NAVSHIPS 92911(A)
VOLUME 1 of 2

TECHNICAL MANUAL

for

RADIO SET
AN/MRC-55

SECTIONS 1 THROUGH 7

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

Clifton, New Jersey, U.S.A.

DEPARTMENT OF THE NAVY

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From: Chief, Bureau of Ships
To: All Activities concerned with the Installation, Operation, and Maintenance of the Subject Equipment

Subj: Technical Manual for Radio Set AN/MRC-55, NAVSHIPS 92911(A)

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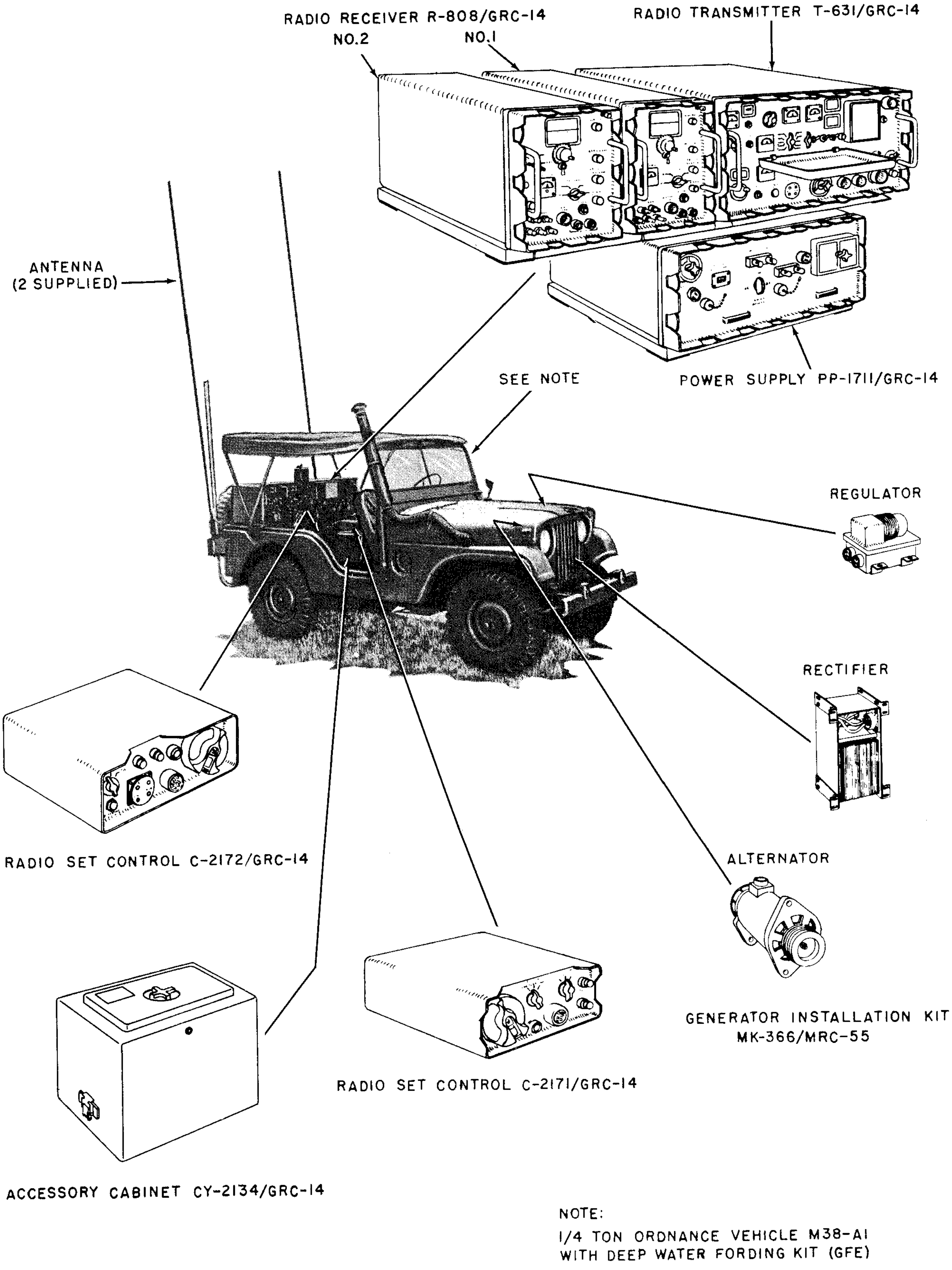


Figure 1-1. Radio Set AN/MRC-55

SECTION 1
GENERAL DESCRIPTION

1-1. INTRODUCTION.

This technical manual covers the theory, installation, operation, and maintenance of Radio Set AN/MRC-55.

1-2. PURPOSE AND BASIC PRINCIPLES.

a. PURPOSE. — Radio Set AN/MRC-55 is designed to provide two-way, high-frequency radio communication at either a fixed or mobile installation.

Note

The nomenclature assigned to identify the equipment for general ground use (fixed installation) is Radio Set AN/GRC-14. When Radio Set AN/GRC-14 is used with Generator Installation Kit MK-366/MRC-55 in a 1/4-ton Ordnance Vehicle M38-A1, the complete equipment (mobile installation) is designated Radio Set AN/MRC-55.

The radio set is capable of the transmission and reception of phone, cw, and frequency-shift keying; and the reception of modulated cw. The equipment transmits within the frequency range of 2 to 30 mc and receives through the range of 2 to 32 mc. The transmitter portion of the equipment covers its frequency range in steps of 100 cps with a nominal 100-watt output level, while the receiver portion is continuously tunable from 2 to 32 mc. Radio Set AN/MRC-55 operates either from its own vehicular power supply or from an external power source.

b. MODES OF OPERATION.

(1) TRANSMISSION.

(a) Radiophone (A3), amplitude modulation, using a push-to-talk method for transmission.

(b) Telegraphy (A1), cw key or cw teletype emission, using break-in keying facilities.

(c) Telegraphy (F1), frequency-shift keying (fsk) teletype with a carrier shift of ±500 cycles, using either neutral or polar keying.

(d) Facilities are provided for simultaneous transmission of radiophone and fsk teletype.

(2) RECEPTION.

(a) Radiophone (A3), amplitude modulation.

(b) Telegraphy (A1), cw key or cw teletype.

(c) Telegraphy (A2), modulated cw (mcw).

(d) Telegraphy (F1), frequency-shift keying (fsk), using internal frequency-shift converter; operating with either neutral or polar teletypewriter.

(e) Facilities are provided for simultaneous reception of radiophone and fsk teletype on the same frequency.

(3) RELAY OPERATION. — The radio set can be used as a relay station (communications link) for automatic retransmission of received radiophone signals.

c. TUNING PROCEDURES. — The receiver portion of Radio Set AN/MRC-55 is manually operated and tuned directly on the receiver front panel. The transmitting equipment is semiautomatically or manually tuned. Tuning is accomplished with a minimum number of operating controls located on the front panels. All operating and tuning controls on both receiver and transmitter are arranged to permit easy and rapid operation. When the transmitter has been set up for a selected operating frequency, tuning of the rf amplifier stages and antenna tuner is automatic. Time required for the automatic tuning portions of the equipment to function is approximately 30 seconds.

d. FREQUENCY SELECTION. — Transmitter frequency is selected by means of six direct-reading front-panel knobs, and is stabilized by locking a variable-frequency oscillator (vfo) to a reference oscillator with a front panel meter. The vfo is provided with a 0-100 calibration dial and associated calibration charts. Rotating drum-type counters are provided for other tuned circuits in the transmitter. The receiver is tuned directly on the front panel, and the selected frequency is displayed on an illuminated calibrated dial.

e. REMOTE OPERATION. — The equipment can be operated from a local remote or a field remote location. At the local remote location, push-to-talk and interphone facilities are provided at the radio operator's position in the vehicle. At the field remote location (up to one mile from the transmitting equipment), push-to-talk, interphone and cw keying with break-in facilities are provided. Remote control of the dynamotor is another feature of the control group.

f. PRIMARY POWER SUPPLY. — The receiving and transmitting equipment may be operated either from a 27.5-volt dc and 24-volt rms primary power source from the vehicle generating equipment, or from an external 115-volt, 60-cycle, ac source. (The 24-volt supply is required only for teletype operation.)

1-3. DESCRIPTION OF UNITS.

Figure 1-1 shows the major units supplied with Radio Set AN/MRC-55 and table 1-1 lists the equipment supplied with the radio set. Equipment required but not supplied with the radio set is listed in table 1–2; shipping box numbers, crated weights, and dimensions are given in table 1–3; the official nomenclature, common name, and reference symbol group for each major component and subassembly in the radio set are listed in table 1–4. Table 1–5 lists the electron tube, transistor and diode complement; table 1–6 lists the crystal complement.

a. RADIO TRANSMITTER T–631/GRC–14. The radio transmitter (figure 1–2) consists of a watertight cabinet (transmitter cover) housing a front panel and the transmitter main chassis. The transmitter main chassis is mounted in a sealed cabinet retained by front panel fasteners. Ventilating louvers may be closed to make the unit submersion-proof. All indicators, controls, and connectors are mounted on the front panel. The blower, antenna transfer relay and intake air filter are mounted as integral components in the main chassis. The main chassis also contains the following subassemblies capable of independent removal and replacement:

- Frequency Generator Units
  - Variable-Frequency Oscillator
  - Reference Oscillator and Mixer
  - Mixer-Stabilizer
- Audio-Frequency Amplifier
- Amplifier-Modulator
- Keyer Group
- Servo Control
- Radio-Frequency Tuner

Each of the subassemblies is provided with facilities for interconnection to the transmitter main chassis. In addition, the main chassis contains a protective power interlock switch.

(1) FREQUENCY GENERATOR UNITS. — Three removable subassemblies comprise the frequency generating section of the transmitting equipment: the variable frequency oscillator (vfo), reference oscillator and mixer, and mixer-stabilizer. The vfo is located on the bottom left front of the transmitter main chassis; the reference oscillator and mixer is located on the bottom right front of the main chassis; and the mixer-stabilizer is located on the bottom right rear of the main chassis between the keyer group and the servo control.

Frequency generation in the transmitter involves the use of a free-running oscillator operating at the output frequency of the transmitter. Accuracy of the variable master oscillator is maintained by comparing its output with the reference oscillator and mixer, providing a stable frequency source. Failure of the reference oscillator and mixer will still permit transmitter operation as a tunable-oscillator, power amplifier-type transmitter on all services except fsk. The mixer-stabilizer provides automatic frequency control for the vfo. Selection of transmitter operating frequency is controlled by a decade system of six knobs on the front panel of the equipment. Detachable couplers, connecting rotary switch shafts to the knobs on the front panel, provide control of rotary switches in the individual units.

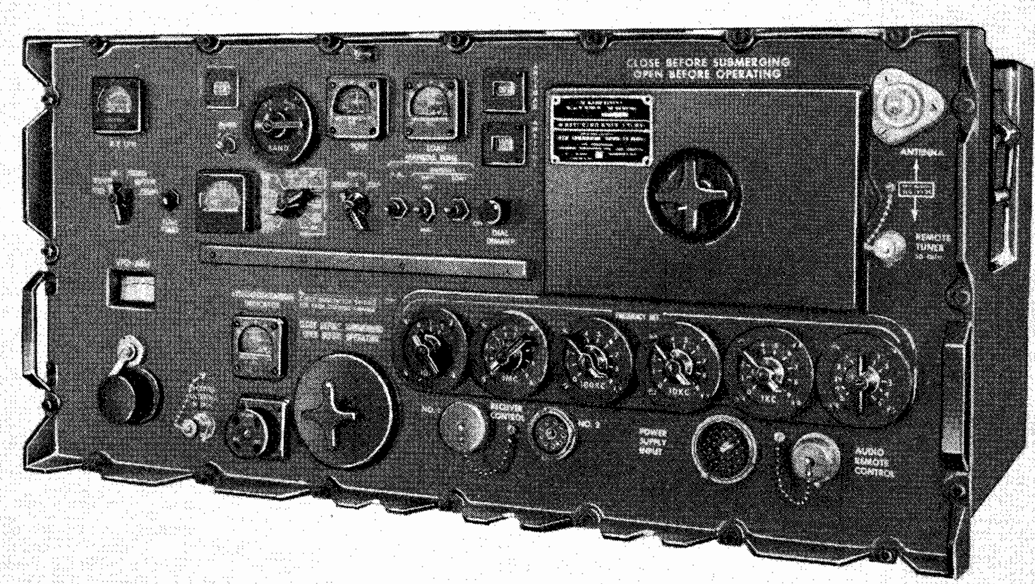


Figure 1–2. Radio Transmitter T–631/GRC–14, Front Oblique View

(2) AUDIO-FREQUENCY AMPLIFIER. — The af amplifier, a plug-in subassembly of the radio transmitter, receives phone input from the microphone or hand sets. During RELAY operation of the radio set, the received signals from the receiver are applied to the af amplifier. It contains circuitry necessary to amplify the audio voltages required to drive the modulator tubes in the amplifier-modulator, and to generate a sidetone signal during cw operation. The latter feature permits the equipment operator to monitor transmissions aurally.

The af amplifier is approximately 7 inches wide by 5-1/2 inches high by 3-1/2 inches deep, and is located on the top front center of the transmitter main chassis. Two captive screws secure the subassembly to the main chassis, and screw-mounted shield covers are provided for the top and both sides. A terminal board within the subassembly contains printed wiring on one side and associated component parts on the other. A shelf bracket contains three electron tubes, relay, transformers, capacitors, and a variable potentiometer.

(3) AMPLIFIER-MODULATOR. — The amplifier-modulator, a removable subassembly of the radio transmitter, is located on the top left of the transmitter main chassis, and is secured by six screws. It contains an input from the af amplifier to the push-pull modulator output stage for voice modulation of the rf carrier, an rf input from the vfo for power amplification, a control voltage from the servo control and a cw keying input from the keyer group. Output of the amplifier-modulator is applied to the rf tuner.

The tuning elements of the two-stage amplifier employ fixed capacitors which are ganged to permit selection by a single bandswitch, and variable inductors which are controlled by a single motor. Each variable inductor consists of the length of silver ribbon which is wound partly on a coil form and partly on a shorting drum. To change inductance, this ribbon is wound from the coil form onto the drum, and vice versa. The coil form and drum are driven synchronously by a motor and gear train for automatic tuning.

The amplifier-modulator is approximately 13 inches wide by 7 inches high by 15-3/4 inches deep. Variable inductors, a bandswitch, electron tubes, and transformers are mounted on top of the chassis; component parts, consisting of a blower assembly for cooling the modulator and power amplifier tubes, a shielded phase detector assembly, and a printed wiring board, are located on the underside.

(4) KEYER GROUP. — The keyer group, a plug-in subassembly of the radio transmitter, is located in the bottom right portion of the transmitter main chassis, between the mixer-stabilizer and the reference oscillator and mixer, where it is secured by two captive screws. It contains the relays and circuitry required to key the transmitter carrier on and off, and those required for automatic tuning of the transmitter. The relays are also used as components of the dynamotor control circuit. The keyer group also provides a dc voltage for use as microphone current supply.

The keyer group chassis is approximately 14-3/4 inches wide by 5-1/2 inches high by 2-1/2 inches deep. Relays and electron tubes are mounted on the outside, on top of the chassis, and component parts are located inside. Two shield covers are screw-mounted to both sides. Two panel-mounted connectors on the bottom of the chassis contain all electrical connections to the main chassis.

(5) SERVO CONTROL. — The servo control is a plug-in subassembly used for automatic operation of the transmitter. It is located in the bottom right rear corner of the transmitter chassis, where it is secured by two captive screws.

This assembly contains two similar servo amplifiers which act under control of sensing voltages to operate the motors that tune to resonance the tank circuits in the amplifier-modulator and the rf tuner. One servo amplifier controls the coil tuning motor in the rf tuner, while the other controls the capacitor tuning motor in the rf tuner and the coil tuning motor in the amplifier-modulator.

The servo control chassis measures approximately 15 inches wide by 6 inches high by 2-1/2 inches deep. The relays and electron tubes are mounted on top of the chassis; the other component parts and a printed wiring board are located on the inside. Two shield covers are screw-mounted on the subassembly, one on each side, and two panel-mounted connectors on the bottom of the chassis provide for all electrical connections to the main chassis.

(6) RADIO-FREQUENCY TUNER. — The rf tuner, a removable subassembly of the radio transmitter, is located on the top right of the transmitter main chassis and is secured by six mounting screws.

It is an impedance-matching device for matching the high input impedance of the antenna to the lower output impedance of the power amplifier stage in the amplifier-modulator. The rf tuner must be bypassed when the antenna input presents a low impedance such as that of a 50-ohm coaxial line or other low-impedance transmission line. Refer to paragraph 3–18*a* for the procedure for bypassing the rf tuner. The rf tuner contains two motor-driven variable elements, a resonating capacitor and a loading coil which is adjusted by the servo control. Impedance matching is achieved by simultaneous adjustment of both the inductive and capacitive elements. For automatic tuning, a phase detector circuit is used to sense the resonance of the circuits and the magnitude of the resulting impedance. The variable inductor is similar to that used in the amplifier-modulator described in paragraph 1–3*a* (3).

The rf tuner, a rectangular open-top chassis, is approximately 14 inches wide by 5-1/4 inches high by 10-3/4 inches deep. The phase detector assembly, rf connector, and cable harness are mounted on the right side of the chassis and the tuning mechanism gear trains are located on the front, all outside the chassis. The two drive motors, the variable capacitor, and the inductor with its shorting drum are located on the inside.

b. POWER SUPPLY PP-1711/GRC–14. — The power supply (figure 1–3) is housed in a watertight cabinet (power supply cover). It is mounted in the vehicle below the radio receivers and radio transmitter. Overall dimensions of the power supply are approximately 29 inches wide by 10 inches high by 17-1/2 inches deep. Ventilating louvers in the cabinet have covers which may be closed to make the unit submersion-proof. The power supply chassis contains the dynamotor, voltage regulators, rectifiers, control circuits and fuses. The power supply furnishes the power required for operation of the major units of Radio Set AN/MRC–55, with facilities for front panel connection of input and output power. In addition, it proprovides power necessary for operation of teletype equipment.

It may be operated either from the 27.5-volt dc and 24-volt rms vehicular generating system, or from an external 115-volt ac source. The 24-volt supply is required only for teletype operation. The transfer is made by means of a three-position switch located on the front panel of the power supply.

When the power supply is operating from the dc output of the vehicular generating system, the following voltages are supplied to the major units:

+1100 volts dc
+312 volts dc
+250 volts dc, regulated
−105 volts dc
+26.5 volts dc, supply to receivers (vehicular operation only)
+26.5 volts dc, control voltage
+115 volts dc, for teletype equipment

When the power supply is operated from an external 115-volt, 60-cycle, ac source, the input voltage is stepped down, rectified, and fed to the dynamotor to provide the same output voltages as are obtained when operating from the vehicular dc power system, except that 115-volt, 60-cycle, ac is supplied to the receiver instead of +26.5-volt dc.

c. RADIO RECEIVER R–808/GRC–14. — Two identical superheterodyne radio receivers with a frequency range of 2 to 32 mc (in four bands) are supplied. (See figure 1–4.) They may be operated as a part of the overall radio set, or individually. Each is capable of receiving cw, modulated cw, phone, and fsk signals. An fsk converter is incorporated for directly keying a teletype loop circuit.

The radio receivers are mounted at the top left of the power supply. Overall dimensions of the radio receiver are approximately 10 inches wide by 13-3/4 inches high by 15-3/4 inches deep. It consists of a watertight cabinet (radio receiver cover) and the main chassis containing the following removable subassemblies:

Radio-Frequency Head
Intermediate-Frequency Amplifier
Amplifier-Power Supply
Frequency-Shift Converter

All indicators, controls and connectors are mounted on the front panel of the radio receiver.

(1) RADIO-FREQUENCY HEAD.—The rf head, a removable subassembly of the radio receiver, is located in the right center of the receiver main chassis, and is mounted on brackets by means of four screws.

It uses two stages of rf amplification. A local oscillator, in conjunction with a tuned harmonic amplifier, is employed to generate an if. frequency for reception of the 2 to 8-mc range. Double conversion with a crystal-controlled converter is utilized in the frequency range above 8 mc. An input from a crystal oscillator in the amplifier-power supply is employed to permit

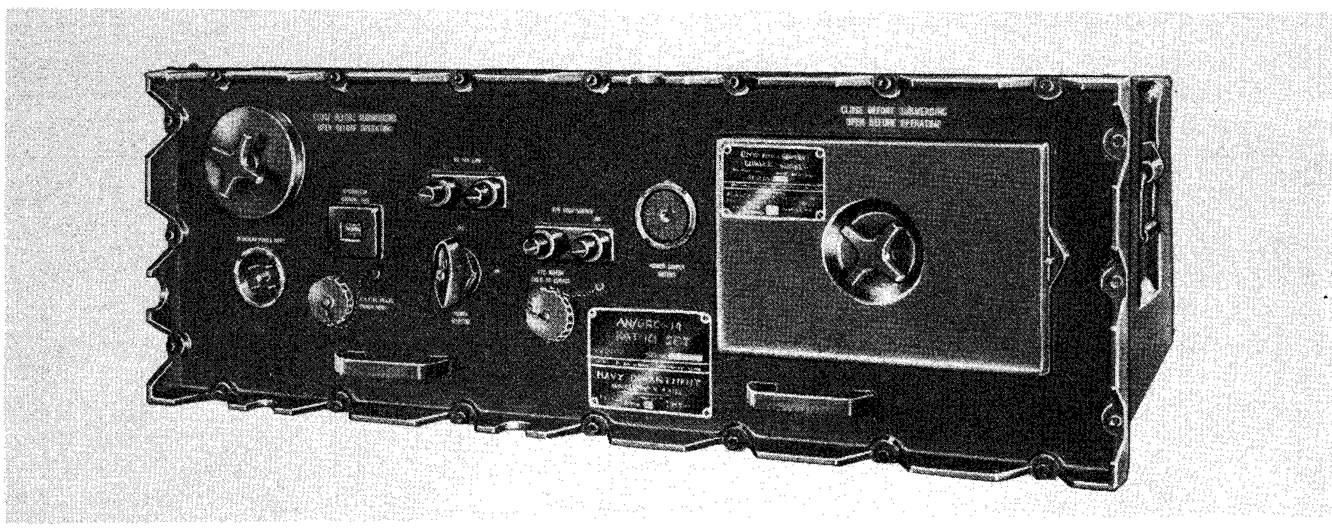


Figure 1–3. Power Supply PP–1711/GRC–14, Front Oblique View

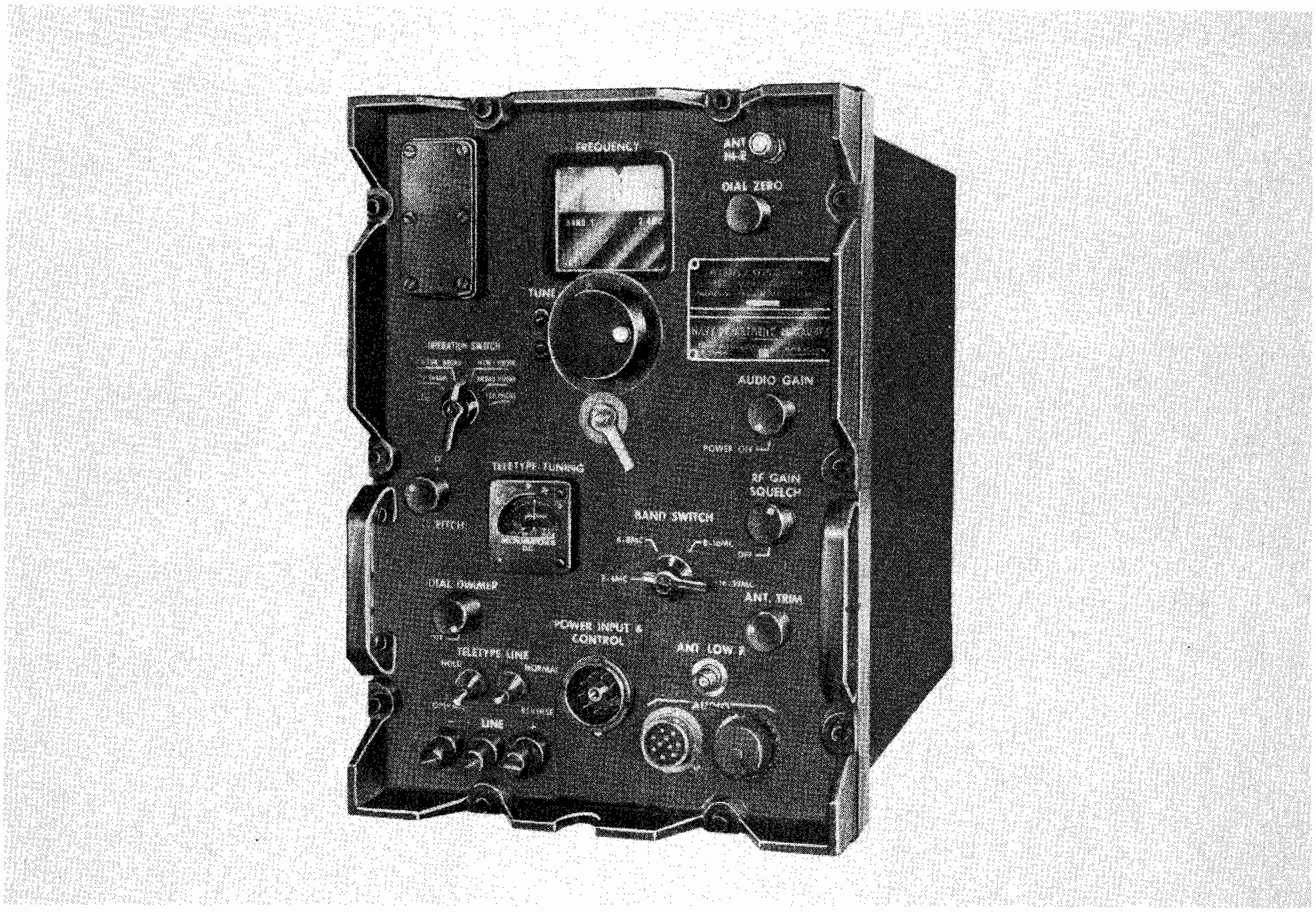


Figure 1-4. Radio Receiver R-808/GRC-14, Front Oblique View

dial calibration at an accuracy of better than 0.05 percent.

Overall dimensions for the rf head are approximately 14-1/4 inches wide by 8-1/2 inches high by 4-3/4 inches deep. Component parts are located inside the chassis with partitions and side covers employed for shielding. The five-section main tuning capacitor is located in a separate compartment, made accessible by removing the screw-mounted side covers. Electron tubes and adjustments for the variable if. and rf transformers are located on the outside, on the top and bottom of the subassembly. Coupling between the receiver front panel controls and the rf head subassembly is achieved by means of flexible couplers and arm assemblies.

(2) INTERMEDIATE-FREQUENCY AMPLIFIER. — The if. amplifier, a plug-in subassembly of the radio receiver, is located in the bottom left corner of the receiver main chassis, and is mounted by means of two captive screws.

The 455-kc signal entering the if. amplifier from the rf head is amplified and converted to an audio signal. Because of a low stage-by-stage gain, four stages of if. amplification are employed. The audio signal output is applied to the input stage of the amplifier-power supply. An output signal is taken off the third if. amplifier for application to the frequency-shift converter. A separate automatic gain control stage is employed to provide an agc voltage. Output from a beat frequency oscillator is applied to the detector stage when the radio receiver is operating on cw.

Overall dimensions of the if. amplifier are approximately 13-1/2 inches wide by 6 inches high by 1-1/4 inches deep. The chassis is rectangular in shape with electron tubes and if. transformers mounted on the outside. Component parts and a printed wiring board are located on the inside, and are shielded by a screw-mounted side cover. Detachable couplings are employed to connect the shafts of the variable components to the receiver front panel controls.

(3) AMPLIFIER-POWER SUPPLY. — The amplifier-power supply, a plug-in subassembly of the radio receiver, is secured by means of screws to the top of the receiver main chassis. It contains the receiver power supply, audio frequency amplifier circuits, and a crystal oscillator used to calibrate the main tuning dial.

The af signal from the if. amplifier is amplified in the audio frequency amplifier circuits and is available at the receiver front panel receptacles for handset, earphone and loudspeaker use in all modes of operation except fsk. The audio signal is also used by the transmitter as a modulating voltage during RELAY operation. An adjustable squelch circuit for am. operation is used to maintain quiet operation of the radio receiver. A noise limiting circuit is used to limit impulse type interference such as atmospheric and ignition noise.

Input power to the power supply portion of the amplifier-power supply is controlled by a switch located on the front panel of Power Supply PP–1711/GRC–14. This power supply provides filament power and plate voltage to all subassemblies of the radio receiver.

When the vehicular generating system is being used as the source of input power, only the transistorized voltage regulator portion of the power supply is used. The vehicular 26.5 volts dc is then applied directly to the voltage regulator, and the voltage regulator output of +21 volts dc is distributed throughout the radio receiver. An additional output of +26.5 volts dc, unregulated, is supplied for use in the receiver.

When an external 115-volt, 60-cycle, ac source is used for input power, it is applied directly to the rectifier portion of the power supply. The stepped-down output of the rectifier, after filtering, is then divided with one part being applied to the voltage regulator circuit to provide a +21-volt dc output, and the other part (+26.5 volts, unregulated) being fed directly to the output of the amplifier-power supply for distribution within the receiver.

(4) FREQUENCY-SHIFT CONVERTER. — The fs converter, a plug-in subassembly of the radio receiver, is located in the bottom center of the receiver main chassis, between the if. amplifier and the rf head, and is mounted by two captive screws.

Two different types of frequency shift converter are supplied as part of the receiver. Radio Receivers R–808/GRC–14 having serial numbers 1 through 115, inclusive, use an af-type discriminator, whereas the remaining receivers use an if.-type discriminator. Both types are mechanically similar and can be physically interchanged.

The frequency-shifted signals from the if. amplifier are fed to the fs converter to obtain discrimination between the mark and space signals in order to operate an fsk keying relay. This relay, which is part of the fs converter is used to operate the teletypewriter selector magnet.

Overall dimensions of the fs converter subassembly are approximately 13-1/2 inches wide by 6 inches high by 1-7/8 inches deep. The unit is rectangular in shape, and has its electron tubes and larger components mounted on the outside. Component parts and a printed wiring board are located on the inside and shielded by a screw-mounted side cover.

d. RADIO SET CONTROL GROUP OA–1444/GRC–14. — Radio Set Control Group OA–1444/GRC–14 (figure 1–5) consists of Radio Set Control C–2171/GRC–14 (local remote control) and Radio Set Control C–2172/GRC–14 (field remote control).

The control group provides keying, talking and listening facilities for Radio Set AN/MRC–55 to a remote point (up to one mile) by means of a telephone line. It also provides ringing and telephone communication between local remote control and field remote control. Another function is the extension of power control (dynamotor) of the radio set to the field remote control unit.

(1) RADIO SET CONTROL C–2171/GRC–14. — Local remote control provides a local terminal in the vehicle for field remote control, in addition to push-to-talk control of the radio transmitter from a remote point in the vehicle.

The interphone circuit between the local and field remote control units consists of line transformers joined by telephone lines, with dry cells installed, and with microphones and phones connected to their respective windings. Ringing is achieved by cranking a hand ringer which operates a bell or call light under control of a switch within the units.

Control and mode of operation of the transmitter are determined by two switches on the front panel (SERVICE and OPERATION). In LOCAL; AM operation, the dynamotor is placed under control of the push-to-talk switch of the microphone or handset.

The local remote control is a compact, lightweight, watertight unit, rectangular in shape, with overall dimensions of approximately 8-3/4 inches wide by 3-1/2 inches high by 10-1/2 inches deep. It may be removed from its case by loosening the two captive thumb screws on the front panel. The submersion-proof front panel contains the control, indicator, ringer, and line terminals.

The local remote control contains three plug-in relays for the control circuit which are necessary for AM, CW/FSK operation from the field remote control. A five-wire cable assembly is used for connecting local remote control to the transmitter front panel.

(2) RADIO SET CONTROL C–2172/GRC–14. — Field remote control provides means for controlling the radio set in am. and cw keying operation over a two-wire telephone line (600 ohms) up to one mile in length. Telephone operation with ringing facilities between the remote control units is also provided. When a teletypewriter set is to be used with the radio set from a remote position, the teletype circuit is connected directly to the radio set in the vehicle and the field remote control is used to turn the dynamotor on and off.

Control of the dynamotor is accomplished by a control circuit consisting of a SERVICE selector switch, a 45-volt dc control voltage supplied by a battery in field

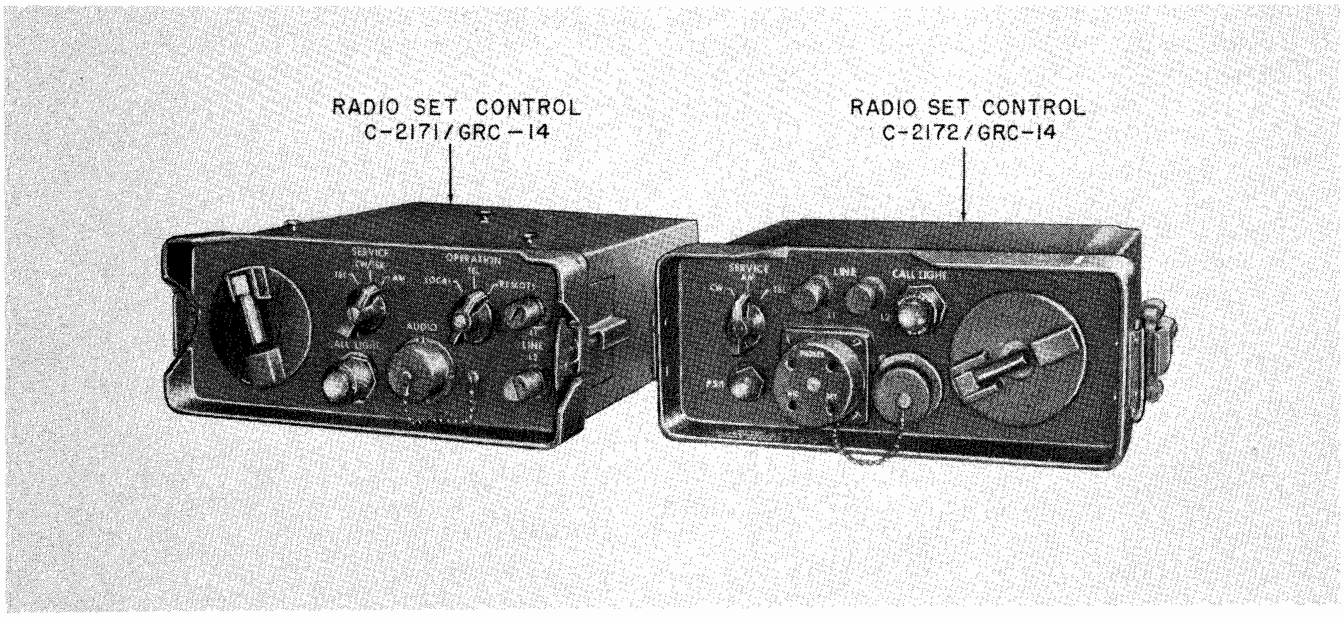


Figure 1-5. Radio Set Control Group OA-1444/GRC-14, Front Oblique View

remote control, and control relays located in local remote control. The circuit is completed by the push-to-talk switch in am. operation, and "key down" or FSK control (on the front panel of the field remote control) in cw keying or fsk teletype operation.

The interphone circuit of field remote control is similar to that of local remote control.

The field remote control is similar in size and appearance to the local remote control. Overall dimensions are approximately 9-1/2 inches wide by 3-1/2 inches high by 7-1/4 inches deep. It may be removed from its watertight case by loosening the snap fasteners at each side. The submersion-proof front panel contains all controls and terminals required for the operation of the field remote control. Provisions have been made for connecting two headsets, a microphone, and a key, in addition to Handset H-33(E)/PT. A carrying strap is provided to facilitate carrying the unit.

e. GENERATOR INSTALLATION KIT MK-366/MRC-55. — The generator system, supplied in kit form, replaces the original 28-volt dc, 25-amp vehicular generating system. It is a heavy duty, 28-volt, 100-amp, rectified ac electrical generating system that includes an alternator (generator), rectifier, regulator assembly, and interconnecting cables.

The alternator is driven by four belts from the engine output shaft, and delivers three-phase, low-voltage energy to the selenium rectifier unit. Voltage from the rectifier is used to charge the vehicle batteries under control of the voltage regulator, and to supply other loads required from the 28-volt dc power system. Full charging rates are obtained at relatively low engine speeds.

f. ANTENNA SET. — The antennas to be used with Radio Set AN/MRC-55 consist of two long-wire antennas for use with a fixed installation, and two whip antennas for vehicular use. Both whip antennas measure 15 feet in length, with either whip antenna extendable to 30 feet for semi-fixed station operation from the vehicle. The whip antennas are mounted by means of mast brackets, in the rear of the vehicle at the port and starboard sides.

Refer to table 3-2 for the list of items comprising the antenna set.

g. ELECTRONIC EQUIPMENT INSTALLATION KIT MK-371/MRC-55 AND MOUNTING BASES.— The installation material consists of the following items necessary for the installation of Radio Set AN/MRC-55 in Ordnance Vehicle M38-A1.

Mounting MT-1832/U (Power Supply)
Mounting MT-1833/U (Transmitter-Receiver)
Mounting MT-1834/U (Accessories Cabinet)
Mast Base MP-57 (2 used)
Insulator Brackets (2 used)
Hardware (all installation hardware, except vehicular generator system hardware)

h. ACCESSORY KIT MK-377/GRC-14.— The accessory kit consists of the following:

Accessory Cabinet CY-2134/GRC-14.
Accessories
Interconnecting Cables

The accessory cabinet is used to store the accessories used with the radio set. The interconnecting cables are used to interconnect the major units of the radio set. The accessories supplied with the radio set consist of the following items. Note that H2901 through H2906, and E2901 and E2902 are located in tool bag A2901.

Headset, type NT–49507
Headset extension cord, type CX–1334/U
Handset, type H–33(E)/PT
Hand microphone, type T–17
Dynamic loudspeaker, type LS–166/U
Telegraph key, type NT–26026
Telegraph key, leg-band type NT–10531
Wrench, hex-head, #4 (H2901)
Wrench, hex-head, #6 (H2902)
Wrench, hex-head, #8 (H2903)
Wrench, hex-head, 1/4 inch (H2904)
Wrench, hex-head, 7/16 inch (H2905)
Wrench, hex-head, 3/8 inch (H2906)
Wrench, hex-head, #10–12 (H2907)
Aligner, core (E2901)
Aligner "J" tran (E2902)
Tool bag (A2901)

1–4. REFERENCE DATA.

a. Nomenclature.— Radio Set AN/MRC–55

b. Contract Data. — NObsr–71017

c. Contractor. — Federal Telephone and Radio Company, Clifton, New Jersey

d. Cognizant Naval Inspector. — Inspector of Naval Material, Newark, New Jersey

e. Frequency Range. —
Transmitter: 2 to 30 mc, in 100-cps steps
Receiver: 2 to 32 mc, continuous

f. Tuning Bands. —
Transmitter: Band 1: 2 to 3 mc
Band 2: 3 to 6 mc
Band 3: 6 to 10 mc
Band 4: 10 to 20 mc
Receiver: Band 1: 2 to 4 mc
Band 2: 4 to 8 mc
Band 3: 8 to 16 mc
Band 4: 16 to 32 mc

g. Type of Frequency Control. — Variable frequency oscillator
Crystal reference oscillator
Frequency shift oscillator

h. Types of Emission and Modulation Capability. — A1 (cw)
A3 (phone) 100%
F1 (fsk) ±150 cps to ±500 cps

i. Nominal Carrier Output (into a 50-ohm load). —
A1: 100 watts
A3: 100 watts
F1: 100 watts

j. Peak Power Output. — 400 watts (A3, 100% modulation)

k. Type Receiver. — Superheterodyne (double conversion on bands 3 and 4)

l. Intermediate Frequency. — 455 kc and 1500 kc

m. Intermediate Frequency Selectivity.—
Sharp: Total bandwith at 6 db points 3.5 ± 0.5 kc
Broad: Total bandwith at 6 db points 7 ± 1 kc

n. Receiver Frequency Range of Local Oscillator. —
Bands 1 and 2: 2.18 to 4.50 mc
Bands 3 and 4: 8.65 to 17.90 mc

o. Type of Reception. — A1, A2, A3, and F1

p. Crystals, Quartz:
Transmitter: 28 crystals
Receiver: 3 crystals

q. Frequency Accuracy. —
Transmitter: ±200 cps after one hour warm-up
Receiver: ±0.05% (between calibration points)

r. Receiver Squelch Circuit. — Cuts off the audio amplifier in the absence of an rf input signal. (Turns on transmitter when using RELAY operation.)

s. Input and Output Impedances. —
Transmitter Input: 100 ohms (microphone)
600 ohms (for line from field remote control)
Transmitter Outputs: High impedance (to match 15 or 30-foot whip, or long-wire antenna)
50 ohms (with rf tuner bypassed)
Receiver Input: 300 ohms (HI–Z); 50 ohms (LOW–Z)
Receiver Output: 600 ohms

t. Response Characteristics. —

Transmitter Audio Frequency: ±3 db of 1000-cycle response over range of 300 to 3500 cycles. The audio frequency response is down 30 db minimum at all frequencies below 100 cycles.

Receiver Audio Frequency (Sharp): Bandwith 350 cps at ±6 db

Receiver Audio Frequency (Broad): Variation in response, between 300 and 3000 cps, does not exceed ±3 db relative to 1000 cps

u. Antenna Characteristics. — Antenna tuning equipment is capable of tuning into a 15 to 30-foot whip antenna, or into a long-wire antenna. Automatic transfer between transmitter and receiver in any operation.

v. Power Supply Characteristics. —

Operating Power Requirements: +26.5-volt dc and 24-volt, 60 to 600-cps ac (24-volt ac required only for teletype operation)
or
115-volt, 60-cps ac

Output voltages (dc): +1100 volts
+250 volts, regulated
+312 volts
−105 volts
+26.5 volts
+115 volts, filtered
+115 volts, unfiltered

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	DESIGNATION	OVERALL DIMENSIONS*			VOLUME*	WEIGHT*
			HEIGHT	WIDTH	DEPTH		
1	Transmitter, Radio	T-631/GRC-14	13-3/4	29	17-1/2	4.04	157
1	Power Supply	PP-1711/GRC-14	10	29	17-1/2	2.94	284
2	Receiver, Radio	R-808/GRC-14	13-3/4	10	17-1/2	1.39	71
1	Control, Radio Set	C-2171/GRC-14	3-3/4	10-3/8	8-7/8	0.2	8
1	Control, Radio Set	C-2172/GRC-14	3-11/16	9-3/8	7-1/8	0.14	7
1 set	Installation Kit, Electronic Equipment	MK-371/MRC-55					
1 set	Installation Kit, Generator	MK-366/MRC-55					91
1 set	Accessory Kit, Cabinet, Accessory	MK-377/GRC-14 CY-2134/GRC-14	9-1/4	7-5/8	11-9/16	0.47	15
1	Mounting	MT-1832/U	1-3/4	14-3/4	4	0.06	7
1	Mounting	MT-1833/U	3-1/2	50	16-3/8	1.66	59
1	Mounting	MT-1834/U	1-5/16	10-3/4	8-1/8	0.07	1
1 set	Antenna Set						22
2	Technical Manual	NAVSHIPS 92911(A)					3

*Dimensions are in inches, volume in cubic feet, and weight in pounds.

TABLE 1–2. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	1/4-Ton, 4 x 4 Ordnance Vehicle	M38–A1	Equipment portage	With deep-water fording kit
1 set	Teletypewriter Set	AN/TGC–6	Teletype transmission and reception	With Teletypewriter TT–4/TG
1	Technical Manual, Teletypewriter TT–4/TG	TM 11–2234 (TO 16–35TT 4–5)	Instructions	
1	Handbook of Test Methods and Practices	NAVSHIPS 91828(A)	Instructions for corrective maintenance	
	Test Equipment	(See table 7–1.)	(See section 7.)	(See table 7–1.)

TABLE 1–3. SHIPPING DATA

SHIPPING BOX NO.	CONTENTS		OVERALL DIMENSIONS*			VOLUME*	WEIGHT*
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
1	Transmitter, Radio	T–631/GRC–14	39	24	23	12.5	230
2	Power Supply	PP–1711/GRC–14	39	24	16	8.7	310
3	Receiver, Radio (No. 1)	R–808/GRC–14	22	17	22	4.8	105
4	Receiver, Radio (No. 2)	R–808/GRC–14	22	17	22	4.8	105
5	Control, Radio Set Control, Radio Set	C–2171/GRC–14 C–2172/GRC–14	12	12	12	1.0	18
6	Mounting Mounting Mounting Desk, Radio Equipment	MT–1832/U MT–1833/U MT–1834/U	52	20	7	4.2	102
7	Accessory Kit Cabinet, Accessory Accessories Interconnecting Cables (7) Antenna Set Insulator Brackets (2) Mast Base (2) Hardware Technical Manual (2)	MK–377/GRC–14 CY–2134/GRC–14 MP–57 NAVSHIPS 92911(A)	46	20	14	7.6	130
8	Installation Kit, Generator	MK–366/MRC–55	22	18	16	3.6	112
9	Equipment Spares		39	24	16	8.7	122

*Dimensions are in inches, volume in cubic feet, and weight in pounds.

TABLE 1-4. GENERAL NOMENCLATURE

OFFICIAL NOMENCLATURE	COMMON NAME	REFERENCE SYMBOL GROUP
Transmitter, Radio T-631/GRC-14	Radio transmitter	
	Main chassis	1301-1399
	Variable frequency oscillator (vfo)	101-299
	Reference oscillator and mixer	401-599
	Mixer-stabilizer	701-799
	Keyer group	801-899
	Rf tuner	1201-1299
	Amplifier-modulator	1001-1099
	Af amplifier	1101-1199
	Servo control	901-999
	Transmitter cover	
Power Supply PP-1711/GRC-14	Power supply	1401-1499
	Power supply cover	
Receiver, Radio R-808/GRC-14	Radio receiver	
	Main chassis	1501-1599
	Rf head	1501-1599
	Amplifier-power supply	1501-1599
	If. amplifier	1601-1699
	Fs converter	1701-1799
	Receiver cover	
Control Group, Radio Set OA-1444/GRC-14	Control group	
Control, Radio Set C-2171/GRC-14	Local remote control (with mounting)	1901-1999
Control, Radio Set C-2172/GRC-14	Field remote control (with mounting)	2001-2099
	Antenna set	3001-3099
Installation Kit, Electronic Equipment MK-371/MRC-55	Installation kit insulator brackets hardware	3101-3199
Mounting MT-1832/U	Power supply mounting	2401-2499
Mounting MT-1833/U	Transmitter-receiver mounting	2301-2399
Mounting MT-1834/U	Accessories cabinet mounting	2601-2699
Installation Kit, Generator MK-366/MRC-55	Generator system	2200-2299
Accessory Kit MK-377/GRC-14	Accessory kit	
Cabinet, Accessory CY-2134/GRC-14	Accessories cabinet	2801-2899
	Accessories interconnecting cables	2100-2199

TABLE 1–5. RADIO SET AN/MRC–55, ELECTRON TUBE, TRANSISTOR AND DIODE COMPLEMENT*

UNIT	ZA-8	1N69	1N251	1N540	1N645	2N117	2N174	2N340	2N539	4JA11DC1AD1	4JA60A	4JA411BC1ADZ	4X250F	6AH6	6AJ5	6CL6	12AT7WA	12BA6	26A6	5651	5654/6AK5W	5687WA	5725/6AS6W	5750/6BE6W	5751	5751WA	5814A	6005/6AQ5W	6082	TOTAL
Transmitter, Radio T631/GRC–14																														
Variable Frequency Oscillator					3																	1					1			5
Reference Oscillator and Mixer																	1				4		1	1						7
Mixer-Stabilizer		2												6																8
Keyer Group					3																							2		5
RF Tuner		4																												4
Servo Control																	2					1			2					5
Amplifier-Modulator		5		4									3			1														13
AF Amplifier																	2	1												3
Power Supply PP–1711/GRC–14										1	2									1						1			2	7
Receiver, Radio R–808/GRC–14																														
Main Chassis							4		2																					6
RF Head															10		2							2						14
Amplifier-Power Supply	2	4				2		4				2			8		4													26
IF Amplifier															10		2													12
FS Converter note 1 / note 2			— / 4		10 / —			4 / 4											8 / 6											22 / 14
Total Number of Each Type note 1 / note 2	2	15	— / 4	4	16 / 6	2	4	8 / 8	2	1	2	2	3	6	28	1	13	1	8 / 6	1	4	2	1	3	2	1	1	2	2	137 / 129

*Includes both receivers.
Note 1. Quantities are for radio sets having receivers with serial numbers 1 through 115 inclusive.
Note 2. Quantities are for radio sets having receivers with serial numbers 116 and following.

TABLE 1-6. RADIO SET AN/MRC-55 CRYSTAL COMPLEMENT

SYMBOL	OSCILLATING FREQUENCY	SYMBOL	OSCILLATING FREQUENCY
RADIO TRANSMITTER T-631/GRC-14			
Y401	3.7 mc	Y415	12 mc
Y402	3.8 mc	Y416	13 mc
Y403	3.9 mc	Y417	14 mc
Y404	4.0 mc	Y418	15 mc
Y405	4.1 mc	Y419	16 mc
Y406	4.2 mc	Y420	17 mc
Y407	4.3 mc	Y421	18 mc
Y408	4.4 mc	Y422	17 mc
Y409	4.5 mc	Y423	16.5 mc
Y410	4.6 mc	Y424	16 mc
Y411	8 mc	Y425	18 mc
Y412	9 mc	Y426	17.5 mc
Y413	10 mc	Y427	11.666666 mc
Y414	11 mc	Y428	13.333333 mc
RADIO RECEIVER R-808/GRC-14			
Y1501	200.000 kc		
Y1502	1955.000 kc		
Y1701	452.500 kc		

NOTES

SECTION 2
THEORY OF OPERATION

2-1. OVERALL FUNCTIONAL DESCRIPTION OF RADIO SET AN/MRC-55.

The major components of Radio Set AN/MRC-55 consist of a transmitter, power supply, two identical receivers, a vehicular ac-dc generation system and two remote control units, mounted in a 1/4 ton 4 x 4 ordnance vehicle (M38-A1), with a deep-water fording kit for mobile use.

Overall functional and detailed descriptions of the components comprising the radio set are found in this section. Refer to figure 2-1 for an overall functional diagram.

To simplify the following discussion, components of the radio set will be referred to by their common names. (See table 1-4.)

2-2. RADIO TRANSMITTER T-631/GRC-14.

a. OVERALL FUNCTIONAL DESCRIPTION.— The transmitter portion of the radio set operates in the frequency range of 2 to 30 mc, covered in four bands. Transmission facilities for cw (A1), phone (A3), and fsk (F1) signals are provided, and simultaneous fsk and phone transmission is possible. The transmitter is capable of operating from a polar or neutral teletypewriter at a remote side as far as one mile away from the equipment. Refer to figure 2-2 for a functional diagram of the transmitter.

The transmitter has an automatic frequency control feature which incorporates two frequency generating sources. Output from the continuously tunable vfo is compared with the output from the reference oscillator and mixer which serves as a frequency standard. Variations of frequency in the vfo are corrected by the reference oscillator and mixer to provide extreme frequency stability. Failure of the reference oscillator and mixer will not disable the transmitter, as operation will still be possible on all services except fsk, although frequency accuracy will be reduced.

Frequency-shift keying is accomplished by changing the frequency of interpolation oscillator V401A (in the reference oscillator and mixer) by a fixed amount.

The rf amplifier portion of the amplifier-modulator and the rf tuner incorporate automatic tuning features. When the operator depresses TUNE START switch S1304, the amplifier stages and the antenna tuner will tune themselves. Manual tuning of these stages can be used in the event of failure of the automatic tuning circuit.

The output of the vfo in the 2 to 30-mc frequency range is fed to the reference oscillator and mixer, whose output includes three frequencies. The 2 to 30-mc output from the vfo is heterodyned to produce a frequency which is in the 2 to 3-mc range. Two oscillators produce frequencies in the 1.6005 to 1.7-mc range and the 3.7 to 4.6-mc range. The latter frequencies are mixed in the mixer-stabilizer to produce a beat frequency which is also in the 2 to 3-mc range. The two heterodyned frequencies, each in the 2 to 3-mc range, are compared in the mixer-stabilizer. If the vfo is exactly on frequency and phase-locked, there will be no output from the mixer-stabilizer. However, if the output frequency from the vfo is inaccurate, a control voltage will be fed back to the vfo to set the oscillator on the correct frequency and phase.

Stabilized output from the vfo is fed to the amplifier-modulator for power amplification. Output of the af amplifier is also applied to the amplifier-modulator for voice-modulation of the rf carrier. To allow for automatic tuning of rf amplifier stages, the vfo output is applied to a phase detector which compares the vfo frequency with the phase of the rf amplifier tank circuit circulating current. If the amplifier tank circuit is not resonant to the vfo frequency, a dc control voltage will be fed to the servo control, which will, in turn, cause a motor to tune variable inductors in the rf amplifier to bring them to the correct resonant point.

The output of the amplifier-modulator is fed to the rf tuner, which matches the antenna input impedance to the output impedance of the power amplifier stage in the amplifier-modulator. The output from the power amplifier is fed to a phase detector in the rf tuner. If the rf tuner is not tuned to the correct resonant and impedance matching points, a dc control voltage will be fed to the servo control which will, in turn, cause motors to tune a variable capacitor and a variable inductor in the rf tuner to the correct points.

Motors in the amplifier-modulator and the rf tuner may also be energized manually by front panel toggle switches. The variable components can then be tuned manually, using front panel meters as tuning indicators.

b. FREQUENCY GENERATING SECTION. *(See figure 2-3.)*— Three separate and removable subassemblies comprise the frequency generator: vfo, reference oscillator and mixer, and the mixer-stabilizer. The

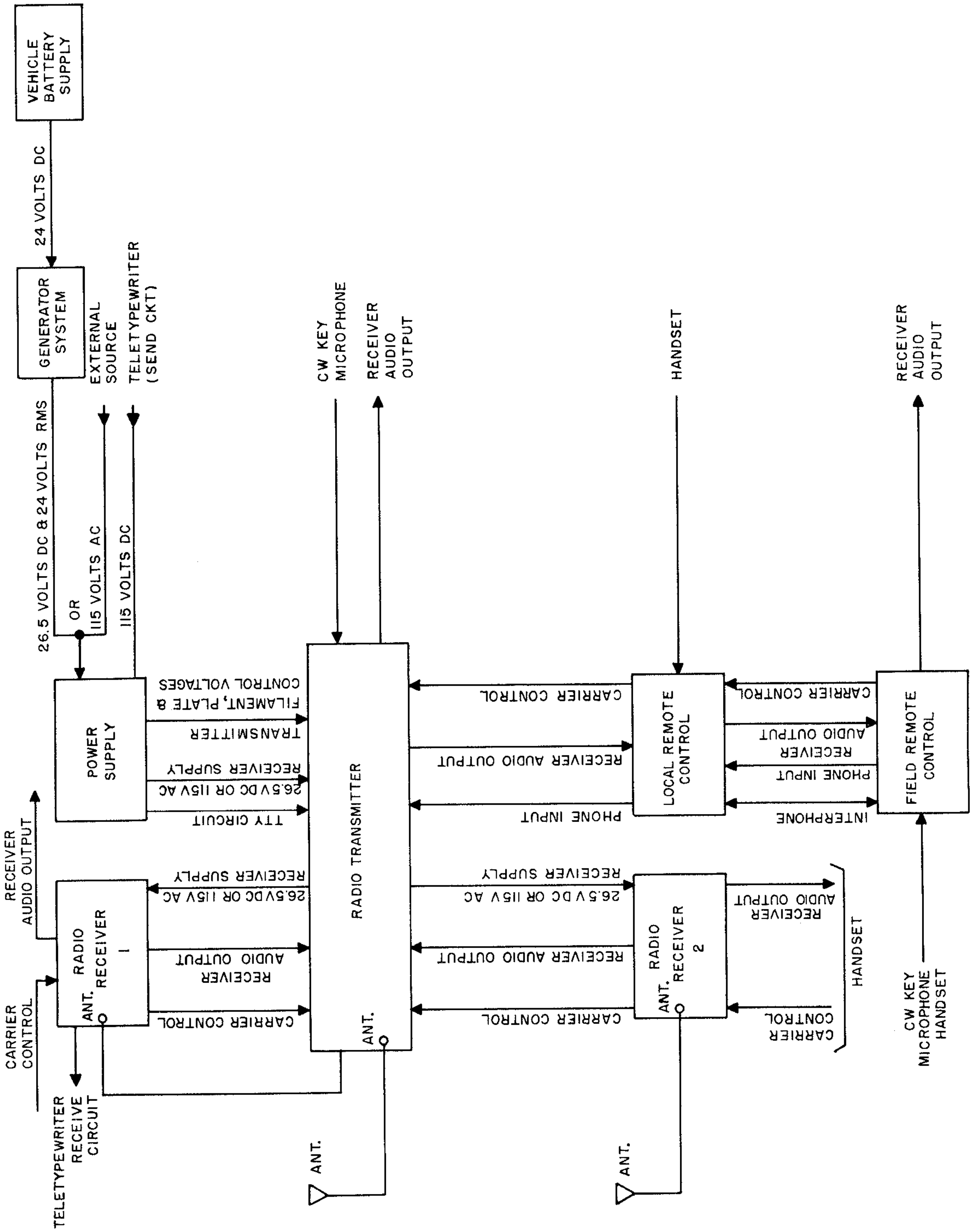


Figure 2–1. Radio Set AN/MRC–55, Block Diagram

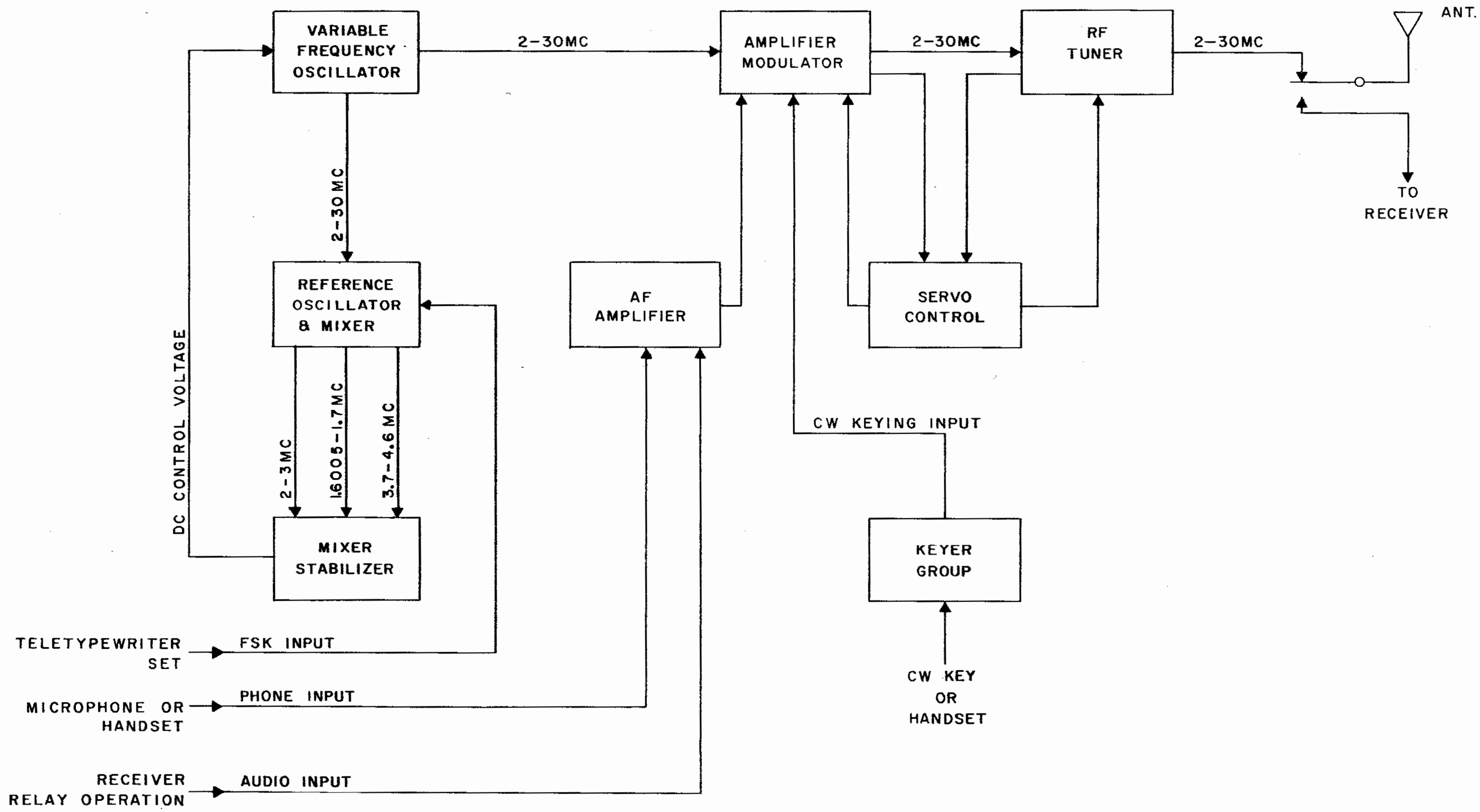


Figure 2-2. Radio Transmitter Functional Block Diagram

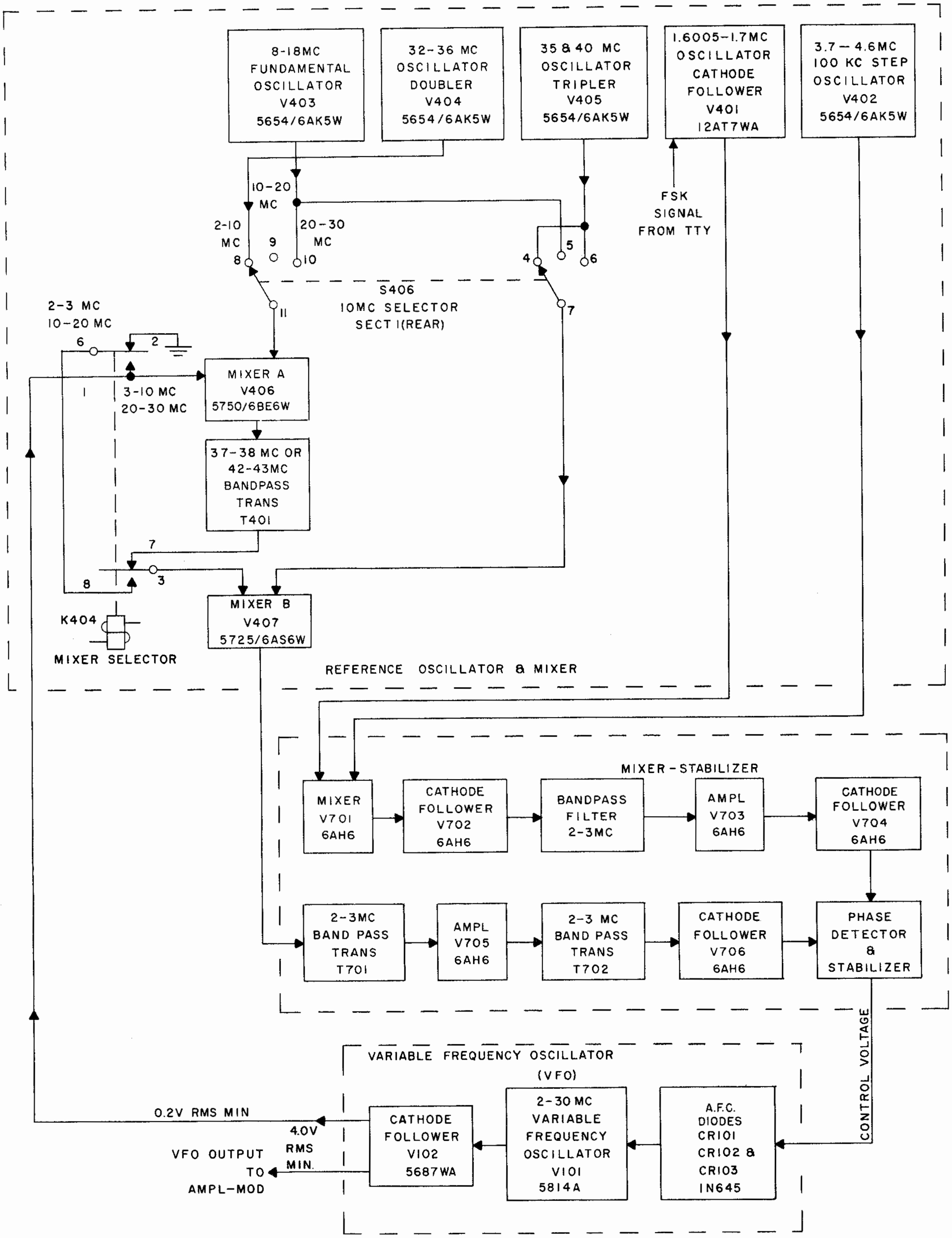


Figure 2–3. Radio Transmitter Frequency Generating Subassemblies, Block Diagram

principle of frequency generation in the radio set involves the use of a free-running tunable oscillator in the vfo covering the 2 to 30-mc range. This tunable oscillator is stabilized by continuous comparison of its output frequency in the mixer-stabilizer with reference frequencies generated in the reference oscillator and mixer. While 13 tubes are utilized in the latter units, failure of any one of these tubes will still permit use of the equipment as a standard tunable-oscillator transmitter for all services except fsk.

The reference frequencies are derived from crystal-controlled oscillators having temperature-controlled crystals, and one LC interpolation oscillator whose principal frequency-determining circuit elements are temperature-compensated. Selection of the desired transmitting frequency, the appropriate crystal harmonic frequencies, and proper setting of the interpolation oscillator is made by a series of knobs, each representing a digit of the output frequency, on the front panel of the equipment. A separate front panel control, which selects transmitting frequencies between the 1-mc points, is rotated until the vfo is locked in at the dial-indicated frequency. The proper 1-mc band of the oscillator is automatically selected by the position of the 10-mc and 1-mc controls.

Locking (stabilizing) is accomplished by a phase detector circuit in the mixer-stabilizer, whose output is displayed on a front panel meter. When the tunable oscillator is locked in, its frequency bears an exact relationship to the frequencies of the crystal oscillators and interpolation oscillator used as references.

When frequency shift transmissions are desired, provision is made in the equipment for adjusting or displacing the frequency of the interpolation oscillator by a controllable amount. This shifting of the reference frequency used for comparison, operating through the variable reactance elements controlling the tunable oscillator, causes the oscillator to shift its frequency by exactly the same amount of shift introduced into the interpolation oscillator.

(1) VARIABLE FREQUENCY OSCILLATOR. — *(See figures 2–4 and 7–60.)* The vfo contains one oscillator stage, three afc diodes, a cathode-follower stage, and two frequency-selecting switches. Voltages of transmitting frequencies in the 2 to 30-mc band are generated by oscillator tube V101 and coupled, through cathode-follower tube V102, to the rf amplifier in the amplifier-modulator. A lower level signal is supplied from tube V102 to the reference oscillator and mixer for derivation of a comparison frequency which is applied to a phase detector in the mixer-stabilizer. A dc error voltage is developed in the mixer-stabilizer and fed back to diodes CR101, CR102, CR103 in the vfo stage to provide automatic frequency control of the oscillator.

(*a*) OSCILLATOR V101 (5814). — Self-excited oscillator tube V101 is composed essentially of two tubes in cascade, resistance-coupled, with the output of the second tube section fed back to the grid of the first tube section. The frequency determining LC tank, coupled to tube V101 through capacitor C181, is selected by 10-mc switch S101 and 1-mc switch S102. Since the first section of tube V101 is connected as a cathode follower, signals at its grid and cathode are in phase. Grid bias for first section is set by the series combination of cathode resistors R105 and R109. Capacitor C182 bypasses resistor R105 for rf so that resistor R109 is the effective rf cathode load. Resistor R109 also serves as the rf signal and dc bias source for the second section which is connected as a grounded-grid amplifier. Amplified signal voltage developed across plate load resistor R106 is in phase with the cathode signal. The positive feedback path, necessary for oscillation, is completed by coupling the in-phase signal at the plate of the second section, through capacitor C180 back to the grid of the first section. Switches S101 and S102 select the desired LC tank circuit. Switch S101 functions as a 10-mc multiplier by selecting one of three main decks of switch S102. Sections 4 front and 5 front of switch S102 select megacycle bands between 2 and 10 mc; sections 2 front, 3 front and 3 rear select between 10 and 20 mc; and sections 1 front and 1 rear, select between 20 and 30 mc. For example: position 5 on switch S102 corresponds to 5, 15, or 25 mc, depending on the band setting of switch S101. Sections 1 rear, 3 front and 5 front of switch S102 are shorting contact types, so that all tank inductors except the one in use on the particular band are shorted out. Note that with switch S101 in the 2 to 10-mc position, the oscillator grid input is shorted to ground on positions 0 and 1 of switch S102. Tuning within each megacycle band is effected by three-section variable capacitor C174. Each megacycle band is spread over the 180-degree rotation of capacitor C174 by means of inductance trimmers, variable shunt capacitors, and sometimes fixed padding capacitors, wired across each coil.

A negative dc keying signal is applied during key-up intervals, through contact 6 of plug P101, to the junction of grid return resistors R104 and R111. This voltage biases off the oscillator grid, preventing unwanted radiations from the oscillator. This bias voltage is removed when the transmitter is keyed. Oscillator output is coupled through capacitor C179 and resistor R115 to cathode follower tube V102.

(*b*) CATHODE-FOLLOWER V102 (5687). — Tube V102 serves as a low impedance source for coupling the oscillator output through connectors J103 and J102 to the rf amplifier portions of the amplifier-modulator and reference oscillator and mixer, respectively. Test point J104 is provided for monitoring output to the rf amplifier. Cathode dc current return is made through resistor R441 in the reference oscillator and mixer.

(*c*) AFC DIODES CR101, CR102, AND CR103 (IN645). — Diodes CR101, CR102, and CR103 are connected across the vfo tank circuit. (At the lower frequencies (2 to 20 mc), CR101 and CR103 shunt CR102 through shorting contacts 9 and 10 of S101. In the 20

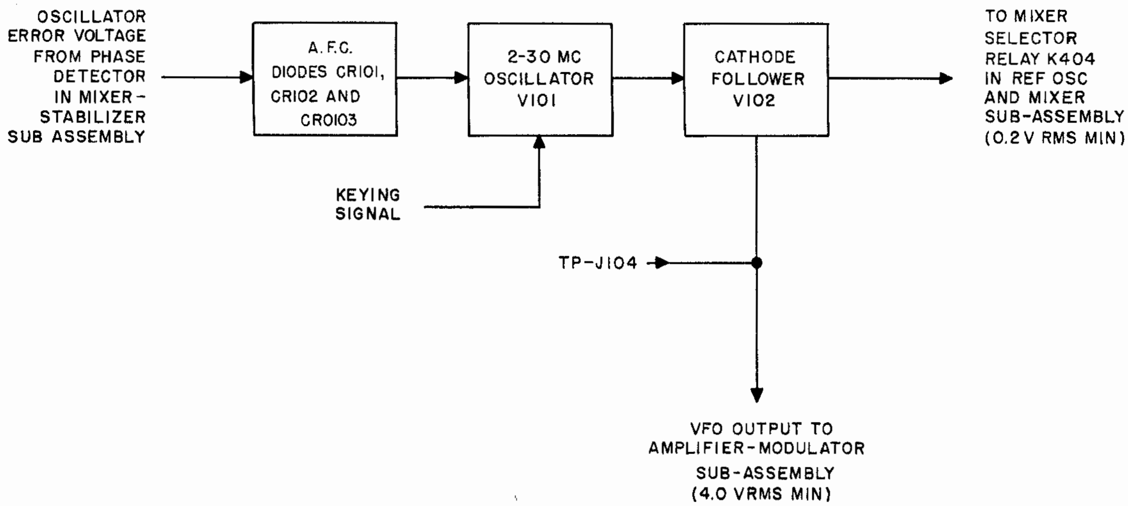


Figure 2–4. Variable Frequency Oscillator, Block Diagram

to 30 mc position of S101, the shorting contacts open, removing CR101 and CR103 from the circuit.)

An inherent characteristic of almost any semiconductor diode (such as type IN645) is that its capacitance will vary in accordance with the magnitude and polarity of the dc voltage applied. The dc error voltage output of the mixer-stabilizer is coupled through contact 5 of plug P101 to the afc diodes. Since the diodes are connected in parallel with the vfo tank, the effective tank capacity and, therefore, frequency vary with respect to dc error voltage.

Note

When referring to the schematic symbol for a crystal diode, consider the arrowhead as being the anode and the bar the cathode. (See figure 2–5.) This system is used throughout this technical manual.

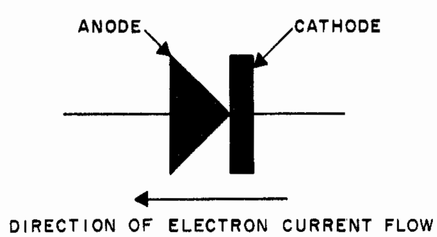


Figure 2–5. Symbol for a Crystal or Metallic Oxide Rectifier

(2) REFERENCE OSCILLATOR AND MIXER. *(See figures 2–6 and 7–62.)* — The reference oscillator and mixer subassembly contains five oscillator stages and two mixers. Oscillator frequencies and mixing configurations are established by band-selecting switches mounted on the transmitter front panel. In order to achieve the frequency stability and accuracy requirements of the equipment, frequency comparison in the mixer-stabilizer subassembly is accomplished within a 2 to 3-mc range for all transmitting frequencies. The reference oscillator and mixer provides the proper frequency generation and conversion required to obtain this 2 to 3-mc range.

Functionally, the reference oscillator and mixer has two main purposes: it converts the vfo output in the 2 to 30-mc range into the 2 to 3-mc range for application to the mixer-stabilizer; it produces reference frequencies which, when heterodyned in the mixer-stabilizer, produce a comparison frequency which is also in the 2 to 3-mc range.

Oscillators V403, V404, and V405 produce outputs which are fed to mixer A (V406) and mixer B (V407) for heterodyning with the 2 to 30-mc vfo output to provide the required 2 to 3-mc output signal. Oscillators V401 and V402 produce the reference frequencies used to obtain the 2 to 3-mc comparison signal.

The operation of the heterodyned vfo frequency channel is somewhat complex and is illustrated in table 2–1. Consider the case where 10-mc selector switch S406 is in the 2 to 10-mc position. (See figures 2–6 and 2–7.) Note that mixer-selector relay K404 remains in the de-energized position for the 3 to 10-mc portion of the 2 to 10-mc transmitting band. Any vfo input frequency in the 3 to 10-mc range is therefore applied directly to mixer tube V406. Oscillator-doubler tube V404 supplies a crystal-controlled heterodyning frequency in the 32 to 36-mc range to tube V406, through contacts 8 and 11 (section 1, rear) of switch S406. In the output of tube V406 only the sum frequency, which lies either in the 37 to 38-mc or 42 to 43-mc range, is accepted by bandpass transformer T401. For each specific transmitter frequency, the required bandpass characteristic of transformer T401 is automatically

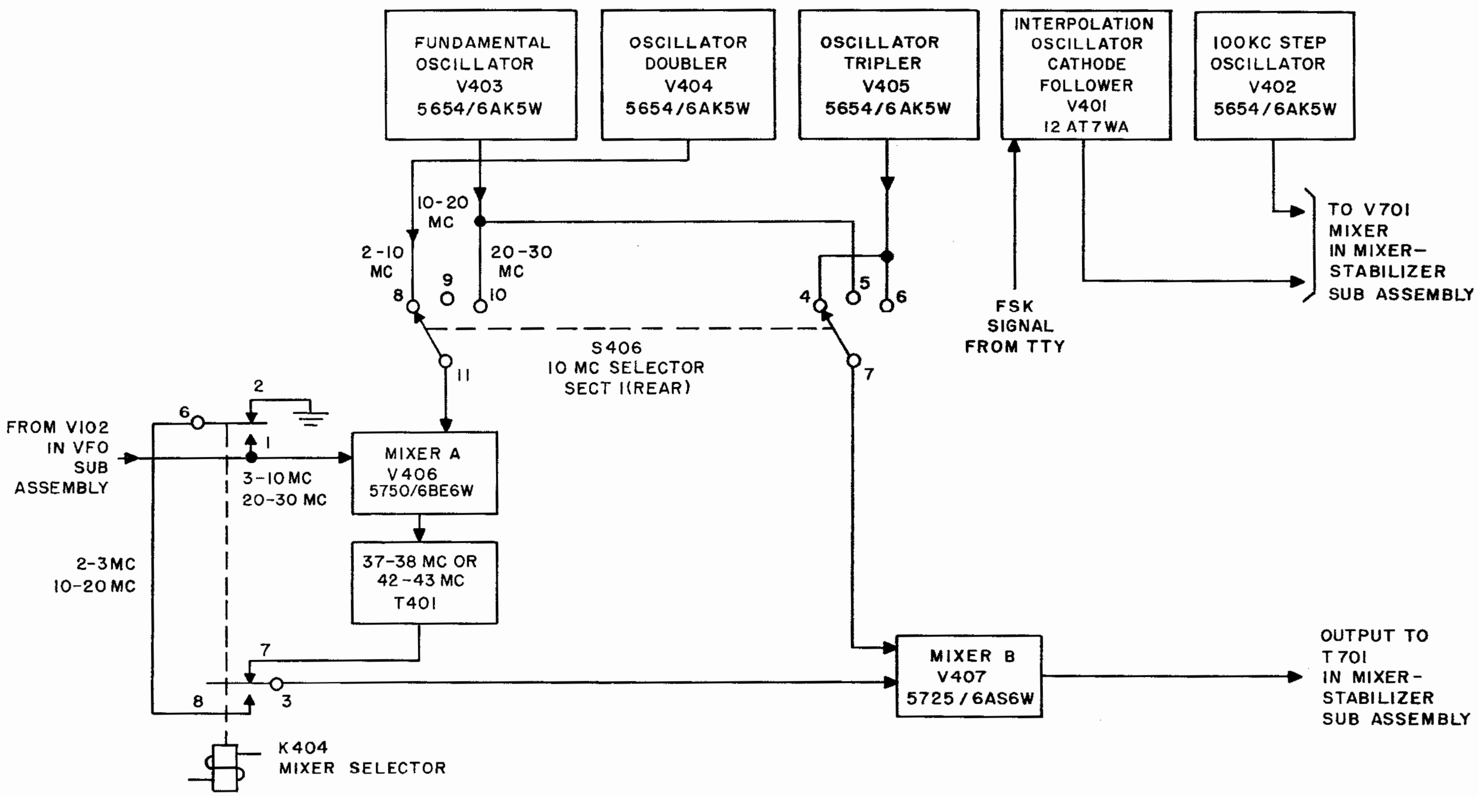


Figure 2–6. Reference Oscillator and Mixer, Block Diagram

TABLE 2-1. REFERENCE OSCILLATOR AND MIXER, HETERODYNING CHART

TRANS. OUTPUT FREQ. (mc)	SWITCH POSITION		INPUT FROM VFO TO MIXER A OR B (mc)	MIXER A (V406)		MIXER B (V407)	
	S406	S405		INPUT FROM V403 OR V404 (mc)	OUTPUT TO MIXER B (mc)	INPUT FROM V403 OR V405 (mc)	OUTPUT TO MIX.-STAB. (T701) (mc)
2–3	0	2	2–3				2–3
3–4	0	3	3–4	34	37–38	35	2–3
4–5	0	4	4–5	33	37–38	35	2–3
5–6	0	5	5–6	32	37–38	35	2–3
6–7	0	6	6–7	36	42–43	40	2–3
7–8	0	7	7–8	35	42–43	40	2–3
8–9	0	8	8–9	34	42–43	40	2–3
9–10	0	9	9–10	33	42–43	40	2–3
10–11	1	0	10–11			8	2–3
11–12	1	1	11–12			9	2–3
12–13	1	2	12–13			10	2–3
13–14	1	3	13–14			11	2–3
14–15	1	4	14–15			12	2–3
15–16	1	5	15–16			13	2–3
16–17	1	6	16–17			14	2–3
17–18	1	7	17–18			15	2–3
18–19	1	8	18–19			16	2–3
19–20	1	9	19–20			17	2–3
20–21	2	0	20–21	17	37–38	35	2–3
21–22	2	1	21–22	16	37–38	35	2–3
22–23	2	2	22–23	15	37–38	35	2–3
23–24	2	3	23–24	14	37–38	35	2–3
24–25	2	4	24–25	18	42–43	40	2–3
25–26	2	5	25–26	17	42–43	40	2–3
26–27	2	6	26–27	16	42–43	40	2–3
27–28	2	7	27–28	10	37–38	35	2–3
28–29	2	8	28–29	9	37–38	35	2–3
29–30	2	9	29–30	8	37–38	35	2–3

selected by the frequency selecting switches. The output of transformer T401, containing the sum frequency only, is coupled through contacts 7 and 3 of relay K404 to mixer tube V407. A crystal-controlled frequency of either 35 or 40 mc is supplied to tube V407 from oscillator-tripler tube V405 through contacts 4 and 7 (section 2, rear) of switch S406. To obtain the required 2 to 3-mc comparison frequency output from tube V407, either the 35 or 40-mc output is automatically selected for tube V405 to correspond with the sum beat frequency output of transformer T401. For a sum frequency in the 37 to 38-mc or 42 to 43-mc range, 35 or 40 mc, respectively, is chosen as the heterodyning frequency for mixer tube V407. The resulting 2 to 3-mc difference beat frequency in the output of tube V407 is accepted by the 2 to 3-mc bandpass transformer T701 in the mixer-stabilizer.

Now consider the special case for transmitting frequencies in the 2 to 3-mc band. Under this condition, relay K404 is energized through switches S405 and

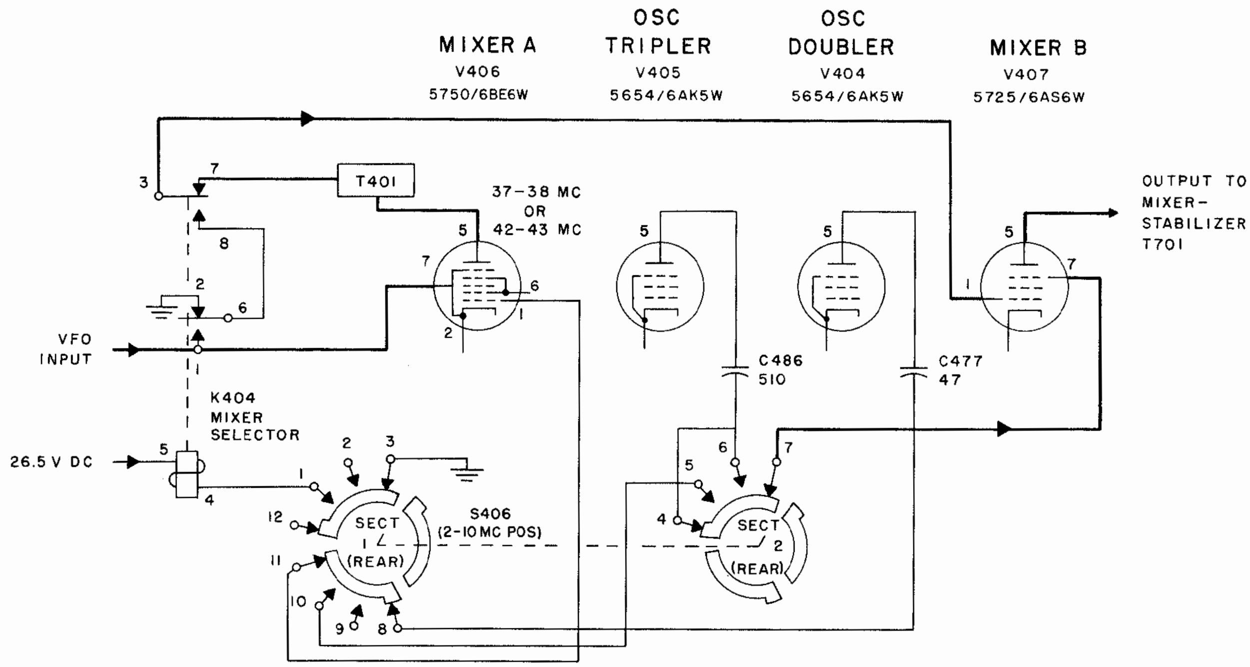


Figure 2–7. Heterodyned VFO Frequency Channel, Simplified Schematic

S406. Relay K404 routes the vfo output to V407 and removes V406 from the input to V407, so that the vfo signal is directly coupled through relay contacts 1, 6 and 8, 3 to V407. Since transformer T701 in the mixer-stabilizer accepts only frequencies within its pass band, mixer tube V407 acts as a straight amplifier for any vfo frequency in the 2 to 3-mc range. The oscillator tripler frequency and resultant beat frequencies generated in tube V407, due to heterodyning of the vfo frequency, are rejected by transformer T701. This simplifies switching by making it unnecessary to decouple tubes V405 and V407 for this relatively small frequency range.

With S406 in the 10 to 20-mc position, relay K404 is energized, and a vfo frequency in this range is applied directly to tube V407. The crystal-controlled heterodyning frequency in the 8 to 18-mc range, generated in fundamental oscillator tube V403, is applied to mixer tube V407 through contacts 5 and 7 (section 1, rear) of switch S406. The difference beat frequency lies in the 2 to 3-mc range, and is therefore accepted by transformer T701 in the mixer-stabilizer.

In the 20 to 30-mc position, switch S406 provides double heterodyning as in the 3 to 10-mc band. To accommodate the 20 to 30-mc vfo range, tube V403 supplies heterodyning frequencies in the 8 to 18-mc range to mixer tube V406, through contacts 10 and 11 (section 1, rear) of switch S406. Sum beat frequencies generated in tube V406 are designed to fall within the 37 to 38-mc or 42 to 43-mc ranges of transformer T401. In all other respects the theory of operation is the same as for the 3 to 10-mc band.

(*a*) SELECTOR SWITCHES. — Band-selecting switch S406 is a two-wafer, three-position, rotary-type switch. Intermediate frequency selecting switches S402, S403, S404 and S405 are 10-position, one-circuit-per-wafer, rotary types, differing only in the number of wafers. Switch S401, the 100-cycle frequency increment selector, is also a rotary, single-wafer type with 11 positions. The positions of these switches correspond to a transmitter frequency setting as indicated on the front panel.

(*b*) INTERPOLATION OSCILLATOR V401A (1/2 12AT7WA). — Tube V401A is a triode oscillator with an LC parallel resonant tank in the grid circuit, variable in 100-cycle steps from 1.6005 to 1.7 mc. The capacitive arm consists mainly of the tank voltage divider formed by the series combination of capacitors C405 and C408. The inductive branch consists essentially of the series combination of capacitor C406, main inductor L401, capacitor C412 and step selected trimmer inductors L402 through L410 in series with inductor L411, through section 1 of 10-kc selector switch S402. Intermediate increments of 1 kc are obtained through 1-kc selector switch S403, by switching individual trimmer inductors L412 through L420 in series with inductor L411. To maintain constant 10-kc steps over the oscillator frequency range, individual compensating capacitors C413 through C438, and C529, C530, C534, and C536 are selected by switch sections 2 and 3 of S402 to shunt capacitors C412 and C408, respectively. The smallest frequency steps (±100 cycles) are provided by shunting capacitors C537 through C546 and C549 through C551 across C408 by means of 100-cycle selector switch S401. As S401 is switched successively through its +1 through +5 positions an increasing amount of capacitance is added to the oscillator tank circuit, causing a decrease in the output frequency of the interpolation oscillator. Conversely, as S401 is switched through its −1 through −5 positions a decreasing amount of capacitance is inserted, causing an increase in the output frequency of V401A. However, due to the difference frequencies produced in V701 by heterodyning the outputs of V401 and V402, a decrease in the output frequency from V401A results in an increase in the resultant frequency output from V701. (See table 2-2.) Because inductor L401 and capacitors C405, C406, C408 and C412 are the main frequency determining tank components, the former is a temperature-compensated type and the latter are precision ceramic types with zero temperature coefficients. Variable capacitor C506 shunts capacitor C406 and tends to prevent drift of oscillator V401 by offsetting the change in capacitance of the S402 tank circuit, caused by a rise in the ambient temperature of the transmitter. Capacitor C506 has been adjusted and sealed at the factory and requires no further adjustment. Capacitor C406 and grid return resistor R401 provide grid leak bias for class C operation. Mutual plate-to-grid impedance coupling to sustain oscillations is provided by capacitor C408, which is supplied rf feedback power from the plate circuit through capacitor C401. Capacitor C498, which normally shunts C408 through contacts 2 and 6 of fsk switching relay K401, is removed when relay K401 is energized for frequency-shift keying. During "space", the series combination of C502 and C503 is shunted across C408. In "mark", this combination, as well as C501, is shunted across C408. This results in shifting the interpolation oscillator frequency by a preset amount. Relay K402 is wired for either polar or neutral keying signals provided by the external teletype equipment.

(*c*) CATHODE-FOLLOWER V401B (1/2 12AT7WA). — The oscillator output at the plate of tube V401A is coupled through dc blocking capacitor C402 to the grid of V401B. Cathode-follower tube V401B provides a relatively low impedance source for the output cable coupled from the cathode through capacitor C404 to mixer stage V701 in the mixer-stabilizer subassembly.

(*d*) 100-KC STEP OSCILLATOR V402 (5654/6AK5W). — Tube V402 is an electron-coupled oscillator with crystal frequency control in the grid circuit. Frequency range is 3.7 to 4.6 mc, in steps of 100 kc, with ten crystals selected by 100-kc selector switch S404. Each crystal (Y401 through Y410) is zero-adjusted on frequency at the factory, by an independent adjustable trimmer capacitor, C446 through C455. The rf screen current is fed back to the control grid through capacitors C443, C441 and C440. Capacitor C441 is shunted by the capacity of the output cable connected to the mixer-stabilizer. Inductor L421, in series with resistor R407, provides a high ac impedance path from cathode to ground for feedback current. Protective bias is provided by cathode resistor R407 in the event of grid leak bias failure. Test point TP-J403 is connected through capacitor C445 to the plate end of plate load resistor R409. The 100-kc step oscillator output is coupled from the cathode of tube V402 through capacitor C442 and connector J402 to mixer stage V701 in the mixer-stabilizer subassembly.

TABLE 2-2. REFERENCE OSCILLATOR AND MIXER, SAMPLE FREQUENCY DERVIATION CHART

INTERPOLATION OSCILLATOR				100 KC STEP OSCILLATOR		MIXER V701 OUTPUT (mc)
SWITCH POSITIONS			V401 OUTPUT (mc)	S404 POS.	V402 OUTPUT (mc)	
S402	S403	S401				
9	9	+5	1.6005	9	4.6000	2.9995
9	9	+4	1.6006	9	4.6000	2.9994
9	9	+3	1.6007	9	4.6000	2.9993
9	9	+2	1.6008	9	4.6000	2.9992
9	9	+1	1.6009	9	4.6000	2.9991
9	9	0	1.6010	9	4.6000	2.9990
9	9	−1	1.6011	9	4.6000	2.9989
9	9	−2	1.6012	9	4.6000	2.9988
9	9	−3	1.6013	9	4.6000	2.9987
9	9	−4	1.6014	9	4.6000	2.9986
9	9	−5	1.6015	9	4.6000	2.9985

(*e*) FUNDAMENTAL OSCILLATOR V403 (5654/6AK5W). — Tube V403 operates as an electron-coupled oscillator similar to tube V402. The fundamental oscillator generates 11 crystal-controlled frequencies from 8 through 18 mc in 1-mc increments, for use as heterodyning frequencies in the 10 to 30-mc transmitting bands. Individual crystals (Y411 through Y421) are selected by either section 3 or 4 of 1-mc selector switch S405 and are zero-adjusted at the factory by means of individual trimmer capacitors. The wafers, in turn, are selected by section 1 of 10-mc band selector switch S406. In the 10 to 20-mc position of switch S406, selected crystals are connected through section 4 of switch S405 and contacts 5 and 7, section 1, of switch S406, to grid coupling capacitor C456. In the 20 to 30-mc position of switch S406, connection is through section 3 of switch S405 and contacts 6 and 7, section 1, of switch S406. Plate and screen dc voltage is supplied to tube V403 by way of contact 3 to contacts 1 and 2, section 2, of switch S406 on the 10 to 20-mc and 20 to 30-mc band positions, respectively. Since tube V403 is not utilized on the 2 to 10-mc band, it is rendered inoperative by opening its dc supply connection. The output of V403 is coupled from the plate through capacitor C460 to contacts 5 and 7, section 2, and contacts 10 and 11 of switch S406 for distribution to the mixer stages V406 and V407. Test point TP-J404 is coupled through dc blocking capacitor C460 to the plate of tube V403.

(*f*) OSCILLATOR DOUBLER V404 (5654/6AK5W). — Tube V404 differs in operation from tubes V402 and V403 only in that its plate load consists of a resonant tank circuit tuned to the second harmonic of the fundamental crystal-generated in the oscillator section. The function of tube V404 is to supply heterodyning frequencies, in 1-mc steps from 32 to 36 ms, for the 3 to 10-mc transmitting band. One of five crystals (Y422-Y426) is selected by section 2 of switch S405, in dial positions 3 through 9. Individual plate tank inductances L425 through L431, selected simultaneously by section 1 of S405, are preset to resonate with distributed capacitance at the corresponding second harmonic frequency. Since tube V404 is not utilized over the 10 to 30-mc transmitting band, plate and screen dc voltage is supplied only in the 2 to 10-mc position of switch S406, through contacts 3 and 12 of section 2. Resistor R419 serves as a dc voltage dropping resistor. The rf output is coupled from the plate through capacitor C531 to frequency test point TP-J405, and through capacitor C477 and contacts 8 and 11, section 1, of switch S406 for distribution to mixer stage V406.

(*g*) OSCILLATOR TRIPLER V405 (5654/6AK5W). —Oscillator tripler tube V405 supplies two heterodyning frequencies for mixing purposes. The fundamental frequency is generated by one of two crystals selected by crystal selector relay K403. A resonant tank circuit in the plate circuit of V405, consisting of variable inductor L433 and the distributed capacitance, is tuned to the third harmonic of the fundamental frequency. In the de-energized position of relay K403, variable inductor L433 is tuned to the third harmonic of 13.333-mc crystal Y428. The setting of switches S406 and S405 determines the operating condition of relay K403. With switch S406 in the 2 to 10-mc position, the 26.5-volt dc return (contact 4) of the relay energizing coil K403 is grounded in positions 3, 4 and 5 of switch S405, section 5, through contacts 12 and 3, section 1, of switch S406. Relay K403 remains de-energized in the 10 to 20-mc position of switch S406. In the 20 to 30-mc position, the ground return through selected positions of section 6 of switch S405 is made through contacts 2 and 3, section 1, of switch S406. When relay K403 is energized, 11.667-mc crystal Y427 is switched into the oscillator circuit through relay contacts 3 and 8 as crystal Y428 is switched out. Simultaneously, relay contacts 1 and 6 close, effectively shunting the parallel combination of capacitor C487 and trimmer C488 across the plate tank and thereby lowering its resonant frequency to the third harmonic of crystal Y427. Trimmer C488 is preset for this frequency. The rf output is taken off the plate and coupled through capacitor C486 to contacts 4 and 6 of section 2 of switch S406 for distribution to mixer stage V407. Capacitor C532 couples the rf output to test point TP-J406.

(*h*) VFO SIGNAL DISTRIBUTION. — Resistor R441 terminates the vfo signal input coaxial cable in its characteristic impedance. The vfo signal is fed directly to grid 3 of mixer tube V406 and contact 1 of mixer selector relay K404 which controls the vfo input to mixer tube V407.

Relay K404 is energized for the 2 to 3-mc and 10 to 20-mc bands only. In the latter case, the 26.5-volt dc return is grounded through contacts 1 and 3 of section 1 of switch S406. For 2 to 3-mc band operation, 1-mc selector switch S405 is operated in FREQUENCY SET position 2. Under this condition, the dc return is grounded by way of contacts 10 and 7, section 5, of switch S405, through contacts 12 and 3, section 1, of switch S406.

(*i*) MIXER V406 (5750/6BE6W). — Heterodyning signals are applied through contact 11, section 1, of switch S406 to the control grid of tube V406 where resistor R427 serves as the control grid dc return. Among the frequency components appearing in the plate circuit, due to the frequency conversion in tube V406, is the sum beat frequency of the vfo and heterodyning signals. The circuit design is such that the sum beat frequency always falls in either the 37 to 38-mc or 42 to 43-mc band. Double-tuned bandpass transformer T401, the plate load of tube V406, is normally tuned to the 42 to 43-mc band with T401 bandpass shift relay K405 de-energized. To obtain proper bandpass characteristics for transformer T401, 32-mc and 33-mc traps are utilized in the secondary of T401 to bypass these spurious frequencies. Variable inductor L435 and capacitor C504 comprise the 32-mc trap; variable inductor L434 with capacitor C515 make up the series-resonant 33-mc trap. The 26.5-volt dc return (contact 4 of relay energizing coil K405) is connected to the coil of tripler crystal selector relay K403, so that the two relays are energized simultaneously for specific settings of switches S405 and S406. These settings always result in sum frequencies of 37 to 38 mc appearing in the plate circuit of tube V406. When relay K405 is energized, trimmer capacitor C510 is connected through relay contacts 1 and 6 across the primary of transformer T401. Trimmer capacitor C512 is likewise connected through relay contacts 3 and 8 across the secondary of transformer T401. Both trimmers are preset to tune transformer T401 for the 37 to 38-mc band.

(*j*) MIXER V407 (5725/6AS6W). — The control grid of mixer tube V407 accepts either the output of tube V406 or the vfo signal through relay K404 and capacitor C533. Heterodyning signals are applied to the suppressor grid through contact 7, section 2, of switch S406. Circuit operation is similar to that of tube V406. The plate load of tube V407, 2 to 3-mc bandpass transformer T701, is physically located in the mixer-stabilizer. A dc blocking capacitor, C520, prevents dc plate current return by way of the coaxial cable through the primary of transformer T701. Resistor R439 returns the dc plate current for tube V407 and serves as the bandwidth damping resistor for the primary of transformer T701. Over the 3 to 30-mc transmitting range, all vfo and heterodyning frequency combinations applied to tube V407 are chosen so that their difference beat frequency falls within the 2 to 3-mc bandpass of transformer T701. (See table 2–1.) In the 2 to 3-mc transmitting range, the vfo signal and 40-mc output of tripler-oscillator tube V405 are applied to tube V407. The resultant beat frequencies in the 37 to 43-mc range are therefore rejected by transformer T701. However, since the fundamental frequencies of two heterodyning signals are always present in the output of a mixer, the 40-mc fundamental will also be rejected and the 2 to 3-mc vfo signal accepted by transformer T701. The 2 to 3-mc rf output is coupled by capacitor C520 to test point TP–J409, and through connector J408 to the mixer-stabilizer.

(*k*) CRYSTAL OVEN. — All crystals are contained in a common oven, temperature-controlled by the series combination of heater winding R426, thermostat S408 and thermal protector E409 shunted across the 26.5-volt dc line. The operating range of S408 is 85° ±2.5°C (185° ±4.5°F). Heater current drain is 1 ampere. Capacitor C505 suppresses arcing across the contacts of S408.

(3) MIXER-STABILIZER. *(See figures 2–8 and 7–64.)* — The mixer-stabilizer contains one mixer stage, two amplifier stages, three cathode-follower stages and a phase detector circuit. It serves to terminate the 2 to 3-mc heterodyned vfo (comparison) frequency, and mix the reference frequency components generated in the reference oscillator and mixer. The resultant reference frequency (also in the 2 to 3-mc range) and the comparison frequency are applied to a phase detector after suitable amplification. A dc control voltage whose polarity and amplitude are dependent on the difference between the two signals, is developed at the detector and is fed back to the vfo.

Bandpass transformer T701 passes the 2 to 3-mc comparison frequency output of mixer tube V407 in the reference oscillator and mixer. After amplification in tube V705, bandpass transformer T702 provides further isolation for the comparison frequency. Output of transformer T702 is coupled to the phase detector through cathode-follower tube V706.

The 2 to 3-mc reference frequency is generated in mixer tube V701 by heterodyning the 1.6005 to 1.7-mc and 3.7 to 4.6-mc signal inputs from interpolation oscillator V401 and 100-kc step oscillator V402, respectively, in the reference oscillator and mixer. The 2 and 3-mc bandpass filter, coupled through cathode follower tube V702, accepts only the 2 to 3-mc component in the output of mixer tube V701. After suitable amplification by tube V703, the 2 to 3-mc reference frequency is coupled through cathode follower V704 to the phase detector circuit.

The phase detector develops a dc voltage whose magnitude and polarity is a function of the difference in phase angle between the reference and comparison frequencies.

(*a*) AMPLIFIER V705 (6AH6). — Double-tuned transformer T701, which comprises the ac plate load impedance for mixer tube V407 in the reference oscillator and mixer, passes only the 2 to 3-mc frequency components of the heterodyned vfo signal. Capacitor C724 serves to maintain proper bandwidth. The output of double-tuned transformer T701 is coupled directly to the grid of amplifier tube V705. Transformer T702, the ac plate load impedance of tube V705, is similar to transformer T701 and provides

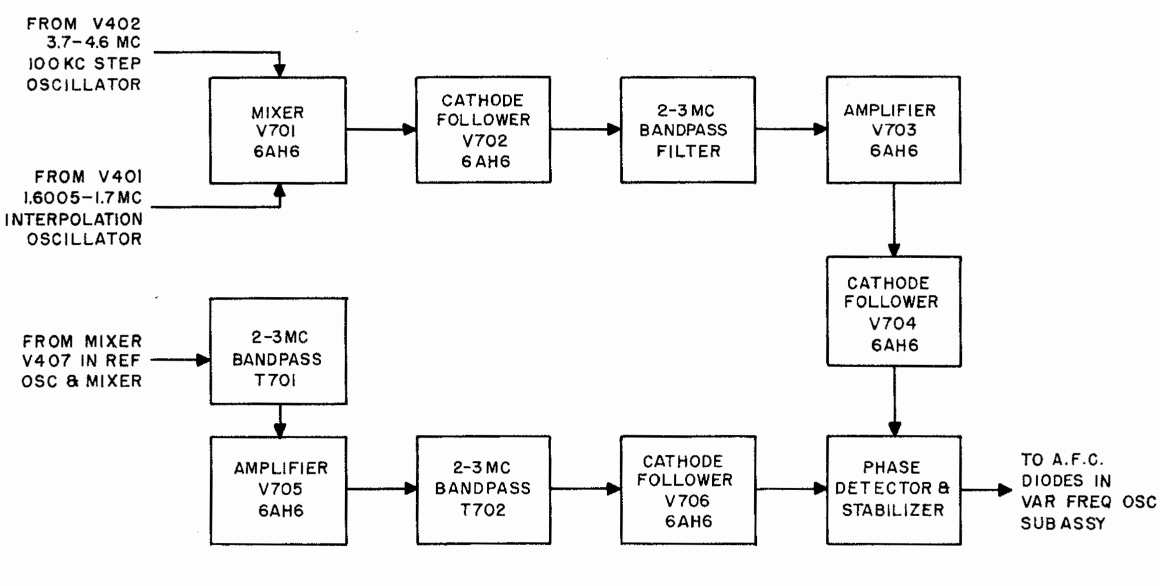


Figure 2–8. Mixer-Stabilizer, Block Diagram

further rejection for rf frequency components lying outside its 2 to 3-mc bandpass. Capacitor C733 couples the signal output of transformer T702 to the grid of tube V706. Capacitor C730 aids in maintaining proper bandwidth.

(*b*) CATHODE-FOLLOWER V706 (6AH6).— Pentode tube V706, connected as a triode, is used as a low impedance cathode follower. To accommodate the negative-going portion of the input waveform, relatively low dc bias is obtained by returning grid leak resistor R724 to the junction of cathode load resistors R725 and R726. Resistor R727 and capacitor C734 serve as a power supply ac decoupling network. Signal output at the cathode is coupled through dc blocking capacitor C735 to the secondary winding center tap of phase detector transformer T703.

(*c*) MIXER V701 (6AH6).—The 100-kc step and interpolation oscillator signal outputs from the reference oscillator and mixer are coupled through connectors J701 and J703, respectively, to a passive mixing network formed by resistors R701, R702, and R703. Resistors R701 and R702 serve to isolate the interpolation and 100-kc step oscillator circuits from each other, thus minimizing interaction. At the junction point of resistors R701, R702 and R703, both oscillator signals are attenuated due to the voltage dividing action of the network. The rf currents of the two frequencies flow from the junction point to ground through common divider resistor R703, and resultant voltages are coupled through C744 to the control grid of mixer tube V701. Resistor R735 functions as the grid dc return. The ac plate load impedance for this stage consists of resistor R706 and variable inductor L701, which comprise a video-type shunt peaking network. Among frequency components appearing in the plate circuit due to the heterodyning action are fundamental and beat frequencies. Because of the high-frequency wide-band response of the shunt peaking network, voltages of these frequencies are transferred through coupling capacitor C703 to the grid of cathode-follower tube V702.

(*d*) CATHODE-FOLLOWER V702 (6AH6).— Tube V702 is identical to cathode-follower tube V706 in operation. The cathode-follower output is connected to a 2 to 3-mc bandpass filter. Due to the extremely sharp cutoff characteristics of this filter, only the 2 to 3-mc difference frequency component is passed through and coupled to the control grid of amplifier tube V703.

(*e*) AMPLIFIER V703 (6AH6).— Since the desired signal in the 2 to 3-mc band is considerably attenuated when passing through the 2 to 3-mc filter, further amplification is provided by tube V703 to increase the signal amplitude to a useful level. Resistor R711 serves as the correct terminating impedance for the 2 to 3-mc bandpass filter and also as the dc grid return for tube V703. The ac plate load impedance for amplifier tube V703 is a series network consisting of resistor R714 and variable inductor L712. The amplified beat frequency is coupled through capacitor C720 to the control grid of cathode-follower V704.

(*f*) CATHODE-FOLLOWER V704 (6AH6).— Tube V704 serves to couple the signal output from the high impedance plate circuit of amplifier tube V703 to the relatively low impedance load formed by the phase detector and stabilizing network. Coupling from the cathode to the primary of transformer T703 is through capacitor C723.

(*g*) PHASE DETECTOR AND STABILIZING NETWORK. *(See figure 2-9.)* — Automatic frequency control is obtained by comparing the phase of the heterodyned vfo (comparison) frequency applied across its ac load impedance, inductor L713, to that of the accurately controlled (reference) frequency appearing across the secondary of transformer T703. Initial frequency lock is accomplished by manually adjusting VFO ADJ control C174 on the front panel through its tuning range, until SYNCHRONIZATION INDICATOR M1305 reads output on both sides of center, then zero centering the meter within the output range. This condition is attained only when the comparison frequency is exactly equal to the reference frequency, and a 90 degree phase relationship exists between them. Impedance of capacitors C736 and C737 is comparatively small for frequencies in the 2 to 3-mc band; therefore, the anode terminals of crystal diodes CR701 and CR702 are effectively connected for rf to the junction of inductor L713 and diode load resistors R728 and R729. Each diode then has impressed across its terminals the vector sum of the comparison frequency voltage across inductor L713, and its respective half of the secondary reference voltage.

The diode loads, resistor R728, capacitor C736, resistor R729, and capacitor C737, provide filtering for the rectified outputs of diodes CR701 and CR702, respectively. Resistor R728 completes the dc path for diode CR701 and the dc path for CR702 is completed through inductor L713 and resistor R729. The resultant dc voltage applied across SYNCHRONIZATION INDICATOR M1305 through meter multiplier R736 is the algebraic sum of the rectified voltages developed across series resistors R728 and R729. Variable resistor R731 controls the error voltage supplied to the vfo and is used to center the 28 bands (1-mc step) in the vfo so that the frequency limits at the band ends conform with the calibration chart attached to the front panel of each transmitter.

Consider the condition where the comparison voltage is 180 degrees out of phase with the reference voltage, and the frequency of both is exactly the same. Assuming terminal 3 of T703 is positive with respect to terminal 5, diode CR702 conducts heavily and the resultant dc output is positive causing meter M1305 deflection to one side of zero-center. Now, consider the other extreme condition where the comparison voltage is exactly in phase with the secondary voltage and both voltages are of the same amplitude as in the 180 degrees out-of-phase condition. Assuming terminal 3 negative with respect to terminal 5, diode CR702 conducts heavily and the resultant dc output is negative in polarity but equal in magnitude to the voltage in the

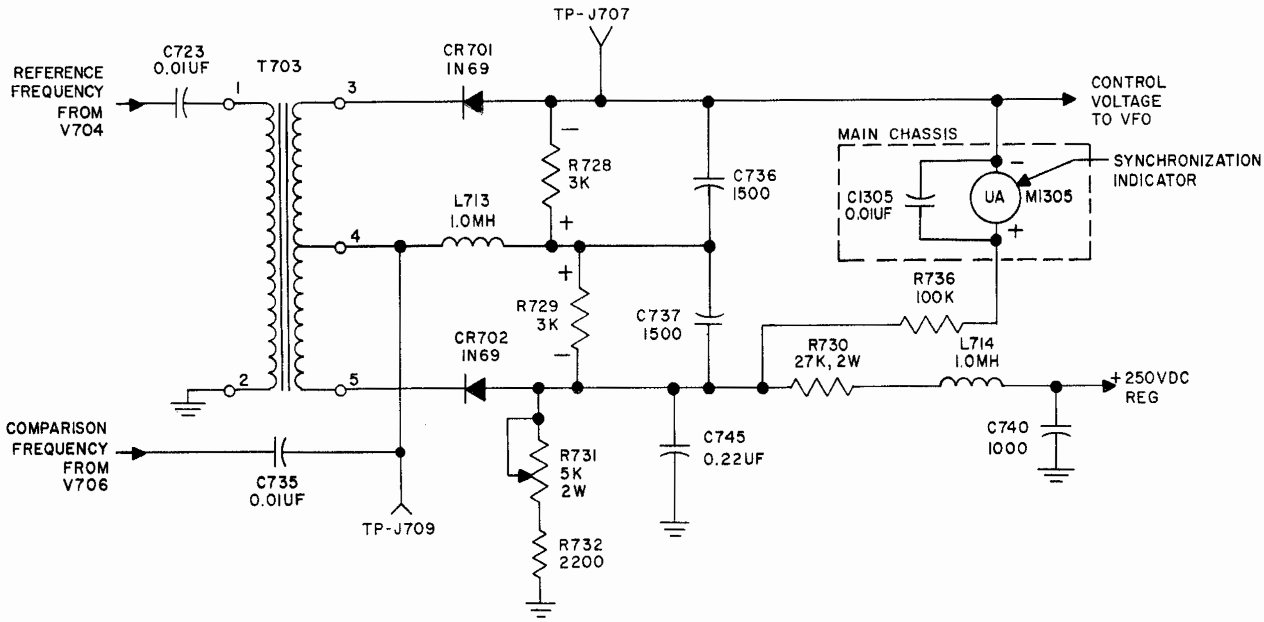


Figure 2–9. Phase Detector and Stabilizing Network, Simplified Schematic

180 degrees out-of-phase condition. Meter M1305 now deflects to opposite side of zero-center by same amount. For zero dc output and no meter deflection, equal amplitude voltages must be developed across the load resistors. This occurs at a phase angle of 90 degrees, since the vector sum of the rf voltages applied to the diodes is equal only at this value. If the phase of the comparison frequency shifts away from its 90 degree relationship with respect to the reference frequency (caused, for example, by vfo frequency drift), the corresponding change in dc from the phase detector causes vfo oscillator tube V101 to be brought back into correct frequency and phase. Also, if the vfo is manually adjusted exactly on frequency, but with a phase difference other than 90 degrees, the output from the phase detector will initially cause the vfo to move off frequency slightly. This will result in a different phase relationship and a different output from the phase detector. Actually the vfo frequency will be automatically varied until the correct 90 degree phase relationship and exact frequency points are obtained.

The dc output is connected through P702 to the main chassis of the transmitter for distribution to the vfo and SYNCHRONIZATION INDICATOR M1305.

c. KEYER GROUP. *(See figure 7–66.)* — The keyer group contains the relays used to key the transmitter on and off, and to accomplish automatic tuning of the transmitter. Keyer group relays are also used as components of the dynamotor control circuit. Theory of operation of the automatic tune and dynamotor control circuit is covered in paragraph 2–5*a*. To avoid repetition, only operation of transmitter on-off keying will be discussed here.

(1) GENERAL. — On-off keying of the transmitter is accomplished by relay K809, which keys the screen voltage supply to power amplifier V1002. Plate voltage to cathode follower-sidetone amplifier V1102 in the af amplifier is also keyed on by K809. Auxiliary keying relay K810 controls antenna transfer relay K1301 in the transmitter, which transfers the common antenna from the receiver to the transmitter and causes receiver disable relay K1501 to energize. A delay circuit is incorporated in the keyer to permit the antenna transfer relay to transfer the antenna back to the receiver only when pauses in keying greater than an adjustable time between 0.2 and one second occur. Antenna transfer relay K1301, when energized, also removes a —105-volt bias from oscillator tube V101 in the vfo, allowing the stage to function. During key-off times, the vfo is kept inoperative to eliminate signal radiation. Rapid pull-in of the relays is accomplished with vacuum tubes to minimize clipping of the transmitted characters.

In addition, a dc voltage (approximately —5 volts) is tapped-off at the junction of R819 and R801 for use as the microphone supply.

(2) KEYER AMPLIFIER V801 AND KEYING DELAY V802. *(See figure 2–10.)* — Keyer amplifier tube V801 is normally cut off by the —105-volt bias applied to its control grid through resistor R808. The —105 volts is a fixed bias obtained from the power supply. During key-down operation (cw) of the transmitter, the grid of V801 is grounded through normally closed contacts 2 and 13 of relay K805; contacts 10 and 12 of SERVICE selector switch S1302, section 2, rear; and contacts 5 and 8 or 6 and 8 of NORMAL-REMOTE-RELAY selector switch S1303, section 2, rear to the cw key. In am. operation, the grid of V801 is grounded through contacts 2 and 13 of K805; contacts 8 and 12 of S1302, section 2, rear; and contacts 15 and

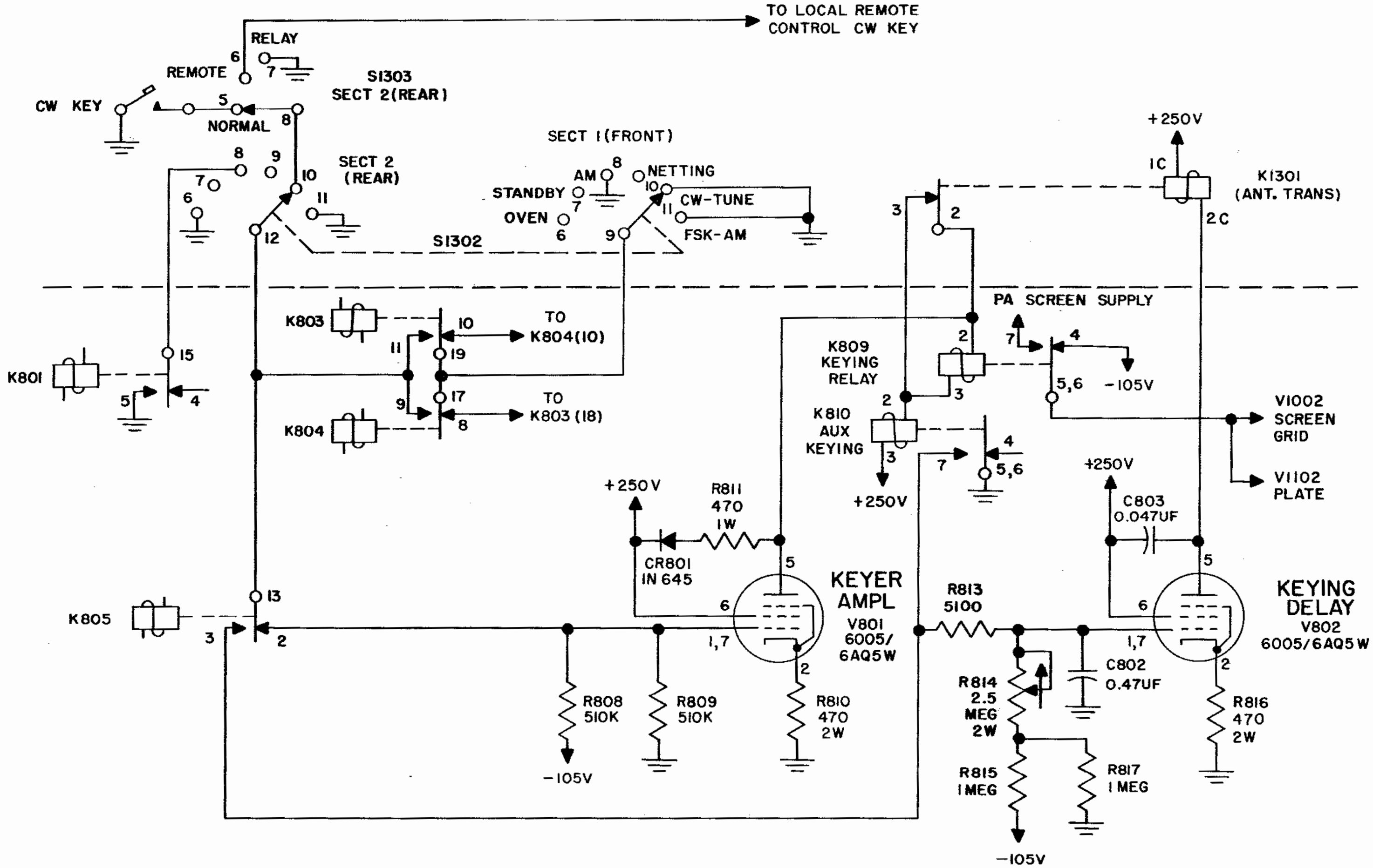


Figure 2–10. Keyer Circuits, Simplified Schematic

5 of energized dynamotor auxiliary control relay K801. During the rf tuning cycle (tune), the grid of V801 is grounded through contacts 2 and 13 of relay K805; contacts 9 and 17 of energized rf tuner tune relay K804, and contacts 9 and 10 of S1302, section 1, front. During fsk and fsk-am. service, the grid of V801 is grounded through contacts 2 and 13 of relay K805 and 11 and 12 of S1302, section 2, rear.

Grounding the grid of V801 causes the —105-volt bias to be removed, and allows the tube to conduct. Resistor R810 will then develop cathode bias to control tube conduction. Tube V801 plate current will flow through normally closed contacts 2 and 3 of K1301 and through the coil of auxiliary keying relay K810, causing the latter relay to energize. Current will not flow through the coil of keying relay K809 at this time because contacts 2 and 3 of K1301 act as a short circuit across the coil. When relay K810 energizes, its contacts 7 and 5, 6 close, grounding the grid of V802 through resistor R813. This removes the —105-volt fixed bias applied to the grid of V802, and allows the tube to conduct. Resistor R816 will then develop cathode bias to control tube conduction. Plate current will flow through the coil of antenna transfer relay K1301 in the transmitter, causing it to energize. When relay K1301 energizes, contacts 11 and 12 open and 13 and 14 close, transferring the common antenna circuitry from the receiver to the transmitter; contacts 8 and 9 open, removing a —105-volt bias from the grid of vfo oscillator tube V101 and allowing the vfo to become operative. (For netting service, the —105-volt bias is disconnected from V101 by S1302, section 3, rear.) Contacts 2 and 3 of K1301 open, removing the short circuit from the coil of keying relay K809, thus allowing the latter relay to energize. When relay K809 energizes, contacts 7 and 5, 6 close, and apply +312 volts to the plate of cathode follower-sidetone amplifier V1102 in the audio frequency amplifier, and to the screen grid of power amplifier tube V1002 in the amplifier-modulator. This allows the stages to function and places the transmitter in full operation.

During the initial phases of the automatic tuning cycle, the operation is somewhat different. In this case, relay K805 is energized keeping V801 cut off and thereby keeping power amplifier V1002 inoperative until further tuning is accomplished. Relay K805 is energized, isolating the V801 grid and grounding the V802 grid through contacts 3 and 13 of K805, 11 and 19 of K803 and 9 and 11 of S1302, section 1, front. This action removes the —105 volts from the V802 grid, allowing the tube to conduct. Tube V802 conduction energizes K1301 which removes the bias from the grid of V101, permitting the vfo to become operative. As the tuning progresses, K805 de-energizes and the keyer tubes operate as described above.

Application of the bias to V802 can be delayed through an adjustable period of 0.2 to one second, through the use of a variable RC time constant formed by potentiometer R814 and capacitor C802. When the grid is ungrounded, V802 will not cut off immediately, and will keep K1301 energized for between 0.2 and one second, depending on the setting of R814. As a result, short pauses in keying will not cause K1301 to de-energize.

Resistor R811 and crystal rectifier CR801, in the plate circuit of V801, are used to damp the high surge voltage developed across the coils of relays K809 and K810 upon the collapse of the energizing current. Resistor R813 serves as a contact protector for relay K810. When the grid of V802 is grounded, R813 prevents instantaneous discharge of capacitor C802 through contacts 7 and 5, 6 of relay K810. The discharge time will be dependent upon the value of R813. Therefore R813 limits the discharge current to a value not exceeding the current contact rating of K810.

E803 normally has its link connected between terminals 2 and 3 (ground). As such it provides a ground return for receiver disable relay K1504 whenever the transmitter is keyed (except for RELAY operation). When the link is connected between terminals 1 and 2, the ground connection is removed and the break-in control line is connected to the +26.5-volt bus. This connection is made only when the transmitter is used with a separate receiver (not part of Radio Set AN/MRC-55) that requires a +26.5-volt supply for operation of its receiver disable relay. (See paragraph 3-13*d*.)

d. AUDIO FREQUENCY AMPLIFIER. *(See figures 2-11 and 7-68.)* — The af amplifier is a removable subassembly containing tubes and circuitry necessary to amplify the audio voltages required to drive the modulator tubes in the amplifier-modulator. A sidetone signal for monitoring purposes in cw service is also supplied by disconnecting the input and output modulation circuits and locally generating the sidetone signal.

(1) INPUT AUDIO FREQUENCY TRANSFORMER. *(See figure 2-12.)* — The primary of transformer T1101 is tapped to provide for two audio inputs. In RELAY service, the audio output of either radio receiver is applied through contacts 11 and 12, section 2, rear, of NORMAL-REMOTE-RELAY selector switch S1303, located on the transmitter front panel, to terminal 3 of step-up transformer T1101. Impedance-matching to the 600-ohm line is provided by the 600-ohm primary impedance of transformer T1101. In NORMAL and REMOTE service, microphone input is applied to terminal 2 at an impedance level of 100 ohms. A dc supply voltage from the keyer group is provided for carbon microphones through terminal 1, which is grounded for ac by capacitor C1118. The 50,000-ohm impedance secondary is terminated by % MOD variable resistor R1313 on the transmitter front panel.

(2) PREAMPLIFIER V1101 (12BA6). — Tube V1101 operates as an amplifier and phase shift oscillator in am. and cw service, respectively, as selected by am-cw sidetone switch relay K1101. (See figure 2-12.) In am. service, audio modulation voltage is applied

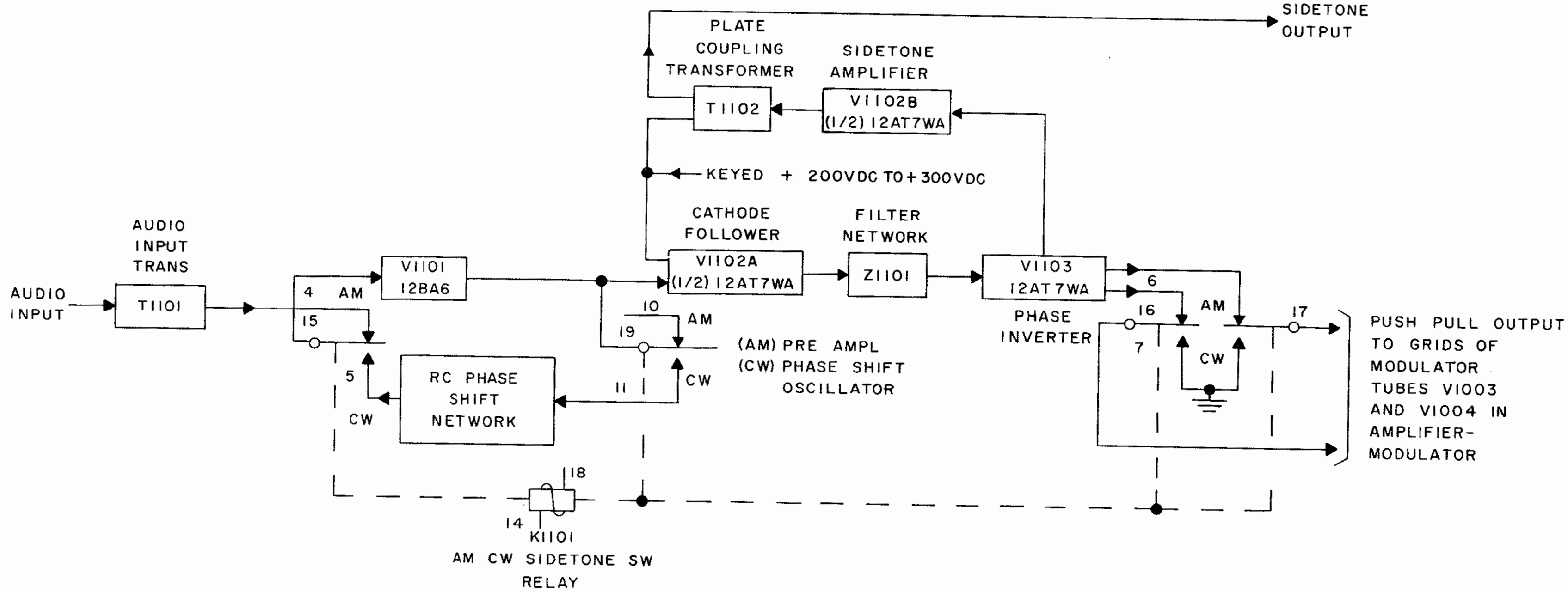


Figure 2–11. AF Amplifier, Block Diagram

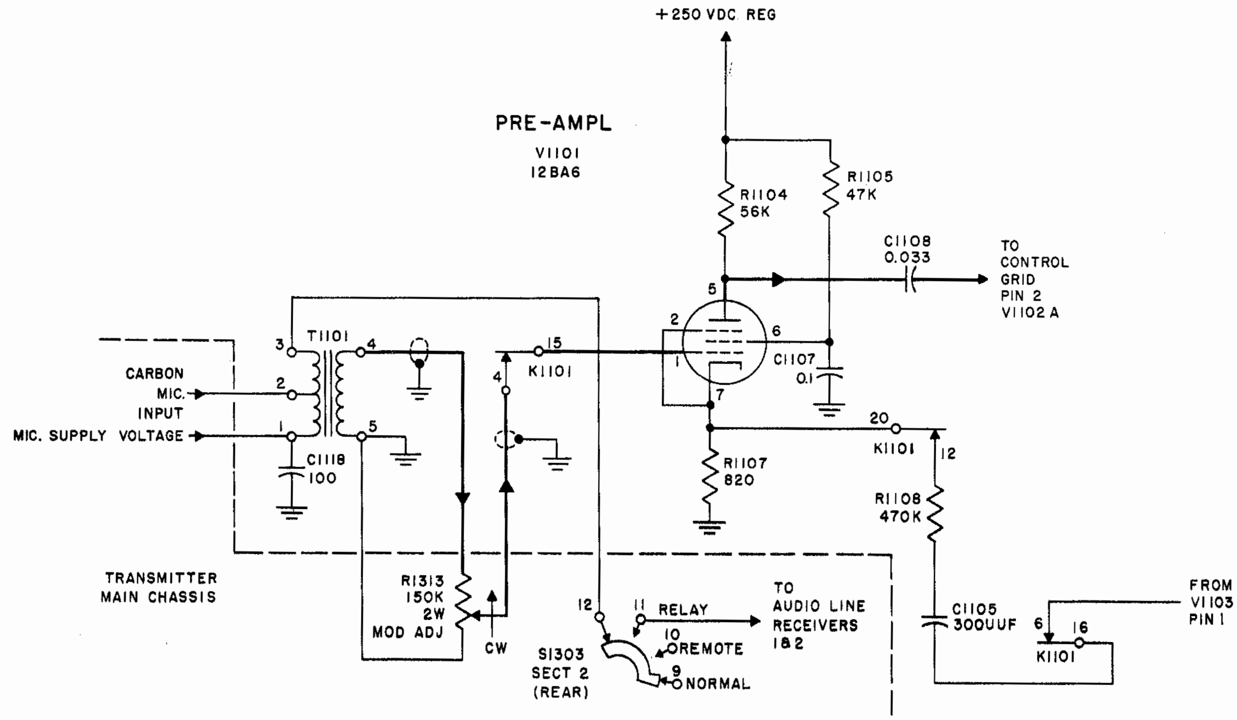


Figure 2–12. Tube V1101 as Preamplifier Circuit, AM Service Simplified Schematic

from the center arm of variable resistor R1313, through contacts 4, 15 of relay K1101, to the control grid of tube V1101. Inverse feedback is provided by tapping off a portion of the output of phase inverter tube V1103 at contacts 6 and 16 of K1101 through the voltage divider formed by capacitor C1105, resistor R1108 and cathode-bias resistor R1107, through contacts 12 and 20 of relay K1101. The amplified audio voltage developed across plate-load resistor R1104 is coupled through dc blocking capacitor C1108 to the control grid of cathode-follower V1102A.

In cw service (see figure 2–13), relay K1101 is energized through contacts 4 and 6, section 3, rear, of SERVICE selector switch S1302 on the transmitter front panel. In this condition, the control grid of tube V1101 is connected through contacts 5, 15 of relay K1101 to one end of an RC phase shift network formed by capacitors C1101, C1102, C1103 and resistors R1101, R1102, and R1103. The opposite end of the network is connected to the plate of tube V1101 through contacts 11, 19 of relay K1101. Contacts 1, 20 of K1101 simultaneously short the cathode of V1101 to ground. Tube V1101 therefore serves as an RC phase shift oscillator, where in-phase feedback is accomplished through the 60 degree phase lead of each similar RC branch for a total phase shift of 180 degrees. The output voltage (generated for sidetone monitoring) has a frequency of approximately 640 cps.

(3) CATHODE FOLLOWER V1102A (1/2 12AT-7WA). *(See figure 2–14.)* — Cathode follower V1102A serves to couple the relatively high impedance plate circuit of tube V1101 to the 400-ohm input of filter Z1101. Low-pass filter Z1101 passes the required audio band of frequencies up to its 3500-cps cut-off frequency. Combination self and fixed cathode bias is utilized for this stage. Self bias is obtained because of the dc voltage developed by the average tube current flow through resistors R1113 and R1114. The dc voltage at the junction of resistors R1114 and R1115, which form a voltage divider from +250 volts dc (regulated) to ground, is applied to the cathode of tube V1102A as fixed bias. Signal output is taken off terminal 3 of filter Z1101 through coupling capacitor C1111 and applied to the control grid (pin 2) of tube V1103. A portion of this signal is taken from terminal 3 of Z1101 and fed back to the control grid of tube V1102A through resistor R1109.

Audio modulation and sidetone output are obtained only when plate voltage is applied to tube V1102, through contacts 5, 6, 7 of keying relay K809 in the keyer group.

(4) PHASE INVERTER V1103 (12AT7WA). — Tube V1103 accepts the single-ended input from filter Z1101 and supplies a balanced push-pull signal output. The amplified and inverted signal at the plate (pin 1) of the first section is proportionately reduced by the voltage dividing and balancing action of resistors R1117, R1118, R1119 and R1120, and is applied to the grid (pin 7) of the second section through coupling capacitor C1113, so that the signal voltages at each plate are equal in amplitude and opposite in phase.

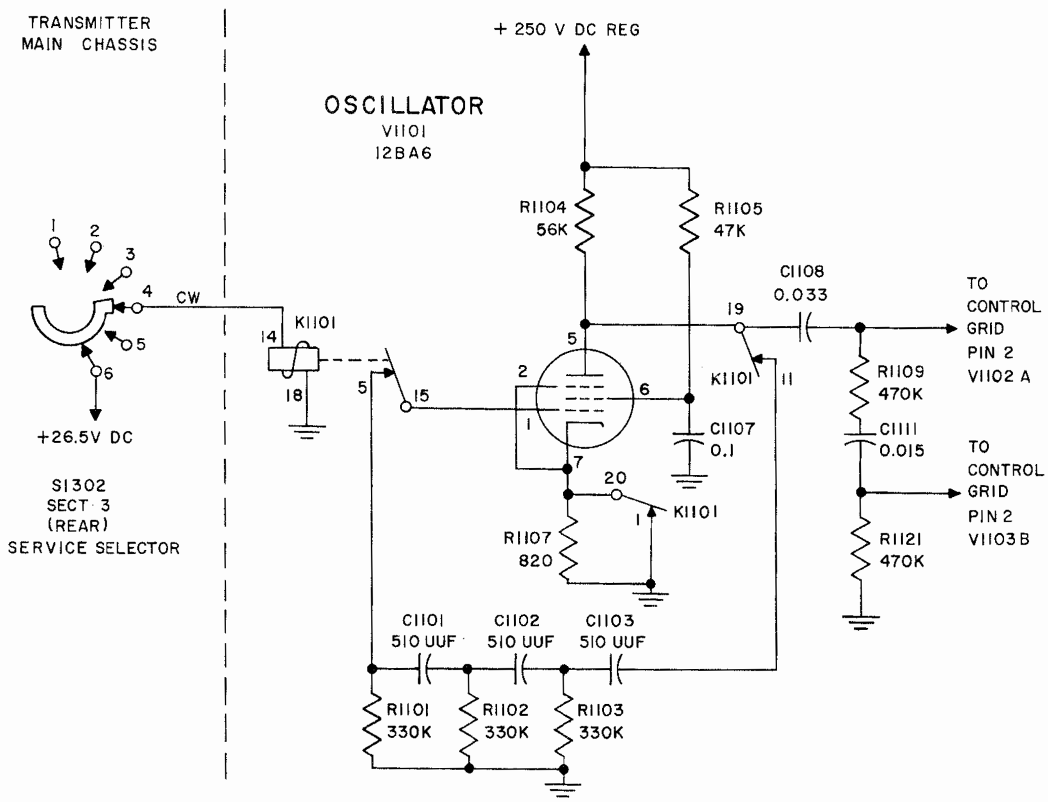


Figure 2–13. Tube V1101 as Oscillator Circuit, CW Service, Simplified Schematic

In am service, signal output voltages are supplied by way of contacts 6, 16 and 8, 17 of relay K1101 through dc blocking capacitors C1115 and C1116, respectively, to the modulator tube grids in the amplifier-modulator.

Signal voltage is removed, and the modulator grids grounded in cw service by the action of relay K1101 in opening contacts 6 and 8 and closing contacts 16 and 17.

(5) SIDETONE AMPLIFIER V1102B (1/2 12AT-7WA. *(See figure 2–14.)* — Signal output from the plate of the first section of tube V1103 is also supplied through dc blocking capacitor C1110 and sidetone level control R1112 as the sidetone signal to be amplified by tube V1102B. The signal is coupled from the plate of V1102B through audio frequency transformer T1102. T1102 has a 600-ohm impedance secondary winding to match the input impedance of external loudspeakers and headphones.

The resistance from the center arm of variable resistor R1112 to ground serves as the grid leak for tube V1102B in am. service.

Plate voltage is keyed on for tube V1102B through the primary of transformer T1102, in the same manner as for tube V1102A.

e. AMPLIFIER-MODULATOR. *(See figures 2–15 and 7–70.)* — The amplifier-modulator is a removable subassembly containing a two-stage radio-frequency amplifier, bandswitching, variable tank circuits and a push-pull modulator stage. The rf amplifier portion of the amplifier-modulator consists of two stages of amplification: V1001 (buffer type 6CL6), and power amplifier V1002 (air-cooled type 4X250F). The two amplifier stages use ganged tuning elements, manual bandswitching, a phase detector circuit, and coil drive motor B1002 for operation as an automatically tuned amplifier. The modulator portion consists of modulation transformer T1002 and modulator tubes V1003 and V1004.

(1) RADIO FREQUENCY AMPLIFIER SECTION V1001 (6CL6) and V1002 (4X250F). *(See figure 2–16.)* — The output of the variable-frequency oscillator is fed through J1001, L1013, and C1001 to the input of buffer tube V1001. Variable inductor L1010 is tuned for maximum rf input. A monitoring detector is connected to the input circuit of V1001 and consists of coupling capacitor C1038, crystal diode CR1003, diode load resistor R1013 and bypass capacitor C1039. Output of the rf voltmeter detector circuit is connected to the front panel meter M1304 to monitor the vfo output fed to the input of the rf amplifier. Tube V1001 is a class A buffer-amplifier, amplifying the input signal to a level sufficient to drive final power amplifier V1002. Bandswitches S1001 and S1002 are ganged and provide four positions used to cover the range of 2 to 30 mc by selecting the proper value of tank circuit capacitance for the frequency band in use.

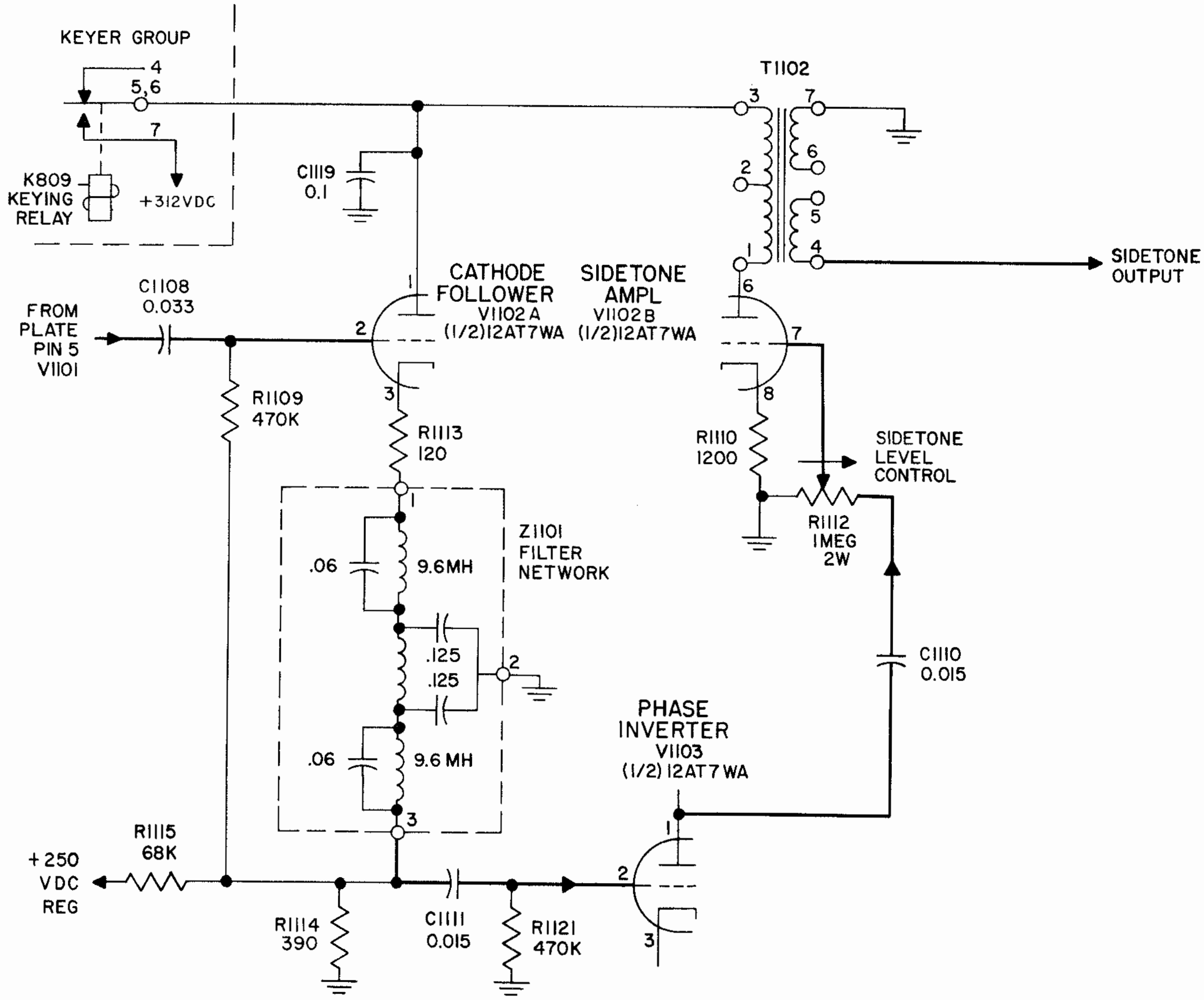


Figure 2-14. Cathode Follower and Sidetone Amplifier Circuit, Simplified Schematic

The capacitor selected by the bandswitch for the operating frequency is the fixed component of the LC resonant circuit. The adjustable components consist of variable-roller-tape coils L1001, L1004 and L1005. Tank coil L1001 is a single-tuned circuit in the plate of buffer stage V1001, and coils L1004, L1005 are used in a double-pi circuit in the plate circuit of power amplifier V1002. The three inductive tank elements, L1001, L1004 and L1005, are mechanically coupled and driven by coil drive motor B1002.

Tuning capacitance in the tank circuits is adjusted so as to maintain tracking of the buffer tank capacitance with the power amplifier tank circuit and so as to obtain an optimum LC ratio. Capacitor C1053 is a plate tank trimmer common to all four bands; the remaining capacitance used is selected by switch S1001 (section 1, rear), and depends on the frequency band selected. On BAND 1 (2 to 3 mc) capacitor C1004 and trimmer C1003 are selected; on BAND 2 (3 to 6 mc) capacitor C1006 and trimmer C1005 are selected, and on BAND 3 (6 to 10 mc), capacitor C1054 and trimmer C1007 are selected. On BAND 4 (10 to 30 mc) no capacitance is switched in by S1001 (section 1, rear) because at frequencies in the 10 to 30-mc range the existing stray shunt capacitance is sufficient. The buffer output is coupled through dc blocking capacitor C1013 to the power amplifier grid. Resistor R1015 serves as a parasitic suppressor, and L1003 as the grid return rf choke.

The radio frequency amplifier is automatically tuned to resonance with the signal supplied by the vfo. The phase detector circuit (see figure 2-17) measures the phase angle to provide control of a servo system to furnish automatic tuning of the tank circuits. The phase detector circuit, consisting of transformer T1001, resistor R1037, and phase detector network Z1001, is connected in series with buffer tuning coil L1001. Transformer T1001 induces a voltage in its secondary in phase with the primary current and of proper amplitude. Discriminator action is obtained by

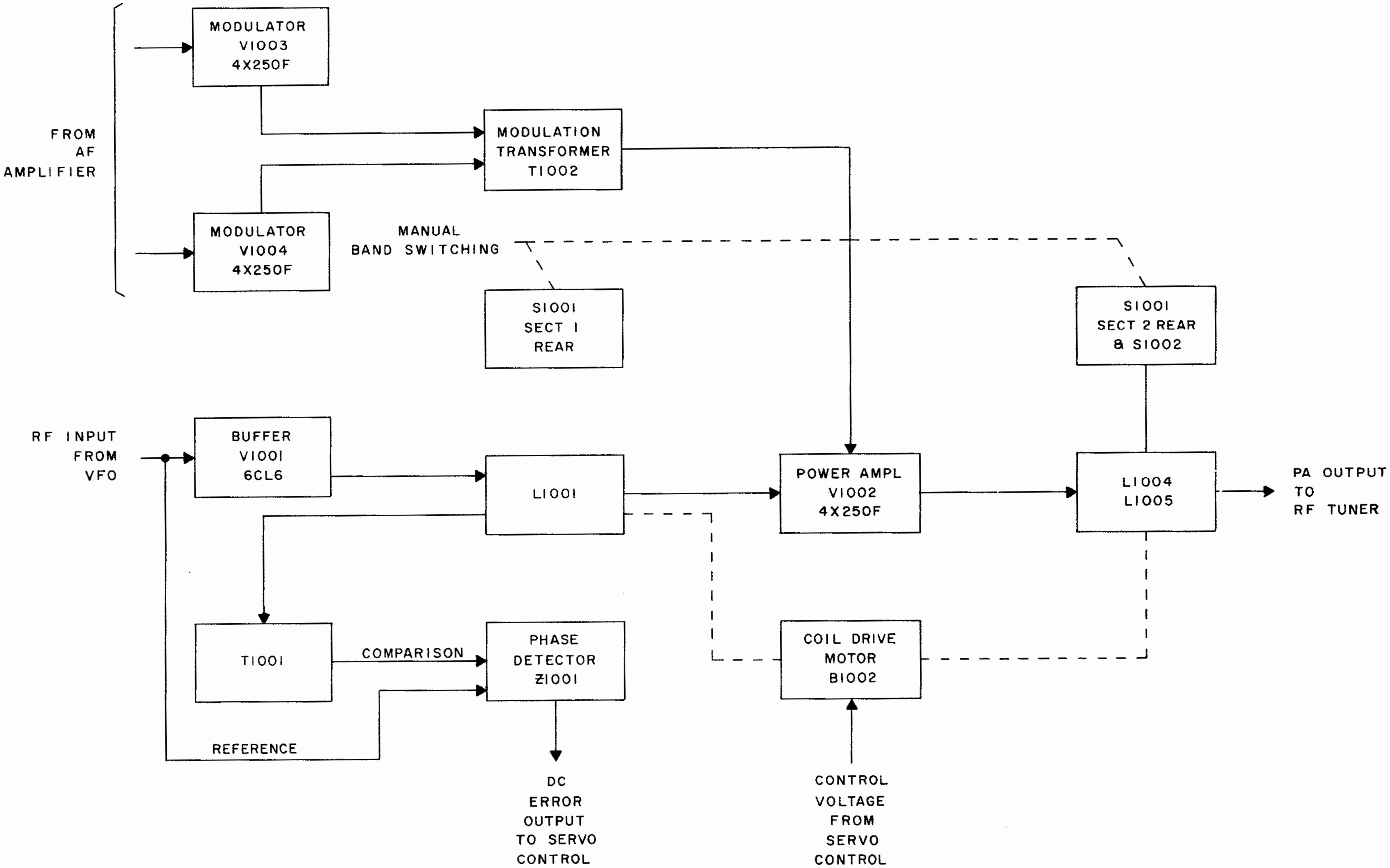


Figure 2–15. Amplifier-Modulator, Block Diagram

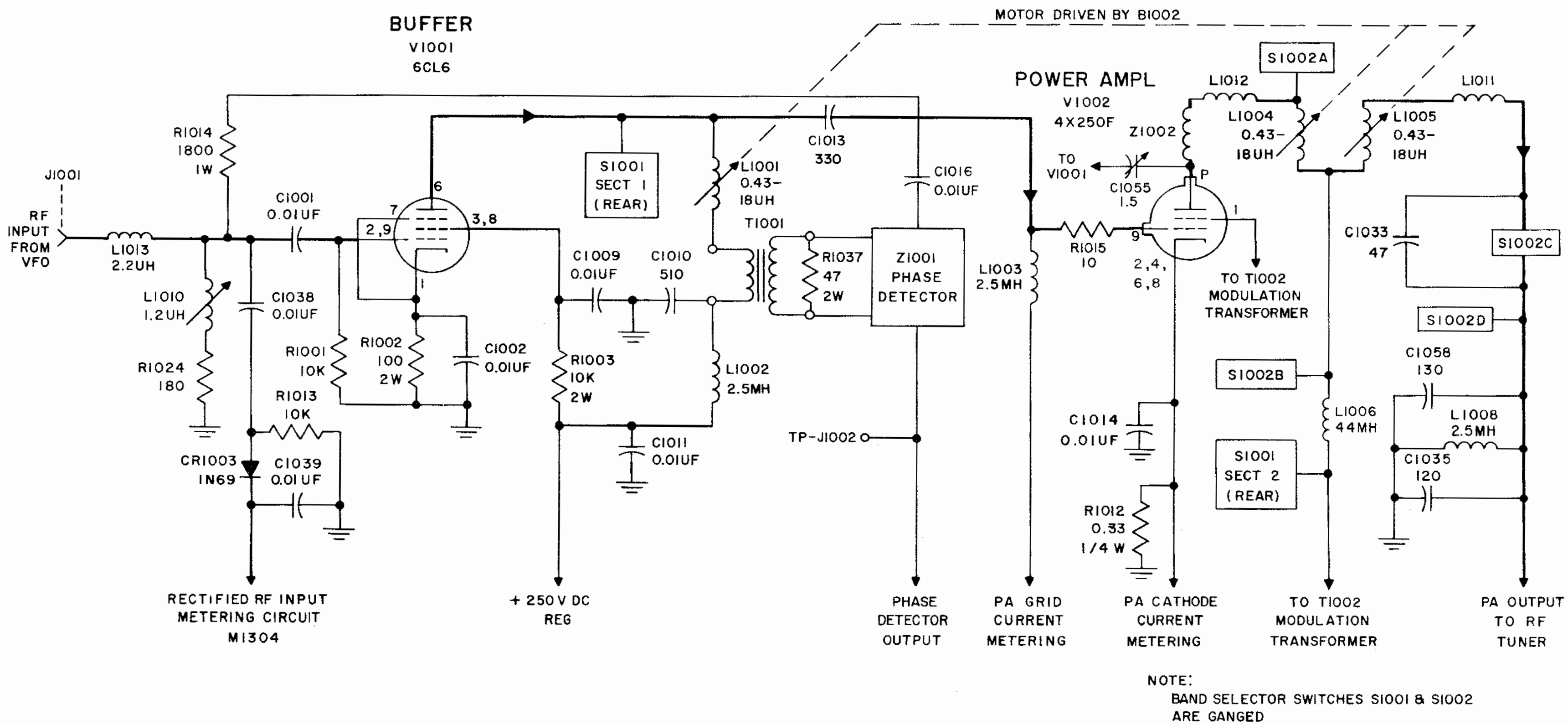


Figure 2–16. Radio Frequency Amplifier Section, Simplified Schematic

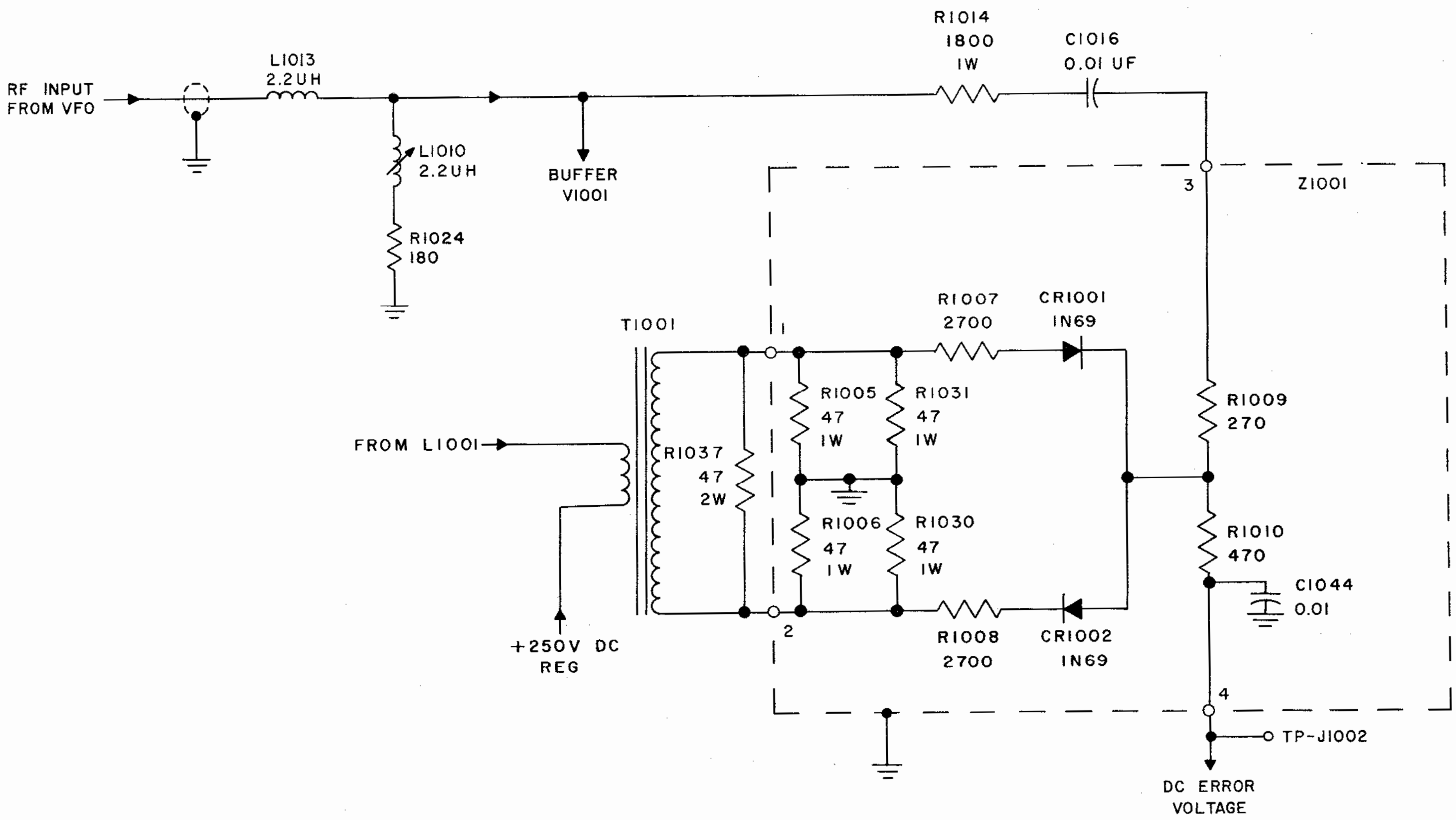


Figure 2–17. Phase Detector Circuit, Simplified Schematic

taking a portion of the buffer input signal through dividers R1014, R1009 and R1010, and adding it vectorially to the voltage obtained at the secondary of T1001. At resonance, the current through T1001 primary is 90 degrees out of phase with the tank voltage, which is 180 degrees out of phase with V1001 grid voltage.

Consequently, a 90 degree phase relationship exists between the voltage taken from the grid of V1001 and the voltage at each end of T1001 secondary. Detuning from a resonant condition causes the tank voltage to lag or lead in accordance with the polarity of the tank circuit reactance, because of the phase shift existing between the combination of L1001 and T1001 with respect to V1001 grid voltage. Vector voltages are rectified by CR1001 and CR1002 to produce either a positive or negative dc control voltage for application to the servo control subassembly. Resistors R1007 and R1008 are diode load resistors, and R1005, R1006, R1030 and R1031 in the secondary of T1001 determine the primary impedance. Capacitors C1018 and C1044 serve as rf bypass and filter capacitors, respectively, for the phase detector dc output voltage to the servo transfer circuit in the keyer group.

Power amplifier V1002 is operated in class C to provide a nominal 100 watts of rf power to the rf tuner. The output tank is a double-tuned pi circuit mutually coupled by capacitance, which provides 60-db minimum harmonic attenuation. The tank circuit of V1002 is similar in mechanical construction to that of V1001 with mechanical coupling between their tuning coils. The mutual coupling capacitance is fixed; thus, coupling varies inversely with frequency over each band, providing constant bandpass characteristics. An output from V1002 is coupled through C1055 to provide neutralization for buffer stage V1001.

The coil of false sense relay K808 is connected in the V1002 grid circuit. When this relay is de-energized, a —105 volt signal is applied to the servo control circuitry. This false sense signal serves as a simulated dc control voltage which is applied to the servo control subassembly to drive B1002 towards resonance. As resonance is approached, V1002 draws grid current causing K808 to energize thereby removing the false sense signal and allowing the control voltage from the phase detector to drive B1002. (This false sense action should not be confused with another false sense signal which is used only by the rf tuner.)

Switch section S1002A selects the primary L1004 tank capacitance to be shunted across C1015, C1057 and C1051. On BAND 1 (2 to 3 mc), capacitors C1017, C1019, C1020, and C1023 are selected; on BAND 2 (3 to 6 mc), capacitors C1019 and C1020; on BAND 3 (6 to 10 mc), capacitor C1020; and on BAND 4 (10 to 30 mc), stray shunt capacitance. The bandpass is maintained constant by adding the proper amount of capacitance by means of switch section S1002B. Switch sections S1002B, S1002C and S1002D select the proper capacitance value for secondary coil L1005. Switch S1001, section 2, rear, selects the proper splatter filter capacitor for each transmission band. Output is taken at the junction of capacitors C1033, C1058, and C1035, and coupled to output jack P1002 and output test point E1002.

High voltage (1100 volts dc) is applied to V1002 through rf choke L1006. Resistor R1004 is a decoupling resistor and C1022 is a bypass capacitor. Resistor R1012 is the PA cathode current-metering shunt. Parasitic oscillations in the plate circuit of V1002 are suppressed by Z1002.

Coil drive motor B1002 is a 26.5-volt dc, split-field motor with gear reduction and brake for actuating the roller-tape tuning coils. The motor is under control of a servo amplifier in the servo unit when in automatic tuning. A double-pole, double-throw jog switch is used for manual tuning. Limit switches S1003 and S1005 control minimum and maximum inductance, respectively, by stopping the motor at the limits of travel. Switch S1004 is a normally open microswitch which closes when the transmitter is ready to commence automatic tuning. This allows the rf amplifier to start tuning. (Refer to paragraph 2–5*c* for detailed description of the automatic tuning circuits.)

Motor B1001 is the cooling motor for power amplifier V1002 and push-pull modulators V1003 and V1004. FL1001 is the filter for blower motor B1001.

(2) PUSH-PULL MODULATORS V1003 and V1004 (4X250F). *(See figure 2–18.)* — The audio input is fed to modulators V1003 and V1004 from the audio frequency amplifier via pins 17 and 19 of connector P1001. Bias to the modulator tubes is adjusted to proper value by potentiometer R1017 in series with R1018. Transformer T1002 is the modulation transformer with two secondaries; secondary (4–5) modulates the plate supply voltage to power amplifier V1002, and secondary (6–7) modulates the screen supply voltage to power amplifier V1002. When the transmitter is used in cw operation, contacts 1 and 2 of relay K1001 effectively short out terminals 4 and 5 of T1002.

Closure of this relay in cw operation prevents high-voltage transients and transformer inductance from affecting output waveshape.

High voltage metering is obtained through voltage divider R1025, R1026, R1027, R1028 and R1033. A percentage modulation check is obtained through resistors R1025, R1026, R1027, R1028, R1033 and capacitor C1050, crystal diodes CR1004 and CR1009, and resistor R1029. Capacitor C1049 is the modulation indicator filter.

Silicon diodes CR1005, CR1006, CR1007, and CR-1008 prevent overmodulation of the signal at the plate of V1002. Since overmodulation would result if the negative-going modulating voltage exceeded the V1002 plate voltage, the diodes are utilized as negative peak limiters. (Four diodes in series are used to provide the

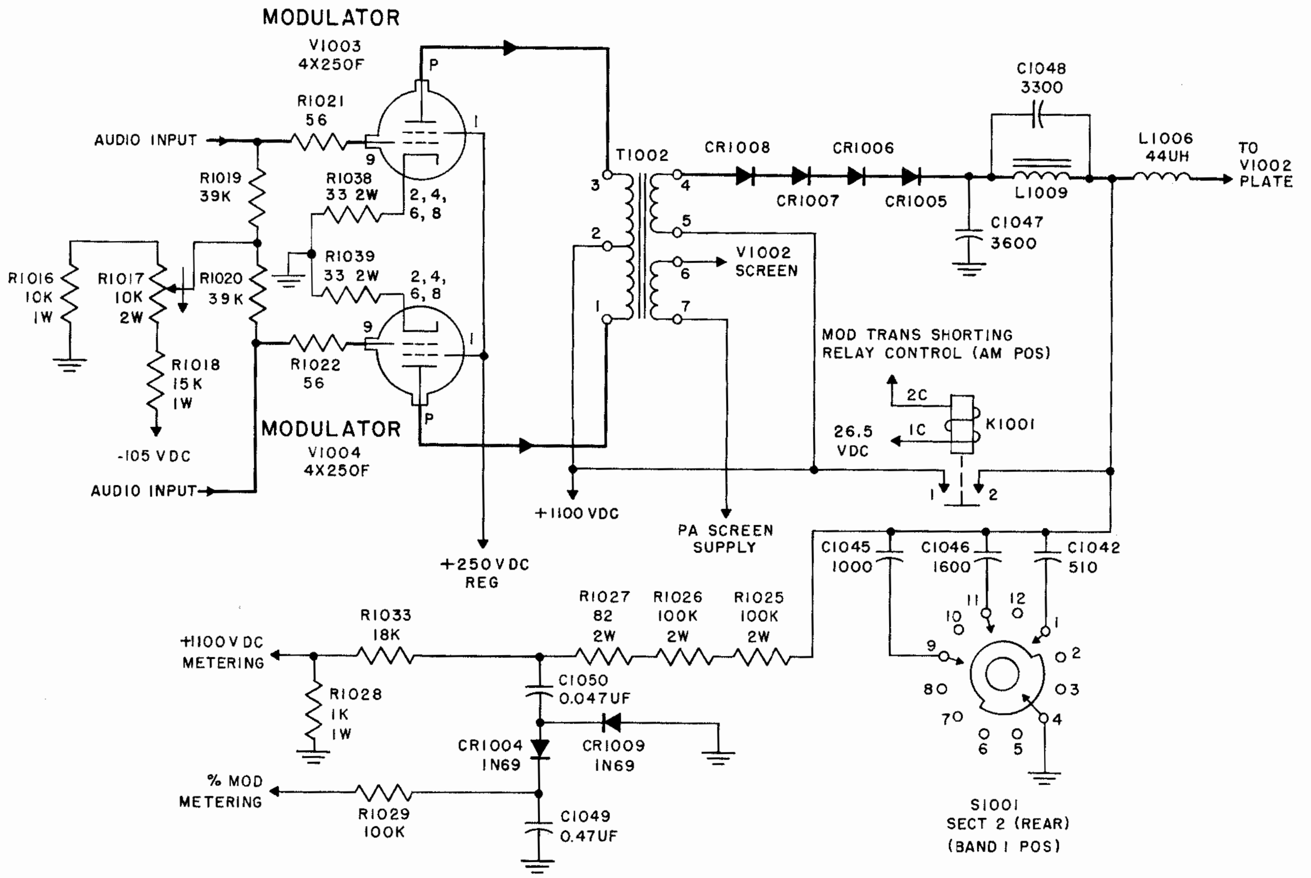


Figure 2–18. Modulator Stage, Simplified Schematic

required inverse voltage rating.) The diodes will conduct as long as the negative peaks of the modulating voltage at terminals 4 and 5 of T1002 do not exceed 1100 volts. If this occurs, the diodes stop conduction, causing the modulation to be limited to 100%.

Switch S1006 functions as part of the rf tuner circuitry. During operation on band 4, S1006 grounds-out the —105-volt false sense signal used by the rf tuner.

f. SERVO CONTROL. *(See figures 2–19 and 7–72.)* — The servo control amplifier is a removable sub-assembly containing two similar chopper-controlled servo amplifiers, one of which is known as the "load" and the other as the "tune" unit. These function during automatic tuning operation to actuate tuning motors in the amplifier-modulator and rf tuner, respectively, in response to dc sensing voltages developed in these units.

The dc control voltage output of the rf tuner magnitude detector is applied to load preamplifier tube V901. Mechanical chopper K901 converts the dc input to ac in conjunction with preamplifier tube V901. The amplified ac output of tube V901 is applied to load amplifier tube V902 and is then, in effect, converted back to dc by additional contacts on chopper K901. Load servo relay K903, connected in the balanced output of tube V902, applies power to the tuning coil motor in the rf tuner, causing the motor to turn until the dc control voltage reduces to zero. (See figure 2–20.)

The "tune" servo amplifier circuit is identical in operation to the "load" servo amplifier circuit, except that it actuates the amplifier-modulator tuning motor and rf tuner tuning capacitor motor in sequence. The dc sensing voltage input to the tuner servo amplifier from the rf tuner or amplifier-modulator phase detector is selected by servo transfer relay K805 in the keyer group, as is the proper tuning motor. Paragraph 2–5 describes the automatic tuning procedure.

Driving voltage for both choppers is the 400-cycle output of oscillator tube V905.

(1) LOAD SERVO AMPLIFIER. — The dc control voltage output of the rf tuner magnitude detector is coupled in parallel to the two grids of load preamplifier tube V901, through resistors R904 and R905 which serve to limit the current through the contacts of chopper K901. Induced rf is removed by the low-pass filter consisting of inductor L901 and capacitors C922 and C901. Resistor R906 provides a permanent dc return for the control voltage and the grids of tube

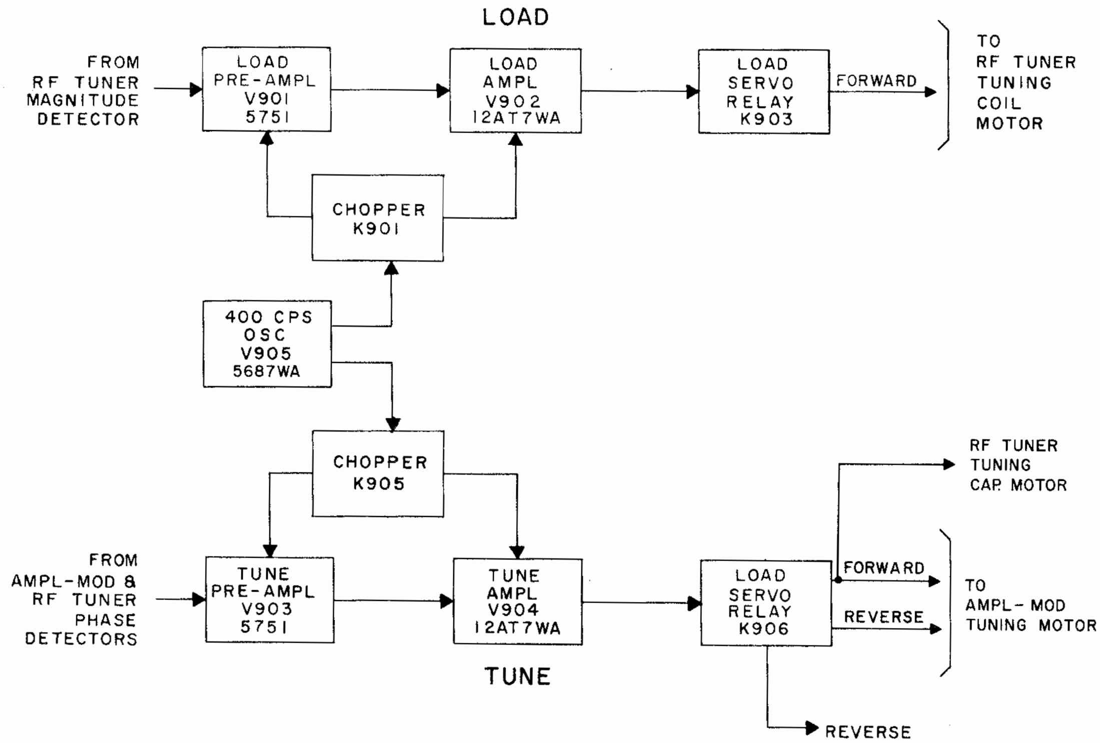


Figure 2–19. Servo Control, Block Diagram

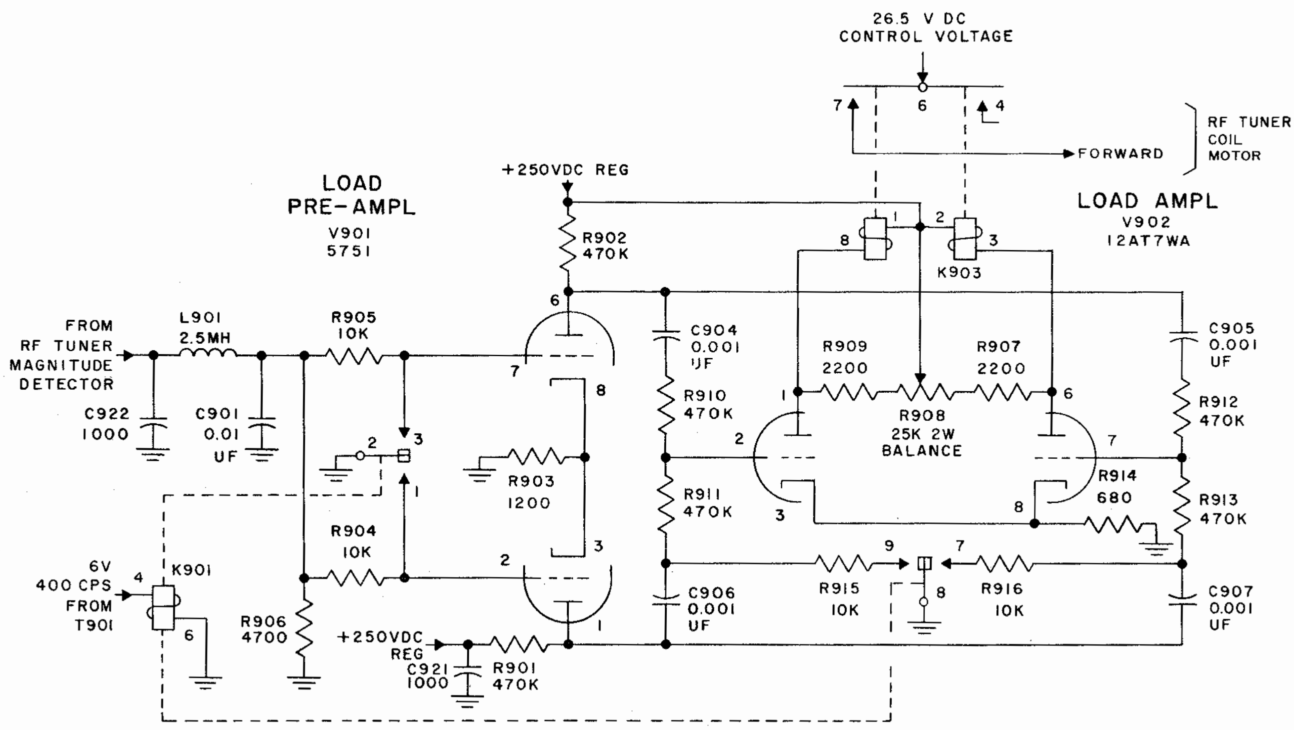


Figure 2–20. Servo Control, Load Circuits V901 and V902, Simplified Schematic

V901. Contacts 1, 2, and 3 of K901 short the grids of V901 alternately at a 400-cycle rate, converting the dc control voltage to a 400-cycle square wave. Each grid receives equal magnitude 400-cycle square-wave voltages which are 180 degrees out of phase with each other. Amplified ac voltages are developed across plate load resistors R901 and R902. The square wave at the plate (pin 6) of the right-hand section of tube V901 is coupled to both grids of load amplifier tube V902 in parallel (figure 2–20), through dc blocking capacitors C904 and C905 and grid resistors R910 and R912. The out-of-phase ac voltage at the plate (pin 1) of the left-hand section of tube V901 is similarly coupled to the two grids of tube V902, in parallel, through capacitors C906 and C907 and resistors R911 and R913. The waveform of the 400-cycle voltage at the left-hand plate (pin 1) of tube V902 resembles a sawtooth rather than a square wave, due to the effect of capacitors C906 and C907 which are alternately grounded through contacts 8 and 7 or 8 and 9 of chopper K901 so that one or the other set of contacts shunts plate load resistor R901 for ac. The relatively long time-constant of the effective RC plate load with respect to the 400-cycle period results in partial integration of the square wave applied to the grid (pin 2) of tube V901. The resultant net voltages applied to the grids of tube V902 is determined by the dc control voltage polarity and the action of chopper K901 in alternately grounding the grids through resistors R911 and R913. Each energizing coil of load servo relay K903 is connected into the plate circuit of one half of tube V902. At balance, or zero dc control volts input, the dc current through each coil is the same, and the moving contact (6) of K903 remains in a neutral position. The 26.5-volt dc control voltage is connected to relay contact 6, which closes to contact 7 or 9, according to whether contacts 6 and 7 or contacts 6 and 4 of K903 are closed by an unbalanced condition in tube V902. To compensate for variations in tubes and components, potentiometer R908, in series with resistors R907 and R909, is adjusted for balanced output with zero dc control volts input. As shown on figure 2–20, there is no output connection from contact 4 of K903. Thus, although the circuitry functions for either positive or negative dc control voltages from the rf tuner, an output from the load servo is provided only for a negative control voltage. This arrangement is used to eliminate motor hunting. Furthermore, since the rf coil motor is always "homed" to the minimum inductance position of the rf coil during the initial phase of the automatic tuning cycle, it is not necessary for the load servo to provide two-way rotation of the motor.

Consider the case where the dc control voltage is negative and contacts 2, 3 and 7, 8 of chopper K901 are closed. During this condition, the left-hand section of V901 amplifies and inverts the negative square-wave input to produce a positive-going one, but because of the action of C907 and R916 (grounded through contacts 7 and 8 of K901) this waveform appears at the plate (pin 1) as a sawtooth. Since the grid of the right-hand section of V901 (pin 7) is grounded (through contacts 3 and 2 of K901) this section becomes effectively a grounded-grid amplifier, and such as amplifies the negative square wave voltage developed across the unbypassed, common cathode resistor R903 to produce a negative square wave at the plate (pin 6) of the right hand section of V901. This negative square wave is of the same peak-to-peak amplitude as the positive sawtooth voltage at the plate of the left-hand section (pin 1) of V901, the action being similar to that which takes place in a cathode-coupled, push-pull amplifier. The voltage applied to the grid (pin 2) of V902 is the net resultant obtained at the junction of grid resistors R910 and R911. Due to the equality of the series rc coupling networks formed by R910, C904 and R911, C906, the two out-of-phase and equal magnitude voltages would cancel at the junction point of R910 and R911 if they were exactly the same shape. However, since the square wave area is greater than that of the sawtooth, the net result is a negative spike which causes a slight decrease in conduction of the left half of V902. However, since contacts 7 and 8 of K901 are closed, the positive sawtooth from V901 (pin 1) is grounded and is thereby prevented from being applied to the right-hand grid of V902. Consequently, the right-hand grid (pin 7) is driven only by the negative square wave from V901 (pin 6) which is coupled through C905. This action results in an unbalanced condition in V902 whereby the left half conducts more than the right half which, in turn, causes contacts 6 and 7 of relay K903 to close.

With the same negative dc control voltage input, consider what happens when chopper K901 swings over to close contacts 1, 2 and 8, 9. The right-hand section of V901 amplifies the negative input square wave, resulting in a positive-going square wave at the plate. With the left-hand grid grounded through contacts 1, 2 of K901, this section amplifies the negative square wave developed across cathode resistor R903. The resultant negative-going waveform at the left-hand plate is still essentially a sawtooth, since capacitor C906 now serves as the plate shunt capacity through contacts 8, 9 of K901. The net resultant voltage applied to the right-hand grid of tube V902 is a positive-going spike due to the summation of the negative sawtooth and larger area positive square wave. This results in slightly more conduction for the right-hand section of tube V902. Simultaneously, the left-hand grid of V902 receives only the positive-going square wave, since the negative sawtooth is shorted to ground at the junction of capacitor C906 and resistor R911. Conduction in the left-hand section of tube V902 is therefore much higher than in the right-hand section, so that the resulting unbalanced condition maintains contacts 6, 4 of relay K903 closed.

Closed contacts 6 and 7 of K903 apply +26.5 volts dc to rf coil drive motor B1202, which increases the inductance of coil L1201 until the correct tuning point is reached.

(2) TUNE SERVO AMPLIFIER.—The tune servo amplifier is similar in design to the load servo amplifier. However, this circuitry provides an output for both negative and positive input control voltages from the amplifier-modulator, thereby permitting two-way rotation of rfa coil tuning motor B1002 during the automatic tuning. The circuitry operates the same as the V901, V902 stages during application of a negative control voltage. When a positive voltage is applied to V903, conditions reverse and conduction through the right half of V904 energizes coil winding 2, 3 of K906, causing contacts 6 and 4 to close. This reverses direction of rotation of the drive motor in the amplifier modulator.

Upon completion of the rfa tuning, servo transfer relay K805 (keyer group) switches the input to V903 from the amplifier modulator to the rf tuner. Tubes V903, V904 then operate to drive rf tuner capacitor motor B1201. This operation is the same as for the load amplifier; that is, B1201 can only tune in the forward direction. As shown in figure 7–57 there is no connection between K906 and the reverse winding of B1201.

(3) 400-CPS OSCILLATOR V905 (5687WA). *(See figure 2–21.)* — Tube V905 resembles a symmetrical free-running multivibrator in that it consists of two amplifier sections with plate-to-grid RC feedback coupling. An LC tank circuit, resonant at 400 cycles, serves as the plate load impedance in place of the plate load resistors found in a conventional multivibrator. Transformer T901 and capacitor C916 form the parallel resonant LC circuit. Assume a positive signal at the grid (pin 2) of tube V905. The phase-inverted signal at the plate (pin 1) is coupled through capacitor C915 to the grid (pin 7). Phase inversion takes place in the right half of V905 so that the signal at its plate is in phase with the signal at the left-hand grid. Capacitor C917 provides the positive feedback path for the in-phase signal. A 400-cycle sine wave of approximately 120 volts is generated across primary terminals 1 and 3 of transformer T901. Due to the step-down turns ratio, 6 volts, 400 cps is developed across terminals 4 and 5 of the secondary to drive the choppers K901 and K905.

g. RADIO-FREQUENCY TUNER. *(See figure 7–74, 2–22 and 2–23.)* — The rf tuner consists of a removable subassembly containing an automatic variable LC network assembly, mounted within the transmitter. It is an impedance matching device for matching the high input impedance of the antenna to the output impedance of the power amplifier stage in the amplifier-modulator.

The rf tuner has two variable motor-driven elements, a variable capacitor and a variable inductor. Impedance matching is achieved by simultaneous adjustment of both the inductive and capacitive elements.

A phase detector circuit, mounted within the rf tuner, consists of a resonance detector and a magnitude detector to sense resonance of the system and magnitude of the resulting impedance. Dc potentials obtained from the phase detector circuit are amplified, and control the motors used to drive inductive and capacitive elements of the rf tuner.

Impedance matching of the LC network to the amplifier-modulator power amplifier is accomplished by a wide-band impedance-matching rf transformer. The amplifier-modulator power amplifier output is fed to input jack J1201 in the rf tuner. The input circuit consists of wide-band rf transformer T1201 which has a nominal input impedance of 50 ohms, when terminated in 15 ohms resistive, over the entire frequency range of 2 to 30 mc. The center tap of transformer T1201 is in series with the variable LC network formed by vacuum capacitor C1201 and variable inductor L1201. The antenna impedance is in parallel with variable inductor L1201.

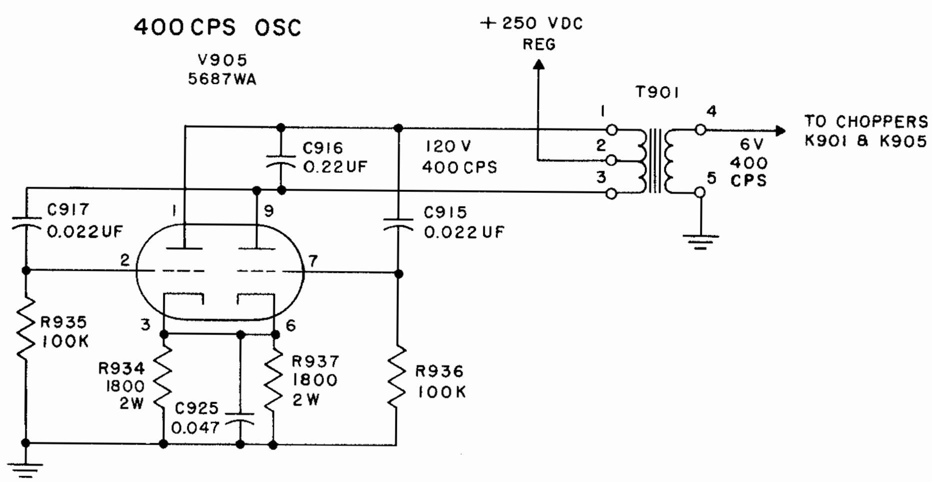


Figure 2–21. Servo Control, 400-CPS Oscillator, Simplified Schematic

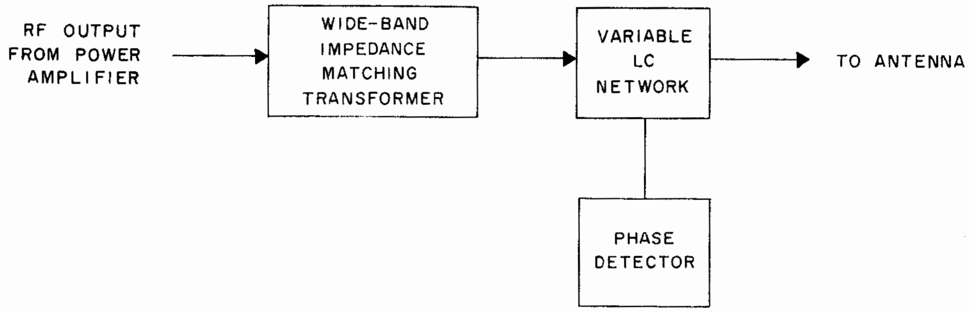


Figure 2-22. RF Tuner, Block Diagram

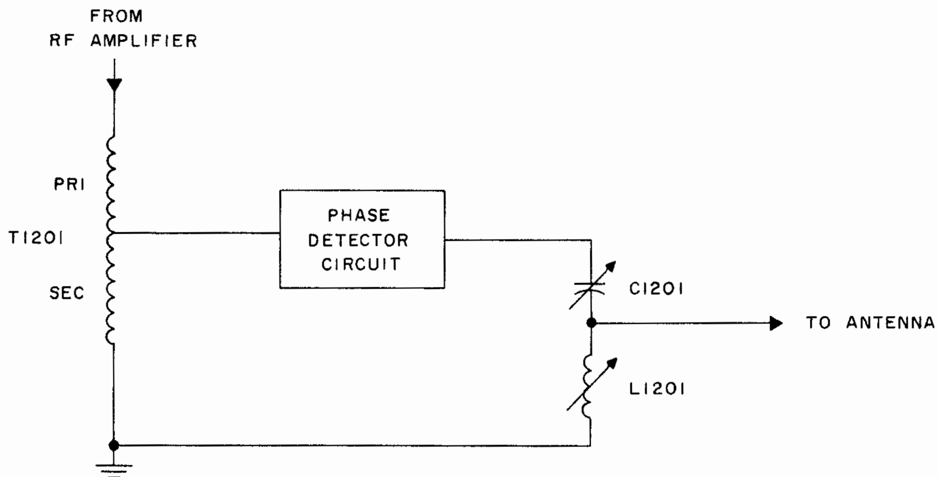


Figure 2-23. RF Tuner, Simplified Schematic

Variable inductor L1201 is a motor-driven, roller tape-type inductor, continuously variable from 0.5 to 50 microhenries. Variable capacitor C1201 is a motor-driven vacuum-type capacitor, furnishing the required capacitance to resonate the wide range of reactances presented by the variable inductor in parallel with the antenna.

Whenever the variable inductor is adjusted to obtain a new impedance, the variable capacitor is tuned to form a resonant circuit, thus presenting a 15-ohm resistive impedance to the primary of T1201.

When an rf input signal is applied to the rf tuner, the antenna tuner phase detector circuit determines the sign of the phase angle of the impedance presented by the variable inductor in series with the variable capacitor paralleled by the antenna. The phase detector also determines the sign of the deviation of the impedance and magnitude with respect to 15 ohms. The measure of phase angle error is determined by a phase discriminator consisting of transformer T1202 and crystal diodes CR1203 and CR1204. (See figures 2-24 and 2-25.)

Voltage induced in the secondary of T1202 by the primary current is in phase with the primary current, and is added vectorially to a voltage obtained directly from the primary by capacitor C1206, series-connected resistors R1211 through R1214, R1215, and rectified by crystal diodes CR1203 and CR1204. Resulting polarity and amplitude of the dc output voltage is a function of the angle of the phase difference between the primary current and voltage. Primary current and voltage are in phase when the circuit is at resonance. To establish a 90 degree phase relationship between the current and voltage vector when resonance has been established, phase shifting networks are provided.

Phase of the "voltage" vector is advanced an amount which is a function of the tangent of the network phase angle of capacitor C1206 and the resistor series combination of R1211 through R1214.

Phase of the "current" vector is retarded an amount which is a function of the network phase angle of the RC combination R1203, C1204 and R1208, and C1205. Circuit tolerances are compensated by variable capacitor C1206. Dc potential obtained from the resonance detector portion of the phase discriminator circuit is applied through decoupling resistor R1217 to the servo control for amplification, and is used to control the capacitor tuning motor B1201.

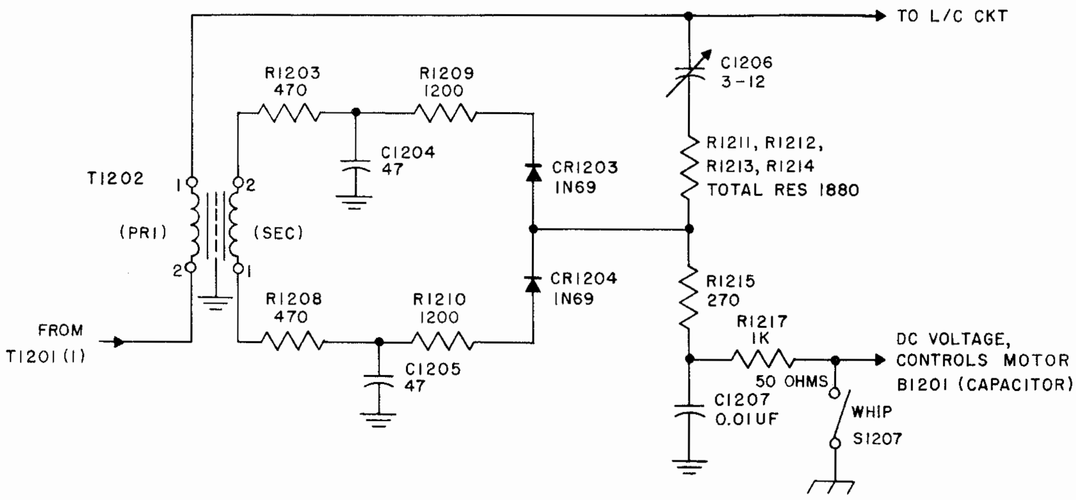


Figure 2–24. RF Tuner, Phase Discriminator Resonance Detector, Simplified Schematic

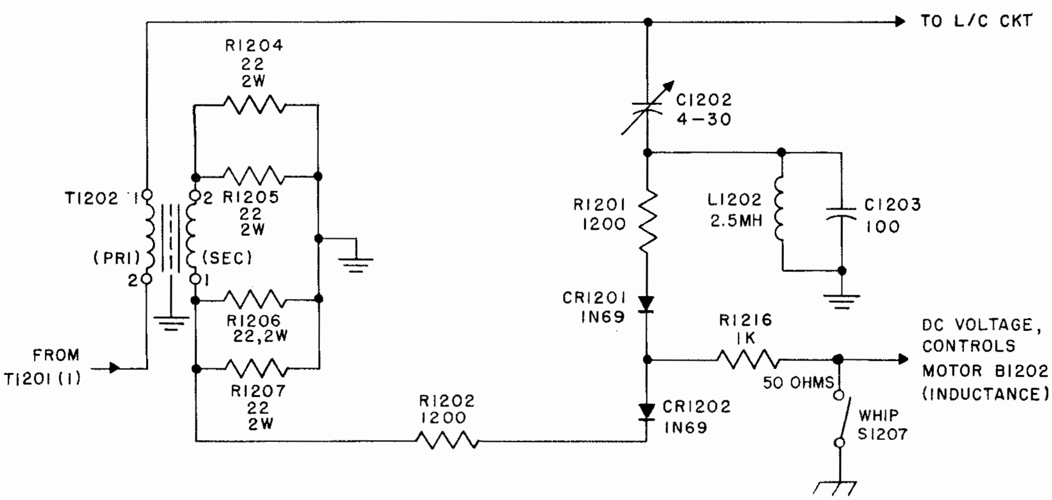


Figure 2–25. RF Tuner, Phase Discriminator Magnitude Detector, Simplified Schematic

Loading is determined by the magnitude detector circuit consisting of CR1201 and CR1202. (See figure 2–25.) Capacitance divider C1202 and C1203 derives a portion of line voltage which is then rectified by CR1201. This voltage is added vectorially to the voltage obtained from the balanced secondary of transformer T1202, whose circuit contains resistors R1204, R1205, R1206, R1207, and rectified by CR1202. This voltage is a function of line current. The two rectified voltages are equal when the load impedance is 15 ohms and the resulting dc potential is zero volts. Polarity of this dc voltage is a direct function of the deviation above or below the 15-ohm impedance. Dc output of the magnitude detector is applied through decoupling resistor R1216 to the servo control for amplification and used to control inductance tuning motor B1202. Resistors R1201 and R1202 are current limiting resistors for the crystal diodes. Inductance L1202 in parallel with C1203 provides a dc return for CR1201.

When rf is applied to the rf tuner, the phase detector determines the phase angle of the impedance presented by the antenna in parallel with the LC network, and the impedance deviation magnitude with respect to 15 ohms. Assume that the vector sum of the impedance is less than 15 ohms. The magnitude detector furnishes negative voltage, causing the servo control to drive the inductor tuning motor towards increased inductance. Simultaneously, the capacitor tuning motor will tune the capacitor for a resonant circuit in response to a sense voltage from the phase detector. Assuming that the capacitor was near maximum capacity, and the resulting impedance inductive, the capacitor would be tuned toward minimum capacity. The variable capacitor keeps the LC network in or near resonance while the variable inductor seeks a 15-ohm series resonant impedance.

As explained in the description of the automatic control circuits (paragraph 4-5), the tuning motors are initially homed, during automatic tuning, to their maximum reverse position. The rf tuner motors will only tune forward; motor rotation will stop when the correct tuning points are reached. (For manual tuning, the motors can be driven both ways.)

Assume that at some frequency below 4.0 mc, the resulting vector sum of the impedances is greater than 15 ohms. Inductance cannot decrease, as it is already at its minimum position. The resulting impedance is capacitive, but the capacitor cannot increase as it is already at its maximum position. When both the capacitor and inductor cannot tune for a resonant circuit, switch S1206, actuated by the capacitor tuning motor in maximum position, applies a momentary "false sense" signal. This signal drives the inductor tuning motor, increasing inductance until the capacitor is resonated. At this point, the capacitor will decrease in order to maintain resonance. The false sense signal is no longer required, for resulting impedance is now lower than 15 ohms. The inductance will continue to increase, by virtue of the magnitude detector, until the impedance is 15 ohms. (This false sense signal is not needed for band 4 operation and is grounded-out by S1006 when operating on band 4.)

The rf tuner is not capable of efficient operation when worked into a 50-ohm load below 6 mc, or 100-ohm load or less below 4 mc; therefore, when operating the transmitter into a low impedance antenna, or when a low impedance transmission line is used, the rf tuner must be bypassed. This is accomplished by removing the rf input to the rf tuner from the amplifier-modulator and placing toggle switch S1207, located on the rf tuner chassis, at the 50 OHMS position. In this position, S1207 disables the rf phase and magnitude detector outputs, thus preventing unnecessary tuning of motor-driven coil L1201 and capacitor C1201.

When the rf tuner is used with the radio set, S1207 must be at the high impedance position (WHIP). Refer to section 3 for detailed instructions for bypassing the rf tuner.

2-3. POWER SUPPLY PP-1711/GRC-14.

a. OVERALL FUNCTIONAL DESCRIPTION. *(See figures 2-26 and 7-76.)* — The power supply furnishes all necessary power required for transmitter operation of Radio Set AN/MRC-55. Its circuitry is contained in a watertight cabinet having facilities for front panel connection of input and output power. The power supply may be operated from either the vehicular 26.5-volt dc, 24-volt ac supply, or from an external 115-volt ac source. In addition to providing all of the necessary filament, plate and control voltages required for the transmitter, the power supply provides the necessary power for operation of teletype equipment. Input power to the receivers passes through the power supply frame and is fed to the internal power supplies of the receivers. The power supply contains a dynamotor, voltage regulators, rectifiers and control circuits. The following voltages are provided at the output of the power supply:

- +1100 volts, high voltage supply
- +312 volts, supply
- +250 volts, regulated
- −105 volts, bias supply
- +115 volts, teletype motor, line and loop supply
- +26.5 volts, filament, blower, oven, and control circuit supply
- +26.5 volts or 115 volts ac, receiver supply

b. INPUT CIRCUITS. (Refer to paragraph 2-4 for a detailed description of the power circuits.) — The power supply may be operated from a vehicular generator system or from a 115-volt ac source. When POWER SELECTOR switch S1401 is in the DC position, the 26.5-volt ac from the vehicular generator system is applied directly to the control circuits for dynamotor and heater power. Microswitch S1404 is a main power auxiliary switch in series with the coil of filament control relay K1401. Switch S1404 will only be actuated when S1401 is at the AC or DC position. The 24-volt ac from the vehicular generator system is applied to one half of the primary of transformer T1402 where it is stepped up and rectified to provide 115-volt dc which is supplied unfiltered to the teletype motor and filtered for the teletype loop supply.

When switch S1401 is in the AC position, the 115-volt ac input voltage is stepped down by transformer T1401 and rectified by CR1401 and CR1402 to provide the 26.5-volt dc for operation of the dynamotor and the other circuits described above. The 115-volt ac is also applied to the primary of transformer T1402. When an ac source is used, the secondary voltage provides 115-volt dc for the teletypewriter motor, and is tapped to provide 115-volt ac for use in the receivers. (See paragraph 4-4 for a description of the control circuits.)

c. DYNAMOTOR AND VOLTAGE REGULATOR CIRCUIT. — Dynamotor D1401 has three outputs: high voltage (+1100 volts), medium voltage (+350 volts), and bias supply (−105 volts). The +1100-volt output is filtered by the LC combination L1402, C1406 and L1407, C1417, and is protected by fuse F1409. The filtered high voltage output (+1100 volts) appears at terminal A of J1403, the output of the power supply. The −105-volt dynamotor output is filtered by L1401A and C1407 and fed through fuse F1410 to terminal T of J1403. The +350-volt dynamotor output is applied through fuse F1408 and LC filter L1406 and C1408 where the path divides with one output being applied across voltage divider resistors R1430 and R1434 to terminal V of J1403 for further delivery to the transmitter (+312 volts). This value of voltage

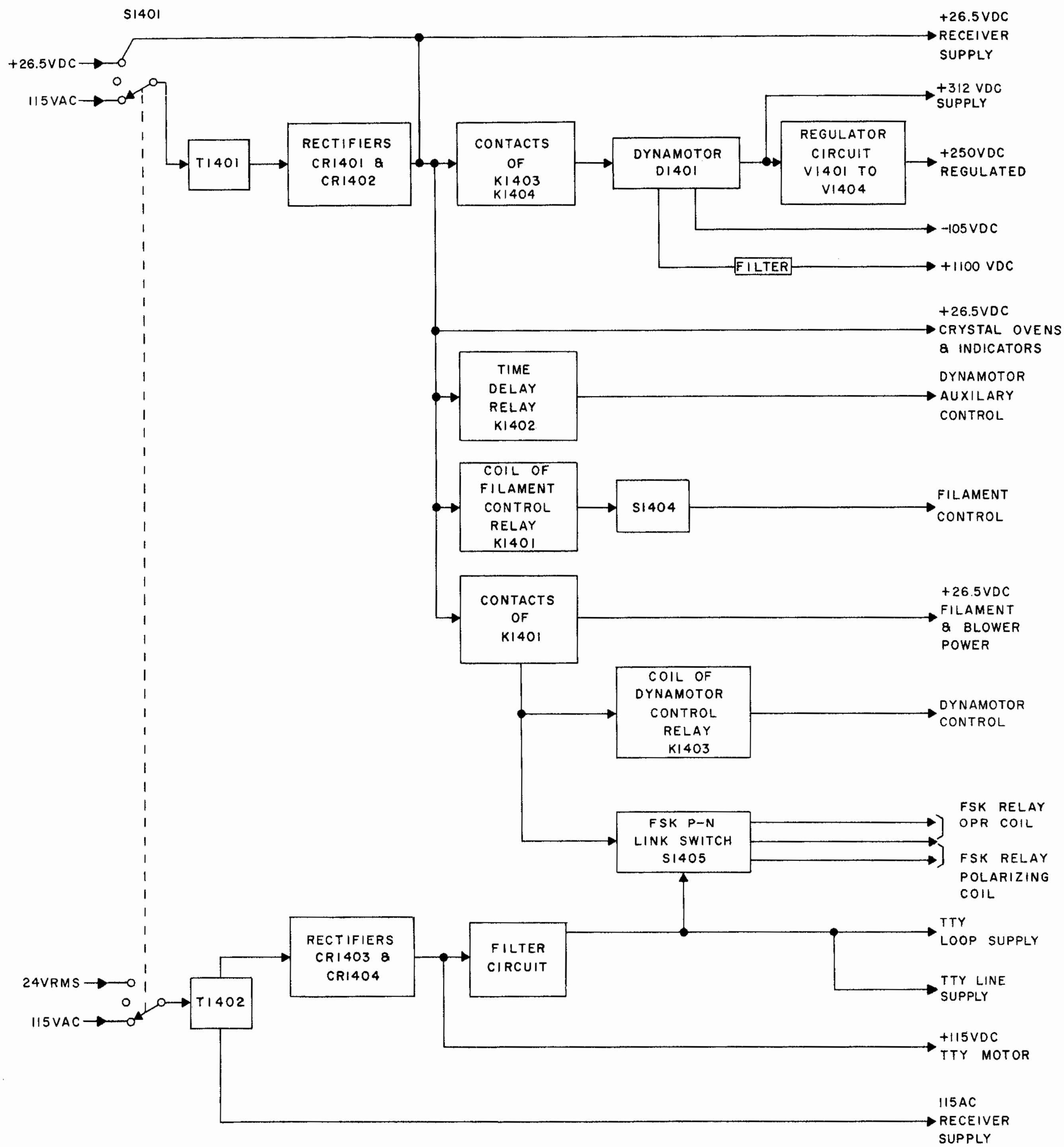


Figure 2–26. Power Supply, Block Diagram

at J1403–V will vary in accordance with power amplifier V1002 conduction. The +350-volt dynamotor output is also applied to the +250-volt regulator circuit consisting of regulator tubes V1401 and V1402 (connected in parallel for increased current capability), control tube V1403, and voltage regulator tube V1404. This circuit is a conventional type of regulator circuit used to compensate for variations in load current and input voltage.

Regulator tubes V1401 and V1402 are in series with the load. The voltage across the load is regulated by controlling the conduction of V1401 and V1402 so that the regulator tubes act as a variable resistor that automatically adjusts itself to the correct value. Conduction, and consequently tube resistance, of the regulators is controlled by V1403 which biases V1401 and V1402 in accordance with the output voltage. Control grid bias for the right half of V1403 is maintained at a fixed potential by V1404; cathode bias is set by potentiometer R1425.

If the output voltage tends to rise, the voltage at the wiper arm of R1425 will become more positive. Since the R1425 arm is connected to the V1403B cathode, plate current will decrease and the plate voltage at pin 6 will increase. This voltage rise also appears at the control grid of V1403A since the two elements are connected. The increased voltage at the control grid causes an increase in plate current and the plate voltage at pin 1 will decrease. This voltage decrease is coupled to the control grids (pin 1, 4) of V1401 and V1402, causing a decrease in the regulator plate current. The increased resistance of the tubes results in an increased voltage drop across V1401, V1402 and, consequently, the output voltage decreases.

The regulators operate in a converse manner to keep the output voltage from decreasing below +250 volts. That is, the V1401, V1402 resistance will decrease, causing an increase in the output voltage.

Potentiometer R1425 is used to set the output voltage at +250 volts.

d. TRANSFORMER T1402 AND RECTIFIER CIRCUITS. *(See figure 2–27.)* When the power supply is operated from a vehicular generator-battery system, 24-volt ac (taken from the vehicular rectifier) is applied across one-half of the primary of transformer T1402. In this case, the transformer is used to step up input voltage to 115-volt ac, which is rectified by CR1403 and CR1404 to provide 115-volt dc to the teletype circuits.

Outputs of rectifiers CR1403 and CR1404 is applied directly to the teletypewriter motor and to the filter circuit consisting of C1404, L1401B, and C1405 through current limiting resistor R1405. The filtered voltage developed across R1406 is connected to the TTY LOOP SUPPLY and DC TTY LINE terminals on the front panel.

When operated from an ac source, this circuit operates as described above, except that the 115-volt ac input is developed across the entire primary of transformer T1402. The 115-volt ac is also coupled to winding 5, 4 and fed to the receiver power supplies. Voltage is transferred to winding 5, 4 in a 1:1 ratio.

e. CRYSTAL OVENS AND INDICATORS.— Voltage applied to the crystal ovens and indicators is taken from the vehicular generator-battery system, when that source is used. When the power supplied is obtained from an ac source, the 26.5-volt dc is derived from the rectifier circuit consisting of CR1401 and CR1402. When switch S1401 is placed in either the AC or DC position, the voltage is applied to the crystal ovens and indicator circuit.

f. CONTROL CIRCUITS. — Switch S1401 is used to place the power supply in either ac or dc operation, or to shut it off. Interlock switch S1402 disconnects the dynamotor control circuit so that the dynamotor will operate only when the chassis is secured in the cabinet. Switch S1404 is ganged to S1401 and is used to open or close the filament control circuit. When switch S1404 is closed, K1402 is also energized and, after a 30-second delay, connects the dynamotor auxiliary control into the circuit.

When a teletypewriter set having its own loop supply is connected to the radio set, LOOP SUPPLY switch S1403 is set at EXTERNAL position. This connects ground to terminal L1 of DC TTY LINE on the power supply front panel. When the local (radio set) loop supply is to be used, switch S1403 is set at LOCAL position. In this position ground is removed from terminal L1 and the local loop supply (+115 volts) is placed in series with the teletype line. KEYING switch S1405 is switched to either NEUTRAL or POLAR depending on the type of teletype installation. This switch changes the wiring for FSK operation relay K402 in the reference oscillator and mixer subassembly of the transmitter. Refer to paragraph 2–4 of this section for detailed descriptions of the control circuits, and to section 3 of this manual for detailed instructions for teletype connections.

2–4. POWER DISTRIBUTION AND CONTROL CIRCUITS.

(See figures 7–24, 7–76, and 7–57.)

The power distribution and control circuits are integral parts of the radio set.

a. INPUT POWER CIRCUIT. — When the vehicular generator system is used, +26.5 volts is supplied directly to the receivers through fuse F1402. When main power control switch S1401 is in any position but OFF, +26.5-volt power is applied through line fuse F1403 to the transmitter frame. Dial lamps DS1302, DS1304, DS1305, DS1306, and DS1307 are illuminated through dimmer control potentiometer R1301. The +26.5 volts is also applied to crystal oven heater winding R426 through the normally closed contacts of the thermostat S408 and thermal protector E409, an electrical link fuse. The thermostat contacts

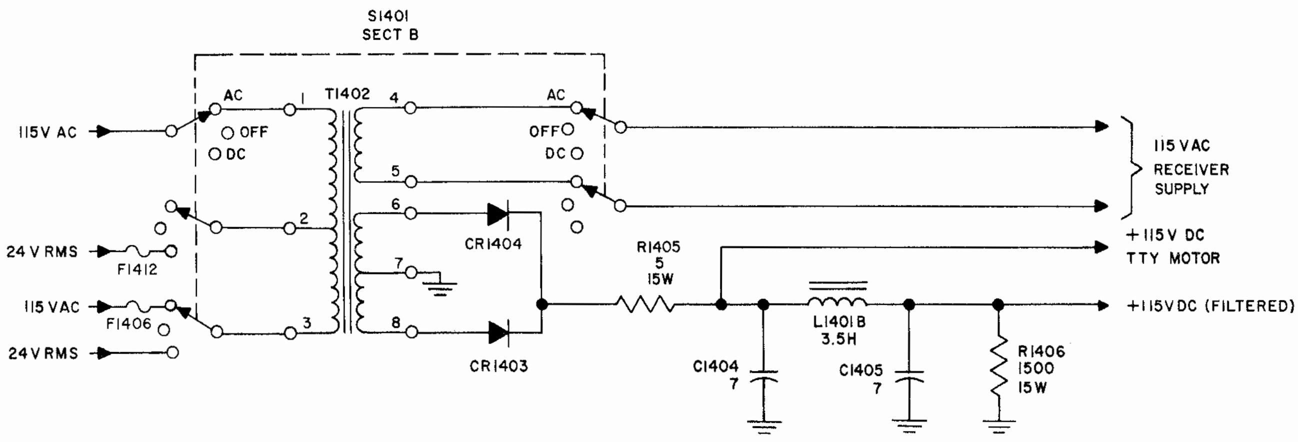


Figure 2–27. Transformer T1402 and Rectifier Circuits, Simplified Schematic

open and close at 85°C ±2.5° (185°F ±4.5°), keeping the crystals in the reference oscillator and mixer at a constant temperature. Capacitor C505, in parallel with S408, eliminates arcing when the contacts of the thermostat open and close.

The primary power control path is also applied through line fuse F1403. Filament control relay K1401 is energized from the +26.5-volt bus line to ground through S1404, which is ganged to S1401, and SERVICE selector switch S1302, section 1, rear, when the switch is in any position except OVEN. Dynamotor time delay K1402, in parallel with K1401, receives power at the same time and becomes actuated 30 seconds after main power control switch S1401 is operated, provided that S1302 is in any position except OVEN. When K1401 energizes, its normally open contacts close, applying power through fuse F1404 to the filaments of power supply tubes V1401, V1402, and V1403. Filament power to all transmitter tubes and blowers B1301 and B1001 is also applied through the closed contacts of K1401 and fuse F1405. Blower B1301 circulates air through the transmitter cabinet and blower B1001 cools the type 4X250F tubes in the amplifier-modulator. Resistor R1305, which is in series with the blowers, is a voltage-dropping resistor used to allow the blowers to run at slow speed when the dynamotor is not energized. When the dynamotor is energized and high voltage is applied, contacts 17 and 9, and 16 and 17 of relay K801 short-circuit R1305 and allow the blowers to operate at full speed.

The +26.5 volts is also supplied through F1404 for use in the dynamotor control and transmitter automatic tuning circuits. The +26.5 volts is also fed through F1404 to keying switch S1405 for application to the fsk relay coils.

b. DYNAMOTOR CONTROL CIRCUIT. — Power to one of the field coils of dynamotor D1401 is applied through fuse F1404 when filament control relay K1401 is energized. Thirty seconds after main power control switch S1401 is placed in the AC or DC position and switch S1302 is placed in any position except OVEN, time delay relay K1402 will actuate and its contacts 3 and 4 will close. Dynamotor auxiliary control relay K801 is energized through closed contacts 3 and 4 of K1402 and switch S1302, section 1, rear, whenever S1302 is in any position except OVEN or STANDBY. For AM, CW-TUNE, and FSK-AM services, the circuit to ground is further completed through REMOTE-NORMAL-RELAY selector switch S1303, section 2, rear, or section 1, rear, respectively. Relay K801 is also energized through contacts 5 and 15 of relay K803 or contacts 5 and 15 of relay K804 when the automatic tuning motors of the transmitter are cycling. This operation is described in paragraph 2–5*b*.

When switch S1303 is in NORMAL position, relay K801 is energized to ground in the following ways: When S1302 is in the AM position, the coil of K801 is connected to terminals 6 and 2 of S1302, section 1, rear, and 12 and 9 of S1303, section 2, rear, to mciro-phone receptacle J1306 on the transmitter front panel, and receptacles J1501 and J1502 on the receiver front panel. Relay K801 will energize whenever the microphone push-to-talk switch is depressed. When S1302 is in the FSK-AM or CW position, the coil is connected to ground through terminals 6 and 5 or 6 and 4 of S1302, section 1, rear, and terminals 4 and 1 of S1303, section 1, rear.

When S1303 is in REMOTE position, relay K801 is energized to ground in the following ways: When S1302 is in AM position, the coil of K801 is connected to terminals 6 and 2 of S1302, section 1, rear, and 12 and 10 of S1303, section 2, rear, then to the local remote control unit. Relay K801 will energize whenever the remote microphone push-to-talk switch is depressed. The coil circuit of K801 does not pass through S1303 when in NETTING position. When S1302 is in FSK-AM or CW position, the coil of K801 is connected to ground through terminals 6 and 5 or 6 and 4 of S1302, section 1, rear, then to local remote control through contacts 4 and 2 of S1303, section 1, rear.

When S1303 is in RELAY position, relay K801 is energized to ground when S1302 is in the AM position. (When S1302 is in the NETTING position, however, relay K801 will be energized regardless of the position of S1303.) For AM relay service, the coil of K801 is connected to terminals 6 and 2 of S1302, section 1, rear, and 12 and 11 of S1303, section 2, rear, to the contacts of squelch relay K1502 in the receiver.

When relay K801 energizes, contacts 20 and 1 close, causing dynamotor control relay K1403 and running-time meter M1401 to energize through cabinet interlock switches S1402 and S1301. The input power is applied to the dynamotor field coil through fuse F1407, contacts of K1403, and K1435, K1404. Relay K1404 and resistance wire R1435 limit the starting current through the dynamotor field coil. The initial current surge is limited by R1435 and the coil inductance of K1404. Then, K1404 energizes and its closed contacts bypass R1435, applying normal voltage to dynamotor D1401.

2-5. AUTOMATIC CONTROL CIRCUITS.

a. GENERAL PRINCIPLES. — The rfa and the rf tuner are tuned sequentially using separate split-field dc reversing motors controlled by a servo amplifier common to both units. This amplifier, designated the "tune" amplifier, is located in the servo control and is used to control the variable tuning coil in the rfa and the variable tuning capacitor in the rf tuner. It receives a dc input from phase detectors located in each of these units.

An additional split field dc reversing motor with its own servo amplifier is used to control the variable tuning coil in the rf tuner. This amplifier, designated the "load" amplifier, is located in the servo control and receives a dc input from a phase detector located in the rf tuner.

The equipment can be manually tuned by directly applying power to the motors through manually operated jog switch S1305, S1306, and S1307, located on the transmitter front panel. The rfa and then the rf tuner are manually tuned, using front panel meters M1302 and M1303 as tuning indicators.

b. OVERALL THEORY OF OPERATION. *(See figures 7-57, 7-58, and 7-66.)* — Automatic tuning is initiated by depressing TUNE START switch S1304 which actuates automatic reset relay K802. This relay bypasses the servo amplifiers and applies 26.5-volt dc power to B1002 (rfa coil control), B1202 (rf tuner coil control), and B1201 (rf tuner capacitor control), driving them to a home position. At the home position, B1002 and B1201 actuate microswitches. These switches (S1004 and S1205) are connected in series so that both motors must be in the home position before tuning can proceed. The series-connected electrical circuit then actuates rfa tune relay K803 through relay K802 which controls plate voltage to the servo control circuitry. Relay K803 also energizes K805, which allows the rfa coil to be resonated by motor B1002 through K906 and K805. When rfa tuning is completed, thermal time delay relay K806 will cause the rfa tune relay to de-energize and allow rf tuner tune relay K804 to take control. Motors B1201 (rf tuner capacitor control) and B1202 (rf tuner coil control) will then turn until the correct resonance and load-matching points are reached. When this occurs, thermal time delay relay K807 will cause control of the transmitter to be returned to normal operational status.

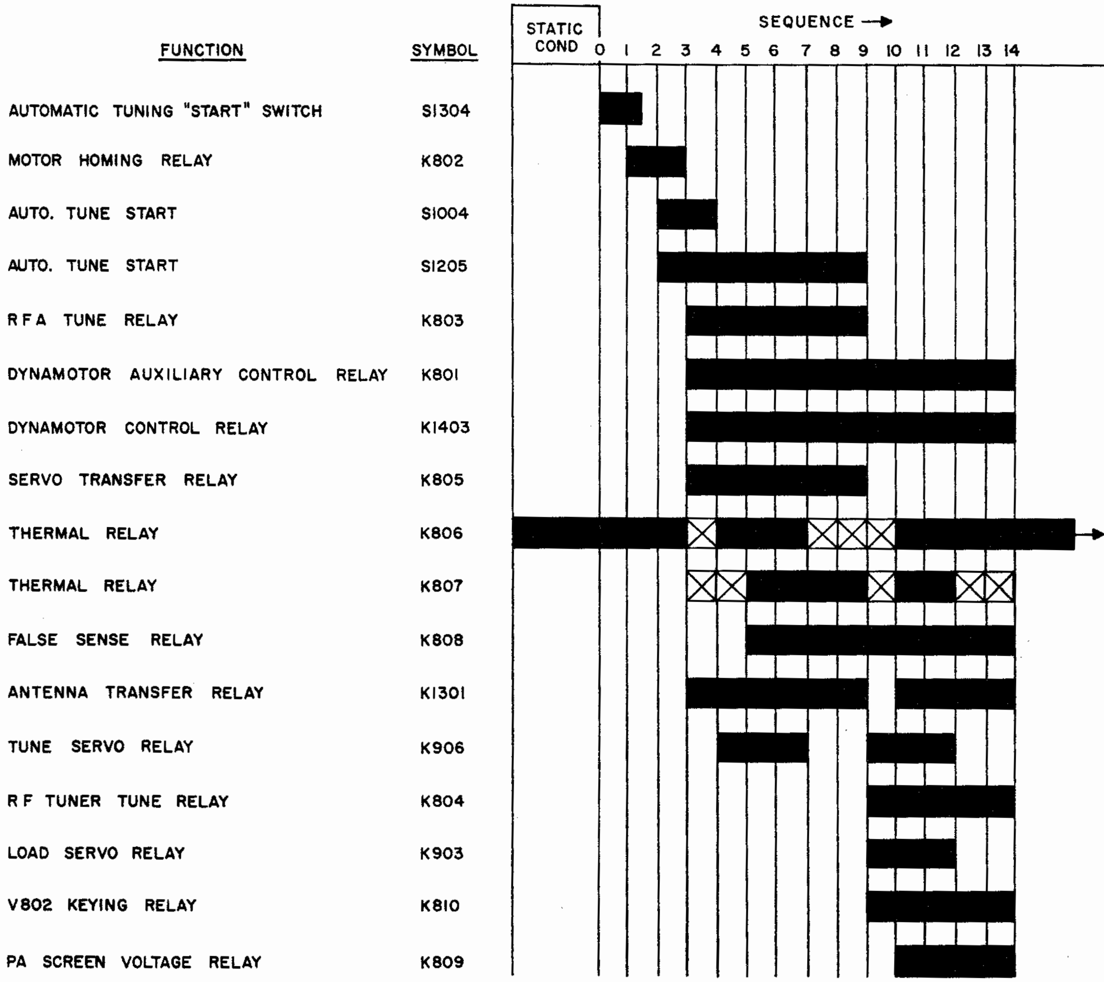
At frequencies below 4.0 mc, automatic tuning is slightly different. In order to resonate the rf tuner at those frequencies, it is necessary to supply a false sense signal to the tuner through false sense signal switch S1206. A false sense signal is also supplied to the rfa through relay K808 when the tuning coils are too far out of resonance to drive the servo amplifiers.

The variable components and their tuning motors are protected from damage by microswitches which remove power to the motors whenever maximum or minimum tuning limits have been reached.

c. DETAILED THEORY OF OPERATION. *(See figures 2-28, 7-57, 7-58, and 7-66.)* — SERVICE selector S1302 is at the CW-TUNE position for automatic tuning of the transmitter. When filament control relay K1401 is energized, 26.5-volt dc power is available through F1404 to the automatic tuning control components. After a time delay of approximately eight seconds, thermal relay K806 will actuate through contacts 2 and 13 of K803, opening contacts 3, 4 and 8, 9.

Depressing the momentary-contact TUNE-START switch S1304 applies 26.5 volts from the control circuit bus to the coil of reset relay K802, through contacts 19 and 10 of K804 and 10 and 19 of K803, to ground through S1302, section 1, front. After S1304 is released, power remains applied to the coil of K802 through contacts 20 and 1 which bypass the switch. Contacts 3 and 13 of K802 close, applying 26.5 volts to motor B1002 (rfa coil control) through S1005 (max L switch). Contacts 5 and 15 of K802 close, applying 26.5 volts to motor B1202 (rf tuner coil control) through S1203 (min L switch). Contacts 7 and 16 of K802 close, applying 26.5 volts to B1201 (rf tuner capacitor control) through S1202 (max C switch). Contacts of relay K802 bypass the servo control stages and cause the motors to turn until their reverse tune limits (or home positions) are reached. When that occurs, microswitches S1005, S1202, and S1203 open and remove the 26.5 volts from the motors.

At the same time that S1005 opens, microswitch S1004 (auto tune start rf coil) will close; at the same



SUMMARIZED SEQUENCE OF OPERATION

1. THERMAL RELAY K806 ENERGIZES APPROXIMATELY 8 SECONDS AFTER INPUT POWER IS TURNED ON.
2. DEPRESS S1304 MOMENTARILY.
3. TUNING MOTORS ARE DRIVEN TO "HOME" POSITIONS.
4. DYNAMOTOR STARTS.
5. POWER AMPLIFIER CIRCUITRY TUNES (B1002 DRIVES RADIO FREQUENCY AMPLIFIER COILS UNTIL CORRECT TUNING POINT IS REACHED.)
6. TRANSMITTER IS KEYED-ON.
7. R-F TUNER CIRCUITRY TUNES. (B1201 AND B1202 DRIVE TUNING COIL AND CAPACITOR UNTIL CORRECT TUNING POINTS ARE REACHED.)
8. APPROXIMATELY 4-10 SECONDS AFTER BOTH R-F TUNER MOTORS STOP, THERMAL RELAY K807 DE-ACTIVATES.
9. TRANSMITTER UN-KEYS.
10. DYNAMOTOR STOPS.
11. TRANSMITTER IS TUNED AND READY FOR OPERATION.

LEGEND:

■ RELAY OR SWITCH ENERGIZED.

☒ POWER REMOVED FROM THERMAL RELAY, BUT RELAY STILL ACTIVATED DUE TO THERMAL LAG.

Figure 2-28. Automatic Tuning Circuitry, Sequence of Operations time that S1203 opens, microswitch S1205 (auto tune start rf tuner coil) will close. These two microswitches are in series with K803 (rfa tune relay). Consequently, the rfa will start to tune only when both B1002 and B1202 are at their home positions. Relay K803 is energized from the 26.5-volt control bus through S1004, S1005 and normally closed contacts 8 and 17 of relay K804 to ground through S1302, section 1, front. Contacts 20 and 1 of K803 close, bypassing S1004 and S1205, causing 26.5 volts to be applied through the K803 contacts to the coil of K803. Contacts 15 and 5 of K803 close, which energize K801 (dynamotor auxiliary control relay) through contacts 3 and 4 of K1402. Contacts 20 and 1 of K801 close to energize K1403 (dynamotor control relay) which applies power to the dynamotor. Contacts 10 and 19 of K803 open, causing K802 to de-energize. Contacts 3 and 13 and 5 and 15 of K802 open, removing the servo amplifier bypass circuit from motors B1002 and B1201. Contacts 7 and 16 of K803 close, causing +250-volt dc (regulated) to be applied to the plates of servo control tubes V901, V902, V903, V904, and V905. Contacts 2 and 13 of K803 open, removing thermal time delay relay K806 from the 26.5-volt control bus. Contacts 3 and 13 of K803 close, placing the thermal relay heating element in series with contact 11 of K805. (Although the 26.5 volts from the control bus is removed from K806, the relay will not de-energize, due to thermal lag and the fact that it receives power from another source almost immediately, as will be shown in the next paragraph.) Contacts 9 and 17 of K803 close, applying power via contacts 2 and 13 of K804 to light. Second thermal time delay relay K807. Closed contacts 9 and 17 also energize K805 (servo transfer relay.)

Contacts 20 and 12 of K805 open to isolate B1202 completely from the 26.5-volt control bus. (This is done to interlock motor B1202. It is possible that K903 may energize during the rfa tuning cycle due to residual circuit effects.) Contacts 13 and 3 of K805 close, grounding the grid of keying delay tube V802 through energized contacts 11 and 19 of K803 and S1302, section 1, front, causing it to conduct. As a result, antenna transfer relay K1301 energizes, and removes bias from the grid of vfo tube V101, causing the vfo to become operative. Contacts 5 and 15 of K805 close, causing the output of the rfa phase detector to be connected to the input of the tune servo amplifier. Contacts 19 and 11 of K805 close, placing contact 4 of K906 in series with the forward winding of B1002 through S1003 and also keeping the heater element of time delay relay K806 energized. Contacts 17 and 9 of K805 close, placing contact 7 of K906 (servo control) in series with the reverse winding of B1002 through R805 and S1005. Conduction of servo amplifier tube V904 will cause K906 (tune servo relay) to close contacts 6 and 4 or 6 and 7 in accordance with the polarity of the input voltage. Consequently, 26.5 volts from the control bus will be applied to either the forward or reverse winding of B1002 through K906 and contacts 19 and 11, and 17 and 9 of K805. Motor B1002 must initially move forward from its home position. Therefore, thermal time delay relay K806 has power applied to it through contacts 11 and 19 of K805, and 4 and 6 of K906 to the 26.5-volt control bus while the motor is tuning forward. Actually, the relay remains actuated until the rfa coil becomes resonated. Upon reaching the resonant point K906 becomes de-energized, removing power to B1002, and causing it to stop turning.

Approximately four to ten seconds after motor B1002 has made its last forward movement and contact 6 of K906 returns to its center position, thermal relay K806 will de-activate and its open contacts 3, 4, and 8, 9 will return to their normally closed positions. This will cause K804 rf tuner tune relay to be energized from the 26.5-volt control bus through the actuated contacts 3, 4 and 8, 9 of K807 to ground through closed contacts 3, 4 and 8, 9 of K806 and S1302, section 1, front. Contacts 17 and 8 of K804 open, causing K803 to de-energize, which causes contacts 2 and 13 of K803 to close and again apply power to time delay relay K806. However, closed contacts 1 and 20 of K804 bypass the K806 contacts 3, 4, and 8, 9, and when they open, power will still be applied to the coil of K804 through contacts 1 and 20. Contacts 5 and 15 of K803 open, but contacts 5 and 15 of K804 close to keep K801 (dynamotor auxiliary control relay) energized. Contacts 19 and 10 of K804 open to prevent the automatic reset circuit from being accidentally energized while tuning is in process. Contacts 7 and 16 of K803 open, but +250 volts, regulated) is still applied to the plates of V901, V902, V903, V904, and V905 through closed contacts 7 and 16 of K804. Contacts 9 and 17 of K803 open, removing thermal time delay relay K807 from the 26.5-volt control bus. Contacts 3 and 13 of K804 close, placing the thermal relay heating element in series with contact 7 of K903 (servo control). (Although the 26.5 volts from the control bus is removed from K807, the relay will not de-activate because of thermal lag and the fact that it receives power from another source almost immediately, as explained in the next paragraph.)

Contacts 9 and 17 of K803 open and de-energize K805 (servo transfer relay). Contacts 2 and 13 of K805 close to ground the grid of keyer amplifier tube V801 through contacts 9 and 17 of K804 and S1302, section 1, front, causing it to conduct. This keys power amplifier tube V1002 to allow resonating the rf tuner. Contacts 15 and 5 open, and contacts 4 and 15 of K805 close, thereby transferring the input to tune servo amplifier V903 from the rfa to the rf tuner. Contacts 19 and 10 of K805 close, thereby transferring the output of servo amplifier V904 from B1002 (rfa coil control) to the forward winding of B1201 (rf tuner capacitor control). Conduction of servo amplifier tube V904 will cause K906 (tune servo relay) to energize and 26.5 volts from the control bus will be applied to the forward winding of B1201 through contacts 19 and 10 of K906. The 26.5 volts is also applied to thermal relay K807 through K906, CR802, and K804, contacts 3 and 13. Likewise, conduction of load servo amplifier tube V902 will cause contacts 6 and 7 of K903 (load servo relay) to close. As a result, 26.5 volts from the control bus will be applied to the forward winding of B1202 through K903. The 26.5 volts is also applied to thermal relay K807 via K903, CR803, and K804. Diode CR802 or CR803 keeps voltage applied to K807 as long as either motor is tuning. The diodes also isolated the two motors from each other, thereby preventing either motor from being driven from the other's supply. The relay remains actuated until the rf tuner is resonated and properly matched to the antenna. Upon completion of the tuning, servo control relays K906 and K903 de-energize, removing power from the rf tuner motors and thermal relay K807.

Approximately four to ten seconds later, thermal relay K807 will cool and de-activate, causing its contacts (3, 4, and 8, 9) to return to their normally open positions. This will cause K804 to de-energize, the automatic control circuits will be disabled, and the transmitter will be ready for operation.

(1) FALSE SENSE RELAY K808. — The coil of relay K808 is connected in the grid circuit of power amplifier V1002. Current to energize the relay is only present when V1002 is near, or at, resonance because at other times V1002 will not be drawing grid current. When K808 is de-energized, −105 volts is applied to the tune servo amplifier (V903) input through normally closed contacts 3 and 4 of K808, and energized contacts 5 and 15 of K805. The −105 volts serves as a simulated control voltage to supply the necessary drive to V903 to energize B1002 and tune the rfa. When resonance is approached, V1002 draws grid current, causing K808 to energize, removing the −105-volt false sense signal from the tune servo amplifier, and allowing the output of the phase detector to assume control of B1002.

(2) FALSE SENSE SIGNAL SWITCH S1206. — At frequencies below 4.0 mc, the rf tuner will not be able to reach a tuning point in the usual way. (Refer to paragraph 2–2.) At such times, rf tuner capacitor C1201 will be at its maximum position. When C1201 is at maximum. microswitch S1206 is closed by motor B1201. This allows −105-volts dc to be applied to the rf tuner phase detector through current limiting resistor R804, closed contacts 16 and 6 of K805 and S1206. This will cause B1202 (rf tuner coil control) to tune the coil, with the result that capacitor C1201 will tune towards minimum to maintain resonance. When this occurs, the false sense signal is no longer required and microswitch S1206, which is closed only at the maximum capacitance position of B1201, will open, removing the false sense signal.

(3) MOTOR LIMIT SWITCHES. — Tuning motors B1002, B1201, and B1202 have limit switches S1003, S1005, S1201, S1202, S1203 and S1204 connected in series with their fields. These are microswitches mechanically connected to the motor shafts by a lead screw mechanism. When the variable components tuned by the motors reach their maximum or minimum positions, the applicable switches will open to remove power from the motors and prevent damage to the components or motors.

2–6. RADIO RECEIVER R–808/GRC–14.

a. OVERALL FUNCTIONAL DESCRIPTION. — Two radio receivers are supplied as components of Radio Set AN/MRC-55. They are identical in design, and are enclosed in watertight cabinets. One receiver may be employed as a standby while the other is operating, or both receivers can be operating at the same time. Signal inputs to the receiver are applied from either a high- or low-impedance antenna which is common to the transmitter, or an independent high- or low-impedance antenna.

The receiver is of the superheterodyne type operating in the frequency range of 2 to 32 mc, covered in the following four bands: 2 to 4 mc, 4 to 8 mc, 8 to 16 mc, and 16 to 32 mc. (The coverage of each band is somewhat greater than listed due to frequency overlap at the extreme ends of each band.) Reception facilities for cw (A1), mcw (A2), phone (A3), and fsk (F1) signals are provided. Provisions are made for simultaneous reception of fsk and phone transmissions on the same frequencies. The receiver is capable of keying a polar or neutral teletypewriter located at a remote site.

It differs from conventional equipments in the following respects: (1) The plate voltage supply for the electron tubes is only +21 volts dc regulated; (2) the frequency-shift converter required for teletypewriter reception is included in the receiver, rather than in accessory equipment; (3) transistors are used, where practical, to reduce heat dissipation.

To allow for two-way relay of communications, the receiver can turn the transmitter on and off automatically for retransmission of received signals when such a service is desired.

As shown in the block diagram, the receiver is conventional in most respects. (See figure 2–29.) The received signal passes through two stages of rf amplification and is then applied to the control grid of the mixer tube. Local injected frequency is obtained from a tunable oscillator followed by a harmonic amplifier. The oscillator is continuously tunable in two ranges of 2.18 to 4.50 mc and 8.65 to 17.75 mc. The harmonic amplifier selects the fundamental oscillator output frequencies for operation on bands 1 and 3 and second harmonies for operation on receiver bands 2 and 4.

When operating on bands 1 and 2 (2 to 8 mc), the difference frequency is applied directly to the input of the 455-kc if. strip. For bands 3 and 4 (8 to 32 mc), the difference frequency is 1500 kc, that must be further mixed in a converter stage to obtain a 455-kc beat signal which is then applied to the if. strip. Provision is also made in the receiver front end to inject a calibration signal at the first rf stage. This frequency is utilized to calibrate the receiver main tuning dial through the use of a movable fiducial pointer.

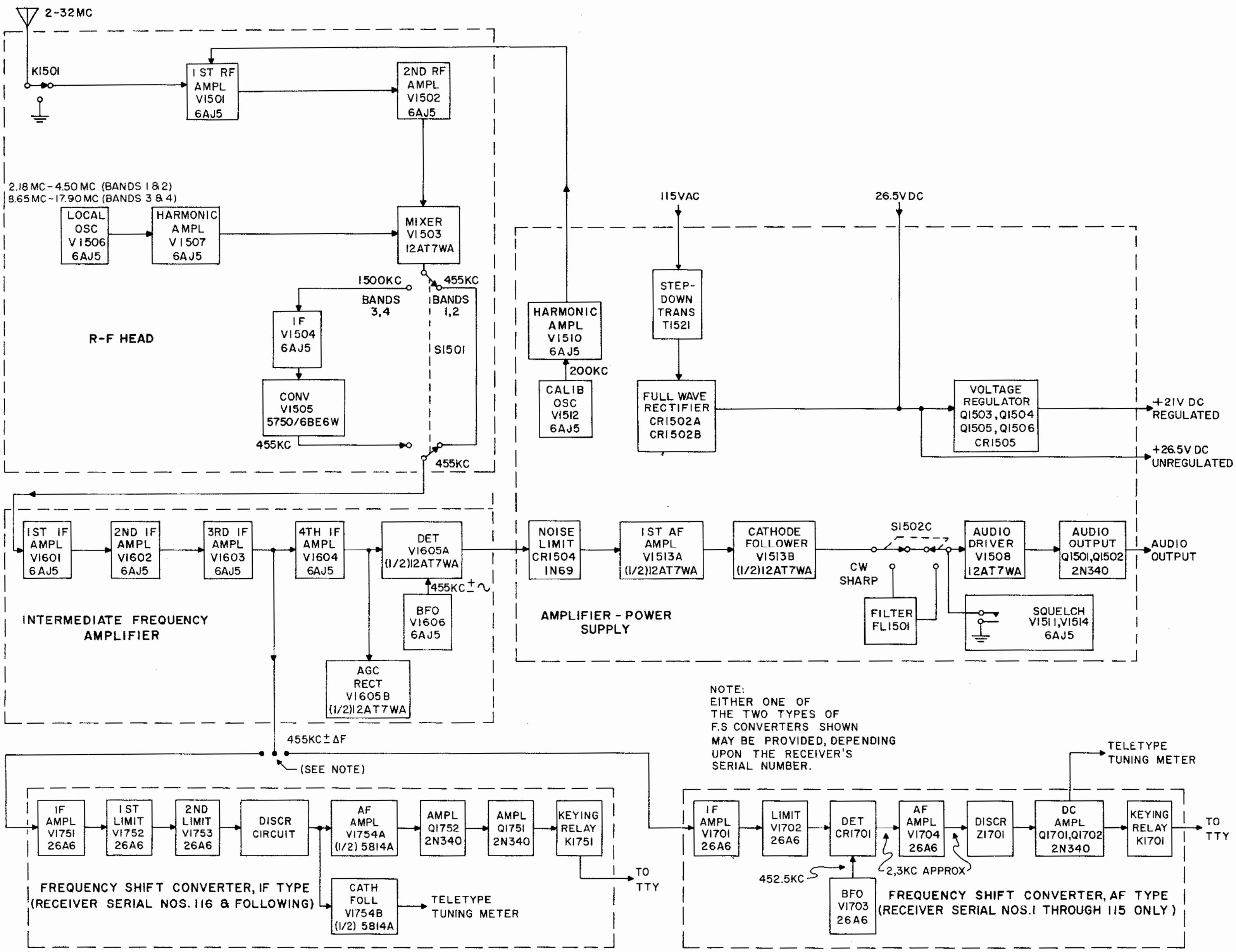


Figure 2–29. Radio Receiver, Block Diagram

The if. signal is then amplified and converted to audio frequencies in the if. strip. Four stages of amplification are necessary because of the low stage-by-stage gain, which is a result of the low value plate voltage. An output signal at the if. frequency is obtained from the third i-f amplifier for application to the frequency-shift converter subassembly. An automatic gain control voltage is developed in the detector stages for use in the rf amplifiers, and in the first three if. amplifiers. In addition, the output from a beat frequency oscillator (bfo) is applied to the detector when the receiver is operating on cw.

Audio frequency output from the detector is passed through a noise-limiter circuit, and then applied to the af amplifiers for all modes of operation except fsk. In the CW SHARP position of the OPERATION SWITCH, the amplifier output is passed through a bandpass filter which is bypassed in the other switch positions. The output of the second audio amplifier is fed to an audio driver stage from which it goes to a transistorized push-pull final amplification stage. Audio output is then available at front panel receptacles for handset, earphone and loudspeaker use. The af strip also incorporates a squelch circuit used during phone operation to quiet the receiver when there is no incoming signal, by disabling the audio section.

When using the receiver for fsk operation, the output from the third if. stage is applied to the frequency-shift converter. Either of two types of frequency-shift converter is used, depending upon the serial number of the R–808/GRC–14 receiver provided. Converters used in receivers having serial numbers 1 through 115 differ from later production models. The two types differ in circuits used, but provide the same function. That is, the frequency-shifted if. signal is demodulated and converted to a dc voltage to energize a keying relay used to operate a teletypewriter selector magnet.

b. RADIO-FREQUENCY HEAD. *(See figures 2–30 and 7–80.)* — The rf head is a removable plug-in subassembly whose function is to amplify rf input signals and convert them to the 455-kc intermediate frequency. Band 1 and band 2 operation use one heterodyning stage to produce the 455 kc. However, operation on bands 3 and 4 requires an additional conversion to obtain the 455-kc intermediate frequency.

(1) ANTENNA INPUT. — Incoming signals from either the high- or low-impedance antenna are applied to the input of the first rf amplifier through BAND SWITCH S1501. Switch S1501 sections 10 and 9 (low-impedance antenna) or 11 and 9 (high-impedance antenna) selects the correct coil (T1501 through T1504) for bands 1 through 4. The appropriate coil is connected across section 5 of main tuning capacitor C1501. The unused coils are grounded by S1501 to prevent any absorption effects.

Receiver break-in operation is accomplished by energizing disable relay K1504 whenever the transmitter is keyed (except for RELAY operation of the radio set). Relay K1504 is energized by providing a ground return for its coil, through E803 in the transmitter keyer group. This is done to prevent feedback and component damage to the received front end when the receiver and transmitter are tuned to the same frequency.

(2) RF AMPLIFIERS V1501 AND V1502 (6AJ5). *(See figure 2–31.)* — The input circuits of rf amplifiers V1501 and V1502 are tuned for resonance with sections 4 and 5 of main tuning capacitor C1501. The two rf stages are conventional amplifiers having tuned interstage coupling for each of the four bands. Variable air dielectric capacitor C1506 is connected across the first rf amplifier (V1501) input circuit and is varied by the front panel ANT TRIM control. This capacitor is an antenna trimmer, and is used to compensate for antenna characteristics at the various frequencies used. Neon lamp DS1501 is also connected across the input circuit for over-voltage protection. When the voltage across the tuned circuit rises to approximately 50 volts (due, for example, to tuning the receiver to the frequency of a nearby transmitter), the lamp will glow and effectively place a low impedance across the circuit, thereby protecting the components from damage.

The +21-volt dc plate supply for V1501 and V1502 is obtained from the amplifier-power supply subassembly, and is applied to V1501 and V1502 through section 8 and section 7, respectively, of S1501. For band 1 operation, the signal is coupled across T1501 applied to the control grid of V1501 for amplification, passed through section 8 of S1501 (terminals 11 and 12), and then placed on the primary winding of T1505. The secondary winding of T1505 and trimmer capacitor C1514 are pretuned for the band 1 frequency range. This filter section is further tuned by C1501, section 4. The signal is applied to the control grid of the second rf amplifier (V1502) through terminals 11 and 12, section 7, of S1501, and coupling capacitor C1510. It is amplified again in the second rf stage, and then applied to the control grid of mixer tube V1503. The gain of the second rf amplifier stage is adjusted by varying the cathode voltage with RF GAIN SQUELCH control R1531. The output coupling from V1502 is similar to the output circuit employed for V1501.

Facilities are provided within the receiver to supply a signal to calibrate the main tuning dial through the use of a movable fiducial pointer. When OPERATION SWITCH S1502 is placed in the CAL position, a 200-kc signal having a high harmonic content is applied from harmonic amplifier V1510 in the amplifier-power supply subassembly, to the suppressor grid and cathode of the first rf amplifier, V1501 through J1511, and follows the same path through the receiver as the received signals.

An agc voltage is applied (during phone operation) to the control grids of V1501 and V1502 from agc rectifier V1605B in the if. amplifier to compensate for fading in the transmitted signal. In addition, the gain of V1501 can be controlled by front panel control R1531, which is in the cathode circuit, and serves as a voltage divider across the regulated +21-volt supply.

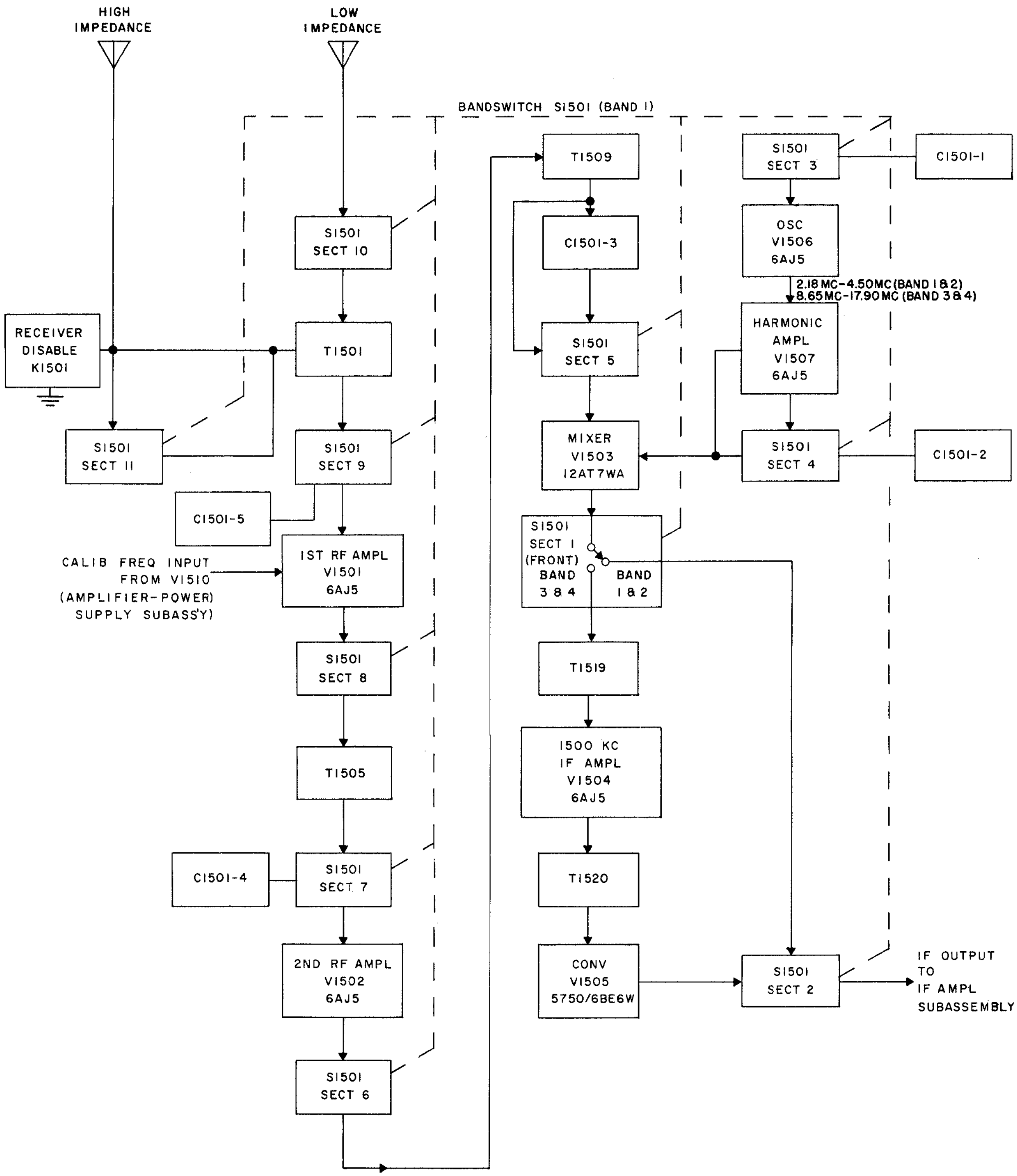


Figure 2-30. RF Head, Block Diagram

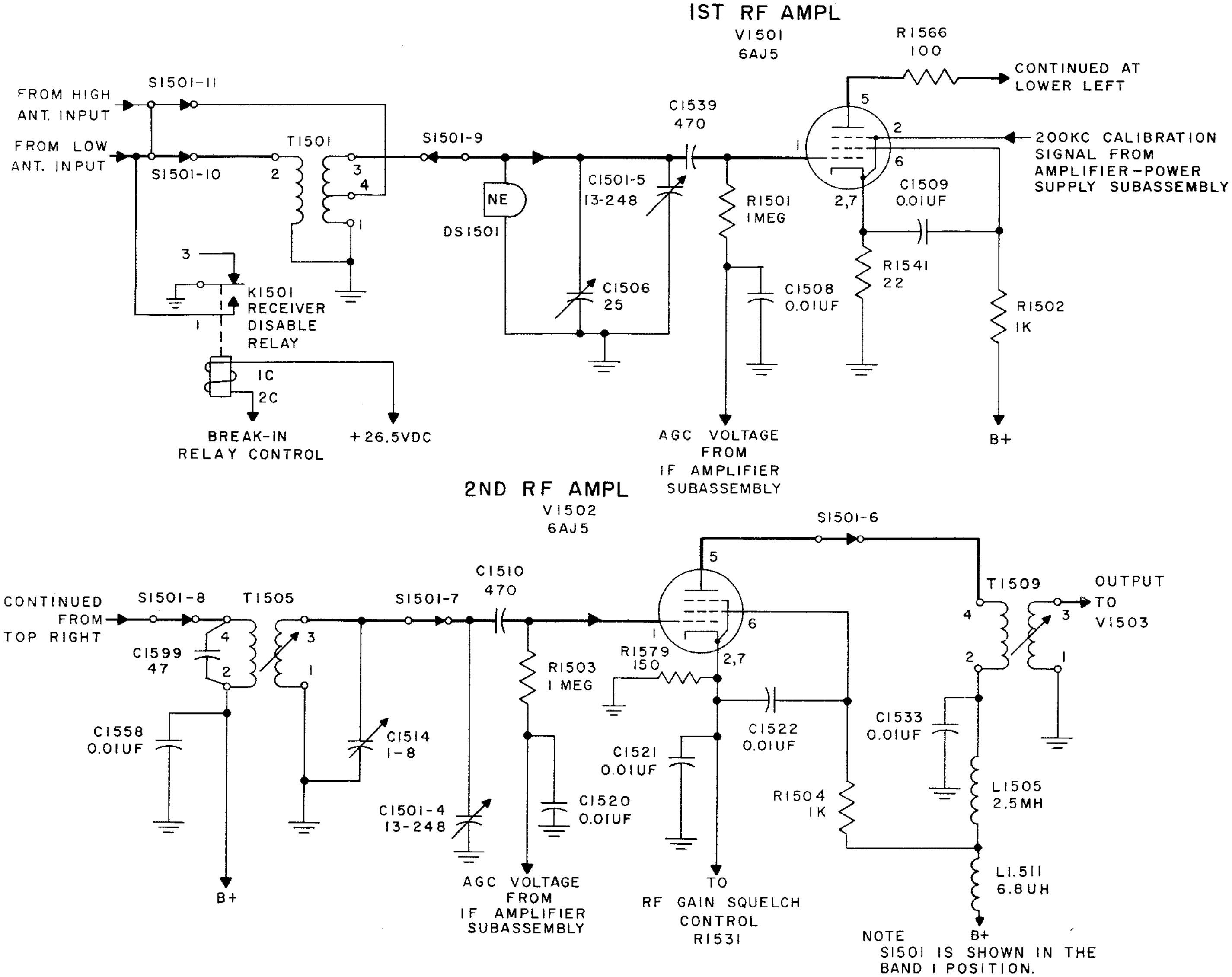


Figure 2-31. RF Amplifiers V1501 and V1502, Simplified Schematic

(3) LOCAL OSCILLATOR V1506 (6AJ5) AND HARMONIC AMPLIFIER V1507 (6AJ5). *(See figure 2-32.)* — Local oscillator stage V1506 is a modified tuned-plate oscillator with a tunable output in the frequency ranges of 2.18 to 4.5 mc (bands 1 and 2) and 8.65 to 17.90 mc (bands 3 and 4). A gang-tuned section of main tuning capacitor C1501 determines the oscillator frequency at any of the four bandswitch positions. Variable transformers T1513 and T1521, together with variable capacitors C1564 and C1591, are pretuned to align the oscillator and provide for correct tracking. The combination of T1513 and C1564 determines the local oscillator frequency in bands 1 and 2, while the combination of T1521 and C1591 determines the frequency in bands 3 and 4. The oscillator output is taken from the grid instead of from the plate to reduce tube loading effects and to increase stability.

Harmonic amplifier V1507 amplifies the fundamental and second harmonic components of V1506 local oscillator output and provides coupling to mixer stage V1503.

The output of oscillator tube V1506 is coupled through C1536 to the grid of V1507, a nonlinear amplifier with a high harmonic output. The plate circuit of V1507 is composed of four tuned circuits, each tuned in conjunction with C1501 (section 2).

Band 1 operation uses C1540 and T1514, which are tuned to the fundamental frequency range (2.18 to 4.50 mc) of the oscillator; band 2 operation uses C1542 and T1515 which are tuned to 1/2 (signal frequency plus 455 kc) (2.178 to 4.427 mc); band 3 operation used C1544 and T1516, which are tuned to the fundamental frequency range (8.70 to 17.90 mc); and band 4 operation uses C1545 and T1517, which are tuned to 1/2 (signal frequency plus 1500 kc) (8.65 to 17.75 mc). Each band of local oscillator outputs has overlap frequencies to allow for a one-percent overlap on each band of the reciver tuning dial.

(4) MIXER STAGE V1503 (12AT7WA) AND 1500-KC IF. AMPLIFIER V1504 (6AJ5). *(See figures 2-33 and 7-80.)* — Mixer stage V1503 uses a type 12AT7WA twin triode tube. The incoming signal from the second rf amplifier (V1502) is applied at the No. 1 grid (pin 7) of tube V1503, and the local oscillator signal from harmonic amplifier V1507 is injected at the No. 2 grid (pin 2).

Test Point TP-J1501 is connected to pin 2 of V1503 to check the output of the local oscillator V1506 and harmonic amplifier V1507. The signal input circuit of V1503 is tuned to the received rf frequency by the third of five ganged sections of the main tuning (TUNE) control, variable capacitor capacitor C1501.

The incoming signal from the second rf amplifier and the local oscillator input from harmonic amplifier V1507 are mixed in V1503. The difference frequency obtained for bands 1 and 2 is 455 kc, and for bands 3 and 4 is 1500 kc.

The 455-kc mixer output for bands 1 and 2 is applied directly to the 455-kc if. strip in the if. amplifier. For band 1, the signal path to the if. amplifier is through terminals 9 and 1 (section 1, front) and 2 and 10 (section 2, rear) of S1501, and through connector J1510. For band 2, the signal path is the same, except that terminals 9 and 3 (section 1) and 4 and 10 (section 2) of S1501 are used.

The 1500-kc mixer output for bands 3 and 4 must first be converted to 455 kc before being amplified by the 455-kc if. strip. The 1500-kc signal for band 3 is applied to the primary winding of T1519 through terminals 9 and 5 of S1501 (section 1, front), and coupled to the control grid of 1500-kc if. amplifier V1504 through the secondary of T1519 and C1569. The signal is then amplified and applied to the input signal grid (pin 7) of converter V1505 through transformer T1520. Band 4 operation is identical except that terminals 9 and 7 of S1501 (section 1, front) are used. The +21-volt plate supply for V1503 and V1504 is obtained from the amplifier-power supply subassembly. For Bands 1 and 2 the plate voltage for V1503 is taken from TB1501-3 and is applied through L1505, L1506, L1502, and terminals 10 and 2 or 4 of S1501 (section 2, rear) and terminals 9 and 1 or 3 of S1501 (section 1, front). For bands 3 and 4, the plate voltage for V1503 is taken from TB1501-3 and applied through L1505, L1506, R1527, the primary of T1519, and terminals 5, 7 and 9 of S1501 (section 1, front). Plate voltage for V1504 is applied only during operation on bands 3 and 4, as the stage is bypassed for the other bands. Plate voltage is applied to the tube through terminals 1 and 5 or 7 of S1501 (section 2, front).

(5) CONVERTER STAGE V1505 (6BE6). *(See figure 2-33)* — Pentagrid converter V1505 generates a 1955-kc signal and mixes it with the 1500-kc output from 1500-kc if. amplifier V1504 during operation on bands 3 and 4, to produce a 455-kc difference frequency necessary for amplification by the 455-kc if. strip in the if. amplifier. The incoming signal from V1504 is applied to T1520, which is resonant at 1500 kc, and applies a signal voltage on the input grid (pin 7) of V1505. Control grid (pin 1) is the oscillator grid. Pin 6 grids are utilized as the oscillator anode and as a shield for the input grid. Quartz crystal Y1502 is the main frequency-determining component, having an oscillation frequency of 1955 kc. The oscillator is free-running; feedback to sustain oscillations is coupled from the oscillator anode to the grid circuit through C1570. TPJ1502 is the test point for 1955-kc oscillator output. The 1955-kc oscillator output mixes the 1500-kc incoming signal to produce a difference frequency of 455 kc for amplification in the if. strip. For band 3 operation, the converter output from the plate of V1505 is applied to the if. strip through terminals 6 and 10 of S1501 (section 2, rear) to the if. amplifier. Band 4 signal path is identical, except that terminals 8 and 10 of S1501 (section 2, rear) are utilized.

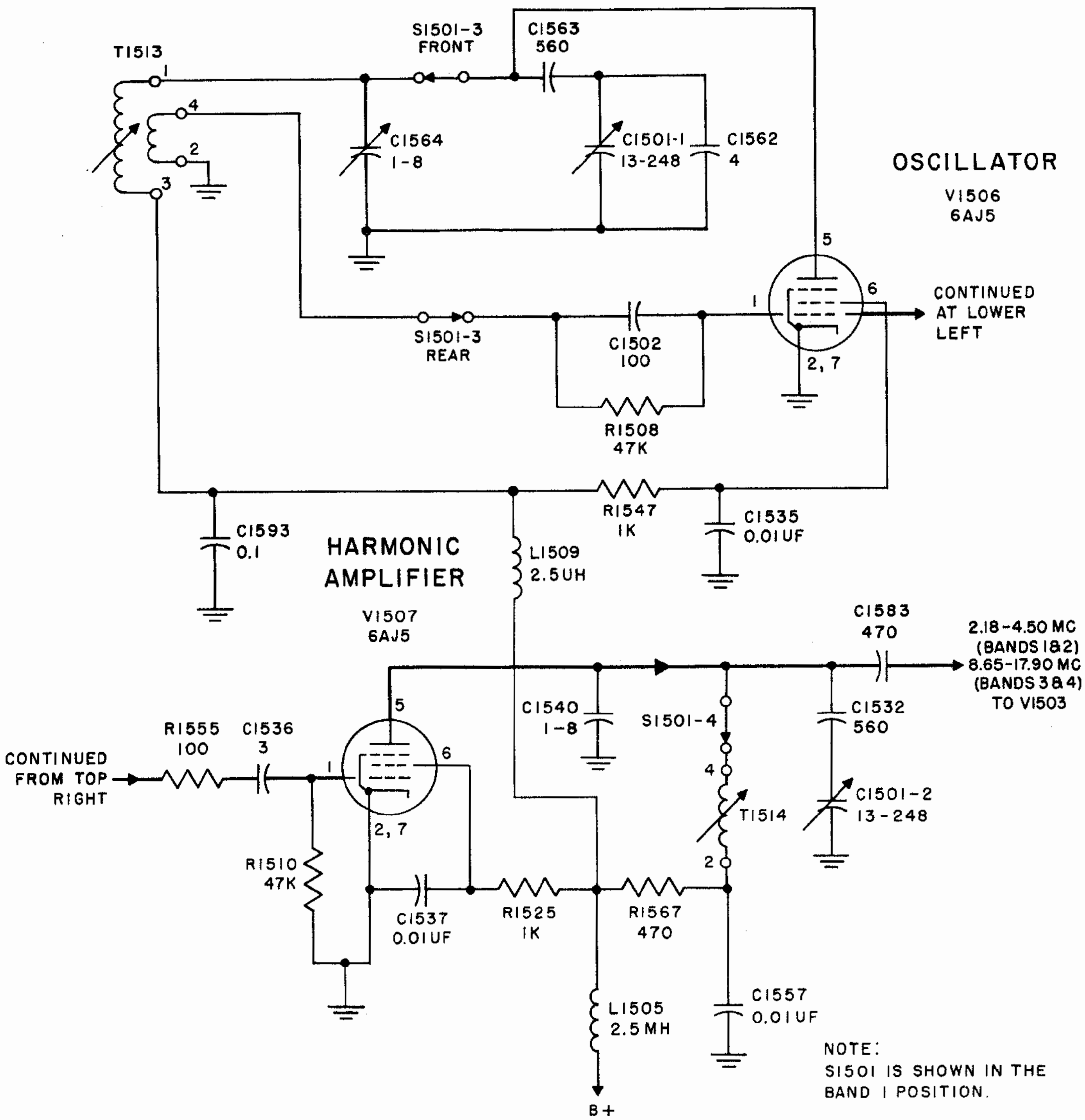


Figure 2-32. Local Oscillator V1506 and Harmonic Amplifier V1507, Simplified Schematic

The +21 volts is applied to the plate of V1505 only during operation on bands 3 and 4; the converter stage is not used for bands 1 and 2. Plate voltage is obtained from terminal 3 of TB1501, and is applied to the plate through L1505, L1506, L1502, and terminals 10 and 8 or 6 of S1501 (section 2, rear).

c. INTERMEDIATE FREQUENCY AMPLIFIER. *(See figures 2-34 and 7-82.)*—The if. amplifier is a removable plug-in subassembly containing four stages of if. amplification, a detector, an agc rectifier, and a bfo.

(1) IF. AMPLIFIERS V1601, V1602, V1603, V1604 (6AJ5).—The 455-kc intermediate frequency from the rf section of the receiver enters the if. strip at P1602 and is applied to the control grid of first if. amplifier V1601, through tuned first if. transformer T1601. Actually, there are several frequencies resulting from the heterodyning action in the mixer and converter stages that enter the if. strip. However, only the 455-kc difference frequency is amplified by the if. stages because of the tuned interstage if. transformers. Bandwidth of if. transformer T1601 can be changed from sharp to broad by operating the bandwidth selector switches S1601 through S1605, which are ganged with OPERATION SWITCH S1502 on the front panel. This varies the coefficient of coupling between the primary and secondary windings of T1601 and, consequently, affects the selectivity of the if. transformer. A sharp if. bandwidth of 3.5 ±0.5 kc, at the 6 db points, is used at all positons of the OPERATION SWITCH except BROAD PHONE and FSK, PHONE. These two positions employ a broad if. bandwidth of

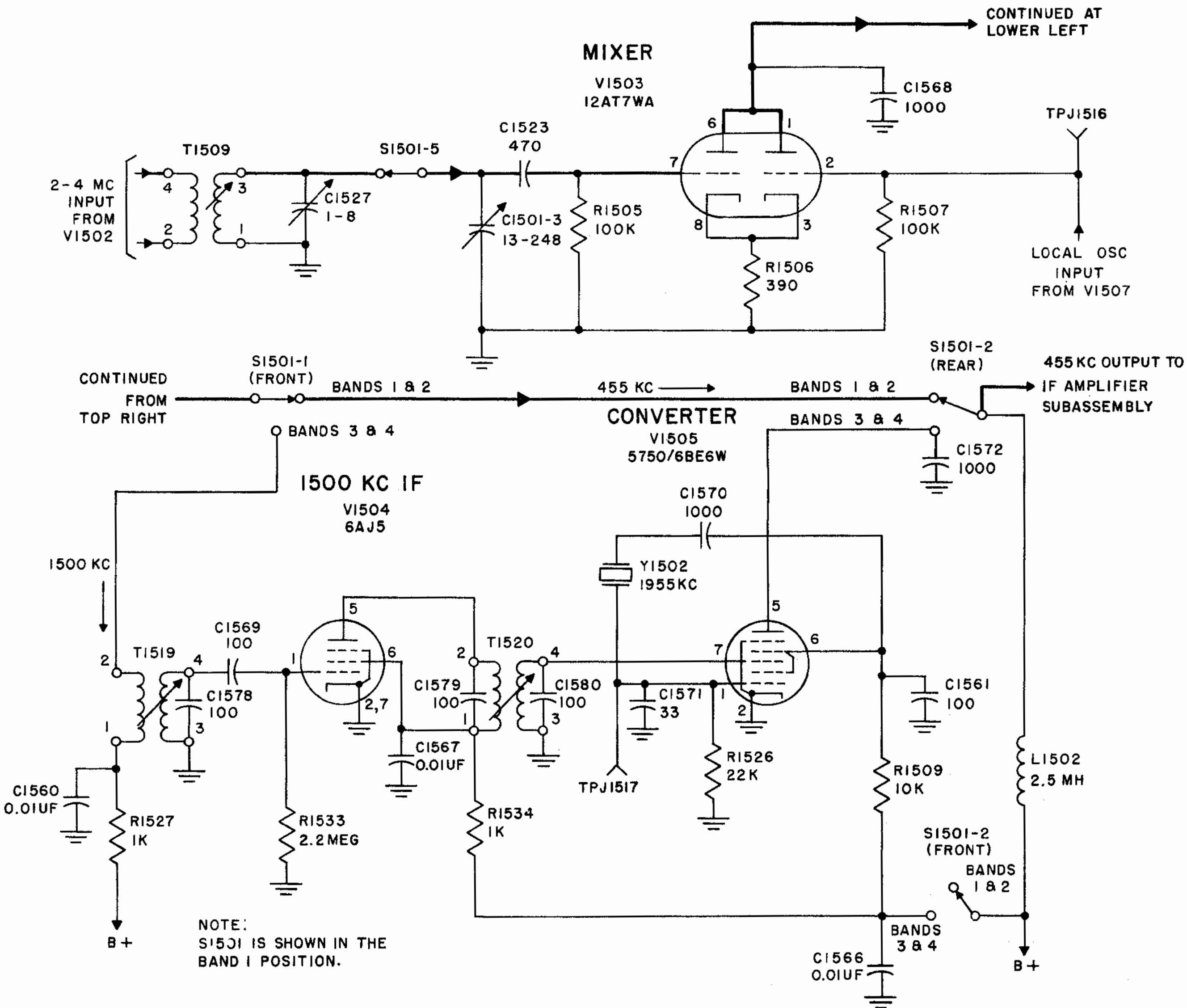


Figure 2-33. V1503, V1504, V1505 Stages, Simplified Schematic

7 ±1kc at the 6 db points. Amplifier stage V1601 is a conventional linear amplifier. Capacitor C1625 in the secondary of T1601 is part of the resonant circuit for the first if. transformer. C1601 is the control grid bypass capacitor and R1601 is the grid return resistor through the agc circuit. R1618 is the cathode decoupling resistor used to prevent unwanted interstage coupling and C1602 is the cathode bypass capacitor. C1603 is the screen bypass capacitor and R1619 is the plate decoupling resistor. Output of the first if. amplifier is coupled to the second if. amplifier, V1602, through the tuned circuit consisting of C1626, T1602 and C1627.

The second, third, and fourth if. amplifiers (V1602, V1603, V1604) operate in a manner similar to V1601 and therefore are not discussed.

Gain of the if. amplifiers is controlled by the manual RF GAIN SQUELCH control R1531 located on the receiver front panel. Gain of the first, second, and third if. amplifiers is also controlled by an agc voltage applied to their control grids from agc rectifier V1605B.

An output is taken from the plate of third if. amplifier tube V1603 and coupled through C1610, to connector P1603, to the input of the frequency shift converter subassembly. However, this unit is operative only when operating with OPERATION SWITCH S1502 in the FSK position.

Output of the fourth if. amplifier, V1604, is coupled to the plate and grid of detector V1605A through the fifth if. transformer, T1605. An output from the plate of V1604 is also coupled through C1614 to agc rectifier V1605B.

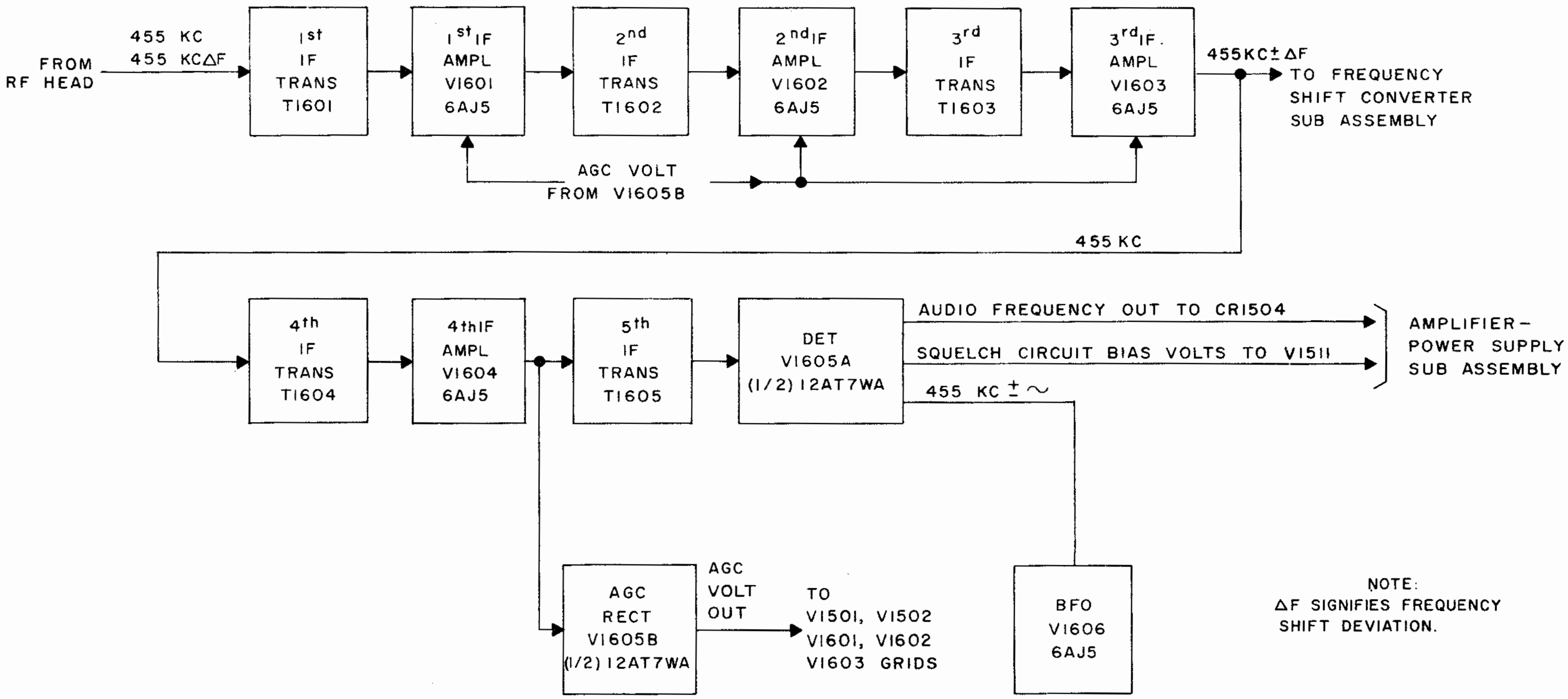


Figure 2–34. IF. Amplifier, Block Diagram

(2) DETECTOR STAGE V1605A (1/2 12AT7-WA). *(See figure 2-35.)* — Output signal of the fourth if. amplifier, V1604, at the intermediate frequency of 455 kc, is coupled through T1605 and applied to the plate and grid of detector V1605A. Tube V1605A is a triode having its plate and grid tied together so as to operate as a diode detector. The positive-going half of the signal causes V1605A to conduct. Conduction (electron flow) takes place from ground through the tube, through the secondary of T1605, and through detector load resistors R1611 and R1612, connected as a voltage divider. The rf is bypassed to ground through capacitors C1617 and C1619. Audio output is taken from the junction of R1611 and R1612 and fed to audio stages in the amplifier-power supply subassembly. R1610 and C1618 form an RC time constant combination for use in the noise limiter (CR1504) circuit located in the amplifier-power supply.

For reception of cw signals, output of beat frequency oscillator tube V1606 is coupled through C1616 to the plate of V1605A, for mixing with the received signal. Original frequencies and the sum and difference frequencies therefore flow through the secondary of T1605. However, only the difference frequency, which is in the audio range, is fed to audio stages in the amplifier-power supply subassembly. The two original frequencies and the sum frequency, which are in the rf range, are bypassed to ground through capacitors C1617 and C1619.

(3) AUTOMATIC GAIN CONTROL RECTIFIER V1605B (1/2 12AT7WA). *(See figure 2-36.)* — The incoming signal at the intermediate frequency of 455 kc is coupled from the plate of the fourth if. amplifier tube, V1604, to the plate and grid of agc rectifier tube V1605B through capacitor C1614. The plate and grid of triode V1605B are directly connected together, and thus the tube operates as a diode rectifier. Under no-signal conditions, this tube is not conducting; under input-signal conditions, the operating point of the tube is determined by the positive potential at the cathode developed across cathode resistor R1613 and dropping resistor R1605, which are in the plate supply line.

Rectifier V1605B will conduct only on the positive-going half of the incoming signal, and conduction will take place through R1613, V1605B, and through R1608 to ground. Voltage drop across R1608, the agc load resistor, will cause a negative potential to exist as its ungrounded end. This negative potential is applied through R1607 to the agc line as a bias for the rf amplifiers during phone operation, and to the first three if. amplifiers. The amplitude of the bias voltage developed across R1608 will be determined by the amplitude of the incoming signal. This will tend to keep the signal level through the front end of the receiver at a constant level. R1607 and C1615 comprise an RC filter in the agc line to eliminate audio voltage variations.

(4) BEAT FREQUENCY OSCILLATOR STAGE V1606 (6AJ5). *(See figure 2-37.)* — The bfo is a conventional shunt-fed Hartley oscillator. The oscillator tank circuit is composed of C1623, C1622, C1638 and L1602. BFO PITCH control C1623 is a variable, air-dielectric capacitor adjusted from the front panel to produce an audible note of the desired pitch. Coil L1602 is a tapped coil which has a tunable iron core

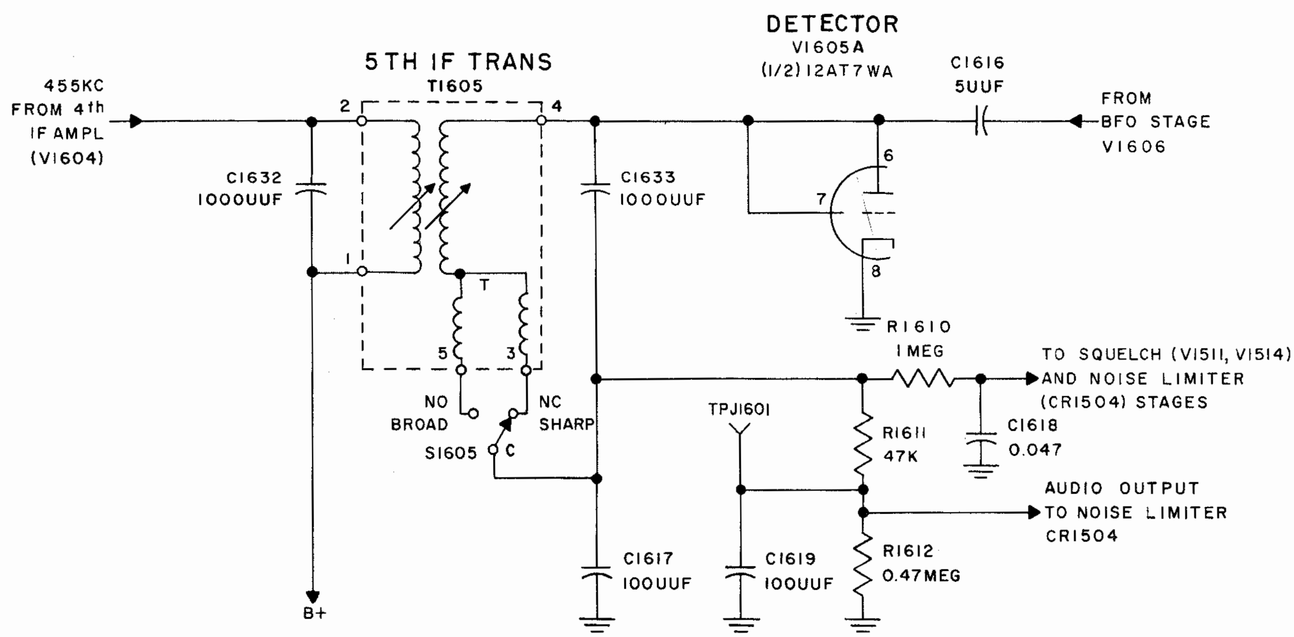


Figure 2-35. Detector Stage V1605A, Simplified Schematic

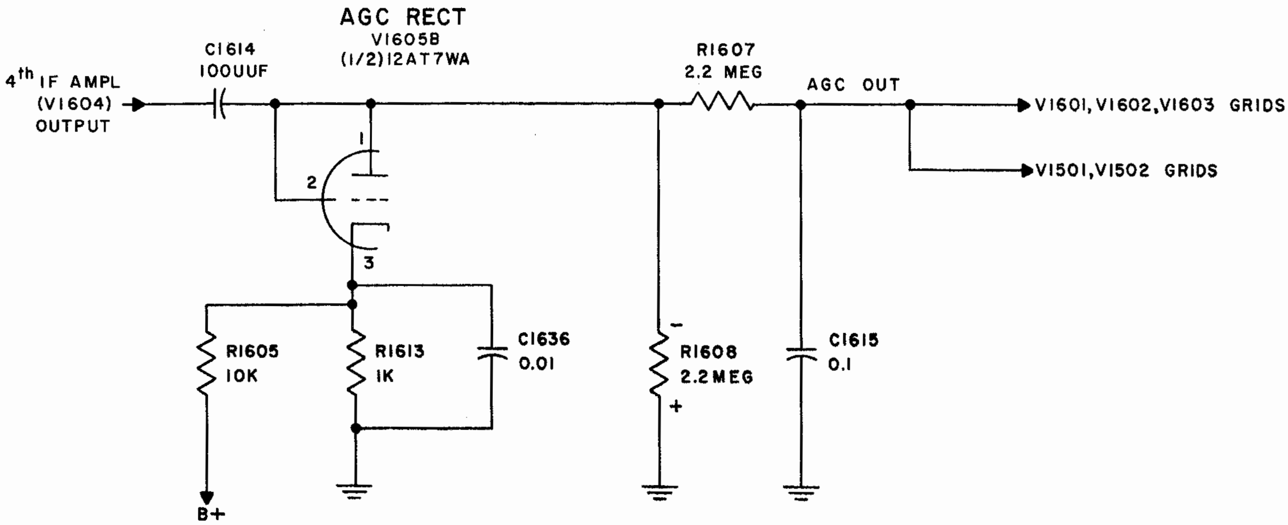


Figure 2–36. AGC Rectifier V1605B, Simplified Schematic

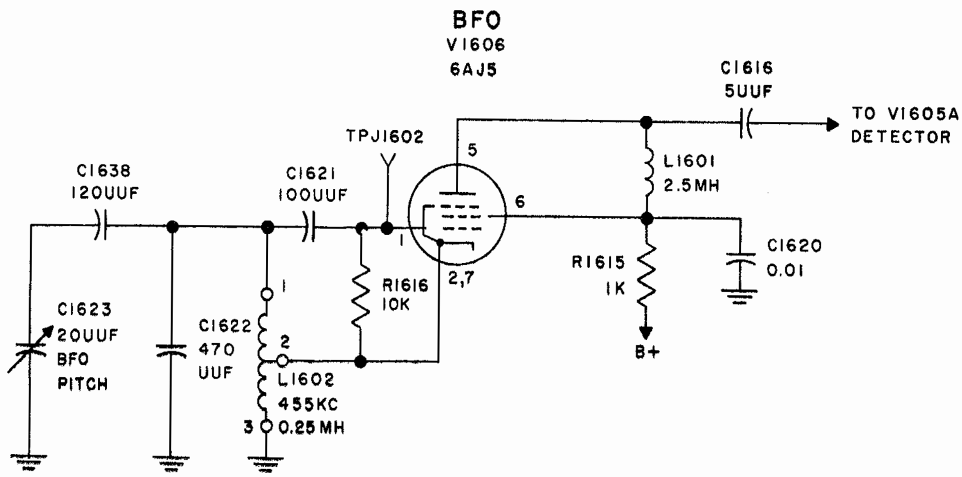


Figure 2–37. Beat Frequency Oscillator V1606, Simplified Schematic

for fine adjustment. The coil is pretuned at the factory, and should not be adjusted under normal operating conditions. Slight changes in oscillator frequency are made with the BFO PITCH control C1623.

Plate and screen voltage for V1606 is applied only when OPERATION SWITCH S1502 is in the CAL, CW SHARP, or CW, FSK BROAD position. At such times, +21-volts dc is applied through R1615 and L1601 to the plate of V1606. Screen voltage is taken from the junction of R1615 and L1601. Coil L1601 is an rf decoupling choke, and R1615 is a decoupling resistor.

Output from beat frequency oscillator V1606 is coupled to the plate of detector tube V1605A through C1616.

d. AMPLIFIER-POWER SUPPLY. *(See figures 2–38 and 7–84.)* — The amplifier-power supply is a removable plug-in subassembly containing the following circuits: a noise limiter and squelch circuit; a triode-type audio amplifier; a cathode follower; an audio driver stage; a transistor push-pull final amplifier; a crystal calibration oscillator and harmonic amplifier; and the receiver power supply components consisting of a rectifier, filter, and transistorized voltage regulator. Input power to the receiver is initially applied to the amplifier-power supply subassembly for rectification (if Radio Set AN/MRC-55 is operating from an external 115-volt, ac source), voltage regulation, and distribution to other receiver subassemblies.

(1) NOISE LIMITER CIRCUIT CR1504 (1N69). *(See figures 2–35 and 2–39.)* — Output of detector V1605A, in the if. amplifier, is applied to the anode of noise limiter crystal CR1504 (a germanium rectifier). The audio voltage output across detector load resistors R1611 and R1612 causes a negative potential to be developed at the junction of R1611 and R1610. This negative potential is applied through R1610 to

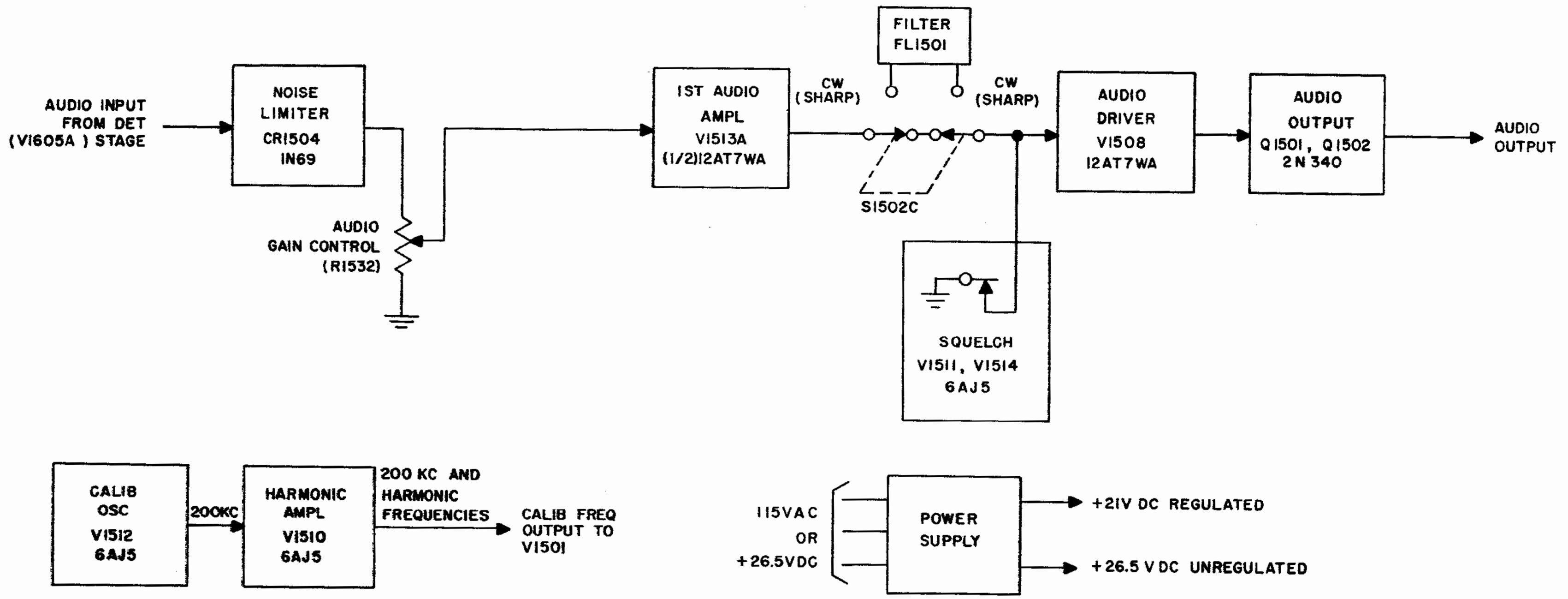


Figure 2-38. Amplifier-Power Supply, Block Diagram

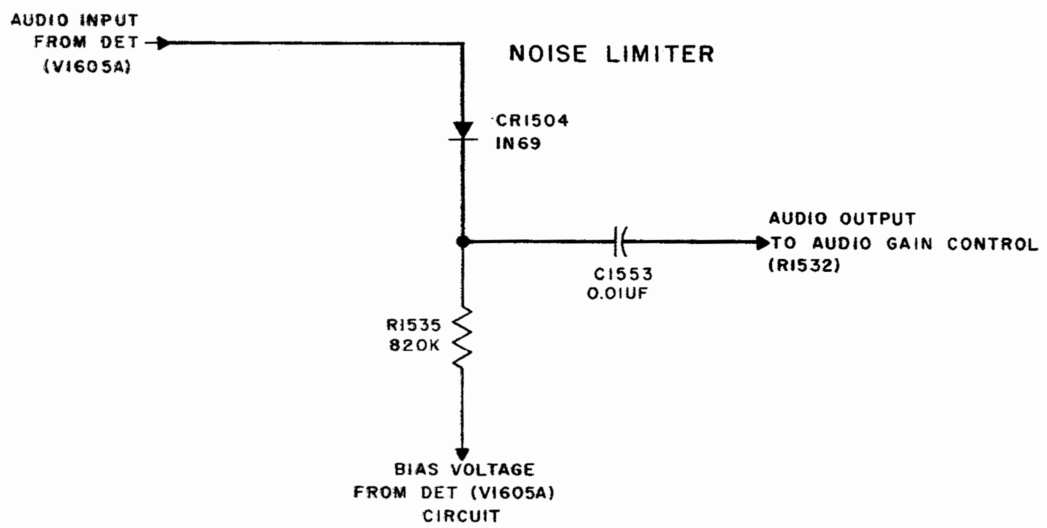


Figure 2-39. Noise Limiter Stage CR1504, Simplified Schematic

C1618, building up on this capacitor a negative charge approximately equal to the total detected voltage between terminal 5 of T1605 (or terminal 3, in the SHARP position of S1605) and ground. This negative potential is used as a bias for CR1504, and is applied to the rectifier cathode through resistor R1535. The audio frequency component of the detected voltage is taken from the detector circuit at the junction of voltage divider resistors R1611 and R1612 and applied to the anode of noise limiter crystal CR1504. Consequently, the cathode of CR1504 is more negative than the anode and a current path for the audio frequency is established through the diode.

In the event that a sharp pulse of noise is received, the long time-constant of R1610 and C1618 does not permit capacitor C1618 to charge to the higher transient voltage. However, the voltage at the junction point of R1611 and R1612 rapidly follows the change, placing the anode of CR1504 at a more negative potential than the cathode, thereby stopping conduction for the duration of the noise pulse and preventing the noise pulse from reaching the audio amplifier stages.

The af signal is coupled to the control grid of the first af amplifier, V1513A through capacitor C1553, front panel audio gain control R1532, and capacitor C1576.

(2) AUDIO AMPLIFIER V1513A (1/2 12AT7-WA) AND CATHODE FOLLOWER V1513B (1/2 12AT7WA). *(See figure 2–40.)* — Audio amplifier V1513A is a conventional linear amplifier operating in the audio range. The audio output from noise limiter CR1504, after attentuation by front panel AUDIO GAIN control R1532, is coupled to the control grid of V1513A through capacitor C1576. Output of V1513A is coupled through C1588 to the grid of cathode-follower V1513B. The cathode follower is employed in order to obtain a low impedance to match the impedance of bandpass filter FL1501. Output of V1513B is coupled through C1552 to wafer C of OPERATION SWITCH S1502. When S1502 is at the CW SHARP position, the audio signal passes through bandpass filter FL1501, which has a center frequency of 1000 cps. Bandwidth of the filter at 6 db down is 350 cps, and bandwidth at 40 db down is 700 cps. Consequently, interference sources are greatly attenuated. When the OPERATION SWITCH is at any other position, bandpass filter FL1501 is bypassed and the audio output from V1513 is fed directly to the grid of audio driver stage V1508.

(3) SQUELCH CIRCUIT V1511 (6AJ5) AND V1514 (6AJ5). *(See figures 7–78, 7–84, and 2–41.)* — The squelch circuit is employed during BROAD PHONE service to provide silent operation of the receiver during times of no-signal reception. This is accomplished by grounding the input (pin 7) of audio driver V1508 through contacts 3 and 4 of de-energized relay K1502.

When OPERATION SWITCH S1502 is set at any position except BROAD PHONE, K1502 is energized through R1519 and S1502A (front) by the +21-volt supply. Thus, contact 3 of K1502 is removed from ground and the audio signal is amplified by V1508. When S1502 is set at BROAD PHONE the +21 volts is removed from the coil of K1502 and the squelch circuit functions as follows: During times of no-signal reception, V1511 conducts freely, providing its cathode circuit is connected to ground via S1505. (S1505 is ganged to R1531 and is closed except when R1531 is rotated to its extreme counterclockwise position.) Tube V1511 plate current through R1551 develops a negative-going potential at the plate end of the resistor which is also connected to the control grid of V1514. This negative potential keeps V1514 cut off. With V1514 cut off, cathode current (K1502 coil current) does not flow and thus K1502 is de-energized. When K1502 is not energized, contacts 3 and 4 are closed, grounding the input to V1508.

During times of signal reception, a negative potential is applied to the control grid of V1511 from the junction point of detector load resistors R1611 and R1610 in the if. amplifier subassembly. The magnitude of this negative potential is proportional to the detected signal level which, in turn, is adjusted with RF GAIN SQUELCH control R1531 which varies the gain of the second rf amplifier and the if. amplifiers. For proper squelching, R1531 is adjusted to the point where the negative potential applied to the control grid of V1511 is sufficient to drive the tube to cut off. With no plate current flowing, there is no voltage drop across R1551 and, therefore, there is no bias applied to the V1514 grid. V1514 conducts through the coil of K1502 which energizes the relay and removes the ground from the input to V1508, allowing amplification of the audio signal.

If squelch operation is not desired, R1531 is rotated to its extreme CCW position. This opens S1505, which cuts off V1511 cathode current. As described above, when V1511 is cut off, V1514 conducts and squelch relay K1502 energizes.

The squelch circuit is also used to provide a separate feature of the radio set. The equipment is designed so that it can be used as an automatic two-way relay station for reception and retransmission of am. signals. The action of squelch relay K1502 also causes contacts 4 and 2 to close. When the transmitter is set for RELAY operation, contacts 2 and 4 complete a circuit which energizes the transmitter.

(4) AUDIO DRIVER V1508 (12AT7WA) AND AUDIO OUTPUT STAGE Q1501 (2N340) AND Q1502 (2N340). *(See figure 2–40.)* — Audio driver V1508 is a twin triode having its sections connected in parallel. When the squelch circuit is employed during phone operation, the grid circuit of V1508 is grounded through the contacts of squelch relay K1502 to provide silent operation of the receiver during times of no-signal reception. The amplified output from V1508 is applied to the primary winding of T1522, the input to audio output stage Q1501, Q1502.

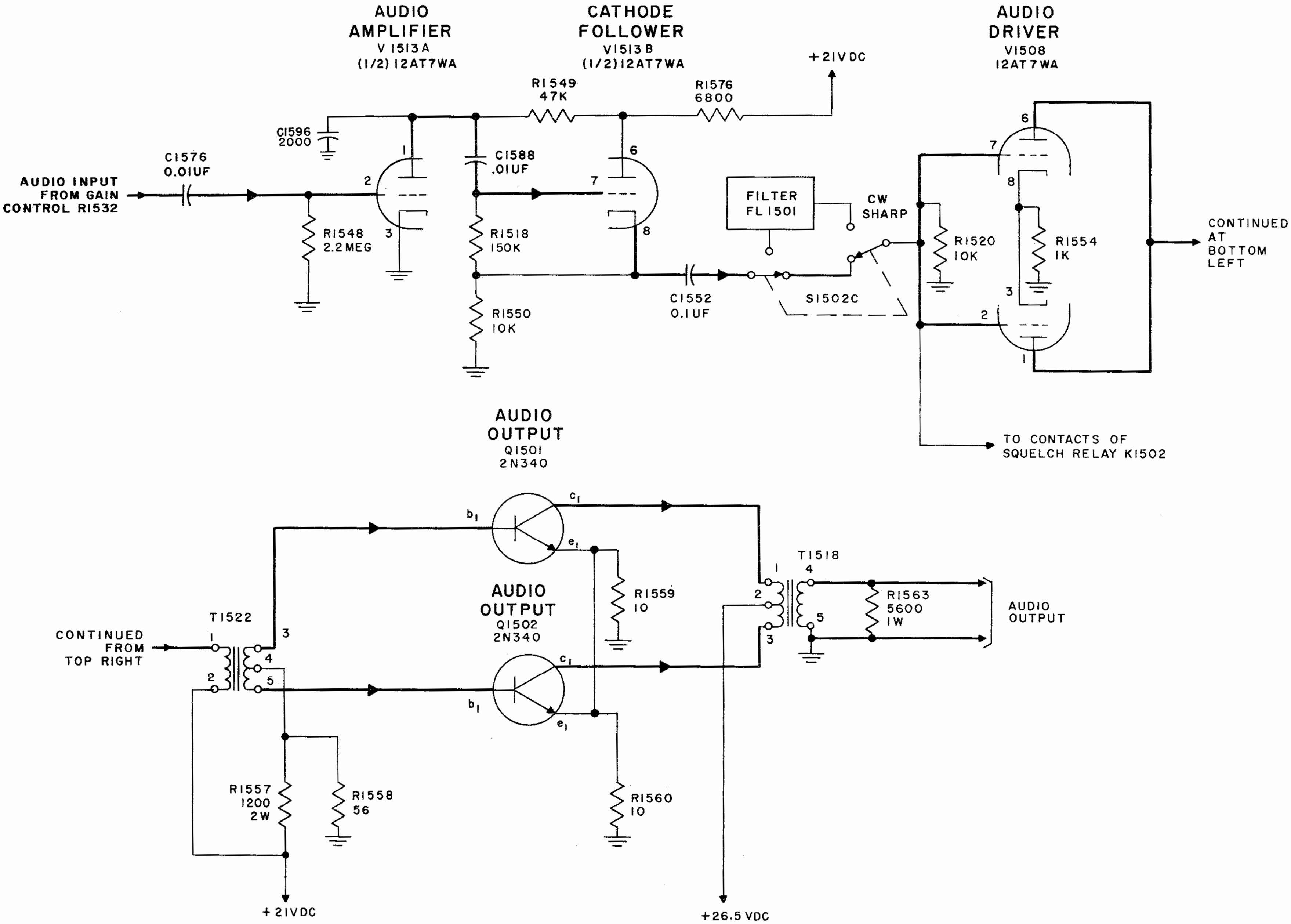


Figure 2–40. Audio Amplifier Stages V1513A, V1513B, V1508, Q1501, Q1502, Simplified Schematic

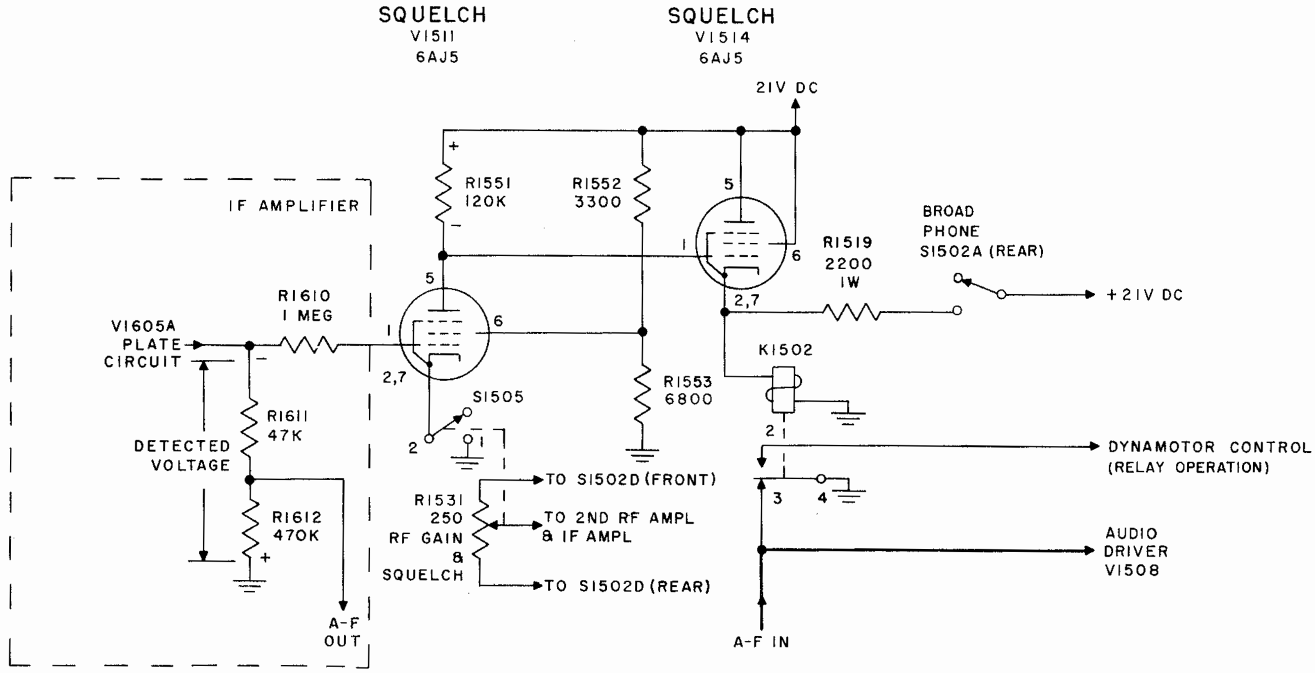


Figure 2-41. Squelch Circuit, Simplified Schematic

The audio output stage consists of two type-2N340 transistors operating in push-pull. They are NPN junction-type transistors connected in a common-emitter configuration, to give large current amplification and high power gain. This usage is analogous to a conventional vacuum-tube triode amplifier, in that the base (b1) is connected as the control grid, the collector (c1) is connected as the plate, and the emitter (e1) is connected as the cathode. As such, the functional operation can be considered the same as a class B, push-pull amplifier stage.

Collector voltage is applied through the primary winding of T1518 from the +21-volt bus. Base bias voltage is obtained from the junction point of R1558 and R1557. These resistors are connected as a voltage divider across the +21-volt supply and, therefore, the positive bias voltage obtained is less than 1 volt. R1559 and R1560 are current limiting resistors in series with the emitters.

The push-pull outputs from Q1501 and Q1502 are combined in T1518 and coupled to audio receptacles on the receiver and transmitter front panels and are applied to the trasmitter for retransmission when the radio set is used for relay service. Resistor R1563 is an output impedance-matching resistor.

(5) CALIBRATOR OSCILLATOR V1512 (6AJ5) AND HARMONIC AMPLIFIER V1510 (6AJ5). *(See figures 2-38 and 2-42.)* — Calibrator oscillator V1512 and harmonic amplifier V1510 are used to produce a signal for use in calibrating the receiver main tuning dial. Plate voltage is applied to V1512 and V1510 only when OPERATION SWITCH S1502 is in the CALIBRATE position. These stages are inoperative at all other times.

Oscillator stage V1512 is a modified electron-coupled Pierce oscillator having an output frequency of 200 kc. Quartz crystal Y1501 is the main frequency determining component and variable capacitor C1547 is a trimmer in the oscillator grid circuit. TPJ1503 is the test point for the oscillator. Feedback to sustain oscillations is coupled from the oscillator anode (screen grid) to the grid circuit through C1548. The 200-kc output is taken from the plate of V1512 and coupled to the grid circuit of harmonic amplifier V1510 through C1550.

Harmonic amplifier V1510 is a non-linear amplifier used to amplify the fundamental frequency of 200 kc, and to supply strong harmonics of that frequency. To accomplish non-linear amplification and resultant harmonics, crystal rectifier CR1501 is placed in the grid circuit to distort the 200-kc signal. Output from the plate of V1510 is coupled through C1577 and applied to the cathode of first rf amplifier V1501 in the rf head. The output from the harmonic amplifier heterodynes with the output from the local oscillator circuitry in the rf head to produce an audible beat note at 200-kc intervals throughout the receiver range. If the fiducial pointer on the tuning dial is correctly lined up, a zero beat will be heard when a dial calibration mark lies under the pointer; if not, the operator moves the pointer until this condition is obtained.

(6) RECEIVER POWER SUPPLY. *(See figure 2-43.)* — All input power to the receiver is applied through the power supply and transmitter main chassis to the receiver power supply. Two outputs are distributed throughout the receiver by the receiver power supply, an unregulated +26.5-volts dc and a regulated +21-volts dc. A full-wave rectifier circuit, comprised

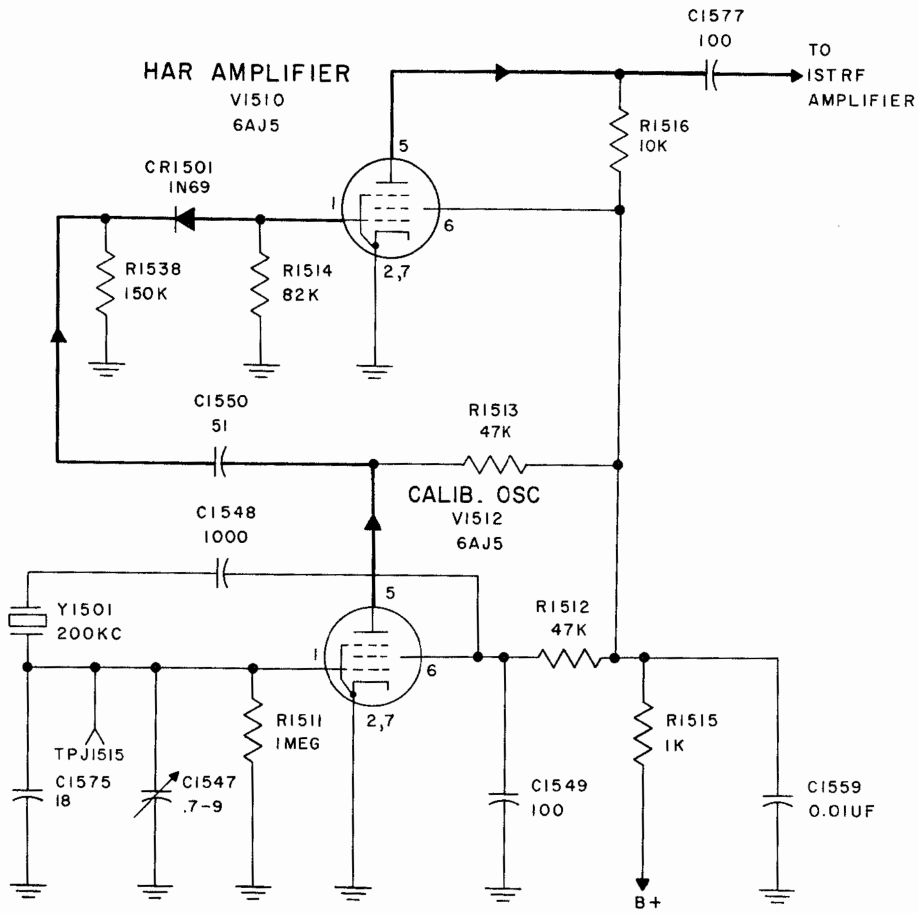


Figure 2-42. Calibrator Oscillator Stages V1512 and V1510, Simplified Schematic

of T1521 and silicon diodes CR1502A and CR1502B, as in or out of the supply depending on whether an ac or dc input is applied. A transistorized voltage regulator, used with ac or dc input, is the final section of the receiver power supply.

Components comprising the voltage regulator circuitry are physically located in the amplifier-power supply assembly and on the interior of the receiver front panel. The latter location is used so that the front panel can serve as a "heat sink" to dissipate the heat generated by the transistors.

When the vehicular generator system is used as the input power source, +26.5 volts, applied to terminal 10 of P1504, protected by fuse F1503, is the input voltage to the regulator circuit (VR1501, terminal 1). The +26.5-volt unregulated supply is taken before the regulator and delivered to terminal 23 of P1504 for further distribution.

When an external 115-volts ac is used as the input power source, input voltage is applied to terminals 19 and 20 of P1504. Step-down transformer T1521 and full wave rectifier CR1502A, CR1502B, and filter L1507 and C1573 convert the alternating source to +26.5 volts. The +26.5-volt output of the rectifier-filter combination is applied to terminal 1 of voltage regulator assembly VR1501.

The voltage regulator circuitry compensates for variations in the +26.5-volt input supply and for changes in load current, thereby maintaining the output at a constant +21 volts. Q1504, Q1503, and the parallel combination of Q1505 and Q1506 are connected in series across the +21-volt output terminal (J1512-3). A decrease in the output voltage causes the Q1505-Q1506 collector current to increase since these are NPN-type transistors. This current increase is amplified by Q1503, causing the output voltage to increase. The output voltage level (+21 volts) is determined by the gain of Q1503. The Q1503 gain is determined by the amount of bias applied to its base and this bias level is established by the amount of Q1504 collector current. Zener diode CR1505 functions in a manner analogous to a voltage-regulator tube to maintain a constant bias at the Q1504 base. Q1504 conduction can be varied with potentiometer R1564 which adjusts

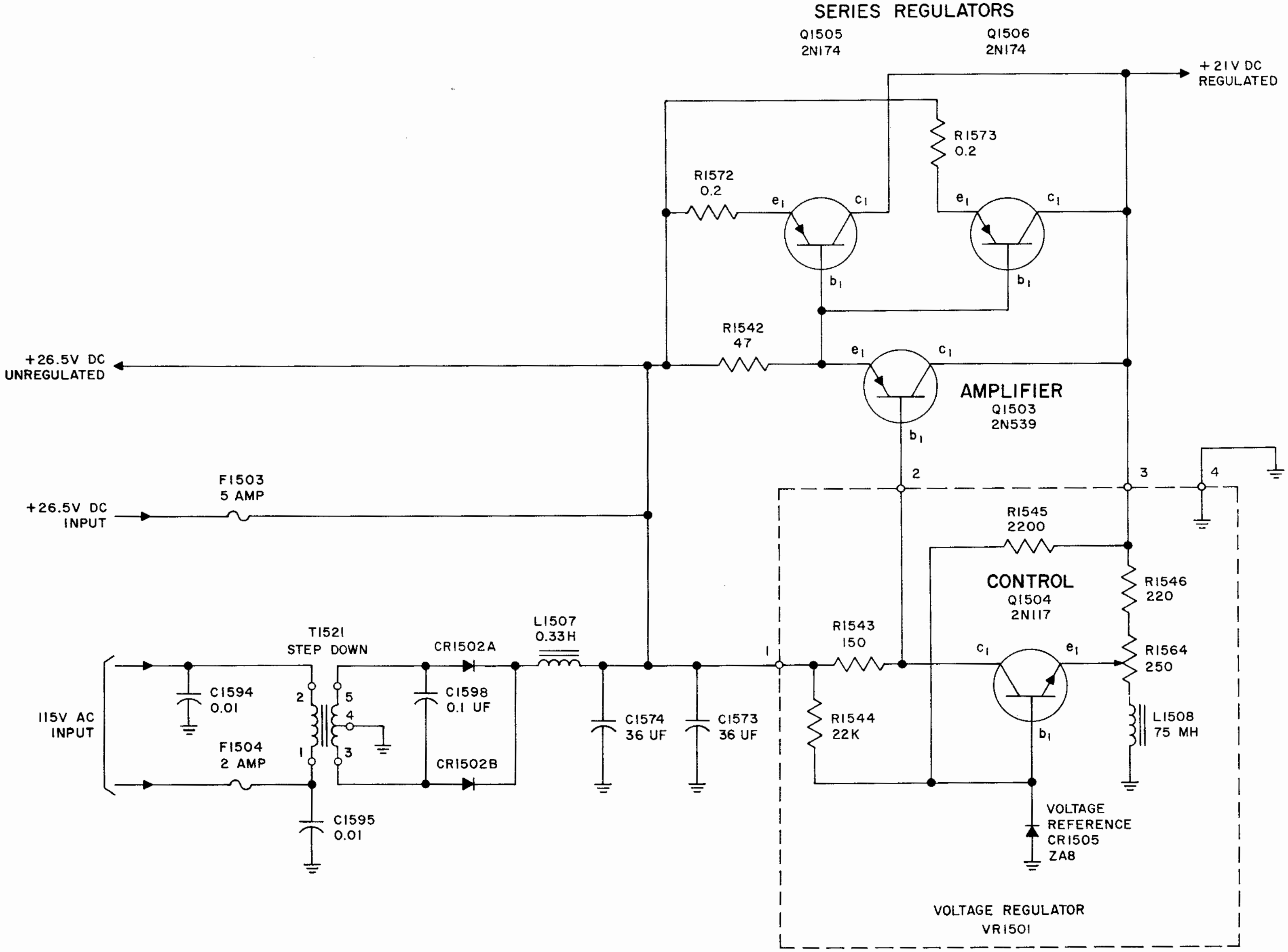


Figure 2-43. Receiver Power Supply, Simplified Schematic

the emitter voltage. Since R1564 can vary the Q1503 base bias, it is used as the +21 volt output adjustment. The Q1503 gain is also determined by the +26.5-volt input applied through R1543 to the collector of Q1504 and base of Q1503. If the supply voltage decreases (becomes less positive) the Q1504 collector current increases and the Q1503 current gain increases, thereby maintaining the output at its +21 volt level.

e. FREQUENCY SHIFT CONVERTER. — Two types of frequency shift converter are provided for use with the receiver. The converters supplied as part of the R–808/6RC/14 receivers having serial numbers 1 through 115 inclusive utilize a mark-space discriminator circuit operating in the audio frequency range. Receivers having serial numbers greater than 115 use a discriminator operating about the 455-kc intermediate frequency. Thus, the converters supplied with the lower-numbered receivers are referred to as "FS Converter, AF Type", while the later production models use "FS Converter, IF. Type".

For explanatory purposes in the following descriptions, the mark signal at the if. frequency is referred to as 455 kc +Δf and the space signal is 455 kc —Δf. (In both expressions, Δf signifies the frequency shift deviation employed at the transmitting station.) The text and drawings follow this procedure throughout. In actual practice this is not always the case. It is just as correct to reverse the terminology and refer to the space signal as 455 kc +Δf and the mark signal as 455 kc —Δf. The mark and space signals will be above or below the if. frequency in accordance with either of the following two factors:

characteristics of the transmitting station or band being received.

The receiver uses single conversion during operation on bands 1 and 2 and double conversion on bands 3 and 4. (See paragraphs 2–6*a* and *b.*) During operation on bands 1 and 2, a received mark signal having a +Δf is converted to a 455 kc —Δf signal. However, since there is double conversion on bands 3 and 4, the additional heterodyning causes the mark signal to be at a frequency of 455 kc +Δf.

The front panel NORMAL-REVERSE switch changes the connections to the teletypewriter to compensate for the above factors.

(1) FS CONVERTER, AF TYPE. *(See figures 2–44 and 7–86.)* — The af type converter is a removable plug-in subassembly. Plate voltage is applied to the unit only when OPERATION SWITCH S1502 is at the CW, FSK BROAD and FSK PHONE positions.

Frequency shift transmissions, shifted at an audio rate about the 455 kc if. frequency, from V1603 in the if. subassembly, are amplified and demodulated to operate a keying relay which is connected to an external teletypewriter.

Figure 2–45 illustrates the waveforms produced during the conversion process.

(*a*) IF. AMPLIFIER STAGE V1701 (26A6). *(See figure 2–46.)* — The output signal of the third if. amplifier, V1603, at the mark frequency of 455 kc +Δf

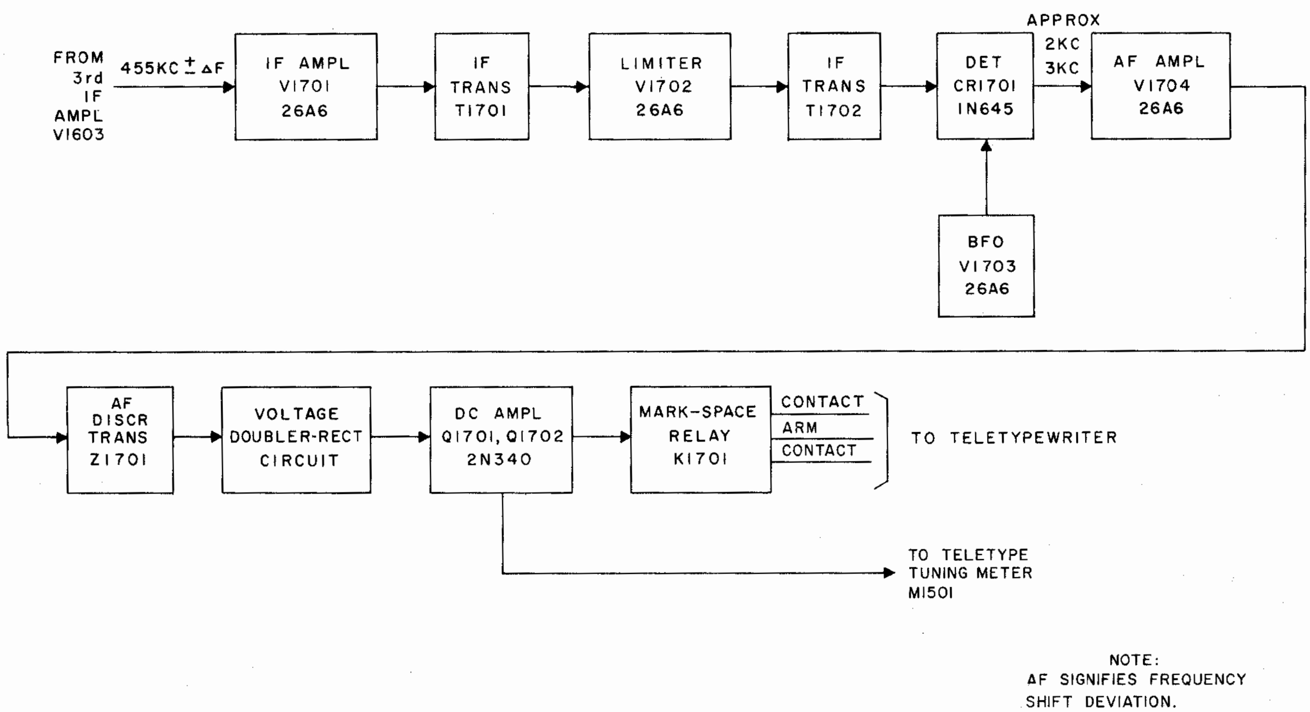


Figure 2–44. FS Converter, AF Type, Block Diagram

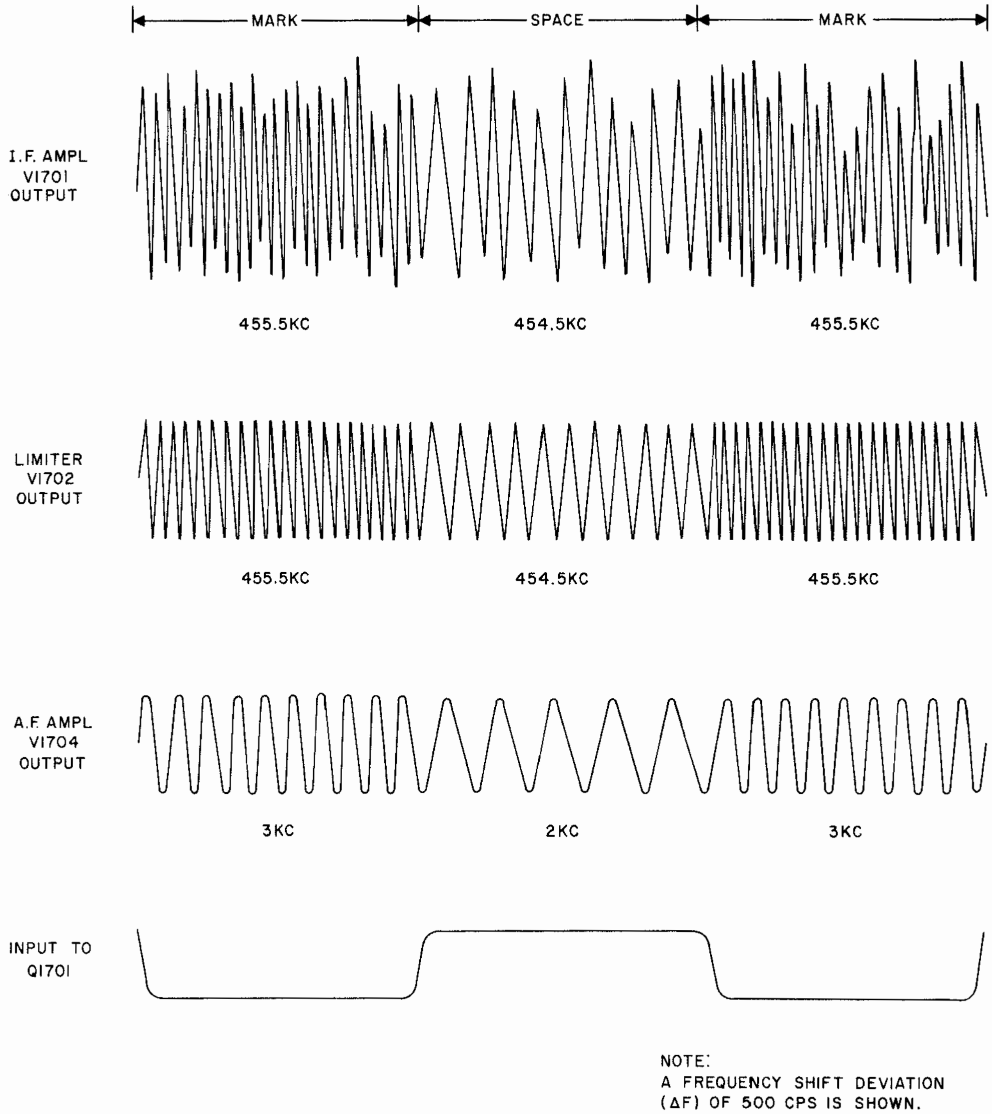


Figure 2–45. FS Converter, AF Type, Theoretical Waveforms

and the space frequency of 455 kc $-\Delta f$ is applied to the control grid of V1701, a conventional pentode amplifier used to provide the gain required for proper operation of the limiter stage. Output of the tube is coupled through if. transformer T1701 to the control grid of limiter tube V1702. T1701 is a bandpass transformer tuned to 455 kc.

(*b*) LIMITER STAGE V1702 (26A6). *(See figure 2–46.)* — Since the space and mark signals are actually a form of frequency modulation, the limiter removes noise peaks and other amplitude variations without affecting the intelligence of the incoming signal. Output from if. amplifier V1701 is applied to the control grid of limiter tube V1702, which operates as an overdriven amplifier.

During the positive peaks of the input signal, the plate is driven to saturation, grid current flows, and consequently a charge is developed on C1702. During negative half-cycles, C1752 discharges through R1702 thereby developing a grid-leak bias which drives V1702 to cutoff. In this way the tube is biased to a level proportionate to the strength of the incoming signal. Positive and negative clipping are obtained because the signal operates both in the plate saturation and cutoff regions of the tube. Although the limiting is not symmetrical, it is sufficient to operate the type of discriminator circuitry used in this converter. Output from the plate of V1702 is coupled across 455 kc if. transformer T1702 to the input of detector stage CR1701.

(*c*) DETECTOR STAGE CR1701 (1N645) AND AUDIO AMPLIFIER V1704 (26A6). *(See figure 2–46.)* — Output from limiter V1702 is applied to CR1701 for conversion to audio mark and space frequencies. The incoming frequency shift transmissions at 455 kc $+\Delta f$ and 455 kc $-\Delta f$ are mixed with the 452.5-kc

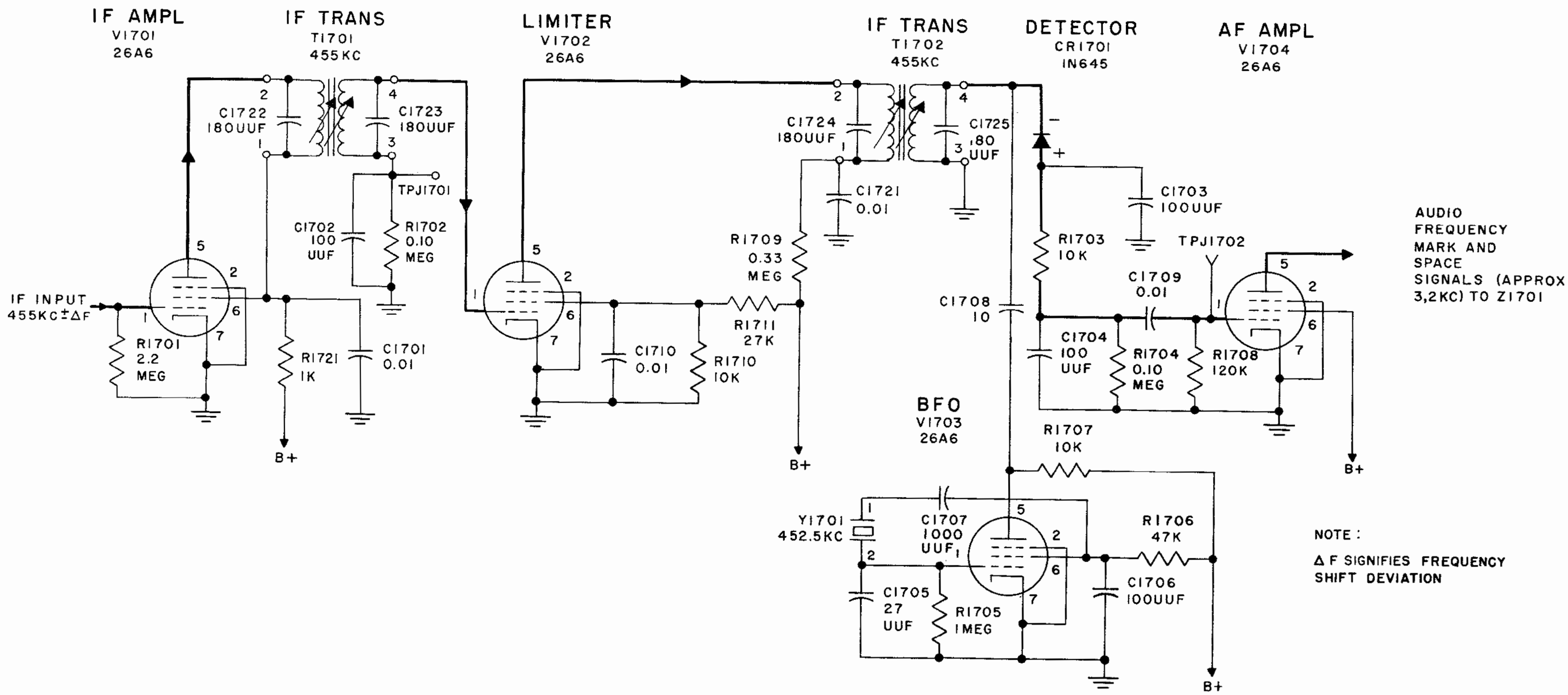


Figure 2–46. FS Converter, AF Type, Stages V1701, V1702, V1703, V1704, CR1701, Simplified Schematic

output of bfo stage V1703 at crystal diode CR1701 to obtain the two required af signals. As a result of the mixing action in the diode, seven frequencies are present in the stage. These frequencies are the bfo output (452.5 kc), mark frequency (455 kc +Δf), space frequency (455 kc —Δf), two sum frequencies (approximately 907 and 908 kc), and two difference frequencies (approximately 2 and 3 kc). However, only the two difference frequencies are in the audio range. The lower frequency signal, approximately 2 kc, is the space frequency and the higher frequency signal, approximately 3 kc, is the mark frequency. The RC filter network composed of R1703, C1703, and C1704 presents a high impedance to the two audio frequencies and a low impedance to the five radio frequencies. Consequently, the radio frequencies are bypassed to ground through C1703 and C1704. Audio frequency space and mark voltages developed across load resistor R1704 are coupled through C1709 to the grid of audio amplifier V1704.

The mark and space signals are amplified in V1704, which is a conventional pentode amplifier, and applied to primary windings of Z1701, the discriminator transformer assembly.

(*d*) BEAT FREQUENCY OSCILLATOR STAGE V1703 (26A6). *(See figure 2–46.)* — Bfo stage V1703 is a modified electron-coupled Pierce oscillator having an output of 452.5 kc. Crystal Y1701 is the main frequency determining component. Feedback to sustain oscillations is coupled from the oscillator anode element (screen grid) to the grid circuit through C1707. The oscillator output is taken from the plate of V1703 and coupled through C1708 to detector CR1701, for mixing with the 455 kc ±Δf mark and space signals.

(*e*) DISCRIMINATOR Z1701 AND VOLTAGE DOUBLER-RECTIFIER CIRCUIT. *(See figures 2–47 and 2–48.)* — The audio frequency mark and space signals are applied to the primary of discriminator transformer assembly Z1701. The discriminator consists of two separate transformers in a single case, with their primaries connected in series. Inductance of winding 5, 6 and capacitance of C1713, C1727 present a low impedance to the lower frequency space signal. Inductance of winding 3, 4 and capacitance of C1712, C1726 present a low impedance to the higher frequency mark signal. A voltage doubler-rectifier network is connected across each secondary winding, and the two networks are connected to the input circuit of dc amplifier Q1701.

The voltage divider-rectifier networks function as follows: A space signal from af amplifier V1704 is coupled to secondary winding 5, 6 of Z1701. (See figure 2–46.) During the half-cycles, when terminal 5 of Z1701 is positive, electron current will flow from terminal 6 through CR1704 and C1717 to terminal 5, charging C1717 to the supply (signal) voltage with the polarity shown in figure 2–47. During the half-cycles that terminal 6 of Z1701 is positive, electron current will flow from terminal 5 through C1719 and CR1705 to terminal 6, charging C1719 to the supply (signal) voltage with the polarity shown in figure 2–47. The capacitances of C1717 and C1719 are large enough so that they retain their charges between half-cycles. Therefore, as the two capacitors are in series, the voltage across C1717 and C1719 is double the signal voltage. Also, because of the rectifying action of CR1704 and CR1705, the space signals will produce positive pulses at the base of dc amplifier Q1701.

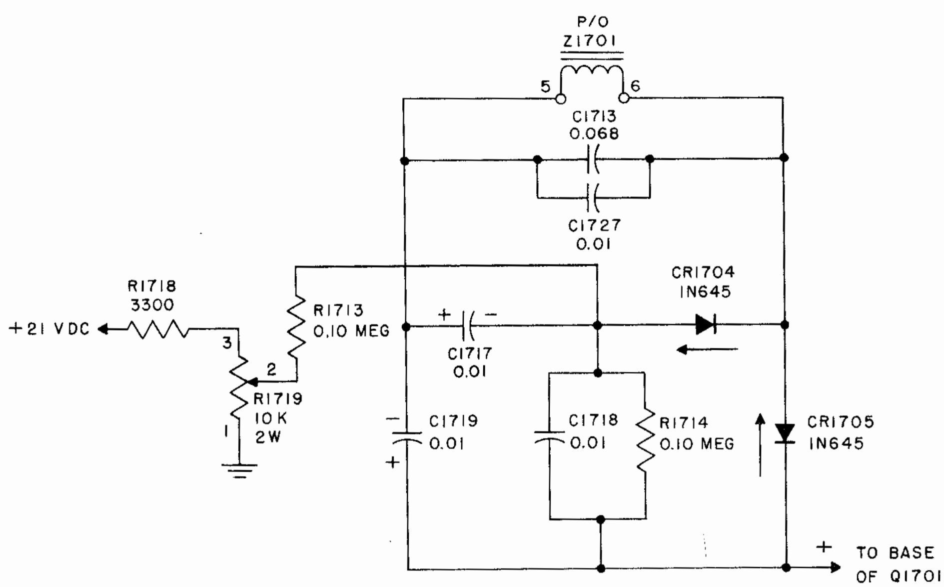


Figure 2–47. AF Discriminator and Space Signal Voltage Doubler-Rectifier Network, Simplified Schematic

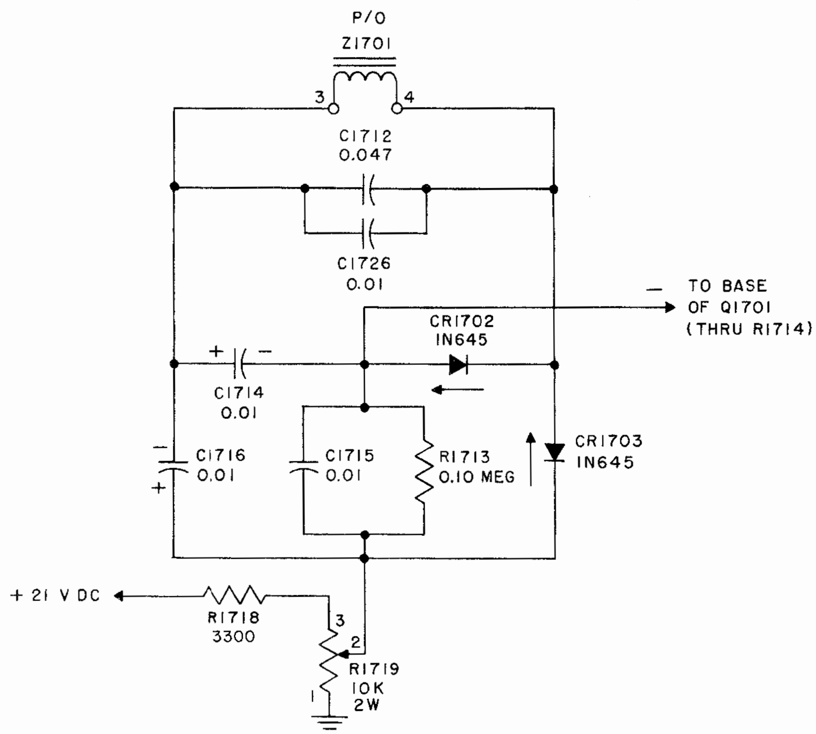


Figure 2–48. Discriminator and Mark Signal Voltage Doubler-Rectifier Network, Simplified Schematic

The mark network (see figure 2–48) operates in a manner similar to the space network, except that the negative end of C1714, C1716 in series goes to the moveable arm of R1719. The negative mark signals are applied to the base of Q1701 through R1714.

The input pulses to Q1701 operate at a positive bias level determined by the setting of voltage divider R1718, R1719.

RC filter networks C1715, R1713 and C1718, R1714 smooth out any ripple that may be present in the voltage doubler-rectifier circuit.

(*f*) DC AMPLIFIER Q1701 AND Q1702 (2N340). *(See figure 2–49.)* — Dc amplifier stage Q1701 and Q1702 controls the operation of keying relay K1701. Relay K1701 is a dual-coil, latching-type relay used to operate a polar or neutral teletypewriter. Both Q1701 and Q1702 are NPN junction type transistors.

Coil 1, 8 of K1701 will energize when Q1702 conduction is sufficient. When this occurs, the resistance of Q1702, in series with coil 1, 8, is less than the impedance of R1725, in series with coil 2, 3. Thus, contacts 6 and 4 will open and 6 and 7 will close. When Q1702 conduction is low, its resistance will be higher than R1725, and coil 2, 3 will have control of the relay, as it is energized to the plate supply line.

A positive bias voltage is applied to the base of Q1701 from a voltage divider comprised of R1718 and potentiometer R1719. Q1701 emitter current through R1724 biases Q1702 in its forward direction, allowing it to conduct. R1719 is adjusted to the point where, with no mark or space input, the Q1702 current produces a collector voltage equal to the voltage drop across R1725. Since the TELETYPE TUNING meter is connected between R1725 and the Q1702 collector, these equal potentials will produce a center scale (zero) reading on the meter. The arm (6) of K1701 will remain latched to either contact 4 or 7.

During the space intervals, the positive pulses applied to Q1701 drive the transistor to heavy conduction. The increased emitter current through R1724 increases the forward bias at the Q1702 collector and Q1702 conducts heavily, energizing coil 1, 8 of K1701. As a result, contacts 6 and 7 close, the teletypewriter is sent to the space position, and the TELETYPE TUNING meter deflects from zero because of the unequal potentials at the meter connections.

A negative mark pulse applied to the base of Q1701 causes a decrease in the bias current at Q1702, causing the resistance of Q1702 to increase to a valve greater than R1725. Thus coil 2, 3 controls the relay causing contacts 6 and 4 to close and sending the teletypewriter to the mark position. Since the potential at the Q1702 collector is more positive than the potential at the top of R1725, the meter deflects to the opposite side of zero. If the receiver is correctly tuned, mark and space signals will cause the meter to fluctuate equally and have an average value of zero.

R1722, C1728 and R1723, C1729 are used to suppress arcing at the contacts of K1701.

As stated in paragraph 2–6*e*, the connections to the teletypewriter can be reversed with the front panel NORMAL-REVERSE switch.

(2) FS CONVERTER, IF. TYPE. *(See figure 2–50 and 7–88.)* — The if. type converter is a removable plug-in subassembly. Plate voltage is applied to the unit only when OPERATION SWITCH S1502 is at the CW, FSK BROAD and FSK PHONE positions.

Frequency shift transmissions, shifted at an audio rate about the 455-kc if. frequency, from V1603 in the if. subassembly, are amplified and demodulated to operate a keying relay which is connected to an external teletypewriter.

Figure 2–51 illustrates the waveforms produced during the conversion process.

(*a*) IF. AMPLIFIER STAGE V1751 (26A6). *(See figure 2–52.)* — The output signal of the third if. amplifier, V1603, at the mark frequency of 455 kc $+\Delta f$ and the space frequency of 455 kc $-\Delta f$, is applied to the control grid of V1751, a conventional pentode

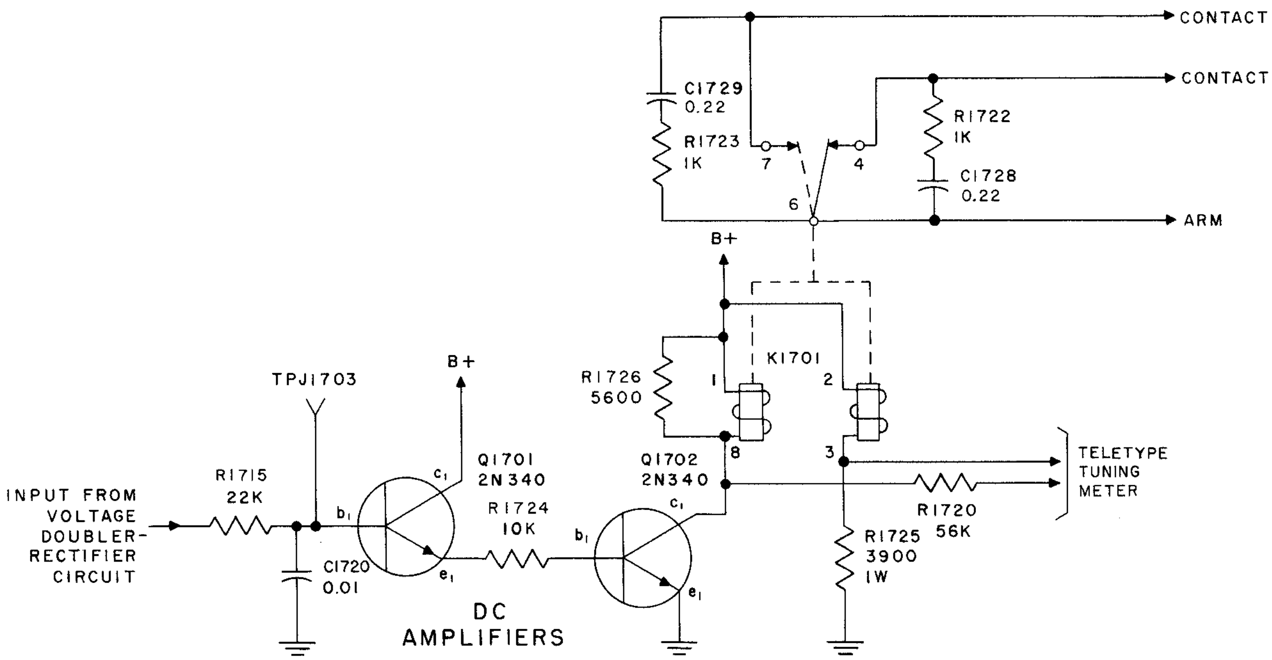


Figure 2–49. FS Converter AF Type, Stage Q1701, Q1702, Simplified Schematic

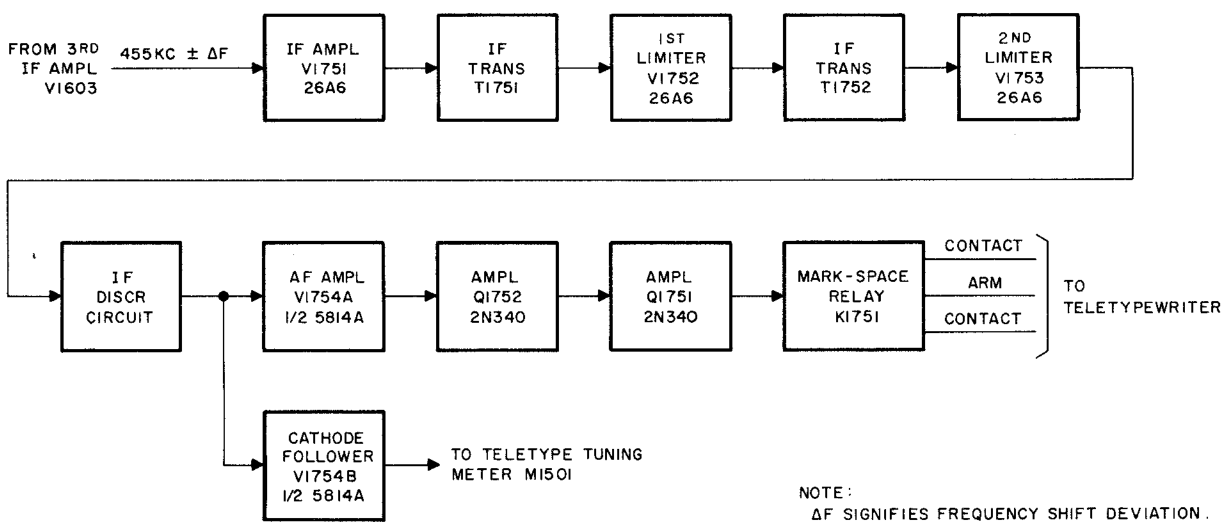


Figure 2–50. FS Converter, IF. Type, Block Diagram

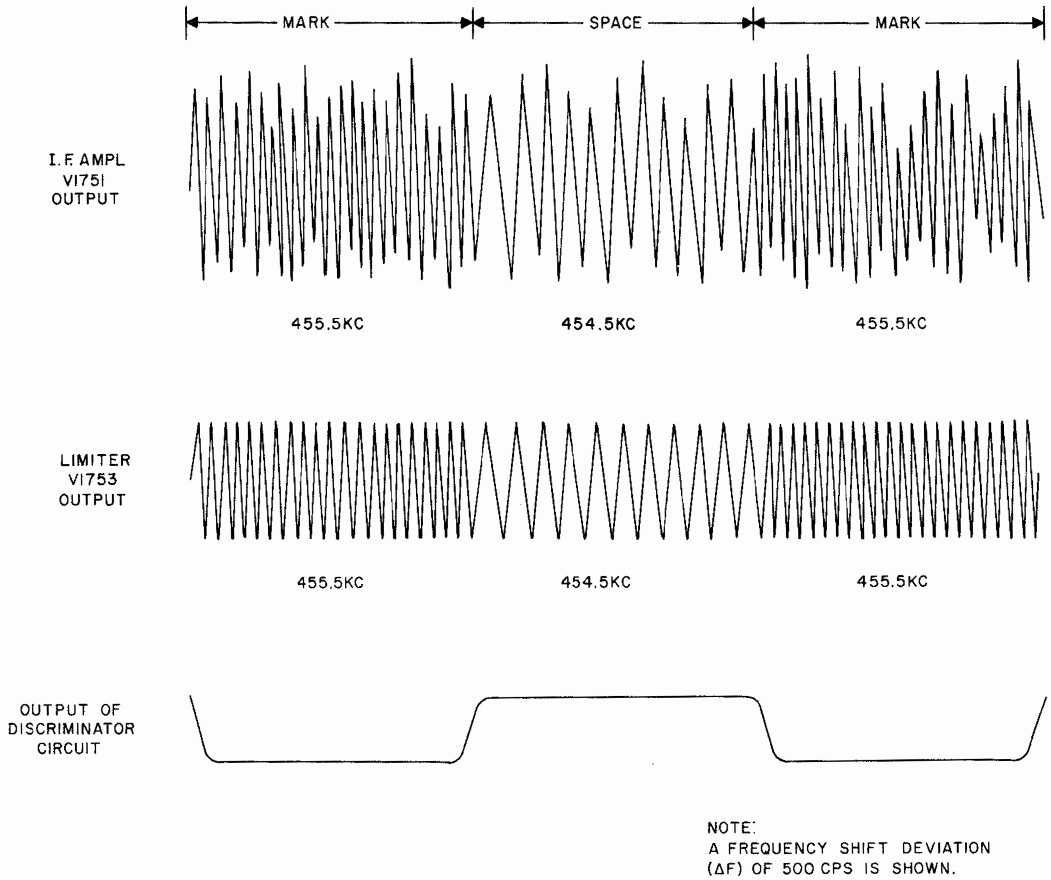


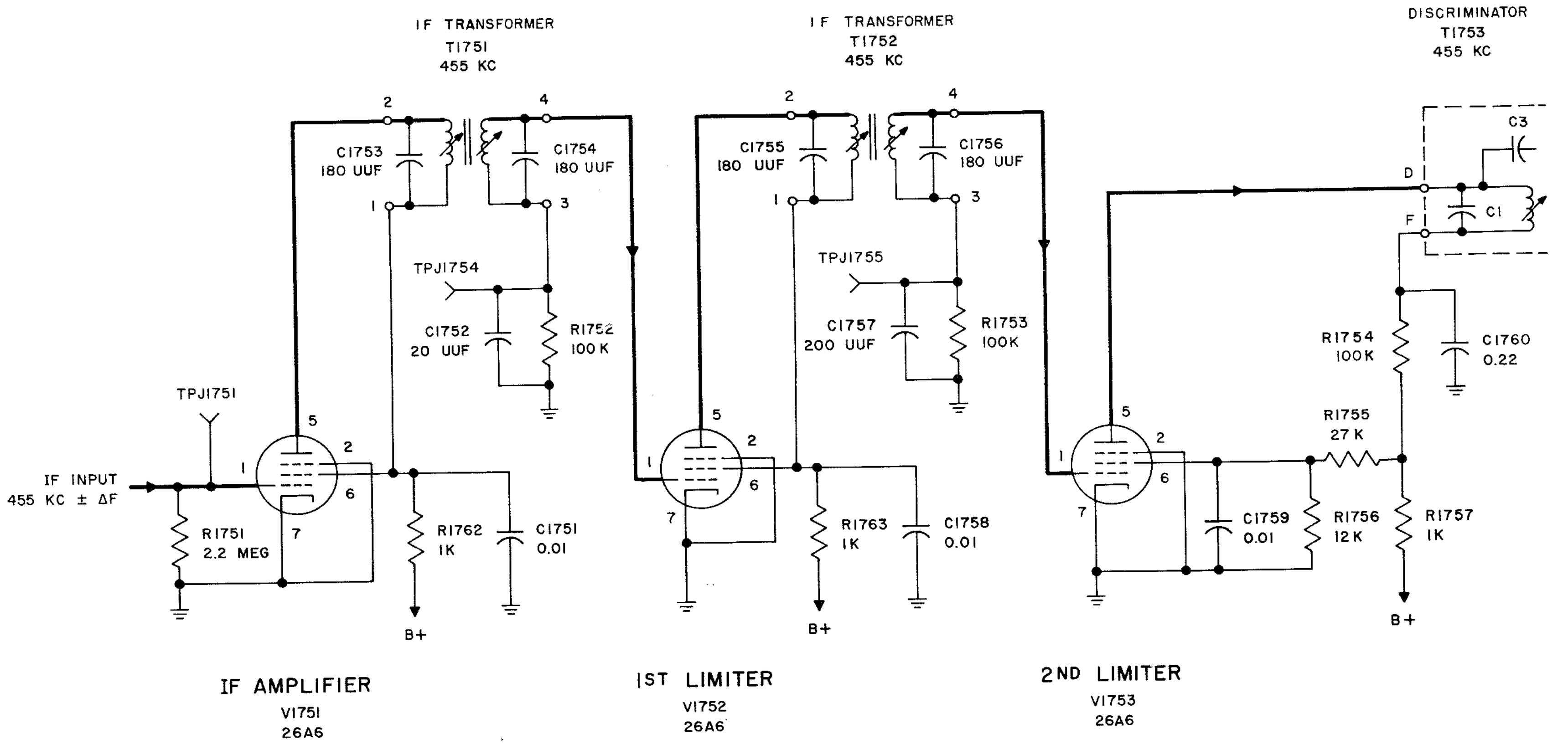
Figure 2-51. FS Converter, IF. Type, Theoretical Waveforms

amplifier used to provide the gain required for proper operation of the limiter stages. Output of the tube is coupled through if. transformer T1751 to the control grid of first limiter tube V1752. T1752 is a bandpass transformer tuned to 455 kc.

(*b*) FIRST LIMITER STAGE V1752 (26A6) AND SECOND LIMITER V1753 (26A6). *(See figure 2-52.)* — Tubes V1752 and V1753 provide negative and positive limiting respectively of the output from if. amplifier V1751. Since the space and mark signals are actually a form of frequency modulation, the limiters remove noise peaks and other amplitude variations without affecting the intelligence of the incoming signal. The discriminator circuit used in the converter is quite sensitive to amplitude variations. Therefore, two limiter stages are used to obtain sufficient clipping of any amplitude variations, thereby providing a steady-level input to the discriminator.

Output from if. amplifier V1751 is applied to the control grid of first limiter V1752. During the positive peaks of the input signal the plate is driven to saturation, grid current will flow and, consequently, a charge will be developed on C1752. During negative half-cycles, C1752 discharges through R1752 thereby developing a grid-leak bias for the tube. This bias will adjust itself to be slightly less than the level of the positive peak value of the signal. Since the RC time constant of the R1752-C1752 combination is approximately equal to the period of the 455-kc signal, most of the positive half-cycle will be amplified, but the portion of the signal below the grid cutoff voltage will be limited. Because of this unsymmetrical limiting action, a second limiter is used. The phase inverted signal at the plate of V1752 is coupled across T1752 to the control grid of second limiter V1753. This stage operates a similar manner as V1752 but, because of the phase reversal through V1752, the unlimited portion of the incoming signal is acted upon. However, since the rf time constant at the V1753 grid is approximately ten times the period of the 455-kc signal, amplification of the positive portion of the signal is restricted and a fairly symmetrical signal is produced at the plate of V1753. The output from V1753 is applied to a discriminator circuit.

(*c*) DISCRIMINATOR CIRCUIT. *(See figure 2-53.)* — A Foster-Seeley discriminator circuit is used to detect the mark and space pulses. This circuit is comprised of transformer T1753, silicon diodes CR-1751, CR1752 and associated components. R1758 and R1759 are the load resistors for CR1751 and CR1752, respectively. The dc electron flow path of each diode is such that the voltage drop across R1758 is negative



NOTE:
ΔF SIGNIFIES FREQUENCY SHIFT DEVIATION.

Figure 2–52. FS Converter, IF. Type, Stages V1751, V1752, V1753, Simplified Schematic

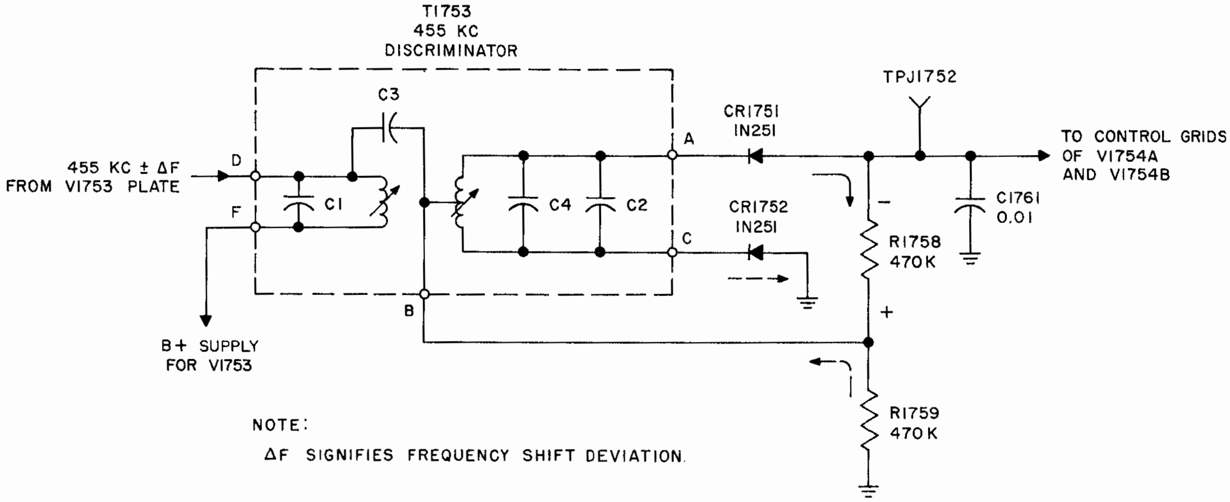


Figure 2-53. IF. Type Discriminator Circuit, Simplified Schematic

and the voltage drop across R1759 is positive with respect to ground. (In this manual, the bar of the diode is considered to be the cathode and the arrowhead is the anode. Electron current flow then is from the bar to the arrowhead. See figure 2-5.)

The primary and secondary windings of discriminator transformer T1753 are tuned to the 455-kc if. frequency. In addition to the transformer coupling, signal voltage from the primary is coupled via C3 (part of T1753 assembly) to a tap on the secondary winding. The principle of detecting the frequency shifted mark and space signals is based on the fact that the capacitive-coupled voltage is out-of-phase with the transformer-coupled voltage.

Consider the case where a non-shifted transmission is being received and the signal is at the if. frequency of 455 kc. The signal which is coupled by C3 is used as the reference voltage. (See figure 2-54.) The transformer-coupled voltage at the T1753 secondary (E_{sec}) is 180 degrees out of phase with the primary reference voltage (E3). At resonance (455 kc), the reactive voltage theoretically is purely resistive and the reactive voltage drop across the secondary is divided into equal and opposite polarity voltages (E1 and E2) (figure 2-54, A.) Since the capacitive-coupled signal (E3) is applied to the secondary tap, the two reactive voltages are each 90 degrees out of phase with the reference signal. The voltages are added vectorially to produce resultant voltages $E1_A$ and $E2_A$. Voltages $E1_A$ and $E2_A$ are applied to the cathodes of CR1752 and CR1751, respectively. Since $E1_A$ and $E2_A$ are equal, the voltage drops across R1758 and R1759 will likewise be equal, but of opposite polarity. As a result the two voltages will cancel and there will be a net zero voltage output from the discriminator circuit.

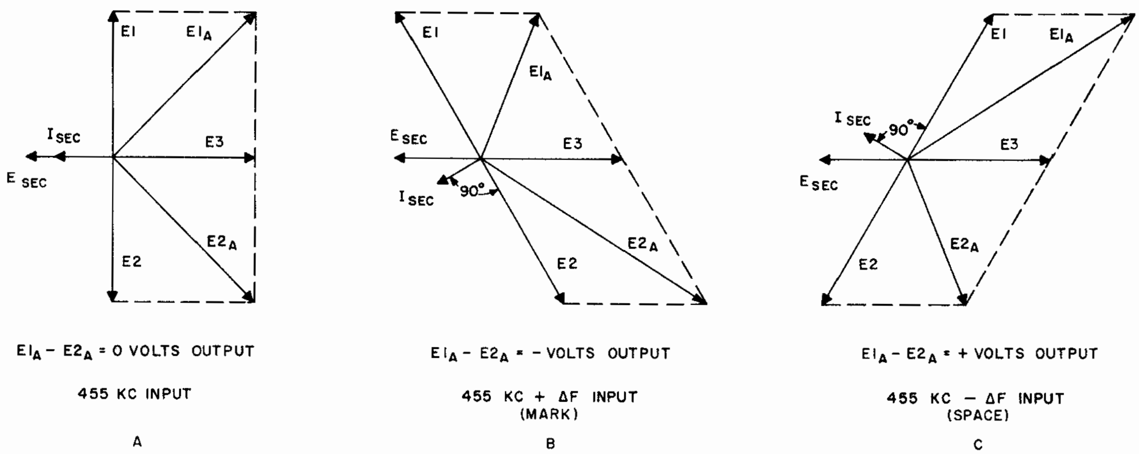
When a mark signal of 455 kc $+\Delta f$ is applied to tuned transformer T1753, the secondary presents an inductive reactance to the transformer-coupled voltage. See figure 2-54, B. The induced secondary voltage (E_{sec}) and current (I_{sec}) are no longer in phase and the secondary current lags the secondary induced voltage. The reactive voltages E1 and E2 are always displaced 90 degrees from the secondary current. Since the capacitively coupled reference voltage (E3) remains at 0 degrees, a frequency shift deviation above 455 kc (mark) causes one half of the reactive voltage (E2) to be less than 90 degrees, and the other half (E1) to be greater than 90 degrees, with respective to the reference voltage. The resultant vector addition causes $E2_A$ to be greater than $E1_A$. This causes CR1751 to conduct more than CR1752 and thus the negative voltage developed across R1758 will be greater than the positive voltage developed across R1759. As a result, the discriminator produces a negative pulse output each time a mark is received.

When the if. signal swings below 455 kc (space) the tuned secondary of T1753 presents a capacitive reactance to the incoming signal. Conditions are reversed from that described above and a positive pulse output is produced. See figure 2-54, C.

The plus and minus output pulses from the discriminator, occuring at the audio frequency keying rate, are fed to the control grids of af amplifier V1754A and cathode follower V1754B. C1761 is an rf bypass capacitor in the output circuit of the discriminator.

(*d*) AF AMPLIFIER V1754A (1/2 5814A) AND CATHODE-FOLLOWER V1754B (1/2 5814A). *(See figure 2-55.)* — The negative and positive mark and space pulses from the discriminator, occurring at an audio rate (Δf), are fed to the control grids of af amplifier V1754A and cathode follower V1754B. The amplified, phase inverted output from the plate of V1754A is coupled through C1763 to the base of Q1752. Cathode follower V1754B provides isolation for TELETYPE TUNING meter M1501 to prevent it from loading down the discriminator circuit.

One terminal of M1501 is connected to the cathode of V1754B while the other terminal is connected to the



LEGEND

+ΔF = FREQUENCY SHIFT DEVIATION (MARK)
−ΔF = FREQUENCY SHIFT DEVIATION (SPACE)
E_{SEC} = T1753 SECONDARY VOLTAGE
I_{SEC} = T1753 SECONDARY CURRENT
E1 = VOLTAGE ACROSS UPPER SECTION OF T1753 SECONDARY
E2 = VOLTAGE ACROSS LOWER SECTION OF T1753 SECONDARY
E3 = T1753 PRIMARY VOLTAGE COUPLED THROUGH C3
$E1_A$ = VOLTAGE APPLIED TO CR1752
$E2_A$ = VOLTAGE APPLIED TO CR1751

Figure 2–54. IF. Type Discriminator Circuit, Operating Characteristics

wiper of potentiometer R1769. Resistors R1768, R1769, and R1770 comprise a voltage divider connected across the +26.5-volt supply. R1769 is a balance adjustment. With no input to the receiver, R1769 is adjusted to obtain an equal potential between the cathode of V1754B and the wiper of R1769. Thus, the TELETYPE TUNING meter has a center scale (zero) reading with no input applied. As a result, the meter will deflect to either side of zero when a frequency shifted transmission is received. If the receiver is correctly tuned, the meter will fluctuate equally and have an average value of zero.

(*e*) AMPLIFIER STAGES Q1752 (2N340) AND Q1751 (2N340). *(See figure 2–55.)* — The space and mark pulses from V1754A are further amplified by Q1752 and coupled through C1769 to the base of Q1751. Transistor stage Q1751 controls the operation of teletype keying relay K1751, a dual coil, latching-type relay used to operate a polar or neutral teletypewriter.

Coil 1, 8 of K1751 is connected in series with Q1751 across the +21-volt supply bus; coil 2, 3 of K1751 is connected in series with R1775 across the +21 volt bus. When Q1751 conduction is low, its resistance is higher than R1775. Thus more current will flow through coil 2, 3 and that section will have control of the relay, causing contacts 6 and 4 to close. When Q1751 conduction is sufficient, its resistance will be less than R1775, and coil 1, 8 will control the relay, closing contacts 6 and 7.

Because of the phase inversion by Q1752, the input to Q1751 consists of positive space and negative mark pulses. A positive bias voltage is applied to the base of Q1751 from the wiper of potentiometer R1779. R1779 is adjusted to provide sufficient Q1751 collector current to close contacts 6 and 7 of K1751 with positive space input pulses applied to Q1751. A negative mark pulse applied to the base of Q1751 causes collector current to decrease, causing the transistor resistance to increase to a value greater than R1775. Thus coil 2, 3 controls the relay, causing contacts 6 and 4 to close and sending the teletypewriter to the mark position.

R1764, C1765 and R1765, C1766 are used to suppress arcing at the K1751 contacts.

As stated in paragraph 2–6*e*, the connections to the teletypewriter can be reversed with the front panel NORMAL-REVERSE switch.

2–7. RADIO SET CONTROL GROUP OA–1444/GRC–14.

Theory of operation of the control group is presented to provide an understanding of how the units comprising the control group are interrelated with each other and with the operations of Radio Set AN/MRC–55.

The control group provides keying, talking and listening facilities for the radio set to a remote point, by means of a telephone line. It also provides telephone communication and ringing between local remote control and field remote control. The extension of power control (dynamotor) of the radio set to local remote and field remote controls is another function of the control group.

Theory discussion in the following paragraphs is based on the overall schematic diagrams for local remote control (figure 7–90) and field remote control

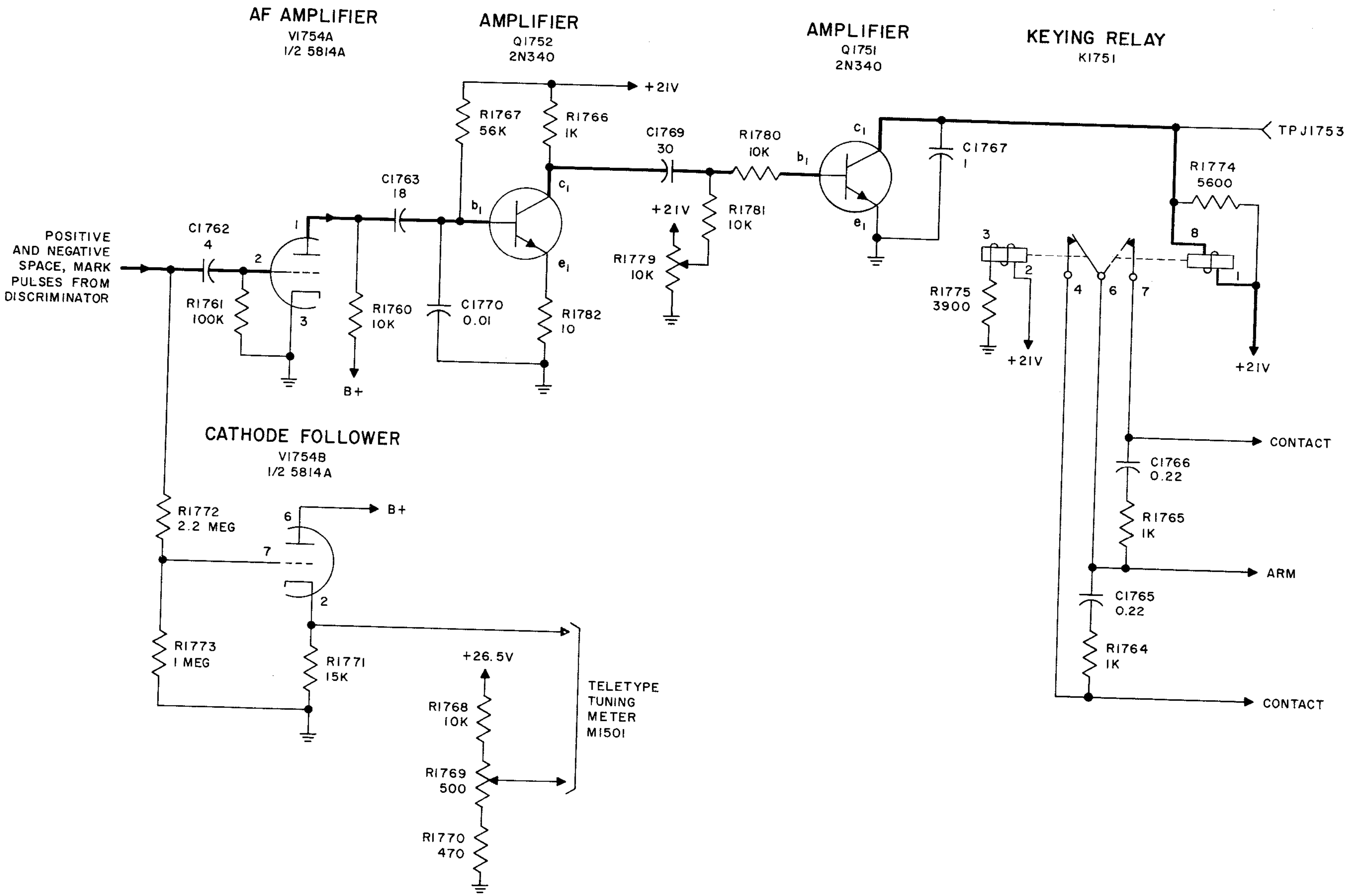


Figure 2–55. FS Converter, I.F. Type, Stages V1754A, V1754B, Q1752, Q1751, Simplified Schematic

(figure 7–92), and the control group block diagram (see figure 2–56).

a. RADIO SET CONTROL C–2171/GRC–14. — Local remote control provides a local terminal for field remote control, in addition to push-to-talk control of the transmitter from a remote point in the vehicle.

(1) INTERPHONE CIRCUIT. — Each of the two control units provides a line transformer (T1901 and T2001) with microphone input, receiver output, and balanced 600-ohm line windings. The transformers joined by the telephone line constitute the basic telephone circuit. With microphones and phones connected to the respective windings of the two transformers and with the dry cells installed in each of the two units, two-way telephone communication between the two control units is made possible.

A duplex telephone circuit is set up when local remote control OPERATION switch S1902 and SERVICE switch S1903 are in the TEL position and field remote control SERVICE switch S2001 is in TEL position. The control voltage of 45 volts dc, supplied by battery BT2003 in the field remote control, and control relays K1901, K1902, and K1903 in the local remote control are disconnected from the line during interphone service. Terminals 2, 3 and 4 of switch S1902, section 1, rear, connect the local remote control microphone to the microphone supply of 3 volts dc, supplied by batteries BT1901 and BT1902. The microphone supply, in turn, is connected in series with the microphone winding 5–6 of line transformer T1901. The microphone circuit is completed by closing the push-to-talk switch on the handset. Voice frequency currents developed across windings 5–6 of T1901 are induced in windings 1–2 and 3–4 of T1901, which are joined by dc blocking and audio bypass capacitor C1901B, selected by terminals 5 and 8 of switch S1903, section 1, rear. This signal is applied to the telephone line binding posts L1 and L2. A portion of the voice signal is developed across phone winding 7–9 of T1901 and returned to the sender's phone as sidetone.

Voice frequency currents received from the field remote control are induced in winding 7–9 of T1901 and applied to the operator's phone. Winding 7–9 of T1901 is returned to ground through terminals 12 and 9 of S1903, section 1, rear.

(2) RINGING CIRCUIT. — Ringer G1901 is a hand-operated ringer which, when cranked, disconnects local bell DS1902 or indicator lamp DS1901, by opening contacts 2 and 3 of G1901, and connects the magneto-type generator (contacts 1 and 3) which is normally disconnected from the circuit. A 20-cycle voltage is generated, passed through each half of

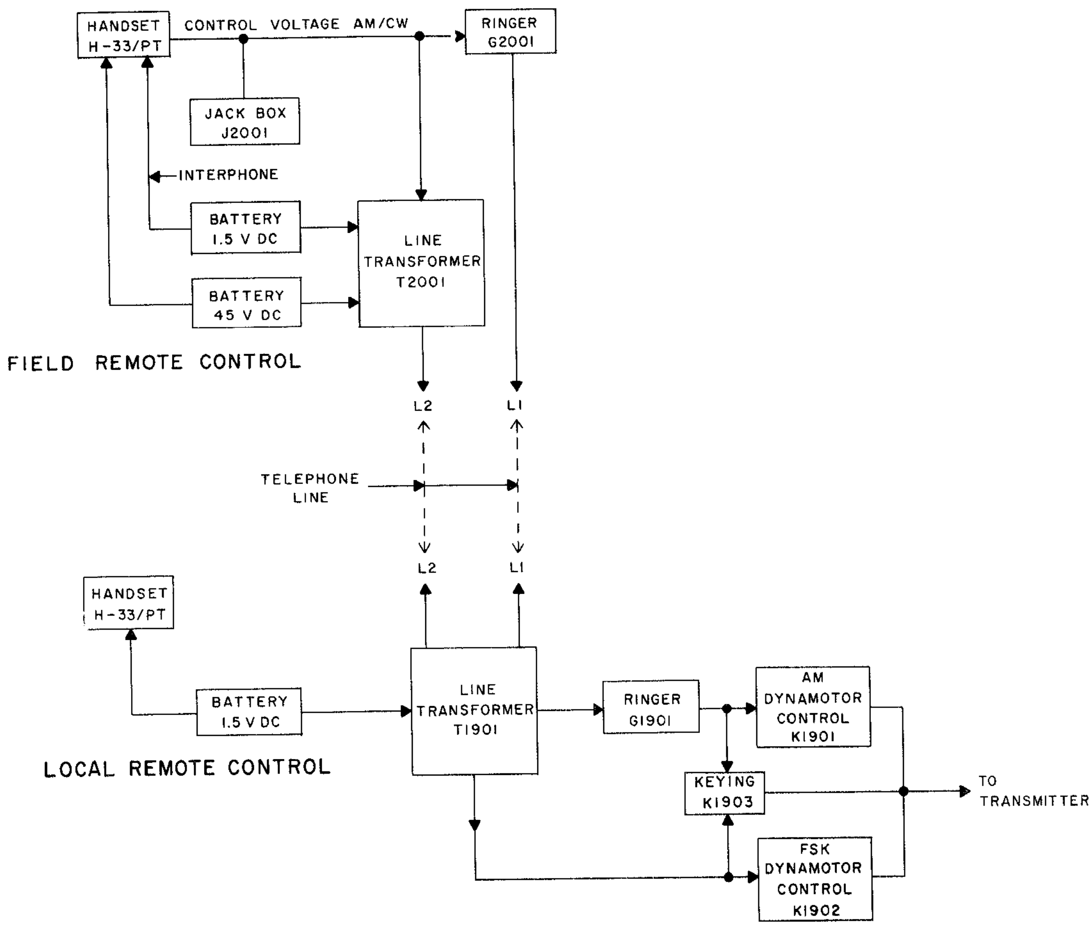


Figure 2–56. Control Group, Block Diagram

windings 1-2 and 3-4 of T1901, and is transmitted over the line to the field remote control. Ringing signals developed across winding 3-4 of T1901 induce a signal across phone winding 7-9 of T1901 and, therefore, can be heard in the headphones of both operators.

The 20-cycle ringing signal is received from the field remote control in the same way as audio signals. This signal passes through the line windings of T1901, through terminals 3 and 2 of generator G1901, and is applied either to a bell or to an indicator lamp, depending on the position of internal LAMP-BELL switch S1901. When switch S1901 is in the BELL position, the bell is connected into the circuit through blocking capacitor C1910A, across dc blocking capacitor C1901B and between terminals 2 and 3 of T1901. With switch S1901 in the LAMP position, the lamp is in series with voltage-dropping resistor R1901 and is connected across the same points in the line circuits as bell DS1902.

(3) AM. CIRCUIT. — The function of turning on the push-to-talk am. circuit is placed under a relay control circuit in the transmitter. Normally, contacts of the relay circuits keep the receiver operative, while the transmitter is in an inoperative condition. When the relay control circuit is energized, the receiver is disabled and the transmitter is turned on. To permit control of this function from a remote control position, the ground return lead for the relay circuits is brought out through a panel connector to local remote control.

When OPERATION switch S1902 is in LOCAL position, and SERVICE switch S1903 is in AM position, the push-to-talk switch on the handset turns the dynamotor on and off. Dynamotor control is accomplished by completing the ground return circuit through the push-to-talk switch, terminals 7 and 8 of switch S1903, section 2, rear, and terminals 1 and 4 of S1902, section 2, rear, and terminal F of P1901 (carrier control) to the transmitter.

In addition, the push-to-talk switch also completes the am. circuit between the microphone and the transmitter. The microphone push-to-talk circuit is connected to the microphone output, terminal C of P1901, which mates with J1305 of the transmitter.

When switch S1902 is in REMOTE position, it transfers control of the dynamotor and transmitter to field remote control.

The receiver audio output, terminal A of P1901, is connected through terminals 5, 7 and 8 of switch S1902, section 2, rear, to the local phone.

(4) MONITORING. — With field remote control in control of the transmitter during am. or cw/fsk operation (S1902 in the REMOTE position and S1903 in AM or CW/FSK position), the local remote control operator may listen to the field operator only during listening periods (key up or push-to-talk switch off), but can talk to the field operator at any time.

When the local remote control unit has control of the transmitter (S1902 in LOCAL position and S1903 in AM position), the field remote control operator cannot hear the local operator, but can talk to him.

This break-in operation by the local remote or field remote operator will not affect transmitter operation.

The field remote operator may be monitored in am. or cw operation from the phone jacks on the transmitter front panel. This is accomplished through the receiver audio output circuit (terminal A of P1901).

b. RADIO SET CONTROL, C-2172/GRC-14. — The field remote control provides the means for controlling the radio set in am. phone and cw keying operation over a two-wire, 600-ohm telephone line up to one mile in length. Telephone operation with ringing facilities between the field remote and local remote operators is also provided. Control of the dynamotor is accomplished from field remote control by means of the push-to-talk switch on the handset. When used with a separate teletype system (fsk), the field remote control is used to turn the dynamotor on and off.

(1) CONTROL CIRCUIT. — Control facilities of field remote control consist of SERVICE selector switch S2002, and a control voltage of 45 volts dc supplied by battery BT2003. The field operator can disconnect the 45-volt battery from the line in TEL (interphone) operation; connect the battery across the line so that L1 is positive and L2 is negative (cw/fsk operation); or connect the battery across the line so that L1 is negative and L2 is positive (am. operation). Connection of the battery across the line is completed by the push-to-talk switch in am. operation, and key-down position during cw/fsk operation. Three control relays located in the local remote control are part of the control circuit for the field remote control. Relay K1901 is the dynamotor control relay in am operation, K1902 (latching relay) controls the dynamotor during cw/fsk operation, and K1903 is the keying relay.

(2) INTERPHONE CIRCUIT.—When SERVICE selector switch S2002 is placed in TEL (interphone) position, terminals 3, 4 and 7, 8 of S2002 disconnect battery BT2003 (45V) from the circuit. Microphone supply batteries, BT2001 (1.5-volt dc) and BT2002 (1.5-volt dc), are connected in series through the push-to-talk switch of Handset H-33/PT to the microphone winding (terminals 5-6) of line transformer T2001. The microphone circuit is not affected by switch positions of S2002 and is only disconnected by releasing the push-to-talk switch. Voice frequency currents developed across winding 5-6 of T2001 are induced in windings 1-2 and 3-4 of T2001. The dc blocking and audio bypass capacitor C2001B, selected by terminals 10, 11 and 12 of switch S2002, connects both windings of T2001 (1-2 and 3-4) in series. This signal is applied to the telephone line through binding posts L1 and L2.

Voice frequency currents received from the local remote controls are induced in winding 7-9 of T2001 and applied to the phones. For a more complete discussion of the duplex telephone circuit, refer to the interphone circuit of local remote control, paragraph 2–7*a*(1).

Jack box J2001 accommodates two additional headsets, connected in parallel across phone winding (7–9) of T2001, and an additional microphone, connected to the microphone winding terminal 6 (through BT2001 and BT2002) and to terminal 5 of T2001.

(3) RINGING CIRCUIT. — Refer to paragraph 7*a*(2) for a discussion on the theory of operation of the ringing circuit for local remote control. This circuit is identical to the ringing circuit in the field remote control.

(4) AM. CIRCUIT. — With SERVICE selector switch S2002 in the AM position, the positive terminal of BT2003 (45-volt dc) is connected to telephone line L2 through terminals 4 and 2 of switch S2002, current limiting resistor R2002, and winding 3–4 of line transformer T2001. The negative side of BT2003 is connected to line L1 through terminals 8 and 6 of S2002, the push-to-talk switch of the handset, terminals F and H of connector J2002, contacts 2 and 3 of ringer G2001, and winding 1–2 of T2001. Closing the push-to-talk switch completes the circuit and places the 45-volt dc control voltage on the telephone line.

Control relay K1901, located in the local remote control, figure 7–90, is energized by the control voltage. One set of contacts (8 and 5) controls the dynamotor; another set of contacts (6 and 7) transfers the voice signals to the transmitter through terminals 7 and 8 of S1902, section 1, rear. Switch S1902 must be in REMOTE position, and switch S1903 must be in AM position.

During push-to-talk am. transmission, voice frequency currents are developed across microphone winding 5–6 of T2001 and induced in windings 1–2 and 3–4 of T2001. This signal is applied to the telephone line through binding posts L1 and L2. Sidetone is induced in the field operator's headset, through winding 7–9 of T2001, by the generated voice currents.

Voice currents enter local remote control through L1 and L2, developed across windings 1–2 and 3–4 of T1901, and are induced in windings 5–6 and 7–9 of T1901. The voice signals are taken from winding 5–6 of T1901 and connected to the microphone output (terminal C of P1901) through terminals 6 and 7 of relay K1901, capacitor C1903, and terminals 7 and 8 of switch S1902.

Turning the dynamotor on and off is accomplished by means of the push-to-talk switch which completes the control voltage circuit and causes relay K1901, located in the local remote control, to be energized. Contacts 5 and 8 of K1901 close the ground return circuit to the dynamotor control, through terminals 3 and 4 of switch S1903, section 2, rear (AM), and terminals 3 and 4 of switch S1902, section 2, rear (REMOTE) to terminal F of P1901.

During listening periods, voice signals from the radio receiver are brought into the local remote control through terminal A of P1901, terminals 5, 7 and 8 of S1902, section 2, rear (LOCAL or REMOTE), and developed across winding 7–9 of T1901. The signals are induced in windings 1–2 and 3–4 of T1901 and applied to the telephone lines through L1 and L2. The audio signals enter field remote control, are developed in the primary windings, induced in the secondary windings of T2001, and applied to the phones from phone winding 7–9 of T2001.

(5) CW KEYING CIRCUIT. — During cw keying at field remote control, SERVICE selector switch S2002 is placed in the CW position. The negative terminal of BT2003 (45-volt dc) is connected to line L2 through switch S2002, current limiting resistor R2002, and winding 3–4 of transformer T2001. The positive terminal of BT2003 is connected to line L1 through switch S2002 the push-to-talk switch, contacts 2 and 3 of ringer G2001, and winding 1–2 of T2001. Switching S2002 from am. to cw operation reverses the polarity of battery BT2003 being applied to lines L1 and L2. Note that the telephone line must be polarized for proper cw operation, because local remote control contains a polarized latching relay K1902 which will latch closed with the first pulse of the telegraph key. Closing contacts 4–6 of K1902 turns on the dynamotor by completing the circuit of the ground return through terminals 2 and 4 of S1903 section 2, rear (CW/FSK), and terminals 3 and 4 of S1902, section 2, rear (REMOTE). The dynamotor will remain on until the field operator reverses the polarity of the control voltage to unlatch relay K1902. This is done by switching S2002 to the AM position and pressing the key once. Momentarily depressing FSK switch S2003 on the field remote control front panel will also latch or unlatch relay K1902, depending on the position of S2002 (CW or AM).

Closing the key in field remote control completes the control voltage circuit to the L1 side of the line. Relay K1903 is a high-speed sensitive keying relay located in local remote control. It is energized by the control voltage and follows the keying at field remote control. In the de-energized position (key-up), the armature terminals 5, 6 (ground) of relay K1903 are connected to contact 4a disconnect position. In the energized position (key down), ground is connected to the cw key control of the transmitter through contacts 5, 6 and 7 of K1903, terminals 11 and 12 of S1902, section 1, rear, and terminal K of P1901.

(6) FSK (TELETYPE) OPERATION. — When a separate teletype (fsk) system is connected to the transmitter by means of a separate loop, field remote control can be used to turn the dynamotor on and off by reversing the polarity of battery BT2003 with switch S2002 (CW and AM), and depressing momentary FSK switch S2003 to complete the circuit.

(7) MONITORING. — When local remote control has control of the transmitter during am. operation (S1902 in LOCAL and S1903 in AM position), the field remote control operator cannot hear the local operator, but can talk to him at any time.

SECTION 6
PREVENTIVE MAINTENANCE

6-1. INTRODUCTION.

Preventive maintenance consists of periodical electrical and mechanical checks and corrective measures taken to keep the radio set and vehicular electrical system in good working condition. Preventive maintenance is intended to keep major breakdowns and interruptions in service to a minimum, by anticipating and correcting minor troubles.

Personnel must become thoroughly familiar with operating conditions so that they will readily detect abnormal indications during periodic inspections of the equipment.

Two types of preventive maintenance are covered in this section: periodic visual inspection (routine maintenance) and functional inspection (system operation). Regular visual inspection of the equipment should be made for dirt, moisture, corrosion, and loose connections which may affect proper operation. Periodic cleaning and proper lubrication will reduce mechanical failures. Functional inspections are accomplished by observing the radio set and vehicular generator system in operation during periodic transmission and reception of test messages.

One of the objectives of periodic functional checks is to note when some phase of the equipment approaches marginal operation. For instance, if the readjustment of a control restores proper function, but the setting of the control for this condition approaches the extreme end of its range, a marginal operating condition is indicated. A possible cause of such a condition is a tube or component part that is outside of tolerance due to aging. The cause of marginal setting of controls should be determined and the condition corrected.

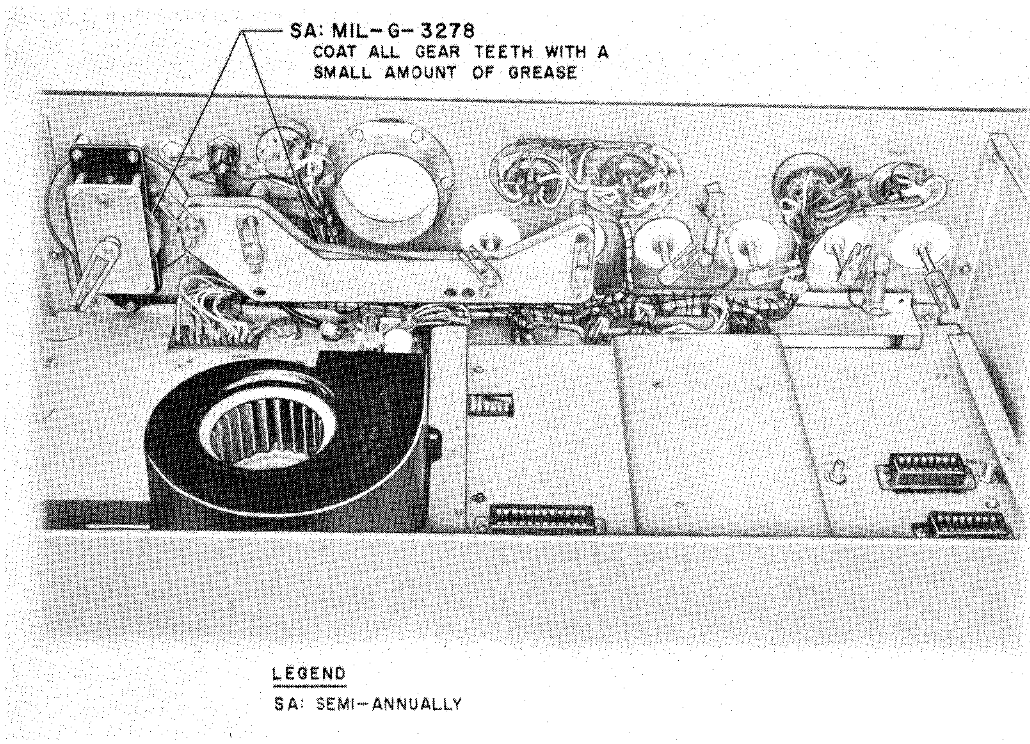


Figure 6-1. Transmitter Main Chassis, Lubrication

TABLE 6–1. ROUTINE MAINTENANCE CHECK CHART

Note

The attention of maintenance personnel is invited to the requirements of chapter 67 of the Bureau of Ships Manual, of the latest issue.

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
	DAILY	
Ventilation.	Check that all ventilating louvers are open and that blowers are operating.	Do not operate radio set without proper ventilation.
Over-all operation of radio set.	Operate radio set according to section 4, and check for normal operation as indicated in table 6–2.	Start vehicular engine before operating radio set (dc only).
Dial lights.	Operate DIAL DIMMER controls on all units.	Replace lamp or fuse as necessary, If fuse burns out a second time, refer to section 7.
Spare fuses.	Check spare fuse holders for missing fuses.	Replace missing spare fuses.
Accessory equipment.	Check condition of accessory equipment in accessory cabinet.	Repair or replace accessories suspected of poor performance.
	WEEKLY	
Exterior items.	Inspect whip antennas for eccentricities, loose fit, corrosion, or damaged insulators.	Readjust, repair or replace, as necessary.
	Remove dirt, moisture and mildew from antennas, accessory equipment, jacks, plugs, carrying bags, straps and panels of units.	Clean with cloth, and drycleaning solvent P–S–661B. Replace worn or torn bags and straps.
	Inspect controls for binding, looseness, misalignment and backlash.	Repair or replace, as necessary.
	Inspect cabinets and mountings for looseness, rust and corrosion.	Tighten screws, bolts and nuts carefully. Remove rust and corrosion with sandpaper and repaint.
	Inspect cables, wires, and shock mounts for cuts, breaks, fraying and deterioration.	Repair or replace, as necessary.
	Check that interconnecting cables between units are secure.	Replace defective cables.
Vehicular batteries.	Inspect batteries for dirt, loose terminals, electrolyte level, specific gravity, damaged cases, shorts or dead cells.	Clean or repair, as necessary. Replace defective or damaged batteries.
Vehicular generator system.	Inspect vehicular fan belts for proper tension.	Tighten, if necessary.
	CAUTION Shut off all power before performing the interior checks on the radio set.	
Interior items.	Inspect electron tubes for loose envelopes, loose caps, connectors, cracked sockets, poor socket spring tension.	Replace defective parts.
	Inspect fixed resistors and capacitors for discoloration, bulges and blistering.	Replace suspected components.
	Inspect variable capacitors for dirt, moisture, loose mountings, etc.	Clean carefully with dry compressed air, and/or a dry brush.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
Interior items (Cont'd)	Inspect contacts of switches, relays and connectors for corrosion, loss of tension and loose mounting nuts.	Clean, burnish or tighten, as required. Use drycleaning solvent P-S-661B for cleaning of contacts.
	Inspect transformers, chokes, and potentiometers for overheating. Clean and tighten connections.	Replace defective parts.
	Check batteries in remote control units.	Replace defective batteries.
	Inspect waterproof gaskets for leaking, and worn or loose parts.	Replace defective parts.
	QUARTERLY	
Dynamotor brushes in Power Supply PP-1711/GRC-14.	Inspect for wear every 100 hours of use or quarterly, whichever occurs first. (Refer to table 6-2.)	Replace, if necessary.
Ribbon conductors in r-f tuner and amplifier-modulator subassemblies of transmitter.	Inspect silver-ribbon conductor for wear by unwinding and winding conductor on coil forms and shorting drum. Use front panel jog switches.	Replace if excessively worn (indicated by small cracks appearing in ribbon).
Electron tubes.	Check tubes for electrical performance.	Replace, if necessary.
Plug-in components; such as relays, subassemblies, etc.	Inspect pins and sockets for dirt or corrosion.	Clean with drycleaning solvent P-S-661B and crocus cloth.
Air filters (intake).	Inspect air filters in power supply and transmitter for excessive accumulation of dust and dirt.	Clean with drycleaning solvent P-S-661B.
	SEMIANNUALLY	
General lubrication.	Examine all moving parts, including gear trains, for binding or dry surfaces.	Refer to lubrication information in paragraph 6-4.
	ANNUALLY	
Radio set over-haul.	Disassemble and clean major units and subassemblies. Repair and replace parts where necessary.	To be performed by authorized maintenance personnel only. (Refer to section 7.)

6-2. ROUTINE MAINTENANCE CHECK.

A practical working schedule is outlined in table 6-1 to aid maintenance personnel in the visual and mechanical inspection of the equipment. It may be found desirable to modify this schedule as experience dictates, depending on the hours of operation and availability of maintenance personnel.

Use a clean, dry, lint-free cloth, or a dry brush to clean away dust and dirt. If necessary, clean the parts with a cloth or brush moistened with drycleaning solvent P-S-661B; then wipe the parts dry with a cloth. For removal of corrosion, use crocus cloth or No. 0000 sandpaper.

Use dry compressed air to remove dust from inaccessible places. Do not use compressed air in the vicinity of speaker cones or meter movements. When using compressed air, always direct the first blast of the air line toward the floor to clear condensed moisture from the line.

CAUTION

When using compressed air, do not use a line pressure in excess of 60 psi. Be careful to prevent mechanical damage from the air blast.

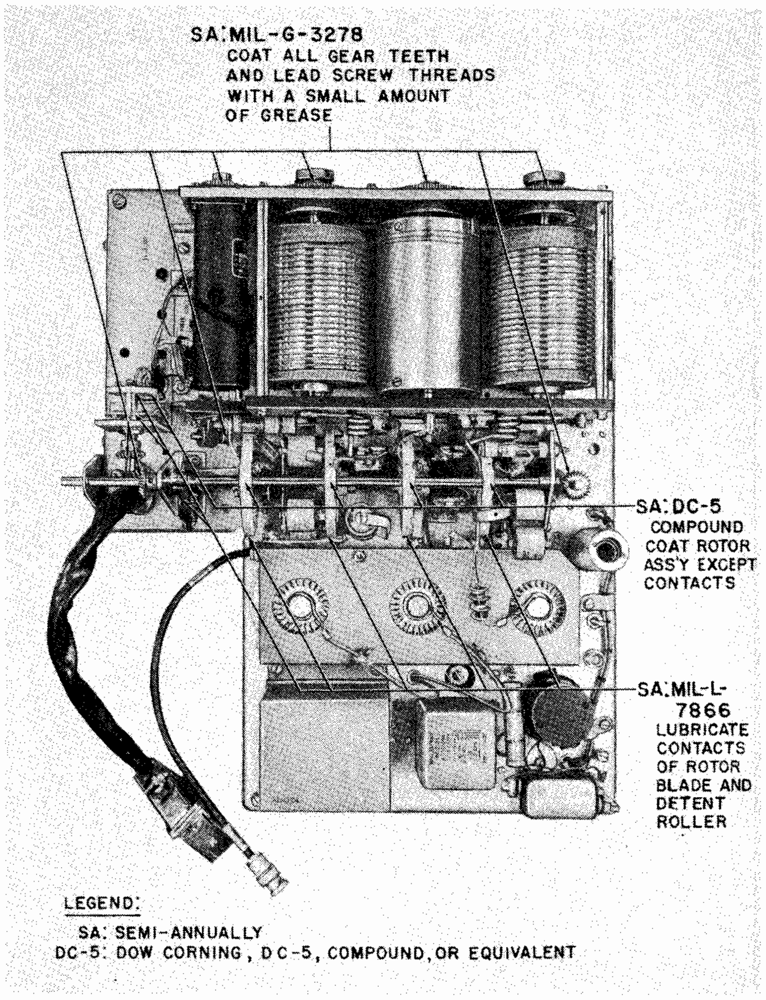


Figure 6–2. Amplifier-Modulator, Lubrication

TABLE 6–2. SYSTEM OPERATION CHECK CHART

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS OR REMEDY
	POWER SUPPLY PP–1711/GRC–14	
Outputs: +250 volt dc regulated, +1100 volt dc, −105 volt dc, +26.5 volt dc.	Use TEST meter on transmitter front panel.	After proper warmup, adjust R1425 on top of power supply chassis for +250 volt dc reading on TEST meter.
Blower operation.	Check louvers for blower operation.	Do not operate the radio set if blower does not operate. (Refer to table 5–3.)
DYNAMOTOR RUNNING TIME indicator.	Read number of hours of dynamotor running time.	Inspect brushes of dynamotor every 100 hours, and record inspections and replacements. (Refer to section 7.)

TABLE 6-2. SYSTEM OPERATION CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS OR REMEDY
	RADIO TRANSMITTER T-631/GRC-14	
Dial lamps.	Dial lamps should be illuminated after 30-second time delay.	DIAL DIMMER control fully clockwise.
Blower operation (two blowers).	Check louvers for blower operation.	Do not operate the transmitter if blower does not operate. (Refer to table 5-3.)
PA cathode current. PA screen current. PA grid current. R-F input to PA.	Use TEST meter on front panel: Ik Ic2 Ig Erf	Compare readings of TEST meter with typical readings. (Refer to table 5-2.)
Position of switch S1207 (WHIP-50 OHMS).	Located on r-f tuner chassis within trnasmitter	With vehicular whip antenna or other high-impedance antenna, S1207 must be in WHIP position; with a low-impedance antenna, S1207 must be in 50 OHMS position and r-f tuner bypassed. (See paragraph 3-18*a*.)
Transmitter operation in all modes of operation for local and remote control and as a relay station.	Make test transmissions according to procedures in section 4, using all four bands. Tune automatically and manually. Use accessories supplied with radio set. Read meters on front panel.	Compare meter readings with typical readings. (If necessary, refer to section 7.)
	RADIO RECEIVER R-808/GRC-14	
Dial lamps on both receivers.	Dial lamp should be illuminated.	DIAL DIMMER control fully clockwise.
Regulated 21-volt d-c supply.	Check voltage on terminal board TB1501, terminal 3, located on r-f head.	Adjust R1564, if necessary. (See paragraph 3-19.)
Receiver tuning in all modes of operation.	Tune both receivers according to section 4, using all four bands. Refer to FREQUENCY TUNE dial and TELETYPE TUNING meter on front panel.	Calibrate, if necessary.
Receiver calibration.	Calibrate each receiver by zero-beating to the transmitter. Use procedure described in section 4.	
	RADIO SET CONTROL GROUP OA-1444/GRC-14	
Function in all modes of operation, remote control of dynamotor, call light and bell operation.	Connect control group by means of one mile of telephone wire. Using procedure in section 4, operate both remote control units.	Check battery voltages under load only. Inspect all batteries. Discard 45-volt battery if terminal voltage is less than 30 volts. Discard dry cells if terminal voltage is less than one volt.
	GENERATOR INSTALLATION KIT MK-366/MRC-55	
Output: 27.5 volts dc.	Observe vehicular voltmeter.	If necessary, adjust VOLTAGE ADJUST rheostat on regulator unit for 27.5 volts.

6–3. SYSTEM OPERATION CHECK.

Table 6–2 lists the functional checks and indications to be observed while operating the radio set. The checks and indications are similar for both a-c and d-c operation.

Energize and operate the radio set according to the procedure in section 4. Record meter readings and indicator positions periodically. Readings taken when trouble appears in the radio set may thus be compared with readings taken when the set is operating properly.

6–4. LUBRICATION.

Oils and greases used for lubricating the radio set are listed in table 6–3 and are catalogued in the Navy Stock List of General Stores, FSC Group 91.

All ball bearings, the mating threads of jacks and plugs on the front panels and interconnecting cables, connector plug locking screws, shaft couplings, mounting screws, panel fasteners and switch detents (ball type) require a thin coating of grease (MIL–G–3278). Cabinet rollers require one drop of oil (MIL–L–7870).

TABLE 6–3. LUBRICANT DATA

ITEM	LUBRICANT	SPEC NO.	STANDARD NAVY STOCK NUMBER
1	Molybdenum Disulfide	MIL–L–7866	
2	Grease, Aircraft and Instrument	MIL–G–3278	WS9150–261–8298 (1-lb can)
3	Lubricating Oil, General Purpose	MIL–L–7870	WR9150–263–3490 (1-qt can)
4	Dow Corning DC–5 Compound		

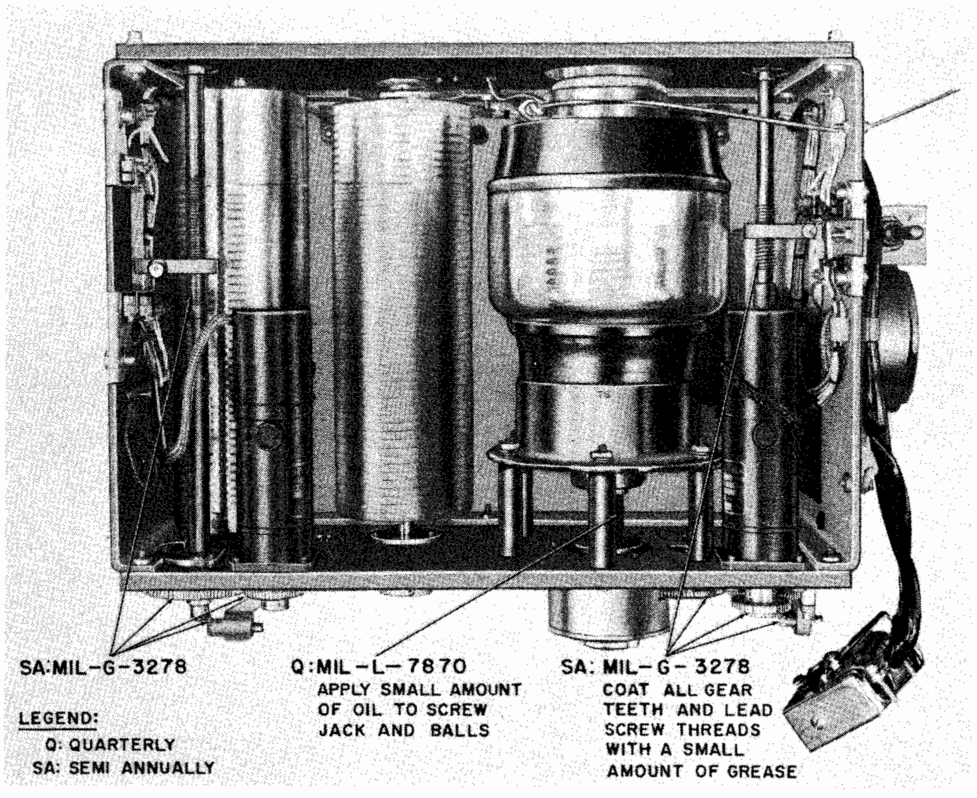


Figure 6–3. RF Tuner, Lubrication

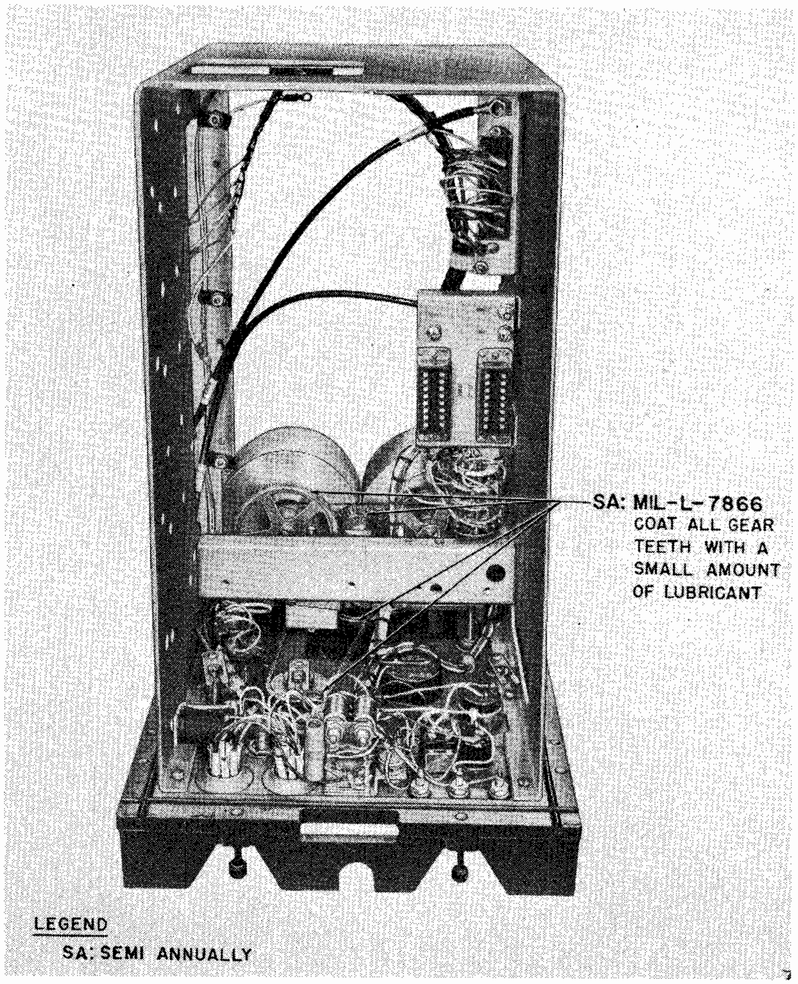


Figure 6-4. Receiver Main Chassis, Lubrication

Note

Clean before lubricating. Do not over-lubricate.

Power Supply PP-711/GRC/14, Radio Set Control Group OA-1444/GRC-14 and Generator Installation Kit MK-366/MRC-55 do not require special lubrication. The alternator unit in the latter is equipped with pre-lubricated neoprene sealed bearings.

a. RADIO TRANSMITTER T-631/GRC-14.—Certain parts of the transmitter are self-lubricated; however, the following subassemblies require lubrication.

(1) MAIN CHASSIS. — Figure 6-1 gives lubrication instructions for vfo dial drive assembly and the rack drive assembly.

(2) AMPLIFIER-MODULATOR. — Figure 6-2 gives lubrication instructions for the gear train, band switch S1002, and the lead screw.

(3) RF TUNER. — Figure 6-3 gives lubrication instructions for the gear trains, lead screws, and ball bearing screw jack.

b. RADIO RECEIVER R-808/GRC-14. — Some parts of the radio receiver are self-lubricated; however, all gear teeth of the dial drive assembly, the bandswitch sprocket, and chain in the receiver main chassis require lubrication (figure 6-4).

NOTES

SECTION 7
CORRECTIVE MAINTENANCE

FAILURE REPORT

Report each failure of the equipment, whether caused by a defective part, wear, improper operation, or an external cause. Use ELECTRONIC FAILURE REPORT form DD787. Each pad of the forms includes full instructions for filling out the forms and forwarding them to the Bureau of Ships. However, the importance of providing complete information cannot be emphasized too much. Be sure that you include the model designation and serial number of the equipment (from the equipment identification plate), the type number and serial number of the major unit (from the major unit identification plate), and the type number and reference designation of the particular defective part (from the technical manual). Describe the cause of the failure completely, continuing on the back of the form if necessary. Do not substitute brevity for clarity. And remember—there are two sides to the failure report—

YOUR SIDE

Every FAILURE REPORT is a boost for you:

1. It shows that you are doing your job.
2. It helps make your job easier.
3. It insures available replacements.
4. It gives you a chance to pass your knowledge to every man on the team.

BUREAU SIDE

The Bureau of Ships uses the information to:

1. Evaluate present equipment.
2. Improve future equipment.
3. Order replacements for stock.
4. Prepare field changes.
5. Publish maintenance data.

Always keep a supply of failure report forms on board. You can get them from the nearest Forms and Publications Supply Distribution Point.

7-1. INTRODUCTION.

The information contained in this section covers procedures and instructions for trouble location, repair, and alignment of all major components in Radio Set AN/MRC-55.

Maintenance personnel must be prepared to repair and restore the equipment to normal operation. The trouble must be determined and localized as quickly and accurately as possible and, further, the cause of the trouble must be determined so that recurrence of equipment failure may be prevented. When repairs or replacements are made, every attempt should be made to duplicate the original condition of the equipment. Standard replacement parts should always be used.

Emergency repairs should be used on a temporary basis only, with every effort made to restore the equipment to its original condition at the earliest possible opportunity.

7-2. THEORY OF LOCALIZATION.

When the radio set operates incorrectly or fails to operate, the source of trouble should be located as quickly as possible by a systematic troubleshooting procedure. The troubleshooting procedure most effective for locating troubles involves a process of elimination commonly referred to as localization. The first step in trouble localization is to trace the fault to the functional operating group responsible for the abnormal operation or failure of the equipment. In this case, the first step is to determine whether the transmitter, receiver, power supplies, or control set is at fault. The second step is to localize trouble within a major unit and isolate the faulty subassembly within that unit. The final step is to find the defective part or parts in the circuit.

7-3. TROUBLESHOOTING AND REPAIR, GENERAL.

This part of the corrective maintenance section contains general instructions for maintenance personnel. Detailed instructions for corrective maintenance are outlined separately for each functional operating group.

The principal units of Radio Set AN/MRC-55 equipment are mounted in four equipment cabinets. Most of the units mounted within these cabinets are removable plug-in subassemblies using printed wiring. All interconnecting cables enter the cabinets via front panel connectors.

a. OVERALL TROUBLESHOOTING PROCEDURES.—Troubleshooting procedures should be accomplished in a logical manner. The equipment has various modes of operation. Therefore, troubles can often be located by attempting operation on the different modes, thus localizing trouble to specific groups of subassemblies. Front panel meters should be observed and the troubleshooting charts (tables 7–2, 7–3, 7–4, 7–7, and 7–8) consulted as further aids in localizing trouble. Standard troubleshooting procedures outlined in NAVSHIPS 91828, Handbook of Test Methods and Practices, should be followed.

For corrective maintenance, the standard Navy-type test equipment (or equivalent) listed in table 7–1 will be required. For overall troubleshooting, refer to table 7–2.

TABLE 7–1. TEST EQUIPMENT REQUIRED FOR CORRECTIVE MAINTENANCE

TEST UNIT	REQUIRED CHARACTERISTICS	RECOMMENDED TYPE
Multimeter (vtvm)	Measure ohms, ac-dc volts, current, rf voltages of 455 kc to 45 mc range.	ME–26/U, H.P. 410B
Vacuum tube voltmeter (ac)	Measure rf voltages of 2 to 30 mc range.	ME–6/U
RF signal generator	455 kc to 45 mc range.	AN/URM–25
Sweep generator	1.5 to 4 mc sweep.	SG–92/U
Frequency counter	455 kc to 45 mc range.	AN/USM–26
Oscilloscope		DuMont type 304A or OS–8A/U
AF signal generator	20 cps to 20 kc range.	LAJ series
Dummy load	600 ohms, 2 watts 50 ohms	DA 91/U
Megger	0.1 to 10,000 megohms, 500-volt test	
Adapter set		49416, 49598, 49992
Dummy antenna	2–8 mc: 5 ohms in series with 80 μμf. 8–16 mc: 40 ohms in series with 300 μμf. 16-32 mc: 250 ohms.	
Microammeter	50–0–50 scale	M1302, M1501

b. MAINTENANCE OF PRINTED WIRING CIRCUITS.—All subassemblies in the transmitter, with the exception of the keyer group and rf tuner, use printed wiring. The receiver uses printed wiring in the if amplifier and the fs converter subassemblies. Power Supply PP–1711/GRC–14 also uses printed wiring to a small degree.

(1) GENERAL.—Troubleshooting of printed circuits is similar to troubleshooting of conventional wired circuits. Since the printed boards are translucent, a 60-watt light bulb can sometimes be placed underneath the side being traced to facilitate locating the connections or open circuits. In some cases, a magnifying glass will assist in locating very small breaks in the wiring. Resistance or continuity measurements of coils, resistors, and capacitors can be made from either side of the board. However, on the wiring side of the board two needle point probes should be used since the lacquer coating must be broken through to make contact.

(2) PRECAUTIONS.

(a) When removing components from the board, be careful to prevent damage to the printed wiring.

(b) Do not apply excessive pressure to the printed circuit board.

(c) Avoid overheating the printed wiring and component terminals. Excessive heat applied by a conventional high-wattage soldering iron or gun may cause the bond between the board and the wiring to break. It is advisable to use a low-wattage (20 to 50 watts) soldering iron to repair printed wiring boards.

(3) TOOLS AND EQUIPMENT.

(a) Solder (type 60/40 with resin core).

(b) Soldering iron (20 to 50 watts).

(c) Lacquer (silicon resin or plastic spray, Krylon or equivalent).

(d) Solvent (methyl alcohol).

(e) Cloth.

(f) Solder pick.

(g) Small wire brush.

(h) Penknife.

(4) REMOVAL OF PRINTED WIRING BOARDS.—It will seldom be necessary to remove the printed board from the subassembly. In most cases, access to the underside is possible without removing the printed board. If removal is necessary, unsolder all connections to the printed board (after identifying the leads and their terminations) and remove the screws securing the board to the subassembly.

(5) REPLACEMENT OF COMPONENTS.—Removal of components such as small resistors and capacitors, that leave a portion of the lead wires exposed between the wiring board and component body, may be accomplished by clipping the leads next to the body. This leaves small wire terminals to which new components may be soldered. If the leads are not long

enough, cut the defective component in half. Then cut through each half until it is broken away from its leads. By this means, sufficient lead length from inside the component will be gained. To install the replacement part, wrap one turn of each lead around each wire terminal (left after removing the old component) and solder the connection.

It may be desired to remove one or both leads of a component from the board without cutting the leads. This is done when the component is to be tested. To do this, heat the connection on the underside of the board with a low-wattage soldering iron. When the solder melts, brush it away with a small wire brush and solder pick. Do not overheat the connection. It may require more than one heating to remove all of the solder, but caution must be taken to avoid excessive heating. Do not leave the iron on the connection while brushing away the solder. Melt the solder, remove the iron, and quickly brush the melted solder away. Then insert a knife blade between the wiring foil and the bent-over component lead and bend the lead perpendicular to the board. While applying the iron to the connections, wiggle the lead until it breaks free while the solder is still molten. Clear the area of any scattered solder, using a cloth and solvent such as methyl alcohol. To reinstall the component, bend over the ends of the component leads against the wiring foil and then resolder the connection with 60/40 low-temperature resin core solder.

Note

It is recommended that new connections be coated with silicone-resin lacquer or a plastic spray for protection against shorts.

(6) REPAIR OF PRINTED WIRING.—Small breaks in the wiring can be filled in with molten solder. Larger breaks can be jumped with ordinary hook-up wire.

TABLE 7-2. RADIO SET AN/MRC-55 OVERALL TROUBLESHOOTING CHART

TROUBLE	SYMPTOMS	PROBABLE CAUSE	CORRECTIVE ACTION
Transmitter or receivers inoperative.	Dial lights not lit with DIAL DIMMER controls fully clockwise.	No input power.	Refer to table 7-4.
Transmitter and receiver No. 1 inoperative.	Unable to tune transmitter. No reception on receiver No. 1; normal reception on receiver No. 2.	Faulty antenna or transmission line.	Inspect connectors for deterioration. Use an ohmmeter to take continuity check. Take a megger reading on transmission line.
Transmitter inoperative.	No indication on R-F LINE meter.	Faulty transmitter or power supply.	Refer to table 7-3.
Transmitter output erratic after being tuned.	TUNE and LOAD meters on front panel erratic.	Malfunction of rf tuner resulting from dust on shorting drum. Poor contact between ribbon conductor and shorting drum.	Clean shorting drum with dry cleaning solvent (P-S-661B).
Operation not possible from local remote control.	No reception or transmission on handset at local remote control; operation normal at receptacles on transmitter.	Faulty local remote control. Faulty handset.	Check continuity of circuits in local remote control. Check or replace handset.
Operation not possible from local or field remote controls.	No reception or transmission at either remote control; operation normal at receptacles on transmitter.	Faulty remote control.	Check interconnecting cables. Refer to table 7-8.
Operation not possible from field remote control in either AM, CW/FSK or TEL.	No reception or transmission at field remote control; operation normal from local remote control.	Faulty field remote control.	Check interconnecting cables. Refer to table 7-8.
No re-transmission of received voice signals with NORMAL REMOTE-RELAY switch on transmitter at RELAY position.	Radio set inoperative.	Receiver squelch circuit operating improperly.	Adjust R-F GAIN SQUELCH control in accordance with section 4.

c. MAINTENANCE OF TRANSISTORIZED CIRCUITS.

(1) GENERAL.—Transistors are generally more rugged mechanically than vacuum tubes. However, they are still comparatively easy to damage by improper treatment or electrical overload. Precautions must be observed which are not normally necessary with vacuum tube circuits.

(2) PRECAUTIONS AND TESTING.—Take care when replacing transistors. Do not overheat transistors or their leads, since excessive heat can easily cause permanent damage. Use a soldering iron of the lowest wattage available. The transistor lead being soldered or unsoldered should be grasped gently with a long nose pliers between the soldering iron and the transistor to help dissipate the heat.

The most effective way of determining whether a transistor is defective is to replace it. However, this technique should only be used after it has been determined that there are no other circuit defects. When testing, a transistor can be easily damaged by application of improper voltages; therefore, an ohmmeter should never be used to check transistors. Damage to the transistor will result from placing the wrong polarity ohmmeter probes on the transistor terminals. A transistor should first be removed from the circuit if it is necessary to check any of its associated components with an ohmmeter. Only voltage measurements should be taken at the transistor terminals.

A defective transistorized stage will usually be located by an incorrect voltage at the transistor terminals. The incorrect voltage will usually be caused by a defective transistor, a defective component part in the stage (or in the next stage), or by trouble in the power supply.

7–4. TRANSMITTER AND POWER SUPPLY TROUBLESHOOTING AND REPAIR.

(See figures 7–1 through 7–32 and 7–57 through 7–77.)

a. TROUBLESHOOTING PROCEDURES. — The technician should first consult the transmitter troubleshooting chart (table 7–3) and the power supply troubleshooting chart (table 7–4) as troubleshooting aids when a failure occurs in the transmitter. The checks listed in the charts are those which may be made with a minimum of time and test equipment. In many cases, however, the trouble may not be easily localized. In such cases, the technician should adopt a systematic procedure to localize the trouble. (Refer to the schematics and voltage and resistance charts for the respective units.) The following procedures may be used as an aid in troubleshooting the transmitter.

(1) If the transmitter operates on all services except fsk, but there is no vfo stabilization, the trouble will probably be found in the reference oscillator and mixer subassembly or the mixer-stabilizer subassembly. If tube replacement in accordance with table 7–2 does not remedy the trouble, further localization should be performed using a dc voltmeter and a voltmeter capable of measuring rf voltages to 40 mc. The measurements obtained should be compared with the values given in table 7–5 to determine if they are normal.

For convenience, place the SERVICE switch at the NETTING position, which will remove the fixed bias from vfo stage V101, allowing it to operate.

The first step in localizing this trouble is to place the dc voltmeter at TP–J707. The reading (32 volts) will vary, plus and minus, as the VFO ADJ goes through the locked-in range. If no reading is obtained at TP–J707, the trouble will be found in the mixer-

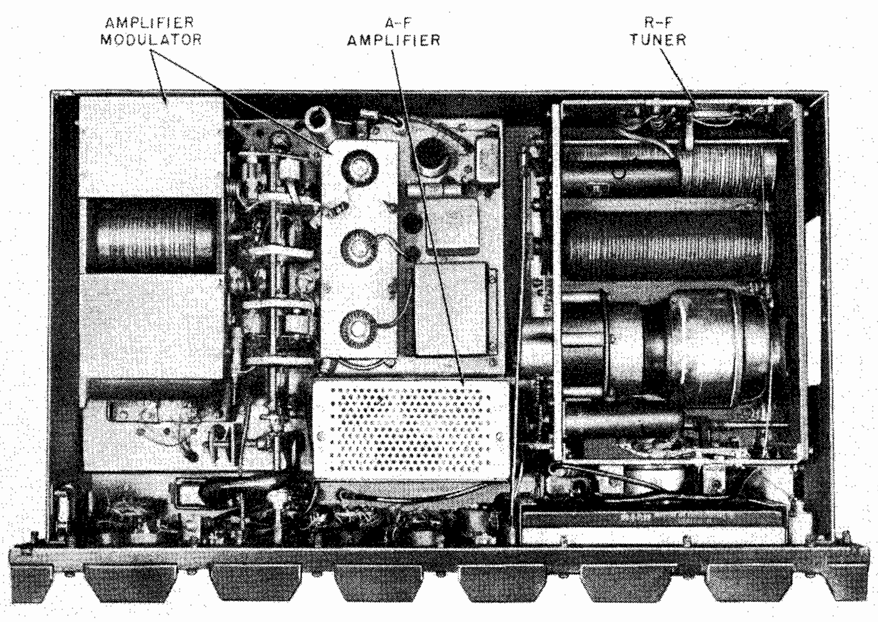


Figure 7–1. Radio Transmitter, Top View

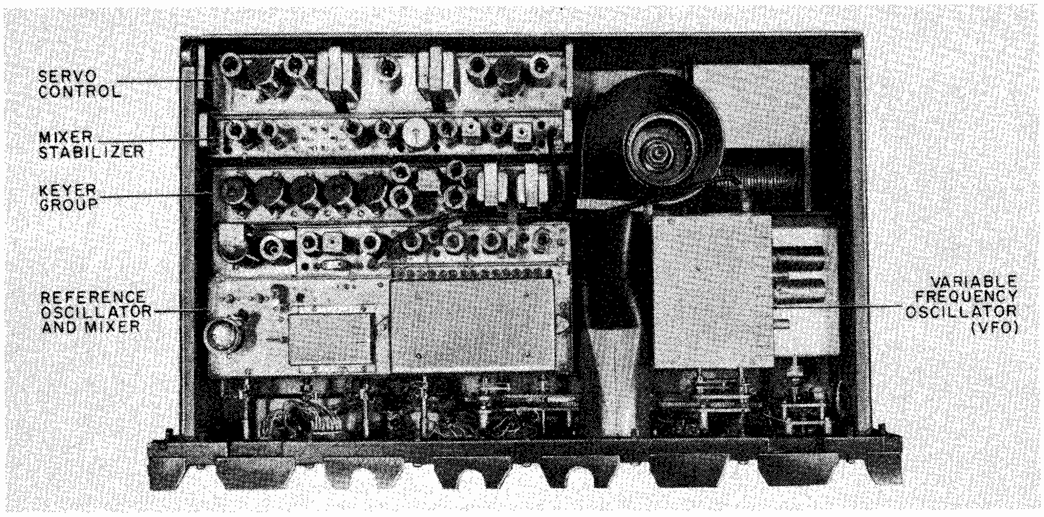


Figure 7-2. Radio Transmitter, Bottom View

stabilizer or reference oscillator and mixer subassemblies. Take rf voltage measurements at TP-J705, TP-J702, and TP-J704. Normal readings at these test points indicate that the reference oscillator and mixer subassembly is not faulty, and the trouble will be found in the mixer-stabilizer. An incorrect reading at TP-J705, TP-J702, or TP-J704 indicates that the reference oscillator and mixer subassembly is faulty.

To isolate a defective stage in the mixer-stabilizer subassembly, measure the rf voltage at TP-J709. If no reading is obtained, the trouble will be found in the V705 or V706 stages. A reading at TP-J709 indicates that the trouble is in the V701, V702, V703, or V704 stages.

Trouble in the reference oscillator and mixer subassemblies can be isolated by the readings obtained at TP-J705, TP-J702, and TP-J704. An incorrect reading at TP-J702 indicates that the V402 stage is faulty. An incorrect reading at TP-J704 indicates that the V401 stage is faulty. An incorrect reading at TP-J705 indicates that the trouble will be found in stages V403, V404, V405, V406, or V407. Refer to table 7-3 as an aid in localizing the particular stage. Readings obtained at test points TP-J404 (V403), TPJ405 (V404), TP-J406 (V405), and TP-J409 (V407) can also be used to locate the defective stage.

(2) If the transmitter is operative on all services except am., the trouble will be found in the af amplifier or amplifier-modulator subassembly. If sidetone is heard when the transmitter is being keyed on cw service, the trouble will be found in the V1103 or V1003, V1004 stages. If the transmitter is inoperative on am. service only, and no sidetone is heard during cw transmissions, the trouble will be found in the V1101 and V1102 stages.

(3) If the transmitter is inoperative for cw, am., and fsk transmissions, it should first be determined if the vfo is operating. Place the TEST meter switch at the Erf position, service switch to CW-TUNE, and key the transmitter. A normal indication eliminates the vfo as the faulty subassembly. If there is no reading on the TEST meter at the Erf position, the trouble may be in the keyer group or the vfo subassemblies. If keyer stages V801 and V802 are operating, the —105 volts bias will be removed from oscillator tube V101 when the transmitter is keyed. Another way of determining if V801 and V802 are operating is to set the service switch to NETTING. If the vfo becomes operative, as indicated on the TEST meter, keyer stage V801 and/or V802 are at fault. If keyer stages V801 and V802 are operating normally, the trouble will be found in the V101 or V102 stage.

If the reading obtained at the Erf position of the TEST meter was normal, the trouble will probably be found in the amplifier-modulator subassembly. Tune the power amplifier stages by placing the TEST meter switch at the Ig position, keying the transmitter, and operating the P.A. jog switch until a maximum reading is obtained on the meter. If it is not possible to obtain a meter reading, or a low indication is obtained, the trouble will be found in the V1001 or V1002 stage.

If the reading obtained at the Ig position was normal, tune the rf tuner by operating the TUNE and LOAD jog switches. The TUNE and LOAD meters initially should read to the left or right of zero and then indicate at zero when the rf tuner is tuned. If there is no indication of the LOAD or TUNE meter when operating respective jog switches, check position of switch S1207 on the rf tuner chassis. With the vehicular whip antenna (or any high-impedance antenna) S1207 must be in WHIP position. When the rf tuner is in tune, the R.F. LINE meter should indicate an output. If the above conditions are not present, the trouble will be found in the rf tuner or in the antenna. Disconnect the transmission line at the transmitter and check continuity to the antenna. In addition, check the transmission line and connectors with a megger. If the antenna and transmission line check satisfactorily, the trouble will be found in the rf tuner. Use an ohmmeter to check the components.

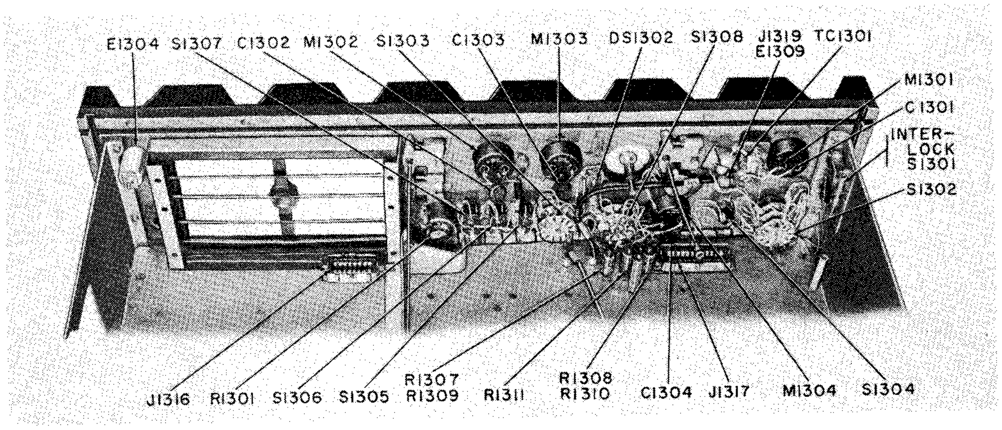


Figure 7–3. Transmitter Main Chassis, Top View

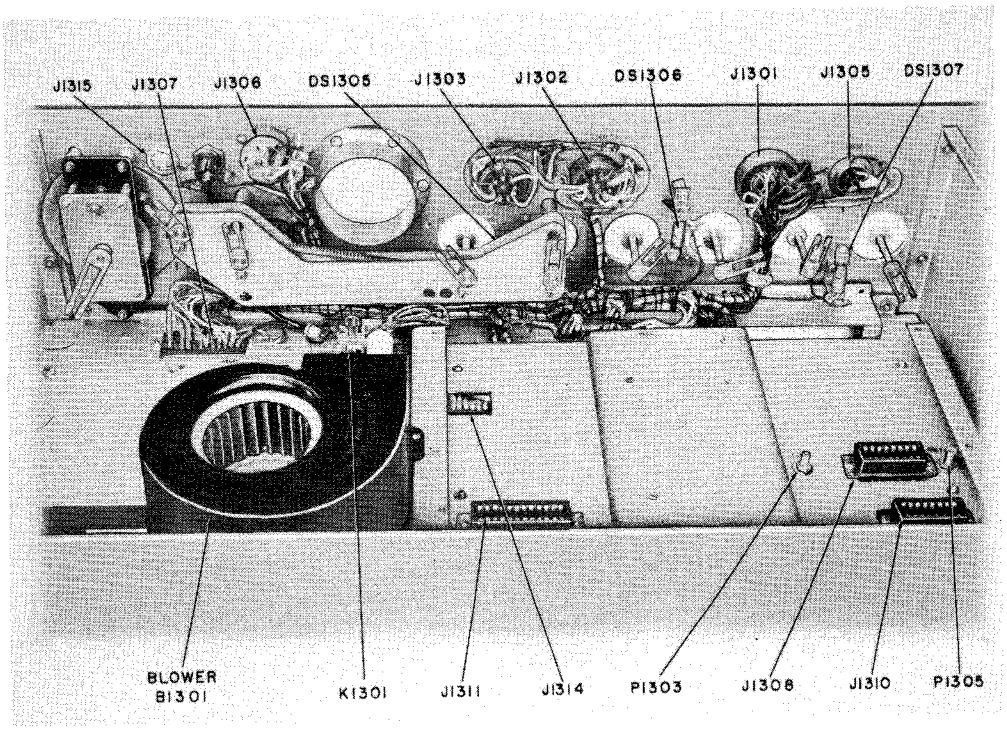


Figure 7–4. Transmitter Main Chassis, Bottom View

b. MECHANICAL ADJUSTMENTS.—The following procedures outline the methods to be followed for removal and repair of transmitter components.

(1) SUBASSEMBLY REMOVAL AND REPLACEMENT.—All transmitter subassemblies may be removed from the main chassis. To obtain access to the subassemblies, loosen the front panel fasteners and remove the main chassis from the cabinet. The subassemblies are uncoupled from the front panel controls when the controls are in their extreme ccw positions. The following procedures should be followed to remove the subassemblies. (See figures 7–1 through 7–4.)

(a) VARIABLE FREQUENCY OSCILLATOR.—The vfo is a plug-in subassembly mounted on the underside of the main chassis. (See figures 7–2 and 7–7 through 7–10.)

Step 1. Turn transmitter main chassis bottom side up.

Step 2. Set 10 MC and 1 MC FREQUENCY SET controls on front panel to their full ccw positions. Rotate VFO ADJ control for dial reading of 100.

Step 3. Disconnect P401 from J102.

Step 4. Loosen four mounting screws securing the vfo to main chassis and gently lift unit to disconnect P101 from J1307. Then disconnect P1307 from J103 and remove unit.

Step 5. To replace vfo in main chassis, reverse removal procedure.

TABLE 7-3. RADIO TRANSMITTER TROUBLESHOOTING CHART

TROUBLE	SYMPTOMS	PROBABLE CAUSE	CORRECTIVE ACTION
No vfo stabilization in the 3 to 10 mc range only.	Unable to obtain off-center deflections on SYNCHRONIZATION INDICATOR by rocking VFO ADJ about the desired frequency. All TEST meter readings normal.	Faulty tube V404.	Replace tube.
No vfo stabilization in the 3 to 10 mc and 20 to 30 mc ranges only.	Same as above.	Faulty tube V405 or V406.	Replace tube.
No vfo stabilization in the 10 to 20 mc and 20 to 30 mc ranges only.	Same as above.	Faulty tube V403.	Replace tube.
No vfo stabilization on any frequency.	Same as above.	Faulty tube V401, V402, V407, V701, V702, V703, V704, V705, or V706.	Replace tube.
No vfo stabilization on any frequency. Unable to tune PA and antenna stages.	Same as above. Also, either no reading or abnormal reading at Erf position of TEST meter.	Faulty tube V101 or V102.	Replace tube.
Same as above.	Same as above. Also, receiver No. 1 reception does not interrupt (or has no decrease in noise level at CW/FSK BROAD position of OPERATION SWITCH) when transmitter is keyed.	Faulty tube V801 or V802.	Replace tube.
Transmitter inoperative.	Dial lights not lit. Blowers not operating.	No input power.	Refer to table 7-4.
Transmitter inoperative.	Incorrect reading at CONT V, BIAS, +250V, or IKV position of TEST meter switch.	Faulty power supply.	Refer to table 7-4.
Transmitter inoperative on am. service only. All other services normal, cw sidetone present.	No indication on TEST meter with switch at the % MOD position.	Faulty tube V1103, V1003, or V1004.	Replace tube.
Transmitter inoperative on am. service only. All other services normal, except for absence of cw sidetone.	No indication on TEST meter with switch at the % MOD position. No sidetone present during cw transmissions.	Faulty tube V1101, V1102.	Replace tube.
Transmitter inoperative on all services.	Either no indication or abnormal indications at the Ig, Ic2, IK, and % MOD positions of TEST meter.	Faulty tube V1001 or V1002.	Replace tube.
Automatic tuning inoperative.	No movement of ANT. LOAD ANT. TUNE and PA TUNE drum counters. All TEST meter readings normal.	Faulty tube V901, V902, V903, V904.	Replace tube.
Automatic tuning inoperative.	No movement of ANT. LOAD and ANT. TUNE drum counters only. All TEST meter readings normal.	Faulty tube V901 or V902.	Replace tube.

TABLE 7–4. POWER SUPPLY TROUBLESHOOTING CHART

TROUBLE	SYMPTOMS	PROBABLE CAUSE	CORRECTIVE ACTION
No input power to both receivers on dc operation only.	Receiver dial light not lit.	Faulty fuse F1402.	Replace fuse.
No input power to both receivers, teletypewriter set inoperative, on ac operation only.	Receiver dial light not lit. Teletypewriter motor not energized.	Faulty fuse F1406.	Replace fuse.
Teletypewriter set inoperative on ac operation only.	Teletypewriter motor not energized.	Faulty fuse F1412.	Replace fuse.
No input power to transmitter on ac operation only.	Transmitter dial lights not lit.	Faulty fuse F1401.	Replace fuse.
Dynamotor and transmitter blowers not operating.	Transmitter dial lights not lit. DYNAMOTOR RUNNING TIME meter reading not changing. No air exhaust at transmitter front panel.	Faulty fuse F1403.	Replace fuse.
Transmitter blowers not operating, transmitter filaments not lit.	Dial lights lit and dynamotor operating.	Faulty fuse F1405.	Replace fuse.
Dynamotor not operating. Power supply filaments not lit.	Transmitter dial lights lit. DYNAMOTOR RUNNING TIME meter reading not changing. Tubes not lit.	Faulty fuse F1404. Power supply cabinet interlock switch S1402 or transmitter cabinet interlock switch S1301 open.	Replace fuse. Properly secure chassis to cabinet.
Dynamotor not operating.	Transmitter dial lights lit, DYNAMOTOR RUNNING TIME meter reading not changing.	Faulty fuse F1407.	Replace fuse.
Transmitter keys continuously; receiver No. 1 inoperative.	No reading at the BIAS position of TEST meter.	Faulty fuse F1410. Faulty dynamotor bias brushes.	Replace fuse. Replace brushes.
Transmitter inoperative.	No reading at the 1KV position of TEST meter.	Faulty fuse F1409. Faulty dynamotor high voltage brushes.	Replace fuse. Replace brushes.
Transmitter inoperative.	No reading at the +250V position of TEST meter.	Faulty fuse F1408.	Replace fuse.

(b) REFERENCE OSCILLATOR AND MIXER.—The reference oscillator and mixer is a plug-in subassembly mounted on the underside of the main chassis. (See figures 7–2 and 7–11 through 7–14.)

Step 1. Turn transmitter main chassis bottom side up.

Step 2. Set all FREQUENCY SET controls on front panel to their full ccw positions

Step 3. Disconnect P401 from J102 and P701 from J408.

Step 4. Loosen four mounting screws that secure subassembly to main chassis and gently lift unit to disconnect P402 from J1308. Then disconnect remaining cables P1303 from J402 and P1305 from J401 and remove unit.

Step 5. To replace reference oscillator and mixer in main chassis, reverse removal procedure.

(c) MIXER-STABILIZER. — The mixer stabilizer is a plug-in subassembly mounted on the underside of the main chassis. (See figures 7-2, 7-15 and 7-17.)

Step 1. Turn transmitter main chassis bottom side up.

Step 2. Disconnect P701 from J408.

Step 3. Loosen two mounting screws that secure subassembly to main chassis and gently lift unit to disconnect P702 from J1309. Then disconnect P1304 from J703 and P1306 from J701 and remove unit.

Step 4. To replace mixer-stabilizer in main chassis, reverse removal procedure.

(d) KEYER GROUP.—The keyer group is a plug-in subassembly mounted on the underside of the main chassis. (See figures 7-2, 7-18 and 7-19.) To remove subassembly, loosen two mounting screws and lift unit out. To replace unit, reverse removal procedure.

(e) AMPLIFIER-MODULATOR.—The amplifier-modulator is a removable subassembly mounted on the top side of the main chassis. (See figures 7-1 and 7-20 through 7-23.)

Step 1. Place SERVICE switch in STANDBY position, and operate MANUAL TUNE P.A. jog switch downward until maximum coil limit is reached and P.A. TUNE counter stops moving. Note reading on counter.

Step 2. Operate ANT. TUNE jog switch to MAX. This will cause the capacitor screw jack in the rf tuner to move inward and leave clearance for removal of amplifier-modulator subassembly.

Step 3. Set BAND switch to 2-3 mc position.

Step 4. Disconnect the three cables between the amplifier-modulator and the main chassis: J1001 from P1308, P1001 from J1317, P1002 from J1319.

Step 5. Remove two screws holding the P.A. TUNE counter flexible coupling to rear of front panel.

Step 6. Loosen six captive screws that secure amplifier-modulator to main chassis and lift subassembly out.

Step 7. To replace subassembly, reverse removal procedure with one exception. Do not replace flexible coupling until tuning coils are back in position. Operate MANUAL TUNE P.A. jog switch in same direction as in step 1. Keep switch operated until limit is reached and motor stops. Make sure that P.A. TUNE counter is at reading noted in step 1. Then replace flexible coupling on counter gear.

(f) SERVO CONTROL.—The servo control is a plug-in subassembly mounted on the underside of the main chassis. (See figures 7-2 and 7-25.) To remove subassembly, loosen two mounting screws and lift unit out. To replace unit, reverse removal procedure.

(g) AUDIO FREQUENCY AMPLIFIER.—The af amplifier is a plug-in subassembly mounted on the top side of main chassis. (See figures 7-1 and 7-27.) To remove subassembly, loosen two mounting screws and lift unit out. To replace unit, reverse removal procedure.

(h) RADIO FREQUENCY TUNER.—The rf tuner is a removable subassembly mounted on the top side of the main chassis. (See figures 7-1, 7-28 and 7-29.)

Step 1. Place SERVICE switch in STANDBY, operate MANUAL TUNE ANTENNA jog switches downward until maximum limits are reached and ANT. LOAD and ANT. TUNE counters stop moving. Note readings on the two counters.

Step 2. Disconnect two cables between the rf tuner and main chassis (P1302 from J1201 and P1201 from J1316); then, disconnect antenna output lead at E1304.

Step 3. Loosen setscrews and remove both ANT. LOAD and ANT. TUNE flexible couplings from shafts near motors B1201 and B1202.

Step 4. Loosen six captive screws that secure rf tuner to main chassis and lift subassembly out.

Step 5. To replace subassembly, reverse the removal procedure with one exception. Do not replace flexible couplings until tuning capacitor and tuning coil are back in position. Operate MANUAL TUNE ANTENNA jog switches in the same direction as in step 1. Keep switches operated until limits are reached and motors stop. Make sure that drum counters are at readings noted in step 1. Replace flexible couplings on motor shafts.

(2) AMPLIFIER-MODULATOR RIBBON CONDUCTOR REPLACEMENT. (Refer to figures 7-5 and 7-20 through 7-22.)

Note

The following instructions apply to each of the coils. The reference numbers on figure 7-5 are shown for replacement of L1004. The numbers also pertain to the applicable parts for L1001 and L1005.

Step 1. Remove amplifier-modulator subassembly from main chassis in accordance with paragraph 7-4 *(b)* (1) *(e)*.

Step 2. Remove three shield covers from coil assembly.

Step 3. Remove three screws mounting coil drive motor B1002, withdraw motor, but do not disconnect motor leads. Tape motor and plug P1001 to base plate to prevent damage during subsequent steps.

Step 4. Unlock knurled knob (1) from shaft (2) of coil form with defective or broken ribbon by loosening two set screws (3). This will permit free rotation of coil form (4) for easy removal of ribbon.

Step 5. Manually rotate metal shorting drum (7), by means of gears, exposing ribbon clamp (5) of defective ribbon. Loosen clamp set screw and remove ribbon.

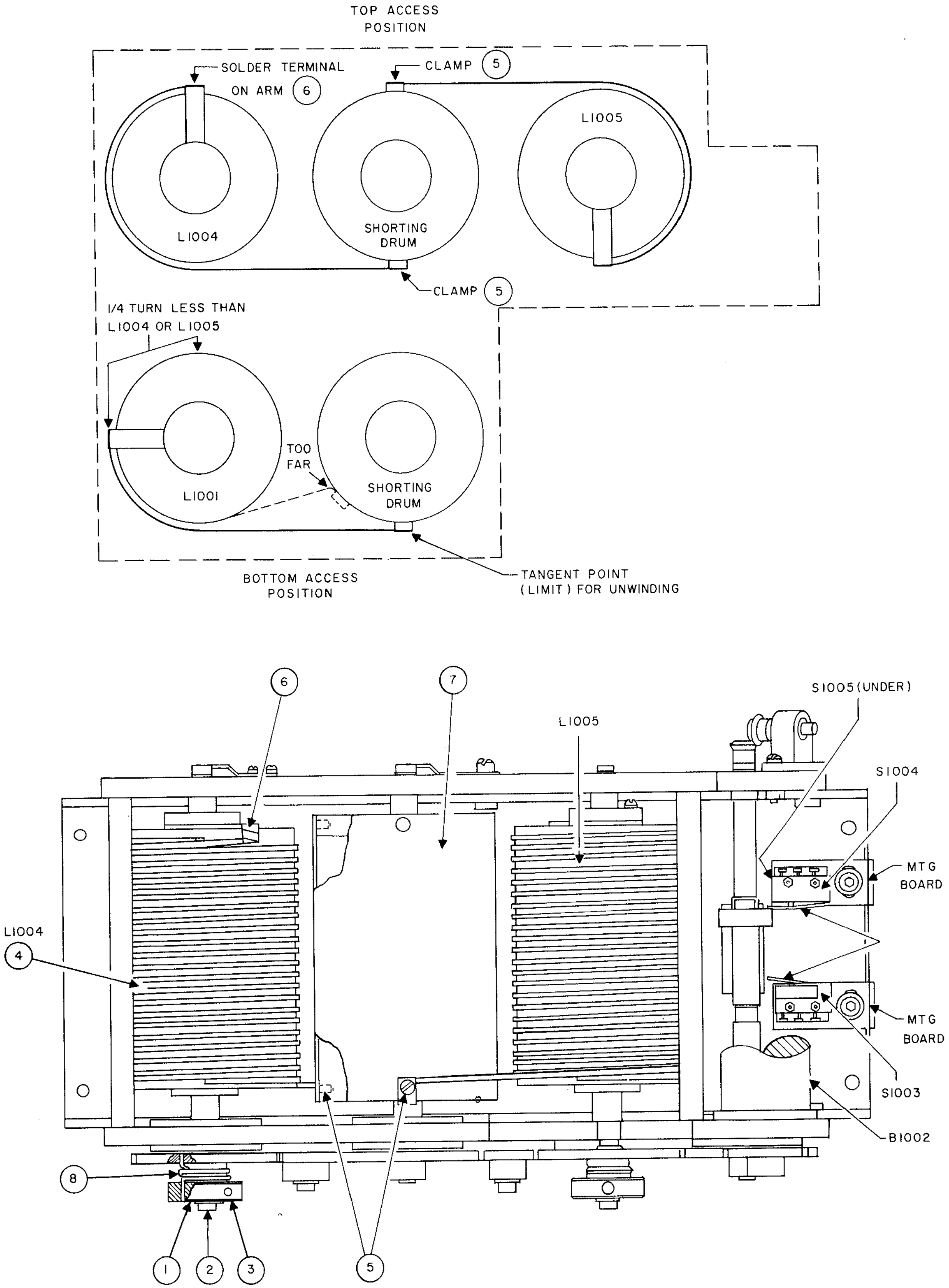


Figure 7-5. Amplifier-Modulator Variable Coil, Assembly Diagram

Step 6. Manually rotate shorting drum assembly in a clockwise direction (viewed from gear train end) until all turns of remaining two ribbons are unwound from metal shorting drum.

CAUTION

Unwind the ribbon with caution so as not to go beyond the limit (ribbon tangent to shorting drum). If this point is passed, a kink will be put in ribbon at the point of fastening (5), thus weakening it.

When a ribbon is to be replaced on L1004, clamping screw (5) is not accessible with zero turns for L1001, L1005 on shorting drum; therefore, it will be necessary to rotate shorting drum 180 degrees in a ccw direction. This will add 1/2-turn of ribbon on shorting drum for L1001 and L1005 and will make accessible clamping screw (5) on shorting drum for L1004. (See figure 7-5.)

Step 7. Secure drum assembly with tape to prevent further movement. Coil form to be wound with new ribbon must be left free to rotate.

Step 8. Hook and solder new ribbon to lug on arm (6) of coil form making sure that the ribbon will lie in proper direction for winding. (See figure 7-5.) Hold ribbon taut and wind it on coil form by rotating coil, causing ribbon to wind in grooves. Be sure to maintain tension by holding form securely until tightening of knurled knob (step 9). Wind coils as follows:

L1001 ...... 22-1/4 turns
L1004 ...... 22-1/2 turns
L1005 ...... 22-1/2 turns

When winding L1004, 22 turns will be on coil form and 1/2 turn will be on shorting drum, with ribbon clamp (5) in accessible position.

Note

Notice the position of the solder terminals (6) on the arm of L1004 and L1005. They must be located as shown in figure 7-5. In addition, L1001 must have 1/4 turn less than L1004 and L1005.

Step 9. After winding, clamp ribbon to drum (7) with screw (5). Cut off excess ribbon, leaving approximately two inches to permit more precise adjustment later, if required. Temporarily, secure ribbon with tape to prevent loosening and groove jumping.

Step 10. Continuing to maintain position of newly wound coil form, adjust tension of spring (8) by turning knurled knob (1) approximately one full turn in a ccw direction. Lock knob on shaft by tightening two set screws (3).

Step 11. Check number of turns and angular position of solder terminals on arm (6) on each coil form in accordance with figure 7-5. If adjustment is necessary, hold free end of ribbon at shorting drum with a pair of pliers and loosen clamp screw (5). Add or remove ribbon to attain desired position of solder lug terminals. This is done so that L1001, L1004, and L1005 will track properly. Cut off excess ribbon at clamping screw (5).

Step 12. Replace motor B1002; this will lock gear train. Then remove all tape.

Step 13. Use clip leads to connect terminals 1, 5, 8 of connector P1001 in amplifier-modulator with terminals 1, 5, 8 of connector J1317 in transmitter main chassis. Connect P2101 from power supply to J1301 on transmitter front panel. Turn on power and place SERVICE switch to STANDBY.

Step 14. Operate MANUAL TUNE P.A. jog switch, on transmitter front panel, to check for proper operation of limit switches S1003, S1004, and S1005 on amplifier-modulator. See paragraph 7-4 *b* (3). Extreme caution must be exercised in operation of jog switch until it has been determined that limit switches are properly adjusted or damage to ribbons may occur.

Step 15. After adjustment of limit switches, P.A. TUNE counter should read 000 at the point where maximum "L" limit switch S1005 operates, as evidenced by no further coil movement. If necessary, adjust counter by removing flexible coupling at amplifier-modulator end and turning gear to change counter reading.

Step 16. Replace three shield covers on amplifier-modulator and replace subassembly in transmitter main chassis in accordance with step 7 of paragraph 7-4 *b* (1) *(e)*.

(3) AMPLIFIER-MODULATOR MOTOR LIMIT SWITCH ADJUSTMENT. (Refer to figure 7-5.)—Minimum "L" limit microswitch S1003 and maximum "L" switch microswitch S1005 should actuate between two turns maximum and one turn minimum from the ends of the ribbons. Actuation of the switches deenergizes motor B1002. Microswitch S1004, the "autotune start rf coil" switch, should actuate before S1005 operates. This should occur within 1/4 turn of maximum inductance (coil form full).

CAUTION

Place SERVICE switch at the STANDBY position before performing this adjustment.

The microswitches are located on movable mounting boards. The boards can be moved by loosening their mounting screws. Position the S1003 mounting boards so that S1003 actuates when there is between two turns and one turn of ribbon remaining on the coils. Position the S1004-S1005 mounting board so that S1005 actuates when there is between two turns and one turn of ribbon remaining on the metal drum. Switch S1004 should be made to actuate 1/4 turn of maximum inductance before S1005. This is done by loosening the hex head screw of the eccentric cam, located on the traveler, and positioning the cam so that it will actuate S1004 at the desired moment.

(4) RF TUNER RIBBON CONDUCTOR REPLACEMENT. (Refer to figures 7-6, 7-28, and 7-29.)

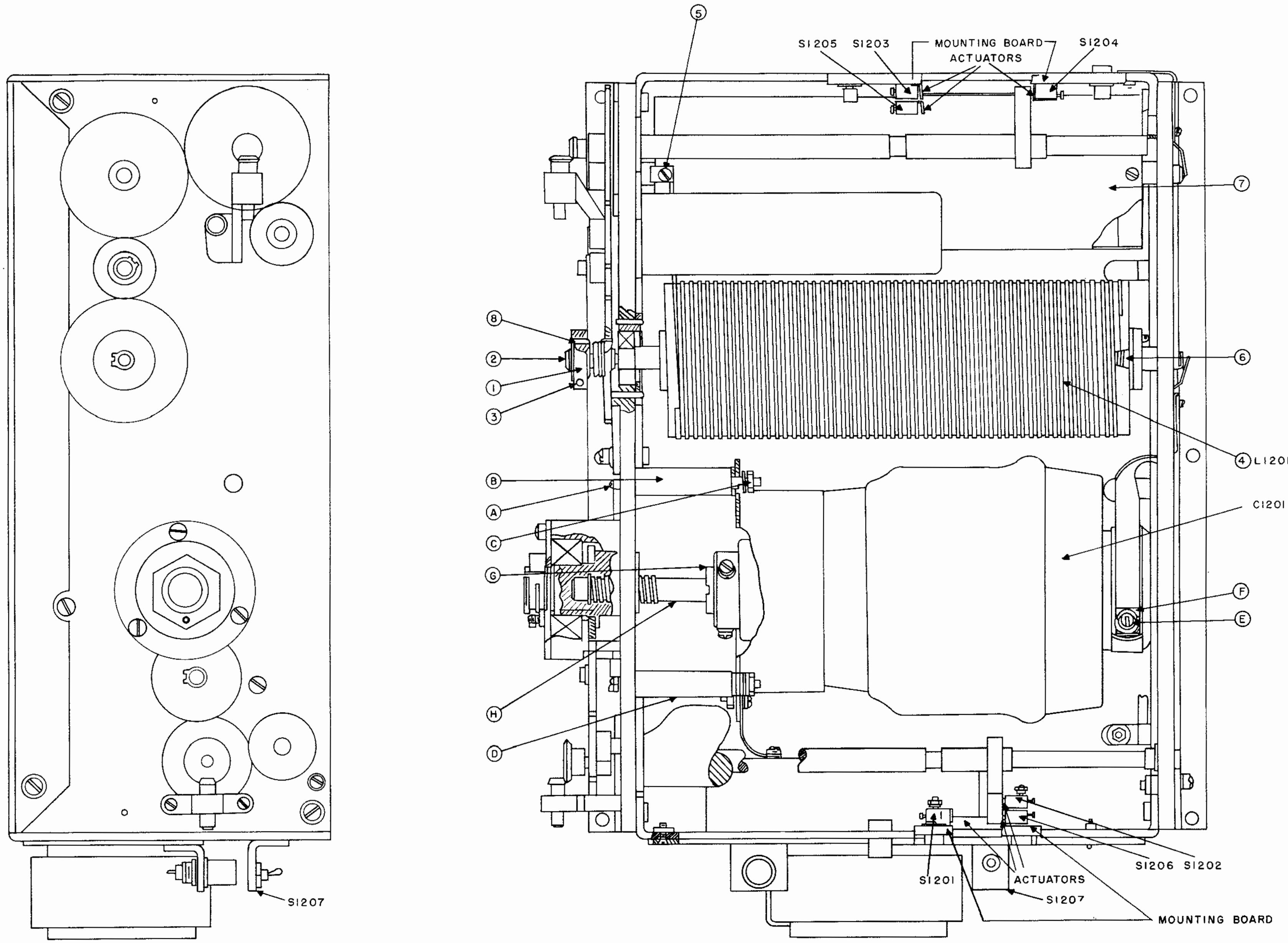


Figure 7–6. Radio Frequency Tuner Variable Coil and Capacitor, Assembly Diagram

Step 1. Remove rf tuner from main chassis in accordance with paragraph 7–4 *b* (1) *(h).*

Step 2. Remove three screws mounting coil drive motor B1202, withdraw motor but do not disconnect motor leads. Tape motor to outside of unit to prevent damage during subsequent steps.

Step 3. Loosen two set screws (3) on knurled knob (2). This will unlock knob and permit free rotation of L1201 coil form for easy removal of defective ribbon.

Step 4. Manually rotate metal shorting drum (7) just enough to expose ribbon clamp (5). Loosen clamping screw, and remove defective ribbon.

Step 5. Replace coil drive motor B1202 to lock shorting drum in position. Ribbon clamp (5) should be in accessible position.

Step 6. Hook and solder new ribbon to lug on arm (6) of coil form (4), making sure that ribbon lies in proper direction for winding. (See figures 7–6 and 7–29.) Hold ribbon taut and wind it on coil form by rotating coil, causing ribbon to wind in grooves. Wind form fully, then pass ribbon under motor, hook to ribbon clamp (5) of shorting drum, and fasten with clamp screw. Maintain tension of coil form and tape windings to prevent loosening and groove jumping of ribbon. Cut off excess ribbon.

Step 7. Continuing to maintain position of newly wound coil form, adjust tension of spring (8) by turning knurled knob (1) approximately one full turn in a ccw direction. Lock knob on shaft by tightening two set screws (3).

Step 8. Remove all tape, then replace rf tuner subassembly in transmitter main chassis in accordance with step 5 of paragraph 7–4 *b* (1) *(h),* but do not connect flexible couplings of drum counters.

Step 9. Turn on power and place SERVICE switch to STANDBY.

Step 10. Operate MANUAL TUNE-ANTENNA LOAD jog switch, on transmitter front panel, to check for proper operations of limit switches S1203, S1204, and S1205 on rf tuner. See paragraph 7–4 *b* (5). Extreme caution must be exercised in operation of jog switch until it has been determined that the limit switches are properly adjusted or damage to ribbon may occur.

Step 11. After adjustment of limit switches, replace flexible couplings in accordance with step 5 of paragraph 7–4 *b* (1) *(h).*

(5) RF TUNER COIL MOTOR LIMIT SWITCH ADJUSTMENT. (Refer to figure 7–6.)—The procedure to be followed in adjusting microswitches S1203, S1204, and S1205 is the same as the adjustments for S1003, S1004, S1005. The procedures outlined in paragraph 7–4 *b* (3) should be followed, referring to figure 7–6 for component location. S1205 should be made to actuate 1/4 turn before S1203.

(6) RF TUNER VACUUM CAPACITOR REPLACEMENT. (Refer to figure 7–6.)—C1201 is a vacuum capacitor which is made variable by moving one plate in and out of the other plate. The movable plate is driven by a piston which is geared to motor B1201.

Step 1. Drive C1201 to its maximum capacitance position (piston fully in) by operating ANTENNA TUNE jog switch on front panel.

CAUTION

This step must be performed to prevent injury to personnel and damage to capacitor C1201.

Step 2. Deenergize transmitter.

Step 3. From rf tuner front panel, remove five screws (A) holding C1201 to supporting posts (B). Hold nuts (C) with a small wrench or pliers while removing the screws.

Step 4. Loosen three screws (D) at base of C1201.

Step 5. Remove leads from capacitor terminal by loosening screw (E) and removing clamp (F).

Step 6. Hold C1201 level. Hold bushing (G) with a wrench and turn C1201 until it unscrews from screw jack (H).

Step 7. To replace C1201, reverse removal procedure. When replacing C1201 on the bushing, make sure that three screws (D) line up with unthreaded portions of the bushing.

(7) RF TUNER CAPACITOR MOTOR LIMIT SWITCH ADJUSTMENT. (Refer to figure 7–26.)—Minimum "C" limit microswitch S1201 and maximum "C" limit microswitch S1202 should actuate at the extreme in and out positions of the driving piston of capacitor C1201. Actuation of the switches causes motor B1201 to deenergize. Microswitch S1206 (the false sense signal switch) should actuate before the extreme in position of the piston is reached.

CAUTION

Place SERVICE switch at the STANDBY position before performing this adjustment.

The microswitches are located on movable mounting boards, which can be moved by loosening their mounting screws. Position the S1201 mounting board so that S1201 actuates when the capacitor piston is at its extreme out position. Position the S1202-S1206 mounting board so that S1202 actuates when the capacitor piston is at its extreme in position. Switch S1206 should be made to actuate before S1202 by loosening the hex head screw of the eccentric cam, on the traveler, and positioning the cam so that it will actuate S1206 before the traveler actuates S1202.

(8) REFERENCE OSCILLATOR AND MIXER CRYSTAL REPLACEMENT. *(Refer to figure 7–12.)*—All of the crystals used in the reference oscillator and mixer subassembly are plug-in units contained in a common temperature-controlled oven. To replace a crystal, remove the two screws securing the oven cover

TABLE 7–5. TEST POINT MEASUREMENTS

Radio Transmitter			
SUB UNIT	TEST POINT	VALUE (RMS VOLTS)	VALUE (DC VOLTS)
Variable frequency oscillator	TP–J104	4	6.6
Reference oscillator and mixer	TP–J403 TP–J404 TP–J405 TP–J406 TP–J409	4 1.8 2–4 0.7–1–3 0.2–0.8	
Mixer-stabilizer	TP–J702 TP–J704 TP–J705 TJ–J707 TP–J708 TP–J709	18 1.1 0.15–0.18 4 5–13	 32 32–40
Amplifier-modulator	TP–J1002		0

Radio Receiver			
		VALUE (DC VOLTS)	
SUB UNIT	TEST POINT	NO INPUT SIGNAL	APPLIED (Note 2)
Radio frequency head	TP–J1516 TP–J1517	—0.23* —1.1 *	—0.22* —1.45*
Amplifier-power supply	TP–J1515	—0.27*	—0.30*
Intermediate frequency amplifier	TP–J1601 TP–J1602	—0.33* —0.07*	—1.00* —0.12*
Frequency shift converter (af type, receiver serial No. 1 through 115)	TP–J1701 TP–J1702 TP–J1703	—0.93** —0.70** 1.68**	—1.45** —0.70** 1.80**
Frequency shift converter (if. type, receiver serial No. 116 and following)	TP–J1751 TP–J1752 TP–J1753 TP–J1754 TP–J1755	—1.0 ** 0.1 ** 14.6 ** —1.84** —2.37**	—1.06** 0.27** 15.00** —1.96** —2.55**

Note 1. DC measurements taken with Simpson Model 260 meter.

Note 2. Readings taken with output from signal generator applied to J1513. Signal generator tuned to 12 mc, output level of 10 μvolts applied across 50 ohms.

*OPERATION SWITCH at BROAD PHONE, RF GAIN SQUELCH control fully counterclockwise, AUDIO GAIN control fully clockwise.

**OPERATION SWITCH at FSK, PHONE, RF GAIN SQUELCH control fully clockwise, AUDIO GAIN control fully clockwise.

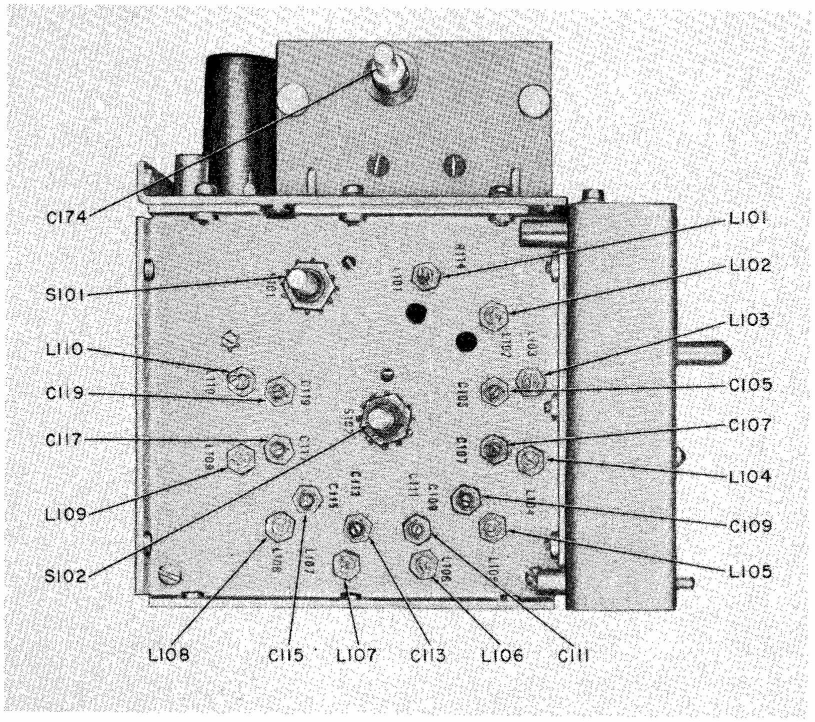


Figure 7-7. Variable Frequency Oscillator, Front View

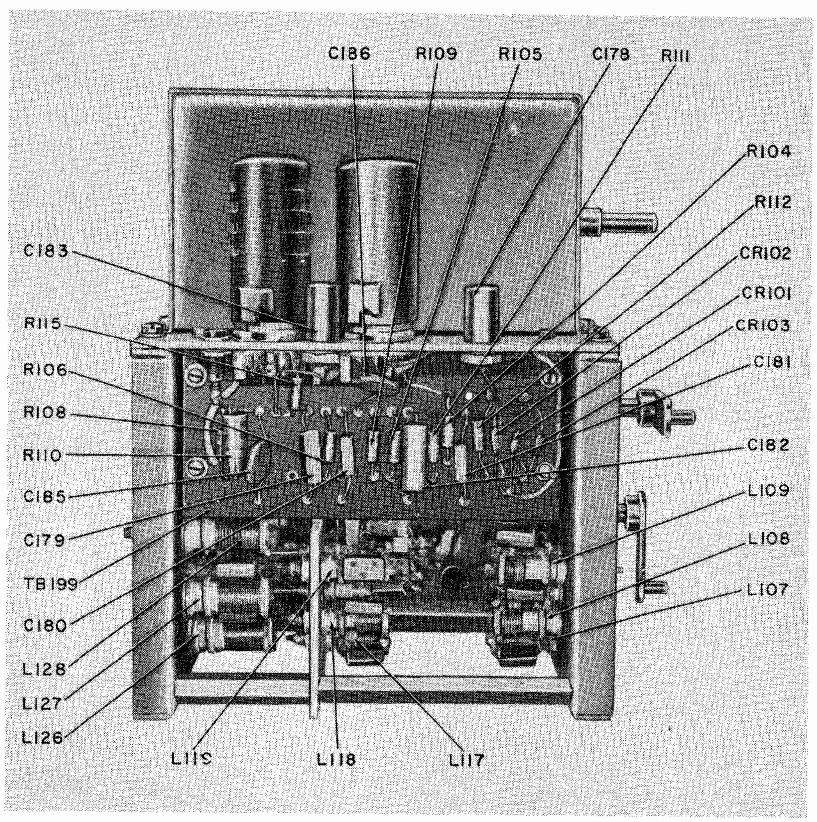


Figure 7-8. Variable Frequency Oscillator, Left Side View

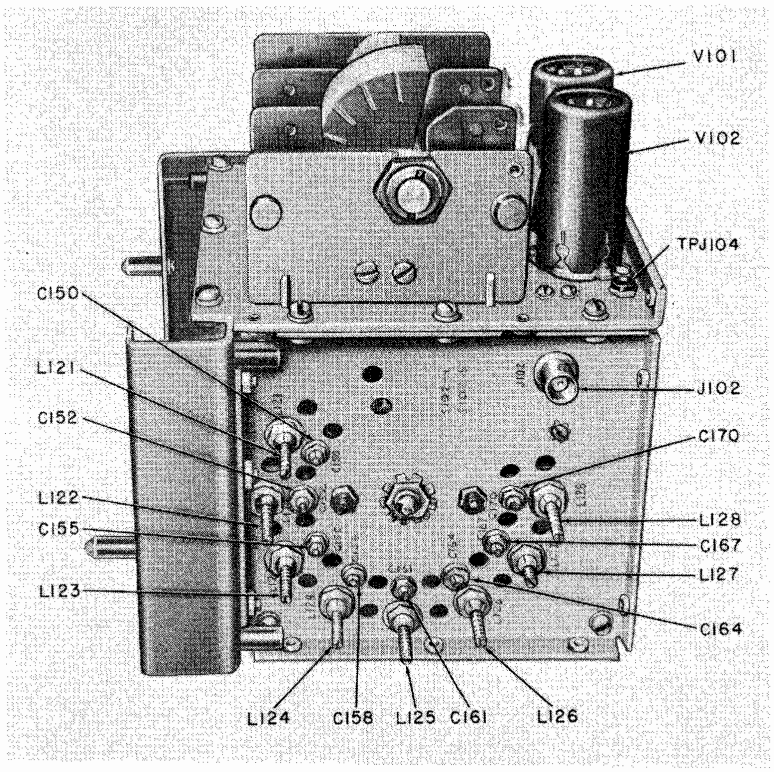


Figure 7–9. Variable Frequency Oscillator, Rear View

to the subassembly, then remove the four screws that secure the inner plate, remove the plate and unplug the crystal. If a crystal is replaced, it may be necessary to readjust its associated trimmer capacitor. Allow the crystal to be heated for one hour, then check the output frequency of the affected stage and, if necessary, realign.

(9) DYNAMOTOR BRUSH REPLACEMENT. *(See figures 7–30 through 7–32.)*—Dynamotor D1401, located in the power supply, contains six brushes. If the +1100, +250, or —105 volts are not present, or if output voltages are erratic, the dynamotor brushes may need replacement.

Four brushes are located in the generator section and are held in place by slotted caps. To remove the brushes, unscrew the caps with a screwdriver and lift out the brushes.

Two brushes are located in the motor (input) section of the dynamotor and are held in place by springs. To gain access to the motor brushes, loosen the two screws on the dust cover, unlock the clamps, and remove the dust cover. To remove the brushes, loosen the screws holding the pigtail leads, lift the springs, and remove the brushes.

Determine if the replacement brush has been seated before installing. If the replacement brush is flat at the contact end, use sandpaper or a fine file to seat (groove) the brush.

c. ELECTRICAL ADJUSTMENTS.—The following procedures outline the methods to be followed in making electrical adjustments and alignments in the transmitter group.

(1) VARIABLE FREQUENCY OSCILLATOR ALIGNMENT. *(See figures 7–7, 7–8, 7–9, and 7–60.)*—The vfo contains free-running tunable oscillator V101, covering the 2 to 30-mc range in 28 bands, each 1-mc wide. Two frequency selector switches S101 (10 mc) and S102 (1 mc) are coupled mechanically to the front panel 10 MC and 1 MC FREQUENCY SET knobs. S101 selects one of three main decks of S102, and S102 selects the desired 1-mc band. Tuning is accomplished over each megacycle band by three-gang variable capacitor C174 and controlled from the transmitter front panel by the VFO ADJ knob.

The purpose of this alignment procedure is to adjust the L and C components of the 28 bands to the desired bandwidth and provide the required frequency overlaps in each position with respect to the desired settings (high and low) of tuning capacitor C174.

CAUTION

> The adjustments of the vfo unit are preset to the correct frequencies and sealed at the factory, and should not require adjustment unless a component part requires replacement. Indiscriminate adjustments should not be attempted under any circumstances.

The following test equipment will be required for the alignment of the vfo. (See table 7–1.):

1 frequency counter
1 vtvm

It will be necessary to remove the vfo from the main chassis, and extend the power cable of the subassembly (P101) by means of a test cable. In addition, the vfo rf output (J103) must be connected to the rfa input (in the amplifier-modulator) by means of a special rf test cable (14-3/4 inches of RG-62A/U cable). The test cable rf connector mates with connector J1001 in the amplifier-modulator and is accessible through a cutout at the rear of the transmitter main chassis.

Step 1. Disconnect error voltage input from mixer-stabilizer to vfo by unsoldering wire to pin 5 of test cable. Apply +32 volts to pin 5 of test cable. The +32 volts can be obtained from a 45-volt battery (type BA-414/U, or equivalent). The +45 volts can be dropped to +32 volts through the use of a 2.5k, 2 watt potentiometer. Connect a 6.2k, 1/2 watt current limiting resistor in series with potentiometer wiper and pin 5 of test cable.

Step 2. Remove VFO ADJ knob and dial assembly from main chassis. Before removing knob, remove knob locking device. Replace knob on dial assembly and connect dial assembly to the C174 shaft on vfo subassembly. Make vfo dial housing secure so that it will not move with respect to the vfo chassis.

Step 3. Allow proper warm-up for transmitter (approximately 30 minutes) and test equipment.

Step 4. Couple vfo output to input of frequency counter by means of a loop wire connected to input terminal of frequency counter and placed around glass envelope of cathode follower tube V102 in vfo.

Step 5. Place SERVICE switch on transmitter front panel at NETTING position following warm-up.

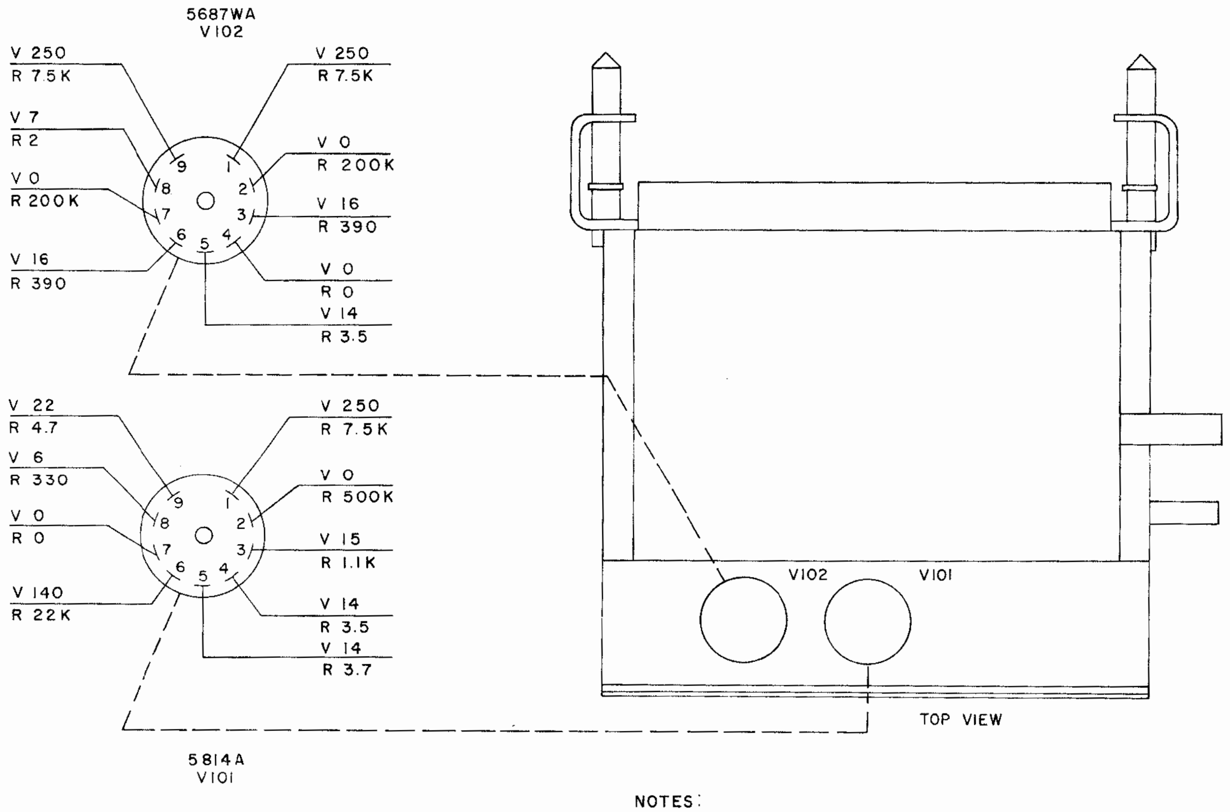
Step 6. Place switch S101 on vfo unit to extreme counterclockwise position. This places S101 at the 2 to 10-mc range position. Place switch S102 to position 2. This places S102 (sections 4 and 5) at the 2 to 3-mc band position.

Note

The relationship of S101 and S102 on the vfo to the front panel FREQUENCY SET knobs makes the extreme counterclockwise position of S101 and S102 zero, the second position from extreme ccw position 1, etc.

Step 7. Back out trimmer C150 full ccw (minimum capacity).

Step 8. Set VFO ADJ (C174) for a dial reading of 10.3 (low frequency end).



NOTES:
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.
3. READINGS TAKEN WITH SERVICE SELECTOR SWITCH IN NETTING POSITION, KEY UP, AND POWER AMPLIFIER STAGE TUNED.

Figure 7-10. Variable Frequency Oscillator, Voltage and Resistance Chart

Step 9. Adjust L121 to indicate a frequency of approximately 2 mc. Note frequency.

Note

The receiver may be used to aid in finding the range in which the vfo is oscillating so that the counter can be set to the proper range for reading. For example, if it is desired to measure 2.5 mc, set the receiver to 2.5 mc at zero beat. Place the receiver antenna near V102 to pick up the oscillator signal and tune L121 until the signal zero beats. Now set the counter to the 2-mc range and the frequency should be indicated (see counter instructions).

Step 10. Set VFO ADJ for a dial reading of 85.0 (high frequency end). Locate frequency (approximately 3 mc) with counter and note frequency.

Step 11. Compare readings noted in steps 9 and 10. Desired bandwidth is 1 mc at dial readings indicated. If bandwidth is too wide to begin with, add capacity by adjusting C150 clockwise and repeat steps 8 through 11. Desired results are:

Low end: 2.0 mc at 10.3 dial reading
Bandwidth: 1.0 mc
High end: 3.0 mc at 85.0 dial reading

If 1-mc bandwidth was obtained as above, but frequency was 2.5 mc and 3.5 mc, adjust L121 to obtain 2.0 mc and 3.0 mc. Total bandwidth of 1.0 mc shall be within ±1 dial division at band ends.

Bandwidth	*Remedy*
Too Short	Add more L and less C
Too Large	Add more C and less L
Off Center	Adjust L

Step 12. Disconnect counter and measure output at TP–J104 with a vtvm. Output of vfo shall be 4.0 volts rms, minimum.

Step 13. Align remaining 7 positions of S102 (2 to 10-mc range) in the same manner as described in steps 7 through 12. Refer to table 7–6 for switch positions of S101 and S102 corresponding VFO ADJ dial settings and list of adjustments.

Step 14. Set S101 to 10 to 20-mc position (center), and S102 to zero position (extreme ccw). This places S102 (sections 2 and 3) in 10 to 11-mc band position.

Step 15. Align all 10 bands in 10 to 20-mc section using procedure described in steps 7 through 12. Use table 7–6. Bandwidth shall be 1 mc and band ends shall be within ±1 dial division. Output voltage at TP–J104 shall be 4.0 volts rms, minimum. There shall be no parasitic oscillation.

Note

The receiver may be used to detect parasitic oscillations. Place the receiver antenna near V102. The oscillator note should be a clear whistle. A rough buzzing note indicates parasitic oscillation caused by improperly dressed ground leads, defective tubes or switch contacts, input grid lead, or component failure.

Step 16. Set S101 to 20 to 20-mc position (extreme cw), and S102 to zero position (extreme ccw). This places S102 (section 1) in 21 to 22-mc band position.

Step 17. Align all 10 bands in 20 to 30-mc section using procedure described in steps 7 through 12. Use table 7–6. Bandwidth shall be 1 mc and band ends shall be within ±1 dial division. Output voltage at TP–J104 shall be 4.0 volts rms, minimum. There shall be no parasitic oscillation.

Step 18. Remove test equipment and +32 volts supply from pin 5 of test cable. Connect and solder wire removed in step 1 to pin 5 of test cable.

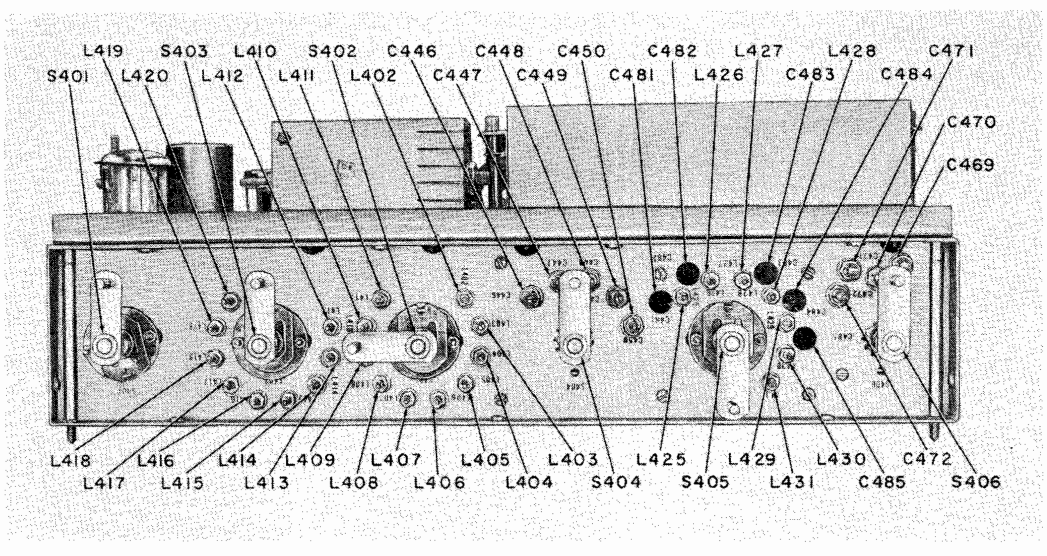


Figure 7–11. Reference Oscillator and Mixer, Front View

TABLE 7-6. ALIGNMENT TABLE FOR VARIABLE FREQUENCY OSCILLATOR

S101		S102		C174 LOW FREQUENCY END (cw)		C174 HIGH FREQUENCY END (ccw)	
POS.	10-MC BAND (MC)	POS.	1-MC BAND (MC)	DIAL SET	ADJUST-MENT	DIAL SET	ADJUST-MENT
0	2–10	2	2–3	10.3	L121	85.0	C150
0	2–10	3	3–4	10.9	L122	85.0	C152
0	2–10	4	4–5	12.4	L123	86.6	C155
0	2–10	5	5–6	13.7	L124	89.1	C158
0	2–10	6	6–7	16.5	L125	90.0	C161
0	2–10	7	7–8	16.0	L126	92.4	C164
0	2–10	8	8–9	21.2	L127	91.4	C167
0	2–10	9	9–10	25.7	L128	89.4	C170
1	10–20	0	10–11	14.5	L111	87.5	C121
1	10–20	1	11–12	14.0	L112	88.0	C123
1	10–20	2	12–13	14.2	L113	88.4	C126
1	10–20	3	13–14	16.8	L114	87.3	C129
1	10–20	4	14–15	17.9	L115	88.2	C132
1	10–20	5	15–16	17.3	L116	89.5	C135
1	10–20	6	16–17	18.2	L117	89.2	C138
1	10–20	7	17–18	18.0	L118	90.6	C141
1	10–20	8	18–19	20.4	L119	89.3	C144
1	10–20	9	19–20	18.2	L120	92.2	C147
2	20–30	0	20–21	13.8	L101	88.7	none
2	20–30	1	21–22	15.6	L102	87.3	none
2	20–30	2	22–23	14.5	L103	88.8	C105
2	20–30	3	23–24	15.0	L104	87.8	C107
2	20–30	4	24–25	16.9	L105	86.4	C109
2	20–30	5	25–26	16.3	L106	87.2	C111
2	20–30	6	26–27	16.8	L107	86.7	C113
2	20–30	7	27–28	15.0	L108	88.0	C115
2	20–30	8	28–29	14.5	L109	86.9	C117
2	20–30	9	29–30	15.1	L110	88.5	C119

Notes:
1. Bandwidth shall be 1 mc.
2. Band ends shall be ±1 dial division.
3. Output voltage at test point TP–J104 shall be 4.0 volts rms, minimum.

Step 19. Check vfo error voltage input with a vtvm connected to test point TP–J707 on mixer-stabilizer subassembly. Reading should be +32 volts with transmitter tuned to 21 mc. If necessary, adjust R731 on mixer-stabilizer for a +32-volt reading.

Step 20. Lock or seal all adjustment screws that were moved during the alignment procedure.

Step 21. Replace vfo dial assembly on transmitter front panel.

(2) REFERENCE OSCILLATOR AND MIXER SUBASSEMBLY ALIGNMENT. *(See figures 7-11 through 7-13 and 7-62.)*—The reference oscillator and mixer subassembly contains five oscillator stages and two mixer stages. The outputs from two of the oscillator tubes, V401 and V402, are applied to the mixer-stabilizer subassembly for mixing. The two heterodyned outputs establish a reference frequency in the 2 to 3-mc range for any transmitting frequency. Oscillator tubes V403, V404, and V405 supply outputs

which heterodyne with the vfo output to obtain a beat frequency which is also in the 2 to 3-mc range.

The appropriate oscillator L–C components are selected by the six front panel FREQUENCY SET controls.

CAUTION

These components are preset to the correct frequencies at the factory, and should not require readjustment unless a component is damaged and requires replacement. Indiscriminate adjustments of these components should not be attempted under any circumstances.

The following test equipment will be required for alignment of the reference oscillator and mixer. (See table 7–1):

1 vtvm
1 rf signal generator
1 sweep generator
1 frequency counter
1 oscilloscope
1 oven (see text)
1 thermometer (see text)

The adjustments for the variable components are marked on the subassembly. (See figure 7–11.) It will be necessary to remove the reference oscillator and mixer from the main chassis to gain access to the

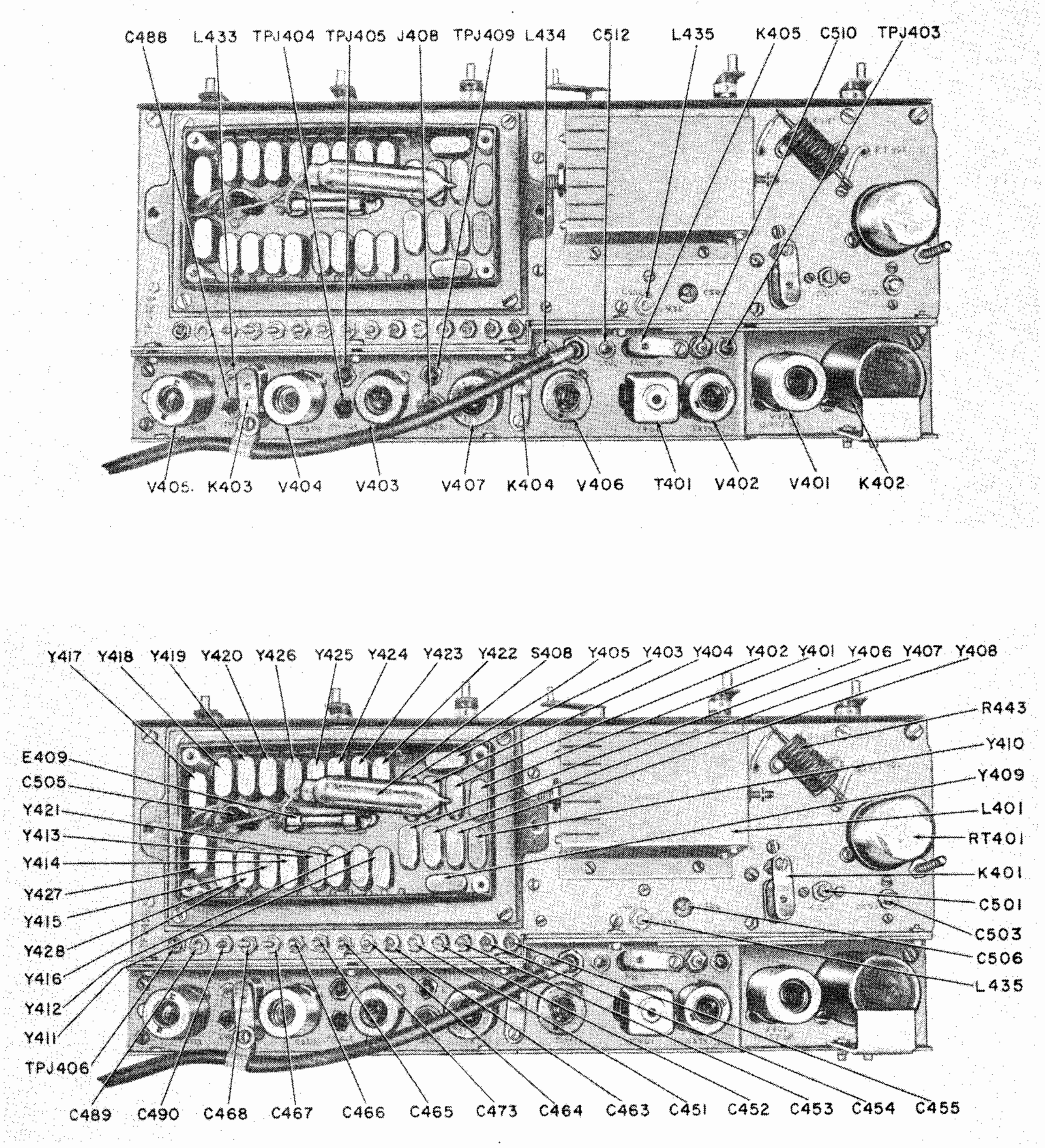


Figure 7–12. Reference Oscillator and Mixer, Top View

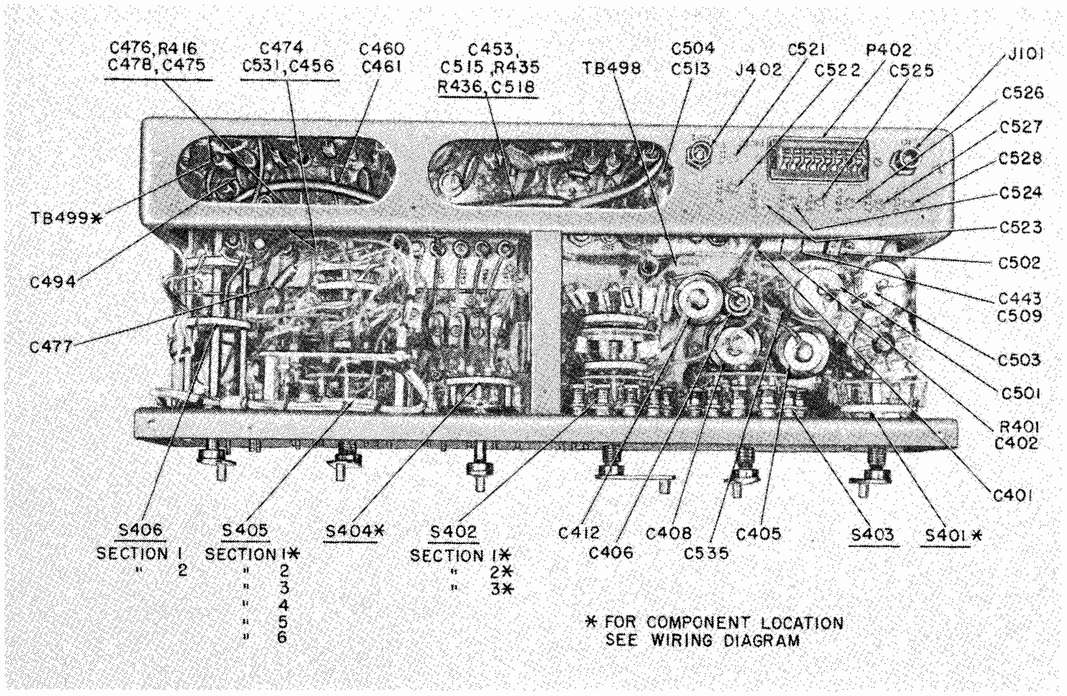


Figure 7–13. Reference Oscillator and Mixer, Bottom View

adjustments. (Refer to paragraphs 7–4 *b* (1) *(b)* for removal procedure.) A test cable assembly must be used to supply power to the subassembly when it is unplugged from the main chassis.

The following steps establish the initial conditions for alignment.

Step 1. Allow crystal oven one hour to attain proper operating temperature before aligning 100-kc step oscillator V402, fundamental oscillator V403, oscillator doubler V404, and oscillator tripler V405.

Step 2. Allow plate and filaments of V401 to attain proper operating temperature (30 minutes) before aligning interpolation oscillator.

Step 3. Make all adjustments with an insulated alignment tool.

Step 4. Leave all covers on during alignments.

Step 5. Disconnect P1308 from J1001 in amplifier-modulator. This will prevent transmitter radiation from affecting frequency measurements.

Note

When referring to the FREQUENCY SET selector switches (S401 through S406), the switch positions are given as they appear on the transmitter front panel. The extreme ccw position is position O, the second position from full ccw is position 1, etc.

(a) INTERPOLATION OSCILLATOR V401.—Interpolation oscillator V401 supplies output frequencies in the 1.6005-1.7 mc range. The output frequency can be varied in 100-cycle steps with selector switches S401, S402, and S403. In addition, the output frequency of V401 is varied to obtain frequency shifting when FSK service is used. The FSK alignment procedure is outlined in paragraphs 7–4 *c* (2) *(b)*.

Step 1. Place SERVICE switch at NETTING position.

Step 2. Set S401 to its center position O, S402 to its extreme cw position 9, and S403 to its extreme ccw position O.

Step 3. Connect output of V401 (at receptacle J401) to input of a frequency counter.

Step 4. Energize transmitter.

Step 5. Set L411 to obtain an output frequency of 1.61 mc ± 10 cycles.

Step 6. Place S402 at position 8, change frequency counter to a frequency of 1.62 mc and adjust L410 for an output frequency of 1.62 mc ± 10 cycles.

Step 7. Remaining 10-kc step coils (L409 through L402) should be adjusted to step the frequency to 1.70 mc, in increments of 10 kc, as S402 is rotated through its positions. Tolerance for each step of S402 is ± 10 cycles, and output at J401 for each step should be 1.0 volts rms, minimum.

Step 8. Place S402 at position 9 and S403 at position 1.

Step 9. Adjust L412 for a frequency of 1.609 mc ± 5 cycles.

Step 10. Remaining 1-kc step coils, L413 through L420, should be adjusted to step the frequency to 1.601 mc in increments of 1 kc, as S403 is rotated through its positions. The tolerance for each step of S403 is ± 5 cycles, and the output at J401 should be 1.0 volt rms, minimum.

Step 11. Place S403 at position 5 (1.605 mc) and realign the 10-kc switch S402 as follows:

Note

Do not realign position 9 (1.61 mc).

Step 12. Place S402 at position 8 and adjust L410 for a frequency of 1.615 mc ± 5 cycles.

Step 13. Remaining 10-kc step coils (L409 through L402) should be adjusted to step frequency from 1.625 mc to 1.695 mc, in increments of 10 kc, as S402 is rotated through its positions. Tolerance should be maintained at ± 5 cycles, and output at J401 should be 1.0 volt rms, minimum.

(b) FREQUENCY SHIFT KEYING. — The space frequency is capable of being adjusted to any frequency 150 to 500 cycles above the 1.65 mc reference frequency. The mark frequency is capable of being adjusted to any frequency 150 to 500 cycles below 1.65 mc. Both space and mark frequencies are factory set with C503 and C501, respectively, to a frequency of 425 cycles, which is the most common frequency shift used. The interpolation oscillator, V401, must be properly aligned before adjusting C503 and C501. The following procedure outlines the frequency shift keying alignment.

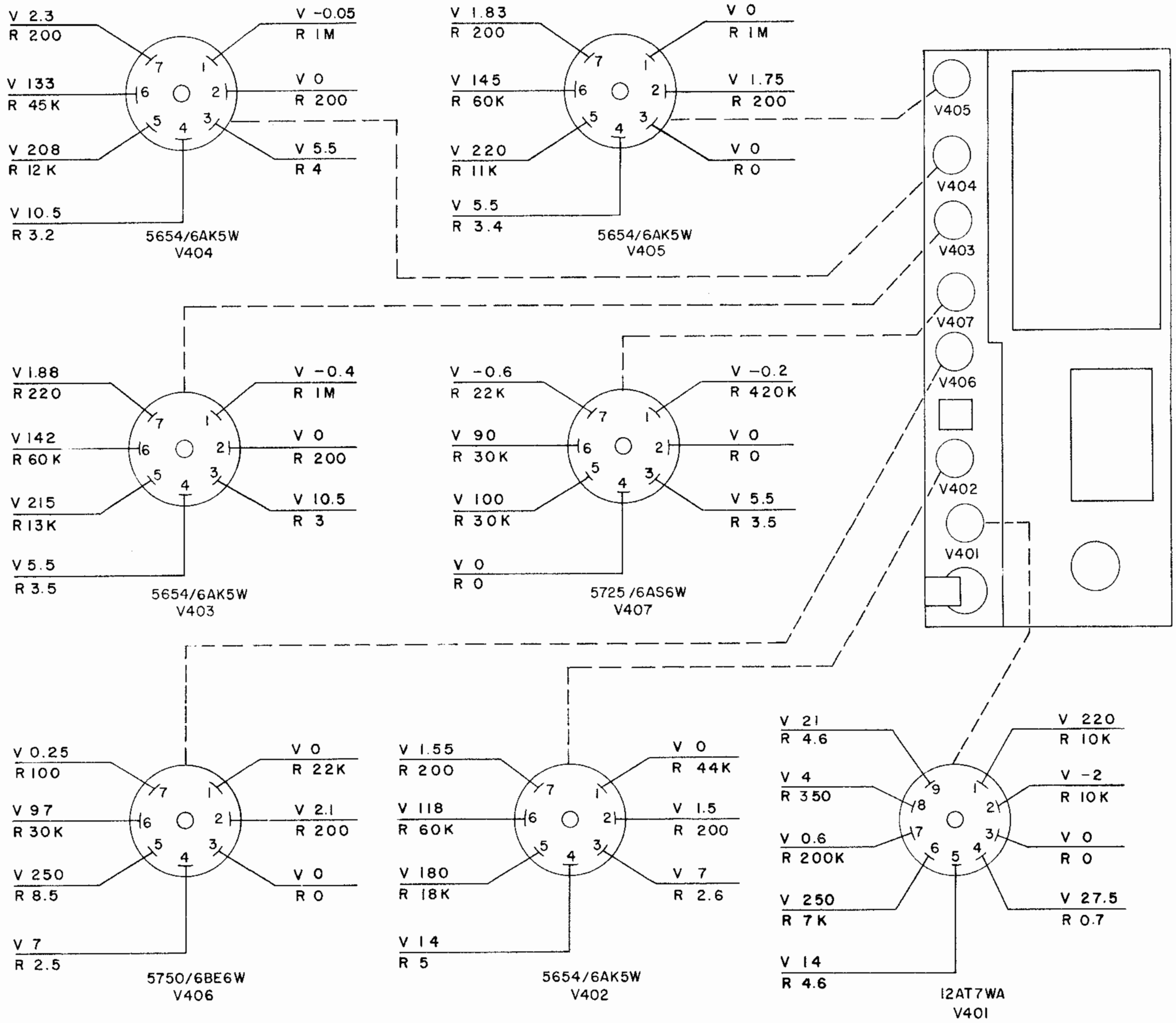


Figure 7-14. Reference Oscillator and Mixer, Voltage and Resistance Chart

Step 1. Place SERVICE switch at NETTING position.

Step 2. Set S401 to its position O; S403 to position O; and S402 to position 5.

Step 3. Connect output of V401, at receptacle J401, to input of a frequency counter.

Step 4. Energize transmitter.

Step 5. Check output from V401. If it is 1.65 mc, it will be necessary to align the V401 stage before continuing to step 7.

Step 6. Place SERVICE switch at FSK-AM position.

Step 7. Check output from V401 with frequency counter. Adjust C503 to obtain amount of shift above 1.65 mc desired as a space frequency. Most commonly used space frequency is 1.65 mc +425 cycles, or 1.650425 mc. Tolerance is ±10 cycles.

Step 8. Remove plug-in relay K402 and place a jumper wire between pins 4 and 6 of the relay socket.

Step 9. Check output from V401 with frequency counter. Adjust C501 to obtain amount of shift below 1.65 mc desired as a mark frequency. Most commonly used mark frequency is 1.65 mc-425 mc cycle, or 1.649575 mc. Tolerance is ±10 cycles.

(c) 100-KC STEP OSCILLATOR V402.—The 100-kc step oscillator (V402) supplies output frequencies in the 3.7 to 4.6-mc range. The output frequency can be varied in 100-kc steps with 100 KC selector switch S404.

Step 1. Place SERVICE switch at NETTING position.

Step 2. Set S404 to position O.

Step 3. Connect output of V402, at test point TP-J403, to input of a frequency counter.

Step 4. Adjust C446 for a frequency of 3.7 mc ±10 cycles.

Step 5. Remaining 100-kc step trimmer capacitors, C447 through C455, should be adjusted to step frequency to 4.6 mc, in increments of 100 kc as S404 is rotated through its positions. Tolerance for each step of S404 shall be ±10 cycles, and output at J402 shall be 10 volts rms, minimum.

Note

The following should be observed when performing alignment in paragraphs 7-4 *c* (2) *(d)*, *(e)*, and *(f)* for fundamental oscillator V403, oscillator doubler V404, and oscillator tripler V405. When adjusting the frequency trimming capacitors, determine the maximum and minimum frequency excursion during the oven cycle (approximately 3 minutes peak-to-peak) and make correction so that the frequency variation due to the oven cycle occurs near the specified frequency.

(d) FUNDAMENTAL OSCILLATOR V403.—Fundamental oscillator V403 supplies output frequencies in the 8 to 18-mc range. The output frequency can be varied in 1-mc steps with the 1 MC selector switch S405.

Step 1. Place SERVICE switch at NETTING position.

Step 2. Set S406 to position 1 (10 to 20 mc) and S405 to its extreme ccw position O.

Step 3. At TP-J404, connect the output from V403 to the input of a frequency counter.

Step 4. Adjust C463 so that the oven cycle mean frequency (f max plus f min divided by 2) equals 8.0 mc ±25 cps. Now set S406 to 20-30 MC position and again note f max and f min of oven cycle. If the mean frequency is exceeded by 50 cps, readjust C463 to equalize the error at both the 10 to 20 and 20 to 30 positions of switch S406. Note the output voltage 1.5 v min in both positions. Perform the remainder of adjustments listed in the following tabulation following the same procedure. (Note that C473 only appears on 20-30 mc position.)

S406 POSITION	S405 POSITION	ADJUST	MEAN F (MC)	±CPS	TP-J404 OUTPUT VOLTS RMS MIN.
10-20	0	C463	8.0	25	1.5
20-30	9	C463 If Req.	8.0	*	1.5
10-20	1	C464	9.0	25	1.5
20-30	8	C464 If Req.	9.0	*	1.5
10-20	2	C465	10.0	25	1.5
20-30	7	C465 If Req.	10.0	*	1.5
10-20	3	C466	11.0	25	1.5
10-20	4	C467	12.0	25	1.5
10-20	5	C468	13.0	25	1.5
10-20	6	C469	14.0	25	1.5
20-30	3	C469 If Req.	14.0	*	1.5
10-20	7	C470	15.0	25	1.5
20-30	2	C470 If Req.	15.0	*	1.5
10-20	8	C471	16.0	25	1.5
20-30	6	C471 If Req.	16.0	*	1.5

S406 POSITION	S405 POSITION	ADJUST	MEAN F (MC)	±CPS	TP-J404 OUTPUT VOLTS RMS MIN.
20–30	1	C471 If Req.	16.0	*	1.5
10–20	9	C472	17.0	25	1.5
20–30	5	C472 If Req.	17.0	*	1.5
20–30	0	C472 If Req.	17.0	*	1.5
20–30	4	C473	18.0	25	1.5

*Within 50 cycles of 10–20 mc position.

(e) OSCILLATOR DOUBLER V404.—Oscillator doubler V404 supplies output frequencies in the 32 to 36 mc range. The V404 grid circuit is tuned in 0.5-mc steps between 16 and 18 mc, and the plate circuit is tuned to twice the oscillator frequency. The output frequency can be varied in 1-mc steps with the 1 MC selector switch S405.

Step 1. Place SERVICE switch at the NETTING position.

Step 2. Set S406 to its extreme ccw position O (2 to 10 mc) and S405 to position 3.

Step 3. At TP-J405, connect output from V404 to input of a frequency counter. Connect a vtvm to TP-J405 for voltage measurements.

Step 4. Adjust C481 for a frequency of 34 mc. Adjust L425 for maximum output (2.0 volts rms, minimum).

Step 5. Set S405 to position 8 and adjust C481 for a frequency of 34 mc. Adjust C481 to equalize the difference between positions 3 and 8. Then adjust L430 for maximum output with S405 in position 8 (2.0 volts rms, minimum).

Step 6. Set S405 to position 4 and adjust C482 for a frequency of 33 mc. Adjust L426 for maximum output (2.0 volts rms, minimum).

Step 7. Set S405 to position 9 and adjust C482 for a frequency of 33 mc. Adjust C482 to equalize the difference between positions 4 and 9. Then adjust L431 for maximum output with S405 in position 9 (2.0 volts rms, minimum).

Step 8. Set S405 to position 5 and adjust C483 for a frequency of 32 mc. Adjust L427 for maximum output (2.0 volts rms, minimum).

Step 9. Set S405 to position 6 and adjust C484 for a frequency of 36 mc. Adjust L428 for maximum output (2.0 volts rms, minimum).

Step 10. Set S405 to position 7 and adjust C485 for a frequency of 35 mc. Adjust L429 for maximum output (2.0 volts rms, minimum).

(f) OSCILLATOR TRIPLER V405.—Oscillator tripler V405 supplies output frequencies of either 35 or 40 mc. The V405 grid circuit is tuned to either 11.667 mc or 13.333 mc and the plate circuit is tuned to three times the oscillator frequency. The appropriate 11.667 or 13.333-mc crystal is selected by relay K403, which is controlled by 1 MC selector switch S405.

Step 1. Place SERVICE switch at NETTING position. Set S406 to position 2 (20 to 30 mc).

Step 2. Connect a vtvm to TP-J406. Set S405 to position 5 (K403 unoperated).

Step 3. Adjust L433 for maximum output (0.5 volts rms, minimum).

Step 4. Disconnect vtvm and connect a frequency counter. Adjust C490 for 40 mc ±25 cycles.

Step 5. Set S405 to position 7 (K403 operated) and adjust C489 and C488 for 35 mc ±25 cycles and a peak voltage of 0.5 volts rms, minimum. When adjusting for peak voltage disconnect counter and connect vtvm to TP-J406.

(g) 32-33-MC TRAP ALIGNMENT.—Inductor L435 is the adjustment for the 32-mc trap, and L434 is the adjustment for the 33-mc trap.

Step 1. Remove tube V405 and replace with a similar 5654/6AK5W with pins 1 and 5 removed (oscillator tripler disabled). Replace all tube shields.

Step 2. Connect a signal generator to P401.

Step 3. Connect a sweep generator to the horizontal (x) terminals of an oscilloscope. Connect the vertical (y) terminals of the oscilloscope to the test point TP–J409. Set scope controls and signal generator output for a suitable amplitude for display.

Step 4. Set switches S401, S403, S404 to zero position. Set S406 to zero (2 to 10 mc) position. Set S405 to position 5 (32 mc from oscillator doubler).

Step 5. Set rf signal generator to feed 32 mc to P401.

Step 6. Adjust L435 for null (minimum beat frequency on oscilloscope).

Step 7. Set rf signal generator to feed 33 mc to P401, and set S405 to position 4 (33 mc from oscillator doubler).

Step 8. Adjust L434 for null (minimum beat frequency on oscilloscope).

Step 9. Repeat steps 6 and 8 as necessary until minimum amplitude of 32 and 33 mc is obtained.

(h) BAND PASS T401.—With relay K405 unenergized, T401 provides a 42 to 43 mc band pass. With K405 energized, T401 provides a 37 to 38 mc band pass.

Connect the test equipment as follows. (See table 7–1):

Step 1. Connect output of an rf signal generator through a T connector to P401. Connect if. output of a sweep generator through the T connector to P401.

Step 2. Connect sweep output of the sweep generator to horizontal (x) terminals of an oscilloscope.

Step 3. Connect vertical (y) terminals of the oscilloscope to test point TP-J409.

1. 42 TO 43 MC BAND PASS (K405 Unergized).

Step 1. Set S405 to position 6.

Step 2. Adjust sweep range of sweep generator and oscilloscope controls for a waveform as shown in view A of figure 7-95. Set oscilloscope for 2 inches (10 cm) vertical deflection. This puts the 3 db point at 7 cm.

Step 3. Select marker (42 mc and 43 mc) from signal generator and adjust T401 primary and secondary coil slugs to meet requirement of view A of figure 7-95. The bandpass shall be 1 mc between the −3 db points on the response curve. The lower limits shall be between 41.95 mc and 42 mc, and the upper limits shall be between 43 mc and 43.05 mc. The valley between the peaks of the response curve shall not exceed −3 db below the highest peak.

2. 37 TO 38 MC BAND PASS (K405 Energized).

Step 1. Set S405 to position 5.

Step 2. Adjust sweep range of sweep generator and oscilloscope controls for a waveform as shown in view B of figure 7-95.

Step 3. Select marker (37 and 38 mc) from signal generator and adjust capacitors C510 and C512 to meet requirements of view B of figure 7-95. The valley between the peaks of the response curve shall not exceed −3 db below the highest peak.

Step 4. Replace tube V405 that was removed in paragraph 7-4 *c* (2) *(g)*, step 1.

(i) TEMPERATURE COMPENSATION ADJUSTMENT C506.—Variable capacitor C506, which compensates for a change in capacitance of the interpolation oscillator V401 tank circuit due to a change in ambient temperature, has been adjusted at the factory and should not require adjustment in the field.

CAUTION

Indiscriminate adjustment of C506 should not be attempted under any circumstances.

An oven with thermostatic control (such as Fisher Scientific Co. No. 13-245-20A), a thermometer with a range of −10 to 110 degrees C (14 to 230 degrees F), and a frequency counter are required for this adjustment.

WARNING

Use a pair of asbestos gloves when handling the heated subassembly and oven.

Step 1. When oven is not in use, keep door shut and set thermostat to hold oven at +45 degrees C (113 degrees F).

Step 2. Set S402 in position 5 (1.65 mc) and all other switches on unit to zero.

Step 3. Set rotor of C506 to minimum capacity position, and mount thermometer (use modeling clay) near C506. Place reference oscillator and mixer subassembly (connected to main chassis by test cables) in oven and heat chassis to +45 degrees C (113 degrees F).

Step 4. When chassis reaches +45 degrees C, connect a frequency counter to J401 and note frequency (starting frequency).

Step 5. Change thermostat of oven to read 85 degrees C (185 degrees F), place subassembly in oven and heat chassis to this temperature.

CAUTION

Do not allow oven temperature to go above 85 degrees C. Damage to reference oscillator and mixer may result.

Step 6. When chassis reaches 85 degrees C, use frequency counter to note new frequency at J401. Adjust C506 to restore original frequency noted in step 4 at 45 degrees C.

Step 7. Decrease oven thermostat to 45 degrees C and leave oven door open. Remove chassis from oven, but do not remove thermometer. Deenergize subassembly. With door open, oven will drop 45 degrees C in about 11 minutes. Chassis will cool to 45 degrees C in about 26 minutes.

When chassis reaches 45 degrees C, reenergize subassembly and measure frequency at J401. If more than 100 cycles off, adjust L401 slug to restore the original frequency, then repeat temperature adjustment of C506 from step 1.

(3) MIXER-STABILIZER ADJUSTMENT. *(See figures 7-15, 7-16, and 7-64.)*

(a) ERROR VOLTAGE.—Variable resistor R731 controls the error voltage fed back to the vfo which results from a comparison of vfo and reference

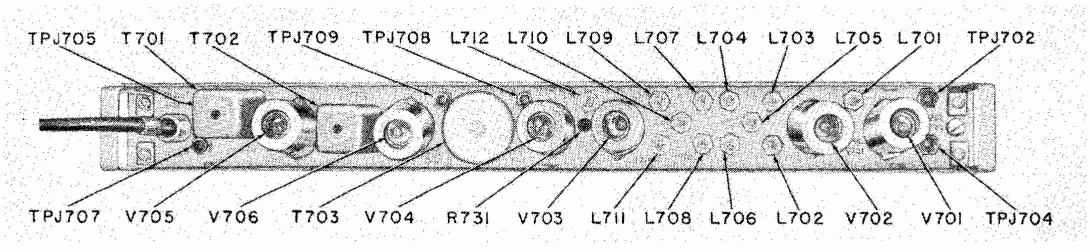


Figure 7-15. Mixer-Stabilizer, Top View

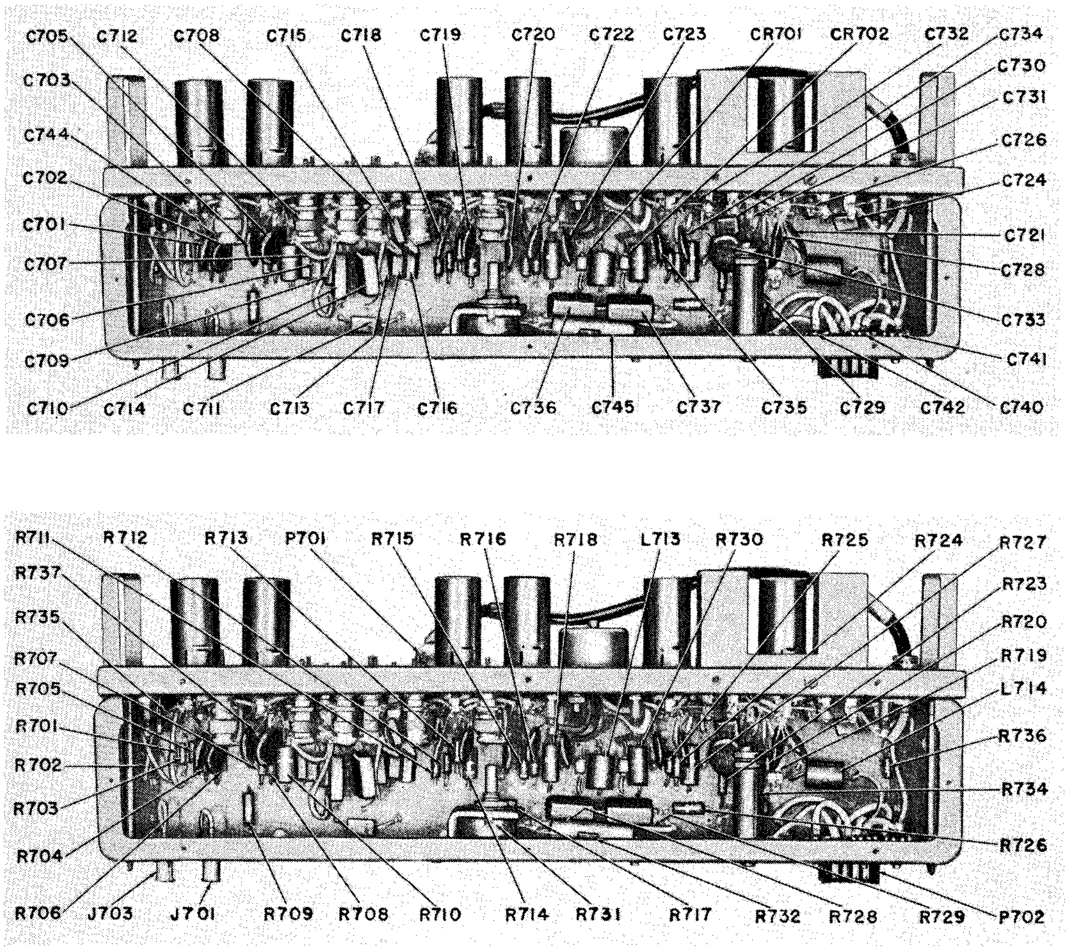


Figure 7–16. Mixer-Stabilizer, Side View

oscillator and mixer outputs in the phase detector and stabilizing network in the mixer-stabilizer.

The following test equipment will be required for alignment of the mixer-stabilizer. (See table 7–1):

1 vtvm (dc)
1 vtvm (ac)
1 rf signal generator
1 sweep generator
1 frequency counter
1 oscilloscope
1 envelope detector (see text)

A check for the setting of this adjustment can be made without removing any units from the transmitter, as follows:

Step 1. Turn on power to transmitter in accordance with instructions given in section 4, and after proper warm-up place front panel controls of transmitter at the following positions:

Control	*Position*
NORMAL-REMOTE-RELAY switch	NORMAL
BAND switch	10-30 MC
FREQUENCY SET controls	21 MC
SERVICE switch	NETTING

Step 2. Turn VFO ADJ control to extreme clockwise limit, then push and release TUNE-START button. Transmitter will tune automatically to 21 mc.

Step 3. The vfo should lock-in, as observed on SYNCHRONIZATION INDICATOR (needle at center-zero position). If vfo fails to lock-in, adjustment of R731 in mixer-stabilizer is in order. R731 adjustment is accessible from the bottom of the transmitter main chassis and is located on the top center of the mixer-stabilizer chassis. (See figure 7–15.)

Step 4. To adjust R731, connect a vtvm to test point TP-J707 on the mixer-stabilizer chassis and adjust R731 for a reading of 32 volts dc on vtvm.

(b) "M" DERIVED BAND PASS FILTER.—This procedure consists of 10 variable inductors which are adjusted for a 2 to 3-mc band pass. The mixer-stabilizer subassembly must be removed from the main chassis for these adjustments. Connect P702 to the main chassis by means of a test cable. For a list of test equipment used in this alignment procedure, see table 7–1.

Step 1. Connect if. output from a sweep generator to J701, and connect sweep output of generator to horizontal (x) terminals of an oscilloscope.

Step 2. Connect positive output of a marker generator (rf signal generator) to J703.

Step 3. Connect a wire from TP-J709 to ground.

Step 4. Connect an envelope detector from TP-J708 and vertical (y) terminals of oscilloscope. Envelope detector may be constructed with a germanium diode, such as a IN34, and a bypass capacitor (250 $\mu\mu$f). Connect cathode of diode to TP-J708 and anode (arrowhead) to oscilloscope. Connect capacitor from anode side of diode to ground. Waveform may be inverted on oscilloscope screen. If desired, reverse connections of diode.

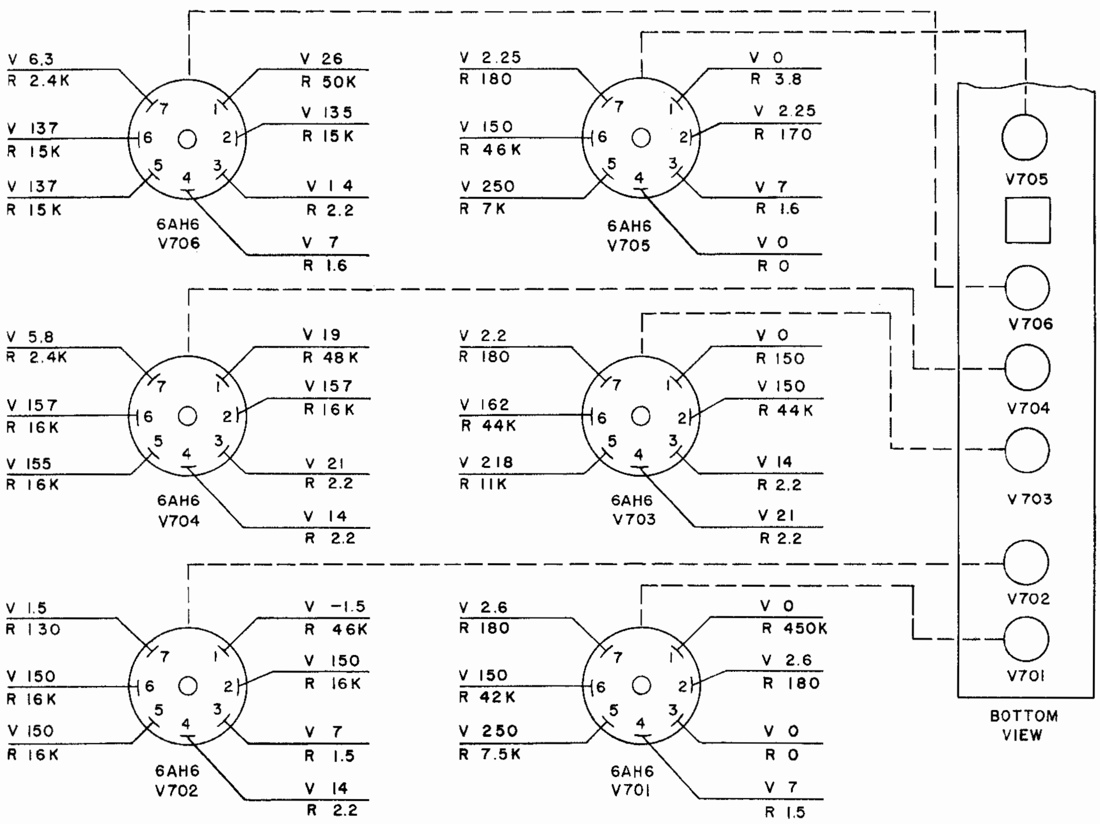
Step 1. Set signal generator to 2.6 mc and connect a vtvm to pin 7 of V702. Adjust L701 for maximum output. Remove vtvm.

Step 2. Set sweep generator to approximately 2.5 mc and observe detected wave shape on oscilloscope. (See view C of figure 7-95.)

Step 3. Align each section of filter in following sequence. Use marker generator to locate portions of detected wave shape. Use a frequency counter to set marker generator to correct frequency. Do not overdrive marker generator. (See view C of figure 7-95.)

Adjustment	*Adjust*	*Resonant Frequency*
L702	minimum	3.2 mc
L703	minimum	1.8 mc
L710	minimum	1.8 mc
L711	minimum	3.2 mc
L704	bandwidth	2.0 mc
L705	minimum	1.8 mc
L706	bandwidth	2.0 mc
L707*	flatness, maximum	
L709	flatness, maximum	
L708*	adjust for bandwidth at 3.0 mc	

* L707 and L708 are interlocking. Adjust for minimum at 3.2 mc and flatness of band pass.



NOTES:
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K = 1000 OHMS; M = 1,000,000 OHMS.
3. READINGS TAKEN WITH SERVICE SELECTOR SWITCH IN NETTING POSITION, KEY UP, AND POWER AMPLIFIER STAGE TUNED.

Figure 7-17. Mixer-Stabilizer, Voltage and Resistance Chart

Step 4. Filter characteristics shall be flat within 3 db between 2 and 3 mc.

Step 5. Adjust L712 for maximum gain and no tilt of band pass characteristic. Attenuation shall be 40 db at 3.2 mc and at 1.8 mc (40 db equals peak voltage times 0.01).

Step 6. Disconnect test equipment from J701 and J703, and remove shorting wire from TP-J709. Remove detector from TP-J708.

(c) T701, T702 BAND PASS FILTER.—The top and bottom slugs of T701 and T702 are adjusted for a 2 to 3 mc band pass.

Step 1. Connect a wire from TP-J708 to ground.

Step 2. Using the detector constructed in step 4 of paragraph 7–4 *c* (3) *(b)*, connect anode side of detector to vertical deflection terminals (y) of an oscilloscope and connect cathode side of detector to cathode side of capacitor C735 (V706, pin 7).

Step 3. Connect sweep output of a sweep generator to horizontal deflection terminals (x) of oscilloscope.

Step 4. Connect if. output from a sweep generator to an 8.2 k, 1/2 watt resistor. To this same side of resistor, connect positive output of a marker generator (rf signal generator) through a decoupling resistor (100 k, 1/2 watt). Connect other side of the 8.2 k resistor (use coaxial cable type 58A/U) to terminal 1 and ground of T701. This places marker generator output and if. output of sweep generator on control grid (input) of amplifier tube V705. Keep sweep rate at a minimum.

Step 5. Align T702 primary and secondary (top and bottom slugs) for proper band pass. (See view D of figure 7–95.) Turn marker generator off from time to time to make sure it is not distorting waveform.

Step 6. Remove generator outputs (8.2 k resistor) from terminal 1 and ground of T701. Reconnect generator outputs through the 8.2 k resistor to P701.

Step 7. Adjust top and bottom slugs of T701 to obtain results shown in view D of figure 7–95.

Step 8. The combined band pass characteristic of T701 and T702 shall be flat within 3 db between 2 and 3 mc. The valley shall occur at 2.4 ±.05 mc. The highest peak to valley shall not be more than 3 db. The attenuation at 3 and 2 mc respectively shall be symmetrical and in excess of 3 db, as viewed on oscilloscope.

(d) AC VOLTAGE.—Following the alignment of the mixer-stabilizer an ac voltage check should be made to see whether proper output is being obtained.

Step 1. Set error voltage adjustment R731 to full clockwise position and ground TP-J709.

Step 2. Connect the rf signal generator to J703. Set signal generator to 2.5 mc at 0.2 volt. Check frequency of signal generator with a frequency counter and output level with a vtvm at TP-J704.

Step 3. Measure output voltage with an ac vtvm connected to TP-J708. Output shall be 5.0 volts rms, minimum, at any frequency between 2 and 3 mc.

Step 4. Remove ground from TP-J709. Disconnect signal generator from J703 and connect it through an 8.2 k, 1/2 watt resistor to P701. Set signal generator to 2.5 mc at 0.2 volt. Check frequency and output of signal generator at TP-J705.

Step 5. Measure output voltage with an ac vtvm connected to TP-J709. Output shall be 4.0 volts rms, minimum, at any frequency between 2 and 3 mc.

Step 6. Remove test equipment and replace mixer-stabilizer in main chassis. Set error voltage adjustment R731 for 32 volts in accordance with procedure given in paragraph 7–4 *c* (3) *(a)*.

(4) KEYER GROUP ADJUSTMENT.*(See figures 7–18 and 7–66.)*—Potentiometer R814 is the adjustment for the keying break-in time delay of the transmitter and can be adjusted from 0.2 to 1.0 second. The setting of this adjustment will depend on desired time delay for break-in. This screwdriver adjustment is set for 0.6 second at the factory.

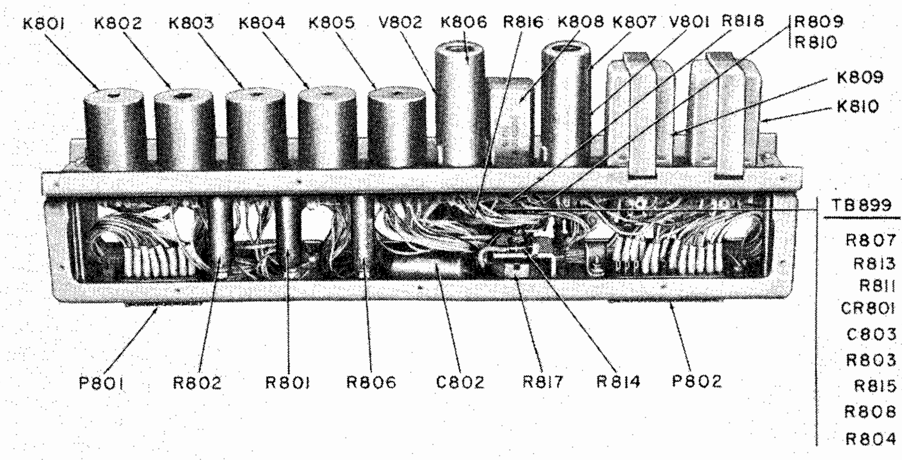
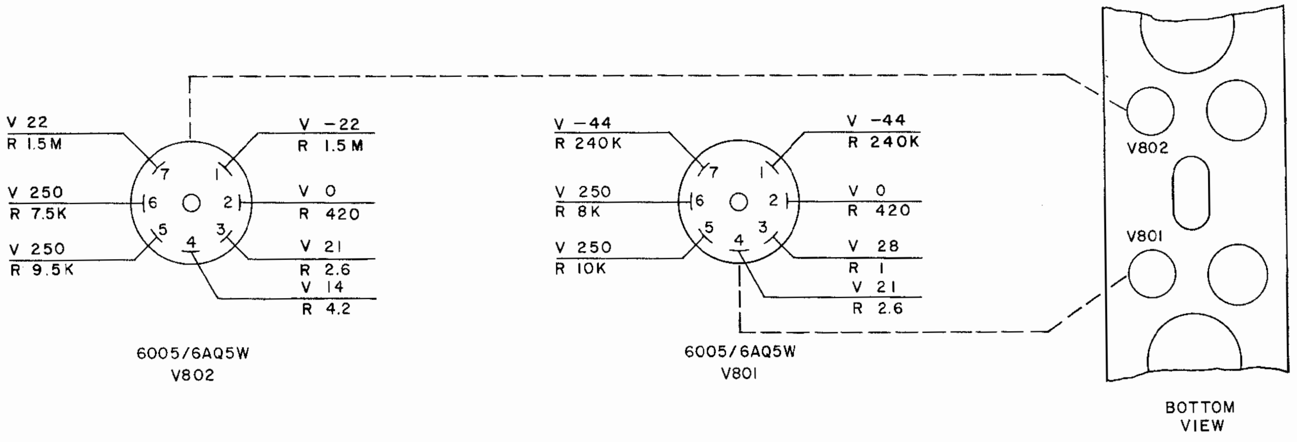


Figure 7–18. Keyer Group, Side View



NOTES:
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKE WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260, K = 1000 OHMS; M = 1,000,000 OHMS.
3. READINGS TAKEN WITH SERVICE SELECTOR SWITCH IN NETTING POSITION, KEY UP, AND POWER AMPLIFIER STAGE TUNED.

Figure 7–19. Keyer Group, Voltage and Resistance Chart

(5) AMPLIFIER-MODULATOR ADJUSTMENTS. *(See figures 7–20 and 7–70.)*

The following test equipment will be required for alignment of the amplifier-modulator. (See table 7–1):

1 milliammeter
1 dummy load (50 ohms)

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside the equipment with the high voltage supply on. Under certain conditions, dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors, etc. To avoid casualties, always discharge and ground circuits prior to touching them. Use a long insulated alignment tool for all adjustments.

(a) MODULATOR BIAS.—Potentiometer R1017, accessible from the top of the amplifier-modulator chassis, is used to adjust the level of the bias on the grids of modulator tubes V1003 and V1004. (See figure 7-20). Adjust R1017 as follows:

Step 1. With equipment turned off, remove plate cap from either modulator tube (V1003 or V1004). Connect a milliammeter in series with plate of tube and plate cap. Set milliammeter to the 0-100 ma scale.

Step 2. After proper warm-up of transmitter, set SERVICE switch to AM position.

Step 3. With zero signal audio input, adjust potentiometer R1017 for a 60 ma reading on milliammeter.

(b) AMPLIFIER.—All adjustments for the amplifier alignment may be made from the top of the subassembly and without removing the subassembly from the main chassis. (See figure 7–20.)

1. PRELIMINARY.

Step 1. Turn off equipment. Disconnect whip antenna from front panel.

Step 2. Connect a 50-ohm dummy load to REMOTE TUNER-50 OHM receptacle on the front panel.

Step 3. Bypass the rf tuner. This can be done by disconnecting P1302 (main chassis) from J1201 (rf tuner) and connecting P1302 to J1320 (main chassis). Place S1207 in rf tuner to 50-OHMS position.

Step 4. Set SERVICE switch to NETTING position.

2. 10 TO 30 MC BAND.

Step 1. Set BAND switch to 10-30 MC position.

Step 2. Tune transmitter automatically to 29.9995 mc.

Step 3. Set TEST meter switch on transmitter to Erf position.

Step 4. Adjust L1010 for maximum output as observed on TEST meter.

Step 5. Operate MANUAL TUNE P.A. jog switch to tune for maximum power output, indicated on R.F. LINE meter.

Step 6. Remove +1100 volts dc from the amplifier-modulator. This may be done by removing fuse F1409, located in the power supply. (See figure 5-1.)

Step 7. Adjust C1053 so that the phase detector output zero coincides with P.A. grid current peak. Read TEST meter in Ig position (See view E, figure 7-95.)

Step 8. Reconnect +1100 volts removed in step 6 by replacing fuse F1409 in power supply then adjust C1052 and C1051 for a peak power output as indicated on R.F. LINE meter. Note P.A. grid current reading (Ig-TEST meter) at this time for reference use later.

Step 9. Remove fuse F1409 to disconnect +1100 volts. Check that output of phase detector is zero when P.A. grid current is at peak. (See step 7.) If the P.A. grid current has changed more than ±20 percent from that noted in step 8, adjustment of neutralizing capacitor C1055 may be necessary.

Note

Do not adjust for maximum possible power output with a resulting sacrifice in phase detector balance. A compromise should be made in the adjustment so that the power output is within the specification, and the phase detector will balance as close to zero as possible.

Step 10. Tune transmitter to 20 mc. Operate MANUAL TUNE-P.A. jog switch to tune for maximum power output, as indicated in R.F. LINE meter. Maximum grid current (Ig on TEST meter) shall also occur at this point. Remove fuse F1409 to disconnect +1100 volts, and check phase detector for zero output. If degeneration is so great as to cause power output to fall below specification, grid may be tuned by adjusting C1053, with +1100 volts connected (F1409 in circuit), in order to recover lost drive.

Step 11. Repeat step 10 with the transmitter tuned to 10 mc.

3. 6 TO 10 MC BAND.

Step 1. Set BAND switch to 6 to 10 MC position and tune transmitter to 8 mc.

Step 2. Operate MANUAL-TUNE P.A. jog switch to tune for maximum power output, indicated on R.F. LINE meter.

Step 3. Remove fuse F1409 and adjust C1007 for peak grid current as observed on Ig position of TEST meter. Check phase detector for zero output. Replace fuse F1409.

Step 4. Tune transmitter to 10 mc and operate P.A. jog switch until maximum power output is obtained. Maximum grid current should also occur at this point. Remove fuse F1409, to turn +1100 volts off, and check phase detector for zero output. Replace F1409.

Step 5. Repeat step 4 with the transmitter tuned to 6 mc.

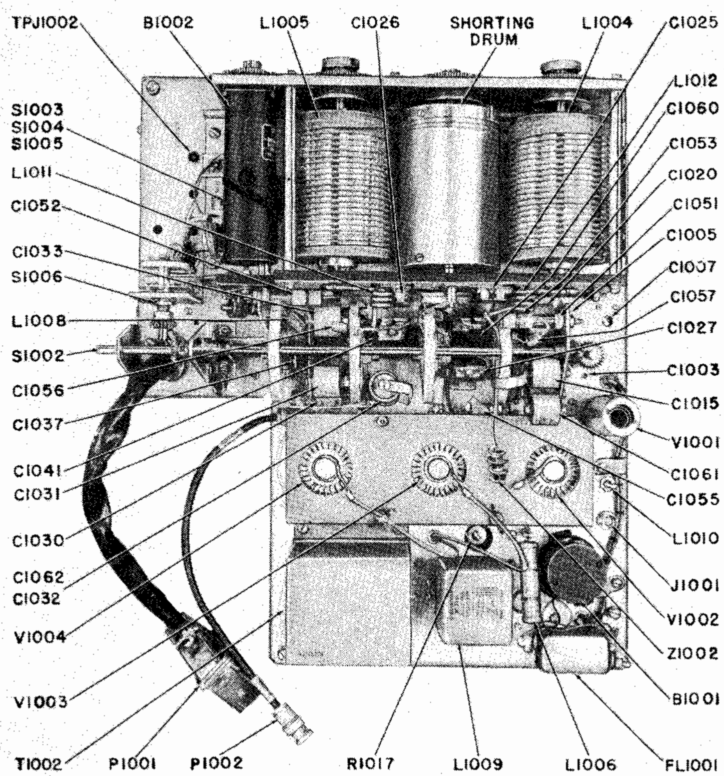


Figure 7-20. Amplifier-Modulator, Top View

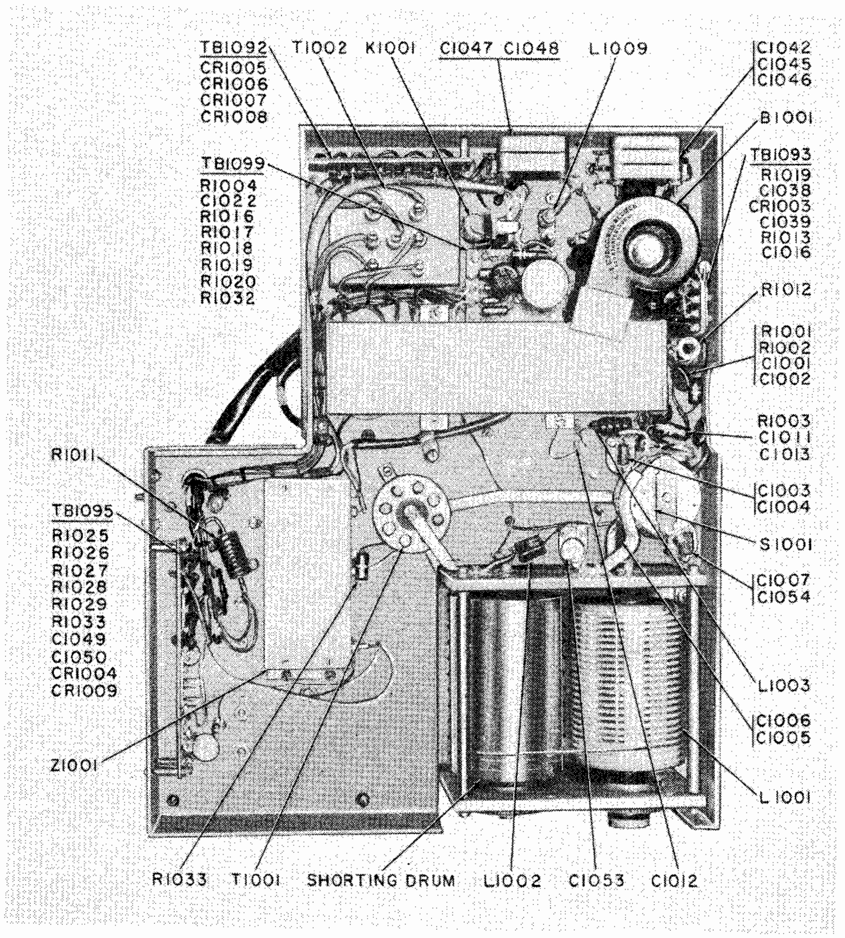


Figure 7-21. Amplifier-Modulator, Bottom View

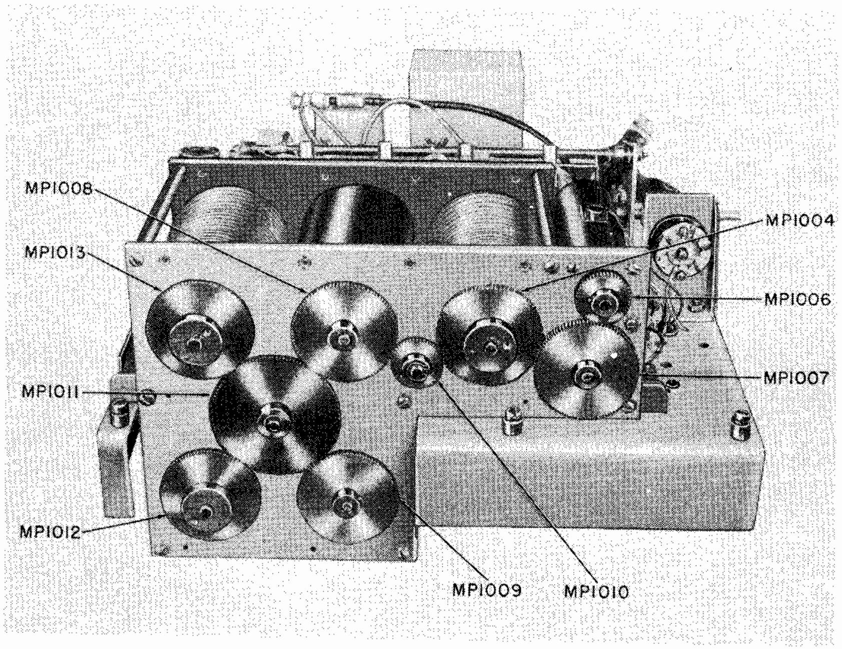


Figure 7-22. Amplifier-Modulator, Rear View

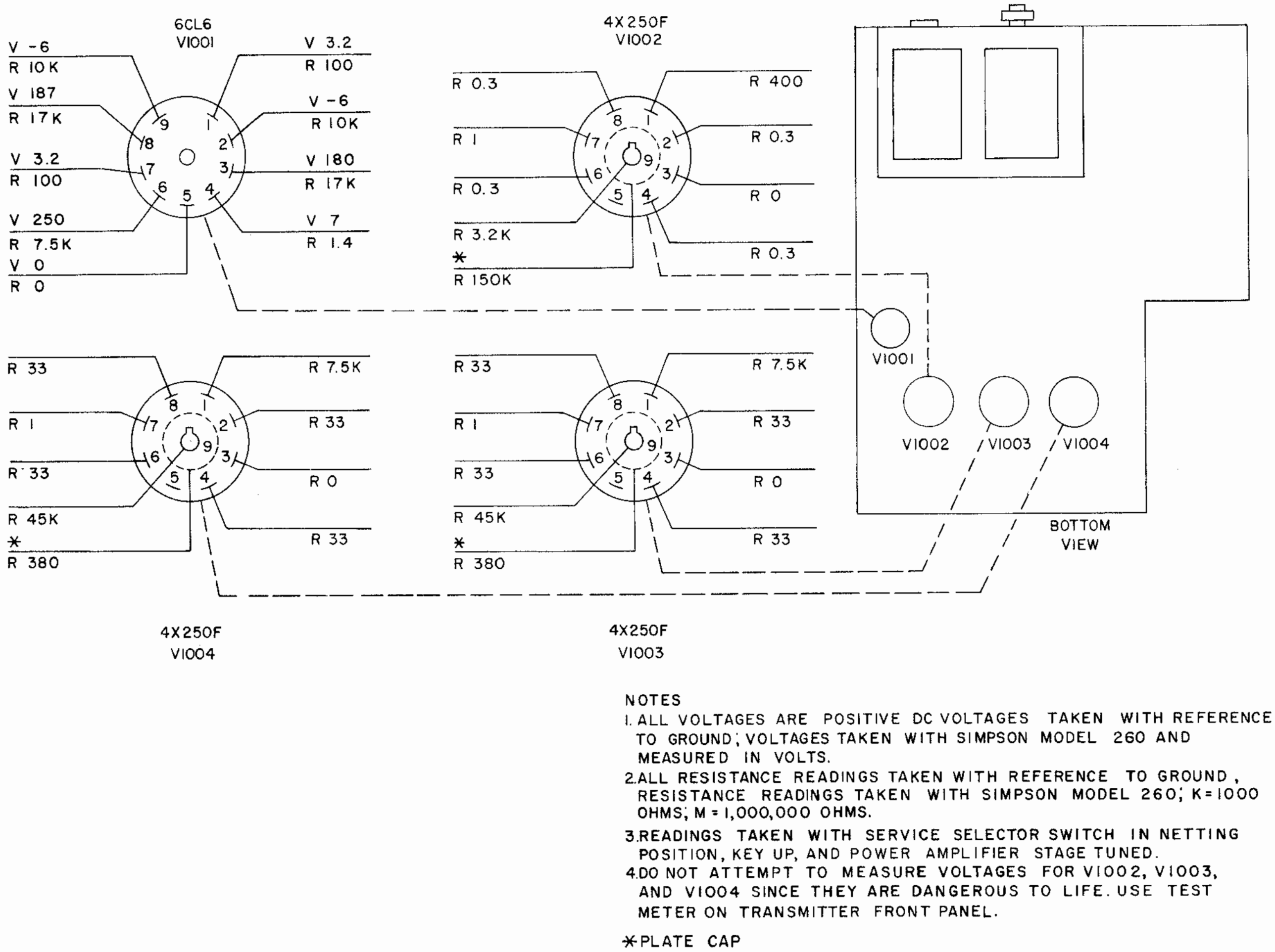


Figure 7-23. Amplifier-Modulator, Voltage and Resistance Chart

4. 3 TO 6 MC BAND.

Step 1. Set BAND switch to 3-6 MC position and tune transmitter to 4.5 mc.

Step 2. Operate P.A. jog switch to tune for maximum power output.

Step 3. Remove fuse F1409 and adjust C1005 so that maximum grid current occurs at this point. Check phase detector for zero output. Replace fuse F1409.

Step 4. Tune transmitter to 6 mc and operate P.A. jog switch until maximum power output is obtained. Maximum grid current should also occur at this point. Remove fuse F1409 and check phase detector for zero output. Replace F1409.

Step 5. Repeat step 4 with transmitter tuned to 3 mc.

5. 2 TO 3 MC BAND.

Step 1. Set BAND switch to 2-3 MC position and tune transmitter to 2.5 mc.

Step 2. Operate P.A. jog switch to tune for maximum power output.

Step 3. Remove fuse F1409 and adjust C1003 so that maximum grid current occurs at this point. Check phase detector for zero output. Replace F1409.

Step 4. Tune transmitter to 3 mc and operate P.A. jogswitch until maximum power output is obtained. Maximum grid current should also occur at this point. Remove fuse F1409 and check phase detector for zero output. Replace F1409.

Step 5. Repeat step 4 with transmitter tuned to 2 mc.

(6) SERVO CONTROL ADJUSTMENTS. *(See figures 7-24 and 7-72.)*—There are two screwdriver adjustments in the servo control, potentiometers R908 and R924 which are used to balance load and tune amplifiers V902 and V904, respectively. These potentiometers are adjusted at the factory and normally do not require adjustment in the field. The servo control unit must be removed from the main chassis for these adjustments.

The following test equipment will be required for alignment of the servo control. (See table 7-1.):

1 vtvm (dc)
2 ohmmeter
1 microammeter (50-0-50 scale)
2 batteries (1-1/2 volt)

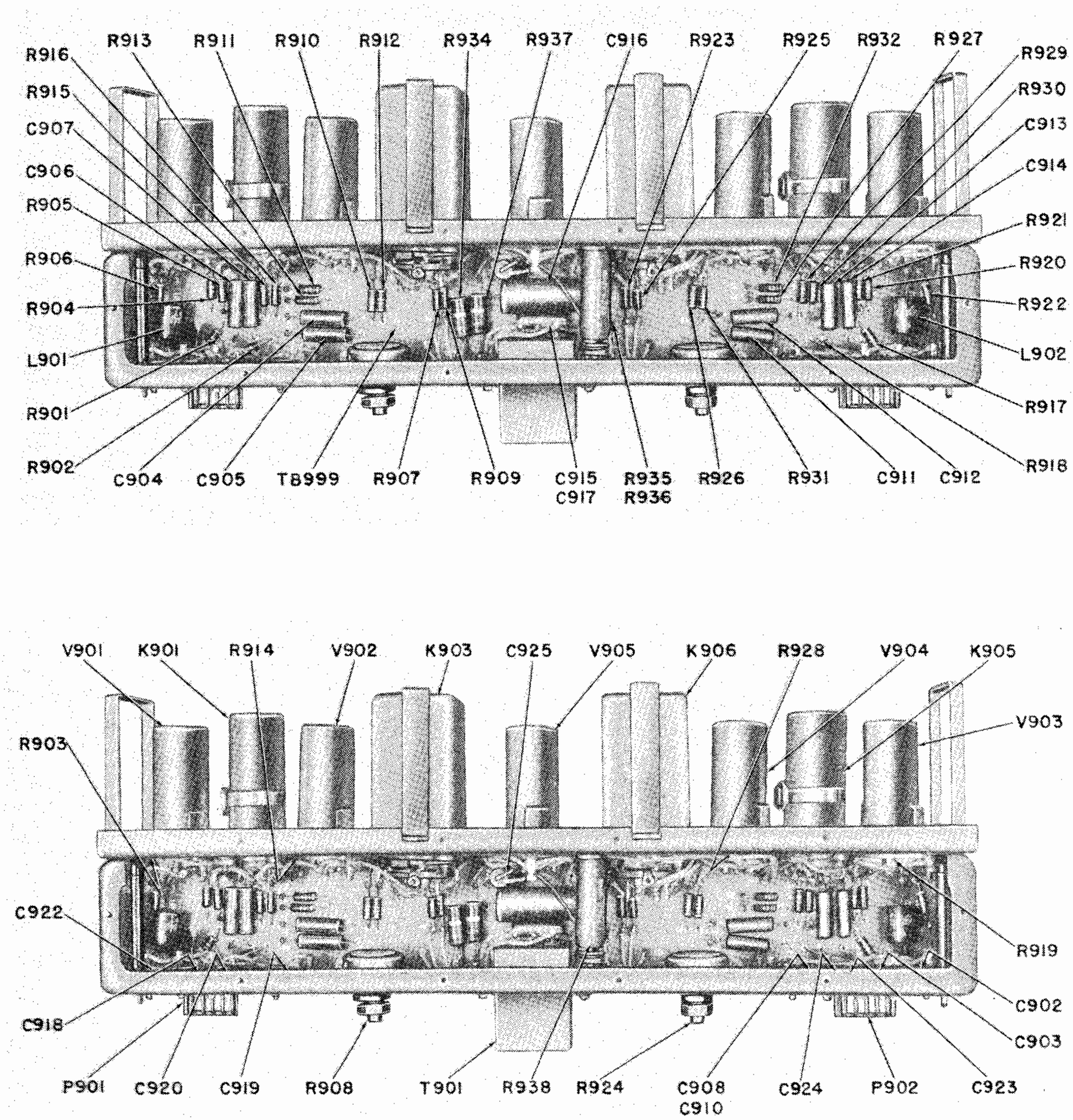


Figure 7–24. Servo Control, Side View

(*a*) PRELIMINARY.

Step 1. Connect +250 vdc (regulated) to terminal 3 of P901 and terminal 3 of P902. This may be done by removing mixer-stabilizer subassembly from the main chassis and connecting clip leads from terminal 3 of J1309 (main chassis) to terminal 3 of P901 and P902.

Step 2. Connect +26.5 volts filament power to terminal 2 of P902. This may be done by connecting a clip lead to terminal 2 of J1309.

Note

For the purpose of this adjustment procedure, +250 volts cannot be taken from terminal 3 of J1312 and J1313, since power is available at this point only during the automatic tuning cycle.

Step 3. Connect a ground lead from terminal 1 of P901 to terminal 1 of J1309.

(*b*) ERROR VOLTAGE POWER SUPPLY.—A substitute variable error voltage will have to be supplied for this adjustment procedure. Construct the error voltage power supply, as follows:

Step 1. Connect negative terminal of a 1-1/2 volt battery to ground (terminal 1 of P901). Connect positive terminal of battery through a 5 k, 1 watt resistor to one side of a 10 k, 2 watt potentiometer.

Step 2. Connect positive terminal of a second 1-1/2 volt battery to ground. Connect negative terminal of battery through a 5 k, 1 watt resistor to other side of potentiometer.

Step 3. Connect a microammeter, with a 50-0-50 scale, in series with a 500 ohm, 2 watt calibration potentiometer to wiper terminal of the 10 k potentiometer. Connect a jumper wire from a wiper terminal to one side of the 500-ohm potentiometer.

Step 4. Connect a clip lead to wiper terminal of the 10 k potentiometer. The other side of clip lead will serve as input for error voltage supply, to terminal 5 of P901 or P902.

(c) BALANCE OF LOAD AMPLIFIER V902.

Step 1. Connect a clip lead from pin 4 of K903 to terminal 4 of P901.

Step 2. Set SERVICE switch on transmitter front panel to STANDBY. Allow two minutes warm-up for filaments, then place SERVICE switch in AM position.

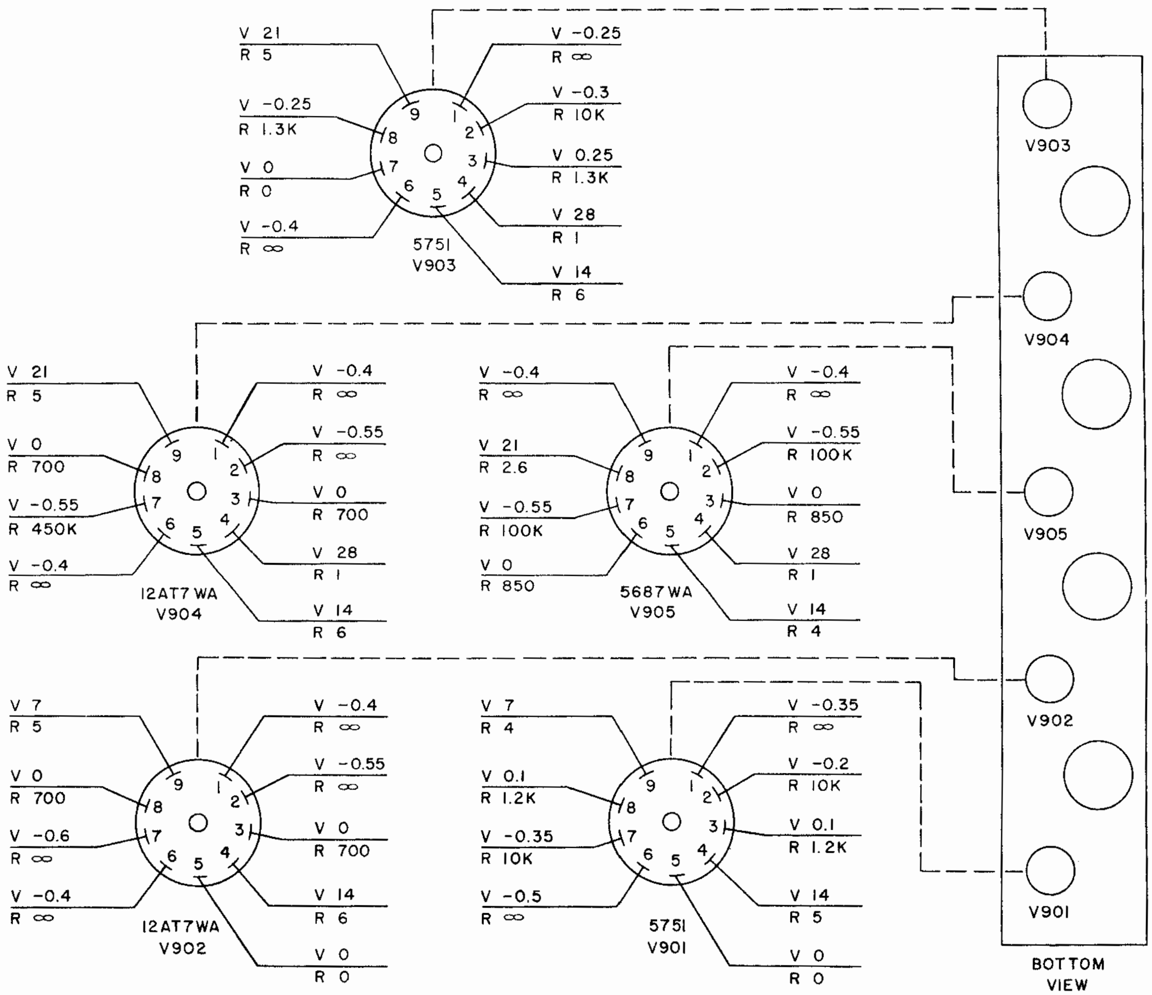
Step 3. Connect error voltage supply input clip lead (from wiper terminal of 10 k potentiometer) to terminal 5 of P901.

Step 4. Connect an ohmmeter between pin 6 and pin 4 of K903. Connect another ohmmeter between pin 6 and pin 7 of K903.

Step 5. Calibrate microammeter so that microammeter dial will read correct input voltage at terminal 5 of P901. This can be done by connecting a vtvm to terminal 5 of P901 and varying input, then comparing readings of vtvm and microammeter. If necessary, adjust 500-ohm microammeter calibration potentiometer. After calibration, rotate 10 k potentiometer to obtain a zero error voltage input to pin 5 of P901 as observed on microammeter.

Step 6. Adjust R908 so that contacts 6–4 and 6–7 of K903 will open (no continuity on either ohmmeter). If adjustment of R908 will not open contacts 6–4 or 6–7, replace in order: V902, K903, and K901 until contacts 6–4 and 6–7 will open with adjustments of R908.

Step 7. Rotate 10 k potentiometer (error voltage input) slowly from plus side to negative side. Observe on microammeter the points at which contacts (6–4 and 6–7) open and close.



NOTES
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS..
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.

Figure 7–25. Servo Control, Voltage and Resistance Chart

Step 8. Adjust R908 until contacts open at equal voltages each side of center zero on microammeter. Tolerance should be within 10 percent.

Step 9. Record the points at which contacts 6–4 and 6–7 open as well as the points at which they close. Limits should be between plus and minus 20 and 50 millivolts.

Step 10. Place SERVICE switch in STANDBY and remove clip lead from pin 4 of K903 and terminal 4 of P901.

(d) BALANCE OF TUNE AMPLIFIER V904.

Step 1. Remove error voltage input clip lead from terminal 5 of P901 and connect clip lead to terminal 5 of P902.

Step 2. Remove ohmmeters from K903 and connect one ohmmeter between pin 6 and pin 4 of K906. Connect second ohmmeter between pin 6 and pin 7 of K906.

Step 3. Place SERVICE switch in AM position, then proceed with balancing of tune amplifier V904. Use same procedure (steps 5 through 9) used to balance load amplifier V902. Adjust R924 as required, and replace V904, K906, and K905, if necessary, to obtain balance.

Step 4. Lock R908 and R924, being careful not to disturb settings. Recheck balance of V902 and V904, then remove test equipment and replace unit in main chassis.

(7) AF AMPLIFIER ADJUSTMENT. *(See figures 7–26 and 7–68.)*—There is only one electrical adjustment in the af amplifier subassembly. Potentiometer R1112, a screwdriver adjustment, is used to set the output level of the 500 ±100 cps sidetone signal generated during cw operation of the transmitter. R1112 is preset for a sidetone output of 1.9 volts rms ±2 db. (1.51 volts to 2.39 volts rms.) If it is desired to readjust R1112, set the SERVICE switch to the CW-TUNE position and key the transmitter. Unlock R1112 and set it to obtain the desired earphone and loudspeaker audio output.

(8) RF TUNER ADJUSTMENTS. *(Refer to figures 7–28, 7–29, and 7–74.)*—The following test equipment will be required for alignment of the phase detector in the rf tuner. (See table 7–1):

1 rf signal generator
1 vtvm (dc)
1 vtvm (ac)

Step 1. Remove rf tuner from main chassis in accordance with paragraph 7–4 *b* (1) *(b).*

Step 2. Remove phase detector assembly from rf tuner chassis by removing four mounting screws and disconnecting strap connection between C1201 and T1202, PRI-1 terminal. Disconnect wires connected to C1209 and C1208 (from P1201 and S1207 junctions).

Step 3. Connect a signal generator to P1201 located on phase detector assembly.

Step 4. Connect a 28 ohm, 1/2 watt resistor (keep leads as short as possible) from T1202, PRI-1 terminal and ground (phase detector cover). Connect a 4.7 k termination resistor between C1209 (vacant terminal) and ground. Connect a 10 k termination resistor between C1208 (vacant terminal) and ground.

Step 5. Connect a dc vtvm from C1209 and ground.

Step 6. Adjust and maintain signal generator output at all frequencies throughout test at 1 volt, rms, measured with an ac vtvm between terminal 2 of T1201 (J1201 input) and ground.

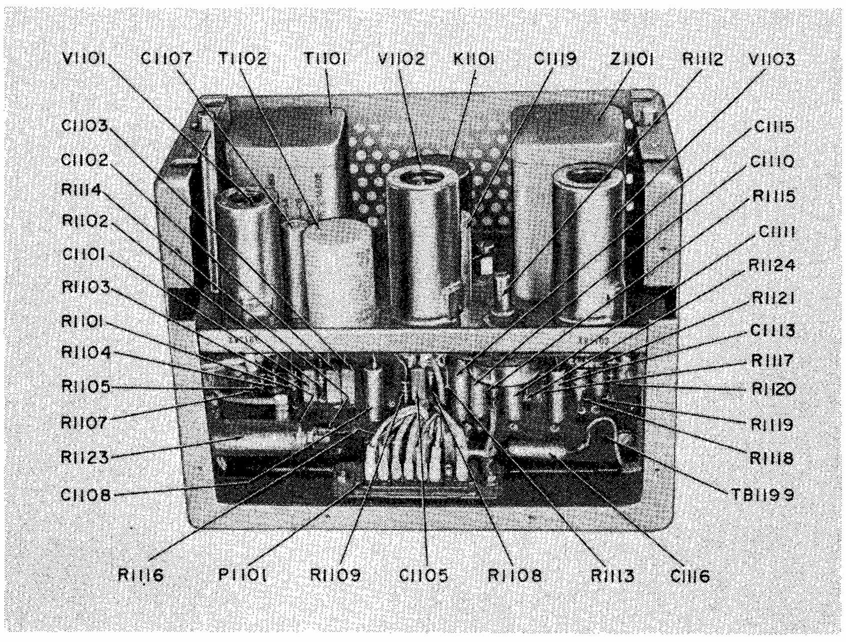
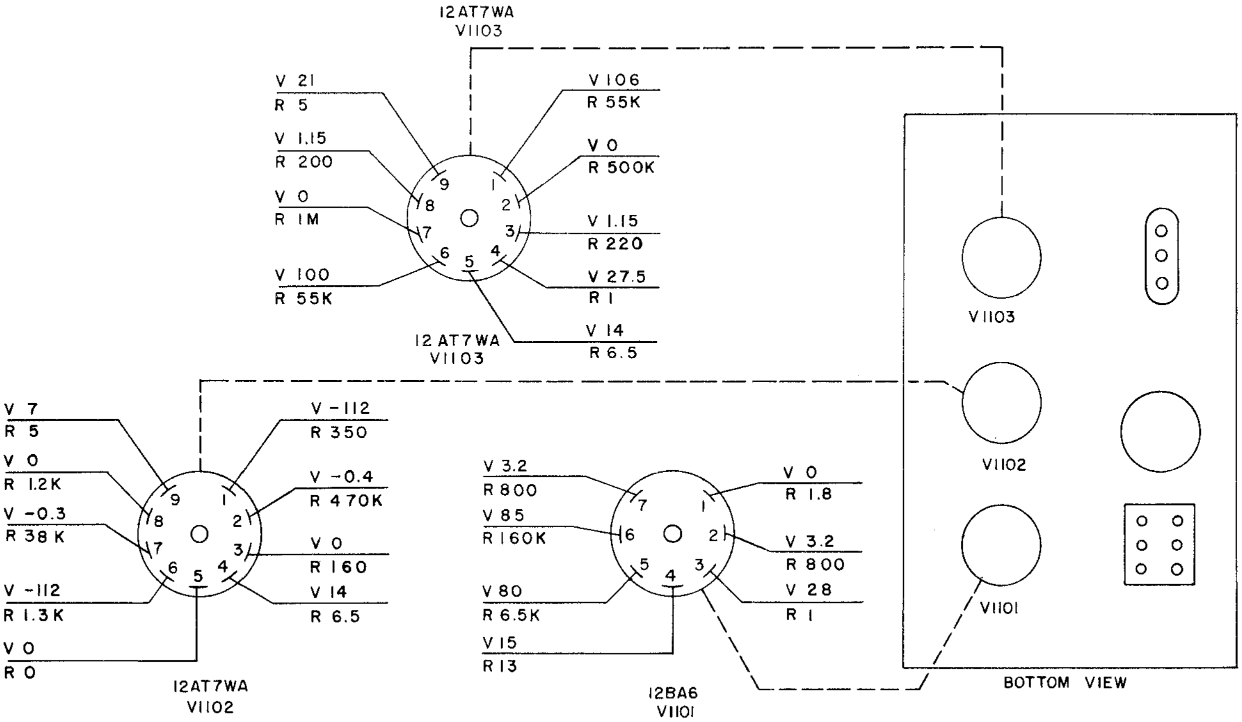


Figure 7–26. Audio Frequency Amplifier, Side View



NOTES:
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K = 1000 OHMS; M = 1,000,000 OHMS.
3. READINGS TAKEN WITH SERVICE SELECTOR SWITCH IN NETTING POSITION, KEY UP, AND POWER AMPLIFIER STAGE TUNED.

Figure 7–27. Audio Frequency Amplifier, Voltage and Resistance Chart

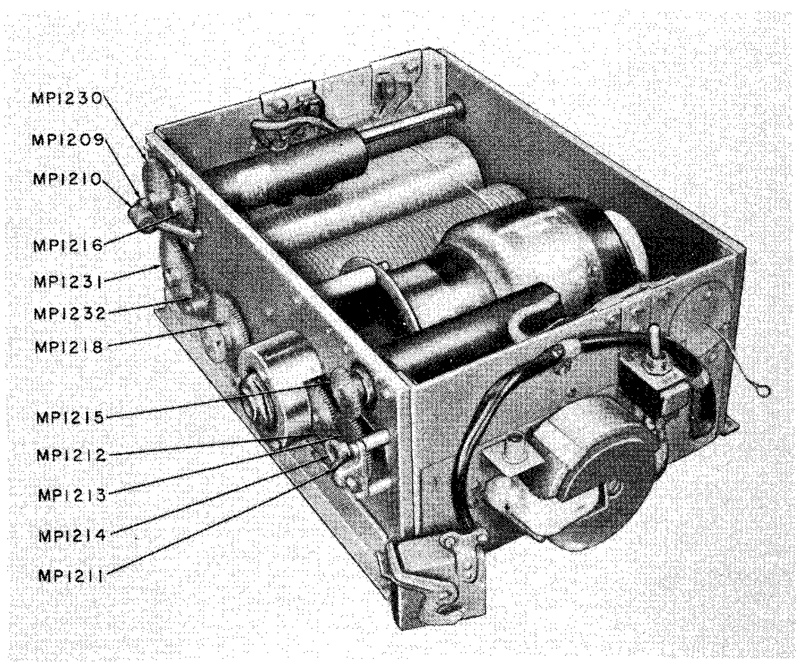


Figure 7–28. Radio Frequency Tuner, Oblique View

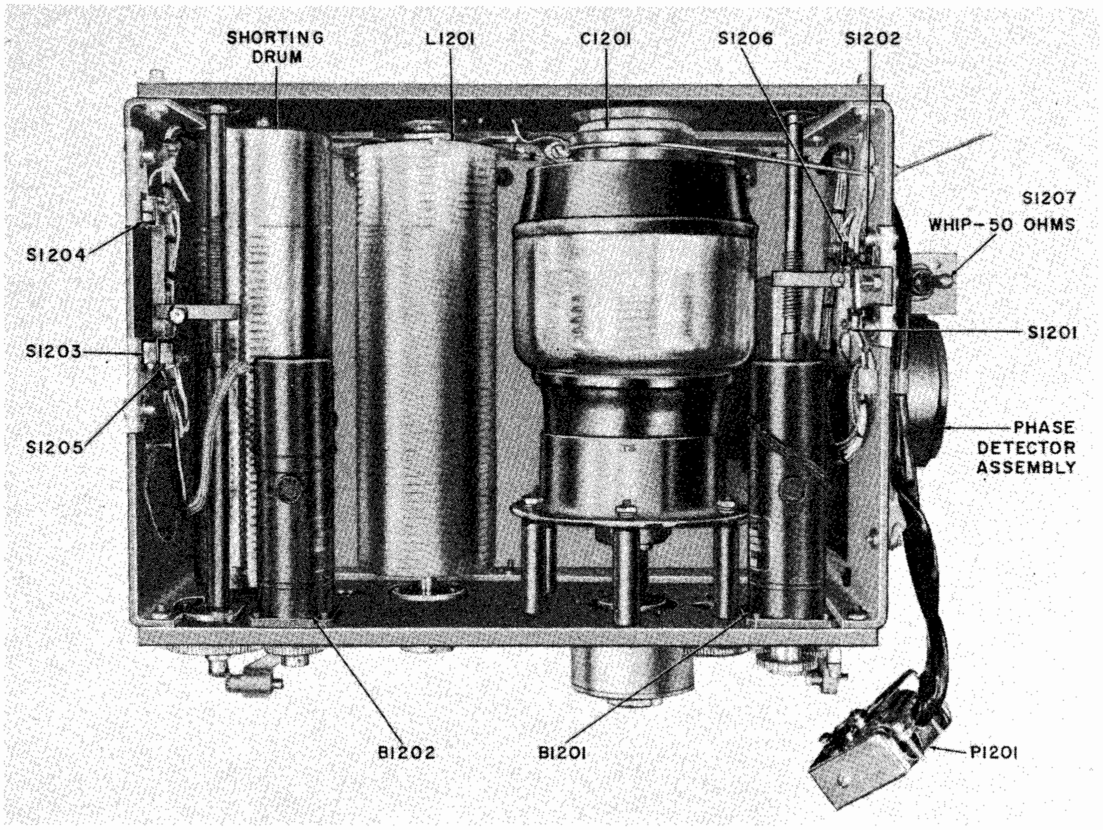


Figure 7-29. Radio Frequency Tuner, Top View

Note

A preliminary adjustment may be made (steps 7 through 14) with cover off, but a final check must be made with cover in place.

Step 7. Rotate C1210 to minimum capacity.

Step 8. Set signal to 2 mc and adjust C1202 starting from maximum capacity so that the output at C1209 is zero millivolts into the 4.7 k load. (Use the 2.5 mv mid-zero on vtvm.)

Step 9. At any frequency from 2 to 30 mc, a minimum of ±2 millivolts shall be obtained with the adjustment of C1202 from its original zero reading. Make checks at 2, 4, 10, and 30 mc and return C1202 to a zero reading after each check. If adjustment of C1202 does not meet the above requirements, diode (CR1201, CR1202) transposing or replacement will be necessary.

Step 10. With C1202 set to zero reading at 2 mc, tune signal generator slowly from 2 mc to 30 mc. Observe that millivolt readings remain within ±0.1 millivolt. If they do not, a compromise adjustment of C1202 may be made.

Step 11. Disconnect dc vtvm from C1209 and connect it to C1208.

Step 12. Repeat steps 6 and 7, except adjust C1206 and observe output with vtvm connected to C1208. If adjustment of C1206 does not meet requirement of ±2 millivolts, minimum, transposition or replacement of diodes CR1203 or CR1204 may be necessary.

Step 13. With C1206 set to zero reading at 2 mc, tune signal generator slowly from 2 to 30 mc. Observe that millivolt readings remain within ±0.1 millivolt. If they do not, a compromise adjustment of C1206 may be made.

Step 14. To meet requirements of step 12, adjustment of C1210 may be necessary. If a plus reading is obtained at C1208 as the frequency increases, adjust C1210 for slightly more capacity. If a negative reading is obtained with increasing frequency, adjust C1210 for less capacity.

Step 15. Recheck output at C1209. (Repeat steps 8 through 10.)

Step 16. Disconnect all test equipment and the three resistors (28 ohm, 4.7 k, and 10 k). Connect wires previously removed between C1209 and P1201 terminal 12; and C1208 and P1201 terminal 10. Replace phase detector assembly in the rf tuner and reconnect strap connection from C1201 to T1202, PRI-1.

(9) POWER SUPPLY ADJUSTMENTS. *(Refer to figures 4-4, 7-30 and 7276.)*—There is only one adjustment necessary in the power supply. Potentiometer R1425, a screwdriver control, is adjusted for +250

volts as indicated on the TEST meter located on the transmitter front panel. The potentiometer is located on the top power supply of the main chassis. The main chassis must be extended from the cabinet to make this adjustment.

d. CRYSTAL DATA.

(1) GENERAL.—The transmitter uses 28 crystals, all located in the reference oscillator and mixer assembly. The crystals are contained in a common temperature-controlled oven. The following circuits are crystal controlled. (Refer to figures 7–12 and 7–62.)

(a) 100-KC STEP OSCILLATOR V402.—Ten quartz crystals are used. The appropriate crystal is selected by S404, the front panel 100 KC FREQUENCY SET control. The fundamental crystal frequency is applied to the mixer-stabilizer subassembly and heterodyned with the output from oscillator V401 to obtain a reference frequency in the 2 to 3 mc range.

CRYSTAL	FREQUENCY	CRYSTAL	FREQUENCY
Y401	3.7 mc	Y406	4.2 mc
Y402	3.8 mc	Y407	4.3 mc
Y403	3.9 mc	Y408	4.4 mc
Y404	4.0 mc	Y409	4.5 mc
Y405	4.1 mc	Y410	4.6 mc

(b) FUNDAMENTAL OSCILLATOR V403.—Eleven quartz crystals are used. The appropriate crystal is selected by S405 and S406, the front panel 1 MC and 10 MC FREQUENCY SET controls. The fundamental crystal frequnecy is heterodyned with output from the vfo subassembly and oscillators V404 and V405 to obtain a comparison frequency in the 2 to 3 mc range.

CRYSTAL	FREQUENCY	CRYSTAL	FREQUENCY
Y411	8 mc	Y417	14 mc
Y412	9 mc	Y418	15 mc
Y413	10 mc	Y419	16 mc
Y414	11 mc	Y420	17 mc
Y415	12 mc	Y421	18 mc
Y416	13 mc		

(c) OSCILLATOR DOUBLER V404.—Five quartz crystals are used. The appropriate crystal is selected by S405, the front panel 1 MC FREQUENCY SET control. The output frequency of oscillator tube V404 is twice the crystal frequency. The output from V404 is heterodyned with outputs from the vfo subassembly and oscillators V403 and V405 to obtain a comparison frequency in the 2 to 3 mc range.

CRYSTAL	FREQUENCY	V404 OUTPUT FREQUENCY
Y422	17.0 mc	34 mc
Y423	16.5 mc	33 mc
Y424	16.0 mc	32 mc
Y425	18.0 mc	36 mc
Y426	17.5 mc	35 mc

(d) OSCILLATOR TRIPLER V405.—Two quartz crystals are used. The appropriate crystal is selected by relay K403 which is energized by S405 and S406, the front panel 1 MC and 10 MC FREQUENCY SET controls. The output frequency of oscillator tube

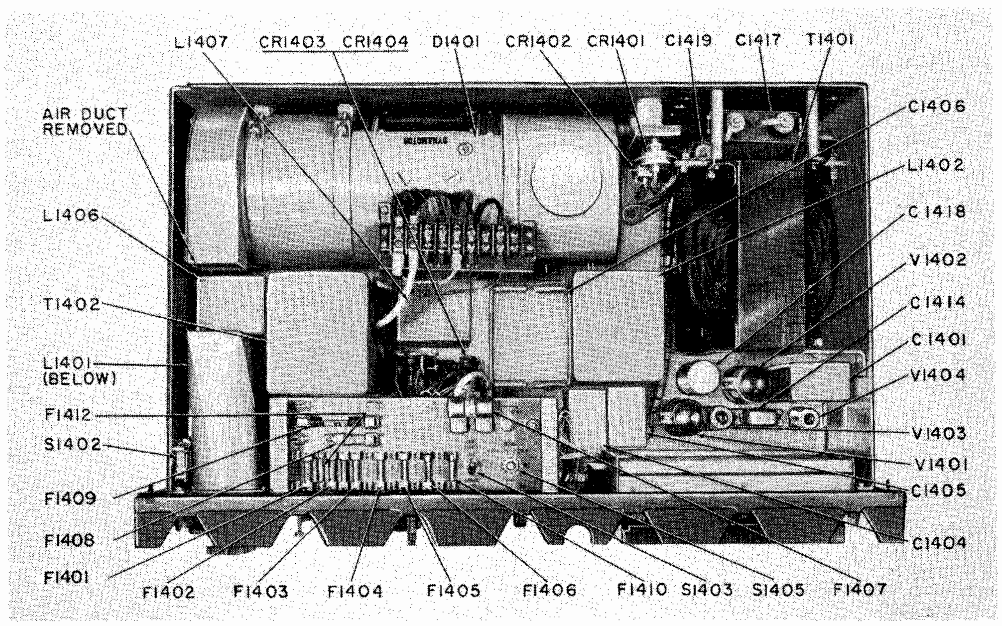


Figure 7–30. Power Supply, Top View

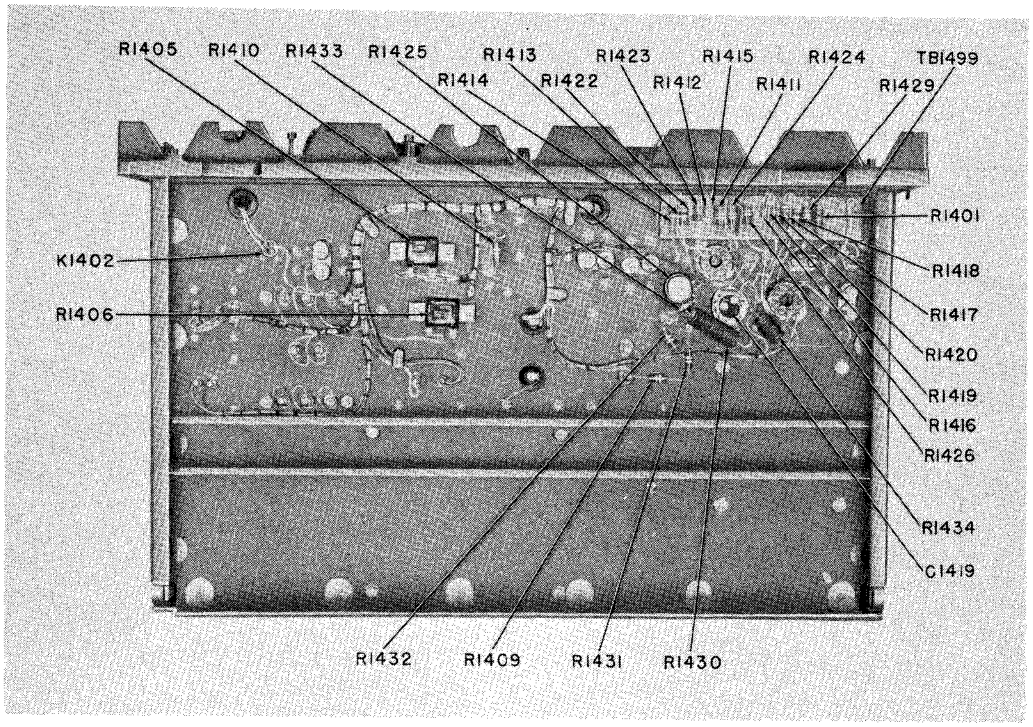
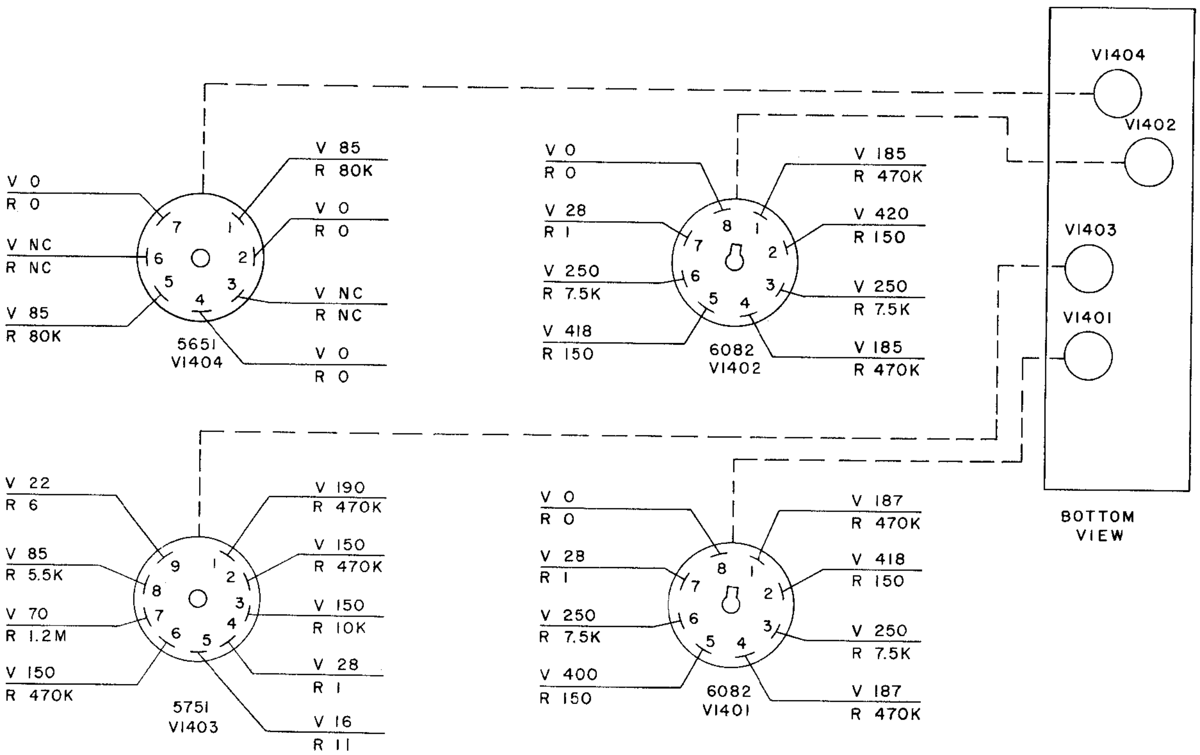


Figure 7–31. Power Supply, Bottom View



NOTES
1. UNLESS OTHERWISE INDICATED, ALL VOLTAGE ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH A SIMPSON MODEL 260 (20,000 OHMS PER VOLT), AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.

Figure 7–32. Power Supply, Voltage and Resistance Chart

V405 is three times the crystal frequency. The output from V405 is heterodyned with the outputs from the vfo subassembly and oscillators V403 and V404 to obtain a comparison frequency in the 2 to 3 mc range.

CRYSTAL	FREQUENCY	V405 OUTPUT FREQUENCY
Y427	11.667 mc	35 mc
Y428	13.333 mc	40 mc

(2) CRYSTAL CHARACTERISTICS. — The 28 crystals used in the transmitter are all of the same type and therefore have the same characteristics. The crystals are type CR-36/U and are hermetically sealed in crystal holders (type HC-6/U). The crystals have an accuracy of ±0.0005 percent from the frequency at 85 degrees C (reference temperature) throughout their operating temperature range of 80 degrees to 90 degrees C. The tolerance of the crystals at the 85 degrees C reference temperature is ±0.002 percent of their designated frequency.

(3) CRYSTAL HOLDER CHARACTERISTICS. —The crystal holders (type HC-6/U) have the following physical dimensions: length 0.750 inch; width 0.345 inch; height 0.765 inch (less pins); number of pins 2; spacing of pins 0.486 inch; diameter of pins 0.050 inch. The crystal is wire-mounted in the metal crystal holder.

7-5. RECEIVER TROUBLESHOOTING AND REPAIR.

(See figures 7-33 through 7-52 and 7-78 through 7-89.)

a. TROUBLESHOOTING PROCEDURES. — The technician should first consult the receiver troubleshooting chart (table 7-7-) as a preliminary aid whenever a failure occurs in the receiver. The checks listed in the chart are those which may readily be made with a minimum of time and test equipment. In such cases where the trouble is not easily localized, the technician should adopt a systematic procedure to localize the trouble.

Note

If the receiver is operative but the output level is low, a sensitivity check of the subassemblies should be performed.

The following procedures may be used as an aid in troubleshooting the receiver.

(1) If the receiver is inoperative on cw, mcw, and phone, but operates normally on fsk, as evidenced by indications on the TELETYPE TUNING meter, the rf head and the first three if. stages are eliminated as a possible source of trouble, as is also bfo stage V1606. If the OPERATION SWITCH is in the BROAD PHONE position, the squelch circuit should be disabled by rotating the RF GAIN SQUELCH control fully ccw before starting troubleshooting. As a quick check, the technician should replace V1604, V1605, V1513, and V1508. If the trouble is still present, start signal tracing. A tube adapter set (type 49416 or equivalent) should be used to gain access to the tube pins.

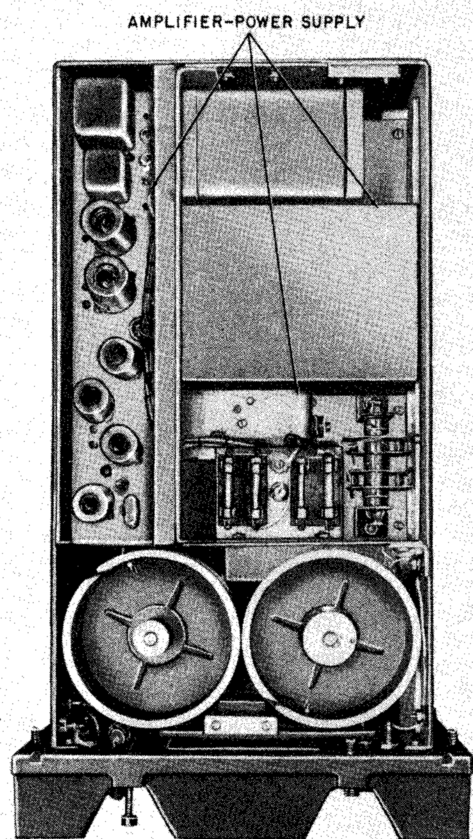


Figure 7-33. Radio Receiver, Top View

CAUTION

Care must be taken while signal tracing to prevent the stages from being overdriven, and thereby obtaining inconclusive results. The output level of the signal generator should initially be set at a low level. If amplifier stages are operating correctly, an increase in output level should be heard as the output of the signal generator is moved towards the receiver front end.

An audio frequency signal (400 cycles) from a signal generator (type LAJ or equivalent) should be injected at the input (pin 2) of audio driver V1508. If an output signal is heard in the loudspeaker or headset, the trouble is probably caused by relay K1502, CR1504, V1513A, fourth if. amplifier V1604, or detector stage V1605A. If an output signal was not heard with a signal injected at pin 2 of V1508, the loudspeaker or headset and interconnecting cables should first be checked, by applying an audio signal

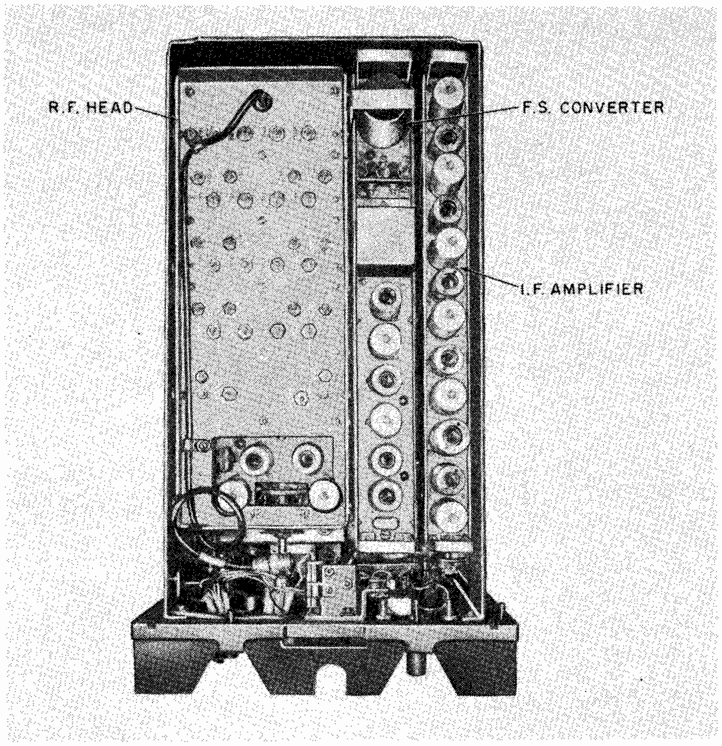


Figure 7-34. Radio Receiver, Bottom View

between terminal 4 of T1518 and ground. If an output is heard, the trouble is in the audio output stage (Q1501, Q1502).

(2) If the receiver is operative on all services except fsk, the fs converter is probably at fault. Replace tubes and check transistor voltages. If tube or transistor replacement fails to cure the trouble, it will be necessary to signal trace the fs converter. Use the TELETYPE TUNING meter as an output indicator.

(3) If the receiver is inoperative for all services, the trouble will be found in the rf head or in the first three stages of the if. amplifier subassembly.

Note

If fsk transmissions are not available, the audio frequency amplifiers and the fourth if. amplifier (V1604) and detector (V1605A) stages cannot be eliminated. These stages should be checked in accordance with paragraph 7-5 *a* (1).

Place the front panel BAND SWITCH on band 1 or 2. This bypasses 1500-kc amplifier V1504 and converter V1505. If the receiver operates on bands 1 and 2 but is inoperative on bands 3 and 4, the trouble will be found in the V1504 or V1505 stage. If the receiver is inoperative on all four bands, disable the squelch circuit (phone operation) by rotating the RF GAIN SQUELCH control fully counterclockwise, and begin troubleshooting.

Replace tubes V1501, V1502, V1503, V1506, V1507, V1601, V1602, and V1603. If the trouble is still present, begin signal tracing. Apply an audio modulated

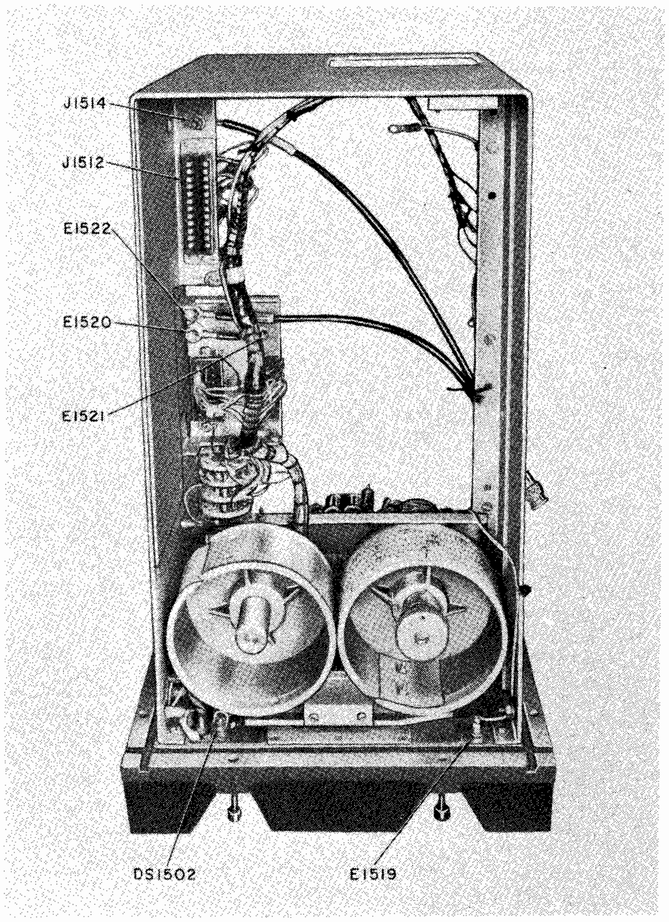


Figure 7-35. Receiver Main Chassis, Top View

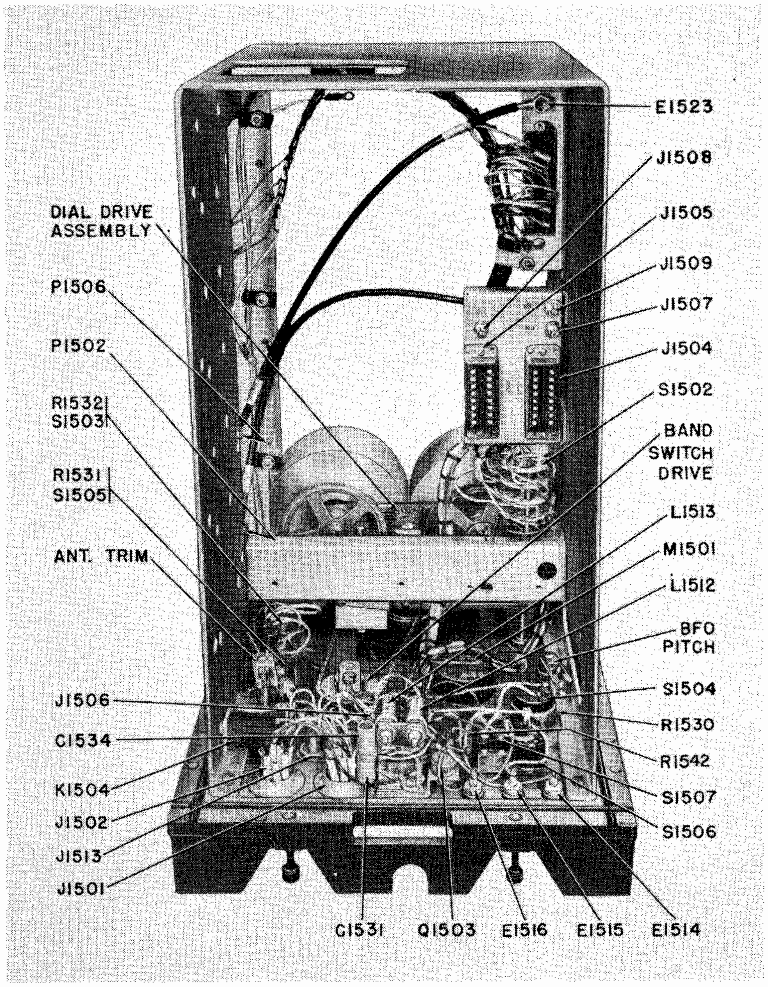


Figure 7–36. Receiver Main Chassis, Bottom View

455-kc signal from a signal generator (LP series or equivalent) to the input of the if. amplifier at P1602. If there is no audio output from the loudspeaker or headset, the trouble will probably be found in the first, second, or third if. amplifier stages. Apply the modulated 455-kc signal to the control grids (pin 1) of V1603, V1602, and V1601, respectively, until the defective stage is isolated.

If an output is heard with an audio modulated 455-kc signal applied at P1602, the trouble will be found in the rf head. The receiver should be set for phone operation on band 1 or 2. Replace tubes V1501, V1502, V1503, V1506 and V1507. (V1504 and V1505 are used only for band 3 and 4 operation.) If tube replacement does not remedy the trouble, start signal tracing.

Tune the receiver to any frequency within the band being used. Adjust an rf signal generator (LP series or equivalent) to obtain an audio modulated signal at the same frequency as that indicated on the receiver FREQUENCY dial. Inject this signal at the control grid (pin 7) of mixer tube V1503. If no output is heard from the receiver, the trouble will be found in mixer stage V1503, oscillator stage V1506, or harmonic amplifier stage V1507.

If an output was heard with a modulated rf signal injected at the control grid of V1503, the trouble will be found in the first or second rf amplifiers, V1501 and V1502, or the antenna input circuit. Isolate the faulty stage by applying a modulated rf signal at the control grid of each of the rf stages, and finally, if necessary, at the antenna input receptacle.

b. MECHANICAL ADJUSTMENTS.—The following procedures outline the methods to be followed for removal and repair of receiver components.

(1) SUBASSEMBLY REMOVAL. — All receiver subassemblies may be removed from the main chassis. To obtain access to the subassemblies, loosen the front panel fasteners and remove the main chassis from the cabinet. The following procedures should be followed to remove the subassemblies. (See figures 7–33 through 7–36.)

(a) AMPLIFIER-POWER SUPPLY.—The amplifier-power supply is a plug-in unit mounted on the top of the receiver main chassis. (See figures 7–33, 7–37, 7–38 and 7–39.) To remove the subassembly:

Step 1. Loosen mounting screws that secure subassembly to main chassis and gently lift unit to disconnect P1504 from J1512. Then disconnect J1514 from P1503 and remove unit.

Step 2. To replace amplifier-power supply in main chassis, reverse removal procedure.

(b) RADIO FREQUENCY HEAD. — The rf head is a removable subassembly mounted on the underside of the receiver main chassis. (See figures 7–34 and 7–43 through 7–45.)

1. REMOVAL.

Step 1. Place BAND SWITCH at the 2-4 MC position and ANT. TRIM. control fully counterclockwise.

Step 2. Disconnect the following: P1505 from J1513 (bottom); P1502 from J1510 (right side); P1506 from J1511 (right side); antenna wire lead from feed through terminal E1525 (right side). Also, disconnect the power supply wire leads from terminal board TB1501 (rear), making a note of connections (color code and terminal numbers) removed so that the leads may be replaced properly later on.

Step 3. Rotate the TUNE knob to extreme ccw position (FREQUENCY dial at zero index mark).

Step 4. Loosen two allen cap screws on shaft coupling MP1530. This coupling is accessible through side cut-out of main chassis and couples shaft of tuning capacitor C1501 to dial drive shaft on main chassis. Slide coupling toward capacitor C1501 until shafts separate.

Step 5. Remove four mounting screws that secure rf head and lift subassembly out. It may be desirable to loosen two mounting screws on fs converter subassembly to facilitate removal of rf head.

2. REPLACEMENT.

Step 1. Set switch S1501 and antenna trimmer coupling arms pointing toward bottom of unit. Make sure that BAND SWITCH on front panel is at

TABLE 7–7. RADIO RECEIVER TROUBLESHOOTING CHART

TROUBLE	SYMPTOMS	PROBABLE CAUSE	CORRECTIVE ACTION
Both receivers inoperative on ac input only.	Dial light not lit with DIAL DIMMER fully clockwise.	No input power.	Refer to table 7–4.
Only receiver No. 1 or receiver No. 2 inoperative on ac input only.	Dial light not lit with DIAL DIMMER fully clockwise.	Fuse F1504 open.	Check fuse and replace if necessary.
		Faulty rectifier circuit.	Check CR1502 and T1521.
Both receivers inoperative on dc input only.	Dial light not lit with DIAL DIMMER fully clockwise.	No input power.	Refer to table 7–4.
Only receiver No. 1 or receiver No. 2 inoperative on dc input only.	Dial light not lit with DIAL DIMMER fully clockwise.	Fuse F1503 open.	Replace fuse.
Receiver inoperative on bands 3 and 4 only.	No output for any mode of operation.	Faulty tube V1504 or V1505.	Replace tubes.
Receiver inoperative only at CW SHARP position of OPERATION SWITCH.	No output.	Faulty filter FL1501.	Replace filter.
Receiver inoperative only at CW, SHARP and CW, FSK BROAD positions of OPERATION SWITCH.	No cw reception.	Faulty tube V1606.	Replace tube.
Receiver inoperative only at CW, FSK BROAD and FSK, PHONE positions of OPERATION SWITCH.	No fsk reception.	Faulty tube, transistor, or crystal rectifier in frequency shift converter.	Replace tube(s) and/or transistor(s) and/or crystal rectifier.
Receiver inoperative only at BROAD PHONE position of OPERATION SWITCH.	No voice reception.	R-F GAIN SQUELCH control improperly set.	Readjust R-F GAIN SQUELCH control.
Calibrating receiver main tuning dial impossible with OPERATION SWITCH at the CAL position.	No beat signals present.	Faulty tube V1512 or V1510.	Replace tubes.

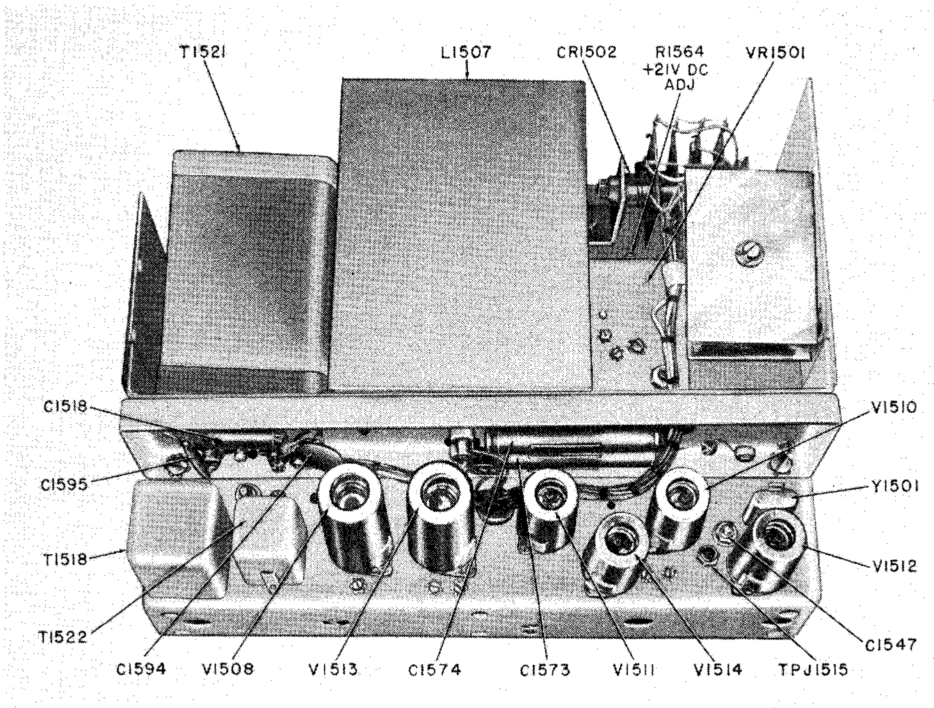


Figure 7–37. Amplifier-Power Supply, Top View

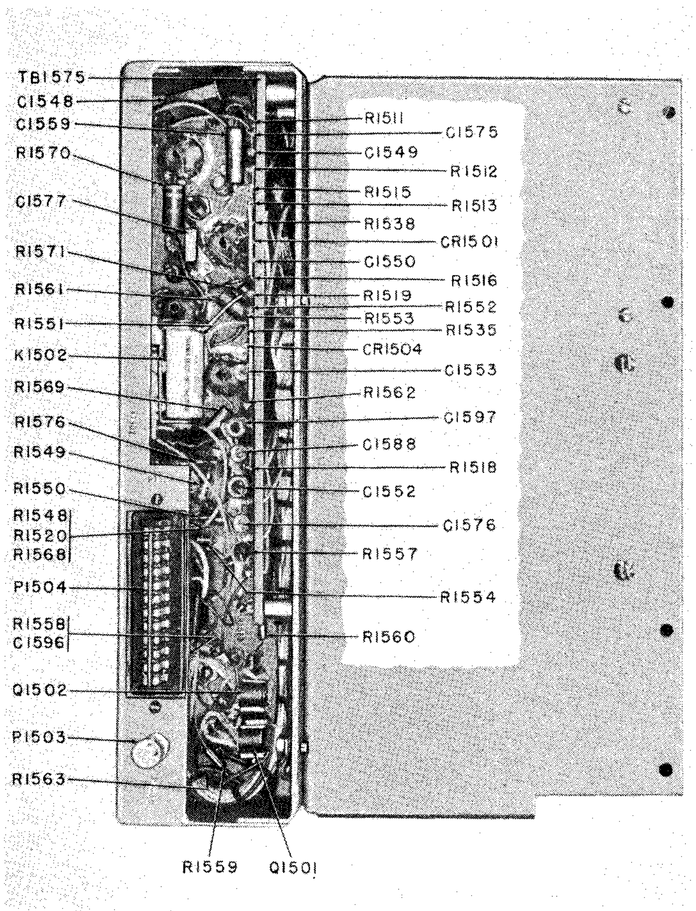
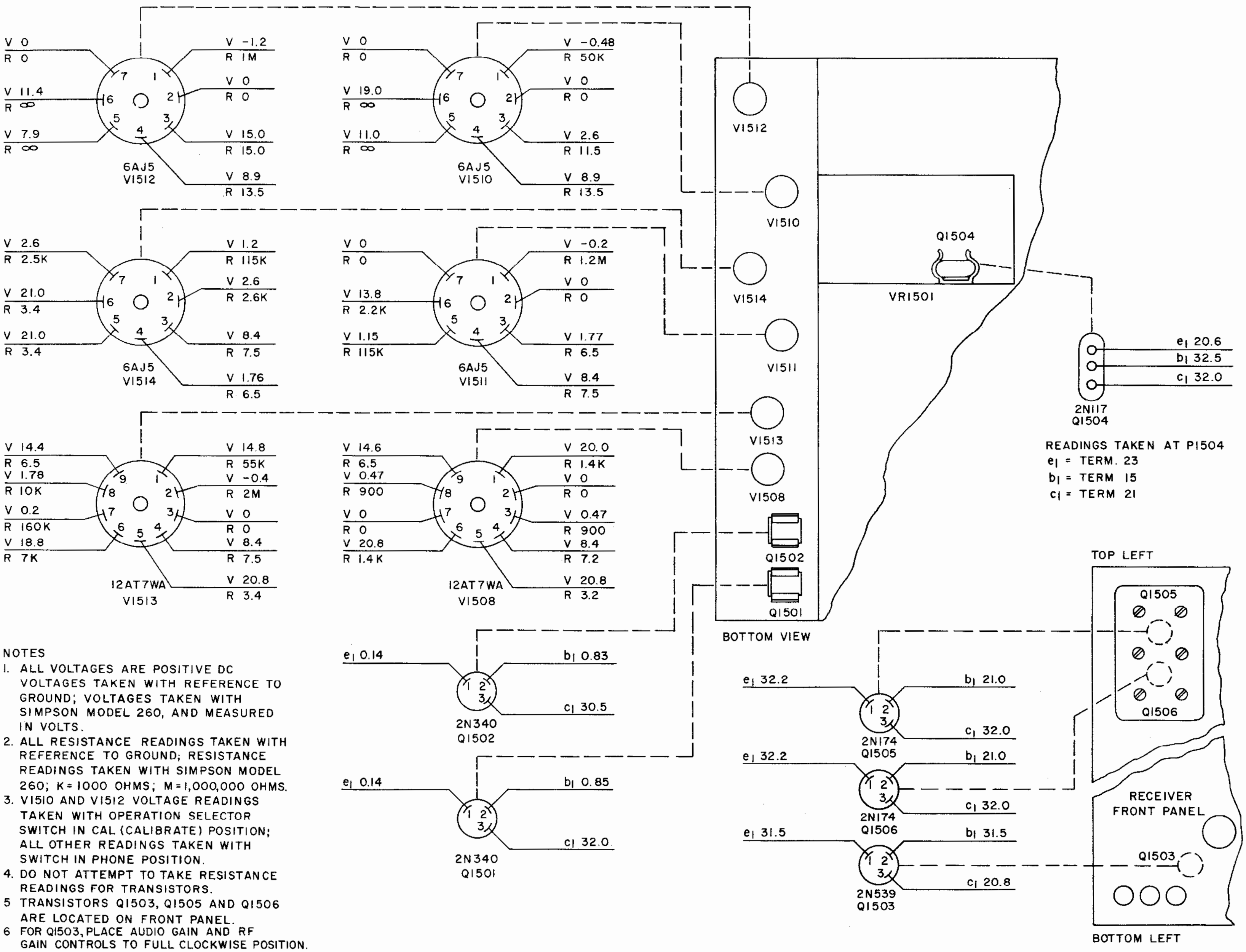


Figure 7–38. Amplifier-Power Supply, Bottom View



NOTES

1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K = 1000 OHMS; M = 1,000,000 OHMS.
3. V1510 AND V1512 VOLTAGE READINGS TAKEN WITH OPERATION SELECTOR SWITCH IN CAL (CALIBRATE) POSITION; ALL OTHER READINGS TAKEN WITH SWITCH IN PHONE POSITION.
4. DO NOT ATTEMPT TO TAKE RESISTANCE READINGS FOR TRANSISTORS.
5. TRANSISTORS Q1503, Q1505 AND Q1506 ARE LOCATED ON FRONT PANEL.
6. FOR Q1503, PLACE AUDIO GAIN AND RF GAIN CONTROLS TO FULL CLOCKWISE POSITION.

7-39. Amplifier-Power Supply, Voltage and Resistance Chart

2-4 MC position, ANT. TRIM. control is at extreme counterclockwise position, and FREQUENCY dial is set to zero index mark.

Step 2. Check to see that tuning capacitor C1501 on rf head is fully meshed. This is observed by removing plug button, located above tube V1506, from side cut-out. Do not replace plug button until later. Position coupling MP1530 on C1501 shaft so that cap screws are facing plug button opening.

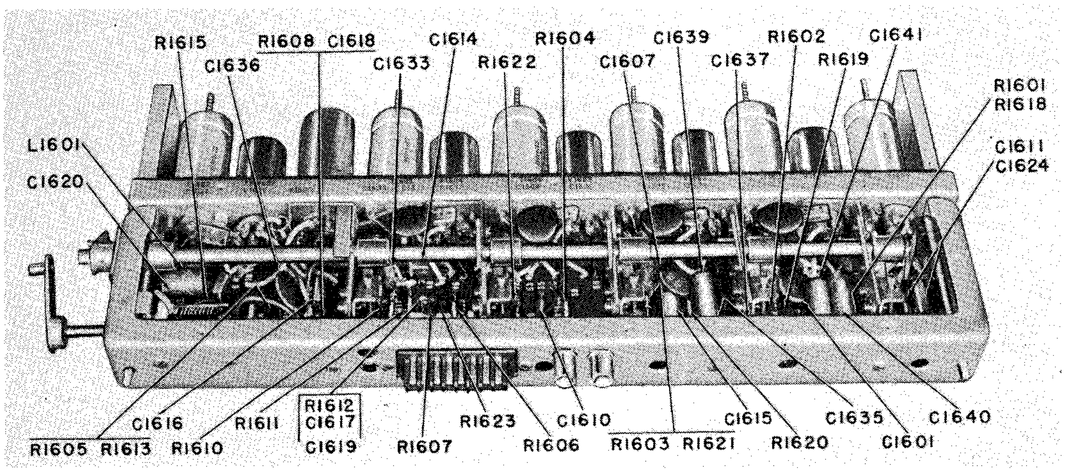
Step 3. Place rf head in main chassis. Examine mechanical alignment of C1501 shaft with dial drive shaft on front panel by viewing from side cut-out. If alignment is not exact, adjust the two height adjustment inserts with a 5/16-inch blade screwdriver. Inserts are located in front mounting holes. Slide coupling MP1530 so that it will be centered equally on both shafts. Coupling should slide easily. If not, adjust height adjustment inserts, as necessary.

Step 4. Replace and tighten four mounting screws. Check to see that coupling MP1530 slides easily on both shafts, if not, loosen mounting screws and readjust height adjustment inserts, then retighten mounting screws. Tighten cap screw of coupling MP1530 on C1501 shaft only.

Step 5. After replacement, check for proper dial calibration, as follows: Check that capacitor C1501 is set to a full mesh position. (It is possible that capacitor may have moved during replacement of rf head.) This is done by inserting a flat tool, such as a screwdriver blade, through plug opening and placing blade on top of stator plate assembly. Turn rotor assembly until it just touches tool at maximum capacity (full mesh). Continuing to hold tool against stator assembly, tighten remaining cap screw on coupling MP1530 while rotating allen wrench to produce a full mesh.

Step 6. Connect cables P1505 to J1513, P1502 to J1510, and P1506 to J1511. Replace antenna wire lead to terminal E1525, and wire leads from power supply to their proper terminals on terminal board TB1501. Replace plug button.

(c) INTERMEDIATE FREQUENCY AMPLIFIER.—The if. amplifier is a plug-in unit mounted on the underside of the receiver main chassis. (See figures 7–34, 7–40, 7–41 and 7–42.)



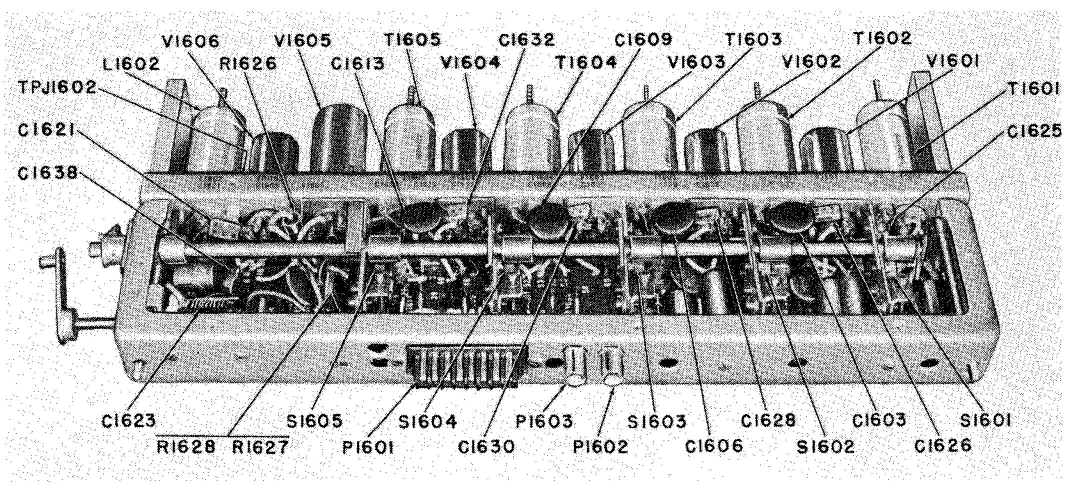


Figure 7–40. Intermediate Frequency Amplifier, Right Side View

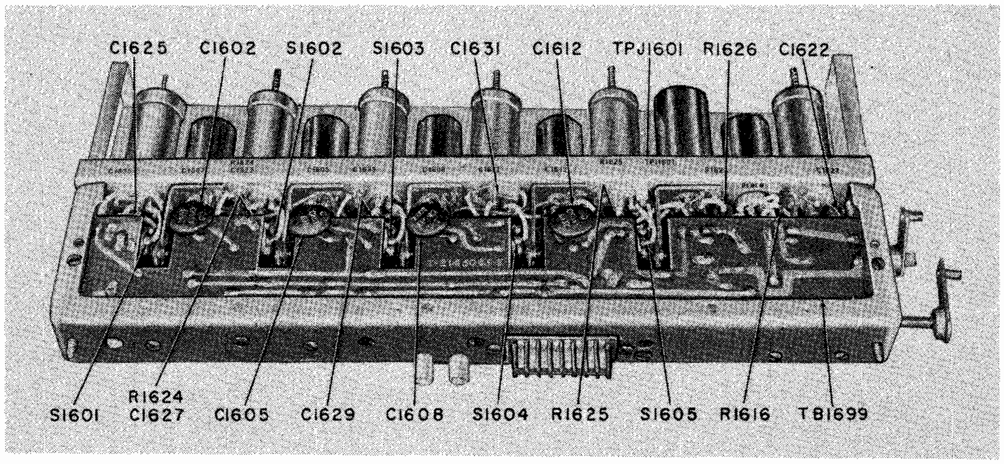
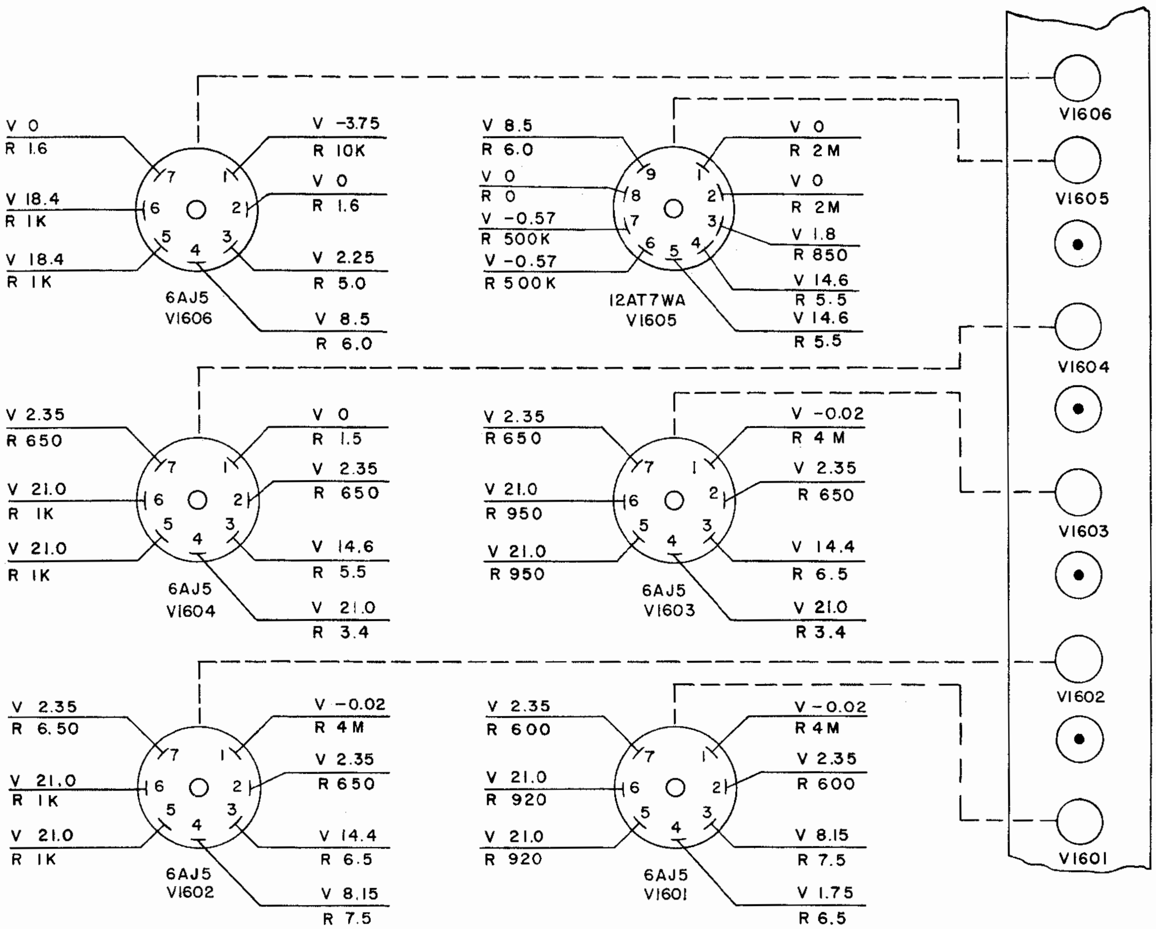


Figure 7–41. Intermediate Frequency Amplifier, Left Side View



NOTES
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.
3. V1606 VOLTAGE READINGS TAKEN WITH OPERATION SELECTOR SWITCH IN CW, FSK BROAD POSITION; ALL OTHER READINGS TAKEN WITH SWITCH IN PHONE POSITION.

Figure 7–42. Intermediate Frequency Amplifier, Voltage and Resistance Chart

Step 1. Rotate BFO PITCH control to its full clockwise position, and place OPERATION SWITCH at CAL. position.

Step 2. Turn main chassis bottom side up, and remove cotter pins that secure link coupling to OPERATION SWITCH on front panel. Remove link coupling.

Step 3. Loosen two mounting screws holding subassembly to main chassis, and gently lift unit to disconnect P1601 from J1504. Then disconnect J1507 from P1603 and J1509 from P1602 and remove unit.

Step 4. To replace the if. amplifier in main chassis, reverse removal procedure.

(d) FREQUENCY SHIFT CONVERTER.—The fs converter is a plug-in unit mounted on the underside of the receiver main chassis. (See figures 7–34, 7–47, 7–48 or 7–34, 7–50, 7–51.)

Step 1. Loosen two mounting screws that secure the subassembly to the main chassis and gently lift unit to disconnect P1701 (or P1751) from J1505. Then disconnect J1508 from P1702 (or P1752) and remove unit.

Step 2. To replace the fs converter, reverse the removal procedure.

c. ELECTRICAL ADJUSTMENTS.—The following procedures outline the methods to be followed in making electrical adjustments and alignments in the receiver. Allow proper warm-up before performing any adjustments. (See table 7–1 for a list of test equipment.)

(1) AMPLIFIER-POWER SUPPLY ADJUSTMENTS. *(See figures 7–37, 7–38 and 7–84.)*—Connect a vtvm (dc) to terminal board TB1501, terminal 3 in rf head. Output at terminal 3 (voltage regulator output) shall be 21 volts dc, adjustable with R1564. Output of calibrator oscillator (V1512) shall be 200 kc. Connect a frequency counter to P1503, and adjust C1547 to obtain 200 kc.

(2) INTERMEDIATE FREQUENCY AMPLIFIER ADJUSTMENTS. *(See figures 7–40, 7–41 and 7–82.)*—It will be necessary to remove the if. amplifier subassembly for the following adjustments. Connect the subassembly to the main chassis by means of test cables.

The following test equipment will be required for alignment of the rf amplifier subassembly. (See table 7–1.)

1 rf signal generator
1 frequency counter
1 vtvm (dc)

(a) IF. TRANSFORMERS T1601 THROUGH T1605.—Disconnect if. input J1509 from P1602, and connect output from a signal generator to if. input through P1602. Connect a dc vtvm to the detector output at TP-J1601. Tune the signal generator to 455 kc and check with a frequency counter. The signal generator should be adjusted to produce a signal output level of approximately 2 volts (measured at TP-J1601). The first if. transformer (T1601) should be aligned first. The signal input should be progressively reduced as more circuits are brought into proper alignment (this keeps meter on scale) with progression of circuit adjustment moving toward the last if. stage. Each new if. transformer installed is aligned by first setting its upper and lower slugs to the full out (ccw) positions, then tuning the upper slug (primary) inward (cw) until a peak is observed on the vtvm, and then tuning the lower slug (secondary) inward (cw) to first peak. After new if. transformers have been adjusted, the remaining transformers should be peaked to bring if. sections into closer alignment.

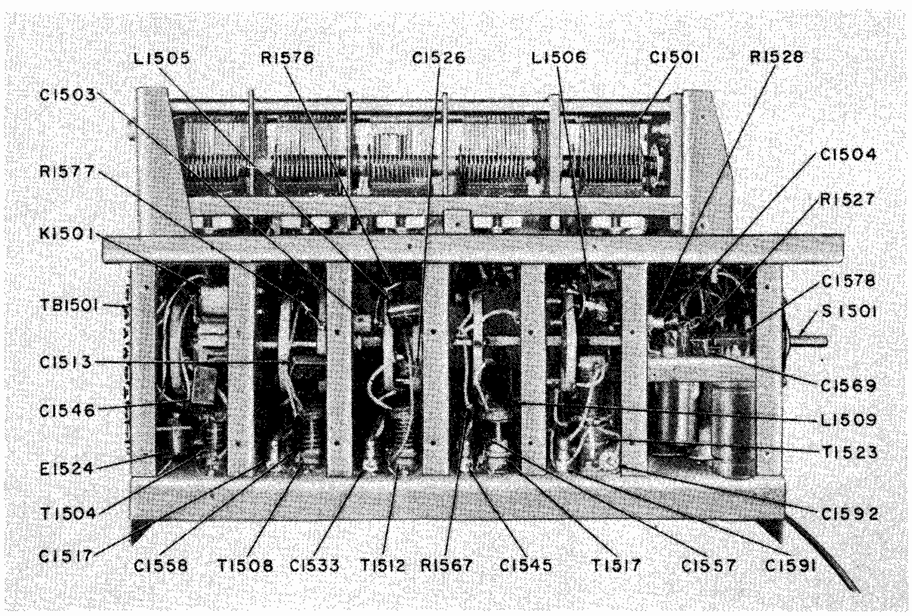


Figure 7–43. Radio Frequency Head, Left Side View

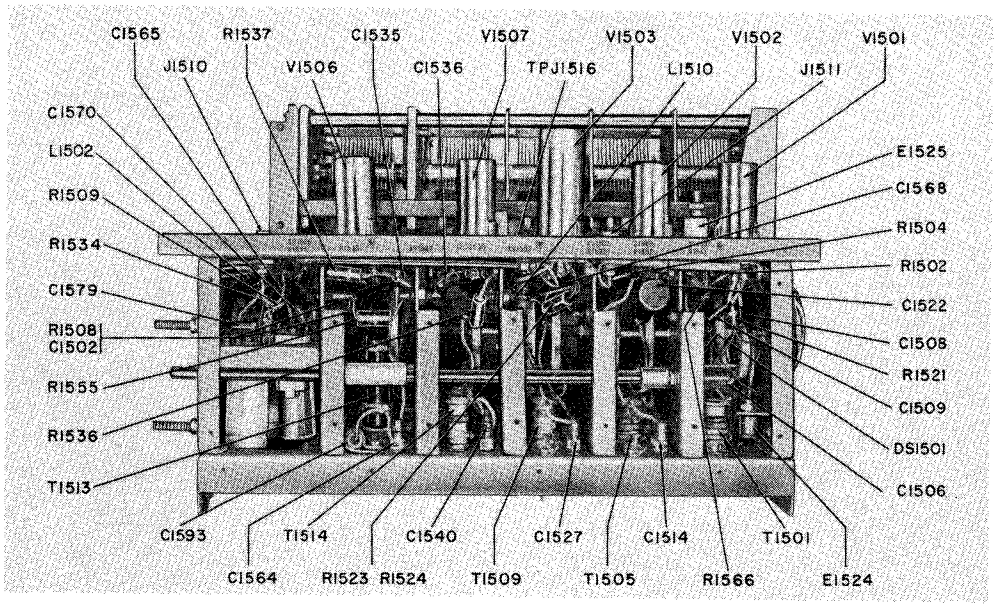


Figure 7–44. Radio Frequency Head, Right Side View

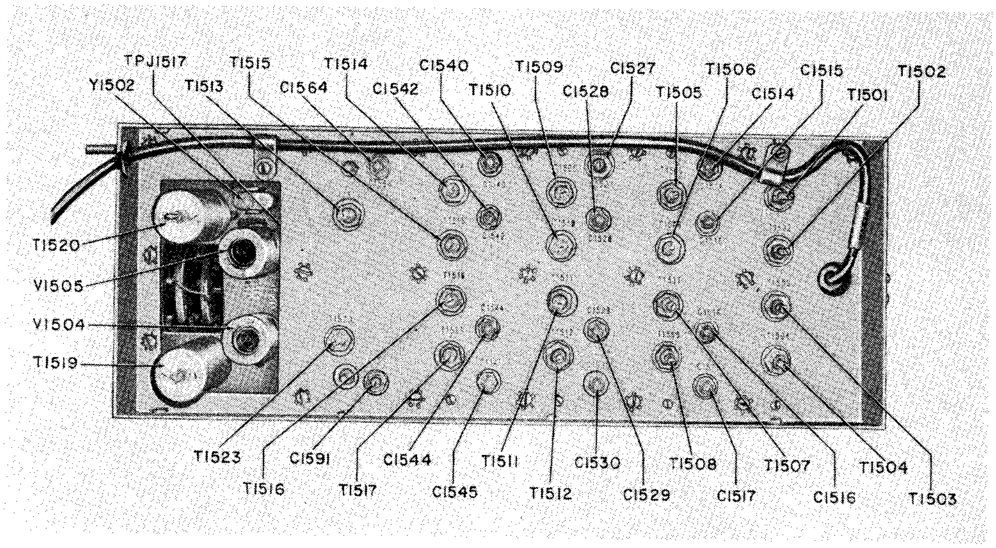


Figure 7–45. Radio Frequency Head, Bottom View

(*b*) BFO V1606.—Disconnect if. input J1509 from P1602. SET BFO PITCH adjust capacitor (C1623) to mid-point using front panel knob. Connect a frequency counter to plate (pin 6) of detector V1605AC, with tube V1605 removed. Adjust coil L1602 from maximum outward extension inward until frequency counter reads 455.0 kc. Full rotation of pitch adjust capacitor shall not cause a frequency change of less than 2.7 kc or more than 3.5 kc.

(3) RADIO FREQUENCY HEAD ADJUSTMENTS. *(See figures 7–43 through 7–46 and 7–80.)*— It will be necessary to remove the rf head from the main chassis for the following adjustments. Connect the subassembly to the main chassis by means of test cables.

The following test equipment will be required for alignment of the rf head. (See table 1–1):

1 vtvm (dc)
1 rf signal generator
1 frequency counter
1 dummy load
1 dummy antenna

(*a*) T1519 and T1520.—Connect a dc vtvm to detector output at TP-J1601. Connect a signal generator to grid of mixer at TP-J1516. Put switch S1501 in BAND 3 (8-16 mc) position. Set RF GAIN SQUELCH for approximately 0.5 volts (noise) at TP-J1601. Set signal generator to 1500 kc (check with frequency counter) and adjust signal generator output for approximately 2 volts at TP-J1601. Adjust T1519

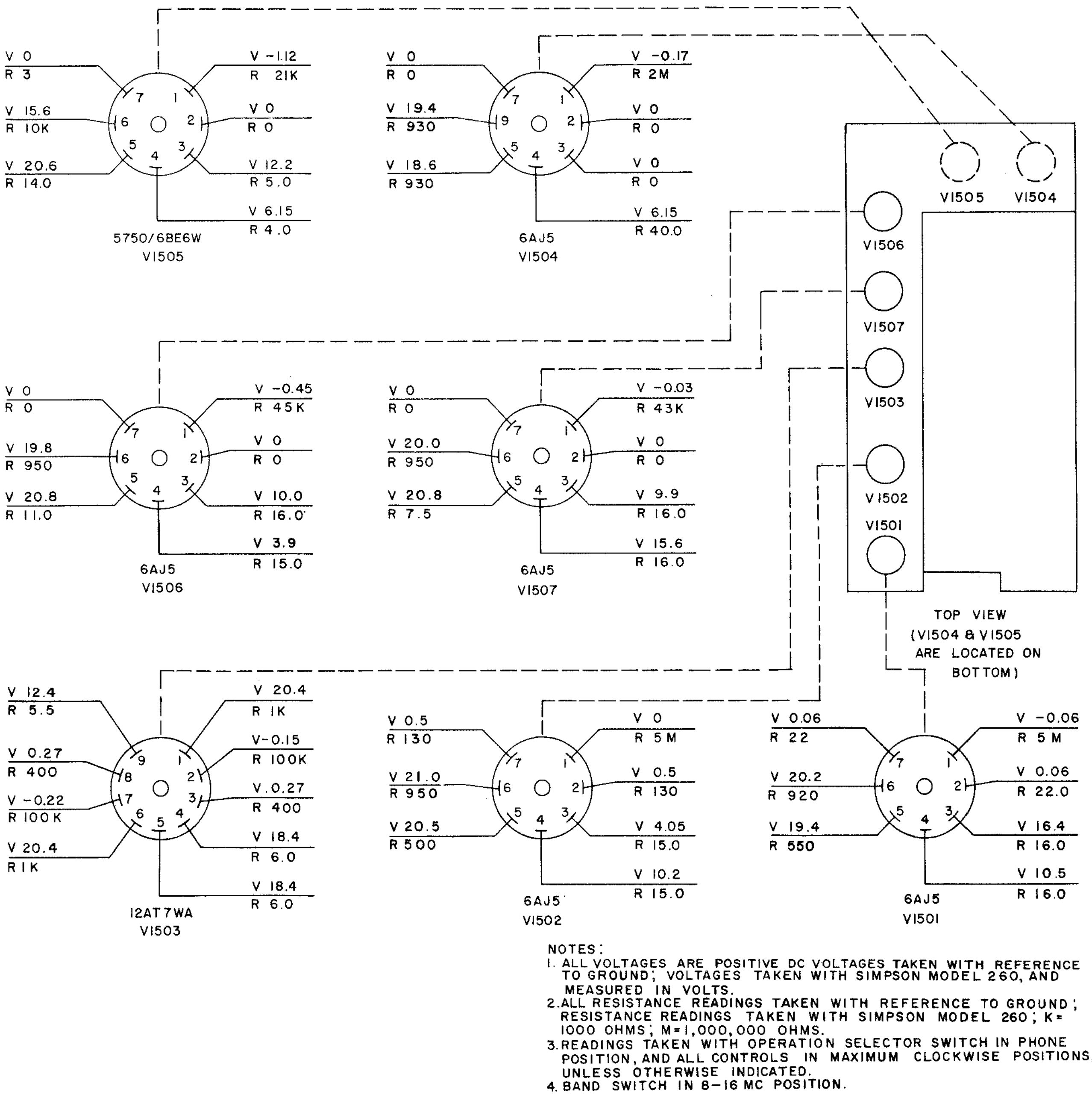


Figure 7-46. Radio Frequency Head, Voltage and Resistance Chart

and T1520 for maximum output by adjusting slugs from maximum outward extensions to first peak. Reduce generator output as coils are brought into alignment.

(b) LOCAL OSCILLATOR V1506 AND HARMONIC AMPLIFIER V1507.

1. PRELIMINARY STEPS.

Step 1. Disconnect antenna.

Step 2. Turn BFO off.

Step 3. Set OPERATION SWITCH to MCW.

Step 4. Set RF GAIN to half scale position.

Step 5. Set AUDIO GAIN control to maximum gain (fully cw).

Step 6. Disconnect signal generator and connect a frequency counter to TP-J1516.

2. BAND 1.

Step 1. Set BAND SWITCH (S1501) to BAND 1, 2-4 MC position.

Step 2. Set FREQUENCY dial (C1501) to read 2 mc.

Step 3. Turn all transformers and capacitors to full out position except those that were previously adjusted.

Step 4. Adjust transformer T1513 for 2.455 mc, indicated on frequency counter. (If unable to tune to 2.455 mc, tune to closest frequency then go on to steps 5 through 8.)

Step 5. Adjust transformer T1514 for maximum dc output indicated on vtvm.

Step 6. Set FREQUENCY dial to 4.0 mc and adjust capacitor C1564 for 4.455 mc indicated on frequency counter. (If unable to tune to 4.455 mc, tune to closest frequency, then go on to steps 8 and 9.)

Step 7. Set FREQUENCY dial to 4.0 mc and adjust capacitor C1540 for maximum dc output indicated on VTVM.

Step 8. Repeat steps 4, 5, and 6 until frequency is correct and dc output is at maximum.

3. BAND 2.

Step 1. Set BAND SWITCH to BAND 2, 4-8 MC position. Set FREQUENCY dial to 4 mc.

Step 2. Tune transformer T1515 for maximum output, indicated on vtvm.

Step 3. Set FREQUENCY dial to 8 mc. Tune capacitor C1542 for maximum output, indicated on vtvm.

Step 4. Repeat steps 1 through 4 until maximum dc output is obtained.

4. BAND 3.

Step 1. Set BAND SWITCH to BAND 3, 8-16 MC position. Set FREQUENCY dial to 8.00 mc.

Step 2. Adjust transformer T1523 for 9.50 mc output indicated on frequency counter.

Step 3. Adjust transformer T1516 for maximum dc output indicated on vtvm.

Step 4. Set FREQUENCY dial to 16.00 mc.

Step 5. Adjust capacitor C1591 for 17.500 mc output indicated on frequency counter.

Step 6. Adjust capacitor C1544 for maximum dc output indicated on vtvm.

Step 7. Repeat steps 1 through 7 until frequency is correct.

5. BAND 4.

Step 1. Set BAND SWITCH to BAND 4, 16-32 mc position. Set FREQUENCY dial to 16 mc.

Step 2. Tune transformer T1517 for maximum output, indicated on vtvm.

Step 3. Set FREQUENCY dial to 30 mc. Tune capacitor C1545 for maximum output indicated on dc vtvm.

Step 4. Repeat steps 1 through 4 until maximum dc output is obtained.

(c) RF AMPLIFIER V1501, V1502.

1. PRELIMINARY STEPS.

Step 1. Repeat all preliminary steps listed under paragraph 7-5 *c* (3) *(b) 1.*

Step 2. Connect a dummy load to AUDIO OUTPUT.

Step 3. Connect a dummy antenna to ANT HI Z receiver input at E1519.

Step 4. Connect a signal generator to dummy antenna.

Step 5. Connect a dc vtvm to detector output at TP-J1601 (if. amplifier).

2. BAND 1.

Step 1. Set BAND SWITCH to BAND 1, 2-4 MC position, and dummy antenna to 2-8 mc.

Step 2. Set signal generator to 4 mc (check with frequency meter). Reduce output as signal tunes in.

Step 3. Rotate receiver FREQUENCY dial toward high end of band until input signal is received. Do not tune to image frequency that appears at twice the if. frequency (455 kc) above the signal expected.

Step 4. Peak antenna trimmer capacitors C1506, C1514, C1527, for maximum audio output indicated on vtvm.

Step 5. Set signal generator to 2.00 mc output.

Step 6. Rotate FREQUENCY dial toward low end of band until input signal is indicated on vtvm (maximum signal slightly above or below 2 mc).

Step 7. Adjust transformers T1501, T1505, and T1509 for maximum audio output indicated on vtvm. Tune transformer T1501 to first peak found from fully extended out position. Tune transformer T1505 to second peak found from fully extended out position. Tune transformer T1509 to first peak found from fully extended out position.

Step 8. Repeat steps through 7 until maximum audio output is obtained.

3. BAND 2.

Step 1. Set BAND SWITCH to BAND 2, 4-8 MC position.

Step 2. Set signal generator for 8 mc output.

Step 3. Rotate FREQUENCY dial toward high side of band until input signal is indicated on vtvm (maximum signal slightly above or below 8 mc).

Step 4. Peak trimmer capacitors C1506, C1515, C1528 for maximum audio output indicated on vtvm.

Step 5. Set signal generator to 4 mc output.

Step 6. Rotate FREQUENCY dial toward low end of band until input signal is indicated on vtvm (maximum signal slightly above or below 4 mc).

Step 7. Adjust transformers T1502, T1506, T1510 for maximum audio output indicated on vtvm.

Step 8. Repeat steps 2 through 7 until maximum audio output is obtained.

4. BAND 3.

Step 1. Set BAND SWITCH to BAND 3, 8-16 MC position and dummy antenna to 8-16 mc.

Step 2. Set signal generator to 16 mc output.

Step 3. Rotate FREQUENCY dial toward the hig' end of band until input signal is indicated on vtvm (maximum signal slightly above or below 16 mc).

Step 4. Peak trimmer capacitors C1506, C1516, C1529 for maximum output indicated on vtvm.

Step 5. Set signal generator to 8 mc output.

Step 6. Rotate FREQUFNCY dial toward the low end of band until input ..gnal is indicated on vtvm (maximum signal slightly above or below 8 mc).

Step 7. Adjust transformers T1503, T1507, T1511 for maximum output indicated on vtvm.

Step 8. Repeat steps 2 through 7 until maximum audio output is obtained.

5. BAND 4.

Step 1. Set BAND SWITCH to BAND 4, 16-32 MC position and dummy antenna to 16-32 mc.

Step 2. Set signal generator to 30 mc output.

Step 3. Rotate FREQUENCY dial toward the high end of band until input signal is indicated on vtvm (maximum signal slightly above or below 30 mc).

Step 4. Peak trimmer capacitors C1506, C1517, C1530, for maximum output indicated on vtvm.

Step 5. Set signal generator to 16 mc output.

Step 6. Rotate FREQUENCY dial toward the low end of band until input signal is indicated on vtvm (maximum signal slightly above or below 16mc).

Step 7. Adjust transformers T1504, T1508, T1512 for maximum output indicated on vtvm.

Step 8. Repeat steps 2 through 7 until maximum audio output is obtained.

(4) FREQUENCY SHIFT CONVERTER, AF TYPE ALIGNMENT. *(See figures 7–47 through 7–49, and 7–86.)*

The following test equipment will be required for alignment of the fs converter, af type. (See table 7–1):

1 rf signal generator
1 frequency counter
1 vtvm (dc)

(a) IF. TRANSFORMERS T1701 and T1702. —It will be necessary to remove the fs converter for the following adjustments. Connect P1701 to J1505 on the main chassis by means of a test cable.

Step 1. Connect output from signal generator to if. input through P1702.

Step 2. Tune signal generator to 455 kc (unmodulated) at 0.5 volt output. Check with a frequency counter.

Step 3. Connect a dc vtvm between TP-J1702 and ground. Select a sensitive scale. There should be a negative output voltage.

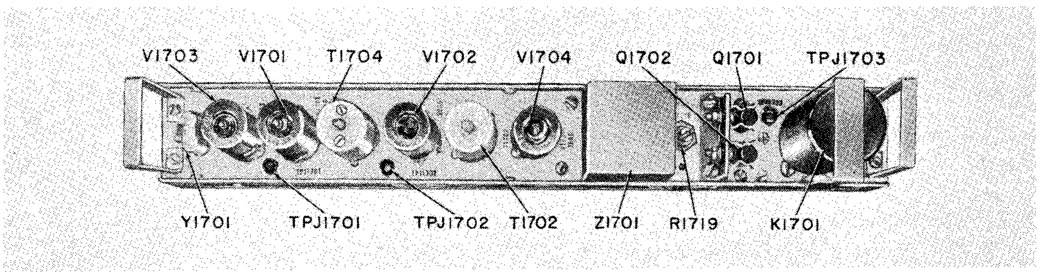


Figure 7–47. Frequency Shift Converter, AF Type, Top View

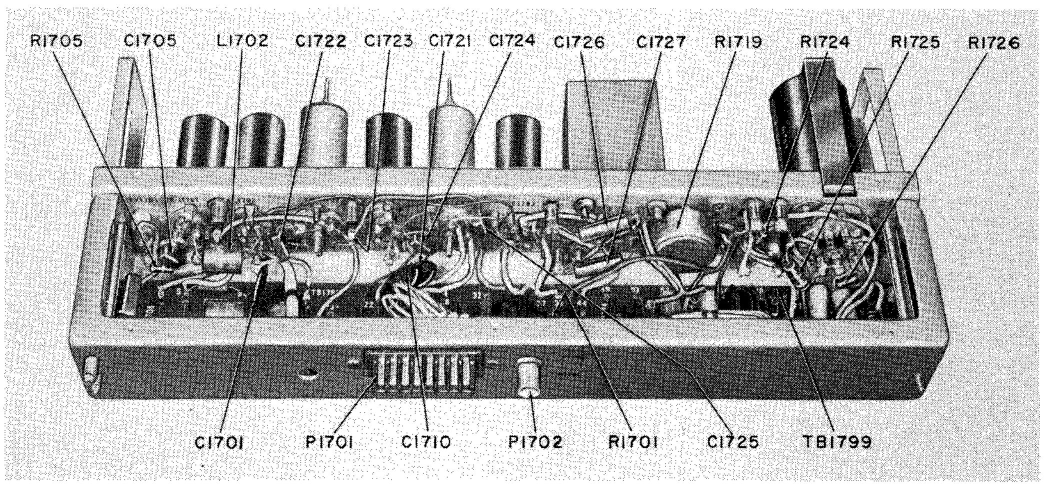


Figure 7–48. Frequency Shift Converter, AF Type, Side View

Step 4. Remove crystal Y1701, then adjust top and bottom slugs of T1701 and T1702 for maximum dc output. Top slugs should be set to first tuning peak reached, start by setting slug to full out (ccw) position. It may be necessary to feed in a large signal at first and observe output at TP-J1701 to peak T1701.

Step 5. After T1701 and T1702 are peaked, repeat adjustments until a maximum output has been obtained.

Step 6. Replace crystal Y1701 and disconnect signal generator.

(b) BIAS ADJUST CONTROL R1719.—It will not be necessary to remove the fs converter from the main chassis for this adjustment.

Step 1. Remove antenna input to receiver.

Step 2. Set OPERATION SWITCH to CW/FSK BROAD position and HOLD-OPERATE switch to OPERATE position.

Step 3. Adjust potentiometer R1719 for a zero reading on TELETYPE TUNING meter M1501.

An alternate method for adjusting R1719 is as follows: With antenna connected to receiver and during reception of space and mark signals, meter M1501 should deflect to one side during mark condition and deflect to the opposite side during space condition. If necessary, adjust R1719 for equal deflection to either side of zero of meter M1501.

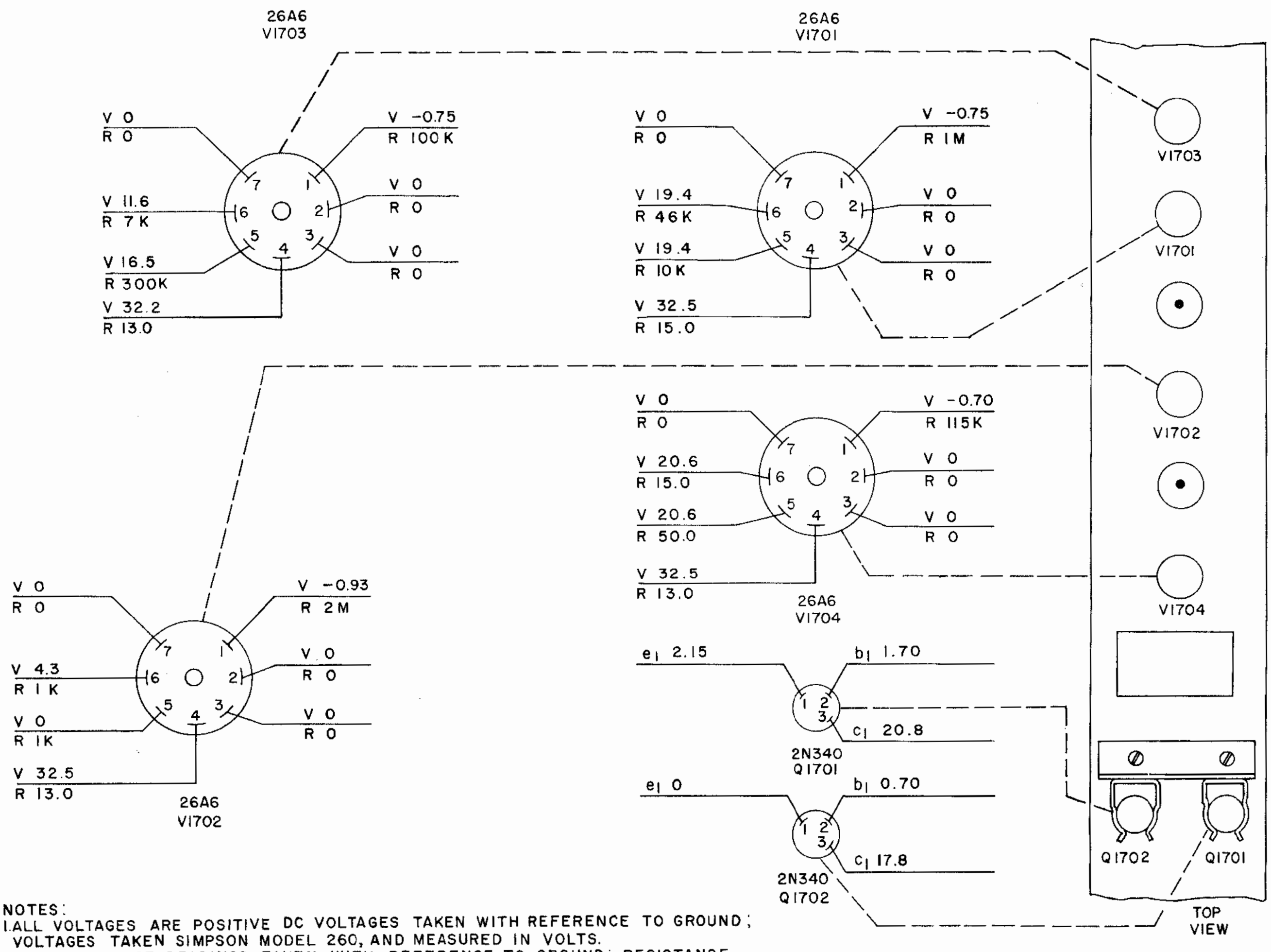
(5) FREQUENCY SHIFT CONVERTER, IF. TYPE ALIGNMENT. *(See figures 7–50 through 7–52, and 7–88.)*

The following test equipment will be required for alignment of the fs converter, if. type. (See table 7–1):

1 rf signal generator
1 vtvm (dc)

(a) IF. TRANSFORMERS T1751 and T1752.—It will be necessary to remove the fs converter for the following adjustments. Connect P1751 to J1505 on the main chassis by means of a test cable.

Step 1. Connect output from a signal generator to if. input through P1752.



NOTES:
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.
3. READINGS TAKEN WITH OPERATION SELECTOR SWITCH IN FSK, PHONE POSITION, AND ALL CONTROLS IN MAXIMUM CLOCKWISE POSITION, UNLESS OTHERWISE INDICATED.
4. DO NOT ATTEMPT TO TAKE RESISTANCE READINGS FOR TRANSITORS.

Figure 7–49. Frequency Shift Converter, AF Type, Voltage and Resistance Chart

Step 2. Set signal generator to 455 kc ±50 cycles, 10 k microvolt, unmodulated output.

Step 3. Connect vtvm to TP-J1754 and adjust top and bottom slugs of T1751 for maximum dc output. Tune to first peak from full counterclockwise position.

Step 4. Connect vtvm to TP-J1755 and adjust top and bottom slugs of T1752 for maximum dc output. Reduce generator input voltage as T1751 and T1752 are peaked. Tune to first peak from full counterclockwise position.

(b) DISCRIMINATOR TRANSFORMER T1753.—The alignment of T1753 follows the alignment of T1751 and T1752.

Step 1. With fs converter removed from main chassis and connected by means of test cables, connect signal generator to if. input P1752.

Step 2. Set signal generator to 454 kc ±50 cycles, 500 microvolts, unmodulated output.

Step 3. Connect vtvm to terminal B of T1753 and adjust primary (top slug) of T1753 for maximum dc output.

Step 4. Set signal generator to 455 kc ±50 cycles, 100 k microvolts, unmodulated output.

Step 5. Set vtvm to 5 volt dc scale and connect vtvm to TP-J1752. Adjust secondary (bottom slug) of T1753 for zero volts.

Step 6. Adjust R1769 for zero, as indicated on TELETYPE TUNING METER M1501.

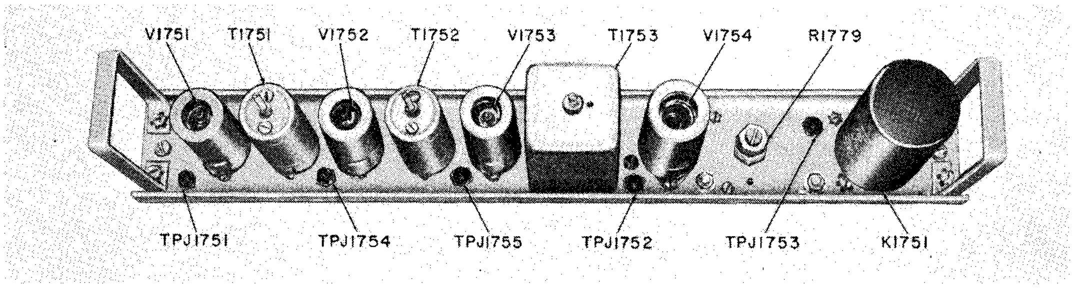
(c) BIAS ADJUST CONTROL R1779.—This potentiometer is a balance adjustment for relay K1751.

Step 1. Disconnect signal generator from P1752 and connect J1508 to P1752 by means of a test cable.

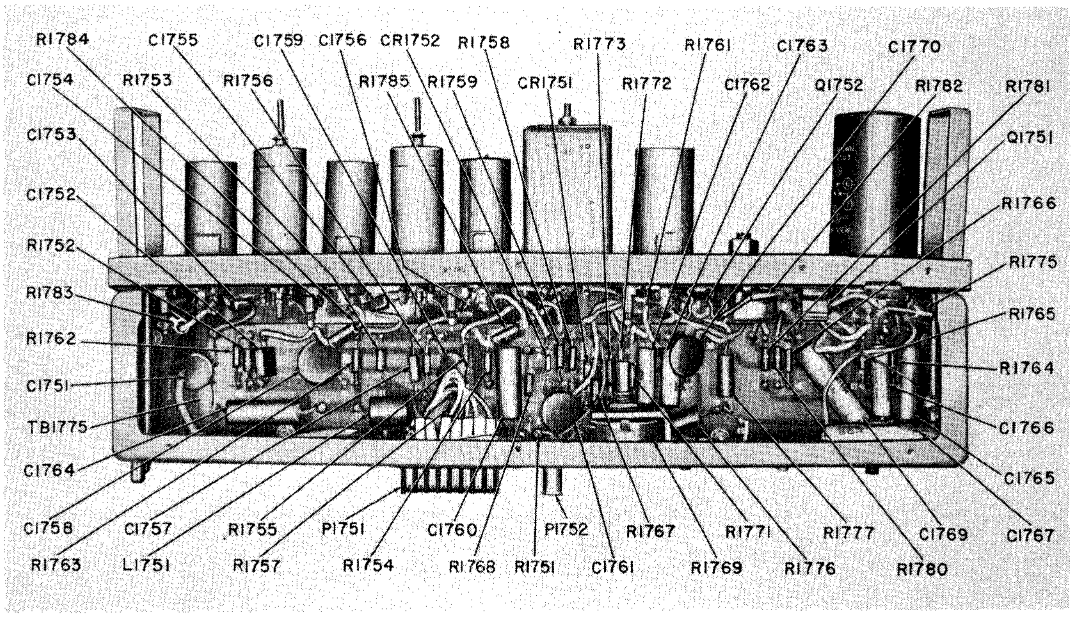
Step 2. Use a vtvm to take voltage readings at pins 3 and 8 of relay K1751. The voltage readings at these points should be equal; if they are not, adjust R1779 until voltages are equal.

Step 3. Tighten locking nut on R1779.

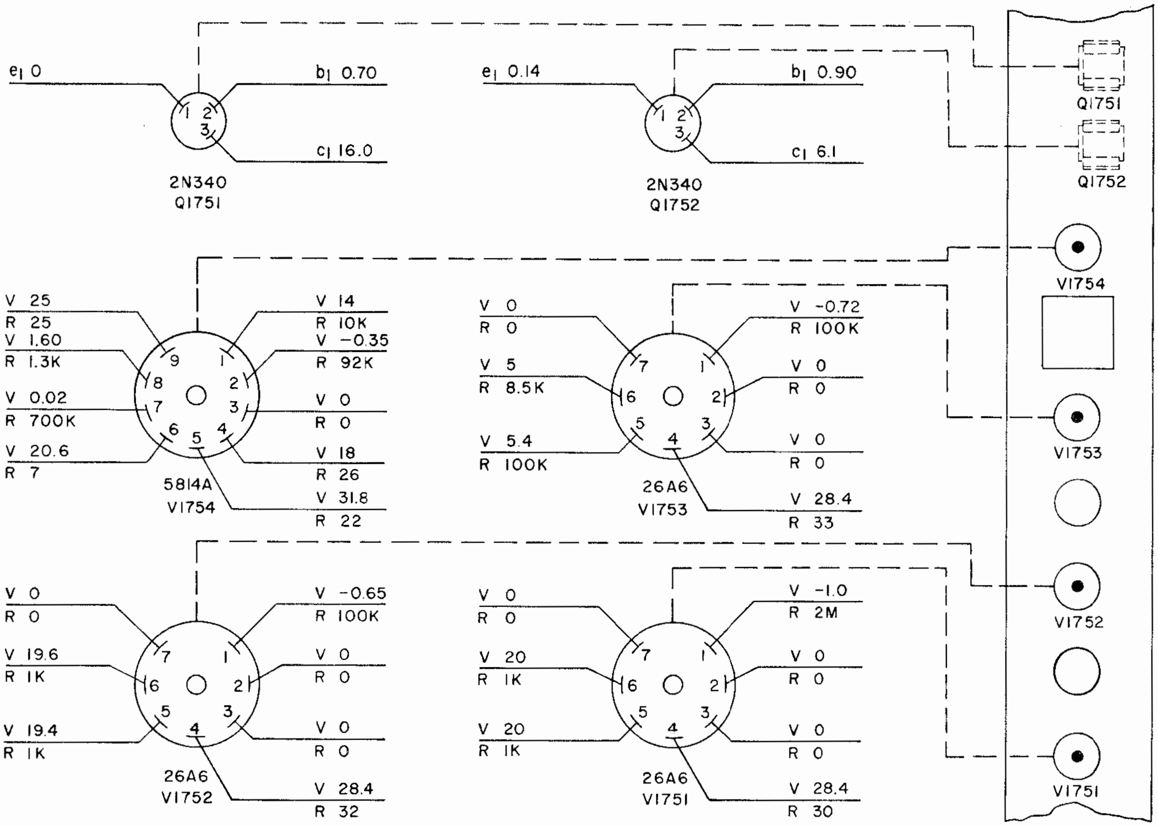
An alternate procedure for obtaining a balance for relay K1751 is to connect a 50-0-50 microammeter between terminals 3 and 8 of K1751. Across these same terminals connect a 22 ohm, 1 watt resistor. Adjust R1779 for a zero reading on microammeter. Tighten locking nut on R1779.



7–50. Frequency Shift Converter, IF. Type, Top View



7–51. Frequency Shift Converter, IF. Type, Side View



NOTES
1. ALL VOLTAGES ARE POSITIVE DC VOLTAGES TAKEN WITH REFERENCE TO GROUND; VOLTAGES TAKEN WITH SIMPSON MODEL 260, AND MEASURED IN VOLTS.
2. ALL RESISTANCE READINGS TAKEN WITH REFERENCE TO GROUND; RESISTANCE READINGS TAKEN WITH SIMPSON MODEL 260; K=1000 OHMS; M=1,000,000 OHMS.
3. READINGS TAKEN WITH OPERATION SELECTOR SWITCH IN FSK, PHONE POSITION, AND ALL CONTROLS IN MAXIMUM CLOCKWISE POSITION, UNLESS OTHERWISE INDICATED.
4. DO NOT ATTEMPT TO TAKE RESISTANCE READINGS FOR TRANSISTORS.

Figure 7-52. Frequency Shift Converter, IF. Type, Voltage and Resistance Chart

d. CRYSTAL DATA.

(1) GENERAL.—The receiver uses 3 crystals. The crystals are in the rf head subassembly, amplifier-power supply subassembly and the af type frequency shift converter. The following circuits are crystal controlled. (Refer to figures 7-80, 7-84, and 7-86.)

(a) CONVERTER V1505. — Quartz crystal Y1502 has a resonant frequency of 1955 kc, which heterodynes with the 1500-kc if. signal generated during operation on bands 3 and 4. As a result, a 455-kc if. signal is produced. The converter stage is inoperative during operation on bands 1 and 2.

(b) CALIBRATOR OSCILLATOR V1512. — Quartz crystal Y1501 has a resonant frequency of 200 kc. The output from oscillator tube V1512 is applied to harmonic amplifier V1510 to generate harmonics of the 200-kc signal. The high harmonic output of V1510 is applied to the rf head subassembly to calibrate the receiver main tuning dial. The V1512 and V1510 stages are only operative in the CAL. position of the OPERATION SWITCH.

(c) BEAT FREQUENCY OSCILLATOR V1703. — Quartz crystal Y1701 has a resonant frequency of 452.5 kc, which heterodynes with the 455 kc $\pm$ Δf space and mark teletype signals. As a result, audio frequencies of approximately 2 to 3 kc are produced. BFO stage V1703 is operative only in the FSK positions of the OPERATION SWITCH.

(2) CRYSTAL CHARACTERISTICS.—Y1502 is a type CR-18/U crystal which is hermetically sealed in a type HC-6/U crystal holder. The crystal has an accuracy of $\pm$0.005 percent throughout its operating temperature range of -55 degrees to $+90$ degrees C.

Y1501 and Y1701 are type CR-46/U crystals and are hermetically sealed in type HC-6/U crystal holders. The crystals have an accuracy of $\pm$0.01 percent throughout an operating temperature range of -40 degrees to $+70$ degrees C.

(3) CRYSTAL HOLDER CHARACTERISTICS.—The crystal holders used with Y1502, Y1501, and Y1701 are type HC-6/U. The crystal holders have the following physical dimensions: length 0.750 inch; width 0.345 inch; height 0.765 inch (less pins); number of pins 2; spacing of pins 0.486 inch; and diameter of pins 0.050 inch. The crystals are wire-mounted in the metal crystal holders.

7-6. CONTROL GROUP.

a. GENERAL.—The control group is composed of a local remote control, which is operated from within the vehicle, and a field remote control, which is usually operated from a remote site. The local remote control serves as a junction for the field remote control. Therefore a failure in the local remote control will usually disable the field remote control.

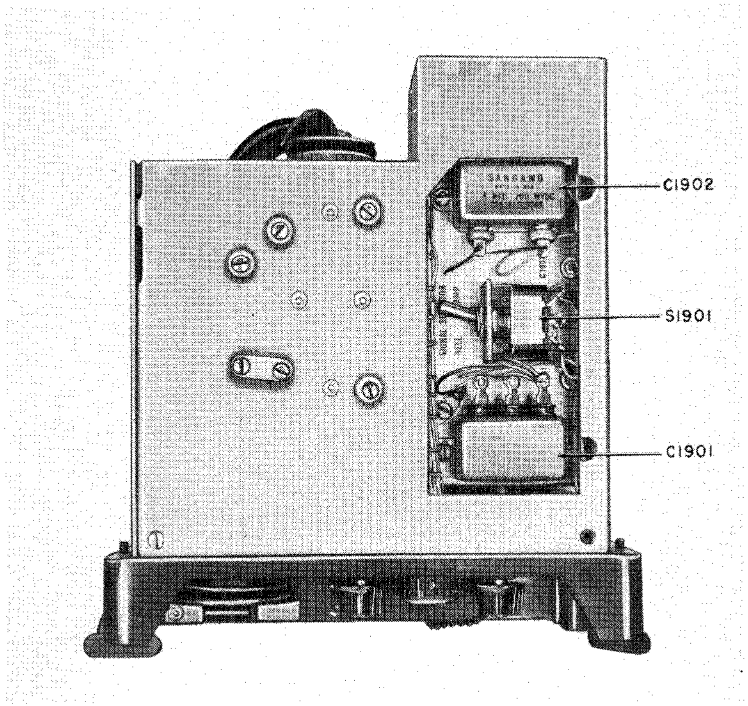


Figure 7-53. Local Remote Control, Top View

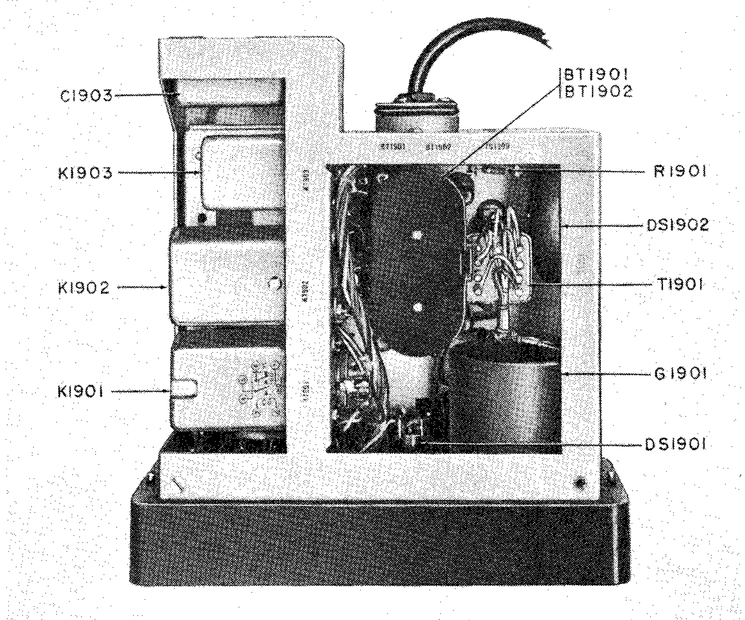


Figure 7-54. Local Remote Control, Bottom View

There are no electrical adjustments at either of the control units. Troubleshooting of the units should be accomplished with a multimeter and with the aid of the control group troubleshooting chart (table 7-8). If trouble cannot be localized by means of the checks listed in the table, the technician should adopt a systematic procedure to localize the trouble. Continuity and voltage checks can be made using the schematic diagrams as a guide. (See figures 7-53 through 7-56 and 7-90 through 7-93.)

Failure of the control units will usually be caused by defective batteries. The field remote control uses two 1-1/2-volt batteries (type BA-30) and one 45-volt battery (type BA-414/U). The local remote control uses two 1-1/2-volt batteries (type BA-30).

b. BATTERY REPLACEMENT. *(Refer to figures 7-54 and 7-56.)*—To remove the two 1-1/2-volt batteries from the local remote control, first remove the control unit chassis from the cabinet by loosening the front panel captive screws. Access to the batteries is gained by depressing the latch on the battery compartment cover and removing the cover.

To remove the two 1-1/2-volt batteries and the 45-volt battery from the field remote control, remove the control unit chassis from the cabinet by unlocking the two front panel latches. The 1-1/2-volt batteries are located under the battery cover. To remove the 45-volt battery, disconnect the octal connector and remove the battery.

c. HAND RINGING GENERATOR REPLACEMENT.—The local remote control and field remote control units have similar hand ringing generators, G1901 and G2001, respectively. The procedures for both generator units are the same.

Step 1. Remove remote control chassis from its enclosure.

Step 2. Remove handwheel from generator by removing handwheel retaining screw and lockwasher.

Step 3. Unscrew and remove generator mounting nut from front panel.

Step 4. Unsolder and remove the five wires from the three terminals on generator. Note location of wires.

Step 5. Slide generator out from behind front panel, and lift from remote control chassis.

Step 6. To replace the hand ringing generator within the remote control chassis, reverse the removal procedure.

7-7. GENERATOR SYSTEM.

a. TROUBLE LOCATION.—When trouble occurs in the vehicular generator system, the following procedure will help to localize the trouble. (See figure 7-94.):

Step 1. Stop engine and determine that all cables are connected properly and securely.

Step 2. Check wiring for frayed insulation or breaks.

TABLE 7-8. CONTROL GROUP TROUBLESHOOTING CHART

TROUBLE	SYMPTOMS	PROBABLE CAUSE	CORRECTIVE ACTION
No AM or CW/FSK operation possible from field remote control.	Operation possible in TEL position.	Defective battery BT2003 in field remote control.	Replace BT2003.
No output from field remote control in AM, CW/FSK or TEL operation.	Ringing circuits operate, and reception on phones is possible.	Contacts in ringer G2001. Microphone defective.	Replace or repair ringer G2001. Replace microphone.
No control of dynamotor by field remote control in CW/FSK operation.	Operation in AM and TEL is possible.	Latching relay K1902 in local remote control.	Replace relay K1902.
No control of dynamotor by field remote control in AM operation.	Field remote control operates in CW/FSK and TEL. Local remote control operates in AM.	Relay K1901 in local remote control. Push-to-talk switch in handset.	Replace relay K1901. Replace or repair.
No CW operation possible from field remote control.	Operation possible in AM and TEL service, and field remote control can turn dynamotor on and off.	Keying relay K1903.	Replace relay K1903.
No operation in TEL service.	Ringing between units is possible, and field remote control operates in AM and CW/FSK.	Defective batteries BT1901, BT1902 or BT2001, BT2002.	Replace defective batteries.

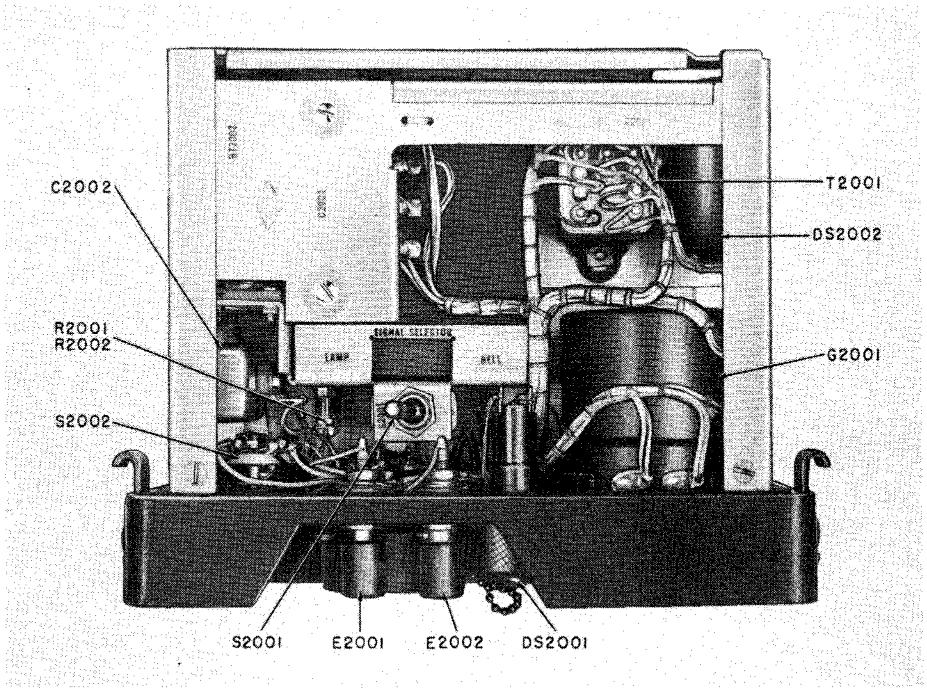


Figure 7–55. Field Remote Control, Top View

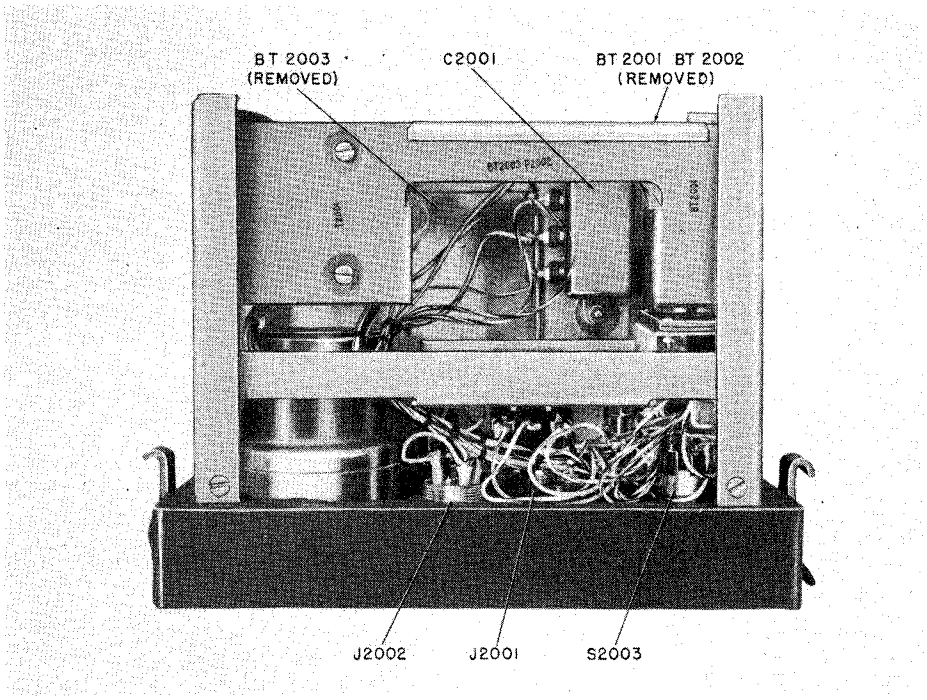


Figure 7–56. Field Remote Control, Bottom View

Step 3. Check fan belts for proper tension.

Step 4. Check that contacts of the load relay in regulator box close when the ignition switch is turned on.

Step 5. If generator system still fails to operate, remove cable between alternator and rectifier, and cable between rectifier and regulator.

Step 6. Use an ohmmeter to check for cable continuity. (Refer to the generator system interconnecting diagram, (figure 3–14).

Step 7. If cables are found to be satisfactory, fault may lie in regulator. If possible, substitute with another regulator known to be in good working order, and perform necessary regulator adjustments as described in paragraph 7–7 *b* (1).

Step 8. If, after replacing regulator in vehicle, generator system still does not operate, check and, if necessary, replace alternator. Refer to paragraph 7-7 *b* (2) for electrical checks of the alternator unit to be made before replacing the unit.

Step 9. If, after replacing alternator in vehicle, generator system still does not operate, replace power rectifier. Damaged plates in rectifier unit are an indication of a faulty rectifier. Refer to paragraph 7-7 *b* (3) for electrical checks of rectifier unit.

Note

Procedure for the removal and replacement of the regulator, alternator and rectifier units is given in section 3 (Installation).

b. REPAIR AND ADJUSTMENTS.

(1) REGULATOR UNIT.—The output of the generator system may be adjusted to 27.5-volts dc, as follows:

Step 1. Remove all loads from generator system, with exception of vehicular batteries.

Step 2. Connect a voltmeter across battery terminals.

Step 3. Start engine and permit it to operate slightly above idling speed. After a few minutes of operation, the voltmeter should indicate 27.5 to 28 volts.

Step 4. If necessary, adjust output voltage to 27.5 volts by means of VOLTAGE ADJUST rheostat located on regulator unit. To gain access to adjustment, remove plug cover on top or front side of regulator.

(2) ALTERNATOR UNIT.—In the event of trouble with the alternator, the following electrical checks and repairs may be performed. The engine must be shut off for these checks.

(a) STATOR WINDING CONTINUITY.—Disconnect the cable between the alternator and the rectifier. With an ohmmeter, check the continuity across the A-B, B-C, and A-C pins of the alternator output connector. Each check must show a closed circuit or low resistance.

(b) GROUND TEST.—With an ohmmeter, check from ground (frame) to pins A-B-C-D-E of the alternator output connector. No circuit should be present. Replace the cable between the alternator and the rectifier.

(c) REPLACEMENT OF BRUSHES.—The slip ring brushes of the alternator may be inspected and replaced, if necessary, as follows:

Step 1. Remove slip ring end fan to check brushes.

Step 2. Check slip ring brushes for wear and a free, smooth fit in brush holders. Worn brushes are indicated when brush length is 5/16 inch, or one-half the length of a new brush.

Step 3. Disconnect two flexible jumpers from brush rigging studs.

Step 4. Hold brush levers clear of the brushes and remove brushes.

Step 5. To insert new brushes, reverse removal procedure described in steps 1 through 4.

(d) FIELD COIL (ROTOR) RESISTANCE CHECK.—Connect an ohmmeter across the two slip rings. The ohmmeter test prods must make direct contact with the slip rings. The rotor winding resistance should measure approximately 1.7 ohms.

Note

Rotor coil resistance measurement made at the connector pins or at the brush levers will be inaccurate because of variations in brush-to-slip ring contact resistance.

(3) RECTIFIER UNIT.—The following procedure is an electrical check on the performance of the power rectifier unit:

Step 1. Remove cable between alternator and rectifier (input), and cable between rectifier and regulator (output).

Step 2. Connect a 25-ampere load in series with an ammeter across pins C-D of output connector.

Step 3. Connect test prods to a fully charged 28-volt battery and make the following checks across pins A, B, and C of the input connector. The ammeter readings should be approximately equal for all measurements.

POSITIVE BATTERY TERMINAL TO	NEGATIVE BATTERY TERMINAL TO
A	B
B	A
B	C
C	B
A	C
C	A

7-8. EMERGENCY MAINTENANCE.

a. GENERAL.—Fuse and electron tube failure will be the most likely and most frequent causes of trouble. Refer to section 5 for fuse and electron tube locations and general information.

b. ELECTRON TUBES.—Table 5-5, and the illustrations in Section 7, will aid in locating and identifying the tubes, transistors and diodes within the subassemblies of the Radio Set AN/MRC-55. Table 7-9 lists the rated characteristics of all types of tubes used in the radio set. These data do not represent maximum operating conditions or rated operating conditions; they represent the conditions under which the tubes were tested.

c. VOLTAGE AND RESISTANCE CHARTS.—Typical voltage and resistance measurements are given for all subassemblies. See the list of illustrations for the figure number and location of the applicable chart.

d. WINDING DATA.—Table 7–10 lists the wire-wound electrical components used in Radio Set AN/MRC–55, and gives data pertinent to them to facilitate emergency repairs in the field.

The components in the following list are not included in table 7–10.

Encapsulated Coils	
L713	L1405
L714	L1502
L901	L1505
L902	L1506
L1002	L1509
L1006	L1510
L1008	L1511
L1009	L1601
L1013	L1701
L1202	L1702
L1404	L1751
Hermetically Sealed Components	
T901	T1402
T1002	L1507
T1101	T1518
T1102	T1521
L1401	T1522
L1402	T1901
L1406	T2001
L1407	Z1701

All wires listed in table 7–10 are AWG copper wire unless otherwise specified. The designations listed along with the wire size identify the wire type as follows:

E—enamel
F2—double fiber synthetic
R2—double resin
ESN—silk covered enamel
DSC—double silk covered
DN—double nylon

In the "Diagram" column of Table 7–10, the numerals refer to items on the page of diagrams included at the end of the table.

The two impregnation methods for moisture and fungus proofing of coils follow:

Notes

1. Inside diameter of coil form and all threads shall be masked during impregnation.
2. Mixed varnish shall be a mixture of 100 parts of Insulex No. 85-IT varnish to 86 parts thinner No. 80, or equivalents.
3. All varnish shall be moisture and fungus-resistant per MIL-V-173A.
4. Inductance shall be measured on Boonton 160-A Q meter. In the case of two winding coils, the winding not under test shall be short circuited with a wire across the leads.
5. Mutual inductance (M) measured after secondary has been adjusted:
   Aiding: terminals 2 and 3 connected together; measurement between terminals 1 and 4.
   Opposing: terminals 3 and 4 connected together; measurement between terminals 1 and 2.

(1) IMPREGNATION METHOD 1.

Step 1. Clean all surfaces of coil form with dry cleaning solvent P-S-661lb. Bake for 1/2 hour at 100°C (212°F). Remove from oven and allow to cool to room temperature.

Step 2. Wind coil. Bake for 1 hour at 100°C (212°F). Remove from oven and allow to cool to 55° to 66°C (130° to 150°F).

Step 3. Brush on mixed varnish. Air dry for 10 minutes. Bake for 1 hour at 100°C (212°F). Remove from oven and allow to cool to 55° to 66°C (130° to 150°F).

Step 4. Repeat step 3.

(2) IMPREGNATION METHOD 2.

Step 1. Apply one coat of coil dope (Amphenoe Polyweld 912, or equivalent).

Step 2. Air dry for three hours.

Step 3. Repeat steps 1 and 2.

TABLE 7-9. TUBE CHARACTERISTICS

TUBE TYPE	FILAMENT VOLTAGE (V)	FILAMENT CURRENT (Amp)	PLATE VOLTAGE (V)	GRID BIAS	SCREEN VOLTAGE (V)	PLATE CURRENT (MA)	SCREEN CURRENT (MA)	AC PLATE RESIST-ANCE (Ohms)	VOLTAGE AMPLIFI-CATION FACTOR (MU)	TRANSCONDUCTANCE (Micromhos)		EMISSION	
										NORMAL	MINIMUM	IS (MA)	TEST VOLTAGE
4X250F	26.5	0.50	1000	−50	350	100 min 250 max	25 max	3260	5	12000		Ib = 200	Eb = 500
6AH6	6.3	0.450	150(1) 300(2)	0	150	12.5(1) 10(2)	2.6	3600(1) 500k(2)	40(1)	8500	6000	40 min	10
6AJ5	6.3	0.175	28		28	2.9	1.05		250	2750	2000		
6CL6	6.3	0.65	250	−3	150	30	7	90k		11600	9200	180 min	20
12AT7WA	12.6	0.15	100*	−5*		3.7*		15k*	60*	4000*			
12BA6	12.6	0.15	250	−20	100	11	4.2	1 mego		4400	3600	60 min	20
26A6	26.5	0.70	26.5	0	26.5	1.6	0.65			1950	1200	50 min	15
5651	DC Starting Voltage 115 v min DC Operating Voltage 87 v			Operating Current 1.5 ma min 3.6 ma max				Regulation 3 vdc Stability 0.1 vdc					
5654/ 6AK5W	6.3	0.175	120	−2	120	7.5	2.5	300k		5000	3750		
5687WA	12.6	0.9	120*	−2*		36*			17.75*	11000*	8000*	125 min*	15*
5725/ 6AS6W	6.3	0.175	120	2	120	5.2	3.5	150k		3200	2500		
5750/ 6BE6W	6.3	0.35	250		100	2.5	7.6	1 mego		500	430		
5751/ 5751WA	12.6	0.175	250*	−3		1.0*			70	1200*	900*		
5814A	12.6	0.175	250*	−8.5*		10.5*		6250*	19.5*	2200*	1750*		
6005/ 6AQ5W	6.3	0.45	250	−12.5	250	45	4.5	52k	45	4100	3000		
6082	26.5	0.6	135	−7		125		280	2	7000	5800		

Notes: *Each Section (1) Triode Connection (2) Pentode Connection

TABLE 7–10. WINDING DATA

DESIGNATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESISTANCE (Ohms)	REMARKS
L101	C2145074G1	1	1 single layer, cw	26R2	11		1.19 μh nom at 20 mc, slug tuning; min Q90; impregnate method 1.
L102	C2145074G2	1	1 single layer, cw	22R2	11		0.58 μh nom at 21 mc; slug tuning; min Q90; impregnate method 1.
L103	C2145074G3	1	1 single layer, cw	21R2	9		0.49 μh nom at 22 mc; slug tuning; min Q90; impregnate method 1.
L104	C2145074G4	1	1 single layer, cw	21R2	9		0.43 μh nom at 23 mc; slug tuning; min Q90; impregnate method 1.
L105	C2145074G5	1	1 single layer, cw	21R2	8		0.38 μh nom at 24 mc; slug tuning; min Q90; impregnate method 1.
L106	C2145074G6	1	1 single layer, cw	20R2	7		0.34 μh nom at 25 mc; slug tuning; min Q90; impregnate method 1.
L107 L108	C2145074G7	1	1 single layer, cw	20R2	7		0.30 μh nom at 26 mc; slug tuning; min Q90; impregnate method 1.
L109 L110	C2145074G8	1	1 single layer, cw	20R2	6		0.27 μh nom at 27 mc; slug tuning; min Q90; impregnate method 1.
L111	C2145074G11	1	1 single layer, cw	26R2	18		1.6 μh nom at 10 mc; slug tuning; min Q70; impregnate method 1.
L112	C2145074G12	1	1 single layer, cw	25R2	16		1.3 μh nom at 11 mc; slug tuning; min Q80; impregnate method 1.
L113	C2145074G13	1	1 single layer, cw	25R2	16		1.2 μh nom at 12 mc; slug tuning; min Q80; impregnate method 1.
L114	C2145074G14	1	1 single layer, cw	24R2	15		1.1 μh nom at 13 mc; slug tuning; min Q80; impregnate method 1.
L115	C2145074G15	1	1 single layer, cw	24R2	14		0.98 μh nom at 14 mc; slug tuning; min Q80; impregnate method 1.
L116 L117	C2145074G16	1	1 single layer, cw	23R2	13		0.86 μh nom at 15 mc; slug tuning; min Q80; impregnate method 1.

TABLE 7–10. WINDING DATA (cont)

DESIG-NATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESIST-ANCE (Ohms)	REMARKS
L118	C2145074G18	1	1 single layer, cw	22R2	11		0.66 μh nom at 17 mc; slug tuning; min Q80; impregnate method 1.
L119	C2145074G19	1	1 single layer, cw	22R2	11		0.61 μh nom at 18 mc; slug tuning; min Q80; impregnate method 1.
L120	C2145074G20	1	1 single layer, cw	22R2	10		0.55 μh nom at 19 mc; slug tuning; min Q80; impregnate method 1.
L121	C2145116G1	1	1 single layer, cw	30R2	50		13.1 μh nom at 2 mc; slug tuning; Q40; impregnate method 1.
L122	C2145116G2	1	1 single layer, cw	26R2	32		6.2 μh nom at 3 mc; slug tuning; min Q60; impregnate method 1.
L123	C2145116G3	1	1 single layer, cw	24R2	24		3.7 μh nom at 4 mc; slug tuning; min Q70; impregnate method 1.
L124	C2145116G4	1	1 single layer, cw	23R2	22		3.0 μh nom at 5 mc; slug tuning; min Q70; impregnate method 1.
L125	C2145116G5	1	1 single layer, cw	22R2	20		2.5 μh nom at 6 mc; slug tuning; min Q70; impregnate method 1.
L126	C2145116G6	1	1 single layer, cw	22R2	18		2.1 μh nom at 7 mc; slug tuning; min Q70; impregnate method 1.
L127	C2145116G7	1	1 single layer, cw	21R2	17		1.9 μh nom at 8 mc; slug tuning; min Q70; impregnate method 1.
L128 L1010	C2145116G8	1	1 single layer, cw	20R2	15		1.7 μh nom at 9 mc; slug tuning; min Q70; impregnate method 1.
L401	B2145835G1	2	2 single layer, cw, shielded	27R2	33 30		47 μh ±1% at 2.5 mc; slug tuning; min Q90; impregnate method 1.
L402 L403	D2145072G18	3	1 pie universal	38EF2	16	0.712	1.82–2.70 μh at 7.9 mc w/slug; min Q35; impregnate method 1.
L404	D2145072G17	5	1 single layer, cw	32EF2	18	0.193	1.35–1.80 μh at 7.9 mc w/slug; min Q60; impregnate method 1.

TABLE 7–10. WINDING DATA (cont)

DESIGNATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESISTANCE (Ohms)	REMARKS
L405	D2145072G16	5	1 single layer, cw	32EF2	17	0.185	1.26–1.75 μh at 7.9 mc w/slug; min Q55; impregnate method 1.
L406	D2145072G14	5	1 single layer, cw	32EF2	15	0.160	1.00–1.50 μh at 7.9 mc w/slug; min Q55; impregnate method 1.
L407	D2145072G13	5	1 single layer, cw	28EF2	14	0.061	0.87–1.10 μh at 25 mc w/slug; min Q85; impregnate method 1.
L408 L427	D2145072G12	5	1 single layer, cw	28EF2	11	0.052	0.63–0.89 μh at 25 mc w/slug; min Q75; impregnate method 1.
L409 L411 L420	D2145072G10	4	1 single layer, cw	28EF2	9	0.039	0.44–0.59 μh at 25 mc w/slug; min Q80; impregnate method 1.
L410 L416	D2145072G7	4	1 single layer, cw	28EF2	6	0.027	0.25–0.32 μh at 25 mc w/slug; min Q70; impregnate method 1.
L412	D2145072G1	4	1 single layer, cw	22EF2	2	0.005	0.045–0.065 μh at 25 mc w/slug; min Q60; impregnate method 1.
L413	D2145072G3	4	1 single layer, cw	22EF2	4	0.006	0.13–0.15 μh at 25 mc w/slug; min Q55; impregnate method 1.
L414	D2145072G4	4	1 single layer, cw	22EF2	5	0.008	0.17–0.19 mc μh at 25 mc w/slug; min Q65; impregnate method 1.
L415	D2145072G5	4	1 single layer, cw	22EF2	6	0.008	0.21–0.27 μh at 25 mc w/slug; min Q70; impregnate method 1.
L417	D2145072G8	4	1 single layer, cw	28EF2	7	0.031	0.31–0.38 μh at 25 mc w/slug; min Q65; impregnate method 1.
L418 L419 L433	D2145072G9	4	1 single layer, cw	28EF2	8	0.036	0.36–0.44 μh at 25 mc w/slug; min Q75; impregnate method 1.
L421 L423 L424 L432	A2145050	7	2 pie universal	36ESN		3.5	50 μh ±10% at 2.5 mc; 75 ma dc rated current; min Q25; hipot ac volts 1000 v rms.

TABLE 7-10. WINDING DATA (cont)

DESIG-NATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESIST-ANCE (Ohms)	REMARKS
L425 L426 L428 thru L431	D2145072G11	4	1 single layer, cw	28EF2	10	0.044	0.53–0.70 μh at 25 mc w/slug; min Q80; impregnate method 1.
L434 L708	D2145073G2	6	1 pie universal	38EF2	22	1.0	3.23–5.8 μh at 7.9 mc w/slug; min Q51; impregnate method 1.
T401	A2145031	8	Primary (3–4), secondary (1–2)	26DSC 26DSC	9 9		Primary and secondary at mid-range, 1 μh at mc; min Q100; 250 wvdc, 10 ma.
L701	D2145073G8	6	1 pie universal	7/41	133	2.41	120–180 μh at 0.79 mc w/slug; min Q45; impregnate method 1.
L702 L704 L706 L711	D2145073G4	6	1 pie universal	5/41	68	1.68	32–53 μh at 2.5 mc w/slug; min Q40; impregnate method 1.
L703 L710	D2145073G5	6	1 pie universal	5/41	80	2.06	47–76 μh at 2.5 mc w/slug; min Q45; impregnate method 1.
L705 L707	D2145073G1	9	1 single layer, cw	32EF2	15	low	1.47–2.47 μh at 7.9 mc w/slug; min Q50; impregnate method 1.
L709	D2145073G3	6	1 pie universal	5/41	54	1.27	20–28 μh at 2.5 mc w/slug; min Q50; impregnate method 1.
L712	D2145073G7	6	1 pie universal	7/41	147	2.97	170–245 μh at 0.79 mc w/slug; min Q53; impregnate method 1.
T701 T702	A2145032	8	Primary (3–4), secondary (1–2)	7/41 7/41			Primary and secondary: 100 μh at 790 kc; min Q45; adjustable; 250 wvdc, 10 ma.
T703	B2145407	10	Primary (1–2), secondary (3–4–5) ct (4)	26 26	20 36 ct		
L1001 L1004 L1005	C2144258-2	—	1 winding, silver ribbon conductor	46.5 ft. lg, 0.062 in. wd, 0.015 in. thk	variable		0.43–18 μh variable tuning. See paragraph 7-4*b*(2) for winding data.

TABLE 7–10. WINDING DATA (cont)

DESIG-NATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESIST-ANCE (Ohms)	REMARKS
L1003	A2133325G3	11	4 pie universal			38	2.5 mh ±10% at 2.7 mc; 125 ma dc rated current; Q47 at 250 kc.
L1011	A2147684	12	Single, right hand, equally spaced	FTR 910000H10 copper, annealed, tinned	3		
L1012	A2147685	13	Single, right hand, equally spaced	FTR 910000H10	3		
T1001 T1202	B2144295–2 B2144295–1	14	1–2 wound on toroidal core of Allegheny Mu-metal; 3–4 grounding strap; turns insulated with electrical tape.	(1–2) copper strip 13 in. lg, 1/8 in. wd, 0.002 in. thk; (3–4) copper strip 0.010 in. thk, 5/16 in. wd,	5		Impedance (min): 180 + j 132 ± 20% at 3 mc 225 + j 136 ± 20% at 5 mc 300 + j 100 ± 20% at 10 mc
Z1002	B2146358	15	Single, left hand, equally spaced, wound on 47-ohm, 2-watt resistor	16	3		
L1201	C2144258–1	—	1 winding, silver ribbon conductor	36.5 ft lg, 0.062 in. wd, 0.015 in. thk	variable		0.5–50 μh variable tuning. See paragraph 7–4*b*(4) for winding data.
T1201	C2144901	16	Single on toroidal core of Allegheny Mu-metal; turns insulated with electrical tape	0.10 in. thk copper strip silver pl, 16-7/16 in. lg, tapered from 3/8 in. to 1/8 in.	tapped at 8-1/8 in.		2 to 30 mc frequency range; input impedance 50 ohms when terminated in 15 ohms; 150 watts.
T1401	A2145142	10	Primary (1–2), secondary (3–4–5) ct (4)				Primary: 115 vac, 60 cps ±10%. Secondary; 28–0–28 vdc at 60 amp. Hipot ac volts 500 vdc.
L1512 L1513	B2148347	1	1 winding 3 layers, closewound, cw	20	60		27 μh at 1 kc; slug tuning; impregnate method 1.

TABLE 7–10. WINDING DATA (cont)

DESIGNATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESISTANCE (Ohms)	REMARKS
T1501	D2145396G1	18	Primary (1–2), single layer, close-wound, cw; secondary (1–3), 1 pie universal	32DSC 5–41 Litz	5 45, tapped at 12		Secondary: 31 μh at 2 mc; inductance start to tap 3.05 μh; impregnate method 1.
T1502	D2145396G2	24	1 single layer, close-wound, cw	28R2	37; tap 1 at 2-1/2; tap 2 at 6		8.6 μh at 7.9 mc; slug tuning; Q93; impregnate method 1.
T1503	D2145396G3	24	1 single layer, close-wound, cw	22R2	18; tap 1 at 1-1/2		2.3 μh at 7.9 mc; slug tuning; Q90; impregnate method 1.
T1504	D2145396G4	22	1 single layer, spaced, cw	18R2	8; tap 1 at 1/4; tap 2 at 2		0.5 μh at 25 mc; slug tuning; Q125; impregnate method 1.
T1505	D2145396G5	17	2 pie universal primary (2–4), secondary (1–3)	5–41 Litz 5–41 Litz	230 43		Primary: 740 μh at 0.78 mc; nom Q55. Secondary: 35.5 μh at 2.5 mc; nom Q40; slug tuning; M:1080 aid, 800 oppose; impregnate method 1.
T1506	D2145396G6	18	Primary (2–4), 1 pie universal; secondary (1–3), single layer, close-wound, cw	5–41 Litz 32DSC	105 30		Primary: 158 μh at 790 mc; nom Q40. Secondary: 9 μh at 7.9 mc; nom Q60; slug tuning; M:222 aid, 122 oppose; impregnate method 1.
T1507	D2145396G7	19	Primary (2–4), 1 pie universal; secondary (1–3), single layer, close-wound, cw	36DSC 24R2	60 16		Primary: 48 μh at 2.5 mc; nom Q18. Secondary: 2.4 μh at 7.9 mc; nom Q32; slug tuning M:86 aid, 57 oppose; impregnate method 1.
T1508	D2145396G8	22	1 single layer, spaced, cw	20R2	7, untapped		0.41 μh at 25 mc; slug tuning; Q150; impregnate method 1.
T1509	D2145396G9	17	2 pie universal; primary (2–4); secondary (1–3)	5–41 Litz 5–41 Litz	64 45		Primary: 49 μh at 2.5 mc; nom Q50. Secondary: 31 μh at 2.5 mc; nom Q60; slug tuning; M:104 aid, 69 oppose; impregnate method 1.

TABLE 7-10. WINDING DATA (cont)

DESIG-NATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESIST-ANCE (Ohms)	REMARKS
T1510	D2145396G10	21	Primary (2-4), 1 pie universal; secondary (1-3), single layer, close-wound, cw	5-41 Litz 32DSC	21-1/2 30		Primary: 9 μh at 7.9 mc; nom Q35. Secondary: 7 μh at 7.9 mc; nom Q40; slug tuning; M:29.2 aid, 11.1 oppose; impregnate method 1.
T1511	D2145396G11	21	Primary (2-4), 1 pie universal; secondary (1-3), single layer, close-wound, cw	36DSC 24R2	11 16		Primary: 2.43 μh at 7.9 mc; nom Q22. Secondary: 1.83 μh at 7.9 mc; nom Q40; slug tuning; M:81 aid, 2.9 oppose; impregnate method 1.
T1512	D2145396G12	23	1 single layer, spaced, cw	20R2	7, untapped		0.41 μh at 25 mc; slug tuning; Q150; impregnate method 1.
T1513	C2147014G1	27	Plate (1-3), grid (2-4), 2 single layer, closewound, cw	30R2 30R2	69 26-1/2		Plate: 27 μh at 2.5 mc, Q100. Grid: 9.1 μh at 7.9 mc, Q100; slug tuning; impregnate method 2.
T1514	D2145396G13	25	1 pie universal	5-41 Litz	40		31 μh at 25 mc; slug tuning; Q80; impregnate method 1.
T1515	D2145396G14	26	1 single layer, close-wound, cw	36DSC	24		8.4 μh at 7.9 mc; slug tuning; Q90; impregnate method 1.
T1516 T1517	D2145396G15	26	1 single layer, close-wound, cw	24R2	13		1.8 μh at 7.9 mc; slug tuning; Q75; impregnate method 1.
T1519	C2144856-3	29	Primary (1-2), single layer; secondary (3-4), 1 pie universal; shielded	10-44 Litz 10-44 Litz	35 85		Primary: 11.5 μh at 2.5 mc; min Q90. Secondary: 100 μh at 2.5 mc; min Q70; double-tuned.
T1520	C2144856-2	30	2 pie universal, primary (1-2), secondary (3-4)	10-44 Litz 10-44 Litz	85 85		Primary and secondary: 102 μh at 790 kc; min Q75; double-tuned.
T1523	C2147014G2	28	Plate (1-3); grid (2-4); 2 single layer, close-wound, cw	24R2 32DSC	13 5-1/2		Plate: 1.74 μh at 7.9 mc; Q100. Grid: 0.68 μh at 25 mc; Q100; slug tuning; impregnate method 2.

TABLE 7-10. WINDING DATA (cont)

DESIGNATION SYMBOL	PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	D-C RESISTANCE (Ohms)	REMARKS
L1602	C2144856-4	31	1 pie universal	10-44 Litz	150, tapped at 84 turns		Terminals (1 to 3): 250 μh at 790 kc; min Q70; terminals (2 to 3); 50 μh at 790 kc; slug tuning.
T1601 T1602 T1603 T1604 T1605	C2144856-1	32	4 windings; L1 (pie universal) L2 (pie universal) L3 (single layer) L4 (single layer)	All 10-41 Litz S.S.	L1-90 L2-90 L3-3 L4-1		L1: 123 μh at 790 kc; min Q70. L2: 126 μh at 790 kc; min Q70; double-tuned.
T1701 T1702 T1751 T1752	C2144856-5	33	2 pie universal primary (1-2), secondary (3-4)	10-44 Litz 10-44 Litz	220 220		Primary: 740 μh at 790 kc; min Q95. Secondary: 780 μh at 790 kc; min Q84; double-tuned.
T1753	A2147158	34	2 windings; primary (D-F) secondary (A-C)				Primary: 980 μh at 455 kc; min Q94. Secondary: 820 μh at 455 kc; min Q86.

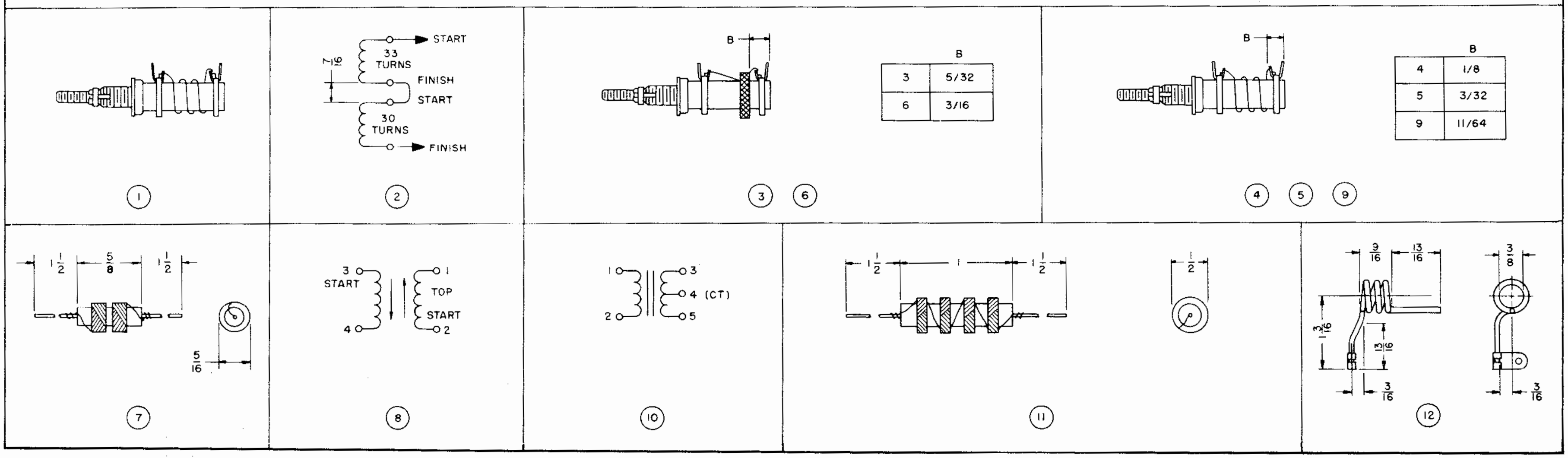
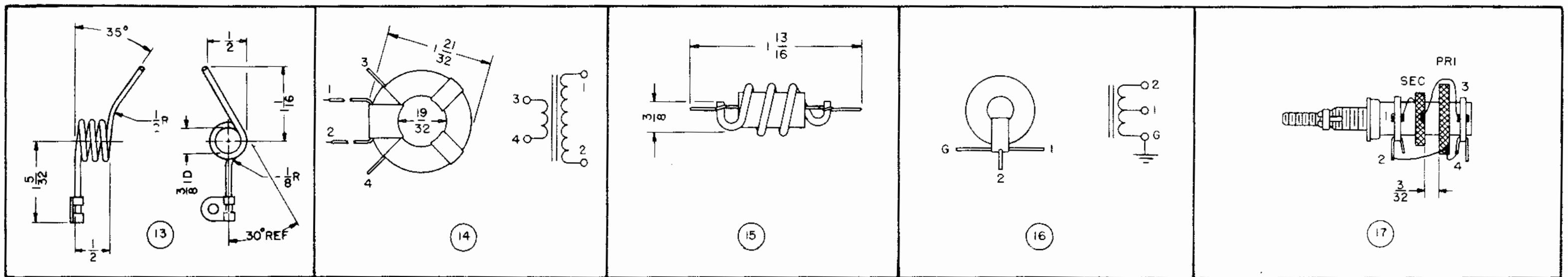
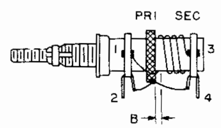


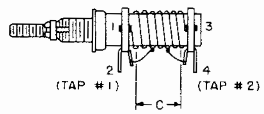
TABLE 7-10. WINDING DATA (cont)





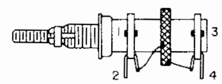
	B
18	1/16
19	1/64
20	3/64
21	0

(18) (19) (20) (21)



	C
22	9/16
23	5/8
24	0

(22) (23) (24)



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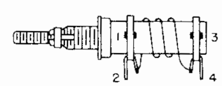

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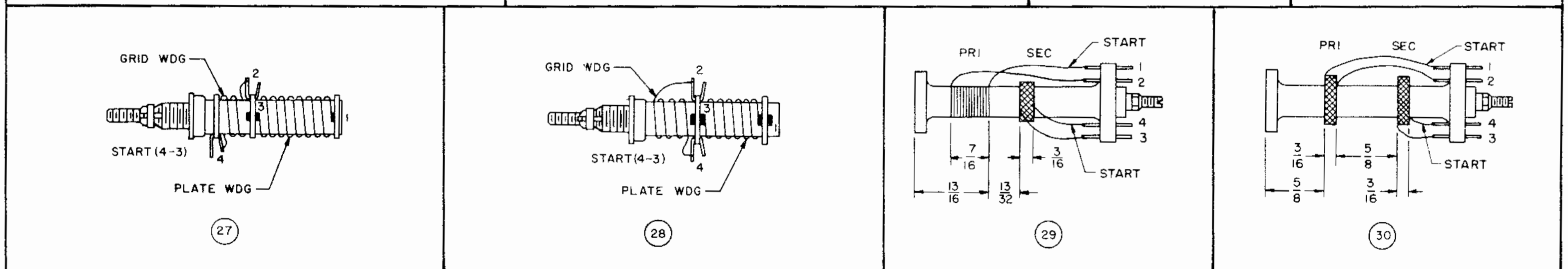
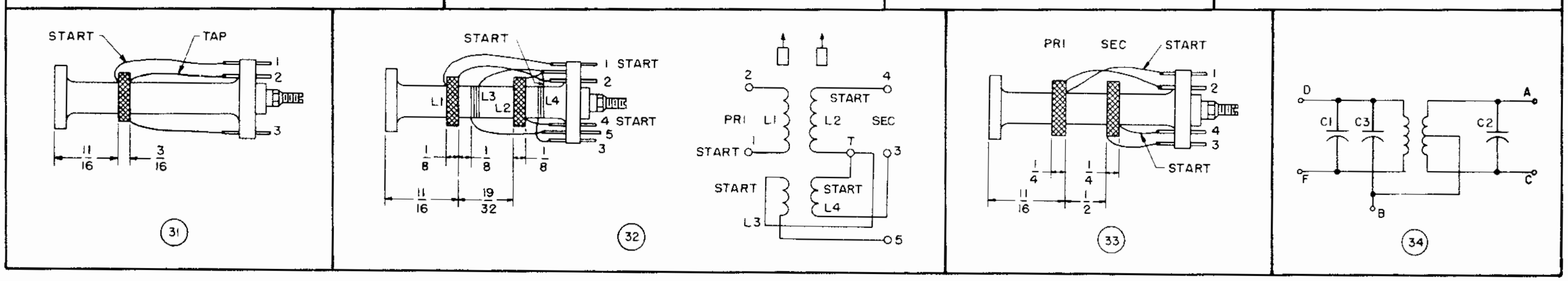
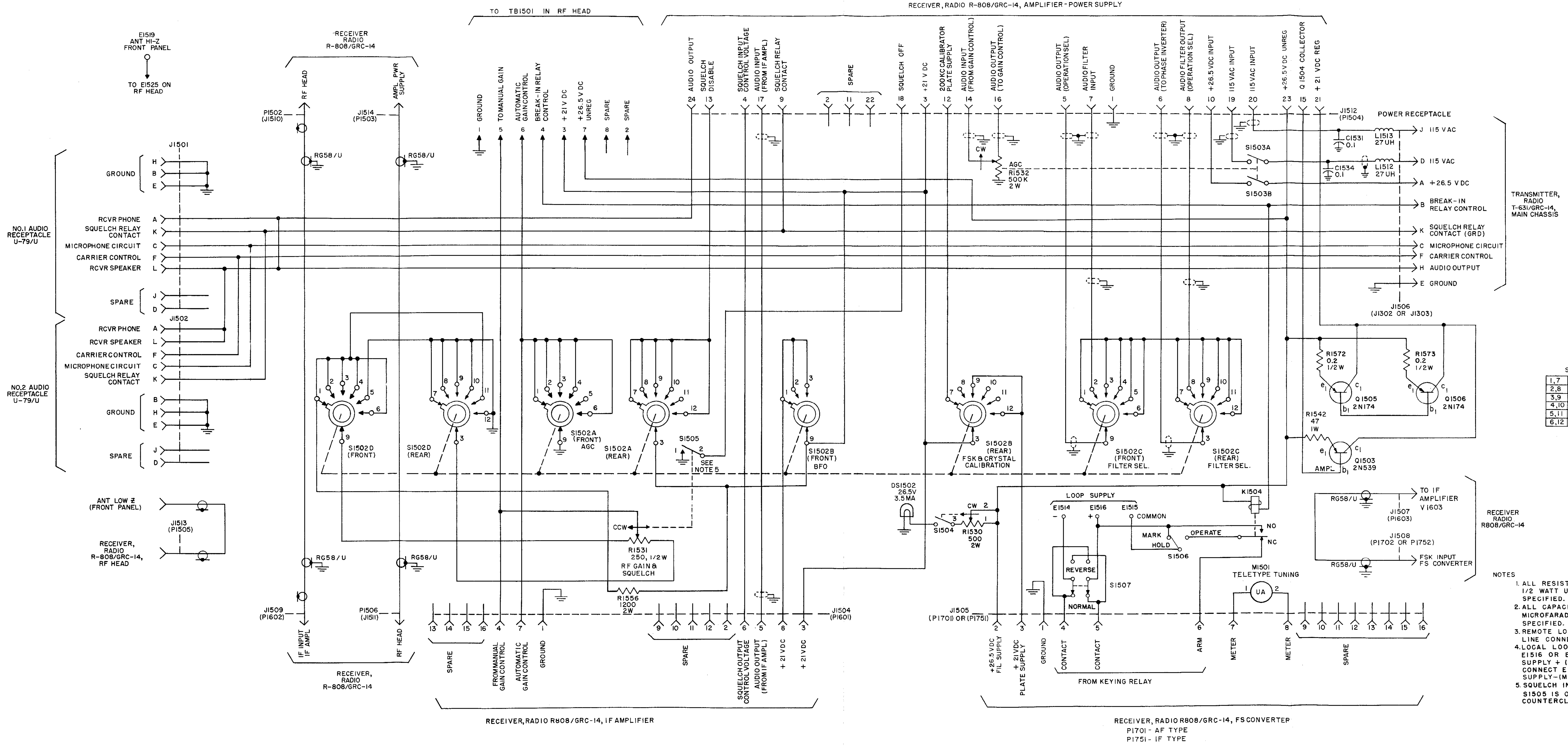






S1502 POSITIONS

1,7	CAL
2,8	CW SHARP
3,9	CW, FSK BROAD
4,10	MCW PHONE
5,11	BROAD PHONE
6,12	FSK, PHONE

NOTES
1. ALL RESISTORS ARE IN OHMS, 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICRO MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. REMOTE LOOP SUPPLY TELETYPE LINE CONNECTED TO E1516.
4. LOCAL LOOP SUPPLY-CONNECT E1516 OR E1514 TO TT LOOP SUPPLY + (PLUS). CONNECT E1515 AND TT LOOP SUPPLY-(MINUS) TO TTY LINE.
5. SQUELCH IN OFF POSITION WHEN S1505 IS OPEN. (R1531 EXTREME COUNTERCLOCKWISE POSITION)

Figure 7-78. Receiver Main Chassis, Schematic Diagram

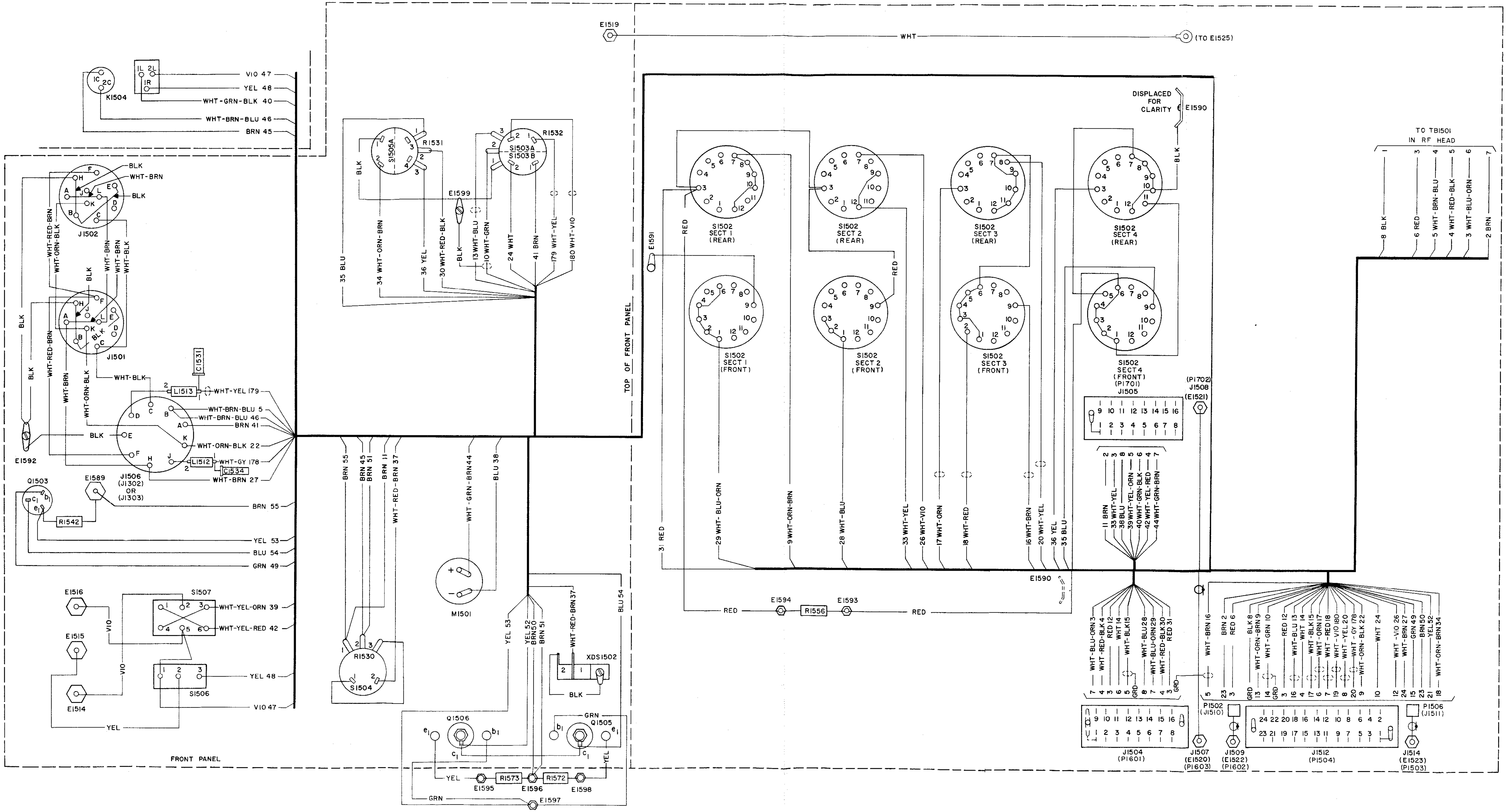
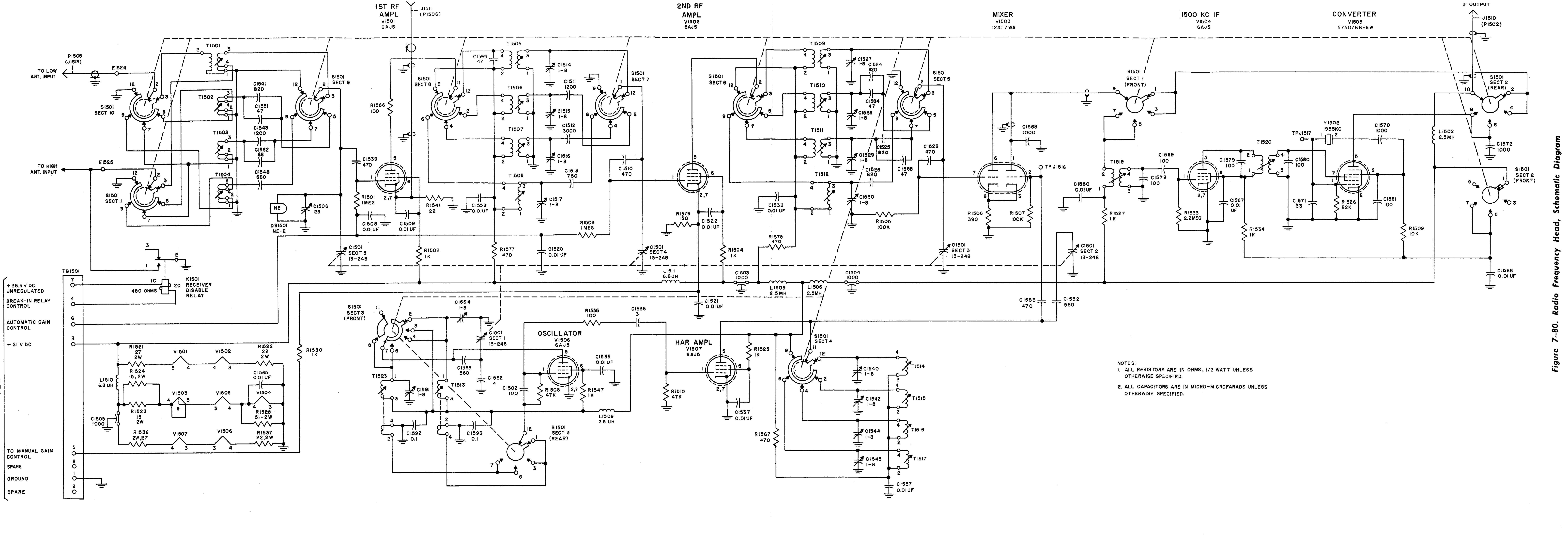


Figure 7-79. Receiver Main Chassis, Wiring Diagram



NOTES:
1. ALL RESISTORS ARE IN OHMS, 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICRO-MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 7-80. Radio Frequency Head, Schematic Diagram

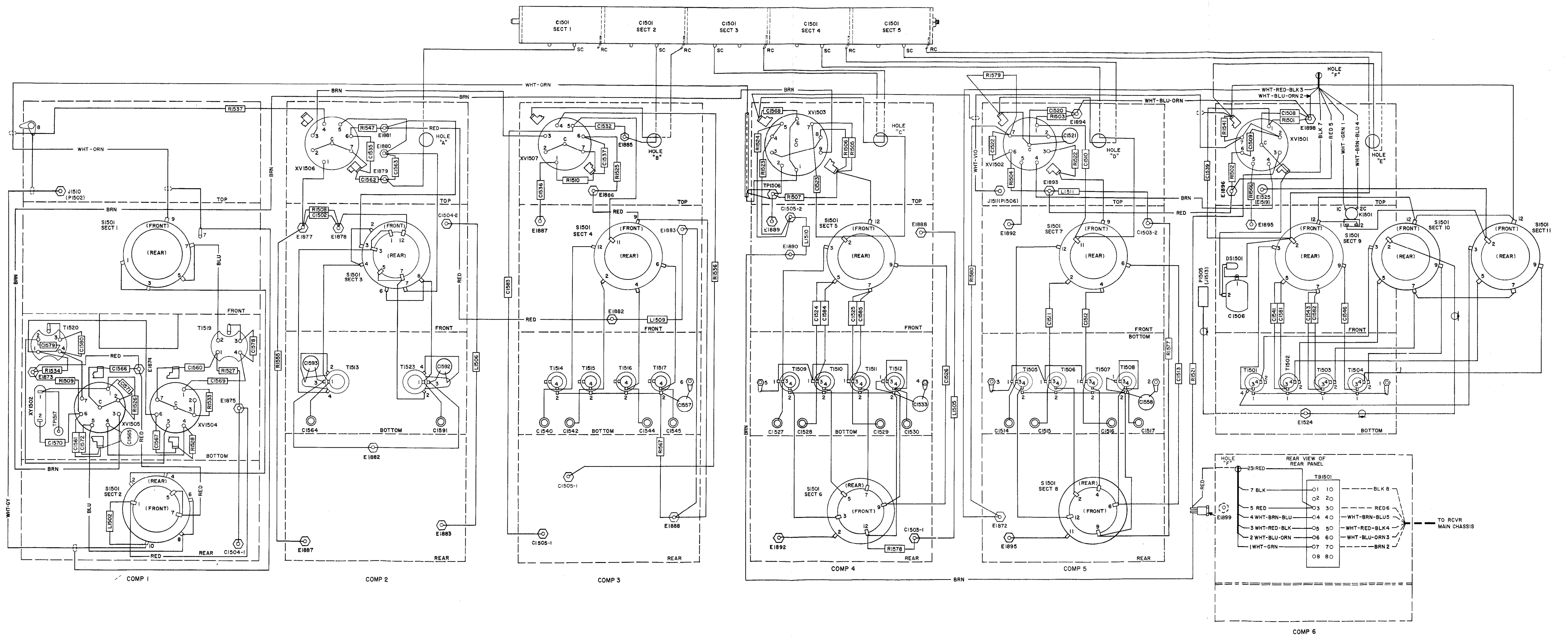


Figure 7-81. Radio Frequency Head, Wiring Diagram

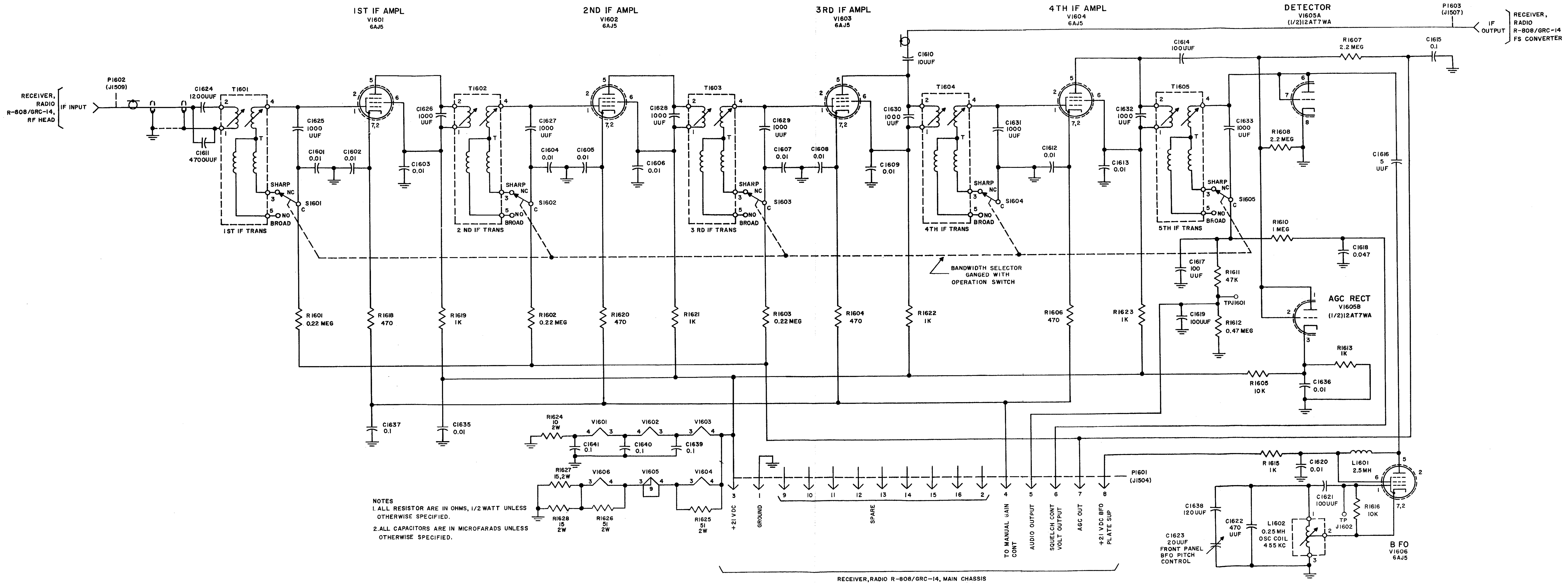
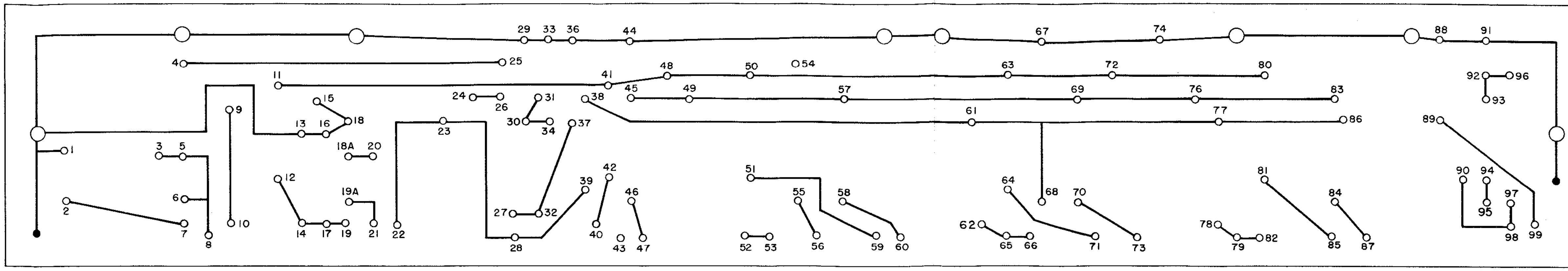


Figure 7-82. Intermediate Frequency Amplifier, Schematic Diagram



PRINTED SIDE OF TB1699

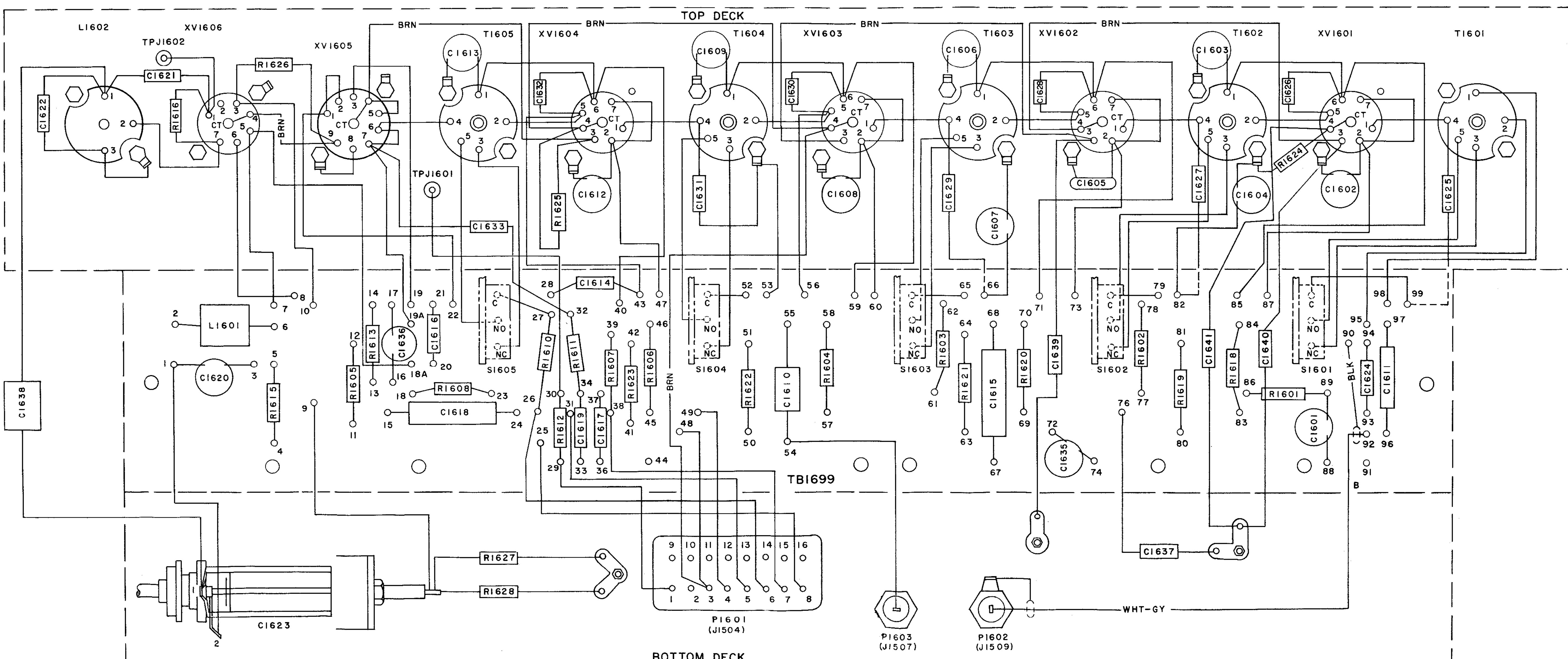
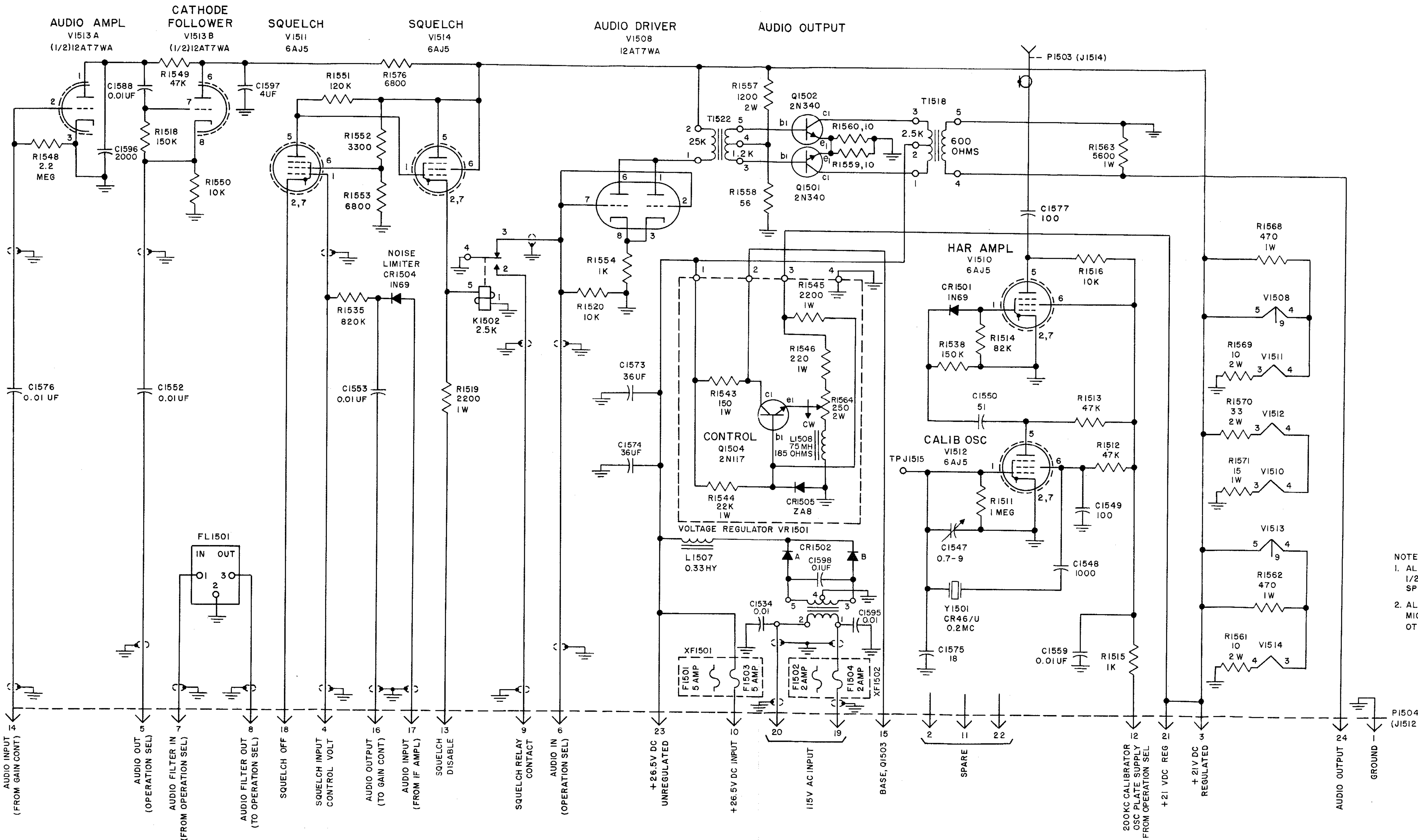


Figure 7-83. Intermediate Frequency Amplifier, Wiring Diagram



NOTES:
1. ALL RESISTORS ARE IN OHMS, 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICRO-MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 7-84. Amplifier-Power Supply, Schematic Diagram

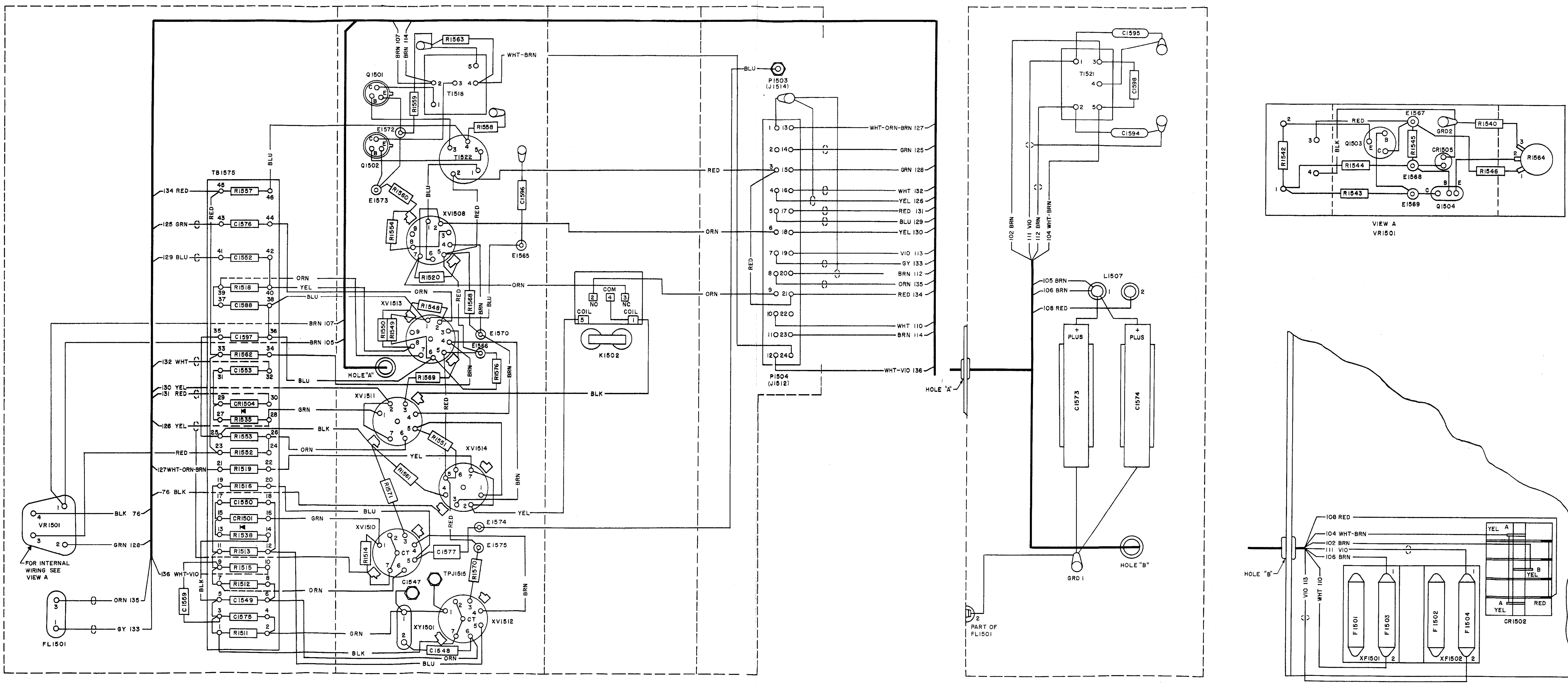
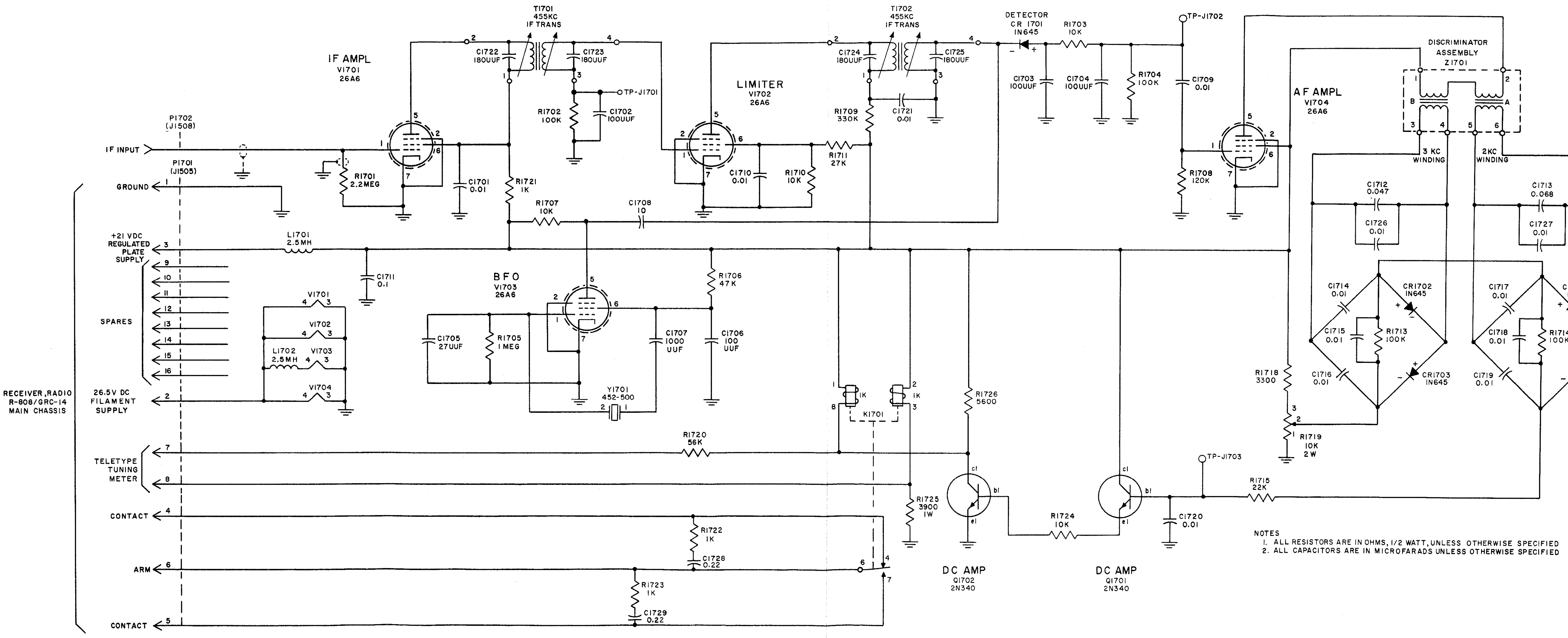


Figure 7–85. Amplifier-Power Supply, Wiring Diagram

THIS SCHEMATIC IS APPLICABLE TO FREQUENCY SHIFT CONVERTERS SUPPLIED AS PART OF RECEIVERS HAVING SERIAL NUMBERS 1 THROUGH 115



NOTES
1. ALL RESISTORS ARE IN OHMS, 1/2 WATT, UNLESS OTHERWISE SPECIFIED
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED

Figure 7-86. Frequency Shift Converter, AF Type, Schematic Diagram

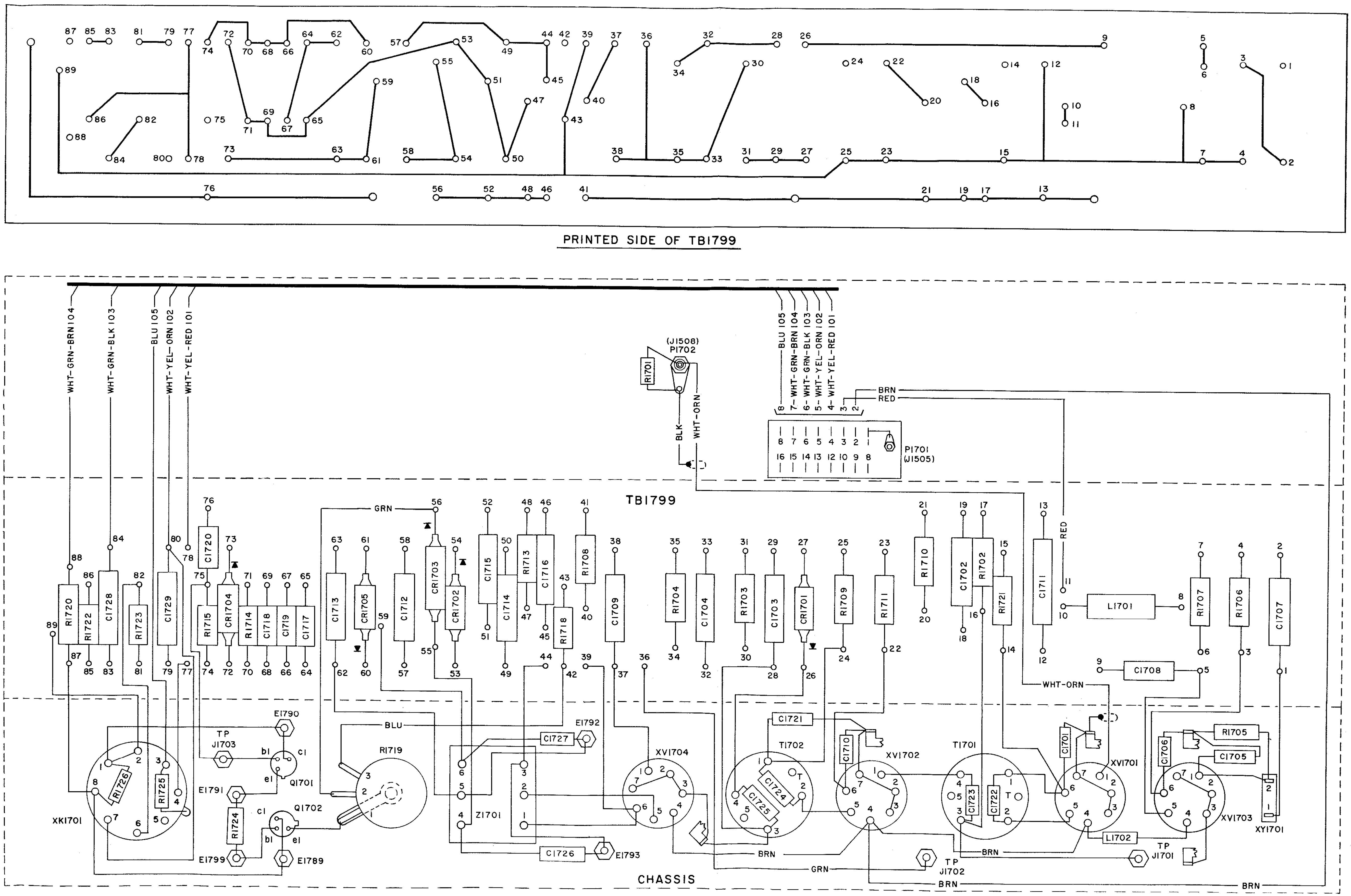
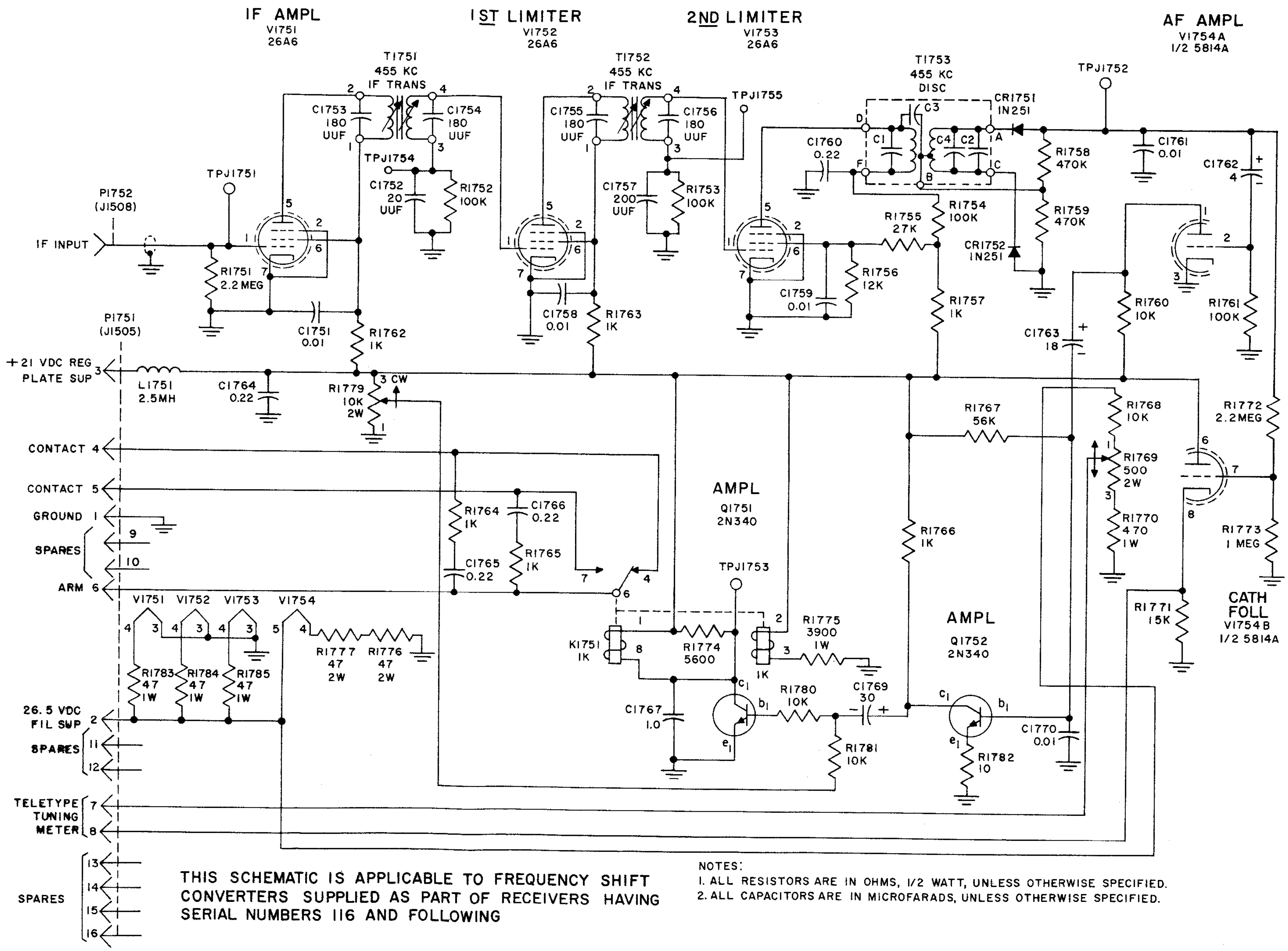


Figure 7-87. Frequency Shift Converter, AF Type, Wiring Diagram



THIS SCHEMATIC IS APPLICABLE TO FREQUENCY SHIFT CONVERTERS SUPPLIED AS PART OF RECEIVERS HAVING SERIAL NUMBERS 116 AND FOLLOWING

NOTES:
1. ALL RESISTORS ARE IN OHMS, 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

Figure 7–88. Frequency Shift Converter, IF. Type, Schematic Diagram

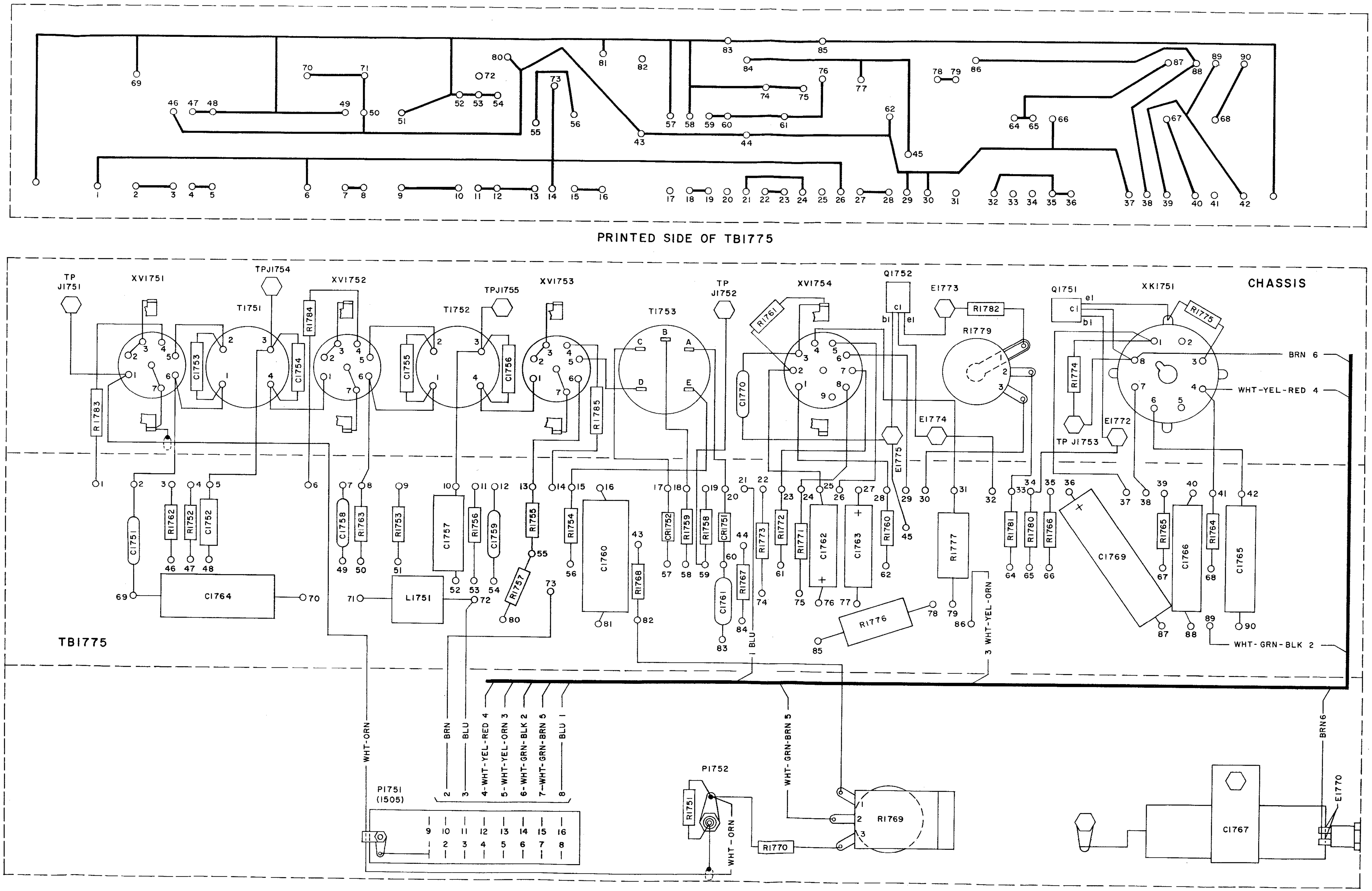


Figure 7-89. Frequency Shift Converter, IF. Type, Wiring Diagram

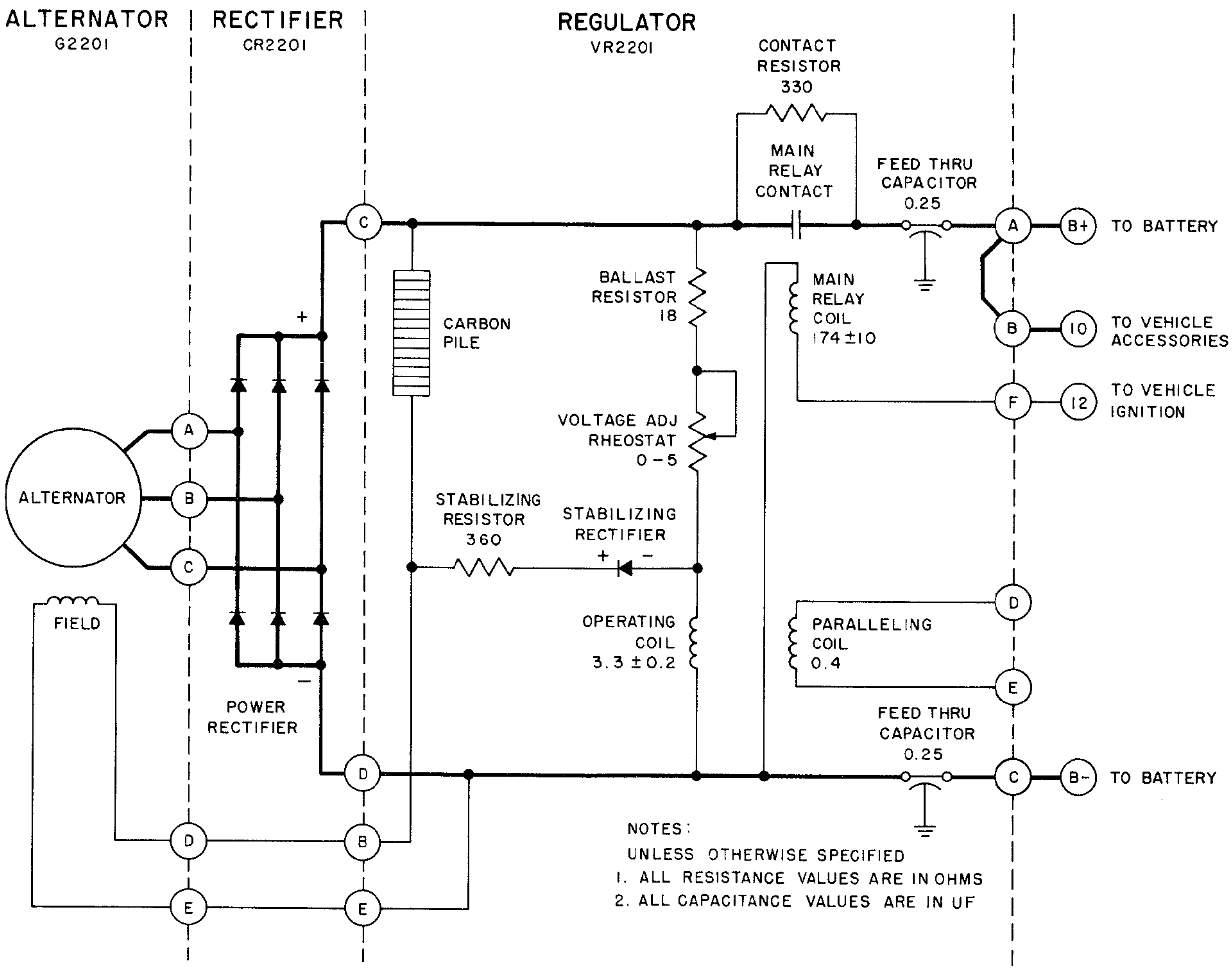


Figure 7-94. Generator System, Schematic Diagram

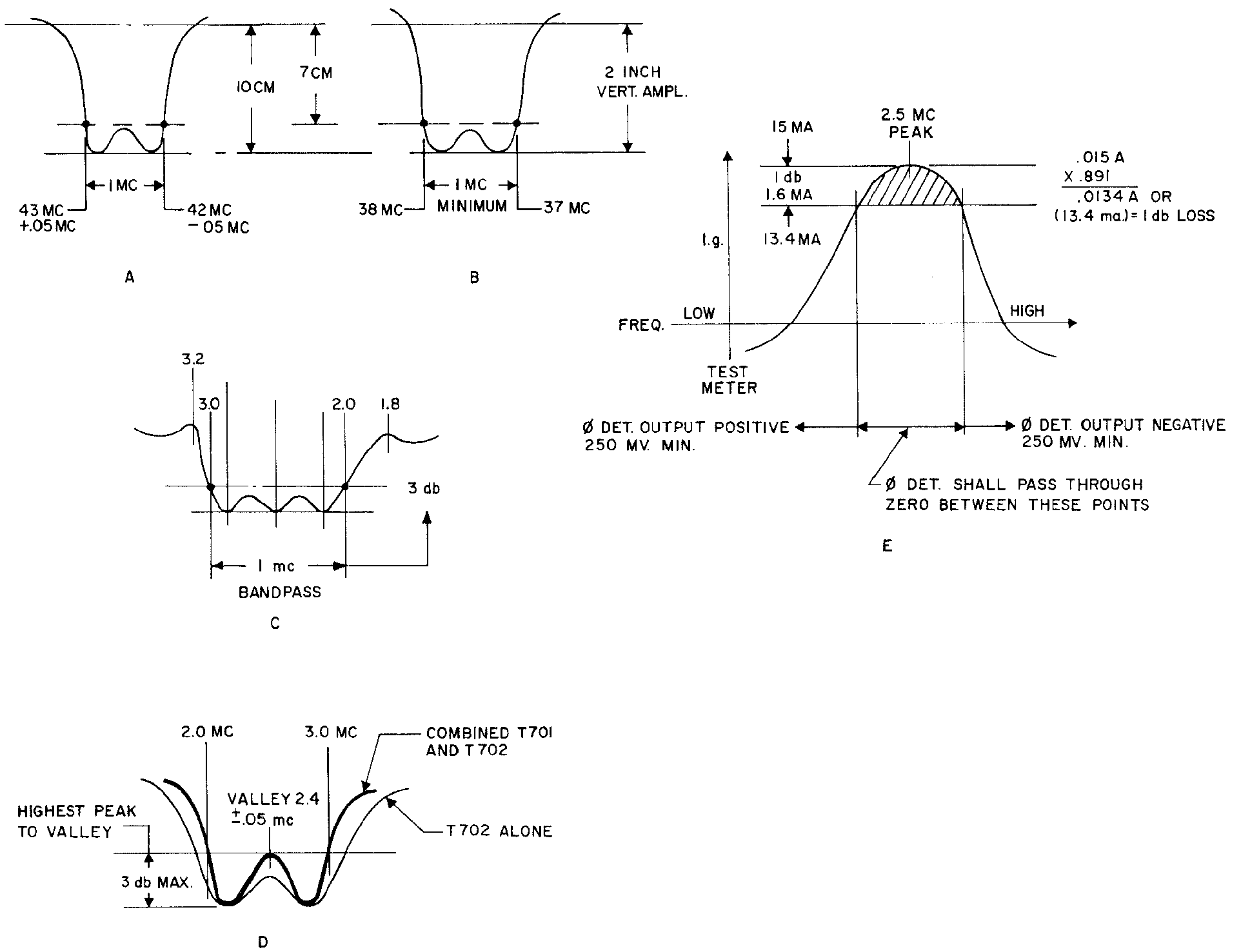


Figure 7-95. AN/MRC-55 Alignment Waveforms

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