DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-870

TO 31R-2FRC10-1

RADIO RECEIVER

R-369/FRC-10

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MAY 1955

FOR OFFICIAL USE ONLY

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TECHNICAL MANUAL No. 11-870
TECHNICAL ORDER No. 31R-2FRC10-1

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
WASHINGTON 25, D. C., *11 May 1955.*

RADIO RECEIVER R-369/FRC-10

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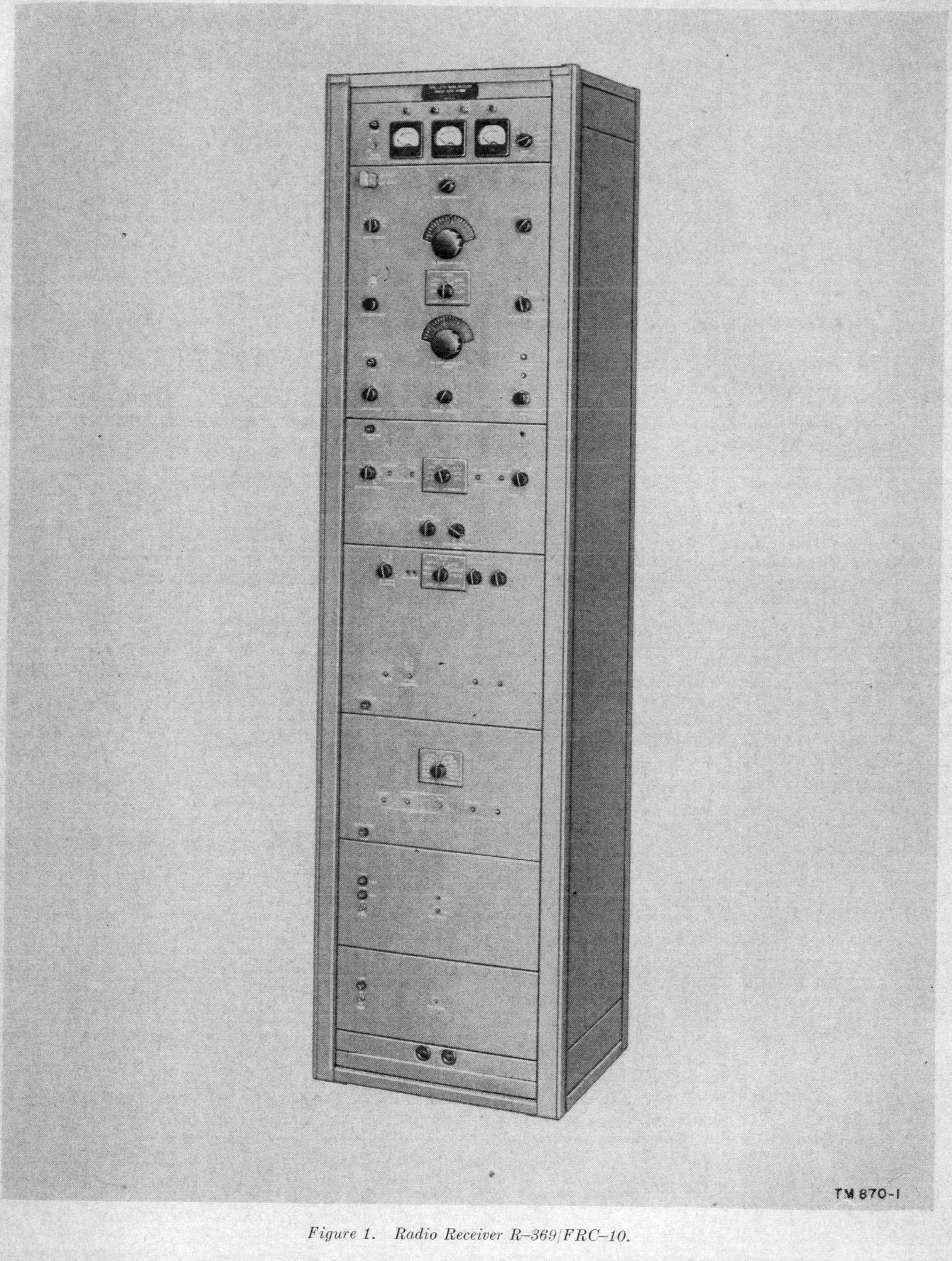

TM 870-1

Figure 1. Radio Receiver R–369/FRC–10.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for the installation, operation, maintenance, and repair of Radio Receiver R–369/FRC–10 (fig. 1).

b. In addition to these instructions, there are two appendixes that cover packaging data and typical factory inspection data.

c. Radio Receiver R–369/FRC–10 is used as part of either Radio Set AN/FRC–10A or Radio Set AN/FRC–10B system (par. 3). Since the function and operation of Radio Receiver R–369/FRC–10 is identical in each system, no difference is made between the two systems in this manual. All references to Radio Set AN/FRC–10 in this manual apply to the unlettered, A, or B model.

d. Forward comments on this publication direct to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J., ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and in performing preventive maintenance:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army) and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AF TO 00–35D–54.

d. DA Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 25).

e. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with the instructions on the back of the form (fig. 26).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. System Application

a. Radio Receiver R–369/FRC–10 is used as the receiving equipment of a single-sideband radio communication system.

b. The three models of the system are Radio Sets AN/FRC–10, AN/FRC–10A, and AN/FRC–10B. The difference between these models is in the types of single-sideband receiver or transmitter used in combination. Functionally, their operation is identical. The following table lists the major equipments that comprise each of the three models.

Radio Set	Radio Receiver	Radio Transmitter	Carrier Terminal
AN/FRC-10	(WECo D-99945) (WECo LC-R1) Navy type REA.	(WECo D-156000) (WECo LC-T1) Navy type TEF.	OA-64/FRC-10 and OA-63/FRC-10.
AN/FRC-10A	R-369/FRC-10	(WECo D-156000) (WECo LC-T1) Navy type TEF.	OA-64/FRC-10 and OA-63/FRC-10.
AN/FRC-10B	R-369/FRC-10	T-265/FRC-10	OA-64/FRC-10 and OA-63/FRC-10.

Note. WECo is the abbreviation for Western Electric Company.

c. Figure 2 contains a simplified block diagram of Radio Set AN/FRC-10B. Two of these sets shown provide a complete two-way system capable of providing signal communications between points thousands of miles apart.

d. One radio system which consists of two Radio Sets AN/FRC-10 operates as follows: six teletypewriter circuits and a manual order circuit (not shown) are connected to Carrier Terminals OA-63/FRC-10 and OA-64/FRC-10. The carrier terminal equipments convert the mark and space impulses supplied by the teletypewriters into two separate audio tones. These audio tones, which comprise the output of the carrier terminal equipment (TM-11-2132, Carrier Terminals OA-64/FRC-10 and OA-63/FRC-10), are used to modulate one sideband of Radio Transmitter T-265/FRC-10 (TM-11-814, Radio Transmitter T-265/FRC-10). In addition, speech signals or other signals of 100 to 6,000 cycles per second (cps) may be used to modulate the other sideband of the transmitter. The resulting modulated radio-

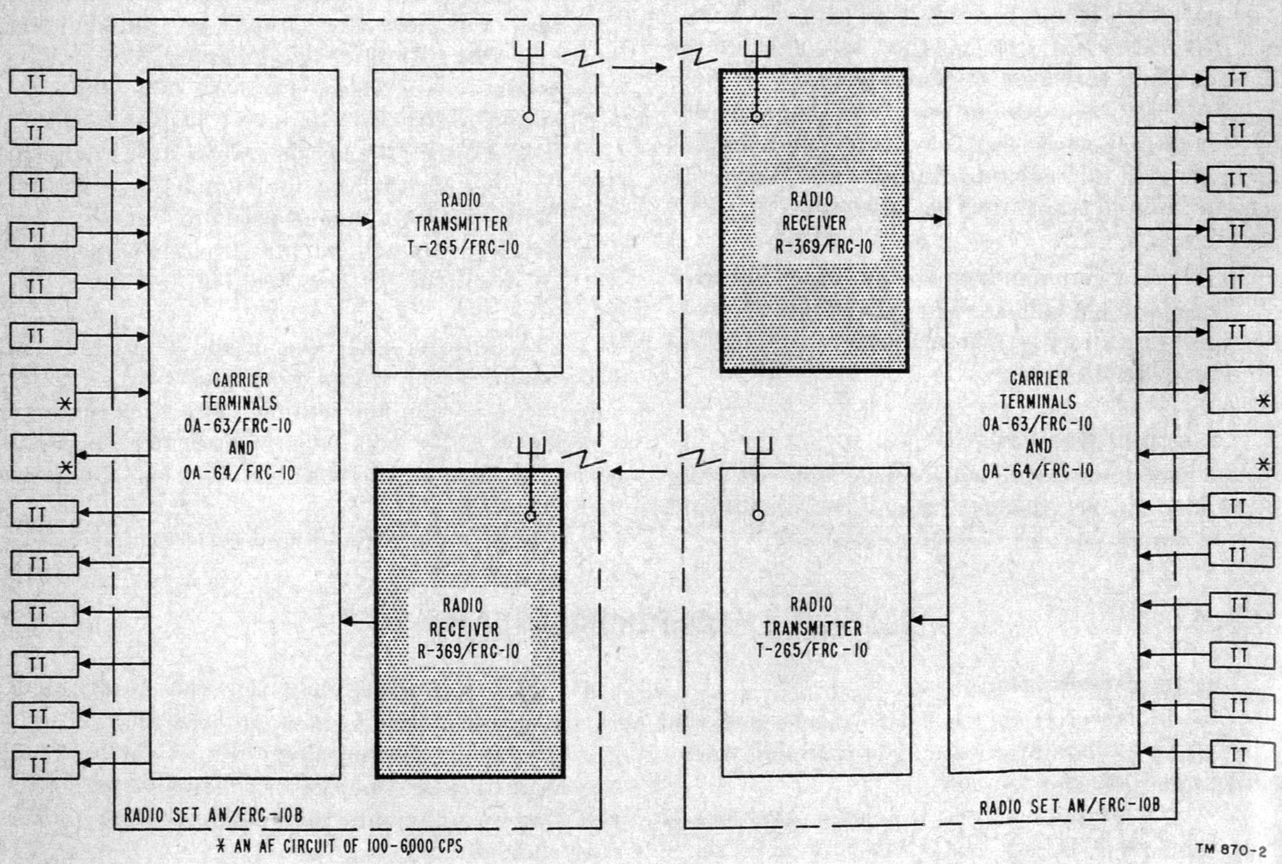

Figure 2. Radio Set AN/FRC-10B, system block diagram.

frequency (rf) output consists of one or two individual sidebands, depending on whether the transmitter receives one or two inputs, that are spaced on either side of the suppressed carrier. The rf signals are demodulated and divided into two separate audio-frequency (af) groups at the distant receiving station. One of these af groups with intelligence corresponding to that contained in one of the sidebands is fed into the carrier terminal equipment that separates intelligence into six separate signals. These signals are now audio tones and are converted to mark and space impulses for application to the receiving teletypewriters. The other af group with intelligence corresponding to that contained in the other sideband comprises the speech output and is available from the other receiver output. A discussion of single-sideband theory (par. 4) is given to enable operating personnel to better understand the operation of Radio Receiver R–369/FRC–10.

e. Radio Receiver R–369/FRC–10 also receives conventional double-sideband rf signals. A loss in signal-to-noise ratio is, however, incurred. The transmitter sending the conventional double-sideband rf signal must have an extreme degree of carrier frequency stability, and the transmitted voice-frequency (vf) band must be between 100 and 6,000 cps.

4. Purpose and Use

a. Radio Receiver R–369/FRC–10 (fig. 1) is the receiving equipment of Radio Set AN/FRC–10, a single-sideband, multichannel, radioteletype, and radiotelephone system. The receiver amplifies and demodulates single-sideband signals in the 4- to 28-megacycle (mc) frequency range. The variety of intelligence transmitted in the lower and upper sidebands can be separated and is presented to separate outputs of the receiver. The receiver outputs, which consist of two individual af bands that contain frequencies from 100 to 6,000 cps, are connected either to Carrier Terminals OA–63/FRC–10 and OA–64/FRC–10 or to appropriate speech equipment. A miscellaneous relay rack bay (fig. 15), supplied with the receiver, is required to connect Radio Receiver R–369/FRC–10 to the carrier terminal equipment and to the receiving antenna. It also contains facilities for simplex and phantom circuits.

b. Radio Receiver R–369/FRC–10 is designed to receive, select, and detect single-sideband radio signals. Either of the two sidebands may be received, or both simultaneously, with different intelligence on each. The signals go from the receiver to the carrier terminal equipment. To explain the operation of the receiver, the theory of double and single sideband is discussed below.

(1) In conventional double-sideband, amplitude-modulated (am.) radio transmission, an af signal is used to modulate the rf carrier. This results in a signal that consists of three rf components, which are the carrier and two (upper and lower) sidebands. The amplitudes of the sidebands vary in the same way as that of the af modulating signal. The sidebands are separated from the carrier by frequencies that are the same as the frequency of the af modulating signal. For example, a 4-mc rf carrier which is modulated by a single 1,000-cps tone appears as shown in A, figure 3. The power in the modulated wave is distributed between the carrier and the sideband components. The carrier power is constant, while the sideband power varies with the degree of modulation. With 100 percent sinusoidal (pure tone) modulation, the sideband power is 50 percent of the carrier power. The average power is much less with speech modulation since a speech signal contains less average power than a sinusoidal signal of equal peak amplitude. Since both sidebands contain the same intelligence, the frequency spectrum occupied by a given band is double that required for a single-sideband system for transmission of the same intelligence. The power dissipated in the carrier contributes nothing to the received intelligence. Suppressed carrier, multichannel, single-sideband transmission minimizes these two inefficiencies. In this type of transmission, a suppressed carrier, with power about 1 percent (−20 decibels (db)) of the power in one sideband, is transmitted as a guide or pilot frequency. It is used in the receiver for automatic volume control (avc) and automatic frequency control (afc). This suppressed carrier is transmitted with one or two sidebands, each of which can contain multiple modulating signals. The frequency versus amplitude distribution of a 4-mc suppressed carrier signal

accompanied by two individual sidebands is shown in B, figure 3. This is a peak instantaneous representation of the signals. Note that the 3.999-mc signal resulted from a 1,000-cps audio input, and that the 4.001575-mc signal resulted from a different (1.575-cps) audio input applied at the same time to the proper input circuit. The suppressed carrier is always constant in frequency and amplitude. It is separated from the sidebands by a narrow passband filter, and is used in tuning the receiver to the selected transmitting station.

(2) The type of single-sideband system used in AN/FRC–10 makes possible a system gain of 6 db over that attained by a conventional am. system of equivalent power output and receiver gain. The narrow frequency spectrum occupied by a single-sideband signal permits the use of a considerably narrower receiver band pass. This results in an improved signal-to-noise ratio which effectively increases the system gain at the receiver end by approximately 3 db. The remaining 3 db increase in the single-sideband system is due to the more efficient distribution of transmitted power in the spectrum. With the conventional am. transmitter 100 percent modulated with a sinusoidal signal, approximately one-half of the radiated power is contained in the carrier, which contributes nothing to the desired intelligence at the receiving end of the system. The remaining 50 percent of radiated power is divided between the upper and lower sidebands, of which only one sideband is demodulated in the receiver system to provide the desired intelligence. This, in effect, results in approximately one-fourth of the radiated power ultimately contributing to the intelligence derived from the signal at the distant receiving terminal. In the case of the single-sideband system of the AN/FRC–10, approximately 90 percent of the radiated power is distributed between the sidebands with only 10 percent radiated in the carrier. Both sidebands contain useful intelligence. Each sideband contains approximately 45 percent of the effective radiated power and both convey intelligence to the receiver. The power ratio of a single-sideband system as compared to a conventional am. system is 45:25 or approximately a 3-db power gain. This, in addition to the receiver gain, provides an overall system gain of 6 db over that of a conventional am. system, with the added advantage of simultaneous transmission of different signals on each of the two sidebands.

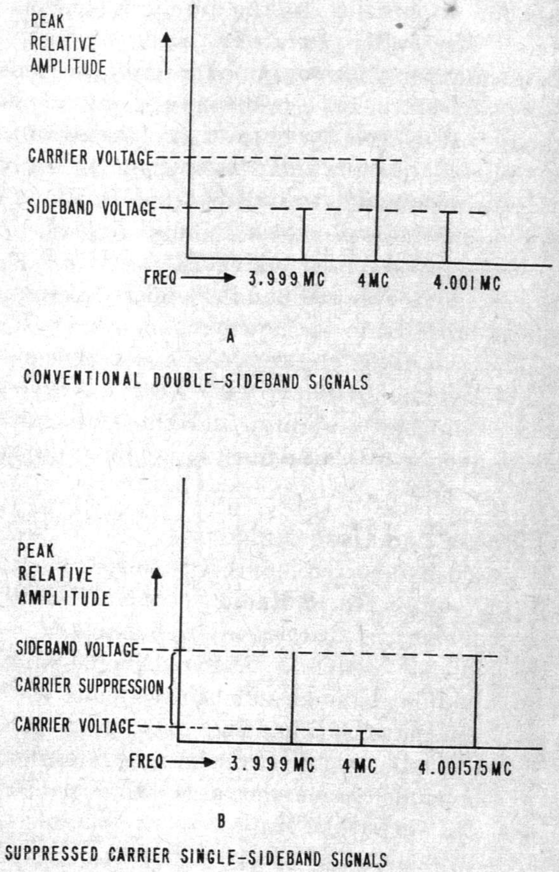

Figure 3. Frequency vs amplitude spectrum of single- and double-sideband signals.

(3) The important differences between Radio Receiver R–369/FRC–10 and a conventional am. receiver are—the use of the selective filters that separate the two sidebands to use the intelligence that each contains, and the generation of a carrier to duplicate that which was suppressed at the transmitter.

c. Radio Receiver R–369/FRC–10 operates over the 4- to 28-mc band in two tuning ranges: 4 to

10.3 mc and 10.3 to 28 mc, using either 10 percent crystal frequencies or continuous tuning. The receiver separates the two individual sidebands, resulting in an output of two individual af bands that include frequencies from 100 to 6,000 cps. Either sideband may contain voice, radioteletype, or other audio tones.

d. The receiver is operated from a 50- to 60-cps, 115-volt ±5 percent alternating-current (ac) power source. Five hundred watts of power are required. Direct-current (dc) voltages for the receiver circuits are provided by two self-contained, vacuum-tube voltage-regulated power supplies. A separate ac outlet is required for the 100-watt heating lamp and convenience outlets.

e. The receiver is designed to receive signals that range in an input level from −140 to −40 db referred to 1 volt across 75 ohms and to deliver an actual output between −6 to +10 volume units (vu). Meter circuity is such that a meter output indicated reading of 0 vu represents +8 vu on the line. The input impedance is 75 ohms; the output impedance is 600 ohms.

f. The ac input circuits to the regulated power supplies are connected through safety switches. Removing a panel mat or cover disconnects the input power to the power supplies. The primaries of four transformers that supply 6.3 volts to the tube filaments are not connected through the safety switches.

5. Technical Characteristics

a. Radio Receiver R–369/FRC–10.

Frequency range:	
Low band	~~4 to 10.3 mc.~~ 4 to 9.5 MC
High band	~~10.3 to 28 mc.~~ 9.5 to 33 MC
Receiver type	Twin-channel, single-sideband, triple-conversion, suppressed carrier, hf receiver. Each sideband can produce separate output.
Types of signals received	Am., upper and/or lower single sideband, or conventional double sideband.
Type of output signal	Two separate audio bands, each containing frequencies from 100 to 6,000 cps, which can carry voice, radioteletype, facsimile, and/or other audio signals.
Carrier level capability	+6 db to −30 db referred to 1 volt across 75 ohms.
Number of tubes	52
Received signal level range.	Signal −140 db to −40 db referred to 1 volt across 75-ohm input produces between −6 and +10 vu audio output.
If. amplifier frequencies	2.8 mc and 100 kc.
Frequency control:	
First beat oscillator	Crystal-controlled, or continuously variable.
Hf crystal frequency for first beat oscillator.	Procedure for finding crystal frequency required for receiving selected radio signal is given in paragraph 32*a*. Provision is made for 10 such crystal frequencies, which range from 4.8 mc to 15 mc.
Second beat oscillator.	Made variable over 15-kc range by knob, and variable over 200-kc range by screwdriver adjustment. *Note.* Afc circuits control first beat oscillator when it is a variable-type oscillator and control frequency of second beat oscillator when the first beat oscillator is crystal-controlled.
Afc circuit	Variable capacitor in first or second beat oscillator circuit (depending on setting of 1ST BEAT OSCILLATOR switch), controls frequency of that oscillator. Two-phase motor driven by afc circuit controls this variable capacitor. Afc circuit operates satisfactorily for variations in carrier frequency not exceeding 5 cps. Afc range is approximately 1.6-kc minimum to 11-kc maximum, depending on received frequency and position of 1ST BEAT OSCILLATOR switch.
Afc squelch	Squelch circuit in receiver temporarily disables afc circuit when noise peaks exceed received carrier level.
Af output level	Af output volume between −6 and +10 vu (output meter indicated output is −14 to +2 vu), with received rf signal of −140 to −40 db referred to 1 volt across 75 ohms (.1 to 10,000 uv).
Avc	Output volume constant within 1.5 db for slow carrier variations from −120 to −60 db referred to 1 volt across 75 ohms (1 to 1,000 uv). Manual volume control is also provided for special conditions.
Space diversity operation.	Facilities are available to connect avc lines of two receivers together to provide advantage of space diversity reception.

Input impedance	75 ohms, coaxial cable from antenna matching transformer at end of rhombic antenna.
Rf input attenuator	Four-step attenuator between receiver input and hf amplifier is provided to reduce intermodulation by strong signals.
Audio range	Two channels (groups A and B), each 100 to 6,000 cps wide.
Output impedance	Matches 600-ohm line impedance.
Alarm circuits and lamps:	
Afc lamp (red) and buzzer.	Indicates that afc capacitor (motor-driven) is approaching either end of its travel.
CARRIER OFF SLOW lamp (red) (normally off).	Indicates when carrier is absent for more than 2 seconds.
CARRIER OFF FAST lamp (amber) (normally off).	Indicates when carrier is absent for more than .5 second.
VF lamp (green) (normally on).	Indicates loss of cathode current in carrier amplifier tube denoting (usually) that +130-volt supply has failed or has not yet turned on. This supply turns on only after +250-volt supply is operating.
Meters:	
CARRIER RECT CURRENT.	Indicates relative strength of incoming received carrier. With avc operating, meter will read linearly from approximately 70 to 130 for signal input change of −120 db to −55 db (referred to 1 volt across 75 ohms).
VOLUME INDICATOR.	Indicates af output level in vu of group A or B. Meter reading is 8 vu below actual output level to line.
DC METERING	Indicates dc or dc potential at 37 selected points in receiver.
Power supply	Two self-contained, regulated rectifiers supply dc potentials. Four separate filament transformers, individually fused, supply all tube filaments except those in rectifier panels.
Power requirements	115 volts ±5 percent, 50 to 60 cps, single-phase.
Power consumed	500 watts, exclusive of load on convenience outlets and/or 100-watt heating lamp. Separate fused switch is required for convenience outlets and/or 100-watt heating lamp.
Physical characteristics:	
Cabinet dimensions	84 in. high by 21½ in. wide by 17 in. deep overall, including base.
Equipment weight	Approximately 550 pounds.
Ventilation	Provided by screened louvres at top and bottom of cabinet.
Access to components.	All wiring, tube sockets, and smaller components are accessible behind front panel mats (except first and second beat oscillators and relay panel 8).
Floor space required	Approximately 7 ft by 4 ft (fig. 16).
Access to vacuum tubes.	All vacuum tubes and large components are accessible through rear cabinet door. Hf amplifier and first demodulator tubes, first and second beat oscillator tubes are further covered.
Controls	All operation and maintenance controls, switches, fuses, meters, and indicator lamps appear on front panel.
Pilot lights	Two lamps for afc unit scale illumination are replaceable under cover from rear. Indicator lamps are replaceable from front.

b. Miscellaneous Relay Rack Bay.

Physical characteristics	84 in. high by 19 in. wide.
Power	None required.
Function	Provides required patching facilities that connect antenna to receiver, receiver to Carrier Terminals OA–64/FRC–10 and OA–63/FRC–10, and input and output connections to second receiver. Space is provided for other equipment if needed, such as branching or order-wire line amplifier.

6. Packaging Data

When packed for shipment, the components of Radio Receiver R–369/FRC–10 are placed in moisture-vaporproof containers that are packed in 18 wooden export crates. The approximate size, weight, and volume of each crate are indicated in the following table. The crate numbers assigned are arbitrary, and may not be the actual crate numbers. *For a complete itemization of all components in each crate, refer to appendix I.*

Note. Items of test equipment listed below may be replaced by equivalent items of standard test equipment. Refer to paragraph 9*a*.

Crate No.	Contents	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)	Volume (cu ft)
1 of 18	Radio Receiver R–369/FRC–10	92½	25½	29¼	746	40
2 of 18	Tubes for power supplies, test data sheets, and hardware for antenna coupling transformer.	16	23	20	44	4. 3
3 of 18	Antenna coupling transformer D–159619, with Instruction Bulletin No. 1093 (WECo).	27	22	20	71	6. 9
4 of 18	Two sets of spare vacuum tubes for receiver	18	22	22	45	5. 0
5 of 18	Loudspeaker set D–124852 (special 100–F) and patching cord.	19⅜	17	16	40	3. 1
6 of 18	Spare tubes for test equipment and loudspeaker set; also miscellaneous parts and maintenance tools.	20	27	22	72	6. 9
7 of 18	Ferris signal generator 22DT	14½	29¾	19⅝	85	4. 9
8 of 18	Hickok tube tester KS–5727, L1, with Instruction Bulletin No. 1200 (WECo).	22	30	27	107	10. 3
9 of 18	Weston volt-ohm-milliammeter 779, type 1; General Radio variac V–5 MT; Cutler-Hammer power switch.	20	27	27	77	8. 4
10 of 18	(Special 19–C) Oscillator D–166636 (TS–379/U), with Instruction Bulletin No. 1124 (WECo).	18¼	25¼	19½	81	5. 2
11 of 18	Measurements Corp. vtvm, model 62 and Attenuator TS–402A/U.	20	27¼	23	68	7. 3
12 of 18	Maintenance tools, hardware, and wire	20	27	21⅞	102	6. 9
13 of 18	Armored cable	15	20⅞	20⅝	106	3. 7
14 of 18	WECo instruction books and circuit description sheets and drawings.	16	23	20	59	4. 3
15 of 18	Carbon tetrachloride	14⅜	18	14	27	2. 1
16 of 18	Miscellaneous relay rack bay with mounting hardware	88	17½	31½	260	28. 1
17 of 18	Writing shelf	20	22	6½	38	1. 7
18 of 18	Components with mounting hardware for miscellaneous relay rack bay.	20	29	22	83	7. 4
	Total weight (lb)				2, 111	

7. Table of Components

a. The following table lists the major components supplied with Radio Receiver R–369/FRC–10. The quantity of the components supplied and the individual unit dimensions are listed. A complete list of all components and their uses is given in appendix I.

Note. Items of test equipment listed below may be replaced by equivalent items of standard test equipment (par. 9*a*).

Component	No. required	Height (in.)	Width (in.)	Depth (in.)	Unit weight (lb)
Radio Receiver R–369/FRC–10	1	84	22½	17	550
Miscellaneous relay rack bay	1	84	20	3	60
Antenna coupling transformer D–159619	1	18	10	5½	16
Loudspeaker set D–124852	1	11½	7½	5½	6
Ferris signal generator 22DT	1	11	19	8	28
Dummy antenna 440A (modify per par. 9*f*)	------	3¾	1 (dia)	------	------
Hickok tube tester KS–5727, L1	1	7¾	18½	16¾	28
Weston volt-ohm milliammeter 779, type 1	1	9	5	6	6
Oscillator D–166636 (TS–379/U) (Special 19–C)	1	9½	15	9	27
Vtvm, model 62 (Measurements Corp.)	1	7	8½	4½	6
Attenuator D–165654 (TS–402A/U)	1	7	4⅛	5½	5
General Radio variac V–5 MT	1	8	6 (dia)	------	8
WECo drawings and instructions (*b* below).					

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

Front view	Panel	TM 11-870 figure number	WECo wiring diagram	WECo assembly drawing	WECo circuit description	WECo schematic diagrams
METERING	1	5,73	T-45034-81	J-41602 C-90	CD-45034-01	SD-45034-01
HIGH FREQUENCY (†)	2	6, 21, 74, 90, 95	T-45034-82, T-45034-87	J-41602 D-90	CD-45034-01	SD-45034-01
INTERMEDIATE FREQUENCY	3	7, 75, 91	T-45034-83	J-41602 E-90	CD-45034-01	SD-45034-01
(*) VOICE FREQUENCY	4	8, 76, 92	T-45034-84	J-41602 F-90	CD-45034-01	SD-45034-01
AUTOMATIC FREQUENCY CONTROL	5	9, 77, 93	T-45034-85	J-41602 G-90	CD-45034-01	SD-45034-01
±130-VOLT RECTIFIER	6	10, 78, 81, 96	T-81047-30	J-86233 A-2	CD-81047-01	SD-81047-01
250-VOLT RECTIFIER	7	11, 79, 82, 97	T-81046-30	J-86232 A-2	CD-81046-01	SD-81046-01
* RELAY (IN REAR)	8	12,80,94	T-45034-86	J-41602 H-90	CD-45034-01	SD-45034-01
† CONTROL UNIT (BEHIND PANEL)	9	27		J-41602 D-90		SD-45034-01

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Figure 4. WECo and TM 11–870 drawings, cross-reference chart.

b. Radio Receiver R369/FRC–10 is designed for use in long-distance point-to-point radio-teletype and/or radiotelephone systems, using equipment such as Radio Set AN/FRC–10. To facilitate the installation, maintenance, and service of the receiver, copies of the manufacturer's circuit description (CD), schematic diagram (SD), engineering drawings (ED), assembly drawings (J), and wiring diagrams (T) are provided with the equipment. This information should be preserved with tbis technical manual and reference to them should be made whenever additional information is required. The WECo drawing information will help during initial installation. The CD, SD, and T numerical designations for the same circuit are usually identical. For example, CD–45034 is the circuit description sheet for the entire receiver. It contains information on changes in components, the purpose and working limits of the circuit, circuit functions, description of circuit operation, and a list of kinds of connecting circuits. SD–45034 contains the schematic diagram for the receiver and a list of the values and tolerances of all parts. ED's show the point-to-point wiring, physical location of components, and pertinent information as to the mechanical assembly of components. T–45034 is the wiring information (wire color codes, etc.). The assembly drawings (J) show where components are located and supply the latest information for the particular receiver supplied. Figure 4 serves as a cross-reference between the WECo drawings supplied with the equipment and the material supplied in this manual.

8. Description of Radio Receiver R–369/FRC–10

The receiver is completely housed in a floor-mounted cabinet that contains seven front panels and one panel mounted inside the cabinet (fig. 4). These panels are standard 19 inches wide.

Panel 1—Metering
Panel 2—High frequency [1]
Panel 3—Intermediate frequency
Panel 4—Voice frequency
Panel 5—Automatic frequency control
Panel 6—±130-volt rectifier
Panel 7—250-volt rectifier
Panel 8—Relay (located in the rear at the level of the top of panel 4)

a. Panel 1. The metering panel (fig. 5) is 5¼ inches high and is mounted at the top of the cabinet. It contains three meters (CARRIER RECT CURRENT, VOLUME INDICATOR, and DC METERING), four signaling lamps (AFC, CARRIER OFF SLOW, CARRIER OFF FAST, and VF), an alarm buzzer (inside), and the dc metering PANEL SELECTOR switch that selects the particular panel with dc voltages or currents to be measured. The MAIN POWER switch and the main power 8 FN fusetron that project through the panel apply 115 volts ac to ac circuit 1. This switch controls ac circuit 1 which supplies ac power to the entire receiver. Ac circuit 2, externally fused, provides power for convenience outlets and/or a 100-watt heating lamp. The 94- to 106-kc intermediate-frequency (if.) filter is bolted to the rear of the panel.

b. Panel 2. The high-frequency (hf) panel (fig. 6) is 21 inches high and contains the rf attenuator, hf amplifier, first demodulator, 2.8-mc first if. amplifier, first and second beat oscillators, second demodulator, and the afc motor control unit. The following control knobs are mounted on the panel: INPUT ATTENUATION DB, INPUT TUNING, HF AMPLIFIER TUNING, RANGE, AFC-ZERO ADJ, PANEL 2 VT CURRENTS, 1ST BEAT OSCILLATOR, 1ST BEAT OSCILLATOR TUNING, 2ND BEAT OSCILLATOR ZERO ADJ, AFC REVERSE, CRYSTAL SELECTOR, and 2ND BEAT OSCILLATOR TUNING. The dials for the hf amplifier and first beat oscillator are located behind fan-shaped openings in the front panel cover or mat to facilitate removal of the mat without altering the settings. The PANEL 2 VT CURRENTS switch connects the DC METERING meter in panel 1 to the circuit components to be tested. With the 1ST BEAT OSCILLATOR switch in the VARIABLE position, the AFC REVERSE switch is thrown to position 1 for frequencies between 4 and 10 mc, and to position 2 for frequencies between 10 and 28 mc. This causes the AFC motor-control unit to turn the afc capacitor in the proper direction to keep the receiver in tune with the distant transmitter. With the 1ST BEAT OSCILLATOR switch in the CRYSTAL position, the AFC REVERSE switch should always be set to position 2, because the second beat oscillator, now controlled by the afc circuits, is always operated below the carrier frequency. The afc action must be reversed to keep the second beat oscillator tracking below the carrier frequency. A 1 AMP fuse mounted on the panel protects the VT HEATERS transformer. Ten plug-in crystals

[1] Panel 2 includes a motor-control unit that contains a motor-operated variable capacitor for afc. Components are designated in the 900 series.

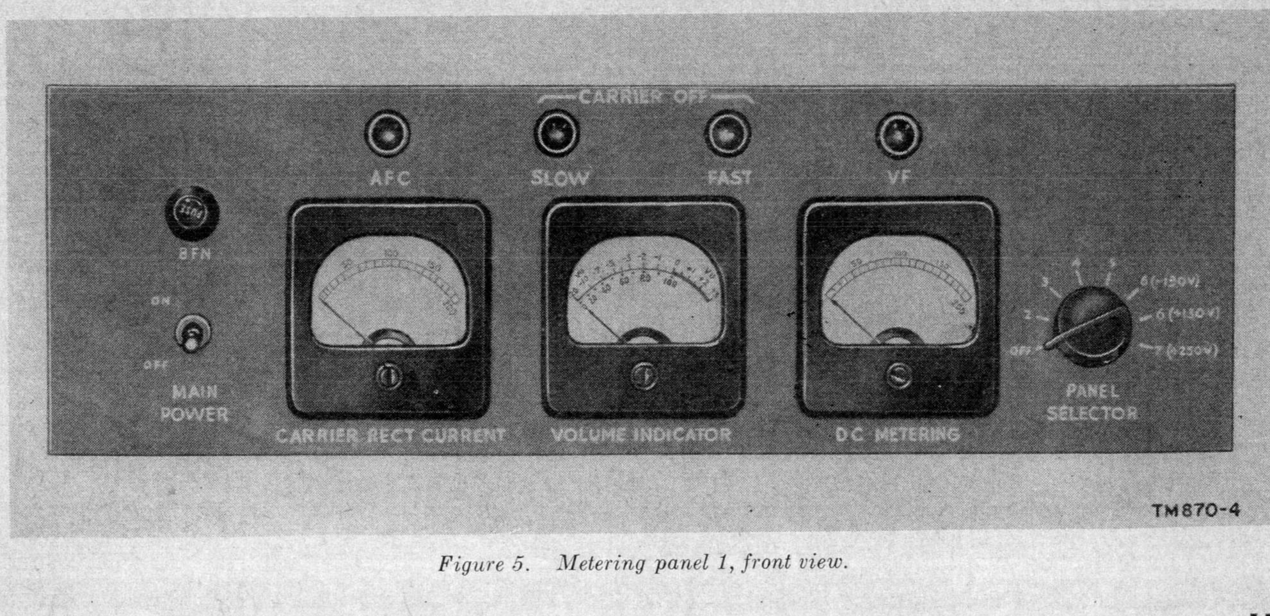

Figure 5. Metering panel 1, front view.

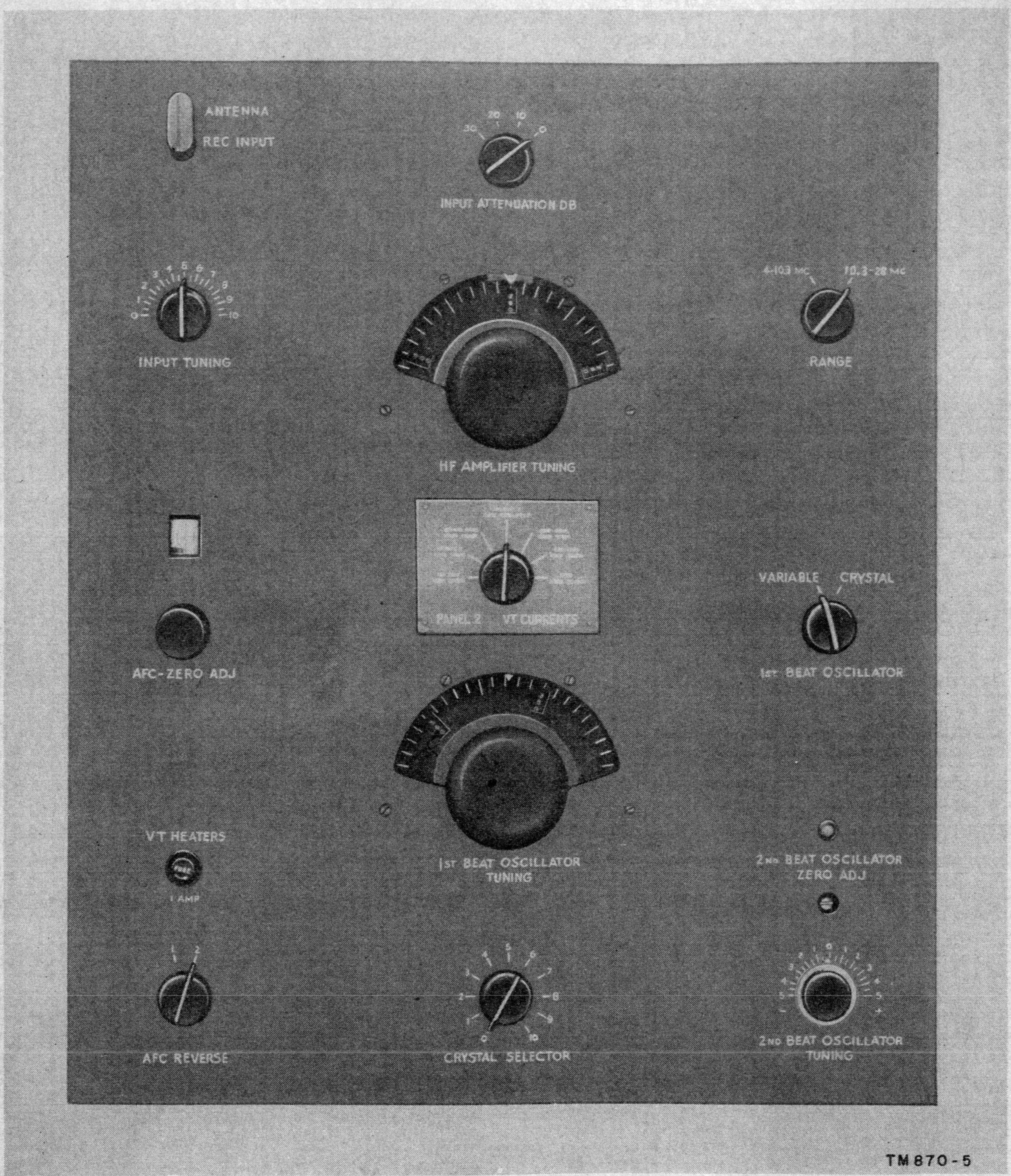

Figure 6. Hf panel 2, front view.

are located in the rear of panel 2. Covers, secured with thumbscrews, provide access to the hf amplifier tube, and screw caps provide access to the first beat oscillator and second beat oscillator tubes.

c. Panel 3. The if. panel (fig. 7) is 10½ inches high and mounts 100-kilocycle (kc) if. amplifiers 1 to 4, carrier amplifiers 1 and 2, sharp 100-kc carrier filter, limiters 1 and 2, avc rectifier, avc amplifier, and afc squelch circuits. The MAN VOL CONTROL, PANEL 3 VT CURRENTS, VOLUME CONTROL, AFC, and CARRIER BRANCH GAIN controls are mounted on this panel. There are also screwdriver adjustments for the avc and afc squelch circuits and a 1 AMP fuse that protects the VT HEATERS transformer. Two tuning tool adjustments for networks N301 and N302 are located in the rear.

d. Panel 4. The vf panel 4 (fig. 8), is 14 inches high and contains the two sideband separating filters, third demodulators, vf amplifiers, carrier amplifier, and the hybrid voltmeter circuit used with the CARRIER RECT CURRENT meter in panel 1. The MONITOR TRANSFER, PANEL 4 VT CURRENTS, CARRIER SUPPLY, and VU METER TRANSFER controls and a double plug MONITOR jack are mounted on this panel. Screwdriver adjustments include VF LINE TRANSFER, DEM CAR GAIN (carrier level control to third demodulators), and VF GAIN A, and VF GAIN B (individual gain controls for groups A and B, af amplifier). The 1 AMP fuse which is mounted on this panel protects the VT HEATERS transformer.

e. Panel 5. The afc panel (fig. 9) is 10½ inches high and mounts a control knob for PANEL 5 VT CURRENTS, the 100-kc crystal oscillator, 100-kc amplifier, carrier amplifier, afc amplifiers 1 to 4, afc rectifiers 1 to 4, and the CARRIER ALARM SLOW control tube. Screwdriver adjustments include 100 KC OSCILLATOR and AUTO FREQ CONTROL. A 2 AMP protecting fuse for the VT HEATERS transformers is located at the lower-left corner of the panel.

f. Panel 6. The ±130-volt rectifier panel (fig. 10) is 8¾ inches high and mounts the +130- and −130-volt regulated power supply. Screwdriver adjustments for setting the +130- and −130-volt dc outputs are included. A PWR switch, a ½ AMP fuse for the −130-volt supply secondary, and a 3.2 FN fusetron for the panel are also included.

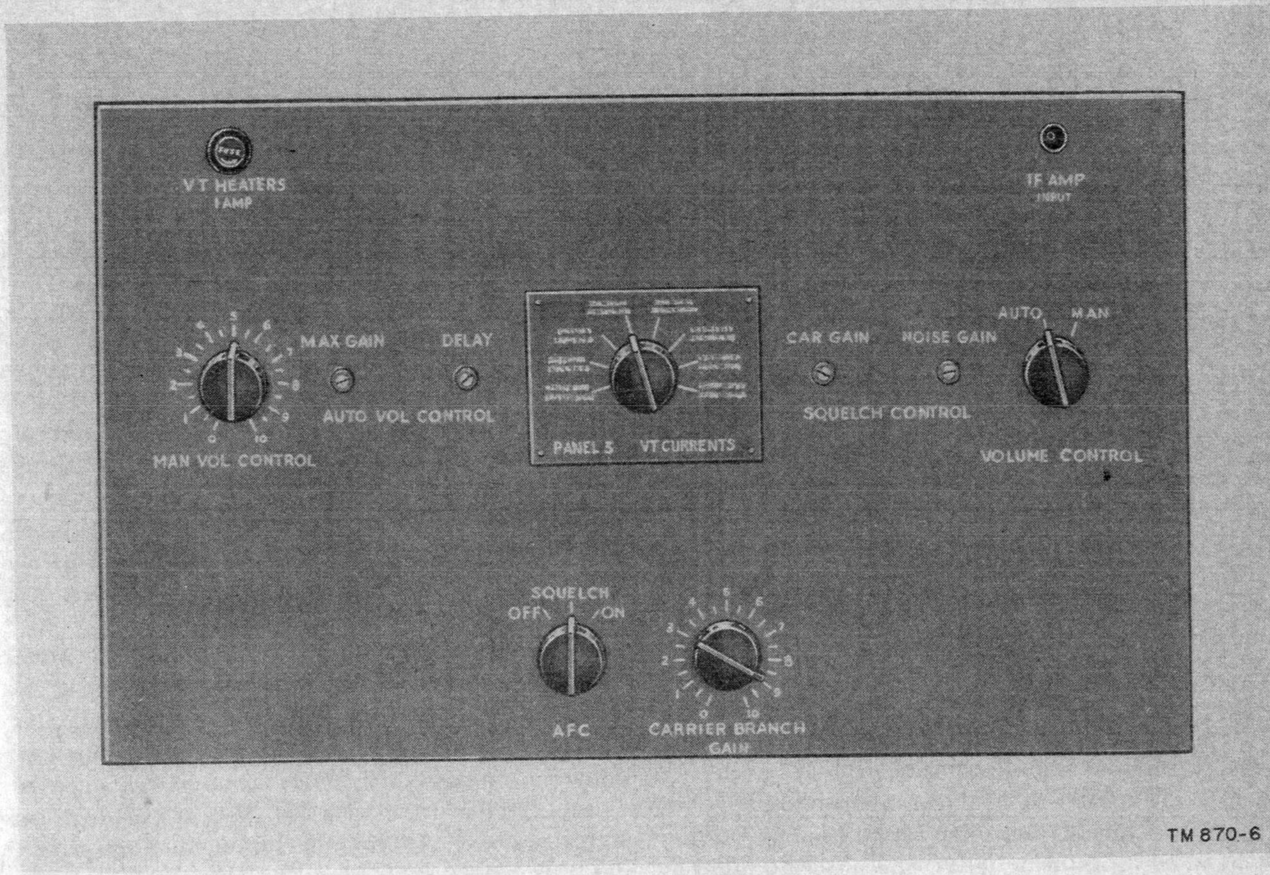

Figure 7. If. panel 3, front view.

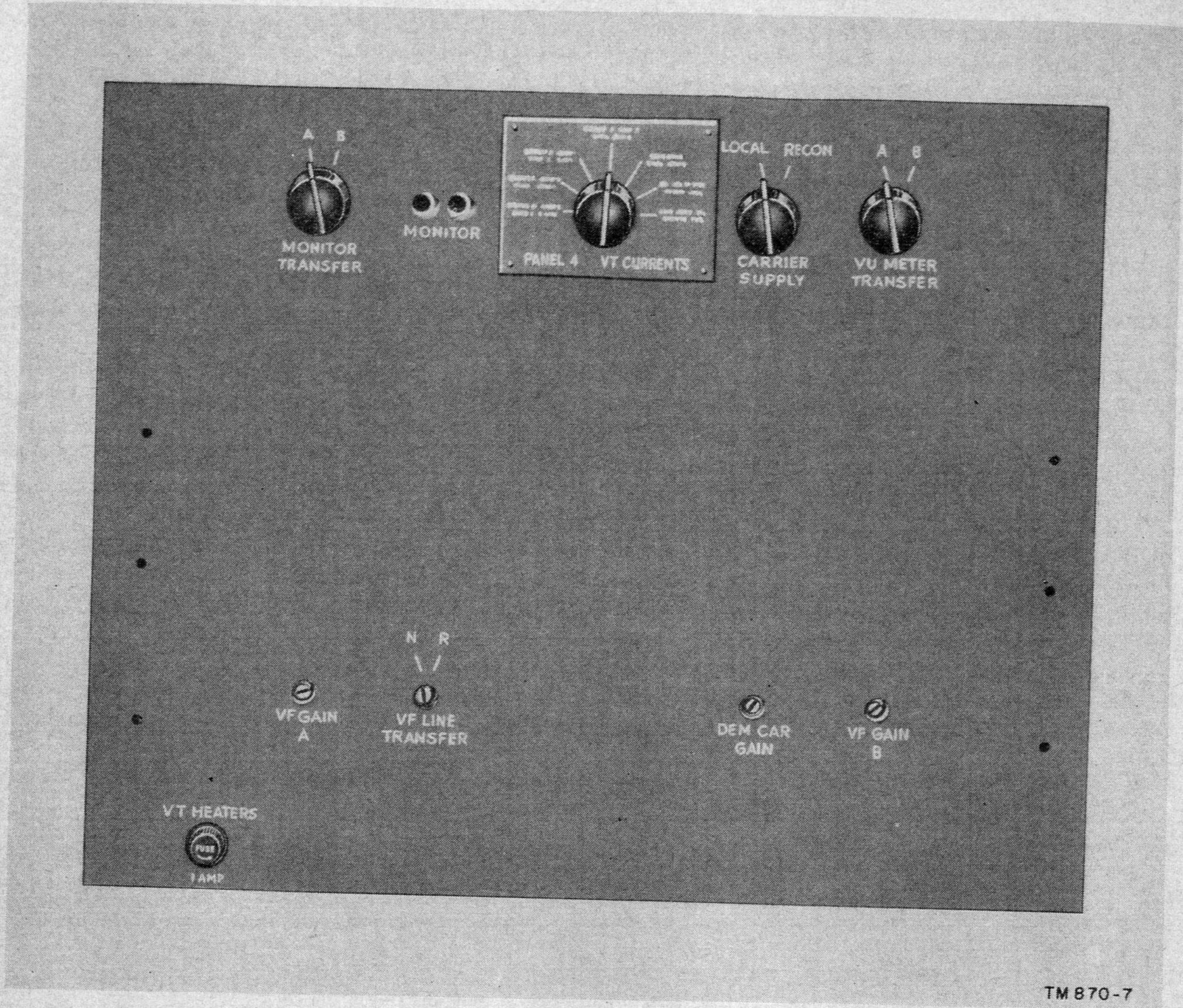

Figure 8. Vf panel 4, front view.

g. Panel 7. The 250-volt rectifier panel (fig. 11) is 7 inches high and contains the +250-volt regulated power supply. It has a screwdriver adjustment for setting the voltage at 250 volts, a PWR switch, and a 3.2 FN fusetron in the primary circuit of the power transformer. When metering panel 1 PANEL SELECTOR switch is set at 7 (+250 V), a full-scale meter reading represents 400 volts, or twice the value shown on the meter. A voltage of 250 volts causes a deflection that reads 125 on the meter scale.

h. Panel 8. The relay panel (fig. 12) is 3½ inches high and is mounted in the rear of the cabinet near the top of panel 4. The relay panel assembly contains four alarm relays, power circuit relays, and two terminal strips (one for audio output and monitoring leads, the other for alarm leads). Provisions for a diversity connection to another single-sideband receiver are incorporated in this panel. Provision is made also for connection of the equipment for recording received signal strength. The relay panel cover has a safety switch. Figure 12 shows the relay panel with its cover and the relay covers removed. This panel can be tilted forward and down for access to components.

i. Control Unit D–170 114. This motor-control unit (fig. 27), in hf panel 2 consists of an ac motor that operates a 3- to 17-micromicrofarad ($\mu\mu$f) variable air capacitor. The capacitor, under control of the motor through the afc circuits, keeps the receiver in tune with the distant radio transmitter station. Components other than the entire control unit assembly have been designated in the

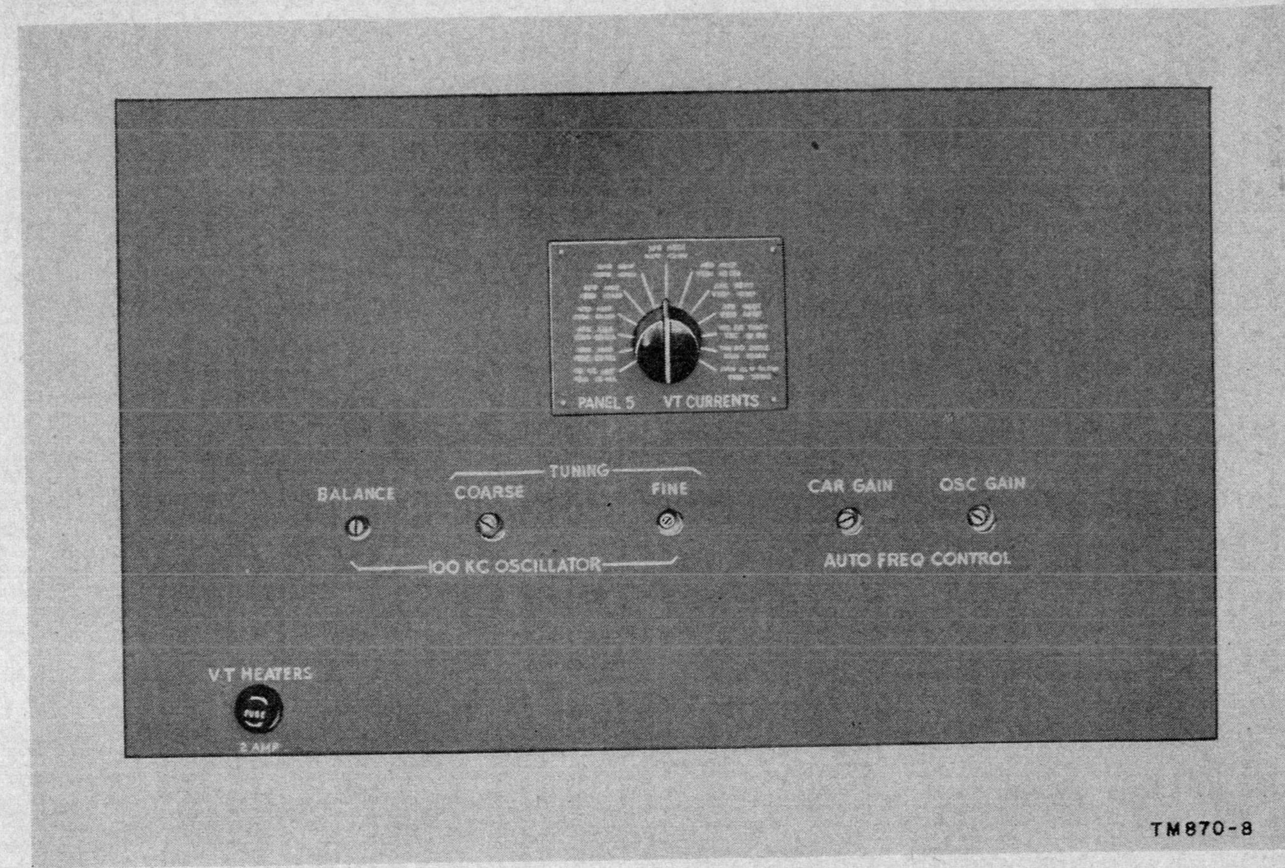

Figure 9. Afc panel 5, front view.

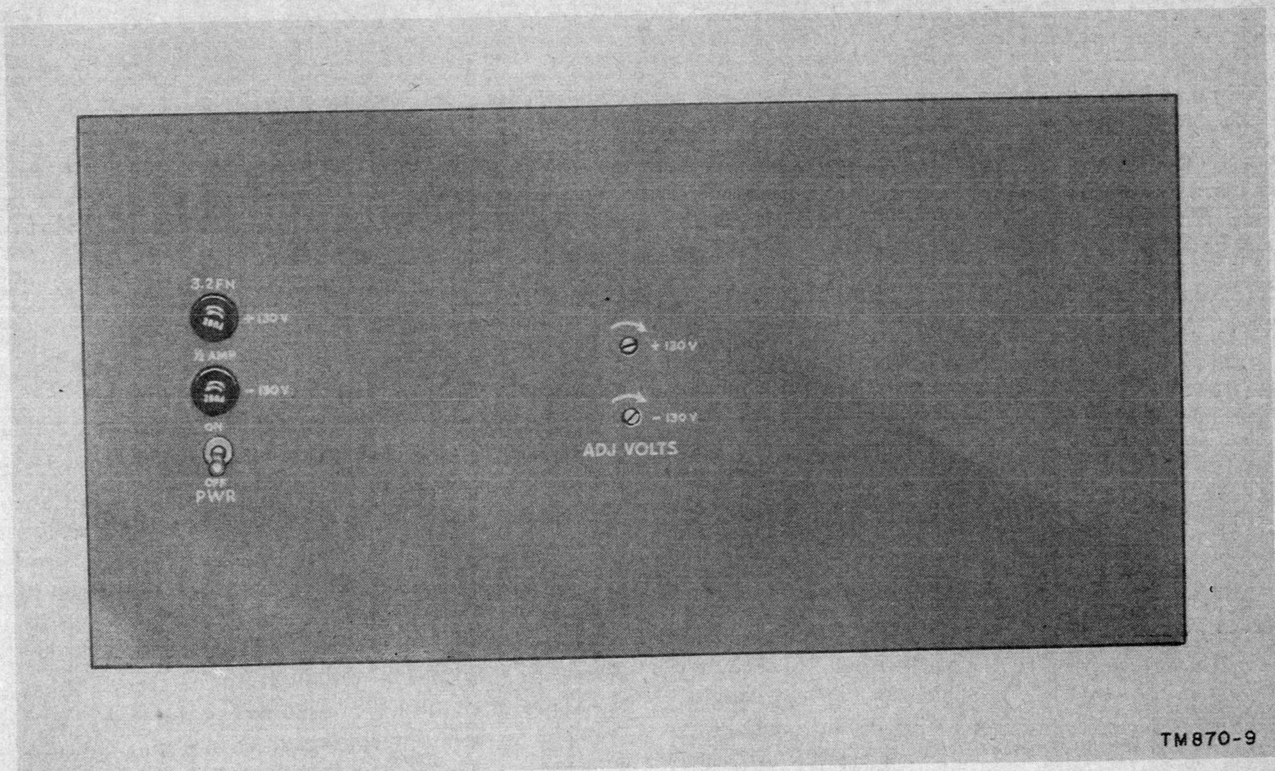

Figure 10. Rectifier panel 6, +130-volt, front view.

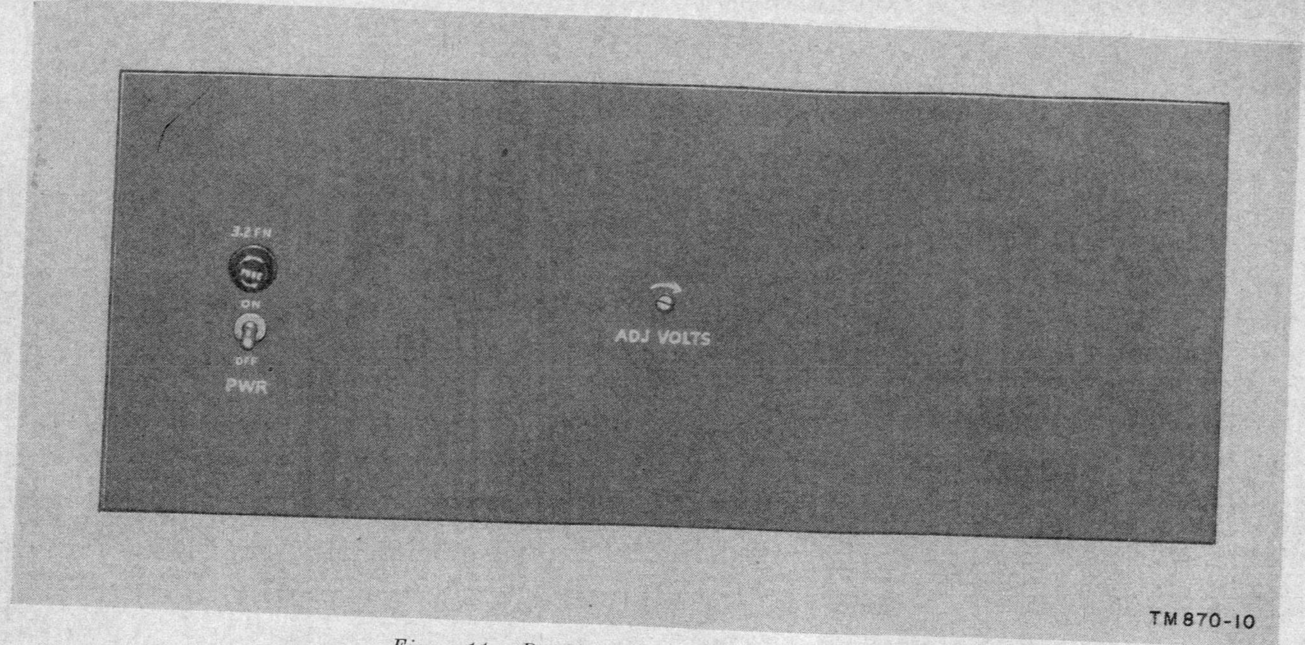

Figure 11. Rectifier panel 7, 250-volt, front view.

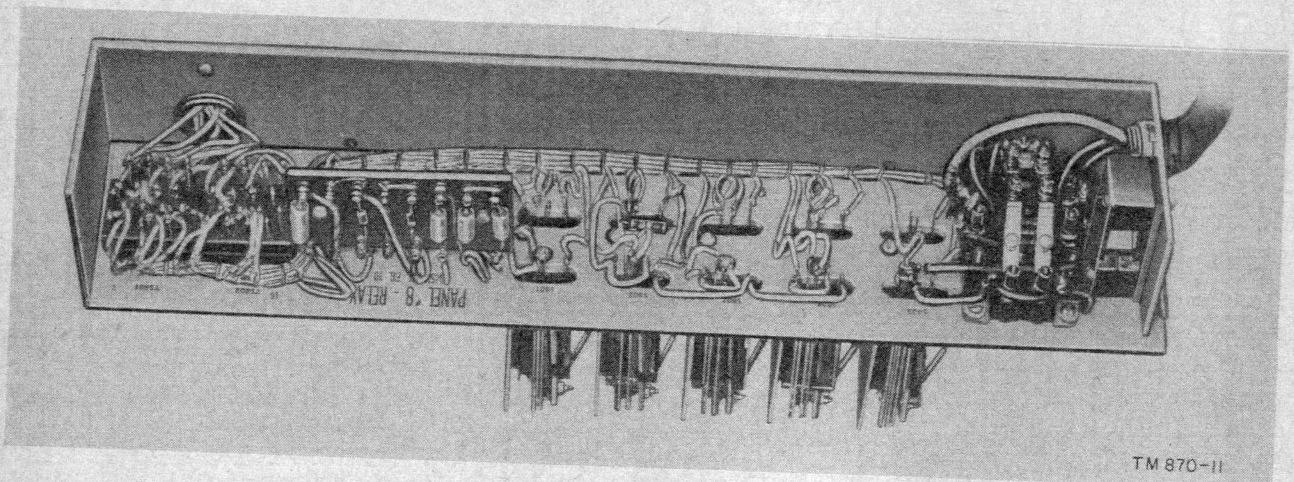

Figure 12. Relay panel 8.

900 number series. The scale associated with the variable capacitor shows through the front mat and is illuminated by two lamps that are accessible from the rear through a cover.

j. Ac Input Circuits. The two wire main 115-volt ac power circuit terminates on a terminal strip, TS1, in a metallic junction box in the rear bottom of the cabinet. Beyond the MAIN POWER switch and its fuse, separately fused circuits supply primary power for each filament transformer and power supply. A second ac power circuit, unfused in the cabinet, is brought to three convenience outlets and a heat lamp socket. These convenience outlets may be used for a soldering iron, signal generator, or other electrical equipment as desired. TP2 on the ground plate is the connection for No. 6 external ground wire.

k. Miscellaneous. A tube puller is hung in the upper left side of the cabinet as viewed from the rear. Pin straighteners for miniature seven- and nine-prong tubes are mounted inside the cabinet on the left side.

l. Doors and Wiring. The door at the rear of the cabinet has screened louvres for ventilation. This door is equipped with a flush latch and gives access to most of the vacuum tubes (three tubes on panel 2 are further covered), crystals, relays, and the external wiring that enters the cabinet. The wiring side of each unit is covered by a panel

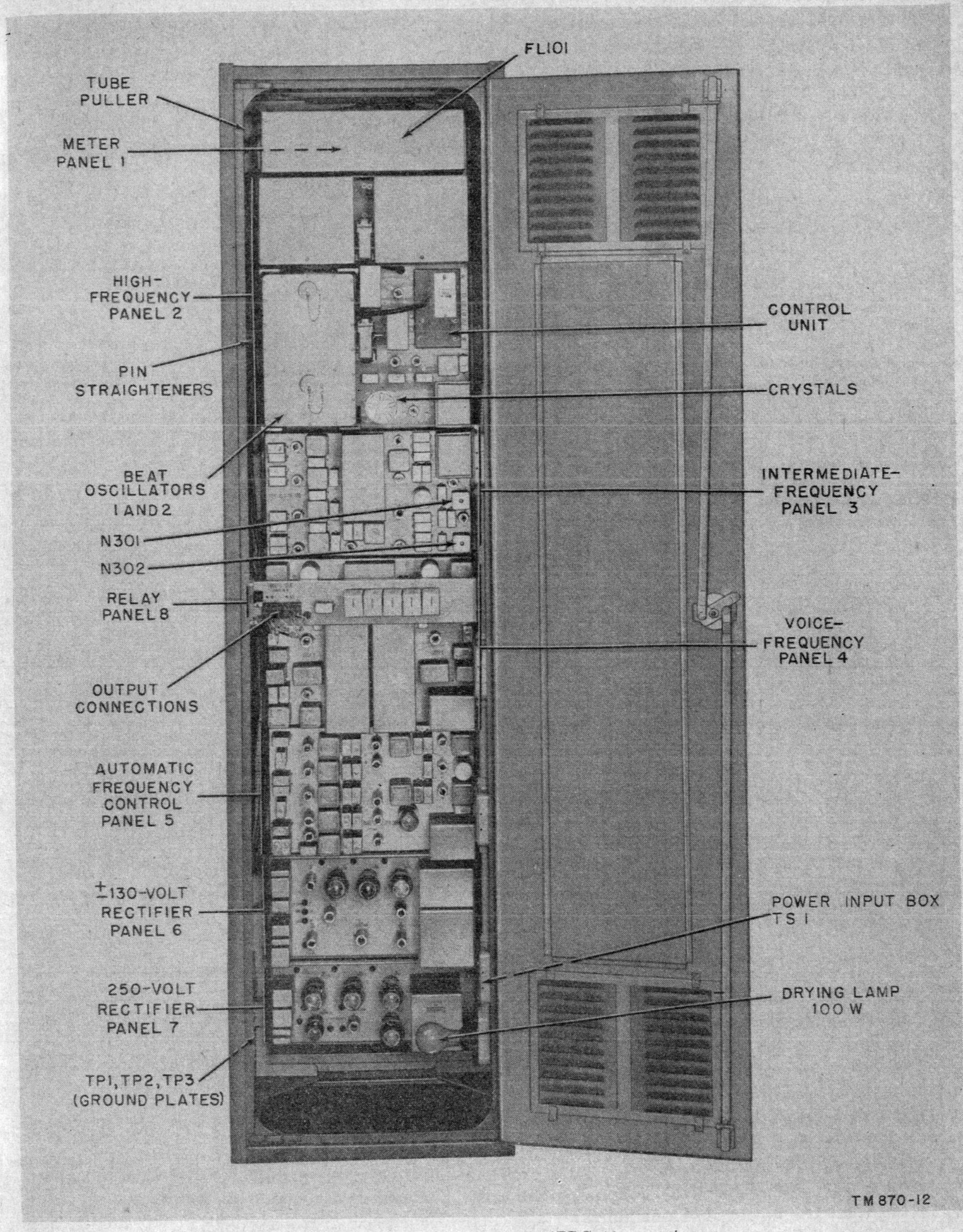

Figure 13. Radio Receiver R–369/FRC–10, rear view.

mat forming the front of the unit, and is equipped with a safety interlock switch. These safety switches open the primary circuits of the rectifiers when a panel mat is removed. Other safety switches are provided on the cover of the hf amplifier plate tuning box and on the relay panel cover (par. 15).

9. Description of Test Equipment and Other Components

a. Test Equipment. The following test equipment (fig. 14) is supplied with Radio Receiver R–369/RFC–10. Standard test equipment items that replace equivalent commercial items are also listed.

Commercial equipment	Technical publication	Equivalent standard equipment	Technical publication	Use
Hickok tube tester Ks–5727, L1.	WECo Instruction Bulletin No. 1200.	Tube Tester I–177 with Tube Tester Adapter Kit MX–949.	TM 11–2627 and TB SIG 2627–2.	Test tubes.
Oscillator D–166636 (Special 19–C); (TS–379/U).	WECo Instruction Bulletin No. 1124; TM 11–2039.	Signal Generator SG–15/PCM.	TM 11–2096	Af signal generator.
Ferris signal generator 22DT.		RF Signal Generator Set AN/URM25B.	TM 11–5551B	Rf signal generator.
Coaxial cable				Patches rf signal generator to receiver for all tests.
30-ohm coaxial cable with output box.				Output cable for 1 VOLT jack on signal generator 22DT. Not normally used in any test.
Dummy antenna 440A (modified per par. 9*f*).				Matches output impedance of rf signal generator to receiver.
Loudspeaker set D–124852 (Special 100–F).				Audibly monitors output of receiver.
Headset 1002C				Audibly monitors output of receiver.
General Radio variac V–5 MT.				To temporarily adjust 115-volt input; power supply capability tests.
Attenuator D–165654 (Special 5–A); (TS–402A/U).		Attenuator TS–402A/U.	TM 11–2044	To adjust signal level during certain test procedures.
Weston volt-ohm-milliammeter 779, type 1.		Multimeter TS–352A/U.	TM 11–5527	Test instrument.
Measurements Corp. vacuum-tube voltmeter, model 62.		Voltmeter TS–505/U	TM 11–5511	Test instrument.

b. Data. Complete information on the capabilities of, and operating instructions for, the various equipments is supplied in accompanying instruction literature. Supplementary information for each item listed in *a* above is contained in *c* through *l* below. Operating personnel may mount the items listed in *c, d, e,* and *j* below on the miscellaneous relay rack bay, if desired.

c. Hickok Tube Tester KS–5727, L1. The tube tester (fig. 14) is mounted in a portable carrying case, 7¾ inches high, 18½ inches wide, and 16¾ inches deep. The case is equipped with a removable cover. Nine tube sockets are provided to permit the testing of all standard and miniature tubes. Facilities are provided for cathode activity and dynamic characteristics tests.

d. Oscillator D–166636 (TS–379/U). The audio oscillator (fig. 14) is mounted in a portable carrying case, 9½ inches high, 15 inches wide, and 9 inches deep. Four knurled screws on the front face plate of the oscillator can be loosened to permit removal of the oscillator from its case. Refer

Figure 14. Test equipment supplied with Radio Receiver R–369/FRC–10.

to TM 11–2039 audio oscillators TS–379/U, TS–379A/U, and TS–379B/U.

e. Ferris Signal Generator 22DT. Signal generator 22DT (fig. 14) is mounted in a self-contained, portable housing, 11 inches high, 19 inches wide, and 8 inches deep.

(1) Use the following supplementary information with the instruction literature that accompanies the equipment.

(2) The signal generator operates over a frequency range from 85 to 40,000 kc in bands indicated by the letter that appears in a small window directly below the range knob. Frequencies that correspond to each range are shown on the direct reading dial. Refer to paragraph 16*c* when setting the dial. A 100-division vernier dial is provided for use with the SC linear calibration scale. This dial revolves five times for each range, each revolution is indicated by the inner scale of the large dial. Thus, 500 divisions are available; for example, 441 would be indicated by the direct reading dial set between 4 and the end of the scale, and the vernier set to 41.

(*a*) Modulation by a 400-cps internal oscillator is done by setting the MODULATION switch to INT. In the EXT. position, a modulation voltage from an external source may be applied through the EXT MOD binding posts located on the left side of the panel.

(*b*) Percent modulation is indicated directly by a rectifier-type meter which is corrected for frequencies up to 12,000 cps. The degree of modulation is regulated by the potentiometer underneath the meter. The modulation characteristics of this signal generator are such that the amplitudes of the sidebands may not be equal.

(3) The main power switch should be left on at all times while testing to minimize frequency drift.

f. Dummy Antenna 440A. The dummy antenna (fig. 14), 3¾ inches long and 1 inch in diameter, may contain a 43-ohm resistor. To match the impedance of Ferris signal generator 22DT to the receiver input, the 43-ohm resistor must be replaced with an IRC BT ½, 62-ohm noninductive resistor that measures 60 ohms. The modified dummy antenna absorbs part of the output of the signal generator. As a result, the output of the dummy antenna is one-half the value indicated on the MICROVOLTS output meter of Ferris signal generator 22DT.

g. Loudspeaker Set D–124852 (Special 100–F). The loudspeaker (fig. 14) consists of a two-stage, resistance-coupled amplifier and a loudspeaker, mounted in a wooden cabinet 7⁹⁄₁₆ inches high, 11½ inches wide, and 5⁵⁄₁₆ inches deep. The power input is 50 to 60 cps, 105- to 125-volt ac, and requires a maximum input of 50 watts. The tubes consist of a 25Z6GT rectifier, 6SL7GT voltage amplifier, and 25L6GT power amplifier. A GE No. 47 lamp is used as the pilot light. This set differs from loudspeaker set model 100–E, which is shipped with the Carrier Terminal OA–64/FRC–10, in that the on-off switch of model 100–E has a standby position. The sets also contain different tube types. The 100–E model contains a 25Z5 rectifier, Raytheon CK–108 voltage amplifier, and type 43 power amplifier. The pilot light for the 100–E model is a No. 40 Mazda lamp. The set is equipped with a flexible cord and a double plug. For a schematic diagram of loudspeaker model 100–F, refer to figure 86.

h. Headset 1002C. Headset 1002C (fig. 14) consists of a pair of headphones, a headband, and a cable equipped with a double plug.

i. General Radio Variac V–5 MT. This variac (fig. 14) is 8 inches high and 6 inches in diameter. It is equipped with a power cord and an on-off switch.

j. Attenuator D–165654 (TS–402A/U). The attenuator (fig. 14) is housed in a metal case 7 inches high, 4⅛ inches wide, and 5½ inches deep. It is equipped with input and output terminal posts and jacks and selectors keys with settings that determine the amount of attenuation inserted. Refer to TM 11–2044, Preliminary Instructions 5A (SPL) Attenuator Per D–165654 (Moisture-Resistant).

k. Weston Volt-Ohm-Milliammeter 779, Type 1. The volt-ohm-milliammeter (fig. 14) is mounted in a wooden carrying case 9 inches high, 5 inches wide, and 6 inches deep. The hinged cover is removable. One set of test leads and the internal battery required for resistance measurements are provided.

l. Measurements Corp. Vacuum-Tube Voltmeter, Model 62. The vacuum-tube voltmeter (vtvm) (fig. 14) is 7 inches high, 4½ inches wide, and 8½ inches deep. It is equipped with a power cord, an on-off switch, and test leads. It is set to zero by the 0 ADJ control, with the voltage range knobs set to the OFF position or midway between any two adjacent ranges. Two output points are provided. One is a permanent ultra-high-frequency (uhf) receptacle on an attached cable that delivers outputs from 1 microvolt (uv) to .1 volt. The other is a high-output jack normally covered by a cap, from which is available .1 to 1.0 volt. A model 440A dummy antenna is supplied for use with the receptacle (low-range) outlet. The dummy antenna may require modification (*f* above). A 30-ohm cable, equipped with an output box that contains a 30-ohm termination, is supplied for use in the high-range jack. This is normally not used, but may be useful if receiver sensitivity is extremely poor because of failure of a major component or mechanical damage.

m. Miscellaneous Relay Rack Bay. The miscellaneous relay rack bay (fig. 15), 19 inches wide and 84 inches high, is usually mounted against the left side of the receiver. Components (*n* through *p* below) that aid in operating and testing the receiver are mounted on the bay.

n. Writing Shelf. The portable writing shelf may be used when making entries into log sheets or as a temporary mount for the loudspeaker set. A telegraph key and sounder for communicating over the simplex leg to the telegraph terminal equipment are mounted on the writing shelf.

o. Jack Mounting Shelf. This shelf contains two rows, each containing 26 positions, left to right on the front of the shelf, in which jacks or dummy plugs can be mounted (fig. 55). The jacks provided can be used to patch one antenna into one or two receivers, to patch the output of the receiver into the line to the carrier terminal equipment, or for other desired patching combinations. Provisions are also included to patch a 20-foot section (approximately) of coaxial cable (LOOP) into the signal path from the antenna to one receiver when two receivers, using a common antenna, are in operation simultaneously. In such cases there is a possibility, at some frequencies, that the tuned input circuit and line of one receiver will act as a shorted stub for the tuned input circuit and line of the other receiver. Patching the 20-foot section into the line of one receiver should eliminate this undesirable condition.

p. Line Repeating Coil Panel. This panel contains coils for phantom and simplex operation. The theory of simplex and phantom operation is explained in paragraph 95.

q. Additional Components. Space is available for other panels such as a branching amplifier, sine amplifiers, communication receiver, and other additional components. Figure 15 shows one set of possible positions for installation of these panels; WECo drawing T–626698 shows another (preferable) installation position.

10. Miscellaneous Components

a. Antenna coupling transformer D–159619 (fig. 18) matches a balanced transmission line or an antenna with a characteristic impedance of 600 to 800 ohms to a 75-ohm coaxial line. The coaxial line is connected to the REC INPUT jack through the jack facilities on the miscellaneous relay rack bay. This coupling transformer is similar to Antenna Coupling Unit CU–128(*)/U, described in TM 11–5000.

b. Coaxial patching plug 341C (PG 201) is used to connect the ANTENNA jack to the REC INPUT jack. It completes the antenna circuit and must be inserted into the two jacks to make the receiver ready for operation.

11. Running Spares

Running spares are listed in appendix I. The spares include two tubes for each tube socket in the receiver and test equipment.

12. Additional Equipment Required

The following equipment is not supplied as part of Radio Receiver R–369/FRC–10, but is required for its installation and operation:

a. Rhombic (three-wire) receiving antenna.

b. A 75-ohm coaxial line from antenna coupling transformer on rhombic antenna pole to miscellaneous relay rack bay. Antenna coupling transformer is designed for ⅞-inch copper coaxial transmission line; miscellaneous relay rack bay is designed for WE 724 or KS 7152 line.

c. External alarm indicators (fig. 19), associated connecting lines, and monitoring facilities.

d. Telephone circuit for coordination with telegraph terminal site.

e. Line to telegraph terminal. Two pairs of metallic lines (frequency response of 100 to 6,000 cps) are required.

13. Differences in Receivers by Serial Numbers

a. Frequency Range. Equipments bearing WECo serial numbers 101 through 157 have a frequency range of 4 to 23 mc. These receivers may be made to cover the range 4 to 28 mc, as do equipments bearing serial numbers 158 and

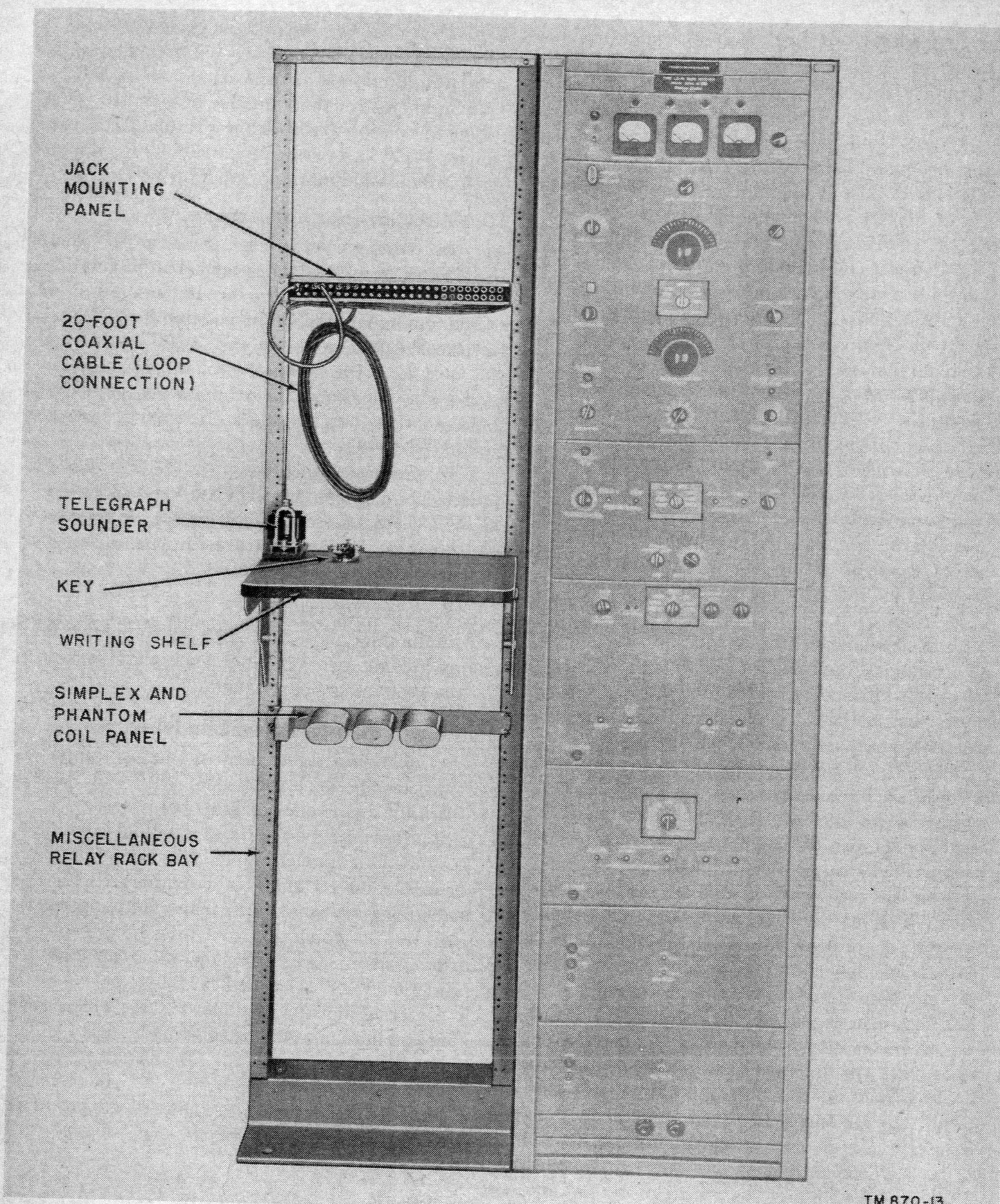

Figure 15. Miscellaneous relay rack bay, front view.

up, by a connection change (par. 25). Typical dial calibration curves for receivers having either frequency range are shown on figure 23.

b. Overload Protection Circuit. An overload protection circuit for filters YF401 and YF402 was not initially installed in equipments bearing WECo serial numbers 149, 150, 146, and earlier serial-numbered receivers. The protection circuit (fig. 38), which consists of RV301, RV302, C340, C341, R396, R397, R398, and R399, prevents possible damage to the crystal filters under some operating conditions. These circuit components should be installed according to paragraph 25*b*.

c. Variable Capacitor Bracket. The improved method of mounting C250 (1ST HEAT OSCILLATOR TUNING capacitor) was not used on equipments bearing WECo serial numbers 134, 132, and earlier serial-numbered receivers. These brackets improve the stability of the receiver and should be installed as indicated in paragraph 25*c*.

d. Resistor R287. Resistor R287 was not installed in equipments bearing serial numbers 150, 146, and earlier serial-numbered receivers. It should be installed as indicated in paargraph 25*d*.

e. Resistor R288. Resistor R288 was not installed in equipments bearing WECo serial number 157 and earlier serial-numbered receivers. It should be installed as indicated in paragraph 25*d*.

f. Radio Station Equipment Specifications (Master Packing List). A specification and installation instruction marked "Exhibit B–(*)" or specification "KME 5000" accompanies each shipment. The information applies only to that particular shipment and others of the same military order number. It contains a job summary, a list of drawings furnished, instruction bulletins furnished, and *installer's notes* needed for the receiver station installation. Item numbers detail exactly how many of each separate item is supplied.

g. Power Supply Tubes. In the power supplies some sets may be supplied with 6AS7G and5R4GY tubes, and other sets with type 421A and 422A tubes. Refer to the notes on figures 81 and 82 for required circuit changes.

h. X and Y Wiring. Figure 87 shows both X and Y wiring in the applicable places. Only X or Y wiring is used at one time in an associated circuit. The partial schematic diagrams show only the latest wiring.

i. Serial Numbers. WECo serial numbers are given on the name plate mounted below the Signal Corps name plate.

CHAPTER 2
INSTALLATION

Section I. SERVICE UPON RECEIPT OF RADIO RECEIVER R-369/FRC-10

14. Siting

a. External Requirements. Highly directional antennas, such as the three-wire rhombic antenna recommended for use with this receiver, require a proper antenna site if high efficiency is to be maintained. The antenna should be erected over flat terrain with no large obstructions, such as hills, cliffs, densely wooded areas, or buildings in the immediate vicinity. The terrain immediately in front of the terminated end of the rhombic antenna should be level for at least 1 mile, with no obstructions higher than 250 feet within that distance. Weak or undesirable signals may be expected if the site chosen is in a depression, valley, or close to steel bridges, underpasses, power lines, or power units. Refer to TM 11-2611, Antenna Kit for Rhombic Receiving Antenna (Drawing ES-E-386-E), for complete details on the erection of rhombic receiving antennas. TM 11-2617, Antenna Kit for Rhombic Transmitting Antenna (Drawing ES-E-368-D), presents data on a three-wire rhombic antenna suitable for transmitting.

b. Interior Requirements. The shelter for the equipment must meet the following requirements:

(1) The floor must be capable of sustaining the weight of the equipment (approximately 800 pounds) in a level position without vibration. If vibration occurs, the receiver may be detuned sufficiently to cause the afc squelch circuits to operate. Excessive vibration may detune the receiver enough to cause the CARRIER OFF FAST and CARRIER OFF SLOW lamps to light. An example of a good foundation would be a concrete pier that extends through, but not supporting, a wooden floor. The pier should rest on solid ground.

(2) Sufficient space must be allowed behind the receiver so that the door may be opened by personnel standing behind the receiver. Sufficient operating space must be allowed in front of the receiver (fig. 16).

(3) Adequate lighting for day and night operation must be provided. Position the receiver so that, under artificial lighting conditions, glare reflected from the meter faces and dials to the operating personnel is minimized.

15. Safety Precautions

a. Be careful when working on the 130-volt and 250-volt B+ circuits, or on the 115-volt ac line connections.

b. There is 115-volt ac on the wiring to the primary side of four filament transformers, even when the safety interlock switches on the panel mats are off.

c. The ac convenience outlets are on a separate circuit.

d. There is no safety switch on the cover of the first and second beat oscillator box.

16. Operating Precautions

a. Plugging into a jack in jack field REC OUT (right side) of the miscellaneous relay rack bay will interrupt the circuit to the carrier telegraph terminal.

b. Do not leave PANEL 4 VT CURRENTS switch in position S B VOLT HYB V401A 20V except to complete a required test. It may introduce intermodulation distortion that reduces the circuit usability for teletypewriter service.

c. When using the test equipment (Ferris signal generator 22DT), be sure that the frame is securely grounded *before* putting the plug in the ac receptacle. Be sure that the proper scale arc is read.

when setting frequency ranges. Sometimes the line-up between the scale arc and letters is not exact.

d. The adjustment of C1 inside the antenna coupling transformer (fig. 18) is factory set and must not be changed.

e. On panel 5, 100 KC OSCILLATOR BALANCE should not be adjusted unless circuit components are changed. Paragraph 117 lists the readjustment procedure, if required. A snap-in blank or piece of tape may be used to cover this adjustment hole.

f. The crystal filters are precision-adjusted (internally) and may be damaged if handled roughly.

g. In the power supplies, do not use 6AS7G and 5R4GY tubes in combination with 421A and 422A tubes. Do not change from 6AS7G and 5R4GY tubes to 421A and 422A tubes without making the required circuit changes shown in the notes on figures 81 and 82.

17. Uncrating, Unpacking, and Checking New Equipment

a. General. Equipment may be shipped in oversea or domestic packing cases. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent installation site. Check to see that all cases are present and that the equipment is undamaged. Keep the packing slips and "Exhibit B–(*)" or specification "KME 5000", to form a part of the station record, and for information if the equipment is to be reshipped.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment might be rendered useless.

b. Step-by-step Instructions for Uncrating and Unpacking Export Shipments.

(1) Place the packing case as near the operating position as is convenient.

(2) Remove and save the packing slip located inside the waterproof envelope attached to the outside of the packing case.

(3) Cut and fold back the steel binding straps.

(4) Remove the nails that hold the top of the packing case with a nail puller. If the case weighs more than 100 pounds, it may be necessary to remove the top and one side of the packing case to facilitate the removal of the contents without damaging them.

(5) Remove the excelsior covering the waterproof container.

(6) Open the waterproof container.

(7) Strip off the gummed paper from the cardboard box inside the waterproof container. Open the box, remove the cardboard fillers, and place the equipment near its final location.

(8) Inspect the equipment for possible damage incurred during shipment.

(9) Check the contents of the packing case against the master packing slip.

(10) Place all packing containers, excelsiors, etc., inside the wooden packing case for future use.

c. Checking. Check the contents against the master packing slip and "Exhibit B–(*)" or specification "KME 5000" included in the shipment. A list of a typical shipment is included in appendix I.

18. Installation of Equipment

a. General. Before Radio Receiver R–369/FRC–10 can be put into operation as a part of Radio Set AN/FRC–10, the following installation operations (*b* through *h* below) must be performed:

(1) Mounting Radio Receiver R–369/FRC–10.

(2) Mounting miscellaneous relay rack bay which is mounted to the left of the receiver. If the physical location of the equipment makes it more convenient to locate the rack to the right of the receiver, this may also be done.

(3) Installing components removed for safe shipment. Several components that are susceptible to shipment damage and which might be lost are shipped separately and must be installed in the receiver.

(4) Installing the antenna coupling transformer. This transformer (in its weatherproof case) is installed on the pole that supports the out-put corner of the rhombic antenna. The transformer acts as a balanced-to-unbalanced line transformer, in addition to providing an impedance match between the 600-ohm, three-wire rhombic antenna and the 75-ohm coaxial line to the receiver.

b. Mounting Radio Receiver R–369/FRC–10. Before securing the radio receiver cabinet to the floor, be sure to leave adequate space, indicated on the floor plan (fig. 16), to open the rear door.

(1) Mark the center points of the four mounting holes on the cement floor.

(2) Use a ⅝-inch star drill and hammer to drill the holes.

(3) Move the receiver into place so that the holes in the floor of the receiver are centered over the holes in the cement floor.

(4) Bolt the receiver to the floor, using the hardware listed in A–A, figure 16.

c. Mounting Miscellaneous Relay Rack Bay. Before mounting the miscellaneous relay rack bay, refer to figure 16.

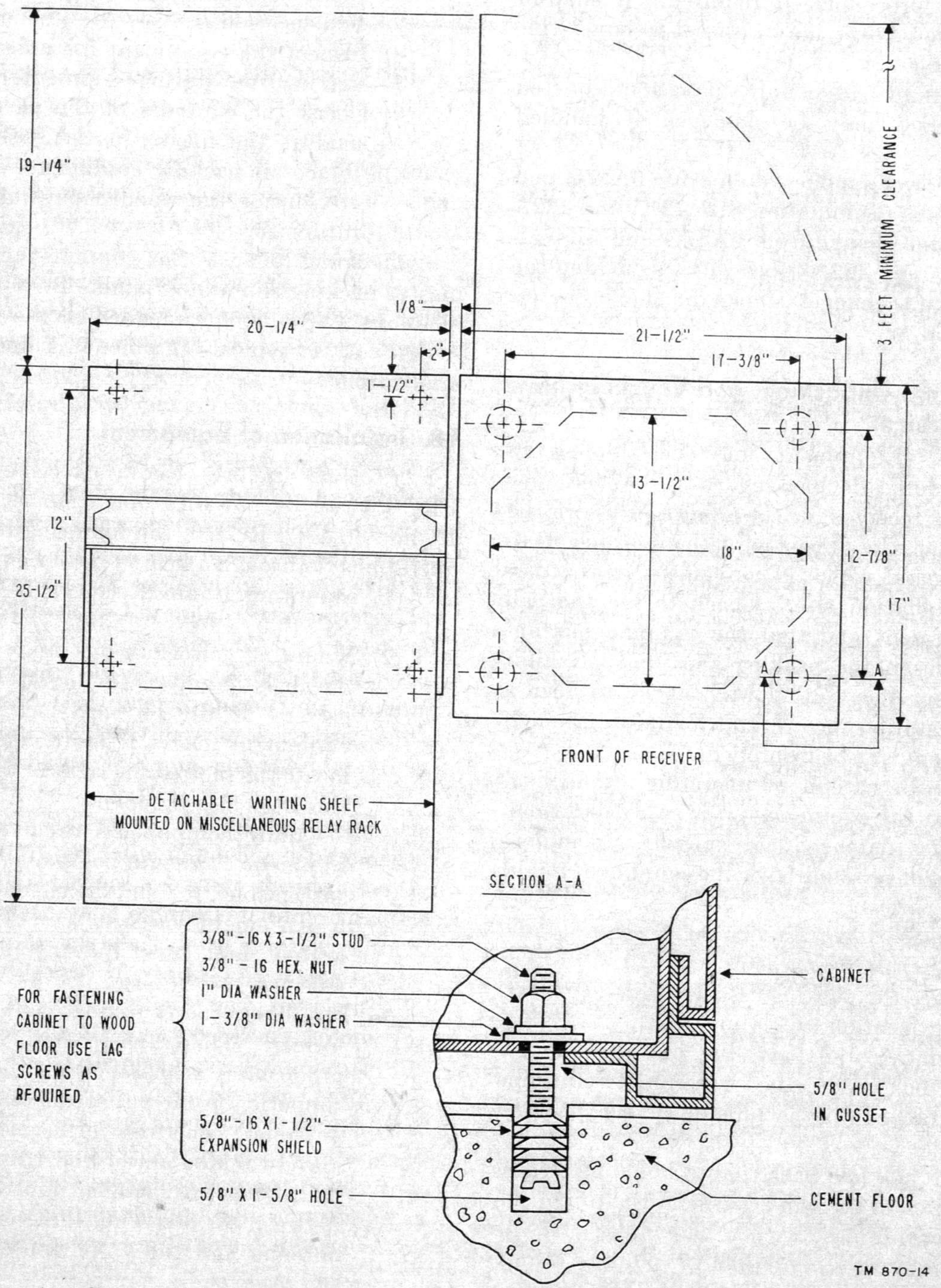

Figure 16. Floor plan for mounting of Radio Receiver R–369/FRC–10 and miscellaneous relay rack bay.

(1) Position the bay against the left side of the receiver with approximately ⅛-inch clearance between the units.

(2) Spot the center of the holes, remove the bay, and then drill.

(3) Bolt the bay to the floor.

d. Components Removed for Safe Shipment. The following components are removed from the receiver at the factory before shipping:

(1) Eight tubes from the power supply compartments: three 5R4GY, two 6AS7G, two 350B, and one 0D3.

Note. In some sets, 422A and 412A tubes are substituted for the 5R4GY and 6AS7G tubes, respectively. Power transformer taps are changed when the tubes are substituted (figs. 81 and 82).

(2) One 341C coaxial plug.

(3) One 100-watt, 120-volt heater lamp (standard 100-watt incandescent lamp).

(4) One Sure-Grip tube puller.

e. Installation of Components Removed for Safe Shipment. To install the components removed at the factory, follow the procedure in (1) through (10) below:

(1) Open the rear door of Radio Receiver R–369/FRC–10, using the flush-latch handle. To facilitate location in the shipment of components, refer to appendix I, the master packing list, Exhibit B–(*), or specification KMD 5000, furnished with the shipment.

(2) Insert 5R4GY tubes into sockets V1 and V2 in panel 7, the +250-volt power supply chassis (fig. 17).

(3) Insert 6AS7G tubes into sockets V3 and V4 in panel 7 (fig. 17).

(4) Insert an 0D3 tube into socket V5 in panel 7 (fig. 17).

(5) Insert a 5R4GY tube into socket V1 in panel 6, the ±130-volt power supply chassis (fig. 17).

(6) Insert 350B tubes into sockets V2 and V3 in panel 6 (fig. 17).

(7) Screw the drying lamp into lamp socket LPS1. The position of the lamp when properly installed is shown in figure 13.

(8) Hang the Sure-Grip tube puller on the hooks provided (fig. 13).

(9) Close the rear door.

(10) Insert the coaxial plug 341C into ANTENNA and REC INPUT jacks located in the upper left corner on the front panel of the receiver at panel 2.

f. Mounting Components of Miscellaneous Relay Rack Bay. Mount the components listed below on the miscellaneous relay rack bay as shown on WECo drawing T–626698 and figure 15. Compare figure 15 and WECo drawing T–626698. Note that the component locations shown on the WECo drawing and those in figure 15 do not correspond. Depending on the circumstances, other installation locations may be used by the installation personnel. Follow the layout given in the WECo drawing if circumstances permit. If they do not, locate the items as necessary. The electrical connections between components must be made in accordance with the instructions given in paragraph 19. To facilitate location (in the shipment) of the components whose installation is described below, see appendix I, the master packing list, Exhibit B–(*) or specification KME 5000, furnished with the shipment.

g. Material To Be Mounted. Mount the following:

(1) Mounting plate type 600–A.

(2) Jack mounting type 230–A.

(3) Writing shelf.

(4) Jack space type 168–A.

(5) Place the loudspeaker set (special 100–F) on the writing shelf and plug its power cord into one of the two convenience outlets located near panel 7 (fig. 13).

(6) Put 39B apparatus blanks in any unused jack spaces such as those labeled "+" in figure 55.

h. Mounting Antenna Coupling Transformer D–159619. Mount the antenna coupling transformer on the pole to which the open ends of the rhombic antenna are connected (Fig. 18, WECo Instruction Bulletin No. 1093, and WECo drawing T–626698). Follow the procedures described in (1) through (6) below:

(1) Mount the legs of the U-brackets 24 inches below the open end of the antenna. Space the brackets 5 inches apart to fit studs on the antenna transformer case.

(2) Bolt the rear face of the antenna coupling transformer to the base of the U-brackets.

(3) Connect the open pair wires from the rhombic antenna to the choke coils attached to the feedthrough insulators

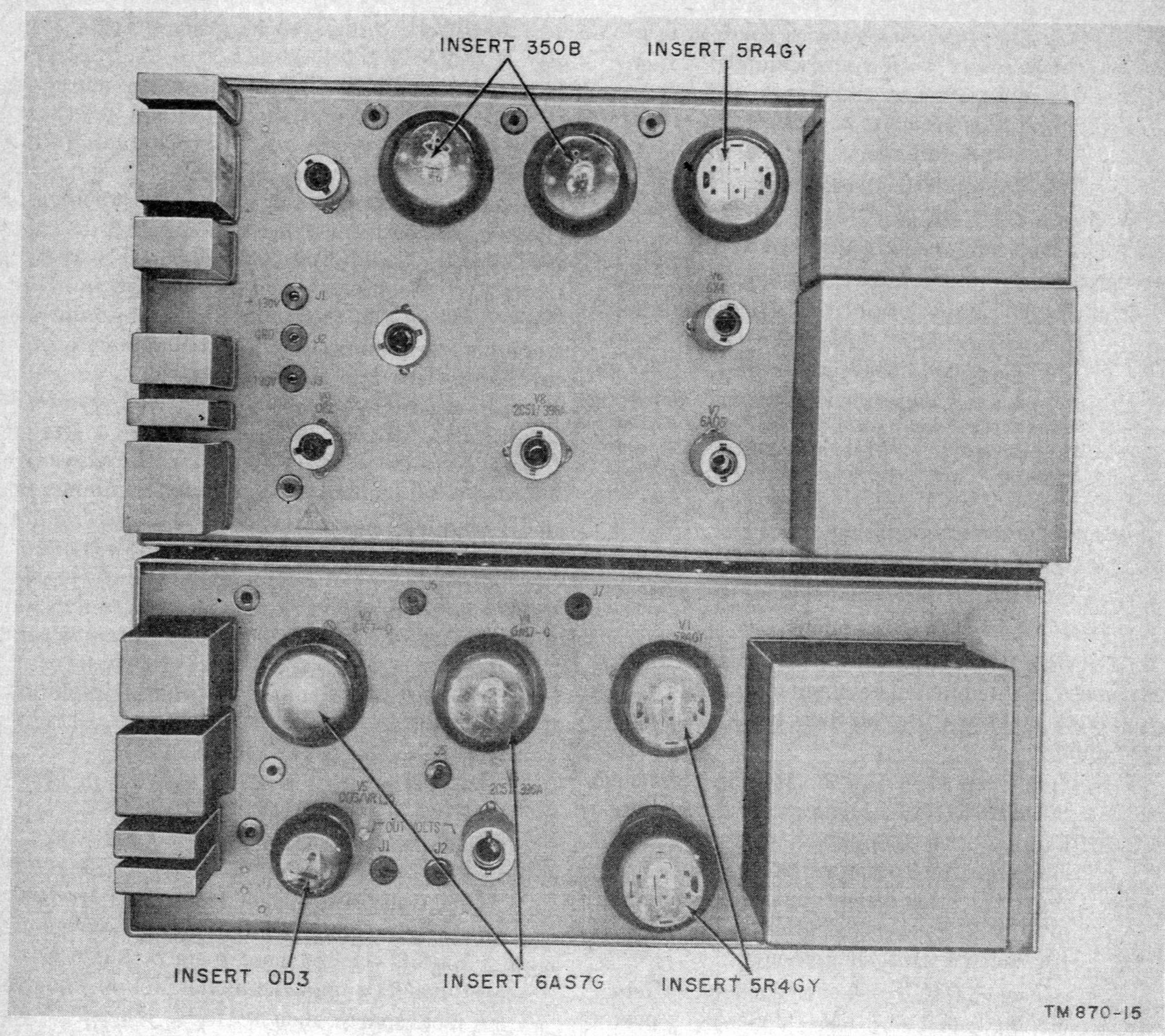

Figure 17. Installation of tubes shipped separately.

on the top of the antenna coupling transformer. Mount choke coils L3 and L4 properly (fig. 18). Also refer to WECo Instruction Bulletin 1093.

(4) Flare the shield of the coaxial cable (used to carry the signals to the receiver through the miscellaneous relay rack bay) to fit the No. 701 compression union.

(5) Connect the inside conductor of the coaxial cable to terminal 2 in the antenna coupling transformer with a short length of No. 22 wire (fig. 18 and WECo drawing T-626698).

(6) Secure the front face plate of the antenna coupling transformer. Tighten the wing nuts uniformly to insure a weathertight seal.

Note. It is important that the shield of the coaxial line be grounded to the case of the antenna coupling unit and at the antenna pole. Make sure there is positive contact. If aerial coaxial line is used or if the outer shield of a buried coaxial line is insulated, the shield should be connected electrically to the lightning arrestor ground at the base of the pole.

Caution: Do not change the setting of C1 in the antenna coupling transformer. It is factory-adjusted and cannot be reset in the field with the tools and information furnished.

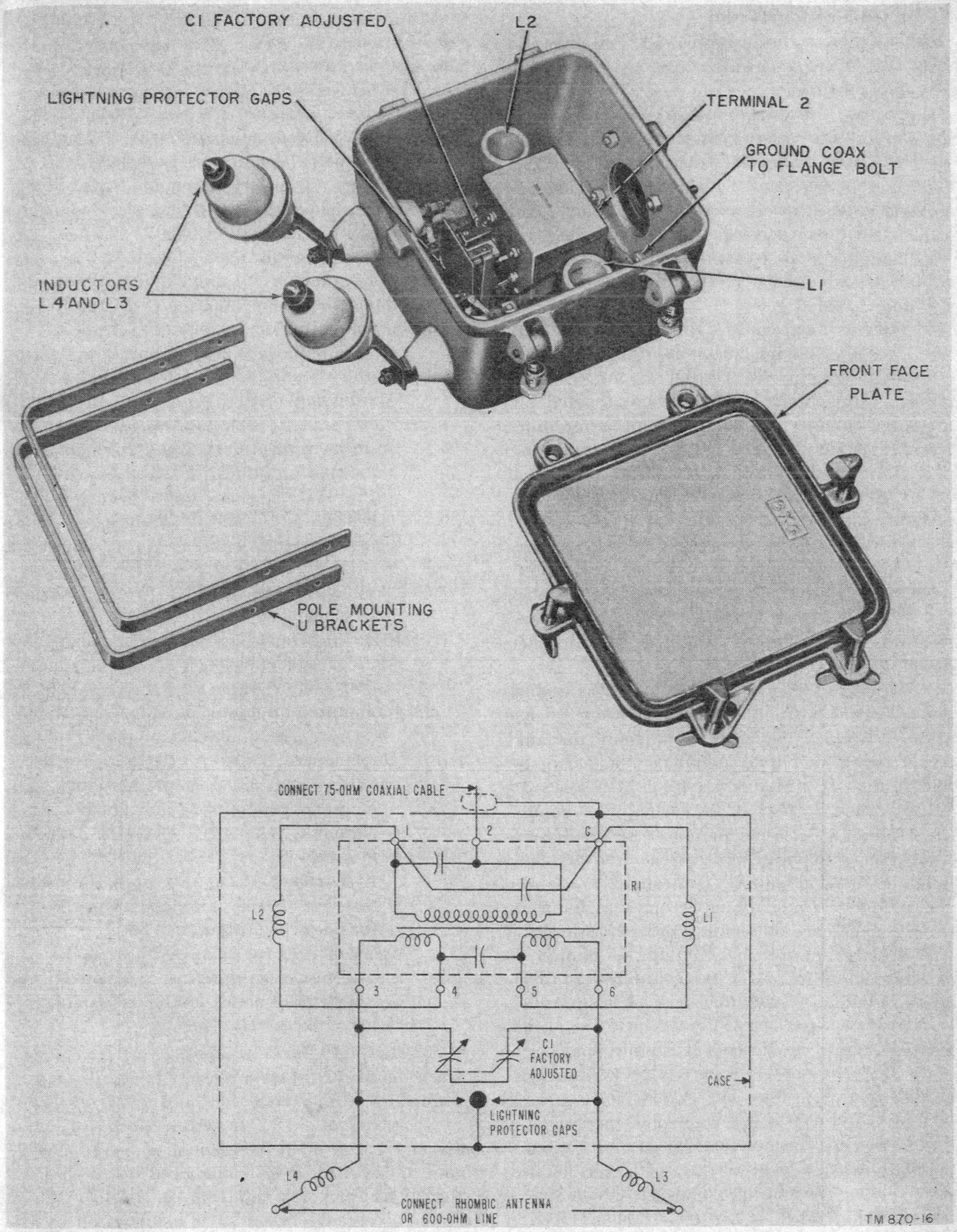

Figure 18. Antenna coupling transformer.

19. Electrical Connections

For references, use figures 55 and 94 and applicable WECo drawings (fig. 4) specified in *a* through *k* below.

a. General. Various rf, audio, and power connections to the receiver and miscellaneous relay rack bay must be made in accordance with the following instructions. Unfasten the removable section in the lower portion of the side panel adjacent to the miscellaneous relay rack bay. This opening is used as the point of entry for all cables that enter the receiver, unless conduit in the floor is used.

b. Ground Connections. Radio Receiver R–369/FRC–10 and miscellaneous relay rack bay are connected together electrically to an external ground. The external ground is constructed by driving a number of metal rods into the ground. These rods should be at least 3 feet long. Connect the ground rods together with No. 6 copper wire. Connect a No. 6 copper wire to the brass terminal lug TP2 on the receiver (fig. 13). Run this wire through the removed panel or a conduit to the miscellaneous relay rack bay, and bolt it securely to the blank panel mounted on the bay. Run another length of No. 6 copper wire from the blank panel to the No. 6 wire on the external ground rods.

c. Main AC Power Lines. Mount the main power cutoff switch on a nearby wall. Run armored duplex No. 14 cable from the main power cutoff switch to terminals 1 and 2 of terminal strip TS1 in junction box J3 (fig. 13 and WECo drawing T–45034–80). This line supplies the 115-volt, 50- to 60-cps power to the receiver. Then run a separately fused ac line from the building lighting supply to terminals 3 and 4 of the junction box. This second run is for the three convenience outlets and heater lamp socket.

d. Antenna Connections. Run the 75-ohm coaxial cable (WECo 724 type) connected to the antenna coupling transformer (par. 18*h*) to the type 465–A coaxial jacks mounted in upper positions 3 and 4 on the jack mounting panel on the miscellaneous relay rack bay (WECo drawing T–626698 and fig. 55). The ANTENNA jacks in positions 3 and 4 are connected in parallel at the factory. In the receiver cabinet, unfasten the removable section at the top of the left side panel. Connect the open end of the 4-foot long coaxial cable (WECo 724 type) to the REC 1 jack (fig. 55). Run the cable through the upper removed section in the side panel of the receiver to the grommet near ANTENNA jack J201 in the hf panel (fig. 74). After the cable is run through the grommet, connect it to jack J201.

e. Vf Connections. The vf group A lines are connected to terminals 17 and 18 on terminal strip TS803 (output connections, fig. 13) mounted on relay panel 8, located in the rear of the receiver. Figure 19 shows terminal strips TS803 and TS804. The vf group B lines are connected to terminals 21 and 22 on TS803. The external monitoring connections for vf group A are connected to terminals 19 and 20, if needed. The external monitor connections for vf group B are connected to terminals 23 and 24, if needed.

(1) Run a pair of lines from terminals 17 and 18 through the lower opening in the side panel of the receiver, and solder these lines to the 410A jacks mounted in lower positions 19 and 20 on the jack mounting plate in the miscellaneous bay (fig. 55). These jacks are labeled GROUP A REC. Connecting cables from the 410A jacks in upper positions 21 and 22, GROUP A LINE, to Carrier Terminal OA–64/FRC–10 are described in *k* below.

(2) Run a pair of lines from terminals 21 and 22 on TS803 through the lower opening, and solder them to the 410A jacks mounted in lower positions 23 and 24 on the jack mounting panel. These jacks are labeled GROUP B REC. Connecting cables from the 410A jacks in upper positions 25 and 26 to Carrier Terminal OA–64/FRC–10 are described in *k* below.

Warning: Do not plug the 1002C headset or 100–F loudspeaker set into these jacks (positions 19–26); it will break the transmission path to the carrier terminal equipment. Instead, use the monitor jacks or the external monitoring terminal connectors.

f. External Alarm Connections. If desired, alarm leads for external buzzers or lamps may be connected to terminals 25, 26, and 27 on TS804 of relay panel 8. The return path for these alarm circuits is made through a connection to ground. Terminal 25 is energized by the circuits that light the red AFC lamp on the front panel of the receiver. Terminal 26 is energized by the circuits that light the green VF lamp on the front panel of the receiver. Terminal 27 is energized

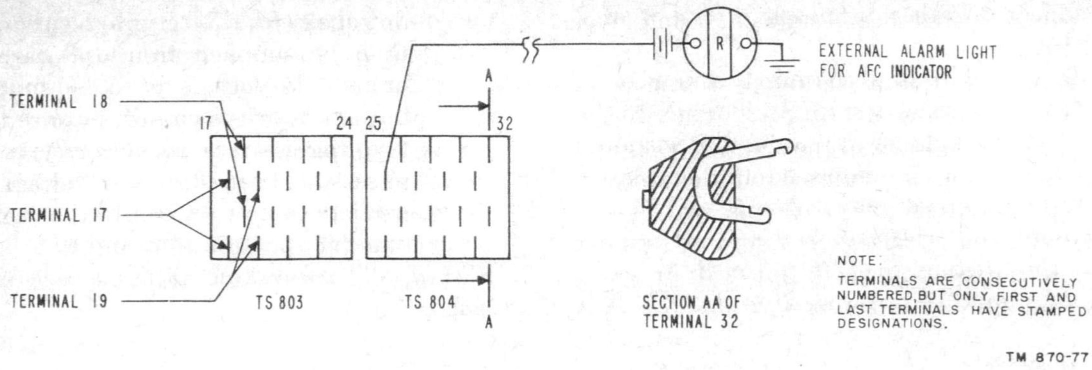

Figure 19. Typical terminal strip arrangement on relay panel.

by the circuits that light the red CARRIER OFF SLOW lamp on the front panel of the receiver. External alarm signal currents should be less than ¼ ampere at 6- to 8 volts for each contact. Figure 19 shows a typical circuit connected to terminal 25. If terminals 25, 26, and 27 are connected together and then connected to a single external alarm signaling device, a single indication will be obtained if any one of the three signaling circuits have a condition other than *normal.* Figure 53 is a schematic diagram of the carrier off alarm circuit.

g. Loop Connection. The 20-foot (approximately) section of WECo type 724 coaxial cable is equipped with 464B jacks at each end. Mount these jacks in upper (LOOP) positions 9 and 10 on the jack mounting panel (fig. 55). The LOOP connection is used whenever two receivers are connected to a common antenna and are operating at frequencies that cause the line and tuned input circuit of one receiver to act like a shorting stub for the tuned circuit of the second. By patching one of the receivers through the proper extra length of coaxial line in the LOOP connection, this condition can be avoided.

h. Space Diversity Connection. Terminal 29 on relay panel 8 terminal strip TS804 is connected to a similar terminal 29 on another R–369/FRC–10. The gain of both receivers then will be controlled by the avc voltage of the receiver which is detecting the stronger radio signal. Signal-to-noise ratio and circuit reliability (for voice signals) are both improved by such operation. This avc voltage is also connected to terminal 28, through an isolating 2.2-megohm resistor, where a vtvm may be connected as a carrier monitor, if desired.

i. Electrical Connections for Simplex and Phantom Operation. Electrical connections for both simplex and phantom operation (fig. 55) are made between the phantom and simplex coil mounting and the jack mounting panels located on the miscellaneous relay rack bay (fig. 15). Follow the wiring procedure described below when using vf lines with impedances of 300 to 1,600 ohms. For lines of other impedance, refer to WECo drawing B403517–1 and T–623959, furnished with the equipment. Refer to *j* below for the recommended wire color coding to be used.

(1) Run a pair of shielded leads from the GROUP A LINE COIL jacks, mounted in upper positions 19 and 20 on the jack mounting strip, to terminals 2 and 5 on simplex coil S1A. Connect together terminals 1 and 6 of this coil.

(2) Run a pair of shielded leads from the GROUP B LINE COIL jacks, mounted in upper positions 23 and 24 to terminals 2 and 5 on simplex coil S2A. Connect together terminals 1 and 6 of this coil.

(3) Run a pair of shielded leads from terminals 4 and 7 on coil S1A to the GROUP A EQUIP jacks mounted in lower positions 21 and 22.

(4) Run a pair of shielded leads from terminals 4 and 7 on coil S2A to the GROUP B EQUIP jacks mounted in lower positions 25 and 26.

(5) Run a lead from terminals 3 and 8, connected together, on S1A to terminal 4 on phantom coil PHA.

(6) Run a lead from terminals 3 and 8, connected together, on S2A to terminal 7 on PHA.

(7) Terminals 2 and 5 on PHA are the input terminals to the phantom circuit that uses the lines to the carrier terminal equipment.

(8) Connect together terminals 1 and 6 of PHA.

(9) Run a lead from terminals 3 and 8 on PHA to terminal 1 on SX. The SX coil is the noise killer of the simplex telegraph circuit and is mounted on the simplex and phantom coil panel (fig. 15).

(10) Mount the telegraph key and sounder on the writing shelf (fig. 15) in series from ground to terminal 2 on SX. The dc voltage for this telegraph circuit should then be supplied from the carrier terminal. If voltage is to be supplied at both ends of the circuit, be sure that the two voltages are poled correctly to add in series. If used, the dc voltage is connected in series with the telegraph sounder and ground connection.

j. Wiring. The following tables are used for all wiring.

(1) *Wire color.*

From	To	Color wire
Jack mounting plate, positions 25 and 26 lower, GROUP B EQUIP.	Repeat coil mounting plate, coil S2A, terminals 4 and 7.	S1 & S1-R.
Jack mounting plate, positions 21 and 22 lower, GROUP A EQUIP.	Repeat coil mounting plate, coil S1A, terminals 4 and 7.	S1 & S1-R.
Repeat coil mounting plate, coil S2A, terminals 2 and 5.	Jack mounting plate, positions 23 and 24 upper, GROUP B LINE COIL.	R & R-G.
Repeat coil mounting plate, coil S1A, terminals 2 and 5.	Jack mounting plate, positions 19 and 20 upper, GROUP A LINE COIL.	R & R-G.
Jack mounting plate, positions 19 and 20 lower, GROUP A REC.	Panel 8 terminal strip TS803, terminals 17 and 18.	Bk & Bk-R.
Jack mounting plate, positions 23 and 24 lower, GROUP B REC.	Panel 8 terminal strip TS803, terminals 21 and 22.	Bk & Bk-R.
Repeat coil mounting plate, coil S2A, terminal 8 or 3.	Repeat coil mounting plate, coil PHA, terminal 7	G.
Repeat coil mounting plate, coil S1A, terminal 8 or 3.	Repeat coil mounting plate, coil PHA, terminal 4	Bk.
Repeat coil mounting plate, coil PHA, terminal 8 or 3.	Repeat coil mounting plate, coil SX, terminal 1	Br-R.
Repeat coil mounting plate, coil PHA, terminals 5 and 2.	Phantom circuit	Y & Y-G.
Repeat coil mounting plate, coil SX, terminal 2	Telegraph key	Bk.
Telegraph key frame	Telegraph sounder	Bk.
Telegraph sounder	Ground or to local battery (properly polarized)	Bk.
On coils S1A, S2A and PHA and also strap terminals.	Strap terminals 3 to 8	Bk.

(2) *Wire size.*

Item	From	To
No. 6 wire	TP2 of ground plate	Blank panel of miscellaneous relay rack (*b* above).
No. 6 wire	Blank panel of miscellaneous relay rack	External ground (*b* above).
Armored cable two-wire	Main power cutoff switch	Terminals 1 and 2; TS1 in J3 (*c* above).
Armored cable two-wire	Building lighting supply	Terminals 3 and 4; TS1 in J3 (*c* above).
Coaxial cable (75 ohms)	Terminals 2 and GND of antenna coupling transformer.	Coaxial jacks in position 3 or 4 (upper) of hf (*d* above).
Coaxial cable (75 ohms)	REC 1 jack (upper) of miscellaneous relay rack bay.	J201 in hf panel 2 (*d* above).

Note 1. Connect external alarms if station layout requires (*f* above).
Note 2. Make loop and space diversity connections if station layout requires (*g* and *h* above).

k. Lines Suitable for Interconnection of Receiver and Carrier Terminal. The two pairs of receiver output lines may be required to carry audio frequencies as high as 6,000 cps. These lines should be capable of being equalized by equipment at the carrier terminal for frequencies up to 5,000 cps. The following are examples of acceptable lines:

(1) Up to 200 miles of 128-mil copper nonloaded open wire.

(2) Up to 20 miles of loaded cable (19 gage B & S, H44 type of loading).

(3) Up to 12 miles of 19 gage nonloaded cable.

Note. For a more complete discussion of lines and their equalization, refer to WECo Instruction Bulletin No. 1120, J68312B Line Amplifier and X–75153D Equalizer Amplifier. This equipment is part of the distortion measuring equipment which is part of the radio transmitter installation.

Section II. CONTROLS AND INDICATORS

20. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason, it is important to know the function of every control. The actual operation of this equipment is discussed in the following sections.

21. Radio Receiver R–369/FRC–10 Knob Controls

(fig. 20)

The following tables list the controls and indicators of the receiver and indicate their functions and normal settings. Figure 71 shows the screwdriver adjusted controls and the metering switch labels.

Note. First column lists one set of normal operating settings or conditions. Others may be required depending on local operating conditions.

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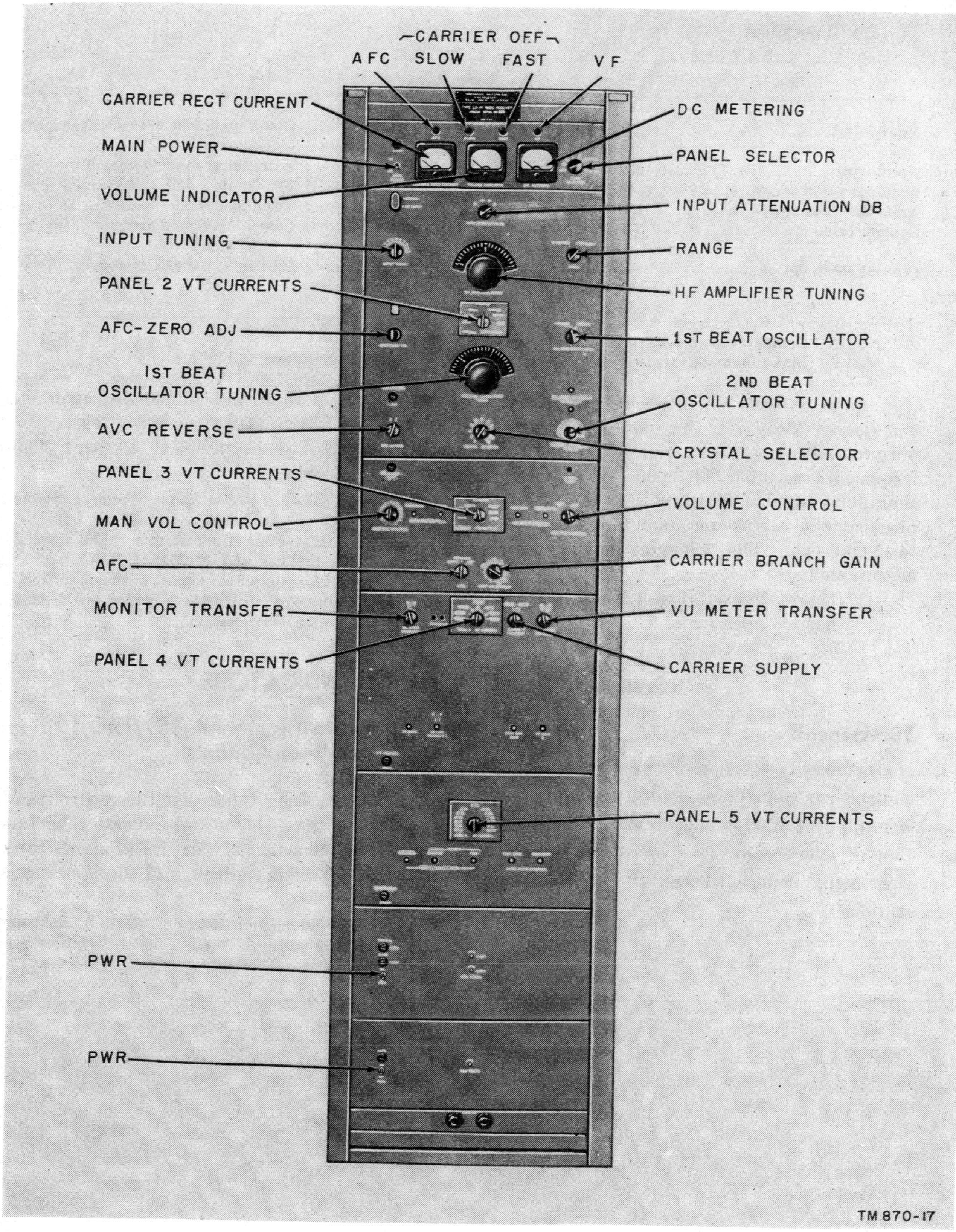

Figure 20. Radio Receiver R–369/FRC–10, front panel knob controls.

a. Panel 1

Normal setting or condition	Control or indicator	Function
Off	AFC red lamp (LP101)	Illumination indicates that AFC tuning capacitor is near either end of its range. Alarm buzzer B101 operates simultaneously with lamp.
Off	CARRIER OFF SLOW red lamp (LP102).	When AFC switch on panel 3 is in SQUELCH position, illumination indicates loss in carrier (caused by fading, mistuning of receiver, low signal-to-noise ratio, etc.) lasting more than 2 seconds. Lamp is always illuminated when AFC switch (D303) is in OFF position. Lamp never lights when AFC switch is in ON position.
Off	CARRIER OFF FAST amber lamp (LP103).	When AFC switch on panel 3 is in SQUELCH position, illumination indicates loss of carrier. For loss of carrier not exceeding 2 seconds, this lamp only will be illuminated. For longer loss of carrier, both LP102 and LP103 will be illuminated. Refer to AFC switch function above.
On	VF green lamp (LP104)	When extinguished, indicates loss of filament, screen, or plate potentials of carrier amplifier V405 or opening of fuse F401.
	8 FN fusetron (FN101)	Protects ac circuit 1 consisting of all power loads except three utility outlets and heater lamp on ac circuit 2.
ON	MAIN POWER switch (D102).	In ON position, it connects ac circuit 1 of receiver to ac power line.
Depends on received signal and circuit and control adjustments.	CARRIER RECT CURRENT meter (M101).	Measures portion of rectified current produced in avc rectifier, V307A, indicating relative strength of received pilot carrier frequency. Reading is under control of manual volume control when VOLUME CONTROL is in MAN position, and shows relative carrier strength after avc action when in AUTO position.
Depends on received signal and circuit and control adjustments.	VOLUME INDICATOR meter (M102).	Indicates vf output level of group A or B signals in vu. VU METER TRANSFER switch (D405) on panel 4 transfers meter to selected group. Meter has 8-db pad, which is 8 vu lower than actual output. For example, reading of zero is actually +8 vu.
See function	DC METERING meter (M103).	Reads direct currents or dc potentials of selected points in receiver. Operates with PANEL SELECTOR switch (D103) and individual panel switches (that is, PANEL 2 VT CURRENTS switch D205, PANEL 3 VT CURRENTS switch D302, PANEL 4 VT CURRENTS switch D402, and PANEL 5 VT CURRENTS switch D502).
6(+130V)	PANEL SELECTOR switch (D103)	Eight positions which function as follows: *Position* — *Function* OFF — Disconnects DC METERING meter from circuit. 2 — Connects PANEL 2 VT CURRENTS switch to DC METERING meter. 3 — Connects PANEL 3 VT CURRENTS switch to DC METERING meter. 4 — Connects PANEL 4 VT CURRENTS switch to DC METERING meter. 5 — Connects PANEL 5 VT CURRENTS switch to DC METERING meter. 6(−130V) — Connects −130-volt output of power supply (panel 6) to DC METERING meter. 6(+130V) — Connects +130-volt output of power supply (panel 6) to DC METERING meter. 7(+250V) — Connects +250-volt output of power supply on panel 7 to DC METERING meter. Meter now reads full scale for 400 volts Adjust supply for meter reading of 125.

b. Panel 2

Normal setting or condition	Control or indicator	Function
With 341C plug inserted in ANTENNA coaxial jack (J201).		Termination for antenna connection from miscellaneous relay rack jack REC 1.
With 341C plug inserted in REC INPUT coaxial jack (J202).		Connection to INPUT ATTENUATION DB switch D202. Connecting J201 to J202 with 341C plug (PG201) connects antenna to receiver.
0	INPUT ATTENUATION DB switch (D202).	Positions 30, 20, 10, and 0. Used to connect different attenuator pads into rf signal path, thus reducing cross-modulation on strong signals. Adjusted so that peak reading of CARRIER RECT CURRENT meter does not exceed 70.
See function	INPUT TUNING capacitor (C202).	Dial scale reads 0 to 10. Variable capacitor used as trimmer in grid circuit of hf amplifier. Adjusted for maximum reading on CARRIER RECT CURRENT meter with avc off.
See figure 23	HF AMPLIFIER TUNING capacitors (C201 and C211).	Dial marked with 500 divisions. Variable capacitor in tuned-grid circuit of hf amplifier V201; ganged with variable capacitor (C211) in tuned-plate circuit of this amplifier. Adjusts circuit to frequency of incoming signal. Resonance indicated by maximum deflection, to right, on CARRIER RECT CURRENT meter when avc is off.
As required	RANGE switch (D203)	Two positions. In 4-10.3 MC position, selects low band. In 10.3–28 MC position, selects high band.
0	AFC-ZERO ADJ capacitor (C901 part of MO 201 control unit).	When AFC switch on panel 3 is in SQUELCH or ON position, this variable capacitor is driven by afc circuits to control frequency of first or second beat oscillator (depending on setting of 1ST BEAT OSCILLATOR switch D209). Depressing knob engages manually operated friction clutch, thus enabling resetting of calibrated scale of unit to 0, or permits fine tuning of receiver to point where afc motor can take control when knob is released. Dial is illuminated with two lamps, LP901 and LP902.
HF AMP V201 20MA	PANEL 2 VT CURRENTS switch (D205).	Seven positions (fig. 71). Permits metering direct currents at selected points in this panel. Determines operating condition of selected stage.
CRYSTAL	1ST BEAT OSCILLATOR switch (D209).	In VARIABLE position, first beat oscillator is variable inductance-capacitance type oscillator using tube V207. Afc circuits control frequency of stage. In CRYSTAL position, first beat oscillator is crystal-controlled and operates on any one of 10 frequencies. Tube V206 is used as oscillator and tube V207 is reconnected to act as limiter and cathode follower for output of crystal oscillator. Also, afc circuits are switched to control frequency of second beat oscillator.
	VT HEATERS (1 AMP fuse (F201).	Protects primary of filament transformer supplying power to filaments of tubes in hf panel 2.
See figure 23	1ST BEAT OSCILLATOR TUNING capacitor (C250).	Variable capacitor in tuned circuit of variable first beat oscillator (V207). Dial is marked with 500 divisions. Controls resonant frequency of stage. Resonance indicated by maximum deflection of CARRIER RECT CURRENT meter right when avc is off. Because of sharp selectivity of circuits coupling signal to CARRIER RECT CURRENT meter, first visual indication of resonance probably will be deflection, to right, on VOLUME INDICATOR meter. When 1ST BEAT OSCILLATOR switch is in CRYSTAL position, V207 no longer acts as oscillator, and varying capacitor peaks output of crystal stage.

Normal setting or condition	Control or indicator	Function
See function	2ND HEAT OSCILLATOR ZERO ADJ capacitor (C260) and switch (D208).	Variable capacitor (C260) in tuned-grid circuit of second beat oscillator and push-button switch (D208) are used simultaneously during initial installation of receiver. Occasional rechecking may be needed. Depressing switch completes signal path so that harmonics (including 28th) of 100 kc go to 2.8-mc if. amplifier. Variable capacitor is screwdriver adjusted so that resonant frequency of second beat oscillator is exactly 100 kc away (lower in frequency) from 2.8 mc. This result is indicated by maximum reading on CARRIER RECT CURRENT meter. Paragraph 30 gives correct procedure when making this adjustment.
See function	AFC REVERSE switch (D206).	Permits reversing direction of rotation of afc motor, depending on whether frequency of first beat oscillator is above or below incoming signal. Set to position 1 for frequencies below 10 mc, and to position 2 for frequencies above 10 mc, when 1ST BEAT OSCILLATOR switch is in VARIABLE position. Always in position 2 when 1ST BEAT OSCILLATOR switch is in CRYSTAL position.
As required	CRYSTAL SELECTOR switch (D207).	In 0 position, it disables first beat oscillator (crystal) V206. In positions 1 through 10, it selects different quartz crystals that control resonant frequency of first beat oscillator (crystal).
As required	2ND BEAT OSCILLATOR TUNING capacitor (C261).	−5 to 0 to +5 scale. Variable capacitor in tuned-grid circuit of second beat oscillator. Control is used for tuning of second beat oscillator. Correct resonant frequency indicated by maximum deflection, to right, of CARRIER RECT CURRENT meter, when tuned to carrier of incoming signal (when avc is off). Slow adjustment of this control (when AFC on panel 3 is in SQUELCH or ON position) will cause AFC-ZERO ADJ dial to rotate under control of afc circuit.

c. Panel 3.

Normal setting or condition	Control or indicator	Function
	VT HEATERS 1 AMP fuse (F301).	Protects primary of filament transformer supplying power to tubes in if. panel 3.
Not used	IF AMP INPUT jack (J301).	Coaxial jack permits injection of 100 ±6 kc signal to 100 kc if. amplifiers for test purposes.
As required	MAN VOL CONTROL potentiometer (P305).	0 to 10 scale. Operates only when VOLUME CONTROL switch D304 is in MAN position. Varies gain of receiver.
Adjusted per paragraph 36	AUTO VOL CONTROL MAX GAIN potentiometer (P304).	Screwdriver adjusted. Adjusts gain of avc dc amplifier so that with no carrier input noise level output is 6 db below normal speech output.
Adjusted per paragraph 36	AUTO VOL CONTROL DELAY potentiometer (P302).	Screwdriver adjusted. Adjusts bias on avc dc amplifier so that with normal carrier plate current of avc dc amplifier produces correct amount of bias voltage for stages controlled by avc circuit.
IF AMP 1 V301 20 MA	PANEL 3 VT CURRENTS switch (D302).	Eight positions (fig. 79). Permits metering direct currents at selected points in this panel.
Adjusted per paragraph 36	SQUELCH CONTROL CAR GAIN potentiometer (P303).	Screwdriver adjusted. Adjusts afc squelch circuit to operate when carrier to noise relationship drops to a predetermined value.
Adjusted per paragraph 36	SQUELCH CONTROL NOISE GAIN potentiometer (P306).	Screwdriver adjusted. Adjusts noise level applied to squelch if. noise detector.

Normal setting or condition	Control or indicator	Function
AUTO	VOLUME CONTROL switch (D304).	In AUTO position, avc circuits are connected to control gain of receiver. In MAN position, gain of receiver is controlled by MAN VOL CONTROL potentiometer, P305.
	AFC switch (D303)	Three-position tap switch that determines type of operation of afc circuits. *Position* — *Function* OFF — Afc circuit disabled. CARRIER OFF SLOW and CARRIER OFF FAST lamps always illuminated. SQUELCH — Afc squelch circuit operative. When noise exceeds carrier, afc circuits are disabled to prevent possible detuning of receiver, causing CARRIER OFF lamps to illuminate. ON — Afc circuits always operative regardless of signal-to-noise conditions. CARRIER OFF lamps never illuminated even with loss of carrier.
Approximately 9.1 (fig. 83)	CARRIER BRANCH GAIN potentiometer (P301).	Used to adjust voltage applied to carrier amplifier (V305) to compensate for degree of carrier suppression in use at transmitter. Indirectly has secondary control of receiver gain. *Note.* Increasing setting of CARRIER BRANCH GAIN control applies larger signal (carrier) to avc circuits and produces higher reading on CARRIER RECT CURRENT meter. Increased signal to avc circuits also produces decrease in receiver gain as indicated by lower reading on VOLUME INDICATOR meter. ***Caution:*** Control should not be used to change receiver gain during operation. It should always be set to correspond with degree of suppression used at transmitter (par. 31 and 39). If greater line output is required than that originally adjusted for (using sideband voltage hybrid reading of 30), it should be obtained by adjusting VF GAIN A or VF GAIN B.

d. Panel 4.

Normal setting or condition	Control or indicator	Function
B	MONITOR TRANSFER switch (D406).	In position A, it connects output of group A vf signals to MONITOR jacks on receiver. In position B, it connects group B vf signals to MONITOR jacks.
	MONITOR jacks (J401 and J402).	Permit plugging in pair of headphones across outputs of either group A amplifier 2 or group B amplifier 2, depending on setting of MONITOR TRANSFER switch. Loudspeaker D–124852 (Special 100–F) may also be used here.
GROUP B AMP 1 V401B 2 MA.	PANEL 4 VT CURRENTS switch (D402).	Seven positions (fig. 71). Permits metering direct currents currents or dc potentials of selected points in this panel. *Caution:* Do not leave on S B VOLT HYB V401A 20V.
LOCAL	CARRIER SUPPLY switch (D403).	In LOCAL position, it selects output of 100-kc oscillator as conversion signal supplied to third demodulators. In RECON position, selects 100-kc reconditioned carrier as conversion signal supplied to third demodulators.
B	VU METER TRANSFER switch (D405).	In A position, it connects output of group A amplifier 2 to VOLUME INDICATOR meter. In B position, it connects output of group B amplifier 2 to VOLUME INDICATOR meter.

Normal setting or condition	Control or indicator	Function
Adjusted per paragraph 29	VF GAIN A potentiometer (P403).	Screwdriver adjusted. Adjusts output level of group A amplifiers.
N	VF LINE TRANSFER switch (D404).	Screwdriver adjusted. In N position, output of group A amplifiers connects to line 1 and output of group B amplifiers connects to line 2. In R position, lines are reversed and output of group A amplifiers connects to line 2, and output of group B amplifiers is connected to line 1.
Adjusted per paragraph 32	DEM CAR GAIN potentiometer (P402).	Screwdriver adjusted. Controls level of 100-kc conversion signal applied to third demodulators.
Adjusted per paragraph 29	VF GAIN B potentiometer (P401).	Screwdriver adjusted. Adjusts output level of group B amplifiers.

e. Panel 5.

Normal setting or condition	Control or indicator	Function
AFC RECT V507 40 MA	PANEL 5 VT CURRENTS switch (D502).	Thirteen positions (fig. 71). Permits metering direct currents at selected points in this panel.
Factory adjusted, do not change.	100 KC OSCILLATOR BALANCE potentiometer (P503).	Screwdriver adjusted. Readjustment normally required only when the 100-kc crystal is changed. Cover hole with snap-in blank.
Adjusted per paragraph 35	100 KC OSCILLATOR COARSE TUNING switch (D503).	Screwdriver adjusted, five position switch. Switches fixed capacitors into oscillator bridge circuit. Sets resonant frequency of oscillator to approximately 100 kc.
Adjusted per paragraph 35	100 KC OSCILLATOR FINE TUNING capacitor (C526).	Screwdriver adjusted. Variable capacitor in bridge circuit of 100-kc oscillator. Adjusts frequency of oscillator to center of bandpass of crystal filter YF301. Used with adjustment of D503.
Adjusted per paragraph 35	AUTO FREQ CONTROL CAR GAIN potentiometer (P502).	Screwdriver adjusted. Adjusts level of 100-kc carrier signal in afc circuits.
Adjusted per paragraph 35	AUTO FREQ CONTROL OSC GAIN potentiometer (P501).	Screwdriver adjusted. Adjusts level of 100-kc crystal oscillator signal in afc circuits.
	VT HEATERS 2 AMP fuse (F501).	Protects primary of transformer supplying filament power to tubes in this panel.

f. Panel 6.

Normal setting or condition	Control or indicator	Function
	+130V 3.2 FN fusetron (F1).	Protects primary of power transformer of +130- and −130-volt power supplies.
	−130V ½ AMP fuse (F2)	Protects secondary of −130-volt power supply transformer.
Set for +130V	ADJ VOLTS +130V potentiometer (P1).	Screwdriver adjustment. Adjusts output voltage of +130-volt power supply.
Set for −130V	ADJ VOLTS −130V potentiometer (P2).	Screwdriver adjusted. Adjusts output of −130-volt power supply.
ON	PWR switch (S1)	In ON position, it connects 115-volt ac circuit to primaries of ±130-volt power supply transformers.

g. Panel 7.

Normal setting or condition	Control or indicator	Function
	3.2 FN fusetron (f1)	Protects primary of +250-volt power supply transformer.
ON	PWR switch (S1)	In ON position, it connects 115-volt ac circuit to primary of +250-volt power supply.
Set for 250V	ADJ VOLTS potentiometer (P1).	Screwdriver adjusted. Adjusts output of +250-volt power supply.

22. Vacuum Tubes and Functions

The designation, type, and function of each tube in Radio Receiver R–369/FRC–10 are listed below:

a. Panel 2.

Designation	Tube type	Function
V201	6BA6	Hf amplifier.
V202	6AS6	First demodulator.
V203	6BA6	2.8-mc amplifier.
V204	6AS6	Balanced second demodulator.
V205	6AS6	Balanced second demodulator.
V206	5591/403B	First beat oscillator (crystal).
V207	2C51	First beat oscillator (variable).
V208	2C51	Second beat oscillator (2.7 mc).

b. Panel 3.

Designation	Tube type	Function
V301	6BA6	If. amplifier 1, 100 kc.
V302	6BA6	If. amplifier 2, 100 kc.
V303	6BA6	If. amplifier 3, 100 kc.
V304	6AQ5	If. amplifier 4, 100 kc.
V305	5591/403B	Carrier amplifier 1, 100 kc.
V306	5591/403B	Carrier amplifier 2, 100 kc.
V307A	½ 6AL5	Avc rectifier.
V307B	½ 6AL5	Squelch carrier rectifier.
V308A	½ 2C51	Avc dc amplifier.
V308B	½ 2C51	Squelch carrier dc amplifier.
V309A	½ 2C51	Squelch, low-frequency noise amplifier.
V309B	½ 2C51	Squelch, low-frequency noise detector.
V310	559/403B	Limiter 1.
V311	5591/403B	Limiter 2.

c. Panel 4.

Designation	Tube type	Function
V401A	½ 2C51	Sideband voltmeter at input to hybrid coil.
V401B	½ 2C51	Group B amplifier 1.
V402	6AQ5	Group B amplifier 2.
V403A	½ 2C51	Carrier voltmeter D3.
V403B	½ 2C51	Group A amplifier 1.
V404	6AG5	Group A amplifier 2.
V405	5591/403B	Carrier amplifier, 100 kc.

d. Panel 5.

Designation	Tube type	Function
V501	5591/403B	100-kc amplifier.
V502	5591/403B	Carrier amplifier, 100 kc.
V503	6AQ5	Afc amplifier.
V504	6AQ5	Afc amplifier.
V505	6AQ5	Afc amplifier.
V506	6AQ5	Afc amplifier.
V507	6X4	Afc rectifier.
V508	6X4	Afc rectifier.
V509	6X4	Afc rectifier.
V510	6X4	Afc rectifier.
V511	5591/403B	100-kc oscillator 1.
V512	5591/403B	100-kc oscillator 2.
V513	5591/403B	Carrier alarm slow.

e. Panel 6.

Designation	Tube type	Function
V1	5R4gy or 422A*.	+130-volt rectifier.
V2	350B	+130-volt voltage control.
V3	350B	+130-volt voltage control.
V4	2C51	+130-volt control amplifier.
V5	0B2	+130-volt voltage regulator.
V6	6X4	−130-volt rectifier.
V7	6AQ5	−130-volt voltage control.
V8	2C51	−130-volt control amplifier.
V9	0B2	−130-volt voltage regulator.

* Tubes 6AS7G and 5R4GY must not be used in combination with tubes 421A and 422A. Refer to notes on figures 81 and 82.

f. Panel 7.

Designation	Tube type	Function
V1	5R4GY or 422A*.	+250-volt rectifier.
V2	5R4GY or 422A*.	+250-volt rectifier.
V3	6AS7 or 421A*.	+250-volt voltage control tube.
V4	6AS7 or 421A*.	+250-volt voltage control tube.
V5	0D3	+250-volt voltage regulator.
V6	2C51	+250-volt control amplifier.

*Tubes 6AS7G and 5R4GY must not be used in combination with 421A and 422A tubes. Refer to notes on figures 81 and 82.

Section III. PREOPERATION TEST PROCEDURES

23. General

Operation of Radio Receiver R-369/FRC-10 consists of tuning the receiver to a selected frequency, operating at that frequency, and changing to a new frequency, as required. To assure proper operation of the receiver, perform the tests described in paragraphs 24 through 38 carefully. Make all of these tests before placing the receiver in operation on a radiotelephone and/or radioteletype circuit. Some of these tests will require the adjustment of screwdriver controls. For rapid approximate resetting of these screwdriver adjustments, mark one end of the screwdriver slot with white paint. When the test has been made, put a small pencil mark on the panel opposite the paint mark for future reference.

24. Sequence of Tests

The preoperational tests should be made in the order given below. Differences may exist between some receivers as noted in paragraph 13. Instructions are given in paragraph 25 for the elimination of the differences. In the following tests, unless otherwise specified, assume that the INPUT ATTENUATION DB control is set at 0.

Test No.	Test	Par. ref
1	Filament voltage check and output voltage adjustment of ±130- and +250-volt rectifiers.	26
2	Operational test of alarm system and safety switches.	27
3	Vacuum-tube currents tests	28
4	Frequency characteristic test of if. and vf circuits.	29
5	Second beat oscillator frequency adjustment	30
6	Calibration of CARRIER BRANCH GAIN potentiometer.	31
7	Gain test of local and reconditioned carrier signals.	32
8	Test and adjustment of avc circuits	33
9	Signal-to-noise ratio test	34
10	100-kc oscillator frequency adjustment and afc action.	35
11	Afc squelch circuit adjustment	36
12	Initial frequency line-up using first beat oscillator (crystal) V206.	37
13	New frequency line-up using first beat oscillator (variable) V207.	38

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25. Procedures to Remove Differences in Equipments

Differences in receivers by serial number are described in paragraph 13. A kit of components, if required, and instructions for application (modification work order) are normally supplied so that important differences can be removed. If these changes have not been made, the following gives the essential information.

a. Frequency Range Change from 4 to 23 Mc to 4 to 28 Mc. Inductances L201 and L204 on 4- to 23-mc range receivers are connected with heavy copper straps to C203 and C212, respectively. To effect the modification, clip this strap ¼ inch beyond its fastening on the coils; then clean the end of this strap and solder it 1⅞ turns down (toward the panel) from the end of the coil. Retrack the hf amplifier (par. 115) and prepare a new calibration curve. Figure 23 shows a typical curve.

b. Overload Protection Circuit (par. 74). Immediate protection should be given to any receiver without an overload protection circuit. The components listed below are mounted on apparatus mounting strip assembly TSE (fig. 75).

(1) Figures 75 and 91 show the location and wiring of the circuit. The required parts are—

(*a*) Capacitors C340 and C341, .01 microfarad (μf) $\pm$10 percent 300 volts.

(*b*) Resistors R398 and R399, 43,000 ohms $\pm$10 percent 1 watt.

(*c*) Resistors R396 and R397, 1,000 ohms $\pm$10 percent ½ watt.

(*d*) Varistors RV301 and RV302, WECo 400A varistor (germanium crystal diode rectifier).

(*e*) Mounting strip TSE for above The assembly with all above parts mounted is coded ED–45104–95G–1 APP MTG STRIP ASSBLY. by WECo.

(*f*) 1 foot, wire, 22 gage, single stranded KS–9819 (White)

(*g*) 1 foot, wire, 22 gage, single stranded KS–9819 (White-Red-Yellow).

(*h*) 1 foot, wire, 22 gage, single stranded KS–9819 (White-Red-Green).

(i) 100-ohm resistor, used only during the installation test for shunting meter M103, DC METERING.

(2) The theory of circuit operation is given in paragraph 74.

(3) Figure 75 shows the installation and figure 91 shows the wiring of the circuit in if. panel 3 (J–41602E unit) of Radio Receiver R–369/FRC–10. Do not solder the white wire permanently to transformer T304 until the test described in (4) below is made.

Caution: When soldering the white lead to terminal 6 of TSE, or when soldering the varistors to the terminals, hold the pigtail wire of the varistor at the varistor with a pair of flat-nosed pliers to avoid overheating the varistor.

(4) The following test should be made to determine if the overload protection circuit is functioning properly.

(*a*) Remove the mats from metering panel 1.

(*b*) Connect a 100-ohm resistor across the terminals of meter M103 (DC METERING). Replace the mat.

(*c*) Remove the mat from if. panel 3.

(*d*) Connect the 22DT signal generator to IF AMP INPUT jack.

(*e*) Set the signal generator to an output of approximately 100 kc and 100 uv (50-uv input to the receiver).

(*f*) Turn the VU METER TRANSFER switch on panel 4 to group B to prevent its going off scale and tune the signal generator in group A.

(*g*) Set PANEL SELECTOR switch to 4 and turn PANEL 4 VT CURRENTS switch to S B VOLT HYB V401A 20V. Temporarily close the safety switch in panel 3, using a taped screwdriver.

(*h*) As the MAN VOL CONTROL is turned clockwise, meter M103 should increase to 200 or above. Turn MAN VOL CONTROL fully counterclockwise.

(*i*) Open the safety switch in panel 3.

(*j*) Connect the wire from TSE terminal 6 to transformer T304 terminal 4. Temporarily close the safety switch in panel 3 again. As the MAN VOL CONTROL is turned clockwise, the maximum reading on M103 should be less than 100. Open the safety switch in panel 3.

(*k*) Remove the 100-ohm shunt from M103.

(*l*) Replace the mats on panels 1 and 3 (J-41602C and J-41602E units).

Note 1. The test makes use of the vtvm in the receiver by shunting the DC METERING meter with a 100-ohm resistor to make it read higher values. The removal of the metering panel 1 mat and the use of the shunting resistor can be avoided if the Measurements Corporation model 62 vtvm is used. Use of this meter at transformer T304 will permit the if. amplifier 4 tube (V304) to be removed during the test, thus protecting the crystal filters. If WECo 400A varistors or a substitute (such as type IN34) are not available, it is possible to mount a dual diode such as the 6AL5 (from spares) behind the mat in place of the varistors. This requires a source of 6.3-volts ac for the filament. The source can be transformer T307, supplying other tubes in the panel. The secondary supplying V307A and V308A is the most lightly loaded and should be used for this purpose.

Note 2. If the complete mounting strip assembly is not available and must be made up from component parts, the following instructions should be followed to establish the polarity of the crystal rectifiers. To test a diode rectifier for polarity, use a 1.5-volt (maximum) battery in series with a 0- to 1-milliampere meter and a 1,500-ohm resistor. Connect the minus side of the battery to one meter terminal and one end of the 1,500-ohm resistor to the other meter terminal. The crystal diode connected between the free end of the 1,500-ohm resistor and the plus terminal of the battery will conduct more when terminal 1 (the arrow head on a schematic diagram) is connected to the plus terminal of the battery than when terminal 2 (the straight line on a schematic diagram) is connected there. In figures 38 and 87, current flow is in the direction that the arrow points (electron flow is in the opposite direction).

c. First Beat Oscillator Capacitor Mounting. In some receivers, C250 is mounted on the side of the oscillator case. To convert to the present method of mounting (fig. 21), two support brackets are required. The brackets required are B 505911 and B 505912 and have been furnished by the manufacturer. Also required, are removal of the three pillars to the side of the case, and careful mechanical alignment to insure that there is no backlash when turning 1ST BEAT OSCILLATOR TUNING dial. This operation is described in BTL Trans. Development Letter 1475.

d. Miscellaneous Resistors. Resistor R287 is a 10,000-ohm, ½-watt resistor, mounted between terminal 6 of D205 and ground. It is wired as shown in figures 87 and 90. It prevents oscillator frequency shift when PANEL 2 VT CURRENTS switch is operated. Resistor R288 is a 1,000-ohm, ½-watt resistor, mounted on terminal strip TSJ in the second beat oscillator (figs. 21, 36, 87, and 95).

26. Filament Voltage Check and Output Voltage Adjustment of ±130- and +250-volt Rectifiers

a. Test the ac line and filament voltages throughout the receiver, following the procedure given in (1) through (12) below:

(1) Set the MAIN POWER switch to the ON position.

(2) Remove the mat of panel 2.

Warning: Line voltage is still on in this panel.

(3) With the volt-ohm-milliammeter, check the ac line voltage across terminals 2 and 4 of TS203 (fig. 74) in the upper left corner of panel 2. Figure 19 indicates the method of reading the terminals numbers. The line voltage reading should be 115 volts ±5 percent. It is desirable to work in the upper part of the voltage tolerance range.

(4) If the line voltage is outside the limits given in (3) above, as a temporary expedient, install variac V5 on the plate of the knockout box used for panel 5, and wire so that the MAIN POWER switch controls the primary of the variac. Adjust the variac to make the voltage reading 115 volts as measured in (3) above.

(5) With the volt-ohm-milliammeter, check the ac voltage across terminals 3 and 5 and across terminals 6 and 7 of transformer T202 (fig. 74), located in the lower left corner of panel 2. The voltages should be between 5.8 and 7.2 volts.

(6) Remove the mat of panel 3.

(7) With the volt-ohm-milliammeter, check the ac voltage across terminals 3 and 5 and across terminal 6 and 7 of transformer T307 (fig. 75), located in the upper left corner of panel 3. The voltages should be between 5.8 and 7.2 volts.

(8) Remove the mat of panel 4.

(9) With the volt-ohm-milliammeter, check the ac voltage across terminals 3 and 5

and across terminals 6 and 7 of transformer T401 (fig. 76), located in the lower left corner of panel 4. The voltages should be between 5.8 and 7.2 volts.

(10) Remove the mat of panel 5.

(11) With the volt-ohm-milliammeter, check the ac voltage across terminals 3 and 4 of transformer T501 (fig. 77), located in the lower left corner of panel 5. The voltage should be between 5.8 and 7.2 volts.

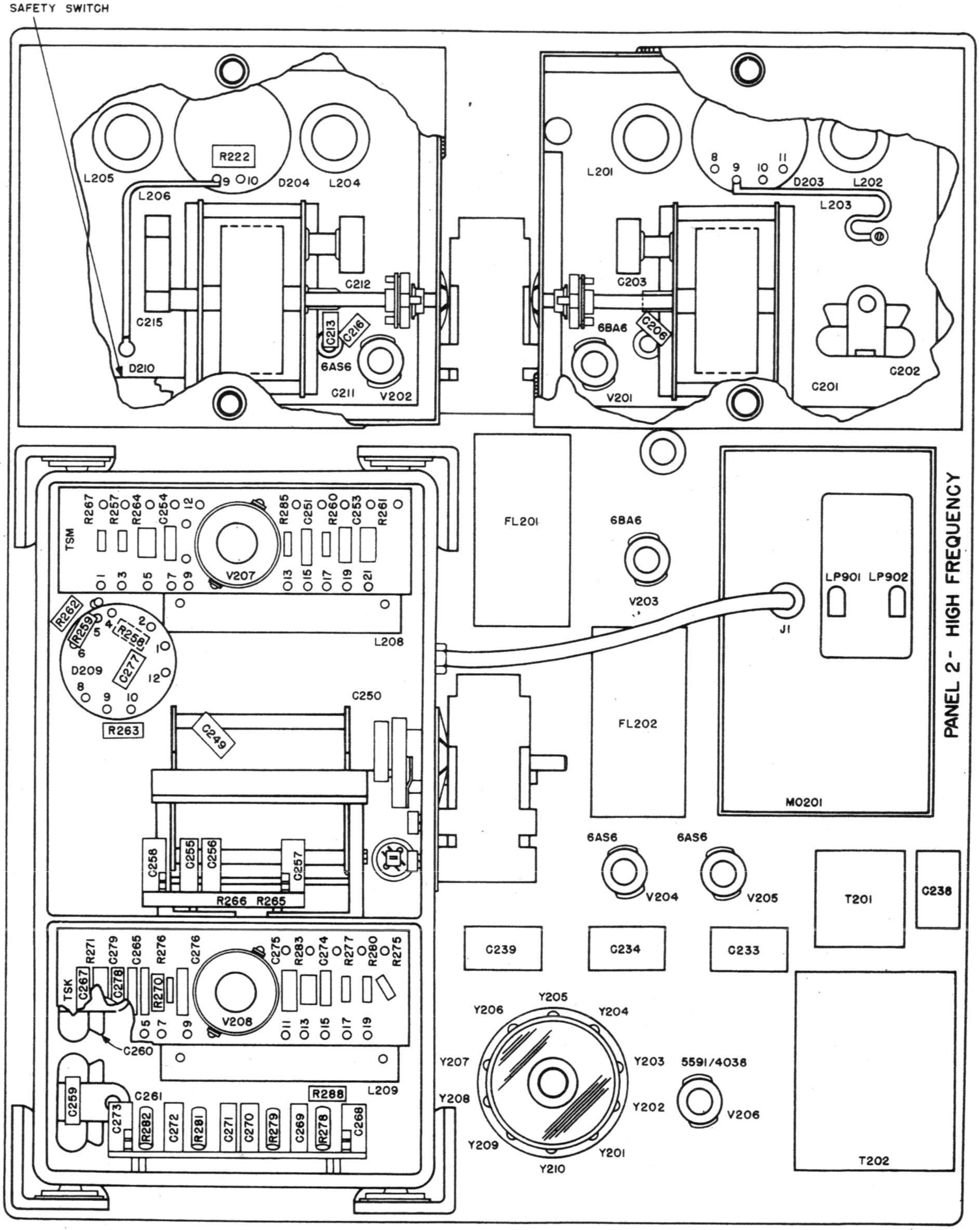

Figure 21. Hf amplifier, panel 2, rear view, component location. TM 870-18

(12) If any of these voltages are out of limits, troubleshooting is required (figs. 88 and par. 107).

b. Test the output voltages of the two regulated tube rectifiers, following the procedures in (1) through (8) below:

(1) Set the two PWR switches on panels 6 and 7 to the ON positions.

(2) Rotate the PANEL SELECTOR switch to the 7(+250V) position.

(3) Observe the DC METERING meter.

(4) Adjust the ADJ VOLTS potentiometer on panel 7 for a reading of 125 on the DC METERING meter. In this particular case, to obtain the value in volts multiply the scale reading by 2. Thus, 125 multiplied by 2 equals 250 volts.

(5) Rotate the PANEL SELECTOR switch to the 6(+130V) position.

Note. This panel operates only after the voltage of panel 7(+250V) is on.

(6) Adjust the +130V ADJ VOLTS potentiometer on panel 6 for a reading of 130 on the DC METERING meter. The multiplying factor of 2 is not required.

(7) Rotate the PANEL SELECTOR switch to the 6(−130V) position.

(8) Adjust the −130V ADJ VOLTS potentiometer for a reading of 130 on the DC METERING meter.

27. Operational Test of Alarm System and Safety Switches

a. The operational test checks the operation of the alarm system and safety switches. If the alarm system has been connected to an external alarm, a cutoff switch may have been installed locally in this extension so that, during maintenance or shutdown, the external alarm may be disconnected. In this test, the external alarm should be checked for correct operation.

b. Follow procedure described in (1) through (10) below:

(1) Remove the 341A coaxial plug from the ANTENNA and REC INPUT jacks.

(2) Rotate the CARRIER SUPPLY switch on panel 4 to the LOCAL position.

(3) Rotate the AFC switch on panel 3 to the SQUELCH position.

(4) Leave the PANEL SELECTOR switch at the 6(−130V) position.

(5) Set the MAIN POWER switch to OFF. Wait 60 seconds and then set the switch back to the ON position and observe the alarm lamps (green VF lamp, amber CARRIER OFF FAST lamp, and red CARRIER OFF SLOW lamp). All three lamps should go on.

(6) Open the rear door of the receiver.

(7) Remove tube V405. Green VF lamp should be extinguished. Reinsert V405 in the socket. Check to see that the lamp lights. Be sure to replace the tube and its shield. Close the rear door.

(8) Push in the AFC-ZERO ADJ knob panel 2. Depress the knob and slowly turn counterclockwise. The audible alarm buzzer and red AFC lamp should become operative as the black 4¾ index appears under the hairline. Depress the knob and turn clockwise. The alarm buzzer and lamp should be inoperative until the red 4¾ index appears under the hairline. The audible alarm buzzer and the red AFC lamp should be operative again.

(9) Restore scale to 0 and release knob.

(10) Set the PANEL SELECTOR switch to the 7(+250V) position. The DC METERING meter should read 125. Adjust, if necessary (par. 26*b*(4)).

28. Vacuum-Tube Currents Test

a. The test below indicates whether the plate, cathode, or grid currents of the principal vacuum tubes are within their normal operating ranges. The output voltages of two self-contained vacuum-tube voltmeters are measured with PANEL 4 VT CURRENT switch in the S B VOLT HYB V401A 20V and CAR VOLT D3 V403A 4V positions.

b. Follow procedures in (1) through (5) below:

(1) Remove the 341A coaxial plug from the ANTENNA and REC INPUT jacks.

(2) Turn the following knobs to these positions:

(*a*) VOLUME CONTROL to MAN.

(*b*) MAN VOL CONTROL to 10.

(*c*) AFC to ON.

(*d*) CARRIER SUPPLY to LOCAL.

Note. Maintain or return to these settings after each check unless otherwise specified in the table under *Special conditions* column ((5) below).

(3) Turn the PANEL SELECTOR switch to 6(−130V), 6(+130V), and 7(+250V),

in turn, and check rectifier output voltages on DC METERING meter. Refer to paragraph 26 for the correct procedure.

(4) Turn the PANEL SELECTOR switch to positions 2, 3, 4, and 5 depending on the panel being checked. Turn the metering knob on each panel to the positions indicated in the chart below to check the scale reading of the DC METERING meter. Readings should be within the ranges shown.

Note. For convenience, meter scale reading ranges are shown in the following table. An actual reading may be obtained by using as a reference the full-scale value in milliamperes or volts shown after the position designation on the individual PANEL VT CURRENTS switches.

(5) PANEL 4 VT CURRENTS switch should not be left in position S B VOLT HYB V401A 20V.

Position	Special conditions [a]	Scale reading range
PANEL 2 VT CURRENTS:		
HF AMP V201 20 MA	MAN VOL CONTROL on 10	120–180.
	MAN VOL CONTROL on 0	10–20.
DEMOND 1 V202 10 MA	MAN VOL CONTROL on 0	120–190.
2.8 MC AMP V203 20 MA	MAN VOL CONTROL on 10	120–180.
	MAN VOL CONTROL on 0	0–5.
DEMOD 2 V204–V205 20 MA	MAN VOL CONTROL on 10	120–190.
B01-XTAL V206 20 MA	CRYSTAL SELECTOR switch on 0	15–40.
	1ST BEAT OSCILLATOR switch on VARIABLE.	
B0 1-VAR V207 20 MA	1ST BEAT OSCILLATOR switch on VARIABLE.	70–110.
	1ST BEAT OSCILLATOR switch on CRYSTAL	30–60.
B0 2 V208 20 MA		10–40.
PANEL 3 VT CURRENTS:		
IF AMP 1 V301 20 MA	MAN VOL CONTROL on 10	120–130.
	MAN VOL CONTROL on 0	0–5.
IF AMP 2 V302 20 MA	MAN VOL CONTROL on 10	120–180.
	MAN VOL CONTROL on 0	0–5.
IF AMP 3 V303 20 MA	MAN VOL CONTROL on 10	120–180.
	MAN VOL CONTROL on 0	0–20.
IF AMP 4 V304 80 MA		70–110.
CAR AMP 1 V305 20 MA	MAN VOL CONTROL on 0	15–50.
CAR AMP 2 V306 20 MA	MAN VOL CONTROL on 0	70–115.
LIMITER 1 V310	MAN VOL CONTROL on 0	65–100.
LIMITER 2 V311	MAN VOL CONTROL on 0	65–100.
PANEL 4 VT CURRENTS:		
GROUP B AMP 1 V401B 2 MA	MAN VOL CONTROL on 0	70–110.
GROUP B AMP 2 V402 80 MA		80–120.
GROUP A AMP 1 V403B 2 MA		70–110.
GROUP A AMP 2 V404 80 MA		80–120.
CAR AMP V405 20 MA		60–110.
S B VOLT HYB V401A 20V	MAN VOL CONTROL on 0	0–10.
CAR VOLT D3 V403A 4V	DEM CAR GAIN control fully clockwise [b]	80 minimum.
	CARRIER SUPPLY switch on RECON	0–25.
	CARRIER BRANCH GAIN control on 0.	
GROUP B AMP 1 V401B 2 MA	*Note.* Leave PANEL 4 VT CURRENTS switch in this position.	70–110.
PANEL 5 VT CURRENTS:		
100 KC AMP V501 20 MA		80–120.
CAR AMP V502 20 MA		65–110.
	AFC switch on OFF	0.
AFC AMP 80 MA V503 through V506	AUTO FREQ CONTROL CAR GAIN and OSC GAIN controls fully counterclockwise.[b]	80–120.
100KC OSC 1 V511 20 MA		80–120.
100KC OSC 2 V512 20 MA		80–120.
CAR ALM SLOW V513 20 MA		75–130.
	AFC switch on OFF (after 15 seconds)	0.

[a] Refer to note in (2) above.
[b] Before rotating screwdriver control, note the position of the slotted shaft so that the control can be returned to its original position after the check is made.

(6) If the required reading cannot be obtained, change the tube. If replacement does not bring the reading within the required range, trouble shooting is required.

(7) Restore all controls to the normal operating positions. Insert the 341A coaxial plug in the ANTENNA and REC INPUT jacks.

29. Frequency Characteristic Test of If. and Vf Circuits

a. This test checks the overall frequency response of the 100-kc if. amplifier, channel filters, and vf group amplifiers. This test should be made with no rf input to the receiver. The 1,000-cps test should be made quarterly and the complete frequency test annually.

b. Follow the procedure given in (1) through (24) below:

(1) For testing GROUP B, set the controls to these positions:

(*a*) PANEL SELECTOR switch to 4.

(*b*) VOLUME CONTROL switch to MAN.

(*c*) AFC switch to OFF.

(*d*) MONITOR TRANSFER switch to B.

(*e*) PANEL 4 VT CURRENTS switch to CAR VOLT D3 V403A 4V.

(*f*) CARRIER SUPPLY switch to LOCAL.

(*g*) VU METER TRANSFER switch to B.

(*h*) Remove the 341C coaxial plug from the ANTENNA and REC INPUT jacks.

(2) Patch the 22DT signal generator through the modified 440A dummy antenna to IF AMP INPUT jack J301. Adjust its frequency to 99 kc and its output for 10,000 microvolts. This delivers a 5,000-uv input to jack J301 (the 100-kc if. amplifiers). Be sure the dummy antenna has been modified as described in paragraph 9*f*.

(3) Check the DC METERING meter for a scale reading of 80.

(4) If this value is not obtained, adjust the slotted shaft DEM CAR GAIN to assure an adequate 100-kc signal from the local oscillator for proper mixing with 99 kc to obtain a 1,000 cps audio output.

(5) Turn the PANEL 4 VT CURRENTS knob to S B VOLT HYB V401A 20V.

(6) Turn the MAN VOL CONTROL knob until the DC METERING meter scale reading is 30.

(7) Remove the plug from the IF AMP INPUT jack.

(8) Check to see that the VF LINE TRANSFER slotted shaft is turned to N; then connect the headset to the MONITOR jacks.

(9) Insert the 600-ohm plug (271D plug) in the GROUP A REC (output) jacks in the miscellaneous relay rack bay. This plug is used to terminate the channel with its characteristic impedance so the VU meter reads properly. Apply the output of the audio oscillator D–166636 (special 19–C (TS–379/U)) to the GROUP B REC output jacks. The oscillator is equipped with binding posts. If a two-wire cord with a suitable double plug (327A) for GROUP B REC jacks is not available to make this connection, use two test leads connected to terminals 21 and 22 of TS803 or relay panel 8. To assure that the wires to the telegraph terminal (connected to these terminals) are opened, insert a 327A plug in the GROUP B LINE COIL jacks. Such a plug is part of the Loudspeaker Set D–124852 (special 100–F); it may be used without turning on the loudspeaker set or disconnecting the 327A plug from it.

(10) Adjust the audio oscillator frequency to 1,000 cps and its output to give a reading of −3 vu on the VOLUME INDICATOR meter.

Note. In the following tests ((11) through (24)), the audio oscillator is used only to provide a reference frequency.

(11) Reinsert the signal generator plug into the IF AMP INPUT jack, and adjust its frequency to 99 kc, listening as the beat note resulting from the 1,000-cps tone in channel B and the audio oscillator tone becomes nearly zero. This is also indicated by a decreasing rate of pulsations of the VOLUME INDICATOR meter needle.

(12) Rotate the VF LINE TRANSFER switch to R. This places the audio oscillator input in channel A and the 600-ohm terminating plug in channel B.

(13) With a screwdriver, adjust the VF GAIN B slotted shaft for a VOLUME INDICATOR meter reading of −3 vu. Restore the VF LINE TRANSFER switch to N.

(14) Change the audio oscillator frequency to give the frequencies shown in the chart below. Change the signal generator frequency and check for approximately zero beat. In each case, throw the VF LINE TRANSFER switch to R to see that the meter reading is within the range given.

Frequency (cps)	Nominal scale reading (vu)
1, 000	−3 (as adjusted in par. 29*b*(13)).
100	−4.5 to −1.5.
300	−4 to −2.
500	−4 to −2.
1, 000	−3.
2, 000	−4 to −2.
3, 000	−4 to −2.
4, 000	−4 to −2.
5, 000	−4.2 to −1.8.
6, 000	−7 to −2.

(15) Remove the plug from the IF AMP INPUT jack and then repeat the above checks for channel A as described in (16) through (24) below.

(16) Set these controls as follows:

(*a*) MONITOR TRANSFER switch to A.

(*b*) VU METER TRANSFER switch to A.

(17) Rotate the VF LINE TRANSFER switch to R to connect the audio oscillator to channel A and the 600-ohm plug to channel B

(18) Adjust the *frequency* of the audio oscillator to 1,000 cps and its output to give a VOLUME INDICATOR meter reading of −3 vu.

(19) Reinsert the signal generator plug into the IF AMP INPUT jack. Increase the signal generator frequency to 101 kc, listening as the resulting beat note between the 1,000-cps tone in channel A and the test oscillator tone becomes nearly zero. Observe the decreasing rate of pulsation of the needle on the VOLUME INDICATOR meter as zero beat is approached.

(20) Rotate the VF LINE TRANSFER switch to N to place the audio oscillator output in channel B with the 600-ohm terminating plug in channel A.

(21) Adjust the VF GAIN A control for a VOLUME INDICATOR meter reading of −3 vu; then, restore the VF LINE TRANSFER switch to R.

(22) Repeat the procedure in (14) above, but set the VF LINE TRANSFER switch to N.

(23) If the required values are not obtained in either case, troubleshooting is required.

(24) Remove the test connections and turn the VF LINE TRANSFER switch to N. Replace the 341C coaxial plug in the ANTENNA and REC INPUT jacks.

30. Second Beat Oscillator Frequency Adjustment

a. This test sets the second beat oscillator frequency at 2.7 mc by applying 100 kc and its harmonics (only the 28th harmonic is used) to the 2.8-mc if. amplifier and by adjusting the 2.7-mc oscillator so that the resulting beat frequency at the output of the second demodulator will be 100 kc.

b. To make the test, follow procedure in (1) through (6) below:

(1) Make sure that power has been applied for at least one-half of an hour before testing.

(2) Remove the 341C coaxial plug from the ANTENNA and REC INPUT jacks.

(3) Set the controls to the following positions:
   (*a*) AFC to OFF.
   (*b*) 2ND BEAT OSCILLATOR TUNING to 0.
   (*c*) MAN VOL CONTROL to 7.5.
   (*d*) VOLUME CONTROL to MAN.
   (*e*) CARRIER BRANCH GAIN to 5.
   (*f*) MONITOR TRANSFER to B.
   (*g*) CARRIER SUPPLY to LOCAL.
   (*h*) VU METER TRANSFER to B.
   (*i*) AUTO FREQ CONTROL OSC GAIN potentiometer to its approximate mid-position.

(4) Plug the headset into the MONITOR jacks.

(5) Apply the harmonics of the 100-kc oscillator to the 2.8-mc amplifier by depressing the 2ND BEAT OSCILLATOR ZERO ADJ push button. Listen for a tone. If no tone is heard, adjust the 2ND BEAT OSCILLATOR ZERO ADJ slotted shaft until a tone is heard. Readjust the 2ND BEAT OSCILLATOR ZERO ADJ slotted shaft for a peak reading on the CARRIER RECT CURRENT meter. The filter in the carrier branch is sharply tuned (±10 cycles) and thus the CARRIER RECT CURRENT meter will deflect only in a narrow range. The maximum reading will coincide with an audio zero beat.

Note. If more than one tone is heard at the beginning of this step, turn the MAN VOL CONTROL knob counterclockwise until only one tone is heard.

(6) Remove the headset. Reinsert the 341C coaxial plug in the ANTENNA and REC INPUT jacks and restore the controls to their normal positions.

31. Calibration of CARRIER BRANCH GAIN Potentiometer

a. This test makes it possible to calibrate the CARRIER BRANCH GAIN control for various values of distant radio transmitter carrier suppression.

b. Use the following procedure in (1) through (10) below:

(1) Remove the 341C coaxial plug from the ANTENNA and REC INPUT jacks.

(2) Patch the 22DT signal generator through the converted 440A dummy antenna to the IF AMP INPUT jack. Adjust the frequency to 100 kc and the output to 5,000 uv. This applies a 2,500-uv input to the 100-kc if. amplifier.

(3) Set these controls to the following positions:
   (*a*) VOLUME CONTROL to MAN.
   (*b*) CARRIER BRANCH GAIN to 5.
   (*c*) MAN VOL CONTROL to 5.

(4) Adjust the signal generator *frequency* for a peak reading on the CARRIER RECT CURRENT meter, turning the MAN VOL CONTROL knob to keep the reading on the scale. Turn the CARRIER BRANCH GAIN control until the peak scale reading is 130.

(5) Position these controls as follows:
   (*a*) PANEL SELECTOR to 4.
   (*b*) PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.

Caution: Leave in this position only for this test.

(6) Rotate the MAN VOL CONTROL knob until the scale reading of the DC METERING meter is 30.

(7) Adjust the CARRIER BRANCH GAIN control to make the peak scale reading of CARRIER RECT CURRENT meter 130. Record the position of the CARRIER BRANCH GAIN control (first entry in the table in (8) below).

(8) Adjust the signal generator output for the 100-kc if. amplifier inputs shown below, by turning the CARRIER BRANCH GAIN knob to give a CARRIER RECT CURRENT meter scale reading of 130 at each input. Record the setting of the CARRIER BRANCH GAIN control.

Output of signal generator (uv)	100-kc if. amplifier input (uv)	Representing carrier suppression (db)	Typical CARRIER BRANCH GAIN control setting
5,000	2, 500	0	4. 8
1,600	800	10	7. 4
500	250	20	9. 1
354	177	23	9. 7

(9) Remove the test connections and the 341C coaxial plug, and restore the controls to their normal positions.

(10) Figure 83 is a typical chart for carrier branch gain dial calibration. Readings obtained in (8) above should show a reasonable correspondence to the chart.

32. Gain Test of Local and Reconditioned Carrier Signals

a. This test checks the gain of the reconditioned carrier system and the gain of the local 100-kc oscillator system for proper levels at the input to the afc system. It also checks the approximate level of each of these two sources of carrier supply at the input to the third demodulators.

b. Follow procedure in (1) through (17) below:

(1) Remove the 341C coaxial plug from the ANTENNA and REC INPUT jacks. Patch the 22DT signal generator through the modified 440A dummy antenna (par. 9*f*) to the IF AMP INPUT jack. Adjust the frequency to 100 kc and the output for 10,000 uv (5,000-uv input to the 100-kc if. amplifier).

(2) Set these controls to the following positions:

(*a*) PANEL SELECTOR to 4.

(*b*) VOLUME CONTROL to MAN.

(*c*) PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.

(*d*) AFC to OFF.

(3) Adjust the MAN VOL CONTROL until the DC METERING meter scale reading is 30 (3 volts).

(4) Turn the CARRIER BRANCH GAIN knob to the position for a carrier suppression of 0 db, referring to paragraph 31.

(5) Readjust the signal generator frequency, which may have drifted, for a peak reading on the CARRIER RECT CURRENT meter.

(6) Adjust the CARRIER BRANCH GAIN control until the CARRIER RECT CURRENT meter scale reading is 100.

(7) Turn the AFC knob to the ON position.

(8) Turn the AUTO FREQ CONTROL OSC GAIN slotted shaft fully counterclockwise to prevent V501 from feeding a signal to the phasing network.

(9) Set the controls to these positions:

(*a*) PANEL SELECTOR to 5.

(*b*) PANEL 5 VT CURRENTS TO AFC RECT V507 40 MA.

(10) Adjust the AUTO FREQ CONTROL CAR GAIN control until the DC METERING meter scale reading is 70.

(11) Turn the AFC knob to the OFF position.

(12) Adjust the AUTO FREQ CONTROL OSC GAIN control until the DC METERING meter scale reading is 70. Turn the PANEL 5 VT CURRENTS knob to the three other AFC RECT positions and note the scale readings. The three readings should lie between 65 and 75 to show that the amplifier and rectifier tube combinations are adequately matched.

(13) Turn the AFC knob to the ON position and check to see that the meter scale reading varies between 10 and 100 because the two 100-kc signals reinforce and cancel each other. The afc circuit is now operating.

(14) Set these controls to the following positions:

(*a*) PANEL SELECTOR to 4.

(*b*) PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.

(*c*) CARRIER SUPPLY to LOCAL.

(15) Adjust the DEM CAR GAIN control until the DC METERING meter scale reading is 80 (1.6 volts).

(16) Turn the CARRIER SUPPLY knob to the RECON position. The meter scale reading should lie between 65 and 95. If it does not, troubleshooting is necessary.

(17) Remove the test connections, install the 341C coaxial plug, and restore the controls to their normal operating positions.

33. Test and Adjustment of Avc Circuit

a. This test covers the adjustment of the avc controls and the measurement of their actions.

b. Follow the procedure in (1) through (15) below:

(1) Adjust the receiver controls in accordance with the tuning charts (fig. 23) for the lowest assigned operating frequency.

(2) Patch the 22DT signal generator through the modified 440A dummy antenna to the REC INPUT jack. Adjust the signal generator for the frequency chosen in (1) above and for an output of 100,000 uv (50,000-uv input to the REC INPUT jack). Set the INPUT ATTENUA-

TION DB control to the 20 position; readjust the INPUT TUNING and HF AMPLIFIER TUNING controls for a peak reading on the CARRIER RECT CURRENT meter.

Note. Small values of uv input are easily obtained by setting the INPUT ATTENUATION DB control to 20. Under this condition, a voltage attenuation of 10 to 1 exists between the REC INPUT jack and the grid of the hf amplifier. For example, a 2-uv reading on the signal generator meter results in a 1-uv output from the modified 440A dummy antenna. The INPUT ATTENUATION DB control then reduces the 1-uv signal, resulting in a .1-uv input to the grid of the hf amplifier.

(3) Terminate both lines by plugging in two 600-ohm terminations (271D plugs or equivalent) into GROUP A REC and GROUP B REC jacks in miscellaneous relay rack bay (fig. 55). This will prevent test signals from going over the line to the telegraph terminal.

(4) Set these controls to the following positions:

(*a*) PANEL SELECTOR to 4.

(*b*) VOLUME CONTROL to MAN.

(*c*) PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.

(*d*) AFC to ON.

(5) Check to see that the DC METERING meter scale reads 30.

(6) Adjust the CARRIER BRANCH GAIN knob until the CARRIER RECT CURRENT meter scale reading is 130.

(7) Remove the signal generator output plug from the REC INPUT jack.

(8) Turn the PANEL SELECTOR to the 5 position and the PANEL 4 VT CURRENTS to any position except S B VOLT HYB V401A 20V.

Note. To prevent distortion, do not leave PANEL 4 VT CURRENTS switch on S B VOLT HYB V401A 20V except when making a test that requires measurement of S B VOLT HYB V401A 20V.

(9) Turn the VOLUME CONTROL knob to the AUTO position. Depress and turn the AFC-ZERO ADJ knob for a midscale reading of 0.

(10) With a screwdriver, turn the AUTO VOL CONTROL DELAY fully clockwise, and adjust the AUTO VOL CONTROL MAX GAIN control for a noise reading of −5 vu on the VOLUME INDICATOR meter. If this reading cannot be obtained, troubleshooting is necessary.

(11) Set the AUTO VOL CONTROL DELAY control to its approximate mid-position.

(12) Reinsert the output plug of the generator into the REC INPUT jack. If necessary, readjust the receiver frequency for a peak reading on the CARRIER RECT CURRENT meter, using the 2ND BEAT OSCILLATOR TUNING control.

(13) Readjust the AUTO VOL CONTROL DELAY slotted shaft until the CARRIER RECT CURRENT meter scale reading is 130.

Note. It takes approximately 8 seconds for the meter reading to become stabilized after the control position is changed.

(14) Position the PANEL 5 VT CURRENTS switch to AFC RECT V507 40 MA.

(15) Adjust the signal generator for the receiver inputs shown in the table below. Read the values on the CARRIER RECT CURRENT, VOLUME INDICATOR, and DC METERING meters. A steady reading of the DC METERING meter (with occasional slow swings) and a noise reading no higher than given below indicate that the receiver avc and afc circuits have stayed in control. If the receiver goes out of control, as indicated by a sudden drop on the CARRIER RECT CURRENT meter, retune as required. The receiver may go out of control when changing the level of the signal generator at low outputs.

Signal generator output setting (uv)	Equivalent receiver input (uv)[a]	Equivalent input to grid of hf amplifier[b] (uv)	CARRIER RECT CURRENT (reading)	Receiver noise less than reading of (vu)[c]
100,000	50, 000	5, 000	130	−20
10,000	5, 000	500	115 min	−20
1,000	500	50	100 min	−20
100	50	5	85 min	−20
10	5	. 5	70 min	−15
4	2	. 2	60 min	−10
2	1	. 1	50 min	−6

[a] Modified 440A dummy antenna is used.
[b] INPUT ATTENUATION DB control is set at 20.
[c] In the last test (1-uv input to the receiver), the VU meter reading required is listed as −6. This means that −6, −7, −8 to −20 all meet this requirement; −5 does not meet this requirement.

(16) Remove the test connections and replace the 241C coaxial plug. Turn the INPUT ATTENUATION DB knob to 0 and the other controls to their normal positions.

34. Signal-To-Noise Ratio Test

a. The test below checks the signal-to-noise ratio of groups A and B at three operating frequencies, throughout the range of the receiver.

b. Follow the procedure given in (1) through (14) below:

(1) Adjust the receiver controls according to the tuning charts (fig. 23) for an assigned operating frequency below 10 mc.

(2) Patch signal generator 22DT through the modified dummy antenna 440A to the REC INPUT jack. Adjust the signal generator for the frequency selected in (1) above and for an output of 10,000 uv (5,000-uv input to the receiver). Readjust the receiver frequency for a peak reading on the CARRIER RECT CURRENT meter, using the 2ND BEAT OSCILLATOR TUNING knob. Terminate each group (A and B) in the miscellaneous relay rack bay with a 217D plug (600 ohms).

(3) Set the following controls to the following positions:

(*a*) PANEL SELECTOR to 4.

(*b*) VOLUME CONTROL to MAN.

(*c*) MONITOR TRANSFER to A.

(*d*) PANEL 4 VT CURRENTS to S B VOLT HYB V401 20V.

(*e*) VU METER TRANSFER to A.

(*f*) AFC to OFF.

(4) Check to see that the DC METERING meter reading is 30. If necessary, turn the MAN VOL CONTROL knob to obtain this value.

Caution: Turn PANEL 4 VT CURRENTS switch to any position *other* than S B VOLT HYB V401A 20V after this step.

(5) Turn the CARRIER BRANCH GAIN knob until the CARRIER RECT CURRENT meter reading is 130.

(6) Remove the signal generator plug from the REC INPUT jack and switch the INPUT ATTENUATION DB to 20.

(7) Adjust the MAN VOL CONTROL knob for a noise reading of -10 VU on the VOLUME INDICATOR meter. Do not disturb this control during the following steps.

Note. If this reading cannot be obtained, troubleshooting is required.

(8) Reinsert the signal generator plug into the REC INPUT jack. Change the output of the signal generator to 10 uv (receiver input 5 uv).

(9) Connect the headset to the MONITOR jacks.

(10) Change the second beat oscillator tuning or the signal generator frequency slightly so that a tone of approximately 1,000 cps is heard in the headset.

(11) Decrease the signal generator output level until the reading of the VOLUME INDICATOR meter is 0 VU. Record the receiver input value, which is one-half of the signal generator output.

(12) Turn the MONITOR TRANSFER and VU METER TRANSFER knobs to the B positions and repeat the procedures in (10) and (11) above.

(13) Adjust the receiver controls according to the tuning charts (fig. 23) for an assigned operating frequency in the 10.3- to 23-mc and then in the 23- to 28-mc ranges. Repeat the procedures in (2) through (12) above for each frequency. The test requirements for groups A and B are listed below.

RANGE settings (mc)	Maximum receiver input (uv)
4 to 10.3	3. 2
10.3 to 23	5. 2
23 to 28	6. 2

(14) Remove the test connections, insert the 341C coaxial plug, and return the controls to their normal positions.

35. Frequency Adjustment (100-kc Oscillator) and Afc Action

a. Follow the procedure below to adjust the 100-kc crystal oscillator frequency and minimize the afc motor drift under no signal conditions. After adjustment, the frequency of the 100-kc oscillator is centered in the band pass of the 100-kc filter of the carrier branch. When the receiver gain is high and there is no signal, it is necessary to minimize any drift of the afc motor.

b. Follow procedure in (1) through (14) below:

(1) Adjust the receiver controls according to the tuning charts (fig. 23) for any convenient frequency, such as 5 mc. Set VOLUME CONTROL to MAN, AFC switch to ON, and CARRIER SUPPLY switch to RECON.

(2) Patch the signal generator 22DT through the modified dummy antenna 440A to the REC INPUT jack. Adjust the signal generator for the frequency selected in (1) above and for a 10,000-uv output (5,000-uv input to receiver).

(3) Adjust the receiver tuning for a peak reading on the CARRIER RECT CURRENT meter; adjust the MAN VOL CONTROL knob as required.

(4) Disconnect the signal generator.

(5) Set the controls to these positions:

(*a*) PANEL SELECTOR to 5.

(*b*) INPUT ATTENUATION DB to 10.

(*c*) PANEL 5 VT CURRENTS to AFC RECT V507 40 MA.

(6) Turn the AUTO FREQ CONTROL OSC GAIN slotted shaft fully counterclockwise.

(7) Adjust the MAN VOL CONTROL knob until the scale reading of the DC METERING meter is 50.

(8) Turn the AFC knob to the OFF position.

(9) Turn the AUTO FREQ CONTROL OSC GAIN slotted shaft until the DC METERING meter reads 70.

(10) Turn the AFC knob to the ON position.

(11) Depress and turn the AFC-ZERO ADJ knob for a scale reading of 0. Release the knob and time the scale movement to either the black ½ or the red ½ mark. The time should be not less than 7.5 minutes.

(12) If this requirement is not met, readjust the slotted shaft of the 100 KC OSCILLATOR TUNING-COARSE and/or 100 KC OSCILLATOR FINE controls. Repeat the procedures in (11) above and in this subparagraph until the requirement is met.

Caution: The 100 KC OSCILLATOR BALANCE slotted shaft is factory-adjusted and must not be disturbed during this test. Adjustment (par. 117) of this control is needed only if the components of this section are changed.

(13) If the oscillator is retuned in (12) above check to see that the adjustments, level of the LOCAL or RECON carrier at the third demodulator (par. 32), have not been disturbed.

(14) Restore the controls to their normal position (par. 21).

c. The test below is made at the time of installation of the receiver. It is used to determine if the afc circuit will control the receiver over an adequate frequency range and will operate quickly to compensate for any drift encountered. It is also useful as a routine preventive maintenance test.

d. Follow the procedure in (1) through (9) below.

(1) Set the controls to these positions:

(*a*) INPUT ATTENUATION DB to 20.

(*b*) VOLUME CONTROL to MAN.

(*c*) AFC to SQUELCH.

(*d*) CARRIER BRANCH GAIN to setting for 20-db suppression (approximately 9.1, par. 31).

(2) Adjust the receiver controls according to the tuning charts (fig. 23) for an assigned operating frequency below 10 mc.

(3) Connect the signal generator through the modified dummy antenna 440A to the receiver and set its frequency to that in (2) above. Set the output of the signal generator to 1,000 uv (500 uv input to the receiver).

(4) Tune the receiver to the signal generator and adjust the MAN VOL CONTROL knob to obtain a reading of 100 on the CARRIER RECT CURRENT meter.

(5) Connect oscillator D–166636 (Special 19–C) (TS–379/U) to the external modulation terminals of signal generator 22DT. Adjust the frequency of the oscillator to 500 cps and its output to maximum. Set the signal generator MODULATION switch to the EXT position.

Note. If it is impossible to obtain adequate modulation of the signal generator, connect a low resistance 1:3 ratio transformer between the oscillator output (primary) and the signal generator (secondary). A WECo 132C input transformer is supplied with some equipments for this purpose. This procedure will give a better match and will normally make it possible to obtain about 50 per cent modulation.

(6) Set the AFC-ZERO ADJ dial to 0. Retune the receiver, using the 2ND BEAT OSCILLATOR TUNING, so that one of the 500-cps sidebands will be received in the carrier channel. When this is accomplished properly, it should be possible to hear two tones, one of 500 and one of 1,000 cps at the monitor jacks with the MONITOR TRANSFER switch set on either A or B.

(7) Set the VOLUME CONTROL knob to the AUTO position.

(8) Slowly change the frequency of the oscillator from 500 cps to 800 cps; this change should take 1 minute. Slowly reduce the oscillator frequency to 200 cps, taking 2 minutes to move the dial from 800 to 200. The receiver should remain in control over the entire range. The dial of the afc control unit will turn during this oscillator frequency change.

(9) Disconnect the signal generator and restore all controls to their normal positions (par. 21). If the receiver does not remain in control during the preceding test, refer to item 17 of paragraph 101.

36. Afc Squelch Circuit Adjustment

a. The test below checks the operation of the afc squelch circuits under the action of receiver noise. Improper operation of the avc circuit, caused by excessive radio noise when the incoming carrier is normal or caused by normal radionoise when the incoming carrier fades, is prevented by the squelch circuit that insures that the afc motor remains inoperative under those conditions.

b. Follow the procedure described in (1) through (33) below:

(1) Set the controls to these positions:
- (*a*) PANEL SELECTOR to 5.
- (*b*) MAN VOL CONTROL to 0.
- (*c*) VOLUME CONTROL to MAN.
- (*d*) AFC to SQUELCH.
- (*e*) CARRIER BRANCH GAIN to 10.
- (*f*) PANEL 5 VT CURRENTS to CAR AMP V502 20 MA.

(2) Terminate each group output by plugging two 600-ohm terminations (271D plugs or equivalent) into the GROUP A REC and GROUP B REC jacks in the miscellaneous relay rack bay (fig. 55). This will prevent test signals from going on the line to the telegraph terminal equipment.

(3) Turn the SQUELCH CONTROL CAR GAIN slotted shaft fully counterclockwise and check the DC METERING meter for a 0 reading. Check to see that the CARRIER OFF SLOW and CARRIER OFF FAST lamps are lighted.

(4) Turn the SQUELCH CONTROL CAR GAIN slotted shaft one-eighth turn clockwise and check to see that the DC METERING reading is still 0. While observing the CARRIER OFF SLOW and CARRIER OFF FAST lamps, continue to turn the shaft clockwise for one-half turn and check to see that the lamps are extinguished when the meter reading reaches 80. The final scale reading should be at least 85. If this requirement is not met, turn the AFC switch to the ON position and observe the DC METERING meter. Check V502 if the reading is not within the range of 65 to 110. If the tube is good and the requirement is still not met, return the AFC switch to the SQUELCH position. Check the relay current flow adjustment (pars. 110 and 111).

(5) Turn the SQUELCH CONTROL CAR GAIN slotted shaft counterclockwise until the meter scale reading is 25, and check to see that the two lamps are lighted. If they are not, readjust the relay until the requirements in this and (4) above are met. Turn the PANEL 5 VT CURRENTS knob to CAR ALM SLOW V513 20 MA and check the DC METERING meter for 0 scale reading.

(6) Turn the PANEL 5 VT CURRENTS knob to CAR AMP V502 20 MA position and turn the SQUELCH CONTROL CAR GAIN slotted shaft clockwise until the scale reading of the DC METERING meter is 85 and the two CARRIER OFF SLOW and CARRIER OFF FAST lamps are extinguished. Observe the lamps when the AFC knob is turned to the OFF position. The CARRIER OFF FAST lamp (amber)

should light in less than one-half second. The CARRIER OFF SLOW lamp (red) should light in about 2 seconds. If the CARRIER OFF SLOW lamp (red) does not light in about 2 seconds, check tube V513 (par. 60, item 60); then, if the requirement is not met, adjust relay S803 CARRIER OFF SLOW (pars. 110 and 111).

(7) Adjust the receiver controls according to the tuning charts (fig. 23) for the lowest assigned operating frequency below 10 mc.

(8) Patch signal generator 22DT through the modified dummy load 440A to the REC INPUT jack. Adjust the signal generator for the frequency selected in (7) above for an output of 10,000 uv (a 5,000-uv receiver input). Adjust the MAN VOL CONTROL knob to give a CARRIER RECT CURRENT reading of approximately 130. Readjust the frequency for a peak reading on the CARRIER RECT CURRENT meter, using the 2ND BEAT OSCILLATOR TUNING control for final adjustment.

(9) Disconnect the signal generator.

(10) Turn the AFC switch to the SQUELCH position.

(11) Turn the CARRIER BRANCH GAIN knob for a carrier suppression of 20 db (approximately 9.1 on the scale). Refer to the table in paragraph 31 and figure 83.

(12) Adjust the MAN VOL CONTROL knob until the VOLUME INDICATOR meter reading is −10 VU.

(13) Turn the SQUELCH CONTROL CAR GAIN fully clockwise and the SQUELCH CONTROL NOISE GAIN fully counterclockwise. The scale reading of the DC METERING meter should be at least 85.

(14) Turn the SQUELCH CONTROL NOISE GAIN about one-fourth turn clockwise. The meter scale reading should decrease to 0 as V502 is cut off.

Note. The action of various controls have been tested in (1) through (14) above. Restore these controls to their normal settings (par. 21) by following the procedure in (15) through (33) below.

(15) To restore the squelch controls to their normal operating positions, turn the VOLUME CONTROL switch to the AUTO position. Depress and turn the AFC-ZERO ADJ knob for a scale reading of 0.

(16) Turn the AUTO VOL CONTROL DELAY slotted shaft fully clockwise and adjust the AUTO VOL CONTROL MAX GAIN slotted shaft for a receiver noise reading of −5 vu on the VOLUME INDICATOR meter.

(17) Turn the AUTO VOL CONTROL DELAY slotted shaft approximately to its midposition.

(18) Connect the signal generator with a signal level of 100 to 10,000 uv through the modified dummy antenna 440A to the REC INPUT jack. Readjust for a peak reading on the CARRIER RECT CURRENT meter, using the 2ND BEAT OSCILLATOR TUNING control.

(19) Readjust the AUTO VOL CONTROL DELAY until the CARRIER RECT CURRENT meter reads 130.

Note. Allow the required 8-second delay between the change in control position and meter reading.

(20) Adjust the frequency of the signal generator to any convenient frequency approximately 5 mc, and adjust its output to 1,000 uv (500-uv input to the receiver).

(21) Set the VOLUME CONTROL knob to the MAN position.

(22) Tune the receiver to the signal generator frequency, adjusting the MAN VOL CONTROL knob for a reading of 70 on the CARRIER RECT CURRENT meter.

(23) Reduce the signal generator output to 100 uv (50-uv input to the receiver).

(24) Turn the SQUELCH CONTROL CAR GAIN shaft clockwise until the DC METERING meter reads 20.

Note. If necessary, readjust the 2ND BEAT OSCILLATOR TUNING control because the afc may not function normally while these squelch adjustments are being made. The receiver must be kept in tune manually.

(25) Increase the signal generator output to 300 uv (150-uv input to the receiver). The lamps should be extinguished and the DC METERING meter reading should increase to at least 70.

(26) Recheck the 2ND BEAT OSCILLATOR TUNING control. Adjust for a maximum reading on CARRIER RECT CURRENT meter.

(27) Decrease the signal generator output to 10 uv (5-uv input to the receiver).

(28) Turn the VOLUME CONTROL knob to the AUTO position. The DC METERING meter should read between 50 and 100.

(29) Remove the signal generator plug from the REC INPUT jack. Adjust the HF AMPLIFIER TUNING knob until a noise reading of —10 vu is obtained on the VOLUME INDICATOR meter.

(30) Adjust the SQUELCH CONTROL NOISE GAIN so that the DC METERING meter indicates 30 on the set noise peaks.

(32) Reconnect the signal generator to the REC INPUT jack and adjust its output to 1.0 uv (.5-uv input to the receiver) and check to see that the DC METERING meter reading fluctuates in the range between 0 and 70.

(32) Disconnect the signal generator and observe that the DC METERING meter reads 0 except for occasional deflections caused by noise of the set.

(33) Return all controls to their normal positions (par. 21).

37. Initial Frequency Line-up Using First Beat Oscillator (Crystal) V206

a. Operate the first beat oscillator with the crystal control for greater stability, particularly at the higher radio frequencies. If crystals are available for the expected operating frequencies, follow the instructions in this paragraph. If no crystals are available, use the procedures in paragraph 38. Crystal types CR–27/U and WECo 22 KS–14193, L2 may be used. The table and examples below indicate the method used in selecting the proper crystal to correspond to the desired operating frequency. Refer to figures 23 and 24.

In range	Required crystal frequency (f_c)*	Operating frequency (f_o)*
4 to 10 mc	$f_o + 2.8$ mc	$f_c - 2.8$ mc.
10 to 17.8 mc	$f_o - 2.8$ mc	$f_c + 2.8$ mc.
17.8 to 28 mc	$\frac{f_o - 2.8 \text{ mc}}{2}$	$2f_c + 2.8$ mc.

* f_o=operating frequency, f_c=crystal frequency

Example I—4 mc:

Required, to order the proper crystal for an operating frequency (f_o) of 4 mc.

Required crystal freq $f_c=f_o+2.8$ mc

$$f_c=4 \text{ mc}+2.8 \text{ mc}=6.8 \text{ mc}$$

Order a 6.8-mc crystal ±2 kc. This tolerance is all that is required in this receiver.

Example II—11 mc:

Required to order the proper crystal for an operating frequency (f_o) of 11 mc.

Required crystal freq $f_c=f_o-2.8$ mc

$$f_c=11 \text{ mc}-2.8 \text{ mc}=8.2 \text{ mc}$$

Order an 8.2-mc crystal ±2 kc.

Example III—18 mc:

Required, to order the proper crystal for an operating frequency (f_o) of 18 mc:

Required crystal freq $f_c=\frac{f_o-2.8 \text{ mc}}{2}$

$$f_c=\frac{18-2.8}{2}=\frac{15.2}{2}=7.6 \text{ mc}$$

Order a 7.6-mc crystal ±2 kc.

b. Instructions for lining up the receiver on a new frequency using the first beat oscillator (crystal) are given in *c* below. When lining up the receiver on a new frequency, the initial settings are determined by means of signal generator 22DT. As soon as the distant transmitter is testing on the new frequency, the final settings may be made by using its incoming signal. The data are then entered on a calibration card to be used in subsequent line-ups at this frequency.

c. Follow procedure in (1) through (15) below:

(1) Set the following controls to the positions indicated:

Control	Position
PANEL SELECTOR	2.
INPUT ATTENUATION DB.	0.
INPUT TUNING	5.
HF AMPLIFIER TUNING	Tuning chart (fig. 23).
RANGE	According to new frequency.
AFC-ZERO ADJ	0.
PANEL 2 VT CURRENTS	BO 1-VAR V207 20 MA.
1ST BEAT OSCILLATOR	CRYSTAL.
1ST BEAT OSCILLATOR TUNING.	Tuning chart (fig. 23).
AFC REVERSE	2.
CRYSTAL SELECTOR	Position of crystal required (refer to subpar. *a* above for crystal frequency calculations).

Control	Position
2ND BEAT OSCILLATOR TUNING.	0.
MAN VOL CONTROL	7.
VOLUME CONTROL	MAN.
AFC	OFF.
CARRIER BRANCH GAIN	For transmitter suppression (approximately 9.1 for 20-db suppression, fig. 83).
MONITOR TRANSFER	A.
CARRIER SUPPLY	LOCAL.
VU METER TRANSFER	A.

(2) Patch signal generator 22DT through the modified dummy antenna 440A to the REC INPUT jack. Adjust the signal generator to the assigned operating frequency. Adjust the signal generator output for 10,000 uv (5,000-uv input to the receiver).

(3) Connect the headset to the MONITOR jacks and adjust the signal generator frequency until a tone is heard in the headset. Readjust the signal generator to the low-frequency tone side until no tone is heard.

(4) Adjust the 1ST BEAT OSCILLATOR TUNING control for a peak reading on the DC METERING meter. The peak will not be a sharp one.

(5) Turn the PANEL 2 VT CURRENTS knob to HF AMP V201 20 MA, and if necessary, adjust the MAN VOL CONTROL knob for a DC METERING meter scale reading of 60.

Note. This reduces the receiver gain to about 70 db below the maximum.

(6) Adjust the signal generator frequency until an audible note is again heard in the headset. Reduce the signal generator output to 1,000-uv (input to the receiver to 500-uv).

(7) Adjust the HF AMPLIFIER TUNING and INPUT TUNING knobs simultaneously for a peak reading on the VOLUME INDICATOR meter. Adjust the MAN VOL CONTROL knob to keep the reading on scale.

(8) Set the following controls to the positions indicated:

(*a*) PANEL SELECTOR to 5.

(*b*) AFC to ON.

(*c*) PANEL 5 VT CURRENTS to AFC RECT V507 40 MA.

(9) Adjust the signal generator frequency to the low-frequency side until no tone is heard in the headset.

(10) Push in and turn the AFC-ZERO ADJ knob until its scale is at 0. Tune the 2ND BEAT OSCILLATOR TUNING control to give a final precise adjustment of the CARRIER RECT CURRENT maximum deflection and observe that the rate of fluctuation of the reading on the DC METERING meter diminishes, showing that the receiver tuning is being controlled by the afc circuits.

(11) Remove the test connections. Insert the 341C plug in the ANTENNA and REC INPUT jacks. Patch the antenna to the receiver at the patching panel on the miscellaneous relay rack bay (fig. 55).

(12) Set these controls to the positions indicated:

(*a*) PANEL SELECTOR to 4.

(*b*) VOLUME CONTROL to AUTO.

(*c*) AFC to SQUELCH.

(13) As soon as the distant radio station is testing on the new frequency and is transmitting standard level test tone with 20-db carrier suppression, readjust the receiver controls as required. Peak the INPUT TUNING, HF AMPLIFIER TUNING, and 2ND BEAT OSCILLATOR TUNING knob if the range of 2ND BEAT OSCILLATOR TUNING is insufficient; then retune 2ND BEAT OSCILLATOR TUNING. Set the PANEL 4 VT CURRENTS switch to the S B VOLT HYB V401A 20V position. *Leave at this position only during this test.* Assuming that the transmitter has been adjusted correctly, check the accuracy of the carrier suppression adjustment by observing the reading of the DC METERING meter. If it is not 30, readjust the CARRIER BRANCH GAIN knob. This will adjust the carrier branch gain to correspond to the carrier suppression at the transmitter. Calibration of this control as made in paragraph 31 should now agree with its present position. Turn the PANEL 4 VT CURRENTS switch to another posi-

tion (GROUP B AMP 1 V401B 2 MA) so that it will not be left on S B VOLT HYB V401A 20V.

(14) Record the following information and settings on a new calibration card:

Transmitter frequency.
INPUT TUNING.
HF AMPLIFIER TUNING.
RANGE.
1ST BEAT OSCILLATOR TUNING.
1ST BEAT OSCILLATOR switch.
CRYSTAL SELECTOR position.
2ND BEAT OSCILLATOR TUNING.
CARRIER BRANCH GAIN.
Signal generator frequency controls:
  Band (   )
  Dial (-mc)
  Vernier dial (0–99)
AFC-ZERO ADJ

(15) Repeat (14) above for each expected 1st beat oscillator crystal-controlled operating frequency.

38. Initial Frequency Line-up Using First Beat Oscillator (Variable) V207

a. Instructions for lining up the receiver on a new frequency using the first beat oscillator (variable) are given in *b* below. When lining up the receiver on a new frequency, the initial settings are determined with signal generator 22DT. As soon as the distant transmitter is testing on the new frequency, the final settings may be made using its incoming signal. The data are then entered on a calibration card to be used in subsequent line-ups at this frequency.

b. Follow procedure in (1) through (10) below:

(1) Set these controls to the positions indicated:

Control	Position
PANEL SELECTOR	2.
INPUT ATTENUATION DB.	0.
INPUT TUNING	5.
HF AMPLIFIER TUNING	Tuning chart (fig. 23).
RANGE	According to new frequency.
AFC-ZERO ADJ	0.
PANEL 2 VT CURRENTS	HF AMP V201 20 MA.
1ST BEAT OSCILLATOR	VARIABLE.
1ST BEAT OSCILLATOR TUNING.	Tuning chart (fig. 23).
AFC REVERSE	1 (frequency below 10 mc or 2 above 10 mc).
CRYSTAL SELECTOR	0.
2ND BEAT OSCILLATOR TUNING.	0.
MAN VOL CONTROL	7.
VOLUME CONTROL	MAN.
AFC	ON.
CARRIER BRANCH GAIN	Refer to figure 83.
MONITOR TRANSFER	A.
CARRIER SUPPLY	LOCAL.
VU METER TRANSFER	A.

(2) Patch signal generator 22DT through the modified dummy antenna 440A to the REC INPUT jack. Adjust the frequency of the generator to the assigned operating frequency. Adjust the generator output for 1,000 uv (500-uv input to the receiver).

(3) Adjust the MAN VOL CONTROL knob, if necessary, to obtain a DC METERING meter reading of 60.

Note. This reduces the receiver gain to about 70 db below the maximum.

(4) Push in and turn the AFC–ZERO ADJ control until the scale reading is 0. Adjust the 1ST BEAT OSCILLATOR TUNING knob until an audible note is heard in the headset and continue to adjust until it lowers in pitch to zero. The 2ND BEAT OSCILLATOR TUNING provides an easily adjustable control for final fine tuning. Tune the 2ND BEAT OSCILLATOR TUNING for a peak reading on the CARRIER RECT CURRENT meter.

(5) Adjust the HF AMPLIFIER TUNING and INPUT TUNING knobs simultaneously for a peak reading on the CARRIER RECT CURRENT meter.

Note. As soon as the receiver is lined up with the signal generator, the avc system will control the first beat oscillator frequency to keep the output of the second demodulator at 100 kc (peak reading on CARRIER RECT CURRENT meter).

(6) Remove the test connections. Insert 341C plug in the ANTENNA and REC INPUT jacks. Patch the antenna to the

receiver with appropriate jacks on the miscellaneous relay rack bay (fig. 55).

(7) Set the controls to the positions indicated:

(*a*) INPUT ATTENUATION DB to 0.

(*b*) PANEL SELECTOR to 4.

(*c*) VOLUME CONTROL to AUTO.

(*d*) AFC to SQUELCH.

(*e*) PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.

Note. Leave in this position for this test only.

(8) As soon as the distant radio transmitter is testing and transmitting a standard level test tone, with a carrier suppression of 20 db, readjust the receiver controls as required. Peak the INPUT TUNING, HF AMPLIIER TUNING, 2ND BEAT OSCILLATOR TUNING knobs. Use the 1ST BEAT OSCILLATOR TUNING knob if the range of the 2ND BEAT OSCILLATOR TUNING knob is insufficient; then retune the 2ND BEAT OSCILLATOR TUNING. Check the accuracy of the carrier suppression adjustment by observing the reading of the DC METERING meter. If it is not 30, readjust the CARRIER BRANCH GAIN knob. Turn the PANEL 4 VT CURRENTS knob to the GROUP B AMP 1 V401B 2 MA position.

(9) Record the following information and settings on a new calibration card:

TRANSMITTER FREQUENCY.
INPUT TUNING.
HF AMPLIFIER TUNING.
RANGE.
1ST BEAT OSCILLATOR TUNING.
1ST BEAT OSCILLATOR switch.
AFC REVERSE.
CRYSTAL SELECTOR position.
2ND BEAT OSCILLATOR TUNING.
CARRIER BRANCH GAIN.
AFC-ZERO ADJ.
SIGNAL GENERATOR FREQUENCY CONTROLS.
BAND (   )
DIAL (mc)
VERNIER DIAL (   )

(10) Repeat the instructions in this paragraph for each expected operating frequency.

CHAPTER 3
OPERATION

Section I. OPERATION UNDER USUAL CONDITIONS

39. General

a. To understand the operation of Radio Receiver R–369/FRC–10, it is necessary first to understand the function of each front panel control. Operating personnel should, therefore, review the front panel control function list (par. 21). The operation of the CARRIER BRANCH GAIN control and its effect on the VOLUME INDICATOR and CARRIER RECT CURRENT meters, however, are unusual and require further explanation. Refer to the simplified block diagram (fig. 22) of the signal paths to the CARRIER RECT CURRENT (M101) and VOLUME INDICATOR (M102) meters.

b. The signal applied from the antenna to the rf section of the receiver consists of a highly suppressed carrier and two sidebands, each bearing different intelligence as shown in B, figure 3. These signals are double-converted to a 100-kc suppressed carrier and sidebands, which are applied to the 100 kc (second) if. section. The output of this if. section is applied to the vf and carrier sections.

(1) The 100-kc carrier is not accepted in the vf section, where the sidebands are separated by filters and then separately demodulated into vf signals. The relative amplitudes of the vf signals may be indicated by the VOLUME INDICATOR meter. An increase in the signal through the rf and if. sections results in an increase sideband amplitude (with avc not operating), which results in an increased reading on the VOLUME INDICATOR meter.

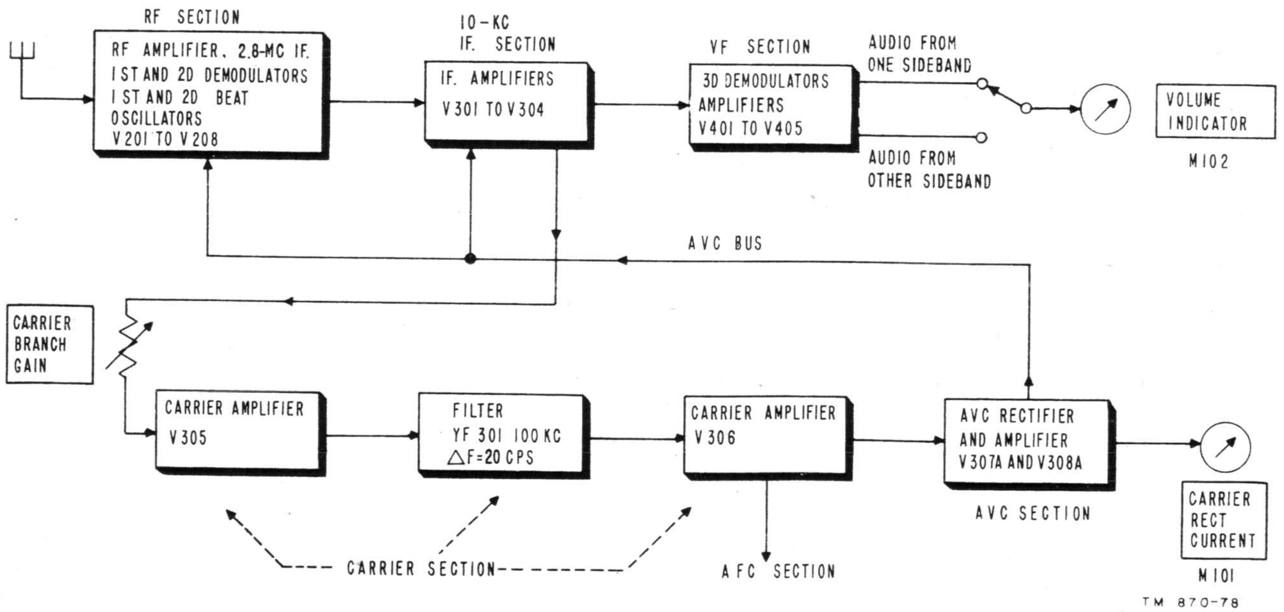

Figure 22. Simplified block diagram, signal paths to meters M101 and M102.

(2) In the carrier section, narrow band-pass filter YF301 rejects the sidebands and passes only the 100-kc carrier to carrier amplifier V306 for amplification. The 100-kc output of the carrier section is applied to the avc section to be rectified and filtered. The amplitude of the rectified and filtered avc signal is indicated by the CARRIER RECT CURRENT meter. An increase in the signal through the carrier section results in an increased avc potential, which results in an increased reading on the CARRIER RECT CURRENT meter. The avc capability is such that a 70-db signal input increase (from 1 uv) results in a change of only 70 to 130 on the CARRIER RECT CURRENT meter.

c. The setting of the CARRIER BRANCH GAIN control determines the output of the carrier amplifiers, thus determining the magnitude of avc bias which will be produced by any level of incoming carrier. With the VOLUME CONTROL switch in the AUTO position, the amount of avc bias will determine the overall gain of the receiver by controlling the gain of the rf and if. amplifier stages. Thus, with the receiver operating on avc and with the CARRIER BRANCH GAIN control set in one position, the level of the incoming carrier alone determines the overall gain of the receiver. Assuming that the amplitude of the incoming sidebands remains constant, an increase in the gain of circuits that amplify the carrier will result in decreased gain in the rf and if. stages that reduce the vf voltage applied to the vf section. This will result in a decreased reading on the VOLUME INDICATOR meter. The CARRIER RECT CURRENT meter, that indicates the relative amplitude of avc voltage, after the avc action will read higher. If, instead of changing the level of carrier into the receiver, the setting of the CARRIER BRANCH GAIN control is increased, the effect will be the same. A decrease in setting of the CARRIER BRANCH GAIN control will increase the sideband output level and the VOLUME INDICATOR reading and decrease the reading of the CARRIER RECT CURRENT meter. In practice, the CARRIER BRANCH GAIN control is set to a previously calibrated point which depends on the amount of suppression in use at the transmitter. Figure 83 shows a sample of a calibration chart, and paragraph 31 gives the calibration method. Under no circumstances should the vf output level be changed by use of the CARRIER BRANCH GAIN control to compensate for variation in level. Although it is possible to compensate partially for differences in transmitter carrier suppression, it is technically undesirable from a system standpoint. The calibration established in paragraph 31 should be observed.

d. When receiving conventional double-sideband rf signals, the CARRIER BRANCH GAIN control should be set at the point shown on the calibration chart (fig. 83) that correspond to carrier suppression of +6 db.

e. An important point to remember in operating and tuning the receiver is the effect of the carrier section on the afc circuits, not shown in figure 22. Since the filter (YF301) has a very narrow passband, the receiver may be tuned incorrectly by passing over the weak carrier and tuning to one of the strong sidebands. This error appears as a change in pitch, or complete garbling of speech and radioteletype signals. When tuning to a signal, the VOLUME INDICATOR meter reading will rise before the CARRIER RECT CURRENT meter reading does. This is caused by the extremely narrow band pass (20 cps) of the carrier branch section of the receiver (100 kc ±10 cps) as compared to the 5,900-cps band pass (100 to 6,000 cps) of the vf sections. For further information on the operation of these circuits, refer to paragraphs 62 and 63.

40. Starting Procedure

This paragraph lists the complete procedure for starting the receiver and tuning in signals within the frequency range of the receiver. In *a* below a list is given of the control settings common to both crystal and variable beat oscillator operation. Paragraph 37 and *b* below cover control settings required when crystal operation of the first beat oscillator is used. Paragraph 38 and *c* below cover controls when the first beat oscillator is a variable oscillator. Further operating instructions common to both crystal and variable beat oscillator operation is given in *d* below.

a. Refer to the calibration records (par. 37 or 38) for previously calibrated control settings that may have to be used as part of the starting procedure. The instructions in this paragraph are complete and assume the receiver is being tuned to a frequency for which it has not previously been calibrated. Thus, when tuning to a frequency for which the receiver has been calibrated, several procedures may be omitted.

(1) Turn the VOLUME CONTROL switch to AUTO to prevent the receiver from being overloaded if a strong signal is tuned in.

(2) Throw the MAIN POWER switch to ON.

(3) Throw the panel 7 PWR switch to ON.

(4) Throw the panel 6 PWR switch to ON.

(5) Set the INPUT ATTENUATION DB knob to 0 (with the antenna connection).

(6) Set the INPUT TUNING knob to mid-scale or its calibrated position.[2]

(7) Set the RANGE switch to the desired range.[2]

(8) Set the HF AMPLIFIER TUNING control as shown in figure 23.[2]

(9) With the 1ST BEAT OSCILLATOR switch at VARIABLE, set the AFC REVERSE switch to position 1 for signal frequencies below 10 mc, and to position 2 for signal frequencies of 10 mc and above.[2]

Note. If the 1ST BEAT OSCILLATOR switch is in the CRYSTAL position, the AFC REVERSE switch should be in position 2 for all signal frequencies.

[2] Predetermined setting can be used.

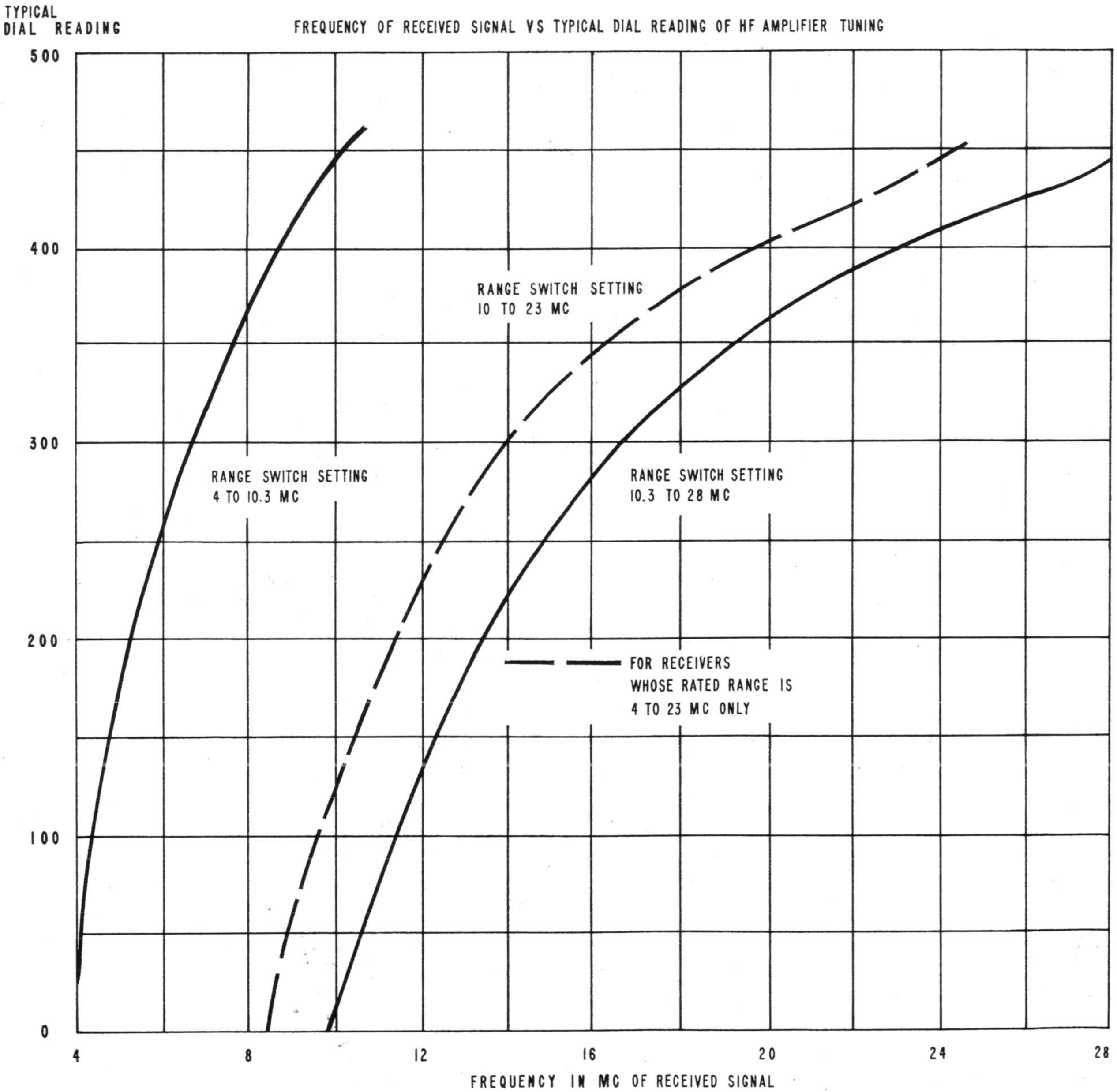

Figure 23. HF AMPLIFIER TUNING and 1ST BEAT OSCILLATOR, typical tuning charts.

(10) Set the AFC-ZERO ADJ knob to 0.

(11) Turn the 1ST BEAT OSCILLATOR switch to VARIABLE.[2]

(12) Set the 1ST BEAT OSCILLATOR TUNING control as shown in typical tuning, figure 23.[2]

(13) Set the CRYSTAL SELECTOR switch to 0.[2]

(14) Set the 2ND BEAT OSCILLATOR TUNING control to 0.[2]

(15) Set the AFC switch on panel 3 to SQUELCH.

[2] Predetermined setting can be used.

(16) Set the CARRIER BRANCH GAIN control for 20-db suppression (par. 31 and fig. 83). This assumes that the transmitted carrier is suppressed 20 db.

(17) Set the CARRIER SUPPLY switch to LOCAL.

(18) Set the MONITOR TRANSFER switch to A.

(19) Set the VU METER TRANSFER switch to A.

(20) Insert the headset plug into the MONITOR jacks.

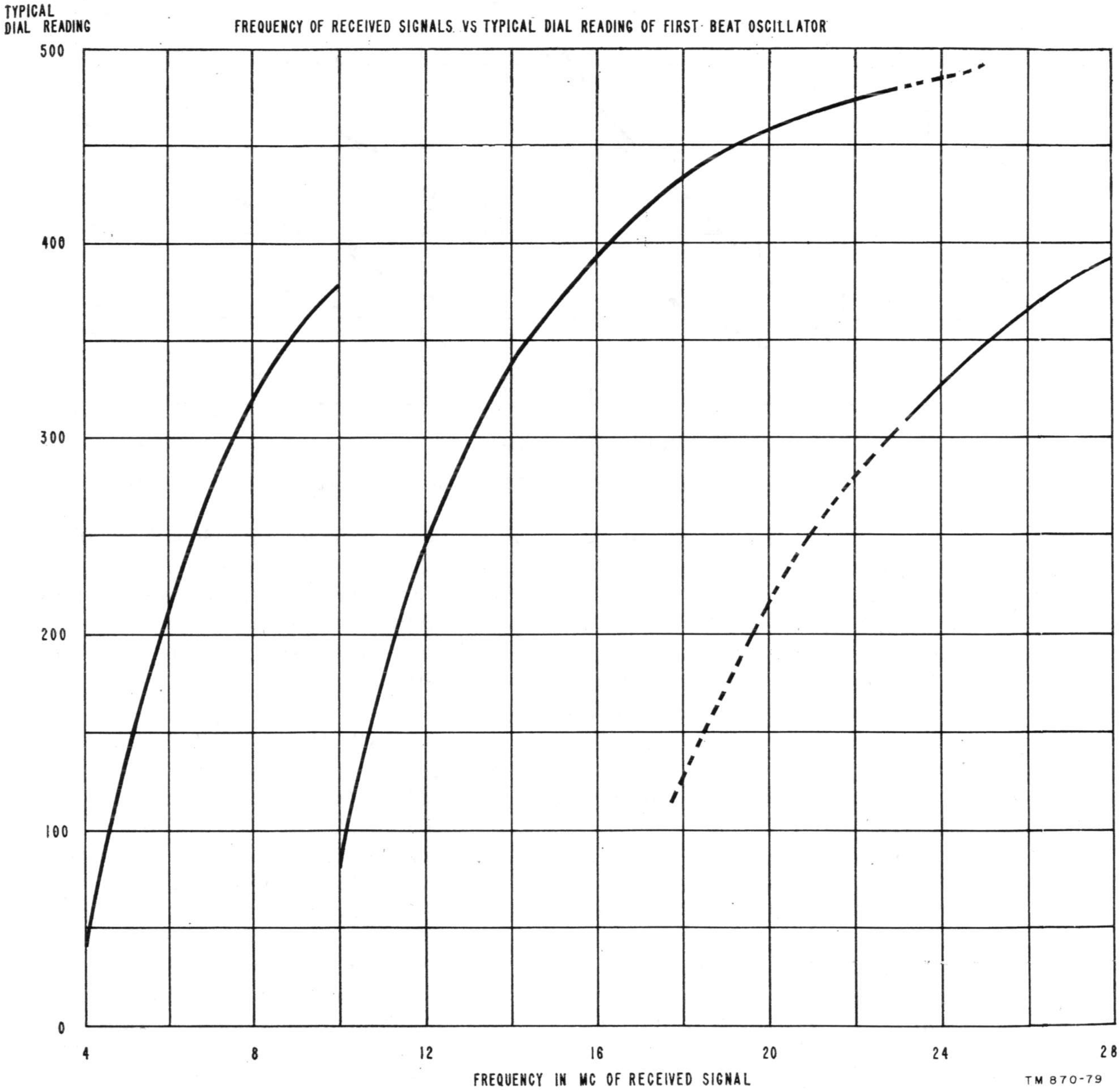

Figure 23—Continued.

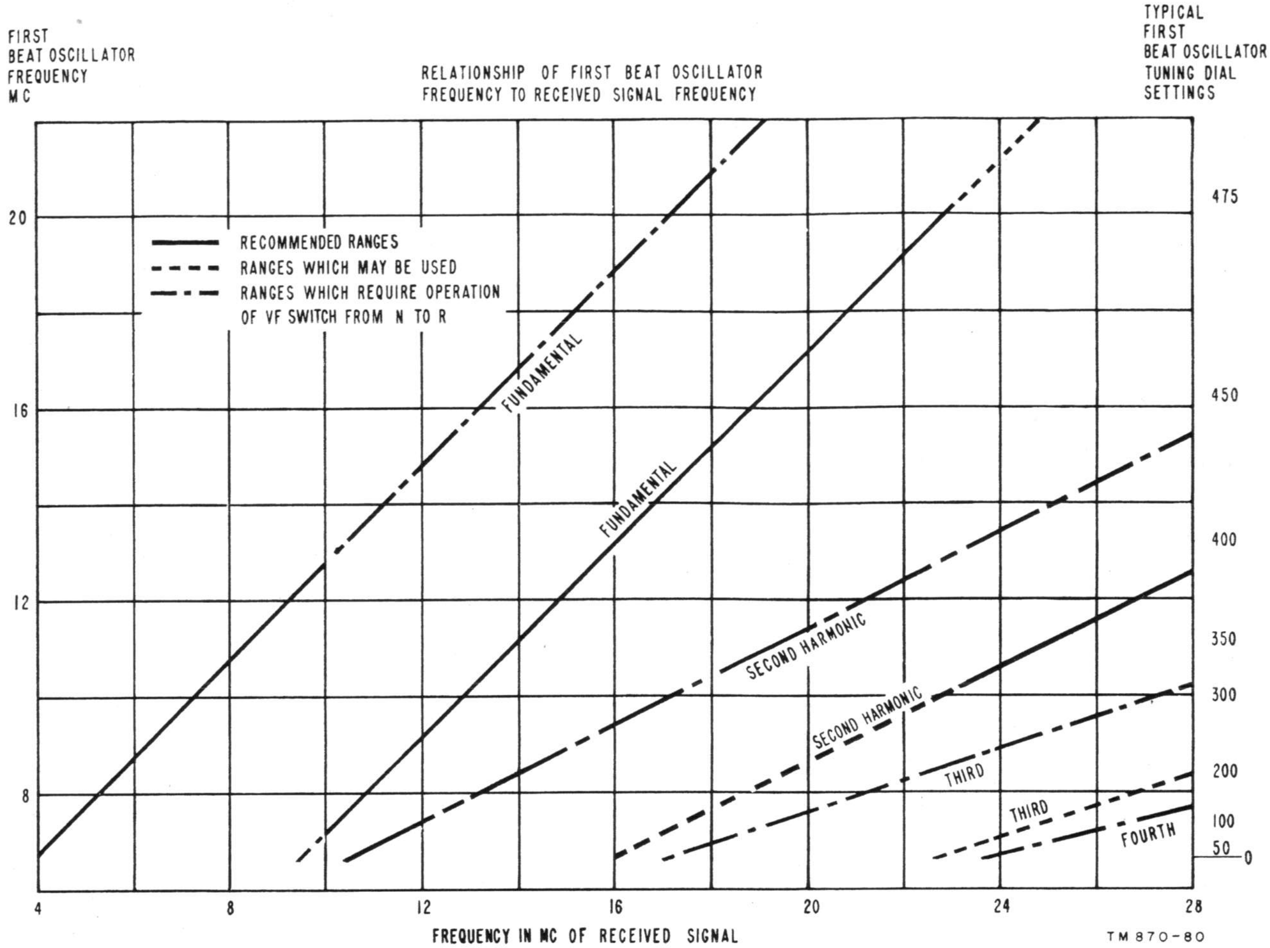

Figure 24. Relationship of 1ST BEAT OSCILLATOR frequency to frequency of received signal.

b. When the 1ST BEAT OSCILLATOR is crystal-controlled, use the following procedure ((1) through (3) below):

(1) Set the CRYSTAL SELECTOR switch to the position (1 to 10) for the desired crystal frequency of the first beat oscillator (crystal). For selection of crystals for specific operating frequencies, refer to paragraph 37.[2]

(2) Set the 1ST BEAT OSCILLATOR control to CRYSTAL.[2]

(3) Adjust, if necessary, the 2ND BEAT OSCILLATOR TUNING for maximum CARRIER RECT CURRENT meter indication. The afc circuit should take hold and control the second beat oscillator frequency indicated by a near steady reading of the CARRIER RECT CURRENT meter.[2]

[2] Predetermined setting can be used.

c. When the 1ST BEAT OSCILLATOR is at VARIABLE, proceed as follows ((1) through (5) below): (The following adjustments require an input signal from a transmitter. If no transmitted signal is available, use the tuning procedures given in paragraph 38.)

(1) Coarse adjustment is made by adjusting the 1ST BEAT OSCILLATOR TUNING knob for zero beat. Fine turning adjustment is done with the 2ND BEAT OSCILLATOR TUNING knob. A zero beat heard in the headset is indicated on the CARRIER RECT CURRENT meter as a maximum deflection to the right. Since the 1ST BEAT OSCILLATOR TUNING adjustment is critical, the first visual indication that the correct frequency is being approached is a deflection on the VOLUME INDICATOR meter. Carefully adjust the 1ST BEAT

OSCILLATOR TUNING and then the 2ND BEAT OSCILLATOR TUNING (preferably) or the AFC-ZERO ADJ controls until the CARRIER RECT CURRENT meter reading is maximum.[2]

Note. 1. The afc motor should take control of the first beat oscillator frequency as soon as the tuning is close as shown by a steady reading of CARRIER RECT CURRENT meter. It may slowly change because neither the afc nor the avc is instantaneous.

Note 2. Since it is possible to tune in one of the incoming sidebands, be sure that it is the incoming *carrier* that is passing through the carrier branch filter and is being indicated on CARRIER RECT CURRENT meter. Refer to figure 3 and note that normally the relative amplitude of the carrier is low compared to the amplitude of the sidebands.

(2) Set the VOLUME CONTROL switch to MAN.

(3) Adjust the MAN VOL CONTROL knob to obtain a signal indication on the CARRIER RECT CURRENT meter.

(4) Adjust the HF AMPLIFIER TUNING and INPUT TUNING controls for maximum deflection on the CARRIER RECT CURRENT meter.[2]

Note. If the peak reading of the CARRIER RECT CURRENT meter exceeds 150, reduce it to 150 with the MAN VOL CONTROL. Adjust the INPUT ATTENUATION DB control only if there is interference from a strong nearby transmitter. Retune the HF AMPLIFIER TUNING and INPUT TUNING controls.

(5) Set the VOLUME CONTROL to AUTO.

d. Continue with the following procedure for both crystal and variable beat oscillator operation.

(1) Set the following controls as indicated below; then proceed with (2) through (9) below.

(*a*) CARRIER SUPPLY switch to LOCAL.

(*b*) VOLUME CONTROL switch to AUTO.

(*c*) PANEL 4 VT CURRENTS switch to S B VOLT HYB V401A 20V (for this test only).

(*d*) PANEL SELECTOR switch to 4.

(2) With the distant transmitter modulated by a standard test tone (carrier suppressed 20 db), check to see that the DC METERING meter average reading is 30. If necessary, adjust the CARRIER BRANCH GAIN knob to obtain this reading.

(3) Set the VOLUME CONTROL switch to MAN.

(4) Adjust the MAN VOL CONTROL knob until an average reading of 30 is obtained on the DC METERING meter. This is to leave the MAN VOL CONTROL at a suitable operating point in case avc is not used.

(5) Set the PANEL 4 VT CURRENTS switch to GROUP B AMP 1 V401B 2 MA position. Do not leave it on S B VOLT HYB V401A 20V.

(6) Set the VOLUME CONTROL switch to AUTO.

(7) Record the frequency being calibrated, and the INPUT TUNING, HF AMPLIFIER TUNING, RANGE, 1ST BEAT OSCILLATOR TUNING, 1ST BEAT OSCILLATOR, 2ND BEAT OSCILLATOR TUNING, AFC REVERSE, CRYSTAL SELECTOR, MAN VOL CONTROL, and CARRIER BRANCH GAIN control and switch settings.

(8) Radio Receiver R–369/FRC–10 is now ready for service as part of Radio Set AN/FRC–10.

(9) Notify the carrier terminal equipment operator that Radio Receiver R–369/FRC–10 is ready for service.

41. Attention During Operation

a. No additional receiver adjustments are required while the receiver is in operation if it has been tuned correctly. When making the initial tune-up, readjust the HF AMPLIFIER TUNING and INPUT TUNING controls after 1 hour. Check to see that the AFC-ZERO ADJ dial is approximately between the red 2 and the black 2. Slowly adjust 2ND BEAT OSCILLATOR TUNING to zero the position of the AFC-ZERO ADJ scale, if required.

b. Periodically check the meter readings listed below to insure that the correct signal level is

[2] Predetermined setting can be used.

supplied to the circuit that connects the receiver to the vf control terminal.

Note. The receiver has been adjusted for normal expected operating conditions. Local conditions may require changes that should be made only with a full knowledge of operating conditions of the entire system. Small changes at the transmitter, receiver, and telegraph terminal, may become a major (incorrect) operating condition. Each component of the system should be correctly adjusted according to a standard procedure rather than to compensate at one point for errors made elsewhere. The error may not be made the next time and then the *compensation* becomes the error. For example, carrier suppression, normally set at 20 db, is incorrectly set at 15 db at the transmitter. The receiver, adjusted for 20-db carrier suppression, will have low audio level output by 5 db. Change the CARRIER BRANCH GAIN or VF GAIN (A or B) controls to correct the effect, increasing the audio output 5 db. Then, when the transmitter is corrected, the receiver audio output will be 5 db too high.

(1) Check the CARRIER RECT CURRENT meter to see that the average scale reading of the incoming signal level is at least 90. During periods of fading or frequency drift, this reading fluctuates.

(2) Check the VOLUME INDICATOR meter reading as follows. If the transmitter carrier suppression is unknown, assume that the settings of VF GAIN A and VF GAIN B controls are correct, and turn the CARRIER BRANCH GAIN control as required (temporarily) to meet the conditions below. If the transmitter adjustment is known to be correct, slightly adjust the VF GAIN A and VF GAIN B controls as shown in (*a*) and (*b*) below:

(*a*) With a single incoming signal from the distant transmitter, modulated by a tone at reference level, check for readings of −3 vu with VU METER TRANSFER knob in position A or B. The test tone may be applied to either group A or B at the transmitter. If necessary, slightly adjust VF GAIN A or B slotted shafts.

(*b*) With incoming *speech*, check the average for 1 minute of major peak deflections, exclusive of the occasional high deflection that does not occur more often than once in 10 seconds. The peaks can usually be averaged over a range of 2 vu. If the average reading is substantially more or less than 0 vu, slightly adjust the VF GAIN A or VF GAIN B control until the average reading is 0 vu. The system as normally used will have telegraph tones on group A and speech on group B.

Note. In this receiver, a VOLUME INDICATOR meter reading of 0 vu results when the steady tone audio output is +8 decibels referred to 1 milliwatt in 600 ohms.

(3) Check the DC METERING meter reading as follows: With PANEL SELECTOR knob left normally at position 6(+130V), an immediate check may be made of the +130-volt supply in case of an alarm indication. Another useful position for the dc metering circuits is at AFC RECT V507 40 MA. In this position, the action of the afc circuit can be checked to see if control is maintained. A continuously moving needle indicates control, while a *dead* needle indicates lack of control.

c. In case of an alarm indication, check the lamps on the metering panel and correct the conditions noted in (1) through (4) below:

(1) The AFC (red) lamp lights and a buzzer operates when the tuning capacitor in the afc unit nears either end of its travel. To extinguish the lamp, push in the AFC-ZERO ADJ knob and turn to reset the scale to 0. Compensate for the change in frequency by slowly readjusting the 2ND BEAT OSCILLATOR TUNING control or, if necessary, the 1ST BEAT OSCILLATOR TUNING and then the 2ND BEAT OSCILLATOR TUNING controls.

(2) The red CARRIER OFF SLOW lamp lights, when the AFC switch is in the SQUELCH position, under these conditions: if the carrier fails or fades for more than 2 seconds; if the receiver is detuned; or if the +130-volt supply fails. To correct the trouble, check the reading of the DC METERING meter and the tuning adjustments of the receiver. The lamp never lights when the AFC switch is in the ON position. The lamp is always lighted when the AFC switch is in the OFF position. When this alarm lamp lights frequently over a short period of time, it is often an indication that the radio circuit path is nearing the

end of its useful circuit time. The control center must be notified.

(3) The amber CARRIER OFF FAST lamp lights intermittently if the carrier fades for approximately ½ second when the AFC switch is in the SQUELCH position. It lights continuously if the carrier fades for a longer time, if the +130-volt power supply fails, or if the AFC knob is turned to the OFF position. To correct the trouble, check the reading of the DC METERING meter and the tuning adjustment of the receiver. The lamp never lights when the AFC switch is in the ON position.

(4) The green VF lamp is extinguished if the +130-volt power supply fails or if the heater circuit to V405 fails. It should, therefore, be on as an indication that the receiver is turned on.

42. Procedure for Frequency Change

The frequency of Radio Receiver R–369/FRC–10 may have to be changed several times each day. The adjustments can usually be made in less than 3 minutes.

a. Set the INPUT TUNING, HF AMPLIFIER TUNING, RANGE, 1ST BEAT OSCILLATOR, 1ST BEAT OSCILLATOR TUNING, CRYSTAL SELECTOR, 2ND BEAT OSCILLATOR TUNING, MAN VOL CONTROL, CARRIER BRANCH GAIN, and AFC REVERSE controls and switches for the new frequency as previously recorded according to paragraph 37, 38, or 40. Set AFC switch to ON or SQUELCH. *Do not change other controls.*

b. If operating with the 1ST BEAT OSCILLATOR switch on CRYSTAL, adjust the 1ST BEAT OSCILLATOR TUNING dial (this will be a very broad adjustment) for a maximum reading on the CARRIER RECT CURRENT meter.

c. If operating with the 1ST BEAT OSCILLATOR switch on VARIABLE, adjust the 2ND BEAT OSCILLATOR TUNING for final (fine) adjustment for a maximum reading on the CARRIER RECT CURRENT meter. The AFC-ZERO ADJ knob may also be used as a fine tuning control.

d. Set the AFC switch to OFF, and adjust the HF AMPLIFIER TUNING and INPUT TUNING controls simultaneously for a maximum reading on the CARRIER RECT CURRENT meter. Be sure that the controls are adjusted so that the carrier branch circuits are actuated by the carrier and not by the sidebands. Refer to note 2 in paragraph 40*c*(1).

e. Set the AFC switch to the SQUELCH position. Set INPUT ATTENUATION DB if necessary to prevent overloading or intermodulation by strong signals.

f. Monitor the incoming signal and, if necessary, repeat the instructions of paragraph 41*b*(1) and (2), and make any gain adjustments to obtain 0 average indication on the VOLUME INDICATOR meter.

g. Notify the carrier terminal equipment and control center operators that the frequency change has been made and the receiver is ready for traffic.

43. Stopping Procedure

a. Throw the MAIN POWER switch to the OFF position.

b. Set the two PWR switches to OFF.

c. Check the rear door to see that the 100-watt heater lamp is on for drying purposes.

d. Notify the carrier terminal equipment and control center operators that the equipment is shut down.

Section II. OPERATION UNDER UNUSUAL CONDITIONS

44. General

The operation of Radio Receiver R–369/FRC–10 may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In paragraphs 45 through 47, procedures are given for minimizing the effect of these unusual conditions.

45. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse condition follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. Operate the set in a heated inclosure. Keep the heater lamp on; do not use larger than a 250-watt lamp.

46. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents or huts. When equipment is installed below ground and is set up in swampy areas, moisture conditions are more acute than normal in the tropics. Ventilation is usually very poor, and the high relative humidity with temperature changes causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than that of the surrounding air. To minimize this condition, keep the drying lamp in operation. Air conditioning should be installed when conditions of extreme humidity occur. The receiver as a whole does not have the standard fungus-resistant and moisture-proofing coating. Protection during transportation and storage is important. A well-constructed station building will generally be adequate protection.

47. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand or dust and dirt that enters the moving parts, motors, etc., of radio equipment. The ideal precaution is to house the equipment in an air conditioned dustproof shelter. The next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Keep the equipment as free from dust as possible.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. PREVENTIVE MAINTENANCE SERVICES

48. Tools and Materials Supplied with Radio Receiver R–369/FRC–10

A list of tools and materials supplied with the radio receiver is listed in appendix I and in the Exhibit B–(*) or KME 5000 specification form shipped with the equipment.

49. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service are kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent troubles from occurring. For more detailed information, see AR 750–5. Adequate time in operating schedules should be allowed for preventive maintenance.

50. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth, or a dry brush for cleaning.

(1) Clean all parts, except electrical contacts, with a cloth or brush moistened with Solvent, Dry-Cleaning (SD); then wipe parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of its fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch (psi) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques refer to TB SIG 178, Preventive Maintenance Guide for Rabio Communications Equipment.

51. Use of Preventive Maintenance Forms
(figs. 25 and 26)

a. The decision as to which items on DA Forms 11–238 and 11–239 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appears on the reverse side of the form.

b. Circled items in figures 25 and 26 are partially or totally applicable to Radio Receiver R–369/FRC–10. References in the ITEM block refer to paragraphs in text which contain additional maintenance information.

52. Performing Preventive Maintenance

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Be especially careful of any screws that are threaded into a plastic or bakelite material since the threads may be stripped easily.

a. External Preventive Maintenance.

(1) Check for completeness and the general condition of the equipment.

(2) Remove dirt and moisture from all equipment components.

(3) Check for normal operation.

(4) Inspect all exposed metal surfaces for rust, corrosion, and moisture.

(5) Inspect cables and cords for cuts, breaks, deterioration, and kinks.

(6) Clean the equipment name plates, exposed labels, and dial and meter windows. Check to see that the dial and meter windows and control knobs are not cracked or broken.

b. Internal Preventive Maintenance.

Note. Items listed below can be accomplished during the periodic operational test of the alarm system and safety switches (par. 27) during which all the front panel mats are removed.

(1) Inspect fixed capacitors (figs. 74–79) for leaks, bulges, and discolorations.

(2) Inspect variable capacitors for dirt, moisture, misalinement of plates, and loose mountings.

(3) Inspect resistors, bushings, and insulators for cracks, chipping, and discoloration. Refer to figures 74 through 80 for component locations.

(4) Inspect the terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.

(5) Inspect terminal blocks for loose connections, cracks, and breaks.

(6) Clean and tighten connections and mountings for transformers, chokes, potentiometers, and rheostats.

c. Preventive Maintenance Tests. Preventive maintenance tests to be made at certain intervals are listed below. The approximate time required to complete the tests and the paragraphs detailing the tests are also listed.

Test No.	Test	Par.	Test interval	Estimated reqd time (minutes)
1	Filament voltage check	26	2 years	60
2	Operational test of alarm system and safety switches	27	Monthly	120
3	Vacuum-tube currents tests	28	Monthly	45
4	Frequency characteristic test of if. and vf circuits	29	Quarterly	75
5	Second beat oscillator frequency adjustment	30	Quarterly	15
6	Calibration of CARRIER BRANCH GAIN potentiometer	31	Monthly	20
7	Gain test of local and reconditioned carrier signals	32	Monthly	30
8	Test and adjustment of avc circuits	33	Quarterly	45
9	Signal-to-noise ratio test	34	Monthly [b]	30
10	100-kc oscillator frequency adjustment	35	1 year	25
11	Afc action test	35	Monthly	25
12	Afc squelch circuit adjustment	36	Quarterly	90
13	Balance test for third demodulators	116	Monthly	60
14	D–170114 control unit	121	2 years [a]	120
15	Relays	111	2 years [a]	240
16	Lubrication (door latches)		1 year	
17	Power supply electrolytics (indicated by excessive power supply noise)		8 years	30
18	Antenna coupling transformer	53	Monthly [c]	30

[a] Only if operating requirements are not met.
[b] For first 3 months and after major changes, weekly; monthly thereafter.
[c] Monthly during periods of electrical storms, every 6 months otherwise.

53. Antenna Coupling Transformer (D–159619) Maintenance

a. The antenna coupling transformer (fig. 18) is protected against ordinary induced electrical charges by lightning protector gaps set to break down at 1,000 volts peak. The gaps between the electrodes of the lightning protector gaps must be not less than .004 inch or more than .006 inch. The gaps may be adjusted after loosening the screws that hold the horizontal electrodes. After adjusting the gaps, retighten the screws and recheck the gap spacing.

Caution: *Capacitor C1 is factory-adjusted,* and cannot be adjusted in the field with the tools and equipment provided.

b. A dc path through the transformer from the inner conductor of the coaxial connector to ground permits measuring the dc resistance of the antenna circuit from the receiver station. A unidirectional rhombic antenna is normally terminated in its characteristic impedance. The dc resistance of the rhombic termination is important since the signal-to-noise ratio will be adversely affected if the termination is incorrect (or open caused by lightning surges).

c. Check the spark gap spacing and antenna resistance monthly during lightning storm periods and once every 6 months during other periods.

Section II. LUBRICATION

54. Lubrication of Afc Tuning Motor

a. General. Afc tuning motor MO 1 (part of MO 201) is equipped with ball bearings packed with ANDOK C grease when manufactured. The bearings are sealed and require no attention. The capacitor shafts coupled to the motor are equipped with oil-impregnated bearings. Therefore, lubrication normally will not be required.

b. Routine Lubrication. If lubrication of the capacitor shafts becomes necessary (failure to meet the afc capability test, par. 35*c*), *sparingly* lubricate the upper and lower bearings with oil, type KS-7470 (fig. 27). Be sure that no oil from the upper bearing of the capacitor shaft leaks down to the shoulder on which the ground brush is making contact. If necessary, remove oil with clean carbon tetrachloride.

55. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is fully explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are fully explained in TB SIG 66, Winter Maintenance of Signal Equipment.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are fully explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

56. Rustproofing and Painting

a. When the rack or panel finish has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles may enter the equipment and cause internal shorting or grounding of circuits.

b. When a touchup job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to

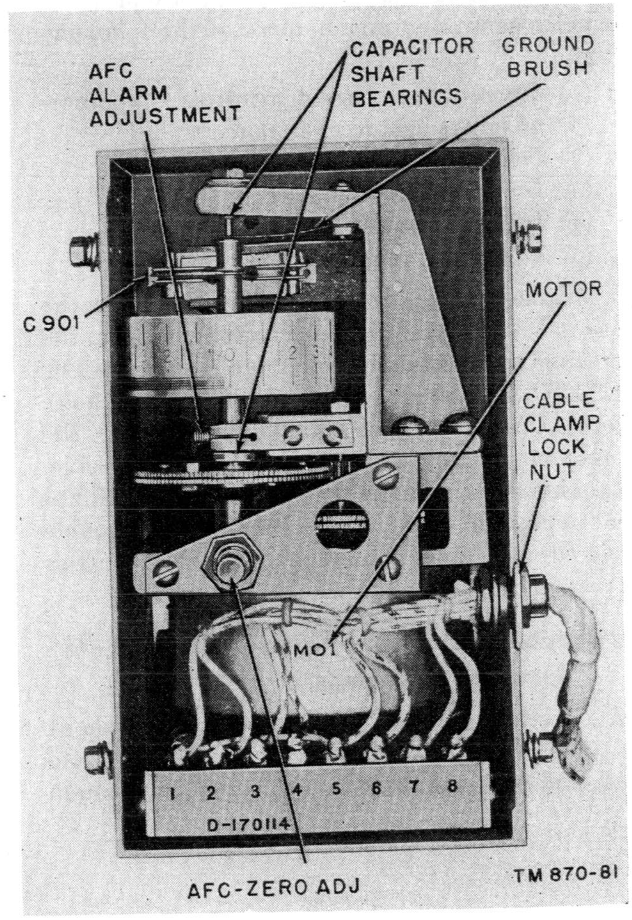

Figure 27. Afc tuning motor assembly and lubrication points.

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complete the preparation for painting. Do not expose plastic dial coverings to solvents. Paint used will be authorized and consistent with existing regulations on that supplied with the equipment.

Section III. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

57. General

a. The troubleshooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, shorted transformers, etc.

b. Paragraphs 58 through 60 help to determine which panel is faulty, and to localize the fault in that panel to the defective stage or item, such as a tube or fuse.

58. Visual Inspection

a. Failure of this equipment to operate properly is usually caused by one or more of the following faults:

(1) Improper settings of controls. For normal settings, refer to paragraph 21.
(2) Defective tubes.
(3) Burned-out fuses.
(4) Incorrect power supply voltages.
(5) Defective components.

b. When the receiver fails to operate and the cause is not immediately apparent, check the operating conditions of each stage, using the DC METERING meter as described in paragraph 60, before starting a detailed examination of the component parts of the receiver. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred. Be sure that all switches and controls are set properly.

59. Troubleshooting by Using Equipment Performance Check List

a. General. The equipment performance check list (par. 60) will help the operator to locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the DC METERING indications, the tolerances of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Position Column. For some items, the information given in the *Position* column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the DC METERING column.

c. DC METERING Column. The values indicated in this column are the normal values to be expected. Some readings indicate the allowable tolerance.

d. Remarks Column. The indications listed in the *Remarks* column include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

e. Corrective Measures Column. The corrective measures listed are those the operator can make. A reference in the table to a troubleshooting paragraph indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

60. Equipment Performance Checklist

Note. Use a pencil to mark the position of the DEM CAR GAIN on panel 4, AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN (panel 5) potentiometer shafts on the front panel as adjusted in paragraph 32. Reset these controls to their original positions on completion of the following tests.

a. Check list

	Item No.	Item	Position	DC METERING	Remarks	Corrective measures
PREPARATORY	1	Antenna	ANTENNA coaxial plug PG201 not plugged in.		All controls should be kept in listed positions unless otherwise noted. Return to these positions after making change.	
	2	MONITOR TRANSFER	B.			
	3	VU METER TRANSFER	B.			
	4	PANEL SELECTOR	7 (+250V).			
	5	VOLUME CONTROL	MAN.			
	6	MAN VOL CONTROL	10.			
	7	AFC	ON.			
	8	CARRIER SUPPLY	LOCAL.			
START	9	MAIN POWER	ON.			
	10	PWR (panel 7)	ON	125 (Actual voltage is twice the scale reading.)		Set ADJ VOLTS on panel 7 for a meter reading of 125. If no reading is obtained, check 8FN fusetron on panel 1 and 3.2 FN fusetron on panel 7. If the fuse is blown, replace with new fuse. If new fuse blows, troubleshoot 250-volt power supply; refer to section I of chapter 5.
	11	PANEL SELECTOR	6 (−130V).			
	12	PWR (panel 6)	ON	130	Green VF lamp will go on short time after PWR switch is operated, indicating that carrier amplifier V405 is conducting. V405 supplies 100-kc conversion frequency to third demodulators, resulting in vf output.	Set ADJ VOLTS −130V control for a meter reading of 130. If no reading is obtained, check ½ AMP fuse on panel 6. If fuse is blown, replace it. If new fuse blows, troubleshoot 130-volt supply. Refer to figure 81.
	13	PANEL SELECTOR	6 (+130V)	130		Set ADJ VOLTS +130 for a meter reading of 130. If no reading is obtained, check 3.2 FN fusetron on panel 6. If new fuse blows, troubleshoot 130-volt supply. Refer to figure 81.

Item No.	Item	Position	DC METERING	Remarks	Corrective measures
14	PANEL SELECTOR	2.			
15	PANEL 2 VT CURRENTS.	HF AMP V201 20 MA	120–180		Change tube V201 (6BA6).
16	PANEL 2 VT CURRENTS.	HF AMP V201 20 MA	10–20	MAN VOL CONTROL to 0 position.	Change tube V201 (6BA6).
17	PANEL 2 VT CURRENTS.	DEMOD 1 V202 10 MA	120–190	MAN VOL CONTROL to 10 position.	Change V202 (6AS6).
18	PANEL 2 VT CURRENTS.	2.8 MC AMP V203 20 MA	120–180		Change V203 (6BA6).
19	PANEL 2 VT CURRENTS.	2.8 MC AMP V203 20 MA	0–5	MAN VOL CONTROL to 0 position.	
20	PANEL 2 VT CURRENTS.	DEMOD 2 V204-V205 20 MA.	120–180	MAN VOL CONTROL to 10 position.	Change V204 (6AS6).
21	PANEL 2 VT CURRENTS.	BO 1-XTAL V206 20 MA	15–40	CRYSTAL SELECTOR switch on 0; 1ST BEAT OSCILLATOR to VARIABLE position.	Change V206 (5591/403B).
22	PANEL 2 VT CURRENTS.	BO 1-VAR V207 20 MA	60–110	1ST BEAT OSCILLATOR switch on VARIABLE position.	Change V207 (2C51). Refer to paragraph 123.
23	PANEL 2 VT CURRENTS.	BO 1-VAR V207 20 MA	25–60	1ST BEAT OSCILLATOR switch on CRYSTAL position.	Check circuit. Refer to paragraph 123.
24	PANEL 2 VT CURRENTS.	BO 2 V208 20 MA	10–40	1ST BEAT OSCILLATOR on VARIABLE position.	Change V208 (2C51).
25	PANEL SELECTOR	3.			
26	PANEL 3 VT CURRENTS.	IF AMP 1 V301 20 MA	120–180		Change V301 (6BA6).
27	PANEL 3 VT CURRENTS.	IF AMP 1 V301 20 MA	0–5	MAN VOL CONTROL on 0 position.	
28	PANEL 3 VT CURRENTS.	IF AMP 2 V302 20 MA	120–180	MAN VOL CONTROL on 10 position.	Change V302 (6BA6).
29	PANEL 3 VT CURRENTS.	IF AMP 2 V302 20 MA	0–5	MAN VOL CONTROL on 0 position.	
30	PANEL 3 VT CURRENTS.	IF AMP 3 V303 20 MA	120–180	MAN VOL CONTROL to 10 position.	Change V303 (6BA6).
31	PANEL 3 VT CURRENTS.	IF AMP 3 V303 20 MA	0–20	MAN VOL CONTROL to 0 position.	
32	PANEL 3 VT CURRENTS.	IF AMP 4 V304 80 MA	70–110	MAN VOL CONTROL to 10 position.	Change V304 (6AQ5).
33	PANEL 3 VT CURRENTS.	CAR AMP 1 V305 20 MA	15–50	MAN VOL CONTROL to 0 position.	Change V305 (5591/403B).

34	PANEL 3 VT CURRENTS.	CAR AMP 2 V306 20 MA	70–115	MAN VOL CONTROL to 0 position.	Change V306 (5591/403B).
35	PANEL 3 VT CUR-	LIMITER 1 V310 2 MA	65–100	MAN VOL CONTROL to 0	Change V310 (5591/403B)

33	PANEL 3 VT CURRENTS.	CAR AMP 1 V305 20 MA	15–50	position. MAN VOL CONTROL to 0 position.	Change V305 (5591/403B).
34	PANEL 3 VT CURRENTS.	CAR AMP 2 V306 20 MA	70–115	MAN VOL CONTROL to 0 position.	Change V306 (5591/403B).
35	PANEL 3 VT CURRENTS.	LIMITER 1 V310 2 MA	65–100	MAN VOL CONTROL to 0 position.	Change V310 (5591/403B)
36	PANEL 3 VT CURRENTS.	LIMITER 2 V311 2 MA	65–100	MAN VOL CONTROL to 0 position.	Change V311 (5591/403B).
37	PANEL SELECTOR	4			
38	PANEL 4 VT CURRENTS.	GROUP B AMP 1 V401B 2 MA.	70–110	MAN VOL CONTROL to 10 position.	Change V401B (2C51).
39	PANEL 4 VT CURRENTS.	GROUP B AMP 2 V402 80 MA.	80–120		Change V402 (6AQ5).
40	PANEL 4 VT CURRENTS.	GROUP A AMP 1 V403B 2 MA.	70–110		Change V403B (2C51).
41	PANEL 4 VT CURRENTS.	GROUP A AMP 2 V404 80 MA.	80–120		Change V404 (6AQ5).
42	PANEL 4 VT CURRENTS.	CAR AMP V405 20 MA	60–120		Change V405 (5591/403B).
43	PANEL 4 VT CURRENTS.	S B VOLT HYB V401A 20V.	0–10	MAN VOL CONTROL to 0 position.	Change V401A (2C51).
44	PANEL 4 VT CURRENTS.	CAR VOLT D3 V403A 4V	Minimum of 80	MAN VOL CONTROL and DEM CAR GAIN fully clockwise.	Change V403A (2C51).
45	PANEL 4 VT CURRENTS.	CAR VOLT D3 V403A 4V	0–25	CARRIER SUPPLY on RECON and CARRIER BRANCH GAIN fully counterclockwise.	Change V403A (2C51).
46	PANEL SELECTOR	5			
47	PANEL 5 VT CURRENTS.	100KC AMP V501 20 MA	80–120		Change V501 (5591/403B).
48	PANEL 5 VT CURRENTS.	CAR AMP V502 20 MA	65–110		Change V502 (5591/403B).
49	PANEL 5 VT CURRENTS.	CAR AMP V502 20 MA	0	AFC to OFF position.	
50	PANEL 5 VT CURRENTS.	AFC AMP V503 80 MA	80–120	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V503 (6AQ5).
51	PANEL 5 VT CURRENTS.	AFC AMP V504 80 MA	80–120	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V504 (6AQ5).
52	PANEL 5 VT CURRENTS.	AFC AMP V505 80 MA	80–120	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V505 (6AQ5).

Item No.	Item	Position	DC METERING	Remarks	Corrective measures
53	PANEL 5 VT CURRENTS.	AFC AMP V506 80 MA	80–120	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V506 (6AQ5).
54	PANEL 5 VT CURRENTS.	AFC RECT V507 40 MA	0–10	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V507 (6X4).
55	PANEL 5 VT CURRENTS.	AFC RECT V508 40 MA	0–10	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V508 (6X4).
56	PANEL 5 VT CURRENTS	AFC RECT V509 40 MA	0–10	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V509 (6X4).
57	PANEL 5 VT CURRENTS.	AFC RECT V510 40 MA	0–10	AUTO FREQ CONTROL CAR GAIN and AUTO FREQ CONTROL OSC GAIN controls fully counterclockwise.	Change V510 (6X4).
58	PANEL 5 VT CURRENTS.	100KC OSC 1 V511 20 MA	80–120		Change V511 (5591/403B).
59	PANEL 5 VT CURRENTS.	100KC OSC 2 V512 20 MA	80–120		Change V512 (5591/403B).
60	PANEL 5 VT CURRENTS.	CAR ALM SLOW V513 20 MA.	75–130		Change V513 (5591/403B).
61	PANEL 5 VT	CAR ALM SLOW V513 20 MA.	0	AFC on OFF position.	

b. Completion of Checks. After completing the items listed in the checklist above, return all the controls to their normal positions shown in paragraph 21. All tubes now have been checked except tubes V307 through V309, tubes V1 through V9 of panel 6, and V1 through V6 of panel 7. The outputs of the power supplies (panels 6 and 7) can be checked directly by switching the PANEL SELECTOR switch in panel 1 to positions 6(−130 V), 6(+130 V), and 7(+250 V).

CHAPTER 5

THEORY OF RADIO RECEIVER R–369/FRC–10

61. General

a. This chapter contains an explanation of the theory of operation of Radio Receiver R–369/FRC–10. The analysis is performed in three steps. First, the receiver is treated as a group of interconnected systems or circuits. Each system or circuit consists of several stages operating together to accomplish a major function, as shown in the simplified block diagram (fig. 28). Second, the complete block diagram (fig. 29) that contains a block for every stage in the receiver is discussed. Third a stage-by-stage analysis of the complete receiver.

b. Radio Receiver R–369/FRC–10 is the receiving equipment of Radio Set AN/FRC–10, a long distance, point-to-point, radioteletype communication system. Radio Receiver R–369/FRC–10 operates over the frequency range of 4 to 28 mc in two bands, 4 to 10.3 mc, and 10.3 to 28 mc. It has an unbalanced 75-ohm input and is designed specifically for reception of single-sideband signals. but may also be used for conventional am. reception. The receiver furnishes the following circuits. A crystal or inductance-capacitance controlled first beat oscillator, a stable afc circuit that requires a minimum of attention, an afc squelch circuit to prevent false operation of the afc circuits during periods of poor signal-to-noise ratio, and metering circuits that facilitate the localizing of defects from the front panel. For the technical characteristics of the receiver, refer to paragraph 5.

62. Simplified Block Diagram
(fig. 28)

a. The simplified block diagram (fig. 28) of Radio Receiver R–369/FRC–10 shows the signal flow path of the incoming rf signals through the stages that demodulate and amplify the signals and control the tuning and gain of the receiver.

b. Incoming rf signals (±6-kc sidebands) are coupled to the hf amplifier, where the selected signal is amplified by the narrow band-pass amplifier stage, excluding much undesirable noise before applying the signal to the first demodulator. The first demodulator combines the rf signal from the hf amplifier with a signal from the first beat oscillator. A 2.8-mc signal (±6-kc sidebands) is selected from the modulation products by an appropriate filter and is coupled to the 2.8-mc amplifier. The output of the 2.8-mc amplifier is coupled to the second demodulator, which combines the 2.8-mc signal with a 2.7-mc signal from the second beat oscillator. A 100-kc signal (±6-kc sidebands) is selected from the modulation products by an appropriate filter and is coupled to the if. amplifiers. The output of the if. amplifiers is coupled to two crystal filters (band pass is 5,900 cps) that separate the sidebands. The two sideband signals (94 to 99.9 kc or 100.1 to 106 kc) then are fed to the two third demodulators where the signals are converted to the original voice (audio) frequencies. A 100- to 6,000-cps output from each demodulator is coupled to separate vf amplifiers. The vf amplifiers increase the amplitude of the signals and apply these signals to the two lines that feed the carrier terminal equipment.

c. A conventional buffer (carrier) amplifier (V405) injects into the third demodulator either a reconditioned 100-kc carrier obtained from the if. signal or a LOCAL carrier supplied by the 100-kc crystal oscillator. Selection of either one of these carriers for demodulation is accomplished by the CARRIER SUPPLY switch. Two limiter amplifiers hold or limit to a constant value the amplitude of the 100-kc carrier signal coupled from the if. amplifiers to the third demodulators. A sharp filter that precedes the limiters passes only the 100-kc carrier component of the if. signal. The output of the limiters is connected to the RECON contacts of the CARRIER SUPPLY switch. The output of the 100-kc oscillator

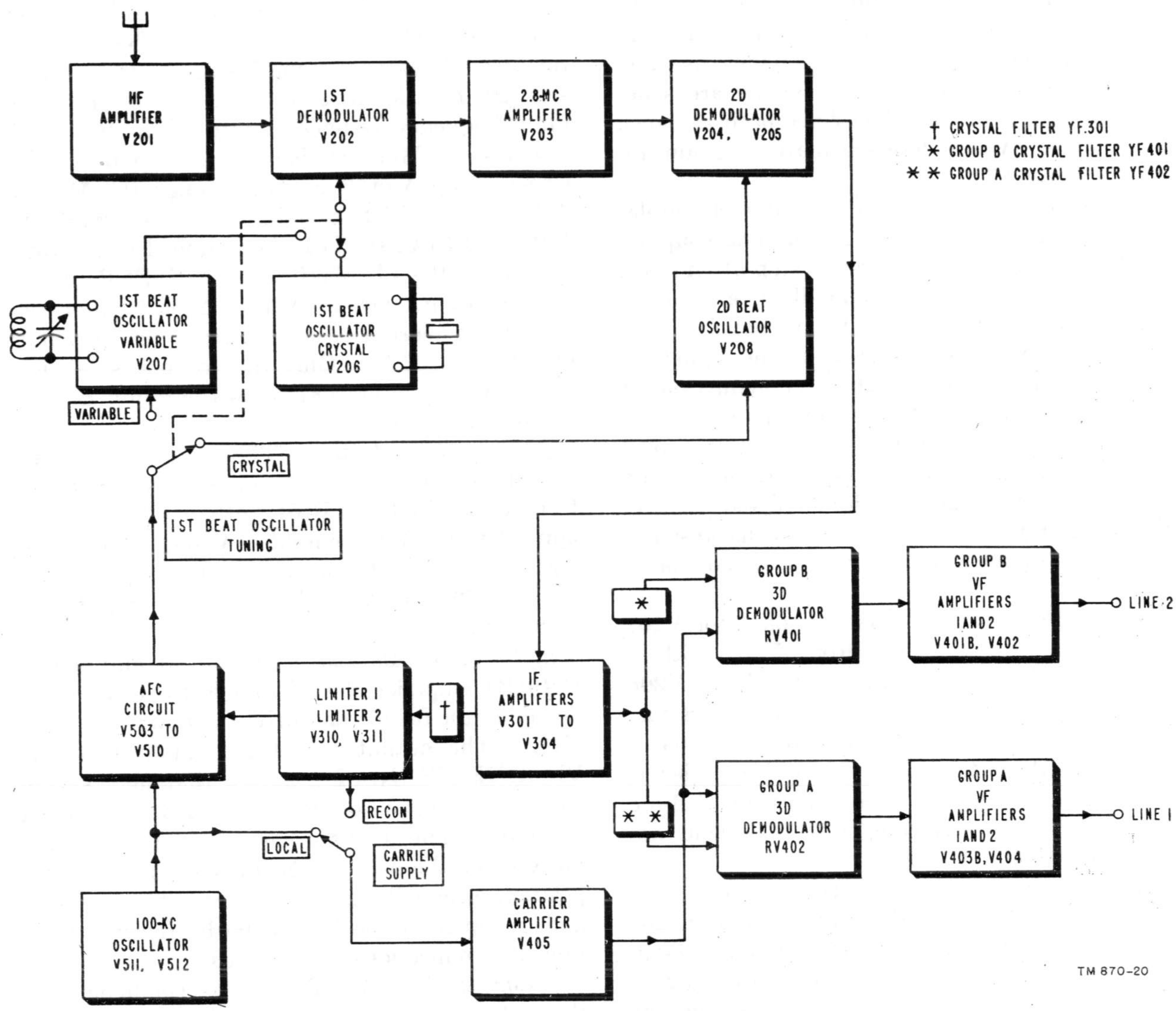


Figure 28. Radio Receiver R–369/FRC–10, simplified block diagram.

is coupled to the LOCAL contacts of the CARRIER SUPPLY switch.

d. An afc circuit is incorporated in the receiver. It functions by variations of the output frequency of the first or second beat oscillator. When the first beat oscillator is of the variable inductance-capacitance type, its frequency is controlled by the afc system. When the first beat oscillator is crystal-controlled, the second beat oscillator is controlled by the afc system. This insures that the signal applied to the if. amplifiers and that used as a reconditioned carrier is exactly 100 kc. This signal must be 100 kc; otherwise, the full gain of the if. amplifiers would not be realized and the sidebands and reconditioned carrier would not be passed through their respective crystal filters, thus causing improper output from the receiver. A direct result of this might be spurious operation of the carrier terminal equipment. The inputs to the afc circuit consist of 100-kc signals from the 100-kc crystal oscillator and from the limiter circuits through a phasing network connection shown on figure 29. Any difference in frequency between the two 100-kc signals causes the afc system to apply the proper amount of correction in the right direction to the beat oscillators as described above.

63. Block Diagram

(fig. 29)

Radio Receiver R–369/FRC–10 is a double-conversion, superheterodyne receiver with a frequency range of 4 to 28 mc. It is designed for the reception of single sideband, suppressed carrier, radioteletypewriter and/or vf signals. The output consists of two independent vf groups that cover a frequency range of 100 to 6,000 cps each. The lower and upper sideband signals are separated by crystal filters. The signal path is shown in figure 29. A complete schematic diagram appears in figure 87.

a. Antenna. A rhombic type antenna couples the incoming signal through an antenna coupling transformer (fig. 18) to a resistive step-attenuator.

b. Attenuator. The 0 to 30 db T attenuator INPUT ATTENUATION DB on panel 2 provides reduction, when desired, of the signals it couples to hf amplifier V201, for reduction of cross-modulation caused by strong signals.

c. Hf Amplifier. Hf amplifier V201 is a preamplifier that amplifies the signal output of the attenuator. The stage provides increased selectivity, image rejection, and better signal-to-noise ratio of the signal it applies to first demodulator V202.

d. First Demodulator. First demodulator V202 mixes the incoming signal from V201 with a signal from first beat oscillator V207 (or V206 and V207), resulting in the first if. of 2.8 mc. This signal is coupled to 2.8-mc amplifier V203.

e. 2.8-mc Amplifier. The 2.8-mc amplifier is the first if. amplifier. It amplifies the 2.8-mc signal from V202 and couples it to second demodulator V204 and V205.

f. Second Demodulator. The second demodulator is a balanced demodulator that mixes the 2.8-mc signal from V203 with a 2.7-mc signal from the second beat oscillator V208, resulting in the second intermediate frequency of 100 kc. It couples the 100-kc signal to if. amplifier 1 (V301). A balanced demodulator is used in preference to other types to cancel the 2.7-mc component of the modulation products.

g. If. Amplifiers. If. amplifiers 1 to 4 (V301 to V304) amplify the 100-kc (±6 kc) if. signal from the second demodulator. The output of if. amplifier 4 (V304) is coupled through a hybrid coil to groups A and B crystal filters. The third if. amplifier supplies a signal to carrier amplifier 1 (V305).

h. Groups A and B. The signal output of if. amplifier 4 consists of a 100-kc reduced carrier with lower and upper sidebands that extend from 94 to 99.9 kc and 100.1 to 106 kc, respectively. Separate intelligence is carried in each sideband. The hybrid coil applies the sidebands to both groups A and B branches, and the filters then reject the carrier and separate the upper and lower sidebands. These sidebands are applied to separate demodulating and amplifying channels. Since each group is identical with the exception of the filter frequency responses, only group B will be described. Monitor jacks are supplied with either group A or B output through the MONITOR TRANSFER switch. The VOLUME INDICATOR can similarly be switched from group A to B by the VU METER TRANSFER switch.

i. Group B. Group B filter YF401 suppresses the 100-kc carrier and the group A sidebands of 100.1 to 106 kc. Only the group B sidebands of 94 to 99.9 kc are passed to the group B third demodulator RV401.

j. Third Demodulator. The group B third demodulator mixes the 94- to 99.9-kc sidebands from crystal filter YF401 with a 100-kc signal applied from carrier amplifier V405. The resulting vf difference frequencies, with a range from 100 to 6,000 cps, are fed to group B amplifiers 1 (V401B) and 2 (V402).

k. Group B Amplifiers. Group B amplifier 1 (V401B) amplifies the vf signals from the third demodulator RV401 and drives vf power amplifier V402. The output of V402 is applied to the VF LINE TRANSFER switch that may switch the vf signal output of groups A and B signals from one output line to the other. In the N (normal position of the VF LINE TRANSFER switch) position, group B signals are connected to line 2 and, group A to line 1. In the R (reverse) position, the connections are reversed.

l. Carrier Branch. The audio component of the 100 kc if. signal is separated by beating the if. signal with a 100-kc carrier in the third demodulator (*j* above). The 100-kc signal used for this purpose is derived from either of two different sources. The first 100-kc source is a crystal-controlled oscillator (V511, V512); the second is the suppressed 100-kc carrier present in the if. signal. The 100-kc signal obtained from the crystal oscillator is called the LOCAL carrier; the 100-kc signal extracted from the if. signal is called the RECON carrier. The reconditioned carrier is obtained from the channel consisting of carrier amplifier 1 (V305), crystal filter YF301, carrier amplifier 2, and limiters 1 and 2.

m. Carrier Amplifier 1 (V305). Carrier amplifier 1 (V305) receives a 100-kc if. signal (with ±6-kc sidebands) from if. amplifier 3, amplifies it, and couples the output to crystal filter YF301.

n. Crystal Filter YF301. Crystal filter YF301 has an extremely narrow band pass of 20 cps (at 1 db down). Consequently, both side bands are attenuated and only a 100-kc signal remains accompanied by radio or set noise falling within the filter pass band. This 100-kc signal is coupled to carrier amplifier 2 (V306).

o. Carrier Amplifier 2 (V306). Carrier amplifier 2 (V306) amplifies the 100-kc (±10 cps at 1 db down) signal from crystal filter YF301 and couples it to the avc, afc, and limiter stages. This signal is used:

(1) As the reconditioned carrier for the third demodulator to demodulate the 100 ±6-kc if. signal and to obtain the original vf components.

(2) In the afc system, where it is compared with the local 100-kc crystal oscillator frequency; if a difference in frequency exists, the afc system acts to reduce the frequency difference to zero.

(3) To operate the CARRIER RECT CURRENT meter.

(4) In the afc squelch circuits, where the noise sidebands are rectified and compared against the signal level. If the signal-to noise ratio is low, the squelch action prevents the afc system from possibly detuning the receiver on noise signals.

(5) To produce negative avc bias that adjusts the gain of the controlled stages.

p. Limiters 1 and 2 (V310 and V311). Limiters 1 and 2 (V310 and V311) amplify the 100-kc signal from carrier amplifier 2 (V306). The output voltage is essentially constant in amplitude. The constant amplitude 100-kc signal from limiter 2 (V311) is applied to carrier amplifier V502 and, through the RECON contacts of the CARRIER SUPPLY switch, to carrier amplifier V405. The screen circuit of limiter 2 rectifies the noise sidebands. The dc produced is compared to dc from the carrier in V309B to operate the afc squelch circuits.

q. Carrier Amplifier V405. Carrier amplifier V405 amplifies the local or reconditioned carrier and injects it into the third demodulators.

r. 100-kc Oscillators 1 and 2 (V511 and V512). The 100-kc oscillators 1 and 2 (V511 and V512) form a bridge-type crystal oscillator supplying a 100-kc constant amplitude signal to carrier amplifier V501, and through the LOCAL connection of CARRIER SUPPLY switch, to carrier amplifier V405.

s. Afc System. The afc system is designed to keep the receiver in tune with the distant transmitter. The frequency of the first or second beat oscillator is so controlled that the frequency of the if. signal is automatically maintained at 100 kc. The frequency of the first or second beat oscillator is maintained within narrow limits by motor-driven capacitor C901. The motor is energized by the difference signal that results from the comparison of the output of the 100-kc crystal oscillator and the 100-kc if. signal. The complete afc system consists of 100-kc amplifier V501, carrier amplifier V502, afc amplifiers V503 to V506, afc rectifiers V507 to V510, the motor-driven capacitor, and the afc squelch system described in *w* below.

t. 100-kc Amplifier V501. The 100-kc amplifier amplifies the output of the local 100-kc crystal oscillator (V511 and V512) and applies it to the resistance-capacitance phase shifting network of the afc system.

u. Carrier Amplifier V502. Carrier amplifier V502 amplifies the reconditioned 100-kc signal furnished by limiters 1 and 2 (V310 and V311). The output of V502 is fed to the phase shifting network, the output of which consists of four phase-quadrature voltages that are applied to the grids of afc amplifiers V503 to V506.

v. Afc Amplifiers V503 to V506. Afc amplifiers V503 to V506 are power amplifiers that amplify the four phase-quadrature 100-kc voltages for application to afc rectifiers V507 to V510. If there is a difference in frequency between the reconditioned and local carrier signals, the output voltages of the afc rectifiers cause the two-phase motor to rotate afc tuning capacitor C901, which retunes the first or second beat oscillators.

w. Afc Squelch System. The afc squelch system consists of squelch carrier rectifier V307B, squelch carrier dc amplifier V308B, squelch low-frequency noise amplifier V309A, and squelch low-frequency noise detector V309B. The afc squelch system controls carrier amplifier V502, which determines whether the afc system will be operative or inoperative. The action of the squelch system is such that a fading signal or an increase of noise cuts off V502, thereby disabling the afc system. This avoids possible detuning of the receiver when noise exceeds the amplitude of the carrier. A strong signal accompanied by a low noise level energizes the afc circuit. The afc switch has three positions: OFF, SQUELCH, and ON. In the SQUELCH position, the system operates as described above;

in the OFF position, the system is inoperative; and in the ON position, the system operates regardless of carrier-to-noise ratio.

x. First Beat Oscillator. First beat oscillator V206 (crystal) and V207 (variable) are available and either may be used. If the 1ST BEAT OSCILLATOR selector switch is in the CRYSTAL position, V206, a crystal-controlled oscillator, is used as the first beat oscillator. The afc system is connected to, and controls the frequency of second beat oscillator V208 when the first beat oscillator is crystal-controlled. There are 10 crystal positions. In the VARIABLE position, an inductance-capacitance variable oscillator is used and the afc system controls its frequency.

y. Avc Rectifier V307A. Avc rectifier V307A rectifies and filters the 100-kc signal from carrier amplifier 2 (V306) and applies the resulting dc potential to the avc dc amplifier. The dc output voltage of the amplifier is coupled through a resistive voltage divider to the grids of hf amplifier V201 and if. amplifier 3 (V303). The 2.8-mc amplifier V203, if. amplifier 1 (V301), and if. amplifier 2 (V302) are connected directly to the dc output voltage of the avc amplifier.

64. Stage-by-Stage Analysis

Paragraphs 65 through 96 cover a stage-by-stage description of the circuitry of Radio Receiver R–369/FRC–10. To facilitate the explanation, simplified schematic and block diagrams are provided. Figure 87 should be used for maintenance and troubleshooting analysis. The first number in each component designation (reference symbol) indicates the physical location of that particular component. Each item mounted on the metering panel is numbered in the 100 series, on the hf panel in the 200 series, on the medium-frequency panel in the 300 series, on the vf panel in the 400 series, on the avc panel in the 500 series, on the relay panel in the 800 series, and components of the afc motor-controlled capacitor are numbered in the 900 series. Circuit designations for each of the two rectifiers and convenience outlets begin with the number 1.

65. Input Circuit
(fig. 30)

a. ANTENNA coaxial jack J201 is the termination for the rhombic-type antenna through the antenna coupling transformer D–159619 recommended for use with this receiver. Bridging coaxial plug PG201 (341C plug) couples the signal from ANTENNA jack J201 into REC INPUT coaxial jack J202. From J202, the signal is coupled to the contacts on the two-section INPUT ATTENUATION DB switch D202.

b. The incoming signal is coupled to the tuned grid circuit of the hf amplifier through a resistive step T attenuator. Reduction of the signal input reduces cross-modulation from strong interfering signals. The attenuator provides attenuation in 10-db steps from 0 to 30 db.

c. When switch D202 is in the 0 position, the signal is applied directly to RANGE switch D203. In the 10 position, resistors R207, R208, and R211 form a pad that provides 10-db attenuation of the signal. In the 20 position, resistors R205, R206, and R209 form a pad that provides 20-db attenuation. In the 30 position, resistors R203, R204, R201, R202, and R209 form a two-section pad that provides 30-db attenuation.

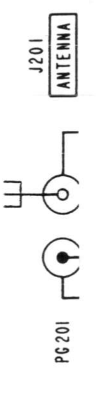
d. The T attenuator is used instead of a simple potentiometer because the T presents constant impedance to the antenna and tuned-grid circuit of hf amplifier V201.

66. Hf Amplifier V201
(fig. 30)

a. Hf amplifier V201 is a conventional tuned-grid, tuned-plate, rf amplifier that uses a miniature tube type 6BA6. This stage amplifies the rf signal of either one of the two frequency bands (4 to 10.3 mc or 10.3 to 28 mc) on which the receiver operates. Selection of the frequency band used is made by RANGE switch D203 which is ganged to D204.

b. The tuned-grid circuit of hf amplifier V201 consists of inductors L201, L202, and L203. Inductor L203 consists of a short piece of wire. The inductances are paralleled by capacitors C201 and C202, both of which are in series with C203. When RANGE switch D203 is in the 10.3- to 28-mc position, L202 is shorted out by the switch, which results in a higher resonant frequency range. HF AMPLIFIER TUNING capacitor C201 tunes the grid circuit of V201 to the frequency of the incoming signal. INPUT TUNING capacitor C202, a low-capacity trimmer capacitor, peaks the circuit for maximum signal input to V201 and compensates for the tracking error in the ganged tuning circuits.

c. The signal voltage is capacitatively coupled through C206 to the grid of V201, amplified, and then developed across the tuned plate load that consists of inductors L204, L205, and L206 (a



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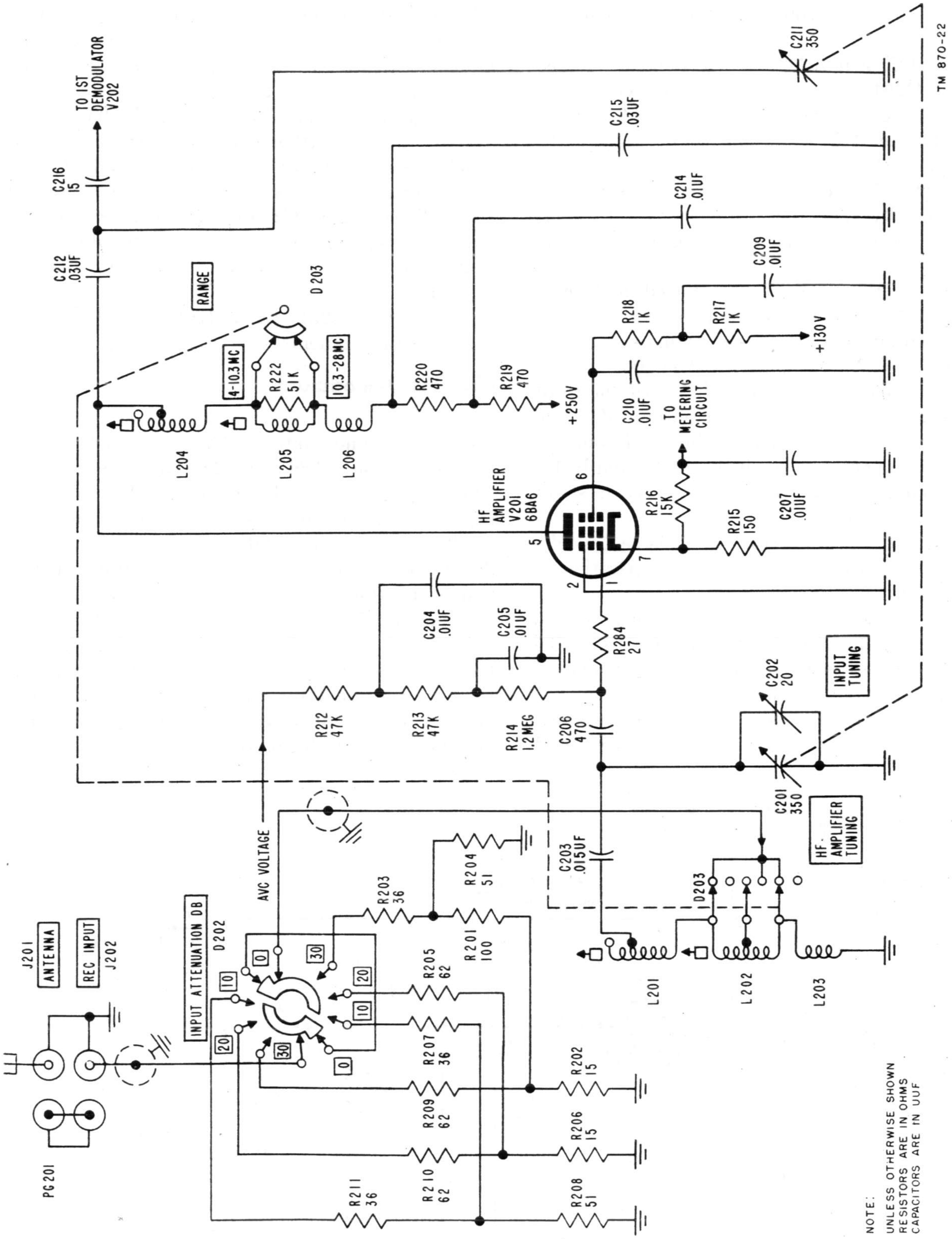

Figure 30. Hf amplifier, schematic diagram.

short piece of wire), connected in parallel with series-connected capacitors C211 and C212. C216 couples the output voltage to the first demodulator.

d. RANGE switch D203 is mechanically linked to switch D204 to permit the simultaneous switching of grid and plate circuits to the same frequency band. In the 10.3- to 28-mc band, switch D204 shorts out L205.

e. HF AMPLIFIER TUNING capacitor C201 is mechanically linked with capacitor C211 to permit simultaneous tuning of the grid and plate circuits.

f. Resistor R284 (antising) is placed in the grid lead of V201 to prevent parasitic oscillations.

g. HF amplifier V201, 2.8-mc amplifier V203, if. amplifier 1 (V301), if. amplifier 2 (V203), and if. amplifier 3 (V303) are all provided with one-third avc voltage. To prevent interaction of these stages through the common arc bus, a decoupling filter, consisting of resistors R214, R213, and R212, and capacitors C204 and C205, is placed in series with the avc circuit.

h. Cathode resistor R215 is unbypassed, resulting in degeneration and more stable operation of the amplifier.

i. To facilitate front panel servicing of the receiver, metering circuits are provided to enable the technician to measure the cathode current of every stage. The cathode current is used as the index of stage condition, since correct cathode current indicates that the control grid potential, and the screen grid and plate currents are probably correct. In addition, the cathode circuit is usually a low-impedance point which enables the metering circuit to be connected to the stage with a minimum of disturbance. Resistance-capacitance filtering further isolates the metering circuit. For this stage, DC METERING meter M103 is connected to the cathode circuit through series multiplier resistor R216. Capacitor C207 acts as an rf bypass capacitor for the metering circuit. R220, R219, C214, C215, R217, R218 and C209 make up plate and screen voltage decoupling networks for V201. C210 is the screen bypass capacitor.

j. Inductors L201, L202, L204, and L205 are slug-tuned for alinement.

67. First Demodulator

(fig. 31)

a. First demodulator V202 is a single tube, miniature-type 6AS6, unbalanced demodulator. The output voltage of the hf amplifier and the output of the first beat oscillator are combined in V202. From the modulation products, the 2.8-mc difference frequency is selected by filter FL201 and is transformer-coupled to the grid of 2.8-mc amplifier V203.

b. Signal voltage from the hf amplifier is impressed on control grid 1, and signal voltage from the first beat oscillator is impressed on suppressor grid 7. This produces varying plate currents composed primarily of the original two frequencies, the

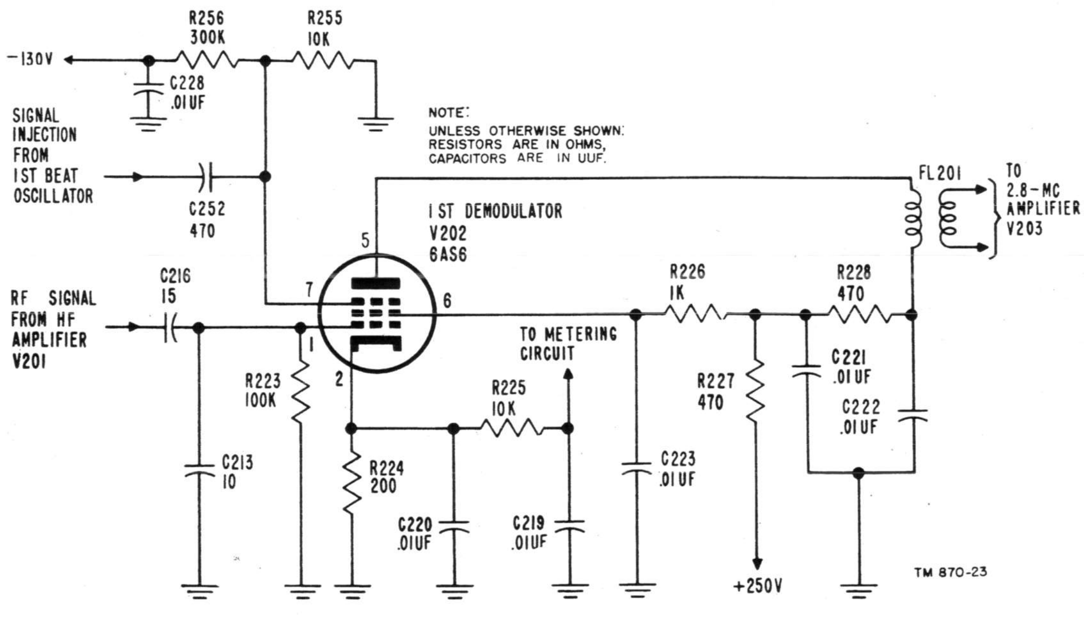

Figure 31. First demodulator, schematic diagram.

sum frequency, and the difference frequency. FL201, an if. transformer tuned to 2.8 mc rejects all but the difference frequency of 2.8 mc and couples it to the 2.8-mc amplifier. FL201 has a band pass of 14 kc, and helps to increase the signal-to-noise ratio. FL201 is tuned at the factory and is not to be retuned in the field.

c. Bias is provided by cathode resistor R224. Resistor R224 is bypassed for rf currents by capacitor C220. Resistor R225 is a series multiplier for the DC METERING meter M103; the metering lead is bypassed by C219. The dc grid return is through resistor R223.

d. Decoupling for the plate voltage supply is accomplished through the use of a two-section resistor-capacitor filter which consists of R228, R227, C221, and C222.

e. Screen-grid, voltage-dropping, and decoupling resistor R226 is bypassed for rf currents by capacitor C223.

f. Capacitors C216 and C213 form a capacitive voltage divider, which couples only a portion of the signal from hf amplifier V201 to grid 1. This maintains a low signal voltage to injection voltage ratio, which is desirable for distortionless demodulation.

g. The suppressor dc voltage is applied through a voltage-dividing and decoupling network (C228, R255, and R256).

68. First Beat Oscillator (Crystal)

(fig. 32)

a. Two first beat oscillators are available, either of which may be used in the generation of the first if. (2.8-mc) signal. One of the oscillators is a continuously variable inductor-capacitor type. When this oscillator is used, its frequency is controlled within narrow limits by the afc system. The other oscillator is a crystal-controlled type operating on any one of 10 predetermined frequencies. The first beat oscillator operates 2.8 mc above the incoming signals over a frequency range from 4 to 10 mc, and 2.8 mc below the incoming signals over a range from 10 to 17.8 mc. From 17.8 to 28 mc, the *second* harmonic of the oscillator is 2.8 mc below the incoming signal. This reduces the range that the first beat oscillator must cover, allowing the use of higher Q circuits and providing more stable operation. The 10-mc transition point for operating the oscillator above or below the carrier frequency is used because of long-standing receiving and transmitting practices. The choice has nothing to do with the 4- to 10.3-mc and 10.3- to 28-mc ranges which are established by design considerations.

b. On figure 24, note that any one of several rf signals will be received depending on the tuning of the hf amplifier. For example, with 1ST BEAT OSCILLATOR TUNING dial set at approximately 100 (or a crystal of 7.4 mc), the hf amplifier can tune in signals at seven frequencies (4.6, 10.2, 12, 17.6, 19.4, 25, and 26.2 mc). Some of these signals will have groups A and B information transposed about the carrier. The signals are shown by the long-short-long dashed curves in figure 24. The VF LINE TRANSFER switch must be in the R position, and the AFC REVERSE switch position may have to be changed for reception of these signals. The short dashed lines indicate tuning ranges that may be used, but which may be unstable frequencywise.

c. Basically, the first beat oscillator (crystal) is a Colpitts oscillator. In the conventional Colpitts oscillator, the tuned circuit consists of an inductance connected in parallel with two capacitors in series. In this oscillator, the Colpitts-type tank circuit is composed of the crystal acting as an inductance paralleled by capacitor C241 and the cathode-to-screen capacitance of the tube. Capacitor C246 serves to place the plate and screen at rf ground, while L207 maintains the cathode above ground for rf. CRYSTAL SELECTOR switch D207, an 11-position rotary tap switch, determines the crystal used. Crystals Y201 through Y210 are made available in positions 1 through 10, respectively. Position 0, which connects grid 1 to ground and thus disables the crystal oscillator, should always be used when the 1ST BEAT OSCILLATOR switch is in the VARIABLE position. This prevents interference which might result from an oscillating crystal.

d. 1ST BEAT OSCILLATOR switch D209 in the CRYSTAL position disconnects cathode 2 and cathode 8 of V207 from each other, disabling V207 as an oscillator. It reconnects the tube as a limiter and cathode follower through which the output of first beat oscillator (crystal) V206 is applied to first demodulator V202. Limiting action assures constant output voltage. Resistor R263 is connected in series with R264 to drop the plate (pin 6) voltage on V207. Tube V207 thus acts as a harmonic generator and is used as such at frequencies above 23 mc. The cathode current of section 2–3–4 of V207, operating as a cathode follower, flows through resistors R257, R258, R259, and R268 to ground. The voltage drop

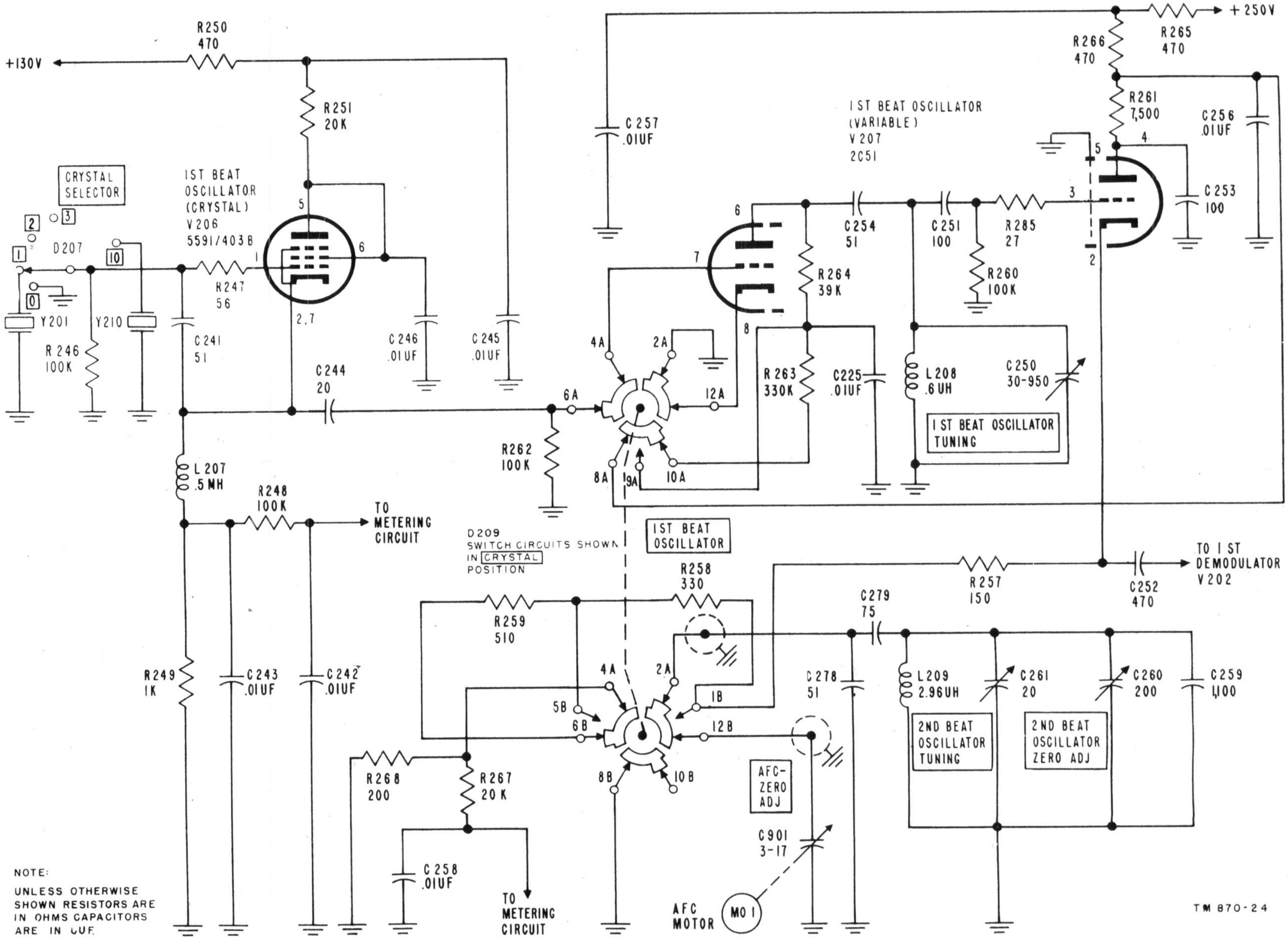

Figure 32. First beat oscillator (crystal), schematic diagram.

across R268 is taken off through meter multiplier resistor R267 for meter M103, shown on panel 1 in figure 87.

e. Capacitor C244 couples energy from crystal-controlled oscillator V206, through contacts 6A and 4A of switch D209, to grid (pin 7) of V207. Signal voltage from the plate (pin 6) is coupled to the grid (pin 3) through capacitors C254 and C251 and resistor R285. Capacitor C252 couples the output from the cathode (pin 2) of V207 to the suppressor (pin 7) of first demodulator V202. Inductor L207, an rf choke, allows the cathode (pin 7) of V206 to remain at rf potential while DC METERING meter M103 is kept at rf ground potential.

f. Plate voltage is applied through resistors R250 and R251 (decoupled by C245 and C246 from the ±130-volt regulated supply) to pin 5 of V206, triode connected.

g. A combination of the cathode bias (R249) and the grid bias (R246) is used on V206. Anti-sing resistor R247 damps out spurious oscillations.

h. When the first beat oscillator is crystal-controlled as described above, 1ST BEAT OSCILLATOR switch D209 connects motor-driven AFC-ZERO ADJ capacitor C901 across the second beat oscillator tuned circuit.

69. First Beat Oscillator (Variable)

(fig. 33)

a. Basically, the first beat oscillator (variable), is a two-stage, rf amplifier with positive feedback between the output of the second stage and the input of the first. This positive feedback maintains oscillations. To restrict the output frequency of the stage to one frequency, the feedback loop is shunted by a filter network that attenuates all frequencies except one. The filter network consists of a parallel resonant circuit in the grid circuit of the first stage. By rejecting all frequencies except its resonant frequency, the tuned circuit allows V207 to oscillate at only one frequency. The tuned circuit is formed by inductor L208 connected in parallel with capacitors C249 and C250. 1ST BEAT OSCILLATOR TUNING capacitor C250 adjusts the circuit to the correct resonant frequency. The tuned-grid circuit signal is developed across grid return R260 and is applied to control grid pin 3, causing the cathode current to vary at the frequency of the grid tank. Since both cathodes are tied together through contacts 12A and 1A of 1ST BEAT OSCILLATOR switch D209, the plate current of the grounded-grid amplifier also varies at the frequency of the grid tank (L208, C250, and C249). A portion of the plate signal voltage developed across R264 of the grounded-grid amplifier is fed back through capacitor C254 to the grid tank, thus sustaining the oscillating currents. Capacitor C252 couples the output from cathode 2 of V207 to suppressor grid 7 of V202. Capacitor C253 serves to complete the connection between the plate and the tuned circuit for rf.

b. When the 1ST BEAT OSCILLATOR switch is in the VARIABLE position, the afc system controls the frequency of the first beat oscillator. This maintains the second if. signal which results from the demodulation of the 2.8-mc first if. signal at 100 kc. Control of the frequency of the variable oscillator is accomplished by AFC-ZERO ADJ motor-driven capacitor C901 connected through R257 to cathode 2 of V207. Since the input impedance presented to the tuned circuit is partially determined by the cathode impedance of the first stage, varying the capacitance in the cathode circuit varies the effective resonant frequency of the tuned grid circuit. The motor that drives the capacitor is controlled so that the frequency of V207 is maintained 2.8 mc away from the frequency of the incoming signals.

c. When the 1ST BEAT OSCILLATOR switch is in the CRYSTAL position, the two sections of V207 are reconnected to form a limiter (fig. 32) and a cathode follower. Under these conditions, section 6–7–8 of V207 becomes a conventional overdriven amplifier. The grid (pin 7) that is grounded when the stage functions as an oscillator is returned to ground through grid-return resistor R262, and receives the output of the first beat oscillator (crystal). A high resistance, R263, is connected in series with the plate to drop the plate voltage to a low value. Because of the amplitude of the input signal, the stage is driven beyond cutoff by the negative peaks of the signal, and into saturation by the positive peaks. This overdriving acts to limit the amplitude of the output signal. As the harmonic content of the output is high it is used when signals higher than 23 mc are received. The output developed in the plate circuit of section 6–7–8 is capacitively coupled to section 2–3–4, which is connected as a cathode follower. The output of the cathode follower is applied to the first demodulator. Capacitor C255 decouples the plate circuit from the B+ supply.

d. The cathode current of section 2–3–4 flows through series resistors R257, R258, and R259

Figure 32. First beat oscillator (crystal), schematic diagram.

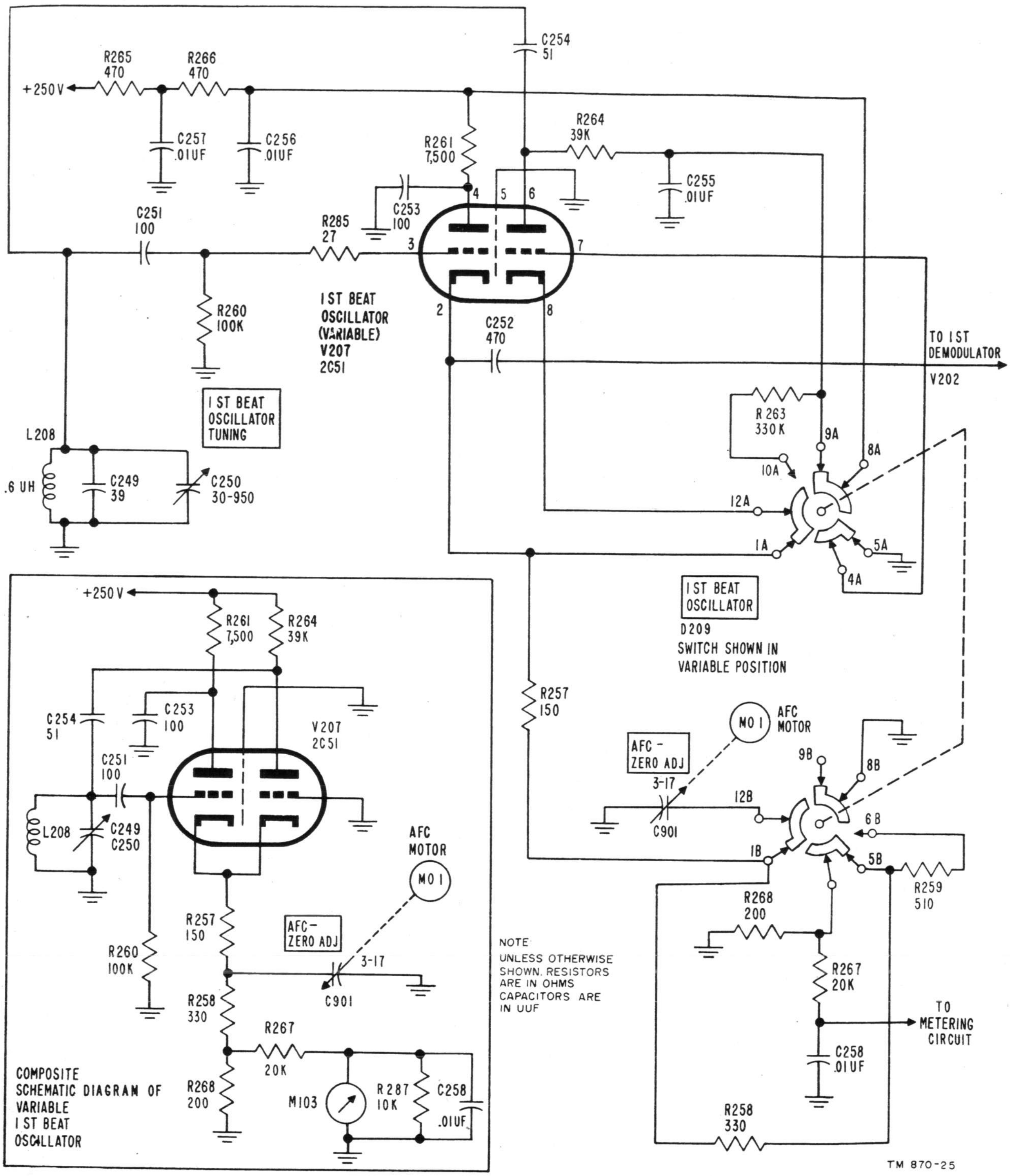

Figure 33. First beat oscillator (variable), schematic diagram.

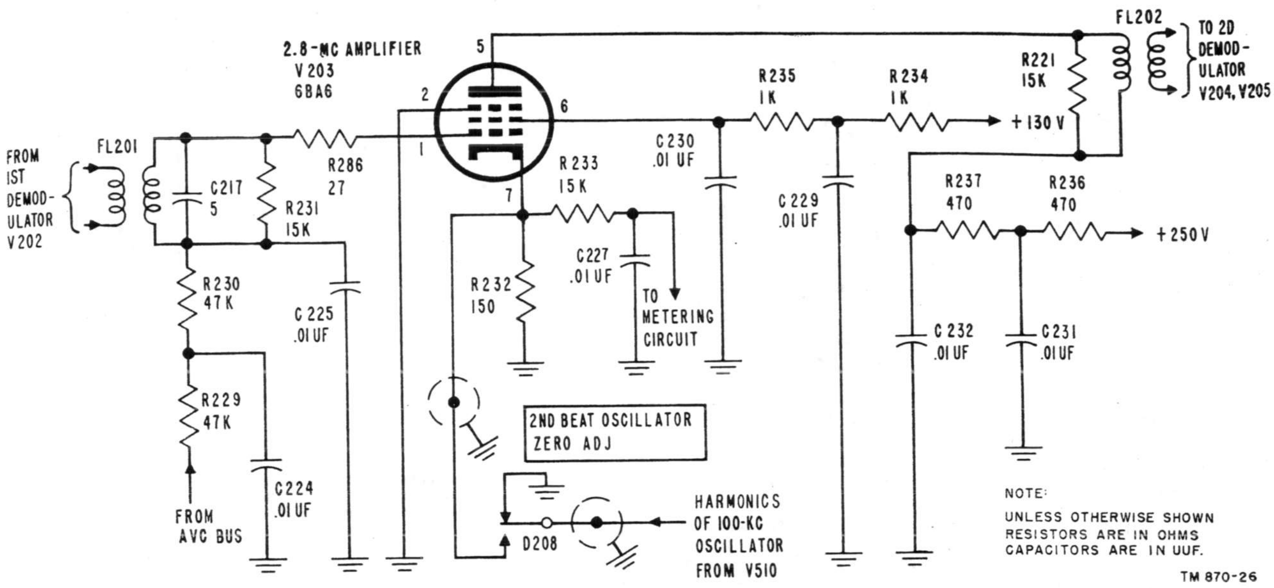

Figure 34. Amplifier, 2.8-mc, schematic diagram.

(and R268 in CRYSTAL position only) to ground. Resistor R267 is the meter multiplier. Resistor R267 and capacitor C258 prevent oscillator frequency shift when the meter is switched in and out of the circuit.

70. Amplifier, 2.8-mc

(fig. 34)

a. The 2.8-mc first if. amplifier, V203, is a pentode amplifier that uses a miniature-type tube 6BA6. It amplifies the 2.8-mc output of the first demodulator and applies its output to the push-pull second demodulator.

b. The secondary of input filter FL201, factory-adjusted to a center frequency of 2.8 mc, couples the input signal to grid 1 of 2.8-mc amplifier V203. The output signal developed across a similar filter, FL202, is coupled to balanced second demodulator V204 and V205. Network R230, R229, C225, and C224 applies full avc voltage to grid 1 through antising resistor R286.

c. The regulated 250-volt plate supply, decoupled by resistor-capacitor network R236, R237, C231, and C232, is applied to the plate, pin 5, of V203 through the primary of FL202.

d. The regulated +130-volt screen grid supply is decoupled by resistance-capacitance network R235 R234, and C229. Capacitor C230 bypasses the screen to ground for signal frequencies.

e. Dc through self-bias resistor R232 is measured by the DC METERING meter. Resistor R233 is the meter multiplier, and capacitor C277 is an rf bypass for the metering circuit.

f. Depressing the 2ND BEAT OSCILLATOR ZERO ADJ pushbutton couples harmonics of the 100-kc crystal oscillator to the cathode of the 2.8-mc amplifier. Only the 28th harmonic is amplified, providing a 2.8-mc signal for tuning the second beat oscillator. The amplifier couples the 2.8-mc signal to the second demodulator, where it is mixed with a signal from the second beat oscillator. If the frequency of the second beat oscillator is adjusted to 2.7 mc and mixed with the 2.8 mc from V203, the resulting if. is 100 kc, and is indicated by a peak reading on the CARRIER RECT CURRENT meter. If the frequency of the second beat oscillator is not 2.7 mc, the resulting if. is not 100 kc. The signal may be passed through a sideband filter and is heard as a tone in the headset. (par. 72*c*). The 2ND BEAT OSCILLATOR ZERO ADJ pushbutton is used only to set the 2ND BEAT OSCILLATOR TUNING control.

71. Second Demodulator V204 and V205

(fig. 35)

a. The second demodulator, V204 and V205, is a balanced demodulator which utilizes two miniature type 6AS6 tubes. The signal voltage of 2.8-mc amplifier V203 is mixed with the output voltage of 2.7-mc second beat oscillator V208 and the output is filtered, leaving only the 100-kc signal. This signal passes through transformer T201 and 94- to 106-kc filter FL101 (fig. 37) to if. amplifier 1 (V301).

b. The center-tapped secondary of FL202 couples 2.8-mc signals of equal amplitude but 180°

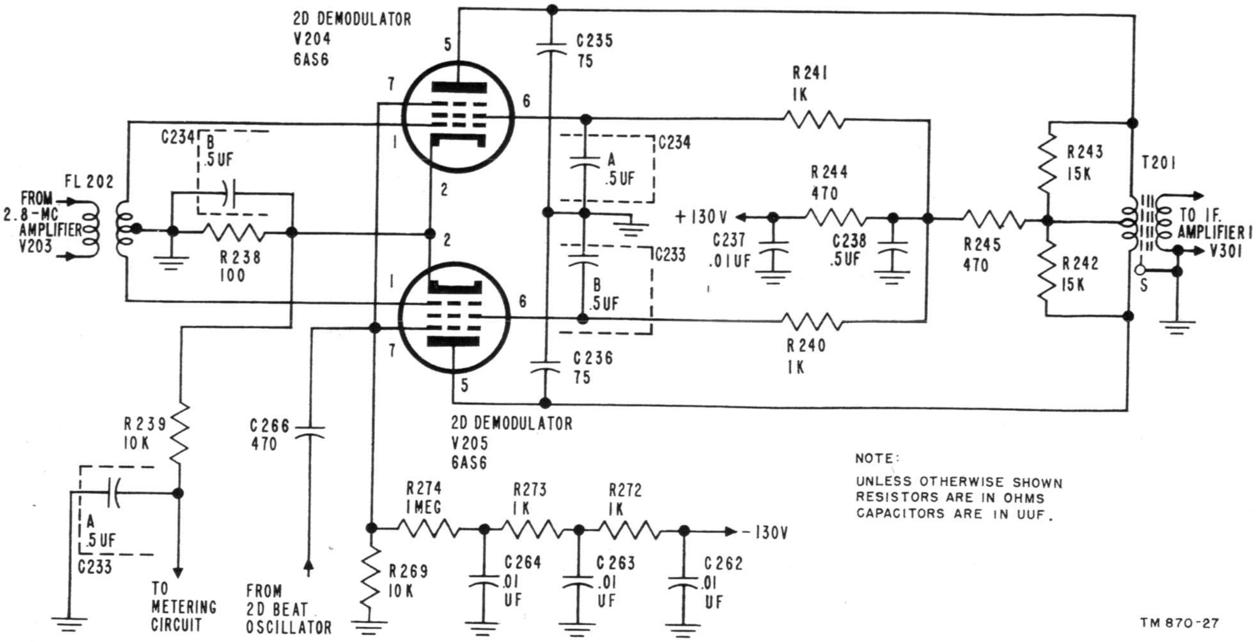

Figure 35. Second demodulator, schematic diagram.

out of phase, to grids 1 of V204 and V205 in typical push-pull fashion. Capacitor C266 couples a 2.7-mc signal from second beat oscillator V208 to the suppressor grids of V204 and V205, which are connected in parallel. The signals mix in the tubes, which results in varying plate currents that consist of the original two frequencies, the sum and difference frequencies. The 2.8-mc and the sum frequency plate signals are bypassed to ground through C235 and C236. Transformer T201 and filter FL101 further discriminate against these signals. The second beat oscillator plate signals (2.7 mc) cancel out in T201 primary. Only the difference frequency of 100 kc with ±6-kc sidebands is developed across the secondary of T201.

c. Transformer T201 couples the 100-kc signal to filter FL101, which has a bandwidth approximately 12 kc. Only the 100-kc signal with the associated sidebands is passed to if. transformer T301 (fig. 37).

d. Cathode bias resistor R238 (fig. 35), bypassed by C234B, provides a potential for metering the current that flows through V204 and V205. Capacitor C233A and resistor R239 filter the dc for the metering circuit.

e. Network R244, C238, and C237 decouples the regulated +130 volts supplied to screen dropping resistors R240 and R241 (bypassed by C233B and C234A, respectively) and plate voltage through isolating resistor R245 to center-tapped plate transformer T201. Resistors R242 and R243 are transformer loading resistors.

f. A −1.3 volts is supplied to the suppressor grids of V204 and V205 through network R272, R273, R274, and R269, bypassed by C262, C263, and C264.

72. Second Beat Oscillator
(fig. 36)

a. Second beat oscillator V208 is a continuously variable inductance-capacitance oscillator that functions exactly like the first beat oscillator (variable) (par. 69). The principal difference is that the resonant frequency of this circuit is fixed at 2.7 mc. Only slight frequency variations are possible when the circuit is being controlled by the afc motor or the 2ND BEAT OSCILLATOR TUNING control. This control is normally used for fine tuning of incoming signals.

b. When 1ST BEAT OSCILLATOR switch D209 is in the CRYSTAL position (fig. 32), contacts 2B and 12B connect the afc circuits to tuned-grid circuit L209, C259, C261, and C260 of the second beat oscillator. The afc system automatically adjusts the tuning of the grid circuit to maintain the output frequency of the second beat oscillator 100 kc away from the signals fed to the second demodulator. Capacitor C277 (fig. 87) is shunted across the second beat oscillator tuned circuit only when the 1ST BEAT OSCILLATOR switch is in the VARIABLE position.

c. The frequency of the oscillator is manually set by 2ND BEAT OSCILLATOR TUNING control C261. The 2ND BEAT OSCILLATOR ZERO ADJ capacitor, C260, enables C261 to be zero-set. In the preoperation test procedures (par. 30), 2ND BEAT OSCILLATOR TUNING capacitor C261 is set to the 0 position. The 2ND BEAT OSCILLATOR ZERO ADJ push button, D208 (fig. 34) is depressed to complete the path from plate 6 of V510, where the 28th and other harmonics of the 100-kc oscillator are present, to cathode 7 of the 2.8-mc amplifier. Although other harmonics of the 100 kc are present, they are attenuated by filter FL202 to such an extent that they may be disregarded. Thus, a 2.8-mc signal can be fed to the amplifier even if no other source of signal is available. The output of the 2.8-mc amplifier is fed to the second demodulator, where it mixes with a signal from the second beat oscillator. A difference in frequency of not more than 115 kc between the 2.8-mc signal and the signal from the second beat oscillator results in an audible beat note at MONITOR jacks J401 and J402, which monitor the receiver output. If the two signals are exactly 100 kc apart, the if. is exactly 100 kc and no audible sound is heard at the MONITOR jacks. Therefore, adjusting the frequency of the second beat oscillator for a zero-beat condition at the MONITOR jacks insures the frequency of the second beat oscillator to be 2.7 mc. This is the correct condition for obtaining a 100-kc if. signal. To obtain this condition, the 2ND BEAT OSCILLATOR ZERO ADJ push button is depressed, and 2ND BEAT OSCILLATOR ZERO ADJ trimmer capacitor C260 is varied until zero-beat conditions are established. Be sure that 2ND BEAT OSCILLATOR TUNING control is set at 0.

73. If. Amplifiers

(fig. 37)

a. The 100-kc output of the second demodulator is amplified by a four-stage if. amplifier. The suppressed carrier and the upper and lower sidebands are amplified in the first three if. amplifiers; the carrier is then tapped off for use in the afc and avc systems, and in the reconditioned carrier circuit. The signal (suppressed carrier and upper and lower sidebands) continues on through the fourth stage, the output of which is applied to a hybrid coil that feeds two signal paths. One path passes the upper sideband; the other passes the lower sideband. Since if. amplifiers 1, 2, and 3 (V301, V302, and V303, respectively), are identical,

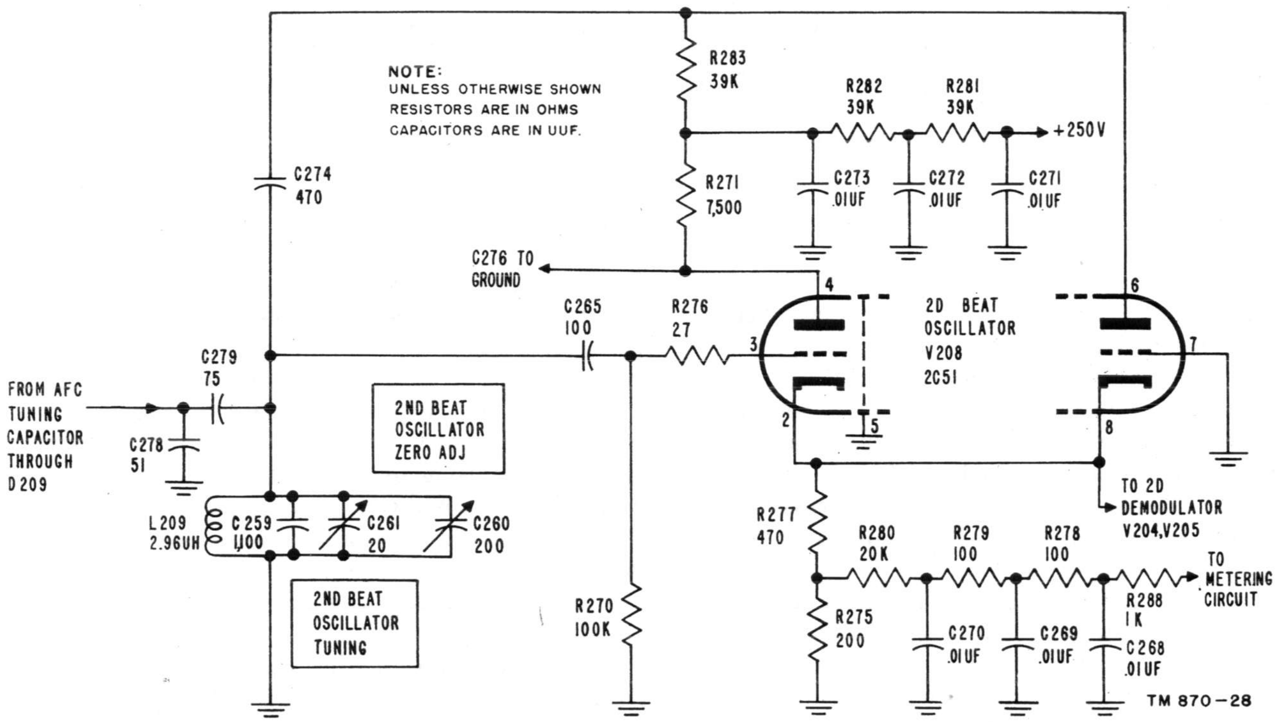

Figure 36. Second beat oscillator, schematic diagram.

only if. amplifier 1 will be described in detail. If. amplifier 4 (V304) is described in paragraph 74.

b. Input transformer T301 couples the 100-kc signal from filter FL101 to grid 1 of V301, through parasitic-suppressing resistor R337. The amplified 100 kc developed across the primary of T302 is transformer-coupled to the grid of V302. Resistors R301 and R308 are transformer-loading resistors. Jack J301, IF AMP INPUT, provides an input to if. amplifier 1 for tests.

c. Network R310, R309, C304A, and C304B decouples the stage from other stages supplied by the regulated +250-volt plate supply. The regulated +130-volt screen supply is decoupled by R306, R307, and C303B. Capacitor C303A is the screen bypass capacitor. Extensive decoupling networks are located in the plate and screen circuits of the if. amplifiers. The reason for this is that positive feedback will occur through the B+ supply in any two amplifier stages separated by a third amplifier. For example, if. amplifier 1 would receive positive feedback from if. amplifier 3, and if. amplifier 2 would receive positive feedback from if. amplifier 4. The overall gain of the if. amplifier is approximately 120 db, or a voltage gain of 1,000,000. If decoupling networks were not used, the stages would oscillate.

d. Avc decoupling network R302, R303, and C301 prevents regenerative feedback through the avc bus. DC METERING circuit resistor R305 is bypassed by C302.

e. If. amplifiers 1 and 2, V301 and V302, receive the full avc bias. If. amplifier 3, V303, receives one-half the avc bias. Additional avc is provided on the lower level stages to minimize distortion caused by cross-modulation. The 2.8-mc if. amplifier V203 receives full avc voltage; hf amplifier V201 receives one-third avc voltage.

74. If. Amplifier 4

(fig. 38)

a. If. amplifier 4 uses a miniature tube, V304, type 6AQ5, which is identical in operation to the other if. amplifiers. The principal circuit difference is a back-to-back germanium diode limiter. The limiter protects crystal filters YF401 and YF402 (fig. 39) from strong signals that damage the crystal elements. The crystal filters couple the signal from if. amplifier 4 to the third demodulators (fig. 29). The magnitude of the signals that reach the if. amplifiers (with avc) is generally not large enough to damage the crystal filters. However, in using manual volume control, if the MAN VOL CONTROL potentiometer were on a high setting, the gain of the if. amplifiers might develop a signal with an amplitude sufficient to shatter the crystals in the filters. The protection circuit (*b* below) prevents this.

b. The junction of the voltage divider that consists of resistors R396 and R398 biases RV301 to −3 volts. The junction of voltage divider R397 and R399 biases RV302 to +3 volts. Any

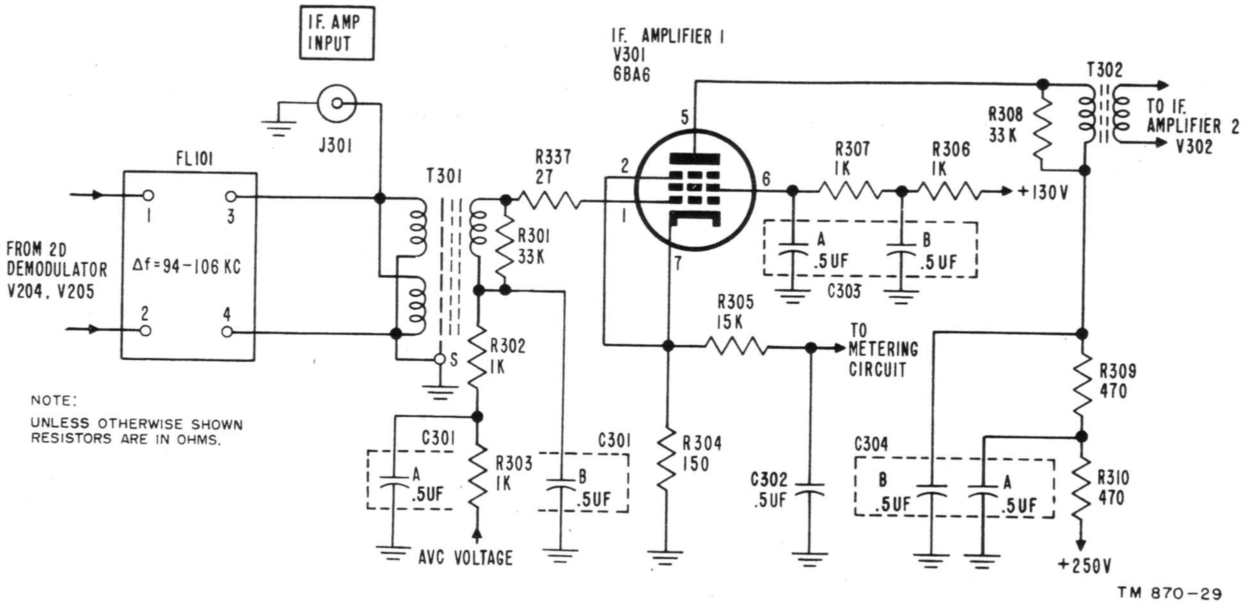

Figure 37. First if. amplifier, schematic diagram.

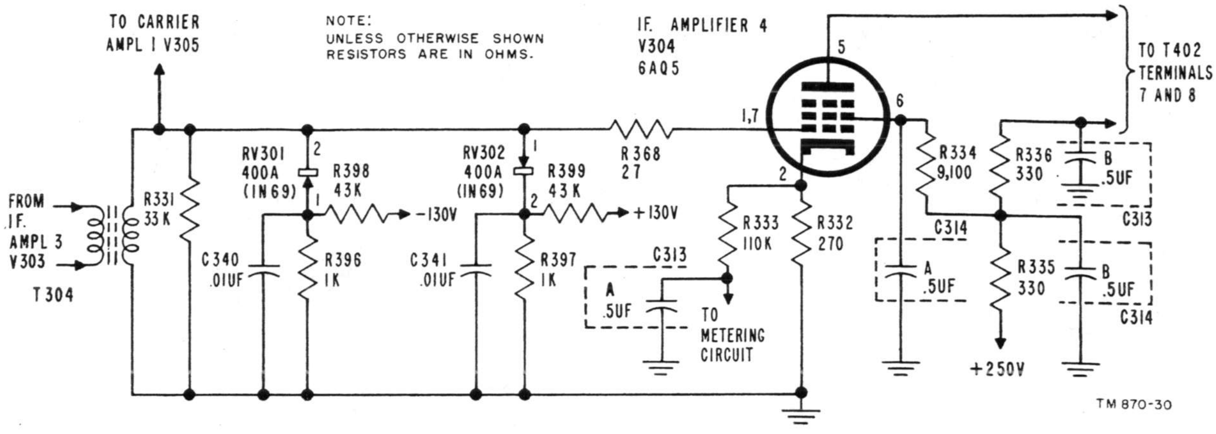

Figure 38. If. amplifier 4, schematic diagram.

signal that appears at the secondary of T304 and exceeds +3 volts permits RV302 to conduct, and any signal that exceeds −3 volts permits RV301 to conduct. When either germanium diodes conducts, the grid of the if. amplifier is effectively connected to ground. Therefore, the signals at the grid of V304 are limited to 3 volts peak amplitude, to limit the maximum output voltage of V304 to crystal filters YF401 and YF402.

c. The amplified output voltage of V304 is developed across terminals 7 and 8 of transformer T402 (fig. 39). The signal input to carrier amplifier 1 is obtained from the secondary of T304.

75. Separation of If. Signal into Upper and Lower Sidebands

a. The if. signal output of V304 consists of an am. signal with a frequency spread from 94 to 106 kc. Two sidebands are contained in this signal; one extends from 94 to 99.9 kc, and the other from 100.1 to 106 kc. Different intelligence is carried in the modulation of the two sidebands. To use the intelligence contained in each of the sidebands, the sidebands are separated by quartz crystal filters and are then demodulated in separate demodulators or detectors. Figure 39 is a simplified schematic of the circuit that distinguishes between the upper and lower sidebands and applies them to the separate demodulator channels.

b. The if. output of V304 is applied to the primary of hybrid-type transformer T402. Two secondaries couple the if. signal to groups A and B channel filters. The third winding, loaded by R426 to match the output impedance of V304, balances the coil so that interaction between Groups A and B channels is prevented.

c. The signal developed across winding 3–4 of T402 is coupled to crystal filter YF401. Crystal filter YF402 receives the output of winding 1–2. Crystal filters YF401 and YF402 are flattopped, sharply selective filters that pass the different sidebands. Terminating and isolating resistive networks, such as R405, R406, R407, and R408, are placed before and after each filter. Crystal filter YF402 passes the upper or group A sidebands from 100.1 to 106 kc; crystal filter YF401 passes the lower or group B sidebands from 94 to 99.9 kc. The output of each filter is applied to separate demodulators. Because the signal paths from each of the third demodulators to the output of the receiver are the same, only the group B circuits will be described.

76. Third Demodulator Group B
(fig. 40)

a. The third demodulator in the group B channel is a full-wave, bridge-type demodulator that uses a copper-oxide varistor, RV401. Crystal filter YF401 passes the 94- to 99.9-kc sidebands to the primary of transformer T403 through a balanced 8–db attenuator, R409 to R412 (fig. 39). A 100-kc demodulating signal is injected at the electrical center of the secondary of T403 through R413 by carrier amplifier V405. Carrier amplifier V405 supplies the 100-kc demodulating signal from one of two sources. One source (normally used) is obtained by throwing the CARRIER SUPPLY switch to LOCAL, thereby connecting the output of the 100-kc crystal oscillator to carrier amplifier V405. The other source is obtained by throwing the CARRIER SUPPLY switch to RECON, thus connecting the reconditioned carrier (obtained from the if. and limiter circuits) to carrier amplifier V405. Either the local or the recon-

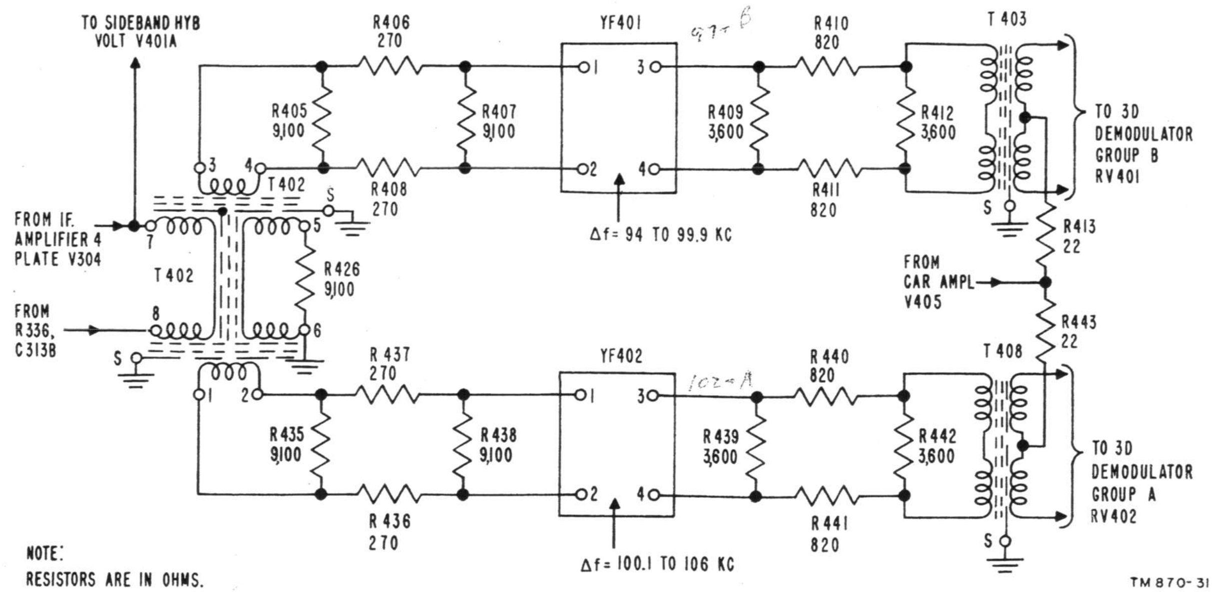

Figure 39. Groups A and B filters, schematic diagram.

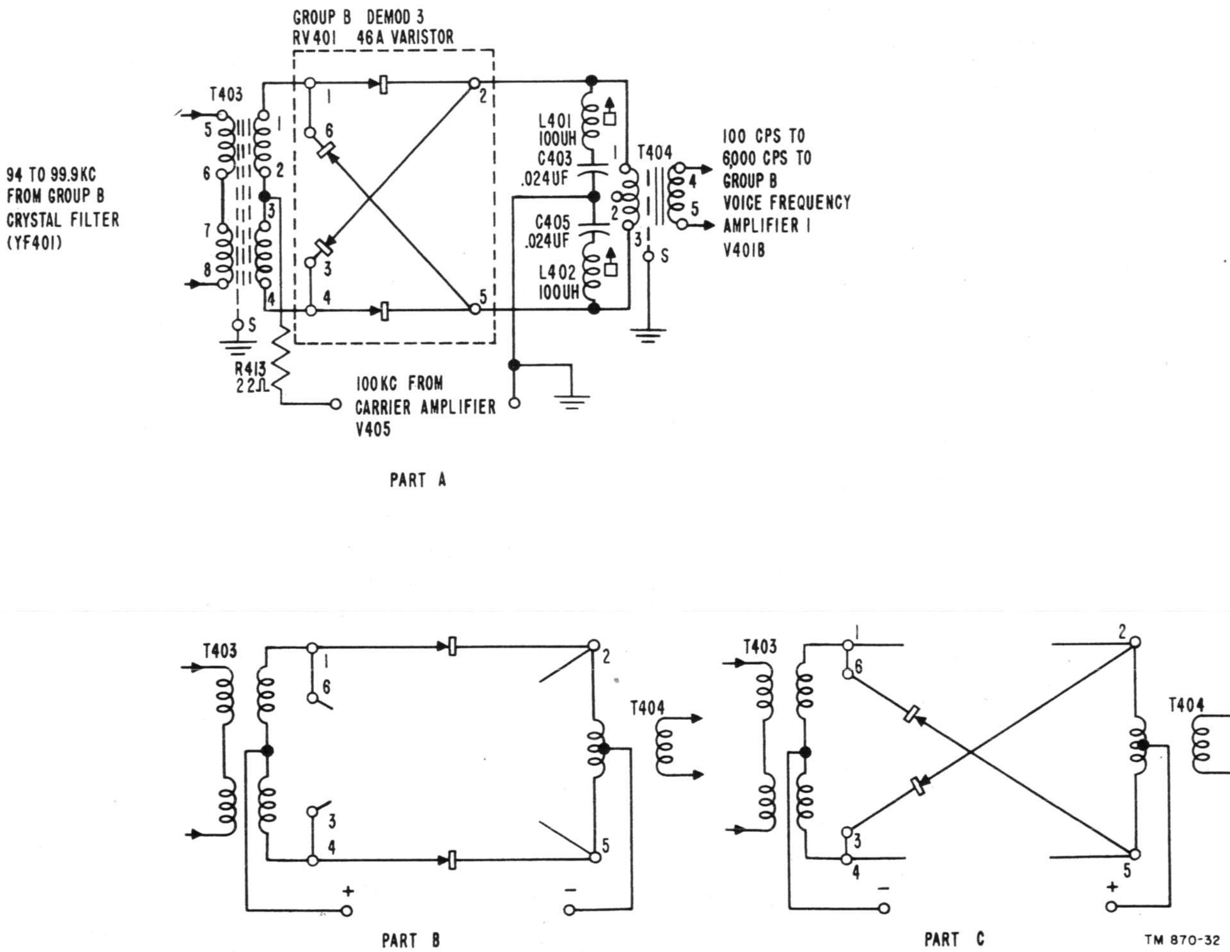

Figure 40. Third demodulator, group B, schematic diagram.

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ditioned carrier may be used in operation. The local carrier is generally preferred, especially when the radio path is subject to fading. Some military privacy systems, however, require the use of the reconditioned carrier.

b. The third demodulator is a lattice-type modulator that uses copper-oxide varistors. The lattice-type modulator is essentially a balanced bridge demodulator, with the advantage of eliminating the reconditioned or the local oscillator carrier from the output. Only the sidebands appear in the output with the hf components being bypassed in the output circuit.

c. The 100-kc output of carrier amplifier V405 is coupled to the modulator through the center tap of T403 and ground. However, terminal 2 of transformer T404 is at ground potential for 100 kc because of the series-resonant networks that consist of inductor L402, capacitors C405 and C403, and inductor L401. The virtual ground at the center tap of T404 results from the grounding of the center of the impedance network. Because the 100-kc demodulating signal from V405 is, in effect, applied to the center tap of T404, the 100-kc signal at both ends of the secondary winding will be at the same potential when the series resonant networks are aligned as in paragraph 116. This condition is necessary for the action of the demodulator.

d. The amplitude of the 100-kc demodulating signal is much greater than that of the if. signal. Consequently, the 100-kc signal determines which varistor will conduct. If terminals 1 and 4 of T403 are positive with respect to ground or terminal 2 of T404 (because of the polarity of the 100-kc demodulating carrier impressed at that instant), varistors 5–6 and 2–3 act as an open circuit (B, fig. 40) while varistors 1–2 and 4–5 conduct. If terminals 1 and 4 of T403 are negative with respect to terminal 2 of T404 at a given instant, varistors 1–2 and 4–5 act as an open circuit, while varistors 2–3 and 5–6 conduct (C, fig. 40). Because the amplitude of the if. signal is much smaller than that of the conversion frequency, it has no effect on the varistor conductivity. The direction of current in the primary of T404 is reversed under the two conditions (fig. 40). Therefore, the if. signal current in the primary of T404 will be reversed at a rate corresponding to the conversion frequency. The resulting wave form contains the original if. signal and demodulation products, but not the conversion frequency (100 kc). The original if. signal is essentially short-circuited by the series-resonant circuit L402, C405, C403, and L401, and the low-frequency demodulation products (of output) are coupled through T404 to group B amplifier 1, V401B. The sum products (about 200 kc) are not effectively amplified in the audio stages. Refer to paragraph 85 for the discussion of the carrier level meter (CAR VOLT D3 V403A 4V) which is connected to this part of the circuit.

77. Group B Amplifier 1
(fig. 41)

a. Group B amplifier 1 is one-half of a miniature twin triode tube V401B type 2C51, a conventional af voltage amplifier. The amplified signal that appears in the output is resistance-capacitance coupled to the grid of group B amplifier 2.

b. VF GAIN B potentiometer P401, in series with R414, applies the vf signal to grid 7 of V401B. V401B is a conventional, audio voltage amplifier. Capacitor C409 couples the amplified signal from plate load R418 to grid 1 of group B amplifier 2, V402.

c. The resistance-capacitance combination which consists of resistor R417 and capacitor C407 decouples the stage from the +130-volt plate supply.

d. Negative feed back between the group B amplifiers 1 and 2 is used to improve the quality of the output. The voltage feedback loop consists of capacitor C408 and resistor R419. Current feedback is provided by returning the grid circuit of V401B to a tap on the cathode of V402. Metering connections to the stage are made at the junction of R415 and R416.

78. Group B Amplifier 2
(fig. 41)

a. Group B amplifier 2, V402, is an af power amplifier that uses miniature beam power tube type 6AQ5. The amplified output is transformer-coupled to the three secondary windings of T405.

b. Windings 1–2 and 3–4 are in series and connect to VF LINE TRANSFER switch D404 (fig. 87). The VF LINE TRANSFER switch switches either vf group from one output line to the other. Monitor winding 5–6 is connected through two attenuating resistors R424 and R425 to MONITOR TRANSFER switch D406 (fig. 87). The contacts on D406 connect either the group A or B signals to MONITOR jacks J401 and J402.

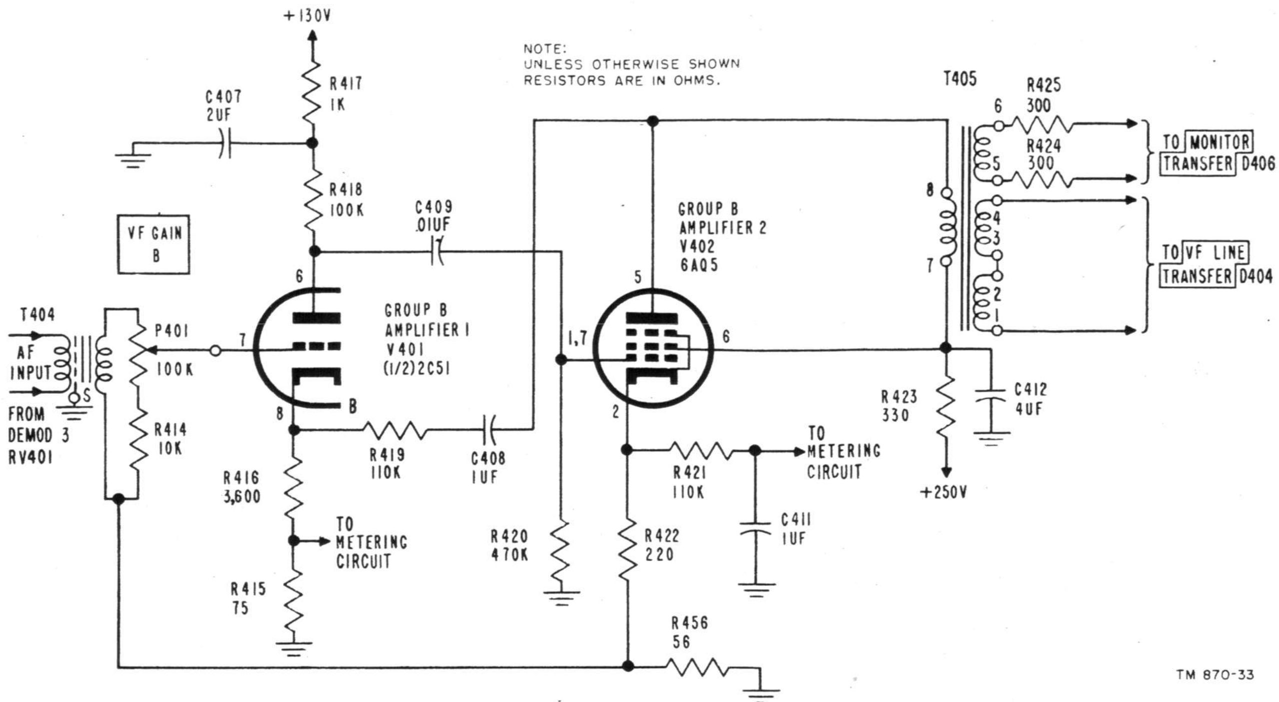

Figure 41. Group B amplifiers, schematic diagram.

c. Plate and screen voltages are obtained from the regulated +250-volt supply through R423. Capacitor C412 bypasses the screen grid (pin 6) for af currents.

d. Self-bias resistors R456 and R422 are tapped at cathode 2 by meter M103 multiplier resistor R421. Capacitor C411 bypasses meter M103 on panel 1 for af currents.

e. VU METER TRANSFER switch D405 (fig. 87) switches VOLUME INDICATOR meter M102 to the group A or B line, and obtains output level indications on either group. Resistors R105 through R107 are arranged so that the meter reads 0 vu when the level of the line is 8 dbm.

79. Carrier Amplifiers 1 and 2

(figs. 42 and 43)

a. Carrier amplifiers 1 and 2 form a two-stage amplifier whose input signal is the if. signal of 100 kc ±6 kc, and whose output frequency is 100 kc ±10 cps (at 1 db down). An extremely selective crystal filter, YF301, is used to obtain the 20-cps band pass. This 100-kc signal, with the very high signal-to-noise ratio resulting from the high selectivity, is used to operate the avc and afc circuits. It is also used as the input to the two-stage limiter, V310 and V311. The limiter, in turn, provides the 100-kc signals used as the reconditioned carrier, and one of the two 100-kc signals used to operate the afc circuit. Refer to the block diagram (fig. 29) for the signal flow paths.

b. The if. signal input to carrier amplifier V305 (a miniature tube type 5591/403B) is obtained from the grid circuit of if. amplifier 4, V304, and is developed across CARRIER BRANCH GAIN potentiometer P301. This control determines the output level of the carrier amplifiers and its setting depends on the amount of carrier suppression in use at the transmitter. It is calibrated during the initial adjustments of the equipment (par. 31*b*). Figure 83 is a typical calibration curve for this control; it shows CARRIER BRANCH GAIN dial settings plotted against transmitter carrier suppression. Normally 20 db suppression is used in the AN/FRC–10 system when both sidebands carry intelligence. Carrier amplifier 1 amplifies the incoming signal and couples the resulting voltage to crystal filter YF301 through transformer T305 and pad R345, R346, and R347. This 20-db pad is used to minimize reflections, caused by impedance mismatch outside the band pass of the filter, and to protect the filter from overloads.

c. Crystal filter YF301 is a very narrow band-pass filter that passes only the 100-kc carrier frequency with sidebands of 10 cps, at 1 db down. Because of the narrow band pass, almost all hum

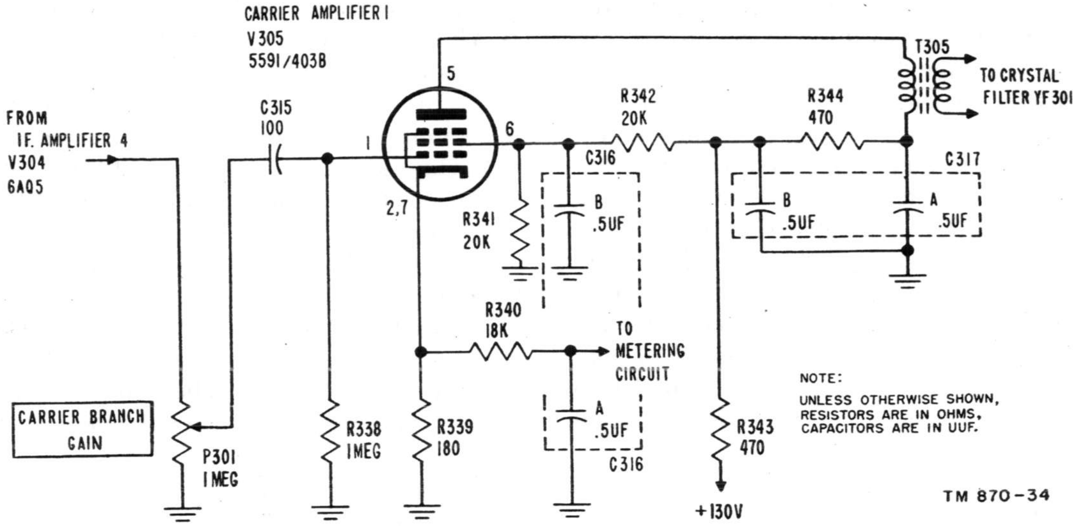

Figure 42. Carrier amplifier 1, schematic diagram.

modulation is excluded from the output of the crystal filter, although ±10 cps of noise modulation remains. The output of the filter is applied to carrier amplifier 2. Carrier amplifier 2, V306 (fig. 43) is similar to carrier amplifier 1 (fig. 42) except for lower input impedance, antising resistor R374, bypass capacitor C319B, and higher screen voltage. The 100-kc output signal of the crystal filter is coupled to the grid of carrier amplifier 2. The amplified signal of carrier amplifier 2 is developed across T306, which couples the signals to plate 7 of avc rectifier V307A and cathode 5 of squelch carrier rectifier V307B.

d. Resistance-capacitance filter R342 to R344 and C316B and C317, decouples the plate and screen circuits of V305 from the +130-volt regulated supply. A similar decoupling network is located in the plate and screen circuits of carrier amplifier 2, V306.

80. Avc System

(fig. 44)

The avc circuit is used to control the gain of the receiver so that the output level will remain constant with moderate variations in the input level. The use of an avc system usually results in a decreased receiver sensitivity. To use the full gain of the receiver with weak signal inputs, an avc delaying device is used. AUTO VOL CONTROL DELAY potentiometer P302 is set during the initial adjustment to prevent application of the avc potentials to the controlled stages (fig. 29)

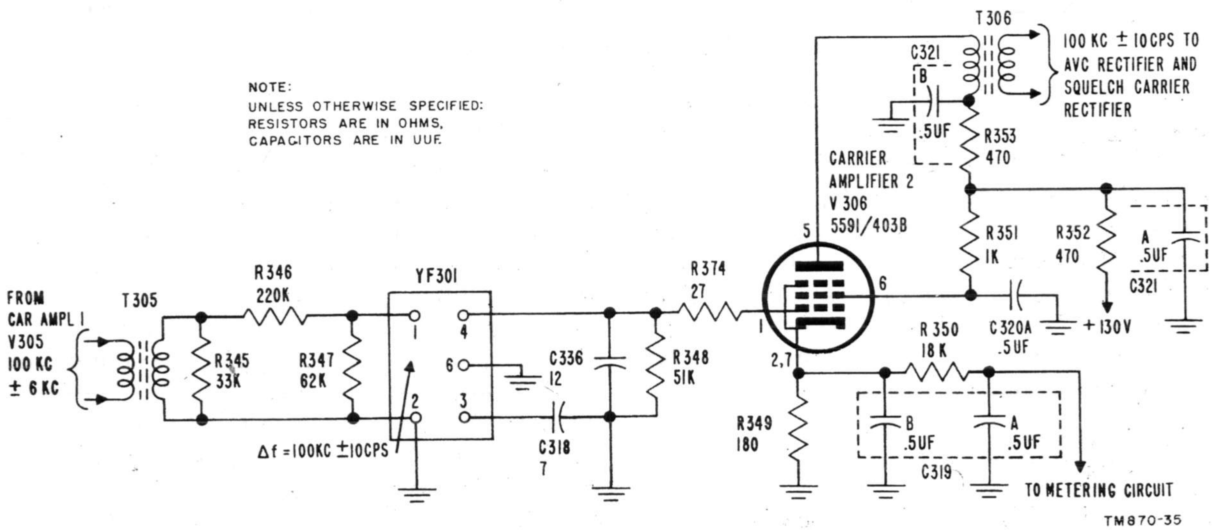

Figure 43. Carrier amplifier 2, schematic diagram.

until the signal level exceeds a certain predetermined value. Three resistors (R369, R370, and R371) form a voltage divider across the developed avc potentials. Their values are chosen so that the full amount of avc voltage is applied to the 2.8-mc amplifier, if. amplifier 1, and if. amplifier 2. One-half of the full amount of avc voltage is applied to if. amplifier 3. One-third of the full amount of avc voltage is applied to the hf amplifier. A greater amount of controlling voltage is applied to the lower level stages to minimize the distortion from cross-modulation. A small amount of controlling voltage is applied to the hf amplifier to obtain a better signal-to-noise ratio. Manual limiter operation, and carrier level indications (CARRIER RECT CURRENT meter M101). It operates with the avc dc amplifier which has a control in the cathode circuit that provides delaying action of the avc voltage on weak signals.

b. One side of the secondary of the input transformer, T306, couples the 100-kc signal from carrier amplifier 2, V306, to plate 7 of V307A; the other side of T306 is bypassed to ground through C320B. During the positive peaks of the signal at the plate, V307A conducts and capacitor C337 charges through R357 to the average level of the rectified 100-kc signal. The potential on C337 is directly proportional to the average carrier signal

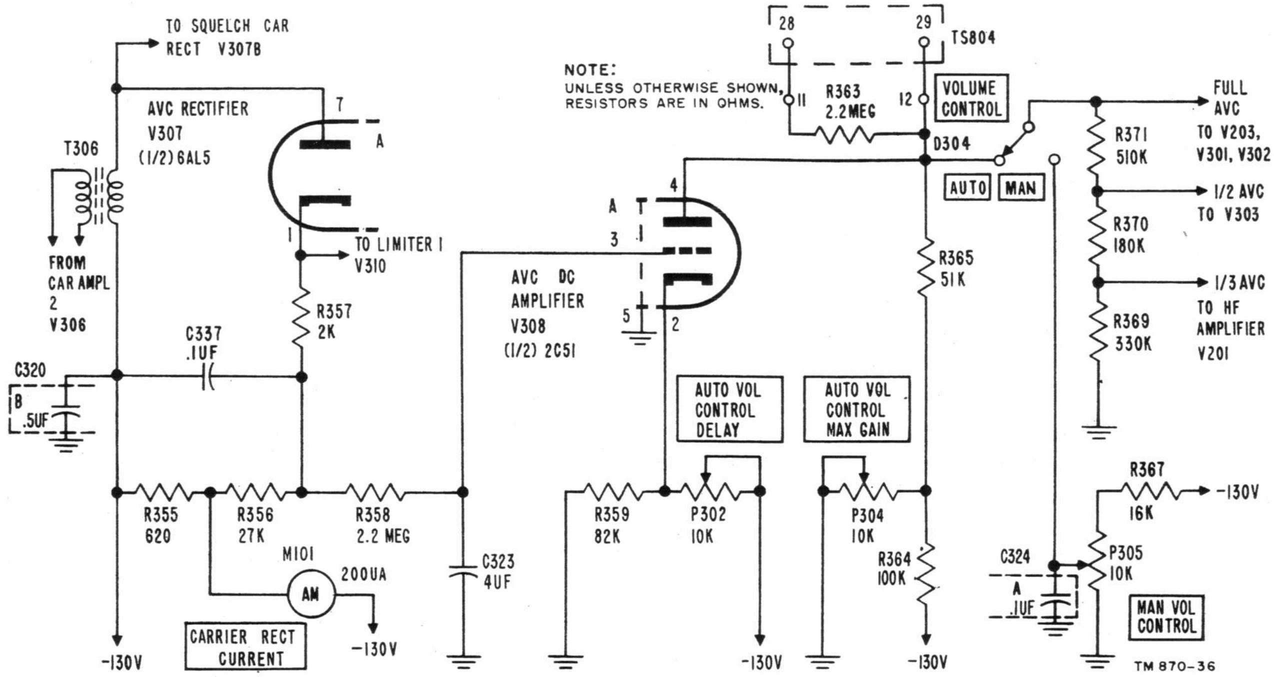

Figure 44. Avc system, schematic diagram.

volume control of the receiver is also provided. Throwing the VOLUME CONTROL switch from AUTO to MAN connects the three resistors, across which the avc potentials are developed, in parallel with the MAN VOL CONTROL potentiometer. The potentiometer, in turn, is supplied with potential from the −130-volt power supply. Any adjustment of the manual volume control changes the potentials across the resistors, thus changing the gain of the receiver.

81. Avc Rectifier

(fig. 44)

a. Avc rectifier V307A, using one-half of miniature duplex-diode 6AL5, supplies voltages for avc, strength because the input to V307A consists of only the carrier of the incoming signal. Because the carrier conveys no intelligence in the form of modulation and is transmitted at constant amplitude by the distant station, changes in its level at the receiving terminal are the result only of fading, etc. Thus, because the carrier level is a better index of average signal strength than sideband level, which will vary in amplitude with modulation, the avc control voltage is obtained from it. Resistor R358 couples this dc potential to grid 3 of avc dc amplifier V308A, where it is used as a control bias for the stage. The junction of diode load resistors R355 and R356 connects to CARRIER RECT CURRENT meter M101 on panel 1. A lead connected directly to cathode 1 of V307A couples the 100-kc signal to the grid circuit of limiter 1. Signal voltage for squelch carrier rectifier V307B is taken off T306 in parallel with the avc rectifier input.

82. Avc Dc Amplifier
(fig. 44)

a. Avc dc amplifier V308A, using one-half of twin triode tube type 2C51 with its associated components, functions as the avc delay circuit and a dc amplifier and AUTO VOL CONTROL MAX GAIN adjustment.

b. Basically, the avc circuits function by generating a negative output voltage with an amplitude that is proportional to the signal strength. This voltage is applied as bias to the stages whose gain must be controlled. As the signal amplitude increases, the voltage becomes more negative, which reduces the gain of the stages and thereby maintains the output of the receiver at a constant level. When the signal level is low, however, eliminate the action of the avc circuit. This avc delay is provided by avc dc amplifier V308A. The receiver, therefore, operates at full gain until the signal level reaches a predetermined value.

c. The avc dc amplifier operates between −130 volts and ground. The plate is operated at or near ground potential because the dc bias voltage developed must be directly coupled to the hf and if. amplifier grids. For the tube to function, the cathode must be connected to a negative voltage source. The negative cathode voltage is furnished by the voltage divider which consists of resistor R359 and AUTO VOL CONTROL DELAY P302. Plate voltage (positive with respect to the cathode) is supplied by the voltage difference set up by the voltage divider which consists of resistor R364 and AUTO VOL CONTROL MAX GAIN P304. The grid of V308A is connected through R358, R356, and R355 to the −130-volt terminal, which places the grid at a negative potential with respect to the cathode.

d. The position of AUTO VOL CONTROL MAX GAIN control P304 determines the static voltage on the stages with avc control. During the initial adjustment procedures, P304 is set to give the proper receiver gain (that is a noise level 5 db below normal speech output). AUTO VOL CONTROL DELAY control P302 is then adjusted to place a potential on the cathode that causes the tube to operate below cutoff. This potential may be adjusted between approximately −116 and −130 volts. The grid voltage is −130 volts furnished through R355, R356, and R358. Thus, the avc potential developed across C337 by low level signals does not cause the amplifier tube to conduct and alter the plate potential, if the amplitude does not exceed the difference between the grid and cathode potentials. As soon as the signal amplitude reaches this predetermined level, the positive voltage developed across C337 allows V308A to conduct. When V308A starts to conduct, plate current flow through R365 causes the potential at plate 4 to become more negative. This potential is coupled to the grids of the avc-controlled hf and if. amplifier tubes. The increase in negative grid potential on the tubes reduces the gain of the avc-controlled stages.

e. Resistor R358 and capacitor C323 form an 8.8-second time-constant network. This long-time-constant circuit prevents the development of an avc voltage by sudden shifts in received signal strength which will occur as a result of noise peaks or flutter fading. Instead, the avc voltage follows the average value of received signal strength and is effective in compensating for changes in signal strength caused by slow fading.

f. In the MAN position, VOLUME CONTROL switch D304 switches the control of the gain of the hf and if. stages to MAN VOL CONTROL potentiometer P305, which has approximately −50 volts across it from the −130-volt supply through R367. The arm of P305 is bypassed with C324A.

g. Resistors R371, R370, and R369 supply full, one-half, and one-third avc or manual volume control potential to the controlled stages.

h. On panel 3, terminals 11 and 12 in the plate circuit of V308A are connected to terminals 28 and 29 on the rear terminal strip, TS804. This makes possible connection of the avc circuits of two or more receivers for space diversity operation (terminal 29 of one receiver connected to terminal 29 of another receiver). They may also be used for connecting a recording vtvm to record variations in received signal strength (terminal 28). Resistor R363 isolates the recording circuit to prevent disturbance in the receiver avc circuits.

83. Limiter Amplifiers 1 and 2
(fig. 45)

a. Limiter amplifiers 1 and 2 use miniature tubes type 5591/403B. A 100-kc signal is coupled to the grid of limiter 1 through C328 from the avc rectifier across R382. The signal drives limiter 1 into the grid current region on the positive excursions of the grid signal, and into cutoff on the negative excursions of the grid signal, thus limiting the amplitude of the output signal. This output is coupled to limiter 2, where the limiting process is repeated. The plate current of limiter 2 is a constant amplitude signal at a frequency of 100 kc. This 100-kc signal is coupled to carrier amplifier V502 as one of the two 100-kc signals used in the afc circuits, and to carrier amplifier V405 for use as the reconditioned carrier for the third demodulators when the LOCAL-RECON CARRIER SUPPLY switch D403 is on RECON. The screen of limiter 2 rectifies the carrier and low-frequency noise components of the signal. Capacitor C335 bypasses the 100-kc ripple so that only the low-frequency audio noise components are coupled to V309, which is the squelch low-frequency noise amplifier for use in the afc squelch control system.

b. Capacitor C328 couples a 100-kc signal from avc rectifier V307A to grid 1 of limiter 1, V310. Capacitor C331 couples the plate signal developed across network N301, which is resonated at 100 kc, to grid 1 of V311. Capacitor C338 is part of the network-resonant circuit. The constant amplitude output voltage of V311 is developed across tuned network N302, where it is coupled to carrier amplifiers V405 and V502. Capacitor C333 matches the impedance of the coaxial cables to that of network N302.

c. Resistance-capacitance filter R386 and C330B decouples the plate from the M130-volt supply. Resistors R385 and R384 and capacitors C330A and C329A decouple plate and screen from the +130-volt supply.

d. Cathode-biasing resistor R383 is bypassed by C329B. A lead connected directly to cathode 7 connects to the metering circuits.

e. Similar cathode, metering, decoupling, and biasing circuits are found in limiter 2, V311.

f. Terminal TPT, between R387 and R395, is used during certain tests. TP302 supports isolating resistor R390 and is the connecting point for the coaxial cable to switch D403.

84. Carrier Amplifier V405

(fig. 46)

a. Carrier amplifier V405 is a conventional, rf buffer amplifier that uses a miniature tube type 5591/403B. It supplies a 100-kc heterodyning signal to both third demodulators. Carrier amplifier V405 obtains its 100-kc input from either the 100-kc crystal oscillator or the reconditioned carrier signal filtered from the 100-kc if. signal. The input applied to V405 is determined by the position of CARRIER SUPPLY switch D403. In the LOCAL position, the output of the crystal

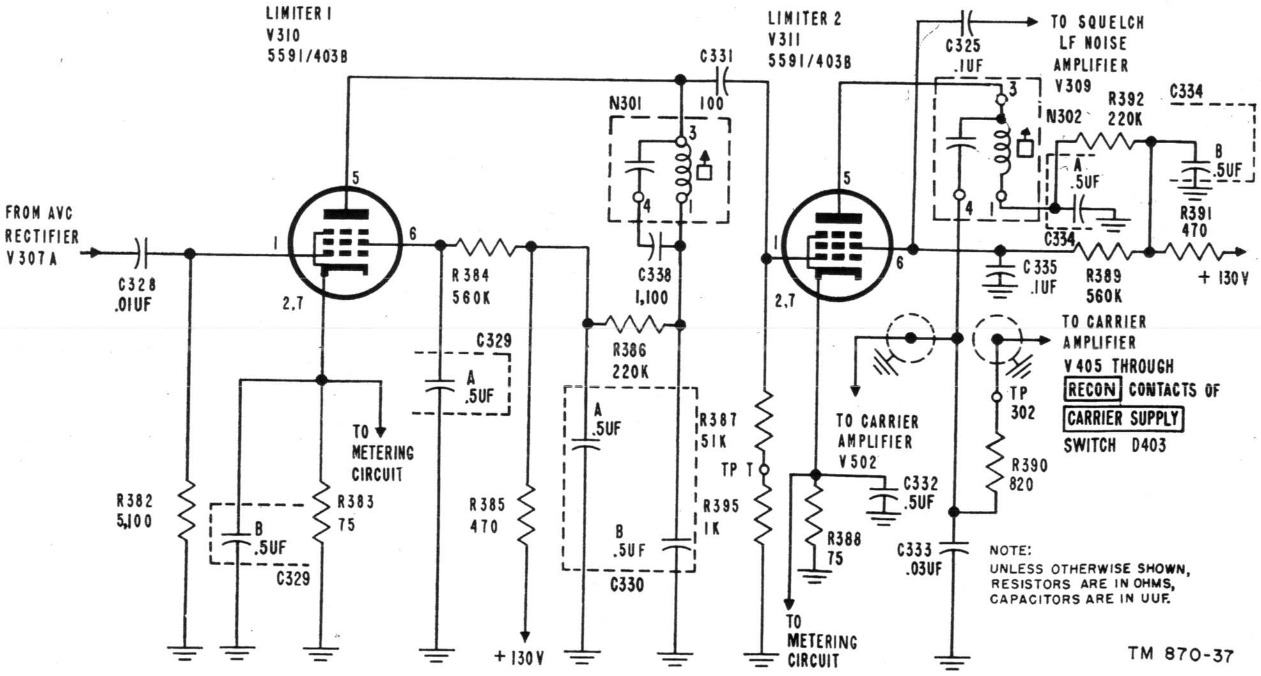

Figure 45. Limiter stages, schematic diagram.

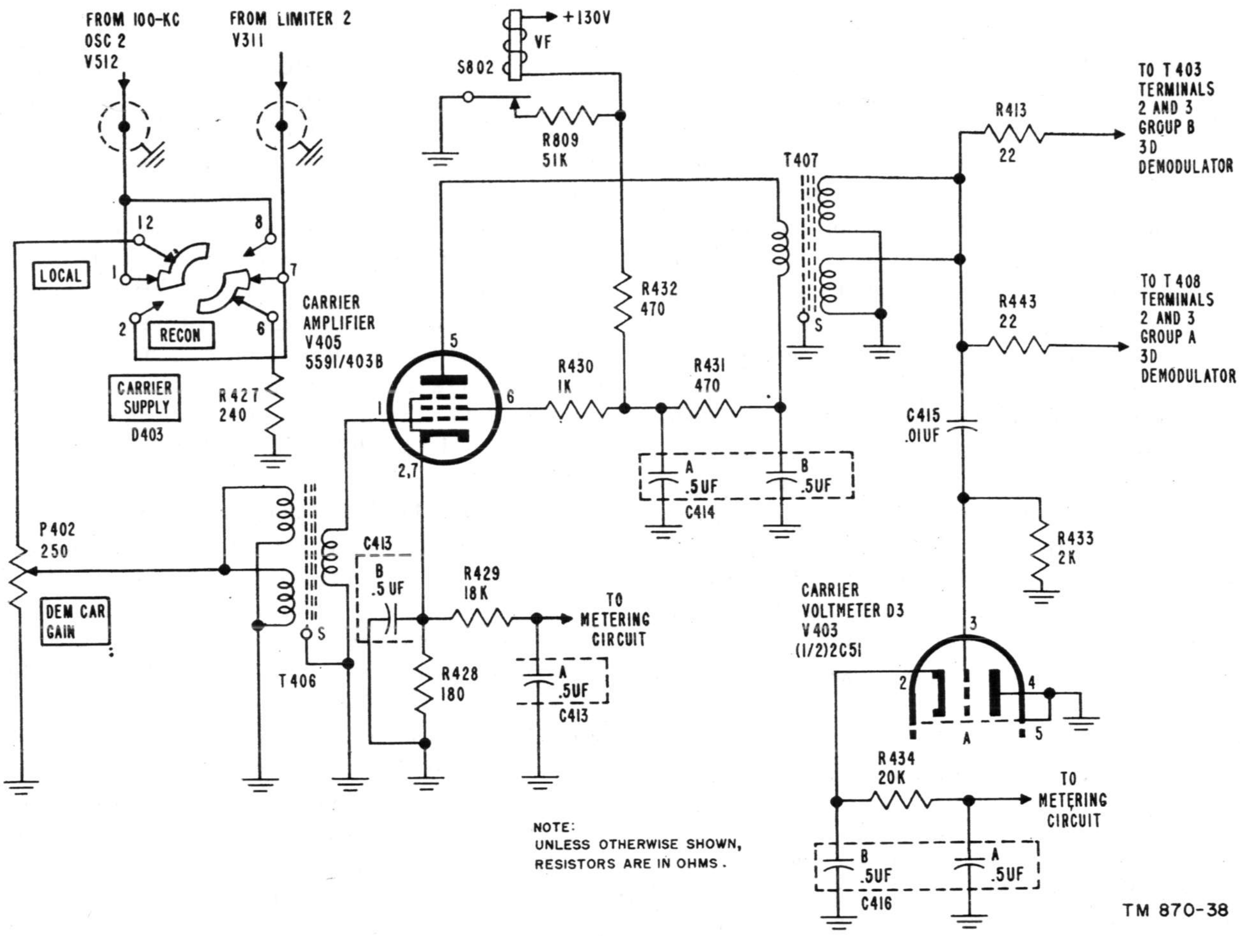

Figure 46. Carrier amplifier V405, schematic diagram.

oscillator is applied across the DEM CAR GAIN potentiometer and the output of limiter 2 is terminated in R427; in the RECON position, the reconditioned carrier is applied across this potentiometer.

b. DEM CAR GAIN potentiometer P402 controls the input level coupled to grid 1 of V405 through T406. The secondary windings, connected in parallel, of plate transformer T407 couple the amplified 100-kc carrier (local of reconditioned) to the center-tapped terminals of transformers T403 and T408. Capacitor C415 couples part of the 100-kc signal to grid 3 of the carrier voltmeter, where it is rectified and filtered. DC METERING meter M103 on panel 1 measures this carrier level when the PANEL SELECTOR switch is on panel 4 and PANEL 4 VT CURRENTS switch is on CAR VOLT D3 V403A 4V.

c. Resistors R432 and R431 and capacitors C414A and C414B decouple the plate circuit from the +130-volt supply. The screen is decoupled from the +130-volt supply by resistor R432 and capacitor C414A and C414B; R430 is the screen dropping resistor.

d. Self-bias resistor R428, bypassed by C413B, is connected at the cathode to meter multiplier R429, which is bypassed by C413A.

e. Plate and screen voltages for this stage are supplied from the +130-volt supply through vf relay S802. Loss of current through the tube, caused by failure of the tube or the +130-volt supply, causes the green vf lamp on the front panel to go out. Lamp contacts on the vf relay (not shown in fig. 46) are shown in figure 87. Release of the relay connects R809 from the plate to ground to assure more sensitive relay reoperation.

85. Carrier Voltmeter D3

(fig. 46)

a. Carrier voltmeter (CAR VOLT D3 V403A 4V) provides the means for determining the carrier level applied to the third demodulators.

One-half of a miniature twin triode tube type 2C51 is used, with the plate grounded. The grid, pin 3, and cathode, pin 2, are used in a rectifier circuit.

b. Tube V403A and its components function as a peal voltmeter. Part of the 100-kc output signal that appears across the secondary of T407 is applied to the grid of V403A. During the positive peaks of the 100-kc signal applied to the grid, capacitor C416B charges through the tube to the peak value of the signal. The discharge path of the capacitor is through meter multiplier resistor R434 and the metering circuit. Thus, the peak positive signal voltage keeps the capacitor charged, and the meter indicates a current proportional to the small discharge current. Capacitor C416A is an ac bypass capacitor for the metering circuit. PANEL 4 VT CURRENTS switch in position CAR VOLT D3 V403A 4V meters this circuit. The cathode circuit of V403A is open until the meter is switched into the circuit.

86. 100-kc Oscillator Circuit

(fig. 47)

a. The 100-kc oscillator circuit consists of a two-stage amplifier that uses two miniature tubes type 5591/403B, with a separate feedback circuit between the output and input. The feedback circuit consists of a bridge in which the output of the amplifier is connected to one diagonal and the input is connected to the other diagonal. One arm of the bridge consists of a switchboard lamp, LP501, the cold resistance of which is much less than that required to balance the bridge. When the oscillator is turned on, there will be little attenuation in the feedback path and the 100-kc current flowing through lamp LP501 will heat it up to bring the bridge closer to balance. A completely balanced bridge would stop the feedback and interrupt the oscillations so that this condition is only approached. As the condition of balance is approached, LP501 cools down and the feedback increases again. By proportioning the bridge elements properly, a stable operating point is quickly achieved, which results in high amplitude stability. Amplitude stability is one requirement of a very stable crystal oscillator.

b. The oscillator tubes are biased to operate class A with drive low enough so that only low level harmonics are produced. The frequency of operation is dependent on the tuned circuit in the bridge arm which consists of crystal unit Y501 and associated tuning capacitors C525 to C530 inclusive. Because Y501 operates at its series-resonant frequency, it will present a low resistive impedance only at resonance. A small change in frequency produces a relatively large change in reactance, effectively altering the bridge conditions and the feedback voltage. As a result, oscillations occur at only one frequency when the bridge circuit constants remain unchanged. Because the frequency stability of the oscillator depends on the Q of the crystal, a very high order of stability results. The output is coupled to the LOCAL contacts of the CARRIER SUPPLY switch and to the afc circuits.

c. 100 KC OSCILLATOR BALANCE potentiometer P503 is used to adjust the crystal arm of the bridge to the correct balance point. It is factory-adjusted and should not be reset unless the crystal is changed. Paragraph 117 gives the adjustment procedure. 100 KC OSCILLATOR TUNING COARSE switch D503 connects one to four 91-$\mu\mu$f capacitors (C527 through C530) in shunt with capacitors C525 and C526, permitting an approximate frequency setting of the 100-kc oscillator. 100 KC OSCILLATOR TUNING FINE variable capacitor C526 (0 to 100 $\mu\mu$f) permits an exact adjustment of the 100-kc oscillator frequency. This frequency is adjusted to approximately 100 kc (par. 35), the midfrequency of the pass band of the narrow crystal filter, VF301, in the carrier branch circuits.

d. Resistors R553 and R554 and capacitors C532A and C532B decouple plate and screen circuits from the +130-volt regulated supply. Screen dropping resistor R551 is bypassed by C531B. Resistor R549 is the cathode resistor. Meter multiplier resistor R550 is bypassed by capacitor C531A.

e. Parasitic suppressor R563 prevents spurious oscillations in the grid circuit of V512.

f. 100-kc oscillator 2, V512, has similar decoupling and metering filters in its plate, screen, and cathode circuits.

g. Capacitor C535 prevents transformer T510 from oscillating at its resonant frequency of 4.5 mc. The secondary windings of T510, connected in parallel, provide coupling to the feedback path as explained above.

h. Capacitor C537 couples the 100-kc signal through R557 to the 100-kc amplifier and, through R556, to the LOCAL contacts of CARRIER SUPPLY switch D403.

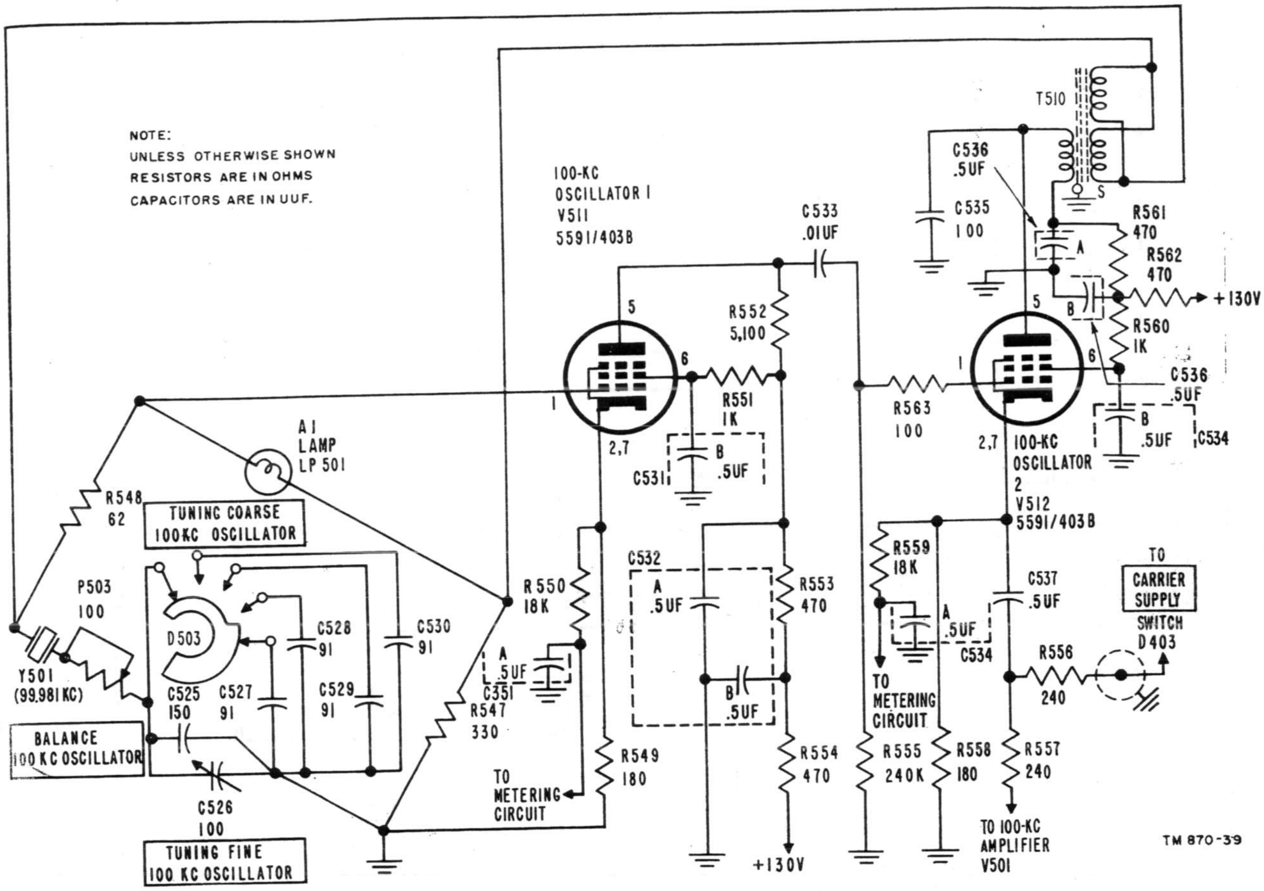

Figure 47. 100-kc oscillator circuit, schematic diagram.

87. Operation of Afc System

(figs. 29, 49, and 50)

a. The operation of the afc system involves the application of power to a two-phase motor. In turn, the motor rotates capacitor C901, which controls the frequency of the first or second beat oscillator (par. 63*s*, *u*, and *w*). Motor MO 1, motor-driven capacitor C901, and a limit switch, which energizes the afc red alarm lamp, LP101, when the capacitor approaches the end of its travel in either direction, comprise the D-170114 afc control unit. Two stages (each with an input potentiometer, P501 and P502) which consist of 100-kc amplifier V501 and carrier amplifier V502, provide the means whereby the 100-kc local oscillator signal and the 100-kc reconditioned carrier signal are made equal in level, and combine the signals into four phase-quadrature voltages. Each of these phase-quadrature voltages, in turn, is coupled to one of four afc power amplifiers. The output of each power amplifier is demodulated, filtered, and coupled to one of the four terminals of the two-phase motor. This motor will not run if voltage is applied to only one pair of windings. The operation of the motor is such that the direction of rotation, within certain limits, depends on the difference in frequency between the 100-kc local carrier and the reconditioned carrier. If the reconditioned carrier frequency is higher than the local carrier frequency, the motor rotates in one direction. When the reconditioned carrier is lower than the local carrier frequency, the motor rotates in the other direction. In the 4- to 10-mc band, the first beat oscillator operates above the incoming signal, and in the 10- to 28-mc band, the first beat oscillator operates below the incoming signal. Thus the direction of motor rotation necessary to make a correction when the frequency of the reconditioned carrier is too low depends on whether the receiver is operating above or below 10 mc. To accomplish this reversal, AFC REVERSE switch D206 is provided. The AFC REVERSE switch is kept in position 1 in the 4- to 10-mc frequency range. The switch is kept in position 2 in the 10- to 28-mc frequency range and when the 1ST BEAT OSCILLATOR switch is in

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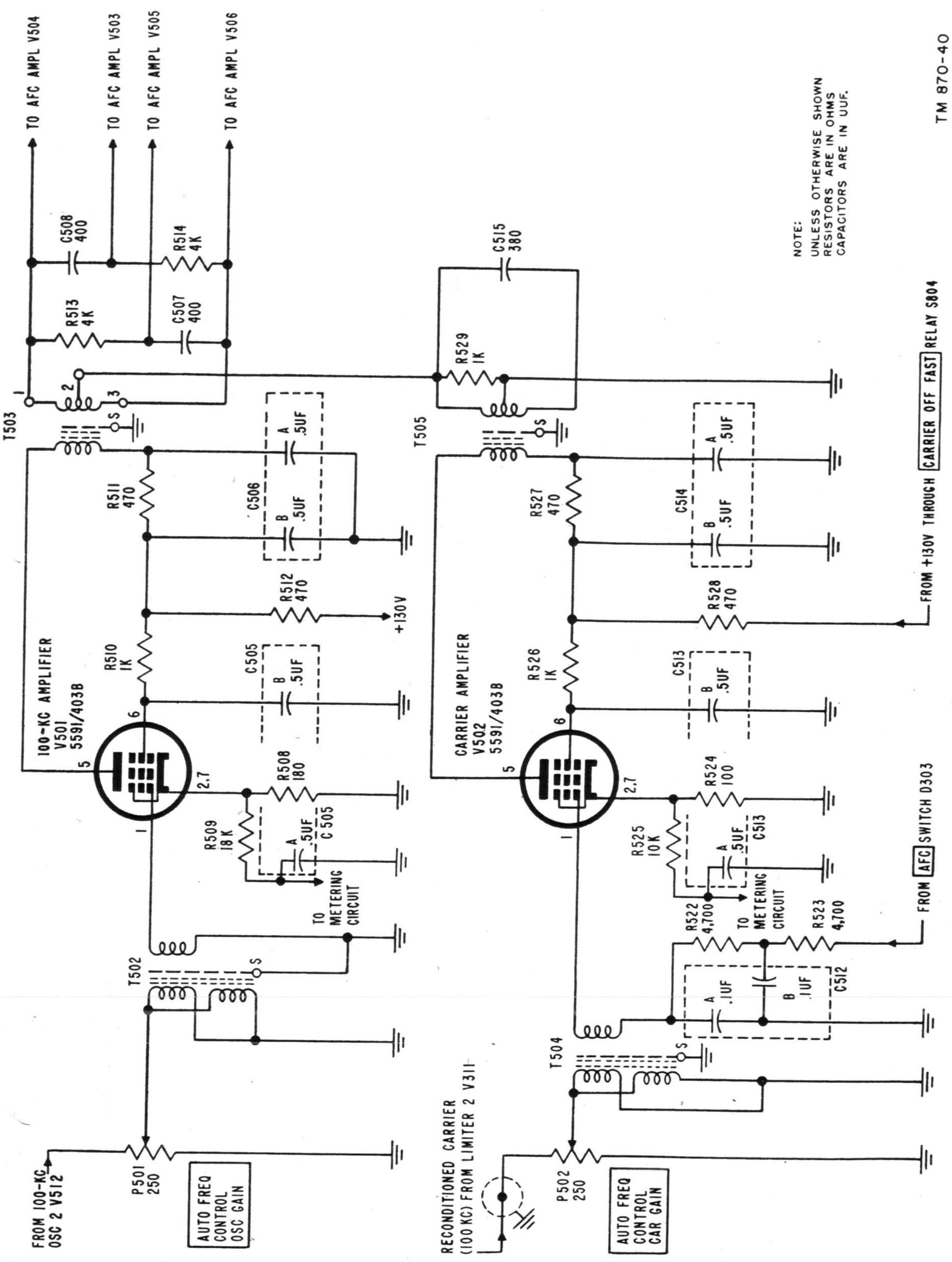

Figure 48. Carrier amplifier V502 and 100-kc amplifier, schematic diagram.

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the CRYSTAL position. Carrier amplifier V502 operates with cathode bias and also a grid control bias that depends on the position of AFC switch D503 (and signal to noise conditions).

Note. The position of AFC REVERSE switch D206 depends on whether the received frequency is above or below 10 mc and not on the position of RANGE switch D203 (fig. 30).

b. A feature of the afc system is an automatic squelch circuit that disables the afc system whenever the rf carrier fades or the noise level increases materially. This prevents the afc system from operating on the noise signals that might result in detuning of the receiver. Make the tests in paragraph 35 correctly so that this circuit will function properly.

88. Carrier Amplifier V502 and 100-kc Amplifier

(fig. 48)

a. The inputs to these stages are the 100-kc signal generated by the 100-kc crystal oscillator and the 100-kc reconditioned carrier from limiter 2, V311. The two stages that operate with each other develop four voltages in phase quadrature. When the signals are not equal in frequency, the frequency difference is applied to the motor windings and the afc motor is made to rotate. The effect of this rotation is to tune the appropriate beat oscillator so that the frequency of the reconditioned carrier is restored to 100 kc.

b. The 100-kc amplifier, V501, which receives the output of the 100-kc oscillator, is a conventional rf amplifier. The primary of T502 is driven by the 100-kc signal taken from AUTO FREQ CONTROL OSC GAIN P501. The amplified output voltage is developed across the primary of T503. The secondary of T503 and the network, composed of resistors R513 and R514 and capacitors C507 and C508, produces the four quadrature voltages.

c. The values of the resistors and capacitors that comprise the quadrature network are chosen so that their impedances are equal at 100 kc. It can then be shown that the output voltages differ from each other by 90° in phase. These voltages are applied to the input of the four afc amplifiers.

d. The center tap of T503 is connected to ground through resistor R529 which, in turn, is connected in the secondary circuit of transformer T505. The 100-kc reconditioned carrier, amplified by carrier amplifier V502, is mixed with the 100-kc oscillator signal. Carrier amplifier V502 is similar in operation to V501 except that the bias of V502 is controlled by the signal-to-noise ratio from the afc squelch circuits, and that B+ is applied through relay S804. Because the reconditioned carrier is applied to center tap terminal 2, terminals 1 and 3 of the transformer are at the same potential for the reconditioned carrier. Thus, for the reconditioned carrier, the opposite sides of the transformer are in phase. Therefore, no difference of potential exists across the phase-splitting network. The reconditioned carrier adds to each of the quadrature voltages, but these added voltages are in phase. The four combined signals, which consist of the four quadrature voltages obtained from the 100-kc oscillator signal and the four in-phase voltages that result from the injected reconditioned carrier, are applied to the afc amplifiers.

89. Afc Amplifiers and Rectifiers

(figs. 49 and 50)

a. The four quadrature voltages developed by the quadrature network (par. 88*d*) are applied to four afc amplifiers which drive four afc rectifiers. The afc rectifiers heterodyne the 100-kc oscillator signal and the reconditioned carrier signal, extract the difference frequency signal, and apply it to the afc motor. The afc motor rotates; this changes the oscillator frequency (first or second beat oscillator, depending on how 1ST BEAT OSCILLATOR switch is set) and causes the reconditioned carrier frequency to return to 100 kc. When the frequency of the reconditioned carrier is 100 kc, the difference frequency is zero and the afc motor is no longer energized.

b. The afc motor has four winding terminals. Each outer terminal is connected to an afc rectifier which, in turn, is connected to an afc amplifier. Since the four afc amplifier and rectifier combinations are identical, only V504 and V508 are described. Figures 29 and 49 show the block diagram of the complete afc system.

Note. A 100-kc signal plus harmonics is supplied from plate 6 of V510, through C538, to the cathode of 2.8-mc if. amplifier V203 when D208 (or panel 2) is pushed. The 28th harmonic of 100 kc is then used (par. 30) to set the 2ND BEAT OSCILLATOR ZERO ADJ.

c. Afc amplifier V504 is a conventional, rf amplifier (fig. 50). The primary of T507, which functions as the plate load for V504, is resonated to 100 kc by its distributed capacity. The

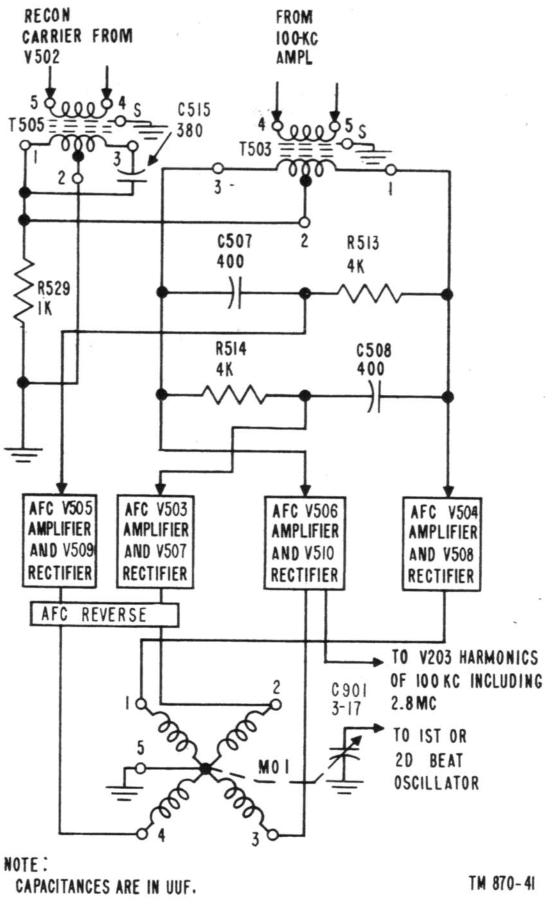

Figure 49. Quadrature network and associated circuits, composite schematic diagram.

amplified signals developed across the primary are inductively coupled to afc rectifier V508.

d. Afc rectifier V508 is a full-wave rectifier that functions as a balanced mixer. The input consists of the 100-kc oscillator signal and the reconditioned carrier. When the frequencies of the two signals differ, a heterodyning action results because of the inherent nonlinearity of the rectifier, and an output voltage is obtained which consists of the two original frequencies plus the sum and difference frequencies. However, only the low-frequency beat signal can reach the afc motor winding because of the low-pass filter which consists of capacitors C511A and C511B and inductor L502. Because the phase of the reconditioned carrier applied to the four afc rectifiers is the same, the phase of the difference frequency signals relative to each other is identical with the phase relationship between the 100-kc oscillator signals; that is, they are in quadrature. Thus when the frequency of the reconditioned carrier is not 100 kc, four difference frequency signals are developed by the afc rectifiers which are in quadrature with one another. These signals are applied to the afc motor, which cause it to rotate and tune the appropriate beat oscillator which corrects the reconditioned carrier frequency.

e. AFC REVERSE switch D206, through which the difference frequency signals are applied to winding 2–4 of the motor, enables the excitation phase to be switched when the receiver is changed from frequencies below 10 mc to frequencies above 10 mc or vice versa, which results in a reversed direction of motor rotation.

f. AFC-ZERO ADJ, a manually operated friction drive, is pushed in to center the afc motor scale at its midposition. A spring pushes out the AFC-ZERO ADJ knob when released. Motor-driven capacitor C901 corrects the frequency of first beat oscillator V207 (variable) $\pm.9$ to ±5.5 kc, depending on the received frequency. When the afc circuit is connected to the second beat oscillator, the frequency correction range is approximately ±1.3 kc. The capacitor shaft is equipped with alarm contacts D901 which actuate afc relay S801. Relay S801 energizes alarm buzzer B101 and red AFC alarm lamp LP101 whenever the afc tuning capacitor is turned to approximately 10° of either end of its range.

g. The control range of afc variable capacitor C901 is as follows (from 5 black to 0 to 5 red):

(1) When controlling first oscillator variable.

Received frequency (mc)	Afc range (kc)	Received frequency (mc)	Afc range (kc)
4	1.8	16	5.6
4.8	2.2	22.8	9
7.2	3.8	28	11
10.4	2.2		

(2) When controlling the second beat oscillator, the afc control range is 2.5 kc.

90. Squelch System

(fig. 51)

a. The squelch circuits, which consist of low-frequency noise amplifier V309A, squelch low-frequency noise detector V309B, squelch carrier rectifier V307B, and squelch carrier dc amplifier V308B prevent the afc motor from operating during severe noise conditions or when the suppressed carrier fades below the noise level. Under both conditions, the afc motor becomes inoperative at

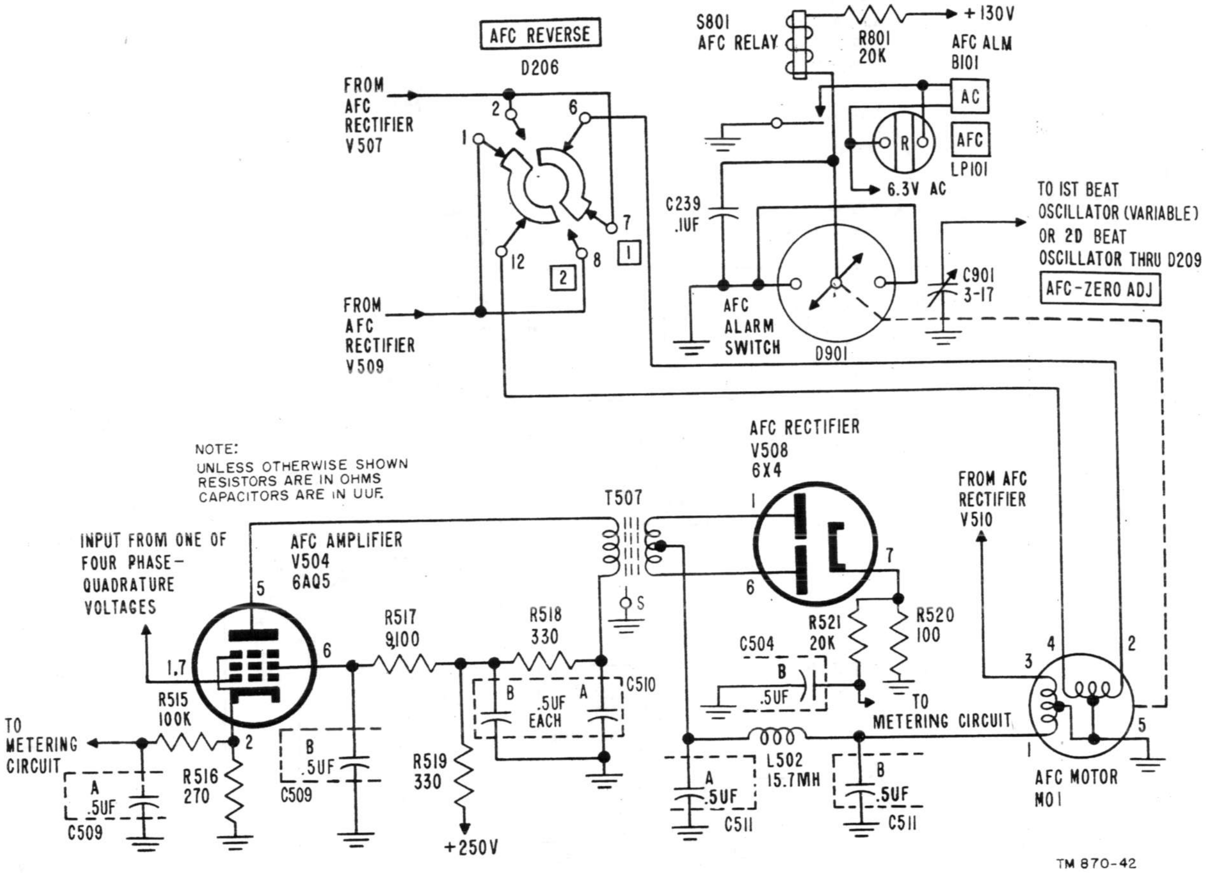

Figure 50. Afc amplifier and rectifier, schematic diagram.

the point where the signal-to-noise ratio falls below a satisfactory predetermined level.

b. In the ON position, AFC switch D303 allows the afc circuits to function, regardless of the signal-to-noise ratio, by grounding the grid return circuit of V502. V502 is provided with suitable self-bias and amplifies under this condition. In the SQUELCH position, the switch contacts apply the potential developed across R380 to the grid of carrier amplifier V502, where it acts as the controlling bias depending on the signal-to-noise ratio. In the OFF position, carrier amplifier V502 is cut off with a negative bias of approximately 20 volts developed at the junction of resistors R377 and R378 in the −130-volt divider network which consists of R376, R377, and R378. When V502 is cut off, the afc circuits do not operate.

c. Transformer T306 couples the 100-kc carrier from carrier amplifier V306 to cathode 5 of squelch carrier rectifier V307B. The dc potential developed across resistor R354 and capacitor C322 is applied as bias to grid 7 of V308B. An increase in carrier signal increases the plate current of V307B. This increases the negative potential developed across R354, which decreases the amplifier plate current that flows through R380. A decrease of current through R380 decreases the negative potential applied as control bias to the grid of V502, thus permitting the afc circuits to operate. SQUELCH CONTROL CAR GAIN potentiometer P303 sets the level that will operate the squelch circuit whenever the carrier drops below a predetermined normal amplitude.

d. Capacitor C325 couples the noise sidebands rectified in the screen circuit of limiter 2, V311 to control grid 3 of squelch low-frequency noise amplifier V309A. SQUELCH CONTROL NOISE GAIN potentiometer P306 controls the noise level applied through C326 to grid 7 of squelch low-frequency noise detector V309B. The plate current of V309B flows through R380. An increase of noise signal supplied to detector tube V309B increases the plate current through R380, and thus increases the negative potential applied as control bias to V502. If the noise in-

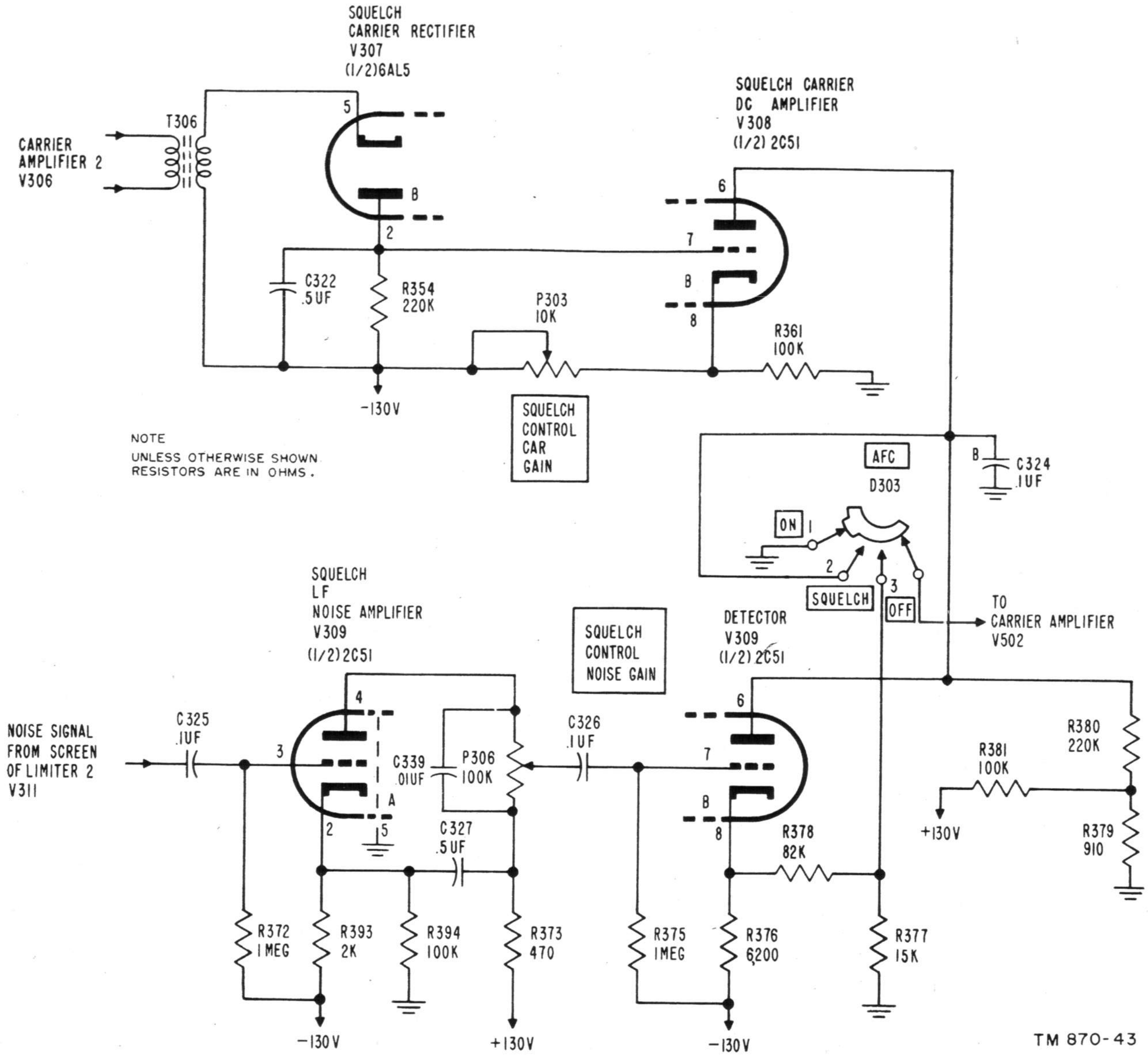

Figure 51. Squelch system, schematic diagram.

put is high enough, this negative potential cuts off carrier amplifier V502 and prevents the afc circuits from operating until the noise level drops.

Note. There is special need of this action when the 100-kc crystal circuit is not tuned exactly to the center of the pass band of YF301.

91. Vf Alarm LP104

(fig. 87)

Relay S802, in series with the +130-volt supply to the plate and screen of carrier amplifier V405, is normally energized by plate and screen currents of V405. Its contacts are normally closed. Loss of filament or plate potentials on V405 deenergizes the relay, opens its contacts, and removes the 6.3-volt ac from T401. This causes green VF lamp LP104 to be extinguished, indicating loss of the carrier signals to the third demodulators or failure of the +130-volt power supply.

92. Power Supplies

(figs. 52, 81, and 82)

A simplified schematic diagram of the 250-volt regulated power supply is shown in figure 52. Figures 81 and 82 are complete schematic diagrams of the 250-volt and the +130- and −130-volt power supply chassis. Because the operation

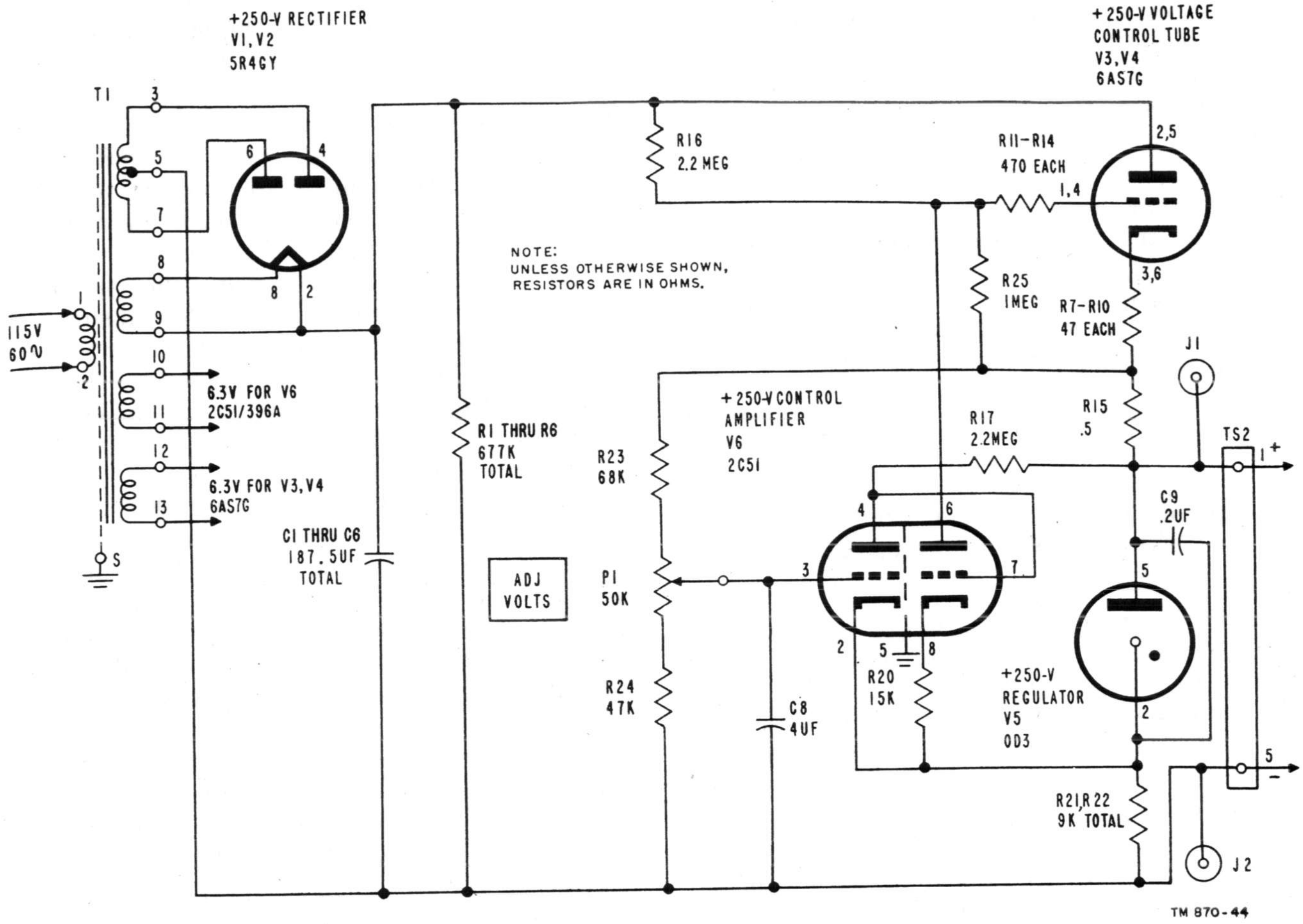

Figure 52. 250-volt regulated supply, composite schematic diagram.

of all three power supplies is the same, only the 250-volt supply will be discussed in detail below.

a. The 250-volt regulated rectifier supplies Radio Receiver R–369/FRC–10 with filtered and regulated 250-volt dc plate power from a 115-volt, 50–60 cps, ac source. Regulation of ±.5 volt or less, is obtained with ac input voltage changes of ±5 volts.

b. The dc output of the rectifier is controlled by the voltage drop across vacuum tubes V3 and V4, in series with V5 and resistors R21 and R22. Two-stage dc amplifier V6 magnifies small changes in output voltage and applies it as an inverse bias control to V3 and V4. As a result, the impedance of V3 and V4 is regulated to maintain the output voltage at a set value.

c. Regulated 250-volt output appears between plate pin 5 of V5 (TS2 terminal 1) and the low side of series resistors R21 and R22. Tube V5 maintains a constant 150-volt drop from plate to cathode over a wide range of currents that may flow through it. Because V5 tends to maintain a constant 150-volt potential, any variation in output voltage must appear across resistors R21 and R22. A variation in output would also appear across series resistors R24, P1, and R23.

d. Assume, for example, that the output voltage decreases to 225 volts. Because of the inherent characteristics of V5, the plate-cathode voltage of V6 is still maintained at 150 volts. The voltage drop across resistors R21 and R22 will, however, decrease by 25 volts. Bias on grid pin 3 of V6 will then become more positive, and cause more plate current to flow through resistor R17; the junction of R17 and the plate pin of V6 will become more negative. This change is applied directly to grid pin 7 of V6, which causes decreased plate current to flow in the corresponding plate circuit which includes resistor R16. A smaller drop in R16 makes the grid of control tubes V3 and V4 more positive and decreases the plate-cathode resistance of V3 and V4, restoring the output voltage to 250 volts; this value is set by ADJ VOLTS P1.

e. Resistors R11 through R14 prevent oscillation of parallel control tubes V3 and V4.

f. The .5-ohm resistor, R15, provides additional voltage control correction, for load current changes.

g. The filter consists of capacitors C1 through C6 connected in series-parallel, shunted by resistors R1 through R6 which balance the voltages across the capacitors (fig. 82).

h. Pin jacks J1 and J2 are output test points.

i. ADJ VOLTS potentiometer P1 is used to adjust the output voltage to 250 volts.

Note. If tubes 422A and 421A are used in place of tubes 5R4GY and 6AS7G, refer to figures 81 and 82 for details of required circuit changes.

93. Carrier Off Slow and Carrier Off Fast Alarm Indicator Lamp System

(fig. 53)

a. This system indicates loss of carrier caused by deep fades, mistune of the receiver, or an increase of the noise level.

b. AFC switch D303, depending on whether it is in the ON, SQUELCH, or OFF position, determines the manner in which the carrier off, slow-fast alarm system operates.

c. In the ON position, AFC switch D303 allows the afc system to operate regardless of the signal-to-noise ratio. Carrier amplifier V502 operates with normal cathode bias and then conducts. Cathode current that flows through the carrier off fast relay S804 to the +130-volt supply energizes the relay, and the relay contacts move to the opposite positions from those in figure 53. Energizing the relay extinguishes CARRIER OFF FAST amber lamp LP103 and grounds the grid 1 circuit of V513 through 1,000-ohm resistor R803, which causes this tube to conduct. Plate and screen currents of V513, which flow through carrier off slow relay S803 to the +130-volt supply, energize the relay, and the contacts move to the positions opposite to those in figure 53. SLOW red lamp LP102 then goes out. The amber and red lamps are always inoperative when the AFC switch is in the ON position.

d. In the SQUELCH position, AFC switch D303 permits the afc system to operate only when a high signal-to-noise ratio exists. The principal difference in circuit operation is that carrier amplifier V502 operates with a controlling bias from V309B (par. 90). If the carrier fades, the controlling bias developed across R380 (fig. 51) will bias V502 beyond cutoff. Plate and screen currents cease flowing, which de-energizes S804 and moves the contacts to the position shown in figure 53. Contacts 1B and 2B on S804 complete the ground connection for FAST amber lamp LP103 and cause it to light. Contacts 1T and 2T on S804 connect the 4.4-second time-constant network, R802 and C520, to −7.6 volts from the

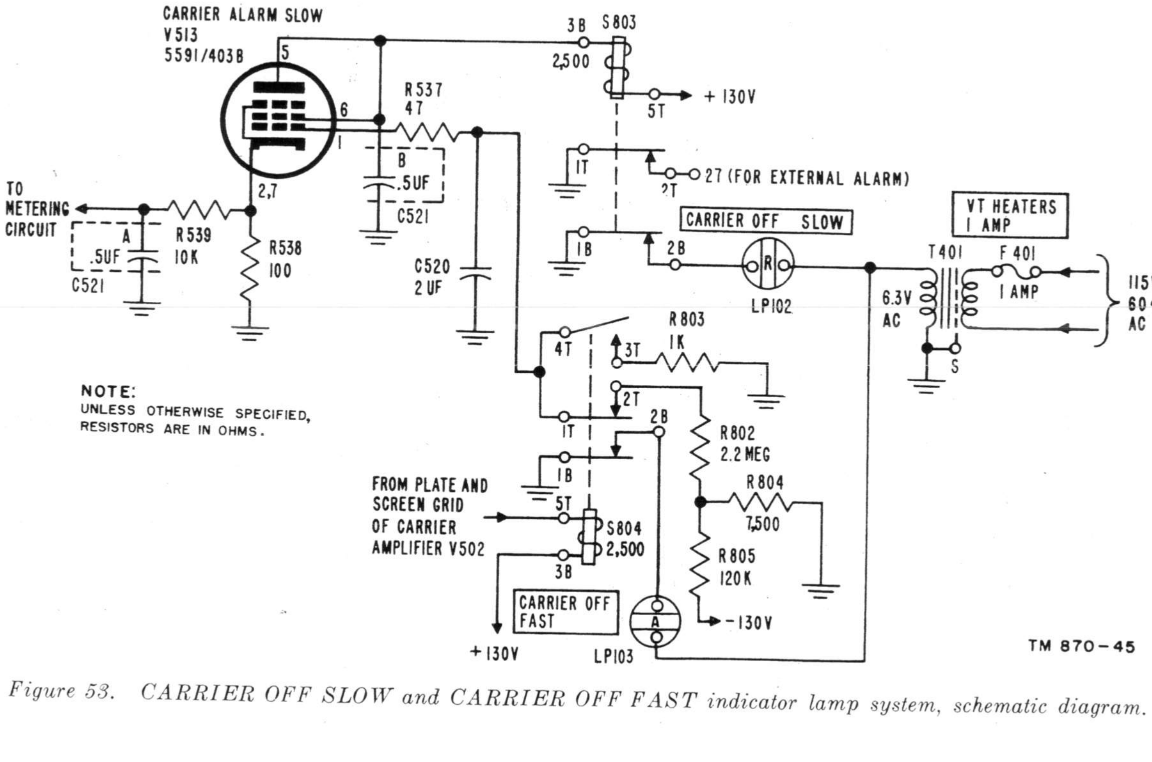

Figure 53. CARRIER OFF SLOW and CARRIER OFF FAST indicator lamp system, schematic diagram.

negative 130-volt supply at the junction of voltage divider R804 and R805. After approximately 2 seconds, capacitor C520 acquires a charge, negative with respect to ground, that cuts off V513. Plate and screen currents of V513 stop flowing through carrier off slow relay S803, de-energizing it and lighting SLOW red lamp LP102. Return of the carrier operates S804; C520 quickly discharges through R803 and the controlling negative bias from V513 is removed, allowing it to conduct. Plate and screen currents of V513 energize relay S803, thus extinguishing red lamp LP102 and amber lamp LP103.

e. In the OFF position, AFC switch D303 allows LP102 and LP103 to remain lighted at all times.

94. Sideband Hybrid Voltmeter

(fig. 54)

a. The sideband hybrid voltmeter is a diode peak voltmeter that is connected to the DC METERING meter when the PANEL 4 VT CURRENTS switch is on SB VOLT HYB V401A 20V.

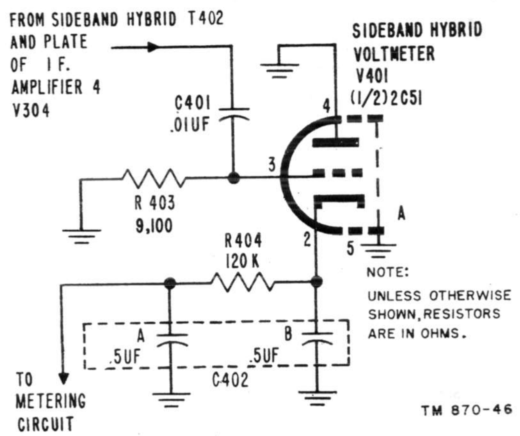

Figure 54. Sideband hybrid voltmeter, schematic diagram.

b. One-half of V401 is used for the diode peak voltmeter. Plate 4 is grounded because it is not required for diode operation of the triode. Capacitor C401 couples 100-kc signals (with ±6-kc sidebands) from the plate of if. amplifier 4 and sideband hybrid coil T402 to grid pin 3 of V401A shunted by R403. The rectified dc potential that appears across capacitor C402B produces current flow in the metering circuit. Resistor R404 is the meter multiplier and C402A is the metering circuit bypass capacitor. This measurement provides an indication of the signal level fed to the crystal filter, third demodulators, and vf amplifiers. If a single signal, even a carrier, is present at the hybrid coil, this meter will read its relative level. Normally, the level of the carrier is so low that the meter indicates the strength of the higher level sidebands only.

Caution: This diode should not be left connected to the metering circuits, because it may increase the intermodulation distortion, and thus reduce the operating margin of the teletypewriter circuits. Do not leave the PANEL 4 VT CURRENTS switch in the S B VOLT HYB V401A 20V position.

95. Miscellaneous Relay Rack Bay

(fig. 55)

The relay rack is used to connect the receiver to its vf lines and antenna.

a. Simplex and phantom circuits are incorporated in the miscellaneous relay rack bay to provide the operating personnel with communication facilities to the carrier terminal site. The simplex and phantom circuits use existing vf or telephone lines to carry additional intellegence without interfering with their original functions.

b. The simplex circuit provides dc telegraph facilities over the two pairs of wires that carry vf signals to the carrier terminal equipment. Depressing the telegraph key connects the center of the secondary of PH A to ground; the ends of the PH A secondary are connected to the electrical centers of the secondaries of S1A and S2A. Potential supplied from the telegraph terminal produces a current in the windings. These telegraph currents divide equally at the midpoints of S1A and S2A. A change in the magnitude of current caused by the make or break of the telegraph key does not produce a potential across the vf lines because the magnetic fields in the transformer oppose each other. This opposition results from the currents flowing in opposite directions through the windings. At the carrier terminal equipment, the normal groups A and B signals are free from interference because the telegraph signals again produce out-of-phase currents in the transformer primary windings. Because the telegraph key is connected to the electrical center of both pairs of vf lines, the four leads provide one lead for the simplex circuit; ground (earth) provides the return path. The SX (noise killer) coil reduces false telegraph operation from noise transients. A 130-volt power supply (through suitable current limiting resistors) is available at the telegraph terminal. If a local voltage source is needed at

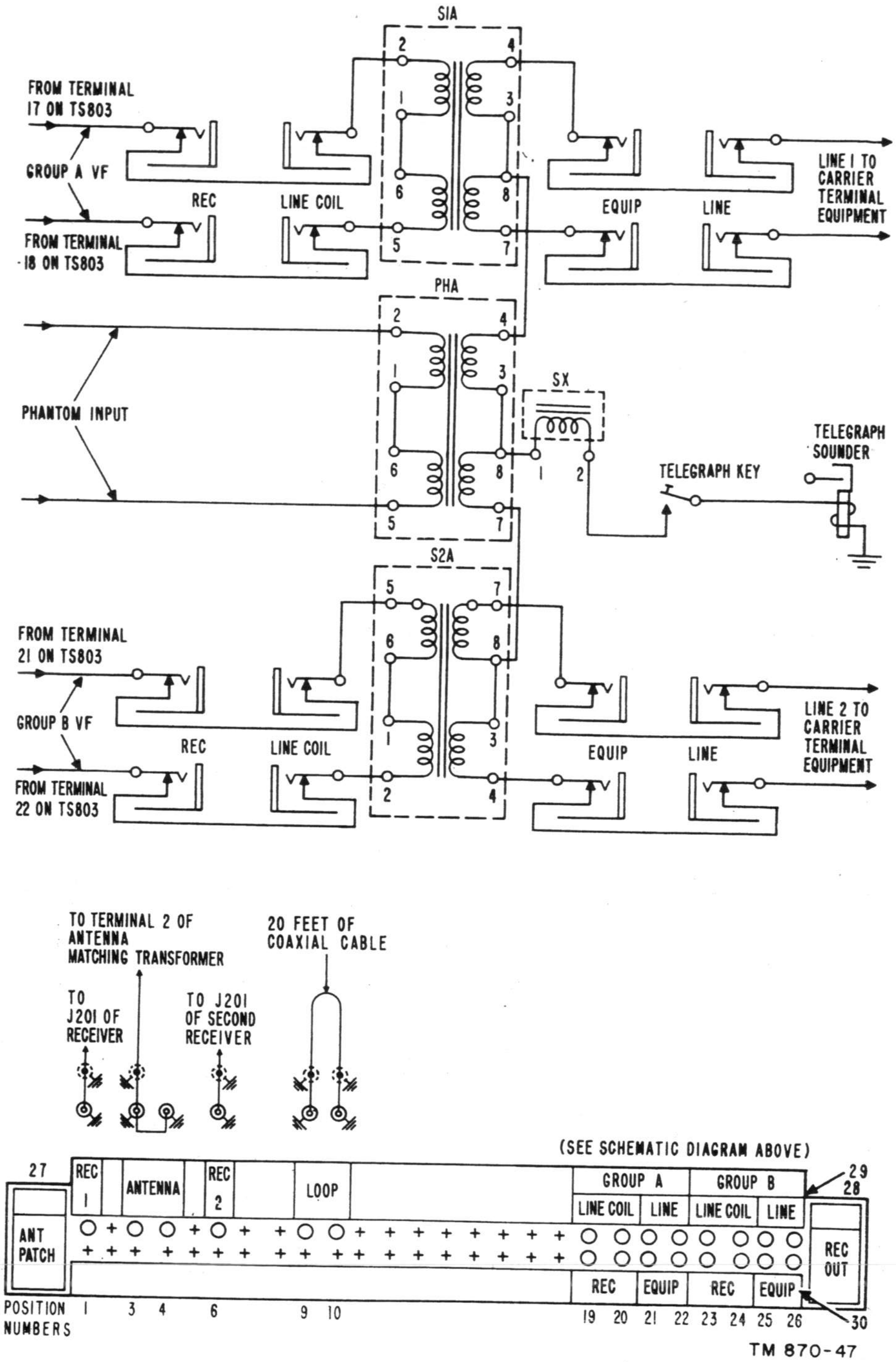

Figure 55. Miscellaneous relay rack bay, schematic diagram.

the receiver end of this simplex circuit, be sure to connect it correctly so that it is in series (with proper polarity) with the voltage from the telegraph terminal.

c. The phantom circuit uses each pair of vf lines for one conductor of a two-wire voice line. Thus, two leads of one vf line provide one wire, and two leads of the second vf line provide the second wire. The phantom circuit is formed by connections made between the secondary of transformer PH A (terminals 4 and 7) and the electrical center of each of the vf transformers (S1A and S2A). Because the two leads of each vf line are identical, any current induced in the phantom circuit devides equally at the electrical center of the transformer. One-half the current flows in the same direction through the two leads of one vf pair, and the other half of the current flows in the reverse direction through the two leads of the other vf pair. No difference of potential exists between adjacent conductors of each pair, and the phantom conversation does not interfere with the reception of group A or B signals at the carrier terminal equipment. On the other hand, because the two wires of the vf line are balanced, the group A or B signals cannot be detected in the phantom circuit.

d. The miscellaneous relay rack bay is equipped with a jack strip which consists of an ANT PATCH side and a REC OUT side. The REC OUT side jacks (positions 19 through 26) are connected to the components described in this paragraph. If a double telephone plug, such as is on the head set furnished with the equipment, is plugged into the two GROUP B LINE jacks (positions 25 and 26 upper) located in the top row on the right end, the head set will be connected to line 2 to the carrier terminal equipment. If plugged into the two GROUP B EQUIP jacks (positions 25 and 26 lower), the headset will be connected to the local equipment, which consists of S2A repeat coil and the output of the radio receiver. The normal condition of these jacks is with no plugs inserted. The jacks are used for test purposes or other special conditions, such as using line 2 for output of GROUP A. Patching GROUP A EQUIP to GROUP B LINE will stop GROUP B intelligence and send GROUP A intelligence on line 2. This may be used if line 1 fails. Positions 1, 3, 4, 6, 9, and 10 upper, of the ANT PATCH side receive coaxial jacks. Short lengths of coaxial cable equipped with coaxial plugs are used in metering connections. Refer to paragraph 19*d* and *g* for further discussion of the ANT PATCH side of the jack strip.

96. Power Circuits

a. Two separate ac power circuits are brought into the receiver (lower center part of fig. 87). The voltage required is 115 volts ±5 percent, 50 to 60 cps. One circuit feeds double convenience outlets J1 and J2 (front of receiver), single outlet J3 (inside rear door), and heating lamp socket LPS1 (inside rear door). The lamp helps to prevent moisture damage and fungus growth in humid climates.

b. MAIN POWER switch D102 is connected in the other power branch. Power passes from the switch, through the 8 FN main power fusetron, FN101, to the panel safety switches. Filament transformers T202, T307, T401, and T501 are fused by F201, F301, F401, and F501, respectively.

c. Transformer T202 has two 6.3-volt windings that supply filament power to the hf panel. Winding 3–5, which supplies V207 and V208, is operated above ground with a positive potential of approximately 25 volts. This potential is applied to one side of the 6.3-volt ac source to reduce the hum modulation which might be generated between the heater and cathode of these tubes. The positive potential is obtained from the +130-volt supply through a voltage divider which consists of resistors R254, R252, and R253.

d. Transformer T307 has two 6.3-volt windings that supply filament power to if. panel 3. Winding 3–5, which supplies V307, V308, and V309, is operated 130 volts below ground to reduce the voltage gradient between heaters and cathodes of these tubes.

e. Transformer T501 supplies 6.3 volts for the filaments of all the tubes in afc panel 5.

f. MAIN POWER switch D102 controls the power for both the regulated rectifiers. The ac power is applied to the +250-volt rectifiers, the output voltage of which is applied to relay S805 through voltage dropping resistors R807 and R808. When relay S805 is energized, its contacts close and impress 115 volts ac across the winding of relay S806 (C801 and R806 across this winding protect the contacts of S805). The contacts of relay S806 close and apply ac power to the +130-volt rectifier.

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing the radio receiver, be extremely careful of the high voltages exposed. Keep one hand in your pocket when measuring socket voltages with the probe. Before touching any part after the voltage is shut off, short the part to ground. Remember primary power with only wall fuse protection can be reached when mats are removed (primary side of filament transformers and fuses are energized).

97. Troubleshooting Procedures

a. General. The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the *circuit* responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective *part* responsible for the abnormal condition. In most cases, trouble is caused by faulty vacuum tubes. Normally, such troubles will be revealed by the vaccuum-tube currents tests (par. 28). A tube tester should not be relied upon, because many tubes that are indicated to be good in a tester may be poor in the actual circuit. A gain test or other performance test of the suspected vacuum-tube circuit is the final check of circuit capability. Some faults, such as burned-out resistors and shorted transformers, can often be located by sight, smell, and hearing. Many faults, however, must be localized by *checking voltage and resistance.*

b. Component Sectionalization and Localization. Use the performance check list (pars. 59 and 60) to aid in isolating the source of trouble. Follow the procedure in the order given. The servicing procedure should cause no further damage to the receiver. First, localize the trouble to a single stage or circuit; then isolate the trouble within that stage or circuit by appropriate voltage, resistance, and continuity measurements. Follow procedure in (1) through (8) below:

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible troubles, such as blown fuses, defective indicator lamps, frayed cables, shorted wires, etc. Tubes with no heater glow showing may or may not be burned out. Through this inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the receiver that might occur through improper servicing methods and in forestalling future failures.

Note. A blown fuse is usually caused by a grounded wire or lug, shorted capacitor, or defective vacuum tube.

(2) *Equipment performance test.* Use the equipment performance check list (pars. 59 and 60) for this test. Failure to meet the indicated meter readings is an indication of improper circuit operation. If the cause of trouble is not eliminated by changing the suspected tube, perform the other tests in (3) through (8) below.

(3) *Troubleshooting chart.* The symptoms listed in this chart (par. 101) will aid greatly in localizing trouble.

(4) *Input resistance measurements.* These measurements (par. 102) are used to de-

termine troubles that might cause short circuits.

(5) *Dc voltage measurements.* These measurements (pars. 103 and 104) indicate the correct dc potentials from selected points in the receiver to ground.

(6) *Dc resistance measurements.* These measurements (par. 105) indicate the correct dc resistance values from selected points in the circuit ground.

(7) *Stage gain charts.* These charts (par. 106) can be used to locate hard-to-find troubles. The tests require the injection of a signal to a stage and the measurement of the resultant gain.

(8) *Intermittent troubles.* In all of the above tests, the possibility of intermittent trouble should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. The trouble may not be in the receiver, but in the installation (mounting, miscellaneous relay rack bay, etc.), or it may be caused by external conditions. In this case, test the installation.

(*a*) Two variables (or two intermittent troubles) are very difficult to locate. The second trouble may not be present when trouble first is observed. As tests proceed, one specific area of trouble is masked by the other trouble. A pattern of going in a series of trouble-locating trials often is a sign of two troubles, both of which are not always present at the same time.

(*b*) In radio stations where many of these receivers have been operating for long periods of time, a type of trouble called *activity trouble* has been observed. Disturbing a unit which has been operating satisfactorily by working on it often results in more troubles. This is often the cause of two variables as noted in (*a*) above.

98. Troubleshooting Data

The material supplied in this manual will help in the rapid location of trouble. The following table lists the illustrations and paragraphs in this manual that will be useful during troubleshooting. The WECo drawings and manuals supplied with this equipment (listed in Exhibit B–(*) or specification KME 5000) will be helpful (app. I).

Figure No.	Paragraph No.	Description
4	----	Panel arrangement, Radio Receiver R–369/FRC–10.
87	----	Schematic diagram, Radio Receiver R–369/FRC–10.
71	----	Location of front panel controls, Radio Receiver R–369/FRC–10.
72	----	Tube locations, Radio Receiver R–369/FRC–10.
88	----	Interpanel, wiring diagram.
89	----	Meter panel 1, wiring diagram.
90	----	Hf panel 2, wiring diagram.
91	----	If. panel 3, wiring diagram.
92	----	Vf panel 4, wiring diagram.
93	----	Afc panel 5, wiring diagram.
94	----	Relay panel 8, wiring diagram.
95	----	First and second beat oscillators, wiring diagram.
96	----	±130-volt power supply panel 6, wiring diagram.
97	----	250-volt power supply panel 7, wiring diagram.
73	----	Metering panel 1, front view, component locations, panel off.
74	----	Hf panel 2, front view, component locations.
75	----	If. panel 3, front view, component locations.
76	----	Vf panel 4, front view, component locations.
77	----	AFC panel 5, front view, component locations.
78	----	+130-volt rectifier panel 6, front view, component locations.
79	----	250-volt rectifier panel 7, front view, component locations.
80	----	Relay panel 8, component locations.
81	----	±130-volt regulated power supply, schematic diagram.
82	----	250-volt regulated power supply, schematic diagram.
	101	Troubleshooting chart.
	102	Input resistance measurements.
	103	Voltage-to-ground measurements.
	104	Point-to-point rectifier voltage test.
	105	Resistance-to-ground measurements.
	107	Dc resistance measurements of transformers and coils.

99. General Precautions

Whenever the receiver is serviced, observe the following precautions carefully. Careless and unnecessary replacement of parts often makes new faults inevitable. Do not service a receiver until a requirement is not met. Note the following points:

a. Before a part is unsoldered, note the positions of the leads. Compare them with the component location figures of this manual and with other available drawings. If the color code of the leads is clearly identifiable and agrees with the figure that shows the wiring, a tag on each lead may not be needed; otherwise tag each lead as required. The following wiring diagrams will aid in component replacement.

Figure No.	Title
88	Interpanel, wiring diagram.
89	Meter panel 1, wiring diagram.
90	Hf panel 2, wiring diagram.
91	If. panel 3, wiring diagram.
92	Vf panel 4, wiring diagram.
93	Afc panel 5, wiring diagram.
94	Relay panel 8, wiring diagram
95	First and second beat oscillator, wiring diagram.
96	±130-volt power supply panel 6, wiring diagram.
97	+250-volt power supply panel 7, wiring diagram.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Do not allow drops of solder to fall into the set, because they may cause short circuits.

d. A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, because a poorly soldered joint is one of the most difficult faults to find.

e. When replacing a part in rf of if. circuits, place the new part exactly where the original one was located. A part which has the same electrical value, but which differs physically in size, may cause trouble in hf circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in decreased gain or possibly in oscillation of the circuit.

f. When trouble is localized in a given stage, first test the tube, if such a test is indicated; then measure the voltage and, finally, the resistance at the tube socket of that stage.

g. Remove only *one* tube at a time when testing. First check to see that the proper type tube is in the socket, and then test the tube; if it is not defective, return it to its proper socket before removing another tube.

h. Isolate and correct any trouble located before proceeding to the next step.

100. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting Radio Receiver R–369/FRC–10 is listed below. The commercial bulletins that describe the test equipment are included with the equipment.

a. Hickok tube tester KS–5727, L1.

b. Oscillator D–166636 (special 19–C); (TS–379/U).

c. 22DT Ferris signal generator.

d. Loudspeaker set D–124852 (special 100–F).

e. Headset 1002C.

f. General radio variac V–5 MT.

g. Attenuator D–165654 (special 5–A); (TS–402A/U).

h. Weston 779 type 1 volt-ohm-milliammeter (20,000 ohms/volt).

i. Measurements Corp. model 62 vacuum-tube voltmeter.

Note. Some of these items of commercial test equipment may be replaced by equivalent standard equipments. Refer to paragraph 9*a*.

101. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the radio receiver. This chart lists the symptoms which the repairman can observe, either visually or audibly, while making a few simple tests.

Symptom	Probable trouble	Correction
1. No. dc output voltage	8 FN fusetron blown (FN101)	Replace fuse.
	MAIN POWER switch (D102) in OFF position.	Throw to ON position.
2. No. +250-volt output	3.2 FN fusetron blown	Replace fusetron (F1), panel 7.
3. No. ±130-volt output	3.2 FN fusetron blown	Replace fusetron (F1), panel 6.
4. No. −130-volt output	½ AMP fuse blown	Replace fuse (F2), panel 6.
5. +250-volt output too high or low	P1 out of adjustment	Readjust ADJ VOLTS (P1), panel 7.
6. +130-volt output too high or low	P1 out of adjustment	Readjust ADJ VOLTS +130V (P1), panel 6.
7. −130-volt output too high or low	P2 out of adjustment	Readjust ADJ VOLTS −130V (P2), panel 6.

*Also applies to panels 3, 4, and 5.

Symptom	Probable trouble	Correction
8. VF lamp inoperative	Defective lamp	Replace lamp (LP104).
	Defective lamp socket	Replace lamp socket.
	Carrier amplifier V405 defective	Replace tube. Check circuit components.
	+130-volt power supply voltage low.	Check +130-volt power supply.
	No heater voltage for V405	Check F401.
9. Normal reception only when CARRIER SUPPLY switch is in RECON position. Afc system also is inoperative.	Defective 100-kc oscillator circuit	Check tubes V511 and V512 and associated components.
10. Normal reception only when 1ST BEAT OSCILLATOR switch is in VARIABLE position.	Defective first beat oscillator (crystal).	Check V206, crystals, and associated components.
	CRYSTAL SELECTOR switch on 0 or at a position with no crystal or wrong crystal.	Correct switch position.
11. Reception normal, but afc system detunes receiver.	AFC REVERSE switch in wrong position, or HF AMPLIFIER TUNING or 1ST BEAT OSCILLATOR incorrectly set.	Throw switch to correct position. Set dials as in figures 23 and 24.
12. No reading on DC METERING meter while varying PANEL 2 VT CURRENTS switch.*	PANEL SELECTOR switch not in position 2.*	Throw switch to position 2.*
	Blown filament transformer fuse for this panel.*	Replace VT HEATERS fuse panel 2.*
13. No reading on DC METERING meter while varying individual panel VT CURRENT switches.	Blown filament transformer fuse	Replace VT HEATERS fuse.
14. Plate current reading of hf amplifier V201 too high.	Gassy tube	Replace V201.
15. Fails if. and vf band-pass test (par. 29) and vf amplifier characteristic test.	Vf amplifier characteristics	Refer to paragraph 122.
Fails if. and vf band-pass test, but passes vf amplifier characteristic test.	Crystal filter failure	Replace crystal filter YF401 or YF402 (depending on which group (A or B) fails test).
16. Fails gain test of local and reconditioned carrier signals (par. 32*b*).		
Too high	V511 or V512 defective. Low output of 100-kc oscillator.	Check tube currents of V511 and V512 (par. 28). Make stage gain test (par. 106*g*(16) through (19)). Change tubes in the 100-kc oscillator and check paragraph 117. Repeat paragraph 32*b*(15) and (16).
Too low	Gain of carrier branch off. V305 or V306 defective.	Check applicable steps in paragraphs 106*g* and 28*b*.
17. Fails afc action test (par. 35*d*)	Defective vacuum tubes in associated circuits.	Make tests of paragraph 60.
	Low and/or unequal levels in afc oscillator-amplifier of afc carrier amplifier circuits.	Make tests of paragraphs 32 and 106.
	Noise from afc squelch circuit operation cutting off V502.	Check afc squelch circuits and adjustments (par. 36).
	Improper lubrication of afc tuning motor.	Relubricate (par. 54).
	Defective afc tuning motor assembly.	Readjust (par. 110). If this does not remedy condition, replace assembly as described in paragraph 108*c*.

*Also applies to panels 3, 4, and 5.

102. Input Resistance Measurements

a. Preliminary Procedures. The tables in *b* and *c* below contain the dc resistance measurements at selected points in the +250-volt supply and the ±130-volt supplies. Throw the MAIN POWER switch to OFF and remove the 8 FN fusetron before making these tests. Use Weston 779, type 1, volt-ohm-milliammeter (or any other 20,000 ohm/volt meter) to make the measurements. Replace the fusetron after completing these tests.

b. Resistance Measurements of 250-Volt Supply.

(1) Lift up and remove the stile strips from the front of the receiver cabinet.

(2) Set the MAIN POWER switch to OFF and remove the 8 FN fusetron.

(3) Remove the front panel mat.

(4) Disconnect the leads on TS2; tag each lead so that it can easily be reconnected to the proper lug on the terminal strip. This may not be necessary if the color code is clear and it follows the wiring diagram (fig. 97). Interpanel leads are shown in figure 88.

(5) Open the rear door and remove all tubes from panel 7 (figs. 17 and 72).

(6) Take readings at the points indicated in the following table. Refer to figures 79, 82, and 97.

From—	To—	Nominal value (ohms)	Remarks
J1	J2	55,000	
J1	J8	50,000	
J3	J7	47	R9.
J4	J7	47	R10.
J5	J7	47	R7.
J6	J7	47	R8.
J2	Pin 8, VI	460,000	Connect + probe of meter to pin 8, and − probe of meter to J2. Wait approximately 3 minutes for capacitors to become fully charged and to stabilize reading.
Pin 4, V2	Pin 6, V2	40	T1 hv winding.
Pin 8, V2	Pin 2, V2	0	T1 filament winding for V1 and V2.
Pin 1, V6	Pin 9, V6	0.13	T1 filament winding for V6.
Pin 8, V4	J7	0.1	T1 filament winding for V3 and V4.
J2	J8	9,000	R21 and R22 in parallel (18,000 each).
J1	J7	0.5	R15.
Pin 1, V3	Pin 4, V3	940	R13 and R14.
Pin 1, V3	Pin 4, V4	940	R11 and R12.
Pin 4, V6	J1	2.2 meg	

(7) Perform in reverse order (1) through (5) above. Be sure to replace the 8 FN fusetron.

c. Resistance Measurements of ±130-volt Supply.

(1) Set MAIN POWER switch to OFF. Remove 8 FN fusetron, panel 1.

(2) Remove all tubes from panel 6 (figs. 17 and 72).

(3) Remove the front panel mat.

(4) Disconnect the leads on TS2; tag each lead so that it can easily be reconnected to the proper lug on the terminal strip. This may not be necessary if the color code is clear and follows the wiring diagram (fig. 96). Interpanel leads are shown in figure 88.

(5) Take the readings at the points indicated in the following table. Refer to figures 17, 78, 81, and 96.

From	To	Nominal value (ohms)	Remarks
J1	J2	18,000	
J1	Pin 6, V4	470,000	R13.
J1	J4	27	R9.
J1	J5	27	R10.
J1	J6	16,000	
J2	J6	1,600	
Pin 3, V3	J2	620,000	Connect + probe to pin 3, and − probe to J2. Wait 3 minutes for capacitors to become completely charged and to stabilize the reading.
J2	Pin 4, V1	2.5	
J1	Pin 7, V4	24,000 to 34,000	Value depends on setting of P1.
Pin 2, V3	Pin 7, V3	0.1	T1 filament winding for V2 and V3.
Pin 2, V1	Pin 8, V1	0.1	T1 filament winding for V1.
Pin 9, V4	Pin 1, V4	0.13	T1 filament winding for V4.
Pin 6, V6	Pin 1, V6	230	T2 hv winding for −130 volts.
Pin 6, V1	Pin 4, V1	50	T2 hv winding for +130 volts.
Pin 6, V6	J3	120	
Pin 1, V6	J3	120	
J3	J7	1,600	R21.
Pin 3, V6	Pin 4, V6	0.2	T2 filament winding for V6 and V7.
Pin 1, V8	Pin 9, V8	0.13	T2 filament winding for V8.
J2	J7	18,800	R23 and R24.
Pin 5, V9	Pin 4, V7	1.0	R29.
J3	Pin 7, V8	10,000 to 25,000	Value depends on setting of P2.

(6) Perform in reverse order (1) through (4) above. Replace 8 FN fusetron.

103. Dc Voltage-to-Ground Measurements

The following chart lists the dc voltage-to-ground measurements. To make these tests without removing the front panel mats, open the rear door and remove the vacuum tubes; then insert the test leads in the appropriate socket terminal. The socket terminals are numbered in a *counter-clockwise* direction from the blank position as viewed from the top of the socket (facing the back of the receiver). Follow procedure in *a* through *c* below:

a. Set the following controls to the indicated positions. After completing the tests, reset the controls.

(1) 1ST BEAT OSCILLATOR to VARIABLE (par. 21).

(2) CRYSTAL SELECTOR to 0 (par. 21).

(3) MAN VOL CONTROL to 0 (par. 21).

(4) VOLUME CONTROL to MAN (par. 21).

(5) AFC to ON (par. 21).

(6) CARRIER BRANCH GAIN to 0 (par. 21).

(7) CARRIER SUPPLY to LOCAL (par. 21).

(8) AUTO VOL CONTROL DELAY to extreme counterclockwise position (par. 33).

(9) VF GAIN A to extreme clockwise position (par. 29).

(10) VF GAIN B to extreme clockwise position (par. 29).

(11) AUTO FREQ CONTROL CAR GAIN to extreme counterclockwise position (par. 36).

(12) AUTO FREQ CONTROL OSC GAIN to extreme counterclockwise position (par. 36).

b. Remove one vacuum tube at a time and, with one test lead grounded, touch the other lead to each socket terminal in turn. Voltage values should approximate the typical values shown in the table below. Certain measurements are made under special conditions, as indicated in the last column of the table. Return to the above standard conditions for the next test.

Tube	Type	Socket pin numbers									Special conditions
		1	2	3	4	5	6	7	8	9	
V201	6BA6	−6.5	0	0	6.3 ac	250	130	0	------	------	
V202	6AS6	0	2	0	6.3 ac	120	116	−4	------	------	
V203	6BA6	−47	0	0	6.3 ac	250	125	0	------	------	
V204	6AS6	0	1.5	0	6.3 ac	114	114	−1.2	------	------	
V205	6AS6	0	1.5	0	6.3 ac	114	114	−1.2	------	------	
V206	5591/403B	0	2	0	6.3 ac	80	80	2	------	------	
V207	2C51	24	4.5	0	190	0	153	0	4.5	24	1 and 9*
V207	2C51	24	4.5	0	215	0	28	−.1	0	24	1ST BEAT OSCILLATOR at CRYSTAL
V208	2C51	24	1.5	0	55	0	49	0	1.5	24	1 and 9*
V301	6BA6	−50	0	0	6.3 ac	249	125	0	------	------	
V302	6BA6	−50	0	0	6.3 ac	249	125	0	------	------	
V303	6BA6	−18	0	0	6.3 ac	249	125	0	------	------	
V304	6AQ5	0	9	0	6.3 ac	226	201	0	------	------	
V305	5591/403B	−.15	.2	0	6.3 ac	121	56	.2	------	------	
V306	5591/403B	−.1	0	0	6.3 ac	110	112	0	------	------	
V307	6AL5	−125	−125	−130	−130	−130	0	−130	------	------	3 and 4*
V308	2C51	−130	−130	−115	−85	0	−.6	−125	−119	−130	1 and 9*
V309	2C51	−130	−120	−120	+30	0	−.5	−116	−117	−130	1 and 9*
V310	5591/403B	0	0	0	6.3 ac	9	15	0	------	------	
V311	5591/403B	−.4	0	0	6.3 ac	20	25	0	------	------	
V401	2C51	25	0	0	0	0	44	5	3	25	1 and 9*
V402	6AQ5	0	10	25	25	214	235	0	------	------	3 and 4*
V403	2C51	25	3.5	0	0	0	44	5	+3	25	1 and 9*
V404	6AQ5	0	10	25	25	214	235	0	------	------	3 and 4*
V405	5591/403B	0	1.3	25	25	98	99	1.3	------	------	3 and 4*
V501	5591/403B	0	1.6	6.3 ac	0	115	117	1.6	------	------	
V502	5591/403B	0	.9	6.3 ac	0	93	95	.9	------	------	
V503	6AQ5	0	10	6.3 ac	0	218	197	0	------	------	
V504	6AQ5	0	10	6.3 ac	0	218	197	0	------	------	
V505	6AQ5	0	10	6.3 ac	0	218	197	0	------	------	
V506	6AQ5	0	10	6.3 ac	0	218	197	0	------	------	
V507	6X4	−34	0	6.3 ac	0	0	−34	0	------	------	
V508	6X4	−34	0	6.3 ac	0	0	−34	0	------	------	
V509	6X4	−34	0	6.3 ac	0	0	−34	0	------	------	
V510	6X4	−34	0	6.3 ac	0	0	−34	0	------	------	
V511	5591/403B	0	1.6	6.3 ac	0	81	111	1.6	------	------	
V512	5591/403B	0	1.5	6.3 ac	0	116	118	1.5	------	------	
V513	5591/403B	0	1	6.3 ac	0	100	100	1	------	------	

*These pairs of numbers refer to pins. There should be 6.3-volt ac between these pins.
Caution: There may be dangerous voltages between each pin and ground.

c. Restore the controls to their normal settings (pars. 21, 29, 33, and 36).

104. Point-to-Point Rectifier Voltage Tests

To make these tests, proceed as follows:

a. Insert the pin ends of the test meter leads in the rectifier pin jacks given in the table below, and read the voltage. The voltage values should approximate the typical values shown.

±130V rectifier		+250V rectifier	
Jacks	Volts	Jacks	Volts
J1–J2	130	J1–J2	250
J2–J3	130	J1–J8	150
J1–J6	105	J3–J7	4.3
J2–J7	105	J4–J7	4.3
J4–J1	1.8	J5–J7	4.3
J5–J1	1.8	J6–J7	4.3
J6–J2	22		

b. Remove the test connections.

105. Dc Resistance Measurements

The following chart lists the dc resistance-to-ground measurements. To make this test without removing the front panel mats, reach in from the rear of the panels and remove the vacuum tubes; then insert the test leads in the appropriate socket terminals. The socket terminals are numbered in a *counterclockwise* direction from the blank position as viewed from the top of the socket. Follow the procedure given in *a* through *h* below.

a. Position the MAIN POWER and both PWR switches at OFF.

b. Set these controls to the following positions:

(1) PANEL SELECTOR to 4.
(2) 1ST BEAT OSCILLATOR to CRYSTAL.
(3) CRYSTAL SELECTOR to 0.
(4) MAN VOL CONTROL to 0.
(5) VOLUME CONTROL to MAN.
(6) AFC to ON.
(7) CARRIER SUPPLY to LOCAL.

c. Turn the slotted shafts of the following controls fully clockwise:

(1) AUTO VOL CONTROL MAX GAIN.
(2) AUTO VOL CONTROL DELAY.
(3) SQUELCH CONTROL CAR GAIN.
(4) VF GAIN A.
(5) DEM CAR GAIN.
(6) VF GAIN B.

d. Maintain the settings shown in *b* and *c* above unless otherwise specified under the *remarks* column of the table in *f* below.

e. To exclude internal resistance of rectifiers when they are not operating, short circuit their outputs by grounding jacks J1 and J3 of the ±130-volt rectifier and J1 of the +250-volt rectifier. Be sure to remove these shorts when the tests are completed.

f. Remove one vacuum tube at a time and, with one test lead grounded, touch the other lead to each socket terminal in turn. The resistance values should be within 20 percent of the values shown in the table below.

Tube	Resistance in ohms between ground and socket terminal numbers									Remarks and differences from test setup
	1	2	3	4	5	6	7	8	9	
V201	1.5 meg	0	0	0	1K	2K	150			
V202	100K	200	0	0	1K	1.6K	10K			
V203	110K	0	0	0	1K	2.2K	150			
V204	0	100	0	0	1K	1.5K	10K			
V205	0	100	0	0	1K	1.5K	10K			
V206	55	1K	0	0	20K	20K	1K			
	100K	1K	0	0	26K	26K	1K			Place CRYSTAL SELECTOR on 1–10.
V207	20K	1.2K	100K	9K	0	350K	100K	0	20K	
	20K	700	100K	9K	0	40K	0	700	20K	Place 1ST BEAT OSCILLATOR on VARIABLE.
V208	20K	700	100K	85K	0	120K	0	520	20K	
V301	9K	150	0	0	1K	2K	150			
	9K	150	0	0	1K	2K	150			Place MAN VOL CONTROL on 10.
V302	2K	150	0	0	1K	2K	150			
V303	250K	150	0	0	1K	2K	150			
V304	150	300	0	0	700	10K	150			
V305	1 meg	180	0	0	1.2K	10K	180			
V306	51K	180	0	0	1.2K	1.5K	180			
V307	25K	220K	0	0	125	Inf*	125			Place MAN VOL CONTROL on 10.
V308	0	10K	2 meg	50K	0	250K	220K	9K	0	Place AFC on OFF.
V309	0	2K	1 meg	100K	0	250K	1 meg	6.2K	0	
V310	5K	75	0	0	220K	560K	75			
V311	51K	75	0	0	220K	560K	75			
V401	24K	120K	9K	0	0	100K	3.5K	3.7K	24K	Place PANEL 4 VT CURRENTS on S B VOLT HYB V401A 20V.
V402	500K	275	24K	24K	850	330	500K			

*Inf=Infinite.

Tube	Resistance in ohms between ground and socket terminal numbers									Remarks and differences from test setup
	1	2	3	4	5	6	7	8	9	
V403	24K	20K	2K	0	0	100K	3.5K	3.7K	24K	Place PANEL 4 VT CURRENTS on CAR VOLT D3 V403A 4V.
V404	500K	275	24K	24K	850	330	500K			
V405	125	180	24K	24K	3.5K	4K	200			
V501	125	200	0	0	1.1K	1.5K	200			
V502	10K	100	0	0	3.5K	4K	100			
	20K	100	0	0	3.5K	4K	100			Place AFC on OFF.
V503	4K	240	0	0	850	9K	4K			
V504	6	240	0	0	850	9K	6			
V505	4K	240	0	0	850	9K	4K			
V506	6	240	0	0	850	9K	6			
V507	2.5K	Inf*	0	0	Inf*	2.5K	100			
V508	2.5K	Inf*	0	0	Inf*	2.5K	100			
V509	2.5K	Inf*	0	0	Inf*	2.5K	100			
V510	2.5K	Inf*	0	0	Inf*	2.5K	100			
V511	400	200	0	0	6.5K	2K	200			
V512	250K	180	0	0	1.1K	1.5K	200			
V513	2.3 meg	100	0	0	2.5K	2.5K	100			

*Inf=Infinite.

g. Remove the straps from the rectifier pin jacks and make the following measurements from the jacks to ground.

Rectifier	Jack	Resistance-to-ground (ohms)	Resistance-to-ground with receiver disconnected from power supplies*
±130 volts	J1	8, 500	10, 500
	J3	6, 500	17, 500
+250 volts	J1	20, 000	60, 000

*Remove receiver leads connected to terminals 1 and 5 on TS2 in the 250-volt supply, and to terminals 1, 5, 6, and 9 on TS2 in the ±130-volt supplies.

h. Remove the test connections from the rectifiers, restore the controls to normal settings, and throw the MAIN POWER and both rectifier PWR switches to ON.

106. Stage Gain Test Procedure

a. Adjust the receiver controls according to the tuning chart (fig. 23) for the lowest assigned operating frequency (or use 5 mc), set the 1ST BEAT OSCILLATOR switch at VARIABLE.

b. Patch the 22DT signal generator through the modified 440A dummy antenna to the REC INPUT jack. Adjust the generator for the frequency chosen in *a*, and for an output of 10,000 μf (5,000-μf input to the receiver).

c. Set the following controls as indicated below:

(1) PANEL SELECTOR to 4.
(2) MAN VOL CONTROL to 10.
(3) VOLUME CONTROL to MAN.
(4) PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.

d. Connect the headset to the MONITOR jacks.

e. Change the frequency of the signal generator slightly. If no tone is heard, the sensitivity of the receiver must be very low. (Make sure the controls are set as indicated in *c* above.) If a tone is heard and the DC METERING meter reading is below 30, the overall gain of the rf and if. sections of the receiver is still low. Connect the 22DT signal generator to the IF AMP INPUT jack through the modified 440A dummy antenna. Adjust the signal generator to 100 kc and for an output of 10 μf (5-μf input to the receiver).

f. Adjust the MAN VOL CONTROL for a reading of 30 on the DC METERING meter. If this reading is not obtainable, the gain of the 100-kc if. stages is too low. Check paragraph 60*a*, 25 through 32 (PANEL 3 VT CURRENTS, V301 through V304). Replace the tubes or remedy the trouble as required. If the MAN VOL CONTROL can be adjusted for a reading of 30, leave the control at this setting for the remainder of the test.

g. Follow the procedure given in the table below. Remove one tube at a time. If a normal indication is not obtained, the stage is defective. To be sure that dc voltage from the receiver does not damage the signal generator, use a .01-μf capacitor in series with the signal generator output.

Step	Signal generator input to	Signal generator frequency setting	Input to receiver (uf) [1]	Control settings	Reading on DC METERING meter (±10%)	Notes
1	REC INPUT jack	Lowest operating	2.1	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	
2	Pin 5, V201	Lowest operating	1.25	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	Remove V202 and V201 after opening the box covers at the top of the hf panel. Replace the cover to close the circuit safety switch.
3	Pin 5, V202	Lowest operating	330	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	--------	
4	Pin 5, V203	Lowest operating	630	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	
5	Pin 5, V204	2.8 mc	280	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	
6	Pin 5, V205	2.8 mc	280	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	
7	If AMP INPUT jack.	100 kc	5	PANEL 4 VT CURRENTS to S B VOLT HYB V401A 20V.	30	Use dummy antenna (modified) on signal generator output.
8	Pin 5, V301	100 kc	1,500	CARRIER BRANCH GAIN control on 9.5.	--------	Reading on CARRIER RECT CURRENT meter should be 100 for V301 to V304.
9	Pin 5, V302	100 kc	2,500	CARRIER BRANCH GAIN control on 9.5.	--------	
10	Pin 5, V303	100 kc	46,000	CARRIER BRANCH GAIN control on 9.5.	--------	
11	Pin 1, V304	100 kc	40,000	CARRIER BRANCH GAIN control on 9.5.	--------	
12	Pin 5, V310	100 kc	33,000	PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	DEM CAR GAIN fully clockwise.
13	Pin 1, V307	100 kc	750	PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	DEM CAR GAIN fully clockwise.
14	Pin 1, V307	100 kc	3,000	PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	DEM CAR GAIN normal (par. 32).
15	Pin 5, V305	100 kc	14,000	PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	DEM CAR GAIN normal.
16	Pin 2, V512	100 kc	100,000	PANEL SELECTOR to 5 and PANEL 5 VT CURRENTS to AFC RECT V507 40 MA.	50	AUTO FREQU CONTROL OSC GAIN fully clockwise.
17	Pin 5, V511	100 kc	93,000	PANEL SELECTOR to 5 and PANEL 5 VT CURRENTS to AFC RECT V507 40 MA.	35	AUTO FREQ CONTROL OSC GAIN fully clockwise.

[1] Signal generator controls set for two times the input to receiver values if modified 440A dummy antenna used.

Step	Signal generator input to	Signal generator frequency setting	Input to receiver (uf) [1]	Control settings	Reading on DC METERING meter (±10%)	Notes
18	Pin 5, V511	100 kc	56, 000	PANEL SELECTOR to 4 and PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	DEM CAR GAIN fully clockwise; then reset to normal (par. 32).
19	Pin 2, V512	100 kc	46, 000	PANEL SELECTOR to 4 and PANEL 4 VT CURRENTS to CAR VOLT D3 V403A 4V.	50	CARRIER SUPPLY on LOCAL.

[1] Signal generator controls set for two times the input to receiver values if modified 440A dummy antenna used.

h. Replace all controls to their normal positions.

107. Dc Resistances of Transformers and Coils

Caution: Some repeating coils and audio transformers are damaged if dc or high amplitude ac is passed through their windings (coils in miscellaneous relay rack bay).

The dc resistances of the transformer windings and the coils are listed below:

Transformer or coil	Terminals	Ohms
L201		0
L202		0
L203		0
L204		0
L205		0
L206		0
L207		12
L208		0
T502	1 and 2	1. 0
T502	3 and 4	1. 0
T502	6 and 5	135
T504	1 and 2	1. 0
T504	3 and 4	1. 0
T504	5 and 6	135
T506	1 and 3	70
T506	4 and 5	210
L501		45
T503	1 and 3	5. 4
T503	4 and 5	72
T507	1 and 3	70
T507	4 and 5	210
T505	1 and 3	5. 4
T505	4 and 5	72
T808	1 and 3	70
T808	4 and 5	210
L503		45
T510	1 and 2	1. 0
T510	3 and 4	1. 0
T510	5 and 6	135
T509	1 and 3	70

Transformer or coil	Terminals	Ohms
T509	4 and 5	210
L504		45
FL202	1 and 2	. 55
FL202	3 and 4	1. 10
L209		0
MO201	1 and 5	2, 300
MO201	2 and 5	2, 300
MO201	3 and 5	2, 300
MO201	4 and 5	2, 300
T501	1 and 2	12. 3
T501	3 and 4	0
T201	1 and 2	1. 2
T201	3 and 5	400
T202	1 and 2	13. 5
T202	3 and 5	0
T202	6 and 7	0
T301	1 and 2	1. 0
T301	3 and 4	1. 0
T301	5 and 6	135
T305	1 and 2	160
T305	3 and 4	160
N301	1 and 3	95
N302	1 and 3	95
T302	1 and 2	160
T302	3 and 4	160
T306	1 and 2	160
T306	3 and 4	160
T303	1 and 2	160
T303	3 and 4	160
T304	1 and 2	160
T304	3 and 4	160
T402	1 and 2	4
T402	3 and 4	4
T402	5 and 6	20
T402	7 and 8	20
T307	1 and 2	13. 5
T307	3 and 4	0
T307	4 and 5	0
T307	6 and 7	0
T406	1 and 2	1. 0
T406	3 and 4	1. 0
T406	5 and 6	135

Transformer or coil	Terminals	Ohms
T403	1 and 2	2. 0
T403	3 and 4	2. 0
T403	5 and 6	4. 0
T403	7 and 8	4. 0
T407	1 and 2	1. 0
T407	3 and 4	1. 0
T407	5 and 6	135
T408	1 and 2	2. 0
T408	3 and 4	2. 0
T408	5 and 6	4. 0
T408	7 and 8	4. 0
L401		1. 1
L402		1. 1
T404	1 and 3	74. 8
T404	4 and 5	3, 700
L403		1. 1
L404		1. 1
T409	1 and 3	74. 8
T409	4 and 5	3, 700
T405	1 and 2	42. 5
T405	3 and 4	53. 5
T405	5 and 6	18
T405	7 and 8	510
T410	1 and 2	42. 5
T410	3 and 4	53. 5
T410	5 and 6	18
T410	7 and 8	510
T401	1 and 2	13. 5
T401	3 and 4	0
T401	4 and 5	0
T401	6 and 7	0
17SC (repeat coil) in miscellaneous relay rack.	1 and 2	18
	5 and 6	18
	3 and 4	27
	7 and 8	27
	9 and 10	27
	11 and 12	27

Section II. REPAIRS

108. Replacement of Parts

a. Replacing Scale-Illuminating Lamps in Afc Motor Control Unit MO 201. To remove and replace burned-out scale-illuminating lamps, reach in through the inspection opening in the rear of the motor control unit housing (fig. 21).

b. Replacing Tuning Dials. Two tuning dials are used in the receiver; one for 1ST BEAT OSCILLATOR TUNING and the other for HF AMPLIFIER TUNING. To remove them, follow procedure in (1) through (5) below:

(1) Remove the stile strips on the front of the cabinet.

(2) Remove all knobs on panel 2. Do not try to remove the knobs on the HF AMPLIFIER TUNING and 1ST BEAT OSCILLATOR TUNING dials, because they are mounted behind transparent mats and protrude through cutouts in them, until the mat is taken off.

(3) Remove the front panel mat.

Note. Set dials at 250; do not move shafts.

(4) Loosen the setscrews and slide the knobs off the shafts.

(5) To replace the dials, reverse the above procedure.

c. Replacing Motor Control Unit (D–170 114) MO 201. To replace motor control unit MO 201, follow procedure in (1) through (6) below:

(1) At the rear of the receiver, disconnect the coaxial cable plug from jack J1 in the back of the control unit housing located at the right side of hf panel 2.

(2) At the front of the receiver, lift up and remove the stile strips from each side of the cabinet front. Remove the coaxial plug and small control knobs from the hf panel. Remove the screws and lift off the panel mat.

(3) Remove the screws and lift off the cover of the motor control unit housing. Unsolder the eight external leads from the terminal strip (fig. 27). Loosen the locknut on the cable clamp assembly and swing the cable form clear of the housing.

(4) Remove the four bolts and nuts that hold the control unit housing to the panel and carry the unit to the test bench; be careful not to jar it.

(5) To install the tested spare unit, reverse the above procedure.

(6) Paragraph 121 gives tests and adjustments of the MO 201 assembly.

109. Refinishing

Instructions for refinishing badly marred panels on exterior cabinets are given in TM 9–2851. Refer to these instructions as necessary.

110. Adjustments of Relays

a. Under normal operating conditions, the relays used in this receiver will not require maintenance for several years.

b. The contacts are made of special metals and operate without attention if the dust covers are left in place. Contact operation has a self-cleaning action and the operation of the lights checks these relay contact operations. Lamps and lamp sockets should be tested before relays are inspected for contact or operational failure.

c. In removing relay covers, be careful not to disturb the springs.

d. Carbon tetrachloride and similar solvents are generally not required unless oil is on the relay. Use only clean solvent.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

e. Use clean, oil free, hard surface, watermarked, bond letter paper to clean relay contacts. Insert the paper between the contacts, operate the relay electrically or mechanically, and pull the paper through but not out of the contacts. (Lint on the edge of the paper might pull off and stay between, or get between, the contacts later.) Open the contacts, and remove and discard the paper.

f. This paragraph and paragraphs 111 through 114 contain detailed descriptions for performing the electrical and mechanical adjustments of the U-type relays, S802 to S804, used in the receiver. Figure 56 shows the relay terminals viewed from the base side of the relay, and the arrangement of the contact springs. The top of the relay is shown at the bottom of figure 56 because the relay panel (8) has to be tipped toward the operator and down when an inspection is being made. The U-type relay used in this receiver is a quick-operating relay with twin sets of contacts on each pair of mating springs. The contact springs are numbered consecutively from left to right facing the contact side of the relay, and from right to left facing the terminal side of the relay (with the top of the relay up). The U-type relays have the same basic construction and the same general requirements and adjusting procedures as other types. One spring of each pair provides the means for setting the contacts so that both pairs make and break at approximately the same point of spring travel. Use of twin contacts provides greater protection against failure caused by lint or dirt between the contacts, provided the springs are properly adjusted so that parallel contacts are made at the same time. The armatures of these relays are not rigidly fastened at the rear as in some other types of relays, but are held in place by hinge pin bearings (fig. 57). In this type of construction, the armature is not rigidly positioned unless the relay is energized. Therefore, the armature must be operated electrically rather than mechanically, to insure accuracy of gaging. The WECo drawing ED45034-012 gives the requirements of the relays used in R-369/FRC-10.

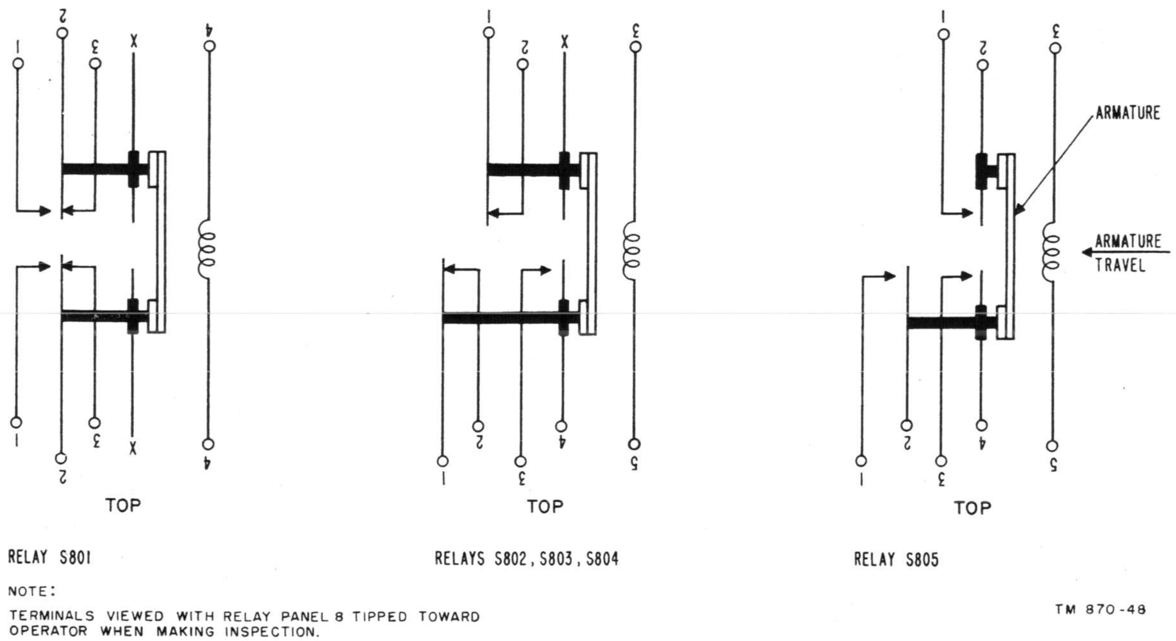

Figure 56. Location of terminals and spring combinations of relays.

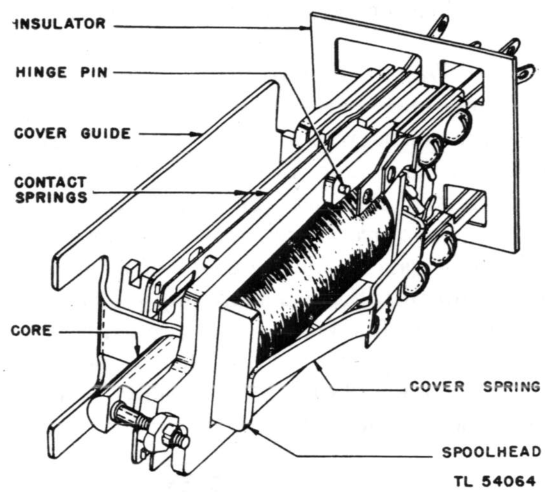

Figure 57. *U-type relay.*

111. Mechanical Requirements and Adjustments of Relays

a. Before proceeding with the following checks and adjustments, clean the relay parts and contacts. Use the cleaning brush or a clean, dry piece of cloth to clear away any dust that has collected on or near the contacts. Protect the adjacent components from flying dust particles. Use an air-sucking device, such as a vacuum cleaner, if available, to remove the dust. Do not touch the relay with the cleaner hose.

b. Inspect the relay contacts and springs. The relay requires no further care when the circuit in which the inspected part is a component operates satisfactorily; the contacts are free of corrosion; and there are no signs of contact pitting or build-ups. Indiscriminate adjustment of equipment, particularly of relays, may result in circuit failure. Therefore, burnish and adjust the relay contacts only when it is absolutely necessary. Continual burnishing of relay contacts wears away the contacts; as a result, continual adjustments of the relay have to be made to compensate for these worn contacts.

c. Relay S801 normally operates on approximately 5.8 ma; however, if it fails to operate with 4.2 ma while under test, readjust the relay to operate on 3.9 ma. This will insure proper operation when in normal use.

d. Refer to paragraph 36*b*(4) for the operational test of S803 and S804. Relays S802, S803, and S804 should operate with 7.4 ma while under test. If not, readjust the relays to operate with 7.0 ma.

e. Relay S805 should operate with 4.7 ma while under test. If not, readjust the relay to operate with 4.4 ma.

112. Burnishing Relay Contacts

Place the blade of the burnisher between the open contacts. Press the contacts firmly against the blade with the aid of an orange stick. Then move the burnisher blade back and forth until the contacts are shiny. Remove any foreign material with a clean, dry cloth.

113. Flushing Relay Contacts

When, because of excessive oil or hardened organic material, burnishing does not clean the contacts, clean and flush them as follows (*a* through *c* below):

a. Dip the flat end of a toothpick into unused carbon tetrachloride and deposit a drop of the liquid on the contact. Do not rub the contact.

b. Apply a few more drops of the liquid to flush away the loosened material.

Note. Do not allow the carbon tetrachloride to come in contact with the relay spoolheads or insulators.

c. After the contacts have dried, burnish them (par. 110*e* or 112).

114. Relay Alinement Procedure

Note. If the contacts are excessively misalined, do not attempt to correct the condition, but replace the relay.

a. Preliminary Procedure. Clean the armature and adjusting nut by passing a piece of cleaning tape back and forth between the armature and the adjusting nut around the adjusting stud (fig. 58).

b. Contact Alinement. Position the relay springs so that mating contacts are properly alined. The centers of the contacts should be exactly opposite each other. If they are not, try to correct this

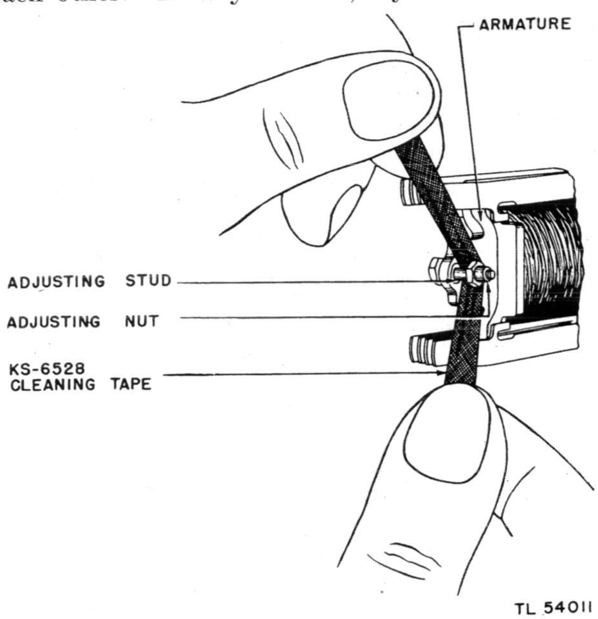

Figure 58. *Cleaning adjusting stud on relays.*

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condition by applying pressure to the free ends of the springs with a spring adjuster; be careful to avoid damaging the springs. If this procedure fails to aline the contacts, remove the relay from the mounting plate. Loosen the spring assembly mounting screws with an offset screwdriver. Center the springs. Tighten the screws securely and replace the relay on its mounting plate.

c. Spring Stud Clearance. The spring studs should not rub on the springs through which they pass when the armature is moved. If necessary, loosen the spring assembly screws and center the springs to meet this requirement.

d. Spring Tang Position. The spring tang is the offset portion of a spring which rests against the side of slots in the spoolhead. It should be positioned so that the free end extends back of the front face of the spoolhead, with the full width of the tang within the spoolhead slot (fig. 59). The tang should not rub or bind against the bottom of the spoolhead slot when the spring moves. Correct the faulty positioning by applying pressure to the end of the springs; use a spring adjuster (fig. 60). Do not distort or damage the springs. If the springs cannot be shifted, remove the relay from its mounting plate and loosen the spring assembly clamping screws sufficiently to shift the springs to correct the fault. Tighten the screws securely and remount the relay.

e. Adjusting Stud Clearance. The armature should not rub against the armature adjusting stud. If the adjusting stud is bent, straighten the stud with the long-nose pliers. Do not damage the stud.

f. Adjusting Stud Nut. The adjusting nut should be sufficiently tight on the stud to prevent it from being turned with the thumb and forefinger. If it is not, back off the nut with a 349 or 474A wrench (fig. 62), and then force the slotted parts of the stud closer together with the long-nose pliers (fig. 61).

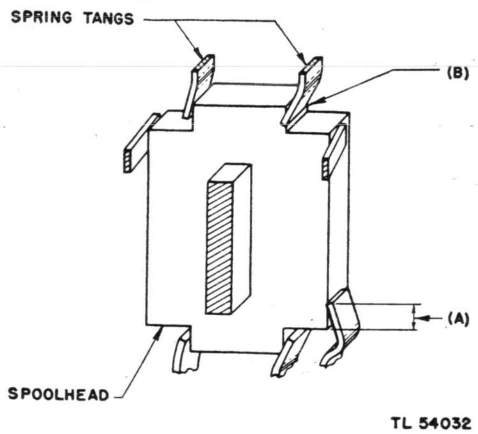

Figure 59. Position of relay spring tangs.

g. Armature Travel. Armature travel is measured by the distance between the core and the nearest stop pin (or nearest point on the armature when stop pins are not provided) when the armature is resting against the adjusting nut. To adjust the armature travel, insert the proper blade of the 66D gage (which consists of 67 individual gage blades) in the armature gap and turn the adjusting nut with a 349 or 474A wrench until the gage fits snugly (fig. 62). The armature travel is 38 for relay S801, 35 for relays S802 through S804, and 29 for relay S805.

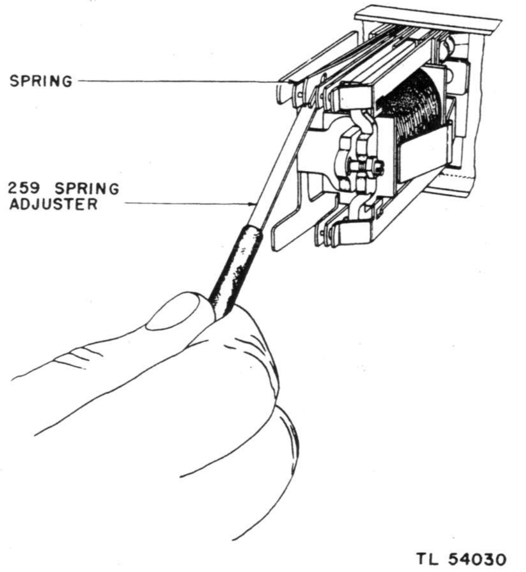

Figure 60. Adjusting spring alinement on relays.

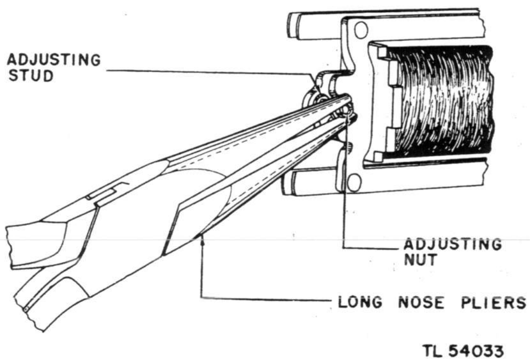

Figure 61. Tightening adjustment nut on stud.

h. Contact Pressure and Spring Tension. The pressure between the closed contacts and the tension of the springs should hold the armature against the adjusting nut. Use the 70D gage (fig. 63). In adjusting a relay, place a 259 or 300 spring adjuster on the spring behind the contacts and studs. Slide it back to a position near the

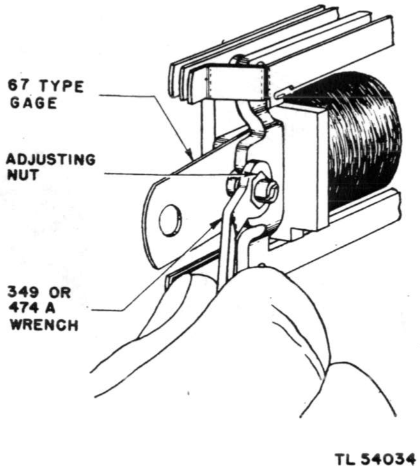

Figure 62. Adjustment of armature travel.

insulators and adjust it to the right or left as required (fig. 64); do not disturb the adjacent springs. Distribute the tensions proportionately between the top and bottom, and light and heavy spring combinations.

i. Stud Gap. There should be a clearance of .003 inch between a stud or bushing and the springs. If there is not, adjust the springs as in *h* above. If difficulty is encountered, bend the spring tang slightly. Do this by holding the spring with a 259 or 300 spring adjuster and bending the tang with the long-nose pliers (fig. 65).

j. Contact Separation. There should be a minimum separation of .005 inch between any pair of

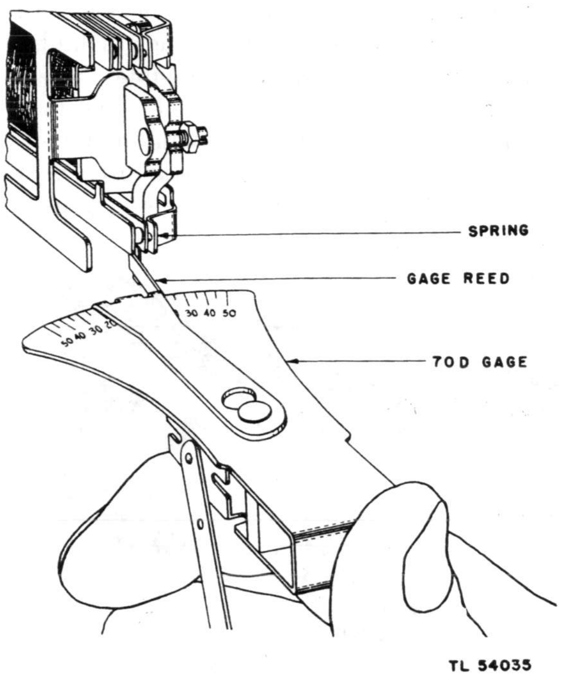

Figure 63. Gaging spring tensions of relay.

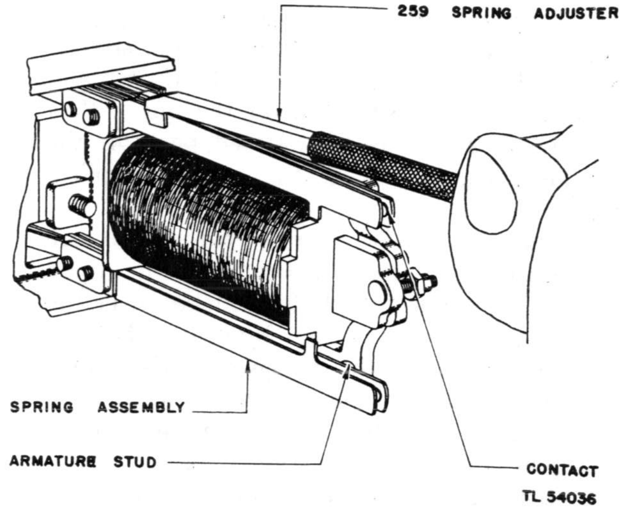

Figure 64. Adjusting spring tension of relays.

normally open contacts, or between any pair of contacts that are opened when the relay is operated. Adjust the spring with a 259 or 300 spring adjuster, follow the procedure for contact pressure in *h* above, or adjust the spring tang according to the procedure given in *d* above.

k. Contact Follow. The follow of all normally open contacts when making contact should be a minimum of .004 inch. Adjust the spring as for contact separation (*j* above). In adjusting the spring, reduce the contact separation towards the minimum.

l. Adjusting Armature Stud Clearance. Visually check to see that there is some clearance between the armature and the adjusting stud in all positions of armature travel. Grasp the adjusting nut with the long-nose pliers and bend the adjusting stud.

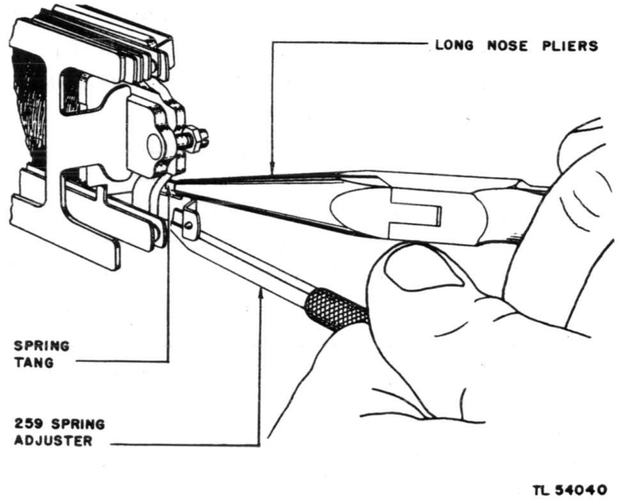

Figure 65. Adjusting spring tangs of relay.

m. Adjusting Stud Nut Tightness. The adjusting nut should be sufficiently tight on the stud to prevent it from being turned with the thumb and forefinger. If it is not, back off the nut with a 474A wrench and force the slotted parts of the stud closer together with the long-nose pliers (fig. 61).

n. Armature Position. Press both armature legs against the hinge bracket with the relay operated, and against the hinge bracket after the relay has been released. Gage by eye. Check to see that the tensions of the springs are satisfactory. If they are not, adjust them as directed in *o* below:

o. Spring Tension. The tension of each spring is measured in grams. On terminals 2 and 3 (fig. 56), the tension is 25 grams. Figure 66 shows how the spring tension is measured. The minimum values of spring tensions are given. If the tension greatly exceeds the specified minimum, the relay may fail to meet its electrical requirement, and the tension will have to be reduced. In readjusting, try to get as much tension in the moving springs as is consistent with meeting other requirements. Distribute the tensions of the moving springs proportionately between the top and bottom spring combinations. Use the 505A, 506A, or 507A spring adjustor, as specified. Use the 505A spring adjuster on the thin springs, because the use of any adjuster that has a wider slot may result in unsatisfactory adjustment. Place the spring adjuster on the spring just behind the operating stud and slide it back to the base of the spring (fig. 67). Adjust the spring to the right or left; be careful not to disturb adjacent springs. Adjust the springs in line with their movement. Avoid tilting them, because tilted springs will cause unequal contact separation of the two pairs of contacts and may result in the failure of one of the contacts on the bifurcated spring to close. If the desired tension cannot be obtained in the above manner without bowing the spring or reducing the clearance between springs below the minimum value, apply the spring adjuster to the spring behind the operating stud and slide it back to the base of the spring. Then draw the adjuster forward to the length of the spring; meanwhile apply enough pressure to form the spring into a slight gradual bow, with the concave surface facing the armature. Repeat the adjustment shown in figure 67.

p. Armature Back Tension. Check the armature back tension (fig. 68). The minimum value is 18 grams. Use the 70H gage for this check. If the armature is not held against the adjusting nut

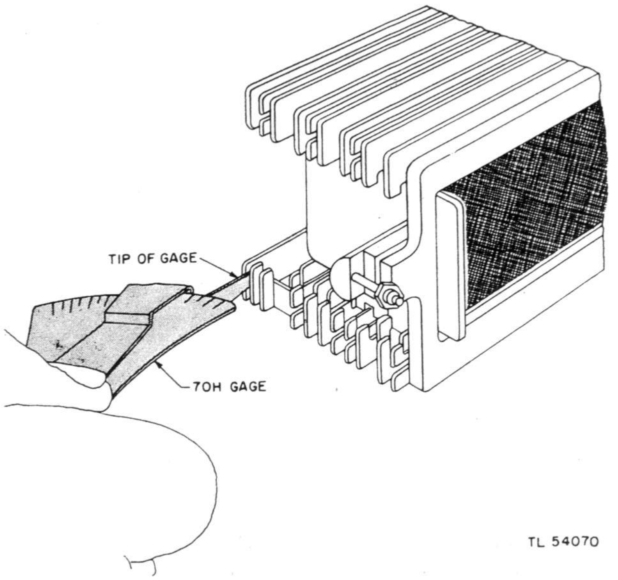

Figure 66. Checking spring tension of U-*type relay.*

with the specified pressure, or if the portion of this pressure in one spring combination is more than 2½ times that of the other spring combination, alter the tension of the A spring. Use the 505A spring adjuster.

q. Spring Stud Clearance. Visually check to see that the spring studs clear the springs through which they pass in all positions of armature travel. If the springs touch the stud, they are probably twisted. Use the spring adjuster to make the necessary correction.

r. Straightness and Separation of Springs. All springs should be free from sharp bends or kinks. A gradual bow in the spring is permissible. There should be a minimum clearance of .008 inch between adjacent springs in both operated and unoperated positions. If necessary, straighten bent springs by following the procedure given in *h* above.

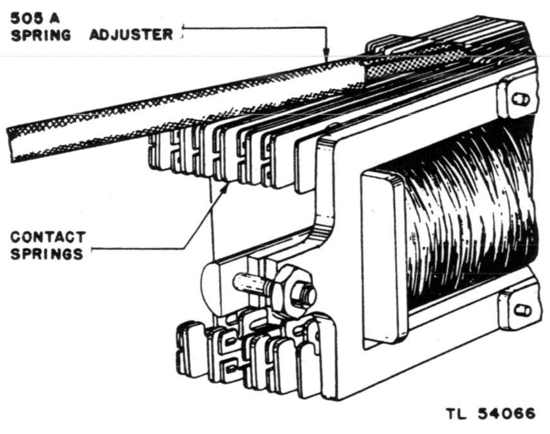

Figure 67. Adjusting spring tension of U-*type relay.*

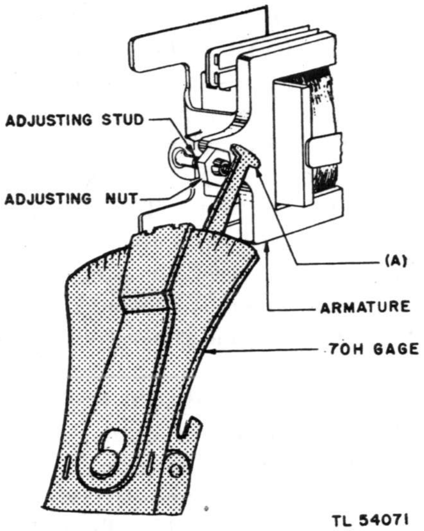

Figure 68. Checking armature back tension of U*-type relay.*

s. Stud Gap. The minimum clearance of the spring stud gap is .006 inch. Stud gaps are important, because they provide for good contact conditions of the break contacts. Slip a 133A gage (.004 inch) over the end of the armature, between the armature and the spring stud. Visually check to see that a slight clearance remains between spring and stud. To adjust, bend the spring tang to the right or left; use a 507A spring adjuster while holding the spring with another 507A spring adjuster (fig. 69).

t. Contact Make. The contacts must make before the armature has reached its fully operated position. Check the contact make as follows: insert the .008-inch blade of the 131A gage between the armature and core. At least one of the twin contacts of each pair of contacts should make when the relay is electrically energized. If it does not, adjust as in *s* above. Check the adjustment in the following manner: insert the .004-inch blade of the 131A gage between the armature and the core and electrically energize the relay. Both twin contacts should make. To be certain that the contacts are made, press the top of the solid spring toward its mating spring with an orange stick (fig. 70). If the solid spring moves perceptibly without moving its mating spring, the contact is not made.

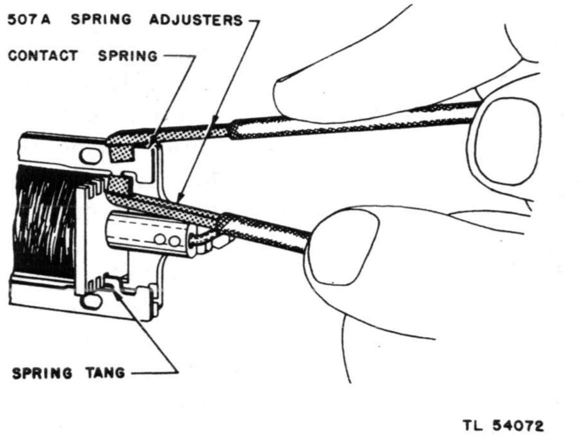

Figure 69. Adjusting spring location of U*-type relay.*

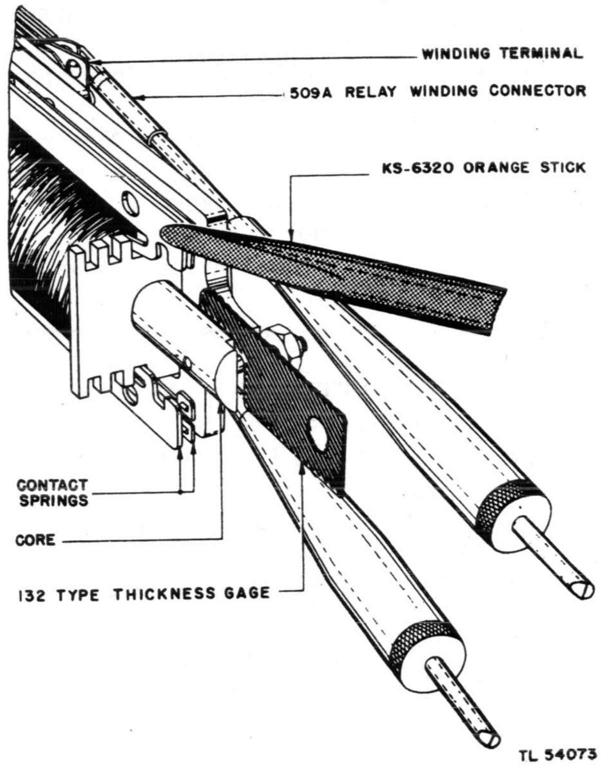

Figure 70. Checking contact make on U*-type relay.*

Section III. ALINEMENT PROCEDURES

115. Tracking Hf Amplifier V201

a. The following procedure checks that the hf amplifier input and output circuits are properly alined and will track within the range of the INPUT TUNING control (*h* through *c* below). Follow this procedure only in case of component failure, replacement caused by damage, or frequency range change (par. 25).

b. It is necessary to have access to four slotted shafts (near the top of panel 2) that extend through from the wiring side. To reach them, remove the panel 2 mat and thus open its safety switch. To protect personnel from dangerous potentials, make a duplicate of the regular mat; use ⅛-inch or ¼-inch transparent Lucite or Plexiglas. Drill four ½-inch holes through it to provide access to the slotted shafts that control the slugs of inductors L202, L201, L204, and L205. Refer to figure 74 for location of L201, L202, L204, and L205. In addition, using the mat as a template, drill the regular control holes and four holes for mounting screws. Reproduce the radial lines (and their numbers) of the INPUT TUNING knob on the substitute mat. As a safety precaution, install the male portion of a door switch on the substitute mat in the position that corresponds to the location of the switch on the regular mat. Labels of controls other than INPUT TUNING can be marked in pencil or rubber stamped and can be protected with shellac or clear lacquer on the control support strips to simplify this operation.

c. To aline the hf amplifier circuits, follow procedure in (1) through (27) below:

(1) Lift up and remove the cabinet stile strips from each side of the cabinet front. Remove hf panel 2, coaxial plug PG201, knobs, and mat.

(2) Mount the transparent mat and remount the knobs.

(3) Set the following controls to the positions indicated:

(*a*) INPUT ATTENUATION DB to 0.

(*b*) RANGE to 10.3–28 MC.

(*c*) 1st BEAT OSCILLATOR to VARIABLE.

(*d*) CRYSTAL SELECTOR to 0.

(*e*) MAN VOL CONTROL to 8.

(*f*) MONITOR TRANSFER to B.

(*g*) Use figure 23 to obtain approximate dial settings required.

(4) Plug the headset into the MONITOR jacks.

(5) Screw the slug of inductor L204 halfway.

(6) Patch signal generator ferris 22DT through modified dummy antenna 440A to the REC INPUT jack. Adjust the frequency to 10 mc and the output to 100 μf (50-μf input to the receiver).

(7) Adjust the 1ST BEAT OSCILLATOR TUNING control to tune to 10 mc.

(8) Turn the HF AMPLIFIER TUNING knob for a maximum 1,000-cps to nine the headset; tune the MAN VOL CONTROL as necessary for a reading of 0 on the VOLUME INDICATOR meter.

(9) Turn the INPUT TUNING knob to 5 and adjust the slug of inductor L201 for a maximum reading on the VOLUME INDICATOR meter.

(10) Turn the INPUT TUNING knob for a maximum output. The knob reading should be between 3 and 7.

(11) If it is not, reset the slug of inductor L204 and repeat (7) through (10) above.

(12) Change the signal generator frequency to 28 mc.

(13) Adjust the 1ST BEAT OSCILLATOR TUNING to tune to 28 mc, refer to figure 23 for typical calibration.

(14) Repeat (8) through (10) above. The reading of the INPUT TUNING knob should now be between 1 and 9.

(15) Turn the RANGE knob to the 4–10.3 MC position.

(16) Screw the slug of inductor L205 halfway in.

(17) Change the signal generator frequency to 4 mc.

(18) Adjust the 1ST BEAT OSCILLATOR TUNING to tune to 4 mc.

(19) Adjust the HF AMPLIFIER TUNING knob for a maximum 1,000-cps tone in the headset; turn the MAN VOL CONTROL knob to obtain a reading of 0 on the VOLUME INDICATOR meter.

(20) Turn the INPUT TUNING knob to 5 and adjust the slug of inductor L202 for a maximum output on the VOLUME INDICATOR meter.

(21) Turn the INPUT TUNING knob for a maximum output. The INPUT TUNING knob reading should be between 3 and 7.

(22) If it is not, reset the slug of inductor L205 and repeat (9) through (21) above.

(23) Change the signal generator frequency to 10.3 mc.

(24) Adjust the 1ST BEAT OSCILLATOR TUNING to tune to 10.3 mc.

(25) Repeat (19) through (21) above. The INPUT TUNING knob reading should now be between 1 and 9.

(26) Disconnect the signal generator. Remove the knobs and transparent mat.

(27) Remount the regular mat, knobs, and stile strips. Insert the 341C coaxial plug,

PG201, and set the knobs in their normal positions (par. 21).

116. Balance Test for Third Demodulators

a. The balance test checks for and corrects a condition of carrier leakage in the third demodulators. Such a condition, generally caused by unbalance in components, is not detrimental to operation of the receiver. It may result in inability to meet other test requirements and generally appears as an abnormally high reading on the VOLUME INDICATOR meter in the absence of a high signal and/or noise level.

b. Because indiscriminate readjustments of the balancing inductors may result in malfunctioning of the equipment, the balance test should be performed only when the above condition is observed, or when components in the third demodulator are replaced. (Refer to par. 13 for changes in receiver design.)

c. Before performing the balance test, make a substitute mat of lucite or plexiglas. A ⅛-inch thick sheet of the material should be cut to the same size as the regular mat and drilled for mounting screws and the regular control shafts. Mark control labels on the control mounting strip in pencil (or rubber stamp) and protect them with shellac (or clear lacquer) to aid in making this test. In addition, four ½-inch holes should be drilled to provide access to the slotted-head slugs of inductors L401, L402, L403, and L404 which are mounted in pairs near the center of the panel. The male portion of a door switch should be mounted on the substitute mat in the same location as that on the regular mat.

d. Follow the procedure given in (1) through (10) below:

(1) Lift up and remove the cabinet stile strips from each side of the cabinet front. Remove the vf panel 4, knobs and mat.

(2) Using a short clip lead, connect terminal 2 of RV401 to ground. Connect the attenuator D–165654 (special 5A) set for 40 db in series with the coaxial test lead to terminals 17 and 18 of terminal strip TS803 which is located on the relay panel (8). Plug the other end of the coaxial test lead in IF AMP INPUT jack J301.

(3) Mount the transparent mat and the CARRIER SUPPLY knob.

(4) Set the controls as follows:

- (*a*) MAN VOL CONTROL to 0 (max CCW).
- (*b*) VOLUME CONTROL to MAN (max CW).
- (*c*) CARRIER BRANCH GAIN for 20 db suppression (obtain from calibration of par. 31).
- (*d*) CARRIER SUPPLY to LOCAL (max CCW).

(5) Turn the VF LINE TRANSFER slotted shaft to R (maximum clockwise).

(6) Adjust the MAN VOL CONTROL knob clockwise until the CARRIER RECT CURRENT meter reading is 150.

(7) Remove the 40-db loss in the attenuator, and disconnect the test lead from RV401. Remove the transparent mat temporarily to perform this step. Replace the transparent mat. Do not readjust the MAN VOL CONTROL knob. If the CARRIER RECT CURRENT meter reading is now 150 or less, no adjustment is required.

(8) If the CARRIER RECT CURRENT meter reading in (7) above is more than 150, adjust the tuning slugs of inductors L401 and L402 until a minimum reading is obtained on the CARRIER RECT CURRENT meter. This minimum should be below a reading of 150 on the CARRIER RECT CURRENT meter. If no minimum can be obtained, check the panel for damage to the associated components and replace, where necessary.

(9) Repeat (7) and (8) above; connect the test lead and attenuator to terminals 21 and 22 of terminal strip TS803 and adjust the slugs of inductors L403 and L404, if required.

(10) Disconnect the test lead. Remove the knob and the transparent mat. Remount the regular mat, knobs, and stile strips. Return all controls to their normal positions (par. 21).

117. 100-KC OSCILLATOR BALANCE Adjustment and Oscillator Output

This procedure checks the amplitude of the output of the 100-kc oscillator and is made whenever any new parts are inserted in the oscillator bridge circuit.

a. Lift up and remove the cabinet stile strips from each side of the cabinet front. Remove the afc panel knob and mat.

b. Connect the vacuum-tube voltmeter from the junction of resistor R548 and 100-kc crystal Y501 to ground; bring the test leads out of the right end of the panel.

c. Remount the panel mat to close the safety switch on the lower left side of the panel; reinsert the left-end mounting screws.

d. Record the reading of the test vtvm.

e. Remove the panel mat and connect the test vtvm from the junction of lamp LP501 and resistor R547 to ground.

f. Repeat *c* and *d* above. The reading should be 2.3 times that in *d* above. If it is not, readjust slotted shaft 100-KC OSCILLATOR BALANCE potentiometer P503. Cover the control with the snap-in blank in the panel hole.

g. Remove the test connections and remount the mat, knob, and stile strips.

h. Set the controls to their normal positions (par. 21).

118. Alining N301 and N302 Peaking Networks

This procedure checks the tuning of networks N301 and N302 whose inductor slugs can be adjusted by a screwdriver from the apparatus side of if. panel 3 (fig. 13). The gain of the reconditioned carrier, two-stage limiter amplifier is also checked.

a. Set the following controls to the positions indicated.

(1) MAN VOL CONTROL to 10.

(2) VOLUME CONTROL to MAN.

(3) CARRIER BRANCH GAIN to 10.

b. Lift up and remove the cabinet stile strips. Remove the if. panel knobs and mat.

c. Connect a microammeter between terminal post T and ground to measure across resistor R395.

Note. Terminal post T is above tube socket VS311 at the left edge of the panel (fig. 91).

d. Bring the test leads out of the right end of the panel and, if practicable, locate the test meter so that it can be seen from the rear of the receiver cabinet. Remount the panel mat to close the safety switch on the upper left edge of the panel. Reinsert the left-end mounting screws. Remount the MAN VOL CONTROL knob.

e. Patch the signal generator through the modified 440A dummy antenna to the IF AMP INPUT jack. Adjust the signal generator frequency to 100 kc and the output for 500-uv input to the 100-kc if. amplifier.

f. Adjust the signal generator frequency control and the MAN VOL CONTROL knob until a reading of 40 is obtained on the CARRIER RECT CURRENT meter. Remove the MAN VOL CONTROL knob.

g. With a screwdriver, turn the slotted shaft of network N301 fully counterclockwise; then turn it slowly clockwise until a peak reading is obtained on the test microammeter. This network is the upper one located at the right rear of the panel.

h. Remove the panel mat (disconnecting signal generator lead if necessary), disconnect the test leads, connect the test meter as a vacuum-tube voltmeter, and connect it through a .01-μf blocking capacitor across capacitor C333 in the lower left corner of the panel.

i. Bring the test leads out of the right end of the panel. Remount the panel mat to close the safety switch. Reinsert the left-end mounting screws (reconnect signal generator if it was disconnected).

j. With a screwdriver, turn the slotted shaft of network N302 fully counterclockwise and then slowly clockwise until a peak reading is obtained on the test voltmeter.

k. Disconnect the signal generator from the IF AMP INPUT jack. Remove the panel mat. Without changing its frequency, connect the signal generator through the modified 440A dummy antenna across resistor R382, which is behind and to the right of MAN VOL CONTROL potentiometer P305.

l. Bring the additional test leads out of the right end of the panel. Remount the panel mat to close the safety switch. Reinsert the left-end mounting screws.

m. Adjust the signal generator for an input that gives an output reading of .3 volt on the test voltmeter. The input should be less than 6,000 uv.

n. If an input greater than 6,000 uv is required to obtain the .3-volt reading, check vacuum tubes V310 and V311, and then recheck the network tuning.

o. Remove the panel mat, disconnect the test leads, and remount the panel mat, knobs, and stile strips.

119. General

This section is intended as a guide in determining the quality of a repaired Radio Receiver R–369/-FRC–10. The minimum test requirements in paragraphs 121 through 125 may be checked by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements can be expected to furnish uniformly satisfactory operation.

120. Test Equipment Required for Final Testing

The test equipment required for final testing is the same as that listed for troubleshooting in paragraph 100. Refer to the appropriate technical manuals for instructions on the use of the test equipment.

121. Afc Motor Assembly

a. These tests of afc tuning motor assembly MO 201 must be performed only by personnel skilled in relay repair. If the requirements for a test are not met, use the tools supplied for relay adjustments to obtain the correct brush pressure, contact spacing, etc.

b. Improper adjustment or inadequate maintenance of the control unit may cause faulty operation and result in the afc motor circuit losing control. To keep troubles at a minimum, the control unit must be cleaned and adjusted every *2 years*.

c. A rectangular plate, which covers an opening in the upper right portion of the rear of the control unit box, should be taken off when a scale-illuminating lamp, LP901 or LP902, is replaced or a limited inspection is made (fig. 21).

d. To test the afc motor assembly, follow the procedure in (1) through (12) below:

(1) At the rear of the receiver, disconnect the coaxial cable plug from the jack in the back of the control unit box, located at the right side of panel 2.

(2) At the front of the receiver, lift up and remove the stile strips from each side of the cabinet front. Remove the coaxial plug and small control knobs from the panel. Remove the screws and lift the panel mat off over the two large control knobs. Loosen and lift off the front cover of the control unit box. Unsolder the eight external leads from the terminal strip at the rear (fig. 27). Loosen the locknut on the cable clamp assembly and swing the cable form clear of the box. Remove the four bolts and nuts that hold the box to the panel, draw the box from the panel, and carry it to the test bench; be careful to handle it without jarring. Install the tested spare unit in reverse order.

(3) Remove the four screws from the rear of the box and draw out the mechanism. With an ohmmeter, measure the resistance between the frame and terminals 1 to 5 in turn. The resistance must be at least 10 megohms.

(4) Measure the resistance of each of the four motor windings by connecting an ohmmeter from terminal 5 to terminals 1 to 4 in turn. The resistance should be between 1,600 and 2,400 ohms. The variation of any one reading must be less than 100 ohms from the average of all four readings.

(5) With a 0 to 150-gram gage, measure the pressure of each tine of the ground brush on the shoulder near the top of the capacitor shaft. The pressure should be 40 to 60 grams. Clean the brush contacts and shoulder with clean carbon tetrachloride.

(6) With the scale set at zero, measure the pressure of the alarm commutator brush against the cap plate on which S1 is stenciled. The pressure should be 5 to 15 grams.

(7) Measure the clearance between the alarm commutator brush and the edge of the shaft cutout. The clearance should be .005 inch.

(8) Measure the alarm contact spacing. It should be .010 inch. Correct it if necessary, by turning the adjusting screw.

(9) Turn the scale to approximately 4¾ inches each direction and note that the alarm contacts close positively. Inspect the contacts, and burnish and clean them if necessary.

(10) The permissible end play in the intermediate and capacitor shafts is from .001 to .004 inch. Check this by holding the top bearing setscrew with an Allen key while locating the locknut with

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a wrench. Turn the setscrew down until it just bears on top of the shaft; then turn it up one sixteenth turn, hold it with the key, and tighten the locknut with the wrench.

Note. Make sure that the bottom end of each shaft rests on the 1/16-inch steel ball.

(11) Turn the capacitor shaft slowly until the capacitor plates are fully meshed, and observe their alinement. The rotor plate should be parallel to and equidistant from the stator plates for all rotor positions. Gage the spacing by eye.

(12) With the capacitor plates fully meshed, place the mechanism in the normal position in its box, hold the box cover in place, and observe the scale line-up. The black 5 line of the scale should line up with the vertical index line of the cover window. If it does not, loosen the scale-mounting setscrew, correct the scale position, and tighten the setscrew.

e. Refer to paragraph 54 for lubrication instructions.

122. Frequency Characteristic Test of Groups A and B Amplifiers

a. This test measures the band-pass characteristics of groups A and B amplifiers to determine if they are essentially flat through the required vf range of 100 to 6,000 cps.

b. To make the test, follow procedure in (1) through (10) below:

(1) Set the VOLUME CONTROL to MAN and the MAN VOL CONTROL to its maximum counterclockwise position.

(2) Insert 217-D plugs into GROUP A REC and GROUP B REC jacks in the jack strip of the miscellaneous relay rack bay (fig. 55).

(3) Connect the output of the audio oscillator D–166636 (special 19–C) to the input terminals of attenuator D–165654 (special 5A); (TS–402A/U). Set the attenuator for 20-db attenuation.

(4) Connect the output terminals of the attenuator to terminals 1 and 3 on T404.

Note. To make connections to the transformer, follow procedure in (*a*) and (*b*) below.

(*a*) Lift up and remove the cabinet stile strips from each side of the cabinet front. Remove the vf panel knob and mat. Using test clips on the end of a twisted pair, make connection to the transformer. The other end of the twisted pair connects to the attenuator D–165654 (special 5A) output. Bring the twisted pair out of the right end of the panel.

(*b*) Remount the panel mat to close the safety switch on the lower left side of the panel; reinsert the left-end mounting screws.

(5) Adjust the oscillator D-166636 for a frequency of 1,000 cps at an output of 0 dbm.

(6) Adjust the attenuator D–165654 (special 5A) until a reading of 0 VU is obtained on the VOLUME INDICATOR meter.

(7) Maintaining the same attenuator (special 5A) setting, readjust the frequency of the oscillator to the values shown below and note the readings on the db meter of the oscillator to maintain a reading on the VOLUME INDICATOR meter of 0 VU. The db meter readings should fall within the range shown in the table below.

Oscillator frequency	Db meter reading
1,000	0.
100	−1 to +1.
300	−1 to +1.
500	−1 to +1.
1,000	0 (exactly).
2,000	−1 to +1.
3,000	−1 to +1.
4,000	−1 to +1.
5,000	−.5 to +1.5.
6,000	−.5 to +2.5.

(8) Reconnect the oscillator between terminals 1 and 3 on T409.

(9) Set the VU METER TRANSFER control to A.

(10) Repeat (5) through (7) above.

123. First Beat Oscillator Output

a. This test checks the drive on first demodulator tube V202 when the first beat oscillator is controlled manually or by a crystal.

b. Follow procedure in (1) through (10) below:

(1) Make sure that power has been turned on for at least ½ hour before testing.

(2) Remove 341C coaxial plug PG201 from the ANTENNA and REC INPUT jacks. Turn the 1ST BEAT OSCILLATOR knob to CRYSTAL.

(3) Remove the cover of the hf amplifier plate tuning box at upper left of panel 2 and remove tube V202 (fig. 72). Connect the vtvm to ground and, through a .01-μf blocking capacitor, to terminal 7 of tube socket VS202.

(4) Bring the test leads out over the top of the box. Remount the box cover to close the safety switch.

(5) Remove the lucite cover of the crystal unit group. Insert a 7.6-mc crystal unit of the nearest available crystal unit in positions Y201–Y210 in succession; turn the CRYSTAL SELECTOR knob to corresponding positions 1–10.

(6) Turn the 1ST BEAT OSCILLATOR TUNING knob to tune the oscillator to the fundamental of the crystal frequency and for a peak reading of the test voltmeter for each crystal position. A reading of 1.5 to 4 volts should be obtained in each position.

(7) Turn the 1ST BEAT OSCILLATOR TUNING knob to tune the oscillator to second harmonic of crystal frequency and for a peak reading of the test voltmeter for each crystal position. A reading of 1.5 to 4 volts should be obtained for each position.

(8) Turn the 1ST BEAT OSCILLATOR knob to VARIABLE.

(9) Check to see that the test voltmeter reading stays within the required range (1 to 3 volts) as the 1ST BEAT OSCILLATOR TUNING knob is turned through its complete range.

(10) Remove the box cover, disconnect the test lead, replace tube V202, and remount the box cover. Restore the crystal unit group to normal and remount its lucite cover. Insert coaxial plug PG201 in the ANTENNA and REC INPUT jacks.

124. Second Beat Oscillator Output

a. This test checks the drive on second demodulator tubes V204 and V205.

b. Follow procedure in (1) through (6) below:

(1) Make sure that power has been turned on for at least one-half hour before testing.

(2) Remove 341C coaxial plug PG201 from the ANTENNA and REC INPUT jacks. Turn the 1ST BEAT OSCILLATOR knob to VARIABLE.

(3) Remove vacuum tube V205. Connect the vtvm to ground and, through a .01-μf blocking capacitor, to terminal 7 of tube socket VS205.

(4) Turn the 2ND BEAT OSCILLATOR TUNING knob to 0.

(5) Depress the 2ND BEAT OSCILLATOR ZERO ADJ knob while adjusting the 2ND BEAT OSCILLATOR ZERO ADJ slotted shaft for a peak reading on the CARRIER RECT CURRENT meter. Release the push button and read the test voltmeter. A reading of .8 to 1.2 volts should be obtained.

(6) Remove the test connections and insert the 341C coaxial plug PG201 in the ANTENNA and REC INPUT jacks.

125. Additional Tests

The tests listed in paragraphs 26 through 38 and in paragraph 60 should now be performed to be certain that the receiver is ready for operation. They are—

Test No.	Test	Paragraph
1	Filament voltage check and output voltage adjustment of ±130-volt rectifier and +250-volt rectifier	26
2	Operational test of alarm system and safety switches	27
3	Vacuum-tube currents tests	28
4	Frequency characteristic test of if. and vf circuits	29
5	2ND BEAT OSCILLATOR frequency adjustment	30
6	Calibration of CARRIER BRANCH GAIN potentiometer	31
7	Gain test of local and reconditioned carrier signals	32
8	Test and adjustment of avc circuits	33
9	Test of signal-to-noise ratio	34
10	100 KC OSCILLATOR frequency adjustment and afc action test	35
11	AFC SQUELCH circuit adjustment	36
12	New frequency line-up using first beat oscillator (crystal) V206	37
13	New frequency line-up using first beat oscillator (variable) V207	38
14	Equipment performance check list	60
15	Returning knobs to normal control settings	21

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

126. Disassembly

The following instructions are recommended as a guide for preparing the radio receiver for transportation and storage:

a. Disconnect the main ac power lines.

b. Disconnect and tag the leads to the miscellaneous relay rack bay at TS803 (fig. 55).

c. Disconnect the antenna and the transmission line.

d. Take down the antenna coupling transformer D-159619 and repack it.

e. Disconnect the ground cable and pull up the ground rods.

f. Remove the tubes from the power supply units (fig. 17).

127. Repacking for Shipment or Limited Storage

a. The exact procedure for repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. For repacking, reverse the instructions given in paragraph 17.

b. Whenever practicable, place a dehydrating agent such as silica gel inside each packing case. Seal the seams of the water-vaporproof barriers with sealing compound or tape. Replace all excelsior and cardboard fillers in each crate.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

128. General

The demolition procedures in paragraph 129 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commanding officer.

129. Methods of Destruction

a. Smash. Smash the crystals, crystal filters, controls, tubes, coils, switches, capacitors, transformers, and headsets; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut cords, headsets, and wiring; use axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT (trinitrotoluene).

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes or other holes, or throw them into streams.

g. Destroy. Destroy everything.

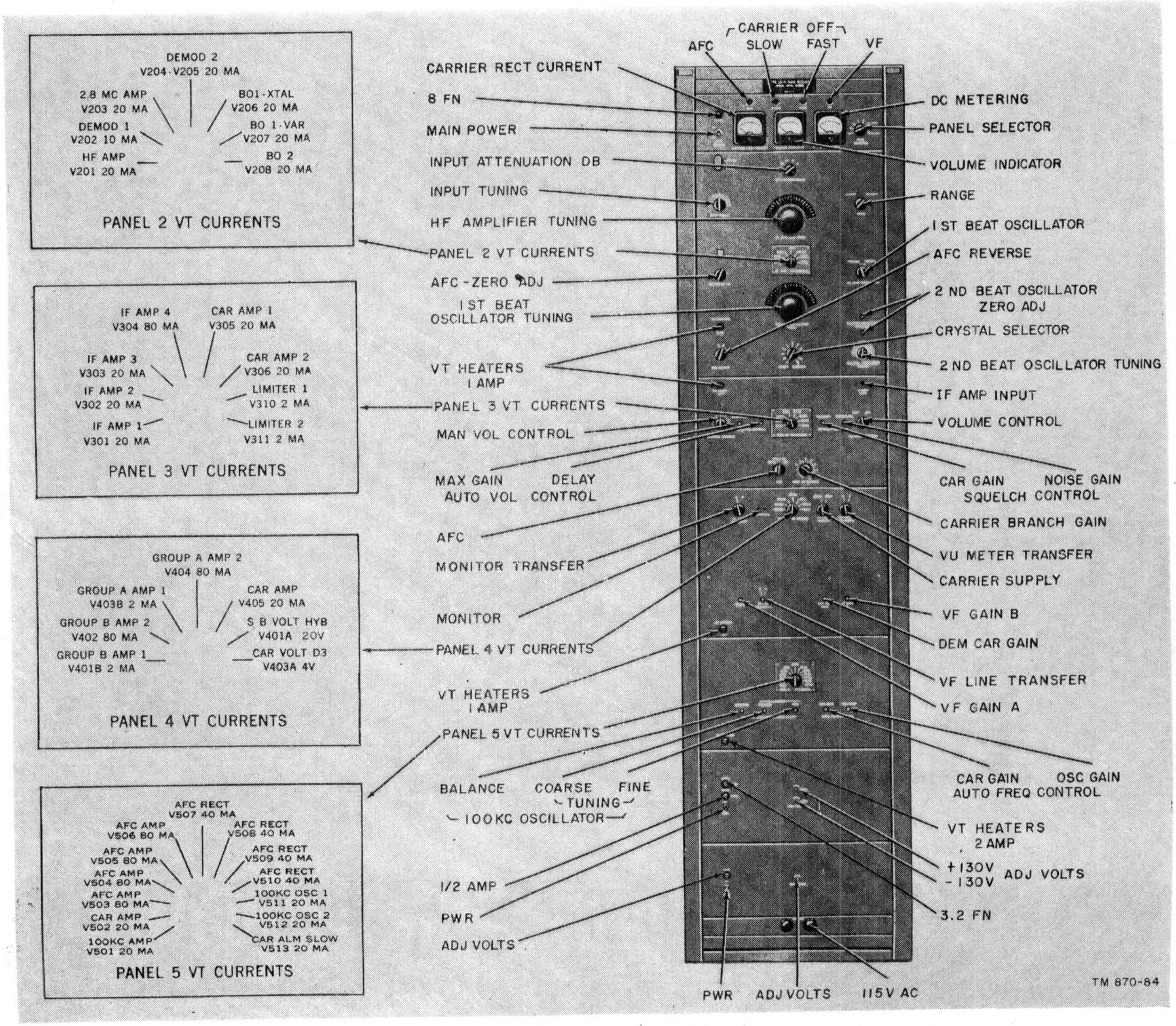


Figure 71. Front panel, control location.

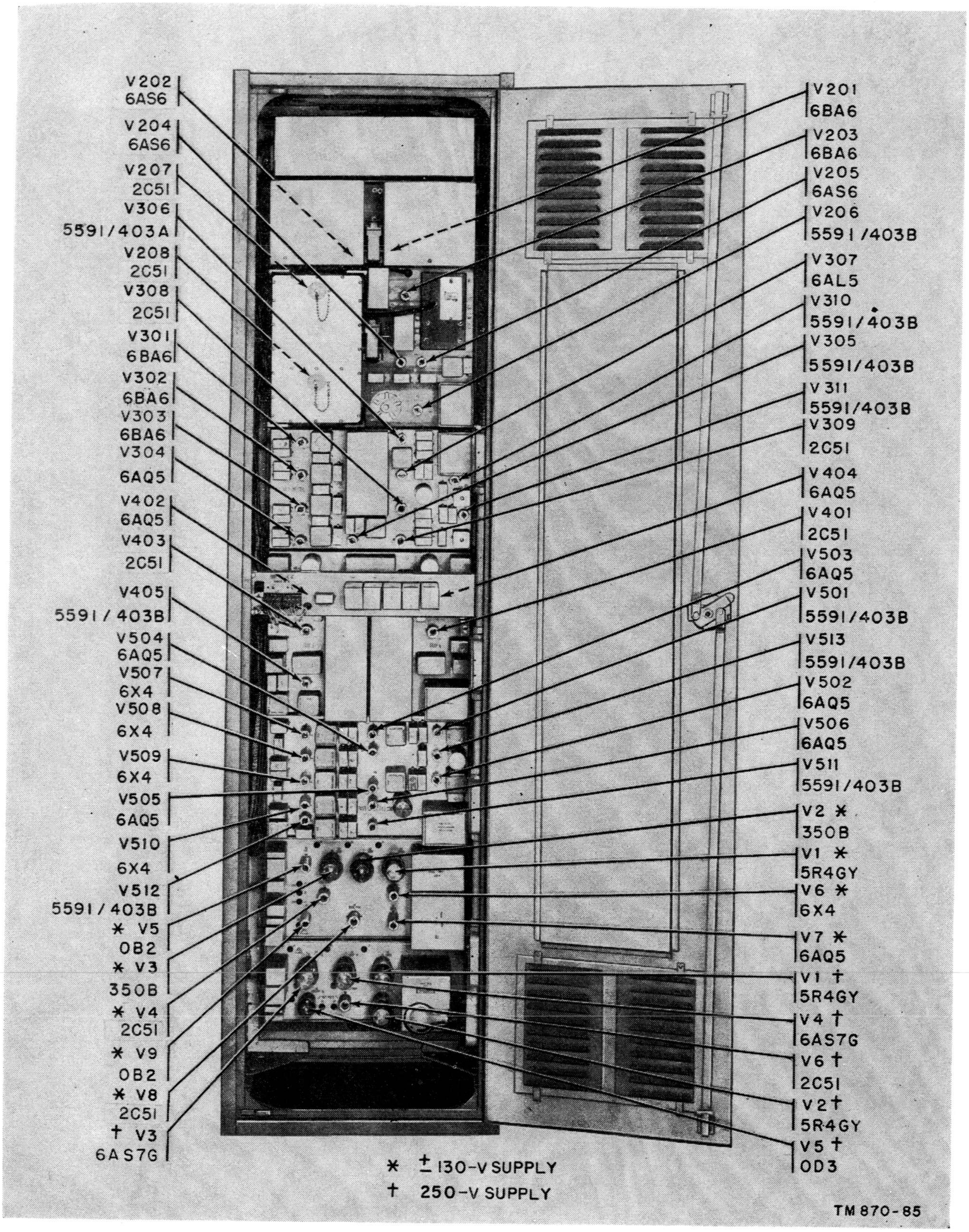


Figure 72. Radio Receiver R-369/FRC-10, tube locations.

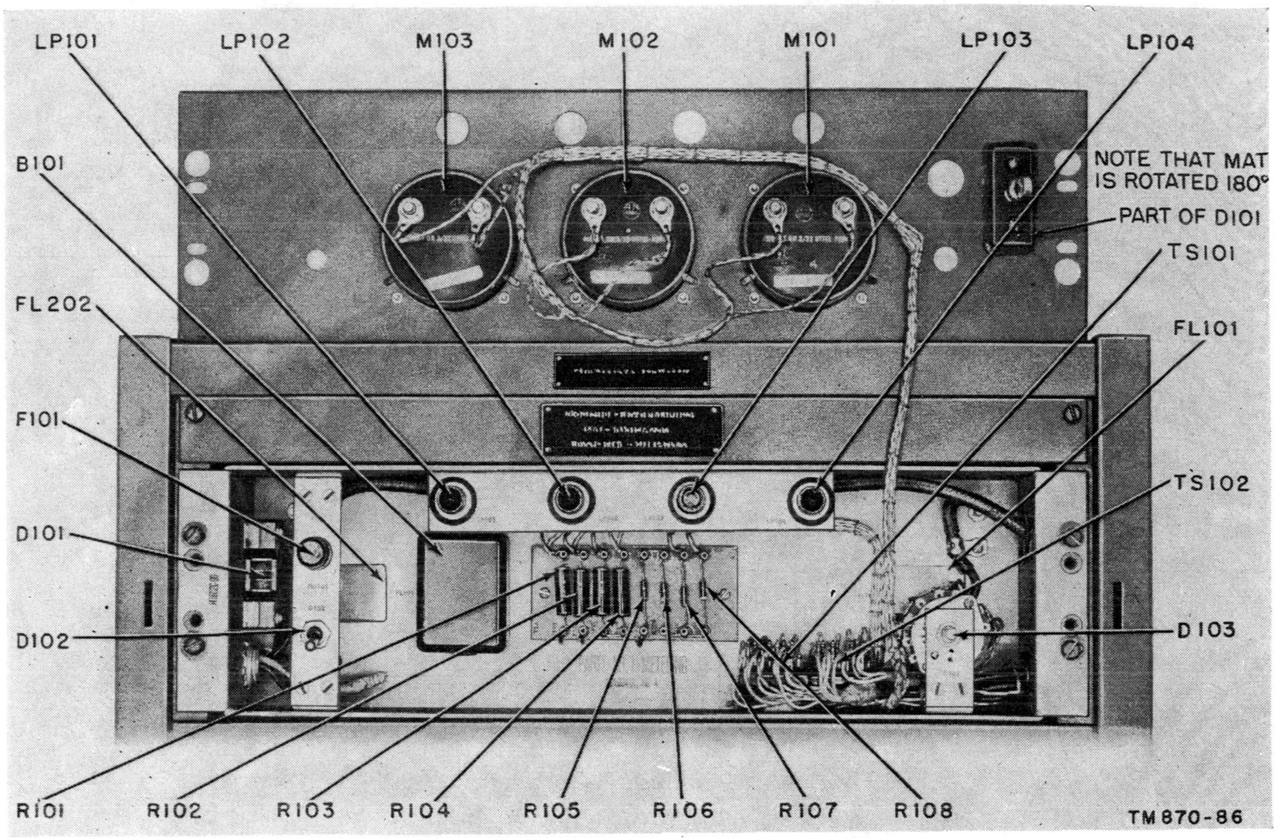


Figure 73. Metering panel 1, front view, component locations.

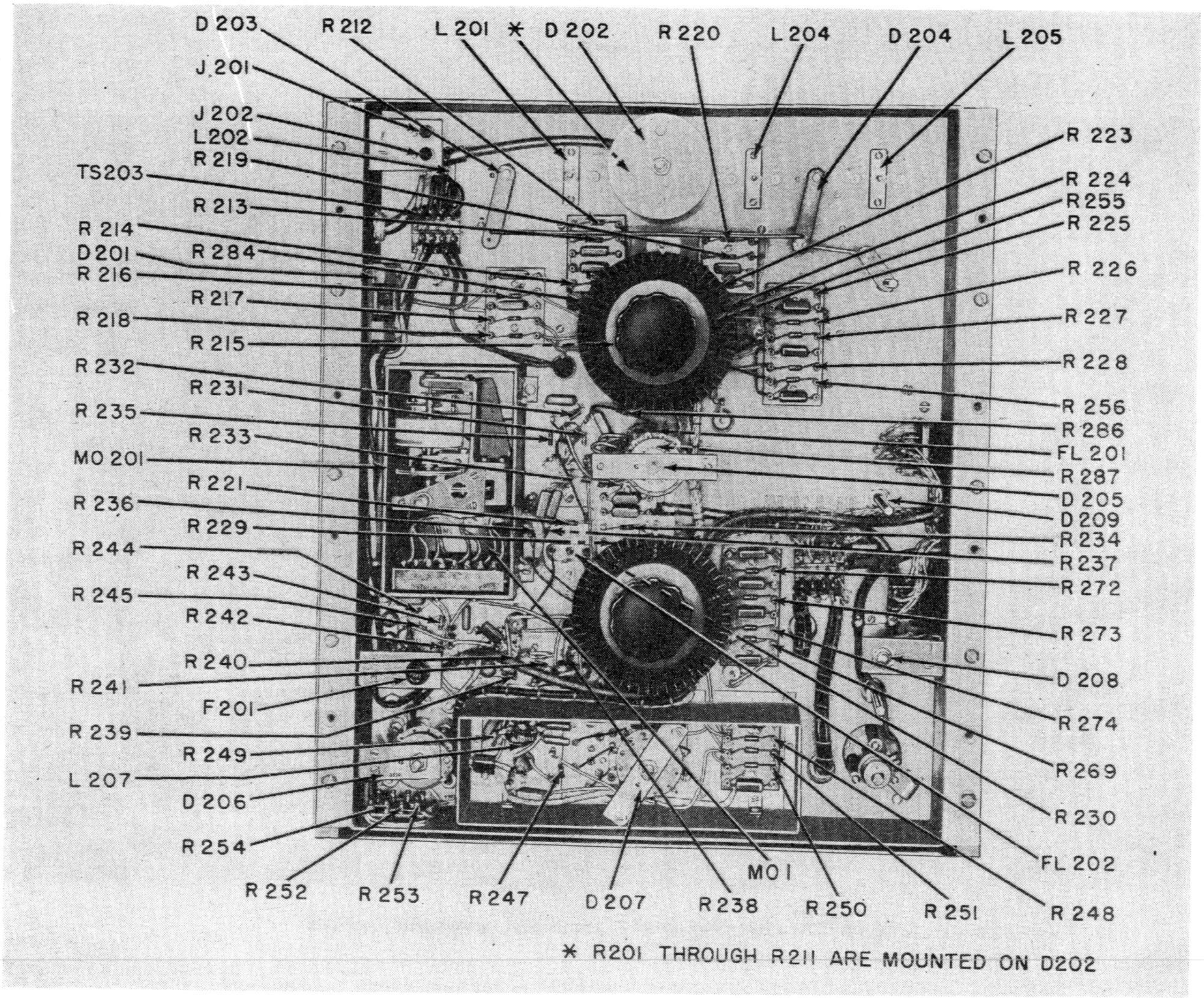


Figure 74. Hf panel 2, front view, component locations.

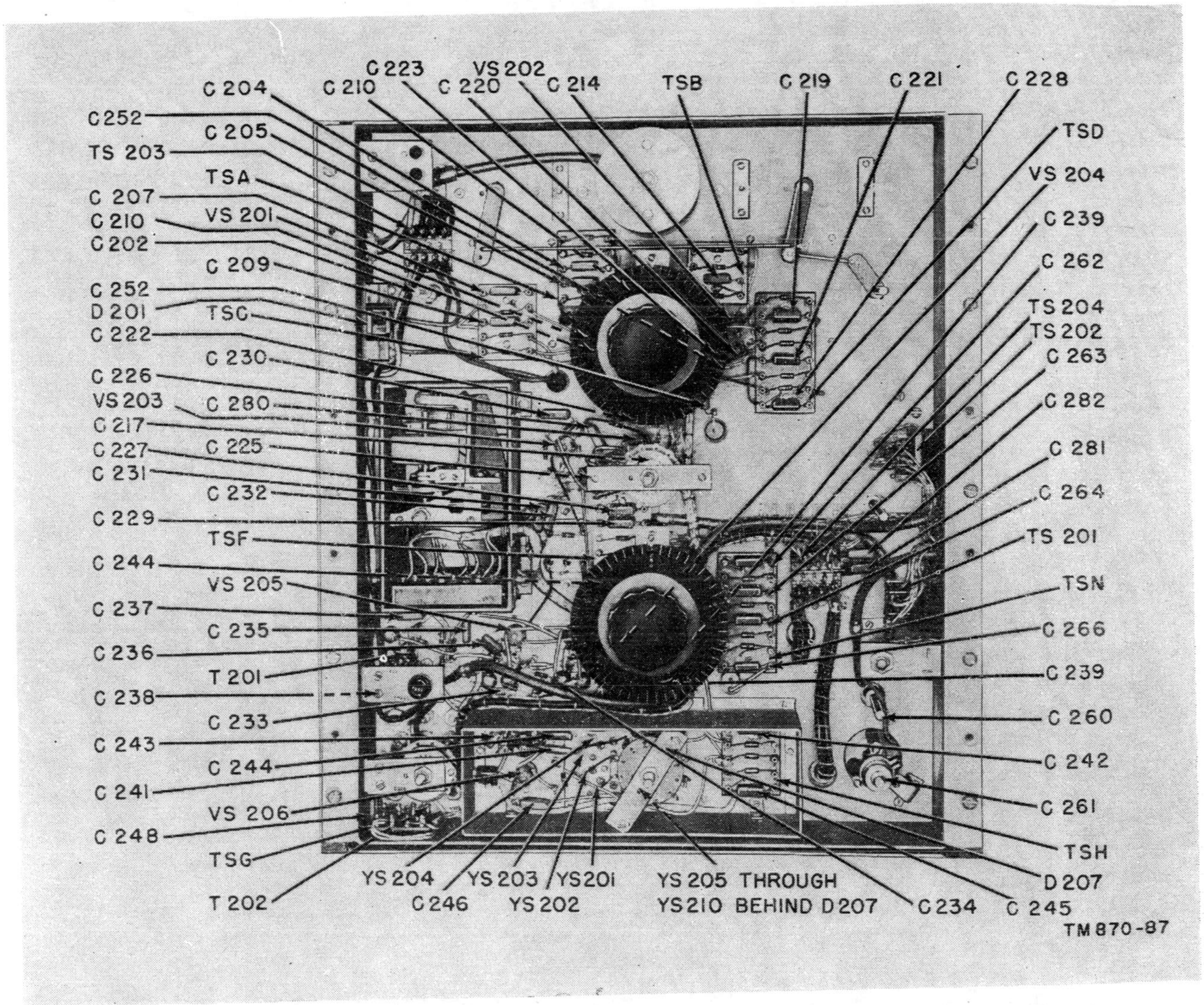


Figure 74.—Continued

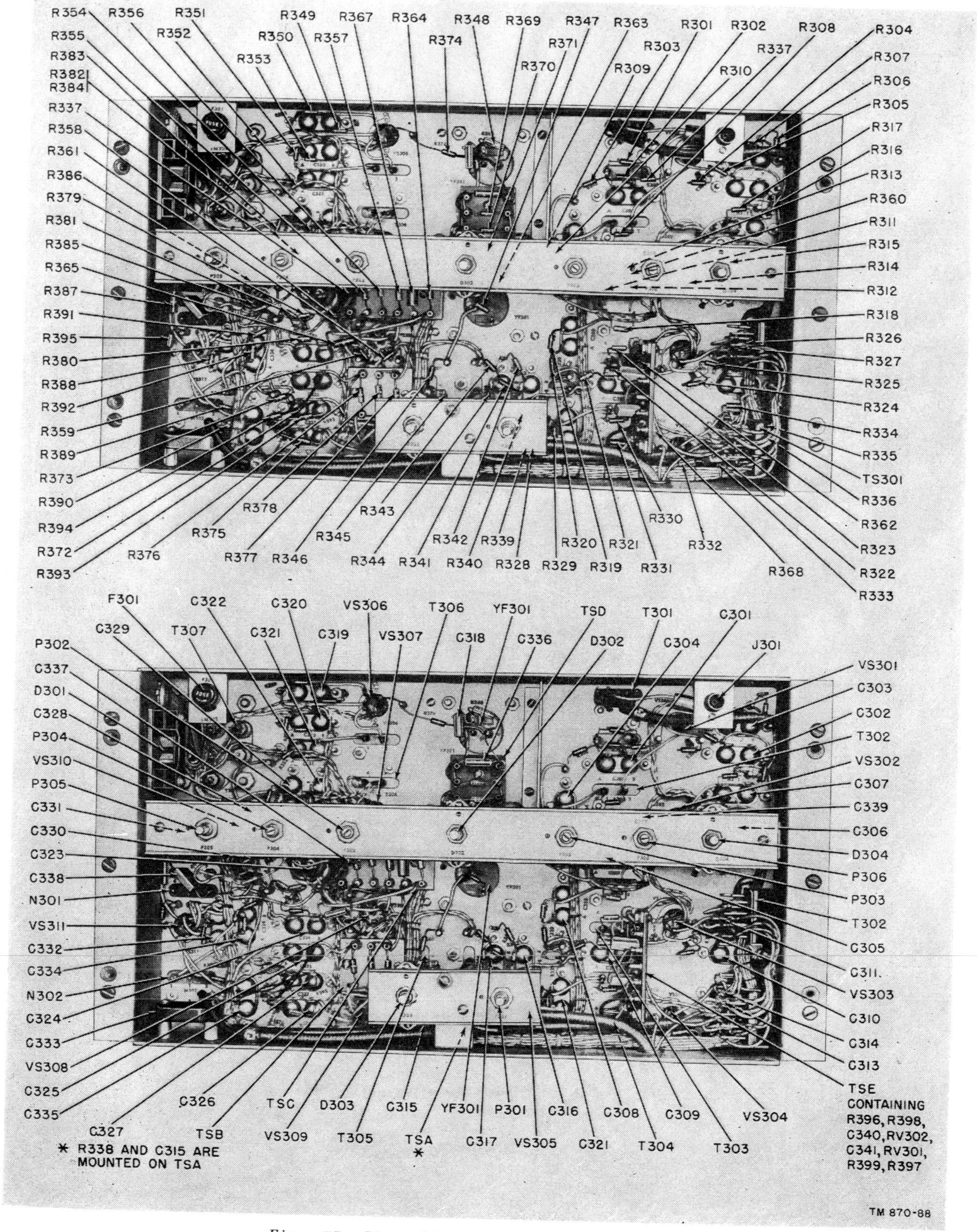


Figure 75. If panel 3, front view, component locations.

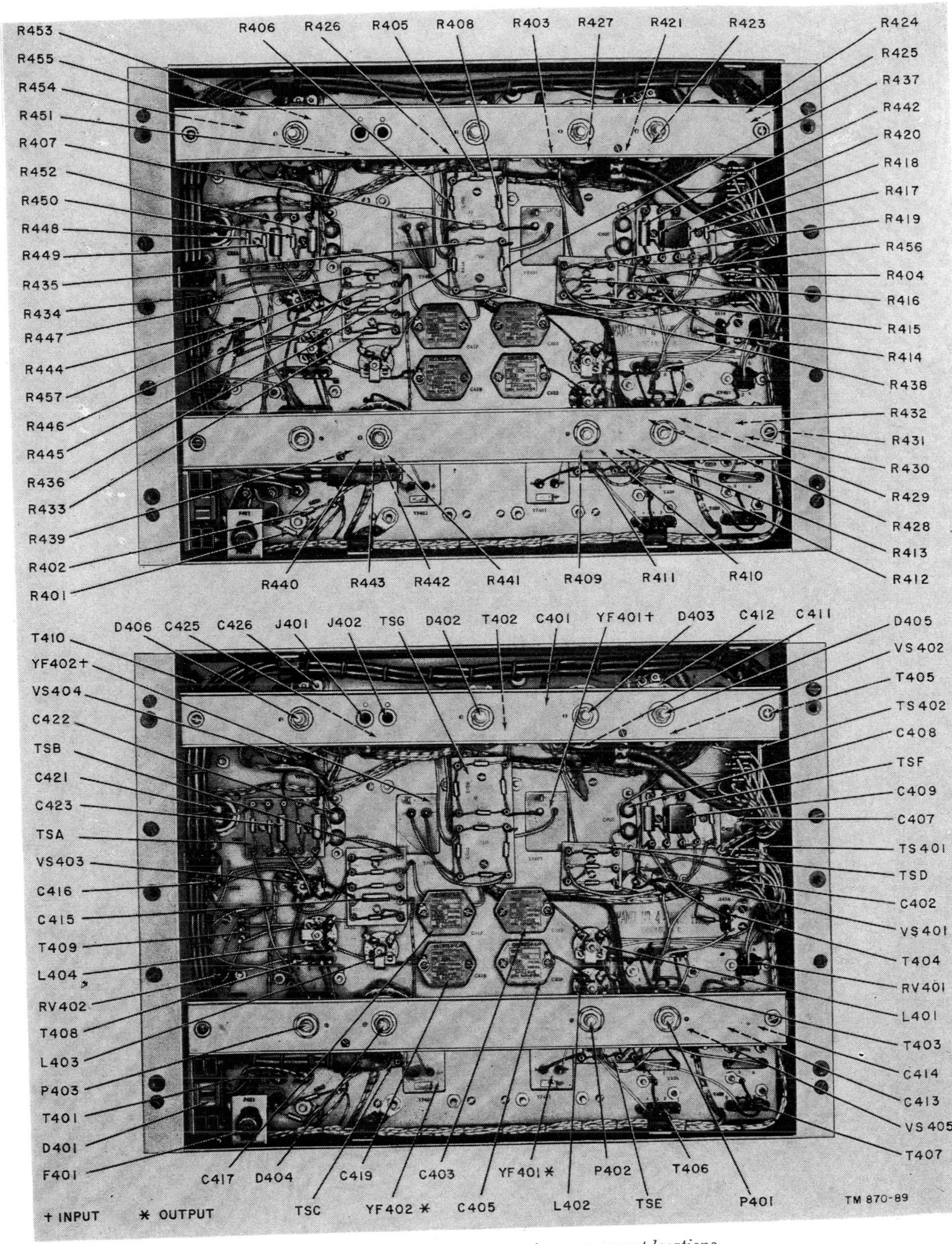


Figure 76. Vf panel 4, front view, component locations.

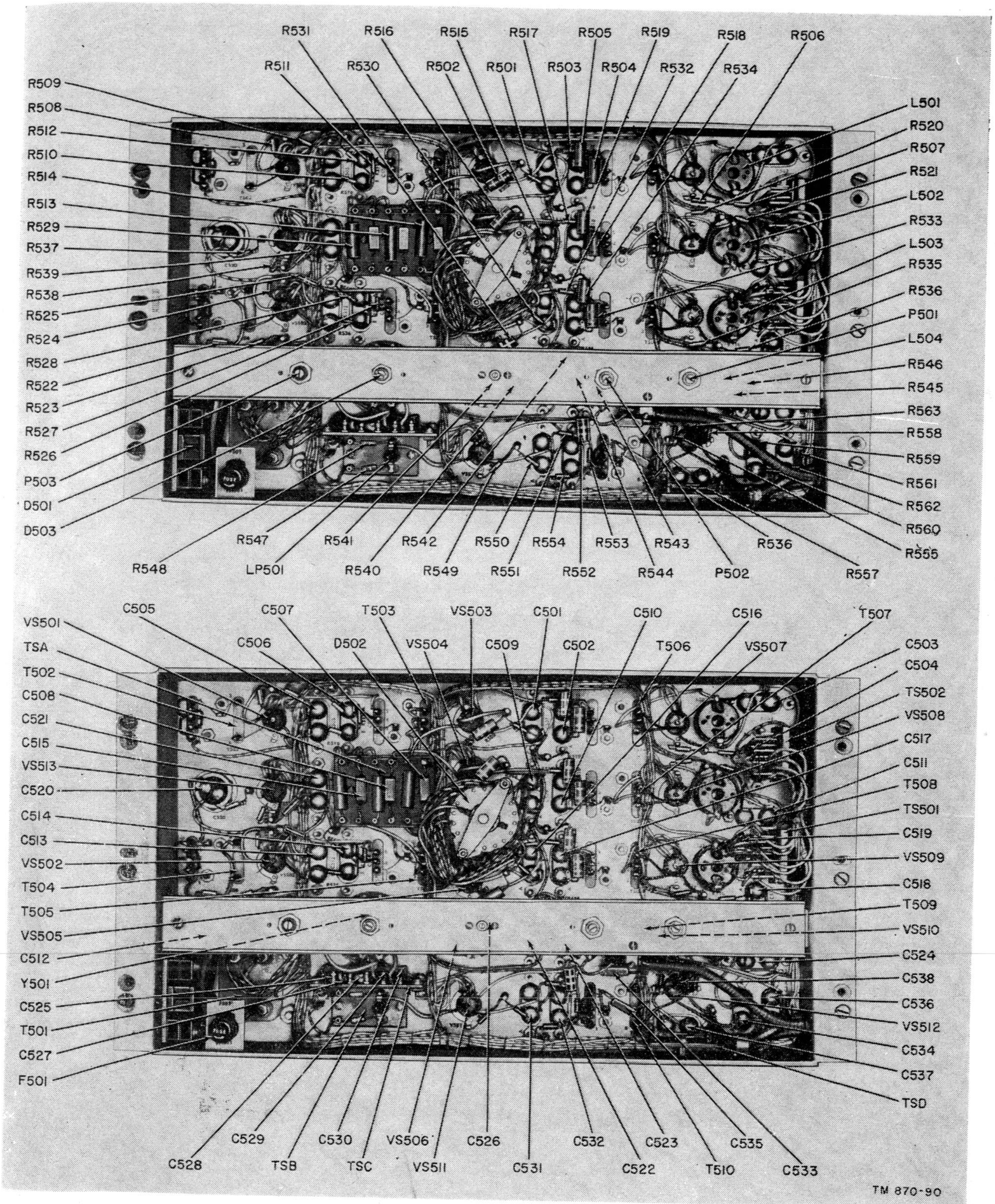


Figure 77. Afc panel 5, front view, component locations.

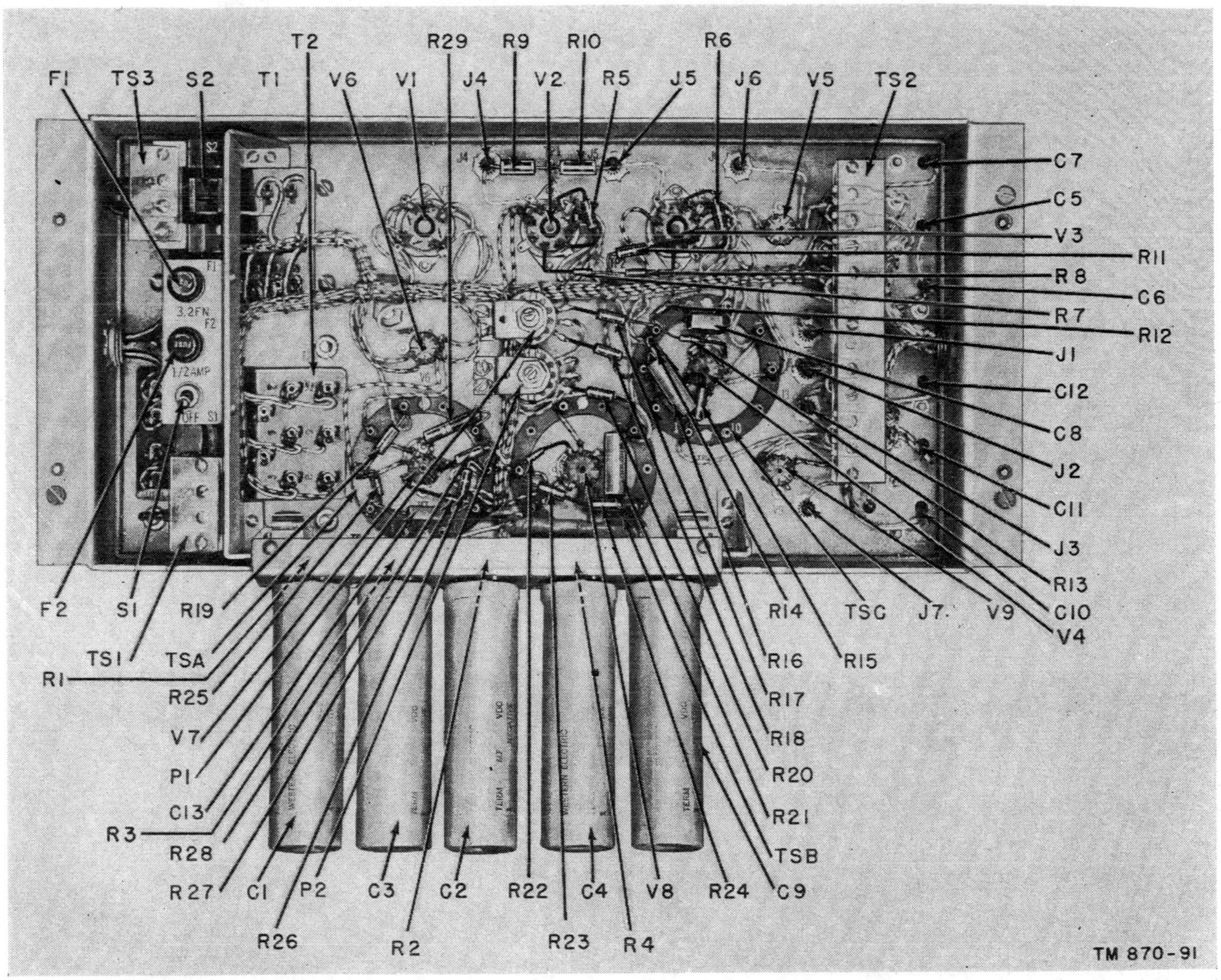


Figure 78. *+130-volt rectifier panel 6, front view, component locations.*

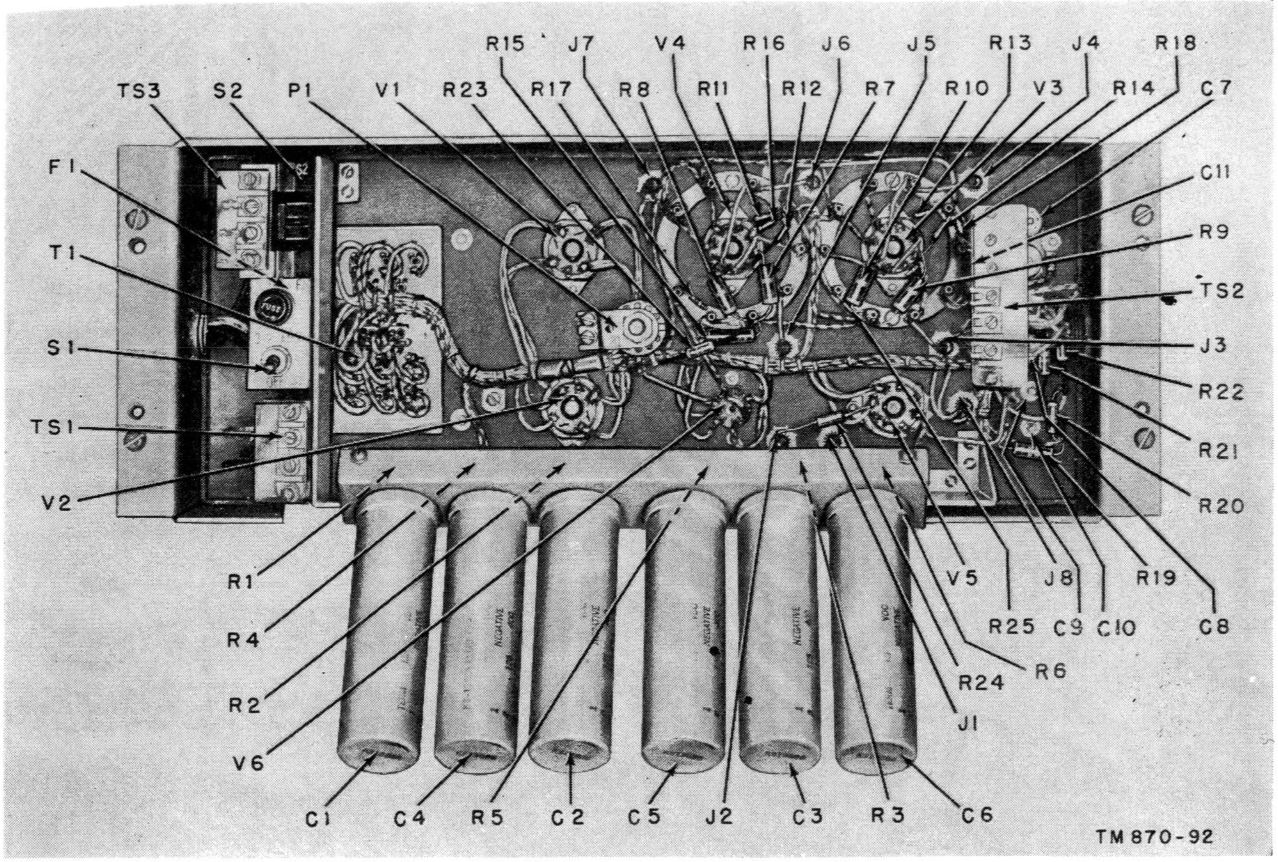


Figure 79. 250-volt rectifier panel 7, front view, component locations.

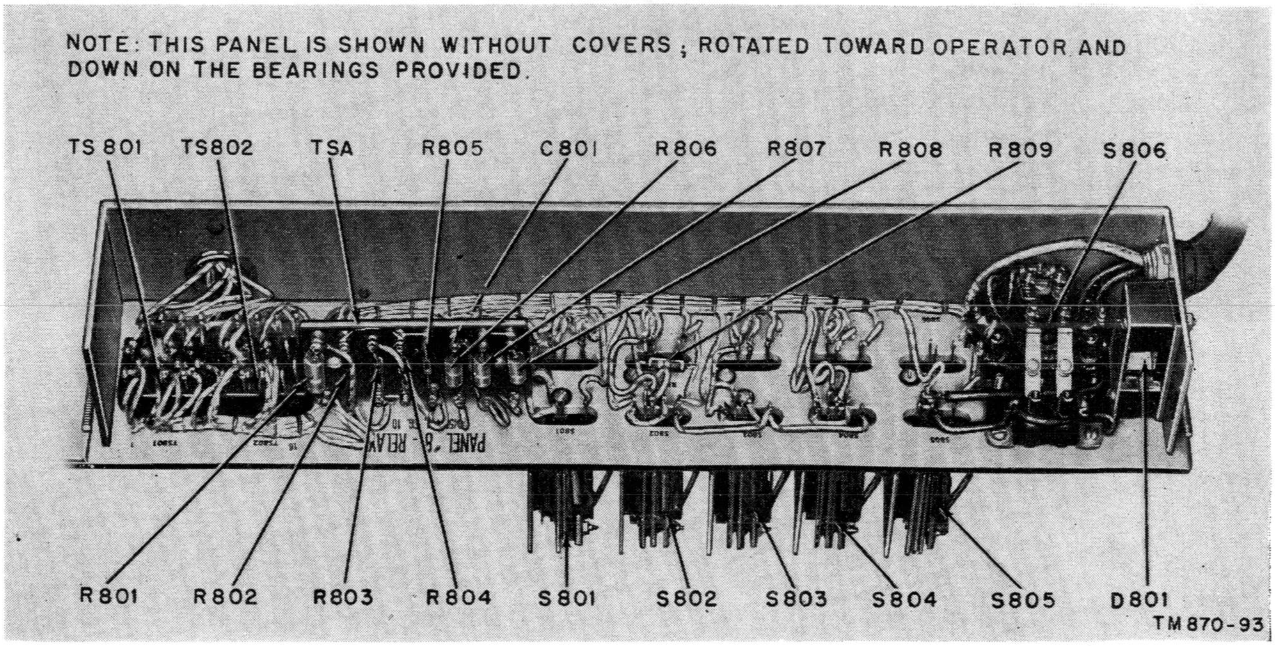
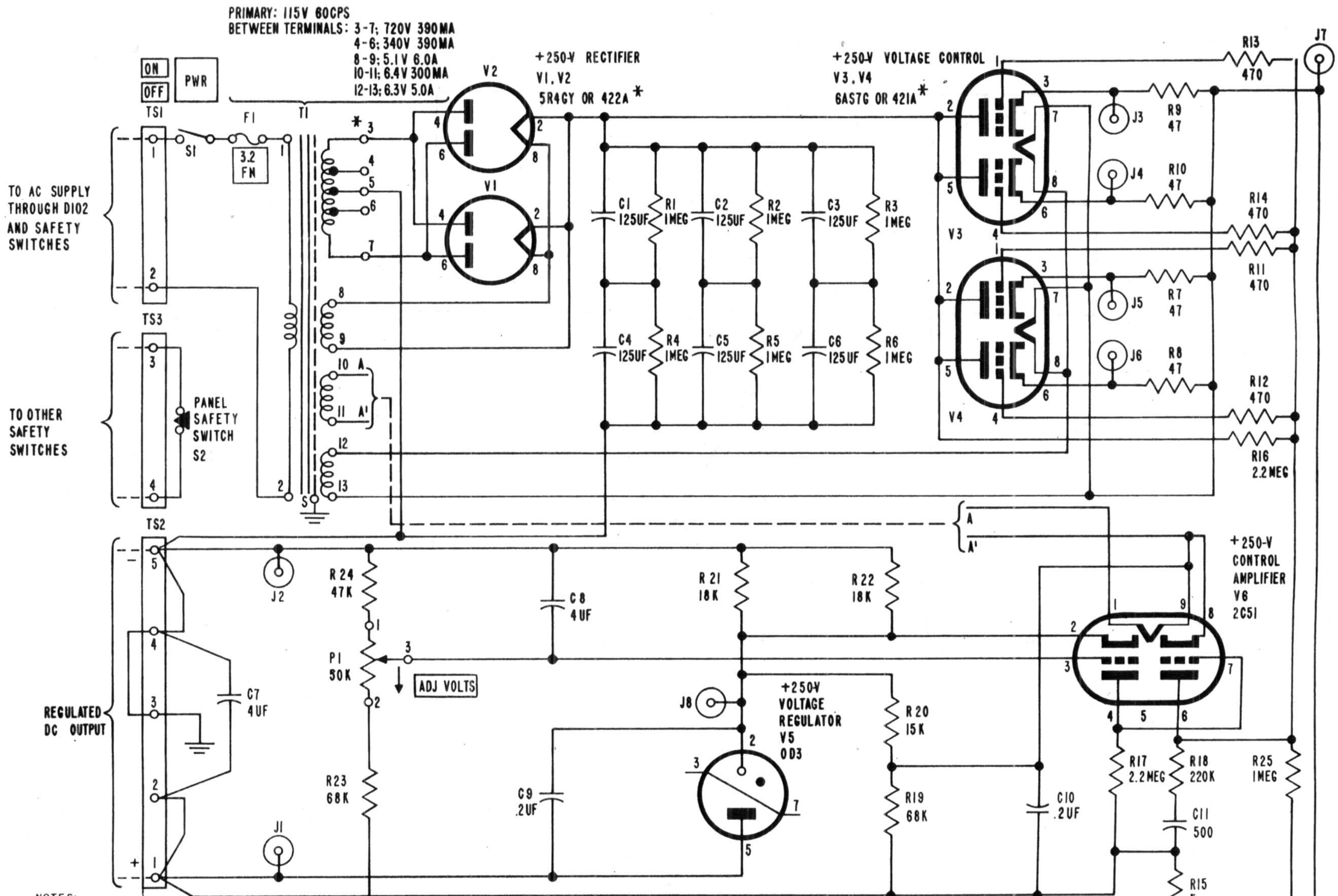


Figure 80. Relay panel 8, component locations.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. * WHEN USING 6AS7G AND 5R4GY TUBES, CONNECT TO T1 TERMINALS 3 AND 7. WHEN USING 421A AND 422 A TUBES, CONNECT TO T1 TERMINALS 4 AND 6. THE 421A AND 422A TUBES MUST NOT BE USED IN COMBINATION WITH THE 6AS7G AND 5R4GY TUBES.

Figure 82. 250-volt regulated supply, schematic diagram.

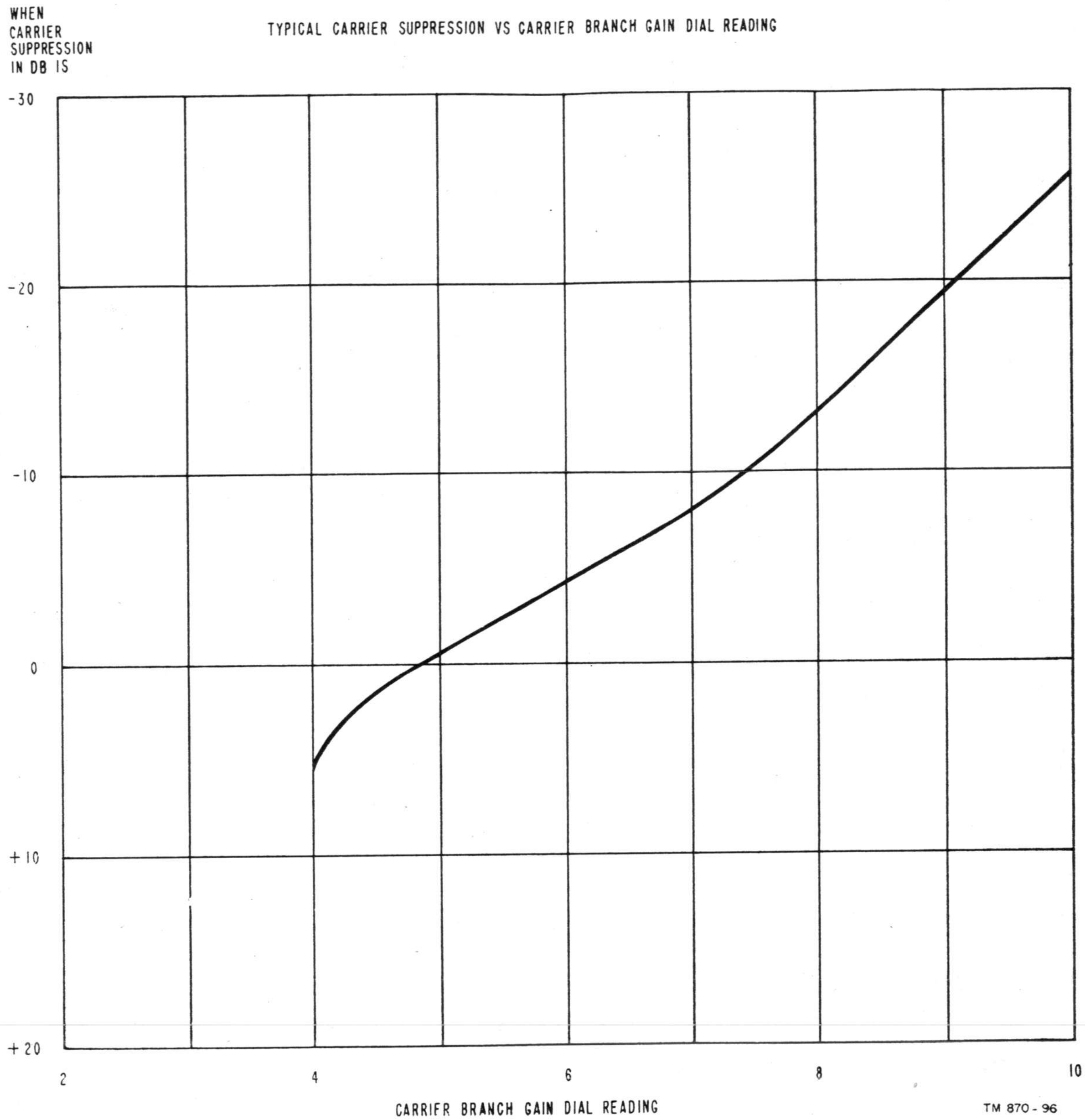
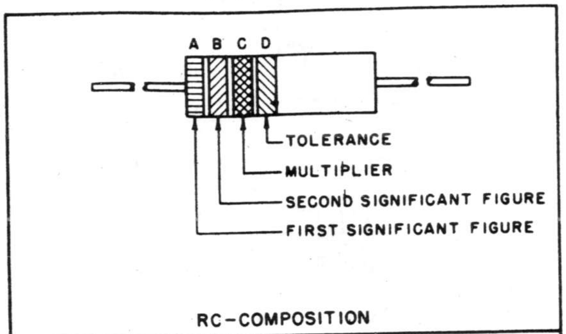
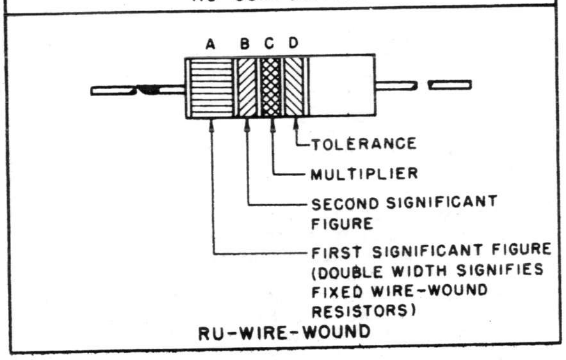


Figure 83. Typical carrier branch gain control calibration chart.

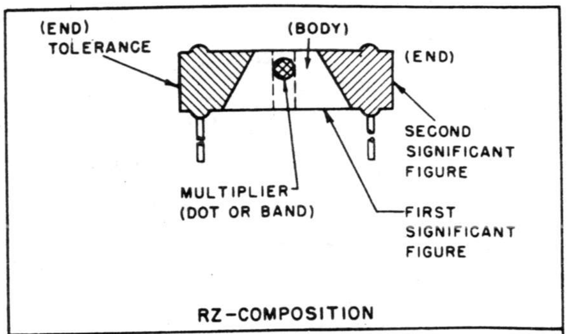
RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

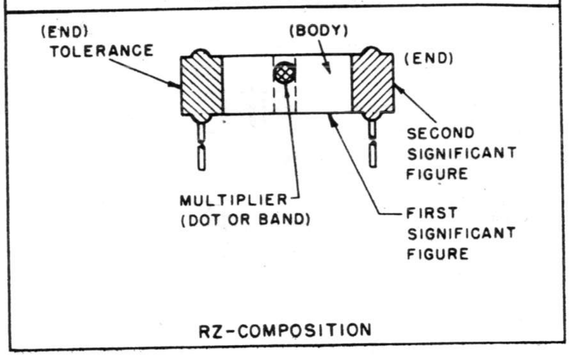
AXIAL-LEAD RESISTORS (INSULATED)





RADIAL-LEAD RESISTORS (UNINSULATED)





RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

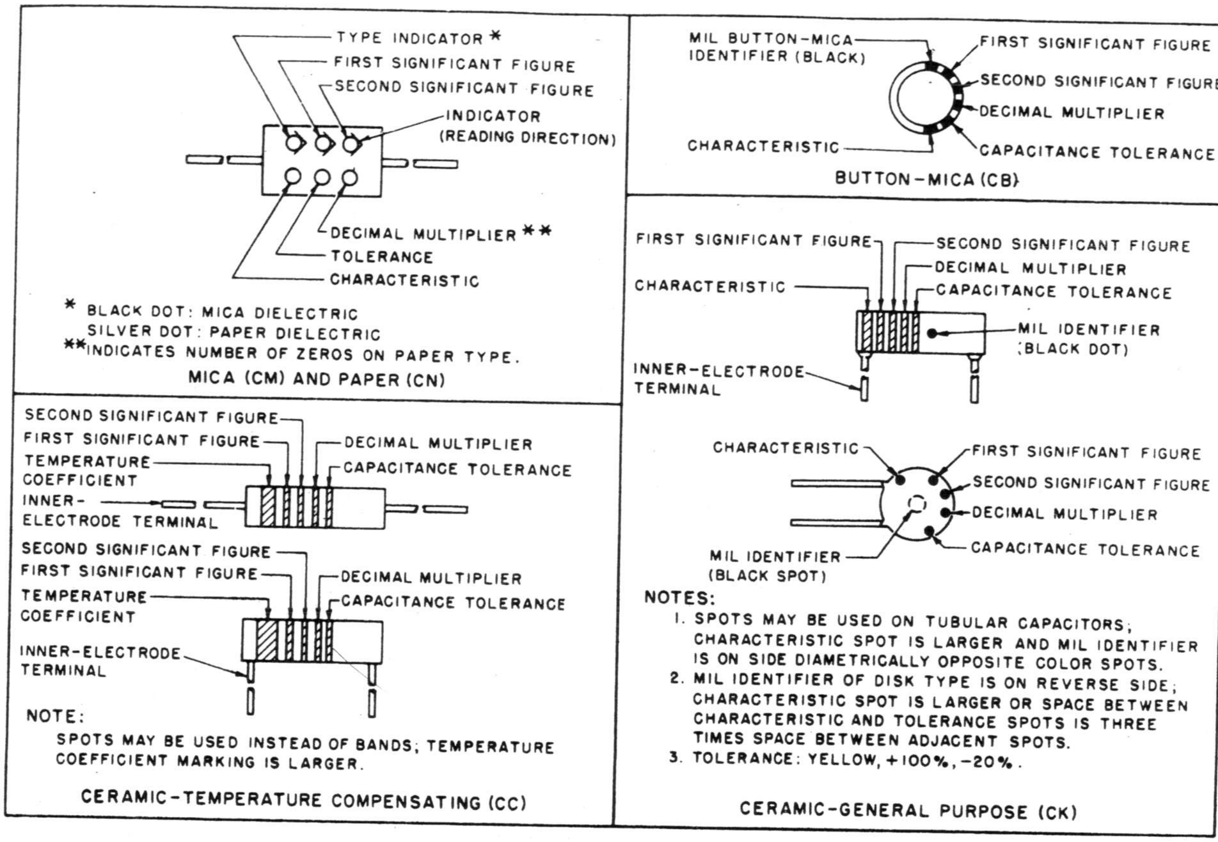
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 84. MIL STD resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC [1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC OVER 10UUF	CC 10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

Figure 85. MIL STD capacitor color codes.

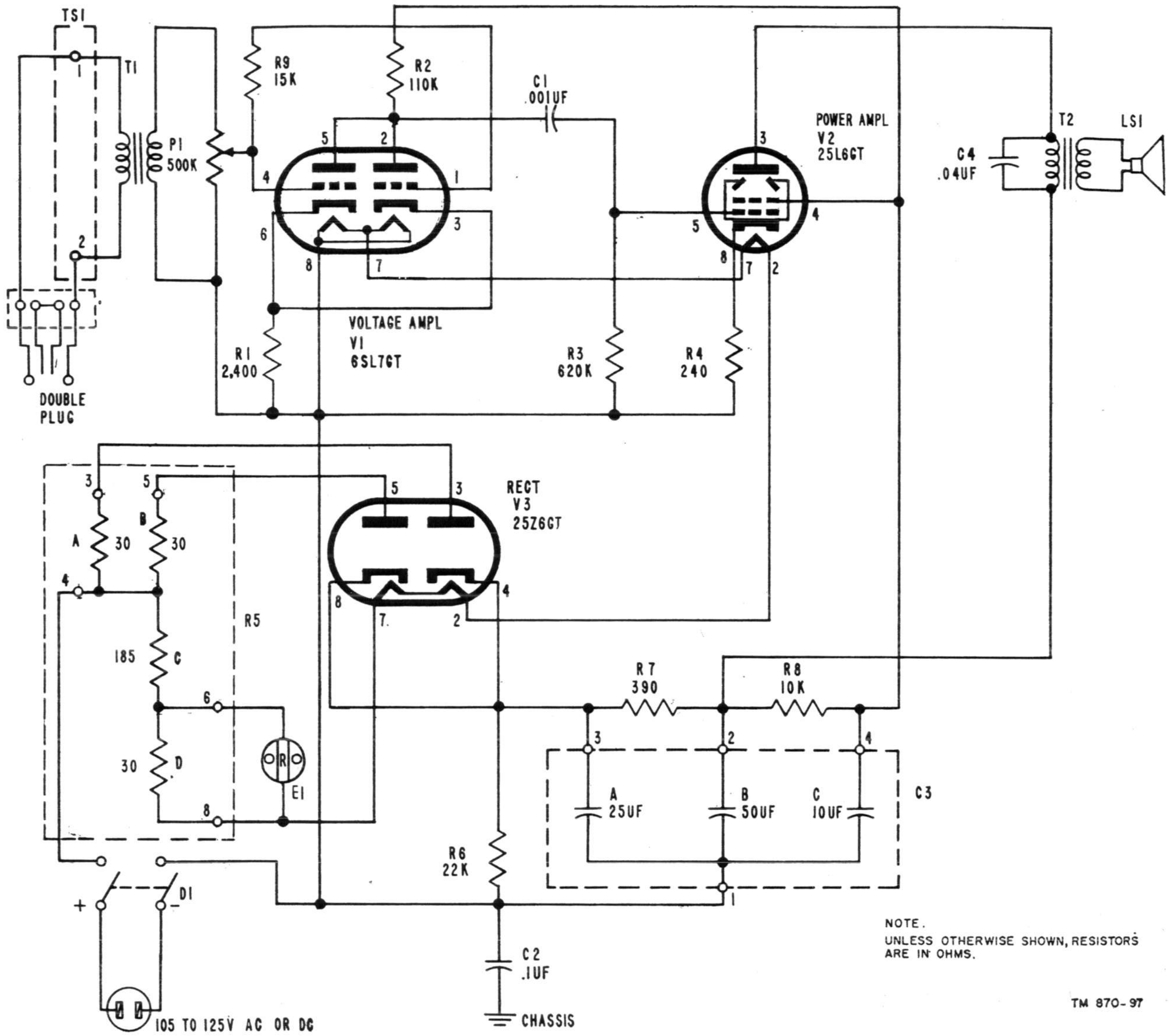


Figure 86. Loudspeaker set 100-F, schematic diagram.

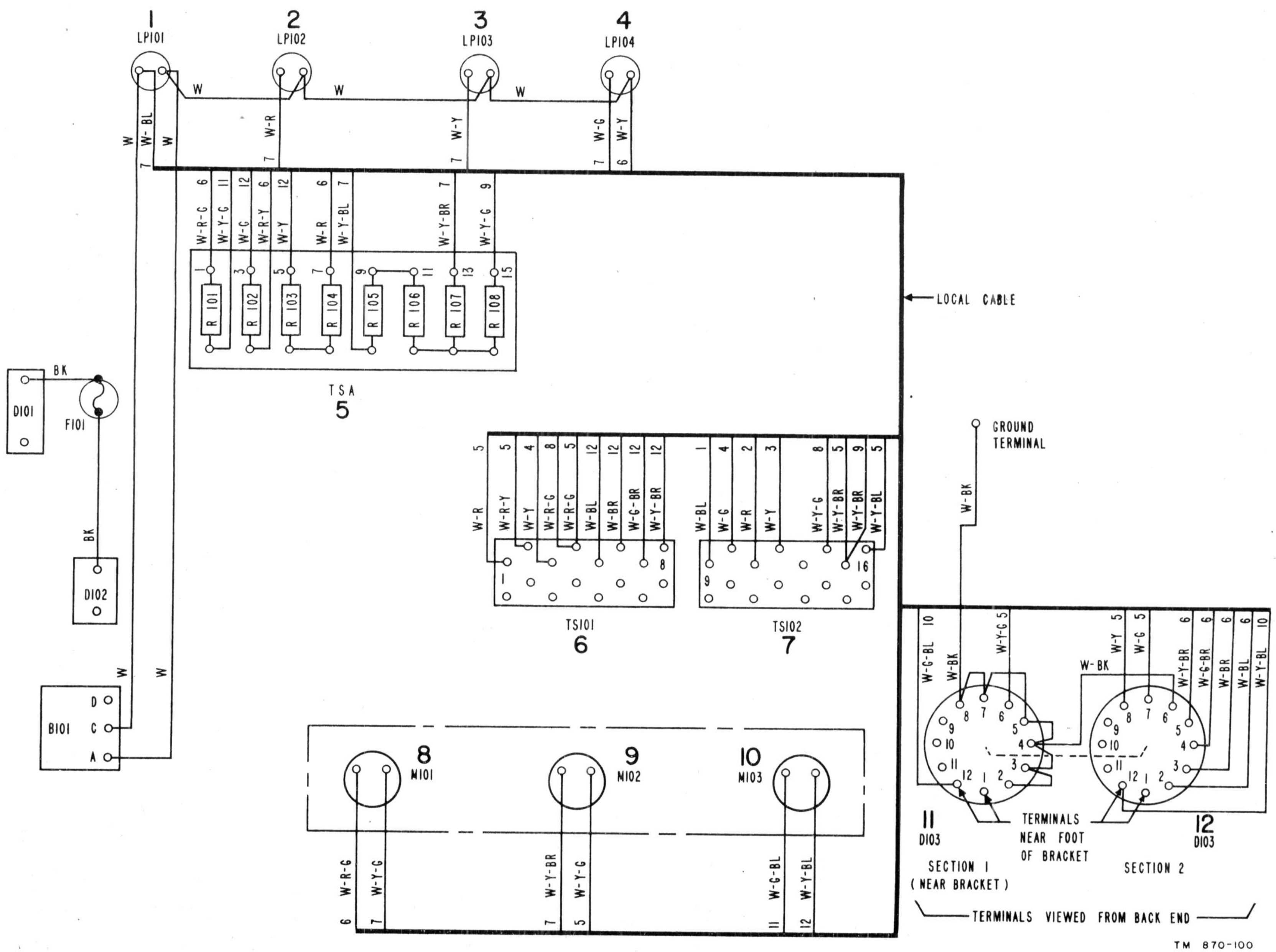


Figure 89. Meter panel 1, wiring diagram.

APPENDIX I

PACKING DATA, LIST OF COMPONENTS, AND FUNCTIONS

When packed for shipment, the components of Radio Receiver R–369/FRC–10 are placed in moisture-vaporproof containers. These containers are placed in 18 wooden crates. The size, weight, and volume of each crate are indicated in the chart in paragraph 6. The following chart indicates the components of each case. Refer to the packaging list attached to each case for the exact contents.

Note. Items may be packed in a different manner from that shown, depending on the supply channel. The crate numbers assigned in the table are arbitrary. For specific details of the individual receiver shipments, refer to the master packing list, Exhibit B–(*) or specification KME (5000) accompanying the shipment.

Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
1 of 18	92 x 29¼ x 25	1 Radio Receiver R–369/FRC–10 assembled and wired for operation from single-phase, 115-volt ±5%, 50 to 60 cps, ac supply, with 600-watt capacity.	
2 of 18	16 x 20 x 23	1 Sure-Grip puller for T–5½ bulb	To remove and install miniature type tubes.
		1 100-watt, 120-volt, A 21 frosted bulb	Drying lamp for receiver.
		1 coaxial plug, 341C	Patches ANTENNA to REC INPUT.
		3 vacuum tubes, 5R4GY	Tubes for receiver power supplies.
		2 vacuum tubes, 6AS7G.	
		1 regulator tube, OD3.	
		2 vacuum tubes, 350B.	
		2 copies of test data sheets for receiver	Factory test data on *this* serial No. receiver, Appendix II is typical.
		1 No. 362D crane hex bushing, 1½″ x ¼″	Hardware used with compression union to connect copper tubing coaxial cable to antenna matching transformer.
		1 conduit lock nut galv., 1½″.	
		1 No. 701 compression union with ⅜″ nut ¼″ pipe thread x ⅜″ OD tube.	
3 of 18	27 x 20 x 22	1 antenna coupling transformer D–159619 drilled for 1½″ National Pipe thread.	
		1 Instruction Bulletin 1093 (for D–159619).	
4 of 18	18 x 22 x 22	10 vacuum tubes, 6BA6	2 sets of spare vacuum tubes for receiver.
		6 vacuum tubes, 6AS6.	
		18 vacuum tubes, 2C51.	
		16 vacuum tubes, 6AQ5.	
		22 vacuum tubes, 5591/403B.	
		2 vacuum tubes, 6AL5.	
		10 vacuum tubes, 6X4.	
		6 vacuum tubes, 5R4GY.	
		4 vacuum tubes, 350B.	
		4 vacuum tubes, OB2.	
		4 vacuum tubes, 6AS7G.	
		2 vacuum tubes, OD3.	

344144—55——11

Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
5 of 18	19⅜ x 16 x 17	Input transformer, 132C	Test and maintenance equipment.
		1 loudspeaker set D–124852, equipped with vacuum tubes (Spl 100–F).	
		1 patching cord 10′ long between plugs. 724 coaxial cable equipped with four 337B plugs.	
		2 patching cords 8′ long between plugs. 724 coaxial cable equipped with four 337B plugs.	
		2 patching cords 4′ long between plugs. 724 coaxial cable equipped with four 337B plugs.	
		5 patching cords 2′ long between plugs. 724 coaxial cable equipped with ten 337B plugs.	
		1 dummy antenna, Ferris Instrument Co., Model 440A, c/w and 43-ohm ±5% noninductive resistor (for 22Dt signal generator).	Modify by replacing the internal 43-ohm resistor with a 62-ohm resistor (1RC BT ½ is suitable, as is next item).
		1 resistor KS–1349021 RM 764305, 62-ohm.	
6 of 18	20 x 22 x 27	1 vacuum tube, OD3	Spare vacuum tubes for Ferris Instrument Co., signal generator 22DT.
		1 vacuum tube, 5Y3.	
		1 vacuum tube, 6J5.	
		2 vacuum tubes, 955.	
		1 vacuum tube, 6SL7–GT	Spare vacuum tubes and lamps for loudspeaker set D–124852 (Spl 100–F).
		1 vacuum tube, 25L6–GT.	
		1 vacuum tube, 25Z6.	
		1 GE lamp No. 47.	
		2 GT vacuum tubes, 12J5	Spare vacuum tubes for oscillator D–166636.
		1 vacuum tube, 12SA7.	
		1 GT vacuum tube, 50L6.	
		1 GT vacuum tube, 35Z5	
		1 vacuum tube, 83	Spare vacuum tubes for tube tester.
		1 vacuum tube, 5Y3–GT or vacuum tube 5W4.	
		2 lamps, neon NE–45, .25-watt, T4½, 115-volt candelabra screw base G. E.	
		4 81 lamps, mazda	Fuse in tube tester.
		2 receivers, 509	1002C headset.
		1 headband, 1B.	
		1 R2EG cord 3′6″ long. Moisture-fungusproofed per X–75136.	
		1 plug, 289B.	
		1 type 724 coaxial cable 8′ long, equipped with one W. E. 337B plug and one Amphenol 83–1 SPN coaxial plug.	Cable to connect 22DT signal generator to Radio Receiver R–369/FRC–10.
		1 type 724 flexible coaxial cable 8′ long equipped with type 83–1 SPN coaxial plug.	To make test cord from 22DT signal generator.
		6 Mueller type 60–S alligator clips	To make test leads for special tests.
		2 plugs, 217D	600-ohm noninductive termination for receiver used in miscellaneous relay rack bay.
		3 protector blocks, 98A	For audio lines lightning protector.
		12 fuses, 11C, 7 amp.	
		2 protector blocks, 26.	
		2 protector blocks, 27.	
		10 noninductive cartridge fuses RM–794552, 15-amp, 250-volt.	

Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
6 of 18	20 x 22 x 27	1 T & B Cat. No. 3962 conduit ground clamp, 1-inch.	Water pipe grounds for frame.
		1 T & B Cat. No. 3963 conduit ground clamp, 1¼-inch.	
		1 T & B Cat. No. 321V angle connector.	
		2 P–284826 washers.	
		8 T & B Cat. No. 300V Titebite connectors	Main panel wire and for grounding.
		1 Klein No. 220 oblique cutting pliers or UTICA No. 39.	General wiring use.
		1 tool-soldering copper holder, 504A.	
		1 one roll rosin solder, 1 lb WR2B Spec. AT 0016.	
		1 tool, 265C, contact burnisher	Relay maintenance.
		1 tool, 363, spring adjuster.	
		1 tool, 376A, dental mirror.	
		1 tool, 474A, 1/16 x ¼ offset wrench.	
		1 tool, 505A, spring adjuster.	
		1 tool, 507A, spring adjuster.	
		1 tool, 508A, armature blocking.	
		2 tools, 509A, relay winding connector.	
		1 buildup remover tool, 527A, handle with replaceable files.	
		1 tool, 582A, spring adjuster.	
		1 KS–6320 tool, orange stick.	
		1 gage, 70–D, 50–0–50 grams.	
		2 cords, 1W13B, single conductor cord 6-ft long terminated by 360-type tool.	
		1 key set, 605, vest pack, kit, Allen Mfg. Co.	
		1 tool, 563A, offset screwdriver.	
		1 KS–15143 cord 18 GA 5S0 2 cond. (RM–832837) 20 ft long.	Extension lamp parts.
		1 KS–7118 lamp guard.	
		1 Hubbel 7057 cap.	
		2 containers KS–13643, ½ pt, light aluminum gray enamel.	For touch-up refinishing of cabinet.
7 of 18	14½ x 19⅝ x 29¾	1 Ferris Instrument Co's signal generator 22DT for operation on 115-volt 50–60 cps, ac, equipped with Amphenol 83–1R coaxial connector, including vacuum tubes. Standard cable for high-voltage output. 1-volt 30-ohm cable with output box containing a 30-ohm termination to fit Amphenol 83–1R output jack, moistureproofed for tropical service.	Rf signal generator for tests.
		1 instruction booklet.	
8 of 18	22 x 27 x 30	1 KS–5727, L1, Hickok tube tester.	
		1 Instruction Bulletin 1200 for tube tester.	
9 of 18	20 x 27 x 27	1 Weston 772 type 6 analyzer or 779 type A volt-ohm-milliammeter.	
		1 V5 MT General Radio variac 860 VA	Adjust line voltage for test or operation if required.
		1 Cutler-Hammer Cat. No. 4131–H201 power cutoff switch.	Main wiring master power switch.
10 of 18	18¼ x 19½ x 25¼	1 oscillator D–166636 (Spl 19–C) equipped with vacuum tubes.	
		1 Instruction Bulletin 1124 for oscillator.	
11 of 18	20 x 23 x 27½	1 Measurements Corp. model 62 vacuum-tube voltmeter.	
		1 attenuator D–165654 (Spl 5A).	

Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
12 of 18	20 x 21⅞ x 27	1 roll AT–6747 ¾″ black friction tape, 75 ft	
		½ lb No. 12 twine (R & J 12027).	
		8 H–555–120 G3 expansion bolts consisting of:	
		8 P428519 expansion shields	Mounting hardware for receiver.
		8 P427634 studs.	
		8 P284166 washers.	
		8 P123117 washers.	
		8 P401452 hexagonal nuts.	
		1 star drill, 7/16″ x 8″	Tools to facilitate mounting of equipment.
		1 star drill, ⅝″ x 8″.	
		1 star drill, ⅝″ x 24″.	
		300 ft P357173 22PBK and Bk-Rd shield wire.	
		100 T & B Cat. No. 4176 conduit straps.	
		100 Diamond N. Y. expansion shields for No. 14 wood screws Cat. 149, Cat. Stock No. 6424.	
		125 No. 14 RHIWD P–160793, 1¼″.	
		1 KS–8740 list 2 soldering copper	Relay maintenance.
		1 KS–8740 list 31B short calorized copper tip.	
		1 KS–8740 list 30B long calorized copper tip, spare.	
		1 Spec. 6267 long-nose pliers 6½″.	
		1 Spec. AT6860N cabinet screwdriver, 3″ blade.	
		1 Spec. AT6860N reg. screwdriver, 4″ blade.	
		1 KS–6854 screwdriver 3½″, ⅛″ blade.	
		1 KS–6015 duckbill pliers, 6″.	
		1 Spec. 6655 diagonal pliers V notch, 5″.	
		1 Crescent A14 4″ adjustable open-end wrench.	
		1 Crescent A16 6″ adjustable open-end wrench.	
		1 KS–2423 cloth.	
		1 KS–7188 paper.	
		1 P–243953 ring for thickness gages equipped with:	
		1 gage, 132A; .008″ thickness.	
		1 gage, 132B; .010″ thickness.	
		1 gage, 132D; .015″ thickness.	
		1 gage, 132J; .029″ thickness.	
		1 gage, 132K; .032″ thickness.	
		1 gage, 132L; .035″ thickness.	
		1 gage, 132M; .038″ thickness.	
		1 gage, 132N; .041″ thickness.	
		1 gage, 132AE; .018″ thickness.	
		1 stud cap gage, 133A.	
		50 ft P357170 slate and slate red 22P shielded wire A300125.	General repair wire.
		50 ft P357171 red and red green 22P wire A300125.	
		25 ft P474072 green 22M–3 wire per A300128.	
		25 ft P47075 black 22M–3 wire per A300128.	
		25 ft P47083 brown-red 22M–3 wire per A300128.	
		25 ft P474534 yellow and yellow-green 22M–3 wire per A300128.	
		25 ft P368407 black 20 AM–1 wire per A300135.	

Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
12 of 18	20 x 21⅞ x 27	25 ft P368414 black-red 20 AM–1 wire per A300135.	
		50 ft 720 cable.	
13 of 18	15 x 20⅝ x 20⅞	150 ft National Armored leaded calk-duplex No. 14 solid.	Main power wire.
		62½ ft National ABC armored cable single No. 6 solid.	Main ground wire.
14 of 18	16 x 20 x 23	2 Instruction Bulletins 1152 for two or three channel radio.	Not normally used in military radio systems.
		2 Instruction Bulletins 1195 for LD–R1 radio receiver.	WECo Instruction Book for R–369/FRC–10.
		2 SD–81046–01, 250v, reg. tube rectifier	WECo drawings.
		2 SD–81047–01, +130v, reg. tube rectifier.	
		2 CD–45034–01, LD–R1 radio receiver	Circuit descriptions.
		2 CD–81046–01, 250v, reg. tube rectifier.	
		2 CD–81047–01, 130v, reg. tube rectifier.	
		2 T–45034–82, hf panel wiring diagram.	
		2 T–45034–83, if. panel, wiring diagram.	
		2 T–45034–84, vf panel, wiring diagram.	
		2 T–45034–85, afc panel, wiring diagram.	
		2 T–45034–86, relay panel, wiring diagram.	
		2 T–45034–87, first and second beat oscillator, wiring diagram.	
		2 T–81046–30, 250-volt, reg. tube rectifier.	
		2 T–81047–30, +130-volt, reg. tube rectifier.	
		2 B–403517–1, rec. line interconn. ckt.	
		2 BA–310927, D–170114 control unit, wiring diagram.	
		2 SD–45034–01, schematic diagram (J–41602–A radio receiver).	
		2 ED–45103–100, crystal selector switch.	
		2 ED–92049–01, methods for terminating coaxial and twin conductor office cable.	
		2 ED–90484–72, radio receiver ground connections.	
		2 ED–90370–73, relay rack assembly.	
		2 ED–90507–70, portable writing shelf.	
		2 ED–90674–70, cable brackets.	
		2 T–626698, misc. radio receiver wiring list and equip. floor plan.	
		2 T–623959, rec. line interconn. ckt.	
		2 H–294–065, instructions for reading WECo wiring diagram.	How to read WECo wiring diagrams and figures 88 through 97.
		2 BO–310928, control unit D–170114, wiring diagram.	
		2 T–45034–80, interpanel, wiring diagram.	
		2 T–45034–81, metering panel, wiring diagram.	
		2 J–41602B–90, cabinet equipment.	
		2 J–41602C–90, metering panel 1.	
		2 J–41602D–90, hf panel 2.	
		2 J–41602E–90, if. panel 3.	
		2 J–41602F–90, vf panel 4.	
		2 J–41602G–90, afc panel 5.	
		2 J–41602H–90, relay panel 8.	
		2 J–41602J–90, first and second beat oscillator	Part of panel 2.
		2 J–86232A–2, +250-volt rectifier.	
		2 J–86233A–2, +130-volt rectifier.	
		2 BO–308671, control unit assembly	Part of panel 2; afc motor assy.
		2 ED–45101–91, ac outlet panel	Convenience outlets.

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Crate No.	Case dimensions (in.)	Contents	Function of contents and remarks
14 of 18	16 x 20 x 23	2 BR–460152, cabinet assembly.	
		2 ED–45103–99, attenuator switch	INPUT ATTENUATION.
15 of 18	14⅜ x 14 x 18	1 pt KS–6815 carbon tetrachloride C. P.	
16 of 18	88 x 31½ x 17½	Miscellaneous relay rack bay:	
		2 lag screws, ⅜″ x 2″.	Mounting hardware.
		2 P432022 nuts.	
		2 P428519 expansion shields.	
		1 P404660 spacer.	
		2 P160127 screws.	
		2 P427634 studs.	
		2 P284172 washers.	
17 of 18	20 x 6½ x 22	1 ED–90507–70, group 1 writing shelf	For miscellaneous relay rack bay.
18 of 18	20 x 22 x 29	1 ED–90674–70, group 3 cable brackets.	
		1 ED–90507–70, group 2 writing shelf.	
		1 jack space, 168A	Metal end bracket with holes in it to accommodate jack mounting.
		1 jack mounting, 230A, equipped with:	
		2 jacks 464A (pos 1 and 6 top row)	Plastic strip with holes to accommodate jacks. Supported on relay rack by 168A jack space.
		1 jack, 465A (pos 3 and 4 top row).	
		8 jacks, 410A (pos 19 to 26 top and bottom).	
		30 apparatus blanks, 39B (pos 2, 5, 7, 8, 11 to 18 top row pos 1 to 18 bottom row).	Metal strips screwed to top of plastic strip with provision for paper names.
		1 designation strip, 99B (pos 29).	
		1 designation strip, 99A (pos 30).	
		1 P417034 designation card (pos 29)	CHAN should read GROUP.
		1 P417035 designation card (pos 30).	
		1 mounting plate, 600A, equipped with:	Plate mounts 4 coils.
		3 repeat coils, 173CS (pos 4, 6, 8)	Coils SIA, PHA, S2A.
		1 retard coil, 307L (pos 10)	Simplex coil, noise killer on simplex circuit.
		1 telegraph key, 1A.	
		1 sounder, 15B (30 ohms)	Optional connection for simplex circuit ground and one pair of wires.
		1 patching cord 4′ long, 724 coaxial cable	Connects receiver ANTENNA jack and REC 1 or REC 2 jack in jack field (hole in top of receiver).
		1 plug, 337B, in one end, other end open	Angle connection to J201. Ant installed after cord goes through grommet.
		1 coaxial cable, 724, 20′ long equipped with: 2 jacks, 464B, one at each end (to be mounted on 230A jack mounting).	To be installed to connect positions 9 and 10 upper in jack field (fig. 55). Coiled and held by brackets.

APPENDIX II

TYPICAL FACTORY INSPECTION TEST DATA

The data given in this appendix is typical of that supplied with each receiver. The test values may change with other serial-numbered receivers.

The test valves are given as a reference only and are not necessarily the required values. Continuing records of similar values of a particular receiver will be useful in predicting component failure and useful life of the tube.

WESTERN ELECTRIC J–41602A LD–R1 RADIO RECEIVER
INSPECTION TEST DATA
SERIAL NO. 118

LD–R1 Radio Receiver		*Serial No. 118*
Voltage Measurements	*Standard Test Meter No. LD–M–103 Reading*	
Rectifiers	+250	+248
	+130	+127
	−130	−126
Ac Voltages	T202, Terminals 3 and 5	6.5
	Terminals 6 and 7	6.5
	T307, Terminals 3 and 5	6.6
	Terminals 6 and 7	6.4
	T401, Terminals 3 and 5	6.5
	Terminals 6 and 7	6.6
	T501, Terminals 3 and 4	6.5
Tube Currents	Controls set as follows:	
	Volume Control Switch D304	Man
	Volume Control P305	MC
	Carrier Branch Gain P301	MCC
	Auto Freq. Control Osc. Gain P501	MCC
	Auto Freq. Control Car. Gain P502	MCC
	Crystal Selector Switch D207	0
	Tube No.	*Meter Reading*
	V201 Hf Ampl	130
	V202 Demod. 1	185
	V203 2.8-mc Ampl	120
	V204, V205 Demod. 2	160
	V206 B01 Crystal	20
	V207 B01 Variable D209 on Variable	80
	V207 D209 on Crystal	35
	V208 B02	20
	V301 If. Ampl 1	135
	V302 If. Ampl 2	135
	V303 If. Ampl 3	125
	V304 If. Ampl 4	92
	V305 Car-Ampl 1	30
	V306 Car-Ampl 2	95
	V310 Limiter 1	75
	V311 Limiter 2	75

Voltage Measurements

Tube Currents

Tube No.	*Meter Reading*
V401B Group B, Ampl 1	95
V402 Group B, Ampl 2	100
V403B Group A, Ampl 1	90
V404 Group A, Ampl 2	94
V405 Car-Ampl	65
V401A SB Volt HYB P305 MCC	7
V403A Car. Volt Demod. 3 (P402 MC) (D403 Local)	100
V403A Car. Volt Demod. 3 D403 Recon.	12
V501 100-kc Ampl	85
V502 Car-Ampl D303 ON	95
V502 Car-Ampl D303 OFF	0
V503 Afc Ampl P501 and P502 MCC	90
V504 Afc Ampl P501 and P502 MCC	85
V505 Afc Ampl P501 and P502 MCC	88
V506 Afc Ampl P501 and P502 MCC	85
V507 Afc Rect.	0
V508 Afc Rect.	0
V509 Afc Rect.	0
V510 Afc Rect.	0
V511 100-kc Osc. 1	80
V512 100-kc Osc. 2	85
V513 Car-Alm Slow D303 ON	90
V513 Car-Alm Slow D303 OFF	0
V201 Hf Ampl P305 MCC	15
V203 2.8-mc Ampl P305 MCC	0
V301 If. Ampl 1	0
V302 If. Ampl 2	0
V303 If. Ampl 3	5

Combined Channel Filter and Voice-Frequency Characteristics

Frequency CPS	*VU Readings* A	*VU Readings* B
100	0	+.7
300	−.2	+.7
500	−.2	+.4
1000	0	0
2000	+.1	+.8
3000	0	+.9
4000	0	+.8
5000	−.2	+.6
6000	−.5	+.5
7000	−4	−16

Signal-to-Noise Measurements

Freq. Mc	*Range*	*A*	*B*
4.8	4–9.5	3	3
7.2	4–9.5	2.7	2.7
10.4	9.5–23	5	5
22.8	9.5–23	5	5

Calibration of Carrier Branch Gain Dial

Carrier Suppression Db	*100-kc Panel Input*	*Carrier Gain Dial*
0	25,000 mv	5.5
−10	8,000 mv	8.0
−20	2,500 mv	9.3
−23	1,750 mv	9.5

Range of AFC on First Beat Oscillator

Input Freq Mc	*Total Change in Freq cps*
4. 8	3200
7. 2	5600
10. 4	3300
22. 8	15000
16. 0	8200

Range on AFC on Second Beat Oscillator

Input Freq Mc	*Total Change in Freq cps*
4. 8	3000

Test of Avc Action

Rec Input	*M101*	*M102*
50, 000 mv	130	−20
500 mv	105	−20
50 mv	88	−20
5 mv	75	−18
2 mv	70	−14
1 mv	60	−8

Calibration

Freq (Mc)	*Input Tuning Dial*	*Hf Tuning Dial*	*Osc Tuning Dial*
3. 9	7	23	105
4	7	43	39
4. 5	6	118	105
5	6. 5	186	161
5. 5	7	237	205
6	6. 5	279	242
6. 5	6. 5	314	274
7	6. 5	343	301
7. 5	6. 5	365	324
8	6. 5	384	344
8. 5	6. 5	401	362
9	6. 5	416	377
9. 5	6. 0	430	390
10	6. 5	444	402
9	3. 5	76	377
10	4	142	402 97
11	4. 5	195	197
12	5. 5	239	267
13	6. 0	277	320
14	6. 5	308	358
15	7	332	386
16	7	353	410
17	7	371	428
18	7	385	443
19	7. 5	399	455
20	7	411	465
21	7. 5	422	474
22	7. 5	432	481
23	7. 5	443	488
24	7. 5	456	495

Squelch Adjustments and Operation	ok	HAV
Safety Switches and Alarms	all ok	WDG

GLOSSARY

Amplitude modulation—One type of modulation which results when audio is applied to a radio transmitter. It results in amplitude changes of the radio-frequency sidebands. The carrier amplitude does not change during amplitude modulation. The carrier may or may not be present and its amplitude may be between those limits.

Balanced line—Equal voltages to ground from each wire.

Band-pass filter—A network of reactive elements arranged to exhibit a frequency discriminating characteristic for a band of frequencies.

Carrier—A single radio frequency radiated by a radio transmitter operating with no modulation. Its amplitude relative to the amplitude of the sidebands is defined by the carrier level.

Carrier level—(usually expressed in db)—A carrier level of −20 db is generally used in the AN/FRC–10 system when both sidebands may carry separate information. This is the same as +20 db.

Carrier suppression—Carrier suppressed (20 db) below a radio-frequency signal that results from audio input at *reference level.*

Carrier supply—Used in Radio Receiver R–369/FRC–10 to demodulate the 100-kc plus 6-kc sideband and the 100-kc minus 6-kc sideband in the third demodulators. It may be derived from a 100 KC LOCAL crystal oscillator or by amplifying, filtering, limiting, and amplifying (to RECON) the suppressed carrier radiated by the transmitter.

Carrier terminal—The equipments OA–64/FRC–10 and OA–63/FRC–10 which convert the dc signals of six teletypewriters to audio tones ranging from 425 to 4,845 cps. A manual telegraph order wire is also available for use of the operating personnel. A 100- to 6,000-cps audio signal (for voice, facsimile, or other audio signal) is also transmitted over wire lines to a radio transmitter. Signals received from a radio receiver over wire lines are converted back to the required dc for six receiving teletypewriters. The received 100- to 6,000-cps audio signal (from group B radio sideband) is available in the *carrier terminal* for use.

Cathode follower—A vacuum-tube circuit in which the output is taken from across the cathode-biasing resistor. The gain of the tube is less than one, the output is of low impedance, and the input is of high impedance.

Channel—A band of frequencies in which a signal is transmitted. Originally *channel A* was a voice telephone circuit and was positioned on one side of the radio carrier. Channel B was a second voice telephone circuit positioned on the other side of the radio carrier. Introduction of voice-frequency radio telegraph (radioteletype) over a *single-sideband* radio circuit (such as the AN/FRC–10 system) made it necessary to use the *carrier terminal* (OA–64/FRC–10 and OA–63/FRC–10). This equipment has six radioteletype *channels* numbered from one through six. *Groups A* and *B* are now (preferably) used to describe the groups of audio frequencies that are used to modulate a single-sideband radio transmitter to produce the sidebands. In the AN/FRC–10 system, *group A* is usually transmitted on the low-frequency side of the carrier when the carrier is below 10 mc, and on the high-frequency side of the carrier when the carrier is 10 mc and above.

Conversion frequency—One of the two components that are mixed in a modulator to translate one signal frequency to another.

Cutoff—Usually used to describe the voltage which, when applied to the grid of a vacuum tube, will reduce its plate current to essentially zero. In describing a frequency characteristic of a line or filter, the *cutoff* frequency is the one which the transmission has decreased to a particular amount (half power or 3db).

Decibel—A unit that represents a ratio of two numbers. It is based on a logarithmic scale and may deal with voltage, current, or power. Example: a ratio of 10 to 1 (ten times) is 10 db when dealing with power, 20 db when dealing with voltage, and 20 db when dealing with current. The decibel is one-tenth of a larger unit the *bel* (which is seldom used).

Dbm—Decibels above (or below) 1 milliwatt. It is a quantity of power expressed in terms of its ratio to 1 milliwatt. 0 dbm is 1 milliwatt. This is the same as .775 volt across 600 ohms or 1.29 milliamperes through 600 ohms. +10 dbm is 10 milliwatts; +20 dbm is 100 milliwatts; +30 dbm is 1 watt; and −10 dbm is .1 milliwatt.

Demodulation—The process of mixing a radio-frequency signal with another and selecting a resulting lower frequency signal from the modulation components. Example: 2.8 mc with ±6-kc sideband signals are demodulated by mixing with 2.7 mc, to 100 kc with ±6-kc sidebands.

Distortion—A change of wave form. When a signal or group of frequencies is passed through an amplifier or other stage in which any change in wave form occurs, *distortion* is said to be present in the stage. *Intermodulation distortion* results in new (usually unwanted) frequencies being generated in a stage caused by a nonlinearity of that stage.

Distortion, frequency response—Unequal amplification of frequencies within the band pass of the equipment in question.

Diversity—The effect of selective fading of signals at the receiver can be minimized by making use of the fact that signals differing in frequency by as little as 100 cps tend to fade independently. By modulating the transmitter in such a manner that a given set of intelligence results in sidebands at different frequencies (this is *frequency diversity* modulation), the possibility of losing intelligence caused by selective fading is minimized. The best of the two received signals is automatically selected.

In *space diversity*—Use is made of the fact that signals induced in two or more receiving antennas spaced several wave lengths (5 to 40) apart are not likely to be fading simultaneously. The signals from these separate antennas, connected to separate receivers whose avc circuits are bridged, will provide a much better signal-to-noise ratio than any one antenna or receiver.

Equalization—Done to a circuit or wire line to bring its frequency response to a particular value. Usually this means raising the low-frequency and high-frequency response or lowering the midfrequency response so that the overall loss is the same at any frequency.

Fading—A variation in received signal strength resulting from changes in the transmission medium. *Selective fading* is discussed under *Diversity*.

Filter—A network of reactive elements so arranged as to exhibit a frequency discriminating characteristic. *High-pass* and *low-pass* filters do just that to certain frequencies depending upon the *cutoff* frequency.

Group A; group B—The preferable terms used to describe groups of audio signals which, when applied to single sideband radio transmitters, produce these sidebands. (See *Channel*.)

Grounded grid amplifier—Provides good shielding between input (voltage applied across cathode circuit) and output. As indicated, the grid is grounded and the stage does not need neutralization. In a transmitter the power of the driver stage is added to the power of the *grounded grid amplifier* stage.

Hybrid coil—An apparatus which provides a method of dividing a signal into two circuit paths (A and B). Of the signal which is applied to the *hybrid coil*, one-half is dissipated in a termination and the remainder is divided equally between two (A and B) circuits. Reflections from (or generated in) circuit A cannot get to circuit B (or B to A) but may pass back through the coil to the input.

Interchange—The name given to a key in Radio Transmitter T–265/FRC–10, which interchanges the positions of the audio input groups (A and B) so that the radio signal will always have the groups in the conventional position in respect to the carrier frequency. The design of Radio Transmitter T–265/FRC–10 is such that this is required for some radio frequencies (10 through 18 mc).

Intermodulation Distortion—Occurs when signals of more than one frequency are simultaneously fed into a circuit in which any nonlinearity exists. The new frequencies so generated may interfere with similar signal frequencies. This is a particularly unwanted condition in the single sideband radiotelegraph (teletype) system AN/FRC–10.

Intermodulation products—The new frequencies produced as a result of intermodulation distortion. These products are divided into a number of orders. The first order is composed of the original frequencies (F1 and F2) which are not caused by the distortion. The second order is composed of the original frequencies beating against each other: for example, F1 plus F2 and F1 minus F2, 2F1 and 2F2. The third order is composed of the second harmonic of one frequency beating against the fundamental of another: for example, 2F1 plus F2, 2F1 minus F2, 2F2 plus F1, 2F2 minus F1, 3F1 and 3F2. The third order distortion products are the most troublesome in Radio Set AN/FRC–10.

Lattice modulation—A type of balanced modulation in which the *conversion frequency* is eliminated from the modulation products.

Level—Generally used as an abbreviation of *power level*. It is commonly expressed in *decibels* above or below one milliwatt.

Load limiting—Used in Radio Transmitter T–265/FRC–10 to maintain full coverage power output with varying audio input levels, without exceeding the peak power output capabilities of the transmitter. It is avc for the transmitter output. Any attempt to get greater than rated peak power output will result in distortion if this feature is not used. The action quickly reduces the gain of a transmitter stage. The gain is increased again somewhat more slowly after the peak ceases, thereby maintaining a high average level of power output.

Local carrier—In the R–369/FRC–10 single sideband receiver. Supplied from a local 100-kc crystal oscillator. It (or RECON carrier) is used in the third demodulators to produce audio from the 100-kc ±6-kc if. amplifiers.

Limiter (two-stage)—Used in the R–369/FRC–10 to remove an amplitude change in the received carrier (due to fading or noise) so that this filtered, amplified, and limited carrier (now a *RECONditioned carrier*) can be used in the third demodulators.

Normal carrier suppression—In AN/FRC–10 single sideband systems. Is 20 db when both sidebands are expected to carry intelligence, and 10 db when only one sideband will be used. Its peak is measured below the peak power output produced by *reference level*.

Parasitic suppressor—Prevents or reduces oscillations at other than the desired frequency. A resistor in series with the grid of a vacuum tube is often used in receivers, and the resistor is shunted by a small coil in transmitters.

Peak power—Two tones, each at *reference level* will produce rated *peak power* output of the single sideband transmitter.

Phantom circuit—A superimposed circuit (providing an additional circuit) obtained by using two, two-wire metallic circuits with suitable repeat coils.

Phase shifter circuit—Used in Radio Receiver R–369/FRC–10 to provide a change in the phase relationships between two 100-kc signals. The output of this circuit through amplifiers and rectifier operates a two-phase motor which is a component of the automatic-frequency-control system.

Privacy—For the purpose of preventing casual eavesdropping, as applied to the AN/FRC–10 single sideband system. It is done by splitting the audio spectrum (with filters) into five bands, and inverting some and transposing some at short intervals.

Reconditioned carrier—Made for the R–369/FRC–10 receiver (for use in the third demodulator to produce audio) by filtering the transmitted (suppressed) carrier, amplifying, and *limiting* it. Normally *local* carrier is used at the third demodulators.

Reference level (*Reference tone amplitude*)—The level in dbm of each of a pair of tones which, when applied to a single sideband radio transmitter, will produce the rated peak power output of the transmitter. It is +3 dbm for the Radio Transmitter T–265/FRC–10, used in the AN/FRC–10 system.

Rhombic antenna.—A directional antenna array in the form of a diamond (rhombus)—the form using three wires in parallel for each side of the diamond. Their physical spacing and configuration is given in TM 11–2617. Such an antenna has better characteristics for both transmitting and receiving than the single wire rhombic antenna. A rhombic antenna has a wide frequency range without adjustment.

Second order distortion.—A distortion product produced in a nonlinear circuit when two signals are present. It is either the sum or the difference of the frequency of the two signals. Example: 1,000 cps and 1,425 cps in a nonlinear circuit will produce *second order distortion* products of 425 cycles and 2,425 cycles.

Simplexed circuit.—A circuit that can be used simultaneously for dc telegraphy at the same time that the lines (four metallic wires) are being used for telephony or other audio use. It is done by use of suitable repeat coils.

Single sideband—A term applied to a method of amplitude modulation in which the audio applied to the transmitter produces only one sideband associated with the radio frequency carrier. The carrier is usually much lower in amplitude than the peak amplitude of the sideband. The other sideband may or may not be used to carry an additional second band of audio intelligence.

Squelch circuit—Used in the R–369/FRC–10 receiver to stop the afc system during the time that noise amplitude exceeds that of the carrier.

Standard test tone—1,000 cps at *reference level.*

Suppressed carrier—A carrier whose peak amplitude is lower than the peak amplitude of the sideband frequency when the transmitter is delivering a specified amount of power with single tone modulation. One standard *suppressed carrier* level is 20 db below the peak radio frequency produced by *reference level.*

Telegraph terminal—The ten bays of terminal equipment (OA–64/FRC–10 and OA–63/FRC–10) which contain equipment that converts the dc signals of six teletype machines into audio tones (from 425 cps to 4,845 cps) so that they may simultaneously be sent as a group on a sideband of the AN/FRC–10 radio system. Facilities are also provided for simultaneously producing the required dc signals for six other teletypewriters from the receiver group of audio tones.

Third order distortion—A distortion product produced in a nonlinear circuit when two signals are present. It is either the sum or difference between one of the two tones and the second harmonic of the other. Example: 1,000 cycles and 1,575 cycles in a nonlinear circuit will produce a third order distortion product of 425 cycles (2,000 cycles minus 1,575 cycles).

Translated downward—To demodulate. Example: the 100-kc if. frequency of the R–369/FRC–10 receiver is a downward translation of the two frequencies applied to the second demodulator. (2.8 mc ±6 kc and 2.7 mc, second beat oscillator).

Twin single sideband—Single sideband using both sidebands, each with separate intelligence. The carrier may or may not be (but generally is) suppressed.

Unbalanced line—A line with different voltages to ground from each conductor. Example: Coaxial cable with the outer sheath grounded.

Varistor—A circuit component (a voltage variable resistor) whose characteristics (resistance) vary with the voltage across the component. Examples: copper oxide rectifier elements connected so as to be nonrectifying (back to back) or germanium diodes similarly connected.

Vogad—Voice operated gain adjusting device used as an automatic gain control for audio signals passing through it.

Voice frequency—Any frequency from 100 to 6,000 cps. A telephone voice frequency circuit may be only 250 to 3,000 cps.

Voice frequency telegraph—Radio or wire telegraphy which uses simultaneously several audio frequencies to carry the information from several dc teletype sources.

Volume unit (vu)—A unit used to specify the audio-frequency power level in decibels above a level of one milliwatt (.001 watt). A volume unit is equal to a decibel only when changes in power are involved or when the decibel value has the same reference point.

Volume unit meter—An instrument whose characteristics are defined by a set of specifications for the purpose of controlling or measuring voice signals. It is calibrated in vu. Needle deflection rate and damping are two of the characteristics that are specified.

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[AG 413.44 (30 Mar 55)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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General, United States Army,
Chief of Staff.

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11-128A, Sig Depot Co (2)
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11-557A,-Abn Sig Co (2)
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NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR-320-50-1.

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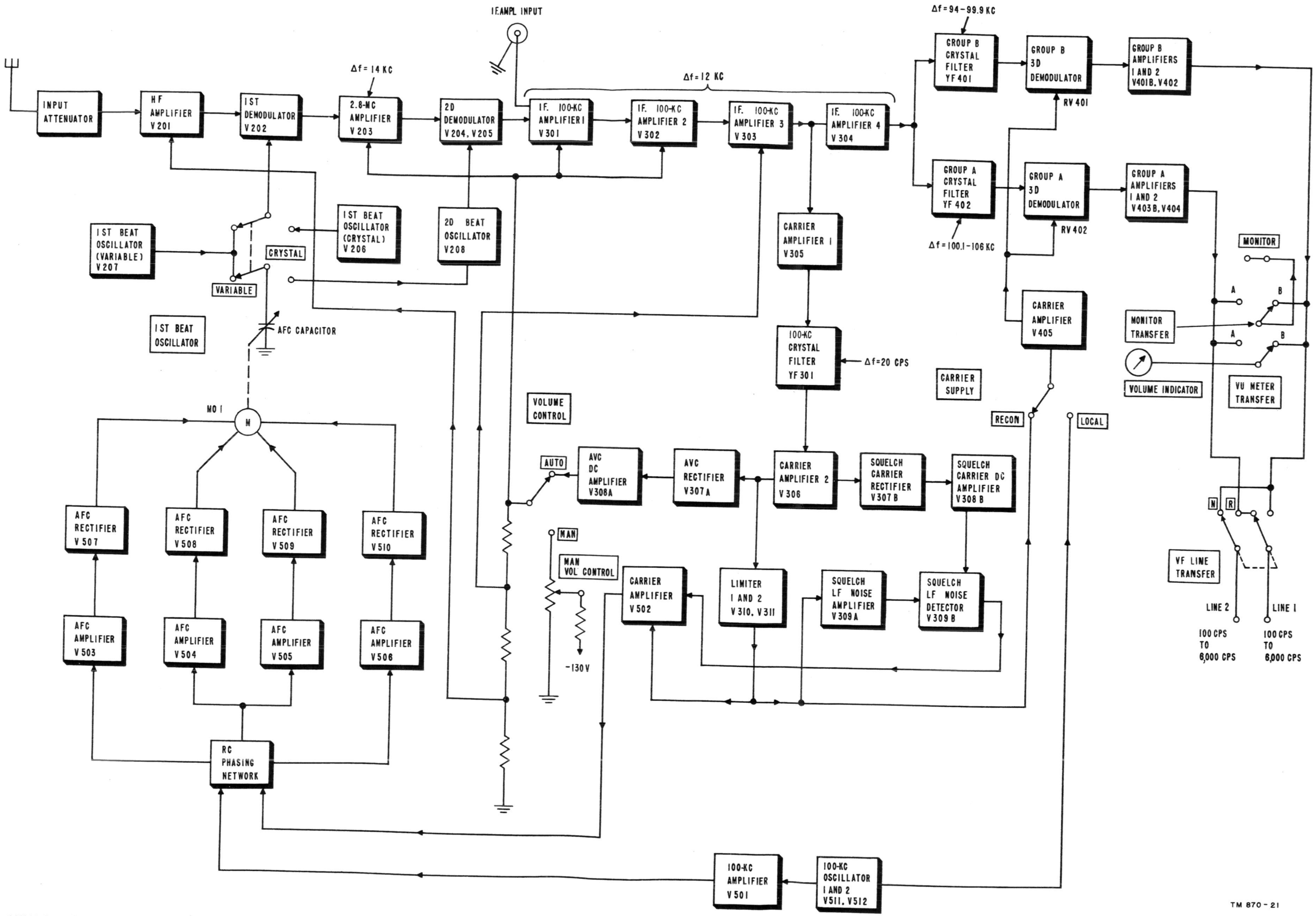


Figure 29. Radio Receiver R-369/FRC-10, block diagram.

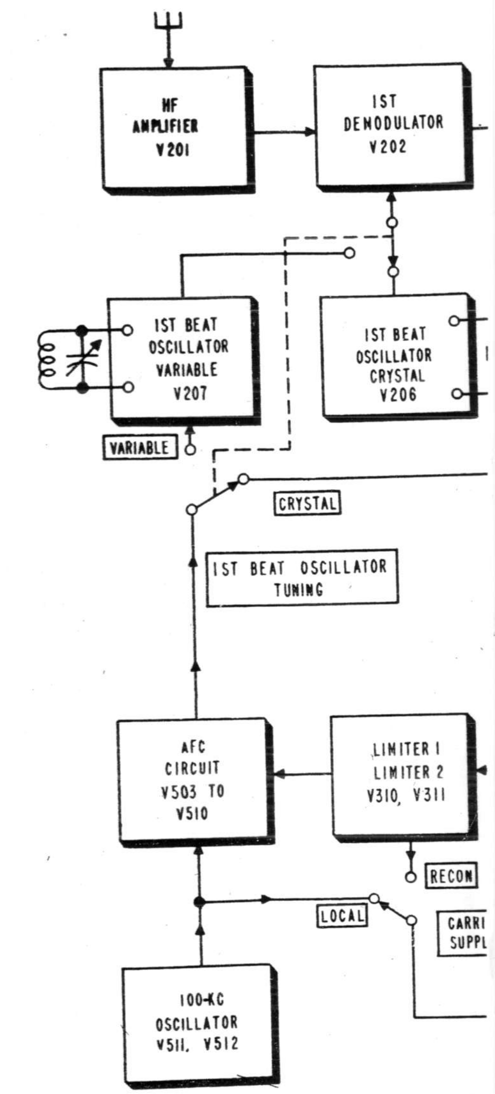
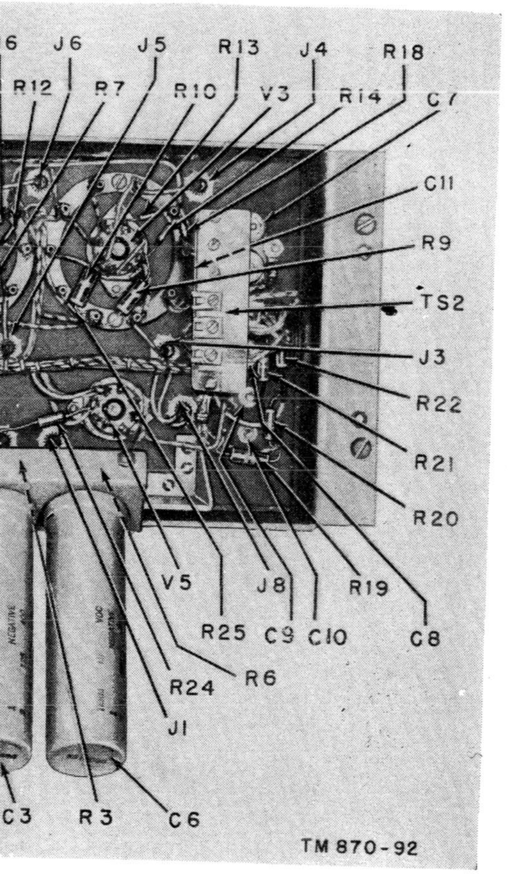


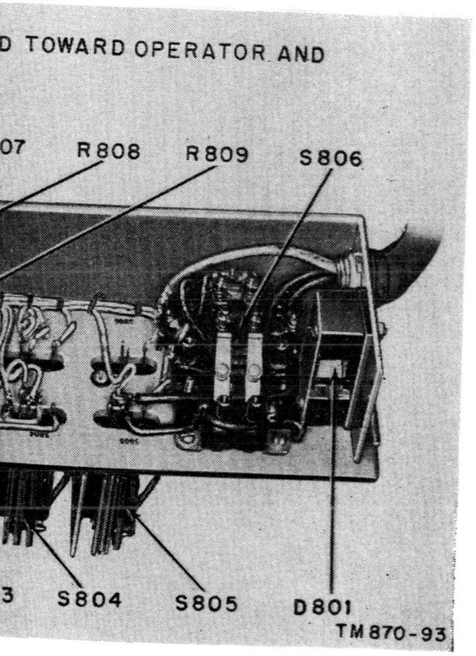
Figure 28. Ra

is coupled to the LOCAL con
CARRIER SUPPLY switch.

d. An afc circuit is incorporate
ceiver. It functions by variations
frequency of the first or second b
When the first beat oscillator is o
inductance-capacitance type, its
controlled by the afc system. W
beat oscillator is crystal-controlled, t
oscillator is controlled by the afc
insures that the signal applied to
fiers and that used as a reconditi
exactly 100 kc. This signal mu
otherwise, the full gain of the if. a
not be realized and the sideband
tioned carrier would not be passed
respective crystal filters, thus ca



omponent locations.



ations.

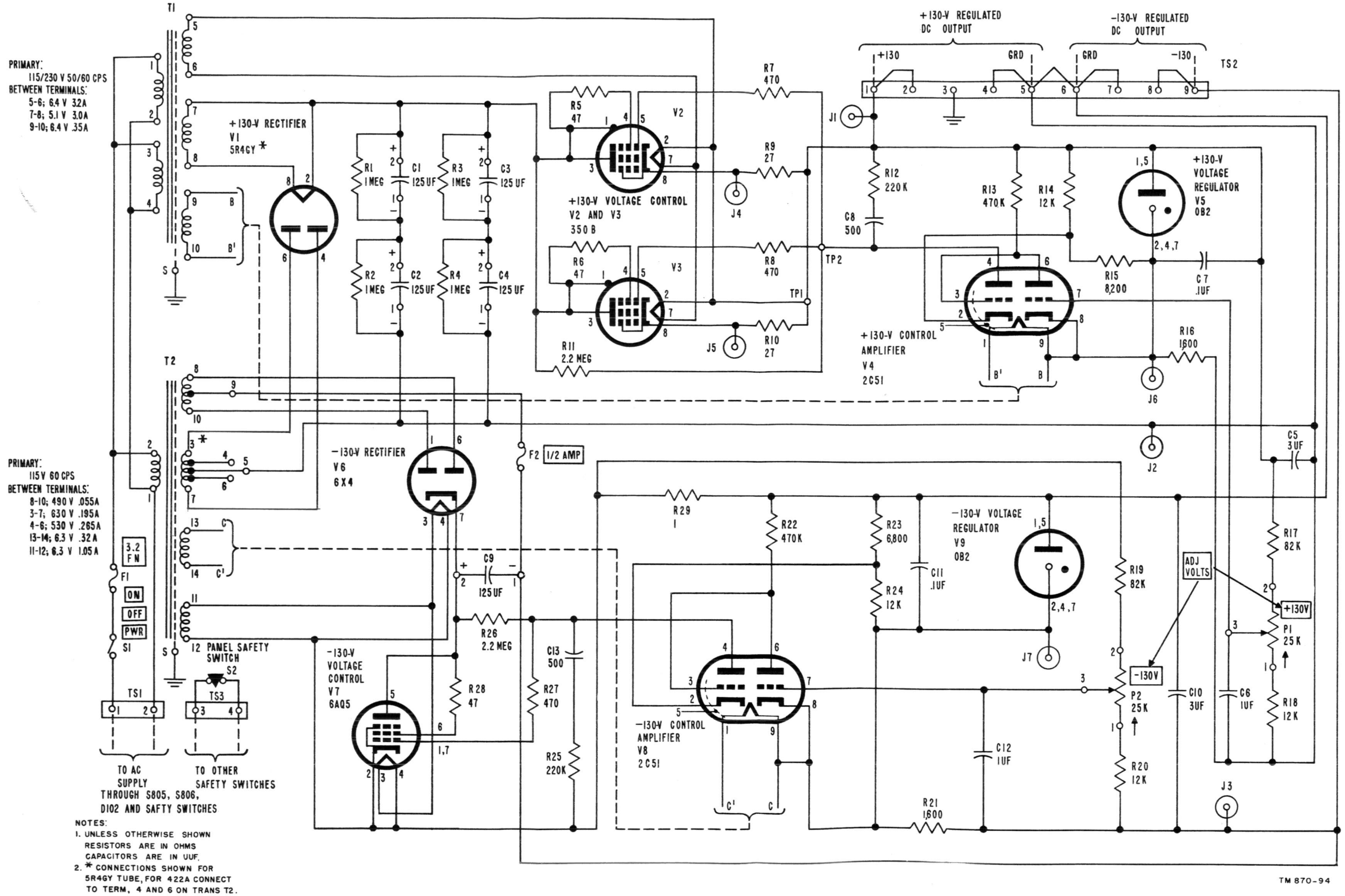
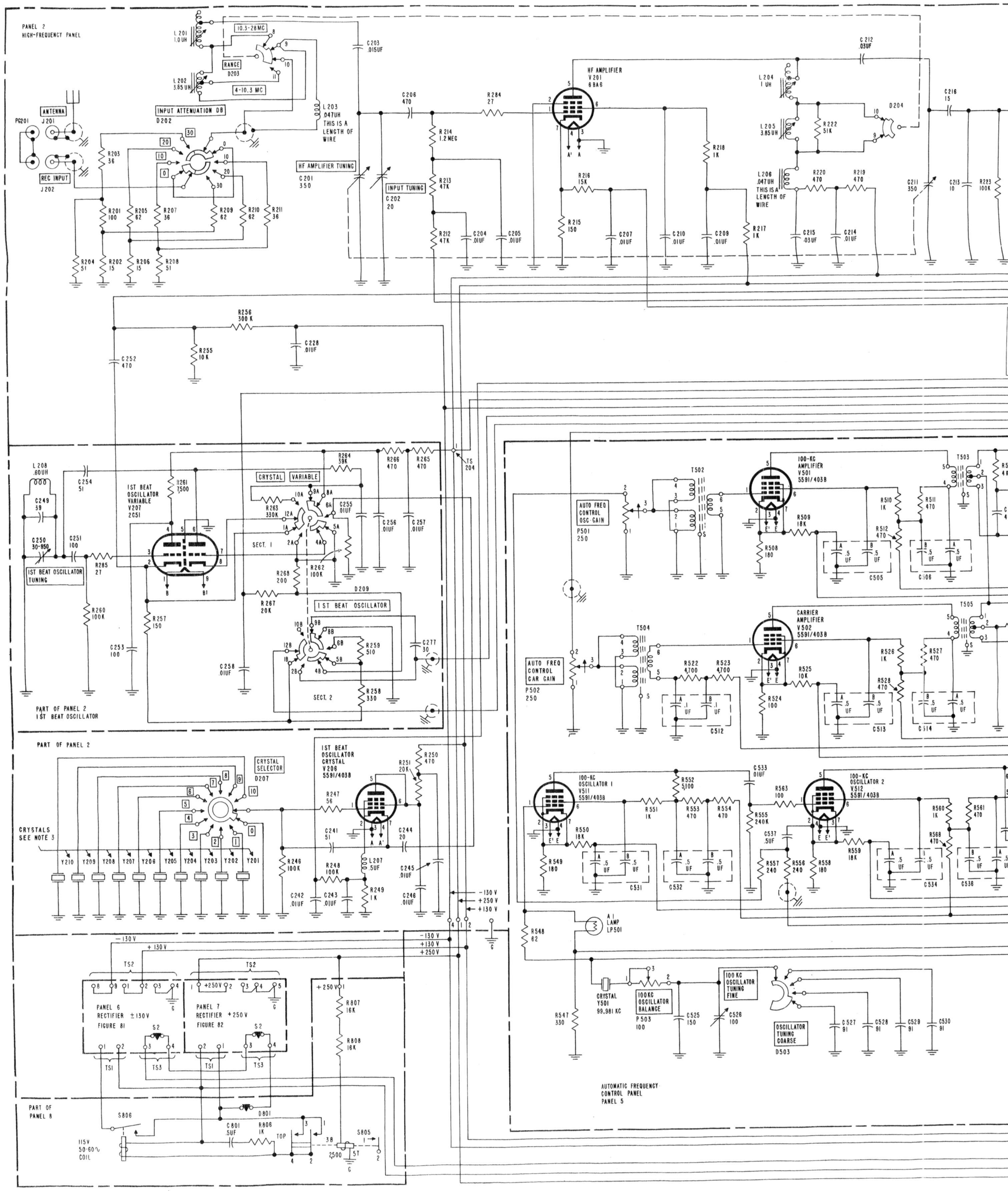
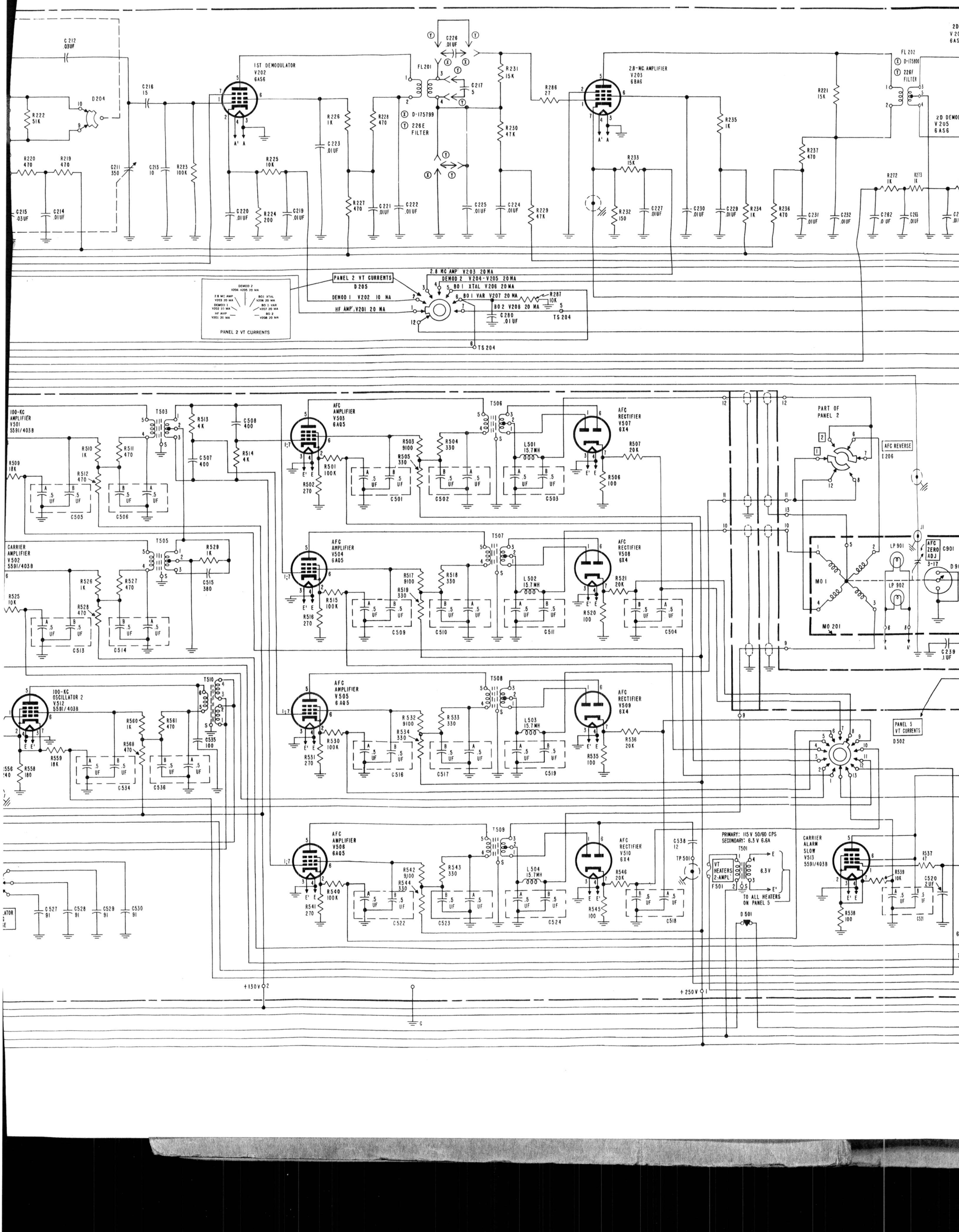


Figure 81. ±*130-volt regulated supply, schematic diagram.*


PANEL 2
HIGH-FREQUENCY PANEL
ANTENNA
J201
PG201
REC INPUT
J202
INPUT ATTENUATION DB
D202
RANGE
D203
10.3-28MC
4-10.3 MC
L201
1.0UH
L202
3.85UH
L203
.047UH
THIS IS A
LENGTH OF
WIRE
HF AMPLIFIER TUNING
C201
350
INPUT TUNING
C202
20
HF AMPLIFIER
V201
6BA6
D204
PART OF PANEL 2
1ST BEAT OSCILLATOR
1ST BEAT OSCILLATOR TUNING
1ST BEAT
OSCILLATOR
VARIABLE
V207
2C51
CRYSTAL
VARIABLE
SECT. 1
SECT. 2
1ST BEAT OSCILLATOR
D209
TS
204
PART OF PANEL 2
CRYSTAL
SELECTOR
D207
CRYSTALS
SEE NOTE 3
1ST BEAT
OSCILLATOR
CRYSTAL
V206
5591/403B
PANEL 6
RECTIFIER ±130V
FIGURE 81
PANEL 7
RECTIFIER +250V
FIGURE 82
PART OF
PANEL 8
115V
50-60∿
COIL
AUTO FREQ
CONTROL
OSC GAIN
P501
250
AUTO FREQ
CONTROL
CAR GAIN
P502
250
100-KC
AMPLIFIER
V501
5591/403B
CARRIER
AMPLIFIER
V502
5591/403B
100-KC
OSCILLATOR 1
V511
5591/403B
100-KC
OSCILLATOR 2
V512
5591/403B
A1
LAMP
LP501
CRYSTAL
Y501
99,981 KC
100KC
OSCILLATOR
BALANCE
P503
100
100KC
OSCILLATOR
TUNING
FINE
OSCILLATOR
TUNING
COARSE
D503
AUTOMATIC FREQUENCY
CONTROL PANEL
PANEL 5



1ST DEMODULATOR
V202
6AS6
2.8-MC AMPLIFIER
V203
6BA6
2D DEMODULATOR
V205
6AS6
2D DE
V204
6AS6
FL201
D-175799
226E
FILTER
FL202
D-175800
226F
FILTER
PANEL 2 VT CURRENTS
D205
2.8 MC AMP V203 20 MA
DEMOD 2 V204-V205 20 MA
801 XTAL V206 20 MA
801 VAR V207 20 MA
802 V208 20 MA
DEMOD 1 V202 10 MA
HF AMP V201 20 MA
TS 204
100-KC
AMPLIFIER
V501
5591/403B
CARRIER
AMPLIFIER
V502
5591/403B
100-KC
OSCILLATOR 2
V512
5591/403B
AFC
AMPLIFIER
V503
6AQ5
AFC
AMPLIFIER
V504
6AQ5
AFC
AMPLIFIER
V505
6AQ5
AFC
AMPLIFIER
V506
6AQ5
AFC
RECTIFIER
V507
6X4
AFC
RECTIFIER
V508
6X4
AFC
RECTIFIER
V509
6X4
AFC
RECTIFIER
V510
6X4
PART OF
PANEL 2
AFC REVERSE
E206
MO 1
MO 201
AFC
ZERO
ADJ
3-17
C901
D901
LP 901
LP 902
PANEL 5
VT CURRENTS
D502
PRIMARY: 115 V 50/60 CPS
SECONDARY: 6.3 V 6.6A
T501
VT
HEATERS
2-AMPL
F501
6.3 V
TO ALL HEATERS
ON PANEL 5
D501
CARRIER
ALARM
SLOW
V513
5591/403B
+130 V
+250 V

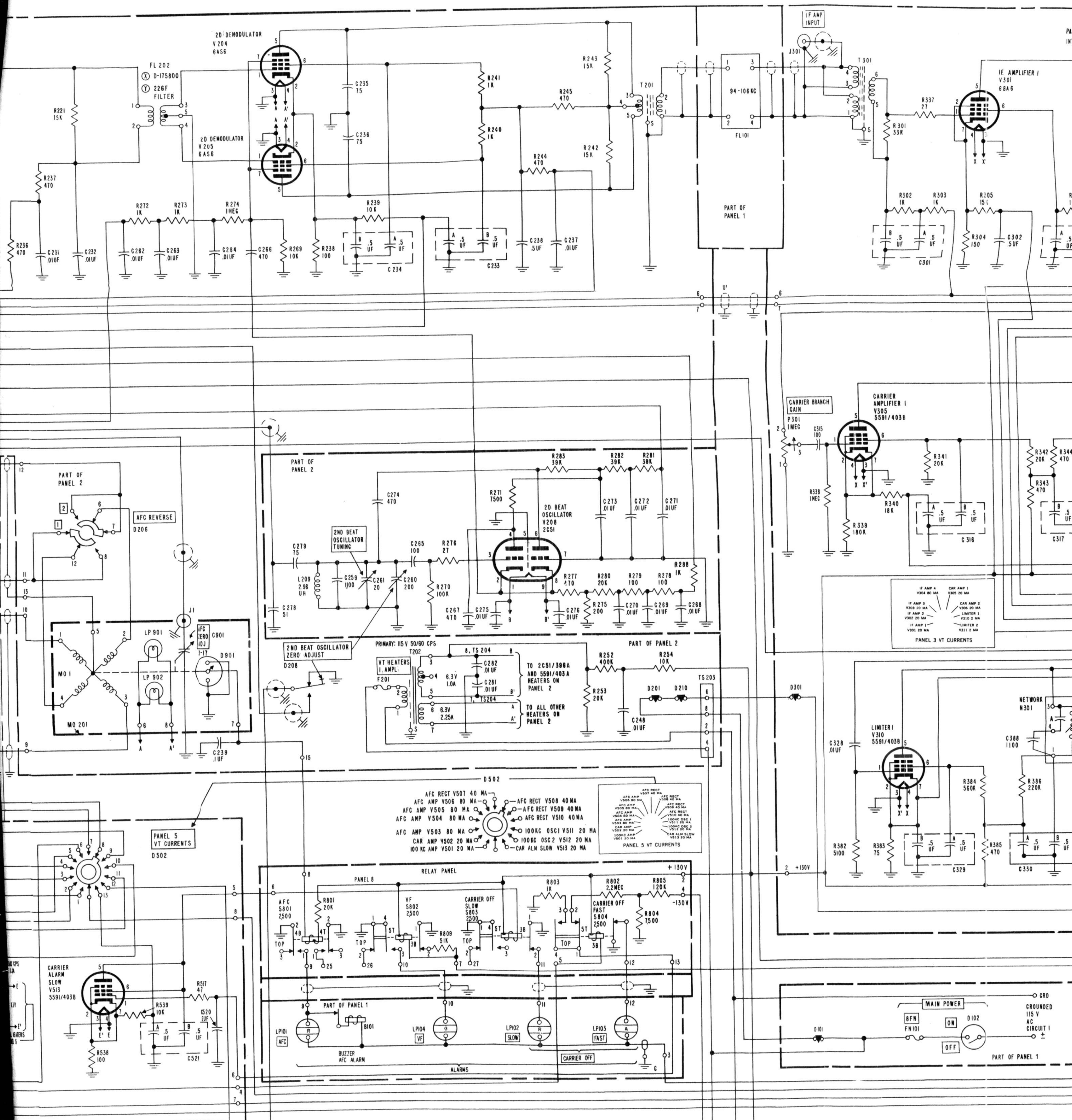


Figure 87. Radio Receiver R-

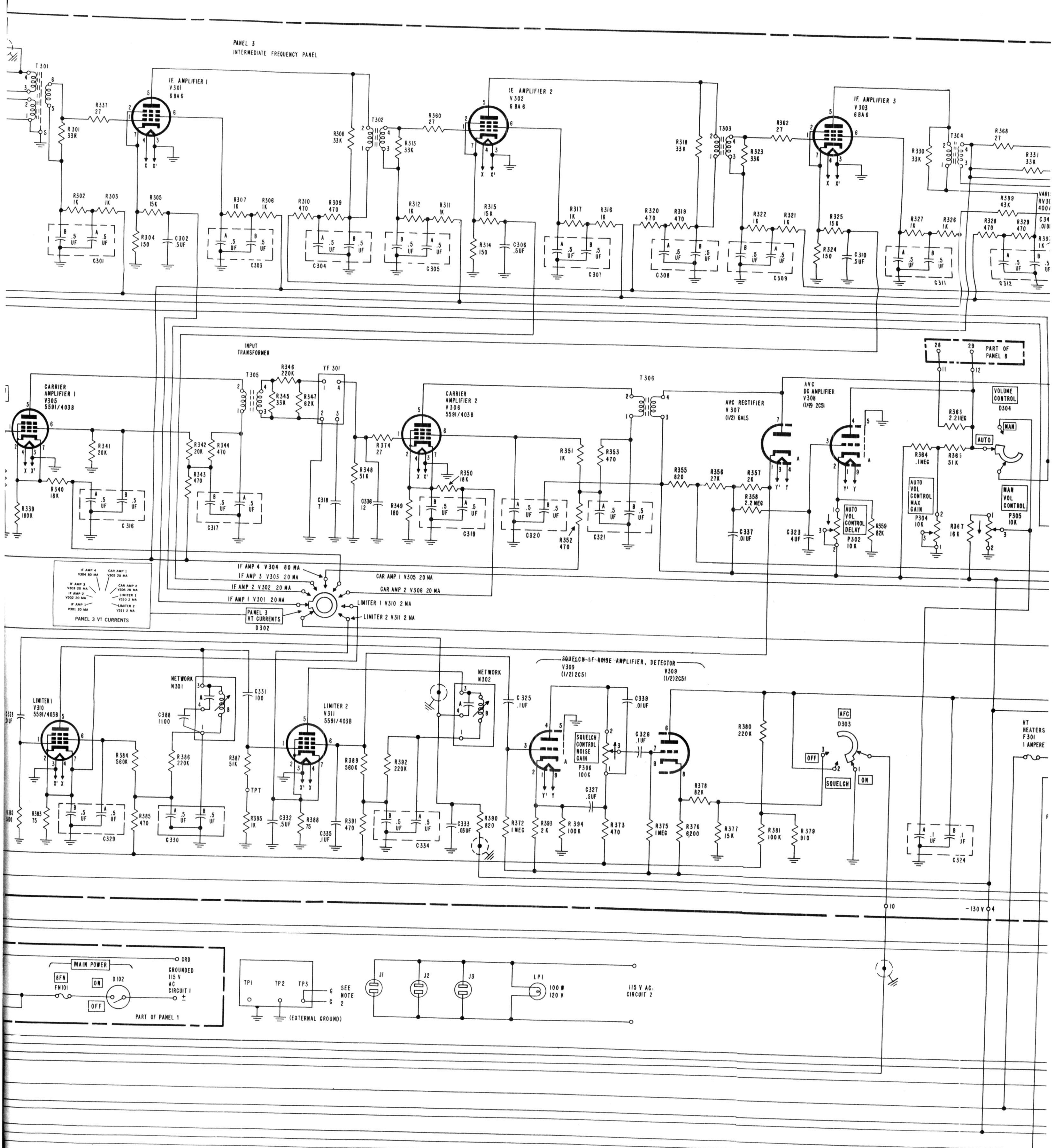
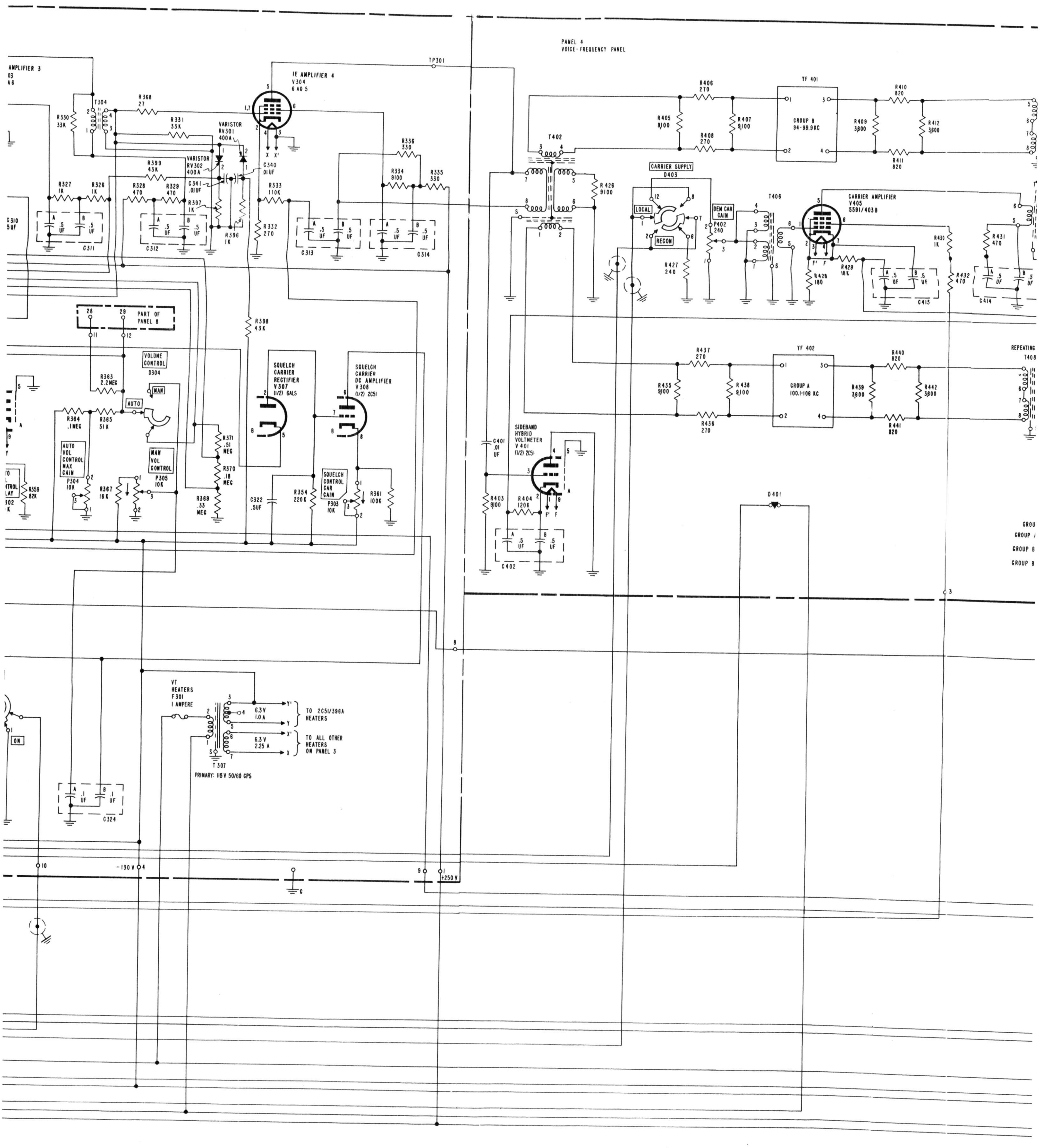
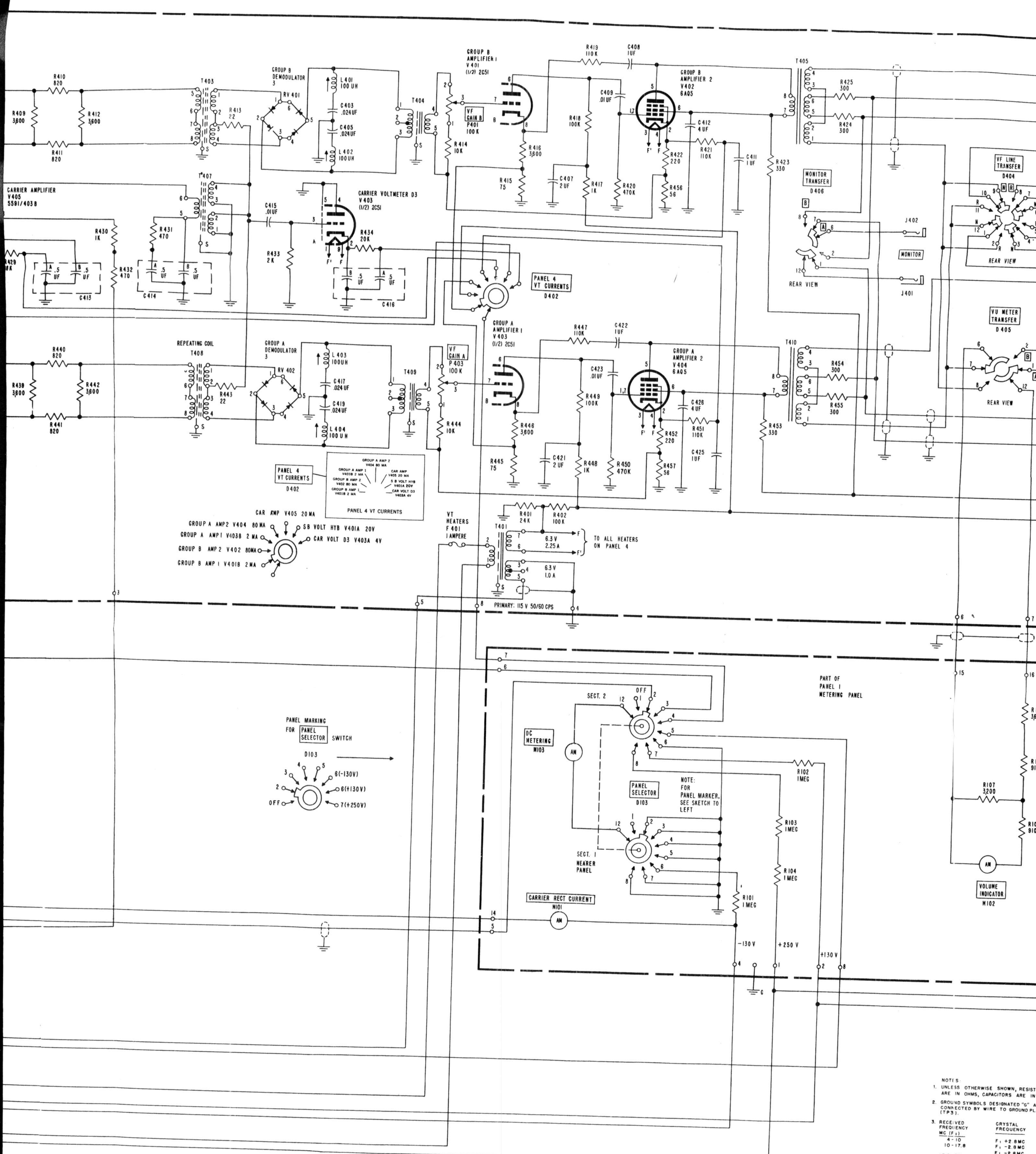


Figure 87. Radio Receiver R-369/FRC-10, schematic diagram.



PANEL 4
VOICE-FREQUENCY PANEL
IF AMPLIFIER 4
V304
6AQ5
TP301
VARISTOR
RV301
400A
VARISTOR
RV302
400A
YF 401
GROUP B
94-99.9KC
YF 402
GROUP A
100.1-106 KC
T402
T406
CARRIER SUPPLY
D403
LOCAL
RECON
DEM CAR GAIN
P402
240
CARRIER AMPLIFIER
V405
5591/403B
PART OF
PANEL 8
VOLUME CONTROL
D304
AUTO
MAN
AUTO VOL CONTROL MAX GAIN
P304
10K
MAN VOL CONTROL
P305
10K
SQUELCH CARRIER RECTIFIER
V307
(1/2) 6AL5
SQUELCH CARRIER DC AMPLIFIER
V308
(1/2) 2C51
SQUELCH CONTROL CAR GAIN
P303
10K
SIDEBAND HYBRID VOLTMETER
V401
(1/2) 2C51
D401
REPEATING
T408
VT
HEATERS
F301
1 AMPERE
T307
PRIMARY: 115V 50/60 CPS
6.3V
1.0A
TO 2C51/396A HEATERS
6.3V
2.25A
TO ALL OTHER HEATERS ON PANEL 3
C324
ON
-130V
+250V

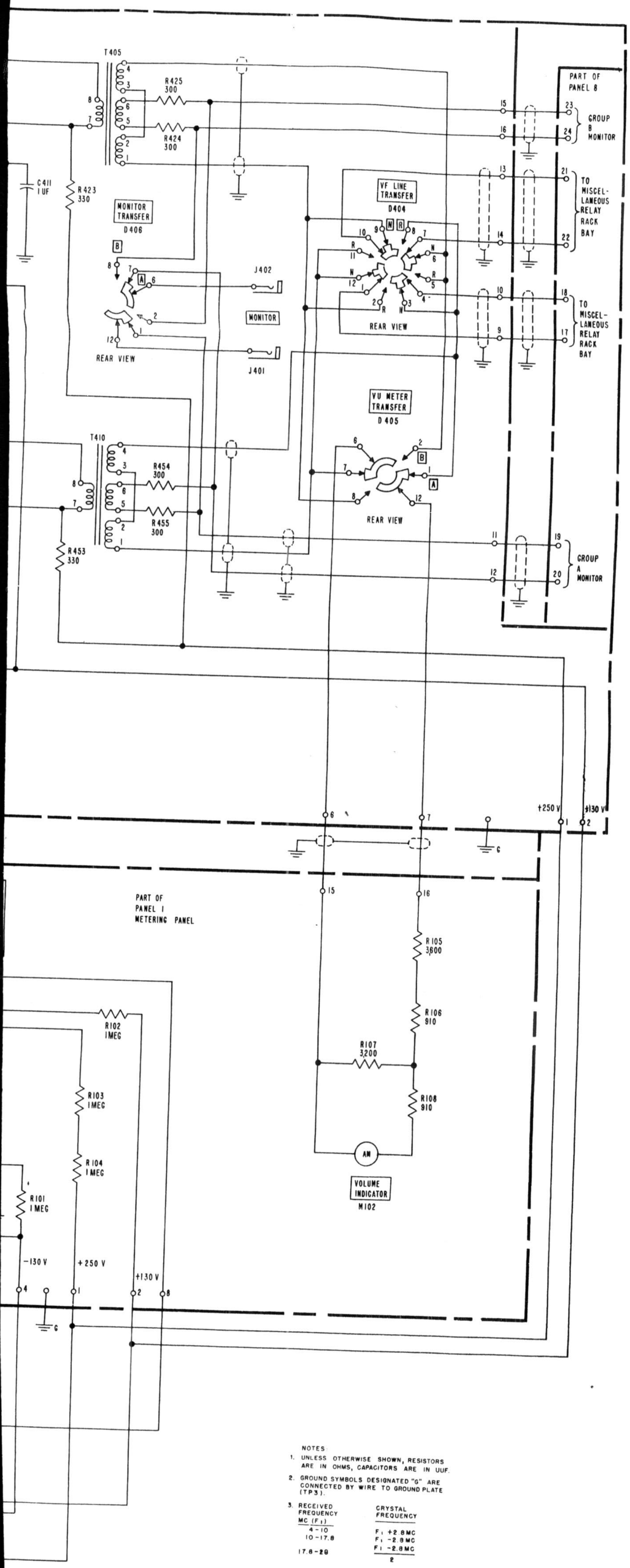


NOTES

1. UNLESS OTHERWISE SHOWN, RESISTOR ARE IN OHMS, CAPACITORS ARE IN
2. GROUND SYMBOLS DESIGNATED "G" ARE CONNECTED BY WIRE TO GROUND PLAT (TP3).
3. RECEIVED FREQUENCY MC (F1) — CRYSTAL FREQUENCY

RECEIVED FREQUENCY MC (F1)	CRYSTAL FREQUENCY
4-10	F1 +2.8MC
10-17.8	F1 -2.8MC
17.8-29	(F1 -2.8MC) / 2

344144 O - 5



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. GROUND SYMBOLS DESIGNATED "G" ARE CONNECTED BY WIRE TO GROUND PLATE (TP3).
3.

RECEIVED FREQUENCY MC (Fs)	CRYSTAL FREQUENCY
4-10	Fs +2.8MC
10-17.8	Fs -2.8MC
17.8-28	(Fs -2.8MC)/2

TM 870-96