SECTION 4
PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION

a. GENERAL.—A general description of Radio Set AN/GRC-27A is presented in section 1. For a comprehensive understanding of the principals of operation of the Radio Set, Section 1 should be studied thoroughly. The following text is an analysis of the electrical circuits and is not concerned with the physical details of the equipment.

This section includes a brief description of the overall electrical and mechanical functions of the equipment. This description is followed by a detailed explanation of each circuit, supplemented where necessary by block diagrams and simplified schematic diagrams.

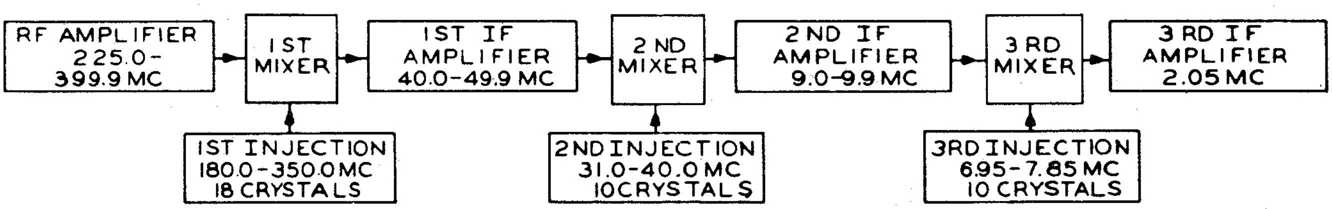
Composite functional block diagrams of Radio Receiver R-278B/GR, Radio Transmitter T-217A/GR, and Modulator-Power Supply MD-129A/GR are shown in figure 4–1. Since the Receiver and the Transmitter can be operated independently, each unit is described separately.

b. RADIO RECEIVER R-278B/GR.

(1) GENERAL.—As shown in figure 4–1, the Receiver consists of a multi-channel receiver section, a frequency selector unit, an audio amplifier, and a power supply. The multi-channel receiver operates on any one of 1750 channels in the frequency range 225.0 to 399.9 mc.

The multi-channel receiver section employs a triple-conversion superheterodyne system using crystal-controlled oscillators employing a total of 38 crystals. These oscillators operate in a synthesizer system to produce the 1750 output frequencies. A motor-driven frequency-selector unit operates the various crystal switches and tuning mechanisms to permit rapid change of operating frequency.

The frequency-selector unit, which is controlled by switches on the front panel of the Receiver, automati-



DIAL READING	R.F. BAND MC.	INJ. FREQ. MC.	CRYSTAL FREQ. MC.	MULT FACTOR
22	220.0 - 229.9	180.0	30.0000	6
23	230.0 - 239.9	190.0	31.6667	6
24	240.0 - 249.9	200.0	33.3333	6
25	250.0 - 259.9	210.0	35.0000	6
26	260.0 - 269.9	220.0	36.6667	6
27	270.0 - 279.9	230.0	38.3333	6
28	280.0 - 289.9	240.0	26.6667	9
29	290.0 - 299.9	250.0	27.7777	9
30	300.0 - 309.9	260.0	28.8888	9
31	310.0 - 319.9	270.0	30.0000	9
32	320.0 - 329.9	280.0	31.1111	9
33	330.0 - 339.9	290.0	32.2222	9
34	340.0 - 349.9	300.0	33.3333	9
35	350.0 - 359.9	310.0	34.4444	9
36	360.0 - 369.9	320.0	35.5555	9
37	370.0 - 379.9	330.0	36.6667	9
38	380.0 - 389.9	340.0	37.7778	9
39	390.0 - 399.9	350.0	38.8889	9

DIAL READING	1ST I. F. BAND MC.	CRYSTAL AND INJ. FREQ. MC.
0	40.0 - 40.9	31.0
1	41.0 - 41.9	32.0
2	42.0 - 42.9	33.0
3	43.0 - 43.9	34.0
4	44.0 - 44.9	35.0
5	45.0 - 45.9	36.0
6	46.0 - 46.9	37.0
7	47.0 - 47.9	38.0
8	48.0 - 48.9	39.0
9	49.0 - 49.9	40.0

DIAL READING	2ND I. F. FREQ. MC.	CRYSTAL AND INJ. FREQ. MC.
.0	9.0	6.95
.1	9.1	7.05
.2	9.2	7.15
.3	9.3	7.25
.4	9.4	7.35
.5	9.5	7.46
.6	9.6	7.55
.7	9.7	7.65
.8	9.8	7.75
.9	9.9	7.85

Figure 4–2. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Frequency Diagram

cally tunes the multi-channel Receiver to any one of ten preset channels. These channels can also be selected from remote units such as Control-Indicator Navy Type 23496 used in conjunction with Radio Set Controls C-1180/GRC-27 or C-1897/GRC-27A. The ten preset channels are set up by banks of rotary selector switches in the selector panel.

The power supply furnishes all required voltages to various components of the Receiver.

(2) MULTI-CHANNEL RECEIVER SECTION.

(*a*) FREQUENCY GENERATING AND TUNING SYSTEM.—The multichannel receiver operates on any one of 1750 frequencies spaced at 0.1 mc intervals. It is completely tuned by the frequency selector unit. The receiver employs a triple conversion superheterodyne circuit using the following radio and intermediate frequencies (also refer to figure 4–2).

CIRCUIT	FREQUENCY RANGE	TUNING STEPS OR INCREMENTS
R-f amplifier	220.0–399.9 mc*	Tuned in 0.1 mc increments.
1st injection	180.0–350.0 mc	Tuned in 18 steps of 10 mc each.
1st i-f amplifier	40.0–49.9 mc	Tuned in 100 steps of 0.1 mc each.
2nd injection	31.0–40.0 mc	Tuned in 10 steps of 1 mc each.
2nd i-f amplifier	9.0–9.9 mc	Tuned in 10 steps of 0.1 mc each.
3rd injection	6.95–7.85 mc	Tuned in 10 steps of 0.1 mc each
3rd i-f amplifier	2.05 mc	Fixed-tuned

* Note that although the normal operating frequency range of the Receiver is 225.0 to 399.9 mc, the synthesizer system employed is capable of providing 50 additional frequencies in the range 220.0 to 224.9 mc.

The r-f amplifier is tuned in 1-mc steps to any frequency in the range from 225.0 to 399.9 mc. The first injection system tunes in 10-mc steps to any frequency from 180 to 350 mc. These two frequencies are mixed in the first mixer to produce a first intermediate frequency of 40.0 to 49.9 mc. The first i-f amplifier will be tuned to one of 100 frequencies spaced 0.1 mc apart. The second injection system generates one of ten frequencies in the range 31.0 to 40.0 mc and mixes this frequency with the output of the first i-f amplifier (40.0–49.9 mc) to produce a second intermediate frequency of 9.0 to 9.9 mc. The third injection system generates one of ten frequencies in the range of 6.95 to 7.85 mc to mix with the output of the second i-f amplifier (9.0–9.9 mc) to produce the third intermediate frequency of 2.05 mc.

The method of tuning the Receiver is as follows: The frequency-selector unit has three rotary output shafts which select the proper crystals and tune various circuits to establish a particular operating frequency. These output shafts are called the 10-mc, the 1-mc and the 0.1-mc shafts. The 10-mc shaft rotates in 18 incremental steps, each increment representing 10 mc. The 1-mc shaft rotates in ten incremental steps, each step representing one mc. The 0.1-mc shaft also rotates in ten incremental steps, each step representing 0.1 mc. By combining the outputs of these shafts and applying the mechanical sum to the tuning of the r-f and i-f circuits, any of 1750 frequencies in the range of 225.0 to 399.9 mc may be selected as explained below.

The r-f amplifier is tuned in 180 one-mc steps by the 10-mc shaft (18 positions) and the 1-mc shaft (10 positions) whose rotary motions are combined in a differential mechanism to produce 180 rotational positions.

The first injection system (main oscillator and frequency multiplier-amplifier sections) is tuned in 18 ten-mc steps by the 10-mc output shaft which also operates the main oscillator crystal selector switch to select one of 18 crystal units.

The first i-f amplifier is tuned by the 1-mc and 0.1-mc shafts, the rotations of which are combined in a differential tuning mechanism to produce one hundred 0.1-mc steps. The crystal selector switch and tuned circuits of the second injection oscillator are controlled by the 1-mc shaft.

The second i-f amplifier is tuned in ten 0.1-mc steps by the 0.1-mc shaft which also operates the crystal selector switch of the third injection oscillator.

As an example of frequency selection in the r-f and i-f sections, assume that the Receiver is to be tuned to a signal frequency of 395.5 mc. Also, assume this to be preset channel number 10. Turn the knurled disks opposite CHANNEL 10 in the preset panel to 395.5 as indicated on the dials. Turn CHANNEL SELECTOR switch to CHANNEL 10. The frequency-selector motor starts and produces a mechanical output which tunes the Receiver as follows: (Note in figure 4–2 that frequencies will be selected as follows in the various sections):

r-f amplifier — 395.0 mc
1st injection system — 350 mc
1st i-f amplifier — 45.5 mc
2nd injection system — 36 mc
2nd i-f amplifier — 9.5 mc
3rd injection system — 7.45 mc
3rd i-f amplifier — 2.05 mc

(*b*) FUNCTIONAL OPERATION OF MAJOR CIRCUITS.—A complete functional block diagram of Radio Receiver R-278B/GR is shown in figure 4-3. Refer to this diagram while reading the following sub-paragraphs.

1. RADIO FREQUENCY AMPLIFIER.—The radio frequency signal is received and amplified by a two-stage amplifier using V101 and V102. The r-f amplifier tuned circuits are tuned in 180 steps by the 10- and 1-mc autopositioner shafts operating through a mechanical differential system.

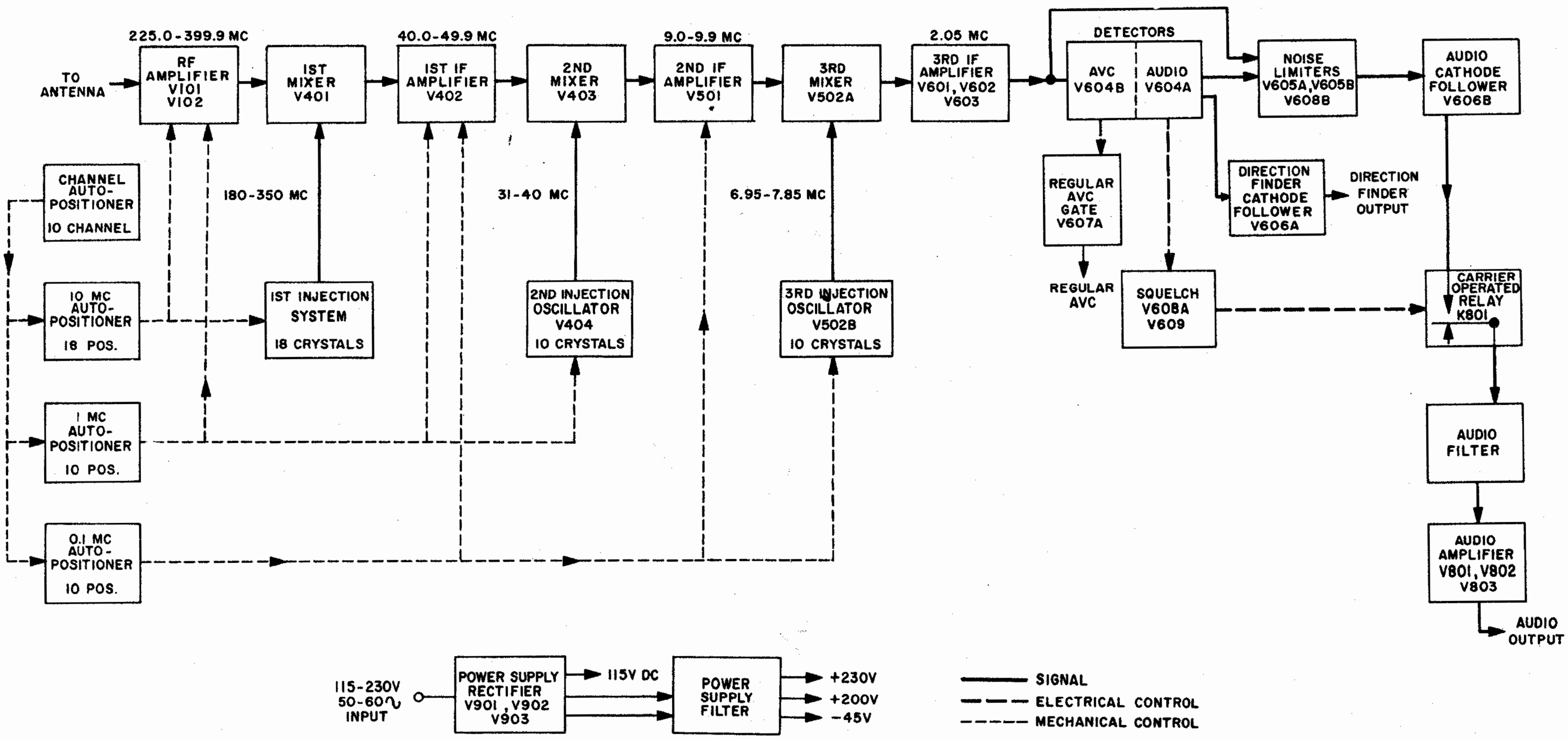


Figure 4-3. Radio Receiver R-278B/GR, Functional Block Diagram

2. FIRST INJECTION SYSTEM.—The output of the r-f amplifier is mixed in the first mixer with a signal from the first injection system to produce a first intermediate-frequency in the range from 40 to 49.9 mc. The first injection system consists of a crystal-controlled oscillator and five stages of multiplication and amplification. Eighteen crystals are employed to provide 18 injection frequencies spaced at 10-mc intervals between 180 and 350 mc.

3. FIRST I-F AMPLIFIER.—The first i-f signal is amplified by a one stage amplifier using V402 and two interstage transformers which are permeability tuned by the differential combinations of the 1 and the 0.1-mc autopositioner outputs. The signal is mixed in second mixer V403 with an injection signal from the second injection system comprising a crystal-controlled oscillator using V404 and one of ten crystals to produce a second intermediate frequency in the range of 9.0 to 9.9 mc.

4. SECOND I-F AMPLIFIER.—The second intermediate frequency signal is amplified by a one-stage amplifier using V501 and two interstage transformers that are permeability tuned by the mechanical output from the 0.1-mc autopositioner. The signal is then mixed in the third mixer, with an injection signal from the third injection system, which used a crystal-controlled oscillator employing ten crystals. The crystal is selected by the 0.1-mc autopositioner so that the last intermediate frequency is always 2.05 mc.

5. THIRD I-F AMPLIFIER.—The third i-f signal (2.05 mc) is amplified by a three-stage fixed tuned amplifier employing V601, V602 and V603, and four double-tuned transformers.

6. DETECTORS, NOISE LIMITERS AND SQUELCH CIRCUIT.—The audio detector detects the audio signal from the third i-f signal. The audio signal is transmitted through the noise-limiter circuits to reduce the effect of impulse-type noise appearing in the signal. The avc detector and avc gate circuit produce a d-c control signal which is applied to various amplifier tubes in order to maintain the audio output level very nearly constant for wide variations in the r-f input signal. The squelch circuit provides a d-c voltage to operate the carrier-operated relay which serves to remove the audio attenuator (QUIETING control) from the audio path whenever a signal is received. A direction finding circuit is provided which utilizes V606A. This feature is not required in the normal communication applications of Radio Set AN/GRC-27A.

7. AUDIO AMPLIFIER.—The signal from the audio detector is amplified by the audio amplifier, which includes V801, V802 and V803. Two output circuits are provided; the main output (3 watts into 600 ohms) appears at the PHONES jack and AUX CONTROL connector while the low level output (+10 dbm) appears at the LOCAL CONTROL and AUX CONTROL connectors.

(3) FREQUENCY SELECTOR SYSTEM.

(*a*) GENERAL.—Radio Receiver R-278B/GR employs a frequency selector system which automatically tunes the Receiver to any one of the 1750 available channels. Physically, the frequency selector section consists of two main parts, the preset panel and the autopositioner. The preset panel provides switches for setting up ten preset, automatically tunable channels, and for setting up one manual channel.

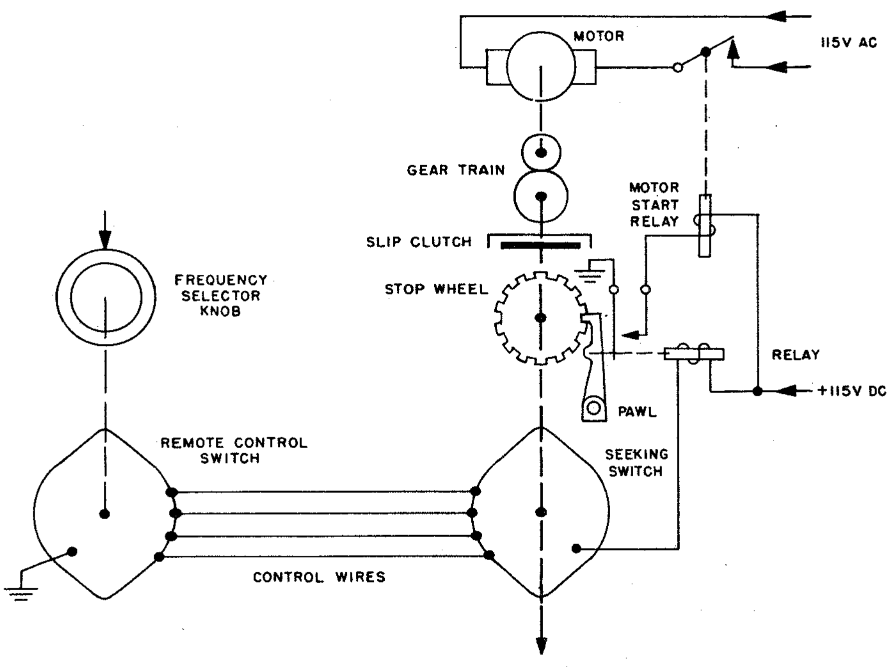


Figure 4-4. Autopositioner, Basic Elements

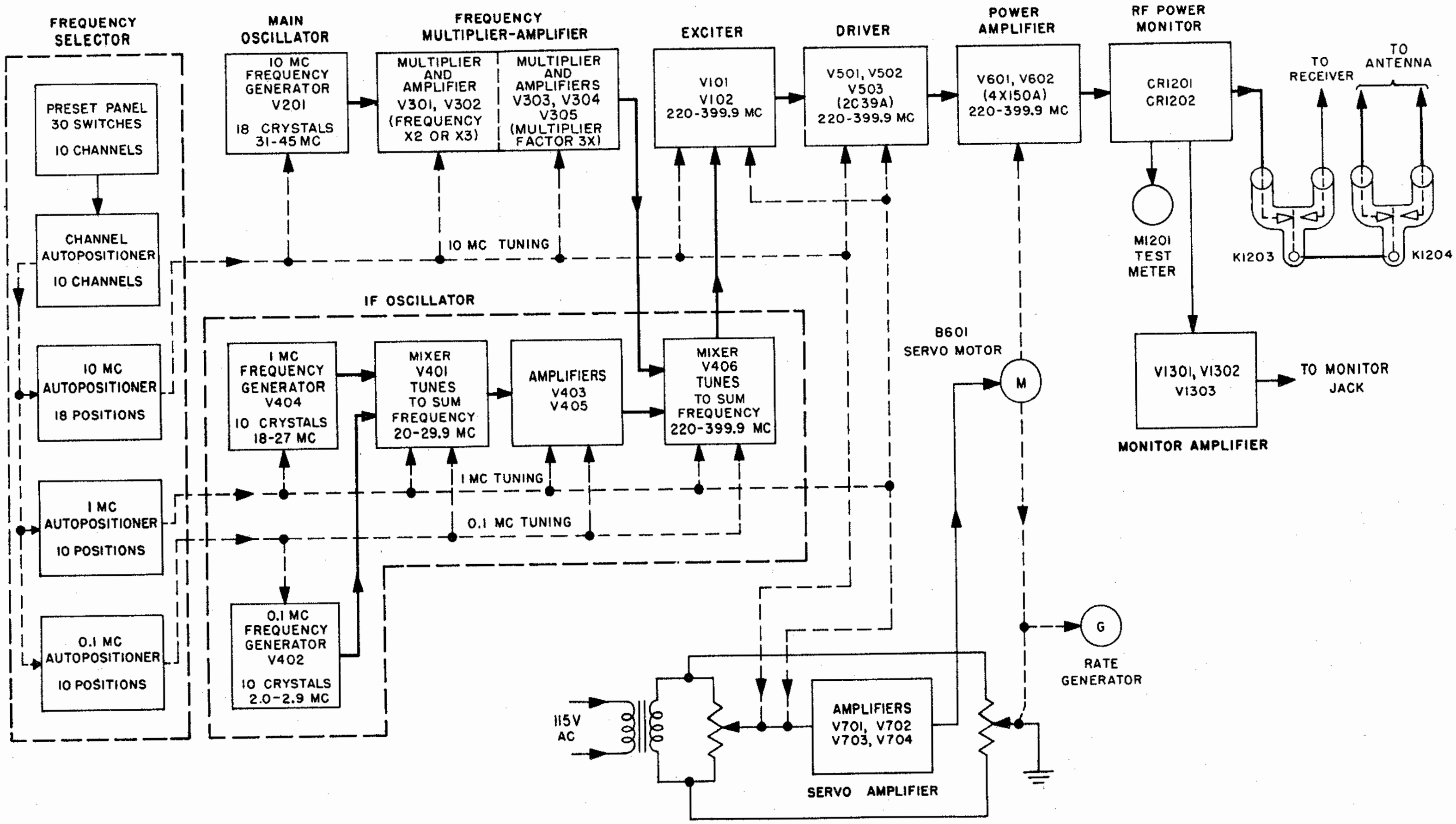


Figure 4–5. Radio Transmitter T-217A/GR, Functional Block Diagram

The autopositioner is an electro-mechanical device actuated by operating a channel selector switch located on the front panel, or by remote control facilities. The autopositioner tunes the receiver to a desired channel selected from the ten preset channels. The manual channel can be selected only from the panel-mounted, channel-selector switch (figure 3–2.)

(*b*) PRESET PANEL.—The preset panel employs 33 rotary switches. For purposes of setting up channels, these switches are arranged in 11 horizontal banks of three switches each. The "tens" mc frequency is set up on the first bank, the "units" mc frequency on the second bank, and the "tenths" mc frequency on the third bank. By combining the settings of the three switches (horizontal rows), the frequency of each of the eleven channels can be read directly. The "manual" channel is set up the same as the other ten channels, except that it is not possible to select the "manual" channel from a remote position. This channel is reserved for the local operator.

(*c*) AUTOPOSITIONER.—The frequency selector unit employs four relay-controlled devices known as autopositioners. An autopositioner is a motor-driven mechanism which positions a shaft to any one of a number of preset positions. The basic elements of an autopositioner are shown in figure 4–4. It consists of a motor and gear reduction, a slip clutch, a rotary shaft to which is fastened a notched stop-wheel, a pawl which engages the notches of the stop-wheel, and a relay which actuates the pawl and operates a set of electrical contacts to start and stop the motor. Associated with each autopositioner is an electrical control system consisting of a control switch and a corresponding symmetrical "seeking" switch which is driven by the autopositioner shaft. This control system is designed so that whenever the control switch and seeking switch are not set to the same electrical position, the autopositioner is energized and operates to drive its shaft (and the driven elements to which it is coupled) to the proper position to restore the symmetry of the control system.

The frequency selector unit employs four autopositioners: the channel autopositioner, the 10-mc autopositioner, the 1.0-mc autopositioner and the 0.1-mc autopositioner. The channel autopositioner energizes the other three autopositioners through the channel energizing switches and the preset panel. The 10-mc, 1.0-mc and 0.1-mc autopositioners each have output shafts which tune the Receiver to the desired operating frequency.

Referring to figure 4–4, the cycle of operation of an autopositioner is as follows:

1. The system is at rest with the control and seeking switches in corresponding positions (open circuit), relay in de-energized position, pawl engaging a stop-wheel notch, and motor not energized.

2. The operator changes the setting of the remote-control selector switch.

3. The control system energizes the relay, lifting the pawl out of the stop-wheel notch and closing the motor control contacts.

4. The motor starts, driving the autopositioner shaft and the rotor of the seeking switch.

5. The seeking switch reaches the point corresponding to the new position of the remote switch, opens the relay circuit and permits the pawl to drop into the corresponding stop-wheel notch to stop the shaft rotation.

6. The motor-control contacts open, and the motor coasts to a stop, dissipating its energy in the slip clutch.

The seeking switch of the control circuit is adjusted to open the relay shortly before the stop-wheel reaches the point where the pawl engages the proper notch. The relay contacts controlling the motor are mechanically operated by the pawl arm so that they do not open until the pawl does drop into the notch.

Note that the slip clutch between the motor and autopositioner not only absorbs the energy of the motor as it coasts to a stop, but also permits the same motor to drive more than one autopositioner, either simultaneously or independently. The motor control contacts of the autopositioner relays are connected in parallel to keep the motor operating as long as any of the autopositioners are energized.

c. RADIO TRANSMITTER T-217A/GR.

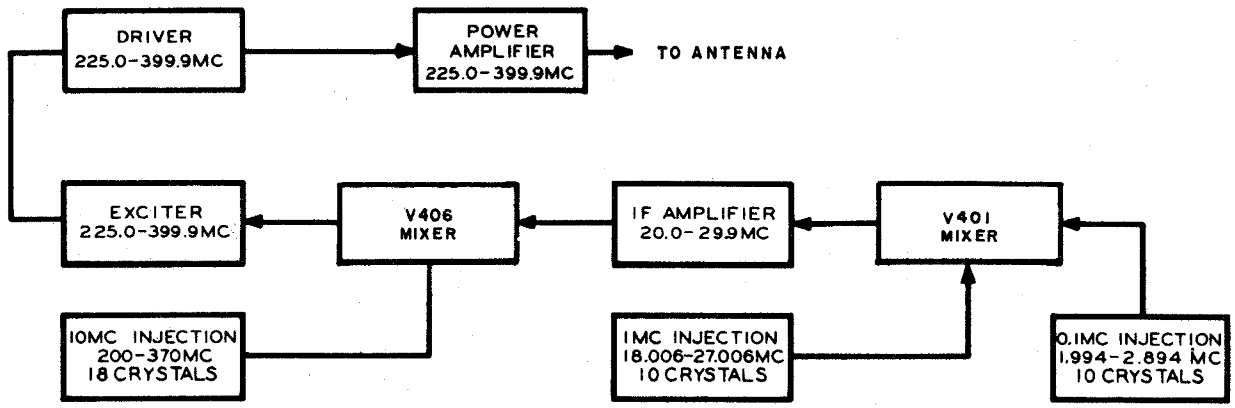
(1) GENERAL.—Radio Transmitter T-217A/GR and its associated Modulator-Power Supply MD-129A/-GR constitute a radio transmitting installation. This transmitter delivers a nominal output power of 100 watts, either tone or voice modulated, in the frequency range of 225.0 to 399.9 mc. Figure 4–1 shows that the transmitter can be considered as a frequency generating system, plus an exciter, driver and a power amplifier. The modulator-power supply provides the transmitter with power and voice or tone modulates the output stage of the transmitter.

Figure 4–5 is the complete functional block diagram of Radio Transmitter T-217A/GR. It shows the interrelation of the various sub-assemblies. A brief description of the major circuits shown in this figure is given in the following paragraphs.

Figure 4–6 is the frequency system block diagram. It shows for any combination of dial readings, which crystals are selected, the frequency multiplication factor, and how the frequencies are mixed to produce the desired output frequency.

(2) FREQUENCY SELECTOR.—The frequency selector system employed in Radio Transmitter T-217A/GR is identical with the system used in Radio Receiver R-278B/GR. A description of the frequency selector system is given in paragraph 4-1b(3).

(3) MAIN OSCILLATOR.—The Main Oscillator is the 10-mc frequency generator. It establishes the frequencies which give the 10-mc points between 220 and 390 mc after they are multiplied six or nine times



DIAL READING	RF BAND MC	INJ. FREQ. MC	CRYSTAL FREQ. MC	MULT FACTOR
22	220.0-229.9	200.0	33.3333	6
23	230.0-239.9	210.0	35.0000	6
24	240.0-249.9	220.0	36.6666	6
25	250.0-259.9	230.0	38.3333	6
26	260.0-269.9	240.0	40.0000	6
27	270.0-279.9	250.0	41.6666	6
28	280.0-289.9	260.0	43.3333	6
29	290.0-299.9	270.0	45.0000	6
30	300.0-309.9	280.0	31.1111	9
31	310.0-319.9	290.0	32.2222	9
32	320.0-329.9	300.0	33.3333	9
33	330.0-339.9	310.0	34.4444	9
34	340.0-349.9	320.0	35.5555	9
35	350.0-359.9	330.0	36.6666	9
36	360.0-369.9	340.0	37.7777	9
37	370.0-379.9	350.0	38.8888	9
38	380.0-389.9	360.0	40.0000	9
39	390.0-399.9	370.0	41.1111	9

DIAL READING	IF AMPLIFIER BAND (MC)	CRYSTAL AND INJ. FREQ. (MC)
0	20.0-20.9	18.0 *
1	21.0-21.9	19.0 *
2	22.0-22.9	20.0 *
3	23.0-23.9	21.0 *
4	24.0-24.9	22.0 *
5	25.0-25.9	23.0 *
6	26.0-26.9	24.0 *
7	27.0-27.9	25.0 *
8	28.0-28.9	26.0 *
9	29.0-29.9	27.0 *

*ACTUAL CRYSTAL FREQUENCIES 6KC ABOVE FREQUENCIES SHOWN.

DIAL READING	IF AMPLIFIER FREQ'S (MC)	CRYSTAL AND INJ. FREQ. (MC)
.0	20.0, 21.0, ETC.	2.0 **
.1	20.1, 21.1, ETC.	2.1 **
.2	20.2, 21.2, ETC.	2.2 **
.3	20.3, 21.3, ETC.	2.3 **
.4	20.4, 21.4, ETC.	2.4 **
.5	20.5, 21.5, ETC.	2.5 **
.6	20.6, 21.6, ETC.	2.6 **
.7	20.7, 21.7, ETC.	2.7 **
.8	20.8, 21.8, ETC.	2.8 **
.9	20.9, 21.9, ETC.	2.9 **

**ACTUAL CRYSTAL FREQUENCIES 6KC BELOW FREQUENCIES SHOWN.

Figure 4–6. Radio Transmitter T-217A/GR, Frequency Block Diagram in the frequency multiplier-amplifier. The main oscillator employs 18 crystals, any one of which is selected by the 10-mc autopositioner. The range of frequencies produced by the main oscillator are between 31.1111 and 45 mc, as shown by figure 4-6.

(4) FREQUENCY MULTIPLIER-AMPLIFIER.—The frequency multiplier-amplifier uses five stages of multiplication and amplification. The signal from the main oscillator is doubled or tripled in the plate circuit of V301. The signal is again tripled in the tuned plate circuit of V303. The frequency multiplier-amplifier delivers one of 18 frequencies spaced at 10-mc intervals in the range of 200–370 mc to mixer V406, in the i-f oscillator.

(5) I-F OSCILLATOR.—(See figure 4–5.) The i-f oscillator section includes two oscillators, referred to as the 1-mc frequency generator and the 0.1-mc frequency generator. Oscillator tube V404 and its ten crystals generate any one of ten frequencies at 1-mc intervals in the 18 to 27-mc frequency range. The frequency generated is determined by the crystal selected and also by the plate tuning accomplished by the 1-mc autopositioner. Oscillator tube V402 and its ten crystals generate any one of ten frequencies at 0.1-mc intervals in the 2.0–2.9 mc frequency range as determined by the crystal selected. These two frequencies are added in mixer V401, amplified in V403 and V405, and the sum frequencies added with the output frequency from the frequency multiplier-amplifier in mixer V406. The i-f oscillator produces one of 100 frequencies spaced at 0.1-mc intervals in the range of 20–29.9 mc.

(6) EXCITER AND DRIVER.—The signal from the second mixer is amplified in the exciter and then in the driver. The exciter and driver sub-assemblies are tuned by the 10-mc and 1-mc autopositioners in 1-mc steps from 220.0 to 399.9 mc. The stages are tuned to the center frequency of each 1-mc band, as the pass-band is broad enough to amplify the 0.1-mc variations at the extreme ends.

(7) POWER AMPLIFIER.—The power amplifier amplifies the output from the driver to produce a nominal output power of 100 watts. A servo motor, which is the output stage of a servo system, tunes the power amplifier throughout the frequency range of 220.0 to 399.9 mc.

(8) SERVO AMPLIFIER.—The servo amplifier operates from an error signal on a servo bridge set up by the 10-mc and 1-mc autopositioners. The output of the servo amplifier operates the servo motor. The servo motor tunes the power amplifier and adjusts the setting of a potentiometer to restore equilibrium to the servo bridge at the time the power amplifier is tuned.

(9) FREQUENCY GENERATION SYSTEM.—The Transmitter operates on any one of 1750 frequencies spaced at 0.1-mc intervals. With the exception of the power amplifier stage, which is automatically tuned by a servo amplifier system, the transmitter is automatically tuned by the frequency selector unit. Three oscillators are employed; their various outputs, when properly multiplied and combined, furnish the 1750 frequencies. Figure 4–6 shows how the frequencies generated by the three oscillators are combined to give the frequency as set up by the "dial reading." The chart below shows the frequency range and tuning increments of each stage in the signal path.

As an example of frequency selection in the i-f and r-f sections, assume that an output frequency of 395.5 mc is desired. Assume this to be channel number 10. Turn the knurled disks opposite channel 10 in the preset panel to 395.5 as indicated on the dials. Turn the CHANNEL SELECTOR switch to channel 10. The frequency selector motor starts and produces a mechanical output which tunes the transmitter as follows: (Note in figure 4–6 that frequencies will be selected as follows in the various sections):

Main Oscillator—41.1111 mc
Frequency Multiplier-Amplifier—370 mc
1-mc injection—23.006 mc
0.1-mc injection—2.494 mc
Exciter, Driver and Power Amplifier—395.5 mc

STAGE	FREQUENCY RANGE	TUNING INCREMENTS
Main Oscillator	31.1111–45 mc	Tuned in 18 steps.
Frequency Multiplier-Amplifier	200–370 mc	Tuned in 18 steps of 10 mc each.
1-mc injection (V404)	18–27 mc*	Tuned in 10 steps of 1 mc each.
0.1 mc injection (V401)	2.0–2.9 mc**	Tuned in 10 steps of 0.1 mc each.
I-f Amplifiers (V402, V403, V405)	20–29.9 mc	Tuned in 100 steps of 0.1 mc each.
Exciter and Driver (see note 1)	220–399.9 mc	Tuned in 180 steps of 1 mc each.
Power Amplifier (See notes 1 and 2)	220–399.9 mc	Tuned in 180 steps of 1 mc each.

*Actual frequency 6 kc (.006 mc) above frequency shown.
**Actual frequency 6 kc (.006 mc) below frequency shown.

Note 1. Note that although the frequency range of the Transmitter is specified as being from 225.0 to 399.9 mc, the frequency generating system employed is capable of providing 50 additional frequencies in the range 220.0 to 224.9 mc.

Note 2. After Serial No. 1000 (approx.) the power amplifier is tuned in 360 ½-mc steps.

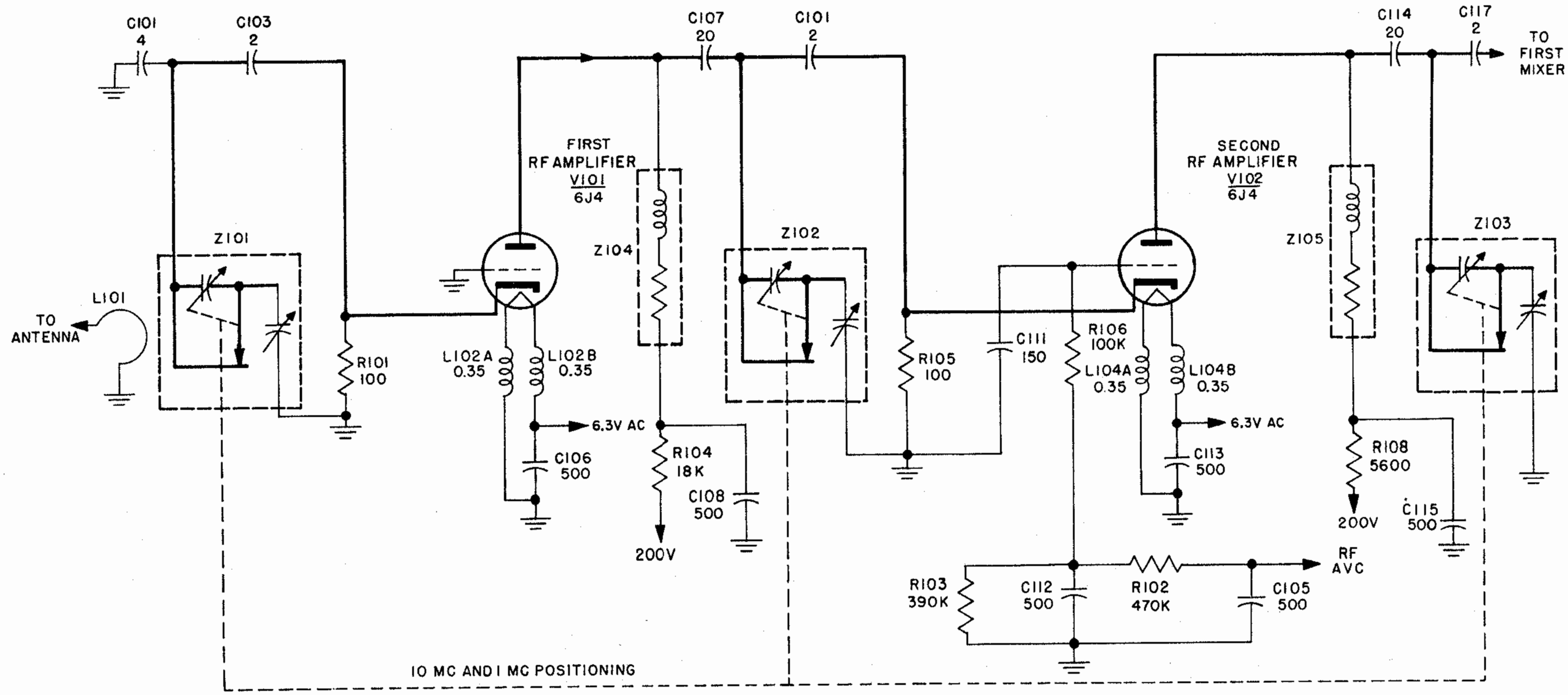


Figure 4–7. Radio Receiver R-278B/GR, Multi-channel Receiver Section, R-F Amplifier, Simplified Schematic Diagram

(10) TRANSMITTER TUNING.—The frequency-selector section has three rotary shafts which select the proper crystals and tune various circuits to produce the desired operating frequency. These output shafts are called the 10-mc, the 1-mc and the 0.1-mc shafts. The 10-mc shaft rotates in 18 incremental steps, each increment representing 10 mc. The 1-mc shaft rotates in ten incremental steps, each step representing 1 mc. The 0.1-mc shaft rotates in ten incremental steps, each step representing 0.1 mc. By combining the outputs of these shafts and applying the mechanical sum to the tuning of the i-f and r-f circuits, any one of 1750 frequencies in the range of 225.0 to 399.9 mc may be selected as explained below.

The 10-mc injection system (main oscillator and frequency multiplier-amplifier sections) is tuned in 18 10-mc steps by the 10-mc output shaft which also operates the main oscillator crystal-selector switch to select one of 18 crystals.

The 1-mc injection system (V404) is tuned in ten 1-mc steps by the 1-mc output shaft which also operates the crystal-selector switch.

The 0.1-mc injection system (V402) is tuned in ten 0.1-mc steps by the 0.1-mc shaft which also operates the crystal-selector switch to select the proper 0.1-mc crystal.

Amplifiers V401, V403, and V405 are tuned by the 1-mc and 0.1-mc shafts, the rotations of which are combined in a differential tuning mechanism to produce one hundred 0.1-mc steps.

The exciter and driver are tuned in 180 steps of 1 mc each by the 10-mc shaft (18 positions) and the 1-mc shaft (10 positions) whose rotary motions are combined in a differential mechanism to produce 180 rotational positions.

The power amplifier is not tuned directly from the auto-positioner output shafts as are the other subassemblies. Instead, it is tuned by a servo amplifier which takes its information from a resistance-type servo bridge. This bridge is set up by the rotary switches driven by the 10-mc and the 1-mc shafts. On serial numbers 1000 and later (approx.), 0.5-mc information is also set up on this bridge. Thus, for serial numbers 1 to 1000, 180 steps of 1 mc each are provided, whereas on equipments having serial numbers above 1000, 360 steps of 0.5 mc each are provided.

d. MODULATOR-POWER SUPPLY MD-129A/-GR.—Modulator-Power Supply MD-129A/GR supplies audio frequency signals, amplified to the necessary levels to modulate the power amplifier. Two audio frequency responses are available, and either one may be selected by the operation of the BANDWIDTH switch on the front panel of the Modulator-Power Supply. In the NORMAL position, the response is from 400 to 3000 cps, while in the BROAD position the response is flat within four db from 200 to 20,000 cps.

In addition to voice modulation of the transmitter, an audio oscillator producing a 1020-cps signal provides tone modulation for MCW transmission.

All d-c power for both the Modulator and Transmitter units, in addition to the a-c filament power for the Modulator, is supplied by the power supply in Modulator-Power Supply MD-129A/GR. Filament power for the Transmitter is taken from transformers incorporated within that unit.

4-2. FUNCTIONAL SECTIONS.

a. RADIO RECEIVER R-278B/GR.

(1) MULTI-CHANNEL RECEIVER SECTION.

(*a*) GENERAL.—The functional block diagram of the Receiver is shown in figure 4-3. As shown in this figure, the multi-channel receiver section includes an r-f amplifier, three injection circuits, three stages of i-f amplification, detectors, noise limiters, cathode followers, a carrier-operated relay and squelch circuit, and audio amplifier and audio signal control circuits. These circuits are described in detail in the following paragraphs.

(*b*) R-F AMPLIFIER.—A simplified schematic diagram of the r-f amplifier is shown in figure 4-7. It consists of two grounded grid amplifiers V101 and V102 which operate in conjunction with three identical r-f tuner circuits Z101, Z102, and Z103. The construction of one of these tuners is shown in figure 4-8.

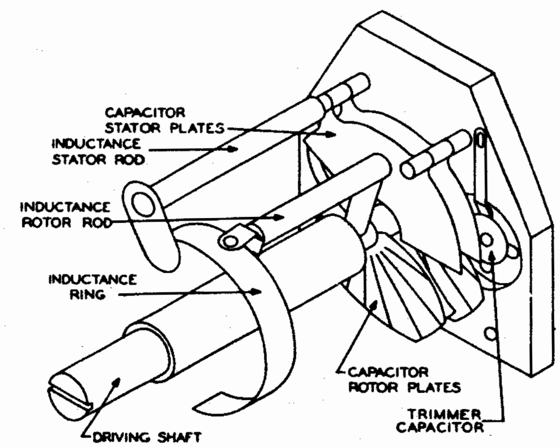


Figure 4-8. Radio Receiver R-278B/GR, R-F Amplifier, R-F Tuner Construction

The r-f tuner consists of a variable capacitor and variable inductor which rotate simultaneously so that in 180 degrees of rotation the resonant frequency changes linearly 180 mc at a rate of 1 mc per degree. The variable capacitor consists of two stator plates and three rotor plates, the front and rear of which are radially slotted for the purpose of alignment adjustments. The inductive loop consists of the inductance stator rod, a ring segment and the inductance rotor rod. The three r-f tuners are geared together and driven through a mechanical differential from the 10-mc and 1-mc autopositioner outputs.

A r-f signal (225.0 to 399.9 mc) enters the Receiver at the antenna terminal and is conducted by type RG-58/U coaxial line through low-pass filter Z1202 to the r-f amplifier input circuit where it is link coupled into the first r-f tuned circuit. The signal is amplified in the two grounded-grid, shunt-fed amplifiers (V101 and V102) which employ the special r-f tuners for interstage coupling. Avc voltage is impressed on the grid of V102. Bifilar chokes in the filament leads and inductive impedances Z104 and Z105 in the plate shunt-fed circuit isolate the power circuits from radio-frequency voltages. The r-f signal is then fed to the first mixer through a connection between the r-f amplifier and the first i-f amplifier.

(*c*) FIRST INJECTION SYSTEM.—The first injection system is contained in two circuits designated as the main-oscillator circuit and the frequency multiplier-amplifier circuit. A simplified schematic diagram of the main-oscillator circuit is shown in figure 4–9. The main oscillator employs a Butler

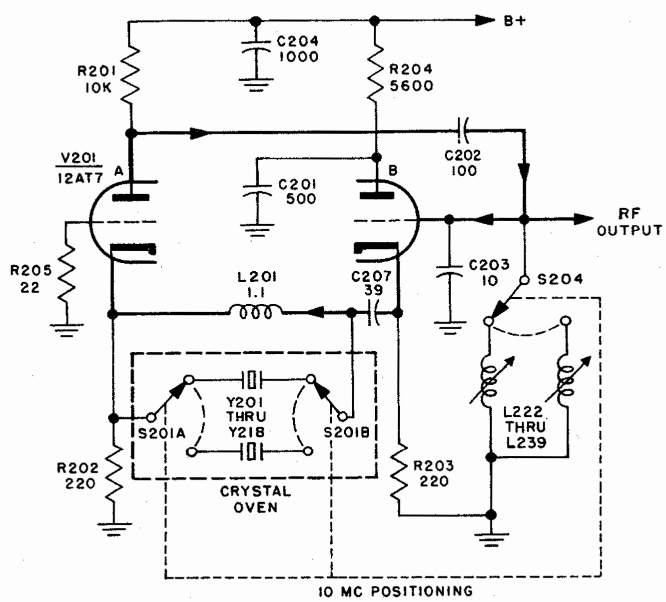


Figure 4–9. Radio Receiver R-278B/GR, First Injection System, Main Oscillator Circuit, Simplified Schematic Diagram

circuit consisting of 18 type CR-32/U crystals and a crystal switch within a temperature-controlled oven, plus oscillator tube V201 and other circuit elements. Tube V201 comprises a grounded grid amplifier followed by a cathode follower which in turn couples back into the grounded grid stage through the crystal.

To understand the operation of this oscillator, consider a random positive pulse appearing at the cathode of grounded grid amplifier V201A. Since the grid is grounded through a 22-ohm resistor, a rise in cathode voltage causes a decrease in plate current and therefore an increase in plate voltage. This positive pulse is coupled to the grid of cathode follower V201B. The cathode voltage follows the grid voltage so that the positive pulse is coupled back to the cathode of the grounded grid amplifier through the crystal. The crystal presents a low impedance path only at series resonance. Thus, oscillations are generated by the stage and sustained in the zero-phase-shift feedback loop. The plate load of the grounded grid amplifier is tuned circuit C203 in parallel with one of 18 inductances selected by the 10-mc autopositioner output. The frequency of oscillation can be adjusted over a small range by adjusting the tuning of the plate circuit. This circuit is normally adjusted so that the frequency of oscillation is precisely as desired, thereby eliminating any inaccuracy in the frequency of the crystal unit. Inductance L201 resonates with the stray circuit capacities at approximately 30 mc. The oscillator signal is fed to V301 through a capacitor and a soldered connection connecting the two units.

The crystal is maintained at a constant temperature by the thermostatically controlled crystal oven. The crystal oven operates on 115 volts a-c and includes two heater elements and two thermostats. One heater element has a rating of approximately 100 watts and is employed to bring the oven to operating temperature rapidly when the equipment is first turned on. The second heater element has a rating of approximately 20 watts and operates intermittently to maintain the oven at the proper temperature (75 degrees C ±5 degrees C).

A simplified schematic diagram of the frequency multiplier-amplifier circuit is shown in figure 4–10. This circuit consists of V301 and V302, a tapered toroidal coil assembly in the plate circuit of the first stage and an r-f tuner, similar to that shown in figure 4–8, in the plate circuit of the second stage. The tapered toroidal coil is a variable inductor made up of 18 turns of wire. A rotary contact progressively adds a turn of wire (from a shorted condition) as the Receiver frequency is changed in ten-megacycle steps from the highest to lowest frequency.

The oscillator signal (26.67 to 38.89 mc, see figure 4–2) is received on the grid of V301. The tapered toroidal coil in the plate circuit is tuned to twice the oscillator frequency for the six lowest injection frequencies and to three times the oscillator frequency for the twelve highest injection frequencies. This signal is fed to the grid of V302. The signal frequency is tripled in this stage as the r-f tuner in the plate circuit is tuned to three times the input to the stage.

The first injection amplifier is a three-stage grounded-grid, shunt-fed amplifier employing V303, V304, and V305 and three special r-f tuners Z305, Z307, and Z309 for interstage coupling. The four r-f tuners of the frequency multiplier-amplifier differ from those used in the r-f amplifier as they have differently shaped capacitor rotor plates and are tuned to a lower frequency. The injection signal (180 to 350 mc) is amplified in this three-stage amplifier and fed to the cathode of the first mixer. Bifilar chokes in the filament leads and inductive impedances Z304, Z306, and Z308 in the plate shunt feed isolate the power

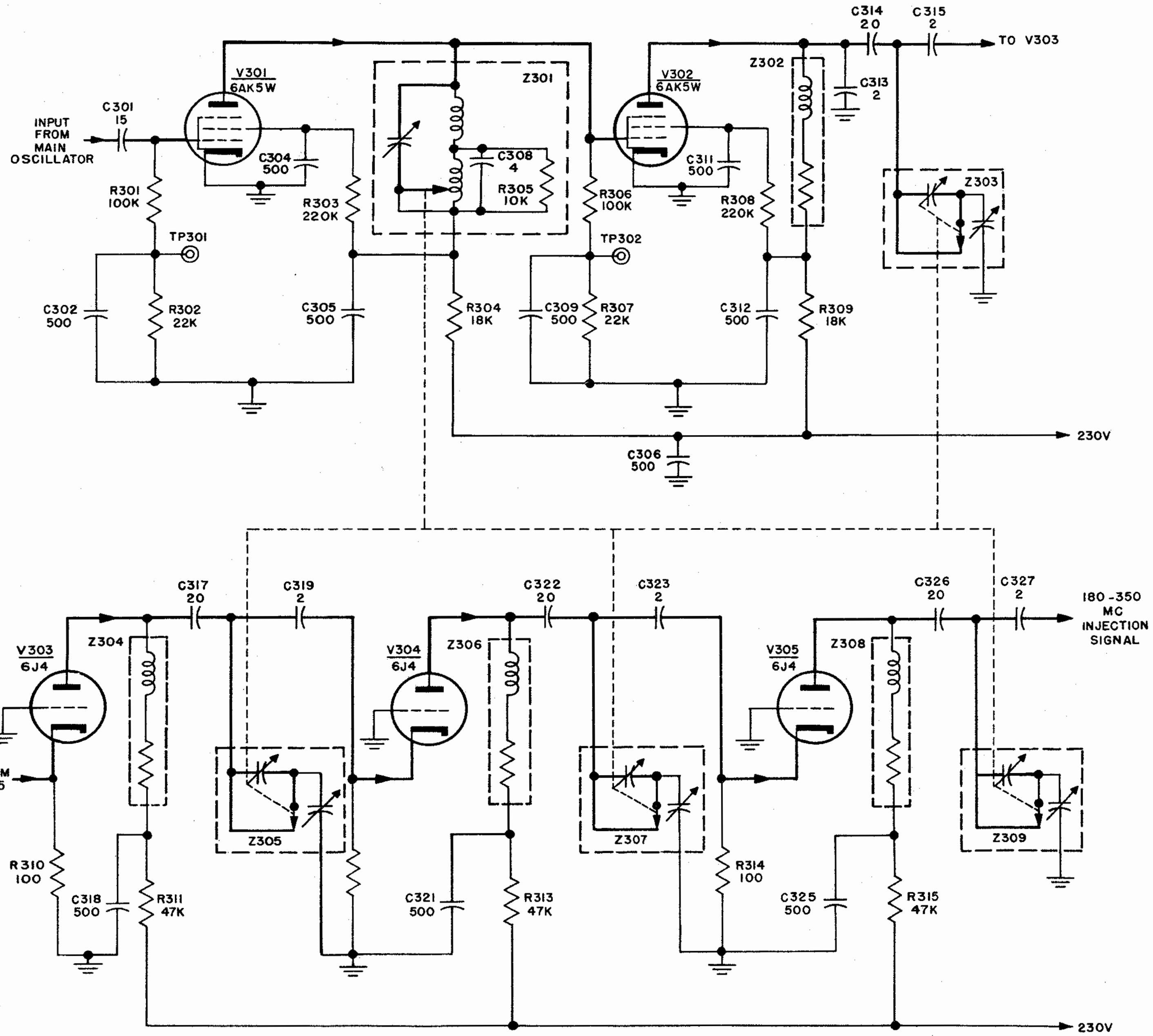


Figure 4–10. Radio Receiver R-278B/GR, First Injection System, Frequency Multiplier-Amplifier Circuit, Simplified Schematic Diagram

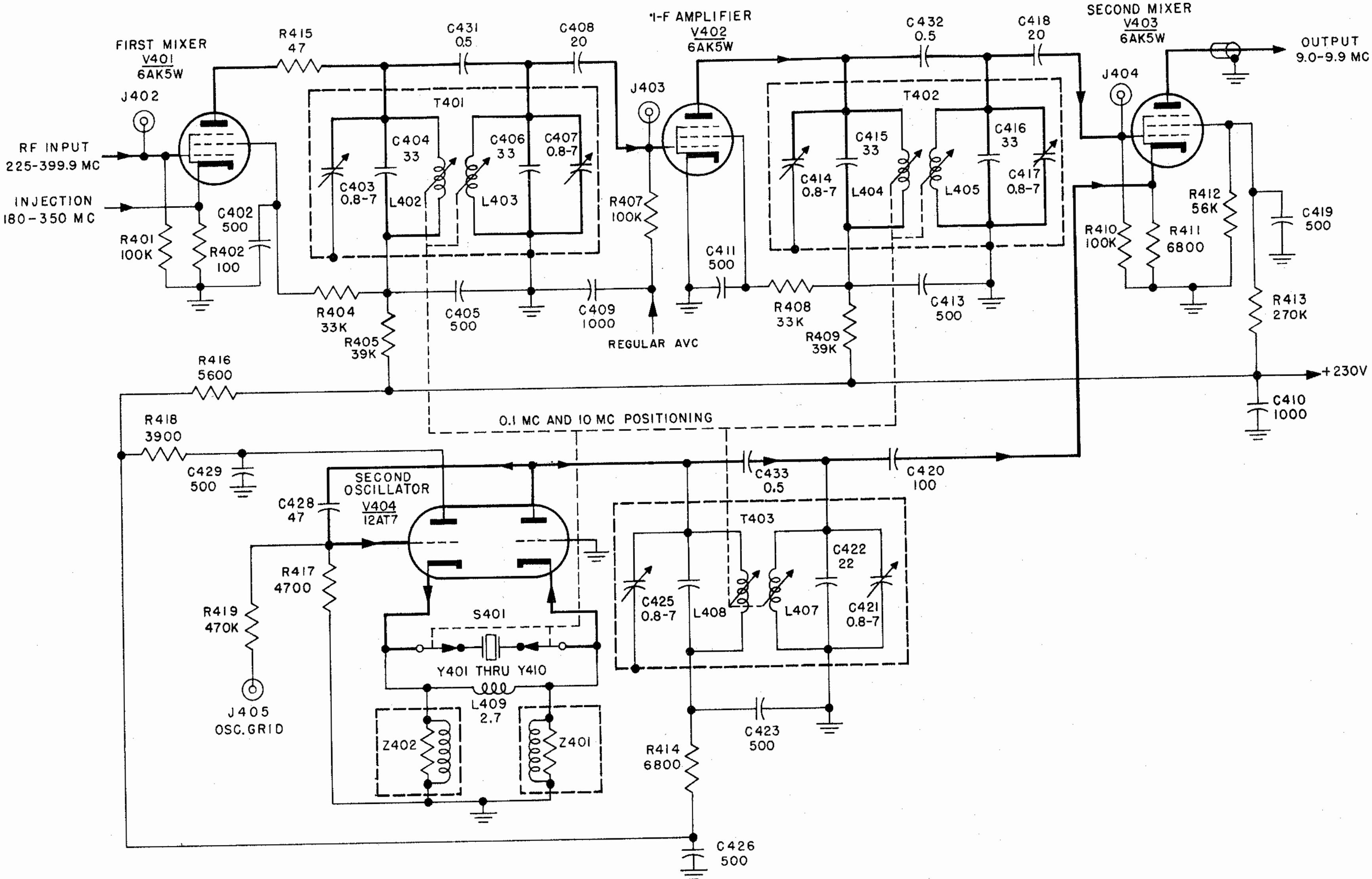


Figure 4–11. Radio Receiver R-278B/GR, Multi-channel Receiver Section, First I-F Amplifier, Simplified Schematic Diagram

circuits from radio frequency energy. All stages in the frequency multiplier-amplifier are tuned from the output of the 10-mc autopositioner through a series of gears. Likewise, the switching in the main oscillator is done from the output of the 10-mc autopositioner.

(*d*) FIRST I-F AMPLIFIER.

1. GENERAL.—A simplified schematic diagram of the first i-f amplifier is shown in figure 4–11. This circuit includes the first mixer, the first i-f amplifier stage, the second oscillator stage, and the second mixer. Each of these circuits is described in the following paragraphs.

2. FIRST MIXER.—As shown in figure 4–11, first mixer V401 combines the r-f signal (225.0 to 399.9 mc) received on the grid with the first injection signal (180 to 350 mc) received on the cathode to produce a first intermediate frequency in the range of 40.0 to 49.9 mc. The output transformer is permeability tuned as explained below.

3. FIRST I-F AMPLIFIER STAGE.—As shown in figure 4–11, this stage consists of V402 and two interstage i-f transformers. This circuit receives the 40 to 49.9 mc i-f signal, amplifies it and feeds it to the grid of second mixer V403. The gain of the stage is controlled by the avc circuit. Because the r-f channels are spaced at 0.1-mc intervals and the injection system is tunable at 10-mc intervals, there are 100 possible first intermediate frequencies. The first i-f interstage transformers, T401 and T402, are therefore made tunable in 100 one-tenth megacycle increments by means of a differential tuning mechanism which includes a tuning rack that is cam driven from the 0.1-mc and 1.0-mc autopositioner outputs (see figure 4–26). The interstage transformers are permeability tuned by powdered iron cores mounted on the rack. Cams on a fixed-bearing shaft, driven from the 0.1-mc autopositioner output, raise or lower a floating shaft driven from the 1.0-mc autopositioner output. Cams on this floating shaft raise or lower the tuning rack. Since each set of cams adjusts the rack in ten steps, the combination of the action of the two sets gives 100 positions of the tuning cores. Threaded studs on the cores make it possible to adjust each core independently during the alignment procedure. Trimmer capacitors across the tuned circuits are provided so that the most linear part of the tuning curve can be selected to give the best tracking.

4. SECOND OSCILLATOR.—As shown in figure 4–11, the second oscillator (or second injection system) is essentially V404 operating in a Butler type oscillator circuit. This circuit employs one of ten type CR-23/U crystal units operating at frequencies from 31.00 to 40.00 mc. The theory of operation of a Butler oscillator circuit is explained in paragraph 4-2*a*(1)(*c*). Selection of the correct crystal unit and tuning of the plate transformer is done by the 1-mc autopositioner output. An injection frequency at each megacycle from 31 to 40 mc is provided. The second injection signal is fed to the cathode of second mixer V403.

5. SECOND MIXER.—The second mixer, consisting of V403 (type 6AK5W), combines the first i-f signal (40.0 to 49.9 mc) received on the grid with the second injection signal (31.0 to 40.0 mc) to produce a second intermediate frequency of 9.0 to 9.9 mc.

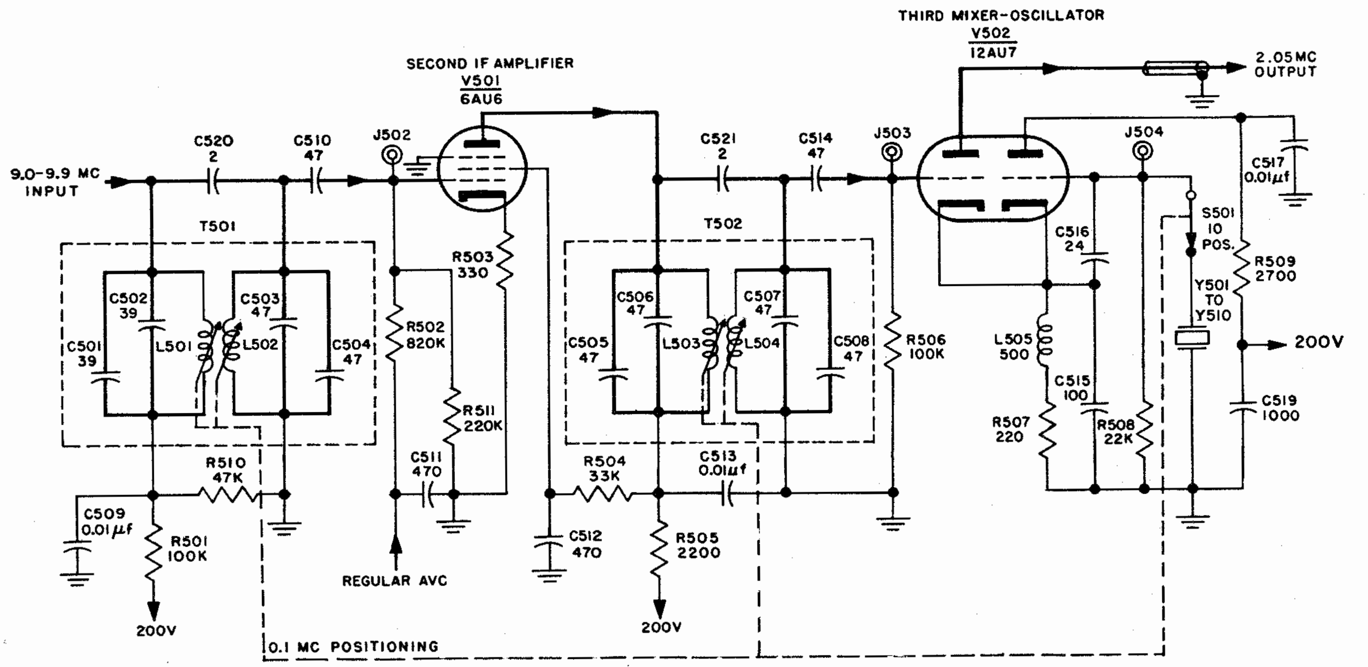


Figure 4–12. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Second I-F Amplifier, Simplified Schematic Diagram

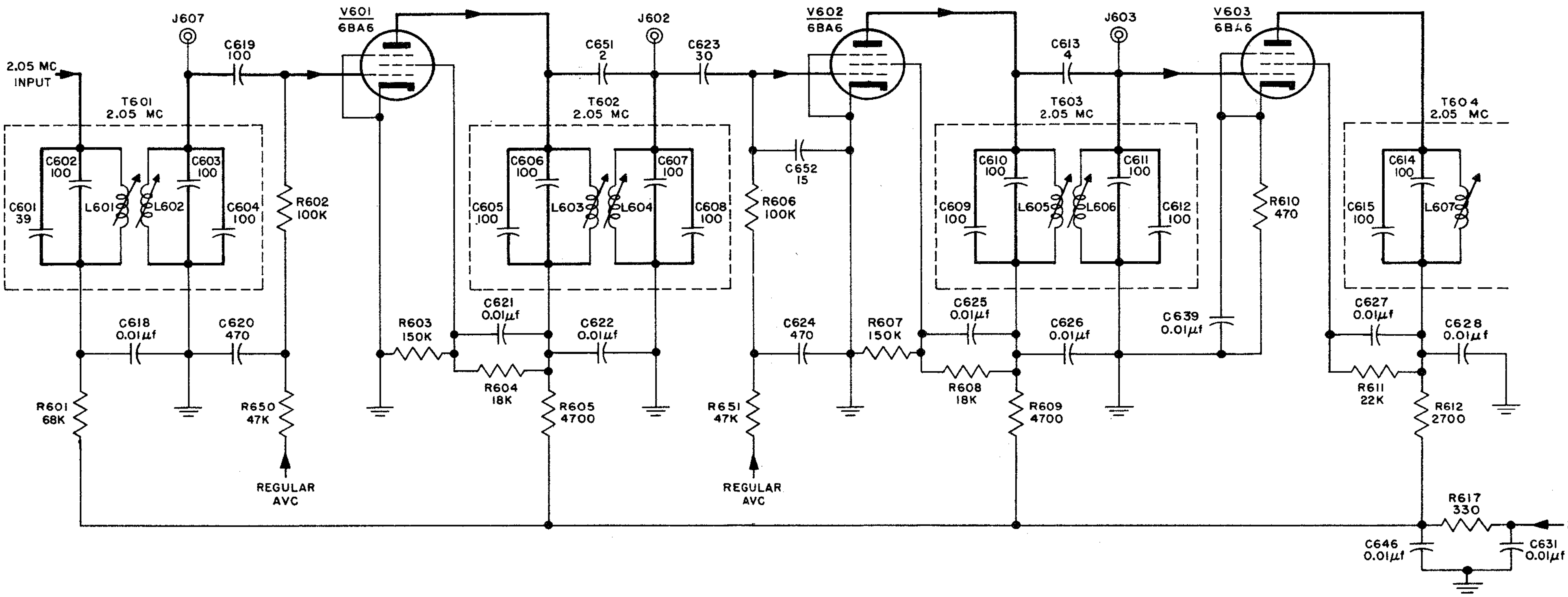


Figure 4–13. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Third I-F Amplifier Stage, Simplified Schematic Diagram

(*e*) SECOND I-F AMPLIFIER.—Figure 4–12 is a simplified schematic diagram showing the second i-f amplifier. This amplifier consists of the second i-f stage and the third oscillator and mixer circuit. The amplifier consists of V501 and tuned circuits. The second i-f signal (9.0 to 9.9 mc) is conducted from the plate of the second mixer to the primary of T501 over type RG-58/U coaxial line and thence to the grid of V501 where it is amplified and fed to the grid of the third mixer. The stage is avc controlled and the interstage transformers are permeability tuned by a cam-driven tuning rack operating from the 0.1-mc autopositioner output.

The third oscillator-mixer consists of V502 and one of ten type CR-18/U crystal units. A Pierce type of oscillator is used to generate one of ten third injection signals in the frequency range 6.95 to 7.85 mc. This signal is impressed on the cathode of the third mixer. The correct crystal unit is selected by the 0.1-mc autopositioner output. The second i-f signal is received on the grid of the third mixer. These signals are combined to produce a third intermediate frequency of 2.05 mc, which is conducted over type RG-58/U coaxial line to T601.

(*f*) THIRD I-F AMPLIFIER.

1. GENERAL.—The third i-f amplifier contains the following circuits: third i-f amplifier, audio and avc detectors, audio and direction finder amplifiers, noise limiters, carrier operated relay and squelch circuit, and avc gate. These circuits are described in the following paragraphs.

2. THIRD I-F AMPLIFIER STAGE.—A simplified schematic diagram of the third i-f amplifier stage is shown in figure 4–13. The third i-f signal is amplified in the three-stage third i-f amplifier consisting of V601, V602, V603, and four interstage i-f transformers tuned to 2.05 mc. The first i-f transformer is overcoupled and the last three are undercoupled. This is done to give the desired band pass characteristics. The first two stages, employing V601 and V602 are avc controlled. The signal is then coupled to output transformer T604 whose secondary is in the audio and avc detector circuits.

3. AUDIO DETECTOR AND NOISE LIMITERS.—A simplified schematic diagram of the audio detector and noise limiters is shown in figure 4–14. The audio detector and noise limiters employ the following tubes: audio detector V604A, series noise limiter V605A, shunt noise limiter V605B, and noise cancellation detector V608B. The diode detector circuit is a conventional circuit in which V604A operates as a rectifier. The diode load consists of R613 and R614 in series, by-passed by C629. The output of the detector is a negative voltage (normally about −8 volts with respect to cathode of V604A) upon which is superimposed the audio modulation signal.

The series diode limiter circuit employs diode element V605A in a circuit that limits the audio output signal to approximately 40 percent upward modulation. Since impulse noises of the type encountered at uhf consist of very sharp pulses of several hundred

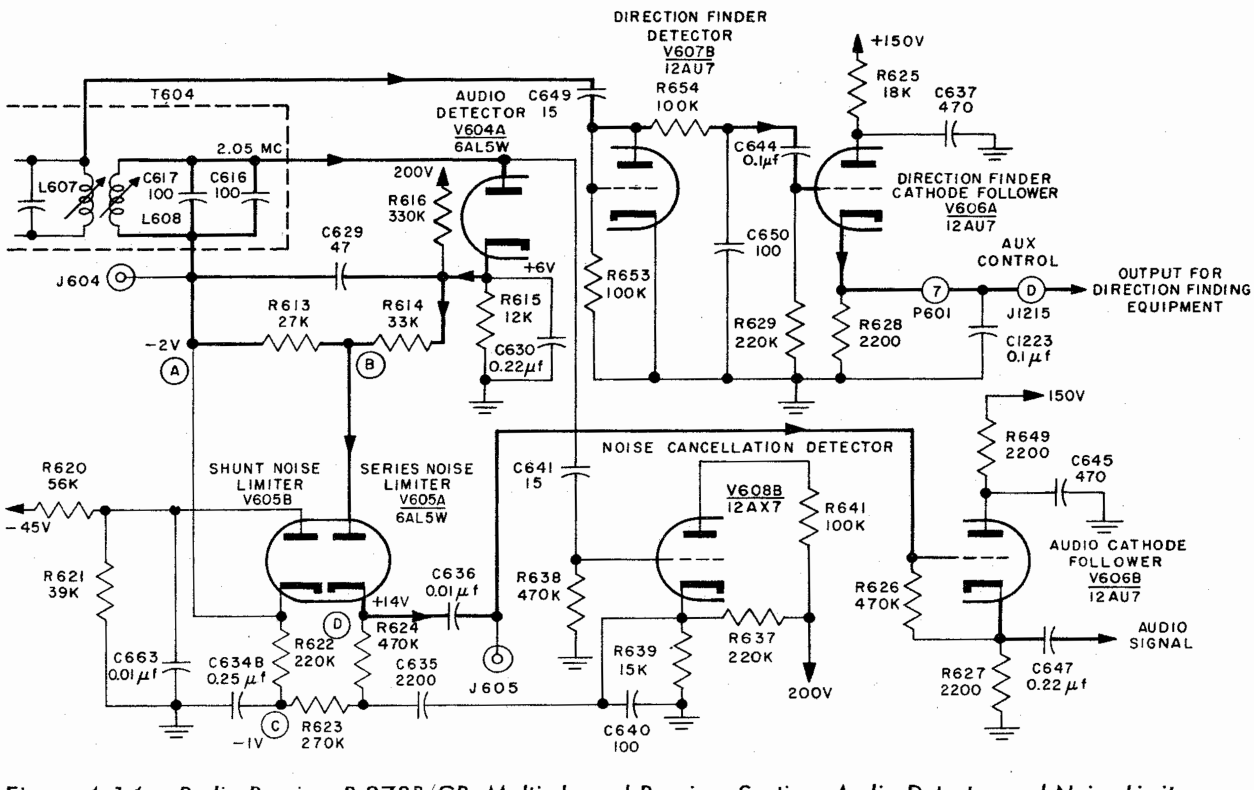


Figure 4–14. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Audio Detector and Noise Limiters, Simplified Schematic Diagram

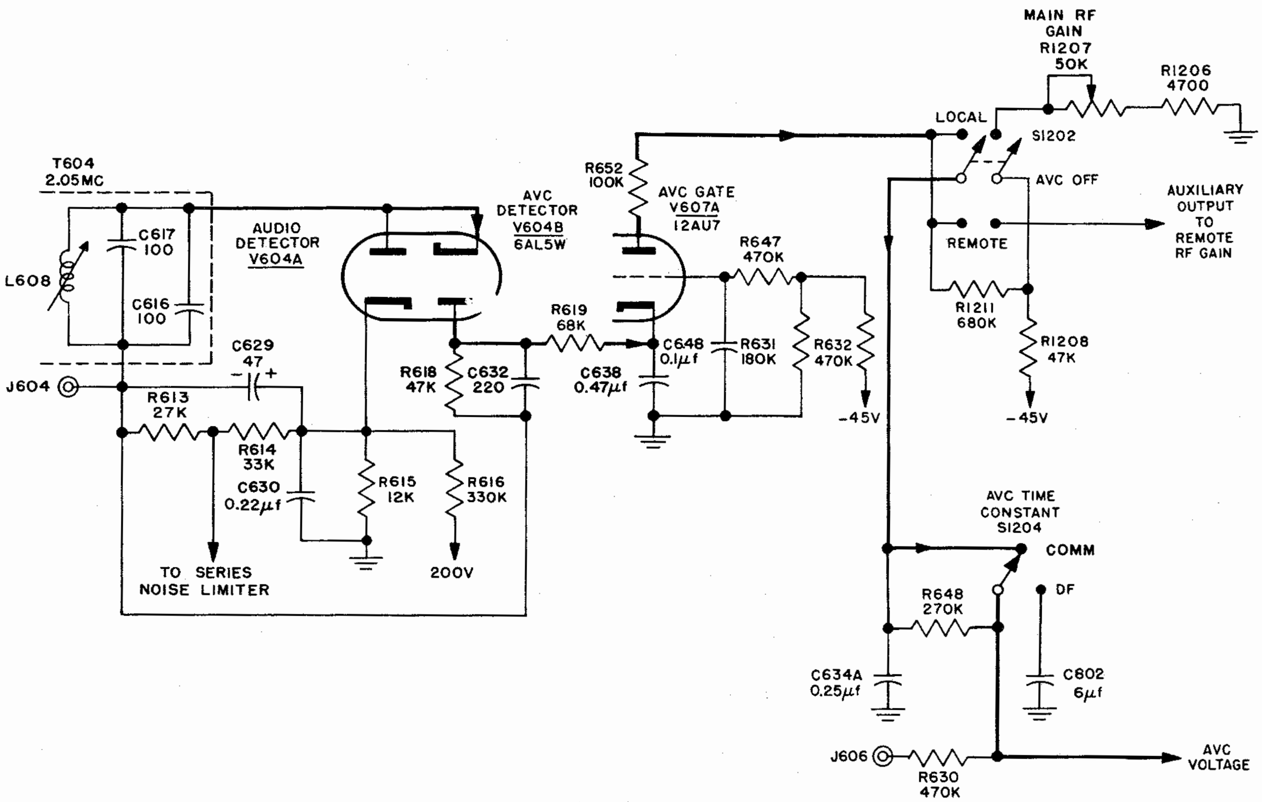


Figure 4-15. Radio Receiver R-278B/GR, Multi-channel Receiver Section, AVC Detectors and AVC Gate, Simplified Schematic Diagram

percent modulation, this limiting action greatly reduces the amount of noise energy transmitted to the audio amplifier circuits without adversely affecting the intelligibility of voice signals. In the circuit employed, the plate of the diode is connected to the junction of R613 and R614. These resistors act as a voltage divider. R622 and C634B act as a filter to establish a reference potential. R623 and R624 in series act as a diode load resistor. The output audio signal is developed across these two resistors.

The operation of this circuit can best be understood by assuming V605A to be an ideal diode; that is, perfectly conducting in one direction and completely non-conducting in the other direction of current flow. With a d-c developed bias of about −2 volts at the output of the detector (point A in figure 4–14), the current flow through the circuit results in d-c potentials at points B, C, and D. Note that point C is bypassed to ground so that its instantaneous potential to ground is not affected by the modulation signal.

When the audio modulation is superimposed on the developed bias, the audio signal is transmitted through the diode from point B to point D, provided the instantaneous potential of point B does not become more negative than that of point C. If the latter occurs, the electronic conduction of the diode will be cut off and point D will remain at the potential of point C until conduction is re-established. From this it can be seen that the upward modulation of the signal transmitted through the noise limiter circuit is limited to about 40 percent modulation (2 volts peak audio signal across the diode with respect to −5 volts d-c bias developed across R614). Downward modulation is not affected by this circuit.

The amount of noise energy remaining in the output of the series diode limiter circuit is further reduced by the introduction of noise pulses of about equal amplitude but of opposite polarity to cause noise cancellation. These pulses are generated by noise cancellation detector V608B. This tube operates as an infinite impedance type of detector in which the i-f signal is applied to the grid of the tube and the detected output appears at the cathode. In this application, the tube is cathode-biased by means of voltage divider R637 and R639 in series to about +15 volts so that only signals exceeding about 100 percent upward modulation are detected. Noise pulses that appear as positive pulses in the cathode circuit are coupled back into the output of the series diode limiter circuit by C635.

A shunt type limiter has also been included in this Receiver for the purpose of protecting the avc and squelch circuits from the effects of noise pulses. In this circuit, diode element V605B is biased by means of voltage divider R620 and R621 to about −15 volts. When an i-f signal of peak amplitude greater than 15 volts is applied to this circuit, the diode conducts and effectively connects a very low impedance across the secondary of T604, thus limiting the i-f voltage that can appear across it. This reduces the effect of noise impulses that would ordinarily generate appreciable avc voltage, thus reducing the sensitivity of the Receiver to desired signals. Since the carrier-operated relay control voltage is also developed by the avc detector-amplifier, this limiter also reduces the tendency of the silencer circuit to open in the presence of noise impulses.

4. AUDIO CATHODE FOLLOWER.—The audio cathode follower, consisting of V606B, is shown in figure 4–14. The audio output of the noise limiter circuit is coupled to the grid of V606B. The output of this stage is developed across cathode resistor R627 and is transmitted through shielded wire to the QUIETING and FREQUENCY RESPONSE controls.

5. DIRECTION FINDER CATHODE FOLLOWER.—The direction finder cathode follower circuit is shown in figure 4–14. By means of this circuit, Radio Receiver R-278B/GR can be used in a direction finding system such as Radio Direction Finder AN/CRD-6.

Referring to figure 4–14, the third i-f signal is detected by direction finder detector V607B and the audio signal developed by this detector is coupled to the grid of V606A by capacitor C644. The output of this cathode follower stage is developed across cathode resistor R628 and is transmitted to pin D of the AUX CONTROL connector.

Normally, Radio Set AN/GRC-27A is not used in direction finder systems aboard ship. Hence, this feature is not described in detail.

6. AVC DETECTORS AND AVC GATE.—A simplified schematic diagram of the AVC circuit is shown in figure 4–15. This circuit includes avc detector V604 and avc gate V607A with its associated circuit. Three controls on the front panel are associated with the avc circuit: AVC TIME CONSTANT switch, MAIN RF GAIN and AVC ON-OFF switch (labelled LOCAL-AVC OFF-REMOTE). The purpose of the avc detectors is to maintain the output of the receiver relatively constant for wide variations of signal input level. The purpose of the avc gate is to provide an avc voltage delay so that weak signals can come through with maximum amplification.

The two sections of the diode detector (V604A and B) with its accompanying circuit, form a voltage doubling circuit for the avc voltage. The cathode potential of V604A is about +6 volts due to bleeder current from the 200-volt supply through R616 and R615. This voltage is sufficient to keep V607A cut off for low values of carrier signal strength. The gain of the r-f and i-f amplifiers is determined by the setting of RF GAIN control R1207. As the carrier level is increased, audio detector V604A (which is also a part of the avc circuit) develops an increasing negative voltage across its load (R613 and R614 paralleled by C629). Likewise, avc detector V604B develops an increasing negative voltage across its load (R618 paralleled by C632). Since these two sections of the diode conduct on opposite halves of the cycle, the voltages developed across the two loads are in series or additive. The combined voltage appears at the plate of V604B and the cathode of avc gate V607A. The grid of V607A is at about −12 volts due to −45-volt bleeder current through R632 and R631. When sufficient input signal is applied, the cathode of V607A becomes sufficiently negative to cause the tube to conduct. The stronger the carrier signal, the more negative is the cathode of V607A, and the more it conducts. The voltage drop across the plate load causes the output avc voltage to become more negative, thereby decreasing the gain of the r-f and i-f amplifiers.

Two time constants are provided by the AVC TIME CONSTANT switch: COMM (communication) position, 0.1 second and DF (direction finder) position, 2 second. With the MAIN RF GAIN set to maximum, avc voltage varies from about −2 to −8 volts, depending on carrier signal strength.

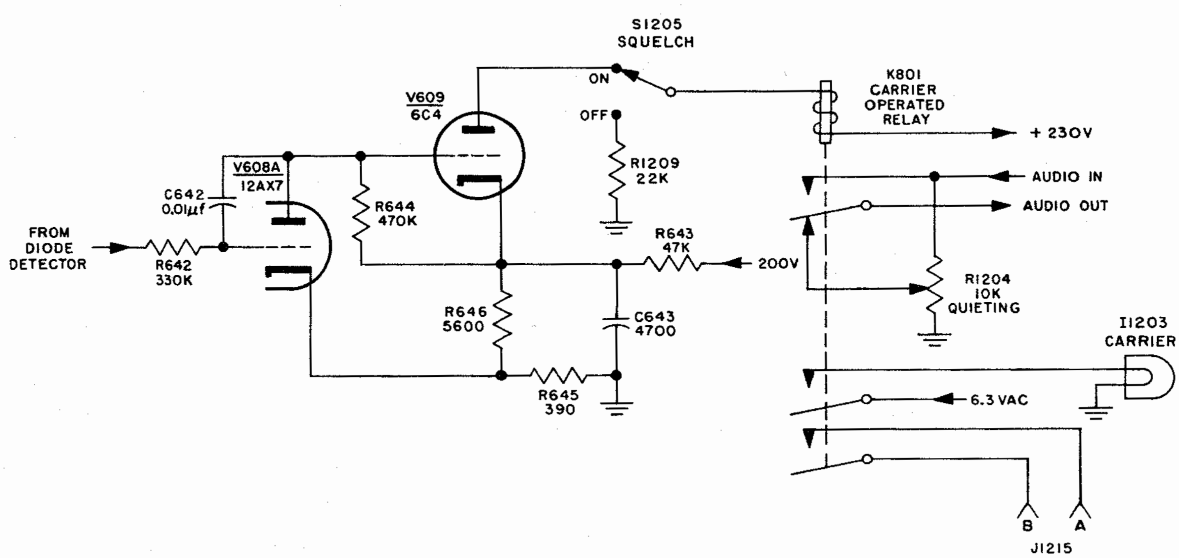


Figure 4–16. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Carrier-Operated Relay and Squelch Circuit, Simplified Schematic Diagram

7. CARRIER-OPERATED RELAY AND SQUELCH CIRCUIT.—The multi-channel receiver is provided with a carrier-operated relay which is actuated by a two stage d-c amplifier that receives its control signal from the audio detector circuit. The circuits are designed so that the relay is actuated whenever a carrier signal of sufficient amplitude (as determined by the setting of the MAIN R-F GAIN control) is received. The carrier-operated relay is provided with three sets of contacts as follows: s.p.s.t. contacts for operation of external equipment, s.p.s.t. contacts for operation of the MAIN CARRIER indicator lamp, and s.p.d.t. contacts for operation of the audio squelch (silencing circuit).

As shown in figure 4–16, the carrier-operated relay circuit includes V608A, V609, and carrier-operated relay K801. The SQUELCH ON-OFF switch and the QUIETING control, located on the front panel of the Receiver, are associated with the circuit.

A negative d-c voltage that is superimposed by an audio frequency is taken from the audio detector load and impressed on the grid of V608A. Capacitor C642 is an audio bypass capacitor. The two stages of the circuit act as a one-kick multivibrator to assure positive activation of the carrier-operated relay.

To follow the operation of the circuit, assume that a carrier signal is received after a period of no carrier input. With no carrier input:

(1) diode detector tube V604 is not conducting, so there is no voltage developed across diode load R613 (see figure 4–14),

(2) the voltage impressed on the grid of V608A is about 6 volts as determined by bleeder R616 and R615, and

(3) V608A is conducting, causing a voltage drop across R644 that makes the grid of V609 negative and V609 is virtually cut-off because of this biasing voltage.

Now consider the reception of a carrier signal:

(1) the grid of V608A becomes negative because of the rectified voltage developed across the diode load,

(2) current through V608A decreases,

(3) tube V609 begins to conduct because its grid is allowed to go positive,

(4) cathode current of V609 flowing through R645 biases V608A even more (this action being regenerative, V608A is quickly cut off), and

(5) V609 conducts to energize carrier-operated relay K801.

When the carrier-operated relay is activated, the MAIN CARRIER indicator is illuminated, the QUIETING control is removed from the audio amplifier circuit, and facilities are provided for the operation of external equipment through pins on the AUX OUTPUT connector. With the SQUELCH switch in the ON position, operation of the carrier-operated relay is as described above. In the OFF position, the carrier-operated relay remains actuated at all times.

(*g*) AUDIO AMPLIFIER AND AUDIO SIGNAL CONTROL CIRCUITS.

1. GENERAL.—A simplified schematic diagram of the audio amplifier and audio signal controls is shown in figure 4–17. Refer to figure 4–3 for the function of these circuits in the multi-channel receiver section. As shown in figure 4–17, the audio amplifier circuit includes two stage lamplifier V801 and push-pull amplifier V802 and V803. The audio signal controls consist of QUIETING control R1204, carrier-operated relay K801, the audio bandwidth filter, and AUDIO GAIN control R1205.

2. AUDIO SIGNAL CONTROLS.—The audio signal developed at the cathode of V606B passes through several audio control circuits before being applied to the grid of V801. The purpose of the QUIETING control is to attenuate the Receiver noise output any desired amount at the time no carrier signal is present. When a carrier signal of sufficient amplitude (as determined by the setting of the MAIN RF GAIN control) is received, the carrier-operated relay operates its contacts so that the audio signal bypasses the QUIETING control, goes through the audio bandwidth filter to the grid of V801.

The audio FREQUENCY RESPONSE switch has two positions: BROAD and NARROW. In the BROAD position, capacitor C1203 is switched into the circuit so that the 200 to 20,000 cps flat response characteristic of the Receiver is employed. In the NARROW position, the audio filter is switched into the circuit so that the audio frequency response is limited to a narrow audio band.

3. AUDIO AMPLIFIER.—The audio signal from the bandwidth control is amplified in two-stage amplifier V801A and V801B and impressed across the primary of transformer T801. Two of the secondary windings furnish a low level output for operation of external equipment. This output appears at the LOCAL CONTROL and AUX CONTROL output jacks. These two windings are ordinarily connected in series. The junction point (used as a center tap) may be connected directly to ground or the two leads may be individually bypassed to ground. The latter arrangement is provided for use with the "double simplex technique" in which a d-c control signal is carried over the lines used for the audio signal. The other secondary winding of T801 applies the signal through AUDIO GAIN control R1205 to the grids of the push-pull amplifier stage consisting of V802 and V803. The output of the push-pull amplifier appears across output transformer T802. A maximum of three watts output is available at PHONES jack J1213 and at pins G and H of the AUX CONTROL.

(2) POWER SUPPLY.

(*a*) GENERAL.—The self-contained power supply of Radio Receiver R-278B/GR supplies power to the multi-channel receiver section, audio amplifier,

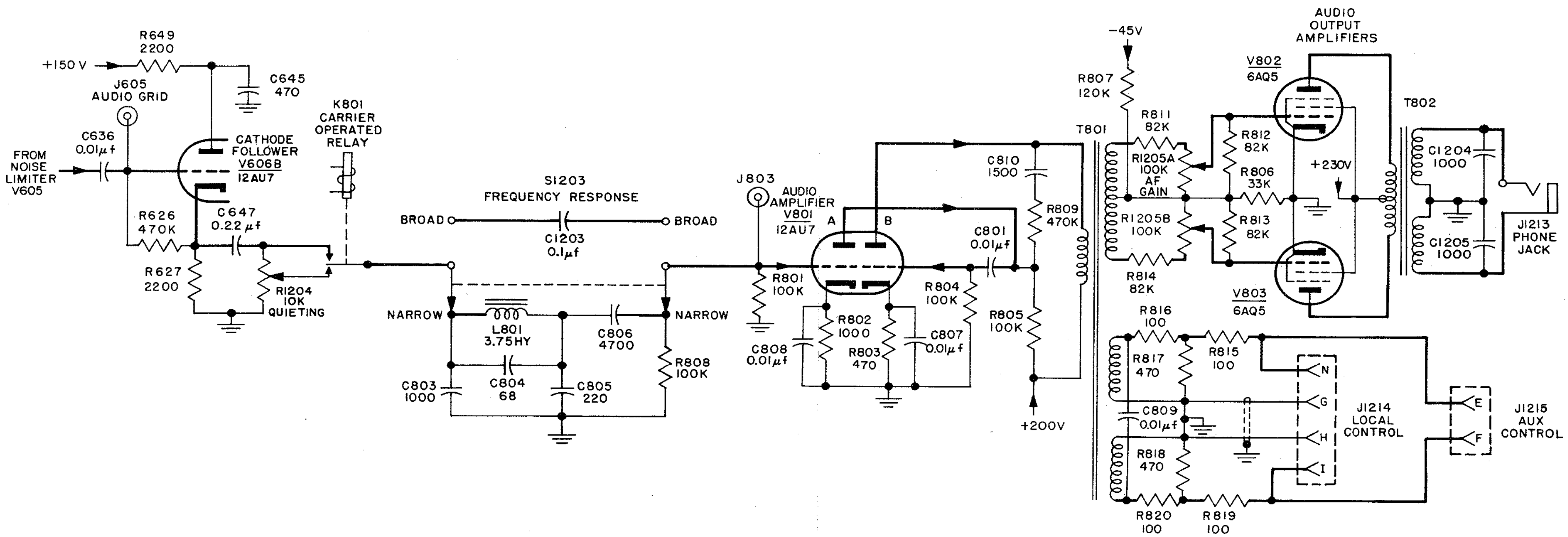


Figure 4-17. Radio Receiver R-278B/GR, Multi-channel Receiver Section, Audio Amplifier and Audio Control Circuits, Simplified Schematic Diagram

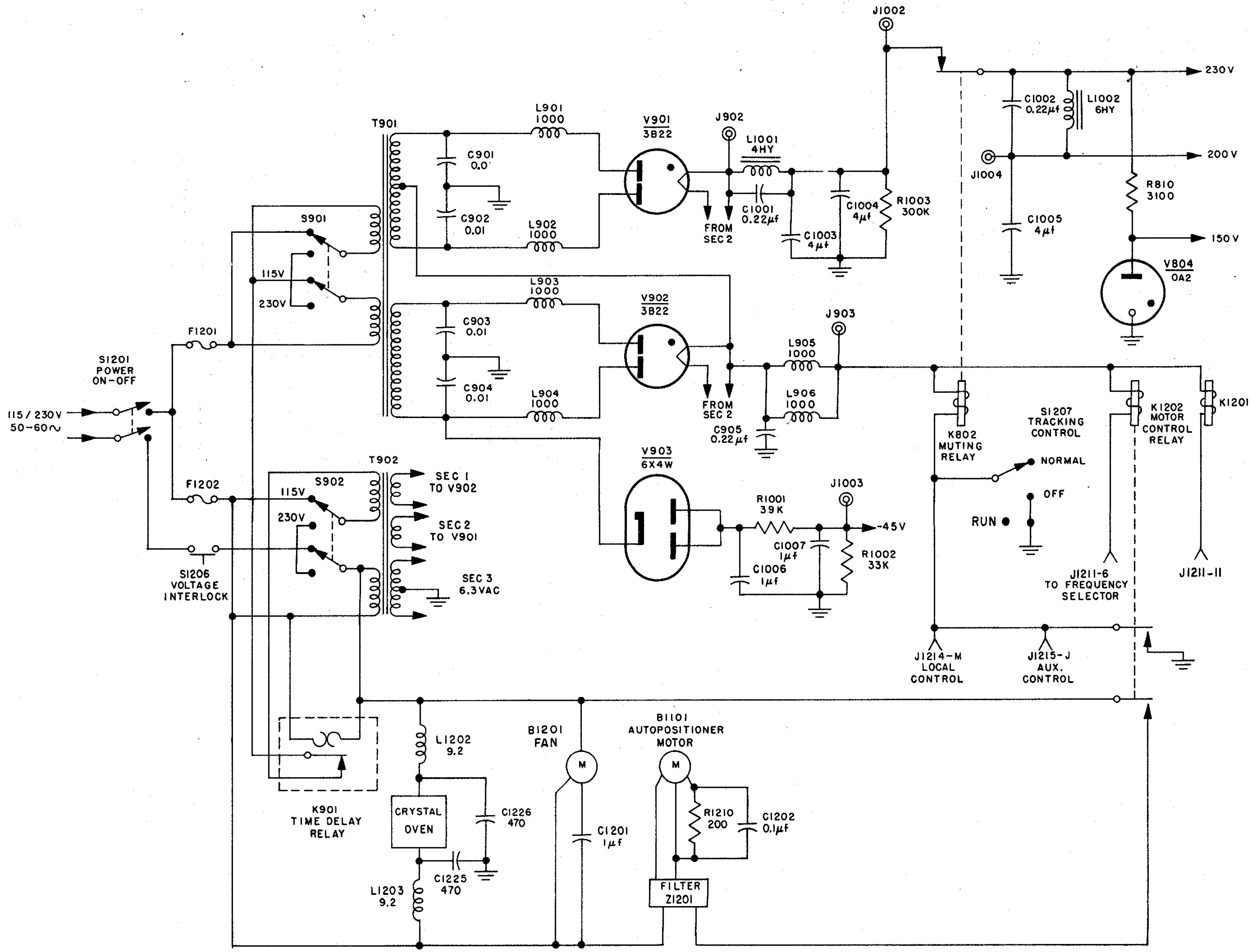


Figure 4–18. Radio Receiver R-278B/GR, Power Supply and Control Circuits, Simplified Schematic Diagram

and frequency selector unit. A detailed analysis of circuits contained in the power supply is given in the following paragraphs.

(*b*) POWER SUPPLY RECTIFIER.—As shown in figure 4–18, the power supply rectifier consists of V901, V902, and V903 working in conjunction with transformer T901 to provide the plate supply, relay supply, and bias supply. Transformer T902 supplies the filament supply.

The Receiver is energized when J1216 is connected to a source of 115 or 230 volts, 50 to 60 cycles and POWER switch is in the ON position. Plate and filament transformers T901 and T902 employ dual winding primaries that are connected so that either 115- or 230-volt operation may be selected by turning switches S901 and S902 to the position that agrees with the line voltage being used. When the POWER switch is turned on, filament transformer T902 is instantly energized through fuse F1202. A time delay of approximately 30 seconds, provided by thermal relay K901, permits the rectifier filaments to reach operating temperature before the plate transformer is energized.

The rectifier section employing gas-filled rectifier V902 is a full-wave circuit that provides 115 volts d-c for the operation of muting relay K802, and the various relays associated with the frequency selector mechanism. This section is connected in series with the full-wave rectifier section employing V901 to provide the plate supply for the operation of the Receiver circuits. A third full-wave rectifier (V903) operates from the same secondary winding as V902 to provide a negative bias supply voltage. Filament transformer T902 is provided with a center-tapped-to ground 12.6-volt secondary winding that provides filament voltage for the Receiver and two 2.5-volt secondary windings that supply filament voltage for V901 and V902. To provide a 115-volt a-c supply for the operation of thermal time delay relay K901, blower motor B1201, frequency selector motor B1101, and the heater elements of the multichannel receiver crystal oven, the primary section of T902 is employed as an auto-transformer.

(*c*) POWER SUPPLY FILTER.—The power supply filter consists of three sections: the 230-volt section, the 200-volt section, and the bias supply section. The 230-volt section is a choke input L section filter. Input choke L1001 is resonated with capacitor C1001 at the second harmonic of the power frequency to supply additional filtering action. The 230-volt output of this filter section is led through the normally closed contacts of muting relay K802 and back to the 200-volt filter section of the power supply filter where additional filtering occurs and the voltage is reduced to 200 volts. The bias supply filter section is a resistor-capacitor filter, the output of which is approximately −45 volts.

Voltage regulator V804, which is located in the audio amplifier unit, may be considered as part of the power supply. This tube supplies regulated 150-volt plate supply for the cathode follower circuits.

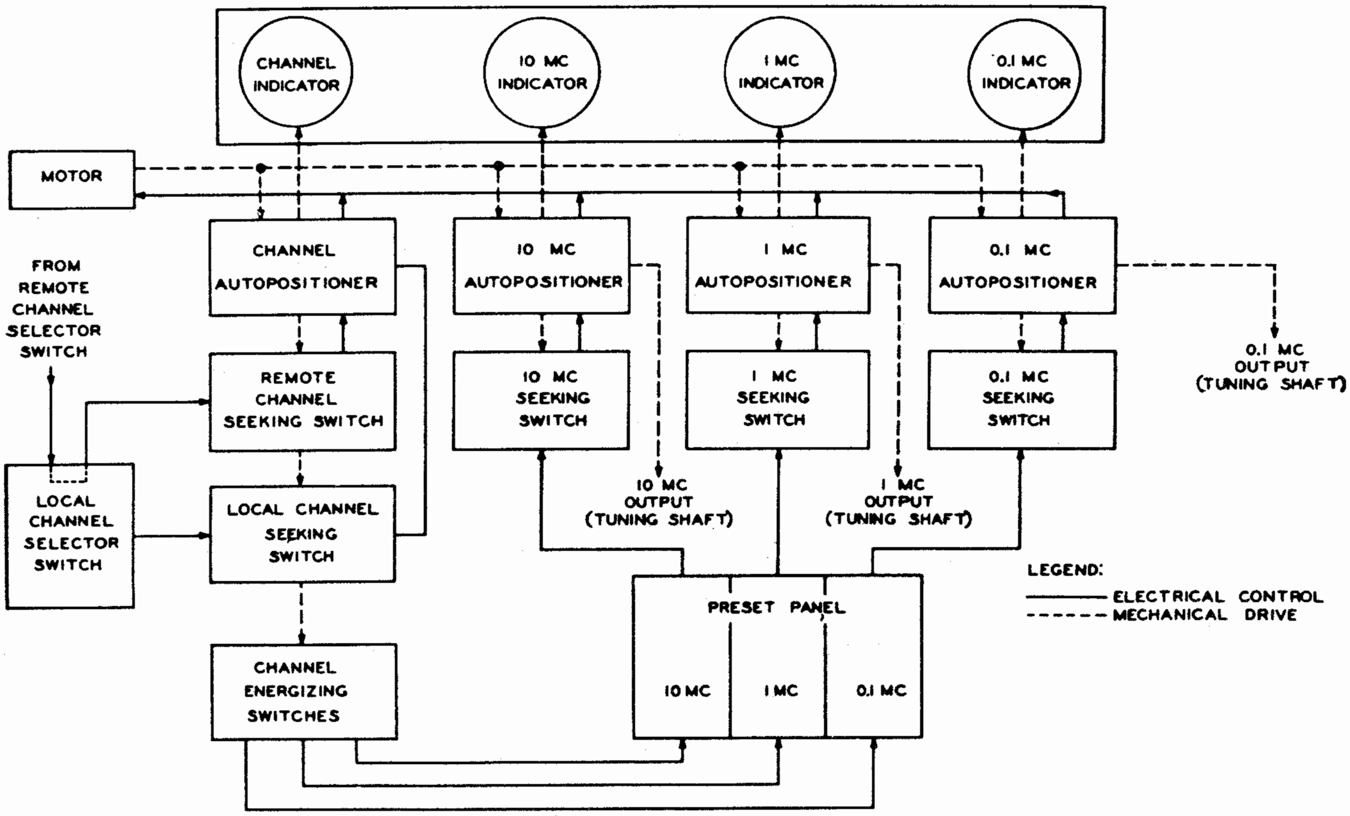


Figure 4–19. Radio Receiver R-278B/GR, Frequency Selector System, Block Diagram

(*d*) POWER SUPPLY VOLTAGE OUTPUTS. — Distribution of the eight voltage outputs are as follows:

1. 230 volts: Plate voltage for the audio output tubes, squelch output tube, r-f injection amplifiers and third i-f amplifiers.

2. 200 volts: Plate voltage for r-f amplifiers, the first i-f amplifier, second i-f amplifier, third i-f amplifier, and plate voltage for first audio amplifier V801.

3. 150 volts: Plate voltage for audio and direction finder cathode follower in the multi-channel receiver section.

4. 115 volts dc: Relay supply and frequency selector unit control circuits.

5. −45 volts: Bias for the audio amplifiers, bleeders for the r-f gain controls, bleeders for avc gates and shunt noise limiters.

6. 115 volts ac: Main oscillator crystal oven heater, frequency selector motor and fan motor, and thermal time delay relay.

7. 6.3 volts ac: Filament voltage supplying the third i-f amplifier.

8. 6.3 volts ac: Filament voltage to all other circuits in the Receiver.

(*e*) MUTING RELAY.—The Receiver is provided with muting relay K802, whose principal function is to silence the Receiver at the time the Transmitter carrier is on. The relay is operated on 115 volts dc and is actuated by providing a ground connection to the relay coil. The muting relay can be actuated from an external source by grounding pin M of J1214 or pin J of J1215 and is automatically actuated whenever the frequency selector mechanism operates or whenever tracking control switch S1207 is set to OFF or RUN. The muting relay interrupts the 230-volt plate supply.

(3) FREQUENCY SELECTOR SYSTEM.

(*a*) GENERAL.—As stated in paragraph 4–1, the frequency selector system automatically tunes the multi-channel receiver section to any one of the 1750 crystal-controlled frequencies in the range 225.0 to 399.9 mc. The frequency selector system consists of the preset panel and the autopositioner. The preset panel consists of a bank of 33 rotary switches on which 11 frequency channels can be "set up." The autopositioner is a mechanical-electrical device that is actuated by the channel selector switch or by remote control facilities.

A block diagram of the frequency selector system is shown in figure 4–19. The switching action usually originates at the local channel selector switch or at the remote channel selector switch, but it may originate at the switches in the preset panel. An example of frequency channel selection follows:

1. The operator changes the position of the local channel selector switch.

2. This energizes the channel autopositioner through the local channel seeking switch.

3. The channel autopositioner energizes the motor.

4. The motor in turn drives the channel autopositioner and the seeking switches and channel energizing switches coupled to it.

5. The seeking switch finds that position that de-energizes the channel autopositioner.

6. The channel energizing switches (now set to a new position) energizes the 10 mc, 1.0 mc and 0.1 mc autopositioners through the preset panel.

7. The motor is no longer energized through the channel autopositioner but is now energized through the other autopositioners.

8. The motor drives these three autopositioners and associated seeking switches.

9. The 10 mc, 1.0 mc, and 0.1 mc autopositioner seeking switches each find their open position thereby de-energizing the autopositioners. At the same time the 10 mc, 1 mc, and 0.1 mc output shafts rotate to that position which properly tunes the Receiver, and the autopositioner indicator dials indicate that frequency.

10. All autopositioners are now de-energized and therefore the motor is de-energized. The frequency selecting cycle has been completed.

(*b*) EXTERNAL CONNECTIONS.—Figure 4–20 shows the control circuit which is external to the frequency selector system but directly associated with it.

(*c*) CHANNEL AUTOPOSITIONER CONTROL RELAY.—The purpose of channel autopositioner control relay K1201 is two-fold. Since this relay requires a much lower value of current and operates on a wider range of control voltage than the autopositioner relays, it is useful in installations where the remote channel selector switch may be located as much as five miles from the Receiver and where the resistance of the control wires is appreciable. When the channel autopositioner control relay is operated by the control circuit, it actuates channel autopositioner relay K1101 and removes power from the other three autopositioner relays, thereby preventing their operation until the channel autopositioner has completed its operation.

(*d*) MOTOR-CONTROL RELAY.—Motor-control relay K1202 has two sets of normally open contacts. When the relay is energized through the operation of any of the autopositioner relays, one set of contacts applies 115 volts ac to autopositioner motor B1101. A second set of contacts energizes the muting relay, which disconnect the plate supply from the Receiver circuits during the interval of frequency change.

(*e*) TRACKING CONTROL SWITCH.—Tracking control switch S1207 is located in the extreme rear, upper right-hand corner of the Receiver.

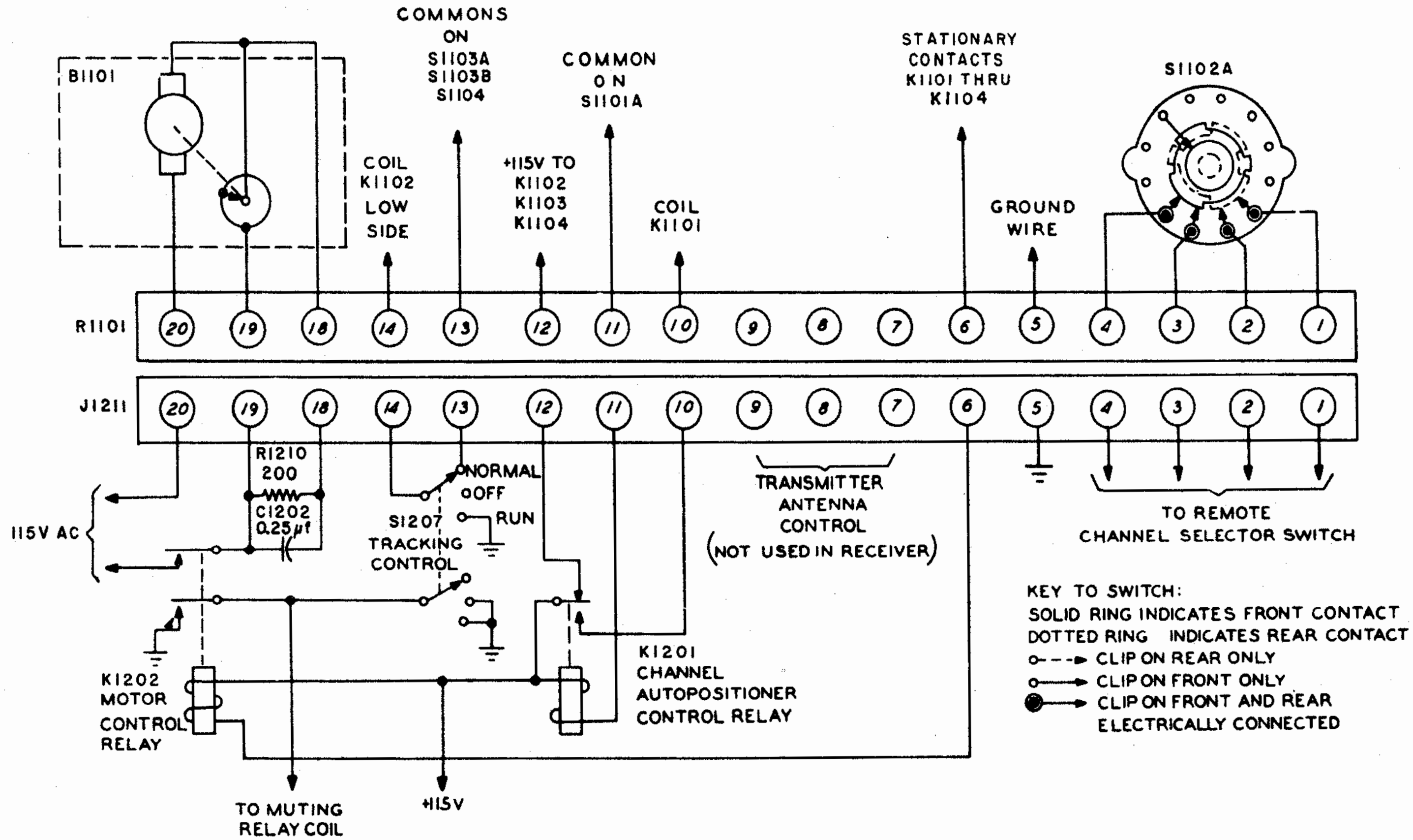


Figure 4–20. Radio Receiver R-278B/GR, Frequency Selector System, External Connections Diagram

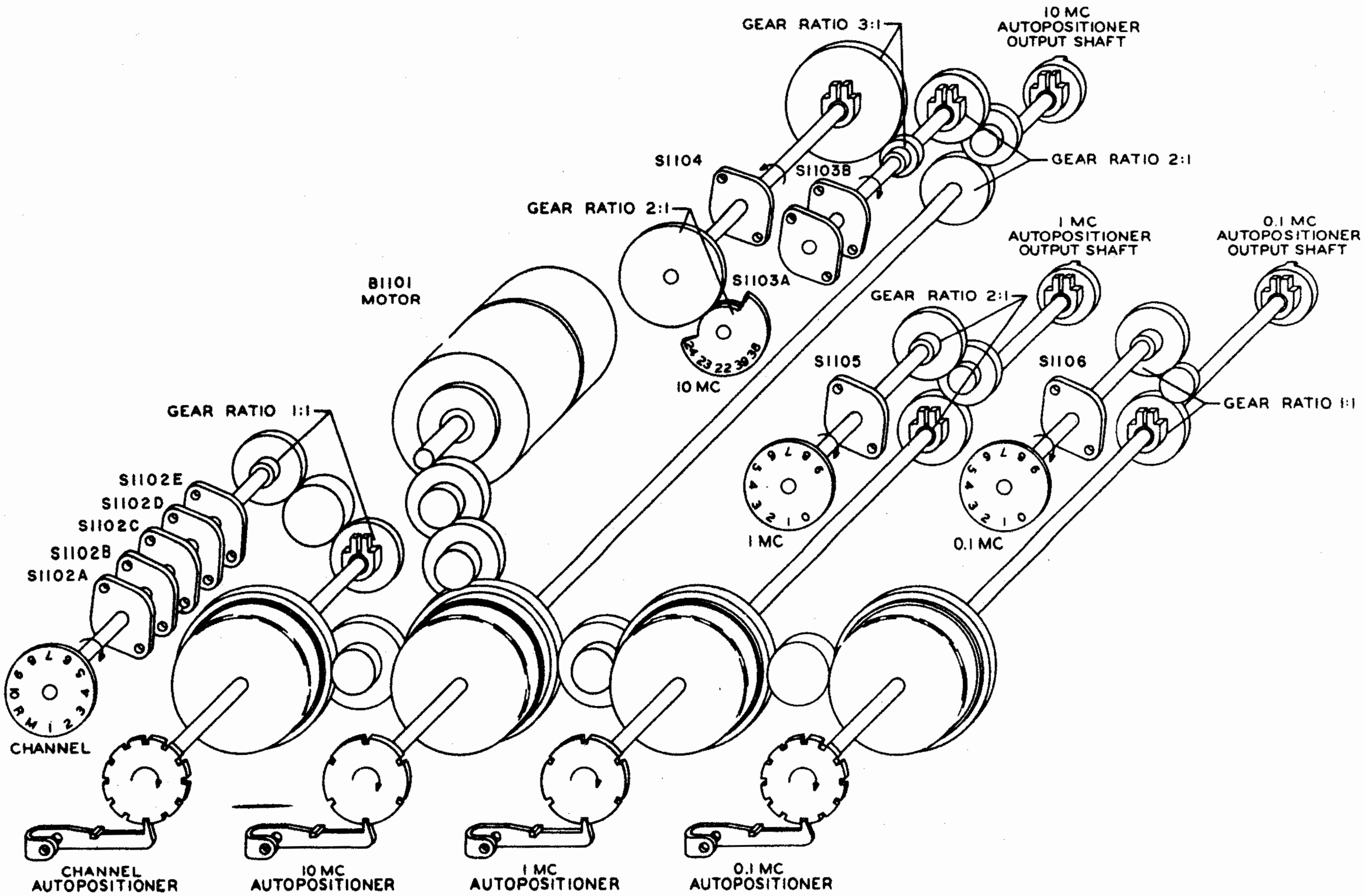


Figure 4–21. Radio Receiver R-278B/GR, Frequency Selector System, Mechanical Drive Diagram

The purpose of the switch is to permit manual control of the 10-mc autopositioner during alignment of the r-f amplifier and frequency multiplier-amplifier. The switch is a two-wafer rotary switch having three positions: NORMAL, OFF, and RUN. In the RUN position, relay K1102 is energized and the 10-mc autopositioner continues to operate until the switch is returned to the OFF position. From the second section of the switch, the muting relay coil is energized when the switch is in the RUN or OFF positions.

(*f*) SEQUENCE OF OPERATION, LOCAL CONTROL.—Referring to figures 4–20 and 5–26, the sequence of operation of the frequency selector system is as follows:

1. Assume that the operator switches local channel selector switch S1101A from channel 1 to MANUAL.

2. This action upsets the symmetry of the system, because channel seeking switch S1102B is no longer in a position corresponding to that of the selector switch.

3. The coil of autopositioner auxiliary relay K1201 is connected to ground by this path: pin 11 of J1211 and P1101, common contact of S1101A, terminal 1 of S1101A, terminal 1 of S1102B, common contact of S1102B to pin 5 of P1101 which is connected to ground.

4. Channel autopositioner control relay K1201 operates, switching 115 volts dc from pin 12 to pin 10 of J1211. This voltage prevents relays K1102, K1103, and K1104 from operating until after the channel autopositioner has completed operation.

5. K1101 is energized. This action lifts the pawl out of the notched stop-wheel and operates two sets of contacts. The normally closed contacts open to place R1101 in series with the coil of K1101 to limit the current through the coil to a low value sufficient to hold the relay energized. The normally open contacts close to energize autopositioner motor start relay K1202 through pin 6 of J1211 and P1101.

6. K1202 contacts close. One set disables the Receiver through operation of the muting relay. The other set energizes autopositioner motor B1101.

7. Referring to figure 4–21, the motor drives the four clutch gears through a step-down geared coupling. Only the channel autopositioner stop-wheel is free to turn, as the other three stop-wheels are locked by their pawls causing their respective clutches to slip.

8. The channel autopositioner shaft revolves until local channel seeking switch S1102B finds its open circuit position (in this case, the position corresponding to MANUAL). The channel autopositioner shaft drives the three channel energizing switches (S1102C, S1102D, and S1102E) and the channel indicator dial to the position corresponding to MANUAL.

9. When the channel seeking switch finds its open position, K1201 is de-energized.

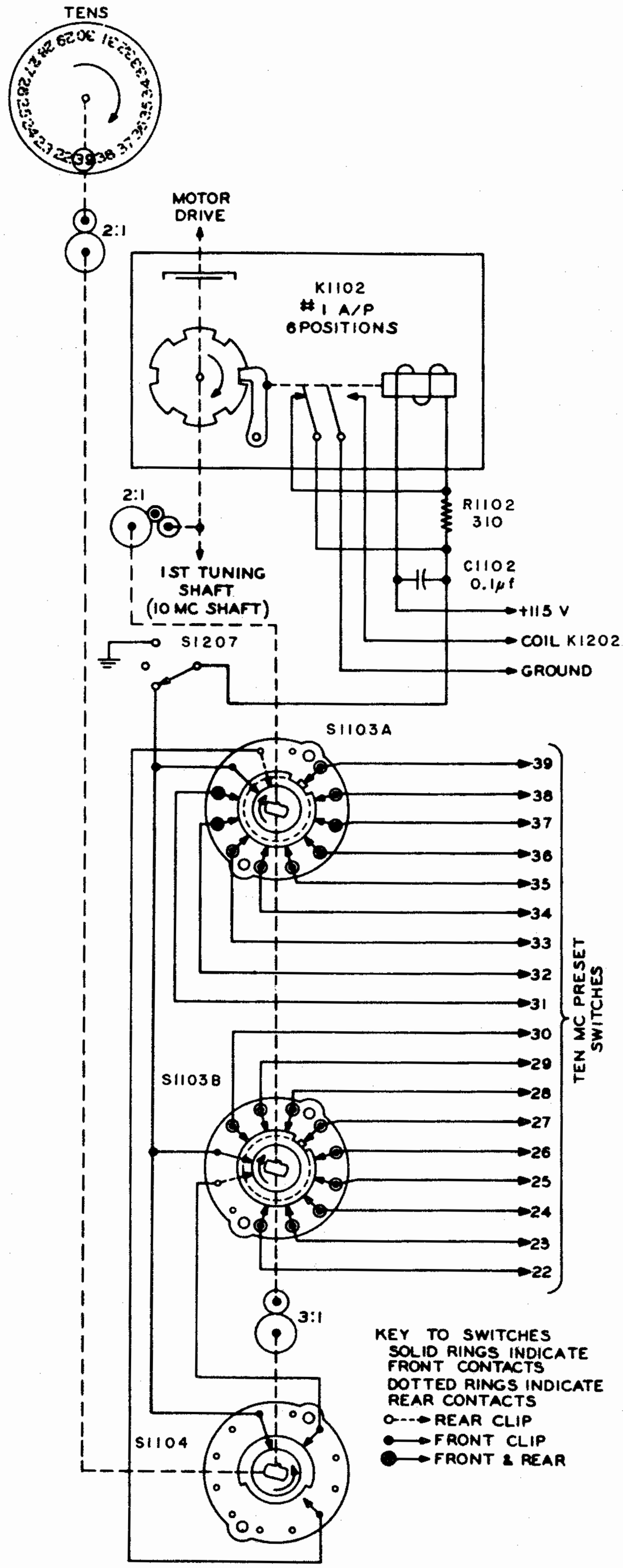


Figure 4–22. Radio Receiver R-278B/GR, 10-mc Autopositioner and Seeking Switches, Simplified Schematic Diagram

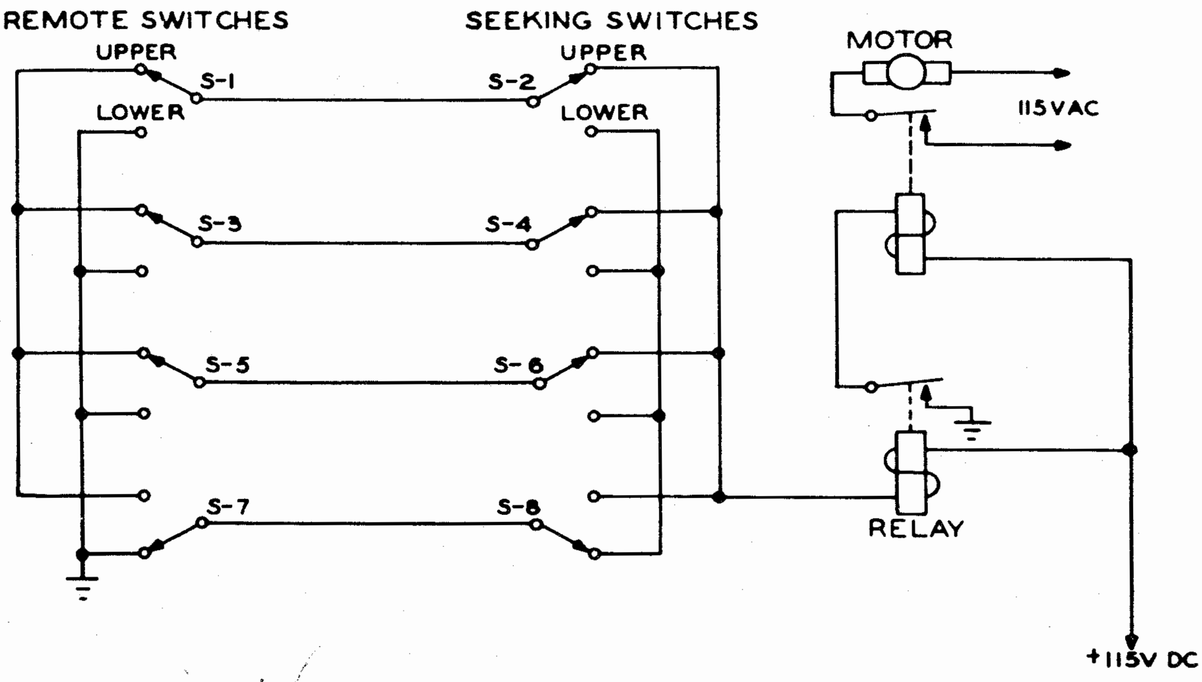


Figure 4–23. Basic Diagram of Binary Control System

10. The 115-volt d-c power is transferred from pin 10 to pin 12 of P1101.

11. K1101 is de-energized and K1102, K1103, and K1104 become energized because the channel energizing switch positions have been changed. The coils of K1102, K1103, and K1104 are connected to ground through their associated seeking switches, through the "manual" preset switches, and through the channel energizing switches, the rotors of which are connected to ground.

12. The "manual" preset switches have previously been set to a particular frequency, say 390.0 mc.

13. The motor is energized since its control circuit is completed through the contacts of these autopositioner relays.

14. The motor drives the 1.0 and 0.1 mc autopositioners until their seeking switches find the open-circuit position.

15. At these switch positions, relays K1103 and K1104 are de-energized and drop their pawls into the correct notch of the stop-wheel, thereby preventing any further rotation of the 1.0 and 0.1 mc autopositioner output shafts.

16. The 1.0 mc and 0.1 mc autopositioners have now been correctly positioned.

17. The 10-mc autopositioner has been "setting up" simultaneously with the "setting up" of the other two autopositioners. The 10-mc autopositioner employs a mechanical and electrical combination of three rotary switches to provide 36 electrical positions; 18 positions establish the 18 frequencies that are spaced at 10-mc intervals and 10 positions that are not physically usable except to provide a return of the tuning mechanism to its starting position. The following paragraph provides a detailed explanation of the seeking switches of the 10-mc autopositioner. To continue the sequence of operation, the coil of relay K1102 is grounded through this path: NORMAL contacts of tracking control switch S1207, rotor of S1103A, wire no. 39 to "manual" preset switch S1117, channel energizing switch S1102C, the rotor of which is connected to ground.

18. K1102 lifts its pawl and the motor control circuit is energized, as described before.

19. The motor drives the 10-mc autopositioner and seeking switches through a gear reduction and clutch until the 10-mc seeking switches find the position that removes voltage from K1102. K1102 drops its pawl into the correct notch and the 10-mc autopositioner output shaft has been correctly positioned.

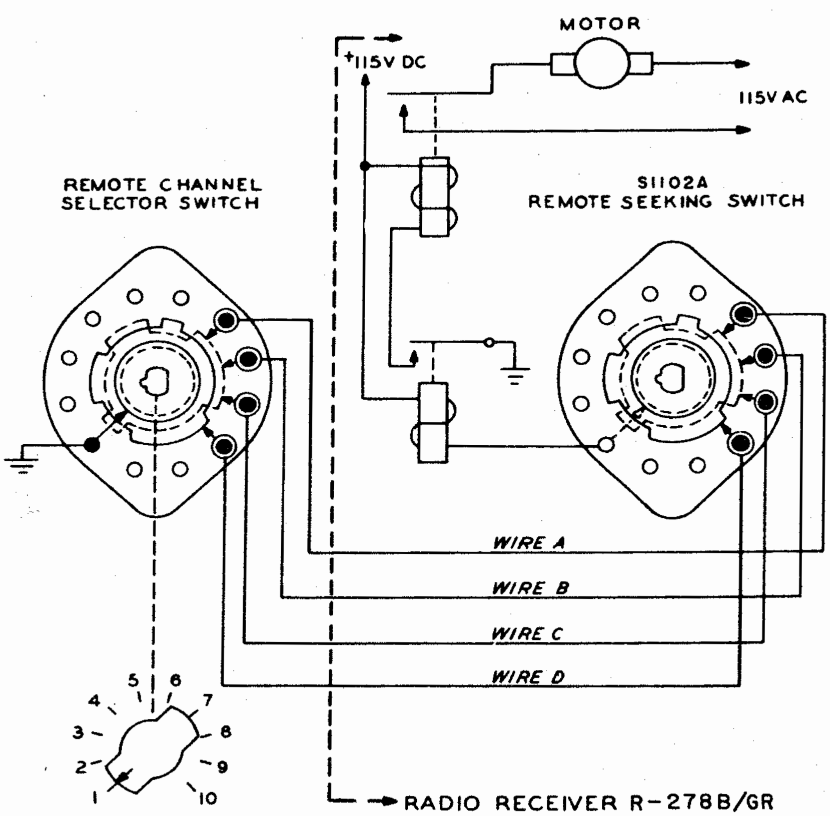
20. The autopositioner system is now correctly set up to establish a Receiver frequency of 390.0 mc. The four autopositioner relays are de-energized so that the motor control circuit and motor are likewise de-energized.

(*g*) OPERATION OF THE 10-MC SEEKING SWITCH SYSTEM.—As shown in figure 4–22, the 10-mc autopositioner employs a mechanical and electrical combination of 3 rotary switches, each having a 12 point stator to give 36 electrical positions. Eighteen positions establish the 18 frequencies that are spaced at 10-mc intervals and 18 positions that are unused except to provide a return of the tuning mechanism to its starting position. The two 10-mc seeking switches (S1103A and S1103B) are of a rotary-wafer type having the two sides complementary to each other so that every switch position makes contact to either front or rear rotor. A third switch (S1104) designated as the blanking switch acts to distinguish between the first, second, and third revolution of the two seeking switches. In the "seeking cycle," the blanking switch for the first 270 degrees revolution of the seeking switches allows S1103A to "investigate" its 9 used positions for an open-circuited condition that will de-energize the control circuits, meanwhile rejecting all positions of S1103B by shorting front and rear blade rotors of S1103B together. For the next 270 degrees revolution of the seeking switches the blanking switch allows S1103B to investigate its 9 active positions and rejects all positions of S1103A by shorting front and rear blade rotors of S1103A together. During the last 540 degrees rotation of the seeking switches, the blanking switch rejects all positions of both S1103A and S1103B by shorting front and rear blade rotors of both switches together. This interval allows the tuning mechanism to travel to its original or starting position of 39 mc. The exact instant at which the two wipers make or break contact with the blanking switch rotor is not critical because there are three unused positions each on S1103A and S1103B that the seeking switches are "investigating" at the time the corresponding wiper is making or breaking contact with the rotor of the blanking switch. This allows a suitable tolerance in the alignment of the blanking switch.

The gearing ratios of the 10-mc autopositioner and associated switches are as follows: stop-wheel to seeking switches 2:1, seeking switches to blanking switch 3:1, blanking switch to 10-mc frequency indicator 2:1. In other words, for one complete "tuning cycle," the 6-notched stop-wheel is required to make 6 revolutions, the seeking switches 3 revolutions, the blanking switch 1 revolution and the 10-mc frequency indicator dial 2 revolutions. The 10-mc autopositioner "sweeps the frequencies" from highest to lowest. The first position of the 10-mc seeking switches positions the output shaft of the 10-mc autopositioner to set up a Receiver frequency of 39x.x mc, the second position produces 38x.x mc . . . and the 18th position of the seeking switches produces 22x.x mc. The last 18 positions are employed for the return travel of the tuning mechanism to the 390-mc position.

(*b*) REMOTE OPERATION OF THE FREQUENCY SELECTOR SYSTEM.—The frequency selector unit may be operated by remote control from Radio Set Controls C-1180/GR or C-1897/GRC-27A.

To provide a positive remote control system for the frequency selector system with a minimum number of control wires, a special binary control system has been developed, using the control wires in various combinations. Four wires and ground are used to control the channel autopositioner to permit remote selection of



CHANNEL	WIRE			
	A	B	C	D
1				X
2	X			
3		X		
4			X	
5	X			X
6	X	X		
7		X	X	
8	X		X	X
9	X	X		X
10	X	X	X	

INDICATES WIRE GROUNDED IN REMOTE CHANNEL SELECTOR SWITCH

NOTE:
SOLID RINGS INDICATE FRONT CONTACTS
DOTTED RINGS INDICATE REAR CONTACTS

KEY TO SYMBOLS:
FRONT CLIP
REAR CLIP
FRONT & REAR CLIPS

Figure 4-24. Radio Receiver R-278B/GR, Frequency Selector System, Channel Coding of Remote Selector Switches

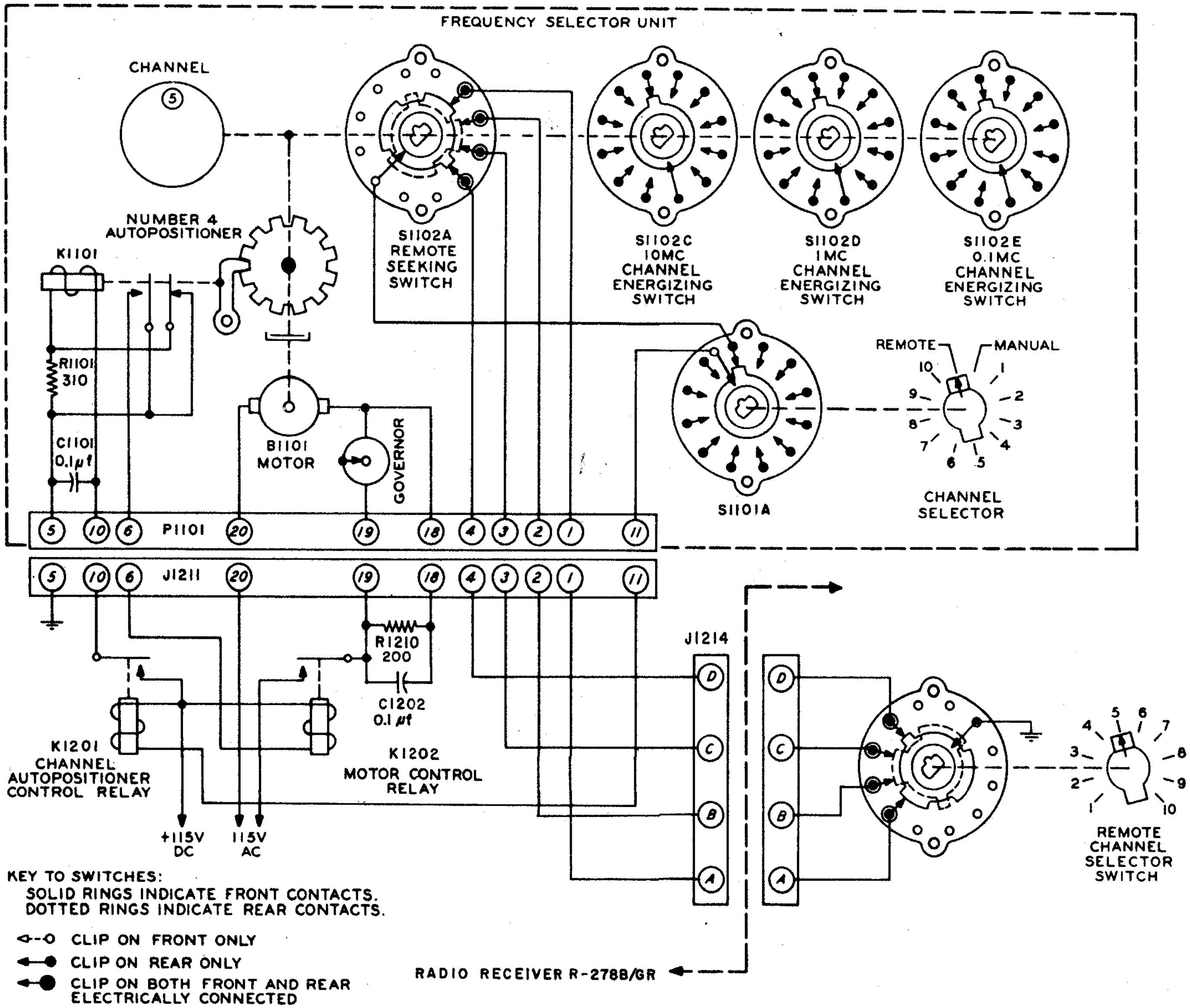


Figure 4–25. Radio Receiver R-278B/GR, Remote Control of Frequency Selector System

any one of the 10 preset channels. This system is most readily explained by a system composed of single-pole double-throw switches as shown in figure 4–23. Note that when the switches are set symmetrically (S1 in the same position as S2, etc., as shown), there is no current path from the relay coil to ground, and the relay and motor remain de-energized. If, however, any one of the control switches is set to a position opposite to that of the corresponding seeking switch, a path to ground will be closed. This action energizes the relay and motor until the seeking switches are repositioned to positions symmetrical to the remote switches, which will again open the relay circuit. The total number of different combinations of switch positions in such a system is 2^n when "n" is the number of control wires used. In the four-wire system shown, 24 = 16 different combinations exist. However, one particular combination is not usable in this application. As can be seen in figure 4–23, if all the seeking switches are set to the "Lower" position, there can be no path from the relay coil to ground, no matter how the remote switches are set, and the system is "dead." Hence, the maximum number of usable combinations is $(2^n - 1)$. Thus, a 3-wire system can control 7 positions; 4 wires, 15 positions; and 5 wires, 31 positions. In this case, it is necessary to control 10 positions, therefore 4 control wires are used.

To make the system of figure 4–23 physically usable for controlling rotary shaft positions, special rotary wafer type switches have been devised to perform the same function. Referring to figure 4–24, each switch consists of two rotor blades, mounted on opposite sides of the switch rotor and insulated from each other. The front and rear rotor blades take the place of the "upper" and "lower" parallel bus connections, respectively, of figure 4–23. It is seen that as the channel selector switch is rotated, 10 combinations of connections are set up as indicated in the table of figure 4–24.

(*i*) SEQUENCE OF OPERATION, REMOTE CONTROL.—To permit remote selections of channels, the local channel selector switch must be set at REMOTE. This action transfers control of the channel autopositioner from the local channel selector switch to the remote channel selector switch. Referring to figure 4–25, the cycle of operation of the channel autopositioner is as follows:

1. The system is at rest with the control and seeking switches in corresponding positions (open circuit), relay in de-energized position, pawl engaging a stop-wheel notch, and motor de-energized.

2. The remote operator changes the setting of the remote channel selector switch.

3. The coil of auxiliary relay K1201 is connected to ground by the following path: pin 11 on connector P1101, the rotor blade of S1101A, the rotor blade of remote channel seeking switch S1102A, the control wires leading to the remote channel selector switch one or more of which is connected to ground through the rotor blade.

4. K1201 operates its contacts that energize K1101, the channel autopositioner relay.

5. K1101 lifts its pawl out of the stop-wheel notch and closes its contacts that energize motor energizing relay K1202.

6. K1202 closes its contacts to energize the motor.

7. The motor starts, driving the autopositioner shaft and the rotor of remote channel seeking switch S1102A.

8. The seeking switch reaches the point corresponding to the new position of the remote channel selector switch, thereby removing the ground connection to auxiliary relay K1201.

9. K1201 opens its contacts to de-energize K1101. K1101 drops its pawl into the notch of the stop-wheel, to stop the shaft rotation.

(4) MECHANICAL DRIVE SYSTEM FOR RECEIVER TUNING.

(*a*) FREQUENCY SELECTOR SYSTEM MECHANICAL DRIVE.—Referring to figure 4–21, motor B1101 is energized at a time when one or more autopositioner pawls have lifted from their stop-wheels. A typical switching operation is given in the following sequences.

1. The channel autopositioner becomes energized so that its pawl releases the stop-wheel and a set of contacts energizes the motor.

2. The motor drives the four clutch plates through a series of gears.

3. Only the channel autopositioner shaft turns. All other clutches slip, since their pawls lock the stop-wheels.

4. The channel indicator and channel switches set up. This action energizes the other three autopositioners.

5. The channel autopositioner pawl engages its stop-wheel and the other three pawls release their stop-wheels.

6. The motor drives the three frequency determining autopositioners through their clutches.

7. The 0.1-mc autopositioner uses a direct drive output and the indicator dial is geared 1:1 to the output shaft.

8. The 1.0-mc output uses a gear ratio of 2:1 to drive the 1.0-mc indicator dial and a gear ratio of 2:1 to drive the 1.0-mc tuning shaft. Therefore, the 1.0-mc autopositioner must make two complete revolutions to complete a tuning cycle.

9. The 10-mc autopositioner is geared to the tuning mechanism in such a way that six complete revolutions of the 10-mc autopositioner are required to complete one tuning cycle. Seeking switches S1103A and S1103B make three revolutions, blanking switch S1104 one revolution, and the 10-mc indicator dial two revolutions.

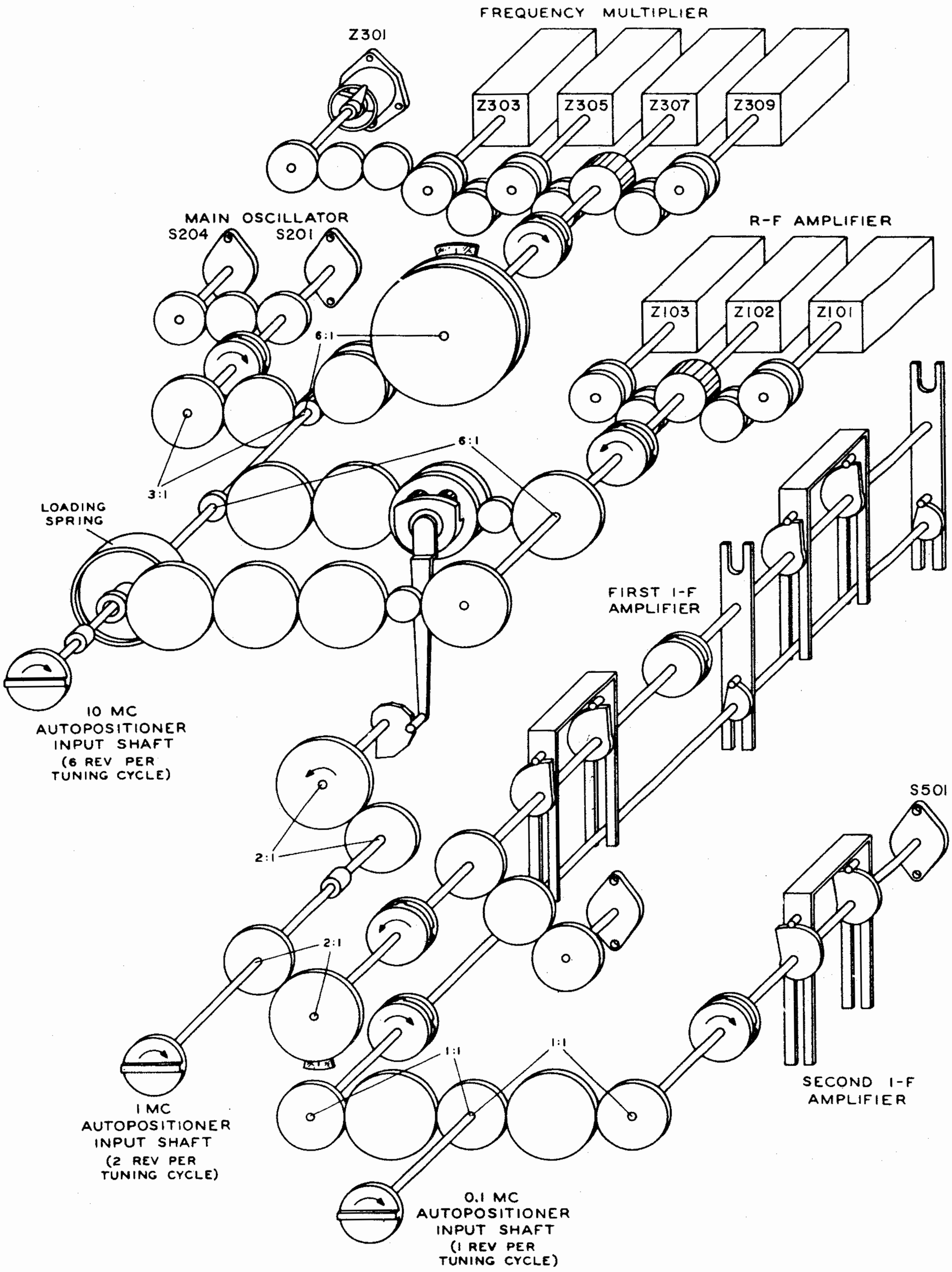


Figure 4-26. Radio Receiver R-278B/GR, Receiver Tuning, Mechanical Drive System

(*b*) TUNING SYSTEM, MECHANICAL DRIVE.—Referring to figure 4–26, the following Receiver circuits receive the following mechanical inputs:

RECEIVER CIRCUIT	MECHANICAL INPUTS
R-f amplifier	10 mc and 1 mc positioning
Main oscillator	10 mc positioning
Frequency multiplier-amplifier	10 mc positioning
First i-f amplifier	1.0 and 0.1 mc positioning
Second i-f amplifier	0.1 mc positioning

(*c*) SECOND I-F AMPLIFIER TUNING.—The second i-f amplifier has one mechanical input. This input is received from the 0.1-mc autopositioner shaft. The gearing ratio is 1:1, so that one revolution of the 0.1-mc autopositioner shaft effects a complete tuning cycle of the second i-f amplifier. Two cams mounted on the tuning shaft of the second i-f amplifier turn 270 degrees to raise the tuning-core table from its lowest to highest position to permeability tune the primaries and secondaries of T501 and T502. The remaining 90 degrees of cam travel allows the tuning rack to drop to its lowest position, which represents the highest tuning frequency. A rotary crystal-selector switch having ten active positions in 270 degrees is mounted on the end of the tuning shaft to select the proper third oscillator crystal unit for the Receiver frequency selected.

(*d*) FIRST I-F AMPLIFIER TUNING.—The first i-f amplifier receives two mechanical inputs on two parallel tuning shafts. The input from the 0.1-mc autopositioner is geared 1:1 through an idler gear and the input from the 1.0-mc autopositioner is geared 2:1 because the 1.0-mc autopositioner makes two revolutions for one tuning cycle. I-f transformers T401 and T402 are permeability-tuned by a differential tuning core table that combines the inputs from the 1.0-mc and 0.1-mc autopositioners to provide 100 tuning steps. The cams mounted on the floating 1.0-mc tuning shaft position the tuning core table in ten steps similar to the tuning of the second i-f amplifier. The cams mounted on the 0.1-mc tuning shaft displace this 1.0-mc tuning shaft in 10 steps to provide a vernier adjustment of the tuning core table position. The Oldham-type sliding coupler permits the floating 1.0-mc tuning shaft to be displaced.

The tuned circuits associated with the second oscillator are permeability tuned in 10 steps by a tuning core table positioned by means of two cams mounted on the fixed-bearing 1.0-mc tuning shaft. The crystal-selector switch of the second oscillator is operated from the fixed-bearing 1.0-mc tuning shaft through an idler gear.

(*e*) MAIN OSCILLATOR TUNING.—The main oscillator crystal-selector switch and coil-selector switch are driven from the 10-mc autopositioner shaft through a 3:1 gear reduction. Since the 10-mc autopositioner shaft makes six revolutions per tuning cycle, these selector switches make two complete revolutions per cycle. The first revolution provides 18 rotor positions for the selection of the proper crystal and coil for the selected Receiver frequency. The second revolution occurs at the time the tuners of the frequency multiplier-amplifier and r-f amplifier of the frequency multiplier-amplifier are in the unused 180 degrees of their tuning cycle.

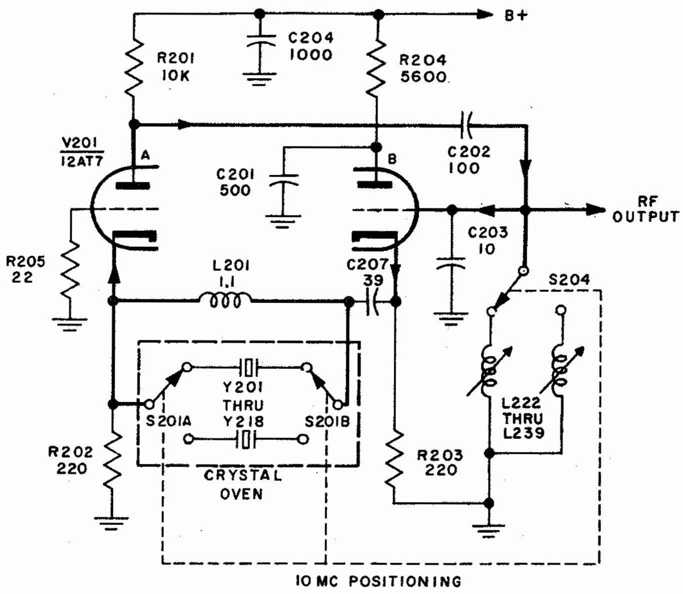


Figure 4–27. Radio Transmitter T-217A/GR, Main Oscillator, Simplified Schematic Diagram

(*f*) FREQUENCY MULTIPLIER-AMPLIFIER TUNING.—The tuning shaft of the frequency multiplier-amplifier is driven by the 10-mc autopositioner shaft through two stages of gear reduction that provide a speed reduction of 6:1. Thus, the tuners make 1 revolution per tuning cycle. The first 180 degrees of rotation provide the 18 operating positions of the tuners. The second 180 degrees of rotation return the tuners to the beginning point of their cycles. The gears employed in the reduction drive are of the split spring-loaded type to reduce possible inaccuracy caused by backlash.

The tuners of the frequency multiplier are driven by the tuning shaft through a system of spur gears which, with the exception of the gears driving the toroidal step tuner, are also of the split spring-loaded type.

(*g*) R-F AMPLIFIER TUNING.—The r-f amplifier tuning shaft is driven from the 10-mc autopositioner shaft through a gearing system that includes a planetary-type differential in which the tuning information provided by the 10-mc autopositioner shaft is combined with tuning information provided by the 1-mc autopositioner shaft. This operation provides 180 operating positions of the r-f amplifier tuners. The 1-mc input is accomplished by a rocker arm driving a pinion of the planetary gear system. This rocker arm is actuated by a cam driven from the 1-mc autopositioner shaft. The cam has its periphery radius-stepped, so that the rocker arm always rides on circle

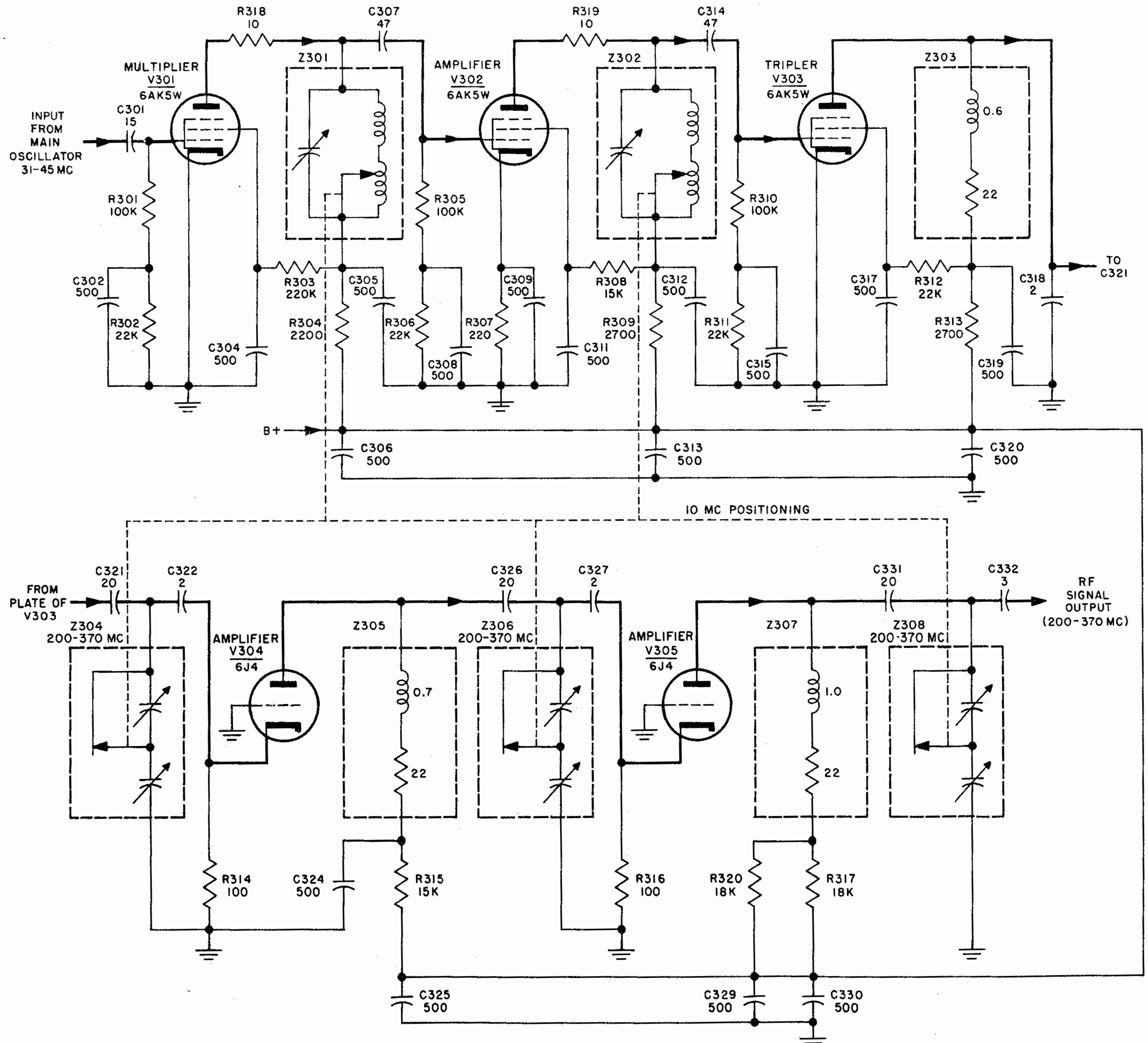


Figure 4–28. Radio Transmitter T-217A/GR, Frequency Multiplier-Amplifier; Simplified Schematic Diagram

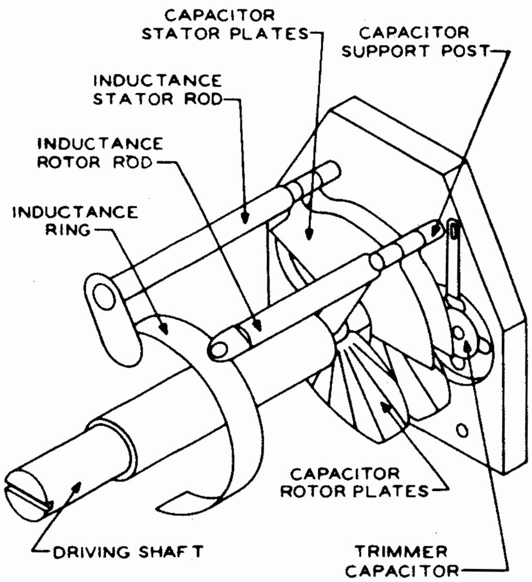


Figure 4–29. Radio Transmitter T-217A/GR, R-F Tuner, Principal Elements

segments with increasing radii as the frequency increases from the zero position through the nine position.

The driving gears provide a 3:1 speed reduction from the 10-mc autopositioner shaft and an additional 2:1 reduction is obtained in the differential mechanism. Thus, the tuning shaft makes 1 revolution per tuning cycle to provide 18 primary tuning positions each of which is divided into 10 steps as determined by the setting of the 1.0-mc autopositioner shaft operating through the differential mechanism. Thus, 180 positions covering 180 degrees rotation are provided. The tuning shaft is coupled back to the 10-mc autopositioner shaft through a system of loading gears and a helical spring to provide spring-loading of the entire gear train.

The r-f amplifier tuners are driven by the tuning shaft through a system of spur-gears employing split spring loaded gears.

b. RADIO TRANSMITTER T-217A/GR.

(1) GENERAL.—The functional block diagram of Radio Transmitter T-217A/GR is shown in figure 4–5. Three of the ten sub-chassis contained in the Transmitter are incorporated in the frequency generating system. These three sub-chassis make up the main oscillator, the frequency multiplier-amplifier, and the i-f oscillator. The outputs of the three crystal oscillators are selectively amplified, multiplied, and mixed to provide the desired frequency for the exciter circuit.

(2) MAIN OSCILLATOR.—A simplified schematic diagram of the main oscillator is shown in figure 4–27. This circuit, employing a Butler circuit, includes V201, a bank of 18 type CR-32/U crystals with a crystal switch all inside a temperature-controlled crystal oven, a bank of 18 coils with an associated switch, and other circuit elements. The oscillator consists of a grounded grid amplifier followed by a cathode follower which in turn couples back into the grounded grid stage through the crystal.

Imagine a random positive pulse appearing at the cathode of grounded grid amplifier V201A. Since the grid is grounded through a 22-ohm resistor, a rise in cathode voltage causes a decrease in plate current and therefore an increase in plate voltage. This positive pulse is coupled to the grid of cathode follower V201B. The cathode voltage follows the grid voltage so that the positive pulse is coupled back to the cathode of the grounded grid amplifier through the crystal. The crystal presents a low impedance path only at series resonance. Thus, oscillations are generated by the stage and sustained in the zero-phase-shift feedback loop. The plate load of the grounded grid amplifier is the tuned circuit C203 in parallel with one of 18 inductances selected by the 10-mc autopositioner output. The frequency of oscillation can be adjusted over a small range by adjusting the tuning of the plate circuit. This circuit is normally adjusted so that the frequency of oscillation is precisely as desired, thereby eliminating any inaccuracy in the frequency of the crystal unit. A 1.1-microhenry inductance (L201) is used to resonate with the stray circuit capacities at approximately 30 mc. The oscillator signal is fed to V301 through a capacitor and a soldered connection connecting the two units.

The crystal is maintained at a constant temperature by the thermostatically controlled crystal oven. The crystal oven operates on 115 volts ac and includes two heater elements and two thermostats. One heater element has a rating of approximately 70 watts and is employed to bring the oven to operating temperature rapidly when the equipment is first turned on. The second heater element has a rating of approximately 30 watts and operates intermittently to maintain the oven at the proper temperature (75 degrees C ±5 degrees C).

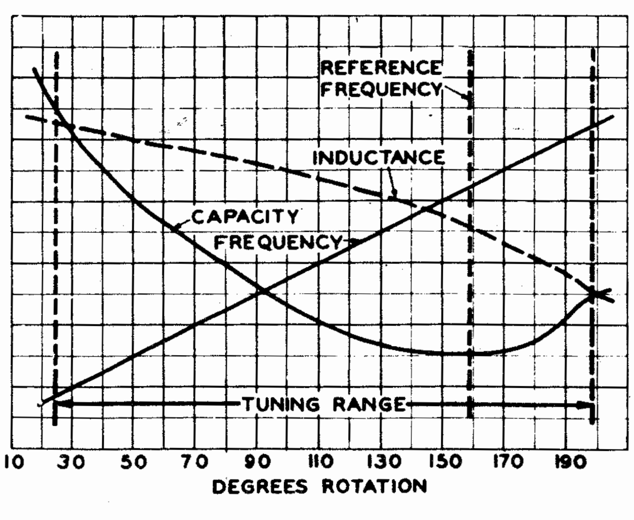


Figure 4–30. Radio Transmitter T-217A/GR, R-F Tuner, Tuning Curves

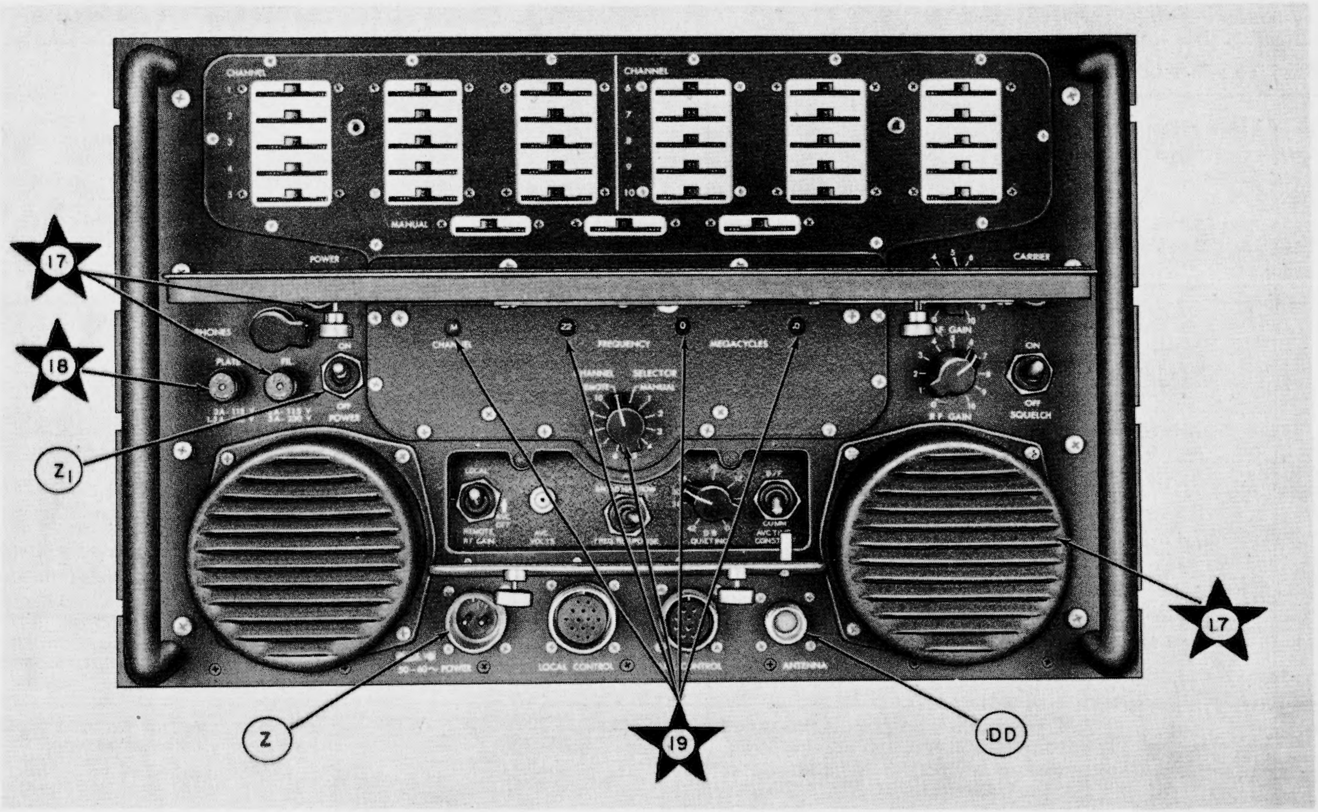


Figure 5–13. Radio Receiver R-278B/GR, Location of Test Points

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	17 Figures 5–13 5–15 5–19 5–27	Make check as indicated in step 7 in table 5–2.	POWER indicator I1202 should light and blower motor B1201 should be heard running.	If I1202 and B1201 are not energized, and interlock S1206 is cheated, replace F1202.
	Z Figures 5–13 5–19		115V AC.	If I1202 and B1201 are still not energized, remove cable from 115V POWER plug and check for 115V AC in cable leading to Receiver.
	Z_1 Figures 5–13 5–19		115V AC.	If reading is normal, check POWER switch S1201; replace if defective. If power is not normal, check ship supply.
2	18 Figures 5–13 5–17 5–18 5–29	Check power supply and power supply filter output voltage using Multimeter ME-25A/U between test point and ground.	J902: +250V DC. J903: +115V DC. J1002: +210 to +250V DC. J1003: −45 to −70V DC. J1004: +180 to +225V DC.	If no voltages exist anywhere, replace F1201.

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART — *Continued*

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
	AA Figures 5–14 5–19 5–29 5–46			If no voltages are present after F1201 is replaced, replace V901, V902, V903, and K901. If no voltages are present, make voltage and resistance checks (refer to figure 5–46). Replace defective component.
	AA_1 Figures 5–14 5–29		J902: +250V DC. J903: +115V DC. J1002: +210 to +250V DC. J1003: −45 to −70V DC. J1004: +180 to +225V DC.	If voltages are normal at J902 and J903 but absent or abnormal at J1002, J1003, or J1004, check connections between P901-J1209 and P1001-J1210. If connections are okay, check for defective component in power supply filter.
3	19 Figure 5–13	Select a frequency channel and note if Frequency Selector system operates to give desired channel.	Channel selected is indicated by dials.	If no frequency selection is made, or frequency selection is incorrect, check for presence of voltages at Frequency Selector chassis. If voltages are present, refer to table 5–8. If Frequency Selector is replaced, realign as described in paragraph 6–3*a*(11) in section 6.
4	20 Figures 5–12 5–15 5–16 5–27 5–28	If no audio output is received from the Receiver, check AVC voltage at J606. Connect R-F Signal Generator AN/URM-26 at J404 adjusted for an output of 9 mc, 30% modulated at 1000 cps. If the Receiver is inoperative at certain frequencies, or audio output is distorted, proceed to Step 12.	No Signal: −2.9V DC. Signal: −4.0V DC.	If AVC voltage is normal replace V801 in audio amplifier, V605 and V606 in Third I-F amplifier.
	BB Figures 5–15 5–27 5–28		No Signal: −2.9V DC. Signal: −4.0V DC.	If audio is still missing, replace relay K801. If audio is still missing or audio is not normal, proceed to step 5.
5	CC Figures 5–12 5–15 5–27	Connect Multimeter ME-25A/U between C302 and ground.	−0.5 to −1.5V.	If indication is abnormal, replace V201. Re-tune main oscillator (see paragraph 6–2*b*(5) in section 6.)
	CC_1 Figures 5–15 5–27 5–40		−0.5 to −1.5V.	If indication is still abnormal, make the voltage and resistance checks indicated in figure 5–40. Replace the defective component. Crystals in the chassis may have to be replaced if Receiver operates normal on some frequencies. Re-tune main oscillator (see paragraph 6–2*b*(5) in section 6).
	CC_2 Figures 5–12 5–14 5–15 5–27 5–41	Connect Multimeter ME-25A/U between C309 and ground.	−0.8 to −2.5V DC.	If indication is abnormal, replace V301. If indication is still abnormal make voltage and resistance checks at XV301 (see figure 5–41. Replace the defective component. Re-tune Frequency Multiplier-Amplifier (see paragraph 6–2*b*(6) in section 6).

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART — *Continued*

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	★ 21	Connect Multimeter ME-25A/U between J402 and ground.	Grid voltage: −1.5 to −3.0V DC.	If normal indication is not obtained, check V101, V102, V302, V303, V304, V305, and V401. Replace defective tube.
	DD Figures 5–13 5–14 5–16 5–27			If all tubes are normal, check antenna connections at J1212, inspect RF low pass filter, and connections between P1201 and J101.
	DD_1 Figures 5–14 5–27 5–39 5–41 5–42			If connections are okay, make voltage and resistance checks at R-F Amplifier, Chassis, Frequency, Multiplier-Amplifier Chassis, and at XV401 (refer to figures 5–39, 5–41, and 5–42). Replace the defective component. Realign chassis that have been repaired (see paragraph 6–2*b* in section 6).
7	EE Figures 5–12 5–14 5–27 5–42	Connect Multimeter ME-25A/U between J405 and ground.	Grid Voltage: 2 to −3V DC.	If normal indication is not obtained, replace V404. If indication is still abnormal, make voltage and resistance checks at XV404 (refer to figure 5–42). Replace the defective component.
	FF Figures 5–12 5–14 5–27	Connect Multimeter ME-25A/U between J502 and ground.	Grid Voltage: approx. −0.9V DC.	If normal indication is not obtained, replace V403. If indication is still abnormal, replace V402.
	FF_1 Figures 5–14 5–27 5–42		Grid Voltage: approx. −0.9V DC.	If indication is still abnormal, make voltage and resistance checks at XV402 and XV403 (refer to figure 5–42). Replace the defective component. If indication is still abnormal, replace First I-F Amplifier Chassis. Re-tune (see paragraph 6–2*b*(4) in section 6).
8	★ 22 Figures 5–12 5–14 5–27	Connect Multimeter ME-25A/U between J504 and ground.	−1.5 to −3.0 V DC.	If normal indication is not obtained, check V501 and V502. Replace defective tube.
	GG Figures 5–14 5–27 5–43			If tubes are normal, make voltage and resistance checks at XV501 and XV502 as indicated in figure 5–43. Replace the defective component. Re-tune (see paragraph 6–2*b*(3) in section 6).

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART — *Continued*

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
9	23 Figures 5–12 5–14 5–16 5–27	Connect R-F Signal Generator AN/URM-26 between J404 and ground. Adjust the generator for an output of 9 mc, 30% modulated, at 1000 cps. Connect Multimeter ME-25A/U between J606 and ground, and attenuate output of generator until Multimeter reading is −0.5V DC. Disconnect Multimeter from J606 and connect to J605.	At J605: Above 0.28V AC.	If indication is not normal, check V604, V605, and V606. Replace defective tube.
	HH Figures 5–12 5–16 5–27		At J604: Above 1.3 V AC. −2.3V Bias.	If tubes are okay, disconnect Multimeter from J605 and connect to J604.

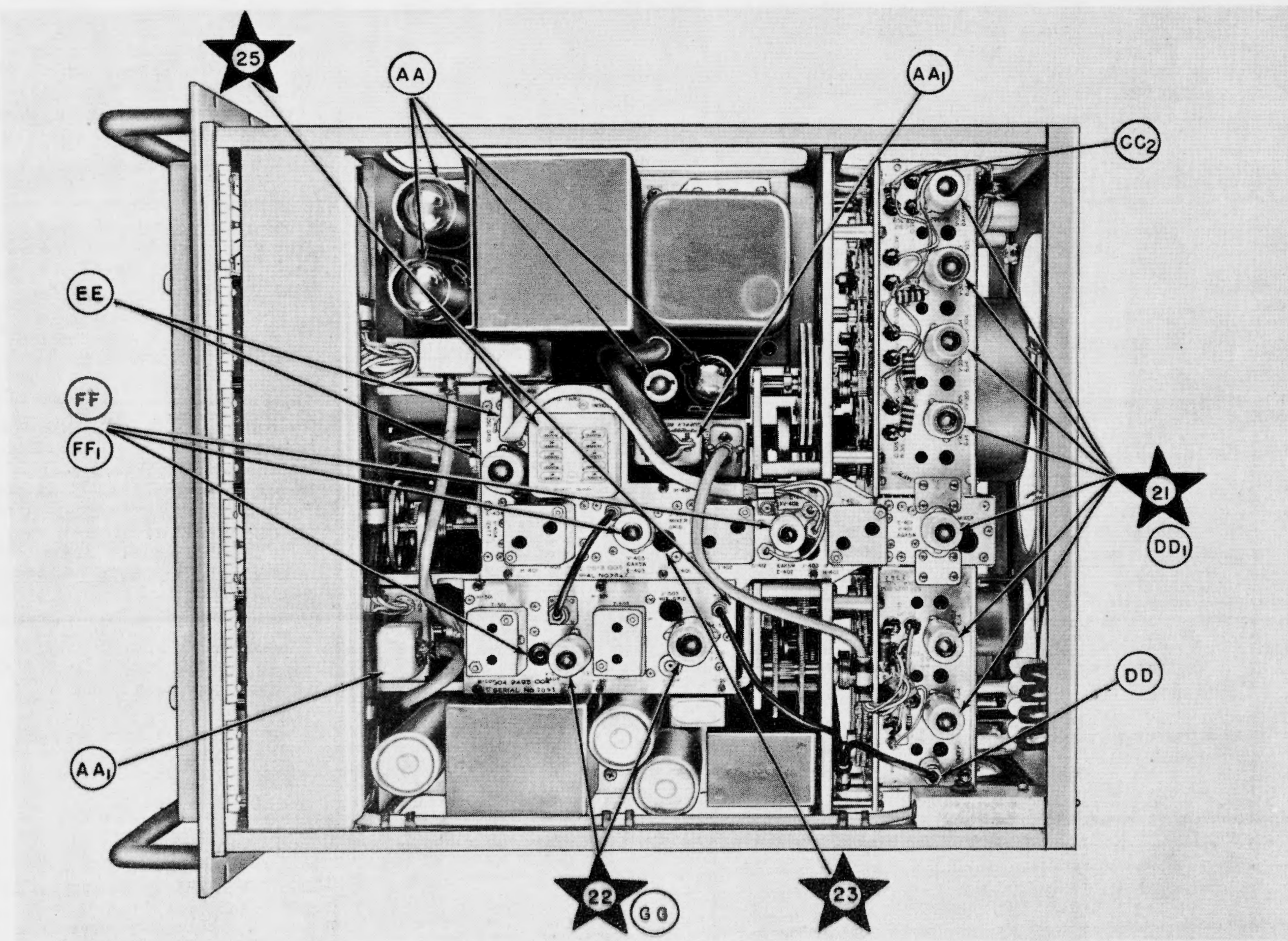


Figure 5–14. Radio Receiver R-278B/GR, Location of Test Points (1 of 2)

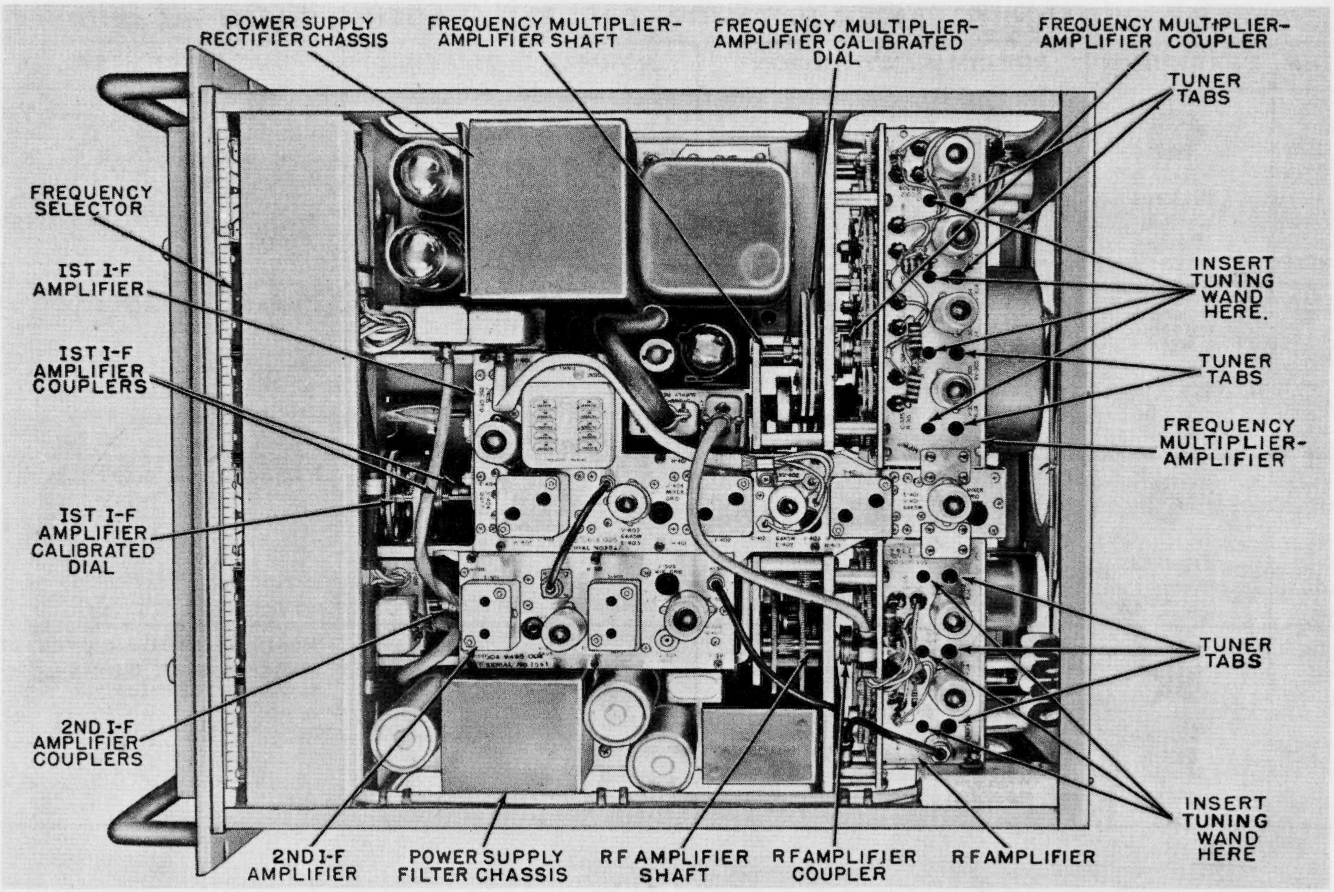


Figure 5-14. Radio Receiver R-278B/GR, Location of Test Points (2 of 2)

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART — *Continued*

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
	HH_1 Figures 5-16 5-27 5-44			If normal reading is not obtained, check V601, V602, and V603. Replace defective tube. If tubes are okay proceed to next step. If normal reading is obtained, trouble lies between J604 and J605. Make voltage and resistance measurements at XV604, XV605, and XV606 as indicated in figure 5-44.
10	HH_2 Figure 5-44			If tubes in O HH_1 check okay, make voltage and resistance checks at all tube sockets in the Third I-F Amplifier as indicated in figure 5-44. Replace the defective component. If trouble has not been located, replace the Third I-F Amplifier Chassis and then re-tune as described in paragraph 6-2*b*(2) in section 6.
11	24 Figures 5-12 5-16 5-18 5-28	With the test equipment set up as described in step 9 above, check for the presence of 1000 cps at J803. Use either an Oscilloscope connected between J803 and ground or Multimeter ME-25A/U.	At J803: Above 0.23V AC.	If no audio is present, check QUIETING control R1204, connection between J1208 and P801, relay K801, FREQ. RESPONSE switch S1203, connections between J1203 and P802, and the audio filter.

TABLE 5-9. RADIO RECEIVER R-278B/GR, TROUBLE SHOOTING CHART — *Continued*

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
	II Figures 5-15 5-28 5-45			If audio is normal, check V801, V802 and V803. If tubes are okay, make voltage and resistance checks at XV801, XV802, and XV803 as indicated in figure 5-45. Replace the defective component.
	II_1 Figures 5-16 5-27	If audio output is distorted, check V605 and V608.		Replace the defective tube.
	II_2 Figures 5-16 5-27	If the carrier-operated relay K801 is not energized when a signal is received, check the squelch circuit (V607 and V608).		Replace the defective tube.
12	25 Figures 5-14 5-15 5-27	If the Receiver is inoperative at certain frequencies, check for a defective crystal in the Main Oscillator, First and Second I-F Amplifier, and check for poor contact on one of the crystal switches or on the toroidal tapered tank of the injection system.		Replace defective crystals. Adjust, burnish or replace defective crystal switches.

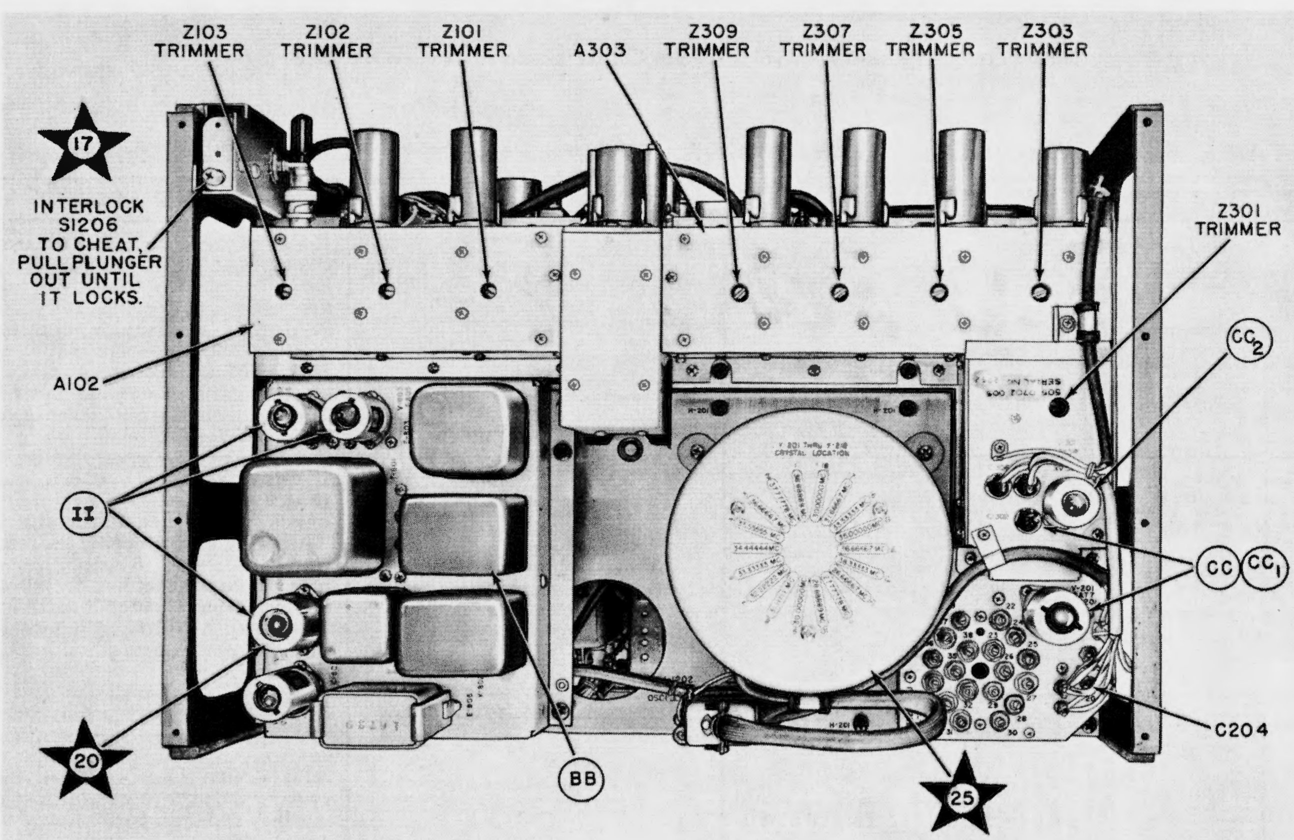


Figure 5–15. Radio Receiver R-278B/GR, Location of Test Points

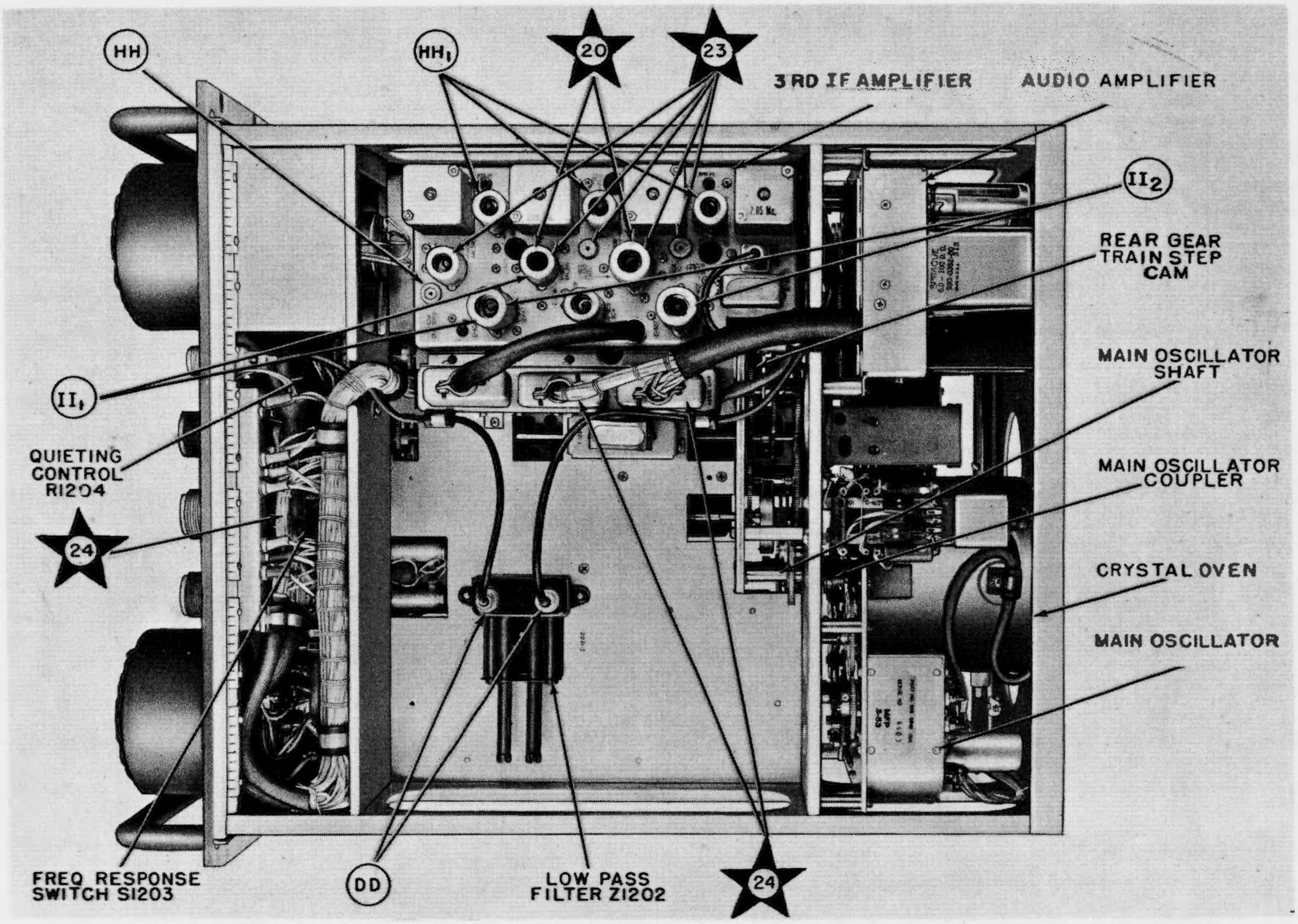


Figure 5–16. Radio Receiver R-278B/GR, Location of Test Points

(3) CONTROL SETTINGS.—Before proceeding with the trouble shooting steps listed in table 5–5, set the controls to the positions shown here.

(*a*) Set the POWER switch on the Receiver front panel to OFF.

(*b*) Set the EMERGENCY switch on the Radio Set Control front panel to ON.

(*c*) Turn the POWER switch on the Modulator-Power Supply to ON.

(*d*) Energize the Transmitter by depressing the START button on the Radio Set Control front panel.

(*e*) Set the NORMAL-EMERG. switch to NORMAL.

(*f*) Set the VOICE-MCW CARRIER ON switch to MCW.

(*g*) Set the AUDIO BANDWIDTH to NORMAL.

(*h*) Set the LIMITER CONTROL to 6.

(*i*) Set the AUDIO GAIN to 6.

(4) MODULATING SECTION TROUBLE SHOOTING CHART.—The modulating section consists of three main circuits: the amplifier and modulator circuit, the mcw oscillator circuit, and the meter circuit. These circuits are shown in figure 5–21. The amplifier and modulator circuit can be considered as the main channel having either voice or mcw tone as an input. In table 5–5, a check is made of the modulating section output signal. If this signal is missing or is not normal, the mcw oscillator (approximately 1000 cps) is then fed into the amplifier and modulator circuit as a test signal for the remainder of the trouble shooting procedure.

Since the meter circuit samples the supply voltages received from the Power Supply section and instructions for trouble shooting this section is given in paragraph 5–6b, no further trouble shooting is required.

In table 5–5, make the checks in the sequence listed to determine the circuit and part at fault. After each preliminary action, compare the indications obtained with the expected results in the NORMAL INDICATION column. If indications are normal, proceed with the next check. If abnormal indications are observed, follow the procedure outlined in the NEXT STEP column.

Figure 5–30 gives voltage and resistance measurements for the electron tubes in the Modulator-Power Supply unit. All measurements made in the equipment should be within 10 percent of the values given in the figure.

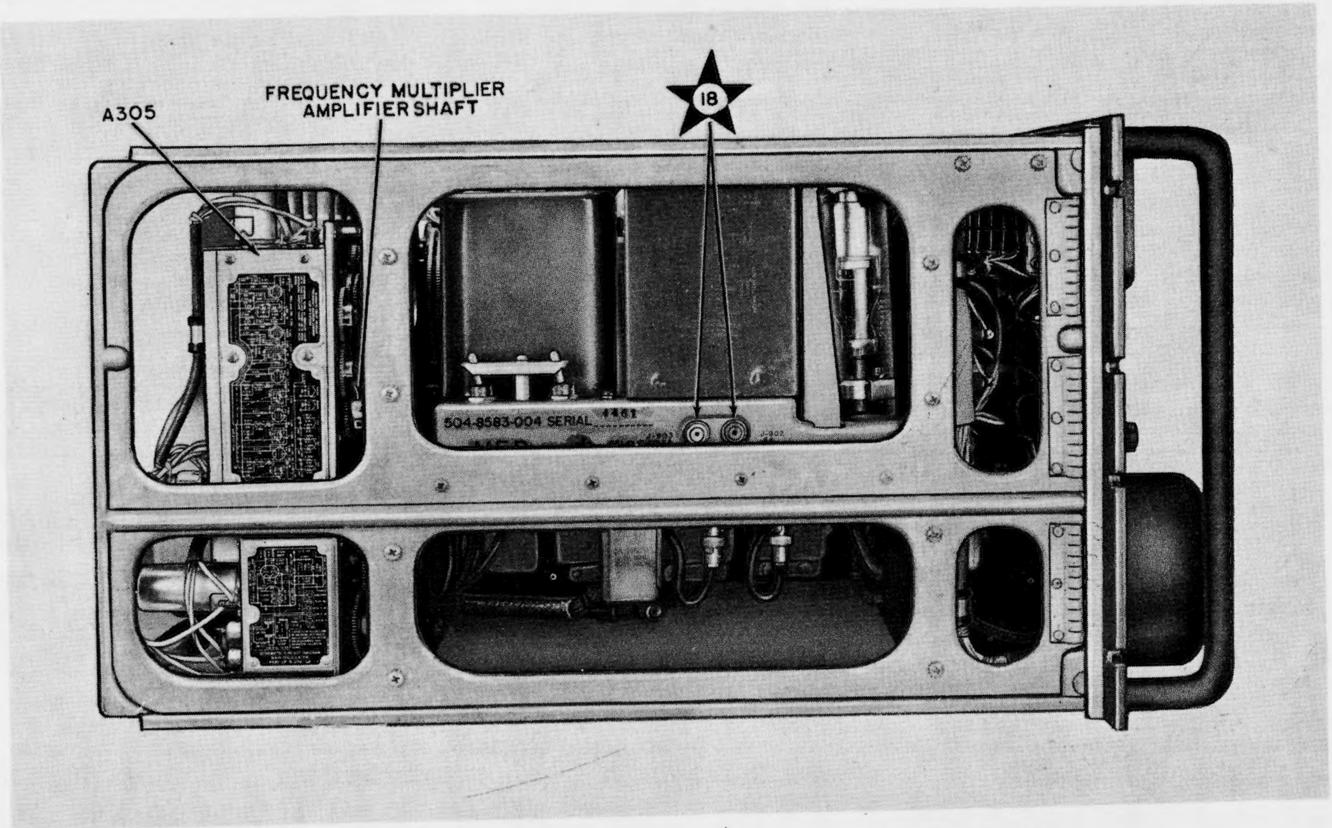


Figure 5–17. Radio Receiver R-278B/GR, Location of Test Points

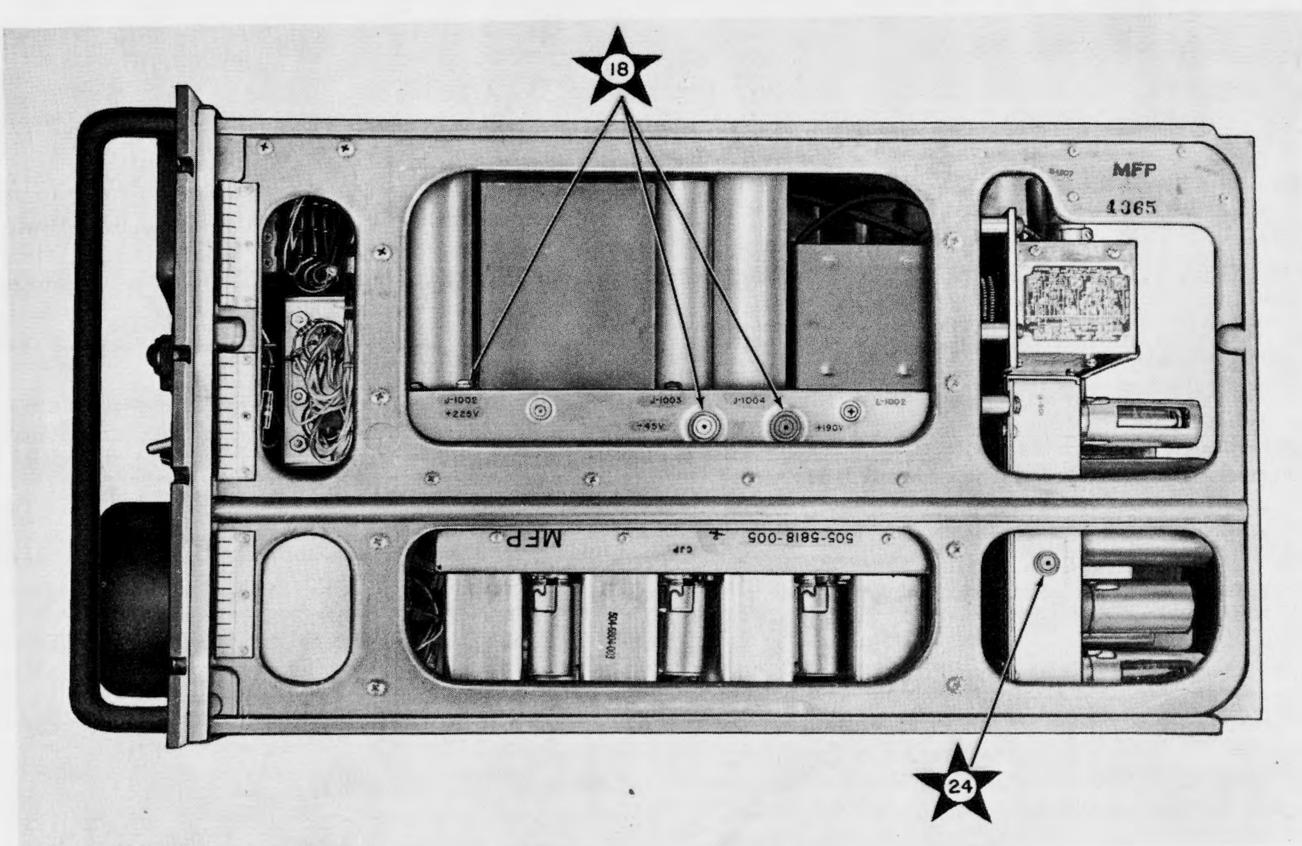
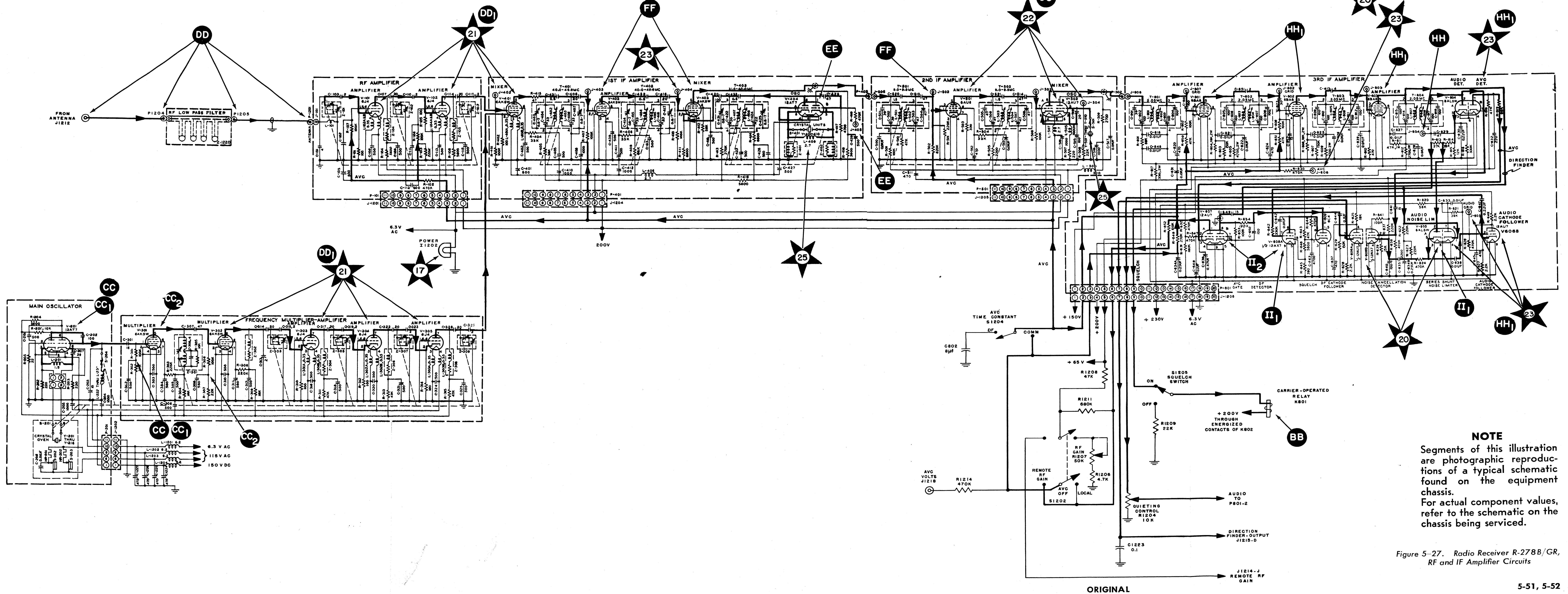


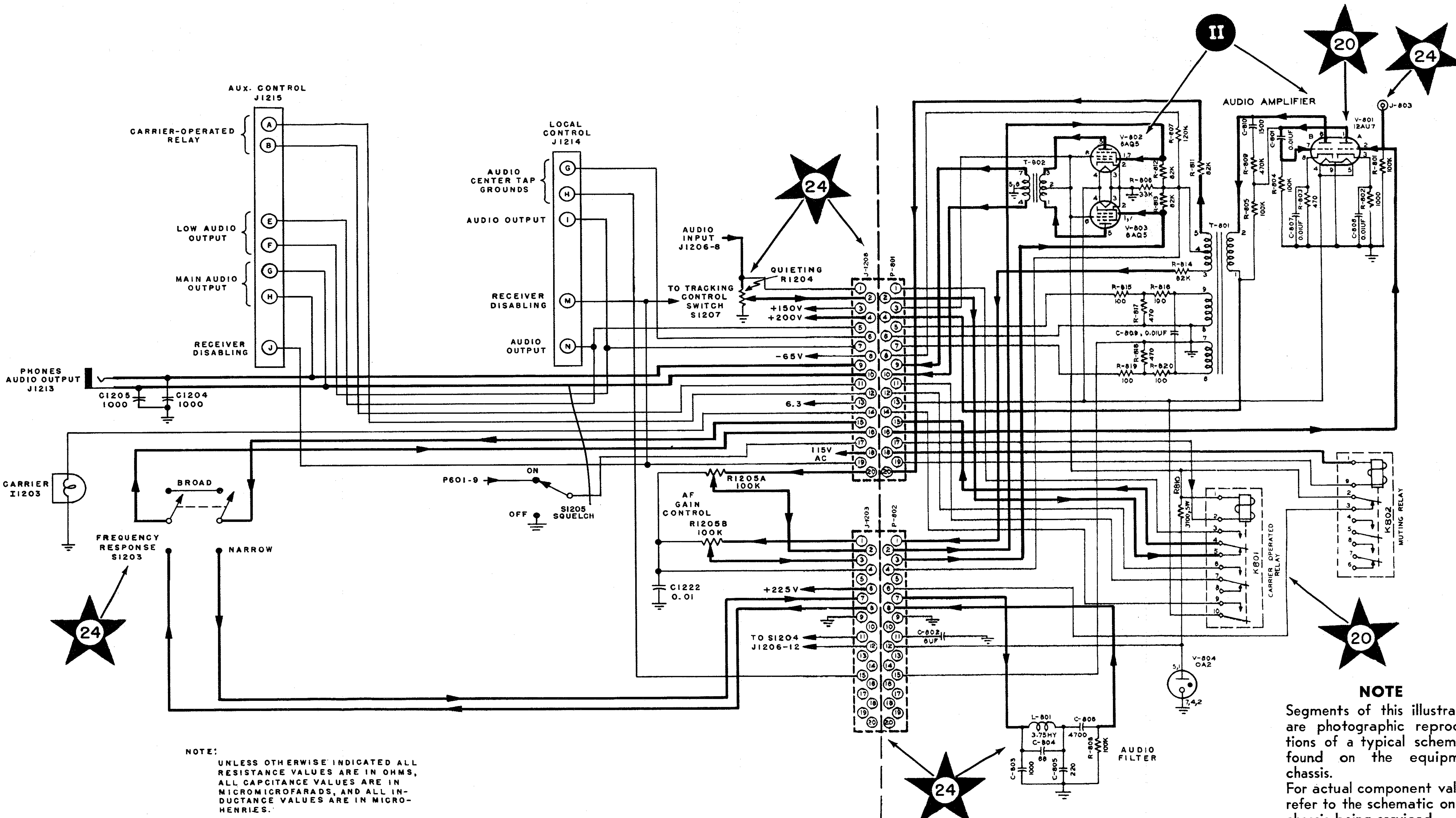
Figure 5–18. Radio Receiver R-278B/GR, Location of Test Points



NOTE

Segments of this illustration are photographic reproductions of a typical schematic found on the equipment chassis.
For actual component values, refer to the schematic on the chassis being serviced.

Figure 5-27. Radio Receiver R-278B/GR, RF and IF Amplifier Circuits



NOTE:
UNLESS OTHERWISE INDICATED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPCITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.

NOTE

Segments of this illustration are photographic reproductions of a typical schematic found on the equipment chassis.
For actual component values, refer to the schematic on the chassis being serviced.

Figure 5 28. Radio Receiver R-278B GR, Audio Amplifier

NOTE
Segments of this illustration are photographic reproductions of a typical schematic found on the equipment chassis.
For actual component values, refer to the schematic on the chassis being serviced.

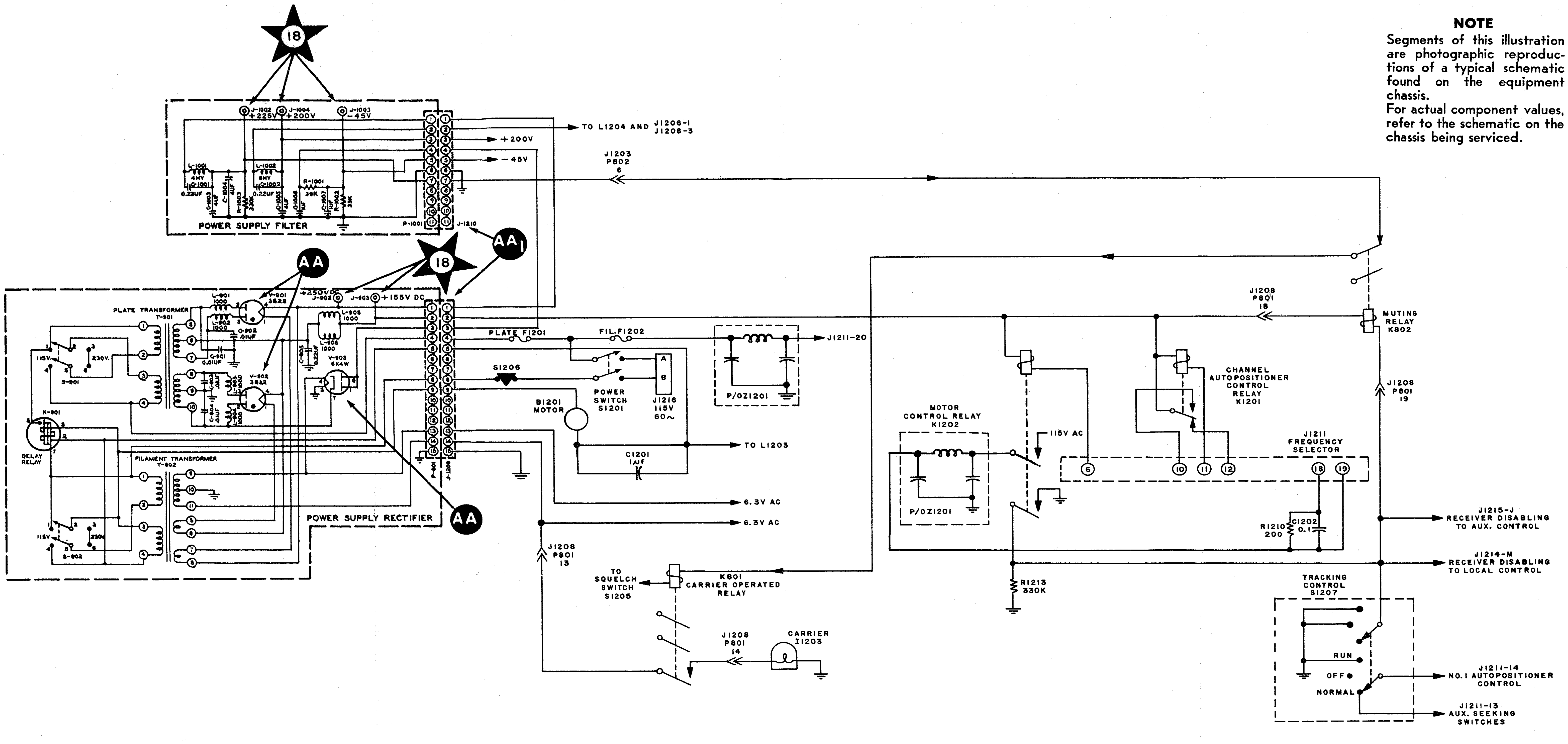
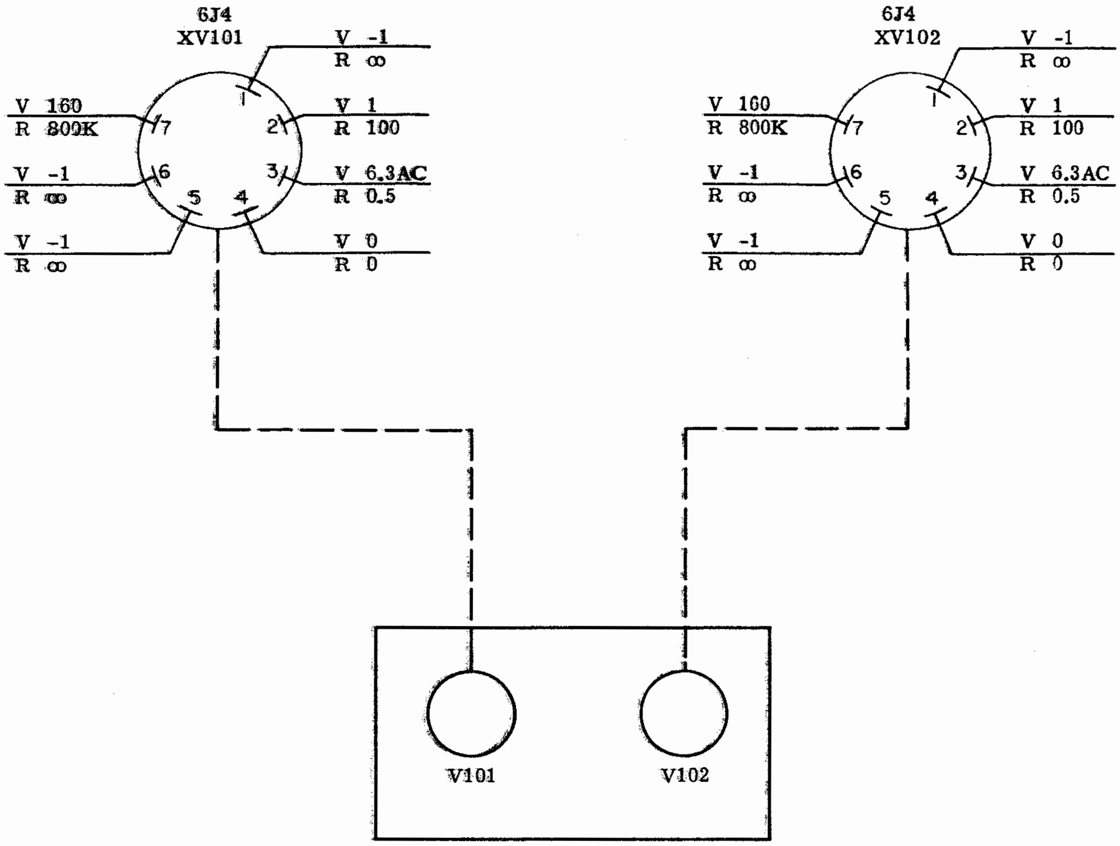


Figure 5-29. Radio Receiver R-278B/GR, Supply Circuit



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

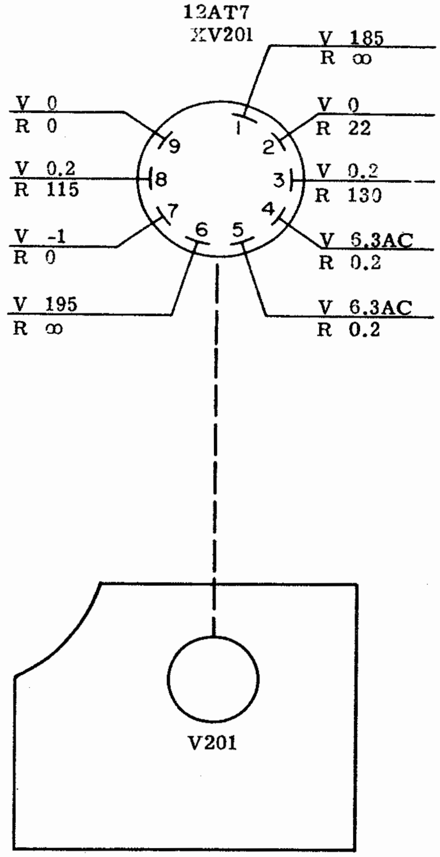
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-39. Radio Receiver R-278B/GR, R. F. Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

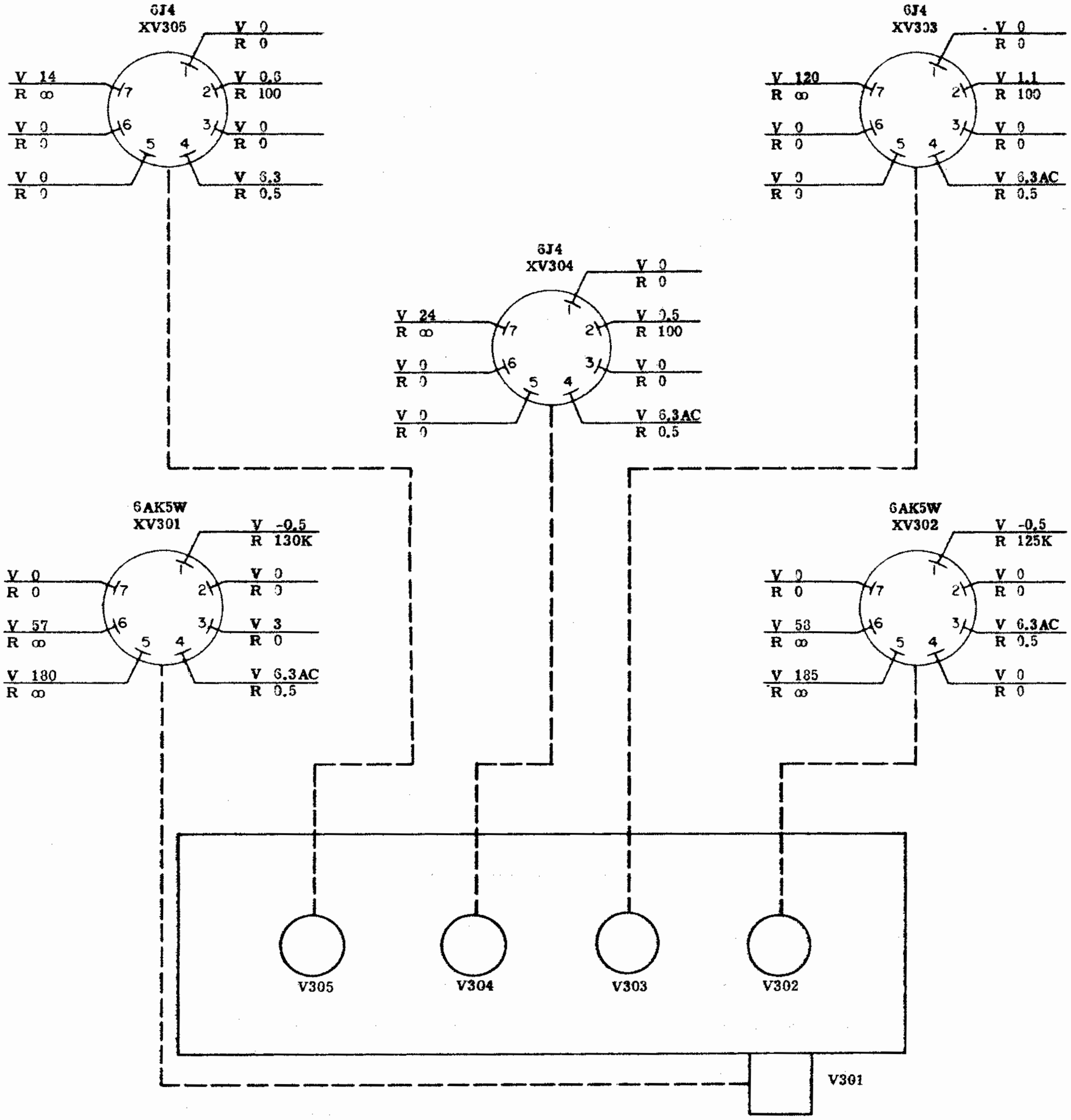
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5–40. Radio Receiver R-278B/GR, Main Oscillator, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

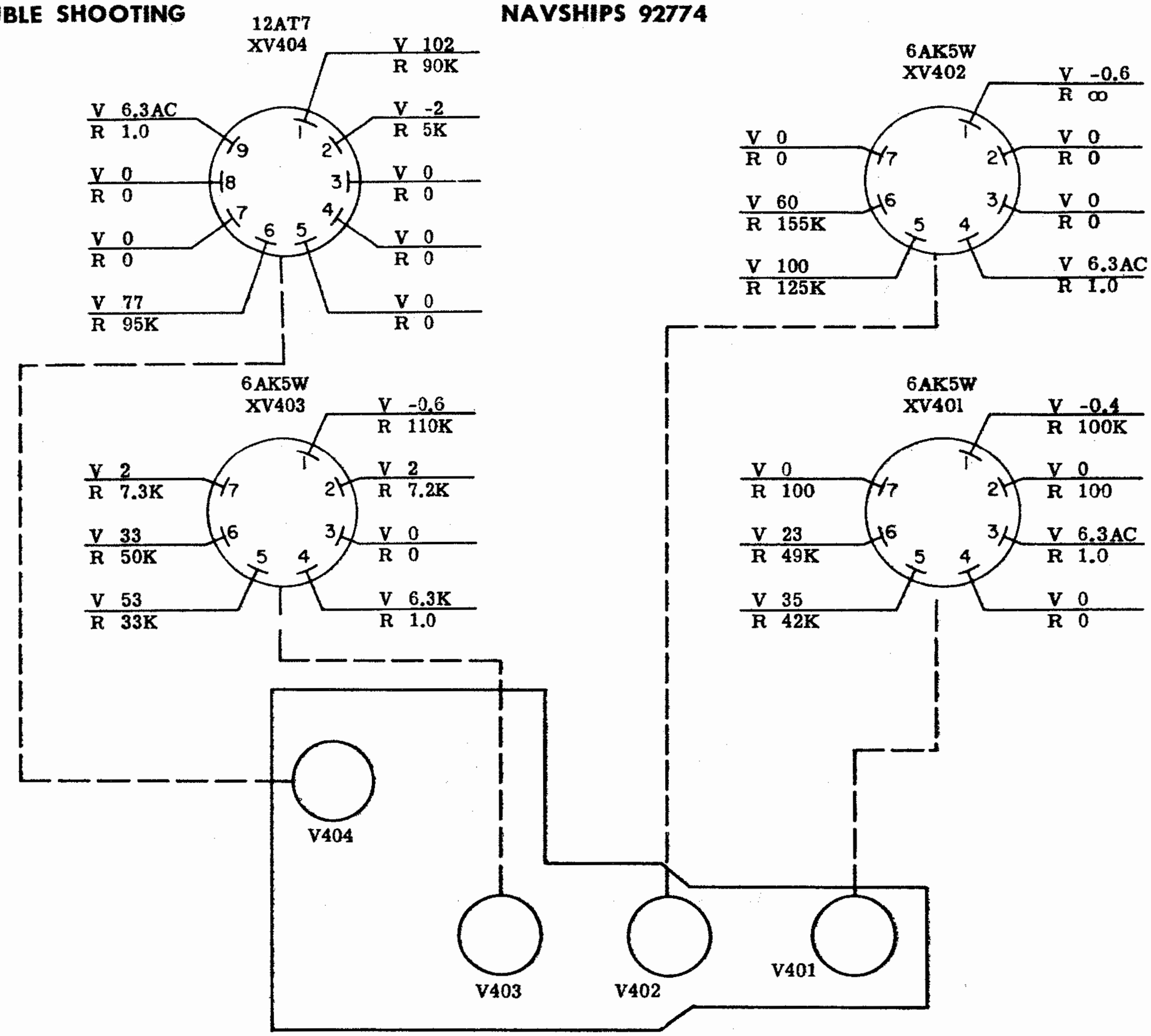
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-41. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

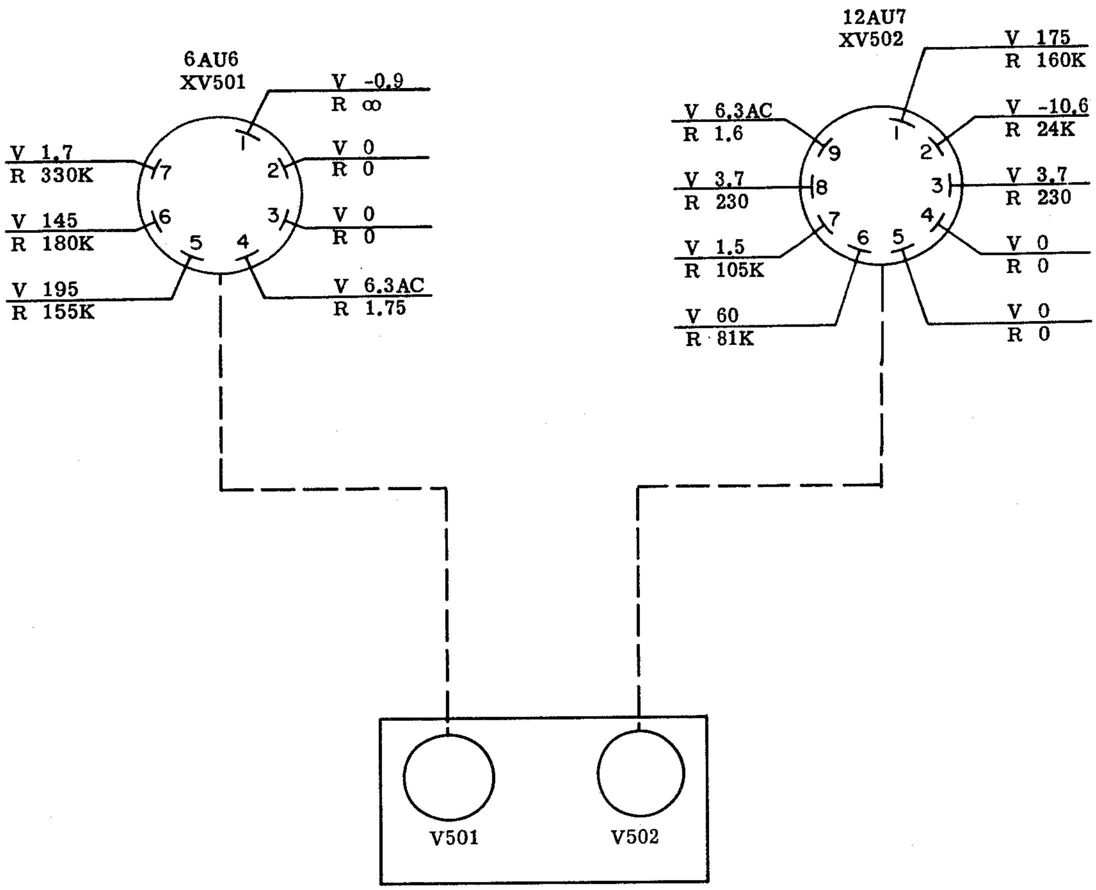
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-42. Radio Receiver R-278B/GR, 1st I-F Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

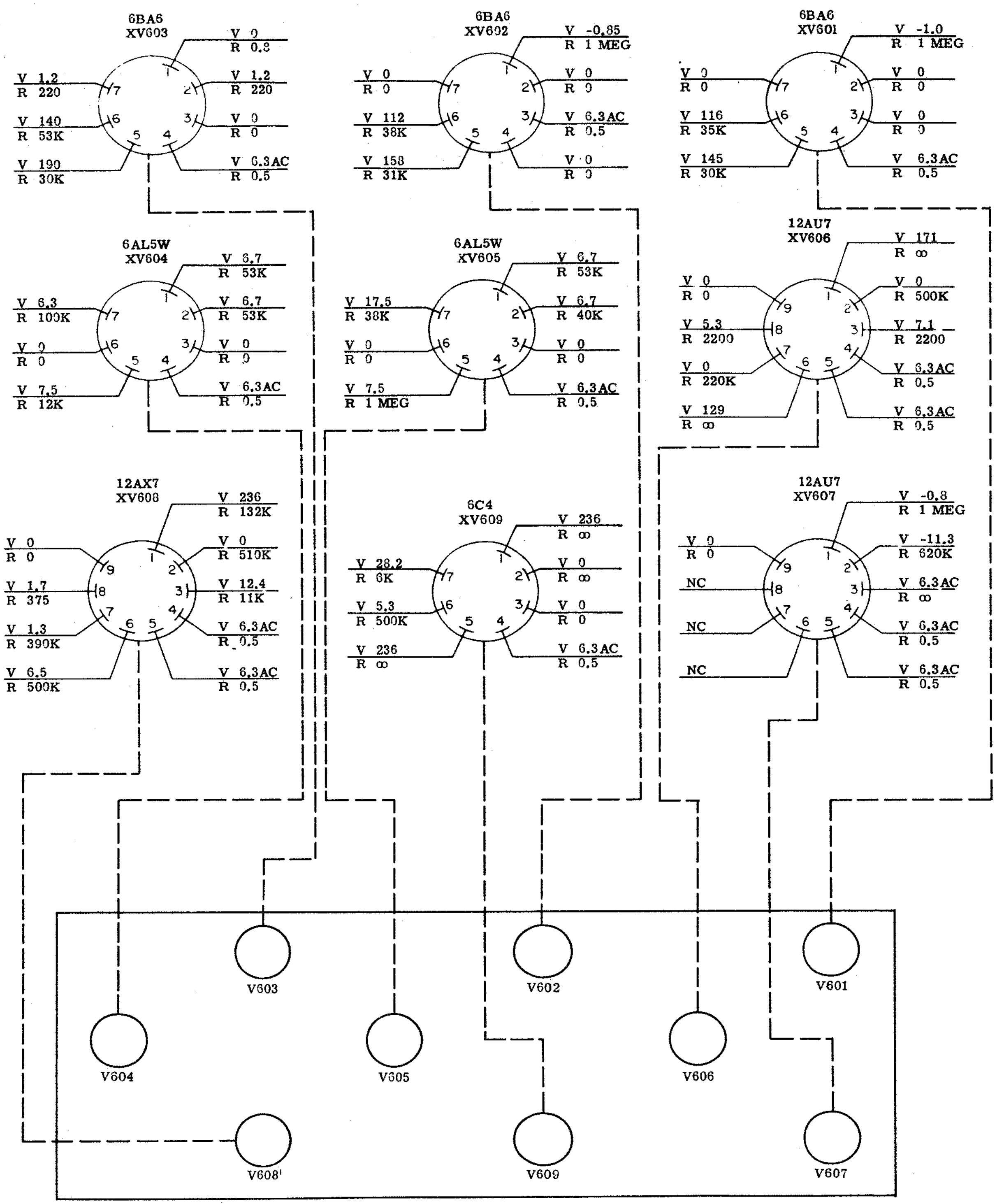
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-43. Radio Receiver R-278B/GR, 2nd I-F Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

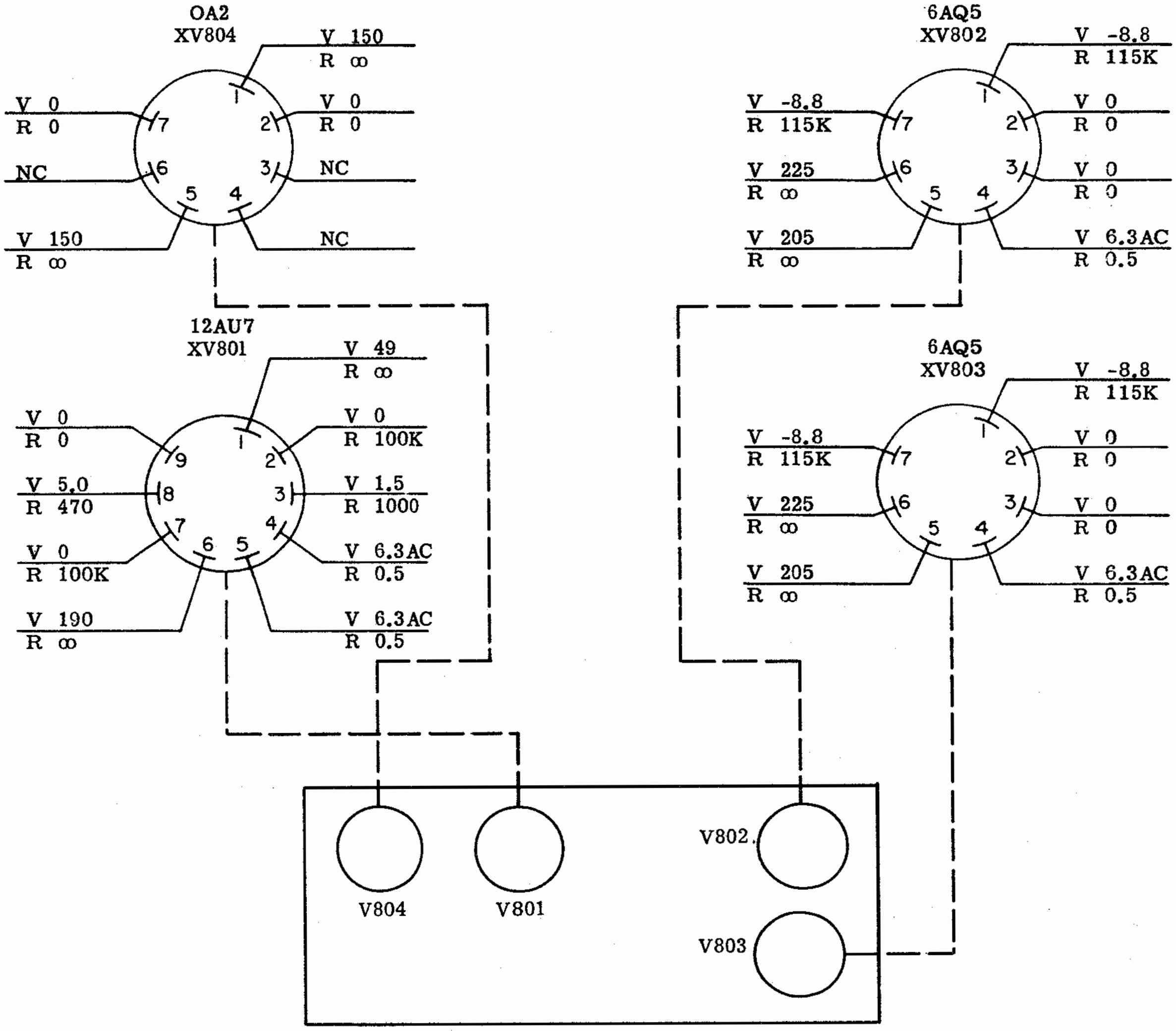
All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V	indicates DC voltage to ground unless otherwise specified.
AC	indicates AC voltage to ground unless otherwise specified.
K	indicates thousands of OHMS.
MEG	indicates millions of OHMS.
∞	indicates infinity.
NC	indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-44. Radio Receiver R-278B/GR, 3rd I-F Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Power plugs were removed from sockets.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

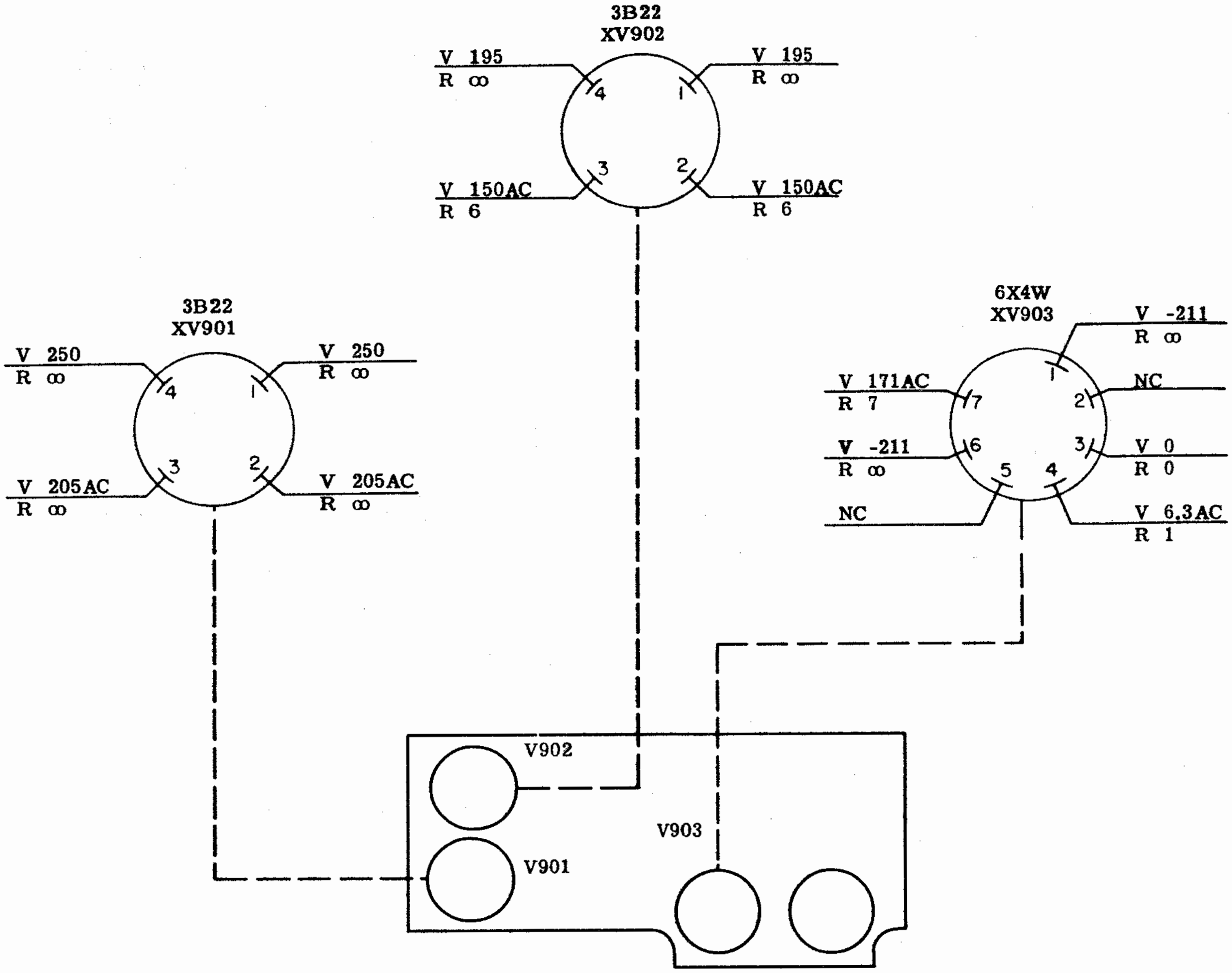
MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5-45. Radio Peceiver R-278B/GR, Audio Amplifier, Voltage and Resistance Chart



NOTES:

For resistance measurements: Disconnect external cables.

For voltage measurements: No signal fed into receiver, Main R-F Gain at maximum position, A-F Gain at maximum position.

AVC switch ON, Squelch switch ON, and Frequency Response switch on NARROW.

All resistances in OHMS unless otherwise specified.

KEY TO SYMBOLS:

V indicates DC voltage to ground unless otherwise specified.

AC indicates AC voltage to ground unless otherwise specified.

K indicates thousands of OHMS.

MEG indicates millions of OHMS.

∞ indicates infinity.

NC indicates no connection.

Readings taken with Multimeter ME-25A/U or equivalent meter having a resistance of 1000 and 20,000-OHMS-Per-Volt for AC and DC measurements, respectively.

Figure 5–46. Radio Receiver R-278B/GR, Power Supply, Voltage and Resistance Chart

SECTION 6
REPAIR

6-1. FAILURE REPORT.

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

"YOUR SIDE"

"Every FAILURE REPORT is a boost for you:
1. It shows that you are doing your job.
2. It helps to make your job easier.
3. It insures available replacements.
4. It gives you a chance to pass your knowledge to every man on the team.

"BUREAU SIDE"

"The Bureau of Ships uses the information to:
1. Evaluate present equipment.
2. Improve future equipment.
3. Order replacements for stock.
4. Prepare field changes.

Always keep a supply of failure report forms on board. You can get them from the nearest District Publications and Printing Office."

6-2. TUNING AND ADJUSTMENT.

The following paragraphs include tuning and adjustment procedures necessary to maintain performance standards normally expected of this equipment. All tests, alignments, and adjustments should be recorded for future reference. Dial settings and voltage and current readings are important aids to corrective maintenance.

Note

A tracking control switch is provided in the Receiver and in the Transmitter as an aid in servicing and aligning the equipment. With this switch in the RUN position, K1102 is continuously energized. By placing this switch in the RUN position and then returning it to the OFF position at the correct instant, it is possible to stop the 10-mc autopositioner at any point for access to the adjustments.

a. TEST EQUIPMENT AND SPECIAL TOOLS.—The following test equipment is required for all of the tests and tuning adjustments in this section.

(1) TEST EQUIPMENT REQUIRED.

ITEM NO.	NOMENCLATURE	CHARACTERISTICS	APPLICATION
1	R-F Signal Generator AN/URM-25A	10 kc to 50 mc; output, 0.1 uv to 0.1 v; mod, 400 to 1000 cps.	For alignment procedures.
2	R-F Signal Generator AN/URM-26	4 to 408 mc; output, 0.1 uv to 0.1 v; mod, 400 to 1000 cps.	For alignment procedures.
3	Frequency Meter AN/USM-29	Fundamentals, 15 kc to 30 mc; harmonics, for higher freq.	Used as frequency standard.
4	Vacuum Tube Voltmeter AN/USM-34	0.01 v to 1000 v.	Used for trouble shooting and alignment.
5	Electronic Multimeter ME-25/U	0 to 1000 v ac-dc; 0 to 1000 ma; 0 to 1000 meg ohms.	Used for trouble shooting and maintenance.
6	Audio Oscillator TS-382 ( )/U	20 to 200 kc, ±2%; output 0 to 100 mw.	Provides audio test signal.
7	Megohmmeter Navy Type 60089	0.1 to 10,000 meg.	For high resistance measurements.
8	R-F Output Load or Wattmeter	52 ohms, resistive 100 w min.	For measuring r-f power.
9	Oscilloscope OS-8/U	Sensitivity, 0.1 v (RMS)/in.; response, ±3 db from 30 cps to 2 mc.	For waveshape analysis.

(2) **TEST EQUIPMENT TO BE FABRICATED.**

ITEM NO.	INSTRUMENT	DESCRIPTION
1	Dummy load	Consists of eight 40-watt, 120-volt light bulbs connected in series. Ceramic bases must be used for high voltage protection. This instrument is used to terminate the high-voltage d-c output from the Modulator-Power Supply during tests or alignments.
2	600-ohm, 5-watt carbon resistor	
3	2 mfd, 600 v capacitor	
4	Tuning wands	See figure 6–1. Each of these two wands consists of a piece of 3/16 inch diameter phenolic rod, 6 inches long. To the end of one rod is attached a brass slug and to the other end is attached a powdered iron slug. To eliminate making parts A and B (shown in figure 6–1), the powdered iron core should be taken from a scrapped i-f can.

(3) **SPECIAL TOOLS SUPPLIED.**

UNIT	NOMENCLATURE
Radio Receiver R-278B/GR	#1 Phillips offset Screwdriver (Vaco #1) #6 Bristo Wrench (Bristol #6) #8 Bristo Wrench (Bristol #8) #10 Bristo Wrench (Bristol #10) #8 Long-handled Bristo Wrench (CR No. 505 0825 002) Special Tuning Tool (CR No. 505 0833 003)
Radio Transmitter T-217A/GR	#1 Phillips Offset Screwdriver (Vaco #1) #6 Bristo Wrench (Bristol #6) #8 Bristo Wrench (Bristol #8) #10 Bristo Wrench (Bristol #10) #8 Long-handled Bristo Wrench (CR No. 505 0825 002) Special Tuning Tool (CR No. 505 1923 002) End Wrench (CR No. 024 0110 00)
Modulator-Power Supply MD-129A/GR	#1 Phillips Screwdriver (L shaped) (Vaco #1) #8 Bristo Wrench (Bristol #8) #10 Bristo Wrench (Bristol #10)

(4) **SPECIAL TOOL REQUIRED BUT NOT SUPPLIED.**

NOMENCLATURE	PURPOSE
#2 Truarc Pliers	Remove retaining rings from shafts.
Tuning Wand (¼ in. dia.)	Check tuning of r-f tuners and i-f transformers.
Tuning Wand (3/16 in. dia.)	Check tuning of 2nd i-f amplifier transformers.
Set of Adapter Plugs	Make tube voltage readings possible without removing chassis.
Non-metallic Tuning Tool (CR No. 024 0039 00)	Adjust r-f trimmers.
Slender tab bending tool made up of blunted scribe with sides ground flat (or equivalent).	Adjusting r-f tuner tabs.

b. RECEIVER ALIGNMENT.

Note

To check interlock S1206 (figure 5–15), pull out the plunger until it locks.

(1) GENERAL.—The following procedures apply to the alignment of a complete unit. In general, servicing will involve the realignment of only one subassembly within the unit. In most cases this involves only slight readjustments, so that many of the detailed steps given here can be omitted. Check for mechanical synchronization before proceeding with the electrical alignment procedures. The check procedure is given in table 6–1.

Note

If synchronization is in error on any subassembly, refer to the paragraph given in table 6–1 under INDICATION.

Note

A tracking control switch is provided in the Receiver and in the Transmitter as an aid in servicing and aligning the equipment. With this switch in the RUN position, K1102 is continuously energized. By placing this switch in the RUN position and then returning it to the OFF position at the correct instant, it is possible to stop the 10-mc autopositioner at any point for access to the adjustments.

Performance standards for the Receiver of Radio Set AN/GRC-27A are given in NAVSHIPS 92383.31. If the standards given there are not met, the alignment procedures given here should be followed.

(2) THIRD I-F AMPLIFIER ALIGNMENT

(*a*) TEST EQUIPMENT REQUIRED

1. R-F Signal Generator AN/URM-25A

2. Frequency meter AN/USM-29

3. Vacuum Tube Voltmeter AN/USM-34

4. 2200-ohm, 2-watt resistor

5. Alignment tool.

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) in 220.0 mc position.

(*c*) TEST SET-UP.

Step 1. Lay the Receiver on its right-hand side.

Step 2. Remove the Third I-F Amplifier subassembly (figure 5–16) from the Receiver chassis.

Step 3. Remove bottom cover plate A602 (figure 6–3).

Step 4. Make electrical connections to Receiver chassis.

Step 5. Remove V501 from the Second I-F Amplifier subassembly (figure 3–4).

(*d*) CONNECTIONS.

Step 1. Connect the VTVM to AVC jack J606 (figure 6–2).

Step 2. Connect R-F Signal Generator AN/URM-25A output lead to J603 (figure 6–2).

WARNING

When servicing a subassembly that has been removed from the Receiver chassis, always ground the subassembly to the chassis.

Note

R-F Signal Generators AN/URM-25A and AN/URM-26 are not sufficiently accurate for the alignment of the various subassemblies of Radio Receiver R-278B/GR without first checking the frequency of these signal generators against a secondary standard such as Frequency Meter AN/USM-29. R-F Signal Generators AN/URM-25A and AN/URM-26 have a calibrated attenuator which is useful in alignment procedures. It is recommended that the frequency of these signal generators be checked against the Frequency Meter prior to each alignment operation.

At the output frequencies of 220 to 400 mc, an alternate method of obtaining an accurate frequency source is to use a Radio Transmitter T-217A/GR known to be operating properly. To use this Transmitter as a signal generator, connect the Transmitter to a 50-ohm absorbing type load using a T-fitting such as UG-413/U at the Transmitter output terminal or at the load. To the T-fitting, connect a suitable length of RG-8/U or RG-58/U coaxial line with a UG-59A/U plug. Remove the inner-conductor pin from the plug and cut the inner conductor of the cable flush with the end of the dielectric. In this manner, a small amount of r-f energy can be coupled capacitively from the Transmitter output for application to the proper points for alignment of the Receiver.

TABLE 6-1. RADIO RECEIVER R-278B/GR, MECHANICAL SYNCHRONIZATION

STEP	FIGURE	POSITION	INDICATION	FREQ. IN MC
1	6-47	Couplers behind front panel as observed from bottom of Receiver.	Scribe lines on couplers aligned with scribe lines on blocks. (See para. 6-3*a*(11) (*b*)1.)	390.0
2	5-14	Calibrated dial ahead of first I-F amplifier.	"0"	390.0
3	5-14	Coupler ahead of second I-F amplifier.	Red dot up. (See para. 6-3*a*(6) (*b*)).	360.9
4	5-14	Iron cores in transformers of second I-F amplifier.	Position for smallest amount of core in coil.	360.9
5	5-14	Two couplers ahead of first I-F amplifier.	Both red dots up. (See para. 6-3*a*(6) (*b*)).	369.9
6	5-14	Iron cores in transformer of first I-F amplifier.	Position for smallest amount of core in coil. (See para. 6-3*a*(5) (*b*)).	369.9
7	5-14	Crystal switch in first I-F amplifier.	Switch on position number "1" (40 mc crystal position). (See para. 6-3*a*(5) (*b*)).	369.0
8	5-16	Step cam in rear gear train.	Follower on highest point on cam. (See para. 6-3*a*(13) (*c*)2).	360.0
9	5-14	Calibrated dial ahead of frequency multiplier amplifier.	"39". (See para. 6-3*a*(4) (*b*)).	390.0
10	5-14	Shaft driving frequency multiplier amplifier.	Gear train is spring loaded removing backlash. (See para. 6-3*a*(13) (*c*)).	Any freq.
11	5-14	Shaft driving R-F amplifier.	Gear train is spring loaded removing backlash. (See para. 6-3*a*(3) (*c*)).	Any freq.
12	5-14	Coupler ahead of frequency multiplier amplifier.	Red dot up. (See para. 6-3*a*(4) (*b*)).	220.0
13	5-15	Rotor bar in all four frequency multiplier amplifier tuners, with A303 removed.	Opposite eyelet at bottom of tuner (bar directly beneath driven shaft, as viewed from top of tuner). (See para. 6-3*a*(4) (*b*)).	220.0
14	5-14	Coupler ahead of r-f amplifier.	Red dot up. (See para. 6-3*a*(2) (*b*)).	360.0
15	5-15	Rotor bar in all three R-F amplifier tuners, with A102 removed.	Vertical position directly above driven shaft. (See para. 6-3*a*(2) (*b*)).	390.0
16	5-17	Toroidal (step) tuner (Z301) as observed with A305 removed.	Contact on smallest turn of coil. (Must have tension holding contact against turn). (See para. 6-3*a*(4) (*b*)).	390.0
17	5-17	Shaft driving toroidal (step) tuner (Z301).	No spring loading. Small back lash movement possible. (See para. 6-3*a*(4) (*b*)).	Any freq.
18	5-16	Shaft driving main oscillator.	No spring loading. Small back lash movement possible. (See para. 6-3*a*(3) (*b*)).	Any freq.
19	5-16	Coupler on shaft driving main oscillator.	Red dot toward bottom of receiver. (See para. 6-3*a*(3) (*b*)).	220.0

(*e*) PROCEDURE.

Step 1. Energize the Receiver, R-F Signal Generator, Frequency Meter, and the Vacuum Tube Voltmeter. For best results, the equipment should be warmed up for at least one hour before alignment.

WARNING

Voltages dangerous to life are present in the exposed circuits when the Receiver is energized in this position. Observe all high-voltage safety precautions.

Step 2. Accurately tune the R-F Signal Generator for a frequency of 2.05 mc and adjust the output to give a Vacuum Tube Voltmeter reading of 2.5 VDC. Check this frequency against Frequency Meter AN/-USM-29 before proceeding to the next step.

Step 3. First peak the secondary and then peak the primary of T604 (figure 6–2) for maximum output. Adjust the R-F Signal Generator to maintain the VTVM reading of 2.5 to 3.5 VDC.

Step 4. Connect the R-F Signal Generator to J602 (figure 6–2) and adjust the Signal Generator for a VTVM reading of 2.5 VDC. Check the frequency of the R-F Signal Generator against the Frequency Meter.

Step 5. Shunt the primary, terminals 1 and 2 of T603, with a 2200-ohm resistor and peak the secondary, (bottom adjustment, figure 6–3) for maximum output. Adjust the Signal Generator to maintain a VTVM reading of 2.5 to 3.5 VDC.

Step 6. Shunt the secondary, terminals 3 and 4 of T603, with the 2200-ohm resistor and peak the primary (top adjustment, figure 6–2) in accordance with step 5 above.

Step 7. Connect the Signal Generator to J607 and adjust the signal generator for a VTVM reading of 2.5 VDC. Check the frequency of the signal generator against the Frequency Meter.

Step 8. Tune T602 using the same procedure as in steps 5 and 6 above.

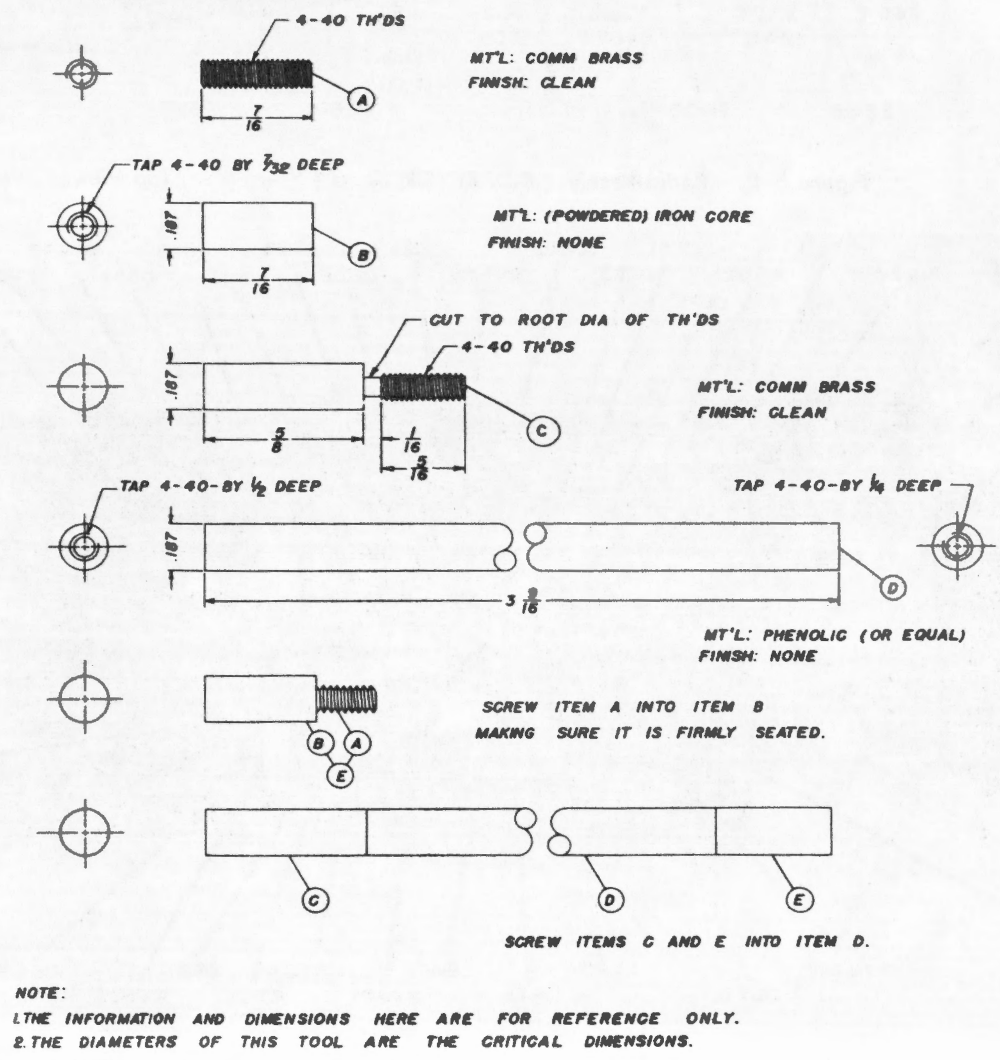


Figure 6–1. Tuning Wand, Outline Drawing

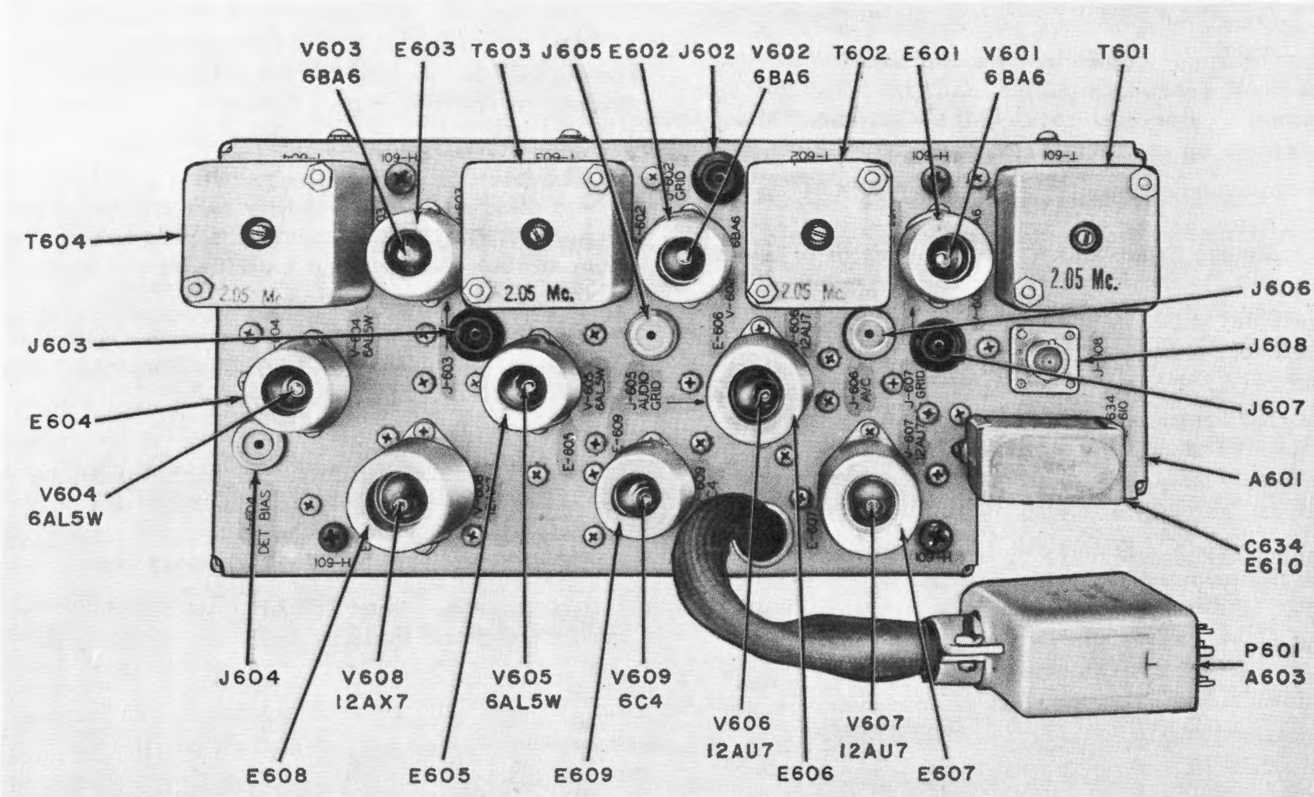


Figure 6–2. Radio Receiver R-278B/GR, Third I-F Amplifier, Top View

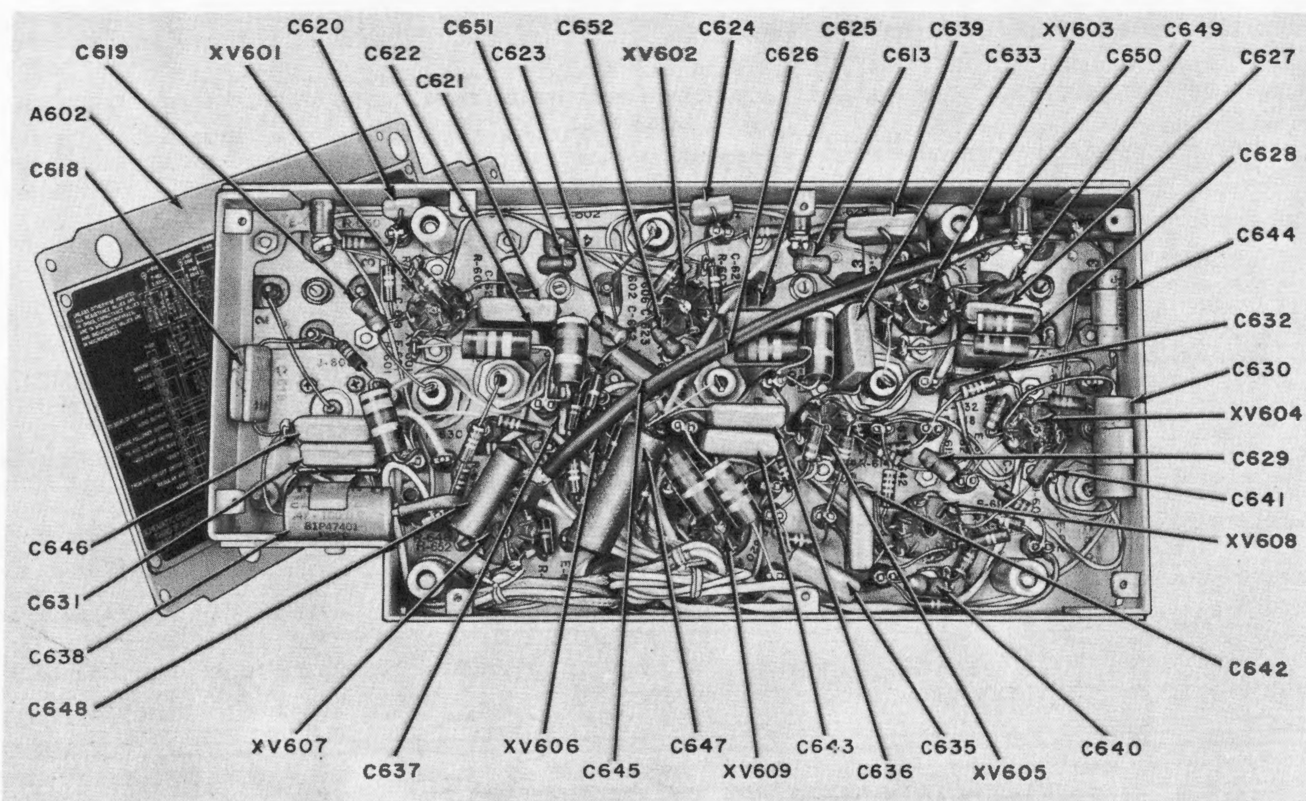


Figure 6–3. Radio Receiver R-278B/GR, Third I-F Amplifier, Bottom View (1 of 2)

Step 9. Connect the Signal Generator to J503 (figure 6–4) and peak T601 using the same procedure as in steps 4, 5, and 6 above.

(3) SECOND I-F AMPLIFIER ALIGNMENT.

Note

Do not remove the second I-F Amplifier subassembly from the Receiver chassis. It must be aligned in its normal position.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-25A

2. Frequency Meter AN/USM-29

3. Vacuum Tube Voltmeter AN/USM-34

4. Alignment Tool

5. Tuning Wand (paragraph 6–2*a*).

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

2. AVC TIME CONSTANT switch (S1204) set in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) to 220.5 mc.

(*c*) TEST SET-UP.

Step 1. Lay the Receiver on its right-hand side.

Step 2. Remove V402 and V404 (figure 3–4) from the First I-F Amplifier subassembly.

Step 3. Remove the Third I-F Amplifier subassembly (figure 5–16) from the Receiver chassis and make the electrical connections. Removal of the Third I-F Amplifier subassembly makes adjustments on the underside of the Second I-F Amplifier subassembly accessible.

(*d*) CONNECTIONS.

Step 1. Connect the VTVM to AVC jack J606 (figure 6–2).

Step 2. Connect the R-F Signal Generator to J404 (figure 6–7).

Step 3. Ground the Second I-F Amplifier subassembly to the Receiver chassis.

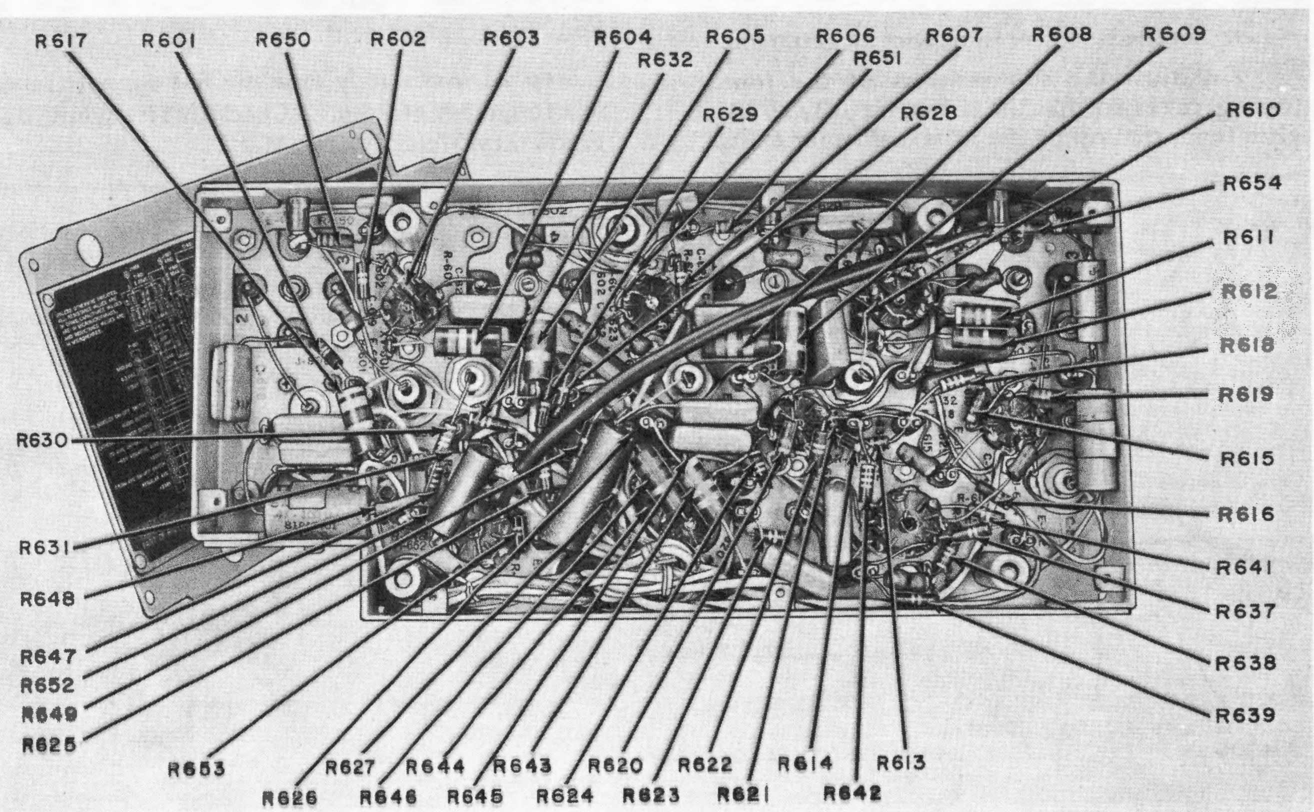


Figure 6–3. Radio Receiver R-278B/GR, Third I-F Amplifier, Bottom View (2 of 2)

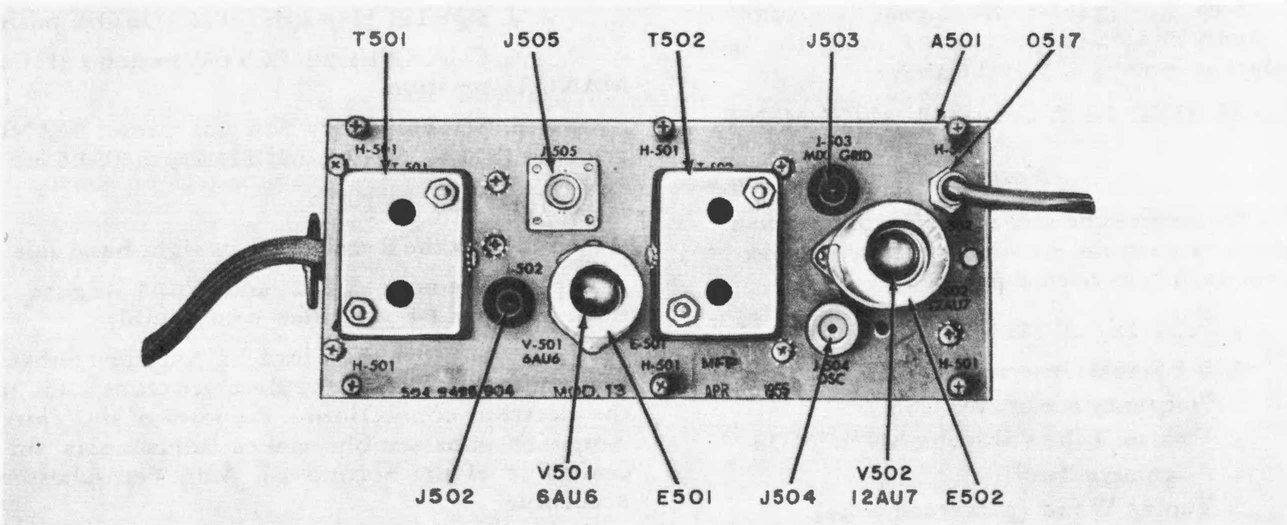


Figure 6–4. Radio Receiver R-278B/GR, Second I-F Amplifier, Top View

(*e*) PROCEDURE.

Note

If the chassis is completely out of alignment or if an i-f transformer has been replaced, an approximate adjustment of the tuning cores can be made as follows:

1. Set the Receiver frequency at 220.9 mc.

2. Adjust the top of each of the four tuning cores so that the cores are 1-3/16 inches from the top of the i-f transformer cans.

WARNING

Observe all high-voltage safety precautions.

Step 1. Energize the Receiver, R-F Signal Generator, and the Vacuum Tube Voltmeter. For best results, the equipment should be warmed up for at least one hour before alignment.

Step 2. Accurately tune the R-F Signal Generator to a frequency of 9.5 mc. Check this frequency against Frequency Meter AN/USM-29.

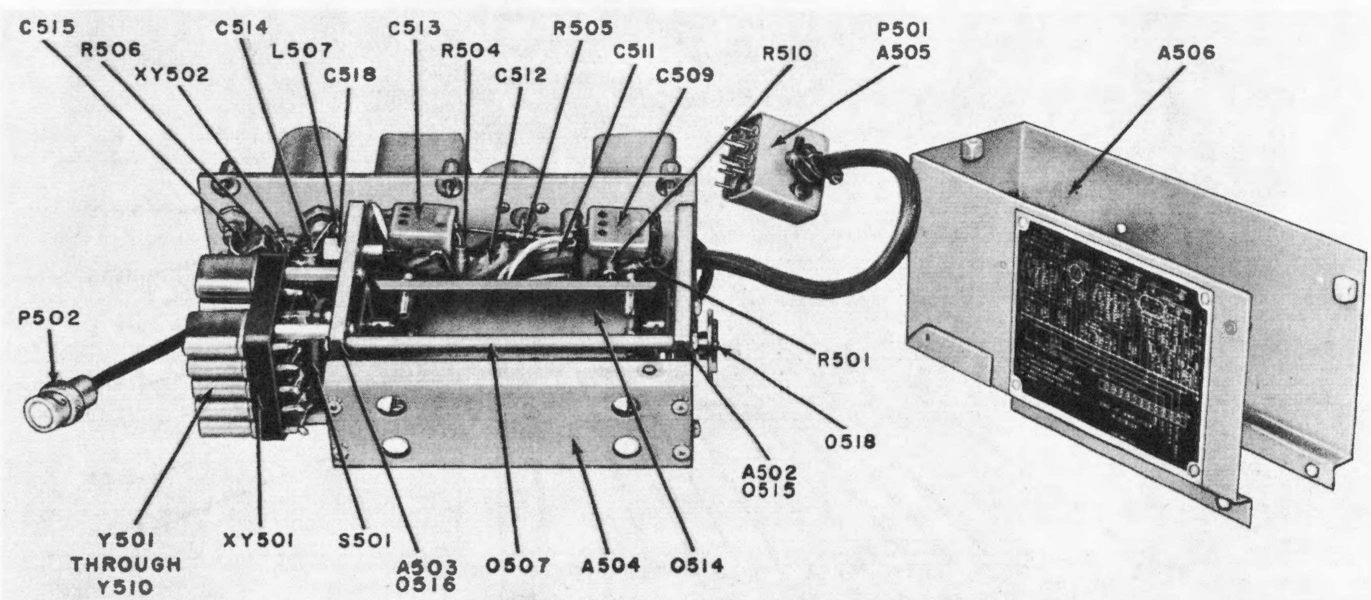


Figure 6–5. Radio Receiver R-278B/GR, Second I-F Amplifier, Side View

Step 3. Adjust the output of the R-F Signal Generator to obtain a VTVM reading of 2.5 VDC at J606.

Step 4. Referring to figures 6–4 and 6–5, first tune the secondary and then the primary of T502 and T501 for maximum output. Adjust the Signal Generator output while tuning T502 and T501 to hold the AVC voltage of 2.5 to 3.5 VDC at J606.

Step 5. Check by means of the tuning wand (paragraph 6–2*a*) to determine whether the Second I-F Amplifier tracks properly at each of the 0.1 mc steps between 9.0 mc and 9.9 mc. This is accomplished in the following manner.

Tune the Receiver in steps from 220.0 mc through 220.9 mc and the Signal Generator from 9.0 mc through 9.9 mc. Insert the tuning wand first into the secondary and then into the coils of T502 and T501 (figure 6–4) and note the VTVM reading each time. The readings should be fairly constant. If the AVC voltage increased when the iron end is in the coil, it is an indication that more iron is needed. Screw the iron core in further. Conversely, if the voltage increased when the brass end is in the coil, less iron is needed. Retract the iron core.

Step 6. Repeat steps 4 and 5 until minimum deviation is obtained over the entire frequency range.

(4) FIRST I-F AMPLIFIER ALIGNMENT.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-26

2. Frequency Meter AN/USM-29

3. Vacuum Tube Voltmeter AN/USM-34

4. Alignment tool

5. Tuning Wand (paragraph 6–2*a*).

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) to 249.9 mc.

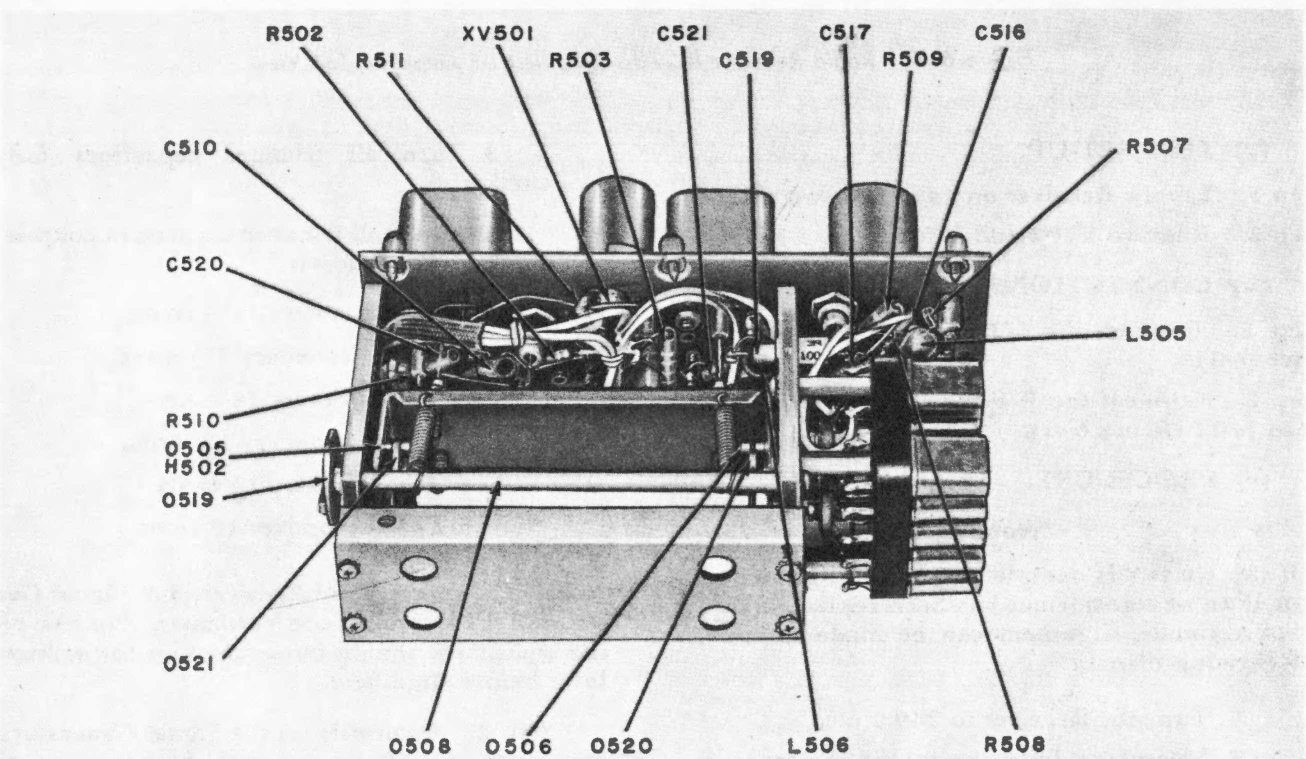


Figure 6–6. Radio Receiver R-278B/GR, Second I-F Amplifier, Side View

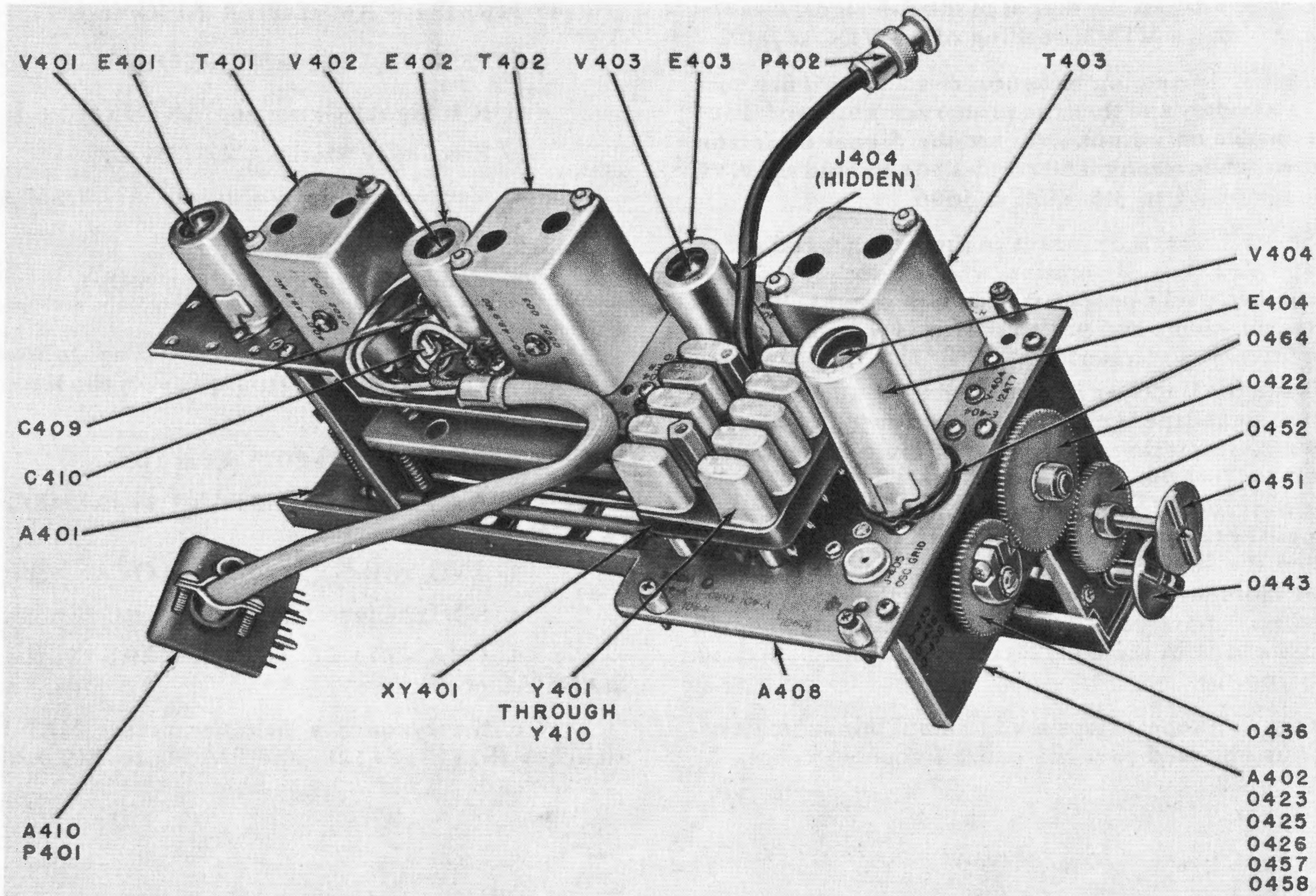


Figure 6–7. Radio Receiver R-278B/GR, First I-F Amplifier, Top View

(*c*) TEST SET-UP.

Step 1. Lay the Receiver on its right-hand side.

Step 2. Remove V102 and V305 (figure 3–4).

(*d*) CONNECTIONS.

Step 1. Connect the VTVM to AVC jack J606 (figure 6–2).

Step 2. Connect the R-F Signal Generator output lead to J402 (figure 6–8).

(*e*) PROCEDURE.

Note

If the chassis is completely out of alignment or if an i-f transformer has been replaced, an approximate alignment can be made in the following manner:

1. Tune the Receiver to 249.9 mc.

2. Measuring from the top of the transformer can, adjust each iron core of T401, T402, and T403 (figure 6–7) to a depth of 1-11/32 inches.

3. Turn all trimmer capacitors fully clockwise.

4. Adjust all trimmer capacitors counterclockwise as follows:

a. T401 primary 11½ turns.

b. T401 secondary 7½ turns.

c. T402 primary 18 turns.

d. T402 secondary 12 turns.

e. T403 primary 10 turns.

f. T403 secondary 10 turns.

Step 1. Energize the Receiver, R-F Signal Generator, and the Vacuum Tube Voltmeter. For best results the equipment should be warmed up for at least one hour before alignment.

Step 2. Accurately set the Signal Generator for a frequency of 49.9 mc. Adjust the output to give a VTVM reading of 2.5 VDC at J606. Check the Signal Generator frequency against Frequency Meter AN/-USM-29.

Step 3. Adjust trimmer capacitors C403, C407, C414, C417, C421, and C425 of T401, T402, and T403 for maximum AVC voltage. These are accessible from the bottom of the Receiver.

Step 4. Tune the R-F Signal Generator to 40.0 mc and the Receiver to 240.0 mc. Again check the Signal Generator Frequency against Frequency Meter AN/USM-29.

Step 5. Use the tuning wand to determine how well each transformer tracks at this frequency and note whether the transformer is tuned above or below 40.0 mc. If iron is needed to increase AVC voltage, it is an indication that the frequency is too high and more inductance is needed. Conversely, if brass is needed, less inductance is required.

Step 6. Tune the R-F Signal Generator to 49.9 mc and check against the Frequency Meter. Set the Receiver to 249.9 mc. Adjust the trimmer capacitor as follows:

a. Turn trimmer capacitor clockwise whne more iron is required to raise AVC voltage.

b. Turn trimmer capacitor counterclockwise when more brass is required to raise AVC voltage.

Step 7. Repeat steps 4 to 6 until minimum deviation is obtained over entire frequency range (40.0 mc to 49.9 mc) of the First I-F Amplifier.

(5) MAIN OSCILLATOR ALIGNMENT.

The frequency of the Main Oscillator is controlled by the crystal selected in the cathode feedback loop, and by tuning the grid circuit at each setting of the Frequency Selector. In the following procedure it is assumed that the crystal selector and coil selector switches are properly syncyronized with the Frequency Selector.

The crystals used in the Main Oscillator are ground to small tolerances. Therefore, when operating at maximum drive they are very close to the correct operating frequency. Two methods of crystal tuning are indicated in this procedure — tuning the crystals for maximum drive, and tuning the crystals to the exact frequency by means of a frequency standard. The first method requires little test equipment but it is not highly accurate. It will suffice generally to obtain satisfactory operation of the Receiver. The second method requires a more elaborate test set-up.

Note

Before performing the following alignment and test procedure, the equipment should be in operation for about one hour in order that the crystal ovens associated with the Main Oscillator and the test equipment will be at normal operating temperature.

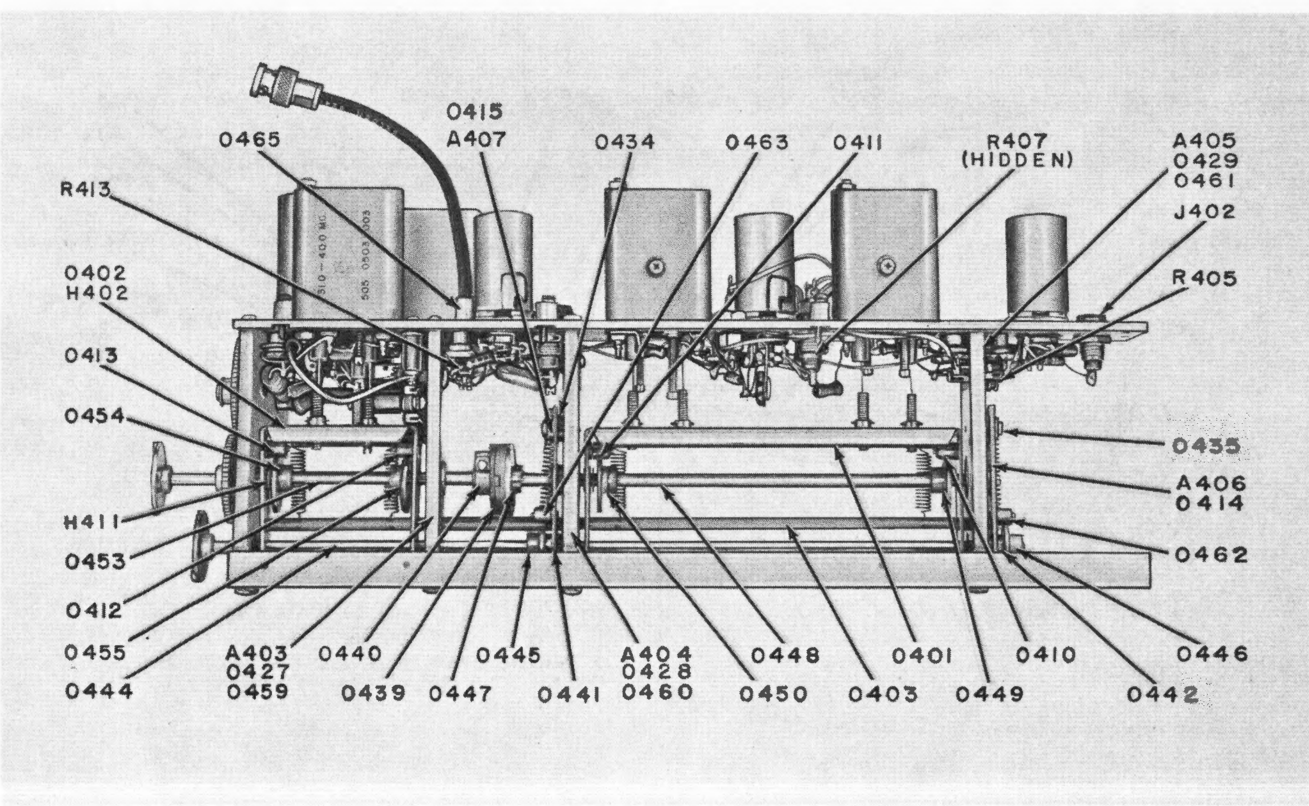


Figure 6–8. Radio Receiver R-278B/GR, First I-F Amplifier, Side View

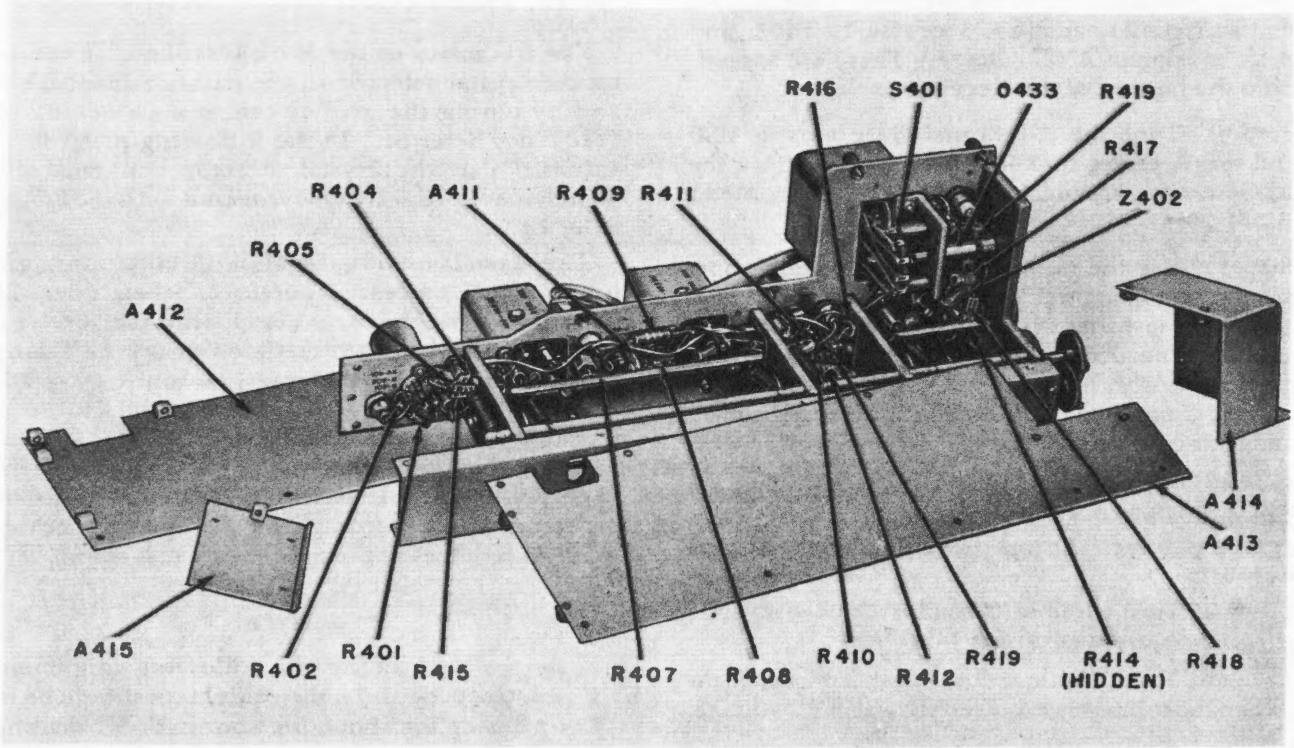


Figure 6-9. Radio Receiver R-278B/GR, First I-F Amplifier, Bottom View (1 of 2)

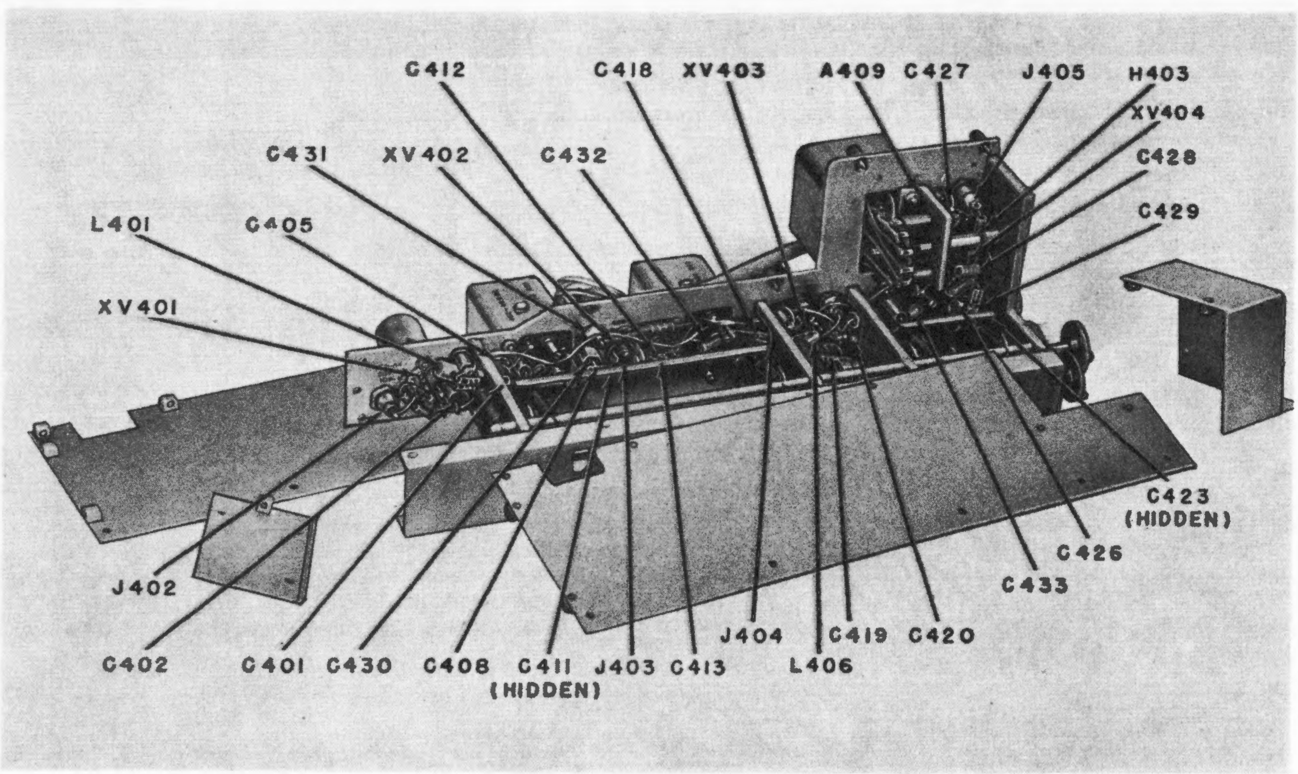


Figure 6-9. Radio Receiver R278B/GR, First I-F Amplifier, Bottom View (2 of 2)

(*a*) MAXIMUM DRIVE ALIGNMENT METHOD.

1. TEST EQUIPMENT REQUIRED.

Vacuum Tube Voltmeter, AN/USM-34.

2. CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

a. RF GAIN (R1207) set at 10.

b. AVC TIME CONSTANT switch (S1204) in COMM position.

c. AVC switch (S1202) in LOCAL position.

d. SQUELCH switch (S1205) in OFF position.

e. CHANNEL SELECTOR switch (S1101) in MANUAL position.

f. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) initially to 220.0 mc.

3. CONNECTIONS.—Connect the Vacuum Tube Voltmeter C302 (● CC in figure 5–15).

4. PROCEDURE.—Adjust L222 through L239 to the frequencies given below, setting each frequency by means of the MANUAL switches.

L222	220.0 mc
L223	230.0 mc
L224	240.0 mc
L225	250.0 mc
L226	260.0 mc
L227	270.0 mc
L228	280.0 mc
L229	290.0 mc
L230	300.0 mc
L231	310.0 mc
L232	320.0 mc
L233	330.0 mc
L234	340.0 mc
L235	350.0 mc
L236	360.0 mc
L237	370.0 mc
L238	380.0 mc
L239	390.0 mc

Adjust each coil until the VTVM gives a maximum reading.

(*b*) FREQUENCY STANDARD ALIGNMENT METHOD.

1. TEST EQUIPMENT REQUIRED.

a. Frequency Meter AN/USM-29

b. Signal Generator AN/URM-26

c. Vacuum Tube Voltmeter AN/USM-34

d. Set of headphones

2. CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

a. RF GAIN (R1207) set at 10.

b. AVC TIME CONSTANT switch (S1204) in COMM position.

c. AVC switch (S1202) in LOCAL position.

d. SQUELCH switch (S1205) in OFF position.

e. CHANNEL SELECTOR switch (S1101) in MANUAL position.

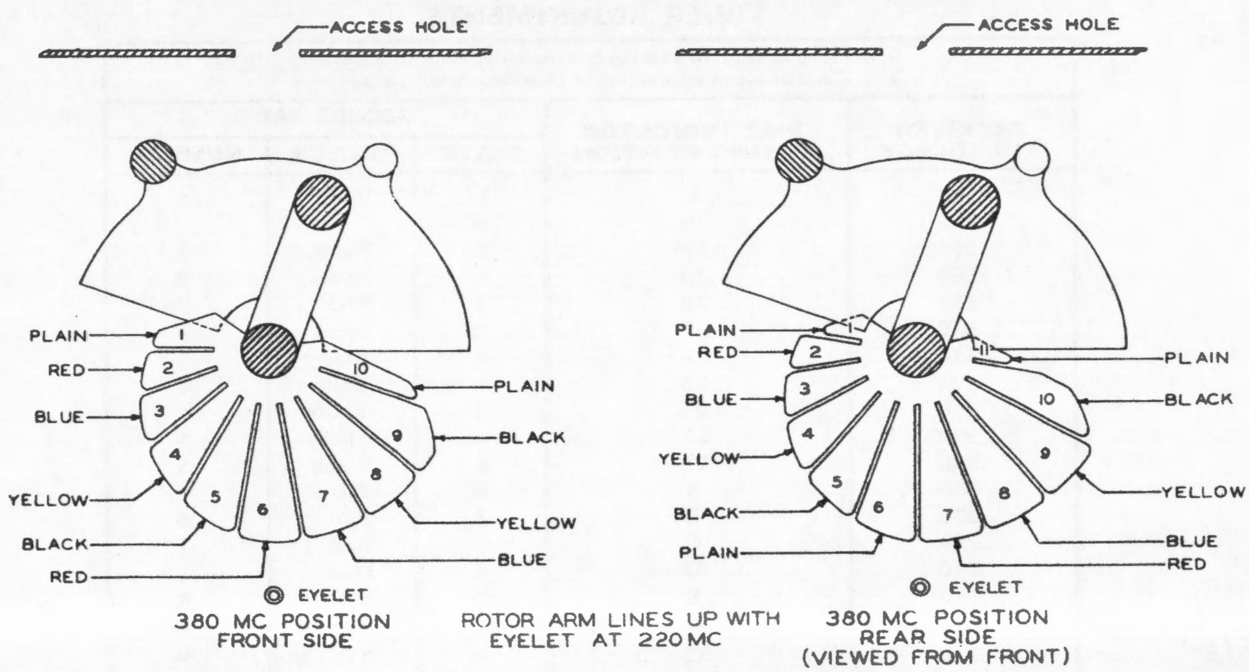


Figure 6–10. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Tuner Capacitor Sectors

f. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) initially to 220.0 mc.

3. CONNECTIONS.—Connect the UNKNOWN FREQ terminal of the Frequency Meter to test point ● CC in figure 5-15.

Note

The highest fundamental frequency of Frequency Meter AN/USM-29 is 30 mc. Hence, it is necessary to use the second harmonic of frequencies between 15.5555 mc and 19.4444 mc to check the crystal frequencies above 30 mc listed in figure 4-2.

4. PROCEDURE.

Step 1. Set Frequency Meter AN/USM-29 to 30 mc and plug the headphones into the phones jack on the front panel of the Frequency Meter.

Step 2. With the Receiver energized, a beat note should be heard in the headphones if the crystal frequency is approximately the same as that of the Frequency Meter. Adjust trimmer L222 as necessary to obtain zero beat.

Step 3. Repeat Step 2 for each of the other 17 crystals.

Step 4. Zero beat the Main Oscillator against the Frequency Meter by adjusting L222 to L239 at the nearest 100-cycle point of the Frequency Meter. (See frequency chart of figure 4-2.) Example: Receiver frequency 300 mc, Main Oscillator frequency 28.8888 mc, Frequency Meter 28.88890 mc.

Note

When the coils are being adjusted to zero beat, tune slightly to each side of zero beat to make sure the crystal is not so far down on its resonant curve that it stops oscillating.

(6) FREQUENCY MULTIPLIER-AMPLIFIER ALIGNMENT.

(*a*) TEST EQUIPMENT REQUIRED.

1. Vacuum Tube Voltmeter, Navy Model OBQ Series

2. Alignment tool

3. Tuning Wand (paragraph 6-2*a*)

4. 470,000-ohm, 1-watt resistor.

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3-2).

1. RF GAIN (R1207) set at 10.

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) to 320.0 mc.

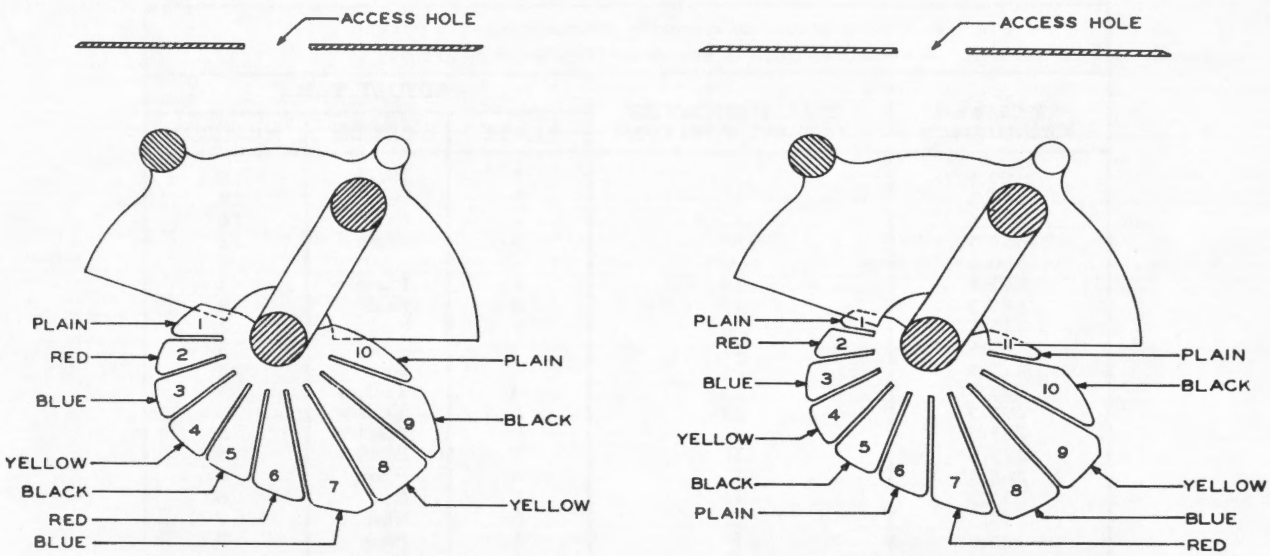
(*c*) TEST SET-UP.—Remove screws from Frequency Multiplier-Amplifier schematic cover A305, but leave the cover in place.

TABLE 6-2. RADIO RECEIVER R-278B/GR, FREQUENCY MULTIPLIER-AMPLIFIER TUNER ADJUSTMENTS.

0 = Plate at rear of assembly (Outside, next to trimmer)
I = Plate at front of assembly (Inside, next to ring)

RECEIVER FREQUENCY	DIAL INDICATOR TUNING POSITION	ADJUST TAB		
		PLATE	COLOR	NUMBER
390	I	I	Plain	10
380*	38	-	-	
370	30	I	Plain	1
360	29	0	Red	2
350	28	I	Red	2
340	27	0	Blue	3
330	26	I	Blue	3
320	25	0	Yellow	4
310	24	I	Yellow	4
300	23	0	Black	5
290	22	I	Black	5
280	A	0	Plain	6
270	B	I	Red	6
260	C	0	Red	7
250	D	I	Blue	7
240	E	0	Blue	8
230	F	I	Yellow	8
220	G	0	Yellow	9

* Trimmer adjustment frequency



360.5 MC POSITION
FRONT SIDE

360.5 MC POSITION
REAR SIDE
(VIEWED FROM FRONT)

Figure 6–11. Radio Receiver R-278B/GR, R-F Amplifier, Tuner Capacitor Sectors

(*d*) CONNECTIONS.—Attach the d-c lead of the VTVM to C309 (● CC_2 in figure 5–14).

(*e*) PROCEDURE.

Step 1. Energize the Receiver and the Vacuum Tube Voltmeter. For best results, the equipment should be warmed up for at least one hour before alignment.

Step 2. Tune Z301 trimmer capacitor (figure 5–15) for maximum negative voltage reading on VTVM.

Step 3. Set the Receiver frequency at 390.0 mc.

Step 4. Check Z301 tuning at 390.0 mc by sliding cover A305 upward enough to insert tuning wand near the coil.

Step 5. If insertion of iron end increases VTVM reading, this is an indication that more inductance is needed. Compress turns of coil.

Step 6. Set the Receiver frequency at 320.0 mc and re-tune the tuner.

Step 7. Repeat steps 4 to 6, until minimum tuning deviation occurs over the frequency range. This completes tuning of Z301.

Step 8. Replace cover A305.

Step 9. Tune Receiver to 380.0 mc.

Step 10. Align Z303, Z305, Z307, and Z309 trimmers (figure 5–15) for maximum output in the following manner:

TO TUNE TRIMMER OF	REMOVE TUBE	ATTACH R-F PROBE OF VTVM TO
Z303	V303	pin 2, XV303
Z305	V304	pin 2, XV304
Z307	V305	pin 2, XV305
Z309	None	Attach VTVM through 470,000-ohm resistor to J402 (Scale to read low negative d-c voltage).

Step 11. With the VTVM still connected to J402, check the tuning of all tuner trimmers for maximum meter indication.

Step 12. Set the Receiver frequency to 390.0 mc.

Step 13. Check the tuning of each tuner by inserting tuning wand in front access holes (figure 5–14). Remember whether iron or brass is required to increase the AVC voltage of each tuner.

CAUTION

Alignment of subassemblies by bending capacitor tabs is a precise procedure and should never be attempted by personnel other than thoroughly experienced technicians.

Step 14. The rest of the tuning procedure consists of bending tuner tabs (figure 5–14) at each 10-mc frequency to bring each tuner to resonance at that frequency. In general, by use of the tuning wand, determine whether more or less capacity is needed, operate the tracking control switch to position the tuners making the tabs accessible, bend the correct tab toward the stator plate for more capacity or away for less capacity. Refer to table 6–2 and figure 6–10

TABLE 6-3. RADIO RECEIVER R-278B/GR, R-F AMPLIFIER TUNER ADJUSTMENTS

0 = Plate at rear of assembly (Outside, next to trimmer)
I = Plate at front of assembly (Inside, next to ring)

RECEIVER FREQUENCY	DIAL INDICATOR TUNING POSITION	ADJUST TAB		
		PLATE	COLOR	NUMBER
395.5	J	I	Black	9
385.5	K	0	Black	10
375.5	L	I	Plain	10
365.5	M	0	Plain	11
360.5*	360.5	–	–	–
355.5	28	I	Plain	1
345.5	27	0	Red	2
335.5	26	I	Red	2
325.5	25	0	Blue	3
315.5	24	I	Blue	3
305.5	23	0	Yellow	4
295.5	22	I	Yellow	4
285.5	A	0	Black	5
275.5	B	I	Black	5
265.5	C	0	Plain	6
255.5	D	I	Red	6
245.5	E	0	Red	7
235.5	F	I	Blue	7
225.5	G	0	Blue	8

* Trimmer adjustment frequency.

to determine which tab to bend at each frequency and to which position of the dial indicator the tuners must be rotated to make the desired tab accessible. The sequence to be followed is: trimmer adjustment at 380 mc, tab bending at 390 mc, 370, 360, . . . and 220 mc.

Step 15. Repeat the entire tab bending process to obtain a more precise adjustment.

(7) R-F AMPLIFIER ALIGNMENT.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-26

2. Frequency Meter AN/USM-29

3. Vacuum Tube Voltmeter AN/USM-34.

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Set Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) to 360.5 mc.

(*c*) CONNECTIONS.

Step 1. Connect the R-F Signal Generator output lead to J1212 (figure 3–2).

Step 2. Connect the VTVM to J606 (★23 figure 5–16).

(*d*) PROCEDURE.

Step 1. Accurately tune the R-F Signal Generator for a frequency of 360.5 mc. Check this frequency against Frequency Meter AN/USM-29.

Note

It will be necessary to check output frequencies against harmonics of the Frequency Meter. In this case, the Frequency Meter should be set at 24.0333 mc. The 15th harmonic of this frequency would then beat with 360.5 mc. This is a precise procedure and should be attempted only by competent technicians. It is recommended that the alternate frequency source described in paragraph 6–2b(2)(d) be used where practicable.

Step 2. Adjust the output of the Signal Generator to obtain a VTVM reading of 2.5 VDC at J606.

Step 3. Align Z101, Z102, and Z103 trimmers (figure 5–15) for maximum output while readjusting the Signal Generator output to give an AVC voltage of 2.5 to 3.5 VDC at J606.

Step 4. The rest of the tuning procedure consists of bending tuner tabs at each 10-mc frequency interval to bring each tuner to resonance at that frequency. Do this while using the tuning wand (figure 5–14) to determine whether more or less capacitance is needed. Operate the tracking control switch in the RUN position to turn the tuners so that their tabs are accessible. Bend the correct tab (figure 5–14) toward the stator plate for more capacitance or away for less capacitance. Refer to table 6–3 and figure 6–11 to determine which tab to bend at each frequency. The sequence to be followed is: trimmer adjustment at 360.5, tab bending at 365.5, 375.5, 385.5, 395.5, 355.5, 345.5, etc., through 225.5 mc.

CAUTION

Alignment of subassemblies by bending capacitor tabs is a precise procedure and should never be attempted by personnel other than thoroughly experienced technicians.

(8) RELAY K801 SENSITIVITY MEASUREMENT.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-26

2. Frequency Meter AN/USM-29

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 0.

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) to 320.0 mc.

(*c*) CONNECTIONS.—Connect the R-F Signal Generator to antenna input J1212 (figure 6–12).

(*d*) PROCEDURE.

Step 1. Energize the Receiver and the R-F Signal Generator. For best results, the equipment should be warmed up for at least 15 minutes.

Step 2. Accurately tune the R-F Signal Generator to a frequency of 320.0 mc. Check against Frequency Meter AN/USM-29.

Step 3. Adjust the R-F Signal Generator output to zero.

Step 4. Advance the RF GAIN control (R1207) to 10.

Step 5. Check carrier-operated relay K801 (figure 6–13). K801 must energize near the maximum RF GAIN control setting.

Step 6. Turn the RF GAIN control to minimum. Relay K801 must energize.

Step 7. Advance the R-F Signal Generator output slowly until K801 becomes energized. K801 energizes between 100 and 500 microvolts.

(9) RECEIVER RESETABILITY.—The purpose of the resetability test is to check the Receiver's ability to reset itself after being positioned to another frequency and then back to the original frequency.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-26

2. Frequency Meter AN/USM-29

3. Vacuum Tube Voltmeter AN/USM-34 Series.

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

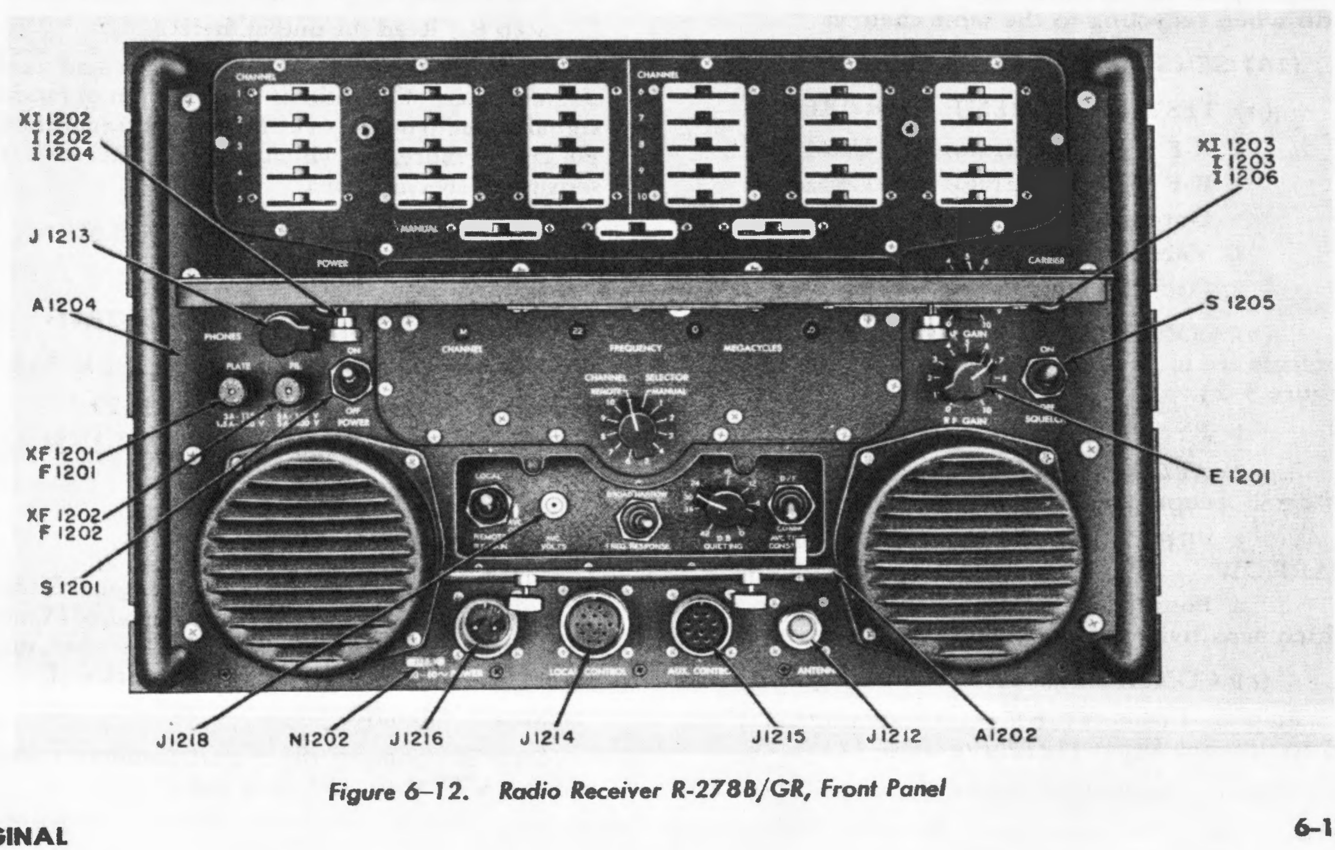


Figure 6–12. Radio Receiver R-278B/GR, Front Panel

2. AVC TIME CONSTANT switch (S1204) in COMM position.

3. AVC switch (S1202) in LOCAL position.

4. SQUELCH switch (S1205) in OFF position.

5. CHANNEL SELECTOR switch (S1101) in MANUAL position.

6. Frequency Selector preset MANUAL switches (S1117, S1128, and S1139) in 320.0 mc position. Check frequency against that of Frequency Meter.

(*c*) CONNECTIONS.

Step 1. Connect the R-F Signal Generator to antenna input J1212 (figure 6–12).

Step 2. Connect the VTVM to J606 (figure 6–2).

(*d*) PROCEDURE.

Step 1. Energize the Receiver, R-F Signal Generator, and the Vacuum Tube Voltmeter. For best results, the equipment should be warmed up for at least 15 minutes.

Step 2. Accurately tune the R-F Signal Generator to a frequency of 320.0 mc.

Step 3. Adjust the output of the R-F Signal Generator to obtain a VTVM reading of 4.5 VDC at J606.

Step 4. Change the frequency of the Receiver and wait for a complete tuning cycle. Re-tune the Receiver to its original frequency (320.0 mc), and record the Receiver input voltage necessary to bring the AVC voltage back to its original reading (4.5 VDC).

Step 5. Repeat step 4 above several times. The sensitivity of the Receiver should not vary more than 6 db when recycling to the same channel.

(10) SENSITIVITY MEASUREMENTS.

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-25
2. R-F Signal Generator AN/URM-26
3. Output Meter
4. Vacuum Tube Voltmeter AN/USM-34
5. Oscilloscope OS-8/U

(*b*) CONTROL SETTINGS.—The following controls are located on the front panel of the Receiver (figure 3–2).

1. RF GAIN (R1207) set at 10.

2. AF GAIN set below clipping level as shown on oscilloscope connected to PHONES jack J1213.

3. FREQUENCY RESPONSE switch set at NARROW.

4. Frequency Selector set at frequency for which sensitivity measurements are desired.

(*c*) CONNECTIONS.

Step 1. Connect R-F Signal Generator AN/URM-26 to antenna input J1212 (figure 6–12).

Step 2. Connect R-F Signal Generator AN/URM-25 by means of several turns of wire loosely coupled around third mixer V502.

Step 3. Connect the Vacuum Tube Voltmeter probe in AVC test jack J606.

Step 4. Connect the output meter (3 mw to 3 w and 600 ohms input impedance) to PHONES jack J1213.

Step 5. Connect the vertical deflection plates of the oscilloscope to the PHONES jack.

(*d*) PROCEDURE. (Refer to the gain chart of figure 5–12).

Step 1. Set Signal Generator AN/URM-26 to the same frequency as the Frequency Selector setting. Adjust the Signal Generator to produce a 6-microvolt r-f signal at the antenna input.

Step 2. Tune the Signal Generator to the Receiver frequency by obtaining maximum indication of the Vacuum Tube Voltmeter which is set to read negative AVC voltage.

Step 3. Record the AVC voltage.

Step 4. Attenuate the r-f signal to 0 microvolts.

Step 5. Set Signal Generator AN/URM-25 to 2.05 mc. Tune the Signal Generator for maximum AVC reading.

Step 6. Adjust the output from Signal Generator AN/URM-25 until the VTVM reads the same as recorded in Step 3.

Step 7. Adjust the Signal Generator for 30 percent modulation at 1000 cps.

Step 8. Read the output meter.

Step 9. Turn off the modulation and read the output meter. The ratio of audio output of modulated signal to audio output of unmodulated signal should be 10 db or more, in which case the Receiver meets sensitivity specifications.

(11) SELECTIVITY MEASUREMENT (I-F BANDWIDTH).

(*a*) TEST EQUIPMENT REQUIRED.

1. R-F Signal Generator AN/URM-25A
2. Frequency Meter AN/USM-29
3. Vacuum Tube Voltmeter AN/USM-34
4. Test Receiver.

(*b*) PROCEDURE.

Step 1. Accurately calibrate the Signal Generator to 2.05 mc by beating it with the Frequency Meter also set at 2.05 mc. By means of the Test Receiver, tune the Signal Generator until a zero beat is obtained.

Step 2. Remove V501.

Step 3. Connect the Signal Generator to J503 and the VTVM to AVC jack J606.

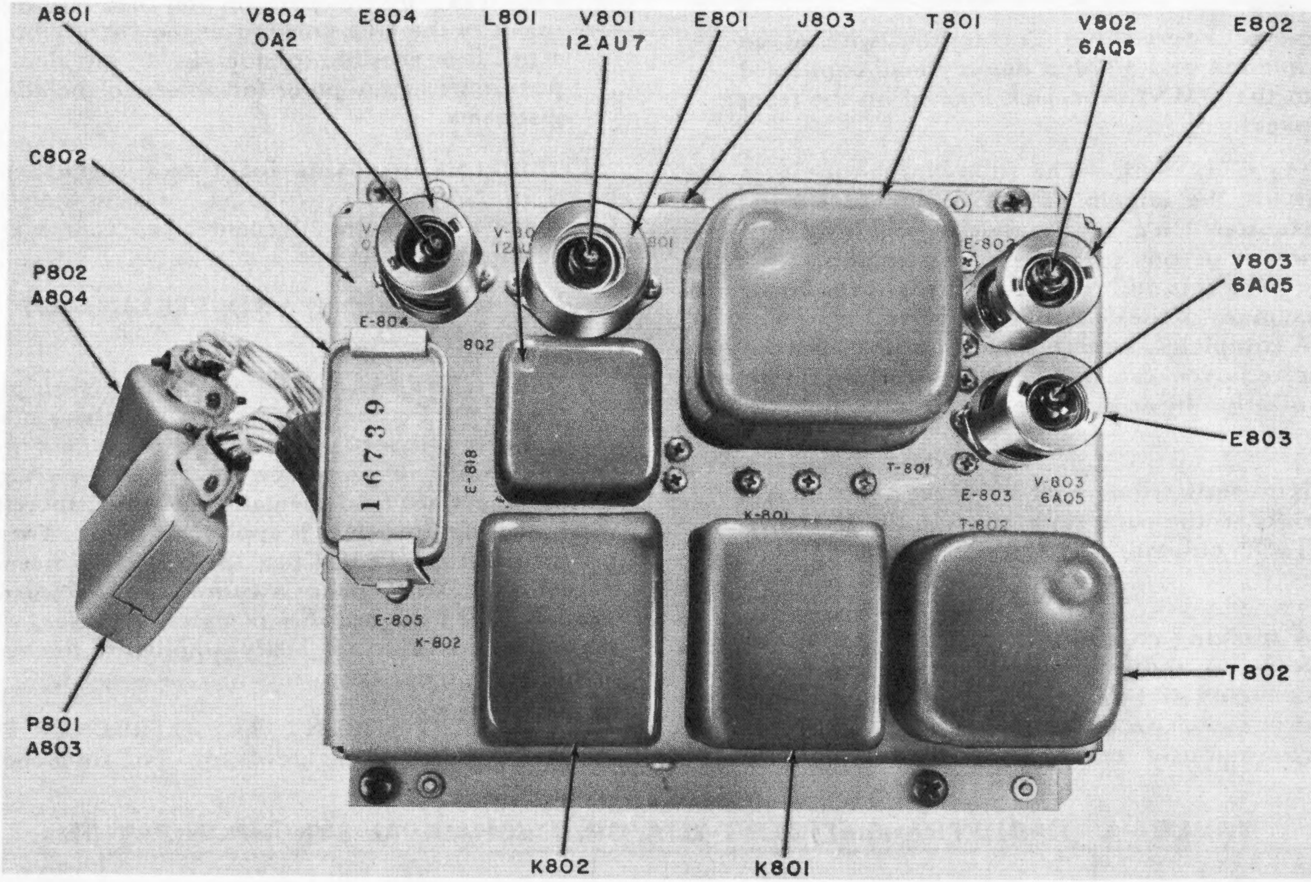


Figure 6–13. Radio Receiver R-278B/GR, Audio Amplifier, Top View

Step 4. With the frequency of the Signal Generator accurately set at 2.05 mc, advance the output to obtain a VTVM reading of 3.0 to 3.5 volts.

Step 5. Record the AVC Voltage.

Step 6. Record the output of the Signal Generator.

Step 7. Advance the output of the Signal Generator to twice the value recorded in Step 6.

Step 8. Change the frequency of the Signal Generator on both sides of 2.05 mc until the AVC reading is obtained as recorded in Step 5. Record the two frequencies. (These are the half-power points. The difference of these frequencies should be not less than 85 kc.)

Step 9. To obtain the 60-db bandwidth, set the Signal Generator output to 1000 times that recorded in Step 6.

Step 10. Change the frequency of the Signal Generator to produce the same AVC voltage recorded in Step 5. (The bandwidth should be less than 225 kc.)

(*12*) RECEIVER OUTPUT MEASUREMENT.

(*a*) TEST EQUIPMENT REQUIRED.

1. Test Transmitter

2. Output Meter.

(*b*) CONNECTIONS.

Step 1. Attach the output of the Test Transmitter to the input of Receiver antenna jack J1212.

Step 2. Attach the Output Meter (terminated in 600 ohms) to PHONES jack J1213.

(*c*) PROCEDURE.—Adjust the settings of the Test Transmitter to produce a 100-microvolt signal, 30 percent modulated by any audio frequency between 200 and 20,000 cps. The Receiver should produce up to three watts at the PHONES jack and 15 dbm (32 milliwatts) at terminals I and N of LOCAL CONTROL jack J1214.

c. TRANSMITTER ALIGNMENT.

WARNING

There are voltages in this equipment that are dangerous to life (1000 volts). When operating the equipment removed from the dust covers, use extreme care to avoid contact with any circuits in the equipment.

CAUTION

Never operate the Transmitter without an antenna or a 50-ohm dummy load connected to the OMNI. Ant. jack located on the front panel.

(1) GENERAL.—The following procedures are given for the alignment and testing of a complete Transmitter. In general, servicing will involve the realignment of one or more subassemblies. In most cases, even this will involve only slight readjustments so that many of the detailed steps given can be omitted.

A completely assembled Transmitter with the dust cover removed can be checked for mechanical synchronization by making the checks given in table 6–4.

Note

If the indications in table 6–4 are not obtained, refer to the paragraph given in the INDICATION column.

Note

A tracking control switch is provided in the Receiver and in the Transmitter as an aid in servicing and aligning the equipment. With this switch in the RUN position, K1102 is continuously energized. By placing this switch in the RUN position and then returning it to the OFF position at the correct instant, it is possible to stop the 10-mc autopositioner at any point for access to the adjustments.

Performance standards for the Transmitter are given in NAVSHIPS 92383.31. If the standards given are not met, the alignment procedures given herein should be followed.

(2) ALIGNMENT AND TESTING OF R-F TUNERS.

(*a*) GENERAL.—The Frequency Multiplier-Amplifier, the Exciter, and the Driver subassemblies (figures 5–4 and 5–10) each contain r-f tuners of the type described in paragraph 4–2*b*(4) in section 4. These tuners are fundamentally the same; therefore, the following procedure is applicable to all. For this procedure it is assumed that the tuner has been repaired or replaced; hence a complete realignment is necessary. In the majority of cases, however, when the tuners are those originally supplied in the equipment, only slight adjustments will be necessary.

(*b*) ADJUSTMENT TO REFERENCE FREQUENCY.—Refer to figure 4–29. The frequency at

TABLE 6-4. RADIO TRANSMITTER T-217A/GR, MECHANICAL SYNCHRONIZATION

ITEM	FIGURE	POSITION	INDICATION	FREQ. IN MC
1	6–71	Couplers behind front panel, as observed from bottom of Transmitter.	Scribe lines on couplers aligned with scribe lines on blocks.	390.0
2	5–10	Calibrated dial ahead of I-F Oscillator.	"0"	390.0
3	5–10	Iron cores in I-F Oscillator Z401 and amplifiers T401, T402 and T403.	Position with least amount of core in coil. (Slightly out of cam valley.) (See para. 6–3*b*(6) (*b*)).	399.9
4	5–10	Crystal switch in high-frequency oscillator of I-F Oscillator.	Switch on crystal number "5". (See para. 6–3*b*(6) (*b*)).	395.5
5	5–10	Crystal switch in low-frequency oscillator of I-F Oscillator.	Switch on crystal number "6". (See para. 6–3*b*(6) (*b*)).	395.5
6	5–14	Step cam in rear gear train.	Follower on highest point of cam.	390.0
7	5–10	Calibrated dial ahead of Frequency Multiplier-Amplifier.	"39"	390.0
8	5–9	Main Oscillator crystal switch and coil switch.	Coil switch making but partially exposed left of tab 22. Crystal switch making on crystal 18.	220.0
9	6–14	Toroidal tuners Z301 and Z302, as observed with A307 removed.	Wiper centered on smallest winding, with gear shoulder against direction of rotation.	390.0
10	6–14	Servo resistor fingers on R1205.	The wiper fingers on R1205 will follow a general pattern. Should be approximately vertical.	390.0
11	5–4	R601 potentiometer.	Within 25° of end of rotation clockwise, as viewed from the shaft end of the potentiometer.	399.9
12		Rotor bar on Frequency Multiplier-Amplifier, Exciter, and Driver Tuners. Allowable tolerances: Frequency Multiplier-Amplifier 1°. Exciter 1°. Driver 1/6°.	Aligned with short stator bar. Bisects access hole of Z101, Z102, Z304, Z306, and Z308. Z103 rotor bar 90° from access hole and toward Z102. (See para. 6–3*b*(4) (*c*), 6–3*b*(5) (*b*), and 6–3*b*(7) (*b*)).	360.5 390.5

(9) FRONT PANEL METER CALIBRATION.—R1204 (figure 6–18) is used to calibrate front panel meter M1201 in the POWER OUTPUT position. If it should be changed from its original setting, a calibrated load (r-f wattmeter known to be accurate) must be used to reset it to the correct position. However, an alternate method that does not require this calibrated load is given in the following procedure.

A negative d-c voltage of about 0.65 volts obtained from the RF Monitor represents about 100 watts of power output from the Transmitter. Using this voltage as a standard and performing the following steps, R1204 can be reset approximately.

Step 1. With the dust cover removed, place the Transmitter on a work bench.

Step 2. Connect all cables between the Modulator-Power Supply and the Transmitter. Connect the Transmitter power output to the antenna or preferably to an r-f wattmeter.

Step 3. Set the Transmitter Frequency Selector to 300.5 mc.

Step 4. Energize the two units and allow approximately 5 minutes for warm up.

Step 5. Connect the d-c lead of a Vacuum Tube Voltmeter to terminal 3 of S1201A (front wafer section of the meter selector switch). Set the VTVM to read a negative voltage of less than 1 volt.

Step 6. Turn meter selector switch S1201 to POWER OUTPUT-WATTS.

Step 7. Set R1204 90 degrees off the full counterclockwise position.

Step 8. Key the Transmitter and detune the Power Amplifier slightly by moving the 300-mc tab on R1205 (figure 6–14) until the VTVM reads −0.65 volt. (Note the original position of the tab.)

Note

If −0.65 volt cannot be obtained, less than 100 watts r-f power is flowing through the RF Monitor (another frequency may be used instead of the suggested frequency in step 3). If the voltage still is not available, lack of continuity may exist between the RF Monitor and terminal 3 of S1201A, or, CR1202 in the RF Monitor is inoperative or the orientation of the pickup loop in the RF Monitor has been changed.

Step 9. Set the Transmitter front panel meter to read 100 watts by adjusting R1204.

Step 10. Remove the VTVM and re-tune the Power Amplifier by returning the 300-mc tab to its original position. The front panel meter reading is now approximately correct.

Should the factory setting of SWR balance control R1227 (figure 6–18) be accidentally moved, reset it to the midpoint of its rotation. The locknut on the shaft of R1227 is tightened to preserve the shaft setting.

d. MODULATOR-POWER SUPPLY ALIGNMENT.

Note

For this procedure, the high voltage output from Modulator-Power Supply MD-129A/-GR should be operated into a dummy load instead of into Radio Transmitter T-217A/-GR. For less detailed checks, a properly operating Transmitter may be used as a load. If the Transmitter is used, the meter readings may vary from those called out in the following procedure.

(1) TEST EQUIPMENT REQUIRED.

(*a*) Multimeter ME-25A/U.
(*b*) Audio Oscillator TS-382A/U.
(*c*) Oscilloscope OS-8/U.
(*d*) Test Oscillator Model LAJ.

(2) CONTROL SETTINGS.—The following controls are located on the front panel of the Modulator-Power Supply (figure 3–3).

(*a*) POWER switch (S1401) to OFF.
(*b*) VOICE-MCW switch (S1404) to VOICE.
(*c*) METER SELECTOR switch (S1405) to OFF.
(*d*) NORMAL EMERG switch (S1402) to NORMAL.
(*e*) AUDIO BANDWIDTH switch (S1403) to NORMAL.
(*f*) AUDIO GAIN control (R1401) to 0.
(*g*) LIMITER CONTROL (R1440) to 0.

(3) TEST SETUP.

(*a*) Cheat interlock switch S1410 (figure 5–5).
(*b*) Tape safety switch S1411 (figure 5–6) to the chassis.
(*c*) Connect J1406 and J1407 (figure 6–24) to a resistive load (figure 6–25).

Note

A high voltage dummy load can be made up with eight 40-watt, 120-volt bulbs in series using ceramic bases for high voltage protection. WARNING: Provide a barrier to prevent contact with this dummy load by personnel.

(4) PROCEDURE.

(*a*) PRELIMINARY TESTS.

Step 1. Turn POWER switch S1401 (figure 6–24) to ON.

Step 2. Read voltage on the A-C Voltmeter (figure 3–3). The reading should agree with the supply voltage.

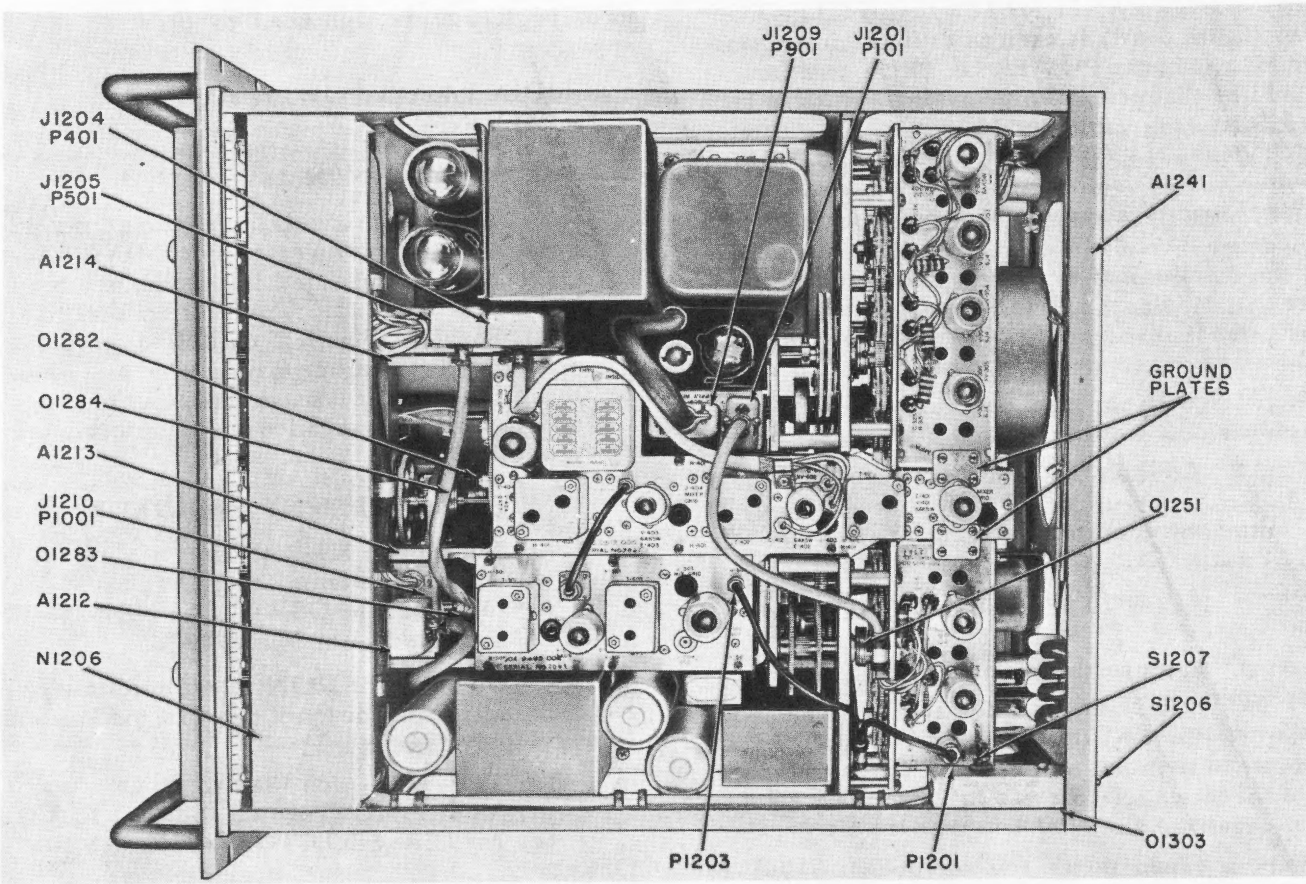


Figure 6–26. Radio Receiver R-278B/GR, Top View

Step 3. Using Multimeter ME-25A/U, check filament voltage between J1409 and J1410. The reading should be approximately 6.2 volts a-c.

Step 4. With the Multimeter connected to J1411 (figure 3–8) the reading should be −30 VDC.

Step 5. With METER SELECTOR switch S1405 (figure 6–24) turned to MOD. PL. and no modulation, test meter M1402 should read 30 to 50 ma dc.

Step 6. With the METER SELECTOR switch turned to PA. PL. and no modulation, M1402 should read 400 ma dc.

Step 7. With the METER SELECTOR switch turned to DR. PL. and no modulation, M1402 should read 92 ma dc.

Step 8. With the METER SELECTOR switch turned to AMP. PL. and no modulation, M1402 should read 55 ma dc.

(b) AUDIO OUTPUT AND GAIN.

Note

In the following procedure, the push-to-talk switch on the microphone should be closed only while taking readings and making observations. It should be open at all other times.

Step 1. Connect the equipment as indicated in figure 6–25.

Step 2. Adjust METER SELECTOR switch S1405 to % MOD.

Step 3. Adjust AUDIO BANDWIDTH switch S1403 to BROAD.

Step 4. Connect the Audio Oscillator to LINE input E1401 and E1402 (figure 6–24). Adjust the Audio Oscillator at 1000 cycles and no output.

Step 5. Close the push-to-talk switch on the microphone and advance the output of the audio oscillator to a level of −50 dbm.

Step 6. Advance AUDIO GAIN control R1401 until the RMS audio voltage across the load is 0.590 times the d-c voltage measured at the same point. (In figure 6–25, 0.590 x $V_2 = V_1$.) Since there is some screen modulation in the Transmitter, this audio voltage will modulate the r-f carrier by 95%.

Step 7. Adjust R1443 (figure 5–2) to calibrate the internal modulation meter to read 95%.

(*c*) AUDIO RESPONSE.—Broadband response should be flat within 3.5 db from 200 to 20,000 cps at 95% modulation using 1000 cps as a reference frequency. This response may be determined by noting the indication of a-c voltmeter V_2 (figure 6–25) while holding the audio input level at a constant −50 dbm and changing the input frequency over this range. Turn AUDIO BANDWIDTH switch S1403 to NORMAL. The response should be as follows:

FREQUENCY	ATTENUATION
200 cps	11 db
400 cps	4 db
1000 cps	0
3000 cps	4 db
5000 cps	11 db

(*d*) LIMITER ACTION.—The audio level at the output of the Modulator with limiting should be maintained within 2 db total variation with a change of 20 db in input level at audio frequencies between 200 and 20,000 cps.

Step 1. Set AUDIO BAND WIDTH switch S1403 to BROAD. With AUDIO GAIN control R1401, reduce the output level 2db below 95% modulation at 1000 cps and adjust LIMITER CONTROL R1440 to the limiting threshold.

Step 2. Increase the input level 20 db and observe limiter action.

Step 3. Adjust R1412 (★7, figure 5–5) to give an output of 95% modulation. Repeat steps 1 and 2 until limiting is within 2 db for 20 db change of input.

Step 4. Check limiter action as outlined in steps 1 and 2 at the following frequencies: 200, 400, 5000, 10,000, 15,000 and 20,000 cps.

(*e*) AUDIO DISTORTION.—Audio distortion should not exceed 8% at any of the following frequencies except at 200 cps, which should not exceed 11%.

NORMAL BAND WIDTH	BROADBAND
400 cps	200 cps
1000 cps	400 cps
3000 cps	1000 cps
	5000 cps
	10,000 cps
	15,000 cps
	20,000 cps

Step 1. Set AUDIO GAIN control R1401 so that the output is 2 db below 95% modulation level with −50 dbm input and with the Audio Oscillator set for 1000 cps.

Step 2. Set LIMITER CONTROL R1440 for the limiting threshold.

Step 3. Raise the input level to −30 dbm and observe the trapezoidal modulation pattern of the Transmitter output at the frequencies listed above. Follow the same procedure for both NORMAL and BROAD positions of the AUDIO BAND WIDTH switch. This method will not show the degree of distortion accurately, but will indicate by a distorted modulation pattern if correction is necessary.

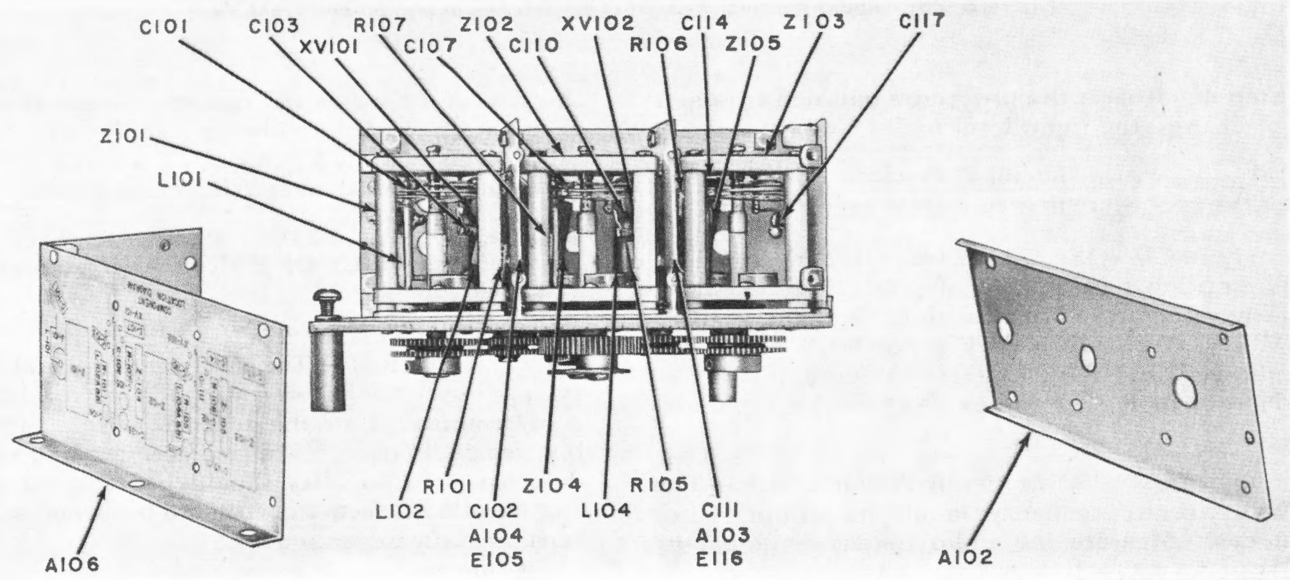


Figure 6–27. Radio Receiver R-278B/GR, R-F Amplifier, Underside View

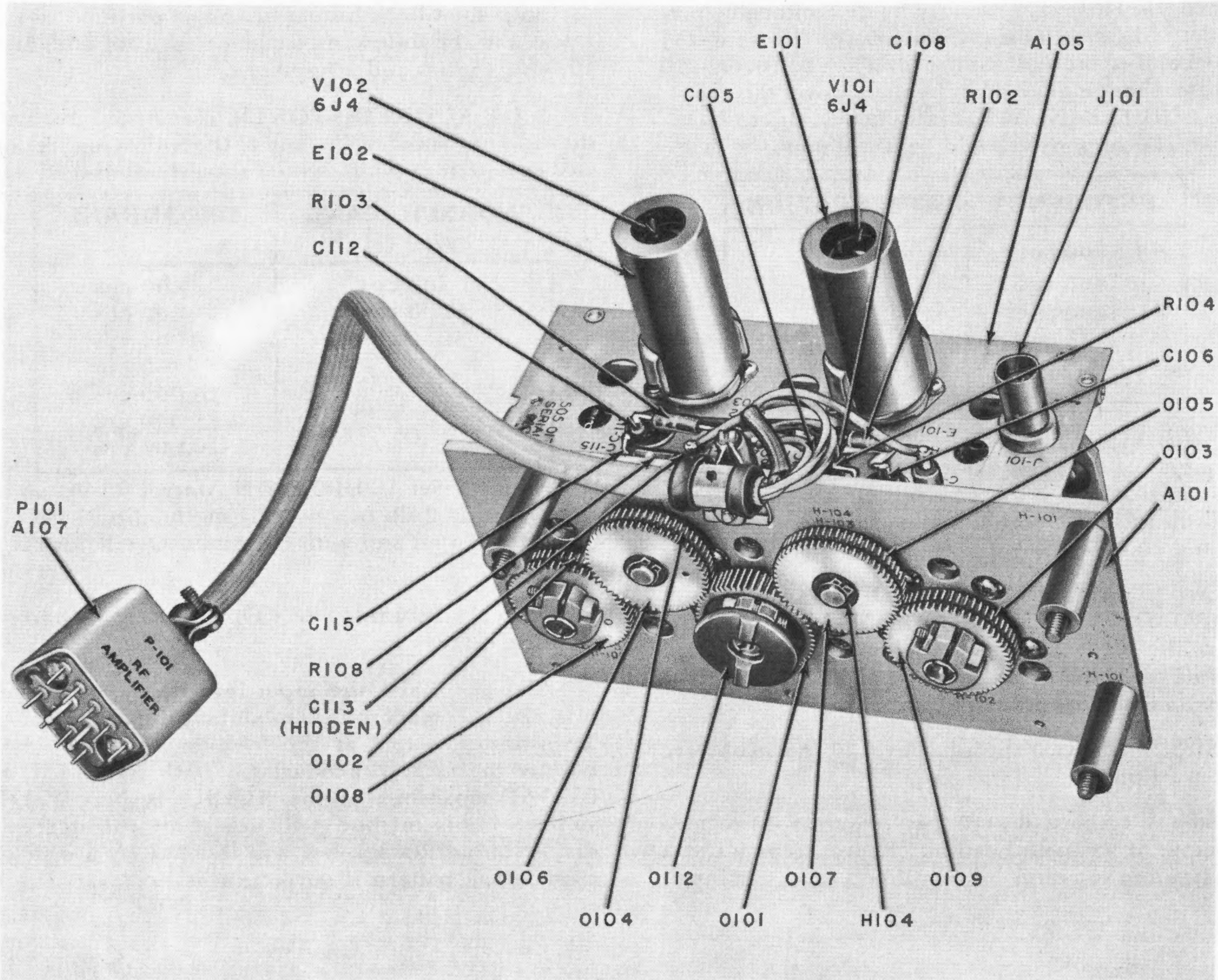


Figure 6–28. Radio Receiver R-278B/GR, R-F Amplifier, Top and Front View

Step 4. Repeat the procedure outlined in step 1 except change the input level to −15 dbm.

Step 5. Raise the input level to +5 dbm and repeat the procedure in Step 3 at the same frequencies.

(*f*) MCW OSCILLATOR OUTPUT.—The MCW oscillator is capable of producing an output level equivalent to 95% modulation. With the VOICE-MCW CARRIER ON switch set to MCW, close the key plugged into KEY jack J1402 and adjust MCW GAIN control R1432 (figure 5–2) for 95% modulation.

(*g*) MCW OSCILLATOR FREQUENCY.—The MCW oscillator frequency should be within 5% of 1020 cps. Measure the audio frequency output by means of Test Oscillator Model LAJ.

(*h*) MCW OSCILLATOR KEYING.—The MCW oscillator should be capable of being keyed at the rate of 25 words per minute. Check the keyed output from the Transmitter by listening to the signal on a receiver while keying at 25 words per minute by hand or with an automatic keying wheel.

6-3. REMOVAL, ADJUSTMENT, REPAIR AND REASSEMBLY OF PARTS AND SUBASSEMBLIES.

a. RECEIVER MAINTENANCE.

(1) GENERAL.—The mechanically-coupled subassemblies of the Receiver can be replaced by spare subassemblies. If trouble is localized to a subassembly, repair if possible with replacement. In general, defective subassemblies should be replaced with a spare and the defective one should be turned over to a repair activity for restoration.

To lubricate the Receiver, partial disassembly is required. Refer to Maintenance Check-off Book for Radio Set AN/GRC-27, NAVSHIPS 92383.41 for lubrication points and type of lubricant to use.

To install a mechanically-coupled subassembly in the Receiver Chassis, set the coupler key in a vertical position with the red dot up (except red dot down for the Main Oscillator subassembly).

To tune various subassemblies in the Receiver, the Receiver Frequency Selector must be set to the reference frequency of the subassembly to be tuned as follows:

Frequency Selector 390.0 mc.
First I-F Amplifier 399.9 mc.
Second I-F Amplifier 399.9 mc.
Main Oscillator 220.0 mc.
Frequency Multiplier-Amplifier 220.0 mc.
R-F Amplifier 360.5 mc.

In the following paragraphs, maintenance for each subassembly and section of the main frame are described. The over-all schematic diagram of Radio Receiver R-278B/GR is shown in figure 6–82. Practical wiring diagrams for the various subassemblies are shown in figures 6–86 through 6–94. Illustrations showing the location of various component parts of the Receiver are given in figures 6–2 through 6–9, 6–13, and 6–26 through 6–51.

(2) R-F AMPLIFIER MAINTENANCE.

Note

Always check realignment of the R-F Amplifier (refer to paragraph 6–2*b*(7)) whenever tubes are replaced or repairs made.

Note

Figures 6–27 and 6–28 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–86 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. With the Receiver energized, set MANUAL CHANNEL preset switches on Frequency Selector to 360.5 mc.

Step 2. Turn CHANNEL SELECTOR switch to MANUAL and wait for tuning cycle to end.

Step 3. Turn POWER switch to OFF. Remove the dust cover and position the Receiver on its front panel handles.

Step 4. Remove rear plate A1241 (figure 6–26).

Step 5. Remove rear plate A415 (figure 6–9) from the First I-F Amplifier.

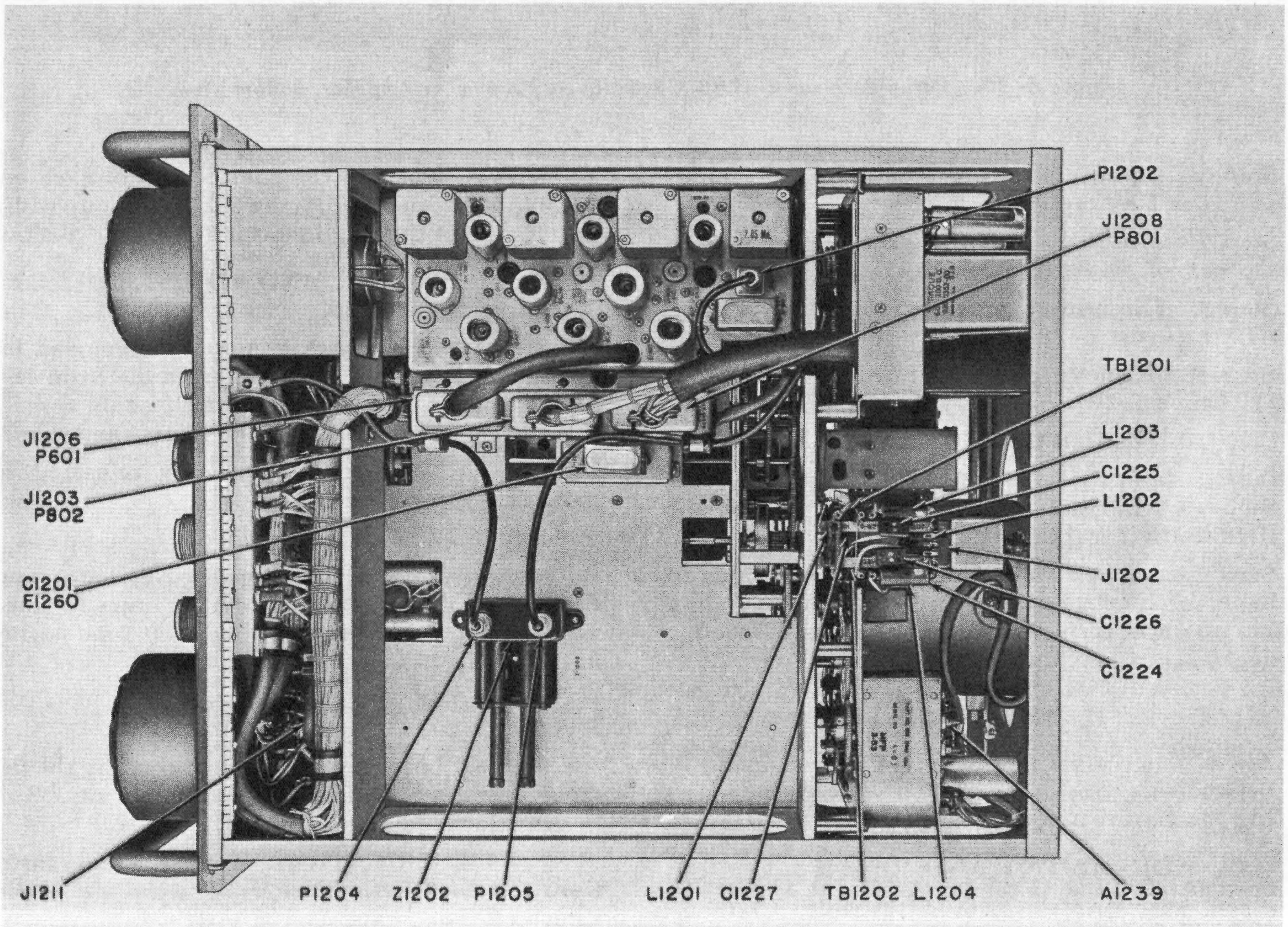


Figure 6–29. Radio Receiver R-278B/GR, Bottom View

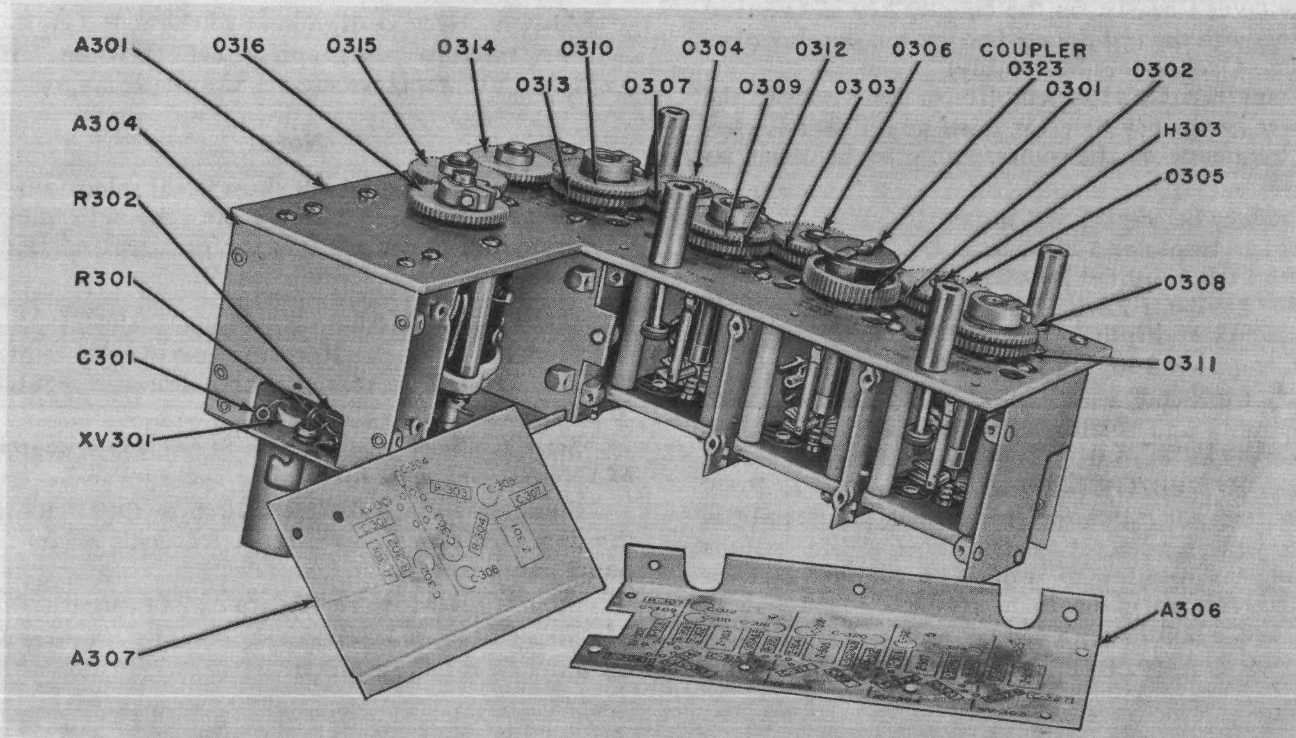


Figure 6–30. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Bottom View

Step 6. Remove small plate between R-F Amplifier and First I-F Amplifier.

Step 7. Unsolder capacitor C117 (figure 6–27) from pin 1 of V401 (figure 6–7).

Step 8. Disconnect antenna connector P1201 from J101 (figure 6–28).

Step 9. Remove power connector P101 from J1201 (figure 6–26).

Step 10. Loosen the three captive screws (red-headed).

Step 11. Lift out the R-F Amplifier. Tape the couplers to their respective frames to prevent loss.

Step 12. When replacing the R-F Amplifier in the Receiver frame, have the key of the coupler in a vertical position with the red dot up and the Receiver frequency set to 360.5 mc.

CAUTION

Allow a nominal clearance of 0.010 inch between sections of the coupler when tightening the captive screws.

(*b*) ADJUSTMENT AND REPAIRS.

1. MECHANICAL SYNCHRONIZATION.

Step 1. With red dot up, set the key of coupler O112 (figure 6–28) in the vertical position.

Step 2. Position the contact arm of each tuner (Z101, Z102, and Z103, figure 6–27) to line up with the center rivet of the ring inductor (360.5-mc position).

2. REMOVAL AND ADJUSTMENT OF TUNERS.

Step 1. With the R-F Amplifier removed from the Receiver, remove the gears from the front of the R-F Amplifier by releasing three clamps from the drive gears and truarcs from the idlers (figure 6–28).

Step 2. Remove the tuner by releasing four mounting screws.

Step 3. Replace the r-f tuner.

Step 4. Mechanically align the r-f tuners by positioning the inductance bars of each tuner to line up with the short stator support bar (360.5-mc position, figure 6–11).

Step 5. Assemble gears on the front plate of the R-F Amplifier.

Step 6. Load the gear train by rotating the gears three gear teeth against the loading spring. Rotate in direction tending to close spring ends.

3. LUBRICATION.—For lubrication instructions for the R-F Amplifier, refer to the Maintenance Check-off Book (NAVSHIPS 92383.41).

(*c*) REPLACEMENT.—To install the R-F Amplifier in the Receiver, reverse the removal procedure.

The alignment procedure for the R-F Amplifier is given in paragraph 6–2*b*(7).

(3) MAIN OSCILLATOR MAINTENANCE.

Note

Always check realignment of the Main Oscillator (refer to paragraph 6–2*b*(5)) whenever tubes are replaced or repairs made.

Note

Figures 6–31 through 6–33 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–91 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. With the Receiver energized, set the MANUAL CHANNEL preset switches of the Frequency Selector to 220.0 mc.

Step 2. Adjust the CHANNEL SELECTOR to MANUAL position, and wait for the tuning cycle to end.

Step 3. Turn Receiver POWER switch to OFF. Remove the dust cover and set the Receiver on its front panel handles.

Step 4. Remove plate A1241 (figure 6–26).

Step 5. Remove cable connection P201 from J1202 (figure 6–29).

Step 6. Remove the small plate between the Main Oscillator and the Frequency Multiplier-Amplifier.

Step 7. Unsolder C301 (figure 6–30) and three wires from solder connections (figure 6–31).

Step 8. Remove the captive mounting screws (red-headed).

Step 9. Lift out the Main Oscillator. Tape the couplers to their respective frames to prevent loss.

Step 10. When reinstalling the Main Oscillator, locate the key of the coupler in a vertical position with the *red dot down* and the Receiver frequency set at 220.0 mc.

(*b*) MECHANICAL SYNCHRONIZATION.

Step 1. Set S201 (figure 6–31) in the closed position for crystal number 18 (220.0-mc position).

Step 2. Set S204 (figure 6–32) in the closed position for coil L222 (220.0-mc position).

Step 3. With *red dot down*, set the key of coupler 0204 (figure 6–33) in the vertical position.

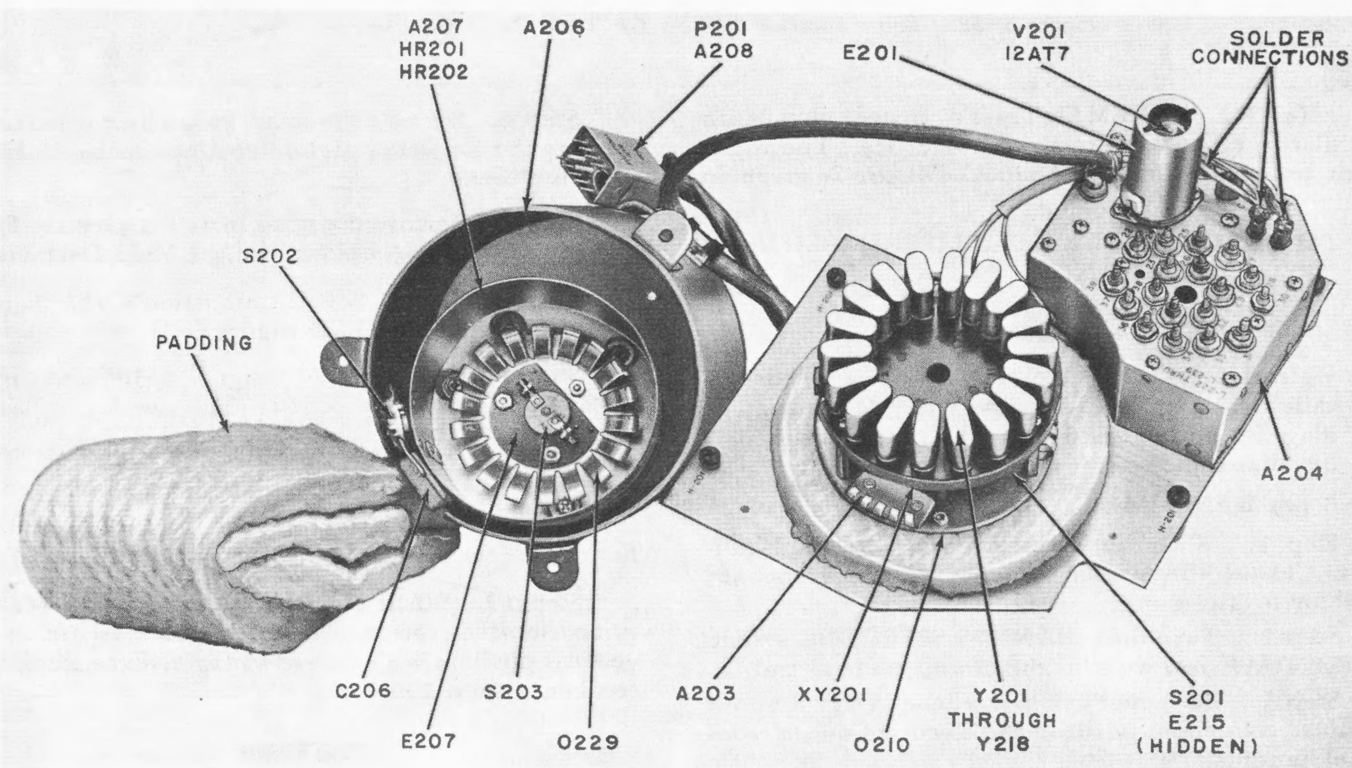


Figure 6–31. Radio Receiver R-278B/GR, Main Oscillator, Top View

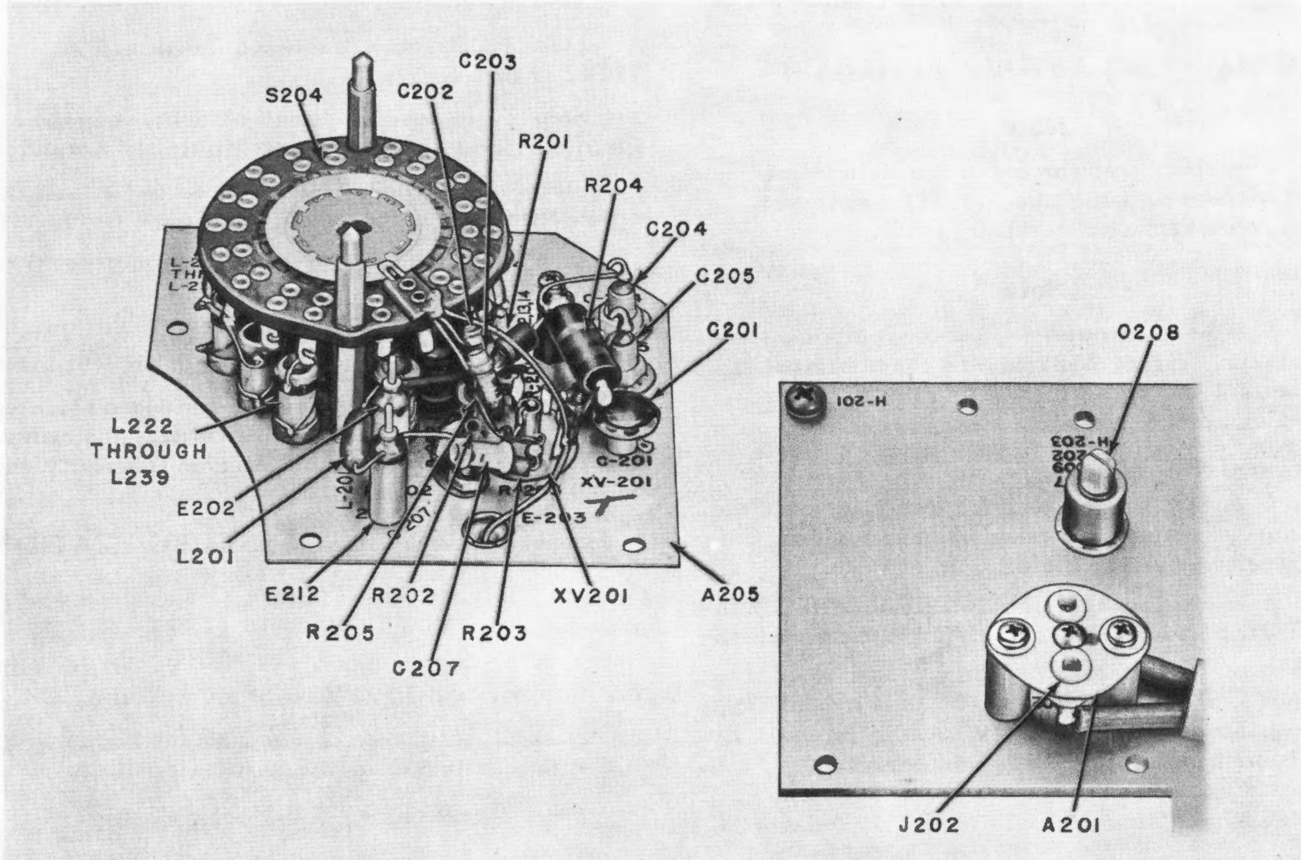


Figure 6–32. Radio Receiver R-278B/GR, Main Oscillator, Underside View

(*c*) REPLACEMENT.—To install the Main Oscillator, reverse the removal procedure. The alignment procedure for the Main Oscillator is given in paragraph 6–2*b*(5).

(4) FREQUENCY MULTIPLIER-AMPLIFIER MAINTENANCE.

Note

Figures 6–34 through 6–36 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–90 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. With the Receiver energized, set MANUAL CHANNEL preset switches of the Frequency Selector to 220.0 mc.

Step 2. Turn the CHANNEL SELECTOR switch to MANUAL and wait for the tuning cycle to end.

Step 3. Turn the POWER switch to OFF. Remove the dust cover and position the Receiver on its front panel handles.

Step 4. Remove plate A1241 (figure 6–26).

Step 5. Remove rear plate A415 (figure 6–9) from the First I-F Amplifier.

Step 6. Remove the small grounding plate connecting the Frequency Multiplier-Amplifier to the First I-F Amplifier.

Step 7. Remove the small plate between the Frequency Multiplier-Amplifier and the Main Oscillator.

Step 8. Remove solder connection C327 (figure 6–34) from pin 2 of V401 (figure 6–7).

Step 9. Unsolder C301 (figure 6–30) and three wires from solder connections (figure 6–31).

Step 10. Unscrew the mounting captive screws (red-headed).

Step 11. Lift out the Frequency Multiplier-Amplifier. Tape the coupler to the frame to prevent loss.

Step 12. When replacing the Frequency Multiplier-Amplifier, place the key of the coupler in a vertical position with the *red dot up* and the Receiver frequency set at 220.0 mc.

CAUTION

Allow a nominal clearance of 0.010 inch between sections of the coupler when tightening the captive screws.

(*b*) ADJUSTMENT AND REPAIRS.

1. MECHANICAL SYNCHRONIZATION.

Step 1. With *red dot up*, set the key of the coupler (figure 6–30) in the vertical position.

Step 2. Position the contact arm of Z301 (figure 6–35) on the largest turn of the coil (220.0-mc position).

Step 3. Position the contact arm of each tuner (Z303, Z305, Z307, and Z309, figure 6–34) to make contact with the bottom end of the ring inductor (220.0-mc position).

2. REMOVAL AND ADJUSTMENT OF TUNERS.

Step 1. With the Frequency Multiplier-Amplifier removed from the Receiver, remove the gears by releasing clamps and removing truarcs (figure 6–30).

Step 2. Remove the tuner by releasing four mounting screws.

Step 3. Replace the r-f tuner.

Step 4. Mechanically align the r-f tuner by positioning the inductance bars of each tuner to line up with the ring eyelet (220.0-mc position, figure 6–30).

Step 5. Assemble gears on the front plate of the subassembly.

Step 6. Load the gear train by rotating the three teeth of the gear against the loading spring. Rotate in direction tending to close spring ends.

3. LUBRICATION.—For lubrication instructions for the Frequency Multiplier-Amplifier, refer to Maintenance Check-off Book (NAVSHIPS 92383.41).

(*c*) REPLACEMENT.—To install the Frequency Multiplier-Amplifier subassembly, reverse the removal procedure. The alignment procedure for the Frequency Multiplier-Amplifier is given in paragraph 6–2*b*(6).

(5) FIRST I-F AMPLIFIER MAINTENANCE.

Note

Figures 6–7 through 6–9 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–87 is the practical wiring diagram.

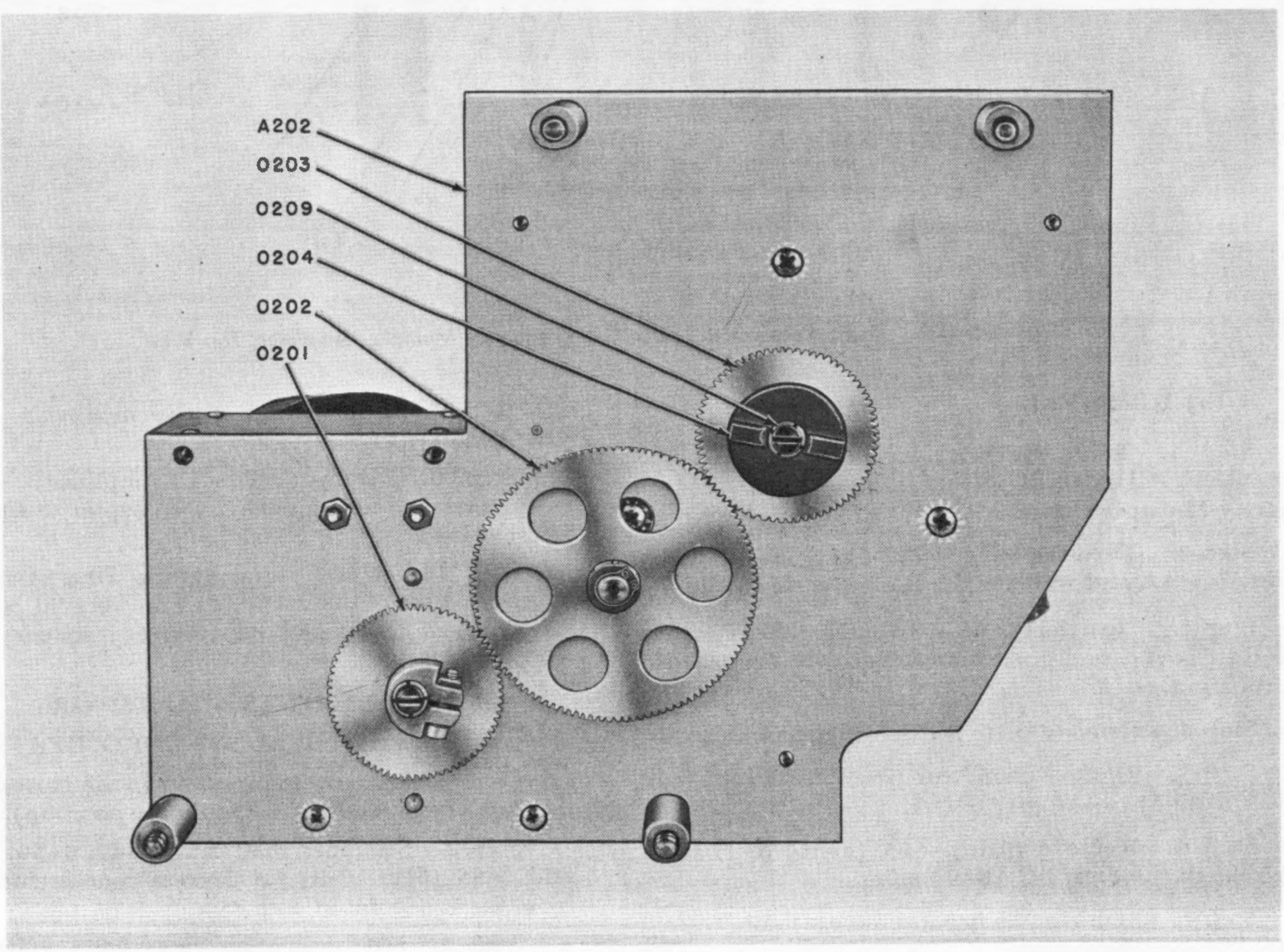


Figure 6–33. Radio Receiver R-278B/GR, Main Oscillator, Bottom View

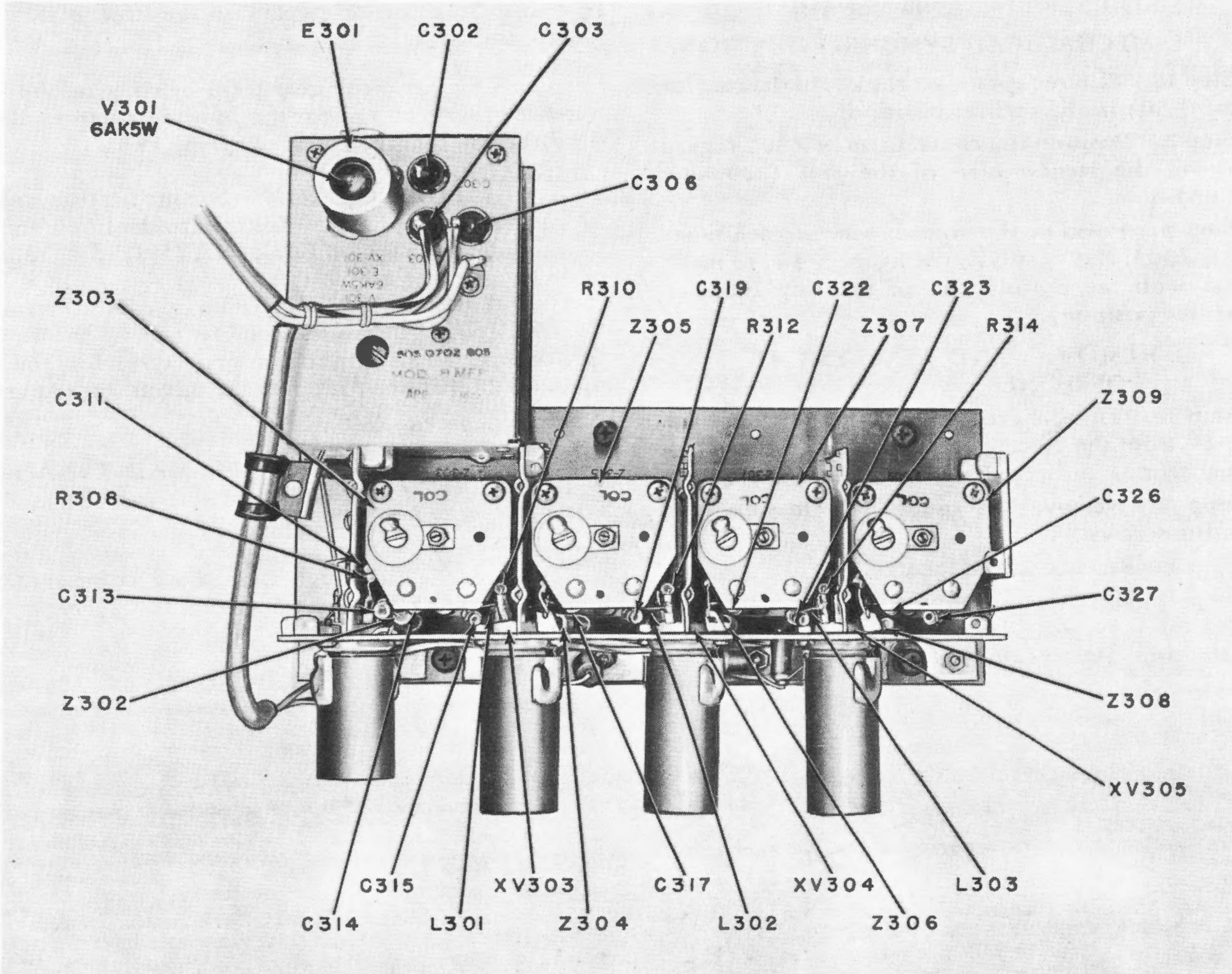


Figure 6–34. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Top View

(*a*) REMOVAL.

Step 1. With the Receiver energized, set the MANUAL CHANNEL preset switches on the Frequency Multiplier to 399.9 mc.

Step 2. Turn the CHANNEL SELECTOR switch to MANUAL and wait for the tuning cycle to end.

Step 3. Turn the POWER switch to OFF. Remove the dust cover, and position the Receiver on its front panel handles.

Step 4. Remove plate A1241 (figure 6–26).

Step 5. Remove connectors P402 from J505, and P401 from J1204 (figure 6–26).

Step 6. Remove plate A415 (figure 6–9) from the rear of the First I-F Amplifier.

Step 7. Remove two ground plates (figure 6–26).

Step 8. Unsolder C117 (figure 6–27) from pin 1 of V401, and C327 (figure 6–34) from pin 2 of V401.

Step 9. Unscrew the captive mounting screws (red-headed).

Step 10. Remove the First I-F Amplifier by sliding to the rear and lifting out. Tape coupler to frame to prevent loss.

Step 11. When replacing the First Amplifier, place the keys of the couplers in the vertical position with the *red dots up* and the Receiver frequency set at 399.9 mc.

(*b*) ADJUSTMENTS AND REPAIRS.

1. MECHANICAL SYNCHRONIZATION.

Step 1. Set S401 (figure 6–9) in the closed position for crystal number 1 (399.9-mc position).

Step 2. Set upper shaft cams 0449, 0450, 0454, and 0455 (figure 6–8) 7.5 degrees counterclockwise from the low point of each cam.

Step 3. Set lower shaft cams 0445 and 0446 (figure 6–8) 30 degrees clockwise from the low point of each cam.

Step 4. With *red dots up*, set the keys of couplers 0443 and 0451 (figure 6–7) in the vertical position.

2. LUBRICATION.—For lubrication instructions for the First I-F Amplifier, refer to the Maintenance Check-Off Book (NAVSHIPS 92383.41).

(*c*) REPLACEMENT.—To install the First I-F Amplifier, reverse the removal procedure. The alignment procedure for the First I-F Amplifier is given in paragraph 6–2*b*(4).

(6) SECOND I-F AMPLIFIER MAINTENANCE.

Note

Figures 6–4 through 6–6 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–88 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. With the Receiver energized, set the MANUAL CHANNEL preset switches of the Frequency Selector to 399.9 mc.

Step 2. Turn the CHANNEL SELECTOR switch to MANUAL and wait for the tuning cycle to end.

Step 3. Turn the POWER switch to OFF. Remove the dust cover, and position the Receiver on its front panel handles.

Step 4. Remove plate A1241 (figure 6–26).

Step 5. Remove connector P501 from J1205 (figure 6–26).

Step 6. Remove connector P502 from J608 (figure 6–2).

Note

To perform step 6, it is first necessary to remove both the R-F Amplifier and the Audio Amplifier, to remove the cable part of P502. Step 6 may be omitted if only a bench check is desired.

Step 7. Unscrew six mounting screws (red-headed).

Step 8. Remove the Second I-F Amplifier by sliding to the rear and lifting it out.

Step 9. When replacing the Second I-F Amplifier, place the key of the coupler in a vertical position with *red dot up* and the Receiver frequency set at 399.9 mc.

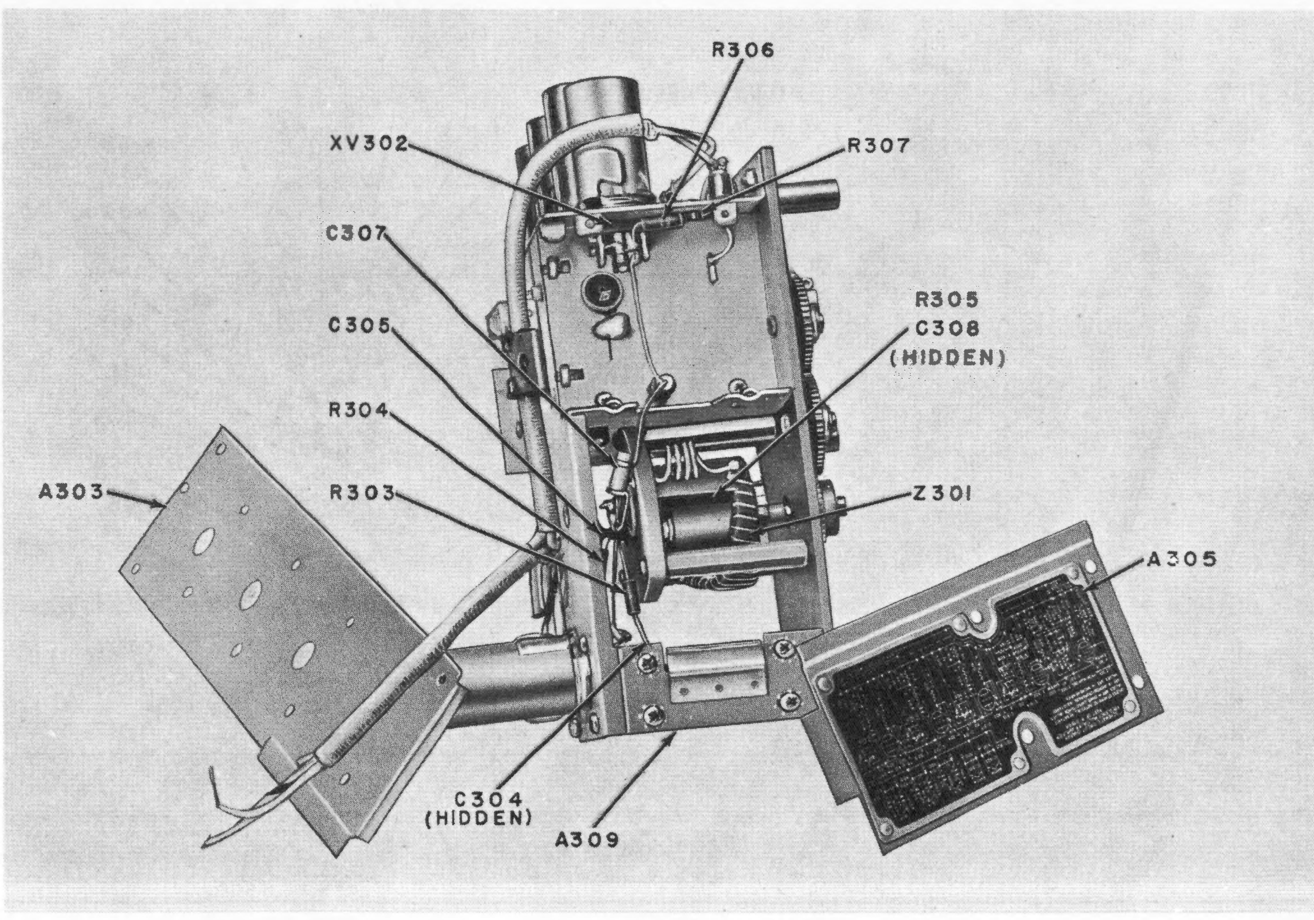


Figure 6–35. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Side View

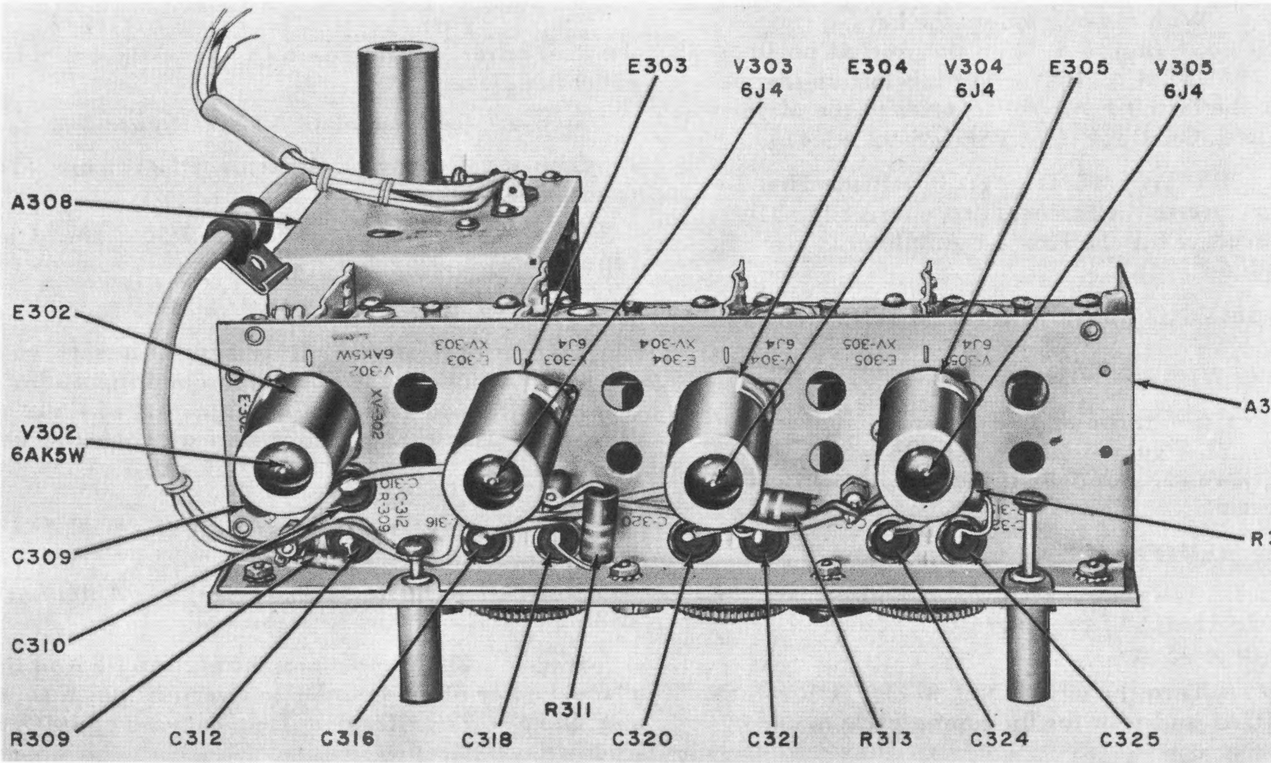


Figure 6–36. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier, Front View

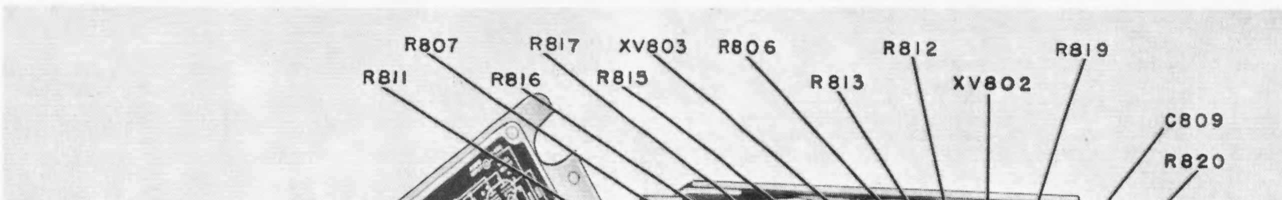


Figure 6–37. Radio Receiver R-278B/GR, Audio Amplifier, Underside View

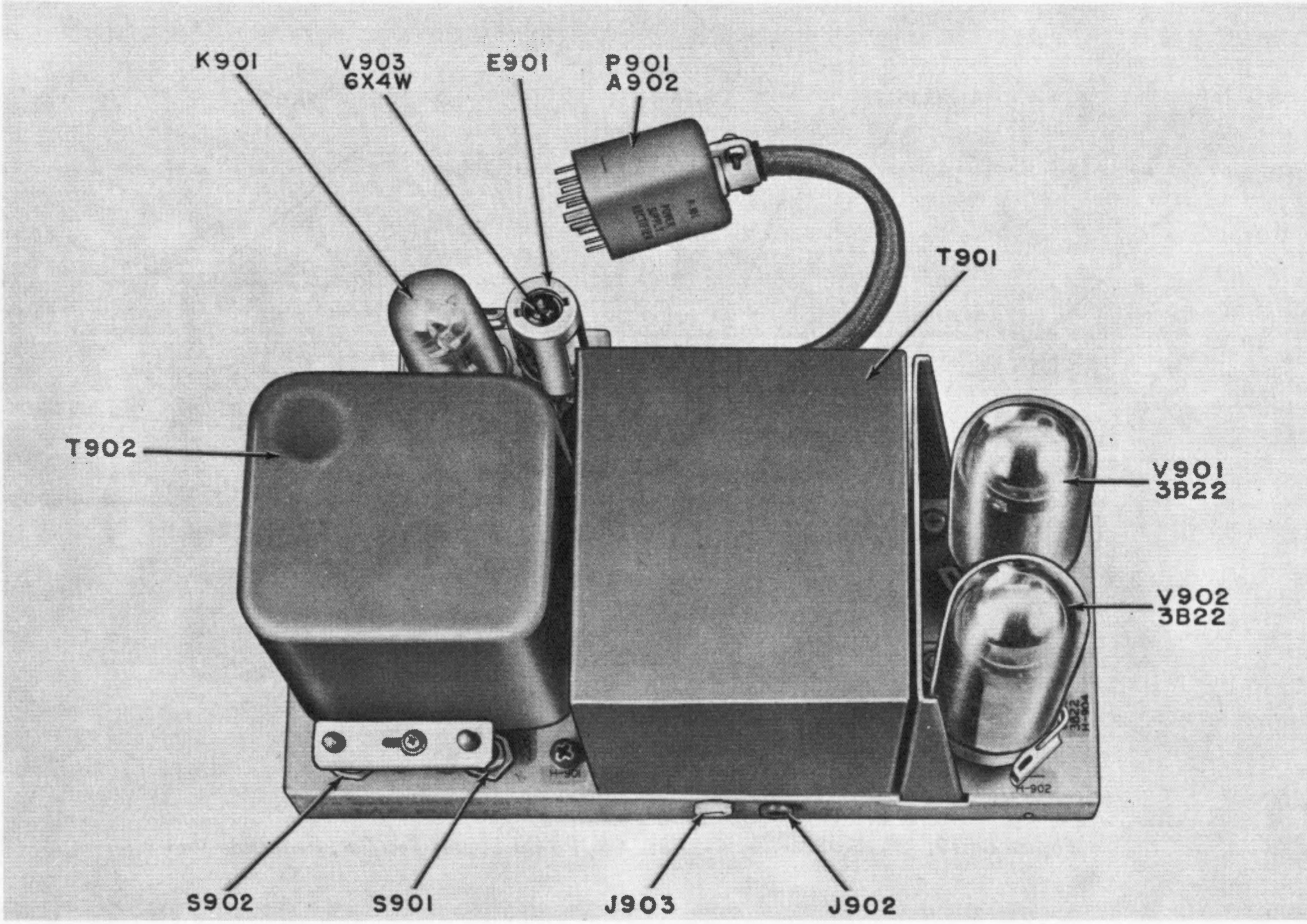


Figure 6–38. Radio Receiver R-278B/GR, Power Supply Rectifier, Top View

CAUTION

Allow a nominal clearance of 0.010 inch between sections of the coupler when tightening the captive screws.

(*b*) ADJUSTMENTS AND REPAIRS.

1. MECHANICAL SYNCHRONIZATION.

Step 1. Set S501 (figure 6–5) in the closed position for crystal number 10 (399.9-mc position).

Step 2. Set cams 0520 and 0521 (figure 6–6) eight degrees clockwise from the low point of the cams.

Step 3. With the *red dot up*, set the key of coupler 0519 (figure 6–6) in the vertical position.

2. LUBRICATION.—For lubrication instructions for the Second I-F Amplifier, refer to the Maintenance Check-off Book (NAVSHIPS 92383.41).

(*c*) REPLACEMENT.—To install the Second I-F Amplifier, reverse the removal procedure. The alignment procedure for the Second I-F Amplifier is given in paragraph 6–2*b*(3).

(7) THIRD I-F AMPLIFIER MAINTENANCE.

Note

Figures 6–2 and 6–3 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–89 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. Remove the dust cover and set the Receiver bottom up.

Step 2. Remove connectors P502 and P601 from J608 and J1206 (figures 6–26 and 6–29).

Step 3. Unscrew four captive mounting screws (red-headed).

Step 4. Lift out the Third I-F Amplifier.

(*b*) REPLACEMENT.—To install the Third I-F Amplifier, reverse the removal procedure. The alignment procedure for the Third I-F Amplifier is given in paragraph 6–2*b*(2).

(8) AUDIO AMPLIFIER MAINTENANCE.

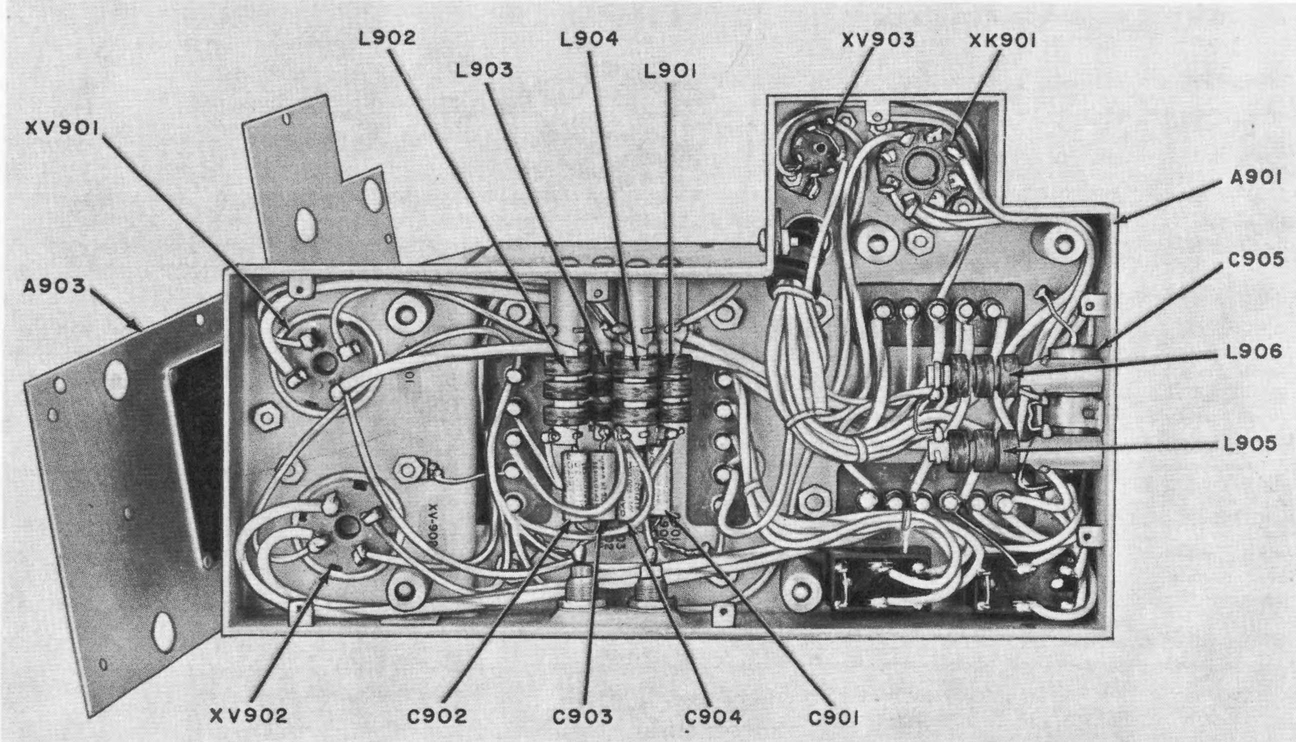


Figure 6–39. Radio Receiver R-278B/GR, Power Supply Rectifier, Underside View

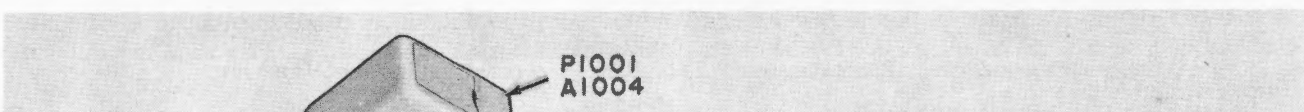


Figure 6–40. Radio Receiver R-278B/GR, Power Supply Filter, Top View

Note

Figures 6–13 and 6–37 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–92 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. Remove the dust cover and position the Receiver on its front panel handles.

Step 2. Remove connectors P801 and P802 from J1203 and J1208 (figure 6–29).

Step 3. Unscrew four captive mounting screws (red-headed).

Step 4. Lift out the Audio Amplifier.

(*b*) REPLACEMENT.—To install the Audio Amplifier, reverse the removal procedure.

(9) RECEIVER POWER SUPPLY MAINTENANCE.

Note

Figures 6–38 and 6–39 show component callouts. Figure 6–82 shows the schematic diagram.

(*a*) REMOVAL.

Step 1. Remove the dust cover and position the Receiver upright.

Step 2. Remove connector P901 from J1209 (figure 6–26).

Step 3. Unscrew five captive mounting screws (red-headed).

Step 4. Lift out the Power Supply Rectifier.

(*b*) REPLACEMENT.—To install the Receiver Power Supply, reverse the removal procedure.

(10) POWER SUPPLY FILTER MAINTENANCE.

Note

Figures 6–40 and 6–41 show component callouts. Figure 6–82 shows the schematic diagram and figure 6–93 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. Remove the dust cover and position the Receiver upright.

Step 2. Remove connector P1001 from J1210 (figure 6–26).

Step 3. Remove four captive mounting screws (red-headed).

Step 4. Lift out the Power Supply Filter.

(*b*) REPLACEMENT.—To install the Power Supply Filter, reverse the removal procedure.

(11) FREQUENCY SELECTOR MAINTENANCE.

Note

Figures 6–42 through 6–46 show component callouts. Figure 6–85 shows the schematic diagram and figure 6–94 is the practical wiring diagram.

(*a*) REMOVAL.

Step 1. Set the Receiver Frequency Selector to 390.0 mc. In case the system has gone "dead" or is mechanically jammed, so that it is not possible to set up this frequency, record the frequency at which the Frequency Selector is tuned before removal.

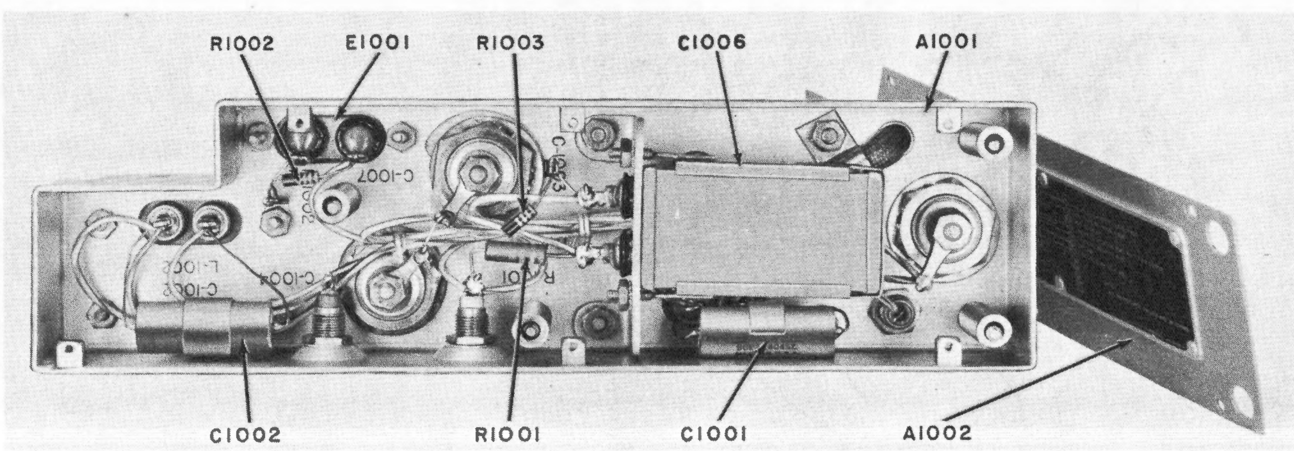


Figure 6–41. Radio Receiver R-278B/GR, Power Supply Filter, Underside View

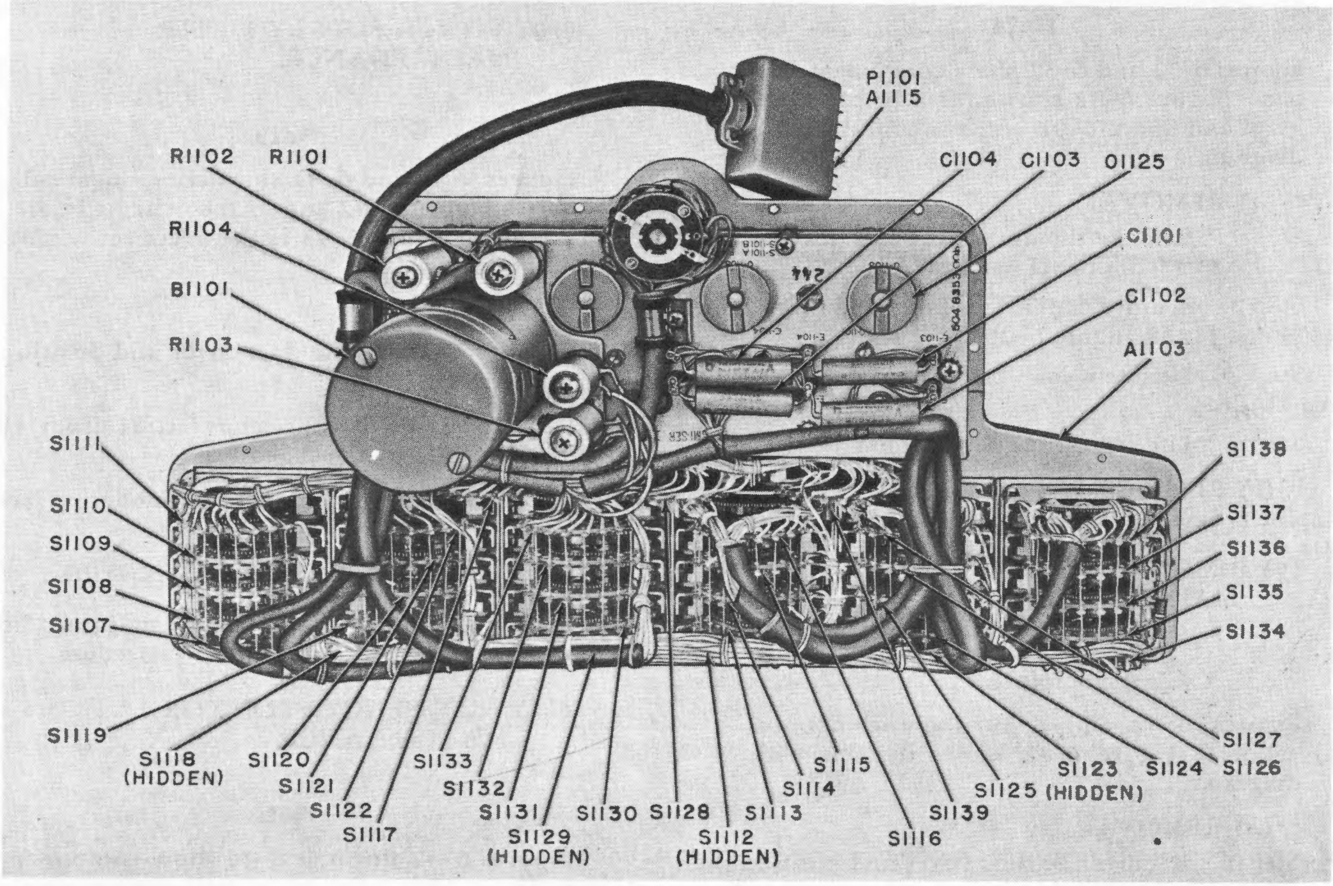


Figure 6–42. Radio Receiver R-278B/GR, Frequency Selector, Rear View

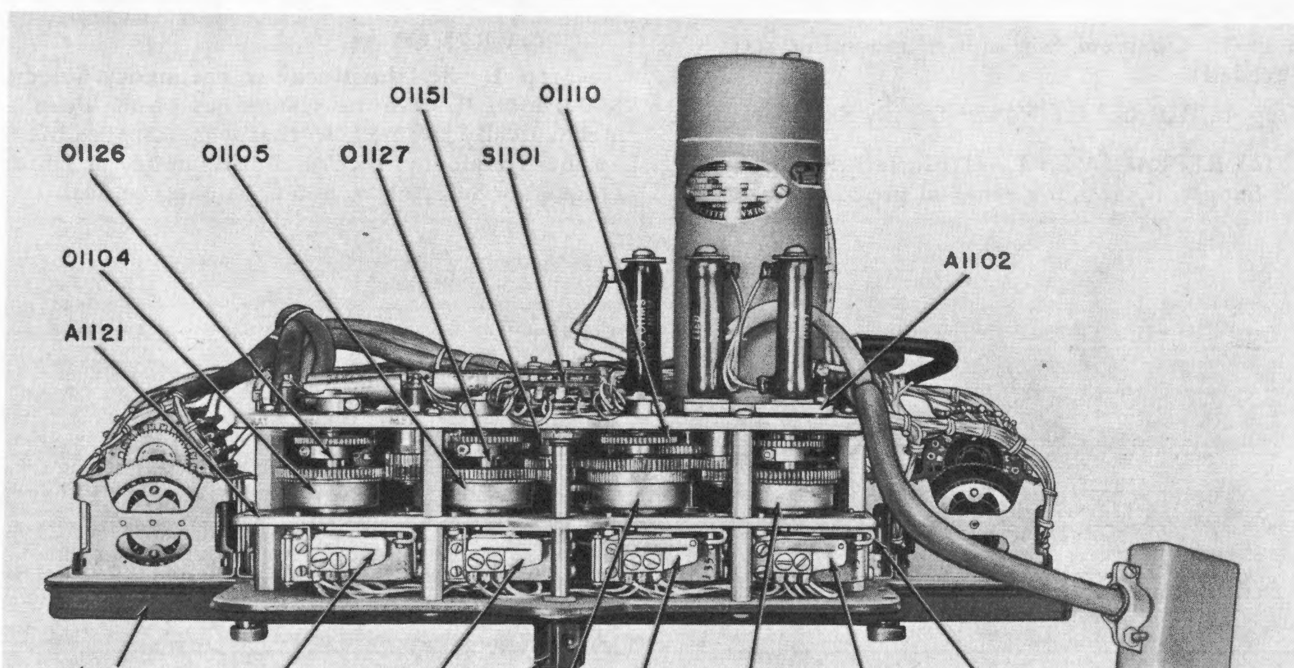


Figure 6–43. Radio Receiver R-278B/GR, Frequency Selector, Bottom View

Step 2. Position the Receiver on its rear plate, so that the front of the Receiver is up.

Step 3. Remove twelve flat-head screws and eight round-head screws on the outside edge of the Frequency Selector.

Step 4. Remove connector P1101 from J1211.

Step 5. Slowly lift straight up on the released subassembly; be careful not to jar or scrap any of the mounted elements against the frame.

Step 6. Retain all couplers and tape them to their respective shafts to prevent loss.

Step 7. Sufficient cable is provided so that the Frequency Selector can be bench-checked with the power on.

Step 8. When replacing the Frequency Selector, set its frequency to 390.0 mc and mark the indicator bars so that they match with marks on the Oldham couplers.

(*b*) ADJUSTMENTS AND REPAIRS.

1. FREQUENCY SELECTOR SYNCHRONIZATION.—Perform the following procedure if the Frequency Selector in the Receiver or in the Transmitter has been repaired to the extent that its timing has been disturbed.

Step 1. Remove panel A1101 (figure 6–45).

Step 2. Remove dials N1101, N1102, N1103, and N1104 (figure 6–46).

Step 3. Loosen clamps on all five gears (01109 and 01110 in figure 6–45). If only one switch is out of time, loosen only the associated gear.

Step 4. Position switches S1102, S1103, S1104, S1105, and S1106 to the 390.0-mc position (figure 6–44).

Step 5. Tighten clamps on gears 01109 and 01110.

Step 6. Remount dials N1101 through N1104 on the switch shafts and position the dials to read 390.0 mc (MANUAL).

Step 7. Tighten set screws; attach overlay plate and preset panel; and tighten set screws in CHANNEL SELECTOR knob with knob pointer indicating at M.

Step 8. Adjust each autopositioner relay frame within limits of mounting hole clearance so that pawl clears periphery of stop-wheel 01129 (figure 6–45) by a minimum of 0.010 inch when the armature is in the energized position. The pawl must seat fully in the stop-wheel when armature is in the de-energized position. Armature must be free when pawl is fully seated.

Step 9. In the de-energized position, adjust the normally open contacts of K1101 for a minimum gap of 0.30 inch (with pawl seated in notch).

Step 10. With the pawl of K1101 resting on the periphery (outer circumference) of stop-wheel 01129 (figure 6–45) the normally open contacts must be fully closed. In the energized position, the normally open contacts must have a minimum contact pressure of 25 grams.

Step 11. In the de-energized position, adjust the normally closed contacts of K1101 for a minimum contact pressure of 25 grams and to maintain contact for a minimum of 0.040 inch travel of the tip of the

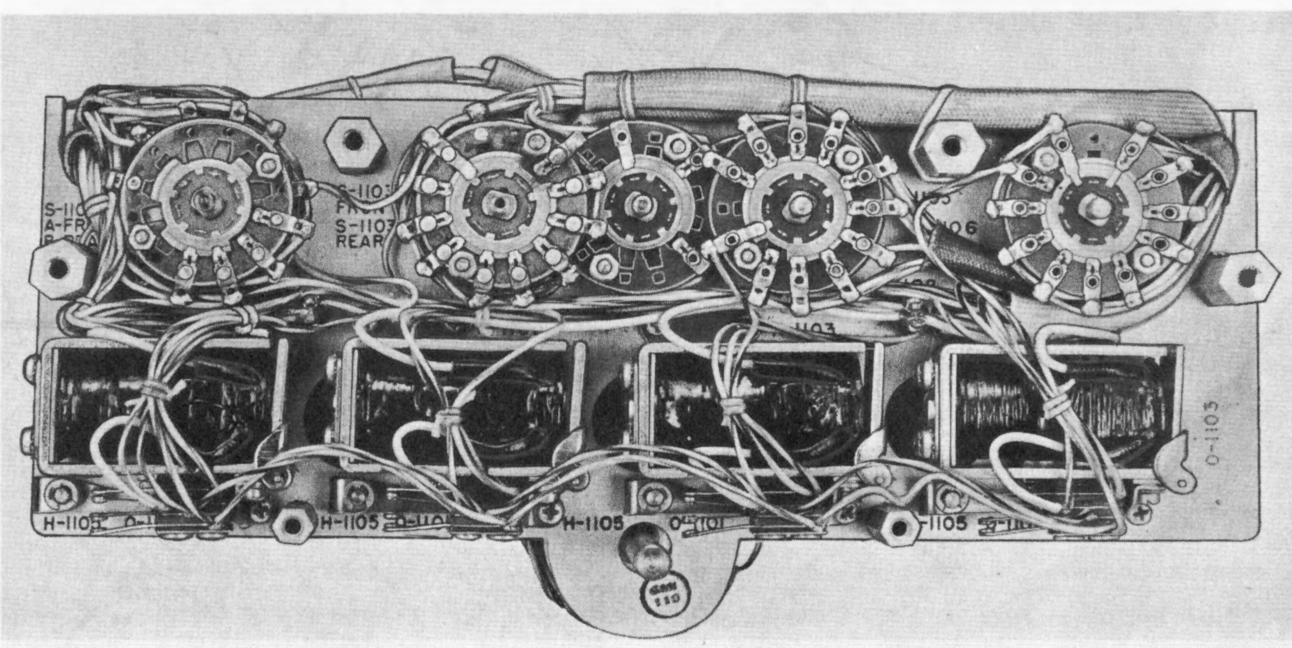


Figure 6–44. Radio Receiver R-278B/GR, Frequency Selector, Showing Switches Set at 390.0 mc

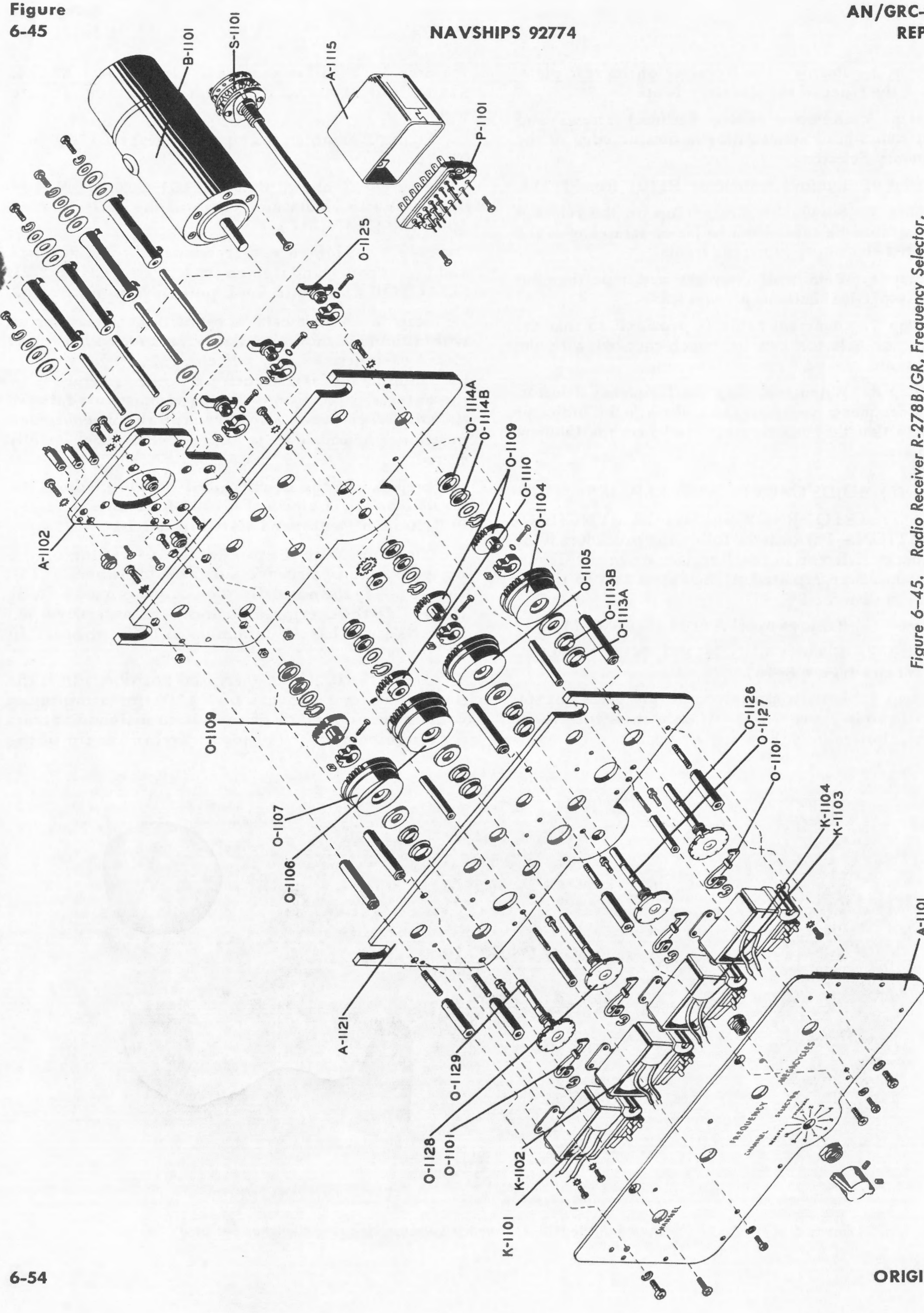


Figure 6–45. *Radio Receiver R-278B/GR, Frequency Selector, Mechanical Section, Bottom View*

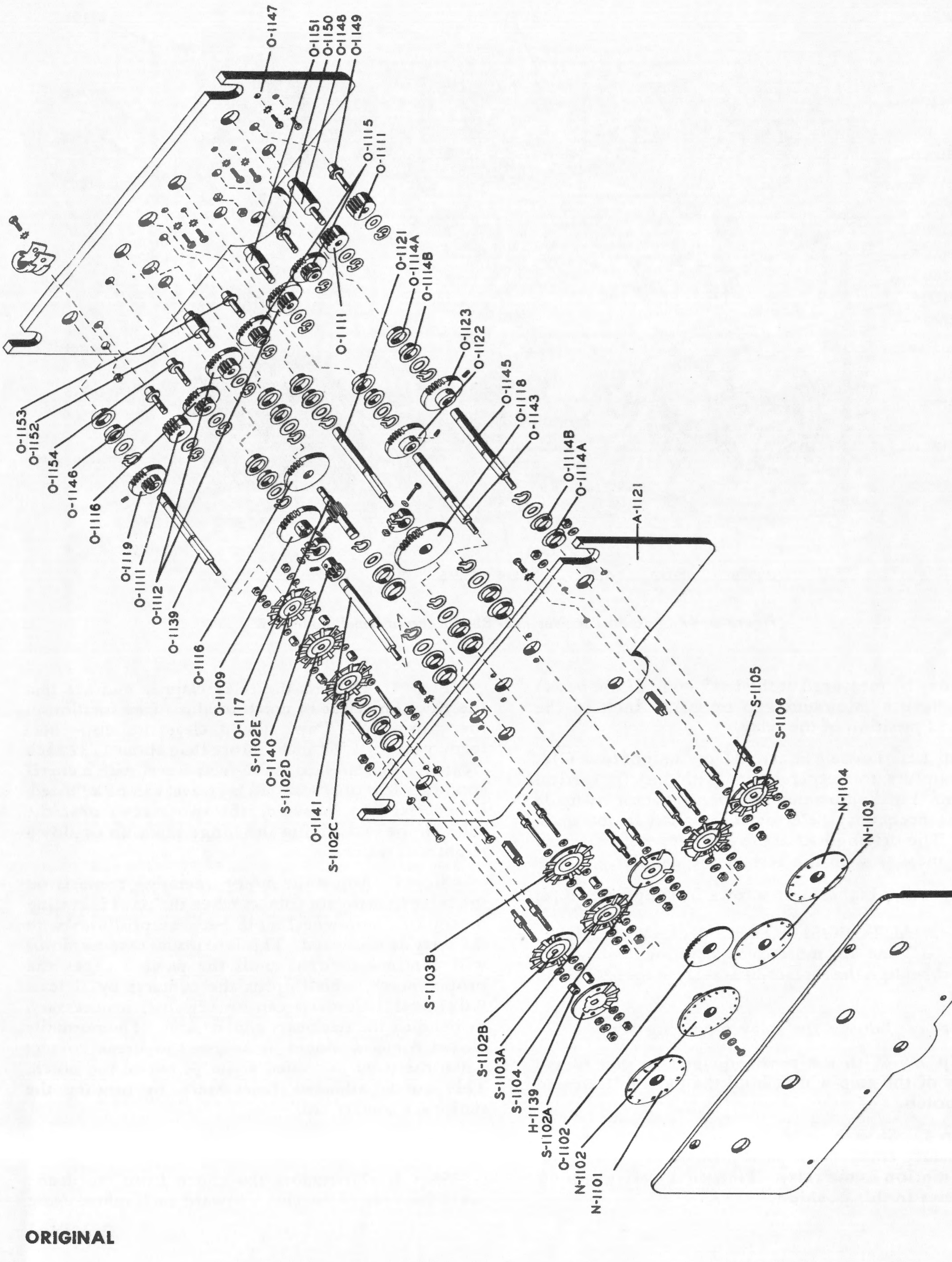


Figure 6–46. Radio Receiver R-278B/GR, Frequency Selector, Mechanical Section, Top View

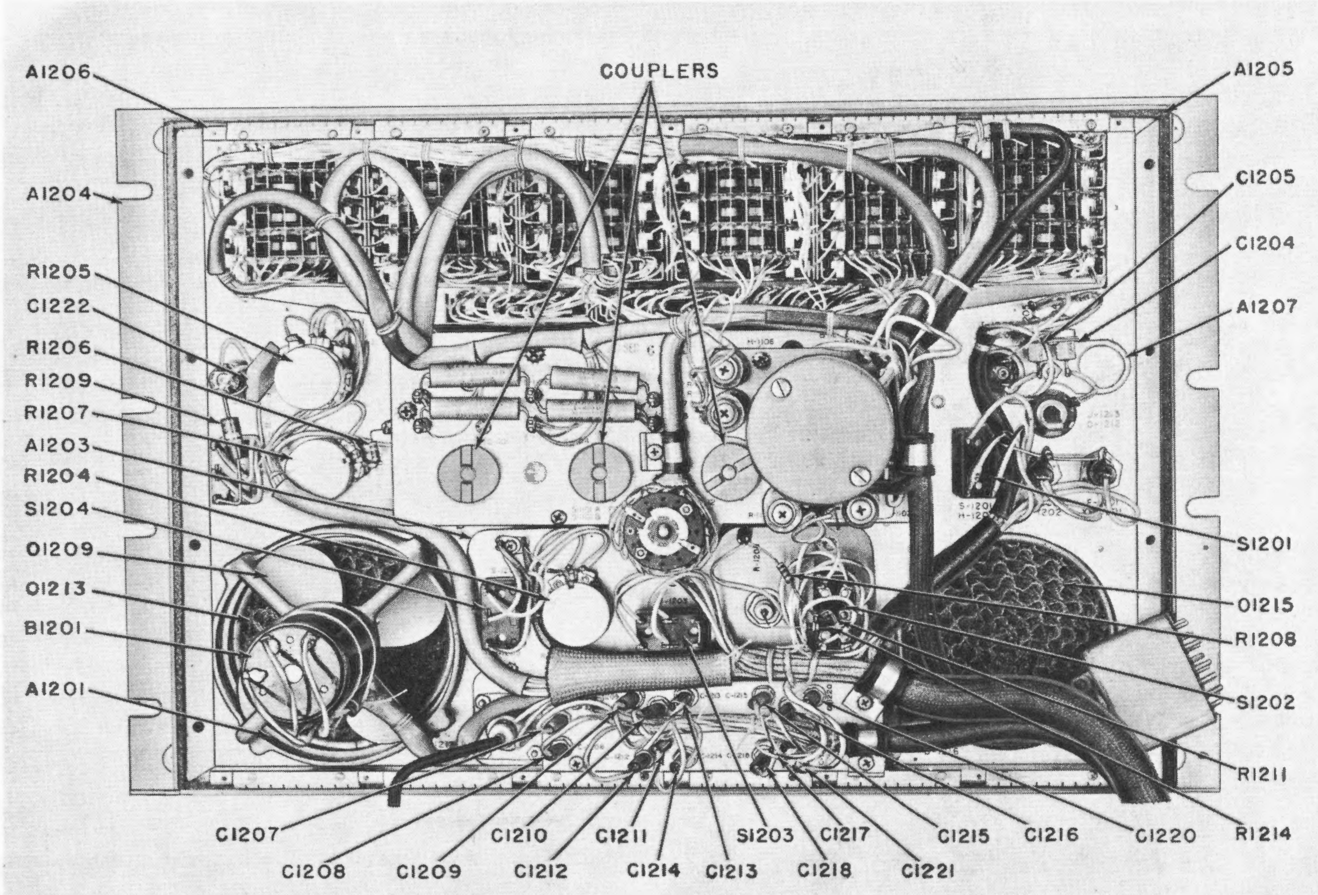


Figure 6–47. Radio Receiver R-278B/GR, Front Panel, Rear View

pawl (may be measured at the back edge of the pawl) and to have a minimum gap or 0.020 inch in the energized position of the relay.

Step 12. Loosely attach driving half of four Oldham couplers to output shafts with key in vertical position. Final adjustment of couplers must be made after the Frequency Selector is installed in the main frame. The driving half of the coupler must be turned until it meshes with the rest of the coupler.

Step 13. Tighten set screws in coupler clamps.

2. AUTOPOSITIONER RELAY ADJUSTMENT.—If one or more autopositioner relays are removed, realign the replacement relay in the following manner.

Step 1. Loosen the relay mounting screws.

Step 2. With the pawl engaged in one of the notches of the stop-wheel, hold the pawl fully seated in the notch.

Step 3. Shift the relay so that the relay frame and the armature contacts the pawl projection to eliminate all lost motion in the relay. Tighten the relay mounting screws in this position.

Step 4. Depress the relay clapper and see that the pawl lifts clear of notch to allow free rotation of the stop-wheel. Pawl should clear the stop-wheel teeth by about 1/64 inch. More than about 1/32 inch clearance indicates excessive relay travel with a corresponding loss of power. Relay travel can be adjusted, if necessary, by loosening the two screws near the relay hinge and sliding the hinge plate up or down slightly as required.

Step 5. Adjust the motor operating contacts on the relay to maintain contact when the pawl is resting on top of a stop-wheel tooth between positions with the relay de-energized. This is to insure that the motor will continue to drive until the pawl engages the proper notch, which opens the contacts by at least 0.025 inch. Contacts can be adjusted, if necessary, by bending the stationary contact arm. The normally closed contacts should be adjusted to break contact when the pawl has lifted about ⅔ out of the notch. This can be adjusted if necessary, by bending the stationary contact arm.

3. CLUTCH MAINTENANCE.

Step 1. To remove the clutch from the drum, press the ends of the clutch toward each other, using smooth-faced parallel-jaw pliers. Slide the clutch out of the drum.

Step 2. To remove the clutch drum from the shaft, remove the Truarc ring with Truarc pliers and while holding the shaft (do not use pawl to hold shaft), loosen the nut with pliers or wrench and proceed to slip the spacer and drum from the shaft.

Step 3. Before replacing the clutch ring in the drum, carefully wipe the inside of the drum to remove oil and grease and inspect the drum surface for scoring.

Step 4. Lubricate the oilite bearing in the mounting plate with a drop of AN-O-4 oil.

Step 5. The number of metal springs within the clutch shoe and the resilience of the metal springs determines the torque of the clutch.

Step 6. Reassemble the autopositioner and make adjustments of relays as outlined in the previous paragraph.

4. MOTOR REPAIR.—The Frequency Selector motor uses self-sealed bearings which require no lubrication or maintenance. The commutator and governor contacts are made accessible by removing a cap over the end of the motor. The contacts should be replaced if they are damaged. Examine the governor contacts and motor brushes for foreign particles; clean if necessary.

5. LUBRICATION.—For lubricating instructions for the Frequency Selector, refer to the Maintenance Check-off Book (NAVSHIPS 92383.41).

(*c*) REPLACEMENT.

Step 1. Set the Receiver Frequency Selector to 390.0 mc.

Step 2. Loosen the three coupler clamps on the Frequency Selector output shafts so that couplers will mesh with mating halves whose index marks coincide exactly with bar marks.

Step 3. Lower the Frequency Selector into the main frame, engaging couplers.

Step 4. Secure the Frequency Selector to the main frame.

Step 5. Adjust the axial position of the couplers so that nominal 0.010 inch exists between mating parts of the coupler.

Step 6. Tighten the clamps on the autopositioner output shaft with screws which are accessible from the bottom of the Receiver.

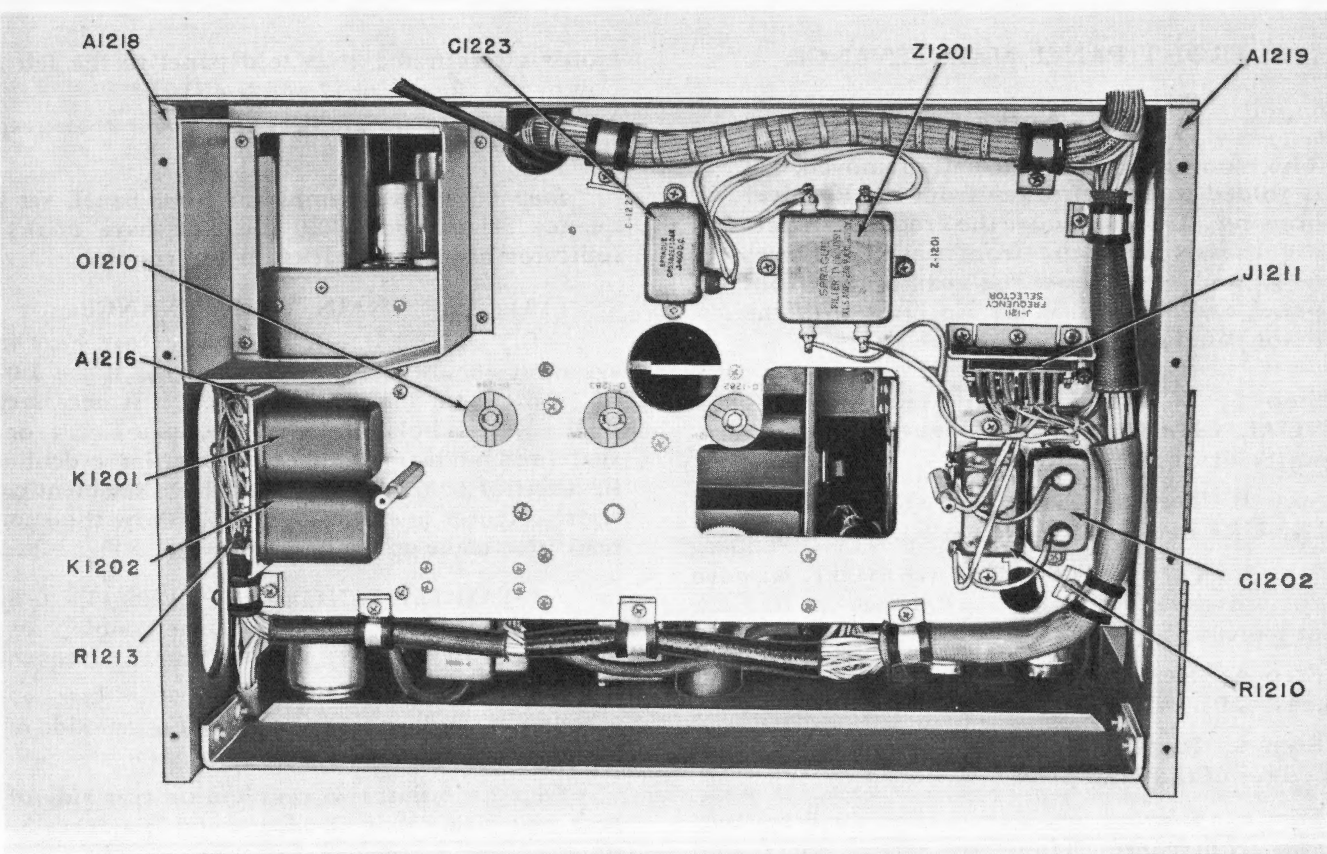


Figure 6–48. Radio Receiver R-278B/GR, Front View, Front Panel Removed

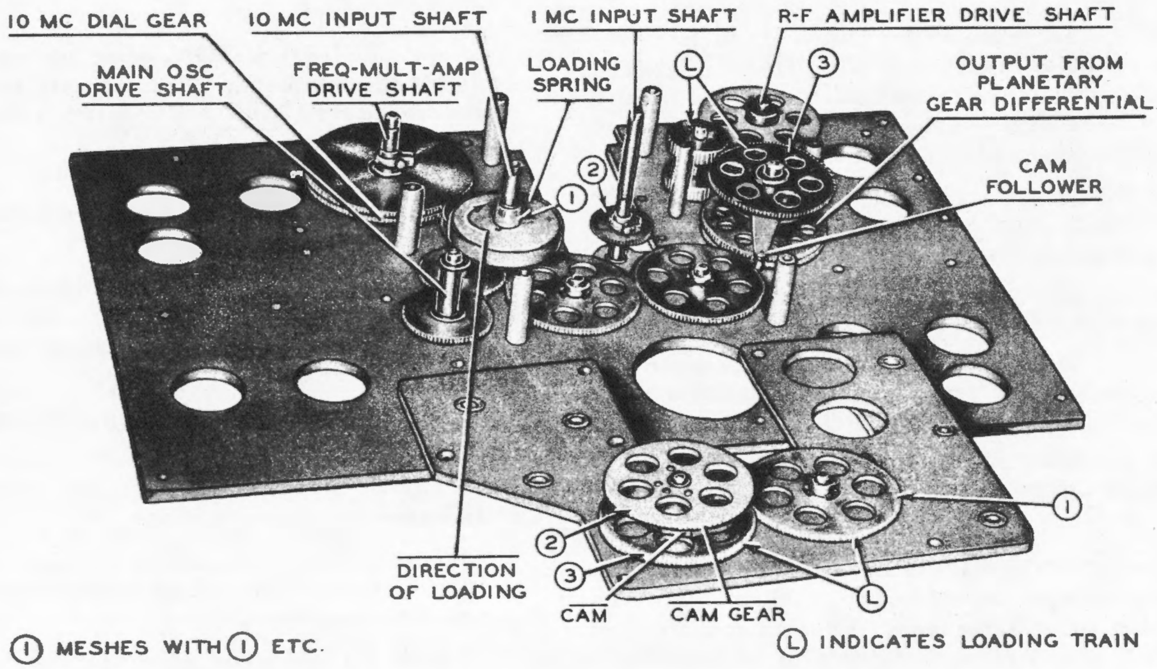


Figure 6–49. Radio Receiver R-278B/GR, Rear Gear Train, Arrangement of Gears

(12) FRONT PANEL MAINTENANCE.

Note

The front panel is not actually removed, but is folded to the left away from the Receiver housing. Do not remove the Frequency Selector chassis from the front panel. Figures 6–47 and 6–48 show the rear of the front panel and the top of the Receiver with the front panel removed, respectively.

Step 1. With the Receiver energized, set the MANUAL CHANNEL preset switches of the Frequency Selector to 390.0 mc.

Step 2. Turn the CHANNEL SELECTOR switch to MANUAL and wait for the tuning cycle to end.

Step 3. Turn the POWER switch to OFF. Remove the dust cover and position the Receiver on its back (front panel up).

Step 4. Remove connector P1101 from J1211 (figure 6–29).

Step 5. Remove eight screws from the two outside edges of the front panel.

Step 6. Remove two screws from the Frequency Selector front panel. These two screws are located near the AF GAIN control and POWER indicator.

Step 7. Carefully lift up on both handles until motor clears frame, then fold panel to the left and downward (figures 6–47 and 6–48).

Step 8. Retain couplers and tape to their respective shafts.

Step 9. On reassembly of front panel, set Frequency Selector to 390.0 mc, and have marks on indicator bar match marks on the coupler.

(13) GEAR TRAIN MAINTENANCE.

(*a*) GENERAL.—If the entire rear gear train assembly (figure 6–49) is replaced, or if the 1.0-mc or 10-mc input shafts are replaced, it is necessary to drill a 1/16 inch hole through the coupler sleeve, or the shaft, and pin them together. The point to drill must be adjusted so that the couplers have sufficient clearance. Figures 6–49 through 6–51 show the components that make up the gear trains.

(*b*) ORIENTING COUPLERS ON GEAR TRAINS.—Position the keys of the couplers in the horizontal direction, at their alignment frequencies as follows:

Step 1. Adjust three couplers on rear side of the front gear plate at 399.9 mc.

Step 2. Adjust two couplers on rear side of the rear gear plate (Main Oscillator and Frequency Multiplier-Amplifier drive) at 220.0 mc.

Step 3. Adjust one coupler on the R-F Amplifier drive gear at 360.5 mc.

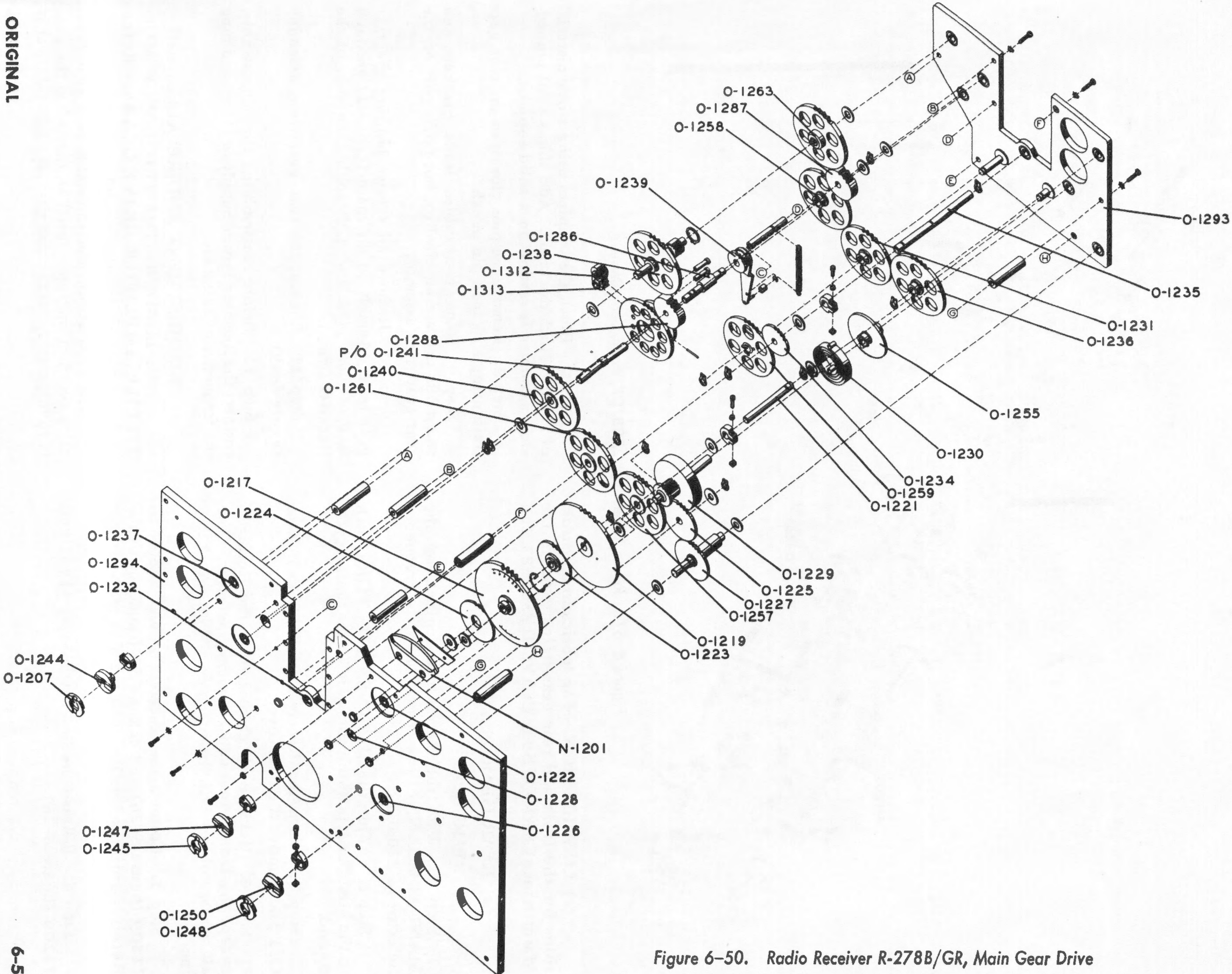


Figure 6–50. Radio Receiver R-278B/GR, Main Gear Drive

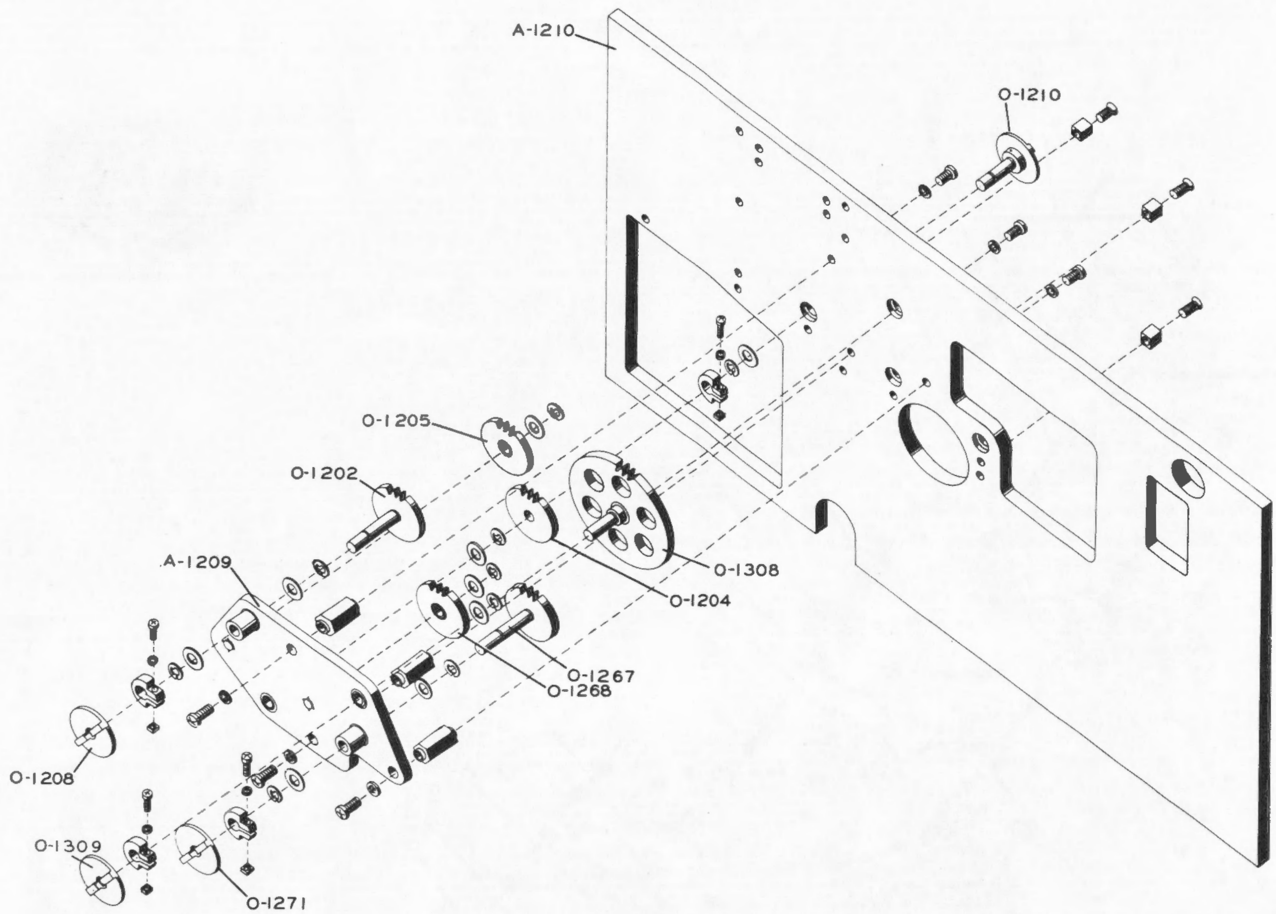


Figure 6–51. Radio Receiver R-278B/GR, Front Gear Drive

(*c*) LUBRICATION.—For lubrication instructions for the front and rear gear trains, refer to the Maintenance Check-Off Book (NAVSHIPS 92383.41).

(*d*) REAR GEAR PLATE.

1. REMOVAL.

Step 1. With the Receiver energized, set the MANUAL CHANNEL preset switches of the Frequency Selector to 220.0 mc.

Step 2. Adjust the CHANNEL SELECTOR switch to the MANUAL position and wait for the tuning cycle to end.

Step 3. Turn the Receiver POWER switch to OFF and remove the dust cover.

Step 4. Remove all chassis from the Receiver, except the front panel and Frequency Selector. Tag all subassemblies with the statement: "Tuned to 220.0 mc."

Step 5. Connect the Receiver Power Supply to J1209 (figure 6–26) and change the frequency of the Receiver until the small ends of the pins of the 10-mc and 1.0-mc shafts are up.

Step 6. Release the bracket holding J1201 and J1209 (figure 6–26).

Step 7. Block the couplers using stock material of about 5/8 inch thickness. Add shims until pinned-sleeve coupler is resting on a solid support.

Step 8. Remove the pins closest to the rear gear train using a 1/16 inch pin punch.

Step 9. Remove all cables, leads, brackets, and stand-offs that are attached to, but not a part of, the rear gear train assembly.

Step 10. Remove all screws holding the rear gear train assembly to the main frame (11 through face of main plate and 4 through each side of the Receiver frame).

Step 11. Lift out the rear gear train assembly (figure 6–49).

Step 12. Before reassembling the subassembly, connect the Receiver Power Supply to J1209 and tune the frequency to 220.0 mc.

2. ADJUSTMENT AND REPAIR.

a. LOADING THE FREQUENCY MULTIPLIER-AMPLIFIER DRIVE GEARS.—Refer to figure 6–49 during the following steps.

Step 1. Position the adjustable rear gear (cam drive on the 1-mc input shaft) so that when the gear is in full mesh with the cam gear, the cam follower is centered on the highest step of the cam (at 390.0 mc). Clamp screw is accessible from the bottom of the Receiver.

Step 2. Tighten the clamp.

Step 3. Loosen the clamp on the large drive gear of the Frequency Multiplier-Amplifier and unmesh the 10-mc dial gear and drive gear from the driving idlers.

Step 4. Rotate the dial gear four dial divisions with respect to the drive gear. Rotate in the direction tending to close spring ends.

Step 5. Remesh gears in nearest tooth space to provide dial indication of "39".

Step 6. Tighten the clamp screw with its head accessible from the top.

Step 7. Loosen screws holding the dial line plate. Adjust the dial line to read exactly over "39" graduation on the dial. Tighten the screws.

b. LOADING THE GEAR TRAIN.

Step 1. Set the Receiver Frequency Selector to 390.0 mc. The cam follower (figure 6–49) will be at its highest point, and the 1.0-mc dial (ahead of First I-F Amplifier) will read 0.

Step 2. Turn the loading spring clockwise 90 degrees by rotating L (figure 6–49).

Step 3. Remesh gears and replace truarc.

Note

To check 90° clockwise loading, make a pencil mark on the disc enclosing the loading spring; watch it advance 90° clockwise. (This should provide a loading torque of 3½ to 5½ inch-pounds on the R-F Amplifier drive shaft.)

3. REPLACEMENT.—To install the rear gear plate, reverse the removal procedure.

(*e*) ADJUSTMENT OF FRONT GEAR TRAIN.—Position the adjustable front gear on the 1-mc input shaft, so that when the gear is in proper mesh with the 1-mc dial gear (0 through 9), the clamp screw is accessible from the bottom and "0" coincides with the fixed mark on front gear plate.

b. TRANSMITTER MAINTENANCE.

(1) GENERAL.—Transmitter T-217A/GR consists largely of a group of subassemblies which are fastened to the main chassis by means of captive screws, the heads of which are painted red to aid in identification for removal. Electrical connection between these subassemblies is accomplished by use of cables terminated in plugs and in some instances, by short wire runs and soldered connections. Mechanical linkage between subassemblies is obtained by the use of couplers with gear trains employed to rotate the various shafts at the desired speed. The location of these subassemblies is indicated in figures 5–4 and 5–10.

Before loosening the captive screws to remove any subassembly with mechanical linkage, the equipment should be set to its reference frequency. The reference frequency to which each of the subassemblies should be set before removal and before reinstalled is listed as follows:

Power Amplifier	390.0
Frequency Selector	390.0
I-F Oscillator	360.0
Exciter	360.0
Driver	360.0
Frequency Multiplier-Amplifier	360.0
Main Oscillator	220.0

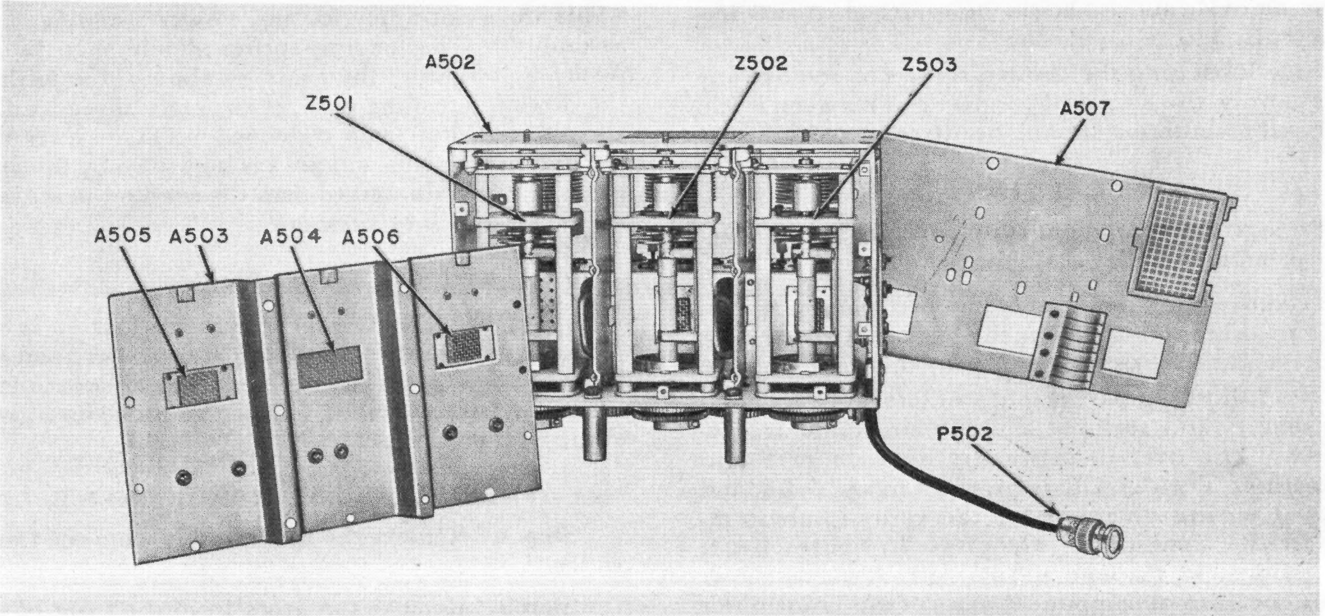


Figure 6–52. Radio Transmitter T-217A/GR, Driver Subassembly, Side View

B1201	4D
C101	1A
C102	1A
C103	1A
C105	1A
C106	1A
C107	1A
C108	1A
C110	1A
C111	1A
C112	1A
C113	2A
C114	2A
C115	2A
C117	2A
C201	1B
C202	1B
C203	1B
C204	1C
C205	1C
C207	1B
C208	1C
C301	2B
C302	2B
C303	2B
C304	2B
C305	2B
C306	2C
C307	2B
C309	2B
C310	2B
C311	2B
C312	2B
C314	3B
C315	3B
C316	3B
C317	3B
C318	3B
C319	3B
C321	4C
C322	4B
C323	4B
C325	4C
C326	4B
C327	4B
C406	3A
C407	3A
C408	3A
C409	3A
C411	3A
C412	3A
C413	3A
C414	3A
C415	3A
C416	3A
C417	3A
C418	3A
C419	4A
C420	4A
C421	4A
C422	4A
C423	4A

C424	4A
C425	4A
C426	4A
C427	4A
C432	3A
C433	4A
C438	3A
C512	6A
C513	6A
C514	6A
C517	7A
C518	6A
C519	7A
C521	6A
C601	7A
C602	7A
C603	7A
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C613	8A
C614	9A
C615	9A
C616	9A
C617	9A
C618	7A
C619	7A
C620	7A
C621	8A
C622	8A
C624	8A
C625	8A
C626	9A
C630	10A
C631	7A
C632	10A
C633	9B
C634A	7B
C634B	9B
C635	9B
C636	7B
	9B
C637	8B
C639	9A
C640	9B
C641	9B
C642	8B
C643	8B
C644	9B
C645	10B
C647	10B
C648	7A
	7B
C649	8B
C650	8B
C651	8A
C652	8A

C802	8E
C803	9D
C804	9C
C805	9D
	10D
C806	10C
C807	9C
C808	10C
C809	9C
C810	9C
C901	2D
C902	2D
C903	2E
C904	2E
C905	2D
C1001	1D
C1002	1D
C1003	1D
C1005	1D
C1006	1D
C1007	1D
C1201	3D
C1202	4E
C1205	4D
C1209	6E
C1211	6E
C1212	6E
C1213	6E
C1223	7E
C1224	2C
C1225	2C
C1226	2C
C1227	2C
F1201	4D
F1202	4D
HR201	1C
I1202	4D
I1203	6D
J101	1A
J403	3A
J404	4A
J502	6A
J503	6A
J504	7A
J602	8A
J605	10B
J607	7A
J803	9A
	10B
J808	7A
J902	2D
J903	2D
J1002	1C
J1003	1C
J1004	1C
J1201	1B
J1202	1C
J1203	8D
J1204	3B

J1205	6A
J1206	8B
J1208	8C
J1209	3E
J1210	2D
J1211	4E
J1212	7F
J1213	4D
J1215	6E
K801	9D
K802	10D
K901	1E
K1201	4D
K1202	3D
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L102A	1A
L102B	1A
L201	1B
L222	1B
L223	1B
L224	1B
L225	1B
L226	1B
L227	1B
L228	1B
L229	1B
L230	1B
L231	1B
L232	1B
L233	1B
L234	1B
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L236	1B
L237	1B
L238	1B
L239	1B
L222	1C
L223	1C
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L226	1C
L227	1C
L228	1C
L229	1C
L230	1C
L231	1C
L232	1C
L233	1C
L234	1C
L235	1C
L236	1C
L237	1C
L238	1C
L239	1C
L301A	3B
L301B	3B
L302A	3B
L302B	3B
L303A	4B
L303B	4B
L403	3A

L404	3A
L405	3A
L406	3A
	4A
L407	4A
L408	4A
L505	6A
L506	7A
L507	6A
L601	7A
L602	7A
L603	8A
L604	8A
L605	8A
L606	9A
L607	9A
L801	9C
L901	2D
L902	2D
L903	2E
L904	2E
L905	2D
L906	2D
L1001	1D
L1002	1D
L1201	2C
L1202	2C
L1203	2C
L1204	2C
P101	1A
P201	1C
P401	3A
P501	6A
P502	7A
P601	8B
P801	8C
P802	8D
P901	3E
P1001	2D
P1101	4E
P1201	1A
P1204	6A
R101	1A
R102	2A
R103	1A
R104	1A
R105	1A
R106	1A
R107	1A
R108	2A
R201	1B
R202	1B
R203	1B
R204	1B
R205	1B
R301	2B
R302	2B
R303	2B
R304	2C
R306	2B
R307	2C

R308	2B
R309	2C
R310	3B
R311	3C
R312	3B
R313	4C
R314	4B
R315	4C
R408	3A
R409	3A
R411	3A
R412	4A
R413	4A
R414	4A
R416	4A
R418	3A
R503	6A
R504	6A
R505	6A
R506	6A
	7A
R507	6A
R509	7A
R511	6A
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R602	7A
R603	8A
R604	8A
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R611	9A
R612	9A
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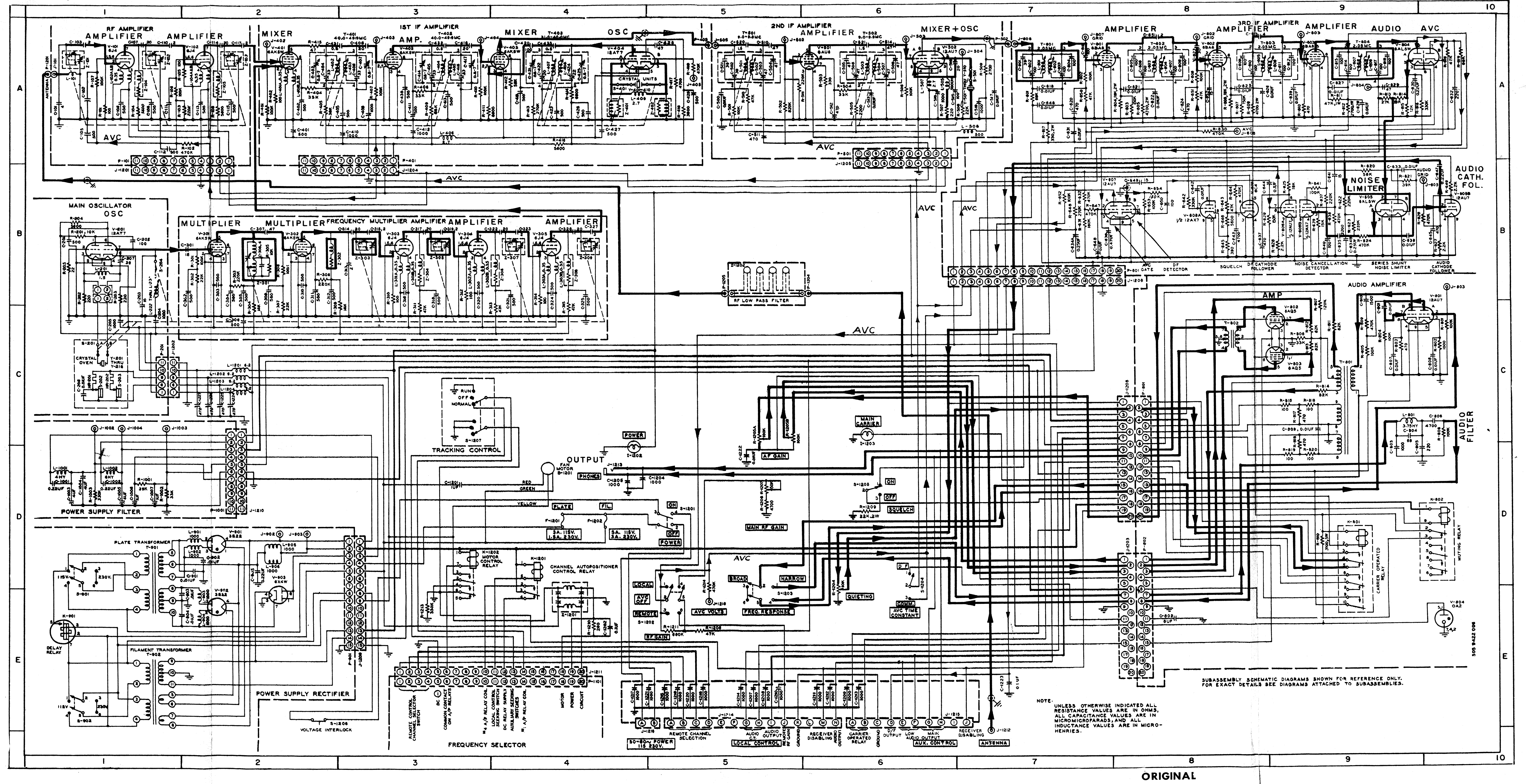
R614	9A
R615	9A
R616	10A
R617	7A
R618	10A
R619	10A
R620	9B
R621	9B
R623	9B
R624	9B
R625	9B
R626	10B
R627	10B
R628	9B
R629	9B
R630	8A
R631	7B
R632	7B
R638	9B
R639	9B
R641	9B
R642	8B
R643	8B
R645	8B
R646	8B
R647	7B
R648	7B

R649	10B
R650	7A
R651	8A
R652	7B
R653	8B
R654	8B
R801	10C
R802	10C
R803	9C
R804	9C
R805	9C
R806	9C
R807	9C
R808	10C
R809	9C
R810	9D
R811	9C
R812	9C
R813	9C
R814	9C
R815	9C
R816	9C
R817	9C
R818	9D
R819	9D
R820	9D
R1001	1D
R1002	1D
R1003	1D
R1204	6E
R1209	6D
R1210	4E
R1213	3E
S201	1C
S203	1C
S204	1B
S401	4A
S501	7A
S901	1E
S902	1E
S1204	6E
S1205	6D
S1207	3C
T401	3A
T402	3A
	4A
T502	6A
T601	7A
T602	8A
T603	9A
T604	9A
T801	9C
T802	8C
T901	1D
T902	1E
V101	1A
V102	2A
V201	1B
V301	2B
V302	2B

V303	3B
V304	3B
V305	4B
V402	3A
V403	4A
V404	4A
V501	6A
V502	6A
V601	7A
V602	8A
V603	9A
V604	9A
V606A	9B
V606B	9B
V606B	10B
V607	8B
V608A	8B
V801	10B
V802	9C
V803	9C
V804	10E
V901	2D
V902	2E
V903	2D
Y201	1C
Y202	1C
Y203	1C
Y204	1C
Y205	1C
Y206	1C
Y207	1C
Y208	1C
Y209	1C
Y210	1C
Y211	1C
Y212	1C
Y213	1C
Y214	1C
Y215	1C
Y216	1C
Y217	1C
Y218	1C
Y401	4A
Y402	4A
Y403	4A
Y404	4A
Y405	4A
Y406	4A
Y407	4A
Y408	4A
Y409	4A
Y410	4A
Y501	7A
Y502	7A
Y503	7A
Y504	7A
Y505	7A
Y506	7A
Y507	7A
Y508	7A
Y509	7A
Y510	7A

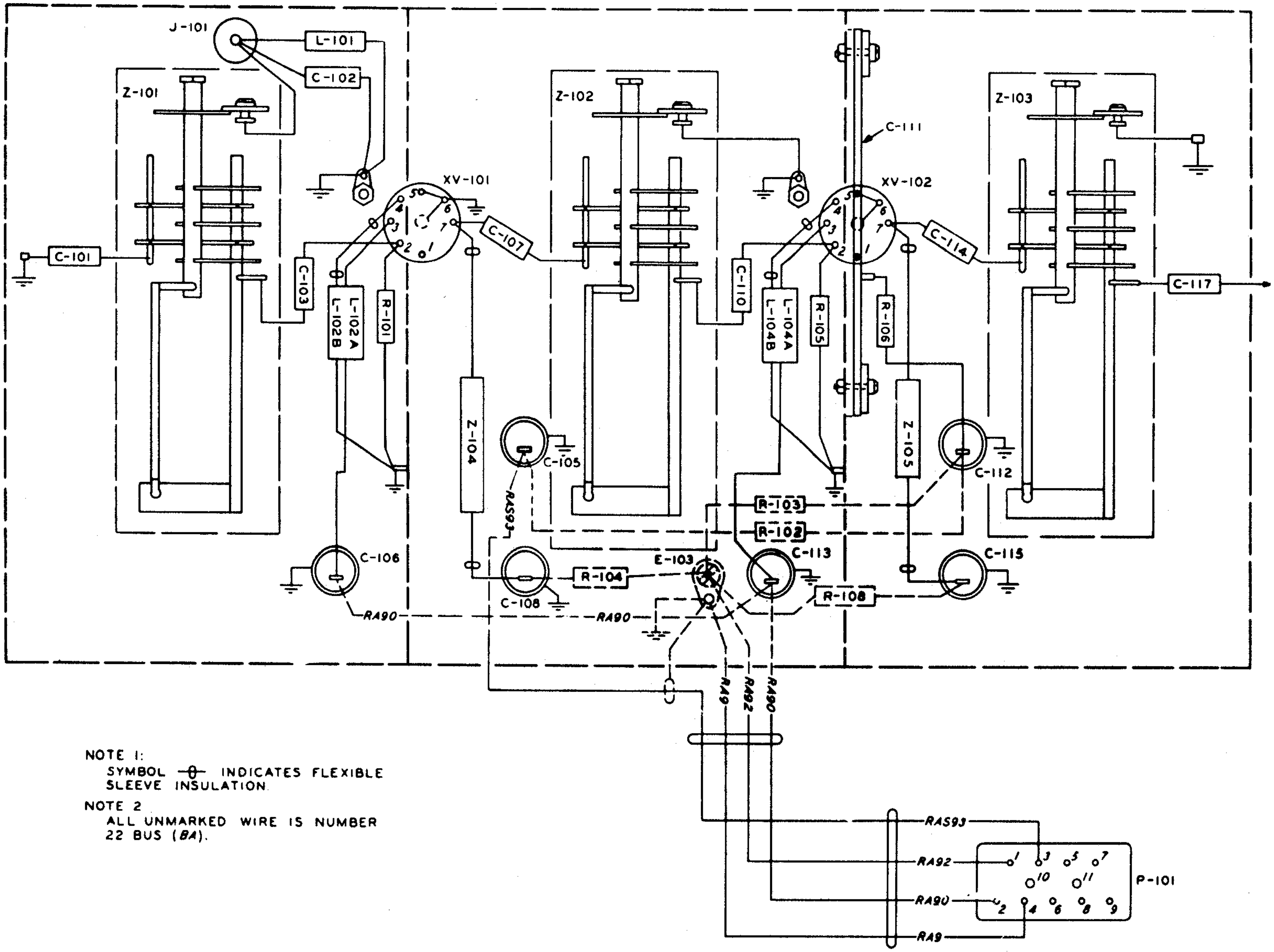
Z101	1A
Z102	1A
Z103	2A
Z104	1A
Z105	2A
Z301	2B
Z303	3B
Z304	3B
Z305	3B
Z306	4B
Z307	4B
Z308	4B
Z309	4B
Z401	4A
Z1201	4E



NOTE

Segments of this illustration are photographic reproductions of a typical schematic found on the equipment chassis.
For actual component values, refer to the schematic on the chassis being serviced.

Figure 6-82. Radio Receiver R-278B/GR, Schematic Diagram



NOTE 1:
SYMBOL —θ— INDICATES FLEXIBLE SLEEVE INSULATION.

NOTE 2
ALL UNMARKED WIRE IS NUMBER 22 BUS (*BA*).

Figure 6–86. Radio Receiver R-278B/GR, R-F Amplifier Subassembly, Practical Wiring Diagram

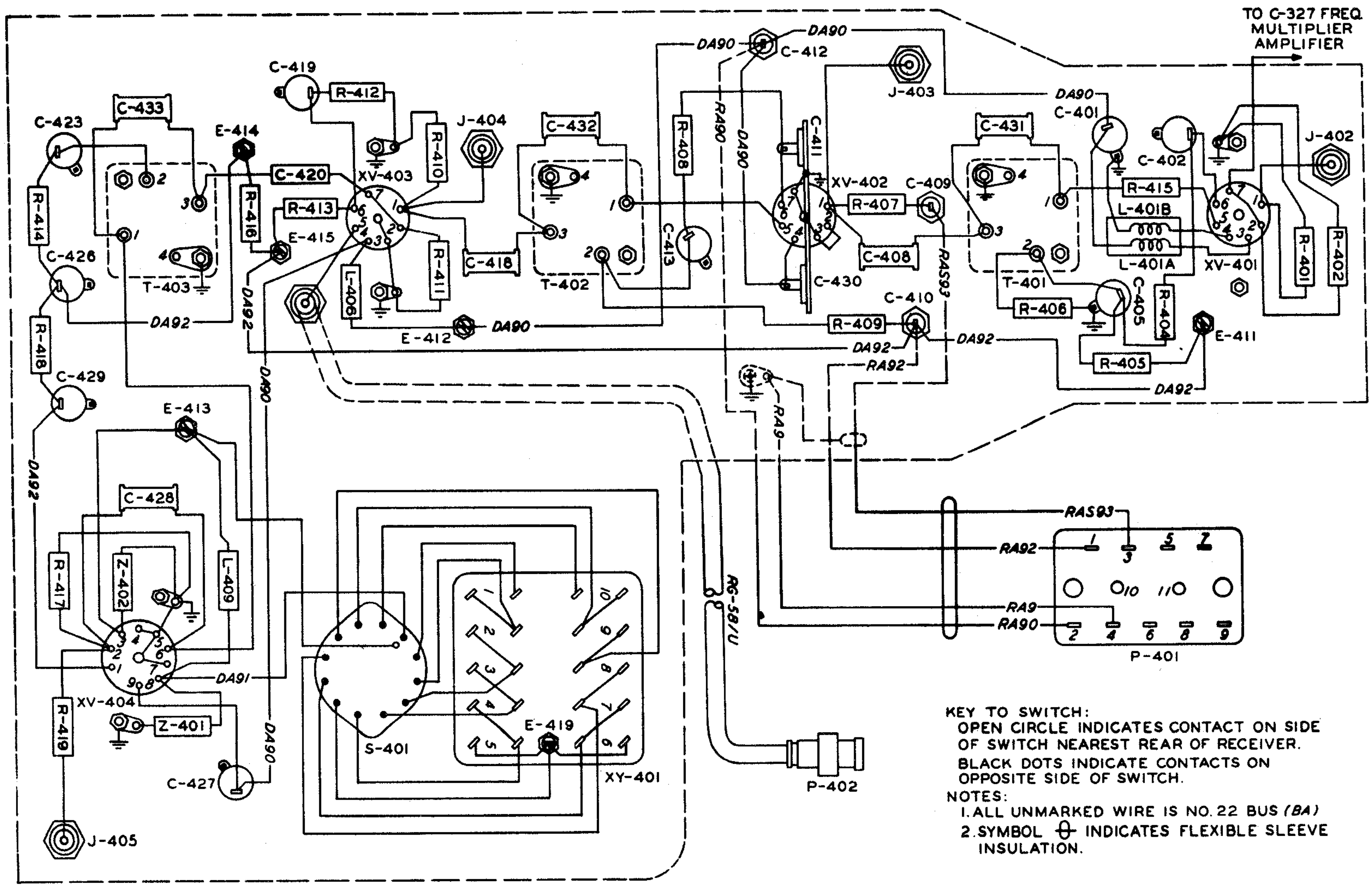
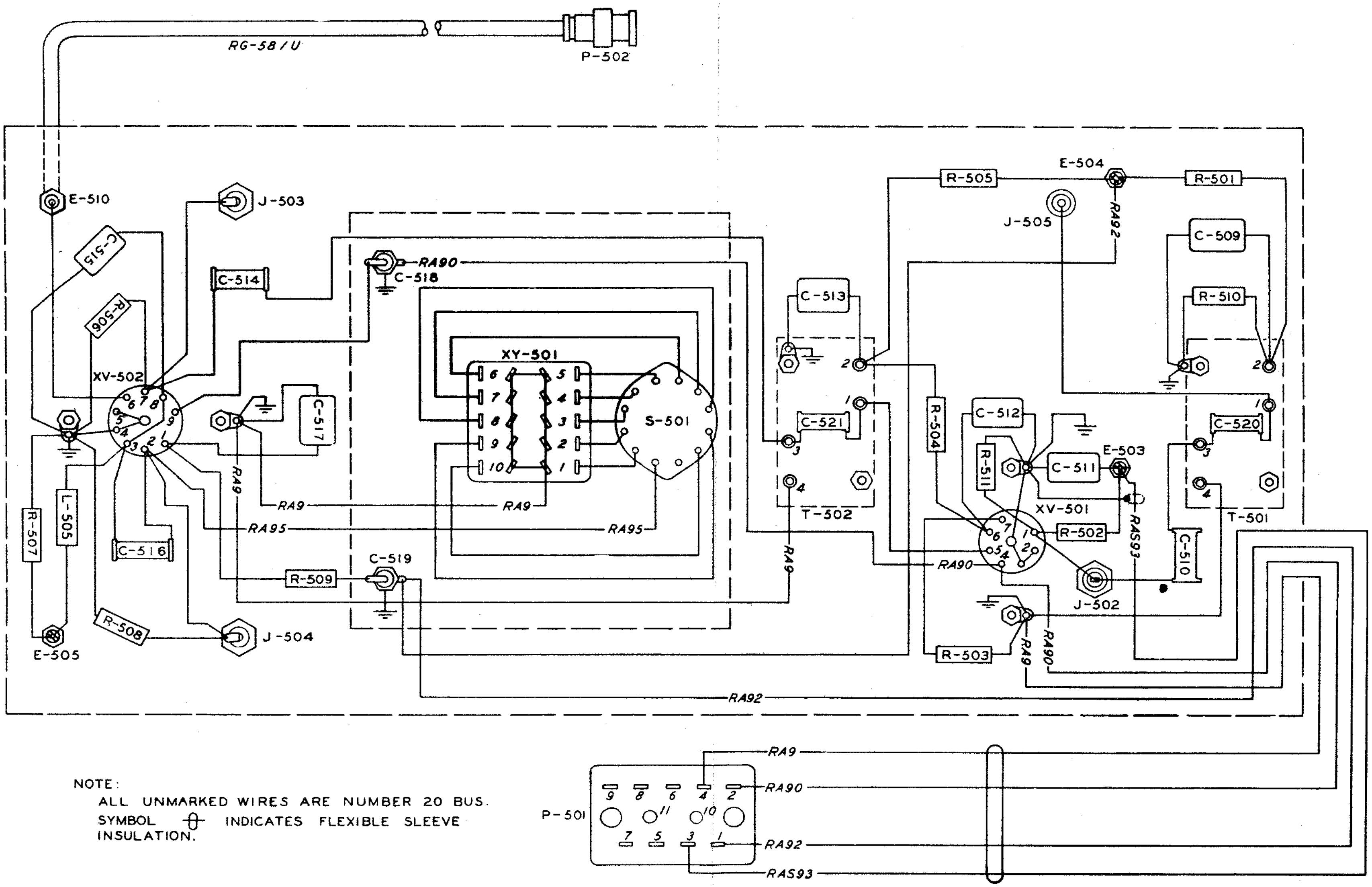


Figure 6–87. Radio Receiver R-278B/GR, First I-F Amplifier Subassembly, Practical Wiring Diagram



NOTE:
ALL UNMARKED WIRES ARE NUMBER 20 BUS.
SYMBOL -θ- INDICATES FLEXIBLE SLEEVE INSULATION.

Figure 6-88. Radio Receiver R-278B/GR, Second I-F Amplifier Subassembly, Practical Wiring Diagram

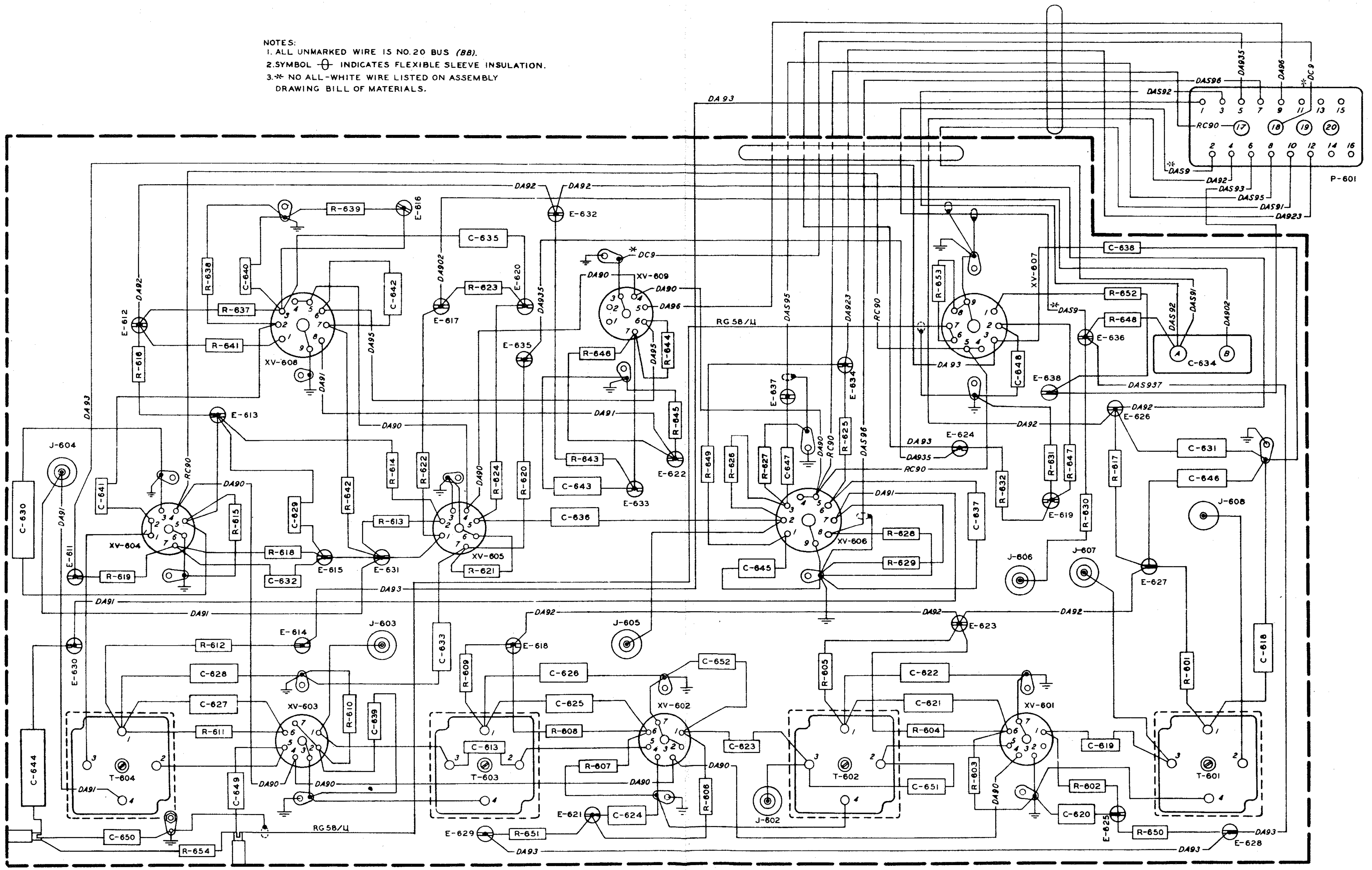
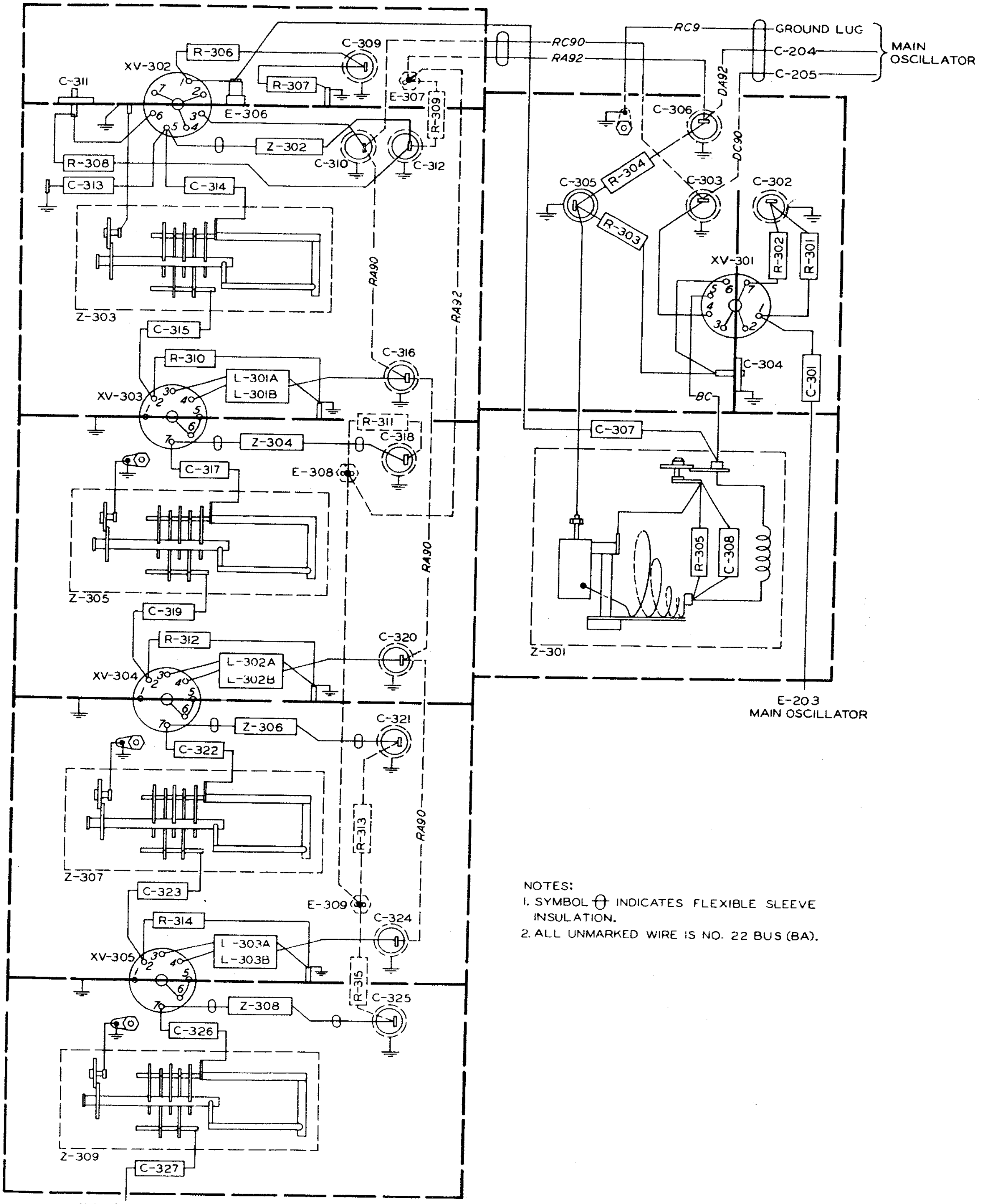


Figure 6–89. Radio Receiver R-278B/GR, Third I-F Amplifier Subassembly, Practical Wiring Diagram



NOTES:
1. SYMBOL ⊖ INDICATES FLEXIBLE SLEEVE INSULATION.
2. ALL UNMARKED WIRE IS NO. 22 BUS (BA).

Figure 6-90. Radio Receiver R-278B/GR, Frequency Multiplier-Amplifier Subassembly, Practical Wiring Diagram

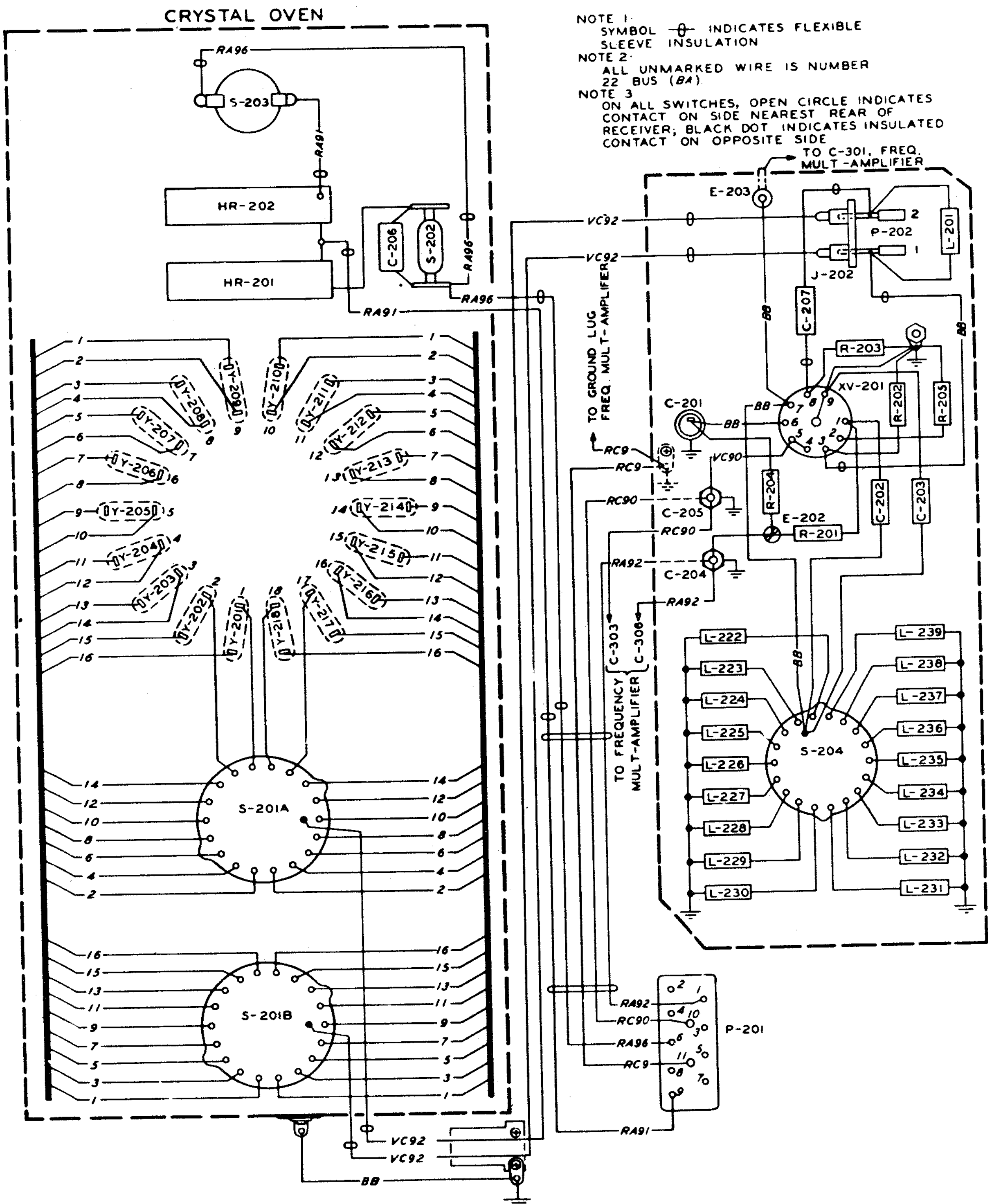
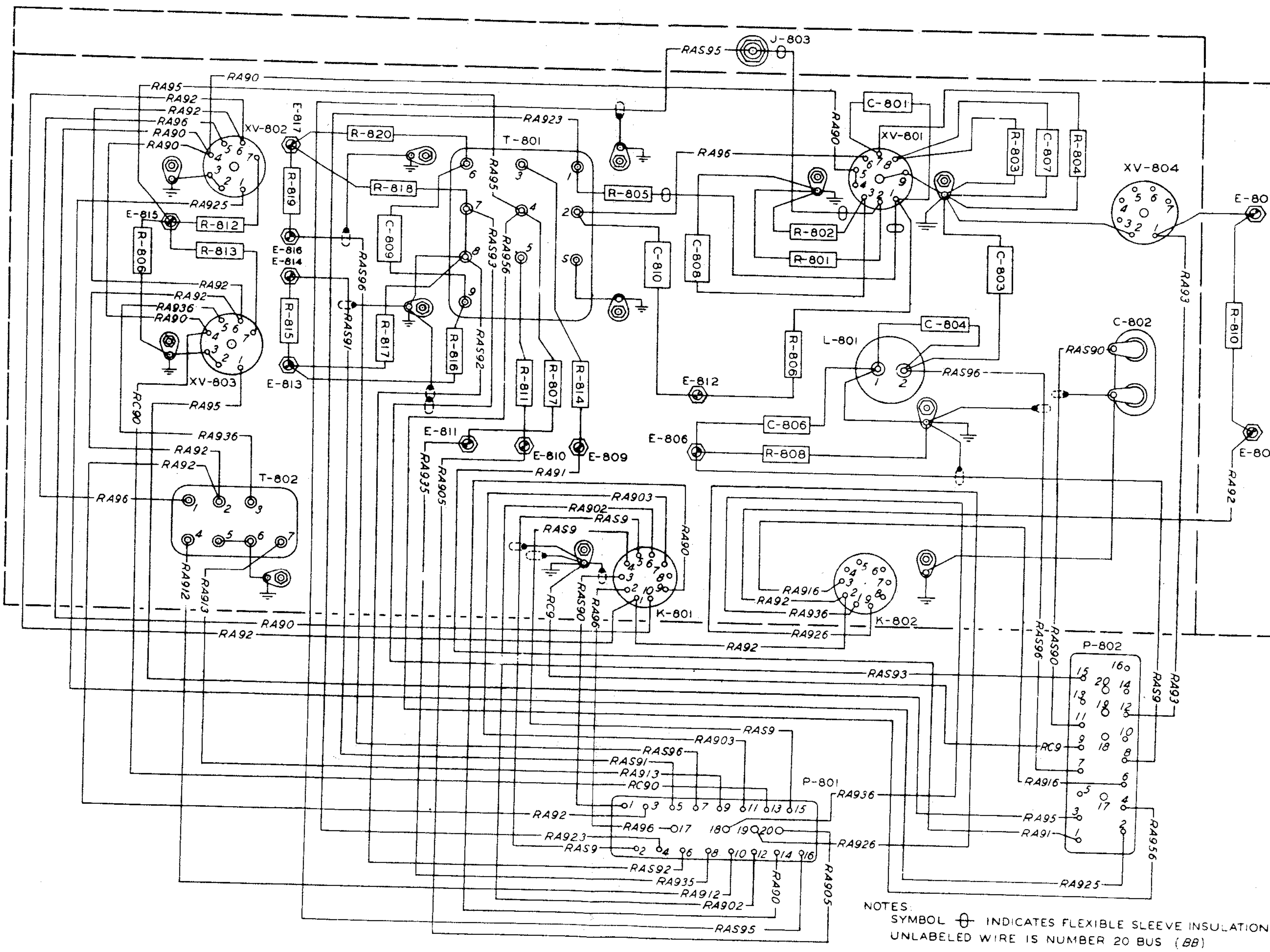


Figure 6-91. Radio Receiver R-278B/GR, Main Oscillator Subassembly, Practical Wiring Diagram



NOTES:
SYMBOL -θ- INDICATES FLEXIBLE SLEEVE INSULATION
UNLABELED WIRE IS NUMBER 20 BUS (BB)

Figure 6-92. Radio Receiver R-278B/GR, Audio Amplifier Subassembly, Practical Wiring Diagram

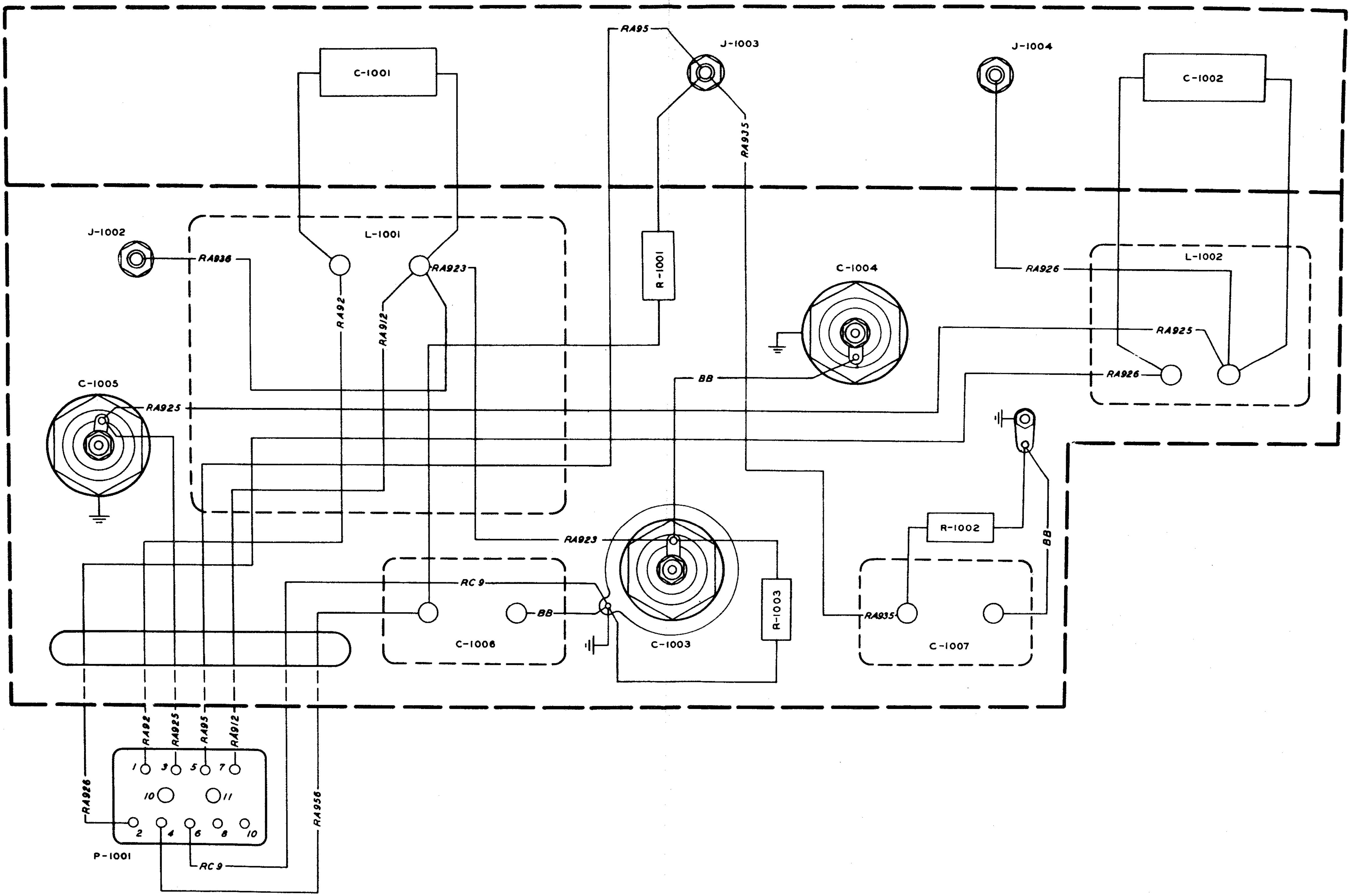


Figure 6-93. Radio Receiver R-278B/GR, Power Supply Filter, Practical Wiring Diagram

Figure 6-94. Radio Receiver R-278B/GR, Frequency Selector, Practical Wiring Diagram