

SECTION I GENERAL DESCRIPTION

*FREQUENCY RANGE
1.5 - 18.5 Mc*

1. GENERAL.

This handbook has been compiled as a guide to the proper installation, adjustment, operation and maintenance of the Radio Set AN/ARR-15 and Radio Set AN/ARR-15A. Refer to figure 1-1 for identification of this equipment.

Since Radio Sets AN/ARR-15 and AN/ARR-15A have the same function and are electrically and mechanically interchangeable, the instructions are based upon the AN/ARR-15 equipment, but apply

equally to the AN/ARR-15A equipment. Where specific differences occur between the two, reference will be made to the specific equipment under discussion.

2. EQUIPMENT SUPPLIED.

The following table lists the equipment supplied by the manufacturer together with the type number, size and weight of each unit:

Quantity per Equipment	Name of Part	Army and Navy Type Designation	Overall Dimensions (Inches)	Weight (Pounds)	Numerical Series of Reference Symbols
1	Radio Receiver LF Oscillator HF Oscillator CFI Unit Relay Unit Dynamotor	*R-105/ARR-15 DY-34/ARR-15	7 $\frac{7}{8}$ x 10 $\frac{3}{8}$ x 21 $\frac{9}{16}$	39.5	100-199 200-299 300-399 400-499 500-599 600-699
1	Receiver Mounting Base	MT-461/ARR-15	3 $\frac{15}{16}$ x 10 $\frac{7}{8}$ x 23 $\frac{27}{32}$	3.31	
1	Power Connector		1 $\frac{5}{16}$ x 2 $\frac{15}{32}$ x 4 $\frac{15}{16}$.69	900-999

* In the AN/ARR-15A equipment, the receiver bears the type designation R-105A/ARR-15.

3. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

The following table lists the equipment required

to complete an installation (furnished by the Government):

Quantity per Equipment	Name of Unit	Army and Navy Type Designation	Required Characteristics
1	Primary Power Supply	Battery and/or Generator	
1	Antenna		Fixed aircraft, ranging from 17 feet to 40 feet in length
*	Headsets	H-1/AR or Equal	
*	Junction Box	J36A/AJA-2A or equal	
*	Jack Box	J-22B/ARC-5	
*	Associated Radio Transmitter	ATC, AN/ART-13 or equal	

* Depends on installation.

4. PURPOSE OF EQUIPMENT.

The Radio Set AN/ARR-15 has been designed for installation in all types of Naval aircraft. The pur-

pose of the equipment is to provide reliable, preset, multi-channel, voice, cw, and mcw, pilot or radio operator controlled reception.

6. AUDIO OUTPUT CHARACTERISTICS.

The audio output is consistent at 500 milliwatts maximum with avc and noise limiter action. With r-f inputs of 10 to 10,000 microvolts, 30 per cent modulated, the output will contain 15% or less distortion. The audio response does not vary more than plus or minus three db relative to the response at 1000 cps for modulation frequencies of 300 to 3500 cps. The maximum attenuation is attained below 300 cps and above 3500 cps. The low pass filter provided for cw reception is down 30 db or more at 1600 cps from 1200 cps reference frequency and within three db from 1200 cps to 300 cps.

7. TYPES OF RECEPTION.

Voice, cw or mcw signals may be received with this equipment. A control on the front panel of the receiver permits the selection of the type of reception. This control is designated CW-MCW-CAL and should be operated to the MCW-CAL position when it is desired to receive voice or mcw signals. When voice modulated or mcw reception is selected, the beat frequency oscillator circuit is disabled, the avc circuit is connected so as to be operative and a variable "T" pad is used to control the input to the headphones. If cw reception is selected, the avc is partially disabled, the "T" pad is disconnected from the audio output circuit, and a potentiometer connected in the cathode circuit of the r-f amplifier and first and second i-f amplifier tube circuits, is used to control the gain. Both "T" pad and potentiometer are operated by the volume control.

8. SUCCESSFUL OPERATING LIMITS.

a. TEMPERATURE.

This equipment is designed to operate at temperatures within range of -40°C to $+60^{\circ}\text{C}$ (-40°F to $+140^{\circ}\text{F}$). At temperatures below -30°C (-22°F), a 20 minute warm-up period in still air should be allowed before making any adjustments or operating the channel selecting mechanism.

b. ALTITUDE.

This equipment will operate satisfactorily up to an altitude of 40,000 feet above sea level.

c. DISTANCE.

The distance limits of this receiving equipment will be determined by the conditions existing at the time of operating (day or night). The interference, time of operating, frequency and many other con-

ditions are the limiting factors. The required performance will be obtained under normal conditions encountered in aircraft radio operation.

9. POWER SOURCE REQUIREMENTS.

This equipment has been designed to operate from a 26.5 volt d-c supply. A variation of the voltage of plus or minus 10% will not materially affect the operation of the equipment. The current drain does not exceed three and one-tenth amperes during warm-up and reception or eight and one-half amperes during operation of the channel selecting mechanism. Dynamotor starting surge is not included in the above figures. Dynamotor starting surge is approximately 15 amperes.

10. TYPE OF CONTROL.

The tuning controls located on the front panel operate all preselection and conversion oscillator circuits of the receiver. Appropriate dials, calibrated in frequency, are associated with these controls to indicate the frequency to which the receiver is tuned. The controls may be operated either manually or electrically. This equipment employs the AUTO-TUNE system of channel selection. Ten frequency channels may be manually selected and the controls locked. The controls may then be repositioned electrically to any one of the ten channels by operating the channel selecting switch on the front panel of the equipment.

Note

The last operator that rotates his power ON-OFF switch to the ON position will have control of the equipment.

11. ANTENNA.

This equipment has been designed to operate with a fixed aircraft antenna ranging from 17 feet to 40 feet in length, which is also used for transmission. The transmitter used with this receiver should have a suitable change over relay, which will ground the receiver antenna connection during transmission.

A spring type binding post, located near the upper edge of the front panel, provides the antenna connection for the equipment.

A spring type binding post, located near the lower edge of the front panel, provides the ground connection for the equipment.

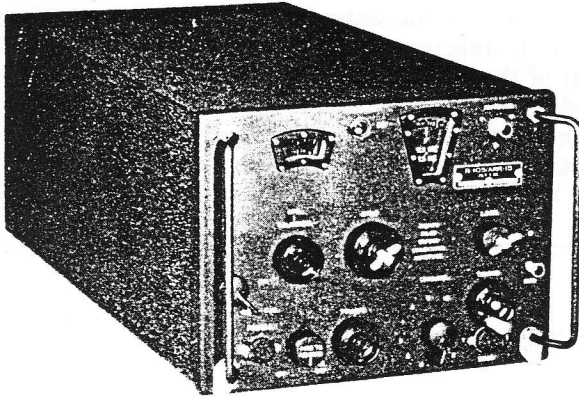


Figure 1-2. Receiver Unit R-105/ARR-15

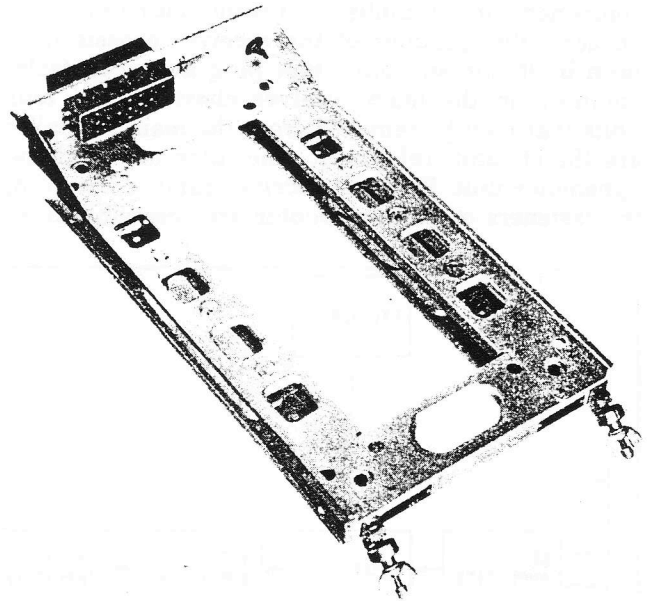


Figure 1-3. Mounting Base MT-461/ARR-15

12. MECHANICAL AND ELECTRICAL CHARACTERISTICS.

a. MECHANICAL DESCRIPTION.

(1) RADIO RECEIVER R-105/ARR-15, DYNAMOTOR DY-34/ARR-15 and MOUNTING BASE MT-461/ARR-15.

The receiver and dynamotor power supply are contained in a single cabinet. The receiver cabinet has been designed to mount on a detachable shock reducing base. The base is designed to be installed as an integral part of the aircraft. The two main sections of the mounting base are held apart by live rubber cushions. It is only necessary to have access to the front of the equipment in order to fasten the unit to or remove the unit from the mounting base. The equipment may be fastened to or loosened from the mounting base by tightening or loosening two wing nuts on the front of the equipment. A multiterminal receptacle is mounted on the rear of the receiver chassis. When the equipment is fastened to the mounting base the plug on the mounting base makes all of the electrical connections to the equipment except the antenna connections. In addition to the shock reducing base on the receiver, a spring and rubber cushioned base is attached to the dynamotor to prevent the vibration that is caused by operation of the dynamotor, affecting the operation of the receiver. The installation section of this handbook gives the procedure to be followed for the mounting of the base and receiver.

No external equipment except an antenna, a set of headphones and a 26.5 volt d-c power source are necessary to complete the installation for panel control. If it is desired to control the receiver from a position some distance from the installation, additional controls are necessary. These controls are duplicates of the controls that are mounted on the receiver panel. Any number of remote control positions may be used with this equipment by con-

necting the controls at the remote position in parallel with those mounted on the receiver panel. Remote control of the receiver is entirely electrical and no mechanical linkages are necessary for the installation.

This receiver is equipped with the AUTOTUNE method of frequency selection. The AUTOTUNE system is an electrically controlled means of mechanically repositioning adjustable elements such as tap switches, variable capacitors and variable inductors to predetermined settings. Any combination of these items may be tuned to any one of several frequency channels by use of this system. In this particular equipment ten frequency channels are available. Any one of these ten frequency channels may be selected by operating a switch on the receiver panel. The AUTOTUNE system will operate to select the frequency channel in a period that will not exceed seven seconds at room temperature and with a normal supply voltage (26.5 v). Lower temperature or lower source voltage or a combination of both will result in an increase in the time necessary to shift frequency channels. The accuracy of repositioning is of a very high order and is not seriously affected by wear, humidity or temperature changes. No tools are necessary for the adjustment of the AUTOTUNE mechanism. Refer to page 2-10 Section II, Paragraph 2. c. Adjustments, for the procedure to be followed when changing a frequency channel.

Every effort has been made in the design of this equipment to reduce to a minimum the time that is required for the repair or replacement of components within the receiver. All components are accessible either from the sides or bottom when the receiver is removed from the cabinet. The

components in assemblies that could not be mounted on accessible portions of the receiver chassis have been built into sub units that plug into receptacles mounted on the main receiver chassis. The four units that may be removed from the main assembly are the cfi unit, relay unit, line filter unit and the dynamotor unit. With the receiver cabinet removed, the fasteners on the dynamotor are accessible from

the top of the receiver. All connections except the connection to the antenna are made to a multiterminal connector plug receptacle mounted on the rear of the mounting rack. Ground connections are made through the connector plug. The connector plug on the receiver is inserted into the plug receptacle when the receiver is secured in place on the mounting rack.

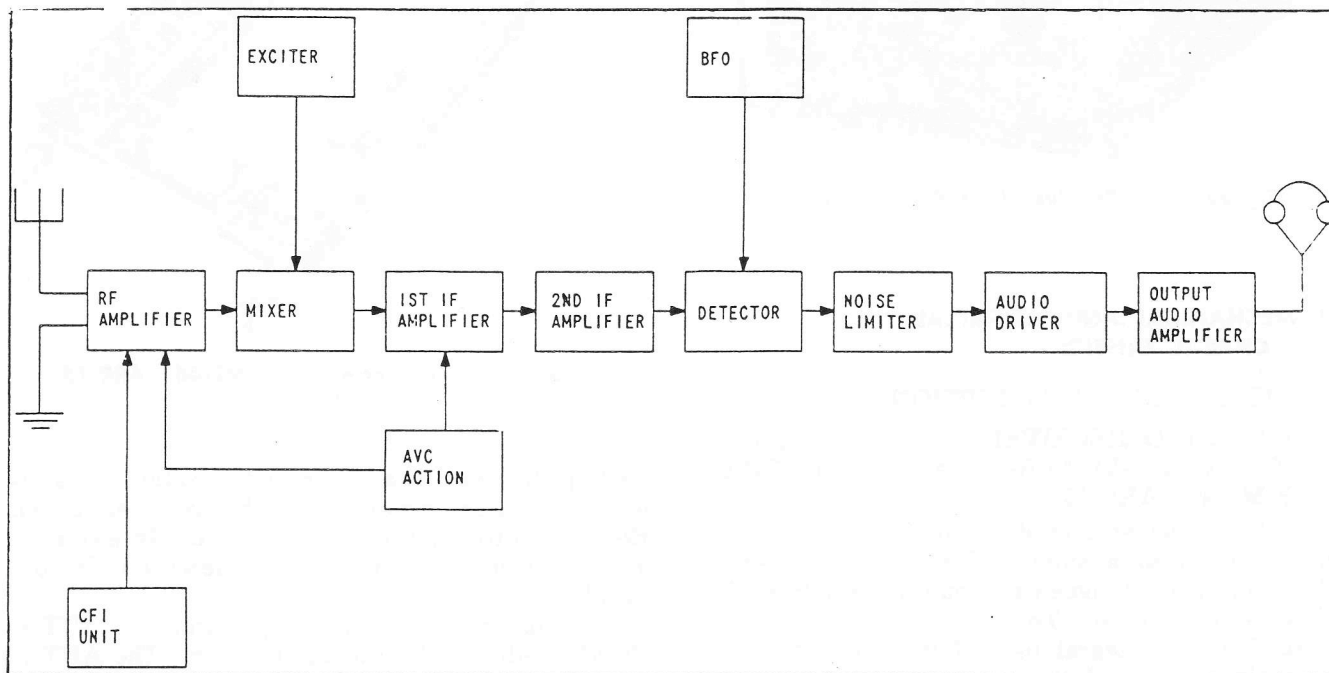


Figure 1-4. Receiver Block Diagram

b. ELECTRICAL DESCRIPTION.

The receiver employs a superheterodyne circuit and will receive cw and amplitude modulated voice and mcw signals. All of the tube heaters and a dynamotor operate from the 26.5 volts d-c power source. The dynamotor furnishes high voltage for the receiving tubes.

(1) RF AND IF AMPLIFIER CIRCUITS.

The superheterodyne circuit employs one stage of r-f amplification and two stages of i-f amplification. The i-f transformers are variable and will tune to frequencies in the range 450 to 550 kc. The variable characteristic of these transformers is used only during the calibrating of the receiver. When the receiver has been calibrated and it is desired to receive a transmitted signal, the i-f transformers are adjusted so that the intermediate frequency, as used for reception, is 500 kc. For calibration and excitation purposes three oscillators have been incorporated in this receiver. The frequency of one oscillator circuit is determined by a 100 kc quartz crystal. Harmonics of this 100 kc signal are used when calibrating the receiver. During actual reception this oscillator is disabled by

removing the plate and screen voltages from the oscillator tube.

The frequency converting stage of this receiver is separately excited. One of the variable frequency oscillators is used to excite the mixer tube. This oscillator operates in the frequency range 2000 to 3000 kc and a frequency multiplier circuit is used to obtain the higher frequency excitation voltages. The remaining oscillator tube is essentially a beat frequency oscillator, but is also used during the calibration of the receiver. The output of this oscillator is in the frequency range 450 to 550 kc. When voice modulated or mcw signals are being received, the beat frequency oscillator circuit is disabled by removing the plate and screen voltage from the oscillator tube. Both of the variable frequency oscillators are precision built, mechanically and electrically, and their output is very stable under extreme conditions of humidity and temperature change.

(2) DETECTOR, AVC, NOISE LIMITER AND AUDIO AMPLIFIER CIRCUITS.

In the R-105/ARR-15 Receiver, the detector circuit employs a fixed crystal detector unit. Two

tubes, a dual diode and a dual triode, are necessary for the noise limiter. The dual triode is a balancer tube while the dual diode functions as the noise limiter tube. In the R-105A/ARR-15 Receiver, the detector circuit employs one-half of a dual triode (diode connected). A dual diode and a section from each of two different dual triodes are used for the noise limiter. The two triodes are balancer tubes while the dual diode functions as the noise limiter tube. A dual triode is used to supply avc voltage, one section of the dual triode is used in a trigger circuit while the other section is used to supply the avc voltage. Two stages of audio amplification provide ample output for the operation of headphones.

(3) POWER SUPPLY CIRCUITS.

The tube filaments are connected in series parallel across the power source. The relay coils are energized by the power source. A plug-in dynamotor unit furnishes the high voltage to the tubes. The motor section of the dynamotor operates from the 26.5 volt d-c power source.

(4) REMOTE CONTROL CIRCUITS.

This equipment has facilities for connection of a remote control unit for remote power control and remote selection of receiving channels. The

remote circuits should be similar to the circuits within the receiver. Any number of remote control units may be used since only one remote control can have control of the equipment at one time, provided the remote power switch is identical to the power switch in the receiver. The power switch (ON-OFF) in the receiver is a special switch which can be turned off manually or by an electrical impulse. The electrical impulse is furnished by the remote control desiring control over the equipment.

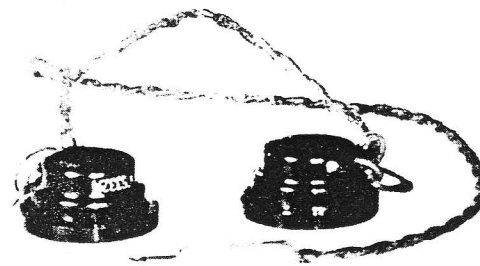
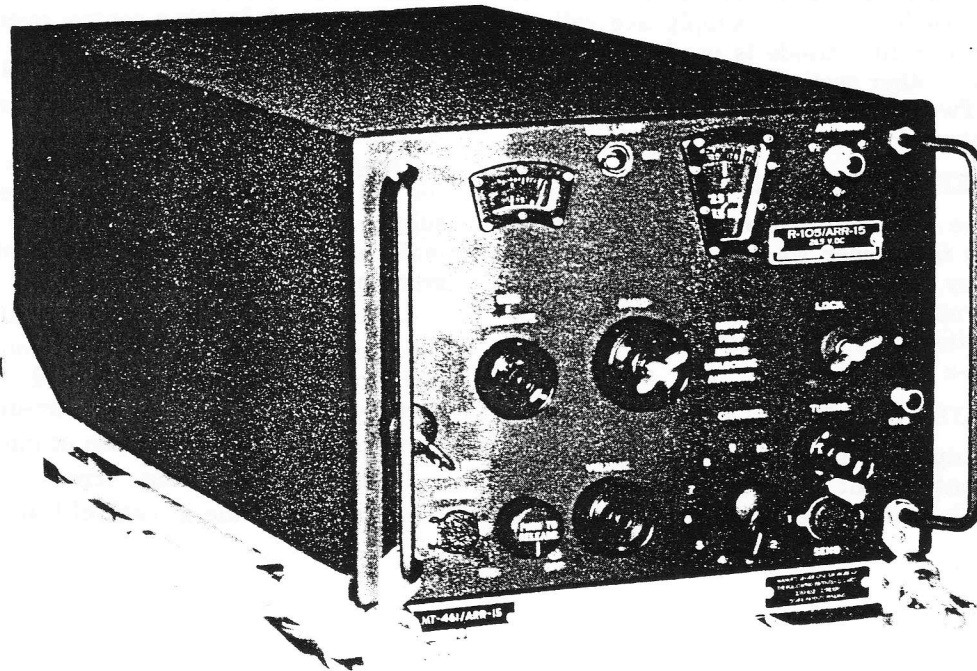
13. PURPOSE OF TROPICALIZATION TREATMENT.

This radio set has been tropicalized as outlined in Specification JAN-T-152.

The purpose of the tropicalization treatment given the equipment is to protect the equipment when subjected to moisture and fungus conditions normally encountered. This treatment is intended to accomplish the following:

- a. To render the surfaces moisture-resistant.
- b. To envelop terminals and connections with a low moisture absorbing film and thereby minimize surface electrical leakage and arc-over.
- c. To retard the absorption of moisture.
- d. To aid in retarding corrosion.
- e. To prevent the growth of fungi.

Radio Receiver R-105/ARR-15



Headset H-1/AR or Equal

Figure 2-1. Radio Set AN/ARR-15—Installation

SECTION II

INSTALLATION AND ADJUSTMENT

I. INSTALLATION.

a. PRELIMINARY.

(1) UNPACKING. (See figure 1-1)—All the equipment for the Radio Set AN/ARR-15 which is supplied by the contractor is in one crate. This equipment consists of a receiver unit, a receiver mounting base, and a power connector to be attached to the mounting base. If the crate is marked with arrows to indicate the upright position, remove the crate cover only. Remove the packing material and lift the units out carefully. Search all the packing material for small packages. Inspect each unit for loose screws and bolts. Be certain that all controls such as switches, dials, etc., work properly. All claims for damage should be filed promptly with the transportation company. If a claim for damage is to be filed, the original packing case and packing material must be preserved. Check the equipment received against the table EQUIPMENT SUPPLIED (Section 1, paragraph 2, page 1-1).

(2) CHECKING VACUUM TUBES AND PLUG-IN UNITS.—Loosen the receiver unit from the cabinet by disengaging the Dzus fastener that protrudes through the rear of the cabinet. Remove the receiver unit from the cabinet by pulling it forward. With the unit removed from the cabinet check all of the vacuum tubes to be certain that the proper tubes are securely inserted in the sockets. (Refer to figure 2-2 for the location of the tubes.) Make sure that all the plug-in units are firmly fastened.

(3) CHECKING CONTROLS FOR PROPER OPERATION.—Unlock the AUTOTUNE mechanism that operates the BAND switch and TUNING control by rotating each locking key two revolutions in a counterclockwise direction. Check each control by rotating it through the entire range.

CAUTION

Do not force the controls to rotate. If the controls do not operate satisfactorily with minimum pressure, check for bent parts, etc.

Check the BAND switch by turning it to each of the six positions. Rotate the TUNING control through the entire range. Rotate the BFO-CALIBRATE control. Turn the CW-MCW-CAL switch to the CW position and to the MCW-CAL position. Turn the ON-OFF switch to the ON position and release it to the OFF position by pressing the knob

toward the panel. Operate the VOLUME control. Rotate the CHANNEL selector switch to each of the ten channels.

After checking the tubes, plug-in units and controls, replace the receiver in the cabinet, push it all the way in and engage the Dzus fastener.

(4) BENCH TEST.

(a) POWER SOURCE.—This equipment has been designed to operate from a 26.5 volt d-c power source. The filaments of the tubes are connected in a series-parallel circuit across the power input. The dynamotor, AUTOTUNE motor and relays operate directly from the 26.5 volt supply. The equipment will operate with voltages 10% above or 10% below 26.5 volts but for the best results the input voltage should be maintained as close to 26.5 volts as possible. High voltages may damage the vacuum tubes. Low voltages may result in insufficient emission from the vacuum tube cathodes. With low voltage the time required to change channels will be longer.

(b) INSTRUMENTS, TOOLS AND EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1. 26.5 volt d-c supply.
2. Wire for connecting power source to plug receptacle (J-901).
3. A set of headphones (approx. 300 ohm).
4. A 500 ohm variable resistor.
5. A single-pole, single-throw switch.
6. A dummy antenna consisting of 10 ohm of non-inductive resistance and a 100 mmf capacitor in series.
7. Audio output meter. (A Weston 687, a milliwattmeter or a 15 volt meter shunted by enough resistance to match the 300 ohm output of the receiver.)
8. Signal generator. (TS-413/U, LP-4 or equivalent.)

(c) TEST BENCH SETUP.—If a number of installations are being made at one base it is desirable to make up a test bench so that each equipment may be checked before being mounted in the aircraft. Considerable time and labor may be saved if all units are checked and operating properly before being installed. (Refer to figure 2-3 for a suggested test bench setup.)

Use number 14 gauge wire for the power leads. Use number 18 gauge wire for the leads from the terminals numbered 4 and 10. Use number 22 wire for all the control leads.

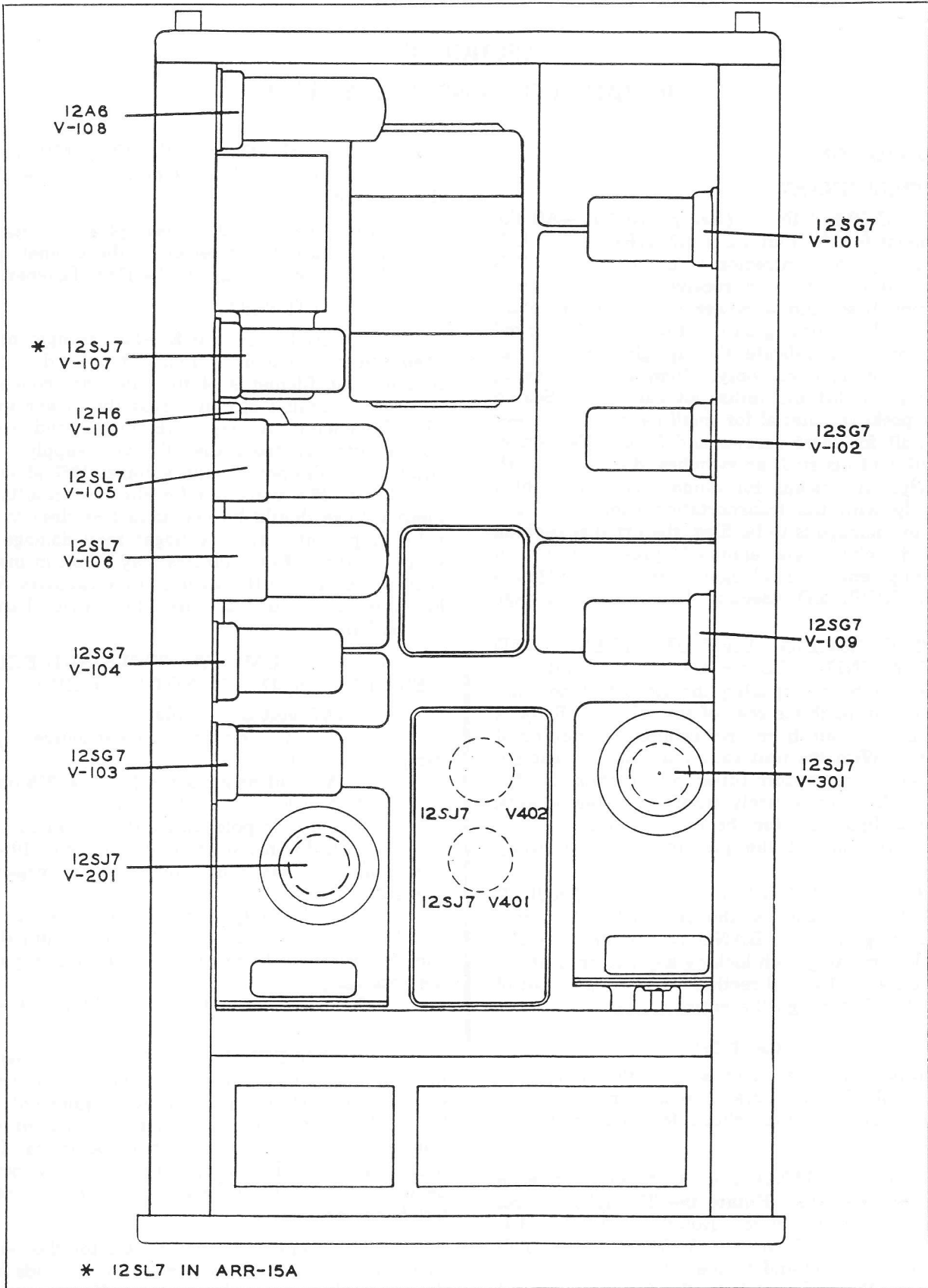


Figure 2-2. Tube Placement Diagram

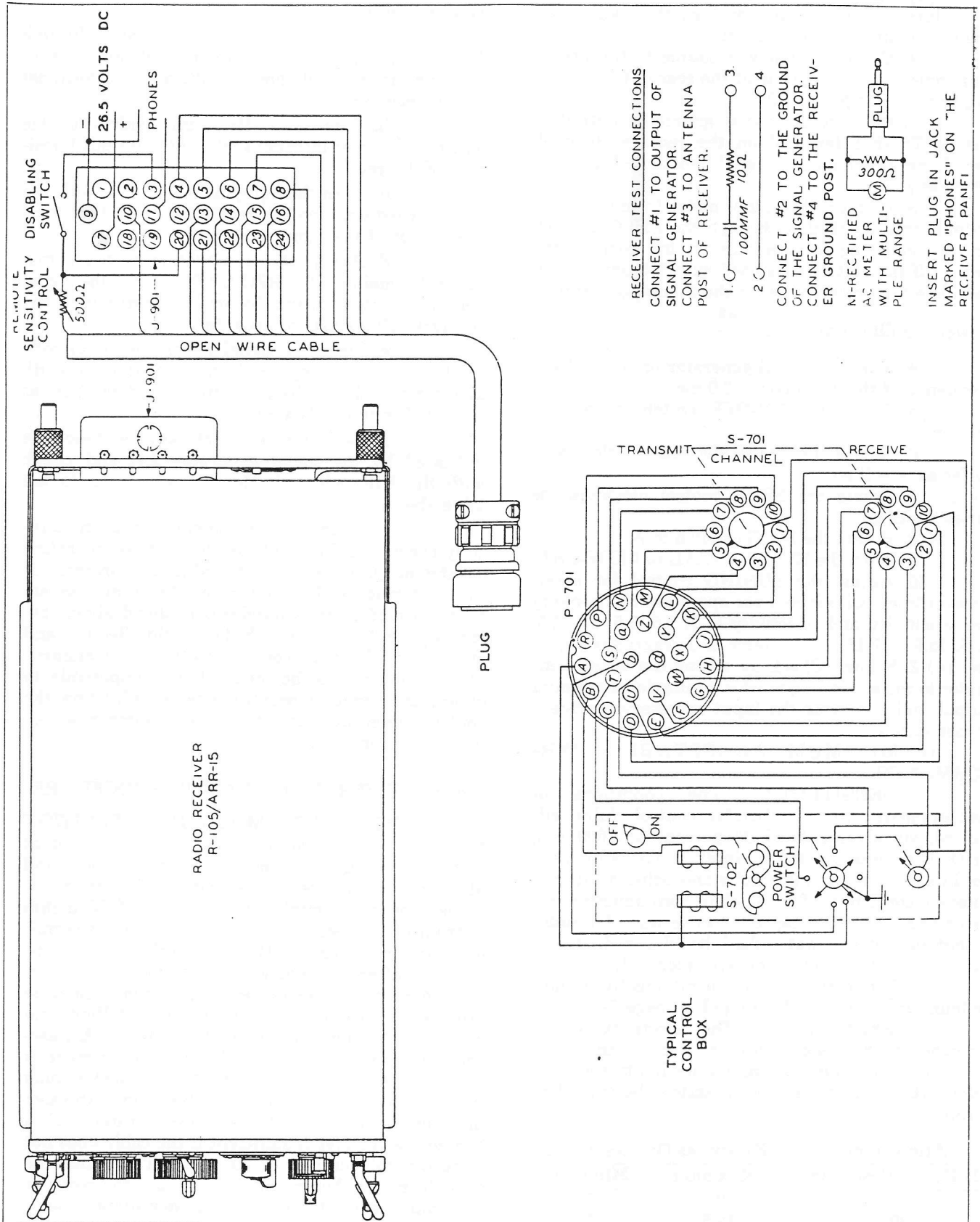


Figure 2-3. Test Bench Set-Up

(d) TEST PROCEDURE.—The following test procedure will reveal any damage that will affect the operation of the equipment.

1. Connect the power source to the proper terminals on the receptacle at the rear of the mounting base. (See figure 2-3.)

2. Connect the signal generator output to the ANTENNA terminal on the receiver through the dummy antenna. (Signal modulated 30% at 1000 cps.)

3. Connect the output meter to the receiver output circuit. (Either through the PHONES jack or by connecting to terminals on the rear of the unit.) If the voltmeter is used with 300 ohm shunt, calculate the power by using the following formula:

$$\text{Power (milliwatts)} = \frac{\text{voltage}^2}{0.3}$$

4. Turn the signal generator on and set the frequency of the generator at 2.0 mc.

5. Rotate the ON-OFF switch to the ON position.

6. Rotate the VOLUME control clockwise as far as it will go.

7. Rotate the SENS control clockwise as far as it will go.

8. Rotate the BAND switch to A.

9. Turn the CW-MCW-CAL to MCW-CAL.

10. Adjust the TUNING control for maximum output. Check receiver operation by checking the sensitivity and selectivity at 2, 2.5, 3.5, 5.5, 8.5, 12.5, 15.0 and 18.1 mc. Refer to Paragraphs (e) 1. and (e) 2. below. Check by setting the signal generator to the above frequencies, tuning for maximum output and observing the input necessary to give a chosen output.

(e) MINIMUM ACCEPTABLE PERFORMANCE.

1. SENSITIVITY. — The conditions of measurement are: VOLUME control fully advanced, signal modulated 30 percent at 1000 cps, PHONE reception with a rf input to the equipment not in excess of five microvolts and using a dummy antenna consisting of a 10 ohm non-inductive resistor and a 100 mmf capacitor in series. An audio output of 100 milliwatts shall be obtained at any frequency with an input of five microvolts.

The method of measuring sensitivity may be found in paragraph 1.d. (3) (e) on page 5-2.

2. SELECTIVITY.—The selectivity of the receiver at 18.1 megacycles per second shall fall within the maximum and minimum limits set forth below. (Conditions the same as stated above in Paragraph (e) 1.):

Attenuation DB Below Resonance	Kilocycles Off Resonance	
	Maximum	Minimum
6	9.0	7.5
20	12.5	7.5
40	22.5	7.5
60	30.0	7.5

The method of checking the selectivity is as follows:

a. Connect the signal generator through the recommended dummy antenna (100 mmf capacitor in series with 10 ohms) to the antenna terminal of the receiver.

b. Connect a 300 ohm loading device (with a db meter incorporated) to the output terminals of the receiver.

c. Turn the equipment ON and, with the BFO turned on, tune the receiver to zero beat with the output of the signal generator.

d. Apply 30% modulation to the signal generator and turn the BFO OFF. Adjust the signal generator output to just below the point where the receiver AVC starts to operate.

e. Tune the signal generator either side of the test frequency until the output on the db meter reads the desired amount of attenuation as indicated in the table above.

f. Read the kilocycles-off-resonance as indicated by the signal generator dial and check with the Kilocycles Off Resonance column in the table above.

When the equipment has been carefully checked and all units are found to be operating satisfactorily, it may be installed in the aircraft. If the performance does not meet the minimum acceptable performance standards outlined above, refer to page 2-11 Paragraph 2.e. of this Section and attempt to adjust the controls so that the standards of performance can be met. If it is impossible to obtain the required performance by adjusting the controls, turn the unit over to the maintenance personnel for servicing.

b. RECEIVER INSTALLATION PROCEDURE.

(1) SELECTING MOUNTING POSITION FOR UNIT. (See figure 8-2)—A clearance of at least one-half inch must be allowed on the sides and at the top for the free movement of the unit on the shock mount. A minimum clearance of 18 inches in front of the receiver should be allowed to permit adjusting the controls. If the controls are not to be adjusted after the receiver is installed in the aircraft, a minimum clearance of four inches must be provided in front of the unit for installing and removing the unit from the mounting base. A clearance of at least four inches behind the receiver is necessary for the removal of the connector plug from the shock mount if the cable comes through the rear of the plug. A clearance of three inches behind the receiver is sufficient if the cable does not come through the rear of the plug. There must be enough space either in front of or above the receiver to permit placing the unit on the mounting base.

(2) PLACING AND SECURING THE MOUNTING BASE. (See figure 8-1)—Use eight

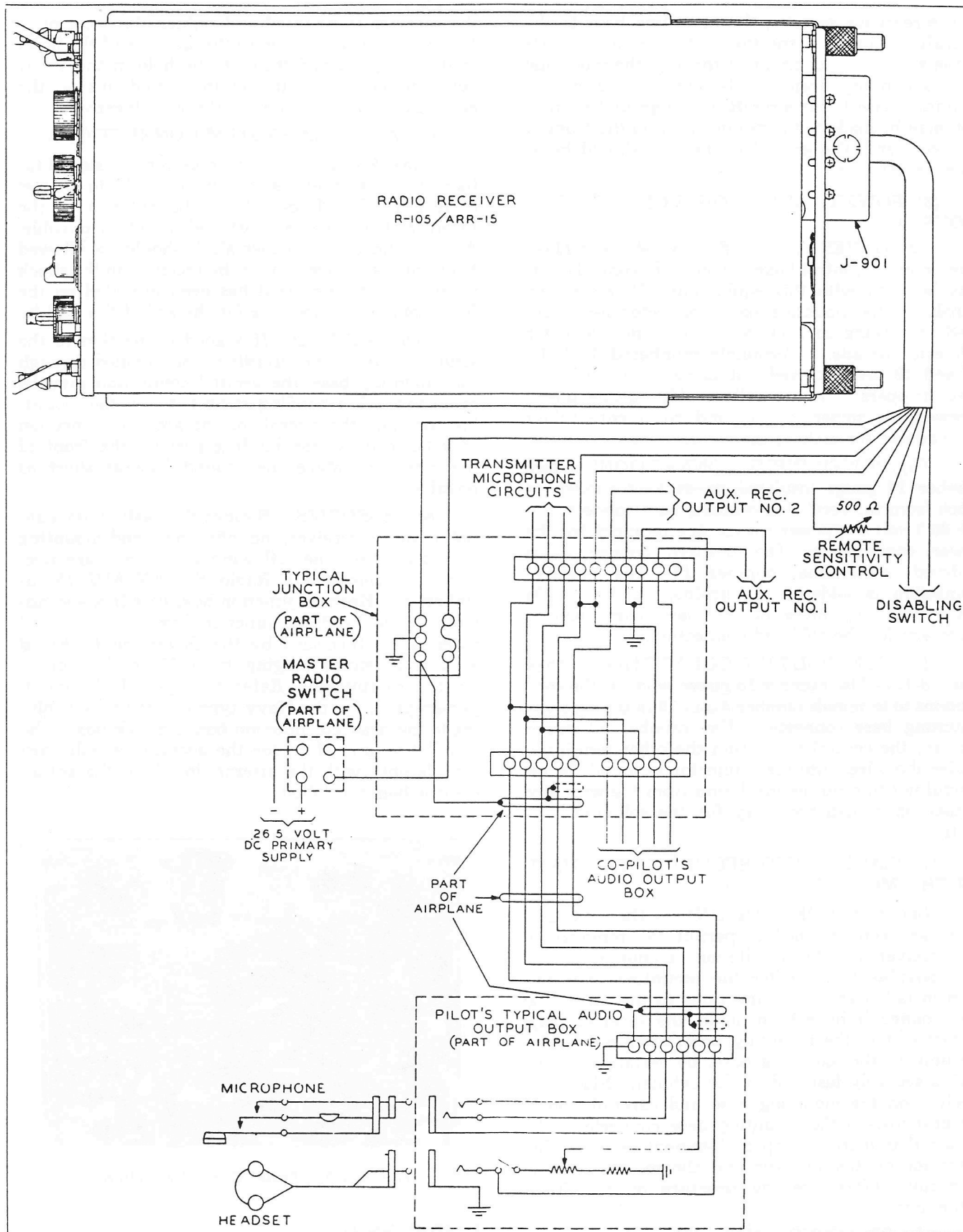


Figure 2-4. Cabling Diagram

#10 screws for securing the mounting base to the aircraft. If a good connection to the structural parts of the aircraft is not obtained through the mounting base, a bonding strap may be connected from the mounting base to the aircraft or the ground connection may be made to the ground post on the front of the receiver. The ground connection should be as short as possible.

(3) POWER AND CONTROL CONNECTIONS.

(a) GENERAL. (See figures 2-4 and 8-11)—One or more control boxes or console control units may be used with this equipment. Nineteen terminals of the mounting base connector J-901 are used in making connections. (See figure 8-10 for connector details.) Terminals numbered 1, 2, 12, 18 and 19 are not used. It is recommended that wire strippers, long nose pliers, side cutting pliers, screwdriver, soldering iron and rosin core solder be available for making the connections.

(b) POWER INPUT CONNECTIONS.—Two number 14 gauge insulated wires long enough to reach from the receiver mounting base connector to the 26.5 volt d-c power source are required for the power connections. The positive connection is soldered to terminal number 17. The negative connection is soldered to terminal number 9. Do not expose any more of the bare wire than is necessary for the soldered connection.

(c) CONTROL LINE CONNECTIONS. (See figure 8-11)—Use number 18 gauge wire for the connections to terminals number 4 and 10 in the receiver mounting base connector. Use number 22 gauge wire for the control leads from the other terminals. Solder the wires into the connector terminals being careful not to strip the insulation from the wire any farther back than necessary for the soldered connection.

(4) PLACING AND SECURING THE UNIT ON THE MOUNTING BASE.

(a) PLACEMENT OF UNIT.—The mounting base has been designed to permit the removal of one receiver and the installation of another in the least possible time. After the mounting base has been installed and all connections to the mounting base connector have been made, the receiver may be fastened to the mounting base. Before placing the unit on the mounting base, be certain that the unit is securely fastened in the cabinet. Place the receiver on the mounting base and carefully push the unit toward the mounting base connector. Be certain that there is proper alignment between the connector on the receiver and the mounting base connector before exerting pressure on the front of the unit.

(b) SECURING UNIT.—When the receiver has been pushed back as far as it will go, lift the lock assemblies over the angles that protrude from

the receiver front panel and tighten the wing nuts. Insert a piece of safety wire through one of the holes in the wing nut and through the hole in the screw between the wing nut and the round nut on the end. Twist the free ends of the wire together.

(5) ANTENNA SYSTEM CONNECTIONS.

(a) ANTENNA.—The receiver is designed for fixed aircraft antennas ranging from 17 to 40 feet in length. The lead-in from the antenna to the receiver should be as short and direct as possible. A minimum of two inches slack should be allowed to permit free movement of the receiver on the shock mounts. A binding post has been provided on the front panel of the receiver for the end of the lead-in.

(b) GROUND.—If a good connection to the structural part of the aircraft is not obtained through the mounting base, the ground connection may be made through a bonding strap between the mounting base and the aircraft or the ground connection may be made to the binding post on the front of the receiver. Make the ground lead as short as possible.

c. ACCESSORIES.—Besides the basic units, consisting of the receiver, mounting base and mounting base connector, the following accessories are necessary to complete a Radio Set AN/ARR-15 installation: Headset, junction box, jack box and antenna. The headsets, junction box, jack box and antenna are furnished by the Government. Fixed aircraft antennas ranging from 17 to 40 feet in length are suitable. Refer to page 1-1 Section I, paragraph 3. for the Navy type designations applying to the headsets, junction box and jack box. The installation procedure for the accessories will vary considerably with the aircraft in which the equipment is being installed.

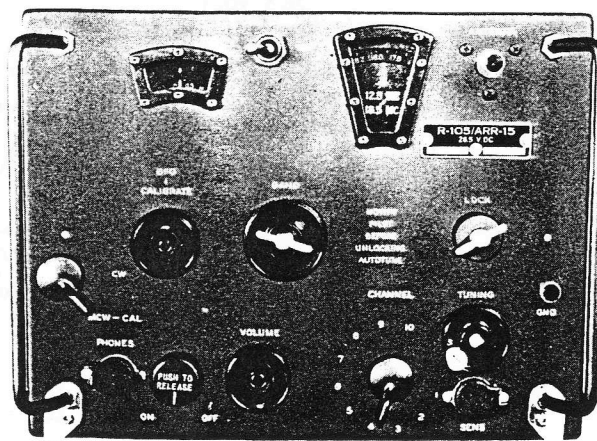


Figure 2-5. Panel Control Functions

2. ADJUSTMENT.

a. GENERAL.—The adjustment of this receiving equipment consists principally of calibration and

AUTOTUNE adjustment. When properly synchronized, no adjustment of the AUTOTUNE mechanism, except the unlocking, setting and locking of the BAND switch and TUNING control, is necessary. The AUTOTUNE mechanism is highly dependable and will only require synchronizing if some part of the mechanism has been replaced or removed for repair. The synchronizing of the mechanism is considered a maintenance operation rather than an adjustment operation. Complete instructions for the synchronizing of the AUTOTUNE mechanism are included in the HANDBOOK of MAINTENANCE INSTRUCTIONS.

Note

To unlock the AUTOTUNE mechanism that operates the TUNING control and the BAND switch, rotate the locking keys two revolutions in a counterclockwise direction. Lock the controls by rotating the locking keys in a clockwise direction until the torque necessary to rotate the keys indicates that pressure is being applied to the stack of AUTOTUNE stop rings.

b. FUNCTION OF CONTROLS.—All of the receiver controls are mounted on the front panel. In each case a word or words have been engraved on the panel to indicate the function of the particular control. The following paragraphs give a brief outline of the elements in the receiver that are operated by each control:

(1) POWER ON-OFF SWITCH.—The power ON-OFF switch, located in the lower left-hand corner of the panel, is a combination manually and electrically operated power and circuit control switch. In addition, the cathode circuits for the r-f amplifier, the mixer, and the first i-f amplifier tubes, the energizing circuit for the cw relay, the circuit to

the CHANNEL selector switch, and the energizing circuit for the primary power control relay are cleared for remote control by an electrical impulse to the electrically operated release section of the switch. The electrical impulse will be received from the control that desires to control the receiver. All ON-OFF switches should be equipped with an impulsing circuit so that only one station may have control at any given instance.

(2) CHANNEL SELECTOR SWITCH.—The CHANNEL selector switch, (figure 2-6,) is used to select any of the 10 available AUTOTUNE channels upon which reception is desired. The numerals that are engraved on the receiver panel correspond to the 10 AUTOTUNE channels. This control operates a single pi switch that is associated with the AUTOTUNE control circuit.

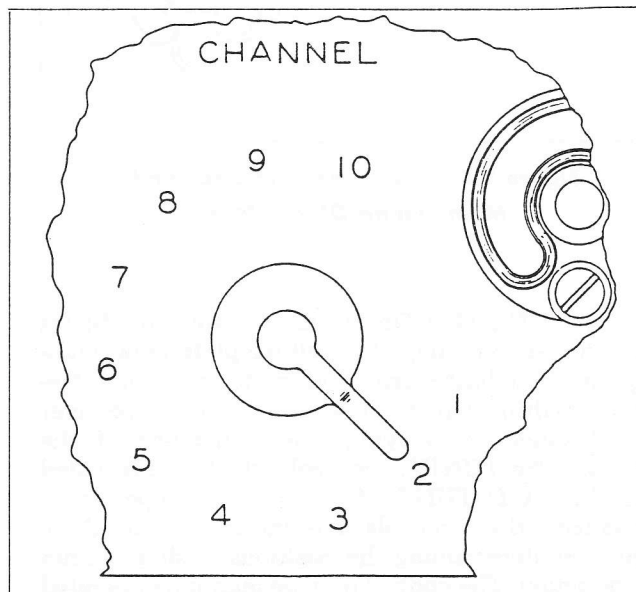


Figure 2-6. Channel Selector Details

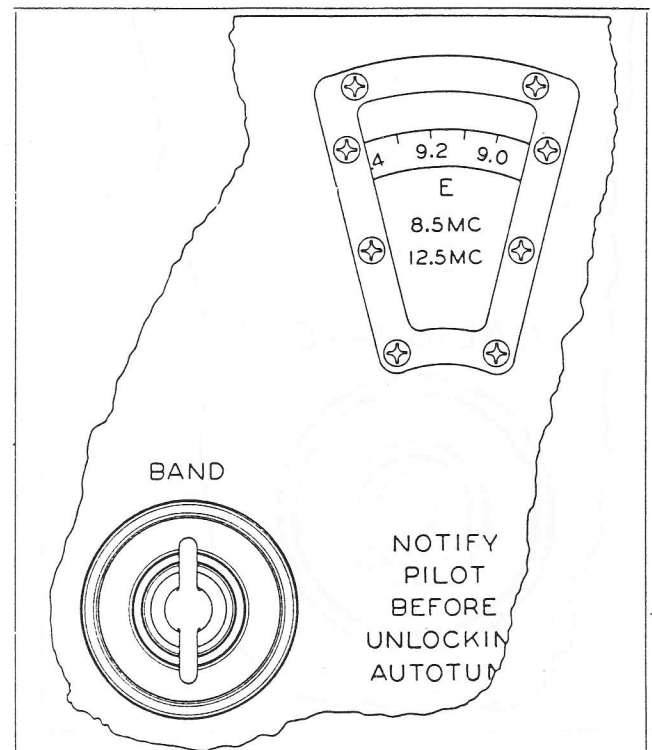


Figure 2-7. Band Switch Details

(3) BAND SWITCH.—The BAND switch, (figure 2-7,) is connected to the AUTOTUNE Singleturn Unit and is used to select the band of frequencies that contain the one upon which reception is desired. The frequency range of the receiver, 1500 to 18,500 kc, is divided into six bands. The frequency band may be manually selected, if the AUTOTUNE Singleturn Unit stop rings are unlocked, by rotating the locking key in a counterclockwise direction. The BAND switch operates a mechanism which selects the r-f coupling and r-f amplifier plate tank circuits that will tune to the band of frequencies in which

reception is desired and selects the proper plate tank circuits for the high-frequency oscillator and frequency multiplier stages.

disables the avc action, and connects a potentiometer in the cathode circuits of the r-f amplifier, mixer and first i-f amplifier tubes. The control may be rotated to vary the frequency of the oscillator 100 kc, 50 kc above and 50 kc below the intermediate frequency (500 kc).

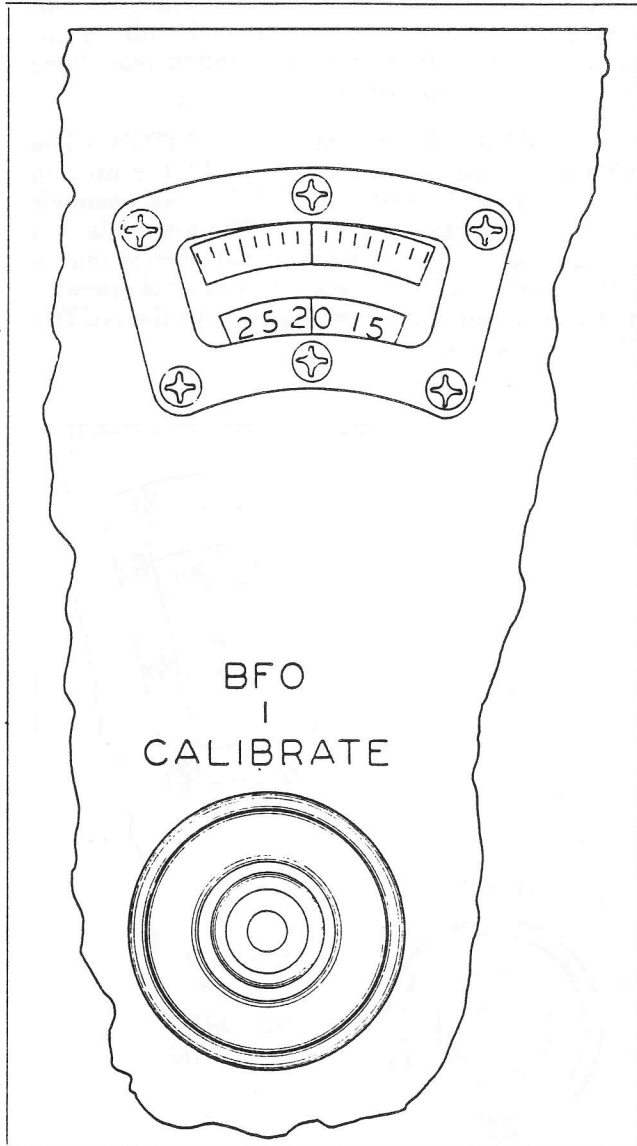


Figure 2-8. Calibrate and BFO Details

(4) BFO-CALIBRATE CONTROL.—This receiver has been provided with a system of calibration that permits the tuning of the receiver circuit to any exact frequency without having to tune for an incoming signal. The BFO-CALIBRATE control, (figure 2-8,) tunes the three i-f transformers and the beat frequency oscillator grid tank circuit by changing the positions of slugs within the inductors. The operation of this control also applies plate and screen voltages to the cfi (crystal-controlled frequency indicator,) oscillator tube, grounds the antenna terminal of the receiver, connects the output of the cfi oscillator to the input circuit of the receiver,

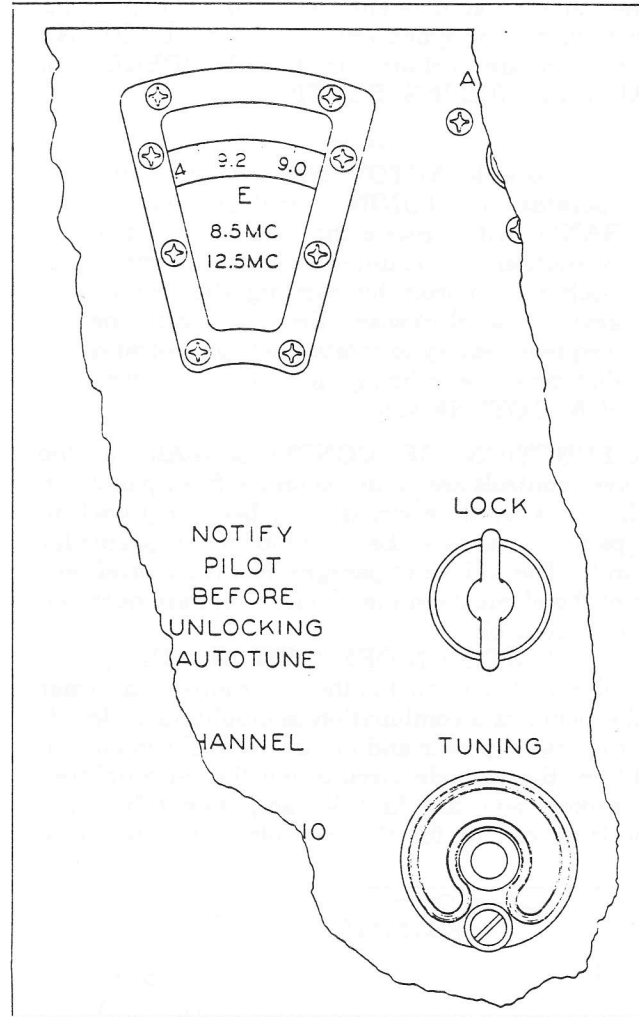


Figure 2-9. Frequency Indicator and Main Tuning Dial Details

(5) TUNING CONTROL.—(Refer to figure 2-9.) The r-f coupling, r-f amplifier plate tank, high-frequency oscillator grid and plate tank, and frequency multiplier plate tank circuits of this receiver are all tuned by varying the inductance of the circuits. The TUNING control, which is associated with the AUTOTUNE Multiturn Unit, operates a mechanism that controls the inductance in these circuits by determining the positions of slugs within the inductors. The control may be manually operated if the stop rings are unlocked. The control may be

unlocked by rotating the locking key in a counter-clockwise direction.

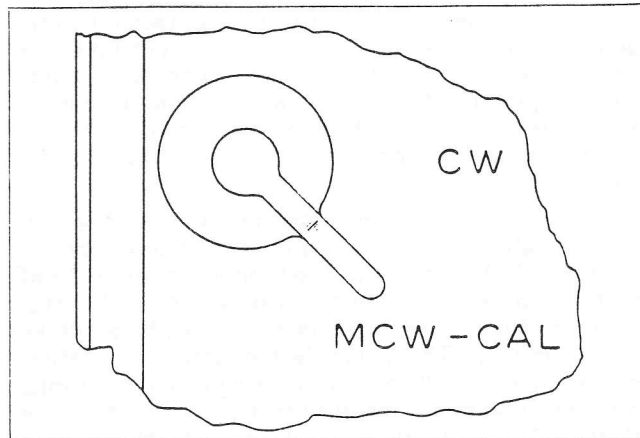


Figure 2-10. CW-MCW-CAL Selector Details

(6) MCW-CAL-CW SWITCH.—(Refer to figure 2-10). When it is desired to receive either mcw or voice modulated signals this switch should be set at the MCW-CAL position. When the switch is in the MCW position the avc circuit is operative and a variable "T" pad is connected between the output of the audio amplifier and the PHONES jack. When the switch is set at the CW position the avc circuit is partially disabled, the output of the audio amplifier is coupled directly to the phones jack, and the volume is controlled by a cathode potentiometer as explained above.

(7) VOLUME CONTROL.—This control operates two sections of variable resistors, a bridged "T" pad and a potentiometer. The "T" pad is connected between the output of the audio amplifier and the PHONES jack whenever mcw reception is selected. When cw reception is selected, a potentiometer is connected in the cathode circuits of the r-f amplifier and first i-f amplifier tubes. When mcw reception is selected the potentiometer is shorted out.

(8) SENS CONTROL.—The threshold sensitivity is controlled by the screwdriver adjustment marked SENS. (See figure 2-11.) This control is connected in series with the cathodes of the r-f, mixer and i-f stages in the receiver for the purpose of adjusting the sensitivity of the receiver to operate most satisfactorily under conditions of electrical interference. A dust cover is placed over the panel opening behind which this control is located.

c. PRINCIPLE OF OPERATION.—This receiver employs a superheterodyne circuit with one stage of r-f amplification and two stages of i-f amplification. The i-f transformers are variable and will tune to frequencies in the range 450 and 550 kc. The variable characteristics of these transformers is used only during the calibrating of the receiver. When

the receiver has been calibrated and it is desired to receive a transmitted signal, the i-f transformers are adjusted so that the intermediate frequency is exactly 500 kc. Therefore the actual intermediate frequency, as used for reception is 500 kc. For calibration, and excitation purposes three oscillators

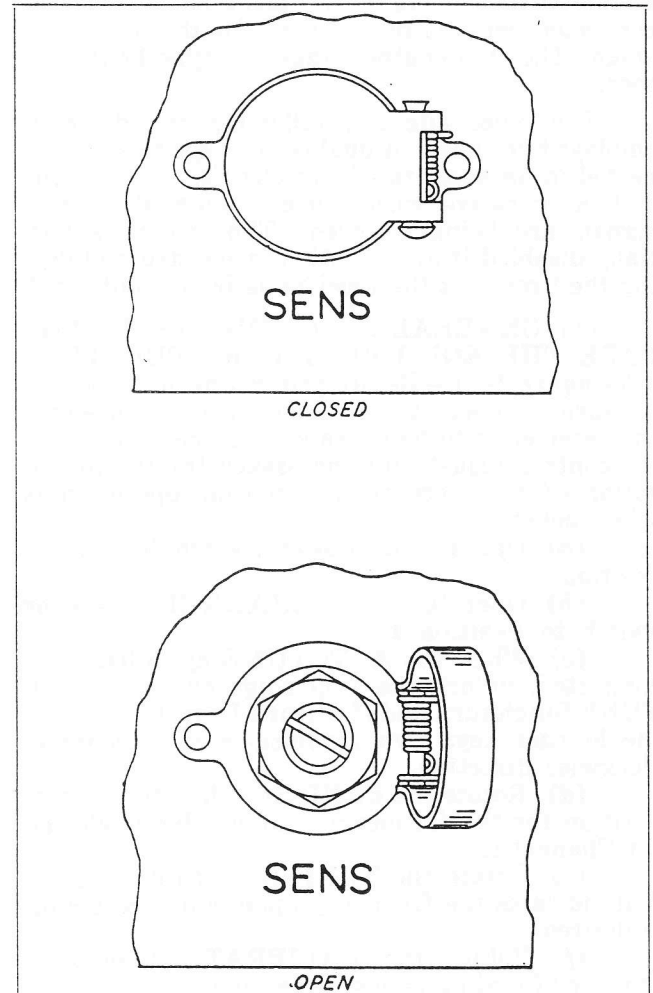


Figure 2-11. Sensitivity Adjustment Details

have been incorporated into this receiver. The frequency of one oscillator circuit is determined by a 100 kc quartz crystal. Harmonics of this 100 kc signal are used when calibrating the receiver. During actual reception this oscillator circuit is disabled by removing the plate and screen voltage from the oscillator tube.

The frequency converting stage of this receiver is separately excited. One of the variable frequency oscillators is used to excite the mixer tube. This oscillator operates in the frequency range 2000 to 3000 kc and a frequency multiplier circuit is used to obtain the higher frequency excitation voltages. The remaining oscillator tube is essentially a beat frequency oscillator, but is also used during the calibration of the receiver. The output of this oscillator is in the frequency range 450 to 500 kc.

When voice modulated or mcw signals are being received, the beat frequency oscillator circuit is disabled by removing the plate and screen voltages from the oscillator tube.

Two stages of audio amplification provide ample output for the operation of headphones at the receiver and for the operation of headphones at the remote control positions. One triode connected pentode tube is used for the first audio stage. The audio output stage is a type 12A6 pentode.

The noise silencer, following the detector, employs two tubes. A dual triode type tube is connected in an accelerated avc circuit. The avc circuit is operative when voice modulated or mcw signals are being received. The circuit is partially disabled if cw reception is selected and during the time that the receiver is being calibrated.

(1) GENERAL ADJUSTMENTS TO PREPARE THE EQUIPMENT FOR OPERATION. (See figure 2-5.)—Before proceeding with the adjustments, choose the 10 frequencies upon which the receiver is to be operated. A brief outline of the control adjustments necessary for the preparation of this receiver for routine operation is given below:

(a) Operate the Power Switch to the ON position.

(b) Operate the CHANNEL Selector switch to Position 1.

(c) When the AUTOTUNE cycle has been completed, unlock the stop rings on the AUTOTUNE Singleturn and Multiturn Units by rotating the locking keys two revolutions in a counterclockwise direction.

(d) Rotate the BAND Switch to the correct position for the frequency that has been selected for Channel 1.

(e) Rotate the TUNING Control until the dial indicates the frequency upon which reception is desired.

(f) Rotate the CALIBRATE Control a number of dial divisions corresponding to the last two digits and fractions thereof of the desired frequency.

(g) While listening to the output of the receiver, rotate the TUNING Control about the desired frequency until zero beat is obtained.

(h) Lock the BAND and TUNING Controls by rotating the locking keys clockwise until the AUTOTUNE stop rings are tight.

(i) Return the CALIBRATE Control to exact "0" setting.

(j) Select the type of reception desired with the CW-MCW switch.

(k) Repeat steps (c) thru (i) for the remaining nine frequencies.

Note

If it is desired to receive voice-modulated signals, operate the CW-MCW-CAL switch to the MCW position.

d. CALIBRATION.

(1) CALIBRATION THEORY.—The Calibrator that is incorporated in this receiving equipment utilizes a crystal controlled oscillator, a variable frequency oscillator and a variable frequency i-f channel. Using the above circuits, the receiver may be accurately tuned to any frequency in the range 1500 to 18,500 kc without having to follow the usual procedure of tuning for a transmitted signal or depending upon tuning dial calibration.

The system depends primarily upon the frequency stability of the cfi unit (crystal controlled frequency indicator) and the frequency stability of the two variable frequency oscillators. The frequency of the cfi oscillator is controlled by a 100 kc quartz crystal. The variable frequency oscillators are precision built and are exceptionally stable. The beat frequency oscillator has been carefully calibrated and should always indicate the proper number of kilocycles of deviation from the 500 kc intermediate frequency. The frequency of the beat frequency oscillator is varied by operating the BFO-CALIBRATE control. This control operates a mechanism which changes the position of the tuning slugs within the low frequency osc. grid inductor and the tuning slugs within the i-f transformers.

During the process of receiver calibration the frequency of the output of the low frequency osc. is set and the frequency of the high frequency oscillator is varied. It is most important that this procedure be followed. The frequency of the high frequency oscillator is varied as the TUNING control is rotated. In order to determine the correct setting of the tuning control for any particular frequency, a condition must be reached where the frequency of the output of the mixer stage is the same frequency as the output of the lf osc.

In the calibration position the output of the cfi is fed into the receiver input circuit and the antenna terminal is grounded by the operation of K-502. All harmonics of the 100 kc oscillator are fed into the receiver but tunable band pass filter circuits in the r-f amplifier and mixer stages attenuate all signals except the harmonic that is used for calibration. Although attenuated, the 100 kc harmonic that is to be used will be of sufficient strength to drive the signal grid of the mixer even when the band pass filter and tank circuits are detuned as much as 50 kc. The hf oscillator tank and multiplier tank circuits are tuned by the same control that tunes r-f amplifier and mixer tank circuits. A 100 kc harmonic of the cfi oscillator is used for calibration 50 kc above and 50 kc below the point. When the r-f amplifier, mixer and exciter circuits are tuned farther than 50 kc away from a 100 kc point, the 100 kc harmonic that is nearest to the frequency to which the r-f, mixer and exciter circuits are tuned becomes the usable signal. The frequency of the exciter output will vary as the TUNING control is rotated but will always be between 450 and

550 kc higher or lower in frequency than the 100 kc harmonic signals. When receiving signals in BAND A, C, or D, the frequency of the input signal is lower than the exciter frequency. When receiving in BAND B, E, or F, the frequency of the input signal is higher than the exciter frequency. With the i-f transformers tuned to the same frequency as the frequency of the output of the beat frequency oscillator, the output of the mixer will be permitted to reach the detector tube when the frequency of the output of the mixer is near the frequency of the output of the low frequency oscillator. Zero beat between these two signals indicates that the output of the mixer is exactly the same frequency as the frequency of the output of the low frequency osc. The receiver is properly calibrated when zero beat between these two signals is obtained.

(2) CALIBRATION PROCEDURE.— As indicated in the paragraphs above, the first step in the calibration procedure is to set the frequency of the beat frequency oscillator. In brief, the procedure from this point consists of setting the position of the TUNING control so that the output of the mixer is of the same frequency as the output of the low frequency osc. *Under no circumstances should the TUNING control be set and the BFO-CALIBRATE used as the variable when calibrating the receiver.*

The calibration procedure and functioning of the circuits during calibration are best explained by using an example. If, for instance, 2125 kc is selected as the frequency to which it is desired to tune the receiver, the procedure outlined below should be followed:

(a) STEP-BY-STEP PROCEDURE.

1. Operate the Power Switch to the ON position.
2. Select the AUTOTUNE channel upon which it is desired to calibrate the receiver.
3. When the AUTOTUNE cycle has been completed unlock the stop rings on the Multiturn and Singleturn Units by rotating the locking keys two revolutions in the counterclockwise direction.
4. Operate the BAND switch to the position that includes the frequency 2125 kc (Band A).
5. Rotate the TUNING control until the dial indicates 2.125 mc.
6. Rotate the BFO-CALIBRATE control until the dial indicates 25.

Note

The BFO-CALIBRATE control should always be set so that the calibration dial indicates the last two digits of the frequency in kilocycles upon which it is desired to calibrate the receiver. If it is desired to calibrate the receiver within a fraction of a kilocycle of a frequency, the BFO-CALIBRATE control should be set so that the calibration dial indicates the last three digits of the frequency including the decimal.

7. With the beat frequency oscillator set as described above and while listening to the output of the receiver, rotate the TUNING control about the 2125 kc point until zero beat between the output of the mixer and the output of the bfo is obtained.

8. Carefully lock the BAND and TUNING controls by rotating the locking keys in a clockwise direction until the AUTOTUNE stop rings are tight.

9. Rotate the BFO-CALIBRATE control back to the "0" setting.

CAUTION

The BFO-CALIBRATE control must be returned to exact zero so that the receiver input circuit will be reconnected to the antenna terminal, the cfi oscillator will be disabled and the i-f channel will be returned to 500 kc. The receiver is now calibrated for 2125 kc on this particular AUTOTUNE channel. The type of reception may be selected by operating the MCW-CAL-CW switch. If it is desired to receive voice modulated signals the switch should be operated to the MCW-CAL position. The AUTOTUNE mechanism will reposition the controls to tune the receiver to 2125 kc whenever this channel is selected.

e. TUNING ADJUSTMENTS.

WARNING

This equipment employs voltages (250 volts) which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment with the cabinet removed. Be certain that the ON-OFF switch is in the OFF position and that the dynamotor has stopped rotating before touching any of the components. When making measurements with the equipment operating and the cabinet removed use dry well-insulated prods.

(1) ADJUSTMENT PROCEDURE—If it is desired to change the frequency of one or more of the AUTOTUNE channels follow the procedure outlined below:

(a) With the Power Switch in the ON position, operate the CHANNEL Selector Switch to the number corresponding to the channel that is to be changed.

(b) When the AUTOTUNE cycle has been completed unlock the AUTOTUNE stop rings by rotating the locking key on the BAND Switch Control and the locking key above the TUNING Control two revolutions in a counterclockwise direction.

(c) Operate the BAND Switch to the band that contains the frequency upon which reception is desired.

(d) Rotate the TUNING Control until the main dial indicates the desired frequency.

(e) Rotate the BFO-CALIBRATE Control so that the calibration dial indicates the last two digits of the frequency desired.

(f) While listening to the output of the receiver, rotate the TUNING Control about the original setting and carefully set the control so that zero beat is obtained.

(g) Carefully lock the AUTOTUNE stop rings by rotating the locking keys in a clockwise direction until tight.

(h) Return the BFO-CALIBRATE Control to the "0" setting.

Repeat the above procedure for as many channels as it is desired to reset.

CAUTION

When locking the AUTOTUNE Controls do not use any instruments. Use only the thumb and forefinger and tighten until the torque necessary to rotate the keys indicates that pressure is being applied to the stack of AUTOTUNE stop rings.

(2) AUDIO ADJUSTMENTS.

(a) **VOLUME.**—There are two methods of controlling the level of the audio output of the receiver. For cw reception a rheostat, located in the cathode circuits of the r-f amplifier and first i-f amplifier tubes, is used to vary the bias on the tubes there by controlling the receiver output. For mcw-cal (MCW-CAL position also used for phone) reception a bridge T pad is used and the rheostat is short circuited. The bridge T pad is connected between the output winding of the audio output transformer and the PHONE jack. The rheostat and bridge T pad are connected to the same shaft and are operated by the VOLUME control located on the front panel. The bridge T pad is not connected in the circuit when cw emission is selected. When adjusting the VOLUME control, the main consideration is understandability and comfort. The automatic volume control circuit will maintain the audio output level within close limits on most signals.

(3) **THRESHOLD SENSITIVITY ADJUSTMENT.**—A rheostat, connected in series with the receiver r-f amplifier tube and first i-f amplifier cathodes, is used to adjust the sensitivity of the receiver. This control, adjusted through a hole in the front panel by a straight lipped screwdriver, is adjusted for best signal to noise ratio for each individual installation. The adjustment should be made with the airplane engine running and the receiver turned ON and completely adjusted but no signal being received. Proceed as follows to complete the adjustment.

(a) Operate the CW-MCW-CAL selector switch to MCW-CAL position.

(b) Rotate the VOLUME control to the full ON position.

(c) Engage the screwdriver slot in the end of the SENS adjustment shaft with a straight lipped screwdriver.

(d) Adjust the SENS control clockwise or counterclockwise until the condition of maximum tolerable noise level from electrical interference is encountered.

(e) If the interference is not great enough to cause discomfort to the operator at any setting of the control, the control should be rotated to the full ON position (extreme clockwise position).

(4) ADJUSTMENT FOR OPERATION.—

When making the TUNING adjustments as described above it must be kept in mind that these adjustments must be carried out for each of the ten channels.

Note

Each AUTOTUNE control must be securely locked before changing channels. The control setting will be lost if the control is allowed to rotate without first locking the stop ring with the locking key.

f. PRE-FLIGHT TEST.

(1) **FREQUENCY.**—If a frequency standard is available, the receiver can be checked for accuracy of calibration against the standard. However, in many instances a frequency standard will not be available, therefore it will be necessary to become familiar with frequencies of various other broadcasting services such as control tower transmitters, fixed services or broadcasting stations. If such checks are not satisfactory, other transmitters in the immediate vicinity may be used to check the receiver calibration. The equipment should be checked on at least two frequencies on each position of the BAND switch, preferably near the upper and lower frequency limits.

BAND vs FREQUENCY	
BAND	FREQUENCY
A	1.5 to 2.5 mc
B	2.5 to 3.5 mc
C	3.5 to 5.5 mc
D	5.5 to 8.5 mc
E	8.5 to 12.5 mc
F	12.5 to 18.5 mc

(2) **RECEIVER SENSITIVITY.**—If a signal generator and output meter are available, the sensitivity of the receiver should be checked on all

positions of the BAND switch. Refer to Page 2-1 Paragraph 1. for the test procedure and the instruments required. The sensitivity measurement conditions are the input value of a 1000 cps 30% modulated signal which results in a six db signal to noise ratio or a 100 mw output, whichever occurs first. Under these conditions sensitivity varies between one uv and two and one-half uv. Average sensitivity is approximately two and one-half uv. If no sensitivity measuring equipment is available, the receiver may be compared with other identical installations, or signals of known reliability can be tuned in and compared. The sensitivity should be checked in at least two positions of the TUNING dial on each range of the BAND switch, preferably near each end of the TUNING range. In event no signals are available for reception, the equipment can be checked by rotating the CW-MCW-CAL control to the MCW-CAL position and listening to the 100 kc signal from the cfi unit. A good signal should be encountered over the complete tuning range of the receiver at every 100 kc. The results of pre-flight test may be checked against typical readings included below.

SENSITIVITY: Typical Meter Readings			
BAND	FREQUENCY MC	INPUT UV	OUTPUT MW
A	2.0	2.4	100
B	3.0	2.0	100
C	4.5	2.5	100
D	7.0	2.5	100
E	10.0	2.3	100
F	15.5	2.5	100

g. FLIGHT TEST.—Due to conditions arising when the airplane is in flight, it is suggested that the equipment be checked as soon as the airplane clears the flight deck. Contact with the radio room of the carrier on phone emission on one channel should disclose any defects due to vibration or noise originating from the airplane.

SECTION III OPERATION

This section contains only the steps that are necessary to control the equipment for routine operation and the actual operations necessary in order to make minor adjustments. All adjustments are outlined in brief form and it is suggested that the operator refer to the ADJUSTMENT section (Section II paragraph 2) of this handbook for a more detailed explanation of the procedure for the adjustment of the receiver circuits and the AUTOTUNE system.

I. STARTING THE EQUIPMENT.

a. PROCEDURE.

(1) Rotate the ON-OFF switch on the receiver front panel or the ON-OFF switch on any remote control unit in a clockwise direction until it catches.

2. STOPPING THE EQUIPMENT.

a. PROCEDURE.

(1) Push the ON-OFF control all the way in toward the panel.

Note

The operator of this radio equipment should become familiar with a means of disconnecting the equipment from the power source, such as a main supply switch or circuit breaker, in case an emergency shut down is necessary.

3. GENERAL.

a. FUNCTION OF THE EQUIPMENT.—This receiver is designed to receive voice cw and mcw

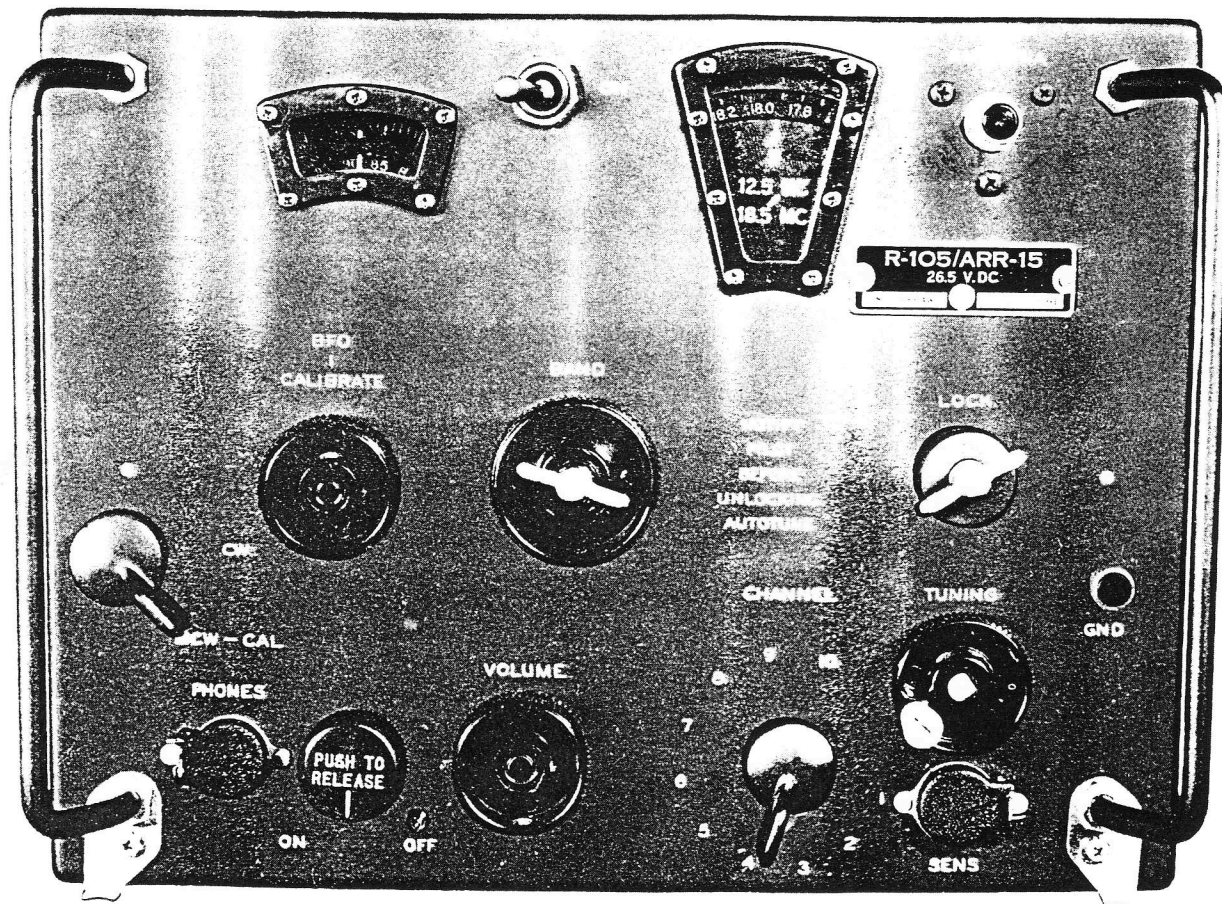


Figure 3-1. Panel Control Functions

signal within the frequency range of 1500 to 18,500 kc. Ten pretuned channels can be selected simply by operating a CHANNEL selector switch. Manual operation is possible by unlocking the tuning controls and allowing the stop rings of the AUTOTUNE heads to slip. One pre-tuned channel setting will be destroyed by this method and will have to be re-set before automatic tuning can be again used on this channel.

Note

The AUTOTUNE controls must be locked before automatic channel selection is attempted. Failure to lock the control will result in the dial settings being lost.

b. NOTES ON OPERATION.

(1) Placing the CW-MCW-CAL selector in the CW position allows cw reception.

(2) Placing the CW-MCW-CAL selector in the MCW-CAL position allows mcw-cal and phone reception.

(3) After the controls have been locked it is good practice to check the locking keys frequently to make certain that they are tight.

(4) If the receiver has been turned off, allow at least one minute for the tubes to rise to operating temperature.

(5) Correct errors in tuning or adjustment of the equipment as soon as possible after discovery.

4. ROUTINE OPERATION.

If the receiver circuits have been tuned and the controls locked for all 10 frequency channels, the procedure outlined below should be followed during routine operation.

a. PANEL CONTROL.—(See figure 3-1)

(1) Insert the headphones cord plug into the PHONES jack.

(2) Rotate the ON-OFF switch to the ON position.

(3) Select the AUTOTUNE channel corresponding to the frequency upon which reception is desired.

(4) Rotate the CW-MCW-CAL selector switch to the position corresponding to the type of reception desired.

(5) Regulate the audio level with the VOLUME control.

(6) Press the ON-OFF control to turn the receiver off.

5. TUNING ADJUSTMENTS.

If it is desired to change the frequency of one or more of the AUTOTUNE channels follow the procedure outlined below: (See figure 3-2)

CAUTION

Do not unlock any AUTOTUNE unit until the pilot has been notified not to take control. (When receiver is connected for remote operation.)

a. With the Power Switch in the ON position, operate the CHANNEL Selector Switch to the number corresponding to the channel that is to be changed.

b. When the AUTOTUNE cycle has been completed unlock the AUTOTUNE stop rings by rotating the locking key on the BAND Switch Control and the locking key above the TUNING Control two revolutions in a counterclockwise direction.

c. Operate the BAND Switch to the band that contains the frequency upon which reception is desired and set the CW, MCW-CAL switch on the CAL position.

d. Rotate the TUNING Control until the main dial indicates the desired frequency.

e. Rotate the BFO-CALIBRATE Control so that the calibration dial indicates the last two digits of the frequency desired.

f. While listening to the output of the receiver, rotate the TUNING Control about the original setting and carefully set the control so that exact zero beat is obtained.

g. Carefully lock the AUTOTUNE stop rings by rotating the locking keys in a clockwise direction until tight.

h. Return the CALIBRATE Control to the "0" setting.

Note

If cw reception is selected rotate CALIBRATE Control a few dial divisions until peak audio output is obtained.

Repeat the above procedure for as many channels as it is desired to reset.

Note

All channels must be set up to receive the same type of emission when the receiver is to be operated from a remote point.

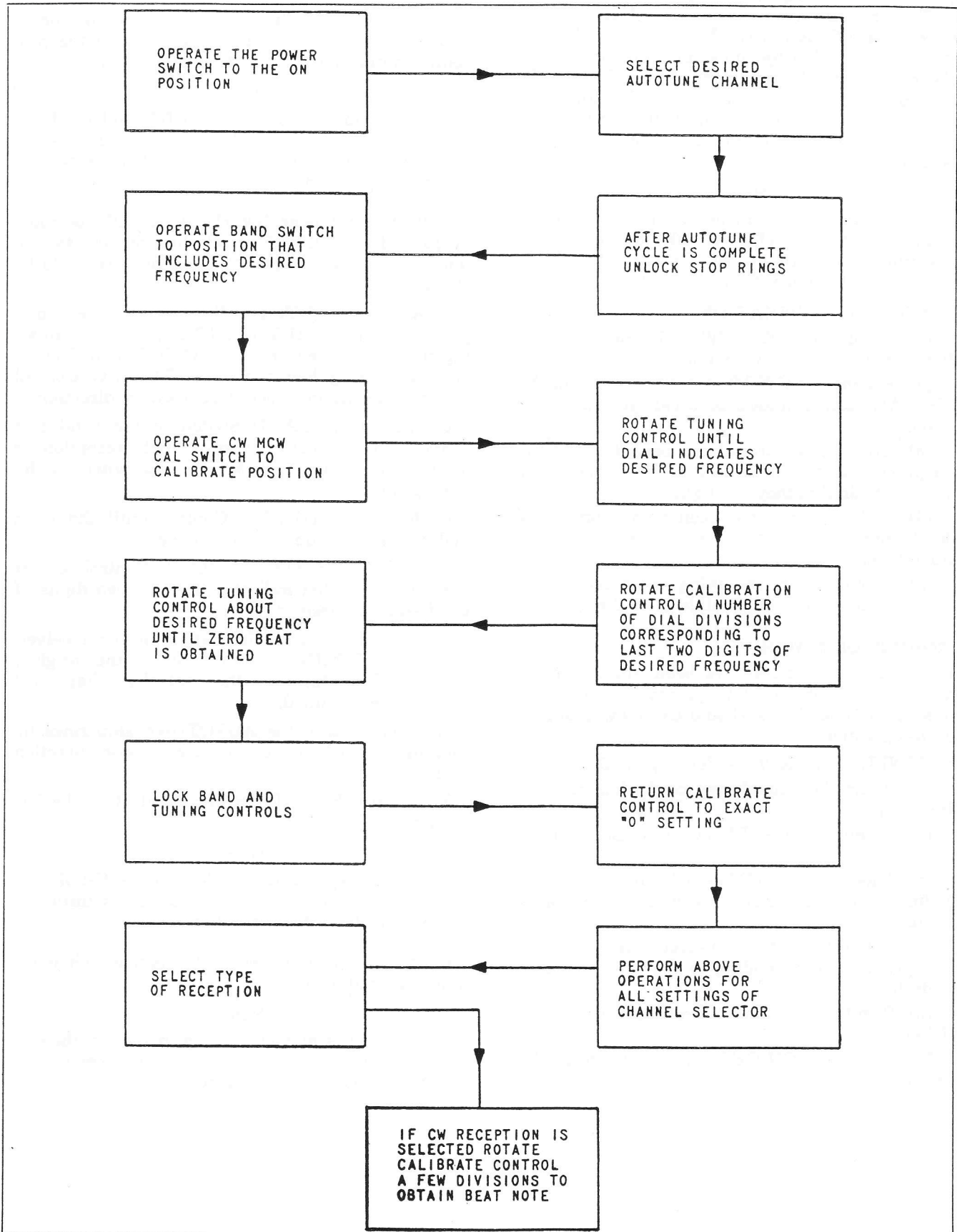


Figure 3-2. Operating Sequence Block Diagram

SECTION IV

THEORY OF OPERATION

I. MECHANICAL CHARACTERISTICS.

a. GENERAL. — Radio Receiver R-105/ARR-15 is constructed in such a fashion that servicing can be accomplished with a minimum of effort. Plug-in units are employed where the use of such units would be of advantage. The cfi unit, the relay unit, the dynamotor unit and the filter unit are all plug-in units. The dynamotor unit is removed by removing the locking wires and disengaging the slide fasteners after which the dynamotor can be pulled straight up and out of the connector. Connections to the cfi, lfo and hfo units are by plug connectors which can be removed without the use of tools. The actual removal of the units require the use of tools, however. Since the procedure is important, refer to the MAINTENANCE section of this book for details on removing these units.

b. AUTOTUNE MECHANISM.

(1) GENERAL. — The Autotune system consists of a group of positioning mechanisms. The positioning mechanisms are connected to tuning elements within the equipment. Each mechanism is provided with a tuning knob so that the elements may be adjusted manually. Each positioning mechanism provides precise angular setting of the tuning element with which it is associated. The position of the tuning element with respect to the mechanism is readily adjustable and the setting for each control is entirely independent of the other controls. Locking bars, located on each tuning dial, lock the tuning element to the mechanism for each predetermined setting of the control.

The accuracy of positioning of the Autotune system is of a very high order. Each setting is inherently independent of wear, backlash, alignment, line voltage, etc. The accuracy of resetting of the tuning elements is comparable to that obtainable with vernier manual controls. All parts are machined within close limits and although operation is most precise there are no delicate adjustments or fragile mechanisms.

The Autotune system that is employed in this equipment consists of a motor, a singleturn unit, a multiturn unit, a control unit, a line shaft, drive gears and the necessary electrical control circuit components. The singleturn and multiturn units are provided with tuning knobs to permit the manual adjustment of the receiver circuit elements with which the units are associated. If given a reasonable amount of care and attention the mechanism will give long periods of trouble free service. Refer to the MAINTENANCE section of this Handbook.

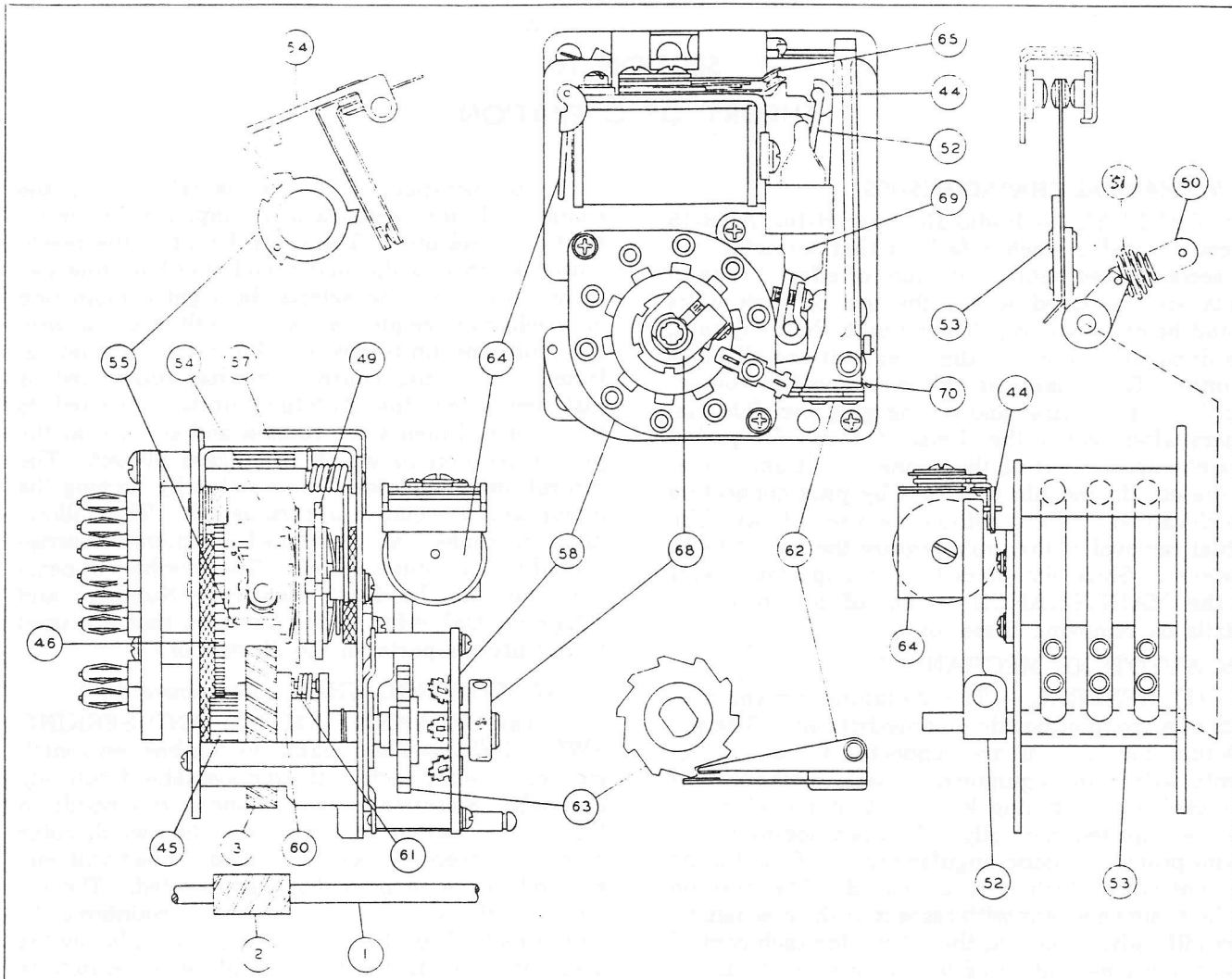
In operation, a channel is selected by the channel selector switch which completes the circuit to the control unit. The control unit is the mechanism which sets the motor and the Autotune elements in motion and selects the right combination of mechanical sequences which will end up with the Autotune units positioned for the channel selected. After the control unit has functioned as just mentioned, the Autotune units connected to the tuning elements are rotated and stopped at the precise position to which they were pre-set. The control unit completes the operation by turning the motor and associated apparatus off. The following paragraphs give a detailed functional description of the Autotune system. The numbers appearing under the heading "Identifying Number" and "Operates On" refer to the numbers that are used to identify the parts on the illustrations.

(2) CONTROL UNIT. (See figure 4-1.)

(a) BREAKER CAM (63) AND SEEKING SWITCH (58).—The seeking switch has ten switch contacts, one for each of the ten available frequency channels. Selection of any channel will result in the seeking switch rotating until the switch rotor reaches an open contact. The open contact will correspond to the channel that was selected. The rotation of the seeking switch is in a counterclockwise direction due to the ratchet drive. The switch does not rotate during the last half of the Autotune cycle. The breaker cam is used for fine adjustment of the seeking switch.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
Timing Switch Cam			
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(60)
4	(60)	Seeking Switch Ratchet Dog	(61)
5	(61)	Seeking Switch Ratchet Tooth	(63)
6	(63)	Timing Switch Cam	(62)
Seeking Switch			
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(60)
4	(60)	Seeking Switch Ratchet Dog	(61)
5	(61)	Seeking Switch Ratchet Tooth	(58)
6	(58)	Seeking Switch	

(b) AUTOTUNE MOTOR CONTROL SWITCH (53) AND STARTING RELAY CONTACTS (65).—When the seeking switch has come to rest in the position that corresponds to the channel that has been selected the Autotune motor control switch is closed. The closing of the switch re-



KEY TO SYMBOLS FOR CONTROL UNIT, MULTITURN UNIT AND SINGLETURN UNIT

- | | | |
|---------------------------------|--|--|
| 1. Line Shaft | 24. Counter Drum Home Stop Gear | 45. Locking Arm Drive Gear |
| 2. Drive Worm | 25. Home Stop Pawl Operating Gear | 46. Locking Arm Spring Gear |
| 3. Worm Gear | 26. Pawl Lifting Toggle Lever | 47. Locking Arm Engage Collar |
| 4. Slip Clutch Drive Gear | 27. Pawl Lifting Toggle | 48. Locking Arm Operating Clutch Drum |
| 5. Slip Clutch Idler Gear | 28. Home Stop Ring | 49. Locking Arm Operating Clutch Cam |
| 6. Slip Clutch Spur Gear | 29. Home Stop Pawl | 50. Locking Arm Operating Clutch Arm |
| 7. Slip Clutch Band Dog | (29A-Pawl Heel) | 51. Locking Arm Operating Clutch Arm Spring |
| 8. Slip Clutch Band | (29B-Pawl Tail) | 52. Locking Arm |
| 9. Slip Clutch Drum | (29C-Pawl Toe) | 53. Autotune Motor Control Switch (S-109) |
| 10. Counter Drum Drive Gear | 30. Stop Ring | 54. Faulty Operation Switch (S-108) |
| 11. Counter Drum Idler Gear | 31. Stop Ring Pawl | 55. Faulty Operation Switch Cam |
| 12. Counter Drum Spur Gear | (31A-Pawl Heel) | 56. Faulty Operation Switch Interlock Arm |
| 13. Planetary Drive Gear | (31B-Pawl Tail) | 57. Faulty Operation Switch Interlock Clutch |
| 14. Planetary Stationary Gear | (31C-Pawl Toe) | Cam |
| 15. Counter Drum Planetary Gear | 32. Pawl Spring | 58. Seeking Switch (S-106) |
| 16. Cam Drum Idler Gear | 33. Stop Ring Drum Lock | 59. Seeking Switch Adjustment |
| 17. Cam Drive Gear Assembly | 34. Tuning Knob Shaft | 60. Seeking Switch Ratchet Dog |
| 18. Cam Drum Spur Gear | 35. Tuning Drive Gear | 61. Seeking Switch Ratchet Tooth |
| 19. Cam Drum Ratchet Dog | 36. Tuning Drive Limit Spline | 62. Breaker Contacts (S-107) |
| 20. Cam Drum Ratchet Tooth | 37. Tuning Idler Gear | 63. Breaker Cam |
| 21. Cam Drum | 38. Tuning Spur Gear | 64. Autotune Starting Relay |
| 22. Counter Drum Slot Ring | 39. Tuning Spur Gear Clutch | 65. Autotune Starting Relay Contacts |
| 23. Counter Drum Slot Ring Pawl | 40. Tuned Element | 66. Locking Arm Operating Clutch Spring |
| (23A-Pawl Heel) | 41. Stop Bar | 67. Single Tooth Ratchet Assembly |
| (23B-Pawl Tail) | 42. Stop Ring Drum Drive | 68. Seeking Switch Locking Collar |
| (23C-Pawl Toe) | 43. Cam Drum Drive Gear | 69. Neon Bulb (surge absorber) |
| | 44. Autotune Motor Control Switch Lock | 70. Indicator Arm |

Figure 4-1. Autotune Control Unit Functional Diagram

verses the Autotune motor to complete the last half of the cycle. When the last half of the Autotune cycle is completed, the Autotune control switch is returned to the original position and the motor is stopped. With the switch in this position the Autotune motor is connected for forward rotation. The motor will operate when the next channel is selected and the energizing circuit of the motor is completed by the closing of the Autotune starting relay switch contacts.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(45)
4	(45)	Locking Arm Drive Gear	(46)
5	(46)	Locking Arm Spur Gear	(49)
6	(49)	Locking Arm Operating Clutch	(50)
7	(50)	Locking Arm Operating Clutch Arm	(52-53)
8	(53)	Autotune Motor Control Switch	
9	(52)	Locking Arm	(44)
10	(44)	Motor Control Switch Lock	(65)
11	(65)	Autotune Starting Relay Contacts	

(c) FAULTY OPERATION SWITCH (54).

—If the selector switch fails to find an open circuit within two revolutions, the faulty operation switch will close and energize the releasing coil of the ON-OFF switch. The energizing of the releasing coil will cause the switch to rotate to the OFF position to disable the equipment.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(45)
4	(45)	Locking Arm Drive Gear	(46)
5	(46)	Locking Arm Spur Gear	(55)
6	(55)	Faulty Operation Switch Cam	(54)
7	(54)	Faulty Operation Switch	

(3) AUTOTUNE SINGLETURN UNIT. (See figures 4-2, 6-26, 6-27 and 6-28.)—The singleturn unit derives its name from the fact that it will mechanically position a tuning element that does not require more than 360 degrees of rotation. The unit includes a friction band type clutch for transmitting the driving torque to the positioning elements, a stop ring drum assembly, a pawl stack, a cam drum and the associated driving gears.

(a) CAM DRUM DRIVE (21).—The cam drum has ten slots, one for each of the ten channels, spaced 36° apart. Selecting any channel will result in the pawl corresponding to the channel dialed coming to rest in the proper slot. The rotation of the cam drum is in a counterclockwise direction only, due to the ratchet drive. The cam drum does not rotate during the last half of the Autotune cycle.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(43,9,40)
4	(43)	Cam Drum Drive Gear	(16)
5	(16)	Cam Drum Idler Gear	(18)
6	(18)	Cam Drum Spur Gear	(19)
7	(19)	Cam Drum Ratchet Dog	(20)
8	(20)	Cam Drum Ratchet Tooth	(21)
9	(21)	Cam Drum	(31A)
	(31A)	Stop Ring Pawl Heel	

(b) STOP RING DRIVE (30).—There are ten stop rings on the stop ring stack, one for each of the ten channels. Keyed washers between stop rings permit each stop ring to rotate independently of all others when the stack is unlocked. Setting the tuned element and locking the stop ring stack at that setting will result in the tuned element returning to this same position when that channel is again selected. The stack of stop rings rotates both counterclockwise and clockwise until stopped by a stop ring pawl.

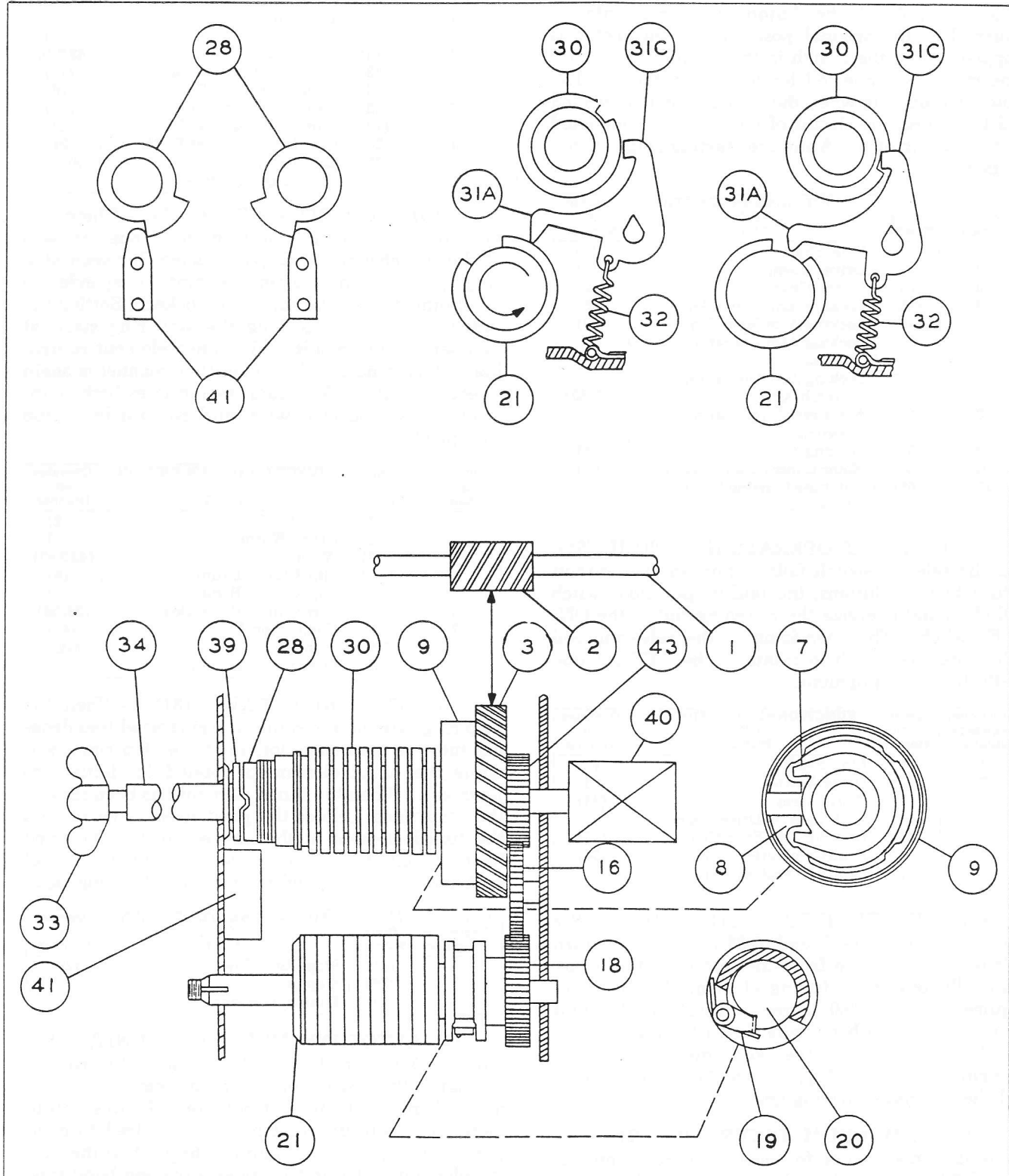
Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(43,9,40)
4	(9)	Slip Clutch Drum	(8)
5	(8)	Slip Clutch Band	(7)
6	(7)	Slip Clutch Band Dog	(28, 30)
7	(28)	Home Stop Ring	(41)
	(30)	Stop Ring	(31C)
	(31C)	Stop Ring Pawl Toe	

(c) STOP RING PAWL (31).—When the stop rings are unlocked the stop ring pawl toes dropping into the stop ring slots hold the stop ring fixed while the tuned element is rotated for initial adjustment. When the tuned element has been set and the stop rings locked, the pawl toes, serve to stop the tuned element at the pre-set point. The pawl heels fall into the cam drum slots allowing the pawl spring to force the pawl toe into the stop ring slots.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
	(31)	Stop Ring Pawl	(30)
	(30)	Stop Ring	
	(40)	Tuning Element	

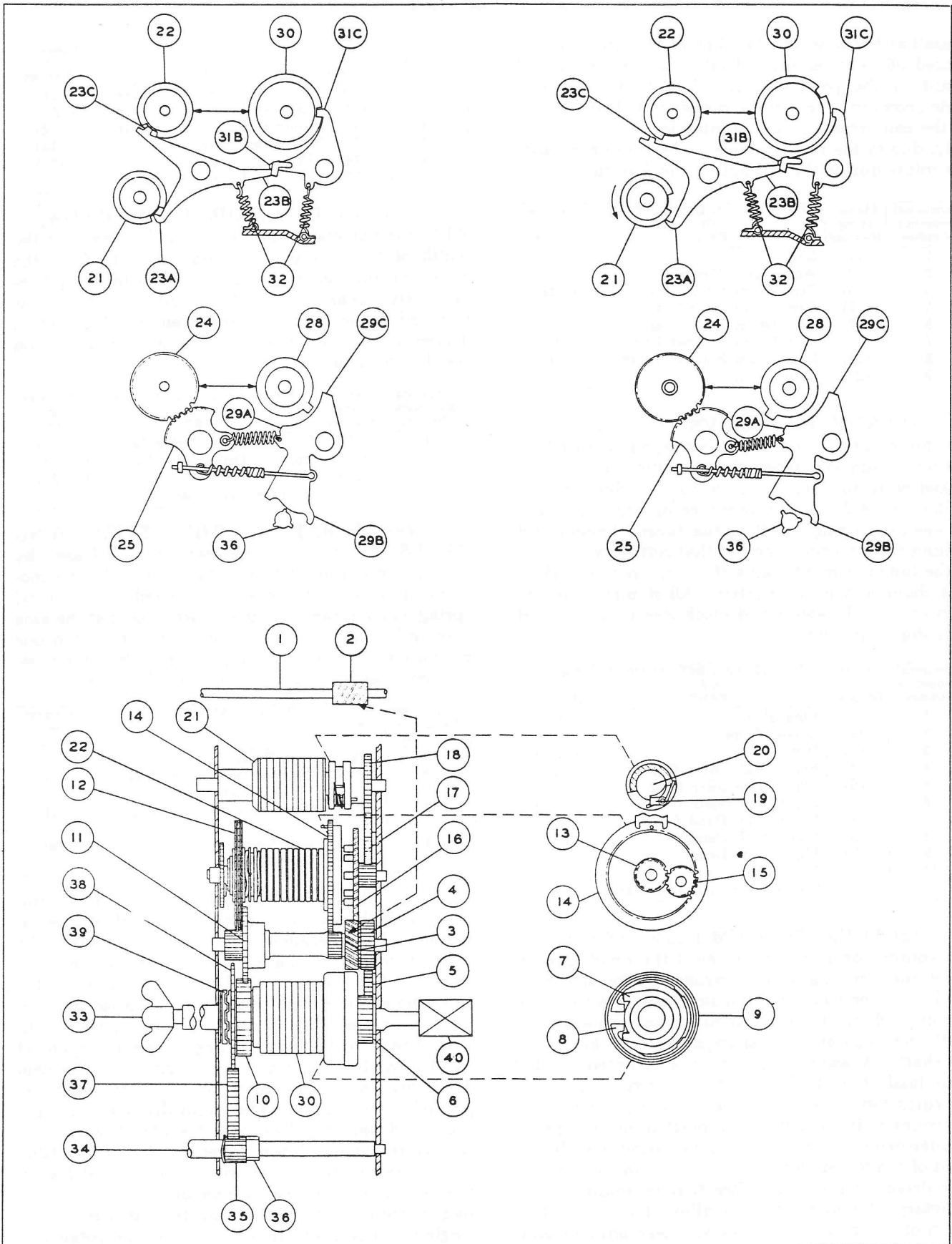
(4) AUTOTUNE MULTITURN UNIT. (See figures 4-3, 6-29, 6-30 and 6-31.)—The multiturn unit mechanically positioning a tuning element requires more than 360 degrees of rotation. In this equipment, the multiturn unit may be required to complete as many as ten revolutions to position the tuning element. The unit includes a friction band type clutch for transmitting the driving torque to the positioning elements, a stop ring drum assembly, a pawl stack, a pawl toggle, a counter drum assembly, a cam drum and the associated driving gears.

(a) CAM DRUM DRIVE (21).—The cam



Note—Key to symbols may be found in Figure 4-1.

Figure 4-2. Singleturn Unit Functional Diagram



Note—Key to symbols may be found in Figure 4-1.

Figure 4-3. Multiturn Unit Functional Diagram

Section IV
Paragraph 1.b.

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drum has ten slots, one for each of the ten channels, spaced 36 degrees apart. Dialing any channel will result in the pawl corresponding to the channel dialed coming to rest in the proper slot. The rotation of the cam drum is in a counterclockwise direction only, due to the ratchet drive. The cam drum does not rotate during the last half of the Autotune cycle.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Worm Gear Drive Worm	(3)
4	(3)	Cam Drum Idler Gear	(4, 16)
5	(17)	Cam Drum Idler Gear #2	(18)
6	(18)	Cam Drum Spur Gear	(19)
7	(19)	Cam Drum Ratchet Dog	(20)
8	(20)	Cam Drum Ratchet Tooth	(21)
9	(21)	Cam Drum	

(b) STOP RING DRIVE (30).— There are ten stop rings in the stop ring stack, one for each of the ten channels. When the Autotune unit is unlocked each stop ring is free to rotate independently of the others due to the presence of keyed washers between each ring. Setting the tuned element and locking the stop ring stack at that setting will result in the tuned element taking this same position when that channel is again selected. All stop rings rotate both counterclockwise and clockwise until stopped by a stop ring pawl.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(1)	Line Shaft	(2)
2	(2)	Drive Worm	(3)
3	(3)	Worm Gear	(4, 16)
4	(4)	Slip Clutch Drive Gear	(5)
5	(5)	Slip Clutch Idler Gear	(6)
6	(6)	Slip Clutch Spur Gear	(7, 40)
7	(7)	Slip Clutch Band Dog	(8)
8	(8)	Slip Clutch Band	(9)
9	(9)	Slip Clutch Drum	(30)
10	(30)	Stop Rings	(10)
	(10)	Counter Drum Drive Gear	

(c) COUNTER DRUM DRIVE (FAST).— The counter drum serves to select the revolution in which the stop ring is to be engaged by the stop ring pawl toe. Ten counter drum slot rings, one for each Autotune channel, are mounted on the counter drum shaft and separated by spacers that are keyed to the shaft. A wavy washer that is mounted on the shaft loads the stack of slot rings axially so that the rings can not easily be turned independently of the counter drum shaft. The position of any given counter drum slot ring is adjusted during the adjustment of the tuned element. At the instant the planetary drive gear changes direction of rotation, the planetary stationary gear is allowed to move the width of the planetary stationary gear pin slot and the counter drum planetary gear ceases to turn. The result is that at the limits of the counter drum rotation, the counter drum rotates more rapidly.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(10)	Counter Drum Drive Gear	(11)
2	(11)	Counter Drum Idler Gear	(12, 13)
3	(12)	Counter Drum Spur Gear	(22)
3	(13)	Planetary Drive Gear	(14)
4	(14)	Planetary Stationary Gear	(22)
5	(22)	Counter Drum Slot Rings	

(d) COUNTER DRUM DRIVE (SLOW).— When the planetary stationary gear has traveled the width of the gear pin slot and ceases to turn, the counterdrum planetary gear is driven by the planetary drive gear. Since the shaft for the gear is fastened to the counter drum assembly, the drum is driven at a slower speed as the gear travels around the driving gear.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(10)	Counter Drum Drive Gear	(11)
2	(11)	Counter Drum Idler Gear	(13)
3	(13)	Planetary Drive Gear	(22)
4	(22)	Counter Drum Slot Rings	

(e) OPERATING THE STOP RING PAWLS.— The stop ring pawl tail is released by the counter drum slot ring pawl tail. At the moment of release, the pawl is actuated by the pawl spring causing the pawl toe to press against the stop ring and to drop into the stop ring slot, within one revolution of the stop ring drum. The above sequence of events positions the tuned element.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(21)	Cam Drum	(23A)
2	(23A)	Counter Drum Slot Ring Pawl Heel	(23B)
3	(23B)	Counter Drum Slot Ring Pawl Tail	(31)
4	(31)	Stop Ring Pawl	(30)
5	(30)	Stop Rings	

(f) TIMING.—At the beginning of the Autotune cycle the cam drum rotates in a clockwise direction. The operation of the cam drum kicks the counter drum slot ring pawl heel from the stop ring slot and lifts the counter drum slot ring pawl toe from the counter drum slot ring. Because the cam drive gear assembly is rotating in a counterclockwise direction, the pawl lifting toggle is expanded by the pawl lifting lever which rides on the cam drive gear pins. The pawl lifting toggle, when expanded, prevents the pawls from dropping into the counter drum ring slots until the direction of rotation is reversed. Upon reversal, the pawl lifting lever is moved in the opposite direction and lowers the toggle, allowing the counter drum slot ring pawl toes to drop. Because the cam drum is driven by a single tooth ratchet, the drum cannot be rotated in a counterclockwise direction. When the counter drum slot ring pawl toe drops into place, the counter drum slot ring pawl rides on the counter drum

ring and drops into the slot. The operation of the counter drum slot ring pawl toe, operates counter drum slot ring pawl tail. The counter drum slot ring tail operates the stop ring pawl tail and permits the stop ring pawl toe to engage the stop ring slot.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(22)	Counter Drum Slot Rings	(23C)
2	(23C)	Counter Drum Slot Ring Pawl Toe	(23B)
3	(23B)	Counter Drum Slot Ring Pawl Tail	(31)
4	(31)	Stop Ring Pawl	(30)
5	(30)	Stop Rings	(40)
6	(40)	Tuning Element	

(g) OPERATION OF THE PAWL LIFTING TOGGLE.—The pawl lifting toggle is located directly below the tails of the counter drum pawls. The toggle base is rigidly attached to the control unit frame. The upper part of the toggle, which lifts the pawl tails, pivots on an arm fastened to the counter drum pawl shaft. The center hinged sections of the pawl lifting toggle is operated by pins on the cam drive gear assembly through the pawl lifting lever. When the counter drum is rotated in a clockwise direction, the pawl lifting lever moves in the direction which collapses the toggle allowing the counter drum pawls to fall into the counter drum ring slots. When the counter drum is rotated in a counterclockwise direction the pawl lifting lever moves in the opposite direction which straightens the toggle under the counter drum pawls preventing the pawls from dropping into the counter drum ring slots.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(17)	Cam Drive Gear Assembly	(26)
2	(26)	Pawl Lifting Lever	(27)
3	(27)	Pawl Lifting Toggle	(22)
4	(22)	Counter Drum Rings	

(h) STOP RING DRUM LIMIT DRIVE.—The counter drum home stop gear is driven by a limiting ratchet within the counter drum. When the counter drum has rotated in a clockwise direction to the predetermined limit, the ratchet drives the counter drum home stop gear in a clockwise direction. The counter drum home stop gear operates the home stop pawl operating gear which in turn operates the home stop pawl. This pawl limits the counterclockwise rotation of the home stop ring. Conversely, rotation of the counter drum home stop gear in the counterclockwise direction limits the rotation of the home stop ring in a clockwise direction.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1		Counter Drum	(24)
2	(24)	Counter Drum Home Stop Drive Gear	(25)
3	(25)	Home Stop Pawl Operating Gear	(29)
4	(29)	Home Stop Pawl	(28)
5	(28)	Stop Ring Drum Home Stop Ring	

(i) TUNING DRIVE. — Half of the tuning spur gear clutch is rigidly attached to the tuning spur gear. When this clutch is not engaged, the tuning gear is independent of the Autotune system and does not rotate with it. When the lock is loosened, the clutch is engaged and the tuning spur gear is coupled to the stop ring drum shaft. The tuning drive gear spline limits the rotation of the tuning drive gear by engaging the stop ring drum home stop pawl tail.

Functional Sequence Number	Identifying Number	FUNCTIONAL DESCRIPTION OF PART	Operates on Number
1	(34)	Tuning Knob	(35)
2	(35)	Tuning Drive Gear	(37, 36)
3	(37)	Tuning Idler Gear	(38)
4	(38)	Tuning Spur Gear	(39)
5	(39)	Tuning Spur Gear Clutch	(40)
6	(40)	Tuning Element	
	(36)	Tuning Drive Gear Spline	

2. ELECTRICAL CHARACTERISTICS.

a. AUTOTUNE ELECTRICAL DETAILS.

(See figure 4-4.)

B-101, MOTOR.—The Autotune motor operates from the 26.5 volt d-c power source and is controlled by the motor starting relay, K-103, and the motor control switch, S-109. The components employed in the Autotune control circuit and the functions of each are given below:

K-103, MOTOR STARTING RELAY. — The motor starting relay is energized by the circuit through the contacts of the primary power control relay, the contacts of the circuit seeking and timing switches, the contacts of the channel selector switch and the contacts of the ON-OFF switch to ground.

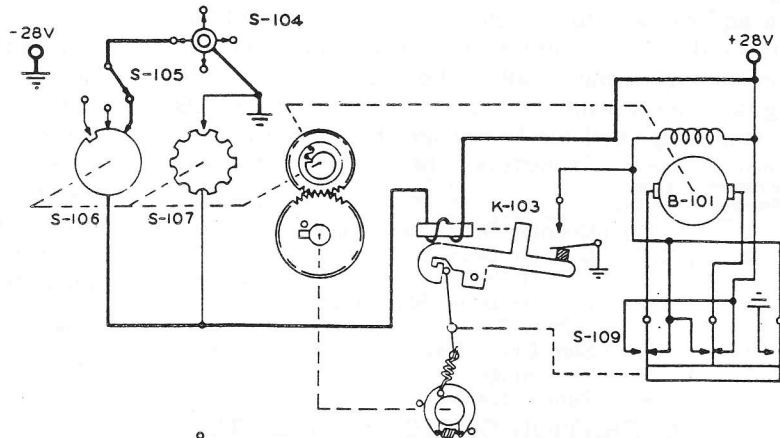
S-109, MOTOR CONTROL SWITCH. — The motor control switch is operated mechanically by the rotation of the motor. Indirectly, the motor control switch is controlled electrically by the motor starting relay. A locking arrangement on the motor starting relay allows the control switch to be operated mechanically only, at specific times.

S-105, CHANNEL SELECTOR SWITCH.—If the ON-OFF switch is in the ON position, the operation of the channel selector switch to a new position will operate the motor starting relay by completing the circuit thru the coil of the relay to ground. The operation of the motor starting relay energizes the motor and begins the Autotune cycle. Any one of ten different frequency channels may be selected by the operation of this switch.

S-106, CIRCUIT SEEKING SWITCH.—The circuit seeking switch is a part of the Autotune control unit and is driven by the motor. For an instant during each of the ten switch positions, the circuit seeking switch is disconnected from ground by the breaker contacts of the timing switch, S-107. The breaker contacts cam is attached to the same shaft as the circuit seeking switch rotating element. The operation of the motor start relay, mechanically

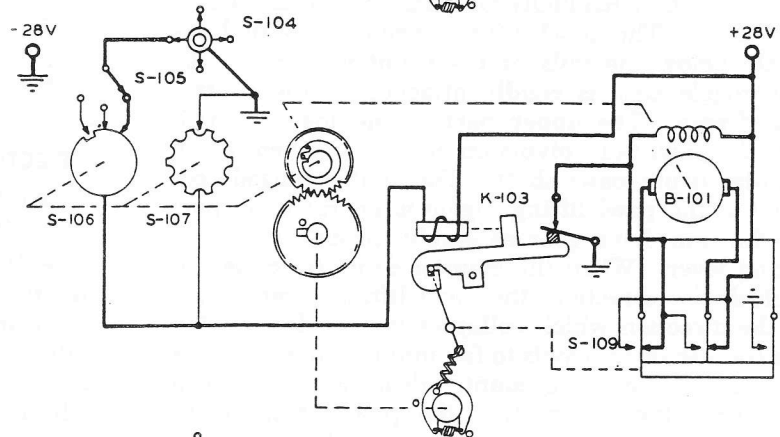
STEP #1

- a. A frequency channel has been selected by manually operating the CHANNEL selector switch, S-105.



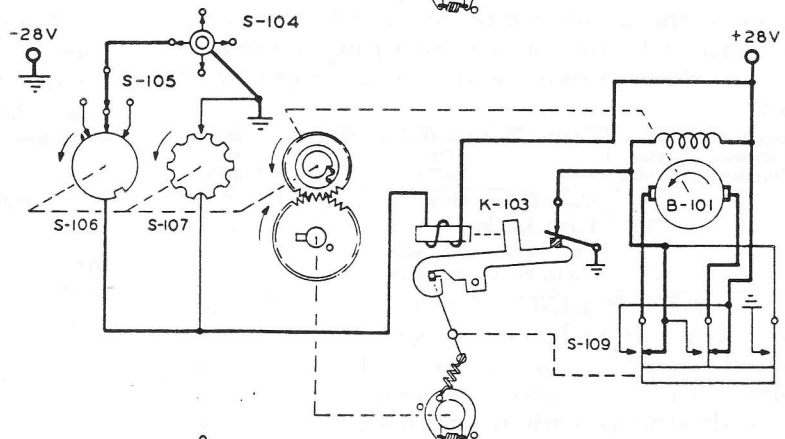
STEP #2

- a. Relay K103 has operated as the result of the completing of the energizing circuit through switch S-105.
- b. The contacts of relay K103 have closed to complete the Autotune motor energizing circuit.
- c. The armature of the motor has not begun to rotate.
- d. The relay locking arm has dropped into the locking position.



STEP #3

- a. The armature of the motor has rotated counterclockwise.
- b. Seeking switch S106 and breaker cam (S107) have rotated one-half of a revolution in a counterclockwise direction.
- c. Relay K103 is still operated.



STEP #4

- a. The motor armature is still rotating in a counterclockwise direction.
- b. The seeking switch, S106, and the breaker cam (S107) have continued to rotate counterclockwise and have reached the position that breaks the energizing circuit of relay K103.
- c. Relay K103 is held closed by the relay locking arm.
- d. The pin on the drive gear approaches the pin on the clutch which drives the actuating arm of both S109 and the K103 locking arm.

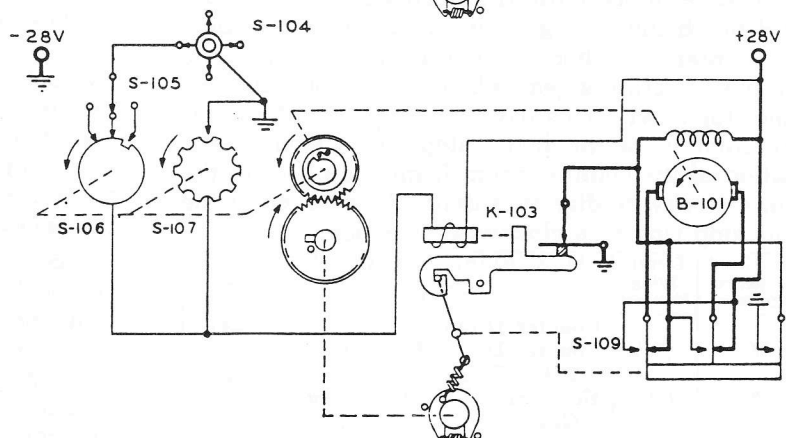
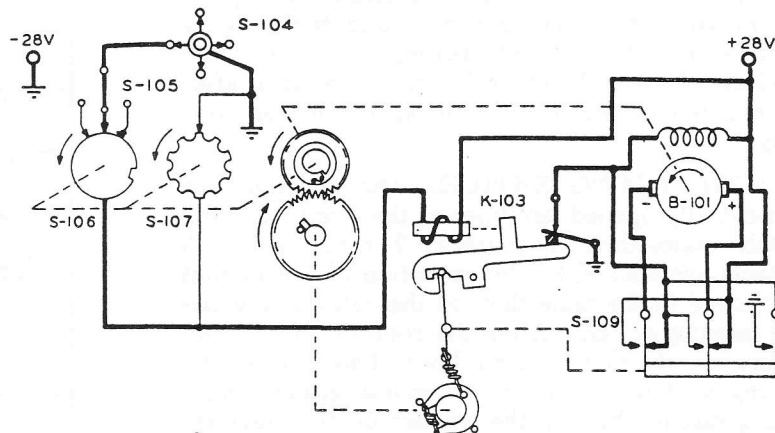


Figure 4-4. Autotune Sequence of Operation (Sheet 1 of 2 Sheets)

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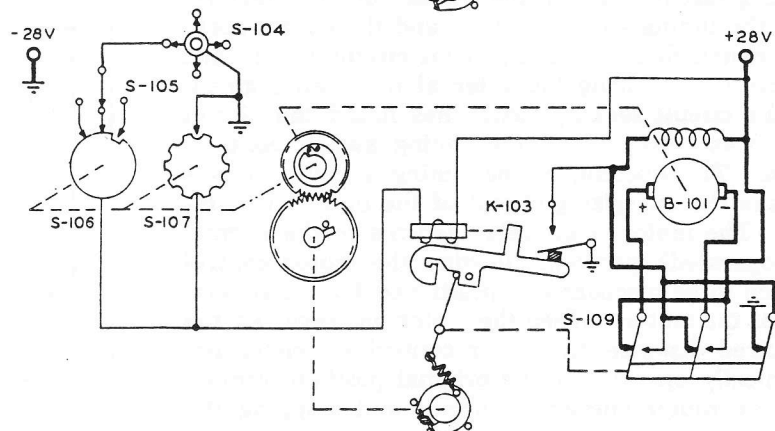
STEP #5

- The motor armature is still rotating in a counterclockwise direction.
- Seeking switch, S106, and the breaker cam (S107) have continued to rotate counterclockwise and have reached the position that closes the energizing circuit of relay K103.
- The clutch has continued to operate and has compressed the spring which drives the actuating arm of S109 and the K103 locking arm. The locking arm has unlocked K103.



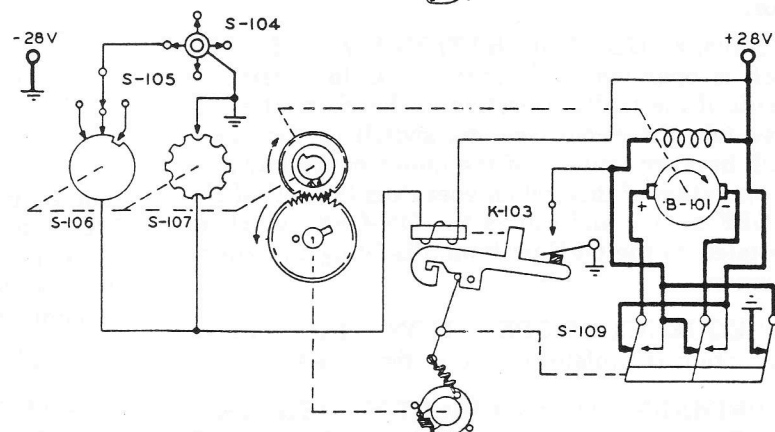
STEP #6

- Seeking switch, S106, and the breaker cam, S107, have reached the position that breaks the energizing circuit of K103.
- Relay K103 opens and causes the motor armature to cease counterclockwise rotation.
- The compressed spring on the locking arm operating clutch operates the motor reversing switch S109, to the reverse position.
- The motor armature begins to rotate in a clockwise direction.



STEP #7

- The motor armature is still operating in a clockwise direction.
- Reversing switch S109 is still held in place by locking arm operating clutch arm spring.



STEP #8

- The pin on the drive gear engages the pin on the clutch, which drives the actuating arm of both S109 and the K103 locking arm, and restores S109 to the original position.
- The motor is de-energized and completes clockwise rotation.
- The Autotune cycle is completed and the system is ready for the selecting of a new frequency channel.

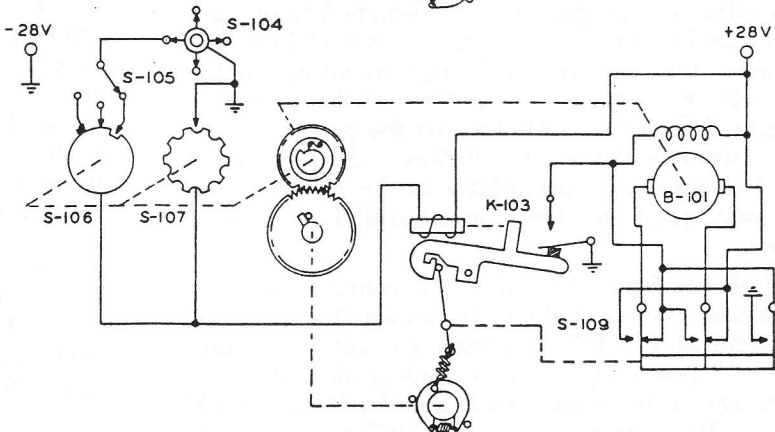


Figure 4-4. Autotune Sequence of Operation (Sheet 2 of 2 Sheets)

locks a motor ground completing circuit into place and prevents the seeking switch and the breaker contacts from finding and opening the circuit that is selected by the channel selector switch until after the rotation of the motor unlocks the motor start relay.

S-107, TIMING SWITCH.—The contacts are momentarily opened ten times as the circuit seeking switch rotates thru 360 degrees. The timing switch contacts are opened by the operation of a cam that is attached to the same shaft as the rotor of the circuit seeking switch. After the rotation of the motor unlocks the motor start relay and substitutes the seeking switch circuit for the motor ground completing circuit through the contact on the start relay, the timing switch contacts and the circuit seeking switch find the open ground circuit within one revolution. During this interval the open segment of the circuit seeking switch has found the circuit that was selected and the timing switch contacts open. The opening of the timing switch contacts breaks the energizing circuit of the motor start relay. The motor start relay returns to the normal (unoperated) position, allowing the motor control switch to be mechanically positioned for the reversing of the motor. When the motor has reversed the required distance, the motor control switch is mechanically operated to the original position, removing the motor energizing circuit and stopping the motor.

S-108, FAULTY OPERATION SWITCH.—This switch is operated if the motor fails to reverse as a result of the faulty operation of the channel selector switch, the circuit seeking switch or the timer switch breaker contacts of the motor control switch. The operation of this switch energizes the coil of the ON-OFF switch and causes the ON-OFF switch to be rotated to the OFF position, disabling the entire equipment.

b. **SEQUENCE OF OPERATION.**—The sequence of operation is explained fully in figure 4-4.

c. **PRIMARY POWER CIRCUITS.** (See figure 4-5.)—This equipment has been designed to operate from a 26.5 volt d-c power source. All of the vacuum tubes that are used in the equipment are of the 12.6 volt heater type. The heaters of the tubes are connected in series-parallel across the power source. The resistance of the filter chokes and leads to the tube heaters reduce the voltage to the correct value for application to the series-parallel connected heaters.

Refer to figure 4-5. With the connections from the power source made to terminals 9, and 17 of connector plug P-101 (terminals 9 negative and terminals 17 positive), complete control of application of voltage to the equipment is held by the ON-OFF switch. The operating of the ON-OFF switch, either the panel switch or a remote switch, to the ON posi-

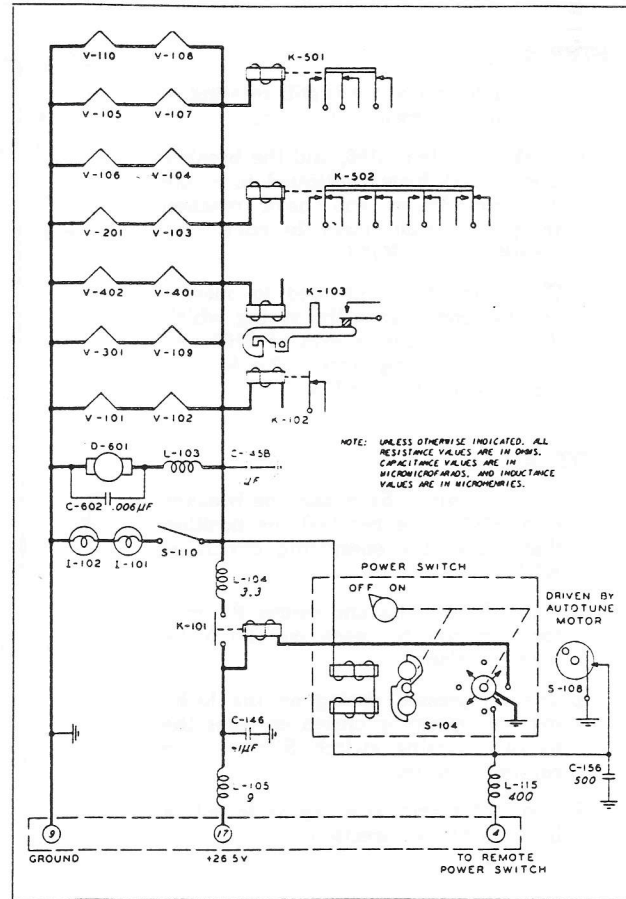
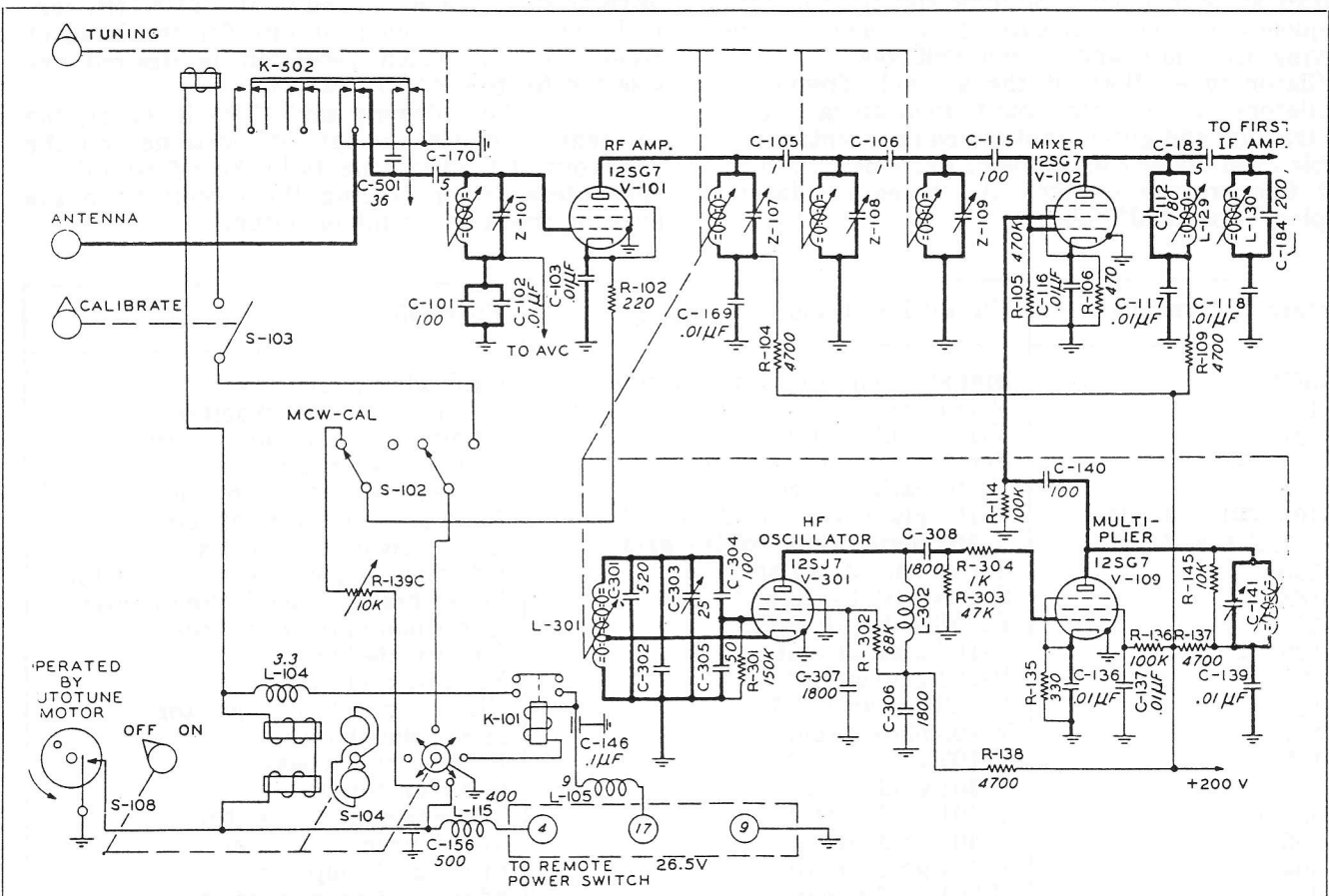


Figure 4-5. Primary Power Circuits

tion energizes the primary power control relay, K-101. The operation of the primary power control relay applies voltage to all vacuum tube heaters, to the two dial lamps and to the motor section of the dynamotor and connects one side of all of the relay coils to the positive side of the power source. The ON-OFF switch may be released either manually or electrically. Identical power control switches are used on the equipment control panel and on the remote control units. The switch contains a solenoid and when the solenoid is energized, the switch is released. The grounding end of the solenoid that is located in the equipment control panel ON-OFF switch is brought out to terminal 4 on connector plug P-101. When the ON-OFF switch is in the ON position, the grounding of the terminal 4 will release the switch and a spring will return the mechanism to the OFF position. All ON-OFF switches that are used with any one installation are connected in parallel and the operating of any one switch to the ON position will energize the solenoid of the ON-OFF switch that is in the ON position.

The following table lists the reference symbols and functions of the control relays:

Reference Symbols	Functions
<p>K-101 PRIMARY CONTROL RELAY</p>	<p>(Operated by ON-OFF switch) When the ON-OFF switch is rotated to the ON position, the primary power control relay K-101 energizes the dynamotor.</p>
<p>K-102 RECEIVER DISABLING RELAY</p>	<p>When the Autotune motor is operating the contacts of the relay K-102 are opened removing the ground circuit from terminal 4 of T-101.</p>
<p>K-103 AUTOTUNE STARTING RELAY</p>	<p>Selecting a channel with switch S-105 operates relay K-103 starting Autotune motor by grounding one side of the field to complete the circuit.</p>
<p>K-501 MCW-CW, CAL RELAY</p>	<p>MCW—In the MCW position the cw-avc is grounded and plate voltage is removed from the bfo. CW, CAL—In the CW-CAL position the cw-avc is operative and plate voltage is applied to the bfo.</p>
<p>K-502 CAL — RECEIVE</p>	<p>CAL—When the relay is in the CAL position, plate voltage is applied to the cfi unit, cw ground is connected, ant circuit is grounded, and the cfi output voltage is connected to the receiver r-f input. RECEIVE—When the relay is in the receive position, plate voltage is removed from the cfi unit, ant connected to r-f input, cfi output voltage is grounded.</p>



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-6. R-F Circuits

d. RECEIVER CIRCUIT DESCRIPTION.

(1) GENERAL. (See figure 1-2.)—This receiving equipment covers a frequency range of one and one-half mc to 18.5 mc. The superheterodyne circuit employs one stage of tuned r-f amplification and two stages of i-f amplification. The normal operating frequency of the i-f stages is 500 kc but the i-f frequency may be varied 50 kc to either side of 500 kc, i.e., 450 to 550 kc, for calibration purposes. For calibration and excitation purposes three oscillators have been incorporated in this receiver. The frequency of one oscillator (cfi) is determined by a 100 kc quartz crystal. Harmonics of 100 kc are used when calibrating the receiver. During actual reception this oscillator circuit is disabled by removing the plate and screen voltages from the oscillator tube. The other two oscillators are variable frequency. One of the variable frequency oscillators is used in conjunction with a multiplier circuit to excite the mixer tube. This oscillator operates in a frequency range of 2000 to 3000 kc and the multiplier circuit is used to obtain the higher frequency excitation voltages. The remaining oscillator is essentially a beat frequency oscillator but is also used during the calibration of the receiver. The output of this oscillator is in the frequency range 450 to 550 kc. With the reception of voice modulated or mcw signals, the beat frequency oscillator circuit is disabled by removing the plate and screen voltages from the oscillator tube. Both of the variable frequency oscillators are precision built, mechanically and electrically, and give output which is exceptionally stable even under conditions of extreme humidity and temperature change. All three oscillators employ Type 12SJ7 tubes.

Detection is accomplished through the use of a type 1N34 fixed crystal rectifier unit (one-half of a 12SL7GT is used in the AN/ARR-15A). The output of the detector is coupled to the audio amplifier stages through a noise limiter consisting of a type 12SL7 dual triode and a type 12H6 dual diode. The audio amplifier consists of two tubes, a type 12SJ7, triode connected, in the driver stage and a type 12A6 beam tube, pentode connected, in the output stage. The delayed avc circuit employs a type 12SL7 dual triode tube.

(2) RECEIVER CIRCUIT FUNCTION.

(a) RF CIRCUITS. (See figure 4-6.)

1. GENERAL.—This receiver employs one stage of tuned r-f amplification. Separate excitation for the mixer is provided by an exciter consisting of the high frequency oscillator and multiplier. The oscillator operates in the frequency range of two mc to three mc. The frequency multiplier is used in conjunction with the oscillator to obtain excitation voltage of the frequency that is necessary for exciting the mixer at the particular frequency that is being received.

The r-f amplifier input and output circuits, the high frequency oscillator grid circuit and the multiplier plate circuit are tuned by varying the position of slugs within the inductors. All of these slugs are positioned by the TUNING control. The proper tuned circuits for the band of frequencies in which reception is desired are selected by the BAND switch.

The following table lists in order, the reference symbols, the circuit locations and the functions of the components in the r-f circuits as encountered when tracing the circuit from the antenna input to the mixer output:

Reference Symbols	Circuit Locations	Functions
K-502	Signal or calibrate input circuit	Calibrate-receive relay
C-170	V-101 grid circuit	Antenna coupler capacitor
Z-101	V-101 grid circuit	r-f amplifier grid tuned circuit
C-101, C-102	Series with Z-101 and gnd	r-f amplifier avc bypass
C-103	V-101 cathode circuit	r-f amplifier cathode bypass
C-105, C-106, C-115	V-101 plate, V-102 control grid	Band pass coupling capacitor
Z-107, Z-108, Z-109	V-101 plate, V-102 control grid	Band pass tuned circuits
C-169	Series with Z-107 and gnd	r-f amplifier plate bypass capacitor
C-183	Series with L-129 and L-130	Mixer-first i-f top coupling capacitor
C-112	Paralleled with L-129	Mixer plate tank capacitor
L-129	V-102 plate circuit	Mixer plate inductor
L-130	V-103 grid circuit	First i-f grid inductor
C-184	Paralleled with L-130	First i-f grid tank capacitor
C-117	V-102 plate circuit	Mixer plate bypass capacitor
C-118	V-103 grid circuit	First i-f avc bypass
L-301	V-301 grid circuit	hf osc grid inductor
C-301, C-302	V-301 grid circuit	hf osc trimmer capacitor
C-303	V-301 grid circuit	hf osc tuning capacitor
C-304	V-301 grid circuit	hf osc grid coupling capacitor
C-305	V-301 grid circuit	hf osc grid shunt capacitor
C-308	V-301 plate circuit	hf multiplier coupling capacitor
R-304	V-109 grid circuit	hf output equalizing resistor

Reference Symbols	Circuit Locations	Functions
C-136	V-109 cathode circuit	Multiplier cathode bypass capacitor
C-141	V-109 plate circuit	Multiplier tuning capacitor
L-101	V-109 plate circuit	Multiplier inductor
C-139	Series with L-109 and gnd	Multiplier plate bypass capacitor
C-140	V-109 plate circuit	hf osc mixer coupling capacitor

2. RF AMPLIFIER CIRCUITS.—The input and output circuits of the r-f amplifier tube, V-101, utilize parallel resonant circuits. These circuits are tuned by slugs in the inductors which are positioned by the TUNING control. The tuning capacitors in the parallel resonant circuits are adjusted so that these circuits track with the other tuned circuits in the receiver. A different set of coils and condensers is provided for each of the six receiver bands and are switched into the amplifier circuits by the BAND switch.

3. EXCITER CIRCUITS. — The exciter consists of the high frequency oscillator and the multiplier. The high frequency oscillator employs a Type 12SJ7 tube, V-301, in a variable frequency oscillator circuit operating within the frequency range of two mc to three mc. The frequency is varied by a tuning slug in the grid inductor, L-301, which is positioned by the TUNING control. The frequency of the high frequency oscillator is always the same for a given setting of the TUNING control regardless of the BAND switch setting.

The plate circuit of the high frequency oscillator is coupled to the control grid of the Type 12SG7 tube, V-109, which is employed by the multiplier. The plate circuit of the multiplier employs a parallel resonant circuit consisting of the inductor, L-101, with a trimmer capacitor in parallel. This circuit is tuned by a slug in the inductor which is controlled by the TUNING control.

Three different trimmer capacitors are used with the inductor, L-101. (See figure 8-9). The particular capacitor needed for the frequency range required to properly excite the mixer is selected by the BAND switch. The multiplier plate circuit is tuned to the fundamental and to the second and third harmonics of the frequency of the control grid voltage by condensers, C-141, C-142 and C-143, respectively. Both the fundamental and the second harmonic of the plate voltage are used to excite the mixer. When the fundamental of the multiplier plate voltage is used, one of the resistors R-145, R-146 or R-147 is connected in the circuit to reduce the output from the multiplier so that radiation from the receiver will be reduced.

The following table shows the capacitor in the multiplier plate circuit and the corresponding frequency ranges for the six positions of the BAND switch:

Band	Capacitor In Circuit	Fundamental Frequency Range MC	Harmonic Used to Excite Mixer Frequency	Range of Excitation Voltage MC
A	C-141	2 to 3	Fundamental	2 to 3
B	C-141	2 to 3	Fundamental	2 to 3
C	C-142	4 to 6	Fundamental	4 to 6
D	C-143	6 to 9	Fundamental	6 to 9
E	C-142	4 to 6	Second	8 to 12
F	C-143	6 to 9	Second	12 to 18

4. MIXER CIRCUITS.—The mixer stage combines the incoming signal voltage which has been amplified by the r-f amplifier with the excitation voltage from the frequency multiplier. The mixer employs a Type 12SG7 tube, V-102, with the signal voltage from the r-f amplifier impressed on the number one grid and the excitation voltage from the multiplier impressed on the number two grid.

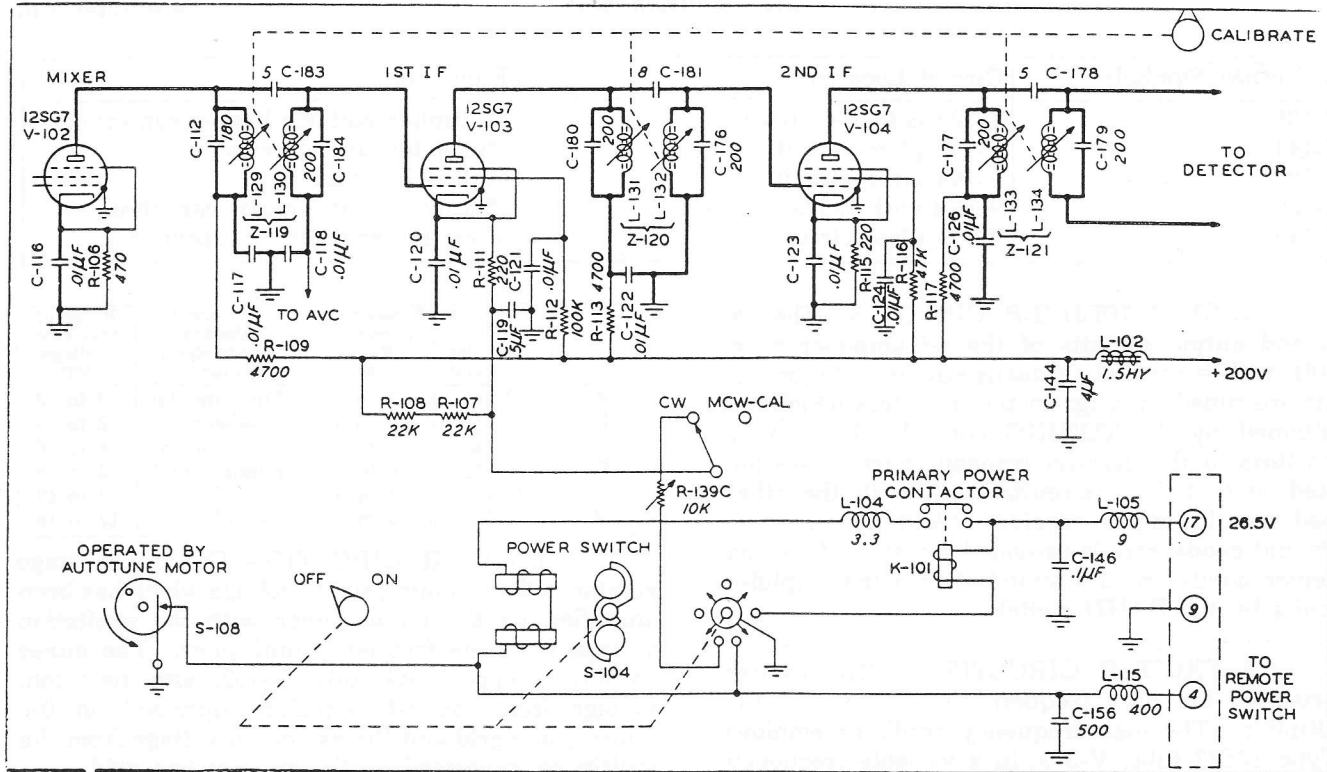
When the receiver is tuned to signals within its frequency range of one and one-half mc to 18.5 mc the frequency of the excitation voltage from the multiplier always differs from the received signal by 500 kc. The heterodyne thus produced appears in the mixer plate circuit which is tuned to a frequency of 500 kc which is the frequency of the voltage amplified by the i-f amplifiers following the mixer.

The following table shows the frequency ranges of the mixer voltages corresponding to the six positions of the BAND switch:

Band	Frequency Range of Incoming Signal MC	Frequency Range of Excitation Voltage MC	Difference Between Incoming Signal and Excitation Voltage MC
A	1.5 to 2.5	2 to 3	+0.5
B	2.5 to 3.5	2 to 3	-0.5
C	3.5 to 5.5	4 to 6	+0.5
D	5.5 to 8.5	6 to 9	+0.5
E	8.5 to 12.5	8 to 12	-0.5
F	12.5 to 18.5	12 to 18	-0.5

(b) I-F AMPLIFIER CIRCUIT. (See figure 4-7.)—Two tuned stages of i-f amplification, employing 12SG7 pentodes, give the receiver the selectivity that is necessary for satisfactory communication. The intermediate frequency, for normal reception, is 500 kc, but during calibration the frequency is varied as much as 50 kc either side of the 500 kc frequency by operating the CALIBRATE control.

The following table lists in order, the reference symbols, the circuit locations and the functions of the components in the i-f amplifier circuits as encountered when tracing the circuit from the mixer output to the detector input:



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-7. IF Amplifier Circuits

Reference Symbols	Circuit Locations	Functions
C-116	V-102 cathode circuit	Mixer cathode bypass capacitor
C-112	V-102 plate circuit	Mixer plate tank capacitor
L-129	V-102 plate circuit	Mixer plate inductor
C-178, C-181, C-183	Z-119, Z-120, Z-121	i-f coupling capacitors
L-130	V-103 grid circuit	First i-f grid inductor
C-184	V-103 grid circuit	First i-f grid tank capacitor
C-116, C-122, C-126	V-102, V-103 and V-104 plate circuits	Plate bypass capacitors
C-118	V-103 grid circuit	avc bypass capacitor
C-120	V-103 cathode circuit	First i-f cathode bypass
C-180	V-103 plate circuit	First i-f plate tank capacitor
L-131	V-103 plate circuit	First i-f plate inductor
L-132	V-104 grid circuit	Second i-f grid inductor
C-176	V-104 grid circuit	Second i-f grid capacitor
C-123	V-104 cathode circuit	Second i-f cathode bypass capacitor
C-177	V-104 plate circuit	Second i-f plate tank capacitor
L-133	V-104 plate circuit	Second i-f plate inductor
L-134	V-105A plate circuit	Detector input inductor
C-179	V-105A plate circuit	Detector input tank capacitor

The plate tank circuit of the mixer tube, V-102, and the grid circuit of the first i-f amplifier tube, V-103, are coupled by capacitor C-183 and are tuned by the first i-f transformer Z-119. The plate tank circuit of the first i-f amplifier tube V-103, and the grid circuit of the second i-f tube V-104 are coupled by capacitor C-181 and are tuned by transformer, Z-120. Voltage for operation of the automatic volume control is coupled from the plate of the second i-f stage through capacitor C-127. The cathodes, screens, grid re-

turns and plate returns of the i-f amplifier tubes are by-passed to ground by suitable capacitors.

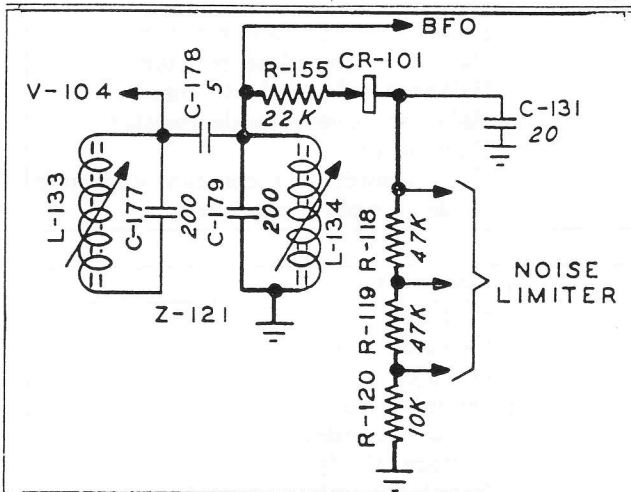
(c) DETECTOR CIRCUIT.— (Refer to figure 4-8.) Rectification of the i-f signal is accomplished by a fixed crystal detector in the AN/ARR-15 equipment and by a diode connected triode in the AN/ARR-15A. The detector is excited by i-f voltage taken from the secondary of the last i-f transformer, Z-121. The output of the detector is coupled through a noise limiter circuit to the grid of the audio driver tube.

The following tables list in order the reference symbols, the circuit locations, and the functions of the components in the detector circuit as encoun-

tered when tracing the circuit from the detector input to the audio output. The first table is for the AN/ARR-15, the second for the AN ARR-15A.

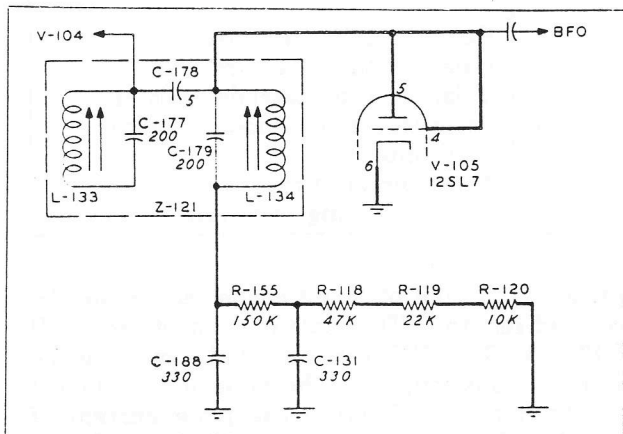
Reference Symbols	Circuit Locations	Functions
L-134	In series with crystal	Input inductor
CR-101	Output of L-134	Rectifier
C-131	Between CR-101 and R-118	r-f filter
R-155	Between CR-101 and Z-121	Detector load
R-118	Between CR-101 and R-119	Detector load
R-119	Between R-118 and R-120	Voltage divider
R-120	Between R-119 and ground	Voltage divider

Reference Symbols	Circuit Locations	Functions
L-134	In series with crystal	Input inductor
V-105	Output of L-134	Detector
C-188	Between L-134 and ground	r-f by-pass
R-155	Between C-188 and R-118	Detector load
C-131	Between R-155 and ground	r-f filter
R-118	Between R-155 and R-119	Detector load
R-119	Between R-118 and R-120	Voltage divider
R-120	Between R-119 and ground	Voltage divider



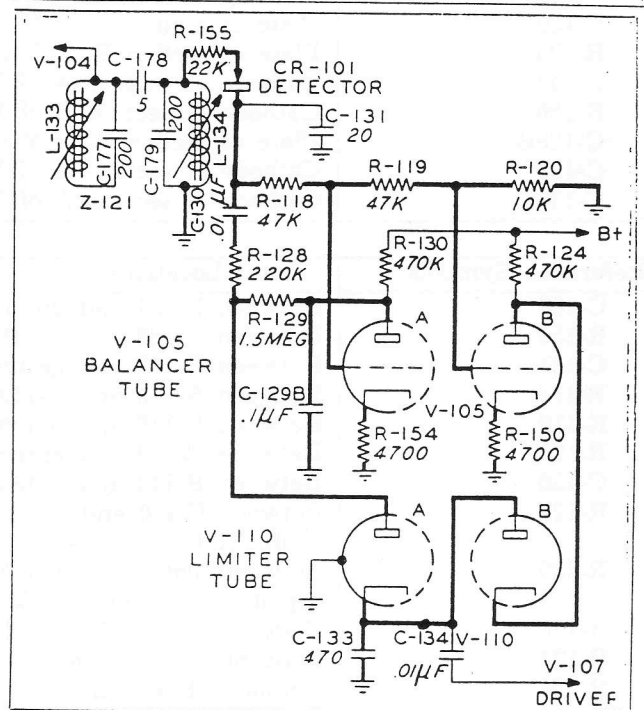
NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-8. Detector Circuits (AN/ARR-15)



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-8A. AN/ARR-15A Detector Circuit



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-9. Noise Limiter Circuit

The crystal detector receives excitation from the secondary of i-f transformer Z-121 which is tuned to the i-f frequency by capacitor C-179. Load resistors R-155 and R-118, and voltage divider resistors R-119 and R-120 form the load for the detector. Audio output from the detector is taken from various points along the detector load. The audio reaches audio driver tube V-107 through the noise limiter circuits.

(d) NOISE LIMITER. — The noise limiter

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employed in this equipment uses two tubes, a dual triode and a dual diode. This limiter will eliminate or greatly attenuate sharp noise impulses such as ignition noise, radar, etc., from the receiver output. Located between the detector and the first audio stage, the limiter acts like a gate, cutting off the audio for the instant of the noise impulse and immediately restoring it at the end of the noise impulse duration.

The following tables list in order, the reference symbols, the circuit locations, and the functions of the components in the noise limiter circuits as encountered when tracing the circuit from the detector output to the noise limiter output. The first table is for the AN ARR-15, the second for the AN/ARR-15A.

In the AN ARR-15, the dual triode, a type 12SL7 tube, is employed in a balancer circuit which

Reference Symbols	Circuit Locations	Functions
C-131	Between crystal and R-118	r-f filter
R-155	Between crystal and Z-121	Detector load
R-118	Between crystal and R-119	Detector load
R-119	Between R-119 and R-120	Voltage divider
R-120	Between R-120 and ground	Voltage divider
C-130	Between R-118 and R-128	Impulse coupling capacitor
R-128	Between C-130 and plate of section A of V-110	Impulse coupling resistor
R-129	Between plate of section A of V-105 and plate of section A of V-110	Limiter time constant resistor
R-130	Plate of section A of V-105	Balancer tube plate resistor
R-124	Plate of section B of V-105	Balancer tube plate resistor
R-154	Cathode of section A of V-105	Balancer tube cathode resistor
R-150	Cathode of section B of V-105	Balancer tube cathode resistor
C-129B	Plate of section A of V-105	Plate filter
C-133	Cathode of section A of V-110	Noise limiter time constant capacitor
C-134	Cathode of section A of V-110	Audio coupling capacitor

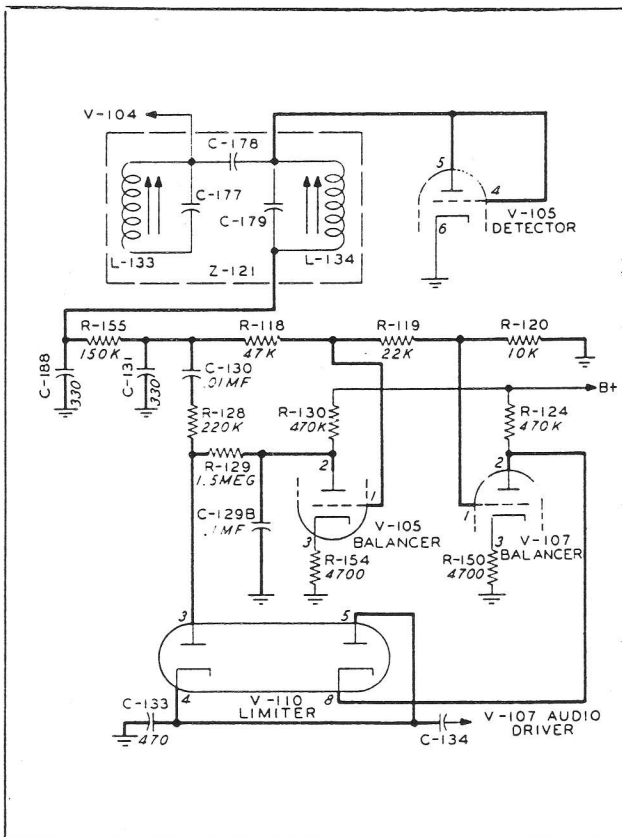
Reference Symbols	Circuit Locations	Functions
C-188	Between L-134 and ground	r-f filter
R-155	Between C-188 and R-118	Detector load
C-131	Between R-155 and ground	r-f filter
R-118	Between R-155 and R-119	Detector load
R-119	Between R-118 and R-120	Voltage divider
R-120	Between R-119 and ground	Voltage divider
C-130	Between R-118 and R-128	Impulse coupling capacitor
R-128	Between C-130 and plate of section A of V-110	Impulse coupling resistor
R-129	Between plate of section A of V-105 and plate of section A of V-110	Limiter time constant resistor
R-130	Plate of section A of V-105	Balancer tube plate resistor
R-124	Plate of section B of V-107	Balancer tube plate resistor
R-154	Cathode of section A of V-105	Balancer tube cathode resistor
R-150	Cathode of section B of V-107	Balancer tube cathode resistor
C-129B	Plate of section A of V-105	Plate filter
C-133	Cathode of section A of V-110	Noise limiter time
C-134	Cathode of section A of V-110	Audio coupling capacitor

amplifies and furnishes an automatic threshold level in order that the limiter will operate equally effective on all percentages of modulation. In the AN/ARR-15A, this function is performed by Section A of V-105 and Section B of V-107.

The dual diode, a type 12H6 tube, is the noise limiter tube in which the interruption of the audio signal takes place.

In operation, both grids of the triode sections receive bias variations at the rate of the audio

frequency by virtue of being connected to the detector load resistor. The plate current of section B of V-105 (ARR-15, V-107 in ARR-15A) varies at the audio rate and is coupled to the cathode of section B of the limiter tube, V-110. The plate current of section A of V-105 varies at an average rate due to filter components C-129B, R-129 and C-133. The plate loading resistors R-130 and R-124 are chosen so that with no audio excitation from the detector, the positive voltage on the plate of section A of V-110



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-9A. AN/ARR-15A Noise Limiter Circuit

is slightly higher than the positive voltage on the cathode of section B of V-110 resulting in a current flow through the limiter tube. Since the plate of section B of V-105 (V-107 in ARR-15A) is coupled to the cathode section B of V-110 an audio signal is obtained from the output of the limiter tube, V-110. If a noise impulse with a steep wave front is received, the grid of section B of V-105 (V-107 in ARR-15A) will be driven more negative which will

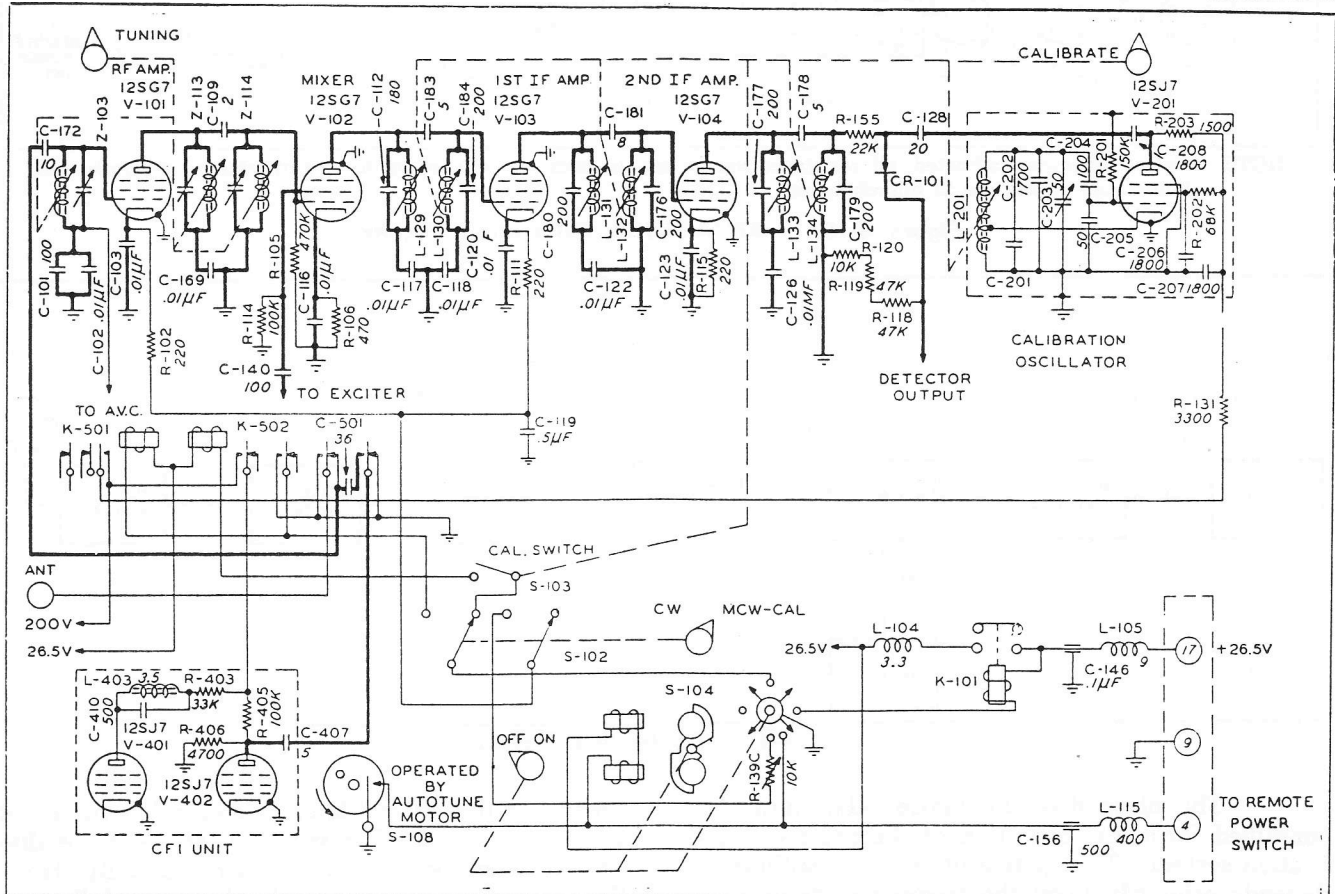
cause a rise in plate voltage in section B of V-105 (V-107 in ARR-15A). The cathode of section B of the limiter tube V-110, being connected to the plate of section B of V-105 (V-107 in ARR-15A), therefore, is driven more positive than the plate of section A of V-110 and the current flow through the limiter tube is interrupted causing a hole to be punched in the signal. While the grid of section A of V-105 receives the same impulse as the grid of section B (section B of V-107 in ARR-15A), the plate of section A does not follow the noise impulse due to the time constant of the filter components C-129B, R-129 and C-133, therefore the plate of section A of limiter tube V-110 does not receive the noise impulse in phase with the cathode of section B of V-110, however the noise impulse is coupled to the plate of section A through resistor R-128 and capacitor C-130 and arrives out of phase, which tends to lower the positive plate potential thus aiding in reversing the polarity between the plate of section A and the cathode of section B of limiter tube V-110, since the plate potential of section A of V-105 varies at an average rate directly proportional to the strength of the incoming signal, the noise limiter threshold is automatically set and the limiter is effective on all values of modulation. The output of limiter tube V-110 is coupled to the grid of the driver tube, V-107, by capacitor C-134.

(e) CALIBRATION CIRCUIT. — The calibrator that is incorporated in this receiving equipment utilizes a crystal controlled oscillator, a variable frequency oscillator and a variable frequency i-f channel. Using the above circuits, the receiver may be accurately tuned to any frequency in the range 1500 to 18,500 kc without having to follow the usual procedure of tuning for a transmitted signal or depending upon tuning dial calibration.

The following table lists in order, the reference symbols, the circuit locations and the functions of the components in the calibration circuit as encountered when tracing the circuit from the output of the cfi unit to the beat frequency calibration oscillator. (Refer to figure 4-10.)

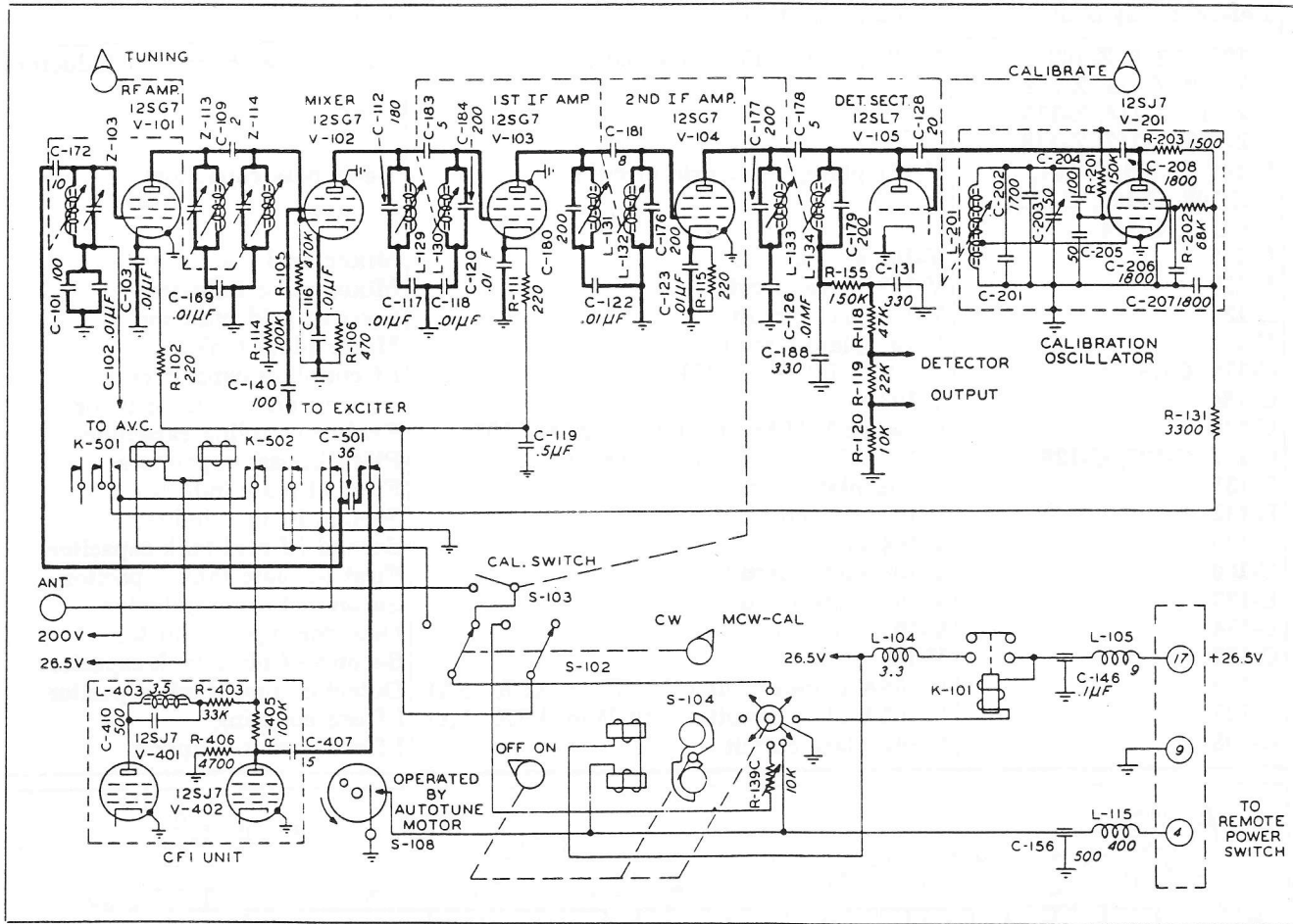
Reference Symbol	Circuit Location	Function
C-407	V-201 plate	Coupling capacitor
C-501	Between K-502 and S-101A	Calibration input capacitor
C-170, C-171, C-172, C-173, C-174, C-175	V-101 grid circuit	Antenna coupling capacitors
Z-101, Z-102, Z-103, Z-104, Z-105, Z-106	V-101 grid circuit	r-f amp grid inductors
C-101, C-102, C-118	V-101, V-103	avc bypass capacitors
C-103, C-120, C-123	V-101, V-103 and V-104 cathodes	Cathode bypass capacitors

Reference Symbol	Circuit Location	Function
Z-107, Z-108, Z-109, Z-110, Z-111, Z-112, Z-113, Z-114, Z-115, Z-116, Z-117, Z-118	V-101 plate, V-102 grid circuits	r-f amplifier band pass inductors
C-105, C-106, C-107, C-108, C-109, C-111, C-113, C-114	V-101 plate, V-102 grid circuits	Band pass capacitors
C-115	V-102 grid circuit	Mixer grid coupling
L-129	V-102 plate circuit	Mixer plate inductor
L-130	V-103 grid circuit	First i-f grid inductor
C-112	V-102 plate circuit	Mixer plate tanks
C-178, C-181, C-183	Z-119, Z-120 and Z-121	i-f coupling capacitors
C-184	V-103 grid	First i-f grid tank capacitor
C-140	Between V-109 plate and grid 2 of V-102	Exciter coupling capacitor
C-117, C-122, C-126	V-102, V-103, V-104 plate circuits	Plate bypass capacitors
L-131	V-103 plate circuit	First i-f plate inductor
L-132	V-104 grid circuit	Second i-f grid inductor
C-176	V-104 grid circuit	Second i-f grid tank capacitor
C-180	V-103 plate circuit	First i-f plate tank capacitor
L-133	V-104 plate circuit	Second i-f plate inductor
L-134	V-105A plate circuit	Detector input inductor
C-177	V-104 plate circuit	Second i-f plate tank capacitor
C-179	V-105A plate circuit (V-105B in ARR-15A)	Detector input tank capacitor
C-128	V-105A plate circuit (V-105B in ARR-15A)	i-f osc coupling
C-208	V-201 plate circuit	i-f osc output coupling



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-10. Calibration Circuit (AN/ARR-15)



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-10A. AN/ARR-15A Calibration Circuits

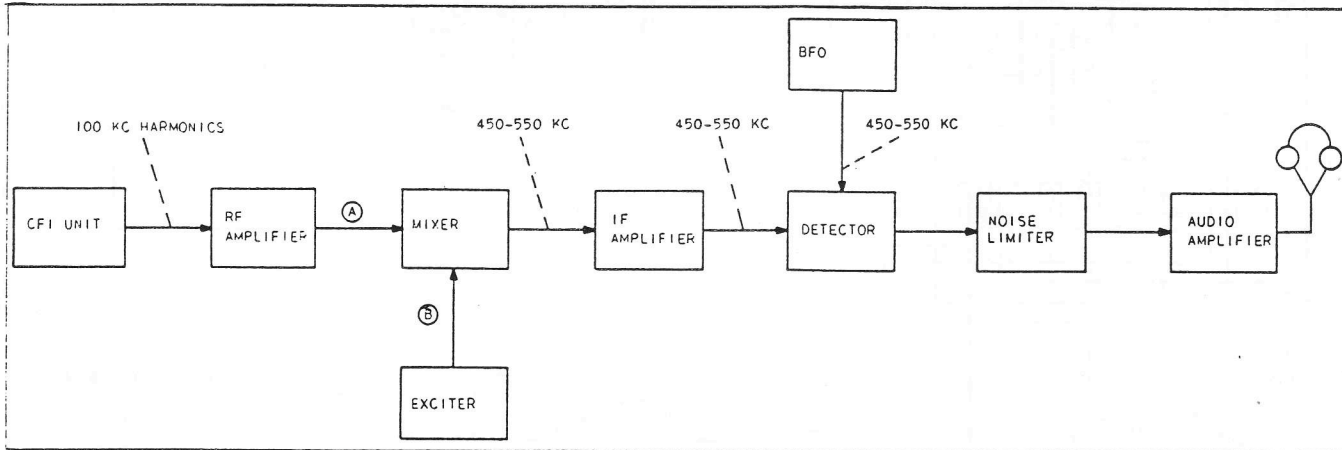


Figure 4-11. Calibration System

The block diagram, figure 4-11, shows, in simplified form, the operation of the receiver calibration system. This system of receiver calibration depends primarily upon the frequency stability of the cfi oscillator and the frequency stability of the two variable frequency oscillators. The fre-

quency of the cfi oscillator is controlled by a 100 kc quartz crystal. The variable frequency oscillators are precision built and are exceptionally stable. The low frequency oscillator has been carefully calibrated and it is reasonable to expect that the calibration dial will always indicate the proper number

of kilocycles of deviation from the 500 kc intermediate frequency. The frequency of the low frequency oscillator is varied by operating the CALIBRATE control. This control operates a mechanism which changes the positions of the tuning slug within the l-f osc grid inductor and the tuning slugs within the i-f transformers.

During the process of receiver calibration the frequency of the output of the low frequency osc is set and the frequency of the high frequency osc is varied. It is most important that this procedure be followed when calibrating the receiver. Reversing the operation by setting the TUNING control and varying the CALIBRATE control will result in a "trial and error" method of calibration and consequently considerable loss of time. If, after once calibrating the receiver for a particular frequency, it is desired to change the calibration even slightly, the low frequency osc frequency should be set and the exciter tuned until zero beat is again obtained.

In order to determine the correct setting of the TUNING control for any particular frequency, a condition must be reached where the frequency of the output of the mixer stage is the same frequency as the output of the low frequency osc. When calibrating the receiver a signal that is generated by the cfi oscillator is used to replace the usual transmitted signal. To obtain output from the mixer that is in the frequency range 450 to 550 kc, the output of the cfi oscillator is beat against the output of the exciter. As indicated in the table below, the frequency of the output of the exciter is sometimes 500 kc higher and sometimes 500 kc lower than the frequency of the signal that is being received. In Bands A, C, and D the frequency of the output of the exciter is 500 kc higher than the fre-

quency of the signal that is being fed into the mixer by the r-f amplifier. In Bands B, E, and F, the frequency of the output of the exciter is 500 kc lower than the frequency of the signal that is being impressed upon the signal grid of the mixer.

Band	Frequency Range	HF Ocs Frequency	Injection Voltage Frequency	Received Freq. Compared to Injection Freq.
A	1.5 mc to 2.5 mc	2 mc to 3 mc	2 mc to 3 mc	-0.5 mc
B	2.5 mc to 3.5 mc	2 mc to 3 mc	2 mc to 3 mc	+0.5 mc
C	3.5 mc to 5.5 mc	2 mc to 3 mc	4 mc to 6 mc	-0.5 mc
D	5.5 mc to 8.5 mc	2 mc to 3 mc	6 mc to 9 mc	-0.5 mc
E	8.5 mc to 12.5 mc	2 mc to 3 mc	8 mc to 12 mc	+0.5 mc
F	12.5 mc to 18.5 mc	2 mc to 3 mc	12 mc to 18 mc	+0.5 mc

When calibrating the receiver, the output of the cfi oscillator is fed into the receiver input circuit and the antenna terminal is grounded by the operation of K-502. All harmonics of the 100 kc oscillator are fed into the receiver but tunable band pass filter circuits in the r-f amplifier and mixer stages attenuate all signals except the harmonic that is to be used for calibration. Although attenuated, the 100 kc harmonic that is to be used will be of sufficient strength to drive the signal grid of the mixer even when the band pass filter and tank circuits are detuned as much as 50 kc. The high frequency osc tank and multiplier tank circuits are tuned by the same control that tunes the r-f amplifier and mixer tank circuits. Thus when the r-f amplifier and mixer tank circuits are detuned from the 100 kc point, the frequency of the output of the exciter is also varied. A 100 kc harmonic of the cfi oscillator is used for calibration 50 kc above and 50 kc below the point. For example, the 4600 kc harmonic of the 100 kc crystal is used when calibrating the receiver to points in the frequency range 4550 to 4650 kc. The 4500 and the 4600 kc harmonics will be of equal strength at 4550 kc and the 4600 and the

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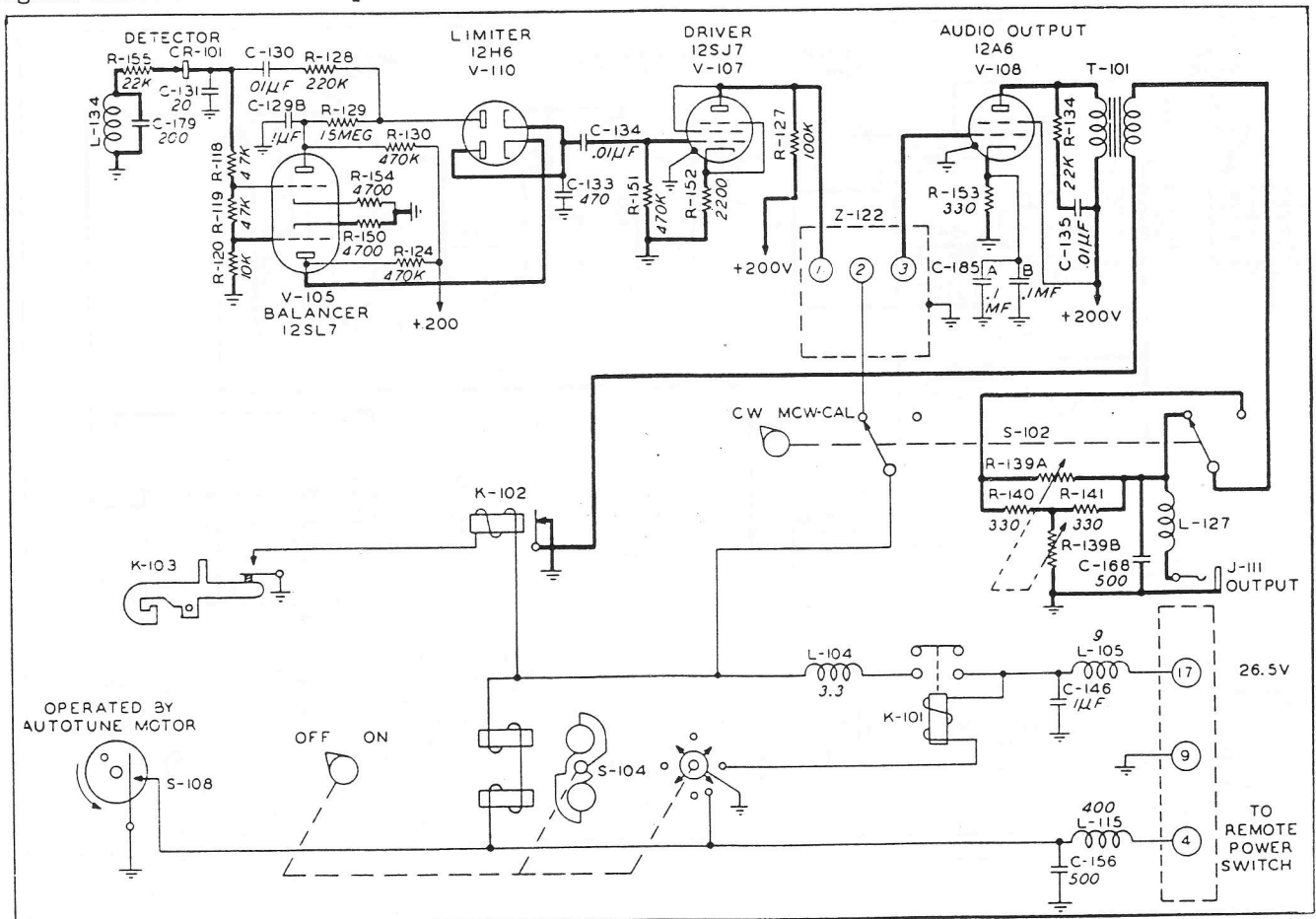
4700 kc harmonics will be of equal strength at 4650 kc. When the r-f amplifier, mixer and exciter circuits are tuned farther than 50 kc away from a 100 kc point, the 100 kc harmonic that is nearest to the frequency to which the r-f, mixer and exciter circuits are tuned becomes the usable signal.

Referring to the block diagram, figure 4-11, the frequency of the usable signal at point A is always an even 100 kc harmonic of the output 100 kc cfi oscillator. The frequency of the signal at point B will vary as the TUNING control is rotated but will always be between 450 and 550 kc higher or lower in frequency than the frequency of the signal at point A. When receiving signals in Bands A, C or D, the frequency of the signal at point A will be lower than the frequency of the signal at point B. When receiving in Bands B, E or F the frequency of the signal at point A will be higher than the frequency of the signal at point B. With the if transformers tuned to the same frequency as the output of the low frequency oscillator, the output of the mixer will be permitted to reach the detector tube when the frequency of the output of the mixer is near the frequency of the output of the low frequency oscillator. Zero beat between these two signals indicates that the output of the mixer is of

exactly the same frequency as the frequency of the output of the lf osc. The receiver is properly calibrated when zero beat between the two signals is obtained.

(f) AUDIO AMPLIFIER CIRCUITS. —

Audio amplification is obtained by one audio driver and one power amplifier stage. The audio voltage that is developed across the diode detector load resistors, R-155, R-118, R-119, and R-120, is impressed across the noise limiter circuit. The current flowing in the limiter tube develops voltage across resistor, R-151. This voltage is applied to the grid of the audio driver V-107 through capacitor C-134. The output of the audio driver V-107 is connected to the input of the audio filter Z-122. The filtered audio voltage is impressed on the grid of the 12A6 power amplifier tube V-108. An output transformer couples the output of the power amplifier to the head phone jack, J-111, through the mcw-cw switch, S-102. A "T" pad attenuator is inserted in series with the output when S-102 is in the MCW position. The audio output is also terminated at pin No. 11 of connector P-101. Operating this switch to CW position takes the "T" pad out of the circuit and disables the avc. Relay contacts on the audio disabling relay K-102 open



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-12. Audio Amplifier Circuit

Section IV
Paragraph 2.d.

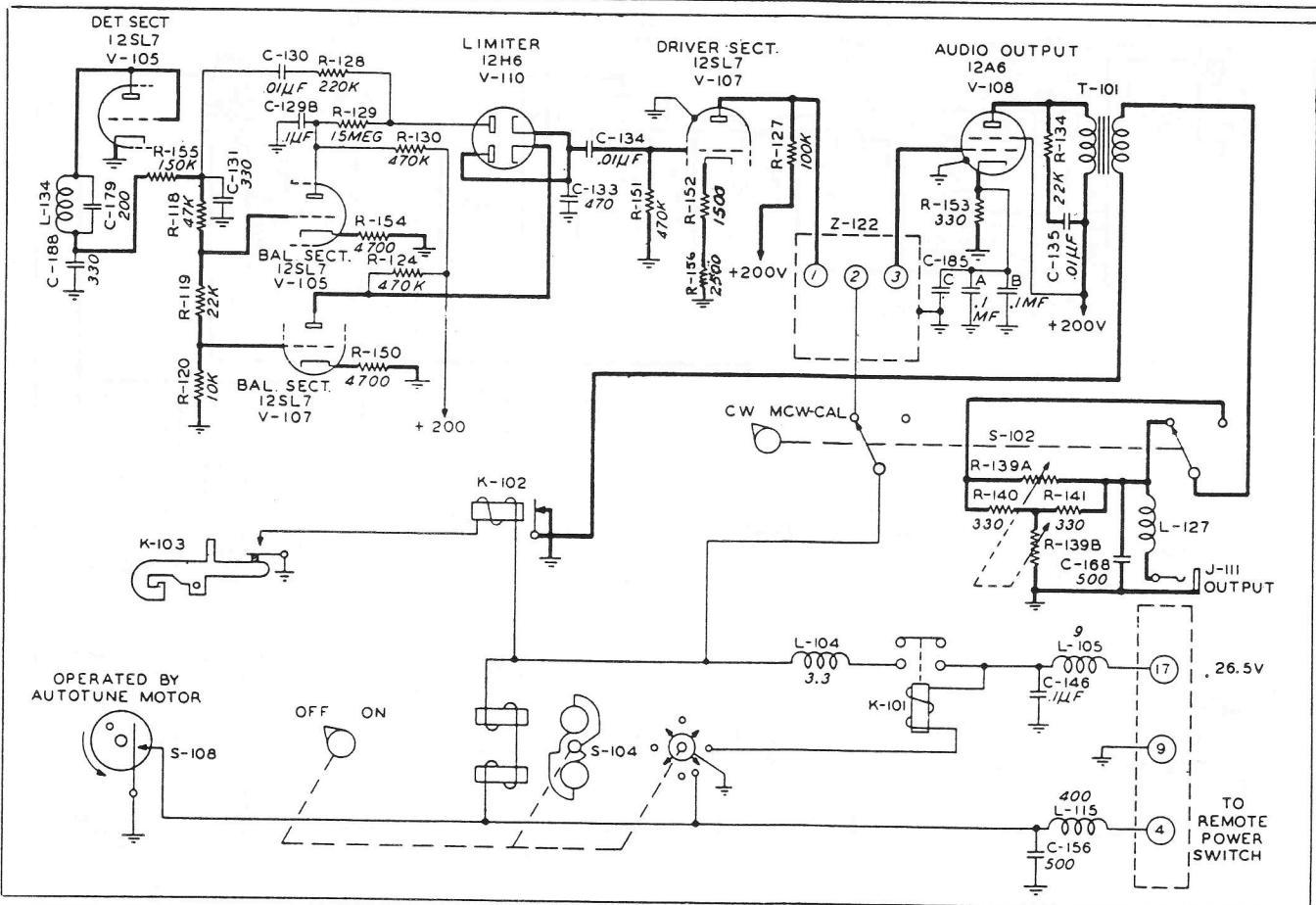
AN 16-30ARR15-3

the secondary circuit of the audio transformer, T-101, when the Autotune system is functioning.

The following table lists in order, the refer-

ence symbols, the circuit locations and the functions of the components in the audio amplifier circuits as encountered when tracing the circuit from the noise limiter output to the audio output connector jack:

Reference Symbol	Circuit Location	Function
C-134	V-107 grid circuit	First audio coupling capacitor
R-151	V-107 grid circuit	Audio driver grid resistor
R-131	Terminal 3 of J-105	l-f osc decoupling resistor
R-127	V-107 plate circuit	Audio driver plate load resistor
Z-122	V-107 plate, V-108 grid	Audio filter
S-102	One section connects Z-122 in circuit	cw-mcw-cal switch
R-153	V-108 cathode	Audio output cathode resistor
C-185	V-108 cathode	Audio output cathode capacitor
R-134, C-135	Connected in series across T-101 primary	Audio equalization network
T-101	V-108 plate circuit	Audio output transformers
R-139A	Connects to R-140 and R-141	"T" pad bridging resistor
R-139B	Connects junction of R-140, R-141 to ground	"T" pad resistor
R-140	Series with R-141 and T-101 secondary	"T" pad resistor
R-141	Series with R-140 and J-111	"T" pad resistor
C-168	Shunted across J-111	Phone jack filter capacitor
L-127	Series with J-111	Audio output r-f filter
J-111	Connected to L-127 and ground	Audio output jack
K-102	Connects one side of T-101 secondary to ground	Receiver disabling relay



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-12A. AN/ARR-15A Audio Amplifier Circuits

(g) AUTOMATIC VOLUME CONTROL. — Delayed avc is employed in this receiver. An accelerated characteristic which enables the avc circuit to reach maximum efficiency on strong signals is a feature of the circuit. Refer to figure 4-13.

The following table lists, in order, the reference symbols, the circuit locations, and the functions of the components in the i-f amplifier circuits as encountered when tracing the circuit from the avc input to the grids of the controlled tubes.

Reference Symbols	Circuit Locations	Functions
C-132	Plate of section A of V-106	Accelerator r-f coupler
C-127	Plate of section B of V-106	AVC r-f coupler
R-123	Plate of section A of V-106	Accelerator plate load
R-126	Cathode of section A of V-106	Accelerator plate load
R-122	Cathode of section A of V-106	Voltage divider resistor
R-133	Between R-122 and ground	Voltage divider resistor
C-129A	Cathode of section B of V-106	Filter capacitor
R-121	Plate of section B of V-106	AVC load
R-125	Plate of section B of V-106	Filter and time constant resistor
C-129C	Between R-125 and ground	Filter and time constant capacitor
R-111	Grid return of V-103	AVC decoupling
C-118	Grid return of V-103	AVC decoupling
R-102	Grid return of V-101	AVC decoupling
C-101, C-102	Grid return of V-101	AVC decoupling

The delay feature of the avc functions in such a fashion that the controlled tubes do not receive any avc voltage while a weak signal is being received, thereby allowing the receiver to operate in the most sensitive condition. This delay feature is obtained by placing a positive voltage on the avc

tube cathode which biases the plate with a negative potential and prevents rectification. However, as soon as the received signal is great enough in amplitude, the signal voltage overcomes the fixed bias and the avc tube begins to function. In order to receive all avc voltage possible from the avc tube,

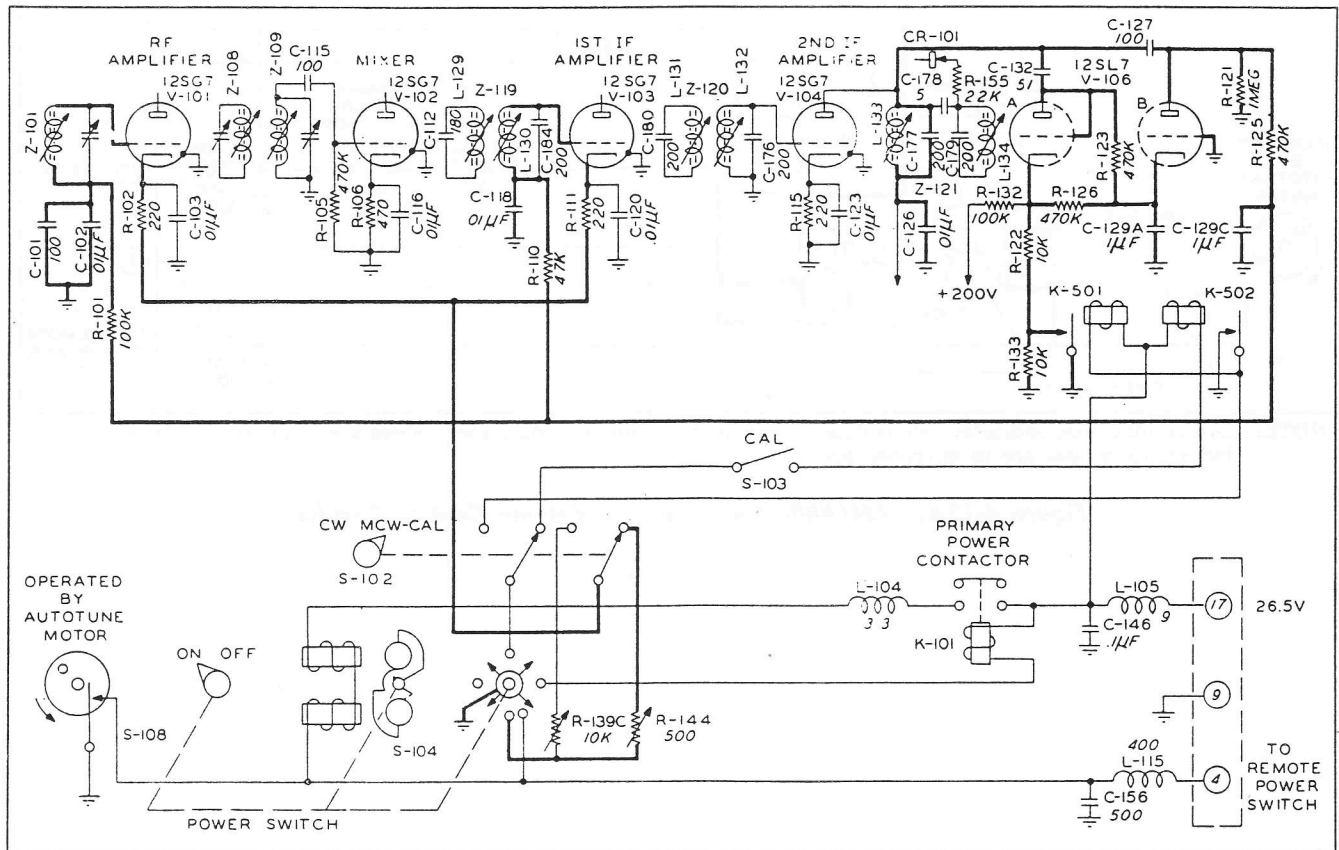
section A of V-106 is connected in a rectifier circuit which rectifies part of the i-f signal and applies a d-c bucking voltage to the delay bias on section B of V-106. In this manner, a strong signal will reduce the delay bias on the avc tube and allow more avc voltage to be generated, thus an accelerated avc characteristic is obtained.

Radio frequency voltage for operation of the avc system is obtained from the primary of i-f transformer Z-121 through capacitor C-127. Resistor R-121 forms the avc load. The grid of the avc tube, section B of V-106, is grounded and the cathode is connected to the positive side of the plate supply through resistors R-126 and R-132.

Section A of V-106 is connected in a diode rectifier circuit which furnishes the bucking voltage that cancels out the delay bias on section B of V-106.

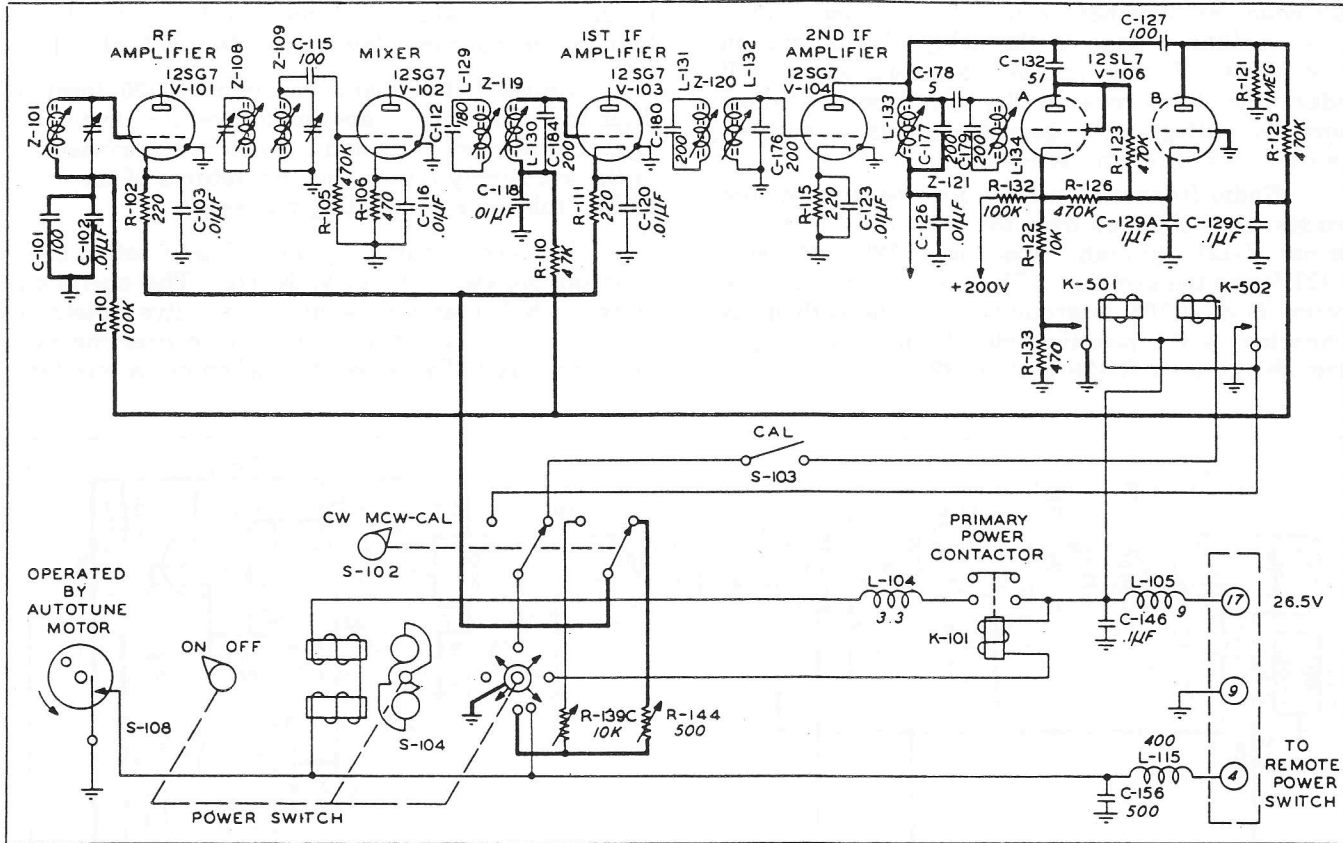
Resistor R-125 and capacitor C-129 form a filter to remove all r-f and audio from the avc voltage. Suitable resistors and capacitors are connected in the avc supply line at the grid returns of the controlled tubes for decoupling purposes.

The avc circuit is connected to a set of contacts on the cw-mcw relay, K-501. The operation of relay K-501 applies a higher positive potential (delay bias) to the avc circuit and causes the avc to become partially inoperative when cw is selected.



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-13. Automatic Volume Control Circuit



NOTE: Unless otherwise indicated, all resistance values are in ohms, capacitance values are in micromicrofarads, and inductance values are in microhenries.

Figure 4-13A. AN/ARR-15A Automatic Volume Control Circuits

SECTION V

MAINTENANCE

1. INSPECTION.

a. GENERAL.—This radio equipment has been constructed of materials considered to be the best obtainable for the purpose and has been carefully inspected and adjusted at the factory to reduce maintenance to a minimum. However, a certain amount of checking and servicing will be necessary to maintain efficient and dependable operation. The following sections have been set up to aid in the checking of the equipment. The inspection procedure is divided into three periods, namely, pre-flight inspection, daily inspection and 100 hour inspection.

b. PRE-FLIGHT INSPECTION.—The purpose of the pre-flight check is to make certain that the equipment is functioning properly and that all parts are securely fastened.

(1) VISUAL INSPECTION.

(a) Check the Autotune locks on the BAND switch and the TUNING control and make certain that both are tight.

(b) Check the antenna and the ANTENNA terminal connection.

(c) Check the mounting base and make certain that the base is securely fastened to the structure of the aircraft and grounded.

(d) Check the condition of the securing clamps on the mounting base and the safety wires that hold the clamp nuts in place.

(e) Check the remote control unit and make certain that the unit is securely fastened.

(f) Check all of the interconnecting wires. If necessary, hand tighten all of the wire plug locking rings. Inspect the interconnecting wires for breaks and loose connections at the plugs.

(g) Check the headphones for loose or broken wires.

(h) Make all other checks that may aid in accomplishing the "purpose" of this inspection.

(2) OPERATION CHECK.—Before each flight the operation of the receiver should be checked. The following operational check will indicate whether or not the receiver is operating normally.

(a) Operate the ON-OFF switch to the ON position and allow a few seconds for the tubes to warm up.

(b) Advance the VOLUME control for the desired audio output.

(c) Select each of the ten frequency channels and listen for a signal of known strength. If a signal

is heard on each of the frequency channels the receiver may be assumed to be operative.

c. DAILY INSPECTION.

(1) GENERAL.—The daily inspection is designed to determine, in general, the condition of the complete equipment and to detect any aggravated conditions, maladjustments, breaks, etc.

(2) VISUAL INSPECTION.—The visual inspection for the daily inspection is the same as for the pre-flight check. Refer to paragraph 1. b., on this page.

(3) OPERATIONAL INSPECTION.

(a) PROCEDURE.

1. Check the receiver for sensitivity against stations of known frequency and signal strength on all channels.

2. Check the controls of the remote control unit.

3. Make certain the dynamotor is running smoothly.

d. 100 HOUR INSPECTION.

(1) GENERAL.—This inspection involves removal of the chassis and should be a thorough and searching visual and operating inspection designed to determine the amount of service that is required and to detect maladjustments and early stages of deterioration of components.

(2) REMOVING RECEIVER CHASSIS.—The first step in the procedure is to remove the receiver from the mounting base. Unfasten the safety wires on the two nuts at the bottom of the front panel and loosen the nuts. Slide the unit forward until the plug and plug receptacle are disengaged. Lift the unit from the mounting rack and place on a bench. Disengage the Dzus fastener at the rear of the cabinet and pull the unit forward to remove the chassis from the cabinet.

(a) REMOVING THE DYNAMOTOR UNIT.—To remove the dynamotor from the receiver chassis, pull out the four snap fasteners at the dynamotor base. The dynamotor will lift out of the plug-in connector located in the base.

(b) VISUAL INSPECTION.

1. With the dynamotor removed from the equipment, remove the dynamotor end shields and check the commutator and brushes for wear.

2. Check the tubes to make certain that all are tight in the sockets.

3. Check all the moving parts in the receiver and any other parts that may have become loose due to vibration.

4. Check the capacitors, resistors and other components for corrosion and deterioration.

5. Check all of the relay and switch contacts for corrosion and pits.

(3) OPERATIONAL INSPECTION.

(a) EQUIPMENT REQUIRED.

1. Power supply—26 volts dc.
2. Mounting base with plug.
3. Connecting cable.
4. Headphones.
5. Signal generator.
6. Dummy antenna—10 ohms, 100 mmf.
7. Output meter.

(b) MANUAL OPERATIONAL CHECK.—

Make certain all the controls are operating properly. Check the CHANNEL, TUNING, CALIBRATE, VOLUME, CW MCW-CAL controls on the front panel.

(c) AUTOMATIC OPERATION
OPERATIONAL CHECK.

1. Plug the receiver unit into the mounting base and connect the cable to a 26.5 volt dc supply.
2. Plug the headphones into the PHONE jack.
3. Connect a ground to the receiver mounting base.

(d) CHECKING PROCEDURE.

1. Lock the TUNING and BAND switch controls.
2. Rotate the ON-OFF switch to the ON position and select channel number one with the CHANNEL selector control.
3. Select each of the ten channels after the Autotune cycle has been completed for each channel.

(e) RECEIVER SENSITIVITY CHECK.

1. Connect a signal generator to the ANTENNA terminal of the receiver through a dummy antenna that consists of 10 ohms non-inductive resistance and 100 mmf of capacitance in series.
2. Connect an output meter to the receiver output.
3. Rotate the ON-OFF switch to the ON position and rotate the CHANNEL selector switch to channel one.
4. Check the sensitivity of the receiver against the table of "Sensitivity vs Frequency" given on this page of this Handbook.
5. Check the sensitivity on all ten channels.

SENSITIVITY vs FREQUENCY

Frequency (mc)	Band	Input (uv)	Output (mw) (30% mod)
2.0	A	2.4	100
3.0	B	2.0	100
4.5	C	2.5	100
7.0	D	2.5	100
10.0	E	2.3	100
15.5	F	2.5	100

2. VACUUM TUBES.

a. PRECAUTIONS FOR SATISFACTORY TUBE LIFE.

(1) Before any tube is removed from the receiver, make certain that the ON-OFF switch is in the OFF position.

(2) The external power supply must not exceed 28 volts. (Normal voltage 26.5 volts dc.)

(3) Operate all of the tubes within five per cent of the rated voltages.

(4) Do not exceed the rated plate current of any of the tubes during normal operation of the equipment.

b. TUBE REPLACEMENT PRECAUTIONS.

(1) All tubes are removed by pulling straight out of the sockets.

(2) Before a tube is replaced, make certain that the type of tube is correct for the socket into which it is being placed.

(3) When replacing the tubes, properly orient the tube pins with respect to the socket and push into place.

c. REPLACEMENT OF TUBES.—Before a tube is discarded, make certain that the tube is at fault and that the trouble is not a loose or broken connection in the equipment. When a tube is known to be defective it should be disposed of immediately so that the tube will not become mixed with good tubes from general stock. Discard all tubes with open heaters, shorted or noisy elements, low emission or any other defect which would cause faulty operation of the equipment. If the tubes in the equipment have been continually in use for a year, replace all the tubes. A marked improvement in performance of the equipment is usually noticeable after the weak tubes have been replaced.

Note

ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

3. TROUBLE LOCATING IN INSTALLED EQUIPMENT.

a. GENERAL.—In case of trouble, look for simple

causes first. Analyze and isolate the difficulty before attempting to remove or dismantle any part of the equipment. A few moments of thought and study of the various possible causes of failure may save hours of haphazard labor. Radio equipment is often damaged by needless disassembly and removal of parts.

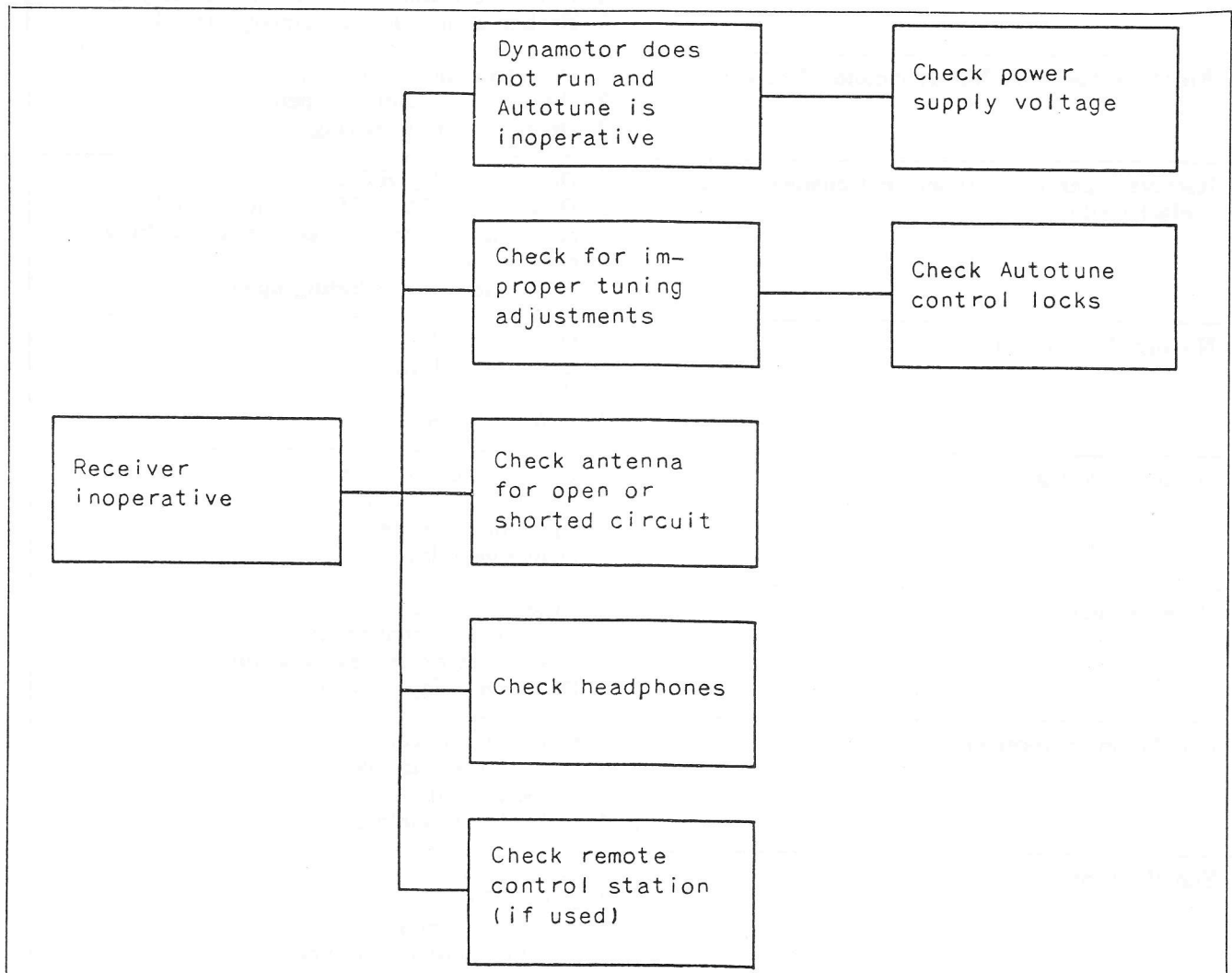
unit is removed from the aircraft the trouble should be determined if possible. The checks in the following trouble locating chart and block diagram should be made to locate the trouble which can be repaired without removing the receiver unit. If the trouble cannot be located and repaired by the following checks, the receiver unit must be removed from the aircraft and taken to a repair station.

b. LOCATING TROUBLE.—Before the receiver

(1) INSTALLED EQUIPMENT TROUBLE LOCATING CHART.

Symptoms	Possible Cause of Trouble
Autotune mechanism does not operate and dynamotor does not rotate.	1. No input voltage. 2. Power source voltage too low.
No signal received	1. Antenna open or short circuit. 2. Defective headphones. 3. Improper tuning.
Receiver inoperative on one or more channels.	1. Improper tuning or a control or controls unlocked.
Receiver operative but remote station inoperative.	1. Defective headphones, cable, plugs, wiring or switch at the remote unit.

(2) INSTALLED EQUIPMENT TROUBLE LOCATING BLOCK DIAGRAM.



(3) REMOVING RECEIVER UNIT
FROM THE MOUNTING BASE.

(a) Remove the safety wire and loosen the nuts that clamp the unit to the shock mounting base.

(b) Using the handles on the front panel, pull the unit straight forward to release the unit from the plug-in connections and rear mounting studs.

4. TROUBLE LOCATING AT REPAIR STATION.

a. PRELIMINARY CHECKS. — The following preliminary checks may be easily performed to locate trouble in the receiver. The checks consist primarily of visual inspections of control positions and equipment performance.

(1) EQUIPMENT REQUIRED.

(a) Power supply—26.5 volts dc.

(b) Power supply cable and plug.

(c) Voltmeter.

Range: 0-10, 0-250 volts dc.

(d) Ohmmeter.

Range: 0-10, 0-100,000, 0-5 megohms.

(e) Spare tubes.

(2) REMOVING CHASSIS FROM CABINET.

—When the receiver has been removed from the shock mounting base, proceed as follows to remove the chassis from the cabinet.

(a) Rotate the Dzus fastener, located on the rear of the cabinet, a half revolution counterclockwise.

(b) Using the two handles on the front panel, pull the chassis from the cabinet.

(3) PRELIMINARY TROUBLE
LOCATING CHART.

Symptoms	Possible Source of Trouble
Equipment dead.	1. Defective ON-OFF switch. 2. Defective primary power control relay K-101. 3. Broken connection in primary circuit.
Autotune operative but dynamotor does not run.	1. Defective motor brushes. 2. Dynamotor windings open. 3. Open circuits in wiring.
Receiver operative but will not change channels electrically.	1. Defective relay K-103. 2. Defective CHANNEL selector switch. 3. Autotune motor brushes are not making proper contact. 4. Autotune motor winding open.
No signals received.	1. Defective tubes. 2. Defective relays. 3. No plate voltage. 4. Defective circuits.
No plate voltage.	1. Defective dynamotor. 2. Shorted filter or bypass capacitor. 3. Open filter choke. 4. Defective relay.
Receiver noisy.	1. Defective tube. 2. Loose wiring connection. 3. Open filter or bypass capacitor. 4. Defective relay contacts.
Oscillation in receiver.	1. Open bypass capacitor. 2. Defective ground connection. 3. Defective tube. 4. Defective shielding.
Signals weak.	1. Weak tubes. 2. Low voltages. 3. Improper tuning. 4. Misalignment of circuits.

b. TROUBLE LOCATING STAGE BY STAGE.

(1) TEST EQUIPMENT REQUIRED.

(a) Audio Signal Generator—TS-382-A/U or Hewlett-Packard 200-C,205-AG.

(b) Signal Generator—TS-413/U,-LP,-5 or equivalent.

Range: 400 kc to 20 mc. (LP-5 Signal Generator recommended.)

(c) Capacitor—.01 mf (approximate).

(2) PROCEDURE.—The installed equipment trouble locating block diagram shows the procedure recommended for the checking for trouble in the receiver. With the receiver trouble symptom in mind, study the block diagram and considerable time may be saved in locating the trouble.

(a) ISOLATING THE TROUBLE.—When the trouble cannot be located in the preliminary checks under Paragraph 4 page 5-4, the stage by stage procedure in the following paragraphs will locate the stage in which the trouble exists.

1. AUDIO STAGES.

a. Connect the output of an audio oscillator through a .01 mf capacitor to the plate of the second audio amplifier tube (Terminal 3 on X-108).

b. Connect the audio oscillator ground lead to chassis ground.

c. Adjust the audio oscillator to approximately 1000 cps, with maximum output.

d. Adjust the VOLUME control to maximum position.

e. Operate the CW MCW-CAL switch to MCW-CAL position.

f. Turn the audio oscillator and receiver on. The 1000 cps signal should be heard in the headphones if the circuits are operative (allow enough time for the tubes to reach the operating temperature).

g. Using the procedure in the above steps, connect the audio oscillator output lead to the following check points and in the following sequence:

(1) Grid of second audio tube, (Terminal 5 on socket X-108).

(2) Plate of audio driver tube, (Terminal 8 on socket X-107).

(3) Grid of audio driver tube, (Terminal 4 on socket X-107).

(4) Cathode and plate of noise limiter tube, (Terminals 4 and 5 on socket X-110).

Note

If a stage is defective the trouble will be between the point where no signal was heard and the last point at which the signal was heard.

2. DETECTOR, AVC AMPLIFIER AND NOISE LIMITER.—If the signal is heard in the

headphones when the output of the audio oscillator is fed to the cathode and plate of the noise limiter tube, it is evident that the audio stages are operative and that the trouble must be in a stage preceding this point. These stages may be checked in much the same manner as the audio stages were checked. Use a signal generator in place of the audio oscillator and proceed as follows:

a. Connect the output lead of the signal generator through a .01 mf capacitor to the i-f coil side of the crystal detector CR-101 in the AN/ARR-15, or to pin 5 of V-105 in the AN/ARR-15A.

b. Connect the ground lead of the signal generator to the chassis ground.

c. Adjust the receiver VOLUME control to the maximum position.

d. Turn on the receiver and signal generator.

e. Make certain the CALIBRATE dial is in the 0 position.

f. Adjust the signal generator to 500 kc and the signal will be heard if the circuits are operative.

3. IF AMPLIFIER STAGES.—Using the same procedure as in the above steps b., c., d., e., and f., connect the output from the signal generator to the following check points in the following sequence:

a. Plate of tube V-104 (Terminal 8 on socket X-104).

b. Grid of tube V-104 (Terminal 4 on socket X-104).

c. Plate of tube V-103 (Terminal 8 on socket X-103).

d. Grid of tube V-103 (Terminal 4 on socket X-103).

e. Plate of tube V-102 (Terminal 8 on socket X-102).

f. Grid of tube V-102 (Terminal 4 on socket X-102).

4. OSCILLATOR, FREQUENCY MULTIPLIER AND MIXER STAGES.—If the signal of the signal generator is heard through the i-f amplifier stages, the oscillator, frequency multiplier and mixer stages may be checked by leaving the signal generator connected to the grid of the mixer tube as in the above paragraph under step f. and adjusting the signal generator and the receiver TUNING dial to a like frequency. The signal will be heard if these stages are operative.

CAUTION

Do not even attempt to loosen a screw in the high or low frequency oscillator units before carefully reading the instructions under paragraph 4., d. page 5-6 in this section.

5. RF AMPLIFIER STAGE.—If a signal is heard when the stages in the above paragraph are checked, the r-f amplifier stage may be checked

with the same receiver and signal generator adjustment. Proceed as follows:

a. Connect the output of the signal generator to the plate of the r-f amplifier tube, V-101 (Terminal number 8 on socket X-101).

b. Grid of the r-f amplifier tube, V-101 (Terminal number 4 on socket X-101).

c. Antenna connection on the front panel.

6. LOW FREQUENCY OSCILLATOR. —

If the receiver operates normally when the CW MCW-CAL switch is in the MCW-CAL position but there is no beat frequency when the switch is in the CW position or if no zero beat can be obtained between the 100 kc check points from the cfi oscillator when the CALIBRATE dial is rotated, the low frequency oscillator unit or circuits are inoperative. (See CAUTION under above Paragraph 4.)

7. CFI UNIT. — If the receiver operates normally but no 100 kc check points can be heard when the cfi unit is turned on by the CALIBRATE dial, the cfi unit or circuits are inoperative.

c. TROUBLE LOCATING IN A STAGE FOUND INOPERATIVE.—When trouble is known to exist in the high or low frequency oscillator units, refer to Paragraph 4., d. on this page 5-6 for the procedure to be followed in replacing oscillator. When trouble is known to exist in any other stage or circuit, use the following procedure to locate the trouble:

(1) Replace the tube with one of the same type that is known to be in good condition and check to see if the trouble is corrected.

(2) Measure the voltage at the tube sockets. Incorrect voltage readings will indicate defective wiring or components.

(3) Check the capacitors for an open or shorted condition. A shorted capacitor usually will cause improper voltages to exist and may also cause resistors and other components to heat excessively. An open capacitor may be located by shunting the capacitor that is suspected with a test capacitor of the same value. An open capacitor will cause noise, oscillation or no signal to be heard.

(4) With the receiver turned off, measure the resistance of both the fixed and variable resistors in the circuit.

(5) With an ohmmeter and a schematic drawing of the circuit, check the continuity of the wiring, coils, transformers, relay contacts and relay coils.

(6) Replace any components found defective in the above checks and operate the receiver to determine if the trouble is corrected.

d. HIGH OR LOW FREQUENCY
OSCILLATOR.

CAUTION

Do not attempt to disassemble any part of

the high or low frequency oscillators until the trouble is definitely proven to exist within the sealed cover. Each oscillator unit was accurately calibrated when installed at the factory and if a unit is loosened or removed from the equipment the calibration will be destroyed.

(1) OPERATIONAL CHECK.

(a) EQUIPMENT REQUIRED. — Receiver containing a beat frequency oscillator and having a frequency range of 450 to 550 kc to 2000 to 3000 kc.

Note

Any frequency measuring instrument may be used to determine if the oscillator unit is operative.

(b) PROCEDURE. — The oscillator unit should be checked while still in the receiver before disassembling any part of the unit. To check the unit proceed as follows:

1. Measure the plate and heater voltage at the connector jack to make certain the voltages are correct.

2. Unsolder and remove the wire from terminal number 4 on the connector jack.

3. Solder a short piece of insulated wire to the above terminal.

4. Connect an insulated wire to the antenna terminal of the test receiver.

5. Twist the insulated wire from the receiver around the wire that is soldered to the oscillator unit connector jack but do not make a connection to the wire.

6. Turn the receiver and test receiver on.

7. Operate the MCW-CW switch to the MCW position for checking the high frequency oscillator; check the low frequency oscillator with the CALIBRATE dial turned on.

8. Tune the test receiver from 450 to 550 kc for checking the low frequency oscillator unit or 2000 to 3000 kc for the high frequency oscillator unit. If no signal can be heard, the oscillator unit is defective.

(c) REPLACEMENT OF TUBE.

1. Remove the four seal headed screws which hold the tube cover to the unit and lift the tube cover off.

CAUTION

Hold the oscillator unit to remove strain when the tube is pulled out and a tube is being inserted.

2. Insert a tube of the proper type that is known to be in good condition.

3. Before replacing the tube cover, turn the receiver on to ascertain if the trouble is corrected.

4. If the trouble is corrected, replace the

tube cover. Use new rubber gaskets for the screws and tube cover.

5. Check the oscillator unit frequency for changes caused by the tube now in use.

(d) REPLACEMENT OF HIGH FREQUENCY OSCILLATOR UNIT.

1. Set the TUNING control at 3.5 mc and the BAND switch "B".

2. Remove the front panel of the receiver.

3. Remove the dial from the Autotune head in front of the oscillator unit.

4. Remove the Autotune head.

CAUTION

Do not move the line shaft or the gears in the Autotune head just removed.

5. Disconnect and remove the cfi unit from the receiver. The cfi unit is bolted to the main chassis by four captive screws which are observed from the bottom of the receiver.

6. Loosen the Bristo set screws in the collar connecting the oscillator tuning shaft.

7. Unscrew the screws which hold the oscillator unit to the Autotune casting and remove the

defective oscillator through the space made by the removal of the cfi unit.

8. Install the new oscillator unit in the receiver using the screws that were removed from the front plate of the defective unit.

9. Replace the cfi unit and restore the connections.

10. Reassemble the Autotune head, dial and front panel but do not tighten the Bristo screws in the collar which fastens to the oscillator unit shaft. (The dial must be set at 3.5 mc band "B" before reassembling).

CAUTION

Do not operate the Autotune mechanism until all of the following adjustments have been made with manual tuning.

11. Unlock both Autotune controls.

12. Operate the CALIBRATE dial to the "0" position.

13. Short or block the calibrate switch to allow the 1-f oscillator and the cfi unit to operate.

14. Tune the test receiver to 3.0 mc on band "B".

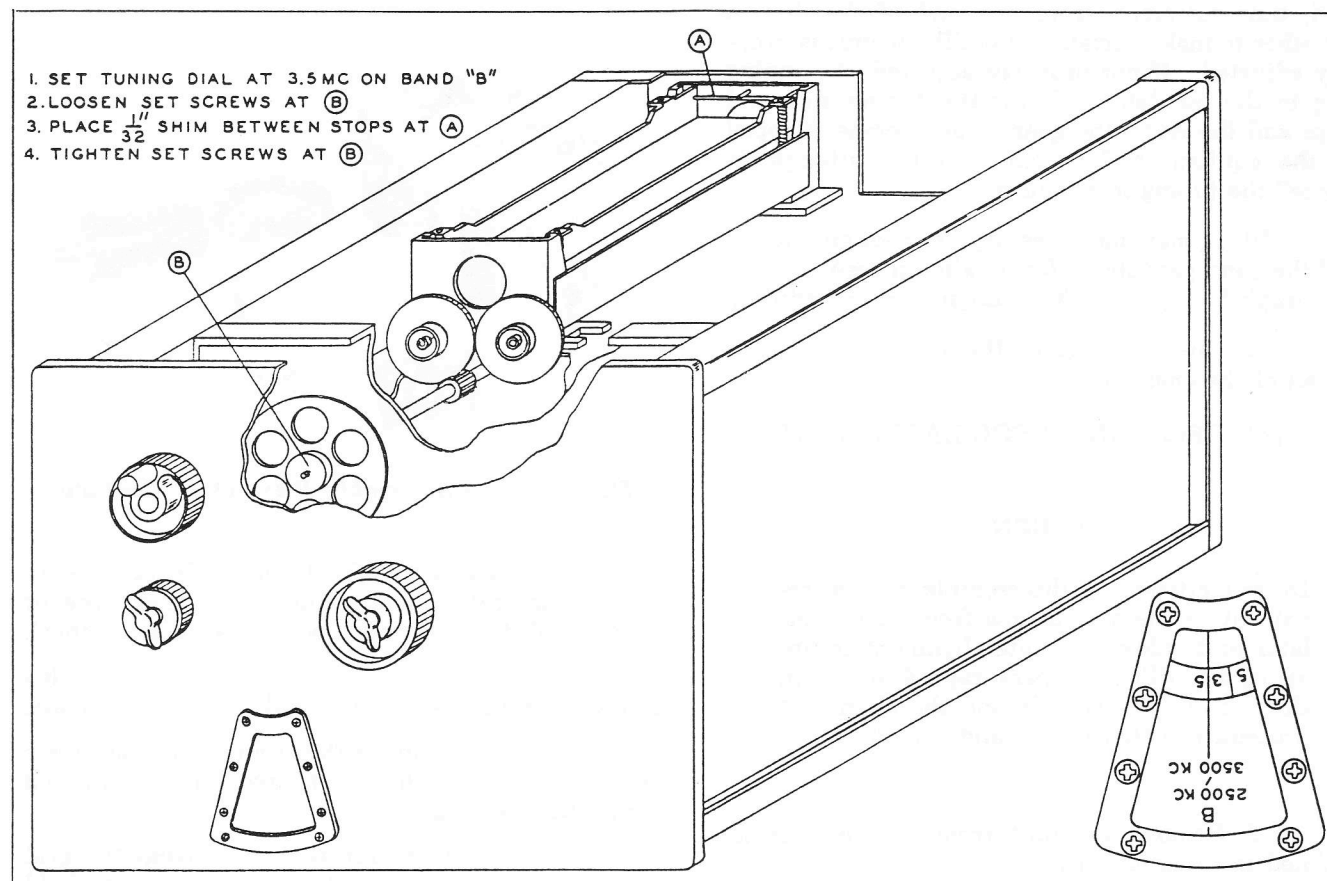


Figure 5-1. Oscillator Alignment

15. Couple the test receiver to terminal number 4 on the high frequency oscillator and tune the oscillator until a beat note is heard in the test receiver. The oscillator must be turned by grasping the oscillator shaft with a thin pliers.

16. While listening to the output of the R105/ARR-15 receiver, tune the high frequency oscillator to zero beat with the CFI signal which should be heard at three and one-half mc.

17. Turn the TUNING dial to 3.5 mc and lock the set screws in the coupling collar on the oscillator shaft. (The incoming signal is five-tenths mc higher in frequency on this band therefore the dial would be set at 3.5 mc when the oscillator is at 3.0 mc).

18. With the tuning dial set at 3.5 mc there should be approximately 1/32 inch clearance between the fixed stop and the movable stop on the tuning coil platform, see Item A figure 5-1. If this clearance is not 1/32 inch, the set screws in the large gear, Item (B) figure 5-1 on the front end of the tuning shaft should be loosened and the clearance between the stops adjusted by inserting a 1/32 inch shim between the stops after which the set screws should be tightened and the shim removed.

19. Before the Autotune mechanism is operated, tune manually from one end of the dial to the other to make certain the oscillator unit is properly adjusted. If not properly adjusted, the tuning slug in the oscillator will hit the tuning slug end stops and the Autotune gears may become stripped or the equipment damaged. Do not attempt to "force" the tuning mechanism.

20. It may be necessary to re-align the r-f and the band pass stages for maximum results. (See paragraph 8. d. page 5-18 for alignment procedure.)

21. Check and reset the Autotune controls for all of the channels.

(e). REPAIRING OSCILLATOR UNITS.

CAUTION

Do not attempt to disassemble and/or repair either the high or low frequency oscillator unit unless complete alignment equipment, as outlined in paragraph 4, d. (f) in this section, is available and the alignment procedure is thoroughly understood.

1. Remove the unit from the receiver as outlined in paragraph (d).

2. Remove the eight seal headed screws

which fasten the tube cover and connector plug to the unit cover.

3. Remove the tube cover and pull the tube and plug from the unit.

4. Remove the three seal headed screws on the rounded end of the unit which fasten the unit cover to the front plate. Remove the unit cover.

5. Check all the components and replace any that are found defective.

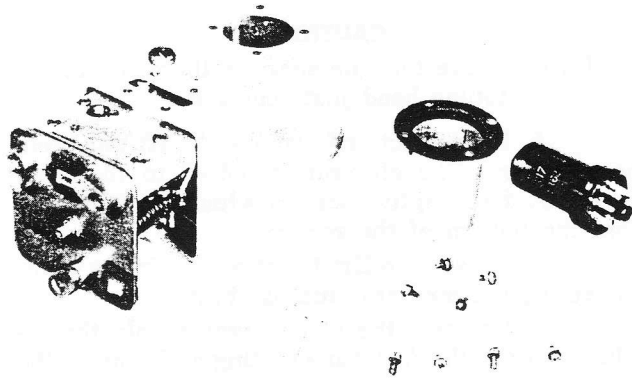


Figure 5-2. Disassembly View of HF Oscillator

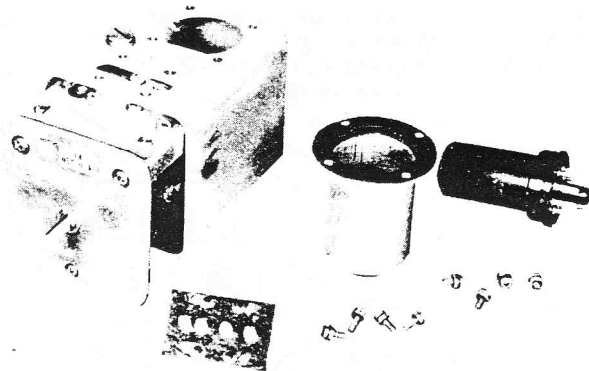


Figure 5-3. Disassembly View of LF Oscillator

a. REPLACING COMPONENTS. — To replace the grid inductor, tuning slug, lead screw or rotary seal, the unit must be further disassembled.

(1) Remove the three seal headed screws from the countersunk holes in the front plate.

(2) Remove the front plate, lead screw and tuning slug with care to avoid losing the end thrust ball bearing.

(3) Unsolder the wires from the grid inductor and remove the three screws which hold the grid inductor to the end plate.

(4) To replace the rotary seal, loosen the two Bristo set screws in the rotary seal collar and pull this section of the rotary seal off the threaded end of the lead screw, after the tuning slug has been removed. The other section of the rotary seal is pressed into a seat on the front plate and may be pried out.

(5) When the grid inductor is replaced, leave the three screws slightly loose.

(6) If the lead screw or the rotary seal is replaced, press the rotary seal onto the lead screw but do not tighten the Bristo set screws into the collar.

(7) Press the remaining section of the rotary seal into the countersunk seat on the front plate.

(8) Grease the lead screw and screw into the tuning slug.

(9) Place a small portion of grease on the thrust end of the lead screw and the ball bearing before inserting the tuning slug into the tuning inductor.

(10) Loosen the lock nut on the front bearing and unscrew the bearing a few revolutions.

(11) Grease the bearing slightly and replace the end plate.

(12) Replace the rubber gaskets on the three screws and tighten the screws firmly.

(13) Space the grid inductor evenly around the tuning slug and tighten the screws into the grid inductor base.

(14) Solder the wires that were disconnected in step (3) above, into place.

(15) Adjust the front bearing and tighten the lock nuts. Repeat this procedure until no end play can be felt and the lead screw runs smoothly and does not bind at any position of the tuning slug.

(16) Adjust the rotary seal collar, by sliding the collar until the spring is compressed to one quarter of the extension and tighten the two Bristo set screws into the rotary seal collar.

(17) Assemble the cover, plug, tube and tube cover, using new rubber gaskets on both the covers and screws. The unit must now be aligned and tested.

(f) OSCILLATOR ALIGNMENT. — The alignment of the high and low frequency oscillator units is important for proper operation of the receiver. An oscillator must be aligned after being disassembled.

1. EQUIPMENT REQUIRED.

- a. Navy LM Series instrument.
- b. Oven - refrigerator

Temperature range: Adjustable from -40°C (-40°F) to $+70^{\circ}\text{C}$ ($+158^{\circ}\text{F}$).

2. PROCEDURE.

a. Connect a 12 volt supply to terminals 1 and 2 of the connector plug.

b. Connect the positive voltage of a 250 volt supply to terminal number 3 and the negative voltage to terminal number 2 of the connector plug.

c. Connect the frequency measuring instrument to terminal number 4 of the connector plug.

d. Attach an indicator knob and dial to the oscillator lead screw shaft.

e. Adjust the frequency measuring instrument for 450 kc for the low frequency oscillator (2000 kc for the high frequency oscillator) and rotate the oscillator dial to this frequency.

f. Note the dial setting and rotate the oscillator unit dial exactly five revolutions for the low frequency oscillator. The frequency should measure exactly 550 kc. (The high frequency oscillator unit output should measure exactly 3000 kc after the dial has been rotated exactly 10 revolutions).

g. If the frequency measures higher or lower, remove the cap screw that is located between the plug and the tube, on top of the unit and adjust the variable capacitor to compensate for the error.

h. Repeat steps e., f., and g. until the exact number of revolutions of the dial will cover the oscillator frequency range.

i. Remove the tube cover and place the unit in an oven that is at a temperature of $+70^{\circ}\text{C}$ (158°F) for several hours to dehydrate and age the components within the oscillator unit.

j. Replace the tube cover and cap screw to seal the unit.

k. Repeat the above steps a. to h. to check any variation which may have occurred.

l. Connect the oscillator unit as in the above steps (a.), (b.), and (c.) and place the unit in the oven-refrigerator. (The unit must be sealed.)

m. Run frequency and temperature charts at the high and low frequency end of the oscillator frequency range while slowly changing the temperature from -40°C (-40°F) to $+70^{\circ}\text{C}$ ($+158^{\circ}\text{F}$).

n. If the frequency drifts more than plus or minus one kc, compensate for the drift by replacing the temperature compensating capacitors, with capacitors of a plus or minus temperature coefficient, whichever is required to correct the drift.

o. When a change is made, repeat the above steps (l.) to (n.) When the performance is satisfactory the unit may be installed in the receiver.

p. Install the hf oscillator in the receiver using instructions outlined in paragraph (d) REPLACEMENT OF HIGH FREQUENCY OSCILLATOR UNIT.

5 REPLACEMENT OF DIAL LAMPS.

Each of the two dial windows on the front panel is illuminated by a twenty eight volt dial lamp. The two lamps are wired in series and are impressed across the 26.5 volt supply. The receiver chassis must be removed from the cabinet to replace the dial lamps. Refer to paragraph 1, d(2), page 5-1, in this section, for the procedure to remove the chassis from the cabinet.

6. SPECIAL MAINTENANCE.

a. MECHANICAL ADJUSTMENT AND REPAIR.

(1) AUTOTUNE SYNCHRONIZATION.—

The synchronization of an Autotune system involves the adjustment of the relative angular positions of the cam drums and the seeking switch. This adjustment insures that the channel chosen by the switch will always be selected properly. The synchronizing adjustment is accomplished by the following procedure.

(a) CONTROL UNIT.

1. Remove the control knobs and panel from the receiver.

2. Remove the necessary pieces of apparatus so that the front of the Autotune units are accessible. It will not be necessary to operate the unit under power to perform the synchronization nor will it be necessary to uncover the control unit.

3. Insert the synchronizing wrench (use a number 10 Bristo wrench) into the right-hand end of the line shaft.

4. Rotate the shaft counterclockwise until the red flag observed through the hole in the top of the control unit, disappears and reappears with a sudden snap.

5. Stop rotating the line shaft, as near as possible, at the point where the red flag snaps into position under the inspection opening in the control unit.

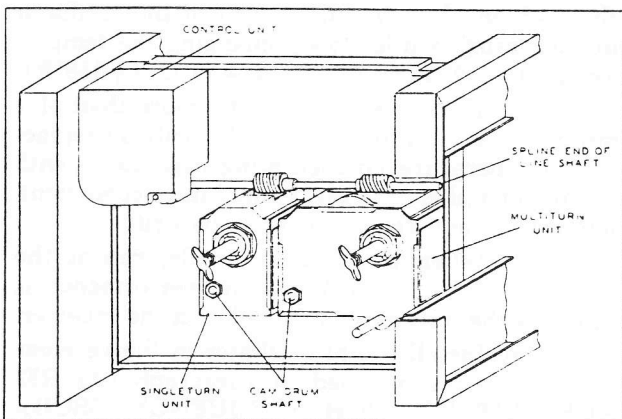


Figure 5-4. Autotune Synchronism Adjustments

6. Rotate the line shaft in the opposite direction six to six and one-fourth revolutions and stop.

(b) MULTITURN UNIT.

7. Insert a number 10 Bristo wrench into the end of the shaft of the cam drum of the multi-turn unit. (Refer to figure 5-4.)

8. Using the wrench, rotate the cam drum as far as possible in a counterclockwise direction.

9. While holding the cam drum as indicated in step 8., loosen the nut that is located on the end of the cam shaft by rotating the nut in a clockwise direction.

10. Again, using the Bristo wrench, rotate the cam drum as far as possible in a counterclockwise direction. (The pawl must be engaged with the stop ring before making this adjustment.)

11. Tighten the nut. (Rotate in a counterclockwise direction.)

(c) SINGLETURN UNIT.

12. Insert the Bristo wrench into the end of the cam drum. (Refer to figure 5-4.)

13. Rotate the cam drum as far as possible in a clockwise direction.

14. Loosen the nut on the end of the cam shaft by rotating the nut in a counterclockwise direction.

15. Rotate the shaft as far as possible in a clockwise direction. (The pawl must be engaged with the stop ring before making this adjustment.)

16. Tighten the nut.

Having completed the above adjustments, the Autotune mechanism will be properly synchronized. To check the synchronization, select an Autotune channel and note the position of the pawls in slots of the cam drums. At room temperature and with normal voltage applied to the motor the pawl should be approximately in the center of the slot on both units. After the synchronization has been checked and the mechanism is found to be operating properly, secure each item that has been loosened with a drop of liquid staking compound.

(2) AUTOTUNE REPAIR.

CAUTION

Do not attempt to repair the Autotune mechanism until all methods of adjustment have been tried and have failed and the following operational checks have been performed.

(a) The following chart will assist in localizing trouble in the Autotune mechanism.

Symptoms	Possible Source of Trouble	Remedy
Autotune system continues to run, recycling instead of reversing.	<ol style="list-style-type: none"> 1. Motor reversing switch S-109 not operating properly. 2. Timing cam switch S-107 not operating properly. 3. Motor does not reverse properly. 	<ol style="list-style-type: none"> 1. Clean, readjust or replace switch. 2. Clean and adjust switch. 3. Replace motor.
Erratic operation.	<ol style="list-style-type: none"> 1. Faulty operation of tuning switch cam. 	<ol style="list-style-type: none"> 1. Move seeking switch S-106 clockwise until the system begins to operate. The distance moved should be a noticeable amount (about 5 degrees). Readjust star cam.
Intermittent operation.	<ol style="list-style-type: none"> 1. Control unit contacts need cleaning. 	<ol style="list-style-type: none"> 1. Burnish the contacts to a smooth glossy surface.
One unit will not position.	<ol style="list-style-type: none"> 1. Check defective unit by rotating locked unit control knob throughout the range of rotation attempting to engage the pawl. 	<ol style="list-style-type: none"> 1. If the pawl can be engaged by this means, resynchronization is probably necessary.
Resynchronization does not remedy non-positioning of unit.	<ol style="list-style-type: none"> 1. Foreign matter in unit. 2. Broken, unhooked or weak pawl spring. 3. "Sticky" pawl. 	<ol style="list-style-type: none"> 1. Clean unit. 2. Reattach or replace. 3. Can be made to operate in an emergency by working in a few drops of AN-0-4 oil into the pawl stack.

(3) RELAYS.—The relays in this equipment will not require service unless a short circuit has caused the contacts to be burned and pitted or damage has resulted from rough handling or improper treatment of the contacts. When it is necessary to clean and readjust a relay, do it carefully. Handle the relay as you would an expensive watch or fine meter. To clean the flat surface contacts, use only a crocus cloth or burnishing tool. Make certain all burns are removed from the contact points and that the surfaces are parallel. Make the contact adjustments carefully. Do not bend the contact spring arms. If the contacts do not close properly, bend the point tip end of the spring slightly. Check and re-check until the spacing is exactly what it should be. If a relay is badly damaged, replace the relay.

(4) SWITCH MAINTENANCE.—Maintenance of switches in this equipment primarily involves adjusting and cleaning. The adjustment and cleaning of the switches should follow the same procedure and use of the same materials as recommended for relays, paragraph 6, (3), on this page, 5-11.

b. AUTOTUNE LUBRICATION. — Under ordinary operating conditions the Autotune mechanism will not require any lubrication for the lifetime of the equipment. If, however, the equipment is operated in a hot arid climate it may be necessary to lubricate the oilite bearings, replenish the oil supply of the oil retainers, and insert new worm gear lubricators into the holders once a year. The lubricants recommended are shown on the following lubrication chart:

LUBRICATION CHART

ASSEMBLY	PART	LUBRICANT				LUBRICATION PERIOD	PROCEDURE		
		CODE	MFR. AND MFR'S TYPE	SPECIFICATIONS					
				ANA	ARMY			NAVY	BRITISH
Autotune Casting	Oilite Bearings	A	Standard Oil Co. of N.J. BE-19584	AN-0-4			DTD 561	Annually	Apply only amount bearing will retain.
Autotune Unit	Pawl Stacks	A	Standard Oil Co. of N.J. BE-19584	AN-0-4				Annually	Apply sparingly with camel hair brush. Remove excess lubricant.
Autotune Unit	Felt Washers	A	Standard Oil Co. of N.J. BE-19584	AN-0-4			DTD 561	Annually	Apply only amount bearing will retain.
Autotune Unit	Spur Gears	D	DOW Corning #7					Annually	Apply sparingly with camel hair brush, remove excess lubricant.
Autotune Casting	Worm felt wick lubricator		Cities Service 7249M					Annually	Replace with new impregnated wicks.
Autotune Casting	Worms, line shaft gear box, thrust bearing	C	Cities Service PD-535A	AN-G-3			DTD 577	Annually	Apply sparingly with camel hair brush, remove excess lubricant.
Slug Platform Drive	Gear Box	B	Cities Service 51A	*				Annually	Repack if necessary.

*AN-G-3 may be used for lubricant B (Cities Service 51A) if extremely low temperature operation is not required.

AN 16-30ARR15-3

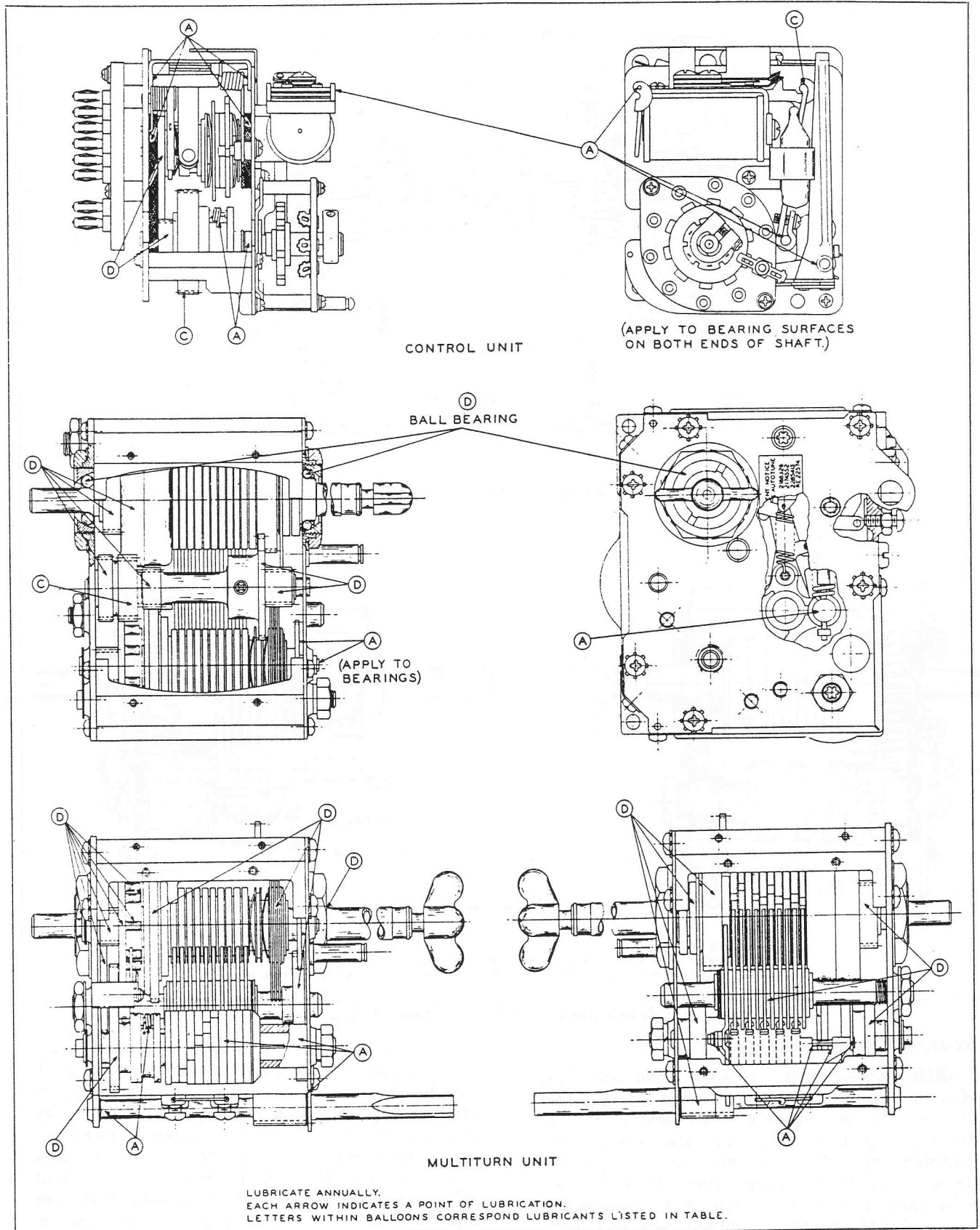
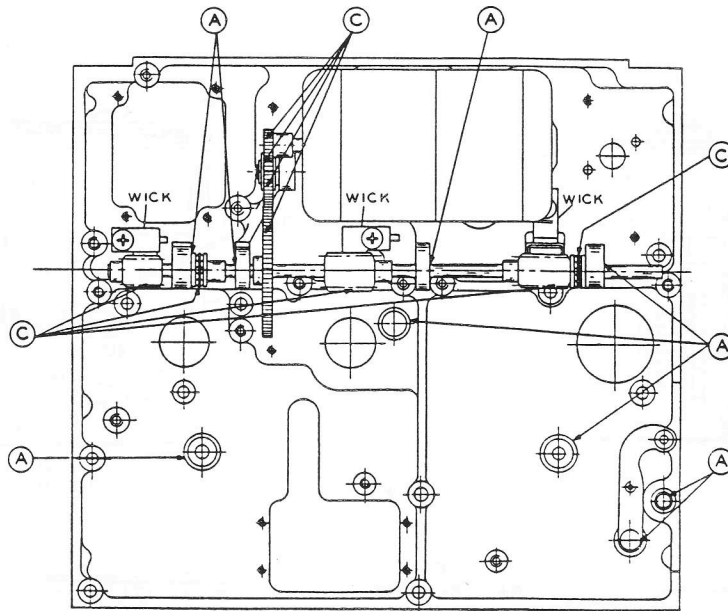
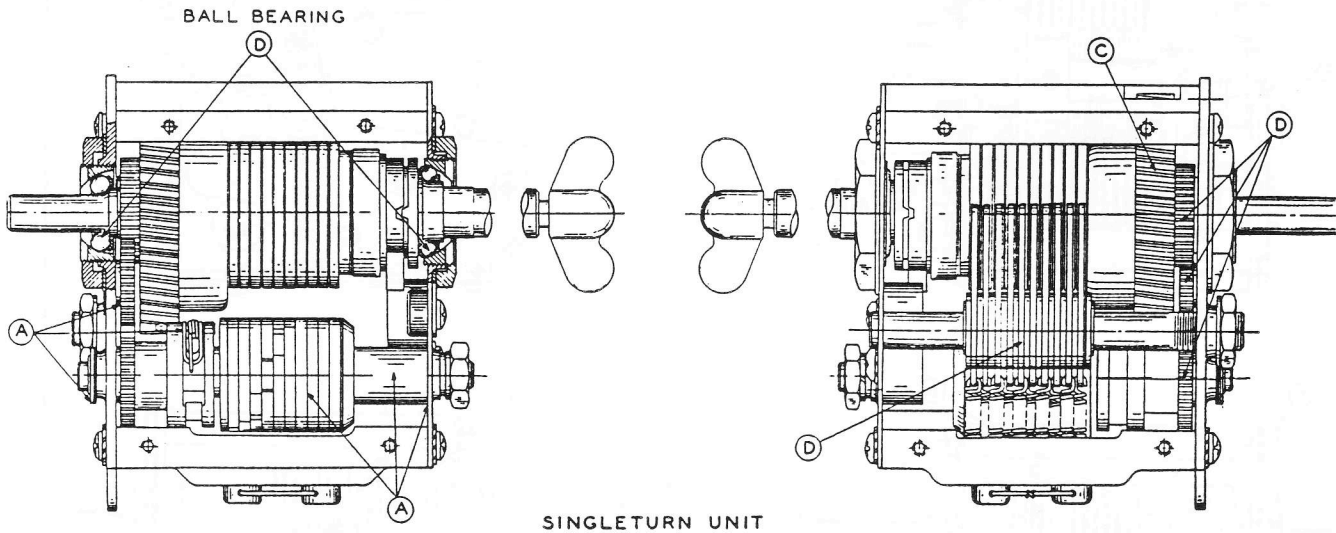


Figure 5-5. Lubrication Chart (Page one of two pages)



AUTOTUNE CASTING



LUBRICATE ANNUALLY.
EACH ARROW INDICATES A POINT OF LUBRICATION.
LETTERS WITHIN BALLOONS CORRESPOND TO LUBRICANTS LISTED IN TABLE.

Figure 5-5. Lubrication Chart (Page two of two pages)

7. DYNAMOTOR MAINTENANCE.

a. BRUSHES.—Replace brushes when less than one-fourth inch long, measured to the spring. The brush pressure is considered satisfactory if one-fourth inch or more of the spring extends out of the brush holder when the screw cap is removed and the brush is touching the commutator. New brushes may be sanded in with a strip of 4/0 sandpaper slipped under the brush and pulled back and forth over a suitable arc of the commutator. It is preferable that new brushes be run in for several hours at

no load, or a light load, to obtain the proper fit before the machine is required to carry the full load. When brushes are removed for any reason, replace each brush in the same holder with the polarity marks face upward. If a brush pigtail is broken or loose in the brush or end cap, the current will have a tendency to go through the brush spring. This condition will cause the spring to over-heat, lose temper and fail to give the proper brush pressure.

b. ARMATURE.—The armature should be removed as follows:

(1) Remove the covers from both ends of the dynamotor.

(2) Remove the brush holder caps and brushes from both the high and the low voltage ends of the commutator.

CAUTION

Notice that each brush is marked so that the brush may be replaced in the same holder and in the same position in the holder.

(3) Blow the dust and dirt from the shield and windings and disconnect the leads from the field coils to the brush holder on the high voltage end at the brush holder terminals.

(4) Remove the nuts from the clamp bolts and remove the end shield.

(5) Carefully remove the armature so as not to lose the end spacers.

c. COMMUTATOR.—A highly polished commutator is very desirable. A dark colored commutator should not be mistaken for a burned commutator. If the surface is smooth and polished and the commutation is satisfactory, the commutator should not be resurfaced. Slight sparking is not necessarily evidence of poor commutation. If the surface of a commutator is dirty, use a clean cloth moistened with a cleaning fluid, such as petroleum spirits, kerosene, or gasoline for cleaning and then rewipe with a dry cloth. Keep the bearings and housing clean. Remove the end covers and blow the dust and dirt out after each 300 hours of operation. This cleaning should also include removing the brushes and wiping the inside of the brush holders and the external surface of the brushes. If any mica of the undercut commutator extends up to the commutating surface, the mica should be undercut. For turning down the commutator or for extensive undercutting, remove the armature from the dynamotor and place in a lathe.

d. BEARINGS AND LUBRICATION. — The bearings are designed for long life but should be replaced if the bearings are loose on the shaft or if not otherwise operating satisfactorily. If the dynamotor is overhauled after each 300 hours of operation, no lubrication will be required between overhauls. To lubricate the bearings, remove the end cover and blow out the dust and dirt. Remove the screws that hold the end shield bearing retainer. Remove the retainer, being careful not to lose any washers from the end of the shaft. Clean out all the old grease. Apply three or four drops of light machine oil to the balls and repack the outer side of the bearings with a small amount of grease. Keep dirt from entering the housing and do not allow grease or oil to drop onto the commutator. Replace the washers and the end shield bearing retainer and cover. If the bearings are to be replaced, it will be necessary to remove the armature. If a puller is not available to remove the bearings, clamp the outer race firmly in a vice and drive the bearing off the shaft by holding a punch against the end of the shaft and tapping the punch lightly with a hammer. Shiming should be done using washers equally divided at both ends. End play of approximately .015 inch maximum is permissible. Whenever a bearing is removed from the housing, wipe the housing with a clean cloth and lubricate the housing sparingly with light machine oil. The inner race fits the shaft with a light press fit and some selection of bearings may be necessary to find one that is not too loose. The outer race should have a sliding fit in the housing. A small piece of pipe with the end smooth and slightly larger than the shaft is useful to press a new inner race onto the shaft. Do not exert pressure on the outer race of a bearing that is being pressed onto the shaft. After replacing a bearing, reassemble the dynamotor and make certain that the armature revolves readily without binding.

e. TROUBLES. — The following chart lists the troubles most often encountered in the operation of a dynamotor and the causes and correction of each:

Symptoms	Possible Cause of Trouble	Remedy
Dynamotor stops or fails to start.	<ol style="list-style-type: none"> 1. Open or loose connections. 2. Shorted capacitor. 3. Brushes not seating properly due to a dirty, sticky or worn condition. 4. Poor commutation due to dirty, oily or rough commutator or high mica. 5. Worn bearings causing armature to strike pole faces or connections. 6. Defective armature. 	<ol style="list-style-type: none"> 1. Tighten connections. 2. Replace capacitor. 3. Remove brushes from holders and clean thoroughly. Seat brushes with 4/0 sandpaper, replace worn brushes. 4. Clean commutator and brushes. If commutator is rough, turn down commutator and undercut mica. 5. Replace bearings. 6. Replace defective armature.
Excessive arcing at the brushes.	<ol style="list-style-type: none"> 1. Poor commutation due to dirty, oily or rough commutator. 2. Brushes not seating properly due to a dirty, sticky, or worn condition or a twisted pigtail. 3. Brush spring weak or defective. 4. Short between commutator bars. 5. Open in armature coil. 	<ol style="list-style-type: none"> 1. Clean commutator and brushes. If commutator is rough, turn down with a lathe and undercut mica. 2. Clean brushes, untwist pigtail connector or replace brush assembly. 3. Replace brush assembly. 4. Clean slots or replace armature. 5. Replace armature.
Rapid wearing of brushes.	<ol style="list-style-type: none"> 1. High mica causing excessive arcing. 2. Dirty commutator. 	<ol style="list-style-type: none"> 1. Turn down commutator on a lathe and undercut mica. 2. Clean commutator and brushes.
Electrical noise in receiver.	<ol style="list-style-type: none"> 1. Sparking at commutator resulting from shorted or open capacitor or connection. 	<ol style="list-style-type: none"> 1. Replace capacitor. Tighten connections.
Mechanical noise and vibration.	<ol style="list-style-type: none"> 1. Armature striking internal wiring. 2. Armature. 3. Worn Bearings. 	<ol style="list-style-type: none"> 1. Rearrange internal wiring. 2. Replace bearings. 3. Replace bearings.

f. ARMATURE WINDING TEST.—Overheating, reduced speed, excessive arcing at the brushes or low output voltage indicates that an armature winding may be shorted. When one or more of the above conditions exists, measure the resistance between pairs of adjacent commutator bars, particularly on the high voltage end of the commutator. A reading between one pair of bars which is more than seven per cent higher or lower than the average of readings between other pairs of bars indicates an open or shorted winding.

8. RECEIVER ALIGNMENT.

a. GENERAL.—The following equipment is required to align the receiver r-f and i-f circuits: A signal generator covering the range 450 to 550 kc and 1500 to 18,500 kc, an adjustable range audio output meter suitably matched to the receiver output impedance of 300 ohms, and a non-metallic screwdriver alignment tool.

b. I-F CIRCUIT ALIGNMENT PROCEDURE.—The i-f channel should be aligned first. Proper alignment will be secured by the following procedure:

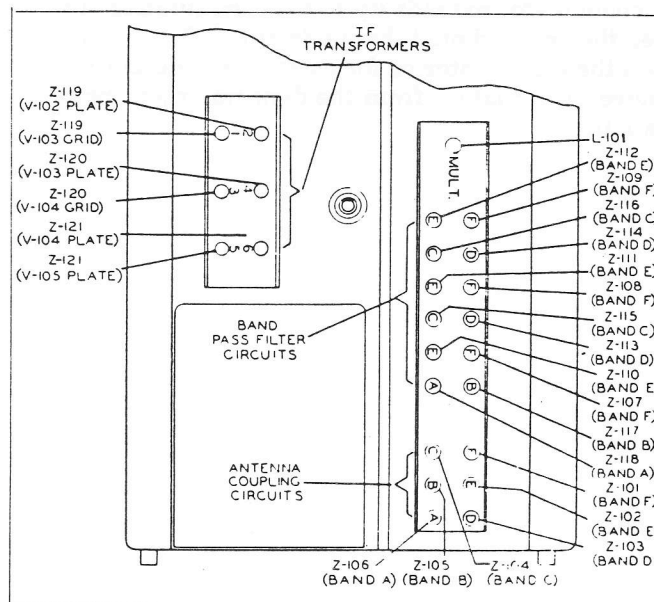


Figure 5-6. Tuned Circuit Locating Diagram, IF and Band Pass Adjustments

(1) Adjust the receiver for MCW operation.
 (2) Connect the output lead of the signal generator to the control grid of mixer tube V-102 (pin No. 4 of X-102). Connect the grounded lead to any convenient receiver chassis point.

(3) Connect the output meter to output jack J-111 and adjust the meter for the lowest range.

(4) Remove frequency multiplier tube V-109 from the receiver.

(5) Adjust the signal generator for exactly 500 kc, minimum signal output, 1000 cycle modulation on.

(6) Turn on the receiver and allow the unit to "warm up" for at least five minutes.

(7) Advance the signal generator attenuation control until a deflection is obtained on the output meter.

(8) Increase the signal generator output and increase the output meter range until a point is found where a further increase in signal generator signal does not cause a corresponding increase in output meter reading. Attenuate the signal generator until a drop of several db is observed in the output meter reading. This output meter reading must not be exceeded during receiver alignment since it indicates a safe margin below the avc threshold level.

(9) Since the first two i-f transformers are overcoupled, a special alignment probe containing a 10,000 ohm resistor is provided to be used in aligning these transformers. The probe will be found clipped to the chassis in the left side of the receiver. Refer to Figure 6-8.

(10) Insert connector on probe in the jack engraved "probe" located on the mounting board of C-125.

(11) Refer to Figure 6-7. The left side of the receiver will be found to have a shield containing three holes numbered 2-3-4 located over the pins of V-103 and V-104, sockets X-103 and X-104.

(12) Contact the terminal on Z-119, to which the coaxial cable is attached, with the probe and adjust i-f slug numbered "1" on the i-f platform for maximum output. Through the hole in the shield numbered "2" contact the transformer terminal with the probe and adjust i-f slugs numbered "2" on the i-f platform (see figures 5-6, 6-3 and 6-4) for maximum output meter readings. Repeat procedure for transformer terminals 2-3-4 and slugs 3-4.

CAUTION

Care must be exercised to constantly attenuate the signal generator during alignment procedure so that the output meter reading does not rise above the level determined in step (8). Failure to do this may result in misalignment of the i-f circuits.

(13) Repeat the adjustment of i-f slugs 1-2-3-4 in the same manner as outlined to correct for any interaction between the circuits.

(14) Rock the frequency control of the signal generator back and forth slowly to locate the "humps" that will be present in the i-f response curve obtained by the preceding tuning procedure. Record the frequency of these "humps" and the output level obtained on each.

(15) Adjust i-f slugs 5 and 6 for maximum output in such a manner as to favor the "humps" found in step (14) to obtain an equal response on each. The object is to obtain the maximum response possible while still maintaining the i-f band width obtained by the procedure for tuning i-f slugs 1-2-3-4.

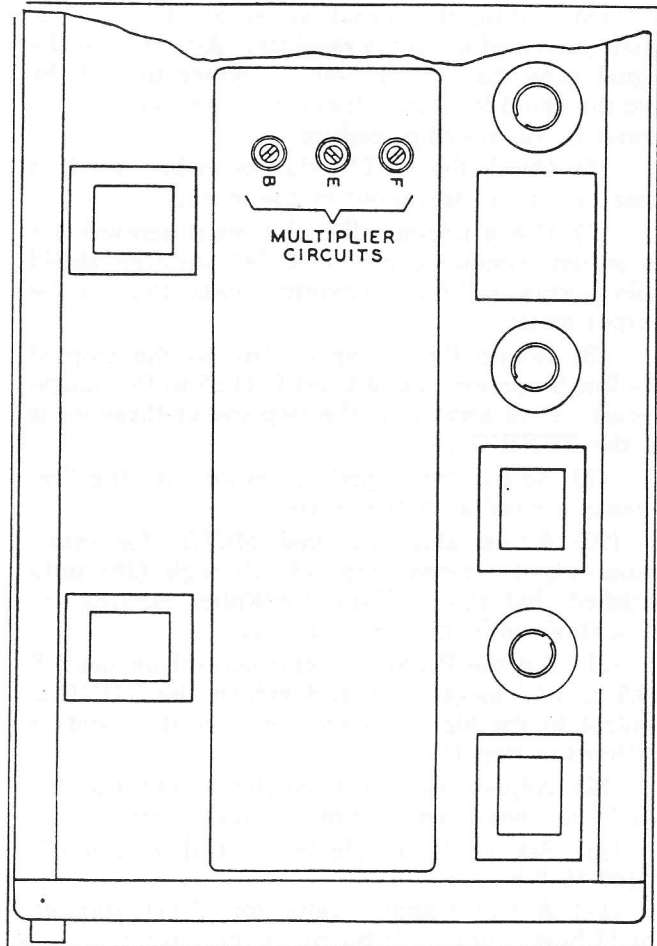


Figure 5-7. Tuned Circuit Locating Diagram, Multiplier Adjustments

c. MULTIPLIER ALIGNMENT.—The multiplier is aligned by means of the slug adjustment of L-101 and the adjustment of C-141, C-142, and C-143. The slug adjustment for L-101 is engraved MULT. and can be located by referring to figures 5-6, 6-3, and 6-4. Variable trimmer capacitors C-141, C-142 and C-143 are located on the right side of the receiver and the slotted shaft screwdriver adjustments are accessible through the holes in the shield engraved F, E and B. Refer to figures 5-7, and 6-6. To align the multiplier, proceed as follows:

(1) Connect the output lead of the signal generator to the antenna terminal of the receiver and

connect the grounded lead to any convenient receiver chassis point.

(2) Connect the output meter to output jack J-111, adjust the receiver for MCW operation, turn the receiver on and allow the unit to "warm up" for at least five minutes.

(3) Loosen the Autotune locking keys and set the BAND selector control for the 12.5 to 18.5 megacycle band (band F).

(4) Rotate the TUNING control to the stop on the high frequency end of the band, then back away from the stop from two or three turns of the TUNING control.

(5) Adjust the signal generator to the frequency arrived at on the receiver. Adjust both the signal generator and the output meter to find the avc threshold level as outlined in steps (7) and (8) under i-f alignment procedure.

(6) Check the MULT. slug to make sure it is near the end of travel out of the multiplier coil.

(7) Use a non-metallic alignment screwdriver to adjust trimmer capacitor C-143 through shield hole engraved F for a maximum indication on the output meter.

(8) Rotate the tuning control to the stop at the low frequency end of band F (12.5 to 18.5 megacycle). Back away from the stop two or three turns of the TUNING control.

(9) Adjust the signal generator to the frequency arrived at on the receiver.

(10) Adjust slug engraved MULT. for maximum output. Repeat steps (4) through (10) until satisfied that the oscillator multiplier circuits are "tracking" with the mixer circuits.

(11) Set the BAND selector control on band E (8.5 to 12.5 megacycle) and return the TUNING control to the high frequency end of the band as outlined in step (4).

(12) Adjust trimmer capacitor C-142 through shield hole engraved E for maximum output.

(13) Set the Band selector control on Band B (2500-3500 kc band).

(14) Adjust trimmer capacitor C-141 through shield hole engraved B for maximum output.

d. RF BAND PASS ALIGNMENT PROCEDURE.—To align the r-f band pass channels, proceed as follows:

(1) Rotate the TUNING control to the stop on the high frequency end of the band, then back away from the stop from two to three turns of the TUNING control.

(2) Adjust the signal generator to the frequency arrived at on the receiver. Adjust both the signal generator and the output meter to find the avc threshold level as outlined in steps (7) and (8) under i-f alignment procedure.

(3) Check the band pass and antenna coil tuning slugs of the band or bands to be aligned to make

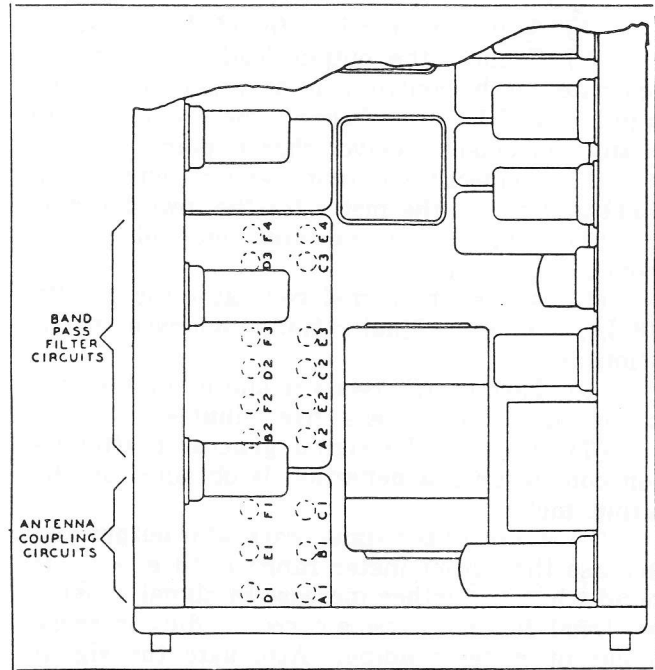


Figure 5-8. Tuned Circuit Locating Diagram, Band Pass and Antenna Coupling Circuits Adjustments

sure they are near the end of travel out of their respective coils. (Refer to figures 5-6, 6-3, 6-4 and 8-9.)

(4) Loosen the screws holding the protective covers of the alignment holes for the antenna coil and band pass coil assemblies, and slide these covers the length of the slots thus exposing the alignment holes. (Refer to figures 5-8, 6-1 and 6-2.)

(5) Stamped on the cover adjacent to each hole will be found a letter and a number. The letter corresponds to the band indicated on the tuning dial and the associated slug as shown on figures 5-6, 6-3 and 6-4. Use a non-metallic alignment screwdriver to adjust the trimmer capacitor corresponding to the band it is desired to adjust.

(6) Trimmer and slug adjustments are numbered consecutively beginning with the antenna coil. Adjustments for any one band should be made beginning with the highest numbered trimmer or slug adjustment and proceed to lower numbered trimmer and slug adjustments. It should be noted that the number of tuned circuits varies with the frequency bands, increasing in number as the frequency is raised.

(7) Each trimmer should be adjusted for maximum reading on the output meter, taking care to back off the signal generator output so as not to exceed the avc threshold level determined in step (2).

(8) After the high frequency end of a given band is adjusted according to the above procedure, tuning control should be rotated to the stop at the low frequency end of the band. Back away from the stop two or three turns of the TUNING control.

(9) Find the frequency with the signal gener-

ator and adjust the correspondingly designated slug for maximum output meter reading.

(10) Repeat steps (1), (7), (8) and (9) until satisfied that the mixer and antenna circuits are "tracking" with the oscillator multiplier circuits on any given band.

9. TROPICALIZATION.

a. GENERAL. — Tropicalization is the overall treatment of communication equipment with an organic coating to help prevent arcing, drifting and short circuits, due to excessive humidity and condensation prevalent in the tropics and the resultant growth of fungus. The places where shorts are most likely to occur, are usually where wires are soldered together, attached to tube sockets, capacitors, transformers, etc., in other words, on any exposed bare wires and their points of connection. The following instructions for the tropicalization of communication equipment deals with the use of INSL-X #27-SA salicylenilide air dry. Coating material containing a mercury-bearing fungicide should never be used on any part of the equipment which under any condition might be placed near a selenium rectifier, either by the design of the sub-assembly or by close contact thru packaging.

b. COATING MATERIAL.

- (1) INSL-X #27-SA contains salicylenilide.
- (2) This coating will air dry to touch in not more than fifteen minutes and dry hard in one hour.
- (3) The coating material as applied must contain 20 percent or more by weight of non-volatile matter.
- (4) The dried film is non-toxic to human beings, so that no injury or skin-irritation will be caused to personnel handling the treated equipment.

c. PREPARATION FOR TREATMENT.

- (1) Expose all parts, circuit elements, etc., so that the coating may be applied effectively and completely over all surfaces to be treated. On assemblies, the case, cans, covers, shields are removed to expose the parts. Where practicable, bend back untreated cables and loosen terminal boards to expose the underside.
- (2) Clean all surfaces of parts to be coated so that they are free from dirt, oil, grease or other foreign matter which would interfere with the adherence or proper function of the coating material. Scrape off all visible deposits of rosin. The use of solvents is not advisable here as it tends to spread a thin coat of rosin over a large area.
- (3) Mask all surfaces or parts where the coating application will interfere with the operation or performance of the equipment. The following are examples of surfaces which are not to be treated.
 - (a) Contact portion of: binding posts, con-

nectors, fuses, jacks, keys, plugs, relays, sockets, switches and variable capacitors.

(b) Surfaces which rub together for electrical or magnetic contact such as those in: bearings, contact fingers, potentiometers, shafts, shields and relays.

(c) Components, parts, and materials such as: cables with plastic insulation, ceramic or mica dielectric capacitors.

(4) Tube socket contacts may be masked by using dummy tubes to protect points of contact.

(5) All surfaces to be coated must be completely dry. Preheating may be necessary to dry parts, if so, the preheating temperature must be safely below the point which may damage the materials.

(6) The same masking materials ordinarily used in painting may be utilized.

d. METHODS OF APPLICATION.

(1) Spraying.

(a) Use a spray gun of a size suitable to the particular operation. The correct amount of pressure applied to the spray gun should be determined by actual experimenting. The ideal pressure will give a wet, even coating. Too great a pressure will give a dry spray. Too wet a spray may give runs and sags.

(b) Spray the equipment from as many directions and angles as is necessary to insure complete coverage with a wet coat.

(c) Surfaces that can not be reached with the spray should be finished with a brush application.

(2) Brushing.

(a) On components requiring extensive masking, brush application of the coating material may prove more efficient than spray application.

(b) Use a container with an opening just large enough to admit the brush.

(c) Place as little coating material in the container as possible. Always fill containers from safety cans. These precautions minimize danger from toxic fumes. Evaporation is also minimized, thus avoiding changes in viscosity which make the material hard to apply.

(d) Apply the coating to the surface of the parts to be treated, with the same precautions used with ordinary painting or varnishing. Avoid running, lumping, or gathering of the coating material into drops. Apply in such a manner that the dried film shall have a clear smooth finish free from defects such as bubbles and wrinkles.

e. DRYING.

(1) Dry the equipment under a hood, or in a well ventilated room, to avoid possible toxic effects of solvent fumes.

Section V
Paragraphs 9.e.-9.f.

AN 16-30ARR15-3

(2) The temperature should be between 21.1°C (70°F) and 37.8°C (100°F). The air must be circulating in order to get quick, complete evaporation of liquids.

f. PROTECTION FROM TOXIC EFFECTS. —
The greatest danger from any possible effects will

be at the moment of evaporation. Proper care in drying will minimize this danger. Special clothing is not required except for the few people who are allergic to the compounds used. Respirators will be necessary only where a heavy concentration of spray is present, or wherever the use of paint or clear lacquer would require this precaution.

NOTES:

1. Test Instruments

- (a) 1000 ohms per volt
 TS-297/U Multimeter or
 Weston 663 } alternates
 Simpson 443
- (b) 20,000 ohms per volt
 TS-352/U Multimeter or
 Navy "OE" } alternates
 Simpson 260
 Hickock 133

- 2. All readings made to ground with input voltage of 27 volts.
- 3. First reading made with 20,000 ohm per volt meter and second reading made with 1000 ohm per volt meter.
- 4. If only one reading is shown, values are identical with both meters.
- 5. Meter scales (letter suffixes) are as follows:
 A—2.5 v C—50 v
 B—10 v D—250 v

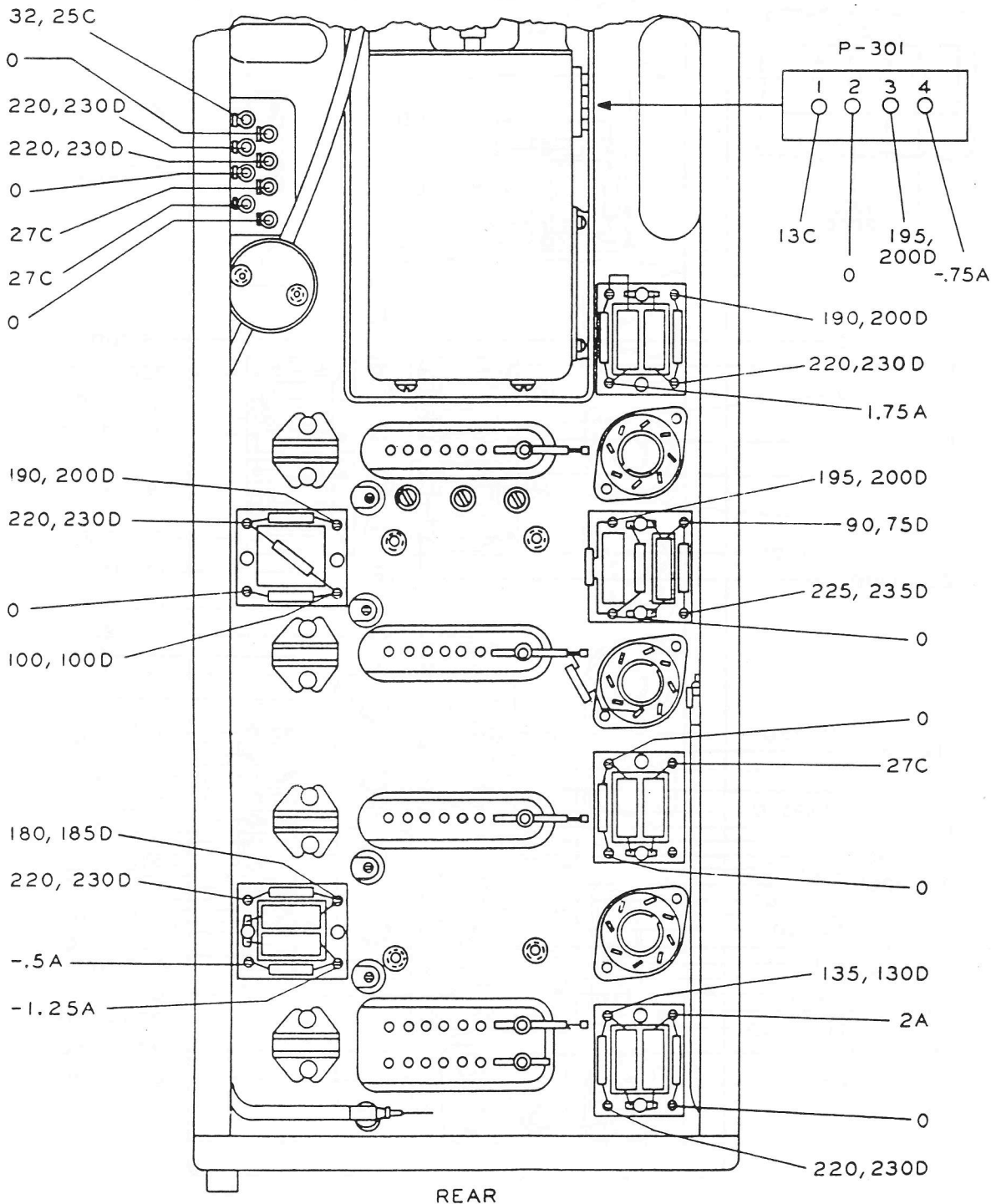


Figure 5-9. Voltage Measurements — Right Side

NOTES:

1. Test Instruments
 - (a) 1000 ohms per volt
 - TS-297/U Multimeter or Weston 663
 - Simpson 443 } alternates
 - (b) 20,000 ohms per volt
 - TS-352/U Multimeter or Navy "OE"
 - Simpson 260 } alternates
 - Hickock 133

2. All readings made to ground with input voltage of 27 volts.
3. First reading made with 20,000 ohm per volt meter and second reading made with 1000 ohm per volt meter.
4. If only one reading is shown, values are identical with both meters.
5. Meter scales (letter suffixes) are as follows:

A—2.5 v	C—50 v
B—10 v	D—250 v

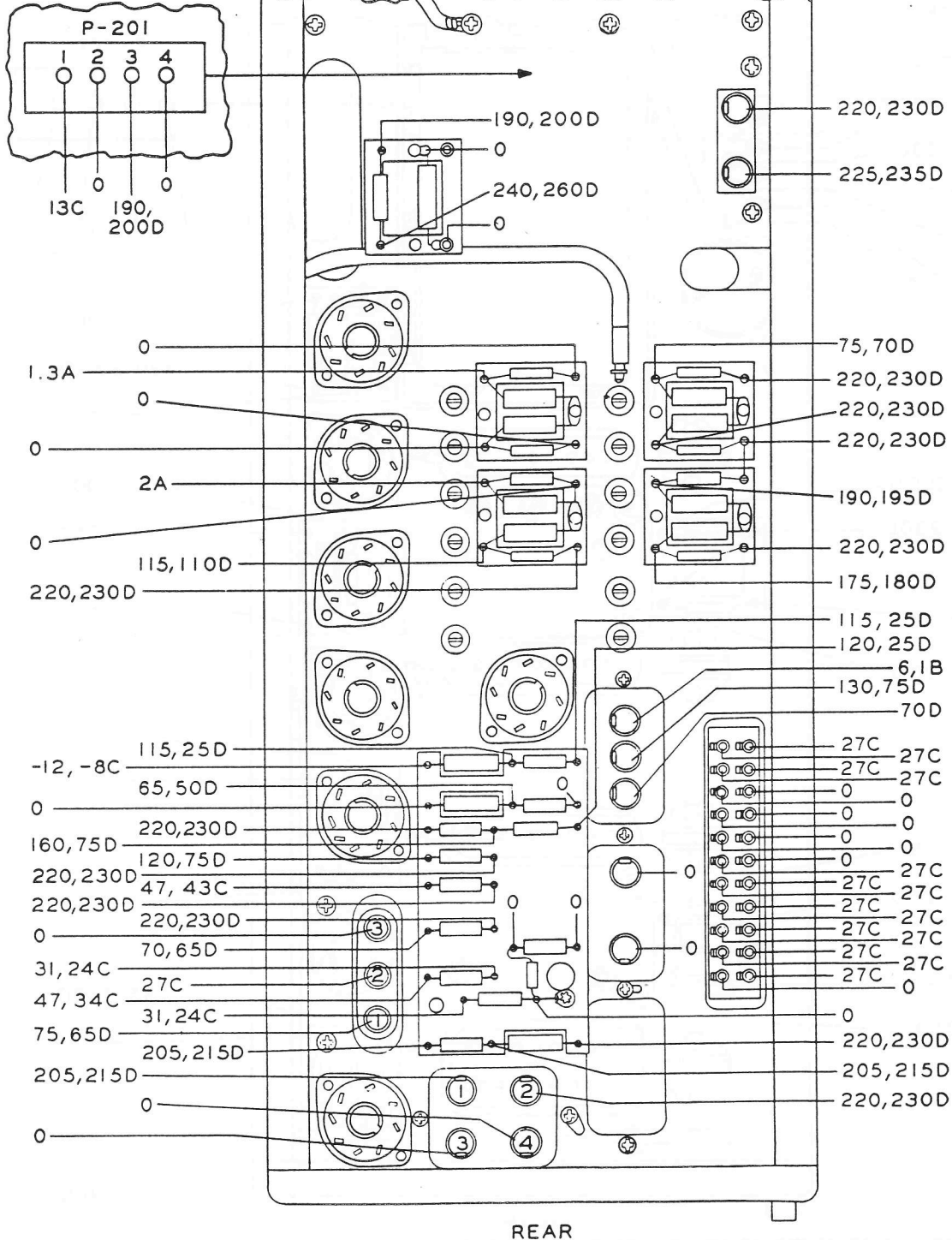


Figure 5-10. Voltage Measurements — Left Side

AN 16-30ARR15-3

NOTES:

1. Test Instruments

- (a) 1000 ohms per volt
 - TS-297/U Multimeter or
 - Weston 663
 - Simpson 443
 } alternates
- (b) 20,000 ohms per volt
 - TS-352/U Multimeter or
 - Navy 'OE'
 - Simpson 260
 - Hickock 133
 } alternates

- 2. All readings made to ground with input voltage of 27 volts.
- 3. First reading made with 20,000 ohm per volt meter and second reading made with 1000 ohm per volt meter.
- 4. If only one reading is shown, values are identical with both meters.
- 5. Meter scales (letter suffixes) are as follows:

A—2.5 v	C—50 v
B—10 v	D—250 v

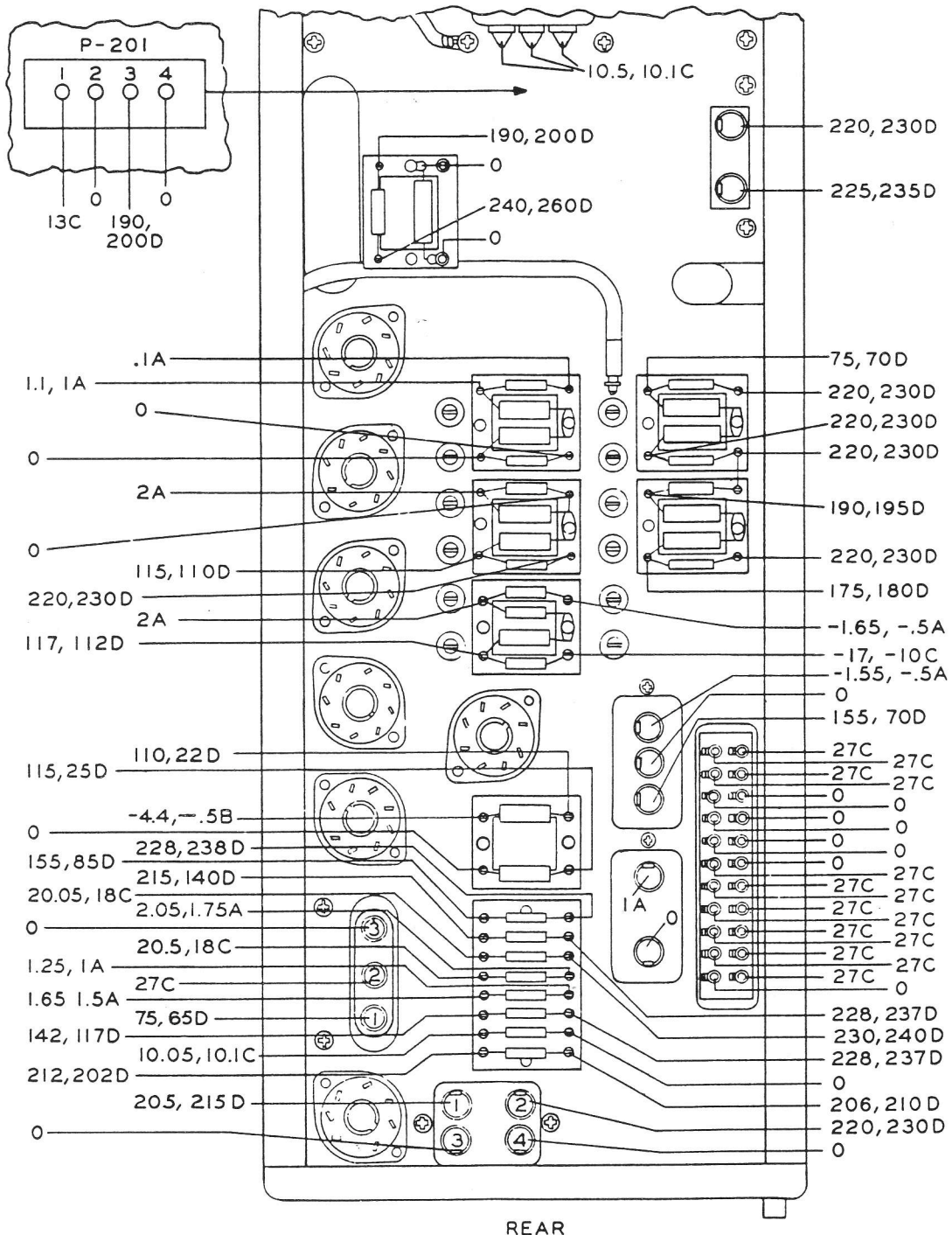
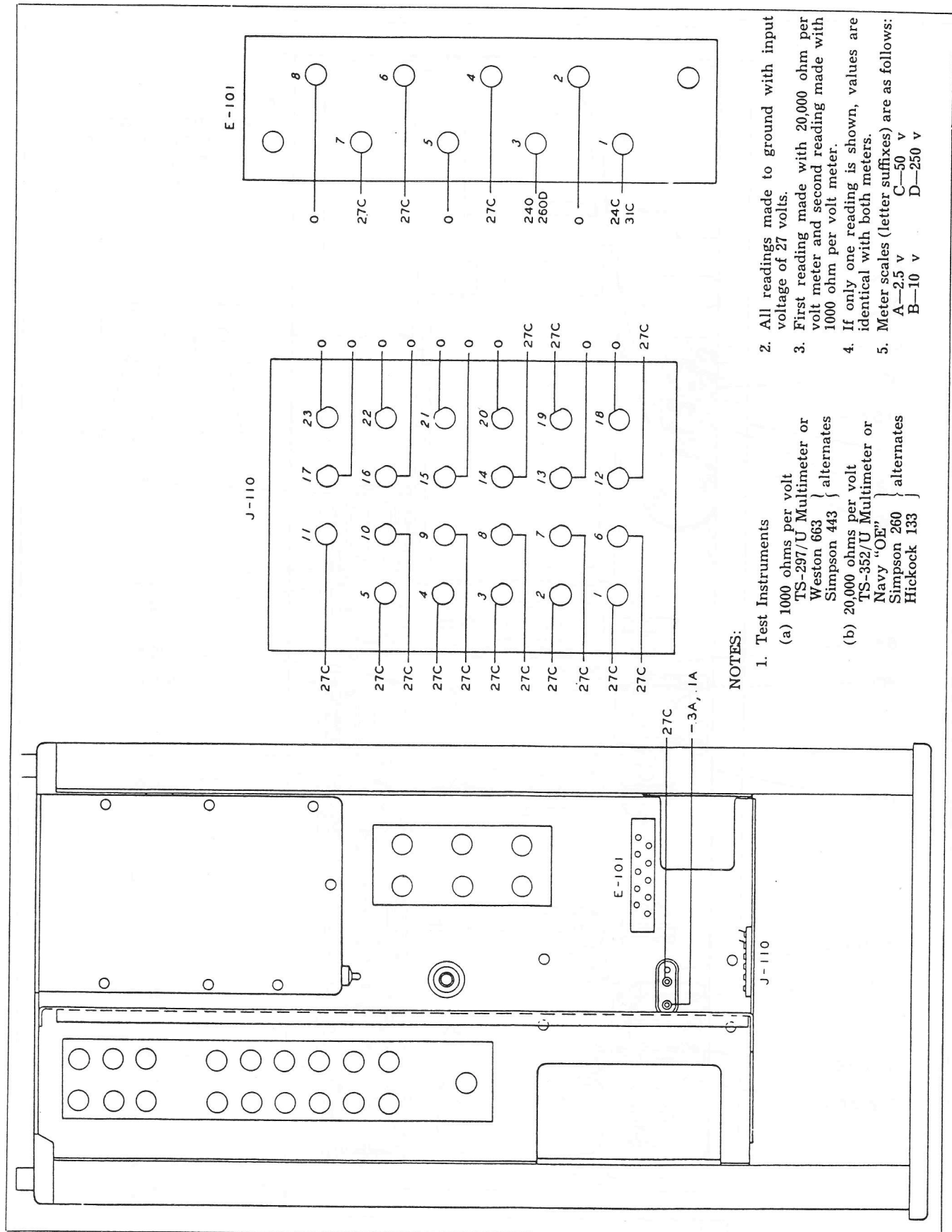


Figure 5-10A. AN/ARR-15A Voltage Measurements — Left Side



NOTES:

1. Test Instruments
 - (a) 1000 ohms per volt
 TS-297/U Multimeter or
 Weston 663 } alternates
 Simpson 443 }
 - (b) 20,000 ohms per volt
 TS-352/U Multimeter or
 Navy "OE" } alternates
 Simpson 260
 Hickock 133 }
2. All readings made to ground with input voltage of 27 volts.
3. First reading made with 20,000 ohm per volt meter and second reading made with 1000 ohm per volt meter.
4. If only one reading is shown, values are identical with both meters.
5. Meter scales (letter suffixes) are as follows:
 A—2.5 v C—50 v
 B—10 v D—250 v

Figure 5-11. Voltage Measurements - Bottom

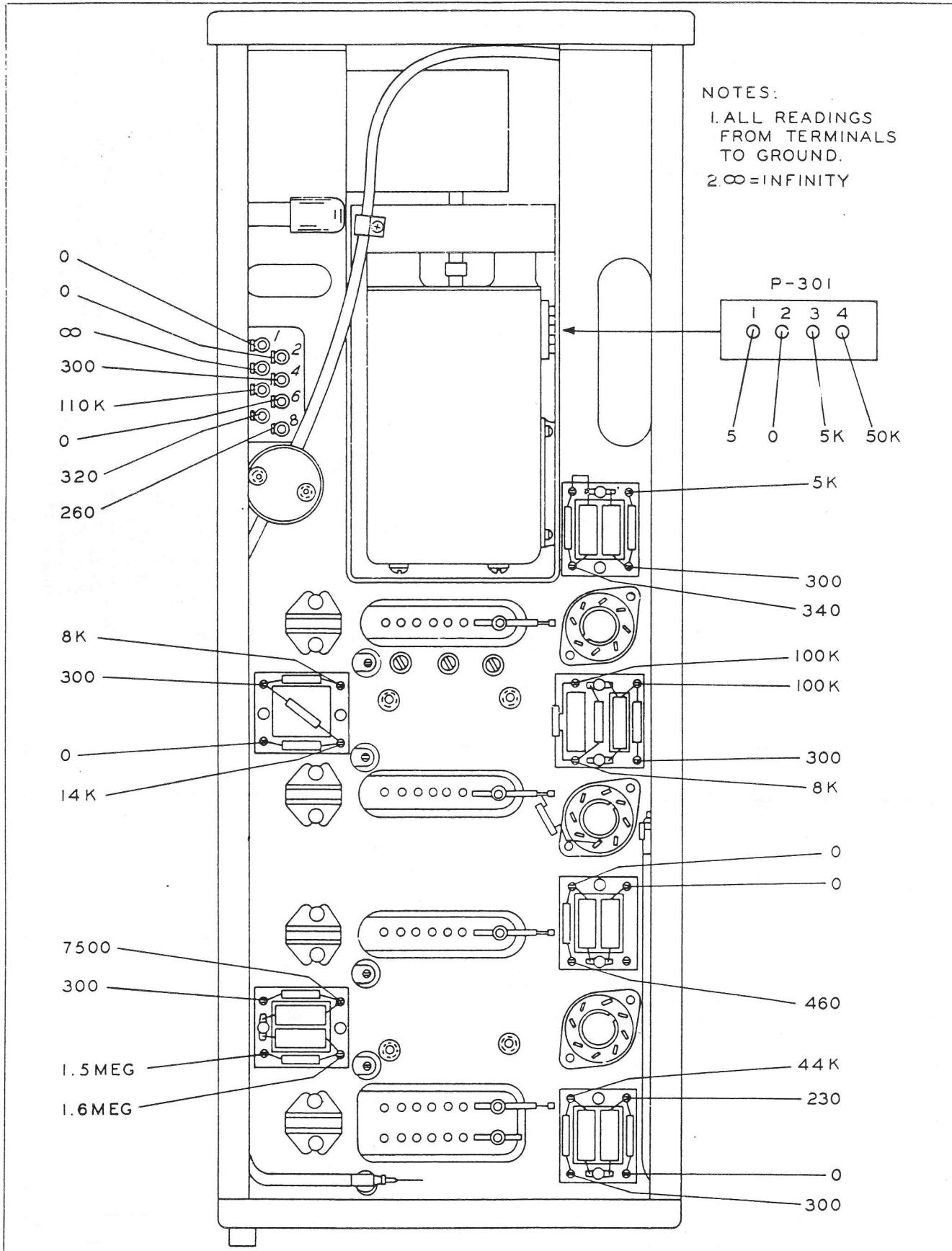


Figure 5-12. Resistance Measurements - Right Side

NOTES:
 1. ALL READINGS FROM TERMINALS TO GROUND.
 2. ∞ = INFINITY

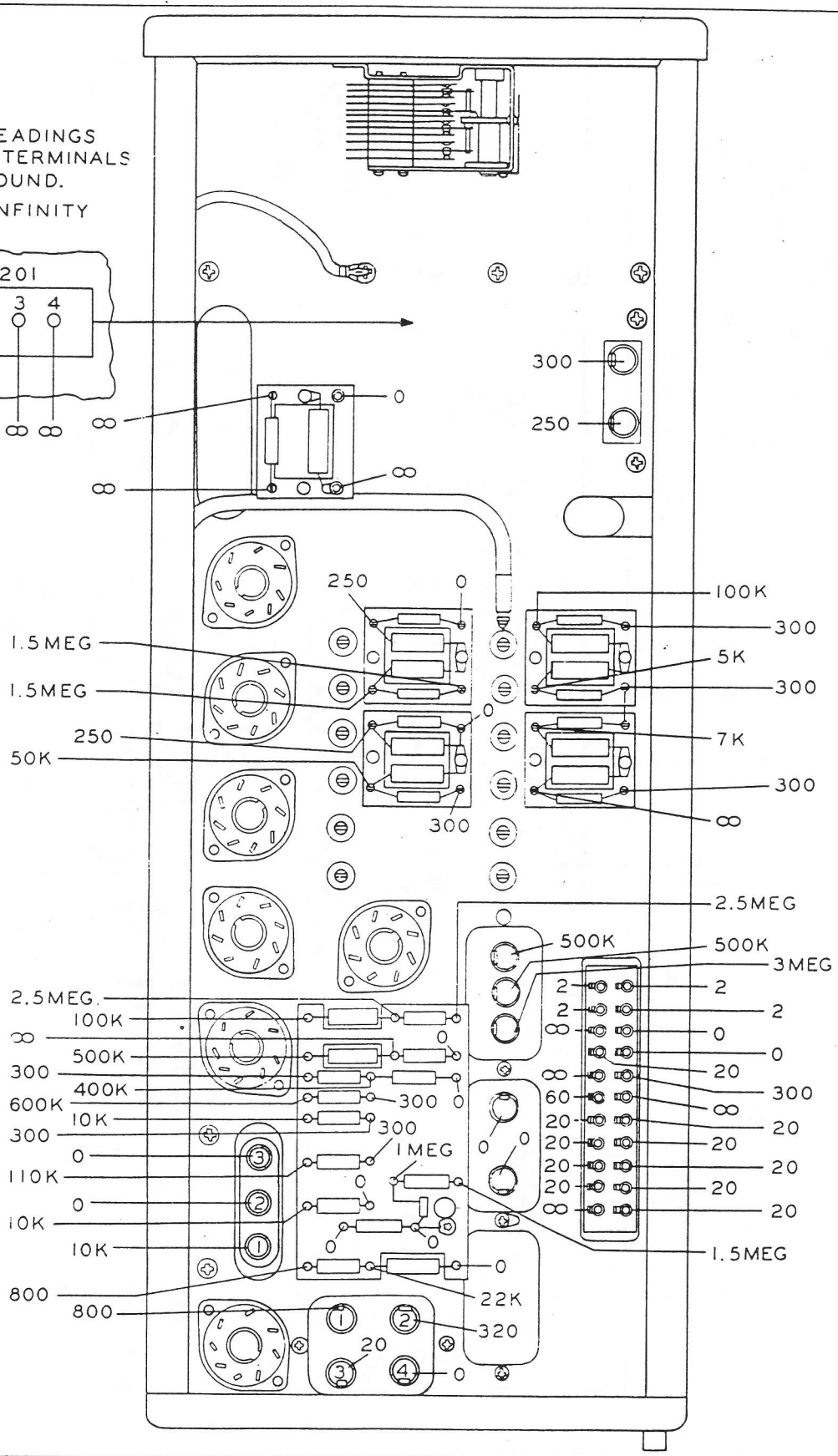
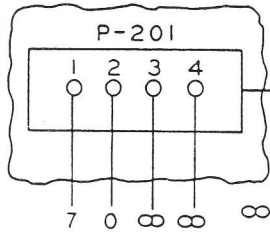


Figure 5-13. Resistance Measurements - Left Side

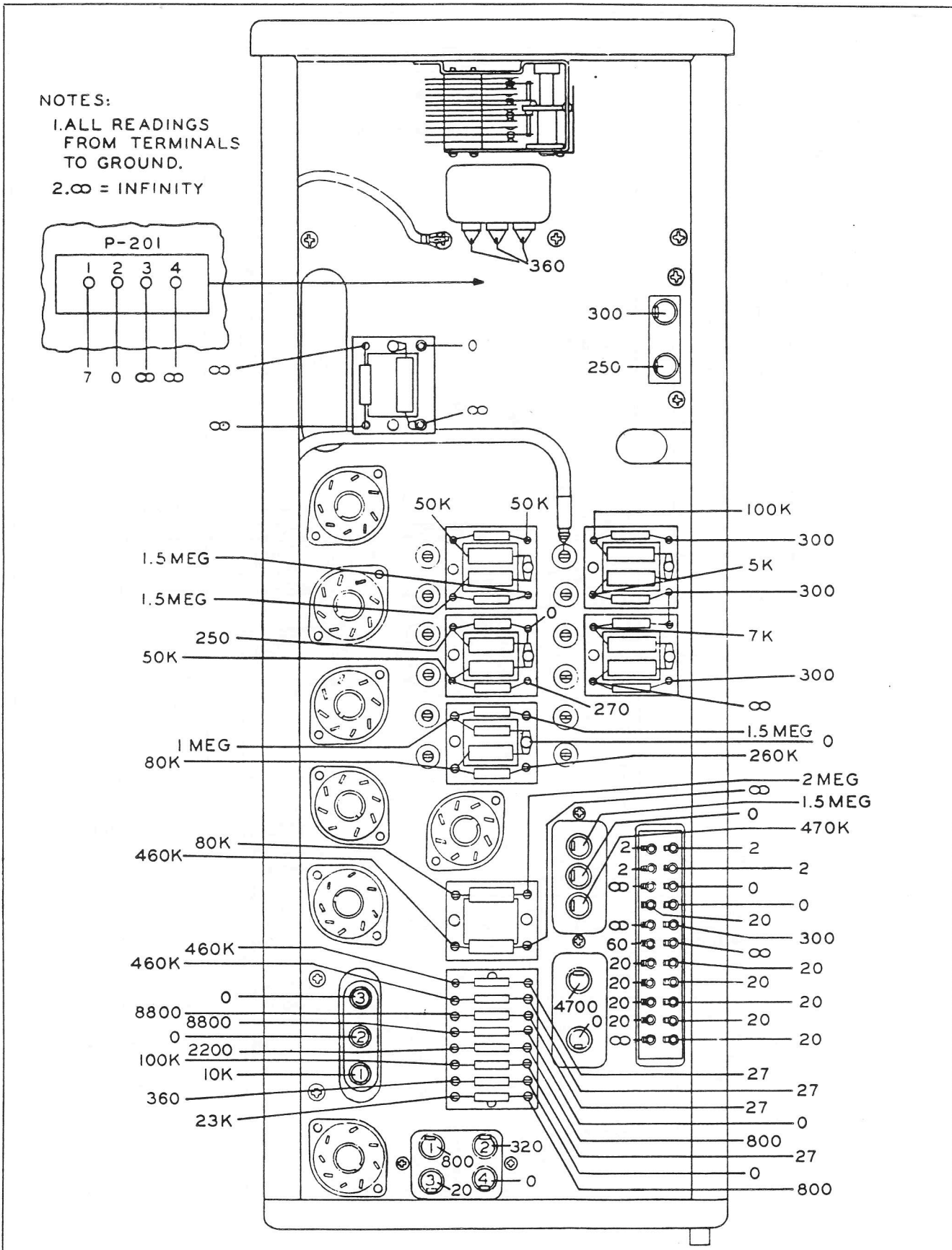
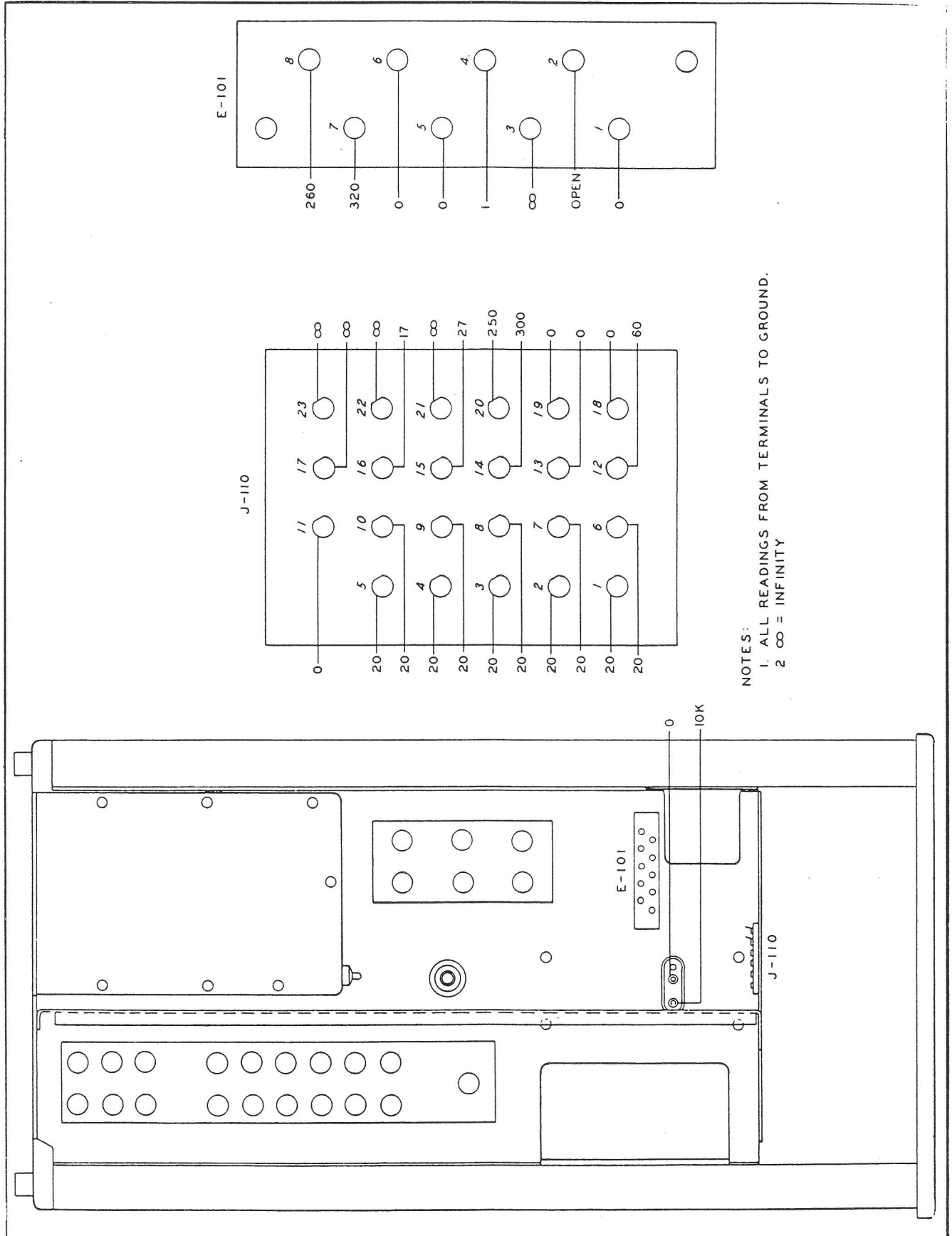


Figure 5-13A. AN/ARR-15A Resistance Measurements -- Left Side

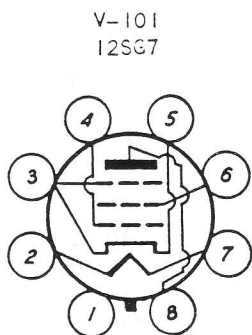
AN 16-30ARR15-3



NOTES:
 1. ALL READINGS FROM TERMINALS TO GROUND.
 2. ∞ = INFINITY

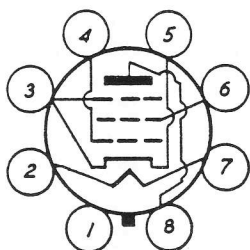
Figure 5-14. Resistance Measurements - Bottom

VOLTAGE TO GROUND
(VOLTS)



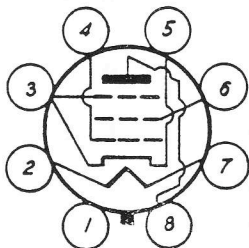
V-101
12SG7

Tube Pin Number	1000 Ohms Per Volt	*Scale	20,000 Ohms Per Volt	*Scale	Resistance To Ground (Ohms)
1	0		0		0
2	0		0		0
3	1.55	A	1.7	A	230
4	— .1	A	— .6	A	1.7 meg
5	1.55	A	1.7	A	230
6	127	D	137	D	45 K
7	13	C	13	C	7
8	183	D	183	D	7,500



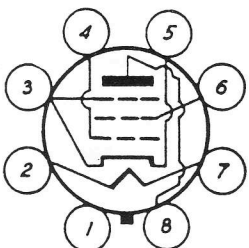
V-102
12SG7

1	0		0		0
2	27.5	C	26.5	C	1
3	.1	A	.1	A	490
4	— .25	A	— .7	A	500 K
5	.1	A	.1	A	490
6	— .05	A	— .05	A	100 K
7	13	C	13	C	7
8	227	D	227	D	6,000



V-103
12SG7

1	0		0		0
2	13	C	13	C	8
3	1.25	A	1.35	A	250
4	0		0		1.6 meg
5	1.25	A	1.35	A	250
6	70	D	75	D	100 K
7	27	C	26.5	C	1
8	192	D	192	D	7,500



V-104
12SG7

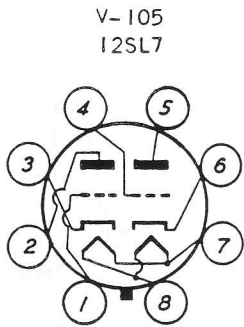
1	0		0		0
2	27	C	27	C	1
3	1.8	A	2.1	A	250
4	0		0		18
5	1.8	A	2.1	A	250
6	112	D	117	D	50 K
7	13.5	C	13.5	C	7
8	177	D	175	D	7,500

1. Test Instruments—
 - (a) 1000 ohms per volt
TS-297/U Multimeter or
Weston 663 } alternates
Simpson 443 }
 - (b) 20,000 ohms per volt
TS-352/U Multimeter or
Navy "OE" } alternates
Simpson 260 }
Hickock 133 }

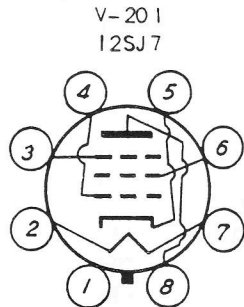
*Meter scales are as follows: A = 2.5 v
B = 10 v
C = 50 v
D = 250 v

Figure 5-15. Tube Socket Voltage and Resistance Measurements (Page one of three pages)

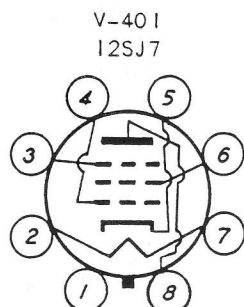
VOLTAGE TO GROUND
(VOLTS)



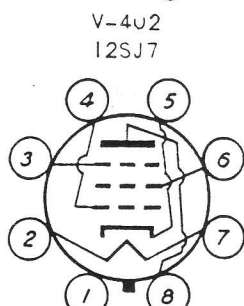
V-105
12SL7



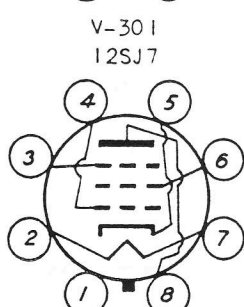
V-201
12SJ7



V-401
12SJ7



V-402
12SJ7



V-301
12SJ7

Tube Pin Number	1000 Ohms Per Volt	*Scale	20,000 Ohms Per Volt	*Scale	Resistance To Ground (Ohms)
1	— .05	A	—1.3	A	50 K
2	75	D	147	D	540 K
3	.25	A	.5	A	5 K
4	— .1	A	— .35	A	10 K
5	50	D	90	D	600 K
6	.5	A	101	A	5 K
7	13.5	C	13.5	C	7
8	0		0		0
1	0		0		0
2	0		0		0
3	0		0		0
4	— .09	A	—2.6	A	160 K
5	0		0		0
6	110	D	115	D	Inf
7	13.5		13.5		14
8	230	D	230	D	Inf
1	0		0		0
2	13.5	C	13.5	C	13.5
3	0		0		0
4	— .25	A	—2.25	A	110 K
5	0		0		0
6	72.5	D	75	D	100 K
7	27	C	27	C	Inf
8	113	D	115	D	150 K
1	0		0		0
2	0		0		0
3	0		0		0
4	—28	C	—30.2	C	50 K
5	0		0		0
6	22		39	C	230 K
7	13.5	C	13.5	C	13.5
8	5.5	B	7.6	B	5 K
1	0		0		0
2	0		0		0
3	0		0		0
4	— .20	A	— .45	A	165 K
5	0		0		0
6	117	D	130	D	Inf
7	13.5		13.5		14
8	230	D	230	D	Inf

*Meter scales are as follows: A = 2.5 v B = 10 v C = 50 v D = 250 v

1. Test Instruments—
 - (a) 1000 ohms per volt
 TS-297/U Multimeter or
 Weston 663 } alternates
 Simpson 443 } alternates
 - (b) 20,000 ohms per volt
 TS-352/U Multimeter or
 Navy "OE" } alternates
 Simpson 260 } alternates
 Hickock 133 }

Figure 5-15. Tube Socket Voltage and Resistance Measurements (Page two of three pages)

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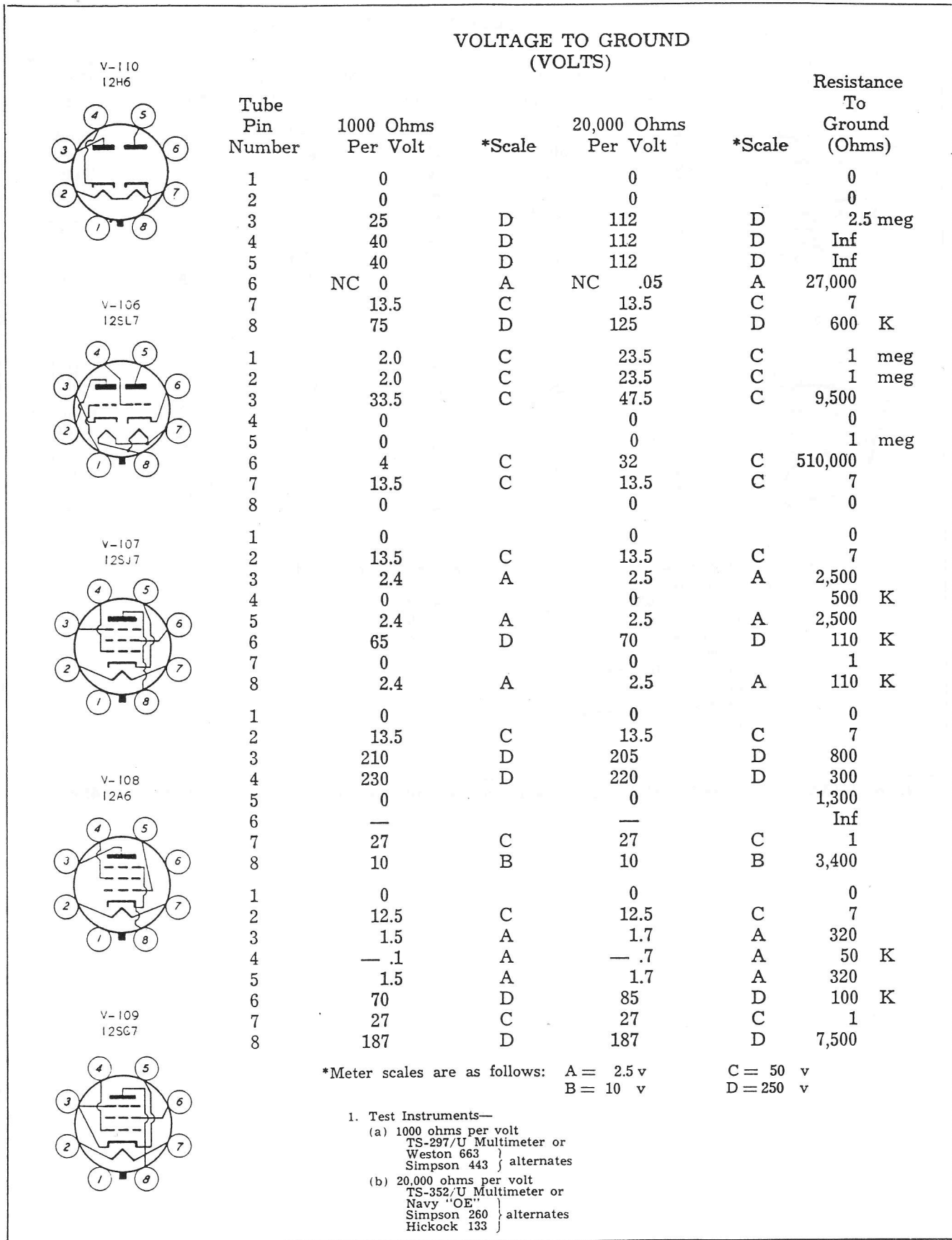


Figure 5-15. Tube Socket Voltage and Resistance Measurements (Page three of three pages)

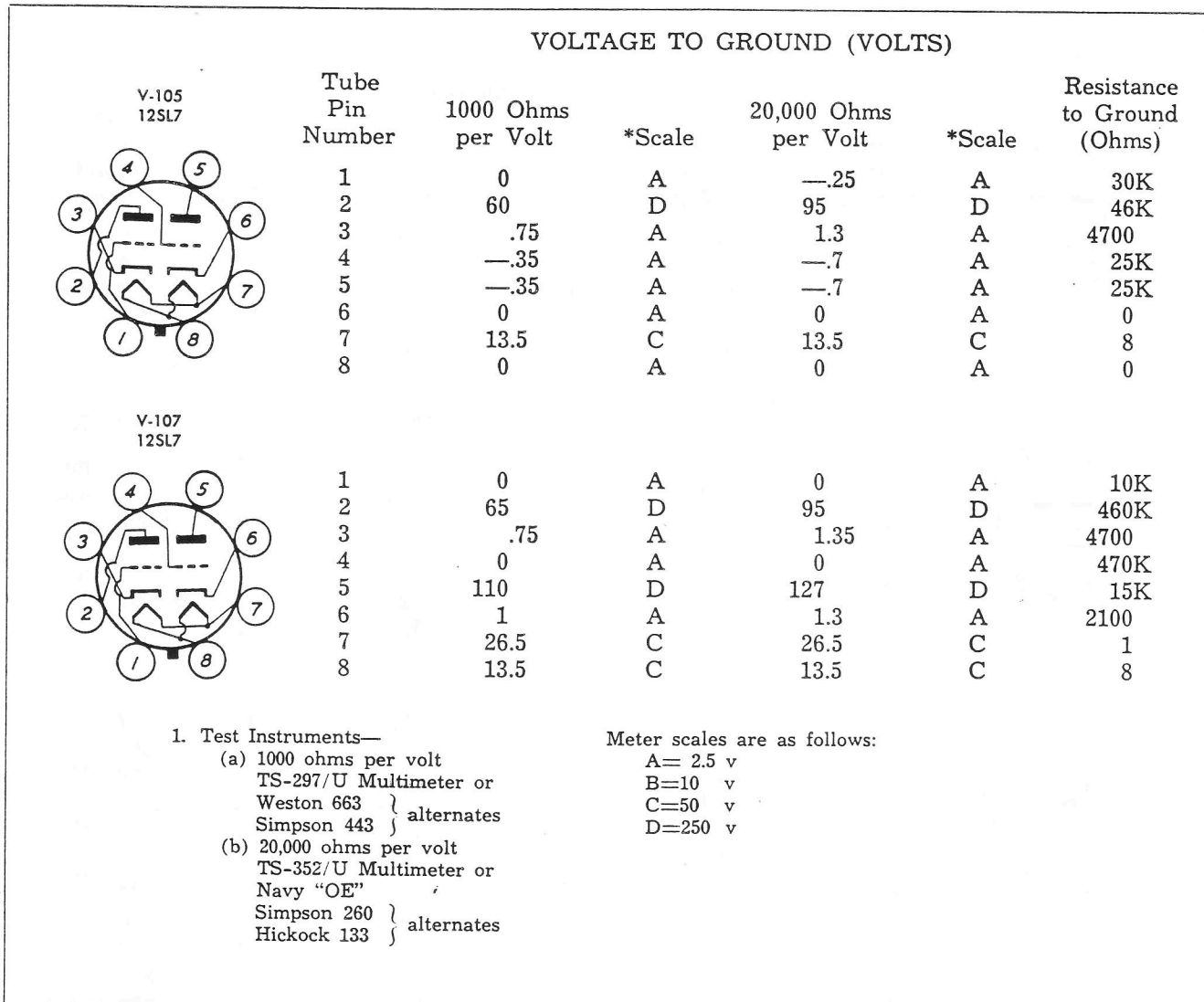


Figure 5-15A. V-105 and V-107 Tube Socket Voltage and Resistance Measurements for AN/ARR-15A

AN 16-30ARR15-3

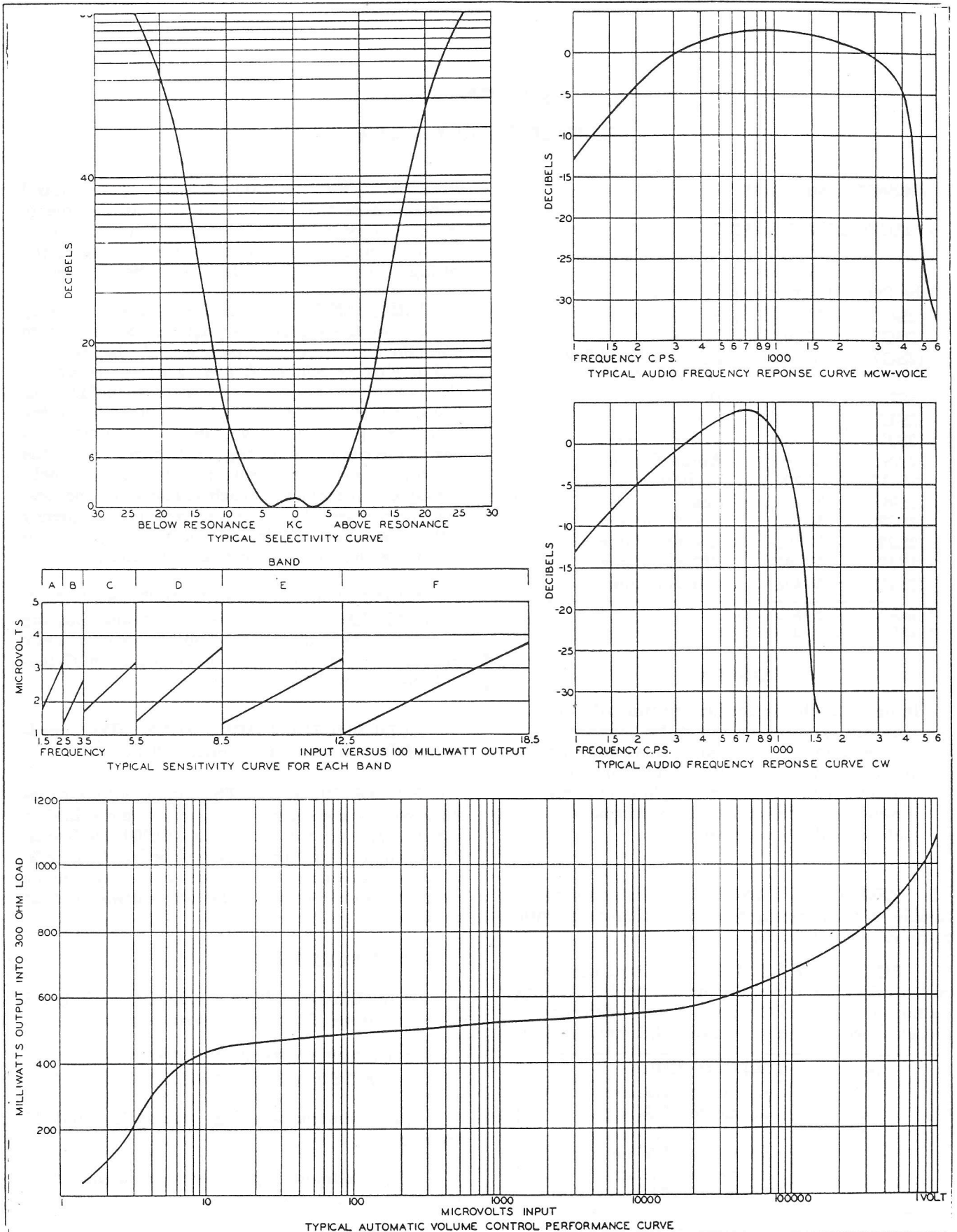


Figure 5-16. Typical Operations Curves

SECTION VI SUPPLEMENTARY DATA

I. TECHNICAL SUMMARY.

a. TUBE COMPLEMENT.

Tube Type	Symbol Designation	Function
12SG7	V-101	R-F Amplifier
12SG7	V-102	Mixer
12SG7	V-103	First i-f Amplifier
12SG7	V-104	Second i-f Amplifier
12SL7	V-105	*Balancer
12SL7	V-106	AVC
**12SJ7	V-107	Audio Driver
12A6	V-108	Audio Output
12SG7	V-109	Multiplier
12H6	V-110	Limiter
12SJ7	V-201	L-F Oscillator
12SJ7	V-301	H-F Oscillator
12SJ7	V-401	CFI Oscillator
12SJ7	V-402	CFI Amplifier

* Detector in AN/ARR-15A

** 12SL7 in AN/ARR-15A

CAUTION

In order to obtain satisfactory tube life the following precautions must be observed:

- (1) Operate the tube filaments within plus or minus five per cent of rated voltages;
- (2) Do not exceed rated plate current through any of the tubes during normal operation of the equipment.

b. FREQUENCY RANGE. — This equipment is capable of receiving signals on any frequency within the range 1500 to 18,500 kc.

c. FREQUENCY BANDS.—The frequency range 1500 to 18,500 kc is covered in six bands. The six positions of the Band Control, together with the frequency range covered by each band, is given below:

Band	Frequency Range
A	1.5 mc to 2.5 mc
B	2.5 mc to 3.5 mc
C	3.5 mc to 5.5 mc
D	5.5 mc to 8.5 mc
E	8.5 mc to 12.5 mc
F	12.5 mc to 18.5 mc

d. NUMBER OF PRE-SET FREQUENCIES. — Ten pre-set frequency channels are provided for

voice, cw or mcw reception from a remote control point or from the receiver unit. It is possible to unlock the controls on the panel and manually tune the receiver on any channel without changing the setting of the controls for the other nine channels.

e. FREQUENCY STABILITY.—The frequency stability of the complete equipment is such as to maintain the resonant frequency of the receiver within plus or minus .03% of a given frequency. The stability tolerance is overall and includes all frequency changes accompanying operation of the equipment, plus frequency changes due to inaccuracies in the channel selecting mechanism. After the adjustment of the controls for the ten channels, subsequent reception on each channel will be possible with a resulting receiver resonant frequency within the allowed tolerance of the frequency to which the channel was originally adjusted.

f. ELECTRICAL CHARACTERISTICS OF RECOMMENDED ANTENNAS.—The antenna coupling circuit has been designed to operate satisfactorily with an aircraft type antenna ranging from 17 feet to 40 feet in length.

g. AUDIO OUTPUT IMPEDANCE.—The impedance of the audio output channel is 300 ohm.

h. POWER OUTPUT.—The audio output capability will be consistent with avc and noise limiter action. With a r-f input of 10 to 10,000 microvolts, 30% modulated, the distortion will be less than 15%. The audio response will not vary more than plus or minus three db relative to the 100 milliwatt output at 1000 cps.

i. POWER SUPPLY.

(1) VOLTAGE.—This equipment is designed to operate from 26.5 volt d-c power source.

(2) CURRENT REQUIREMENTS AT SPECIFIED RATED VOLTAGE.

(a) Maximum starting current is about 15 amperes.

(b) Maximum required current for Autotune operation is eight and one-half amperes.

(c) Maximum requirements during actual reception is three and one-tenth amperes.

j. DYNAMOTOR.

(1) MANUFACTURER. — A. G. Redmond Company, Owallo, Michigan.

(2) MANUFACTURER'S TYPE.—GH-19.

(3) RATING.

(a) INPUT: 26.5 volts d-c at 1.75 amps.

(b) OUTPUT: 220 volts at .1 amps.

(4) The maximum permissible ambient temperature is +40°C (+104°F).

k. AUDIO FREQUENCY RESPONSE.

(1) MCW-VOICE.—Within plus or minus three db from 300 cps to 3500 cps.

(2) CW.—Down 30 db at 1600 cps from 1200 cps reference and within plus or minus three db from 1200 to 300 cps.

l. SENSITIVITY.—The sensitivity of the receiver is such as to permit the attainment of at least 100 milliwatts audio output at 1000 cps, with the resultant signal plus noise to noise ratio of six db for phone (modulation on vs modulation off), under conditions of a r-f input to the equipment, (30%

modulated at 1000 cps for phone measurements) not in excess of five microvolts.

The overall selectivity of the receiver measured at 18,500 kc will fall within the maximum and minimum limits set forth below:

Attenuation db Below Resonance	Kilocycles Off Resonance	
	Maximum	Minimum
6	9.0	7.5
20	12.5	7.5
40	22.5	7.5
60	30.0	7.5

m. AUTOMATIC VOLUME CONTROL PERFORMANCE.—The avc action for phone signals is such that with one millivolt signal, modulated 30% at 1000 cps, the audio output power will be 500 milliwatts (−10% +20%) and when the modulated signal input is varied from 10 to 100,000 microvolts, the audio output power will not vary more than two db relative to the output at one millivolt input. The receiver is protected against blocking under conditions of input signals up to two volts.

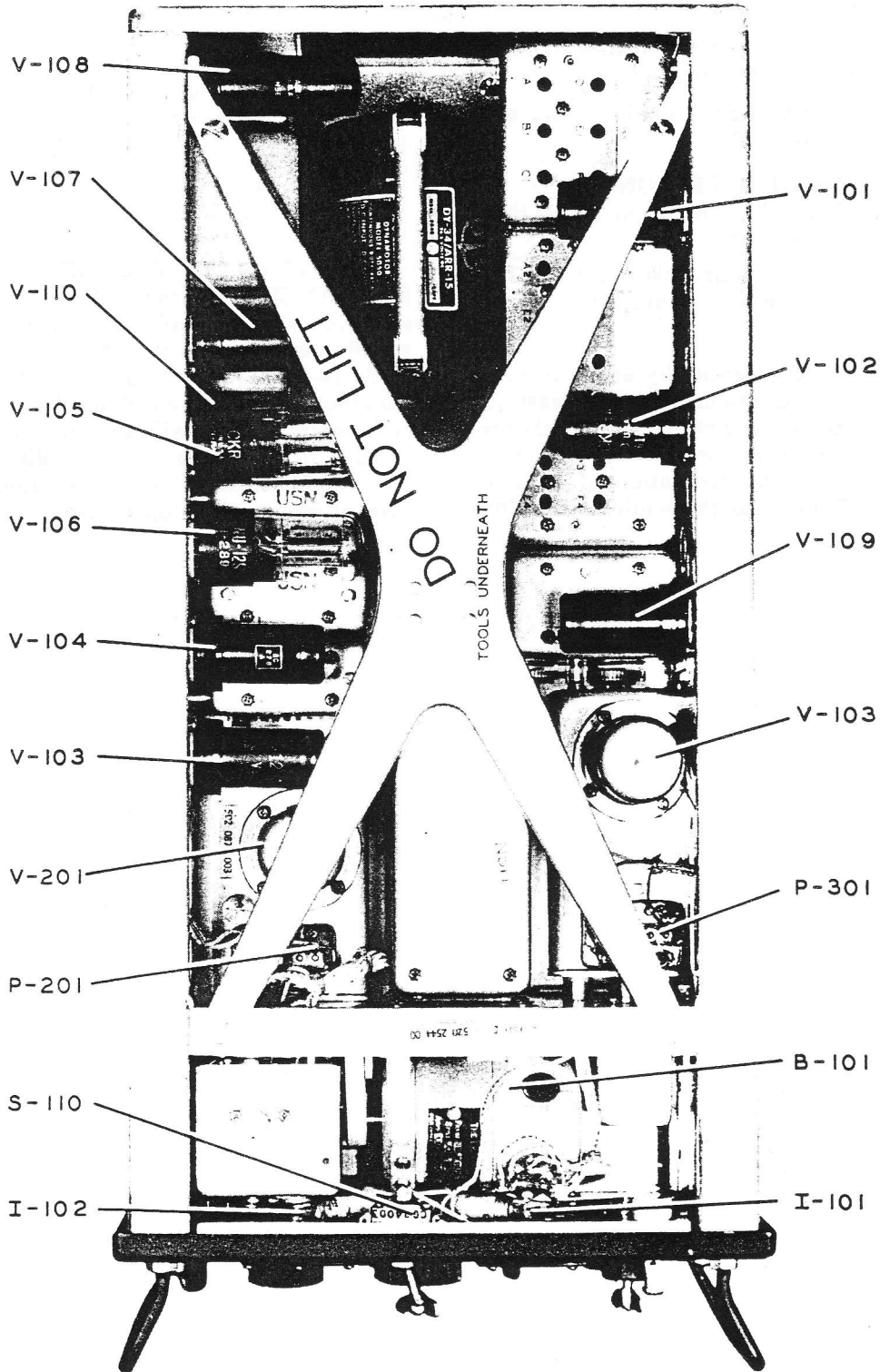


Figure 6-1. Receiver-Top

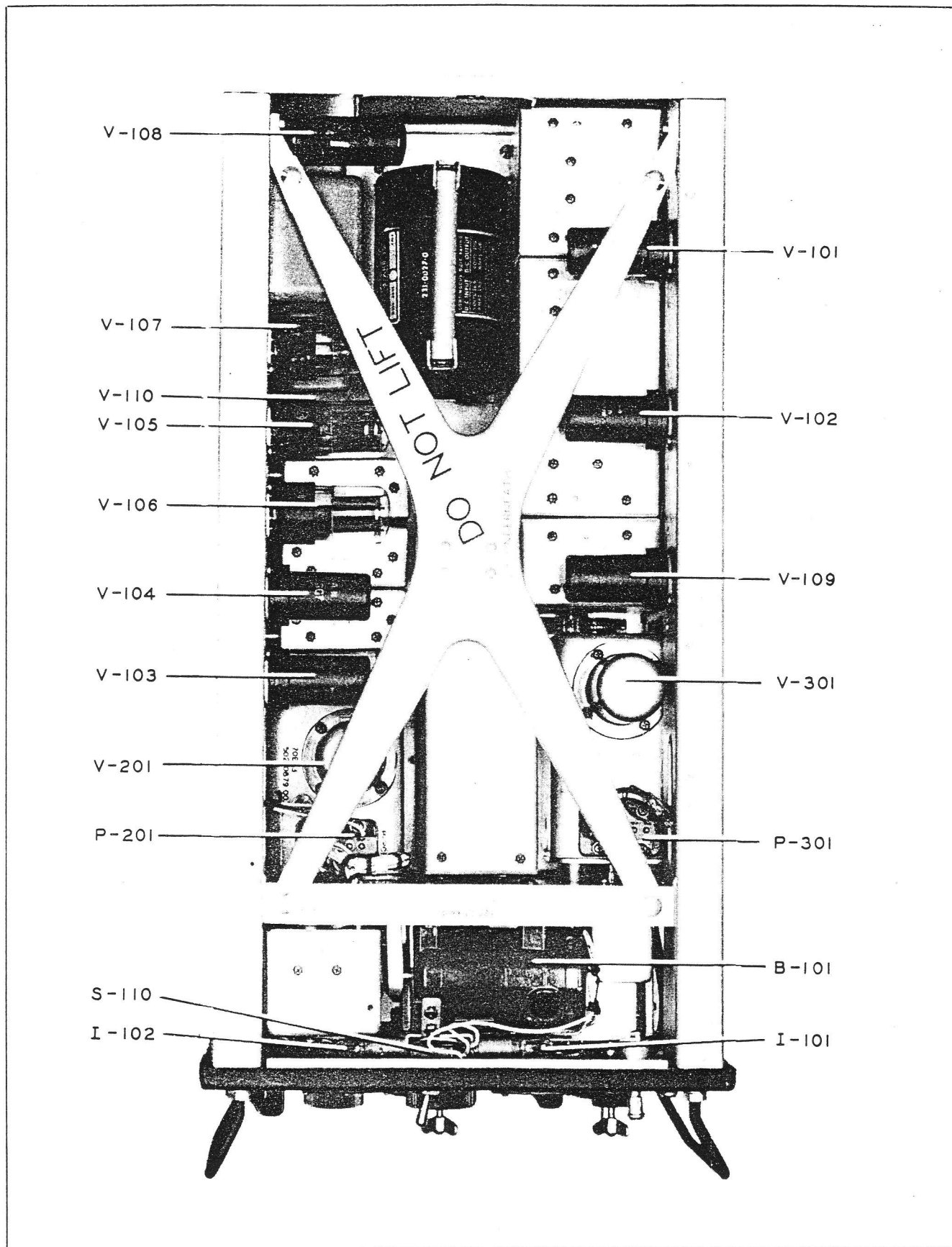


Figure 6-1A. R-105A/ARR-15 Receiver, Top

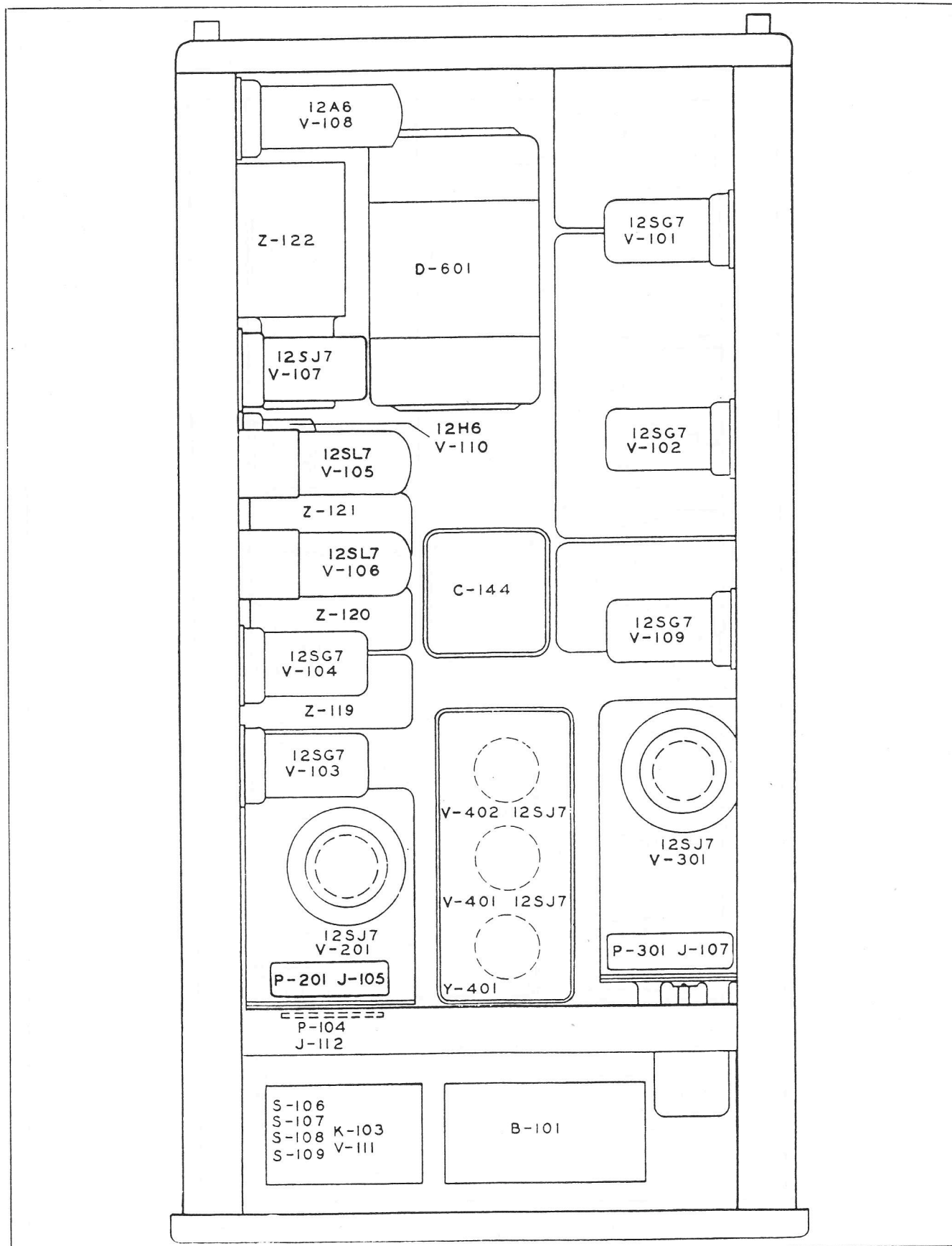


Figure 6-2. Receiver Parts Arrangement—Top

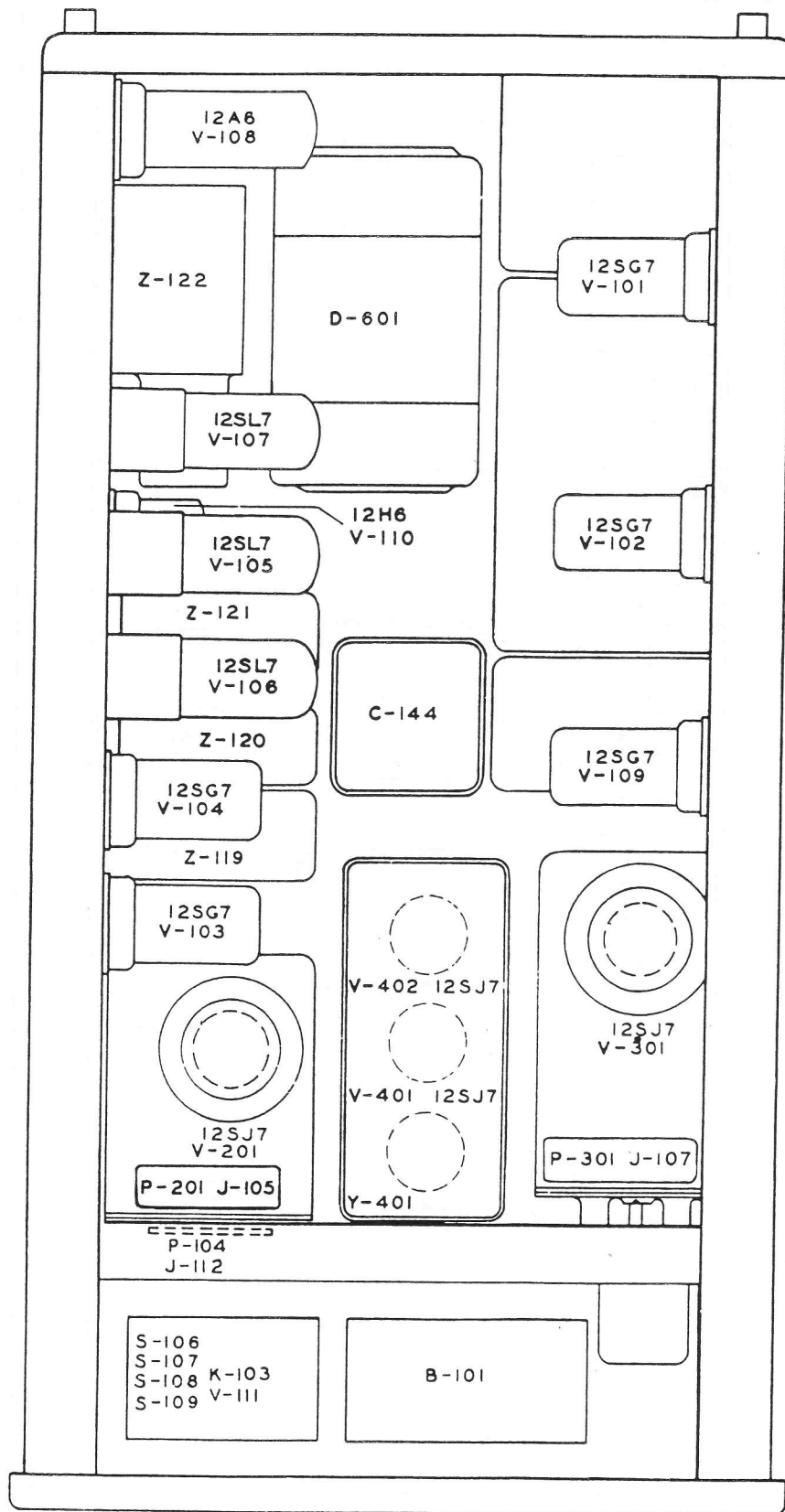


Figure 6-2A. R-105A/ARR-15 Receiver Parts Arrangement, Top

AN 16-30ARR15-3

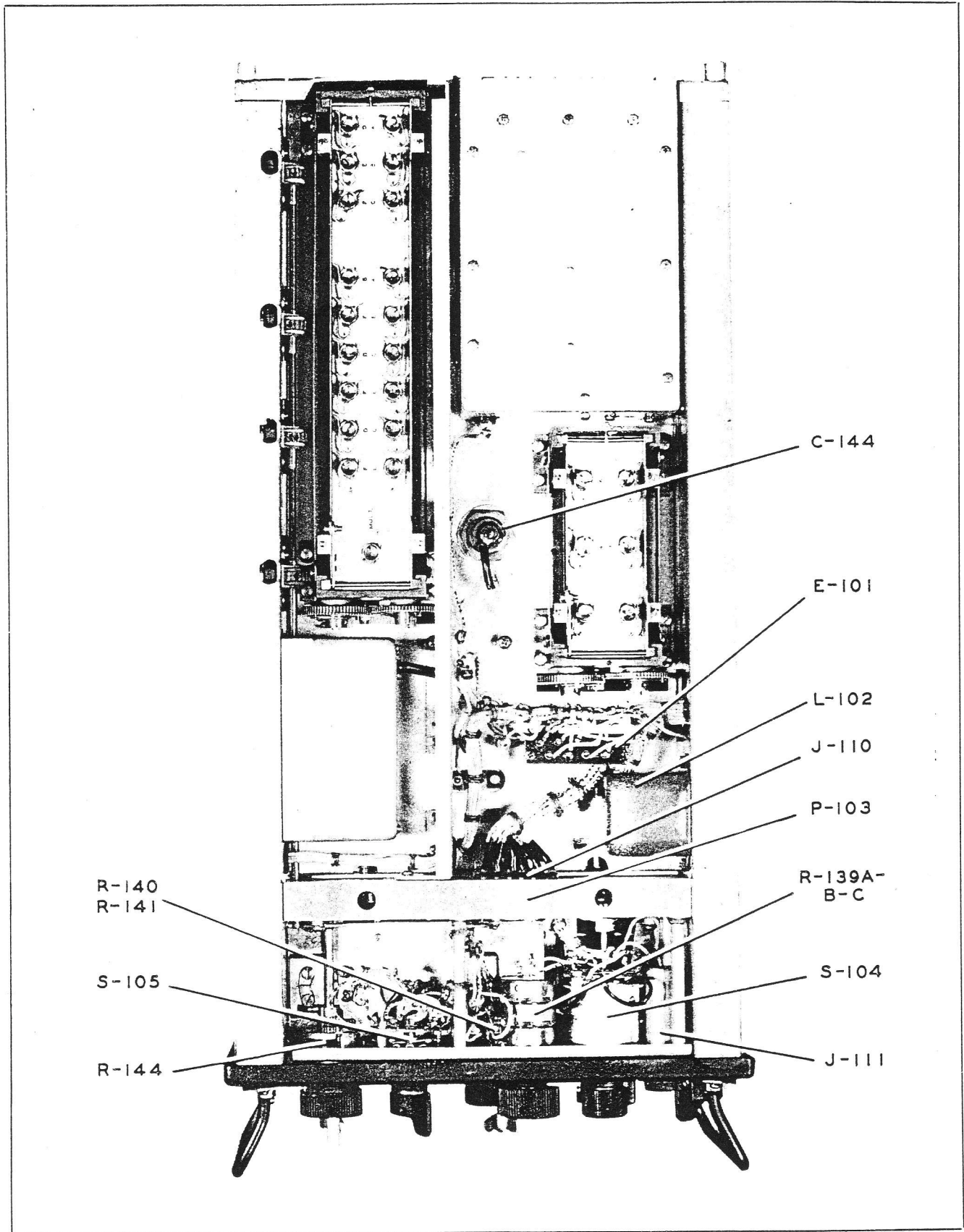


Figure 6-3. Receiver—Bottom

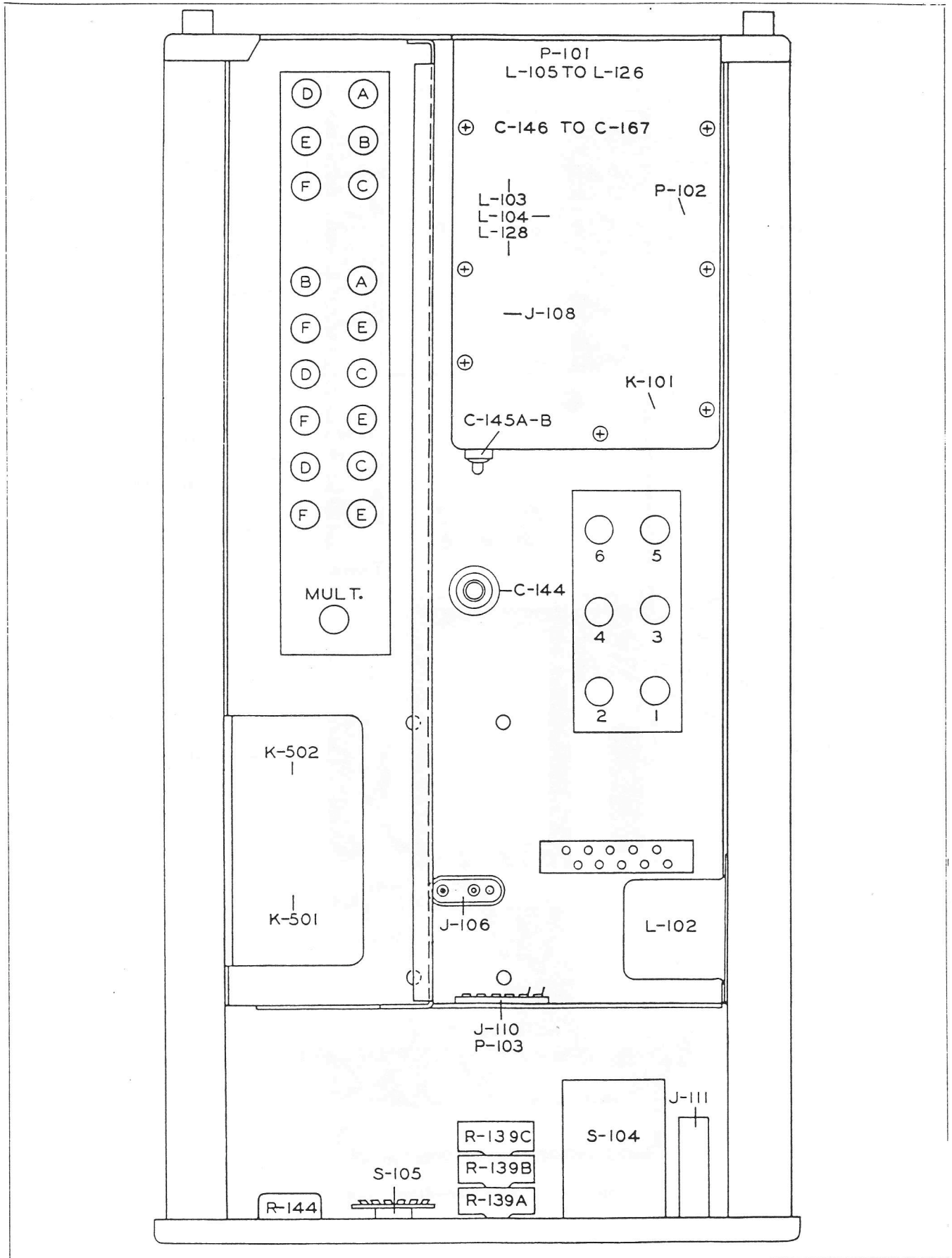


Figure 6-4. Receiver Parts Arrangement—Bottom

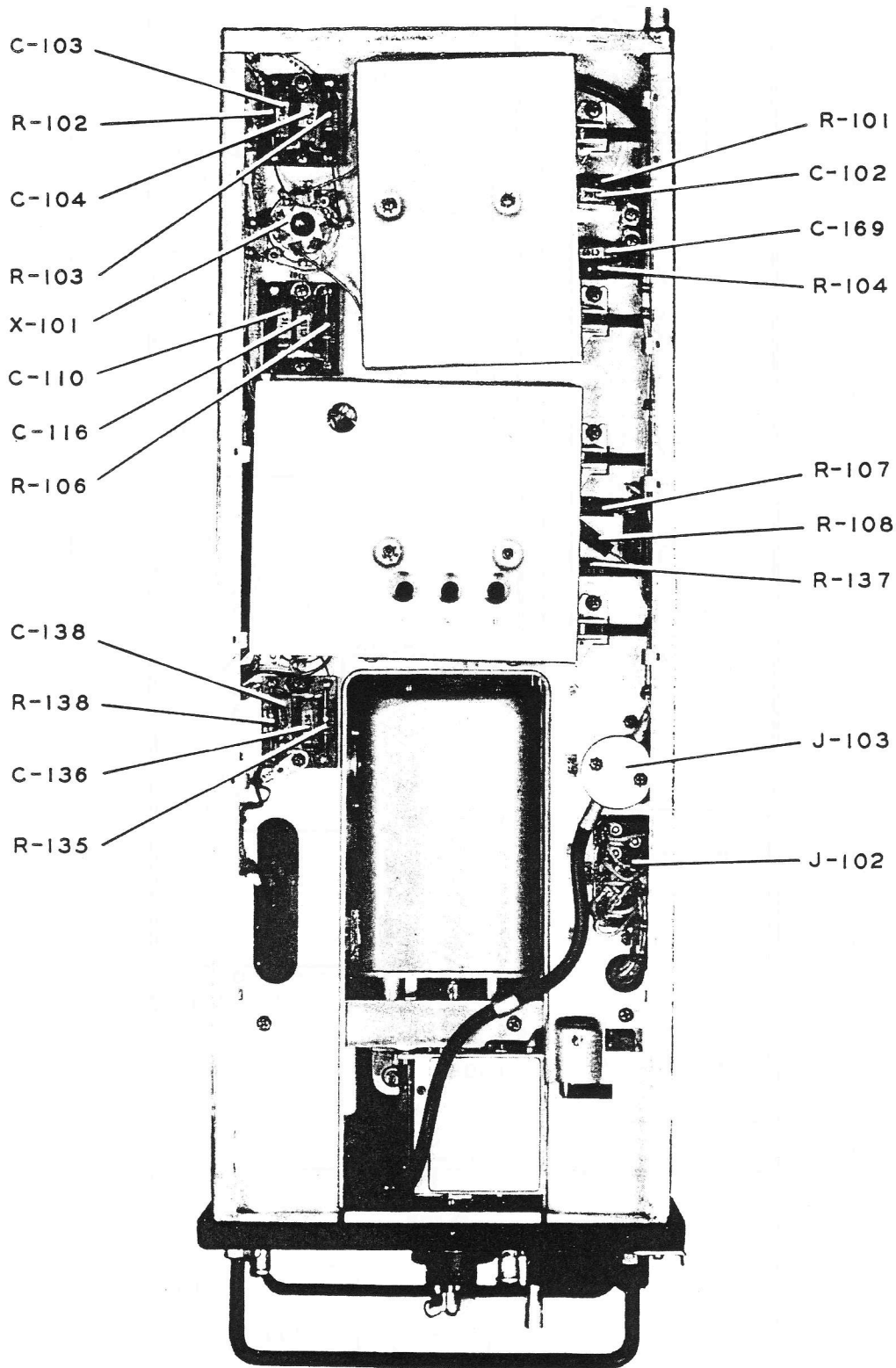


Figure 6-5. Receiver—Right Side

AN 16-30ARR15-3

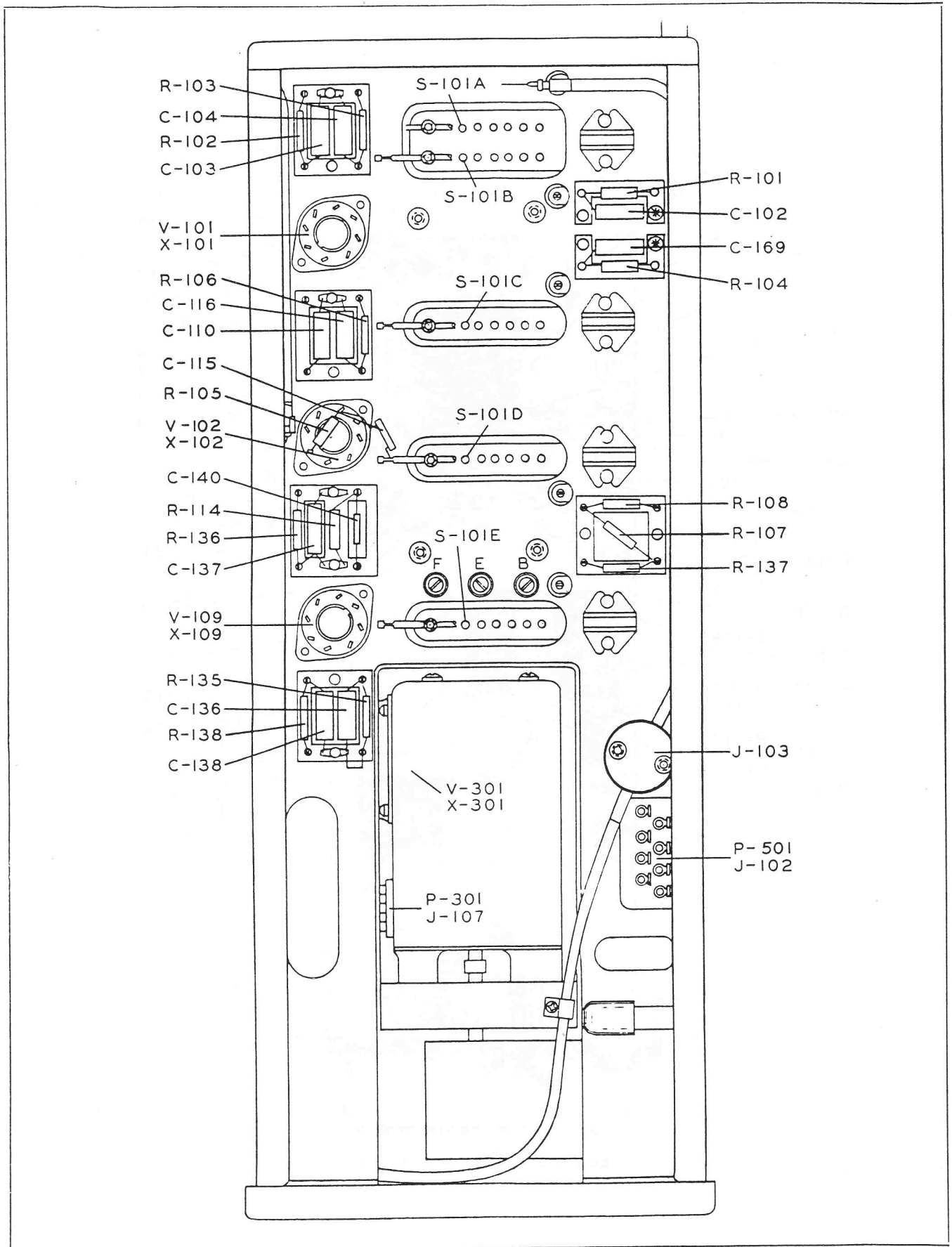


Figure 6-6. Receiver Parts Arrangement—Right Side

AN 16-30ARR15-3

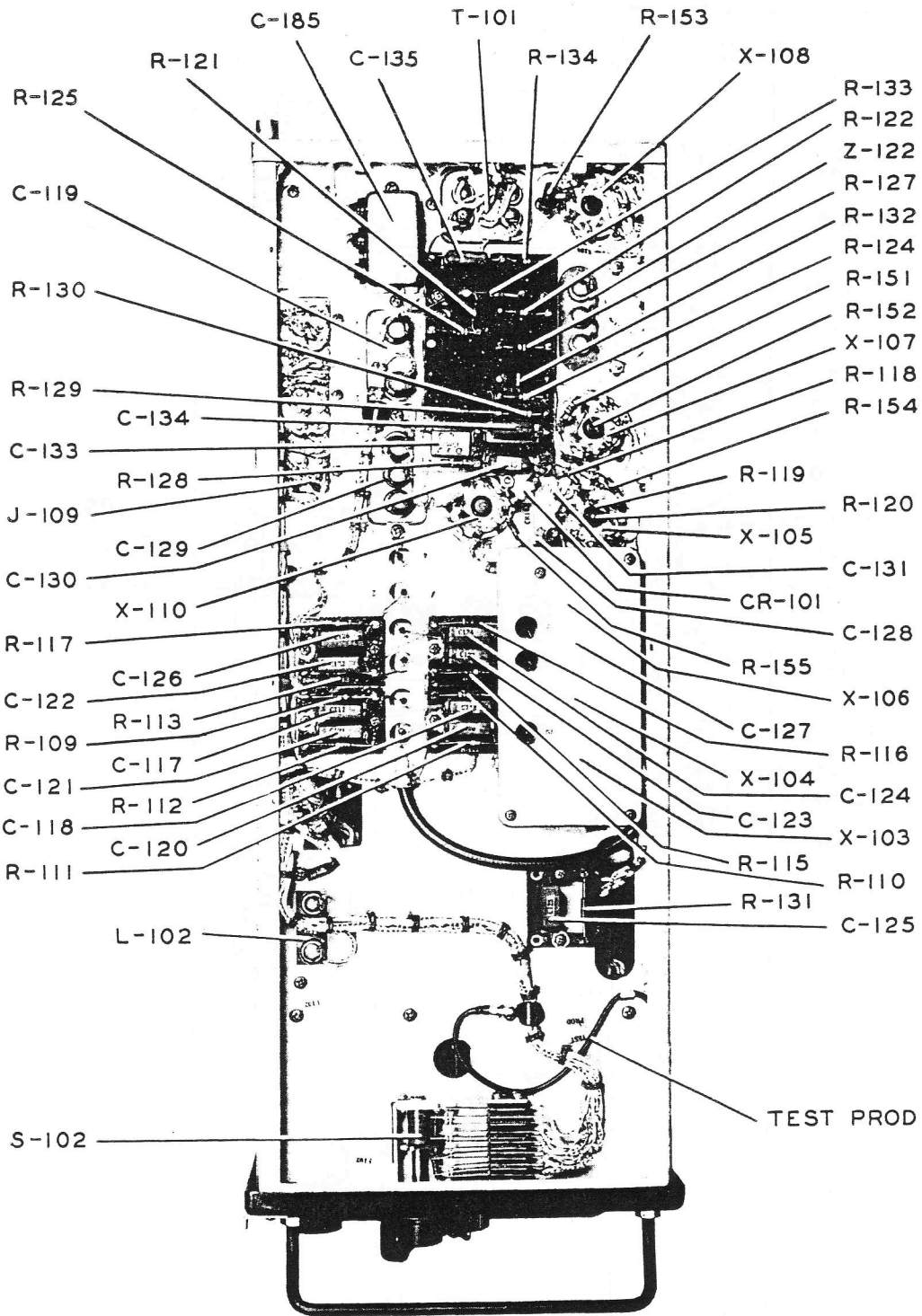


Figure 6-7. Receiver—Left Side

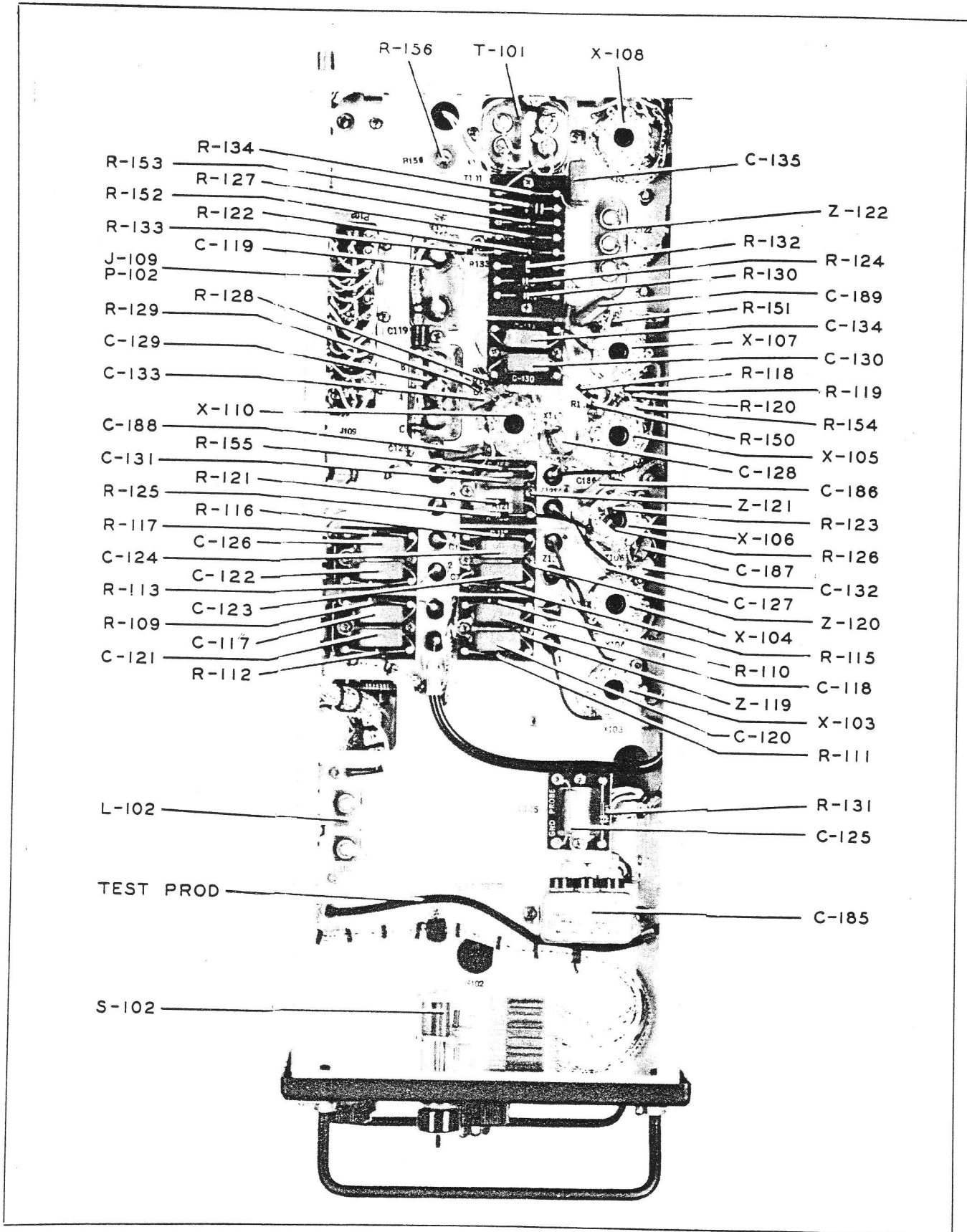


Figure 6-7A. R-105A/ARR-15 Receiver — Left Side

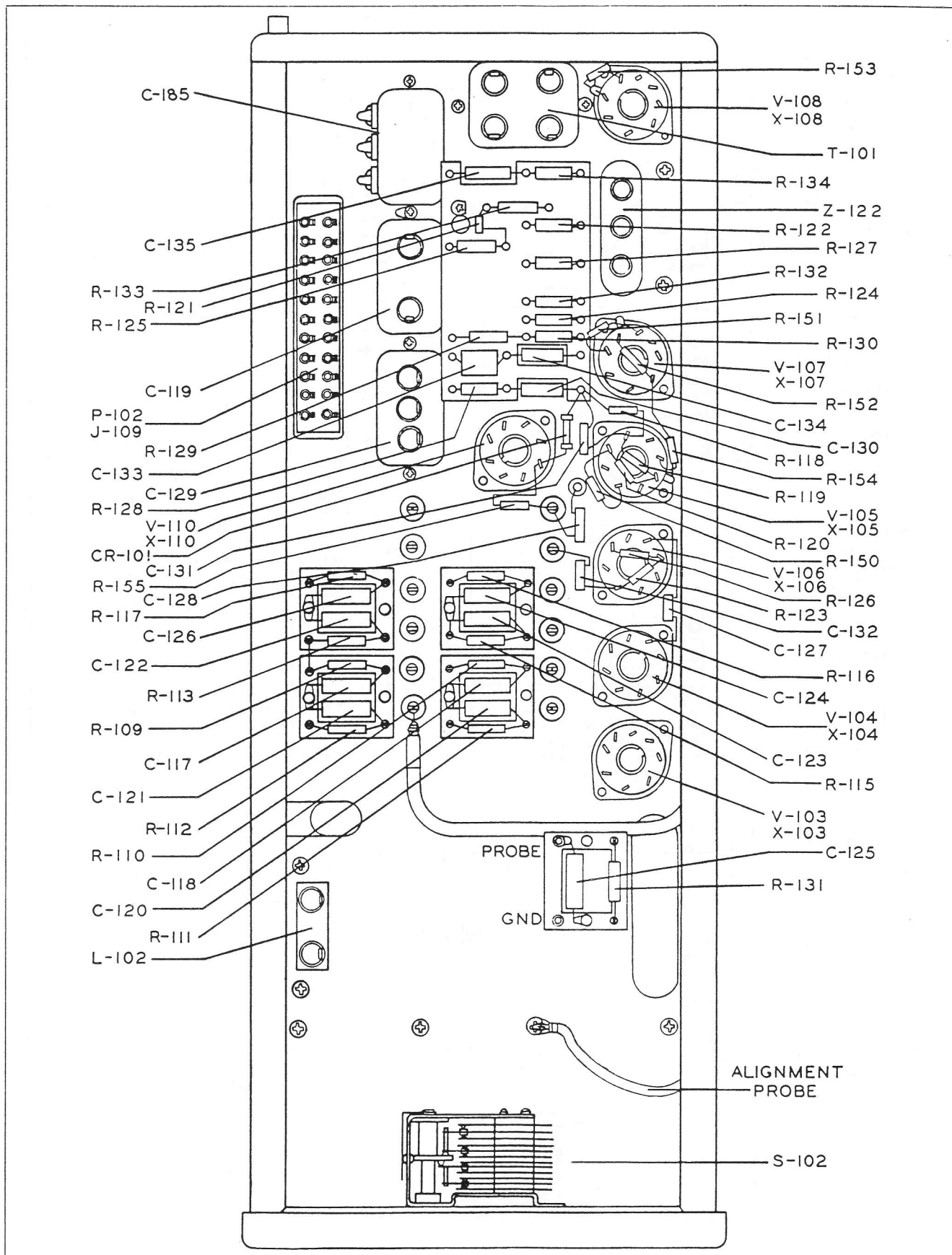


Figure 6-8. Receiver Parts Arrangement—Left Side

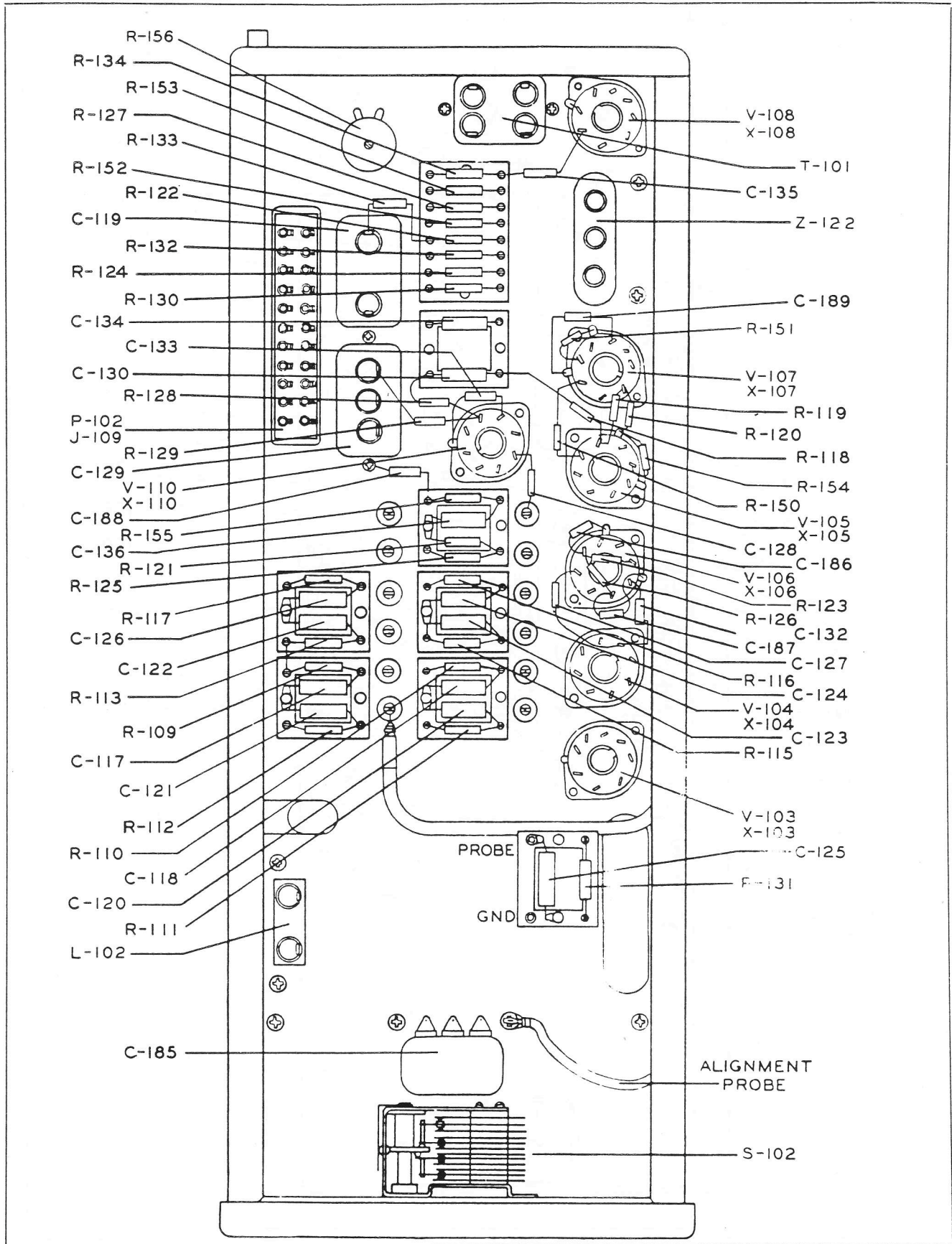


Figure 6-8A. R-105A/ARR-15 Receiver Parts Arrangement - Left Side

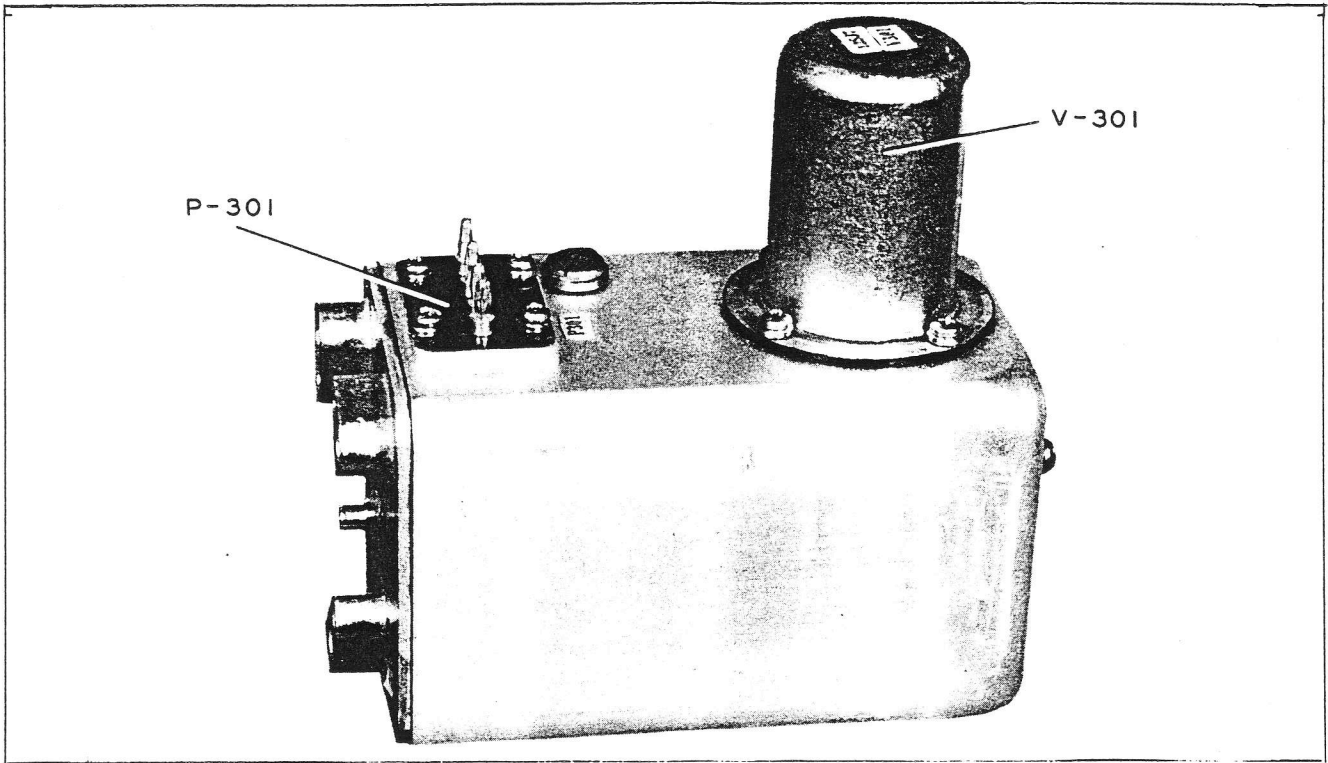


Figure 6-9. High Frequency Oscillator, Top Enclosed

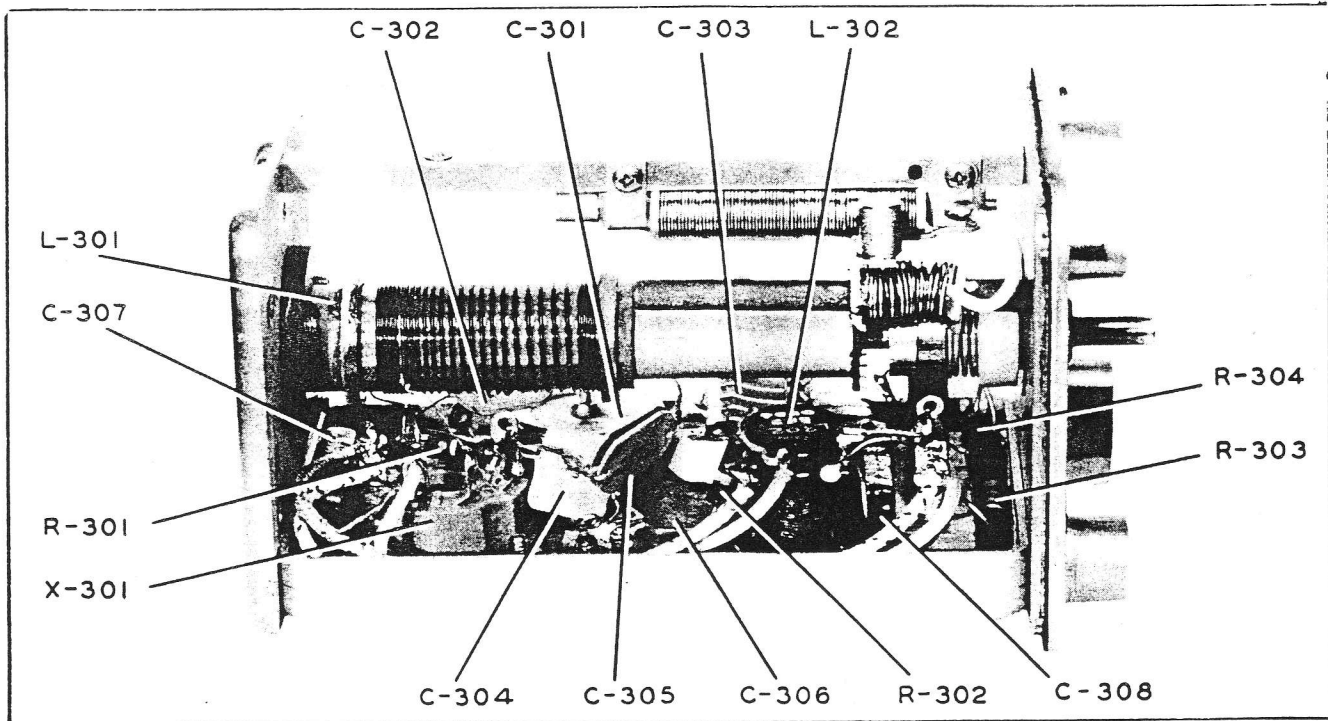


Figure 6-10. High Frequency Oscillator, Open

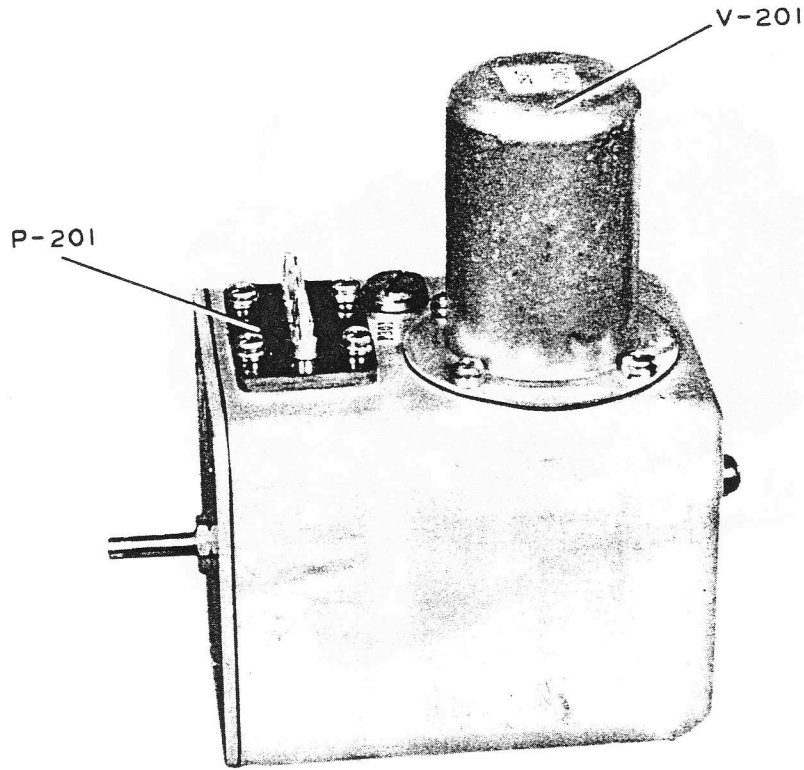


Figure 6-11. Low Frequency Oscillator, Top Enclosed

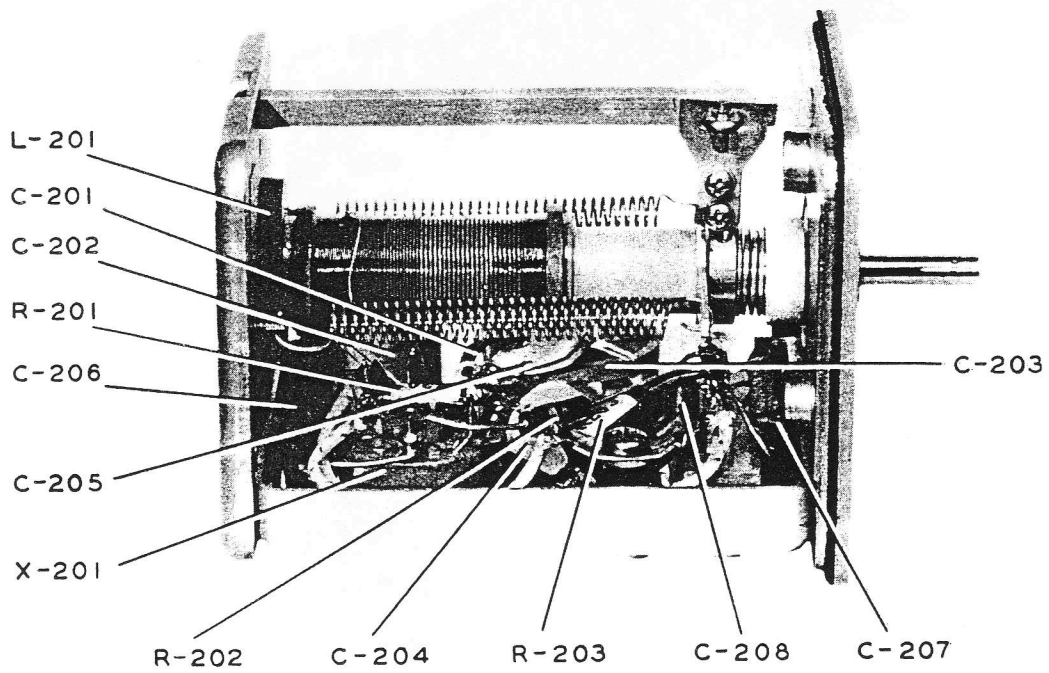


Figure 6-12. Low Frequency Oscillator, Open

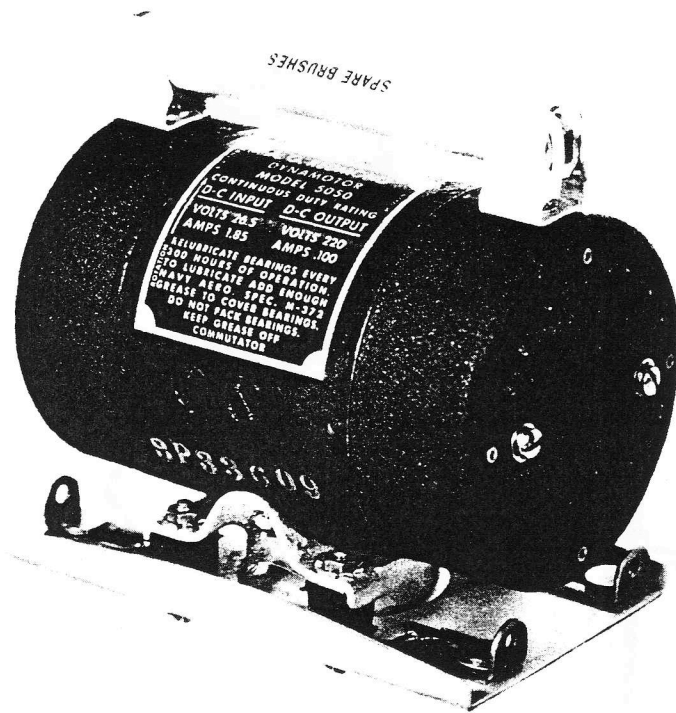


Figure 6-13. Dynamotor Unit

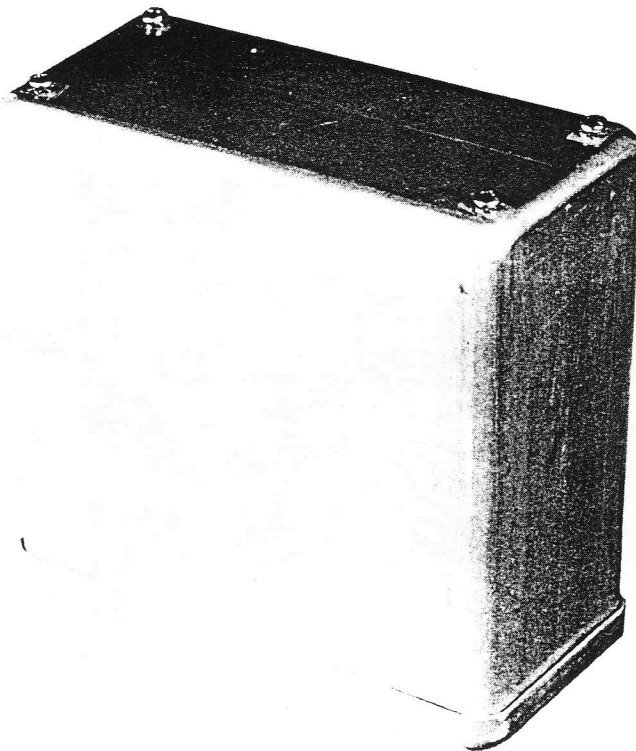


Figure 6-14. CFI Unit, Enclosed

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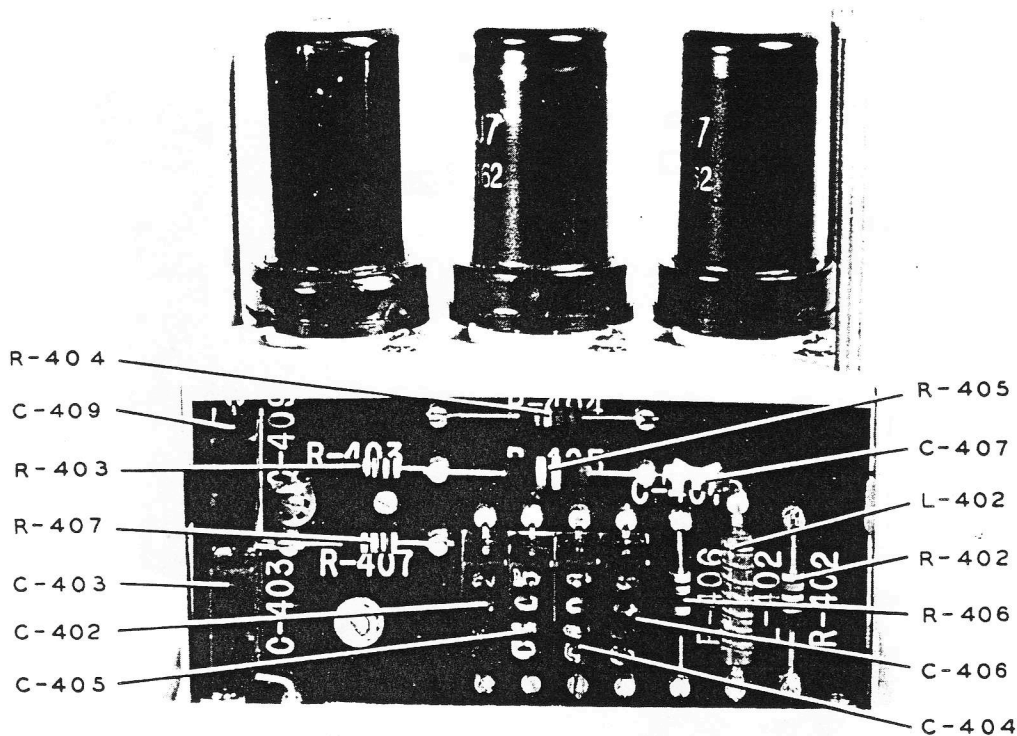


Figure 6-15. CFI Unit, Mounting Side

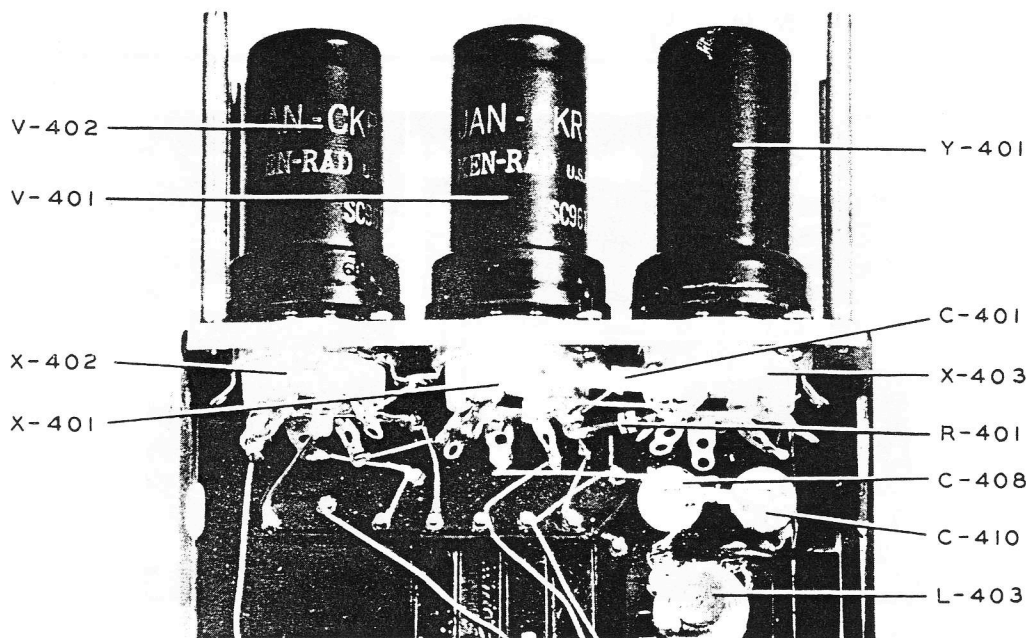


Figure 6-16. CFI Unit, Wired Side

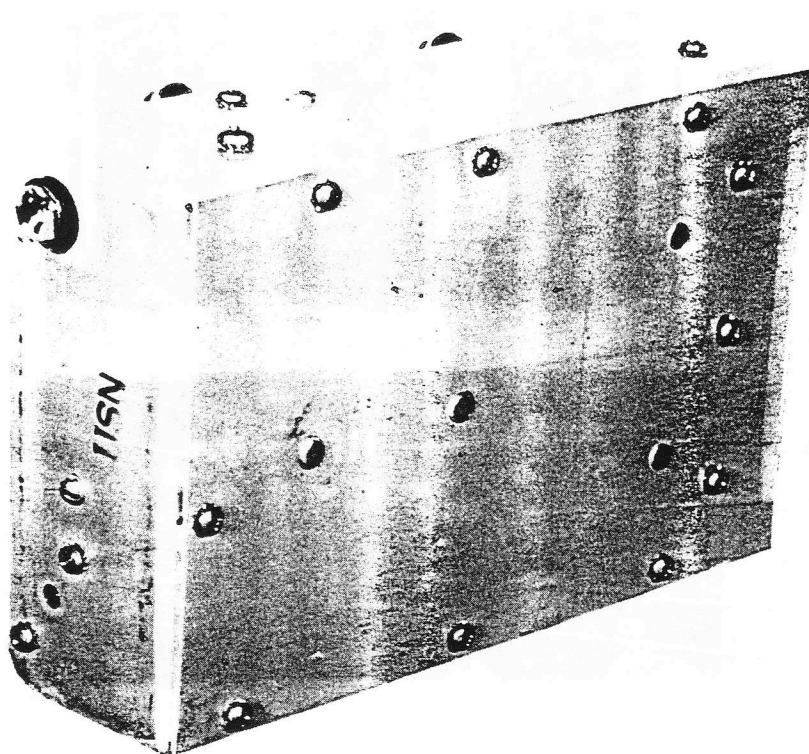


Figure 6-17. Filter Unit, Bottom Enclosed

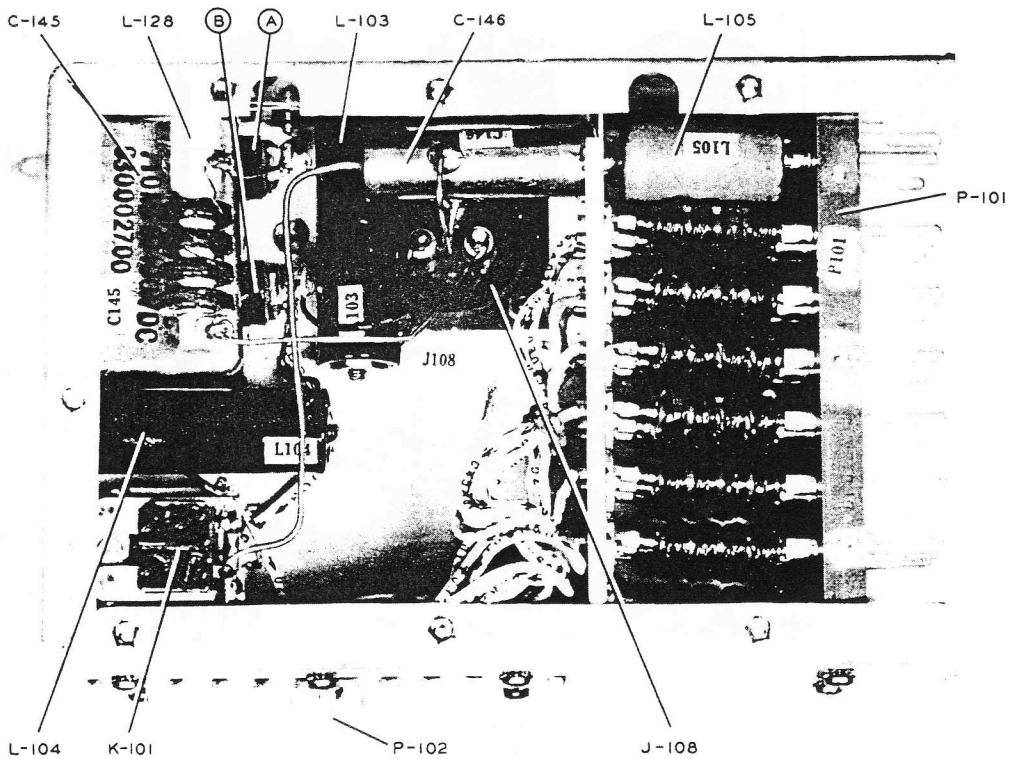


Figure 6-18. Filter Unit, Bottom Open

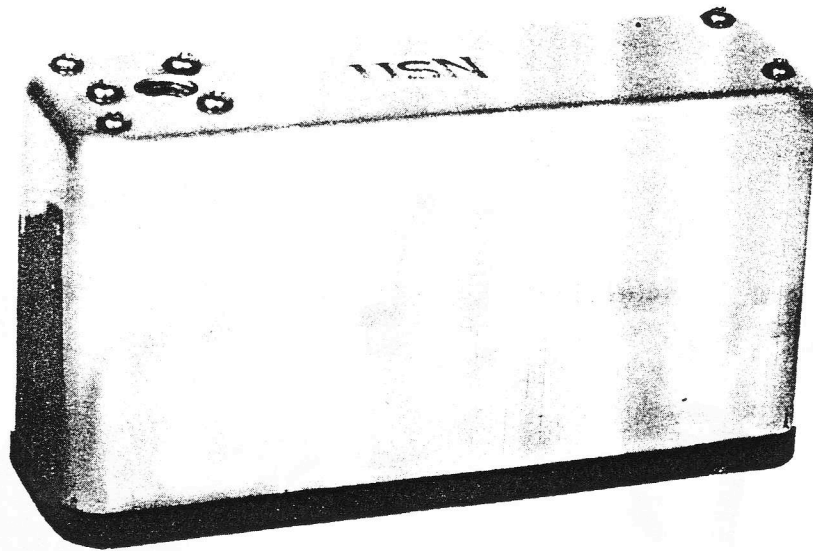


Figure 6-19. Relay Unit, Side Enclosed

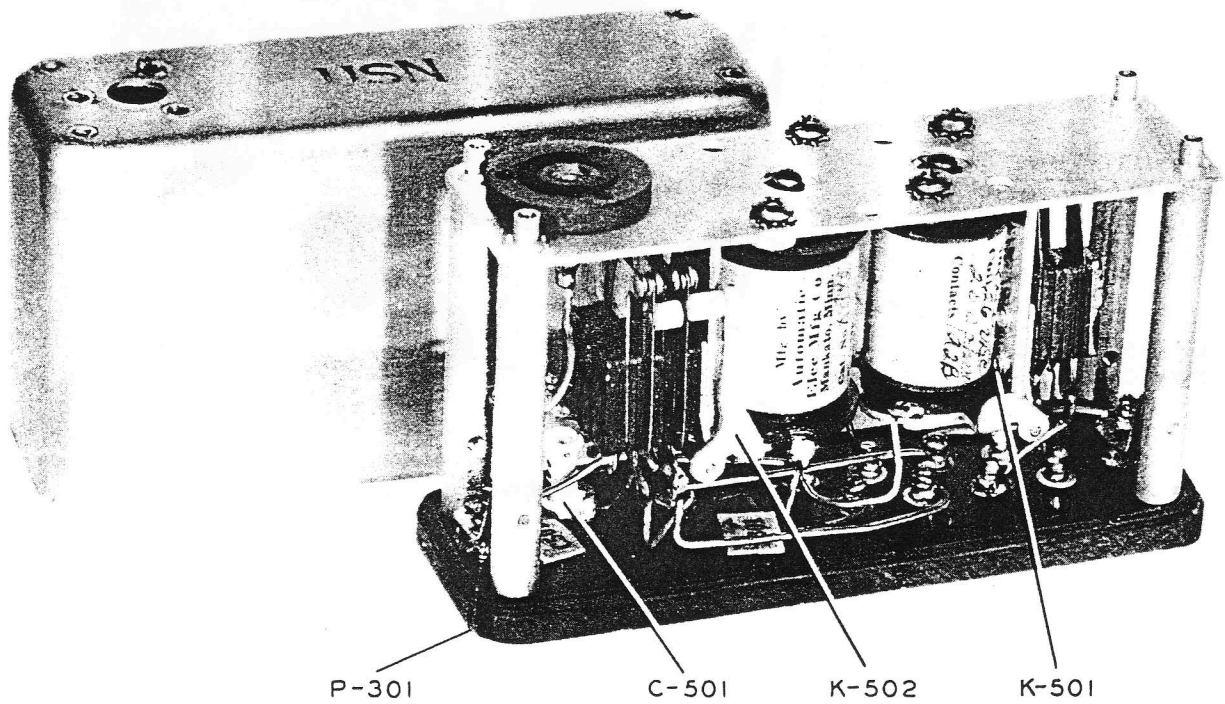


Figure 6-20. Relay Unit, Side Open

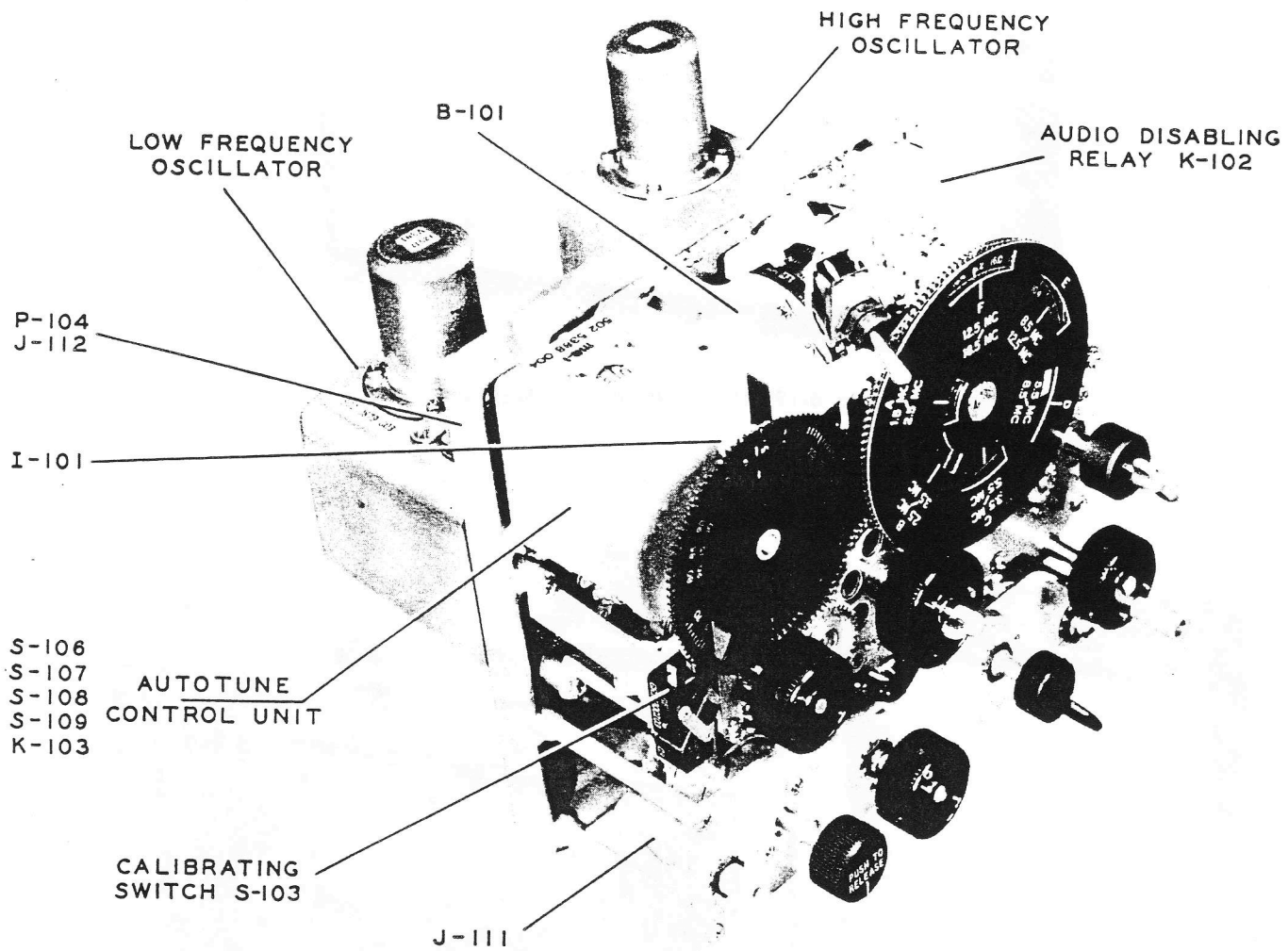


Figure 6-21. Autotune Casting Assembly—Top Left Oblique

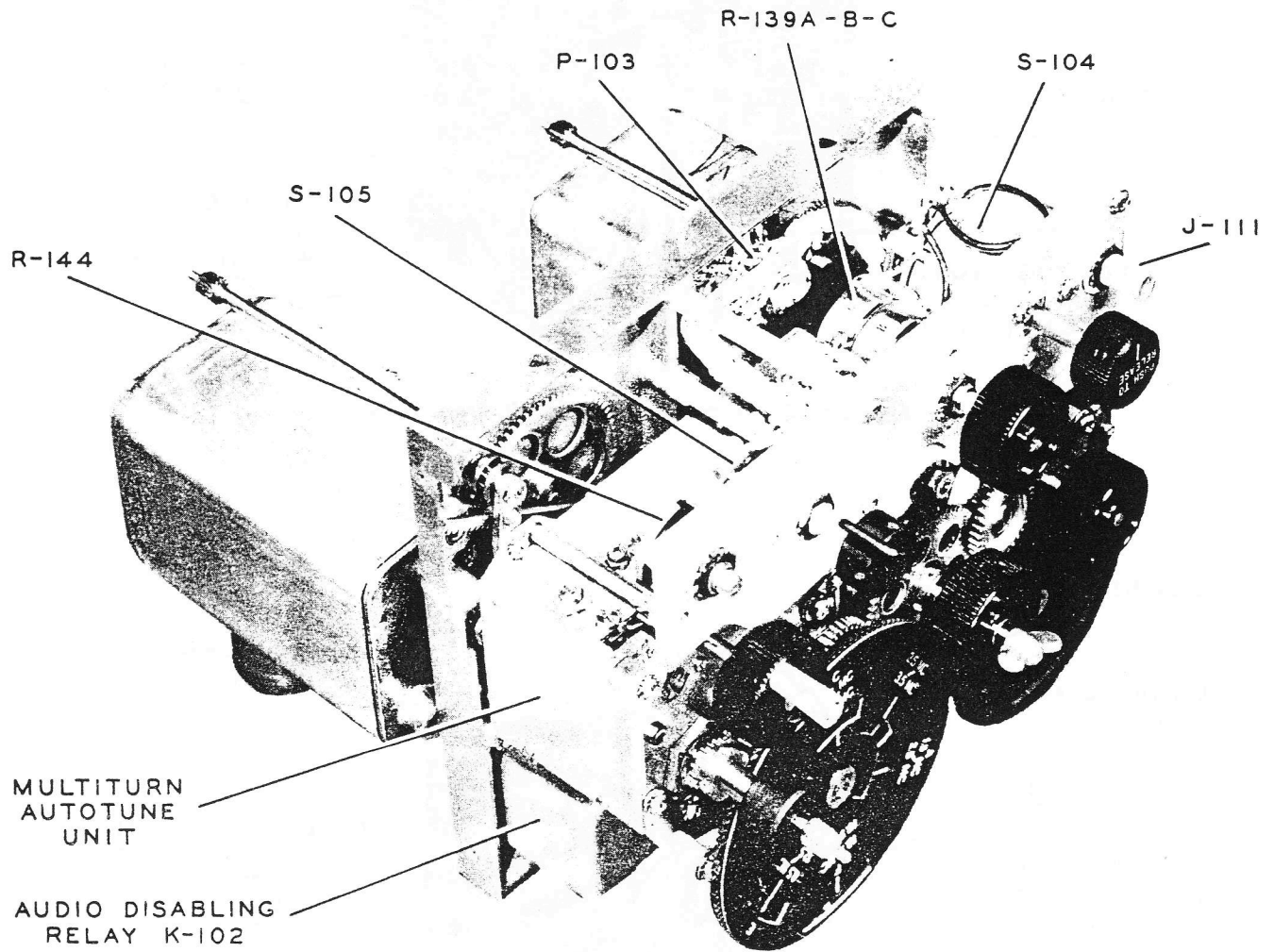


Figure 6-22. Autotune Casting Assembly—Bottom Right Oblique

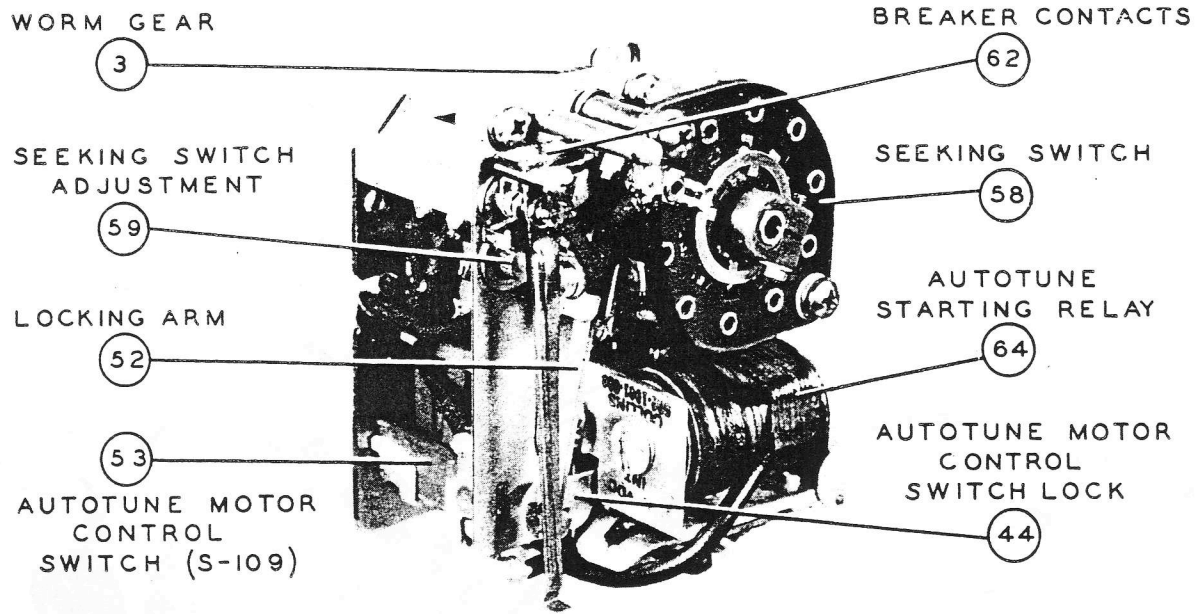


Figure 6-23. Autotune Control Unit, Front View

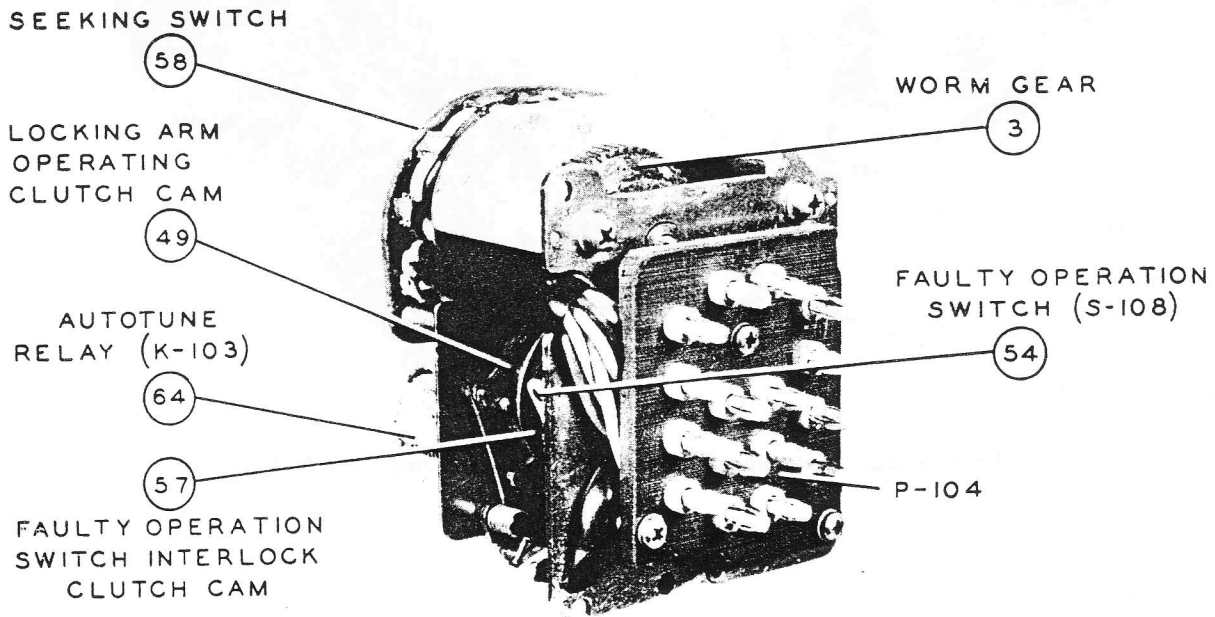
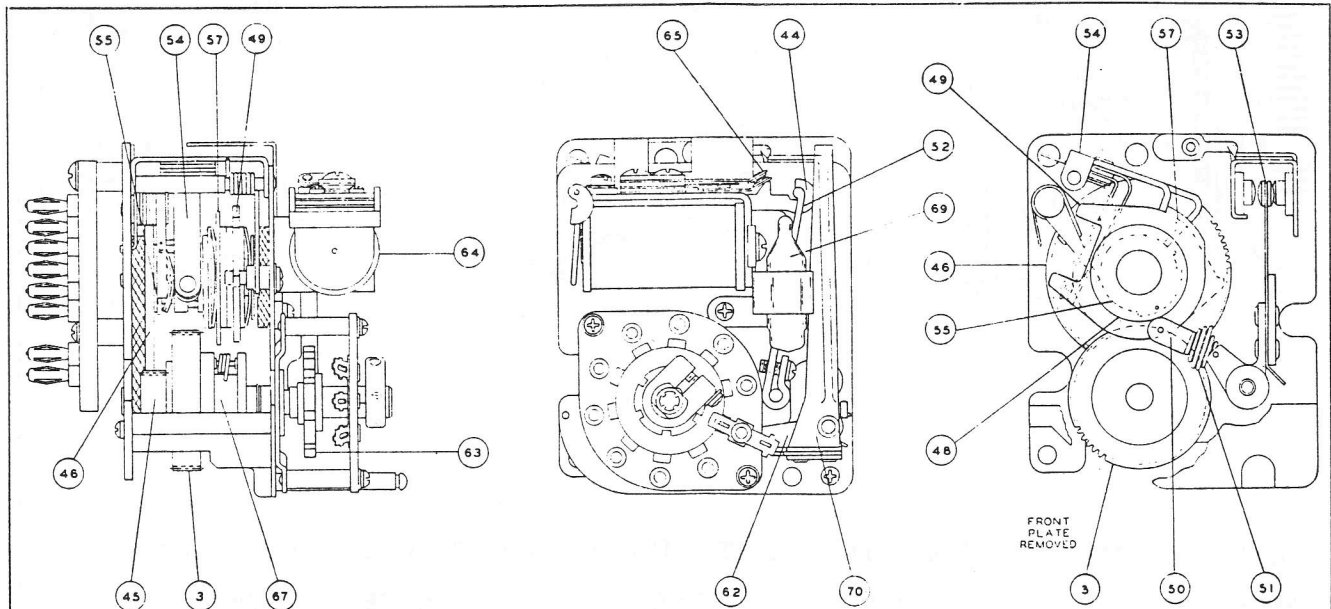


Figure 6-24. Autotune Control Unit, Rear View

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KEY TO SYMBOLS FOR CONTROL UNIT, MULTITURN UNIT AND SINGLETURN UNIT

- | | | |
|---------------------------------|--|--|
| 1. Line Shaft | 24. Counter Drum Home Stop Gear | 45. Locking Arm Drive Gear |
| 2. Drive Worm | 25. Home Stop Pawl Operating Gear | 46. Locking Arm Spur Gear |
| 3. Worm Gear | 26. Pawl Lifting Toggle Lever | 47. Locking Arm Engage Collar |
| 4. Slip Clutch Drive Gear | 27. Pawl Lifting Toggle | 48. Locking Arm Operating Clutch Drum |
| 5. Slip Clutch Idler Gear | 28. Home Stop Ring | 49. Locking Arm Operating Clutch Cam |
| 6. Slip Clutch Spur Gear | 29. Home Stop Pawl | 50. Locking Arm Operating Clutch Arm |
| 7. Slip Clutch Band Dog | (29A-Pawl Heel) | 51. Locking Arm Operating Clutch Arm Spring |
| 8. Slip Clutch Band | (29B-Pawl Tail) | 52. Locking Arm |
| 9. Slip Clutch Drum | (29C-Pawl Toe) | 53. Autotune Motor Control Switch (S-109) |
| 10. Counter Drum Drive Gear | 30. Stop Ring | 54. Faulty Operation Switch (S-108) |
| 11. Counter Drum Idler Gear | 31. Stop Ring Pawl | 55. Faulty Operation Switch Cam |
| 12. Counter Drum Spur Gear | (31A-Pawl Heel) | 56. Faulty Operation Switch Interlock Arm |
| 13. Planetary Drive Gear | (31B-Pawl Tail) | 57. Faulty Operation Switch Interlock Clutch |
| 14. Planetary Stationary Gear | (31C-Pawl Toe) | Cam |
| 15. Counter Drum Planetary Gear | 32. Pawl Spring | 58. Seeking Switch (S-106) |
| 16. Cam Drum Idler Gear | 33. Stop Ring Drum Lock | 59. Seeking Switch Adjustment |
| 17. Cam Drive Gear Assembly | 34. Tuning Knob Shaft | 60. Seeking Switch Ratchet Dog |
| 18. Cam Drum Spur Gear | 35. Tuning Drive Gear | 61. Seeking Switch Ratchet Tooth |
| 19. Cam Drum Ratchet Dog | 36. Tuning Drive Limit Spline | 62. Breaker Contacts (S-107) |
| 20. Cam Drum Ratchet Tooth | 37. Tuning Idler Gear | 63. Breaker Cam |
| 21. Cam Drum | 38. Tuning Spur Gear | 64. Autotune Starting Relay |
| 22. Counter Drum Slot Ring | 39. Tuning Spur Gear Clutch | 65. Autotune Starting Relay Contacts |
| 23. Counter Drum Slot Ring Pawl | 40. Tuned Element | 66. Locking Arm Operating Clutch Spring |
| (23A-Pawl Heel) | 41. Stop Bar | 67. Single Tooth Ratchet Assembly |
| (23B-Pawl Tail) | 42. Stop Ring Drum Drive | 68. Seeking Switch Locking Collar |
| (23C-Pawl Toe) | 43. Cam Drum Drive Gear | 69. Neon Bulb (surge absorber) |
| | 44. Autotune Motor Control Switch Lock | 70. Indicator Arm |

Figure 6-25. Control Unit Sections

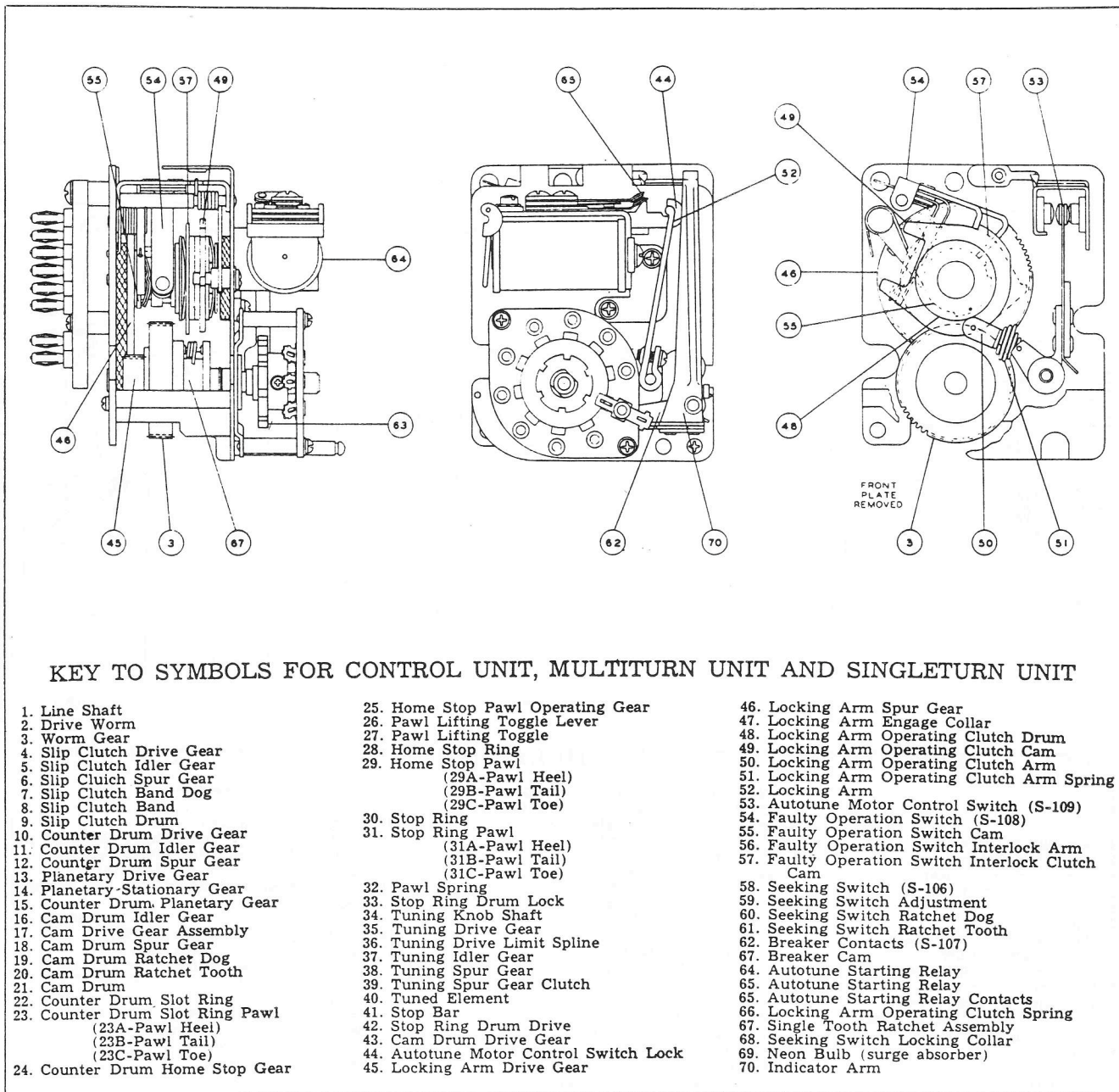


Figure 6-25A. AN/ARR-15A Control Unit, Sections

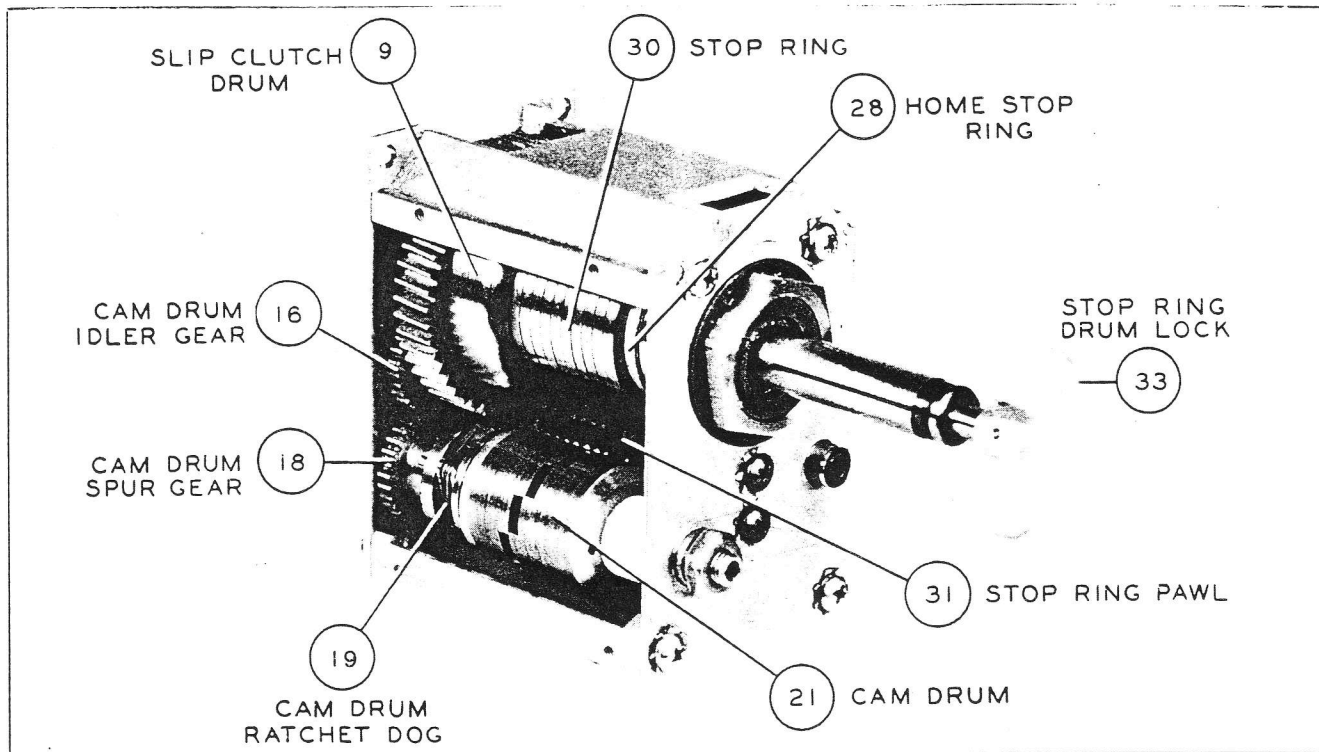


Figure 6-26. Singleturn Unit, Front View

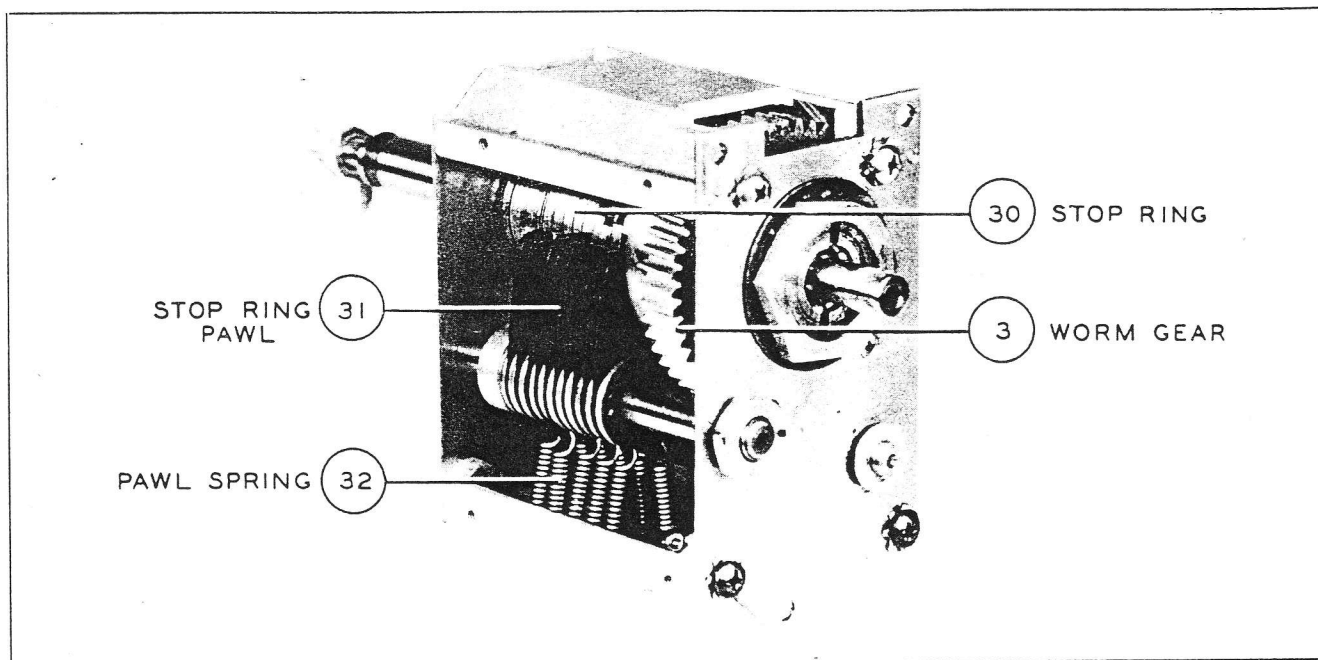
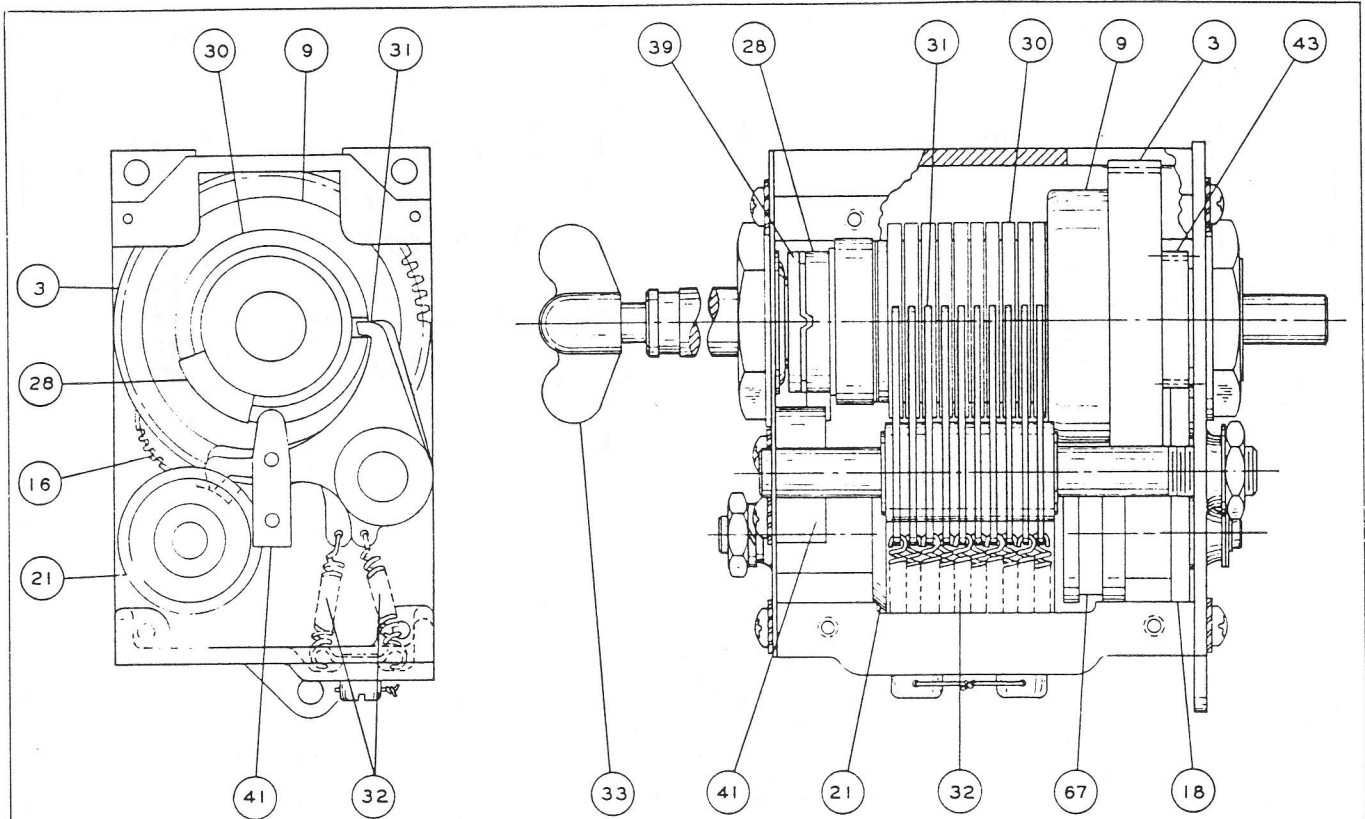


Figure 6-27. Singleturn Unit, Rear View



KEY TO SYMBOLS

- | | | |
|---------------------------------|---------------------------------------|-------------------------------|
| 1. Line Shaft | 19. Cam Drum Ratchet Dog | 30. Stop Ring |
| 2. Drive Worm | 20. Cam Drum Ratchet Tooth | 31. Stop Ring Pawl |
| 3. Worm Gear | 21. Cam Drum | (31A—Pawl Heel) |
| 4. Slip Clutch Drive Gear | 22. Counter Drum Slot Ring | (31B—Pawl Tail) |
| 5. Slip Clutch Idler Gear | 23. Counter Drum Slot Ring Pawl | (31C—Pawl Toe) |
| 6. Slip Clutch Spur Gear | (23A—Pawl Heel) | 32. Pawl Spring |
| 7. Slip Clutch Band Dog | (23B—Pawl Tail) | 33. Stop Ring Drum Lock |
| 8. Slip Clutch Band | (23C—Pawl Toe) | 34. Tuning Knob Shaft |
| 9. Slip Clutch Drum | 24. Counter Drum Home Stop Drive Gear | 35. Tuning Drive Gear |
| 10. Counter Drum Drive Gear | 25. Home Stop Pawl Operating Gear | 36. Tuning Drive Limit Spline |
| 11. Counter Drum Idler Gear | 26. Anvil Operating Clutch Arm | 37. Tuning Idler Gear |
| 12. Counter Drum Spur Gear | 27. Anvil | 38. Tuning Spur Gear |
| 13. Planetary Drive Gear | 28. Home Stop Ring | 39. Tuning Spur Gear Clutch |
| 14. Planetary Stationary Gear | 29. Home Stop Pawl | 40. Tuned Element |
| 15. Counter Drum Planetary Gear | (29A—Pawl Heel) | 41. Stop Bar |
| 16. Cam Drum Idler Gear | (29B—Pawl Tail) | 42. Stop Ring Drum Drive |
| 17. Cam Drum Idler Gear #2 | (29C—Pawl Toe) | 43. Cam Drum Drive Gear. |
| 18. Cam Drum Spur Gear | | |

Figure 6-28. Singleturn Unit, Sections

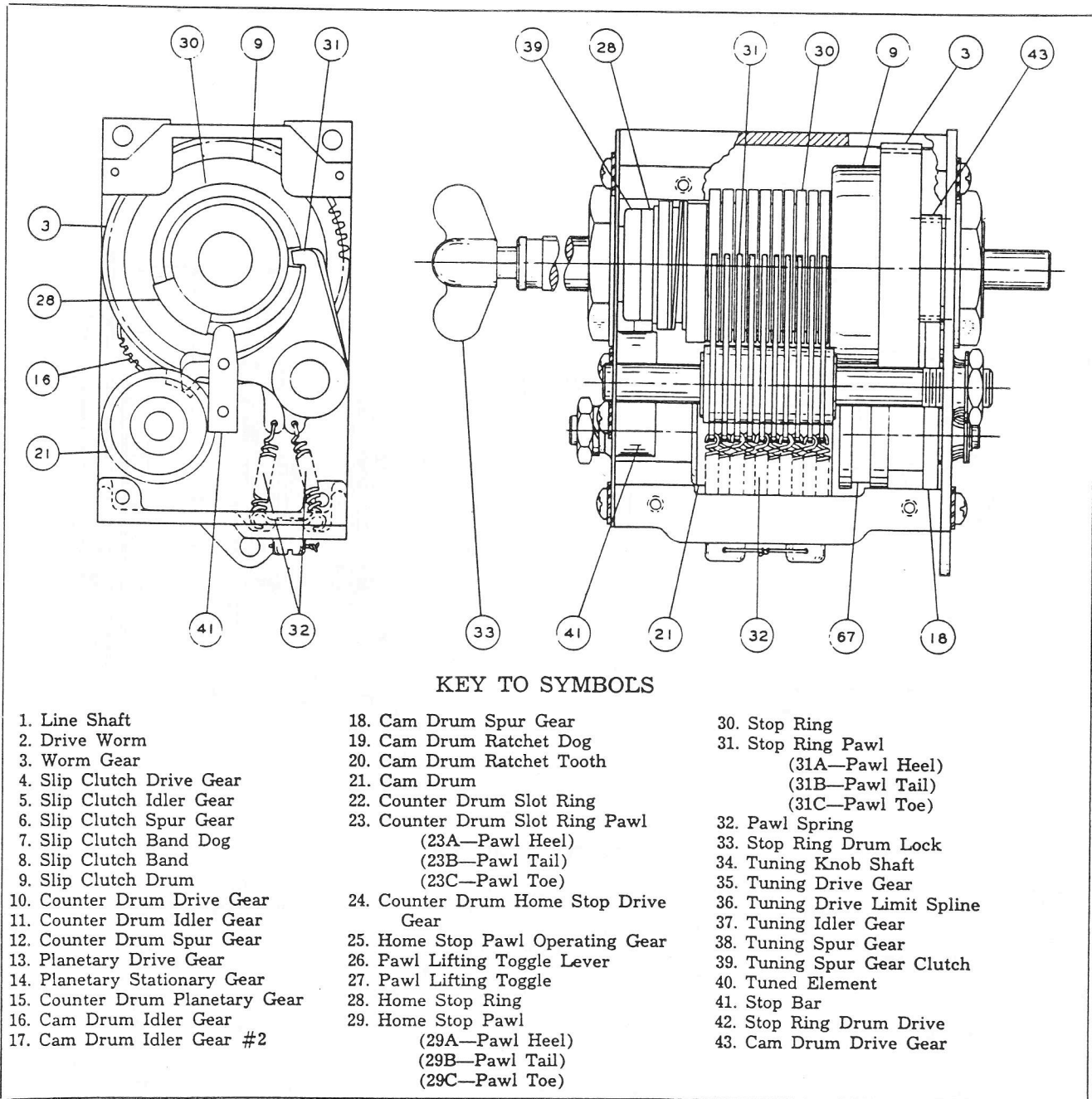


Figure 6-28A. AN/ARR-15A Singleturn Unit, Sections

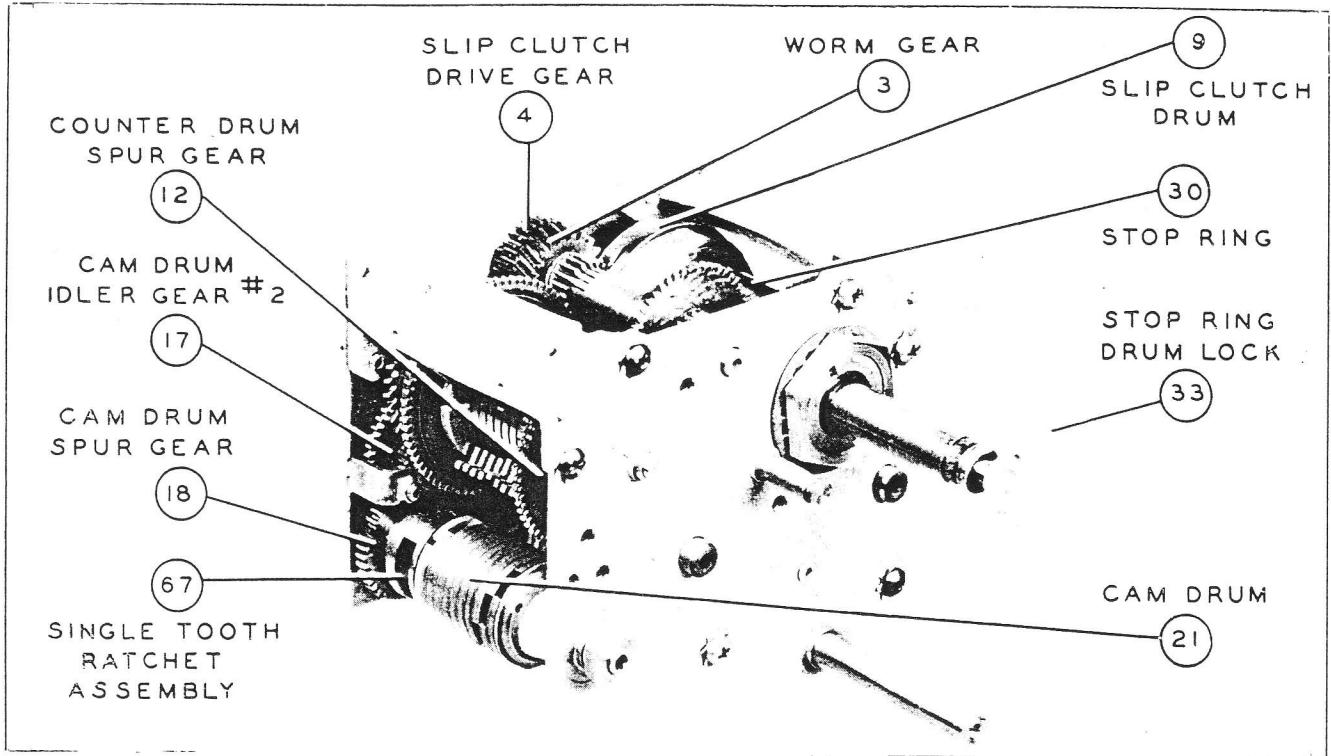


Figure 6-29. Multiturn Unit, Front

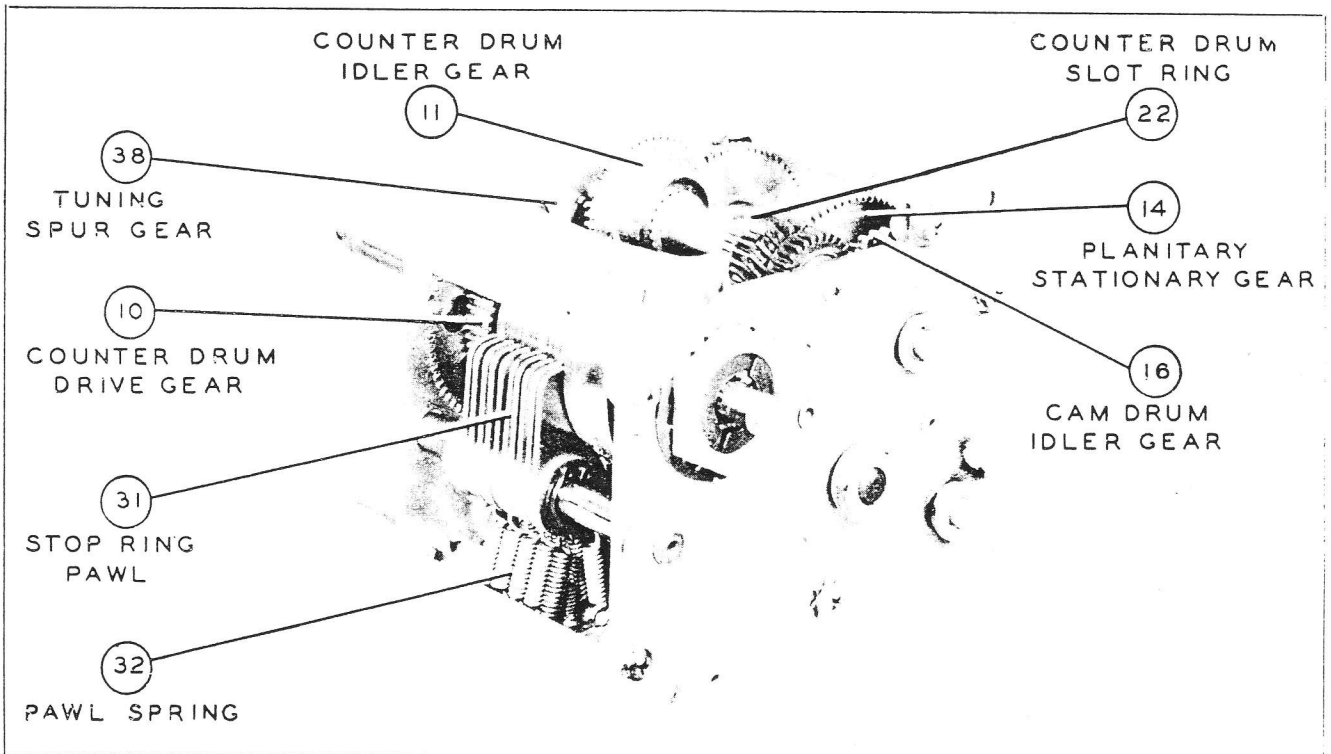


Figure 6-30. Multiturn Unit, Rear

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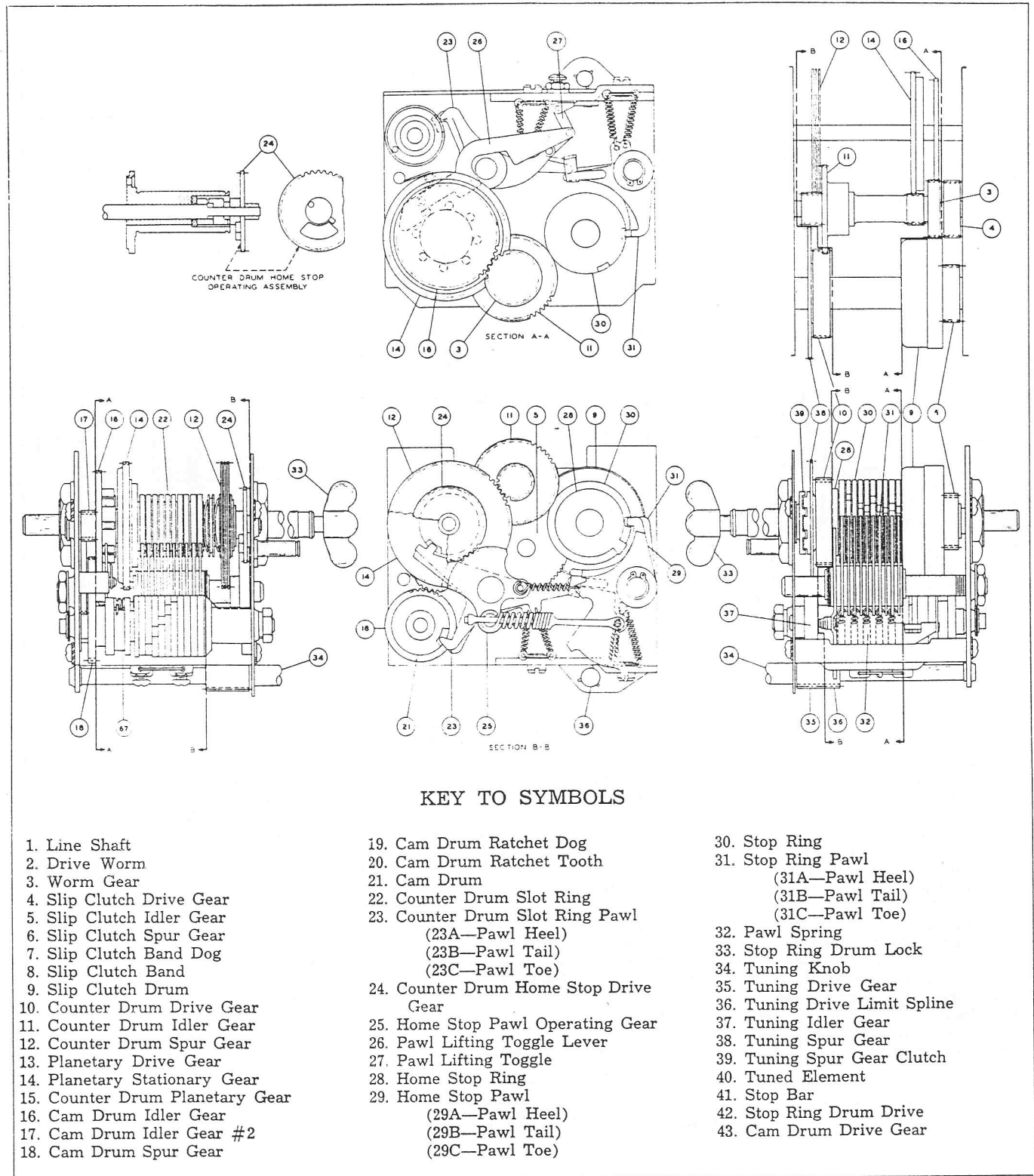


Figure 6-31. Multiturn Unit, Sections

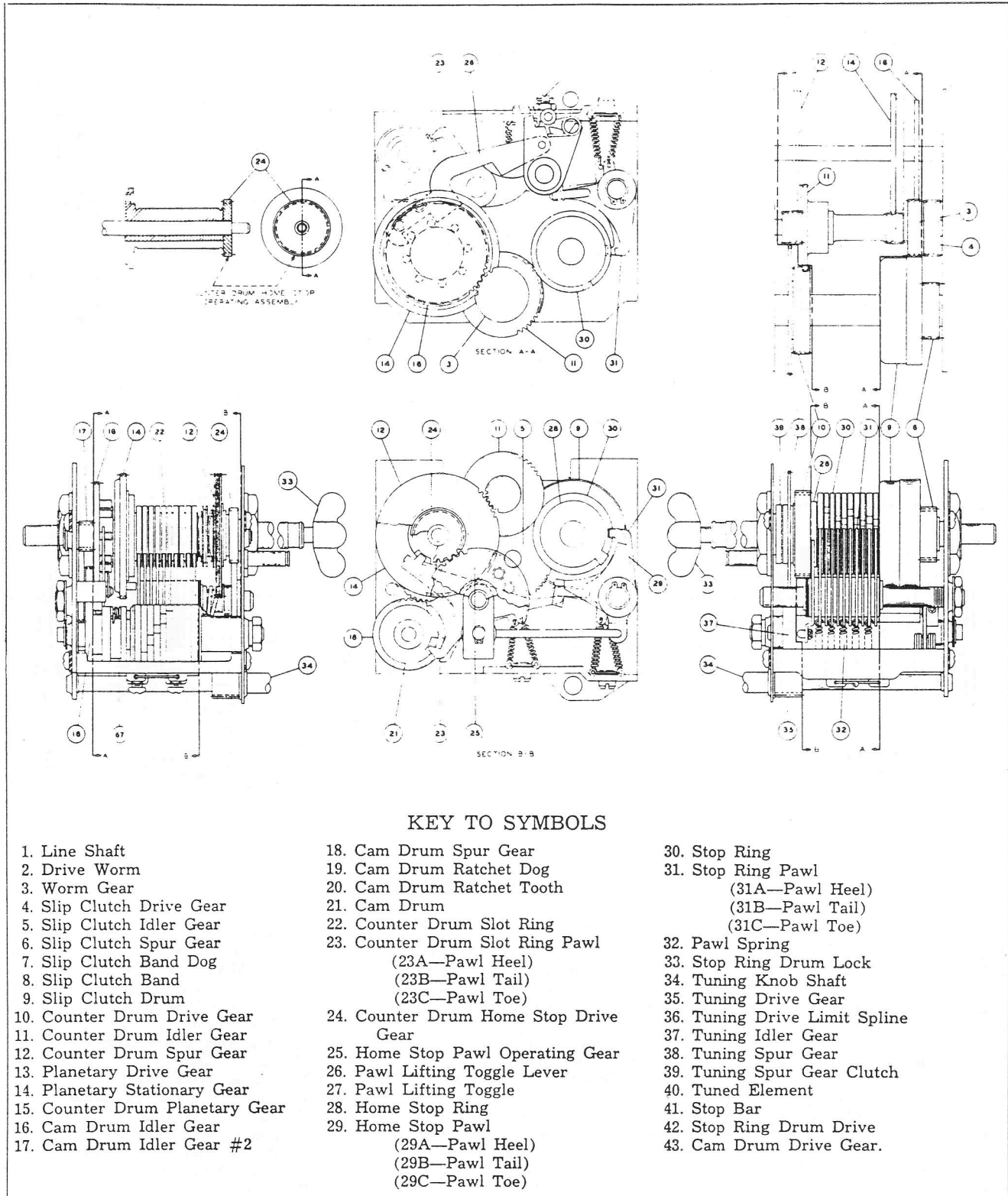
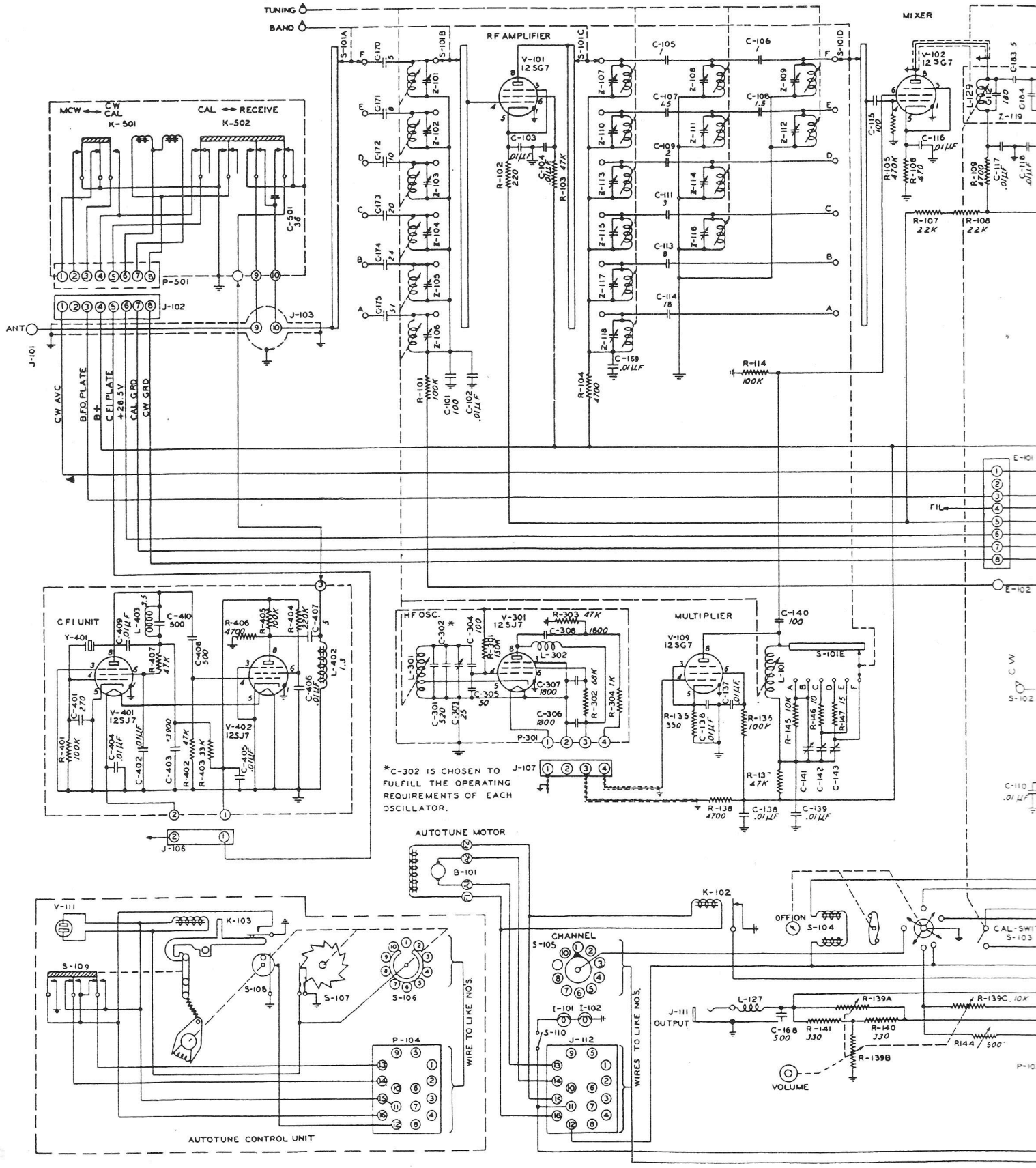
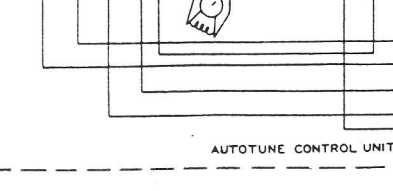
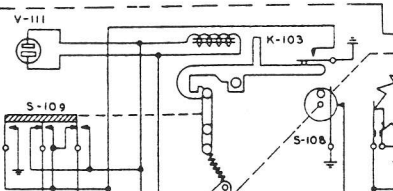
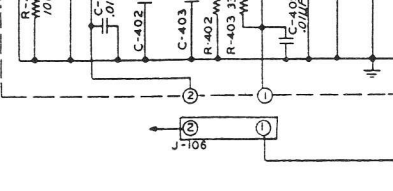
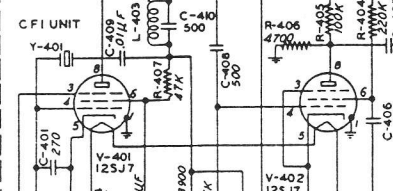
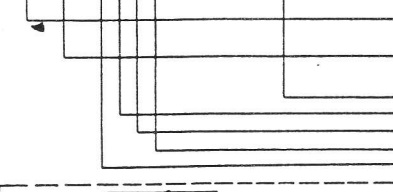
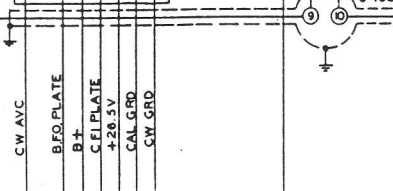
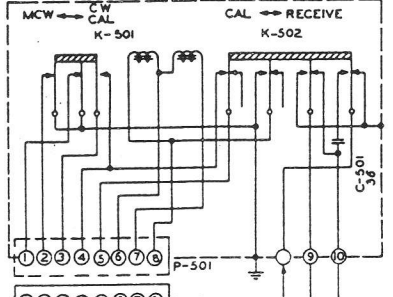


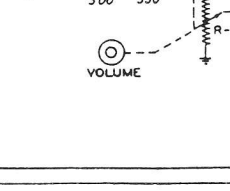
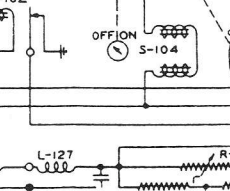
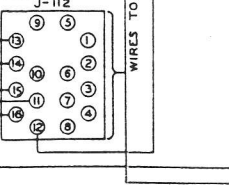
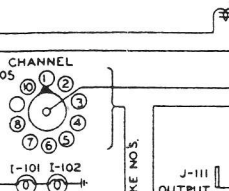
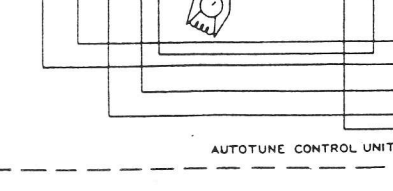
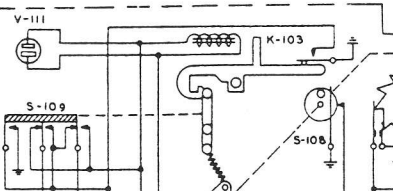
Figure 6-31A. AN/ARR-15A Multiturn Unit, Sections

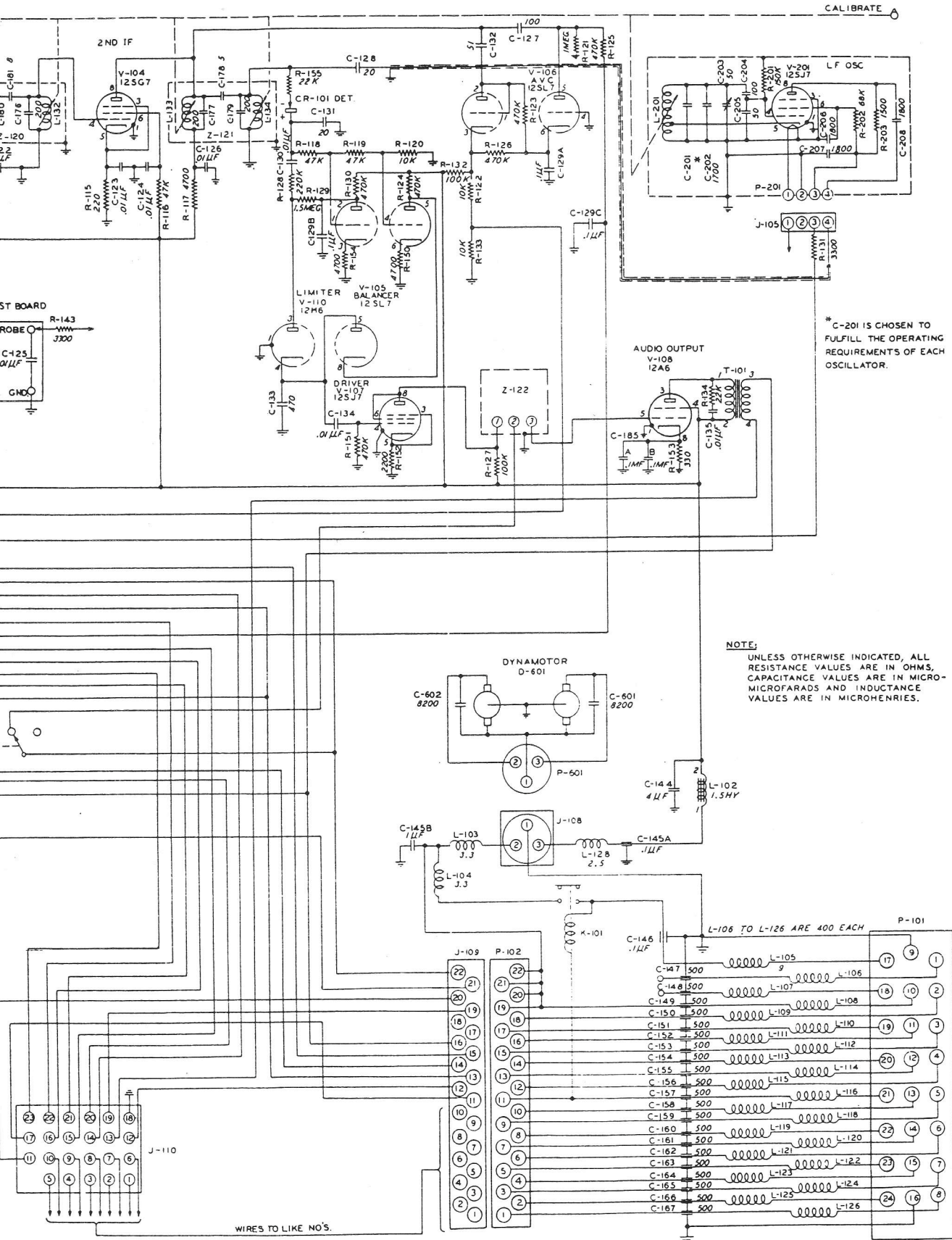


TUNING
BAND



* C-302 IS CHOSEN TO FULFILL THE OPERATING REQUIREMENTS OF EACH OSCILLATOR.

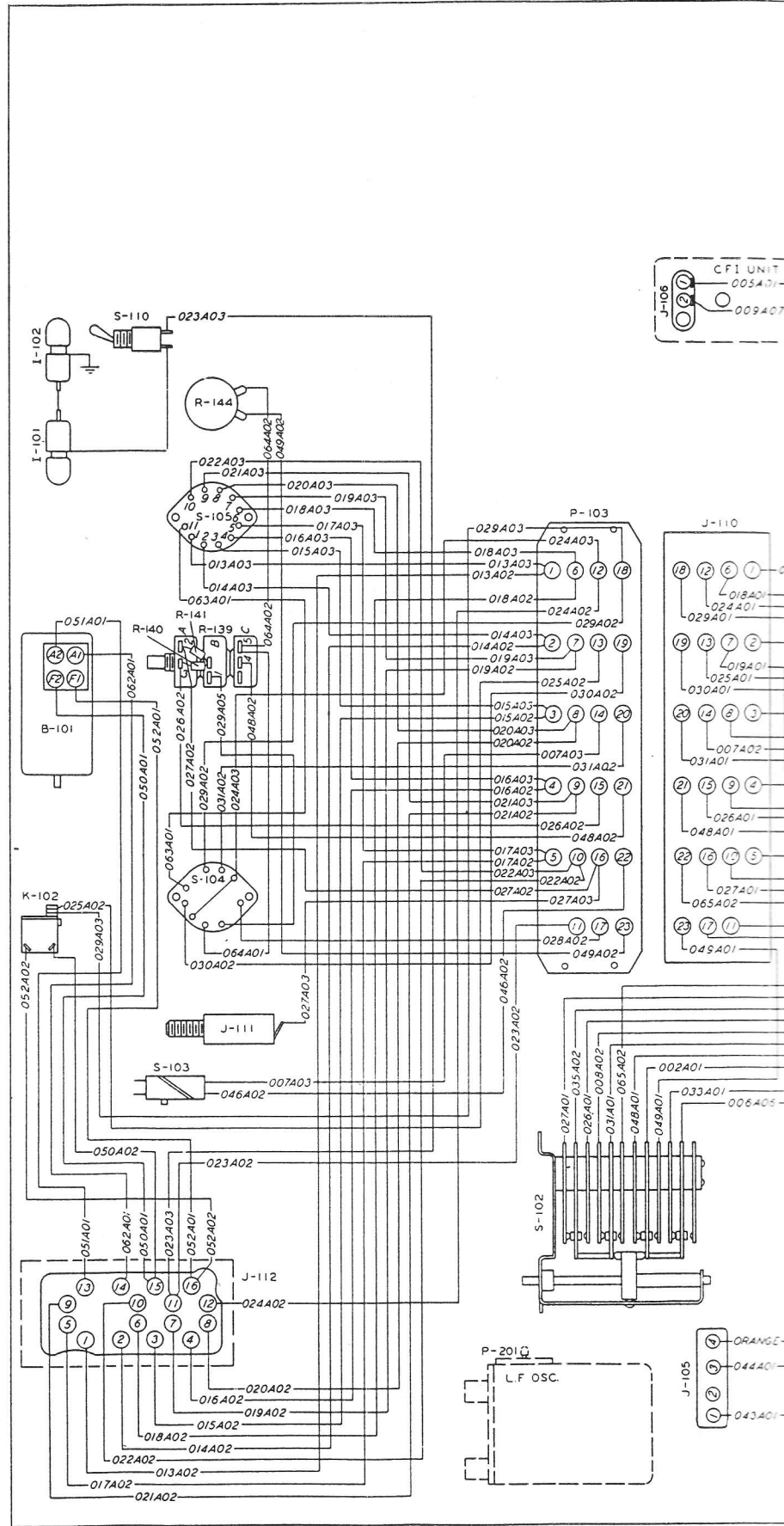




* C-201 IS CHOSEN TO FULFILL THE OPERATING REQUIREMENTS OF EACH OSCILLATOR.

NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICRO-FARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.

Figure 8-9. Receiver Complete Schematic Wiring Diagram



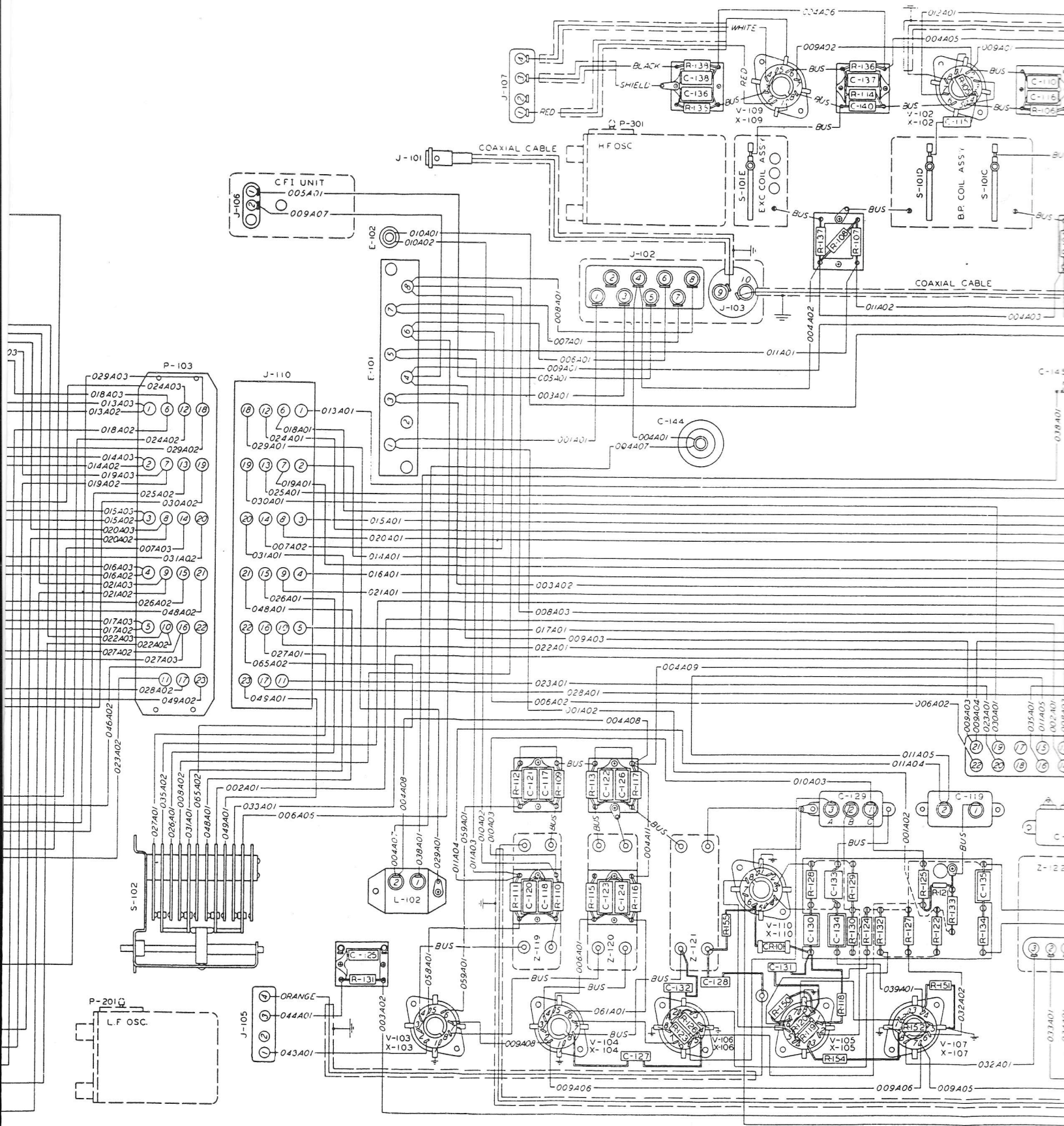


Figure 8-8. Receiver Practical Wiring

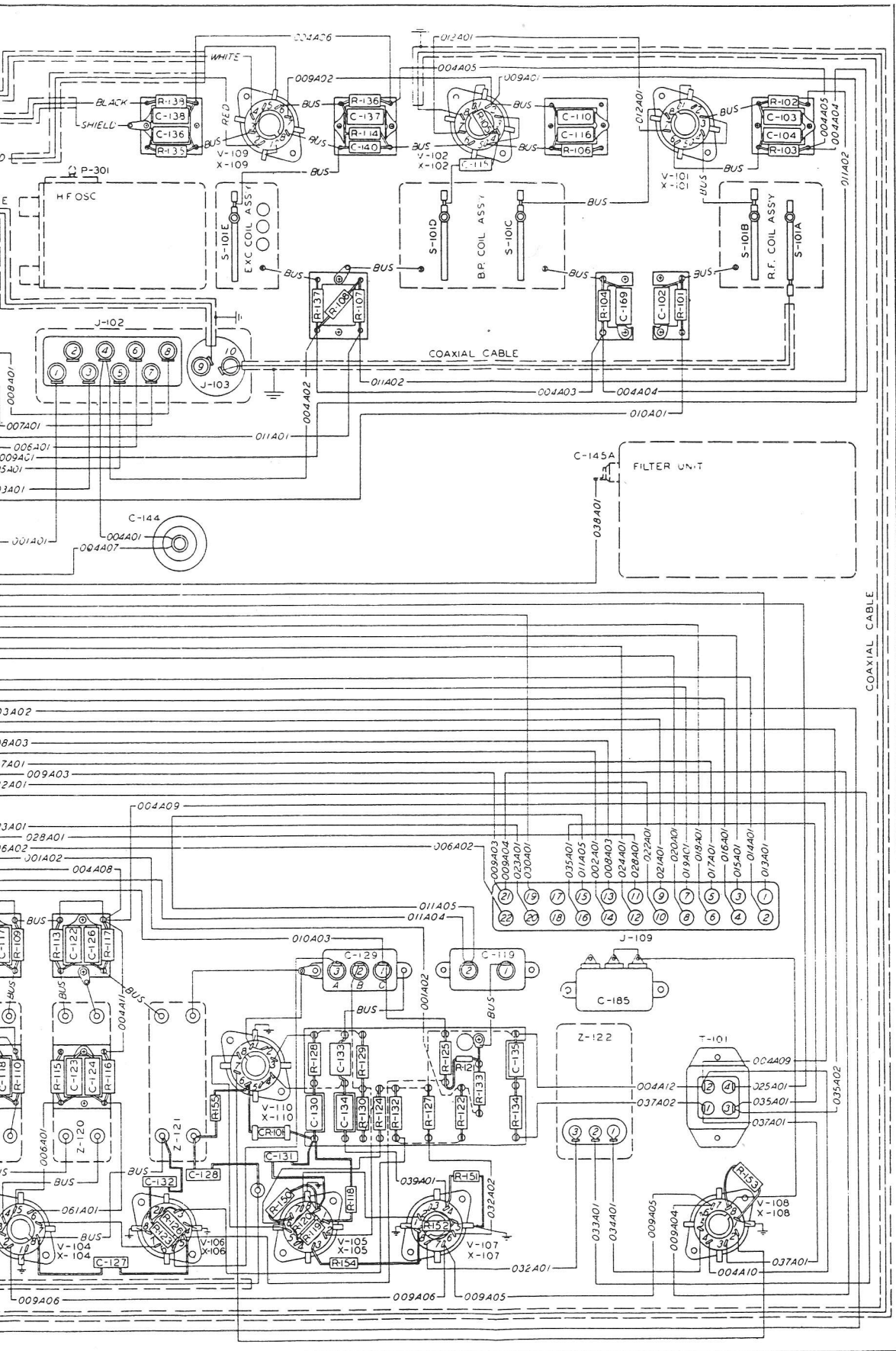


Figure 8-8. Receiver Practical Wiring Diagram