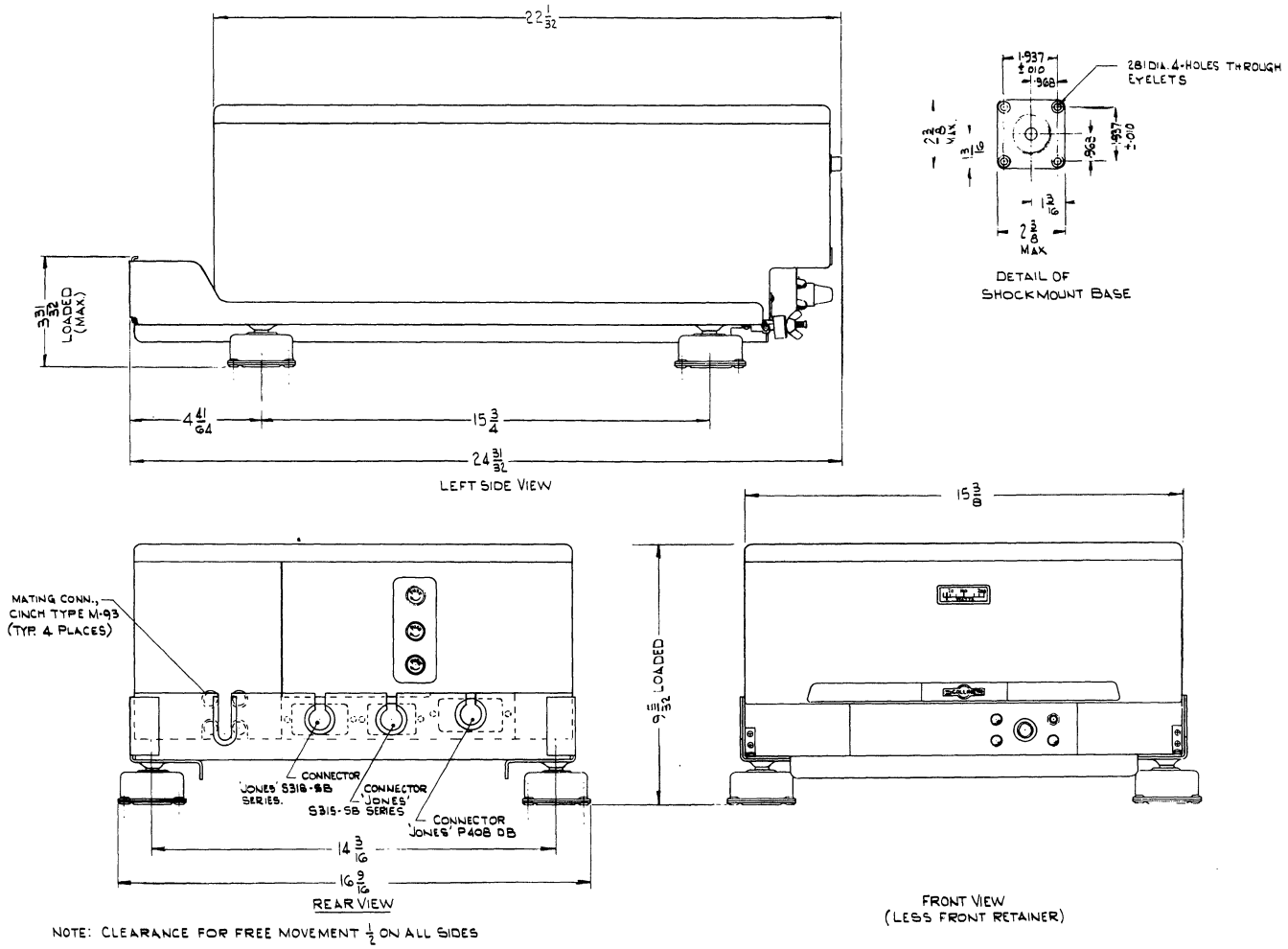


Figure 2-1 Transceiver 32MS-1A, Outline and Mounting Dimensions

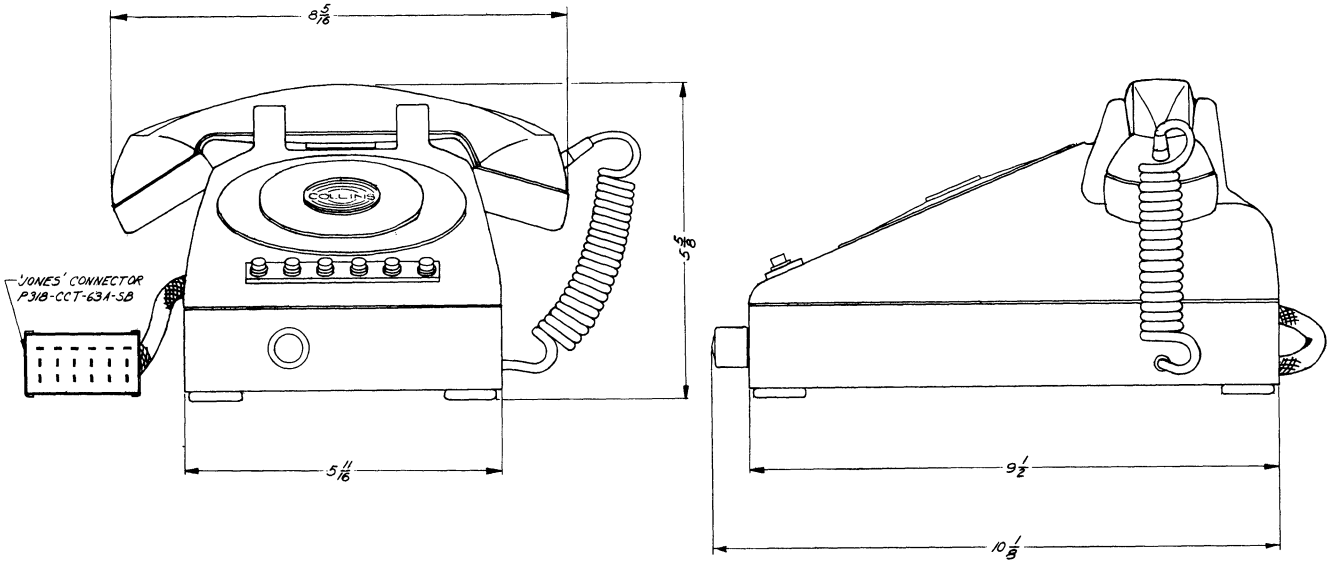


Figure 2-2 Control Unit 48A1-SW, Outline and Mounting Dimensions

SECTION II

INSTALLATION

2.1 UNPACKING AND INSPECTING EQUIPMENT

Remove all packing material, and carefully lift the units from their crates. Be careful when uncrating; use a nail puller to open the crates. Check the equipment against the packing slips and list of equipment supplied (Tables 1-1 and 1-2 of this handbook). Inspect each unit for physical damage. If damage exists, save packaging material and packing containers to substantiate claim with transportation agency.

2.2 INSTALLATION

2.2.1 Mounting

Transceiver 32MS-1A for fixed station utilization may be set on desk or bench as desired. A suitable shockmount is available for mobile station operation. Figure 2-1 shows typical outline and mounting dimensions for the transceiver. When using the shockmount, the four legs are removed.

Figures 2-2 and 2-3 show outline and mounting dimensions for the 48A1-SW and 48B2-SW Control Units respectively.

2.2.2 Wiring Connections

Figures 7-1 through 7-9 contain inter-unit and external wiring connections. Interconnecting cables as required for different configurations of equipment should be made up routed and connected as shown in Figures 7-1 through 7-9. When shipped, the a-c power supply unit is wired for 115 volts operation.

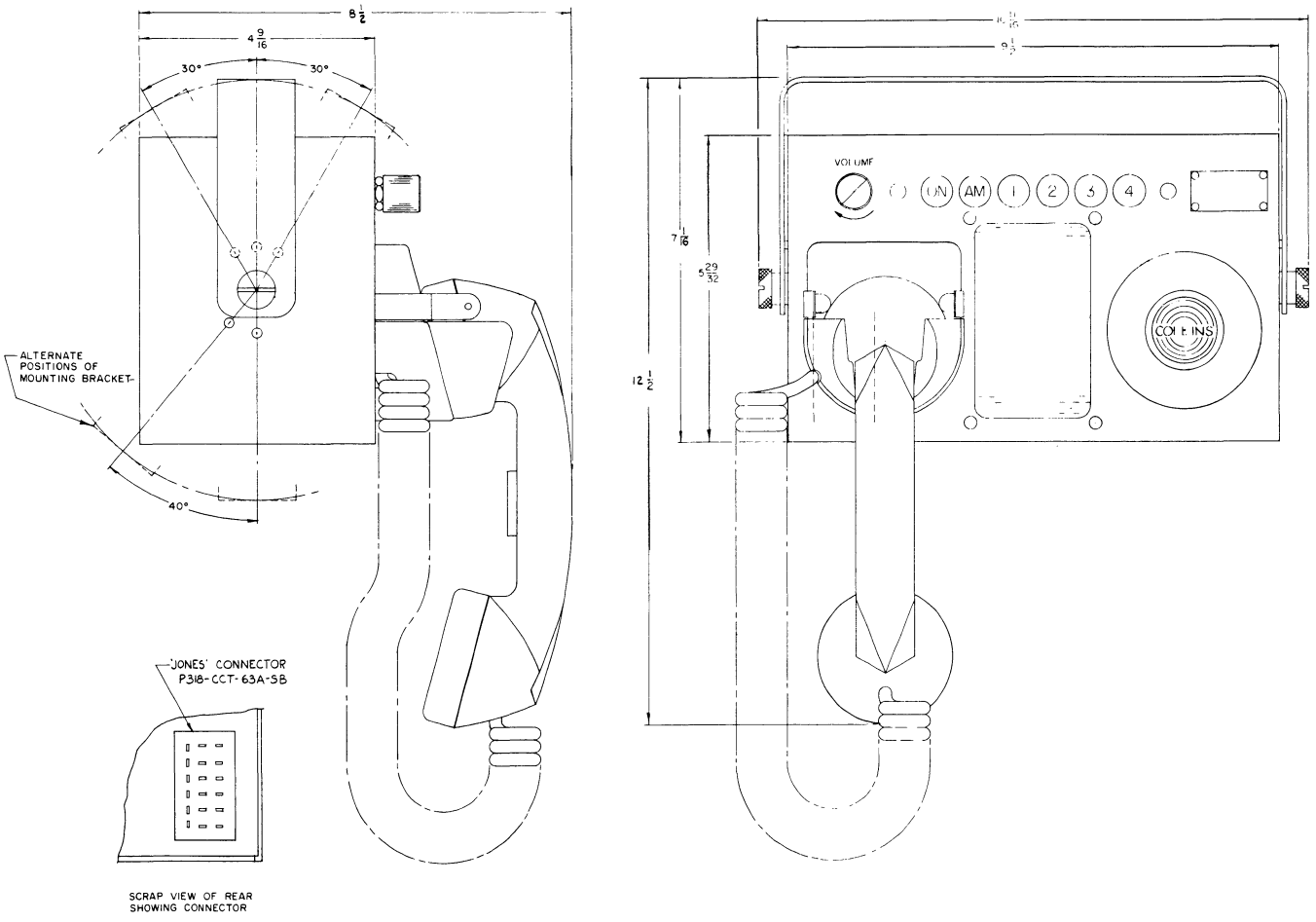


Figure 2-3 Control Unit 48B2-SW, Outline and Mounting Dimensions

For operation on a 230 volt primary, rewire jumpers in the power supply unit as illustrated in Figure 7-4.

2.2.3 Antenna Connections

An individual jack (J_1, J_2, J_3, J_4) is provided for each transceiver channel, at the rear of the 32MS-1A. Installations which provide a single feed system for all channels are accommodated by jumpering at the internal switch wafer S9.

The antenna connections at the rear are push-on phono plug switchcraft type 3501M.

2.2.4 Initial Alignment

The 32MS-1A is normally factory tuned and adjusted for operation with 50 ohm unbalanced antennas on the designated operating channels. When connected into such antenna systems the only adjustments required are:

(a) Touch-up tuning and loading of the PA tanks.

(b) Adjustment of microphone current.

In instances where a new channel is to be used, refer to paragraph 5.4 for complete tuning procedures.

NOTE

The PA tuning and loading adjustments are made with a non-reactive 52 ohm load. Each channel should be readjusted for the antenna used. The range of adjustment available will handle a VSWR of 2.5 to 1 or less.

2.3 INSTALLATION, FIELD

2.3.1 General

For installation, refer to Figures 2-1, 2-2, 2-3.

2.3.2 Fixed Station Installation

Mount the transceiver as described in para 2.2.1.

2.3.3 Wiring Connections

Connect associated equipment to 32MS-1A using Figures 7-1 through 7-9.

CAUTION

If 12V or 28V DC supplies are used make sure that proper source polarity is applied to DC supply.

2.3.4 Mobile Installation

(a) Select location of 32MS-1A in available space. Allow clearance on all sides to assure adequate ventilation. Drill holes and attach the shockmount tray with self-tapping screws. In case the surface is uneven, an adaptor bracket should be prepared to fasten the 390L-1A shockmount down in the required position.

(b) Determine necessary length of power cable from car battery to 32MS-1A and cut to required length.

(c) Select location (under the dashboard of car) for mounting the 48B2-SW control.

(d) Determine necessary length of control cable between 48B2-SW unit and 32MS-1A.

CAUTION

Be sure to observe correct polarity of power source before connecting the power cable. DO NOT connect the power cable to a battery which has a positive ground. To do so will destroy all six transistors in the power supply.

(e) Select location on the rear fender for the centre loaded mobile whip antenna. Drill hole and fasten the antenna mount, determine and cut a proper length of coax cable RG-58/U between antenna and 32MS-1A.

(f) For suppression of noise encountered in mobile operation, the following suggestions may be helpful. Use resistor type spark plugs, and install coaxial-bypass capacitors at ignition coil, generator and voltage regulator leads. Use bracket-mounted coaxial capacitors in the battery and generator leads to the voltage regulator and a 0.005 microfarad (or smaller) disk ceramic or mica capacitor from the field lead to ground. If capacitor bypasses are not satisfactory here, remove them, and use chokes in series with the leads from field and armature terminals of generator. Place these chokes as close to the voltage regulator as possible. For the field lead choke, wind 12 turns of No. 18, wire on a 1/4 inch powdered iron core. For the armature lead, wind 12 turns of No. 14 or larger wire on a 1/4 inch powdered iron core.

If a bypass capacitor is used from the field lead to ground, do not use a larger value than 0.005 mf unless a 4 ohm resistor is placed in series with it. Ground the rear end of the exhaust pipe to the car body, using copper braid. General information concerning the problem of ignition noise and suggested methods of noise suppression are available in current handbooks.

2.4 INITIAL ADJUSTMENT

Remove the top cover of Transceiver 32MS-1A and check that the power supply is compatible with the power source available. Connect the power cable to the power source.

There is one pre-operating adjustment required. Refer to the schematic diagram Figure 7-2 or 7-3. This adjustment consists of setting the microphone current in the control units to 50 ma by means of potentiometer R16. In normal operation, the +24 volt d-c source that supplies the microphone is provided by the transceiver power supply. (This is a separate 24 volt power supply from that used for the speaker amplifier transistors and the indicator lights for the push-buttons). To adjust the microphone current, carry out the following procedures:

(a) Connect a 24 volt d-c source in series with a 0-100 ma meter.

(b) Connect the meter and d-c source across the audio output of the microphone circuit pins 5 and 6 of the connector. Remove the handset from the cradle.

(c) Using a flathead screwdriver, adjust R16 for a microphone current of 50 ma, as indicated by the meter. The R16 adjustment is reached through an access hole in the bottom of the 48A1-SW or by removing the dust cover of the 48B2-SW.

2.5 POST INSTALLATION CHECK

2.5.1 SSB OPERATION

Move the meter switch located inside the 32MS-1A top cover to the ALC-S position. Select SSB mode on Control Unit 48A1-SW or 48B2-SW (AM light off). Allow sufficient time for the transceiver to warm up. Listen on the handset. Check that none of the fuse-out indicators are illuminated. After the warm-up period, noise or signals should be audible on the handset. Adjust the volume control for a comfortable audio output level.

Make sure that the antenna is connected to the 32MS-1A. Switch the meter selector to the PA CATH position. Switch the OPR-TUNE switch to OPR position. Press the test button on the front of the transceiver. The meter should indicate between 10 and 15 on the watts scale.

CAUTION

Do not hold button down for more than 15 seconds at a time.

Switch the OPR-TUNE switch to TUNE position. With the test button depressed, move the meter selector switch to FWD POWER position. The meter should indicate approximately 90 watts forward power. Switch the meter selector to REV PWR position. With the test button depressed, the meter should indicate not more than 25 watts reflected power. Move the meter switch to the PA CATH position. The meter should indicate between 80 and 150 on the watts scale. Release the test button. Move the OPR-TUNE switch to OPR position. Press the transmit button on the handset and speak into the microphone of the handset. The meter indication should increase. Move the meter switch to FWD POWER Position and speak into the microphone. The meter indication should increase. Move the meter switch to the ALC-S position.

2.5.2 AM OPERATION

Move the meter-selector switch to ALC-S position. Select AM mode on the control unit. Allow sufficient time for the transceiver to warm up. Listen on the handset. Check that none of the fuse-out indicators are illuminated. After the warm up period, noise or signals should be audible on the handset. Move the meter selector switch to PA CATH position. Move the OPR-TUNE switch to OPR position. Press the test button on the front of the transceiver. The meter should indicate approximately 40 watts. Move the meter selector switch to FWD POWER position, and depress the test button. The meter should indicate approximately 25 on the watts scale. With the test button depressed and the meter selector switch in the REV PWR position, the meter should indicate not more than 6 watts reflected power. Move the meter selector switch to FWD POWER position and speak into the microphone: the meter indication should increase. Move the meter switch to ALC-S position. Replace the cover on Transceiver 32MS-1A.

Figure 3-1 Control Unit 48A1-SW, Operating Controls

SECTION III

OPERATION

3.1 GENERAL

The following paragraphs provide operating instructions for Transceiver 32MS-1A by means of Control Unit 48A1-SW. Since the operating controls and the operation of the 48A1-SW and 48B2-SW are identical, the same general instructions can be used for either unit.

3.2 OPERATING CONTROLS

The operating controls of Control Unit 48A1-SW are illustrated in Figure 3-1. These controls and their functions are as follows:

(a) A pushbutton ON switch which provides on-off control of the transceiver and the speaker amplifier in the control unit.

(b) A pushbutton AM switch which provides mode selection.

(c) Four pushbutton switches 1, 2, 3 and 4 which provide channel selection for the transceiver.

(d) A VOLUME control for the speaker amplifier.

(e) A push-to-talk switch on the handset.

3.3 OPERATING PROCEDURES, SSB MODE

Operating procedures for use of the 32MS-1A as a single sideband transceiver are as follows:

(a) Push the ON button. The indicator light on the ON button should come on.

(b) Push the assigned channel button 1, 2, 3, or 4. For standby operation, this is all that is necessary.

(c) When the call arrives remove the handset from the cradle.

(d) Either adjust the VOLUME control and use the speaker, or turn down the volume and use the headphone to receive the call.

(e) For transmit, press the push-to-talk button on the handset. Hold the handset so as to speak directly into the microphone. Speak clearly and distinctly. Do not shout.

3.4 OPERATING PROCEDURES, AM MODE

Operating procedures for use of the 32MS-1A as a compatible amplitude modulated transceiver are as follows:

(a) Push the ON and AM and assigned channel buttons. The indicator lights in these buttons should come on. For standby operation this is all that is necessary.

(b) Carry out the same operating procedures as for single sideband reception and transmission described in Paragraph 3.3. steps (c) through (e).

NOTE

The meter selector switch in Transceiver 32MS-1A must be in the ALC-S position.

SECTION IV

PRINCIPLES OF OPERATION

4.1 GENERAL

Transceiver 32MS-1A utilizes common oscillators, r-f amplifier and tuned circuits for both transmit and receive functions. All tuned circuits are pretuned for appropriate channels. The pretuned circuits and crystals are selected from the control unit. Mode of operation, AM or SSB, is selectable from the applicable control unit. The 32MS-1A is equipped with provisions for antenna coupler autopositioning. The circuits of Control Unit 48A1-SW and Control Unit 48B2-SW are essentially identical. The schematic diagrams of the 48A1-SW and 48B2-SW are shown in Figures 7-2 and 7-3 respectively. The circuits are basically simple four-wire telephone sets.

4.2 BLOCK DIAGRAM

Figure 4-1 is a block diagram of AM/SSB Transceiver 32MS-1A. The heavy solid line represents the signal path during transmit operation. The heavy dotted lines indicate the signal path during receive operation and the thin solid lines indicate control voltages, alc and agc.

4.3 TRANSMITTER OPERATION

4.3.1 SINGLE SIDEBAND OPERATION

Refer to Figures 4-1 and 7-1. Audio signals from the control unit are fed via terminals 5 and 6 of connector J5 to the audio input transformer T1. The output of the audio transformer is fed to the speech clipper CR11 and CR12, and then to V7, which is an audio amplifier and cathode follower. The output of the cathode follower is coupled to the balanced modulator, consisting of CR13, CR14, CR15 and CR16. R-f at 455 kc from crystal oscillator V1A drives isolation amplifier V1B. The output of V1B is fed to the balanced modulator. Audio and 455 kc rf are mixed within the balanced modulator. Double sideband suppressed carrier output from the balanced modulator is fed to mechanical filter FL1. Mechanical filter FL1 removes the upper sideband and allows the lower sideband to pass on to balanced mixer V2. R-f generated in channel oscillator V10A is fed to phase inverter V10B which excites balanced mixer V2. If the channel crystal is 455 kc below the channel frequency, the output of balanced mixer V2 is lower sideband suppressed carrier. The output of V2 is fed to r-f amplifier V3. R-f amplifier V3 excites r-f driver V4 which drives the power amplifier V5 and V6. The output of the power amplifier will be upper sideband suppressed carrier if the channel crystal is 455 kc above the desired channel frequency.

4.3.2 AMPLITUDE MODULATED OPERATION

Operation of Transceiver 32MS-1A on AM is similar to operation on SSB. The major difference is that the r-f carrier from the 455 kc isolation amplifier is bypassed around the balanced modulator and mechanical filter by the carrier reinsertion control. The resulting balanced mixer excitation consists of lower sideband plus carrier and channel oscillator information. Lower sideband plus carrier excitation drives the r-f amplifier. The output of Transceiver 32MS-1A during AM operation is upper sideband plus carrier, if the channel crystal is 455 kc above the desired channel frequency and lower sideband plus carrier if the channel crystal is 455 kc below the desired channel frequency.

4.4 RECEIVER OPERATION

4.4.1 SINGLE SIDEBAND OPERATION

Refer to Figures 4-1 and 7.1. R-f signals are fed from the antenna to r-f amplifier V3. The output signal from V3 is fed to receiver mixer V11 where it is mixed with channel oscillator information from V10A. The output signals of receiver mixer V11 are fed through mechanical filter FL1 to first i-f amplifier V12. The output of the first i-f amplifier is coupled to second i-f amplifier V13. The output of the second i-f amplifier is fed to product detector V14, where it is mixed with the signal from the 455 kc oscillator V1. The audio amplifier V15 drives the 600 ohm line through transformer T2 which is connected to the control unit.

4.4.2 AMPLITUDE MODULATION OPERATION

Operation of Transceiver 32MS-1A for AM reception is similar to single-sideband reception, except for the following: The output signals of the receiver mixer are fed through an i-f transformer, instead of mechanical filter FL1, to the first i-f amplifier. The output signal from the second i-f amplifier is fed to AM detector CR18 instead of product detector V14. The output of AM detector CR18 is coupled to audio amplifier V15.

4.5 CIRCUITS DESCRIPTION

4.5.1 AUDIO CLIPPER

Diodes CR11 and CR12 and their associated network form a series type audio clipper. The forward bias at the junction of CR11, CR12 and R24 is adjusted to cause a negative reference potential to appear at that junction. A positive going signal at the junction of T1, R21 and C24 is coupled through the low impedance of C24, CR11, CR12 and C35 to the grid of audio amplifier V7A. The positive going signal appears across resistor R24. If the positive going signal appearing across R24 should cause the reference junction of CR11, CR12 and R24 to appear positive relative to ground, CR12 will stop conducting. When CR12 stops conducting, it appears to be a very high resistance to the positive going signal. This action limits magnitude of the positive going signal that can appear at the grid of audio amplifier V1A.

A negative going signal appearing at the junction of T1, R21 and C24 is coupled through the low impedance of C24, CR11, CR12 and C35 to the grid of audio amplifier V7A. The negative going signal appears across resistor R23. If the negative going signal across R23 should cause the junction of R23, R22 and CR11 to appear negative relative to the reference potential at the junction of CR11, CR12 and R24, CR11 will stop conducting. When CR11 stops conducting, it appears to be a very high resistance to the negative going signal. This action limits the magnitude of negative going signal that can appear at the grid of V7A. Transceiver 32MS-1A uses positive and negative peak audio clipping. The clipper threshold is -3dbm input on AM and +8dbm on SSB.

4.5.2 SPEECH AMPLIFIER AND TONE OSCILLATOR

When the OPR/TUNE switch S3 is in the TUNE position, tube section V7A is connected as a phase-shift audio oscillator operating at approximately 1400 cps. When S3 is in the OPR position, V7A is connected as a conventional class A pentode autio amplifier. The output of V7A is coupled to the grid of cathode follower V7B, through TRANSMIT AUDIO Gain control R61 and coupling capacitor C43.

4.5.3 CATHODE FOLLOWER

V7B is a conventional cathode follower. It is used to obtain a low-impedance signal source for balanced modulator CR13, CR14, CR15 and CR16.

4.5.4 BALANCED MODULATOR

The balanced modulator is composed of CR13, CR14, CR15 and CR16 and their associated network. The series type diode modulator uses single-ended audio frequency and radio frequency inputs and balanced double sideband suppressed carrier output. The balanced modulator output is coupled to mechanical filter FL1 through C165 and C48. Potentiometer R40 is the carrier balancing resistor. Capacitor C47 is used for additional balancing to reduce carrier feedthrough, Capacitor C50 tunes the input coil of mechanical filter FL1.

4.5.5 MECHANICAL FILTER

The mechanical filter is a mechanically resonant device which receives electrical energy, converts it into mechanical vibration, then converts the mechanical energy back into electrical energy at the output. The centre frequency of the mechanical filter is 453.2 kc and the bandwidth of the half-power points is 2.7 kc. The output of the mechanical filter is coupled to the balanced mixer.

The mechanical filter removes the upper sideband of the double sideband suppressed carrier input signal and passes the lower sideband only.

4.5.6 BALANCED MIXER

The balanced mixer V2 receives its excitation from the balanced modulator via the mechanical filter and from the channel oscillator via the phase inverter. One grid of the balanced mixer is fed by the mechanical filter.

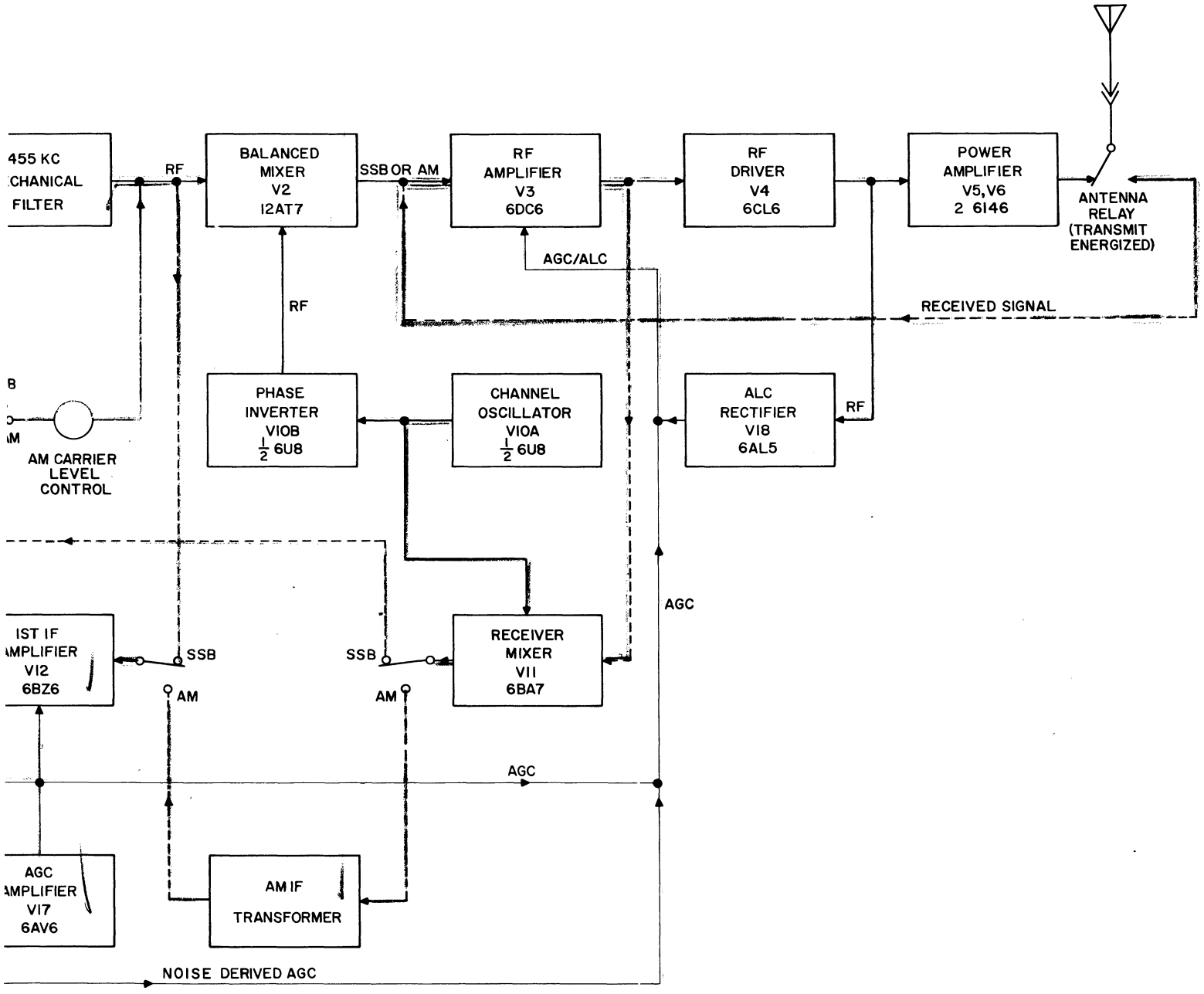
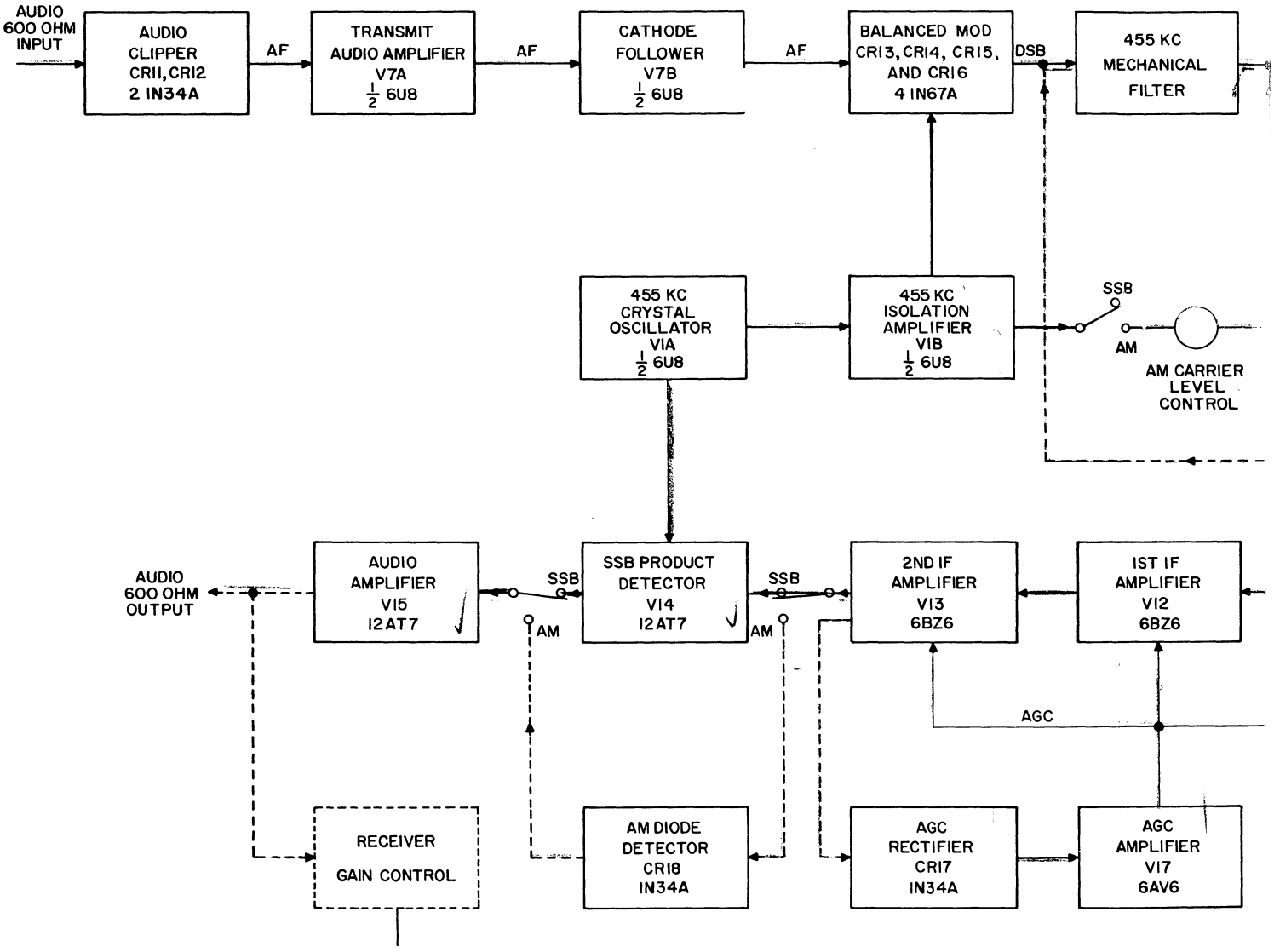


Fig. 4-1 Transceiver 32MS-1A, Block Diagram


AUDIO 600 OHM INPUT
AUDIO CLIPPER CRII, CRI2 2 IN34A
AF
TRANSMIT AUDIO AMPLIFIER V7A ½ 6U8
AF
CATHODE FOLLOWER V7B ½ 6U8
AF
BALANCED MOD CRI3, CRI4, CRI5, AND CRI6 4 IN67A
DSB
455 KC MECHANICAL FILTER
455 KC CRYSTAL OSCILLATOR VIA ½ 6U8
455 KC ISOLATION AMPLIFIER VIB ½ 6U8
SSB
AM
AM CARRIER LEVEL CONTROL
AUDIO 600 OHM OUTPUT
AUDIO AMPLIFIER VI5 I2AT7
SSB
AM
SSB PRODUCT DETECTOR VI4 I2AT7
SSB
AM
2ND IF AMPLIFIER VI3 6BZ6
IST IF AMPLIFIER VI2 6BZ6
AGC
RECEIVER GAIN CONTROL
AM DIODE DETECTOR CRI8 IN34A
AGC RECTIFIER CRI7 IN34A
AGC AMPLIFIER VI7 6AV6

The other grid is grounded at r-f. The cathodes of the balanced mixer are fed in push-pull by the phase inverter. The output of the balanced mixer is via the parallel connected plates of V2. R66 is a balancing potentiometer and is adjusted to reduce to a minimum the channel oscillator frequency energy which appears at the plates of balanced mixer V2.

The output of the balanced mixer is fed to the r-f amplifier.

When the output frequency of the balanced mixer is the difference between the channel oscillator frequency and the modulated 455 kc lower sideband suppressed carrier signal, the output of the balanced mixer will be upper sideband suppressed carrier.

4.5.7 OUTPUT FREQUENCY RELATION

If the 455 kc signal is modulated with a 2 kc tone, the output of the balanced modulator will be 453 kc and 457 kc (the 455 kc signal is balanced out in the balanced modulator). The mechanical filter will not pass the 457 kc signal. The 453 kc signal (lower sideband) is passed by the mechanical filter to the balanced mixer. The modulating tone is mixed with the channel oscillator frequency. Assume the channel oscillator frequency is 8000 kc, the output of the balanced mixer will be 8000 kc - 453 kc = 7547 kc. The signal represents the modulation sideband. If the 455 kc signal appeared in the output of the balanced mixer, its frequency would have translated to 8000 kc - 455 kc = 7545 kc. It is apparent that the sideband signal is 2 kc higher than the "carrier" frequency, and due to subtractive mixing has been inverted from a lower to an upper sideband.

4.5.8 RADIO FREQUENCY AMPLIFIER

The r-f amplifier V3 is a class A amplifier using a remote cutoff pentode. This stage is bridge neutralized. The input and output coils are selected by the channel selector switch. The r-f amplifier gain is controlled by alc during transmit operation and agc during receiving operation. The output is coupled to the r-f driver.

4.5.9 RADIO FREQUENCY DRIVER

The r-f driver V4 is a class AB_1 linear amplifier and is bridge neutralized. The input and output coils are selected by the channel selector switch. The output of the r-f driver is coupled to the power amplifier.

4.5.10 POWER AMPLIFIER

Power amplifier V5 and V6 is a linear amplifier using two beam power tubes in parallel and operated under class AB_1 conditions. Grid current impulses are minimized by the alc circuit. Feedback from the power amplifier plate to the cathode of the r-f driver is used to improve the linearity in the power amplifier stage. The output of the power amplifier is fed through the directional wattmeter to the channel selector switch, which selects the proper antenna connector. The output of the power amplifier is tuned by π-L networks selected by the channel selector switch.

4.5.11 AUTOMATIC LOADING CONTROL

Alc rectifier V18 is a duo-diode. Grid current impulses from the power amplifier are fed through capacitor C159 to the cathode of one diode and the plate of the other diode. The second diode is shunted across the impulse signal line and the first diode is in series with the impulse signal line. This connection results in a voltage-doubler-rectifier configuration. The rectified grid impulses are filtered and applied to the grid of the r-f amplifier as control voltage. The negative voltage on the grid of the r-f amplifier as a result of the alc voltage, reduces the gain of the r-f amplifier. Reducing the gain of the r-f amplifier reduces the excitation of the r-f drive, which in turn reduces the excitation to the power amplifier. Reducing the drive to the power amplifier decreases the magnitude of the grid current impulses and thus decreases the distortion caused by grid current.

4.5.12 RECEIVER MIXER

The receiver mixer, V11 is a conventional pentagrid mixer. The received signal from the r-f amplifier is coupled into grid 3, pin 7 of the 6BA7. The channel oscillator signal is injected on grid 1, pin 2 of the 6BA7. The oscillator injection signal from V10, pin 6 is fed through diode gate CR19. During transmit operation, CR19 is reverse biased by being connected to +250 volts via pins 7 and 8 of relay K3 and decoupling network. The reverse bias condition of CR19 prevents the oscillator signal from appearing on grid 1, pin 2 of the receiver mixer. The cathode d-c path is opened during transmit by opening contacts 8 and 9 of K2 during transmit operation.

The output signal of the receiver mixer is coupled through mechanical filter FL1, while the 32MS-1A is in SSB mode, or i-f transformer T5 while in AM mode, to i-f amplifier V12. Selection of mechanical filter or i-f transformer is accomplished by selective biasing of diode gates CR20 and CR21 and keying relay K4.

4.5.13 I-F AMPLIFIERS

The i-f amplifiers are conventional class A amplifiers using high gain pentodes. The outputs of the two i-f amplifiers are transformer coupled to the following stage. The transformer coupling is supplemented by a small amount of capacitive coupling to increase bandwidth. The output signal from the second i-f amplifier, V13, is fed to product detector V14, AM detector CR18, and agc rectifier CR17.

4.5.14 PRODUCT DETECTOR

The product detector, V14, is a twin triode. The i-f signal is coupled into one of the grids, pin 2: this section of the tube is connected as a cathode follower. The above section is directly coupled to the cathode of the second triode section. The bfo signal from the 455-kc oscillator is coupled into the grid, pin 7, of the second triode section. The i-f signal and the bfo signal are mixed in this section of the twin triode.

The output of the second triode section is bypassed to ground for i-f, bfo, and the higher product signals and only the difference frequency appears across the plate load resistor R38. The audio output signal from the product detector is coupled to the audio amplifier via relays K5 pins 11 and 12.

4.5.15 AM DETECTOR

The AM detector CR18, is a conventional diode detector. The output of the AM detector is fed to the audio amplifier via relay K5 pins 10 and 11.

4.5.16 AUDIO AMPLIFIER

The audio amplifier is a twin triode, V15. Audio from the detectors is coupled through relay K5 pin 11 to pin 2 of the 12AT7 audio amplifier. The output of the audio amplifier is coupled through transformer T2 to connector J5. During transmit operation the grid, pin 7 of the audio amplifier is grounded through the contacts pins 2 and 1, of relay K1.

4.5.17 AGC SYSTEM

The agc rectifier CR17, agc amplifier V17, and the associated network form an agc system with d-c amplification. Agc voltage is applied to the r-f and i-f amplifiers.

4.5.18 A-C POWER SUPPLY

The a-c power supply may be used on either 115 or 230 volts 50-400 cps. The schematic diagram, figure 7-4 shows the unit connected for 115-volt operation. For 230-volt operation, the primaries of each transformer are series connected.

4.5.19 12-VOLT POWER SUPPLY

The 12 volt power supply is to be used with a 12-volt, d-c power source. Refer to figure 7-5 schematic diagram of the unit. Transistors 4Q1 through 4Q4 are operated as a push-pull parallel oscillator. The low and high voltage oscillators are frequency locked by coupling the emitter of 4Q6 with the bases 4Q1 and 4Q2, and the emitter of 4Q5 with the bases of 4Q3 and 4Q4. The banks of resistors in the base leads of 4Q1 through 4Q4 are a current balancing network.

4.5.20 28-VOLT POWER SUPPLY

The 28-volt power supply is to be used with a 28-volt d-c power source. Refer to figure 7-6 schematic diagram of the unit. Transistors 3Q1 and 3Q2 operate as a push-pull oscillator. Diodes 3CR3 through 3CR6 inclusive are spike clippers. Transistors 3Q5 through 3Q7 inclusive, diode 3CR2, Zener diode 3CR1, and the associated circuits form a transient blanking network to suppress transients which may appear on the 28 volt source line. Transistors 3Q3 and 3Q4 operate as a push-pull oscillator. The low and high voltage oscillators are frequency locked by coupling the emitters of 3Q3 and 3Q4 to the bases of 3Q1 and 3Q2.

4.5.21 AUTOMATIC RECEIVER GAIN CONTROL

The automatic receiver gain control, Collins part number 528-0127-00, is a noise operated device used for controlling receiver gain. Receiver noise at 2650 cps is amplified, rectified and fed to the 32MS-1A agc line as control voltage. Since most voice audio power occurs near 800 cps, the voice audio being received by the 32MS-1A has very little or no effect on the long-term d-c output of this unit.

The 32MS-1A receiver gain is thus controlled by noise rather than voice-modulated input. Figure 6-16 is a top view and figure 7-7 is a schematic diagram of the automatic receiver gain control board. Q1 and Q2 are noise amplifiers. CR1 and CR2 perform full wave rectifier functions. CR4 is an agc output limiter and CR5 is the agc delay diode. CR3 with R11 and C12 is a nonlinear time constant device which is not used in the 32MS-1A. Removing the ground from pin F of the connector will result in an additional 10 db control available from this unit. When the unit is installed, pin F is grounded to the 32MS-1A chassis.

4.5.22 REMOTE CONTROL UNIT

Refer to figures 7-2 and 7-3 schematic diagrams of Control Units 48A1-SW and 48B2-SW respectively.

The headphone circuit consists of the headphone transformer T1, capacitors C2 and C3, potentiometer R2, and the +24 volt d-c input. The audio signal is coupled into the headphone circuit through T1. Capacitor C2 blocks d-c voltage from the headphones. Capacitor C3 provides additional filtering for the power source. Potentiometer R2 limits current flow through the headphones and, in addition, provides a volume control for the speaker amplifier.

The speaker amplifier consists of two transistorized class B push-pull amplifier stages. The input signal is obtained from potentiometer R2, which functions as a volume control.

In normal operation, the speaker amplifier is in standby, drawing approximately 10 ma of current, when the ON button has been pressed. An incoming signal is coupled through C4 and R4 to the base of Q1. The collector output of Q1 is developed in one half of T2. The signal across resistor R6 in the emitter circuit of Q1 provides the input signal to Q2. The collector output of Q2 is developed in the other half of T2 in push-pull with the previously mentioned collector output of Q1.

Bias for transistor Q1 is obtained from a voltage divider consisting of resistors R5 and R8. The Q2 bias is obtained from a voltage divider consisting of R7 and R11. Resistors R9 and R10, respectively, limit current through Q1 and Q2 to a safe value.

The output of the Q1-Q2 stage is coupled by transformer T2 to the input of the second push-pull amplifier Q3 and Q4. The operation of the second stage is identical to that of the first stage, except that the inputs of Q3 and Q4 are obtained from a center-tapped transformer winding, rather than by the method used for the Q1-Q2 transistors. The push-pull output of the second stage is coupled to the speaker by transformer T3.

The microphone circuits of the remote control units consist of the microphone, transformer T4, potentiometer R16, capacitors C7 and C8, and hookswitch S7C. In the off hook position of S7C, as illustrated in Figure 7-2, the audio output circuit is closed to provide an output signal and to give off-hook supervision to the central office ringing circuit. This switch opens when the handset is placed on the hook. Transformer T4 couples the microphone output from the microphone circuit to the output of the control unit. Resistor R16 provides an adjustment for microphone current, and capacitors C7 and C8 are used for coupling and bypass.

The push-to-talk switch, which is physically located on the grip of the handset, provides a ground to the transceiver. This ground performs the necessary push-to-talk switching at the transceiver.

Selector switches S1 through S6 are six individual pushbutton switches. Each switch functions to provide a ground at the transceiver to perform the specified switching. The four channel selector switches S3 through S6, are mechanically interlocked so that when one is depressed, the other three are released. In the 48A1-SW, the on-off switch S1 is also interlocked with the four channel selector switches, so that when the on-off switch is depressed, all channel switches return to their off positions. There is no interlock between the on-off switch and the channel selector switches in the 48B2-SW.

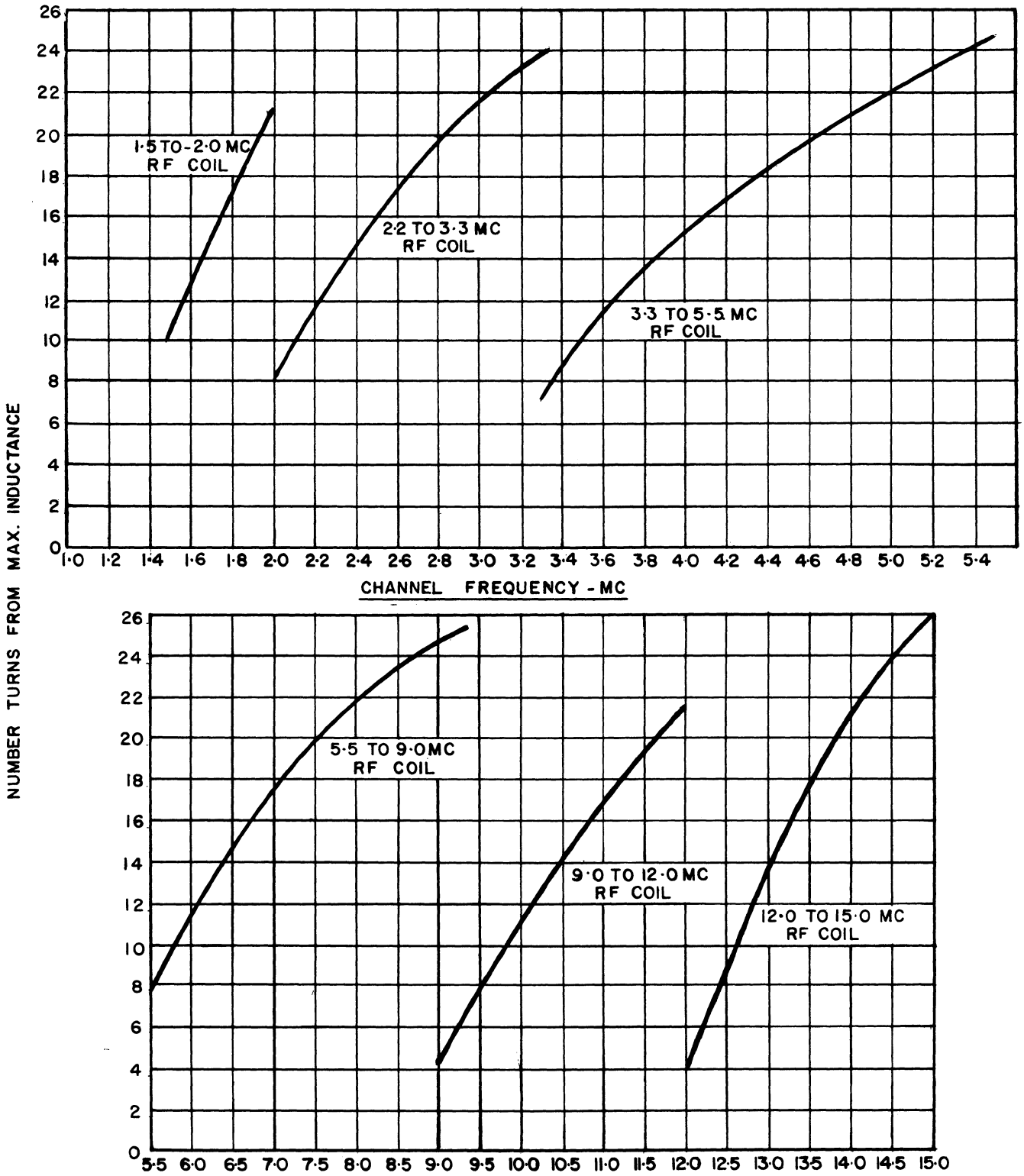


Figure 5-1 Calibration Curves for Antenna and R-F Coils

SECTION V

MAINTENANCE

5.1 GENERAL

This section contains trouble-shooting procedures, alignment instructions and performance tests for Transceiver 32MS-1A and disassembly and assembly procedures for Control Unit 48A1-SW and Control Unit 48B2-SW.

5.1.1 TEST EQUIPMENT

The following test equipment items (or equivalents) are suggested for testing Transceiver 32MS-1A.

(a) 48A1-SW or 48B2-SW control Unit.

(b) R-f signal generator, capable of 1.0 volt input (Measurements Corporation Model 65B).

(c) Vacuum-tube voltmeter, Ballantine Model 310A.

(d) Volt-ohm-milliammeter, Simpson 260.

(e) Audio generator, Heathkit AG-9.

(f) 52-ohm load, Bird Model 820.

(g) Communications receiver, general coverage - with S-meter, Collins 51J or equivalent type.

5.2 INSPECTION

5.2.1 GENERAL

It is suggested that, at the beginning of station operation the operator make a log of meter readings (including output power readings) and that the operator continues keeping this log up to date. A comparative check of meter readings over a period of time will give an indication of over-all transceiver operations. Also, trading log information with other stations within the radio net helps in determining over-all equipment operation.

5.2.2 VISUAL INSPECTION

Remove the covers from the 32MS-1A, and make a visual inspection of circuit components and relay and switch contacts. Remove any dust or dirt that may have accumulated.

5.2.3 METER ADJUSTMENT

Before attempting to troubleshoot or tune the 32MS-1A, the meter adjustment should be checked. The transceiver should be in receive operation during this adjustment. Turn the power on and allow the 32MS-1A to warm up. Move the meter selector switch to ALC-S position. Adjust the meter ZERO-adjust potentiometer, R81, to obtain a zero indication on the meter.

5.3 TROUBLE SHOOTING

The following procedure is to be used in trouble shooting Transceiver 32MS-1A under emergency conditions. Malfunctioning units should normally be returned to overhaul facilities for repair and alignment. Below are checks that can be made.

5.3.1 LOW TRANSMITTER OUTPUT

If transmitter output is low, make the following checks with the transceiver in SSB mode, the OPR-TUNE switch in TUNE position, and the test button on the front of the transceiver depressed.

CAUTION

Do not hold the test button depressed for more than a few seconds at any time.

(a) Check the forward-to-reflected power ratio with a directional wattmeter or other instrument. The forward power should be approximately 90 ± 20 watts with a-c supply and 70 ± 20 watts with d-c supply. The reflected power should not exceed 20 percent of the forward power indication. If reflected power is greater than 20 percent of the forward power indication, check cables, coaxial transmission line and antenna.

(b) Check the power amplifier cathode current. Switch the meter selector to the PA CATH position for this check. The meter should indicate between 80 and 150 on the watts scale. If the indication is high, perform the power amplifier tuning procedure as outlined in paragraph 5.4.

(c) Check the grid drive. Grid drive is checked with the meter selector in the ALC-S position. The meter should indicate 20 ± 5 on the watts scale. If the indication is low increase the transmit audio gain control: use the substitute tube method outlined in paragraph 5.3.4 substituting V1, V2, V3, V4, V7, V10. If grid drive is low on one channel only, substitute crystal associated with low-output channel. If alc indication is normal and PA cathode indication is low, switch the OPR-TUNE switch to OPR position and check the power amplifier static cathode current. The indication on the meter with no tone or modulation and the test button depressed should be between 10 and 15 as indicated on the watts scale. If not, adjust the PA GRID BIAS potentiometer to obtain the proper indication on the watts scale. If alc indication is normal and the PA CATH indication is low, try PA tuning-loading procedure per paragraph 5.4 If still low, substitute V5 and V6.

5.3.2 RECEIVER INOPERATIVE

If the receiver is inoperative, use the substitute tube method per paragraph 5.3.4. Substitute for tubes V12, V13, V11, V3, V14, V15, V10 and V1. Substitute channel crystals if the unit is inoperative on one channel only.

5.3.3 TRANSMITTER INOPERATIVE

If the transmitter is inoperative, use the substitute tube method per paragraph 5.3.4. Substitute V1, V2, V10, V3, V4, V7, and V5 and V6. Substitute channel crystals if the unit is inoperative on one channel only.

5.3.4 TUBE SUBSTITUTION TROUBLE-SHOOTING METHOD

Check the V-number of the tube to be replaced. Check the tube type and location. Choose the proper tube type from the spare parts kit. Remove the tube which is to be replaced.

NOTE

Remove only one tube at a time.

Place the substitute tube of the same type from the spare parts kit in the transceiver. Be careful not to bend the tube pins during removal or installation. Try the radio with the substitute tube installed. If the transceiver is still inoperative, remove the substitute tube and replace the original tube. Check the next V-number and tube type. Repeat the above procedure until the unit functions properly. Be sure to allow sufficient time for the transceiver to warm up if the unit is turned off during tube change periods. Allow time for the substitute tube to warm up if the unit has not been turned off during the tube change period.

WARNING

Turn Transceiver 32MS-1A off before touching the power amplifier tubes V5 and V6. Voltages present within the power amplifier shield cage are dangerous to life.

5.4 TUNING PROCEDURE

Ensure that the coils inserted in Transceiver 32MS-1A cover the range in which the channel frequency falls (the frequency range of the coils is stenciled on the coils). Ensure that the transceiver is set to the channel to be aligned. Do not adjust the coils of the other channels while the transceiver is set on a specific channel.

Insert desired channel crystals into channel crystal ovens, HR2, and HR3. Channel crystals are located according to oven pins as follows:

CHANNEL	CRYSTAL LOCATION
1	Pins 7 and 8 of HR3
2	Pins 3 and 4 of HR3
3	Pins 3 and 4 of HR2
4	Pins 7 and 8 of HR2

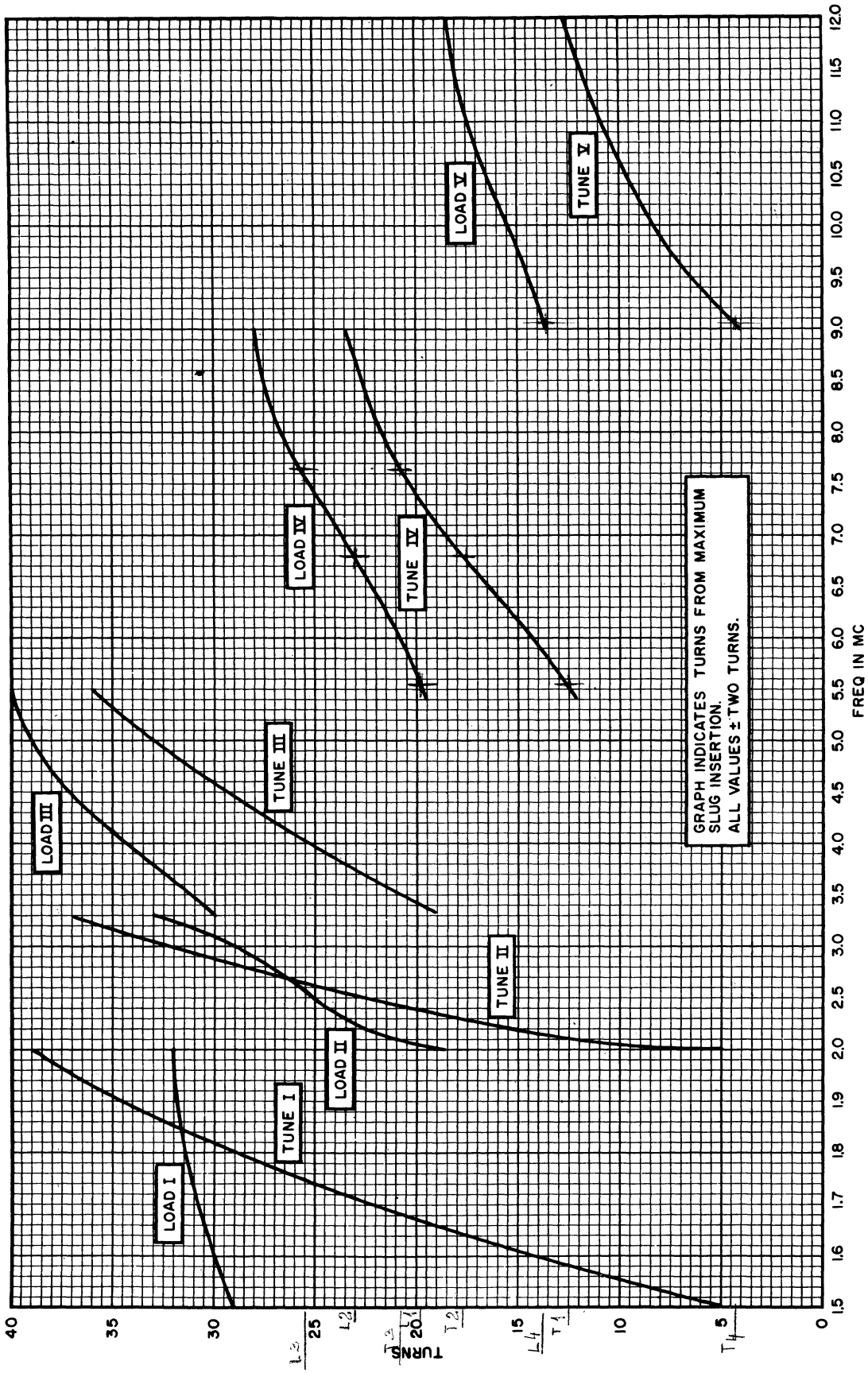


Figure 5-2 PA Coil Calibration for 52 Ohm Load

(a) Turn the slugs of the coils to be aligned all the way in.

(b) Refer to figure 5-1 and turn the slugs out the proper number of turns corresponding to the channel frequency.

(c) Refer to figure 5-2 and run the rollers of the power amplifier tuning and loading coils to the position corresponding to the channel frequency.

(d) Move the meter switch to PA CATH position.

(e) With the OPR-TUNE switch in OPR position, depress the test button on the front of the transceiver. Adjust the power amplifier bias control to obtain a meter indication of 10 to 15 on the watts scale.

NOTE

Setting the power amplifier static current to less than an indication of 10 will result in distorted output. Setting the power amplifier to an indication of more than 15 will result in shortened tube life.

(f) Attach a 52-ohms, nonreactive dummy load to the antenna connector on the rear of the 32MS-1A.

(g) With the meter selector in PA CATH position, switch the OPR-TUNE switch to TUNE position.

(h) Turn the transmit audio gain control full counterclockwise.

(i) Depress the test button on the front of the 32MS-1A and turn the transmit audio gain control clockwise far enough to obtain an indication on the meter slightly higher than 10 on the watts scale.

(j) Adjust the slugs of the r-f coils to obtain maximum indication of power amplifier cathode current. Decrease the audio gain control each time that tuning the slugs causes a significant increase in power amplifier cathode current.

NOTE

At higher frequencies the coils may be adjusted to the wrong mixing product frequency (i.e. 455 kc on the other side of the channel injection frequency) or to the channel injection frequency. There will be an output indication, even with OPR-TUNE switch (S3) in OPR position.

If moving S3 to OPR position does not eliminate the wrong mixing frequency output, remove the crystal oven with the proper channel crystals to eliminate the channel injection frequency output. If, after removing the channel crystal, the channel injection frequency output is not present, reinsert the crystal and rebalance the balanced mixer as described in para. 5.4.1(g).

If the PA cathode current is still high, this indicates oscillation in one or more r-f stages. In this case the r-f stage, transmit driver and PA stage should be neutralized as described in para 5.5.

CAUTION

Do not allow the cathode current to exceed 40 on the watts scale for more than a few seconds at a time. Release the test button and allow the tubes to cool when the 40 reading has been exceeded.

(k) For the following adjustments, it is suggested that the unit be keyed by the telephone handset so that the PA may be allowed to cool while not being adjusted. Advance the TRANSMIT AUDIO gain control until PA cathode current is slightly increased.

(l) Refer to Figure 5-2 for approximate PA coil settings for a 52-ohm resistive antenna. Adjust the TUNE coil in the appropriate PA Tank coil assembly in either direction until PA cathode current dips. Adjust for current minimum.

(m) Increase the transmit audio gain control setting until PA cathode current stops increasing.

(n) If the PA CATH current reads 150 the TX is properly loaded. If PA CATH current is below 150 the TX is underloaded. Increase loading by turning the loading coil in a clockwise direction and retuning the tune coil for a dip each time loading is increased appreciably.

Repeat these steps until a reading of 150 is obtained. If PA CATH current is above 150 the TX is overloaded and the reversal of the above steps must be done.

NOTE

For this adjustment, the transmitter should be on for not more than 10 seconds at a time with 10 seconds off to ensure good PA tube life.

(o) Repeat steps (k) through (n) for each channel. Be sure the CHANNEL SELECTOR is set to the channel being aligned.

(p) Since tolerance is permitted in grinding channel crystals to frequency, it may be necessary to trim these crystals to channel frequency. If no frequency standard is available, the appropriate channel trimmer can be adjusted until the received signal from a station on the desired channel is received satisfactorily.

(r) Adjust the TRANSMIT AUDIO gain to read 15 on the meter with meter switch in ALC-S position.

5.4.1 CARRIER BALANCE

(a) Loosely couple a general coverage receiver to the 52-ohm nonreactive load. Connect the load to the antenna connector of Transceiver 32MS-1A.

(b) Turn the TRANSMIT AUDIO gain control to minimum and select SSB mode on the control unit.

(c) Move the OPR-TUNE switch to OPR position.

(d) Tune the general coverage receiver to the channel frequency.

(e) Depress the test button on the front of the 32MS-1A and adjust the carrier balance potentiometer R40 and capacitor C47, CARRIER BAL, for minimum indication on the general coverage receiver. Adjust these two controls alternately several times: there is some interaction between the controls and several adjustments are necessary to obtain an absolute minimum.

(f) Release the test button.

(g) Select the highest frequency channel and the SSB mode. Tune the general coverage receiver to the channel injection frequency. Balance R66 and C108 for a minimum indication on the receiver S-meter.

5.5 NEUTRALIZATION

Neutralization should not be attempted unless the unit shows instability on transmit at high frequency, and all other trouble sources have been eliminated. Perform the tuning procedure of paragraph 5.4 above. Connect a 52-ohm nonreactive load to the output of Transceiver 32MS-1A. Select the highest frequency channel. Turn the transmit audio gain control to minimum (fully counterclockwise). Switch to SSB mode of operation. Move the OPR-TUNE switch to TUNE position.

5.5.1 R-F AMPLIFIER

(a) Remove the screen and plate voltages from V3. Leave low and high voltages on other circuits.

(b) Connect a general coverage receiver antenna terminals to the 32MS-1A output jack. Tune the general coverage communications receiver to the channel frequency.

(c) Adjust the transmit audio gain control to obtain a midscale indication on the S-meter of the general coverage receiver.

(d) Using an insulated alignment tool, adjust C113 for minimum output indication on the S-meter of the receiver.

(e) Tune the r-f amplifier plate coil for maximum indication on the S-meter.

(f) Adjust C113 for minimum output indication on the S-meter. Disconnect the receiver.

(g) Restore the plate and screen voltages.

5.5.2 R-F DRIVER

(a) Remove plate and screen voltages from V4. Leave low and high voltages on all other circuits.

(b) With the general coverage receiver connected as in 5.5.1, tune the receiver to the channel frequency and adjust the transmit audio gain control of the 32MS-1A to obtain a mid scale indication on the S-meter of the general coverage receiver.

(c) Using an insulated alignment tool, adjust C137 for minimum indication on the S-meter.

(d) Adjust the r-f driver plate coil for maximum indication on the S-meter.

(e) Adjust C137 for minimum output as indicated by the receiver S-meter.

(f) Restore the screen and plate voltages to V4.

5.5.3 POWER AMPLIFIER

(a) Remove the screen voltage from V5 and V6 and remove the HV Fuse. Leave low and high voltages on all other circuits.

(b) With the general coverage receiver connected as in paragraph 5.5.1, tune to the channel frequency and adjust the 32MS-1A transmit audio gain control to obtain midscale indication on the S-meter of the general coverage receiver.

(c) Using an insulated alignment tool, adjust C156 for minimum indication on the S-meter of the receiver.

(d) Adjust the PA TUNING for maximum indication on the receiver S-meter, and readjust C156 for minimum indication on the S-meter. Disconnect the receiver.

(e) Restore the screen voltage to V5 and V6. Replace HV fuse.

5.5.4 FEEDBACK NEUTRALIZATION

(a) Couple the antenna terminals of the general coverage receiver through a 22-pf capacitor to the plate of V3.

(b) Connect a signal generator through a 10-pf capacitor to the above chassis end of C140, a feedthrough capacitor. Ensure that the interconnecting coaxial leads, signal generator to transceiver and transceiver to general coverage receiver, are short and the shields of the coaxial leads are grounded securely.

(c) Remove the crystal oven containing the crystal associated with the channel to which the transceiver is set.

(d) Remove the screen fuse and turn the power on.

(e) Move the OPR-TUNE switch to OPR position.

(f) Tune the signal generator and general coverage receiver to the highest channel frequency.

(g) Press the test button on the front of the 32MS-1A. Adjust the output level of the signal generator to obtain a midscale indication on the general coverage receiver S-meter if possible.

(h) Using an insulated alignment tool, adjust C141 for minimum S-meter indication. Remove the signal generator and receiver connections from the transceiver. Replace the screen fuse.

5.6 RECEIVER I-F ALIGNMENT AND AUDIO OUTPUT CHECK

(a) Select AM mode of operation.

(b) Connect a signal generator to the grid of V11. Set the signal generator to 455 kc, 30 percent modulated. Adjust the output level control of the signal generator to obtain a slight indication on the S-meter of the 32MS-1A. (S-meter in ALC-S position).

(c) Connect a swamping tool consisting of a 0.01 uf capacitor in series with a 4700-ohm resistor across terminals A and C of T3.

(d) Tune the top slug of transformer T3 for maximum deflection of the S-meter of the 32MS-1A.

(e) Remove the swamping tool from terminals A and C. Place the swamping tool across terminals D and F of T3.

(f) Tune the bottom slug of T3 for maximum deflection on the S-meter of the 32MS-1A.

(g) Repeat the above procedure for i-f transformers T4 and T5. Swamp terminals A and C before tuning the top slugs and terminals D and F before tuning the bottom slugs. The top slugs of the i-f transformers adjust the tuning of the primary windings. The bottom slugs adjust the tuning of the secondary windings. Terminals D and F are connected to the primary windings and terminals A and C are connected to the secondary windings.

NOTE

Keep the output level of the signal generator adjusted to yield the minimum usable indication on the meter of the 32MS-1A during adjustment of i-f transformers T3, T4 and T5.

(h) Select SSB mode of operation. Tune the signal generator to 453.5 kc. Turn off the modulation of the signal generator. Adjust the output of the signal generator to obtain a slight indication on the meter of the 32MS-1A. If the signal generator level is between 100 and 500 microvolts, the receiver i-f stages are operating properly.

(i) Adjust the mechanical filter tuning capacitors C50 and C87, to obtain an indication of maximum on the meter of the 32MS-1A.

(j) With the signal generator input set at AVC threshold, (as in step (h)) increase the setting of the receiver audio gain control R31. A beat note between the 455 kc crystal oscillator and the 453.5 kc signal should be heard in the handset of the control unit.

(k) Connect a vacuum tube voltmeter between pin 8 of connector J5 and ground. Retune the signal generator to 453.5 kc or to maximum indication on the vacuum tube voltmeter. Adjust the receiver audio gain control R31 to produce a reading of 0.4 volts on the vacuum tube voltmeter. If the audio gain is low, check V12, V13, V14, V15 and their associated circuits.

5.7 A-M CARRIER INSERTION AND R-F GAIN CONTROL ADJUSTMENTS

(a) Turn all r-f gain controls R110, R111, R112 and R113 to maximum clockwise position.

(b) Select AM mode of operation.

(c) Check and record the power output of the 32MS-1A on each channel.

(d) Select the channel showing the lowest power output and adjust the CARRIER INSERT control, R133 to obtain an indication of 25 watts output.

(e) Select the other channels one at a time and adjust their respective r-f gain controls to obtain an indication of 25 watts output on each channel.

NOTE

R110 is channel 4 gain control

R111 is channel 3 gain control

R112 is channel 2 gain control

R113 is channel 1 gain control

5.8 TRANSMIT AUDIO GAIN CONTROL ADJUSTMENT

(a) Connect a 1 kc audio signal generator across the input of the audio input transformer T1. Connect a VTVM across the output of audio transformer T1.

(b) Select SSB mode of operation.

(c) Adjust the audio signal generator to obtain an indication of zero dbm.

(d) Adjust the TRANSMIT AUDIO gain control, R61 to obtain an indication of 25 watts output.

(e) Remove the signal generator and VTVM.

5.9 AGC THRESHOLD ADJUSTMENT

(a) Select a channel which yields nominal gain in receiver operation.

(b) Connect a signal generator to the antenna terminal of the 32MS-1A. Tune the signal generator to the channel frequency and adjust the output level of the signal generator to 2.5 microvolts.

(c) Connect a d-c vtvm to the agc line of the 32MS-1A.

(d) Adjust the AGC ADJUST R4 to obtain -1.0 volt indicated on the vtvm.

(e) Remove the vtvm and signal generator.

(f) Readjust the Meter as described in para. 5.2.3.

5.10 DISASSEMBLY OF CONTROL UNIT 48A1-SW

To disassemble the 48A1-SW Control Unit proceed as follows:

(a) Remove the volume control knob by loosening the two Allen-Head set screws and pulling the knob from the shaft.

(b) Remove the two holding screws that hold the top in place. Access to these screws is obtained through holes in the bottom of the unit. One screw is located in the front of the unit, and one at the back.

(c) Lift the top from the unit.

(d) Take out the four holding screws (one at each corner) which hold the base plate to the bottom cover.

(e) Lift the assembly from the bottom cover and invert.

(f) Remove the two holding screws from the heat sink of the printed circuit board.

(g) Disengage the printed circuit board connector and remove the board from the assembly.

5.11 REASSEMBLY OF CONTROL UNIT 48A1-SW

Reassemble the 48A1-SW Control Unit by reversing the procedures of Para. 5.10.

5.12 DISASSEMBLY OF CONTROL UNIT 48B2-SW

To disassemble the 48B2-SW Control Unit, proceed as follows:

(a) Remove the dust cover from the back of the control unit after loosening two holding screws. One screw is located at the top of the unit, and one at the bottom.

(b) After the back dust cover is removed, remove two holding screws from the heat sink of the exposed printed circuit board.

(c) Disengage the printed circuit board connector and remove the printed circuit board from the assembly.

5.13 REASSEMBLY OF CONTROL UNIT 48B2-SW

Reassemble the 48B2-SW Control Unit by reversing the procedures of Para. 5.12.