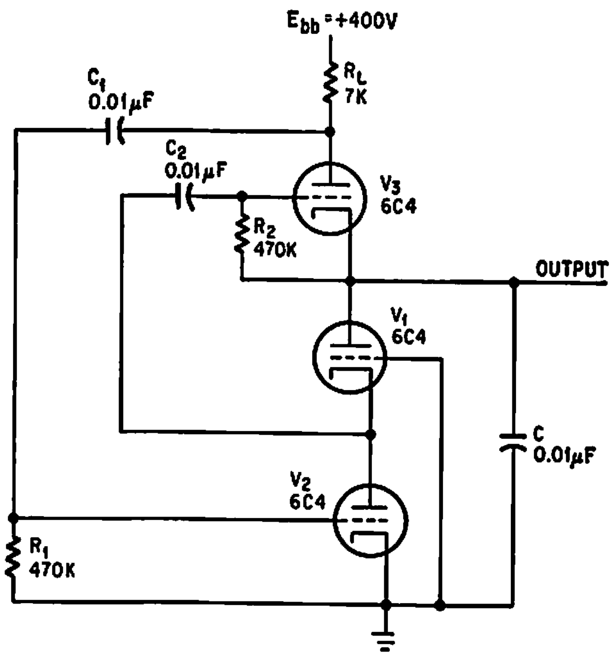
TANGENTIAL WAVEFORM GENERATOR—Generates approximation of tangent function for slant-range correction of video signal from airborne infrared scanner. Ramp mvbr Q5-Q6 and timing mvbr Q1-Q2 are triggered simultaneously.—J. L. Woika, Generating Tangential Sweeps for Infrared Mapping, *Electronics*, 34:41, p 64–66.



DARLINGTON WITH BOOTSTRAP FLIP-FLOP SWEEP—Transistor Q3 in Darlington connection improves linearity of controllable sweep comparable to vacuum-tube phantastron.—J. B. Payne III, Voltage-Controlled Bootstrap Generator, *Electronics*, 33:11, p 177–178.

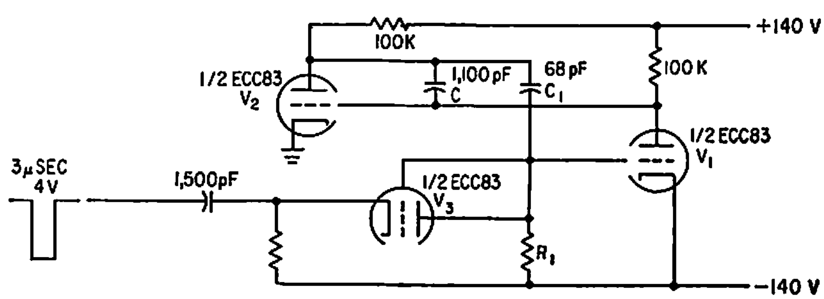


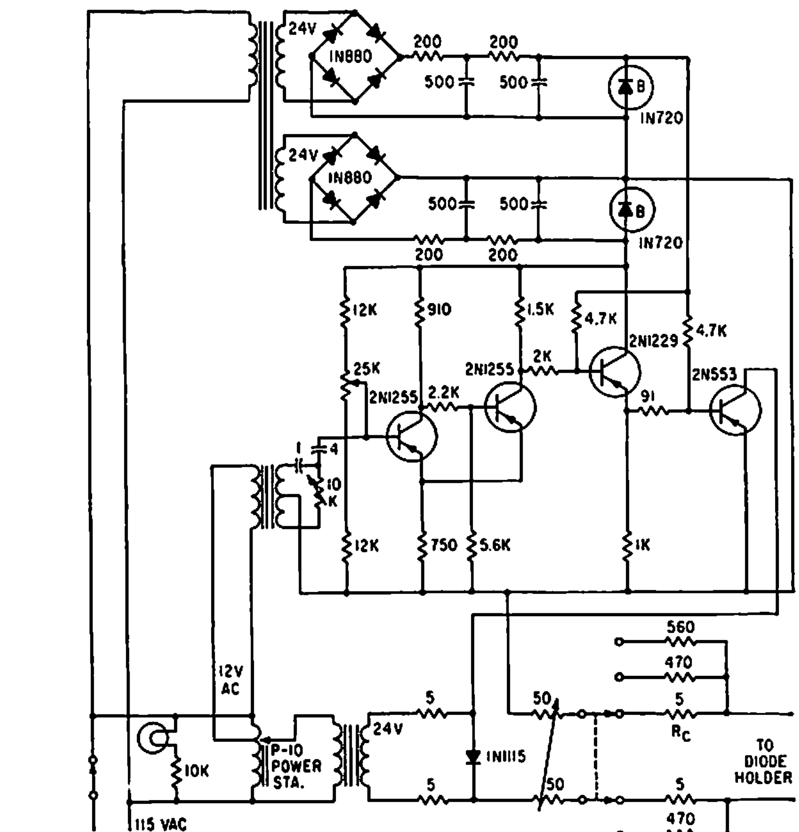
FAST-RESET SAWTOOTH—Regenerative pnp-npn pair in positive-feedback circuit Q1 is constant-current charging source for C1, with R2 varying charging rate and free-running frequency, which can range from 60 cps to 1 Mc.—N. C. Hekimian, PNP-NPN CIRCUITS: New Look at a Familiar Connection, *Electronics*, 35:47, p 42–46.



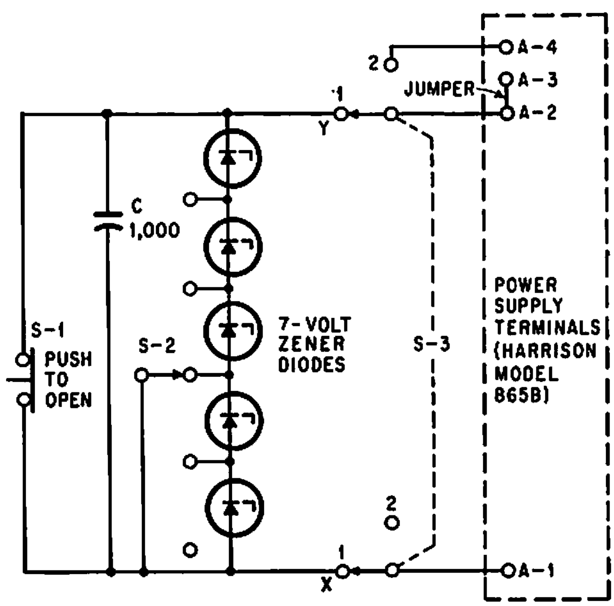
FREE-RUNNING GROUNDED GRID—Has higher output impedance than other time-base sweep circuits. Reducing RL increases period.—C. Sing, Grounded-Grid Circuit Sweeps Better Than Miller or Bootstrap, *Electronics*, 38:6, p 83–84.

TRIODE PHANTASTRON SWEEP—Active elements V1-V2 serve with isolation diode V3 to give action of single pentode with good sweep linearity.—A. S. Kislovsky, Sweep Circuits Using Two Three-Terminal Active Elements, *Electronics*, 35:12, p 54–55.

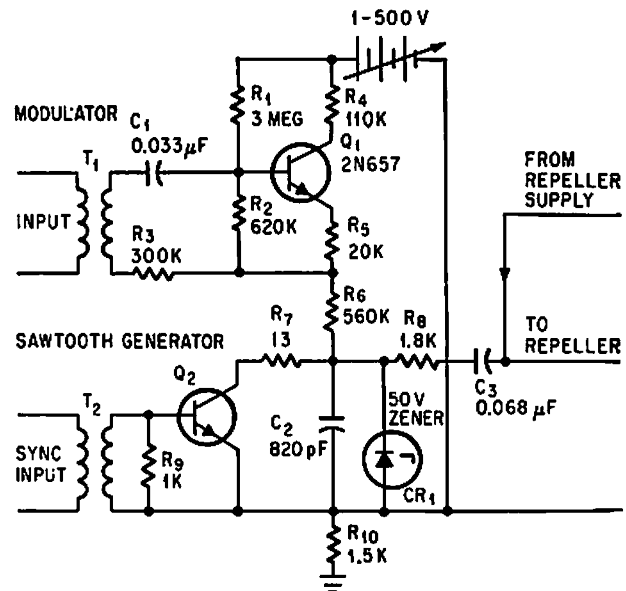




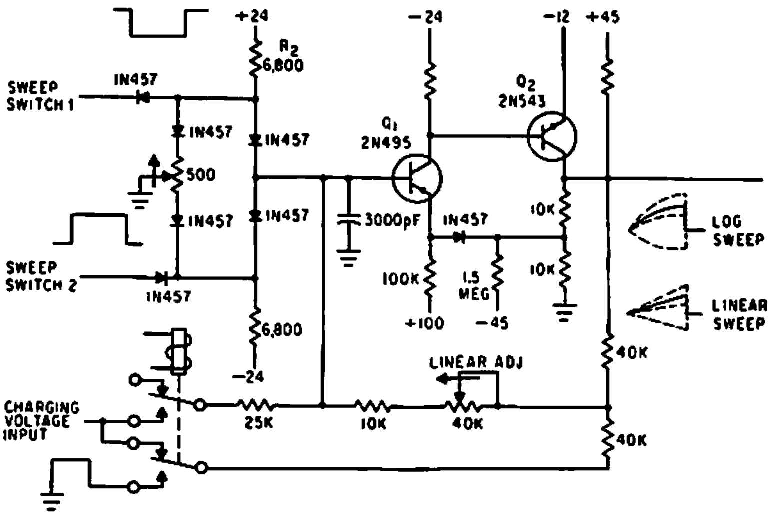
SWEEP FOR CURVE TRACER—Schmitt trigger produces square waves to drive power switch used for obtaining characteristic curves of tunnel diodes in unstable negative-resistance region.—H. G. Dill and M. R. MacPherson, Tracing Tunnel Diode Curves, *Electronics*, 33:32, p 62–64.



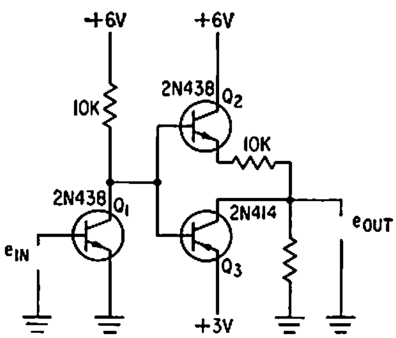
SLOW SWEEP—Large electrolytic capacitor and five zener diodes connected across standard transistor-regulated power supply give sweep voltage that increases 2 v per second, for classroom demonstrations.—M. H. Crothers, Added Capacitor Sweeps Power Supply, *Electronics*, 37:17, p 62.

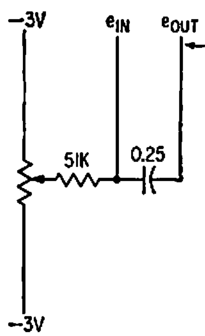


SAWTOOTH VOLTAGE GENERATOR MODULATES KLYSTRON—C2 is charged through R6 and discharged through Q2 operated in avalanche mode. Flyback time of sawtooth is about 90 nsec. Sweep rate is 33.3 kc.—W. H. Chiles and H. G. Lafuse, Sweeping Carrier Signals Through Interference, *Electronics*, 37:16, p 94–96.

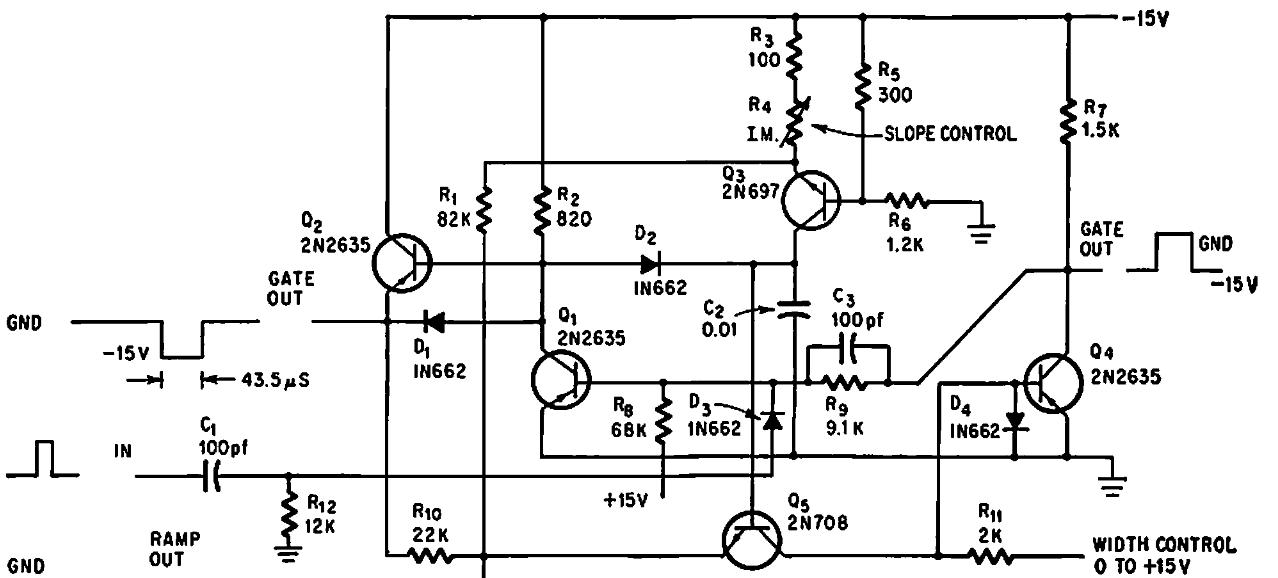


LOG SWEEP—Resistance coupling in feedback loop permits positive-going as well as negative-going waveforms. Circuit gives choice of logarithmic, exponential, or linear sweep output. Relay switches between linear and long sweep.—J. Curry and W. Sander, Bootstrap Generates Logarithmic Sweeps, *Electronics*, 33:52, p 60.

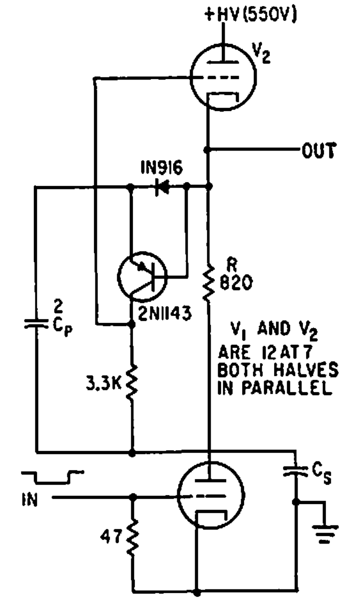




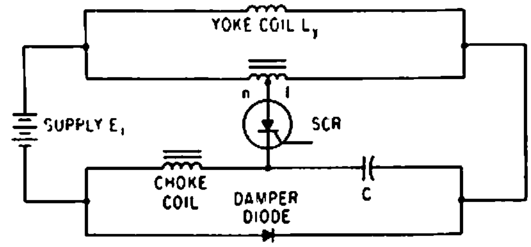
THREE-TRANSISTOR PHANTASTRON—Use of both pnp and npn transistors gives desired current partition, while feedback required for sweep generator is provided by potentiometer arrangement at right.—N. C. Hekimian, Phantastron Circuits Using Transistors, *Electronics*, 34:8, p 46–47.



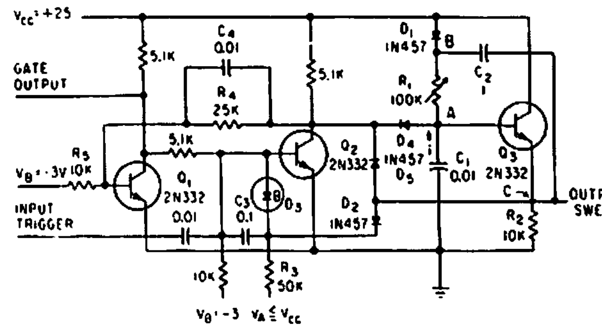
PHANTASTRAN—Transistorized version of phantastron eliminates voltage pedestal by connecting C2 directly to ground. Slope is independent of gain of Q4 and is varied by R4 ove. range of 100 to 1. Duty cycle can be up to 98%. R4 is 1,000 ohms and width control voltage is 0.4 v for ramp output shown.—G. Marosi, Novel Sweep Circuit Eliminates Ramp Pedestal, *Electronics*, 38:26, p 68.



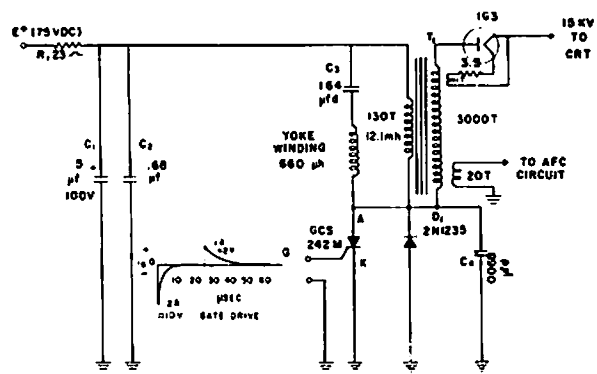
BOOTSTRAP SWEEP FOR CRO—Hybrid circuit has high linearity and moderate sweep speed.—F. C. Creed, Hybrid Bootstrap Circuits Increase Sweep Linearity, *Electronics*, 34:31, p 46–48.



SCR HORIZONTAL SWEEP—Scr, fired by trigger pulse at start of retrace, transfers to yoke coil the energy stored in 1.27-mfd capacitor C. At end of retrace, energy transfer is completed, damper diode turns on, and energy in yoke returns to supply source E1, giving linear sweep current through yoke. Scr can be General Electric C35, C36, or C40 series. Yoke is 200 microhenrys.—T. Tarui, New Deflection Circuit Uses SCR, Saves Power, *Electronics*, 36:32, p 56–57.

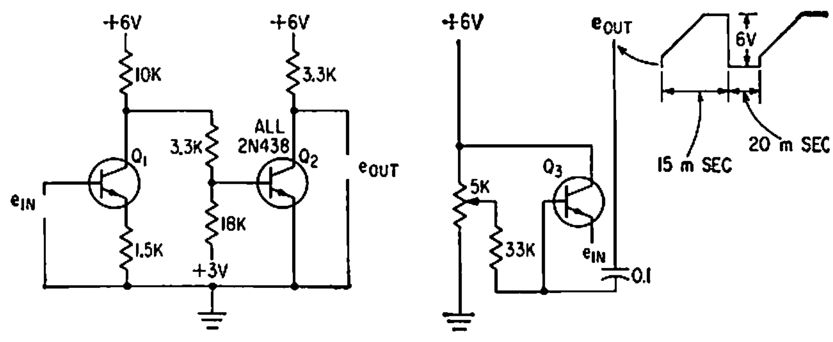


VARIABLE BOOTSTRAP FLIP-FLOP SWEEP—Gives same type of waveform as phantastron. Output pulse length can be varied by d-c bias or by control voltage.—J. B. Payne III, Voltage-Controlled Bootstrap Generator, *Electronics*, 33:11, p 177–178.

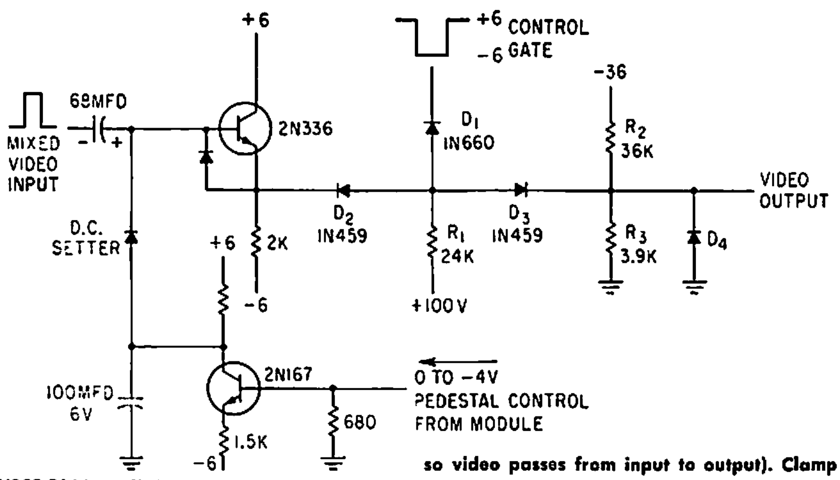


GCS HORIZONTAL SWEEP—Uses gate-controlled switch GCS to replace horizontal output tube in television receiver, and semiconductor diode D1 to replace damper. GCS can cut off 2.5-amp peak current in 500 nsec. —J. W. Motto, Jr. GCS Sweep Circuit, *EEE*, 12:5, p 89–90.

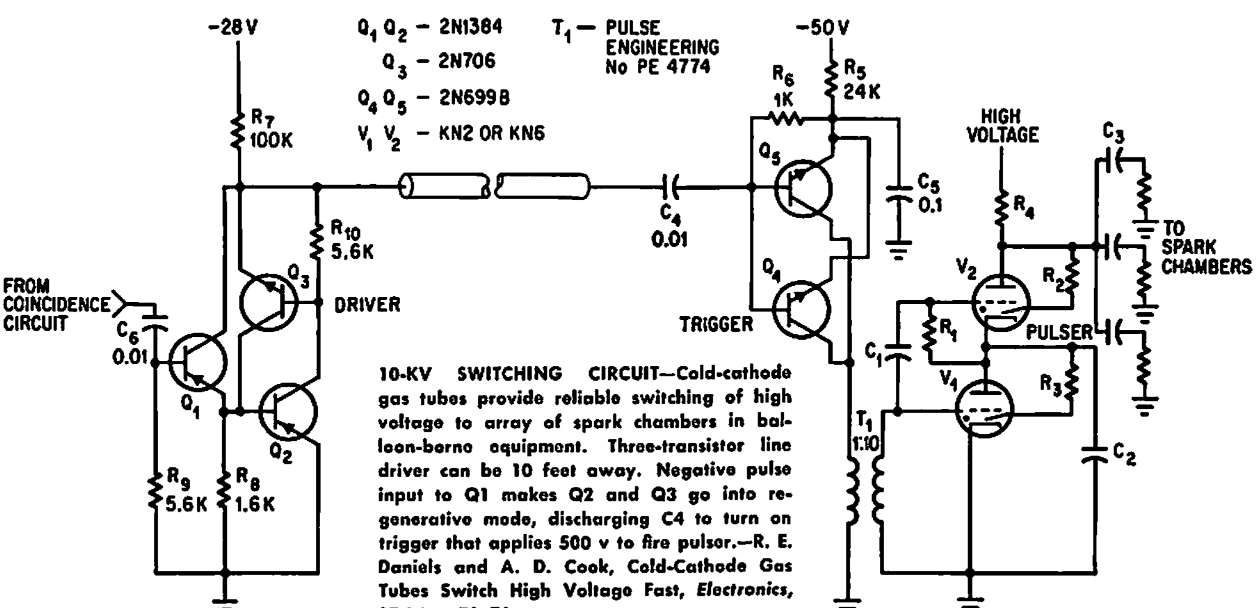
TWO-TRANSISTOR PHANTASTRON—Q1 and Q2 simulate vacuum-tube phantastron sweep generator. Since input impedance is low, linearity can be improved by using emitter-follower Q3.—N. C. Hekimian, Phantastron Circuits Using Transistors, *Electronics*, 34:8, p 46–47.



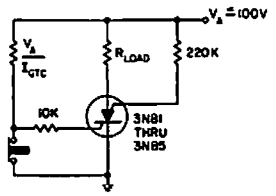
CHAPTER 84
Switching Circuits



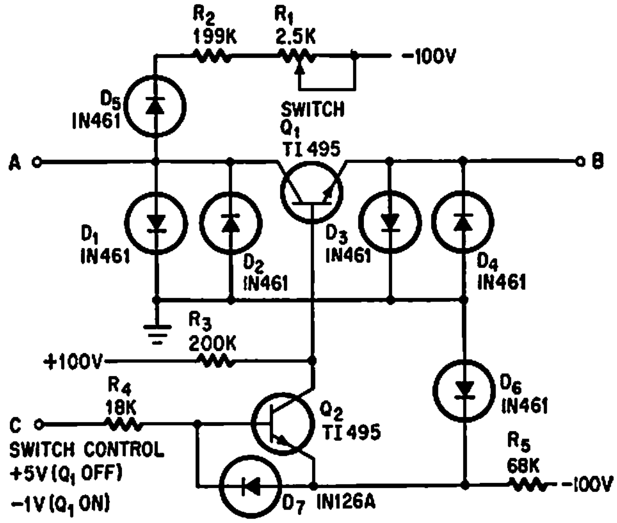
THREE-DIODE SWITCH FOR VIDEO TIME SHARING—Gate pulse applied to diode D1 draws current from R1 through D1 (switch open) or through D2 and D3 (switch closed so video passes from input to output). Clamp diode D4 keeps base line of output always positive.—T. Vagt, New Light on Air Traffic: Bright Plan Display with Alphanumerics, *Electronics*, 36:30, p 42–46.



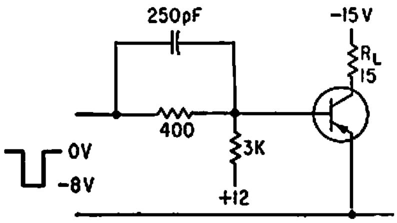
10-KV SWITCHING CIRCUIT—Cold-cathode gas tubes provide reliable switching of high voltage to array of spark chambers in balloon-borne equipment. Three-transistor line driver can be 10 feet away. Negative pulse input to Q1 makes Q2 and Q3 go into regenerative mode, discharging C4 to turn on trigger that applies 500 v to fire pulser.—R. E. Daniels and A. D. Cook, Cold-Cathode Gas Tubes Switch High Voltage Fast, *Electronics*, 37:14, p 72–73.



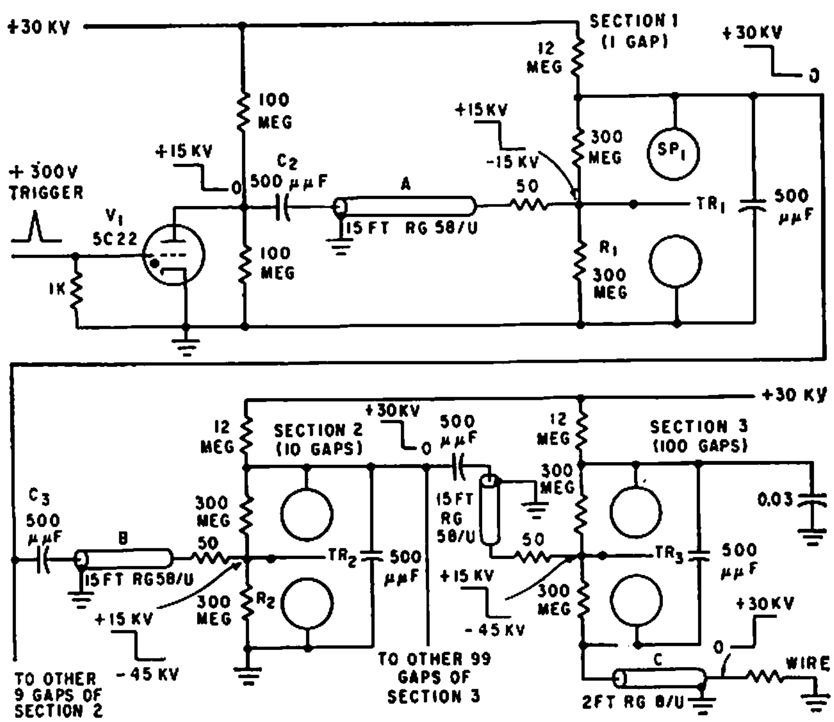
SCS CONTACT ISOLATOR—Eliminates contact bounce in grounded-switch arrangement where switch is opened to trigger scs.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.



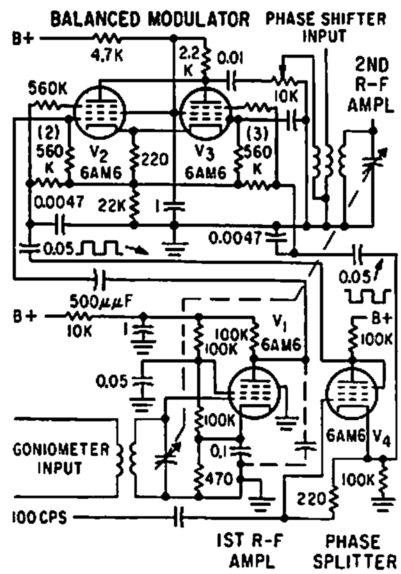
OPERATIONAL AMPLIFIER CONTROL—Switch must pass 1 ma in either direction (A to B or B to A). Diode pairs D1-D2 and D3-D4 are voltage limiters, while Q1 is basic switching element. Switching time is about 2 microsec. Used as sample-and-hold circuit, with 500-microsec sampling interval.—R. W. Maloy, Transistor Switch Passes Current Both Ways, *Electronics*, 38:1, p 79.



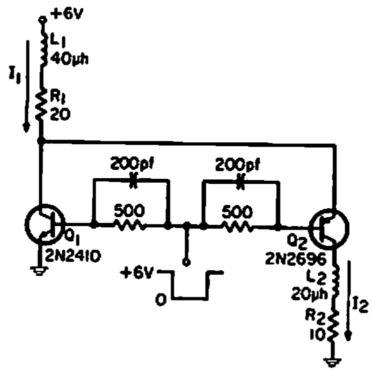
HIGH-CURRENT HIGH-SPEED SWITCH—Alloy junction transistor (2N2648 germanium) has useful frequency range up to 10 Mc for switching up to 1 amp with gain of 50 in 0.8 microsec.—Medium Power Transistor Has Multiple Uses, *Electronics*, 36:1, p 132.



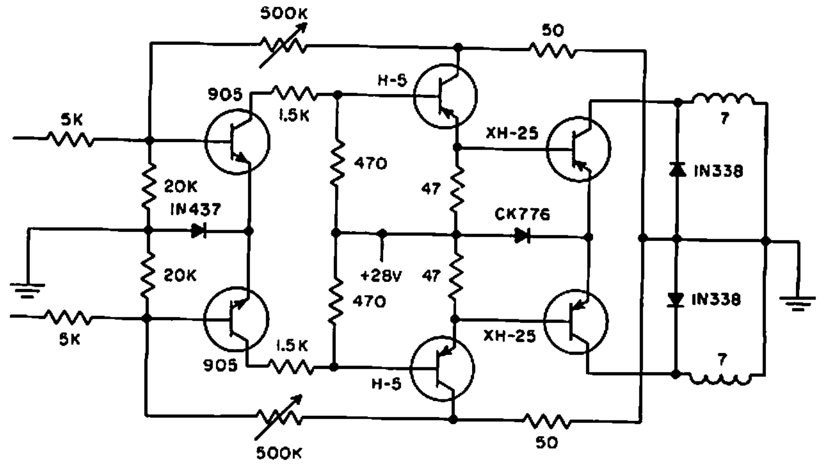
SPARK-GAP SWITCH—Bank of 111 spark gaps switches 30 kv in less than 10 millimicrosec, to explode wire for generating plasma in shock tube or generating hypersonic waves in wind tunnel. Jitter problem is solved by using one spark gap to trigger another. Thyratron V1 fires section 1 having single gap, and this triggers 10 gaps in section 2, each of which in turn triggers 10 gaps in section 3.—H. B. McFarlane, Spark Gaps for Fast High-Voltage Switching, *Electronics*, 32:31, p 72–73.



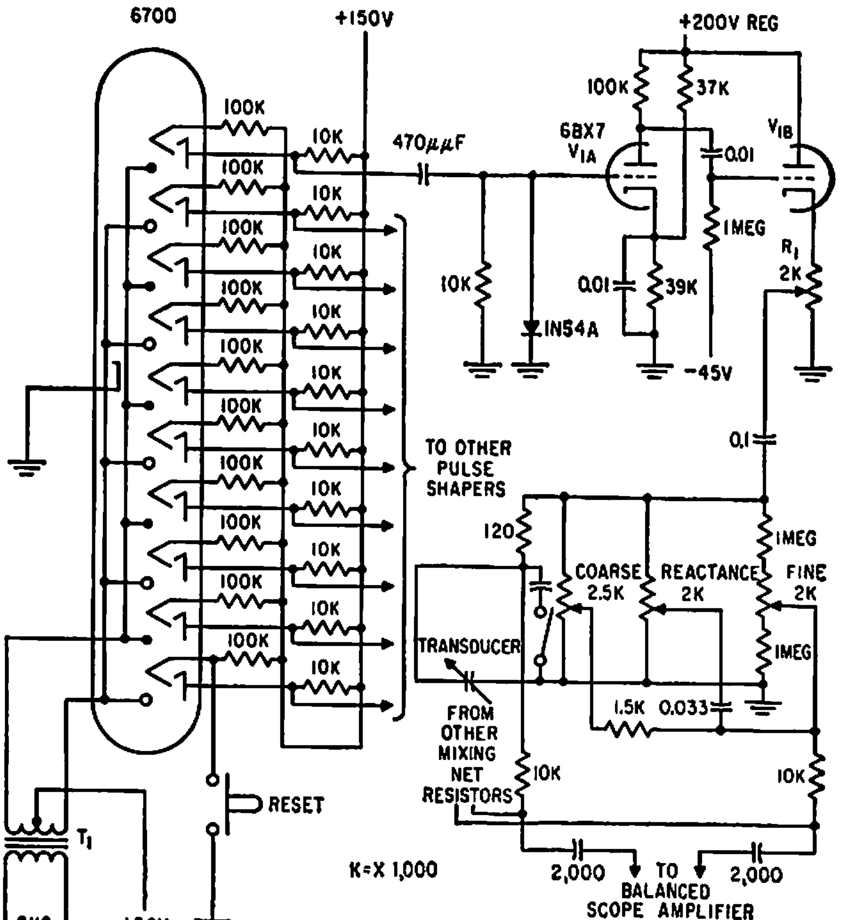
ELECTRONIC R-F SWITCH—V1 isolates goniometer from balanced modulator tubes V2 and V3, which provide 90° phase shift of goniometer signal. V2 and V3 are made to conduct alternately by 100-cps drive applied to their suppressor grids by phase-splitter V4.—J. F. Hatch and D. W. G. Byatt, Direction Finder with Automatic Readout, *Electronics*, 32:16, p 52–54.



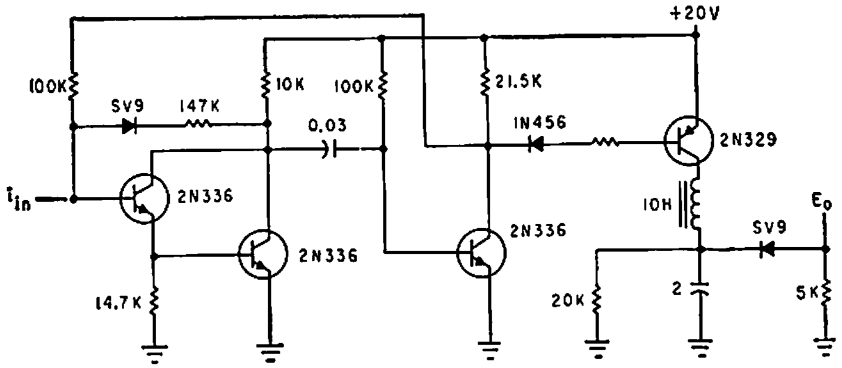
FAST INDUCTIVE SWITCHING—Fast-rise current switching circuit provides current as fast as it can be switched into highly inductive load. Used as current driver for digital computer memory arrays as well as for speeding up ordinary relays.—T. W. Collins, Fast-Rise Current Switch, *EEE*, 13:1, p 65–66.



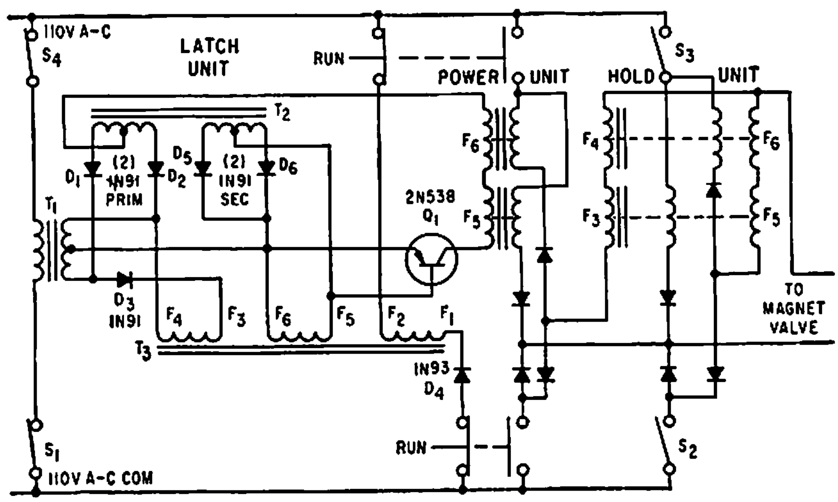
HIGH-SPEED TRANSISTOR RELAY—Push-pull switch handles up to 10 amp with rise time of 50 microsec. Rising d-c voltage at input produces no output until predetermined level is reached, when power supply voltage is suddenly switched across load. Circuit remains locked in until input voltage drops below trip level. Trip voltage is determined largely by breakdown voltage of 1N437 zener diode.—D. L. Anderson, Fast Transistor Relay, *Electronics*, 31:11, p 145.



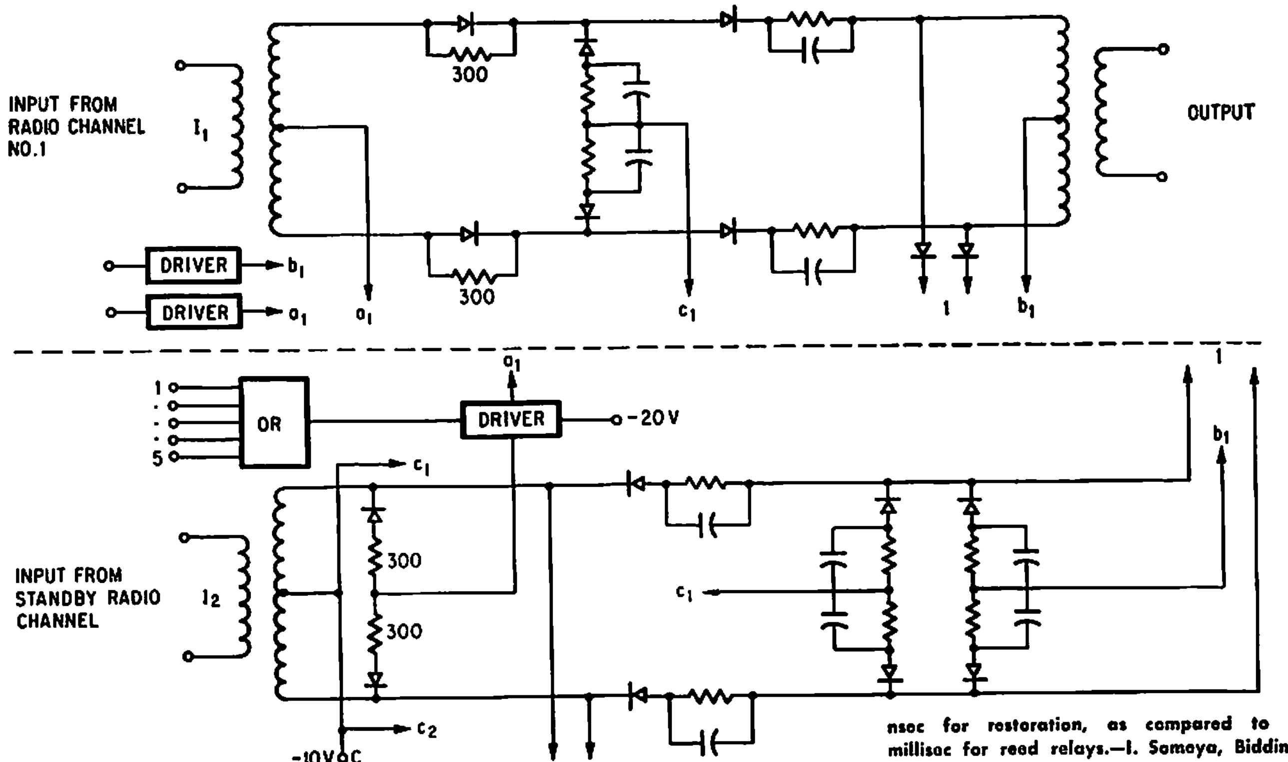
SWITCHING CAPACITANCE TRANSDUCERS—Beam-switching tube pulses bridges sequentially. Each bridge has pressure-sensitive capacitance transducer that unbalances bridge in proportion to changes in pressure. Outputs of bridges are displayed as pulse pattern corresponding to pattern of pressure imposed on auto seat.—A. Stiebel, High-Speed Switching of Low Level Signals, *Electronics*, 32:12, p 54–55.



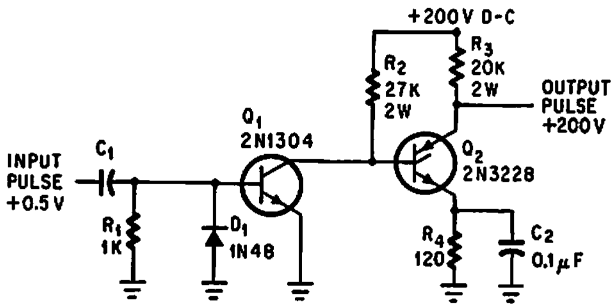
MISSILE COUNT-DOWN SWITCH—Level-sensitive switch uses nonlinear negative feedback to provide stable operation (within 1.5%) over 100°C temperature range. Monostable mvbr is followed by rectifying transistor and filter. For signals above trigger level, circuit is periodically switched into its transient state.—D. W. Boensel, Switching Circuits for Missile Count-Downs, *Electronics*, 32:31, p 76–78.



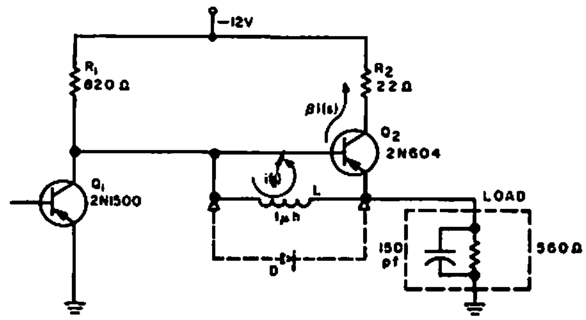
PUNCH PRESS SAFETY SWITCH—Static switching control for dangerous presses requires that both hands of operator be on run pushbuttons, out of danger area, before ram can descend. To prevent operators from jamming or taping one or more buttons closed, control circuit stops press at end of cycle. Both buttons must then be released and depressed again to start new cycle. Self-excited magnetic amplifier operates much like snap switch.—S. A. Zarleng, Static Switching Techniques for Machine-Tool Safety, *Electronics*, 32:24, p 57–59.



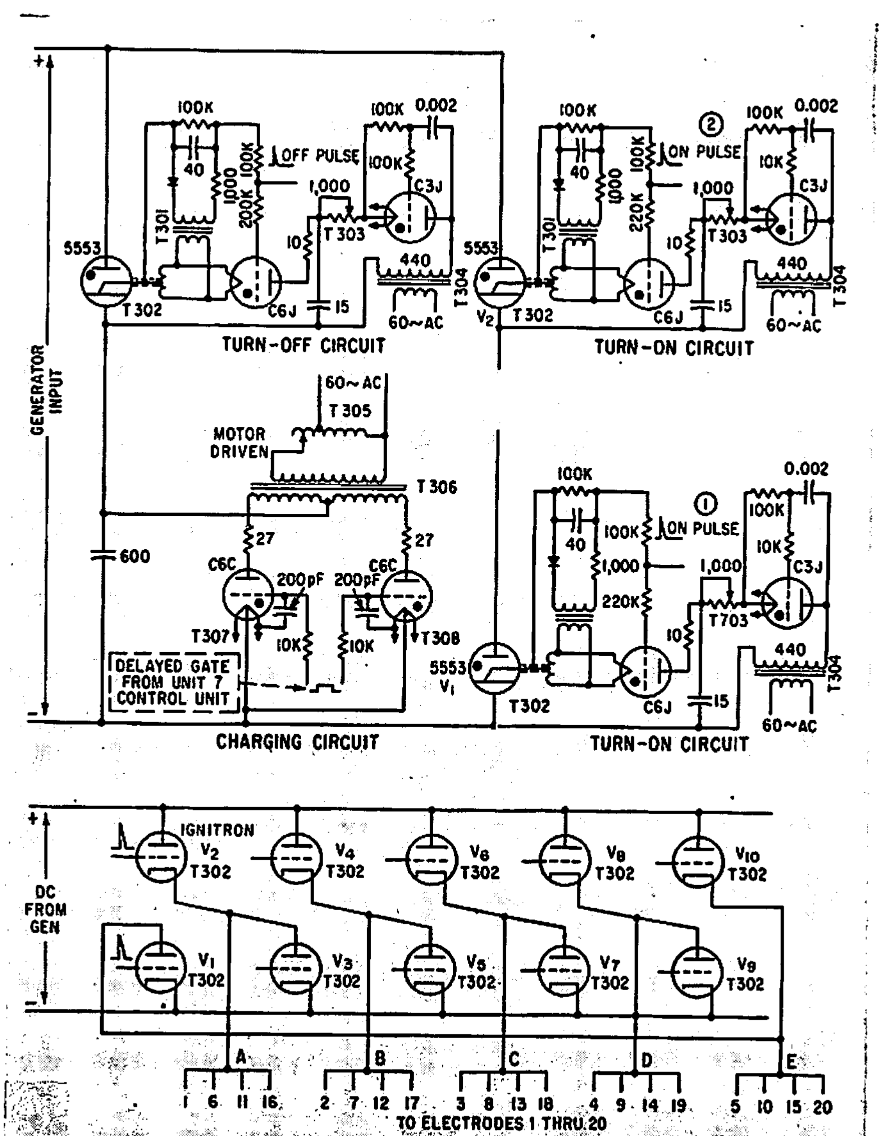
SOLID-STATE SWITCHING—Used in high-speed data transmission system having 15-gc bandwidth. Use of Kita diodes gives transition time of 20 nsec for break and 40 nsec for restoration, as compared to 1 millisec for reed relays.—I. Somoya, Bidding For World Leadership in Solid State Microwave Gear, *Electronics*, 38:25, p 99–105.



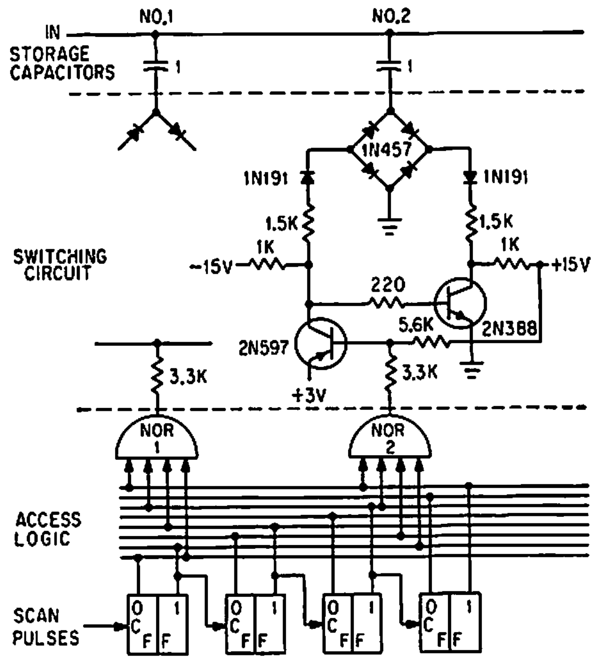
FAST ACTION AT 10 KC—Reverse bias is applied to gate of scr at cutoff to make switch open rapidly. Rise time is 10 microsec and fall time 5 microsec for switching 10 ma at up to 10 kc.—E. L. Dosch, SCR Switch Turns Off With Reverse Bias, *Electronics*, 38:7, p 88.



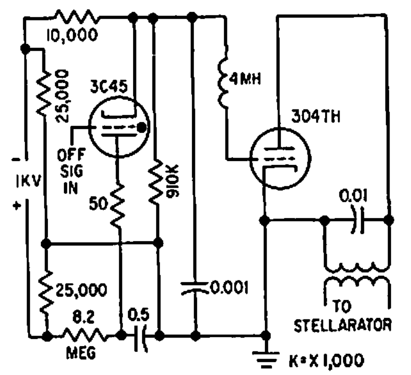
FORCED SWITCHING—Bypassing of emitter-follower with inductor L cuts normal 70-nsec switching time to 38 nsec. Use of diode D across L improves rise time without affecting fall time.—T. Asai, Forced-Switching Emitter Follower, *EEE*, 12:2, p 29.



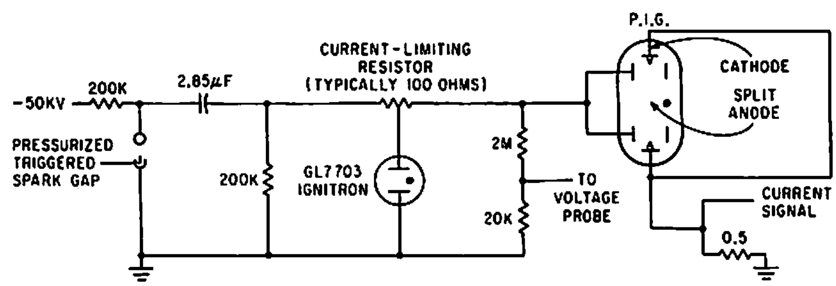
ELECTRIC FISH FENCE—Output of 360-kw d-c generator is applied to row of electrodes in sequence by pair of high-voltage ignitron tubes that rurn pulse on and off for each electrode in turn. Single turnoff ignitron terminates pulse period of whichever loaded ignitrons are conducting.—C. D. Volz, Ignitron-Pulsed Electric Fence Guides Migrating Salmon, *Electronics*, 35:16, p 50–52.



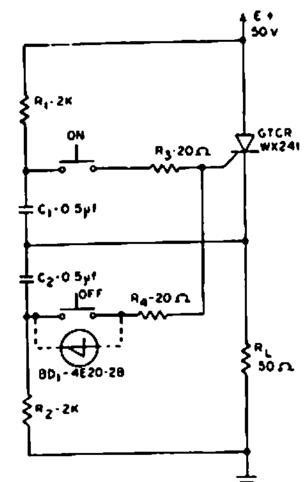
ROW STORAGE UNIT FOR MAGNETIC CONTOUR DISPLAY—Scan pulses activate *nor* gates in sequence. For 11 by 11 display matrix, there are 11 *nor* gates each with its switching circuit. On read-in, *nor* gate output of −10 v activates switching circuit, grounding its capacitor and making capacitor charge up to value of that data point.—W. W. Anderson, Latest Antisubmarine Aid—Magnetic Contour Display System, *Electronics*, 36:32, p 58–61.



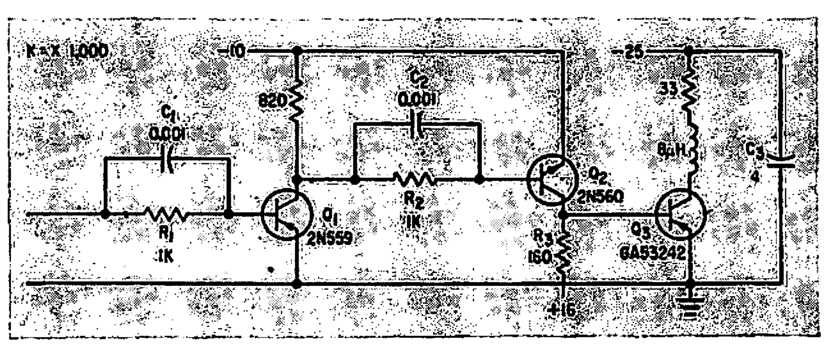
CROWBAR—Used to cut off oscillator sharply in tank circuit of stellarator. Consists of tube with plate holdoff rating comparable to peak instantaneous output tank voltage. At end of pulse, grid is driven to +500 v and tube becomes low impedance across tank, to damp out oscillation within a cycle or two.—R. L. Gamblin, Radio-Frequency Circuits for Plasma Physics, *Electronics*, 32:27, p 50–52.



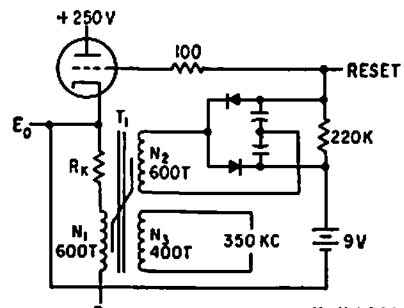
IGNITRON SHORTS SPARK GAP—Used for continuous production of plasma in mirror-geometry magnetic field of Philips ionization gage. Ignitron shorts spark gap about 100 microsec after discharge begins. Ionization gage (PIG) receives positive potential at peak of externally applied magnetic field by closing of triggered spark gap.—M. F. Wolff, Plasma Engineering—Part 1: Generating and Heating Plasma, *Electronics*, 34:24, p 47–53.



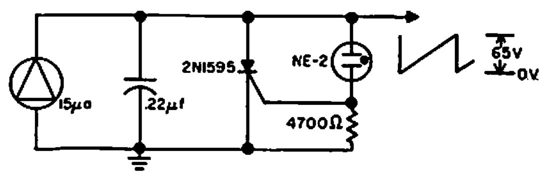
GATE-TURNOFF D-C CIRCUIT BREAKER—Closing *on* switch discharges C1 into gate to initiate turn-on. Closing *off* switch discharges C2 out of gate, opening power circuit.—J. W. Motto, Jr., Switching Circuits Using the Gate Turnoff Controlled Rectifier, *EEE*, 13:3, p 52–55.



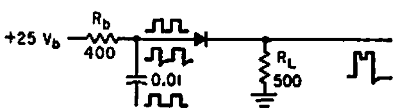
MEMORY DRIVER AMPLIFIER—Proves 750-ma current pulse for 8-microhenry load, at repetition rate of 0.25 Mc. Positive turnoff voltage is automatically applied, with no extra loss in gain or power, by driving pnp transistor Q3 with npn transistor Q2.—J. S. Ronne, Computer Switching With High-Power Transistors, *Electronics*, 33:10, p 44–47.



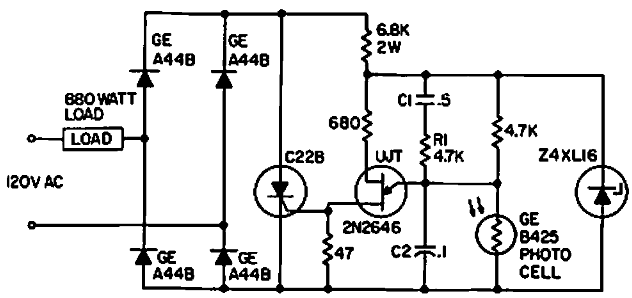
SATURABLE REACTOR LATCH—Offers operating simplicity, high speed, and low cost. Transistor model can switch in less than 0.5 microsec. Current through N1, when V1 conducts, saturates core of T1.—W. J. Reap, Simple Latch Circuit Uses Saturable Reactor, *Electronics*, 33:2, p 66.



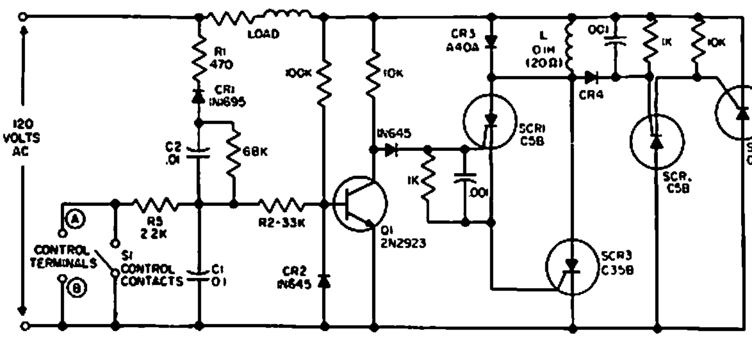
NEON-LAMP CAPACITOR DISCHARGER—Used to discharge capacitor being charged from constant-current source providing about 15 microamp. Circuit has extremely high impedance until breakdown, then low enough impedance to discharge capacitor to fraction of volt.—R. W. Biddlecomb, High-Current Switch Has High ON/OFF Z Ratio, *EEE*, 12:2, p 29.



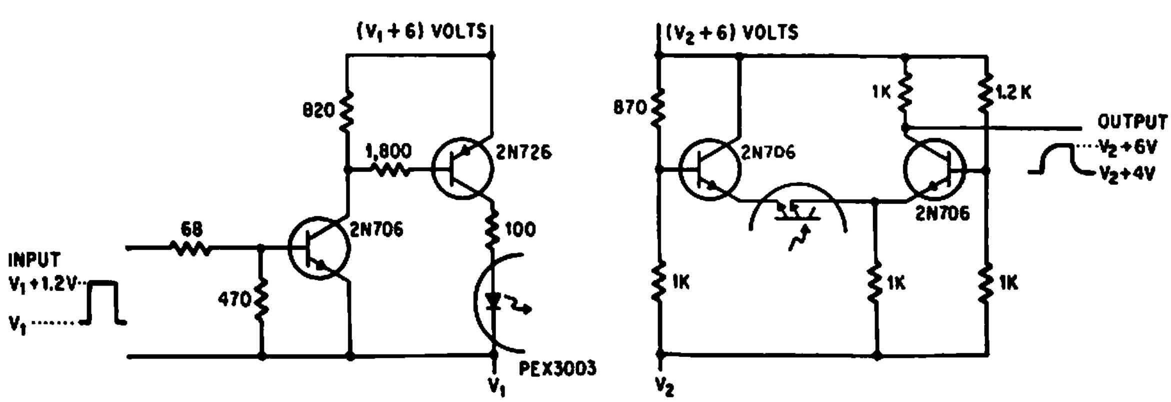
NR DIODE AS BISTABLE SWITCH—Bonded negative-resistance diode switches to high-current state on arrival of first pulse. Pulse is shut off before capacitor current through diode falls below negative spike on trailing edge of pulse.—A. P. Schmid, Jr., Negative-Resistance Diode Handles High Power, *Electronics*, 34:34, p 44–46.



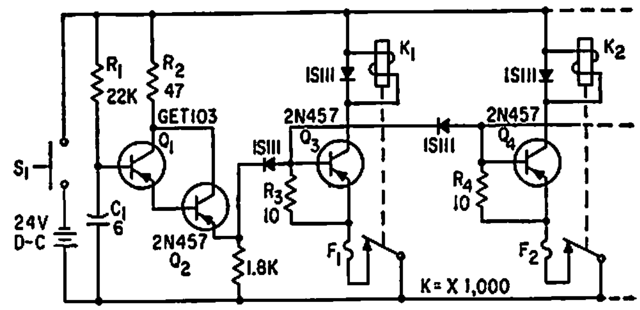
SENSITIVE A-C POWER SWITCH—Used to switch load in response to gradually changing signal, as from photocell or thermistor. Provides snap-action switching from full on to full off, with differential between switching conditions adjustable over wide range by changing C1 and R1.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 331.



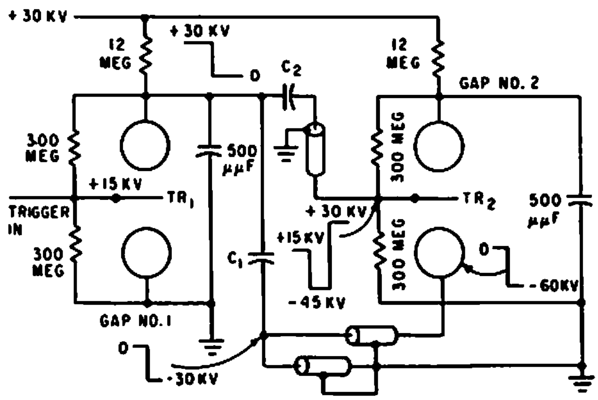
5-KW A-C SWITCHING WITH FULL-WAVE SCR'S—Provides interference-free switching from 120-v a-c line on continuous basis. By replacing C35's and CR3 with higher-rated devices, additional power can be controlled. Interference-free switching ability was utilized in reducing intolerable noise level in broadcast receiver to inaudibility. For high-impedance or open-lead circuits, 1,000-ohm bleeder resistor may be necessary across load.—F. W. Gutzwiller, RFI-less Switching with SCRs, *EEE*, 12:3, p 51–53.



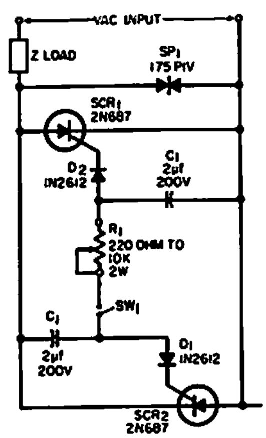
LIGHT-BEAM COUPLING—Gallium arsenide light source and silicon photodetector prevent interaction between drive circuit and output of binary switch.—E. L. Bonin, Light-Coupled Semiconductor Switch for Low-Level Multiplexing, *Electronics*, 38:3, p 54–59.



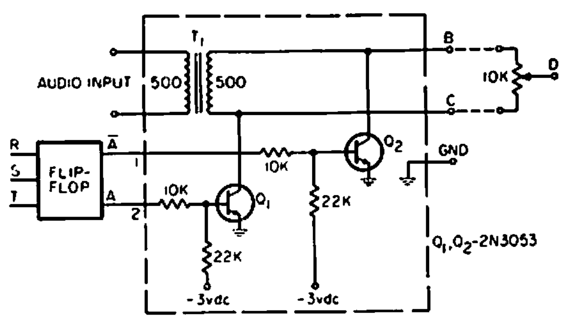
SEQUENTIAL SWITCHING—Shock-resistant design releases number of solenoid-operated mechanical locks at 10-millisec intervals. Single-stroke ramp generator Q1 starts sequence when closing of initiation switch S1 discharges C1. Q2 reduces loading on timing circuit R1-C1 when large base currents are drawn. Ramp is sufficiently linear to provide adequate timing accuracy for eight operations.—D. H. Thompson and D. Simpson, Time-Sequence Switch, *Electronics*, 33:28, p 64.



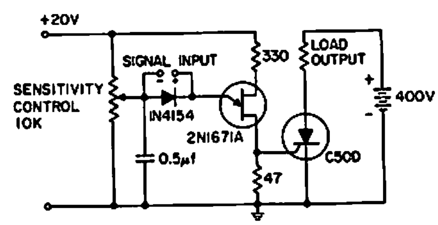
1-MILLIMICROSEC SPARK-GAP SWITCH—Spark gaps are mounted so ultraviolent radiation from gaps that fire earlier in 111-gap operating sequence irradiate succeeding gaps. Intense radiation from earlier gaps reduces statistical firing delay, or jitter, of succeeding gaps. Breakdown of gap is further speeded by connecting low-potential end of gap to trigger source with short length of cable and blocking capacitor, which in turn is grounded by similar cable.—H. B. McFarlane, Spark Gaps for Fast-High Voltage Switching, *Electronics*, 32:31, p 72–73.



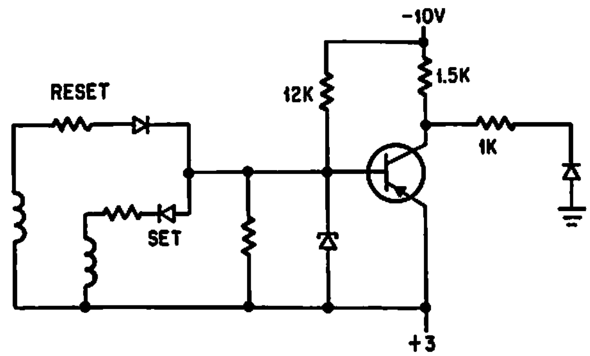
HIGH-POWER SCR STATIC SWITCH—Prevents burning of switch or relay contact when switching large inductive loads. Switch contacts here carry only trigger current for silicon controlled rectifiers. If desired, output power can be varied by changing time constant R1-C1 to control scr firing angle. Will switch primary of transformer having 4,200 v-a secondary load.—J. A. Moraites, High Power AC Static Switch, *EEE*, 12:8, p 71.



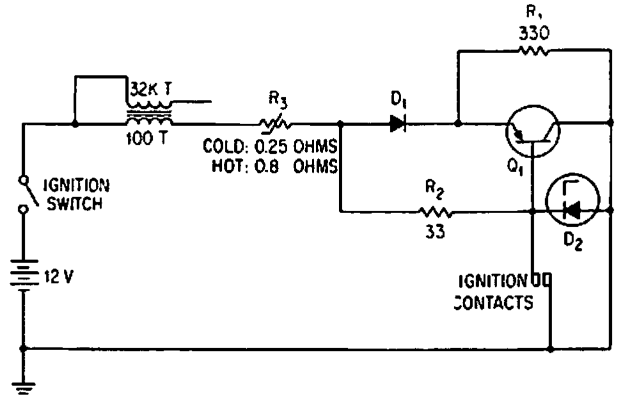
AUDIO SWITCH—Switches audio signal on and off under control of flip-flop. With potentiometer across output, phase can be reversed. With two of these switches connected to same flip-flop, and each excited by different audio signal, potentiometer connected between B outputs will provide signal from wiper to ground that alternates from one audio signal to other as flip-flop changes state. Pot setting determines relative amplitudes of two signals. Can be used to generate a-f shift-keying signals.—F. Stevens, Audio On-Off, Phase-Reversing Switch, *EEE*, 14:6, p 91–92.



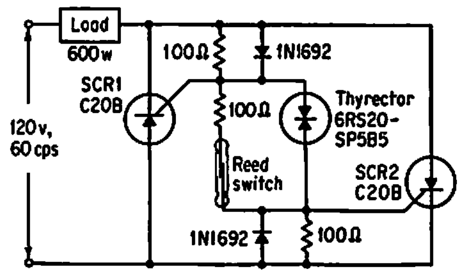
SENSITIVE D-C POWER SWITCH—Stays on after being triggered, to give latching action. Power input is 2.5 microwatts, power output is 44,000, and power gain is 92 db.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 331.



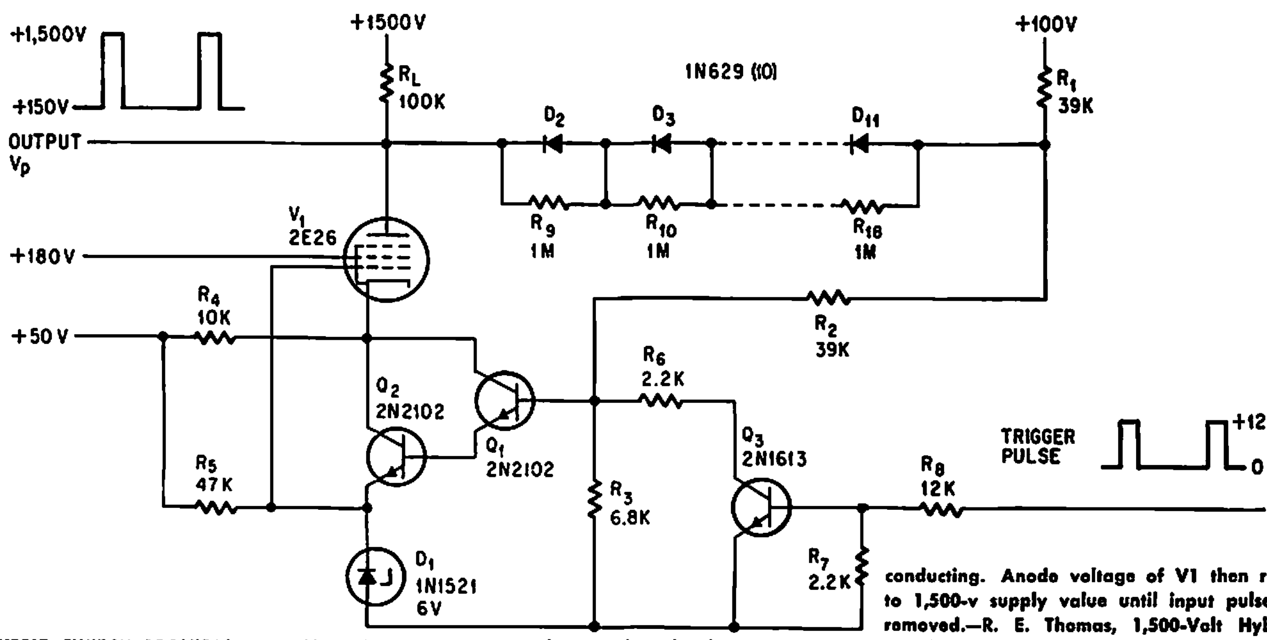
TEMPORARY MEMORY—Arrangement using Esaki or tunnel diode is equivalent to bistable flip-flop. Used in 24-channel pulse code modulation system.—T. Kojima and M. Watanabe, When You're Second, You Try Harder, *Electronics*, 38:25, p 81–89.



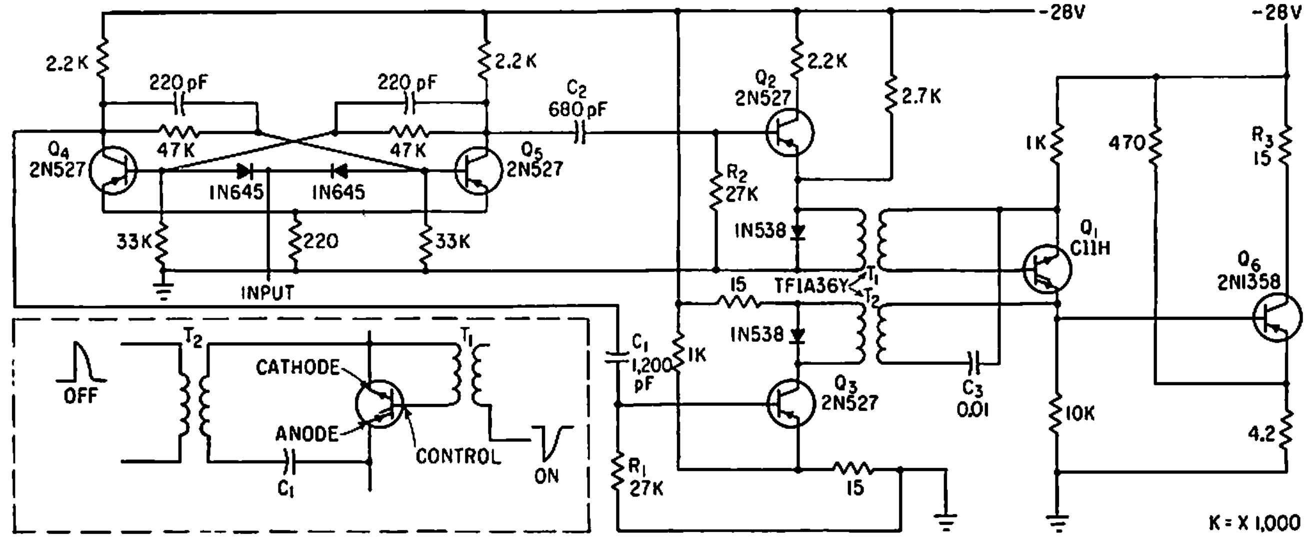
TRANSISTOR-SWITCHED IGNITION—Ignition breaker points handle only current of about 0.25 amp for switching transistor Q1, increasing contact life, while transistor handles 9-amp peak ignition coil current. Diode D1 reverse-biases emitter-base junction when distributor contacts are open, to ensure transistor cutoff at high temperature. Zener D2 clips peaks of transients that might damage transistor.—S. B. Gray, Home and Auto Controls, *Electronics*, 36:19, p 52–56.



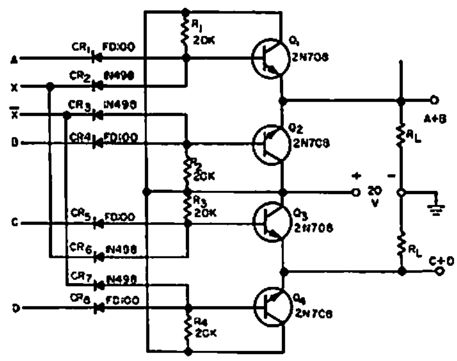
SCR-REED A-C SWITCH—Magnetic reed switch makes ideal trigger for silicon controlled rectifiers, even though nine components are required for switching 600-w load.—M. P. Southworth, Bidirectional Static Switch Simplifies Ac Control, *Control Engineering*, March 1964, p 75–76.



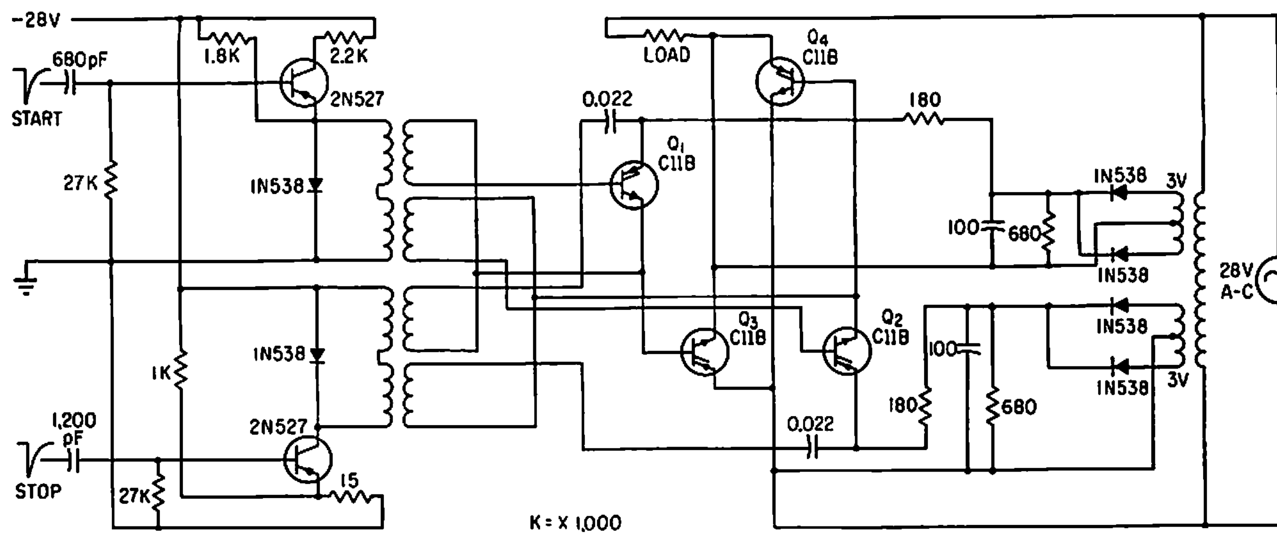
HYBRID SWITCH PROVIDES 1,500 V PULSE—Trigger pulse at 12 v saturates Q3, voltage across R3 drops below level of zener D1, and Q1 and Q2 turn off, making V1 stop conducting. Anode voltage of V1 then rises to 1,500-v supply value until input pulse is removed.—R. E. Thomas, 1,500-Volt Hybrid Switch has Low "On" Impedance, *Electronics*, 37:22, p 74–75.



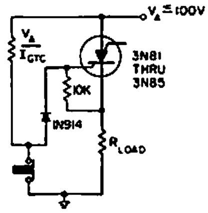
FAST SWITCHING OF D-C POWER—Power transistor Q6 switches 20 w d-c through 15-ohm load R3 under control of scr Q1, which in turn is controlled by start-stop pulse amplifiers Q2 and Q3, and multivibrator Q4-Q5. Switching rate can be up to 700 cps.—J. E. Roberts, Controlled Rectifiers for Fast Power Switching, *Electronics*, 35:17, p 58–59.



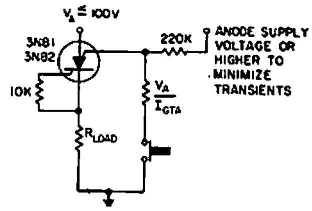
SOLID-STATE DPDT SWITCH—Eight diodes and four transistors connected as shown give same action as double-pole double-throw relay.—R. C. Going, Solid-State DPDT Relay, *EEE*, 11:10, p 26–27.



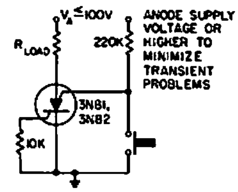
FAST SWITCHING OF A-C POWER—Pulsed scr's Q1 and Q2 turn on load-current-carrying scr's Q3 and Q4 under control of start-stop pulses from an external vibrator that feeds the 2N527 start-stop pulse amplifiers. Each pulsed scr has its own 3-v source. Load being switched requires 350 ma at 400 cps.—J. E. Roberts, Controlled Rectifiers for Fast Power Switching, *Electronics*, 35:17, p 58–59.



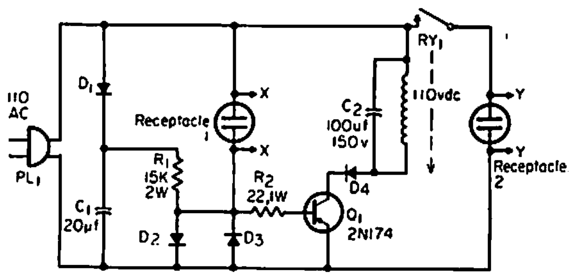
SCS CONTACT ISOLATOR—Eliminates contact bounce when both switch and load are grounded and opening of switch triggers scs.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.



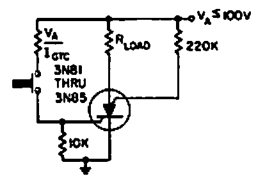
SCS CONTACT ISOLATOR—Eliminates contact bounce when switch is closed to trigger scs, with both switch and load grounded.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.



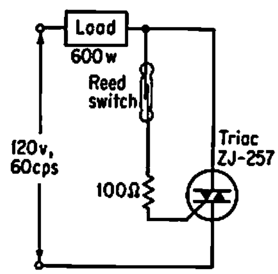
GROUNDED-SWITCH SCS CONTACT ISOLATOR—Eliminates contact bounce when switch is closed to trigger scs, because load current increases rapidly and latches on.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.



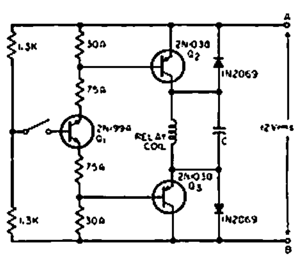
A-C POWER INTERLOCK—Any device drawing over 5 w (up to amount allowed by D2-D3) will produce 60-cps square wave at base of Q1 when device is turned on, to energize relay through Q1 and apply power to receptacle 2.—C. J. Ulrick, AC Power Interlock, *EEE*, 13:6, p 65.



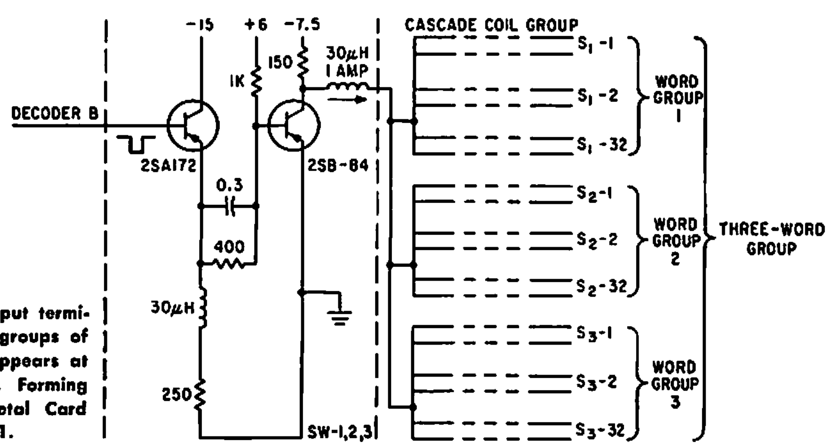
UNGROUNDED-SWITCH SCS CONTACT ISOLATOR—Eliminates contact bounce when switch is closed to trigger scs, because load current increases rapidly and latches on.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 433.



TRIAC-REED A-C SWITCH—Gate-controlled semiconductor switch (G-E Triac) and magnetic reed switch provide on-off a-c switching with minimum components. Gate signal of 3 v at 50 ma, either polarity, triggers Triac for handling 600-w load.—M. P. Southworth, Bidirectional Static Switch Simplifies Ac Control, *Control Engineering*, March 1964, p 75–76.

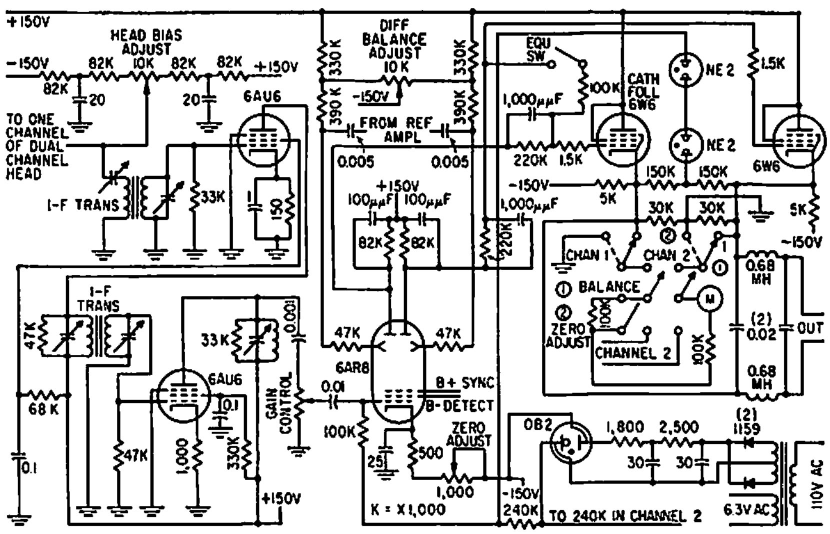


A-C RELAY DRIVE—Drives 12-v a-c relay with transistors triggered by low direct current of pair of switch contacts. Can drive any a-c relay rated in voltage up to breakdown rating of transistors.—R. K. Walters, Transistor Driven AC Relay, *EEE*, 11:2, p 25–26.

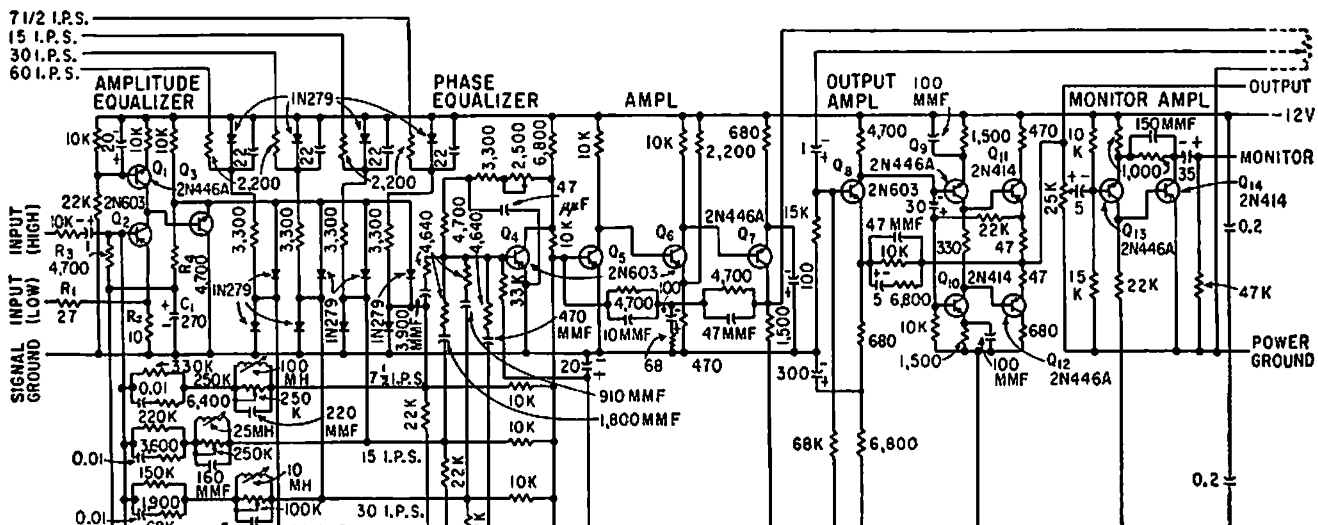


MEMORY MATRIX SWITCHING—Output terminal, connected to three word coil groups of matrix, is grounded when pulse appears at input.—J. Yamato and Y. Suzuki, Forming Semi-Permanent Memories with Metal Card Storage, *Electronics*, 34:46, p 136–141.

CHAPTER 85
Tape Recorder Circuits

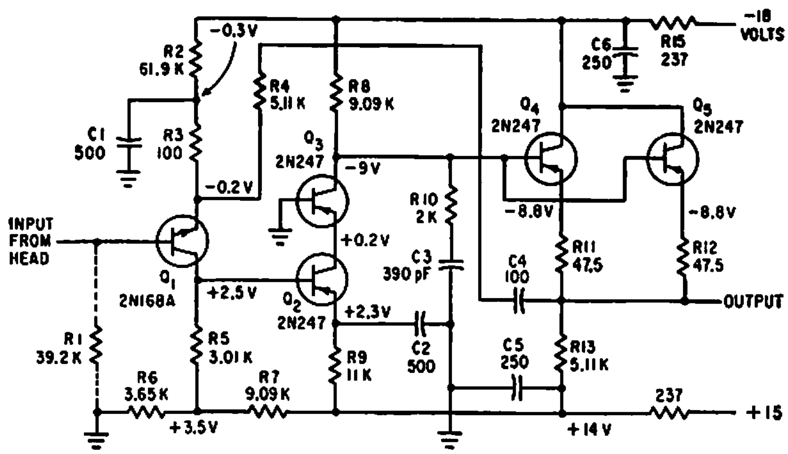


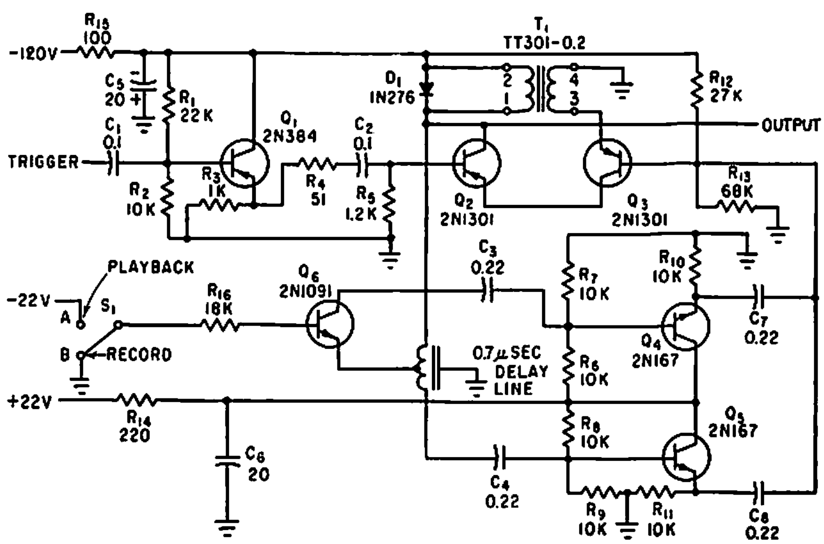
SYNCHRONOUS DETECTOR FOR ZERO-SPEED TAPE PLAYBACK—Tuned amplifiers with 200-kc center frequency and 20-kc bandwidth separate second harmonic signal containing intelligence from composite head output signal. Output of 6AR8 coupled to push-pull stage gives balanced output.—M. E. Anderson, Magnetic Head Reads Tape at Zero Speed, *Electronics*, 32:10, p 58–60.



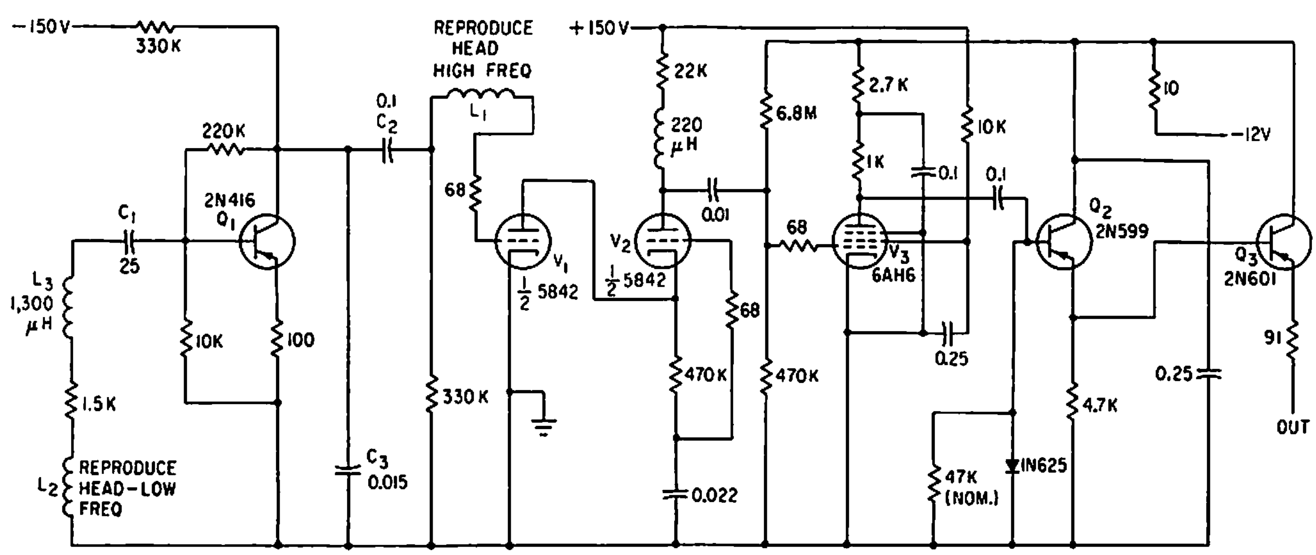
DIRECT-REPRODUCE CIRCUIT—Switching and equalization networks extend upper frequency limit to 250 kc for instrumentation tape. Amplifier section provides voltage gain of 14 db and output impedance below 50 ohms, for driving long, low-impedance lines.—D. R. Steele, More Bandwidth for Magnetic Recorders, *Electronics*, 33:2, p 44–47.

MAGNETIC-TRANSDUCER PREAMP—Gain is constant at 49 within 2% for a-c source impedances ranging from 0 to 5,000 ohms, such as magnetic read heads. Gain remains constant within 3 db from 10 cps to 1 Mc.—S. R. Parris, Wideband Transistor Preamplifier Handles Low-Resistance Transducers, *Electronics*, 34:11, p 57–59.



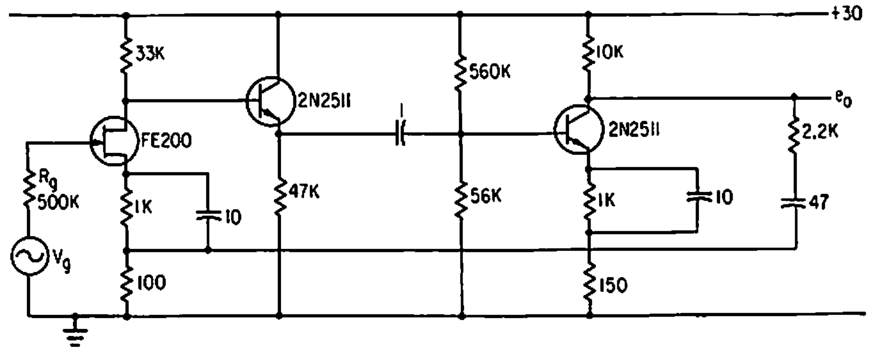


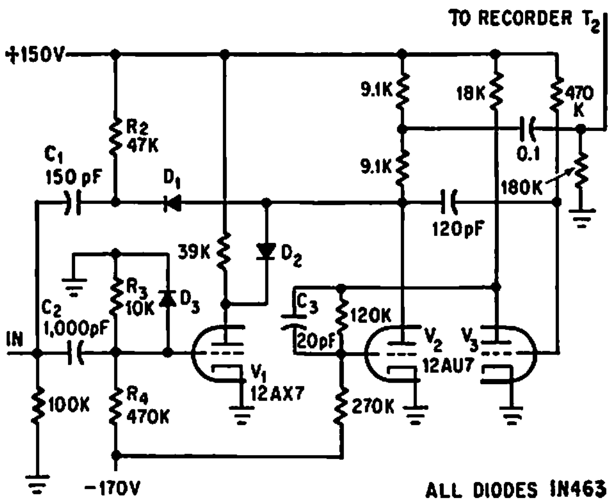
DELAY-LINE PULSES FOR VIDEO RECORDER—Blocking oscillator arrangement gives 0.3 microsec pulse length for recording by time-division multiplexing of 52 channels on two-track video recorder, and 0.8 microsec pulses when S1 is set for playback.—M. H. Damon and F. J. Messina, High-Density Storage of Wideband Analog Data, *Electronics*, 35:13, p 45–49.



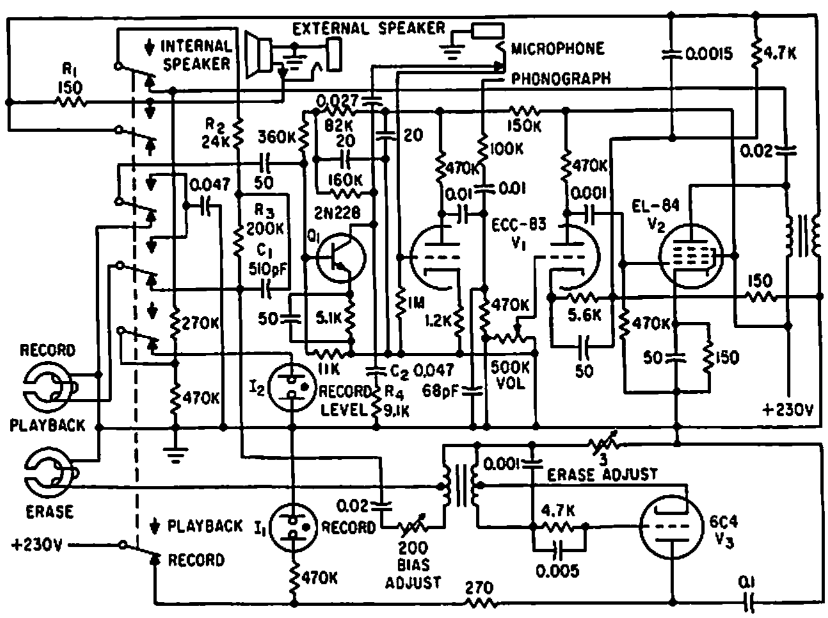
VIDEO TAPE PREAMP—Two windings on reproduce head extend frequency response to 1 Mc. Winding L2 is connected conventionally to input of Q1; when transistor gain drops off at higher frequencies, L1 at input of first tube takes over. Preamp output to 91-ohm line is 1.5 v peak to peak.—G. N. Johnson, W. R. Johnson, and J. T. Mullin, Magnetic Recorder Response, *Electronics*, 34:10, p 186–188.

FET REDUCES PREAMP NOISE—When impedance of source Vg is high, field-effect transistors reduce overall signal-to-noise ratio in preamp for reproduce head of tape recorder.—J. J. Rado, Designing Input Circuits with Lowest Possible Noise, *Electronics*, 36:31, p 46–49.

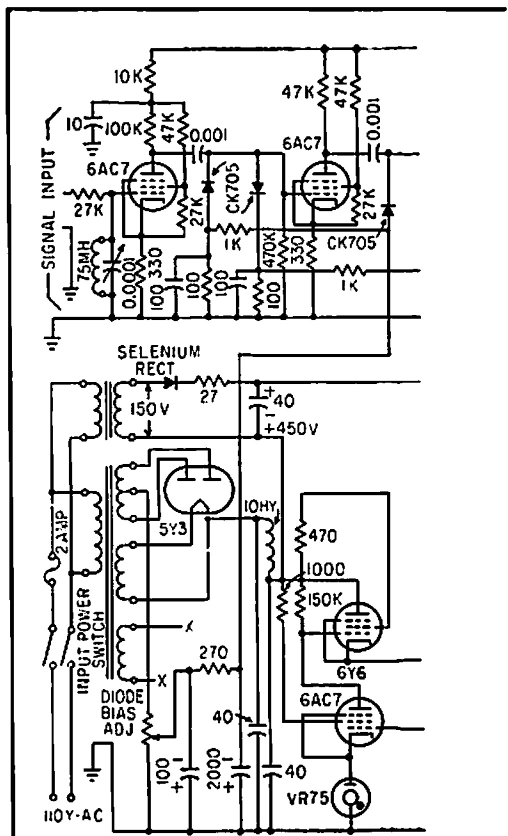




TIMING-SIGNAL RECORDER—Low-cost analog magnetic tape recorder is modified to store rectangular event-timing signals for biomedical experiments. Input gate signal is differentiated in pulse shaper C1-R2. C2 with R3, R4, and D3 produce alternately positive and negative pulses corresponding to leading and trailing edges of gate. V1, biased off, blocks negative pulses. Output at T2 after inversion by V2 consists of 30-microsec negative pulses with peak of 50 v, which can be fed to tape recorder.—G. Silverman, Modified Tape Recorder Stores Timing Signals, *Electronics*, 39:13, p 75–76.

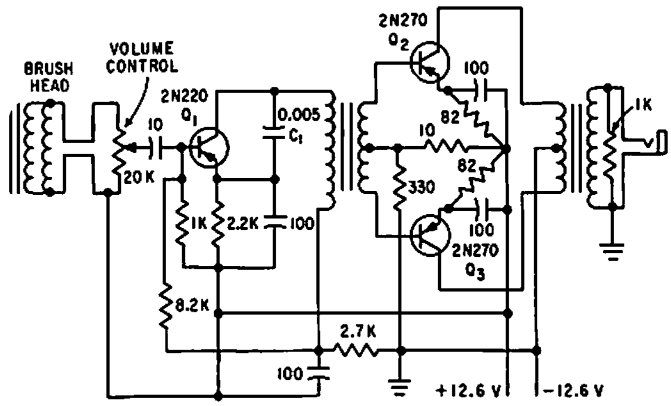


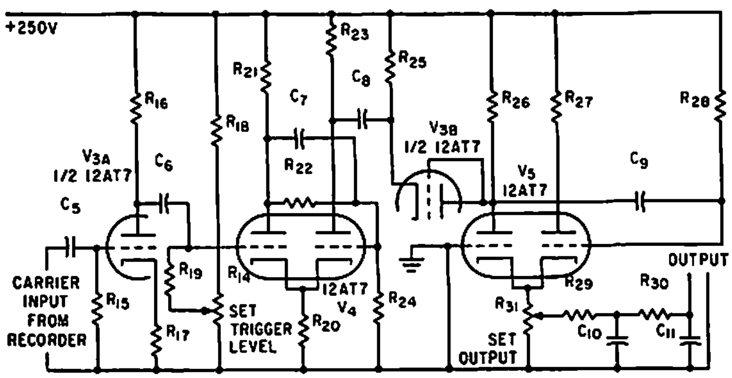
STRIPE-ON-FILM RECORD-PLAYBACK—Transistor preamplifier is used only on playback. Two-stage recording amplifier has 10 db of negative feedback from secondary of output transformer to linearize frequency response and reduce distortion. Oscillator V3 supplies bias and erase current at 40 kc.—J. M. Moriarty, R. B. Johnson, and R. J. Roman, Magnetic Sound Track of 8-MM Home Movies, *Electronics*, 33:35, p 61–63.



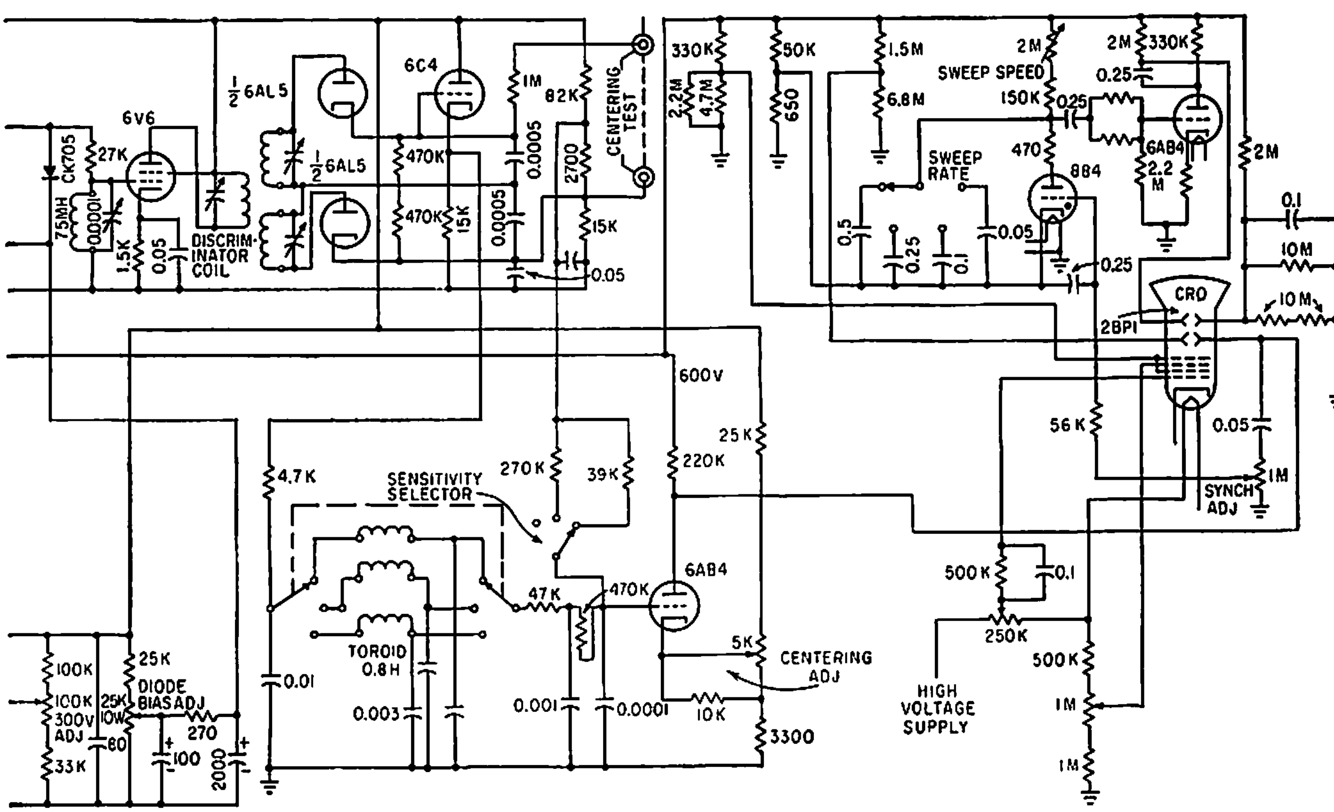
MEASURING TAPE WOW AND FLUTTER—Circuit uses 40-kc carrier, calibrated cro, and

HIGH-FREQUENCY COMPENSATION—Compensates for 23 db/decade loss above 500 cps in high-frequency response caused by spacing pickup head 1 mil from magnetic tape of vlf induction radio link.—E. A. Hanysz, J. E. Stevens, and A. Meduvsky, Communication System for Highway Traffic Control, *Electronics*, 33:42, p 81–83.

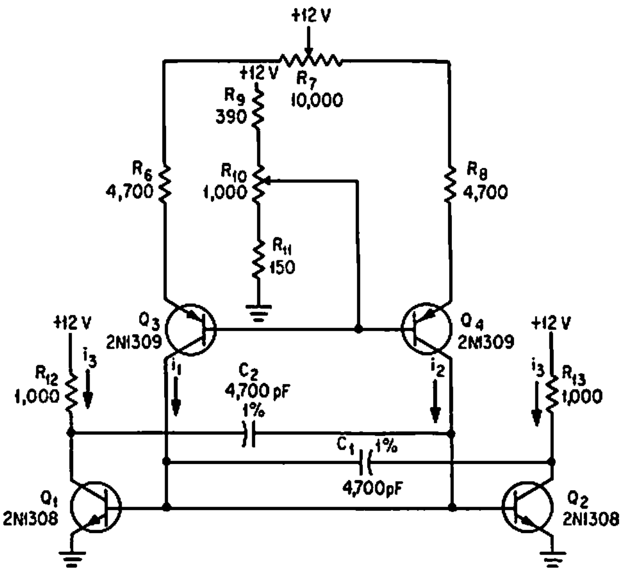




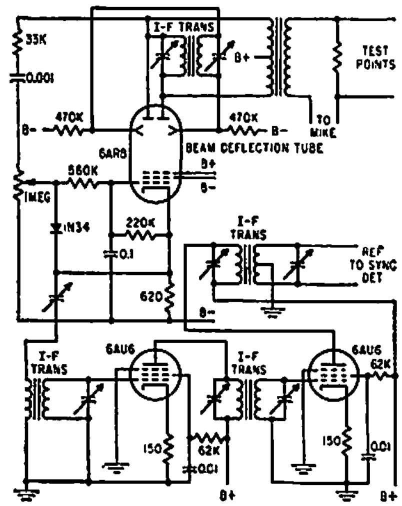
F-M DEMODULATOR FOR TAPE RECORDER—Removes low-frequency frequency-modulated nerve-potential signal from 7.5-kc carrier recorded on magnetic tape. Amplifier V3a feeds squarer V4 that is connected as Schmitt trigger to give square-wave output for differentiation by C8-R25. Negative-going edge of resulting square wave triggers monostable mvbr V5 which serves as demodulator.—K. D. Broadfoot, F-M Magnetic Tape System Records Low-Frequency Nerve-Fiber Potentials, *Electronics*, 34:28, p 66–67.



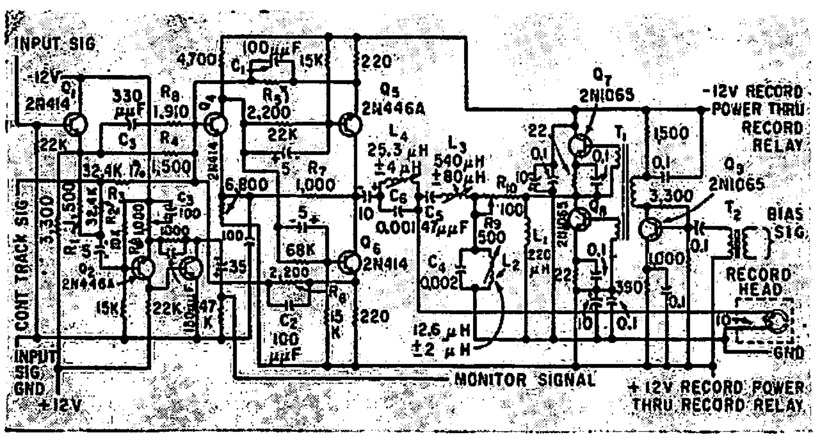
various spectrum cutout filters to show all drift, wow, and flutter components from d-c to 4,000 cps for magnetic tape recorder.—J. T. Mullin, Precise Measurement of Wow and Flutter, *Electronics*, 33:26, p 100–102.



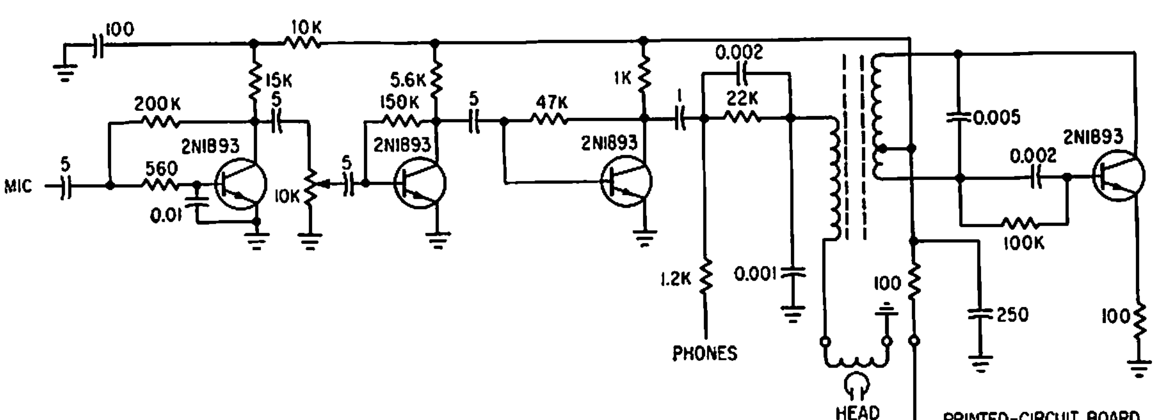
INDEPENDENT-CONTROL MVBR TESTS TRANSPORT—Timing resistors of conventional astable are replaced by adjustable constant-current sources using transistors Q3 and Q4. R7 controls mark/space ratio and R10 controls frequency.—C. J. Dakin, Novel Multivibrators Test Tape Transports, *Electronics*, 37:7, p 40–43.

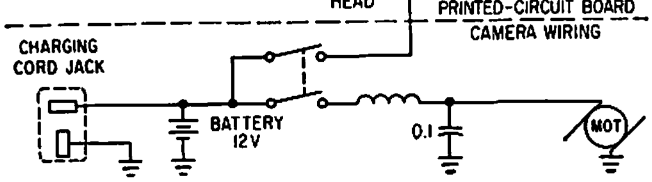


ZERO-SPEED TAPE PLAYBACK OSCILLATOR—Permits playback of recorded high-frequency signals at extremely slow speeds so highest frequency component is within limited bandwidth of pen recorder. 100-kc excitation oscillator and reference amplifier use beam deflection tube.—M. E. Anderson, Magnetic Head Reads Tape at Zero Speed, *Electronics*, 32:10, p 58–60.

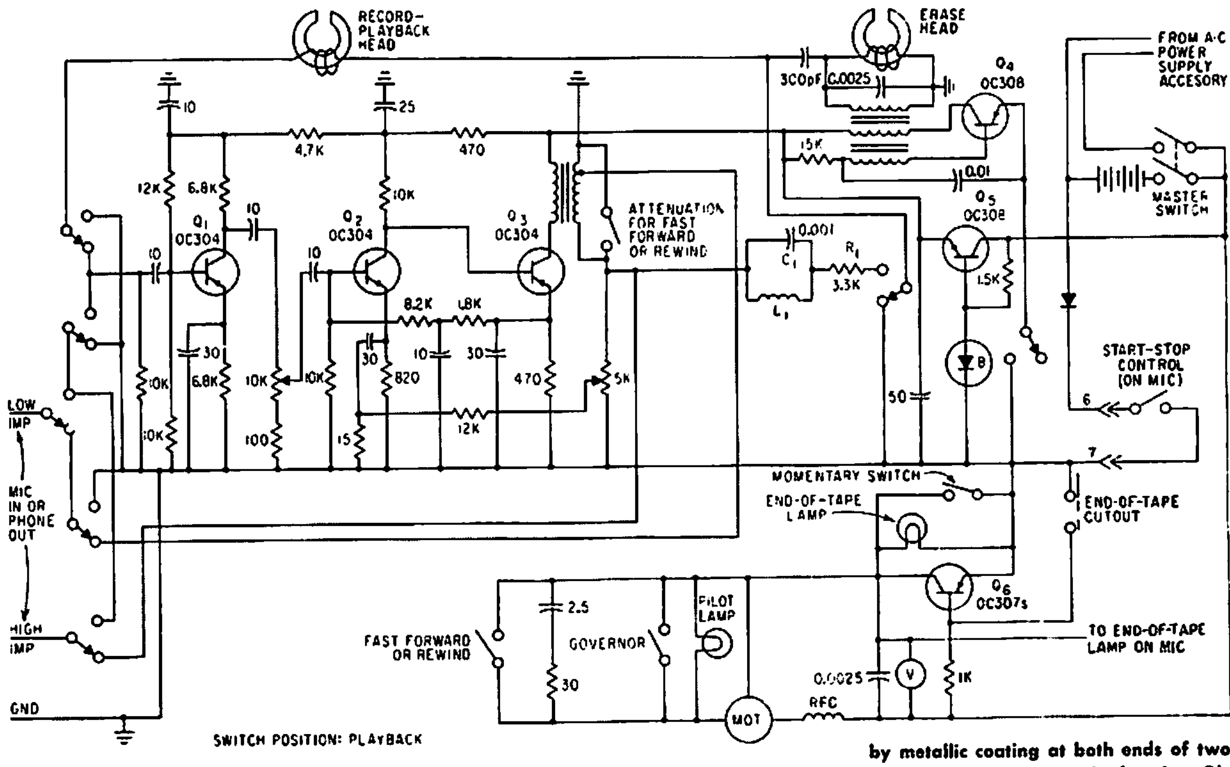


INSTRUMENTATION RECORDER—Bandpass is 250 cps to 250 kc. Uses input emitter-follower, head driver, bias amplifier, and monitor amplifier. Square-wave bias signal is supplied to each channel from master oscillator.—D. R. Steele, More Bandwidth for Magnetic Recorders, *Electronics*, 33:2, p 44–47.

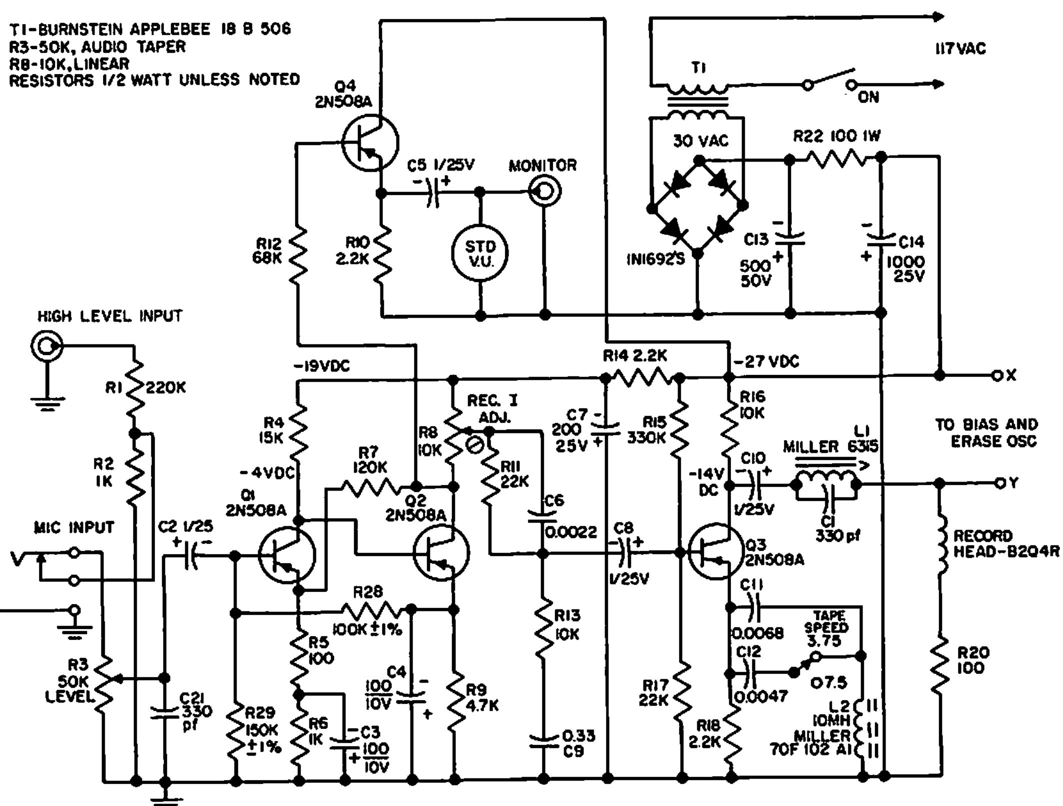




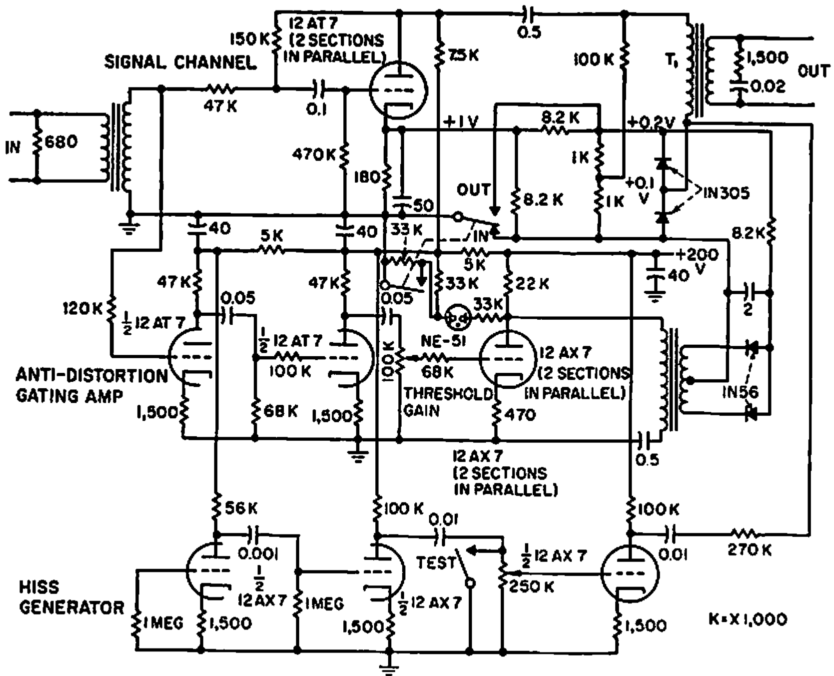
MAGNETIC RECORDER FOR 8-MM MOVIE CAMERA—Silicon transistors serve as amplifiers and oscillator for recording on magnetic stripe. Frequency response is 100 to 1,000 cps.—S. B. Gray, Appliances and Housewares, *Electronics*, 36:20, p 46–49.



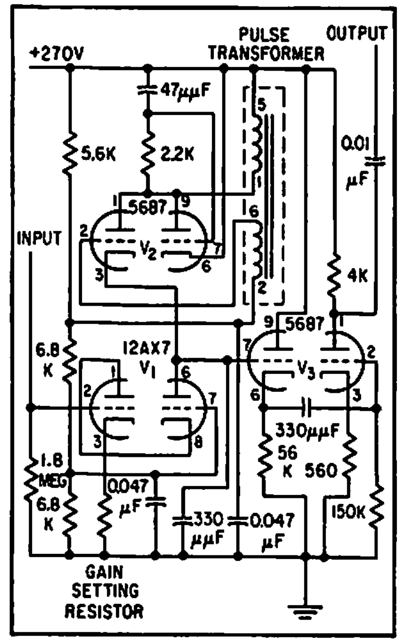
BATTERY-OPERATED DICTATING MACHINE—Amplifier voltage is regulated by Q5 and zener diode. Q6 functions as on-off switch controlled either by microphone switch or by metallic coating at both ends of two-track tape.—L. Hannemann, Pocket-size Dictating Machine, *Electronics*, 33:44, p 73.



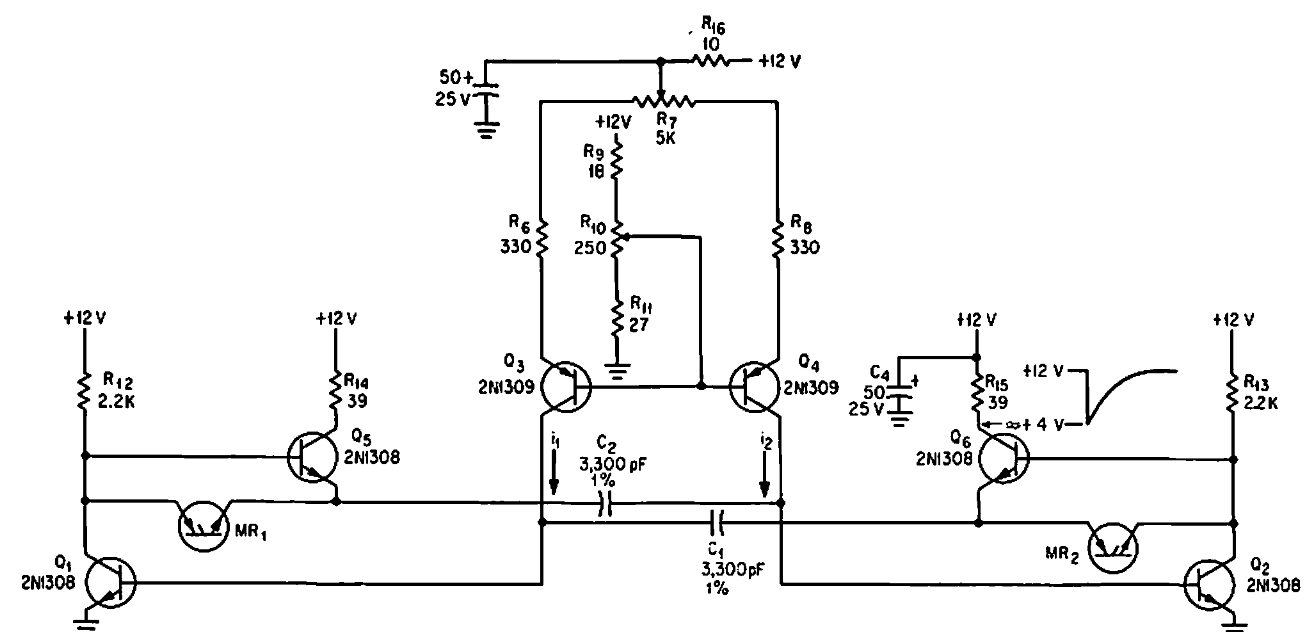
RECORDING AMPLIFIER—Has sufficient input impedance for medium-high-impedance magnetic microphone. Includes equalization to produce flat response with Nortronics low-impedance recording head when playback preamp is adjusted for NAB equalization at tape speed of 7.5 inches per second.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 272.



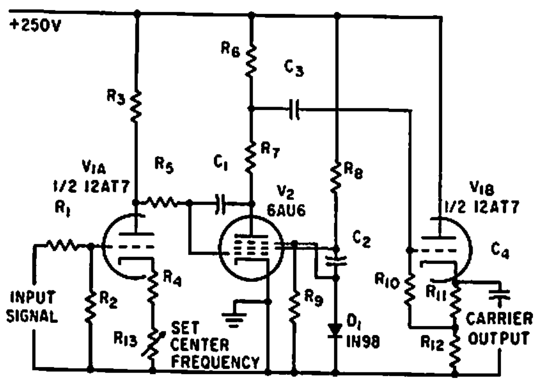
MAG TAPE PRINT-THROUGH SUPPRESSOR—Echoes occurring before and after true signal in recorded magnetic tape stored for some time, called print-through, and noticeable chiefly during soft musical passages and during recorded speech or singing, are suppressed by biased-diode type of quieting avc that silences audio channel whenever signal drops to 40 db below peak. Each diode is back-biased 0.1 v. If program peaks are 10 v, diodes become nonconducting for all signals more than 40 db below this peak. To prevent loss of desired signal near the zero axis, signals above the threshold are amplified, rectified, filtered, and used in time-constant circuit to keep diodes conducting throughout each spoken word.—D. Cronin, Squelch Circuit Mutes Magnetic Tape Echoes, *Electronics*, 31:19, p 66–67.



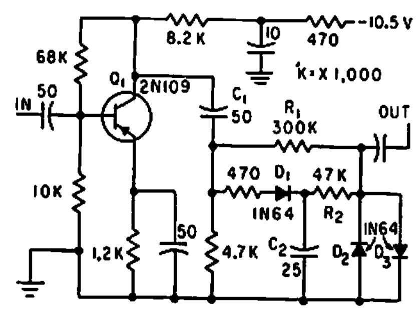
25-75 KC FREQUENCY MODULATOR—Frequency changes are linear within 1% with changes in input voltage. Circuit can easily be modified for other frequency ranges. Designed for use with magnetic tape recorders. Cf is primary frequency-determining element. —P. S. Bengston, Frequency Modulator Covers 25-75 Kc, *Electronics*, 31:31, p 100–106.



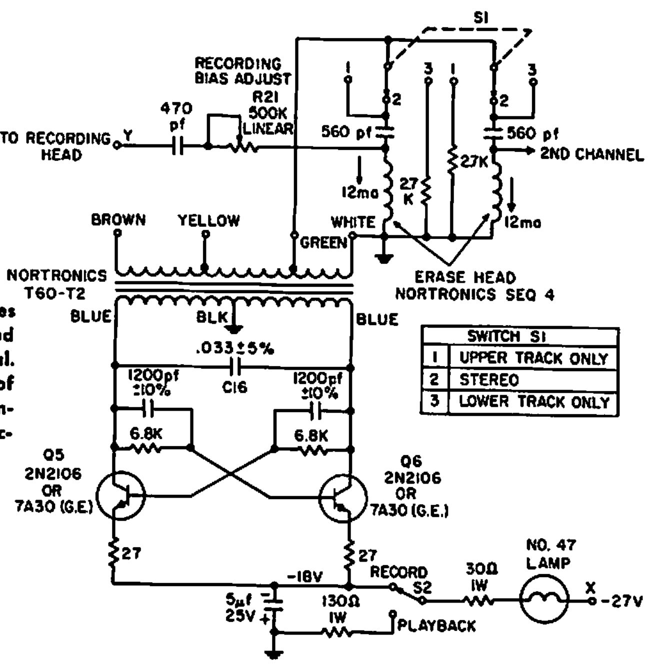
EIGHT-TRANSISTOR MVBR—Emitter-followers Q5 and Q6 increase gain by providing low-impedance path for recharging timing capacitors. R7 controls mark/space ratio and R10 controls frequency.—C. J. Dakin, Novel Multivibrators Test Tape Transports, *Electronics*, 37:7, p 40–43.



F-M MODULATOR FOR TAPE RECORDER—Miller-effect transitron oscillator V2 generates 7.5-kc carrier that is frequency-modulated by low-frequency action potentials from nerve fibers, to permit recording on ordinary tape recorder.—K. D. Broadfoot, F-M Magnetic Tape System Records Low-Frequency Nerve-Fiber Potentials, *Electronics*, 34:28, p 66–67.

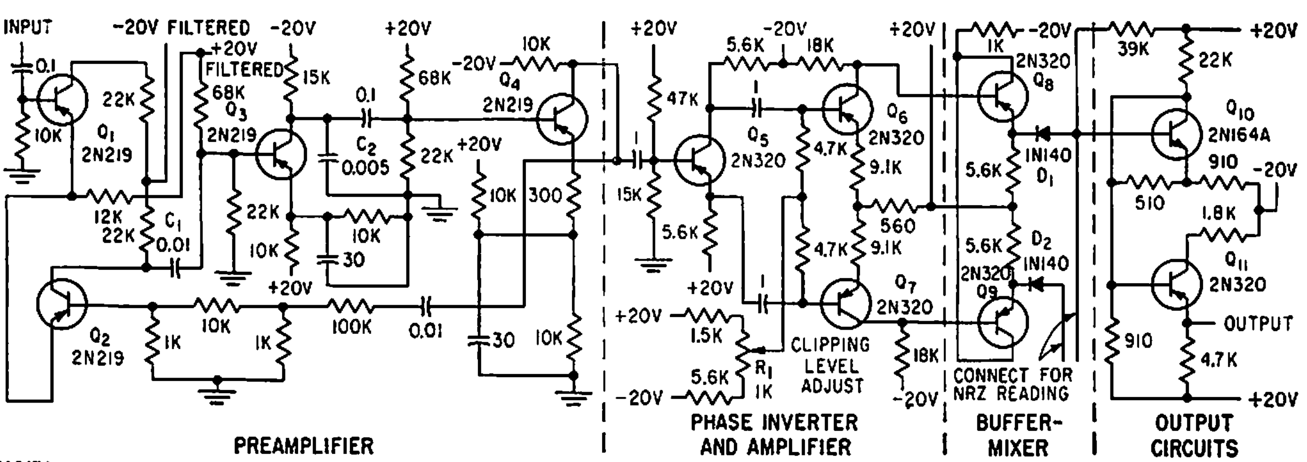


COMPRESSOR—Has unity gain, expansion of 3 db, and compression of 12 db. Gain adjustments are automatic. Used to maintain even recording level during tape-recorded interviews.—E. C. Miller, Audio Volume Compressor, *Electronics*, 33:2, p 62.

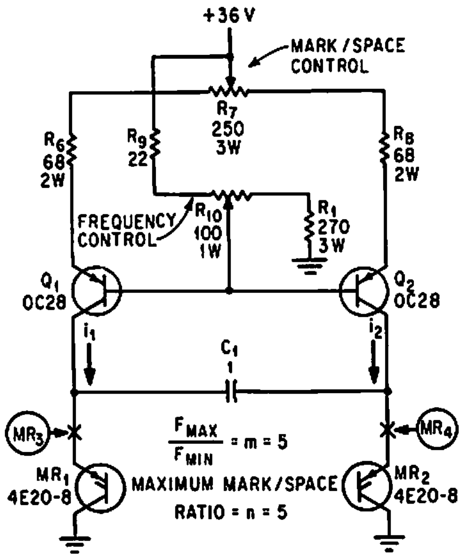


ERASE AND BIAS OSCILLATOR—Provides ample power for 60 db erasure of saturated tape, using 10 ma of 80-kc erase signal. Total power output is 1.5 w at efficiency of 60%. Bias current is same frequency.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 278.

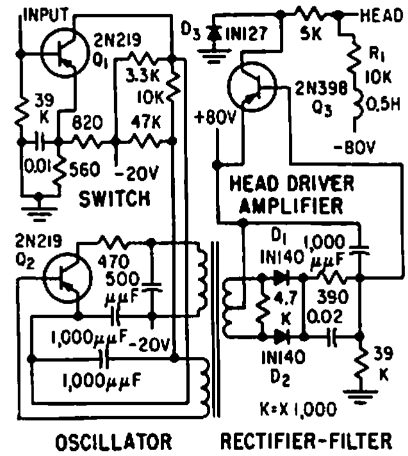
SWITCH S1	
1	UPPER TRACK ONLY
2	STEREO
3	LOWER TRACK ONLY



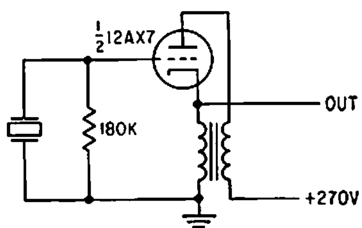
DIGITAL DATA READ AMPLIFIER—Presents 10,000-ohm input impedance to read head. No-signal input produces −4 v output; peak input as low as 1.35 mv zero-to-peak produces +4 v output. Gives satisfactory reading at pulse repetition rates up to 22 kc.—R. F. Shaw, Universal Tape Amplifiers for Digital Data Systems, *Electronics*, 31:41, p 91–93.



SHOCKLEY-DIODE MVBR TESTS TRANSPORTS—For testing tape transports, frequency can be varied over 15:1 range and mark/space ratio from 1:15 to 15:1. Shockley diodes MR1 and MR2 serve as changeover switch. Two additional diodes, at MR3 and MR4, are needed if reverse voltage rating of diodes is less than their striking voltage.—C. J. Dakin, Novel Multivibrators Test Tape Transports, *Electronics*, 37:7, p 40–43.



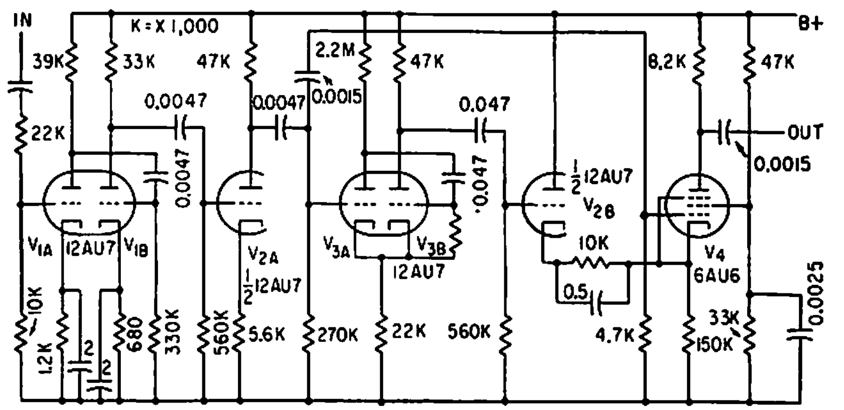
DIGITAL DATA WRITE AMPLIFIER—Delivers 8-ma swing to record head. Rise time is 15 millisec, sufficient for nonreturn-to-zero recording at 20 kc, using head with 50-mh inductance. Carrier-type amplifier overcomes usual stability and level problems associated with d-c amplifiers.—R. F. Shaw, Universal Tape Amplifiers for Digital Data Systems, *Electronics*, 31:41, p 91–93.

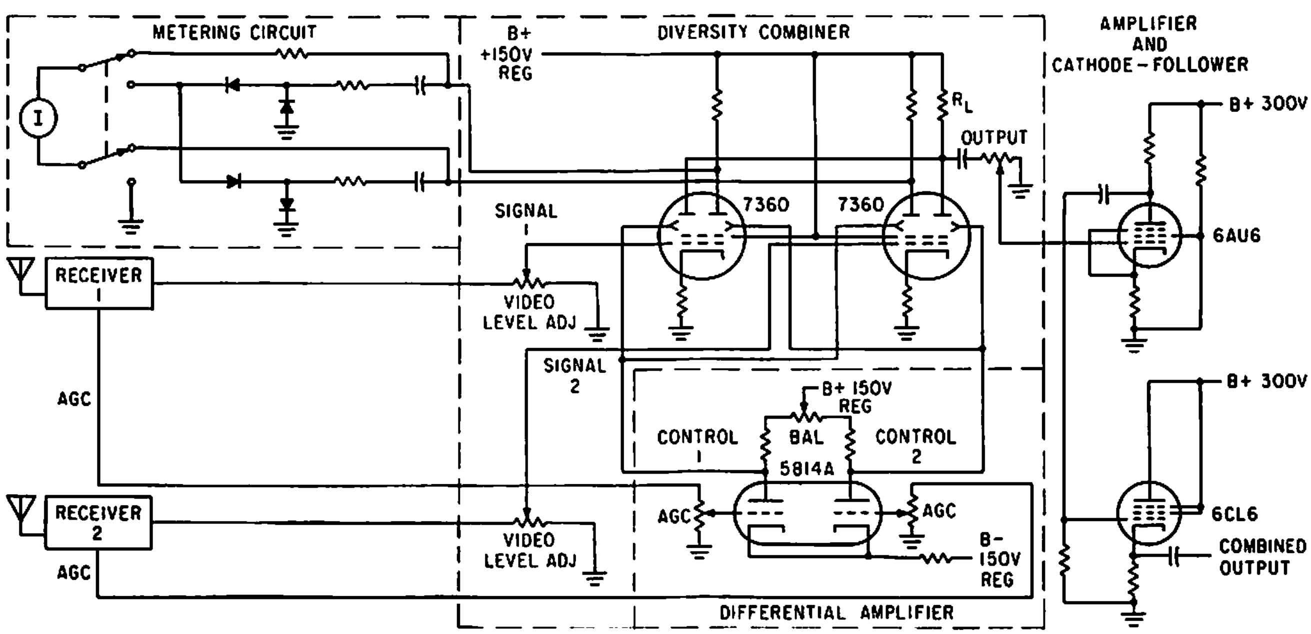


CRYSTAL-CONTROLLED BLOCKING OSCILLATOR—Used for recording 50-kc reference base on magnetic tape in 10-channel instrumentation system. Circuit is ordinary plate-to-cathode coupled blocking oscillator with crystal substituted for capacitor. If free-running frequency (without crystal) is lower than crystal frequency by no more than 40%, oscillator locks to crystal frequency.—P. S. Gengston, Blocking Oscillator is Crystal Controlled, *Electronics*, 31:25, p 88–90.

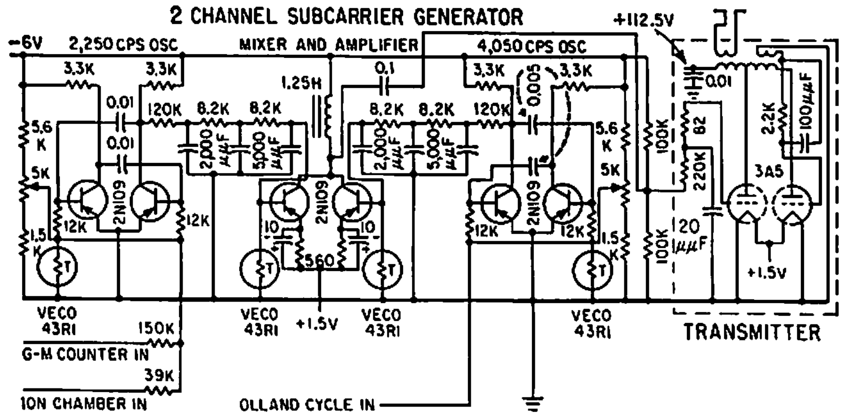
CHAPTER 86
Telemetry Circuits

GATED AMPLIFIER FOR RECEIVER—Input from f-m discriminator of ground receiver for neutron-detecting radiosonde contains two subcarrier oscillator frequencies plus steep unwanted pulses at audio blocking rate of 10 to 200 cps. Three-stage amplifier feeds amplified input signals to one-shot mvbr V3A-V3B for blocking of unwanted pulses. Output of gated amplifier V4 then contains only bursts of the two desired subcarrier frequencies.—L. Hillman and R. C. Haymes, Modifying a Telemetry System for Balloon-Borne Neutron Detection, *Electronics*, 34:11, p 60–63.

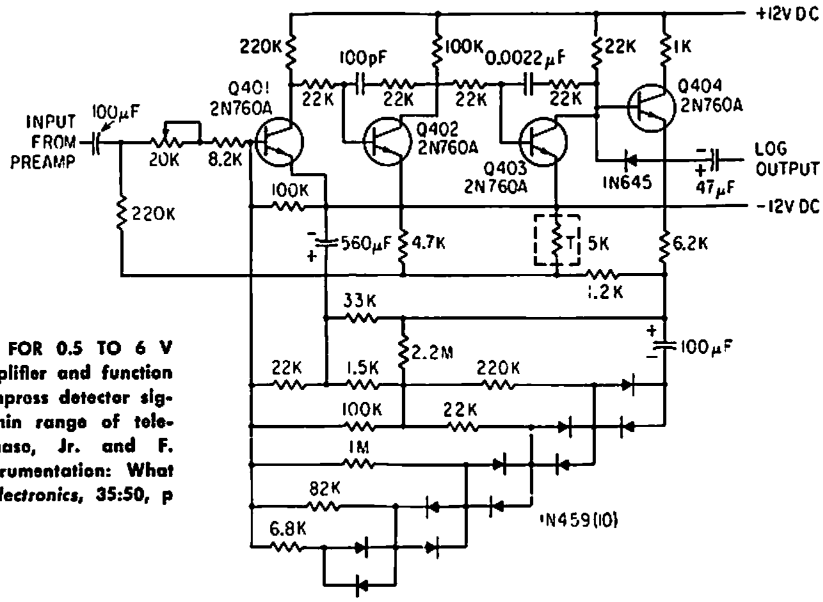




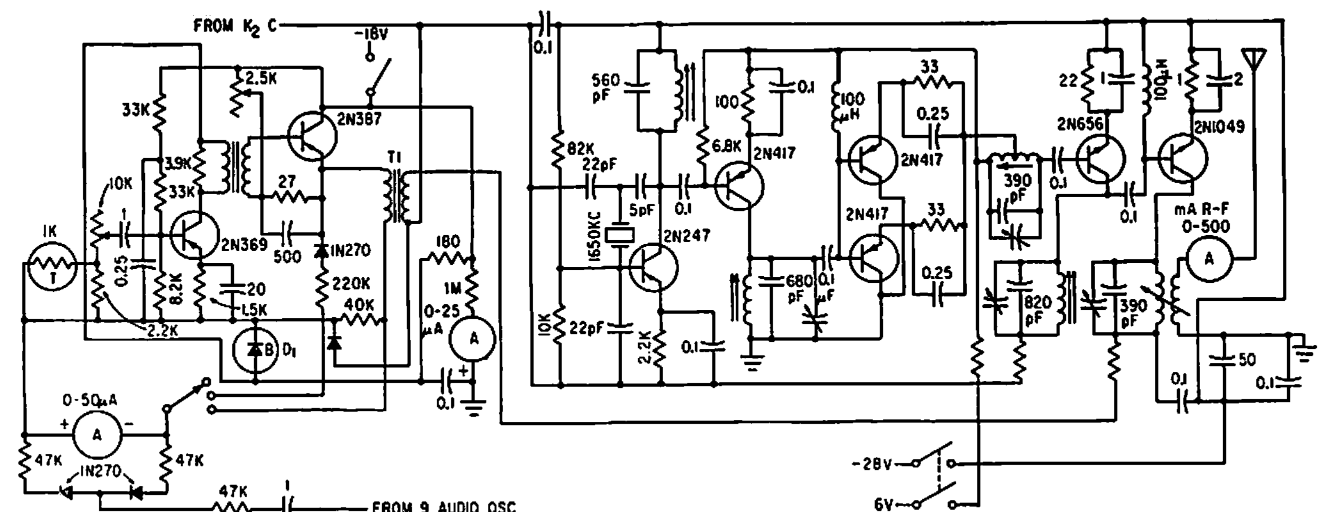
TWO-CHANNEL DIVERSITY COMBINER—Beam-deflection tubes provide ratio-squared combining of two telemetry receiving channels, to counteract fading signals from tumbling or spinning spacecraft missile. Video signals go directly to control grids of type 7360 deflection tubes, while control voltages from receivers are applied to the respective deflection electrodes through differential amplifier.—V. A. Ratner, Telemetry Diversity Combiner Uses Beam Deflection Technique, *Electronics*, 35:4, p 42–43.



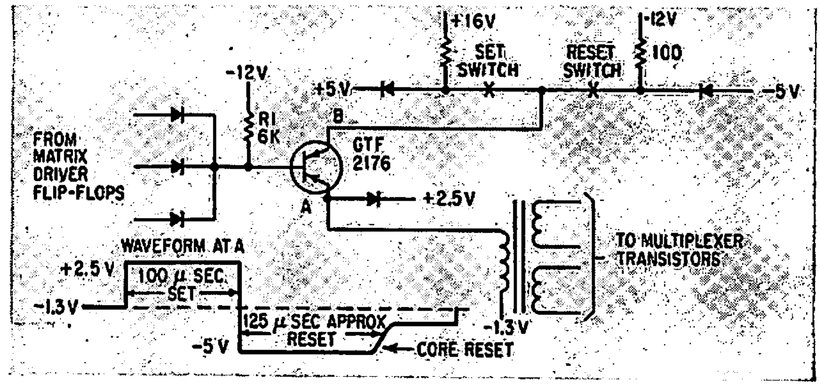
F-M/F-M TRANSMITTER—Output power is 0.5 w at 95 Mc, and range is 400 miles. Provides two channels.—L. E. Peterson, R. L. Howard, and J. R. Winckler, Balloon Gas Monitors Cosmic Radiation, *Electronics*, 31:45, p 76–79.



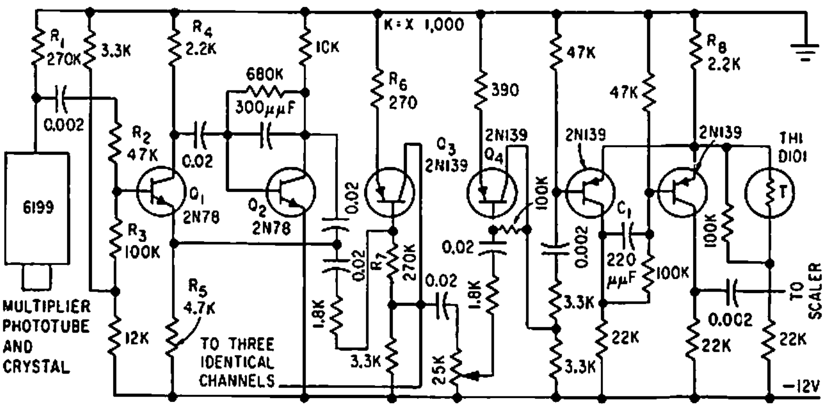
LOGARITHMIC AMPLIFIER FOR 0.5 TO 6 V D-C—Uses operational amplifier and function generator principle to compress detector signal levels to values within range of telemetering system.—S. Chase, Jr. and F. Schwarz, Mariner II Instrumentation: What Will It See on Venus?, *Electronics*, 35:50, p 42–45.



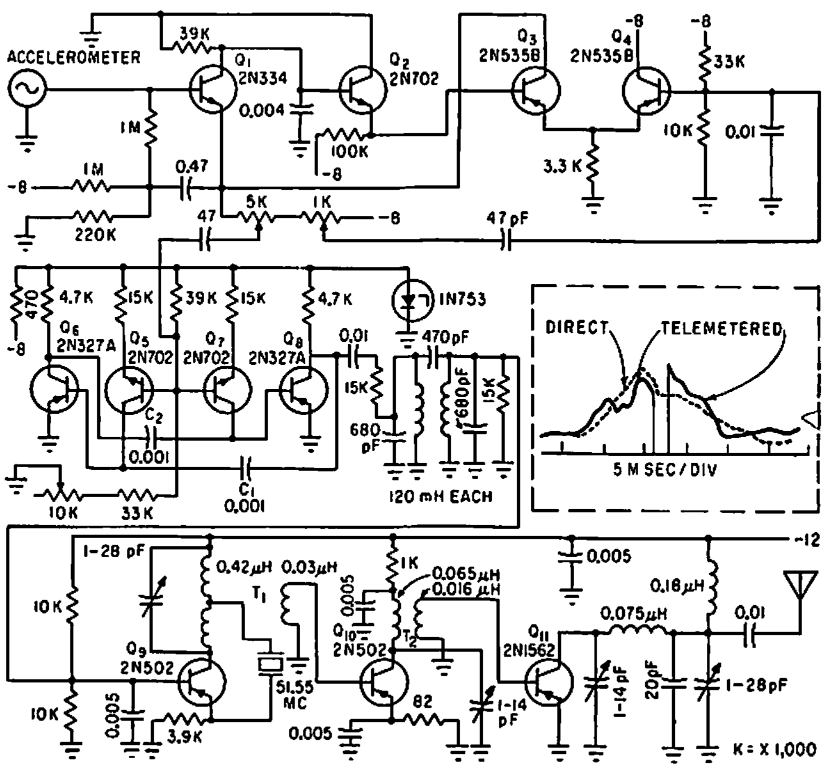
WIND VELOCITY TRANSMITTER—Battery-operated transmitter at remote mountain site uses transmitters exclusively, for power economy, to telemeter wind direction and velocity for predicting avalanches. Modulator uses nine separate 2N366 audio oscillators (not shown) that feed 2N369 class-A buffer.—R. Beaulieu and G. Neal, Wind Velocity Telemetering System, *Electronics*, 33:29, p 68–70.



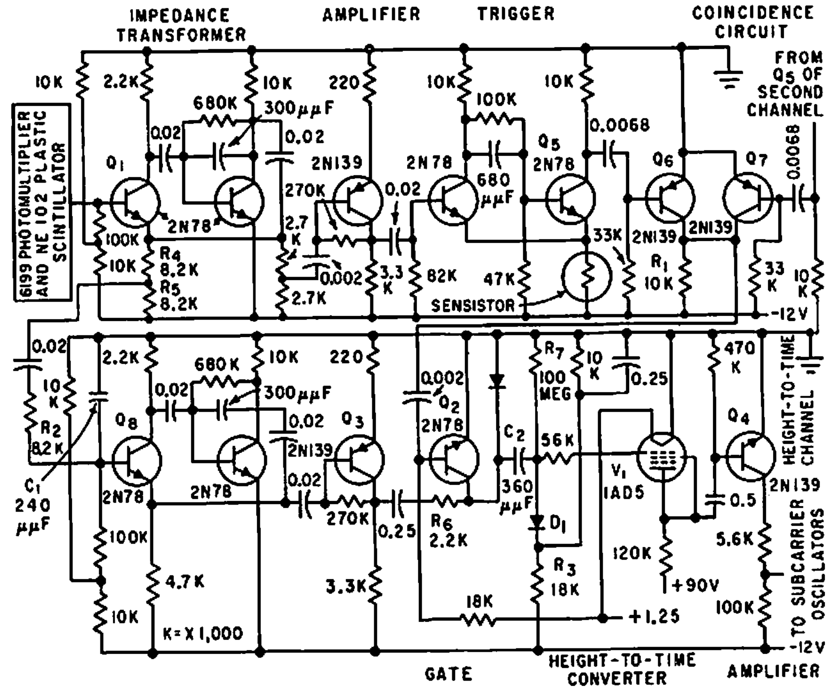
MULTIPLEX DRIVER—Diode matrix drives bilateral transistors similar to core memory drivers. Drive circuit is regulated to within 10%.—J. V. Dirocco and J. W. Peghiny, Low-Level Encoding Approach: Latest Details of Titan II Telemetry, *Electronics*, 35:47, p 36–39.



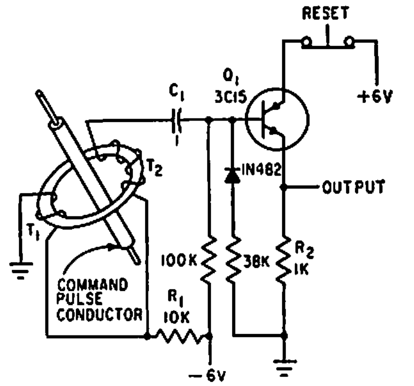
FOUR-CHANNEL DISCRIMINATOR—Common amplifier and four individual amplifiers drive triggers for four channels of scalers. Common amplifier supplies 7 v on common bus from Q3 to four potentiometers, settings of which determine discrimination point for each channel.—D. Enemark, Balloon-Borne Circuits Sort High-Altitude Cosmic Rays, *Electronics*, 32:35, p 52–55.



FOOTBALL-HELMET TRANSMITTER—Impact data sensed by accelerometer in helmet is transmitted to sideline receiver by f-m/f-m transmitter. Use of subcarrier oscillator makes transmitter more immune to shock and vibration than with conventional main-channel oscillator.—J. S. Aagaard and J. L. DuBois, Telemetering Impact Data from the Football Field, *Electronics*, 35:14, p 46–47.

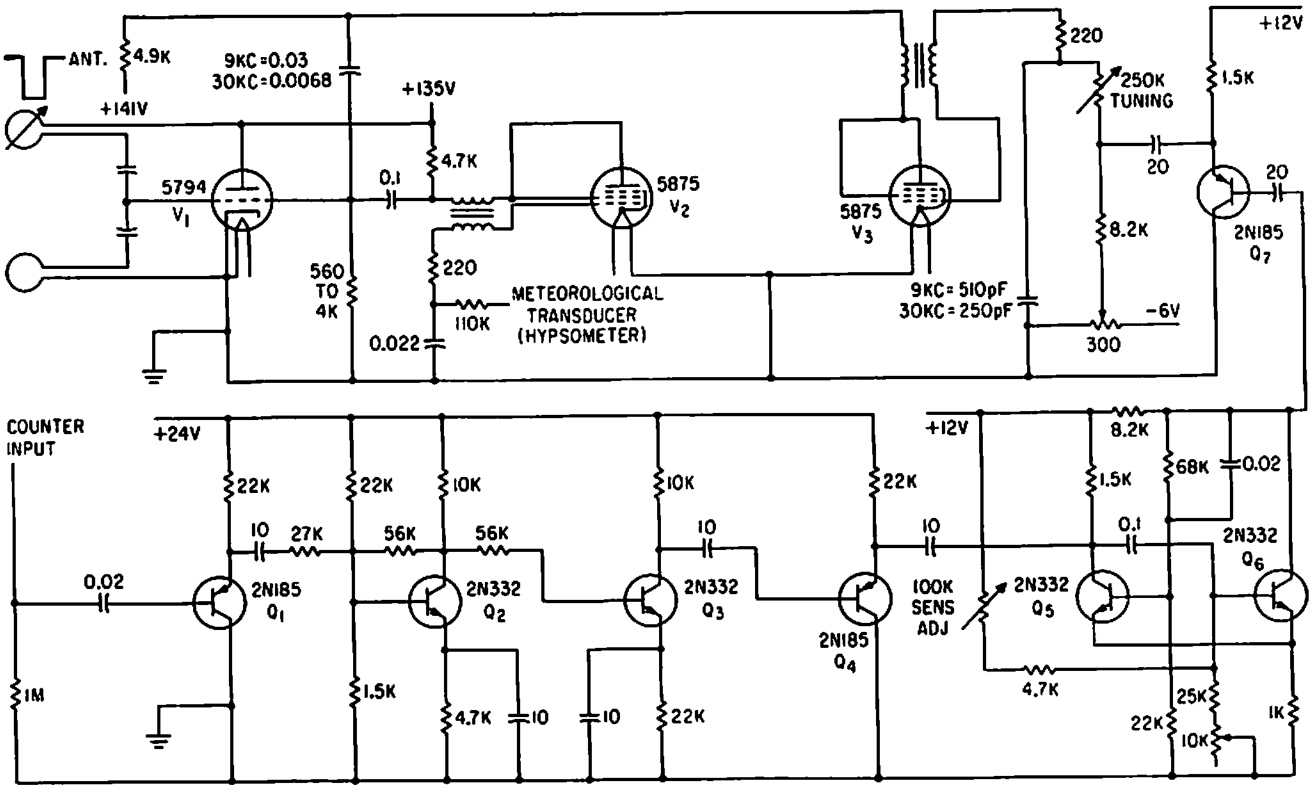


ENERGY-LOSS TELESCOPE—Uses sensistors to help compensate for temperature effects. Circuit normally employs two identical channels for the two multiplier phototubes, to drive coincidence circuit that feeds height-to-time converter.—D. Enemark, Balloon-Borne Circuits Sort High-Altitude Cosmic Rays, *Electronics*, 32:35, p 52–55.

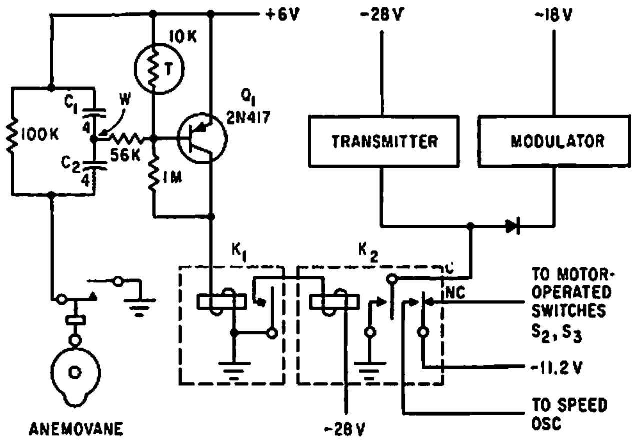


T_1 = 1,000 TURNS, T_2 = 2,000 TURNS NO. 40 ON TOROIDAL ARNOLD 3T-7428-DI CORE

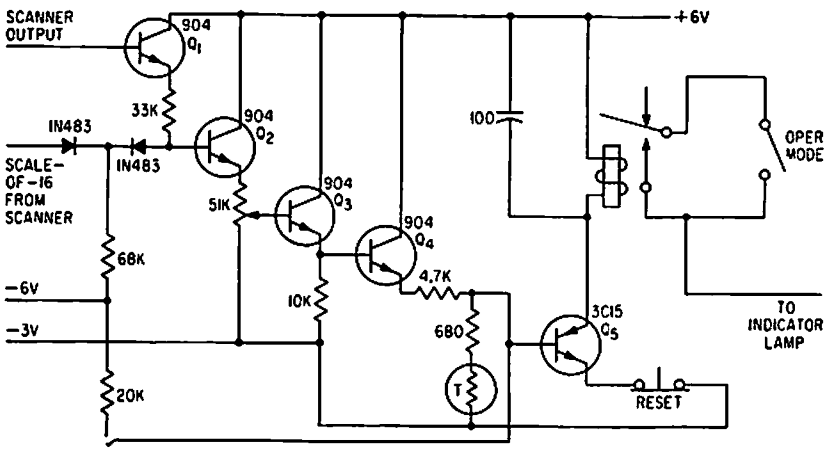
PULSE COMMAND MONITOR—Toroid in control electrode circuit of solid-state thyratron Q1 triggers circuit on when command pulse passes through insulated conductor, without affecting command circuit for such critical functions as arming of missile.—R. C. Wright, Collecting Data from Live Missiles in Flight, *Electronics*, 34:12, p 46–49.



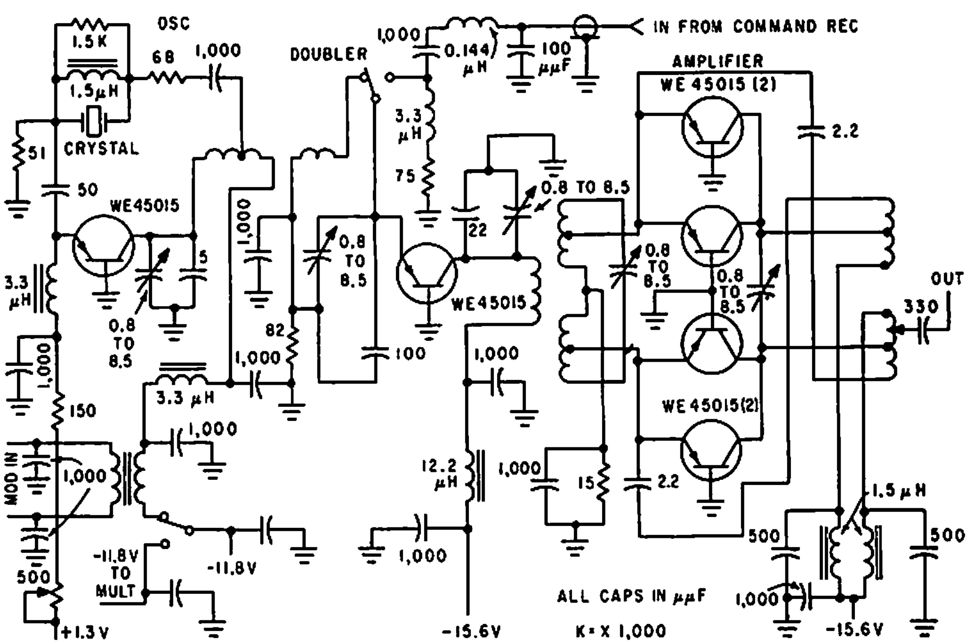
NEUTRON-COUNTING TRANSMITTER—Used with cosmic-ray neutron counter to drive conventional radiosonde. Signals above preset amplitude trigger subcarrier gate that in turn frequency-modulates r-f carrier.—L. Hillman and R. C. Haymes, Modifying a Telemetry System for Balloon-Borne Neutron Detection, *Electronics*, 34:11, p 60–63.



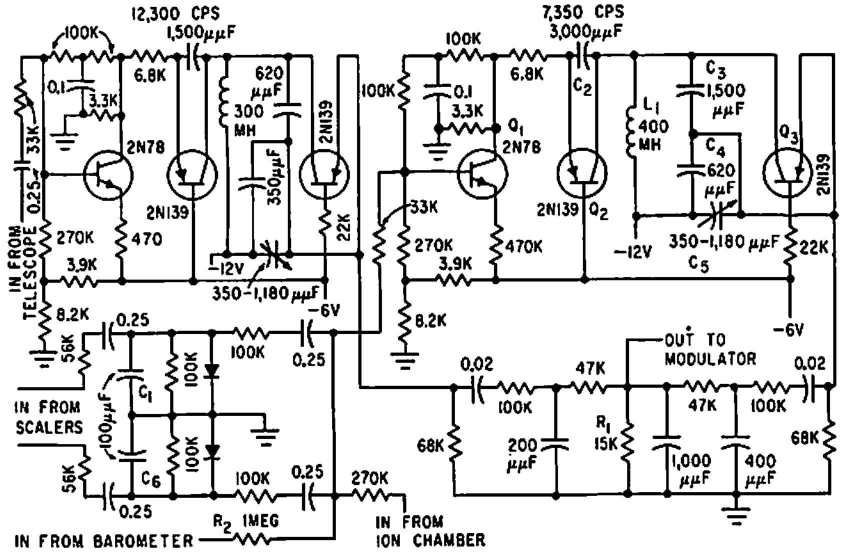
ANEMOVANE AUDIO OSCILLATOR—Used for telemetering wind velocity. Cam switch closes for each mile of wind that passes the anemometer cups, applying voltage to C1 and C2 in series and making Q1 conduct and pull in K1. This energizes velocity audio oscillator of telemetry system.—R. Beaulieu and G. Neal, Wind Velocity Telemetering System, *Electronics*, 33:29, p 68–70.



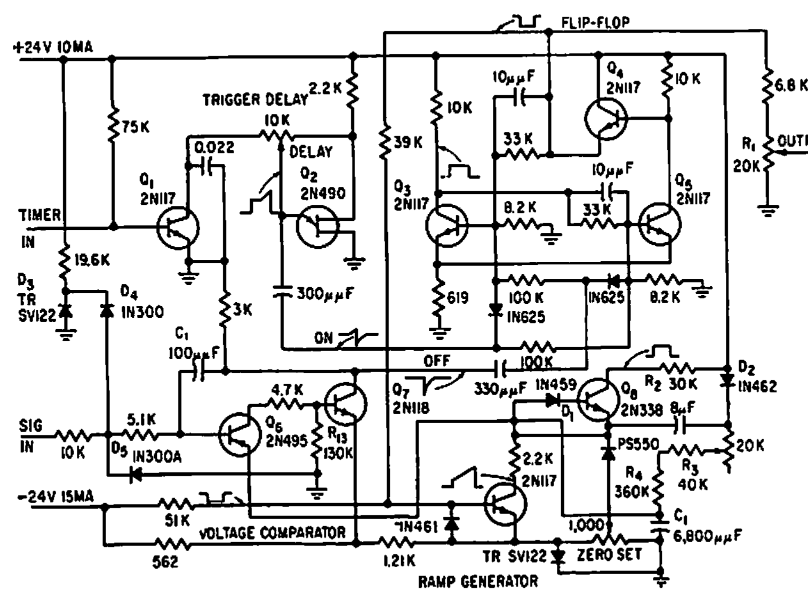
MALFUNCTION MONITOR—Used for monitoring missile in flight while maintaining radio silence of telemetry transmitter unless abnormal condition is detected. After arming of missile, monitor can be used to transmit missile kill data.—R. C. Wright, Collecting Data from Live Missiles in Flight, *Electronics*, 34:12, p 46–49.



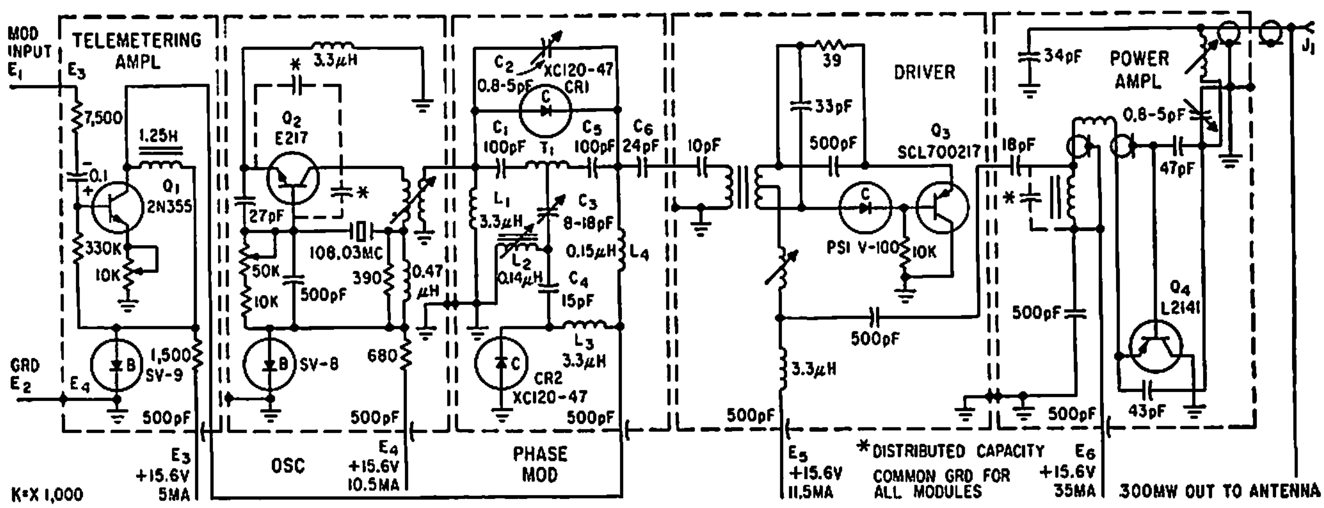
LUNAR PROBE TRANSMITTER—Five subcarrier channels are used in f-m/p-m systems to transmit ion density, two levels of micrometeorite particle impacts, magnetic field strength, and compartment temperature. Output stage uses four transistors in push-pull parallel to give 400 mw output.—R. R. Bennett et al., Circuits for Space Probes, *Electronics*, 32:25, p 55–57.



STABLE SUBCARRIER OSCILLATOR—Two Colpitts oscillators, designed for 7,350 cps and 12,300 cps, are used with reactance-type frequency modulation. Input stage of each oscillator is temperature-stabilized by d-c feedback.—D. Enemark, Balloon-Borne Circuits Sort High-Altitude Cosmic Rays, *Electronics*, 32:35, p 52–55.

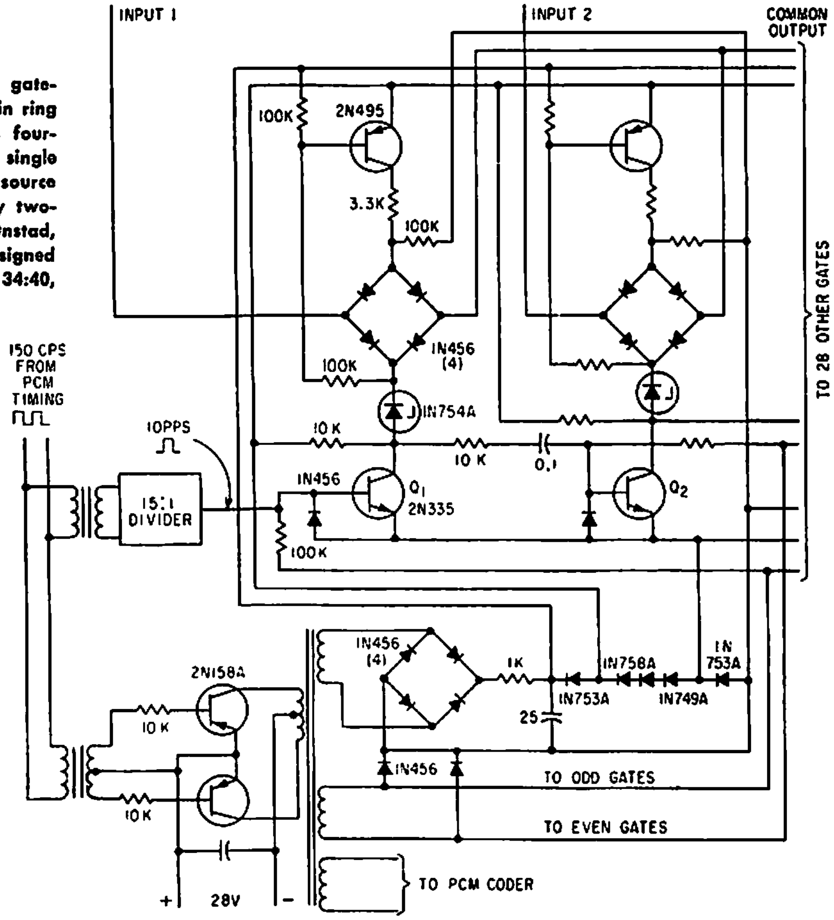


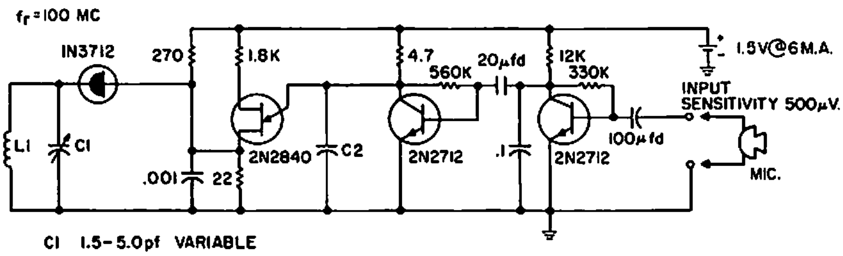
PDM KEYER—High linearity, low crosstalk and jitter, and high effective input impedance are provided by transistor pulse-duration-modulation keyer. Circuit includes bistable flip-flop, linear ramp generator, and voltage comparator. Output pulse widths vary with signal amplitude.—D. A. Williams Jr., Transistors Ruggedize Airborne Telemetry Keyer, *Electronics*, 31:37, p 81–83.



SATELLITE TRANSMITTER—Novel phase modulator, based on bridged-T network, gives simple design along with wide modulating capability. Transmitter has output of 300 mw at 108 Mc for telemetering data for up to 18 months from Van Allen radiation belt.—A. J. Fisher, W. R. Talbert, and W. R. Chittenden, Telemetry Transmitter for Radiation Satellite, *Electronics*, 33:19, p 68–69.

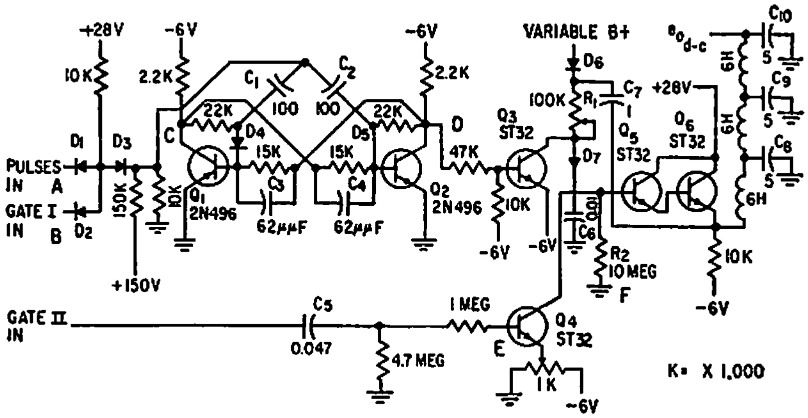
PCM TELEMETRY MULTIPLEXER—Permits gate-switching transistors Q1-Q2 to double in ring counter and control sequencing. Uses four-diode bridge for each gate, with single transformer-coupled floating voltage source switched to each gate in succession by two-transistor switching gate.—R. C. Onstad, Solid-State 30-Channel Multiplexer Designed for Minimum Components, *Electronics*, 34:40, p 77–79.



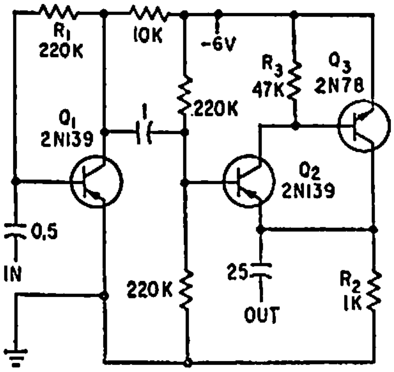


C1 1.5–5.0pf VARIABLE
C2 .047 TO 0.2μfd
L1 ≅ 0.2μh (6 TURNS #16, 3/8" I.D.)

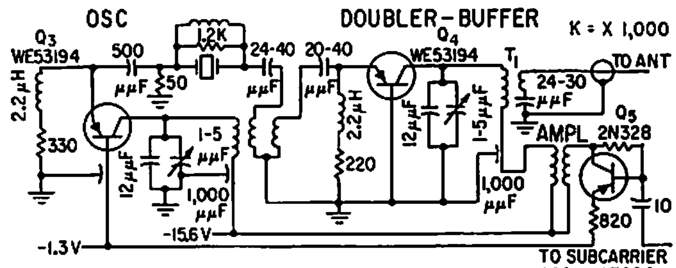
100-MC LINK TRANSMITTER—Signal picked up by microphone is amplified by first 2N2712, which turns off second 2N2712, allowing C1 to charge up and fire 2N2840 unijunction oscillator, producing pulse that modulates tunnel-diode transmitter.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 362.



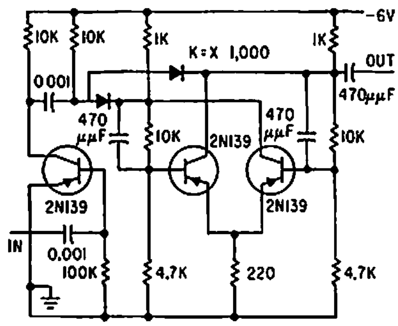
PPM DEMODULATOR—Input is modified two-input semiconductor diode *and* gate, driving bistable mvbr, modified bootstrap sweep, and filter to give d-c data voltage output.—L. Weisman, Telemetry Demodulator Using Modified *And* Gate, *Electronics*, 32:8, p 54–57.



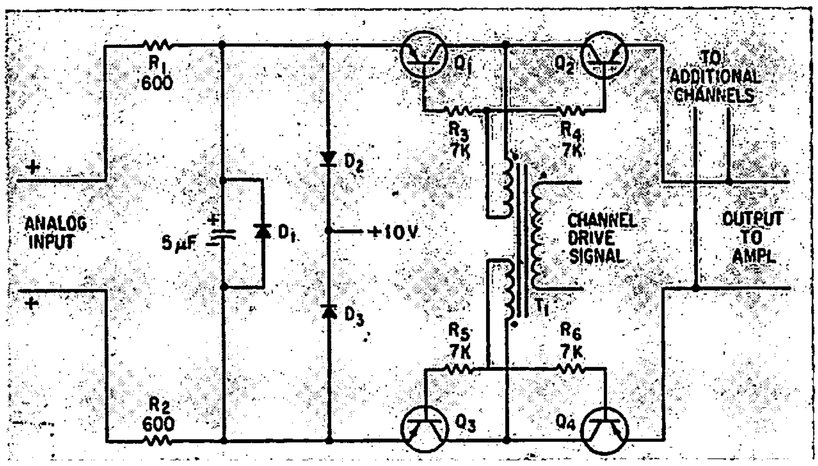
F-M MODULATOR—Provides at least 200 kc deviation when applied to base of oscillator transistor, before severe distortion sets in. Feedback keeps output impedance low.—D. Enemark, Transistors Improve Telemeter Transmitter, *Electronics*, 32:11, p 136–137.



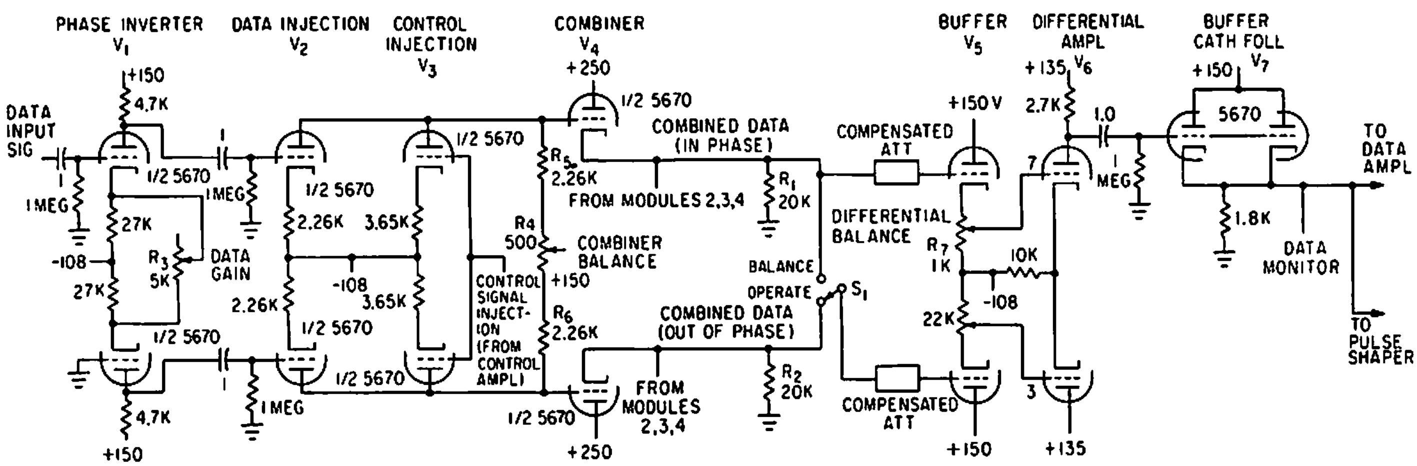
60-MW TRANSMITTER—Amplitude modulation is applied at collector of amplifier-doubler Q4.—H. L. Richter et al., Instrumenting the Explorer I Satellite, *Electronics*, 32:6, p 39–43.



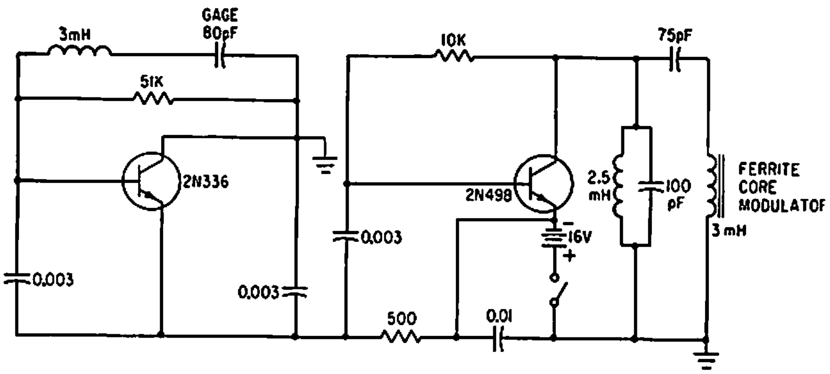
BASIC SCALER—Each scaler stage is bistable circuit with trigger amplifiers between each pair of stages. Used to make 512 counts from ion chamber give one output to telemetry system.—D. Enemark, Balloon-Borne Circuits Sort High-Altitude Cosmic Rays, *Electronics*, 32:35, p 52–55.



MICRO-MULTIPLEXER—Solid-state high speed time-division commutator connects several low-level inputs, one at a time, to common differential bus. Each multiplexer channel consists of two transistor switch pairs.—J. V. Dirocco and J. W. Peghiny, Low-Level Encoding Approach: Latest Details of Titan II Telemetry, *Electronics*, 35:47, p 36–39.

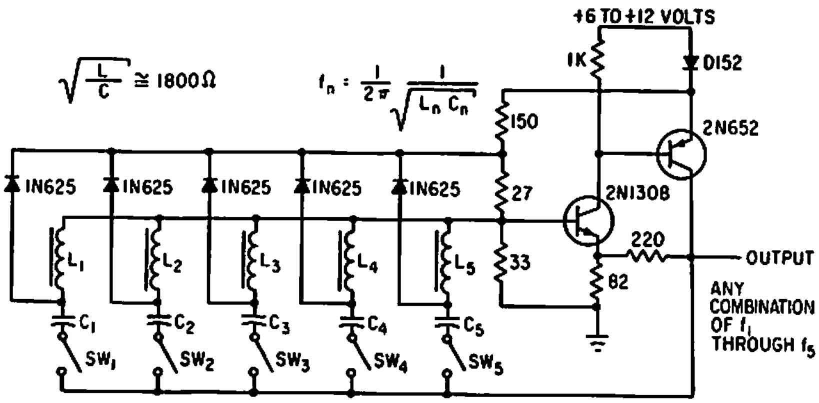


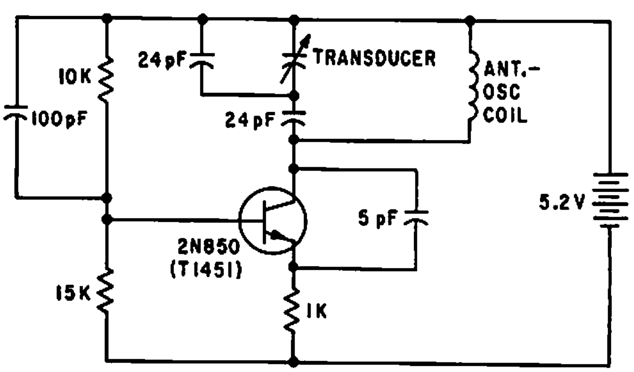
POST-DETECTION DIVERSITY COMBINER—Can handle any IRIG modulating signal and feed any telemetry receiver having external agc output. Will combine two, three, or four channels.—W. Casson and R. C. Robinson, Versatile Diversity Combiner Handles Most Missile-Range Signals, *Electronics*, 35:44, p 40–43.



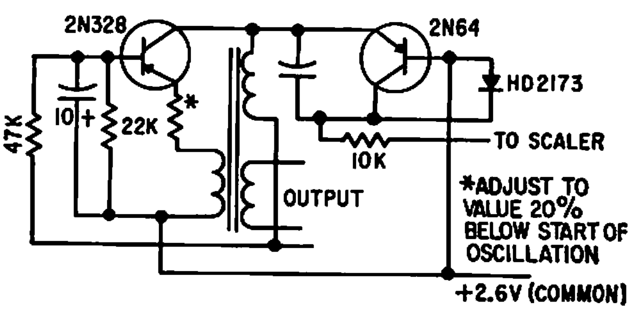
PROJECTILE ACCELERATION TELEMETER—Microwave signal at 24,000 Mc is aimed down barrel of howitzer by sheet aluminum reflector that is replaced after each firing. Variations in reflection coefficient of ferrite device on projectile nose modulate reflected microwave signal from moving projectile, at frequency dependent on acceleration. Circuit shows encapsulated transducer mounted on nose. Capacitance gage produces frequency shift of 70-kc subcarrier that is proportional to acceleration, for driving ferrite-core modulator through amplifier stage.—W. M. Kendrick and L. A. Peters, Projectile Telemetry with Microwaves, *Electronics*, 33:38, p 68–71.

FIVE-FREQUENCY OSCILLATOR—Two-transistor circuit generates up to five different tones simultaneously for five-bit parallel encoder for telemetry. Starting transients are built up in individual series-tank circuits. Amplitude of oscillation stabilizes at value where energy from negative-resistance source equals energy lost in tanks.—R. Stapelfeldt, Multitone Oscillators—New Source of Simultaneous Frequencies, *Electronics*, 36:1, p 86–87.

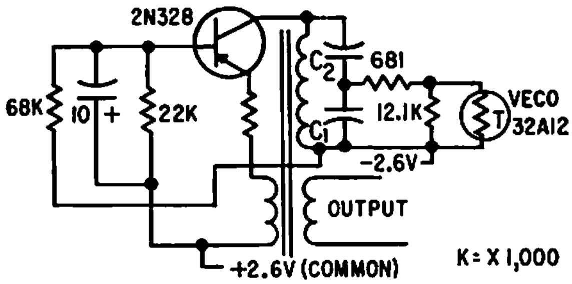




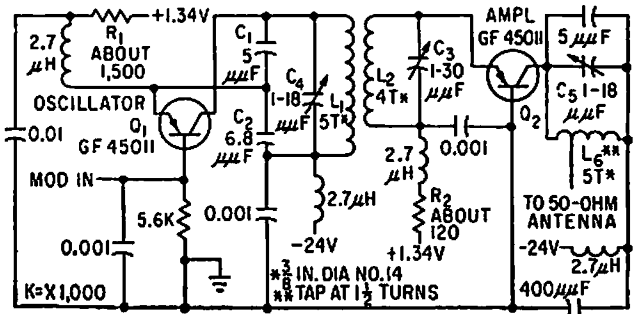
PROJECTILE NOSE PRESSURE TELEMETER—Variable-capacitance pressure transducer modulates 150-Mc carrier for telemetering stagnation pressure at nose of projectile during flight. Antenna-oscillator coil has four turns of No. 24 AWG wire, 0.16 inch inside diameter.—O. H. Bock and P. L. Clemens, Aerodynamic Measurements in a Hypervelocity Gun Range, *Electronics*, 34:44, p 33–37.



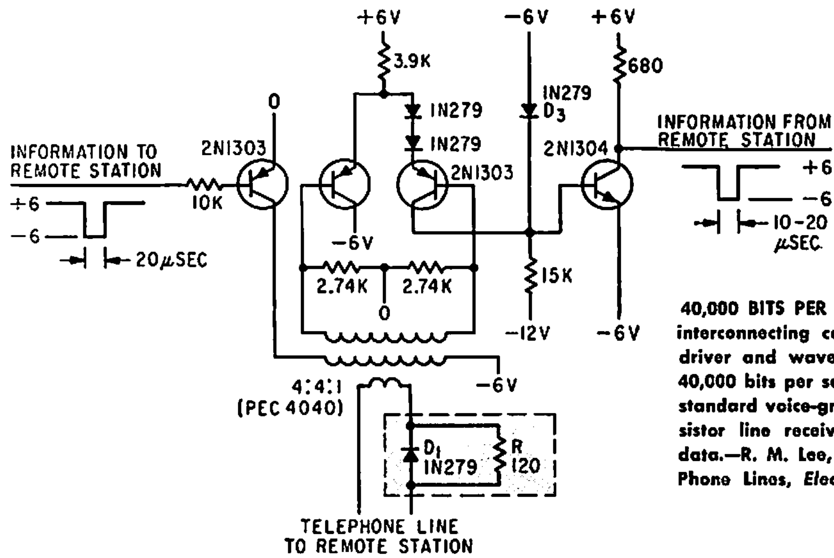
CURRENT-CONTROLLED SUBCARRIER OSCILLATOR—Uses time-controlled reactance modulation. Operating frequency is altered by introducing alternating current having same frequency but 90° out of phase with oscillator voltage. Frequency shift thus produced is proportional to amount of additional current fed into tuned circuit.—H. L. Richter et al., Instrumenting the Explorer I Satellite, *Electronics*, 32:6, p 39–43.



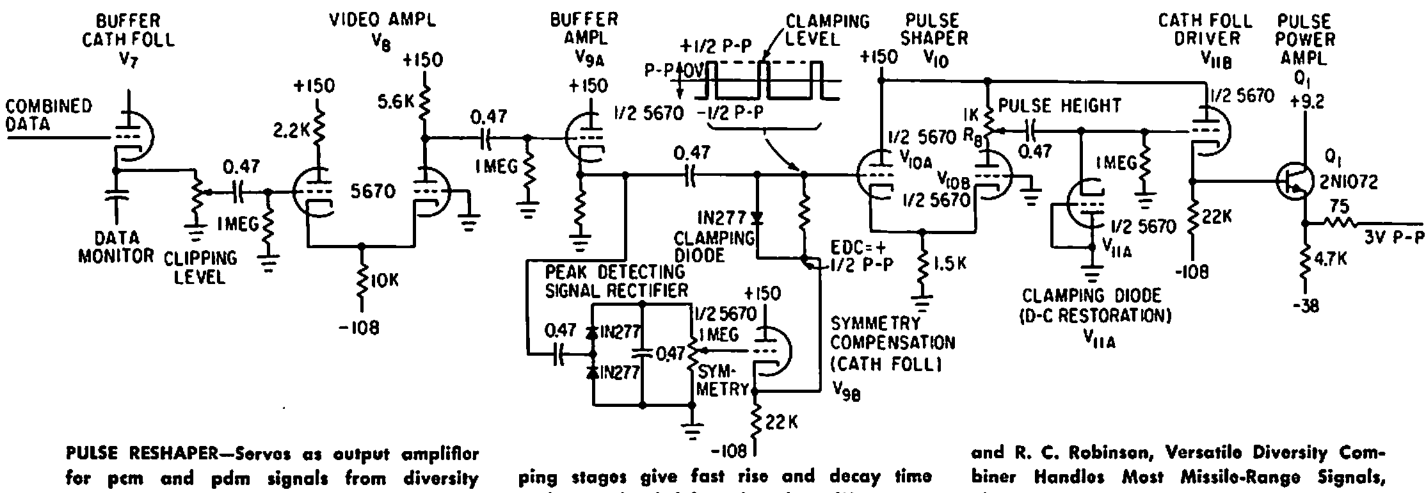
RESISTANCE-CONTROLLED SUBCARRIER OSCILLATOR—Required 7.5% frequency deviation is obtained with ratio of 1.5 for C1/C2.—H. L. Richter et al., Instrumenting the Explorer I Satellite, *Electronics*, 32:6, p 39–43.



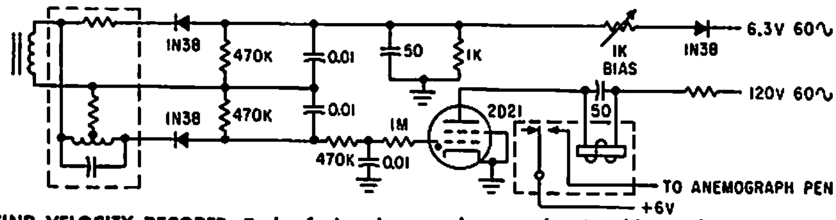
F-M TRANSMITTER—Provides 250 mw at 92 Mc, for use with balloon-borne ionizing radiation detectors. Variable-frequency oscillator can be used because only moderate stability is required.—D. Enemark, Transistors Improve Telemeter Transmitter, *Electronics*, 32:11, p 136–137.



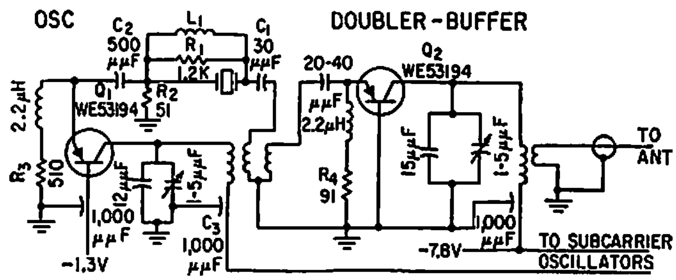
40,000 BITS PER SEC OVER PHONE LINE—For interconnecting computers, one-transistor line driver and wave shaper permit transmitting 40,000 bits per second up to half a mile over standard voice-grade phone lines. Three-transistor line receiver and pulse slicer receive data.—R. M. Lee, Speeding Digital Data Over Phone Lines, *Electronics*, 36:39, p 30–31.



PULSE RESHAPER—Serves as output amplifier for pcm and pdm signals from diversity combiner circuit. Over-amplification and clipping stages give fast rise and decay time without risk of false triggering.—W. Casson and R. C. Robinson, Versatile Diversity Combiner Handles Most Missile-Range Signals, *Electronics*, 35:44, p 40–43.

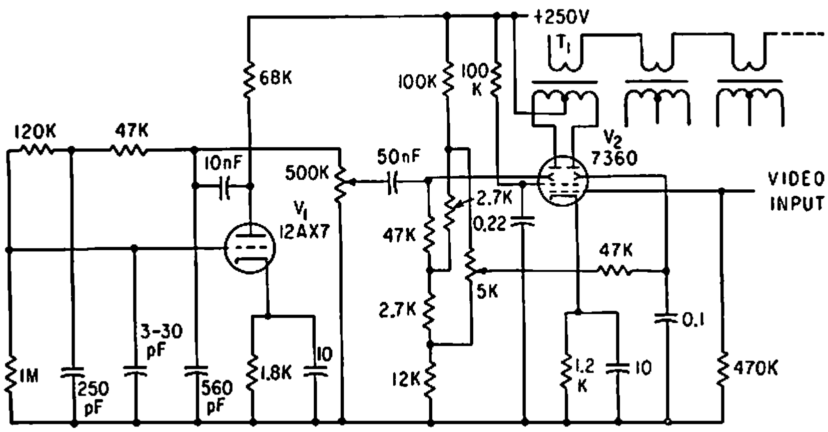


WIND VELOCITY DECODER—Each of nine decoders in receiver of wind direction and velocity telemetering system has notch filter of different frequency. At resonant frequency of filter, desired audio tone is blocked, causing thyratron to fire for part of every supply voltage cycle. Resulting pulsating d-c pulls in sensitive plate relay, operating pen of anemograph.—R. Beaulieu and G. Neal, Wind Velocity Telemetering System, *Electronics*, 33:29, p 68–70.

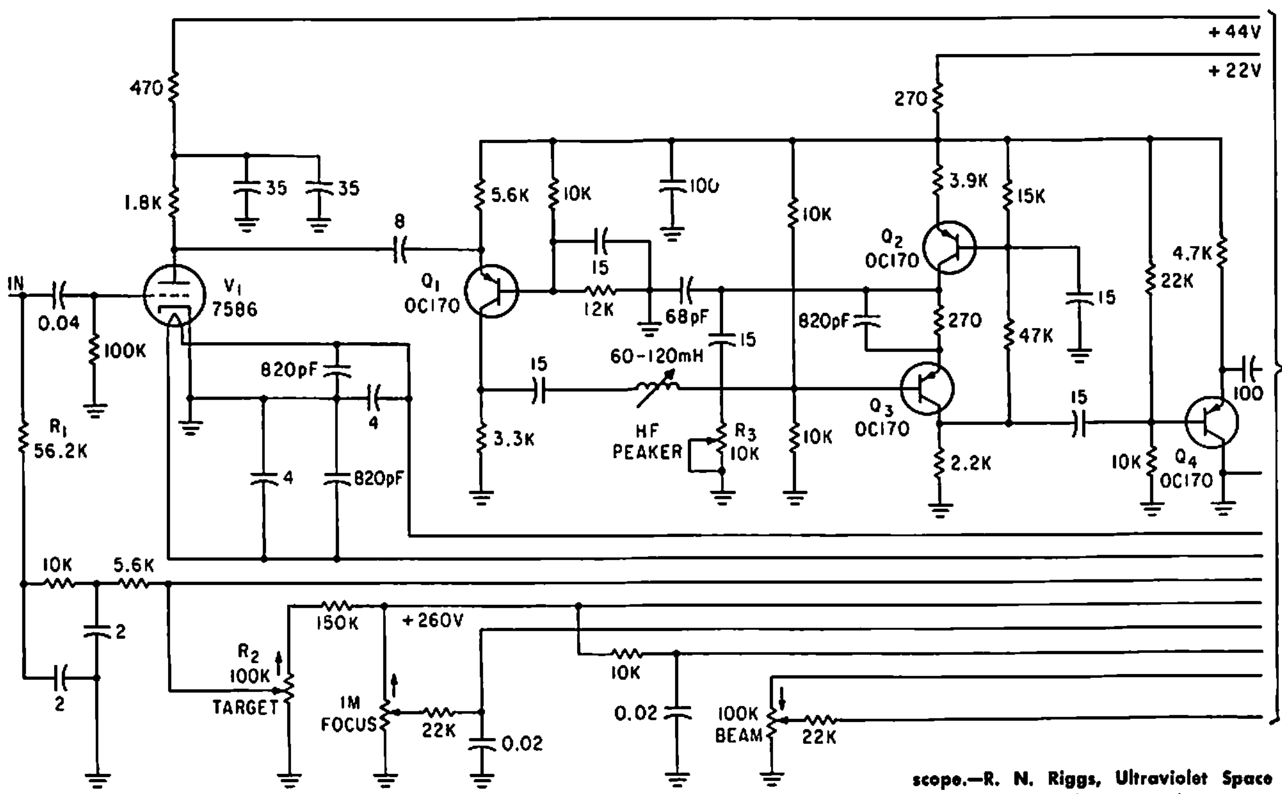


LOW-POWER 54-MC TRANSMITTER—Draws only 5 ma at 8 v d-c. Phase modulation is produced by varying voltage applied to collector of Q1.—H. L. Richter et al., Instrumenting the Explorer I Satellite, *Electronics*, 32:6, p 39–43.

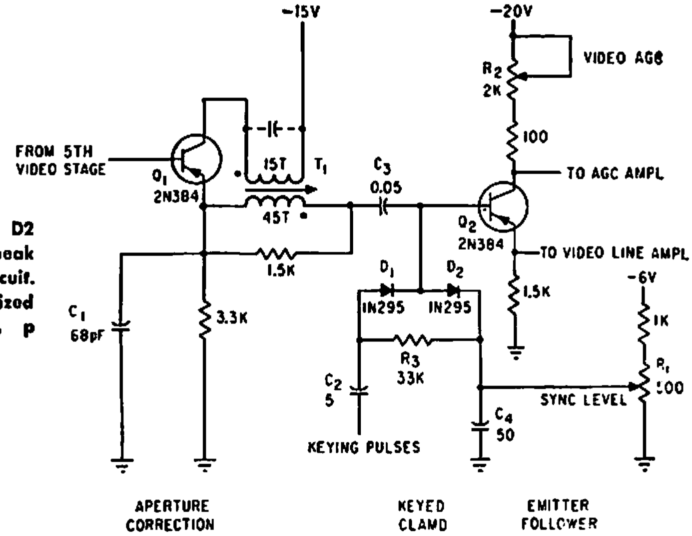
CHAPTER 87
Television Camera Circuits



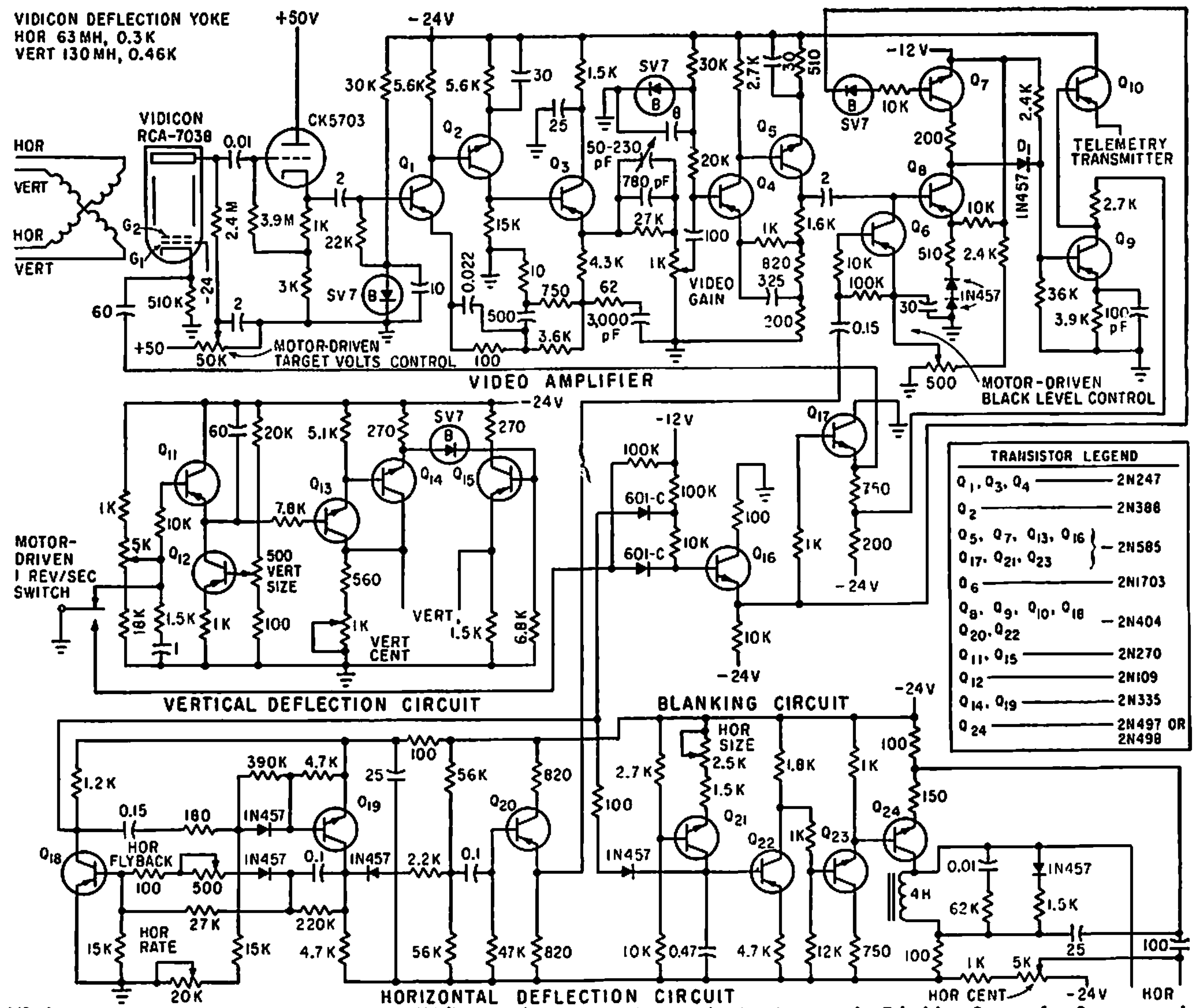
FLAT-TV GENERATOR-MODULATOR—R-C generator V1, generating one of nine different carrier frequencies, feeds deflection plate of beam deflection tube V2, while video modulation from camera is fed to grid 1 of V2 to modulate the carrier.—B. Binggeli and E. Fatuzzo, Solid-State Panels: Will They Bring Flat-Display TV?, *Electronics*, 35:26, p 67–70.



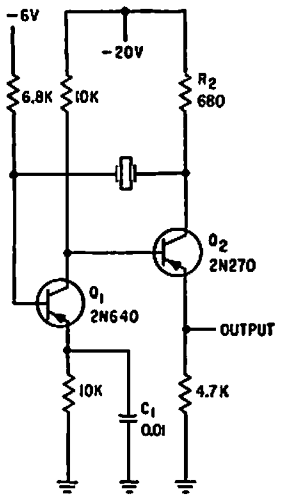
NUVISTOR-TRANSISTOR CASCODED TV CAMERA PREAMP—Noise figure is 3 db and video bandwidth about 6 Mc. Used with uvicon camera tube for ultraviolent telescope.—R. N. Riggs, Ultraviolet Space Telescope Will Scan the Stars, *Electronics*, 35:46, p 37–43.



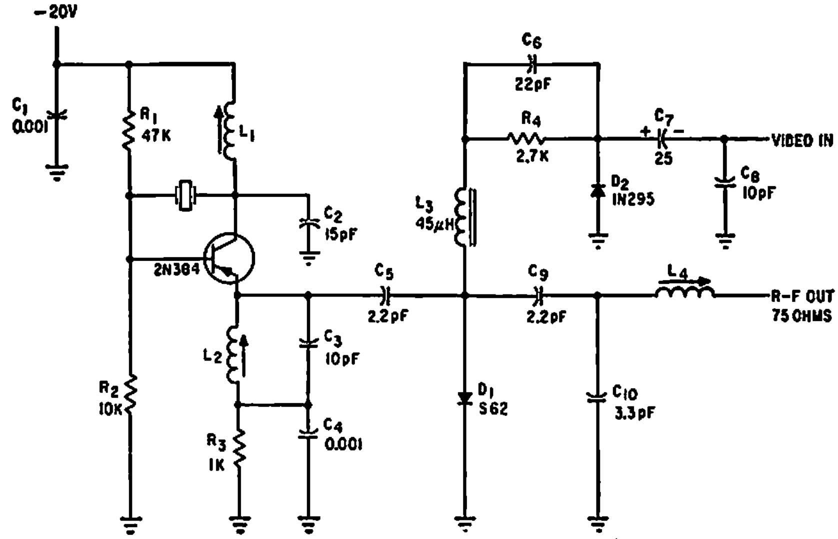
APERTURE-CORRECTING CIRCUIT—Diode D2 of keyed clamp acts as conventional peak rectifier d-c restorer for tv camera circuit. —D. G. Carraon, Designing Transistorized Television Cameras, *Electronics*, 33:37, p 72–75.



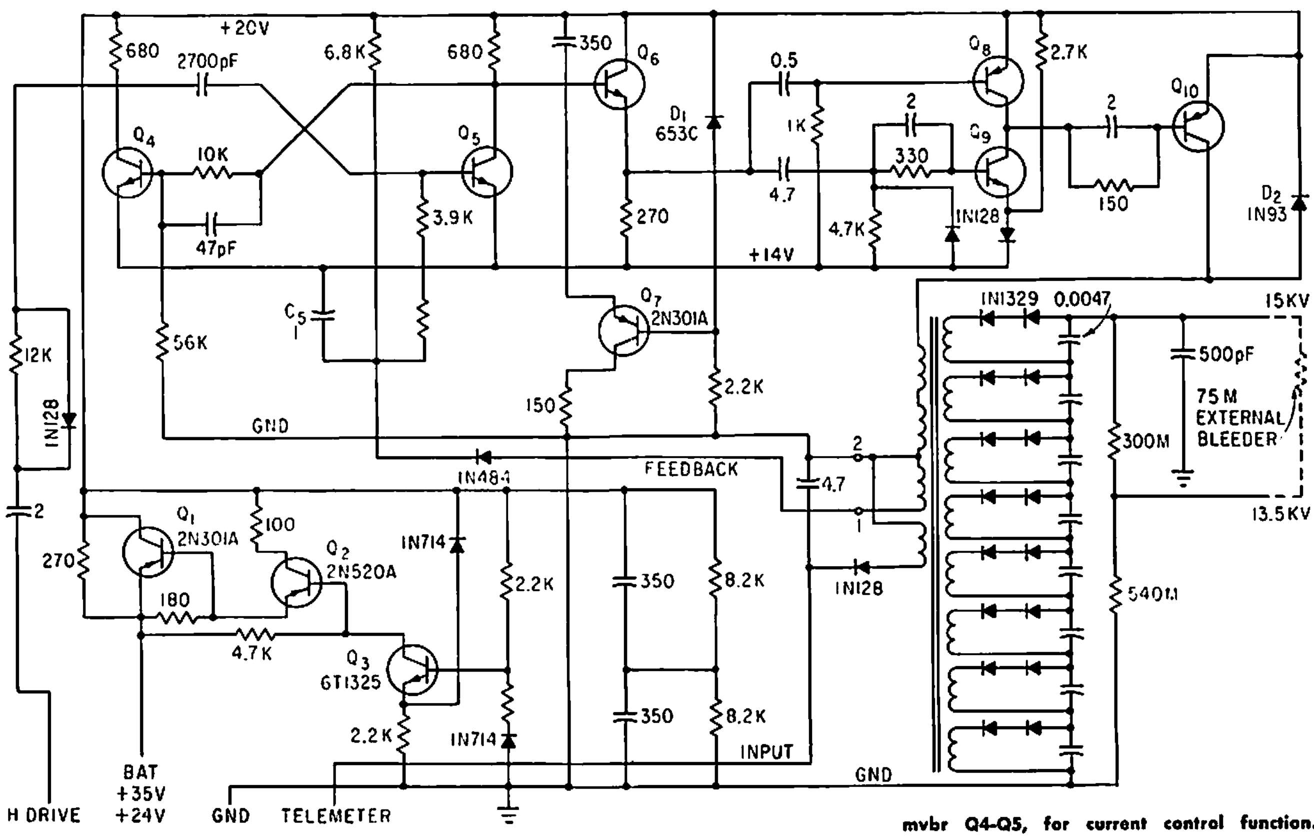
AIRBORNE TV SUNSPOT CAMERA—Used with slow-scan tv system for high-altitude solar photography from balloon. Uses 500-cps horizontal scan without interlace for 500-line resolution, requiring 200-kc bandwidth. Video output of camera goes to 2-w commercial 225.7-Mc f-m telemetry transmitter exciting 10-w power stage.—L. E. Flory et al., Television System for Stratoscope I, *Electronics*, 33:25, p 49–53.



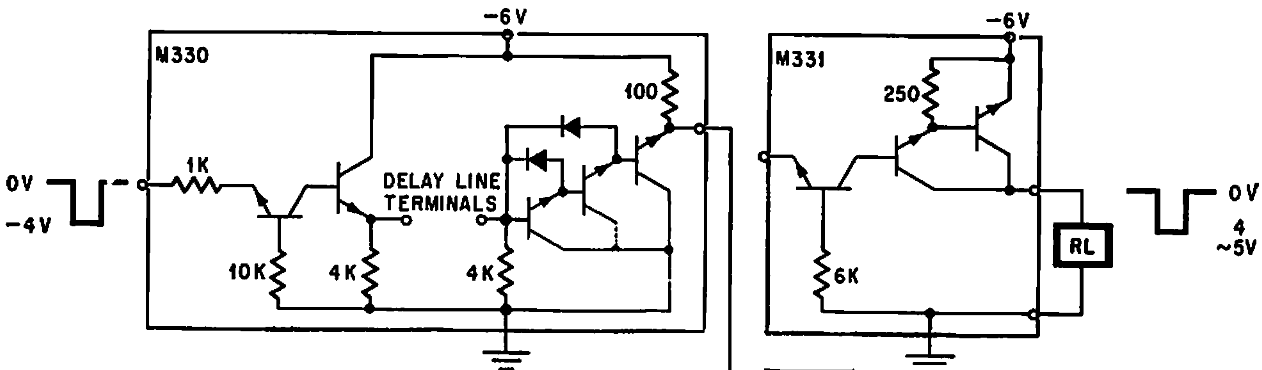
31.5-KC CRYSTAL OSCILLATOR—Provides sync signals for tv camera sweeps. Crystal vibrates in lowest-frequency natural mode of long thin bars, resulting in high impedance and difficulty in exciting crystal, and making it necessary to use two transistors in symmetrical collector-coupled mvbr oscillator.—D. G. Carroon, Designing Transistorized Television Cameras, *Electronics*, 33:37, p 72–75.



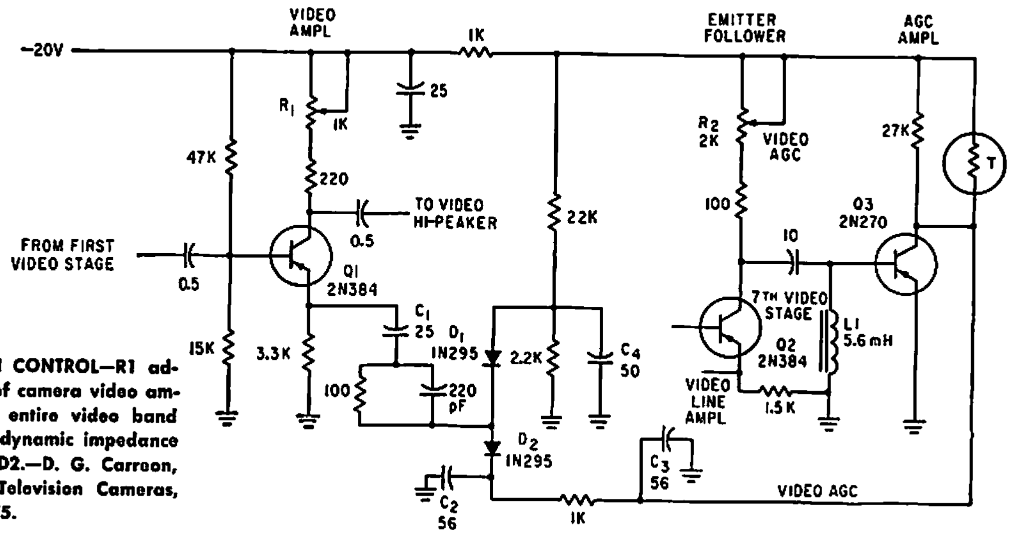
R-F MODULATOR—Crystal frequency is half the desired r-f value. L2 and C3 are tuned to second harmonic to give desired r-f channel for tv camera. R-f output is 50 mv into 75-ohm load.—D. G. Carroon, Designing Transistorized Television Cameras, *Electronics*, 33:37, p 72–75.



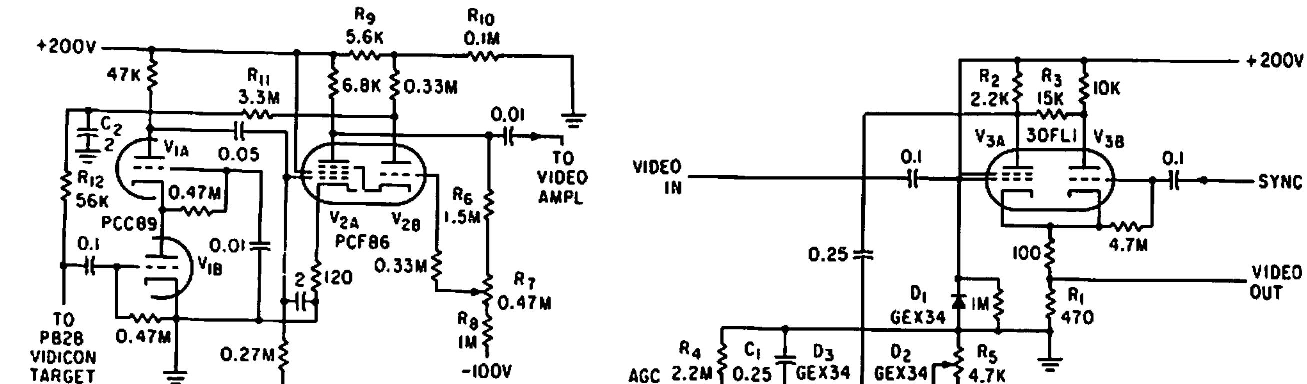
15,000 V FOR UVICON—Holds voltage and current output within 1% for 10% increase or decrease in input. Saturation, related to load current, is sampled at terminals 1 and 2 of output transformer and applied as feedback to control asymmetry of mvbr Q4-Q5, for current control function. Output current is about 15 microamp.—R. N. Riggs, Ultraviolet Space Telescope Will Scan the Stars, *Electronics*, 35:46, p 37:43.



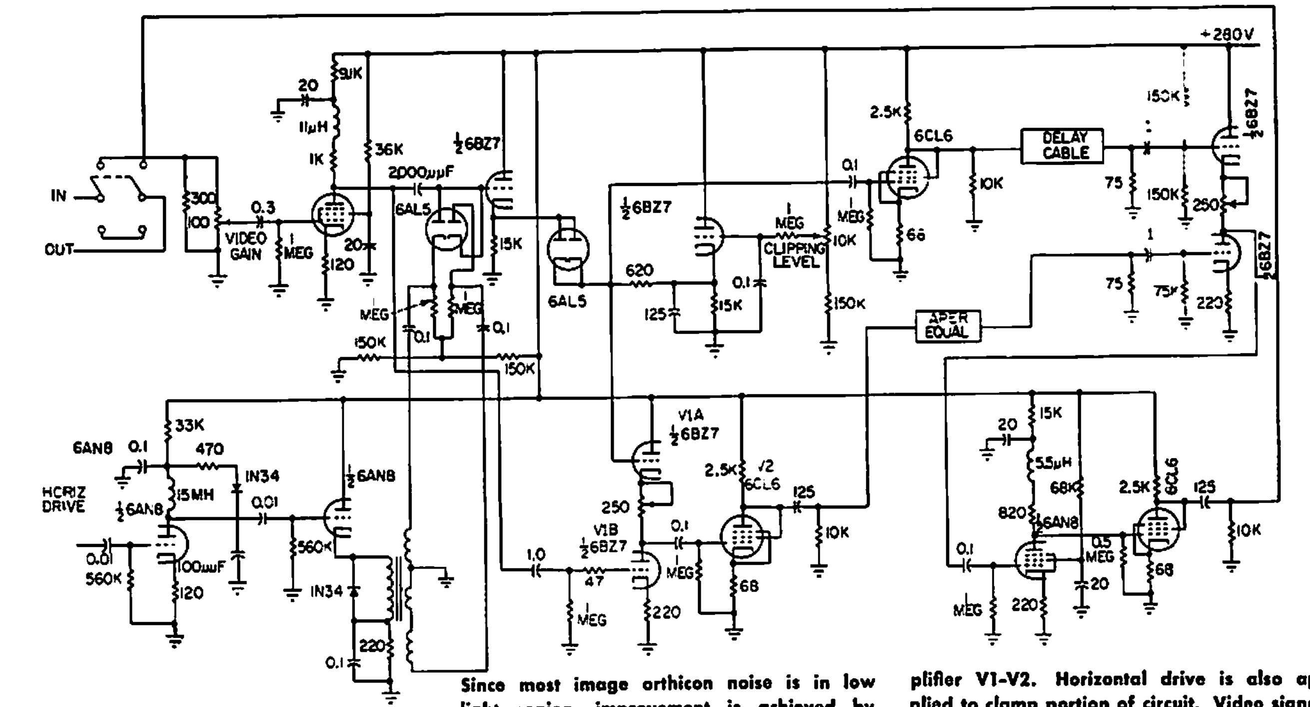
SYNC SIGNAL DISTRIBUTOR—Integrated circuit on two chips distributes synchronizing signal to many television cameras in studio. Delay circuit may be added if needed. Emitter-follower output stage uses Darlington connection for maximum input impedance, while chip for output section (right) uses Darlington to obtain high d-c current gain.—Y. Tarui, Japan Seeks Its Own Route to Improved IC Techniques, *Electronics*, 38:25, p 90–98.



AUTOMATIC VIDEO GAIN CONTROL—R1 adjusts low-frequency gain of camera video amplifier. Gain control over entire video band is achieved by nonlinear dynamic impedance characteristic of D1 and D2.—D. G. Carroon, Designing Transistorized Television Cameras, *Electronics*, 33:37, p 72–75.



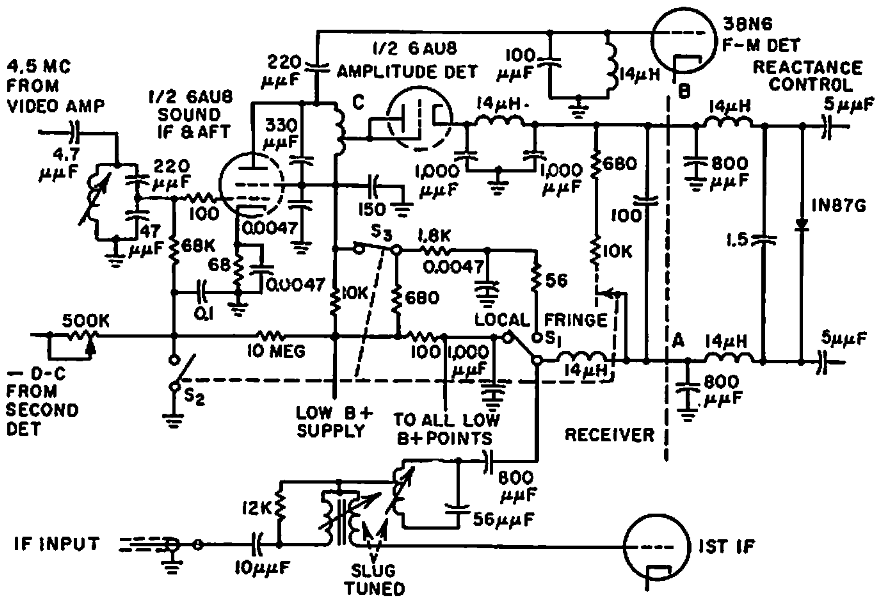
AUTOMATIC SENSITIVITY CONTROL FOR VIDICON—Positive-going blanked video on grid of video amplifier output stage V3A serves to produce negative agc voltage that increases with camera signal, to reduce gain of first video amplifier stage V2A when light input to vidicon camera increases.—P. C. Kidd, Automatic Sensitivity Control for Vidicon TV Camera, *Electronics*, 35:6, p 52.

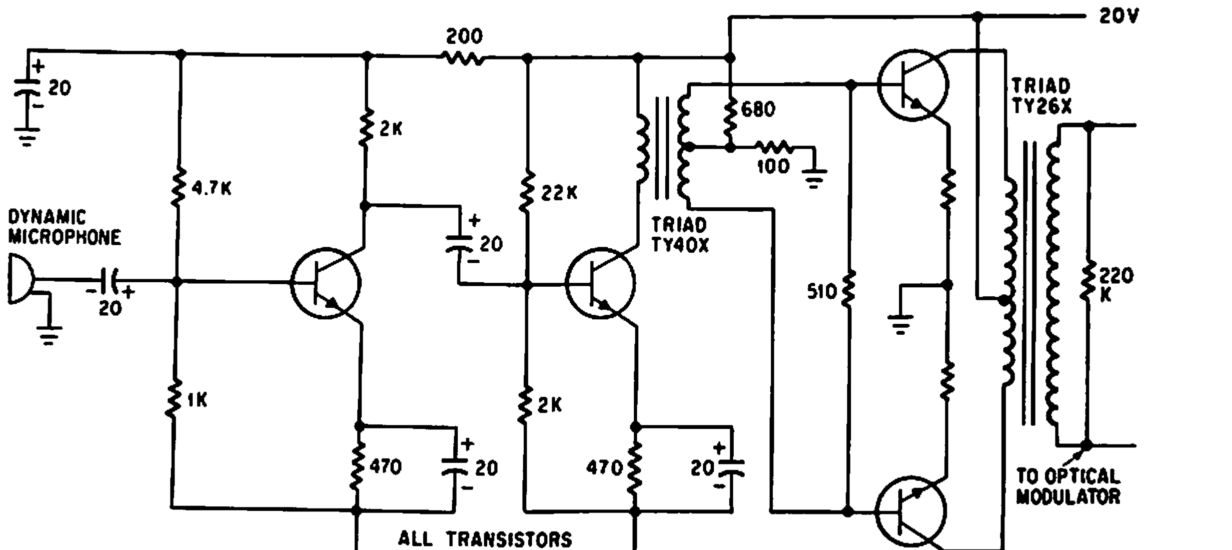


CAMERA HIGHLIGHT EQUALIZER—Provides better signal-to-signal noise ratio and improved definition over conventional aperture equalizers covering full brightness range. Since most image orthicon noise is in low light region, improvement is achieved by dividing signal into two parts and equalizing only relatively quiet highlight portion. Complete video signal is amplified and applied to white clipper and to difference amplifier V1-V2. Horizontal drive is also applied to clamp portion of circuit. Video signal is clamped at white clipper, where highlights are clipped from signal.—M. V. Sullivan, Highlight Equalizer Sharpens Tv Pictures, *Electronics*, 31:3, p 72–74.

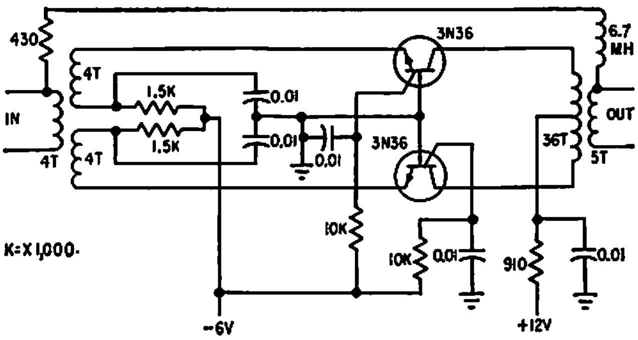
CHAPTER 88
Television Circuits—Black-and-White

AUTOMATIC LOCAL-FRINGE TUNING—Complete automatic fine tuning system combines features of fringe switching and automatic-manual operation. Switching transients are reduced by 180-mmfd capacitor.—C. W. Baugh, Jr., and L. J. Sienkiewicz, Sound Signal Tunes Tv Automatically, *Electronics*, 31:17, p 54–58.

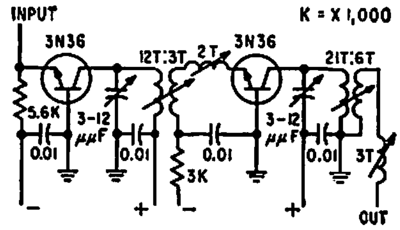




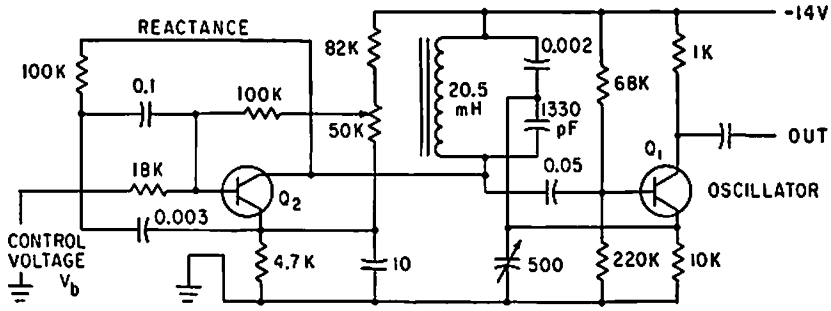
LASER TV—Audio driver delivers 300 v peak to peak to KDP optical modulator controlling gas laser.—C. J. Peters et al., Laser-Television System Developed With Off-The-Shelf Equipment, *Electronics*, 38:3, p 75–78.



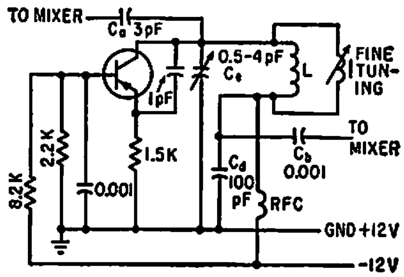
CCTV RECEIVING TERMINAL—Used with repeater (not shown) that makes up for loss in last section of cable. Amplifier then raises level about 10 db. Selective negative feedback improves transmission characteristic over bandwidth of 3 to 17 Mc.—L. G. Schimpf, Carrier Transmission for Closed-Circuit Television, *Electronics*, 32:24, p 66–68.



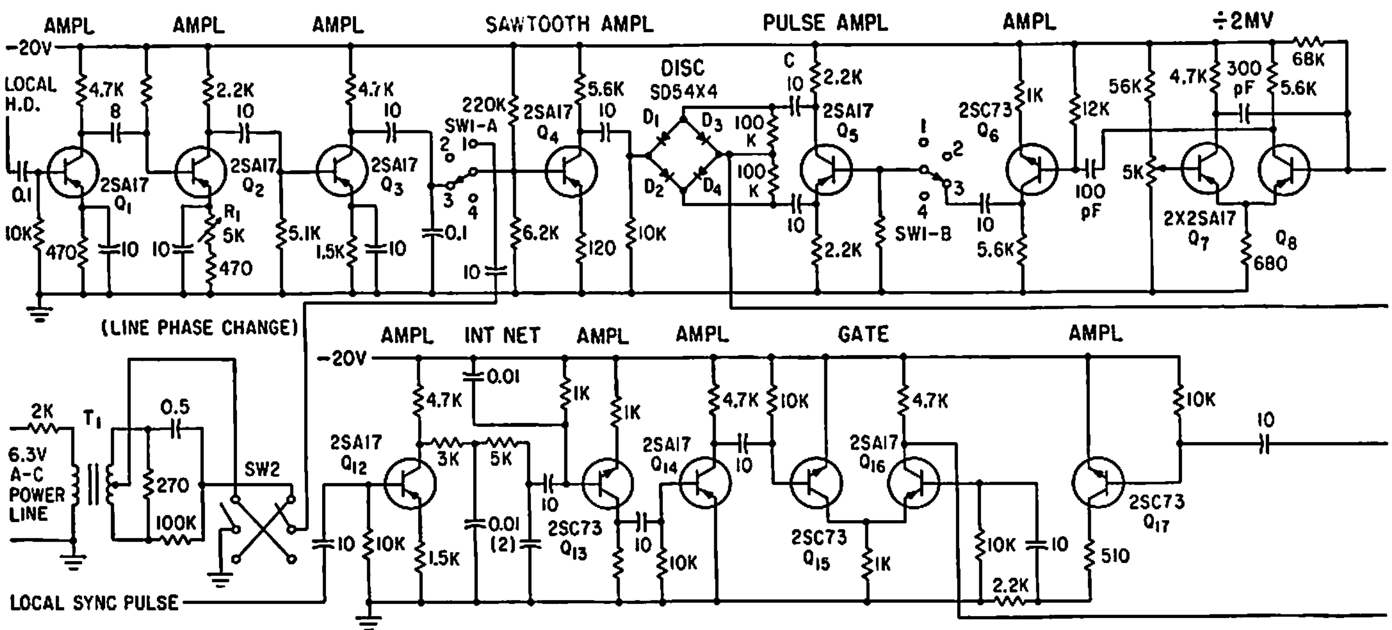
CCTV 10-MC REPEATER—Has gain characteristics to match losses in 0.5 mile of coaxial cable. Mismatching is used at input and between stages to stabilize gain and cut it down to required 18 db at 15 Mc.—L. G. Schimpf, Carrier Transmission for Closed-Circuit Television, *Electronics*, 32:24, p 66–68.



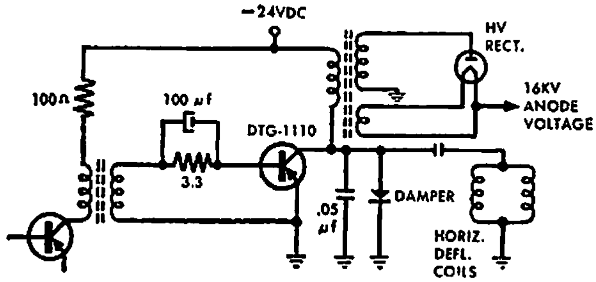
INDUCTIVE-TRANSISTOR SYNC LOCK—D-c bias of inductive-reactance transistor Q2 is controlled by modulating voltage from oscillator Q1.—Y. Fujimura and N. Mii, Automatic Frequency Control with Reactance Transistors, *Electronics*, 33:40, p 97–99.



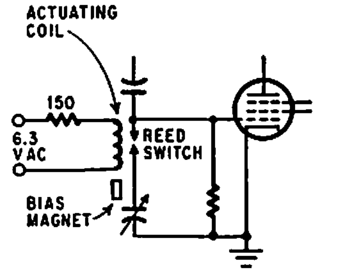
MESA-TRANSISTOR TUNER OSCILLATOR—Uses common-base transistor connection, which is regenerative at high frequencies. Additional feedback capacitance between emitter and collector assures dependable oscillation. With emitter current of 2 ma, circuit can supply about 20 times the 300 microwatts required by mixer. Sliding-core coil gives 2:1 change in inductance for fine tuning.—H. F. Cooke, Designing Tv Tuners with Mesa Transistors, *Electronics*, 33:15, p 64–69.



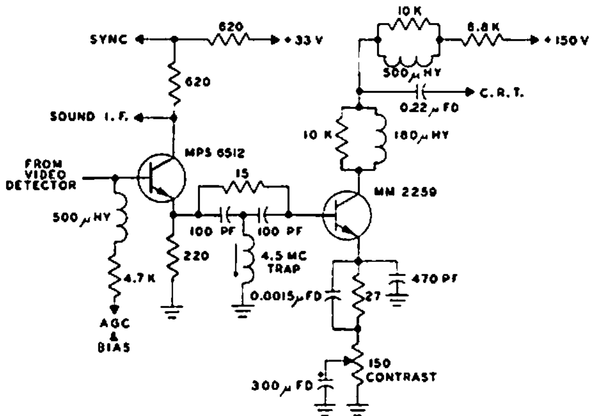
CAPACITIVE-TRANSISTOR SYNC LOCK—Provides stable sync lock of signal generator against noise interference on tv station relay



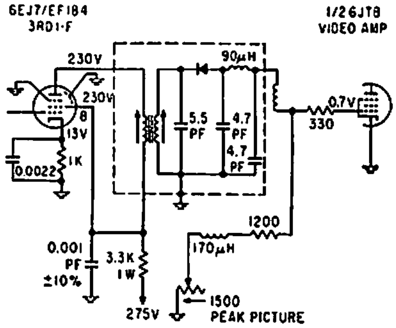
HORIZONTAL DEFLECTION—Uses 200-v 15-amp transistor with high power dissipation characteristics and low thermal resistance. Drive requirements are substantially reduced because transistor has high saturated current gain.—High-Power Nu-Base Germanium Transistors (Delco Radio ad), *Electronics*, 39:7, p 20–21.



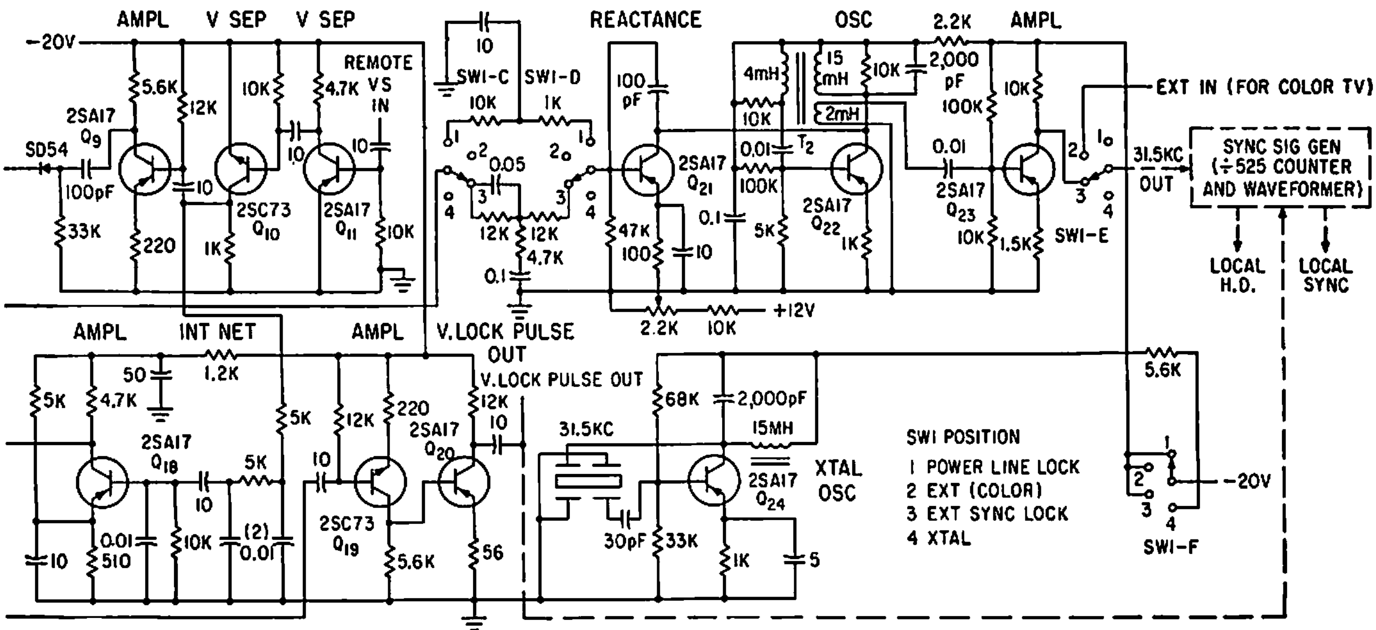
HORIZONTAL SYNC TRANSIENT DISPLAY—Reed switch operated at field frequency from a-c heater voltage, with permanent magnet providing magnetic bias to get 60 cps, permits observing single transient continuously while making tv receiver circuit adjustment.—M. B. Knight, Reed Switches for Breadboarding, *Electronics*, 37:16, p 93.



TWO-STAGE SOLID-STATE VIDEO AMPLIFIER—Provides cathode drive for crt of tv receiver, along with sync takeoff from driver. Driver also serves as sync amplifier, first sound amplifier, and keyer for agc stage.—D. L. Wollensen, "Solid-State Television Video Amplifiers," Motorola Application Note AN-165, Dec. 1965.

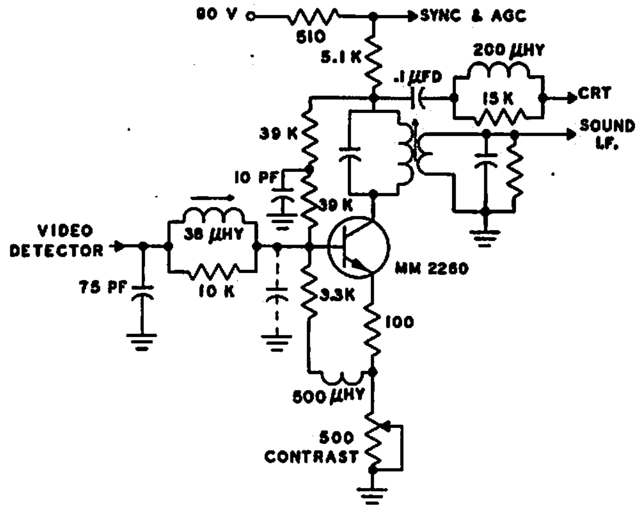


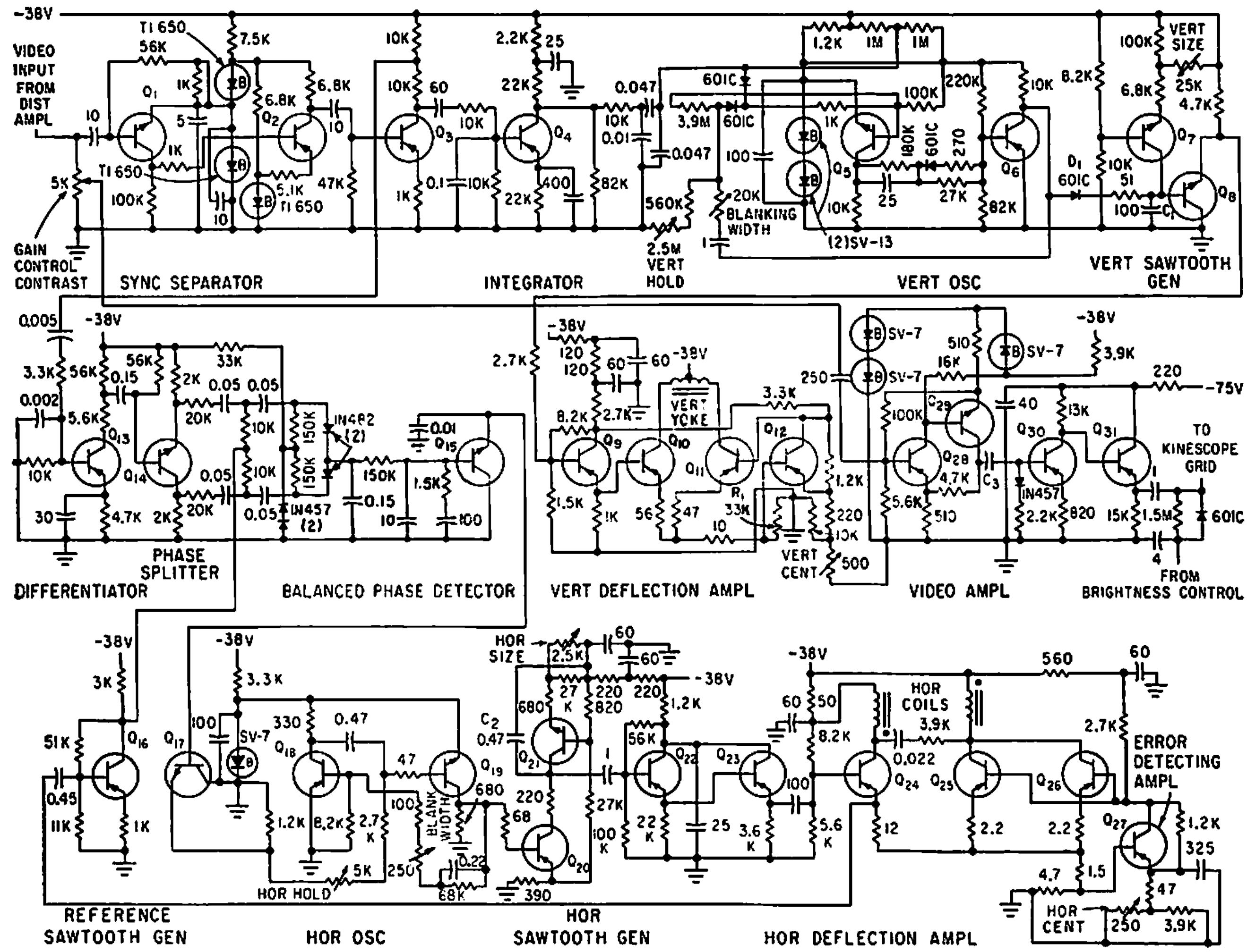
PEAK PICTURE CONTROL—Variable resistor in video detector load circuit can be adjusted to improve snowy pictures in fringe areas.—Tv Set Size Shrinks, *Electronics*, 36:23, p 22.



lines.—Y. Fujimura and N. Mii, Automatic Frequency Control with Reactance Transistors, *Electronics*, 33:40, p 97–99.

ONE-STAGE TRANSISTOR VIDEO AMPLIFIER— Overcomes Miller capacitance effect that normally causes excessive high-frequency rolloff. Intended for 12-inch and smaller b-w receivers, and provides direct cathode-ray drive. Bandwidth is 2 Mc. Uses MM2260 npn high-voltage silicon epitaxial transistor.—D. L. Wollesen, "A Single Stage Video Amplifier," Motorola Application Note AN-186, Feb. 1966.

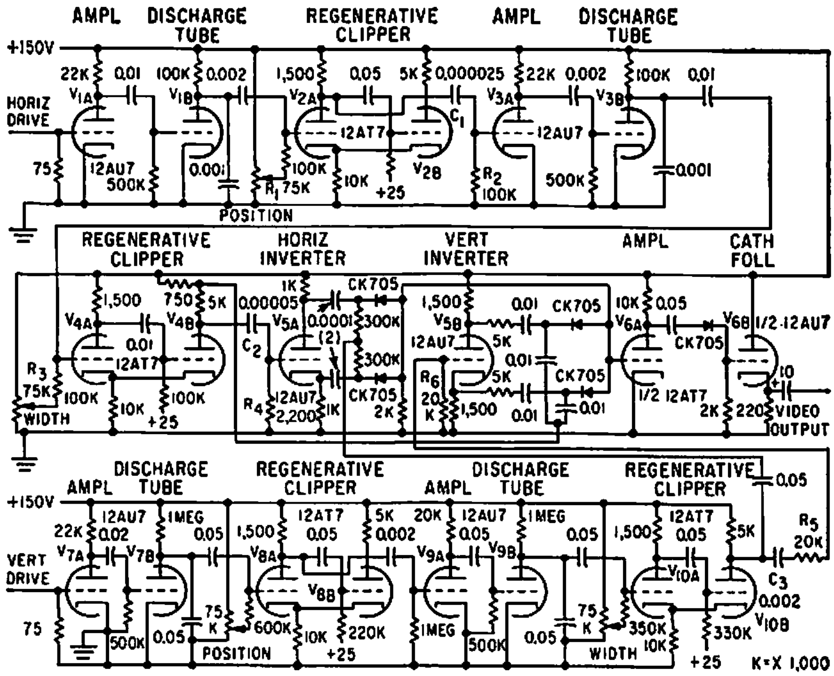




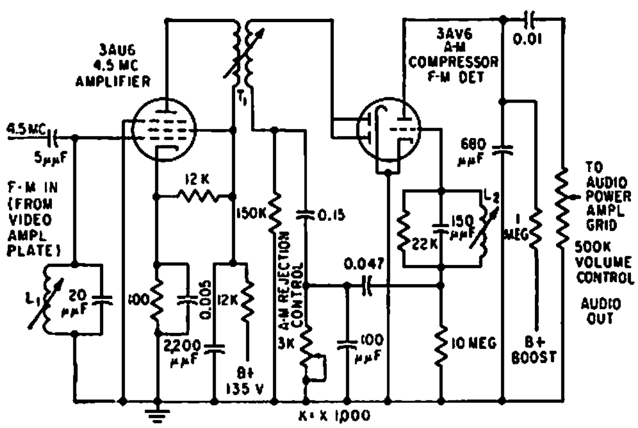
TRANSISTOR LEGEND

$Q_1, Q_7, Q_8, Q_{17}, Q_{19}, Q_{21}, Q_{29}$	2N585
Q_5, Q_{15}	2N335
$Q_2, Q_3, Q_4, Q_6, Q_9, Q_{12}, Q_{13}, Q_{18}, Q_{20}, Q_{22}, Q_{23}, Q_{27}, Q_{28}$	2N404
Q_{14}	2N388
Q_{16}	2N586
$Q_{10}, Q_{11}, Q_{24}, Q_{25}, Q_{26}$	2N158
Q_{30}, Q_{31}	2N247 (SELECTED FOR E_C: 75V)

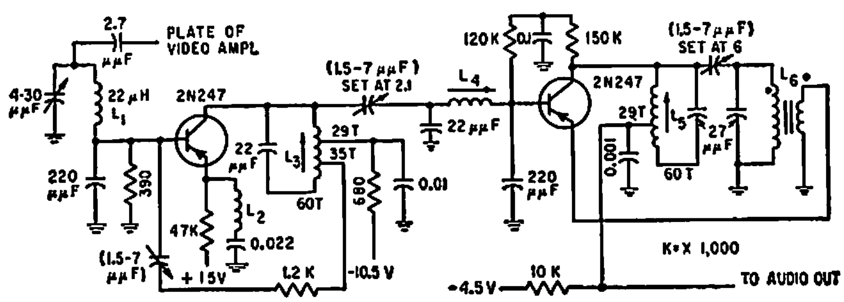
SLOW-SCAN TV RECEIVER— Signals from f-m telemetry system in balloon are picked up by commercial receiver and fed to distribution amplifier serving three monitors, having identical circuits as shown. Video bandwidth is 200 kc.—L. E. Flory et al., Television System for Stratoscope I, *Electronics*, 33:25, p 49–53.



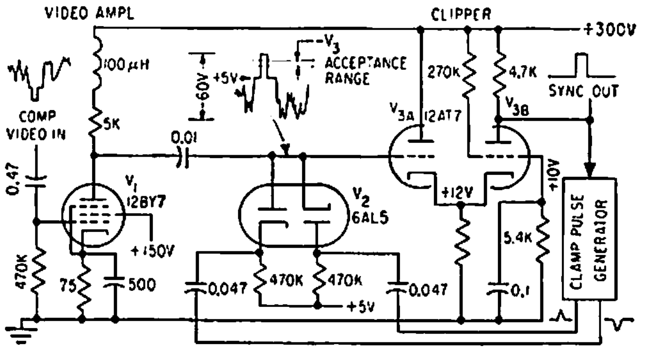
OUTLINE GENERATOR FOR TV STUDIO—Produces variable-size rectangles in any desired position on tv screen, including horizontal or vertical white lines, for emphasizing particular part of picture during educational tv broadcast.—G. Southworth, Outline Generator for Educational Television, *Electronics*, 32:14, p 52–53.



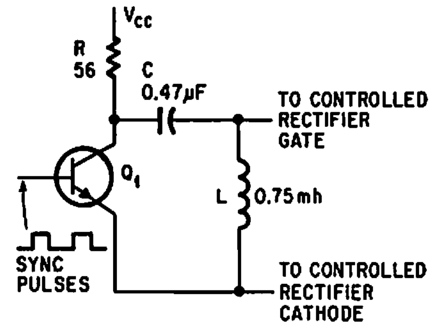
DELTA TV SOUND—Costs less than ratio detector sound system. Uses discriminator circuit with triode operating as power detector, with cancellation of undesired a-m fundamental.—R. B. Dome, Inexpensive Sound for Television Receivers, *Electronics*, 32:9, p 66–68.



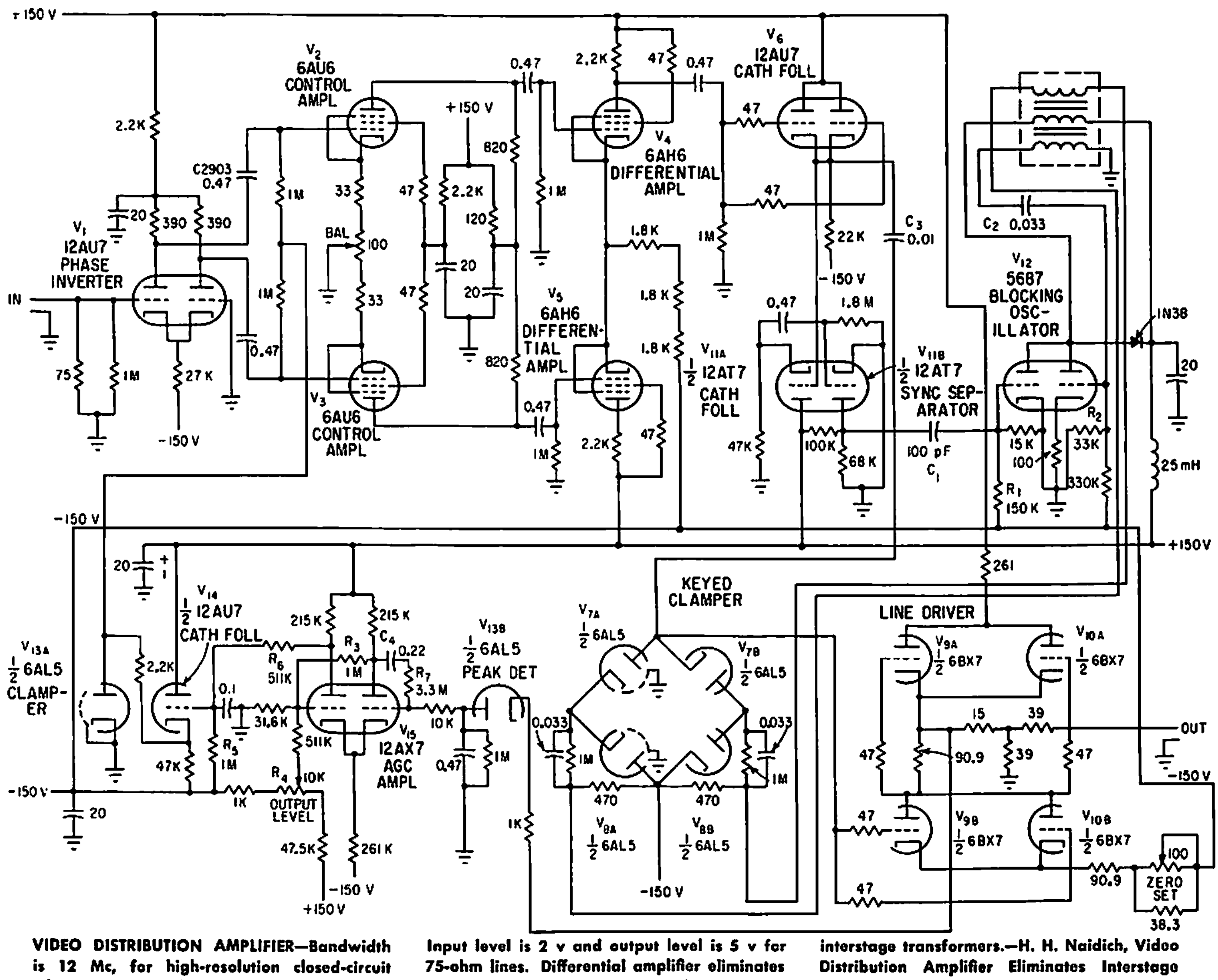
TV SOUND SLOPE DETECTOR—Uses drift transistor as efficient, highly sensitive oscillating linear-slope detector, injection-locked by one-stage sound driver. A-m rejection is uniformly high over full detector bandwidth. Audio output is constant, independent of carrier strength.—M. Meth, Tv Sound Detector Uses Drift Transistor, *Electronics*, 32:8, p 62–64.



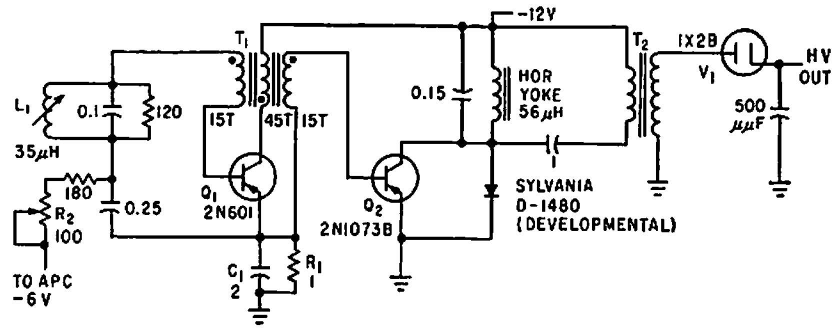
CLAMPED SYNC SEPARATOR—Separates sync from composite input signal at studio, for automatic video level control.—J. O. Schroeder, Holding Video Levels While Switching Studios, *Electronics*, 32:22, p 96–98.



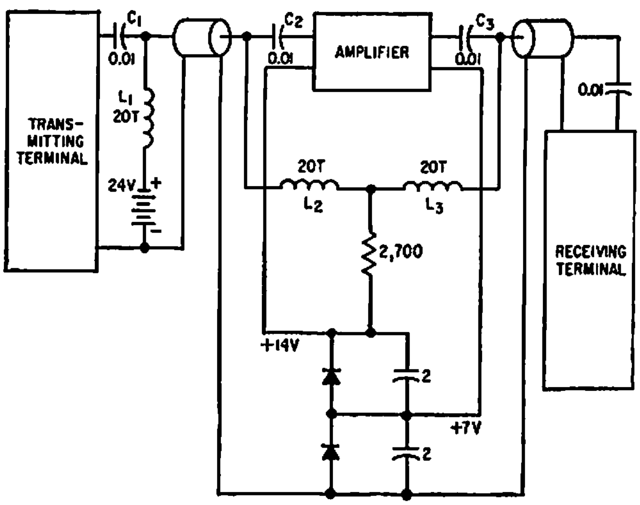
SCR FOR HORIZONTAL OUTPUT—Sync pulses saturate driver Q1, permitting C to charge, for achieving fast turnoff after gate-turnoff scr conducts yoke current for 27 microsec to deflect electron beams.—L. D. Shergalis, Scr's for 19-Inch Tv, *Electronics*, 37:23, p 97–98.



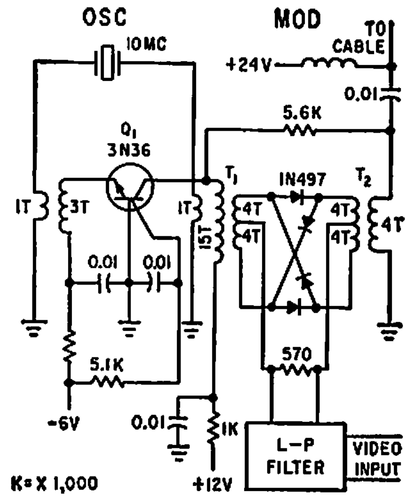
VIDEO DISTRIBUTION AMPLIFIER—Bandwidth is 12 Mc, for high-resolution closed-circuit television and high-speed facsimile systems. Input level is 2 v and output level is 5 v for 75-ohm lines. Differential amplifier eliminates second harmonic distortion without use of interstage transformers.—H. H. Naidich, Video Distribution Amplifier Eliminates Interstage Transformers, *Eectronics*, 34:24, p 58–61.



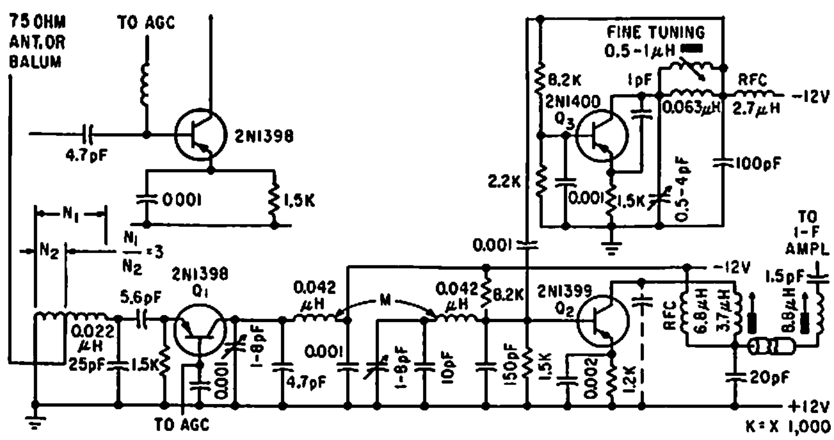
HORIZONTAL DEFLECTION—Two-transistor circuit provides high ratio of reverse to forward base drive. Oscillator current is 0.12 amp, output-stage current 0.72 amp, and push-pull yoke current is 11 amp.—M. Fischman, Transistorized Horizontal Deflection for Television, *Electronics*, 32:33, p 60–63.



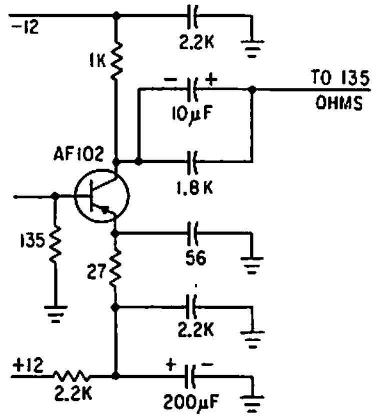
CCTV REPEATER POWER SUPPLY—Operates from 24-v battery at transmitting terminal. C1 isolates battery voltage from terminal equipment, and L1 prevents shorting of signal. Two 7-v zener diodes in series serve as voltage regulators.—L. G. Schimpf, Carrier Transmission for Closed-Circuit Television, *Electronics*, 32:24, p 66–68.



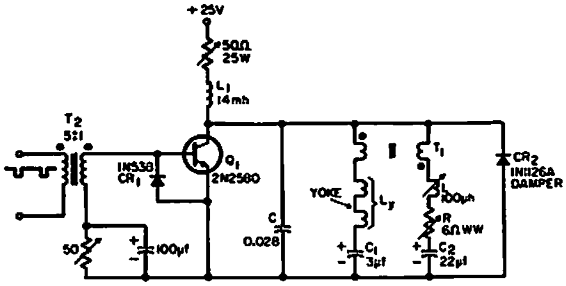
CCTV 10-MC CARRIER TRANSMITTER TERMINAL—Uses single tetrode transistor in oscillator to feed four-diode balanced modulator. Peak level of modulator output is 4 db below 1 mw.—L. G. Schimpf, Carrier Transmission for Closed-Circuit Television, *Electronics*, 32:24, p 66–68.



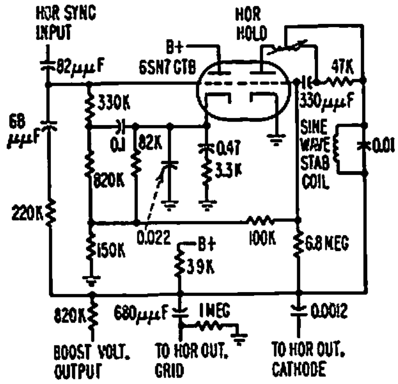
FOUR-TRANSISTOR TUNER—Diffused-base mesa transistors permit design of tv tuners with noise performance equal to that of tube tuners. Article gives complete design procedure for r-f amplifier, mixer, and oscillator stages.—H. F. Cooke, Designing Tv Tuners with Mesa Transistors, *Electronics*, 33:15, p 64–69.



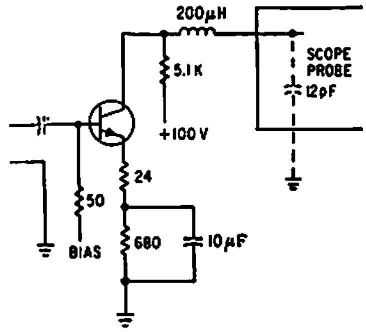
EMITTER FEEDBACK PEAKING GIVES 100-MC BANDWIDTH—Four identical AF102 stages amplify pulse output of delta modulator in tv waveguide link.—C. Kramer and J. C. Balder, Delta-Modulated Television Waveguide Link, *Electronics*, 36:31, p 50–52.



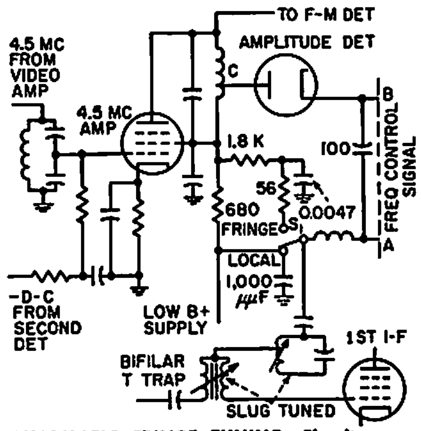
LINEAR TRANSISTORIZED HORIZONTAL SWEEP—Placing transformer in yoke circuit provides better than 0.5% linearity for deflecting 16-inch crt having 52° deflection angle and 15-kv acceleration voltage. Line rate is 28.35 kc with 945 lines. Supply voltage determines width or amplitude of sweep. C can be increased to get 525-line rate.—J. W. Greininger, Improving Linearity in Transistorized Horizontal Sweeps, *EEE*, 12:9, p 61–62.



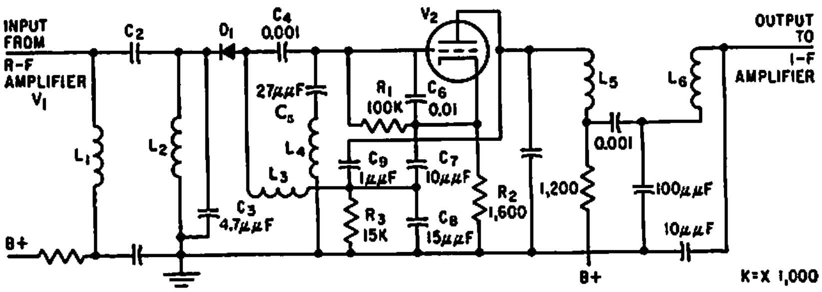
STABILIZED HORIZONTAL OSCILLATOR—Sine-wave stabilization or ringing coil pulls Synchroguide horizontal oscillator frequency back to correct value when tube or other components drift in value.—W. E. Babcock, Unusual Tube Effects Cause Circuit Troubles, *Electronics*, 31:37, p 90–93.



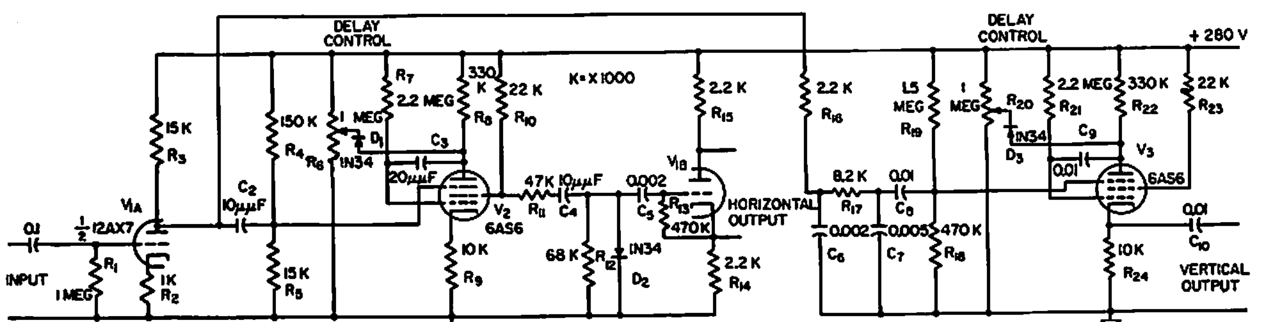
VIDEO OUTPUT AMP—With 2N834 circuit, output is sufficient to drive crt.—W. D. Roehr, Epitaxial Process Improves Transistor Characteristics, *Electronics*, 34:9, p 52–53.



AUTOMATIC FRINGE TUNING—Circuit serves to disable sound track, to increase amplitude of sound carrier, so weak picture carrier will be tuned higher on i-f pass band, at point of desired fringe tuning.—C. W. Baugh, Jr. and L. J. Sienkiewicz, Sound Signal Tunes Tv Automatically, *Electronics*, 31:17, p 54–58.



DIODE MIXER FOR TUNER—1N87 semiconductor diode mixer D1 improves isolation of r-f amplifier from 6ER5 tube V2, connected as Colpitts oscillator.—E. H. Hugenholtz, One-Tube Oscillator Mixers for Tv and F-M Tuners, *Electronics*, 33:3, p 76–79.

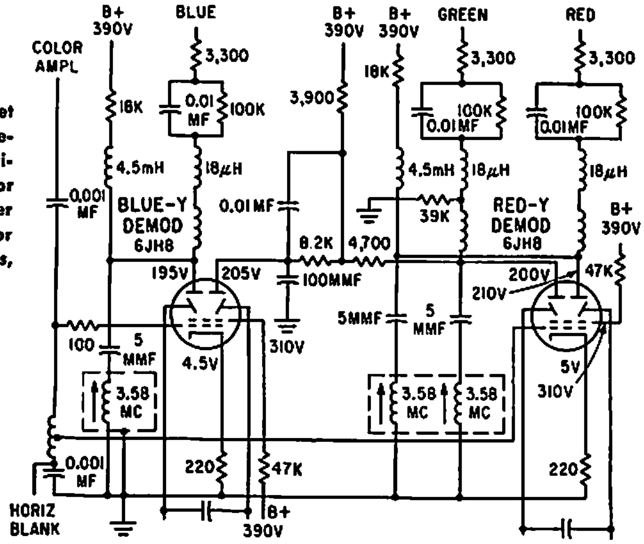


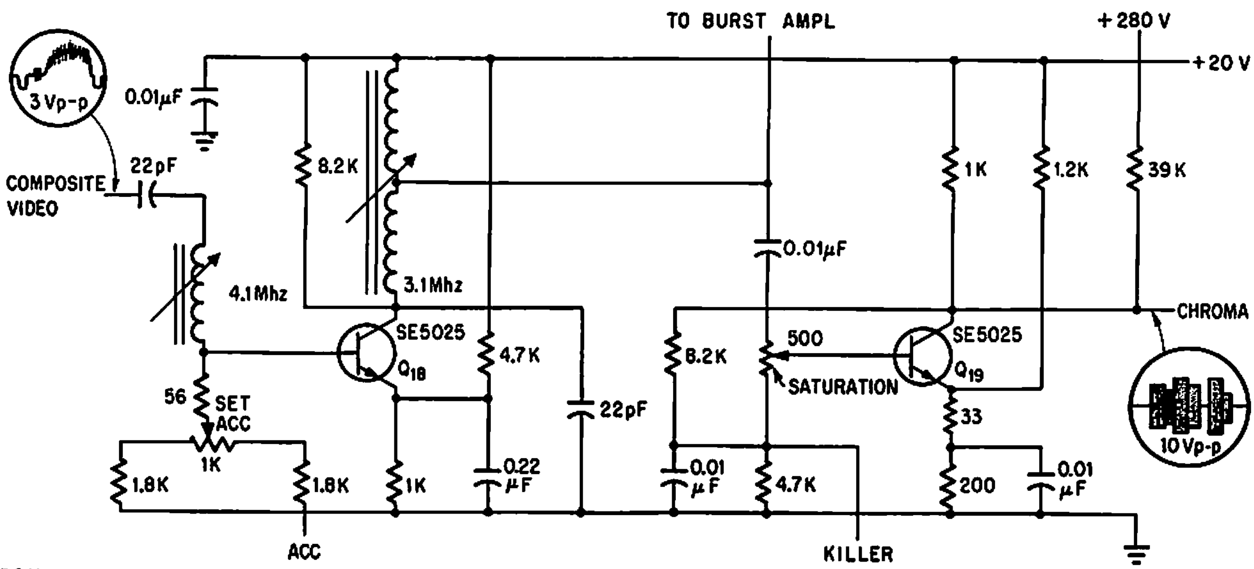
PULSE-CROSS DISPLAY GENERATOR—Phantastron circuits delay horizontal and vertical sync pulses, when added to monitor or tv receiver, to provide display for checking operation of tv station sync generator.—H. E. O'Kelley, Pulse-Cross Modification of Tv Receivers, *Electronics*, 31:9, p 54–55.

CHAPTER 89

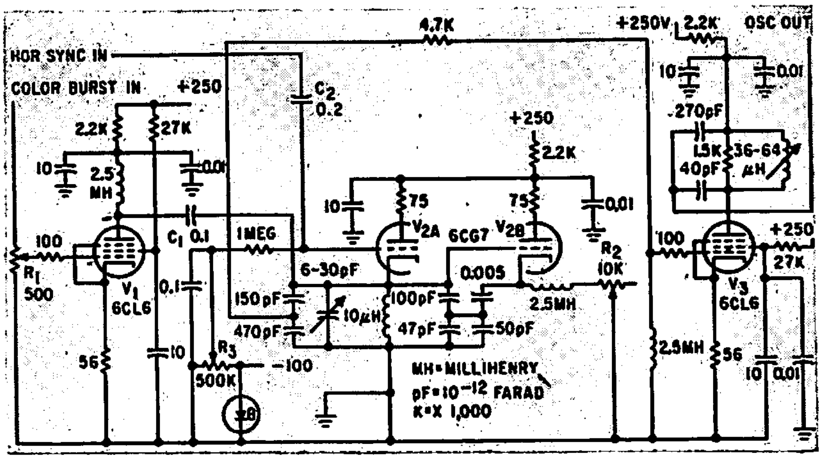
Television Circuits—Color

COLOR DEMODULATOR—Uses two 6JH8 sheet beam tubes as red and blue luminance demodulators. Balanced outputs of both polarities on plates of tubes eliminate need for additional phase inverter stages to recover green luminance signal.—Color Demodulator Uses Beam Switching Tubes, *Electronics*, 34:36, p 30–31.

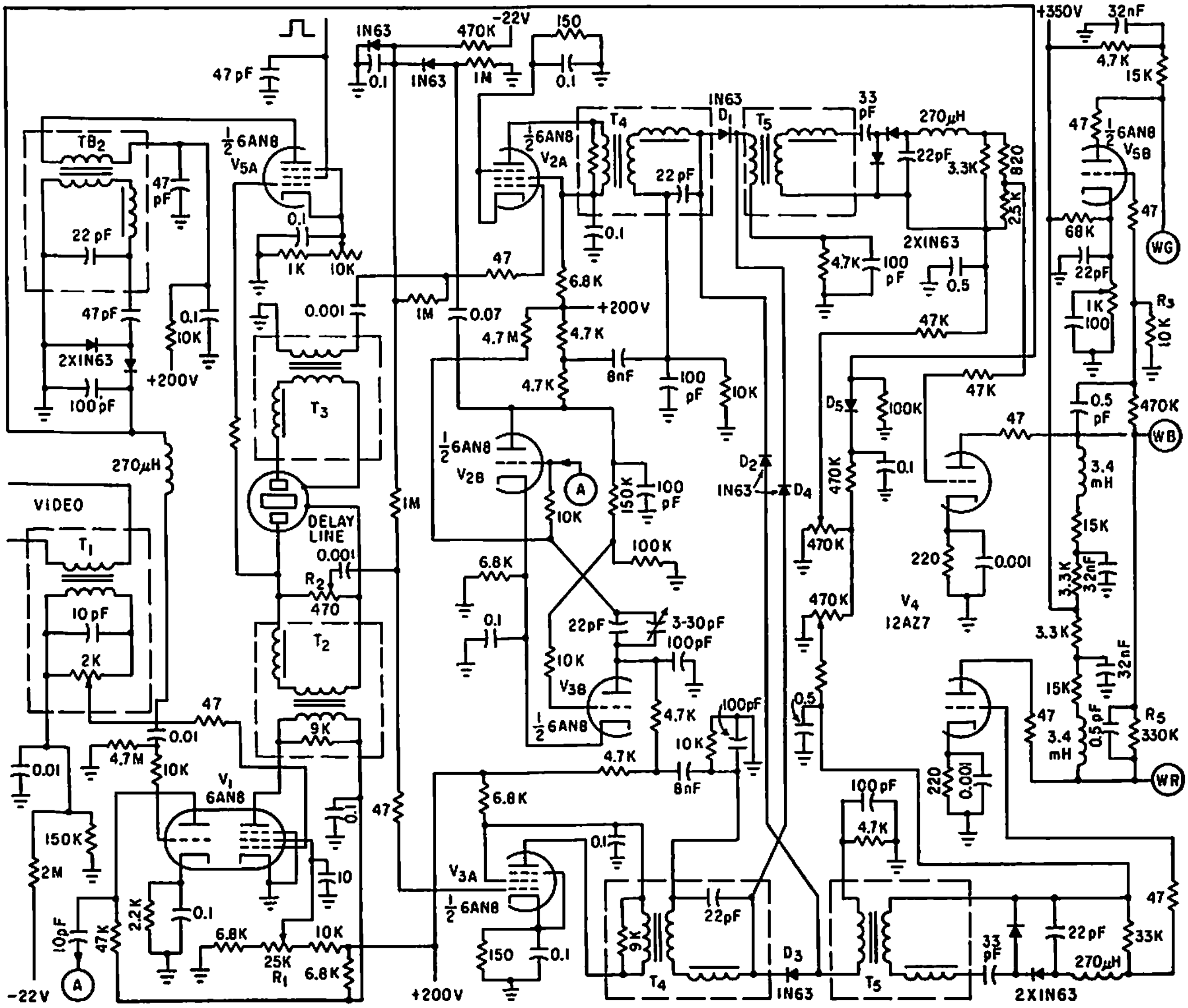




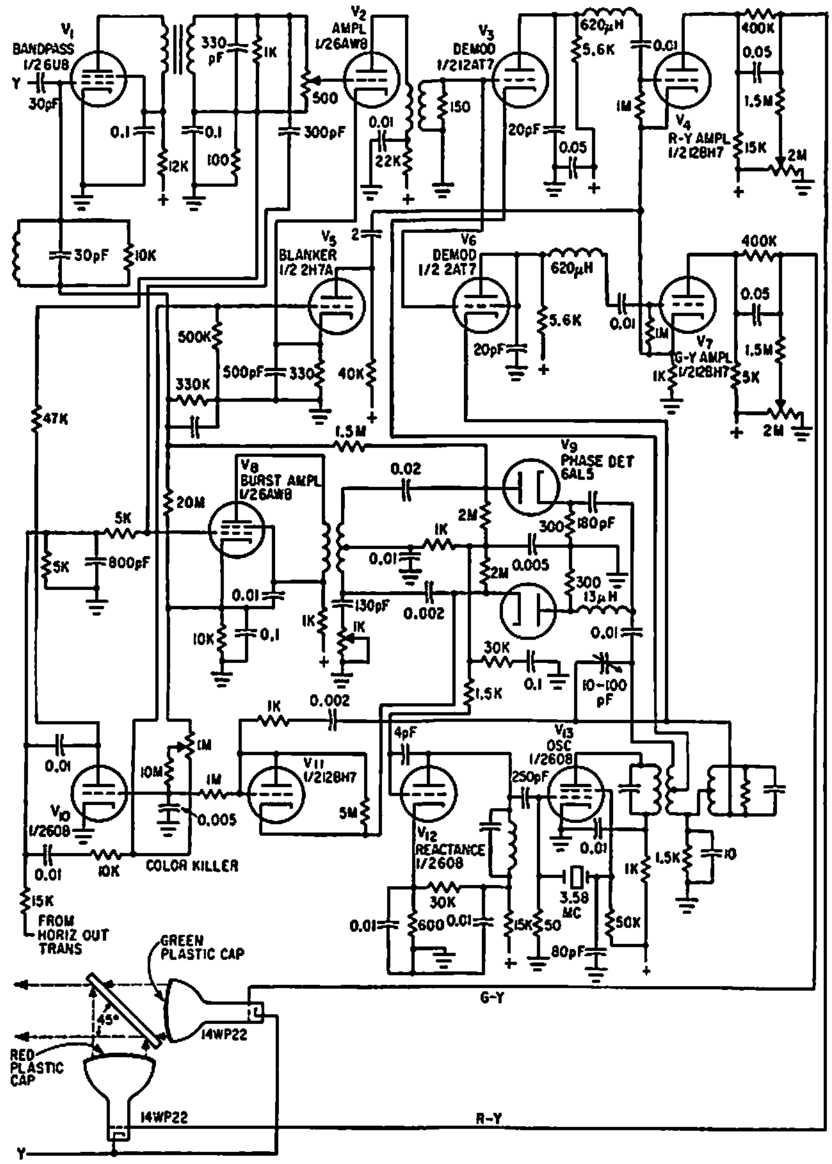
CHROMA AMPLIFIER—Used in transistorized color tv to provide response slope opposite that of i-f amplifier. Automatic color control signal reduces voltage gain of first stage Q18. Color killer signal cuts off Q19 during monochrome operation.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



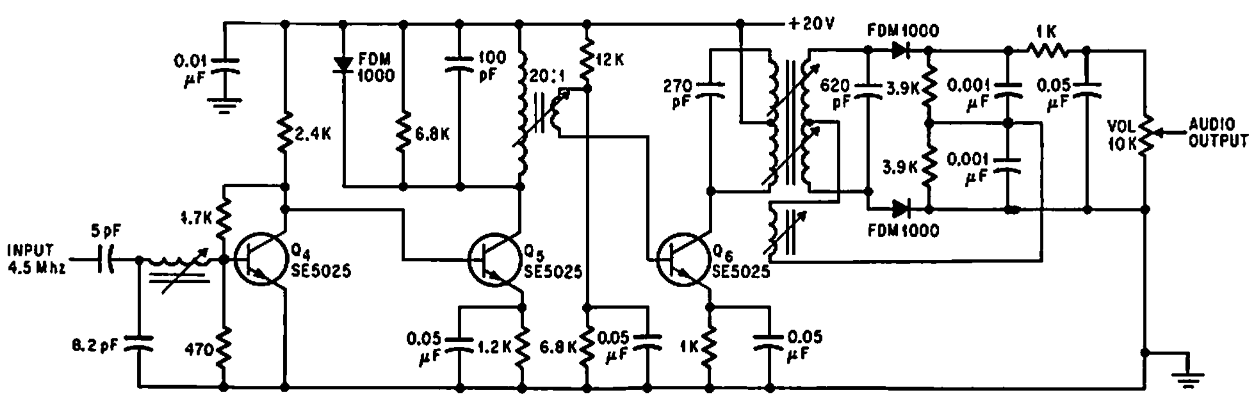
COLOR-BURST-GATED OSCILLATOR—For playback of color tv recordings on magnetic tape, color burst is removed from composite video signal on tape, amplified by V1, and used to gate 3.58-Mc start-stop oscillator V2 to make this oscillator ring at burst frequency. Regenerated 3.58-Mc signal is amplified by V3 and fed to decoder for demodulating chroma information.—J. Roizen, Magnetic Recording of Color Television, *Electronics*, 33:1, p 76–79.



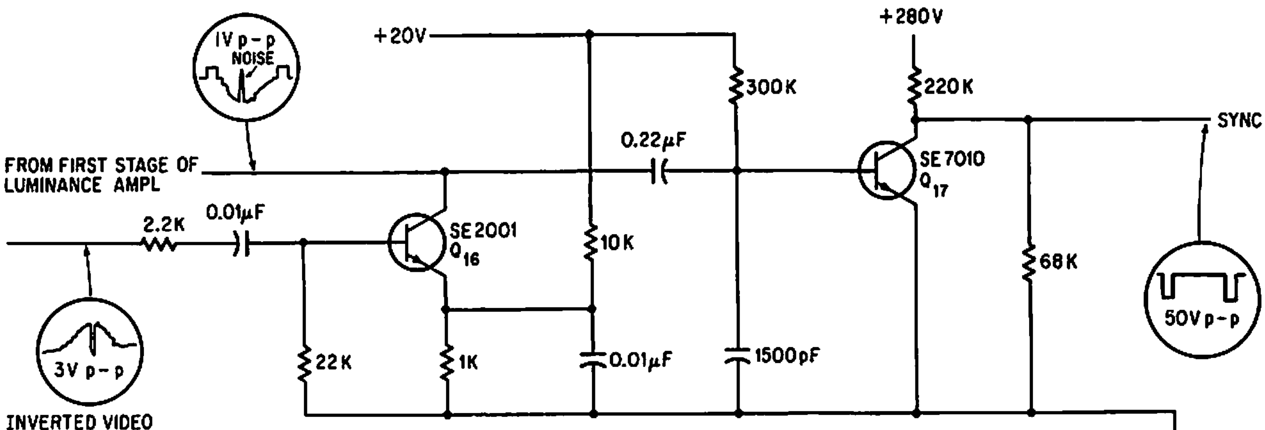
FRENCH COLOR TV CHROMINANCE—SECAM system uses time multiplexing of two chrominance signals, transmitted sequentially, with one-line memory in receiver circuit.—R. Chaste, P. Cassagne, and M. Colas, Sequential Receivers for French Color Tv System, *Electronics*, 33:19, p 57–60.



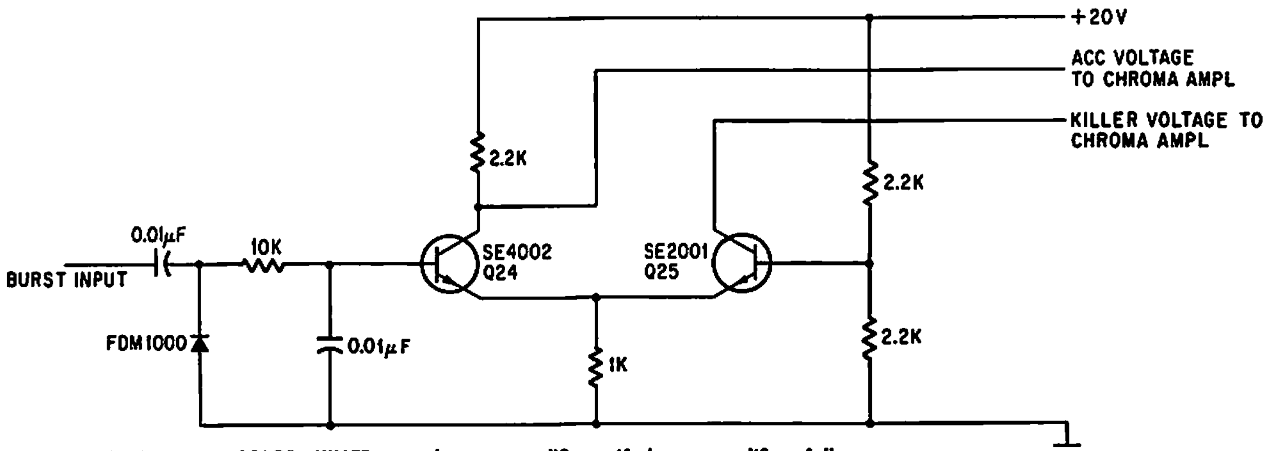
TWO-COLOR TV—Picture is viewed on half-silvered mirror that combines images of red and green 14-inch picture tubes. Receiver circuits accept standard NTSC color signal. Chief drawback is narrow angle of vision.—K. Hashimoto, Color TV Based on Land Theory uses Two Single-Gun Tubes, *Electronics*, 35:38, p 54–55.



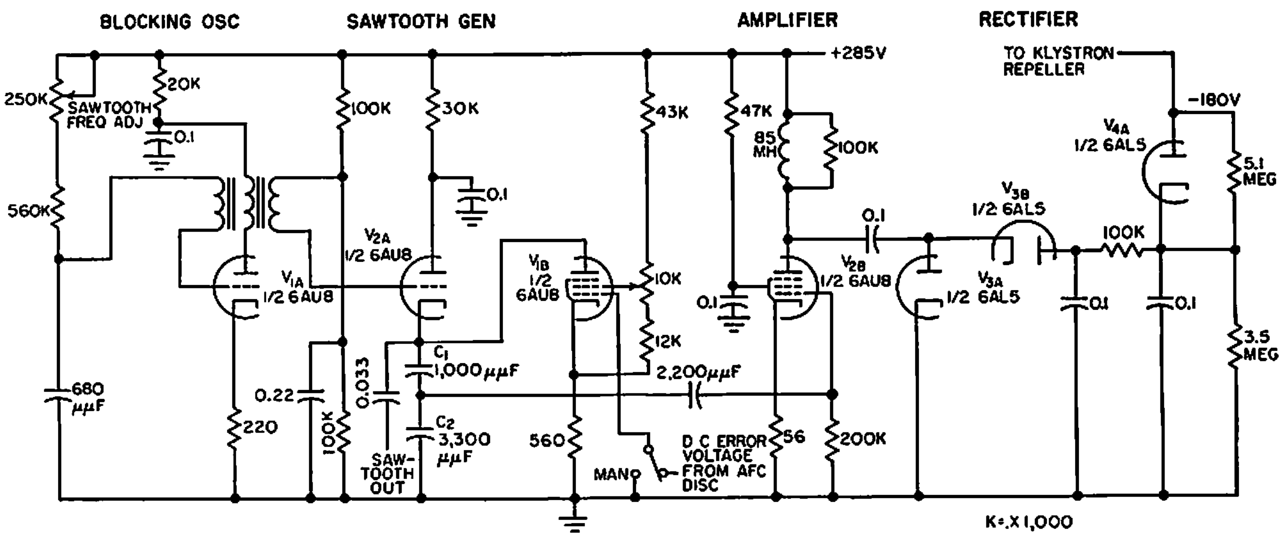
SOUND I-F FOR COLOR TV—Uses three transistor stages and Foster-Seeley discriminator to give audio output of 1 v peak to peak. —D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



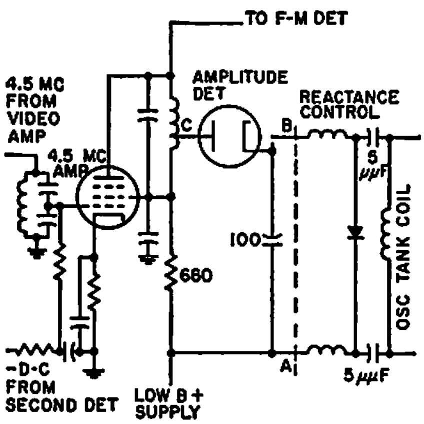
COLOR SYNC SEPARATOR—Transistorized version eliminates noise from horizontal sync pulses and isolates sync from video information. Noise theshold is established by voltage divider in emitter circuit of Q16.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



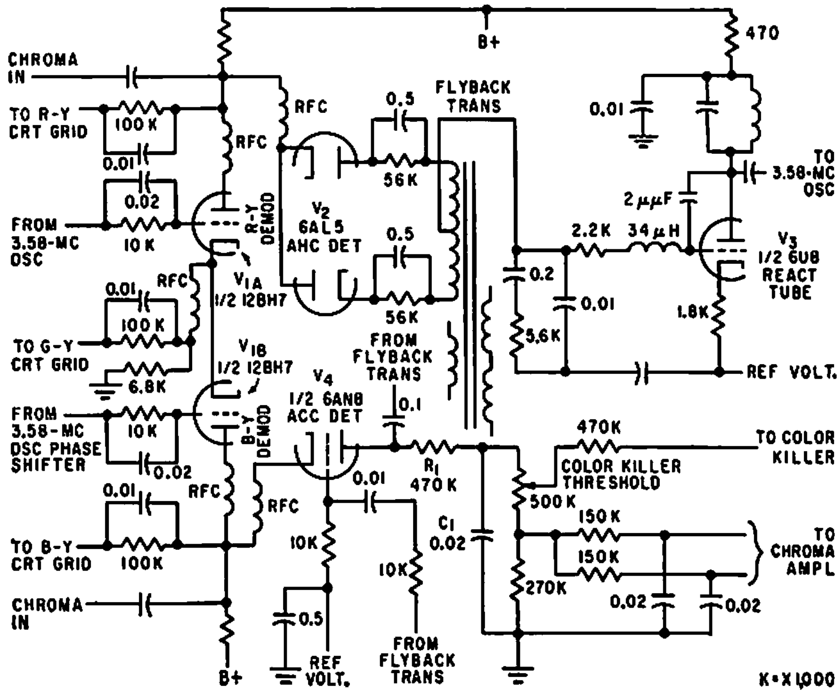
CHROMA CONTROL AND COLOR KILLER—Uses amplifier burst as reference to determine amount of bias on first stage of chroma amplifier. If burst amplifier falls below certain level, color killer voltage cuts off chroma amplifier automatically.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



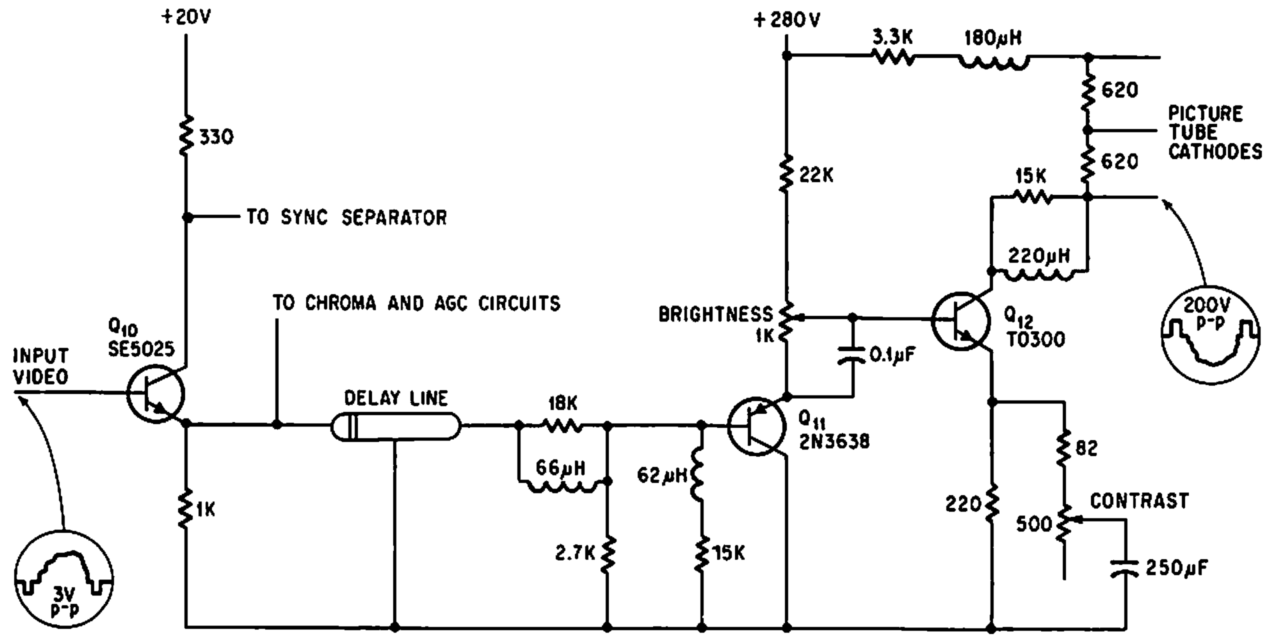
AFC FOR COLOR TV KLYSTRON—Used with visual f-m transmitter for microwave relay. Klystron locks to crystal i-f difference frequency to provide required high degree of stability. Calibrated wavetrap modifies sawtooth waveshape of afc to provide internal frequency monitoring.—T. G. Custin and J. Smith, Relay System Diplexes Audio and Color Video, *Electronics*, 31:25, p 64–67.



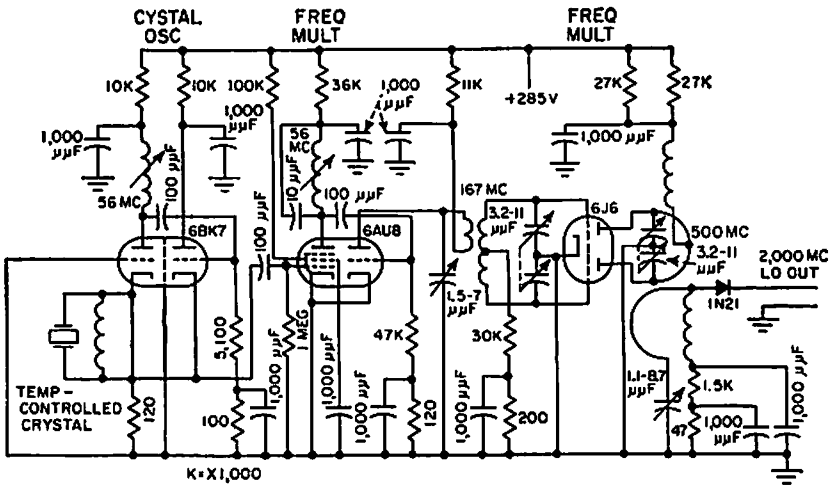
AUTOMATIC FINE TUNING—Amplitude of 4.5-Mc intercarrier sound signal controls sound-to-picture ratio to provide automatic fine tuning. Automatic control of beats between picture harmonics and sound carrier closely approximates manual tuning. Circuit is particularly valuable for remote control of color tv sets.—C. W. Baugh, Jr., and L. J. Sienkiewicz, Sound Signal Tunes Tv Automatically, *Electronics*, 31:17, p 54–58.



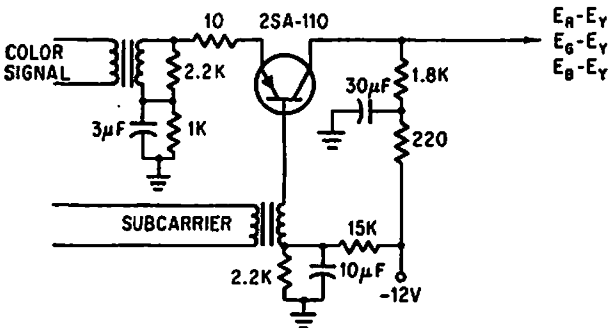
AUTOMATIC CHROMA CONTROL—Improves stability of hue, saturation, noise, and pull-in characteristics of received color tv signals. Low-frequency diode gate corrects subcarrier oscillator phase from synchronous demodulator signals and establishes signal level for a chroma control circuit.—Z. Wiencek, Automatic Controls for Color Television, *Electronics*, 32:20, p 58–59.



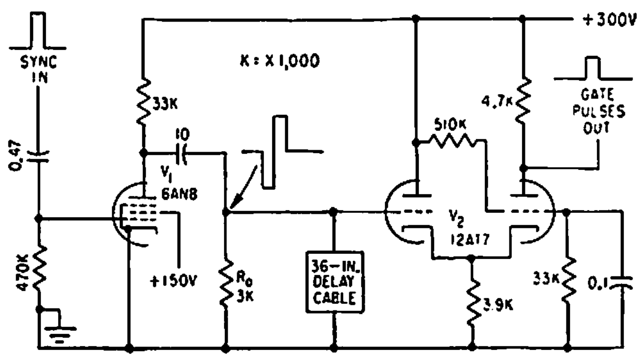
LUMINANCE AMPLIFIER—Provides bandwidth of 2 Mc, with 200-v output, for color set having transistors in all except deflection and rectifier circuits. Brightness is controlled by shifting base bias voltage of Q12, and contrast by varying a-c emitter impedance of Q12.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



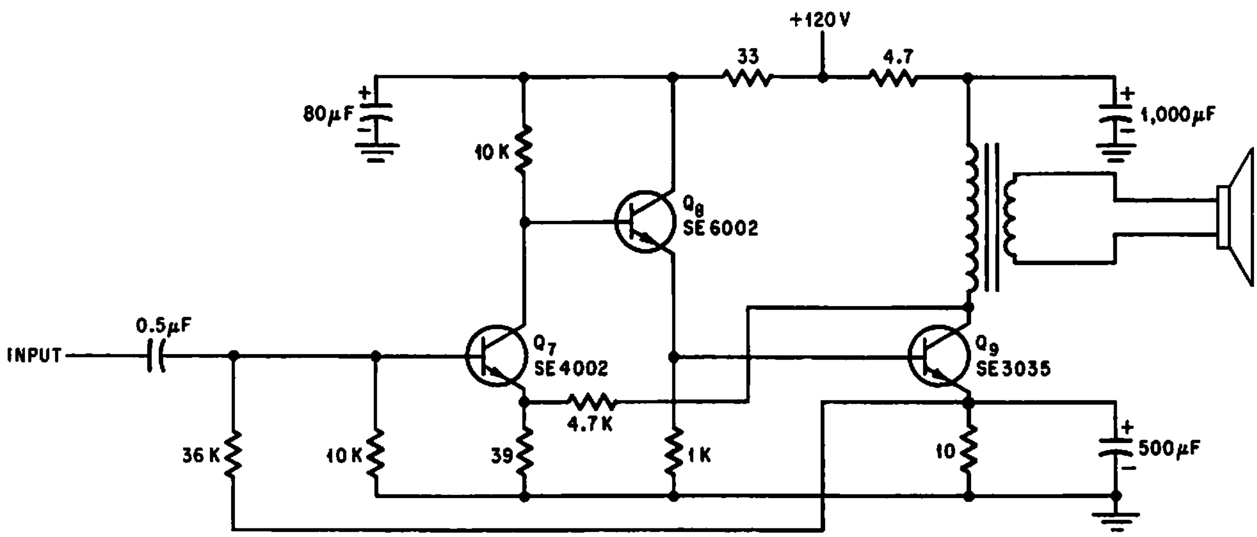
REFERENCE OSCILLATOR FOR COLOR TV KLYSTRON—Used in afc system that locks 2,000-Mc klystron to crystal oscillator reference frequency. Receiving-tube multipliers provide 50 mw at 500 Mc, and silicon crystal diode quadruples this to give 0.25 mw at 2,000 Mc. Used in mobile microwave relay system for color tv pickups.—T. G. Custin and J. Smith, Relay System Diplexes Audio and Color Video, *Electronics*, 31:25, p 64–67.



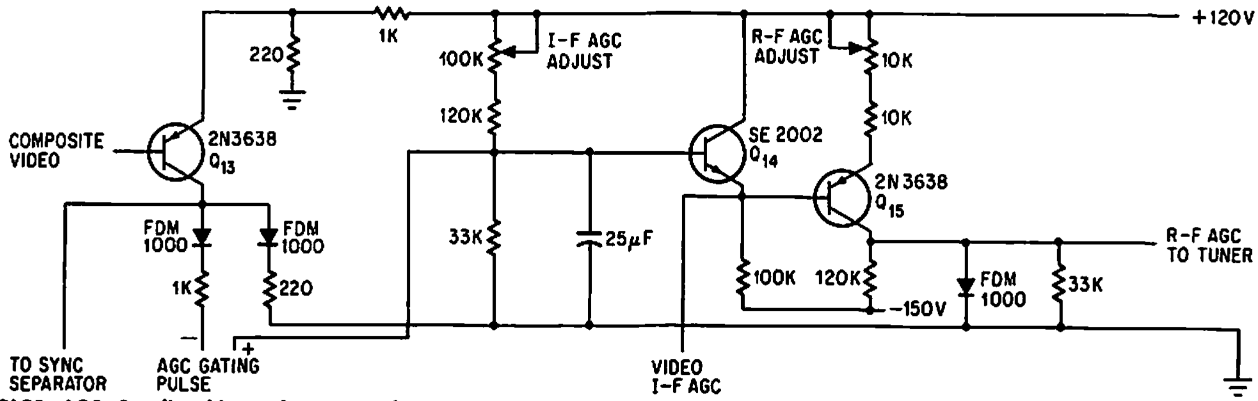
COLOR DEMODULATOR—Single demodulator in Japanese 7-inch color tv recovers the three difference signals in sequence by impressing color signal with local subcarrier that is advanced 120° in phase for each line.—Y. Sugihara, H. Ito and A. Haraguchi, From Japan a Startling New Color TV Set, *Electronics*, 38:11, p 81–94.



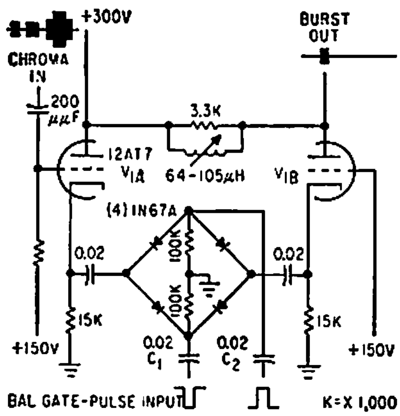
COLOR-BURST GATING-SIGNAL GENERATOR—Provides burst gating pulses for operating balanced-diode gate used in studio switching of color tv programs.—J. O. Schroeder, Holding Video Levels While Switching Studios, *Electronics*, 32:22, p 96–98.



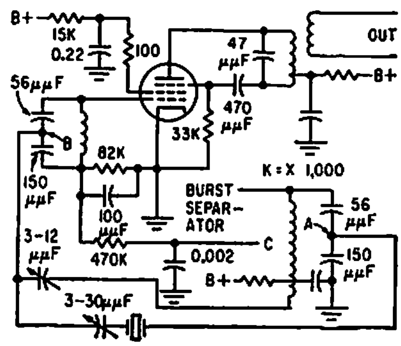
TRANSISTORIZED COLOR TV AUDIO—Three-stage class A amplifier provides output of 2 w. Feedback from emitter of Q9 to base of Q7 provides over-all d-c stability.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



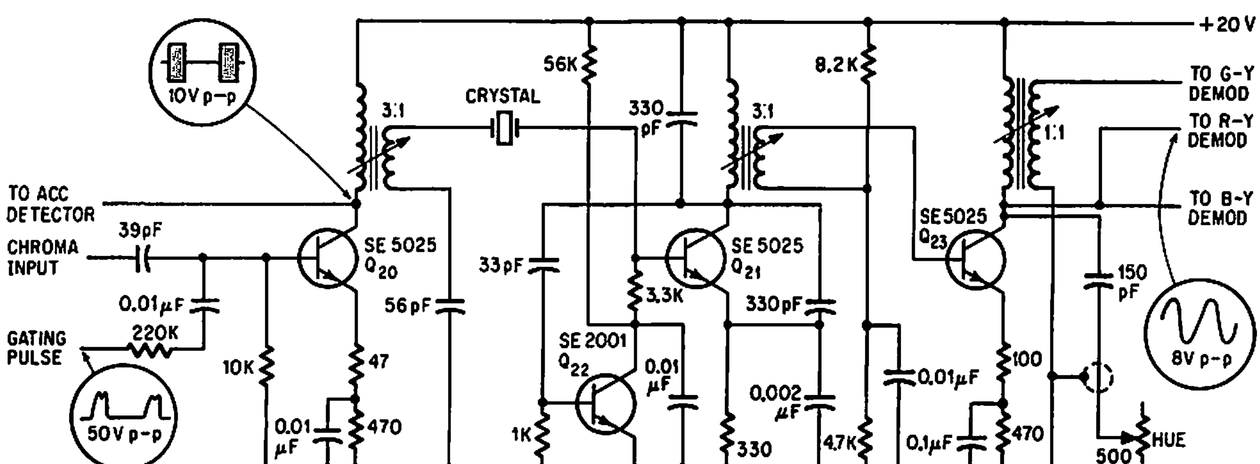
COLOR AGC—Supplies bias voltage to r-f and video i-f stages of color set using transistors in all but deflection and rectifier stages, to maintain video output amplitude at about 3 v.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



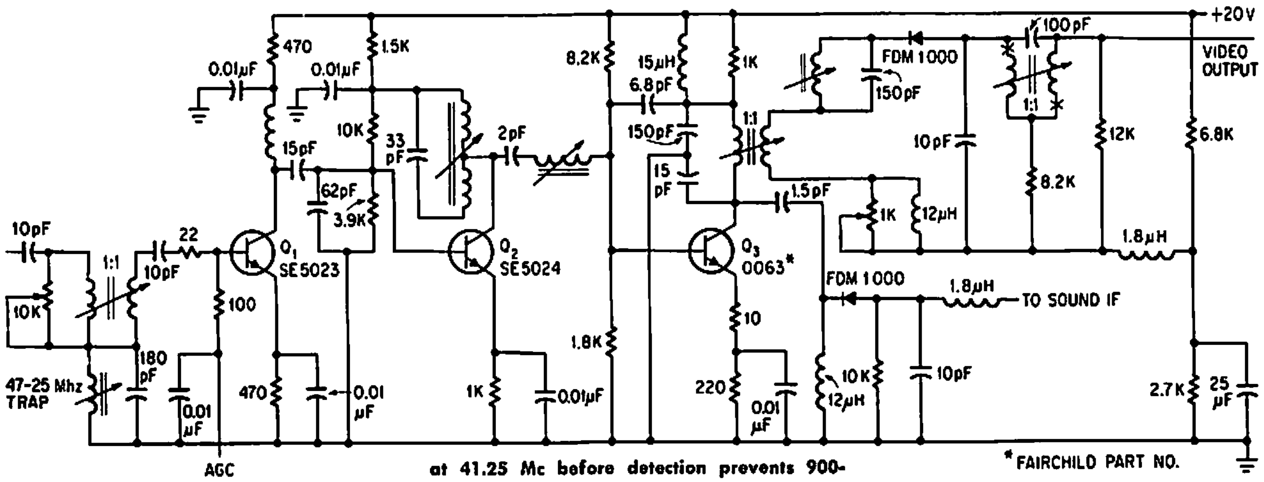
BALANCED-DIODE COLOR-BURST GATE—Used in automatic video-processing amplifier that instantly compensates for wide variations in color or monochrome input signal levels, to maintain output signal components at correct levels.—J. O. Schroeder, Holding Video Levels While Switching Studios, *Electronics*, 32:22, p 96–98.



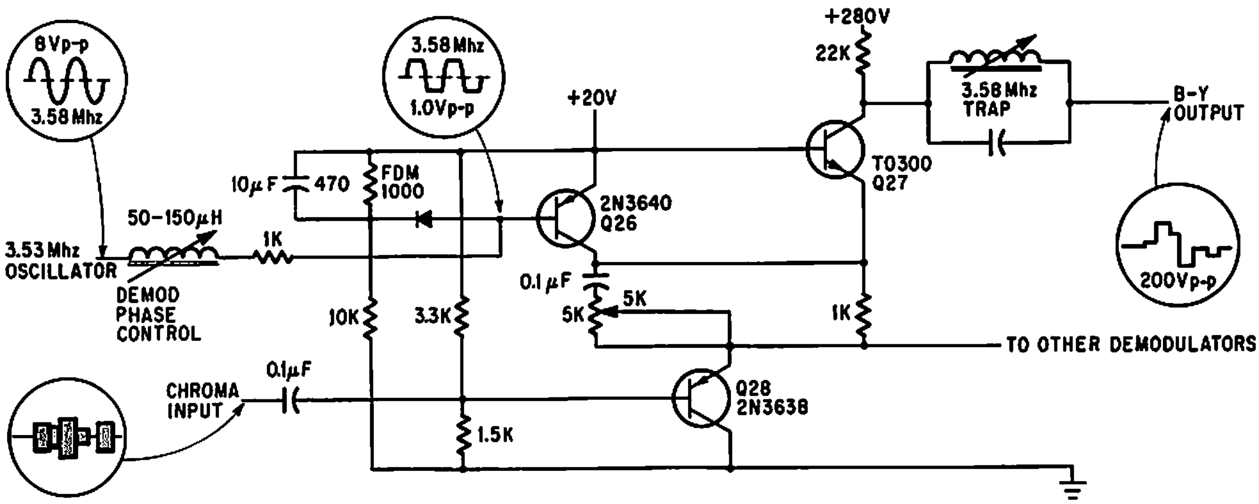
COLOR HOLD—Uses passive filter to separate color subcarrier frequency from sync burst, along with injection-locked oscillator that combines amplitude limiting and power amplification for direct drive of color demodulators.—I. N. Meth, Locked Oscillator for Color Tv, *Electronics*, 32:39, p 91–92.



COLOR BURST AMPLIFIER—Burst amplifier Q20 and 3.58-Mc crystal oscillator Q21 are driven by output of first stage of chroma amplifier of transistorized color tv. Amplifier burst locks oscillator frequency to subcarrier frequency required by color demodulators, and provides reference burst for automatic color control circuit.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.



COLOR VIDEO I-F—Three-stage amplifier has forward agc on first stage Q1. Sound trap at 41.25 Mc before detection prevents 900-Mc beat between color subcarrier and sound carrier.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.

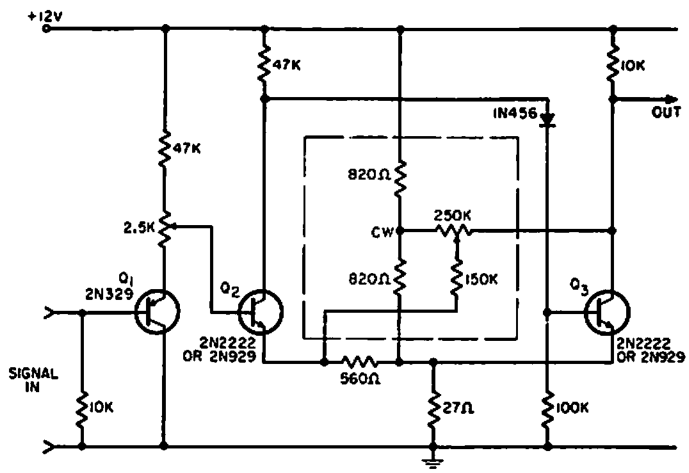


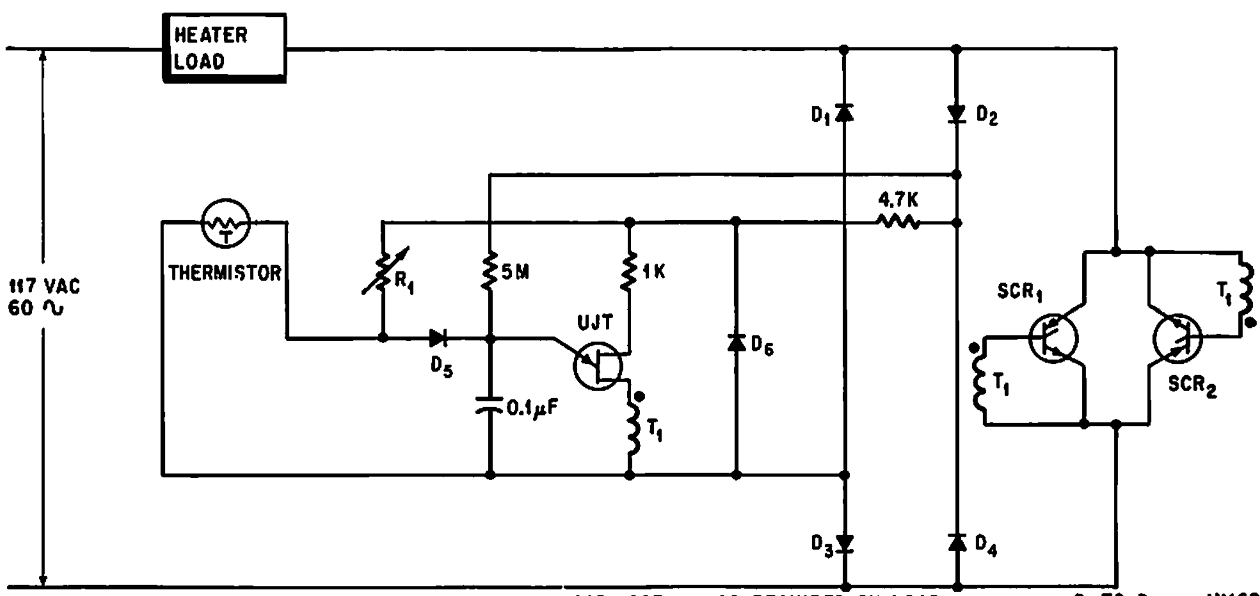
B-Y DEMODULATOR—Used in transistorized color tv. R—Y and G—Y demodulators are identical except for having different demodulation phase angle.—D. Bray, Solid State Makes Debut in Big-Screen Color Tv, *Electronics*, 39:8, p 99–105.

CHAPTER 90

Temperature Control Circuits

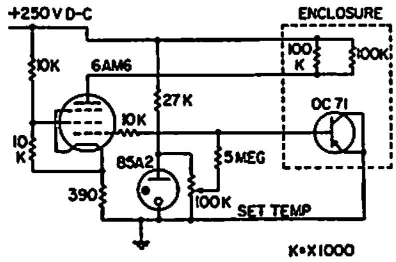
SCHMITT TRIGGER AS TIME-PROPORTIONING TEMPERATURE CONTROL—Hysteresis of Schmitt trigger (difference between turn-on and turn-off signal levels) is adjusted with negative feedback instead of positive, to reduce hysteresis to less than 1 mv. Trigger point can be adjusted above or below ground reference despite use of only one power supply. Modification of negative feedback causes duty-cycle-controllable oscillation. Potentiometer adjusts circuit gain smoothly over wide range.—P. Lefferts, 'Super' Schmitt Uses Negative Feedback, *EEE*, 12:12, p 52–53.



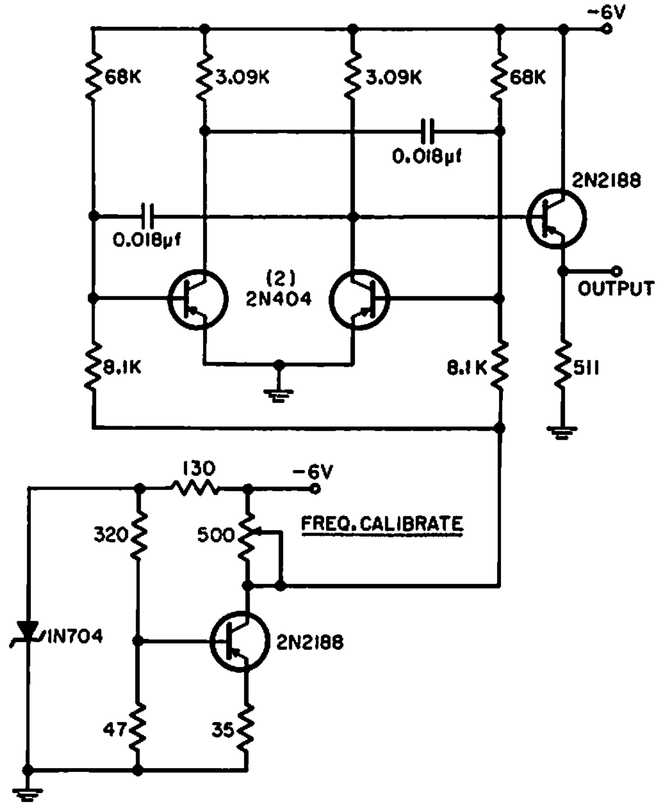


SCR_1, SCR_2	–	AS REQUIRED BY LOAD	D_1 TO D_4	–	1N1695
UJT	–	2N2647	D_5	–	1N1692
R_1	–	DEPENDENT ON THERMISTOR	D_6	–	1N1776
T_1	–	SPRAGUE 35ZM900 PULSE XFMR			

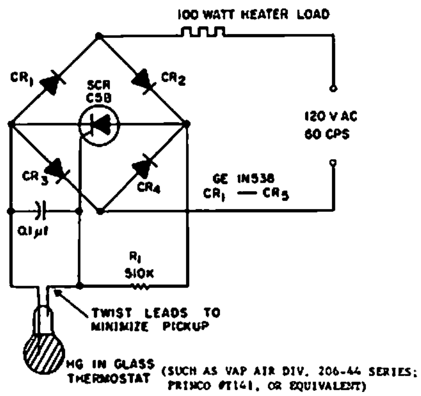
THERMISTOR IS SENSOR FOR OVEN CONTROL—When oven temperature drops, thermistor resistance increases, making unijunction transistor trigger earlier in line voltage cycle so scr's deliver more power to oven. —J. C. Hey, The Widening World of the SCR, *Electronics*, 37:25, p 78–85.



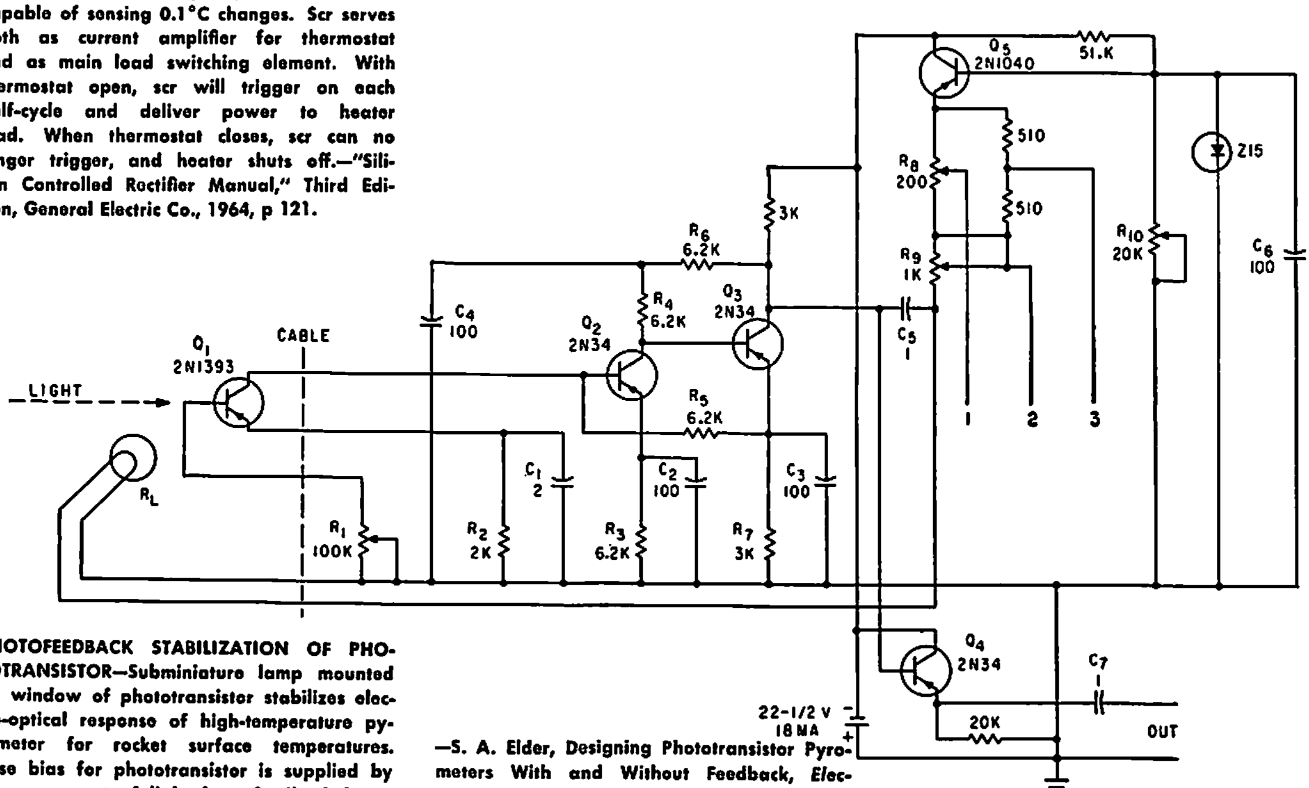
HYBRID THERMOSTAT—Utilizes reverse characteristics of pnp junctions for temperature control. Provides continuous control with higher sensitivity than thermistors, along with quiet operation, remote resetting of temperature, and small thermal time constant. Chief disadvantage is high impedance.—H. Sutcliffe, Transistor Temperature Controller, *Electronics*, 31:13, p 81–84.



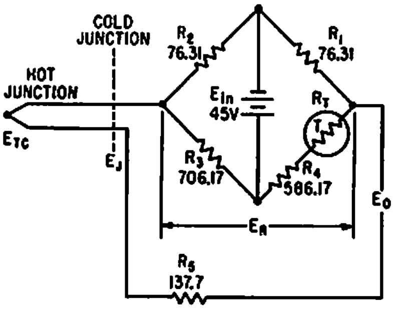
TEMPERATURE TELEMETER FOR BALLOON—Designed for range of −70 to +70°C, for which circuit produces frequency change of 1.5 kc. Uses temperature-sensitive base-to-emitter voltage of transistor, which varies linearly with temperature, as transducer for voltage-controlled oscillator based on astable mvbr.—G. F. Ingle, Using Transistors for Temperature Measurement, *EEE*, 11:8, p 53–55.



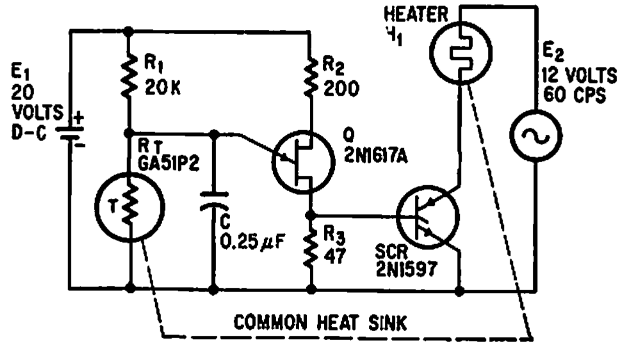
MERCURY THERMOSTAT AND SCR CONTROL HEATER—Uses mercury-in-glass thermostat capable of sensing 0.1°C changes. Scr serves both as current amplifier for thermostat and as main load switching element. With thermostat open, scr will trigger on each half-cycle and deliver power to heater load. When thermostat closes, scr can no longer trigger, and heater shuts off.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 121.



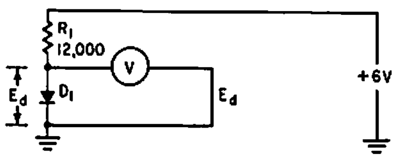
PHOTOFEEDBACK STABILIZATION OF PHOTOTRANSISTOR—Subminiature lamp mounted on window of phototransistor stabilizes electro-optical response of high-temperature pyrometer for rocket surface temperatures. Base bias for phototransistor is supplied by d-c component of light from feedback lamp. —S. A. Elder, Designing Phototransistor Pyrometers With and Without Feedback, *Electronics*, 34:49, p 56–60.



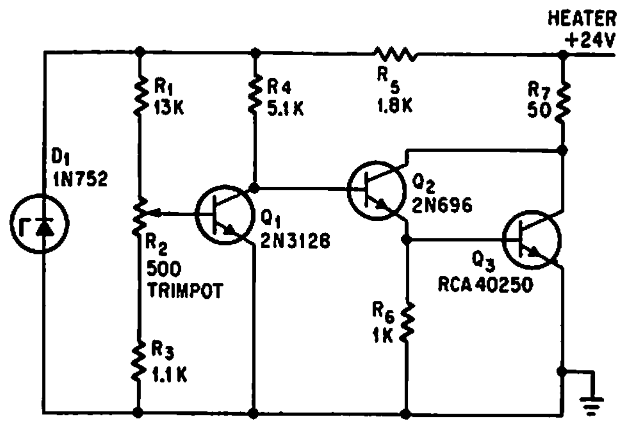
TEMPERATURE-COMPENSATING THERMOCOUPLE BRIDGE—Temperature-sensitive resistor RT in bridge provides voltage to compensate variations in cold-junction voltage during missile flight testing.—J. B. Brownwood, Thermocouple Compensating Circuit Design, *Electronics*, 35:1, p 98–100.



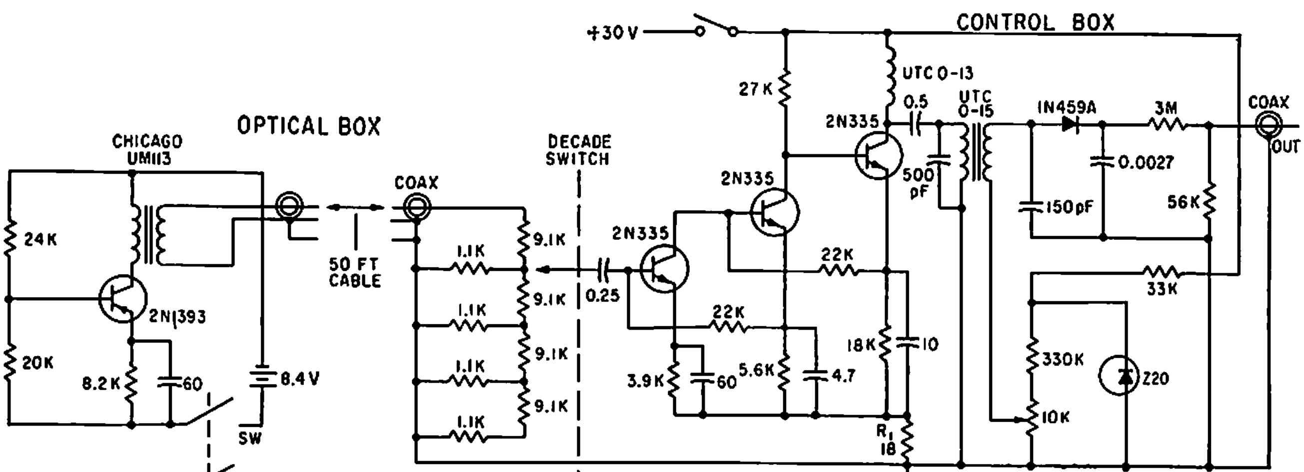
0.01°C DIFFERENTIAL—Scr conducts until heater reaches desired temperature, when thermistor T turns off unijunction oscillator Q.—R. G. Ferrie, Thermostat Operates With 0.01°C Differential, *Electronics*, 37:26, p 65.

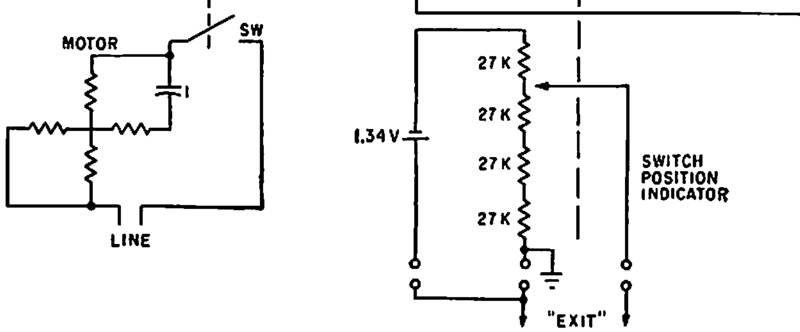


SIMPLE DIODE SENSOR—Meter measures voltage drop across germanium diode (such as 1N2326), which varies linearly with temperature from near absolute zero to a high limit around 45°C, which is upper limit of diode base material.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.

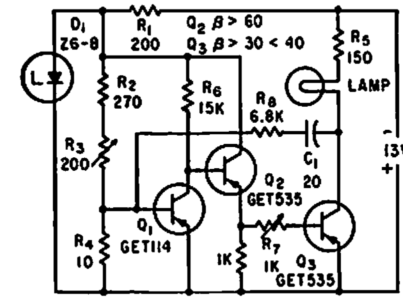


TRANSISTORS SENSE TEMPERATURE—Transistor Q1, mounted in tight thermal contact with heater R7, will maintain crystal oven within 0.2°C of 70°C.—S. Greenblatt, Transistor Becomes Sensor In Temperature Regulator, *Electronics*, 37:28, p 65.

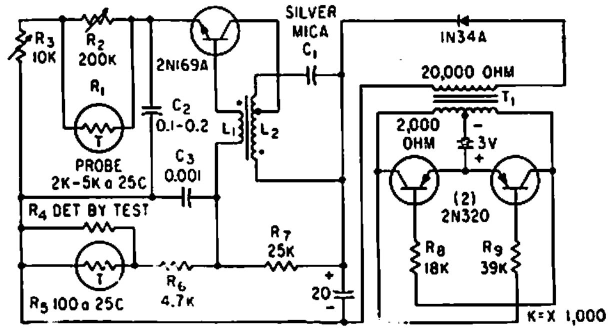




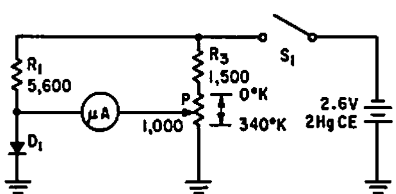
MEASURING HIGH TEMPERATURES—Used for automatic recording of missile and rocket surface temperatures. Phototransistor, connected in common-emitter mode, requires no preamp. Decade amplifier in control box is stabilized by 34 db of feedback through R1. Diode demodulator provides d-c output for recording.—S. A. Elder, Designing Phototransistor Pyrometers With and Without Feedback, *Electronics*, 34:49, p 56–60.



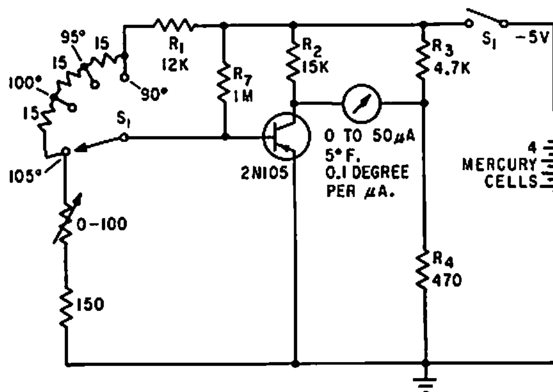
ROAD ICING ALARM—Sensing transmitter mounted on auto about 2 feet above road, with junction of transistor connected to case, is connected to low-frequency oscillator having lamp load. R7 is adjusted so lamp is out but on verge of flashing of 2°C. When temperature drops, lamp flashes. Duration of each flash increases down to 0°C after which lamp remains on.—J. A. Irvine, Reducing Winter Skids with a Transistor Warning Circuit, *Electronics*, 36:4, p 56–58.



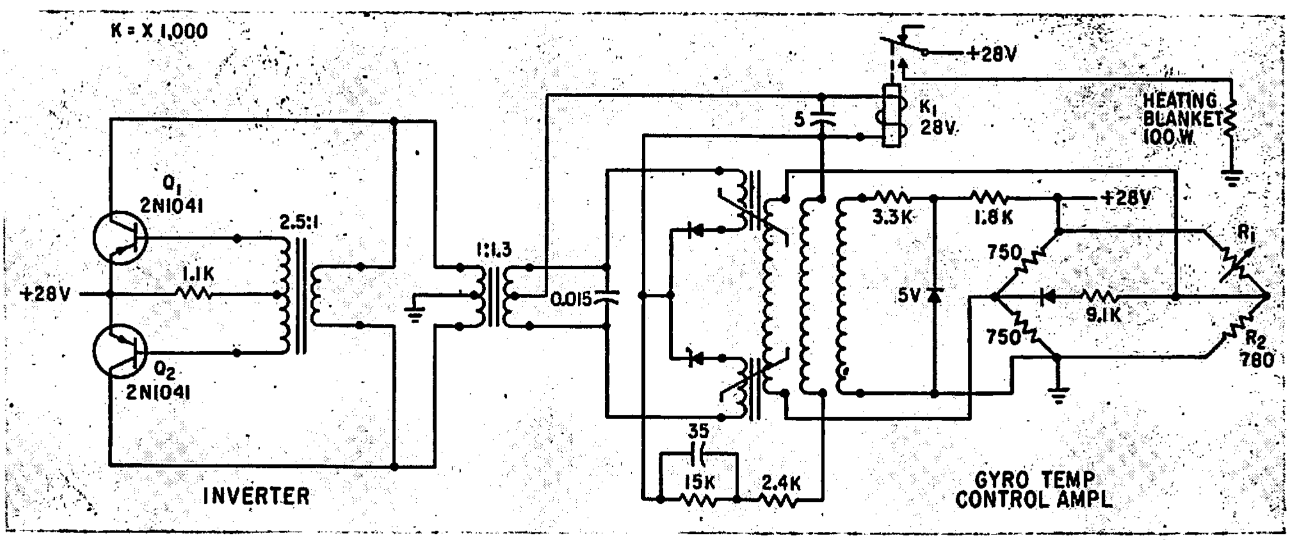
TEMPERATURE TRANSMITTER—2N169A transistor is used in tuned-collector oscillator, with large R-C time constant in emitter circuit to give self-modulator for quenching action. Variation in quench break is accomplished with temperature-sensing element R1, consisting of glass-enclosed bead thermistor.—R. H. Elsken, Temperature Telemetry Aids Frozen Food Study, *Electronics*, 33:33, p 129–131.



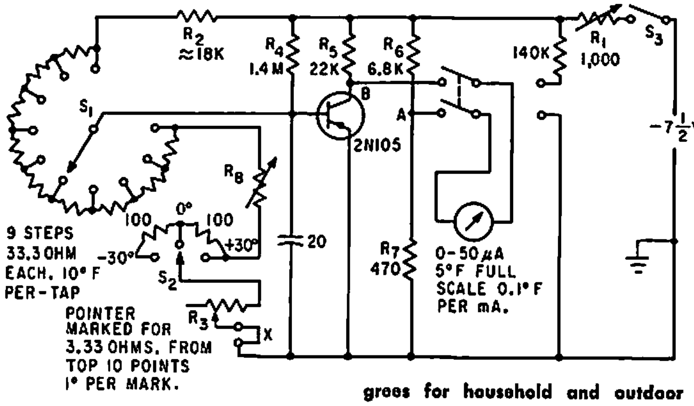
WIDE-RANGE DIODE THERMOMETER—Temperature-sensing germanium-diode bucking-voltage microammeter has null indicator, covers full usable range of from near absolute zero to about 45°C with resistance values shown.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.



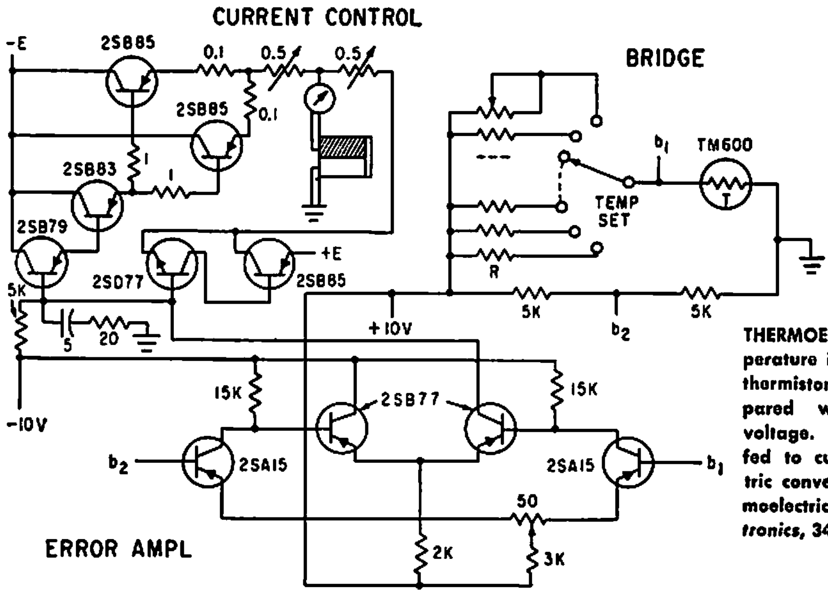
BODY-TEMPERATURE TRANSISTOR THERMOMETER—Covers range of 90° to 105°F in three steps, with temperature indicated on meter that measures base bias of germanium transistor, for which bias varies linearly with temperature.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.



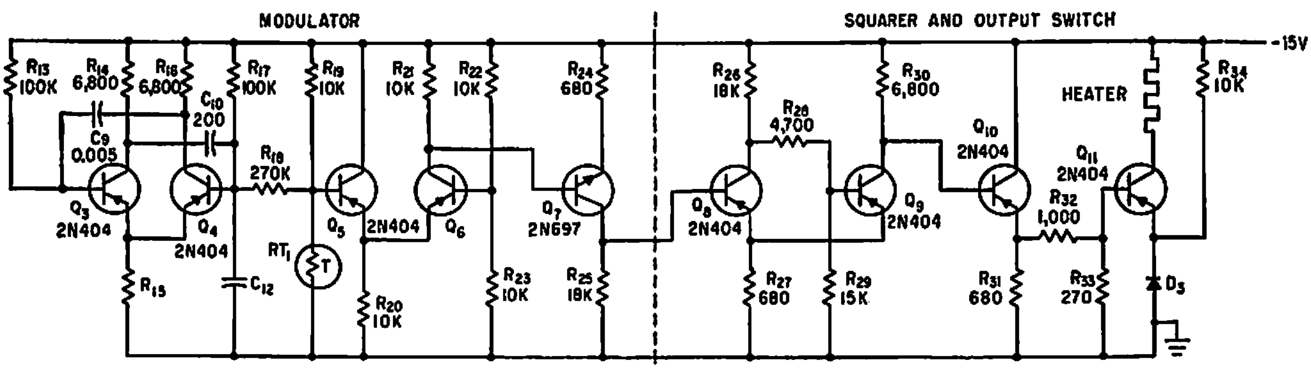
GYRO TEMPERATURE CONTROL—Regulates temperature to 0.5°F by sensing differences between gyro-mounted temperature-sensitive resistor R1 and fixed resistor R2 in bridge. Magnetic amplifier for bridge operates relay K1 to energize gyro heater when temperature is low.—R. E. King and H. Low, Solid-State Guidance For Able-Series Rockets, *Electronics*, 33:5, p 60–63.



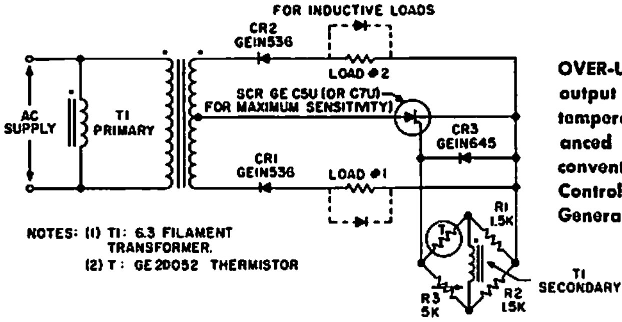
TRANSISTOR THERMOMETER—Base bias of germanium transistor varies linearly with temperature over wide range, at about 0.0014 v d-c per deg F. Meter is connected to measure base bias and calibrated in degrees for household and outdoor temperatures. Range switch S1 covers 0 to 100°F in ten steps, and S2 extends range 30° in both directions.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.



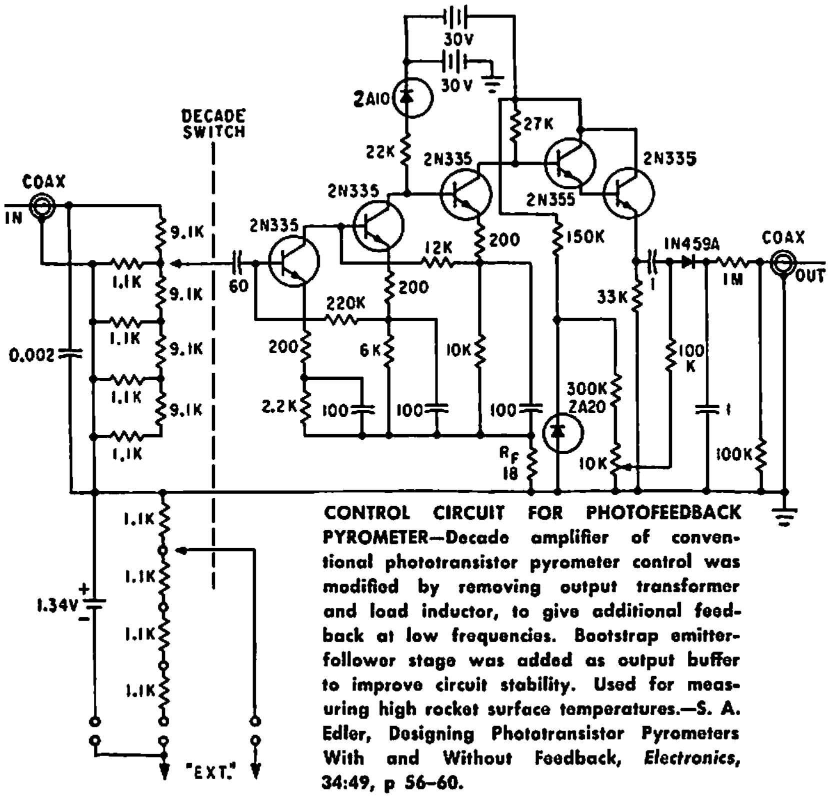
THERMOELECTRIC COOLING CONTROL—Temperature inside cooling chamber is sensed by thermistor bridge and bridge output is compared with temperature-setting reference voltage. Difference voltage is amplified and fed to current control circuit of thermoelectric converter.—M. Nagata and Z. Abe, Thermoelectric Elements for Circuit Cooling, *Electronics*, 34:41, p 54–55.



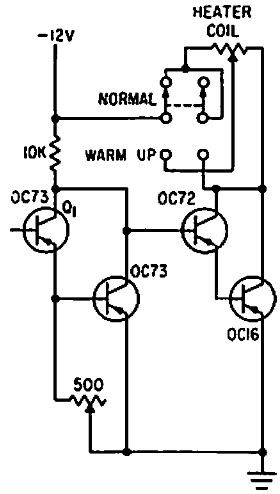
CRYSTAL OVEN—Thermistor RT1 senses temperature of crystal oscillator cavity and modifies output of asymmetric free-running mvbr Q3-Q4 whose output is integrated by C12. Thermistor is followed by modulator, amplifier Q7, and four-transistor switch that applies power at fixed repetition frequency but with *on* time per cycle controlled by thermistor.—M. Lysobey, Microminiature Crystal Oscillator Using Wafer Modules, *Electronics*, 35:15, p 60–61.



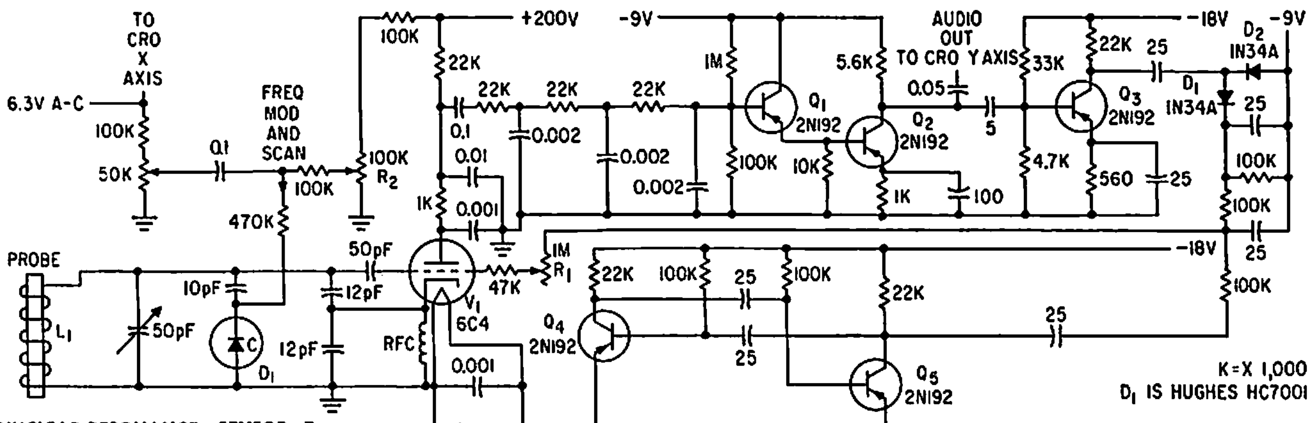
OVER-UNDER TEMPERATURE MONITOR—Dual output can be used to drive high and low temperature indicator lamps or relays. Balanced bridge may also be used to trigger conventional scr-load combinations.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 120.



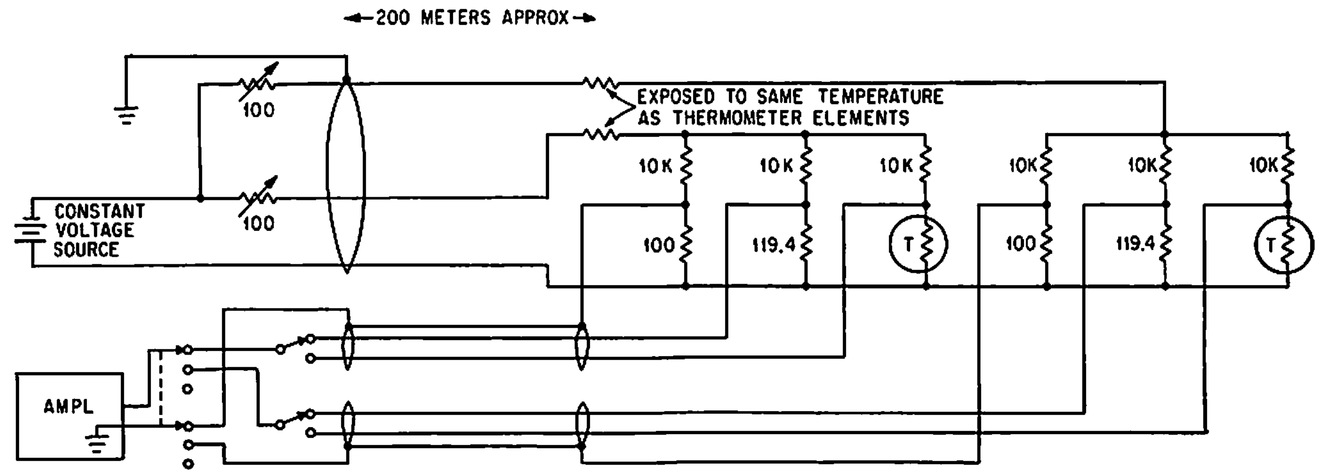
CONTROL CIRCUIT FOR PHOTOFEEDBACK PYROMETER—Decade amplifier of conventional phototransistor pyrometer control was modified by removing output transformer and load inductor, to give additional feedback at low frequencies. Bootstrap emitter-follower stage was added as output buffer to improve circuit stability. Used for measuring high rocket surface temperatures.—S. A. Edler, Designing Phototransistor Pyrometers With and Without Feedback, *Electronics*, 34:49, p 56–60.



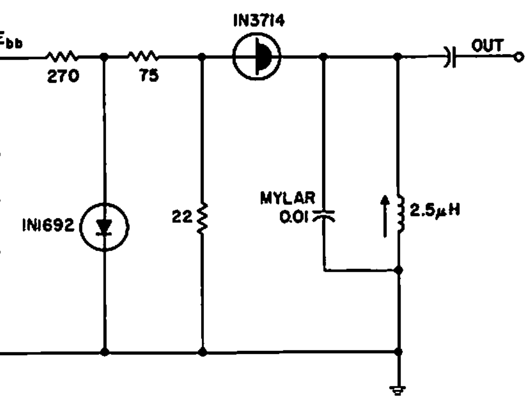
TEMPERATURE DRIFT CONTROL—Used to minimize thermal drift in d-c amplifier. Temperature-sensing element Q1 controls current through heater of temperature-controlled block. Base of Q1 is left floating. Variations in ambient temperature are reduced by factor of 10 inside block, and transistors are maintained at 40°C.—A. Potton, Telemetry System for Testing Automobiles, *Electronics*, 33:43, p 57–59.



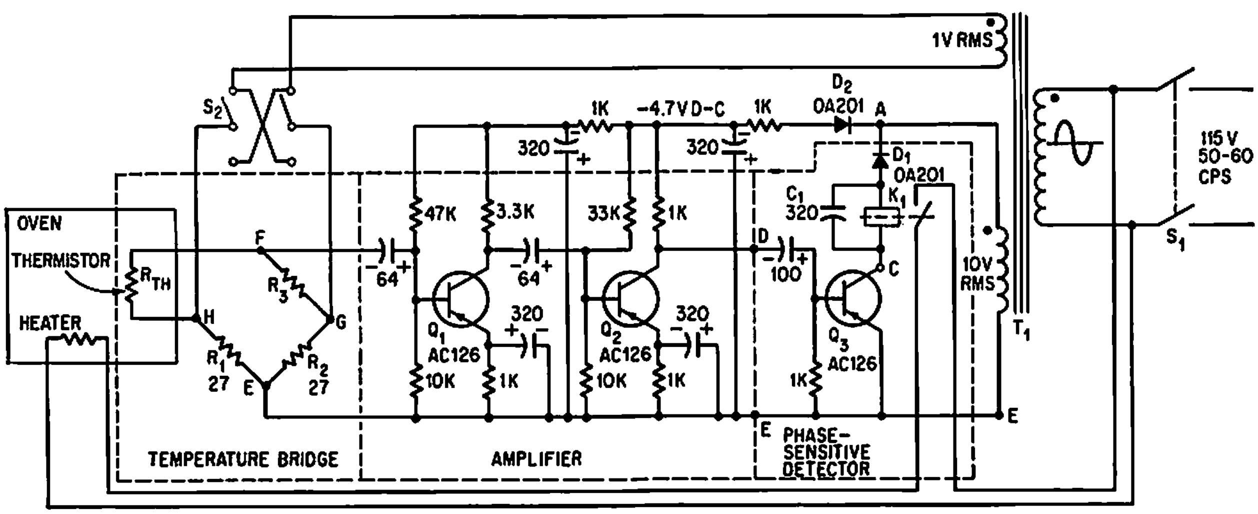
NUCLEAR-RESONANCE SENSOR—Temperature telemeter depends on absorption of r-f energy by chlorine molecule in proportion to temperature. When spectrometer oscillator V1 is tuned to frequency of correct absorption line, each oscillator pulse sets up oscillations in probe that last long enough to affect starting voltage for next oscillator pulse. After plate detection and low-pass filtering to suppress quench frequency, signal goes to two-stage a-f amplifier Q1-Q2, whose output to cro indicates whether spectrometer is on nuclear resonance frequency.—C. Dean, Using Nuclear Resonance to Sense Temperature, 33:28, *Electronics*, p 52–54.



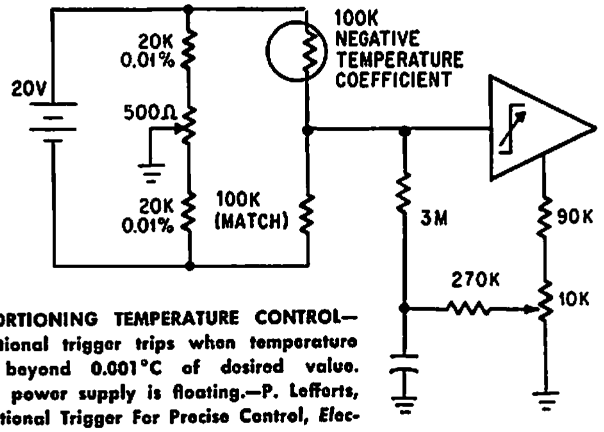
THERMISTORS CORRECT THERMOMETER LINEARITY—Zero-temperature-coefficient resistors mounted near resistance thermometer element offset variation of lead resistance with temperature.—F. J. Goldwater, Low-Cost Digital System Records Weather Data, *Electronics*, 37:2, p 34–36.



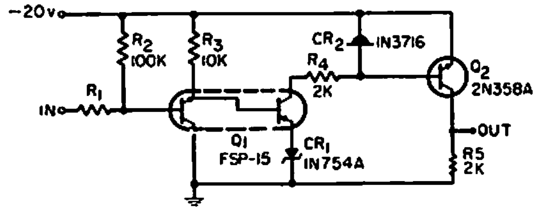
1.1-Mc TEMPERATURE-SENSING OSCILLATOR—Uses mylar capacitor as main temperature-sensing element, with temperature coefficient of 0.5 kc/°C, in tunnel-diode oscillator that translates temperature changes into frequency changes.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 350.



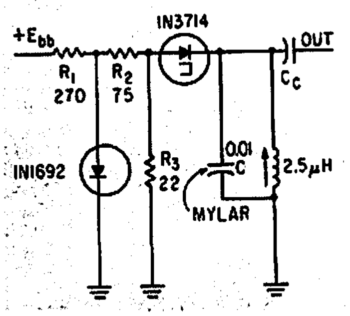
HIGH-ACCURACY CONTROL—Holds temperature constant to within 0.1°C for any value between −25 and 200°C. For controlling refrigerated unit instead of oven, switch S2 is placed in its other position and output relay is then used to energize solenoid valve that controls flow of refrigerant.—G. H. P. Kohnke, Electronic Thermostat Controls Temperature to Within 0.1°C, *Electronics*, 39:1, p 100–102.



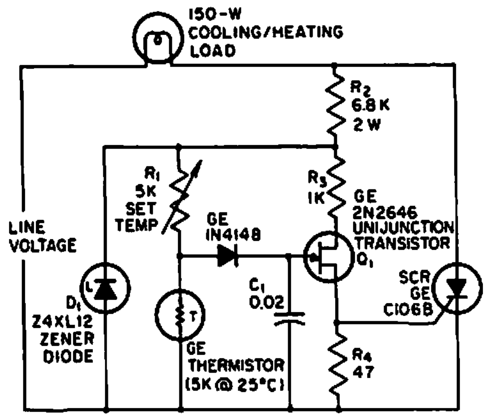
PROPORTIONING TEMPERATURE CONTROL—Operational trigger trips when temperature goes beyond 0.001°C of desired value. Bridge power supply is floating.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



LOW-HYSTERESIS D-C LEVEL DETECTOR—Serves as temperature control when thermistor or other temperature-sensing resistive device is connected to input. Dual complementary transistor Q1 is high-stability d-c amplifier, with zener diode CR1 providing threshold level. With sharp-breaking characteristic for zener, hysteresis can be less than 10 mv between turn-on and turn-off. —P. C. Murray, Accurate DC-Level Detector, *EEE*, 13:12, p 65.

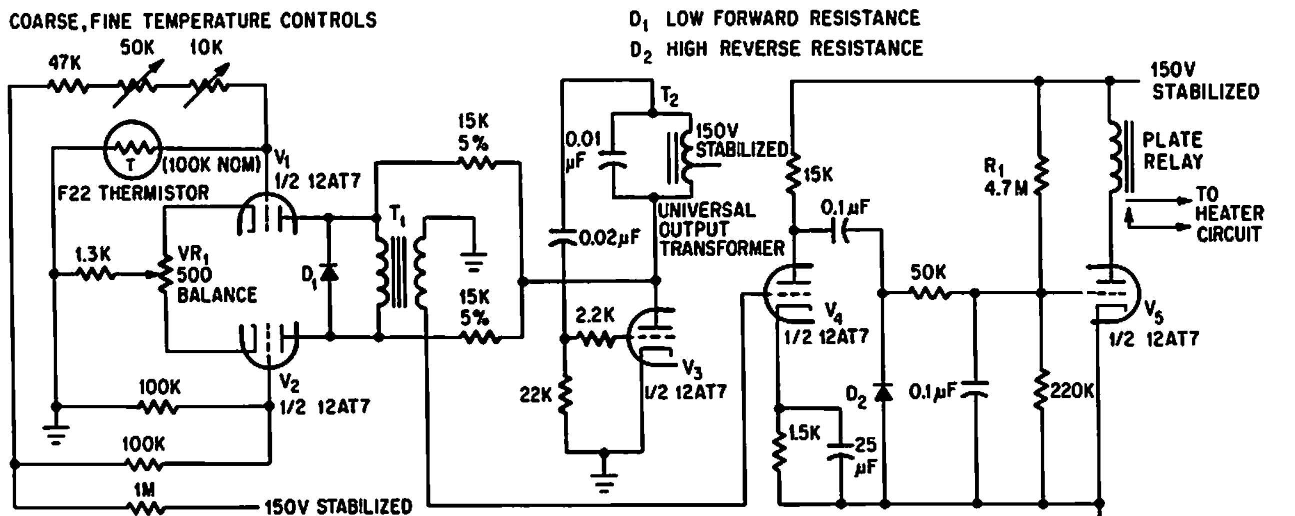


TEMPERATURE-SENSING TD OSCILLATOR—Mylar capacitor with known and reproducible temperature characteristics makes oscillator frequency vary with temperature. Diode bias regulator circuit is used.—E. Gottlieb and J. Giorgis, Tunnel Diodes—Using Them as Sinusoidal Generators, *Electronics*, 36:24, p 36–42.

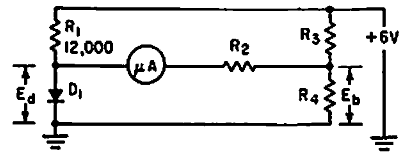


REVERSE THERMISTOR AND R1 FOR COOLING LOAD

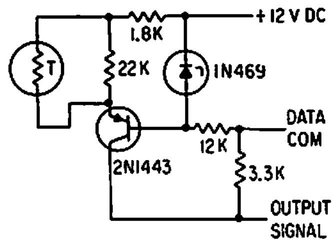
BATH TEMPERATURE CONTROL—Used to maintain temperature of photographic developer solution constant. When temperature drops, thermistor resistance increases and scr is turned on earlier in each cycle by ujt.—J. Embinder, SCRs in the Consumer Market, *EEE*, 14:8, p 100–103.



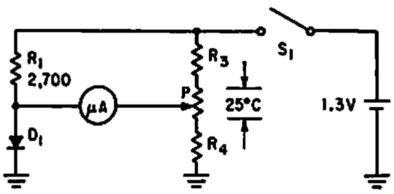
TEMPERATURE CONTROL—Fast thermal response is obtained with high-resistance thermistor in bridge circuit, feeding chopper V1-V2. V3 is Hartley oscillator operating at about 400 cps, to plate-modulate chopper tubes. When bridge is unbalanced by thermistor, pulses in secondary of T1 act through amplifiers V4 and V5 to operate relay.—G. A. R. Trollope, Thermistor Regulator Provides Fast Response, *Electronics*, 39:5, p 106–107.



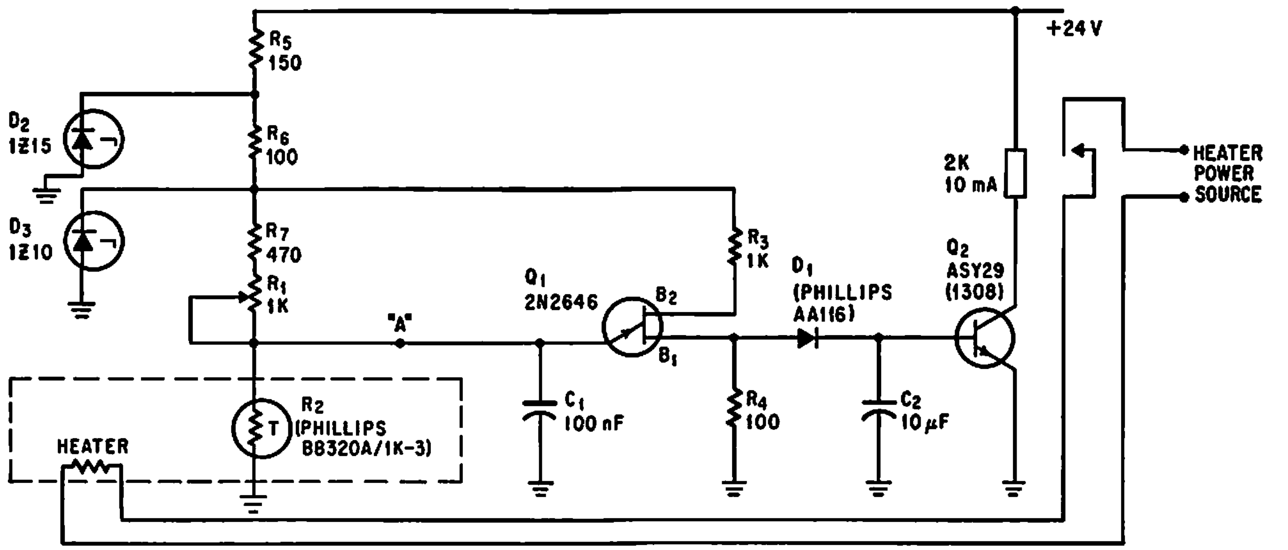
LIMITED-RANGE DIODE THERMOMETER—Values of R3 and R4 determine portion of temperature spectrum to be measured, while R2 determines full-scale temperature value of meter, which may be as low as 25°C. Meter depends on fact that voltage drop across germanium diode is linear function of temperature.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.



TEMPERATURE MONITOR—Senses variations in ambient temperature near telemetry detector in space probe. Zener diode maintains constant voltage on transistor base.—S. Chase, Jr. and F. Schwarz, Mariner II Instrumentation: What Will It See on Venus?, *Electronics*, 35:50, p 42–45.

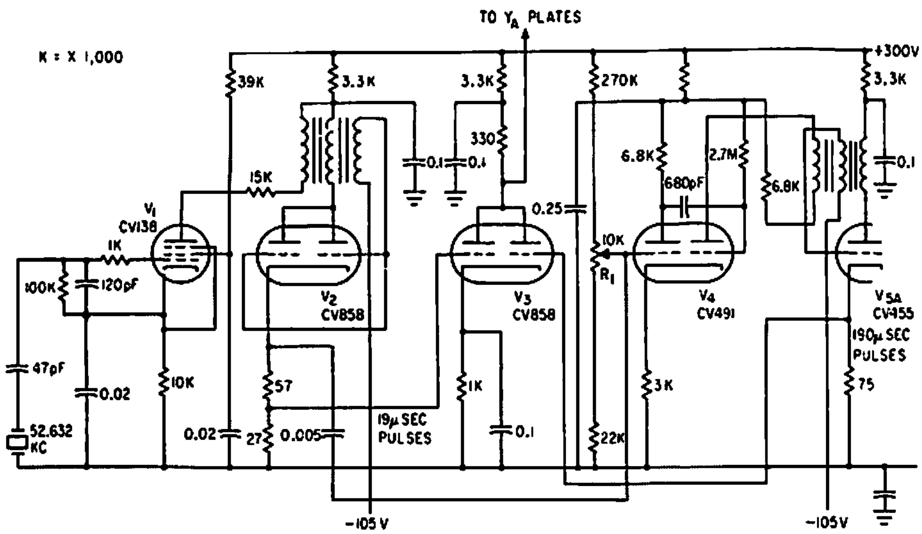


NULL-INDICATING DIODE THERMOMETER—Microammeter serves as null indicator. When potentiometer is adjusted for zero current, arm of potentiometer indicates temperature value directly. Values of R3 and R4 are chosen to place 25°C range anywhere from near absolute zero to about 40°C.—L. E. Barton, Measuring Temperature with Diodes and Transistors, *Electronics*, 35:18, p 38–40.

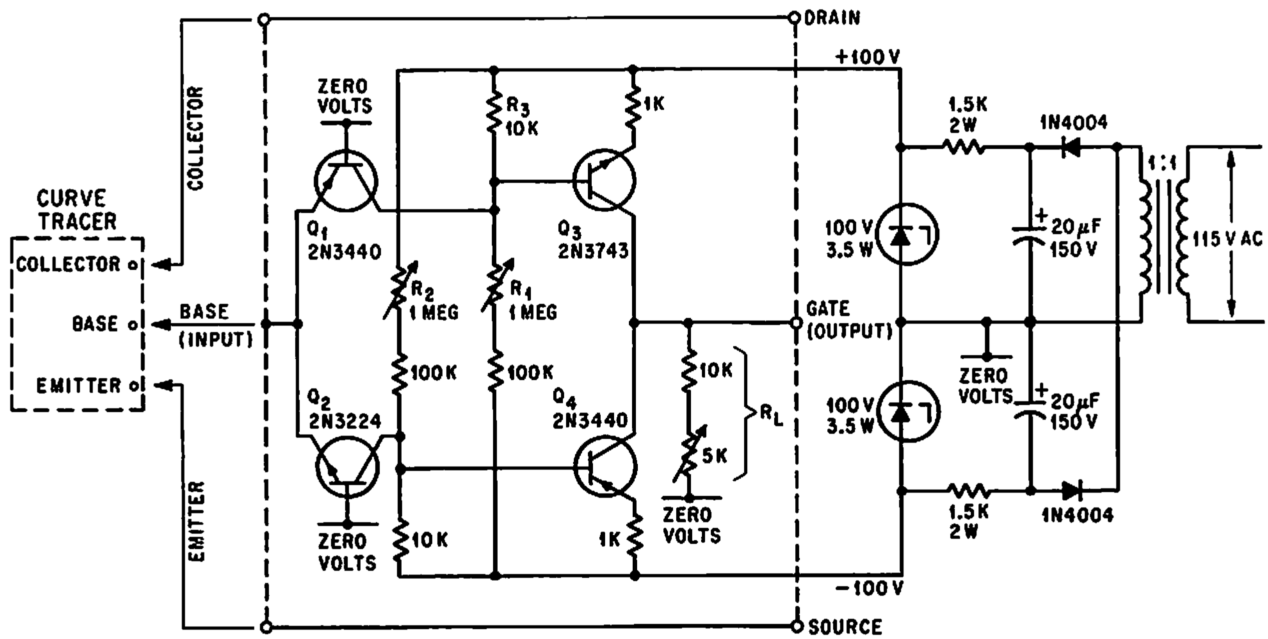


LIQUID BATH THERMOSTAT FOR 0.01° CONTROL—Based on thermistor R2, which has linear temperature coefficient of −6% per degree C from 15 to 35 degree C. R2 is one element in relaxation oscillator also consisting of Q1, C1, R1, R3, and R4.—K. van der Geer, Control is Accurate to 0.01°C, *Electronics*, 39:12, p 111.

CHAPTER 91
Test Circuits

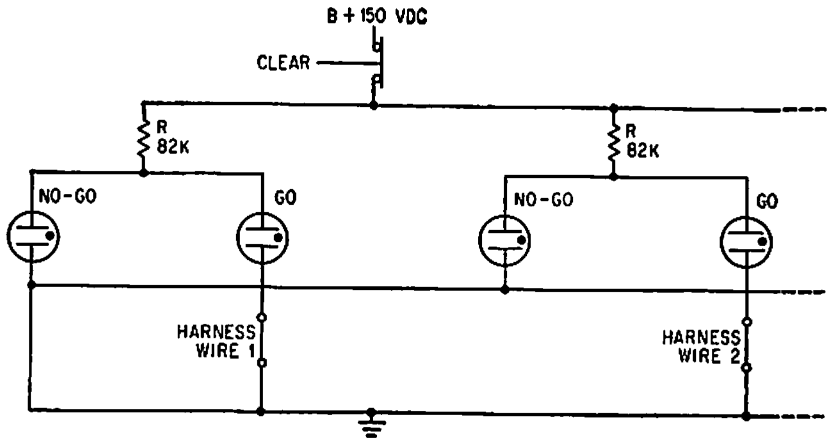


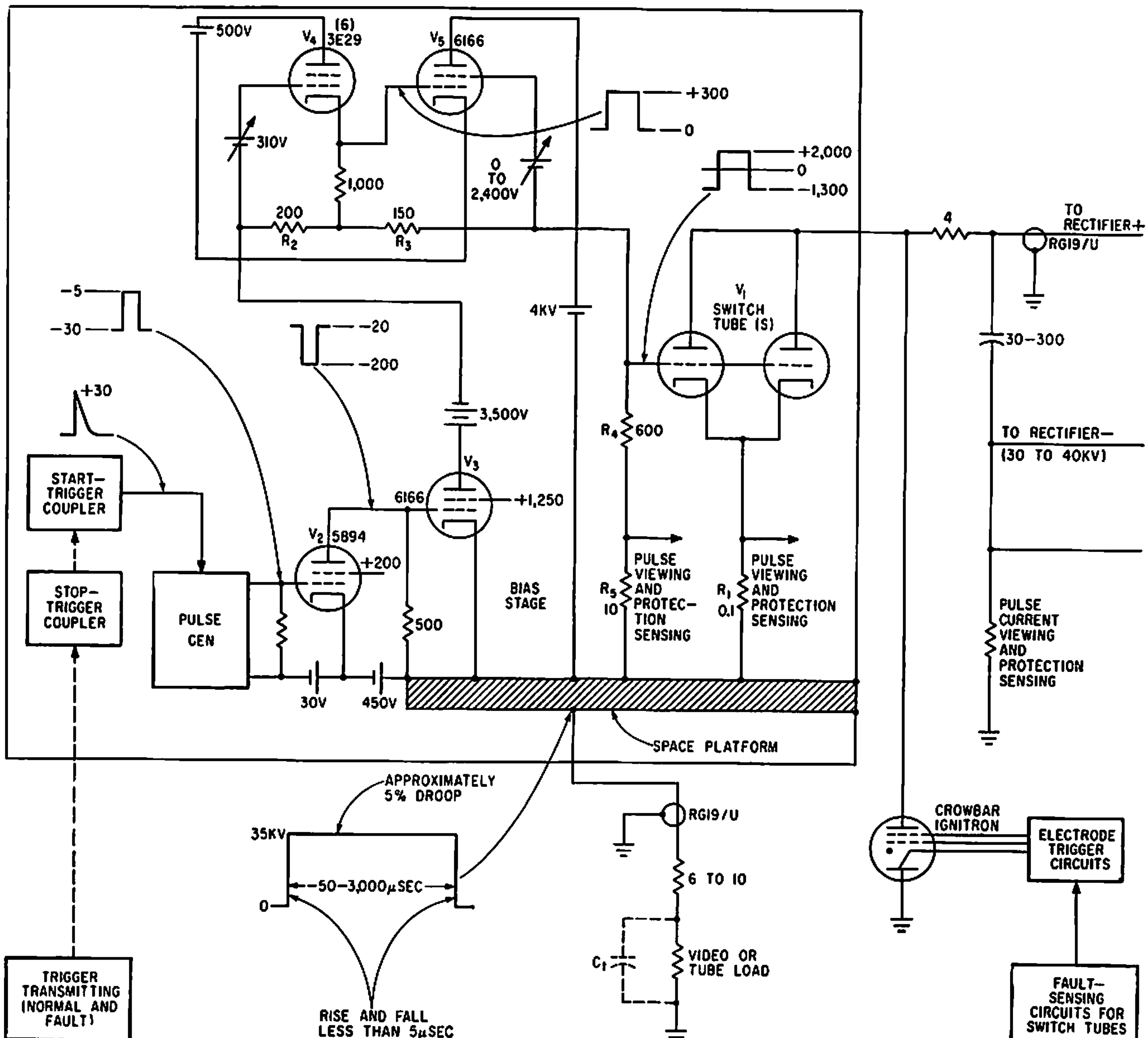
MARKER PULSE GENERATOR—Crystal oscillator V1 triggers blocking oscillator V2 to produce sharp pulses at 19-microsec intervals. These feed mono V4, whose output triggers blocking oscillator V5 to give larger pulse every 190 microsec for dual-beam scope of pulse-echo cable fault finder.—F. Jones and J. H. Reyner, Compact New Instrument Finds Undersea Cable Faults, *Electronics*, 35:37, p 48–50.



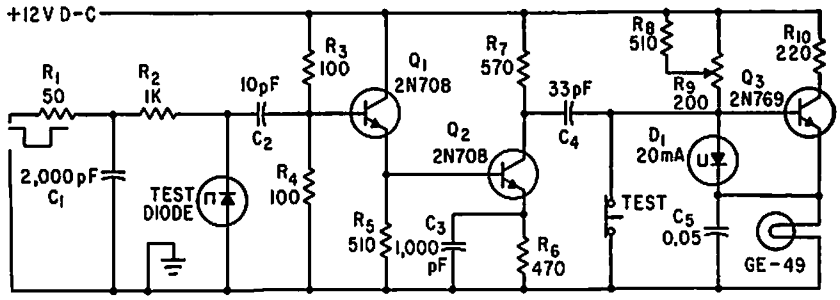
FET ADAPTER FOR CURVE TRACER—Used to convert input current steps from Tektronix 575 or other curve tracer to output voltage steps for fet gate.—R. Williams, Adaptor for Curve Tracer Tests FET's at High Voltage, *Electronics*, 39:5, p 104–105.

HARNESS TESTER USES NEON FLIP-FLOPS—One end of each harness wire under test is grounded. Other end completes circuit for GO glow lamp. Discontinuity in wire opens GO cathode, decreases voltage drop through R, and makes NO-GO lamp glow.—Harness Tester Detects and Indicates Intermittent Faults, *Electronics*, 37:4, p 56–57.

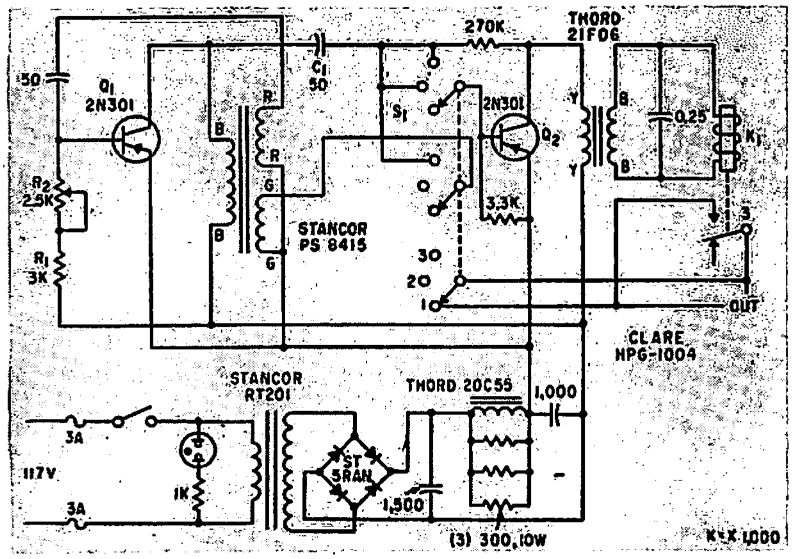




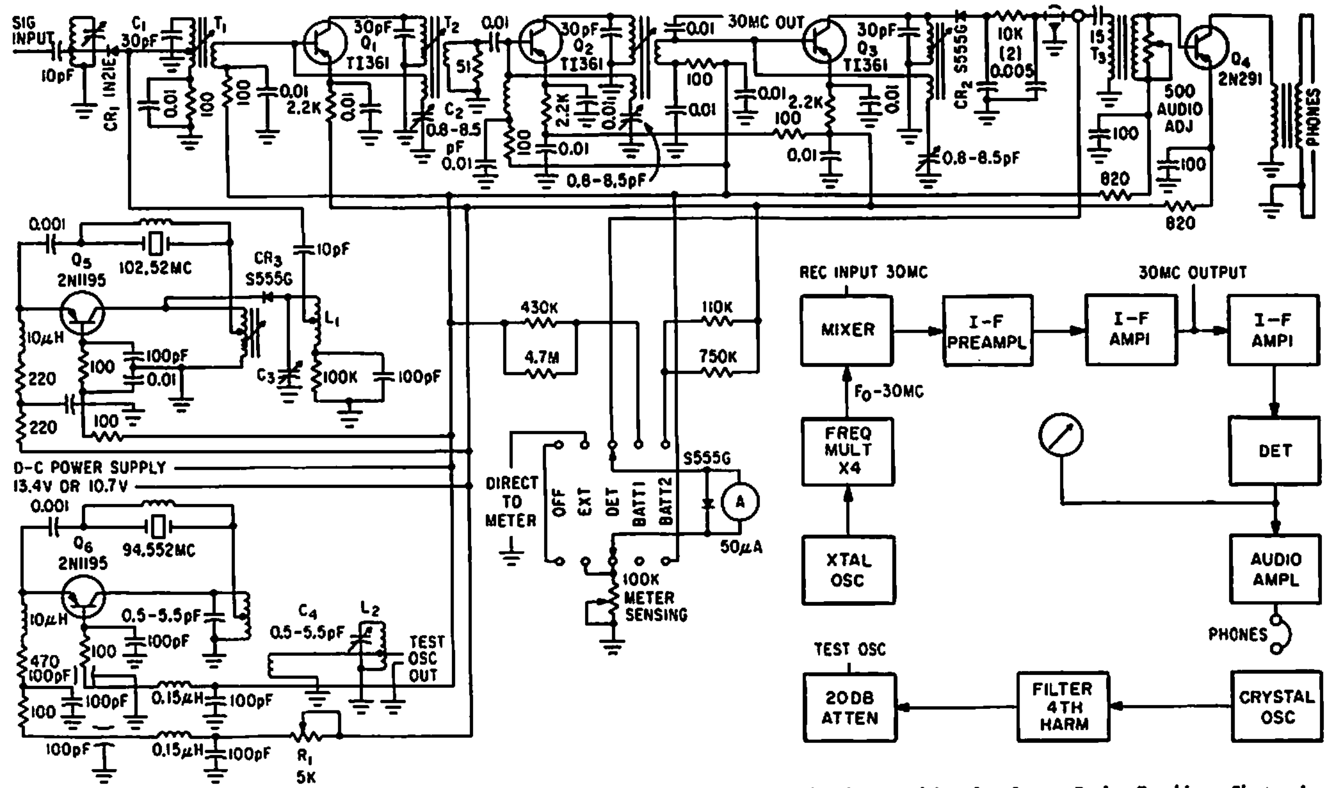
CROWBAR IGNITRON—Multimegawatt high-vacuum modulator tubes for large radars are protected during tests by circuit that is triggered by fault sensors. Total response time for firing ignitron crowbar is below 10 microsec.—T. E. Yingst, Circuits to Control and Protect High-Power Modulator Tubes, *Electronics*, 35:4, p 56–61.



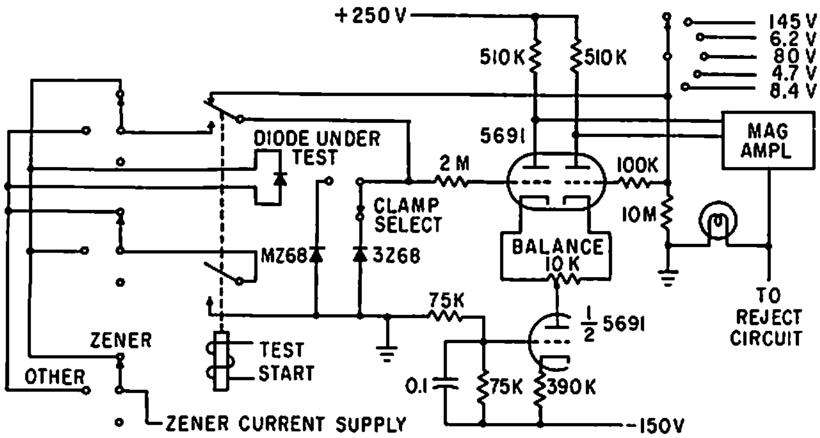
TUNNEL-DIODE SWITCHING-TIME TESTER—With values shown, will light only if tunnel diode under test switches within 0.5-nsec.—J. E. Gersbach and I. Lieber, Switching-Time Tester for Tunnel Diodes, *Electronics*, 35:16, p 48–49.



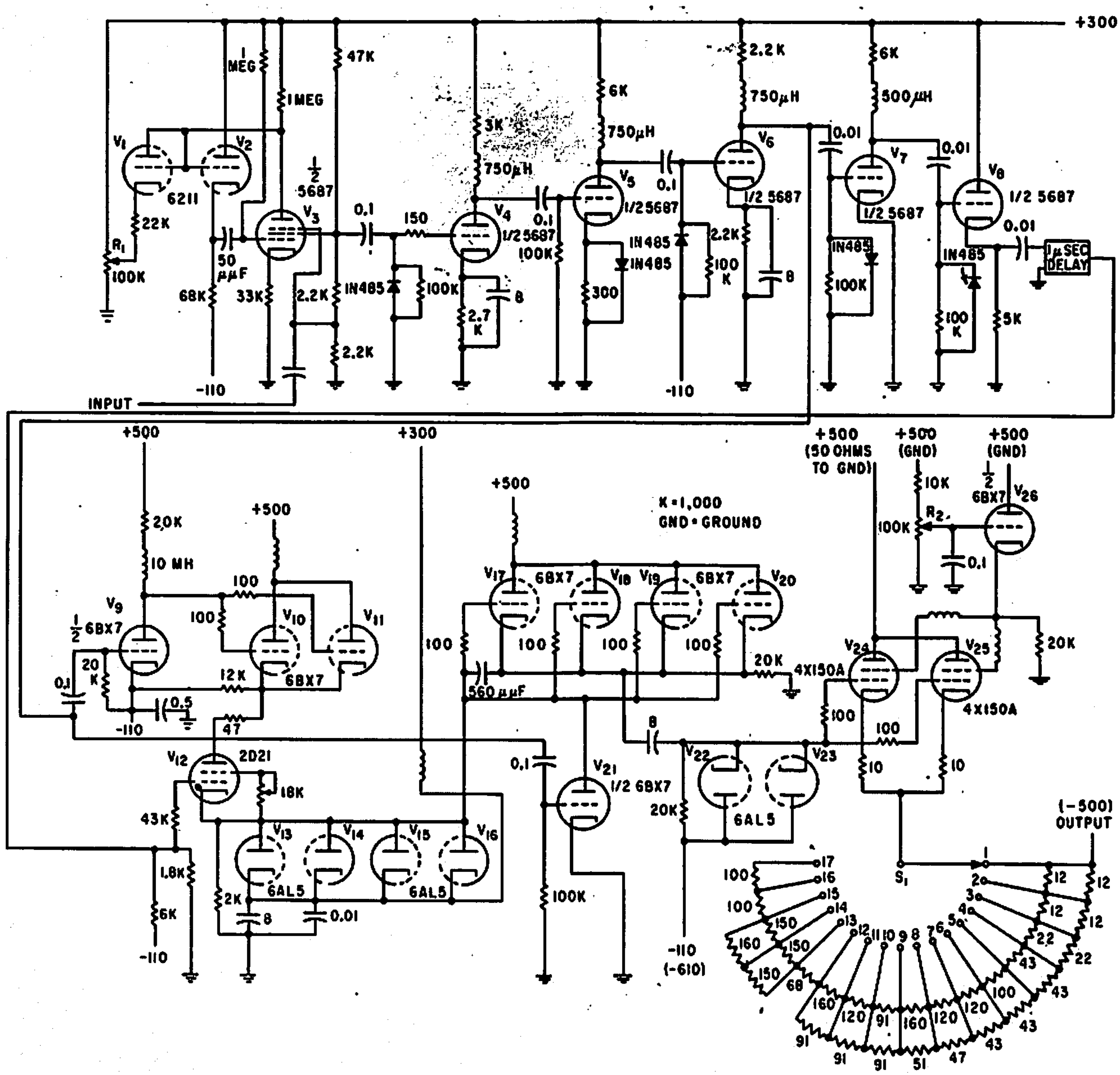
TUNNEL-DIODE TEST ATTACHMENT FOR CURVE TRACER—Adapter switches sweep voltages of curve tracer on and off at reduced duty cycle to prevent overheating of tunnel diode while determining its series resistance. Increasing R1 gives lower duty cycle, because R1-R2 control frequency of inductively coupled series-resonance feedback oscillator Q1.—L. M. Zappulla, Low Duty Cycle Tunnel-Diode Tester, *Electronics*, 35:4, p 47.



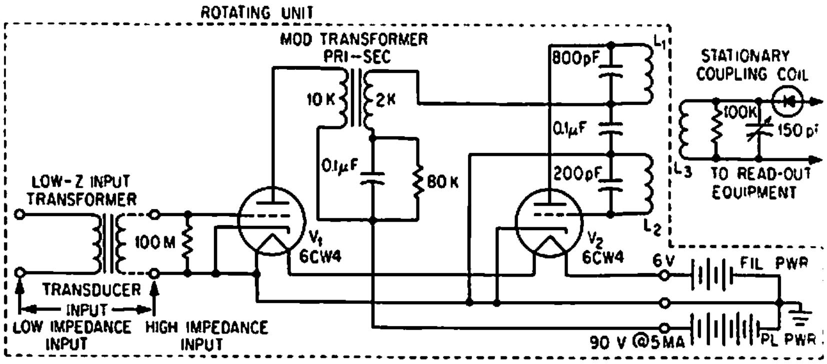
PARAMP TEST SET—Supplies c-w signal that can be injected into parametric amplifier under test, and indicates relative power output of paramp on meter. Test set also has 30-Mc output for feeding automatic noise-figure meter.—C. F. Brett, Parametric Amplifier for Space Probe Tracking, *Electronics*, 34:4, p 41–45.



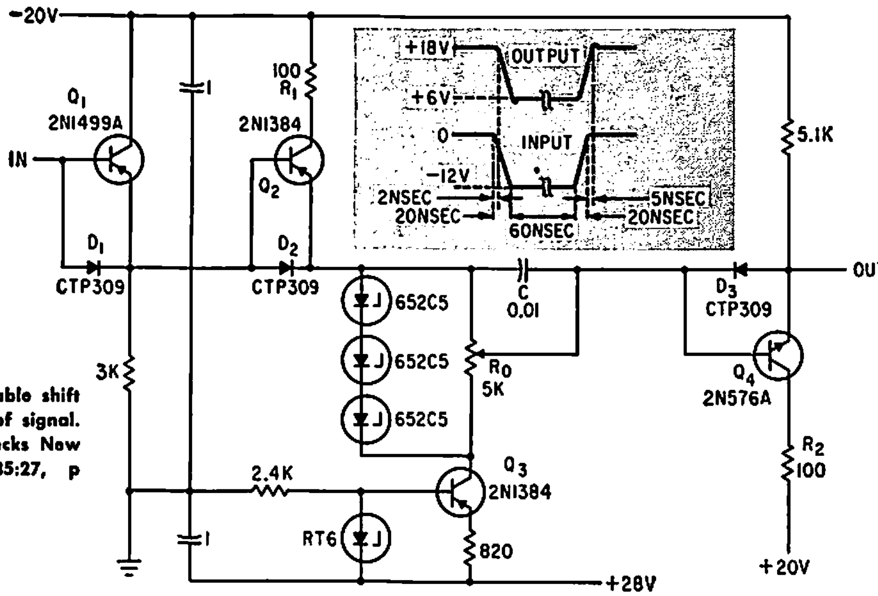
DIODE TESTER—Three-triode constant-current difference amplifier triggers magnetic amplifier that drives reject mechanism of automatic zener voltage tester for diodes.—E. V. Marrott and V. S. Zucco, High-Speed Automatic Diode Tester, *Electronics*, 34:2, p 93–95.



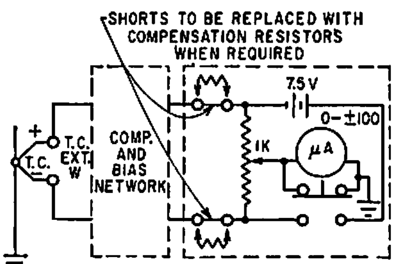
CURRENT PULSE GENERATOR—Used for production testing of ferrite memory cores. Provides pulse amplitudes from 200 ma to 3 amp at repetition rates up to 20 kc.—H. W. Goss, Current Pulse Generator Tests Magnetic Cores, *Electronics*, 33:1, p 80–81.



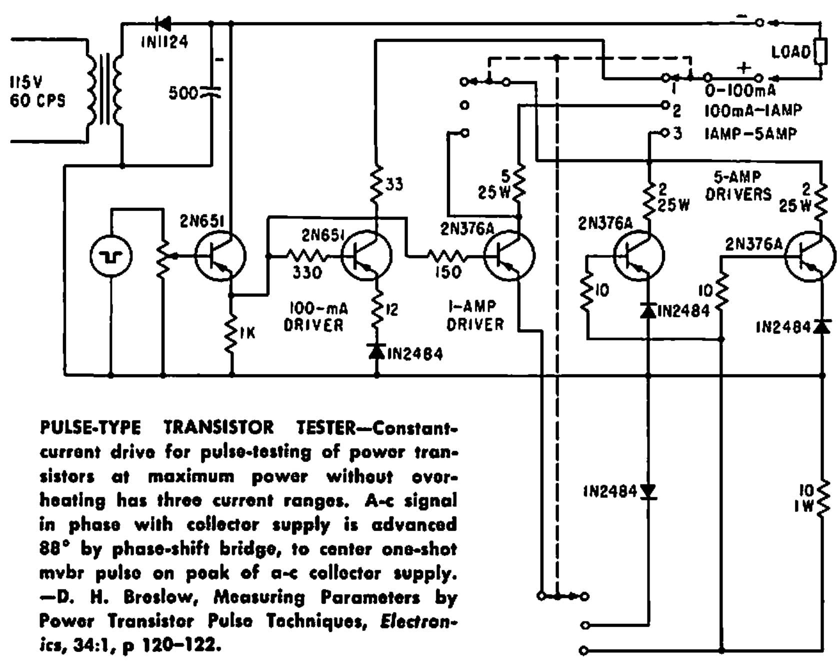
INDUCTIVE TELEMETRY FOR ROTATING TEST FIXTURE—Transducer, oscillator, modulator, and battery supply rotate with device under test. Carrier frequency of 1 Mc, modulated over range of 200 to 10,000 cps, is transferred inductively from rotating output coils L1-L2 to stationary pickup coils.—H. Baumann, Inductive Telemetry Improves Spin-System Measurements, *Electronics*, 36:46, p 41–42.



D-C LEVEL SHIFTER—Provides adjustable shift of up to 18 v in d-c voltage level of signal. —T. Mollinga, D-C Level Shifter Checks New Computer Modules, *Electronics*, 35:27, p 44–45.

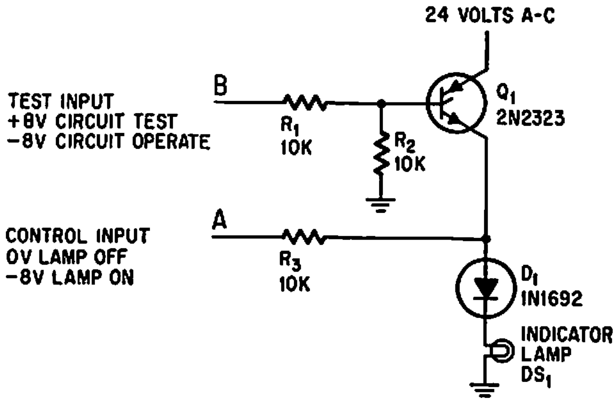


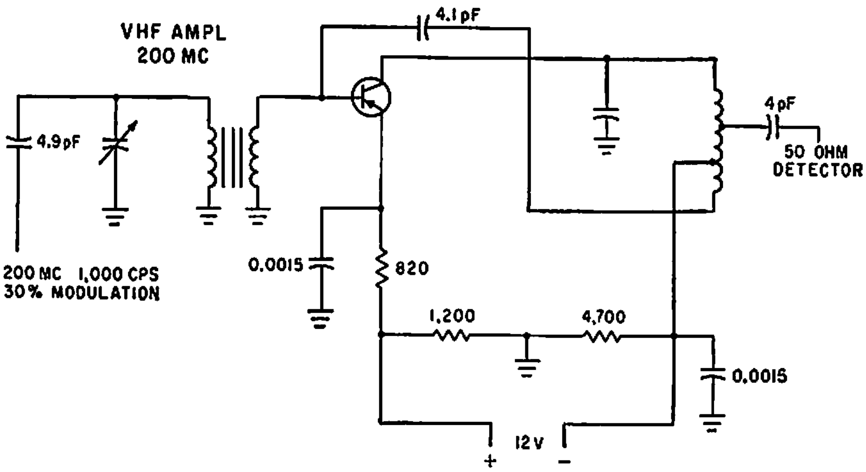
NONHEATING THERMOCOUPLE TESTER—Potentiometer completes bridge circuit of simple test set that checks thermocouple installations for thermal contact, electrical continuity, and correct polarity, without causing temperature change at thermocouple junction. Operation depends on resistance difference between thermocouple wires, which ranges from 6.5 ohms per 100 feet of 28-gage copper wire to 266 ohms for Chromel-P.—S. Meieran, Tester Checks Out Thermocouple Circuits, *Electronics*, 36:11, p 102–106.



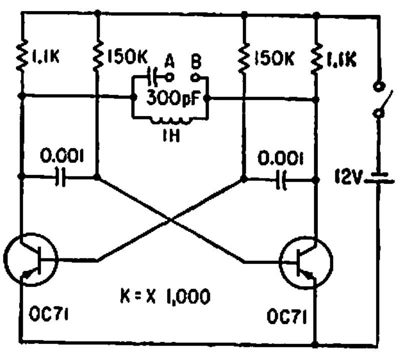
PULSE-TYPE TRANSISTOR TESTER—Constant-current drive for pulse-testing of power transistors at maximum power without overheating has three current ranges. A-c signal in phase with collector supply is advanced 88° by phase-shift bridge, to center one-shot mvbr pulse on peak of a-c collector supply. —D. H. Breslow, Measuring Parameters by Power Transistor Pulse Techniques, *Electronics*, 34:1, p 120–122.

NEGATIVE-LOGIC LAMP DRIVER—Uses one scr and only five components per lamp, to switch lamps rapidly, without relays or excessive loading of control source. Positive test signal at B checks circuit and lamp. Control signal (−8 v) forward-biases gate electrode and scr fires during positive a-c half-cycles.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.

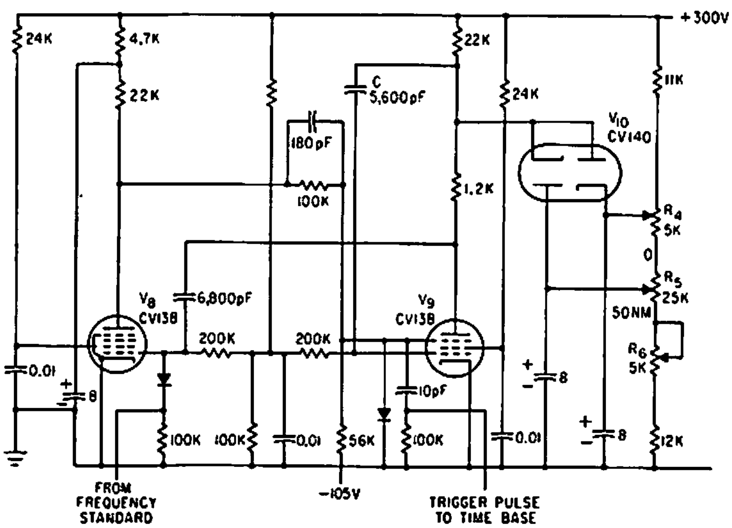




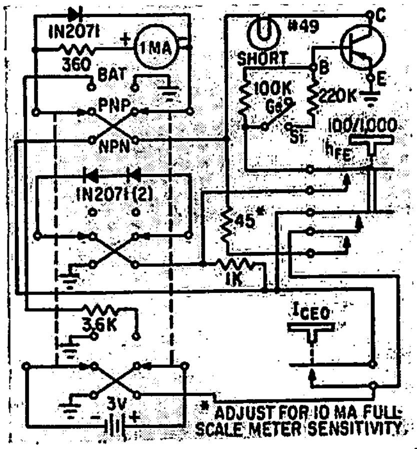
VHF TRANSISTOR AMPLIFIER TESTER—Has fixed match, neutralization, and bias for use as standard test circuit for transistors in tv or vhf r-f amplifier stage. With 2N1742 transistor, power gain is 19 db, bandwidth up to 16 Mc, and maximum noise 5.5 db. —G. J. Flynn, Engineering Trends in Consumer Electronics, *Electronics*, 34:1, p 115–117.



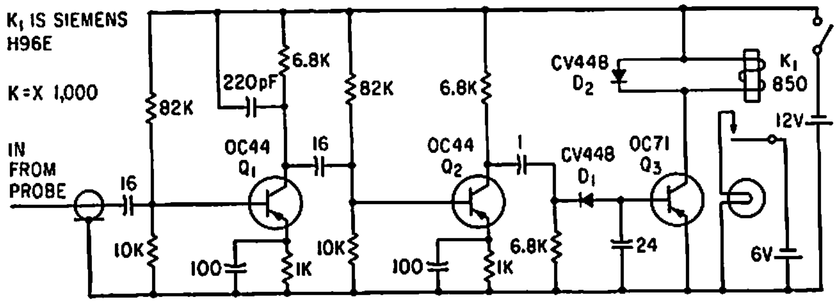
20-KC WIRE-TRACING MVBR—Used as signal source for identifying particular wire at midpoint in cable, for splicing. Ends of wire are connected between A and B, to become part of parallel-tuned circuit of astable mvbr. Tiny probe coil with amplifier is then used to locate wire carrying 20-kc signal.—J. S. Rushton, Probe Identifies Cable Wiring, *Electronics*, 34:9, p 51.



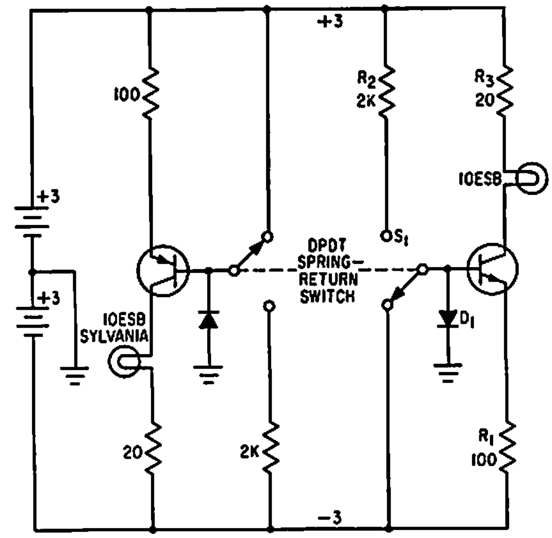
TIME-BASE GENERATOR—Variable time delay V8-V9 permits selecting portions of cro display in pulse-echo cable fault finder. Adjustment range is 190 to 1,140 microsec, or 10 to 60 nautical miles.—F. Jones and J. H. Rayner, Compact New Instrument Finds Undersea Cable Faults, *Electronics*, 35:37, p 48–50.



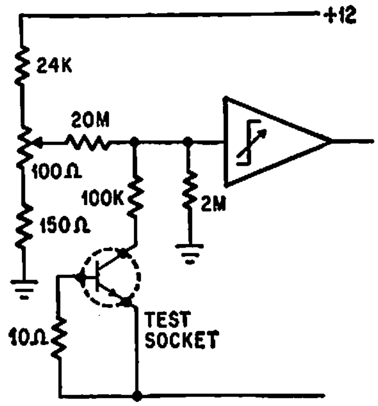
TRANSISTOR TESTER—Leakage current and common-emitter current amplification are checked by using forward voltage drop across two silicon rectifiers in series as reference voltage. Base current of transistor under test is held constant by switching series base resistance.—G. F. Montgomery, Building a Simple Transistor Tester, *Electronics*, 36:16, p 56.



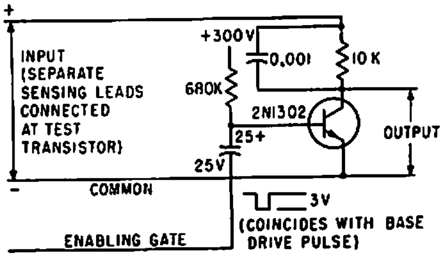
20-KC WIRE-TRACING PROBE—Used to identify wire in middle of long cable, carrying 20-kc mvbr signal. Pickup probe for amplifier has 600 turns wound on U-shaped transformer steel. Relay closes and energizes lamp when probe is held near correct wire.—J. S. Rushton, Probe Identifies Cable Wiring, *Electronics*, 34:9, p 51.



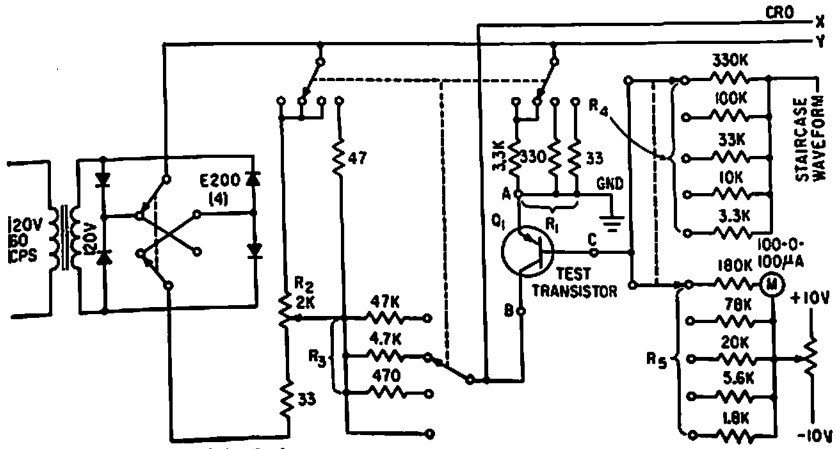
LOW-COST TRANSISTOR TESTER—Indicates, in one simple operation, whether transistor has had catastrophic failure and, if not, whether it can provide minimum data (gain) of 20 at 30 ma. Test circuit is inverter with emitter degeneration resistor R1 providing control of collector current during warm-up of indicator lamp.—E. H. Sommerfield, Simple Transistor Tester Uses Lamp for Indicator, *Electronics*, 34:36, p 80.



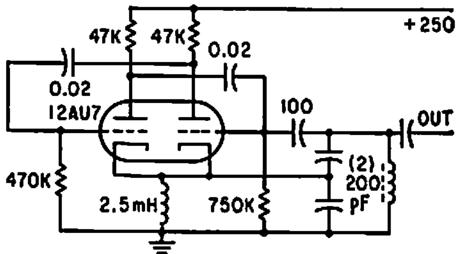
LEAKAGE TESTER—Operational trigger trips when transistor leakage is above 5 ma. Response time is 40 millisec.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



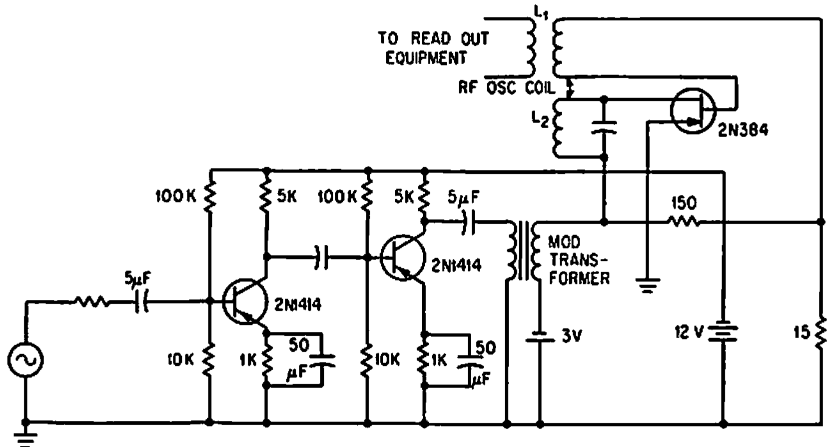
POWER TRANSISTOR TEST GATE—Rectangular pulse opens saturated amplifier; gate output is then a series of pulses whose amplitude is equal to voltage across power transistor under test when full load current is drawn.—D. H. Braslow, Measuring Parameters by Power Transistor Pulse Techniques, *Electronics*, 34:1, p 120–122.



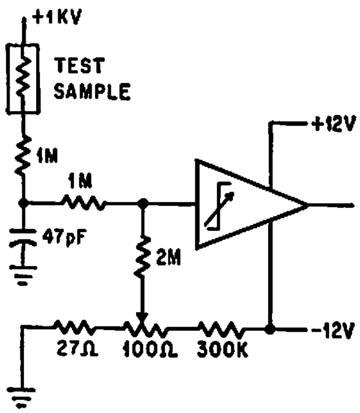
TRANSISTOR CURVE TRACER—Staircase waveform generator supplies test transistor with six values of base current during each cycle, to develop family of curves for cro. Range switches give wide choice of test voltages and currents. Four-layer and tunnel diodes can also be checked.—C. J. Candy, Simplified Curve Tracer for Transistors and Diodes, *Electronics*, 33:34, p 68–70.



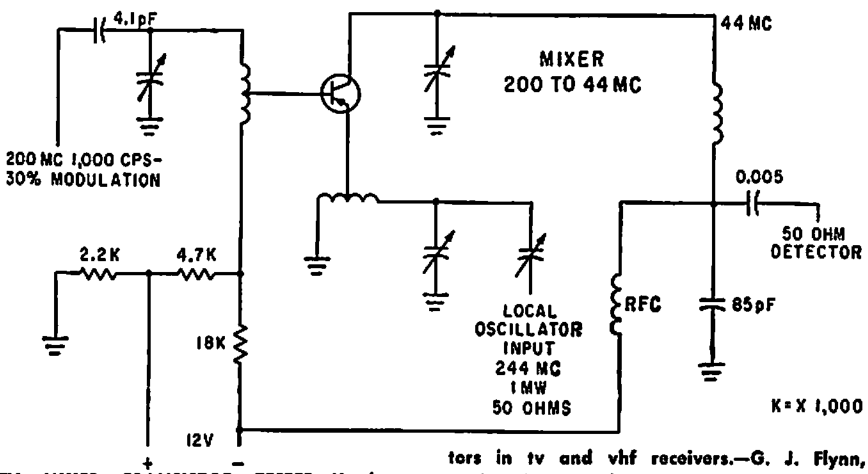
TACHOMETER TESTER—Free-running mvbr, half of which is connected as Colpitts oscillator, gives 1-Mc sine wave, 100% modulated by 15-cps square wave, for testing two-channel tachometer using radioactive sources.—R. R. Bockemuehl and P. W. Wood, Unique Two-Channel Tachometer uses Radioisotopes, *Electronics*, 35:49, p 44–45.



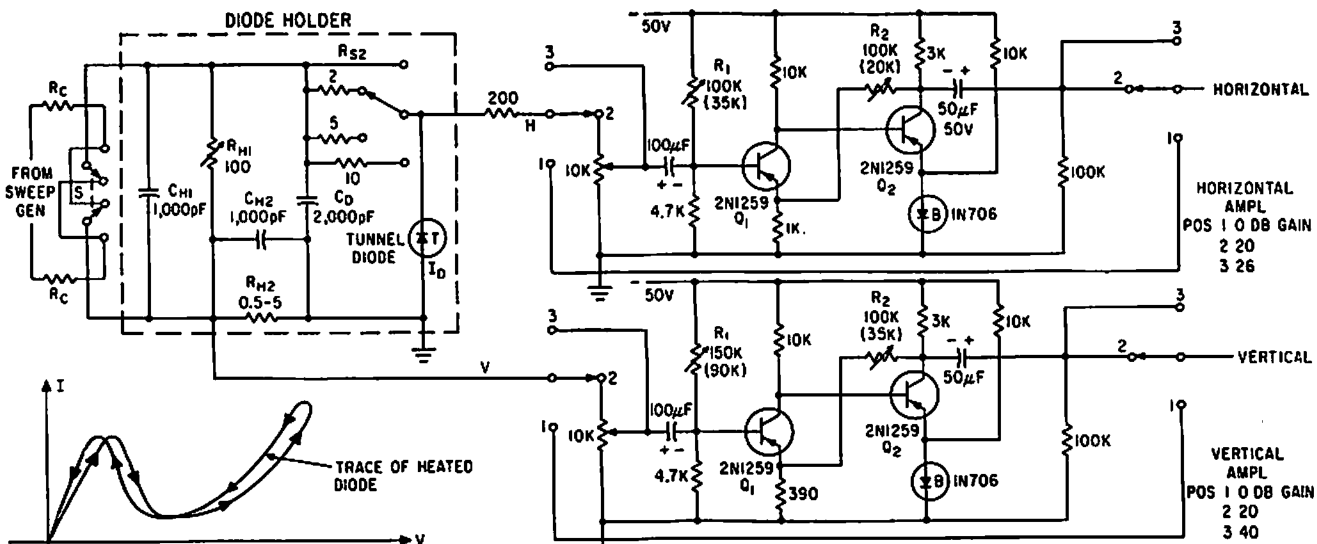
INDUCTIVE TELEMETRY FOR SPIN TEST—Transistors in modulated oscillator-transducer package withstand over 6,000 rpm on spin test while radiating measured data inductively from oscillator coils L1-L2 to stationary coil of readout equipment.—H. Baumann, Inductive Telemetry Improves Spin-System Measurements, *Electronics*, 36:46, p 41–42.



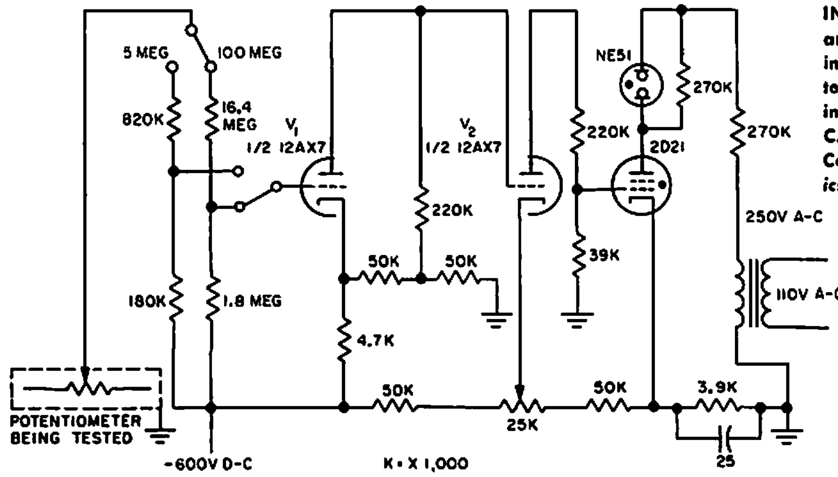
HI-POT TESTER—Operational trigger trips when resistance of sample under test is less than 500,000 meg.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



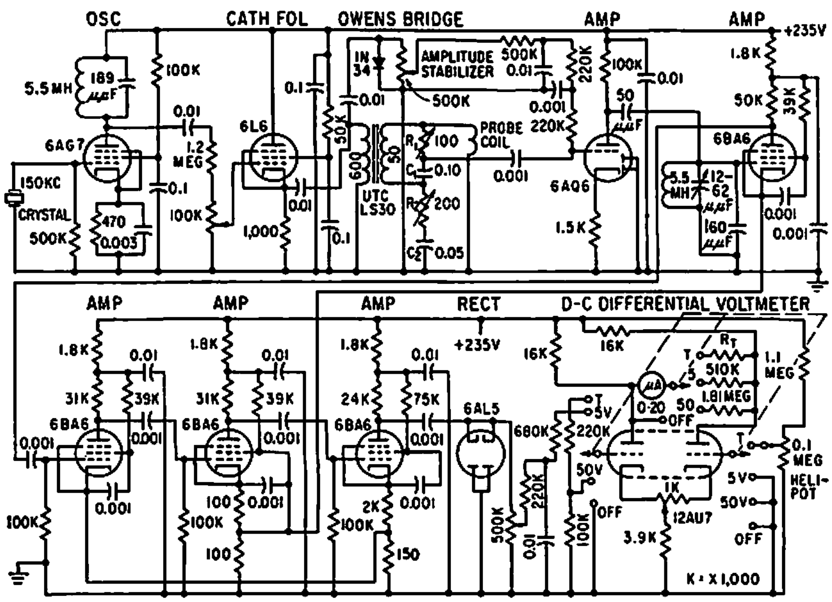
TV MIXER TRANSISTOR TESTER—Used as standarized test circuit for mixer transistors in tv and vhf receivers.—G. J. Flynn, Engineering Trends in Consumer Electronics, *Electronics*, 34:1, p 115–117.



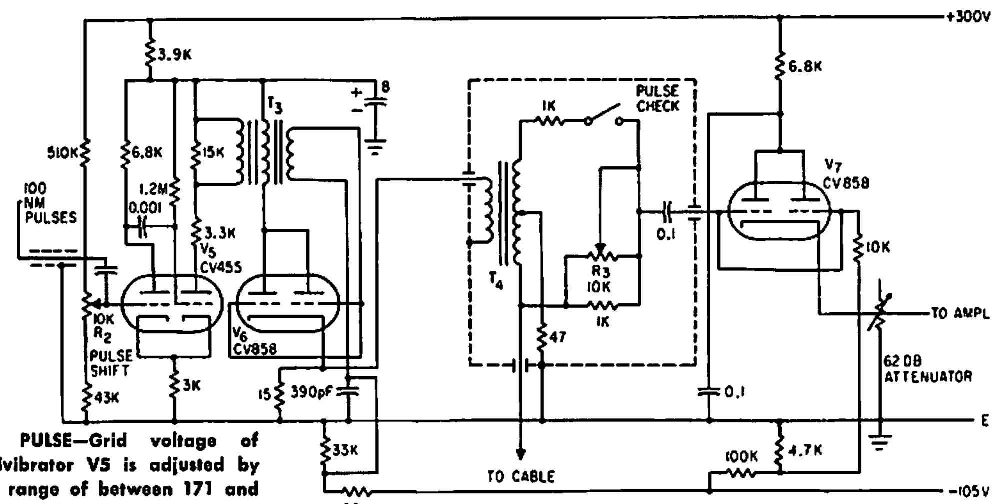
TUNNEL DIODE CURVE TRACER—Diode holder uses germanium blocks as low-inductance resistors, for tracing negative-resistance region of tunnel diode. Heating effects may cause double trace.—H. G. Dill and M. R. MacPherson, Tracing Tunnel Diode Curves, *Electronics*, 33:32, p 62–64.



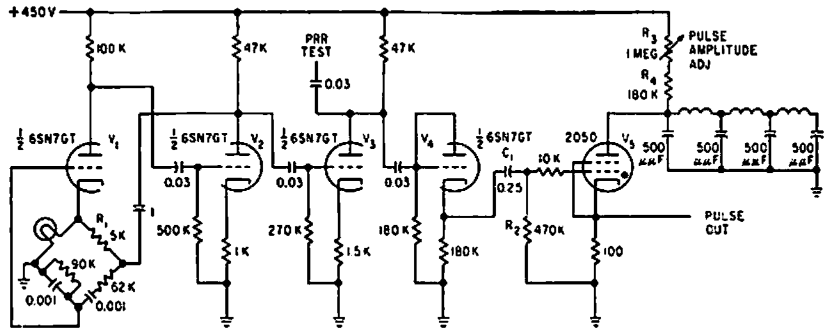
INSULATION RESISTANCE TESTER—Amplifiers and thyratron give go-no-go indication of insulation resistance. Used in production testing of potentiometer-type pressure-sensing instruments over their operating ranges.—C. N. Boode and C. E. Calohan, Analog Comparator for Production Testing, *Electronics*, 31:13, p 47–49.



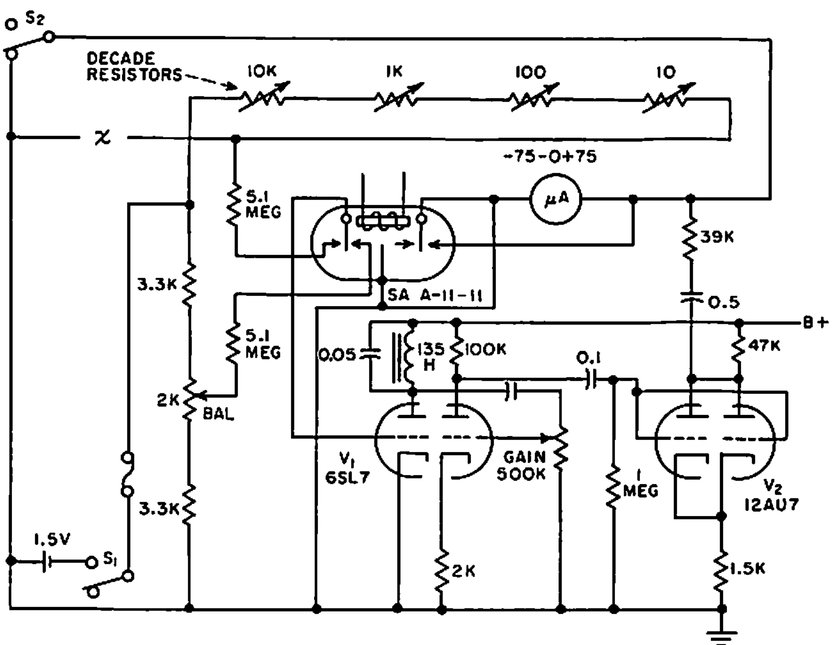
EDDY-CURRENT WIRE FLAW DETECTOR—High-sensitivity eddy-current instrument gives meter indication or permanent record of surface or internal cracks and voids smaller than 0.001 inch in 0.055-inch-diameter zirconium wire used for positioning fuel elements of nuclear reactors. Wire is run through probe coil energized at 150 kc by crystal oscillator, and change in impedance of coil due to flaw is measured with modified Owens bridge. Output of bridge is amplified in five stages, then rectified for measurement by d-c differential voltmeter.—R. G. Myers and C. J. Renken, Detecting Invisible Flaws in Wire, *Electronics*, 31:39, p 72–73.



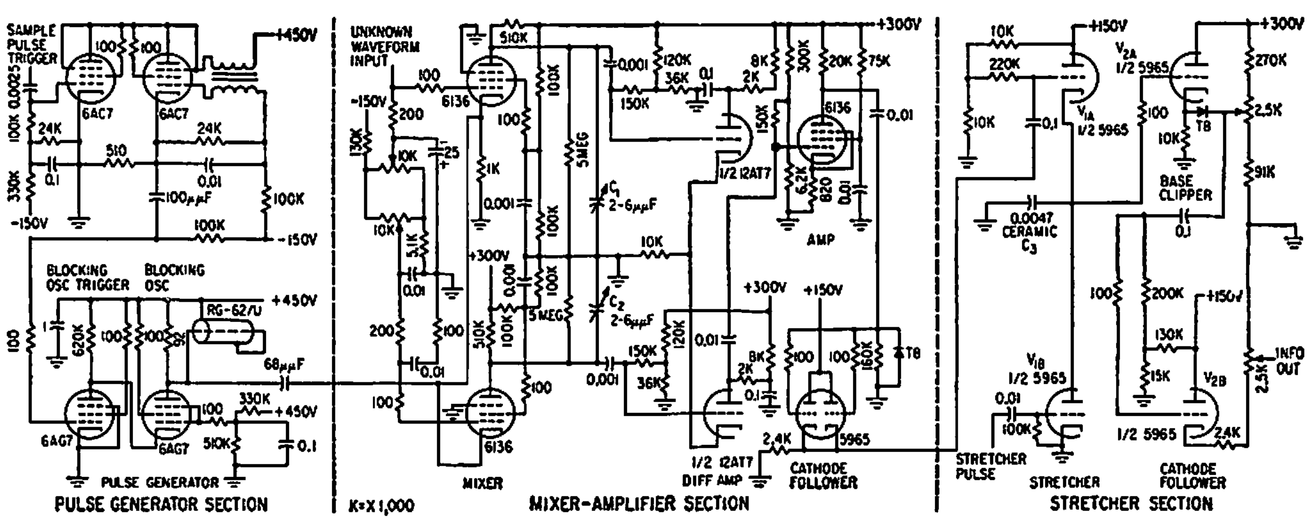
VARIABLE-DELAY PULSE—Grid voltage of monostable multivibrator V5 is adjusted by R2 to give delay range of between 171 and 228 microsec, corresponding to 9 to 12 nautical miles of cable under test. Used in pulse-echo fault finder to generate transmitted pulse in synchronism with marker pulse generator.—F. Jones and J. H. Reyner, Compact New Instrument Finds Undersea Cable Faults, *Electronics*, 35:37, p 48–50.



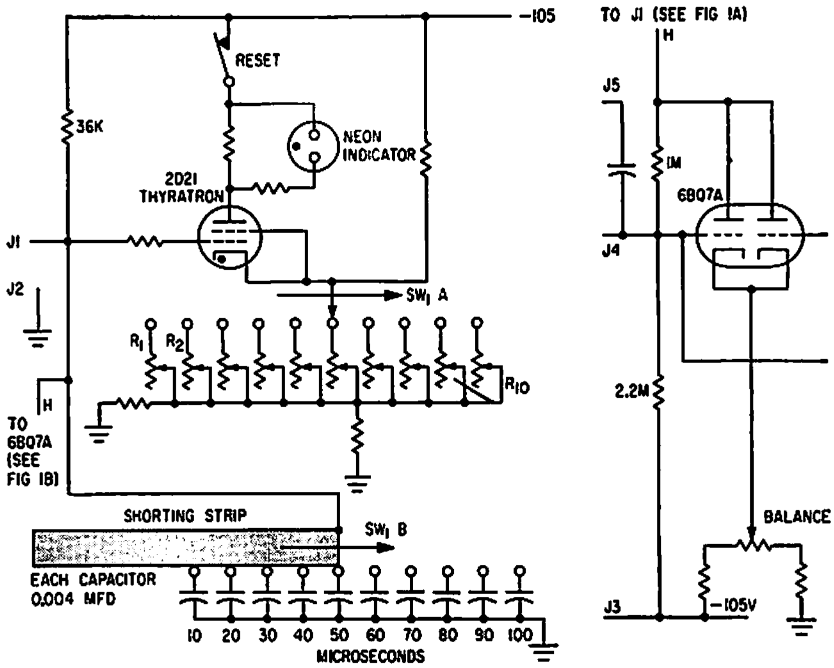
TUBE LIFE-TEST PULSER—Pulse generator produces 0.25-microsec pulses at 50 v for life-testing of 1 to 15 microwave triodes at a time. Amplitude and repetition rate are adjustable within limits.—R. S. Ringland, Pulse Modulator Works into Variable Load, *Electronics*, 31:37, p 102–103.



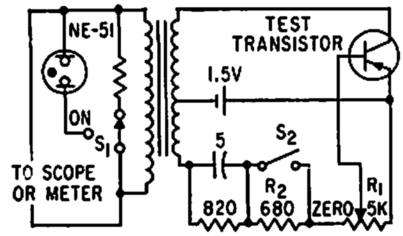
RESISTANCE CHECKER—Amplified error voltage from Wheatstone bridge feeds 75-0-75 microammeter to indicate whether resistance under test is higher or lower than desired value and within preset tolerance. Instrument range is 9,999 ohms in 1-ohm steps. Gives go-no-go indication, to speed production testing.—D. S. Randall, Go No-Go Motor Speeds Resistance Check, *Electronics*, 31:9, p 66–68.



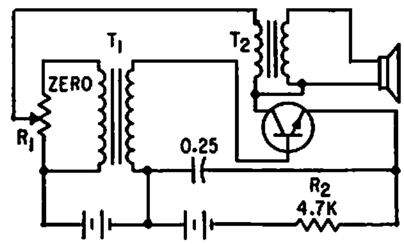
WAVEFORM TESTER—Used in high-speed testing of ferrite cores, transistors, transformers, and other components requiring waveform measurement. Based on sampling of unknown waveform at discrete intervals and comparing resulting digital output with that provided by perfect component.—B. Agusta, Sorting Components by Measuring Waveforms, *Electronics*, 32:7, p 56–59.



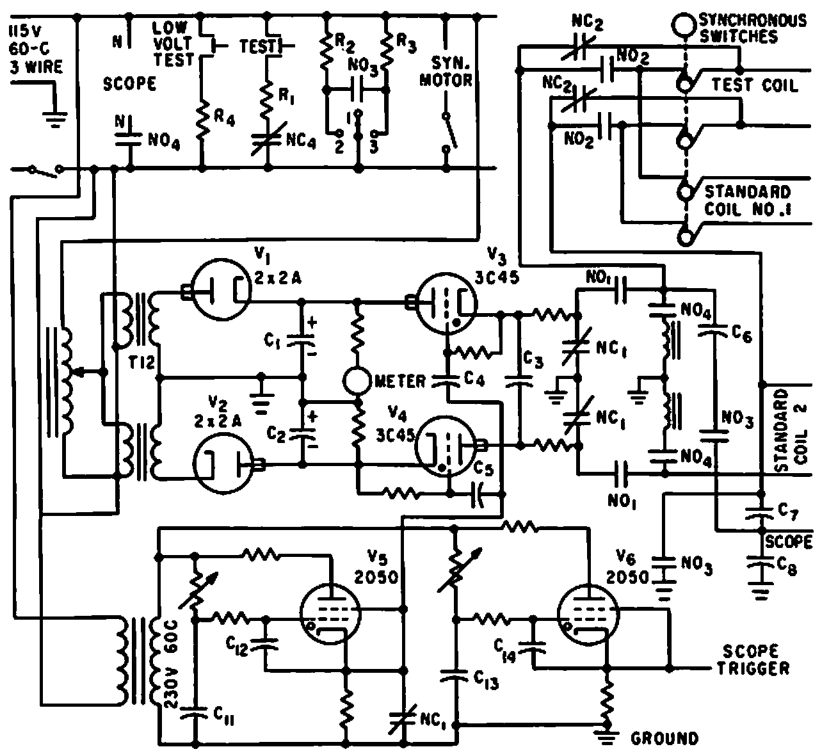
RELAY CONTACT CHATTER TESTER—Monitors either open or closed contacts, in 10-microsec increments for intervals of from 10 to 100 microsec. Thyratron conducts if relay contacts remain open (or closed) longer than predetermined interval. Inverter (at right) triggers thyratron during testing of contacts, and is normally open. Contacts under test are connected to J3 and J4.—E. H. Kopp, Production Line Checker for Relay Contact Chatter, *Electronics*, 33:21, p 94–95.



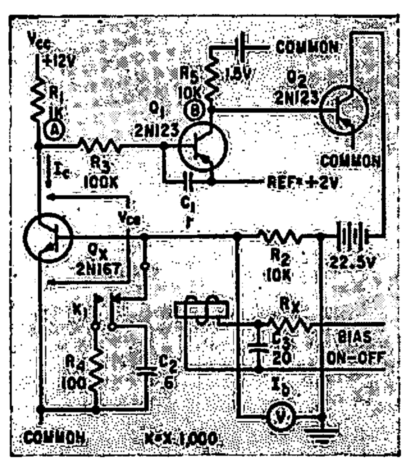
DYNAMIC TRANSISTOR TESTER—Uses blocking oscillator and depends on fact that open, shorted, or excessively leaky transistors will not oscillate. Good transistors should oscillate with R1 set at zero, and make neon lamp glow if S1 is on.—L. G. Sands, Dynamic Testers For Transistors, *Electronics*, 33:8, p 66–67.



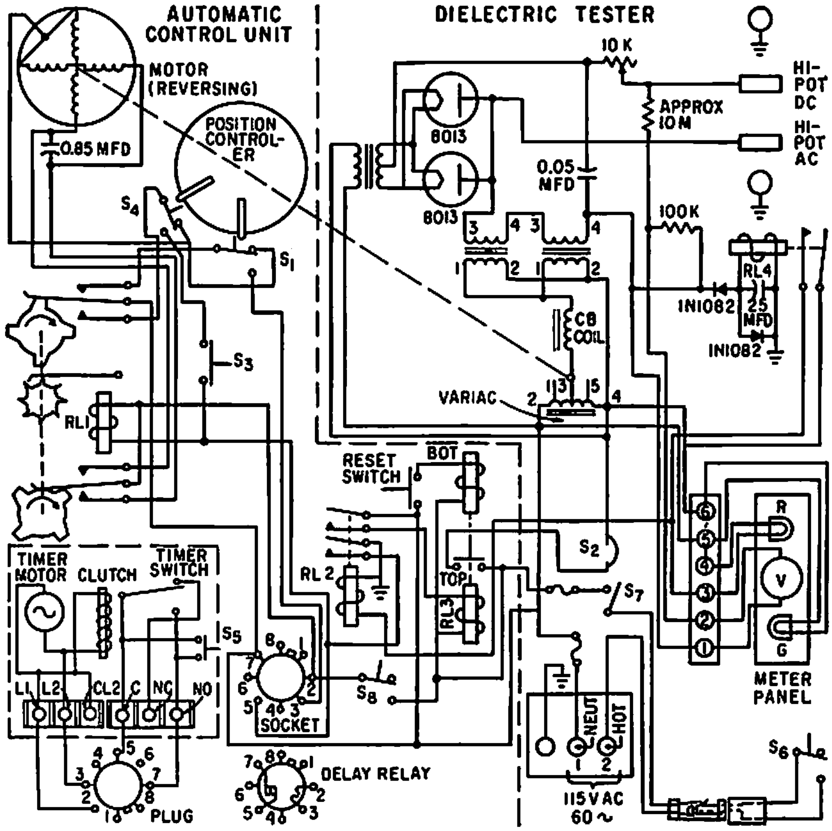
TRANSISTOR TESTER WITH SPEAKER—Blocking-oscillator test circuit provides tone from speaker only when transistor is good (not open, shorted, or leaky). Runaway transistors can be detected by providing npn-pnp switch and reversing it to stop oscillation for a few seconds, then restoring correct position. If transistor then oscillates at different frequency or will not resume oscillation, it is a runaway.—L. G. Sands, Dynamic Testers For Transistors, *Electronics*, 33:8, p 66–67.



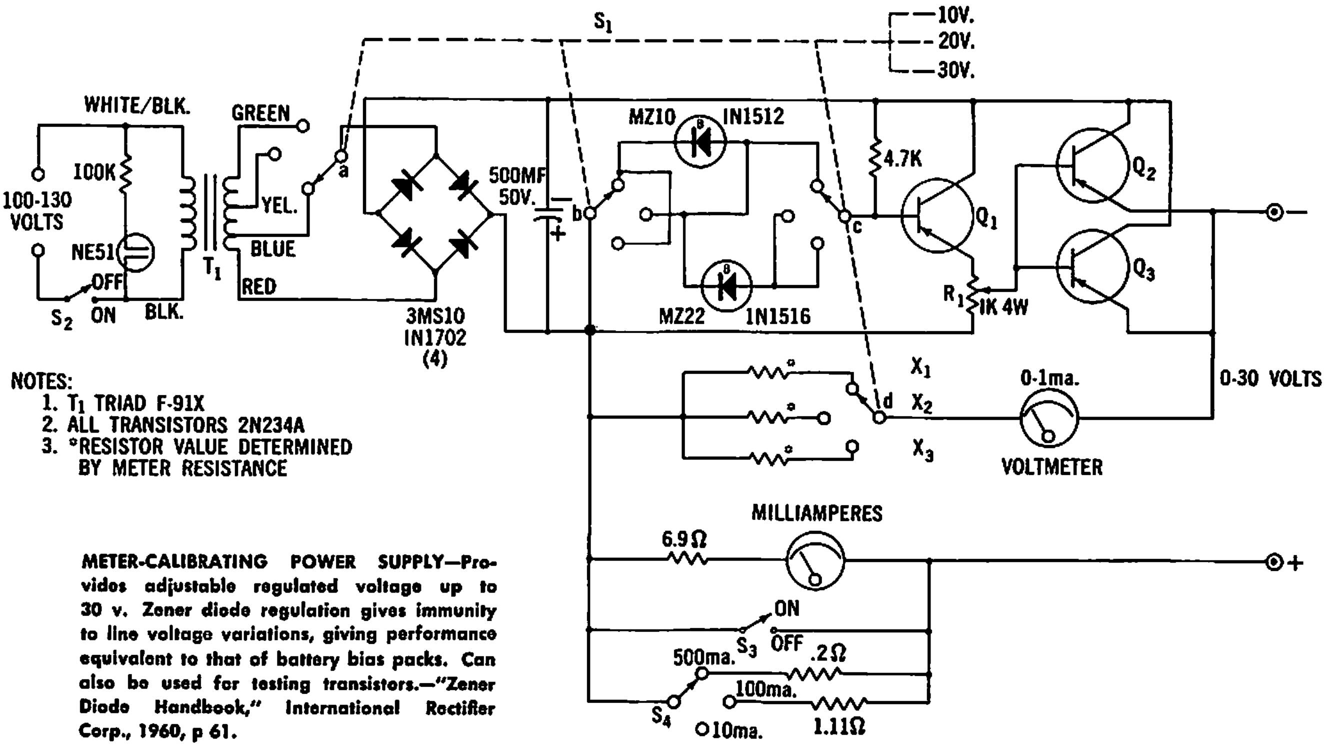
ARMATURE-TESTING BRIDGE—Identical current pulses are injected into perfect standard armature and production armature being tested. Transient response, displayed on cro, permits fault diagnosis and location. Choice of four operating modes provides operating flexibility.—H. R. Weed and S. K. Weed, Pulse Response Pinpoints Armature Faults, *Electronics*, 33:24, p 70–72.



AUTOMATIC BETA CHECKER—Holds collector current of test transistor Qx at preset value while base current is measured and beta determined.—E. P. Hojak, Automatic Measurement of Transistor Beta, *Electronics*, 32:49, p 114–115.

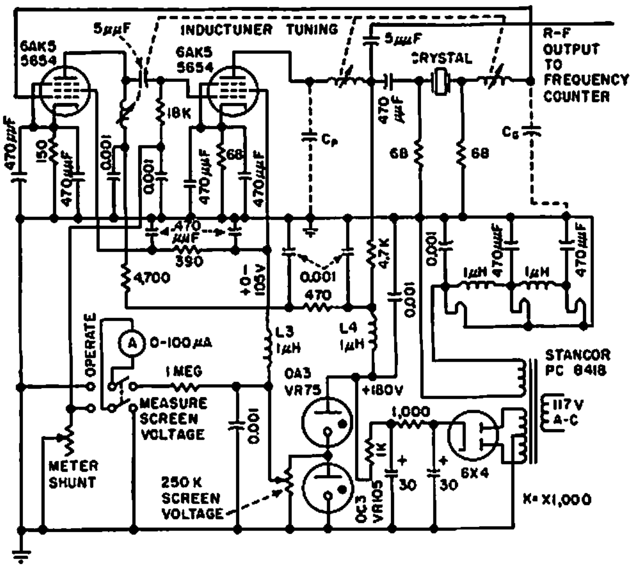


DIELECTRIC-STRENGTH TESTER—Automatic sequencing of test functions minimizes high-voltage danger to operator and improves accuracy of readings. Control system may be inserted in any commercial high-pot tester. —F. J. Clounio, P. M. Degroat, and E. M. Szymanski, Control Makes Test Safe, Accurate, *Electronics*, 33:19, p 88–91.

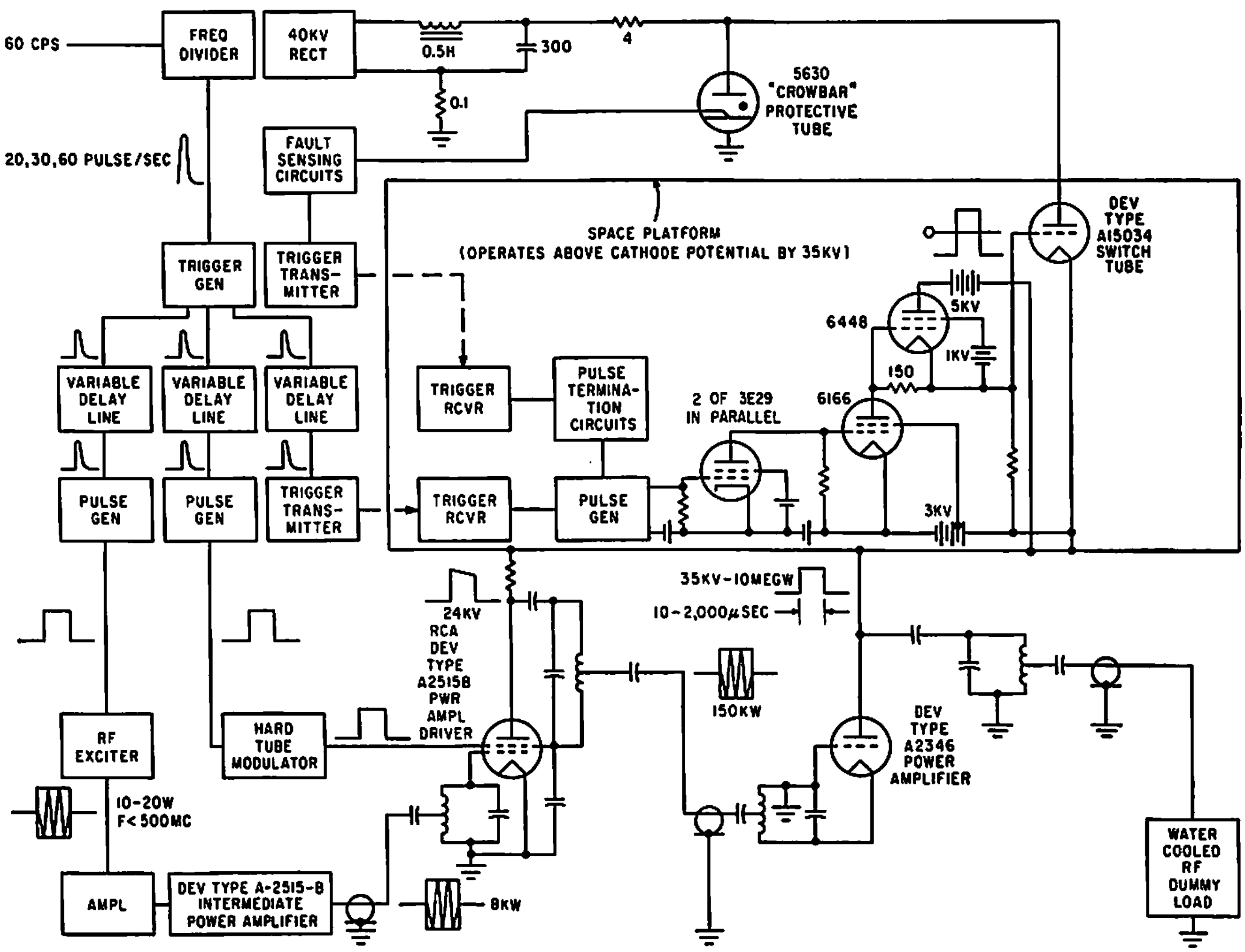


NOTES:
1. T_1 TRIAD F-91X
2. ALL TRANSISTORS 2N234A
3. *RESISTOR VALUE DETERMINED BY METER RESISTANCE

METER-CALIBRATING POWER SUPPLY—Provides adjustable regulated voltage up to 30 v. Zener diode regulation gives immunity to line voltage variations, giving performance equivalent to that of battery bias packs. Can also be used for testing transistors.—"Zener Diode Handbook," International Rectifier Corp., 1960, p 61.

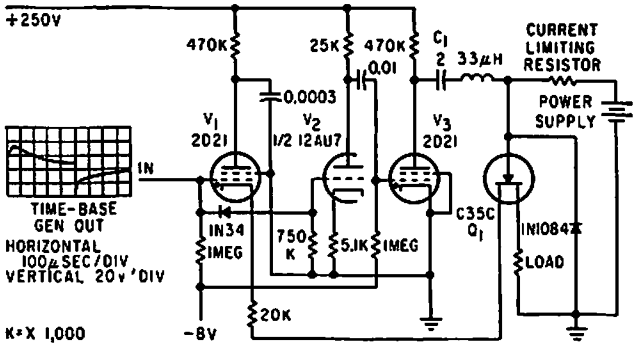


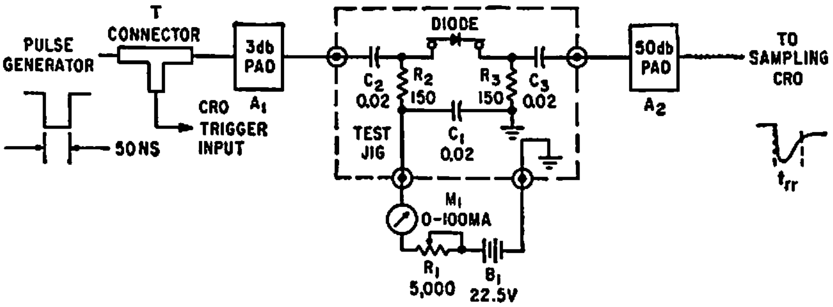
QUARTZ OVERTONE CRYSTAL CHECKER—Rapidly measures equivalent parameters, in range of 75 to 200 Mc, by combining active and passive measuring systems. Crystal being measured controls frequency stabiltiy of oscillatory circuit of crystal impedance meter. —D. W. Robertson, Plug-in Bridge Checks VHF Quartz Crystals, *Electronics*, 31:19, p 82–85.



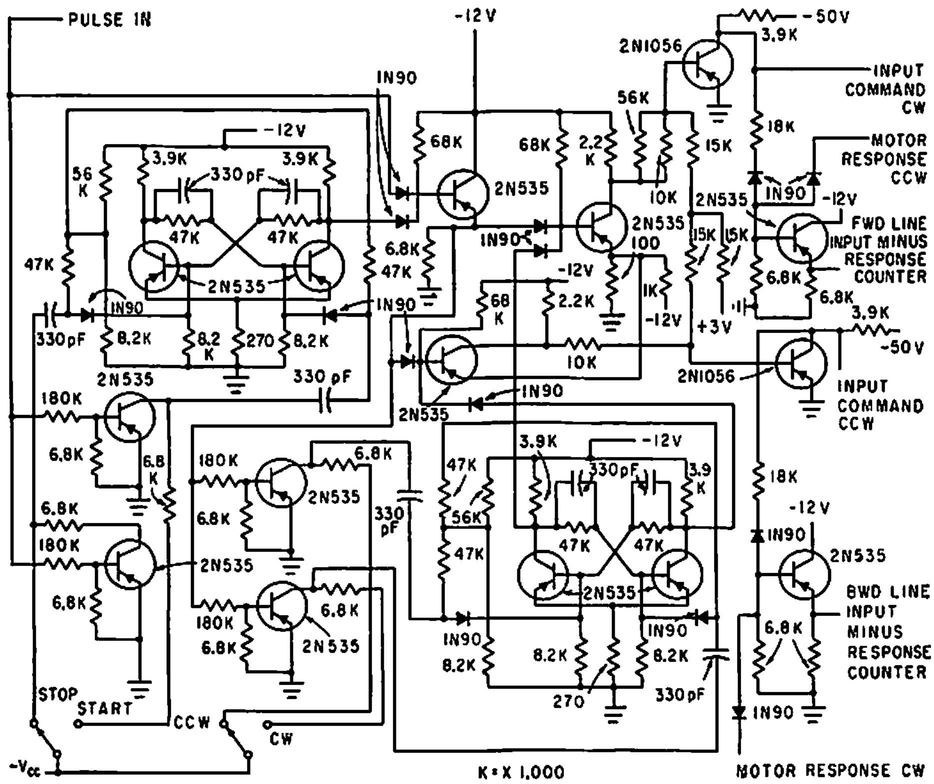
TESTING 300-KW UHF TUBE—If arc develops in protected A2346 tube, ignitron crowbar circuit grounds power supply in less than 5 microsec. Keying circuits operate at 35-kv plate voltage of tube under test, applied in pulses 10 to 2,000 microsec wide through switch tube. Peak plate current is almost 300 amp during 5-megawatt output test. —G. Flynn, Super-Power Electron Tube for UHF Band, *Electronics*, 33:15, p 70–72.

ELECTRO-EXPLOSIVE DEVICE TESTER—Uses combination of tubes and solid-state thyratron to generate single pulse up to 100 amp with duration of several millisec, for testing detonators, primers, squibs, and explosive switches.—V. W. Goldie, R. G. Amicone, and C. T. Davey, Generating Pulses With Solid-State Thyratrons, *Electronics*, 32:33, p 70.

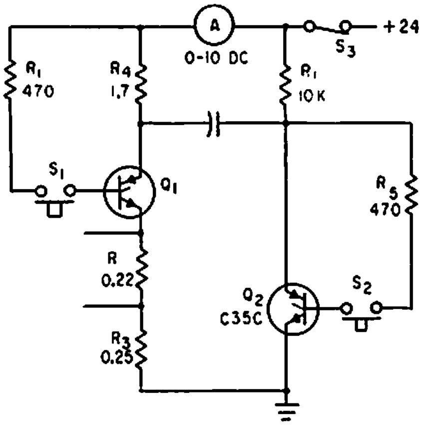




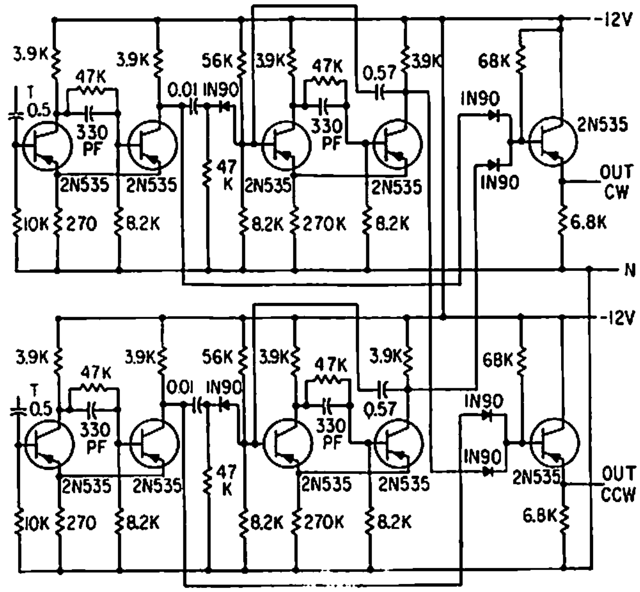
SWITCHING DIODE TESTER—Used in checking performance of computer diodes when handling steep-edged, short-duration pulses. Negative input pulse cuts off diode current, and sampling oscilloscope with 1,000-Mc bandwidth permits study of diode recovery times down to 500 picosec.—W. S. Eckess and P. G. Ducker, Measurement of Diode Switching Characteristics, *Electronics*, 33:15, p 59–61.



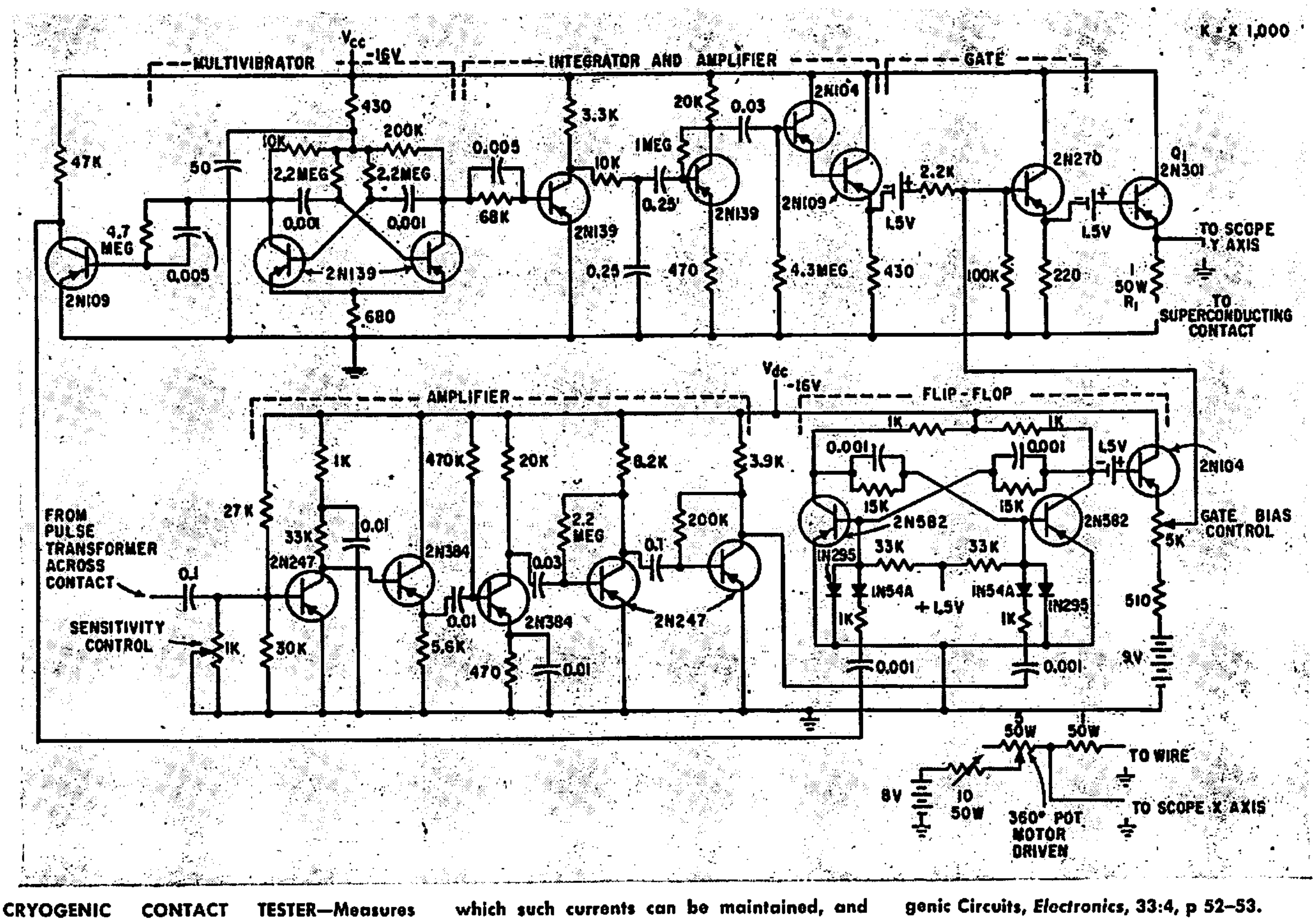
STEPPER MOTOR TESTER—Digital test equipment automatically evaluates performance of magnetically detented stepper motors in several modes, for wide variety of test conditions. Analyzer compares number of applied voltage steps with number of motor movements. Pulse train from power amplifier is gated through logic circuits that prevent switching from occurring in middle of pulse, and keep input pulse line closed even when switching motor direction.—H. J. Weber and M. Weiss, Analyzing Magnetically-Detented Stepper Servo Motors, *Electronics*, 33:39, p 71–74.



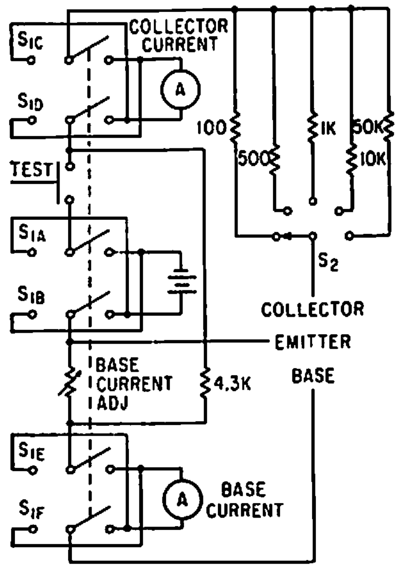
MEASURING SCR TURNOFF TIME—Q1 in parallel inverter circuit is triggered by closing S1, to give 10 amp of test current. When S2 is closed after warmup, Q2 turns on, connects positively charged plate of C1 to cathode of Q1, and makes reverse current flow. If turnoff time of Q1 is less than 12 microsec, it will remain turned off and ammeter reading will return to zero. If test rectifier fails to turn off, S3 should be opened immediately to prevent overheating.—D. V. Jones, Turn-Off Circuits for Controlled Rectifiers, *Electronics*, 33:32, p 52–55.



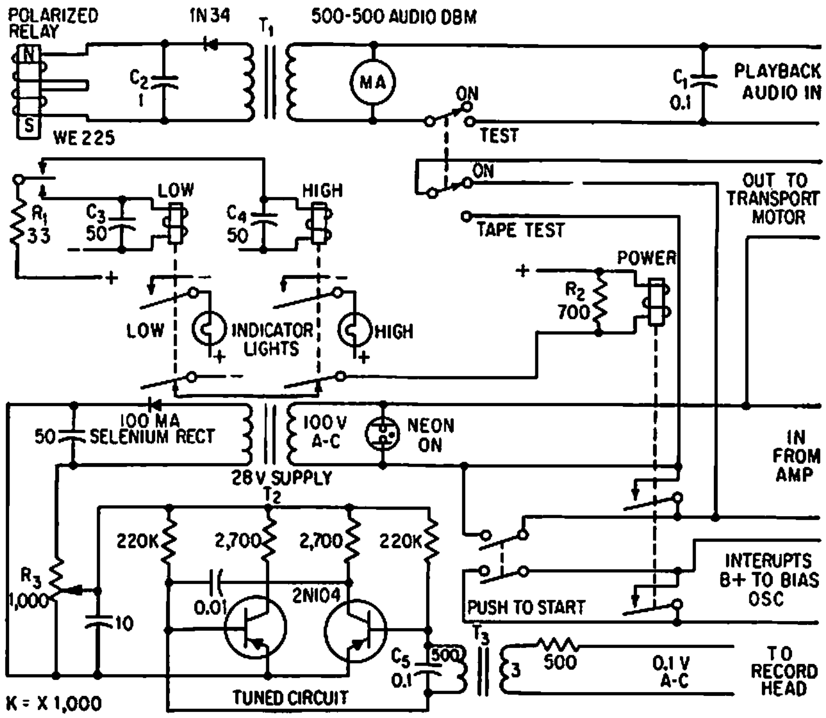
STEPPER MOTOR RESPONSE LOGIC—Clockwise and counterclockwise pickoff channels each drive monostable mvbr, with output of each being added to signal of other channel. Direction-of-rotation information is supplied because pulses appear only on line whose pickoff's signal came first.—H. J. Weber and M. Weiss, Analyzing Magnetically-Detented Stepper Servo Motors, *Electronics*, 33:39, p 71–74.



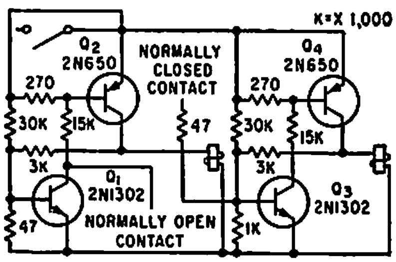
CRYOGENIC CONTACT TESTER—Measures critical current in superconducting contacts during periods shorter than 100 microsec in which such currents can be maintained, and gives oscilloscope display.—J. I. Pankove and R. Drake, Measuring Critical Current in Cryogenic Circuits, *Electronics*, 33:4, p 52–53.



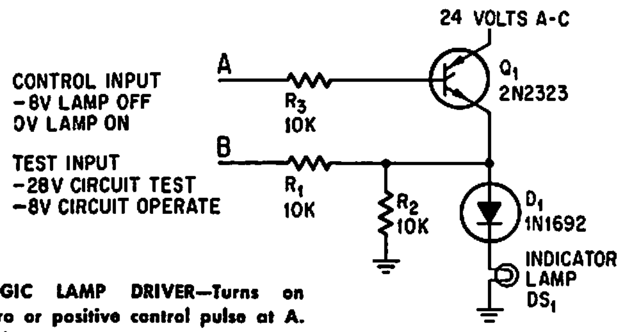
TRANSISTOR GAIN AND LEAKAGE TESTER—Designed for general testing of production units. Switch S1 changes over from npn to pnp transistors. After controls are set for a specific transistor type, checking involves only noting base current when test button is pressed.—F. W. Kear, Simple Test for Transistor Quality, *Electronics*, 35:39, p 80–81.



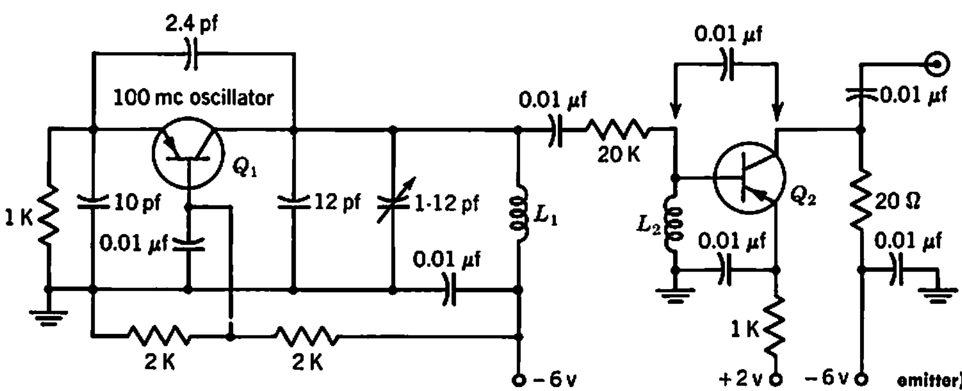
MAGNETIC TAPE FLAW DETECTOR—Transistor oscillator records steady test tone on tape. Machine stops during playback when reproduced level indicates flaw that would make tape unsuitable for broadcast use. Polarized relay charges memory capacitor as it responds to transient. Capacitor discharges into coil of slower relay, which in turn stops transport. —N. J. Thompson, Detector Pin-Points Magnetic Tape Flaws, *Electronics*, 32:2, p 50–51.



CONTACT TESTER—Determines whether contacts have maintained their normally open or closed conditions during shock and vibration testing. Dual circuit monitors both types of contact.—F. W. Kear, Contact Monitoring for Vibration Tests, *Electronics*, 33:15, p 78–79.

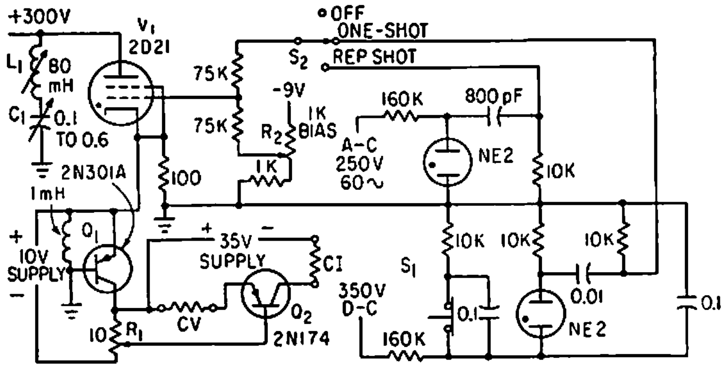


POSITIVE-LOGIC LAMP DRIVER—Turns on lamp for zero or positive control pulse at A. Negative pulse at B tests condition of circuit and lamp.—A. E. Popodi, Reliable Repertoire Of Display Circuits, *Electronics*, 38:2, p 60–66.

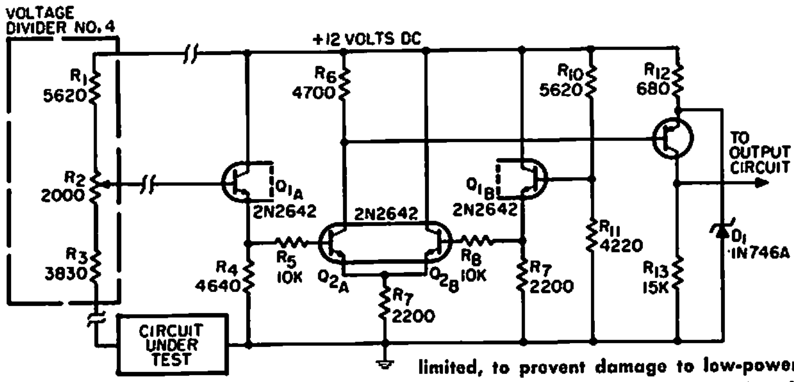


Q_1 2N1407 or 2N1143
Q_2 Test transistor
L_1 5 turns #18 tinned buss 1/4" dia 7/16" length no core
L_2 3.3 μh rfc

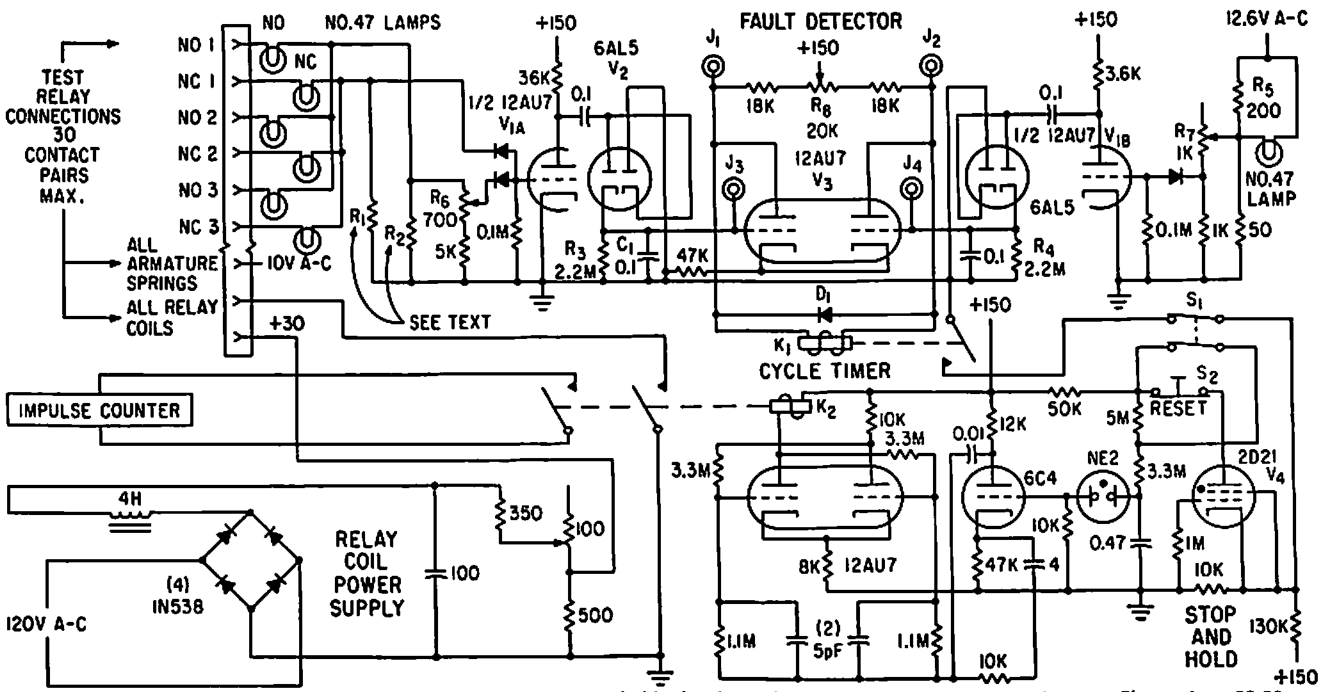
100-MC NOISE FIGURE TEST SET—Used in measuring upper noise-corner frequency of transistors, by measuring small-signal short-circuit forward current transfer ratio (common emitter) h-fe or f-T.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 305.



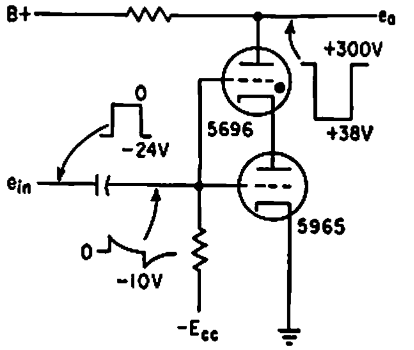
ELECTROEXPLOSIVE PULSER—Used in determining energy required to fire 50% of devices being tested. Uses thyratron as pulse generator, transistor for pulse shaping, and power transistor as linear amplifier to give either constant-current or constant-voltage pulses over wide range (0 to 10 v or 0 to 10 amp at durations of 100 to 1,000 microsec).—L. A. Rosenthal, Generator Delivers Constant Current or Voltage Pulses, *Electronics*, 33:38, p 82–84.



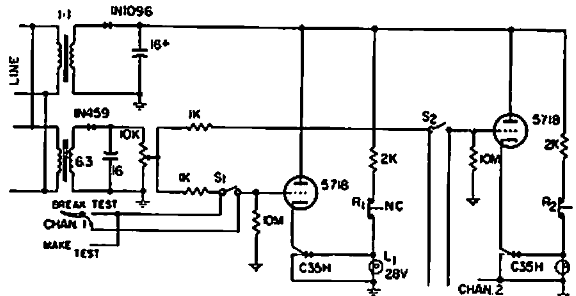
PARALLEL-PATH CONTINUITY CHECKER—Used for monitoring nonseparable parallel paths for continuity in automatic testing equipment. Current through circuit under test is limited, to prevent damage to low-power circuits. Resistance levels for continuity checks are set at 5, 20, 100, and 1,000 ohms.—R. H. Wassum, Parallel-Path Continuity-Checking Circuit, *EEE*, 14:8, p 164–166.



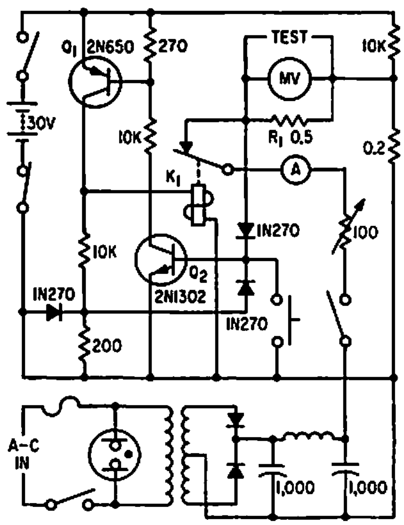
RELAY TESTER—Up to 30 relays are cycled automatically for minutes or hours to break in contacts and show up early defects. Tester stops and holds for intermittent contact fault, and lights lamp to identify faulty contact.—F. Trainor, Automatic Relay Tester Detects Intermittents, *Electronics*, 33:50, p 79–81.



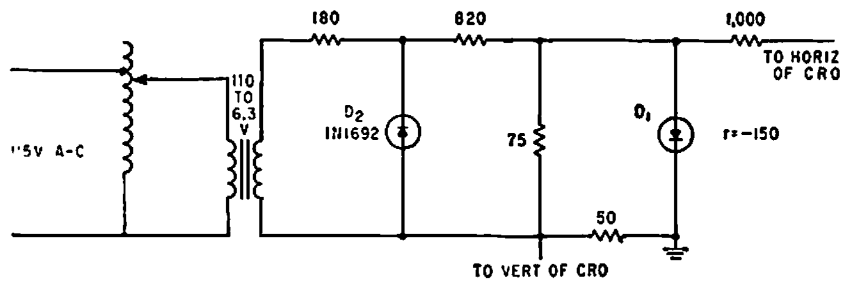
DIAL TELEPHONE TESTER—Delivers large pulses without being sensitive to changes in load, through use of thyratron in flip-flop.—Thyratron Used for Bistable Circuit, *Electronics*, 32:6, p 64–65.



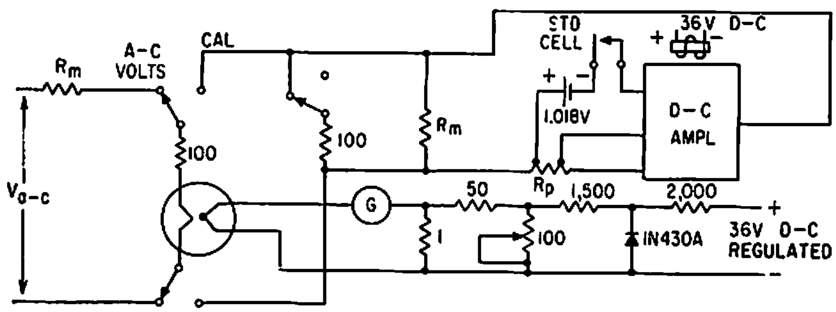
VIBRATION TEST MONITOR—Gives visual indication of momentary contact malfunctions in components during vibration testing. Also indicates permanent open or short. Each channel monitors one component. In testing device having normally closed contacts, lamp should come on initially. Lamp goes out if contacts open momentarily. If lamp remains on after reset switch for channel is pushed and released, open was momentary. If lamp goes out on release, open is permanent.—Component Vibration Test Monitor, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 159.



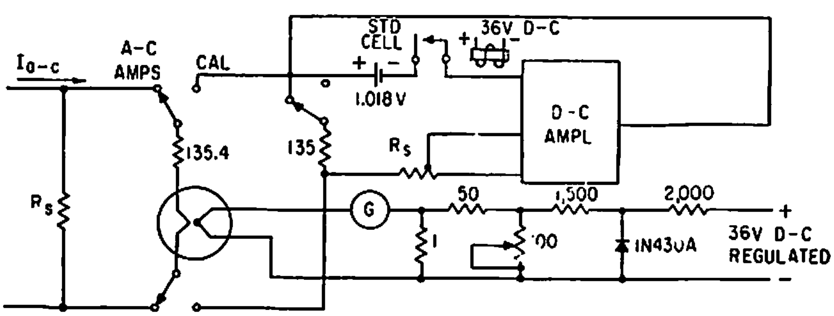
CONDUCTIVITY TESTER—For nondestructive testing of printed-circuit conductors, through-hole plating, soldered joints, and coils, in resistance range from 0 to 50 milliohms and currents up to 5 amp. Q1 and Q2 protect millivoltmeter from open-circuit voltage overloads by energizing relay K1, interrupting rectified output from a-c power supply.—F. W. Kear, Unit Measures Printed Circuit Resistances, *Electronics*, 34:4, p 64–65.



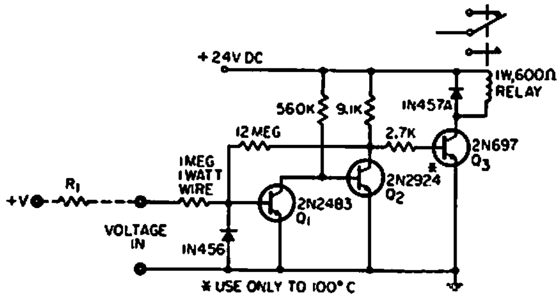
TUNNEL DIODE TESTER—Curve-tracing circuit provides cro traces as aid in determining proper bias and circuit impedances for operating tunnel diode as switch, amplifier, or oscillator.—R. P. Murray, Biasing Methods for Tunnel Diodes, *Electronics*, 33:23, p 82–83.



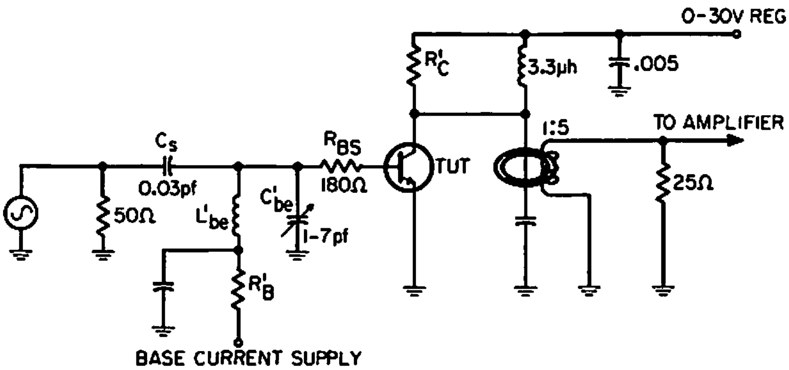
A-C TO D-C VOLTAGE STANDARDIZATION—High-gain d-c amplifier is used in feedback circuit to standardize a-c voltages directly to standard cell.—E. A. Gilbert, Feedback Circuits for A-C Instrument Calibration, *Electronics*, 33:40, p 94–96.



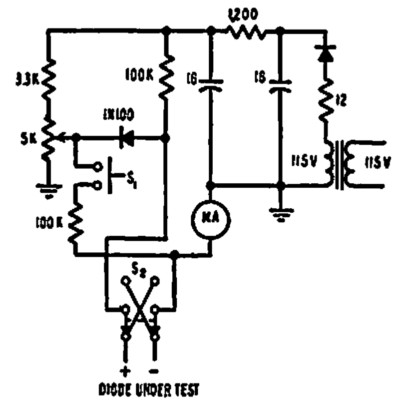
A-C TO D-C CURRENT STANDARDIZATION—Used to standardize alternating currents directly to standard cell.—E. A. Gilbert, Feedback Circuits for A-C Instrument Calibration, *Electronics*, 33:40, p 94–96.



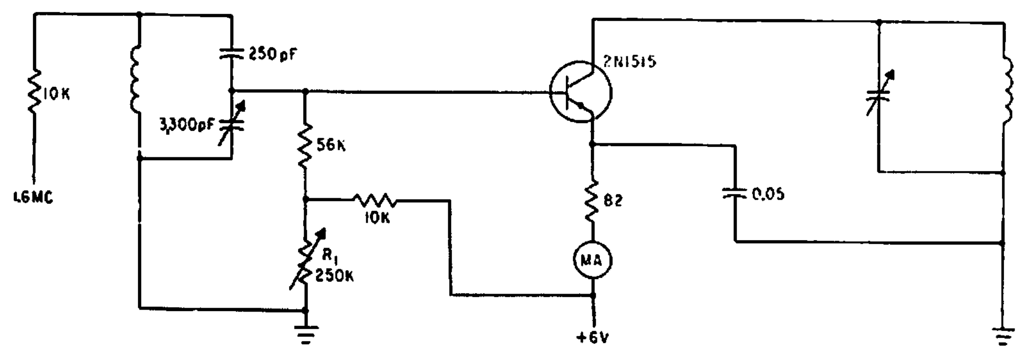
LEAKAGE TESTER—High-reliability current-detecting Schmitt trigger responds to nanoampere inputs for leakage testing of capacitors, diodes, and insulation, yet is not damaged or even affected by overloads of 1,000 v at input. Input of 300 na will trigger output relay.—P. Lefferts, Schmitt Triggers on Nanoamp Inputs, *EEE*, 14:6, p 91.



TRANSISTOR MEASUREMENTS AT 100 MC—Used to measure h-fe at 100 Mc, where all circuit parameters become more significant and make accurate measurements difficult. Circuit has provisions for separating measured signal from noise, high-gain pre-meter amplifier, and accurate method of metering r-f level. Maximum error is under 5%.—W. H. Hamlin, How to Measure h-fe at 100 mHz, *EEE*, 13:6, p 70–72.



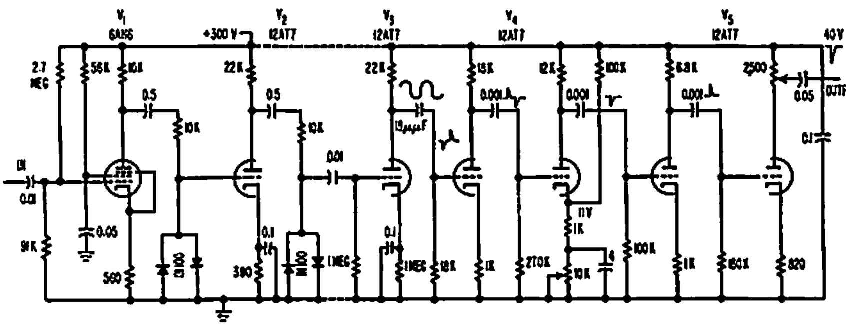
DIODE TESTER—Measures germanium diode reverse (leakage) current rapidly at 50 v back voltage, with no shock hazard and no danger to meter or diode even if diode is shorted or inserted incorrectly. S1 converts meter from ammeter to voltmeter for measuring test terminal voltage. R2 adjusts test voltage to desired half-scale meter reading value. S2 permits checking diode in both directions.—I. J. Levy, Reverse-Current Tester Speeds Diode Checks, *Electronics*, 31:1, p 88–90.

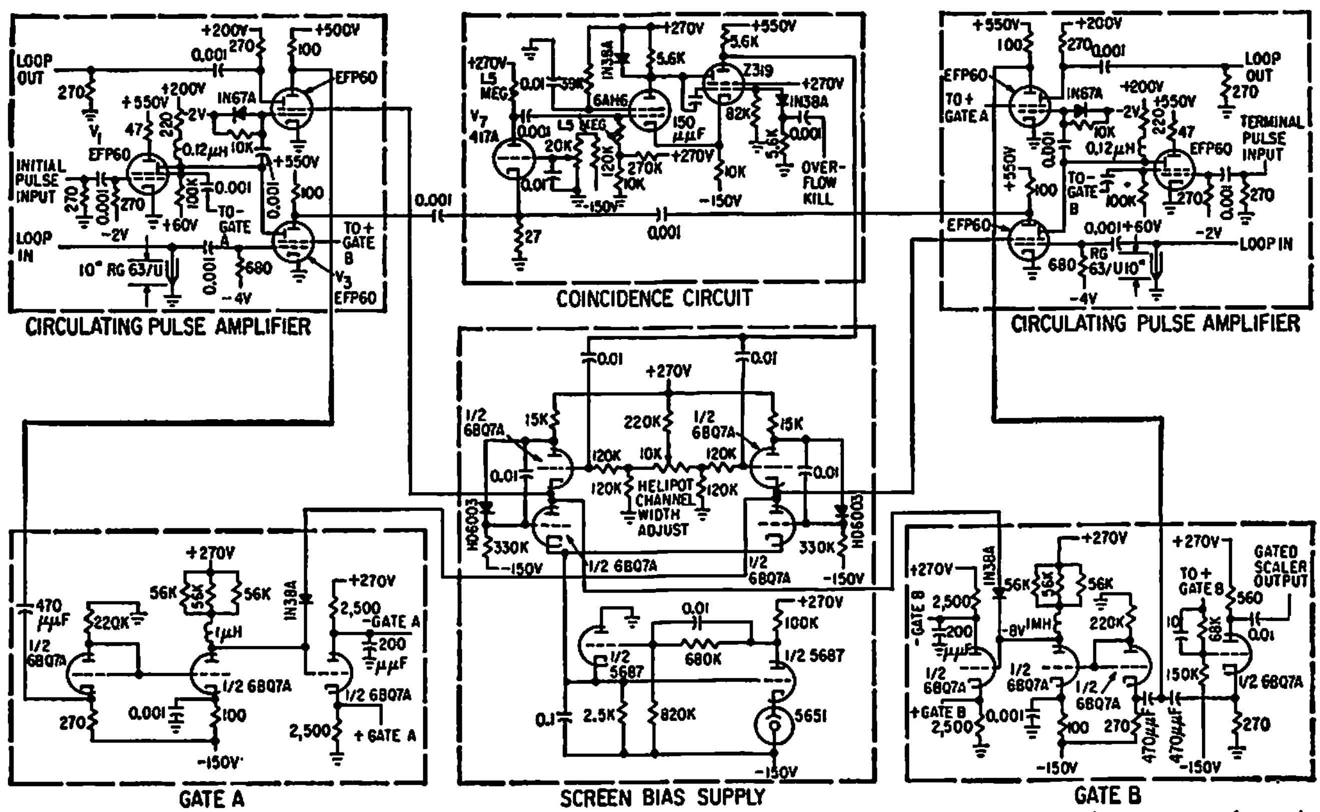


TRANSISTOR TEST CIRCUIT—Measures power gain, with emitter current varied manually by R1 in base circuit. Used to determine conditions for uniform emitter current, required for uniform gain in transistor circuits despite variations in d-c beta values of transistors.—K. Redmond, Biasing Transistors for Uniform Gain, *Electronics*, 33:50, p 74–75.

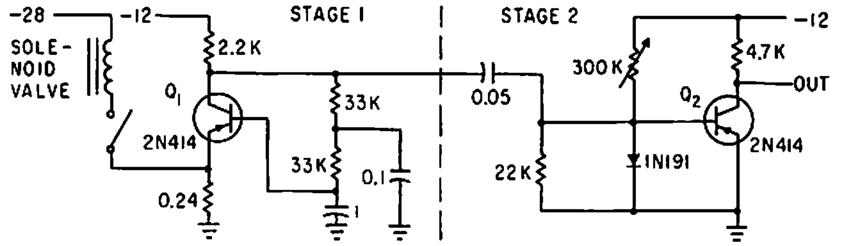
CHAPTER 92
Timer Circuits

A-C ZERO LOCATOR—Locates zero of a-c voltage within 0.1 microsec for 50-kc input signal. Operation is independent of input signal amplitude between 0.15 and 30 v p-p. Used for accurate measurement of time interval between given number of cycles of exponentially decaying 50-kc signal.—L. Costrell, A-C Zero Locator, *Electronics*, 31:3, p 98–101.

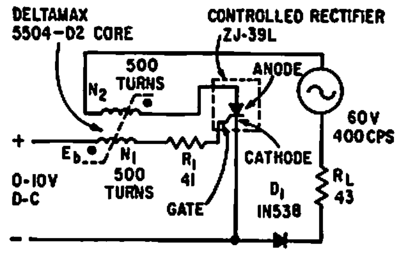




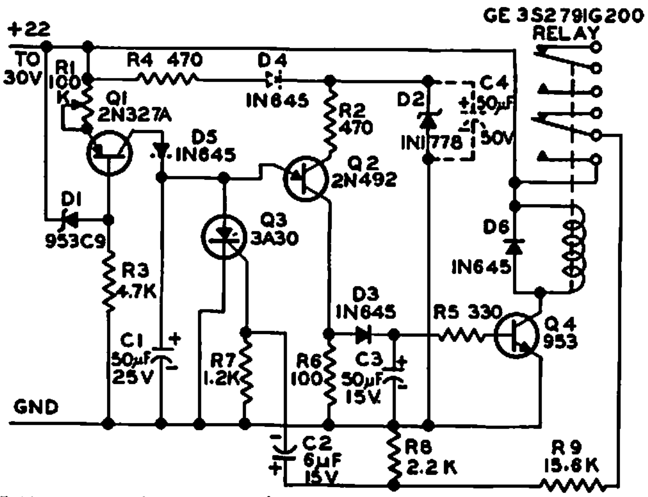
TIME INTERVAL ANALYZER—Gives high resolution (better than 1 millimicrosec) for multichannel measurements of short-life nuclear particles. Two pulses, defining time interval, are fed into the same loop-forming ends of two transmission lines. By making coincidence circuit spacing slightly smaller on terminal pulse lines than on initial pulse lines, terminal pulse is made to overtake initial pulse. Pulses approach coincidence at 1 millimicrosec per transit, so count of transits before coincidence gives time interval.—H. W. Lefevre and J. T. Russell, Vernier Chronotron Times Nuclear Particle Flight, *Electronics*, 32:10, p 44–47.



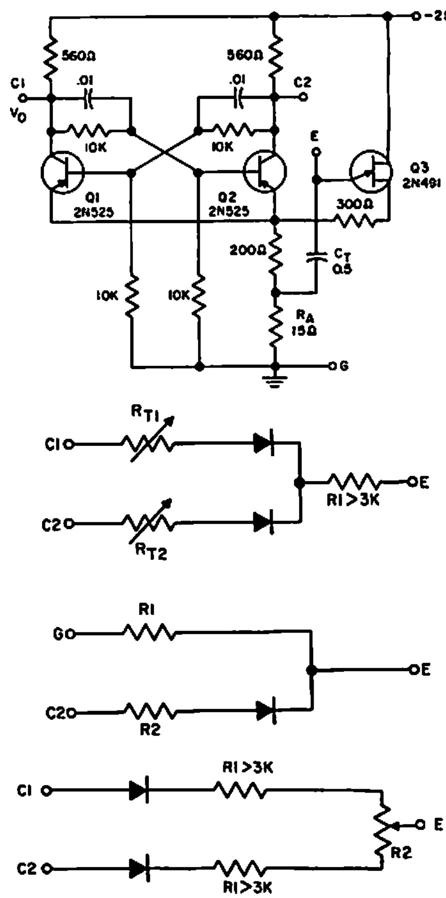
MEASURING VALVE-CLOSING TIME—Determines exact time of valve closure from waveshape of current in solenoid. Energizing current is differentiated and shaped, to trigger circuits that measure interval between solenoid switch closing and final solenoid position.—R. L. Kissner, Determining Closure Time in Missile Control Valves, *Electronics*, 33:42, p 88–89.



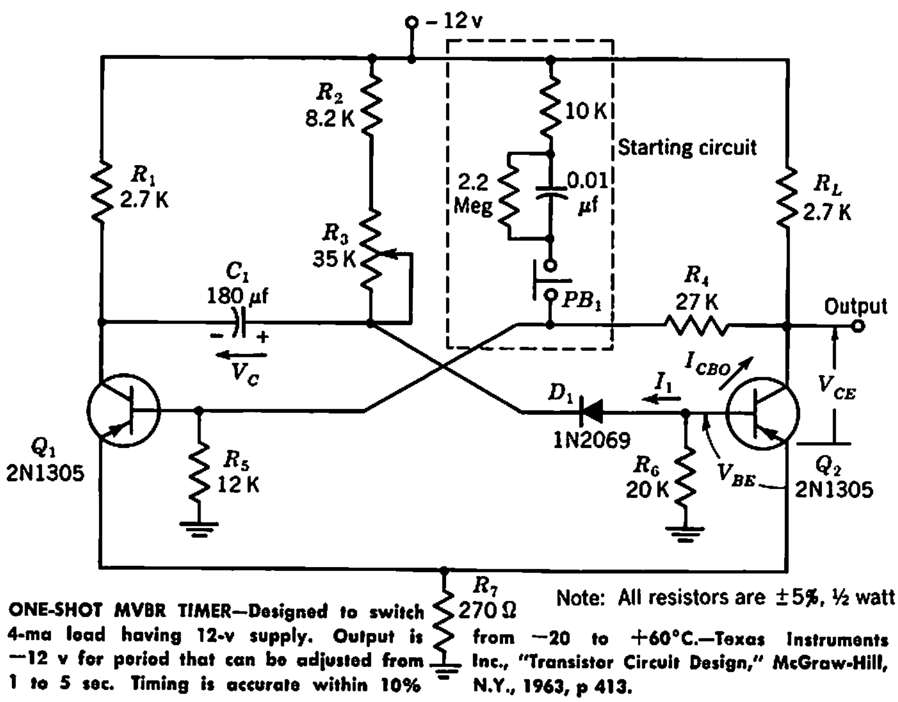
SATURABLE-REACTOR TIMER—Varying d-c bias voltage applied to control winding of saturable reactor changes time for magnetic flux to reach final value, permitting use of circuit as frequency divider for timing applications. In 400-cps circuit shown, division can be adjusted over range from 1 to 10. Output diode prevents thermal runaway in controlled rectifier when anode is going negative and gate is positive to cathode.—J. S. Sicko, Counting and Timing Circuits Use Saturable Reactor, *Electronics*, 33:19, p 61–63.



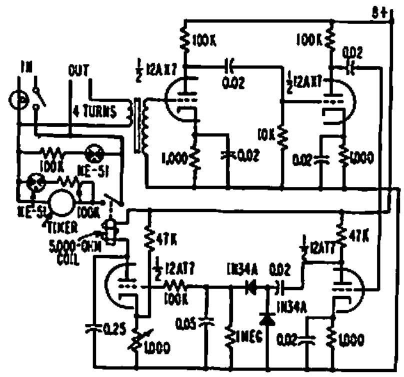
REPEAT-CYCLE TIMER—Provides output pulses over dynamic range of several thousand. Will tolerate large ripple from power source. If D4, D5, and C4 are added as shown in dotted lines, will tolerate transients up to 100% of supply voltage with several microsec duration.—Low-Frequency Stairstep Generator and Timing Circuit, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 144.



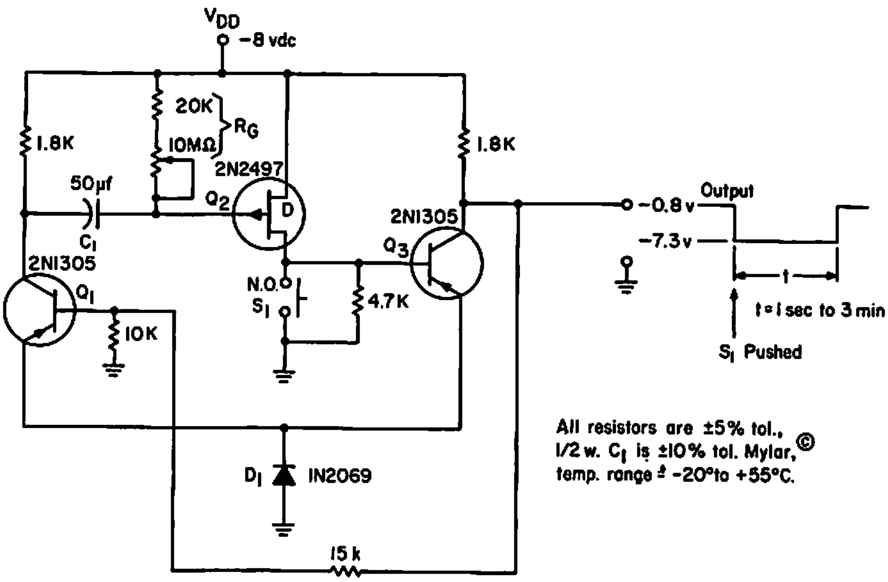
BASIC HYBRID UJT-PNP TIMER—Serves as symmetrical square-wave mvbr when fixed or variable resistor is connected between E and G. Serves as one-shot mvbr when fixed or variable resistor is connected between C1 and E. Other configurations shown for external connections give constant or variable-frequency nonsymmetrical multivibrators.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 338.



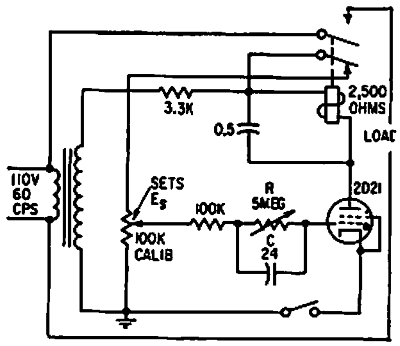
ONE-SHOT MVBR TIMER—Designed to switch 4-ma load having 12-v supply. Output is −12 v for period that can be adjusted from 1 to 5 sec. Timing is accurate within 10% from −20 to +60°C.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 413.



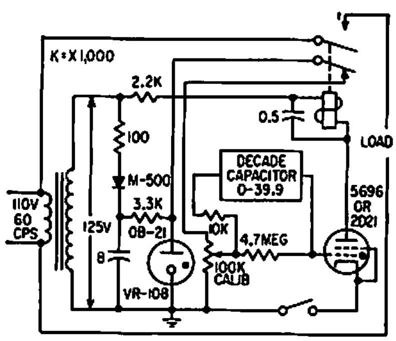
PLUG-IN TOOL-USE TIMER—Serves as running-time meter for soldering guns, electric drills, and other portable power tools. Tool is plugged into outlet on timer, eliminating need for connections to switch of device under test. Load capacity is from 25 to 1,000 w.—R. L. Ives, Circuit Times Operation of Portable Tools, *Electronics*, 31:5, p 62–64.



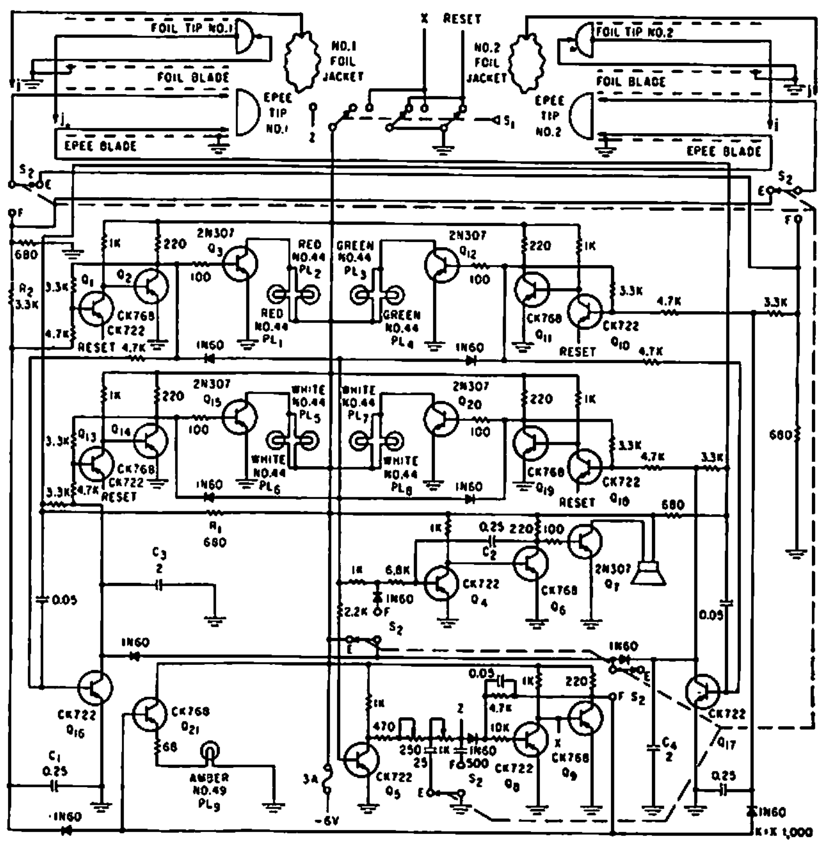
FET TIMER—Darlington-like pair Q2-Q3 serve with Q1 as monostable mvbr, most useful as timer because high input impedance allows use of modest capacitors to obtain long time delays. In stable state, Q2 is on and Q3 is saturated, holding Q1 off.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 89.



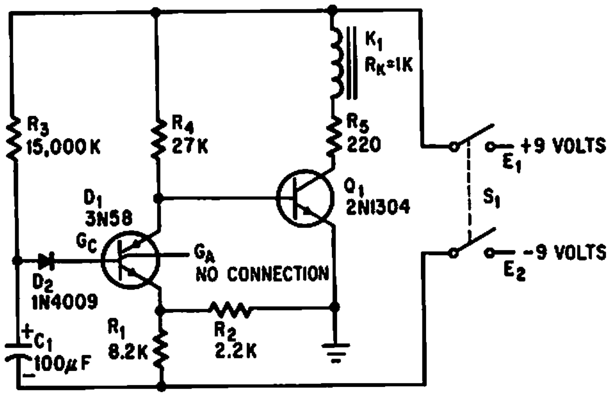
BASIC THYRATRON TIMER—Is not completely linear, partly because of contact potential in grid circuit, but nonlinearity errors are usually less than 3% up to about 60 sec.—R. L. Ives, Timer Made More Linear, *Electronics*, 32:5, p 66–69.



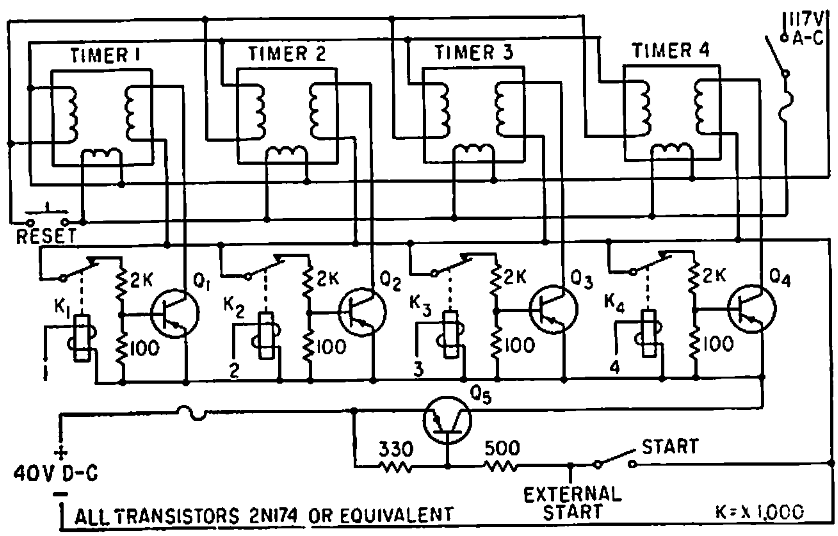
IMPROVED THYRATRON TIMER—Linearity is improved by varying capacitance rather than resistance in grid circuits. Timing error is less than 1% for 1 to 400 sec.—R. L. Ives, Timer Made More Linear, *Electronics*, 32:5, p 66–69.



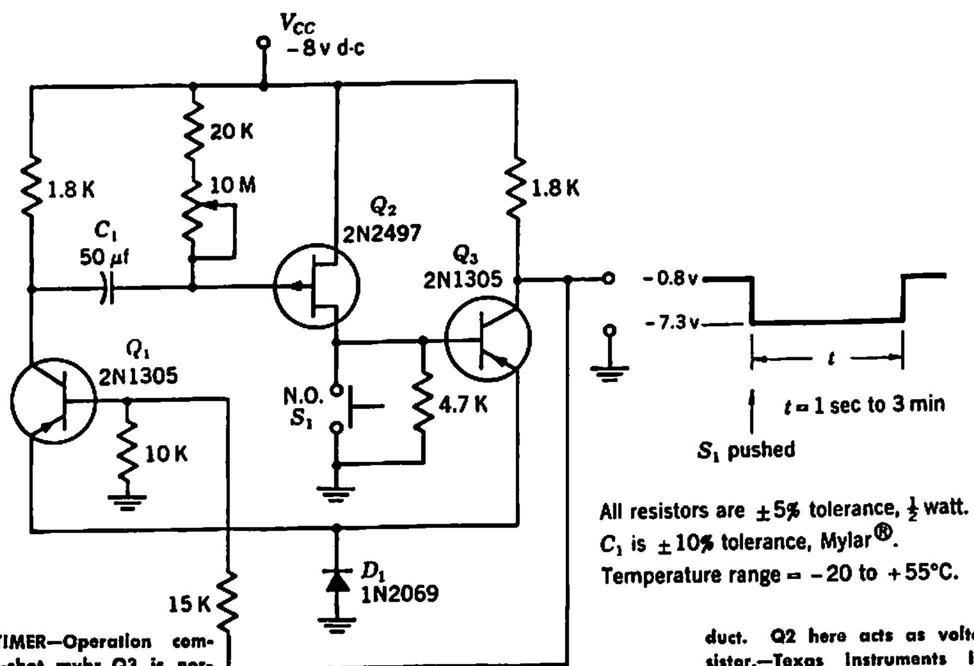
FENCING TOUCH TIMER—Detects touches in either epee or foil fencing, determines if touch is held long enough to score point, then starts timing interval in which other fencer may also score. Lamps indicate status of match. Loudspeaker sounds tone when sequence of touches is correct, and switch S1 must then be reset for next scoring sequence.—W. R. Durrett, Electronic Judging of Fast-Moving Sports Contests, *Electronics*, 32:32, p 114-115.



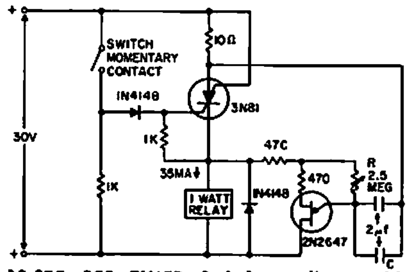
15-MINUTE SCS TIMER—Transistor and silicon controlled switch together serve to open relay 15 minutes after it is activated by manual closing of battery switch, for operating recording instruments.—T. H. Charters, Low-Cost Time Delay Controls Recorder, *Electronics*, 37:18, p 84.



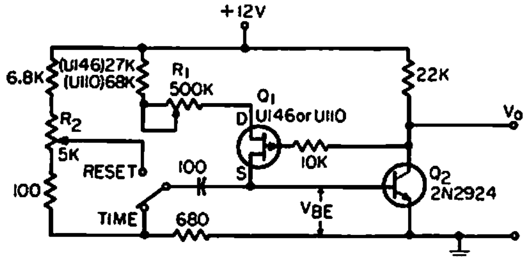
START-STOP CONTROL—Low-cost transistor arrangement controls four precision timers used for simultaneous measurement of time interval of four integrating circuits. Time between first digital output pulse and firing of circuit is determinable within 0.01%.—F. W. Kear, Tests Show Control is Key to Timer Accuracy, *Electronics*, 33:27, p 62.



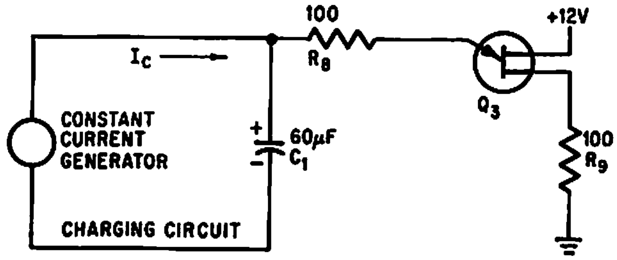
LINEAR-SCALE FET TIMER—Operation compares to that of one-shot mvbr. Q3 is normally on and C1 is charged. When S1 is closed, Q2 and Q3 turn off. Q3 remains off until charge on C1 decreases to point where Q2 is turned on sufficiently to make Q3 conduct. Q2 here acts as voltage-variable resistor.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 519.



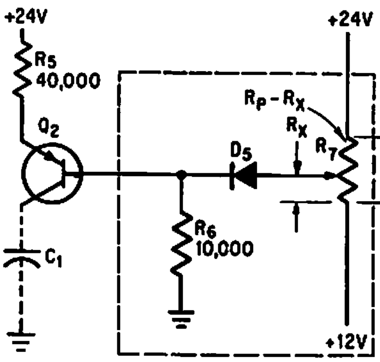
10-SEC SCS TIMER—Switch applies positive pulse to gate of scs, triggering it on and thereby supplying power to relay load and ujt timing circuit. At end of timing interval, determined by R-C, timer feeds negative pulse to anode to turn off scs.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 435.



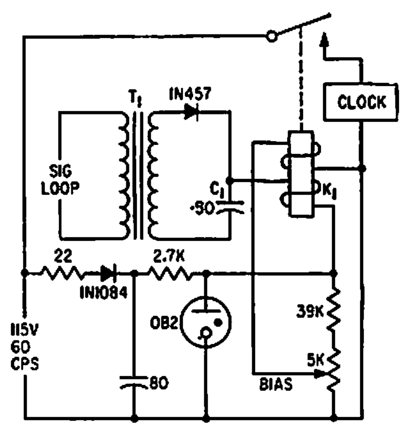
SOLID-STATE TIMER—Uses fet constant-current source to eliminate timing errors due to unregulated power supplies and line transients. Range of 0.1 to 50 sec is controlled by R2.—J. Geakie, Simple Fet Timer, *EEE*, 14:3, p 62.



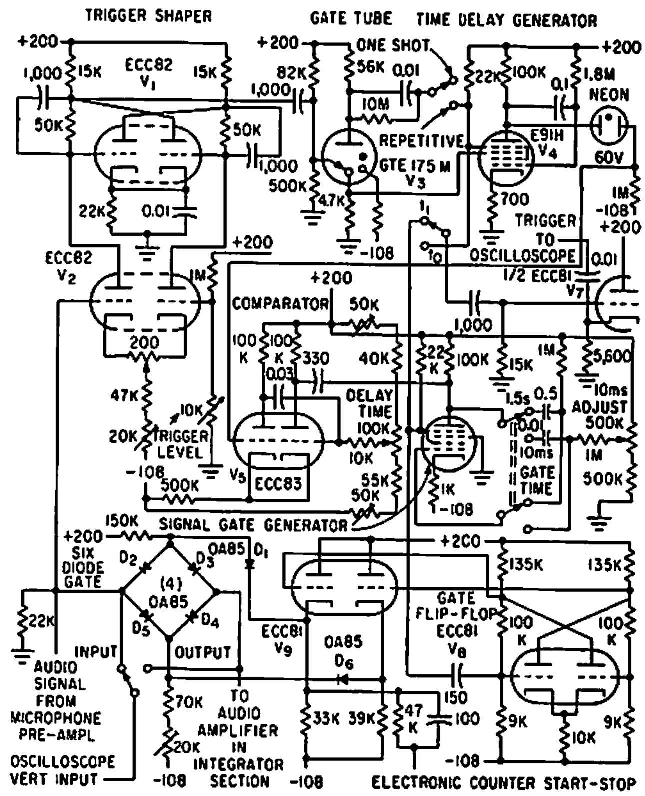
UJT TIMER—Charging current of C1 should be greater than 20-microamp peak-point current at which Q3 is triggered and less than 8-ma sustaining current of Q3, so ujt will turn off after it is triggered. 2N2422A may be used for Q3.—A. A. Lampell, Off-the-Shelf Integrated Circuits for Versatile and Accurate Timer, *Electronics*, 38:25, p 70–73.



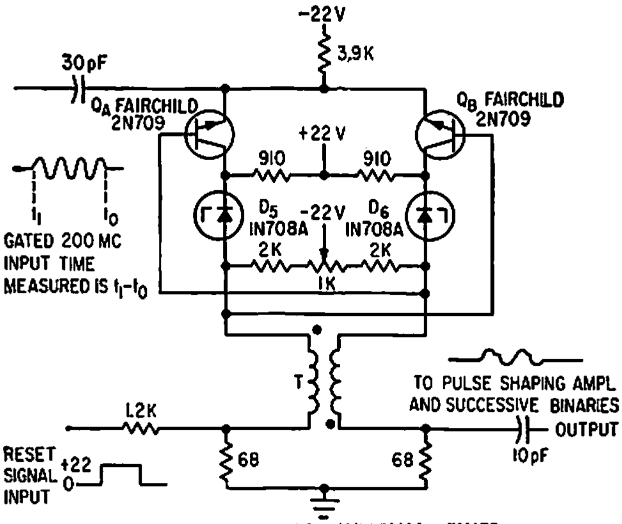
CONSTANT-CURRENT GENERATOR—Insures that voltage across charging capacitor of unijunction-transistor timer increases linearly with time. Maximum charging current is about 0.3 ma with 2N2605 for Q2 and 1N643 for D5. R7 is 1,000-ohm potentiometer.—A. A. Lampell, Off-the-Shelf Integrated Circuits for Versatile and Accurate Timer, *Electronics*, 38:25, p 70–73.



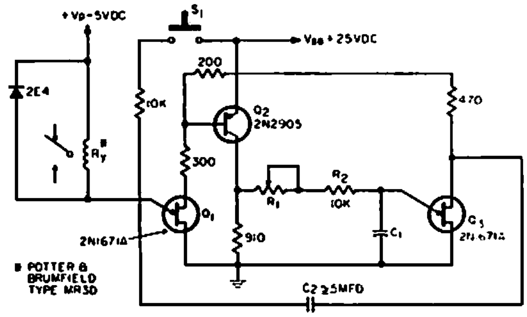
TELEPRINTER CHARACTER COUNTER—Simple circuit switches on timer clock only when teleprinter keying impulses are present, to give indication of traffic volume, flow, and routing.—R. E. Pafenberg, Character Counter Aids Teletypewriter Routing, *Electronics*, 34:17, p 120-121.



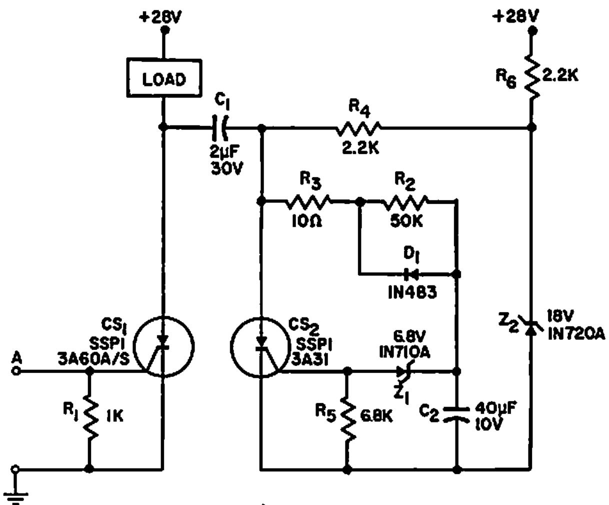
AUDITORIUM ACOUSTICS TIMER—Can be set to accept any portion of incoming sound signal for feeding to electrostatic squarer and digital counter. Microphone preamp feeds gate input and trigger shaper. Time base consists of phantastron sawtooth generator and comparator giving delay time linearly variable from 0 to 120 millisec.—J. P. A. Lochner and P. Meffert, Electrostatic Squarer for Acoustic Measurements, *Electronics*, 33:35, p 66–68.



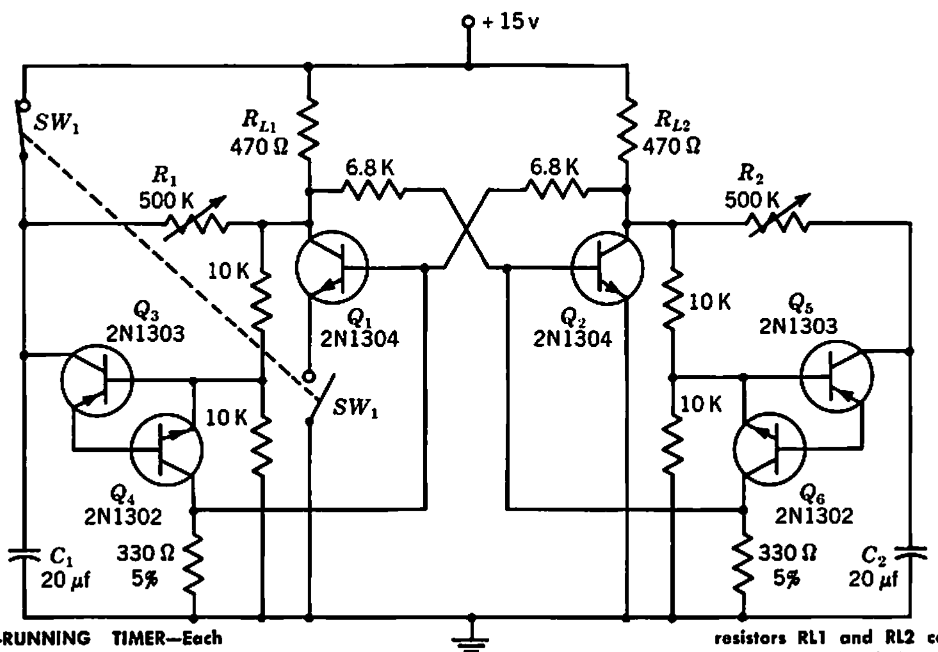
200-MC BINARY FOR INTERVAL TIMER—Gated 200-Mc input is fed to both emitters. Individual zener diodes provide collector bias. Base bias is obtained from collector resistor load of opposite transistor. Potentiometer permits perfect balancing. Time intervals are measured accurately to 5 nsec.—C. S. Coffey, VHF Counter Measures Time Intervals Precisely, *Electronics*, 36:34, p 27–29.



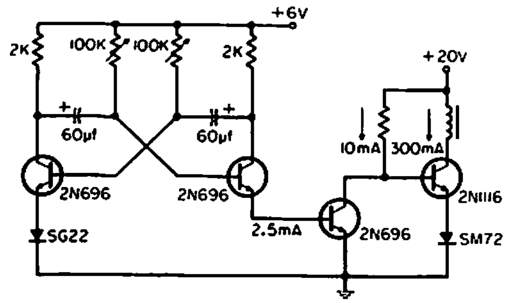
UJT INTERVAL TIMER—Inexpensive relay provides excellent timing accuracy and high isolation in circuit using power gain of emitter junction of ujt Q1. Timing is determined by R1, R2, and C1.—N. H. Kadivnik, Interval Timer, *EEE*, 12:5, p 75.



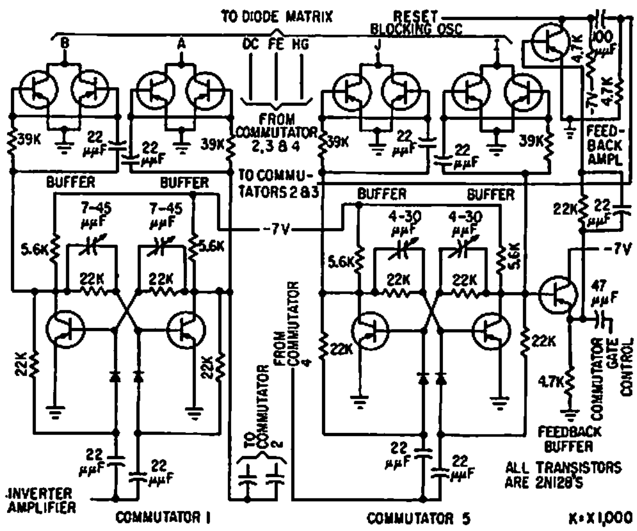
HIGH-CURRENT SCS INTERVAL TIMER—When triggered by low-level 5-microsec pulse, furnishes 1 amp to load for 1 sec. Advantages are simplicity and high reliability through use of silicon controlled switches.—Y. J. Lubkin, High Output Interval Timer, *EEE*, 10:9, p 92.



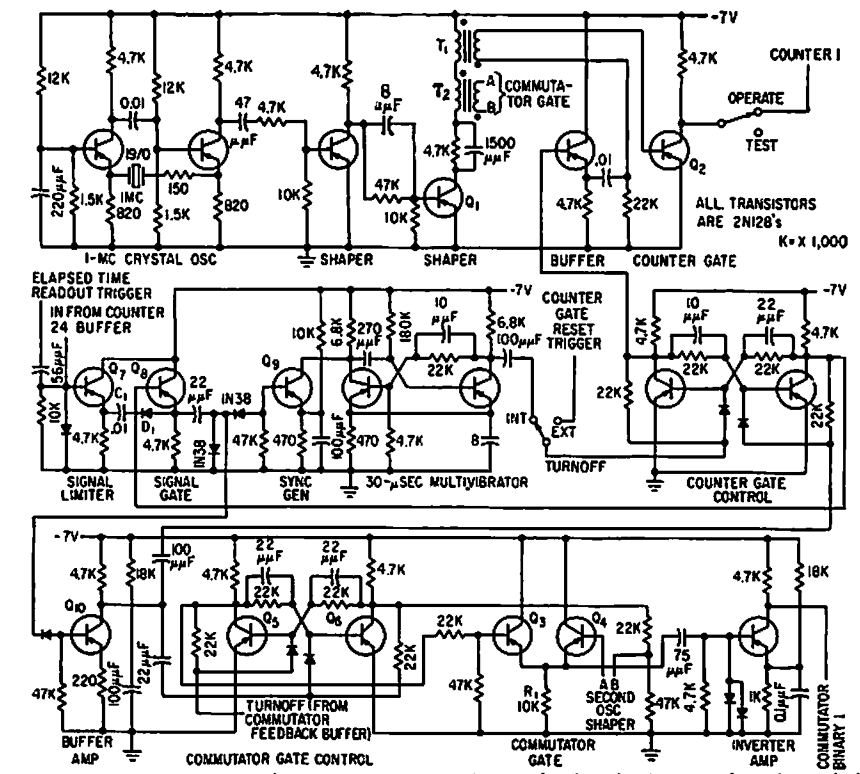
DUAL-OUTPUT FREE-RUNNING TIMER—Each output may be controlled separately. With stable power-supply voltage and constant ambient temperature, accuracy of 0.1% may be expected with this type of repeating timer. Switch is shown in off position. Load resistors RL1 and RL2 can be replaced with 500-ohm relay coil shunted by 1N2069 diode. —Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 414.

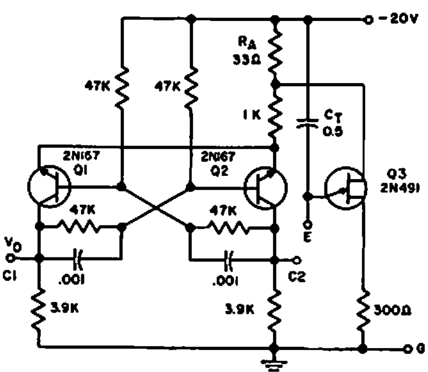


RECYCLING WITH VARIABLE DUTY CYCLE—Two 100K variable resistors control on and off times. Gives time delays from 0.3 to 6 sec.—P. Gheorghiu, Recycling Timing with Variable Duty-Cycle, *EEE*, 13:4, p 41.



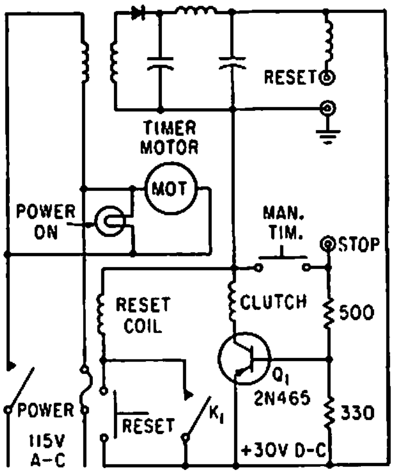
ENCODER COMMUTATOR—Commutator, buffer, and feedback circuits are given for elapsed-time encoder. After oscillator has triggered 24 elapsed-time counters during storage period, oscillator is switched to electronic commutator controlling diode matrix switch. Counter data is then read out serially through matrix and fed to crt for photographing.—R. J. Kelso and J. C. Groce, Encoder Measures Random Event Time Intervals, *Electronics*, 32:12, p 48–51.



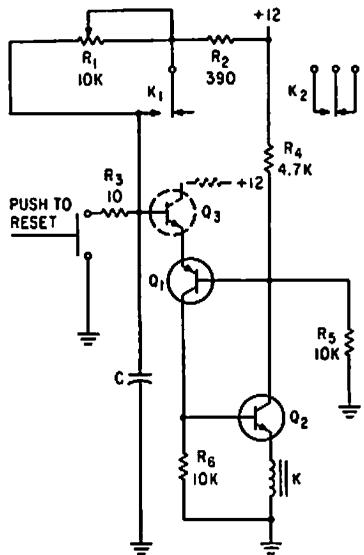


BASIC HYBRID UJT-NPN TIMER—Serves as symmetrical square-wave mvbr when fixed or variable resistor is connected between E and G. Serves as one-shot mvbr when fixed or variable resistor is connected between C1 and E. Other external connections give constant or variable-frequency nonsymmetrical multivibrators.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 338.

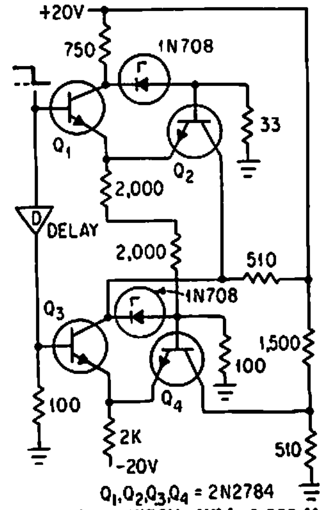
ENCODER OSCILLATOR—Used to trigger 24 elapsed-time counters until end of storage period, for storing and reading out elapsed time between consecutive but randomly occurring events. Gates are designed to maintain amplitude of trigger pulse above half the supply voltage over wide temperature range.—R. J. Kelso and J. C. Groce, Encoder Measures Random Event Time Intervals, *Electronics*, 32:12, p 48–51.



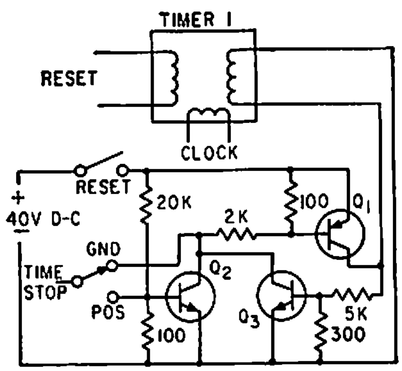
CLUTCH COIL FOR TIMER MOTOR—Start-and-stop signals are applied to stop jack, for automatic timing. Manual-timing pushbutton applies 0-v signal to stop jack, to make Q1 conduct. Fast switching time of transistor permits reading time to within 0.005 millisec.—F. W. Kear, Electromechanical Timer for Lab Applications, *Electronics*, 36:7, p 78–79.



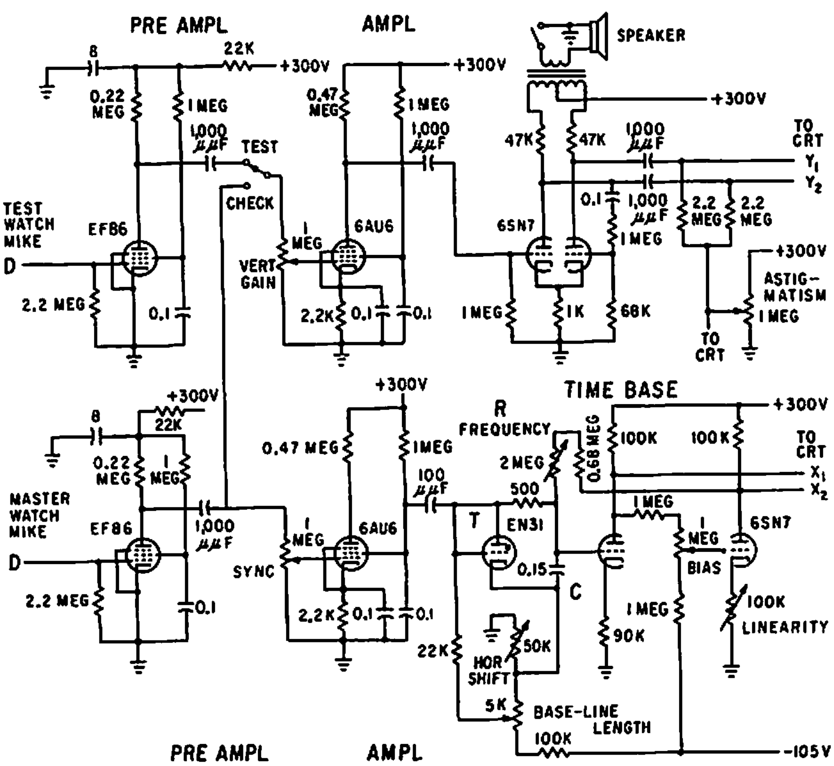
INTERVAL TIMER—Interval is determined by C, which can be paralleled capacitors to increase range.—N. C. Hekimian, PNP-NPN CIRCUITS: New Look at a Familiar Connection, *Electronics*, 35:47, p 42–46.



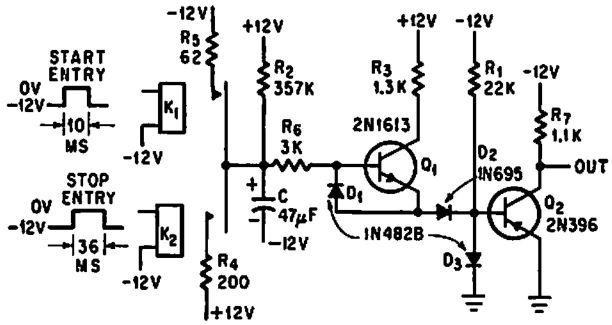
CURRENT-MODE SWITCH—With 1,000-Mc time base applied to base of Q2, two current-mode switches together serve to give accuracy of 0.5 nsec in measurement of time intervals with quinary scaler.—R. Engelmann, Quinary Scalers: Measure Time Intervals Digitally, *Electronics*, 37:5, p 34–36.



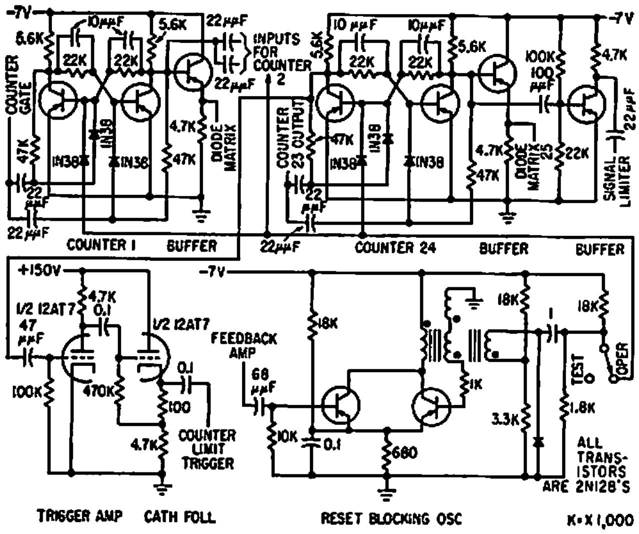
DUAL-POLARITY START-STOP CONTROL—Switches connect relay coils either to positive bus or to ground, so timer can be controlled by either positive or negative pulses. Additional transistor, used in place of relay, provides stop switching. Q3 forms clamping circuit for use where stop pulse duration is too short.—F. W. Kear, Tests Show Control is Key to Timer Accuracy, *Electronics*, 33:27, p 62.



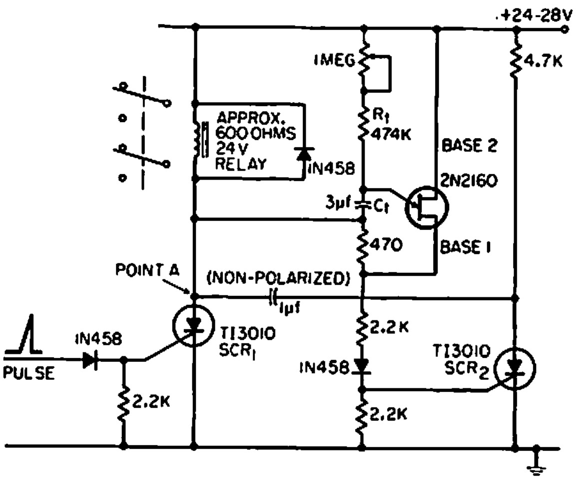
WATCH TIMER—Simple time base, with high linearity, is achieved by two-stage d-c amplifier having unity gain, back-coupled to R-C integrator. Time-base reference, synchronized with master clock, can check accuracy of any timing device.—S. T. Kiewiod, Watch Timer with Precise Time Base, *Electronics*, 31:51, p 84–85.



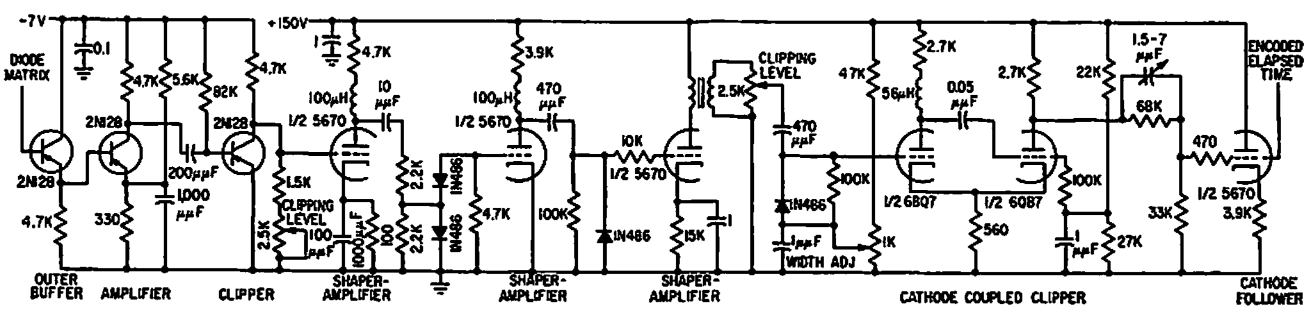
13-SEC TIMER—Two silicon transistors start timing action when 10-millisec start pulse closes reed relay K1, making output transistor Q1 conductive for 13 sec. Timing period can be shortened by applying 36-millisec pulse to K2.—H. W. Hines and L. C. Radzik, Electronic Timer Provides Long Delay, *Electronics*, 37:17, p 63.



ENCODER COUNTER—Counter, limit trigger, and blocking oscillator are given for encoder used for storing and reading out elapsed time between consecutive randomly occurring events. First 23 counters are identical.—R. J. Kelso and J. C. Greco, Encoder Measures Random Event Time Intervals, *Electronics*, 32:12, p 48–51.

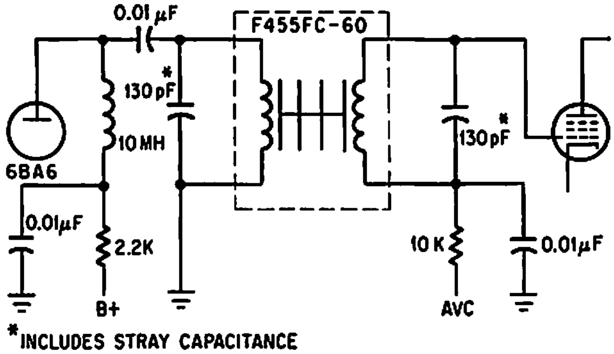


INTERVALOMETER—Operates at end of predetermined period to produce second predetermined time period in range of 5 to 10 sec. Developed for medical electronic research. Standby current is only 5 ma.—E. L. Dewig, Inexpensive UJT-SCR Intervalometer, *EEE*, 14:7, p 104.

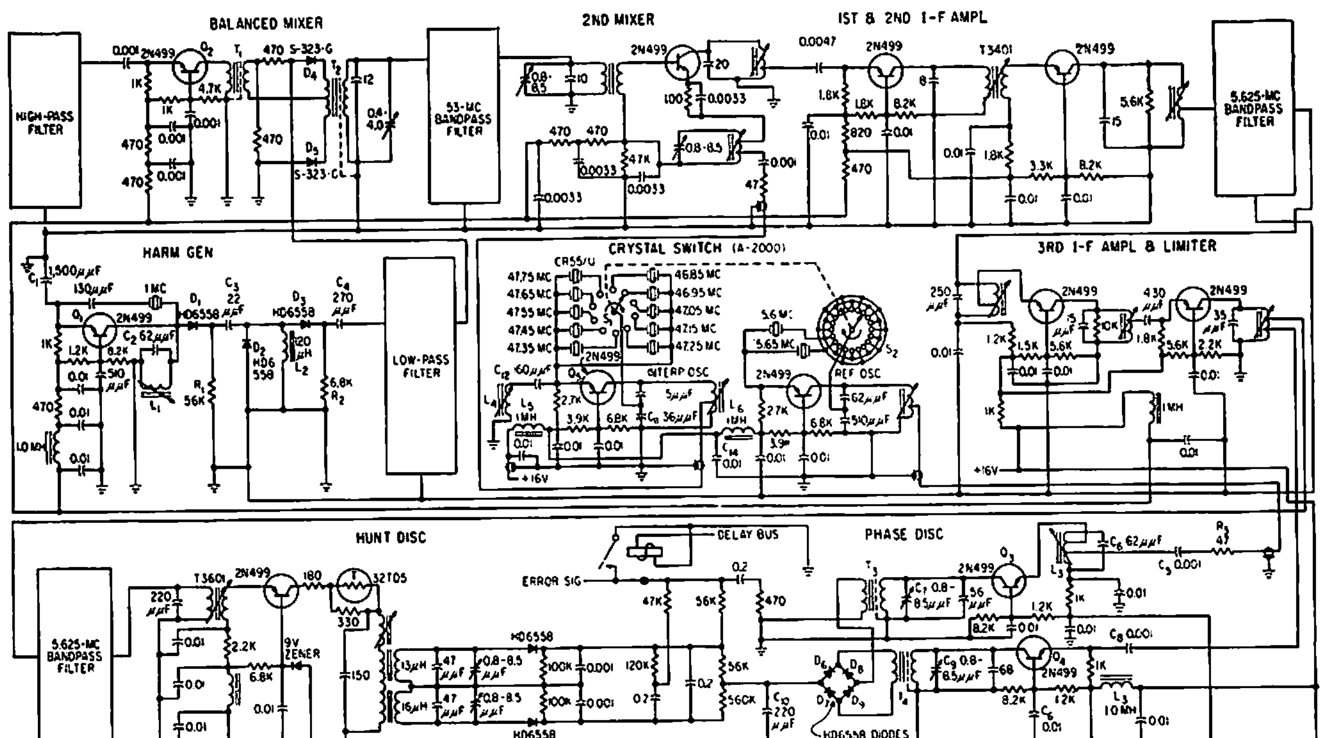


ENCODER OUTPUT—Output circuits are given for encoder used in storing and reading out elapsed time between consecutive randomly occurring events. Cathode follower stage provides low output impedance to give desired output waveform on crt for showing encoded elapsed time.—R. J. Kelso and J. C. Greco, Encoder Measures Random Event Time Intervals, *Electronics*, 32:12, p 48–51.

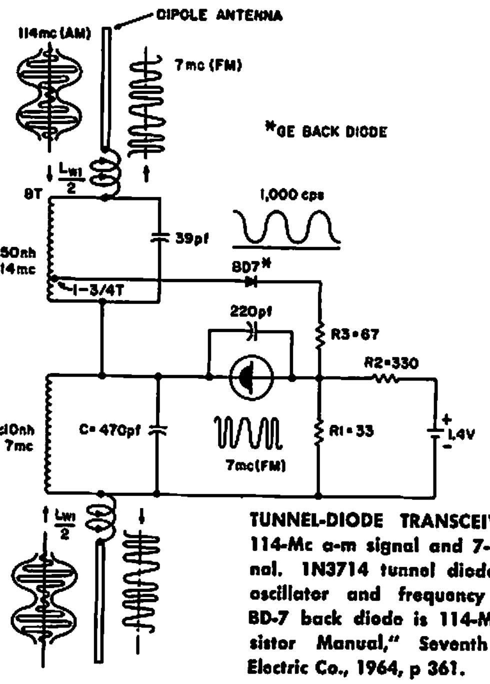
CHAPTER 93
Transceiver Circuits



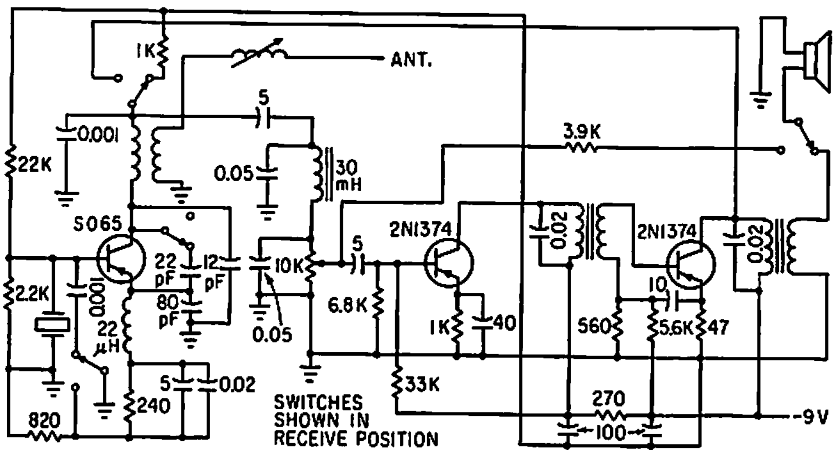
CB FILTER—Electromechanical filter with 6-kc bandwidth at 455 kc gives 8 db signal-to-noise improvement.—Filtering the Chatter on Citizens' Band, *Electronics*, 38:5, p 81.



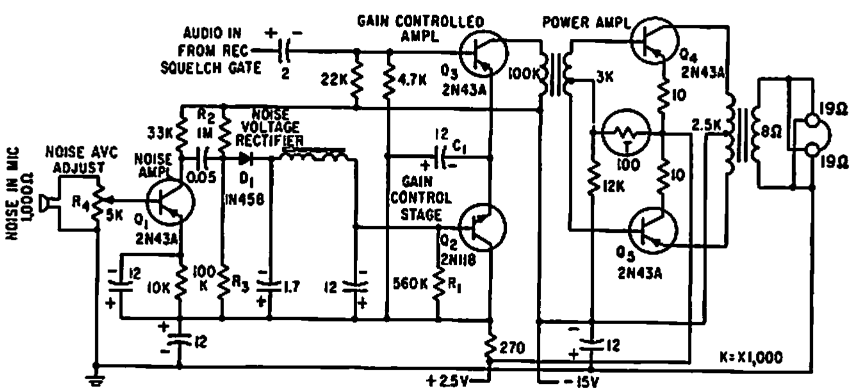
920-CHANNEL CRYSTAL REFERENCE—Controlled-frequency mobile radio transceiver, operating in two bands, uses improved bandpass filter techniques that double number of channels per megacycle of spectrum. Oscillator-stabilized system is designed for 50-kc channel spacing and selects any of 920 channels between 30 and 76 Mc.—F. Brauer and D. Kammer, Mobile Radio System Provides 920 Channels, *Electronics*, 31:41, p 96–99.



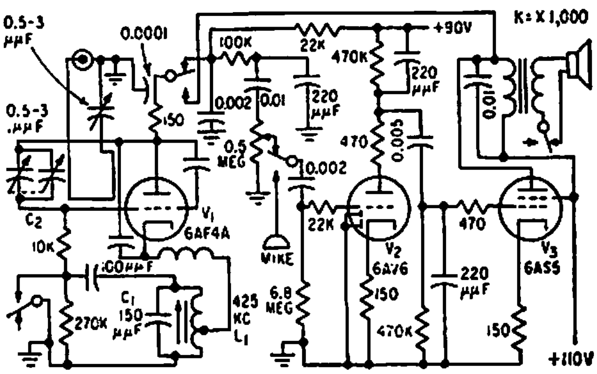
TUNNEL-DIODE TRANSCEIVER—Is tuned for 114-Mc a-m signal and 7-Mc f-m output signal. 1N3714 tunnel diode acts as 7-Mc r-f oscillator and frequency modulator, while BD-7 back diode is 114-Mc detector.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 361.



THREE-TRANSISTOR CB TRANSCEIVER—Has 30-mw r-f output and range of several thousand feet. Detector uses 40-kc quench. Draws 15 ma for receive and 30 ma for transmit. Loudspeaker serves as microphone for transmitting.—I. Solomon, Citizens Band Equipment Design, *Electronics*, 33:45, p 70–72.

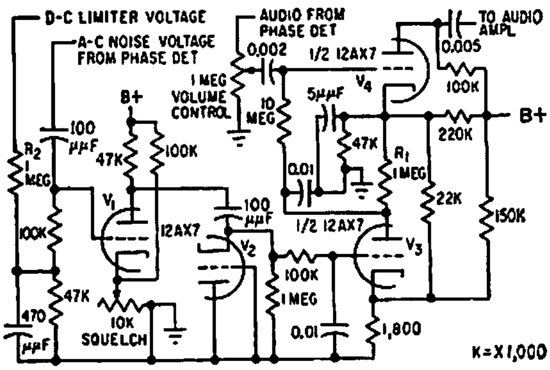


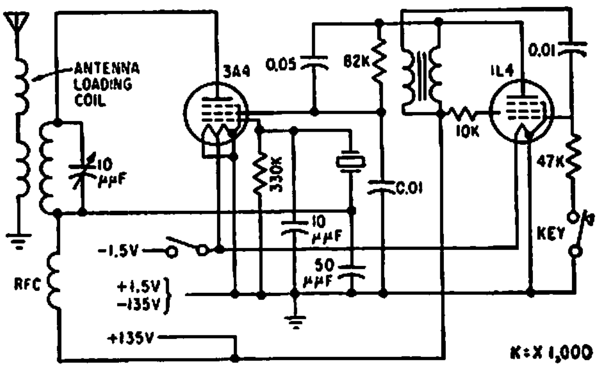
NOISE-ACTUATED AVC—Emitter current of 2N43A controlled low-level audio amplifier stage Q3 is regulated indirectly by sound pressure level of ambient noise. With no noise, gain of controlled amplifier is prevented from going to zero by applying quiescent conduction bias through R1 to gain-control stage Q2.—D. C. Gibson, Helmet Transceiver for Flight Deck Communications, *Electronics*, 33:39, p 56–60.



CLASS-B CB TRANSCEIVER—On transmit, V1 is self-excited power oscillator, V3 is a-m modulator, and V2 is speech amplifier. On receive, V1 is superregenerative r-f amplifier, V3 is audio power amplifier, and V2 is first audio stage.—L. G. Sands, Citizens Radio Revision Spurs Equipment Design, *Electronics*, 32:15, p 55–57.

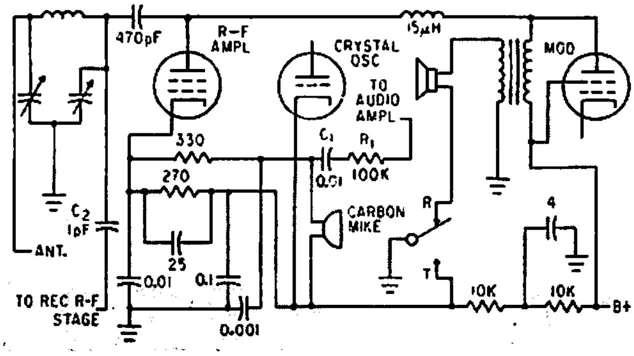
CB SQUELCH—Actuated by d-c limiter voltage and a-c noise voltage. With no signal, output of noise amplifier V1 is converted into positive voltage by noise rectifier of V2 and applied to grid of squelch control tube V3, making it conduct and drive grid of V4 more negative, to squelch noise.—L. G. Sands, Citizens Radio Revision Spurs Equipment Design, *Electronics*, 32:15, p 55–57.

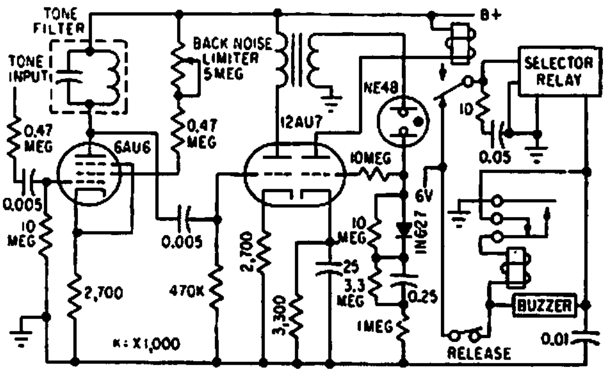




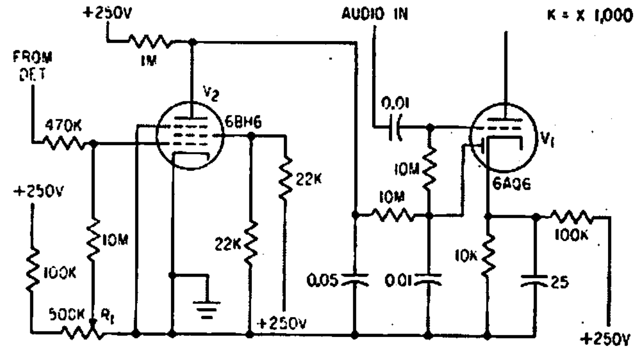
CLASS-C CB TRANSMITTER—Control signal may be tone-modulated a-m, with different tones to control several functions on one frequency.—L. G. Sands, Citizens Radio Revision Spurs Equipment Design, *Electronics*, 32:15, p 55–57.

CB WITHOUT SEND-RECEIVE RELAY—With switch in transmit position, carbon mike gets some of r-f amplifier current, and audio signals in last audio stage Heising-modulate transmitter. During reception, receiver local oscillator gets plate voltage, loudspeaker is connected, and cathodes of transmitter crystal oscillator and r-f amplifier are made positive to cut them off.—L. Solomon, Citizens Band Equipment Design, *Electronics*, 33:45, p 70–72.

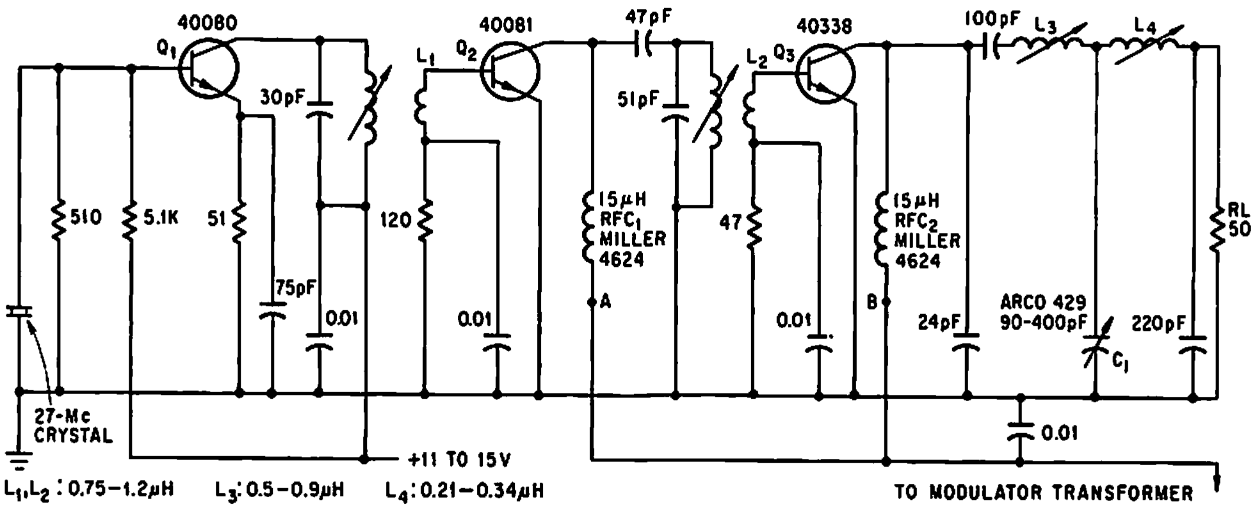




CB DECODER—Responds to telephone-dial digital tone pulses from receiver. Rejects noise pulses and functions even when noise is stronger than desired single-tone signal. Used in mobile dial telephones.—L. G. Sands, Citizens Radio Revision Spurs Equipment Design, *Electronics*, 32:15, p 55–57.

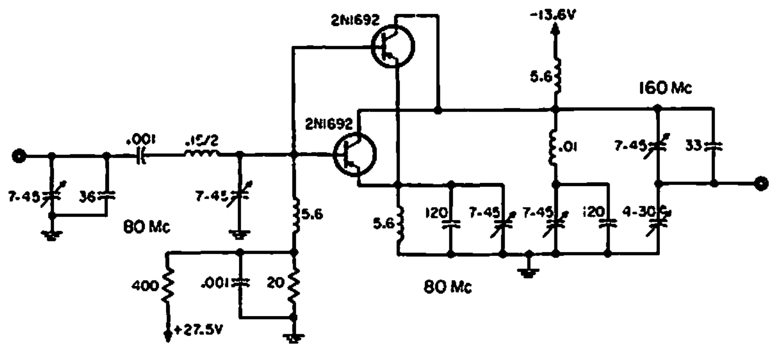


NOISE SQUELCH—When negative-going signal is received from detector, control grid of squelch tube V2 goes negative until positive bias set by squelch control R1 is overcome. Used in Vocaline CB transceiver.—L. Solomon, Citizens Band Equipment Design, *Electronics*, 33:45, p 70–72.

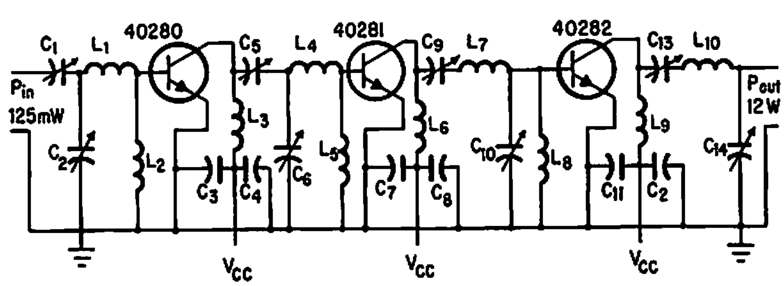


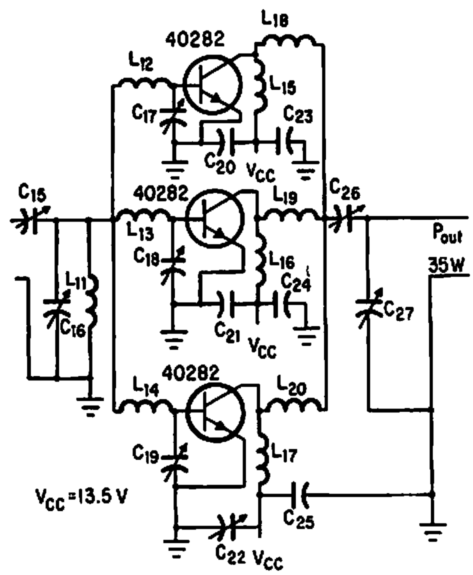
CB—Three overlay transistors provide 5 w for 27-Mc citizens-band a-m transmitter.—D. J. Donahue and B. A. Jacoby, Putting the Overlay to Work at High Frequencies, *Electronics*, 38:17, p 78–81.

CHAPTER 94
Transmitter Circuits



STANDARD PARALLEL-TRANSISTOR OUTPUT DOUBLER—Input is tuned to 80 Mc and output to 160 Mc. Parallel tuned circuit with built-in trap is required in output circuit to suppress 80-Mc fundamental. Conversion power gain is 6 db. Maximum power is 650 mw.—W. A. Rheinfelder, Choosing the Best Transmitter Output Stage, *EEE*, 11:10, p 48–53.





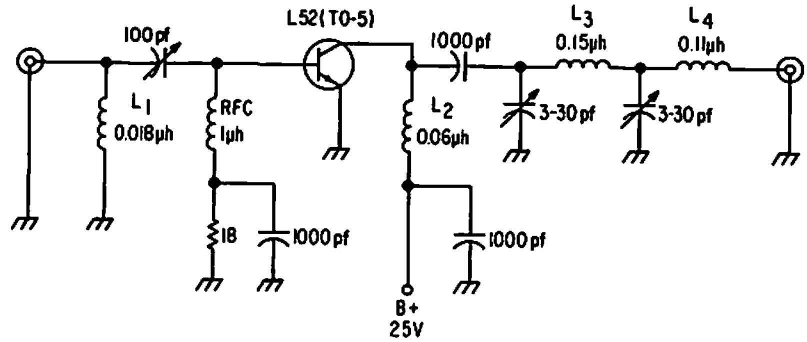
Inductor	Turns	Wire size	Inside dia. (inch)	Length (inch)
L_4, L_7	3	16	3/16	1/4
L_9	1	16	1/4	3/8
L_{10}	2	16	1/4	5/16
L_{12}, L_{13}, L_{14}	5	16	1/4	1/2
L_{18}, L_{19}, L_{20}	2	16	1/4	1/4
L_{15}, L_{16}, L_{17}	2	18	1/8	1/8
L_1	2	16	3/16	1/4

L_2, L_5, L_8: ferrite choke, 450 ohms
L_3, L_6, L_9, L_{11}: 0.1 microhenry

Capacitors
C_1: 3-35 pF
C_2, C_6, C_{16}, C_{17}, C_{18}, C_{19}, C_{27}: 8-60 pF
C_3, C_7, C_{11}: ceramic disk, 0.1 μF
C_4, C_8, C_{12}, C_{24}, C_{23}, C_{25}: feed-through, 1500 pF
C_5, C_9, C_{10}, C_{13}, C_{14}, C_{26}: 7-100 pF
C_{15}: 1.5-20 pF
C_{20}, C_{22},
C_{21}: ceramic disk, 0.2 μF

175-MC F-M MOBILE AMPLIFIER—Overlay transistors operating directly from 13.5-v auto battery give 12 w from three stages and 35 w when output stage is added. Overall d-c to r-f efficiency of transmitter is about 60%.—D. J. Donahue and B. A. Jacoby, Putting the Overlay to Work at High Frequencies, *Electronics*, 38:17, p 78–81.

1 W AT 170 MC—Single L52 feeds 1 w to 50-ohm antenna through pi-L network. Power gain is 4 db and efficiency is 30% for class C operation.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 323.



Po = 1 watt power gain = 4 db average

V_{cc} = 25v

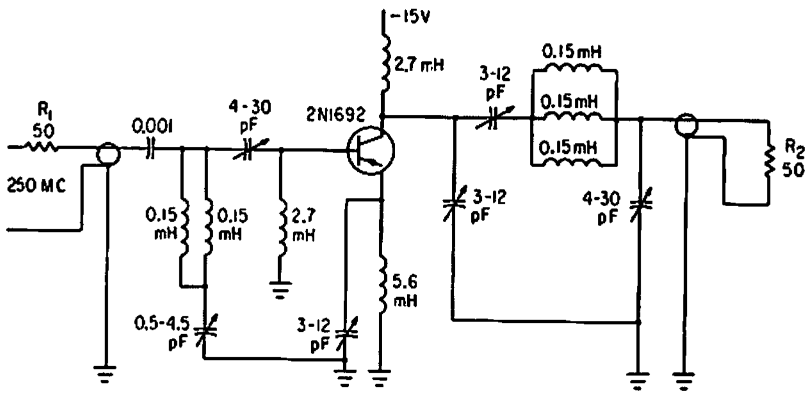
I_C = 125ma

L_1 = 1 T No.14 Buss, 0.5" diam

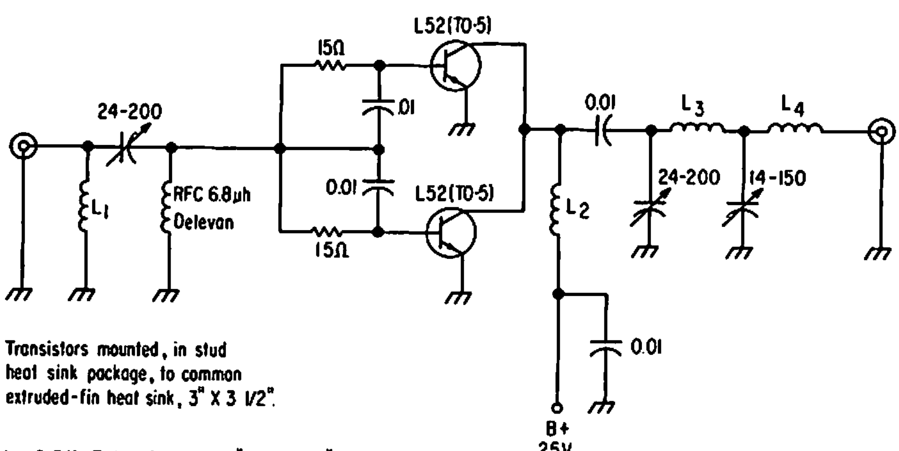
L_2 = 3 T No.14 Buss, 0.4" diam, 0.3" long

L_3 = 5 T No.14 Buss, 0.4" diam, 0.5" long

L_4 = 4 T No.14 Buss, 0.4" diam, 0.4" long



NEUTRALIZED EMITTER BOOSTS H-F GAIN—New operating mode increases h-f gain more than 20 db, reduces interstage matching problems, improves selectivity and stability, and cuts cost. Based on neutralizing of emitter-circuit inductances with small variable capacitor from emitter to ground and r-f choke to provide d-c path from emitter to ground. Technique works best above 100 Mc.—Extend Transistor Frequency, *Electronics*, 34:44, p 25.



Transistors mounted, in stud heat sink package, to common extruded-fin heat sink, 3" X 3 1/2".

L_1 = 2 3/4 T No.16 Buss, 0.4" diam, 0.3" long, L = .067µh

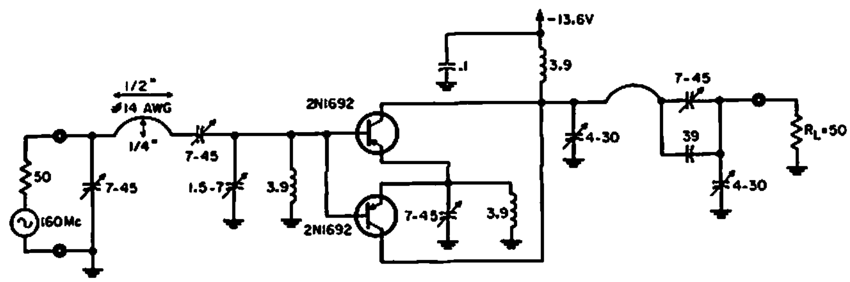
L_2 = 5 T No.16 Buss, 0.4" diam, 0.4" long, L = .14µh

L_3 = 5 T No. Soldereze, 0.5" diam, 0.4" long, L = .22µh

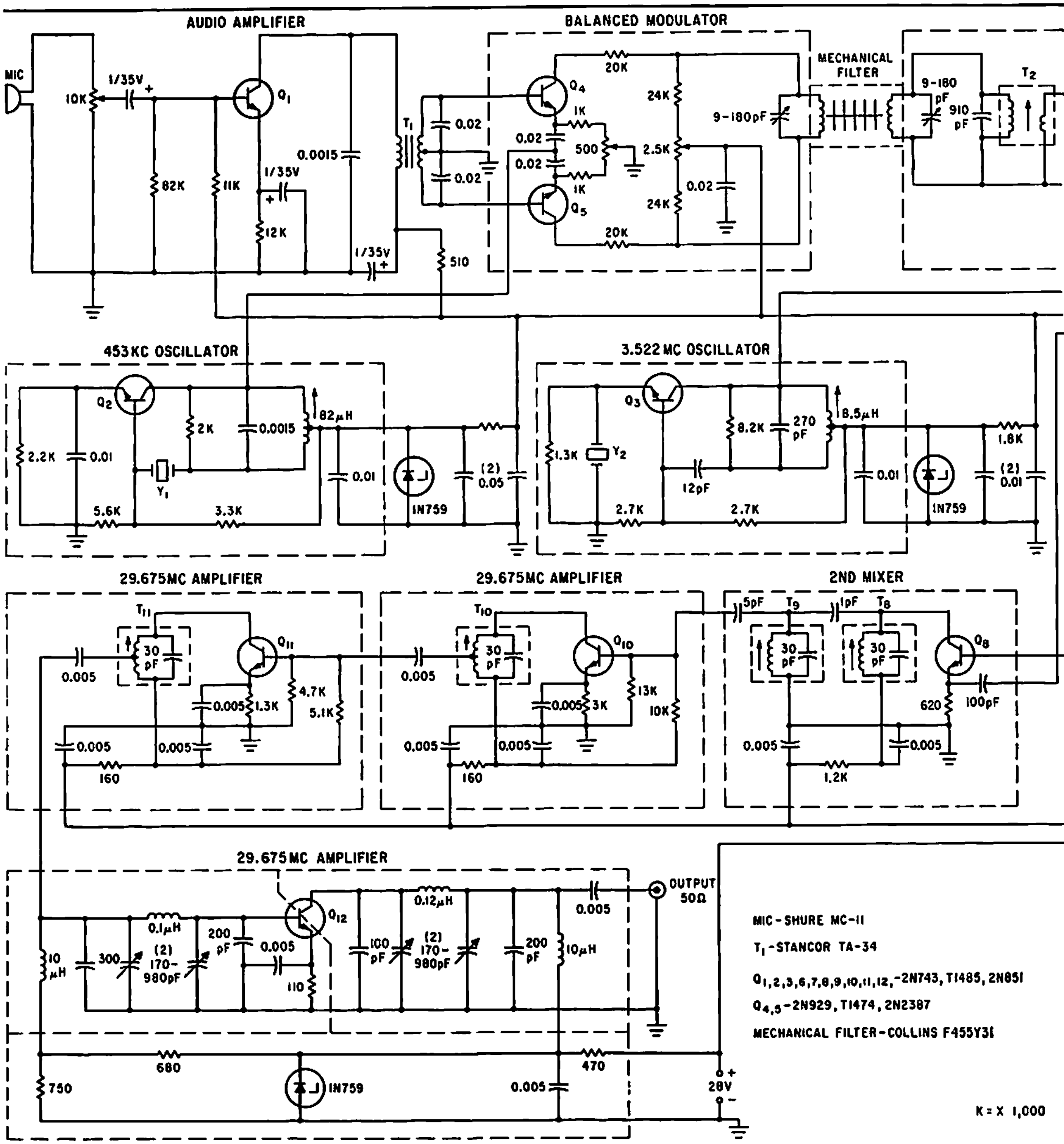
L_4 = 6 T No. Soldereze, 0.5" diam, 0.5" long, L = .34µh

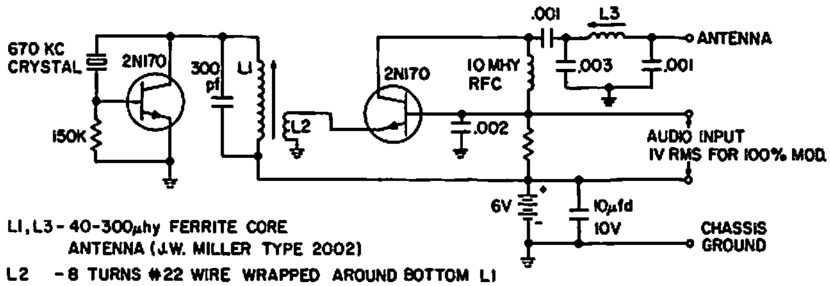
Power out = 10w
Power gain = 10db
DC Power in = 600ma at 25v = 15w

10 W AT 50 MC—Two L52's in parallel provide 10 w output power with 10 db gain. Separate biasing resistors are used in base circuits to balance operating currents. Input and output impedances are both 50 ohms, and overall efficiency is 65%.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 323.



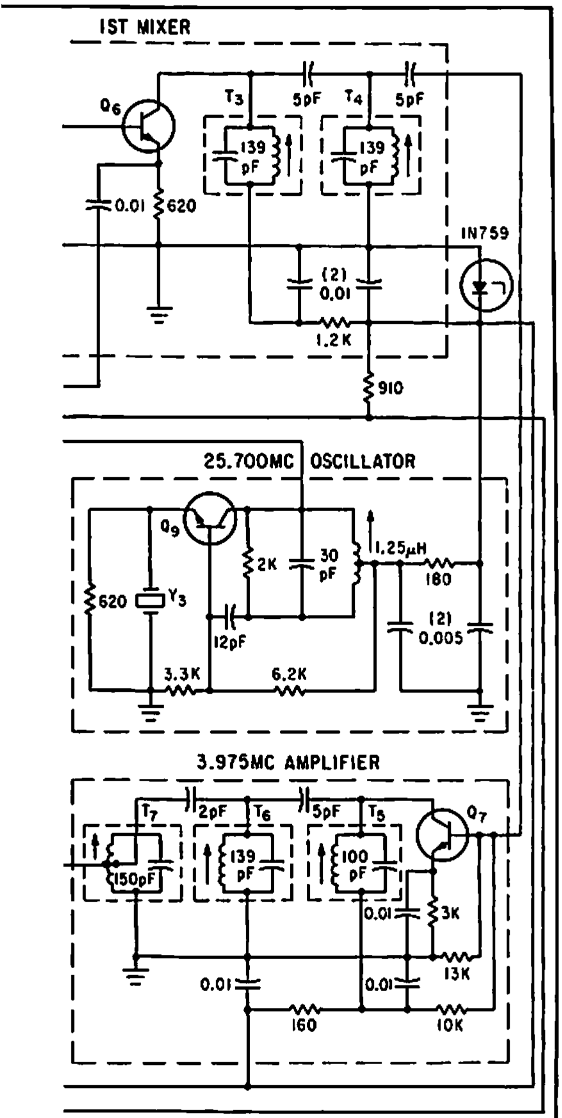
PARALLEL-TRANSISTOR OUTPUT STAGE WITH EMITTER TUNING—Variable capacitor common to both emitters, together with r-f choke for d-c path, provides efficient tuning and increased power gain at outputs near maximum of 2 w. Chief drawback is reduced power gain at low input levels.—W. A. Rheinfelder, Choosing the Best Transmitter Output Stage, *EEE*, 11:10, p 48–53.





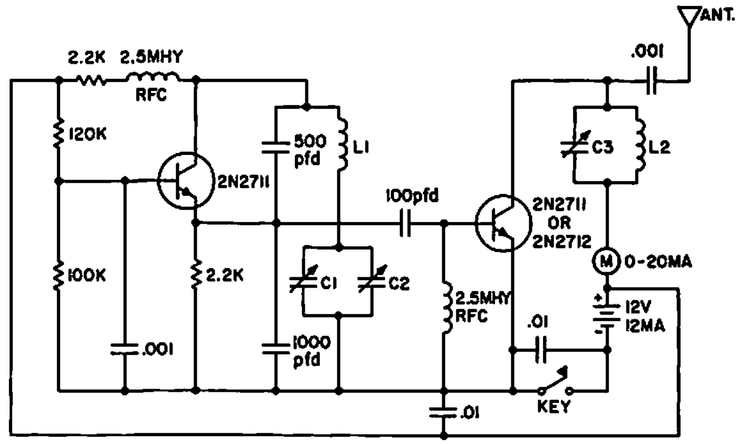
L1, L3 - 40-300μhy FERRITE CORE ANTENNA (J.W. MILLER TYPE 2002)
L2 - 8 TURNS #22 WIRE WRAPPED AROUND BOTTOM L1

LOW-POWER BROADCAST-BAND TRANSMITTER—Crystal-controlled 670-kc oscillator and single-transistor amplifier stage provide 400 microwatts a-m for antenna.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 386.



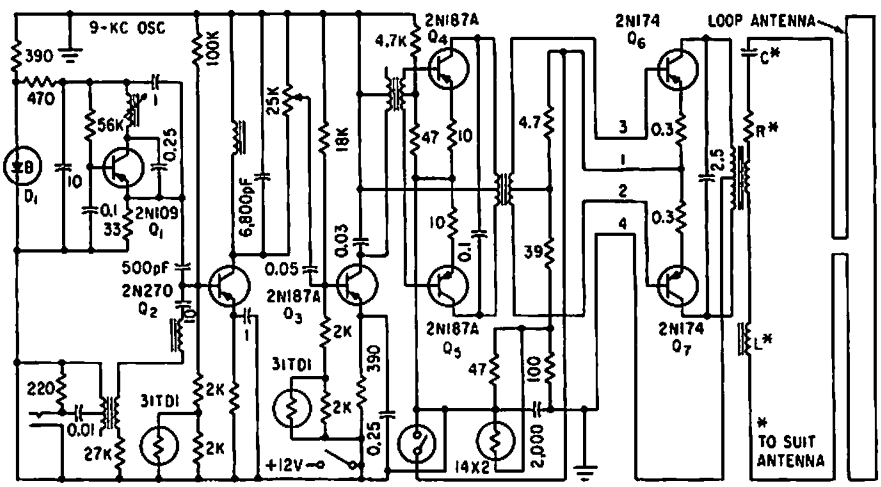
CRYSTAL COMPLEMENT			
SIDEBAND	Y_1	Y_2	Y_3
UPPER	453KC	3.522MC	25.700MC
LOWER	457KC	3.518MC	25.700MC

SSB EXCITER—Silicon transistors reduce noise and increase reliability of single-sideband exciters. Circuit shown, for 10-meter band, gives choice of upper or lower sideband.—D. L. Wilcox, Single-Sideband Exciter uses Planar Silicon Transistors, *Electronics*, 35:32, p 65–67.

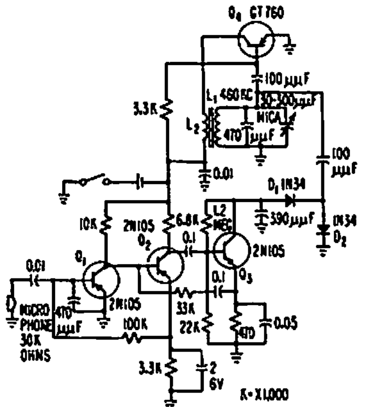


C1 5-15pf BANDSPREAD VARIABLE L1 57T
C2 5-55pf BANDSET VARIABLE L2 35T
C3 6-80pf FINAL TUNING VARIABLE
B & W NO. 3016 MINI-DUCTOR COILS 1" DIA 32T/INCH

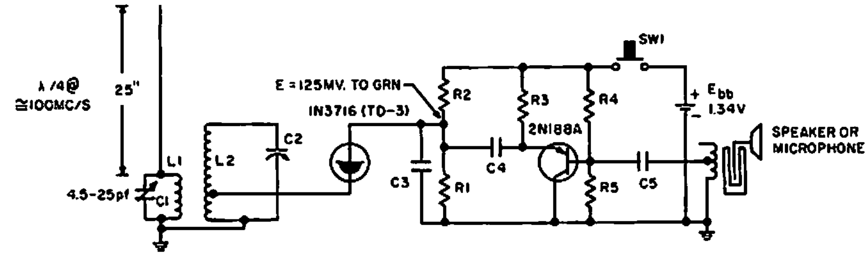
LOW-POWER VFO C-W 80-METER TRANSMITTER—Power output is 100 mw in amateur band.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 386.



9-KC OSCILLATOR STABILIZER—Insures 24 w output over temperature range of −20 to +120°F. Zener diode voltage-regulating circuit prevents changes in collector supply voltage of oscillator Q1. Base-driven modulator Q2 may be fed from tape repeater preamp, microphone, or master control center serving induction radio system using roadside telephone-line loops.—E. A. Hanysz, J. E. Stevens, and A. Meduvsky, Communication System for Highway Traffic Control, *Electronics*, 33:42, p 81–83.

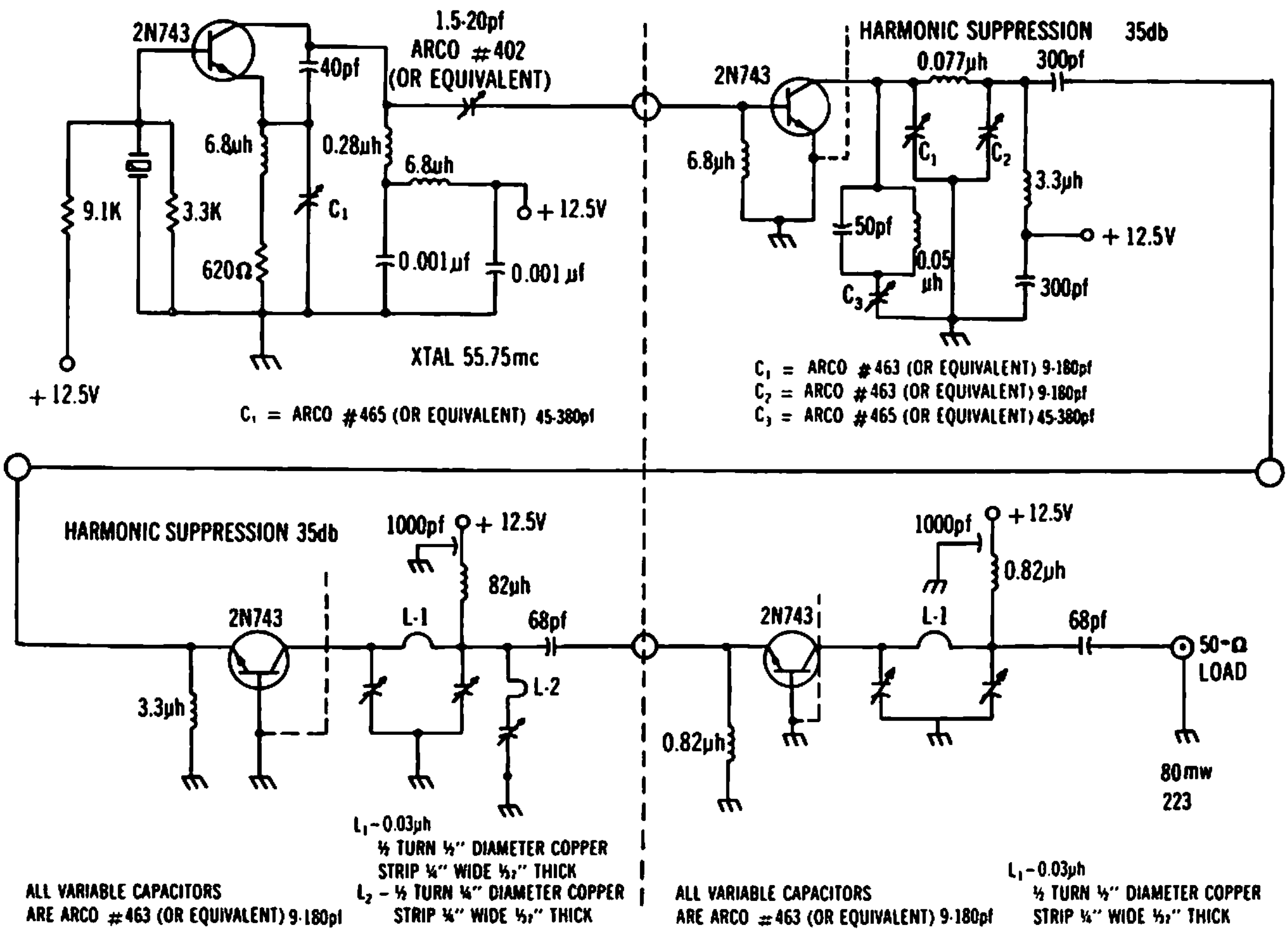


460-KC F-M WIRELESS MICROPHONE—Radiates about 0.2 micromicrowatt directly from tank circuit to establish induction field within usable area of auditorium stage without exceeding FCC radiation field limitation. Normal speaking voice produces peak f-m deviation of about 10 kc.—G. F. Montgomery, Wireless Microphone Uses F-M Modulation, *Electronics*, 31:1, p 54–55.



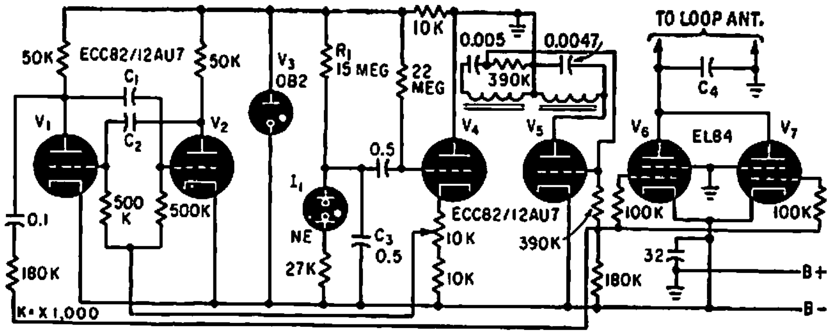
L1 2 TURNS #16 COPPER 3/8" ID SPACED 1/8" FROM GROUND END OF L2 (ADJUST FOR BEST STABILITY)
L2 6 TURNS #16 COPPER 3/8" ID CLOSE-WOUND AND CONNECTED DIRECTLY TO C2. TAPPED 1 TURN FROM GROUND.
C1 4.5-25μμfd CERAMIC TRIMMER
C2 1.5-5μμfd VARIABLE
C3 800μμfd (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
C4 50μfd 6 VDC ELECTROLYTIC (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
C5 1μfd 35 VDC (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
R1 18Ω 1/2 W 5%
R2 150Ω 1/2 W 5%
R3 470Ω 1/4 W
R4 10KΩ 1/4 W
R5 10KΩ 1/4 W
E_{bb} MALLORY RM-12R MERCURY CELL 1.34VDC-3600 MAH
Sw1 NORMALLY OPEN SPST "PUSH-TO-TALK" SWITCH
SPKR 2" PM SPEAKER
1N3716 (TD-3) 4.7MA AXIAL TUNNEL DIODE

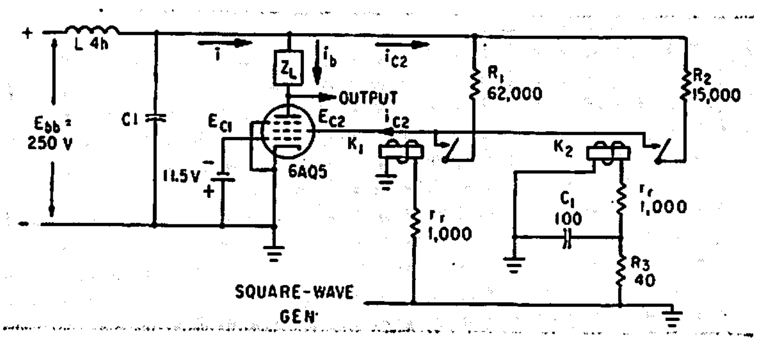
F-M WIRELESS MICROPHONE—Transmitter has range of 200 yards when used with sensitive commercial receiver covering 96-110 Mc. Transistor stage frequency-modulates tunnel-diode oscillator.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 357.



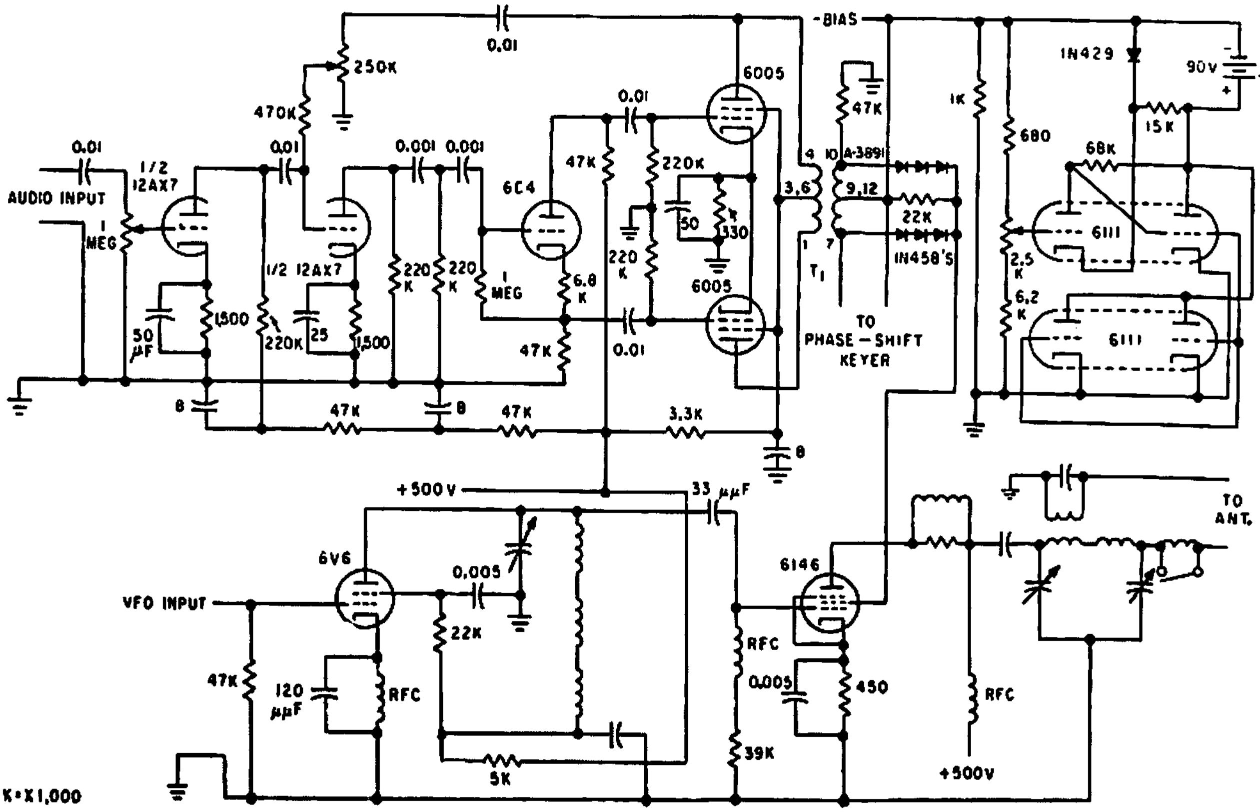
223-MC TELEMETRY TRANSMITTER—Crystal-controlled Colpitts delivers 10 mw to first doubler. Second doubler has trap to eliminate 11.5-Mc fundamental. Power output to final is about 45 mw at 223 Mc. Class C final delivers 100 mw to 50-ohm load.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 326.

PAGING TRANSMITTER—Feeds single-wire loop surrounding area to be covered. Multivibrator V1-V2 produces carrier frequencies in range from 15 to 30 kc, keyed on and off at various repetition rates in range from 1/50th to 1/200th second, for selective paging of up to 45 different receivers.—J. G. DeGraaf, Selective Paging System Uses Coded Transmission, *Electronics*, 33:9, p 68–70.

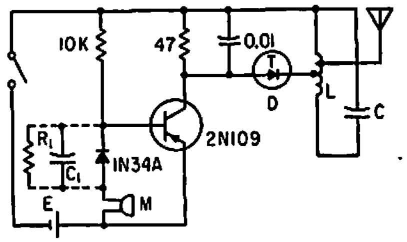




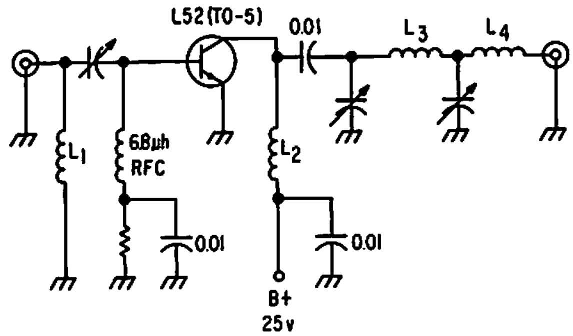
VOICE-OPERATED CONTROL WITH DAMPING—Relays provide timed sequential switching of pentode load to LC-filtered power supply when operator speaks into microphone, thereby preventing overshoot.—E. L. Harris and O. J. M. Smith, Novel Circuit Damps Transients in Voice-operated Transmitters, *Electronics*, 35:39, p 66–67



CARRIER SUPPRESSION—Suppressed-carrier modulation improves efficiency of medium-power transmitter and provides noise advantages of exalted-carrier detection in receiver.—J. Dysinger, W. Whyland, and R. Wood, New Suppressed-Carrier Modulation Technique, *Electronics*, 33:6, p 47–49.

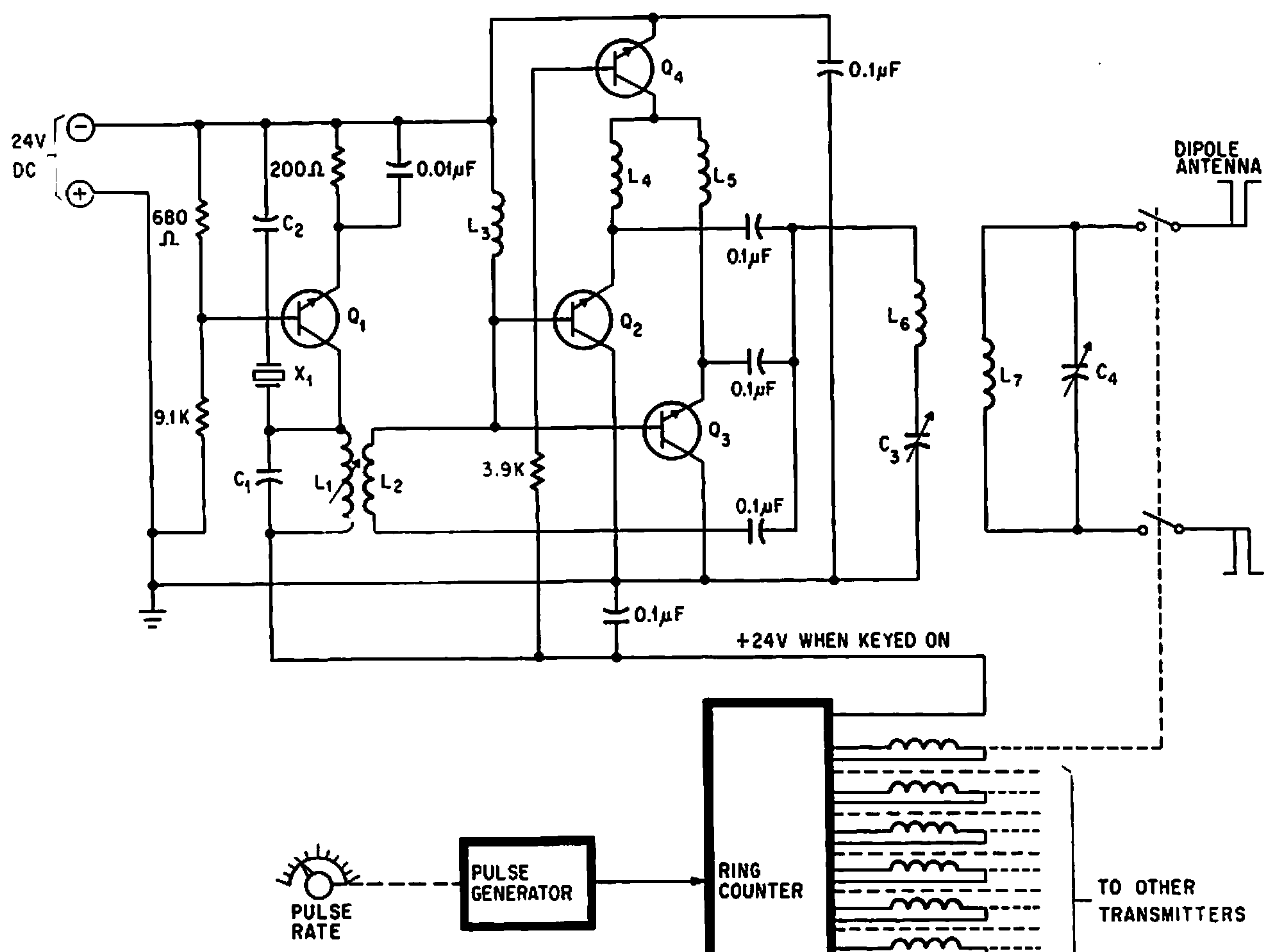


F-M WIRELESS MIKE—Oscillator-modulator using single tunnel diode produces 35-kc frequency deviation per mv of modulating signal at 90 Mc. When fed by dynamic mike, range is up to 100 feet. If pre-emphasis is desired, diode 1N34A may be replaced by R1-C1 circuit shown in dotted lines, having time constant of 75 microsec.—W. Ko, Tunnel Diode F-M Wireless Microphone, *Electronics*, 33:47, p 93–95.

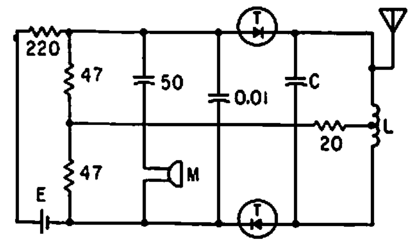


L_1= 3T NO. 16 Buss, 0.4 diam, 0.3" long, L=0.085μh
L_2=4T NO. 16 Buss, 0.4 diam, 0.4" long, L=0.12μh
L_3=8T NO. 16 Soldereze, 0.5 diam, 0.5" long, L=0.5μh
L_4=10T NO. 16 Soldereze, 0.4 diam, 0.6" long, L=0.34μh

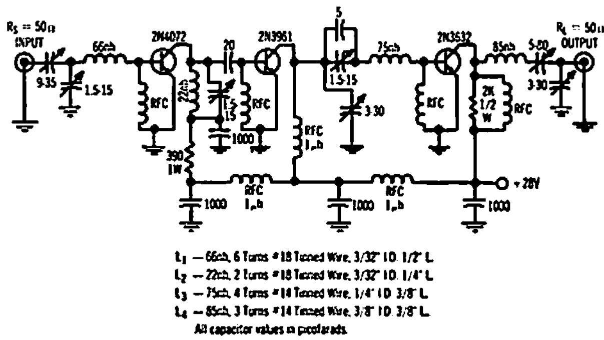
1 W AT 50 MC—Relatively high breakdown voltage of L52 transistor permits amplitude modulation. Overall efficiency is 65%. Combination pi-L network matches common-emitter class-C stage to 50-ohm antenna.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 322.



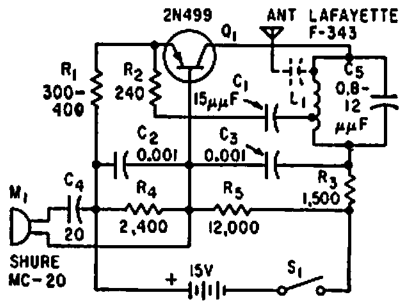
MEASURING ANTENNA RADIATION PATTERN—Eight transmitters, towed as group around ground antenna by airplane, have frequencies spaced throughout bandwidth of antenna under test, from 2 to 50 Mc. Pulse-controlled ring counter switches transmitters up to 40 times per second. All transistors are type 2N3053.—C. Barnes, Transmitters Towed Through Air Test Antenna's Radiation Pattern, *Electronics*, 38:21, p 96–101.



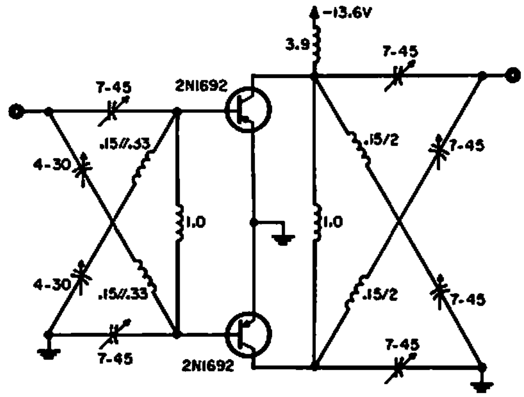
TUNNEL-DIODE WIRELESS MIKE—Two cascaded 2-ma germanium tunnel diodes serving as cascade oscillator and 90-Mc f-m modulator give range of over 100 feet. Coil L is about 5 microhenrys, with five turns a quarter-inch in diameter and half an inch long. C is 24 pf.—W. Ko, Tunnel Diode F-M Wireless Microphone, *Electronics*, 33:47, p 93–95.



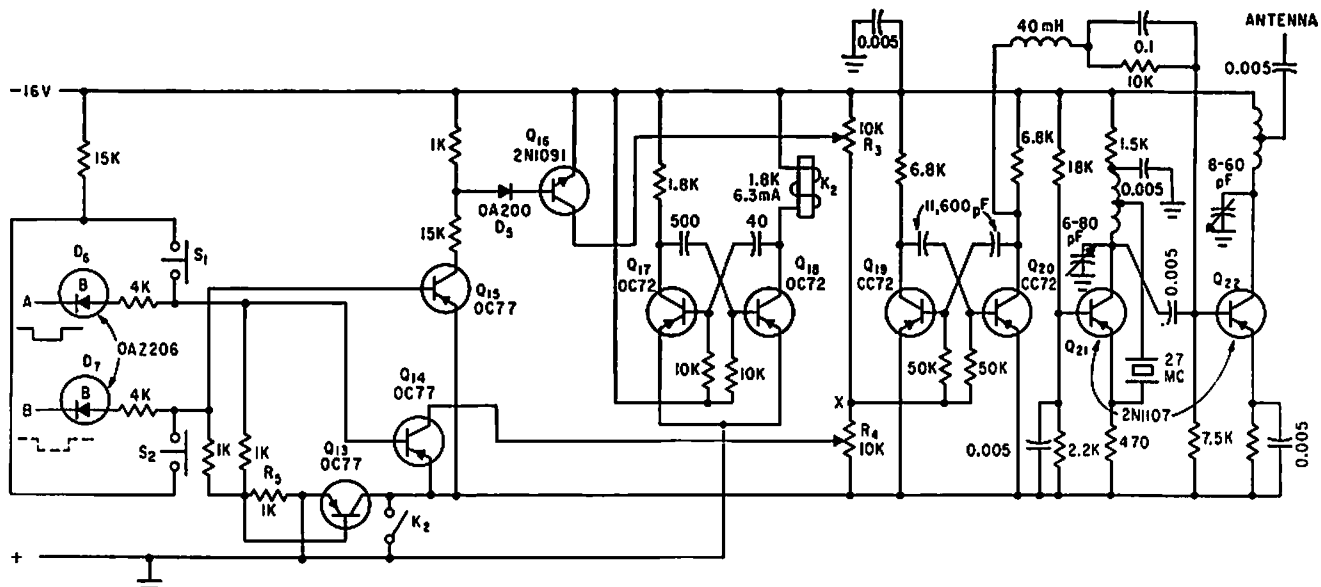
160-MC 15-W POWER AMPLIFIER—Simple three-stage r-f power transistor circuit provides 30.5 db power gain with efficiency of 62%, on 28-v supply.—Solid-State Power Amplifier Design (Motorola ad), *Electronics*, 39:14, p 48–49.



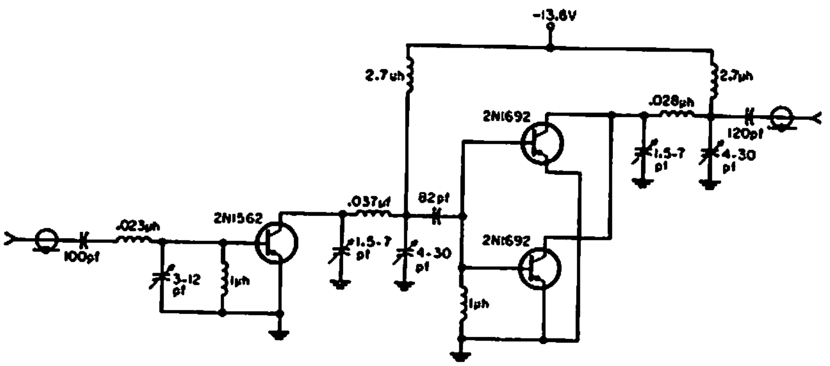
MINIATURE F-M TRANSMITTER—Single 2N499 transistor performs functions of r-f oscillator, frequency modulator, and audio amplifier for tiny portable transmitter having range of 200 feet. Suitable for use with public-address system.—D. E. Thomas and J. M. Klein, How to Construct a Miniature F-M Transmitter, *Electronics*, 32:31, p 80–81.



PUSH-PULL OUTPUT WITH LATTICE FILTERS—Preferred for frequencies above 30 Mc because lattice arrangement without transformers is much easier to construct and align than standard push-pull circuit.—W. A. Rheinfelder, Choosing the Best Transmitter Output Stage, *EEE*, 11:10, p 48–53.

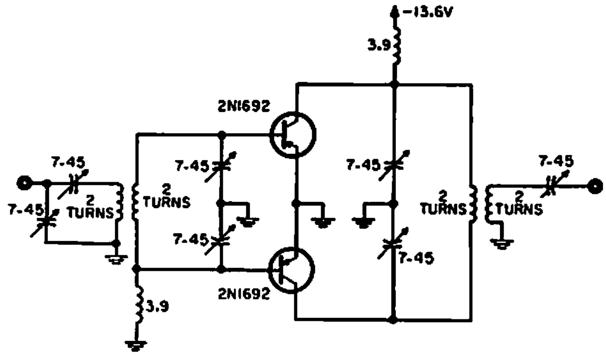


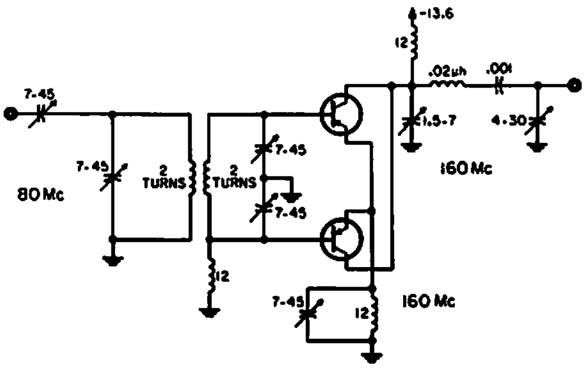
27-MC REMOTE-EVENT TRANSMITTER—Gives 400-cps modulation for pulse at input A, 1,400 cps for pulse at B, and 800-cps check pulses every 2 sec, for transmitting bird flight data to remote recorder.—P. A. Tove and J. Czekajewski, Infrared Curtain System Detects and Counts Moving Objects, *Electronics*, 34:31, p 40–43.



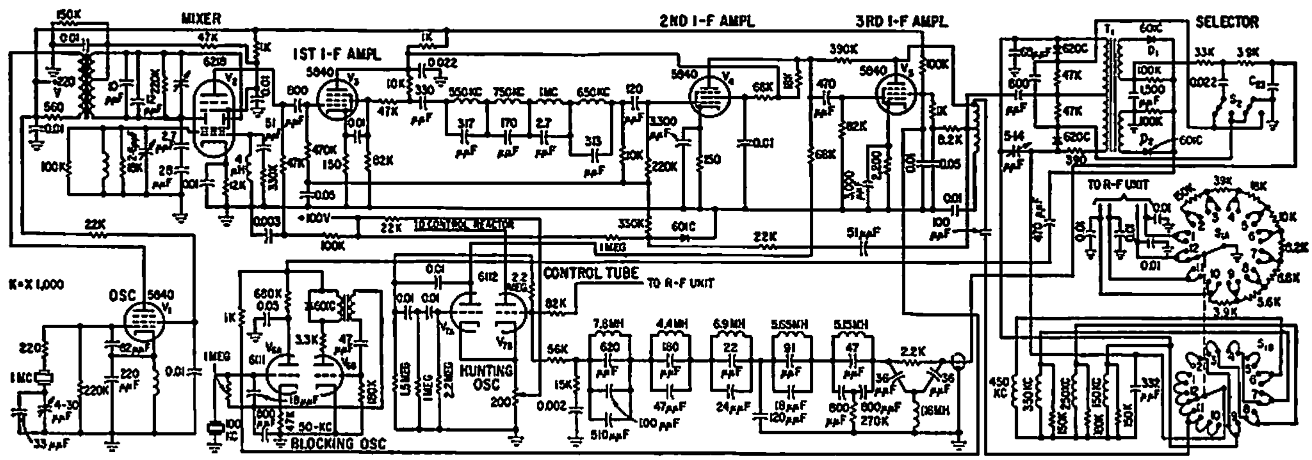
LOW-POWER PARALLEL-TRANSISTOR OUTPUT—Conventional transistor arrangement provides up to 2 w output with power gain of 10 db. Chief advantage is simplicity.—W. A. Rheinfelder, Choosing the Best Transmitter Output Stage, *EEE*, 11:10, p 48–53.

LOW-POWER PUSH-PULL OUTPUT—Efficiency is higher than with normal parallel output stage, yet overall efficiency is only 48% for 1.9-w output because emitter tuning is not effective and power gain is accordingly reduced.—W. A. Rheinfelder, Choosing the Best Transmitter Output State, *EEE*, 11:10, p 48–53.

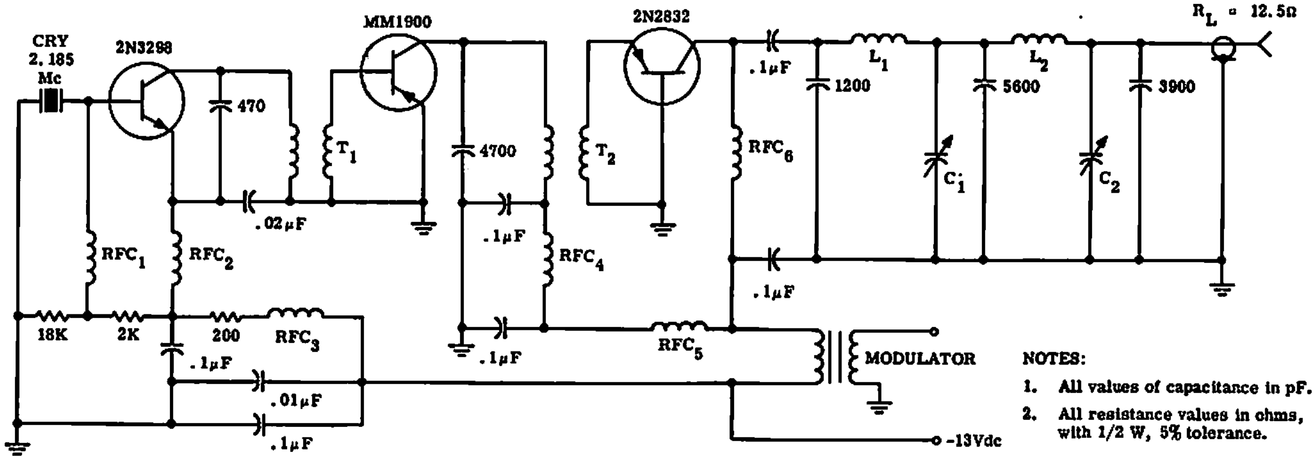




PUSH-PUSH OUTPUT DOUBLER—Input is conventional push-pull configuration providing out-of-phase signals for both transistors, but for output circuit both transistors operate in parallel into standard pi network. This cancels fundamental and odd-order harmonics, leaving only second harmonic predominating in output circuit. Transistors can be 2N1692. —W. A. Rheinfelder, Choosing the Best Transmitter Output Stage, *EEE*, 11:10, p 48–53.

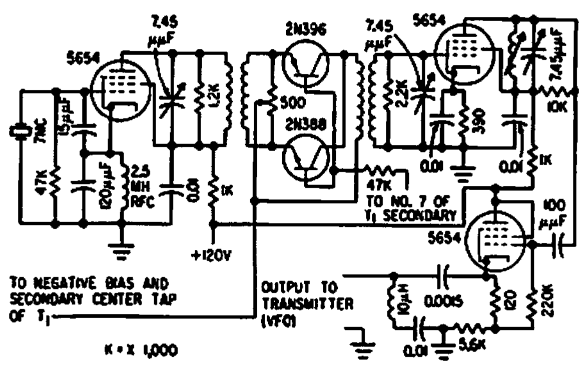


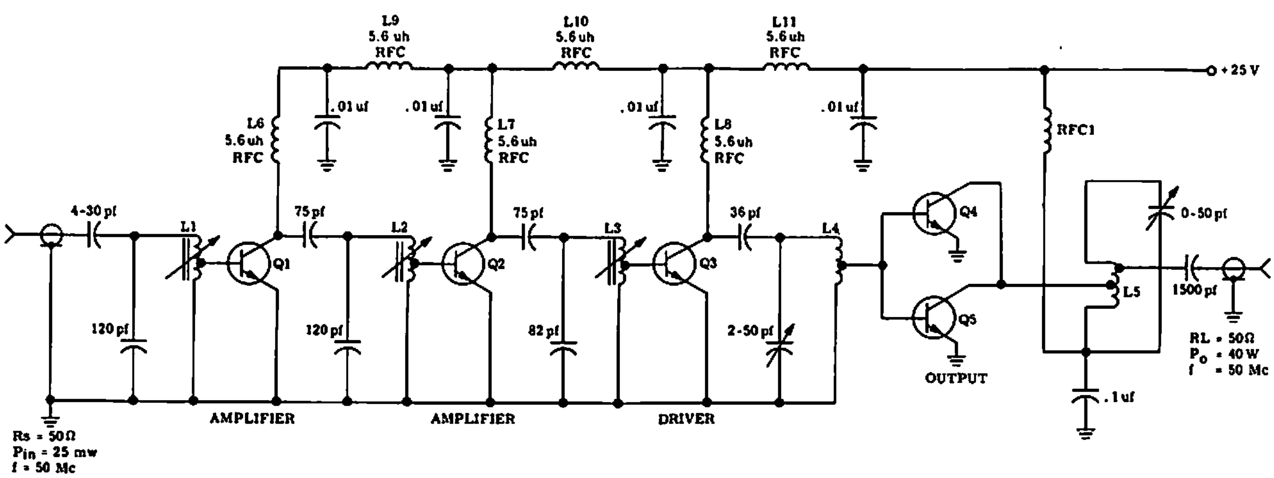
STEPPED FREQUENCY EXCITER—Provides crystal-controlled output frequency in 100-kc steps at 1-sec intervals from 31.05 to 54.95 Mc, with each step an odd multiple of 50 kc. Used to control pulse transmitter and receiver at widely separated locations, for observation of mutual propagation conditions between the two points. Frequency control of r-f oscillator is obtained by mixing sample r-f signal with 1-Mc reference and comparing components of product with 50-kc pulse spectrum supplied by pulse generator V6B.—Frequency Stepper for Radio Propagation Tests, *Electronics*, 32:4, p 44–46.



2.185-MC MARINE-BAND TRANSMITTER—Grounded-base Colpitts oscillator uses series-mode crystal with driver and output stage. Current drain is only 1.5 amp from storage battery. No converter is required. Output is 13-w rms carrier.—R. J. Brubaker, "An All-Solid-State Marine Band Transmitter," Motorola Application Note AN-156, Feb. 1966.

PHASE-SHIFT KEYER—Used with double-sideband suppressed-carrier modulation. Crystal-controlled Colpitts oscillator drives transistor gate, which in turn feeds conventional tuned pentode r-f amplifier and tuned cathode follower.—J. Dysinger, W. Wyland, and R. Wood, New Suppressed-Carrier Modulation Technique, *Electronics*, 33:6, p 47–49.





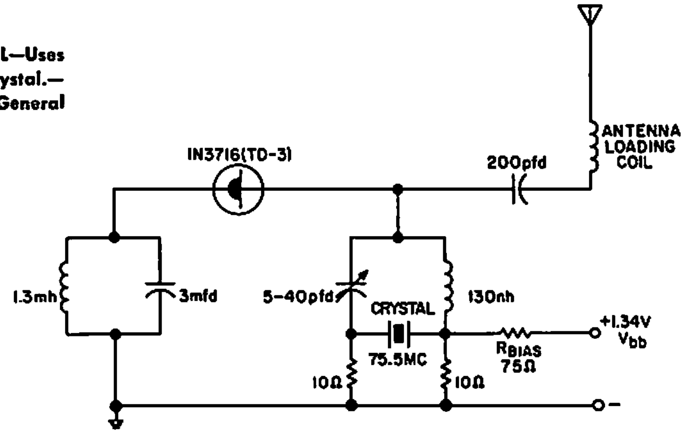
L1, L2 = 4 T, #16, 1/4 I. D., 1/2 L, SLUG-TUNED TAPPED 1/2 T FROM GND. .07 TO .1 uh
L3 = 4 T, #16, 3/8 I. D., 5/8 L, SLUG-TUNED TAPPED 1/2 T FROM GND. .12 TO .15 uh
L4 = 4 T, #14, 1/2 I. D., 5/8 L, AIR WOUND TAPPED 1/2 T FROM GND. .18 uh
L5 = 4 T, 1/8 COPPER TUBING, 3/4 I. D., 1" L, AIR WOUND, TAPPED 1/2 & 1 1/2 T FROM GND. .27 uh

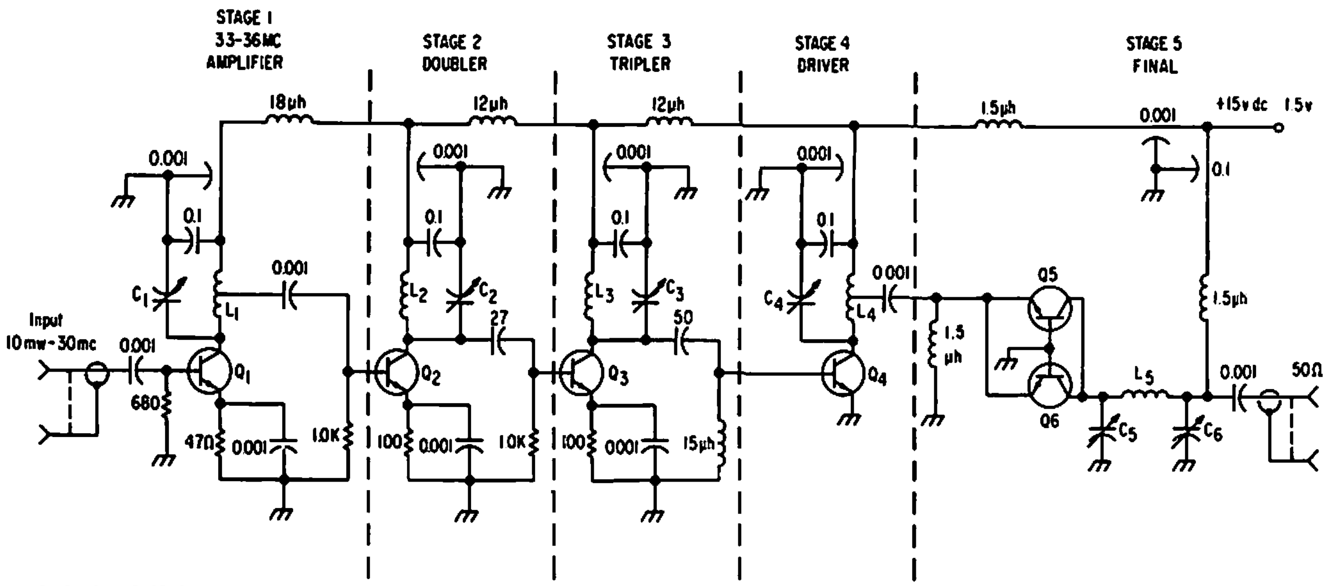
Q1 = 2N2951
Q2 = 2N2950
Q3 = 2N2948
Q4, Q5 = 2N2947

RFC 1 = 16 T #24 ENAMEL, 1/4 I. D.

40 W AT 50 MC—Can be used with phase-modulated oscillator as drive source, or with crystal oscillator for straight c-w operation. Grounded emitter leads in driver Q3 and power amplifier should be as short as possible to prevent degeneration.—R. Brubaker, "A Solid-State Transmitter with 40 Watts Output at 50 MHz," Motorola Application Note AN-172, Dec. 1965.

73.5-MC SELF-MODULATED CRYSTAL—Uses tunnel diode oscillator to modulate crystal.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 357.





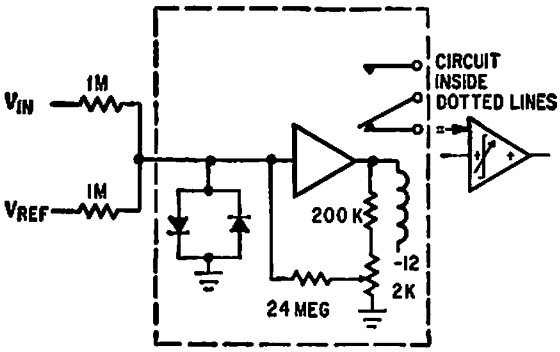
C_1, C_2, C_6 = 8-60pf
C_3, C_4, C_5 = 1.5-20pf
All other capacitor values in μf

L_1 = 8T, 1/4" Form with core, tap center
L_2 = 6T, 1/4" Form
L_3 = 2T, 1/4" Form

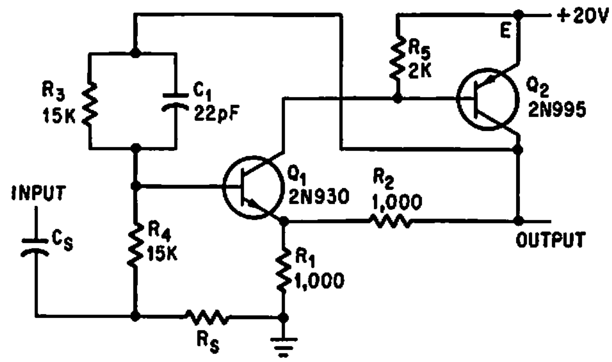
L_4 = 2T, 1/4" Form, tap center
L_5 = 3T, 1/4" Form
Q_1 Thru Q_6 = SM2498

NARROWBAND 162-180 MC TRANSMITTER—First stage acts as buffer for oscillator, while Q2 and Q3 multiply frequency. Class-C power amplifier using two SM2498 transistors in parallel delivers 300 mw to 50-ohm load.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 325.

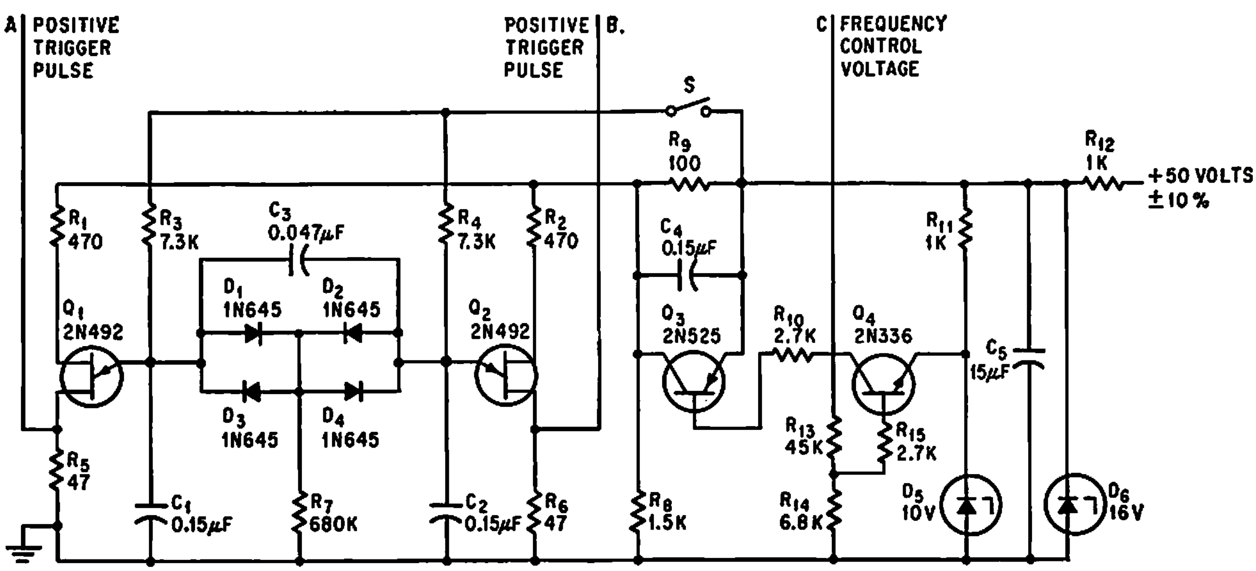
CHAPTER 95
Trigger Circuits



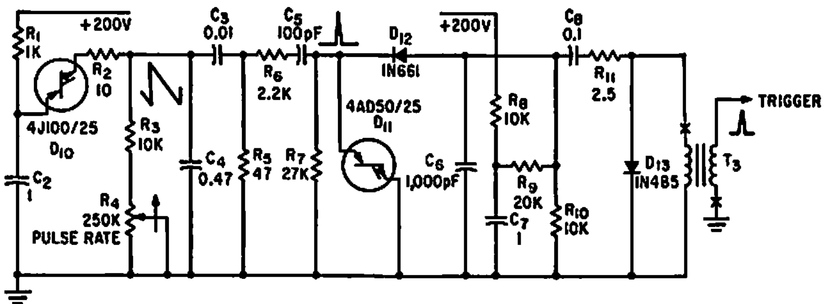
OPERATIONAL TRIGGER—Combines some features of operational amplifier with those of Schmitt trigger. Input diodes prevent amplifier saturation.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



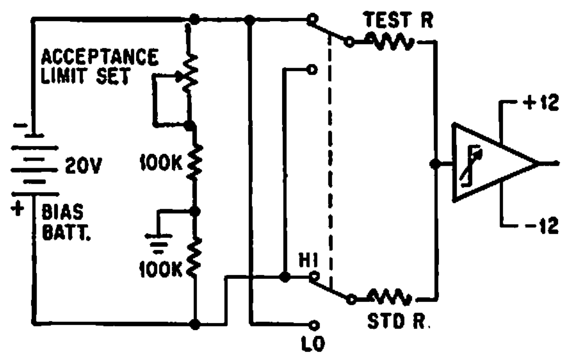
INPUT TURNS BOTH TRANSISTORS ON—Unlike Schmitt trigger, both transistors stop conduction when input is removed.—L. L. Kleinberg, Complementary Shaper Replaces Schmitt Trigger, *Electronics*, 37:26, p 66.



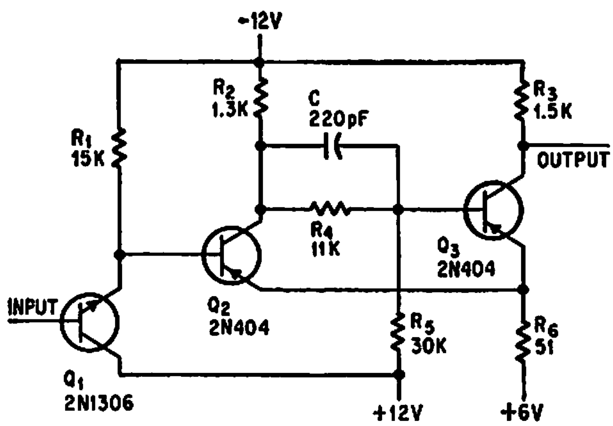
DUAL-PULSE TRIGGER—Dual triggers supply alternating pulses for driving d-c to d-c voltage converter connected to A and B. Frequency of triggering can be adjusted from 650 to 900 cps by varying base-to-base voltages of unijunction transistors.—T. Wilson, Voltage Controls Dual-Pulse SCR Trigger, *Electronics*, 37:28, p 62–63.



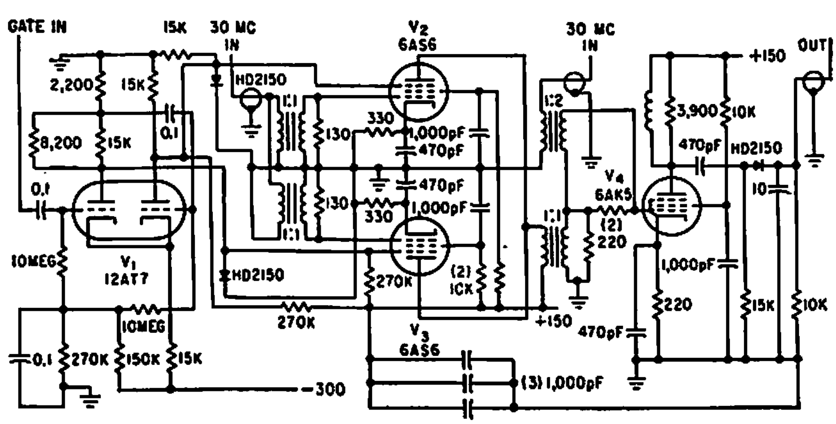
PULSER FOR 250-KW MODULATOR—Trigger generator for scr modulator uses two-layer and four-layer diodes to provide pulse burst repetition rates up to 25 kc.—H. G. Heard, Controlled Rectifier Produces Quarter-Megawatt Pulse Power, *Electronics*, 34:25, p 54–55.



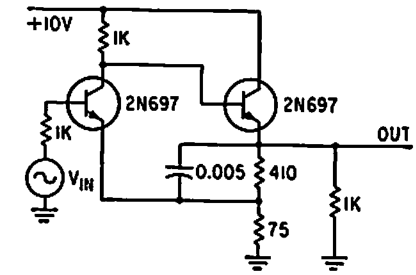
RESISTOR TESTER—Operational trigger is tripped by bridge circuits when resistor under test is 0.11% high for switch position shown. Reversing switch gives same sensitivity for low resistors.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



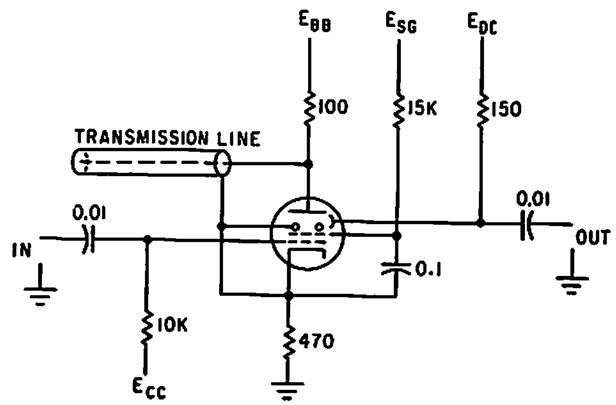
VOLTAGE-LEVEL TRIGGER—Output pulse appears when input is 6.0 v but not for inputs up to 7 volts above or below this level. Circuit then continues on until input drops below 5.4 v.—R. F. Woody, Precise 6-Volt Input Triggers Circuit, *Electronics*, 38:14, p 80.



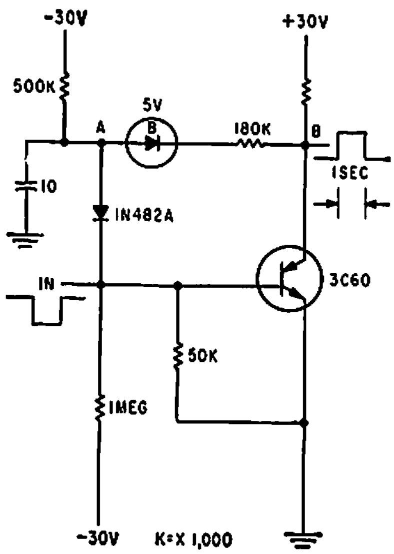
CHOPPER AND PHASE DETECTOR—Input gate signal operates Schmitt trigger V1, to give identical but oppositely phased signals for phase detector of instrument for measuring phase differences between two signals.—R. T. Stevens, Precision Phasemeter for CW or Pulsed UHF, *Electronics*, 33:10, p 54–57.



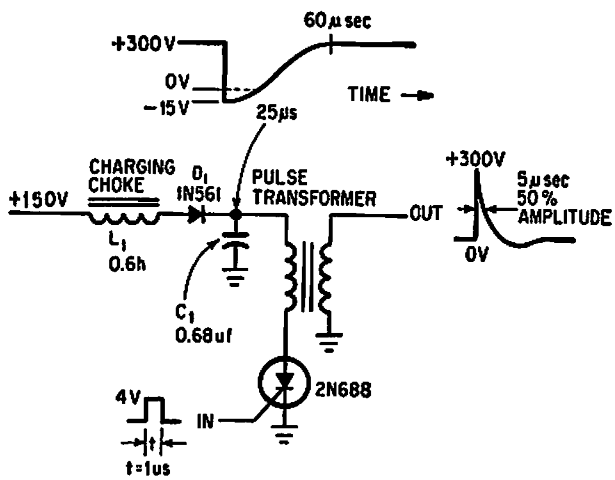
D-C TRIGGER DRIVES HIGH-C COAX—Emitter-follower incorporated in Schmitt circuit provides signal shaping needed to drive high-capacitance cable with good rise time and few components.—G. Klein, Schmitt Trigger Drives Low Impedance Loads, *Electronics*, 36:33, p 28–29.



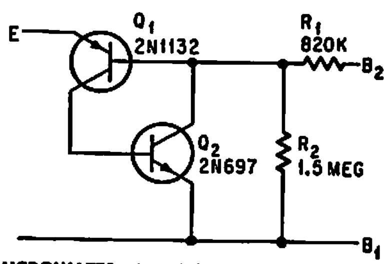
TRIGGER WITH TRANSMISSION-LINE FEEDBACK—Feedback capacitor is replaced by open-circuited section of transmission line. Duration of output pulse taken across dynode load of secondary-emission pentode is adjusted by varying line length.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



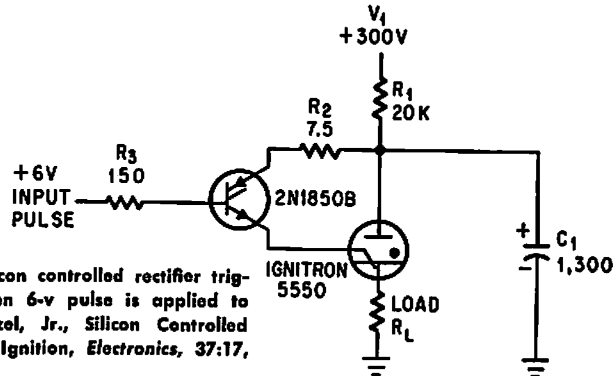
PNPN ONE-SHOT—Provides up to 10 sec delay. Circuit is normally on, with point A at −11 v and B at +1 v. Negative trigger applied to base of pnpn unit operates circuit.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



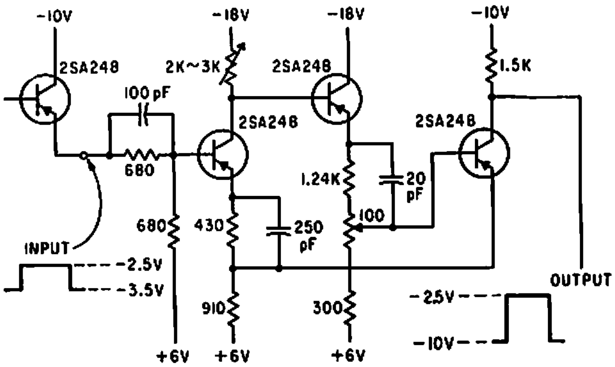
NOISE-IMMUNE SCR TRIGGER GENERATOR—Modification of line-type radar modulator gives general-purpose triggering circuit that is immune from noise. Expensive pulse-forming network of conventional scr trigger is replaced by capacitor. Sharply peaked output pulses are ideal for triggering radar modulators for firing strobe flashtubes. Scr conducts for 10 microsec after triggering, and C1 is negative for next 15 microsec because of ringing with L1, so false triggering can occur from low-level noise pulses for only last 5 microsec, by which time capacitor has charged enough to forward-bias scr so large triggering pulse is again required to turn it on. Circuit is ready for next trigger 60 microsec after C1 is discharged. Maximum prr is 12 kc.—J. E. Curry, No Pulse-Forming Network in SCR Trigger Generator, *Electronics*, 39:18, p 97–98.



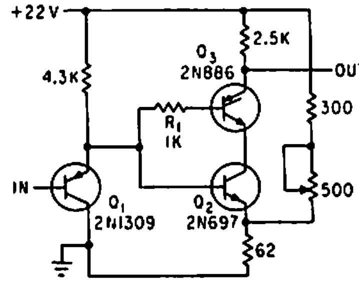
MICROWATTS AT QUIESCENCE—Circuit has same characteristics as single unijunction transistor but dissipates only microwatts of power when off.—R. A. Wilson, Pnp Plus Npn Equals Unijunction Transistor, *Electronics*, 38:5, p 94–95.



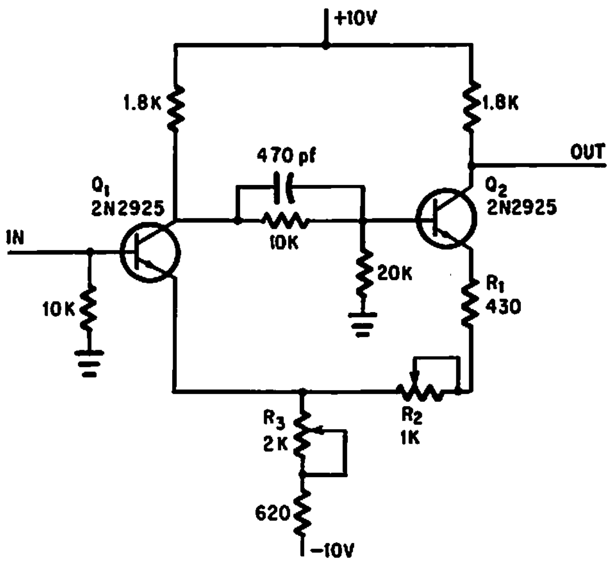
SCR TRIGGER—Silicon controlled rectifier triggers ignitron when 6-v pulse is applied to gate.—L. E. Frenzel, Jr., Silicon Controlled Rectifier Triggers Ignition, *Electronics*, 37:17, p 62–63.



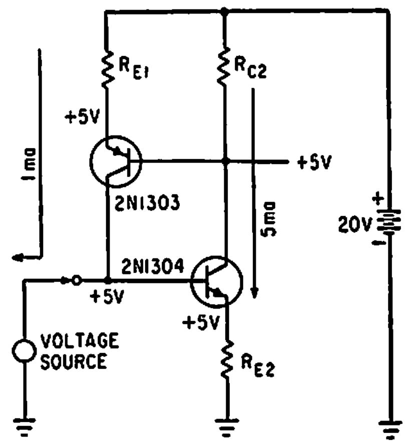
CUTOFF SCHMITT—Conventional current-feedback version, in which one of the two active transistor elements is generally cut off, performs reliably even though optimum operating regions for transistors cannot always be achieved.—H. Inose, Y. Yoshida, and H. Tada, Noncutoff Circuits Improve Trigger Switching, *Electronics*, 35:30, p 36–39.



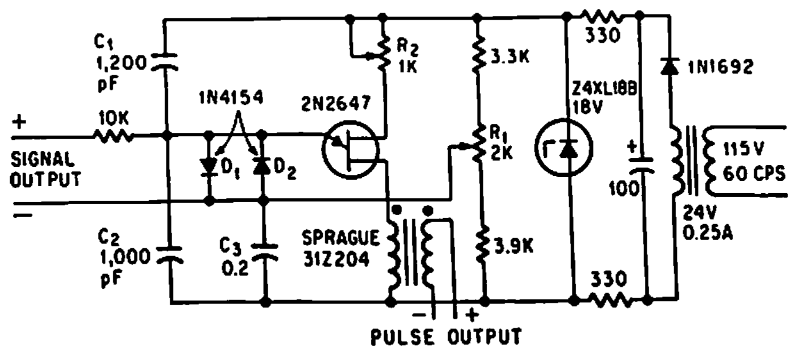
SCR IMPROVES SCHMITT TRIGGER STABILITY—Input signals to 200 kc give consistent triggering over wide range of temperature, source impedance, and input impedance, and hysteresis is reduced by order of 10.—M. Schmidt, Improved Schmitt Trigger Uses SCR, *Electronics*, 36:17, p 68.



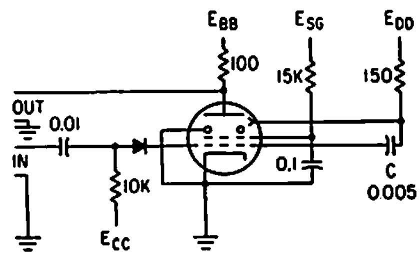
$1.75 SCHMITT—Use of inexpensive transistors and fixed resistors in place of potentiometers keeps cost low. Hysteresis control R2 and trigger level control R3 are optional. Output is 8 v peak to peak at 50 kc.—A. Pacela, Low-Cost Schmitt Trigger Reduces Hysteresis, *Electronics*, 38:24, p 63–64.



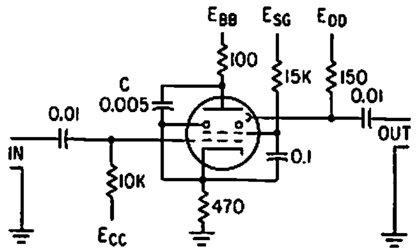
SERIES SCHMITT—Complementary transistors are either both on or both off, conserving power for trigger, comparator, flip-flop, one-shot, and oscillator applications. With 20-v supply, RE1 is 15 K, RC2 is 3K, and RE2 is 1K. —J. K. Skilling, New Complementary Transistors make Series Schmitt Circuits Practical, *Electronics*, 35:35, p 52–53.



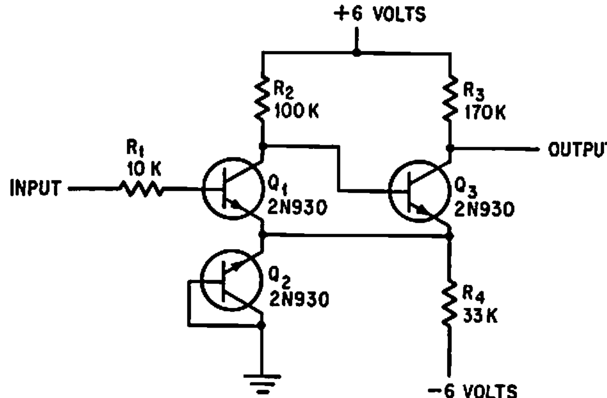
VOLTAGE SENSING—Unijunction transistor is triggered when input signal is slightly positive, and then generates pulses as long as input remains positive. Output can be used to trigger flip-flop or turn on scr's.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105-110.



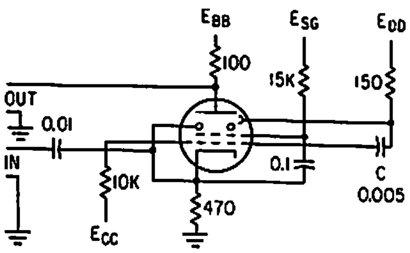
DYNODE-TO-GRID POSITIVE FEEDBACK—Produces negative output pulse across plate load of secondary-emission pentode. Feedback is from dynode to control grid, rather than from plate to cathode. Diode insures that feedback pulse does not affect other circuits, and makes feedback nearly independent of input generator impedance. Used in high-speed, short-duration pulse work.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



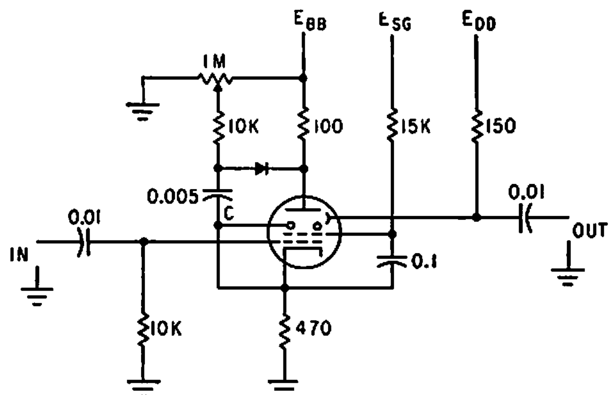
SECONDARY-EMISSION PENTODE TRIGGER—Produces positive output pulse across dynode load each time it is triggered by positive grid pulse. Used in high-speed, short-duration pulse work.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



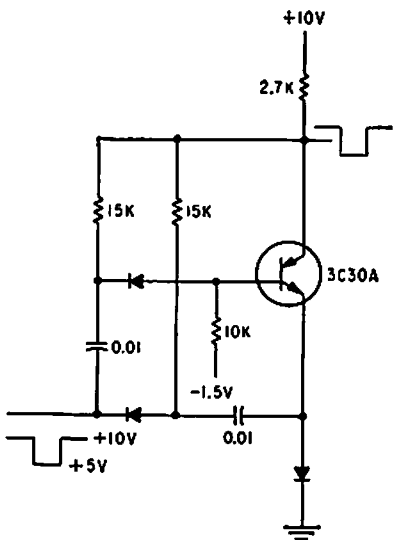
DIODE-COUPLED SCHMITT—Uses include pulse-width modulation of d-c voltage for switching amplifiers, wave shaping, and voltage or current monitoring. Low dynamic resistance of diode formed by Q2 keeps hysteresis (difference between turn-on and turn-off) down to 10 mv.—D. D. Robinson, Diode-Coupled Schmitt Trigger, *Electronics*, 37:31, p 50–51.



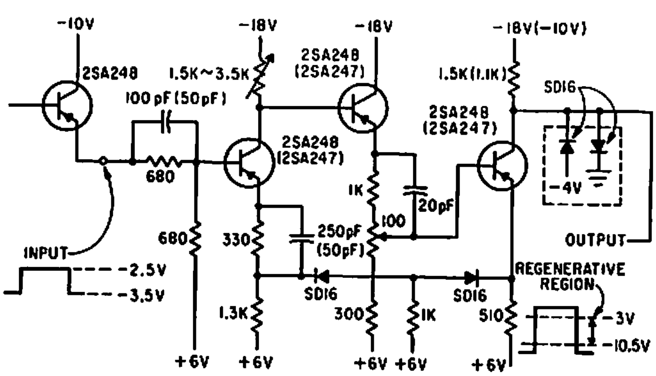
NEGATIVE-PULSE TRIGGER—Diode is not necessary in input circuit of secondary-emission pentode, since feedback is from dynode to control grid and negative trigger pulse is impressed on cathode. Used in high-speed, short-duration pulse work.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



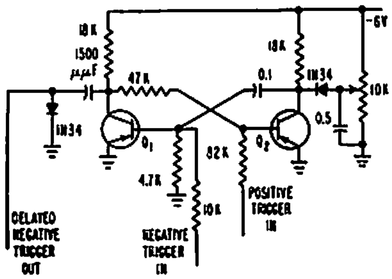
VARIABLE-SENSITIVITY TRIGGER—Biased diode in feedback circuit prevents regeneration. Feedback cannot occur until negative-going pulse greater than bias appears at plate of secondary-emission pentode. Diode bias varies sensitivity, allowing use as pulse-height discriminator also.—E. J. Martin, Jr., How to Use the Secondary-Emission Pentode, *Electronics*, 33:41, p 60–63.



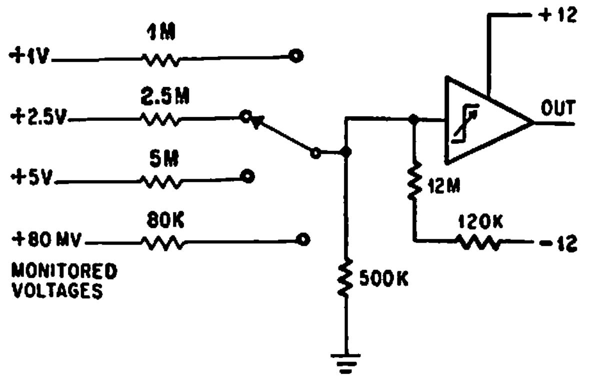
PNPN FLIP-FLOP BINARY COUNTER—Negative trigger pulses produce 2:1 operation. Can be driven from identical flip-flop or from collector of npn silicon transistor.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



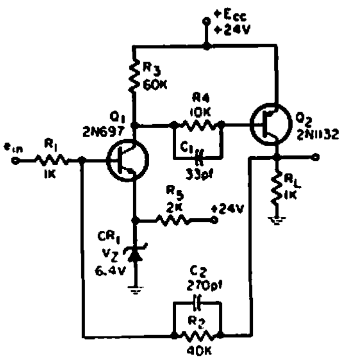
NONCUTOFF SCHMITT—Both amplifiers are always connected to their current sources, hence are never cut off and can operate in optimum region, with no risk of damage by inverse base-emitter voltage. Output voltage alternates between two levels.—H. Inose, Y. Yoshida, and H. Tada, Noncutoff Circuits Improve Trigger Switching, *Electronics*, 35:30, p 36–39.



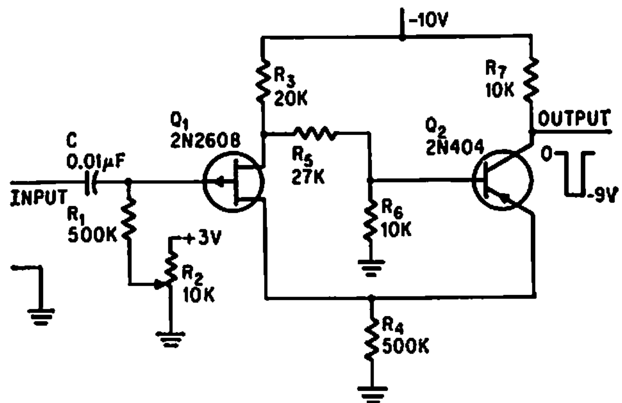
DELAYED TRIGGER GENERATOR—Provides controllable positive or negative delayed trigger. When used to see leading edge of multivibrator pulse on cro, trigger starts cro sweep and delay generator. After preset time, delay generator produces pulse used to trigger mvbr.—H. L. Armstrong, Transistorized Trigger and Delay Generators, *Electronics*, 31:3, p 96–98.



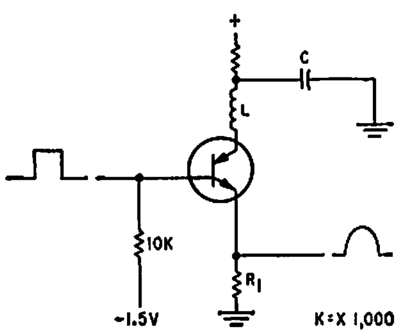
VOLTAGE MONITOR—Input voltage sensitivity better than 0.7 mv is obtained from operational trigger.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



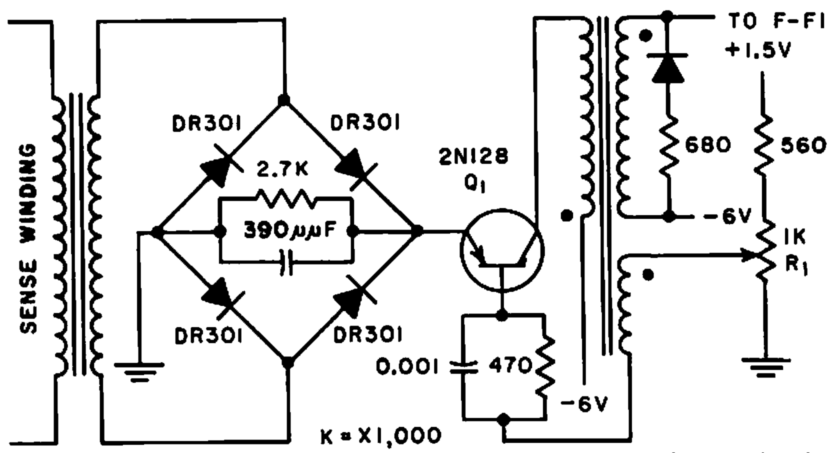
REGENERATIVE-SWITCHING TRIGGER—Advantages over conventional Schmitt include reduced power consumption (neither transistor conducts during off state), full-range output voltage swing, and low output impedance. Some input signal appears in output. Rise and fall times are 0.15 microsec. —R. K. Vieth, Trigger Circuit Gives Less P-diss, More V-out, *EEE*, 11:12, p 28.



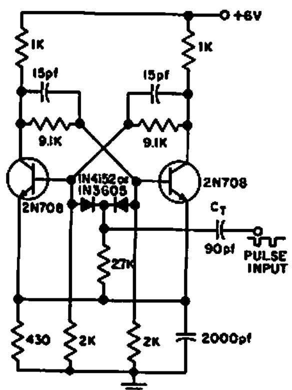
HIGH-IMPEDANCE SCHMITT—Use of fet Q1 for input stage gives high input impedance, as required for threshold detector circuit. Output pulse is square wave at up to 100 kc triggering. Turnoff threshold is about 0.2 v below turnon.—L. R. Lott, FET Increases Schmitt Trigger Input Impedance, *Electronics*, 38:15, p 65.



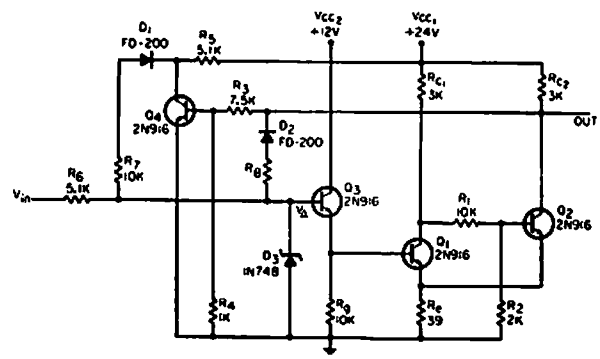
LC PULSE GENERATOR—Provides half-sinusoid output determined by L and C, when pnpn unit is triggered on by low-level positive pulse applied to its base.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



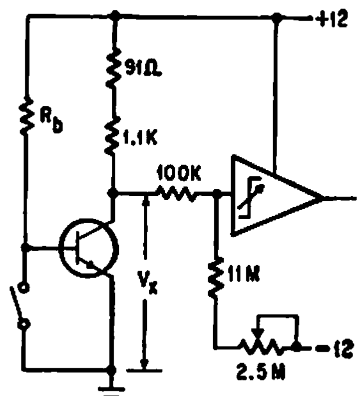
SENSE AMPLIFIER—Blocking-oscillator transistor amplifier is triggered by output of diode bridge network. Rectification assures that readout voltages of both polarities are sensed. Diodes attenuate small signals greatly relative to large signals, increasing signal-noise ratio at rectifier output to about 20:1. —C. S. Warren, W. G. Rumble, and W. A. Helbig, Transistorized Memory Monitors Earth Satellite, *Electronics*, 31:3, p 66–70.



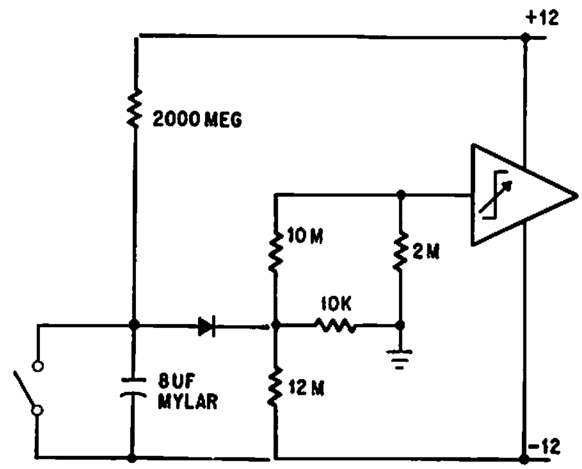
BASE-TRIGGERED FLIP-FLOP—Maximum trigger rate for steering circuit exceeds 5 Mc with negative trigger pulse amplitude from 0.75 to 2 v. Requires less trigger energy than collector triggering but more accurately controlled trigger amplitude.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 197.



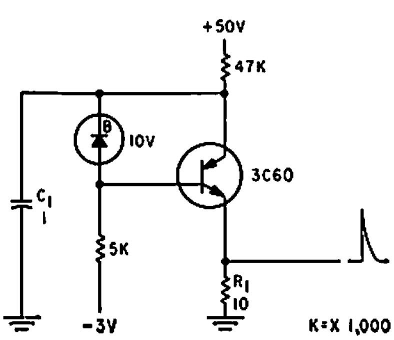
VARIABLE-HYSTERESIS SCHMITT—R7 adjusts lower trigger point, and R8 adjusts upper trigger point.—R. S. Hughes, Variable-Hysteresis Schmitt Trigger, *EEE*, 13:7, p 41.



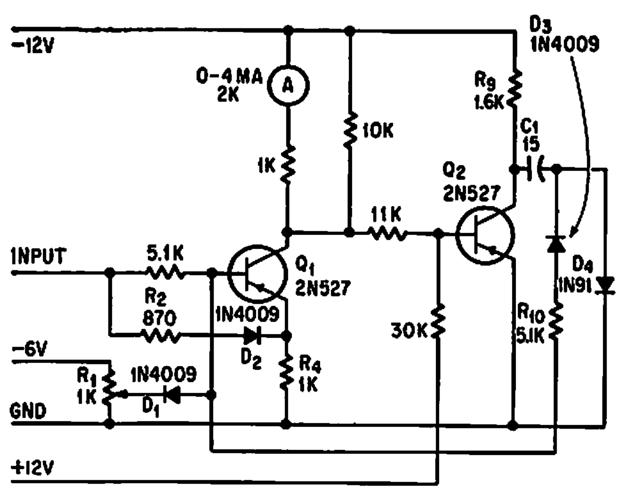
SATURATED TRANSISTOR MEASUREMENT—Transistor under test is biased to saturate collector to within 100 mv of ground for 10-ma collector load. Operational trigger then trips when Vx is 1 mv above 100 mv.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



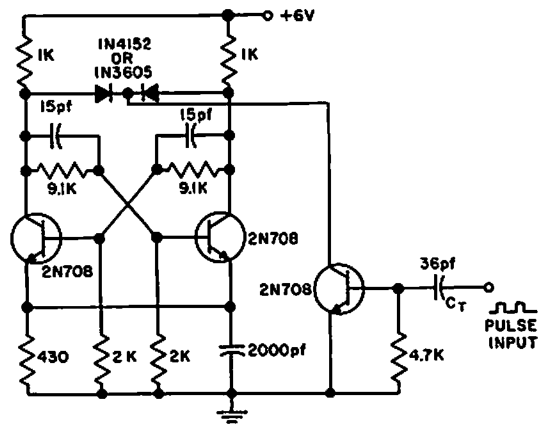
HOURS OF DELAY—Capacitor starts charging from −12 v to +12 v when switch is opened. Diode begins conducting at ground potential, and operational trigger trips when diode passes 2 na. Timing accuracy is high.—P. Lefferts, Operational Trigger For Precise Control, *Electronics*, 37:28, p 50–55.



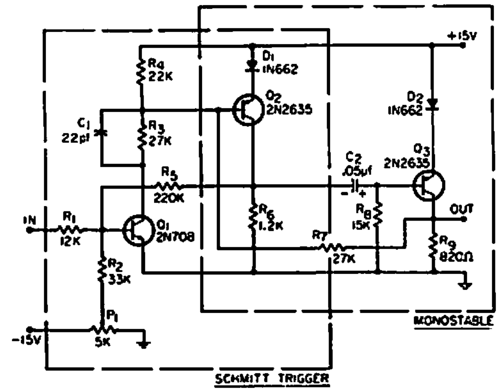
PULSE GENERATOR—Delivers 1-amp peak output current having duration of 10 microsec when pnpn unit is triggered on by low-level positive pulse applied to its base.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



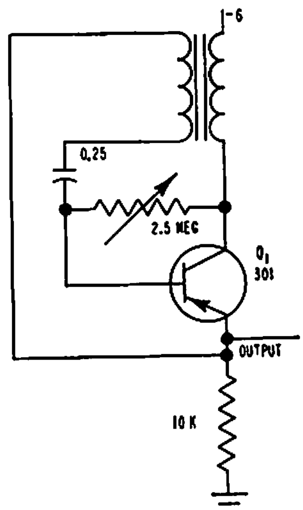
RANDOM-PULSE DETECTOR—Either positive or negative pulses above predetermined minimum amplitude force Q1 into saturation and turn Q2 off, causing the meter to deflect immediately. Circuit may also be used as pulse stretcher or threshold detector.—C. F. Johnson and J. T. Loiselle, Bipolar Pulse Detector Features Meter Display, *Electronics*, 38:24, p 63.



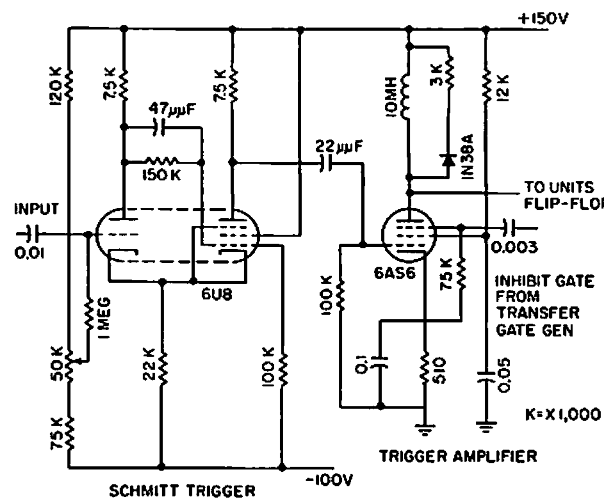
COLLECTOR TRIGGERING WITH TRIGGER AMPLIFIER—Used in early stages of counter to increase speed, while permitting automatic assembly in all stages. For 1-Mc trigger rate, less than 1 v of positive trigger amplitude is needed.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 198.



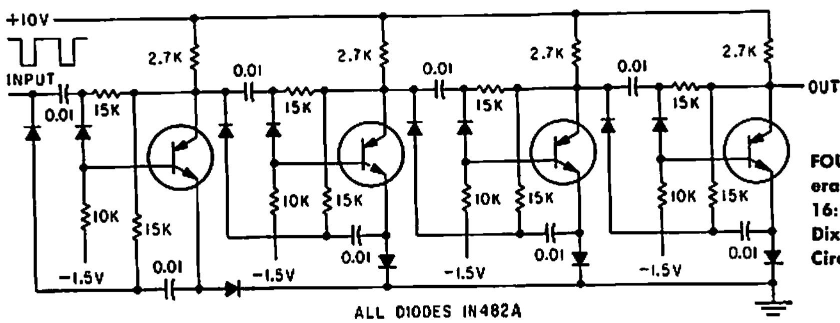
COMBINATION SCHMITT-MONOSTABLE—Three transistors in complementary connection give Schmitt trigger (Q1-Q2) and monostable mvbr (Q2-Q3) in which triggering level is accurately controlled. Output pulse width is independent of input because circuit is regenerative.—G. Marosi, Combination Schmitt Trigger-Monostable Multivibrator, *EEE*, 13:10, p 77.



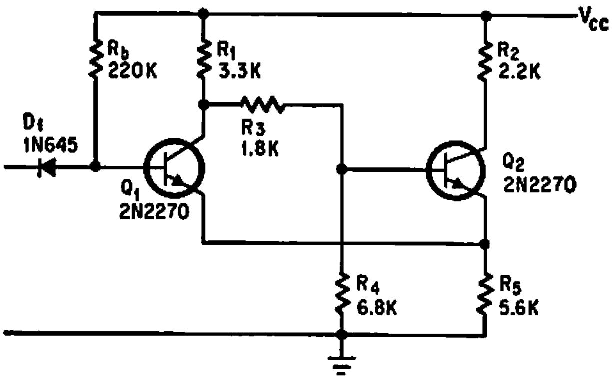
BLOCKING-OSCILLATOR TRIGGER GENERATOR—Generates relatively narrow pulses at adjustable repetition rate. Audio transformer provides positive feedback.—H. L. Armstrong, Transistorized Trigger and Delay Generators, *Electronics*, 31:3, p 96–98.



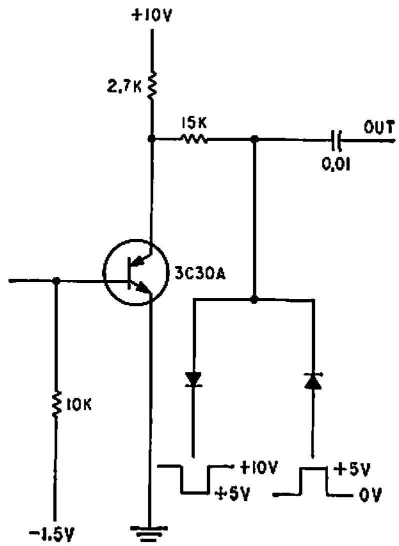
ADJUSTABLE SCHMITT TRIGGER—Accepts either sine waves or pulses. Adjustable input level control allows trigger to occur on any desired portion of input waveform. Amplifier stage drives flip-flop of units decade counter directly.—R. W. Wolfe, Decade Decimal Counter Speeds Printed Readout, *Electronics*, 31:3, p 88–90.



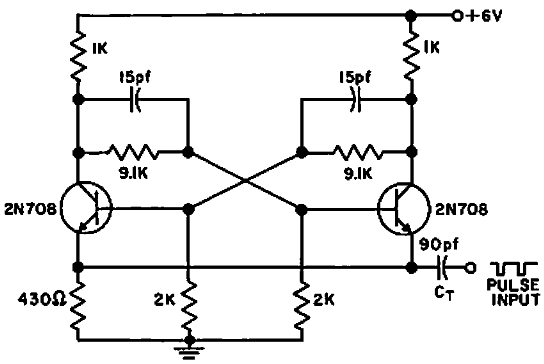
FOUR-STAGE PNPN BINARY COUNTER—Operates on negative trigger pulses, to provide 16:1 division.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



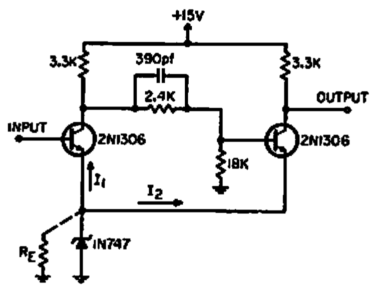
DIODE-MODIFIED SCHMITT TRIGGER—Addition of Rb and D1 reduces loading on driving circuit when Q1 is on, thereby preventing input signal from being clamped. Same signal may therefore drive other Schmitt triggers having higher trigger levels.—J. Gaon, Diode and Resistor Increase Input Resistance of Schmitt, *Electronics*, 39:12, p 110–111.



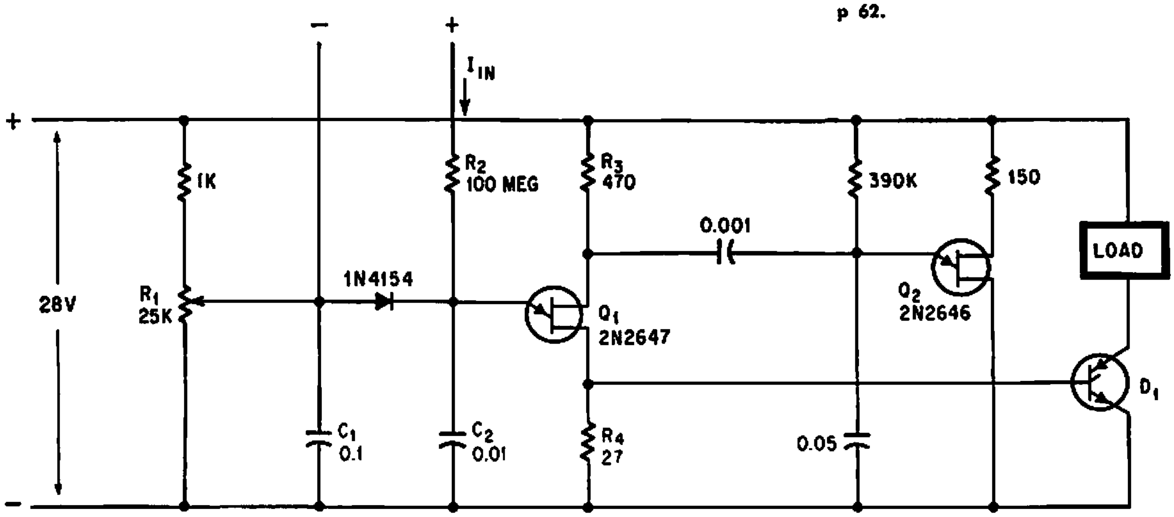
BASIC PNPN MEMORY—Delivers either positive or negative pulse output, accomplished by means of coupling diodes and transition memory capacitor.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



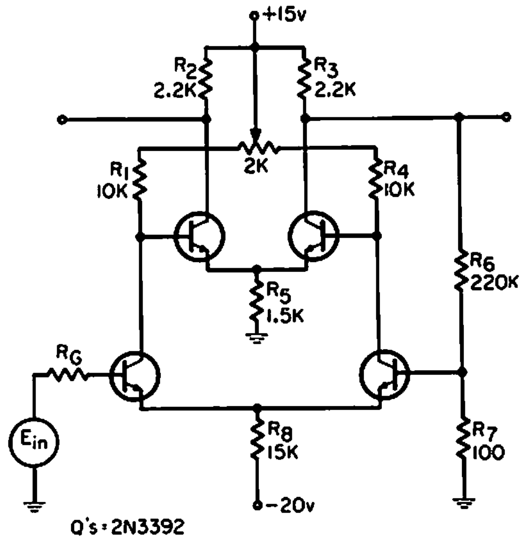
EMITTER-TRIGGERED FLIP-FLOP—Pulse input makes alternate sides of flip-flop conduct on alternate trigger pulses. Maximum trigger rate exceeds 2 Mc with trigger amplitude from 4 to 12 v. Chief limitation is high trigger current required.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 196.



ZERO-HYSTERESIS SCHMITT—Turn-on and turn-off voltages are made identical by using zener diode in place of RE.—R. A. Wilson, Zero-Hysteresis Schmitt Trigger, *EEE*, 13:2, p 62.

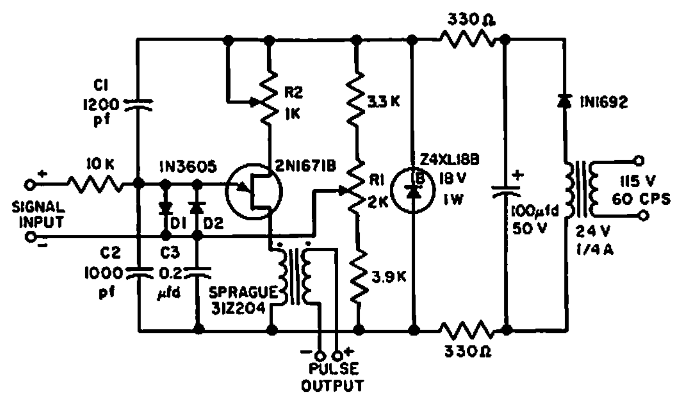


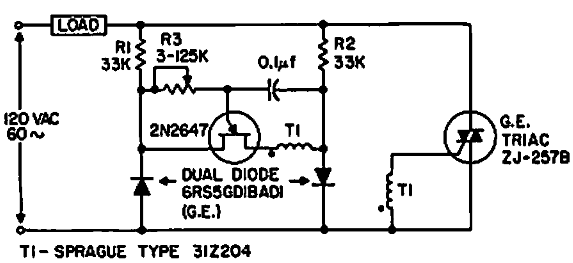
CURRENT SENSING—Input current of only 40 na will charge C2 and raise voltage at emitter of Q1 to triggering level. C1 and C2 then discharge through R4, and resulting generating pulse triggers scr D1 in series with load. Recovery is rapid.—D. V. Jones, Quick-On-The-Trigger Design, *Electronics*, 38:12, p 105-110.



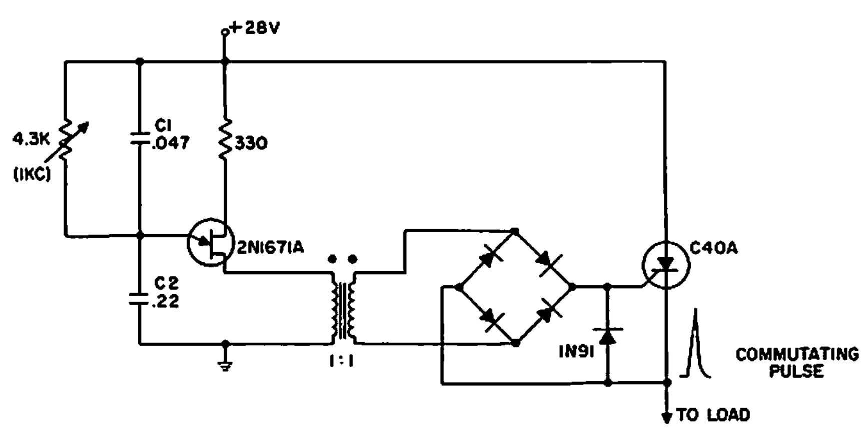
LOW-LEVEL THRESHOLD DETECTOR—Determines when millivolt-range signal exceeds adjustable threshold. Circuit is similar to Schmitt trigger. Forward gain of amplifier is increased by adding second differential amplifier stage having two low-cost transistors and three resistors. Hysteresis can be as low as 2 mv, as compared to 100 mv in standard Schmitt.—R. M. Muth, Stable Threshold Circuit With Low Hysteresis, *EEE*, 14:1, p 64.

VOLTAGE-SENSING TRIGGER—Long-term stability is better than 10 mv, and can be improved still more by adding two silicon diodes in series with R2. Ideal for use in go-no-go applications.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 325.

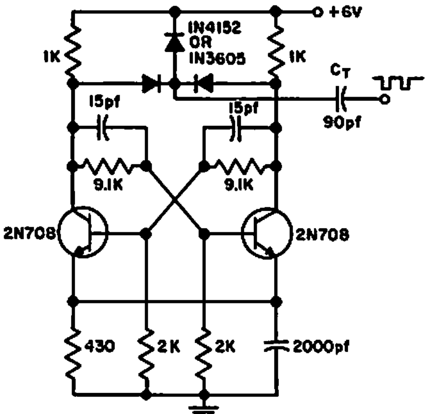




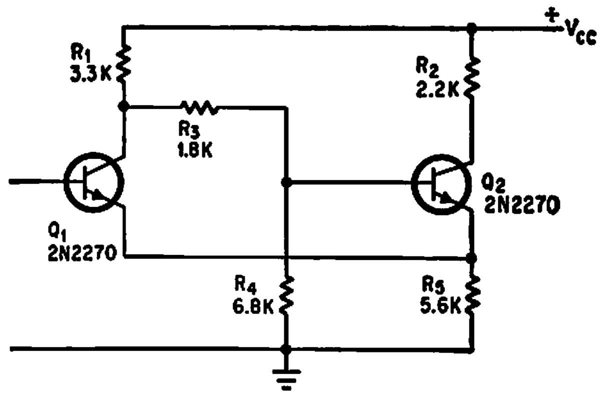
UJT/TRIAC PHASE CONTROL—Has wide range of stable control, without hysteresis or dependence upon supply voltage. Used in automatic feedback control systems, since ujt is essentially half of balanced bridge, with built-in unbalance detection.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 330.



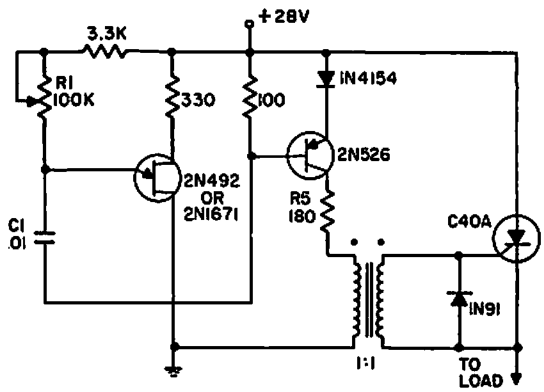
TRANSIENT-ATTENUATING TRIGGER—Transformer coupling and diode bridge between ujt and scr greatly attenuate transients, to prevent premature triggering of ujt when used for impulse commutation in d-c choppers and inverters.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 333.



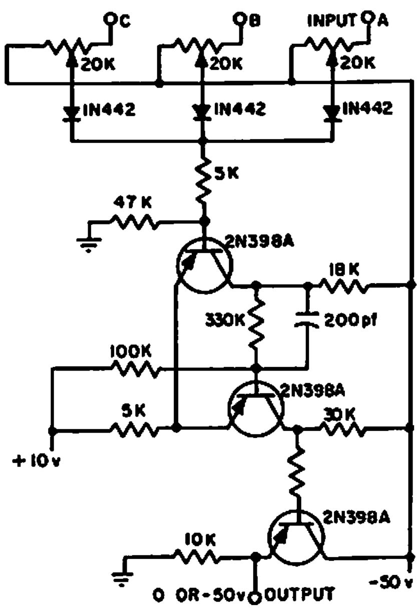
FAST-RECOVERY COLLECTOR TRIGGERING—Additional diode, used in place of resistor from midpoint of diode pair to +6 v, has high back impedance to prevent shunting of trigger pulse during triggering period, and has low forward impedance to insure fast recovery.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 198.



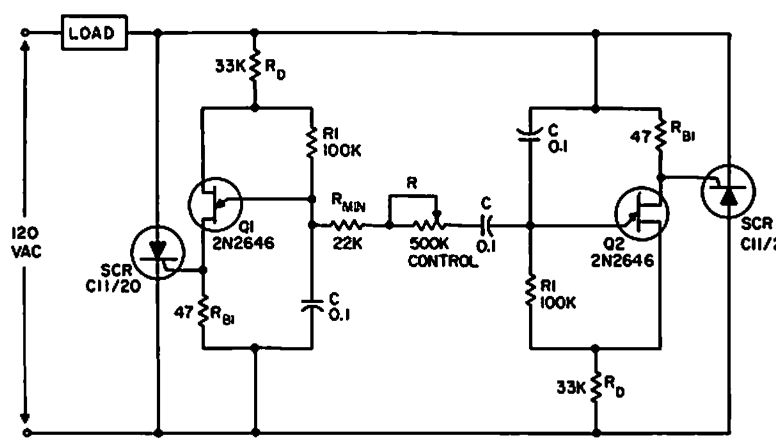
CONVENTIONAL SCHMITT TRIGGER—Q1 is turned on when input exceeds 6.5 v, and input remains clamped at this level. As a result, input signal cannot drive additional Schmitt circuits that may have higher trigger levels.—J. Gaon, Diode and Resistor Increase Input Resistance of Schmitt, *Electronics*, 39:12, p 110-111.



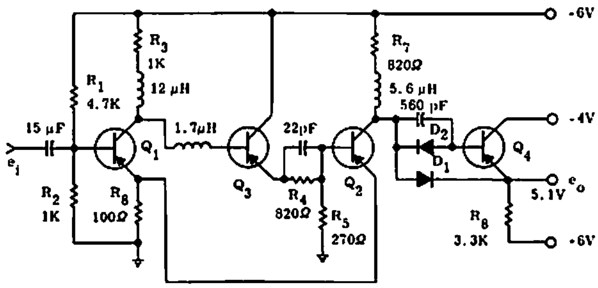
20-KC TRIGGER GENERATOR—Uses ujt to drive 2N526 transistor from cutoff to saturation. Since energy in C1 is not used to trigger scr, small capacitor can be used, thereby increasing operating frequency limit. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 333.



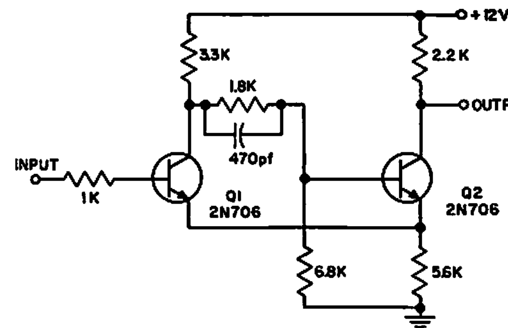
THREE-INPUT TRIGGER—Digital logic permits use of only one Schmitt trigger for monitoring number of variables that can have different voltage levels at which trigger action is desired. Potentiometers provide independent control of set points for each positive input. Each input then triggers circuit independently at its particular theshold, provided circuit was not previously triggered. Circuit is taken from NASA-SP-5022 Technology Utilization Report, Lewis Research Center.—Multiple-Input Trigger Circuit, *Electromechanical Design*, Nov. 1965, p 66.



SIMPLIFIED FULL-WAVE UJT-SCR TRIGGER—Consists of two basic half-wave circuits placed back to back, with emitters of ujt's cross-coupled with network that exerts full-cycle phase control over both scr's.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 330.

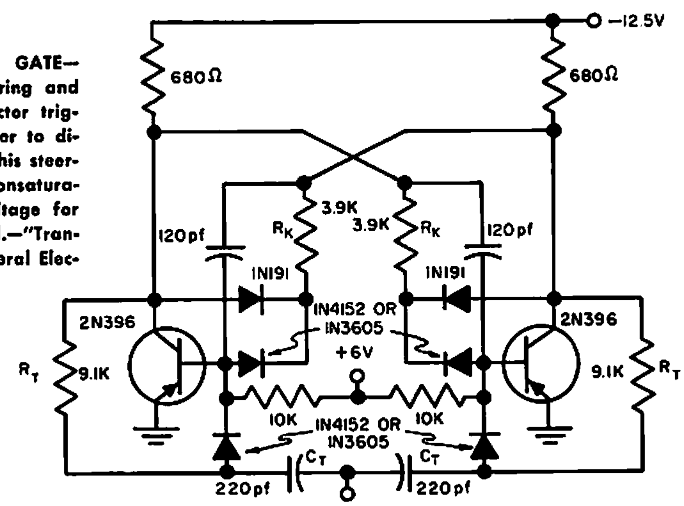


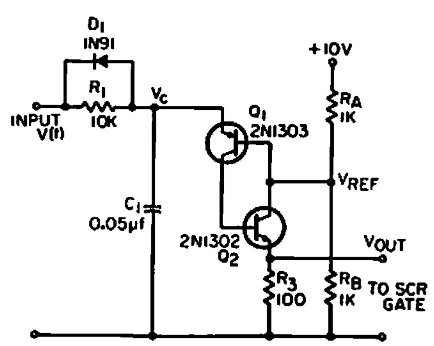
10-MC SCHMITT—Will operate as square-wave generator in range of 100 cps to 10 Mc, using 2N695, 2N705, or 2N711 mesa transistors.—P. A. McInnis, "Low-Cost Computer Circuits," Motorola Application Note AN-130, Nov. 1965.



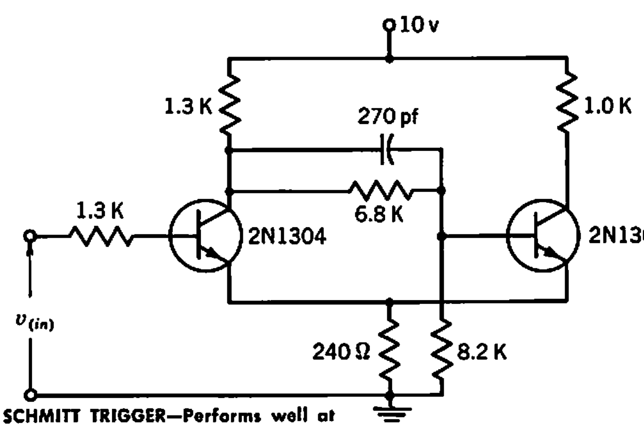
1-MC SCHMITT TRIGGER—Q1 conducts when input exceeds 6.8 v. Q2 always conducts if input is below 5.2 v. Ambient temperature range is 0 to 71°C. Output at collector has 2 v minimum level change.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 200.

BASE TRIGGERING WITH HYBRID GATE—Combines sensitivity of base triggering and trigger amplitude variation of collector triggering. Bias potential varies in order to direct trigger pulse more effectively. This steering scheme is attractive for some nonsaturated circuits, when collector-base voltage for conducting transistor is very small.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 199.

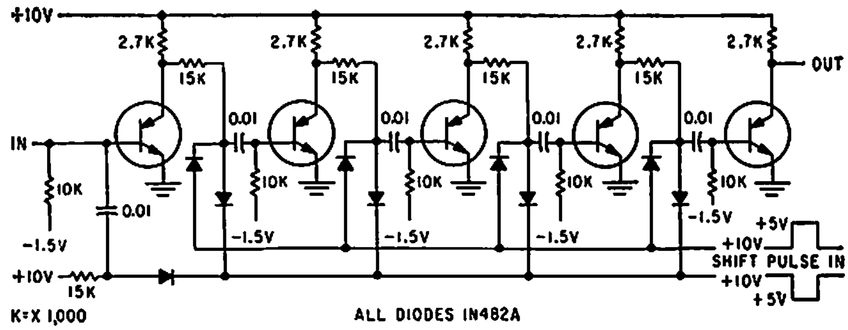




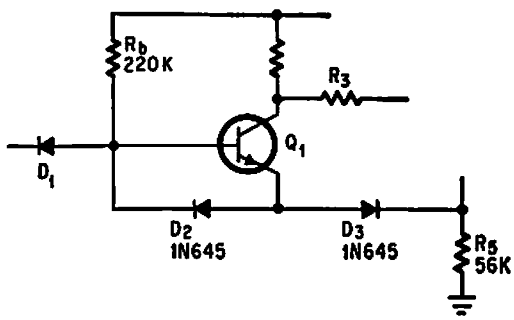
TRANSIENT-REJECTING SCR TRIGGER—Integrator combined with voltage comparator detects difference in voltage-time areas of data pulses and random transients. Data pulses passed are 8 v high and 0.5 millisec wide.—S. B. Marshall, Noise-Rejecting SCR Trigger Circuit, *EEE*, 14:7, p 102–104.



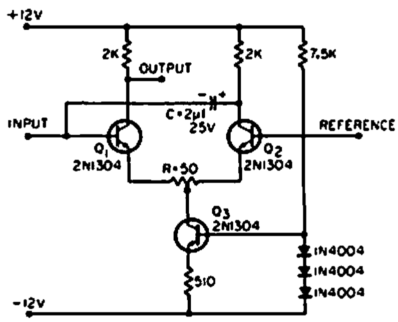
TYPICAL SCHMITT TRIGGER—Performs well at frequencies up to 100 kc. Capacitor may be removed for low-frequency operation. Widely used to produce square wave from sinusoidal input, because regenerative circuit changes states abruptly when input signal crosses specific d-c triggering levels.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 382.



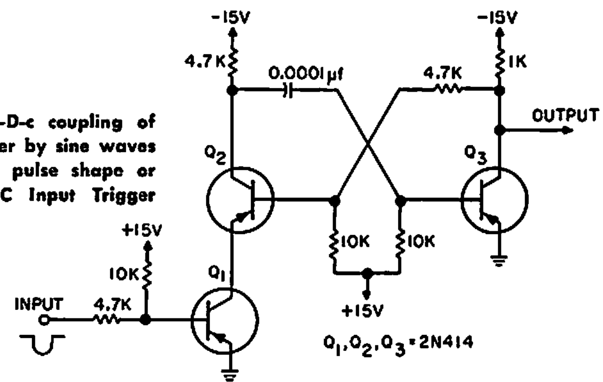
PNPN SHIFT REGISTER—Consists of five one-bit memory elements connected in cascade. —J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.



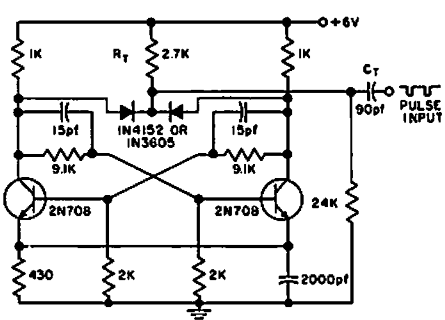
PROTECTIVE DIODES FOR SCHMITT TRIGGER—Addition of diodes D2 and D3 to modified Schmitt trigger having isolating diode D1 prevents reverse breakdown of emitter-base junction of Q1.—J. Gaon, Diode and Resistor Increase Input Resistance of Schmitt, *Electronics*, 39:12, p 110–111.



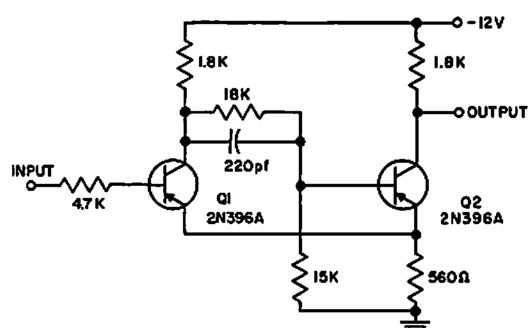
LOW-HYSTERESIS TRIGGER—Differential-amplifier pair, with constant-current source Q3 replacing emitter resistor, serves as level detector with low hysteresis. Good up to 60 kc.—D. B. Campbell, Low-Hysteresis Trigger Circuits, *EEE*, 13:1, p 76.



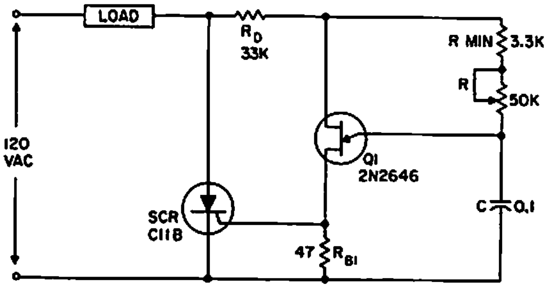
TRIGGER FOR ANY INPUT—D-c coupling of input permits triggering either by sine waves or pulses, independently of pulse shape or rise time.—P. L. Writer, DC Input Trigger Circuit, *EEE*, 10:9, p 29.



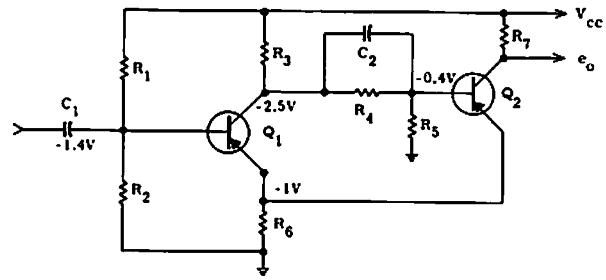
COLLECTOR-TRIGGERED FLIP-FLOP—Diodes with basic flip-flop serve as steering circuit, with negative input pulse being used to trigger collectors. Maximum trigger rate exceeds 5 Mc with trigger amplitude from 4 to 12 v. —"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 197.



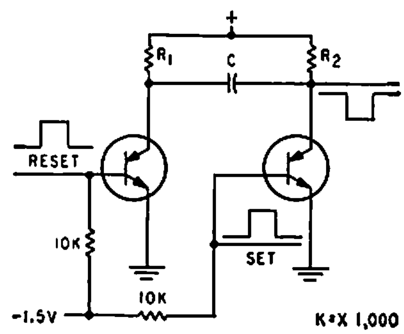
500-KC SCHMITT TRIGGER—Used for waveform restoration, signal level shifting, squaring, and d-c level detection. Q1 conducts if input is more negative than −5 v. Q2 conducts when input is more positive than −2 v. Operating range is −55 to 71°C.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 200.



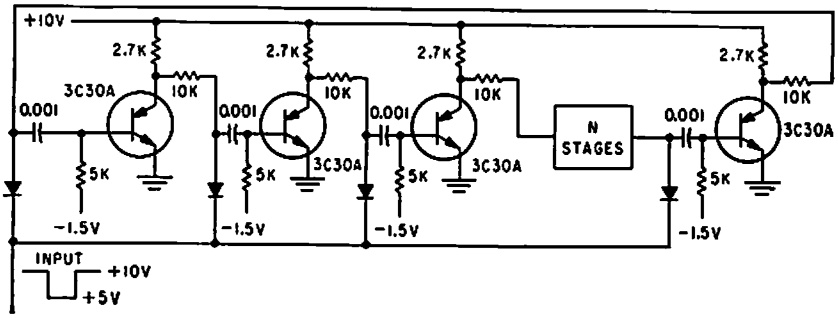
SIMPLIFIED UJT-SCR TRIGGER—Emitter timing circuit and base-2 of ujt are supplied directly from a-c line, with dropping resistor RD keeping peak voltage on ujt within specifications.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 329.



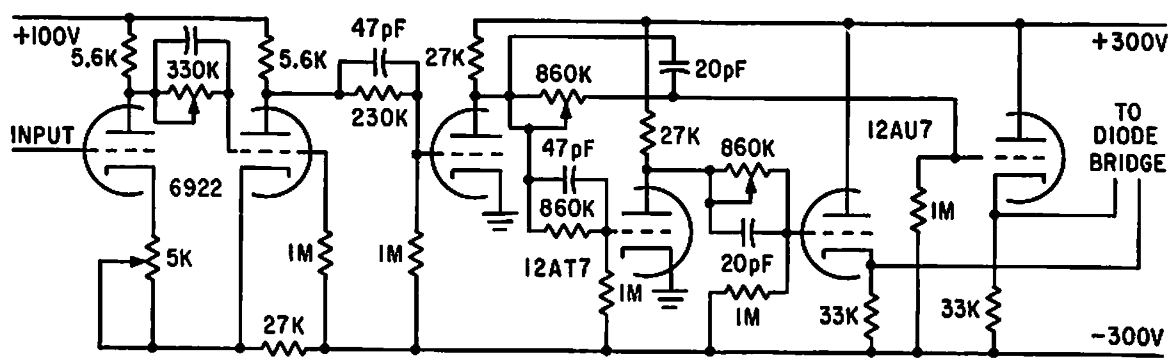
LOW-COST BASIC SCHMITT—Developed for use with inexpensive 2N711 germanium pnp mesa switching transistors. Can serve as source of 10-Mc square waves, as pulse restorer, or as general-purpose square-wave generator.—P. A. McInnis, "Low-Cost Computer Circuits," Motorola Application Note AN-130, Nov. 1965.



POWER FLIP-FLOP—Delivers square-wave output pulse of 1 amp when pnpn unit is triggered on by low-level positive pulse applied to its base.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.

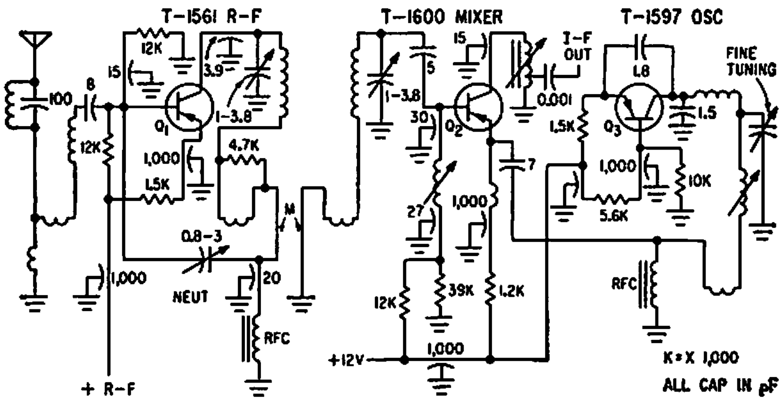


N-STAGE RING COUNTER—Uses modified memory circuit, in which input pulse turns off all pnpn stages except that following on stage.—J. B. Hangstefer and L. H. Dixon, Jr., Triggered Bistable Semiconductor Circuits, *Electronics*, 32:35, p 58–60.

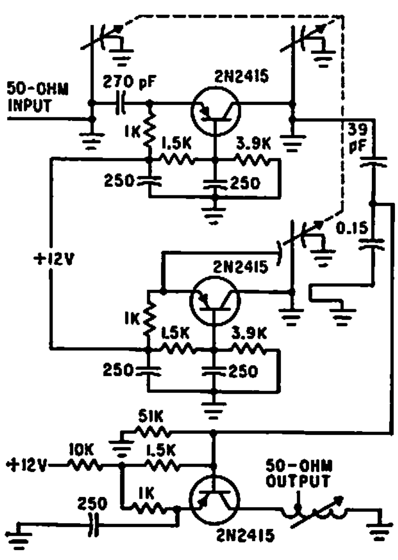


50-V PUSH-PULL PULSES FOR DIODE BRIDGE—Schmitt trigger acts as comparator about 0 v and provides input to two pulse amplifiers. Cathode followers furnish push-pull output at low impedance necessary to drive a 6AL5 diode bridge. Permits two sample-hold circuits to be run as memory pair in analog computer.—T. A. Brubaker, Precision Analog Memory has Extended Frequency Response, *Electronics*, 34:39, p 141–143.

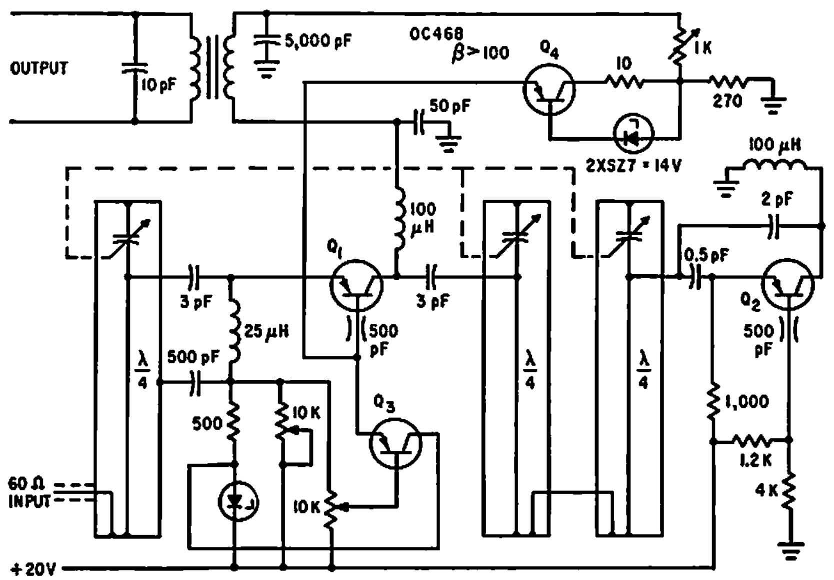
CHAPTER 96
Tuner Circuits



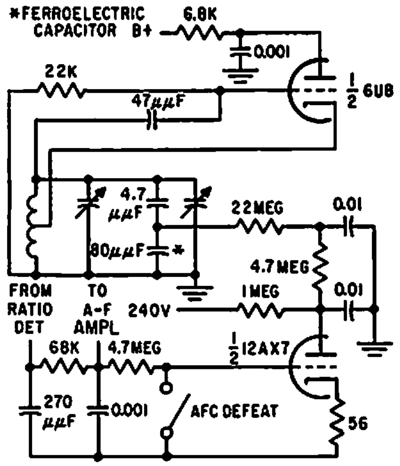
PORTABLE TV TUNER—Three transistors in vhf tuner provide 19 db power gain even for channel 13, with 12 db noise factor. V. Mukai and P. V. Simpson, Transistorized Tuners For Portable Television, *Electronics*, 33:12, p 76–78.



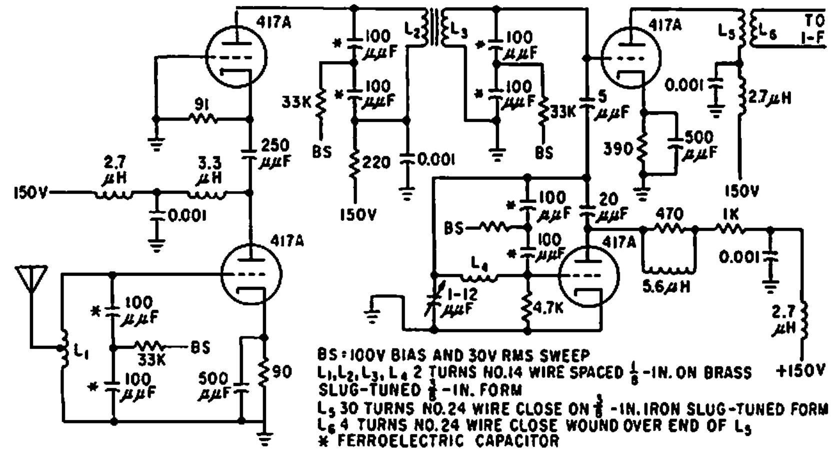
3-TRANSISTOR UHF TUNER—Conversion gain is up to 9 db and noise figure around 8 db, with drain of 18 ma at 12 v.—Transistors Provide Gain in TV Tuner, *Electronics*, 35:26, p 25.



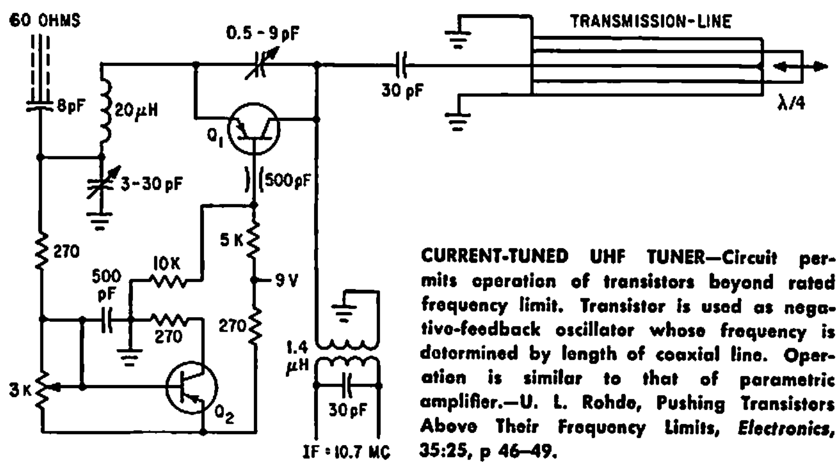
TRANSIT-TIME DIODE UHF/SHF TUNER—Two electronically regulated voltage sources are required to control current-tuned condition and collector voltage, using transistors OC468 and TF65 with zener diodes. One transistor operates in harmonic-generation mode as pump oscillator, comparable to parametric amplification.—U. L. Rhode, Pushing Transistors Above Their Frequency Limits, *Electronics*, 35:25, p 46–49.



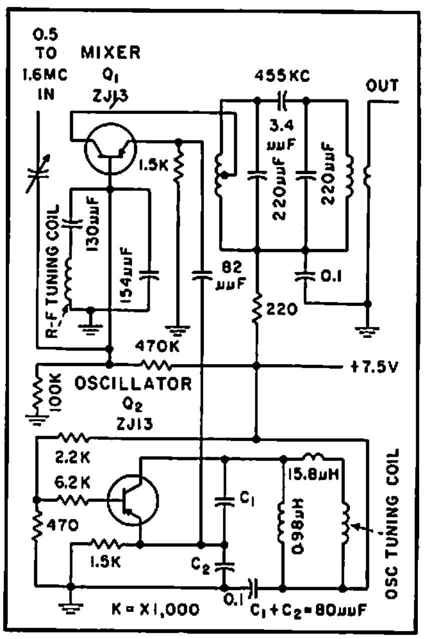
AFC FOR F-M TUNER—Obtained by amplifying change in output from ratio detector as caused by local oscillator drift, and applying resulting error signal to voltage-tunable ferroelectric capacitor in local oscillator through d-c amplifier.—T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.



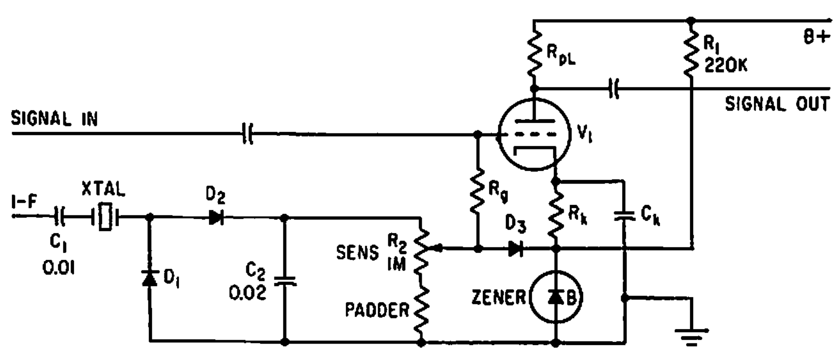
PANORAMIC FRONT END—Can be made as three plug-in units, each containing the electrically tunable r-f, mixer, and local oscillator stages to cover 35 to 70, 70 to 130, and 130 to 200 Mc. Each plug-in front end has eight voltage-tunable ferroelectric tuners. —T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, *Electronics*, 32:3, p 52–55.



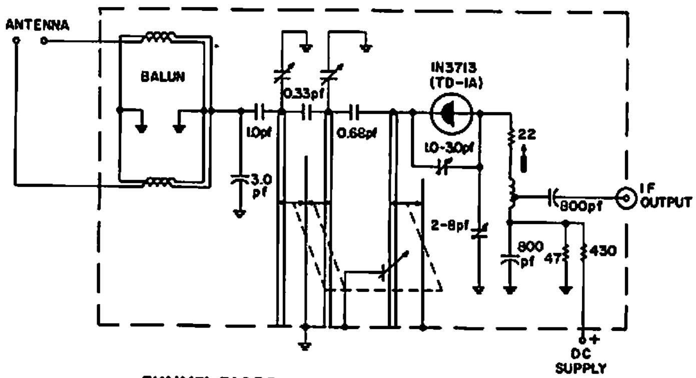
CURRENT-TUNED UHF TUNER—Circuit permits operation of transistors beyond rated frequency limit. Transistor is used as negative-feedback oscillator whose frequency is determined by length of coaxial line. Operation is similar to that of parametric amplifier.—U. L. Rohde, Pushing Transistors Above Their Frequency Limits, *Electronics*, 35:25, p 46–49.



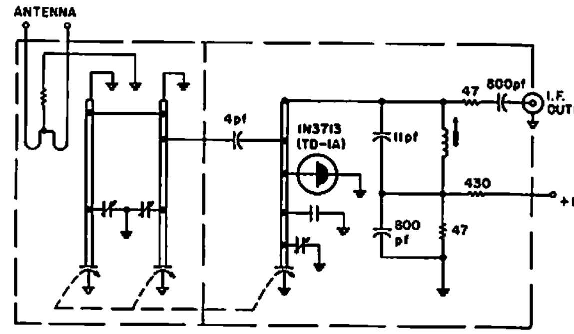
FERRITE-CUP TUNER—Rotary-axial tuner consists of two pairs of ferrite cups with ground D-shaped center cores, ganged to produce linear frequency variation from 500 to 1,600 kc with 270° rotation. Operating frequencies can be extended to 15 Mc.—E. A. Abbot and M. Lafer, Miniature Ferrite Tuner Covers Broadcast Band, *Electronics*, 31:9, p 72–73.



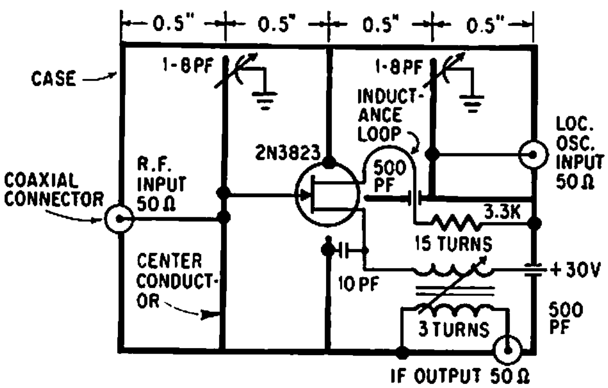
IMPROVED CODAN—Applied to first audio tube of receiver. Tube is biased off by zener diode in cathode circuit, and keep-alive current is supplied to zener from B+. Actuating codan, consisting of crystal, voltage-doubling rectifier, smoothing capacitor C2, and load, produces positive output only when signal is received from i-f. Crystal is at i-f center frequency. Audio is thus unblocked only when voltage of desired signal, as set by R2, is sufficient to overcome cutoff bias in cathode circuit.—R. L. Ives, Crystal Codans Give Accurate Receiver Tuning, *Electronics*, 33:22, p 113.



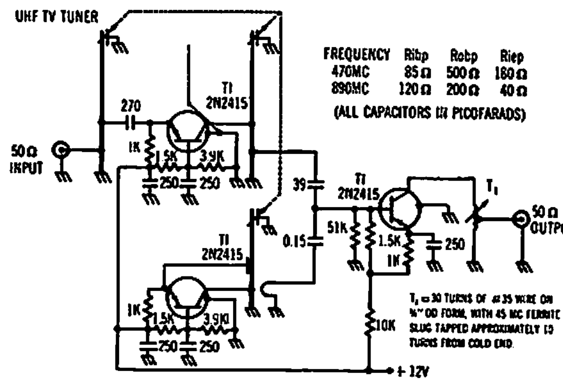
TUNNEL-DIODE UHF TUNER—Uses self-oscillating tunnel-diode converter circuit.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 359.



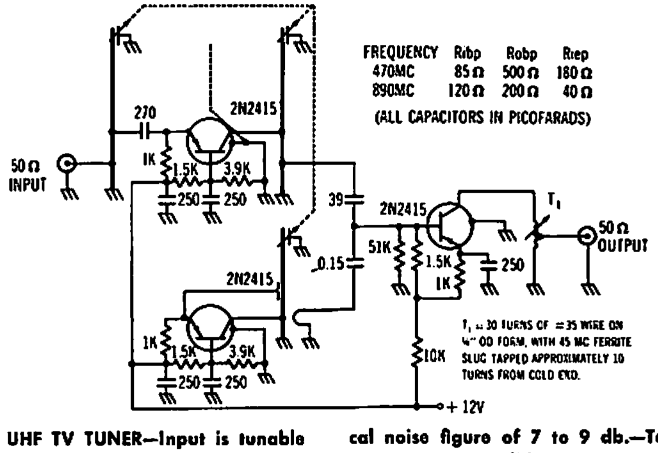
CAPACITIVELY TUNED TUNNEL-DIODE TUNER—Uses self-oscillating tunnel-diode converter circuit.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 359.



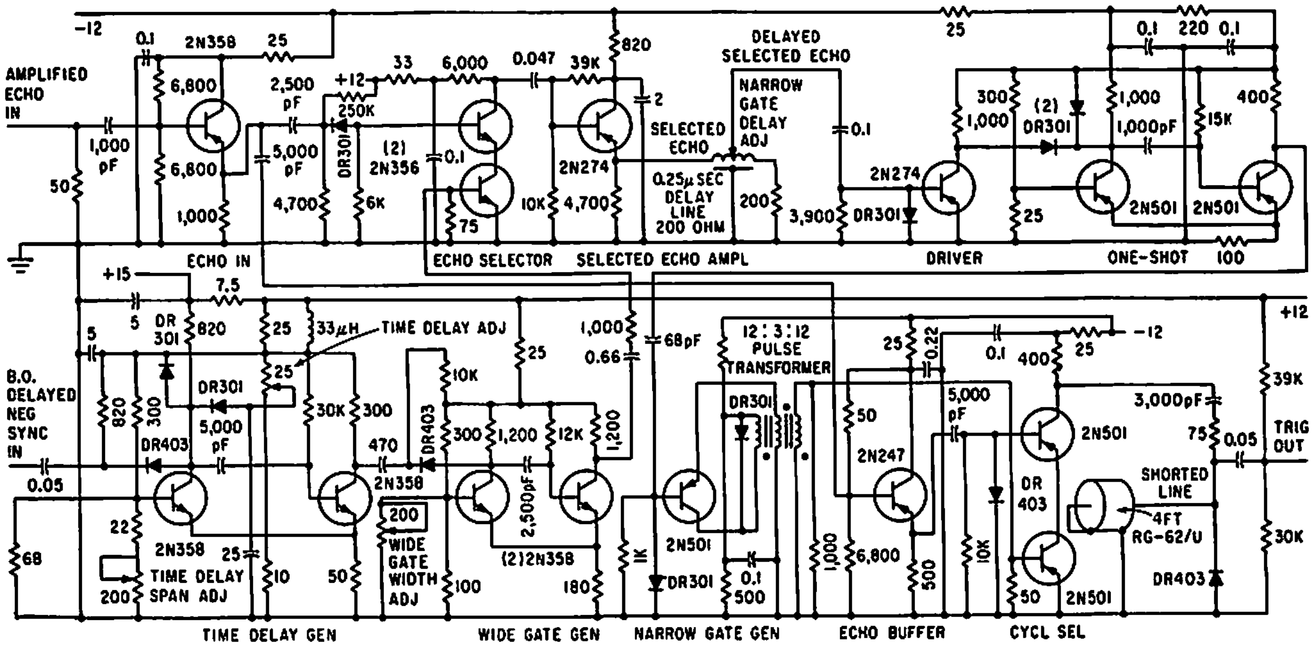
FET MIXER FOR UHF TV TUNER—Uses strip transmission lines. Ground-plane conductors divide circuit into three shielded cubicles, for r-f input, local oscillator output, and i-f output.—S. M. Weaver, For a Good Mixer, Add One FET, *Electronics*, 39:6, p 109–112.



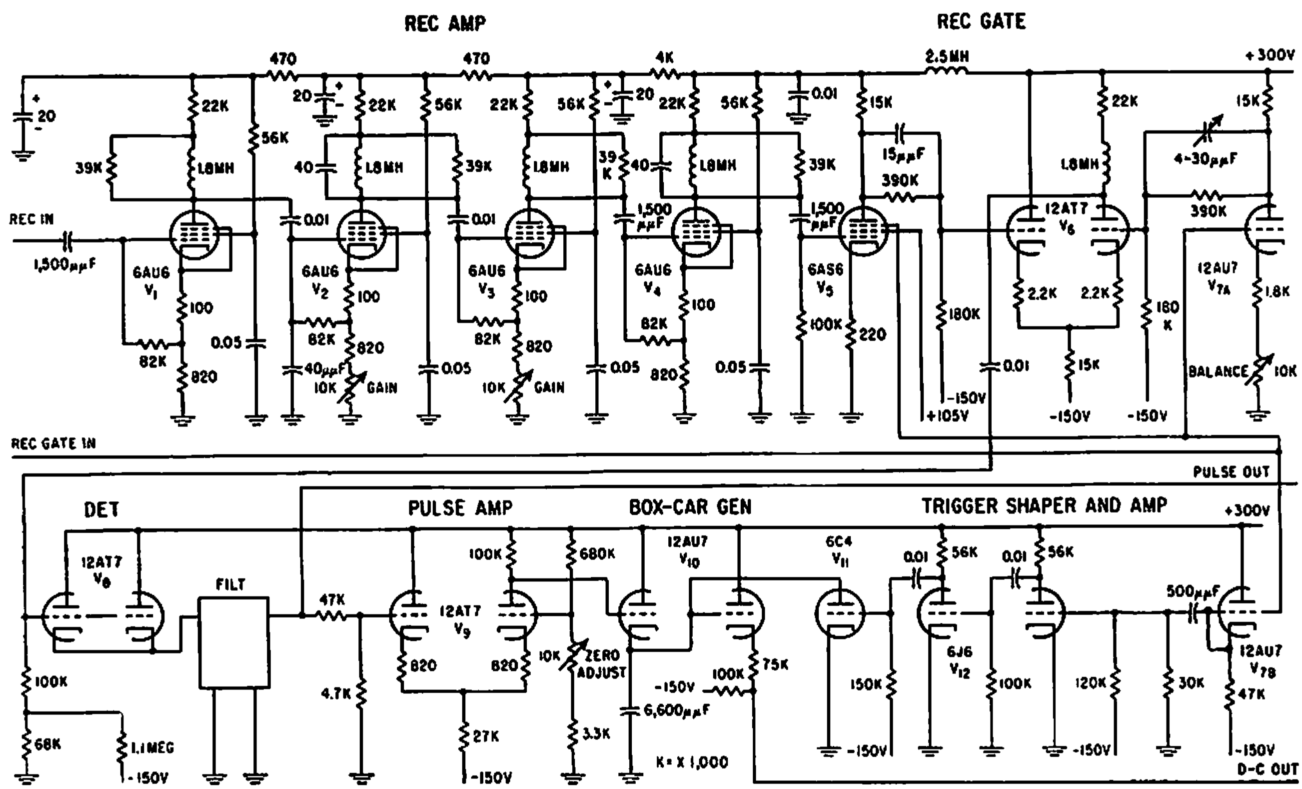
TRANSISTORIZED UHF TV TUNER—Gain is 3 to 9 db over tuning range of 470 to 890 Mc and noise-figure is 7 to 9 db, with output at 45 Mc. Current drain is only 18 ma at 12 v.—Transistorized UHF Tuner Features Low Noise, High Gain, *Electronics*, 36:2, p 15.



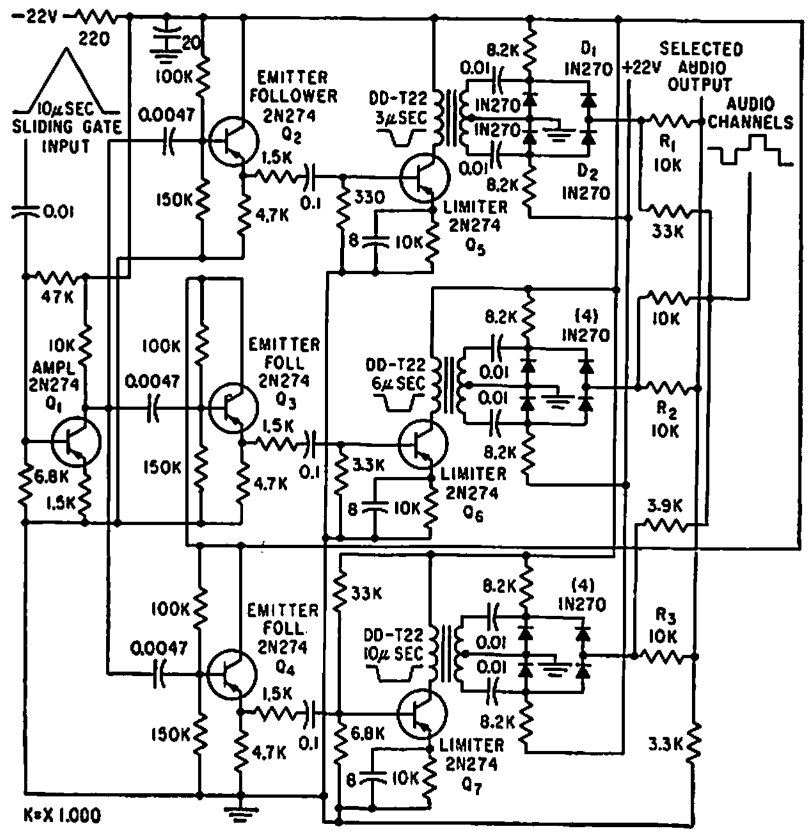
LOW-NOISE UHF TV TUNER—Input is tunable from 470 to 890 Mc, and output is 45 Mc. Gain is 3 to 9 db over uhf band, with typical noise figure of 7 to 9 db.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 299.



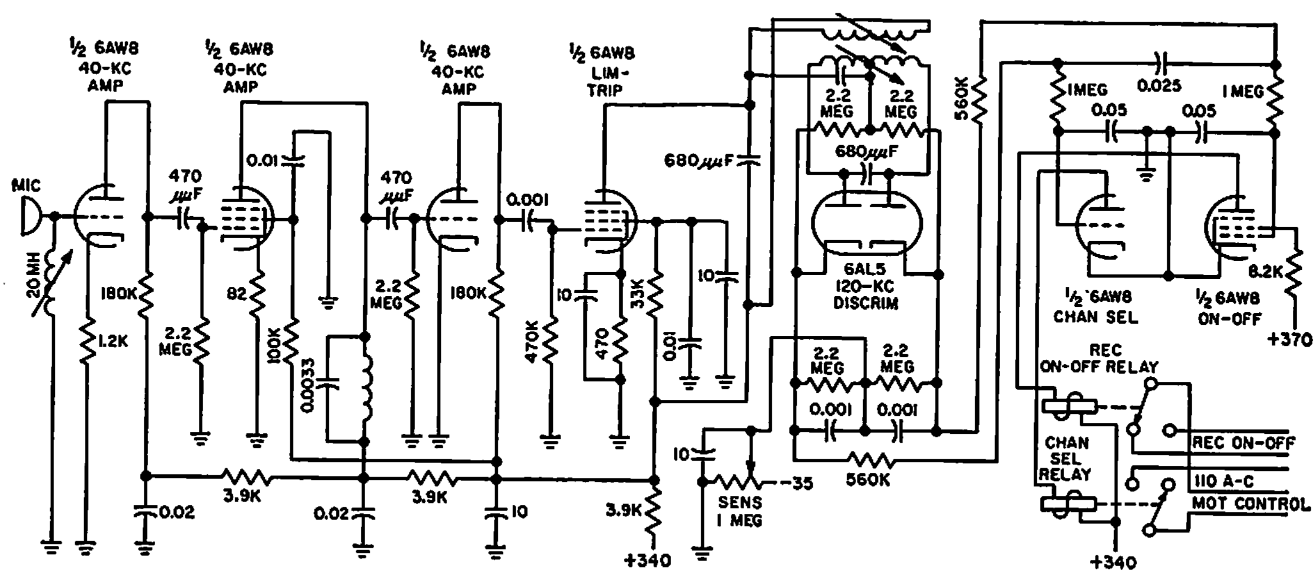
SING-AROUND TRIGGER GENERATOR—Electrical echo signals generated by receiving transducer pass through 10-Mc tuned amplifier to trigger generator that delays selected detected echo and combines it with undetected echo in fast series-transistor coincidence circuit to obtain trigger output pulse for transmitter of ultrasonic velocity measuring system.—R. L. Forgacs, Precision Ultrasonic Velocity Measurements, *Electronics*, 33:47, p 98–100.



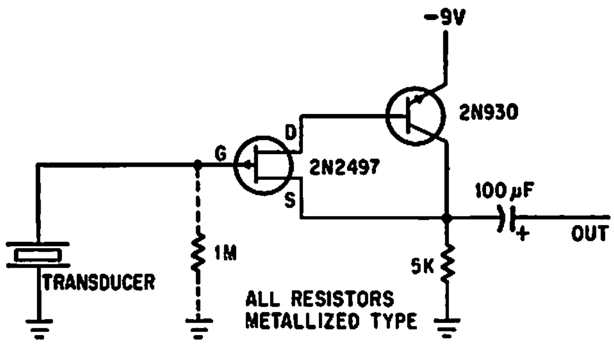
UNDERSEA PROPAGATION RECEIVER—Amplified output of receiving transducer is fed to receiver gate that acts like switch in that output appears only when pulse is applied. Receiver is thus sensitive only for short intervals of time in which return is expected. Output of receiver gate is detected by V8 and filtered to get pulse envelope for crt. Receiver pulse is also amplified by V9 and used to charge capacitor in boxcar generator, so amplitude of pulse is remembered in interval between pulses. To make boxcar generator forget old amplitude when another pulse arrives, receiver gate is shaped into narrow pulse used to discharge capacitors through V11 just before arrival of next pulse.—W. C. Gore, Ultrasonics Tests Undersea Propagation, *Electronics*, 31:35, p 32–35.



SONAR AUDIO SELECTION GATE—Triangular sliding gate of sonar target classifier selects from channel positions the sample chosen for monitoring by sonar operator-trainee, with smooth transition from one channel to another.—M. H. Damon, Jr., Tape Target Classifier Trains Sonar Operators, *Electronics*, 33:13, p 65–69.

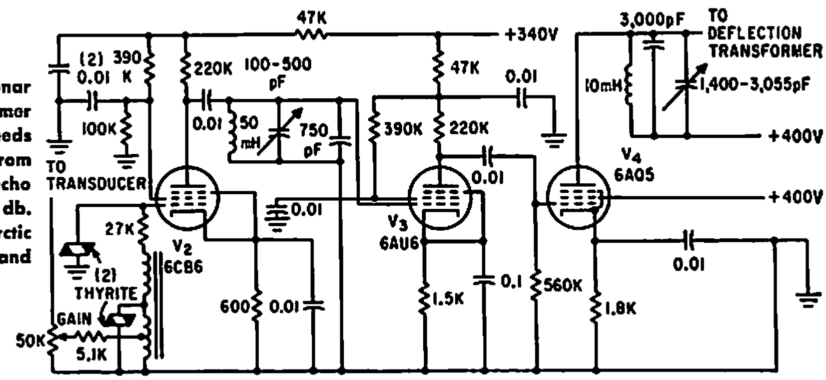


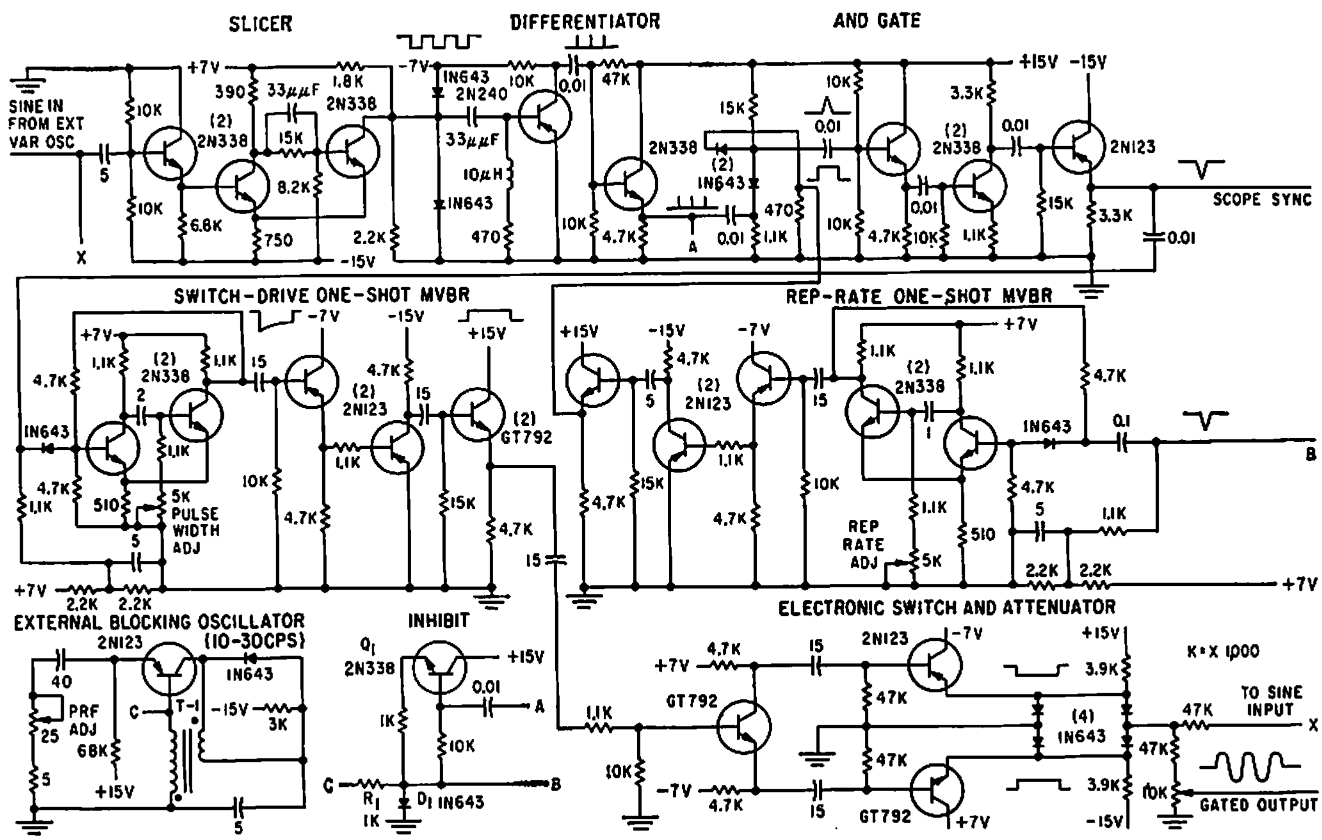
TV CONTROL RECEIVER—Uses barium titanate transducer as microphone, tuned with 20-mh coil to provide peaks at control frequencies of 38.5 and 41.5 kc. Balanced discriminator detects the two ultrasonic tones. Frequency shift of continuous ultrasonic tone activates tuning-motor relay. Both audio and video are killed during tuning. Also provides remote on-off control of power.—N. Frihart and J. Krakora, Ultrasonic Tones Select Tv Channels, *Electronics*, 31:23, p 68–69.



HYDROPHONE PREAMP—Fet eliminates unwanted noise and added capacitance caused by long cables connecting hydrophone to shore station. Voltage gain is unity. Can be used with cables up to 3,000 feet long. If hydrophone moves in water, use 1-meg resistor between gate and ground to suppress low-frequency excursions of signal.—F. Watlington, Hydrophone Preamplifier Cuts Cable Noise, *Electronics*, 39:16, p 120.

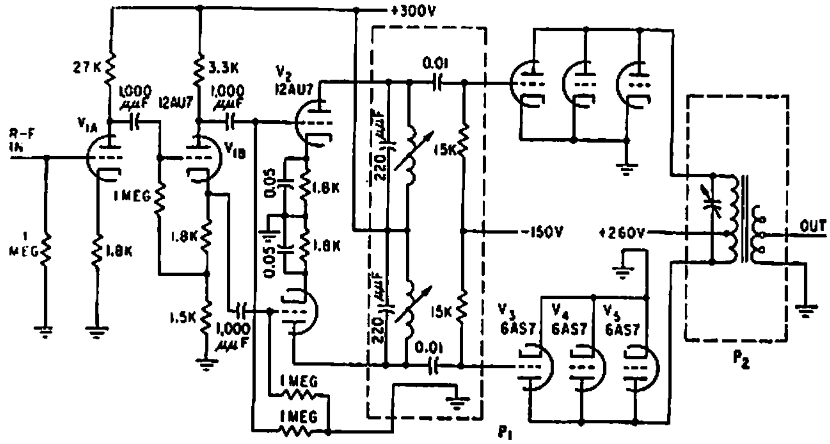
22-KC SONAR—Amplifier is coupled to sonar transducer through 8:1 step-up transformer and resistor-varistor network. Circuit feeds cathode-ray display that protects V2 from overload and possible blocking during echo return time. Receiver gain is 137 db. —L. H. Dulberger, Sonar to Survey Arctic Ocean Shelf Transmits Through Ice and Water, *Electronics*, 34:31, p 44–45.

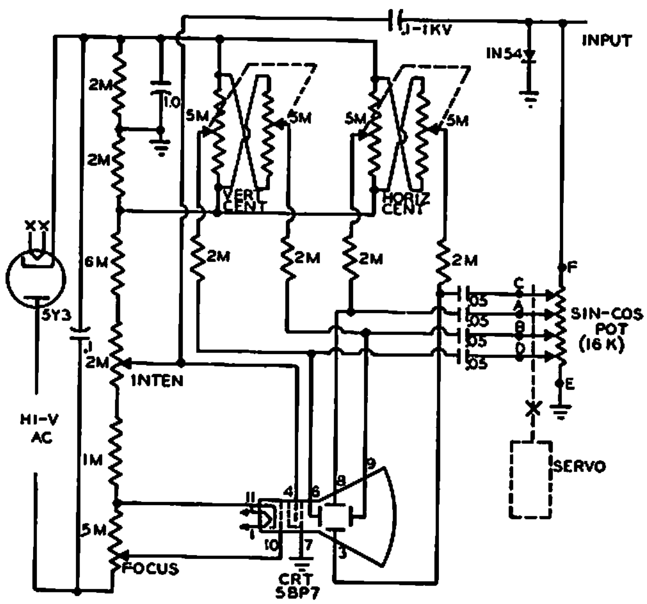




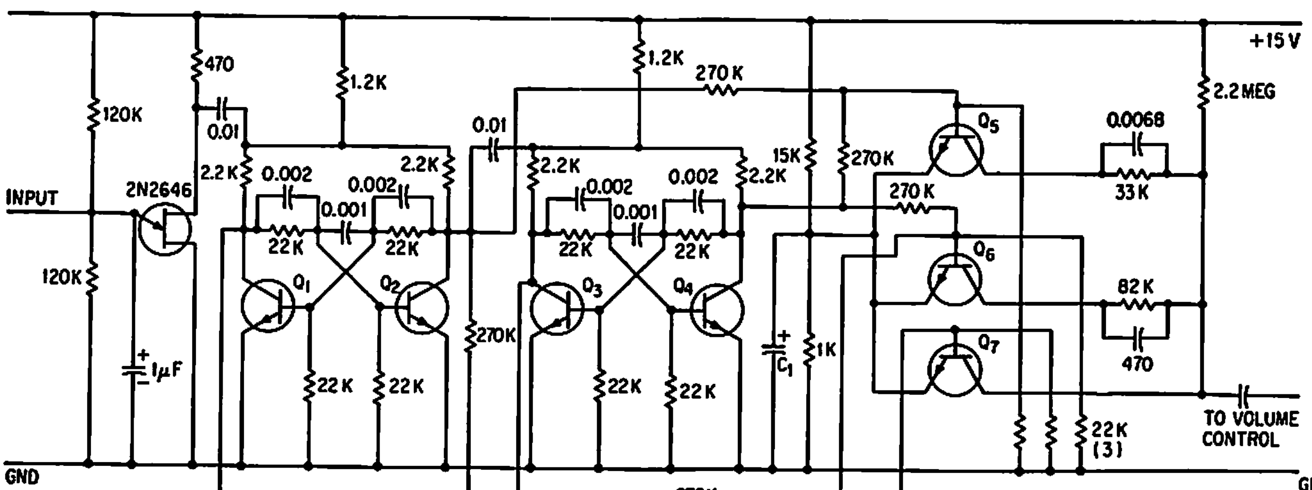
ZERO-CROSSING SYNCHRONIZER—Variable-frequency sinusoidal wavetrain output, starting at zero crossing, is produced by gating circuit. Used to determine attenuation and velocity characteristics of ultrasonic delay lines. Covers 20 cps to 300 kc. External blocking oscillator allows use of alternative repetition rate generator when required. —J. A. Wereb, Jr., Zero-Crossing Technique Syncs Wavetrain Outputs, *Electronics*, 32:19, p 64–65.

UNDERSEA PROPAGATION TRANSMITTER—Develops 100-v peak signal across 100-ohm matched resistive load of crystal transducer, for mean power output of 50 w. Is fed by r-f oscillator through transmitter gate that generates voltage pulse whose width is variable from 10 to 5,000 microsec, to turn on transmitter for corresponding time. P1 and P2 are plug-in circuits that must be changed when operating frequency is changed in range of 25 to 150 kc.—W. C. Gore, Ultrasonics Tests Undersea Propagation, *Electronics*, 31:35, p 32–35.



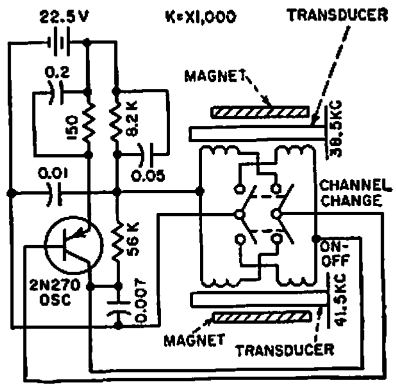


SONAR BEARING INDICATOR—Visual indicator using ordinary cro can be synchronized with rotating directional underwater acoustic transducer, to indicate relative bearing of arriving signal from target. Transducer synchro output, proportional to bearing, drives small servo motor having standard 4-tap sine-cosine potentiometer. Detector output is applied across pot, and four vector outputs are fed to cathode-ray deflection plates. A-c voltage produces rotating bar, and diode clipping of half the signal converts bar to pointer emanating from center of screen. With target signal present, input amplitude is adjusted to produce line from center to edge of screen.—Target Bearing Indicator, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 123.

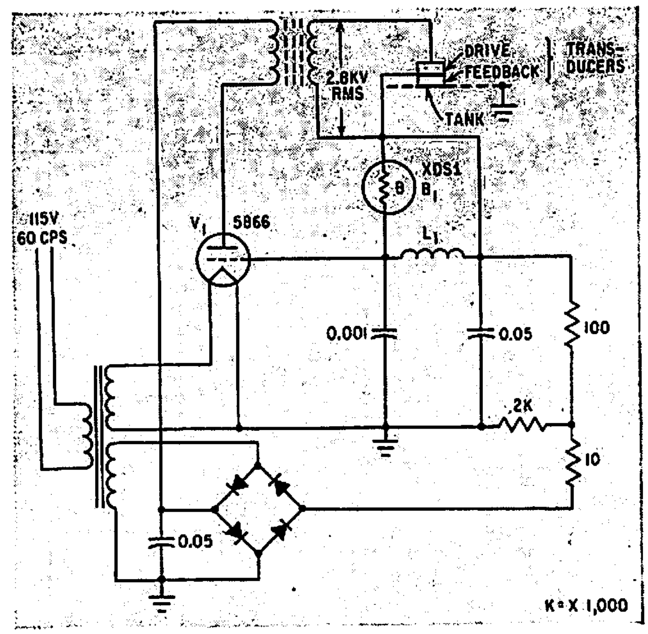


Q = 2N2926
K = × 1,000
C_1 = OPTIONAL 100

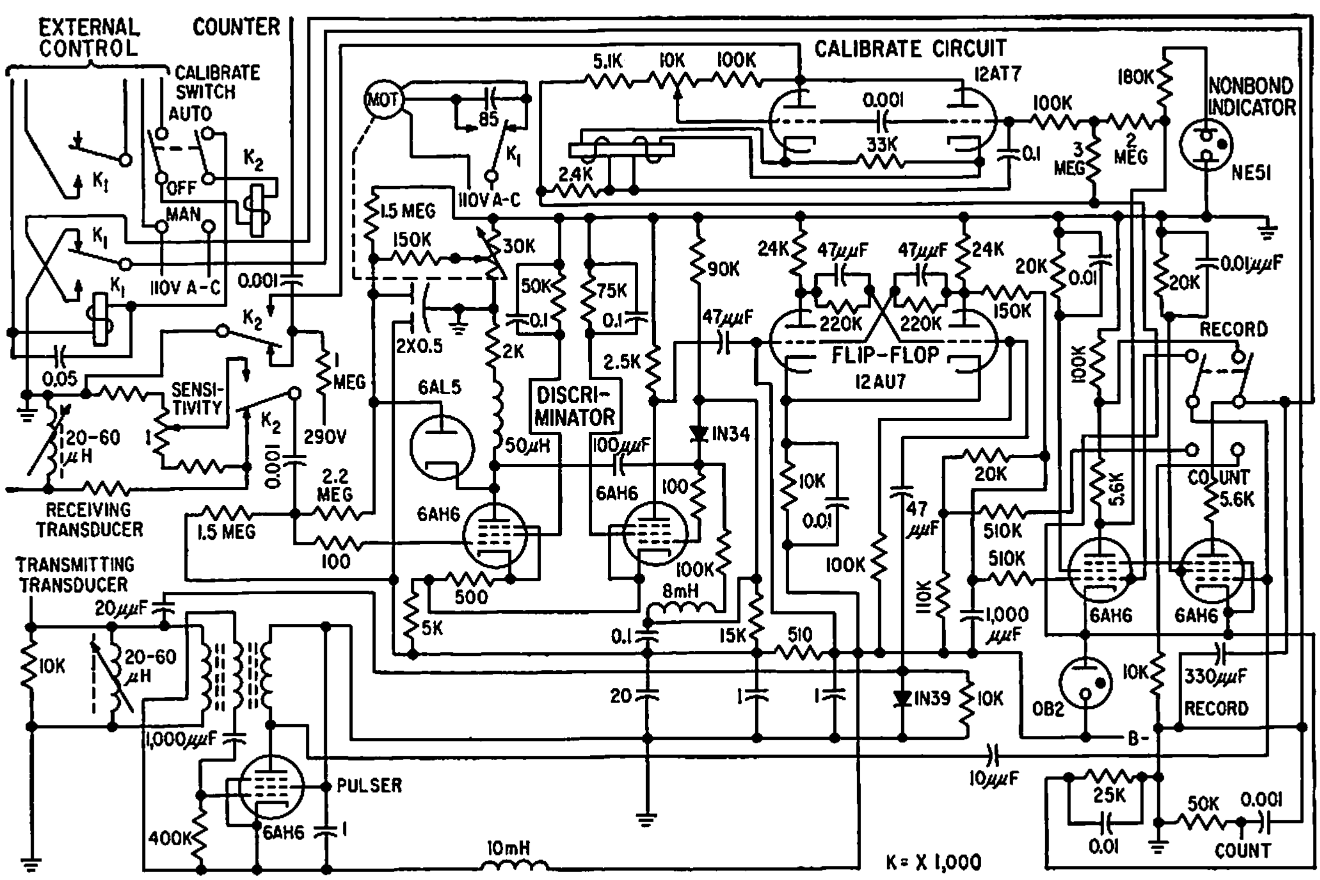
REMOTE TV VOLUME CONTROL—Ultrasonic bursts from handheld transmitter are picked up by microphone and fed to ujt threshold detector 2N2646 that also generates trigger pulse. Two cascaded bistable dividers control three transistors shunted across volume control, to give full volume (no shunting) and three lower volume levels.—J. H. Phelps, Transistors Instead of Relays Tune TV Volume, *Electronics*, 37:9, p 32–33.



MAGNETOSTRICTION TV REMOTE CONTROL—Frequency of transistor oscillator is controlled by either of two lengths of nickel tubing, each floating inside form having two coil windings. One coil acts as driver and the other as pickup to provide feedback voltage for sustaining oscillation at control frequencies of 38.5 and 41.5 kc. Aluminum diaphragms on front ends of tubing increase acoustic output.—N. Frihart and J. Krakora, Ultrasonic Tones Select Tv Channels, *Electronics*, 31:23, p 68–69.

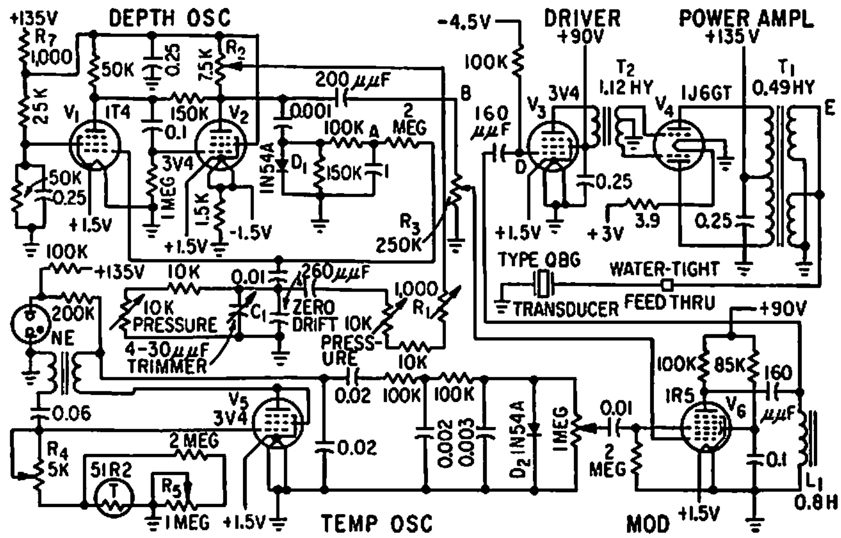


SELF-TUNED ULTRASONIC GENERATOR—Current from feedback transducer goes through ballast lamp B1, keeping oscillator circuit V1 tuned to desired frequency between 20 and 40 kc.—S. Vogel, Ultrasonic Equipment in Industry, *Electronics*, 34:4, p 52–55.

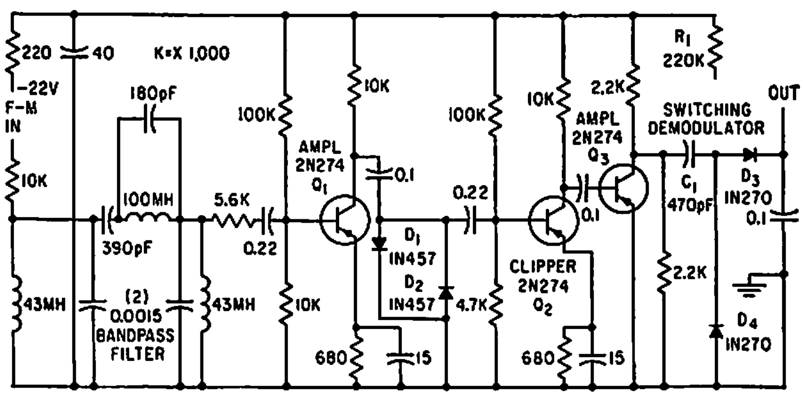


K = X 1,000

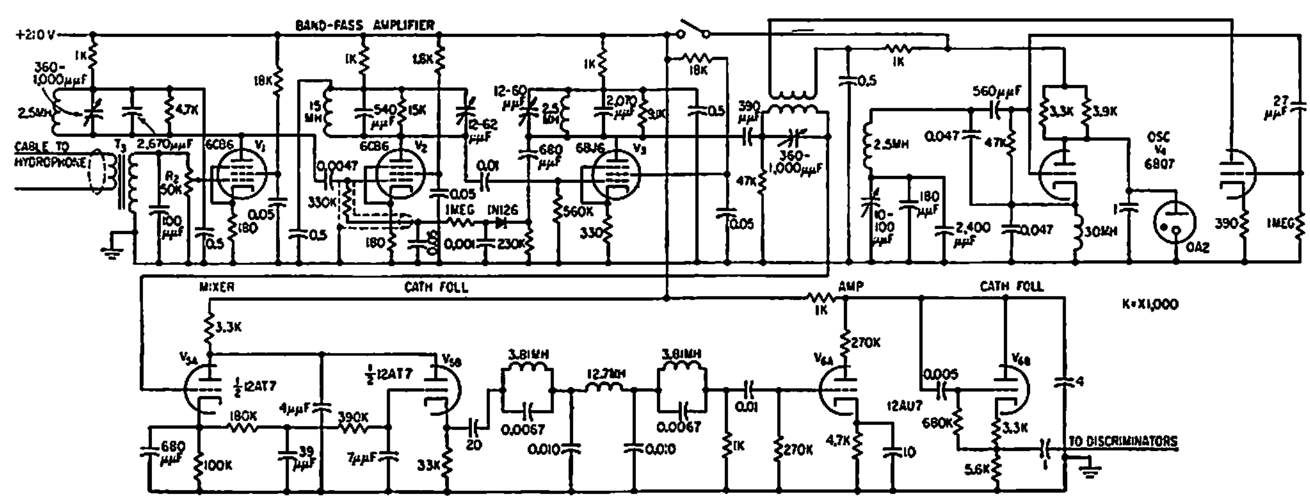
900-KC FLAW DETECTOR—Attenuation of ultrasonic pulses beamed through test piece reveals presence and extent of internal defects, such as nonbonds between aluminum cladding and uranium core. Test piece and transducers are submerged in water to provide good coupling for 900-kc ultrasonic wave from barium titanate transducer of pulser. Motor sets discriminator threshold to equal signal received from attenuator.—J. D. Ross and R. W. Leep, Ultrasonic Pulses Detect Reactor-Slug Flaws, *Electronics*, 31:25, p 59–61.



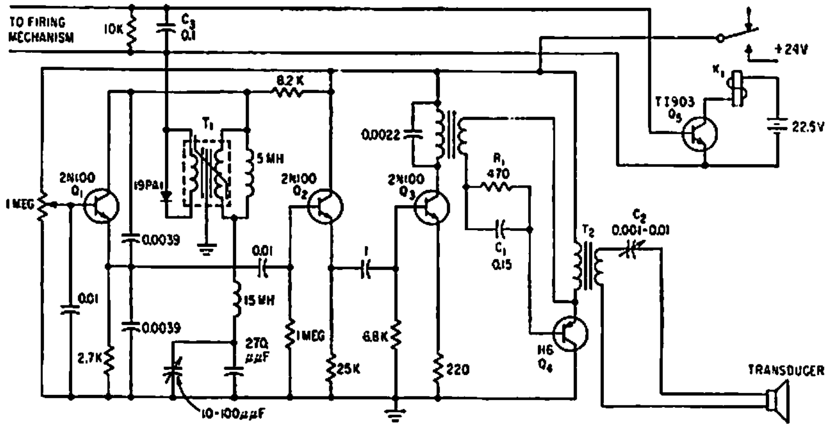
WATER DEPTH TELEMETER—Determines exact depth of trawl net under water, for interception of desired school of fish. Continuous depth information is transmitted to trawler by modulated 21-kc ultrasonic beam, along with water temperature.—F. H. Stephens, Jr., Underwater Telemeter for Trawl Fishing, *Electronics*, 32:13, p 66–68.



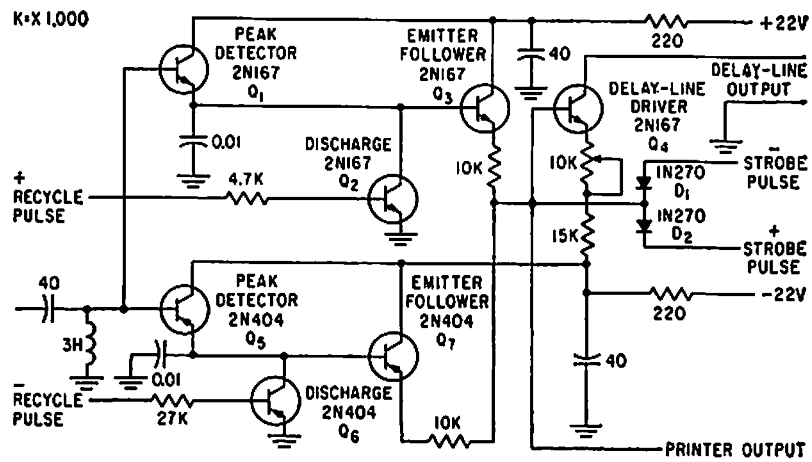
19.5-KC SONAR F-M DEMODULATOR—Used in playback of active sonar f-m signals multiplexed onto one track of magnetic tape, for training students at land-based sonar. Bandpass filter at input demodulator selects band of frequencies associated with desired f-m carrier. Output from filter is amplified and clipped for switching demodulator, whose output is varying component of average modulating signal current.—M. H. Damon, Jr., Tape Target Classifier Trains Sonar Operators, *Electronics*, 33:13, p 65–69.



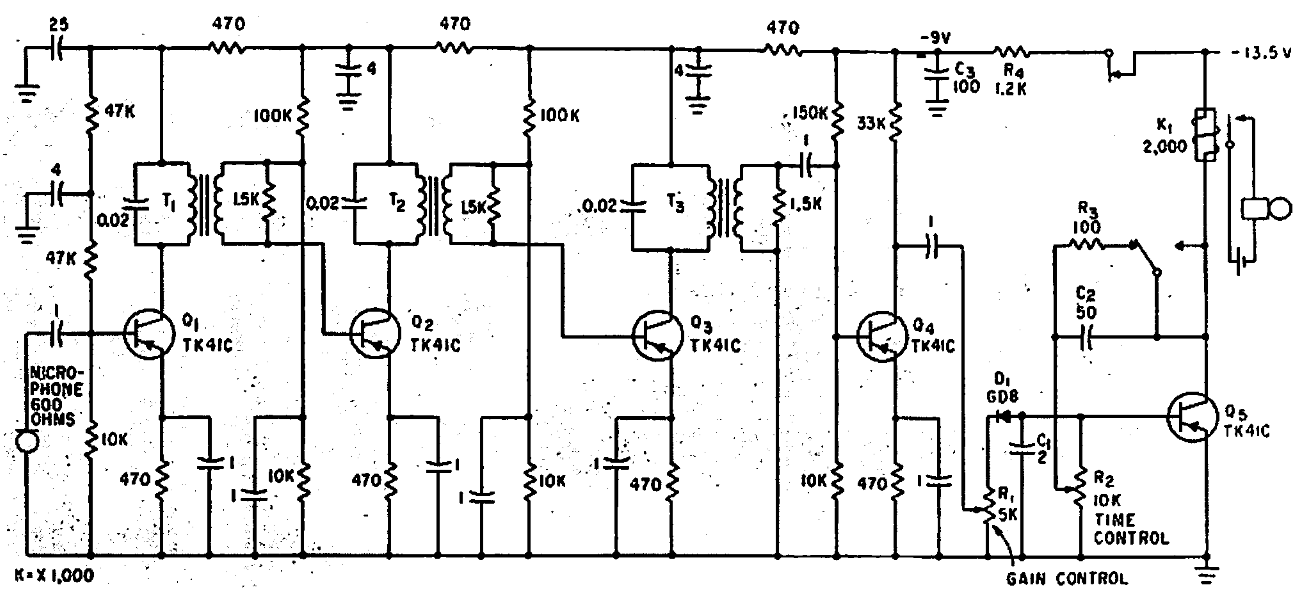
60-KC HYDROPHONE RECEIVER—Shore-based receiver responds to four signal frequencies in 60-kc region, at levels as low as 1 microvolt, coming from receiving hydrophone through up to 15,000 feet of 120-ohm underwater cable. Output of cathode follower V6B is connected to four Foster-Seeley discriminators (not shown) that demodulate signals for driving recorder. Used in monitoring performance of four underwater mines while test ship passes over.—M. J. Aucremanne and D. D. Woolston, Telemeter System Relays Undersea Ordnance Data, *Electronics*, 31:41, p 84–87.



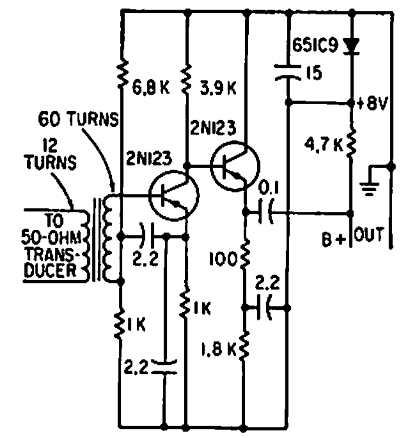
60-KC UNDERWATER TRANSMITTER—Consists of oscillator, buffer, driver, and power amplifier feeding barium titanate projector. Bandwidth is 1 kc in 60-kc region. Used to monitor underwater mine operation as test ships pass over. Receiving hydrophone on bottom may be up to 600 feet away. When mine senses approach of target, relay K1 is activated, turning on transmitter.—M. J. Aucremanne and D. D. Woolston, Telemeter System Relays Undersea Ordnance Data, *Electronics*, 31:41, p 84–87.



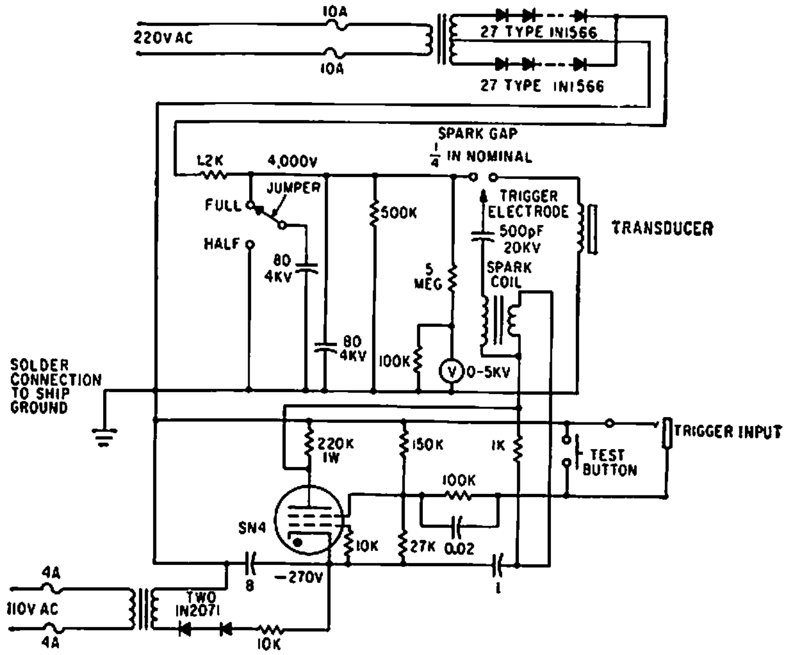
SONAR PEAK-AMPLITUDE DETECTOR—Reshapes pulses from playback amplifiers handling pulse-amplitude-modulation time-division multiplex signals recorded and reproduced in magnetic-tape storage system, to provide narrow 2-microsec pulses coinciding with reference playback clock and having amplitude proportional to peak amplitude of input pulse sample. Used in training sonar operators at land-based sonar. —M. H. Damon, Jr., Tape Target Classifier Trains Sonar Operators, *Electronics*, 33:13, p 65–69.



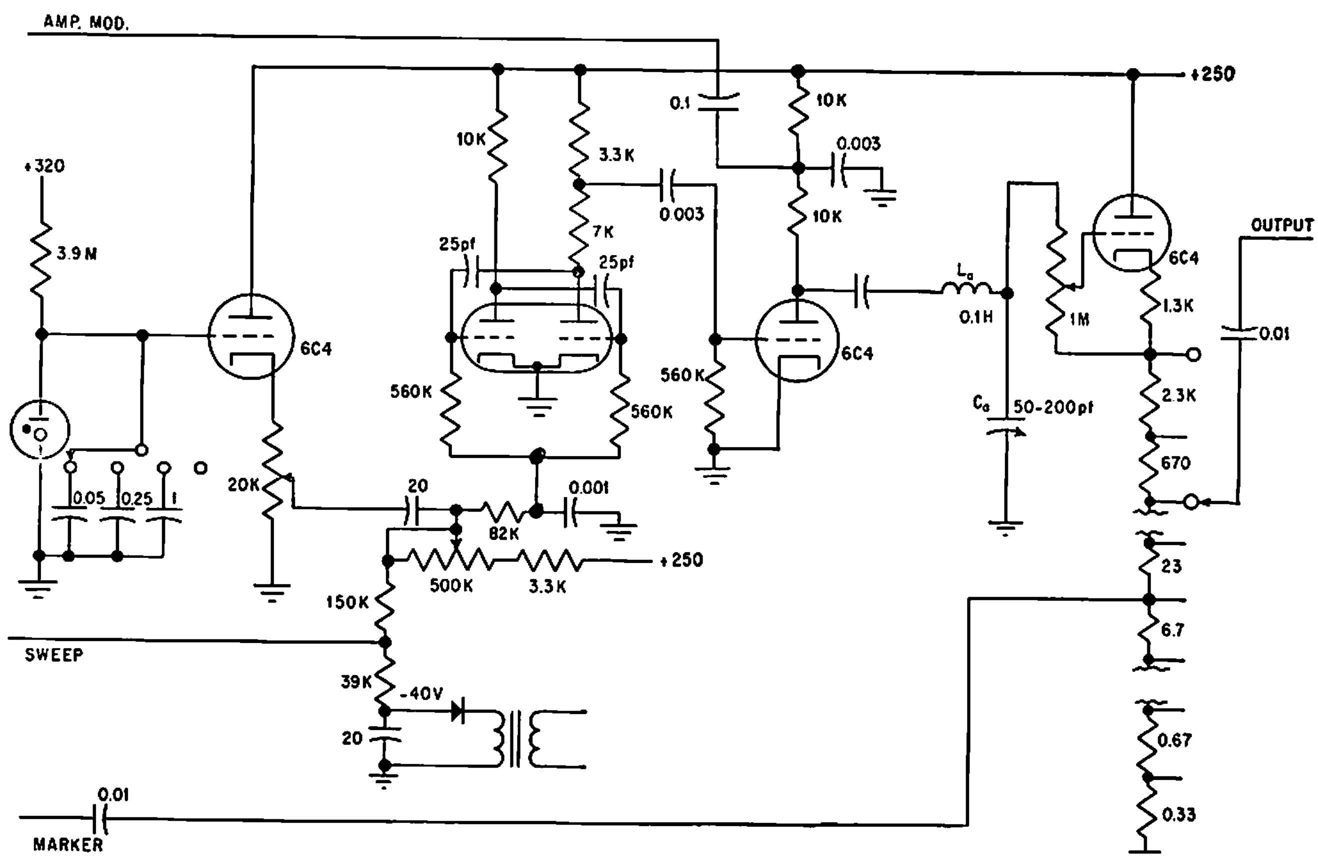
RESPONDER FOR 13-KC DOG WHISTLE—Tuned stages Q1-Q2-Q3 each having 700-cps bandwidth, staggered to give total bandwidth of 1.7 kc for amplifier. Untuned stage Q4 maximizes gain yet prevents operation of device by circuit noise. Diode detector D1 makes Q5 conduct, energizing relay K1 and sounding response bell for 25 sec (controlled by charging of C3).—M. R. McCann and I. Aleksander, Ultrasonic Frequency Responder Aids Blind, *Electronics*, 34:43, p 48–49.



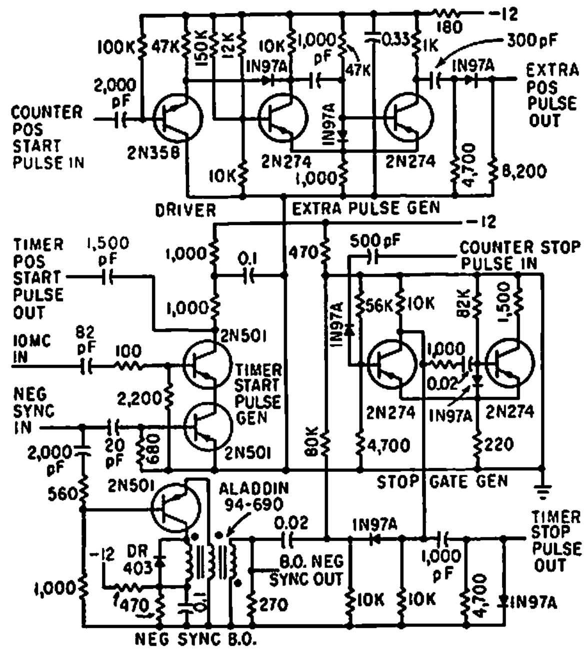
BROADBAND HYDROPHONE PREAMP—Provides gain of 35 db at 250 kc, with extremely low noise figure (within 1 db of thermal). Operating power of 20 ma d-c can be fed down same RG/8 coax used to transmit signal.—R. N. Foss, Transistor Preamp has Very Low Noise, *Electronics*, 31:29, p 92–96.



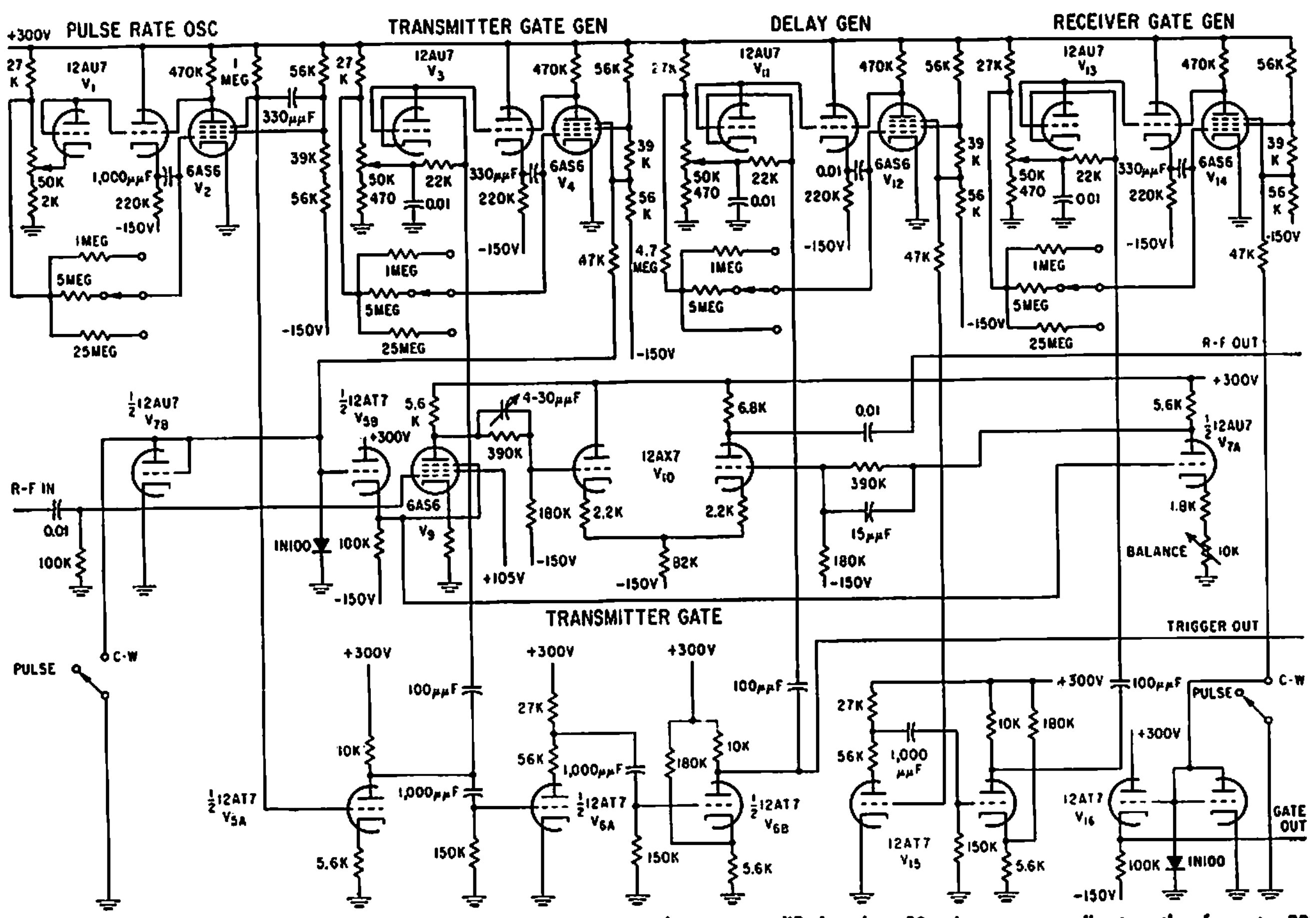
SONAR THUMPER—Strobotron tube circuit energizes spark coil, ionizing spark gap and discharging bank of 4,000-v capacitors through underwater transducer coil, causing adjacent aluminum plate to produce high-power sound pulse that penetrates sediment layers and bedrock for oceanographic research.—New Sonar Thumper Charts Ocean Subbottom, *Electronics*, 34:5, p 56–57.



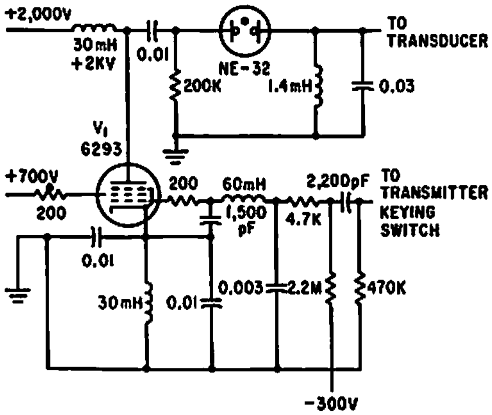
TV REMOTE CONTROL TESTER—Grid-controlled mvbr has sweep of 0 to 7 kc, with center frequency adjustable from 36 to 44 kc. Maximum output is 85 v peak-to-peak. Neon-tube sweep generator operates at 1, 6, and 22 cps. Used for testing ultrasonic remote controls.—G. Row, Sweep Generator Tests Ultrasonic Remote Controls, *Electronics*, 34:47, p 64–66.



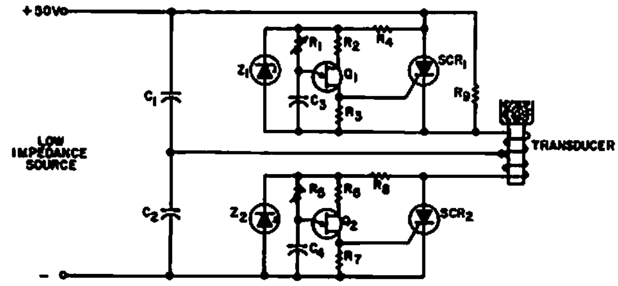
SING-AROUND COUNTER CONTROL—Timer start-pulse generator is fast series-transistor coincidence circuit. Stop-gate generator is one-shot mvbr that prevents 1N97A diode from passing blocking oscillator negative sync pulse until mvbr fires. Used to count number of sing-around cycles and measure total time in system for measuring ultrasonic velocity in liquids and solids.—R. L. Forgacs, Precision Ultrasonic Velocity Measurements, *Electronics*, 33:47, p 98–100.



UNDERSEA PROPAGATION GATE GENERATORS—Pulse-rate oscillator V1 generates pulses with variable time interval from 0.3 to 170 millisec for triggering rate. Normal operation is at 80 millisec, corresponding to 12.5 cps. Trigger pulses are amplified and delivered to circuits that trigger transmitter and delay generators for two receivers, and synchronize crt sweep. Used to measure changes in propagation time of less than 20 microsec over direct path of up to 300 feet in sea water.—W. C. Gore, Ultrasonics Tests Undersea Propagation, *Electronics*, 31:35, p 32–35.

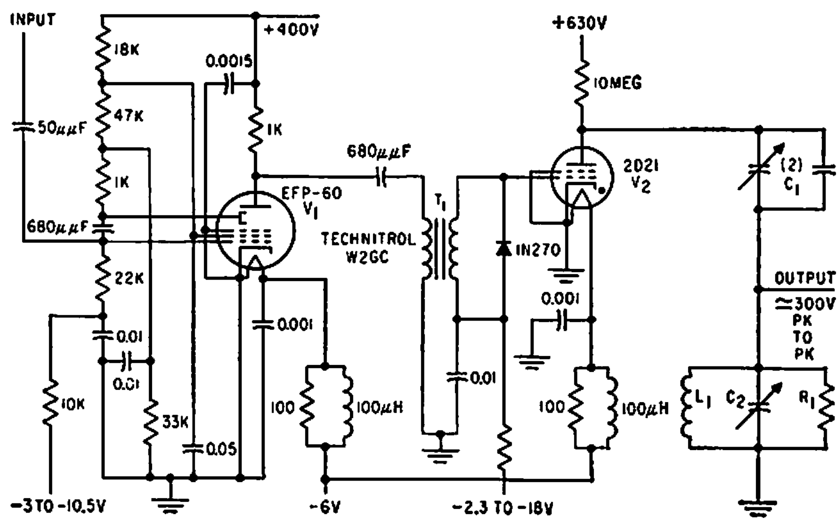


22-KC SONAR—Key pulse allows Clapp oscillator to operate for 1 millisec at 22 kc, with keying 25 times per second.—L. H. Dulberger, Sonar to Survey Arctic Ocean Shelf Transmits Through Ice and Water, *Electronics*, 34:31, p 44–45.

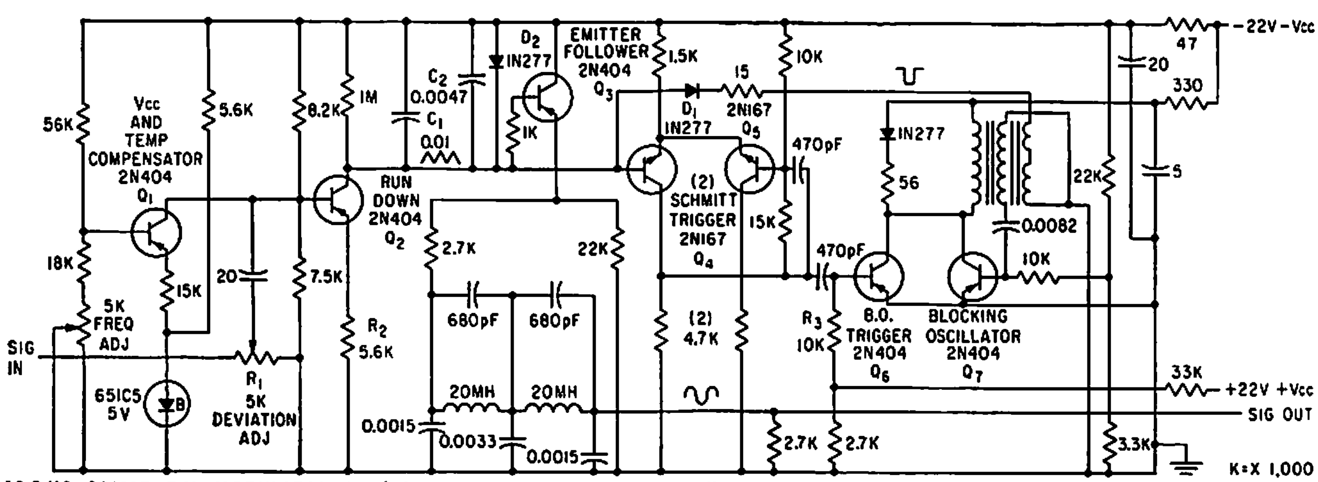


C_3–0.003μf, 100V PAPER
C_4–0.003μf, 100V PAPER
C_1 AND C_2–0.8μf, GE 28F1310
R_1–25K, 2W POTENTIOMETER
R_2–180Ω, 1W
R_3–100Ω, 1/2W
R_4–2.2KΩ, 2W
R_5–25K, 2W POTENTIOMETER
R_6–180Ω, 1W
R_7–100Ω, 1/2W
R_8–2.2KΩ, 2W
R_9–10KΩ, 2W
Q_1–GE 2N2647
Q_2–GE 2N2647
SCR_1–GE C200X31
SCR_2–GE C200X31
Z_1–Z4XL22
Z_2–Z4XL22

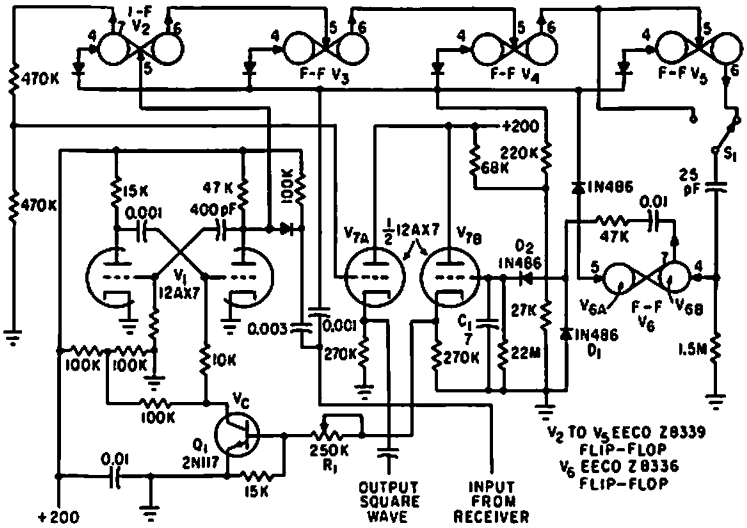
100-W 25-KC ULTRASONIC GENERATOR—Frequency-doubling mode permits use of inexpensive scr's. Load resistance is in magnetostrictive transducer winding L. Circuit is actually 25-kc inverter triggered at 12.5-kc repetition rate.—"Silicon Controlled Rectifier Manual," Third Edition, General Electric Co., 1964, p 16



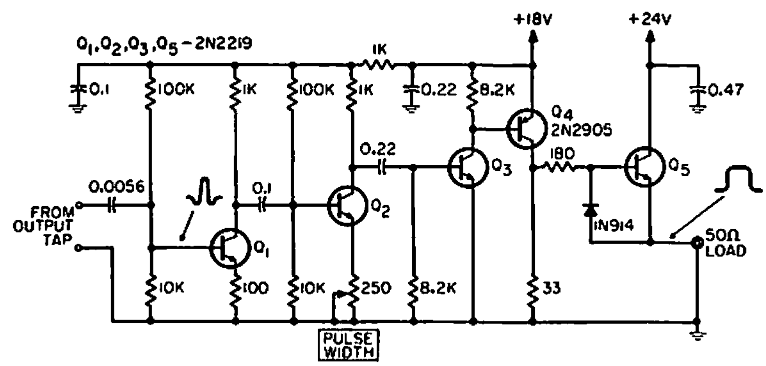
THYRATRON-SWITCH TRANSMITTER—Receives 100 or 1,000-pps trigger pulse from rate generator and produces pulse of r-f oscillations that decays from maximum peak-to-peak of 300 v, for measuring ultrasonic velocity in metal test sample. Pulse jitter is less than 1 millimicrosec, for accurate measurement of time interval between ultrasonic echo pulses.—R. L. Forgacs, Removing the Jitter from Thyratron Pulses, *Electronics*, 32:20, p 60–61.



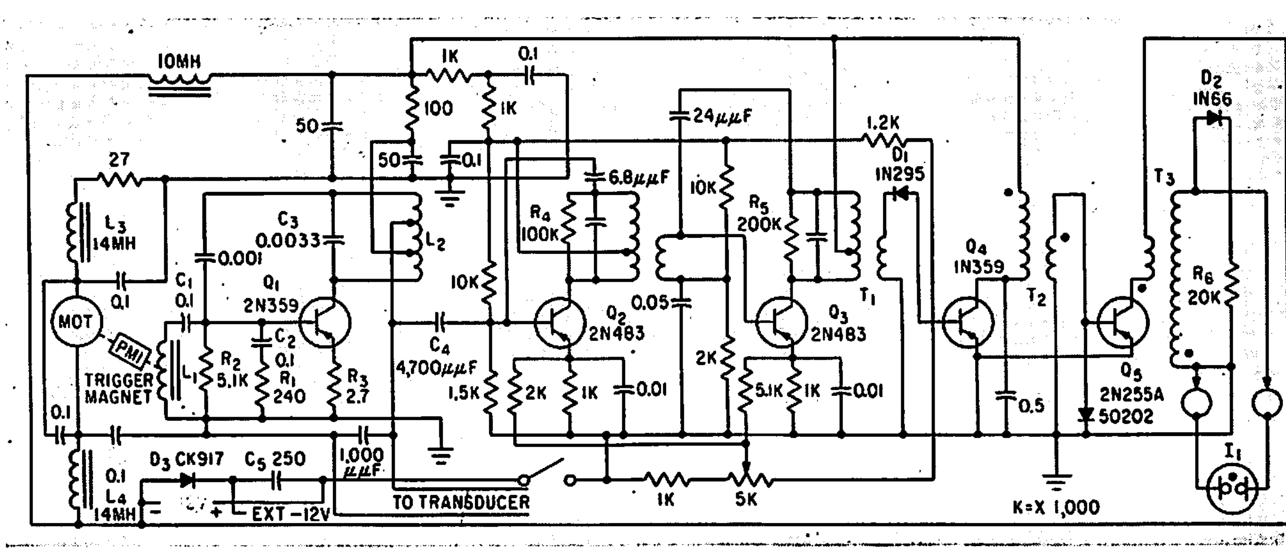
19.5-KC SONAR F-M MODULATOR—Used in recording signals from active sonar on magnetic tape, for later playback to control land-based sonar used in training operators. Modulator is basically sawtooth generator whose repetition frequency is changed by amplitude of modulating input signal. —M. H. Damon, Jr., Tape Target Classifier Trains Sonar Operators, *Electronics*, 33:13, p 65–69.



PRF MULTIPLIER—Multiplies pulse repetition frequency of ultrasonic receiver by factor of either 4 or 8, into range between 35 and 85 cps at which synchronous motors of indicator system work best. Multiplication is based on controlled mvbr oscillator V1, whose frequency can be varied from 40 to 180 cps by varying control voltage Vc. Multiplier feedback circuit acts to control this voltage so mvbr frequency is exact multiple, 8 or 16, of input pulse rate.—H. F. Messias, Ultrasonics Measures Flow Velocity of Rivers, *Electronics*, 34:41, p 56–69.

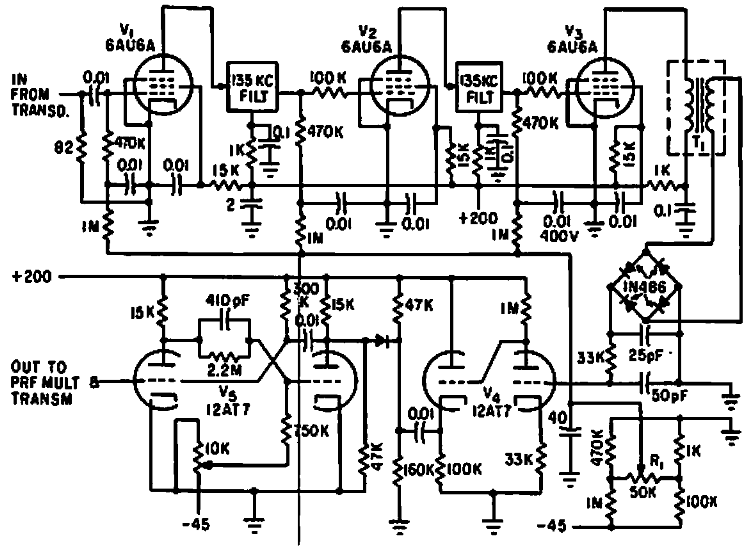


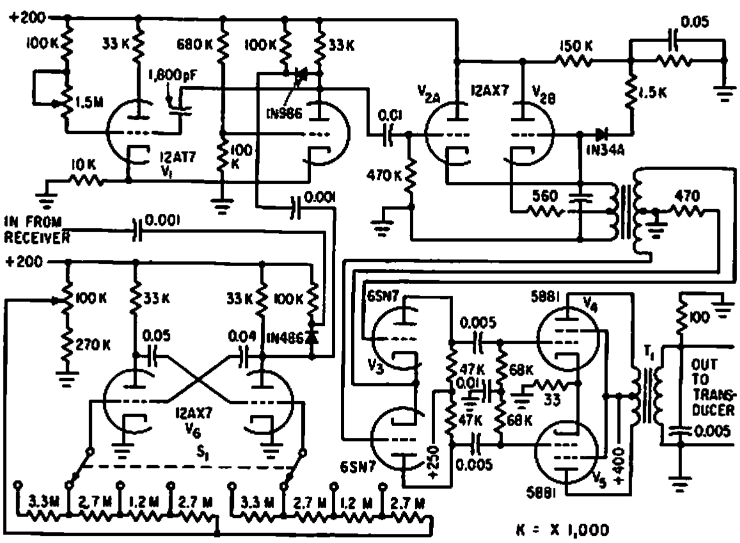
MAGNETOSTRICTIVE DELAY LINE AMPLIFIER—Used to reshape output signal of delay line used as 12-event serializer. Q3 clips two negative peaks of signal and Q4 flattens pulse. Pulse width control adjusts gain of Q2 to vary pulse width.—R. P. Rufer, How to Measure Simultaneous Events with Magnetostrictive Delay Lines, *EEE*, 14:5, p 44–49.



PORTABLE FISH FINDER—Measures depth up to 120 feet and provides lower-intensity echoes from schools of fish. Indicator is neon lamp at end of rotating arm driven by constant-speed motor. Magnet triggers 200-kc ultrasonic transmitter and makes neon lamp glow at zero on circular scale. Lamp glows again for each echo pulse from fish and for bottom echo.—H. C. Single, Portable Depth Finder for Small Boats, *Electronics*, 33:6, p 50–51.

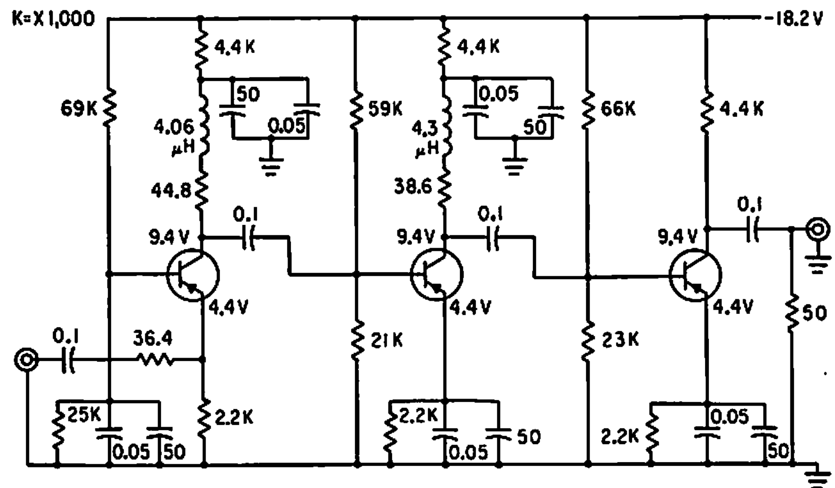
TRF RECEIVER—Operates at either 85 or 135 kc. Input impedance is 72 ohms to match transducer. Detected pulse of rectifier bridge is amplified in direct-coupled amplifier V4 and differentiated at its output, to trigger one-shot mvbr V5, which in turn triggers transmitter and prf multiplier in computing circuitry.—H. F. Messias, Ultrasonics Measures Flow Velocity of Rivers, *Electronics*, 34:41, p 56–59.



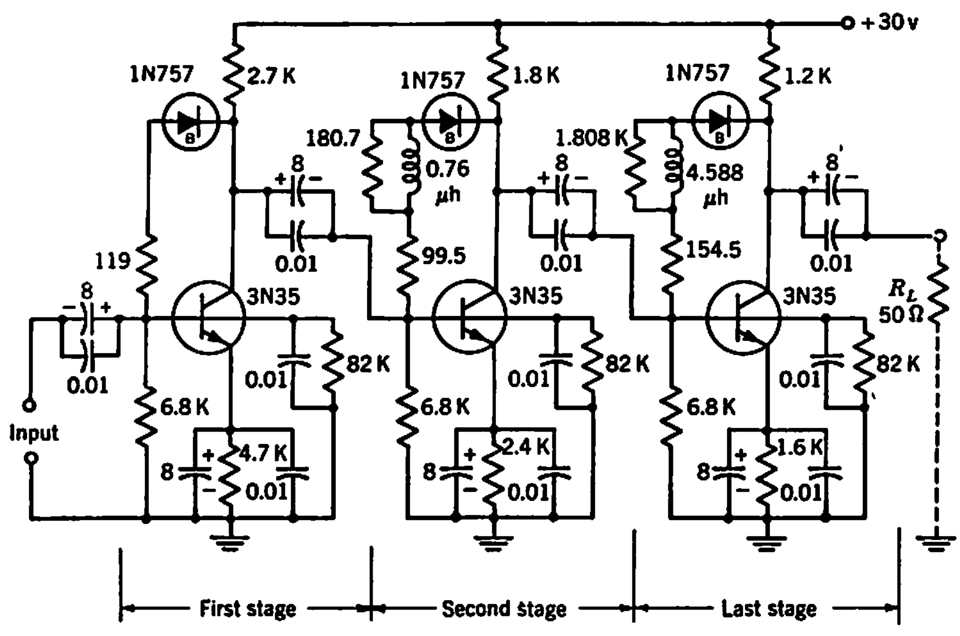


PULSED 30-W TRANSMITTER—Uses pulsed Hartley oscillator operating at either 85 or 135 kc, followed by push-pull driver amplifier, push-pull power amplifier, and power amplifier that feeds 72-ohm transducer through step-down transformer Q1. Oscillator operates for 1-millisec period controlled by V1, which in turn is triggered by negative pulse coming from receiver through free-running mvbr V6.—H. F. Messias, Ultrasonics Measures Flow Velocity of Rivers, *Electronics*, 34:41, p 56–59.

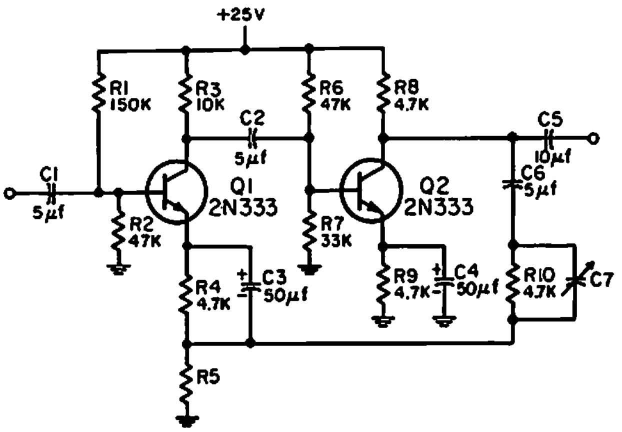
CHAPTER 98
Video Circuits



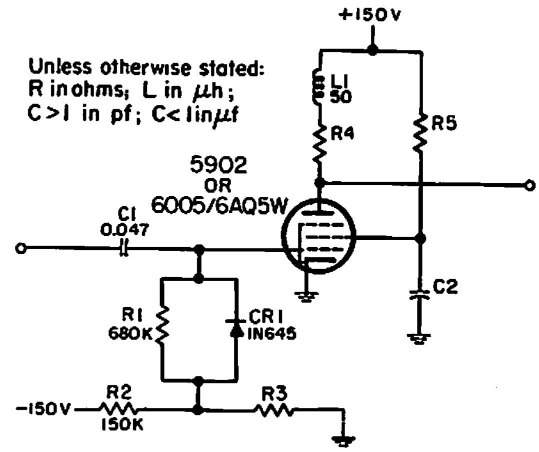
CASCADED SHUNT-PEAKED STAGES—Design procedure is given for n identical one-pole stages. Bandwidth of total cascaded amplifier is equal to bandwidth of single stage multiplied by shrinkage factor of 0.64 for two stages, 0.51 for three, and 0.44 for four. Two-stage example shown gives gain of 8.5 and bandwidth of 2.1 Mc.—R. S. Pepper and D. O. Pederson, Designing Shunt-Peaked Transistor Amplifiers, *Electronics*, 33:49, p 68–70.



SILICON WIDEBAND VIDEO AMPLIFIER—Employs feedback around each of its three stages, with zener diode for stabilizing collector-emitter voltage. Voltage and current amplification are 20 db, and useful frequency range is 3.2 kc to 32 Mc.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 267.



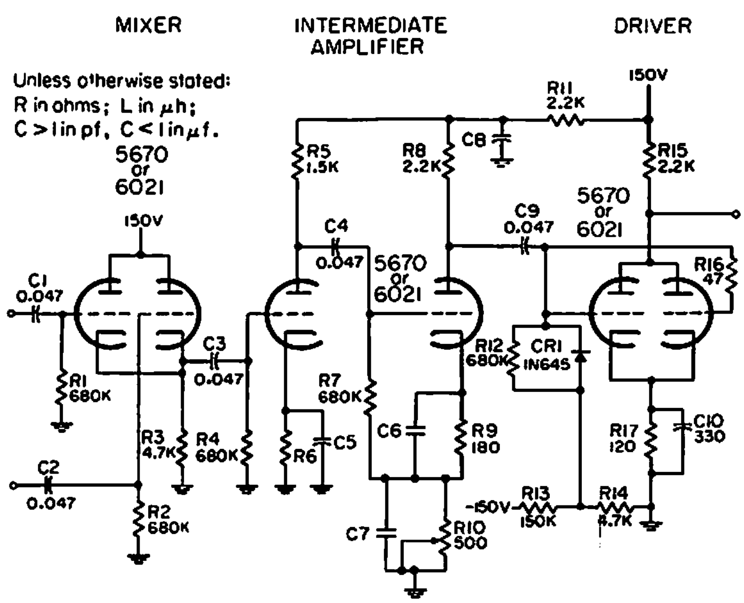
PREFERRED LOW-LEVEL AMPLIFIER—Serves as high-gain amplifier providing stable gain over wide temperature range, with maximum output of 2 v. Is noninverting, has input impedance of 20,000 ohms, and will operate into loads above 10,000 ohms. Several circuits may be cascaded. 2N333 has been dropped from Preferred List, but 2N335 can be used if operating point is adjusted for its larger beta. Voltage gains of 45, 20, or 10 are obtained for R5 = 100, 220, and 470 ohms respectively.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 18 (originally PC 201), p 18–2.



Components:

	6005/6AQ5W	5902
R3	10KΩ	18KΩ
R4	2.2KΩ	2.7KΩ
R5	0	47KΩ
C2	not used	0.1 to 2.0 μf

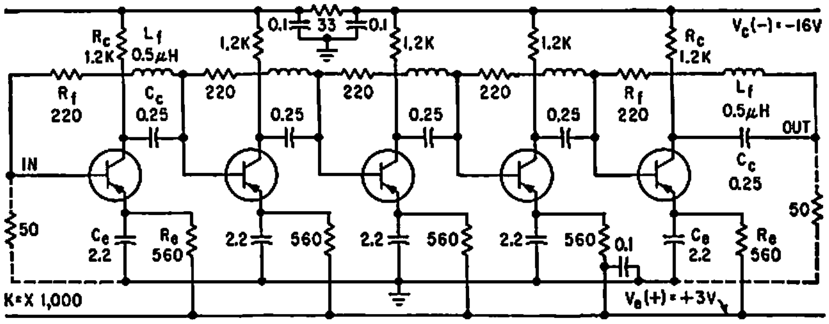
PREFERRED BEAM-POWER DRIVER—Used in search radars to amplify video signals to 60-v level required for intensity modulation of cathode-ray indicator. Input polarity is positive. Amplification is 7.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 28, p 28–2.



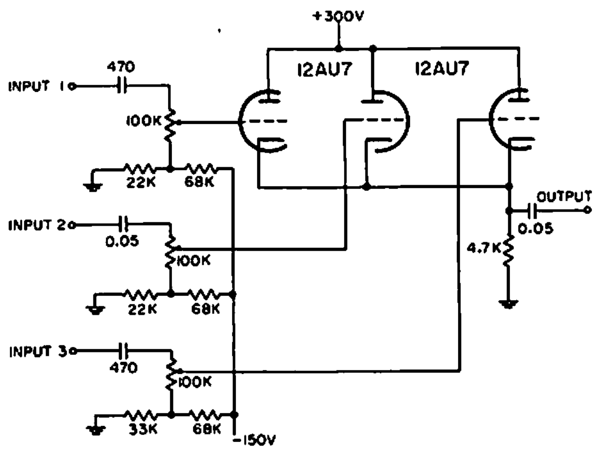
Components:

Tube type	R6	C5	C6	C7
5670	180Ω	180 pf	390 pf	100pf
6021	220Ω	150	560	150

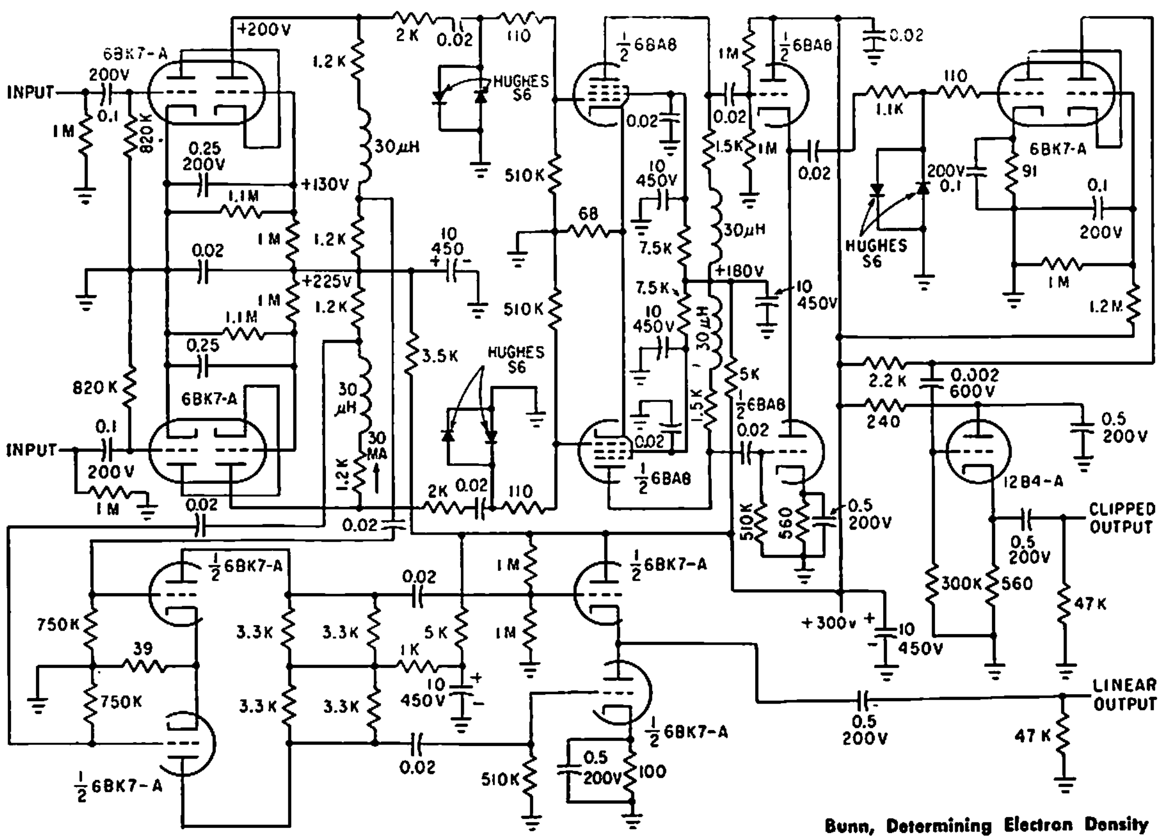
PREFERRED VIDEO AMPLIFIER CHAIN—Designed for use in radar display system to mix positive radar video with positive marker pulses, to invert combined signals, and to amplify them sufficiently to intensity-modulate cathode-ray indicator. Input polarity is negative. Maximum peak amplitude is 60 v. Amplification is variable from 30 to 60.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 25, p 25–2.



100-MC-BANDWIDTH VIDEO AMPLIFIER—Shunt feedback networks around each stage reduce overall gain at low frequencies, trading gain for bandwidth, so that five cascaded stages give overall gain of 50 db. —J. C. de Broekert and R. M. Scarlett, Transistor Amplifier has 100 Megacycle Bandwidth, *Electronics*, 33:16, p 73–75.

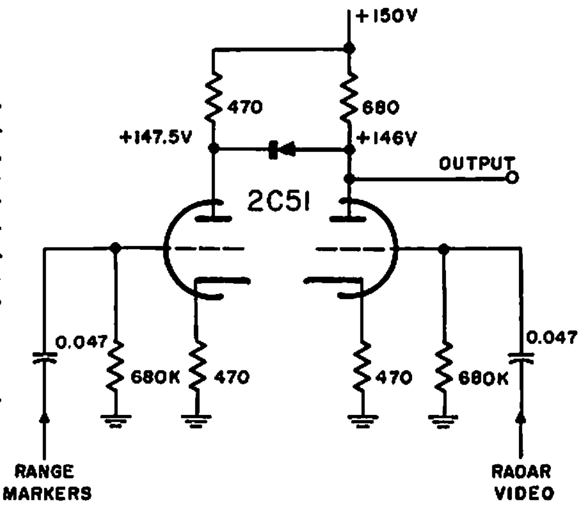


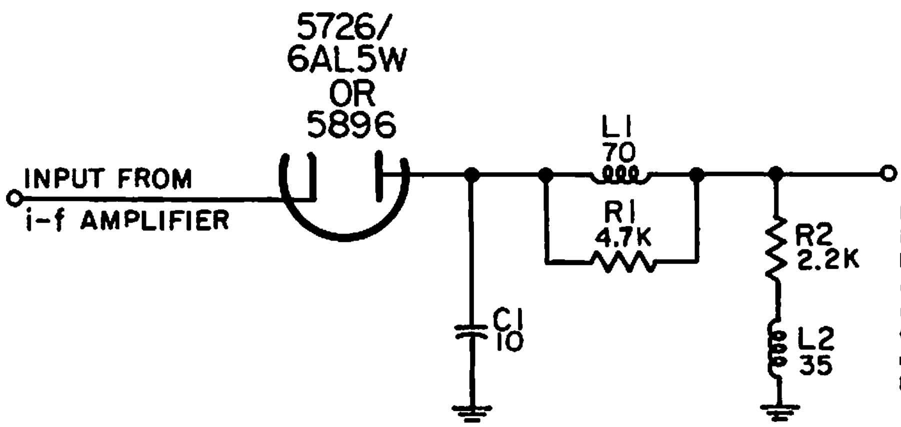
TRIPLE-INPUT VIDEO MIXER—Each grid is biased to cutoff, so mixer accepts only positive-polarity pulses having sufficient amplitude to overcome this bias.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–2.



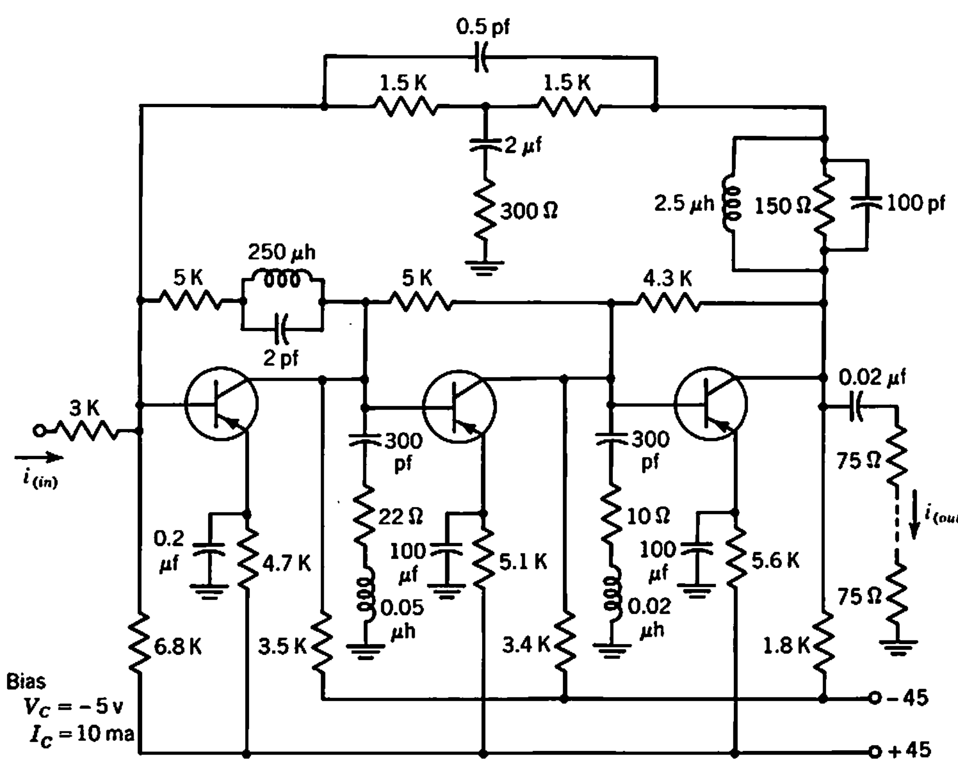
PUSH-PULL CLIPPER—Accepts balanced output of video preamp in microwave interferometer system and provides both linear and clipped outputs for oscilloscope.—H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.

PARTIAL-ADDING MIXER—Semiconductor diode connected between plates in nonconducting direction, with 1.5 v back voltage, reduces additive factor of common-plate mixer. Marker input must have sufficient amplitude to overcome diode back-bias before marker signal can appear at output. Positive radar video at input appears as negative output. At coincidence, radar video biases diode to extent that only small amount of marker pulse can pass and add to radar video.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–9.

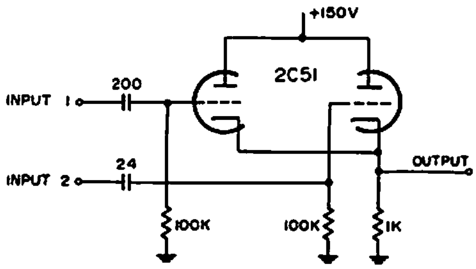




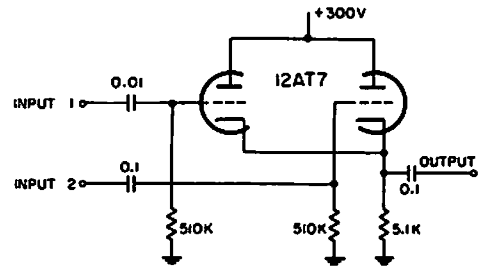
PREFERRED VIDEO DETECTOR—For demodulating pulse-modulated i-f signals in range between 20 and 70 Mc. Video output pulses are negative, with 40 nsec rise time and 70 nsec fall time.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 20, p 20–2.



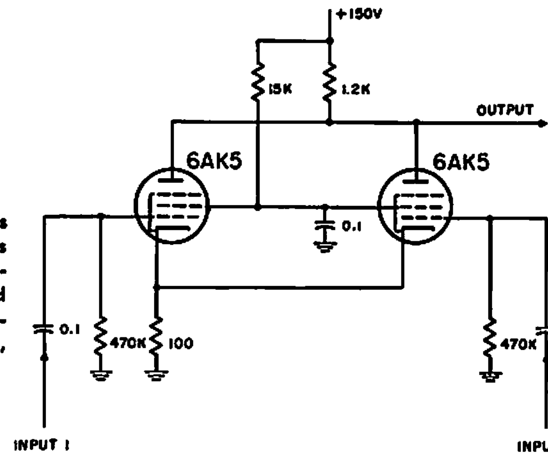
DIFFUSED-BASE GERMANIUM VIDEO AMPLIFIER—Use of standard stability criteria for wideband amplifiers gives current gain of 34 db up to 50 Mc when using any diffused-base germanium mesa transistor similar to 2N2415. D-c biasing uses both series and shunt feedback to each stage, enabling circuit bandwidth to be extended to d-c if necessary.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 268.



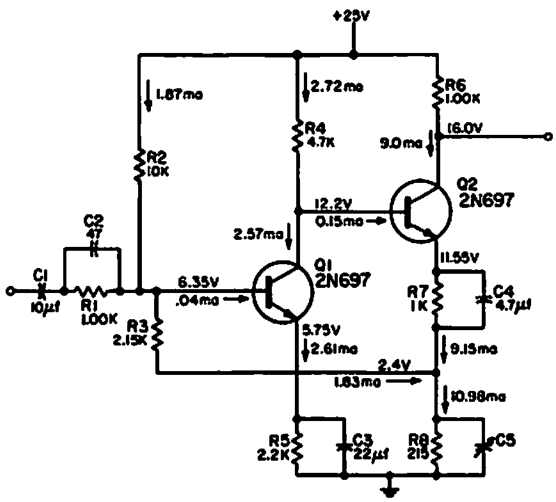
RANGE STROBE MARKER MIXER—Common-cathode dual-triode video mixer is used for combining two positive-polarity radar range strobe markers.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–2.



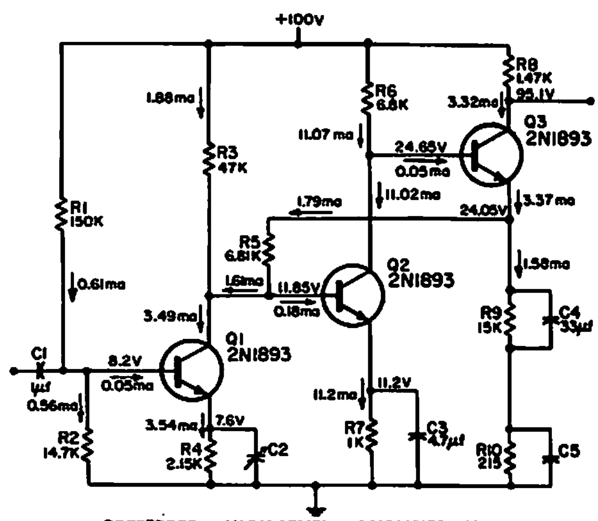
MARKER-IFF MIXER—Combines 9-v positive markers with iff signals from 2 to 10 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–2.



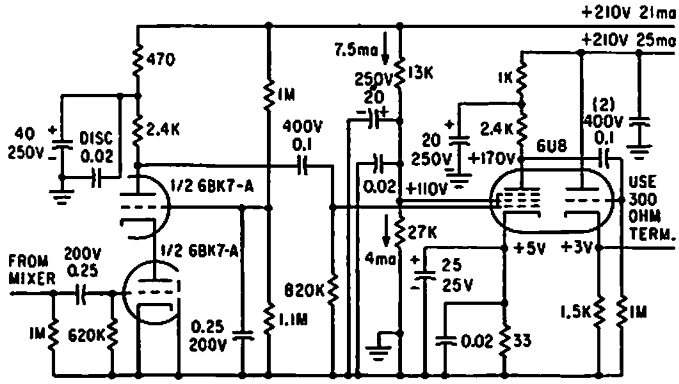
PENTODE COMMON-PLATE MIXER—Circuit is good adder for coincident inputs. Operates best with positive input pulses and negative-going output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–7.



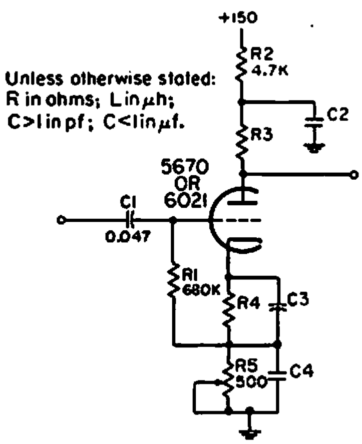
PREFERRED INTERMEDIATE-LEVEL AMPLIFIER—Is noninverting linear pulse voltage amplifier. May follow radar second detector. Minimum bandwidth is 3 Mc and maximum output 6 v. Signal polarity is positive input and positive output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 19 (originally PC 219), p 19–2.



PREFERRED HIGH-LEVEL AMPLIFIER—Linear pulse voltage amplifier, designed primarily as crt intensity modulation device, has minimum bandwidth of 3 Mc. Takes positive input pulses and gives maximum negative output of 55 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, PSC 20 (originally PC 220), p 20–2.

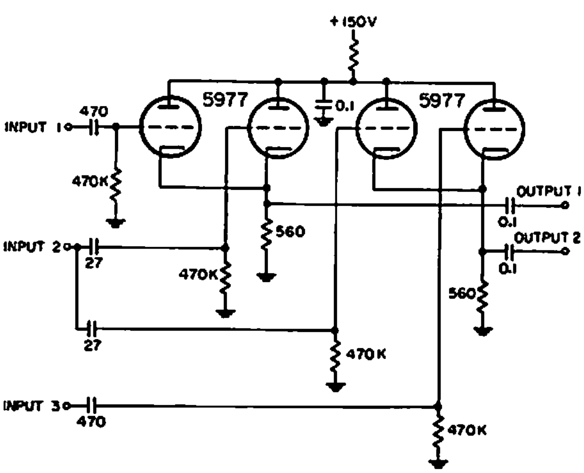


HIGH-GAIN VIDEO PREAMP—Used in microwave interferometer system when additional gain is required along with 3-Mc bandwidth. —H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.

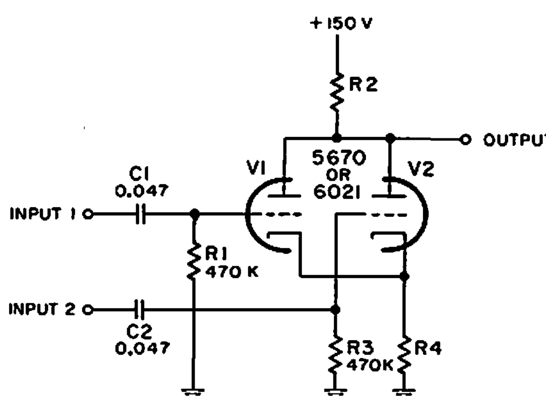


PREFERRED INTERMEDIATE-LEVEL AMPLIFIER—Designed to amplify 1-v signal, such as output of mixer or cathode follower, to level required for input to video driver. Amplification of 3 to 5 may be increased by cascading. Use of R5 and C4 is optional.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 26, p 26–2.

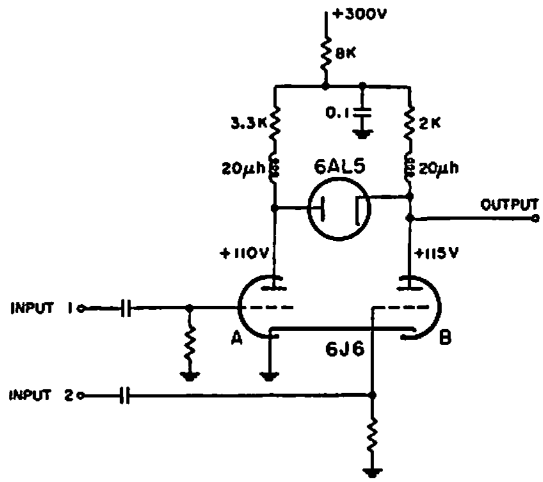
R3	Tube type	R4	C3	C4
1.5KΩ	5670	180Ω	180 pf	47 pf
	6021	220Ω	150	47
2.2KΩ	either	180Ω	270	68



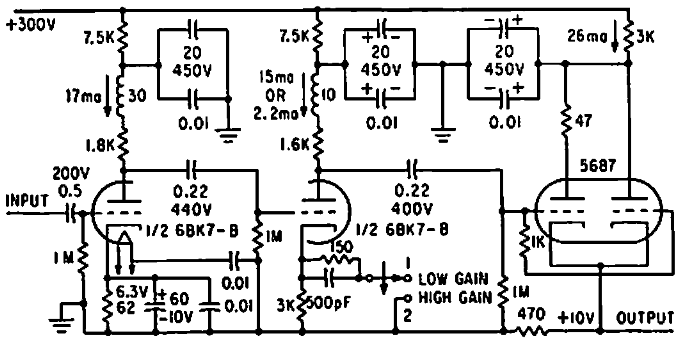
THREE-INPUT TWO-OUTPUT MIXER—Uses two separate common-cathode video mixers. Same heading markers are inserted into both mixers from input 2, while other inputs handle independent markers.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–3.



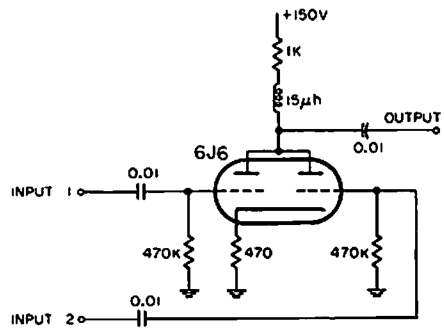
PREFERRED LOW-LEVEL COMMON-PLATE MIXER—Combining of video signals with pulses is accompanied by inversion of input signal. Value of R4 is 270 ohms for 5670 and 470 ohms for 6021. R2 is 680 ohms for 5670 and 1 K for 6021. Input signals must be positive.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 24, p 24-2.



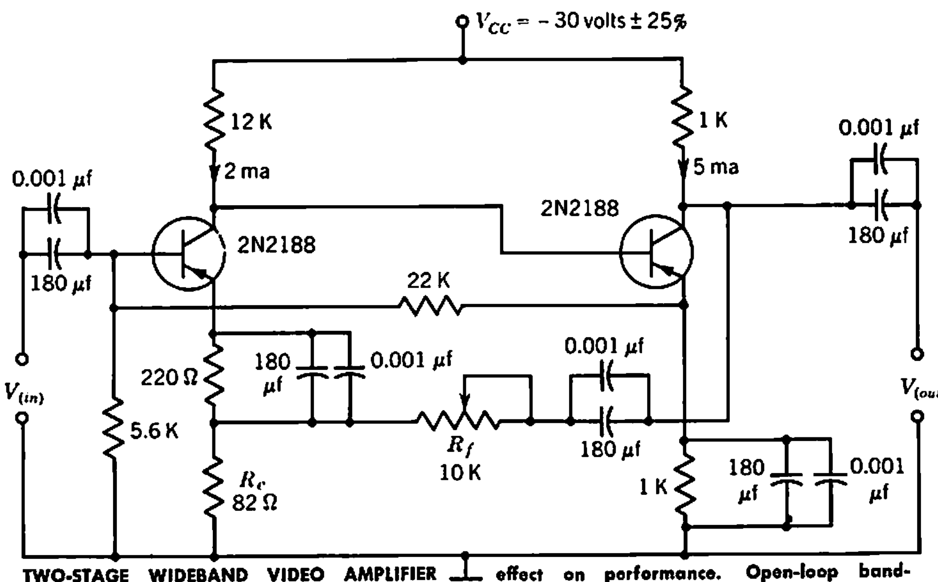
NONADDITIVE COMMON-PLATE MIXER—Plates are coupled by diode that is nonconducting because plate is at lower potential than cathode. If input pulses are not coincident, negative pulse of sufficient amplitude at either input will appear at output. If inputs are coincident, positive pulse appearing at plate of section A will not appear at output unless of sufficient amplitude to overcome bias established by positive output from section B. Radar video must be applied to input 2, since output of section A must overcome 5-v diode bias.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–4.



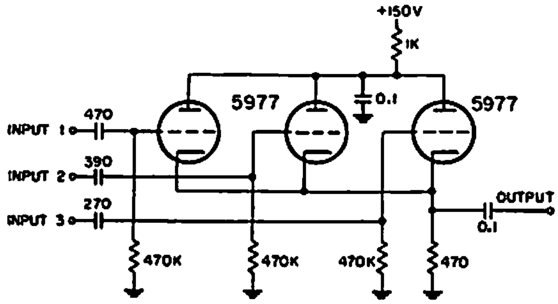
SINGLE-ENDED VIDEO PREAMP—Single-ended input from balanced mixer is achieved by terminating one arm of mixer. Bandwidth is 3 Mc. Used in microwave interferometer system.—H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.



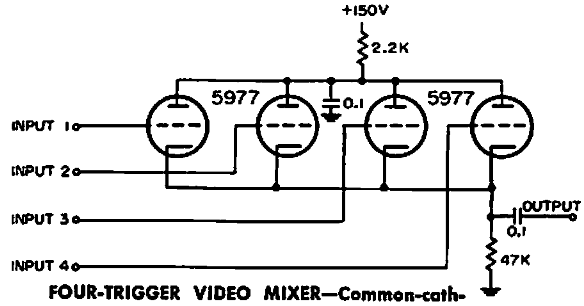
DISTANCE-MARKER MIXER—Uses compensated plate load for triodes to combine distance markers with radar video.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–3.



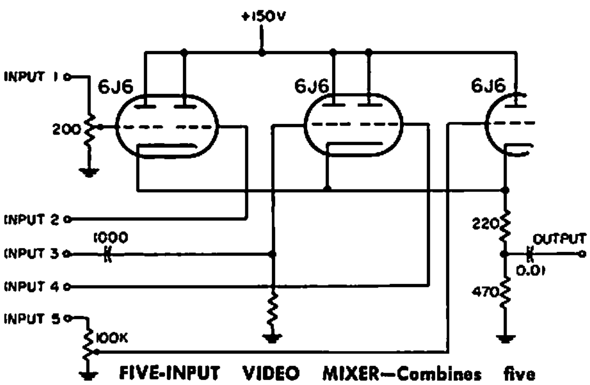
TWO-STAGE WIDEBAND VIDEO AMPLIFIER—D-c feedback provides stable d-c operation for normal production spread of components and normal temperature variations. Supply voltage changes up to 25% have negligible effect on performance. Open-loop bandwidth is 1 Mc for 50 db gain, and bandwidth at 30-db closed-loop gain is 17 Mc.—Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 269.



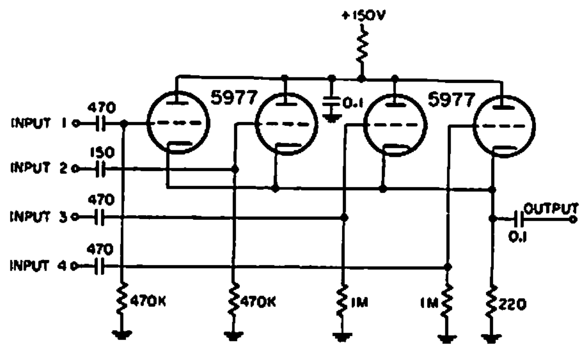
THREE-INPUT VIDEO MIXER—Used in radar systems for combining any three of the following: radar video, beacon, range markers, range strobe, and azimuth markers.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–1.



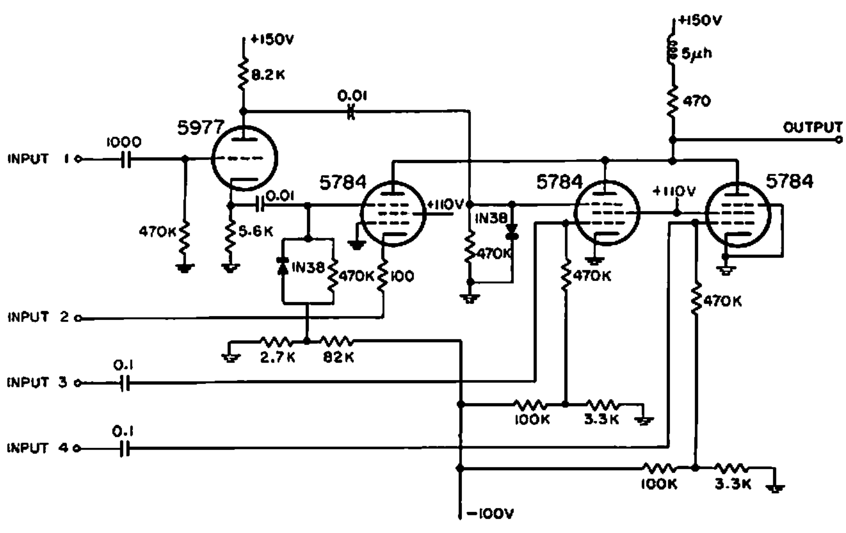
FOUR-TRIGGER VIDEO MIXER—Common-cathode arrangement with 47K cathode resistor allows nonadditive mixing of four positive trigger pulses having amplitudes in vicinity of 50 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4-1.



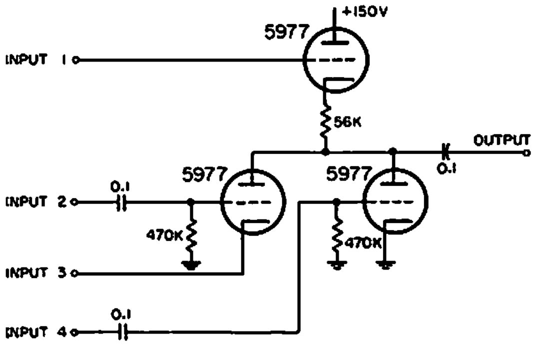
FIVE-INPUT VIDEO MIXER—Combines five radar marker inputs.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–2.



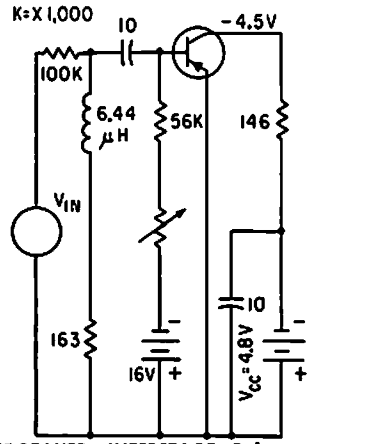
FOUR-INPUT VIDEO MIXER—Used for combining four different positive-polarity marker pulses in radar system.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–1.



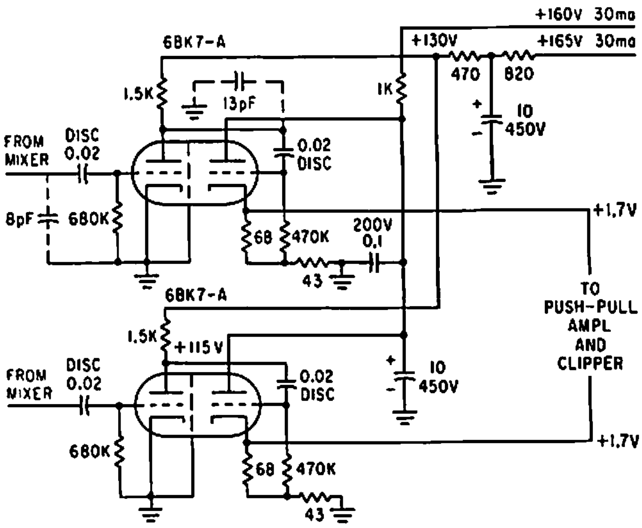
THREE-PENTODE MIXER—Triode is used as phase splitter. Both positive and negative signals are combined from four inputs. High-frequency compensation is used in common plate circuit of pentodes.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–5.



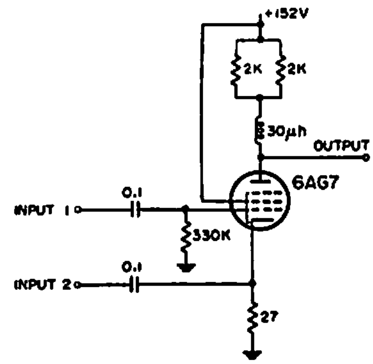
FOUR-INPUT HIGH-LEVEL PULSE MIXER—Triode in series with plate load of mixer provides for additional blanking pulse.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4-3.



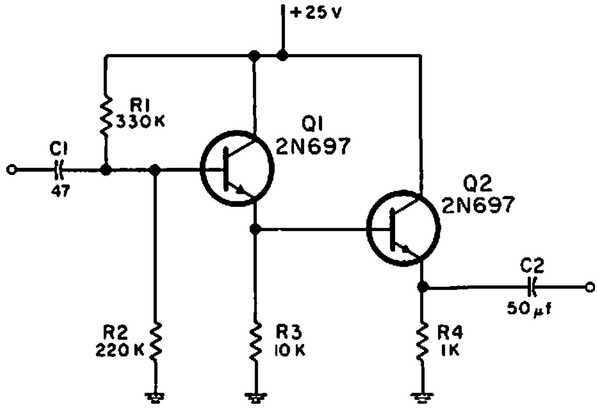
SHUNT-PEAKED INTERSTAGE—Pole-zero cancellation design procedure for using shunt peaking gives simple cascaded broadband video amplifier. Gain is 10.4 and bandwidth is 1.05 Mc.—R. S. Pepper and D. O. Pederson, Designing Shunt-Peaked Transistor Amplifiers, *Electronics*, 33:49, p 68–70.



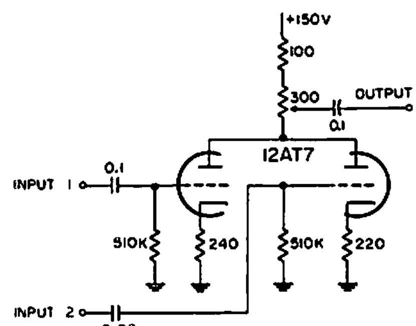
VIDEO PREAMP—Accepts output of balanced mixer of microwave interferometer system. Bandwidth is 3 Mc.—H. L. Bunn, Determining Electron Density and Distribution in Plasmas, *Electronics*, 34:14, p 71–75.



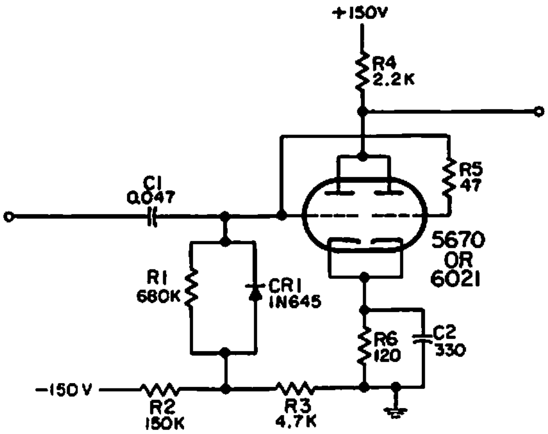
PENTODE MIXER—Negative video plus iff signals are inserted at grid, while range strobe, from cathode output of blocking oscillator, is applied to cathode.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4-4.



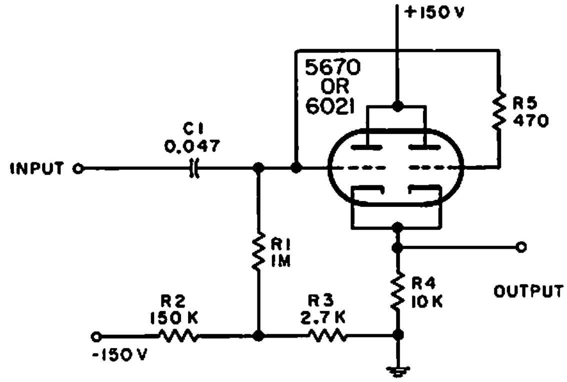
PREFERRED PULSE EMITTER-FOLLOWER—Two-stage cascaded emitter-follower is intended primarily as video line driver for positive pulses. Will drive load impedances as low as 50 ohms. Input impedance is about 80,000 ohms in parallel with 25 pf. May be modified for negative inputs by replacing Q1 and Q2 with complementary pnp types and reversing polarity of collector supply. Voltage amplification is 0.975 and power gain is 30 db.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. II, Semiconductor Device Circuits, 1962, PSC 21 (originally PC 221) p 21-2.



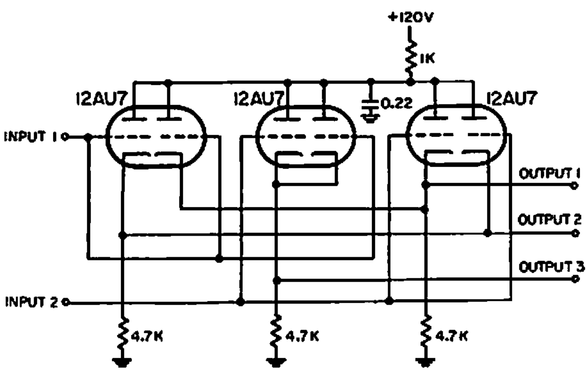
COMMON-PLATE TRIODE MIXER—Has two inputs, for combining mixed markers and radar video. Cathode resistors are unbypassed, for gain stabilization.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4-3.



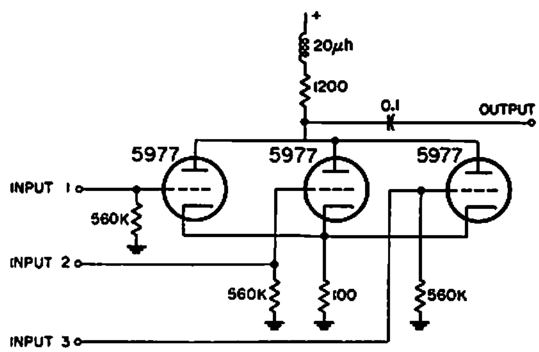
PREFERRED TRIODE DRIVER—Used to amplify video signals for intensity modulation of cathode-ray tube. Accepts positive inputs and gives negative output. Amplification is 5.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 27, p 27–2.



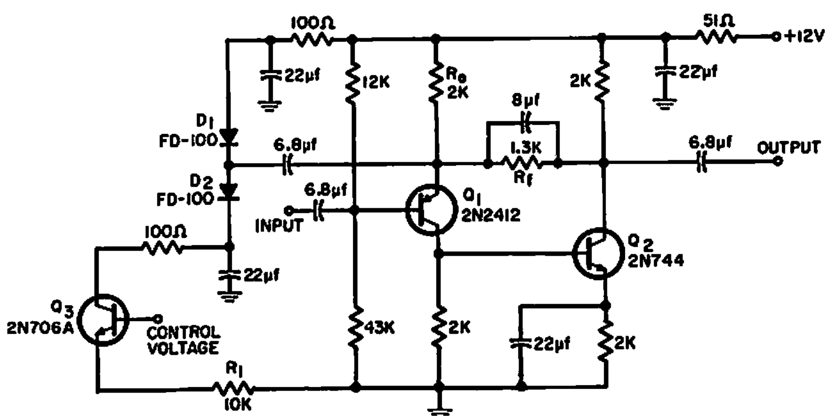
PREFERRED LOW-LEVEL PULSE CATHODE FOLLOWER—Used to couple output of low-level video stage to resistive load in applications where high-duty-factor signal makes direct coupling desirable.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 22, p 22–2.



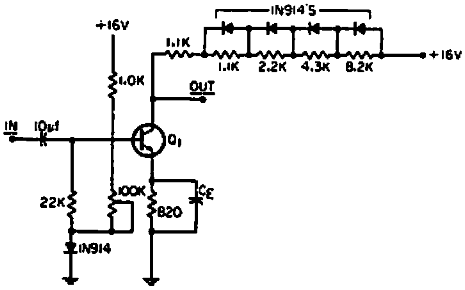
TWO-INPUT THREE-OUTPUT MIXER—Combines two inputs and distributes them to each of three independent outputs, which are connected to separate indicators.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–3.



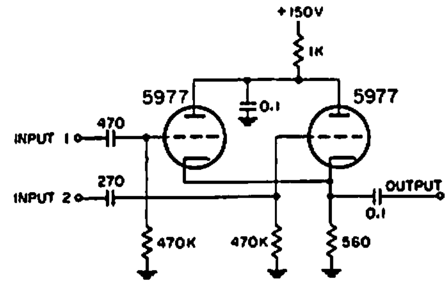
THREE-INPUT IFF MIXER—Common-plate connection serves for combining three iff signals. Common cathode resistor provides some degeneration.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–3.



VOLTAGE-CONTROLLED GAIN—Silicon diodes serve to vary gain of wideband video amplifier over range from 2 to 32 db, with bandwidth remaining almost constant at 12 Mc and input impedance constant at 10K.—R. S. Hughes, A Wideband Video Amplifier with Variable Gain, *EEE*, 12:8, p 54–55.

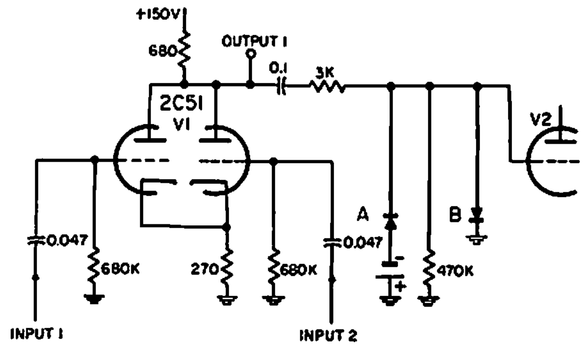


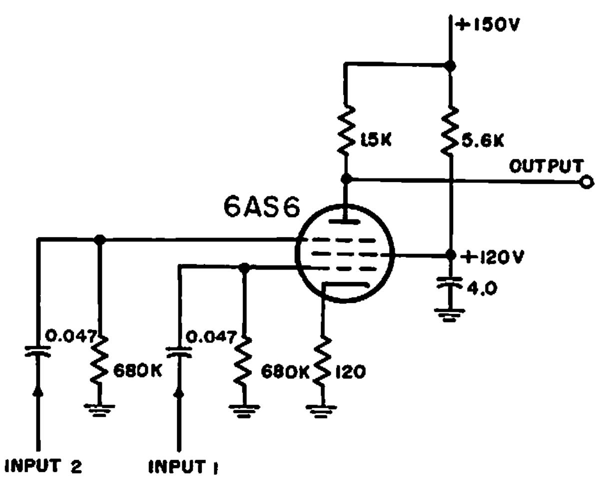
COMPRESSION AMPLIFIER—Single transistor serves as compression amplifier having 50 db dynamic range, for nonsaturating amplification of widely ranging video signals. Provides minimum output of 1 v for 20 mv input, but does not saturate with 6 v input. Circuit gain is minimum of 1 and maximum of 15. Two circuits are cascaded in actual application.—R. W. Cotterman, One Transistor, 50 Db Dynamic Range Compression Amplifier, *EEE*, 13:5, p 46.



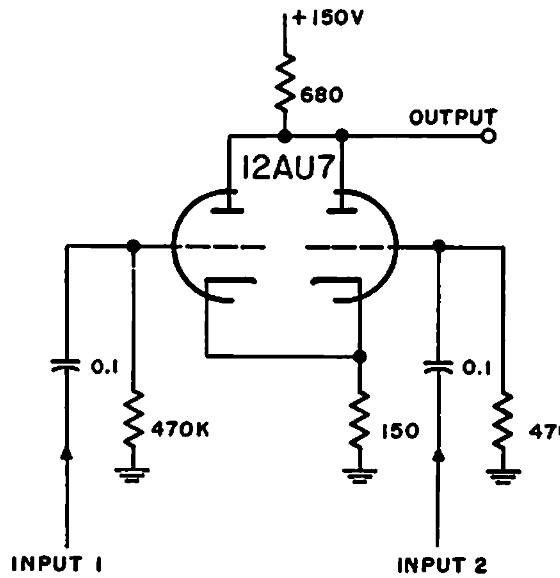
TWO-INPUT MIXER—Used to combine range and heading markers in radar system.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–1.

MIXER-LIMITER—Common-plate mixer uses diode-limiting coupling circuit to nullify adding feature. Bias voltage on diode sets limiting level.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–8.

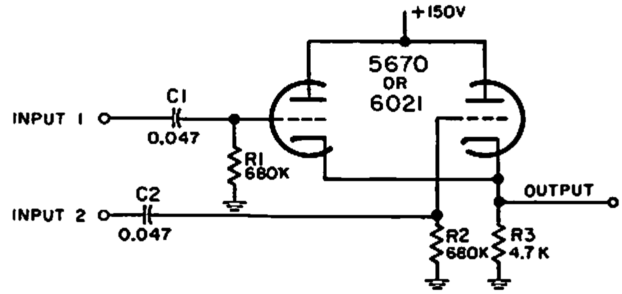




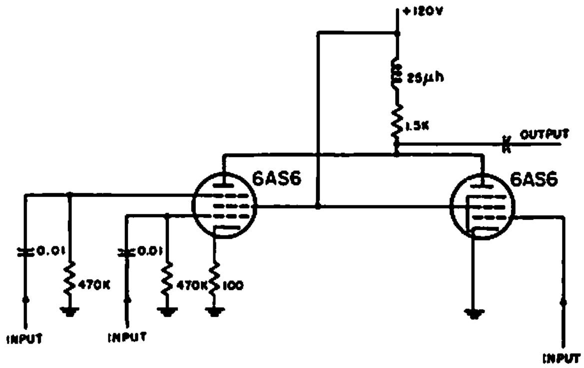
DUAL-GRID PENTODE MIXER—Uses 6AS6, in which suppressor grid has cutoff characteristic similar to control grid. Pulses of higher amplitude, such as markers, should be impressed on suppressor grid, since its transconductance is about one-fourth that of control grid. Chief drawback is need for large screen bypass capacitor.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–9.



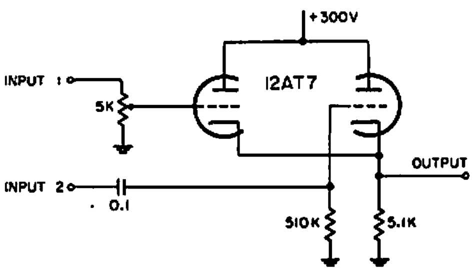
TRIODE COMMON-PLATE MIXER—Is good adder for coincident inputs. Proves unity gain. Generally preferred to pentode common-plate mixers.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–8.



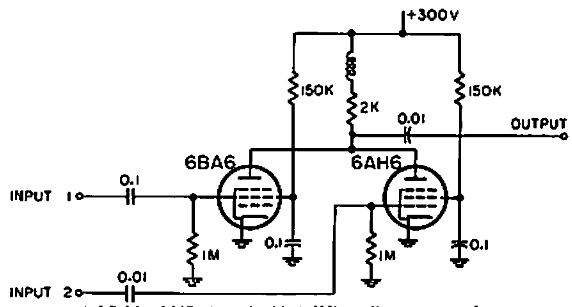
PREFERRED COMMON-CATHODE MIXER—Combines video signals and pulses from two inputs, as for radar video, beacon signals, range markers, range strobes, and azimuth markers. Mixer is nonadditive and noninverting, can handle fast rise times, but amplification is less than unity and it cannot handle negative inputs.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. I, Electron Tube Circuits, 1963, PC 23, p 23–2.



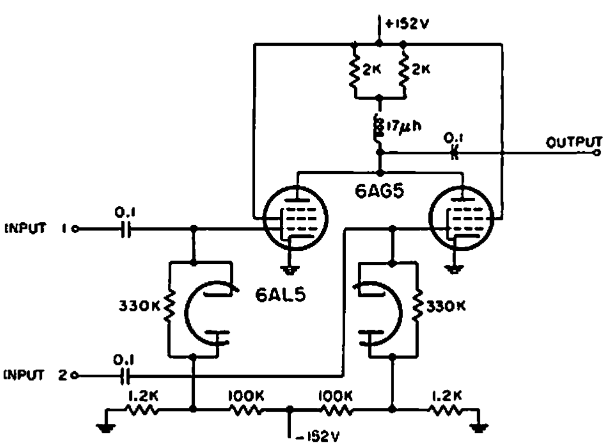
THREE-INPUT TWO-PENTODE MIXER—Distance markers and iff signals are inserted at separate grids on one tube, while radar video from input 3 is impressed on control grid of other pentode.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–4.



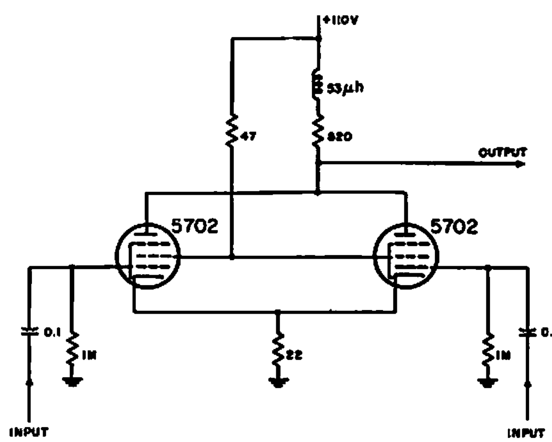
RANGE STROBE MARKER-IFF MIXER—Combines positive-polarity markers with iff signals, to give 8-v positive output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–2.



RADAR AND BEACON MIXER—Two pentodes combine two inputs into single output.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–5.

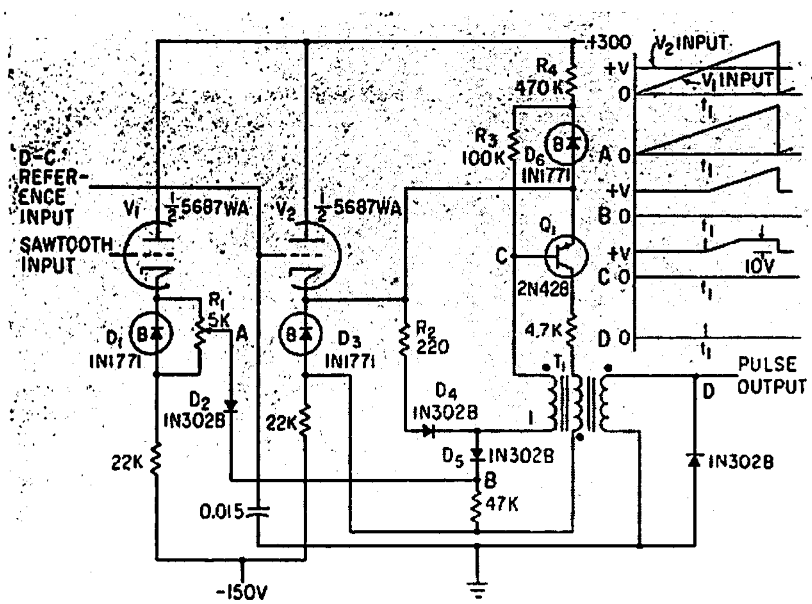


TWO-PENTODE RADAR AND IFF MIXER—Each grid is clamped by diode to establish base line of positive input pulse at −1.8 v.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–5.

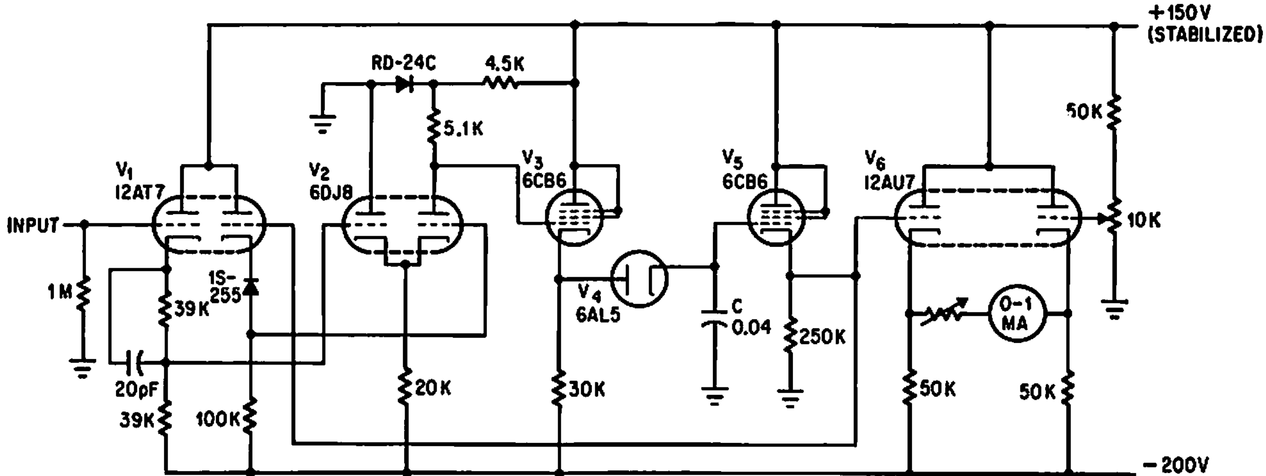


TWO-PENTODE MIXER—Combines range markers and radar video. Compensated load improves high-frequency response.—NBS, "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment," Vol. 1, Electron Tube Circuits, 1963, p N4–4.

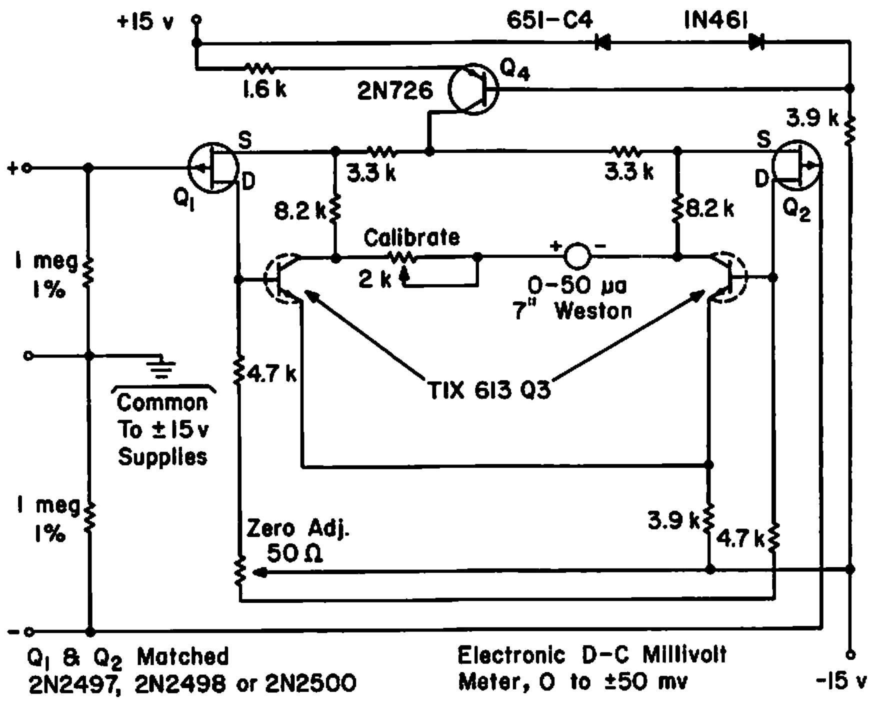
CHAPTER 99
Voltage Measuring Circuits



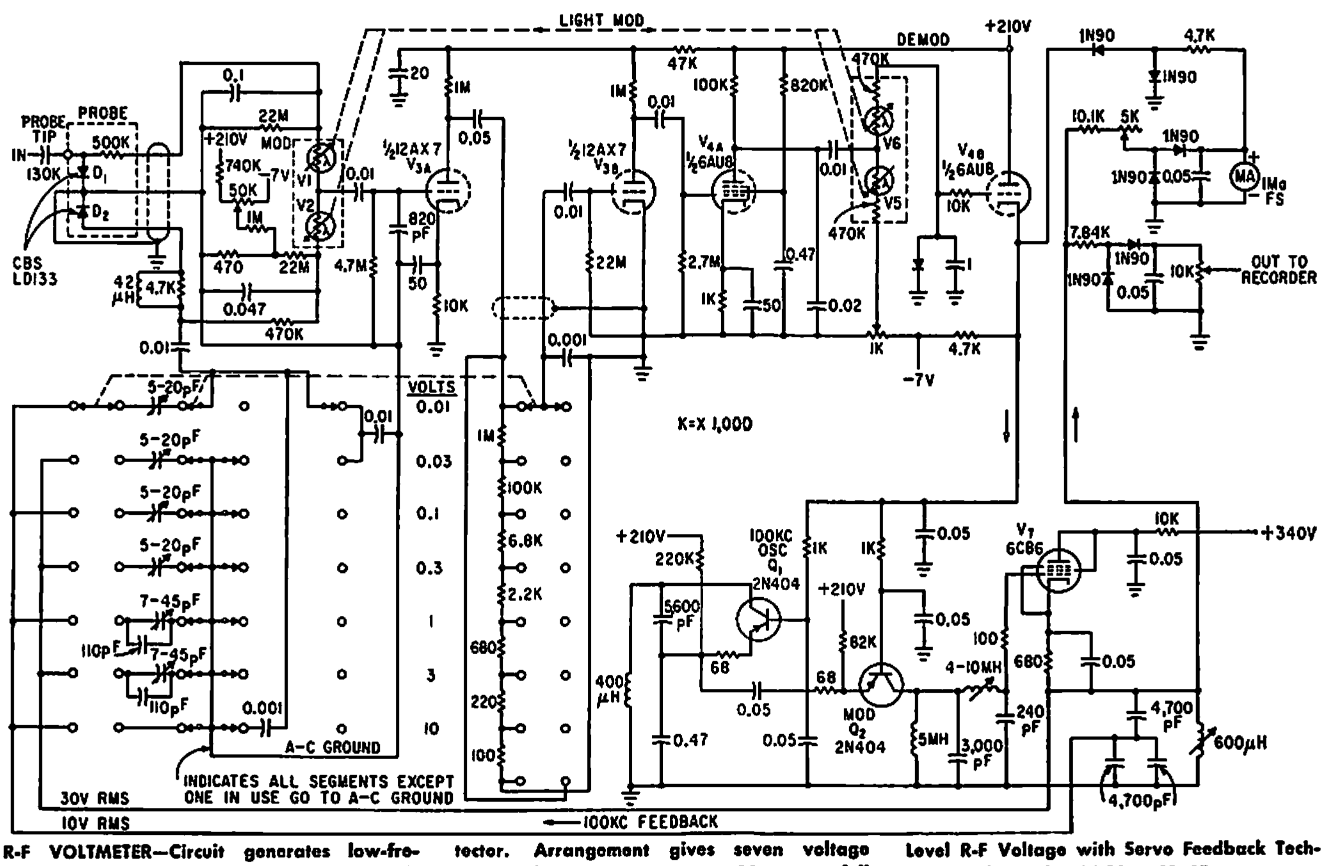
D-C VOLTAGE COMPARATOR—Compares long-duration sawtooth input with d-c reference and generates pulse when inputs coincide.—R. D. Valentine, D-C Voltage Comparator Circuit Uses Tube and Transistor, *Electronics*, 34:24, p 66.



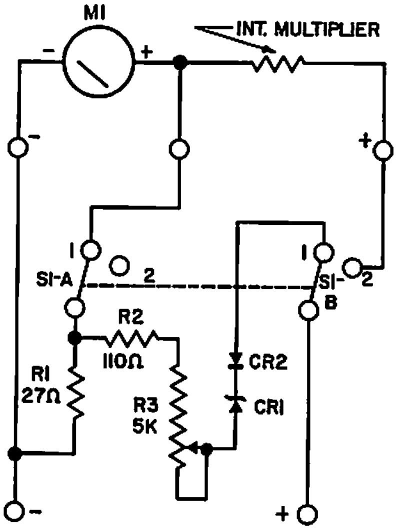
PEAK VOLTMETER FOR NARROW PULSES—Addition of dual-triode amplifier V2 to conventional peak voltmeter reduces charging time constant while increasing available time for measuring peak value. Linearity is good up to 40 v.—M. Uno, Amplifier Improves Peak Voltmeter Response, *Electronics*, 37:14, p 73.



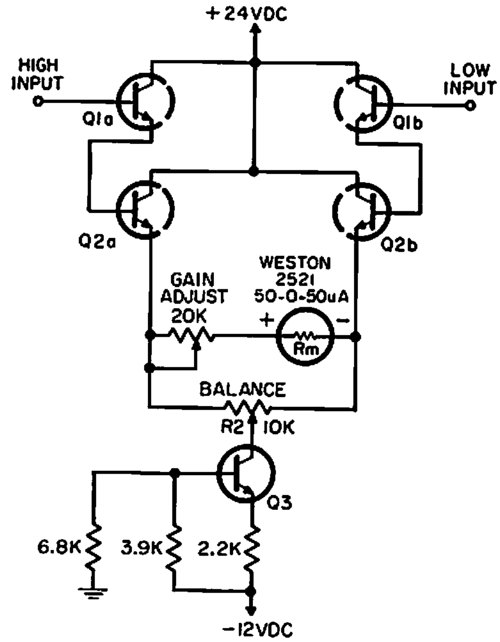
FET-PNP D-C MILLIVOLTMETER—Differential amplifier uses pair of simple feedback amplifiers having voltage gain of 3, output impedance of 50K, input sensitivity of 20 meg/v, and common-mode rejection ratio of 1,000 to 1.—Texas Instruments Inc., "Solid-State Communications," McGraw-Hill, N.Y., 1966, p 136.



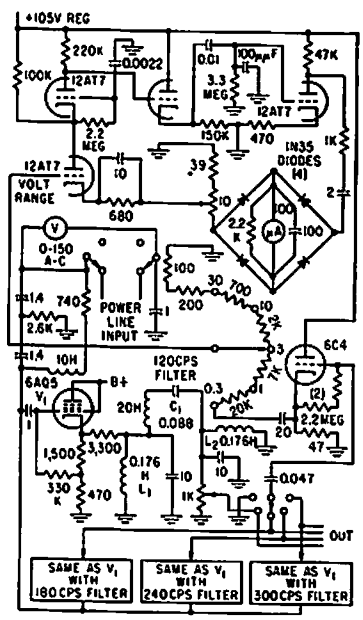
R-F VOLTMETER—Circuit generates low-frequency waveform whose amplitude is equivalent to that of unknown r-f voltage, using photochopper modulator V1-V2 as error detector. Arrangement gives seven voltage ranges, from 10 mv rms to 10 v rms full scale, over frequency range of 500 kc to 1,000 Mc.—T. C. Anderson, Measuring Low-Level R-F Voltage with Servo Feedback Techniques, *Electronics*, 34:28, p 63–65.



DUAL-RANGE D-C VOLTMETER—With switch in position 2, serves as standard 0-50 v d-c voltmeter. With switch in position 1, R1 is shunted across 50-mv, 1-ma meter to allow about 3 ma through 27-v, 1-w zener diode CR1. CR2 diode 1N540 is for temperature compensation. About 27 v is then held across the diodes, and meter scale represents 27 to 32 v, with sensitivity of 0.1 v d-c per division. R3 is used for calibration.—M. W. Raybin, Dual Range DC Voltmeter, *EEE*, 10:12, p 31.



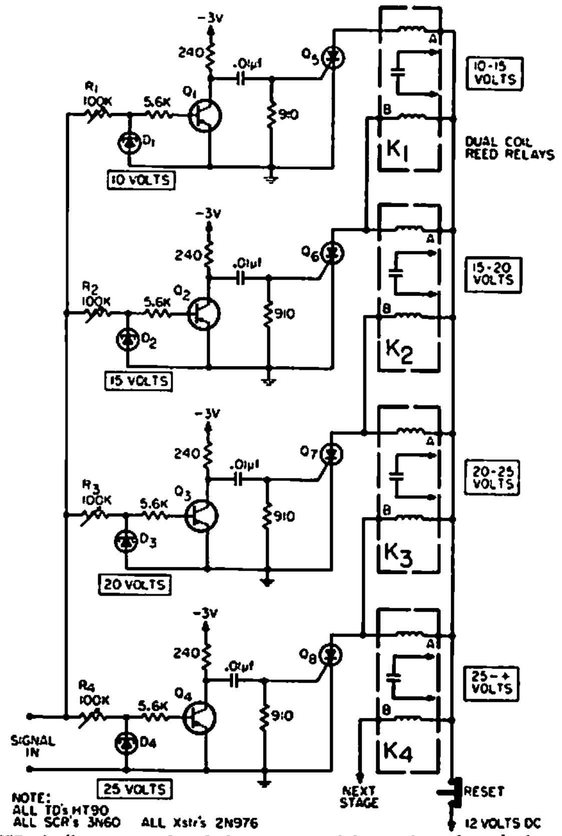
DIFFERENTIAL VOLTMETER—High-impedance differential-input transistorized panel voltmeter has stable zero point, eliminating need for undesirable zero control. Meter compares voltage under test with known zener-regulated reference voltage. Circuit is differential Darlington-connected emitter-follower using pair of 2N2060's. Bias point is stabilized by constant-current sync connected to 2N1613 transistor. Accuracy is 1% if unmatched source impedance is less than 10K. —A High-Stability Differential Voltmeter, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 152.



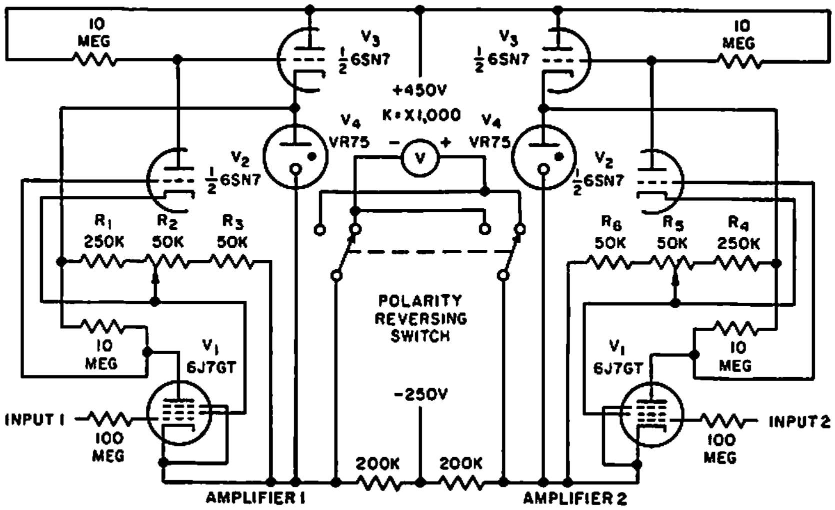
FILTER COMPONENT VALUES

FREQ CPS	L_1 H	C_1 μF
180	0.0781	0.0391
240	0.0438	0.0219
300	0.0283	0.0142

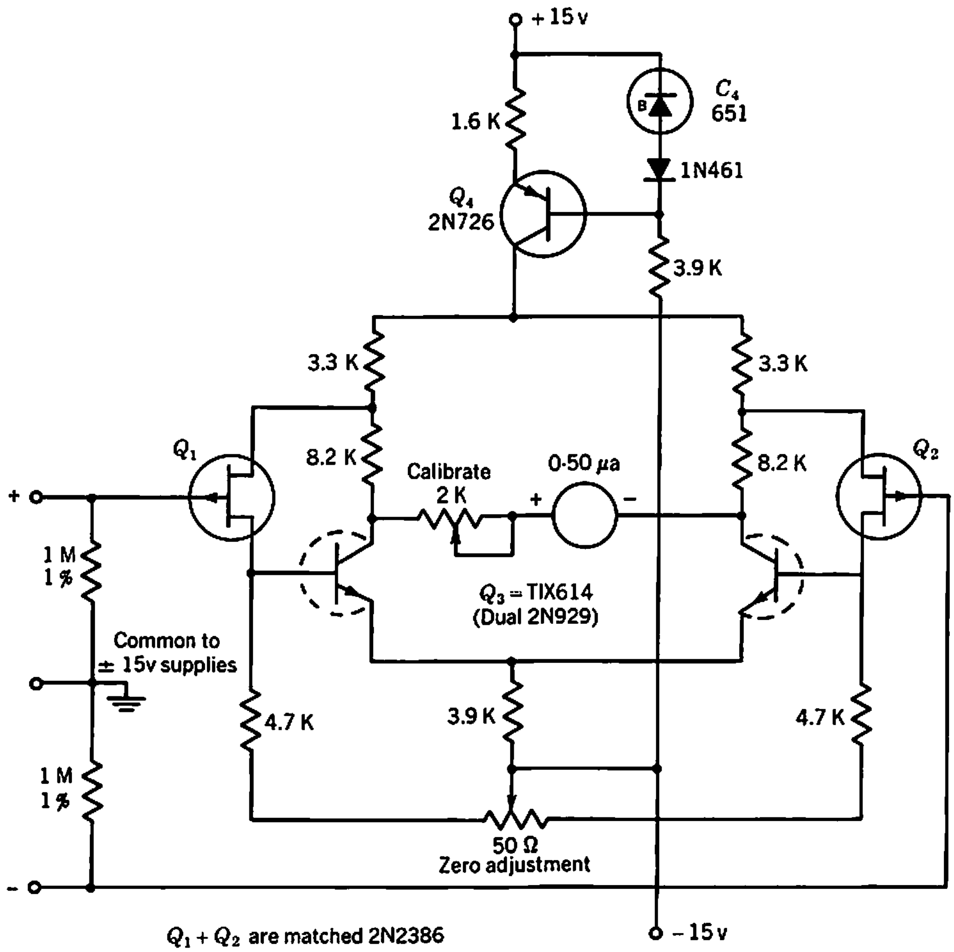
POWER-FREQUENCY HARMONIC METER—Has four bandpass filters, tuned to first four harmonics of 60 cps, and vtvm that measures voltage at each filter output, in five ranges covering from 0.3 to 30 v full scale.—R. S. Brown, Tuned Voltmeter Reads Harmonic Amplitude, *Electronics*, 32:3, p 68.



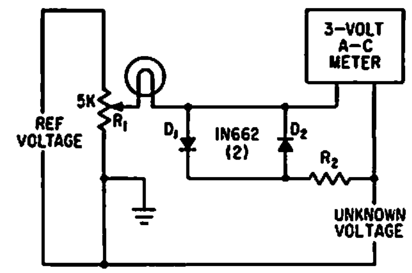
PULSE PEAK METER—Indicates peak of fast voltage pulse to within one of several predetermined voltage ranges established by tunnel-diode level-sensing circuit and indicated by series of exclusive-or dual-coil reed relays.—J. C. Rich, Pulse-Peak Indicator, *EEE*, 13:2, p 61.



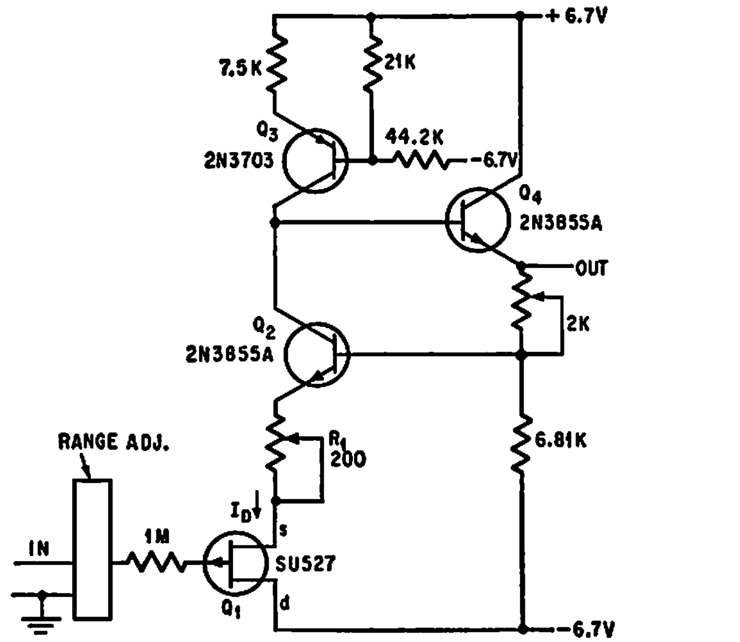
HIGH-IMPEDANCE DIFFERENTIAL VTVM—Infinite input impedance is obtained in direct-coupled d-c amplifier by continuously and automatically feeding back to input a bucking voltage equal to signal voltage. Use of both inputs permits differential measurements of small signal voltages at mean levels between −150 and +300 v, for measuring grid-cathode potentials in high-impedance circuits or for balancing high-impedance push-pull circuits. Instead of input voltage dividers, range resistors are used in output circuit. Voltage supply need not be regulated.—V. D. Schurr, D-C Amplifier Expands Input Voltage Range, *Electronics*, 31:23, p 87–89.



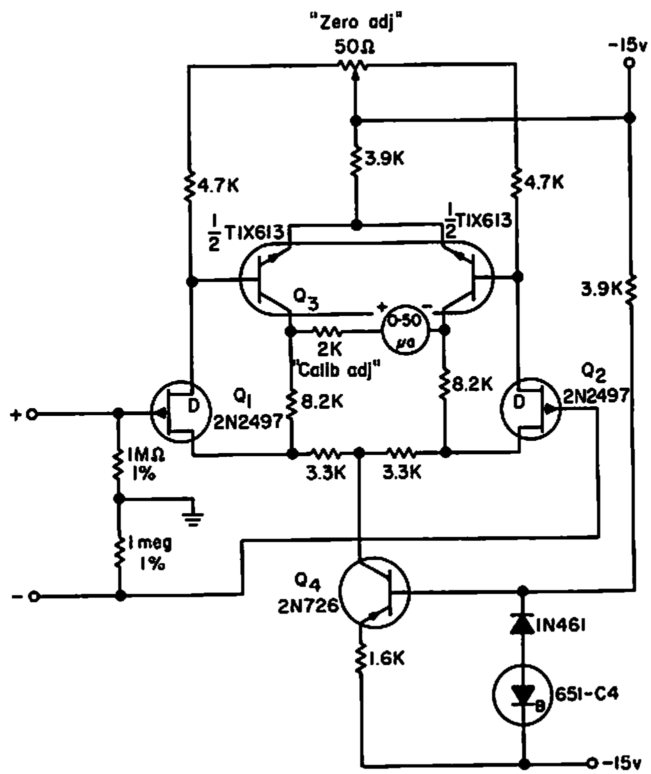
FET D-C MILLIVOLTMETER—Uses differential amplifier assembled from pair of simple two-stage feedback amplifiers having voltage gain of 3. Input sensitivity of meter is 20 meg per v and common-mode rejection ratio is 1,000 to 1. Temperature characteristics are reasonably good when using matched fet's. —Texas Instruments Inc., "Transistor Circuit Design," McGraw-Hill, N.Y., 1963, p 522.



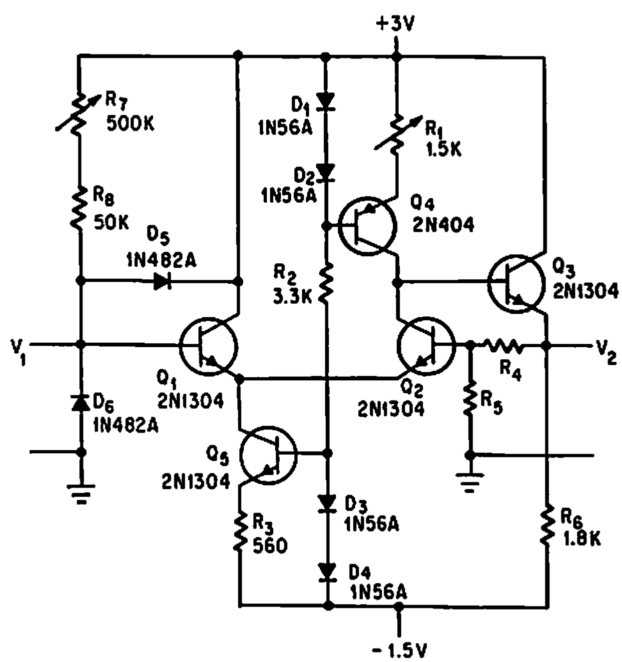
VOLTAGE RATIO METER—Simple circuit, having resolution better than 0.1% for measuring ratio of two voltages, also serves as accurate null detector when difference voltage is less than 0.5 v. A 115-v, 6-w lamp limits voltage applied to meter when difference voltage exceeds 0.5 v. R2 is chosen to give full-scale deflection when difference between the two voltages is maximum.—P. A. Lenk, Circuit Permits Accurate Voltage Ratio Measurements, *Electronics*, 34:52, p 56–57.



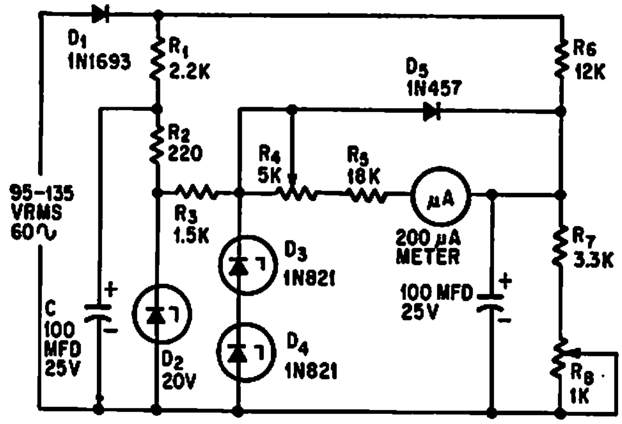
DIRECT-COUPLED AMPLIFIER—Gives high input impedance and low drift at low cost, with approximately unity gain. Uses one fet and three bipolar transistors. Suitable for d-c voltmeter having 0.1 v full scale on lowest range. Temperature drift is low.—J. M. Colwell, Direct-Coupled Amplifier Cuts Cost of D-C Voltmeter, *Electronics*, 39:12, p 109–110.



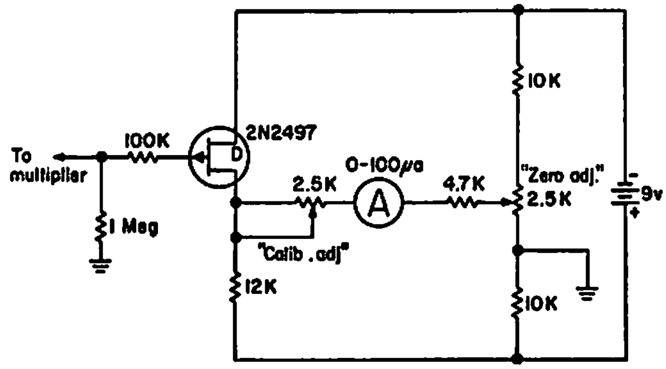
FET D-C MILLIVOLTMETER—Consists of two circuits much like bootstrapped source-follower, differentially connected and fed by active current source. Input of 50 mv produces full-scale deflection, making sensitivity 20 meg/v.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 110.



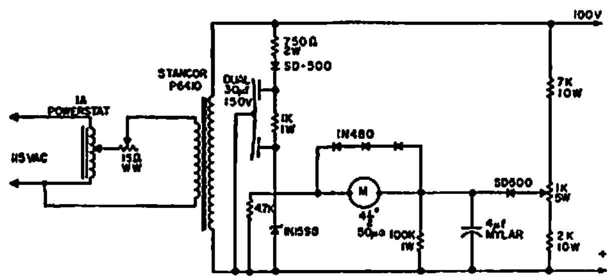
HIGH-GAIN D-C PREAMP FOR VTVM—Use of current source as load resistor of Q2 minmizes battery supply effect on zero setting. Additional current source Q5-R3-D3-D4 serves in place of common-emitter resistance for Q1-Q2 to reduce sensitivity to negative supply voltage excursions and boost open-circuit gain above 300. Preamp will extend 1.5-v range down to 500, 150, and 50 mv full-scale for voltage measurements in semiconductor circuits without damaging transistors. —A. K. Scidmore, Low-Cost Emitter-Follower Extends Voltmeter's Range, *Electronics*, 39:3, p 87.



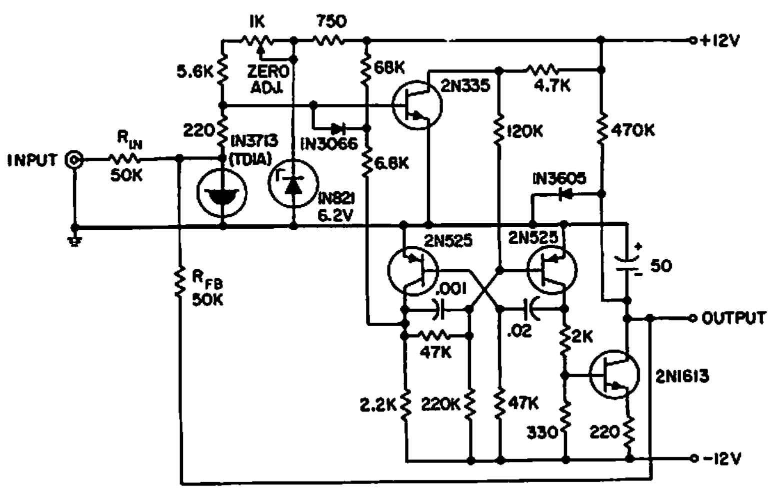
PRECISION A-C VOLTMETER—Measures a-c voltages between 95 and 135 v with 0.6% accuracy while using ordinary 2% accuracy meter. Zener diodes provide reference voltage.—D. S. Belanger, Simple Circuit Increases Measurement Accuracy, *Electronics*, 38:22, p 69.



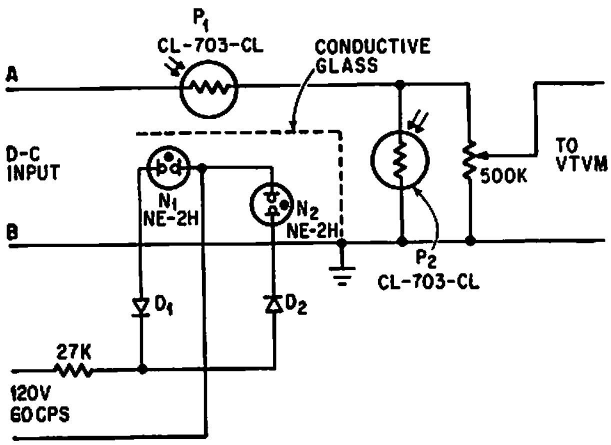
SIMPLE FET VOLTMETERS—Uses single active device to indicate full scale at 1 v input, for sensitivity of 1 meg per volt. Bias is at 300 microamp drain current, approximately point of zero drift.—L. J. Sevin, Jr., "Field-Effect Transistors," McGraw-Hill, N.Y., 1965, p 109.



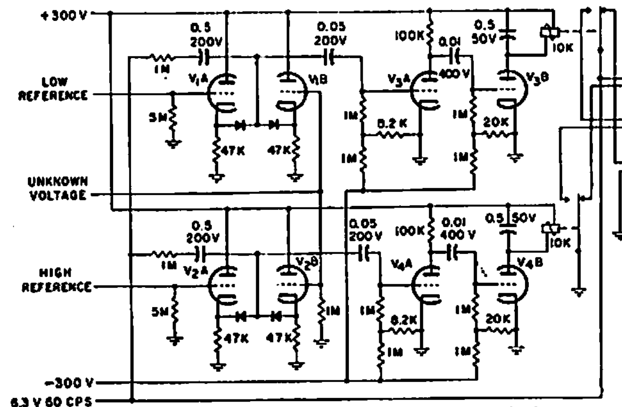
100-V A-C REFERENCE—Accurate 100-v rms source is used as reference voltage for divider to correlate vacuum-tube voltmeters. Meter is altered to zero-center, with new scale indicating voltages up to 1.825 v on each side of 100-v center value. D-c voltage on one side of meter is held constant by zener diode, and is compared with positive voltage applied to other meter terminal by divider action without stabilization. Initial standardization is done by adjusting input controls for 100-v output as determined by reference standard. Output potentiometer is then adjusted to make meter correspond (center of scale). Three diodes protect meter when unit is turned on.—Standardized AC Voltage Reference Source, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 151.



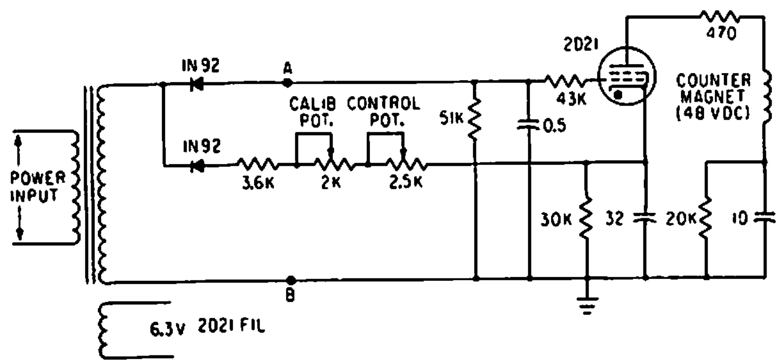
PEAK-SENSING OPERATIONAL AMPLIFIER—Operates as slideback sensing circuit to give d-c output that is proportional to positive peak of repetitive input signal. Will measure peaks of pulses as narrow as 1 nsec.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 371.



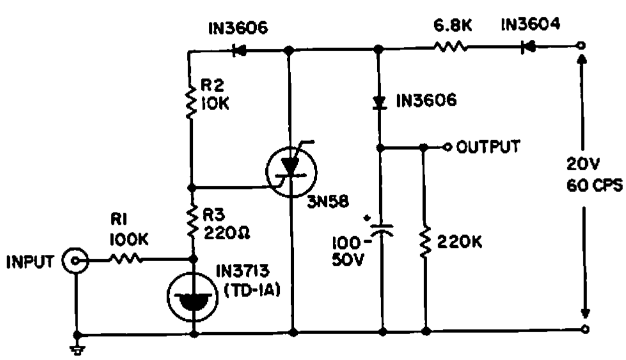
PHOTOCELL CHOPPER—Allows millivolt d-c voltages to be measured accurately with ordinary average-reading vtvm. Neon lamps are fired alternately by rectified 60-cps line voltage, causing Clairex photocells to alternate between low and high resistance states and thereby chop d-c input voltage being measured.—I. Queen, Chopper Adapts Voltmeter to D-C, *Electronics*, 38:22, p 66–67.



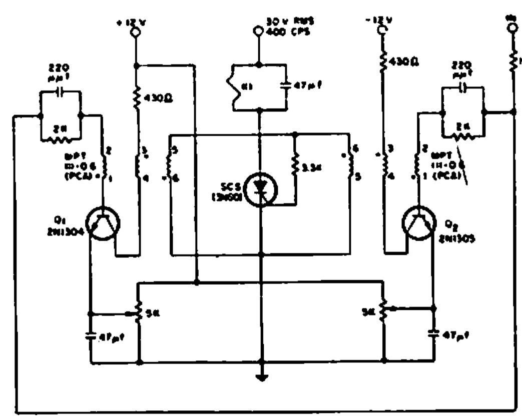
GO-NO-GO VTVM—For applications in which voltage with specified tolerance must be monitored by unskilled production-line personnel. Three lamps indicate voltage. Go band can be as narrow as 0.1 v. Basic range of 100 v can be extended with dividers.—A Go No-Go Vacuum Tube Voltmeter, "Electronic Circuit Design Handbook," Mactier Pub. Corp., N.Y., 1965, p 156.



VOLTAGE DIP COUNTER—Each time a-c line voltage drops below adjustable threshold level, thyratron fires and operates electromagnetic counter. Used to count dips that might affect computer operation.—T. D. Koranye, Thyratron Monitors Line-Voltage Dips, *Electronics*, 34:1, p 126.



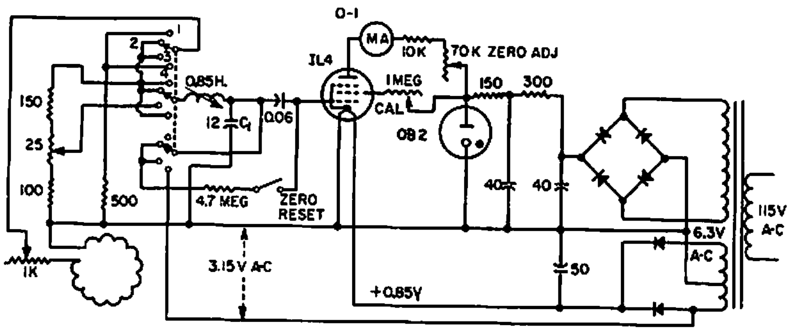
A-C OPERATED PEAK-READING VOLTMETER—Uses tunnel diode and silicon controlled switch to give d-c output proportional to positive peak of input signal.—"Transistor Manual," Seventh Edition, General Electric Co., 1964, p 371.

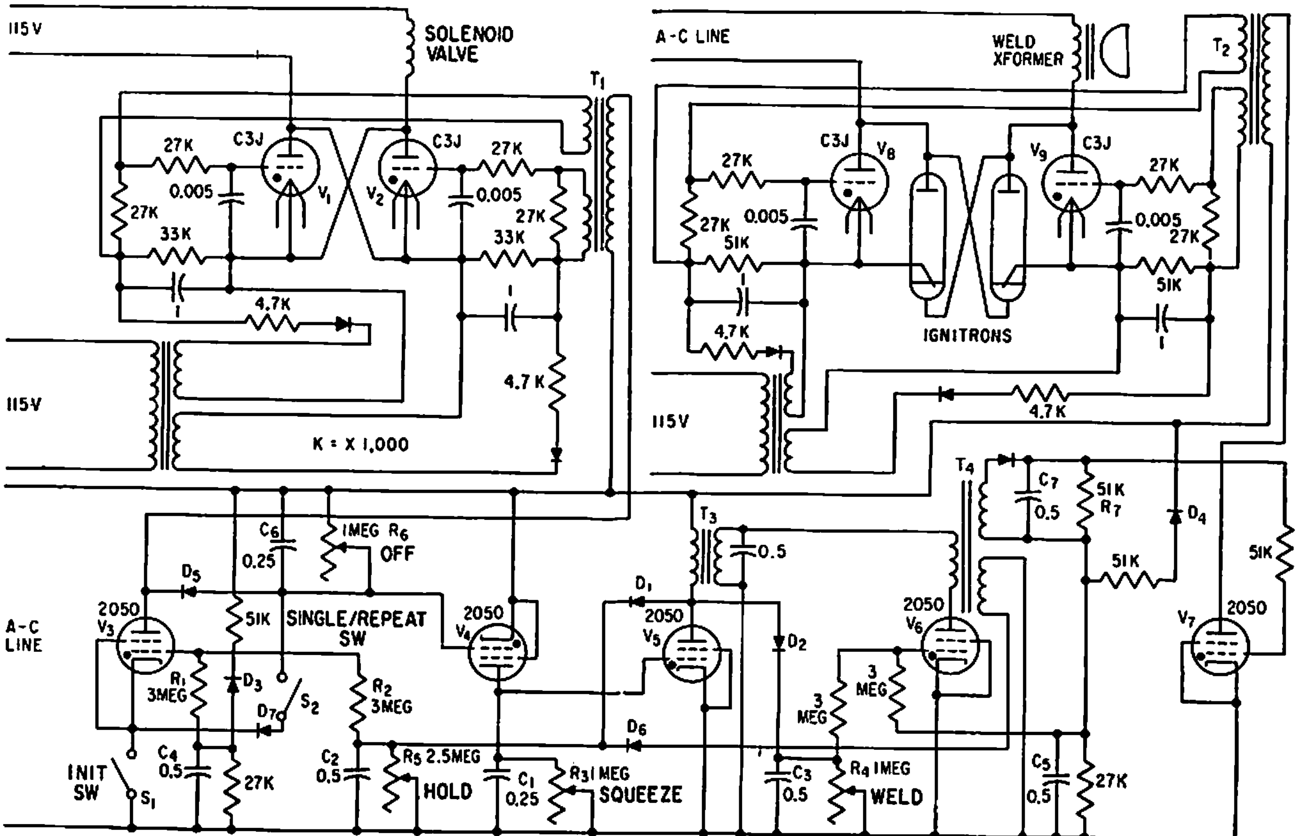


PRESET VOLTAGE-LIMIT MONITOR—Used in automatic testing equipment to determine if voltage is within required go-band. Uses complementary transistors in blocking oscillator circuits with high input impedance and with low hysteresis at switching limits.—L. Smith, High-Impedance Voltage Monitoring Circuit, *EEE*, 12:4, p 65.

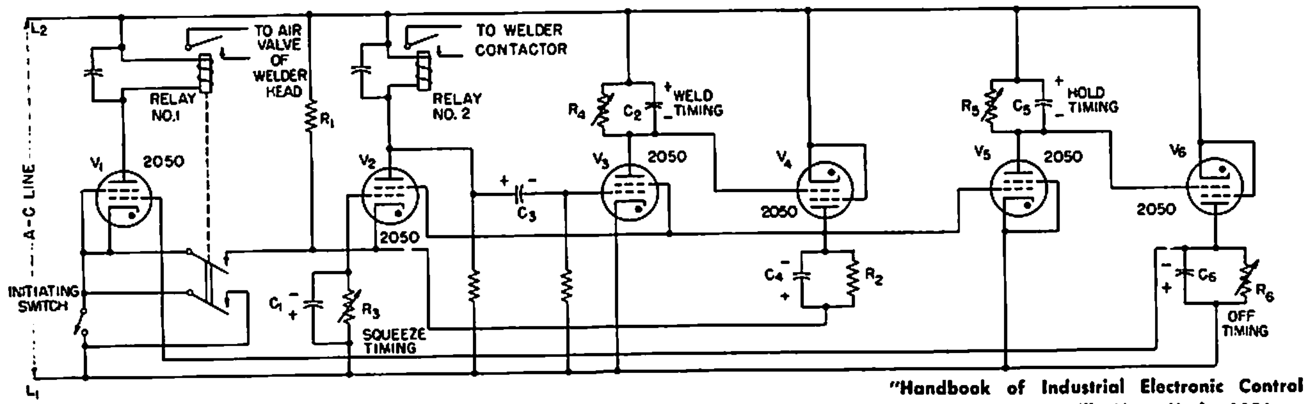
CHAPTER 100
Welding Circuits

MEASURING SPOT-WELDING CURRENT—Toroid placed around one of welder electrodes develops voltage that is function of rate of change of magnetic flux produced by alternating current flowing through weld. Peak-reading a-c electronic voltmeter is used to measure resulting voltage across toroid. Selector switch positions are: 1—no signal input; 2—0 to 15,000 amp; 3—0 to 30,000 amp; 4—calibration.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, 1959, p 326.

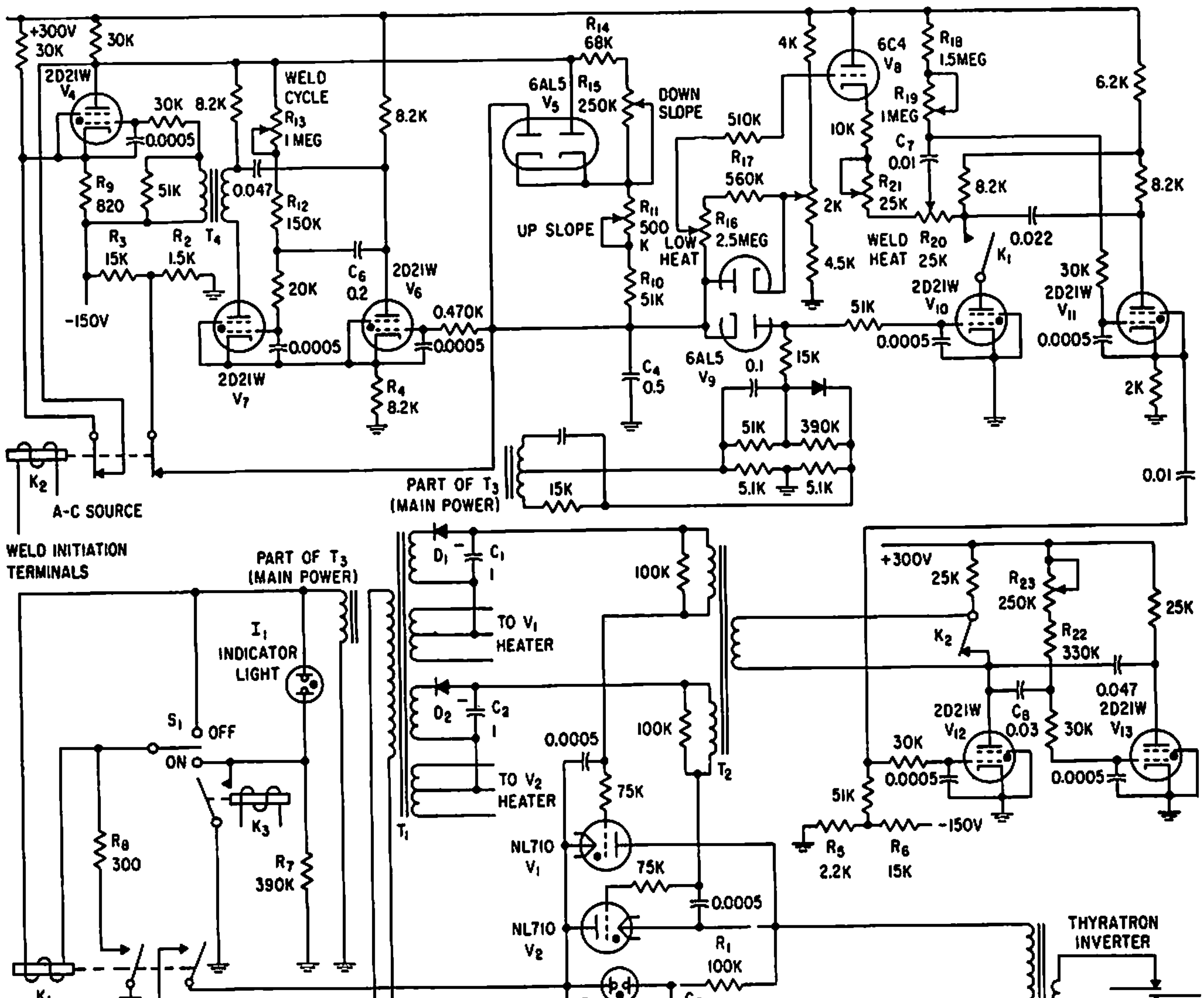




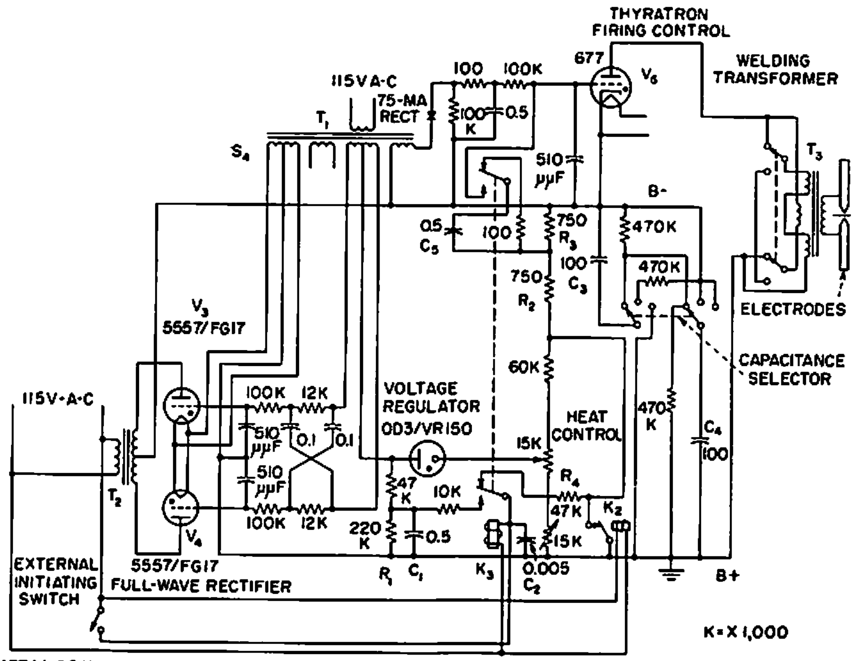
TIMER FOR RESISTANCE WELDING GUN—Provides exact timing control for squeeze, weld, and hold, as well as fast-repeat recycling, by control of thyratrons. Can be operated anywhere from single-shot to over 600 spots per minute. Timer is designed for fail-safe operation.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, New York, 1959, p 322.



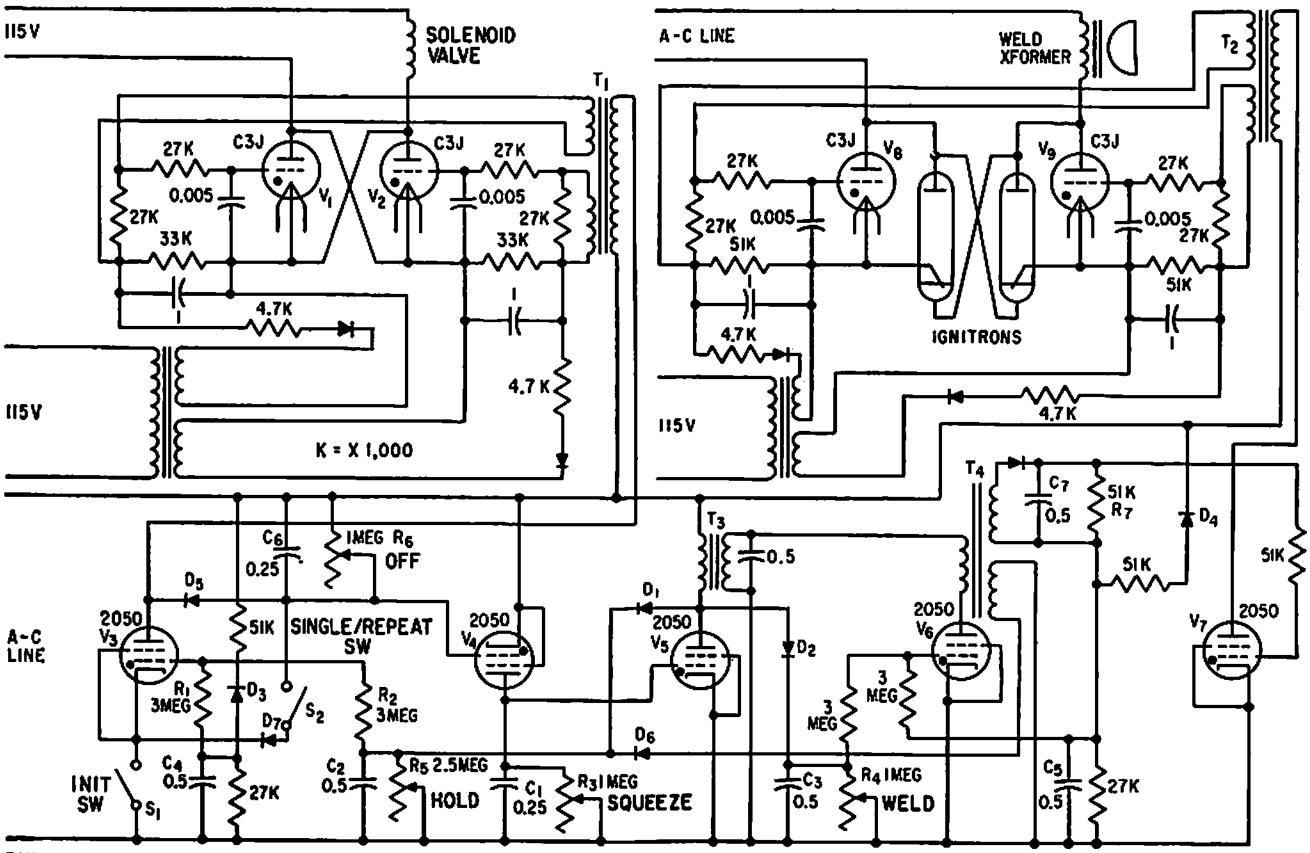
SPOT-WELDING TIMER—Five-thyratron sequence timer for resistance-type spot welder meets auto industry requirements for efficiency and reliability.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 343.



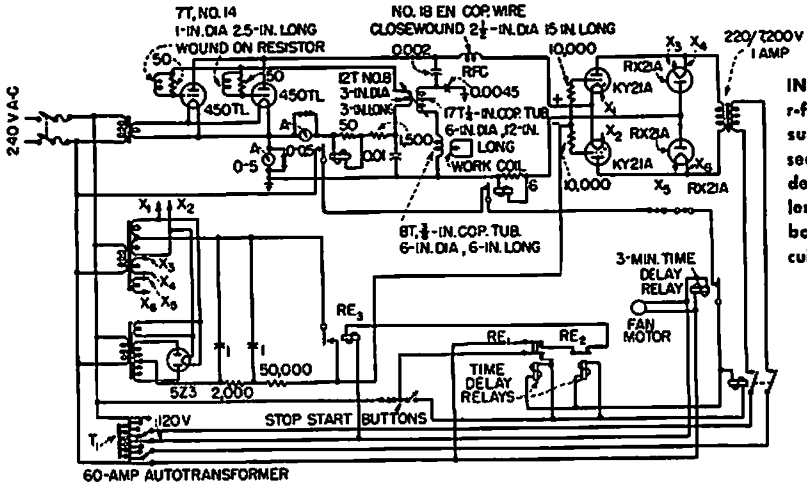
HEAT PROGRAM TIMER—Controls weld energy for production-line welding of electron tubes and other small components. Functions controlled are low heat, weld heat, up-slope time, weld time, and down-slope time. Adjustable potentiometers permit changing each of these times.—A. V. Ranis, Heat Program Timer Controls Weld Energy, *Electronics*, 31:23, p 76–78.



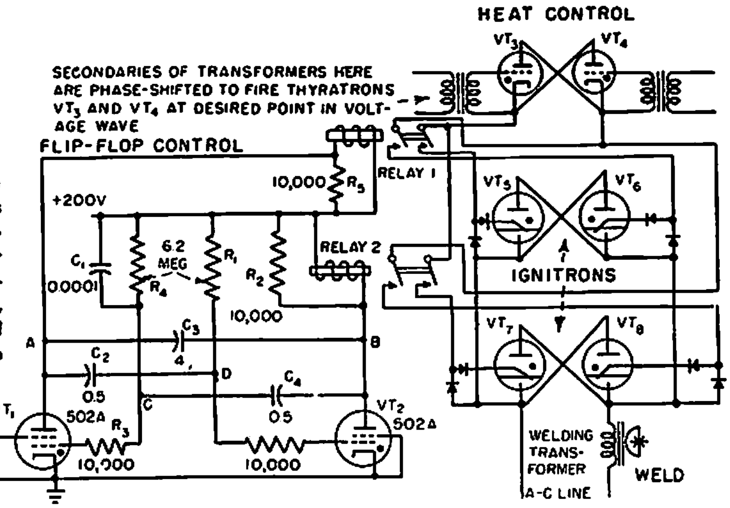
METAL-FOIL SPOTWELDING CONTROL—Permits precise control of high-energy capacitor discharge used in welding extremely thin and highly conductive foils or fine wires. Heat control provides range of 650 to 1,500 v for level at which energy is stored, and selector switch gives choice of 50, 100, and 200 mfd for storage capacitor.—J. Markus, "Handbook of Electronic Control Circuits," McGraw-Hill, New York, 1959, p 321.



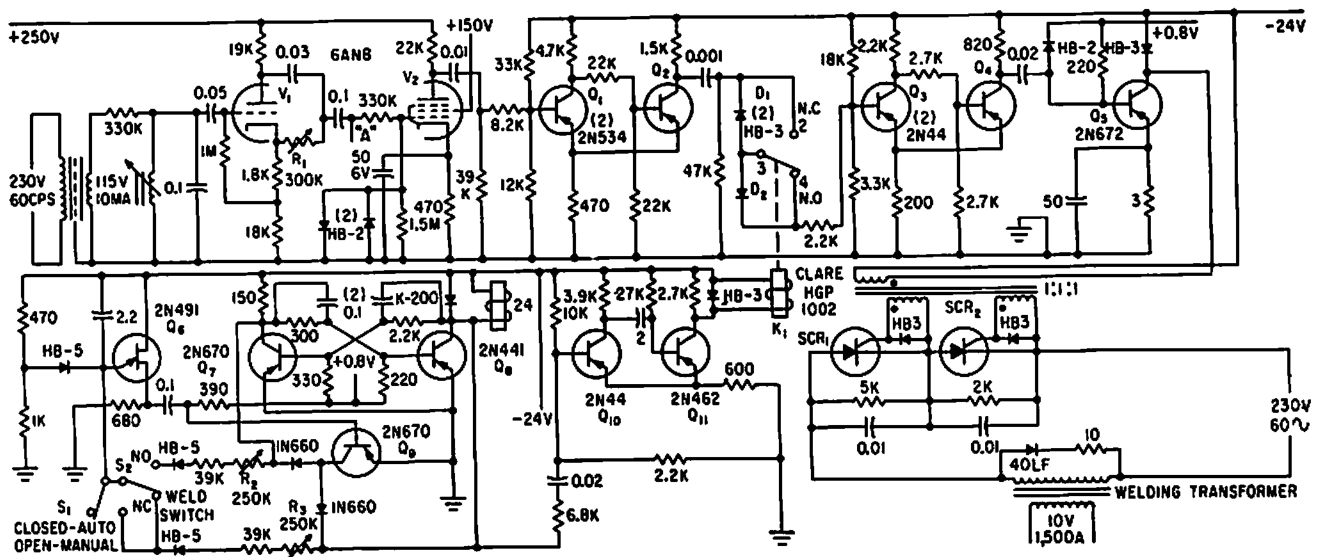
FOUR-FUNCTION WELDING TIMER—Thyratrons serve as relays for controlling squeeze time, weld time, hold time, and off time in high-speed resistance welding. Control provides fail-safe operation, reduces transients by accurately adjusting ignitron firing angle, and gives accurate repetition of timing cycle. —S. C. Rockafellow, Electronic Control Times High-Speed Welding Cycle, *Electronics*, 31:33, p 70–73.



INDUSTRIAL BRAZING CIRCUIT—Applies high r-f power peaks in short-duration pulses, such as 11 kw for 2 sec or 45 kw for 0.5 sec, repeated every 5 sec. Settings of time-delay relays RE1 and RE2 determine pulse lengths.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 340.

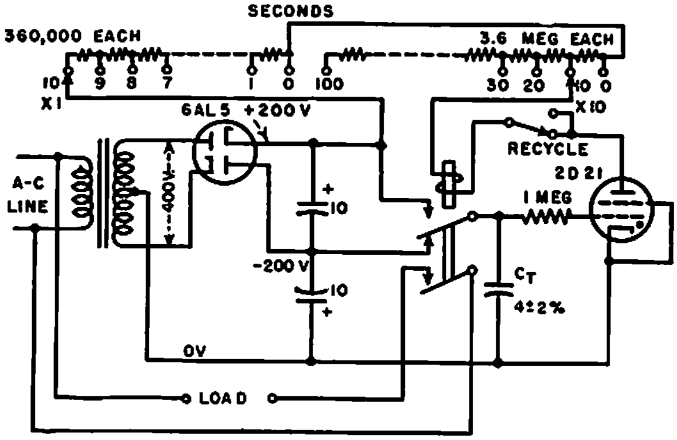


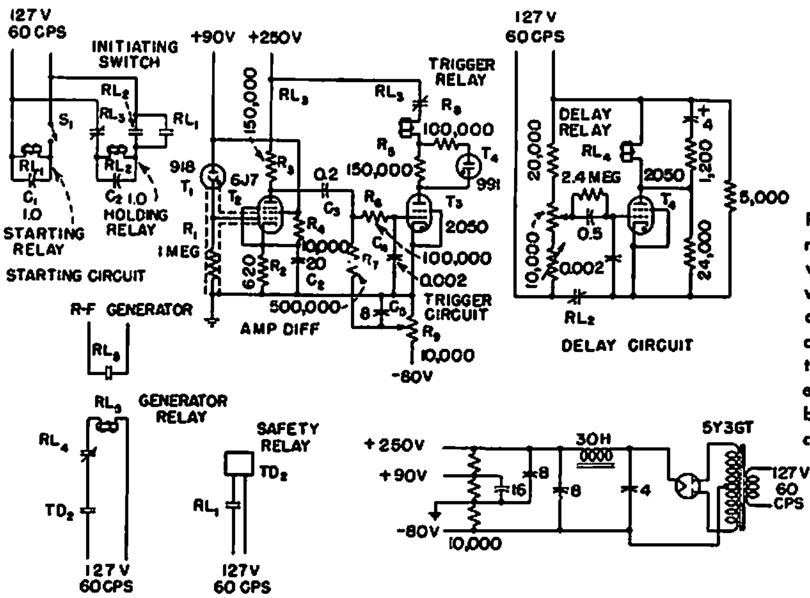
HEAVY-DUTY WELDER CONTROL—Flip-flop thyratron circuit makes pairs of ignitrons share load alternately, to prevent overloading of tubes when welder is used for heavier weld or for longer time than originally intended.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 342.



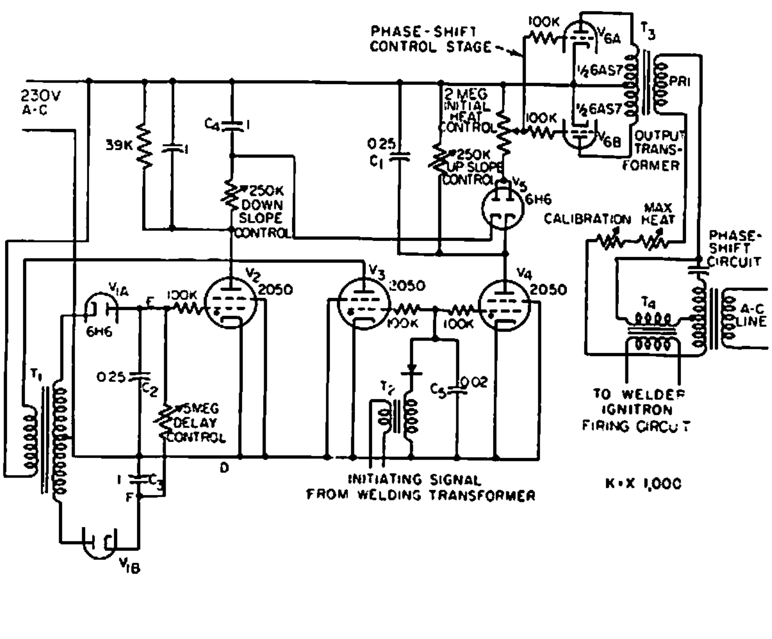
THIN-FOIL WELD CONTROL—Control circuit uses gated rectifiers to generate welding pulses for rates up to 15 welds per second in foils up to 10 mils thick.—D. D. Kline, Automatic Welder for Thin Foils, *Electronics*, 33:36, p 48–49.

PRECISION WELD INTERVAL TIMER—Stable timer provides intervals repetitive to accuracy of 0.75%, from 1 to 110 sec in 1-sec increments. Can be used for welder, enlarger, and other industrial controls.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 292.

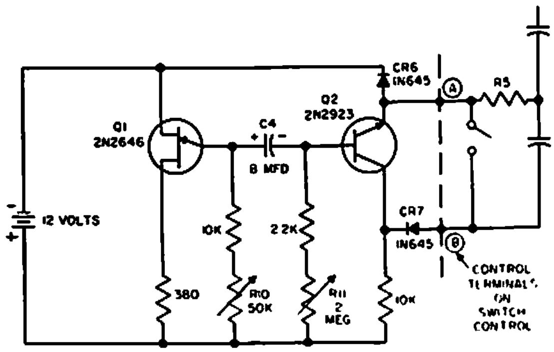




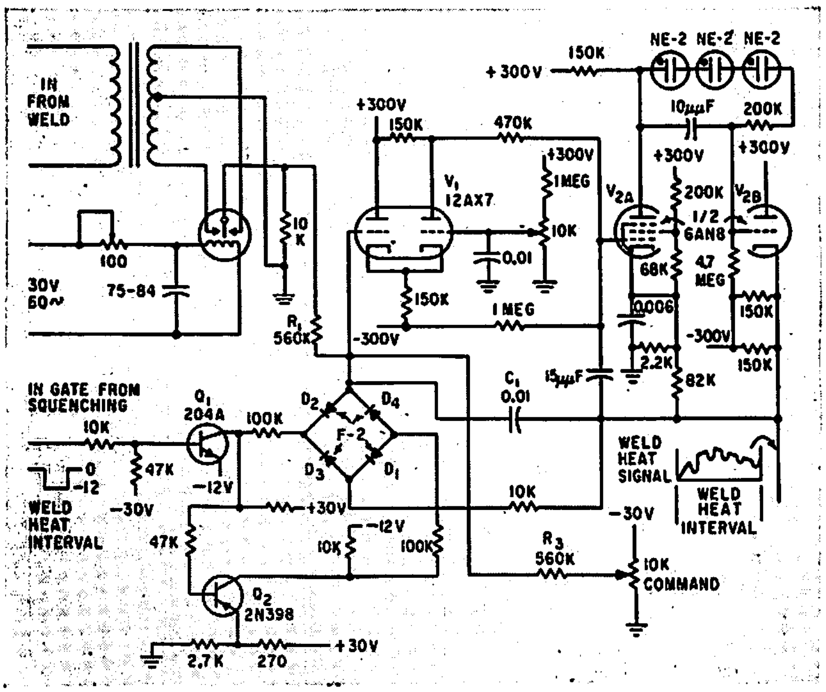
PHOTOELECTRIC WELD MONITOR—Shuts off r-f generator automatically after copper flows when welding exhaust tubulation to metal vacuum tube. Light is reflected by molten copper into phototube that initiates shutdown, with 0.6 sec delay introduced intentionally to allow copper to flow around entire seal.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 344.



CURRENT-SLOPE CONTROL FOR RESISTANCE WELDING—Varies buildup and decay rates of current, to increase weld quality and uniformity. Consists essentially of variable resistance inserted in phase-shift circuit of main welding control.—J. Markus and V. Zeluff, "Handbook of Industrial Electronic Control Circuits," McGraw-Hill, New York, 1956, p 340.



MODULATOR CONTROL FOR FULL-WAVE SCR SWITCH—Used with high-power a-c scr switching circuit to provide regulation by varying ratio of full *on* cycles to full *off* cycles of supply voltage. Also suitable for oven and furnace temperature control, motor control, and flashers. With R10 at 10K, variation of R11 from zero to maximum produced 40:1 load voltage swing.—F. W. Gutzwiller, RFI-Less Switching with SCRs, *EEE*, 12:3, p 51–53.



WELD TEMPERATURE CONTROL—Welding voltage passes through transformer for synchronous rectification to give signal for operational amplifier V1-V2. Output, which is integral of difference between command voltage and resistive input voltage, is used to provide correct fusion temperature under varied welding conditions.—G. R. Archer, Feedback and NOR Logic Yield Sound Spot Welds, *Electronics*, 33:8, p 48–51.

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