ELECTRONIC LINK ENGINEERS

REMOTE CONTROL UNITS

TYPES 1890 Ed. 2

AND

1938 Ed. 2

OPERATING INSTRUCTIONS

AND

SERVICE NOTES

LINK RADIO CORP.

125 WEST 17th STREET

NEW YORK 11, N. Y.

In addition to The Remote Control Units described in this Instruction Book the following coordinating equipment is in regular production.

30-50 MC EQUIPMENT

Radio Transmitter-Receiver Type 2365-LR—30-watt land station assembly
Radio Transmitter-Receiver Type 50-UFS—50-watt land station assembly
Radio Transmitter-Receiver Type 250-UFS—250-watt land station assembly
Radio Transmitter-Receiver Type 3000-UFS—3000-watt land station assembly
Mobile Radio Equipment Type 2365-M—Complete 30-watt two-way mobile assembly
Mobile Radio Equipment Type 75-FMTR-7A—Complete 75-watt two-way mobile assembly

72-76 MC EQUIPMENT

Radio Transmitter-Receiver Type 1498 Ed. 6—50-watt land station assembly
Radio Transmitter-Receiver Type 1505—250-watt land station assembly

152-174 MC EQUIPMENT

Radio Transmitter-Receiver Type 2210-LR—10-watt land station assembly
Radio Transmitter-Receiver Type 1907 Ed. 2—50-watt land station assembly
Radio Transmitter-Receiver Type 2490—75-watt land station assembly
Radio Transmitter-Receiver Type 1908—250-watt land station assembly
Mobile Radio Equipment Type 2210-M—Complete 10-watt two-way mobile assembly
Mobile Radio Equipment Type 50-FMTR-7C—Complete 50-watt two-way mobile assembly

A complete line of Selective Calling and Selective Squelch equipment is available. Also, a complete list of antennas for these frequencies is maintained. For information write, giving the details of your problem.

LINK RADIO CORPORATION
125 WEST 17th STREET
NEW YORK 11, N. Y.

Reissue 1/31/50

MODIFICATION NOTICE
for
Radio Transmitter-Receiver Type 250-UFS Ed.7 with PMC

Change 250-UFS Book on Page 7, beginning with Sub-paragraph 5 (a) (3) to:

(3) ADJUSTMENT OF AUDIO GAIN CONTROLS.

(a) Adjustment of Transmitter PMC and Audio GAIN Controls. - The PMC level and audio GAIN controls (R42 and R30) must be adjusted simultaneously and in conjunction with a frequency deviation measuring device such as Frequency Meter Type 2051A.

Set up a Frequency Meter Type 2051A, couple it to the output circuit of the transmitter and apply an audio tone of approximately 1000 cps at a level of 1 volt across the 500 ohm input terminals (terminals 5 and 6 on the control panel).

Set the PMC level control (R42) to its maximum (clockwise) position. (This permits a maximum possible peak frequency deviation of about 17-20 kc.)

Set the audio GAIN control (R30) to its minimum (counterclockwise) posit[illegible]

Increase the audio GAIN control setting until Frequency Meter Type 2051A shows that the frequency deviation has stopped increasing linearly with the setting of the audio GAIN control and indicates about 17-20 kc peak swing.

Decrease the setting of the PMC level control until the frequency meter indicates a peak swing of ±15 kc. THIS IS THE CORRECT SETTING AND SHOULD NOT BE TOUCHED THEREAFTER.

For use with normal speech inputs adjust the audio GAIN up or down until the desired microphone sensitivity is reached.

WITH AN AUDIO INPUT OF 1000 CYCLES AND THE AUDIO GAIN CONTROL SET TO THE MAXIMUM (FULLY CLOCKWISE) POSITION, AN INPUT OF APPROXIMATELY -20 DB (.173 volts) IS REQUIRED FOR A PEAK DEVIATION OF ±15 KC.

LINK RADIO CORP. 125 W. 17th Street NEW YORK CITY

9/23/49

MODIFICATION NOTICE
for
250-UFS Ed.7

The equipment on this order has been modified by use of a newer type (Ed.7) receiver. Instructions for the 12-UF Ed.7 are to be found in the attached 50-UFS instruction book.

The operating features are unchanged from those shown in the 250-UFS Ed.7/6A book.

K5BKC

W5CXJ

WARNING

The operating voltages of this transmitter are dangerous. Accidental contact with parts of the circuit carrying these voltages is almost certain to be fatal. Use extreme care when making any adjustments with the doors open and remove the high voltage whenever it is practical to do so. The presence of another person is always desirable in case of emergency and is recommended. Above all, always make sure that the power is off before reaching inside the cabinet.

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Arthur L. Broyles WA5KF

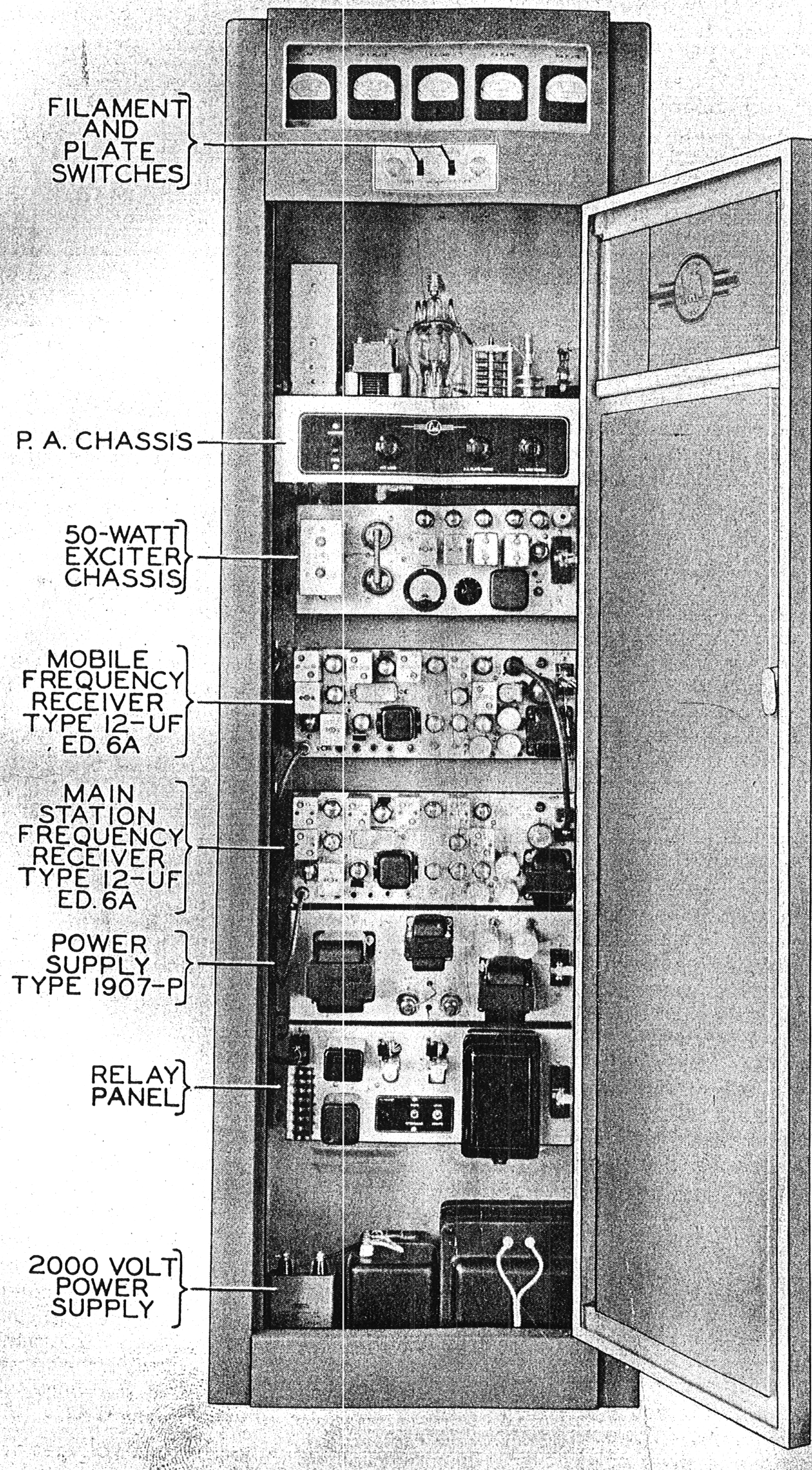


Figure 1. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Open Front View

1. INTRODUCTION.

Radio Transmitter-Receiver Type 250-UFS-Ed 7 is a complete assembly designed for two-way communication in the 30-50 megacycle very high frequency band. It consists of the 250-UFS-Ed. 7 250-watt FM transmitter, one or two 12-UF-Ed. 6A FM receivers, and all accessories for accomplishing an operating two-way communication system in a fixed station (figs. 1 and 2). The equipment is designed to derive all of its primary energy from 115 volt 50-60 cycle A-C lines. Two basic models of the 250-UFS are available as standard equipment. The 250-UFS-A is a single receiver model designed for use in systems in which only one main station is required and all units operate on the same frequency. A two-receiver model, the 250-UFS-B, is based on the requirements of a system using different frequencies for mobile and main station transmission. One receiver is tuned to the mobile frequency and the other to the main station frequency. Provision is made in the control circuit to open the squelch of the mobile frequency receiver and mute the main station frequency receiver at the will of the operator in order to insure reception of mobile transmissions free of interference from the other main stations in the system.

2. DESCRIPTION.

(a) General.—The power amplifier, exciter, power supplies, receiver(s) and relay panel are mounted in a completely enclosed cabinet. Front and rear doors give immediate access to all adjustments and circuit components for servicing. At the top front of the cabinet is located a meter panel containing five meters, reading P.A. plate voltage and current, I.P.A. plate current, P.A. grid current, and line voltage. This panel is indirectly illuminated by a 40-watt lumiline lamp and is protected by a glass window. Directly below the meter panel are the filament and plate switches and their associated pilot lamps.

Inside the cabinet are located the P.A. chassis (at the top), the exciter, receiver (or two receivers in the 250-UFS-B), exciter power supply, relay panel and P.A. high voltage supply in the order named. Terminals available from the front of the cabinet are provided for connection to the two-wire/four-wire remote control line and the 115-volt A-C power line. The remote control feature provides receiver-transmitter and control facilities over two or four telephone wires when used with a Link Remote Control Unit Type 1890. The handset for local control is mounted inside the cabinet.

A-C line fuses, overload relays, door switches, and all interwiring are built into the cabinet, which forms a completely operative unit as shipped from the factory.

Further characteristics appear below:

Overall cabinet size	24″ wide, 15″ deep, 78″ high
Total weight	380 lbs.
Total weight (packed for domestic shipment)	550 lbs.
Power input	From 115 volt A-C source Standby: 225 watts (with one receiver only) Transmitting: 1100 watts
Frequency range	30-50 mc
System audio response	±3 db, 300-3000 cycles

(b) Radio Transmitter Type 250-UFS Ed. 7.—Radio Transmitter Type 250-UFS-Ed. 7 is a 250-watt (nominal output) frequency-modulated unit. Its more salient characteristics may be listed as follows:

Power output	250 watts nominal
Type of emission	Frequency-modulated
Frequency deviation	±15 kc
Tube types	(1) 7A4, (2) 7C7, (1) 7F7, (1) 7W7, (1) 7C5, (2) 807, (1) 250TH or 454H, (2) 816, (2) 866A.
Output impedance	50-200 ohms single ended—usually fed into concentric line
Control	2-or 4-wire remote by self-contained relays—provisions for coordinated receiver control. Also complete control by means of local handset

Radio Transmitter Type 250-UFS Ed. 7 is a frequency-modulated unit utilizing the phase shift method of obtaining the desired deviation. This permits both direct crystal control of the carrier frequency and a simple circuit design with no critical tuning adjustments. It is designed for a maximum frequency deviation of ±15 kc in its operating range of 30 to 50 megacycles. A carrier power of 250 to 400 watts is available under normal operating conditions.

The transmitter is entirely self-contained within a single cabinet. Frequency generation, modulation and the necessary frequency multiplication are accomplished in a single 7″ rack mounting exciter chassis with an output of 50 watts on the carrier frequency. This power is amplified to the 250 watt level by a triode amplifier mounted on a shelf directly above the exciter. Power for the P.A. plate is derived from a single-phase full-wave rectifier supply located in the bottom of the cabinet and rated at 2000 volts at 300 ma. Coordination and control are accomplished by a relay panel located above this supply.

Eight tubes are included on the exciter chassis, six of which are of the low drain receiving type.

The tube types and their uses are as follows:

1 Type 7A4	Audio amplifier
1 Type 7F7	Crystal oscillator, phase modulator
1 Type 7W7	1st frequency doubler
1 Type 7C7	2nd frequency doubler
1 Type 7C7	Frequency quadrupler
1 Type 7C5	3rd frequency doubler
2 Type 807	Intermediate power amplifiers

From the above list it is seen that the crystal frequency is multiplied 32 times in order to obtain the final operating frequency. A meter and meter switch are provided on the chassis to read the grid current of each stage for convenience in making adjustments. All tuning adjustments are straightforward and small errors in making them will not affect the output frequency, quality or modulation level in any way.

Filament and plate voltages for the transmitter are supplied by Power Supply Type 1907-P which is mounted on a separate 19 inch rack chassis. A filament transformer supplies 6.3 volts AC for the transmitter filaments and

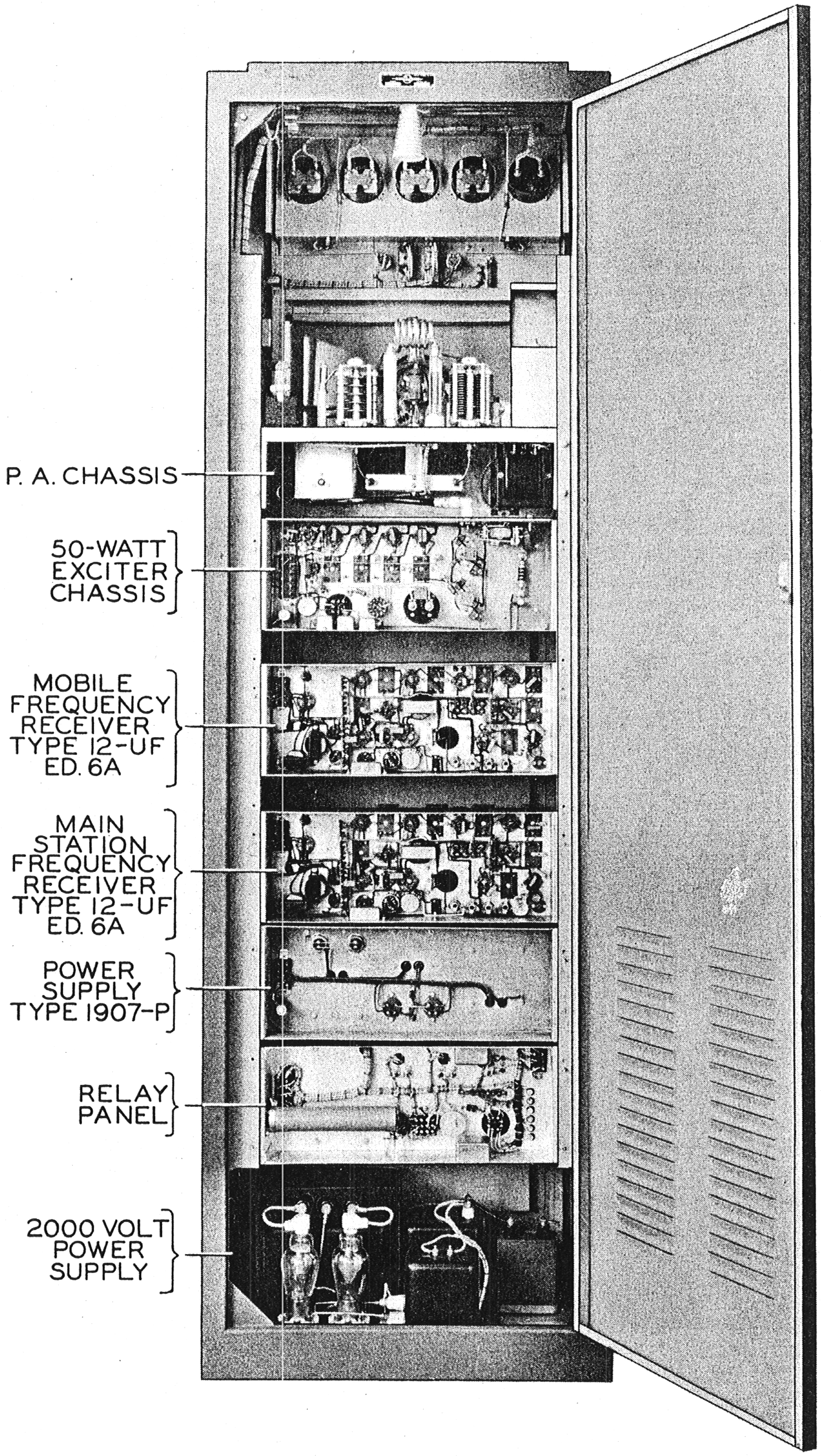


Figure 2. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Open Rear View

filament current for the type 816 rectifiers. The high voltage rectifier supplies 410 or 475 volts DC at 250 ma.

The power amplifier consists of a single 250TH or 454H tube which is connected in a conventional grid-neutralized triode circuit and operates with high efficiency and stability. All tuning controls are brought out to the front edge of the shelf on which the amplifier is mounted and provide unusual ease in adjustment. The 2000 volt D-C supply for this stage uses two 866A tubes in a single-phase full-wave rectifier circuit, employing a single-section choke-input filter.

(c) Radio Receiver Type 12-UF Ed. 6A.—Radio Receiver Type 12-UF Ed. 6A is a 12-tube, crystal-controlled, single-frequency, frequency-modulation, superheterodyne receiver designed particularly for the reception of frequency-modulated signals of the type generated by Radio Transmitters Type 25/35/50/75-UFM, 50-UFS, 250-UFS and 3000-UFS. Some pertinent characteristics follow:

Frequency range	30-50 mc
Type of signal	Frequency modulated
Frequency deviation	±15 kc
Audio response	±3 db 300-3000 cycles (system) (sharp cut-out filter attenuates frequencies above 3000 cycles)
Power supply	Self-contained
Power input	65 watts from 115-volt 50-60 cycle A-C source
Output impedance	500 ohms
Mounting	7" of standard 19" relay rack
Control	Coordinated with 250-UFS control
Power output (into 500 ohms)	Approximately 1 watt

Radio Receiver Type 12-UF Ed. 6A utilizes 12 tubes in a double conversion superheterodyne circuit. The tube types and their uses are as follows:

1 Type 7AG7	R-f amplifier
1 Type 7AG7	Mixer
1 Type 7AG7	Crystal oscillator-multiplier
1 Type 7AG7	I-f amplifier
1 Type 7S7	Converter
1 Type 7C7	First limiter
1 Type 7AG7	Second limiter
1 Type 7A6	Discriminator
1 Type 7A6	Squelch rectifier
1 Type 7F7	First audio, squelch
1 Type 7B5	Audio output
1 Type 80	Rectifier

Two quartz crystals are employed to insure stable receiving conditions under all variations of temperature and humidity. The double i-f system makes possible excellent bandpass characteristics with a very favorable image ratio.

Three tuning meter jacks are located on the receiver chassis. One is for measuring the grid current of the first limiter, thus indicating resonance in all the preceding stages. The second is for measuring the grid current of the second limiter and the third is to permit adjustment of the balance of the discriminator circuit. The two former require the use of a zero to one milliampere meter while the third requires a fifty or one hundred microampere meter, center-zero type preferred. A monitor jack across the 500-ohm output is located on the receiver chassis to permit aural monitoring of the receiver when the loudspeaker is remotely located.

3. UNPACKING.

The 250-UFS Cabinet is shipped packed in a wooden crate. All chassis are removed for shipment and packed separately in cardboard containers to minimize damage during transport. To reassemble the complete unit, unpack all components. Place the chassis in place from the front of the cabinet, (see fig. 1) hooking them over the heads of the screws already in place on the rack. Tighten these screws securely and plug the cable connectors onto their appropriate chassis receptacles.

The rectifier tubes (2-816 and 2-866A) and the P.A. tube are removed from their sockets and shipped in separate cartons. When these tubes are unpacked, all packing material should be removed from around them and the elements carefully inspected for loose or broken parts. In placing the tubes in their sockets, all connections should be firmly made without placing any strain on the tube caps or leads.

4. INSTALLATION.

Installation of the 250-UFS consists merely of attaching power, antenna and control cables. All power for the unit is derived from a 115-volt 50-60 cycle A-C source. Power input terminals are provided on the right hand side of the cabinet for this purpose. Because of the relatively large power drain of the transmitter, direct connection to the power line is recommended. In any case, adequate current-carrying capacity of the power connection must be provided to insure proper operation.

Provision has been made in the Relay Panel of Radio Transmitter-Receiver Type 250-UFS for either two-wire or four-wire control operation. Figure 7 on page 15 shows the connections to terminal strip E401 for the control system desired. The instructions supplied with Remote Control Unit Type 1890 show the connections at the remote control unit for either type of operation.

The coaxial line from the antenna should be brought through the hole provided in the top of the cabinet and connected to the antenna transfer relay located on the P.A. shelf by means of the adapter supplied.

5. TUNING AND OPERATION.

(a) Tuning and Adjustment.

(1) Radio Receiver Type 12-UF Ed. 6A.—To turn on the receiver, advance the VOLUME control on the receiver chassis about half way to its maximum position. The first few degrees of rotation will apply primary power to the receiver power supply.

With the volume control advanced and the SQUELCH switch in the OFF position, a loud rushing noise should be heard in the loudspeaker even with the antenna disconnected. If the SQUELCH switch is placed in the ON position, all output from the loudspeaker should cease because of the action of the squelch circuit.

The loud noise present in the loudspeaker with the SQUELCH switch OFF is entirely normal and characteristic of an FM receiver of adequate sensitivity. Any amount of noise introduced into the receiver or picked

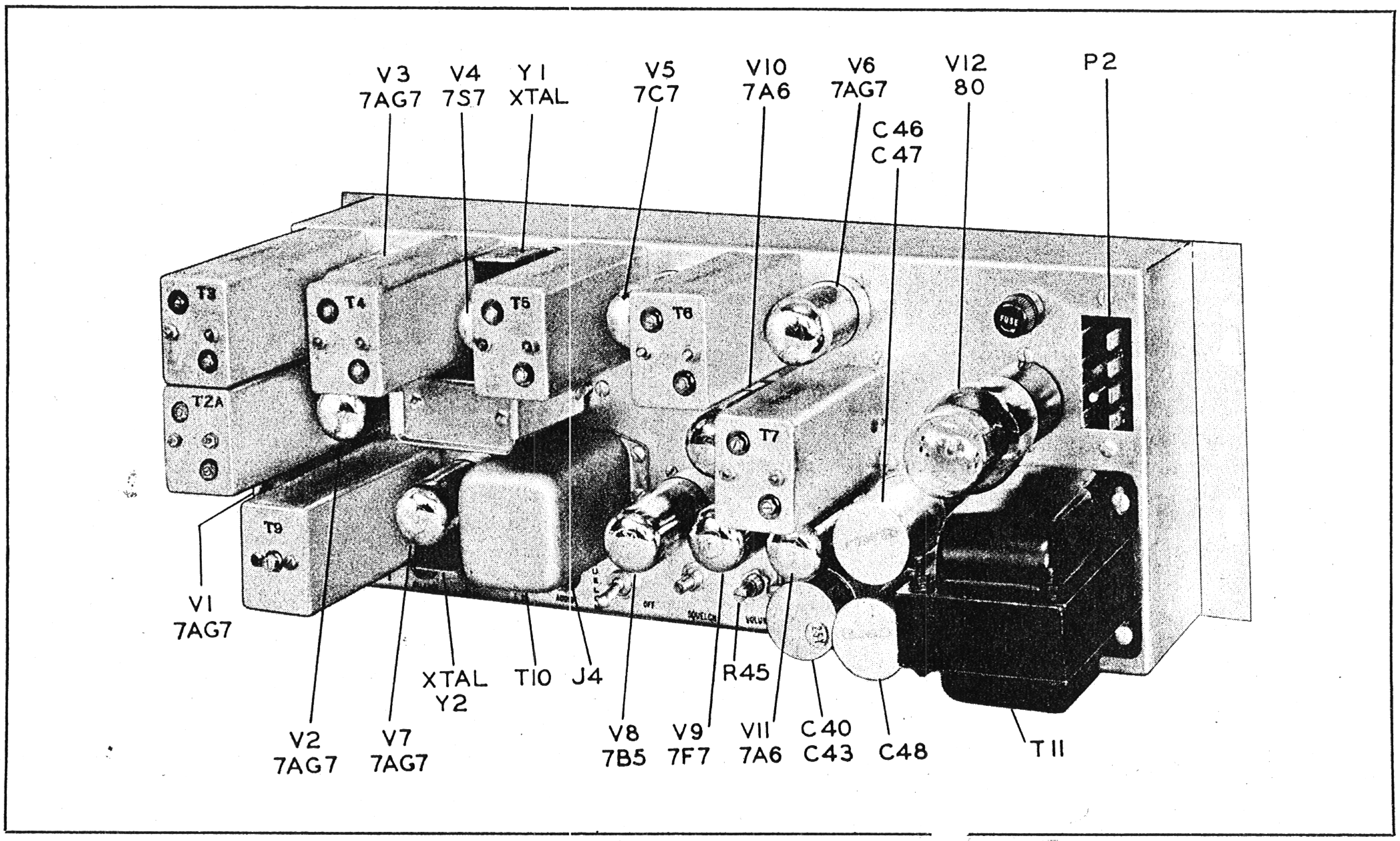


Figure 3. Radio Receiver Type 12-UF-Ed. 6A, Top of Chassis View

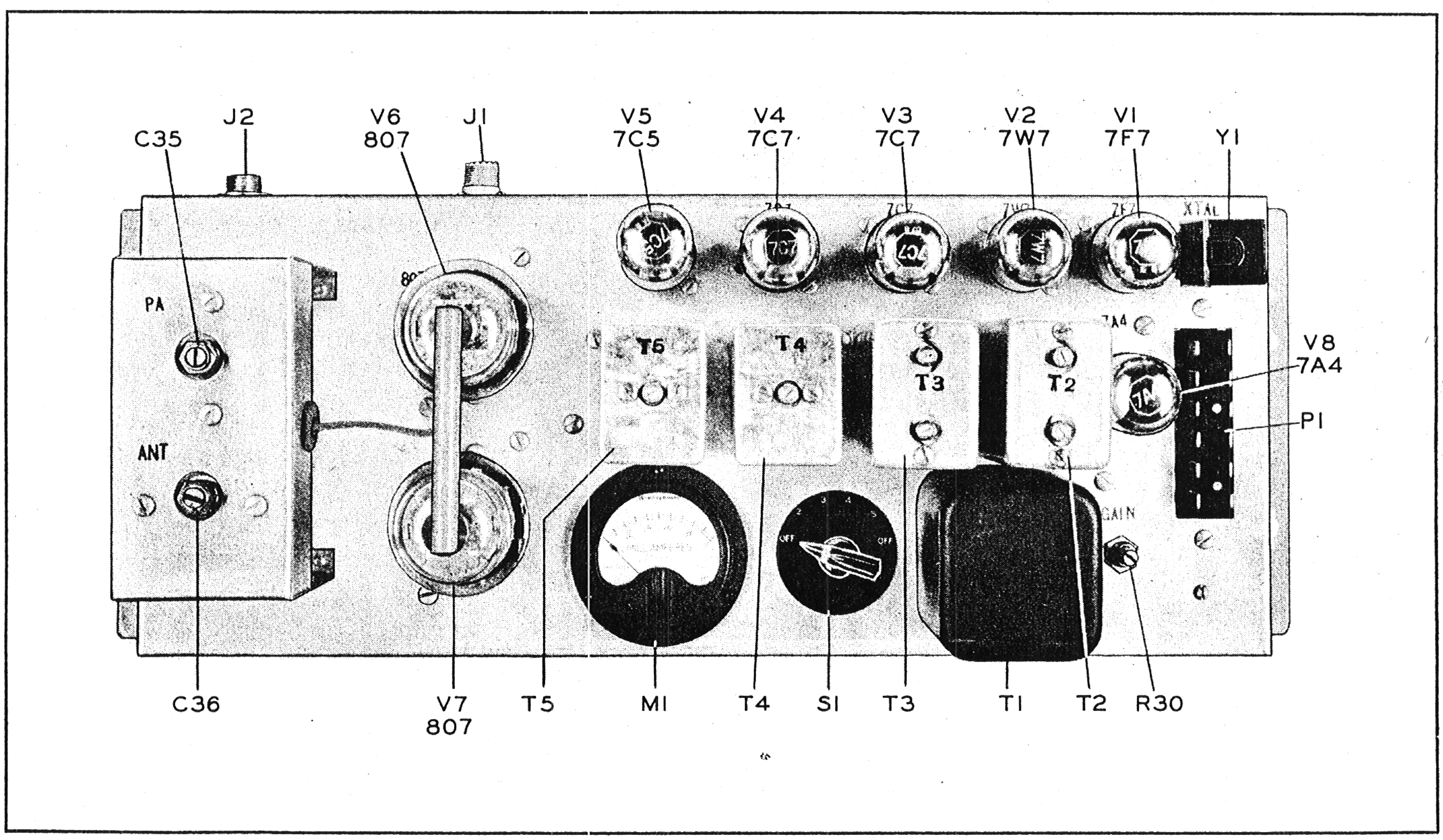


Figure 4. Exciter Chassis Radio Transmitter Type 250-UFS-Ed. 7, Top View

up by the antenna will not alter or intensify the characteristic sound of this noise unless a carrier is being received. In the latter case, even a weak signal will greatly reduce or completely suppress the noise.

When shipped from the factory the 12-UF Ed. 6A receiver is equipped with the proper tubes and crystal and is tuned approximately to the specified operating frequency.

In addition, the approximate positions of the tuning adjustments are marked with red lines to facilitate tuning. With the antenna connected to the receiver, plug a one milliampere meter into jack J1 (marked L1) and adjust T1, T2, T3, T4, T5, and T9, tuning for maximum current in the meter while receiving a weak signal on the desired frequency. Tuning must be made to a signal weak enough so that at resonance, not more than one-tenth milliampere deflection is obtained in the tuning meter.

Next, plug the tuning meter into jack J2 (marked L2) and adjust the tuning controls on T6 for maximum current in the meter. The primary of T7 is tuned at the factory and its adjustment is so broad that it need not be changed in the field. To tune the secondary of T7, plug a fifty or one-hundred microampere meter, center-zero type preferred, into jack J3 (marked BALANCE) and, with a non-metallic screwdriver, adjust the secondary tuning control marked BAL. for zer[illegible]ding on the microammeter while receiving a strong s[illegible]

After the receiver has been completely tuned, the SQUELCH control may be adjusted. The most sensitive position of this control is completely clockwise. With the adjustment in this position and the SQUELCH switch ON, advance the volume control and observe the output of the receiver with no signal input. Turn the squelch adjustment in a counterclockwise direction until the output of the receiver is entirely silent. This adjustment will hold for most noise conditions, no matter how severe, as a result of the special circuits incorporated in the design of the 12-UF Ed. 6A. Note that in its most sensitive position, the squelch sensitivity is better than one-tenth microvolt and that even this very sensitive adjustment may prove sufficient in many cases to silence the receiver between signals.

(2) Radio Transmitter Type 250-UFS-Ed. 7.—When shipped from the factory Radio Transmitter Type 250-UFS-Ed. 7 is equipped with the proper tubes and crystal and is tuned correctly to the specified operating frequency. In addition, the approximate positions of the tuning adjustments of the exciter are marked with red lines to facilitate tuning.

A meter and meter switch are an integral part of the exciter and serve to measure the grid currents of the various stages. The position numbers on the meter switch correspond with the numbers on the tops of the r-f transformers. Thus, r-f transformer T2 is tuned for maximum current on the meter with the meter switch in position 2, etc. For initial tune-up it can be assumed that all the circuits are in proper tune except the P.A. and antenna tuning adjustments.

The transmitter may be energized for tuning or testing purposes from the switches on the unit or by placing the RADIO-INTERPHONE switch on the relay panel in the RADIO position, the LOCAL-REMOTE switch in the LOCAL position and pressing the handset button. In either case, the filament switch on the front of the 250-UFS must first be turned on. To permit adjustments to be made with the doors open, the LOCAL-REMOTE switch automatically short-circuits the door interlock switches when thrown to the LOCAL position. When in this position, it also opens the remote control circuit, thereby preventing the application of power by the remote operator. Plate power may then be applied—either by the PLATE switch from the front of the cabinet, or from the push-to-talk button on the local control handset—and tuning adjustments made. The protective function of the door switches should be restored when adjustments are completed by returning the LOCAL-REMOTE switch to REMOTE.

WARNING

HIGH VOLTAGES ARE USED IN THIS TRANSMITTER. KEEP AWAY FROM LIVE CIRCUITS. CONTACT WITH THEM MAY PROVE FATAL.

In order to tune the output circuit of the transmitter, disconnect the antenna cable from the antenna transfer relay, place the antenna tuning capacitor C307 at maximum capacity, throw the TUNE-OPERATE switch to TUNE, and adjust the P.A. tuning capacitor C305 for minimum plate current as read on the meter on the front of the cabinet. This current should be approximately 35 milliamperes. Connect the antenna and re-resonate the P.A. TUNING adjustment for minimum current. Now decrease the antenna tuning capacity in small amounts, retuning the P.A. TUNING each time for minimum current. Continue this process until the P.A. plate current is 100 milliamperes on the minimum adjustment of the P.A. TUNING. Throw the TUNE-OPERATE switch to OPERATE and continue this process until a P.A. plate current of 250 ma is obtained. The transmitter is now adjusted for 250 watts output.

The output level may be increased by continuing this loading procedure until a current of 300 ma is obtained on resonance. Because of the heavier load imposed on the tube, slightly shorter tube life may be expected. In the average installation, no appreciable increase in service range will be observed at the higher power level because of the many other factors which also influence the effective range.

In making the preliminary adjustments on the low level stages, the plate voltage should either be reduced by placing the TUNE-OPERATE switch in the TUNE position or removed entirely by unscrewing the dropping resistor R504 (top rear of cabinet) from its socket.

(3) Adjustment of Audio Gain Controls.

(a) Adjustment of Transmitter Audio Gain.—The gain of the exciter audio amplifier (fig. 4) is controlled by potentiometer R30 and its proper adjustment requires the use of a receiver tuned to the same frequency as that of the transmitter. If the Radio Receiver Type 12-UF Ed. 6A in the equipment cabinet is not on the same frequency, it is possible to use a mobile or other receiver which is tuned to receive signals from the transmitter being adjusted.

Plug a test meter into the first limiter metering jack on the receiver. Place the transmitter in operation and note the first limiter grid current reading on the receiver test meter. This should be done with the transmitter audio gain control in the off (fully counterclockwise) position. While talking into the handset in a normal manner, slowly advance the setting of the audio gain control until modulation peaks cause the receiver first limiter grid current to swing downward not more than ten percent of the unmodulated reading. This is the correct setting. For example, if a no signal first limiter grid current of 200 μa is obtained, the correct position would be where the meter varies between 180-200 μa.

NOTE: Since the audio level of the local handset may be several db higher or lower than that from the incoming line, this fact should be taken into account and adjustment made using the normal source of audio.

(b) **Adjustment of Receiver Audio Gain.**—The receiver gain control (R45) should be advanced (clockwise) until the audio level, on modulation peaks, reads not more than +4 db on the telephone line. A volume indicator or db meter is used to read this level at the line terminals (Nos. 5 and 6) on the relay panel with the telephone line connected.

(4) **Neutralization.**—Stabilization of the triode power amplifier is accomplished by the use of a grid neutralized circuit in which variable capacitor C302 couples the proper amount of feedback voltage to the grid to counteract that due to the normal grid-plate capacitance. This capacitor is adjusted to the correct setting at the factory and locked in position. If readjustment is found necessary in the field, the following procedure is recommended.

WARNING

DO NOT TOUCH THE NEUTRALIZING CAPACITOR WITHOUT FIRST GROUNDING IT TO BE SURE THE HIGH VOLTAGE IS OFF.

With plate voltage impressed on the P.A., tune the P.A. plate circuit off resonance to 250 ma on each side and observe the grid current for each condition. These values should be equal and approximately 10 ma less than the on-resonance value. If they are not, turn off the plate voltage and readjust C302 by ½ turn either way. Apply plate voltage and again observe the off-resonance grid currents. If they deviate more than before, adjust the capacitor in the opposite direction. Repeat this procedure until the currents are identical.

(b) Operation.

(1) **Remote Control.**—When Radio Transmitter-Receiver Type 250-UFS-Ed. 7 is used from the remote control position the FILAMENT switch at the top front of the equipment cabinet must be ON, and the PLATE switch OFF. The RADIO-INTERPHONE switch on the relay panel must be in the RADIO position and the LOCAL-REMOTE switch in the REMOTE position with both cabinet doors closed. At the remote control point, the output of the microphone amplifier should be adjusted as described in the instructions for Remote Control Unit Type 1890. To transmit, lift the handset from the hang-up hook at the remote control unit, press the push-to-talk button on the handset and talk into the mouthpiece in a natural tone of voice. Immediately after talking, release the push-to-talk button. The incoming signal will be audible in the handset receiver. At the end of the communication, replace the handset on the hang-up hook.

In the 250-UFS-B, removal of the handset from the switch hook opens the squelch circuit of the mobile frequency receiver and mutes the main station receiver. After this, transmission and reception are accomplished in the normal manner by means of the handset push-to-talk button.

(2) **Local Control.**—Radio Transmitter-Receiver Type 250 UFS-Ed. 7 as normally supplied has the local handset and hangup mounted inside the cabinet for maintenance and test purposes prohibiting unauthorized operation of the equipment. If regular operation from this point is desired, the handset may be mounted outside of the cabinet.

For local operation the FILAMENT switch at the top of the equipment cabinet is turned ON with the LOCAL-REMOTE switch on the relay panel in either position. The RADIO-INTERPHONE switch should be in the RADIO position. However, when the front door is opened to provide access to the handset, the LOCAL-REMOTE switch must be placed in the LOCAL position, permitting normal transmission with the door open, and also opening the D-C path of the telephone line control circuit, affording protection from application of high voltage from the remote point when tuning or adjusting the transmitter.

Transmission is accomplished by lifting the handset from the hang-up hook, pressing the push-to-talk button and talking into the mouthpiece in a natural tone of voice.

When adjustments are completed return the LOCAL-REMOTE switch to the REMOTE position, restoring the remote control functions and the protection afforded by the door switches.

(3) **Interphone.**—Emergency communication with the remote control points may be effected without the transmitter going on the air by placing the RADIO-INTERPHONE switch in the INTERPHONE position. This switch connects a battery into the local microphone circuit and opens the plate power contactor control circuit.

The interphone function is provided without the battery when the LOCAL-REMOTE switch is in the LOCAL position and the RADIO-INTERPHONE switch is in the RADIO position. In this condition, the remote and local operators may hear not only each other but all incoming signals. Radiation from the transmitter may be reduced to a low value, if desired, by removing the plate voltage from the power amplifier.

For normal operation the RADIO-INTERPHONE switch is left in the RADIO position.

(4) **Operating Technique.**—Good operating technique is characterized by speaking distinctly in a normal voice and by keeping each transmission brief. If there are several instructions to be given, it is better to state them one at a time and have each acknowledged. Avoid long one-sided discussions. Before calling, be sure the air is clear. If you can hear one of your units, even though he may not be calling you, don't attempt to put in a call as you may garble the communication already in progress.

6. CIRCUIT DESCRIPTION.

(a) Radio Transmitter Type 250-UFS-Ed. 7.

(1) General.—Radio Transmitter Type 250-UFS-Ed. 7 is a frequency modulated transmitter utilizing the phase-shift method of obtaining frequency deviations and as such exhibits considerably different characteristics than the usual amplitude-modulated units. Intelligence is conveyed in variations of the constant amplitude carrier frequency about a mean value as contrasted in amplitude modulation to the intelligence being contained in amplitude variations of the constant frequency carrier wave. The use of the phase-shift method of frequency modulation allows direct crystal control of the mean carrier frequency, a necessity in unattended equipment. It requires, however, considerable frequency multiplication after modulation to generate sufficient frequency deviation. A number of small, low drain tubes are used for this function, and a total frequency multiplication factor of 32 is effected. In working with FM transmitters certain handicaps are encountered that make unusable many of the "rules-of-thumb" that have been helpful in servicing amplitude modulated equipment. Oscilloscopes are of little value in checking since no change of pattern is discernible during modulation. In fact modulation is accompanied by no readily measurable change of any kind in the r-f output of the transmitter.

(2) Exciter.

(a) Oscillator-Modulator.—The twin triode V1 (7F7) acts as both crystal oscillator and phase modulator. The first half of the tube operates as a resistance-coupled aperiodic oscillator circuit. The crystal, which is connected between grid and plate, operates on the 32nd sub-harmonic of the output frequency. Since the output frequency range is 30-50 megacycles, the crystal frequency will lie between 937.5 and 1562.5 kc.

The second half of the 7F7 acts as a phase modulator. The r-f output of the crystal oscillator is impressed on the phase-modulator grid by means of blocking capacitor C4. The cathode circuit is provided with a large amount of degeneration by unbypassed resistor R3. Because of this degenerative feedback, the transconductance of the triode is abnormally low—so low that the plate current is affected about as much by the direct grid-plate capacitance as by the transconductance. The two effects result in plate current vectors almost 180 degrees apart, and the total plate current is the resultant of the two components. In phase it will be about 90 degrees removed from the phase of the voltage impressed on the grid.

When audio is impressed on the grid, thereby periodically changing the bias, and in consequence, the transconductance, the plate current, in both amplitude and phase undergoes a periodic change. The amplitude modulation is unimportant, and is removed in the frequency multipliers which follow, but the phase modulation remains and is the essential element of the transmitted signal.

The phase modulation is modified by the use of a frequency-correcting circuit consisting of resistor R5 and capacitor C5. These elements are connected between the phase modulator grid and audio amplifier V8. The frequency-correcting circuit is introduced because the frequency deviation brought about by phase modulation is linearly proportional to frequency, and pure phase modulation would become troublesome at high audio frequencies. The correcting circuit causes the deviation vs. frequency curve to begin to flatten out above 2000 cycles.

(b) Frequency Multipliers.—The frequency deviation which may be produced in a modulator such as described above is relatively small, usually not more than a value equal to the modulating frequency (otherwise severe distortion is encountered). To get sufficient deviation (±15 kc) the frequency of the modulated wave must be multiplied considerably. (In this case it is multiplied by a factor of 32.) The multiplication is accomplished by a quadrupler and three doublers, which act as Class C radio frequency amplifiers with grid-leak bias. The grid drive in each case is well above saturation so that slight changes in tuning or reduction in tube emission can have little effect on succeeding stages. Up to this point, all stages use receiving type tubes working at relatively low plate and filament currents.

(c) Intermediate Power Amplifier.—The intermediate power amplifier utilizes two 807 beam transmitting tubes (V6 and V7) in parallel as a class C amplifier. Grid leak bias is used and, as in the preceding stages, the grid current is metered for alignment and testing. The plate tank and antenna circuit is of the Pi type for harmonic suppression and ease of adjustment. This circuit consists of plate tuning capacitor C35, the tank coil L6, and the loading capacitors C36 and C37. The output is fed through blocking capacitor C38 to relay K1.

(d) Audio Amplifier and Input Circuits.—Audio input to the transmitter is derived either from a single-button carbon microphone or from a remote-control line. Input transformer T1 provides a 50 ohm or a balanced 200/500 ohm termination respectively for these two applications. Actually the transformer is terminated on one half of the secondary in such a manner that the input impedance across the 0-200 terminals is approximately 500 ohms. Microphone current is derived from the cathode circuit of the third doubler V5 and is filtered by capacitor C41.

The output of transformer T1 is amplified in the 7A4 audio amplifier, tube V8, and fed to the phase modulator from the voltage divider R33, R34. R30 is an adjustable gain control.

(3) Power Amplifier.—A single type 250TH or 454H tube is used in a grid-neutralized amplifier circuit to raise the output of the transmitter to the 250/400 watt level. The driving energy from the I.P.A. is applied to the grid through the coupling coil L301 and the tuned grid circuit L302-C301. Bias voltage is generated by the flow of grid current through resistor R301. A 100 ma D-C meter on the meter panel is provided to permit observation of the grid current. The plate tank and antenna circuit is of the Pi type for ease of adjustment and maximum harmonic suppression. This circuit is formed by the plate tuning capacitor C305, the inductance L303 and the antenna loading capacitor C307. D-C plate voltage is introduced into the circuit at a low radio frequency potential point through r-f choke L304 and is prevented from entering the antenna circuit by the blocking capacitor C306. The radio frequency output is connected to the transmission line through the contacts of the antenna transfer relay, K301.

PARTS LIST—EXCITER CHASSIS RADIO TRANSMITTER TYPE 250-UFS-Ed. 7

Cir. Sym.	Description	Part No.
	CAPACITORS	
C1	Fixed, Mica, 2000 μμf, ±20%	CM20-B-202-M
3	Fixed, Ceramic, 50 μμf, ±10%	CMC338-500-K
4	Fixed, Ceramic, 100 μμf, ±10%	CMCK-101-K
5	Fixed, Mica, 1500 μμf, ±10%	CM30-B-152-K
6	Fixed, Mica, 510 μμf, ±20%	CM20-B-511-M
7	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
8	Variable, Air, Dual, 3-54 μμf	CVA-SD2978
8A	Part of C8	
8B	Part of C8	
9	Fixed, Mica, 3900 μμf, ±20%	CM30-B-392-M
10	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
11	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
12	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
13	Variable, Air, Dual, 3-54 μμf	CVA-SD2978
13A	Part of C13	
13B	Part of C13	
14	Fixed, Mica, 3900 μμf, ±20%	CM30-B-392-M
15	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
16	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
17	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
18	Variable, Air, 3-54 μμf	CVA-SD2833
19	Fixed, Mica, 3900 μμf, ±20%	CM30-B-392-M
20	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
21	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
22	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
23	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
24	Fixed, Paper, Oil, .5 μf, 600 Volts	CPO-504-600
25	Variable, Air, 3-76 μμf	CVA-SD3056
26	Fixed, Mica, 5100 μμf, ±20%	CM35-B-512-M
27	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
28	Fixed, Mica, 5100 μμf, ±20%	CM35-B-512-M
29	Fixed, Mica, 10,000 μμf, ±20%	CMB10-B-103-M
30	Fixed, Mica, 2000 μμf, ±20%	CMB10-B-202-M
31	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
32	Fixed, Mica, 10,000 μμf, ±20%	CMB10-B-103-M
33	Fixed, Mica, 2000 μμf, ±20%	CMB10-B-202-M
34	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
35	Variable, Air, 25 μμf	CVA-CS-9524-25
36	Variable, Air, 140 μμf	CVA-CS-9524-140
37	Fixed, Mica, 100 μμf, ±20%	CMB10-B-101-M
38	Fixed, Mica, 2000 μμf, ±20%	CMB10-B-202-M
39	Fixed, Mica, 2000 μμf, ±20%	CM30-B-202-M
41	Fixed, Electrolytic, 25 μf, 50 Volts	CE-256-50A
42	Fixed, Electrolytic, 25 μf, 50 Volts	CE-256-50A
43	Fixed, Mica, 5100 μμf, ±20%	CM35-B-512-M
44	Fixed, Ceramic, 15 μμf, ±10%	CC21CG-150-K

Cir. Sym.	Description	Part No.
	RESISTORS	
R1	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
2	Fixed, Carbon, 470,000 ω, ±10%, ½ Watt	RC20-474-K
3	Fixed, Carbon, 22,000 ω, ±10%, ½ Watt	RC20-223-K
4	Fixed, Carbon, 47,000 ω, ±10%, ½ Watt	RC20-473-K
5	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
6	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
7	Fixed, Carbon, 220,000 ω, ±10%, ½ Watt	RC20-224-K
8	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
9	Fixed, Carbon, 1000 ω, ±10%, 1 Watt	RC30-102-K
10	Fixed, Carbon, 1000 ω, ±10%, ½ Watt	RC20-102-K
R11	Fixed, Carbon, 220,000 ω, ±10%, ½ Watt	RC20-224-K
12	Fixed, Carbon, 220,000 ω, ±10%, 1 Watt	RC30-224-K
13	Fixed, Carbon, 1000 ω, ±10%, 1 Watt	RC30-102-K
14	Fixed, Carbon, 1000 ω, ±10%, ½ Watt	RC20-102-K
15	Fixed, Carbon, 220,000 ω, ±10%, ½ Watt	RC20-224-K
16	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
17	Fixed, Carbon, 1000 ω, ±10%, 1 Watt	RC30-102-K
18	Fixed, Carbon, 1000 ω, ±10%, ½ Watt	RC20-102-K
19	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
20	Fixed, Carbon, 1000 ω, ±10%, 1 Watt	RC30-102-K
21	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
22	Fixed, Carbon, 1000 ω, ±10%, ½ Watt	RC20-102-K
23	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
24	Fixed, Wire Wound, 2500 ω, ±5%, 25 Watt	RW25-252-J
25	Fixed, Wire Wound, 15,000 ω, ±5%, 10 Watt	RW10-153-J
26	Fixed, Carbon, 100 ω, ±10%, 1 Watt	Part of 1710-130 Assembly
27	Fixed, Carbon, 100 ω, ±10%, 1 Watt	Part of 1710-130 Assembly
28	Fixed, Carbon, 100 ω, ±10%, 1 Watt	Part of 1710-358 Assembly
29	Fixed, Carbon, 100 ω, ±10%, 1 Watt	Part of 1710-358 Assembly
30	Variable, Carbon, 500,000 ω	PC-504SS6Z
31	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
32	Fixed, Carbon, 2200 ω, ±10%, 1 Watt	RC30-222-K
33	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
34	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
35	Fixed, Composition, 5.55 ω, ±2%, ½ Watt	RCPR5-5R55-G
*36	Fixed, Carbon, 25 ω, ±10%, 1 Watt	RC30-250-K

Cir. Sym.	Description	Part No.
	TUBES	
V1	Osc.-Mod.	7F7
2	1st Doub.	7W7
3	2nd Doub.	7C7
4	Quad.	7C7
5	3rd Doub.	7C5
6	I.PA.	807
7	I.P.A.	807
8	Audio Amp.	7A4

Cir. Sym.	Description	Part No.
	INDUCTORS AND CHOKES	
L1	2.5 mh choke	12381
2	Parasitic suppressor choke (includes R26)	1710-130

* Used where internal resistance of M1 is 25 ω.

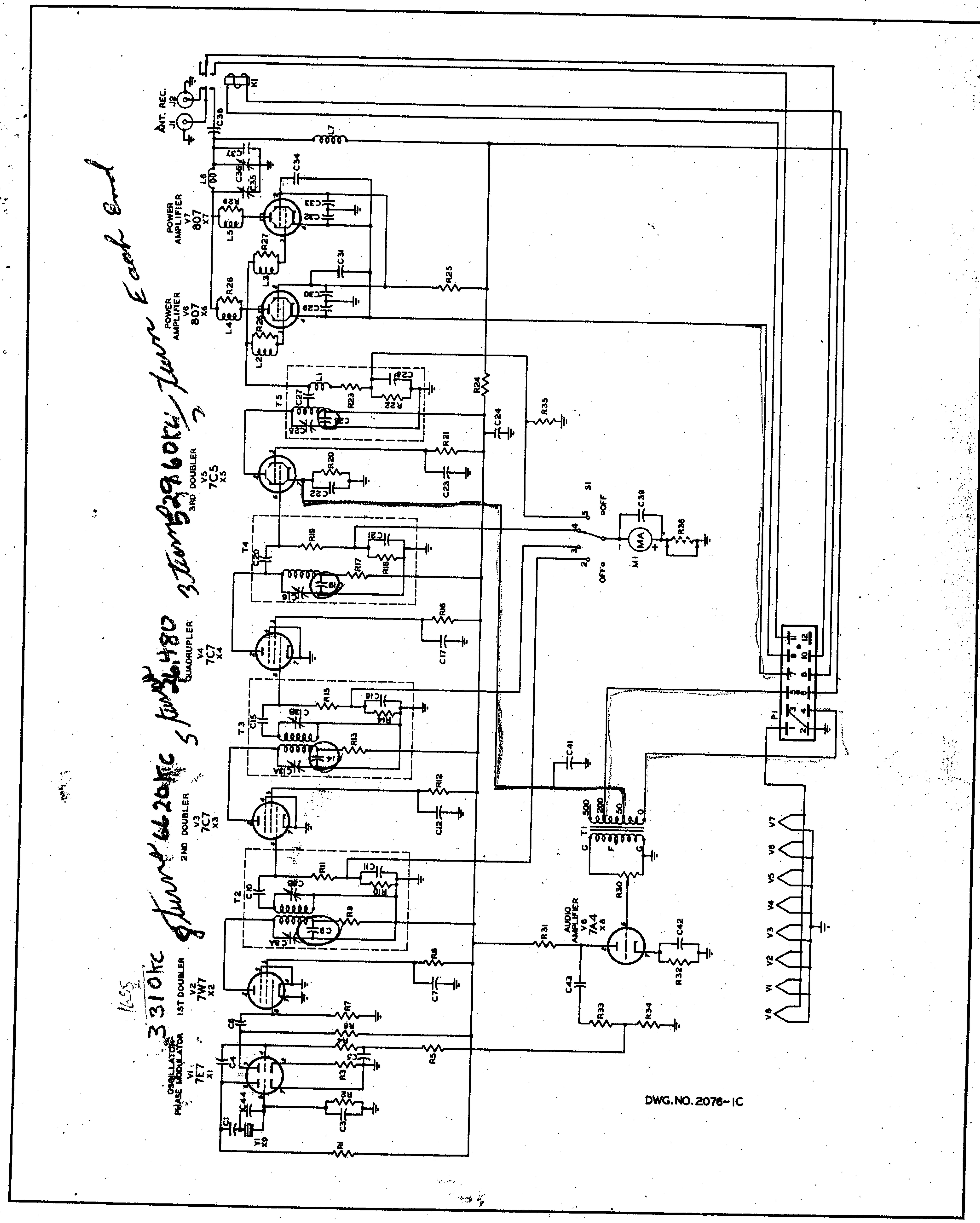


Figure 5. Exciter Chassis Radio Transmitter Type 250-UFS-Ed. 7, Schematic Diagram

PARTS LIST—EXCITER CHASSIS RADIO TRANSMITTER TYPE 250-UFS-Ed. 7 (Cont'd)

Cir. Sym.	Description	Part No.
	INDUCTORS AND CHOKES (Cont'd)	
L3	Parasitic suppressor choke (includes R27)	1710-130
4	Parasitic suppressor choke (includes R28). Assembly consists of plate caps and suppressors	1710-358 Assembly
5	Parasitic suppressor choke (includes R29)	Part of 1710-358 Assembly
6	P.A. tank inductance	
	30-35 mc	1710-97
	35-40 mc	1710-109
	40-44 mc	1710-A3
	44-50 mc	1710-74
7	2.5 mh choke	12381
	RELAYS	
K1	Antenna Relay	1000-LR110
	CONNECTORS	
J1	Antenna, Single Contact, female	SO-239
2	Receiver, Single Contact, female	S-101
P1	12 Contact, male	P-412-AB-1/16"
	TRANSFORMERS	
T2	First doubler plate tuning	1710-519
3	Second doubler plate tuning	1710-520
T4	Quadrupler plate tuning	1710-521
5	Third doubler plate tuning	1710-569
6	Audio	C-1981
	SOCKETS	
X1	8 Contact, Loctal	52A12355
2	8 Contact, Loctal	52A12355
3	8 Contact, Loctal	52A12355
4	8 Contact, Loctal	52A12355
5	8 Contact, Loctal	52A12355
6	5 Contact	RSS5
7	5 Contact	RSS5
8	8 Contact, Loctal	52A12355
9	4 Contact, Crystal	9827-F
	CRYSTAL	
Y1	1/32 channel frequency	FM-8
	METER	
M1	0-1 ma, 2½" round case	MR24W001DCMA
	SWITCH	
S1	6 Position Meter Switch	SWRE-2P6TNS

The transmission line to the antenna is connected to the input of the receiver(s) when antenna transfer relay K301 is in its released position. When two receivers are employed, the one tuned to the station frequency should be plugged into the connector at the rear of the relay box. A small inductance, L305, is provided in series with this connector to prevent the loading introduced by the additional receiver from impairing the sensitivity of the mobile frequency receiver.

(4) **Control and Power Circuits.**—The 250-UFS is designed for remote control over a two-wire four-wire telephone line. In the 250-UFS-A, the functions of carrier control, transfer of the audio circuit from receiver output to transmitter input, and automatic overload reset are furnished. An additional relay incorporated in the 250-UFS-B adds remote operation of the receiver squelch circuit.

Four relays are mounted on the relay panel to accomplish these operations. These include a main plate power contactor (K404), a control relay (K401) (actuated by the control line voltage), an overload relay (K402) and an overload locking relay (K403). The last three control the voltage applied to the operating coil of the plate power contactor which, in addition to applying primary voltage to the plate transformers, short-circuits the receiver audio output, and also short-circuits the filament standby resistor thereby raising the P.A. filament voltage to normal whenever plate voltage is applied to the P.A. When it is considered desirable to maintain full filament voltage during standby periods, short circuit the filament dropping resistor.

The overload locking relay is actuated by the overload relay and is reset by simply releasing the handset push-to-talk button, or opening the PLATE switch, whichever is in use. An additional relay incorporated in the second receiver of the 250-UFS-B provides for the remote opening of the squelch circuit of the receiver in which it is contained, and the simultaneous muting of the other receiver.

For the purpose of analysis, the primary power circuits of the 250-UFS may be divided into two sections, filament and plate. The line voltage connection first passes through two fuses and then the FILAMENT switch S501. When this switch is operated, the circuit is completed to the filament bus. Connections are then made to the 866A filament transformer T502, the exciter filament transformer T202, the P.A. filament transformer T301, the receiver(s), the green FILAMENT pilot lamp and the plate power control circuit.

The plate circuit is connected from the fuses to the plate bus through the plate contactor. The coil circuit of this relay includes a series connection of the contacts on the control relay, the overload relay, overload locking relay, and the front and rear door safety switches. A switch marked PLATE (S502) at the top front of the equipment cabinet is connected in parallel with the contacts on the control relay to provide local power control for tuning and adjustment.

Connections of plate primary power are made to the primary of the exciter plate transformer T201, the P.A. plate power transformer T501 and the antenna transfer relay K301. A toggle switch S301 marked TUNE-OPERATE is mounted on the front edge of the P.A. shelf. This switch is connected across a resistor (R504) in series with the primary of the P.A. plate power transformer and allows the operator to reduce the plate voltage applied to the final amplifier while adjusting the exciter or tuning the P.A. plate circuits.

PARTS LIST—P. A. CHASSIS RADIO TRANSMITTER TYPE 250-UFS-Ed. 7 (Cont'd)

Cir. Sym.	Description	Part No.
	RECEPTACLES	
J301	Single Contact, Female, chassis type	S-101
302	Single Contact, Female, chassis type	S-101
	RELAYS	
K301	Antenna Transfer, D.P.D.T., 115 Volts AC coil	1000-LR-115
	CABLES	
W301	R-F Transmission Line with P301 one end	
	PLUGS	
P301	Single Contact, Male	PL-259-A
302	8 Contact, Male, chassis type	P-408-AB-1/16"

Additional control functions are provided by two small toggle switches located on the relay panel. These are marked LOCAL-REMOTE and RADIO-INTERPHONE. The LOCAL-REMOTE switch (S401) is a D.P.D.T. type which opens the D-C path of the telephone line control circuit and short-circuits the door interlock switches when placed in the LOCAL position. The RADIO-INTERPHONE switch (S402) is a 4 P.D.T. type which opens the plate power contactor control circuit and introduces a battery into the local handset microphone circuit. The battery is provided only for interphone use when it is not considered desirable to go on the air. The interphone function is provided without the battery when the LOCAL-REMOTE switch is in the LOCAL position and the RADIO-INTERPHONE switch is the RADIO position. In this condition the remote and local operators may hear not only each other but all incoming signals. Radiation from the transmitter may be reduced to a low value if desired by removing the plate voltage from the power amplifier by unscrewing R504 or lifting the plate caps from the 866A rectifier tubes. This feature is provided to facilitate adjustment of the equipment and will be used only on rare occasions. For normal operation this switch is left in the RADIO position.

The normal operating sequence of the 250-UFS power control circuits is as follows:

1. Operation of the filament switch S501 applies primary power to all filaments and receiver(s).

2. a. Remote Control.—For normal remote operation of Radio Transmitter-Receiver Type 250-UFS-Ed. 7 the RADIO-INTERPHONE switch should be in the RADIO position and the LOCAL-REMOTE switch in the REMOTE position. Both doors should either be closed or the interlock switches held by hand.

   In the single receiver model (250-UFS-A) the D-C control voltage (50 V) is impressed on the line by the control relay (K401) which operates and transfers the two-wire line from the receiver output to the transmitter input. At the same time, the plate power control circuit is completed, energizing the plate power control relay K404. This relay applies primary energy to the 2000 volt and 400 volt plate transformers and the antenna transfer relay K301. Another pair of contacts on K404 short-circuits the filament standby resistor R503, thereby raising the P.A. filament voltage to its full operating value.

   When two receivers are employed, a modification of the control circuit described above provides remote operation of the squelch circuit of one receiver and muting of the other. The operating coil of the relay located on the first receiver chassis (Dwg. No. 2024-6) is connected in series with the transmitter control relay K401 and adjusted to operate on 3 ma DC. When the correct value of control voltage (30 V) is impressed on the line by a "B" control unit, the receiver relay operates and opens its squelch control circuit, thereby allowing the receiver to function at maximum sensitivity. At the same time, another contact on the relay blocks the grid of the first audio tube in the second (main station frequency) receiver, thereby effectively muting it.

   When a relay current of 8-10 ma is supplied from the remote control unit (70-90 V) both the receiver relay and the transmitter control relay operate, thereby providing all the features described in 250-UFS-A in addition to receiver control.

   b. Local Control.—For local operation, the LOCAL-REMOTE switch may be in either position. As normally supplied, the local handset and hangup are mounted inside the cabinet. When the front door is opened to provide access to the handset, the LOCAL-REMOTE switch should be placed in the LOCAL position, thus permitting normal transmission with the door open. This handset is provided for the convenience of service personnel in making routine checks and adjustments, or in case of telephone line failure. Mounting it inside the cabinet prohibits unauthorized operation of the equipment. However, if regular operation from this point is desired, the handset may be mounted on the outside of the cabinet. In this case, operation of the transmitter may be accomplished by means of either the local or remote handset when the LOCAL-REMOTE switch is in the REMOTE position. When the local handset is in use, a portion of the B voltage of the receiver is applied to the voltage divider R407 and R408 to provide control current. Microphone current is derived from the cathode circuit of the 7C5 (V5) in the exciter. The sequence of operation for local

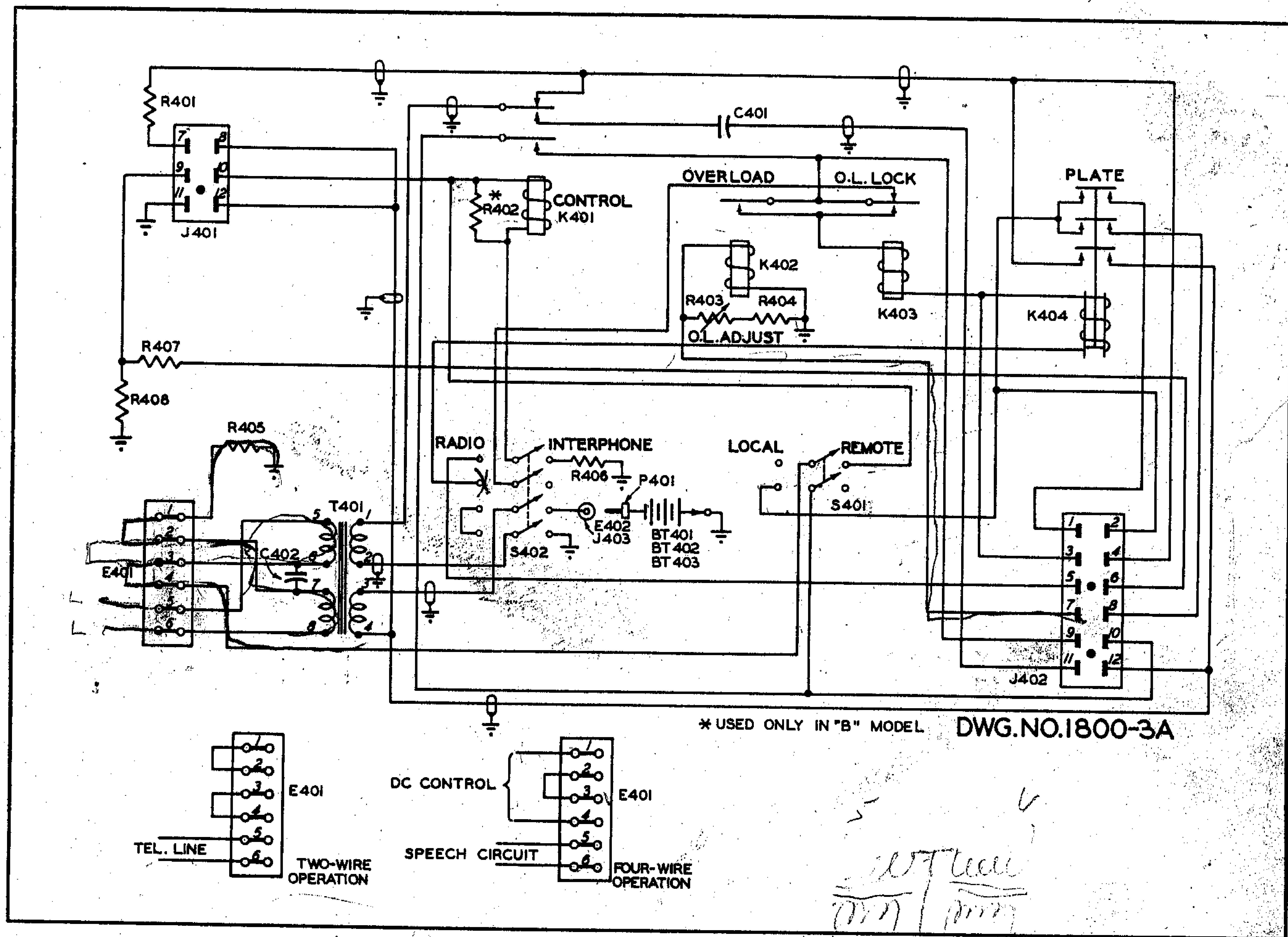


Figure 7. Relay Panel Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Schematic Diagram

PARTS LIST—RELAY PANEL RADIO TRANSMITTER-RECEIVER TYPE 250-UFS-Ed. 7

Cir. Sym.	Description	Part No.
	CAPACITORS	
C401	Fixed, Paper, Oil, 1 µf, 600 Volts	CPO-105-600
402	Fixed, Paper, Oil, 1 µf, 600 Volts	CPO-105-600
	RESISTORS	
R401	Fixed, Carbon, 1,000 ω, ±10%, 1 Watt	RC30-102-K
402	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
403	Variable, Wire Wound, 30 ω	RWV-300SS-6S
404	Fixed, Carbon, 5 ω, ±10%, 1 Watt	RC30-050-K
405	Fixed, Carbon, 1,000 ω, ±10%, 1 Watt	RC30-102-K
406	Fixed, Carbon, 4,700 ω, ±10%, 1 Watt	RC30-472-K
407	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
408	Fixed, Carbon, 33,000 ω, ±10%, 1 Watt	RC30-333-K
	SWITCHES	
S401	D.P.D.T., Bat Handle	SWT-2P2T-3A
402	4 P.D.T., Bat Handle	SWT-4P2T-3A

Cir. Sym.	Description	Part No.
	TRANSFORMERS	
T401	Audio	6327-A
	CONNECTORS	
J401	6 Contact, male, chassis type	P-406-AB-1/16"
402	12 Contact, male, chassis type	P-412-AB-1/16"
403	Single Contact, female, chassis type	402
P401	Banana Plug, with 1/4" 6-32 male thread	419
	BATTERIES	
BT401 to 403	Flashlight Cell, 1.5 Volt	950
	RELAYS	
K401	Control, 3,300 ω or 6500 ω Coil	ANE-T or APE-T
402	Overload, 50 ω	FDC-T
403	Overload Locking	FRC-T
404	Plate, 13 Amperes, 110 Volts 60 cycle AC	AB-702-2PI-13-110
	MISCELLANEOUS	
E401	Terminal Strip, six terminals	6-142
402	Standoff, lucite, 1 1/8" x 5/8", tapped 8-32 one end, other end tapped 1/4-32	
403	Resistor Strip -7-	RS-15

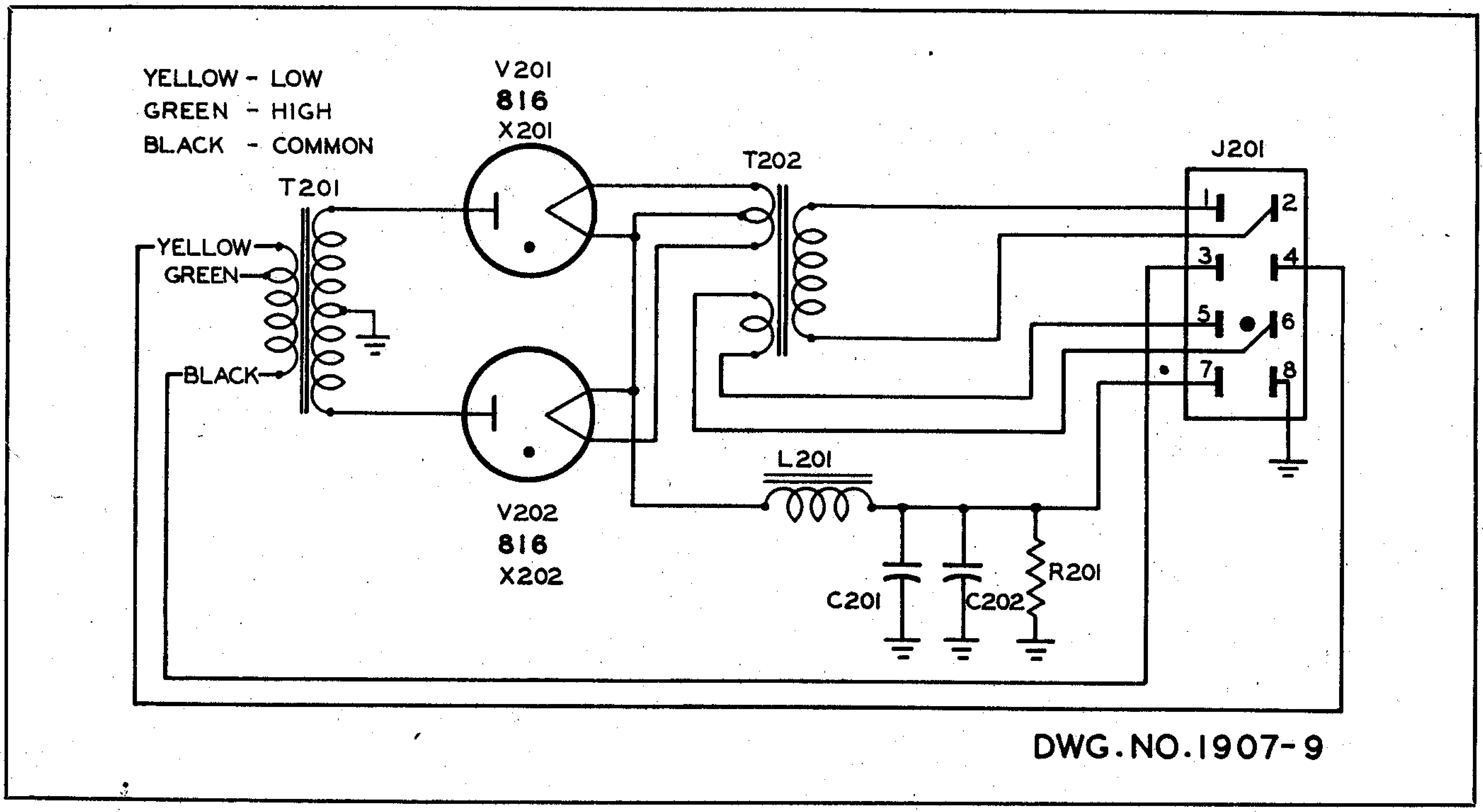


Figure 8. Exciter Power Supply Type 1907-P, Schematic Diagram

PARTS LIST—EXCITER POWER SUPPLY TYPE 1907-P

	CAPACITORS			TRANSFORMERS	
C201	Fixed, Paper, Oil, 4 µf, 600 Volts	CPO-405-600-1	T201	Plate	C-4891
202	Fixed, Paper, Oil, 4 µf, 600 Volts	CPO-405-600-1	202	Filament	7211
	RESISTORS			TUBES	
R201	Fixed, Wire Wound, 40,000 ω, ±5%, 20 Watts	RW20-403-J	V201	Vacuum	816
	RECEPTACLES		202	Vacuum	816
J201	8 Contact, Male	P-408-AB-1/16"		SOCKETS	
	CHOKES		X201	4 Contact	MIP4-T
L201	Filter	0122U	202	4 Contact	MIP4-T

control is exactly the same as that described above for the remote control.

3. Overload protection is provided for the P.A. by the overload relay K402 and the locking relay K403. When an overload occurs, K402 operates and energizes K403. K403 in turn operates, opens the control circuit and locks itself in that position. The circuit is automatically restored to the normal operating conditions when the control relay is released; thus it is only necessary to release the button in the remote control handset to reset the overload relay. A continuous overload will therefore cause the transmitter to turn itself off again each time the button is pressed until the cause has been corrected. The overload circuit is also effective when the transmitter is turned on by the plate switch on the front of the transmitter cabinet so as to protect the P.A. while tuning. The operating point of the overload relay should be adjusted to a value approximately 30% above the normal operating current by varying the resistor (R403) shunted across its operating winding. A test current for this operation is easily obtained by tuning the P.A. plate slightly off resonance until the desired value is obtained and then slowly rotating the O.L. ADJUST knob until the relay operates.

(b) Radio Receiver Type 12-UF Ed. 6A.

(1) General.—While Radio Receiver Type 12-UF Ed. 6A is designed to receive signals wherein the intelligence is conveyed in the variations of carrier frequency about a mean frequency instead of variations in the amplitude of the carrier about a mean level as in amplitude modulation, there are only three fundamental differences between amplitude and frequency modulation receivers.

The first difference is in the bandpass characteristics. Since the carrier frequency varies over a band of plus and minus 15 kc about the mean carrier frequency, the receiver has to accept a band at least 30 kc wide. Thus the intermediate-frequency transformers are designed to pass a relatively wide band compared to an AM receiver.

The second difference is that since only variations in frequency are to be converted into intelligence, amplitude variations of the signal must be removed. This function is accomplished by the limiters. They are, in effect, saturated amplifiers so that increasing the input to them above a certain level will cause no increase in their output. Thus they "limit" the magnitude of the signal applied to the discriminator to a constant level. The excellent signal-to-noise ratio of the 12-UF receiver is largely due to the use of two cascaded limiters. On signals too weak to effectively saturate the first limiter, the second limiter is already saturated and removing whatever amplitude noise variations the first limiter has permitted to pass.

The third difference is in the method of detection; that is, the conversion of frequency variations into audio frequencies. This function is accomplished by the discriminator transformer (T7) and the 7A6 detector.

(2) R-F Amplification and Mixing.—The antenna input circuit of Radio Receiver Type 12-UF Ed. 6A is designed to match a 50-70 ohm concentric line. A 7AG7 (V1) serves as a high gain r-f amplifier with both grid and plate circuits tuned for maximum efficiency. The output of the r-f amplifier is converted to the first intermediate frequency of 5000 kc in the 7AG7 mixer (V2) by beating against the output of the local oscillator.

(3) Crystal Oscillator.—The local oscillator is a crystal-controlled 7AG7 r-f pentode (V7). The tank circuit is tuned to the fourth or fifth harmonic of the crystal and a portion of the voltage appearing across it is injected into the mixer grid circuit to obtain the desired frequency conversion.

(4) I-F Amplifier and Converter.—One stage of amplification on 5000 kc is provided using a 7AG7 (V3) as the amplifier. Its output is applied in turn to the 7S7 converter (V4) where the frequency is changed to the final intermediate frequency of 456 kc. This is accomplished by using the oscillator portion of V4 as an aperiodic oscillator with a 5456-kc crystal connected between plate and grid. The crystal is of the same high quality as the signal frequency crystal.

The beat between the 5000-kc output of the first i-f stage and the 5456-kc crystal results in the final intermediate frequency of 456 kc which is amplified, passed through the i-f transformer T5, and applied to the grid of the 7C7 first limiter (V5).

(5) Limiters.—The two following stages (V5 and V6) utilize 7C7 and 7AG7 tubes respectively as current limiting amplifiers, and the circuits and actions of the two stages are identical. The tubes are operated at low plate and screen voltage and without bias except that derived from the grid leak and capacitor combinations R33, C20, and R35, C27. These stages act as class C amplifiers, giving no increase in output current or voltage once the impressed grid voltage has exceeded a threshold value of about 2 volts RMS. Voltages above this value cause increasing rectification in the grid circuit, automatically setting up a bias to limit the peak plate current. Due to the low plate and screen grid voltages saturation occurs at a low level of grid voltage. The time constant of the grid leak and capacitor is chosen to be long compared to the 456-kc intermediate frequency, but short enough to follow rapidly-fluctuating, high frequency noise peaks.

By cascading two such stages the limiting effect of one tube is multiplied by the limiting effect of the other and essentially perfect limiting is obtained. Furthermore, by properly proportioning the circuit constants of the first limiter, the input to the second limiter grid is maintained at the optimum voltage for most effective action.

The grid return circuits of all the r-f and i-f tubes contain high resistances. By this means, blocking of any of the stages on strong signals is eliminated due to the bias developed across those resistors as soon as the associated grid draws current. A further advantage of this method is that as the incoming signal strength is increased, the tubes ahead of the first limiter will also act as limiters as soon as their grids draw current.

Sufficient gain is incorporated in the receiver so that the smallest incoming signal which could be considered comparable with the noise generated in the grid circuit of the first tube causes saturation of the second limiter. The first limiter is in turn saturated by signals of 0.25 µv or over.

(6) Discriminator.—The output of the second limiter, free of amplitude variations, is fed through discriminator transformer T7 to the 7A6 balanced detector (V11). The primary and secondary of the discriminator transformer are coupled both inductively and capacitively. Two voltages of different phase are thus applied to each half of the 7A6. The discriminator is so adjusted that when a steady carrier (456 kc) is received the voltage applied to the two halves of the 7A6 causes equal and opposite currents to flow through the load resistors R40 and R41. Thus the resultant voltage appearing across the two resistors is zero.

If any frequency other than 456 kc appears at the discriminator the out-of-phase components of the 7A6 will be unbalanced and a positive or negative resultant voltage will appear across R40 and R41. The sign and magnitude of this voltage will follow the frequency of the impressed i-f voltage rather than amplitude changes in it. In this manner an audio voltage (varying in amplitude) is derived from the frequency variations of the incoming signal. The fact that the resultant D-C output voltage of the discriminator and detector should be zero when a carrier of the correct frequency is impressed, is useful to assist in tuning this transformer. A jack is connected through filter resistors R20 and R21 to the output of the 7A6 so that a sensitive microammeter (0-100 µa center-zero type preferred) may be plugged in and the necessary adjustments made for zero reading.

(7) Squelch Circuits and Audio Amplifier.—The audio frequency output of the discriminator is passed through a voltage divider network consisting of resistors R20 and R21 where the output of the discriminator is reduced to prevent overloading of the 7F7 audio amplifier (V9). The audio frequency is then applied to grid G2 of V9. The first triode section of V9 is used to disable the second section when no carrier is received. The actuating voltages for the squelch circuit are obtained from two sources. One is rectified limiter grid current and is dependent on signal or noise level. The

PARTS LIST—RADIO RECEIVER TYPE 12-UF-Ed. 6A

Cir. Sym.	Description	Part No.
	CAPACITORS	
C1	Variable, Air, 3-54 μμf	CVA-SD2833
2	Fixed, Ceramic, 100 μμf, ±10%	CMCK-101-K
3	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
5	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
6	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
7	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
8	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
9	Variable, Air, 3-34 μμf One section of dual consisting of two 3-34 μμf	CVA-SD2838
10	Variable, Air, 3-34 μμf One section of dual. See C9	
11	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
12	Fixed, Ceramic, 5 μμf, ±20%	CMCK-050-M
13	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
14	Variable, Air, 3-34 μμf One section of dual consisting of two 3-34 μμf	CVA-SD2838
15	Variable, Air, 3-34 μμf One section of dual. See C14	
16	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
17	Fixed, Paper, 50,000 μμf, 400 Volts Part of block containing 7-50,000 μμf and 1-250,000 μμf, 400 Volts	CPB-SJ-171-A
18	Variable, Air, 3-34 μμf with 55 μμf padder One section of dual consisting of two 3-34 μμf	CVA-SD-2838 with CMS20-D-550-H
19	Fixed, Mica, 5,100 μμf, ±20%	CM35-5-B512-M
20	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
21	Variable, Air, 3-34 μμf with 55 μμf padder One section of dual. See C18	
22	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17.	
23	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17	
24	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17	
25	Variable, Air, 3-34 μμf with 55 μμf padder One section of dual consisting of two 3-34 μμf	CVA-SD2838 with CMS20-D-550-H
26	Variable, Air, 3-34 μμf with 55 μμf padder One section of dual. See C25	
27	Fixed, Mica, 100 μμf, ±10%	CM20-B-101-K
28	Fixed, Ceramic, 100 μμf, ±10%	CMCK-101-K
29	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17	
30	Fixed, Paper, 50,000 μμf, 400 Volts One section of block consisting of three 50,000 μμf, 400 Volts	CPB-3XD-RHW
31	Fixed, Mica, 510 μμf, ±20%	CM20-B-511-M
32	Variable, Air, 3-34 μμf with 107 μμf padder One section of dual consisting of two 3-34 μμf	CVA-SD-2838 with CMS20-D-1070-H
33	Variable, Air, 3-34 μμf with 83 μμf padder One section of dual. See C32	Part of C32 with CMS20-D-830-H padder

Cir. Sym.	Description	Part No.
C34	Fixed, Ceramic, 100 μμf, ±10%	CMCK-101-K
35	Fixed, Ceramic, 100 μμf, ±10%	CMCK-101-K
36	Fixed, Ceramic, 4 μμf, ±20%	CMCK-040-M
37	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17.	
38	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
39	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C30	
40	Fixed, Electrolytic, 10 μf, 150 Volts One section of dual consisting of 10 μf, 150 Volts +20 μf, 25 Volts	CEB-SA105910-C
41	Fixed, Mica, 510 μμf, ±20%	CM20-B-511-M
42	Fixed, Mica, 5,100 μμf, ±20%	CM35-B-512-M
43	Fixed, Electrolytic, 20 μf, 25 Volts One section of dual. See C40	
44	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
45	Variable, Air, 3-76 μμf	CVA-SD3056
46	Fixed, Electrolytic, 8 μf, 450 Volts One section of dual consisting of 8 μf + 8 μf, 450 Volts	CEB-8450-A
47	Fixed, Electrolytic, 8 μf, 450 Volts One section of dual. See C46	
48	Fixed, Electrolytic, dual 8 μf, 450 Volts	CEB-8450-A
49	Fixed, Paper, 250,000 μμf, 400 Volts One section of block. See C17	
50	Fixed, Paper, 50,000 μμf, 400 Volts One section of block. See C17	
51	Fixed, Mica, 2,000 μμf, ±20%	CM30-B-202-M
52	Fixed, Mica, 2,000 μμf, ±20%	CM20-B-202-M
53	Variable, Air, 3-34 μμf One section of dual consisting of two 3-34 μμf	CVA-SD2838
54	Variable, Air, 3-34 μμf One section of dual. See C53	
55	Fixed, Mica, 2,000 μμf, ±20%	CM20-B-202-M
	RESISTORS	
R1	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
2	Fixed, Carbon, 150,000 ω, ±10%, 1 Watt	RC30-154-K
3	Fixed, Carbon, 470,000 ω, ±10%, 1 Watt	RC30-474-K
4	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
5	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
6	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
7	Fixed, Carbon, 150,000 ω, ±10%, 1 Watt	RC30-154-K
8	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
9	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
10	Fixed, Carbon, 68,000 ω, ±10%, 1 Watt	RC30-683-K
11	Fixed, Carbon, 68,000 ω, ±10%, 1 Watt	RC30-683-K

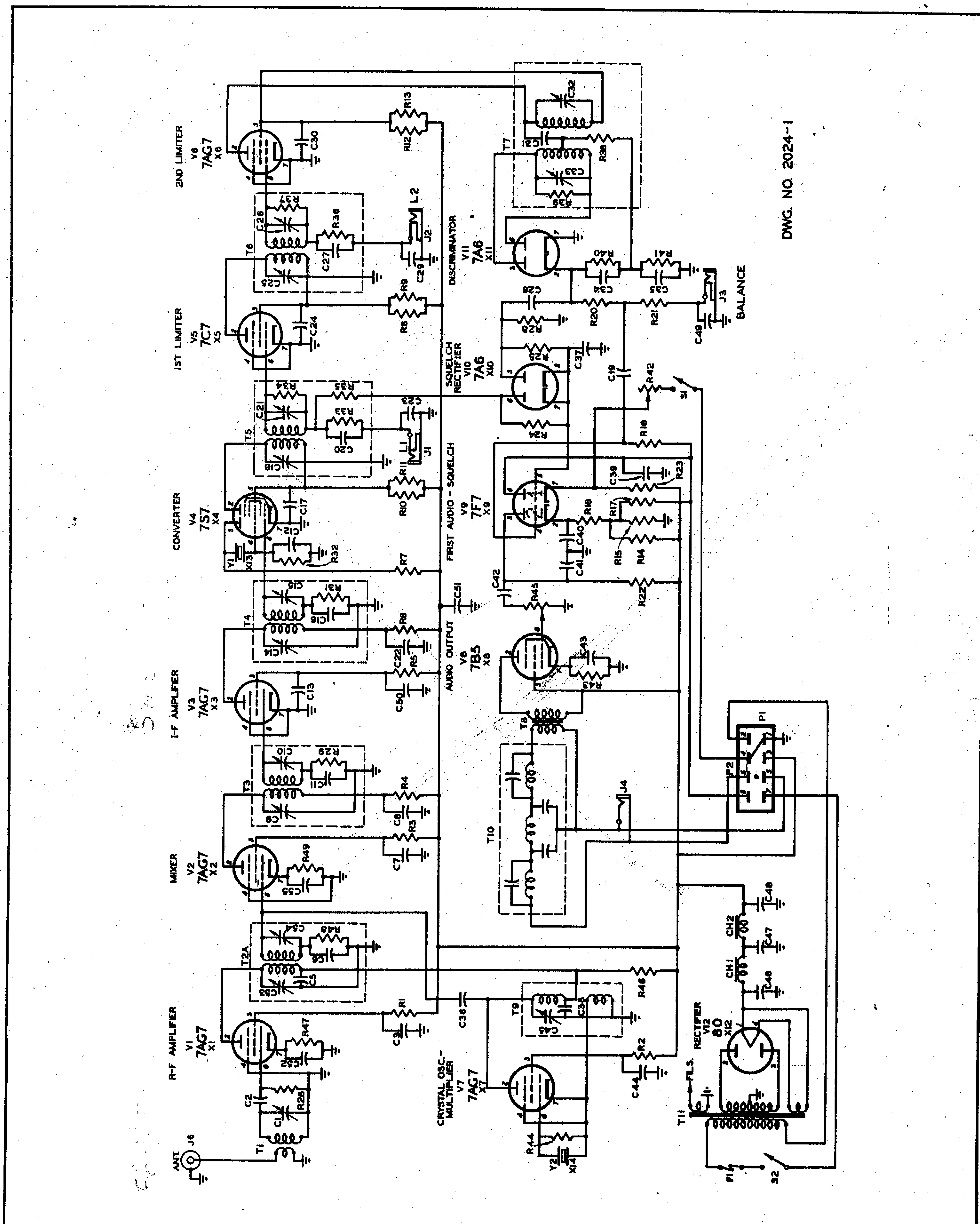


Figure 9. Radio Receiver Type 12-UF-Ed. 6A, Schematic Diagram

PARTS LIST—RADIO RECEIVER TYPE 12-UF-Ed. 6A (Continued)

Cir. Sym.	Description	Part No.
	RESISTORS—Cont.	
R12	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
13	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
14	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
15	Fixed, Carbon, 22,000 ω, ±10%, 1 Watt	RC30-223-K
16	Fixed, Carbon, 4,700 ω, ±10%, 1 Watt	RC30-472-K
17	Fixed, Carbon, 220,000 ω, ±10%, 1 Watt	RC30-224-K
18	Fixed, Carbon, 1 megohm, ±10%, 1 Watt	RC30-105-K
20	Fixed, Carbon, 220,000 ω, ±10%, 1 Watt	RC30-224-K
21	Fixed, Carbon, 47,000 ω, ±10%, 1 Watt	RC30-473-K
22	Fixed, Carbon, 220,000 ω, ±10%, 1 Watt	RC30-224-K
23	Fixed, Carbon, 100,000 ω, ±10%, 1 Watt	RC30-104-K
24	Fixed, Carbon, 4.7 megohms, ±10%, ½ Watt	RC20-475-K
25	Fixed, Carbon, 4.7 megohms, ±10%, ½ Watt	RC20-475-K
26	Fixed, Carbon, 1 megohm, ±10%, ½ Watt	RC20-105-K
28	Fixed, Carbon, 470,000 ω, ±10%, ½ Watt	RC20-474-K
29	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
31	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
32	Fixed, Carbon, 47,000 ω, ±10%, ½ Watt	RC20-473-K
33	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
34	Fixed, Carbon, 47,000 ω, ±10%, ½ Watt	RC20-473-K
35	Fixed, Carbon, 470,000 ω, ±10%, ½ Watt	RC20-474-K
36	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
37	Fixed, Carbon, 47,000 ω, ±10%, ½ Watt	RC20-473-K
38	Fixed, Carbon, 22,000 ω, ±10%, ½ Watt	RC20-223-K
39	Fixed, Carbon, 47,000 ω, ±10%, ½ Watt	RC20-473-K
40	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
41	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
42	Variable, Carbon, 6,000 ω	PC-602SS6S
43	Fixed, Carbon, 1,000 ω, ±10%, 1 Watt	RC30-102-K
44	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
45	Variable, Carbon, 250,000 ω, with switch	PC-254DS6Z
46	Fixed, Carbon, 10,000 ω, ±10%, 1 Watt	RC30-103-K
47	Fixed, Carbon, 330 ω, ±10%, ½ Watt	RC20-331-K

Cir. Sym.	Description	Part No.
R48	Fixed, Carbon, 100,000 ω, ±10%, ½ Watt	RC20-104-K
49	Fixed, Carbon, 3,300 ω, ±10%, ½ Watt	RC20-332-K
	CHOKES	
CH1	Filter	TR-957
2	Filter	TR-957
	SOCKETS	
X1 to 11	8 Contacts, Loctal	52A12355
12	4 Contacts	MIP-4T
13	2 Contacts, Crystal	9827
14	2 Contacts, Crystal	9827
	RELAY	
K1	6,500 ω coil, 1 C contact	APC
	SWITCHES	
S1	S.P.S.T., Toggle, Bat Handle	SWT-1P1T-3A
2	Part of R45	
	FUSES	
F1	1 Amp.	3AG-1
	CRYSTALS	
Y1	Crystal, 5456 kc	MC-9
2	Crystal, Channel Frequency	MC-9
	CONNECTORS AND JACKS	
J1	Tuning Meter Jack	IJ-102
2	Tuning Meter Jack	IJ-102
3	Balance Meter Jack	IJ-102
4	Audio Jack	IJ-102
5	Fuse Holder	HKM/HKP
6	Single Contact, female, chassis type, with ring	S-101
P1	8 Contact, male, chassis type	P-408-AB-1/16"
	TRANSFORMERS	
T1	Antenna Consists of windings 1710-17 and 1710-18; also capacitor CVA-SD2833	1710-504
2A	RF	1710-725
3	IF, 5 mc	1710-582
4	IF, 5 mc	1710-575
5	IF, 456 kc	1710-508
6	IF, 456 kc	1710-509
7	Discriminator	1710-510
8	Output	6226
9	Oscillator	1710-584W
10	Audio filter	7133-A
11	Power	6248
	TUBES	
V1	R-F Amplifier	7AG7
2	Mixer	7AG7
3	I-F Amplifier	7AG7
4	Converter	7S7
5	1st Limiter	7C7
6	2nd Limiter	7AG7
7	Oscillator-Multiplier	7AG7
8	Audio Output	7B5
9	1st Audio-Squelch	7F7
10	Squelch Rectifier	7A6
11	Discriminator	7A6
12	Rectifier	80

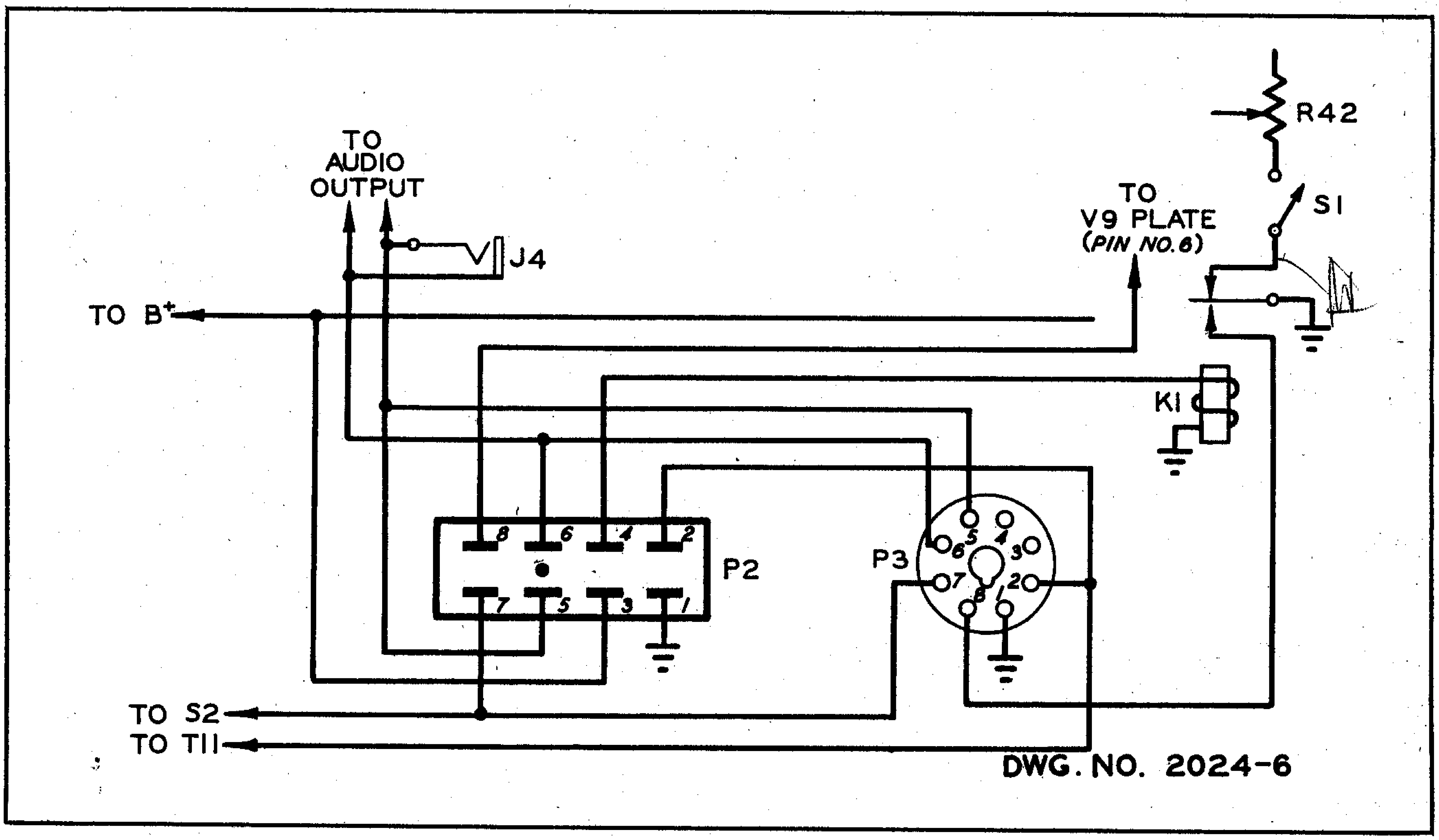


Figure 10. Radio Receiver Type 12-UF-Ed. 6A, Partial Schematic Showing Connections for "B" Control

other is the high-frequency audio component at the output of the discriminator and is dependent only on signal-to-noise ratio.

The negative voltage generated by the passage of the first limiter grid current through R34 is applied to the first triode grid of V9 (7F7) through isolation resistors R35 and R24. The latter resistor is connected across diode V10 (7A6) which acts as a noise trap to eliminate the rectified audio noise present in the limiter grid circuit. An appropriate time constant in the squelch circuit is effected by capacitor C37. The higher audio frequency components appearing at the discriminator output are selected by capacitor C28 and rectified in the other half of the 7A6 squelch control diode (V10). A ground return is provided by resistors R25 and R28.

Under standby or no signal conditions a small negative voltage is applied to the squelch control circuit due to set noise being rectified in the first limiter grid circuit. At the same time the fluctuation noise present in the receiver causes a positive voltage to be generated and applied to the squelch control circuit as shown above. These two voltages tend to balance each other under any noise conditions, since an increase or decrease in fluctuation noise will cause like changes in both bucking components. The first triode grid of V9 is then normally slightly above ground potential. The corresponding cathode of V9 is also positive by virtue of the voltage divider R23-R42, and R42 is adjusted to just render the squelch half conducting.

The cathode of the audio portion of V9 is also held positive by the voltage divider R14-R15, but at a considerably higher potential than the squelch cathode. With the squelch portion conducting, a voltage drop will occur through R17, placing the grid at a sufficiently negative voltage with respect to its cathode to cause plate current cut-off and blocking of the audio output.

When a signal is received, more negative voltage is generated in the first limiter grid circuit and at the same time the noise quieting property of the FM receiver causes less audio noise to be rectified and consequently a less positive voltage applied to the squelch control circuit. These changes are aiding in polarity and cause the potential on the grid of the squelch half of V9 to go in the negative direction, thus the squelch half of V9 will become non-conducting.

With no potential drop through R17 the audio grid assumes the potential existing at the junction of R14, R15 and R16, and the audio portion of V9 acts as a normal amplifier. The switch in the cathode circuit of the squelch triode is primarily intended to render the receiver operative during alignment and servicing.

Due to the design of the limiters, the squelch circuits and the audio amplifiers, an excellent degree of noise discrimination is obtained in Radio Receiver Type 12-UF Ed. 6A. The squelch may be set so that a signal of less than one-tenth microvolt will completely open the receiver while noise peaks of very high intensity will not be received.

The 7F7 audio amplifier is followed by a 7B5 output pentode (V8) with the volume control in the grid circuit.

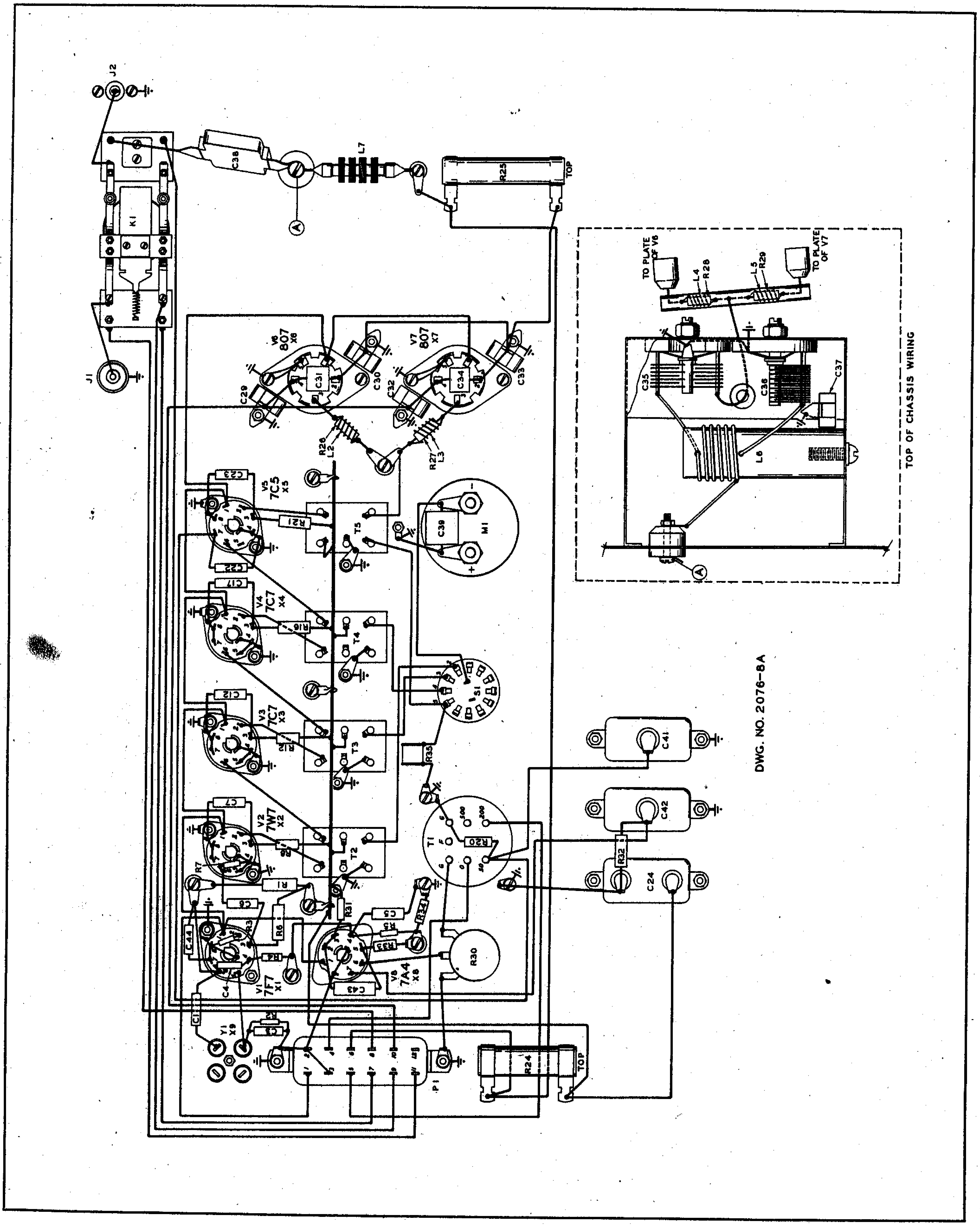


Figure 11. Exciter Chassis Radio Transmitter Type 250-UFS-Ed. 7, Wiring Diagram

of the output tube. The audio output from the 7B5 is passed through output transformer T8 and audio filter T10 to pins 5 and 6 on plug P2. T10 is an "M derived" filter with a 3000 cycle cut-off, so as to attenuate the higher audio frequencies. A monitoring jack (J4) is bridged across the 500-ohm line at this point.

7. MAINTENANCE AND SERVICE.

(a) Radio Transmitter Type 250-UFS-Ed. 7.

(1) Maintenance.—Radio Transmitter Type 250-UFS-Ed. 7 is accurately adjusted at the factory for the specified operating frequency and only the brief tuning procedure given in Section 5 need usually be followed on installation. For routine maintenance checks however, a more thorough check-up of transmitter performance is desirable to locate tubes that might be getting weak and should be replaced. As has been previously explained, a large factor of safety exists in the output of each stage of the transmitter so that no drop in power output will result from one or more tubes depreciating to a considerable extent. A routine check will, moreover, indicate these weak tubes before any loss in performance is noticed.

A meter and meter switch are located on the front of the exciter chassis. They afford a complete check-up on the condition of the unit. The numbering of the meter switch and r-f transformers is so coordinated that the meter switch is placed in position 2 to tune transformer T2, etc. The meter reads the grid currents of the second doubler, quadrupler, 3rd doubler, and I.P.A. respectively. The I.P.A. plate current is read on the meter on the front of the cabinet. It is used to adjust the I.P.A. plate and loading circuits as described in Section 5. A 0-1 D-C milliammeter is used to read the currents in positions two through five and a 0-250 D-C milliammeter for the I.P.A. plate current.

All tuning adjustments except for the output circuit are made for maximum grid current in each successive stage and the following table indicates typical readings. The values given are average at a line voltage of 115 volts. Higher or lower voltages will, of course, slightly alter readings.

Switch Position	Transf.	Circuit	Current
2	T2	7C7 2nd doubler grid	0.4 ma
3	T3	7C7 Quadrupler grid	0.3 ma
4	T4	7C5 3rd doubler grid	0.5 ma
5	T5	807 I.P.A. grids	*4.-4.5 ma
		807 I.P.A. plate	135-145 ma
		250TH P.A. grid	60-65 ma
		250TH P.A. plate	250 ma

(For 250 watts rated output with a plate voltage of 2000 volts).

*With a meter having a 0-1 ma scale this value is 0.4 to 0.45.

A substantial decrease below any of these values will indicate a weak tube, probably in the stage whose plate circuit is being tuned, and that tube should be replaced.

VOLTAGE CHART—EXCITER CHASSIS RADIO TRANSMITTER TYPE 250-UFS-Ed. 7

PIN NO.	V1 7F7 Osc.-Mod.	V2 7W7 1st Doub.	V3 7C7 2nd Doub.	V4 7C7 Quad.	V5 7C5 3rd Doub.	V6 807 P.A.	V7 807 P.A.	V8 7A4 Audio Amp.
1	±6.3	±6.3	±6.3	±6.3	±6.3	±6.3	±6.3	±6.3
2	22.5	*	*	*	*	275**	275**	*
3	*	130	120	300	280	X	X	*
4	X	0	0	0	0	X	X	X
5	X	0				0	0	X
6	*	X	X	X	X			X
7	0	0	0	0	2.5			4.3
8	0	0	0	0	0			0

*—Plate supply voltage is 320 volts; not read at tube pin.

**—With P.A. loaded to 150 ma.

X—No readings to be taken on these pins.

Plate voltage of 807's should be approximately 460 volts.

25,000 ohms per volt meter used for all readings. Taken between pin and ground.

115 volts A-C input to power supply, and plate transformer on low voltage tap.

(2) Service and Test.—Maintenance of Radio Transmitter Type 250-UFS-Ed. 7 will consist primarily of routine tube replacements when necessary. All components are operated under conditions which insure long life, and failures are rare in field service. Since every stage is metered, nearly all possible conditions will be reflected in the meter readings, and servicing is reduced to simple deduction. Section 7a(1) has covered the routine tuning of the transmitter. By comparison with values known from experience to be normal, trouble may be quickly isolated in a particular tube or stage.

The condition of the tubes in all the low power stages may readily be observed by the appropriate grid current readings. In the I.P.A. stage, however, another simple method may be used to detect tube deterioration long before replacement is necessary. It should be stated here that in general tube tester readings should not be relied on to give the full story on whether or not a tube is suitable for service. Tube testers will commonly show a poor tube to be good and vice versa simply because they do not test the tube under its operating conditions in the actual set. The equipment under discussion has been designed to have an ample factor of safety, and tubes need not necessarily be replaced at the first sign of weakening. Many more hundreds of hours of service may still be left in the tubes without causing any drop in the performance of the set. Furthermore, it has now been well established that there is no sound reasoning behind replacing a tube merely because it has served a certain number of hours. In the case of the 807 I.P.A. stage, tube deterioration may usually be detected long before loss of output is imminent and replacement justified. This deterioration may be detected by operating the exciter at normal primary voltage and completely detuning the I.P.A. tank circuit. The I.P.A. plate current will normally rise to 250 ma with new tubes. As the tubes deteriorate, this off-resonance current will approach closer and closer the on-resonance current of 145 ma and the "dip" will accordingly become less. When the off-resonance current becomes so close to the on-resonance current (say 165 ma) that only a slight dip is observable, the r-f output will start to decrease and the need of new 807's is indicated. All these tests assume, of course, that the preceding stages have been checked and found to be normal.

In making this test, the output may be observed on the P.A. grid current meter. In general, if the lower off-resonance plate current of the I.P.A. is accompanied by a reduction of P.A. grid current to 45 ma or less, the 807's should be replaced.

The condition of the 250TH tube may be indicated by an interpretation of the plate and grid meter readings. Since the normal cause of the tube ageing is low filament emission, the most common symptom will be a gradual reduction in both plate and grid currents. The type of tube employed will give nearly normal output until the grid current has decreased to 45 ma. The emission may be tested by tuning the plate circuit off-resonance and observing the plate current. In general, an increase to 300 ma or more will indicate a tube capable of further service. Since the high peak currents demanded for AM are not required for FM, longer life will normally be obtained in the latter service.

(3) Changing Frequency.—In tuning the 250-UFS-Ed. 7, each transformer is tuned for maximum current in the like numbered meter switch position. In some cases, however, there may be more than one maximum in the tuning range of the capacitor, since the necessary range will permit the quadrupler to tune to other than the fourth harmonic. The exciter tuning adjustments when made to the original frequency at the factory are marked with red lines so that no mistake can normally be made in making routine adjustments. When changing to a new frequency however, care should be taken to insure the proper selection of harmonics.

Transformer T4 will very often show two tuning points corresponding to the fourth and either the third or fifth harmonics. These may readily be separated by observing the position of the tuning capacitor. All capacitors have stops limiting the rotation to 180 degrees. Maximum capacity is fully clockwise. Since the tuning range corresponds to 30-50 mc, reference to the desired operating frequency will fix the approximate position of the capacitor.

The I.P.A. plate and P.A. grid circuits will be found to have but one response point if the preceding stages are properly aligned. For a small departure from the original frequency (not more than 2 mc), the P.A. plate will also require only retuning. For a greater change in frequency, the P.A. plate inductance, L303, will require readjustment or replacement. Roughly, eight turns of the same size tubing wound to the same diameter coil as that furnished will be required for the lower fifth of the 30-50 mc band. Seven, six, five and four turns, respectively, will be found approximately correct for the upper four-fifths of the band.

(b) Radio Receiver Type 12-UF-Ed. 6A.

(1) Maintenance.—The receivers are carefully tuned at the factory to the specified operating frequency but should be retuned upon installation as indicated in Section 5. Routine maintenance checks should include realignment of these same circuits. The correct settings of the transformers have been marked with red lines and these markings should be used as a guide when making any adjustments. It should be noted that for these adjustments the signal source must be accurately adjusted to the proper frequency. Signal generator calibration charts are not accurate enough for this purpose. The input signal should either be obtained by direct pickup from a crystal-controlled transmitter or from a signal generator which has been adjusted to zero beat against a crystal-controlled transmitter on the correct frequency.

The frequency of the signal generator may be adjusted to that of a crystal-controlled transmitter by use of the discriminator balance, as follows:

1. Plug a test meter into jack J3 on the front of the receiver chassis.
2. Apply a strong signal from a transmitter on the correct frequency.
3. Note the reading on the meter and, if it is not zero, readjust the secondary tuning (BAL.) capacitor on the top of transformer T7 with a non-metallic screwdriver to obtain a zero reading on the meter.
4. Remove the source of signal from the receiver. The discriminator is now in exact adjustment, and may be used as a frequency indicator.

5. Apply a strong signal from the signal generator to the receiver antenna connector (P1) and note the reading on the "balance" meter. As the frequency of the signal generator is adjusted slightly above and below the proper operating frequency, the "balance" meter should swing sharply to opposite sides of the zero position. When the signal generator is adjusted in this manner for zero meter reading, its output is on the correct frequency.

The primary of the discriminator transformer (T7) is set at the factory and need never be readjusted. It will be found that this circuit is so band-spread and over-coupled, that there is no possible change in the tuning of the primary that cannot be compensated for by readjusting the secondary. When any of the tubes associated with the foregoing circuits are changed, those circuits should be retuned. The variations encountered in tubes may cause a marked detuning at very-high frequencies.

(2) **Sensitivity Check.**—If a signal generator whose output is calibrated in microvolts, (or one whose output can be attenuated to a low level) is available, the sensitivity of the receiver can be checked. When the receivers are shipped from the factory their sensitivity is such that a signal of one microvolt or less when applied to antenna connector P1, will cause a meter reading at jack J1 of at least 40 microamperes. If a signal generator whose output can be attenuated but which is not directly calibrated is available, it can be checked against a new receiver. The attenuator setting for some particular tuning meter reading can be noted and other receivers checked for sensitivity against this criterion.

(3) **Service and Test.**—The following section is offered to assist the service engineer in quickly localizing and remedying failures that may arise during the operation of the receiver. A circuit diagram, parts list and voltage chart are included.

(*a*) In setting up the receiver for operation on a frequency in the 30 to 50 megacycle band other than that for which it was tuned at the factory, or if a complete realignment of the receiver is desired, a crystal of the right frequency for the new operating frequency is inserted into the crystal socket beside the 7AG7 oscillator tube (V7). The oscillator frequency is the difference between the signal and the 5000-kc intermediate frequency. The crystal is ground to one-quarter the oscillator frequency for signal frequencies below 37.0 mc, and to one-fifth the oscillator frequency for signal frequencies above 37.0 mc. The red lines on the transformer cans should be used as a guide to the approximate setting.

(*b*) After the oscillator has been set roughly, r-f transformer T2 may be adjusted. While feeding a strong signal on the new signal frequency into the antenna, plug a tuning meter into jack J1 (marked L1) and tune T2 for maximum current. This transformer is marked with red lines in the same manner as the oscillator and the approximate setting can be arrived at in the same manner. The antenna transformer may next be adjusted for maximum current in the tuning meter. Once the approximate setting of the tuning controls is determined in this manner, the signal input is decreased until only a slight indication is obtained on the tuning meter and the adjustments on T1, T2, T3, T4, T5 and T9 set carefully for maximum current in the tuning meter.

(*c*) The last i-f transformer (T6) is past the first limiter grid circuit and the tuning meter will give no indication of proper tuning in jack J1. To tune T6, plug the tuning meter into jack J2 (marked L2) and tune for maximum current. The discriminator transformer is next adjusted by plugging a center-zero microammeter into jack J3 (marked BALANCE) and adjusting the secondary of T7 for zero reading on the meter while receiving a signal. After the discriminator transformer has been balanced, the signal should be removed from the receiver and the balance meter reading noted. It should stay within 4 μa of center-zero reading.

If it does not, the indication is that the bandpass characteristics are not accurately centered on the carrier frequency. A careful check on the tuning adjustments using a weak signal should correct the difficulty. The receiver is now in tune except for the antenna tuning which must be adjusted upon installation.

(4) **Receiver Failures.**—With the squelch switch in the OFF position, the receiver normally emits a loud hiss when no carrier is being received and the tracing of this hiss through the receiver affords a simple method of localizing failures that might occur. If the r-f, mixer and high-frequency i-f tubes are removed from their sockets, most of the loud hiss should disappear. The remaining hiss is due to the noise generated in the grid circuit of the converter. When the 7AG7 i-f amplifier (V3) is plugged in, the hiss should rise nearly to maximum level. When mixer V2 is added, the hiss will increase slightly, apparently indicating that most of the noise comes from the high-frequency i-f stage. This is actually not true, since the noise generated in the grid circuit of the mixer merely overrides and masks the noise previously heard. When the r-f stage is added, a similar effect takes place but no increase in hiss level is normally heard since the second limiter is already saturated with noise. It is suggested that the service engineer familiarize himself with the sound of a normal receiver by removing the mixer, then the first i-f amplifier, and then the converter. Thereafter, if a failure should occur in the receiver, he will be able to localize it by the absence of the hiss.

The operation of the entire receiver up to the grid circuit of the first limiter may be checked by noting the tuning meter reading with a signal applied to the input. Since the tuning meter at J1 measures the grid current of the first limiter, increase of the tuning meter reading with increase in signal input indicates that the receiver is operative up to that point. The gain of the receiver to the first limiter may be measured if a calibrated source of signal is available. It should require not more than one microvolt input to the antenna to cause a 40 microampere deflection in the tuning meter.

The graph on page 27 indicates the approximate first limiter grid current to be expected at various signal levels. It will be noticed from this graph that by the use of a more sensitive tuning meter (i.e., 0-50 or 0-100 microamperes) very weak signals may be more accurately judged. The meter used for balance may be used for this purpose.

Vacuum tubes may vary considerably in efficiency at very-high frequencies, therefore a check on the gain of

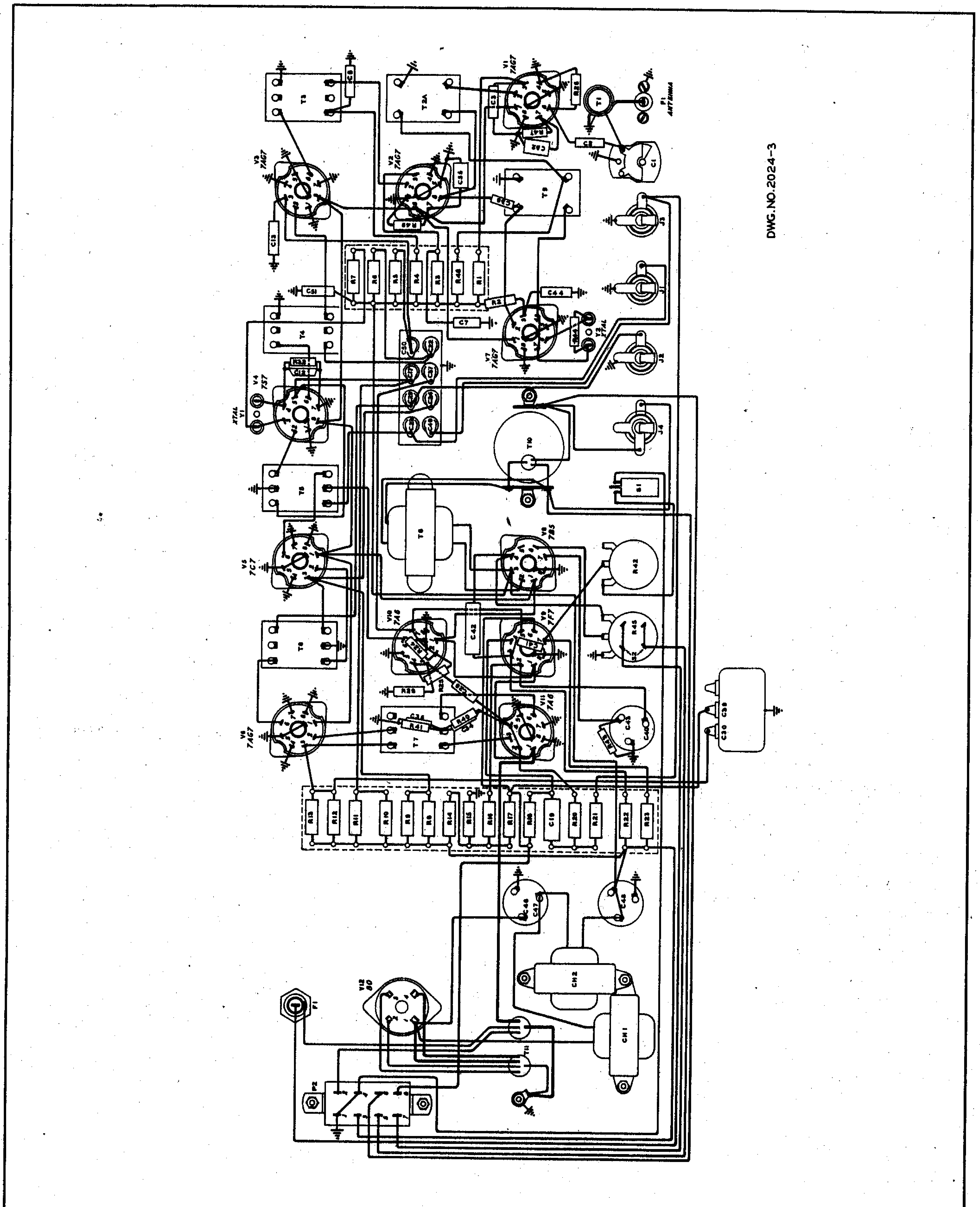
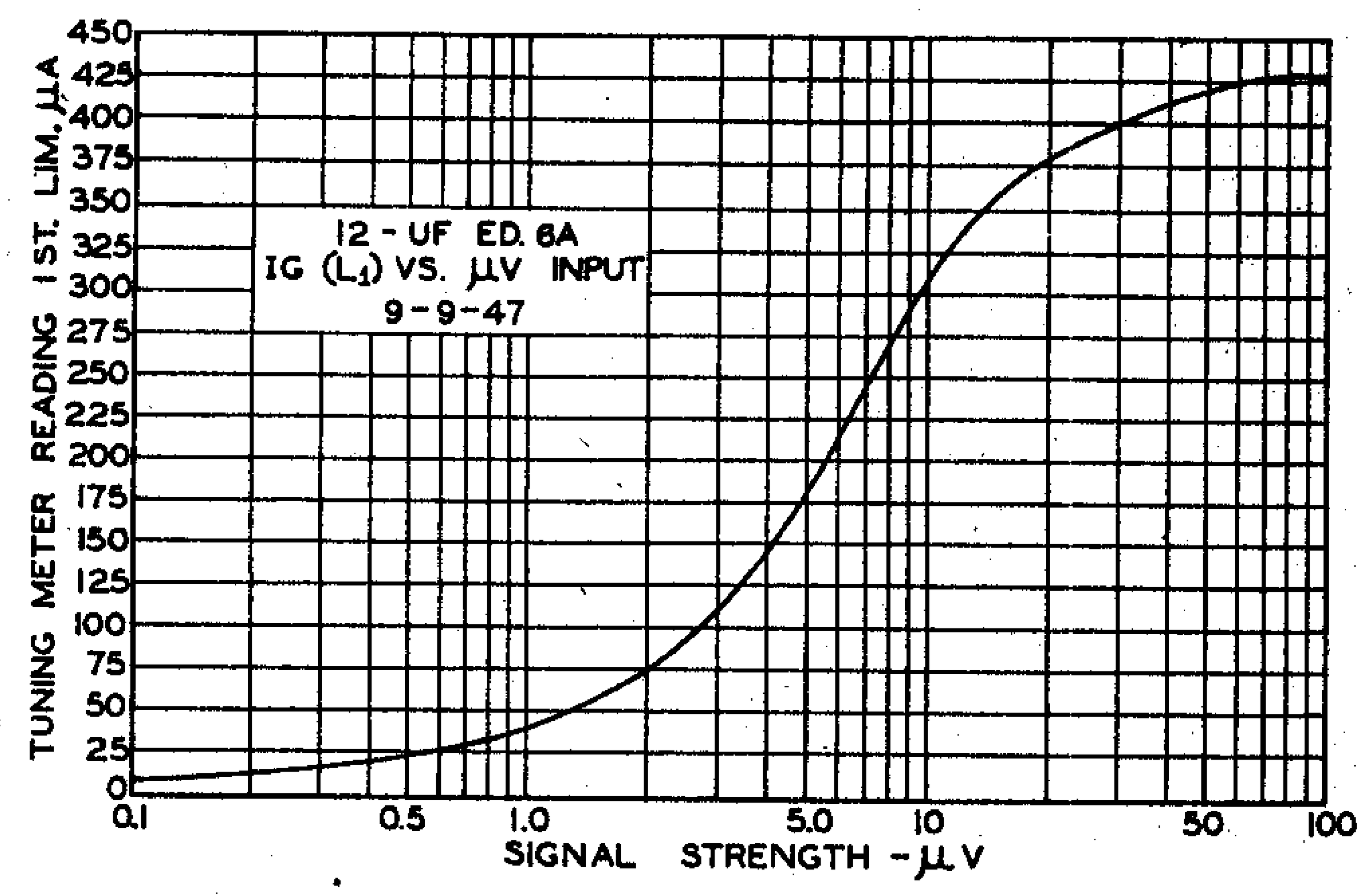


Figure 12. Radio Receiver Type 12-UF-Ed. 6A, Wiring Diagram

TUNING GRAPH 12-UF-Ed. 6A



the receiver should be made whenever one of them is changed. Tubes testers offer no sure method of testing tubes for operation at high frequencies and a much more rapid and satisfactory method of determining tube deterioration is to substitute a tube known to be good in place of the suspected tube and noting the difference in receiver operation.

Weakening of the squelch tube generally manifests itself in failure of the squelch circuit to close and therefore a need to change the setting of the squelch control in a counterclockwise direction. Here, too, the best criterion for judging the efficiency of the tube is to substitute a tube known to be good in place of the one suspected.

Other failures that may arise would be of the well-known resistor or capacitor failure type that should be easily localized by the service engineer since they manifest the same symptoms in an FM receiver as in an amplitude modulated one. Reference to the voltage chart, circuit diagram and parts list should simplify the solution of this type failure. However, if any difficulty is encountered our service department is ready to extend its full cooperation.

8. DATA FOR REPEATER OPERATION.

(a) General.—The data which follows is provided to cover typical installations of Radio Transmitter-Receiver Type 250-UFS-Ed. 7 when used as a repeater station either separately or in conjunction with other station equipment such as Link Radio Transmitter-Receiver Type 1498-Ed. 6.

There are several possible methods of using Radio Transmitter-Receiver Type 250 UFS-Ed. 7 for this purpose, the most common of which are outlined in this section. See the block diagram, figure 13. While specific information is given for Radio Transmitter-Receiver Type 250-UFS-Ed. 7 only general data on other equipment is included.

(b) Types of Repeaters.

(1) One-Way Repeater.—A one-way repeater is one in which the carrier-operated relay in the associated receiver controls the transmitter in the same equipment cabinet, and through it, repeats an incoming message. This is the simplest form of repeater, but requires separate antennas for transmitter and receiver. It is usually operated only as a radio-controlled station.

(2) Two-Way Repeater.—A two-way repeater is one in which two separate radio transmitter-receiver equipments are used to provide transmission and recep-

VOLTAGE CHART—RADIO RECEIVER TYPE 12-UF Ed. 6A

PIN NO.	V1 RF 7AG7	V2 MIXER 7AG7	V3 IF 7AG7	V4 CONV. 7S7	V5 1ST LIM. 7C7	V6 2ND LIM. 7AG7	V11 DISC. 7A6	V10 SQLCH 7A6	V9 AF 7F7 SQ.OFF	V9 AF 7F7 SQ.ON	V8 AF 7B5	V7 OSC. 7AG7	V12 RECT. 80
1	±6.6	0	0	0	±6.6	±6.6	±6.6	±6.6	±6.6	±6.6	±6.6	±6.6	285
2	215	250	210	80	85	165	X	X	90	80	250	215	±270
3	170	140	135	50	85	165	X	X	200	250	260	185	±270
4	0	0	0	X	0	0	X	X	70	17	X	0	285
5	0	0	0	80	0	0	0	0	X	X	-	0	
6	X	X	X	X	X	X	X	X	85	18	X	X	
7	1.3	4.2	0	0	0	0	0	X	260	0	22	0	
8	0	±6.6	±6.6	±6.6	0	0	0	0	0	0	0	0	

Meter resistance: 25,000 ohms per volt
No signal input
First column under V9 (7F7) is with squelch switch OFF and second with switch ON
Squelch control fully counterclockwise
Squelch switch off except where noted
Readings taken between pin and ground
X-No readings on these pins

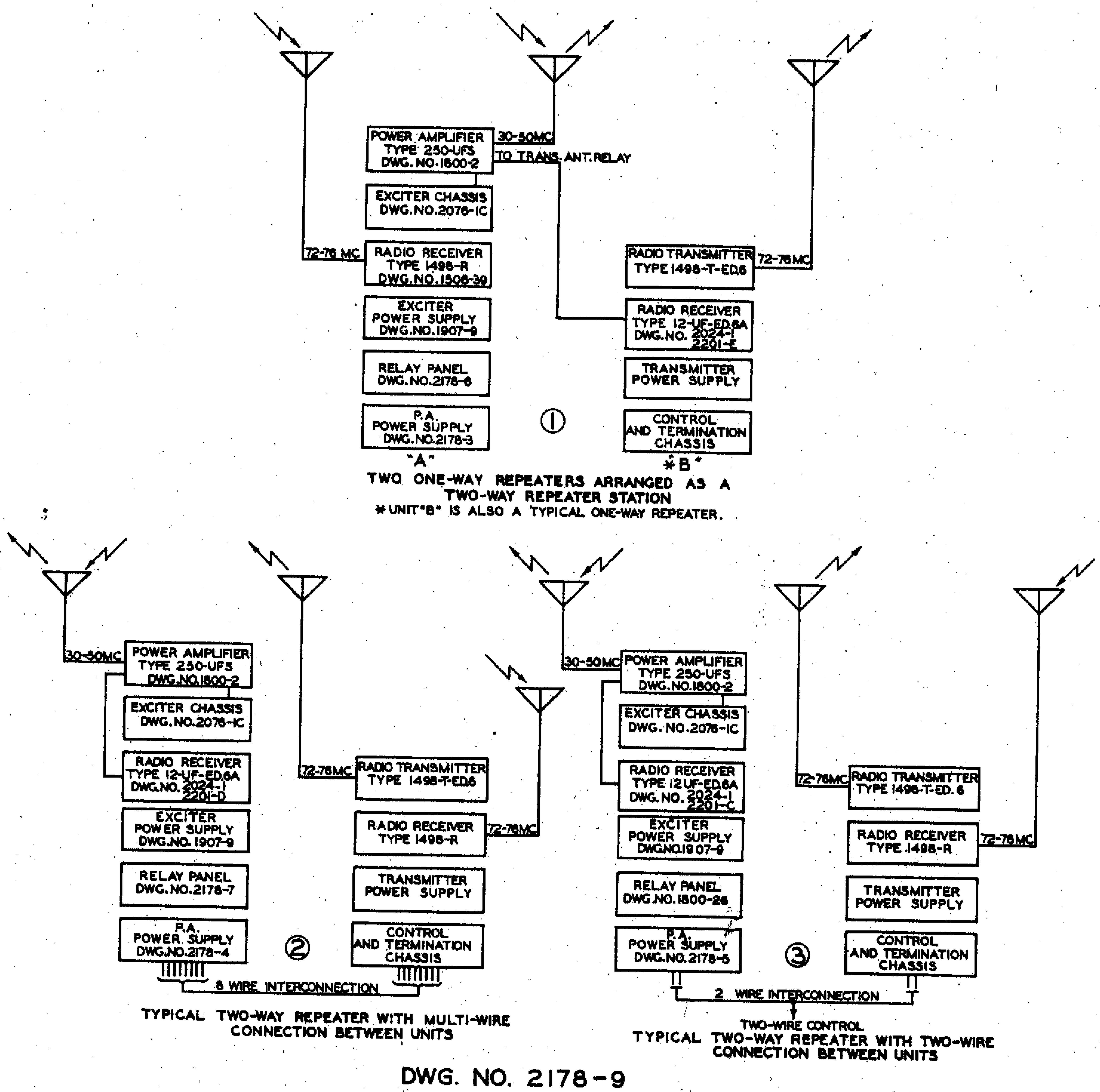


Figure 13. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Block Diagram of Repeater Stations

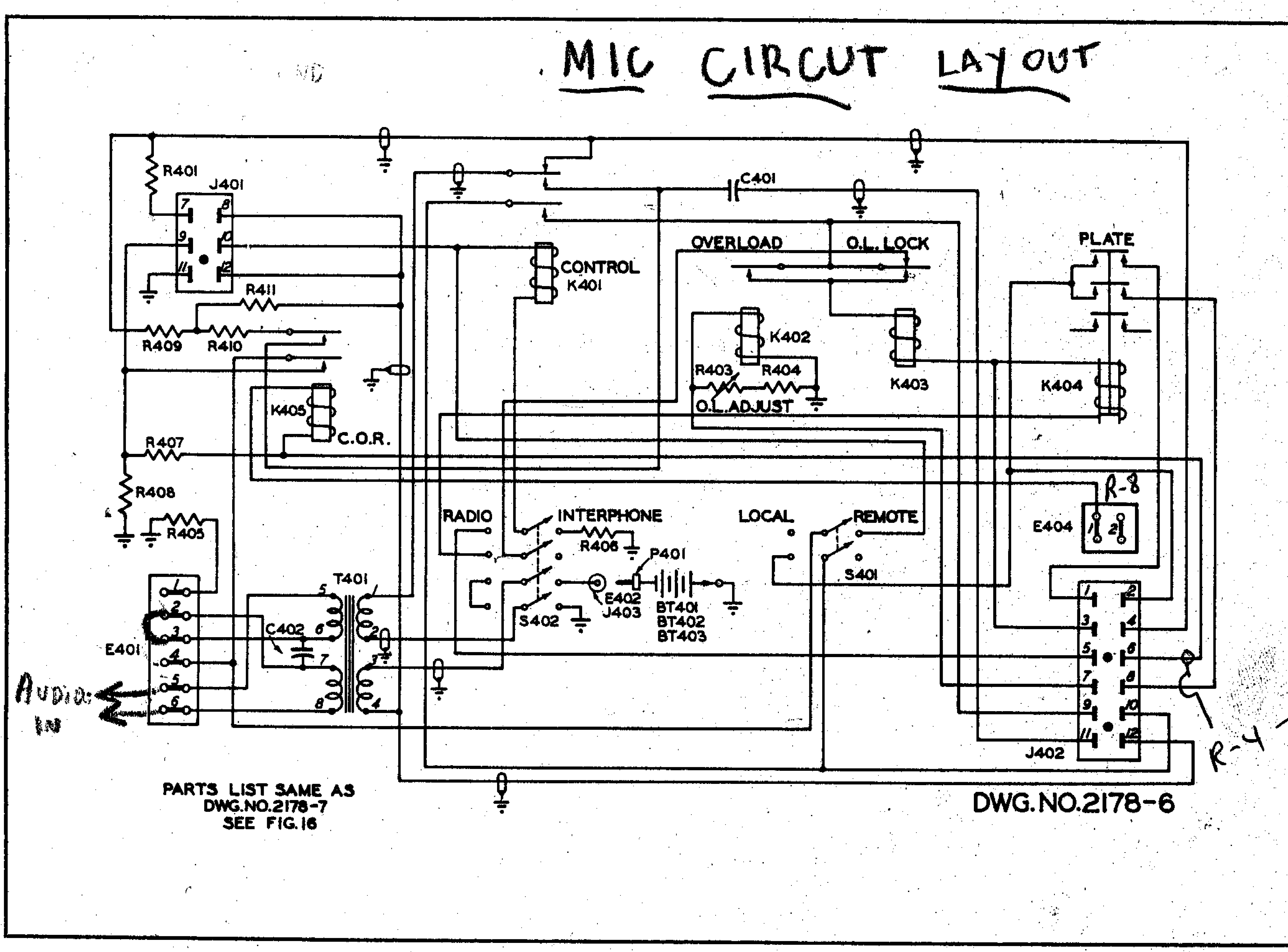


Figure 14. Relay Panel for 250-UFS-Ed. 7 as Modified for One-Way Repeater Use

tion in opposite directions. There are three different basic ways in which this may be accomplished. They are described below as Methods 1, 2 and 3.

Method 1.—Two one-way repeaters are commonly used as a two-way repeater station as in remote control of 30-50 mc land-mobile stations. In this case a 1498-R (72-76 mc) receiver is included in the 250-UFS cabinet in place of the 12-UF-Ed. 6A receiver and the 12-UF-Ed. 6A receiver is placed in the 1498 (72-76 mc) transmitter cabinet.

This is the preferred and most simple method of operating a two-way repeater.

Its one disadvantage is that the local handset located on each equipment cabinet hears signals from one direction and transmits in the opposite direction. In order to talk and listen in the same direction it is necessary to speak into one handset and listen to the handset or speaker on the other repeater.

Method 2.—Where it is desired that each cabinet include all the components to provide communication in one direction on the circuit, two separate radio transmitter-receiver equipments, such as Radio Transmitter-Receiver Type 250-UFS-Ed. 7 and Radio Transmitter-Receiver Type 1498-Ed. 6, may be arranged with a multi-wire connection between the units. Modification of both Radio Transmitter-Receiver Type 250-UFS-Ed. 7 and the Radio Transmitter-Receiver Type 1498-Ed. 6 which controls it is required in order to allow the receiver in one unit to control and modulate the transmitter in the other unit. The block diagram (figure 13) shows the general arrangement for this type station.

Method 3.—If two-wire remote control in addition to radio and local control is necessary, the two transmitter-receiver equipments are set up as described in Method 2 above, except that a two-wire line connects the respective equipments together.

The two-wire control however introduces complicated adjustment procedures which discourage its use.

(c) One-Way Repeaters.

(1) General.—When Radio Transmitter-Receiver Type 250-UFS-Ed. 7 is used as a one-way repeater, separate antennas and non-interfering frequencies between transmitter and receiver must be used.

The equipment (when modified for repeater operation—see figs. 14 and 15) will function as a radio repeater station (providing the above conditions are met) by merely turning on the receiver, placing the receiver RELAY ON-

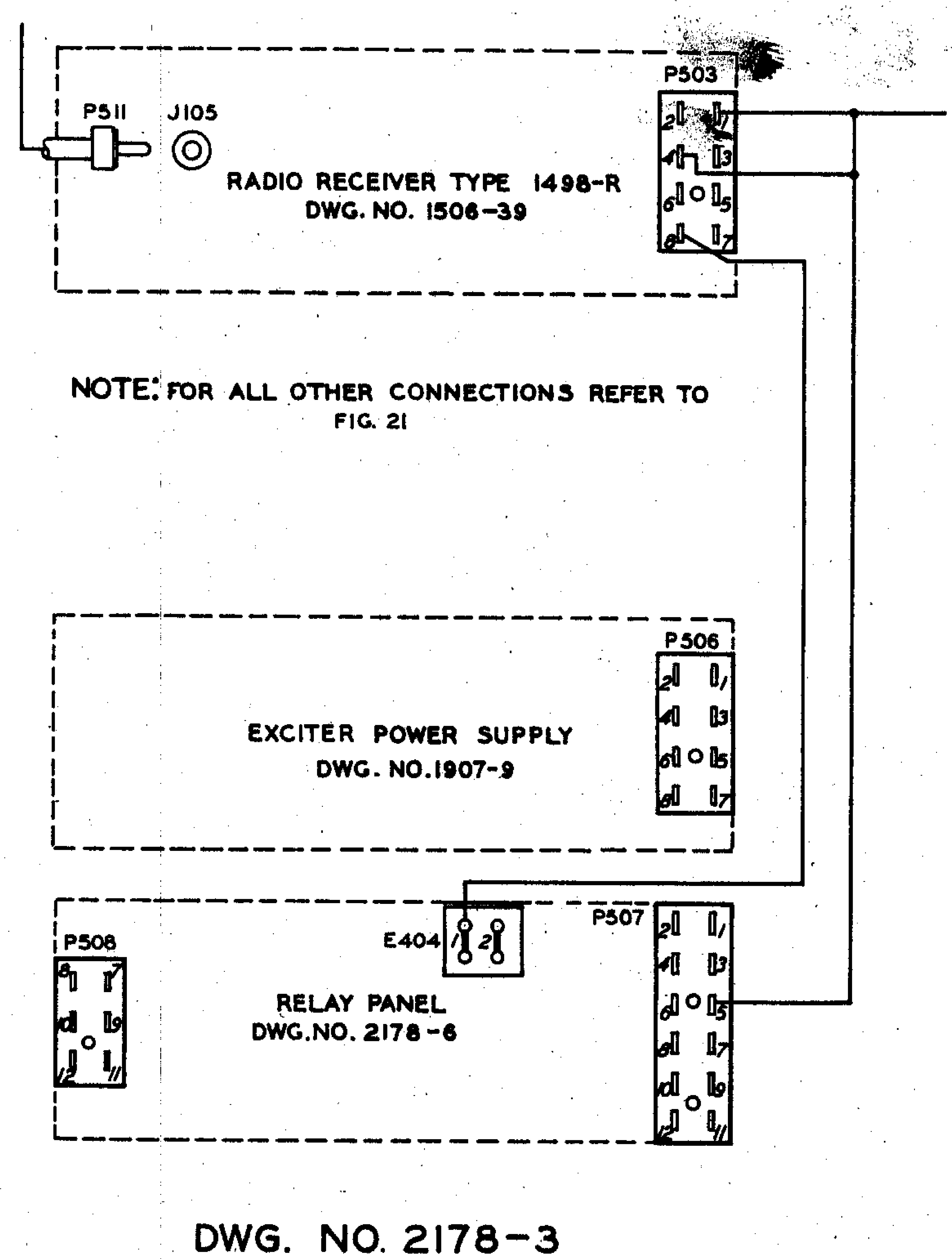


Figure 15. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Cabinet Interconnections as Modified for One-Way Repeater Use

OFF switch in the ON position, and turning on the transmitter filaments by means of the FILAMENT switch at the top front of the equipment cabinet. The 250 UFS-Ed. 7 transmitter will then repeat any message coming through Radio Receiver Type 1498-R, without sacrificing either local or remote control facilities. The repeater function is entirely automatic once adjusted, and, since the conversation going through the repeater is picked up on the associated receiver all repeated communications are heard at both local and remote control points. The remote and repeater functions are disconnected whenever the LOCAL-REMOTE switch is placed in the LOCAL position.

(2) Adjustment and Operation of Radio Receiver Type 1498-R.

(*a*) After the squelch control of Radio Receiver Type 1498-R has been adjusted as shown in Section 5(a) of the instruction book for Radio Transmitter-Receiver Type 1498-Ed. 6, the carrier-operated relay should be adjusted. Since it is controlled by the squelch circuit, its operation is adjusted by means of the squelch control R146.

(*b*) To test operation of the carrier operated relay throw the receiver RELAY ON-OFF switch S103 OFF, the carrier-operated relay K405 should then be released. Throw the SQUELCH switch S101 to OFF and the RELAY ON-OFF switch S103 to ON and observe the operation of the carrier-operated relay K405. The relay should close.

(*c*) Throw the squelch switch S101 ON and see if relay K405 releases. If it does not release, adjust the SQUELCH control R146 counterclockwise until relay K405 does release. With the SQUELCH switch, S101, ON (assuming no signal is being received) or the RELAY switch, S103, OFF the relay should be released. With the squelch switch S101 OFF and the RELAY switch S103 ON the relay should be operated or "pulled up"

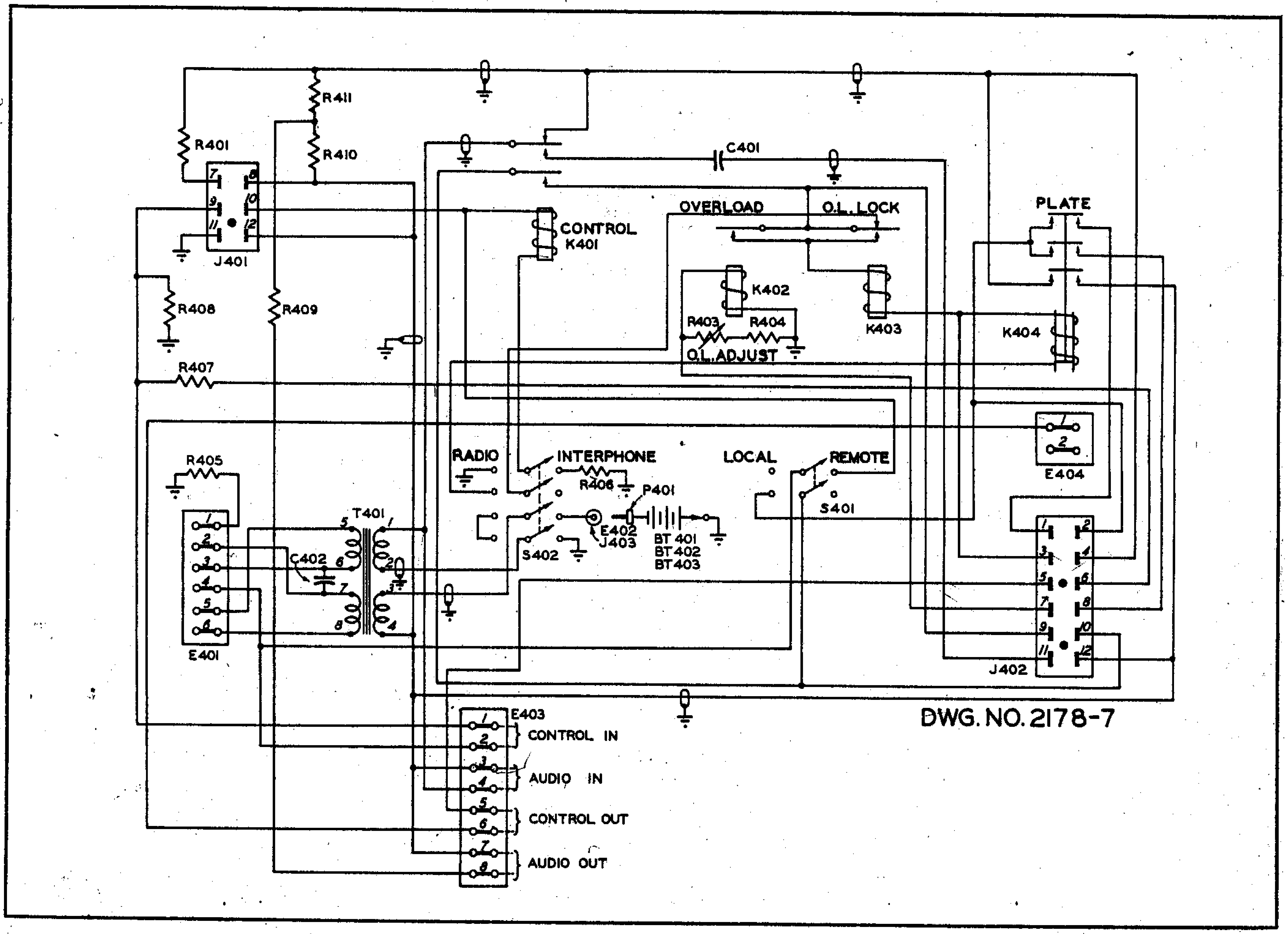


Figure 16. Relay Panel for 250-UFS-Ed. 7 as Modified for Multi-Wire Repeater Use

PARTS LIST—RELAY PANEL RADIO TRANSMITTER-RECEIVER TYPE 250-UFS-Ed. 7 AS MODIFIED

	RESISTORS	
R409	Fixed, Carbon, 470 ohms, ±10%, 1 Watt	RC30-471-K
410	Fixed, Carbon, 470 ohms, ±10%, 1 Watt	RC30-471-K
411	Fixed, Carbon, 470 ohms, ±10%, 1 Watt	RC30-471-K
	MISCELLANEOUS	
E403	Terminal Strip, 8 terminals	8-142
404	Terminal Strip, 2 terminals	2-142
	RELAY (on fig. 14 only)	
K405	Carrier Operated Repeater Control, 6500 ω Coil	APD-T
	ALL OTHER PARTS AS ON FIGURE 7	

(d) Two-Way Repeaters.

(1) Method 1.—When two one-way repeaters are used at the same location communication is afforded on a two-way basis. This arrangement requires two transmitter and two receiver frequencies. See the block diagram (figure 13) for a typical arrangement.

The local handset on each cabinet functions in a normal manner controlling the transmitter and receiver with which it is associated. It should be borne in mind however, that for local operation it will be necessary to transmit on one unit and listen on the other.

(2) Method 2.—When it is desired to include in each cabinet all the components necessary to provide communication in one direction, two separate radio transmitter-receiver equipments are necessary. This arrangement allows repeater operation of either transmitter from the carrier-operated repeater relay on the receiver in the opposite cabinet, by means of a multi-wire cross-connection between the units.

To provide these control and connection facilities the relay panel of Radio Transmitter-Receiver Type 250-UFS-Ed. 7 is modified as shown on figure 16.

When so modified, the relay panel provides connection points for audio input, audio output, control out and control in, allowing connection to the other equipment cabinet. See figure 17 for connections to the 250-UFS-Ed. 7.

When Radio Transmitter Type 250-UFS-Ed. 7 is controlled by the 1498 it may be put on the air from the radio remote control location in the normal manner. The use of two different frequencies and antennas for the transmitter and receiver in the 1498 allows positive

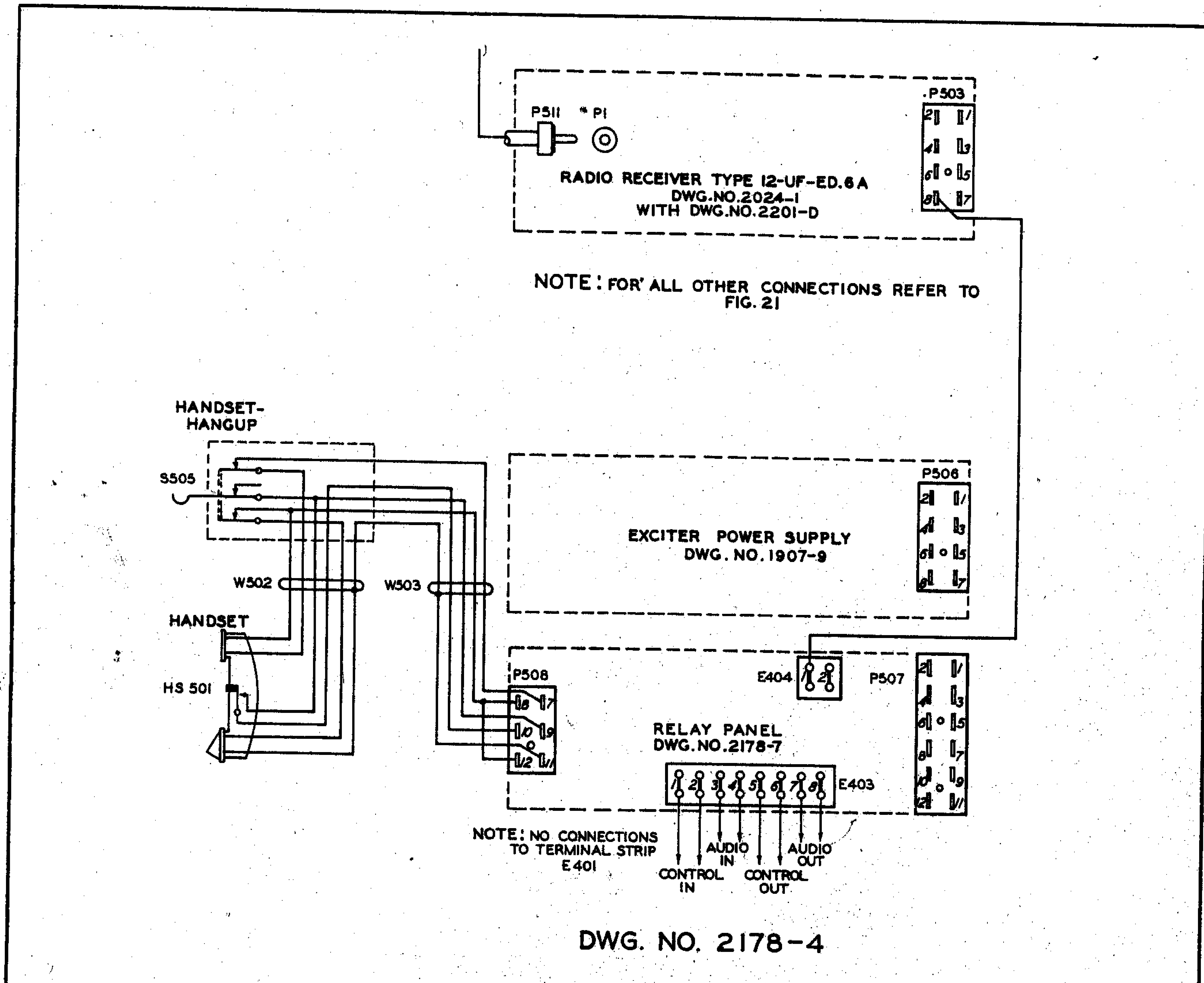


Figure 17. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Cabinet Interconnections as Modified for Multi-Wire Repeater Use

control of the 250-UFS-Ed. 7 transmitter at all times regardless of whether or not the receiver is relaying through the 1498-T-Ed. 6 transmitter. This arrangement is most important since it allows the system to be operated at all times in spite of undesired signals, high noise level or diathermy interference which might put the 1498-T transmitter on the air.

When operated this way, the local handset on the 1498 retains priority in the control of that unit. However, on the 250-UFS-Ed. 7 it is necessary to place the LOCAL-REMOTE switch in the LOCAL position to prevent repeater operation.

(3) Method 3.

(a) General.—When two-wire remote control is also necessary, the two equipment cabinets are connected together by a single telephone pair. To permit local, radio and/or remote control operation, the relay panel is modified as shown on figure 18. Figure 19 shows the connections to this panel. Normal local handset functions are maintained at each equipment cabinet.

Any signal picked up by the 12-UF Ed. 6A receiver in 250-UFS-Ed. 7 is automatically relayed through Radio Transmitter Type 1498-T-Ed. 6 to the radio remote control location, and at the same time will be heard at the wire-controlled control point.

The 250-UFS-Ed. 7 may be put on the air by the 1498 from the radio remote control location in the normal manner. The control circuits are so interlocked that whenever a signal is received by the 1498-R the control relay in the 1498 is rendered inoperative. The use of two different frequencies and antennas with the transmitter and receiver of the 1498 permits positive control of the relay transmitter at all times. This is most important since it allows the system to be operated in spite of undesired signals, high noise level or diathermy interference which might put the 1498-T transmitter on the air.

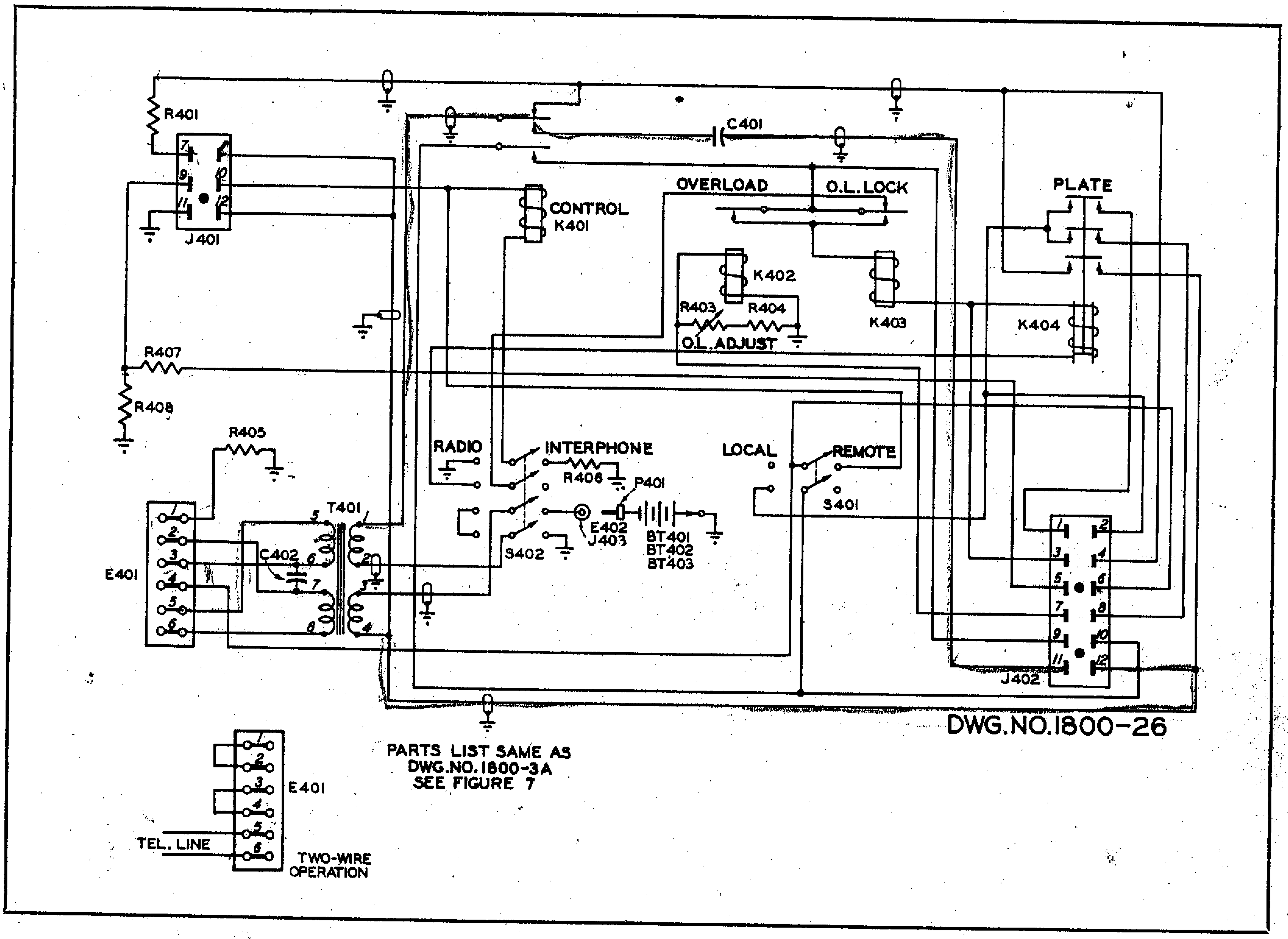


Figure 18. Relay Panel for 250-UFS-Ed. 7 as Modified for Two-Wire Repeater Use

(*b*) Adjustment.—After interconnecting the units with a two-wire line adjust the audio levels as follows:

1. The modulation gain control on the exciter chassis of the 250-UFS-Ed. 7 should first be adjusted for local handset operation then the volume control on the 1498-R adjusted for proper modulation level. The instruction manual for the 1498 will give the proper procedure to be followed.
2. With the 1498-R volume control set for proper modulation of the 250-UFS-Ed. 7 transmitter, the volume of the speaker on the 1498-Ed. 6 cabinet may be adjusted with the volume control mounted near the hang-up box. Next adjust the modulation circuits of the 1498-T-Ed. 6 for proper local handset operation then, with the 1498-T-Ed. 6 repeating, adjust the volume control on 12-UF-Ed. 6A receiver for the proper modulation level.
3. The squelch controls of both relay receivers should be set well away from threshold operation in order to minimize the possibility of their taking control of the system because of interfering signals or noise.

(c) Operation.

1. Radio Relay Operation.—The control circuits of the 250-UFS-Ed. 7 and 1498-Ed. 6 are arranged so that operation of the carrier-operated relay in either unit applied a DC voltage to the line which operates the transmitter in the other unit. They are so designed that a control line voltage of 40 volts will operate the 1498-T control relay while approximately 95 volts is required to operate the control relay in the 250-UFS-Ed. 7.

The 12-UF-Ed. 6A receiver in the 250-UFS-Ed. 7 cabinet applies the lower voltage to the control line and turns on the 1498 transmitter, while the 1498-R receiver in the 1498-Ed. 6 cabinet applies the higher voltage to the line, thus controlling the 250-UFS-Ed. 7 transmitter. The operator at the radio control location always has full control of the system and can put the transmitter on the air regardless of whether or not a signal is being received on the local receiver.

The audio circuits are interconnected so that the opposite receivers modulate the transmitters in order to accomplish relaying.

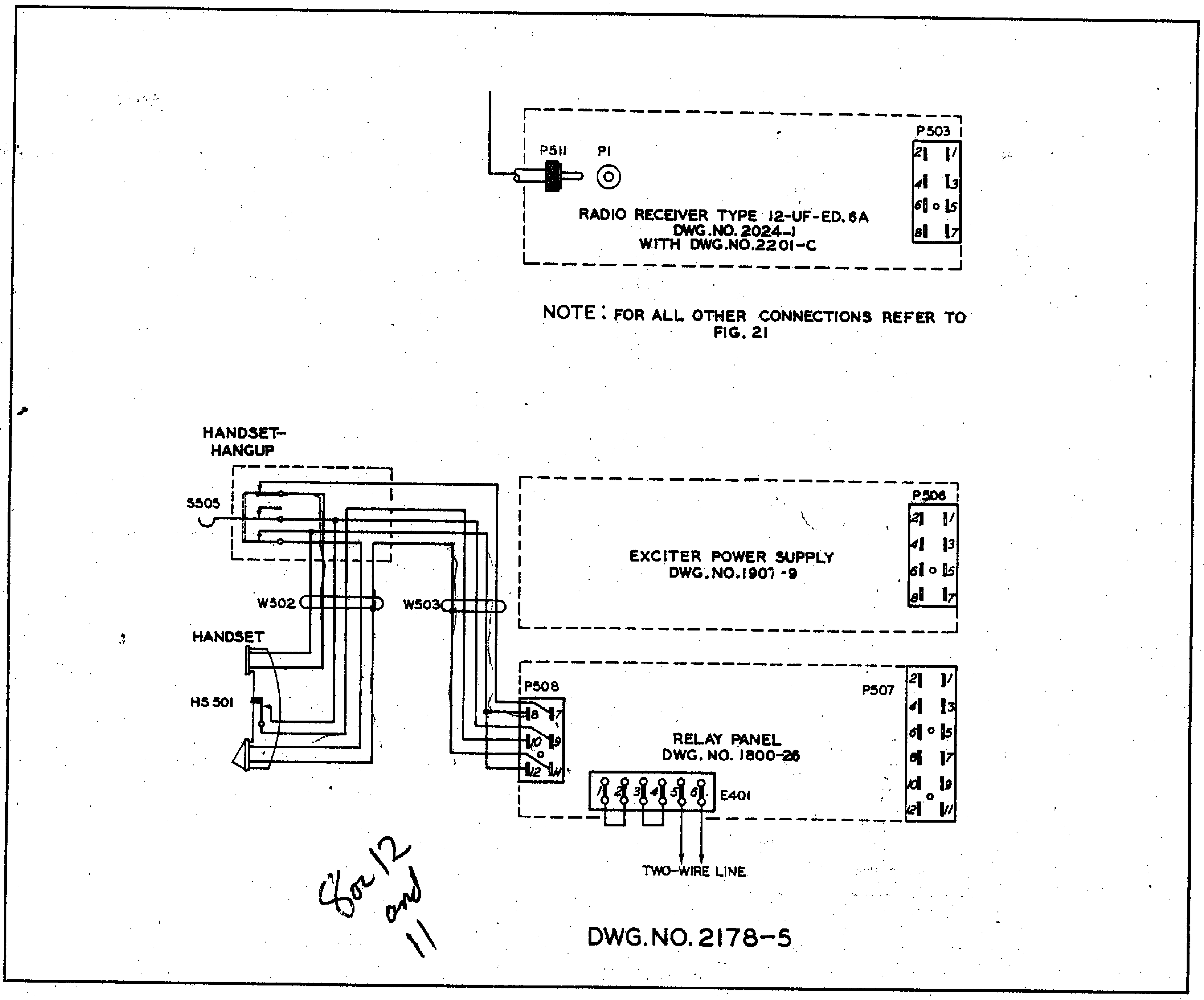


Figure 19. Radio Transmitter-Receiver Type 250-UFS-Ed. 7, Cabinet Interconnections as Modified for Two-Wire Repeater Use

2. Two Wire Control Operation.—When operating from a two-wire control point, the relay and audio voltages are bridged across the control line connecting the two transmitters. The remote control unit applies 95 volts to the control line starting both transmitters. This will enable the radio control point to know that the repeater is in use from the wire control point.

3. Local Handset Operation.—The control circuits of the 250-UFS-Ed. 7 are so arranged that lifting the handset from the hang-up box allows normal local operation. Placing the LOCAL-REMOTE switch in the LOCAL position prevents repeater, or two-wire operation.

In local operation of the 1498 it is possible under high line voltage conditions to have the 250-UFS-Ed. 7 turned on when the 1498 transmitter is turned on. If the line voltage is abnormally low, the 1498 will not operate from the local handset until one side of the two-wire line is disconnected from Control and Termination Chassis in the 1498.

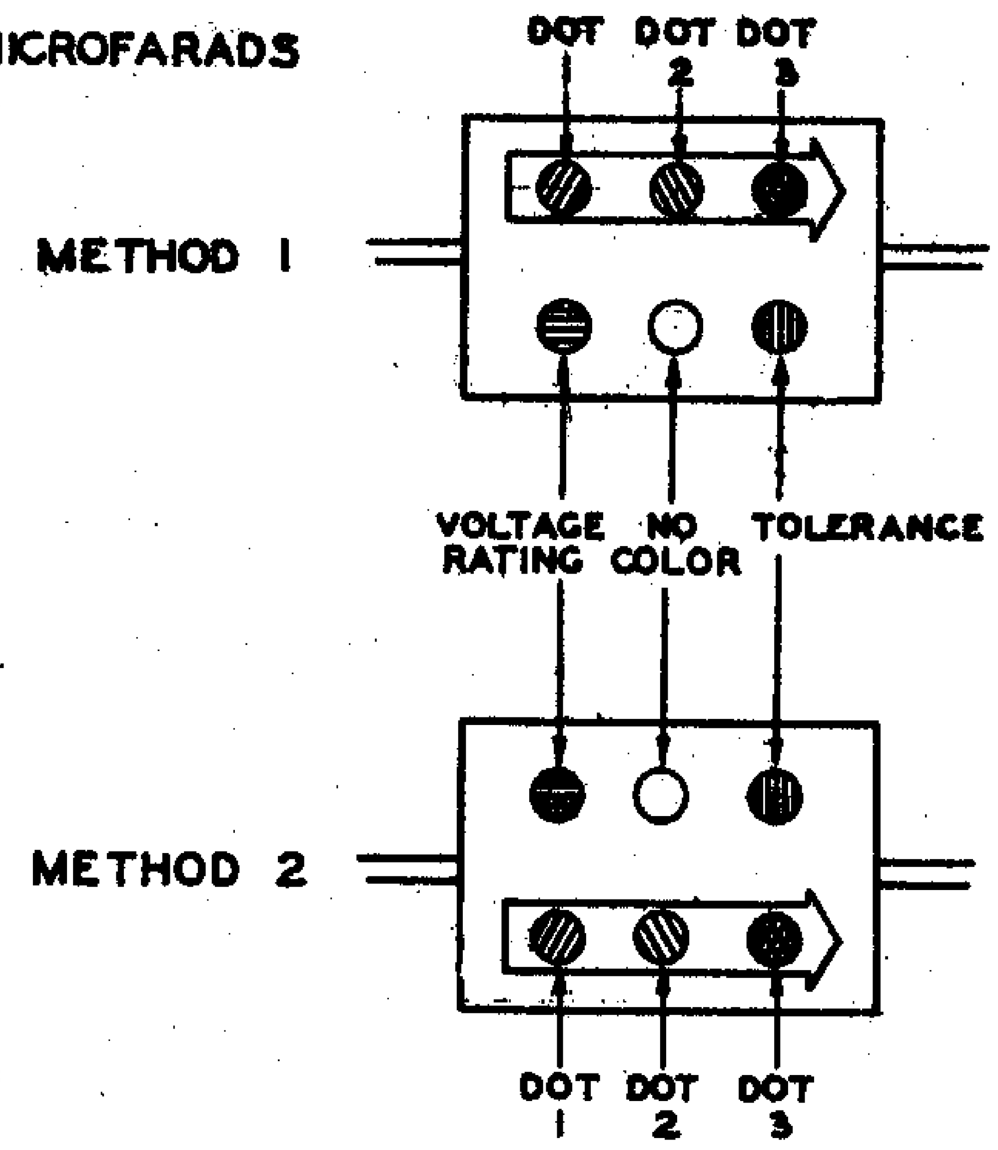
9. CONCLUSION.

The Engineering Department of the Link Radio Corporation is anxious to cooperate with users of LINK radio equipment to insure continued, high grade service from it. To this end we welcome inquiries or reports of unusual service problems. Write the Engineering Department, Link Radio Corporation, 125 West 17th Street, New York 11, N. Y.

RMA STANDARD COLOR CODE CHART – 3 DOTS

CAPACITY IN MICRO-MICROFARADS

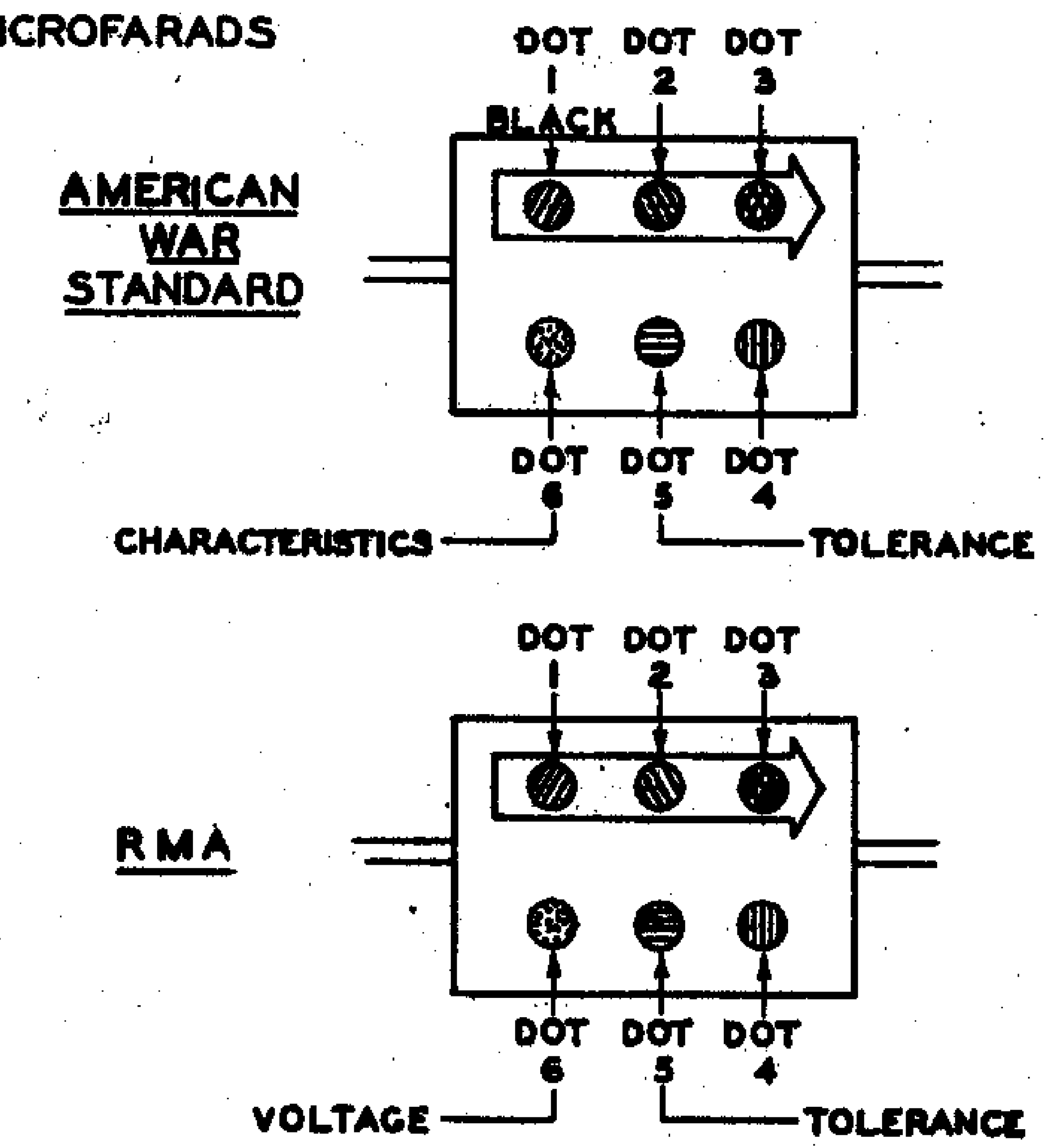
COLOR	1st DOT *1st Digit*	2nd DOT *2nd Digit*	3rd DOT *Decimal Multiplier*
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	
BLUE	6	6	
VIOLET	7	7	
GRAY	8	8	
WHITE	9	9	
GOLD	—	—	0.1
SILVER	—	—	0.01



AMERICAN WAR STANDARD & RMA 6 DOT COLOR CODE CHART

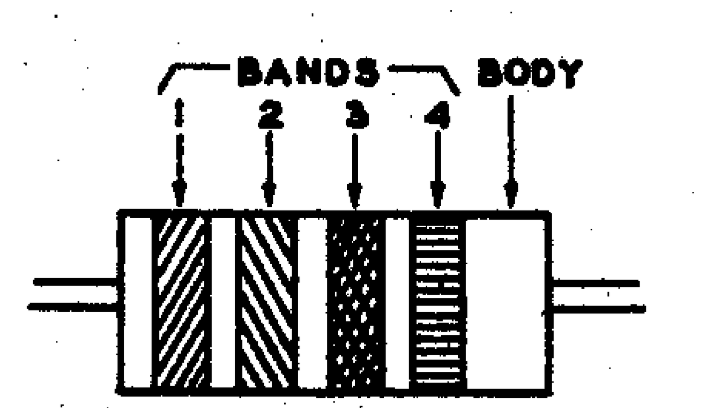
CAPACITY IN MICRO-MICROFARADS

COLOR	1st DOT *1st Digit*	2nd DOT *2nd Digit*	3rd DOT *3rd Digit*	4th DOT *Decimal Multiplier*
BLACK	0	0	0	1
BROWN	1	1	1	10
RED	2	2	2	100
ORANGE	3	3	3	1,000
YELLOW	4	4	4	10,000
GREEN	5	5	5	
BLUE	6	6	6	
VIOLET	7	7	7	
GRAY	8	8	8	
WHITE	9	9	9	
GOLD	—	—	—	0.1
SILVER	—	—	—	0.01



RMA STANDARD COLOR CODE CHART *for* RESISTORS

COLOR	1st BAND *1st Digit*	2nd BAND *2nd Digit*	3rd BAND *Decimal Multiplier*
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000



BAND 4 IS FOR TOLERANCE

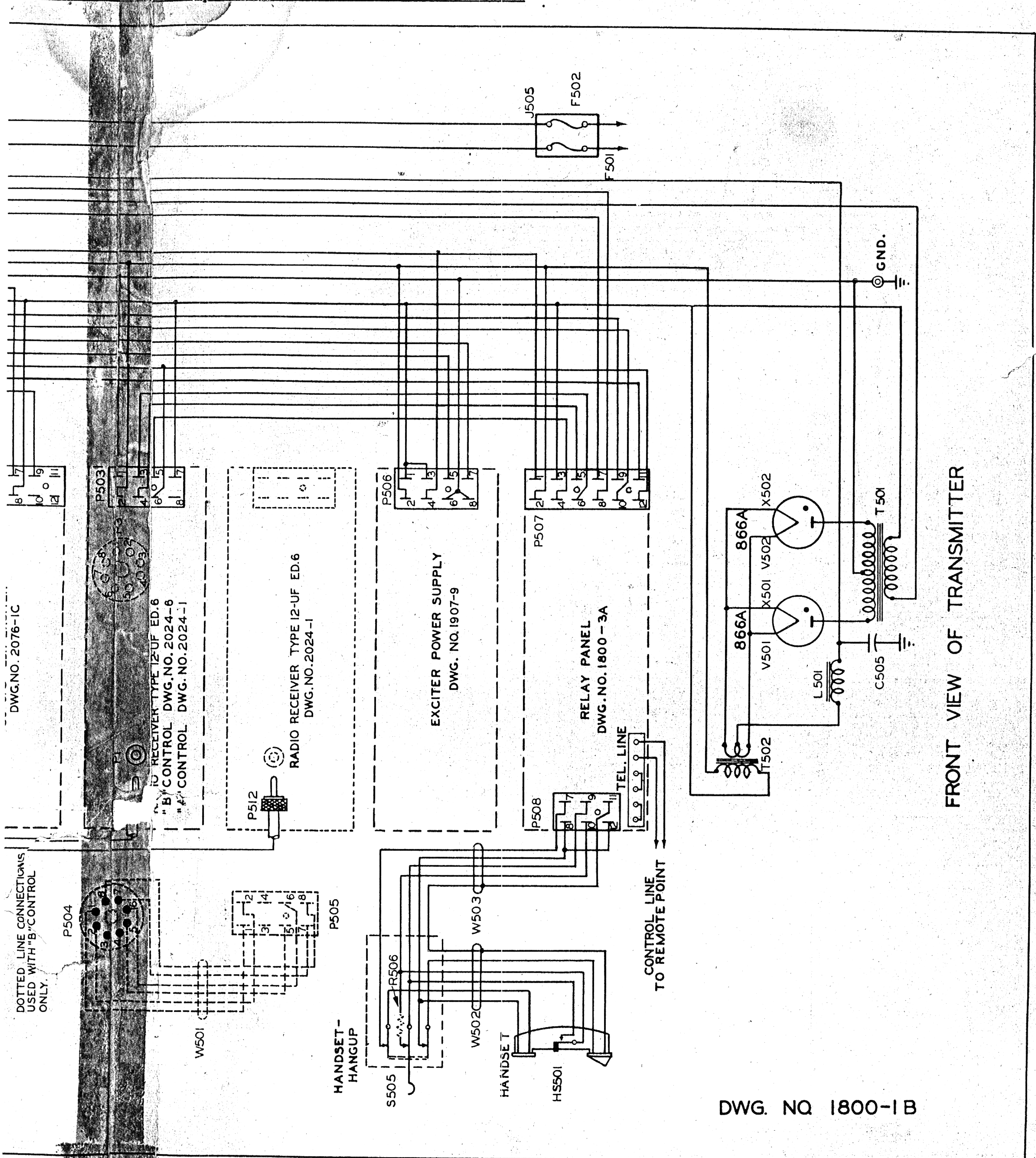
Figure 20. Color Codes for Mica Capacitors and Resistors.

PARTS LIST—EQUIPMENT ASSEMBLY RADIO TRANSMITTER-RECEIVER TYPE 250-UFS-ED. 7

Cir. Sym.	Description	Part No.
	CAPACITORS	
C501	Fixed, Mica, 2000 μμf, ±20%	CMBE10-B-202-M
502	Fixed, Mica, 2000 μμf, ±20%	CMBE10-B-202-M
503	Fixed, Mica, 2000 μμf, ±20%	CMBE10-B-202-M
504	Fixed, Mica, 2000 μμf, ±20%	CMBE10-B-202-M
505	Fixed, Oil, 2 μf, 2500 Volts DC	CPO-205-2500
	RESISTORS	
R501	Fixed, Wire Wound, 1000 ω, 10 Watts	RW10-102-J
502	Fixed, Wire Wound, 200,000 ω, 100 Watts	RWP100F-204-G
503	Fixed, Wire Wound, 50 ω, 80 Watts	RW80F-500-J
504	Glo-Coil Heater Element	RWH-600-(415A)
505	Fixed, Wire Wound, 1000 ω, 10 Watts	RW10-102-J
506	Fixed, Carbon, 33,000 ω, ±10%, 1 Watt (3-100,000 ω ±10%, 1 Watt in parallel)	RC30-104-K
	METERS	
M501	0-3000 v DC, 3½" Rectangular	MS34W-003DCKV (15ma)
502	0-500 ma DC, 3½" Rectangular	MS34W-500-DCMA
503	0-100 ma DC, 3½" Rectangular	MS34W-100-DCMA
504	0-250 ma DC, 3½" Rectangular	MS34W-250-DCMA
505	0-150 v AC, 3½" Rectangular	MS34W-150-ACVV
	SWITCHES	
S501	Despard, D.P.S.T.	SWD-2P1T-10A
502	Despard, D.P.S.T.	SWD-2P1T-10A
503	Push Button, S.P.S.T.	SWPB-1P1T-6A
504	Push Button, S.P.S.T.	SWPB-1P1T-6A
505	Hook Switch, Handset Hang-up	G-2-3-Reg.
	PILOT LAMPS	
I501	6 Watt, 120 Volt	S6
502	6 Watt, 120 Volt	S6
503	Lumiline, 115 Volt, 40 Watts	T8
	TRANSFORMERS	
T501	Plate: Pri., 115 Volts, 50-60 cycles; Sec., 2350-2350 Volts, 0.32 amp.	7284-N
502	Filament: 115 Volt Pri.; 2.5 Volt Sec.	8217-N
	INDUCTORS	
L501	High Voltage Filter Choke	7282-N
	TUBES	
V501	Rectifier, Mercury Vapor	866A
502	Rectifier, Mercury Vapor	866A

Cir. Sym.	Description	Part No.
	SOCKETS	
X501	4 Contact	210
502	4 Contact	210
	RECEPTACLES	
J501	Pilot Lamp, Red	147-1000-R
502	Pilot Lamp, Green	147-1000-G
503	Lamp Socket and Holder	49X698
	Holder	49X622
504	Glo-Coil Socket	9402
505	Fuse Block	34367
	FUSES	
F501	15 Amperes, Cartridge	GE1463
502	15 Amperes, Cartridge	GE1463
	CONNECTORS	
P501	8 Contact, Female, cable type	S-408-CCT
502	12 Contact, Female, cable type	S-412-CCT
503	8 Contact, Female, cable type	S-408-CCT
504	8 Contact, Male, cable type	86-PM8
505	8 Contact, Female, cable type	S-408-CCT
506	8 Contact, Female, cable type	S-408-CCT
507	12 Contact, Female, cable type	S-412-CCT
508	6 Contact, Female, cable type	S-406-CCT
509 to 512	Single Contact	P-101-¼"
	HANDSET	
HS501	Handset, with switch	F3H
	CABLES	
W501	Receiver Inter-connecting cable with P504 one end and P505 other end	
502	Handset Cable, with HS501 one end	
503	Handset Hang-up—Relay Panel Interconnecting cable with P508 one end	
504	R-F Cable, P. A. to Station Frequency Receiver with P509 and P512	
505	R-F Cable, P. A. to Mobile Frequency Receiver with P510 and P511	
	MISCELLANEOUS	
	Resistor Clips, large 600 Volt	31-60A (600 V)
	Resistor Clips, small	31-60A (250 V)
	Plate Caps	36001 or SPP9
(4)	Standoffs, ceramic, 1" x ¾"	1010
(6)	Standoffs, ceramic ¾" x ½"	1402

WA5KTC



Type 250-UFS Ed. 7 Equipment Cabinet Interconnections

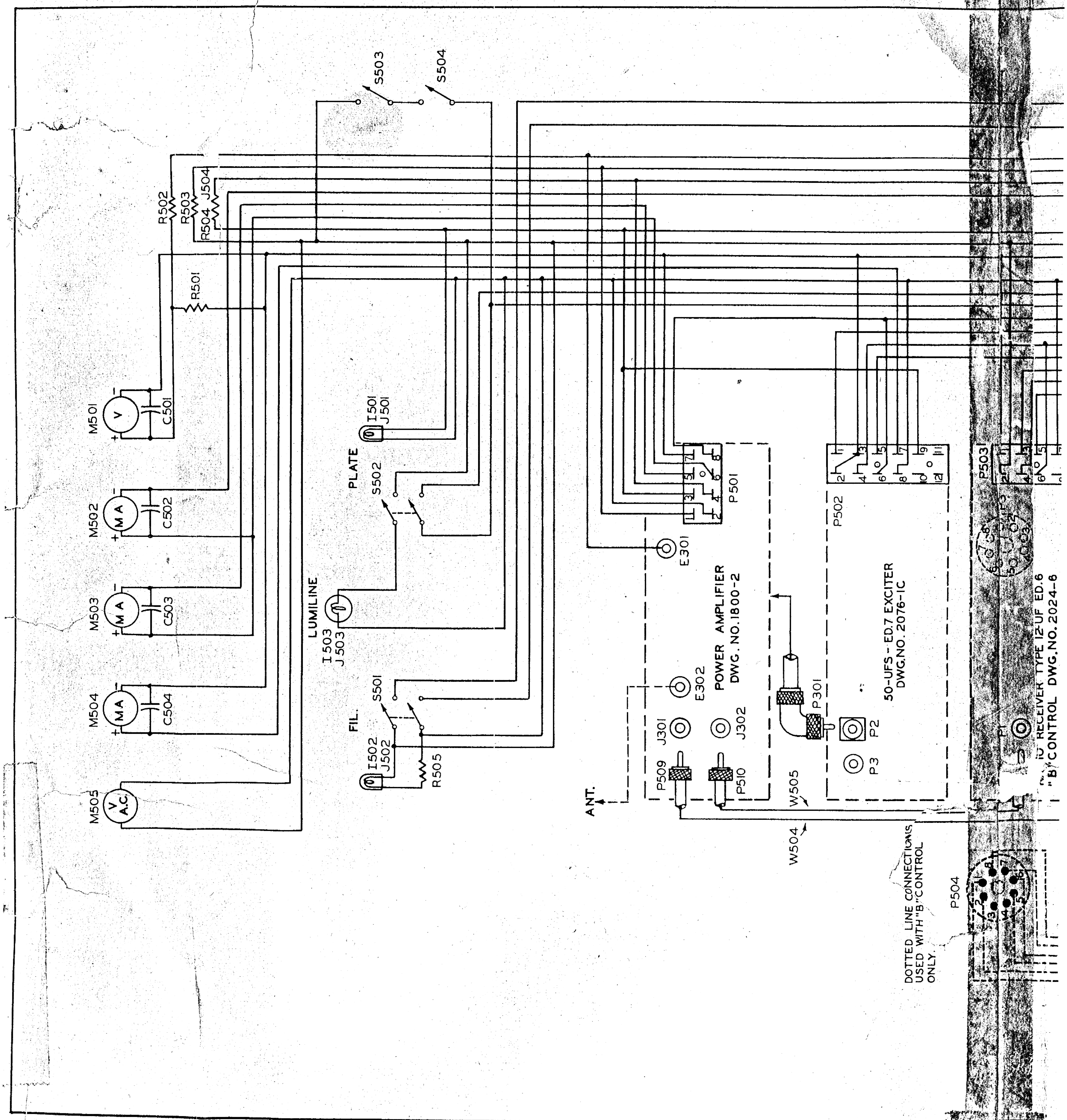


Figure 21. Radio Transmitter-Re‑eiver Type 250-UFS Ed. 7, E

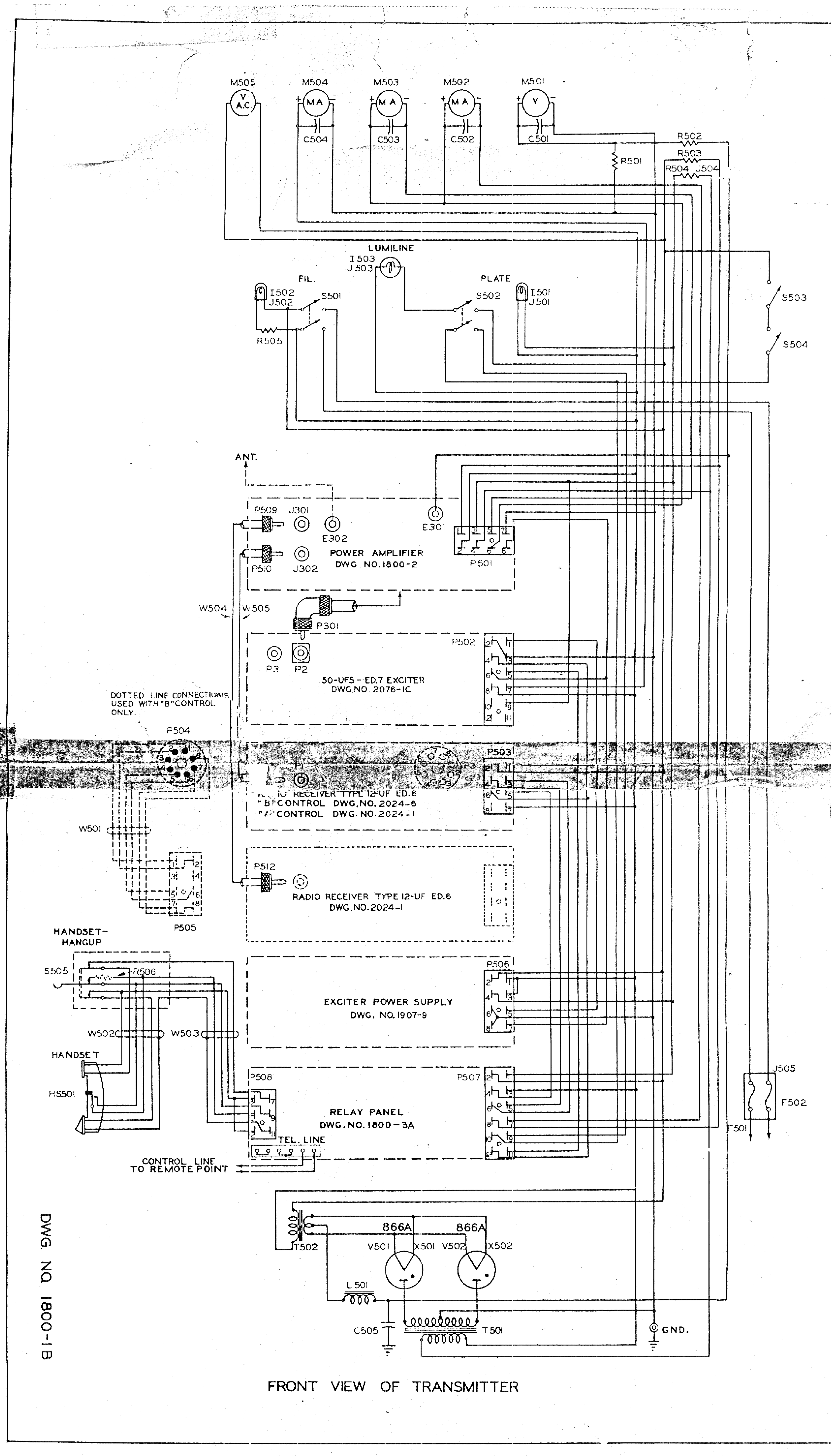


Figure 21. Radio Transmitter-Receiver Type 250-UFS Ed. 7 Equipment Cabinet Interconnections

Link

Radio Corporation