

MODULATOR-DRIVER

MODEL

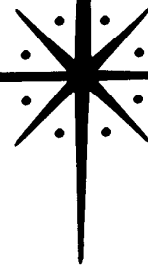
730



EICO

INSTRUCTION

MANUAL



ELECTRONIC INSTRUMENT CO. INC.
3300 NORTHERN BLVD., L. I. CITY 1, N. Y.





MODEL 730

MODULATOR - DRIVER

general description

The new EICO Model 730 is a superb, truly versatile modulator at low cost. It can deliver 50 watts of undistorted audio signal for phone operation — more than sufficient to modulate 100% the EICO Model 720 90-watt CW Transmitter or any transmitter whose RF amplifier has a plate input power of up to 100 watts. The multi-match output transformer matches most loads between 500 to 10,000 ohms and the unique over-modulation indicator permits easy, reliable monitoring, thus precluding any need for a plate meter. The Model 730 provides low level speech clipping and filtering with peak speech fre-

quency range circuitry. Low distortion is also achieved through the use of feedback and the employment of premium quality audio power pentodes. The vacuum tube rectifier is the extra-rugged, slow warm-up GZ34, which eliminates high starting voltages and lengthens electrolytic and tube life. Balance and bias adjustment controls are also provided and the finest quality, conservatively rated parts are used throughout. The Model 730 is also an excellent low impedance driver for a class B high-power modulator.

SPECIFICATIONS

Power Output: 50 watts.

Output Transformer Matching Impedances: 500 to 10,000 ohms.

Inputs: Low level, high impedance — crystal or dynamic mikes. High level, low impedance — phone patch, etc.

Tubes: 1-ECC83/12AX7 speech amplifier, 1-6AL5 speech clipper, 1-6AN8 amplifier driver, 2-EL34/6CA7 power output, 1-EM84 over-modulation indicator, 1-GZ34 rectifier.

Power Requirements: 117 volts, 60 cycles; 150 watts drain.

Size: HWD — 6" x 14" x 8".

Weight: 21 lbs.

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circuit description

MICROPHONE PRE-AMPLIFIER (V1): A 12AX7/ECC83 dual triode V1 is used as the microphone pre-amplifier. Contact bias is used in the first stage to obtain the greatest amplification. The gain control R4 is placed in the grid circuit of the second stage. To attenuate power-wasting low frequencies outside the speech range, the coupling capacitor C2 is low-valued (.001 mf). A phone patch input (J2) is also located at a low-impedance point in the second stage. In the latter service, the gain control R4 is set to minimum and the second stage behaves as a grounded grid amplifier. If the gain control is not set at minimum, mixing with the microphone is possible. Bias is obtained with an un-bypassed cathode resistor R6, which also provides negative feedback for reduced distortion in this stage. An RF filter (R1, C1) is employed at the input of the first stage to reduce any tendency towards RF feedback through the modulator.

CLIPPER-FILTER (V2): A 6AL5 dual-diode V2 is employed as a series type clipping circuit. The clipping level is controlled by varying the common diode plate voltage by a potentiometer R9 in a voltage divider circuit. The output of the clipper is fed through a low pass filter L1, C5, and C6 to suppress high order harmonics generated by peak clipping. The clipper, when adjusted by means of the over modulation indicator, prevents the voice peaks from over-modulating the transmitter. The result is a reduction of any spurious sidebands and a restriction of bandwidth of the modulated wave. In addition the effective speech level of the signal will be raised 8-12 db. This gives the audio "punch" that is desirable under QRM conditions.

VOLTAGE AMPLIFIER & PHASE INVERTER (V3): A 6AN8 pentode-triode V3 is used as a voltage amplifier (pentode) direct-coupled to a split-load phase inverter (triode). Negative feed-back from the secondary of the modulation transformer is introduced at the cathode of the voltage amplifier.

OUTPUT STAGE (V4 & V5): A pair of EL34 premium audio power amplifier tubes V4 & V5 are operated in push-pull, class AB1. Fixed bias is obtained from a separate adjustable bias supply and a balance potentiometer.

R19 is provided so that the tubes can be electrically balanced. The multi-tap modulation transformer, which allows flexibility in matching any desired load between 500 and 10,000 ohms, has a separate secondary winding providing the required feedback voltage for the outside loop returning to the cathode of the voltage amplifier. The use of feedback greatly reduces distortion and extends the range of uniform frequency response, resulting in increased clarity and pleasantness of speech. Another important value of feedback is the considerably improved regulation of the output, which is useful when the modulator is used to drive a class B load.

POWER SUPPLIES: The plate power supply is a full-wave capacitor-input type employing the rugged GZ34/5AR4 indirectly heated rectifier V7. The center-tap of the high voltage winding of T1 which operates this supply is grounded either through PLATE SUPPLY switch S2 or through a connection from pin 8 of OUTPUT octal socket J5. The latter permits the modulator to be tuned on and off by a set of contacts in the antenna change-over relay ("off" when transmitter is set to "standby", and "on" when transmitter is set to "transmit"). A separate bias supply, employing a selenium rectifier SR1 in a half-wave circuit, provides the necessary fixed bias for the output tubes. Potentiometer R29 controls the bias voltage.

OVER-MODULATION INDICATOR (V6): An EM84 electron-ray tube V6 provides visual indication of over-modulation when the Model 730 is employed as a plate modulator. Over-modulation is evidenced by clipping which occurs when the peak value of the audio output signal from the modulator exceeds the plate voltage of the RF amplifier. A negative voltage then appears at the grid of V6, causing the two green indicating bars of the tube to overlap. The peak value of the audio output signal of the modulator is controlled by the setting of the CLIPPING LEVEL control R19, which sets the plate voltage of the diode clipper V2 circuit and therefore the signal clipping level. R19 should be set so that the bars approach each other closely but do not overlap, which indication corresponds to 100% modulation.

functions of controls

GAIN Control: Controls gain of microphone preamplifier. Not operative as a gain control for phone patch service since it must be set to zero for this service unless mixing with the microphone is desired.

CLIPPING LEVEL Control: Sets voltage levels at which audio signal is clipped. Since the GAIN Control is between the CLIPPING LEVEL Control and the modulator microphone input, the CLIPPING LEVEL control also sets the maximum peak-to-peak amplitude of the modu-

lator output and can be set to prevent the possibility of over-modulation.

OVER-MODULATION Indicator: An electron-ray indicator at the output of the modulator. Overlapping of the green indicating bars occurs when the output audio signal exceeds the plate voltage of the RF amplifier stage being modulated (over-modulation). The CLIPPING LEVEL Control described above can be set to avoid this condition.

PLATE SUPPLY Switch: Turns plate power supply of modulator ON and OFF. At the OFF position, remote control of this supply is possible via a connection from pin 8 of OUTPUT Socket J5 to a set of contacts on the antenna change-over relay. At the ON position, remote control is disabled.

AC Switch: Connects or disconnects unit from a-c line.

OUTPUT Socket: Modulator output and remote control connection are taken from this socket. Desired output

Impedance selected by pin connections in plug.

MICROPHONE Connector: Input for high impedance crystal or dynamic microphone.

PHONE PATCH Input: Low-impedance input for phone connection.

TEST Jacks: Meter connections for output tube balance adjustment.

electrical installation

1. Securely connect a heavy wire from the ground binding post of the modulator to the ground binding post of the transmitter. (The transmitter ground binding post should be connected to a true earth ground.)

2. Wire the octal plug provided to select the desired modulator output impedance as required by the load. Pin 1 is common and the remaining pins from 2 to 7 provide a choice of impedances (see table below). Note that pin 1 is always connected to the plate and screen circuits of the modulated RF stage and the other selected pin from 2 to 7 is always connected to the plate supply (B+). If a remote control relay or an antenna change-over relay with a spare set of contacts is being used, wire pin 8 of the plug for connection to one contact of the relay and make a connection from the ground binding post to the other relay contact to provide remote switching of the modulator plate supply by the function switch of the transmitter.

J5 Pin#	Impedance	J5 Pin#	Impedance
1	Common	5	6500Ω
2	500Ω	6	7500Ω
3	3000Ω	7	10,000Ω
4	5000Ω	8	Plate supply remote switching

Fig. 1 is diagram of the required interconnections between the EICO Model 720 Transmitter, the Model 730 Modulator, and an antenna change-over relay with a spare set of contacts for remote switching. Note that pin 1 of the octal plug going to the 730 connects to pin 6 of the octal plug going to the 720, and that pin 4 of the 730 plug connects to pin 4 of the 720 plug.

The operation of the remote control relay in conjunction with the modulator remote switching leads from pin 8 of the octal plug and ground is as follows: Pin 8 of the output octal socket in the modulator is internally connected to the center-tap of the high voltage secondary winding of the power transformer. The plate power supply of the modulator does not operate unless this center-tap is grounded. When the relay is energized (at the transmit function of the transmitter), the relay contacts used for remote switching are closed and thereby the center-tap is grounded, causing the modulator plate supply to operate. When the relay is not energized (at the standby and tune functions of the transmitter), the center-tap is left floating and the modulator plate supply is inoperative. The remote switching operation just described requires that the PLATE SUPPLY Switch of the 730 be set to OFF. At the ON position, the center-tap is internally grounded in the modulator and remote switching is disabled.

3. Connect a high-impedance crystal or dynamic microphone to the MICROPHONE input connector.

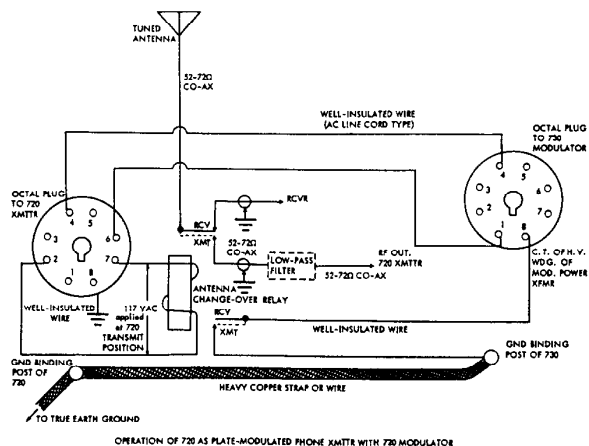


Fig. 1

operating instructions

1. The Model 730 should not be operated without a proper load under signal conditions, as the high voltages generated in the modulation transformer may damage it. If it is used with a remote switching relay that turns on the modulator plate supply only at the transmit function of the transmitter, you are protected against this cause of damage. If no relay is used, the 730 plate supply must be turned on and off manually by means of the PLATE SUPPLY switch. Set the transmitter FUNCTION switch to TRANSMIT before turning the modulator PLATE SUPPLY switch to ON, and turn the PLATE SUPPLY switch to OFF before turning the transmitter FUNCTION switch to STANDBY or OFF.

2. Adjustment of the GAIN and CLIPPING LEVEL controls is made under operating conditions (modulator connected to transmitter set at the transmit function) in the following manner. First, turn the GAIN and CLIPPING LEVEL controls to zero. Speaking into the microphone in a normal voice from a normal distance (about 6 inches),

turn up the GAIN control until the OVER-MODULATION indicator shows overlapping of the green bars occurring on peaks of normal speech. Now turn up the CLIPPING LEVEL control until the over-lapping on normal speech peaks disappears. Check the adjustment by speaking into the microphone quite loudly; loud speech should not be able to cause over-lapping on peaks if the adjustment is correct. Finally, turn up the GAIN control another fifteen divisions. This will give about 10 to 12 db of speech clipping as is normally desirable.

NOTE: If the 730 is being used to drive a higher-power modulator, the OVER-MODULATION INDICATOR evidently can no longer indicate over-modulation of the transmitter. The high-power modulator will usually have a plate meter which serves this purpose. The GAIN and CLIPPING LEVEL controls of the 730 are adjusted in the same way as described above, only the plate meter is observed for indication of over-modulation.

maintenance

The BIAS ADJ. and the BALANCE ADJ. for the output stage must be adjusted by kit builders before initial use of the amplifiers — factory wired units will have had these adjustments made. The BALANCE ADJ. will have to be readjusted by all users whenever one or both of the EL34 output tubes is replaced or if it is suspected that dc unbalance in the output tubes has occurred in the course of use.

a) PRELIMINARY STEPS TO BIAS & BALANCE ADJUSTMENTS: Set AC switch to OFF and disconnect modulator from the transmitter and any remote switching relay (remove plug from octal socket J5). Connect a resistive load of proper value (5K Ω for output taps appropriate to use with 720) to the output of the modulator. Set the GAIN and CLIPPING LEVEL controls to zero. Set PLATE SUPPLY switch to OFF. Set both the BIAS ADJ. control and the BALANCE ADJ. control at the approximate center of their ranges of rotation. Connect the a-c line cord to the a-c power line, and then set the AC switch to ON.

b) SETTING BIAS ADJ. control (BIAS VOLTAGE ADJUSTMENT): Use either a VOM of at least 20,000 Ω per volt sensitivity and $\pm 3\%$ accuracy on dc voltage measurement or a VTVM. Set the instrument at the minus or negative DC volts functions and a range of not less than 50 volts or more than 150 volts (the closer the point on the scale at which the reading is to full scale, the more accurate it is). Rest the modulator on either short side and remove the bottom plate. Locate the arm (center contact lug) of the BIAS ADJ. control and connect the "hot" meter lead to it. Touch the common or ground meter lead to any unpainted point on the chassis (ground) and read the negative dc voltage on the meter. Adjust the BIAS

ADJ. control for a reading of -43 dc volts (negative). Now set the PLATE SUPPLY switch to ON and allow one minute for warm-up, after which the bias reading should drop to about -42 volts. Disconnect the meter leads when this is completed.

c) SETTING BALANCE ADJ. CONTROL: Set the VOM or VTVM at either the plus or minus DC voltage function and select the lowest DC voltage range. Connect the meter leads to the two TEST jacks on the rear chassis apron. If the meter pointer deflects to the left of zero, reverse the leads. Adjust the BALANCE ADJ. control for a zero or minimum reading. This completes the balance adjustment, whereupon the meter leads can be removed from the TEST jacks.

d) Set the VOM or VTVM at the plus DC voltage function and select the lowest DC voltage range (not higher than 3 volts full scale). Insert the "hot" meter lead into either one of the TEST pin jacks and touch the common or ground meter lead to any unpainted point on the chassis (ground). Readjust the BIAS ADJ. control for a meter reading of 0.7 volt.

e) Repeat step c.

f) Repeat step d.

TROUBLE SHOOTING and OPERATING NOTES

Your amplifier should require little service except for normal tube replacement. We recommend no substitutions for the tube types used in this modulator except as stated. The EL34 and 6Z34 types are distributed nationally by

the Amperex Electronic Corporation (230 Duffy Ave., Hicksville, L. I., N. Y.) and Mullard Ltd. (International Electronics Corp., 81 Spring St., N. Y. 12, N. Y.) If necessary, replacements can be obtained directly from EICO.

The Model 730 is intended for operation at a line voltage of 117VAC. To afford conservative operation of the unit in areas of high line voltage, both 117V and 125V taps have been provided on the primary of the power transformer. The normal connection in both kit and wired units is the 117V tap. The amplifier components will be operating within their ratings with the 117V tap so long as the line voltage does not exceed 124V. If the line voltage in your location exceeds 124V, it will be necessary to rewire the power transformer primary connections for 125V operation. To do this, it will be necessary to remove the bottom plate and connect the black-green lead (125V power transformer primary tap) to the AC switch terminal S1-1 instead of the black-red lead (117V primary tap). If you have built the kit according to instructions or purchased a wired unit, you will find the black-green lead strapped back on the black-red lead. Of course you must remove the line cord plug from the outlet before rewiring. The rewiring procedure is as follows:

1. Unsolder the black-red lead from AC switch terminal S1-1.
2. Remove electrical tape holding black-green lead to black-red lead.
3. Strip 1/2" insulation from end of black-green lead.
4. Cut off the stripped end of the black-red lead. Bend the end of this lead back on itself (about an inch) and tape it very carefully to the black-green lead so that the end of the black-red lead is entirely insulated and can not short out against the chassis. This is very important.
5. Connect and solder the black-green lead to AC switch terminal S1-1.

NOTE: Disconnect the amplifier from the power line and discharge capacitors prior to making any resistance check

and prior to removing either or both of the EL34 output tubes V3 and V4 or disabling the bias supply. Do not turn the amplifier on with either of the output tubes removed or the bias supply disabled.

To facilitate servicing, remedial and trouble-shooting procedures have been provided in the TROUBLE SHOOTING CHART that follows. A VOLTAGE AND RESISTANCE CHART is also provided as an aid in locating defective components.

WARNING: If the modulator is operated at any time without the bottom plate, the operator is exposed to lethal high voltage points. Not only are the high voltages developed in the modulator present, but the even higher voltages developed in the transmitter are brought into the modulator via the interconnecting leads going to OUTPUT socket J5. In any case, never leave the modulator in an operative state with the bottom plate removed, especially if children have access to it.

SERVICE

If trouble develops in your instrument which you can not remedy yourself, write to our service department listing all possible indications that might be helpful. If desired, you may return the instrument to our factory where it will be placed in operating condition for \$7.50 plus the cost of parts replaced due to their being damaged in the course of construction. NOTE: Before returning this unit, be sure all parts are securely mounted. Attach a tag to the instrument, giving your home address and the trouble with the unit. Pack very carefully in a rugged container, using sufficient packing material (cotton, shredded newspaper, or excelsior), to make the unit completely immovable within the container. The original shipping carton is satisfactory, providing the original inserts are used or sufficient packing material is inserted to keep the instrument immovable. Ship by prepaid Railway Express, if possible, to Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damages in transit if packing IN HIS OPINION, is insufficient.

VOLTAGE AND RESISTANCE CHART

	PIN NO.								
TUBE	1	2	3	4	5	6	7	8	9
GZ34 V7	0	475* DC	0	380 AC	0	380 AC	0	475* DC	
12AX7 V1	68	0	0	3.1 AC	3.1 AC	145	0	0.95	3.1 AC
6AL5 V2	35	35	3.1 AC	3.1 AC	35	0	35		
6AN8 V3	260	75	85	3.1 AC	3.1 AC	75	35	0	0.85
EL34 V4	0.7	3.1 AC	460	445	-36	-36	3.1 AC	0.7	
EL34 V5	0.7	3.1 AC	460	445	-36	-36	3.1 AC	0.7	
EM84 V6	—	0	19	3.1 AC	3.1 AC	350	190	0	190

*5.0VAC between 2 & 8; remove tube to measure

All voltages measured to ground with a high input impedance
VTVM. GAIN and CLIPPING LEVEL controls set to zero,
PLATE SUPPLY and AC switches set at ON. No input signal.
Appropriate load resistor connected to output.

	PIN NO.								
TUBE	1	2	3	4	5	6	7	8	9
GZ34 V7	INF.	Above 100K	INF.	INF.	INF.	INF.	INF.	Above 200K	
12AX7 V1	550K	1M	0	25	25	160K	0	680	25
6AL5 V2	220K	400K	25	25	220K	INF.	400K		
6AN8 V3	60K	320K	47K	25	25	320K	1.05 Meg	100K	680
EL34 V4	10	25	100	1350	221K	220K	25	10	
EL34 V5	10	25	100	1350	221K	220K	25	10	
EM84 V6	INF.	DO NOT MEASURE	10K	47	47	10K	480K	INF.	480K
J5	INF.	INF.	INF.	INF.	INF.	INF.	INF.	INF.	

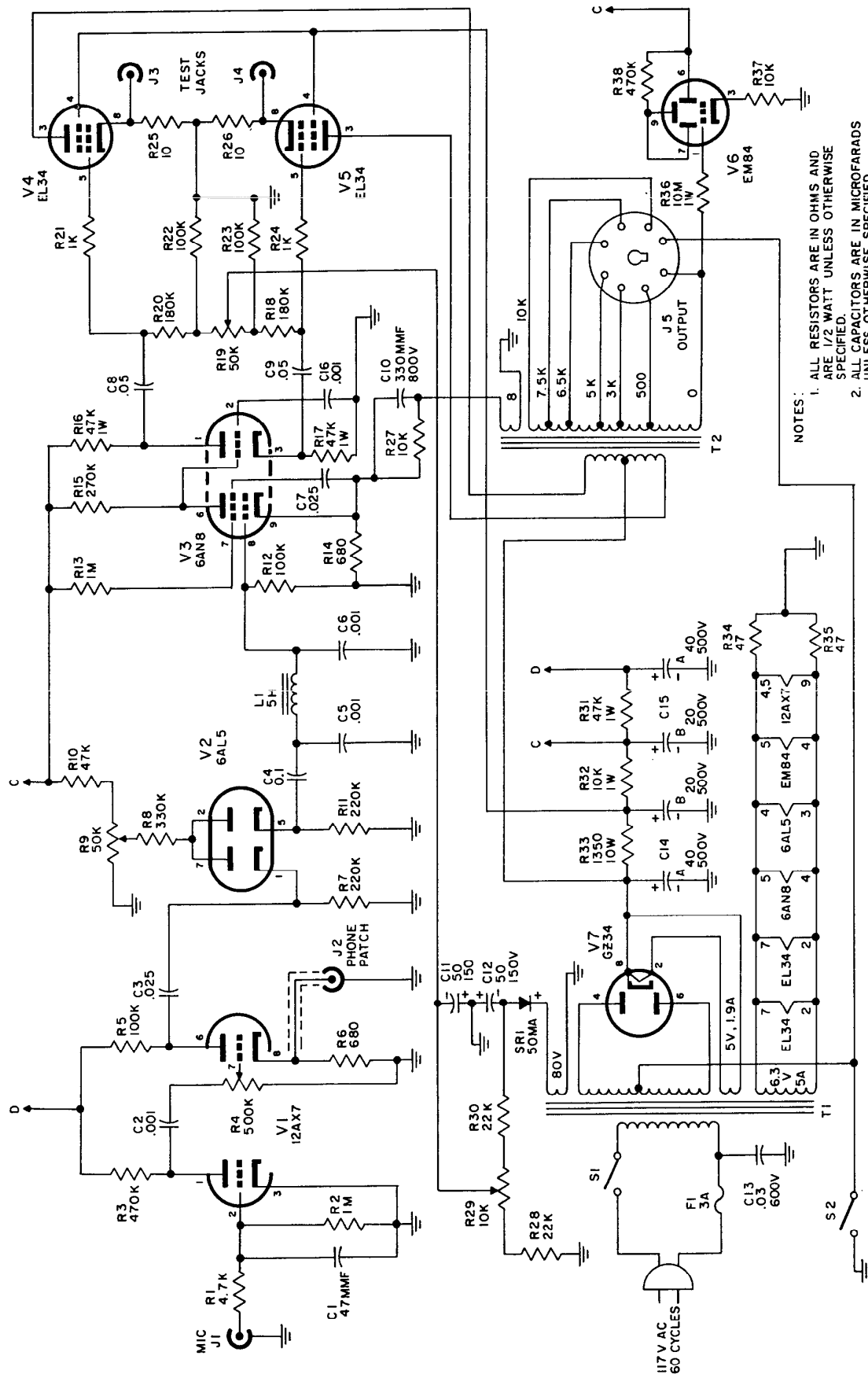
All resistance values measured to chassis with pin 8 of the GZ34 tube grounded
except, of course, when the resistance to ground of pins 2 and 8 of the GZ34
is being checked. GAIN and CLIPPING LEVEL controls set to zero, PLATE
SUPPLY and AC switches set at OFF. Plug removed from OUTPUT socket J5.
Line cord disconnected from a-c power line.

REPLACEMENT PARTS LIST

Stock #	Symbol	Description	Am't.	Stock #	Symbol	Description	Am't.
22533	C1	cap., disc., 47mmf ±10%	1	90057	V3	tube, 6AN8	1
22521	C2, 5, 6, 16	cap., disc., .001mfd (1000 or 1K) ±10%	4	90040	V4, 5	tube, EL34	2
22517	C3, 7	cap., disc., .025" (25,000 or 25K) GMV	2	90058	V6	tube, EM84	1
20039	C4	cap., paper, .1mfd, 400V ±10%	1	90044	V7	tube, GZ34	1
20042	C8, 9	cap., paper, .05mfd, 400V ±10%	2	97800	XF1	fuseholder	1
22512	C10	cap., disc., 330mmf, 800V ±10%	1	97027	XV1, 3	socket, 9 pin min., top mount	2
23015	C11, 12	cap., elec., .50mfd, 150V	2	97033	XV2	socket, 7 pin min., top mount	1
20043	C13	cap., paper, .03mfd, 600V	1	97032	XV4, 5, 7	socket, octal	3
24008	C14, 15	cap., elec., 20-40mfd - 500V	2	97025	XV6	socket, 9 pin min., bottom mount	1
91005	F1	fuse, 3A	1	97300		shield, 9 pin tube	2
51000	J1	jack, omphenol	1	97301		shield, 7 pin tube	1
50014	J2	jack, phono	1	40000		nut, hex #6-32	16
50007	J3, 4	jack, pin	2	40001		nut, hex 3/8 - 32	3
97032	J5	jack, octal	1	40002		nut, hex 15/32-32	2
34003	L1	choke, 5H	1	40003		nut, ring 15/32-32	2
10430	R1	resistor, 4.7K, 1/2W, ±10%	1	40007		nut, hex #4-40	10
10407	R2, 13	resistor, 1 Meg, 1/2W, ±10%	2	40008		nut, hex #8-32	13
10431	R3, 38	resistor, 470K, 1/2W, ±10%	2	40016		nut, hex 1/2-24 (for fuseholder)	1
18043	R4	pot., 500KΩ, linear	1	40017		nut, tin., #8-32	10
10410	R5, 12, 22, 23	resistor, 100KΩ, 1/2W, ±10%	4	41000		screw, #6-32	15
10406	R6, 14	resistor, 680Ω, 1/2W, ±10%	2	41003		screw, #8-32 x 3/8	14
10417	R7, 11	resistor, 220K, 1/2W, ±10%	2	41016		screw, #4-40	10
10412	R8	resistor, 330K, 1/2W, ±10%	1	41072		screw, #8-32 x 3/4	4
16004	R9	pot., 50KΩ, linear	1	42000		washer, 3/8 lock	3
10428	R10	resistor, 47KΩ, 1/2W, ±10%	1	42001		washer, 3/8 flat	2
10419	R15	resistor, 270KΩ	1	42002		washer, #6 lock	16
10849	R16, 17,	resistor, 47KΩ, 1W, ±10%	3	42007		washer, #4 lock	10
11537	R18, 20	resistor, 180KΩ, 1/2W, ±5%	2	42008		washer, #8 lock	13
18029	R19	pot., 50KΩ, linear	1	42029		washer, 1/2" rubber (for fuseholder)	1
10432	R21, 24	resistor, 1KΩ, 1/2W, 10%	2	42030		washer, 3/8 flat fibre	1
11703	R25, 26	resistor, 10Ω, 1W, 1%	2	43000		lug, #6	1
11500	R27	resistor, 10KΩ, 1/2W, 5%	1	43001		lug, 3/8	1
10424	R28, 30	resistor, 22KΩ, 1/2W, 10%	2	43004		lug, #8	2
18015	R29	pot., 10KΩ, linear	1	46000		grommet, 3/8	1
10853	R32	resistor, 10KΩ, 1W, ±10%	1	46001		grommet, 1/4	1
14800	R33	resistor, 1350Ω, 10W, ±10%	1	46004		grommet, 5/8	2
10526	R34, 35	resistor, 47Ω, 1/2W, ±5%	2	46008		foot, rubber	4
10835	R36	resistor, 10 Meg.Ω, 1W, ±10%	1	51007		octal plug and hood	1
10400	R37	resistor, 10KΩ, 1/2W, ±10%	1	52001		binding post	1
61000	S1, S2	switch, toggle SPST	2	53029		knob, 3/4" diam.	2
93003	SR1	rectifier, 50 ma	1	57000		line cord	1
30029	T1	transformer, power	1	58004		wire, hook up, 1/64" wall	length
32012	T2	transformer, modulation	1	58019		wire, hook up, 1/32" wall	length
54013	TB1	1 post, left, w/gnd.		58300		spaghetti	length
54003	TB2	2 post		58408		cable, single conductor	length
54004	TB3	2 post, w/gnd.		58501		wire, bare #22	length
54002	TB4	1 post, right, w/gnd.		66074		manual of instructions (wired)	1
54017	TB5	1 post, up, right		66324		manual of instructions (kit)	1
90034	V1	tube, 12AX7	1	81195		chassis	1
90017	V2	tube, 6AL5	1	81196		bottom plate	1
				81197		bracket	1

TROUBLE-SHOOTING CHART

SYMPTOM	CAUSE	SYMPTOMS	CAUSE
House power line fuse blows. Fuse F1 remains intact.	Short in line cord.	a) No voltage	Defective V7, C14 shorted, S2 open, Defective wiring from c.t. of h.v. sec. of T1 to either S2 or J5 pin 8 or defective T1.
Fuse F1 blows.	If the modulator causes a replacement fuse to blow with rectifier tube V7 removed, then primary, high voltage secondary, filament, or bias windings of T1 are shorted, C13 may be shorted, or there may be a short in the bias supply circuit. If the modulator does not cause F1 to blow when V7 is out of the socket, but does cause F1 to blow when V7 is placed back in the socket, then check for a short in the B+ circuit, shorted or excessively leaky C14 or C15, or defective V7, V4, or V5.	b) Low voltage	Low line voltage, Defective T1, Connection to C14 from pin 8 of V7 is broken, Open or excessively leaky C14, Shorted or excessively leaky C15, V4 and V5 under-biased and drawing excessive current.
Rectifier V7 filament not lit.	5V winding of T1 open or incorrect/defective wiring to V7 socket.	c) High voltage	High line voltage, V4 and V5 over-biased and not drawing normal current, Defective V4, V5, R33, R32 open, R25, R26 open, T2 defective.
Any or all other tube filaments not lit.	6.3V winding of T1 open or incorrect/defective wiring of tube sockets.	OVER-MODULATION INDICATOR V6 not closing properly (fuzzy)	Reversed output connections to J5, Open R36, Defective V6.
DC voltage at V7 cathode (pin 8) is in- correct as specified below.			



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