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WAR DEPARTMENT TECHNICAL MANUAL **TM11-1540**

RADIO SET AN/TPS-3
SERVICE MANUAL

THEORY AND TROUBLE SHOOTING

CONFIDENTIAL

WAR DEPARTMENT • 1 MARCH 1944

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ERRATA

Figure 39.

Manufacturer drawing numbers on the following schematic references have been changed in figure 39A to the following:

R75, R77, R79, and R134 to 63G1306.
R76, R78, R128, R130, and R133 to 63G1059.
R74 to 63G1060.

Figure 28A: C17 to 22G922 and R249 to 63G1028.

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TM 11-1540 [redacted]

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WASHINGTON 25 D.C. 1 March 1944

TM 11-1540, War Department Technical Manual, Radio Set AN/TPS-3 Service Manual Theory and Trouble Shooting, is published for the information and guidance of all concerned.

[A. G. 300.7 (31 Jan. 44)]

By order of the Secretary of War

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:
X
(For explanation of symbols see FM 21-6.)

As prescribed in paragraph 9a, FM21–6:

Armies (Sig) (5); Corps (Sig) (5); Def C (2); Dept (5); Sv C (Sig) (5); IBn 11 (4); IC 11 (4); Arm & Sv Bd (2); Sig C Rep Shs (2); ASF Dep (Sig Sec) (2); Sig Dep (Oversea) (10); Gen'l Dep (Sig Sec) (10); PE (2); Air Force Dep (Sig Sec) (5); Sig C Inspec Zones (2); Sig C Proc Dists (2).

IBn 11: T/O & E 11–400, Sig AW Orgn = Bn Hq (A).

IC 11: T/O 11–107; 11–237; 11–592; 11–587; 11–597; 11–617; 11–400, Sig AW Orgn = Radar Rep Plat (U); 11–500, Sig Sv Radar Maint Team (EC); 11–287.

For explanation of symbols, see FM 21–6.

WARNING

HIGH VOLTAGE
is used in the operation of
this equipment.

DEATH ON CONTACT
may result if operating personnel
fail to observe safety precautions.

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DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT — 1. Smash — Transmitter tube. Smash receiver and indicator units (units are readily removable from the console). Smash modulator unit; be sure oil-sealed compartment is destroyed. Smash pulse transformer, T-R assembly, and transmission line system in lower part of console. Smash power unit; be sure the rotary spark gap is destroyed. Smash the antenna assembly.

2. Cut — Wiring, electrical connections, coaxial cable, and dipole.

3. Burn — Tent, antenna frame, and console. Use power unit gasoline and oil.

4. Bend — Antenna shaft and transmission lines.

5. Burn or scatter — Scatter transmitter tube after smashing. Bury and scatter remains which will not burn.

DESTROY EVERYTHING

SAFETY NOTICE

Voltages used in this equipment are high enough to endanger life and may be fatal if contacted by operating personnel. Operators must be careful not to contact high-voltage plate circuits or 115-volt a-c input connections while checking or servicing equipment.

Extreme caution must be exercised when adjusting the frequency of the transmitter. Dangerously high voltages are present in the power supplies of the receiver and modulator units. High-voltage capacitors in these power supplies must be discharged manually.

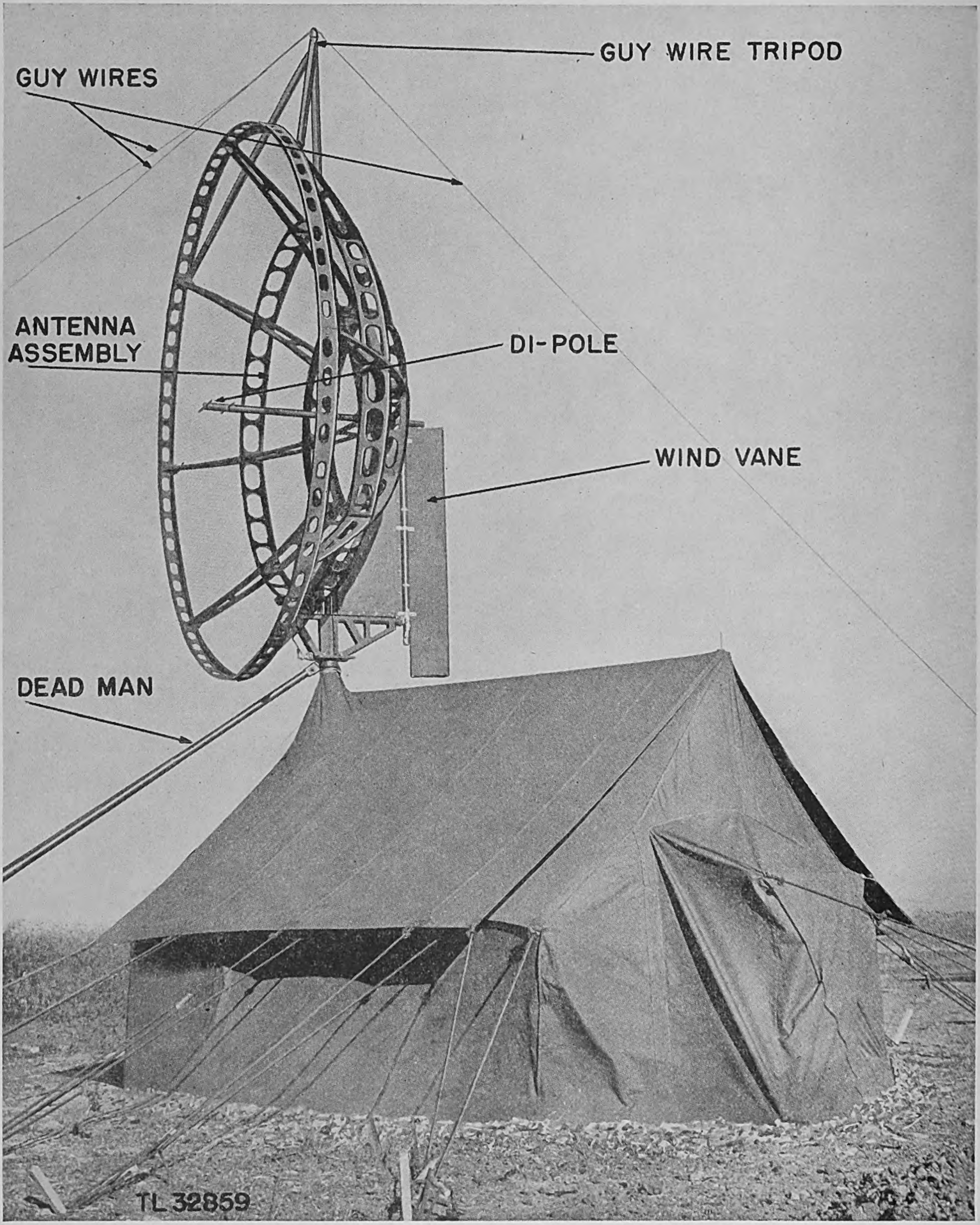


Figure 1. Radio Set AN/TPS-3.

[redacted]

CHAPTER 1

THEORY

SECTION I

DESCRIPTION OF RADIO SET AN/TPS-3

1. PURPOSE.

a. Introduction. Radio Set AN/TPS-3 is a 600-megacycle, light-weight, radar set designed chiefly for medium-long-range early-warning against aircraft. Basically the set is a radar search unit which transmits a high-power, short-duration r-f pulse, and then receives signals from objects capable of reflecting back part of the r-f energy in the transmitted pulse. The received energy is applied to visual indicators which show the distance in miles and the azimuth bearing in degrees of the objects causing the reflection.

b. Description. This set consists of a main console (fig. 2), an r-f plumbing system, and a dipole antenna using a parabolic reflector. The console with its feeder system forms one leg of a tripod. The other two legs of the tripod are wooden members, called "deadmen". These deadmen are anchored in the ground and provide support for the antenna. As added support, the antenna is guyed at the top by three wires fixed by ground stakes. The entire system with the exception of the antenna is housed in a wall tent (fig. 1). When delivered, the radio set comes packed in heavy export shipping crates. Inside the heavy packaging are light-weight air-transit cases. These transit cases are suitable for carrying the set by hand or for loading it into aircraft for air-transport.

c. Wall Tent. (1) The tent used with Radio Set AN/TPS-3 is provided with a light-proof entrance, an opening for a ventilating fan, and two console-ventilating boots. These boots are attached to the two exhaust ducts on the console.

(2) For ventilating purposes the tent is provided with a fan which draws air through the entrance, the tent, and out the other side at the top of the tent. In cold climates the boots are not connected to the console ducts, and the heat dissipated by the set is used to warm the tent.

(3) The tent is provided with a sod cloth which should be buried with the dirt removed in digging the drainage trench around the tent. This cloth serves as an excellent air seal and improves the tent's light-tightness. The tent is also provided with a fly of light material which provides ventilation, further light-tightness, and insulation from the direct rays of the sun.

2. CHARACTERISTICS OF COMPONENTS.

a. Radio Set AN/TPS-3.

(1) Frequency, 590-610 megacycles.
(2) Azimuth coverage, 360°.
(3) Altitude coverage, up to 30,000 feet.
(4) Range, up to 120 miles.
(5) Power consumption, 1900 watts.

b. Receiver R-59/TPS-3.

(1) Frequency, 590-610 megacycles.
(2) Intermediate frequency, 30 megacycles.
(3) Overall bandwidth, 2.5 megacycles.
(4) Anti-jamming circuit, discriminator and blanking circuit.

c. Indicator ID-51/TPS-3.

(1) Presentation, 5-inch "A" tube; 7-inch PPI tube.
(2) Ranges, 20, 60, and 120 miles.
(3) Range accuracy, 2 miles.
(4) Azimuth accuracy, 2 degrees.

d. Transmitter T-52/TPS-3.

(1) Frequency, 590-610 megacycles.
(2) Power output, 200 kilowatts peak.

e. Modulator MD-16/TPS-3.

(1) Repetition rate, 200 cycles per second.
(2) Pulse duration, 1½ microseconds.
(3) Output, 8000 volts, 180 amps, peak.

f. Power Unit PU-6/TPS-1.

(1) Output (rated) 115 volts, 400 cycles. 1000 watts; 24 volts d-c; 400 watts.
(2) Fuel, 80 to 100 octane gasoline.
(3) Operation, gasoline engine driven, one cylinder, two cycle.
(4) Lubrication, SAE No. 10 oil mixed with gaso-

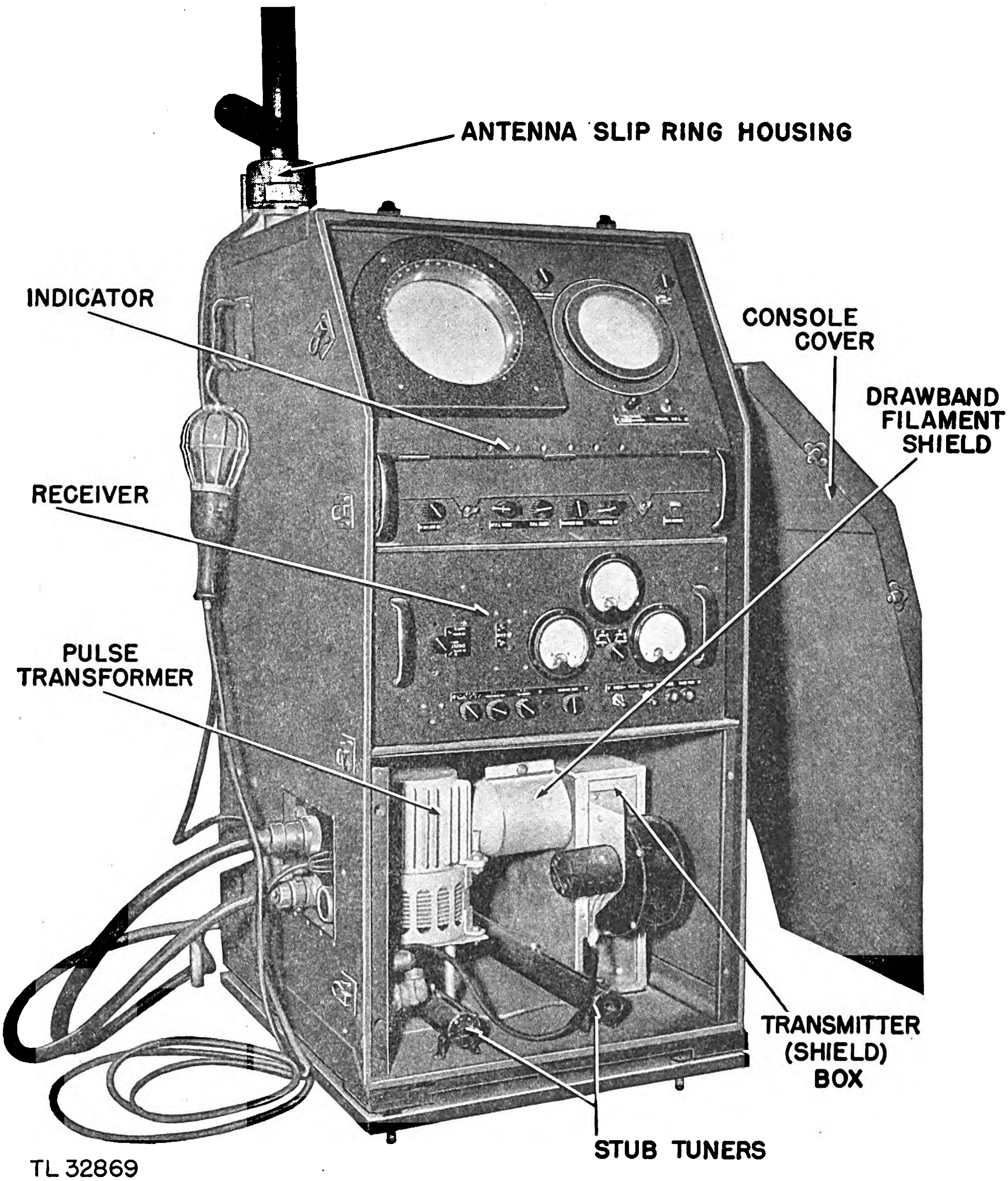


Figure 2. Console with lower panel removed.

line (SAE No. 30 or No. 50 oil must be used in confined areas with limited air circulation).

3. GENERAL DESCRIPTION OF RADIO SET AN/TPS-3.

a. Introduction. A simplified block diagram is shown in figure 4. Radio Set AN/TPS-3 operates on a nominal frequency of 600 megacycles and is tuned to operate on this frequency when shipped. All circuits have a sufficiently wide band-pass to permit efficient operation over the range of frequencies from 590 to 610 megacycles. The frequency of the system should not be changed unless there is interference from nearby radar stations operating on the same frequency, or if other interference is experienced.

b. Transmitter. The transmitting tube is a push-pull dual-triode oscillator. The 8,000-volt positive pulse from the modulator is stepped up and inverted to a negative 24,000 volts in the pulse transformer. This pulse is used to supply the high plate voltage required to set the transmitting tube in oscillation. The r-f energy is supplied to the antenna through the T-R system. A portion of the modulator pulse, taken from the pulse transformer, is used to trigger the sweep circuits in the indicator.

c. Modulator. The modulator initiates the pulse which triggers the transmitter and at the same time triggers the sweep-generating and range-marker circuits. The modulator contains the high-voltage supply which is used to charge the pulse-forming line. An 8,000-volt positive pulse is produced which is fed into the pulse transformer.

d. T-R System. Since a single antenna is used for both receiving and transmitting, provision must be made in the antenna system for automatic switching from transmission to reception. This is accomplished by the action of the T-R box and anti T-R spark gap. Both the T-R box and the transmission line may be tuned for maximum transfer of power.

e. Antenna. A single antenna is used for receiving and transmitting. The antenna is an horizontally polarized, half-wave dipole which is located at the focal point of a 10-foot diameter parabolic reflector. The entire antenna assembly is rotated in azimuth by a drive-motor controlled by a switch on the indicator panel. The antenna may be rotated continuously in one direction, or may be rotated to the left or right to "track" a target.

f. Power Unit. A standard power unit (fig. 3) PU-6/TPS-1, is used to generate 115-volt, 400-cycle, alternating current and 24-volt direct current. See TM 11-933. The generator is driven by a single cylinder, two cycle, gasoline engine. The 115-volt, 400-cycle output is supplied to the high-voltage transformer in the modulator and to the power-supply transformer in the receiver. The 24-volt d-c output is supplied to the relay, antenna, and fan motors. The power unit also contains the rotary spark gap used to dicharge the pulse-forming line in the modulator.

g. Receiver. (1) GENERAL DESCRIPTION. The receiver consists of a two stage r-f amplifier, a crystal converter or mixer, a six-stage, broad-band i-f amplifier, a diode detector, and a single-stage video amplifier. An intermediate frequency of 30 megacycles is used.

(2) ANTI-JAMMING CIRCUIT. The anti-jamming circuit is located on the receiver chassis and is electrically switched into the receiver circuit when enemy jamming is encountered. The anti-jamming circuit improves radar reception during pulse-jamming or continuous wave-jamming (either modulated or unmodulated).

(3) POWER SUPPLY. The power supply located on the receiver chassis furnishes the regulated plate voltages, the accelerating voltages for the indicator tubes, and the filament voltages. The primary voltage is obtained from the 115-volt, 400-cycle output of the power unit, PU-6/TPS-1.

h. Indicator Unit. (1) GENERAL. The indicator unit consists of a five-inch, electrostatic deflection, cathode-ray tube ("A" scope), a seven-inch magnetic deflection cathode-ray tube (PPI tube), sweep circuits associated with the cathode-ray tubes, and range-marker circuits. The sweep circuits are arranged to produce sweeps for ranges of 20, 60, and 120 miles. Range markers appear for every 10 miles of range, and every fifth range marker is accentuated. The sweeps and range markers are triggered the instant the transmitted pulse occurs.

(2) TARGET PRESENTATION.

(*a*) *"A" Scope.* On the "A" scope, only the range of the target is indicated. The range is estimated using the range marker pips which appear for every ten miles of range. Figure 5 shows a target at range of 15 miles for each of the three range settings.

(*b*) *PPI tube.* On the PPI tube, both the range

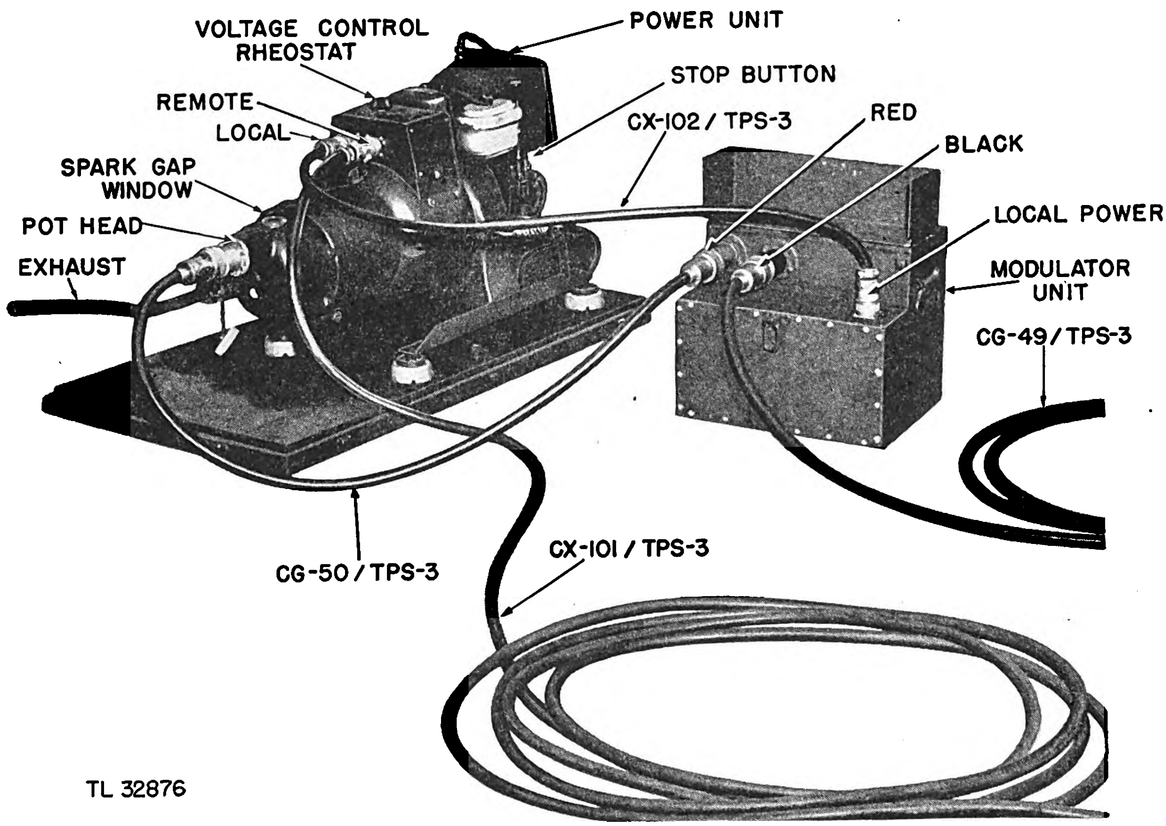


Figure 3. Power unit and modulator.

and azimuth are indicated. The rim of the tube is divided into degrees, and range markers appear as concentric circles for every 10 miles of range. Figure 6 shows a target at a range of fifteen miles and 30° in azimuth for each of the three range settings.

4. DETAILED DESCRIPTION OF RADIO SET AN/TPS-3.

a. Introduction. A functional block diagram is shown in figure 7. For clarity in description the set is considered as consisting of three main components; the radio frequency system, the receiver unit, and the indicator unit. Physically, the console contains the indicator unit, receiver unit, T-R system, pulse transformer, transmitter, and transmission line tuning stubs. Connections between these units are made within the console. The modulator and gasoline driven generator each are separate units. The vertical antenna support extends through the upper part of the console. This support is actually the r-f transmission line.

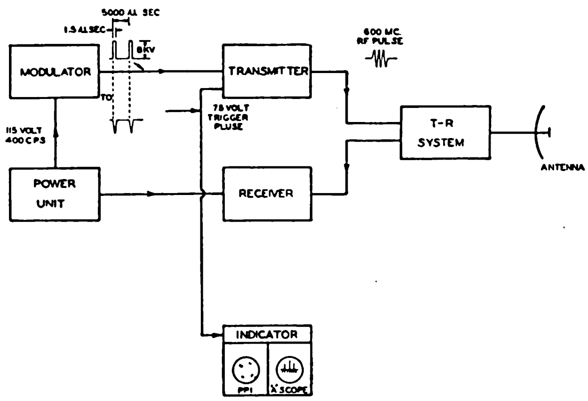
b. Radio-Frequency System. (1) GENERAL. The radio-frequency system (fig. 7) consists of the transmitter tubes, modulator pulse transformer, power unit and rotary spark gap, the transmission lines and T-R system, and the antenna system.

(2) TRANSMITTER TUBE. The transmitter tube is set in oscillation every 5,000 microseconds (repetition frequency 200 pulses per second) by the negative 24,000-volt pulse from the pulse transformer. The resultant radio-frequency energy is a 600-megacycle pulse, approximately 1.5 microseconds in duration with a peak power of approximately 200 kilowatts. The transmitter tube is a special push-pull dual-triode. Fixed tuned-plate and tuned-grid lines are enclosed in the glass envelope. The resonant line of the filament circuit is outside the glass envelope, and its length can be adjusted by means of a shorting bar. The frequency of oscillation can, if necessary, be changed from 590 to 610 megacycles by adjusting this shorting bar.

(3) PULSE TRANSFORMER. The pulse transformer is used to step up and invert the pulse from the modulator. The 8,000-volt positive pulse from the modulator is supplied to the primary of the

transformer. The output of the secondary is a negative 24,000-volt pulse which is supplied to the transmitter. The secondary is a bi-filar winding (twin winding). An additional winding is used to provide a 75-volt negative pulse for triggering the indicator sweep and range marker circuits.

(4) MODULATOR. The modulator develops the 200 cycle-per-second pulse which is used to set the system in operation. The 200-cycle pulse repetition frequency is controlled by the speed and number of pins of the rotary spark gap, which is a part of the Power Unit PU-6/TPS-1. The modulator box contains the high-voltage doubler circuit, the pulse-forming line, and the charging choke. Charging the



TL 32936
Figure 4. Simplified block diagram of radio set.

pulse-forming line by means of the high-voltage doubler circuit, and discharging the line by means of the rotary spark gap produces an 8,000-volt positive pulse of 1.5-microseconds duration. This pulse is supplied to the primary of the pulse transformer where it is stepped up to 24,000 volts and inverted.

(5) T-R SYSTEM.

(a) Description. The T-R system is a switching arrangement which automatically switches the antenna to either the receiver or transmitter. The T-R box is tunable to the radio frequency used.

(b) Pulse Duration. The pulse duration is only 1.5 microseconds in duration. During this short period the transmitted energy is provided with a low impedance path to the antenna, while a high impedance is introduced across the receiver input to prevent the transmitted pulse from entering and damaging the receiver.

(c) Receiving Period. The transmitter is inactive during the largest portion of the cycle, and the receiving period occupies most of the 5,000-microsecond interval. During this period, a low-impedance path between the antenna and receiver is provided for the reflected energy, while a high impedance is introduced across the transmitter circuit to prevent dissipation of the reflected energy into the transmitter.

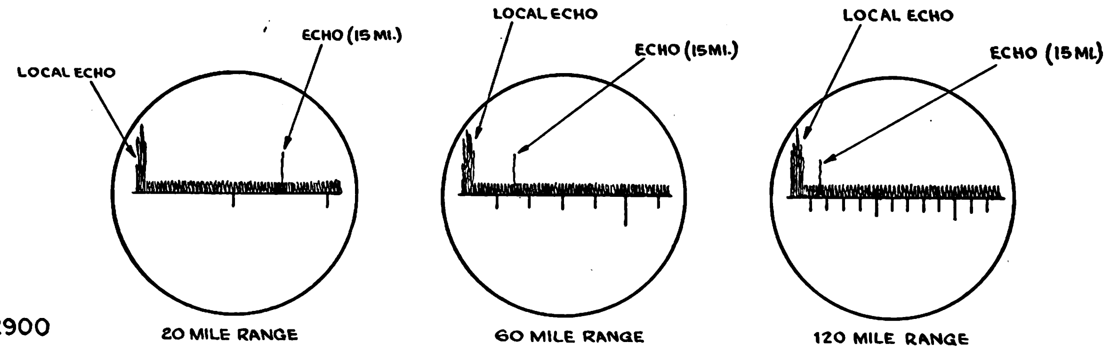
(6) ANTENNA. The antenna is a 10-foot diameter parabolic reflector with a dipole at its focal point. The reflecting surface consists of copper-plated 1-inch wire mesh. The antenna is used both for receiving and transmitting. The half-wave dipole at the focal point and the reflector radiate the energy in the form of a beam in a manner similar to the way a searchlight beam is formed. To obtain full coverage, the antenna is rotated in azimuth by a drive motor controlled by a switch on the indicator panel. Coverage in elevation depends upon the vertical antenna pattern. The pattern in turn is determined both by the height of the antenna above the reflecting surface and the nature of the terrain. The antenna may be rotated continuously in one direction at variable speed or may be rotated to the left or right to track a target.

(7) TRANSMISSION LINES.

(a) Rotating Joint. A coaxial line is used for the transmission of energy between the antenna and the components in the console. Since this coaxial line is also the rotating shaft of the antenna, a rotating joint must be inserted in the line where the shaft enters the console. The selsyn transformer used for rotating the PPI sweep is connected to the inner conductor of the rotating shaft through a friction clutch.

(b) Tuning. Two tuning stubs located near the transmitter input to the transmission lines are used for adjusting the transmission line for maximum transfer of power between the transmitter and line. The antenna is matched to the line by a fixed broadband quarter-wave impedance transformer.

(8) POWER UNIT. The 115-volt, 400-cycle alternating current and 24 volt direct current required by this set are furnished by a standard Power Unit PU-6/TPS-1, as described in TM 11-933. The 115-volt output is supplied to the primary of the transformer in the modulator high-voltage supply and to the primary of the transformer in the



TL32900

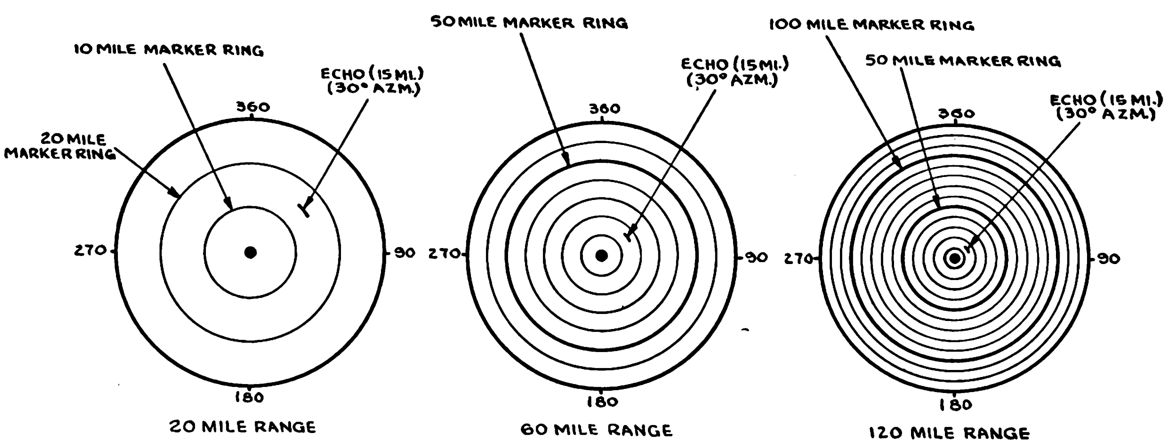
Figure 5. "A" scope patterns.

power supply located in the receiver. The 115-volt alternating current required for the IFF unit is also furnished by this power unit. The 24-volt d-c is supplied to the fan and blower motors and to the relay and antenna drive motor. The power unit also contains the rotary spark gap used by the modulator.

c. Receiver Unit (*fig.* 7). (1) GENERAL. In addition to the receiver stages, the receiver chassis contains the anti-jamming circuits and the power supply circuit.

(2) RECEIVER. The receiver is a typical, pulse radar receiver using a crystal converter. Two r-f amplifier stages precede the converter. The input of the first r-f stage is connected to the T-R assembly by means of a 75-ohm coaxial line. The r-f signal is mixed with the local oscillator voltage to give an intermediate frequency of 30 megacycles. The i-f amplifier consists of six tuned stages and has an overall bandwidth of 2.5 megacycles. The gain of the receiver is controlled by varying the screen grid voltage of the 3rd and 4th i-f stages. The i-f signal is rectified by the diode detector and amplified by one video stage. A positive video pulse is obtained from the video output. This output can be switched directly to the video amplifiers in the indicators or can be switched through the anti-jamming circuit to the video amplifiers.

(3) ANTI-JAMMING CIRCUIT. A special section of the receiver unit is devoted to circuits to aid reception when enemy jamming is encountered. The circuits are arranged so that satisfactory operation may be obtained when the jamming signal is a pulse, a modulated continuous wave, or an unmodulated continuous wave. It is important that the operator be thoroughly familiar with the use and operation of the anti-jamming circuit. With practice, the effects of various types of jamming signals may be materially reduced and operation can be maintained during adverse conditions. The anti-jamming circuit is controlled by a switch on



TL 32899

Figure 6. PPI scope patterns.

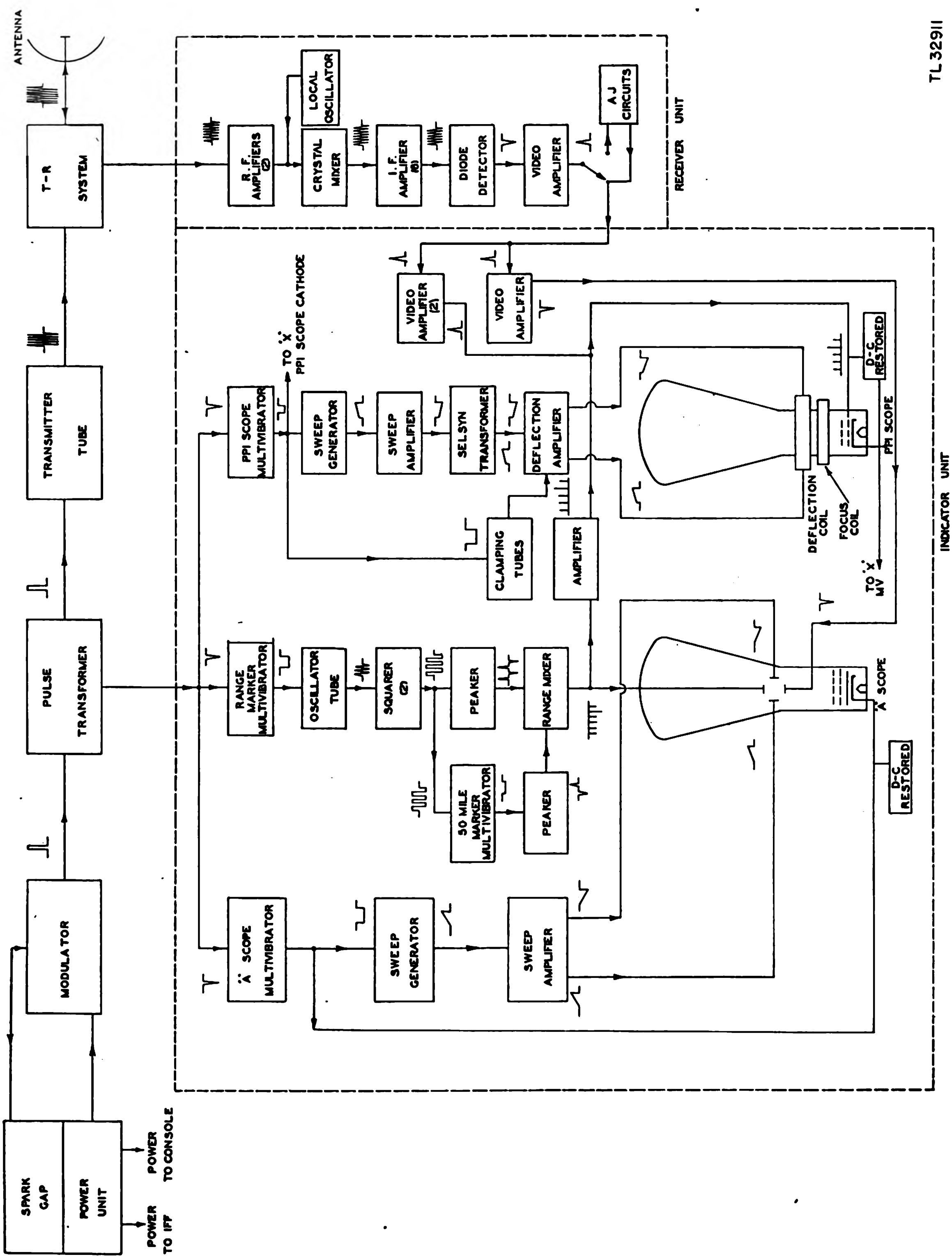


Figure 7. Detailed block diagram.

the front of the receiver panel, and the entire unit may be switched off under normal conditions.

(4) POWER SUPPLY. The power supply located on the receiver chassis furnishes the following voltages:

(a) The filament voltages for the cathode-ray tubes, the transmitter tube, the indicator, and the receiver tubes.

(b) The +2000 and —2000 voltages for the anodes of the cathode-ray tubes.

(c) The regulated plate and screen voltages for the indicator and receiver.

d. Indicator Unit (fig. 7). (1) GENERAL. The indicator unit contains the "A" scope, the "A" sweep circuit, the PPI tube, the PPI tube, sweep circuit, the range marker circuit, and additional video amplifiers. Sweep circuits for ranges of 20, 60 and 120 miles are obtained. Range markers appear for every 10 miles of range. An additional section of the range-marker circuit accentuates every fifth range marker. Both the sweeps and the range markers are initiated at the instant the transmitted pulse is produced. The 75-volt negative pulse from the pulse transformer is used to trigger these circuits.

(2). "A" SCOPE AND ASSOCIATED SWEEP CIRCUITS.

(a) General. The "A" scope is a 5-inch, electrostatic-deflection, cathode-ray tube requiring a sawtooth waveform voltage for the sweep. The sweep is applied to both deflecting plates by a push-pull circuit.

(b) Multivibrator. The sweep is started when a variable-delay multivibrator is triggered by the 75-volt negative pulse from the pulse transformer. The output of the multivibrator is a negative gate the width of which is dependent upon the range required. The electrical constants of the multivibrator determine the gate width, and each position of the range switch insert different values of electrical constants into the circuit.

(c) Sweep Generator. The negative gate from the multivibrator is used to cut off the sweep generator tube which produces a positive sawtooth voltage.

(d) Sweep Amplifier. The output of the sweep generator is supplied to a push-pull, sweep amplifier. This amplifier produces a positive and negative sawtooth voltage which is applied to the horizontal deflection plates of the "A" scope.

(e) "A" Scope. To avoid confusion the tube is "blanked" during the inactive part of the cycle. That is, the grid is made much more negative with respect to the cathode to turn off the beam during the unused part of the cycle. Since the total period is 5,000 microseconds, and the 60-mile sweep, for example, is on for 645 microseconds, it is clear that the inactive period represents the greater portion of the cycle. The output of the multivibrator performs the blanking operation. An additional video stage is used to amplify and invert the positive output of the receiver video stage. The amplified, negative, video signal is applied to the lower vertical deflection plate to obtain an upward deflection,

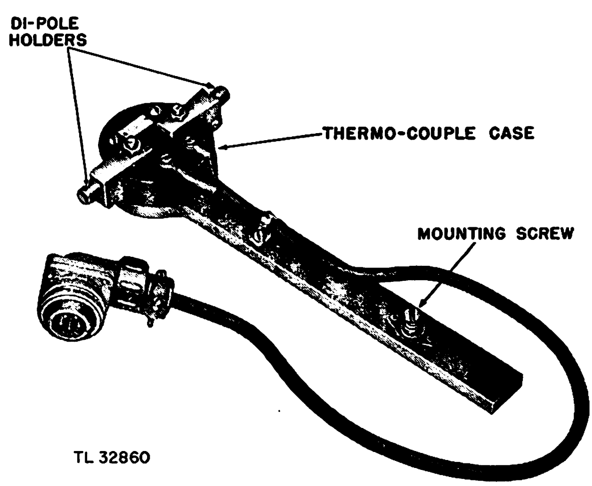


Figure 8. Thermocouple.

evidenced as a positive pip on the face of the indicator.

(3) PPI SCOPE AND ASSOCIATED SWEEP CIRCUITS.

(a) General. The PPI is a 7-inch magnetic deflection, cathode-ray tube. The PPI tube, in contrast to the "A" scope, requires a sawtooth sweep *current* through the magnetic deflection coils. This scope has a screen with a long persistance that retains images for several seconds. The sweep trace is rotated in synchronism with the antenna by means of a selsyn transformer whose rotor is connected to the antenna mast.

(b) Multivibrator. The multivibrator circuit for the PPI is similar to the multivibrator circuit for the "A" scope, but in addition, the output of the

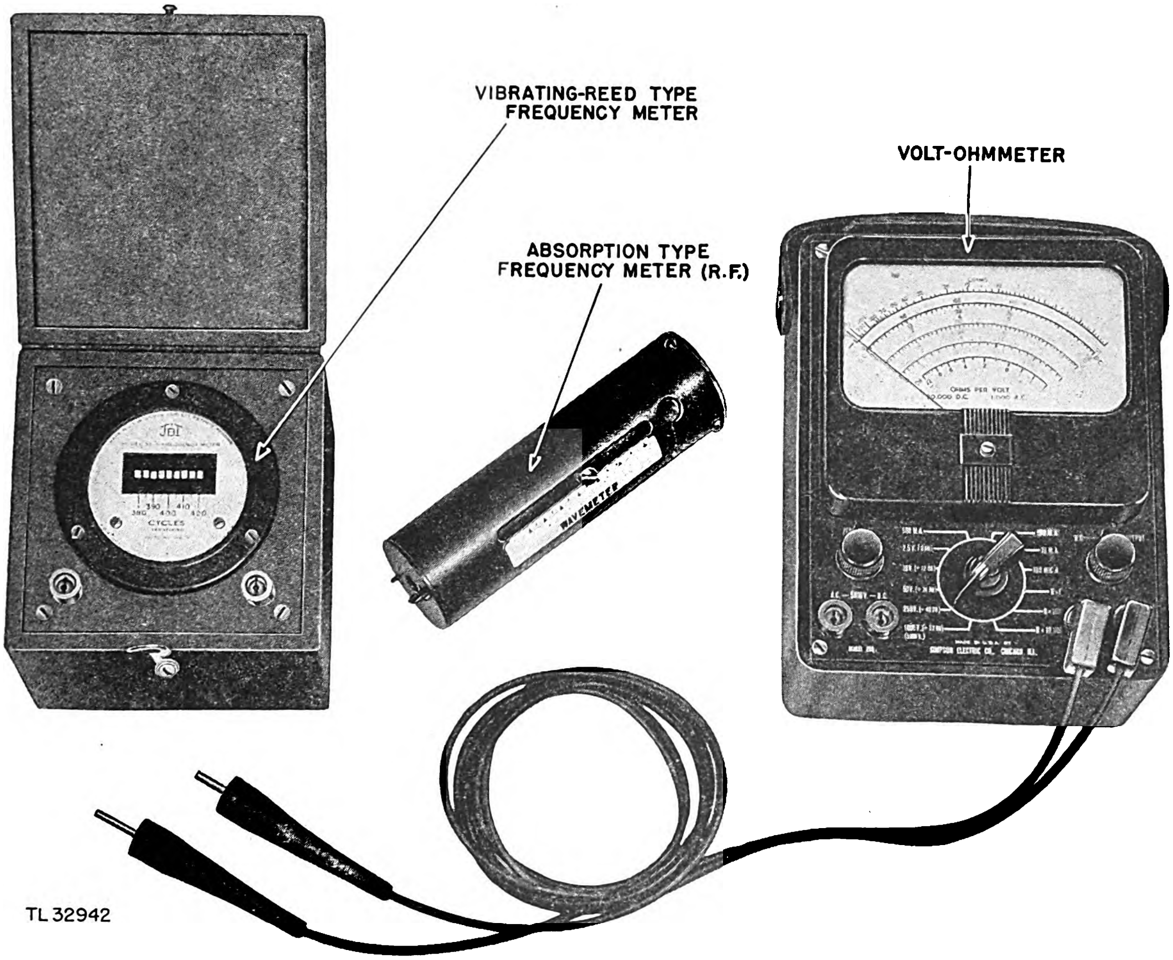


Figure 9. Test equipment.

PPI sweep multivibrator must supply a gate to unclamp the clamping tubes.

(c) Sweep Generator. The negative gate from the multivibrator is used to cut off the sweep generator. A trapezoidal voltage is generated by this tube. The trapezoidal voltage is amplified and finally produces an inverted or negative sawtooth current in the deflection coils.

(d) Selsyn Transformer. The output of the sweep amplifier is applied to the rotor of the selsyn transformer on the antenna mast. The selsyn stator produces trapezoidal voltages of varying amplitudes depending upon the position of the antenna.

(e) Deflection Amplifiers. The deflection amplifiers consist of a push-pull circuit for each of the horizontal and vertical deflection coils. The outputs of the selsyn transformer stator coils are amplified by these circuits and applied to the deflecting coils.

(f) Clamping Tubes. Two clamping tubes provide a voltage divider for each set of deflection amplifiers. The clamping tubes insure that the sweep for each cycle starts at the center of the scope by keeping the d-c bias on the deflection amplifiers fixed between sweeps.

(g) PPI Scope. As in the "A" scope, the PPI scope must be made inoperative during the interval between sweeps. As in the "A" scope, this is accomplished with the negative gate from the output of the multivibrator. The output of the deflection amplifiers produce a rotating sweep on the PPI scope screen. The video signal applied to the grid must be a positive signal. For this reason two video stages are used to amplify the positive video output from the receiver video stage.

(h) D-C Restorers. These tubes prevent the intensity grids of the PPI and "A" scope tubes from being driven positive by the blanking signal.

(4) RANGE MARKER CIRCUITS.

(a) General. Range markers are generated to provide an electronic range scale on the scope. The range markers on the "A" scope appear as negative pips below the base line. On the PPI scope the range markers appear as concentric circles when the antenna is turning.

(b) Multivibrator. The same negative pulse that triggers the "A" scope and PPI scope multivibrators also triggers the range marker multivibrator. However, the length of this gate is wider than the widest gate of the other two multivibrators. This provides a sufficient number of range markers for the longest range.

(c) Oscillator Tube. The negative gate from the multivibrator cuts off the oscillator tube. A series of oscillations is produced during the period the tube is cut off. The frequency of the oscillations is such that 10-mile marker pips are produced.

(d) Squarer. The sine wave oscillations from the previous stage are amplified and clipped to produce square waves by the two stages in the squarer circuit. The output, therefore, is a square wave signal of the same frequency as the sine wave oscillations.

(e) Peaker. The square-wave signal is impressed across a short, time constant, r-c circuit or peaker circuit. The output is a series of positive and negative pips. The period between two positive peaks corresponds to 10 miles of range.

(f) 50-Mile Marker Multivibrator. To simplify interpretation of the range calibration, the fifth range marker has been accentuated. This means the 50 and 100-mile range markers are more prominent than the other 10 mile markers.

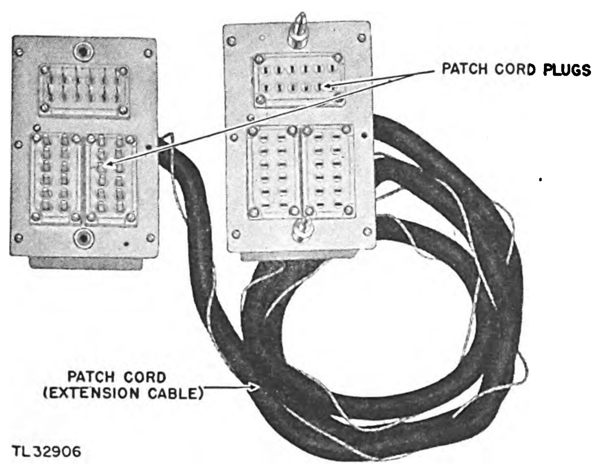


Figure 10. Extension Cables.

(g) 50-Mile Marker Peaker. The square wave output from the multivibrator is peaked by the r-c peaker circuit. The period between pips corresponds to 50 miles of range.

(h) Range Mixer. In the range mixer, the outputs of the two peaker circuits are mixed to produce a series of negative short pips, then a long pip, then four short pips, etc. The output of the range mixer is thus the desired 10 and 50 mile range marker pips. Since the output is negative, the range marker pips can be applied directly to the upper vertical deflecting plate of the "A" scope. However, a positive range marker signal must be applied to the PPI scope. For this reason the output of the range mixer is inverted by an amplifier stage.

(5) INDICATOR PRESENTATION.

(a) General. The reflected signals are presented on the "A" scope and on the PPI tube. For general, early-warning use, the PPI tube is most useful because of the long persistence of the screen. Tracking the target is accomplished more easily by means of the "A" scope, although the PPI tube may be used for this purpose. Once a target is detected, the range and azimuth may be read directly by means of the marker pips and the azimuth scale. In early-warning PPI operation, the set is entirely automatic, and the persistence of the PPI tube keeps targets in view for several seconds.

(b) "A" Scope. On the "A" scope the targets appear as pips that extend above the base line. The height of the pip is dependent upon the size and distance of the target. The range of the target is indicated as the distance from the beginning of the sweep to the leading edge of the echo pip. The range is estimated by using the marker pips which extend below the base line. Range marker pips appear for every ten miles of range. Figure 5 shows a target and range markers for each of the three range settings.

(c) PPI Tube. Both range and azimuth are indicated on the PPI tube. The rim around the face of the tube is divided into 360 equal divisions and each division represents one degree of azimuth. Radiating outward from the center to the rim of the tube is a fine line or "sweep trace" developed by the electron beam. This sweep trace moves like the spoke of a wheel and is synchronized with the

rotation of the antenna. It indicates the direction in which the antenna is pointing. The target appears as a bright spot, and, when associated with the degree scale around the rim of the tube, this spot indicates the direction of the target in azimuth. The distance to the target is indicated by the distance of the spot from the center of the tube. The range is estimated from its position relative to a series of concentric rings which appear for every 10 miles of range. Figure 6 shows a target and range markers for each of the three range settings.

5. ASSOCIATED ITEMS FURNISHED FOR OPERATION AND MAINTENANCE.

a. Thermocouple Unit. A weather proof thermocouple unit (fig. 8) is supplied. It is mounted within the parabolic reflector. This unit provides an indication of transmitter power output and is useful in tuning the set.

b. Test Equipment Supplied. The following test equipment (fig. 9) is shipped with the set:

(1) Voltmeter and ohmmeter with leather carrying case and leads.

(2) Reed type frequency meter, 380-420 cycles.

(3) Wave meter, 570-630 megacycles.

(4) Extension cables (fig. 10) for operating the receiver and indicator while these units are removed from the console.

SECTION II

RADIO FREQUENCY SYSTEM

6. GENERAL DESCRIPTION.

a. The r-f system of Radio Set AN/TPS-3 consists of the following, as shown in figure 12.

(1) Transmitting tube.

(2) Transmission line, stub tuners, and stub supports.

(3) T-R system.

(4) Rotary joint.

(5) Quarter-wave transformers.

(6) Antenna.

b. Although the modulator (fig. 13) is not actually a part of the r-f system, it is described in this section because it is closely related to the operation of the transmitter. It consists of a voltage-doubler power supply, a d-c resonant charging circuit, and a pulse-forming line (network). A rotary spark gap on the generator shaft in the power unit completes the discharge path for the pulse forming line. An 8,000-volt, positive pulse is generated in the modulator and fed through a cable into the primary of the pulse transformer located in the console. The output of this 3 to 1 transformer is a 24,000-volt negative pulse which is fed to the cathode of the transmitting tube where radio frequency oscillations are set up.

c. The transmitter tube (fig. 15), a specially designed, high-frequency, oscillator tube, has its output connected to a stub-supported, coaxial transmission line equipped with stub tuners (fig. 11). A T-R box and anti T-R spark gap prevent transmitted energy from entering the receiver and reflected energy from being dissipated in the transmitter. A rotary joint in the coaxial transmission line makes possible the rotation of the half-wave length, dipole antenna used as the radiator. A quarter-wave transformer matches the impedance of the transmission line to that of the antenna.

d. The output of the antenna is a series of r-f pulses. The pulses reflected from targets are picked up by the antenna, and conducted through the r-f system to the receiver.

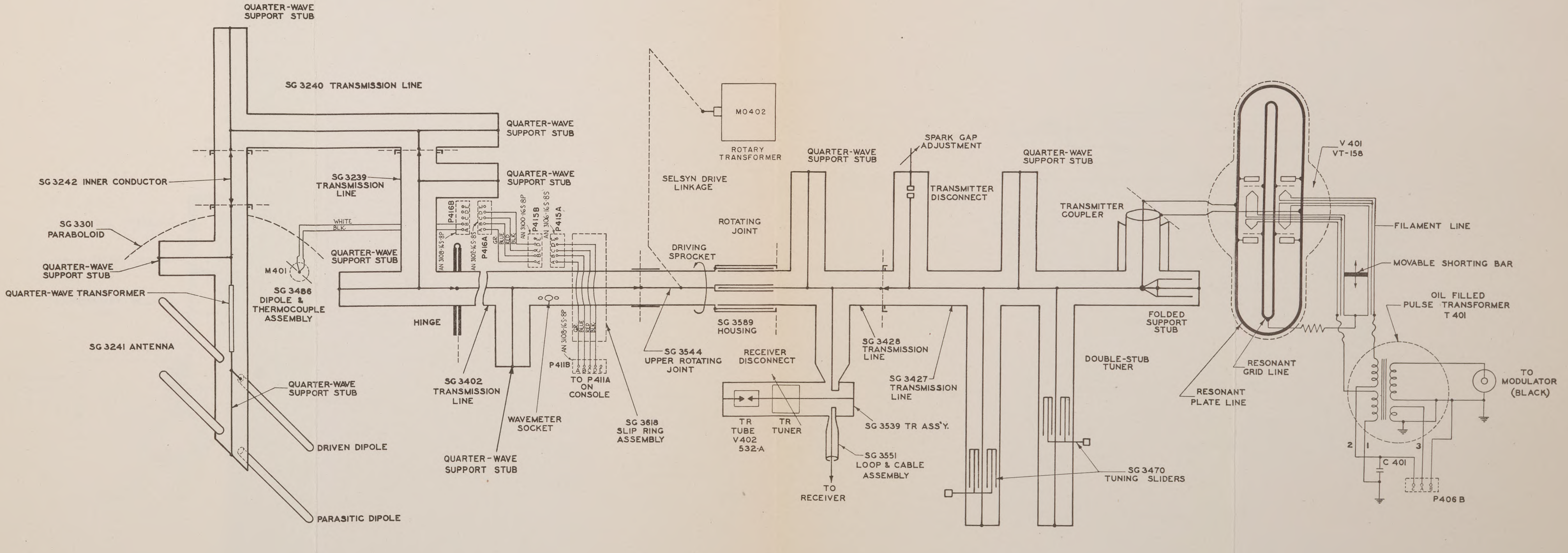
7. MODULATOR.

a. Description. Physically, the modulator consists of three parts; a metal box located outside the tent near the motor generator, a rotary spark gap mounted on the end of the motor generator shaft, and a pulse transformer located in the main console. The metal modulator box is made up of two compartments, one of which is filled with oil. The oil compartment contains a high-voltage, 400-cycle transformer, several voltage doubling capacitors, a charging choke, and a pulse forming network. The other compartment contains the rectifier tubes and sockets, the relay, and a protective spark gap. Figure 13 shows a simplified diagram of the modulator and its associated high-voltage power supply.

b. Purpose. The modulator unit initiates the pulse which triggers the transmitter tube so that the latter produces a powerful 600-megacycle pulse. At the same time, a portion of the modulator pulse taken from the pulse transformer is used to trigger the "A" scope sweep, the PPI scope sweep, and the range-marker circuits.

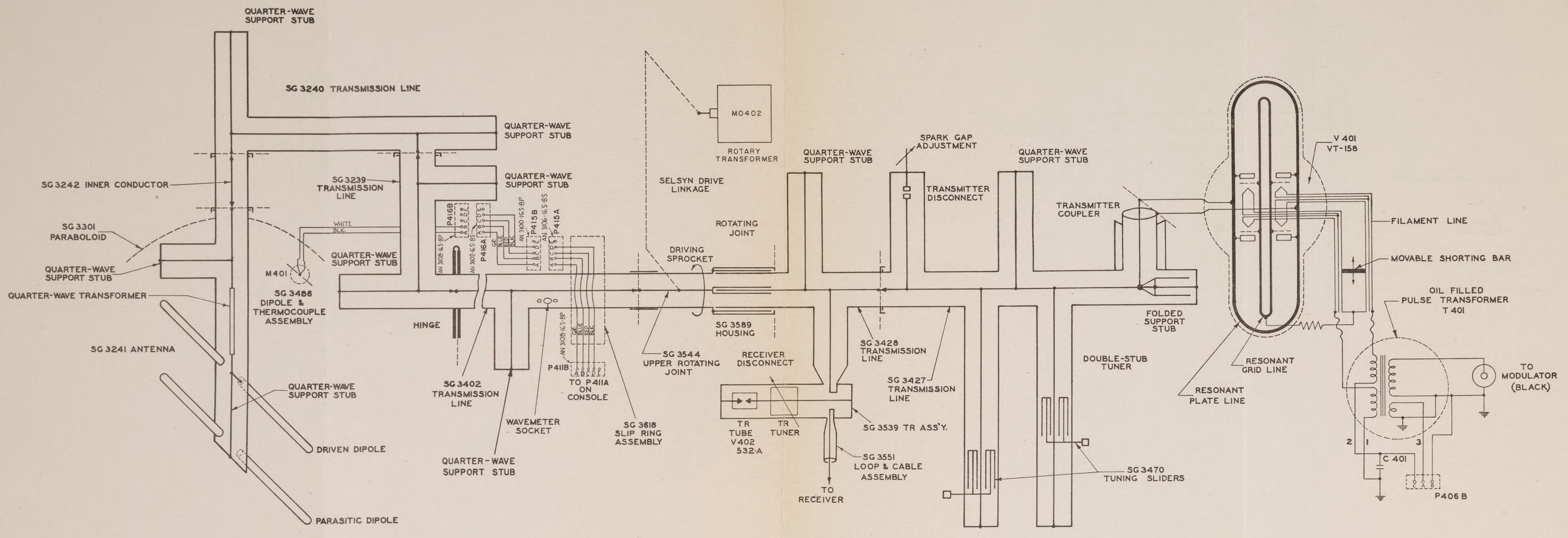
c. Power Supply. (1) SWITCHES. To turn on the modulator, the modulator ON-OFF switch on the power unit must be thrown to the ON position. Two additional switches are located on the front panel of the receiver unit (fig. 19). Both switches must be turned to the ON position in order to generate the high-voltage pulse. These two, the MAIN POWER SUPPLY and the TRANSMITTER switches, when in the ON position, energize relay RE301, located in the modulator unit (fig. 13). This relay shorts out a compensating resistor located in the head of the generator. In this way, the voltage at the console remains constant and independent of the additional modulator load.

(2) *Rectifier and Voltage Doubler.* The primary of the high-voltage transformer T301 receives 115 volts a-c from the power unit when RE301 is energized. The secondary of the transformer provides 3,500 volts rms to the voltage-doubler rectifier. On one half of the high-voltage cycle, tube V302 becomes conductive and charges capacitor C301B to approximately 4,000 volts. On the other half cycle, tube V301 becomes conductive and charges capacitor C301A to approximately 4,000 volts. The two capacitors are in series, so that the sum of the two voltages is 8,000 volts d-c. Since the capacitors do



NOTE:
DASH LINES REPRESENT COUPLINGS BETWEEN TRANSMISSION LINE SECTIONS.

Figure 11. R-F functional schematic.



NOTE:
DASH LINES REPRESENT COUPLINGS BETWEEN TRANSMISSION LINE SECTIONS.

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Figure 11. R-F functional schematic.

not discharge appreciably during non-conducting half cycles, the voltage output is relatively free from ripple. The keying pulses are locked in with the ripple frequency so that the output of the modulator effectively remains constant. Tube V303 shunting the primary of transformer T301, acts as an overload spark gap, and shorts the primary of the transformer if the input voltage becomes excessive.

d. Pulse Transformer (fig. 16). The pulse transformer is located in the sealed oil compartment of the modulator unit. It is of the bifilar (twin winding secondary) type and is capable of passing high-frequency pulses of 1.5 microseconds duration. This 1 to 3 step-up transformer receives a positive, 8,000-volt pulse on the primary from the discharge of the pulse-forming network. The output from the secondary is a 24,000-volt negative pulse applied to the filament and plate of the transmitting tube.

e. D-C Resonant Charging. (1) A d-c resonant charging circuit is used in charging the pulse-forming line. This charging circuit is analagous to a source of voltage (a battery), a choke coil, a capacitor, and a switch (fig. 14). These correspond to the voltage-doubler power supply, the charging choke, the pulse-forming line, and the rotary spark gap respectively.

(2) When a voltage is applied to this d-c resonant circuit, the capacitor voltage-waveform becomes a damped oscillation. The first rise in voltage is an overshoot to about twice the applied potential. If the switch is closed at the instant the condenser is charged to about twice the applied EMF, (16,000 volts), the capacitor will discharge. Since the impedance of the transformer is matched to the impedance of the pulse-forming line, half of the voltage to which the condenser, or line, has been charged, will appear across the primary of the pulse transformer.

(3) The pulse duration is equal to the time required for the capacitors of the pulse-forming line to discharge. The constants of the pulse-forming line are such that the output pulse is square and 1.5 microseconds in duration as previously explained. The pulsing or repetition frequency, determined by the firing of the rotary spark gap, is 200 cycles per second.

f. Pulse-Forming Line (network). (1) The modulator power supply charges a pulse-forming line PUL301 through a charging choke CH301 (figs. 13 and 16). In this d-c resonant charging circuit, the pulse-forming line is charged to about 16,000 volts, i.e., twice the power supply voltage. When the rotary spark gap fires, the pulse-forming line is discharged into a matched load. Half of the 16,000 volts appear across this load. The load, across which 8,000 volts is impressed when the spark gap fires, is the primary of the pulse transformer T401. A negative, 24,000-volt, 1.5 microsecond pulse is taken off the secondary of the 3 to 1 pulse transformer and applied to the filament of the transmitter tube. Effectively, since the plate of the transmitter is grounded, a 24,000-volt pulse is applied between the filament and plate of the transmitter tube.

(2) The pulse-forming line, consisting of a number of chokes and capacitors, is in series between the charging choke CH301 and the primary of the pulse transformer T401, as shown in figure 14. The coils in this pulse-forming line are of different values, all of the order of 7 microhenrys. The total inductance is 37.5 microhenrys. The five shunt capacitors in the line are each 0.003 microfarad. The design of the circuit is such that the output to the pulse transformer is a square pulse 1.5 microseconds in duration. The duration of the pulse is equal to the length of time required for the pulse-forming line to discharge. This discharge of the capacitors in the pulse-forming line takes place when an 8,000-volt voltage wave travels from the spark-gap end of the pulse-forming line to the open end of the line where it is reflected. The reflected wave of voltage completes the discharge of the capacitors in the pulse-forming line on its way back to the spark-gap end of the line. When the reflected wave reaches the spark-gap end of the line, the capacitors in the line are completely discharged. The time required for the capacitors in the pulse-forming line to discharge is 1.5 microseconds; therefore the width of the pulse produced is also 1.5 microseconds.

g. Rotary Spark Gap. (1) The spark gap, mounted on the shaft of the generator, rotates at the motor speed of approximately 4,000 rpm. A stationary pin (electrode) mounted directly on the end of a high-voltage socket, is tied to and is at the same potential as the pulse-forming line. The spark gap has three pins mounted on the rotor. The rotor is grounded by means of a carbon brush which wipes a grounded copper disc. When the rotor turns and a rotary pin comes in close proximity to the

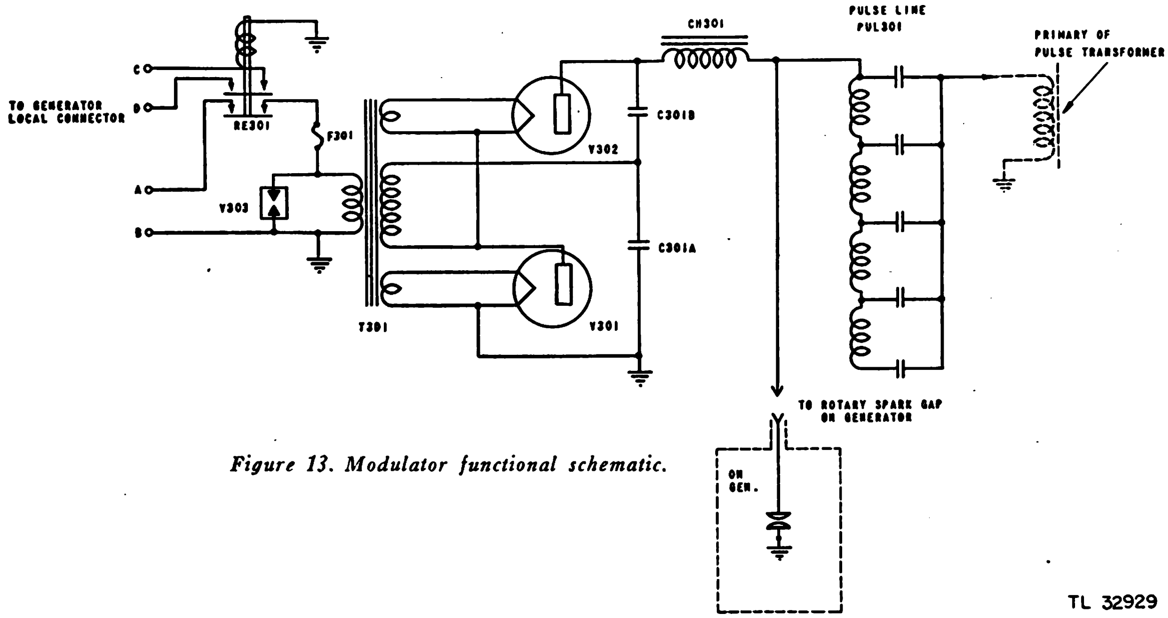


Figure 13. Modulator functional schematic.

stationary pin, the voltage jumps the gap and allows a path for discharge of the pulse-forming line. The current flows from the line through the spark gap to ground and through the primary of the pulse transformer back to the pulse-forming line (fig. 13). This causes a positive voltage pulse across the pulse-transformer primary.

(2) The spark gap discharges the pulse-forming line three times per revolution, or 12,000 times per minute. This establishes a pulse repetition rate of 200 times per second. The pulse line attains a maximum charge before the spark gap is in position to fire again, 5,000 microseconds later.

8. TRANSMITTER TUBE.

a. The transmitter tube is a special push-pull dual triode oscillator (figs. 15 and 16). Resonant lines inside the tube envelope function as tuned circuits. Two connections at zero r-f potential points on the resonant grid line are brought out of the envelope. One is used for returning the grid circuit to the filaments through the self-biasing resistor mounted underneath the tuned filament line. The other is not used. The plate connections are brought out of the envelope and fed into the transmitter coupler. The frequency of oscillation may be changed by adjusting the shorting bar on the filament line. Shortening the line will increase the output frequency; increasing the length of line will decrease the output frequency.

b. The pulse transformer is constructed with a bifilar, or double secondary winding, so that filament heating power can be fed to the transmitter tube through the windings of the pulse transformer. By means of this arrangement, the filament transformer can be maintained at ground potential. The four filaments of the transmitter tube are connected in series and 44 volts are applied so that an 11-volt drop appears across each filament.

c. The 8,000-volt pulse from the metal modulator box is carried through a 50-ohm transmission line to the console where it is impressed across the primary of a pulse transformer T401. This 1 to 3 step-up transformer inverts the polarity of the pulse voltage and matches it to the 500-ohm input impedance of the transmitter tube. The negative 24,000-volt pulse from the secondary of the pulse transformer is impressed directly between the filaments and plates of the transmitter tube. The plates of the tube are grounded. Therefore, the negative pulse on the filaments causes the tube to conduct for the 1.5 microseconds of pulse duration. The peak power of the pulse is about 200 kilowatts.

d. The output ultra-high-frequency wave pulse, taken off the plates of the transmitter tube, is fed through the T-R system to the radiating dipole.

e. The frequency of the transmitted energy may be determined by using the wavemeter supplied as a part of the test equipment. Insert this meter into the special wavemeter socket in the transmission line just above the slip-ring assembly. Adjust the slider on the meter until maximum brilliance of the neon bulb is observed. The pointer on the meter will then indicate the output frequency.

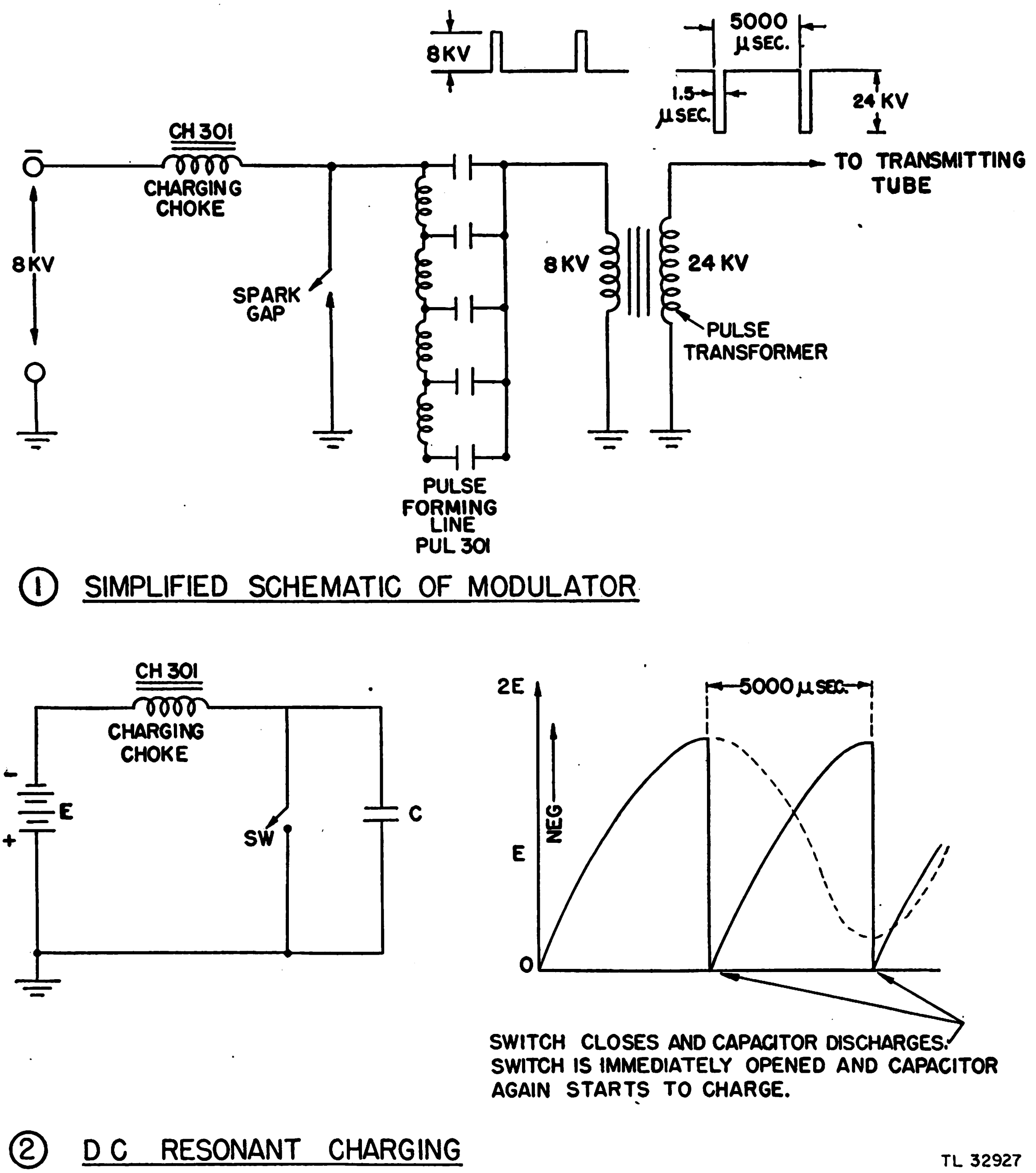


Figure 14. D-C resonant charging schematic.

9. TRANSMISSION LINE.

a. Support. The transmission line is a coaxial line, the inner conductor of which is supported by stubs. These supports are electrically short-circuited, quarter-wave stubs which offer maximum impedance at the point where they are connected to the transmission line. The support stub closest to the transmitter is folded back inside itself to conserve space as shown in figure 11.

b. Construction. The push-pull transmitter is connected to the coaxial transmission line by means of a balancing coupler. In addition to the two concentric conductors of the line, a third, or outside conductor, surrounds the line and connects to the outer coaxial conductor one-quarter wavelength from the end. The transmitter tube shield comprises this outermost conductor. The shield is grounded and isolates the terminal of the transmis-

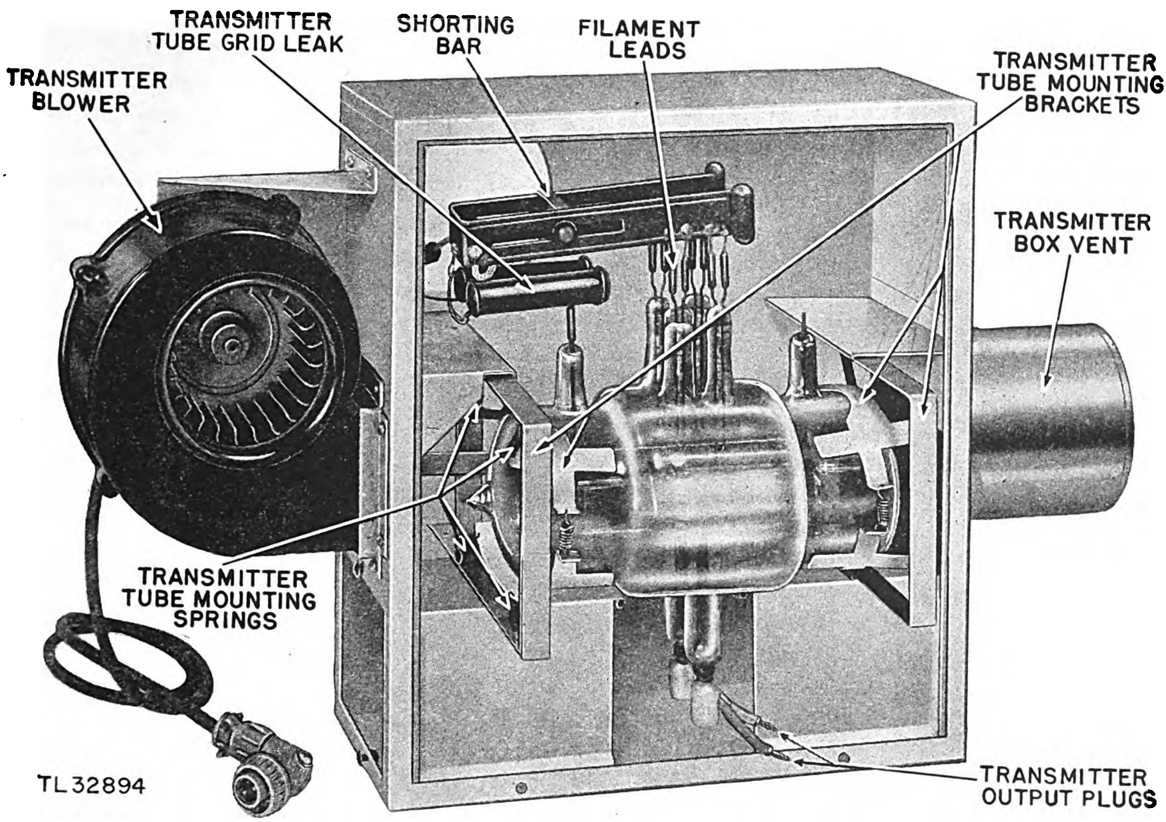


Figure 15. Transmitter tube assembly, cover removed.

sion line outer conductor from ground. This permits push-pull operation of the transmitter.

c. Stub Tuners. Impedance matching is essential for maximum transfer of power. The output impedance of the transmitter is matched to the impedance of the transmission line by means of two short-circuited stubs of variable length, which are shunted across the transmission line and spaced ⅜ of a wave-length apart (fig. 11). The lengths of the stubs are varied by tuning sliders. Changing the positions of the sliders varies the impedance of the stub lines and thereby varies the impedance reflected to the transmission line. The stubs should be adjusted until the output meter reads a maximum. At this setting, the transmitter tube and transmission line impedances are matched. This condition results in maximum radio-frequency power-output and minimum corona discharge in the transmitter.

d. Quarter-Wave Transformer (fig. 11). For maximum transmission and reception of r-f energy, it is necessary that the transmission line be matched to the antenna dipole assembly. This impedance matching is accomplished by using a fixed quarter-wave transformer. The impedance transformer is merely a quarter-wave section of the inner coaxial line, the diameter of which has been increased.

e. Rotating Joint. A rotating joint (fig. 11) is required to join the upper rotating part of the coaxial transmission line to the fixed lower part. Each joint consists of resonant, quarter-wave, line sections, so arranged as to make zero-impedance connections without using current-carrying sliding contacts. The outer rotating joint rests on a ball, thrust-bearing. The inner rotating joint contains a rotating drive which couples to the selsyn transformer.

f. Selsyn Drive Mechanism. The selsyn transformer is located on the axis of rotation and below the transmission lines. The drive shaft is brought out from the inner rotating joint through the inner conductor of a quarter-wave support stub. It is electrically neutral, and its only function is to turn the selsyn in exact synchronism with the rotation of the antenna.

10. T-R SYSTEM.

a. Function. To use one antenna for both receiving and transmitting, it is necessary to provide an automatic switching system so that the antenna can be switched back and forth between transmitter and receiver. The T-R box and the anti T-R spark gap form the required automatic switching device, as shown in figure 11. A picture of the T-R box assembled and disassembled is shown in figures 84 and 85.

b. Components. (1) T-R BOX. A T-R gas tube is placed in a cavity resonator one-quarter wavelength from the transmission line. A coupling loop, in the cavity resonator, couples the cavity resonator to the transmission line. A second coupling loop in the resonator connects to a coaxial cable leading to the receiver-input terminals. These components, exclusive of the receiver cable, are commonly referred to as the T-R box. A dielectric tuning slider, in the cavity resonator, permits tuning of the T-R box to the radio frequency. When tuned, the T-R box couples received energy from the main transmission line to the receiver with little loss. See figure 11. (2) ANTI T-R SPARK GAP. The anti T-R spark gap is a tungsten air gap one-quarter wavelength from the main transmission line. Adjustment of this gap may be made with the knurled knob on the end of the anti T-R stub. Turn the knob fully clockwise to close the gap contacts. Then turn the knob 1/8 of a turn in a counter-clockwise direction. This gives a gap clearance of 1/16 inch which is the correct setting.

c. Operation During Transmitting Period. The anti T-R spark gap breaks down during the transmitted pulse. The resulting short circuit reflects an infinite impedance, looking into the quarter-wave stub (fig. 11). The T-R gas tube is also fired by the transmitted pulse. The resulting short circuit detunes the T-R box resonant cavity and produces a high impedance looking into the receiver. Under these conditions, the transmitted pulse passes directly through the r-f system to the antenna.

d. Receiving Period. The received signal is not great enough to fire the anti T-R spark gap. Since this spark gap is now open, it represents an infinite impedance. One-half wavelength away, or at the junction of the transmission line and receiver line coupling loops, a high impedance is looking into the transmitter. The received signal is not strong enough to fire the gas tube in the T-R box. The T-R box quarter-wave cavity is then resonant with an open at one end and a short at the other. Under these conditions, the received signal is coupled through the resonant cavity and passes directly into the receiver. Thus the T-R box and the anti T-R spark gap act to prevent the transmitted energy from entering the receiver, and to prevent the received signal from being dissipated in the transmitter.

11. ANTENNA.

a. Antenna Array. The transmitted pulse passes along the r-f system to the half-wave dipole antenna which serves both as a radiator and receiver of r-f pulses. In front (on the side away from the parabolic reflector) of this "driven" antenna is a parasitic dipole which acts as a reflector to direct the r-f energy into the parabolic reflector.

b. Beam Angle. The energy radiated by the antenna strikes the 10-foot parabolic reflector and is then radiated into space as a beam of r-f energy.

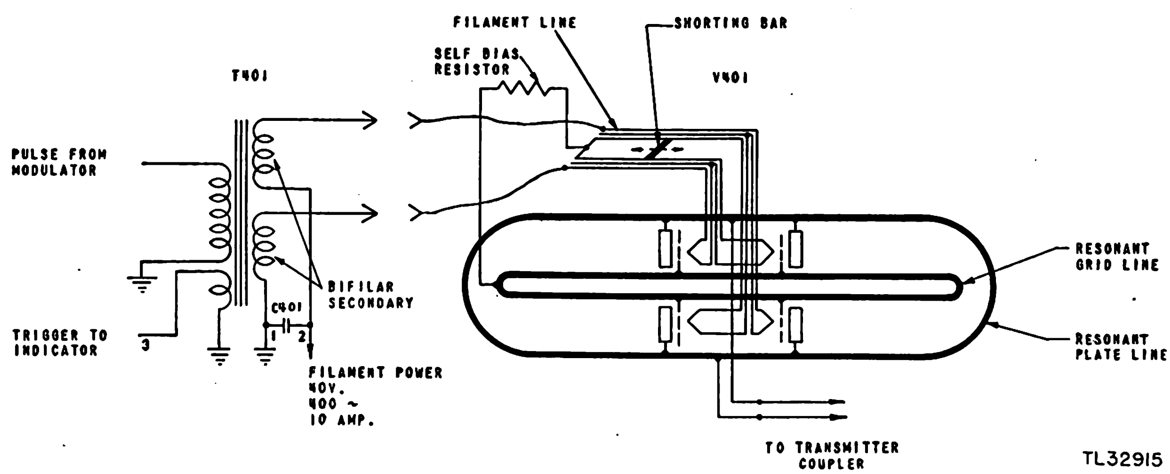


Figure 16. Transmitter functional schematic.

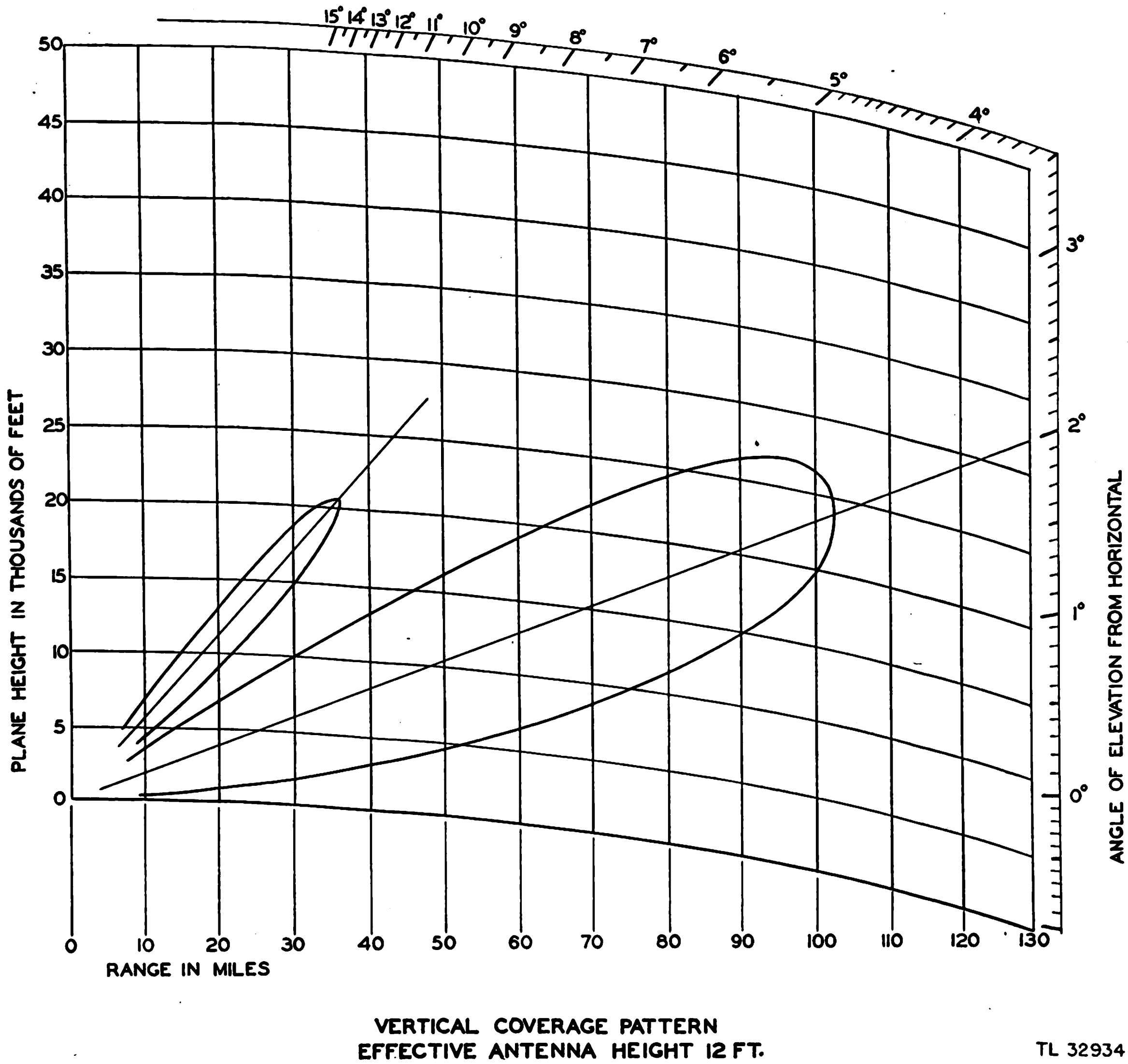


Figure 17. Antenna vertical coverage pattern, 12 foot site.

The beam width at the half-power point is approximately 10°.

c. Ground Reflection. Since the energy radiation pattern is affected by ground reflections, the coverage of the antenna array will vary as the height of the antenna is changed and with the nature of the reflecting surface.

d. Antenna Height. (1) With the effective height equal to 12 feet, the main lobe makes an angle of 2° with the horizontal. Figure 17 indicates that in this case, a plane flying in at 20,000 feet should first be picked up at 100 miles; a plane flying in at 10,000 feet, at about 75 miles; and a plane flying in at 5,000 feet, at about 50 miles.

(2) Better low-angle coverage of an area is obtained if the effective height of the antenna is increased. This facilitates the detection of low-flying aircraft. With the effective height of the antenna equal to 24 feet, the main lobe makes an angle of about 1° with the horizontal.

(3) Figure 18 shows that a plane flying in at 20,000 feet will come in over the main lobe but will be picked up by the second lobe at about 70 miles. A plane flying in at 10,000 feet will first be picked up

at about 95 miles; a plane flying at 5,000 feet, at about 70 miles; and a plane flying at 2,500 feet, at about 50 miles.

e. Rotation. (1) SEARCHING. The assembly, including the dipoles and reflector, is so constructed and mounted that it can be rotated in a complete circle. This rotation is accomplished by an antenna drive-motor controlled by the TRACK-PPI switch located on the front panel of the indicator. Turning this switch to the PPI position causes the antenna and parabolic reflector to rotate continuously.

(2) TRACKING. When continuous rotation is not desired, but tracking of a target is required, the TRACK-PPI switch should be in the TRACK position. When in this position, the antenna assembly can be rotated to the left or right by holding the TRACK LEFT-RIGHT switch in the desired position. The speed of rotation is controlled by the ANT. SPEED control and may be increased up to the maximum speed of five revolutions per minute.

f. Drive Motor. (1) The antenna is driven by a shunt-connected 24-volt d-c motor, running at approximately 10,000 rpm. A built-in reduction gear

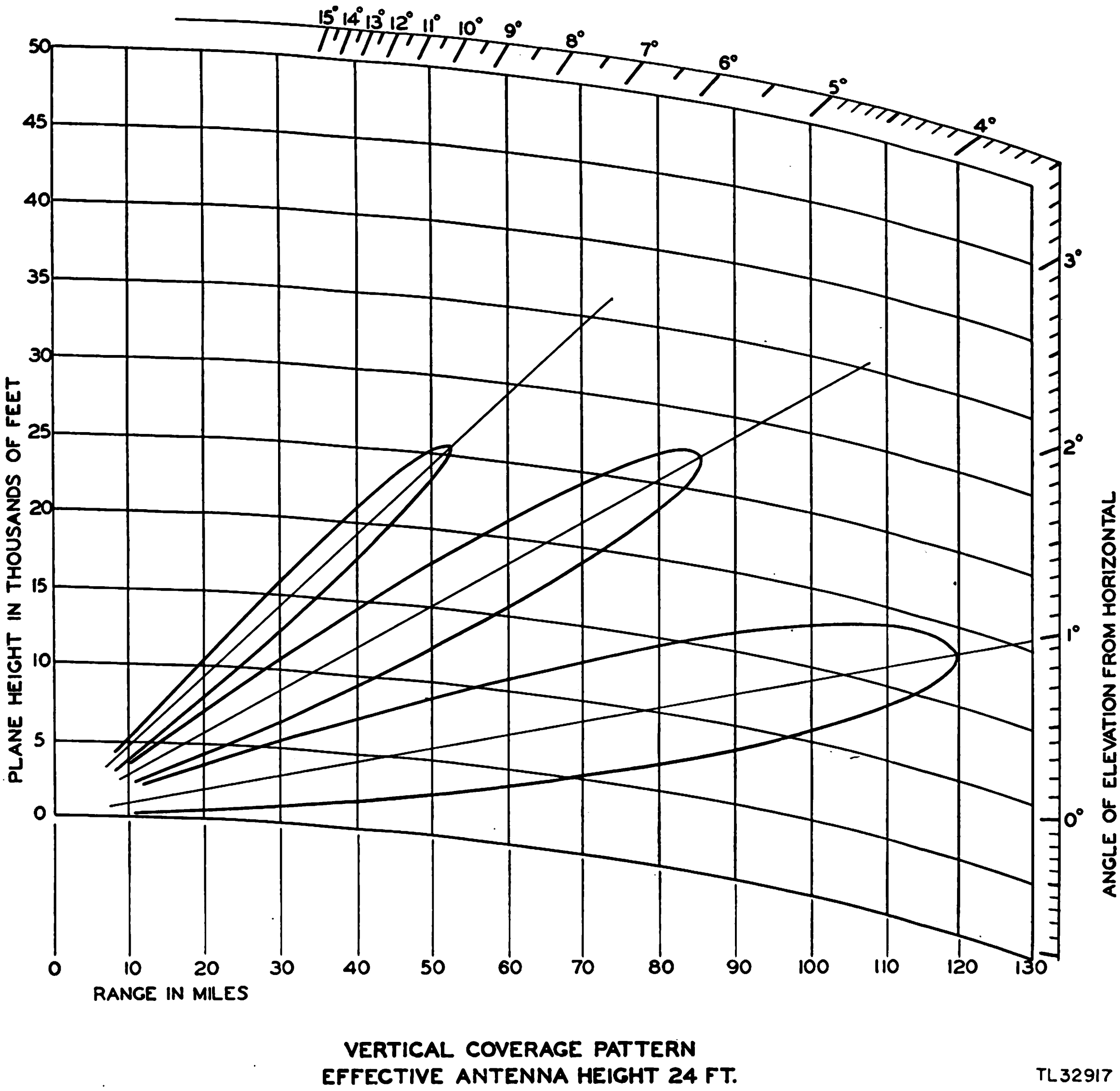


Figure 18. Antenna vertical coverage pattern, 24 foot site.

box with a ratio of 560 to 1 is connected to a chain drive that turns the antenna at about 5 rpm. The motor speed is adjustable by a potentiometer located on the front panel of the indicator. This potentiometer feeds the armature circuit. The motor is reversed by reversing the polarity of the armature voltage with the TRACK LEFT-RIGHT switch. When this switch is in the neutral position, the armature is shorted out to give dynamic braking. The shunt field is permanently connected to the 24-volt d-c source. The maximum armature current is limited by an additional fixed resistor when the TRACK-PPI switch is in the TRACK position to protect the switch. The speed in this position is thus somewhat lower than the maximum speed attained when the switch is in the PPI position.

(2) The 560 to 1 speed reducer has a built-in ball and socket clutch which slips with a loud, clicking sound if the antenna rotation is impeded while the drive motor is operating. This clutch may slip on sudden reversals of the antenna.

g. Thermocouple. A weather-proof thermocouple (fig. 8) is provided for tuning up the set and checking its power output. The thermocouple plugs into a small receptacle on the frame of the parabolic reflector. The output of the thermocouple is fed by means of a short cable which plugs into an AN connector on the mast. The indicator is read on the output meter located on the panel of the receiver.

CHAPTER 1. THEORY

SECTION III

RECEIVER R-59/TPS-3

12. GENERAL. A block diagram of the receiver is shown in figure 20. The receiver contains the r-f amplifiers, local oscillator, crystal mixer, i-f amplifiers, detector, video amplifier tubes, and a special anti-jamming circuit which can be switched in when required. The main low-voltage power supply for both the indicator and the receiver, and the high-voltage supply for the cathode-ray tubes are located on the receiver chassis. A front view of the receiver chassis is shown in figure 19. Simplified schematic diagrams are shown in figures 22 to 27. For circuit details refer to the complete schematic diagram shown in figure 28.

13. R-F AMPLIFIERS.

a. The r-f signal from the T-R box is fed from the multiple-plug board to the input of r-f amplifier #1, tube V201, through a coaxial cable (figure 22). The outer conductor of this cable is connected to the grounded grid of the tube. The inner conductor is connected to the shell of tube V201. This shell is coupled to the cathode of the tube by a capacitor within the tube. The r-f signal is thus impressed between the grid and cathode of the tube. See figure 21 for photograph of receiver r-f assembly. There is an external adjustable loop between the grid and cathode of the tube. The inductance of this loop, together with the grid to cathode capacity within the tube, comprise a tuned circuit for the incoming r-f signal. The INPUT screwdriver control, located on the front panel of the receiver, is used to tune this loop to the r-f signal frequency and thus obtain maximum output.

b. A coaxial resonant line in the plate circuit of the first r-f amplifier is tuned to the signal frequency by means of capacitor C212. This control is marked PLATE #1 and is located on the front panel of the receiver. The gain of the stage can be varied by changing the bias on the cathode of the tube. Adjust potentiometer R201, the BIAS #1 control. The choke coils L201, L202, and L203 in the filament and cathode circuits prevent r-f coupling between the stages.

c. A coaxial cable takes the output r-f signal from the tuned plate circuit of the first r-f amplifier at

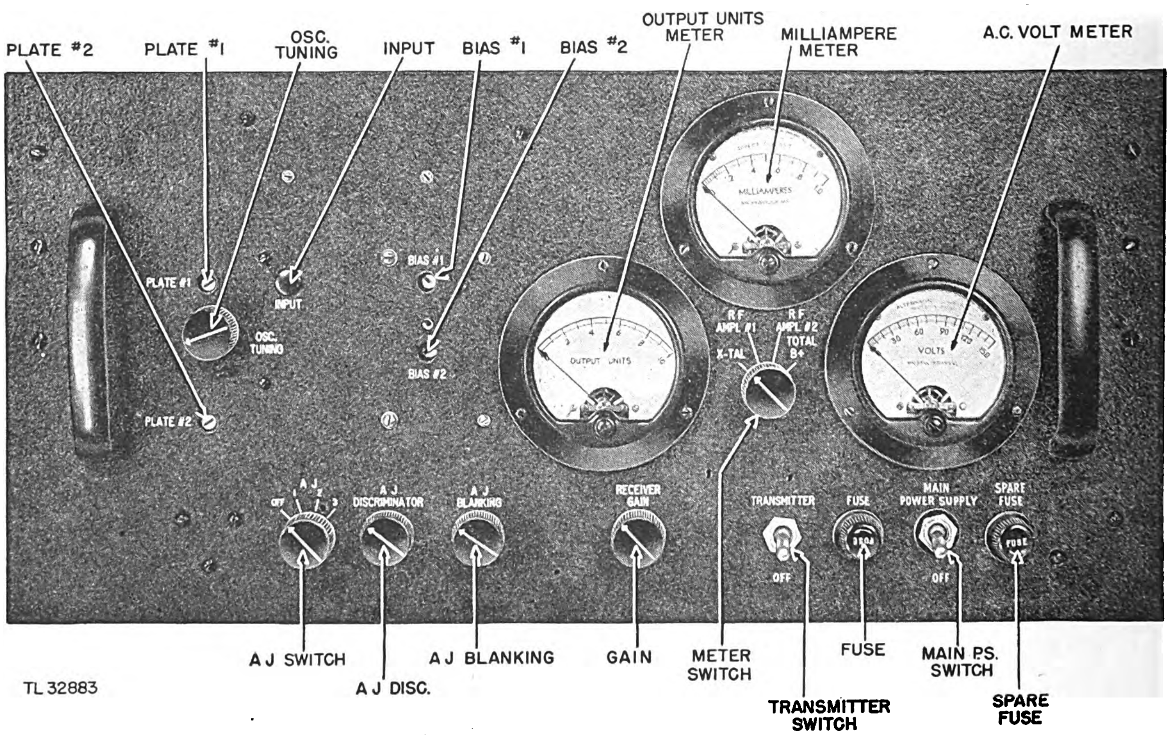


Figure 19. Front panel of receiver.

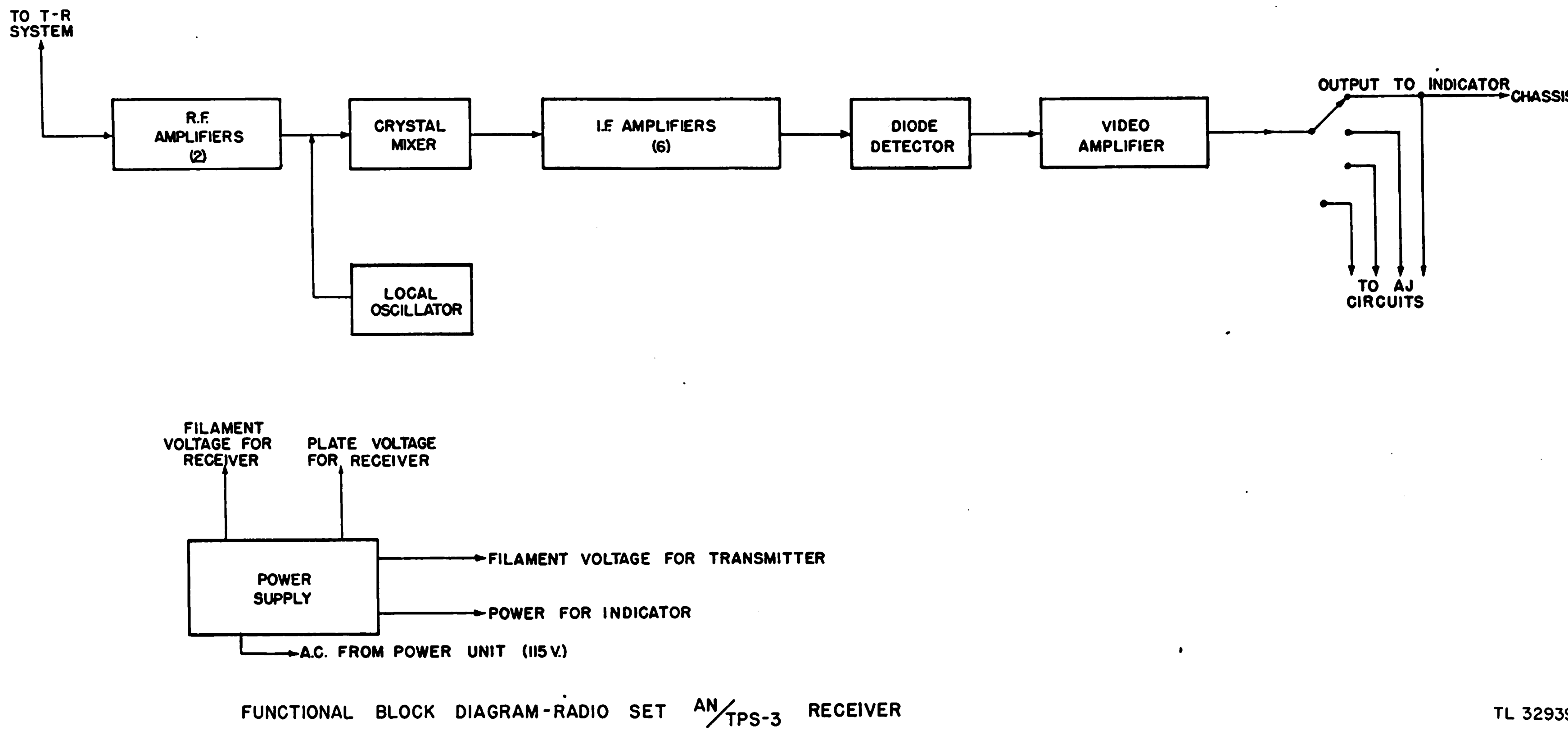


Figure 20. Simplified block diagram of receiver.

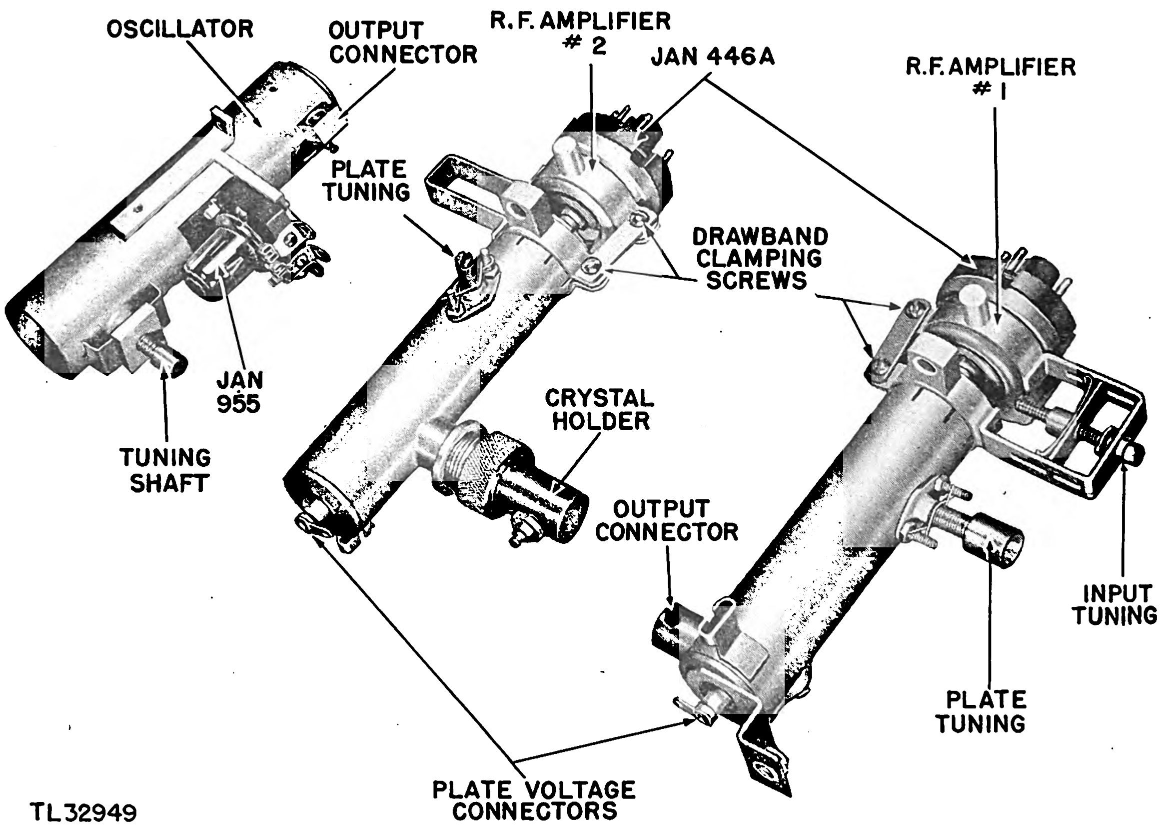


Figure 21. R-F assembly of receiver.

a low-impedance point and feeds the signal to the input of tube V202 (fig. 22). The second r-f amplifier is similar to the first stage, except that the tuned metal loop between grid and cathode is non-adjustable. It is fixed-tuned to the center of the receiver tuning range. The r-f output of the second r-f amplifier can be read on meter M203 when the meter switch SW202 is in the r-f amplifier #2 position. The bias of this stage can be varied with potentiometer R203, the BIAS #2 control, on the front panel of the receiver. Capacitor C213, the PLATE #2 control, is used to tune the resonant plate circuit of the second r-f amplifier.

14. LOCAL OSCILLATOR. To generate the desired i-f signal, it is necessary to mix the r-f signal with the frequency of a local oscillator and tune the first i-f stage to the difference between the two frequencies. Tube V203 is used as a local oscillator (fig. 22). The plate of this tube is connected to a resonant, coaxial line or tank circuit which oscillates at the desired frequency, 30 megacycles above or below the r-f signal. The output of the plate circuit is coupled back to the grid circuit in a phase such that oscillations are sustained. The frequency of the oscillator can be varied by adjusting capacitor C207, the OSC. TUNING control located on the front panel of the receiver. The output frequency from the oscillator-tuned, plate circuit is fed through a coaxial cable to an oscillator coupling loop. This loop is inductively coupled to the grid-cathode loop of tube V202. Therefore, both the r-f signal and the local oscillator signal appear between the grid and cathode, and hence on the plate of the second r-f amplifier, tube V202. Although the resonant-plate line of tube V202 is tuned by capacitor C213 to the r-f signal, the oscillator frequency signal will be amplified slightly.

15. CRYSTAL MIXER. A rectifying type crystal mixer is connected to the resonant line at a low-impedance point (fig. 22). This crystal mixes the r-f and local oscillator signals. The output rectified signal is coupled through capacitor C216 to the grid of the first i-f stage through a network tuned to 30 megacycles. Only the i-f signal gets through to the i-f amplifiers. The fitting which holds the crystal provides a capacity by-pass path to ground for the r-f currents. Coils L214 and L215, and capacitor C216 form a critically coupled, double-tuned i-f circuit which matches the crystal impedance to the grid impedance of the first i-f amplifier. Capacitor C217 and resistor R206 form a decoupling network feeding meter M203, so that

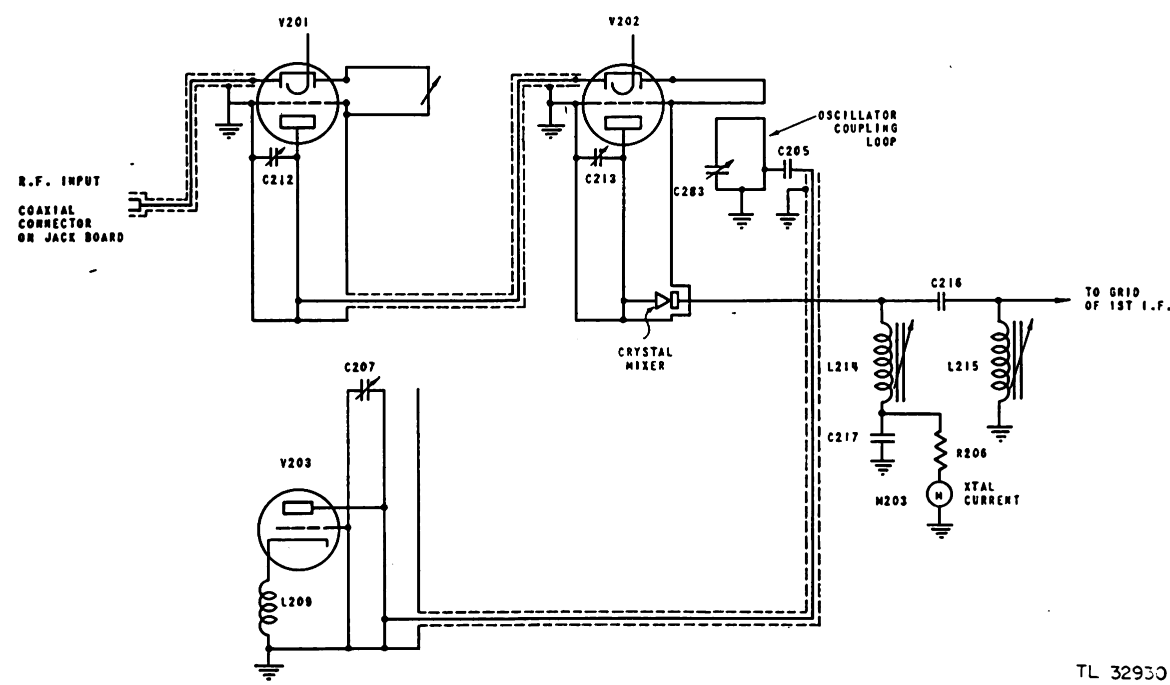


Figure 22. R-F amplifier, oscillator and crystal mixer functional schematic.

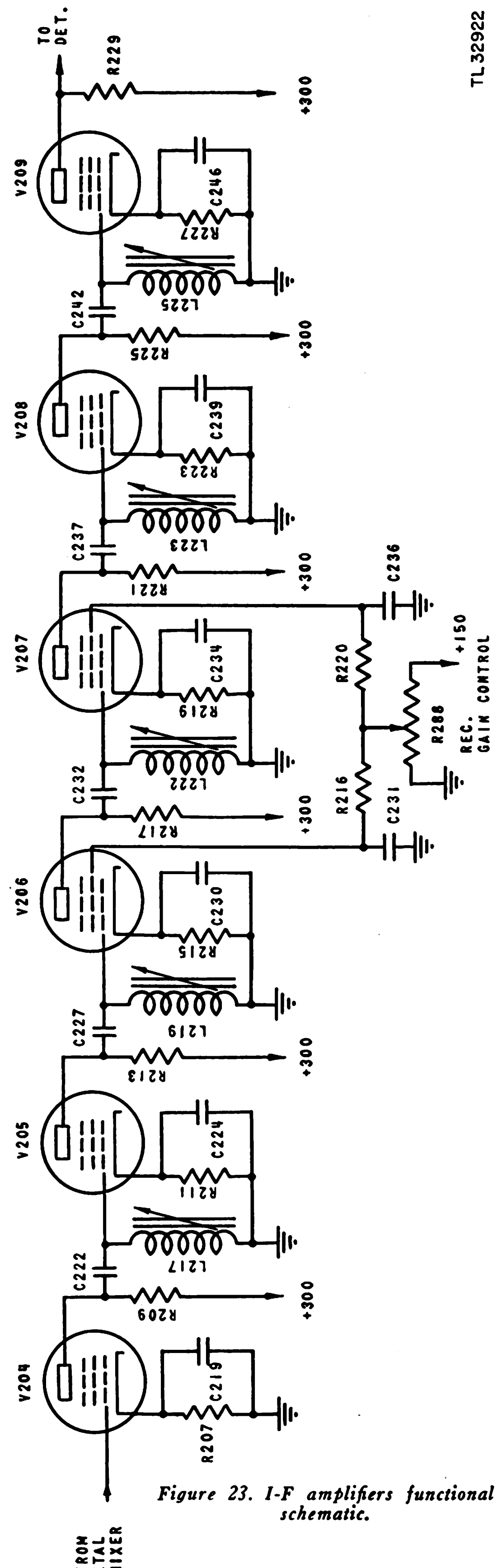


Figure 23. I-F amplifiers functional schematic.

the rectified crystal current can be read when the meter switch SW202 is in the X-TAL position.

16. I-F AMPLIFIERS. The i-f channel consists of six amplifier tubes V204 to V209, as shown in the simplified schematic diagram (figure 23). The signal voltage from the crystal mixer is impressed on the grid of the first amplifier tube V204. This signal voltage is amplified by V204 and appears on the plate of this tube, across the plate load resistor R209. This amplified signal voltage is coupled to the grid of the second stage, V205 by capacitor C222. Coil L217 is tuned to the i-f, at 30 megacycles. Resistor R207 provides cathode bias for the first i-f tube. Capacitor C219, by-passing the cathode resistor, prevents degeneration. The five succeeding i-f amplifiers function in the same manner. The RECEIVER GAIN control, potentiometer R288, varies the positive voltage applied to the screen grids of the 3rd and 4th i-f stages, tubes V206 and V207. Varying the screen voltage from 0 to 150 volts in this manner controls the gain of these tubes, and therefore the amplitude of the signals to be fed to the cathode-ray tubes in the indicator.

17. DETECTOR. The signal from the 6th i-f amplifier is fed through capacitor C249 to the cathode of the diode detector V210 (figure 24). Since the signal is fed to the cathode, only the negative half cycles cause the tube to conduct the output, which is taken off the load resistor R231 and is a negative video pulse. Capacitor C251, which partially by-passes the load resistor, is made small enough so that the remaining i-f is about 10% of the video pulse. This i-f component of the video signal is necessary for the operation of the a-j blanking circuit, as explained in paragraph 19 below.

18. VIDEO AMPLIFIER.

a. The video pulse is coupled through capacitor C253 to the grid of tube V211, the video amplifier (fig. 24). Tube V211 is slightly biased through resistor R232. The video pulse is amplified by the tube and appears in the plate circuit as a positive video signal. When the anti-jamming circuit is not used, the output of the video amplifier is fed through the AJ switch SW201, to the multiple plug board. From here it goes on to the video amplifier in the indicator unit.

b. The video amplifier tube V211 is biased so that a strong signal drives the grid sufficiently negative to cut off the tube. When this point is reached, a further increase in signal does not increase the size of the pulse on the plate of tube V211. Since the i-f signal is superimposed on the video signal, a strong signal will cut off the tube before the i-f signal can get through the tube. This fact is an important consideration in the analysis of the anti-jamming circuit.

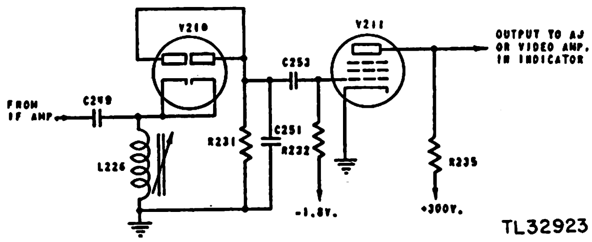


Figure 24. Receiver detector and video functional schematic.

19. ANTI-JAMMING CIRCUITS.

a. General Description. The receiver contains i-f and video circuits which are designed to minimize the effects of strong signals which would otherwise overload the receiver and prevent the reception of desired signals. The circuits are shown in block form in figure 25.

b. A-J Circuits. There are two separate a-j circuits: the blanking circuit and the video discriminator as shown in the block diagram, figure 25. The AJ switch SW201 is used to select the proper circuit. When the AJ switch is in the OFF position, the a-j circuits are bypassed completely. Under these circumstances, the signal passes directly from the i-f video amplifier in the receiver unit to the video amplifier stage in the indicator unit. In the #1 position, the blanking circuit is used. The purpose of the blanking circuit is to blank or remove a strong pulse-type jamming signal, but allow a desired target signal to come through. In the #3 position, the video discriminator circuit is used. The purpose of the video discriminator circuit is to remove a continuous-wave jamming signal (with or without low frequency modulation). In the #2 position, both the blanking circuit and the video discriminator circuit are used.

(1) BLANKING CIRCUIT.

(a) When the switch is in position #1, the output of the video amplifier in the receiver unit is coupled to the grid of the first blanking tube V212. Each video signal, applied to the blanking amplifier V212, has some intermediate frequency signal component (about 10%). The blanking amplifier rejects the video part of each signal and amplifies only the i-f part of the signal. The amplified i-f signals are detected by the blanking detector V214, and the resulting new video signals are further amplified by the video amplifier V215. The video signals are then fed to the indicator where they are presented on the PPI and "A" scopes in the usual way.

(b) The blanking circuit rejects strong interfering signals because these signals do not have any i-f component. The i-f component of a strong signal is removed by the limiting action of the 1st video stage V211 (par. 18b). However, all video signals not strong enough to drive V211 to the cut-off point, will have an i-f component and will be amplified and detected by the blanking circuit and so fed on to the indicator. In this way the blanking circuit rejects strong pulses which would otherwise get through to the indicator and cause interference.

(2) VIDEO DISCRIMINATOR CIRCUIT. As shown in the block diagram, figure 25, the discriminator circuit consists of three video amplifier stages which are designed to reject the lower video frequencies present in some types of jamming signals. This is accomplished by using short-time, constant, r-c circuits in the coupling elements. These r-c circuits do not interfere with the normal echo, which is only 1.5 microseconds wide, but prevent jamming signals of longer duration from getting through to the indicator.

c. Circuit Details. (1) BLANKING CIRCUIT.

(a) A simplified schematic diagram of the a-j circuits is shown in figure 26. Switch SW201 in the OFF position bypasses the a-j circuits completely. In position #1 the signal is coupled by C256 to the grid of V212. L234 is tuned to the i-f signal, presenting a high impedance to the intermediate frequency, but a very low impedance to video frequencies. If the video pulse is limited in V211 (fig. 24) no corresponding i-f signal will be present on the grid of V212 (fig. 26). If the video pulse is not limited, there will be i-f signal present on the grid of V212. In either case no video pulse is impressed on this grid because L234

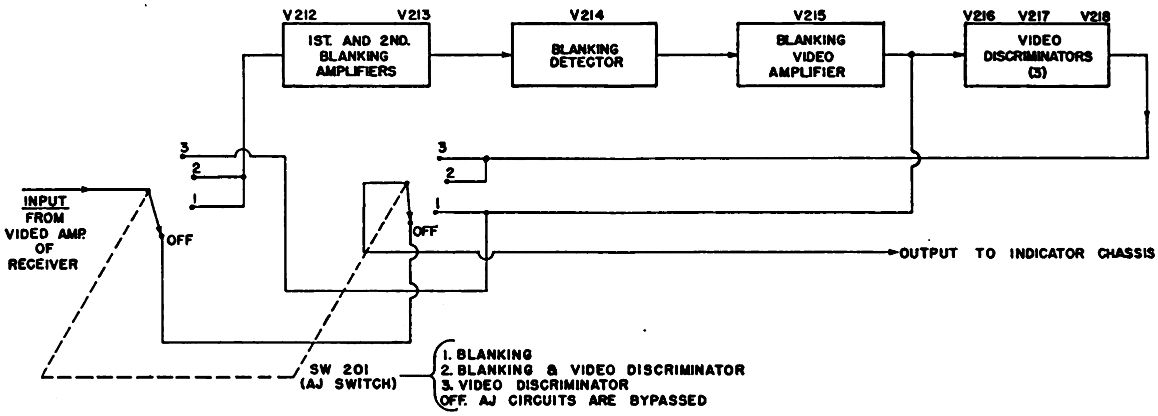


Figure 25. AJ block diagram.

presents a low impedance to video frequencies. R239 loads L234 to provide an input circuit that does not tune too sharply. C257 bypasses the cathode to ground, so that the i-f input voltage appears between grid and cathode. The i-f signal is amplified by V212 and appears across the plate load resistor R242. C260 couples the signal into the grid of V213. L231 is tuned to i-f frequency. The resistor network R237, R238, R240, and R243, provides an adjustable self bias for V212 and V213, and in so doing, controls the amplification of V212 and V213. R240 and R243 insure that the bias cannot be reduced below a safe voltage. Adjusting R237 makes it possible to increase the bias beyond the point where the plate current of V212 and V213 cuts off.

(*b*) The signal is further amplified by V213 and appears across its plate load resistor R254. C264 couples the signal to the grid of V214, L232 being tuned to i-f frequency. V214 functions as a diode detector, R290 providing the diode load. C265 bypasses the cathode to ground for i-f frequencies. Due to its non-linear characteristic, V214 detects the i-f signal and produces a video pulse on its plate, across R248. C269 couples this pulse to the grid of V215. L237 and C268 form a filter to reduce the amount of i-f frequency grid of V215. The video pulse is amplified by V215 and appears across its plate load resistor R251. The video pulse goes through L230, which eliminates any i-f that V215 has passed, and through the switch SW201 to the indicator.

(2) DISCRIMINATOR CIRCUIT. With SW201 on position #2, the signal goes through the blanking circuit in the manner just described, but instead of then going to the indicator, the video signal is coupled through C273 into the grid of V216 (fig. 26). The a-j discriminator control R252 is a potentiometer type voltage divider, which controls the amount of video signal that is impressed on the grid of V216. R253 provides self bias for V216 and C274, bypasses across the plate load resistor R254, and is coupled by C277 into the grid of V217. R256 returns the grid of V217 to ground, and in conjunction with C277 forms a filter which passes video frequencies to the grid of V217, but rejects undesired low frequencies (resulting from jamming). R289 provides self bias for V217, and C278 bypasses the cathode to ground. V217 further amplifies the signal, R260 being the plate load resistor; C280 couples the signal into the grid of V218, R262 returning the grid to ground. C280 and R262 form a filter in the same manner as C277 and R256. V218, operating with zero bias, further amplifies the signal, R264 being its plate load resistor. From the plate of V218, the signal goes to SW201 and thence to the indicator. With the switch SW201 on position #3, the video signal is coupled directly through C273 and R252 to the grid of V216, and goes through the discriminator circuit as described above, the blanking circuit not being used.

20. POWER SUPPLY.

a. General. The power supply (fig. 27) on the receiver chassis supplies the power for operating all components of the equipment, with the exception

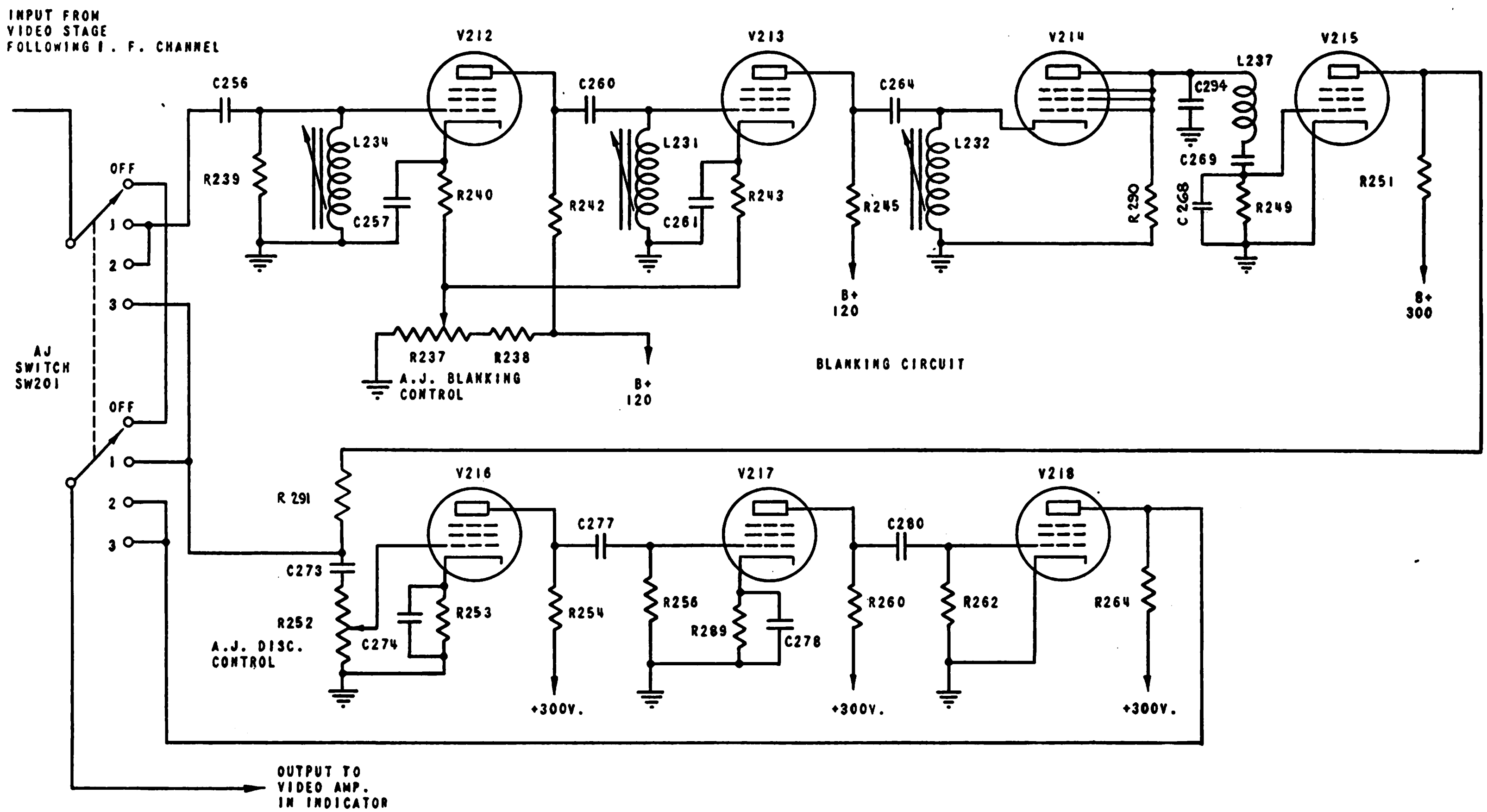


Figure 26. A J functional schematic

TL 32920A

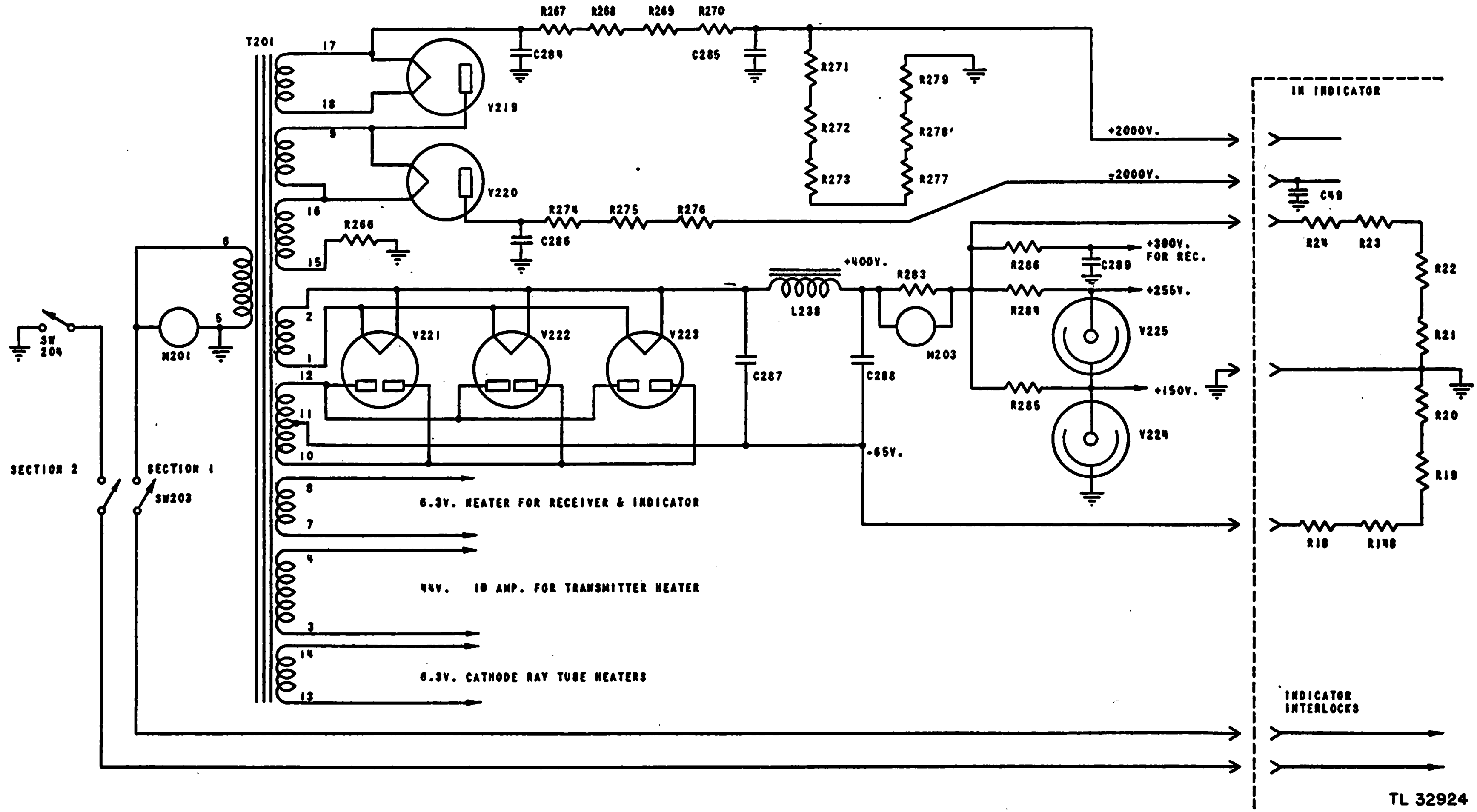


Figure 27. Receiver power supply schematic.

RESISTORS

R201	500 ohm	Pot.	C226	.001	μf
R202	100 ohm	1/2 W.	C227	100	μμf
R203	500 ohm	Pot.	C228	500	μμf
R204	100 ohm	1/2 W.	C229	.001	μf
R205	1200 ohm	1/2 W.	C230	.001	μf
R206	150 ohm	1/2 W.	C231	.001	μf
R207	150 ohm	1/2 W.	C232	100	μμf
R208	470 ohm	1/2 W.	C233	500	μμf
R209	820 ohm	1/2 W.	C234	.001	μf
R210	470 ohm	1/2 W.	C235	.001	μf
R211	150 ohm	1/2 W.	C236	.001	μf
R212	470 ohm	1/2 W.	C237	100	μμf
R213	820 ohm	1/2 W.	C238	500	μμf
R214	470 ohm	1/2 W.	C239	.001	μf
R215	150 ohm	1/2 W.			
R216	470 ohm	1/2 W.	C241	.001	μf
R217	470 ohm	1/2 W.	C242	100	μμf
R218	470 ohm	1/2 W.	C243	500	μμf
R219	150 ohm	1/2 W.	C244A	.5	μf
R220	470 ohm	1/2 W.	C244B	.5	μf
R221	470 ohm	1/2 W.	C244C	.5	μf
R222	470 ohm	1/2 W.	C244D	.5	μf
R223	150 ohm	1/2 W.	C245	82	μμf
R224	470 ohm	1/2 W.	C246	.001	μf
R225	820 ohm	1/2 W.	C247	.001	μf
R226	470 ohm	1/2 W.	C248	.001	μf
R227	150 ohm	1/2 W.	C249	100	μμf
R228	470 ohm	1/2 W.	C250	.001	μf
R229	1500 ohm	1/2 W.	C251	10	μμf
R230	470 ohm	1/2 W.	C252	82	μμf
R231	2000 ohm	1/2 W.	C253	.1	μf
R232	270M ohm	1/2 W.	C254	500	μμf
R233	510M ohm	1/2 W.	C255	.001	μf
R234	15M ohm	1/2 W.	C256	5	μμf
R235	1000 ohm	1/2 W.	C257	.001	μf
R236	150 ohm	1/2 W.	C258	.001	μf
R237	10M ohm	Pot.	C259	.001	μf
R238	270M ohm	1/2 W.	C260	100	μμf
R239	4700 ohm	1/2 W.	C261	.001	μf
R240	150 ohm	1/2 W.	C262	.001	μf
R241	470 ohm	1/2 W.	C263	.001	μf
R242	4700 ohm	1/2 W.	C264	100	μμf
R243	150 ohm	1/2 W.			
R244	470 ohm	1/2 W.	C266	.001	μf
R245	4700 ohm	1/2 W.			
			C268	10	μμf
			C269	.1	μf
R249	10M ohm	1/2 W.	C271	10	μμf
R250	33M ohm	2 W.	C273	500	μμf
R251	1000 ohm	1/2 W.	C274	.01	μf
R252	10M ohm	Pot.	C275	100	μμf
R253	150 ohm	1/2 W.	C276	.01	μf
R254	1500 ohm	1/2 W.	C277	100	μμf
R255	68M ohm	1/2 W.	C278	.01	μf
R256	22M ohm	1/2 W.	C279	100	μμf
R257	470 ohm	1/2 W.	C280	100	μμf

of the motors and the modulator. All of the necessary voltages are developed by one transformer, T201. Terminals 5 and 6 are the primary. An a-c voltmeter, meter M201, is connected across the primary and indicates the voltage applied to the primary. The a-c input (between 110 to 115 volts) is brought from the motor generator plug 201B (through an interlock arrangement) to the receiver unit. The MAIN POWER SUPPLY switch, SW203, when placed in the ON position, places this input voltage on the transformer primary. The TRANSMITTER switch SW204, when placed in the ON position supplies a ground for the 24-volt supply necessary to energize the high-voltage relay in the modulator unit. Note that it is impossible to turn the transmitter on until the receiver power supply is turned on. A safety interlock arrangement is also provided so that power transformer T201 does not receive a-c voltage unless the indicator chassis is in the console.

b. Low-Voltage Supplies. (1) Terminals 13 and 14 of the power transformer provide 6.3 volts for the heaters of the two cathode-ray tubes in the indicator. Terminals 3 and 4 provide 44 volts to heat the filaments of the transmitter tube. Terminals 7 and 8 provide 6.3 volts for the heaters of both indicator and receiver tubes. Tubes V221, V222, and V223, connected in parallel, function as full-wave rectifiers, obtaining their plate voltage from terminals 10 and 12. Terminal 11 is the center tap of this winding. Terminals 1 and 2 provide 5 volts to heat the filaments of the rectifier tubes V221, V222, and V223. Capacitors C287 and C288, and choke L238 form a choke-capacitor filter to reduce the ripple of the rectified voltage. The total B+ current can be read on meter M203 when the meter switch is in the TOTAL B+ position.

(2) The resistor network, serving as the required voltage divider, is physically located in the indicator unit. This network, resistors R18, R148, R19, R20, R21, R22, R23, and R24, is grounded between resistors R20 and R21. Therefore, the output voltage taken off resistors R18, R148, R19, and R20 is negative, while positive plate and screen voltage is taken off the rest of the network resistors. Resistor R286, in the receiver unit, drops the voltage to 300 volts for use in the receiver circuits, while resistor R284 provides 255 volts. Resistor R285 provides 150 volts for use in the receiver circuits. These voltages are held to their proper values by regulating gas tubes V224 and V225. Tube V224 is a gas tube which provides a constant 150-volt drop, while tube V225 provides a constant 105-volt drop. The drop across both regulators in series provides the required 255 volts. The potential at resistor R18 is —65 volts, while the potential at resistor R283 is +400 volts.

c. High-Voltage Supplies. (1) Terminals 15 and 16 provide 2,500 volts. Terminal 15 is connected through resistor R266 to ground. This resistor limits the peak current. Terminals 16 and 9 provide 2.5 volts for heating the filament of tube V220. Similarly, terminals 17 and 18 provide 2.5 volts for tube V219. Capacitors C286 and C49 (C49 is in indicator chassis) and resistors R274, R275, and R276, filter the output voltage of rectifier tube V220. Capacitors C284 and C285, and resistors R267, R268, R269, and R270 filter the output voltage of rectifier tube V219.

(2) The current from the plate of rectifier tube V220 flows through two parallel resistor networks located in the indicator unit. One network, resistors R110, R111, R112, R113, R114, R115, and R116, provides the PPI scope voltage, while network resistors R55, R57, R58, R59, R60, R61, R62, R149, and R63 provide the "A" scope voltages. Since the rectifier filament end of these networks is grounded, the output off resistor R110 is a very high negative potential (—2,000 volts). The output plate current of rectifier tube V219, flowing from ground through resistor network R279, R278, R277, R273, R272, and R271 produces a very high positive potential across resistor R271 (+2,000 volts).

(3) The negative 2,000-volts potential is applied to the cathode circuit of the cathode-ray tubes while the positive 2,000-volt potential is applied to the accelerating anodes. The resulting 4,000-volt difference in potential supplies the necessary acceleration of the electron beam for best operation of the cathode-ray tubes.

SECTION IV

INDICATOR UNIT

21. FUNCTION. Radio Set AN/TPS-3 employs two indicating devices, an "A" scope, and a PPI scope (fig. 29). These cathode-ray tubes are used to indicate visually the range and azimuth of targets within 100 miles of the equipment. Although both scopes may be used to obtain range and azimuth, the "A" scope is used most effectively for range determination, while azimuth can most easily be determined on the PPI scope. The "A" scope may also be used as a monitoring or tuning device.

22. DESCRIPTION.

a. "A" Scope Circuit (fig. 31). In the "A" scope circuit, the heater, cathode, grid, focusing anode, and accelerating anodes constitute a conventional electron gun.

(1) INTENSITY.

(a) Electron emission from the cathode is controlled by the potential difference between grid and cathode. Making the cathode of the "A" scope more or less negative by manual operation of the "A" INT. control (fig. 29), (potentiometer R58) increases or decreases the density of the electron stream with consequent increase or decrease in the intensity or brightness of the spot on the screen.

(b) The stream of electrons emitted from the cathode is drawn by the more positive anodes

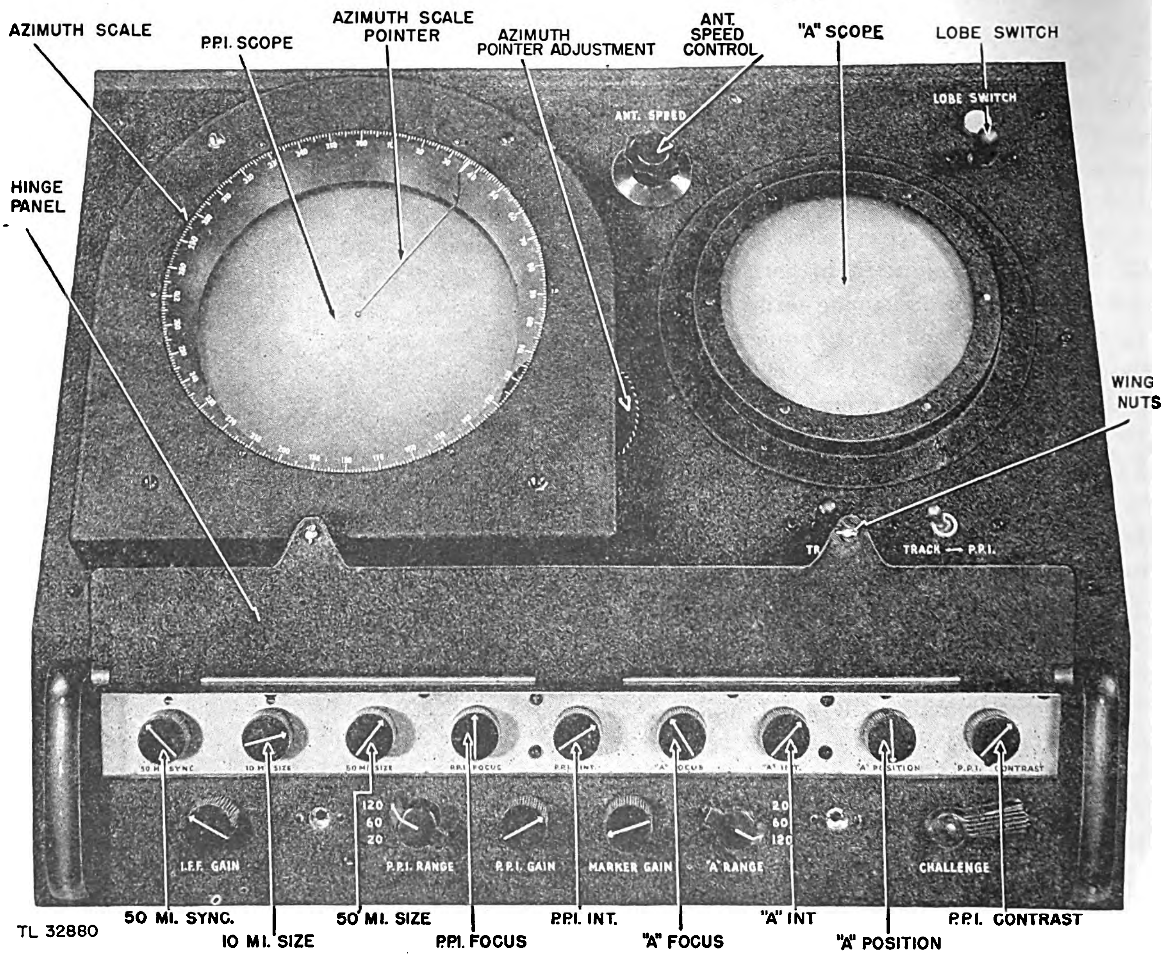


Figure 29. Indicator chassis, panel open.

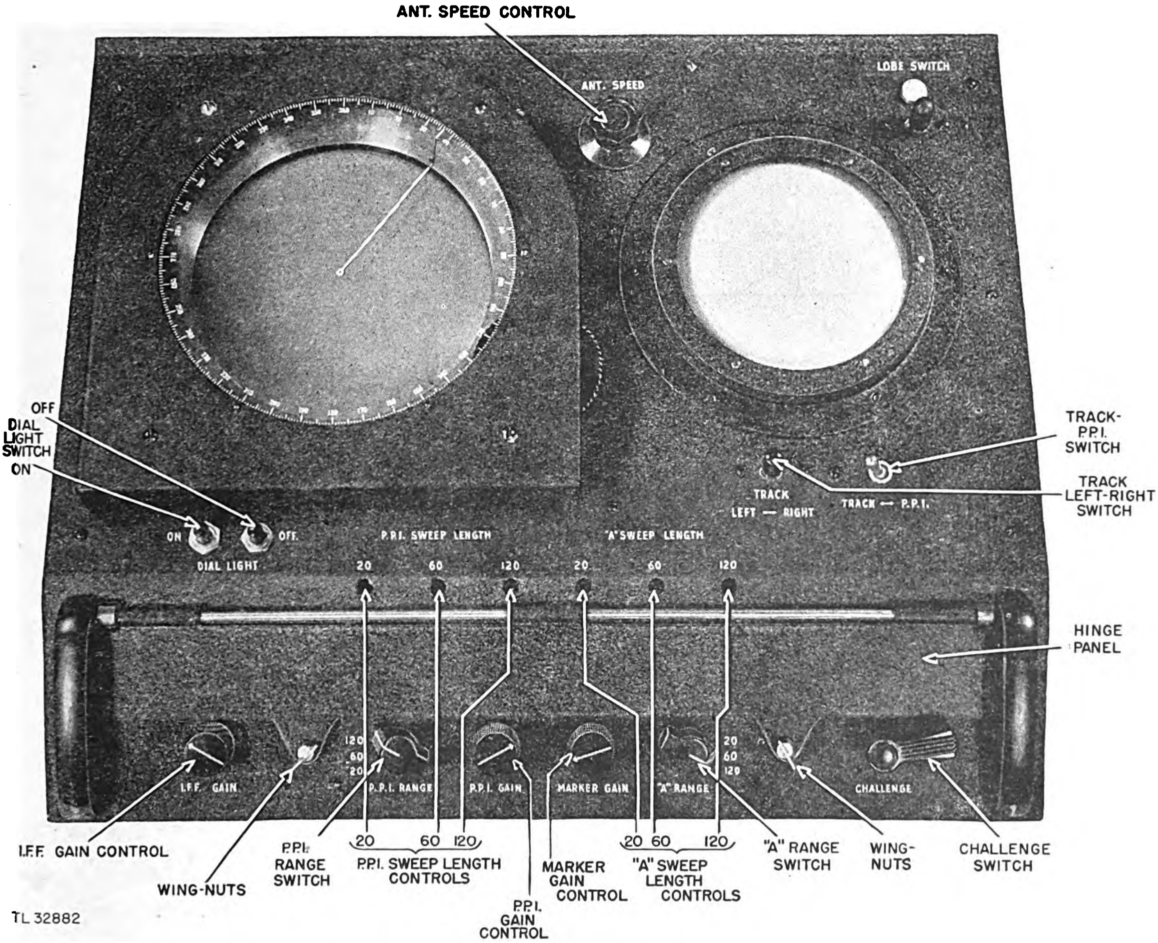


Figure 30. Indicator chassis, panel closed.

toward the screen of the cathode-ray tube. A 4,000-volt potential difference exists between the cathode and final anode. To decrease insulation difficulties, however, the cathode of the tube is supplied with —2,000 volts from the voltage-divider network, while +2,000 volts is impressed on the final anode through a connecting clip located on the glass envelope. The second accelerating anode is kept at ground potential and is thereby 2,000 volts positive in relation to the cathode.

(2) FOCUSING. The beam of electrons streams through the electrostatic lens formed by the difference in potential between the grounded accelerating anode and the more negative focusing anode. The warping of the electrostatic flux lines between these two anodes, when correct, will form the electron stream into a narrow beam focused at a point on the screen. The lens curvature is controlled by the "A" FOCUS control, potentiometer R60 (fig. 29).

(3) DEFLECTION PLATES.

(a) As the electron beam passes through the deflection plates, it is deflected either vertically or horizontally, depending on the potential difference between the opposite pairs of deflection plates. The sweep voltage moves the beam across the face of the tube from left to right at a constant rate for the period of time necessary for an echo to return from a target at extreme range, and then returns it to the left almost instantly. If, at the same time, a negative signal voltage variation is placed on the lower vertical deflection plate, the beam is deflected in an upward direction on the screen.

(b) The deflection plates are kept at an *average* potential substantially the same as that of the chassis. Therefore, beam focusing is undisturbed, and it is not necessary to use high-voltage capacitors to isolate the deflection plates from the rest of the equipment.

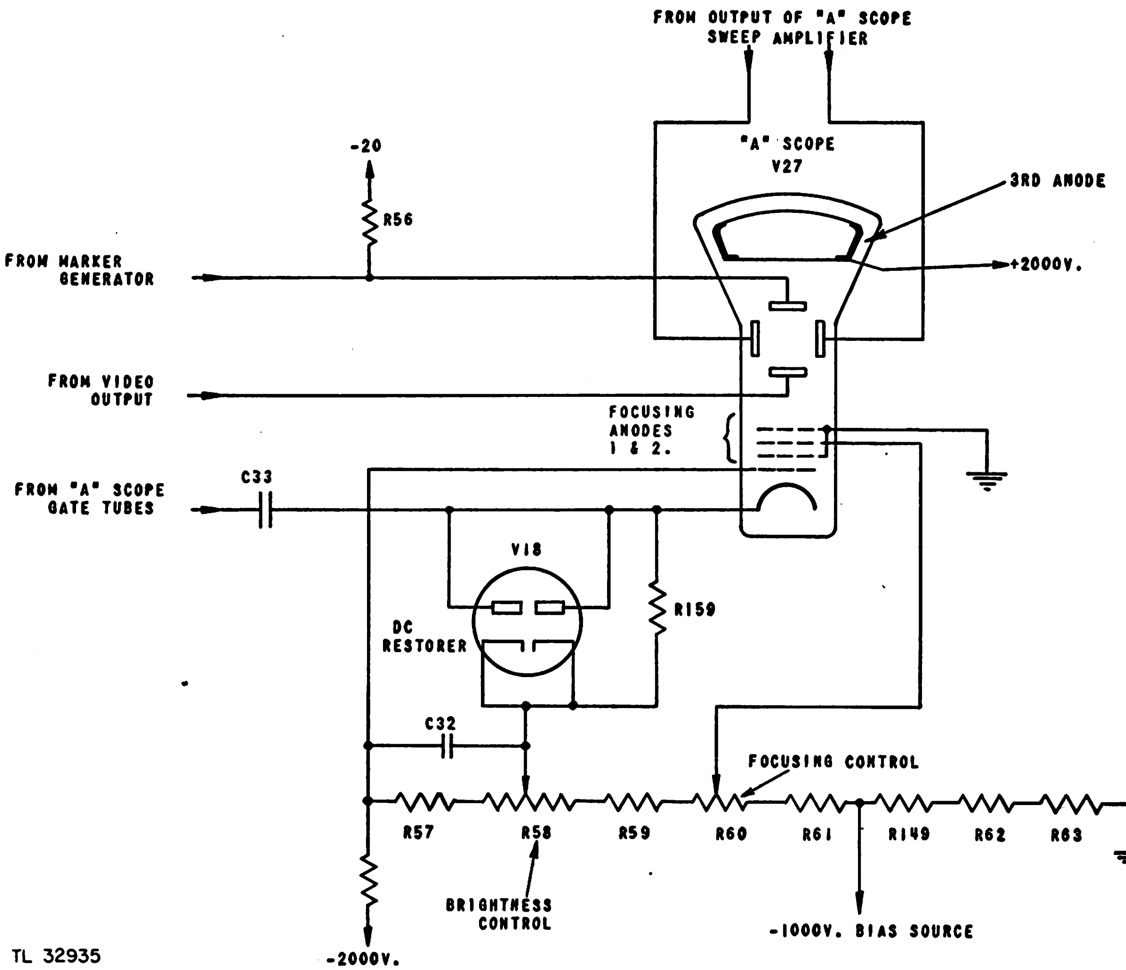


Figure 31. "A" scope functional schematic.

(4) SCREEN. The 5-inch screen of the scope is made of a fluorescent material which glows at the point where it is struck by the electron beam. Since the position of the electron beam will vary, dependent upon the sweep and signal voltages applied to the deflection plates, the position of the glowing spot on the screen will likewise vary. The speed of movement of the spot, however, is so rapid that, to the human eye, it appears as a line, a waveshape, or a pattern, dependent upon the voltages impressed on the deflection plates.

b. PPI Scope Circuit (fig. 32). The PPI is a cathode-ray tube of the magnetic deflection type. Similar to the "A" scope in many respects, the PPI scope also requires a 4,000-volt potential difference between cathode and final anode. The cathode is kept at 2,000 volts below ground, while the second anode is at ground potential. The final anode is at a +2,000-volt potential.

(1) INTENSITY. The brightness of the spot on the screen can be varied by changing the potential difference between cathode and grid by the PPI INT. control (fig. 29), potentiometer.

(2) FOCUSING. The PPI FOCUS control (fig. 29), potentiometer, varies the amount of current through the focus coil, and thus serves as a focusing adjustment. The coil is mounted in a yoke located around the neck of the tube. Changing the current through the coil varies the strength of the magnetic lines of force, thereby correcting for the lens curvature. The control should be adjusted until the electron beam is focused to a point on the screen.

(3) DEFLECTION COILS.

(a) The lateral deflection of the electron beam

is accomplished in the PPI scope by the magnetic deflection yoke. This yoke consists of a frame of iron laminations with two sets of windings. These windings are poled in such a way that a strong magnetic field is developed when current is flowing through the coils. The magnetic fields produced by the two sets of windings are at right angles to each other, producing a vertical or a horizontal deflection of the beam dependent upon which set or which portion of windings is energized. It should be noted that the electron beam is always deflected at right angles to the direction of the magnetic field. Therefore, the windings which produce horizontal deflection are in a vertical position, and conversely the windings set in a horizontal position produce a vertical deflection.

(b) These two sets of windings are energized from the output of a pair of push-pull amplifier tubes. The current through the windings is the full plate current of these amplifier tubes. Resistors R144 and R145, shunted across the deflection windings, help dampen out any parasitic oscillations and thus preserve the linearity of the sweep current.

(4) SCREEN. The 7-inch screen of the scope is made of a highly persistent fluorescent material. The sweep current in the deflection coils develops a fine sweep trace on the screen. Radiating outward from the center of the tube toward its edge, this sweep trace moves like the spoke of a wheel, in accordance with the rotation of the antenna. Target echoes, fed as positive pulses to the grid of the cathode-ray tube, appear as bright spots along the sweep line. Although the sweep trace is rotating, targets are visible even after the trace has moved away, this is caused by the screen's persistency.

23. SWEEP CIRCUITS.

a. Introduction. (1) To produce the necessary sweep traces or time base lines, it is necessary to develop a linear wave voltage for the A scope and a linear wave current for the PPI scope. If, for example, a positive sawtooth waveform voltage were impressed on one of the horizontal deflection plates of the "A" scope, as the plate became more and more positive, the electron beam would be attracted closer and closer to the plate. The beam would move across the screen linearly, that is, at the same rate of speed for any given distance. At the termination of the sawtooth waveform, the almost instantaneous drop in voltage would repel the electron beam so that it would revert back to its point of origin. The next sawtooth wave would cause a similar sweep. The same effect can be produced by introducing a positive sawtooth waveform to one of the horizontal deflection plates, while simultaneously a negative sawtooth waveform could be applied to the opposite horizontal deflection plate. The resultant push-pull effort likewise produces a sweep line. Since the PPI scope employs electromagnetic deflection, a sawtooth *current* waveform must be generated to develop the necessary sweep lines.

(2) To enable accurate range determination, it is important that the sweep line start at the same instant that the transmitter pulses. This is possible if a portion of the same pulse which triggers the transmitter is used to trigger the sweep circuits. This negative pulse, about 75 volts in amplitude and taken off a small portion of the pulse transformer winding, simultaneously triggers the "A" scope sweep, PPI scope sweep, and range marker circuits. The INDICATOR schematic, figure 39, clearly shows that the same pulse is fed simultaneously through capacitors C13 (range marker circuit), C35 ("A" scope circuit), and C52 (PPI scope circuit). This is graphically represented in the block diagram, figure 7.

b. "A" Scope. The purpose of the "A" scope sweep circuit is to produce the necessary sawtooth waveforms, both positive and negative, to be impressed on the horizontal deflection plates in push-pull arrangement so that a time-base line is generated.

(1) MULTIVIBRATOR STAGE.

(a) General. The negative triggering pulse from the pulse transformer is applied through capacitor C35 to the grid of the first section of tube V12 (fig. 33). Tube V12 is a start-stop type of multivibrator which produces the gate (negative square wave pulse) necessary to trigger the sweep generator tube. Normally, during the inactive portion of a cycle of operation, the first section of tube V12 is conductive while the second section is non-conductive. Tube V12b is kept at cut-off by the negative 85 volts impressed on its grid through the voltage divider net-work of resistors R72, R71, and R68. This high bias is necessary to keep the multivibrator from breaking into self-sustained oscillation. When the negative trigger pulse is impressed upon

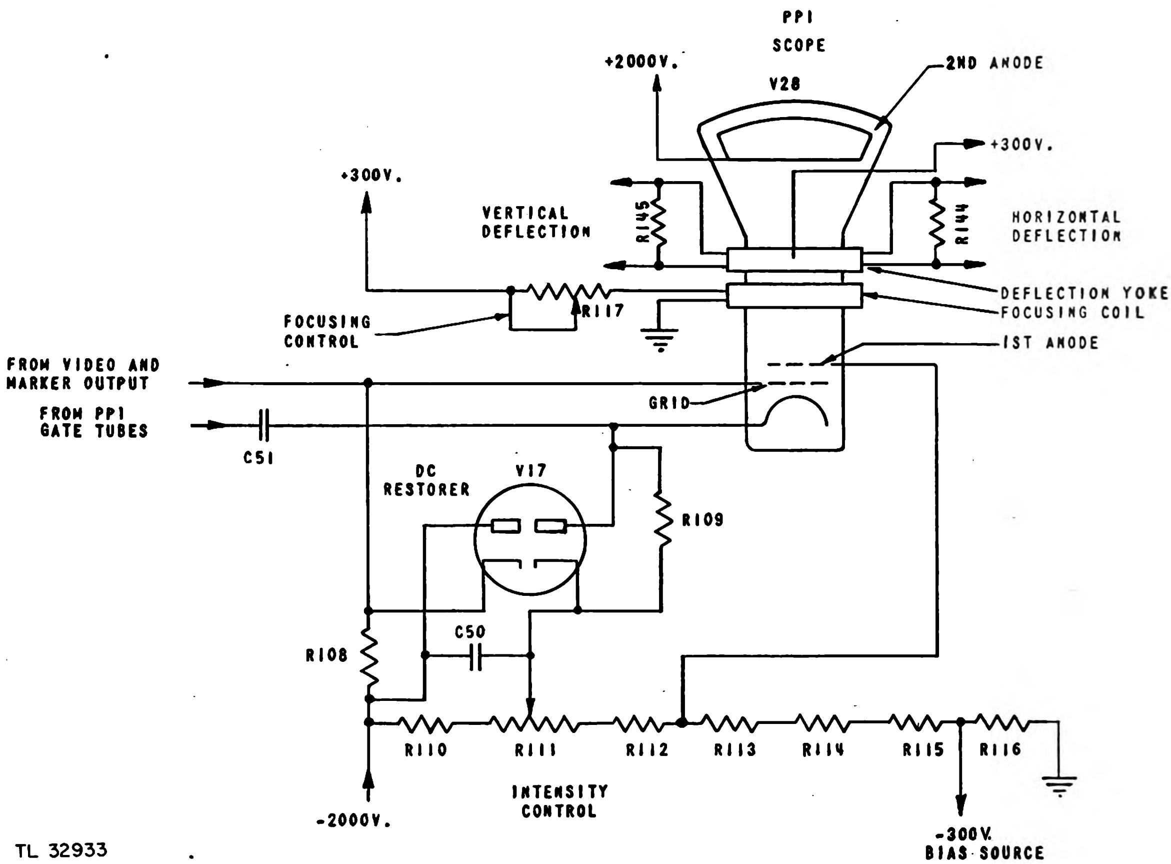


Figure 32. PPI scope functional schematic.

the grid of tube V12a, the grid is driven to below cut-off. The plate potential of the tube then rises to the full 400 volts. This voltage rise, coupled to the grid of the second section of the tube through capacitor C37, allows tube V12b to conduct. The plate voltage on this section drops, due to current flow through the plate resistor. The drop in potential is applied back to the grid of the first section through the coupling capacitor C36. This keeps tube V12a below cut-off. Capacitor C36 discharges to ground through the grid resistors R65, and R150 (20 mile range) and the grid potential eventually rises to the point above cut-off where tube V12a conducts again. The tube's plate voltage then decreases, and this drop in potential impressed upon the grid of the tube V12b cuts off the tube. This condition exists until the next negative triggering pulse starts the cycle of operation again. The output pulse, taken off the plate of tube V12b, is a negative square wave. The duration of this pulse depends upon the time that tube V12a is cut off, and is determined chiefly by the size of the capacitor C36 and the grid resistors R65 and R150 (resistors in circuit with switch set at 20-mile range). See the heavy-lined portion of the circuit schematic shown in figure 33. With the high resistance in the grid circuit, the duration of the pulse is longer than with low resistance in the circuit. The reason is that the amount of time necessary for the capacitor to discharge is longer with a high resistance than with a low resistance.

(*b*) *Range Switch.* A three position "A" SCOPE range switch SW2 is used for the three ranges. See indicator schematic, figure 39. Each position inserts a different resistance in the grid circuit. The larger the resistor, the longer the range will be. The range switch therefore increases the resistance to widen the gate and lengthen the range. It must be noted that the longer the range, the more time is necessary for the sweep to cover that range. Since approximately 10.7 microseconds are required for a transmitted pulse to travel out to a target and back again when the target is 1 mile from the transmitter, a 214 microsecond sweep is necessary for the 20-mile range. Likewise, 642 microseconds are required for the 60-mile range sweep and 1,284 microseconds for the 120-mile range sweep.

(c) Gate Controls. To compensate for variations in the values of grid resistors, it is possible to adjust the width of the gate (the output negative square waves) by adjusting the resistance in the grid circuit of the tube V12a (fig. 33). There are three GATE CONT. potentiometers (R150, R151, and R152) supplied for this purpose, one to be used for each range (see indicator schematic, fig. 39). These are screwdriver adjustments located on a bakelite strip in the underside of the indicator chassis (fig. 98). These adjustments are usually preset, and normally need not be disturbed.

(2) SWEEP GENERATOR STAGE (fig. 33).

(a) General. The output negative pulse from the multivibrator is coupled through capacitor C38 to the grid of tube V13b. Due to the high positive voltage on the grid of this tube (90 volts), considerable current flows through the tube, producing a sizeable voltage drop across the plate resistors. The resulting plate voltage is very low. There is, therefore, a very low voltage across capacitor C39 which is connected from the plate of the tube to ground. When the negative pulse from the multivibrator is fed to the grid, the tube is driven to cut-off, and the full voltage develops at the plate of the tube. Capacitor C39 thus charges exponentially, and since the output is taken from the capacitor to ground, the waveform appearing at the grid of the amplifier tube V14 is the exponential voltage rise of the charging capacitor. This voltage rise is linear for the first part of the exponential. At the termination of the negative triggering pulse, tube V13b again becomes conductive, and capacitor C39 discharges almost instantly through the tube. The output waveform is thus a positive sawtooth.

(b) Sweep Length Controls (fig. 33). The length of the sweep on the individual ranges can be adjusted by varying the SWEEP LENGTH controls, potentiometers R75, R77, or R79. See figure 39. Varying the resistance in the capacitor charging path changes the rate of charge, thereby changing the length of the sweep. The controls are screwdriver adjustments located on the front panel of the indicator (fig. 30). One control is supplied for each range.

(3) SWEEP AMPLIFIER STAGE (fig. 33).

(a) General. The sawtooth waveform is directly coupled to the grid of tube V14. The plates of tubes V14 and V16 are connected to the "A" scope horizontal deflection plates through a voltage-divider network. Tubes V14 and V16 constitute a push-pull, cathode-coupled, sweep amplifier stage. The positive sawtooth waveform impressed on the grid of tube V14 causes an increase in current flow through the tube and a corresponding decrease in plate voltage. At the same time, the increased current through the tubes' common cathode resistor, R80, causes a greater voltage drop on that resistor or a greater negative bias on tube V16. The plate voltage of this tube increases linearly in sawtooth fashion. Effectively, therefore, the output of tube V14 is a negative sawtooth wave coupled through capacitor C42 to one of the "A" scope horizontal deflection plates. Simultaneously, a positive sawtooth waveform taken off the plate of tube V16, is coupled through capacitor C43 to the other "A" scope horizontal deflection plate. The net result on the scope deflection plates is a push-pull action, whereby the plate which has the negative sawtooth pushes the electron beam, while the plate with the impressed positive sawtooth voltage pulls the beam. The time base line, or sweep, is thereby produced on the "A" scope screen.

(b) "A" Position Control. The grid of tube V16 is supplied with a positive d-c voltage from the horizontal centering control (fig. 33). This control, "A" POSITION potentiometer R92, varies the bias on the tube, thus changing the plate current through the tube. This in turn changes the average potential prevailing at the plate. In this manner the average potential of one deflecting plate is being changed, while the other is left constant. This shifts the sweep trace across the screen of the "A" scope without affecting the length of the sweep.

c. PPI Scope. The purpose of the PPI scope sweep circuit is to produce the necessary sawtooth waveform current through the deflection coils so that a time-base line is generated.

(1) MULTIVIBRATOR STAGE.

a. General. The same pulse, originating in the pulse-transformer, that triggered the "A" scope sweep circuit, simultaneously triggers the PPI scope sweep circuit. The negative triggering pulse of about 75 volts amplitude is fed through capacitor C52 to the grid of the first section of tube V11 (fig. 34). This PPI start-stop type of multivibrator is essentially a duplicate of the "A" multivibrator. The detailed circuit analysis of the multivibrator is given in paragraph 25. The output pulse, taken from the plate of tube V11b, is a negative square wave.

(*b*) *Range Switch.* A three position PPI RANGE switch SW1 is used for the three ranges. (See indicator schematic, figure 39). Each position inserts a different resistance in the grid circuit of the multivibrator tube. The longer the range, the larger is the resistor in the grid circuit. The larger the resistor, the wider is the gate or the longer the range setting.

(c) Gate Controls. To compensate for variations in the values of the grid resistors, it is possible to adjust the width of the gate (the output negative square wave) by adjusting the resistance in the grid circuit of tube V11a. There are three GATE CONT. potentiometers (R153, R154 and R155) supplied for this purpose, one to be used for each range. (See indicator schematic, figure 39). These are screwdriver adjustments located on a bakelite strip in the underside of the indicator chassis (fig. 98). These adjustments are usually preset and normally need not be disturbed.

(2) SWEEP GENERATOR STAGE.

(*a*) *General.* The PPI scope used is a cathode-ray tube of the magnetic deflection type. In order to apply a linear sweep to this PPI tube, a sawtooth current must be formed in the deflection coils. To obtain a sawtooth wave current, a trapezoidal voltage wave must be applied to the deflection coils. This trapezoidal wave is produced by combining a square wave voltage and a sawtooth wave voltage. The square wave component overcomes the inertia of the coils' inductance and makes possible a linear current sweep. The sweep generator tube V13a produces the trapezoidal wave voltage.

(b) Sweep Circuit. Tube V13a has a positive bias voltage applied to the grid through resistor R126 (fig. 34). The tube conducts heavily and acts as a low impedance across capacitor C56, causing low voltage across the capacitor. When the negative pulse is applied to the sweep generator grid circuit from the second section of the multivibrator, the sweep generator tube is driven to cut-off. Plate current ceases, the plate voltage rises, and the capacitor then charges to the voltage applied through the plate resistor network. The output waveform across the capacitor alone would be exponential or sawtooth. However, the output waveform is taken from the capacitor and the resistor R127 (20-mile range) in series. The voltage rise across the resistor R127 is instantaneous, and this fixed voltage is superimposed on the sawtooth voltage of the capacitor. The output waveform will, therefore, show an instantaneous upward surge, after which the capacitor begins to charge. The result is a trapezoidal output wave. The proper time constant for each range setting is controlled by the PPI RANGE switch, SW1.

Note: On the 20-mile range (see indicator schematic, fig. 39) capacitor C64 is coupled from the plate of the first multivibrator section (tube V11a) to the high end of the charging network. During the active part of the cycle, therefore, the full +400 volts is applied to the capacitor charging path. The speed of the sweep is thus increased to to the required rate of 214 microseconds per sweep length.

(c) Sweep Length Controls. The length of the sweep on the individual ranges can be adjusted by varying the SWEEP LENGTH controls, potentiometers R129, R131 or R134. See indicator schematic, figure 39. Changing the resistance in the capacitor charging path changes the rate of charge, thereby changing the length of the sweep. The controls are screwdriver adjustments located on the front panel of the indicator (fig. 30). One control is supplied for each range.

(3) SWEEP AMPLIFIER (fig. 34). The output trapezoidal waveform voltage from the sweep generator is directly coupled to the grid of the PPI sweep amplifier, tube V15. The cathode resistor R135 is not bypassed. The resultant degeneration improves the linearity of the stage. Choke CH1, used in the plate circuit, assures the maximum power transfer to the selsyn rotor. The amplified output of this tube is fed through capacitor C59 to the rotor winding of the selsyn transformer.

(4) SELSYN TRANSFORMER (Fig. 35).

(a) The sweep circuit must be designed to rotate the sweep around the face of the scope in exact accordance with the rotation of the antenna mast. This is made possible by the selsyn transformer. The selsyn transformer is coupled directly to the antenna shaft through a friction clutch. The rotor of the selsyn transformer thus turns with the antenna. The angular position of the rotor winding always corresponds with the azimuth position of

the antenna. Four field windings of the rotary transformer are spaced 90° apart surrounding the rotor winding (fig. 34). The function of the resistor R136, shunting the rotor, is to reduce the input impedance of the transformer and make it resistive.

(*b*) The trapezoidal sweep voltage from the PPI sweep amplifier tube V15, applied to the rotor winding through capacitor C59, induces the sweep voltage into the field windings. Opposite field windings are connected in series so that the voltage induced into one adds to the other. The amount of voltage induced into either pair of field windings is dependent upon the angular relationship of the field windings with respect to the rotor winding. If the rotor winding is parallel to a pair of field windings, maximum voltage is induced. If the rotor winding is perpendicular to a pair of field windings, no voltage is induced. Any angular position between would cause the voltage to be divided between all windings in relation to the angular position. The voltages from the field windings of the selsyn transformer are applied to the grids of the PPI deflection amplifiers.

(5) DEFLECTION AMPLIFIER STAGE. The trapezoidal sweep voltages from the selsyn-transformer field windings are applied to the grids of the PPI deflection amplifiers, tubes V20, V22, V24 and V26 (fig. 34). These amplifiers, connected in push-pull, energize the fixed deflection coils on the cathode-ray tube. Tubes V24 and V26 make up one push-pull amplifier combination, and tubes V20 and V22 make up the other.

(6) DEFLECTION COILS (fig. 34). The deflection yoke of the cathode-ray tube consists of windings through which the plate current from the deflection amplifiers flow. This current, increasing in one amplifier and decreasing in the other, causes magnetic beam deflection. The deflection coils are arranged 90° apart around the cathode-ray tube so that current from one set of the push-pull tubes produces a deflection of the beam in a direction 90° from the displacement caused by the other set of tubes. Since the excitation voltages vary as the rotor of the selsyn transformer is turned, and since the deflection coils are arranged 90° apart, as in the selsyn stator, a rotating field is produced by the deflection coils which is always in line with the field produced by the stator of the selsyn. The sweep rotates with the turning of the transformer rotor. The path of the spot is as a radial line starting from the center of the screen and sweeping to the outer edge. The sweep line rotates 360° on the screen in accordance with the rotation of the antenna mast.

(7) CLAMPING TUBES CIRCUIT.

(*a*) *General.* For proper presentation on the PPI tube screen, it is necessary that the trace line start at the exact center of the screen. The clamping tube circuit accomplishes this centering. Steady current flowing through the deflection coils of the PPI cathode-ray tube controls the position of the spot on the screen. If equal currents are flowing in these coils, an equal field is built up around each coil, and the spot is held in the center of the scope. The currents through the deflection coils of the PPI scope are the plate currents of the four amplifiers, tubes V20, V22, V24, and V26. In order to make these currents equal, an equal and constant grid bias to each of the tubes must be applied between sweeps. The clamping tubes do this *during the interval in which there is no sweep voltage being applied.*

(*b*) *Description.* Four duo-triode tubes, V19, V21, V23, and V25, are used in the clamping tube circuits. The two sections of each tube are used for each amplifier. See indicator schematic, figure 39. Consider only the two sections of clamping tube V23 (fig. 34) without any sweep voltage or "unclamping" voltage being applied. The circuit functions as a voltage divider. The two triodes of tube V23 are connected in series with +90 volts applied to the plate of V23a. The cathode of V23b is near ground potential. The grids of the two sections are tied together. Applying B+ potential to both grids through resistor R139 makes both sections of the tube highly conductive. As plate voltage is applied, current flows through the two sections in series. The voltage drop across each tube develops in proportion to the amount of plate resistance each tube offers. The resistance offered by the circuit of tube V23b is greater than the resistance of the second section because of the cathode resistor R102 in the circuit of the first section. The voltage drop across each section develops in proportion to the amount of resistance each section offers. The bias on the grid of the amplifier tube V24 is the potential existing at the junction of cathode and plate between sections one and two. The junction point, which remains at a constant potential during the interval

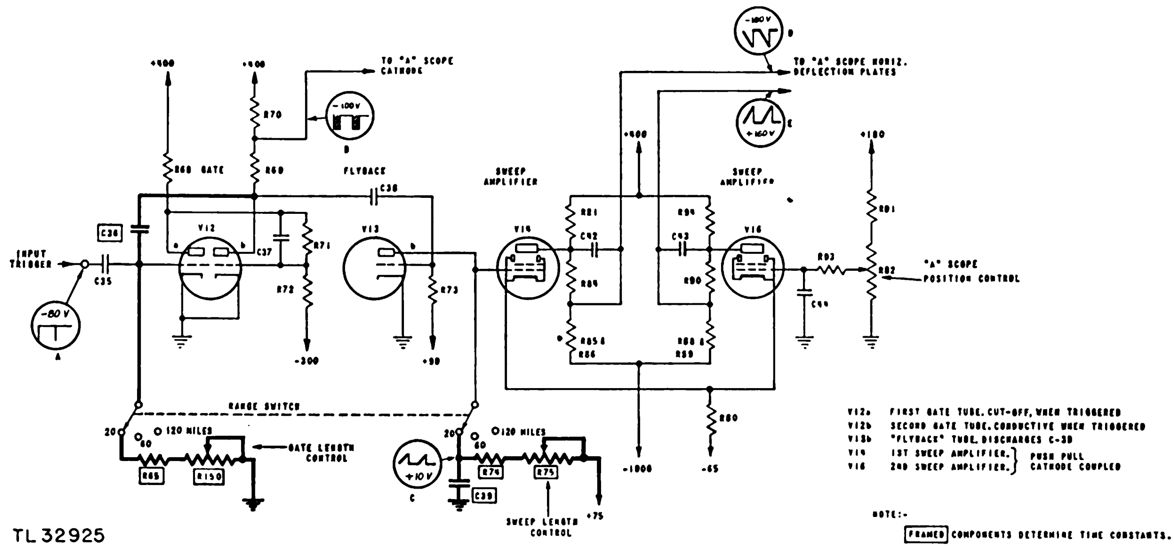


Figure 33. "A" scope sweep functional schematic.

that no sweep voltage is applied, is connected to the grid of the deflection amplifier tube V24. Three identical circuits are used for the other three deflection amplifiers, V20, V22, and V26, thereby clamping the grids of all the sweep amplifier tubes at the proper potential during the inactive period. The grids set to a potential, such that the resulting plate currents through the deflection coils of the PPI cathode-ray tube are equal, thereby holding the spot at the exact center of the fluorescent screen.

(*c*) *Unclamping.* Since the plate-cathode junction of the clamping tubes is connected to the grid of the deflection amplifiers, the low impedance of the clamping tubes is eliminated while sweep voltage is being applied to the grids of the sweep amplifiers from the selsyn transformer. This is accomplished by applying a negative square wave to the grids of the clamping tubes. This negative square wave, or unclamping voltage, is obtained from the voltage divider network (R124 and R125) in the plate circuit of the second section of the multivibrator tube, V11b (fig. 34). The wave is applied at the same instant the sweep voltage is impressed on the grids of the deflection amplifiers. The negative square wave is coupled to the grids of the four clamping tubes through capacitors C45, C47, C60 or C62, and is of sufficient amplitude to cause the clamping tubes to be biased beyond cut-off for the duration of the sweep. In this way the grids of the sweep amplifiers are unclamped and move freely. The sweep voltage disappears at the same instant the negative pulse from the multivibrator disappears, and the grids of the sweep amplifiers are again clamped to the same potential that existed prior to the sweep. The spot on the fluorescent screen is again forced to return to the center.

(*d*) *Centering Controls.* See Indicator schematic figure 39. The PPI CENTERING controls, potentiometers R101 and R106, vary the resistance in the cathode circuit of the two clamping tubes (V19 and V25), thereby varying the voltage on the grids of two of the push-pull sweep amplifier tubes. Potentiometer R101 causes the screen spot to move horizontally, and potentiometer R106 causes the spot to move vertically. These controls, physically located on the upper deck at the rear of the indicator (fig. 97) should be adjusted so that the spot on the screen is centered.

(*e*) *Circularity Control.* The CIRCULARITY control, potentiometer R98, controls the magnitude of the sweep voltage at the grids of one set of deflection amplifier tubes V20 and V22 (fig. 34). The deflection produced by each set of deflection coils may thus be equalized so that a completely circular trace is seen on the screen. This control is located on the upper deck at the rear of the indicator (fig. 97).

24. BLANKING CIRCUITS.

(*a*) *Purpose.* The pulse recurrence frequency of the equipment is 200 cycles per second. This means that from the start of one pulse to the start of the next takes approximately 5,000 microseconds. There is, therefore, a considerable time interval between the return of one sweep trace and the start of the next. For example, the total sweep time on the 20-mile range is but 214 microseconds. Means must be provided to cut off the electron beam during the inactive period to avoid confusion and to prevent damage to the scope screens. The circuit components permit the blanking out of the scopes during inactive periods between sweeps and unblanking of the scopes for the duration of the sweep.

(*b*) *"A" Scope Blanking.* The "A" scope blanking circuit is designed to cause the cathode of the "A" scope to be less positive in respect to its grid during the time the sweep line is to be viewed on the screen. This means that when the cathode is less positive with respect to the grid, sufficient electron flow is allowed for the spot or trace to appear. When the cathode is more positive with respect to the grid, the electron flow is cut off so that no spot can appear.

The positive voltage used to blank the "A" scope is taken from the junction of resistors R69 and R70 in the plate circuit of the multivibrator tube V12b; (see indicator schematic, figure 39) and is coupled to the cathode of the "A" scope through capacitor C33 (fig. 31). The positive voltage, during the inactive part of the cycle, does not affect the cathode potential of the "A" scope due to the action of the d-c restorer tube V18 which conducts during this period. The low resistance of the tube, when conducting, keeps the cathode of the scope at approximately the same potential as the intensity potentiometer R58. The potential at potentiometer R58 is sufficiently positive in relation to the more negative grid so that the "A" scope is kept inoperative during the inactive part of the cycle. However, during the active part of the cycle, the plate of tube V12b drops in potential. This drop in potential (negative gate) drives the plate of V18 negative and hence it no longer conducts. Thus the d-c restorer prevents the cathode from going positive but has no effect when the cathode is driven negative. Therefore, the potential on the cathode of the "A" scope becomes less positive with respect to the grid, and the scope is unblanked for the duration of the sweep.

(*c*) *PPI Scope Blanking.* The PPI blanking circuit functions just as the "A" scope blanking circuit. The positive voltage used to blank the tube is taken from the junction of resistors R124 and R125 in the plate circuit of the tube V11b. See indicator schematic, figure 39. The d-c restorer tube employed in this blanking circuit is V17b (fig. 32). Since the PPI scope is intensity modulated, negative surges build up a charge on coupling capacitor C7 (to the video amplifier output). To prevent the effect of negative surges, the first section of the d-c restorer, tube V17a, is connected across resistor R108 in the grid circuit. Tube V17a conducts with a negative surge and bypasses this unwanted voltage.

(*d*) *D-C Restorers.* The d-c restorer tube V18 (fig. 31) also serves to keep the sweep trace on the "A" scope in a stable position. Likewise, tube B17 (fig. 32) keeps the intensity modulation of the PPI scope constant for the sweep trace. The average potential of the sweep-voltage pulses varies for the different ranges. The d-c restoring action of tubes V17 and V18, eliminates varying average potentials and maintains stability of sweep-trace action.

25. RANGE MARKER CIRCUIT.

a. Purpose. The range marker circuit provides electronic range scales on the indicators.

b. Description. (1) GENERAL. For markers to appear on the PPI screen, it is necessary to increase the intensity of the sweep voltage at certain points. As the sweep revolves, the points of greater intensity produce circles because of the long light persistency of the screen (fig. 6). When a positive pulse is applied to the grid of the cathode-ray tube, there is a greater electron flow to the fluorescent screen. This produces a point of greater intensity. The range marker circuit supplies positive pulses at the proper time on each range so that the PPI screen is actually marked at 10-mile intervals. Likewise, the range marks appear on the "A" scope screen as pips because of the voltage variations applied to the vertical deflection plate. This screen is also marked at 10-mile intervals.

(2) 10-MILE MARKERS. The pips (for "A" scope) or concentric circles (for PPI scope) developed by the range marker circuit appear at 10-mile intervals. On the 20-mile range, two markers appear at the 10-mile and 20-mile points on the sweep. On the 60-mile range, six markers appear spaced 10 miles apart. On the 120-mile range, 12

markers appear evenly spaced across the sweep line. Range determination is thereby made possible.

(3) 50-MILE MARKERS. To avoid confusion and to simplify reading, the 50 and 100-mile range markers appear as enlarged pips on the "A" scope and as brighter concentric circles on the PPI scope.

c. Multivibrator Stage. The negative pulse from the pulse transformer, used to trigger the "A" and PPI scope sweep circuits, simultaneously triggers the range marker circuit. This pulse is fed to the grid of tube V5 through capacitor C13 (fig. 36). Tube V5 is a start-stop multivibrator of the same type used in the sweep circuits. Because of the constants of the circuits, the gate period is longer than that of the 120-mile range in the previously described multivibrator circuits. Since 10.7 microseconds are required for a transmitted pulse to travel out to a target and back again when a target is one mile from the transmitter, the elapsed time between each range mark is approximately 107 microseconds. Because oscillations are used to develop the required 10-mile range markers, a resonant circuit must be tuned to oscillate at a frequency of approximately 9,300 cps. The frequency of this oscillation is such that each full wave corresponds to one 10-mile marker after squaring and differentiation. A tuned circuit in the next stage is provided to oscillate at the required frequency.

d. Oscillator Stage. A tuned circuit, L3, C17, and C18, is provided in the cathode circuit of this stage to oscillate at a frequency of approximately 9,300 cps. See the heavily lined tank circuit in figure 36. The peaks of oscillation occur 107 microseconds apart, and these peaks can be used to give the desired range marks at 10-mile intervals. Tube V6a is normally fully conductive because its grid is tied to a high positive potential. The triggering pulse causes a negative potential at the plate of tube V5b of the multivibrator. This negative gate (fig. 37) coupled through capacitor C16 to the grid of the oscillator tube, drives the grid below cut-off. The sudden cessation of current flow through tube V6a shock-excites the resonant circuit, L3, C17, and C18 into oscillation. The oscillations are amplified by tube V6b. Part of the voltage produced in V6b is fed back into the coil so that the oscillations are kept at constant amplitude. When the multivibrator gate goes positive, tube V6a begins to conduct again and quickly damps out the oscillations. The sine-wave oscillations (fig. 37) are fed to the grid of tube V7a.

e. Square Stage (fig. 36) (1) GENERAL. The grid of tube V7a is biased highly negative so that it clips off the negative peaks of the incoming sine wave. After reversal of polarity, clipped waves appear at the plate of tube V7a (fig. 37). This output is then fed to the grid of tube V7b which is also biased strongly negative. As a result, square waves are produced in the plate of tube V7b (figure 37). This output is fed to the grid of tube V10a through coupling capacitor C21.

(2) 10-MILE MARKER PEAKER STAGE. Capacitor C21 and resistor R39 (fig. 36) comprise a very short time constant differentiating or peaking network. Although a square wave voltage of long duration is applied, the capacitor C21 charges so quickly that the voltage appearing across the grid resistor R39 drops almost instantly. For each of the ascending and descending portions of the input square wave, short positive and negative peaks respectively (fig. 37) are impressed upon the grid resistor R39 of the range mixer tube V10A.

(3) 50-MILE MARKER MULTIVIBRATOR AND PEAKER. It is desirable to make every fifth range mark longer (for "A" scope) or brighter (for PPI scope) to simplify reading the scope screen. The square waves (fig. 37) developed at the plate of tube V7b, are fed to the grid of the range mixer tube, and are also coupled through capacitor C25 to the grid of tube V8a. Tube V8a amplifies the square wave and feeds it (fig. 37) to the following multivibrator stage. Tubes V8b and V9a comprise a multivibrator. Because of the high positive voltage on its grid (fig. 36) Tube 8b is normally conducting, while tube V9a with its grid tied to a negative potential is normally inoperative. The negative leading edge of the square wave from tube V8a (fig. 37) coupled through capacitor C27 to the grid of tube V8b drives the grid of the first section of the multivibrator to below cut-off. The rising voltage at the plate of this tube, coupled through capacitor C28 to the grid of the second section of the multivibrator, tube V9a, causes that tube to conduct. The plate potential of tube V9a drops, and this negative voltage, coupled back through capacitor C29 to the grid of tube V8b, keeps the first section of the multivibrator cut off even after the square wave has disappeared from V8a. The tube remains cut off until the capacitor C29 dis-

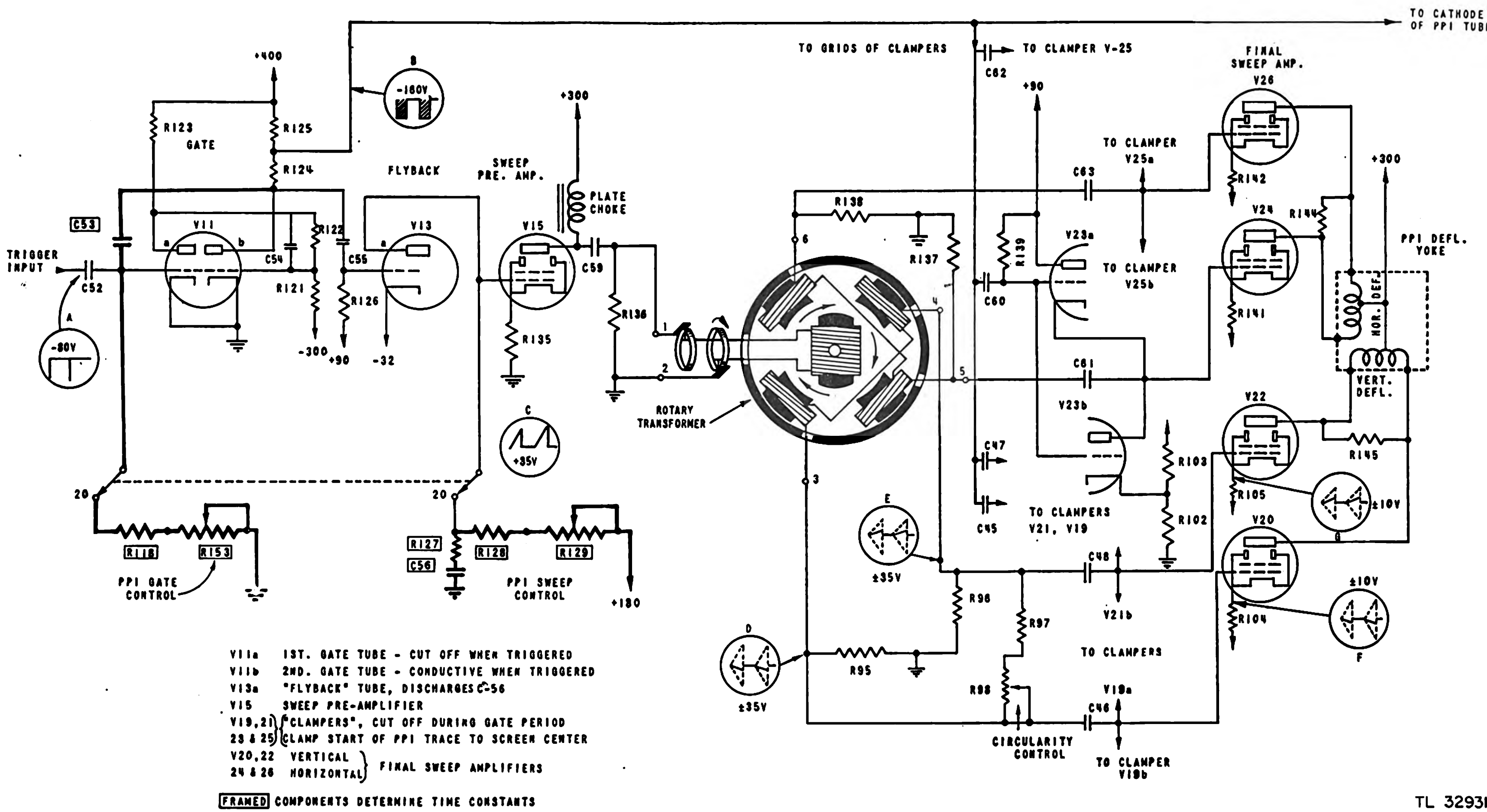


Figure 34. PPI scope sweep functional schematic.

charges sufficiently for the grid of the tube V8b to rise above cut-off. This occurs after about 480 microseconds, or about 45 miles, because of the long time constant involved (capacitor C29, and resistors R50 and R49). See heavily lined capacitor discharge path in Figure 36. Shortly thereafter, the fifth square wave pulse or 50-mile marker trips the multivibrator again, and the same sequence of action occurs. The output taken from the plate of tube V9a (fig. 37) is fed through a differentiating or peaking circuit, consisting of capacitor C30 and resistor R54, to the grid circuit of tube V9b. See figure 37 for waveform picture after differentiation. The output positive and negative peaks (fig. 37) are fed through capacitor C26 to the grid of tube V10b, the range mixer tube.

f. Range Mixer Stage (1) GENERAL. Tube V10 operates in two sections (fig. 36). However, the output of both sections is combined or mixed. The input to the grid of tube V10a consists of the positive and negative 10-mile range marker pips from the plate of tube V7b (fig. 37). The input to the grid of tube V10b consists of the positive and negative 50-mile range marker pips from the plate of tube V9b (fig. 37). Since the grids of the range mixer tube are operated below cut-off, the output, taken from the plate of the tube, will be negative peaked waves at 10-mile intervals, with every fifth range marker of greater amplitude (fig. 37). The sizes of the range marker pips can be varied by controls located on the front panel of the indicator. *Note that the illustrations in Figure 37 are not drawn to scale.*

(2) RANGE MARKER CONTROLS (fig. 36).

(*a*) The bias on the range mixer tube V10a can be varied by adjusting the 10-mile size control, potentiometer R38. Therefore, the amplitude of the 10-mile marker pips may be adjusted to a desired size.

(*b*) The bias on the range mixer tube V10b can be varied by adjusting the 50 MILE SIZE control, potentiometer R42. Therefore, the amplitude of the 50-mile marker pips may be adjusted to a desired size.

(*c*) The bias on both sections of the range mixer tube V10 can be varied by adjusting the MARKER GAIN control, potentiometer R40. Therefore, the amplitude of both 10-mile markers and 50-mile markers may be adjusted simultaneously.

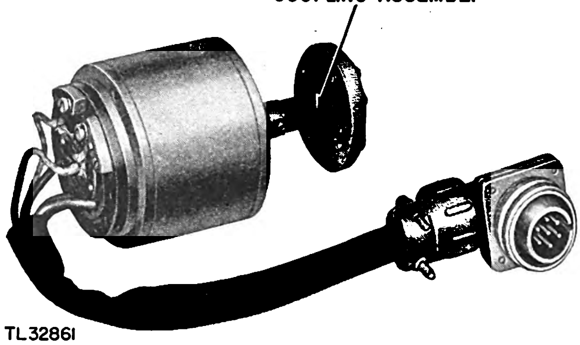


Figure 35. Selsyn transformer.

(*d*) "A" 50-MILE SYNC. control, potentiometer R49, is provided in the discharge path of capacitor C29 in the multivibrator circuit. Increasing the resistance in this circuit increases the length of time the first section of the multivibrator cuts off. It is possible to keep the tube cut off beyond the fifth range marker so the large pip occurs at every sixth range mark. Conversely, the pip can be made to appear at the fourth range mark when resistance is decreased. Optimum operation is insured when this enlarged pip is synchronized to the 50-mile range marker.

26. SIGNALS AND RANGE MARKERS. The video signals and range markers are fed to both "A" and PPI scopes for target and azimuth determination.

a. How Impressed on "A" Scope. Signals and range markers are impressed on the vertical deflection plates of the "A" scope. These voltage variations impressed on the electron beam, which is sweeping across the screen, causes corresponding voltage waveforms on the screen.

(1) RANGE MARKERS. The negative 10-mile and 50-mile range marker pips, taken from the plate of range mixer tube V10, are fed through capacitor C34 directly to the upper vertical deflection plate of the "A" scope (fig. 31). The negative waveshapes deflect the electron beam in a downward direction so that the marker pips appear below the trace line, spaced at 10-mile intervals with every 50-mile marker on enlarged pip.

(2) SIGNALS. The positive video signals from the receiver are fed through the multiple plug board to the indicator unit.

(*a*) *Indicator Video Amplifier* (fig. 38). The video amplifier, Tube V1, is biased through resistor

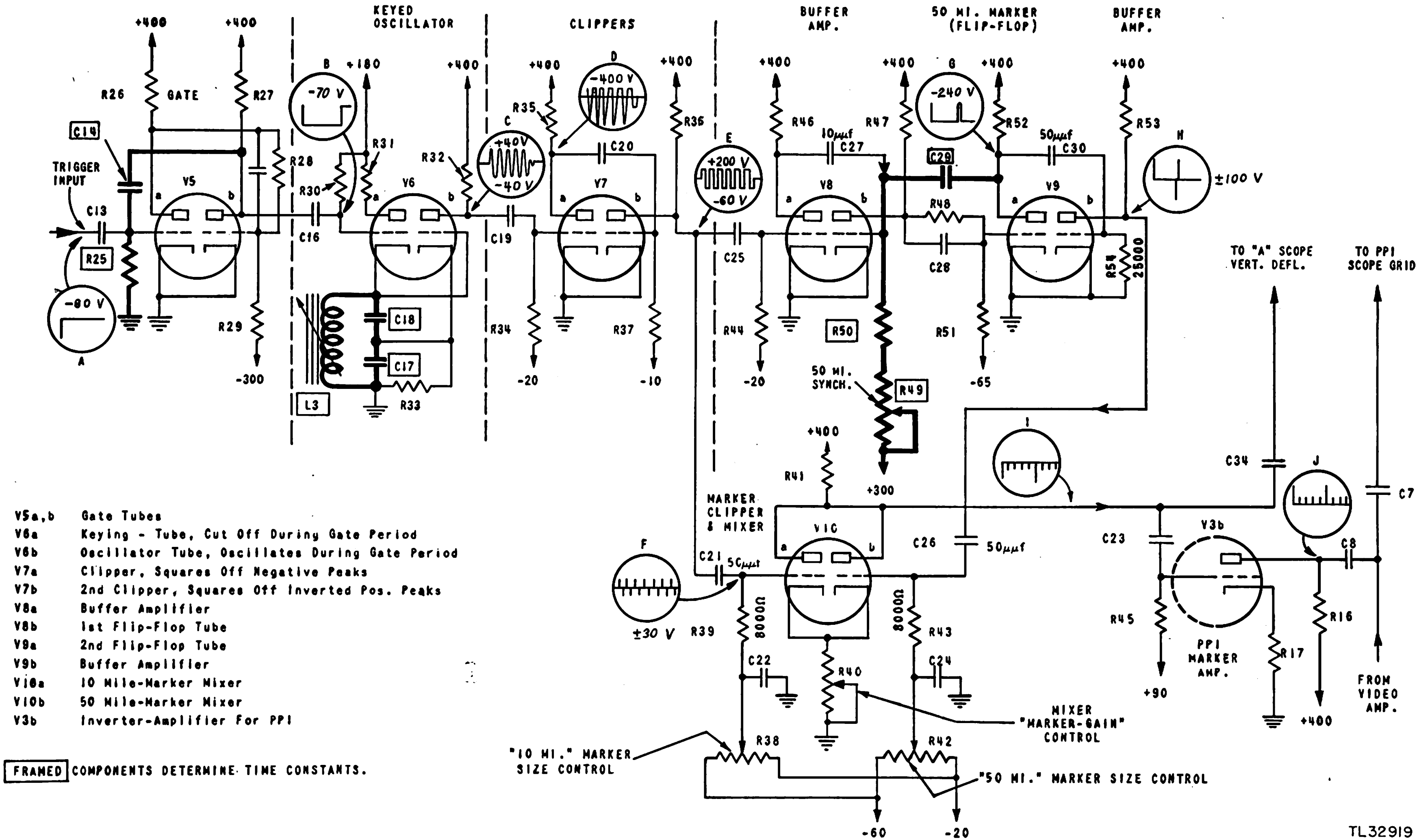


Figure 36. Range markers functional schematic.

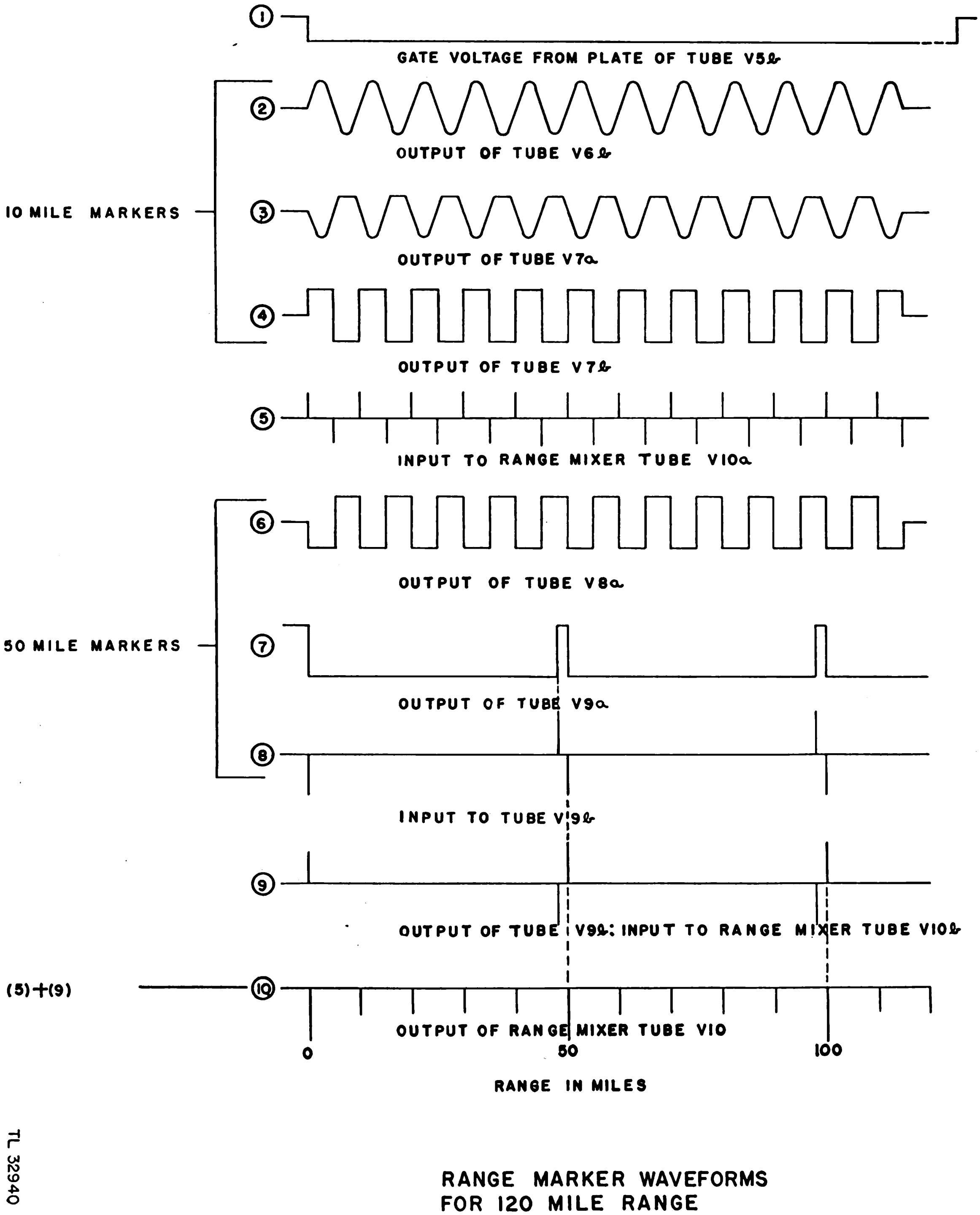
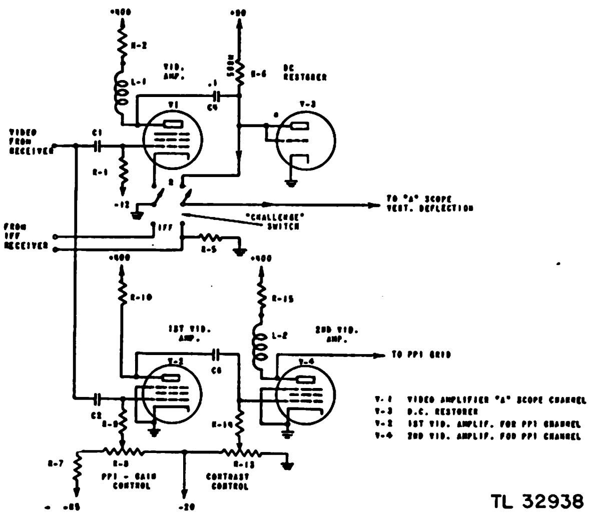


Figure 37. Range markers circuit waveforms.

R1 to —12 volts, so that the output of the stage is a negative video signal. Coil L1 in the plate circuit preserves the band width and thereby maintains the shape of the received pulses. Tube V1 is the last stage in the "A" scope video channel. The negative video signal is fed through capacitor C4, and through the CHALLENGE switch SW-3 directly to the lower vertical deflection plate of the "A" scope. The video signal causes an upward deflection of the electron beam so that all received signals appear above the time base line on the "A" scope screen.



TL 32938

Figure 38. Indicator video functional schematic.

(*b*) *D-C Restorer* (fig. 38). Tube V3A is a d-c restorer for the "A" video signal. This tube is essentially a diode since grid and plate are tied together. The tube is normally conductive because of the positive 90 volts applied to the plate through resistor R6. The application of signals of negative polarity render this shunting diode inoperative so that the signal appears on the deflection plate of the "A" scope. However, any parasitic positive swings will be shunted through the tube and cannot appear on the scope screen. Moreover, the average potential applied to the deflection plate will be constant so that there can be no shifting of the trace line.

b. How Impressed on the PPI Scope. The PPI tube requires more amplification than the "A" scope channel, and furthermore requires pulses of positive polarity since the tube is grid-intensity modulated. (1) RANGE MARKERS. Since the output of the range mixer tube V10 is negative, the 10-mile and 50-mile marker pips are fed to another amplifier stage so that a positive output can be secured. The negative marker pips are fed through capacitor C23 to the grid of tube V3b (fig. 36). The positive peaks, taken from the plate of this PPI marker amplifier are fed through capacitor C8 combined with the output from the video signal, and the combined voltages are fed through capacitor C7 to the grid of the PPI scope. The resultant intensity modulation causes the range marks to appear, while the trace rotating, as concentric circles spaced at 10-mile intervals. The 50-mile circle appears as a brighter trace and range can be read more easily.

(2) INDICATOR VIDEO AMPLIFIER SIGNALS. The positive video signals from the receiver are fed through the multiple plug board to the indicator unit.

(*a*) Since the PPI scope requires amplified signals of positive polarity, the incoming positive signal is fed to two amplifiers in series, V2 and V4 (fig. 38). The first amplifier, tube V2, is provided with a variable bias from the PPI GAIN control, potentiometer R8. The second amplifier, tube V4, also has a variable bias from the PPI CONTRAST control, potentiometer R13. See figure 29.

(*b*) Contrary to the action of the PPI GAIN control which clips off signal pulses smaller than a certain level, the PPI CONTRAST control clips the peaks of the signals amplified by the 1st amplifier stage, and thus eliminates excessive amplitudes from the video channel. This is necessary in order to forestall the blurring of the PPI scope screen upon the arrival of very strong signals. These two controls are visible on the PPI screen while the strongest signals are cut down sufficiently so that they do not blur the screen.

(*c*) The positive signal waveforms are combined with the positive range marker pips at capacitor C7, and are coupled to the grid of the PPI scope. D-c restorer tube V17a prevents parasitic negative surges from being impressed on the grid.

(*d*) The resultant intensity modulation causes the range marks to appear, while the trace is rotating, as concentric circles spaced at 10-mile intervals. Signals will appear spaced at intervals on the scope dependent upon the range and azimuth of the targets which produced the echo signals.

CAPACITOR LIST

REFERENCE SYMBOL	CAPACITY	VOLTAGE	REFERENCE SYMBOL	CAPACITY	VOLTAGE
C1	.05 µf	600 V.	C36	400 µµf	500 V.
C2	.05 µf	600 V.	C37	25 µµf	500 V.
C3	8 µf	600 V.	C38	.05 µf	600 V.
C4	.05 µf	600 V.	C39	.0015 µf	500 V.
C5	8 µf	600 V.	C40	.003 µf	500 V.
C6	.05 µf	600 V.	C41	.006 µf	500 V.
C7	.1 µf	3000 V.	C42	.05 µf	600 V.
C8	.05 µf	600 V.	C43	.05 µf	600 V.
C9	8 µf	600 V.	C44	.1 µf	400 V.
C10	8 µf	600 V.	C45	.01 µf	600 V.
C11	8 µf	600 V.	C46	.01 µf	600 V.
C12	8 µf	600 V.	C47	.01 µf	600 V.
C13	50 µµf	500 V.	C48	.01 µf	600 V.
C14	.005 µf	500 V.	C49	.1 µf	3000 V.
C15	25 µµf	500 V.	C50	.1 µf	400 V.
C16	.01 µf	600 V.	C51	.1 µf	3000 V.
C17	.05 µf	600 V.	C52	50 µµf	500 V.
C18	.01 µf	300 V.	C53	400 µµf	500 V.
C19	.01 µf	600 V.	C54	25 µµf	500 V.
C20	400 µµf	500 V.	C55	.05 µf	600 V.
C21	50 µµf	500 V.	C56	.001 µf	300 V.
C22	.1 µf	400 V.	C57	.003 µf	500 V.
C23	.01 µf	600 V.	C58	.006 µf	500 V.
C24	.1 µf	400 V.	C59	1 µf	600 V.
C25	100 µµf	500 V.	C60	.01 µf	600 V.
C26	50 µµf	500 V.	C61	.01 µf	600 V.
C27	5 µµf	500 V.	C62	.01 µf	600 V.
C28	25 µµf	500 V.	C63	.01 µf	600 V.
C29	200 µµf	500 V.	C64	25 µµf	500 V.
C30	50 µµf	500 V.	C65	.02 µf	600 V.
C31	.1 µf	3000 V.	C66	500 µµf	500 V.
C32	.1 µf	400 V.	C67	.001 µf	300 V.
C33	.1 µf	3000 V.			
C34	.01 µf	600 V.			
C35	50 µµf	500 V.			

RESISTOR LIST

REFERENCE SYMBOL	RESISTANCE	WATTAGE	REFERENCE SYMBOL	RESISTANCE	WATTAGE
R1	220M ohm	1/2 W.	R86	2.4 megohm	1 W.
R2	1500 ohm	1 W.	R87	100M ohm	1 W.
R3	6000 ohm	10 W.	R88	2.4 megohm	1 W.
R4	15M ohm	10 W.	R89	2.4 megohm	1 W.
R5	220M ohm	1/2 W.	R90	1 megohm	1/2 W.
R6	470M ohm	1/2 W.	R91	220M ohm	1/2 W.
R7	10M ohm	1/2 W.	R92	50M ohm	Pot.
R8	10M ohm	Pot.	R93	470M ohm	1/2 W.
R9	220M ohm	1/2 W.	R94	10M ohm	20 W.
R10	820 ohm	1/2 W.	R95	1300 ohm	1/2 W.
R11	6000 ohm	20 W.	R96	1300 ohm	1/2 W.
R12	15M ohm	10 W.	R97	4700 ohm	1/2 W.
R13	1000 ohm	Pot.	R98	10M ohm	Pot.
R14	220M ohm	1/2 W.	R99	1 megohm	1/2 W.
R15	2500 ohm	10 W.	R100	1 megohm	1/2 W.
R16	15M ohm	10 W.	R101	100 ohm	Pot.
R17	1000 ohm	1 W.	R102	51 ohm	1 W.
R18	75 ohm	50 W.	R103	51 ohm	1 W.
R19	20 ohm	10 W.	R104	390 ohm	2 W.
R20	20 ohm	10 W.	R105	390 ohm	2 W.
R21	3000 ohm	10 W.	R106	100 ohm	Pot.
R22	3000 ohm	10 W.	R107	50 ohm	10 W.
R23	3000 ohm	10 W.	R108	470M ohm	1/2 W.
R24	500 ohm	50 W.	R109	470M ohm	1/2 W.
R25	130M ohm	1/2 W.	R110	120M ohm	1/2 W.
R26	20M ohm	10 W.	R111	100M ohm	Pot.
R27	20M ohm	10 W.	R112	100M ohm	1/2 W.
R28	2.2 megonm	1/2 W.	R113	390M ohm	1 W.
R29	2.2 megohm	1/2 W.	R114	470M ohm	1 W.
R30	4.7 megohm	1/2 W.	R115	470M ohm	1 W.
R31	10M ohm	2 W.	R116	390M ohm	1 W.
R32	22M ohm	1 W.	R117	.25M ohm	Pot.
R33	2200 ohm	1/2 W.	R118	150M ohm	1/2 W.
R34	22M ohm	1/2 W.	R119	470M ohm	1/2 W.
R35	27M ohm	2 W.	R120	1 megohm	1/2 W.
R36	15M ohm	2 W.	R121	2.2 megohm	1/2 W.
R37	330M ohm	1/2 W.	R122	2.2 megohm	1/2 W.
R38	10M ohm	Pot.	R123	20M ohm	10 W.
R39	8200 ohm	1/2 W.	R124	10M ohm	2 W.
R40	10M ohm	Pot.	R125	10M ohm	2 W.
R41	470 ohm	1 W.	R126	470M ohm	1/2 W.
R42	10M ohm	Pot.	R127	68M ohm	1/2 W.
R43	8200 ohm	1/2 W.	R128	470M ohm	1/2 W.
R44	100M ohm	1/2 W.	R129	IMEG. ohm	Pot.
R45	1 megohm	1/2 W.	R130	470M ohm	1/2 W.
R46	27M ohm	1/2 W.	R131	IMEG. ohm	Pot.
R47	20M ohm	10 W.	R132	47M ohm	1/2 W.
R48	160M ohm	1/2 W.	R133	470M ohm	1/2 W.
R49	5 megohm	Pot.	R134	IMEG. ohm	Pot.
R50	1 megohm	1/2 W.	R135	150 ohm	1 W.
R51	39M ohm	1/2 W.	R136	4700 ohm	1/2 W.
R52	15M ohm	10 W.	R137	1000 ohm	1/2 W.
R53	25M ohm	10 W.	R138	1000 ohm	1/2 W.
R54	22M ohm	1/2 W.	R139	1 megohm	1/2 W.
R55	27M ohm	1/2 W.	R140	1 megohm	1/2 W.
R56	1 megohm	1/2 W.	R141	390 ohm	2 W.
R57	120M ohm	1/2 W.	R142	390 ohm	2 W.
R58	100M ohm	Pot.	R143	22M ohm	1/2 W.
R59	150M ohm	1/2 W.	R144	22M ohm	1/2 W.
R60	500M ohm	Pot.	R145	22M ohm	1/2 W.
R61	150M ohm	1/2 W.	R146	10 ohm	Pot.
R62	470M ohm	1 W.	R147	25M ohm	Pot.
R63	560M ohm	1 W.	R148	20 ohm	10 W.
R64	100M ohm	1/2 W.	R149	470M ohm	1 W.
R65	150M ohm	1/2 W.	R150	100M ohm	Pot.
R66	470M ohm	1/2 W.	R151	250M ohm	Pot.
R67	1 megohm	1/2 W.	R152	500M ohm	Pot.
R68	20M ohm	10 W.	R153	100M ohm	Pot.
R69	10M ohm	2 W.	R154	250M ohm	Pot.
R70	10M ohm	2 W.	R155	500M ohm	Pot.
R71	2.2 megohm	1/2 W.	R156	150 ohm	1/2 W.
R72	2.2 megohm	1/2 W.	R157	150 ohm	1/2 W.
R73	470M ohm	1/2 W.	R158	500 ohm	20 W.
R74	220M ohm	1/2 W.	R159	470M ohm	1/2 W.
R75	IMEG. ohm	Pot.	R160	2 ohm	25 W.
R76	470M ohm	1/2 W.			
R77	IMEG. ohm	Pot.	R162	100M ohm	1 W.
R78	470M ohm	1/2 W.			
R79	IMEG. ohm	Pot.			
R80	2000 ohm	10 W.			
R81	10M ohm	20 W.			
R82	33M ohm	1/2 W.			
R83	56M ohm	1/2 W.			
R84	1 megohm	1/2 W.			
R85	2.4 megohm	1 W.			

TUBE LIST

V1	JAN. 6AG7	V18	JAN. 6H6GT
V2	JAN. 6AG7	V19	JAN. 6SN7GT
V3	JAN. 6SN7GT	V20	JAN. 6V6GT
V4	JAN. 6AG7	V21	JAN. 6SN7GT
V5	JAN. 6SN7GT	V22	JAN. 6V6G7
V6	JAN. 6SN7GT	V23	JAN. 6SN7GT
V7	JAN. 6SN7GT	V24	JAN. 6V6GT
V8	JAN. 6SN7GT	V25	JAN. 6SN7GT
V9	JAN. 6SN7GT	V26	JAN. 6V6GT
V10	JAN. 6SN7GT	V27	JAN. 5CP1
V11	JAN. 6SN7GT	V28	JAN. 7BP7
V12	JAN. 6SN7GT		
V13	JAN. 6SN7GT		
V14	JAN. 6V6GT		
V15	JAN. 6V6GT		
V16	JAN. 6V6GT		
V17	JAN. 6H6GT		

SWITCH LIST

SW1	3 POS. ROTARY SW.
SW2	3 POS. ROTARY SW.
SW3	2 POS. SPRING RETURN ROTARY SW.
SW5	DUAL S.P.D.T. } SPRING RETURN TO INDICATED POSITION
SW6	DUAL S.P.D.T. } SPRING RETURN TO INDICATED POSITION
SW7	4 POLE D.T.
SW8	SINGLE CIRCUIT(NORMALLY OPEN) SW.
SW9	SINGLE CIRCUIT(NORMALLY CLOSED) SW.

PILOT LIGHTS

PL1	PANEL LIGHT 6-8V .15 AMP.
PL2	PANEL LIGHT 6-8V .15 AMP.
PL3	LOBE SW. LIGHT 6-8V .15 AMP.
PL4	FLUORESCENT DIAL LIGHT 115V 6W

PLUGS

P1A	INDICATOR TO CONSOLE(MALE)
P1B	INDICATOR TO CONSOLE(MALE)
P1C	INDICATOR TO CONSOLE(MALE)

COILS

L1	R.F. PLATE CHOKE
L2	R.F. PLATE CHOKE
L3	OSCILLATOR

CHOKE

CH1	PLATE

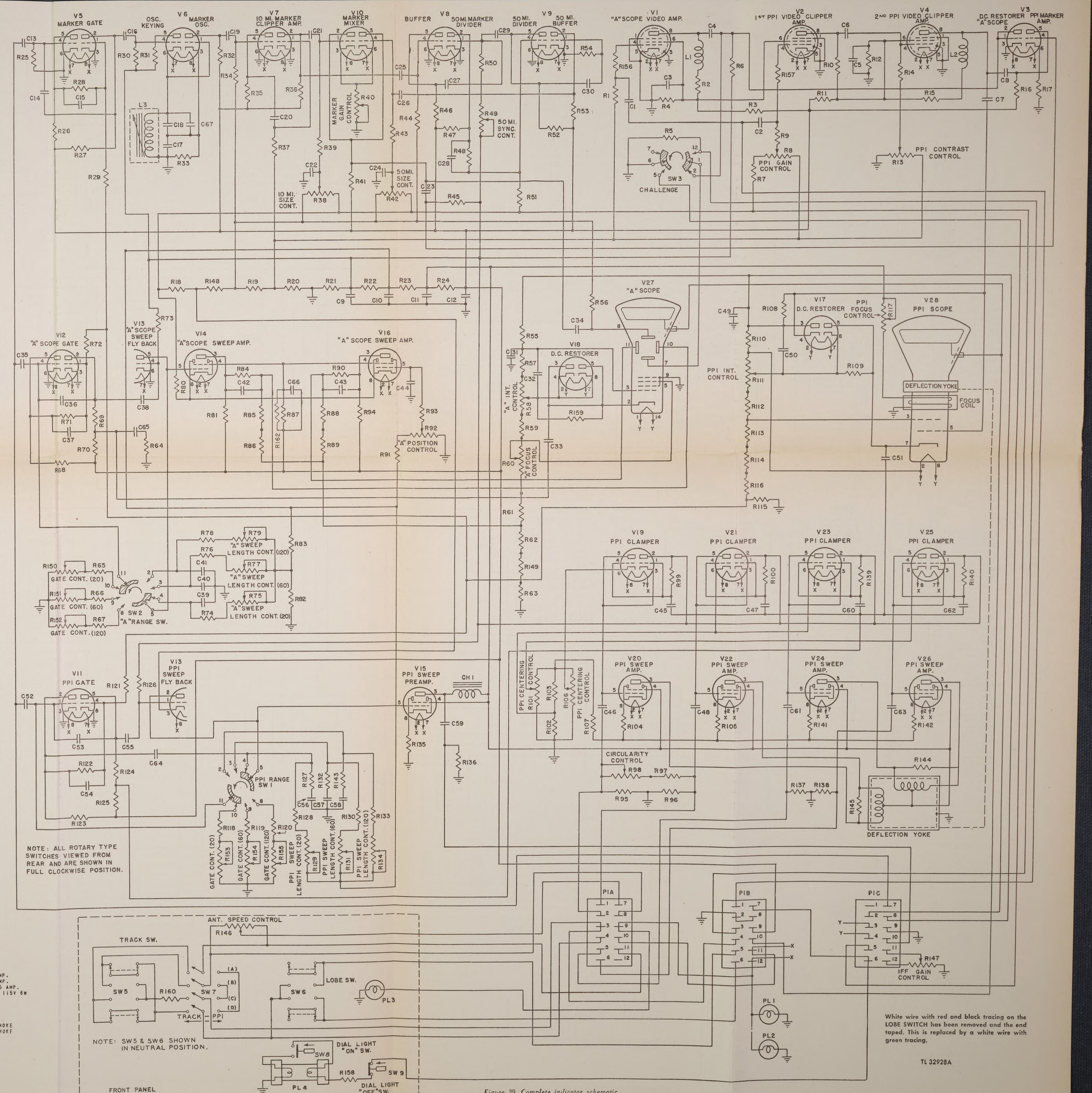


Figure 39. Complete indicator schematic.

CAPACITOR LIST

REFERENCE SYMBOL	CAPACITY	VOLTAGE	REFERENCE SYMBOL	CAPACITY	VOLTAGE
C1	.05 µf	600 V.	C36	400 µµf	500 V.
C2	.05 µf	600 V.	C37	25 µµf	500 V.
C3	8 µf	600 V.	C38	.05 µf	600 V.
C4	.05 µf	600 V.	C39	.0015 µf	500 V.
C5	8 µf	600 V.	C40	.003 µf	500 V.
C6	.05 µf	600 V.	C41	.006 µf	500 V.
C7	.1 µf	3000 V.	C42	.05 µf	600 V.
C8	.05 µf	600 V.	C43	.05 µf	600 V.
C9	8 µf	600 V.	C44	.1 µf	400 V.
C10	8 µf	600 V.	C45	.01 µf	600 V.
C11	8 µf	600 V.	C46	.01 µf	600 V.
C12	8 µf	600 V.	C47	.01 µf	600 V.
C13	50 µµf	500 V.	C48	.01 µf	600 V.
C14	.005 µf	500 V.	C49	.1 µf	3000 V.
C15	25 µµf	500 V.	C50	.1 µf	400 V.
C16	.01 µf	600 V.	C51	.1 µf	3000 V.
C17	.05 µf	600 V.	C52	50 µµf	500 V.
C18	.01 µf	300 V.	C53	400 µµf	500 V.
C19	.01 µf	600 V.	C54	25 µµf	500 V.
C20	400 µµf	500 V.	C55	.05 µf	600 V.
C21	50 µµf	500 V.	C56	.001 µf	300 V.
C22	.1 µf	400 V.	C57	.003 µf	500 V.
C23	.01 µf	600 V.	C58	.006 µf	500 V.
C24	.1 µf	400 V.	C59	1 µf	600 V.
C25	100 µµf	500 V.	C60	.01 µf	600 V.
C26	50 µµf	500 V.	C61	.01 µf	600 V.
C27	5 µµf	500 V.	C62	.01 µf	600 V.
C28	25 µµf	500 V.	C63	.01 µf	600 V.
C29	200 µµf	500 V.	C64	25 µµf	500 V.
C30	50 µµf	500 V.	C65	.02 µf	600 V.
C31	.1 µf	3000 V.	C66	500 µµf	500 V.
C32	.1 µf	400 V.	C67	.001 µf	300 V.
C33	.1 µf	3000 V.			
C34	.01 µf	600 V.			
C35	50 µµf	500 V.			

RESISTOR LIST

REFERENCE SYMBOL	RESISTANCE	WATTAGE	REFERENCE SYMBOL	RESISTANCE	WATTAGE
R1	220M ohm	1/2 W.	R86	2.4 megohm	1 W.
R2	1500 ohm	1 W.	R87	100M ohm	1 W.
R3	6000 ohm	10 W.	R88	2.4 megohm	1 W.
R4	15M ohm	10 W.	R89	2.4 megohm	1 W.
R5	220M ohm	1/2 W.	R90	1 megohm	1/2 W.
R6	470M ohm	1/2 W.	R91	220M ohm	1/2 W.
R7	10M ohm	1/2 W.	R92	50M ohm	Pot.
R8	10M ohm	Pot.	R93	470M ohm	1/2 W.
R9	220M ohm	1/2 W.	R94	10M ohm	20 W.
R10	820 ohm	1/2 W.	R95	1300 ohm	1/2 W.
R11	6000 ohm	20 W.	R96	1300 ohm	1/2 W.
R12	15M ohm	10 W.	R97	4700 ohm	1/2 W.
R13	1000 ohm	Pot.	R98	10M ohm	Pot.
R14	220M ohm	1/2 W.	R99	1 megohm	1/2 W.
R15	2500 ohm	10 W.	R100	1 megohm	1/2 W.
R16	15M ohm	10 W.	R101	100 ohm	Pot.
R17	1000 ohm	1 W.	R102	51 ohm	1 W.
R18	75 ohm	50 W.	R103	51 ohm	1 W.
R19	20 ohm	10 W.	R104	390 ohm	2 W.
R20	20 ohm	10 W.	R105	390 ohm	2 W.
R21	3000 ohm	10 W.	R106	100 ohm	Pot.
R22	3000 ohm	10 W.	R107	50 ohm	10 W.
R23	3000 ohm	10 W.	R108	470M ohm	1/2 W.
R24	500 ohm	50 W.	R109	470M ohm	1/2 W.
R25	130M ohm	1/2 W.	R110	120M ohm	1/2 W.
R26	20M ohm	10 W.	R111	100M ohm	Pot.
R27	20M ohm	10 W.	R112	100M ohm	1/2 W.
R28	2.2 megohm	1/2 W.	R113	390M ohm	1 W.
R29	2.2 megohm	1/2 W.	R114	470M ohm	1 W.
R30	4.7 megohm	1/2 W.	R115	470M ohm	1 W.
R31	10M ohm	2 W.	R116	390M ohm	1 W.
R32	22M ohm	1 W.	R117	25M ohm	Pot.
R33	2200 ohm	1/2 W.	R118	150M ohm	1/2 W.
R34	22M ohm	1/2 W.	R119	470M ohm	1/2 W.
R35	27M ohm	2 W.	R120	1 megohm	1/2 W.
R36	15M ohm	2 W.	R121	2.2 megohm	1/2 W.
R37	330M ohm	1/2 W.	R122	2.2 megohm	1/2 W.
R38	10M ohm	Pot.	R123	20M ohm	10 W.
R39	8200 ohm	1/2 W.	R124	10M ohm	2 W.
R40	10M ohm	Pot.	R125	10M ohm	2 W.
R41	470 ohm	1 W.	R126	470M ohm	1/2 W.
R42	10M ohm	Pot.	R127	68M ohm	1/2 W.
R43	8200 ohm	1/2 W.	R128	470M ohm	1/2 W.
R44	100M ohm	1/2 W.	R129	IMEG. ohm	Pot.
R45	1 megohm	1/2 W.	R130	470M ohm	1/2 W.
R46	27M ohm	1/2 W.	R131	IMEG. ohm	Pot.
R47	20M ohm	10 W.	R132	47M ohm	1/2 W.
R48	160M ohm	1/2 W.	R133	470M ohm	1/2 W.
R49	5 megohm	Pot.	R134	IMEG. ohm	Pot.
R50	1 megohm	1/2 W.	R135	150 ohm	1 W.
R51	39M ohm	1/2 W.	R136	4700 ohm	1/2 W.
R52	15M ohm	10 W.	R137	1000 ohm	1/2 W.
R53	25M ohm	10 W.	R138	1000 ohm	1/2 W.
R54	22M ohm	1/2 W.	R139	1 megohm	1/2 W.
R55	27M ohm	1/2 W.	R140	1 megohm	1/2 W.
R56	1 megohm	1/2 W.	R141	390 ohm	2 W.
R57	120M ohm	1/2 W.	R142	390 ohm	2 W.
R58	100M ohm	Pot.	R143	22M ohm	1/2 W.
R59	150M ohm	1/2 W.	R144	22M ohm	1/2 W.
R60	500M ohm	Pot.	R145	22M ohm	1/2 W.
R61	150M ohm	1/2 W.	R146	10 ohm	Pot.
R62	470M ohm	1 W.	R147	25M ohm	Pot.
R63	560M ohm	1 W.	R148	20 ohm	10 W.
R64	100M ohm	1/2 W.	R149	470M ohm	1 W.
R65	150M ohm	1/2 W.	R150	100M ohm	Pot.
R66	470M ohm	1/2 W.	R151	250M ohm	Pot.
R67	1 megohm	1/2 W.	R152	500M ohm	Pot.
R68	20M ohm	10 W.	R153	100M ohm	Pot.
R69	10M ohm	2 W.	R154	250M ohm	Pot.
R70	10M ohm	2 W.	R155	500M ohm	Pot.
R71	2.2 megohm	1/2 W.	R156	150 ohm	[illegible]
R72	2.2 megohm	1/2 W.	R157	150 ohm	[illegible]
R73	470M ohm	1/2 W.	R158	500 ohm	[illegible]
R74	220M ohm	1/2 W.	R159	470M ohm	[illegible]
R75	IMEG. ohm	Pot.	R160	2 ohm	[illegible]
R76	470M ohm	1/2 W.			
R77	IMEG. ohm	Pot.	R162	100M ohm	1 W.
R78	470M ohm	1/2 W.			
R79	IMEG. ohm	Pot.			
R80	2000 ohm	10 W.			
R81	10M ohm	20 W.			
R82	33M ohm	1/2 W.			
R83	56M ohm	1/2 W.			
R84	1 megohm	1/2 W.			
R85	2.4 megohm	1 W.			

TUBE LIST

V1	JAN. 6AG7	V18	JAN. 6H6GT
V2	JAN. 6AG7	V19	JAN. 6SN7GT
V3	JAN. 6SN7GT	V20	JAN. 6V6GT
V4	JAN. 6AG7	V21	JAN. 6SN7GT
V5	JAN. 6SN7GT	V22	JAN. 6V6G7
V6	JAN. 6SN7GT	V23	JAN. 6SN7GT
V7	JAN. 6SN7GT	V24	JAN. 6V6GT
V8	JAN. 6SN7GT	V25	JAN. 6SN7GT
V9	JAN. 6SN7GT	V26	JAN. 6V6GT
V10	JAN. 6SN7GT	V27	JAN. 5CP1
V11	JAN. 6SN7GT	V28	JAN. 7BP7
V12	JAN. 6SN7GT		
V13	JAN. 6SN7GT		
V14	JAN. 6V6GT		
V15	JAN. 6V6GT		
V16	JAN. 6V6GT		
V17	JAN. 6H6GT		

SWITCH LIST

SW1	3 POS. ROTARY SW.
SW2	3 POS. ROTARY SW.
SW3	2 POS. SPRING RETURN ROTARY SW.
SW5	DUAL S.P.D.T. } SPRING RETURN TO INDICATED POSITION
SW6	DUAL S.P.D.T. } SPRING RETURN TO INDICATED POSITION
SW7	4 POLE D.T.
SW8	SINGLE CIRCUIT(NORMALLY OPEN) SW.
SW9	SINGLE CIRCUIT(NORMALLY CLOSED) SW.

PILOT LIGHTS

PL1	PANEL LIGHT 6-8V .15 AMP.
PL2	PANEL LIGHT 6-8V .15 AMP.
PL3	LOBE SW. LIGHT 6-8V .15 AMP.
PL4	FLUORESCENT DIAL LIGHT 115V 6W

COILS

L1	R.F. PLATE CHOKE
L2	R.F. PLATE CHOKE
L3	OSCILLATOR

PLUGS

P1A	INDICATOR TO CONSOLE(MALE)
P1B	INDICATOR TO CONSOLE(MALE)
P1C	INDICATOR TO CONSOLE(MALE)

CHOKE

CH1	PLATE

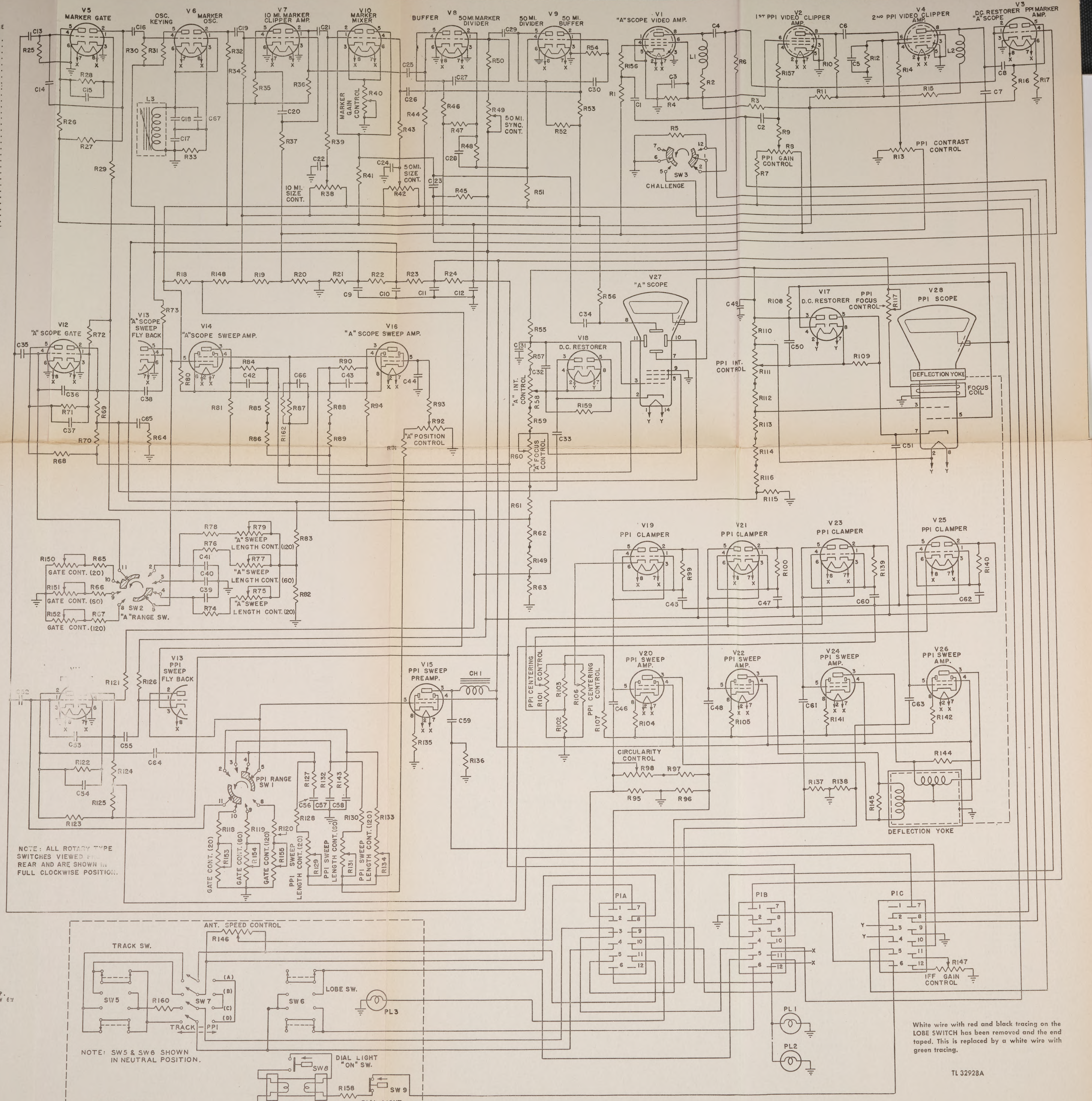


Figure 39. Complete indicator schematic.

CHAPTER 2
GENERAL TROUBLE SHOOTING

SECTION I

VOLTAGE MEASUREMENTS

27. INTRODUCTION. The measurement of voltage is one of the basic tests to locate defects in radar equipment. After a defect has been isolated to a single stage of the equipment, voltage and resist-

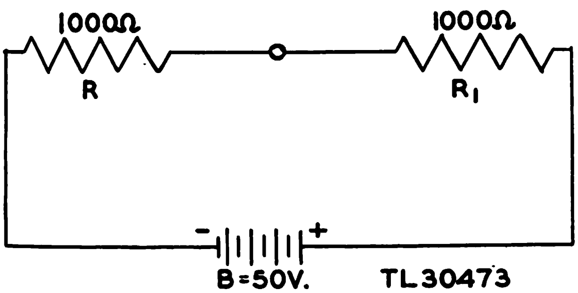


Figure 40. Voltage measurements functional schematic.

ance measurements are used to locate the defective part. In some cases, voltage measurements are best suited to the conditions; in other cases, resistance measurements are more practical. In most cases both types of measurements can be used. This section of the manual explains the fundamentals of voltage measurement and describes their practical applications for locating defective parts or conditions.

28. GENERAL CONSIDERATIONS. The section on resistance measurements states that parts in an electrical system are always connected in either a series circuit, a parallel circuit, or a series-parallel circuit. Through such circuits current flows whenever a voltage is applied. This voltage is known as the voltage source or the applied voltage. It may be obtained in many ways: from batteries, generators, power supplies (rectifiers), etc. In addition, the voltage source may be either direct current or alternating current.

29. D-C VOLTAGE DISTRIBUTION IN SERIES CIRCUITS.

a. Voltage Distribution. (1) Figure 40 illustrates an applied voltage (battery) of 50 volts connected in a series circuit with two resistors of 1,000 ohms each, making the total resistance 2,000 ohms. As calculated by Ohm's Law, the amperage equals 0.025:

$$I = \frac{E}{R} = \frac{50}{2000} = \frac{1}{40} = 0.025 \text{ amperes}$$

A current of 0.025 amperes flows through each part of this circuit, because there is only one path of current flow in a series circuit.

(2) A voltage drop across resistor R, and using Ohm's Law again, the voltage equals 25 volts:

$$E = I \times R = 25 \text{ volts.}$$

The voltage across resistor R1 must also be 25 volts, because both resistors have a value of 1,000 ohms. The total of the voltage drops across R and R1 is equal to 50 volts, the applied voltage. *The sum of the individual IR (voltage) drops in a series circuit is equal to the applied voltage.* This law holds true regardless of the number of the resistances in the circuit or the ohmic value of these resistances. (A resistance need not be a resistor. A resistance may be a transformer winding, a choke oil, or any other part possessing a value of d-c resistance.)

(3) Figure 41 shows another example of voltage drops in a series circuit. The total resistance in this circuit is:

$$2{,}000 + 3{,}000 + 1{,}000 + 44{,}000 = 50{,}000 \text{ ohms.}$$

The applied voltage is 100 volts, and the current in

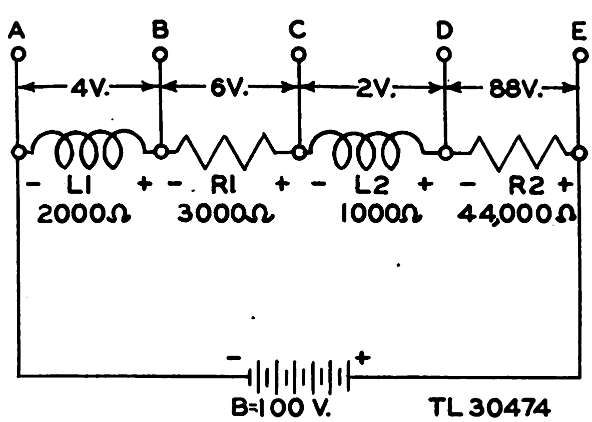


Figure 41. Voltage measurements functional schematic.

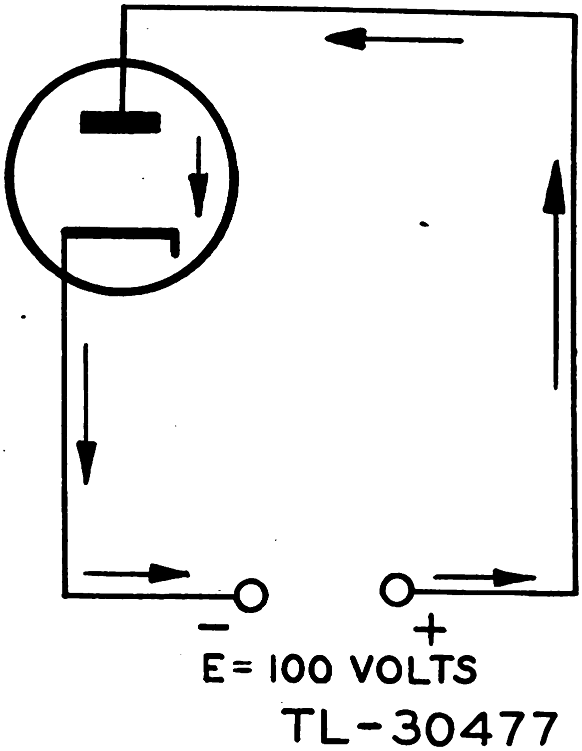


Figure 42. Voltage measurements functional schematic.

the circuit as computed by Ohm's Law, equals 0.002 amperes:

$$I = \frac{E}{R} = \frac{100}{50{,}000} = 0.002 \text{ amperes.}$$

(*a*) The voltage drop across L1 is:
$E = I \times R = 0.002 \times 2{,}000 = 4$ volts.

(*b*) The voltage drop across R1 is:
$E = I \times R = 0.002 \times 3{,}000 = 6$ volts.

(*c*) The voltage drop across L2 is:
$E = I \times R = 0.002 \times 1{,}000 = 2$ volts.

(*d*) The voltage drop across R2 is:
$E = I \times R = 0.002 \times 44{,}000 = 88$ volts.

(*e*) The sum of these individual voltages is:
$4+6+2+88 = 100$ volts, which is equal to the applied voltage.

b. Difference of Potential. (1) It has been shown that voltage drops take place across the resistances in a circuit. This means that different points in the circuit have higher or lower potentials *with respect to other points in the circuit.* This condition is called *difference of potential.*

Figure 41 shows the battery labeled plus (+) and minus (—), or positive (+) and negative (—). Using point A as a reference point, the voltage between:

A and B = 4 volts
A and C = 10 volts (4+6)
A and D = 12 volts (4+6+2)
A and E = 100 volts (4+6+2+88)
B and C = 6 volts
B and D = 8 volts (6+2)
B and E = 95 volts (6+2+88)
C and D = 2 volts
C and E = 90 volts (2+88)
D and E = 88 volts

(2) These voltages show the voltage drops between the various points in this circuit. The potential of any point with respect to any other point in the circuit is determined by the voltage drop between two points. Whether the point is negative or positive with respect to any other point is determined by the relative positions of the two points in relation to the course of the applied voltage. As the circuit is followed around from the positive side of the applied voltage to the negative side of the applied voltage, the point which is nearer the positive side will be at the higher potential and will be positive with respect to points beyond it. For example:

Point A is negative with respect to any other point.

Point E is positive with respect to any other point.

Point B is negative with respect to points D, C, and E and positive with respect to point A.

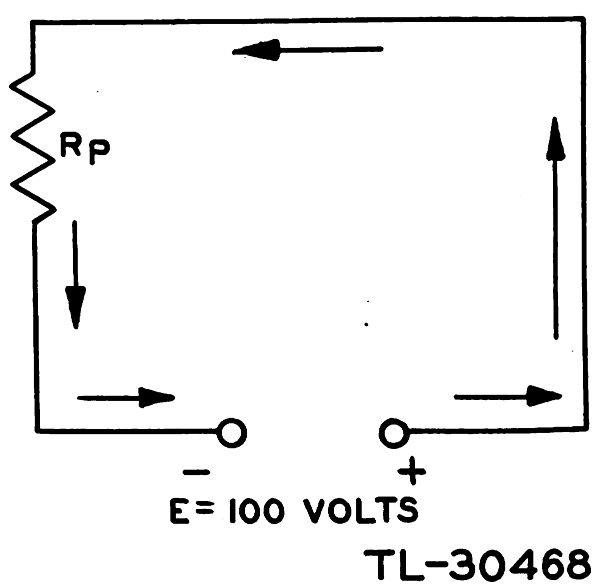


Figure 43. Voltage measurements functional schematic.

Point C is negative with respect to points D and E and positive with respect to points A and B.

Point D is negative with respect to point E and positive with respect to points A, B, and C.

The above material is given to show the voltage relationships of different points in a direct current circuit.

c. Plate Circuit. (1) Current flow through the cathode-plate circuit of a diode vacuum tube is shown in figure 42. Although the cathode and plate elements inside the tube are not mechanically joined, current does flow between these elements when the plate has a higher potential than the cathode. In addition, this current flow causes a voltage drop inside the tube as a resistance (d-c plate resistance of the tube) exists between these elements. This circuit can be represented as shown in figure 43, with the resistance Rp symbolizing the resistance between the plate and cathode of the tube.

(2) Another illustration of a plate-cathode circuit series connection is shown in figure 44, and is the same as figure 42 with the addition of resistor RL. Representing the plate-cathode resistance of the tube as Rp and giving values of 25,000 ohms and 100,000 ohms to the resistances, as shown in figure 45, the voltage drops in this circuit can be determined. The total resistance is 125,000 ohms and the applied voltage is 100 volts. Therefore,

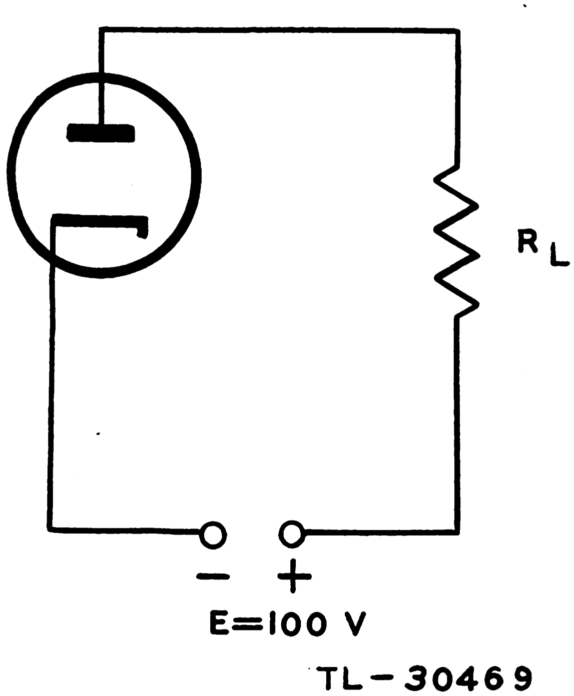


Figure 44. Voltage measurements functional schematic.

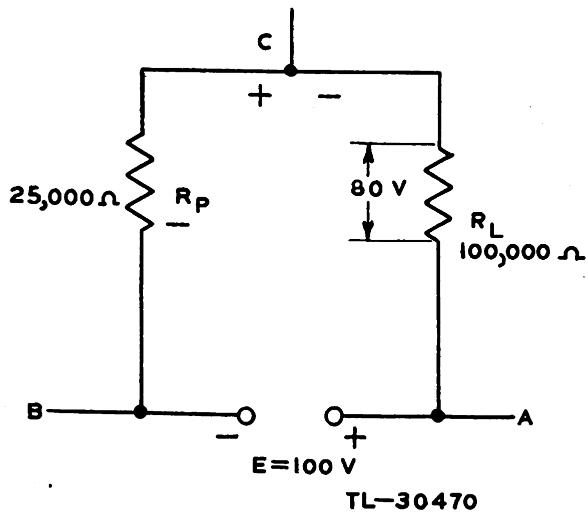


Figure 45. Voltage measurements functional schematic.

$$I = \frac{E}{R} = \frac{100}{125{,}000} = 0.0008 \text{ amperes.}$$

The voltage drop across RL is

$E = I \times R = 0.0008 \times 100{,}000 = 80$ volts.

The voltage drop across Rp is

$E = I \times R = 0.0008 \times 25{,}000 = 20$ volts.

The total of the voltage drops is $80+20 = 100$ volts, which is equal to the applied voltage.

Considering the points A, B, and C, point A is the most positive point and point B the most negative point.

Point A is positive in respect to any other point.

Point B is negative in respect to any other point.

Point C is negative in respect to point A and is positive in respect to point B.

(3) Figure 46 shows another illustration of a plate-cathode circuit (series circuit). The total resistance is 200,000 ohms, and the applied voltage is 250 volts. The current through this circuit is 0.00125 amperes. This circuit can be solved for voltage drops by the same procedure as was used in the previous examples, with only the number and values of the resistance differing.

d. Bias Circuits. (1) The normal operation of the most vacuum tube circuits requires the application of a steady d-c voltage of proper value on the grid element of the tube. This voltage is called a bias voltage, or grid bias voltage, and is always considered in

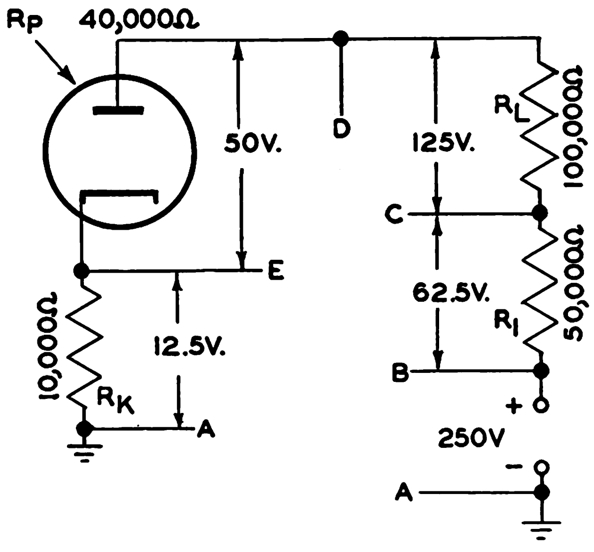


Figure 46. Voltage measurements functional schematic.

reference to the voltage on the cathode element of the tube. For example: If the potential on the cathode is zero volts, and the potential on the grid is minus 3 volts, the grid is said to have a negative bias of 3 volts. Or, if the cathode potential is positive 10 volts and the grid potential is zero, the grid is said to have a negative potential of 10 volts. This is true because the grid is 10 volts *less* positive or 10 volts *more* than the cathode, or reference point.

(2) Bias voltages are of three general types: cathode bias, fixed bias, and grid-leak bias.

(*a*) *Cathode Bias.* This type of bias voltage utilizes the voltage drop across a cathode resistor placed in the plate-cathode circuit of a vacuum tube stage. This voltage drop develops a positive potential on the cathode of the tube. Since no potential is applied to the grid, there exists a difference of potential between the grid and cathode elements. This is the bias voltage. The diagram in figure 47 is similar to those previously shown with the addition of a grid element in the tube and a resistor Rg. The plate-cathode series circuit causes a voltage to drop 10 volts across cathode resistor Rk. The ground or chassis is connected to the most negative point (the minus side of the applied voltage) and causes the cathode to be 10 volts positive, in reference to the chassis ground. In the diagram, resistor Rg has a zero voltage drop across it, a condition which exists when no current flows through the resistor Rg. This is normal in a Class A amplifier and means that the grid can be considered at the same potential as the chassis ground, in other words 10 volts more negative than the cathode. The cathode bias has thus placed the grid at 10 volts negative. In reference to the cathode, this relation is the only one considered in determining grid bias voltage. Another method of obtaining a potential on the cathode of a vacuum tube is by the use of a voltage divider connected in the plate-cathode circuit. Figure 48 illustrates such a circuit. In this circuit, the current through the plate-cathode circuit causes a current to flow through resistor RL in the same manner as previously described. In addition, a current also flows through the series resistances R1, R2, and R3, which are connected across the applied voltage of 250 volts. The sum of these currents flowing through resistor Rl causes a voltage drop across resistor R1. This voltage drop determines the potential on the cathode of Vl, and this potential results in a bias voltage on the grid with respect to the cathode, similar to the previous example.

(*b*) *Fixed Bias.* Bias voltage may be applied to the grid element of a tube by the application of an external voltage. Figure 49 illustrates a circuit showing the cathode connected to the chassis and the minus side of the applied or plate voltage. A battery of 4½ volts (commonly called a C bat-

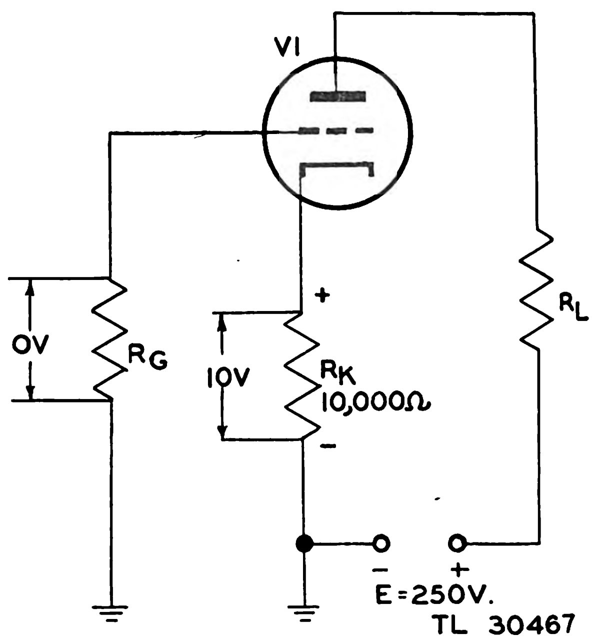


Figure 47. Voltage measurements functional schematic.

tery) is shown connected in series with resistor Rg between the grid of Vl and the chassis. When no current flows through resistor Rg, there is no voltage drop across Rg, and the grid may be regarded as of the same potential as the minus side of the battery. This makes the grid potential 4½ volts negative in reference to the cathode of V1 or the chassis. An actual bias circuit usually places the battery with a low voltage rectifier supply.

(*c*) *Grid Bias.* In the previous examples, it was stated that the voltage drop across a grid resistor is zero when no current flows through this resistor. In some instances, as in Class C amplifiers, current is caused to flow through the grid resistor. Figure 50 shows a circuit which utilizes such a current flow, which is called grid current. In this circuit, the cathode is connected to the chassis and is at the same potential as the chassis. Current inside the tube will flow between the cathode and the grid, providing the grid has a positive potential in respect to the cathode. A high a-c voltage is shown being introduced on the grid of V1. This a-c voltage is positive, and at other times will be negative. When the a-c voltage is positive, the grid becomes positive and current flows between the cathode and grid V1. When the a-c voltage is negative, no current flows. This action is somewhat similar to the flow of plate-cathode current. The resistor Rg completes the circuit for the grid current, and a voltage drop caused by the flow of grid-cathode current takes place across Rg. The current through Rg is pulsating direct current because of the rectifying action between the

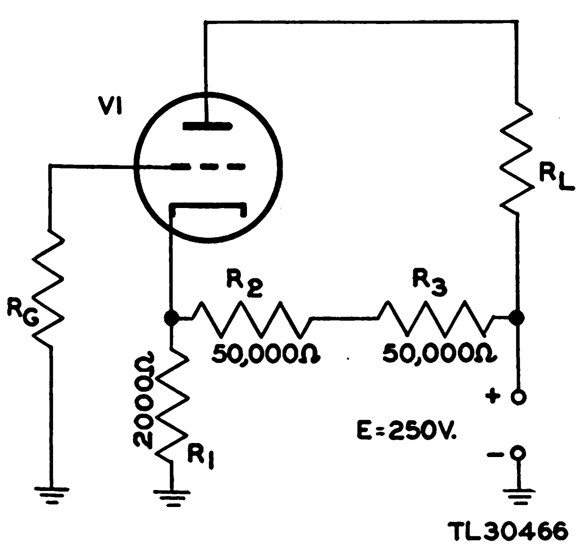


Figure 48. Voltage measurements functional schematic.

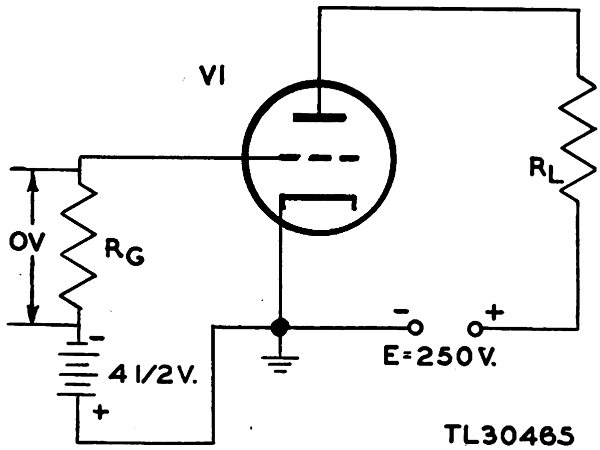


Figure 49. Voltage measurements functional schematic.

grid and cathode of V1. The direction of this current flow is such that the grid becomes negative in reference to the chassis, and in reference to the cathode. This difference of potential places negative bias voltage on the grid of the tube.

d. Screen Grid Voltages. Figure 51 illustrates a circuit showing the application of a screen grid circuit. Current flows between the screen and cathode elements inside V1 when the potential on the screen is more positive than the potential on the cathode. This screen circuit is a simple series circuit comprising the resistor Rk, the resistance between the cathode and screen of V1, and the resistors Rs and R1. The applied voltage is 250 volts. Voltage drops will appear around this circuit in the same manner as around a plate-cathode circuit. The chief difference will be that the current through any screen-cathode circuit is much smaller than the current through a plate-cathode circuit.

e. Suppressor Grid Voltages. Suppressor grids, which are placed inside a vacuum tube between the screen grid and the plate, are usually connected to the cathode or to the chassis. In a few cases, a positive potential from an applied voltage is placed on the suppressor grid. Here, too, when the suppressor grid is made positive in reference to the cathode, a current flows between the suppressor grid and the cathode.

30. D-C VOLTAGE DISTRIBUTION IN PARALLEL AND SERIES-PARALLEL CIRCUITS.

a. General. Parallel connection of resistances affects the resistance measurement. This was explained

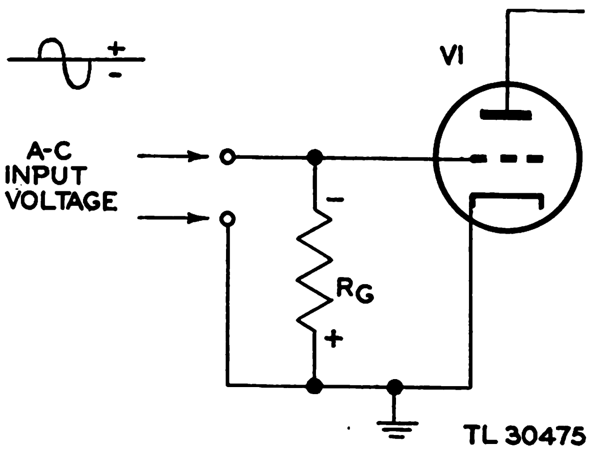


Figure 50. Voltage measurements functional schematic.

in the section on resistance measurements. It was shown that two or more resistances, when connected in parallel, are treated as a single resistance equal to the combined value of the units. This combined value was found to be lower in resistance value than the resistance of the smallest unit. The voltage drop across a parallel combination, therefore, will be determined by Ohm's Law where the voltage equals the current multiplied by the resistance. The resistance will be the combined resistance of the parallel combination and *not* the resistance of any individual branch. Series-parallel connections are treated in the same manner as series resistances when each parallel connection is considered as a single resistance. The single resistance will be the resultant combined value of the units in parallel. Figure 52 shows a series-parallel circuit.

b. Method of Finding Applied Voltage. The plate-cathode circuit is comprised of the resistors and R1 and Rp (plate resistance of the tube), the parallel resistors R2 and R3, and the resistor R4. The applied voltage is 250 volts. Solving first for the combined resistance value of R2 and R3,

$$R = \frac{R2 \times R3}{R2 - R3} = \frac{80{,}000 \times 80{,}000}{160{,}000} = 40{,}000 \text{ ohms}$$

The series resistance is:

40,000 + 50,000 + 30,000 + 5,000 = 125,000 ohms.

The current through the circuit is:

$$I = \frac{E}{R} = \frac{250}{125{,}000} = 0.002 \text{ amperes.}$$

The voltage drops across each of the resistances is now determined.

Across R1 ... E = I×R = 0.002× 5,000 = 10 volts.

Across Rp ... E = I×R = 0.002×30,000 = 60 volts.

Across R2&R3 E = I×R = 0.002×40,000 = 80 volts.

Across R4 ... E = I×R = 0.002×50,000 = 100 volts.

The total of all the voltage drops is:

10+60+80+100 = 250 volts, which is equal to the applied voltage. The plate terminal of the tube (point P) has a voltage of + 70 volts in reference to the chassis ground. The cathode (point k) has a voltage of + 10 volts in reference to the chassis ground. The point X has a voltage of — 150 volts in reference to the chassis ground. Point X also has a voltage of — 80 volts in reference to the plate of the tube (point P). Various other differences of potential can be determined by selecting different reference points in the circuit.

31. A-C VOLTAGE DISTRIBUTION.

a. Alternating voltages can be divided into three general types: 60-cycle voltage from the power unit or commercial power lines, audio-frequency voltages between 15 and 15,000 cycles per second, and radio frequencies, which are above the audio-frequency range.

b. In this section, only the 60-cycle power unit voltages will be treated. Audio frequencies in the

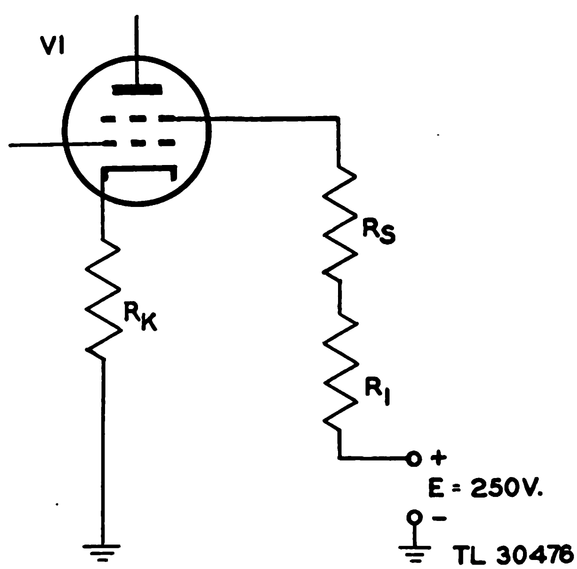


Figure 51. Voltage measurements functional schematic.

equipment are measured by means of the test oscilloscope, and radio frequencies are measured by means of the vacuum tube voltmeter.

c. The power from the power unit or commercial line will be at 60 cycles per second and at 115 volts when properly adjusted. It is used in the equipment in the following ways:

(1) In some cases, the 115-volt a-c is fed directly to motors, heaters, lights, soldering irons, and other appliances.

(2) In other cases, the 115-volt a-c is fed to transformers which increase the voltage. These transformers are located throughout the equipment, especially in rectifiers.

(3) In other cases, the 115-volt a-c is fed to transformers which lower the voltage. This is necessary in order to obtain the proper voltage for such use as supplying low voltage for the filaments of the tubes.

d. A-c voltages at various points in the equipment are given throughout the manual in the diagrams and in the text.

32. PRACTICAL EXAMPLE OF CHECKING VOLTAGES IN AN AMPLIFIER STAGE.

a. Figure 53 illustrates a typical amplifier stage. The values for the various parts are labeled as well as the input voltages. The normal voltages at the tube socket contacts are:

	1	2	3	4	5	6	7	8
V3	7.2	6.3 a-c	0	0	7.2	195	0	185

NOTE: All voltages are dc unless otherwise specified.

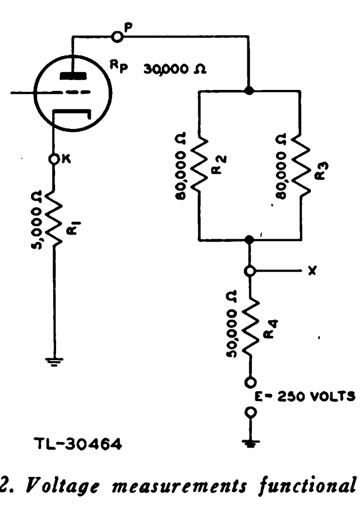


Figure 52. Voltage measurements functional schematic.

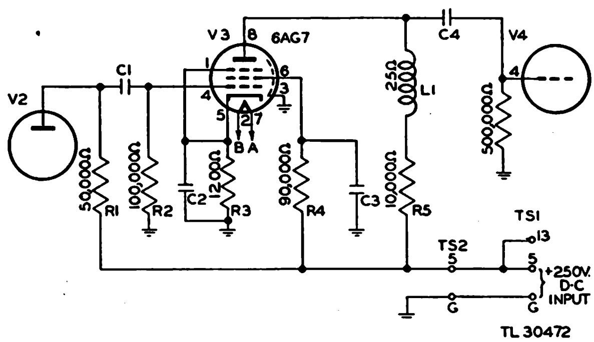


Figure 53. Voltage measurements functional schematic.

Checking this stage for an abnormal voltage measurement is accomplished by testing the voltages between the socket contacts and the chassis.

b. The voltage between contact 1 and the chassis is normally 7.2 volts (by referring to chart above). This voltage should be the same as that between socket contact 5 and chassis since they are directly connected, as explained in subparagraph *e* following.

c. The voltage contact 2 and the chassis should be 6.3 ac since it is one side of the filament. On the diagram, no connections are shown since the filament of amplifier tubes are always connected to a low-voltage ac source. In the event that this voltage is abnormal, the voltage should be checked across the winding of the transformer which supplies the voltage. If the voltage on the transformer is normal, the only trouble can be a broken connection between the transformer and the contact. If the voltage on the transformer winding is abnormal, the voltage on the transformer primary winding should be measured. If the primary voltage is normal and the winding that delivers the filament voltage is abnormal, the transformer is either defective, or an abnormally high drain is being placed on the filament winding. This can be checked by removing one of the wires from the filament winding and again testing the voltage across this winding. If the transformer is defective, the voltage reading will still be abnormal. If the transformer is normal, the voltage will be a little higher than usual. If, however, the voltage on the transformer primary is abnormal, the source of this voltage must be checked.

d. The voltage between contact 3 and the chassis should be zero since this contact is directly connected to the chassis.

e. The voltage between contact 4 and the chassis should be zero since this is a class A amplifier and no grid current flows through resistor R2 normally. If condenser C1 should short-circuit, however, the high positive voltage on the plate of tube V2 would be delivered to contact 4, and a d-c positive voltage reading would be obtained. Likewise a short-circuit between contact 4 and any connection with an applied voltage on it would also cause a reading on contact 4. It is also possible for a short-circuit inside the tube to cause a reading on this contact.

f. The cathode voltage is checked as follows: (1) The voltage on contact 1 and 5 should normally be 7.2 volts. The plate-cathode and the grid-cathode circuits normally cause a current flow through the cathode resistor R3. This current is normally 0.006 amperes since the resistor is rated at 1,200 ohms and the voltage across it is 7.2 volts.

$$I = \frac{E}{R} = \frac{7.2}{1200} = 0.006 \text{ amperes.}$$

(2) If no voltage is obtained, the trouble may be a lack of the + 250-volt applied voltage, a burned out tube V3, a burned out resistor R3, a shorted capacitor C2 (this capacitor if shorted, would connect the cathode to the chassis), a broken connection, resistor R4 and the coil L or resistor R5 open-circuited.

(3) If the voltage was found to be low, the trouble could be a tube (V3) with low emission, a leaky capacitor C2, an open-circuited resistor R4 or R5, a shorted capacitor C3 or C4, low +250 applied voltage, an open-circuited coil L1, a poor connection, or a change in the resistance value of any of the resistors. If the voltage was found to be too high, the trouble could be a gassy tube, a short-circuited resistor or coil, too high an applied voltage, or a connection in either the plate-cathode or screen-grid-cathode circuits shorted by another external high-voltage source.

g. The screen and voltage is checked as follows:

(1) The voltage on contact 6 should normally be 195 volts. The voltage drop across the resistor normally would be 55 volts since the voltage on one side of the resistor is 195 volts and on the other side is 250 volts. The normal current through this resistor would be 0.0006 amperes.

$$I = \frac{E}{R} = \frac{55}{90{,}000} = 0.0006 \text{ amperes.}$$

(2) If no voltage is obtained on contact 6, the trouble could be lack of an applied voltage, an open-circuited resistor R4, a broken connection, or a shorted capacitor C3.

(3) If the voltage on contact 6 is too low, the trouble could be a gassy tube, a leaky capacitor C3, too low an applied voltage, or too low a bias voltage on the grid of V3 (grid is biased by the 7.2 volts on the cathode).

NOTE: A gassy tube, or lowering of the grid bias of V3 would increase the current through the screen grid-plate circuit. Increasing this current would put more current through resistor R4. The voltage drop across R4 would then be greater since E = IxR or the larger the current through a resistor of a given value, the larger the voltage drop. The voltage on the screen grid would be the applied voltage less the voltage drop across R4. If capacitor C3 was leaky or shorted, the screen grid of V3 would be connected near or at ground potential, lowering the voltage on contact 6. The current through R4 would rise if C3 was defective, since this would be the only resistance between the applied voltage and the chassis ground. Most likely resistor R4 would burn out because of the high current flow unless it had an ample power rating. Any cause that would make high current flow through the screen grid-cathode circuit might burn out either R3 or R4.

h. The voltage between contact 7 should normally be zero according to the chart above since this contact is connected directly to the chassis ground.

i. The plate voltage is checked as follows: (1) The voltage between contact 8 and the chassis should normally be 185 volts. This voltage is at one of the points in the plate-cathode circuit which comprises resistor R5, coil L1, the plate resistance of tube V3, and resistor R3. The applied voltage in this circuit is +250 volts. The voltage drop across R5 and L1 in series is 65 volts (250 volts—185 volts). The current through R5 and L1 is 0.0064 amperes.

$$I = \frac{E}{R} = \frac{65}{10{,}025} = 0.0064 \text{ amperes.}$$

(2 If no voltage is obtained on contact 8, the trouble could be a lack of applied voltage, an open circuited resistor R5 or coil L1, or a broken connection between terminal 5 on TS1 and contact 8. If the voltage on contact 8 is too low, the trouble could be a gassy tube (V3), too low an applied

voltage, a shorted or leaky capacitor C2, or a shorted resistor R3. A gassy tube V3, shorted or leaky capacitor C2, or a shorted resistor R3, would cause the current through the plate-cathode circuit to rise, increasing voltage drop across R5 and L1. This would lower the voltage on contact 8. Increased current through this circuit may also burn out resistor R3 or R5 unless their power rating is ample.

(3) If the voltage is too high, the trouble could be a burned out tube V3, low emission in V3, a burned out resistor R3, a shorted resistor R5, or coil L1, too high an applied voltage, or a burned out resistor R4. If the tube was burned out or resistor R3 was open, no current would flow through the plate-cathode circuit, and there would be no voltage drop between the applied voltage and the plate of the tube.

(4) Capacitor C4, a coupling capacitor to the grid of V4, can be checked for a shorted or leaky condition by measuring the voltage between contact 4 on V4 and the chassis ground, when the normal 185 volts is on the plate of V3. If the positive d-c voltage is higher than normal when measured on contact 4 of V4, the capacitor is leaky or shorted.

SECTION II

RESISTANCE MEASUREMENTS

33. INTRODUCTION.

a. Use. Measuring resistance is one of the most important methods used to localize trouble to a particular part of a stage after the trouble has been traced to that stage by utilizing the senses, signal tracing, or signal substitution.

b. Checking Standard Value. Each part of a radio set (transformers, chokes, connecting wires, etc.) has a resistance value, and, when used singly or in connection with other parts, it constitutes a circuit which must be tested. The resistance value of each part is usually constant, unless the part becomes defective. Consequently, a check against the resistance value of each part can be used as a method of locating a defective part. For example, the resistance across a mica capacitor (or the resistance across any other open circuit or nonconducting path for direct current) is practically infinite. Should a resistance measurement below 50 megohms be obtained, the mica capacitor is defective (*shorted* or *leaky*).

34. RESISTANCE OF PARTS. All conductors possess some quantity of resistance. In wires, most commonly used as conductors, the resistance depends on:

a. Material. The resistance per unit length of wire, called *resistivity,* depends on the type of metal used. Silver and copper wire have a low resistance per unit length; iron and nichrome have a high resistance; long lengths (coils, transformer windings, etc.) have high resistance.

c. Cross-section. The greater the cross-section of wire, the lower the resistance. Conversely, the smaller the cross-section, the higher the resistance.

d. Temperature. The resistance of a length of wire increases with a rise in temperature. The converse is true in rare cases.

35. COMMON RESISTANCE VALUES. The table of resistance values normally encountered in service work is shown below. This table refers specifically to transformers and chokes. All values shown are approximate and represent a cross-section of commonly encountered parts.

TABLE I
NORMAL RESISTANCE VALUES

Name of part	Resistance value (ohms)
R-f transformer, primaries.	0 to 5
R-f transformer, secondaries.	0 to 5
I-f transformer, primaries.	0 to 10
I-f transformer, secondaries.	0 to 10
A-f transformer, primaries.	500 to 3,000
A-f transformer, secondaries.	1,000 to 8,000
Power transformer, plate windings.	200 to 2,000
Power transformer, primary winding.	0.1 to 15
Rectifier filter chokes.	150 to 800
R-f chokes.	0 to 50
Resistors.	0.2 to 10,000,000 (10 meg)

NOTE: Zero ohms indicates a negligible resistance measurement.

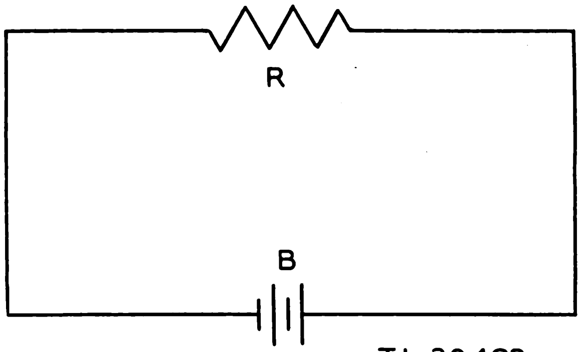


Figure 54. Resistance measurements functional schematic.

36. TOLERANCE VALUES FOR RESISTANCE MEASUREMENTS. Tolerance represents the normal difference that may be obtained and accepted between the rated value and the measured value of a resistance. Resistors have a definite tolerance rating, varying from plus or minus 1 percent for the *precision* resistors to plus or minus 10 percent for the majority of resistors. Thus a resistor rated at 500,000 ohms plus or minus 10 percent would be normal if the meter read between 450,000 and 550,000 ohms. Transformer and choke windings are held to a much closer resistance tolerance (from a fraction of 1 percent to 4 percent).

37. FACTORS AFFECTING RESISTANCE MEASUREMENT.

a. Before making resistance measurements, allow the set to cool for a few minutes, because temperature differences *will* affect the resistance value.

b. The connection of an individual part into a circuit which contains other parts will affect the resistance measurement, although it will not affect the resistance value of the individual part. A detailed explanation is offered in the following paragraphs.

38. SERIES, PARALLEL, AND SERIES-PARALLEL CIRCUITS. When two or more parts are connected in a radio circuit, they are always connected in one of three kinds of circuits: a series circuit, a parallel circuit, or a series-parallel circuit.

a. Series Circuits. (1) GENERAL. A series circuit is one in which the current has but one path. Figure 54 shows a battery connected across a resistor in a simple series circuit. It is not necessary that R be a resistor. It may be a transformer winding, choke coil, or some other winding which possesses a value of resistance.

> NOTE: Only the d-c resistance of the winding is considered. Its a-c characteristics are of no interest, because this method of testing entails only d-c measurements. Signal input, turns ratio of the transformer, a-c impedance, etc., are not considered. The important factor is the d-c resistance which is first measured and then compared with the rated value of the winding to determine if it is still in its normal condition.

(2) UNITS IN A SERIES CIRCUIT. Any number of units may be employed in a series circuit, providing that they allow for the flow of continuous current and that they are so arranged that only one path is available for the flow of the current. The total resistance in any series circuit is the sum of the individual resistances of the parts comprising the circuit. The actual resistors may be distant from each other and still be so connected electrically that they constitute a series circuit. Figure 55 illustrates a series circuit. Note that the d-c resistance of the coil windings is considered an integral part of the circuit.

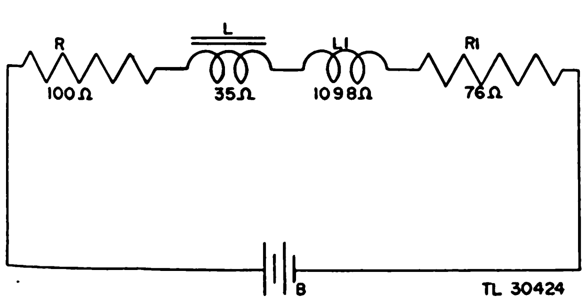


Figure 55. Resistance measurements functional schematic.

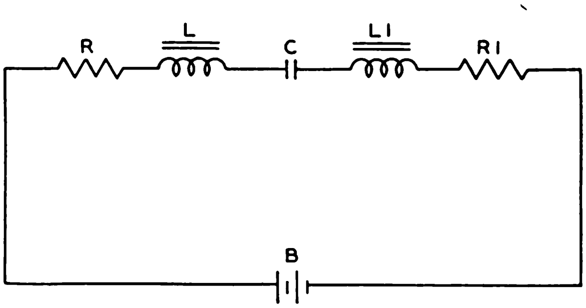


Figure 56. Resistance measurements functional schematic.

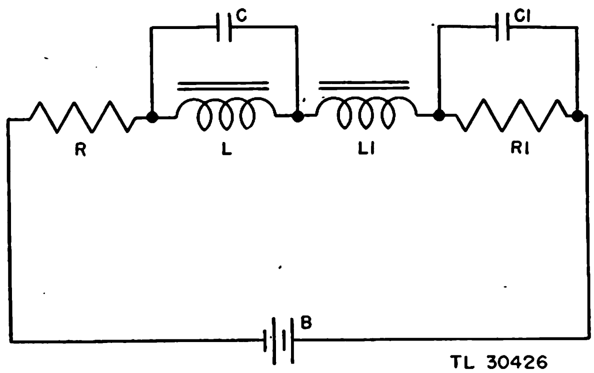


Figure 57. Resistance measurements functional schematic.

(3) CAPACITANCE IN A SERIES CIRCUIT.

(a) Series Capacitance. Figure 56 illustrates a capacitor in a series circuit. A capacitor used in the manner shown will prevent the flow of direct current, and the resistance of this circuit would then become equivalent to infinity (open circuit) for direct current, assuming that a good capacitor is used.

(b) Parallel Capacitance. Figure 57 illustrates resistors and coils in a series circuit with one resistor and one coil shunted by (parallel with) capacitors. The two capacitors do not interfere with the flow of direct current, because there is only one continuous path for it to follow. Here again, the total resistance of the circuit is the sum of the individual-part resistances. A leaky capacitor, however would offer another path of flow for the direct current and thus would change the total resistance of the series circuit.

(4) PRACTICAL EXAMPLES OF SERIES CIRCUITS. Figure 58 shows the use of resistances in an amplifier stage. A, B, C, D, and E are used as reference points.

(a) Screen Circuit. This simple series circuit consists of resistor R3. To trace this circuit, connect the ohmmeter between points A and B as shown by the dotted line. (The ohmmeter uses a self-contained battery as a voltage source.)

(b) Plate Circuit. This series circuit consists of coil L1 and resistor R3. To trace this circuit, connect the ohmmeter between points A and C. The total resistance (ohmmeter reading) between points A and C will be the sum of the resistances of R3 and L1, or 50,060 ohms.

(c) Cathode Circuit. This series circuit consists of resistors R1 and R2. To trace this circuit, connect the ohmmeter between points A and E. The total resistance (ohmmeter reading) between points A and E will be the sum of the resistances of R1 and R2, or 135,000 ohms.

(d) Other Circuits. Other examples of series circuits to be found in this amplifier stage are located between the various points shown in the table below:

TABLE II
OTHER SERIES CIRCUIT VALUES IN FIGURE 58

Points in circuit	Total resistance (ohms)
A and D	130,000
D and E	5,000
E and B	185,000
E and C	185,060
D and B	180,000
D and C	180,060

NOTE: When measuring resistance, it is most important to examine the circuit critically for parallel paths of current flow. The net resistance of a parallel circuit differs materially from the resistance of any individual part within the parallel circuit.

b. Parallel Circuits. Parallel circuits are used for several reasons, mainly: to provide a resultant value of resistance which is not easily or economically available with a single resistor, or to distribute current flow in such a manner that the current flowing

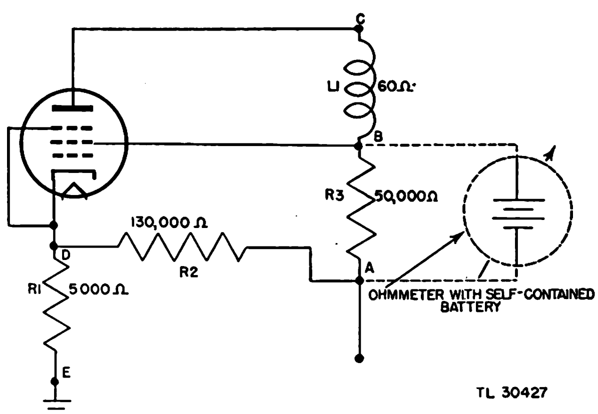


Figure 58. Resistance measurements functional schematic.

through the various units does not exceed the current-carrying capacity of the units.

(1) CURRENT AND RESISTANCE IN PARALLEL CIRCUITS. A series circuit can offer only one path for the flow of current; a parallel circuit, however, may offer any number of paths (always more than one). In a parallel circuit the current paths must be so arranged that the voltage source may act independently upon each. In figure 59, battery B causes current to flow through two resistors, R and R1. The current flowing through R is dependent upon the value of R and the voltage of B. A similar condition exists in the R1 circuit. The value of R1 and the voltage of B determine the current in that branch. The removal of resistor R would not interfere with the current flow through R1. Conversely, the removal of R1 would not affect the current flow through R. In each case, the branch currents depend upon the resistance of the individual branches. According to Ohm's law, as shown below, the current through R is 0.5 ampere (500 milliamperes), and the current through R1 is 0.5 ampere (500 milliamperes).

$$I = \frac{E}{R} = \frac{50}{100} = \frac{1}{2} = 0.5 \text{ amperes.}$$

The total current flowing out of the battery is the sum of the branch currents, or 1.0 ampere (1,000 milliamperes). The total resistance of the circuit, as measured by an ohmmeter or calculated by Ohm's law, would be the total voltage (50 volts) divided by the total current (1 ampere), or 50 ohms. Note that the resultant resistance is 50 ohms, despite the fact that each resistor is rated at 100 ohms. As defined in the rule on parallel resistance, ***the resultant, or combined resistance, of any parallel combination is less than the resistance of the lowest part.***

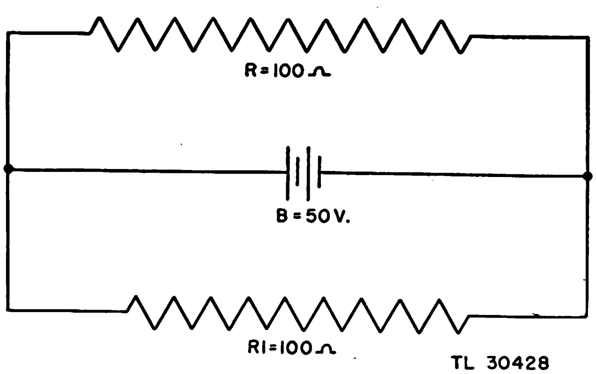


Figure 59. Resistance measurements functional schematic.

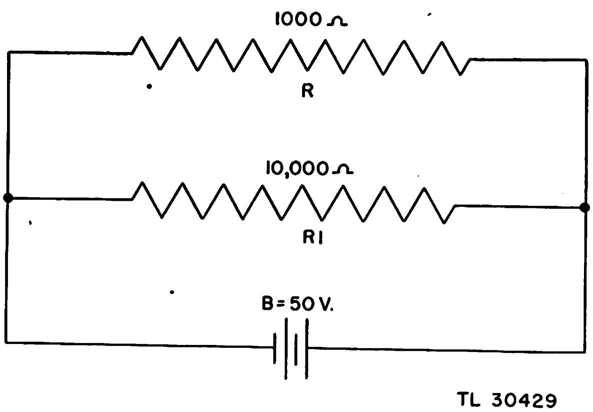


Figure 60. Resistance measurements functional schematic.

(2) TWO UNITS IN A PARALLEL.

(a) In figure 59, the resistors R and R1 are in parallel, because they are connected between the same two points in the circuit. Two units are also in parallel when they are connected in ***shunt*** with each other. Use of the term ***shunt*** signifies a parallel connection.

(b) Figure 60 shows another parallel circuit. In this case, resistor R has a resistance of 1,000 ohms, and resistor R1 a resistance of 10,000 ohms. The lowest resistance in this parallel combination is the branch R, rated at 1,000 ohms. The resultant resistance of the combination, therefore, must be less than the resistance of R. The current through R (according to Ohm's law) is 0.05 ampere, and the current through R1 is 0.005 ampere. Thus, the total circuit resistance is equal to the total current (0.055 ampere) divided into the total voltage (50 volts), as follows:

$$R = \frac{E}{I} = \frac{50}{.055} = 909 \text{ ohms.}$$

(3) MORE THAN TWO UNITS IN PARALLEL. Any number of units may be used in a parallel circuit, and these units may have any ohmic value of resistance.

(4) DETERMINATION OF PARALLEL RESISTANCE. When working with parallel circuits, it is not customary to go through the routine of determining branch currents, adding these currents, and then solving for the total resistance by applying Ohm's law. The following subparagraphs contain the specific laws which may be used to determine the total resistance of parallel circuits.

(a) When all the units in a parallel combination have similar values of d-c resistance, the combined,

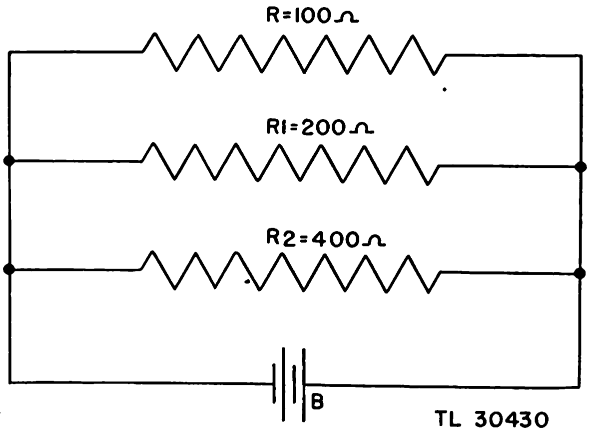


Figure 61. Resistance measurements functional schematic.

or resultant resistance is the value of one of the units divided by the number of units connected in parallel. Figure 59 shows two 100-ohm resistors connected in parallel. The resultant resistance of this combination is 100/2 or 50 ohms. If figure 59 contained 10 such units, the resultant resistance would be 10 ohms.

(b) When the units connected in parallel have unlike values of resistance, the resultant, or combined resistance, is equal to the reciprocal of the sum of the reciprocals of the resistances of the individual branches. The reciprocal of a number is 1 divided by that number. For example, the reciprocal of a resistance R is 1/R. If R is one of the branches of a parallel circuit and has a value of 100 ohms, the reciprocal of that branch is 1/100 or 0.01. Figure 61 shows a parallel circuit with three branches. The resultant resistance of this circuit is figured as follows:

$$\frac{1}{\frac{1}{R}+\frac{1}{R1}+\frac{1}{R2}}=\frac{1}{\frac{1}{100}+\frac{1}{200}+\frac{1}{400}}=$$

$$\frac{1}{.01+.005+.0025}=\frac{1}{.0175}=57 \text{ ohms.}$$

(c) When two resistances of unlike value are connected in parallel, the resultant value is equal to the product divided by the sum. The equivalent resistance of R and R1, as shown in figure 60, is:

$$R=\frac{R\times R1}{R+R1}=\frac{10{,}000\times 1{,}000}{10{,}000+1{,}000}=\frac{10{,}000{,}000}{11{,}000}=$$
$$909 \text{ ohms.}$$

Note that the rule in subparagraph (*b*) above may be applied to a parallel circuit of two branches. Using the product-and-sum method, however, may prove simpler, because this method can be applied to any number of resistances connected in parallel merely by solving for two at a time. Three resistors, R, R1, and Rs, are shown in figure 61. The product-and-sum method can be first applied to determine the combined resistance of R and R1. Then, when the resultant resistance is calculated, it may be combined with R2 (again by the product-and-sum method) to give the total resultant resistance. Likewise, this total may be combined with a fourth parallel branch, and then computed to give a new total for a four-branch parallel circuit. The use of this method is not compulsory; the choice of method is left to the individual.

(5) OTHER UNITS IN PARALLEL. The combined or resultant resistance of a parallel circuit containing coils, chokes, or transformer windings is determined by exactly the same methods used to determine the resistance of resistors. The d-c resistance of the winding is considered in the same manner as the rated resistance of any resistor.

(6) PRACTICAL EXAMPLES OF PARALLEL CIRCUITS. Figure 62 shows a single-amplifier stage V1 with parallel connection of parts in the screen grid, plate, and grid circuits. The cathode circuit consists of a simple series connection.

(a) Screen-grid Circuit. This circuit shows the use of two resistors between A and D. The same circuit is shown in simple form in figure 63. The ohmmeter is connected between points A and D, and the resultant resistance read on the ohmmeter should be 40,000 ohms. The ohmic value of the two resistors is similar (80,000 ohms each), and, since there are two resistances, the resultant resistance will be computed as follows:

$$R=\frac{80{,}000}{2}=40{,}000 \text{ ohms.}$$

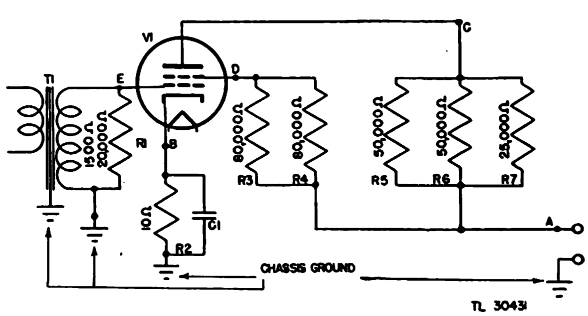


Figure 62. Resistance measurements functional schematic.

A reading of 80,000 ohms on the ohmmeter indicates that one of the resistors is defective. If an open circuit (no reading) is obtained, both resistors are defective, or one of the connecting wires between A and D is broken.

(b) Plate Circuit. This circuit illustrates the use of three resistors between A and C. An ohmmeter connected between A and C will normally show a reading of 12,500 ohms. To verify this reading, use the reciprocal method shown below:

$$\frac{1}{1+1+1} = \frac{1}{\frac{1}{50,000}+\frac{1}{50,000}+\frac{1}{25,000}} =$$

$$\frac{1}{0.00002+0.00002+0.00004} =$$

$$\frac{1}{0.00008} = 12,500 \text{ ohms.}$$

If a reading greater than 12,500 ohms is obtained, it indicates a defective resistor or resistors. For example, if resistor R7 were burned out, the reading of the ohmmeter would be 25,000 ohms, which is the resultant of resistors R5 and R6 in parallel.

(c) Grid Circuit. Figure 62 shows a grid circuit comprised of a resistor and a transformer secondary winding. The measurement is made between points E and ground (the chassis). An ohmmeter is used to make this and all subsequent measurements.

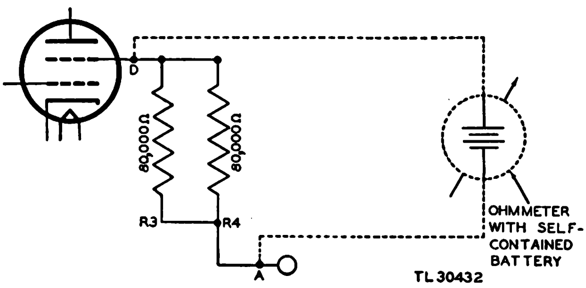


Figure 63. Resistance measurements functional schematic.

The measurement will show 1,391 ohms (fractions of ohms in higher resistance values cannot be read on the average ohmmeter). The normal resistance can be calculated by the use of the product-and-sum method, as follows:

$$R = \frac{1,500 \times 20,000}{1,500+20,000} = \frac{30,000,000}{21,500} = 1,391 \text{ ohms.}$$

If a resistance of 1,500 ohms is measured, resistor R1 is defective. If a resistance of 20,000 ohms is measured, the transformer winding is burned out or open-circuited. In this example there is a possibility of a lower than normal reading, if the transformer winding is shorted to the grounded transformer core.

NOTE: In every case of parallel connections, the resultant resistance is less than the lowest rated resistance in the combination.

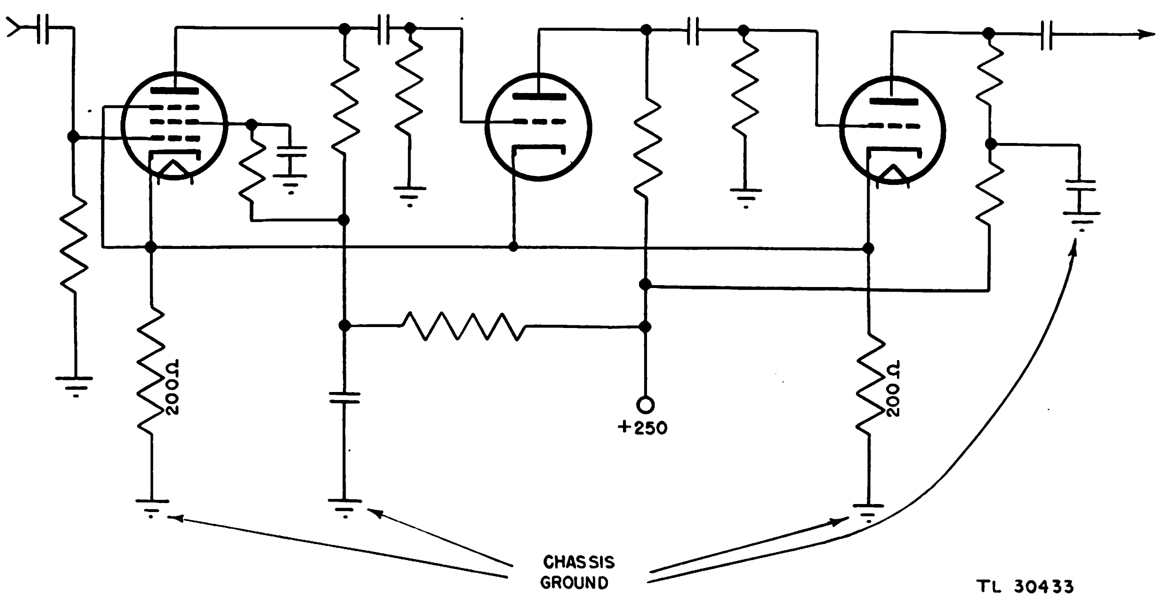


Figure 64. Resistance measurements functional schematic.

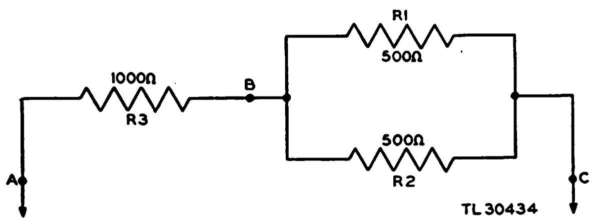


Figure 65. Resistance measurements functional schematic.

(d) Cathode Circuit. The circuit in figure 62 shows a simple series circuit between the cathode (B) and ground. The measured resistance should be the same as that of resistor R2, or 10 ohms. If capacitor C1 (cathode bypass capacitor) were leaky, a parallel circuit would be formed, because the leaky capacitor would offer a path for the flow of direct current. In this case, the lower resultant-resistance measurement would reveal the defective capacitor.

(e) Remote Parts in Parallel. Another practical example of a simple parallel circuit is shown in figure 64. The cathode circuits in this diagram should be examined. Two 200-ohm resistors are connected in parallel. Under normal conditions a resistance measurement from cathode to ground would show a correct value of 100 ohms, although each of the units measures 200 ohms. If either resistor were

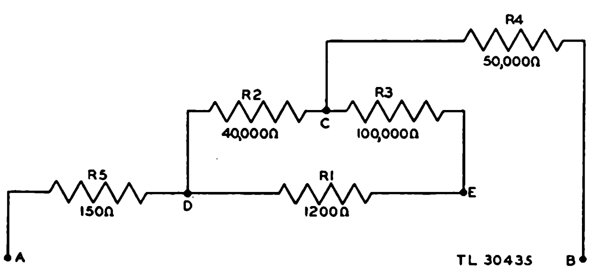


Figure 66. Resistance measurements functional schematic.

defective or open, the measurement between cathode and ground would read 200 ohms. While it is true that each resistor is 200 ohms, in this case a resistance measurement of 200 ohms would indicate the existence of a defect. This example shows why the presence of parallel circuits is important when using resistance measurement to aid in localizing defects. ***Study all circuits for the possibilities of parallel connections.***

c. Series-parallel Circuits. (1) GENERAL. A series-parallel circuit is a combination of a series and a parallel circuit. To measure resistance in these circuits, apply the laws governing series circuits and parallel circuits; the law to be used depends entirely upon the circuit arrangement. A simple series-parallel combination of resistors R1, R2, and R3 is shown in figure 65. The resistance between points A and B is 1,000 ohms. The resistance between points B and C is 250 ohms, since this is a simple parallel combination. The resistance between points A and C will be the sum of R3 and the resultant of R1 and R2, or 1,000 plus 250, or 1,250 ohms. In this case, R1 and R2 were treated as a single resistor (after solving for the resultant

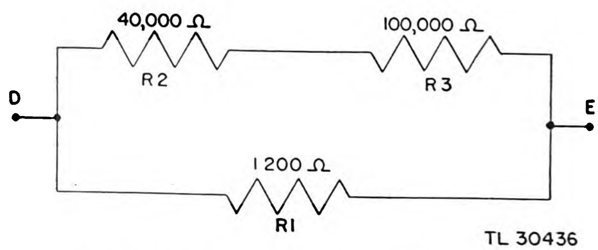


Figure 67. Resistance measurements functional schematic.

resistance of their parallel combination). The system was then considered as a series circuit between points A and C.

(2) TYPICAL SERIES-PARALLEL CONNECTION. Figure 66 shows a more complicated series-parallel arrangement. Although the appearance of the circuit is apt to be confusing, determining its resistance is simple. Five reference points, A, B, C, D, and E are shown, and ohmic values of the resistors are designated. ***The total resistance between any two points depends entirely upon the type of resistance structure between those two points.*** As explained in the following subparagraphs, it is necessary in many instances to reconstruct the circuit diagram of the network in order to simplify its arrangement.

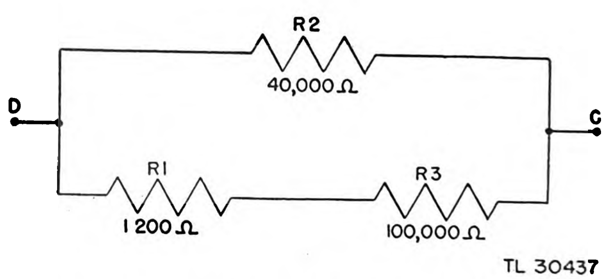


Figure 68. Resistance measurements functional schematic.

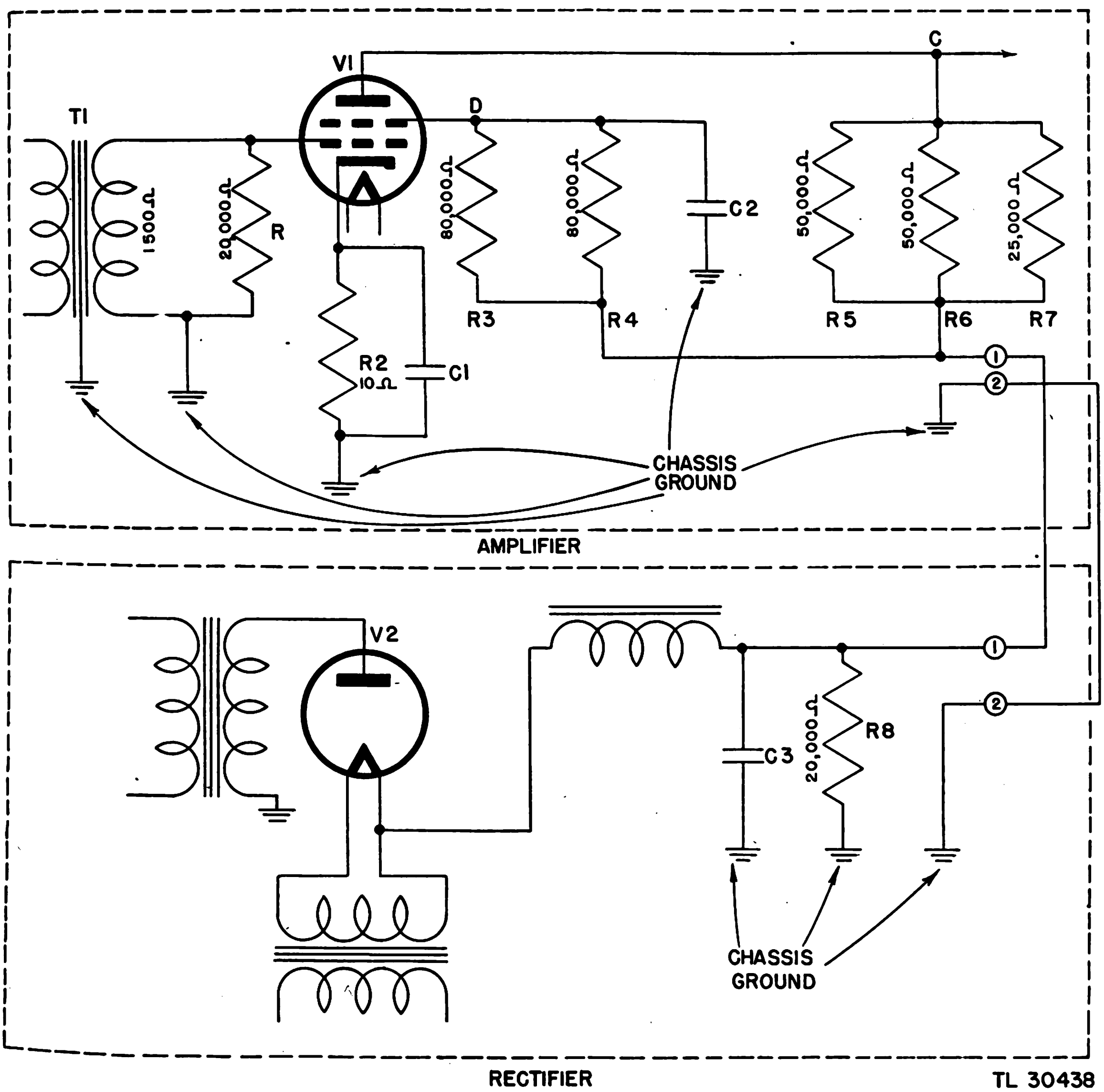


Figure 69. Resistance measurements functional schematic.

(a) If a resistance check is made between D and E, the circuit is as shown in figure 67. If the resistance test is between D and C, the circuit is as shown in figure 68. Note that figure 67 shows R1 in parallel with the series combination of R2 and R3. In figure 68, R2 is in parallel with the series combination of R1 and R3. Although the two systems appear alike, the resistance between D and E differs from that between D and C.

(b) Figure 68 shows a resistor of 40,000 ohms (R2) in shunt with the series combination of 1,200 and 100,000 ohms (R1 and R3). R1 and R3 in series have a total resistance of 101,200 ohms. Thus, the resultant value of the parallel combination would be figured as follows:

$$\frac{R2 \times (R1 + R3)}{R2 + (R1 + R3)} =$$

$$\frac{40{,}000 \times (1{,}200 — 100{,}000)}{40{,}000 + (1{,}200 + 100{,}000)} =$$

$$\frac{40{,}000 \times 101{,}200}{40{,}000 + 101{,}200} = \frac{4{,}048{,}000{,}000}{141{,}200} =$$

28,668 ohms.

(c) The resultant value calculated in subparagraph (*b*) above differs from that secured when

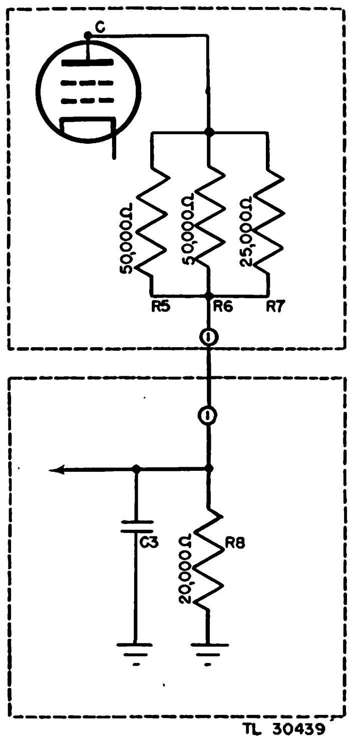


Figure 70. Resistance measurements functional schematic.

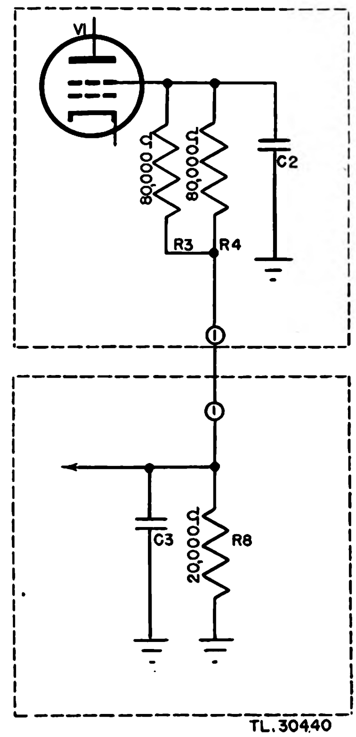


Figure 71. Resistance measurements functional schematic.

checking between points D and E (fig. 67). Between points D and E the same resistors R1, R2, and R3 are found as between points D and C, but their arrangement is different (fig. 68). The parallel combination now consists of one branch total of 140,000 ohms (100,000 plus 40,000) in shunt with the other branch of 1,200 ohms, and can be figured as follows:

$$\frac{140{,}000 \times 1{,}200}{140{,}000 + 1{,}200} = \frac{168{,}000{,}000}{141{,}200} = 1{,}189 \text{ ohms.}$$

(*d*) In figure 68, resistor R5 is always a series resistor between any two reference points, since the current between points A and D has only one possible path, the path through R5. The same holds true for resistor R4.

(*e*) The resistance between other points is shown in the following table:

TABLE III
RESISTANCE OF OTHER POINTS IN FIGURE 66

Points	Resistance (ohms)
A and D	150
A and C (A to D + D to C)	28,668 + 150 = 28,818
A and E (A to D + D to E)	1,189 + 150 = 1,339
A and B (A to D + D to C — C to B)	28,668 + 150 + 50,000 = 78,818
D and B (D to C + C to B)	28,668 + 50,000 = 78,668
B and E (B to C + C to D)	29,249 + 50,000 = 79,249
B and C	50,000

NOTE: It is important to understand the resultant resistance values between different test points, because it will be necessary to test from point to point in order to include all units.

(3) PRACTICAL EXAMPLES OF SERIES-PARALLEL CIRCUITS. Figure 76 shows an amplifier stage similar to that shown in figure 69, with a rectifier supply added.

(*a*) *Plate Circuit of V1.* The circuit between the chassis (ground or common connection) and the plate of tube V1 comprises a series-parallel connection. As usual, the chassis connection for the plate circuit is in the rectifier supply. (The chassis of the amplifier can be used as one connection for the ohmmeter, since the chassis of the amplifier and rectifier are connected together.) This circuit is shown in simple form in figure 70. Note that R8 is in series with the three parallel resistors R5, R6, and R7, when test points are selected between the plate of the tube (c) and the chassis. An ohmmeter connected between these points will read 32,500 ohms when all parts are normal. To verify this reading, follow the steps listed below:

1. Determine the resultant resistance of the parallel combination of R5, R6, and R7.

$$R = \frac{1}{\frac{1}{R5}+\frac{1}{R6}+\frac{1}{R7}} = \frac{1}{\frac{1}{50{,}000}+\frac{1}{50{,}000}+\frac{1}{25{,}000}} = \frac{1}{0.00002 + 0.00002 + 0.00004} = \frac{1}{0.00008} =$$

12,500 ohms.

2. Add the values of R8 and the resultant of R5, R6, and R7 (12,500 plus 20,000 equals 32,500 ohms, which is the normal resistance between the plate of V1 and the chassis). Note that capacitor C3 is connected across resistor R8.

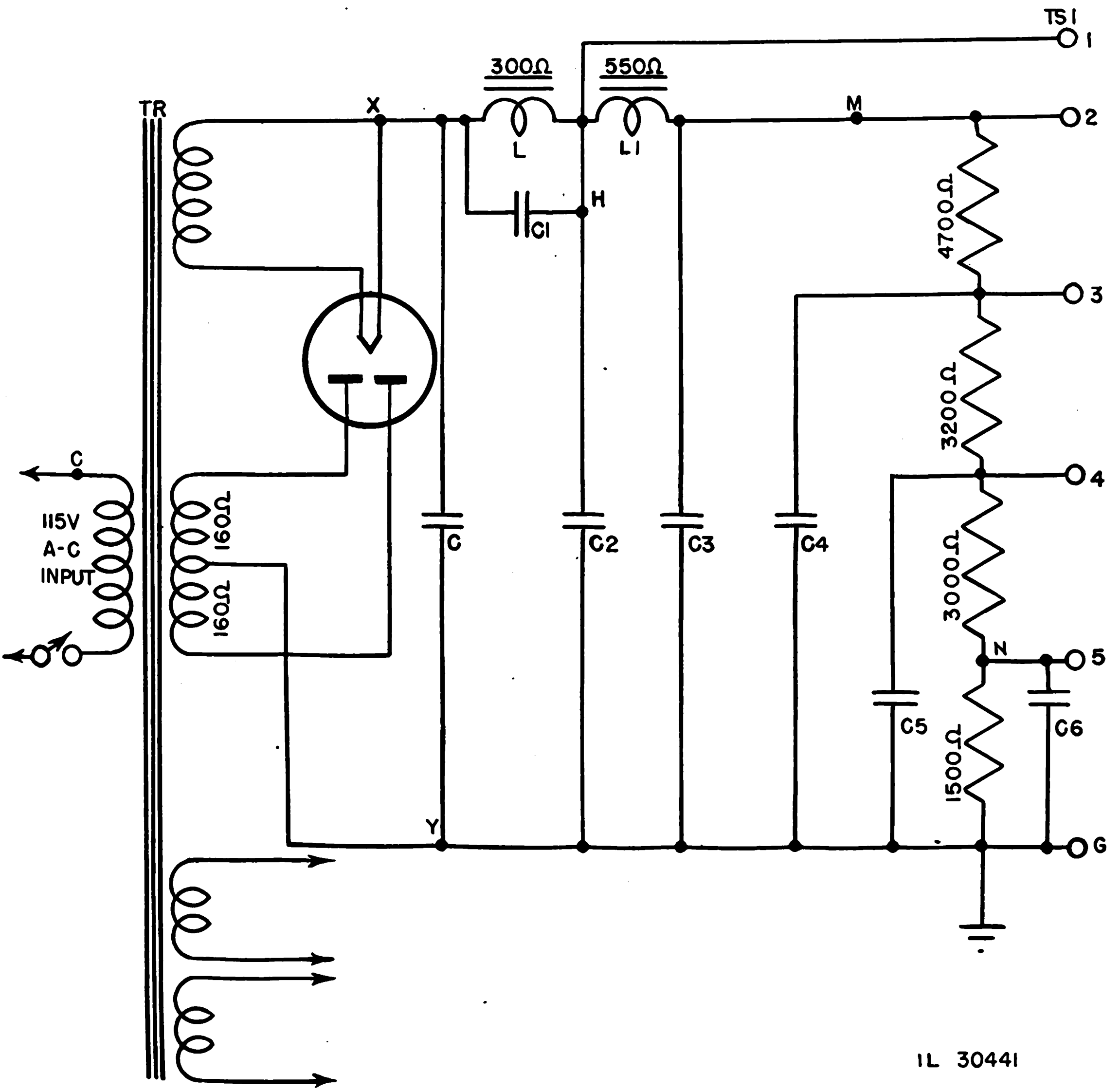


Figure 72. Resistance measurements functional schematic.

If the capacitor is good, it will have no effect on the measurement. However, if C3 is shorted because of the parallel connection, R8 will also be shorted out. If R8 were shorted, the resistance between the plate of V1 and the chassis would be abnormal, or 12,500 ohms. If one or more of the resistors in the parallel combination (R5, R6, R7) were burned out (open-circuited), the reading would be *greater* than normal. If resistor R8 were open-circuited, no reading (infinity) would be obtained.

(*b*) *Screen Grid Circuit of V1.* The circuit between the chassis and the screen grid of V1 is another series-parallel connection and is shown in simple form in figure 71. This circuit is checked by the same procedure as that of the plate circuit. In this case, a capacitor (C2) is in parallel with resistors R3 and R4. Assuming that the capacitor is good, its presence will have no effect on the d-c resistance measurement when the capacitor is connected in shunt with a resistor. However, if C2 were shorted, it would connect the screen grid of the tube V1 to the chassis and a *zero* reading would be obtained. Both leads of the ohmmeter would then be connected to the chassis.

39. RESISTANCE MEASUREMENTS IN RECTIFIERS.

a. Figure 72 illustrates a rectifier circuit with six outputs taken off terminals No. 1 to No. 5 and terminal G on terminal strip TS1. This circuit can be checked for resistance measurements as a single unit (with external wires disconnected) by starting with the rectifier-tube filament. The following subparagraphs show the methods used in checking resistances in rectifier circuits. These methods can be applied with slight variations to practically any type of standard rectifier.

b. The resistance between points X (rectifier filament) and terminal No. 1 is 300 ohms, which is the d-c resistance of the choke coil L. Note that one side of choke coil L and capacitors C and C1 join at point X. These capacitors have no effect upon the d-c resistance of the choke coil L. Shorted capacitors, however, will affect choke coil L. In the circuit arrangement of the capacitors in the illustration, when capacitor C is shorted it will short-circuit test points X and Y. The circuit between X and terminal No. 1 has no connection with test point Y; consequently, even if C is short-circuited, the 300-ohms resistance measurement between X and B1 will not be affected. On the other hand, if C is intact and capacitor C1, which is connected in shunt with choke coil L, is shorted, the circuit between point X and terminal No. 1 will measure zero resistance.

c. The resistance between point X and point M should read 850 ohms. If C1 is shorted, the resistance between points X and M will be 550 ohms instead of 850 ohms. If the first test between points X and B1 indicated a shorted capacitor, the test from points X to M would merely be additional proof of this condition. Such a test must also be made to ascertain if the connection between choke coils L and L1 is intact and to check L1. It is true that troubles in the equipment usually occur singly, but there exists the possibility of a dual effect; consequently, all tests must be made.

d. Using X as the reference point, it is possible to continue checking the various sections of the system and to determine the condition of each and every winding or resistor in the rectifier. With X as one test point, the other test points alternately become Nos. 1, 2, 3, 4, 5, G, and both rectifier-tube anode terminals. A simpler method of checking can be used, however, as follows: Examine the wiring diagram of the rectifier, and note that the total resistance between X and either one of the tube anodes is the sum of the following: 300 ohms, 550 ohms, 4,700 ohms, 3,200 ohms, 3,000 ohms, 1,500 ohms, and 160 ohms. Thus, the total resistance equals 13,410 ohms. This will be correct if all the windings and resistors are intact and if the capacitors are not shorted.

e. Shorted filter capacitors prevent rectifier tests of any kind when the rectifier is in service, because of the unavoidable overload and the possibility of damage to the rectifier. Consider each of the capacitors shown with respect to short circuits and the effect upon the total resistance measurable between X and one of the tube anodes.

(1) If C is shorted, the resistance between X and the rectifier plate is 160 ohms. The reason for this is, obviously, that the shorted capacitor short-circuits the filter system but has no bearing upon the d-c resistance of the plate winding.

(2) If C1 is shorted, the total resistance becomes 13,110 ohms, showing a decrease of 300 ohms from

the required value. Obviously, the 300-ohm winding is shorted.

(3) If C2 is shorted, the total resistance becomes 460 ohms. With the 160-ohm plate winding having a fixed value, an additional 300-ohm circuit resistance is required to total 460 ohms. Consequently, the short circuit occurs at the junction of the 300-ohm unit and the remainder of the system.

(4) If the measured value is 1,010 ohms it consists of the rectifier winding and the two chokes.

(5) If C4 is shorted, the total resistance is 5,710 ohms, since the 1,500-ohm, 3,000-ohm, and 3,200-ohm sections are shorted out of the circuit.

(6) If C5 is shorted, the total resistance is 8,910 ohms, since the 3,000 and 1,500-ohm sections are shorted.

(7) If C6 is shorted, the total resistance is 12,910 ohms.

NOTE: Tolerance values have not been considered in the examples given above. Remember, however, that tolerance values must be taken into consideration when making actual measurements within the equipment. Since normal tolerance values range from 1 percent up to 10 percent, the readings obtained will vary up to 10 percent from the rated values.

40. RESISTANCE MEASUREMENTS BETWEEN TUBE SOCKET CONTACTS AND CHASSIS.

a. General. As was explained previously, resistance measurements are taken between the socket contacts and the chassis after the trouble has been

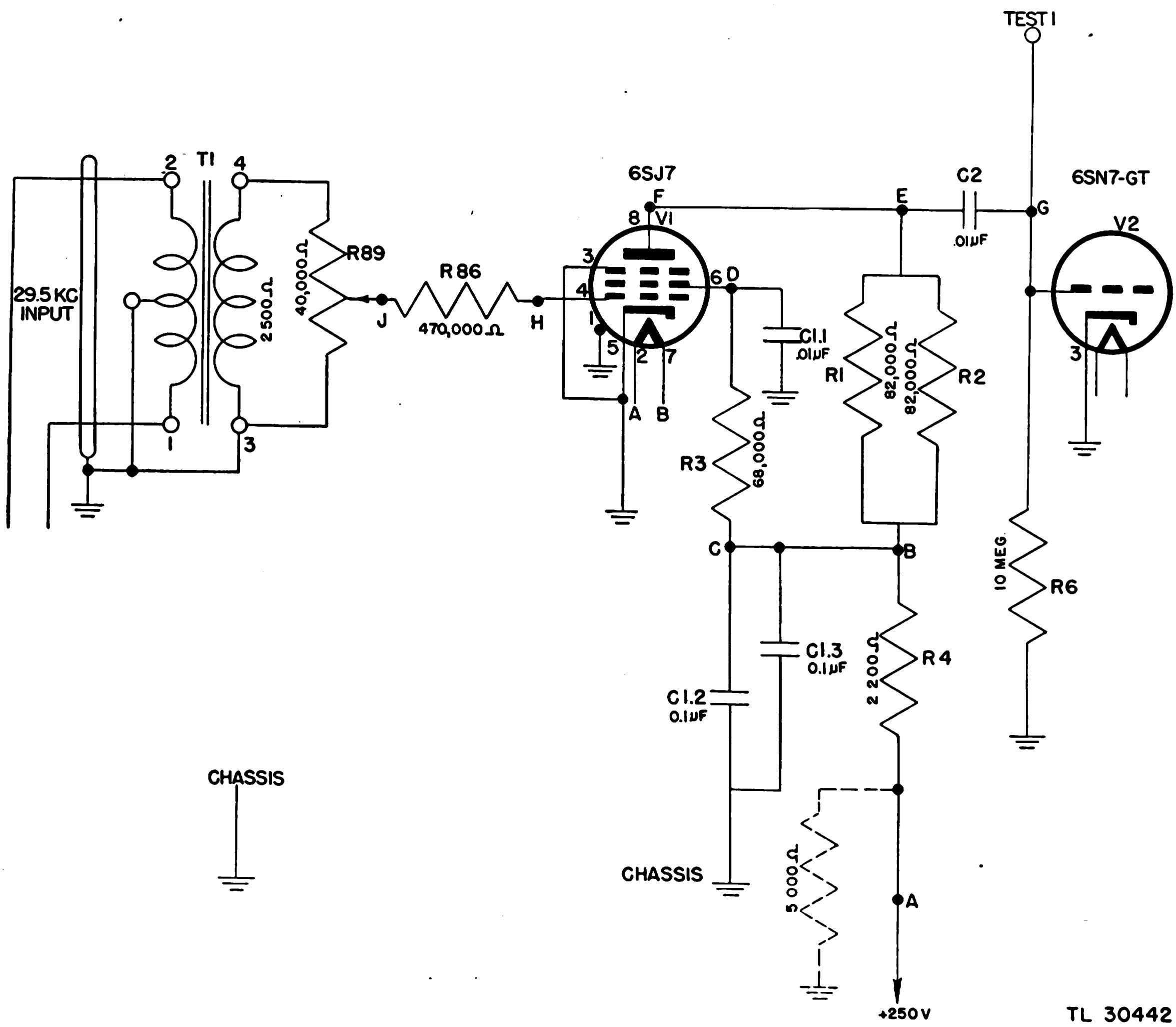


Figure 73. Resistance measurements functional schematic.

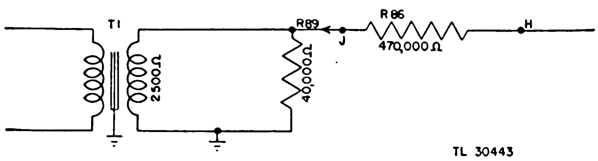


Figure 74. Resistance measurements functional schematic.

localized to a single stage of the equipment. Although resistance measurements may be used to localize trouble to a single stage, the procedure would take too long. Instead, the start-stop procedure senses, signal tracing, and signal substitution (all described in other sections of this manual) are used to locate the defective stage speedily. The following material consists of a few practical examples which show how resistance measurements are used to localize the trouble to the individual part within a defective stage.

b. Practical Examples. Figure 73 shows the schematic diagram of amplifier stage V1 in an oscilloscope. Signal tracing proved that the input voltage to the secondary of transformer T1 was normal, but that the input voltage to the grid of V2 was abnormal. This meant that the trouble had been localized either to the amplifier stage V1 or to its associated circuits. The tubes V1 and V2 were first checked and found normal. The d-c input voltage (marked +250v) from the rectifier supply was also normal. If this voltage had been abnormal, the trouble probably would be within the rectifier circuits. Voltage measurements were also made between socket contacts 2 and 7 to check the heater voltage; the check showed that the proper voltage existed. These steps were preliminary to the resistance tests of the stage. Resistances between the socket contacts and the chassis were then made and compared with the normal values listed below. (All

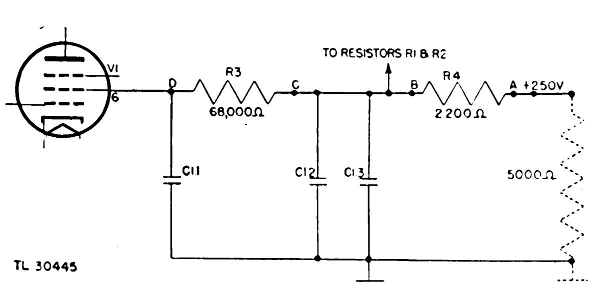


Figure 75. Resistance measurements functional schematic.

values have a plus or minus 10 percent tolerance.) The resistance measurements in the subparagraphs below will determine the abnormal condition unless the trouble is an open-circuited capacitor or a defective tube socket.

Resistance measurements between socket contacts of tube VS1 and chassis

Socket contact No.	Resistance measurement (ohms)
1	0
2	0
3	0
4	500,000
5	0
6	75,200
7	0
8	48,200

(1) If zero resistance is not obtained between socket contact 1 and the chassis, the only possibility could be a broken connection or a poorly soldered joint.

(2) Socket contact 2 is one of the heater connections and is covered under voltage measurement in subparagraph *a* preceding.

(3) If zero resistance is not obtained between socket contact 3 and the chassis, the only possibility could be a broken connection or a poorly soldered joint.

(4) If a reading of approximately 500,000 ohms is not obtained between socket contact 4 and the chassis, this circuit must be traced in the following manner:

(*a*) Measure the resistance between points H and J in order to test R86. The resistance should be 470,000 ohms plus or minus 10 percent. If it is not, the resistor is defective. (Point J will be the center contact or moving arm on potentiometer R89.)

(*b*) Measure the resistance between H and the chassis. When the potentiometer is rotated to maximum clockwise, a simple series-parallel circuit is obtained, and it should have a resistance of 472,350 plus or minus 10 percent. This circuit is shown in simple form in figure 74. A double check is made by moving the ohmmeter leads to test between point J and the chassis. This check should show approximately 2,350 ohms resultant resistance of the parallel circuit, because resistor R86 is no longer being measured. The first test, however, checked the connections between points H and J. If this test showed an abnormal resistance, follow the method of checking described in subparagraph (*e*) following.

(*c*) Measure the resistance between J and the chassis when the potentiometer is rotated completely counterclockwise. The resistance measurement should be practically zero. If not, follow the method described in subparagraph (*e*) following.

(*d*) Measure the resistance between J and the chassis when the potentiometer is set at midscale. A simple parallel circuit is now obtained with part of the resistance of R89 in one branch and part in the other branch (fig. 74). The resistance should be 10,585 ohms plus or minus 10 percent. If not, follow the method described in subparagraph (*e*) following.

(*e*) If any of the measurements in subparagraphs (*b*), (*c*), or (*d*) is abnormal, the leads to transformer T1 and to potentiometer R89 should be disconnected and these parts should be tested individually. When testing transformer T1, measure the resistance from each of the five terminals to the core or chassis. This will check the possibility of a short between the winding and the transformer core.

(5) If zero resistance is not obtained between socket contact 5 and the chassis, the only possibility could be a broken connection or a poorly soldered joint.

(6) If 75,000 ohms is not obtained between socket contact 6 and the chassis, an abnormal condition is indicated. Using the basic circuit shown in figure 75, the reason for the abnormal condition can be determined by the method described below:

(*a*) Measure the resistance between point A and the chassis. In this case it is 5,000 ohms and represents the resistance in the rectifier supply and other parallel circuits. This resistance will not influence the operation of the stage as far as voltage input at point A is concerned.

(*b*) Measure the resistance between point B and the chassis. This should read 5,000 and 2,200 ohms or a total of 7,200 ohms. If the resistance is greater, resistor R4 is defective; if the resistance is less, capacitor C1.2 or C1.3 is probably leaky or shorted.

(*c*) Measure the resistance between point C and the chassis to check the connection between points B and C. This resistance should also read 7,200 ohms.

(*d*) Measure the resistance between point D and the chassis. This should show 75,200 ohms, which is the sum of 5,000, 2,200, and 68,000 ohms. If this resistance is greater, resistor R3 is defective; if this resistance is less, capacitor C1.1 is probably leaky or shorted.

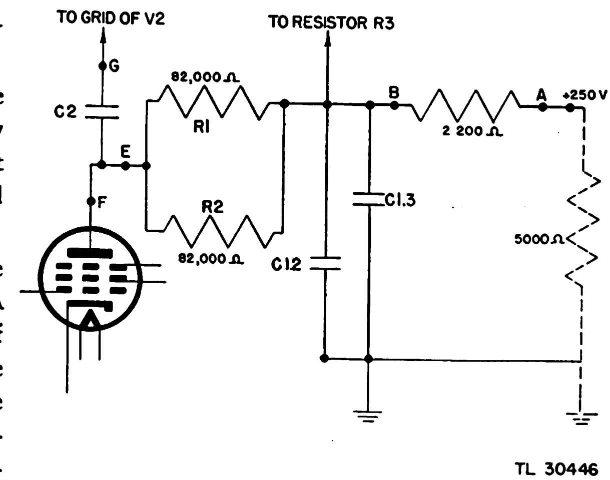


Figure 76. Resistance measurements functional schematic.

NOTE: In all tests, do not overlook the possibility of a poorly soldered connection or a short circuit of parts or leads to the chassis or other parts. It is a good policy to complete the tests between all points before disconnecting or replacing any parts, because two or more abnormal measurements may be traced to one defective part.

(7) Socket contact 7 is one of the heater connections and was covered under voltage measurement.

(8) If 48,000 ohms is not obtained between socket contact 8 and the chassis, an abnormal condition is indicated. Using the basic circuit in figure 76, the abnormal condition may be determined in the following manner:

(*a*) Measure the resistance between point A and the chassis; this resistance will be 5,000 ohms [see explanation for socket contact 6 in subpar. (6) (*a*) above].

(*b*) Measure the resistance between point B and the chassis. This will be 7,200 ohms [see explanation under socket contact 6, subparagraph (6) (*b*) above].

(*c*) Measure the resistance between point E and the chassis. This should show the sum of 5,000, 2,200, and the resistance of the parallel combination of resistors R1 and R2, which is 41,000 ohms. The three combined total 48,200 ohms, allowing a plus or minus 10 percent tolerance. If this measurement is 41,000 ohms greater than normal, or 89,200 ohms, it indicates that either R1 or R2 is defective. If an open circuit is obtained (no reading), R1 and R2 are probably defective. But, if these resistors are normal, the trouble is a broken connection or a poorly soldered joint.

(9) The tests are now complete except for the coupling circuit to the grid of V2, where originally the signal input had been found abnormal. The coupling capacitor C2 is first checked for a leaky or shorted condition by measuring the resistance between points E and G. The reading should show infinity. The cathode and grid circuits of V2 must also be checked, because these will influence the signal input to V2.

NOTE: It was observed when checking between socket contacts 6 and 8 and the chassis that two tests were common. For this reason, it is advisable to complete the resistance test for a stage before replacing any parts. Thus a double and sometimes a triple check can be made and the defective part positively identified before any parts are replaced.

41. USE OF WIRING DIAGRAMS AND KNOWLEDGE OF SCHEMATICS. The technician should become thoroughly familiar with all wiring diagrams and schematics in the equipment so that he can make resistance tests quickly. Series, parallel, and series-parallel circuits should be studied, and also the indications of trouble in such events. While schematics are most useful for studying the circuits, the wiring diagrams must also be known so that the technician can trace the physical layout of parts and connections.

42. SUMMARY OF RESISTANCE MEASUREMENTS.

a. Make allowance for tolerance values.

b. In any series circuit, the total resistance is the sum of the individual resistances.

c. Assuming that a capacitor is good, the connection of a capacitor ***in shunt*** with a resistance in any circuit will not affect the d-c resistance measurement.

d. The d-c resistance of a good mica or paper capacitor is over 50 megohms per microfarad and can be considered as an open circuit, or infinity, in d-c measurements.

e. The resultant resistance of any parallel combination is less than the resistance of any one of the units in the parallel combination. Actually the resistance is less than the lowest resistance in the combination.

f. Series-parallel systems are a combination of series and parallel circuits.

g. When making resistance tests, ***critically*** examine the circuits for a possible parallel connection.

h. The power source is ***always turned OFF when making resistance tests.***

i. Capacitors should always be discharged before making resistance measurements. This is especially necessary when high-voltage capacitors are involved.

j. When using the ohmmeter, make sure a good contact is obtained between the test leads and the test points.

k. In measuring high-resistance values, do not allow the fingers to touch the test leads or test points, because this will affect the readings.

l. When measuring resistances with an ohmmeter which has several ranges of resistance readings, be certain to select the proper range, especially on low-resistance values.

m. The final resistance test of a defective part should be made while this part is disconnected from all other parts.

n. Resistance tests should always ***precede*** voltage tests in rectifier supplies, because of the possible damage to the rectifier if power were to be applied.

SECTION III

LOCALIZATION OF FAULTS USING THE STARTING PROCEDURE

43. INTRODUCTION.

a. The starting procedure below repeats in detail the step by step procedure required to place Radio Set AN/TPS-3 in operation. Each step in the procedure requires the completion of a specific action or series of related actions. If the equipment is normal, each of the actions indicated in the step-by-step procedure should produce certain definite results. Most of these results can be seen on scope screens or on meters or heard as the procedure is followed step by step.

b. If the expected result of any given step is not obtained, it is evident that a defect exists. In each step of the procedure, the particular component or part which may be the cause of this abnormality, is listed. By following this system throughout the start procedure, defects are readily located and simple faults may be remedied.

44. STARTING STEPS.

a. STEP NO. 1

(1) With the power unit in operation, check to make sure that the modulator switch (MODULATOR SWITCH ON POWER UNIT PU/-TPS-1) is in the ON position.

(2) *If the overload relay falls out, shut off the power unit and short the high voltage cable between the power unit and modulator, and check*:

(*a*) Power plug, connecting power unit to modulator, for shorts.

(*b*) Inside the accessible section of modulator at the power terminals for shorts.

(*c*) Power unit for shorts in wiring between plug outlet and overload relay. Refer to TM 11-933 for trouble shooting in the power unit.

b. STEP NO. 2.

(1) Check the tent fan, console ventilating fan, and transmitter blower for proper operation.

(2) *If fans are not operating, check*:

(*a*) For 24 volts d-c at plug board on lower left side of console. Use volt-ohmmeter to check this voltage, by simply plugging the test prods into the 24-volt outlets.

(*b*) *If the 24 volts d-c is not present, check*:

1. D.-C. overload relay in power unit.
2. Power cables between the power unit and console and their corresponding plugs, for broken leads.

c. STEP NO. 3.

(1) Turn ANT. SPEED control half way up. Throw TRACK-PPI switch to the TRACK position and push TRACK LEFT-RIGHT switch first to the right and then to the left. Antenna should rotate clockwise and counter-clockwise, respectively.

(2) *If antenna does not rotate, check*:

(*a*) Indicator unit. See that it is properly engaged with the plug board at the rear of the console. It must be pushed all the way into the console.

(*b*) The drive-chain tension on the drive sprocket, with the receiver removed from the console. Also check for torque and slack in rotating the antenna from left to right.

(*c*) Continuity of field and armature windings on motor.

(*d*) Wiring connecting the drive motor to its current source in the console.

NOTE: When the load on the motor is excessive, a loud clicking noise is heard. This is the ratchet clutch slipping. Look for something obstructing or arresting the rotation of the antenna.

d. STEP NO. 4.

(1) Check the antenna to see that it is not obstructed. *If antenna is obstructed by tent ridgepole*:

(*a*) Raise the console by using leveling screws.

(*b*) If the ground is soft, additional support under leveling platform may be needed.

(*c*) Tent poles may have sunk into the ground.

(*d*) Check leveling of console with carpenter's level.

e. STEP NO. 5.

(1) Set meter switch to the TOTAL B+ position. Throw MAIN POWER SUPPLY switch to the ON position, and check to see that meter reads between 0.5 and 0.7 ma.

(2) If meter reads more than 0.7 ma, throw the MAIN POWER SUPPLY switch to OFF position IMMEDIATELY.

(*a*) Excessive current drain may result from many sources in the receiver or indicator units. Refer to detailed trouble shooting procedure in sections V and VI.

(*b*) If meter reads less than 0.5 ma, also refer to section V.

f. STEP NO. 6.

(1) With MAIN POWER SUPPLY switch in the ON position, check the jewel pilot light on the indicator panel to see that it lights up.

(2) *If pilot light does not light up, check:*

(*a*) Control knob lights under hinge panel of indicator unit. *If these lights operate, check condition of pilot light bulb.*

(*b*) Overload relay in power unit if no lights are operating.

(*c*) That receiver and indicator are firmly seated in console.

(*d*) Condition of fuse on receiver panel.

(*e*) Presence of 115-volt a-c at plug board on lower left side of console by inserting trouble light with extension, into a-c outlet. *If voltage is not present, check*: plugs and cables between unit and console. If a-c reaches console plug board, check: indicator and receiver power wiring and wiring from plug board at lower left side of console to the console units.

g. STEP NO. 7.

(1) Remove the 4-inch cover plate from the front of the transmitter box at bottom of console and inspect the filaments visually to see that they are lit.

(2) *If they do not light, throw MAIN POWER SUPPLY switch to OFF position, and check*:

(*a*) Fuses, located at front of console terminal board (lower left side of console in a small, black shield box).

(*b*) *If fuses are OK, refer to detailed trouble shooting procedure in section IV.*

h. STEP NO. 8.

(1) Set meter switch (on receiver panel) to the R-F AMPL #1 position. Meter should read from 0.5 to 0.6 ma. If reading is off, adjust the BIAS #1 control until meter reads proper value.

(2) *If reading cannot be changed by this adjustment, check*: Bias #1 control for poor connections (inside receiver) or defective tube. Refer to section V detailed trouble shooting procedure.

(3) Set the meter switch to the R-F AMPL #2 position. Meter should read 0.5 to 0.6 ma. as in the case of R-F AMPL #1. *If reading is off,* adjust BIAS #2 control until the reading is the proper value.

(4) *If reading cannot be changed by this adjustment,* check the BIAS #2 control for poor connections.

(5) Set the meter switch to the XTAL position. Meter should read from 0.4 to 0.9 ma.

(6) *If meter is off* adjust R-F PLATE #2 control (on front of receiver panel) until current rises to a peak. This is about the proper operating point and should be between 0.4 and 0.9 ma. *If this adjustment has no effect on reading,* trouble is indicated in the receiver and most likely in the r-f stages. Refer to detailed trouble shooting procedure in section V.

i. STEP NO. 9.

(1) After a delay of not less than one minute after turning on MAIN POWER SUPPLY switch, throw the TRANSMITTER switch to the ON position. The screens of the "A" and PPI scopes should light up showing the two sweep lines.

(2) *If these sweep lines are not visible,* increase the "A" INT. control and the PPI INT. control, located under the hinge panel on the indicator unit. If adjustment of these controls does not light up the screens, refer to the detailed trouble shooting procedure in section VI.

j. STEP NO. 10.

(1) Check the sweep lines on the two scopes for erratic sweeps.

(2) *If no sweep lines appear on the scopes, or if the sweep is very erratic, the modulator and/or indicator may not be functioning properly. Check* the spark gap on the power unit through the circular peep-hole if sparking is normal.

(*a*) TURN OFF ALL POWER, including the power unit.

(*b*) Check the large high-voltage cable connecting the modulator to the console and the large (short) cable connecting the power unit to the modulator for proper connections.

(*c*) Remove lower panel on front of console and check wiring at terminals of pulse transformer. Refer to figures 79 and 80 for console wiring and schematic diagrams. If wiring and cables are OK, refer to the detailed trouble shooting in sections IV and VI for corrective measures for transmitter modulator, and the sweep circuits of the indicator unit.

k. STEP NO. 11.

(1) Check to see that horizontal sweep line on the "A" scope is centered properly on the screen and that the line is nearly as long as the face of the scope.

(2) *If the sweep line is not centered*:

(*a*) Adjust the "A" POS. control under the hinge panel on the front of the indicator unit.

(*b*) *If this has no effect*:
Look for trouble in the "A" scope (sweep amplifier section) of the indicator unit. Poor connections at the control are a likely defect. Refer to detailed trouble shooting in section VI.

(3) *If the sweep is not focused to a sharp, narrow line*:

(*a*) Adjust the "A" FOCUS control hinge panel on indicator unit.

(*b*) *If this has no effect,* look for trouble in "A" scope section of the indicator unit. Refer to detailed instructions in trouble shooting section VI.

(4) *If sweep line is not of proper length on any one range,(determined by moving the "A" RANGE switch through the three positions*:)

(*a*) Adjust the 20, 60, and 120 sweep length controls, located just below the "A" scope on the indicator panel, on the corresponding ranges of the range switch.

(*b*) *If any one of these controls has no effect on the length of the sweep line,* refer to the detailed trouble shooting section VI as there is trouble in the "A" scope sweep circuits of the indicator unit.

l. STEP NO. 12.

(1) Check to see that the sweep line on the PPI scope is centered properly. See that it starts from the center of the face of the scope, and extends to the outer edge on each of the ranges. Check all three ranges by setting the PPI RANGE switch on the lower left of the indicator panel to the 20, 60, and 120 positions, respectively.

(2) *If on any one or all of these range settings the sweep is not of proper length,* adjust the 20, 60, and 120 controls (screwdriver adjustments) just below the PPI scope, until the sweep length is correct. If these adjustments have no effect on the length of the sweep, refer to the detailed trouble shooting section VI, for corrective measures. The trouble is probably in the PPI sweep circuits.

(3) *If the sweep is not centered properly:*

(*a*) Remove the indicator unit from the console (do not support weight of indicator by handles or panel) and connect the extension cable between the unit and the console plug board at upper rear of console. This supplies the indicator unit with power, as shown in figure 77.

(*b*) Center the sweep by means of the PPI CENTERING controls located on the subchassis at the rear of the indicator unit.

(*c*) *If these controls have no effect (or insufficient effect) on the centering of the sweep,* refer to the detailed trouble shooting procedure in section VI. After repair has been made, return the indicator unit to the console. Be sure that it is all the way in and properly engaging the plug board in the rear of the console.

(4) If the PPI sweep is not focused to a sharp, narrow line, adjust the PPI FOCUS CONTROL under the hinge panel on the indicator unit. If this has no effect on the focus of the sweep, there is trouble in the PPI focus coil or power supply circuits of the indicator unit. Refer to the detailed trouble shooting procedure section VI.

m. STEP NO. 13.

(1) With the sweeps visible, properly focused and centered on the scope screens, and the "A" RANGE and PPI RANGE switches in the 120 range position, 12 marker pips (the 5th and 10th of which are about twice as long as the others) should be seen along the horizontal sweep line on the "A" scope. The twelve pips should point downward.

(2) On the PPI scope, these markers are represented as small brilliant dots along the sweep line. Two of these dots are heavier than the others, (the 5th and 10th, counting from the center of the scope to the outer edge.)

(3) *If these markers do not appear:*

(*a*) Adjust MARKER GAIN control on the front of the indicator panel.

(*b*) Increase 10 MI. SIZE and 5 MI. SIZE controls.

(4) If markers appear but the 50 and 100-mile markers do not occur as the 5th and 10th markers, adjust the 50 MI SYNC control until they do.

(5) *If no markers occur with any of these adjustments,* refer to section VI for trouble shooting details on the marker-pulse, multivibrator section of the indicator unit.

n. STEP NO. 14.

(1) Rotate the antenna by throwing the TRACK LEFT-RIGHT switch on the indicator panel to either the right or left, making sure that the TRACK-PPI switch is in the TRACK position. As the antenna is rotating, view the PPI scope to see that the concentric circles, produced by the markers (dots) along the sweep line, are symmetrical.

(2) *If the pattern produced is not quite circular:*

(*a*) Shut off the TRANSMITTER switch and then the MAIN POWER SUPPLY switch.

(*b*) Remove the indicator from the console and attach the extension cable (patch cord) between it and the plug board at the upper rear of the console. This will supply the indicator unit with power.

(*c*) Turn on the MAIN POWER SUPPLY switch and allow one minute for the tube filaments to warm up, then throw the TRANSMITTER switch to the ON position.

(*d*) Start the antenna in rotation again and adjust the CIRCULARITY control, located on the elevated chassis at the rear of the indicator unit, until the marker circles become exactly symmetrical.

(3) *If adjustment of this control does not affect the shape of the marker circles, the trouble is apparently in the indicator unit.* Refer to the detailed trouble shooting procedure on the sweep amplifier section of the indicator unit in section VI. After repair of trouble, shut off the power, replace indicator unit in console, and turn on the power again.

o. STEP NO. 15.

(1) Increase the RECEIVER GAIN control until receiver noise (grass) is seen along the horizontal sweep of the "A" scope. Also, be sure that the PPI GAIN control on the indicator panel is turned up to a point where noise just appears on the PPI scope. As the antenna is rotated, echoes, (pips extending upward from the horizontal sweep line on the "A" scope) should be seen. These echoes appear as arcs on the PPI screen.

(2) *If these indications do not occur,* check OUTPUT UNITS meter on the receiver panel to see that the transmitter is delivering power to the antenna.

CAUTION: BE CAREFUL OF THIS METER AND DO NOT JAR IT AGAINST ANYTHING AS IT IS VERY DELICATE. NEVER MAKE A CONTINUITY CHECK ON IT AS THE METER WINDING WILL BURN OUT!

(3) *If OUTPUT UNITS meter reads zero but the transmitter is noisy or makes a hissing sound,* remove the panel from the lower front of the console and adjust the capacity stub tuners on the floor of the console. Tune for maximum indication on the OUTPUT UNITS meter and/or minimum noise from the transmitter.

(4) If OUTPUT UNITS meter still reads zero, shut off *ALL* power and refer to the detailed trouble shooting procedure in section IV, under transmitter. It is possible that the high-voltage pulse from the modulator is not getting to the transmitter tube. Trouble may also be in the OUTPUT UNITS meter (on receiver panel) or its associated circuit.

(5) If OUTPUT UNITS meter is OK (about half scale) and no echoes can be seen, retune the receiver as prescribed in TUNING PROCEDURE in TM 11-1340.

(6) If no echoes are obtained while the antenna is rotated after retuning the receiver,

(*a*) Turn off all power at the console, remove the receiver from the console, and attach extension cable.

(*b*) Refer to detailed trouble shooting procedure in section IV.

(7) After receiver trouble has been located and repaired, remove the extension cable and return receiver to console, making sure that the receiver securely engages the plug board at the rear of the console and is seated firmly.

p. STEP NO. 16.

(1) Check echoes on indicator screen.

(2) *If echoes appear on the screen but seem to be small compared to the grass along the sweep line on the "A" scope:*

(*a*) Retune the receiver as described in TM 11-1340, going over the controls several times to peak the echoes on the "A" scope.

(*b*) If this does not improve echoes and/or any of the tuning controls on the receiver cause no effect on the size of the echo see detailed trouble shooting for the receiver in section V.

q. STEP NO. 17.

(1) Check the grass along the sweep on the A scope.

(2) *If echoes can be seen on the scopes but the grass along the sweeps on the "A" scope varies in height along the length of the sweep line, the anti T-R spark gap is not firing. To remedy this effect:*

(*a*) Shut off the TRANSMITTER switch and remove the lower panel from the console.

(*b*) Toward the back of the console is the anti T-R stub knurled screw adjustment (fig. 83).

(*c*) Turn this screw all the way clockwise until the contacts are touching.

(*d*) Back off the screw ¼ of a turn in a counter-clockwise direction. This gives a gap clearance of 0.10 inch and should remedy the variation of the grass on the "A" scope. If this gap is shorted, the size of even a strong echo will be reduced considerably.

(*e*) Retune the T-R box (directly above the anti T-R stub) for maximum size of signal on the "A" scope by moving the slider (along the top of the cylinder) in its slot.

(*f*) Replace lower front panel on the console.

SECTION IV

TROUBLE SHOOTING THE MODULATOR, TRANSMITTER AND TRANSMISSION LINE

45. INTRODUCTION. This section of the chapter discusses trouble shooting in the modulator, transmitter, and transmission line systems of Radio Set AN/TPS-3. These units are broken down into several headings which represent the most significant symptoms. For the most part, these symptoms are of trouble likely displayed on the scopes of the indicator unit. Also the OUTPUT UNITS meter on the receiver panel and the sound of the corona discharge around the transmitting tube play a large part in determining the source of the trouble.

46. SYMPTOMS AND THE LOCATION OF TROUBLE.

a. Scopes Normal But OUTPUT UNITS Meter Reads Zero. (1) The echoes received from targets appear on the screen as pips of normal amplitude, and the sizzling transmitter noise is at a

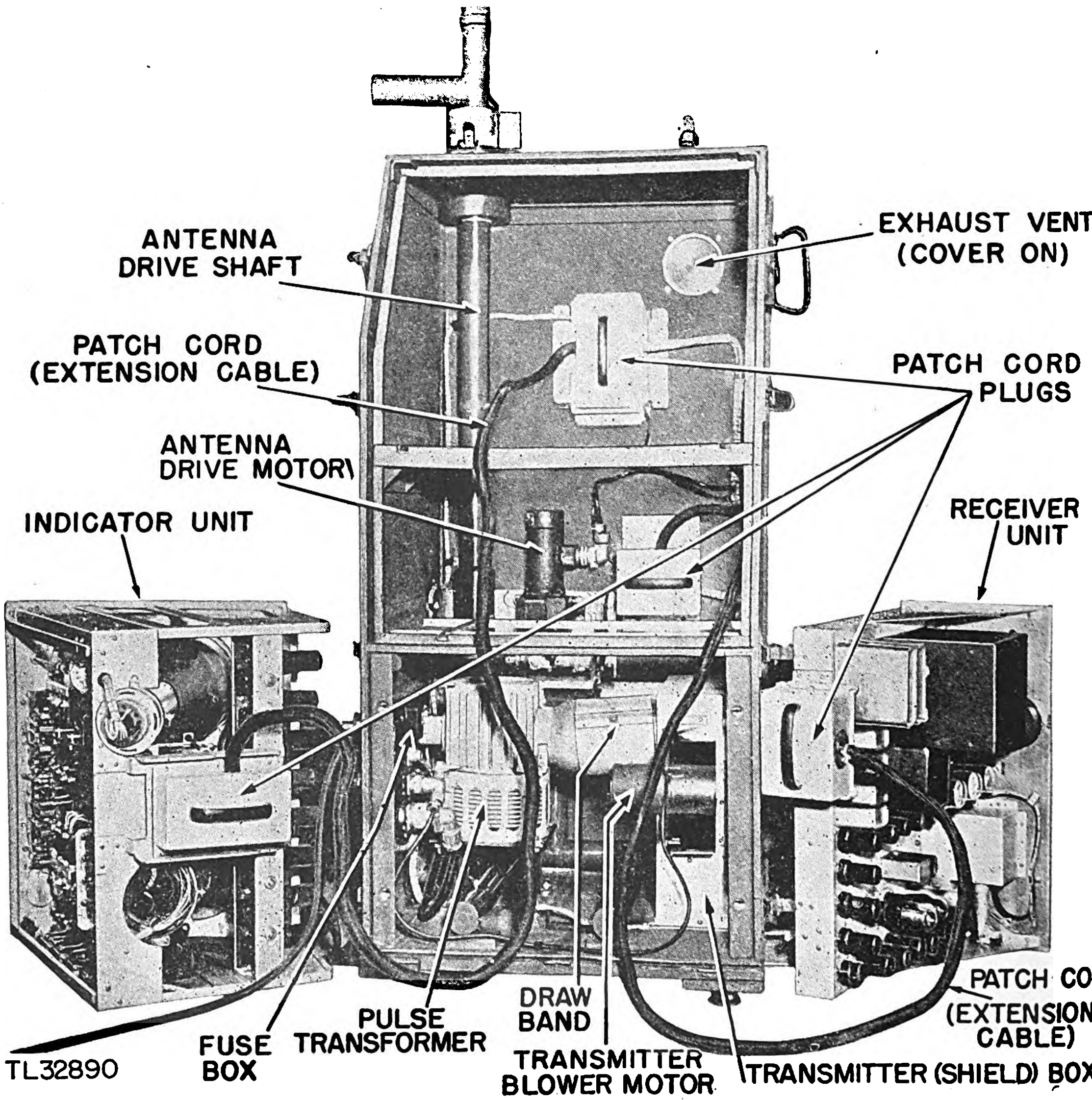


Figure 77. Console with chassis removed.

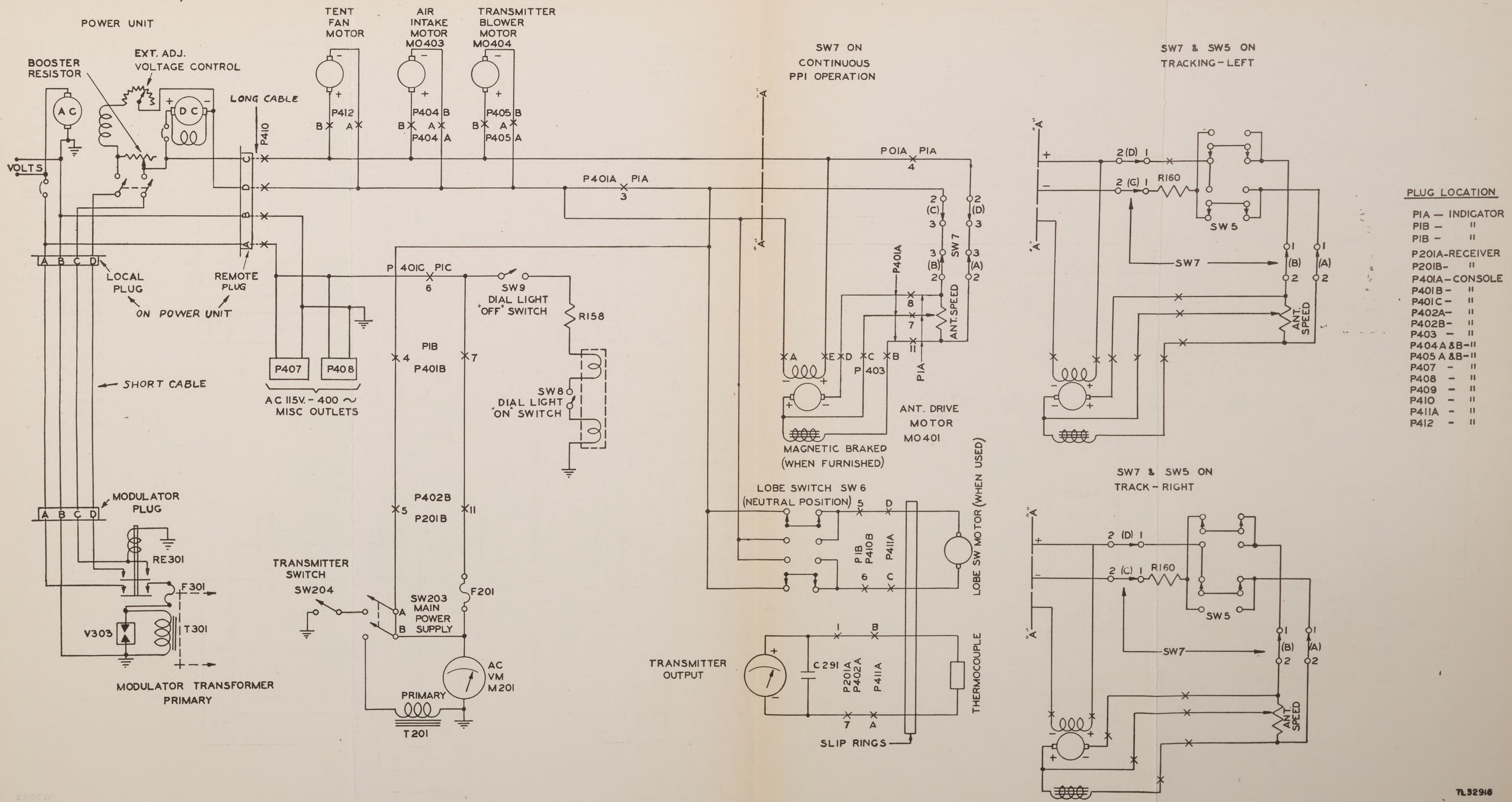


Figure 78. Simplified power distribution diagram.

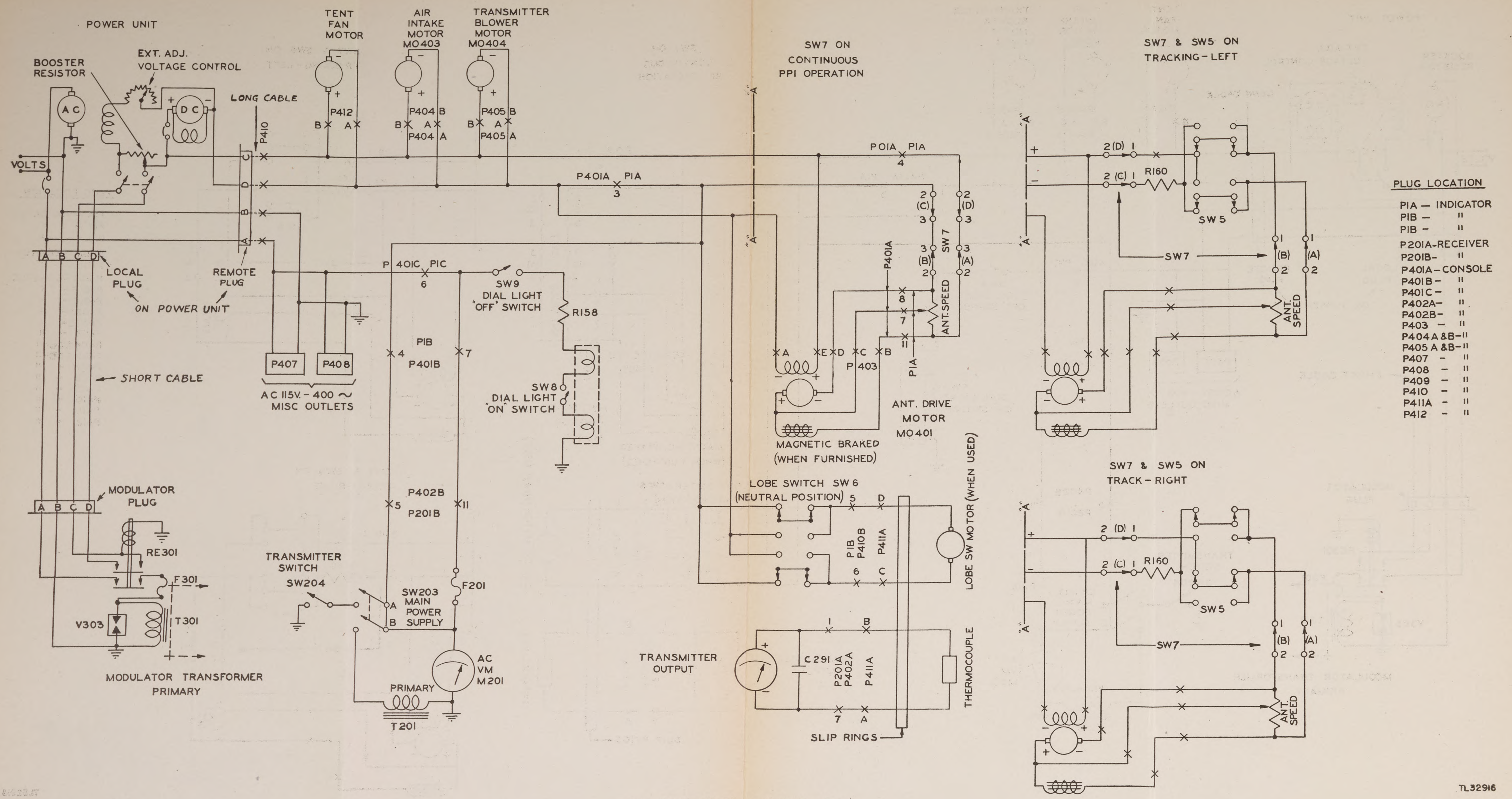


Figure 78. Simplified power distribution diagram.

minimum. The OUTPUT UNITS meter does not indicate any output from the transmitter. The OUTPUT UNITS meter is probably at fault.

(2) Remove the receiver from the console and inspect the wiring from the output meter to the plug board assembly at the rear of the receiver. If this checks OK, keep the receiver out of the console and check the brushes, slip rings, and housing just above the console. Frequently these brushes which connect the thermocouple to the output meter, become dirty, or the brush spring tension becomes inadequate. The brushes may be removed and cleaned with fine sandpaper.

(3) If these slip rings and brushes are OK, check the thermocouple dipole assembly in the lower portion of the parabola for continuity. If the thermocouple is open, it must be replaced. Normally this unit does not cause trouble unless it has been dropped or jarred.

(4) If all leads and cables are intact, brushes are clean and making good contact, and the thermocouple is normal, the OUTPUT UNITS meter on the receiver panel is probably damaged and requires replacement. This meter is delicate and its internal resistance is extremely low. Never check for continuity across its terminals for there is danger of damaging the coil. Check to see that the shorting wire across the meter has been removed. The wire is used as a precautionary measure during shipment of the set and should be removed for operation.

b. No Corona Discharge, No Echoes on Scopes, Zero Output on OUTPUT UNITS Meter, Sweep Normal.

(1) The fact that the screen of the scope shows no echoes being received and the OUTPUT UNITS meter reads zero, is almost a certain indication that the transmitter or the transmission line is at fault. However, if the transmitter has no sizzling sound when the stub tuners are adjusted, the trouble is immediately localized to the transmitter.

(2) To make sure that one or both of the high voltage windings in the pulse transformer are not open, a check must be made on the output of this pulse transformer to see that the pulse voltage is present and of the rated value.

(*a*) TURN OFF ALL POWER.

(*b*) Fasten a six inch piece of bare copper wire to the frame of the pulse transformer (fig. 82). Loosen the draw band between the pulse transformer and the transmitter box, and remove it. Bend the other end of the bare wire so that it is 3/8 inch from one of the two filament connecting leads to the transmitter box.

(*c*) Now start the power unit, and put the modulator switch ON. Throw the MAIN POWER SUPPLY switch to the ON position, and allow at least 30 seconds for the tubes in the console to reach operating temperature. Quickly throw the TRANSMITTER switch ON and OFF. DO NOT KEEP THE SWITCH ON FOR MORE THAN AN INSTANT OR DAMAGE TO THE EQUIPMENT WILL RESULT.

(*d*) If the gap breaks down, this shows that the correct value of pulse voltage is being fed to the transmitter and that the pulse transformer is operating properly. If the gap does not break down, the pulse transformer has been damaged and must be replaced. Turn off the power including the power unit and short the high-voltage cable as described in paragraph *e*. (12) below.

(*e*) Check for continuity between terminal No. 1 on the pulse transformer and one of the filament connecting leads to the transmitter tube (fig. 11). Check for continuity between terminal No. 2 on the pulse transformer and the other filament connecting lead. If either of the above mentioned checks on the continuity of windings on the pulse transformer show any one of these windings to be open, the pulse transformer must be replaced.

(3) Transmitter Tube.

(*a*) If the gap breaks down, or replacement of the pulse transformer (if a winding was open) does not remedy the trouble, the transmitter must be investigated. Making sure that all power is off and the high-voltage cable is shorted as described in subparagraph *e*. (12) below, remove the small cover plate on the lower front of the transmitter box. Reach in through the four-inch opening in the box, and with the fingers, check to see that the banana plugs which are attached to the leads from the plate caps of the transmitter tube are firmly pushed into the two holes on the end of the transmitter coupler. One of these holes is in the inner conductor pin, the other on the rim of the outer pipe.

(*b*) Start the power unit, turn the modulator ON switch ON, throw the MAIN POWER SUPPLY switch ON and by looking into the four-inch opening, check to see that the filaments light on the transmitter tube. If they do not light, check for filament voltage across the banana plug terminals at the pulse transformer.

(*c*) If the filament voltage is OK, check the transmitter tube. To do this, it is necessary to remove the transmitter box. Unscrew the knurled knob just inside the four-inch opening on the front of the box on the floor of the console. Also reach into the box through this opening and pull out the banana plugs from the transmitter coupler. Remove the banana plugs on the filament connecting leads from the pulse transformer. Remove the blower motor cord from the receptacle on the left side of the console. The box is on a track and may now be slid out of the console. On the right side of the box is a removable cover. Slide this out (fig. 86).

(*d*) Check the wiring from the tunable lecher line to the filaments of the tube (fig. 88). Make sure that all connectors are tight and free from corrosion. Make sure the transmitter shorting bar is kept clean at the point where it contacts the lecher line. Also make sure that this shorting bar is tightly clamped. Using the ohmmeter, check the filaments of the tube for continuity. If the filaments are open, the tube must be replaced.

(*e*) The resistance of the grid resistor should be checked. Its value is approximately 80 ohms. If this resistor is open, replace it.

(*f*) Assemble the transmitter tube and its components into the transmitter box. Return the box to the console by sliding it into the grooved plate at the base of the console. The banana plugs on the plate connector leads must be plugged into the transmitter coupler as mentioned previously. Plug the banana plug on the filament connecting leads into the jacks provided on the pulse transformer. Put back the knurled screw on the lower front of the transmitter box, and also return the draw band to its position between the pulse transformer and the transmitter box. Tighten the draw band screw on the top of the drawband.

(*g*) Turn on the power unit, throw the MAIN POWER SUPPLY switch ON and after a 30-second warm-up period for the tube filaments in the console, throw the TRANSMITTER switch ON.

(*h*) The plate of the transmitter tube has a characteristic dull red color when operating efficiently. If the tube does not show this color it must be replaced.

c. Corona Discharge at Transmitter Box, No Echoes on Scopes, Zero Output on OUTPUT UNITS Meter, Sweep Normal.

(1) When the transmitting tube is oscillating and delivering power to the antenna, only a small amount of sizzling noise emanates from the transmitter. If the R-F transmission line on the antenna is badly adjusted, loud arcing will be heard and the smell of ozone will fill the air. This arcing may be seen through the four inch opening on the front of the transmitter box jumping between the corona balls and around the filament line.

(2) Turn All Power off (including the power unit) and short the high-voltage cable as described in subparagraph *e*. (12) below, before proceeding further.

(3) Having checked the transmitting tube and its associated circuit, including the plate connector leads to see that they are plugged into the transmitter coupling stub, a check should be made on the transmission line feeding the antenna.

(4) Make sure that all couplings in the transmission line, including those within the console, are tight and not damaged. When these couplings are tightened, a good connection is automatically made, but it is possible that the transmission line may have been damaged before assembly to the extent that couplers do not engage properly (figs. 89 and 83).

(5) Check especially the inner conductor joint in the antenna hinge; both inner conductors should be well-centered before coupling so that they engage without short-circuiting the transmission line. The couplings within the console need very little attention other than to see that they are tight.

(6) The steel transmission line mast which fits into the coupler on top of the console must seat firmly against the stop at the bottom of its socket. Loosen the clamp, lift the mast slightly (not over ½ inch) and allow it to drop back. If it is seating properly, it can be felt to hit the stop in the socket.

(7) Next, check the transmission line inner conductor through the hub of the parabola. This is a separate piece which must be carefully plugged in before the dipole is coupled to the parabola. If it is in place but incorrectly seated, it may short circuit the transmission line to the antenna.

(8) In the interest of conserving weight, the transmission line, antenna structural support assembly, wind vane assembly, and antenna dipole supports are

PLUGS

P401A	FEMALE CONNECTOR (12 CONTACT)
P401B	FEMALE CONNECTOR (12 CONTACT)
P401C	FEMALE CONNECTOR (12 CONTACT)
P402A	FEMALE CONNECTOR (12 CONTACT)
P402B	FEMALE CONNECTOR (12 CONTACT)
P402C	FEMALE CO-AXIAL
P414A	MALE CO-AXIAL
P414B	FEMALE CO-AXIAL
P403	FEMALE (AN-3108-16S-8S)
P404A	FEMALE (AN-3102-12S-3S)
P404B	MALE (AN-3108-12S-3P)
P405A	FEMALE (AN-3102-12S-3S)
P405B	MALE (AN-3108-12S-3P)
P406A	FEMALE (AN-3102-18-5S)
P406B	MALE (AN-3108-18-5P)
P407	FEMALE (A.C. RECEPTICAL)
P408	FEMALE (A.C. RECEPTICAL)
P409	FEMALE (AN-3102-28-1S)
P410	MALE (AN-3102-20-14P)
P411A	FEMALE (AN-3102-16S-8S)
P412	FEMALE (AN-3102-12S-3S)
P413A	FEMALE (AN-3102-16S-1S)
P413B	MALE (AN-3108-16S-1P)

FUSES

F401	15 AMP. TYPE 4AG

MOTORS

MO401	24 V. D.C. SHUNT WOUND
MO402	ROTARY TRANSFORMER
MO403	24 V. D.C. SERIES WOUND
MO404	24 V. D.C. SERIES WOUND

CONDENSER

C401	.04 uf 1250 V. D.C.
C402, C403, C404, C405	1000 uuf 300V. D.C.

TRANSFORMERS

T401	PULSE TRANSFORMER

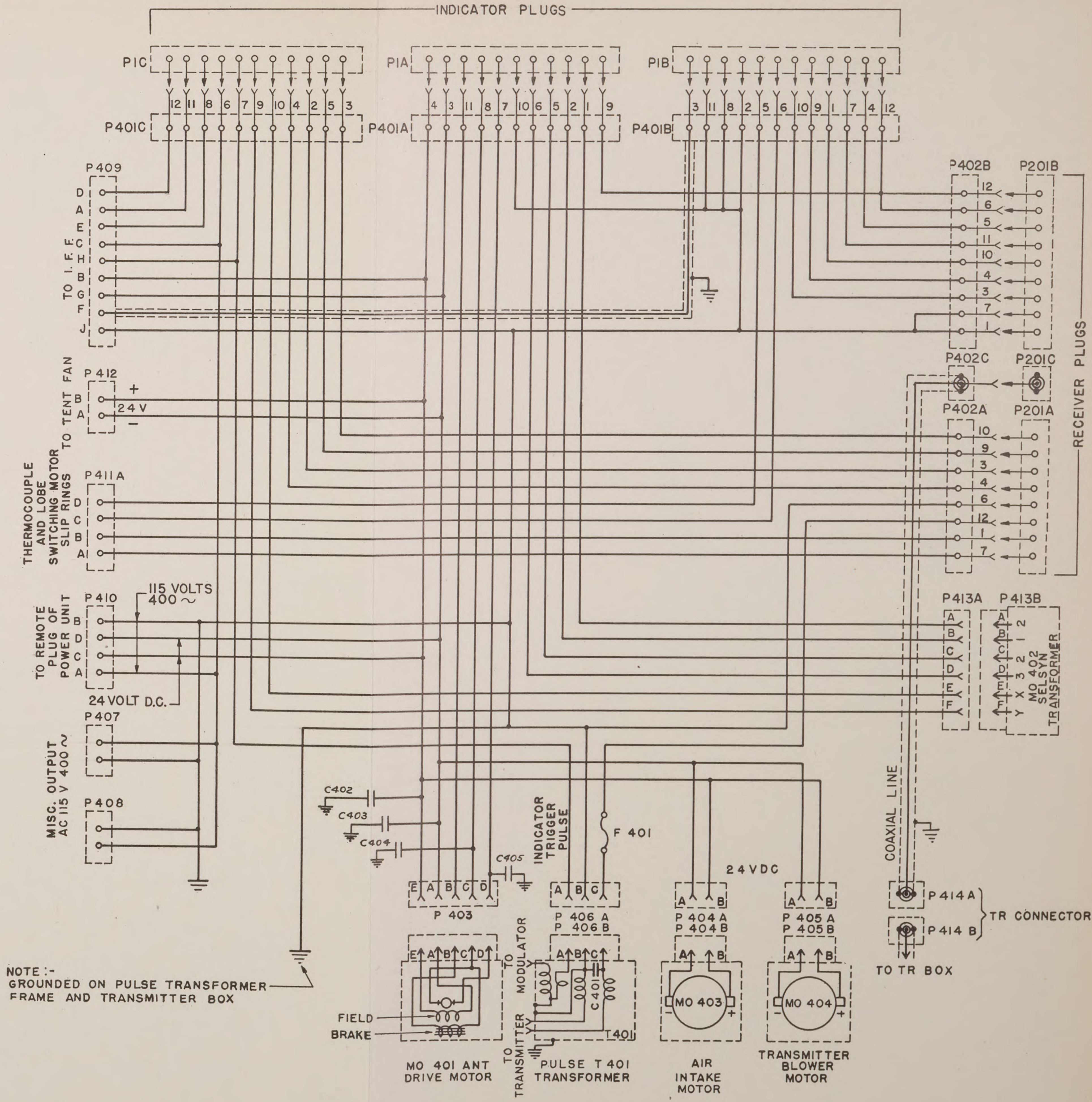


Figure 79. Console functional schematic.

PLUGS

P401A	FEMALE CONNECTOR (12 CONTACT)
P401B	FEMALE CONNECTOR (12 CONTACT)
P401C	FEMALE CONNECTOR (12 CONTACT)
P402A	FEMALE CONNECTOR (12 CONTACT)
P402B	FEMALE CONNECTOR (12 CONTACT)
P402C	FEMALE CO-AXIAL
P414A	MALE CO-AXIAL
P414B	FEMALE CO-AXIAL
P403	FEMALE (AN-3108-16S-8S)
P404A	FEMALE (AN-3102-12S-3S)
P404B	MALE (AN-3108-12S-3P)
P405A	FEMALE (AN-3102-12S-3S)
P405B	MALE (AN-3108-12S-3P)
P406A	FEMALE (AN-3102-18-5S)
P406B	MALE (AN-3108-18-5P)
P407	FEMALE (A.C. RECEPTICAL)
P408	FEMALE (A.C. RECEPTICAL)
P409	FEMALE (AN-3102-28-1S)
P410	MALE (AN-3102-20-11P)
P411A	FEMALE (AN-3102-16S-8S)
P412	FEMALE (AN-3102-12S-3S)
P413A	FEMALE (AN-3102-16S-1S)
P413B	MALE (AN-3108-16S-1P)

FUSES

F401	15 AMP. TYPE 4AG

MOTORS

M0401	24 V. D.C. SHUNT WOUND
M0402	ROTARY TRANSFORMER
M0403	24 V. D.C. SERIES WOUND
M0404	24 V. D.C. SERIES WOUND

CONDENSER

C401	04 uf 1250 V. D.C.
C402, C403, C404, C405	1000 uuf 300V. D.C.

TRANSFORMERS

T401	PULSE TRANSFORMER

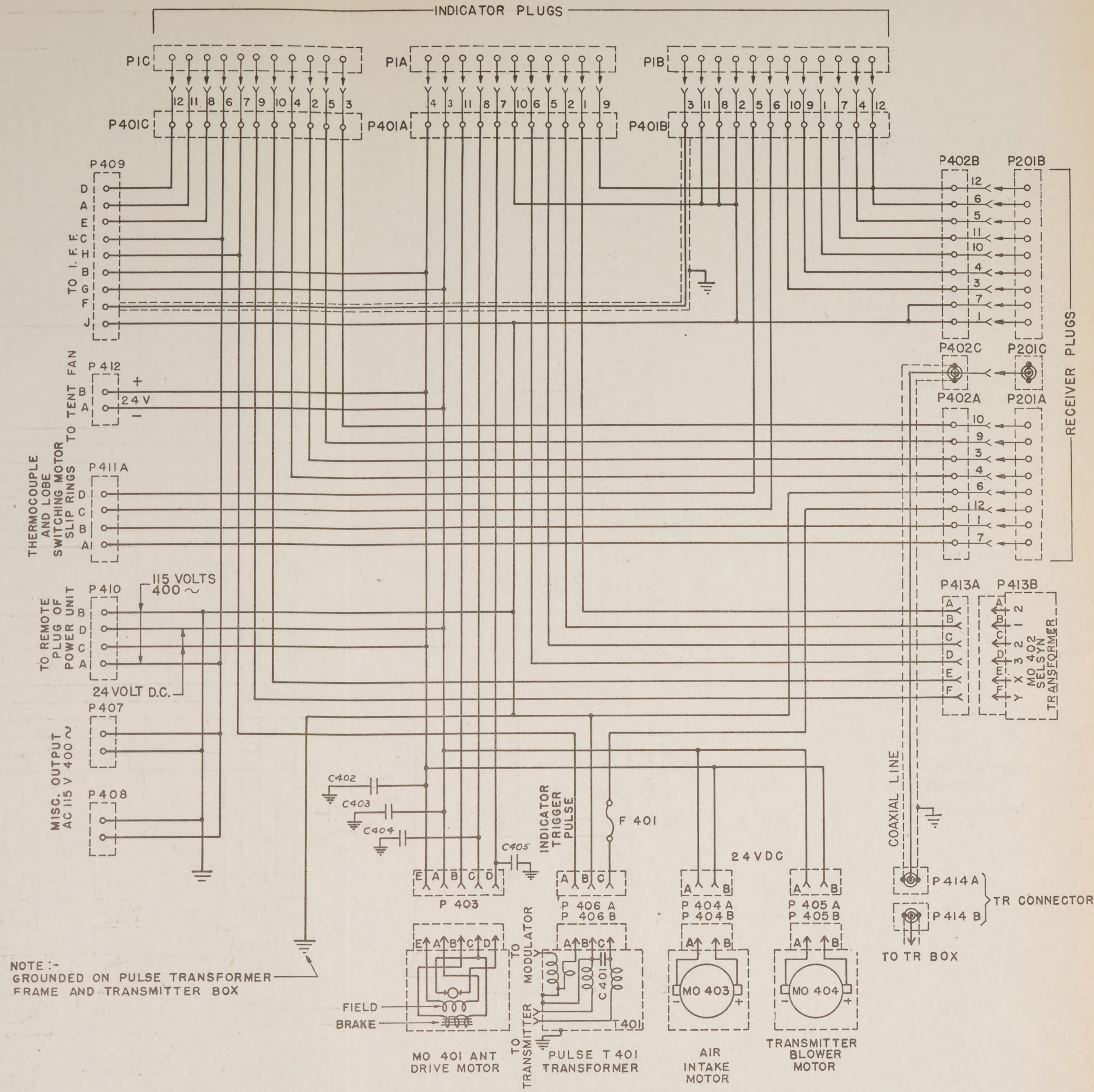
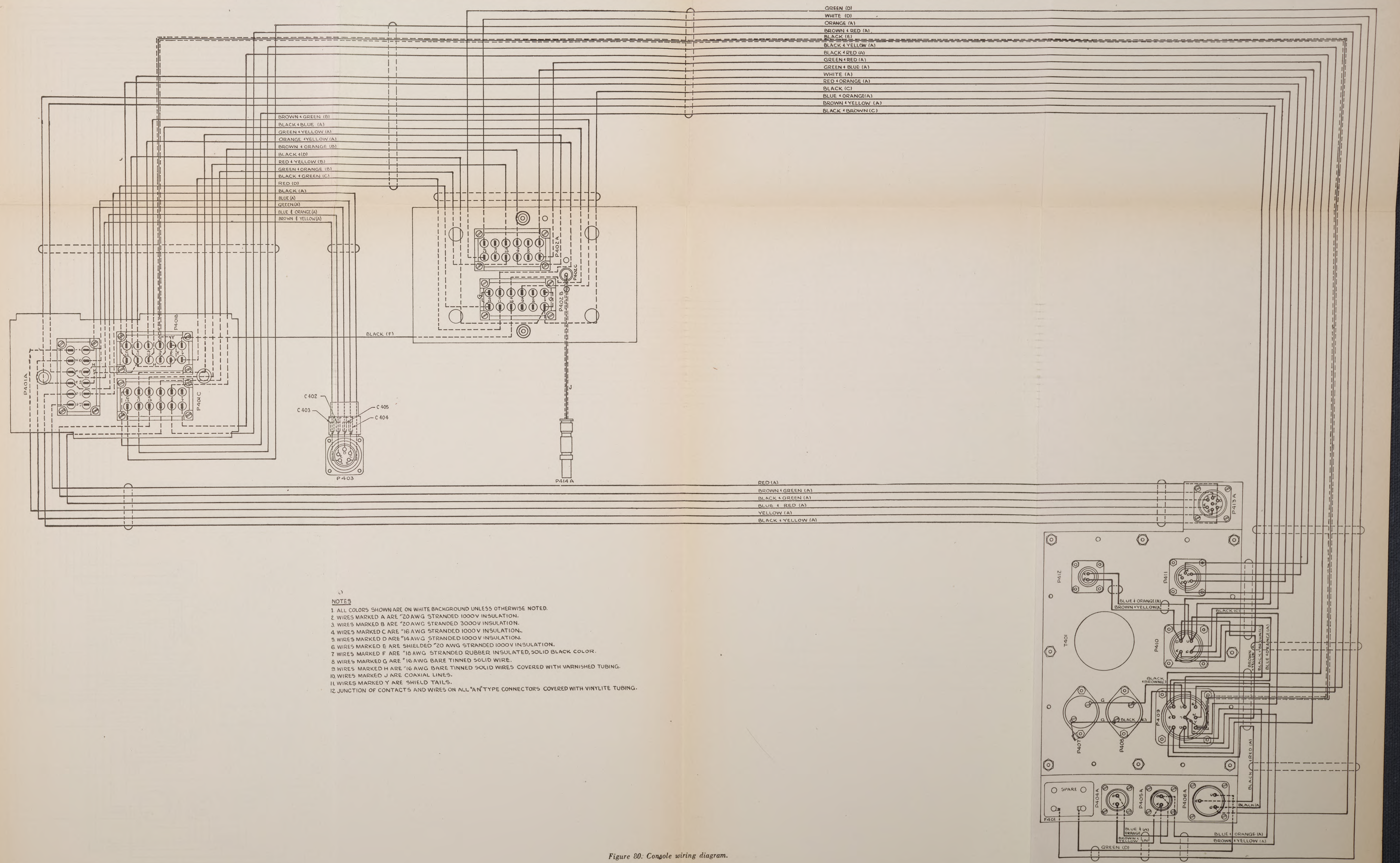


Figure 79. Console functional schematic.



NOTES

1. ALL COLORS SHOWN ARE ON WHITE BACKGROUND UNLESS OTHERWISE NOTED.
2. WIRES MARKED A ARE #20 AWG STRANDED 1000V INSULATION.
3. WIRES MARKED B ARE #20 AWG STRANDED 3000V INSULATION.
4. WIRES MARKED C ARE #16 AWG STRANDED 1000V INSULATION.
5. WIRES MARKED D ARE #14 AWG STRANDED 1000V INSULATION.
6. WIRES MARKED E ARE SHIELDED #20 AWG STRANDED 1000V INSULATION.
7. WIRES MARKED F ARE #18 AWG STRANDED RUBBER INSULATED, SOLID BLACK COLOR.
8. WIRES MARKED G ARE #16 AWG BARE TINNED SOLID WIRE.
9. WIRES MARKED H ARE #16 AWG BARE TINNED SOLID WIRES COVERED WITH VARNISHED TUBING.
10. WIRES MARKED J ARE COAXIAL LINES.
11. WIRES MARKED Y ARE SHIELD TAILS.
12. JUNCTION OF CONTACTS AND WIRES ON ALL "AN" TYPE CONNECTORS COVERED WITH VINYLITE TUBING.

Figure 80. Console wiring diagram.

TL 32944A

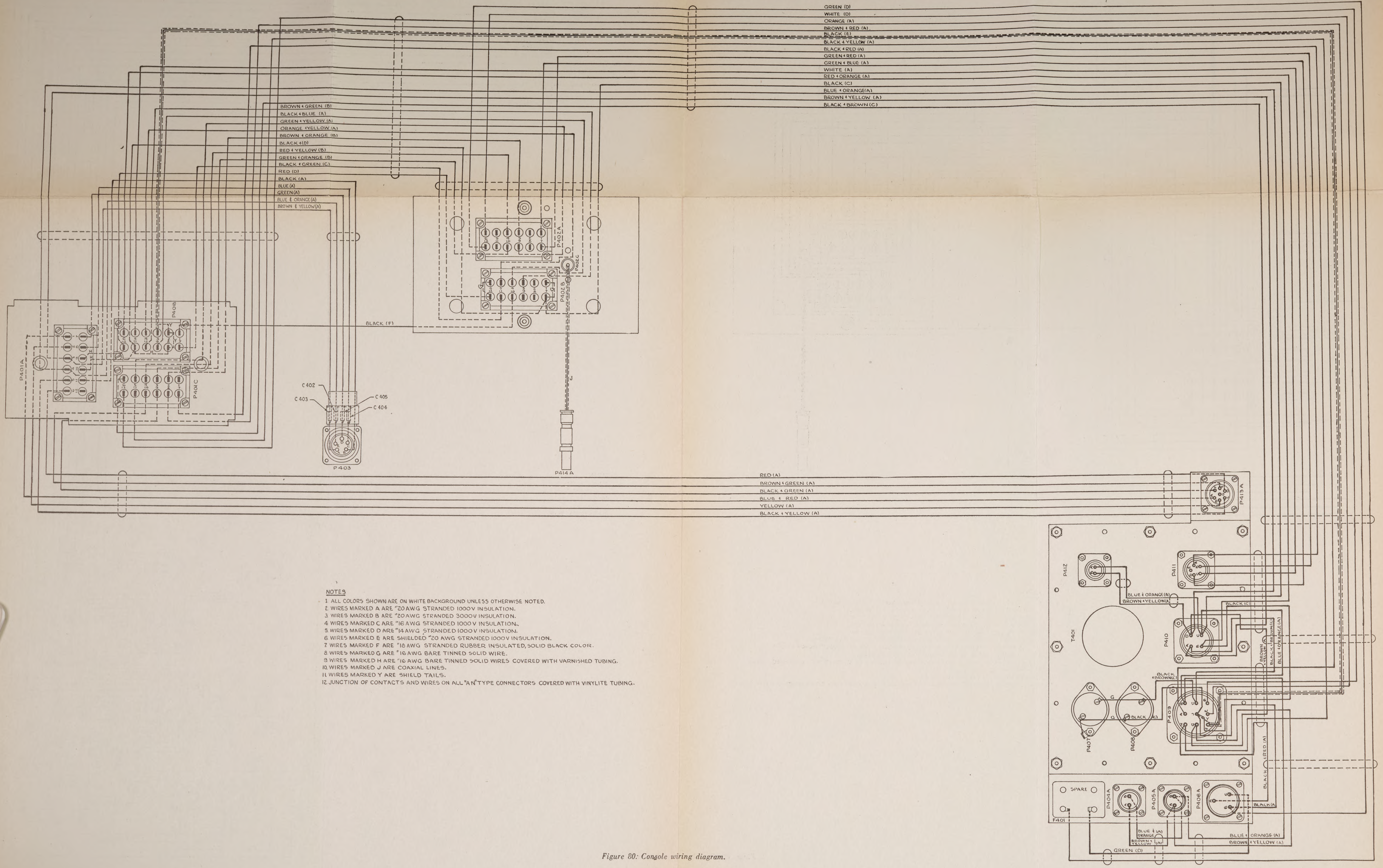


Figure 80: Console wiring diagram.

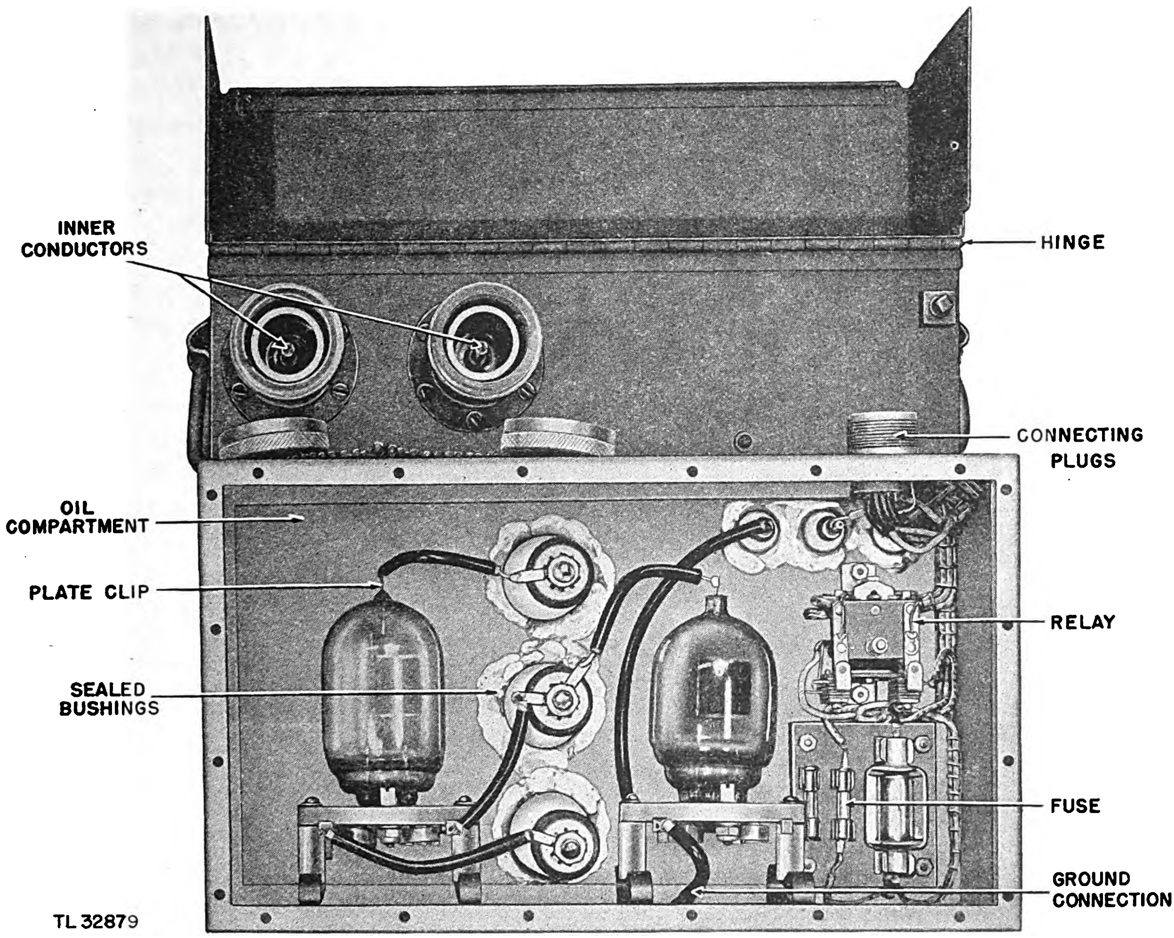


Figure 81. Modulator box with front cover removed.

constructed of thin wall tubing. If this tubing should be heavily dented, the transmission line may become short circuited or the spacing between the inner conductor and the outer tubing may be reduced to the point where arcing occurs. This may be detected by the sound of arcing within the tubing.

(9) Check the dipole assembly within the parabola to see that it has not been broken or badly dented. There should be no obstructions between the elements of the assembly.

(10) Even though the transmission line and antenna may be in proper working order, the transmitter is firing properly, and energy is being radiated by the antenna, still no echoes may be seen on the scopes. The transmission line to the receiver might be at fault. Check the connector on the coaxial cable between the T-R box and the receiver plug board at the rear of the console. Make sure that these connectors are properly engaged (fig. 83).

(11) Check the adjustment of the anti T-R spark gap. The knurled screw should be turned fully clockwise. The points of the gap are now touching. Turn the screw 1/4 of a turn counterclockwise. This is the proper gap-clearance and is about 0.010 inches. Frequently it is necessary to increase this gap a little. The best adjustment can be determined by viewing the "A" scope after an adjustment has been made. The grass should be of uniform gradation along the length of the sweep line.

(12) Check the tuning of the T-R box (figs. 83 and 84). The slider should be adjusted to about midway along the slot until echoes on the screen are of maximum height. If this has no effect, remove the T-R box from the end of the stub by loosening the screws. Remove the circular plate on the side of the box, and examine both this coupling loop and the loop inside the mounting stub. These should be clean and straight so they will fit into the slots in the T-R box (fig. 85). It may be

necessary to replace the T-R tube if damaged. This is extremely rare as the voltage at this point is not high enough to cause damage. The only method of determining damage to this tube, is to replace it with a new one, (see figure 85 for assembly) and observe the action on the scopes.

d. Sweep Erratic But Vertical Deflection On "A" Scope is Present and OUTPUT UNITS Meter Shows Output From Transmitter.

(1) Check to see that all power is off including power unit, and that the high-voltage cable is shorted as described in subparagraph *e.* (12) below.

(2) Remove the lower front panel from the console, and remove the plug to the ventilating fan. Check for continuity between terminals A and B on the male plug at the end of the cable from the pulse transformer (fig. 82). This is the secondary (tertiary) winding that supplies the indicator unit with its synchronizing voltage. Unsolder one lead from the capacitor C401 and check it for a short. If shorted, replace it with a new capacitor. If the capacitor is OK, solder the removed lead back to its terminal.

e. Sweep Erratic and No Vertical Deflection Present On "A" Scope. The OUTPUT UNITS Meter Reading is Zero.

(1) Under these conditions the output from the modulator may be faulty, and this circuit should be checked thoroughly. Remove the high-voltage cable from the plug board at the left side of the console.

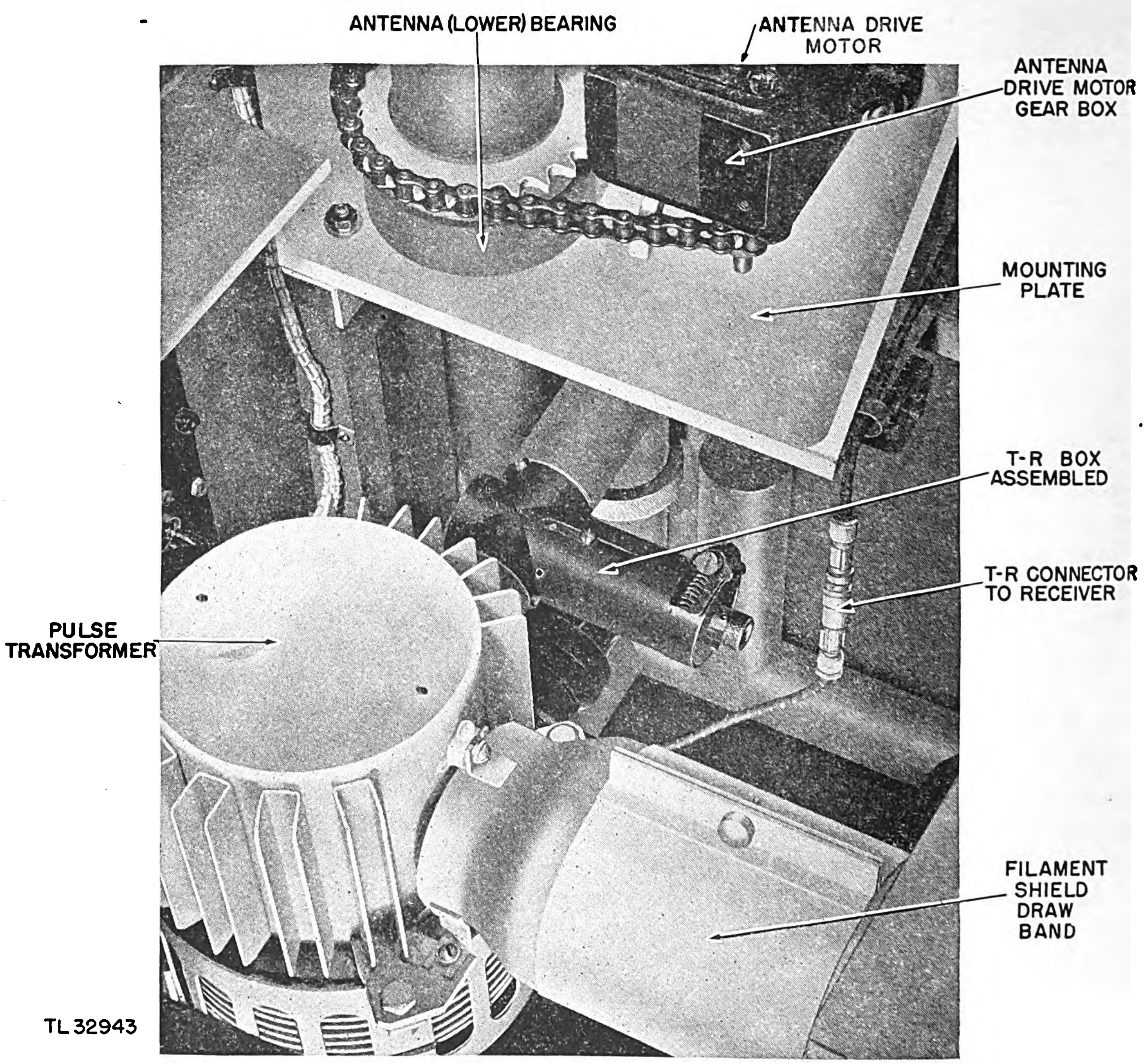


Figure 82. Lower corner of console.

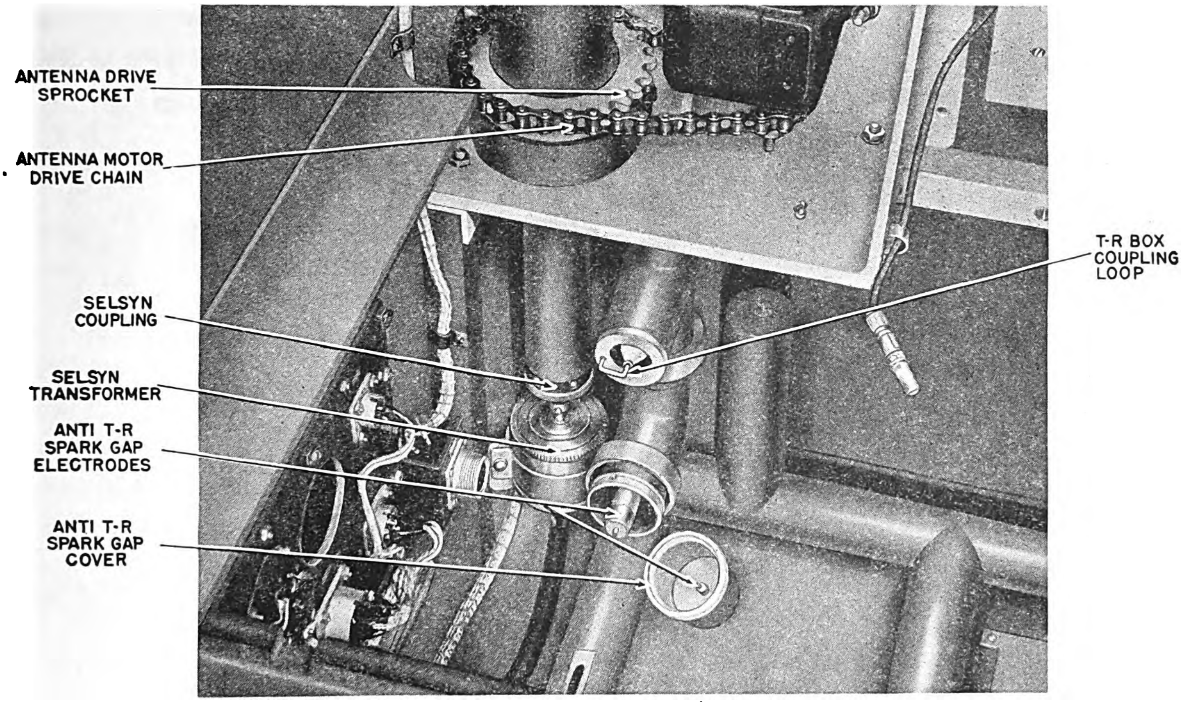


Figure 83. Close up of console interior plumbing, corner.

Check for continuity between the inner conductor and the shell of the high-voltage receptacle on the plug board.

(2) Using the wire clip lead, short the inner conductor of the long high-voltage cable leading to the console, to the outer shell of the plug (modulator end). Remove the other end of the cable from the plug board on the lower left side of the console and check between the inner and outer conductor (shell)

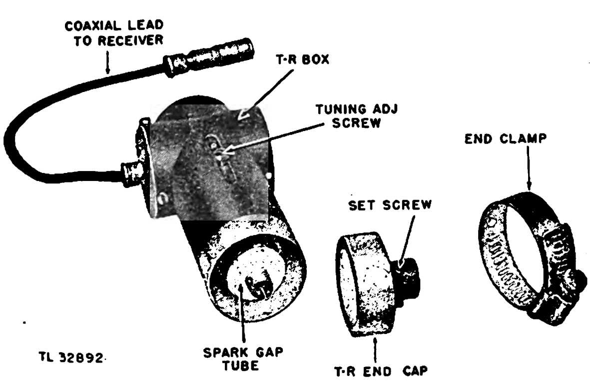


Figure 84. T-R, assembly.

for continuity. If there is no continuity, replace the cable with the spare.

(3) Start the power unit and allow it to reach operating speed. Throw the MODULATOR OFF-ON switch to the ON position. Throw the MAIN POWER SUPPLY switch ON and allow at least 30 seconds for the filaments in the console to warm up. Turn the TRANSMITTER switch ON.

(4) Go to the power unit and look through the peep hole to see if the spark gap is firing properly. If it is not, throw the TRANSMITTER switch to the OFF position. Remove the cover plate from the side of the modulator unit (fig. 81). See that the relay in the modulator operates when the TRANSMITTER switch is turned ON and OFF. If the relay does not close as the TRANSMITTER switch is thrown to the ON position, hold the relay closed with a two-foot dry stick. The filaments of the rectifier tubes in the modulator should now light. Check the relay winding for the presence of 24 volts d-c.

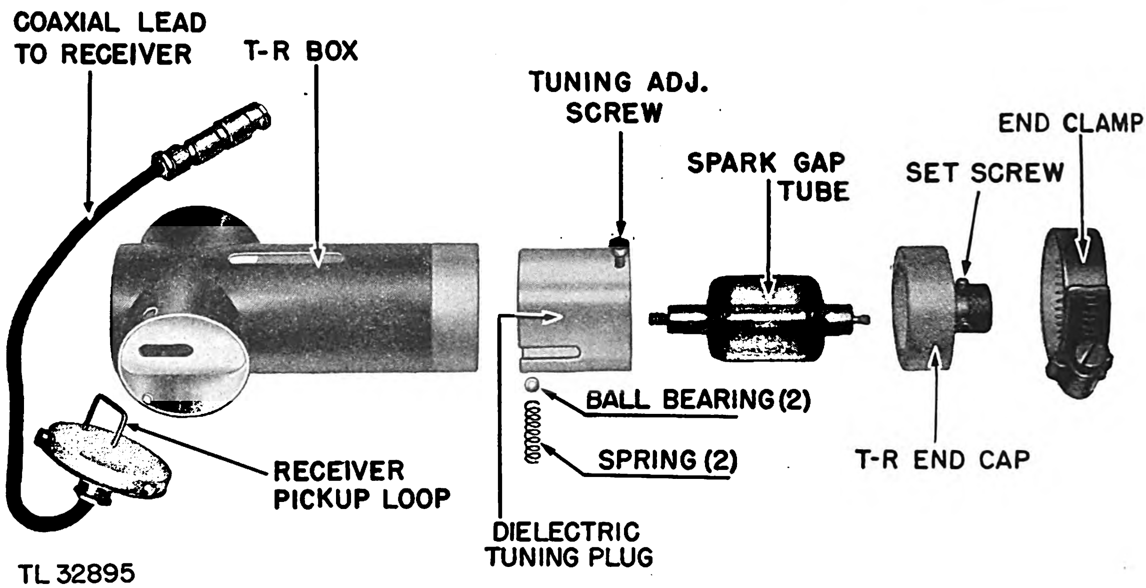


Figure 85. T-R, disassembled.

CAUTION: Be careful while taking this reading to hold the test prods as far back on their handles as practicable.

(5) If the 24 volts d-c is not present, check to see that it is being generated by the power unit. To do this, throw the TRACK LEFT-RIGHT switch to either position with the TRACK-PPI switch in the TRACK position. If the 24 volts is present, the antenna should rotate.

(6) If the 24 volts d-c is being generated but is not present here, making sure that the MODULATOR switch on the power unit is thrown to the ON position, check continuity of connecting cable to the modulator unit.

(7) If the 24 volts d-c was present at the relay in the modulator, the relay winding is probably open. Check this winding, with all switches and power unit off, for continuity. If the winding is open, replace the relay.

(8) If the filaments of the rectifier tubes in the modulator do not light when the relay is closed, check the fuse F301 between the relay and the primary of the transformer. If this is blown, replace it.

(9) If the fault is not found, check for 115 volts a-c by placing the voltmeter test prods across the terminals of the spark gap overload tube. If the 115 volts is not present, check at the power unit control box, as in the case of d-c. If the a-c is present across the overload tube, shut off all power, and check the primary of the transformer for continuity.

(10) If no voltage exists at the tube sockets, check the wiring and soldered connections from the tube sockets to the transformer filament winding. If these are intact, check the winding for continuity (fig. 13). If the winding is open, the modulator unit must be replaced.

(11) If either one or both of the tubes does not light, interchange the two tubes. Since only one-half of the filaments is used in each tube, the other halves will now be connected. If this does not cure the fault, check the continuity of the filaments of the tubes, and replace any that have both filaments open. If they still do not light, check for loose or broken connectors at the sockets.

(12) Turn OFF the power. Throw the TRANSMITTER switch to the OFF position and throw the MAIN POWER SUPPLY switch to the OFF position. Both of these switches are located on the receiver panel at the console. Turn the power unit OFF. Be sure to discharge the high-voltage capacitors in the modulator.

CAUTION: This step must be carefully performed each time it is done. Lethal voltages are present.

(a) Remove the high-voltage cable, with the red plug on its end, from the socket at the end of the power unit (generator).

(b) Be careful to grasp this cable by the rubber portion and do not touch the metal shell of the connector plug.

(c) Hold an insulated screwdriver well up on the insulation and keep the hand away from the metal portion. Touch the edge of the plug at the open end with the edge of the screwdriver, and, holding it there, push the tip against the inside prong which is the inner conductor.

(d) Keep your face away from this plug as violent sparking takes place when the cable is shorted.

(e) It is now safe to work inside the modulator. Be careful, however, since a small charge (about 10 percent of the original) is still across the capacitors. A slight shock may be experienced if direct contact is made by an individual between the hot side of the capacitors and the case.

(13) With ohmmeter, check the charging choke for continuity. Placing one test prod on the plate of V-302 rectifier. Try one plate, then the other to determine the proper one. Place the other test prod

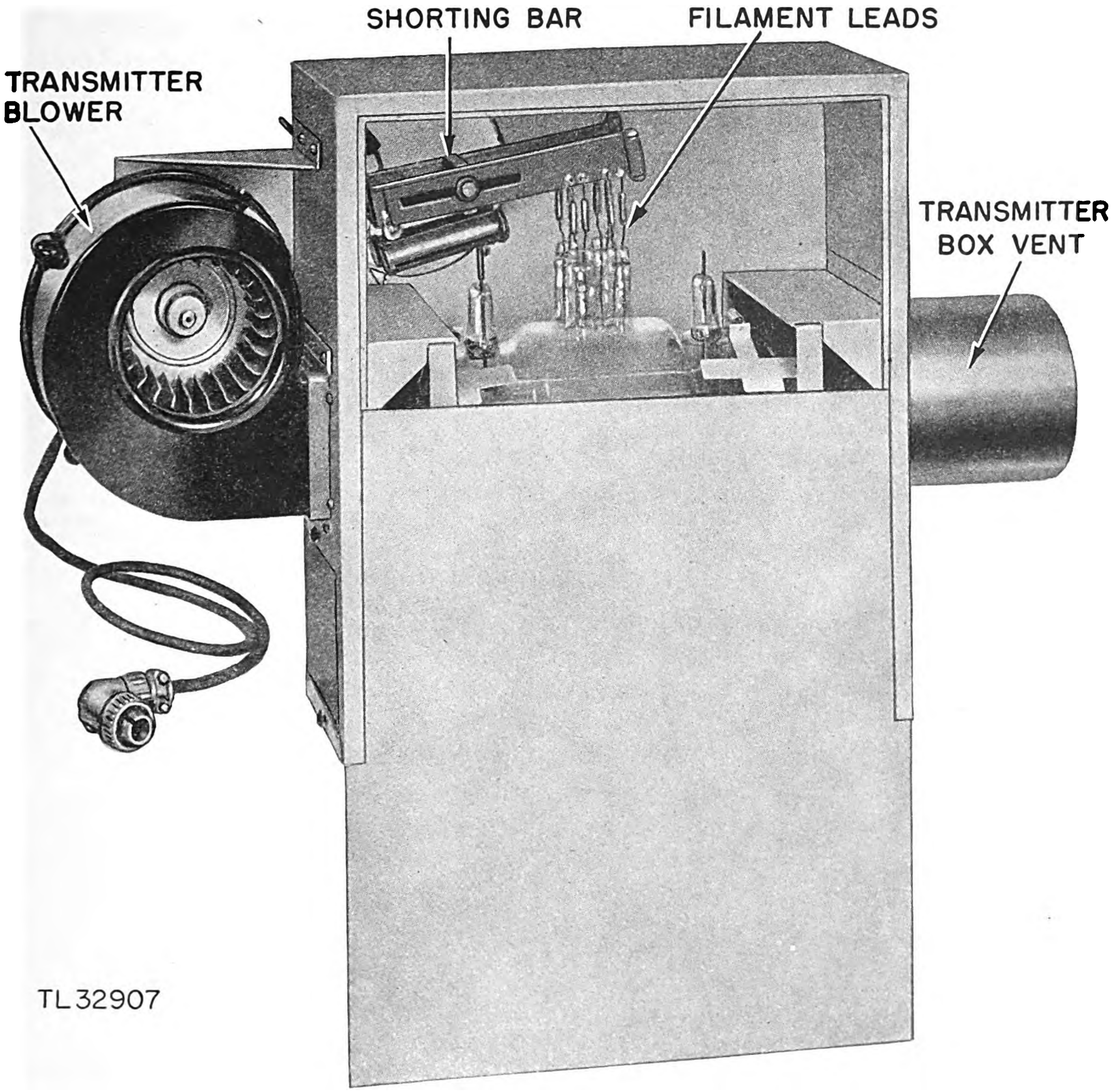


Figure 86. Transmitter tube assembly, cover partially removed.

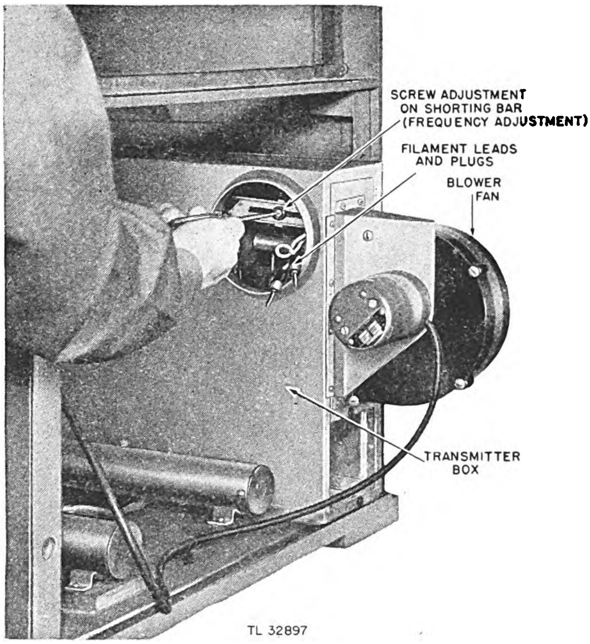


Figure 87. Changing frequency of transmitter.

on the inner conductor of the cable just removed. If the choke is open, the entire modulator unit must be replaced.

(14) Remove the high-voltage cable from the black extension receptacle on the modulator. Check between the inner conductor of the black receptacle and the inner conductor of the short, high-voltage cable (previously removed from power unit) with the ohmmeter. There should be no reading. If there is a low resistance, the pulse forming line is shorted and the modulator unit must be replaced as above.

(15) Replace all cables.

47. ANTENNA REMOVAL AND REPLACEMENT.

a. General. The antenna drive system consists of a motor, a rotation gear box, a sprocket and chain, and the antenna mast. The antenna mast is held in position by 3 sets of ball bearings, one of which is exposed to the elements. Because special lubricating and servicing procedures are involved, it is important to discuss the detailed removal procedure of the parts involved.

b. Servicing the Ball Bearings and Housings.

(1) The ball bearing under the antenna hinge may be serviced by dismantling the antenna as follows:

(*a*) Remove the guy wires.

(*b*) Lower the parabolic reflector.

(*c*) Remove the hinge pin.

(*d*) Unfasten the deadmen.

(*e*) Remove the 6 screws holding the bottom plate of the bearing housing.

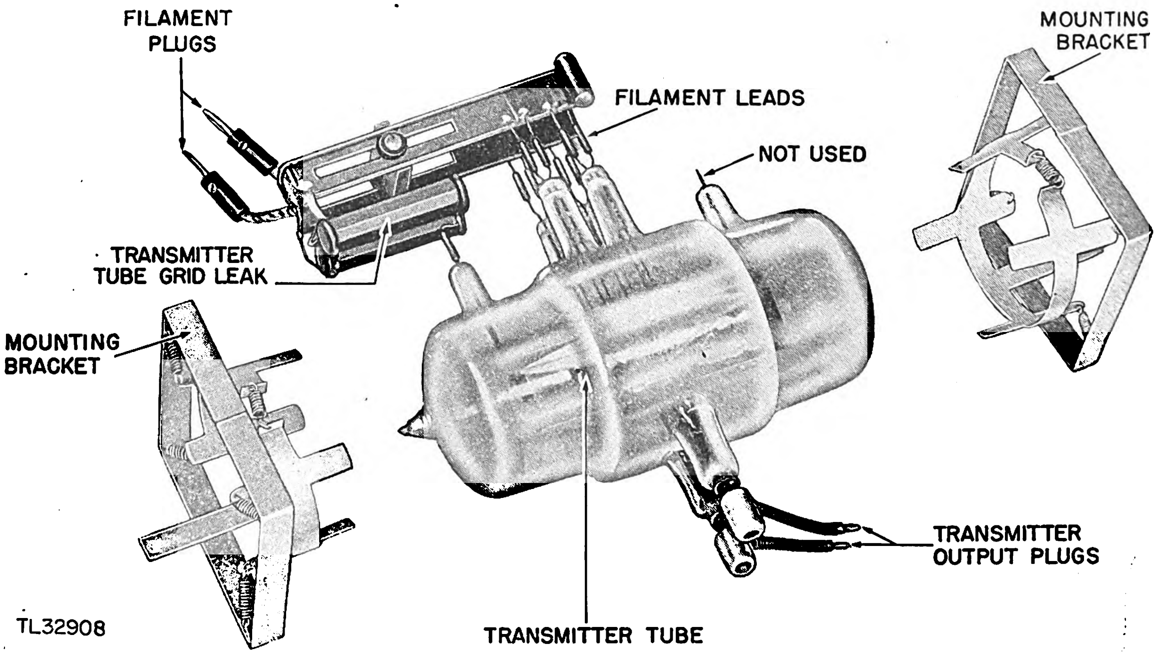


Figure 88. Transmitter tube.

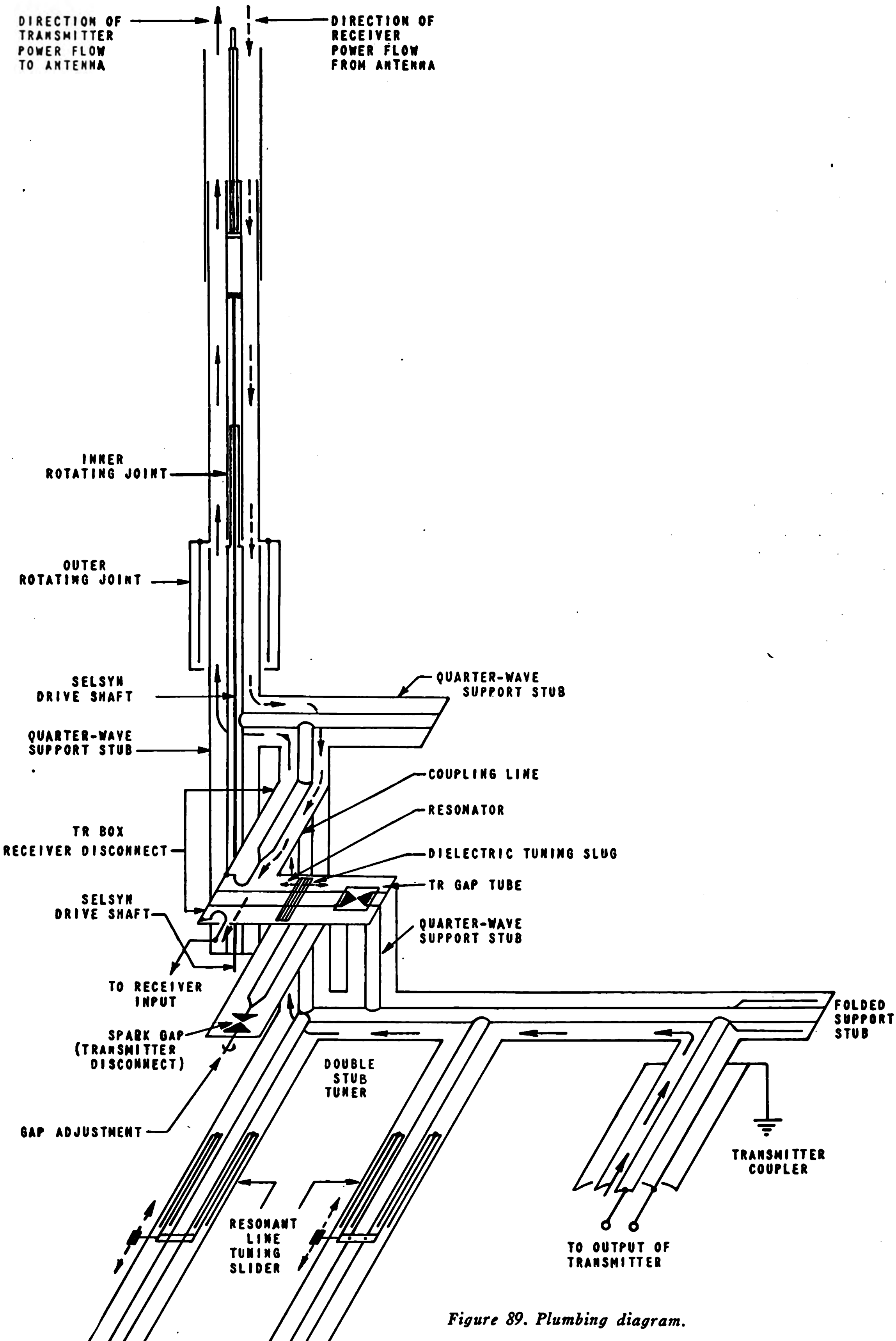


Figure 89. Plumbing diagram.

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(*f*) When the plate is dropped, the bearing is exposed for the application of grease or servicing.

(2) The top bearing at the guy wire tie is readily accessible for greasing or servicing after the parabolic reflector is lowered. Loosen the set screw in the side of the housing and lift the housing off the bearing.

(3) The two mast bearings in the console may be serviced by dismantling as follows:

(*a*) Dismantle the antenna by:

1. Removing the guy wires.
2. Lowering the parabolic reflector.
3. Removing the hinge pin.
4. Unfastening the deadmen.

(*b*) Lift the antenna support mast out of the console.

(*c*) Remove the receiver and indicator chassis.

(*d*) Remove the lower console filter panel.

(*e*) Remove the pulse transformer from the console.

(*f*) Loosen the antenna motor mounting screws, and slide the motor so as to loosen the antenna drive chain.

(*g*) Remove the key link from the chain, and remove the chain.

(*h*) Loosen the two set screws at the top end of the rotary transformer coupling. This is located in the back bottom corner of the console directly under the vertical transmission line.

(*i*) Remove the transmission line inner conductor by lifting it out of the console.

(*j*) Loosen the circular clamp around the tounge-and-slot splice in the upper section of the console transmission line.

(*k*) Remove the six acorn nuts holding the flange on the top of the console, and remove the flange.

(*l*) Drop the top bearing housing down over the transmission line inside of the console.

(*m*) Lift the uppermost section of the transmission line out of the top of the console.

(*n*) The upper bearing housing can now be readily removed from the console and the bearing repacked with grease or serviced.

(*o*) The lower bearing housing can now be removed from the console by lifting the remaining section of the upper transmission line about 6 inches and swinging the bearing housing forward and down.

(*p*) The ball bearing is PRESSED into the housing and must be greased or serviced without being removed.

SECTION V

TROUBLE SHOOTING THE RECEIVER

48. GENERAL. Voltage and resistance checks can be used to advantage in isolating and determining faulty operation. The receiver voltage and resistance measurements for normal operation are shown in Figures 94 and 95. EXTREME CARE MUST BE EXERCISED IN TAKING MEASUREMENTS AS HIGH VOLTAGE IS PRESENT IN THIS UNIT.

49. POWER SUPPLY. (fig. 27).

CAUTION: Power supply trouble may do permanent damage to the components. If such trouble is suspected, the power should be switched on only for the very short time necessary to make measurements or observations.

a. Fuse. If the a-c voltmeter on the receiver panel does not indicate, the fuse F201 may need replacing. The MAIN POWER SUPPLY switch should be *off* while changing the fuse. (fig. 19).

b. Low-Voltage D-C Supply. (1) INDICATION. No meter reading on the TOTAL *B*+ position of the meter switch indicates probable failure of this supply. An off-scale reading indicates a short circuit in the indicator or receiver proper.

(2) RESISTANCE MEASUREMENTS. The resistance measured between transformer terminal #2 and the chassis would be 3,000 ohms; between terminal #11 and the chassis should be 130 ohms. These resistances must be measured with the indi-

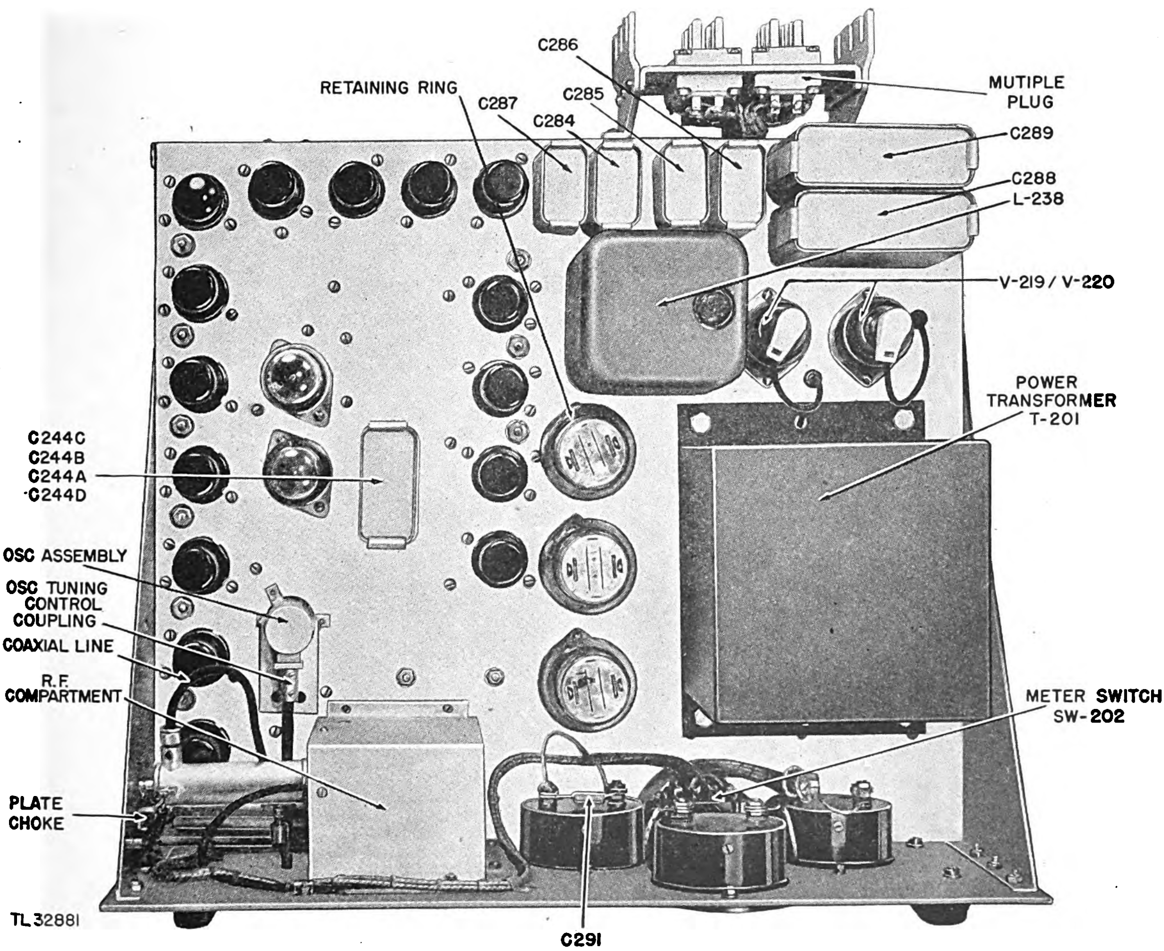

Figure 90. Receiver chassis, top view.

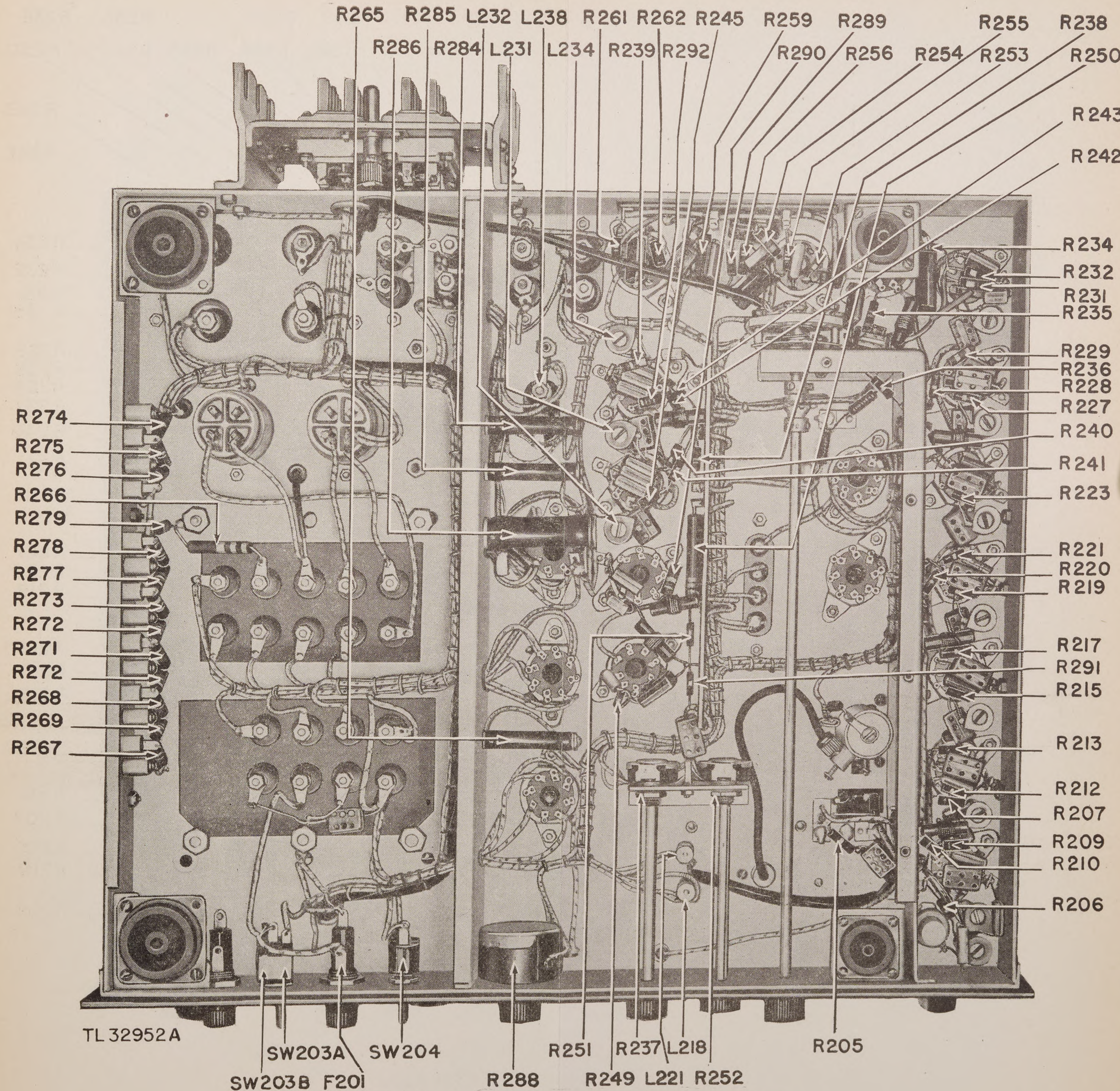

Figure 91a. Underside of receiver chassis, showing resistor locations.

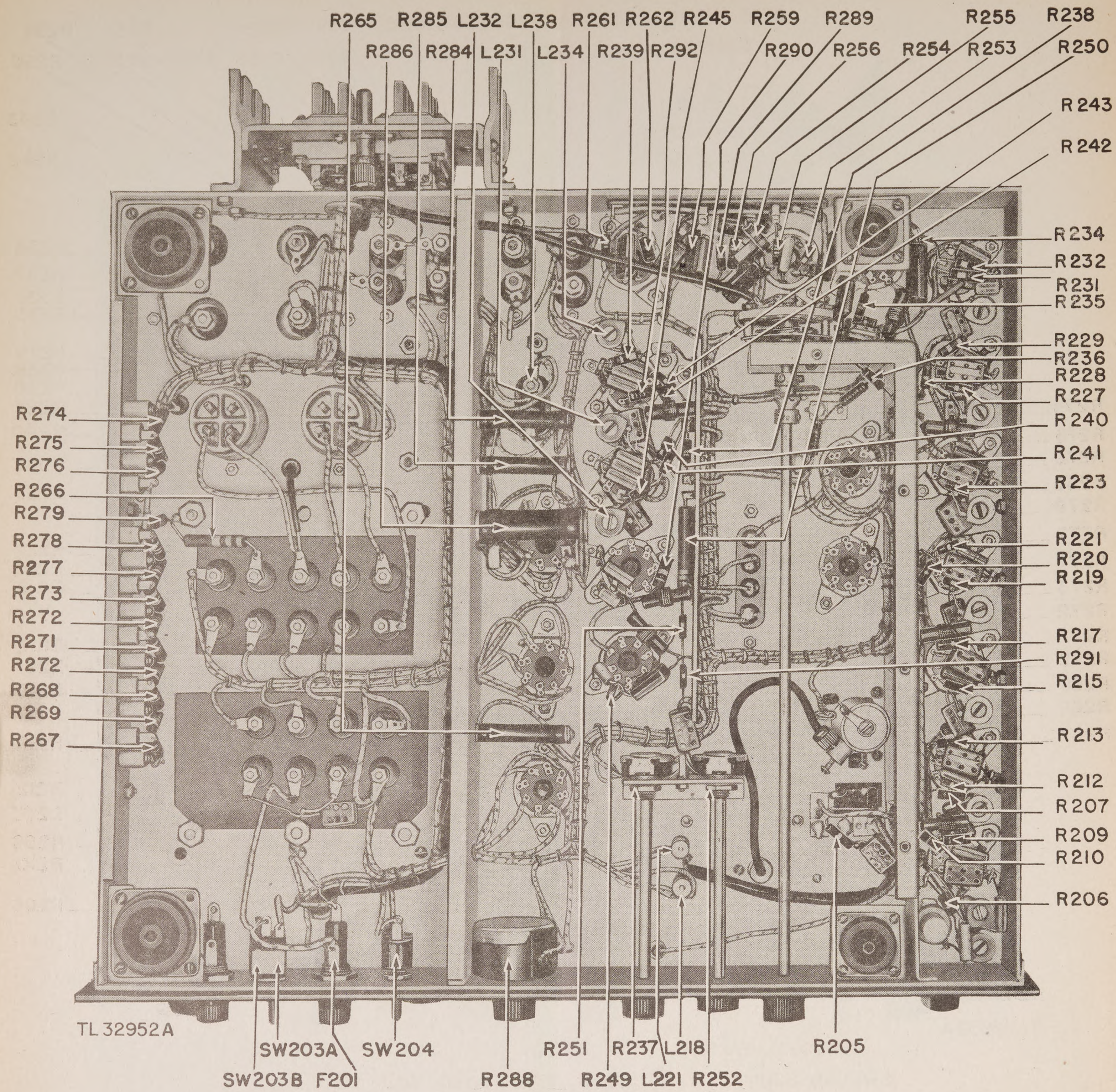

Figure 91a. Underside of receiver chassis, showing resistor locations.

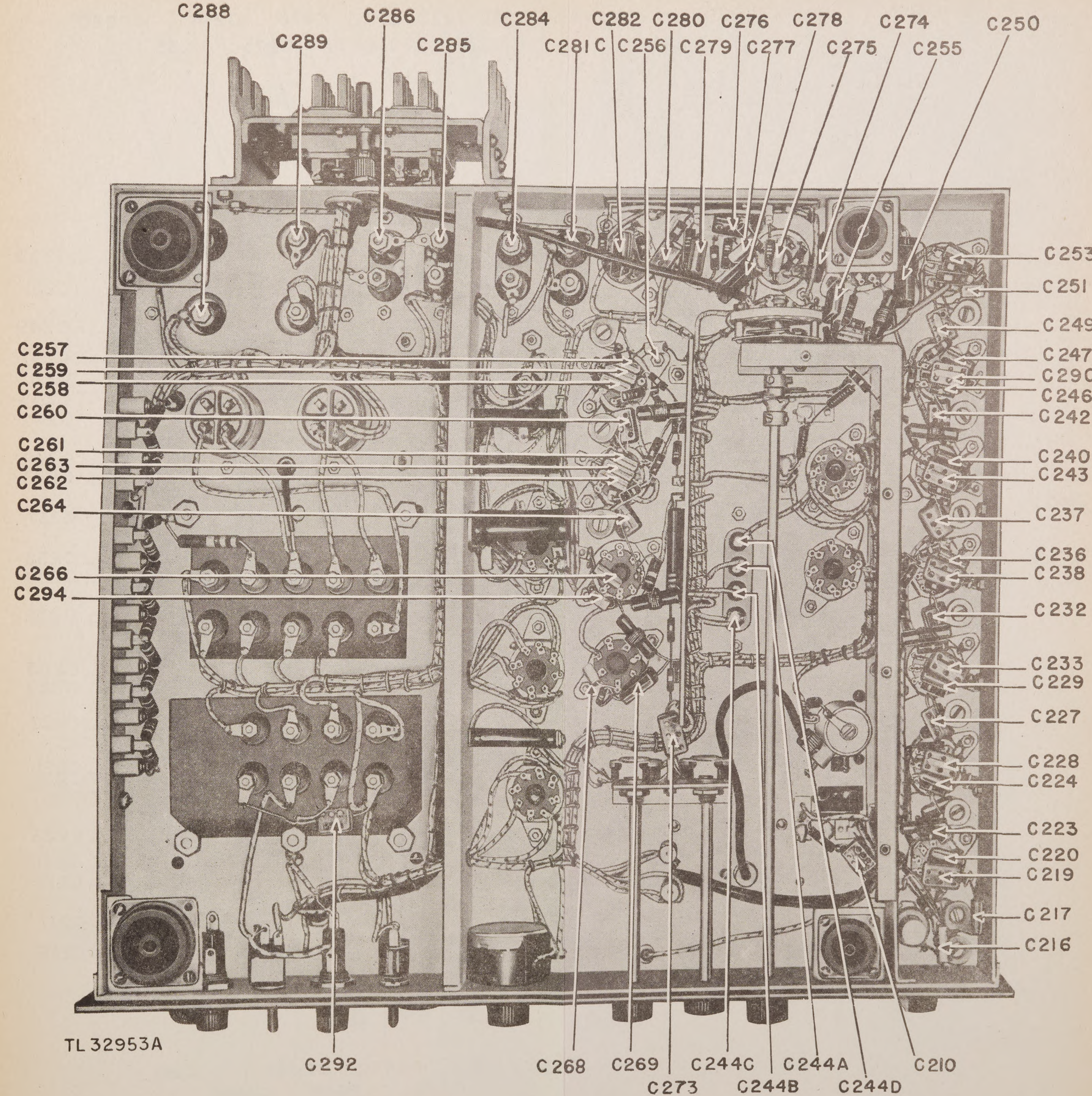

Figure 91b. Underside of receiver chassis showing capacitor locations.

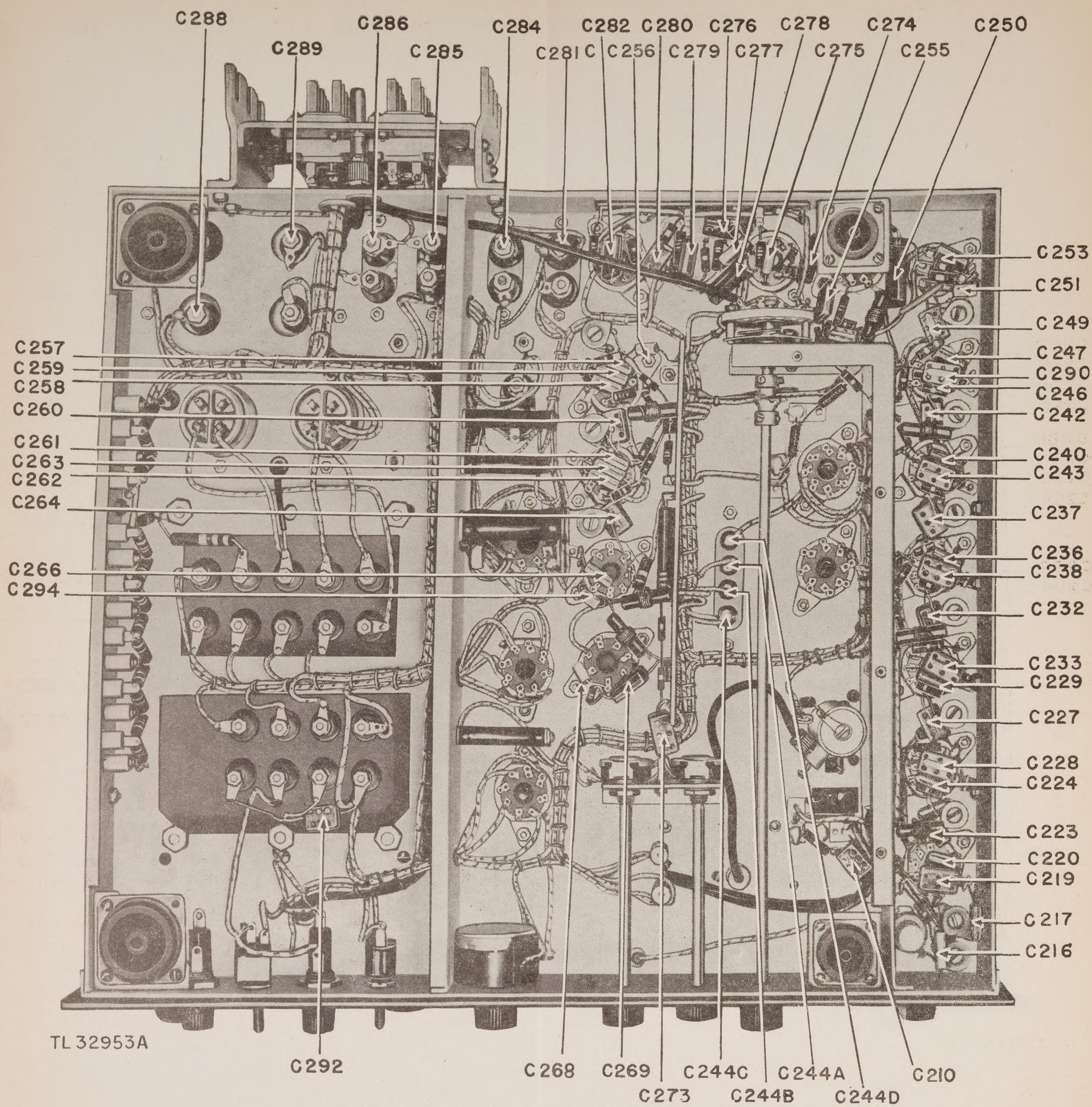

Figure 91b. Underside of receiver chassis showing capacitor locations.

cator connected to the receiver through the extension cable and console wiring.

(3) VOLTAGE MEASUREMENTS. When the set is operating normally, +425 volts should exist between terminal #2 and the chassis, with —70 volts between terminal #11 and chassis. The three 5U4G rectifier tubes (V221, V222, V223) are likely to fail simultaneously, so it is advisable to change them all when one is changed.

(4) REGULATION. The 150-volt and 255-volt taps are regulated by the voltage regulating tubes, V224 and V225. Failure of either or both of these tubes will cause unstable screen grid and plate voltages. The voltage on the plate of V224 should read 150 volts, and on the plate of V225, 255 volts. These tubes should not be removed while the radio set is in operation. However, if it is observed that these tubes flicker or otherwise perform in an unusual manner, replace them.

c. High-Voltage (2,000 volts D-C Supply (fig. 27). (1) The most probable cause of failure is a burned out 2X2 tube, (V219 or V220). A slight glow is visible at the cathode when these tubes are operating normally, and can readily be seen by operating the receiver on its side so that the cathodes are visible.

(2) Failure of the +2,000 volts developed by V219 can be identified by a reduced brilliance and enlarged presentation on the "A" scope. Failure

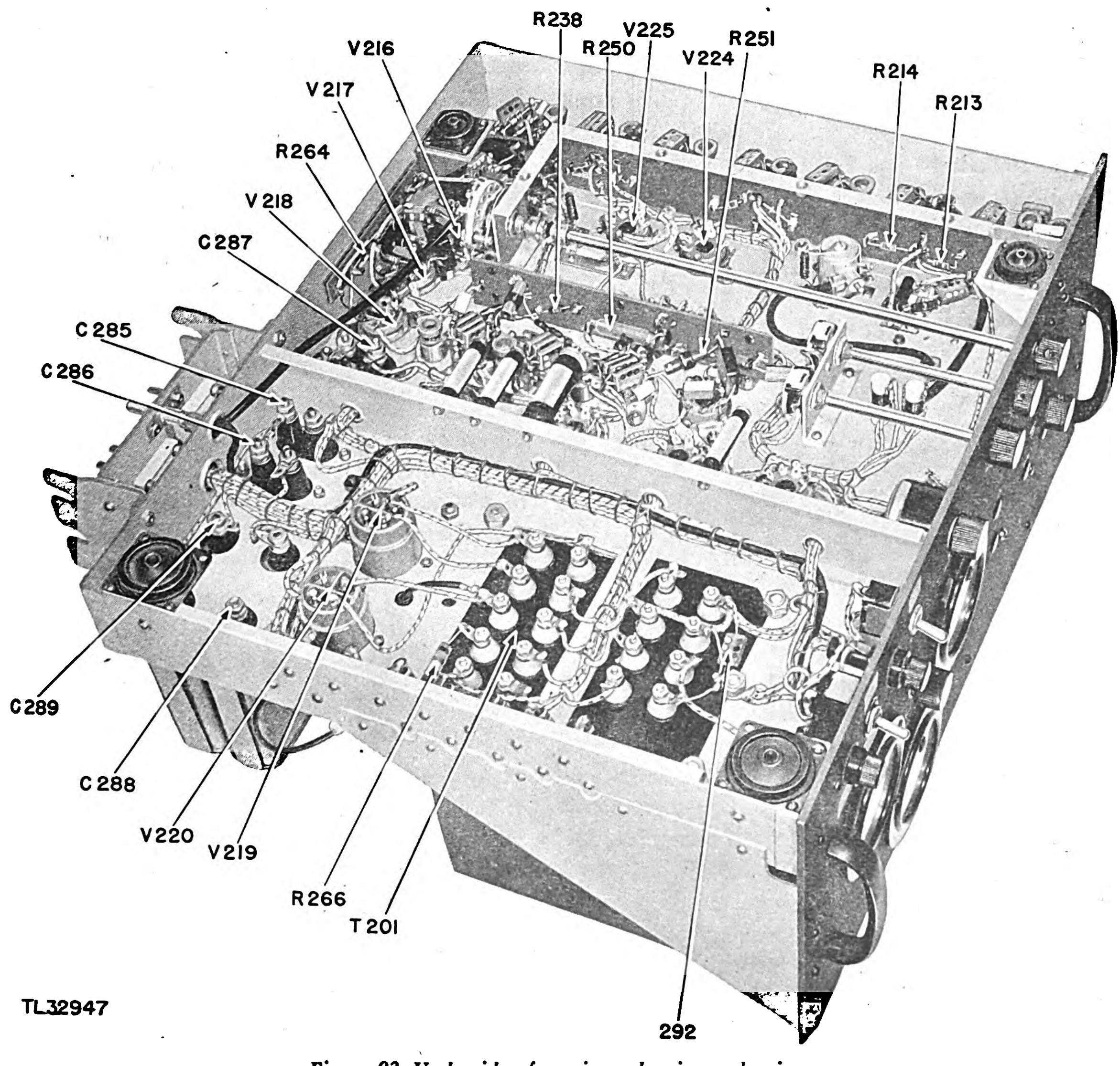

Figure 92. Underside of receiver chassis, angle view.

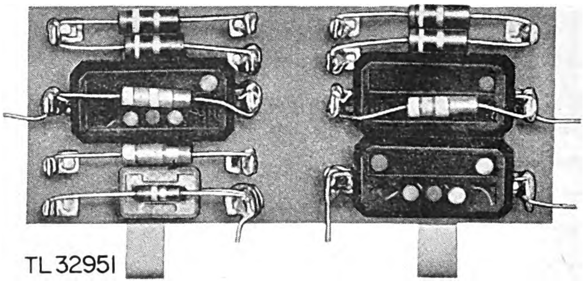

Figure 93. Terminal strip.

of the —2,000 volts, developed by V220 results in no "A" scope illumination.

CAUTION: These voltages are dangerous and care should be taken in measuring them.

d. Power Transformer—In addition to the voltages supplied to the rectifiers, this transformer supplies 6.3 volts for the heaters of all tubes, (terminals 7 and 8), 6.3 volts for cathode-ray tube heaters, (terminals 13 and 14), and 44 volts for heating the transmitter tube filaments, (terminals 3 and 4). The other transformer voltages are:

Terminal No.	Volts a.c.
1 and 2	5
10 and 12	800
15 and 16	2500
9 and 16	2.5
17 and 18	2.5

If a failure of the transformer is suspected, measure these voltages.

50. R-F AMPLIFIERS V201, V202.

a. Indication. If the meter reading is low or zero on meter positions R-F AMPL #1 or R-F AMPL #2, it indicates that the corresponding tube has failed. Check the BIAS adjustment and the plate supply connector (through hole in panel supporting bracket) to make sure that the tube is at fault. The voltage on the plate supply connectors should be +225 volts. If the meter reads off scale on R-F AMPL #1 or R-F AMPL #2, check the corresponding plate supply connector and associated wiring for a short circuit to the chassis. It is improbable that both tubes would fail simultaneously, so if there is no meter indication on either R-F AMPL #1 or R-F AMPL #2, check for voltage on plate supply connectors, and for heater voltage, (base pin #7 of V201 and V202) before replacing tubes.

b. Removal and Replacement. (See figures 91 and 92 for bottom view of receiver unit). (1) Remove the amplifier shield cover. (figs. 21 and 90). This will require taking out eight screws.

(2) Take out the two screws mounting the tube socket and bias control assembly to the panel. These screws are adjacent to the bias adjusting holes on the front side of the panel.

(3) Slide the tube socket assembly to the right (toward the meters on the panel) until it is disengaged from the tubes. The tubes are clamped in their tuned coaxial lines and will not come out as the tube socket assembly is removed.

(4) The tubes are each held in place by two clamping rings, or draw bands, one around the metal base of the tube and the other around the outside of the tuned coaxial line. The tube may be removed after loosening both draw bands. Turn the draw band about four turns counterclockwise to loosen them. Rocking or turning the tube slightly will make it slide out easily. If the inner rod of the tuned coaxial line slides out as the tube is removed, carefully slide it back to its original position.

(5) Insert the new tube into the socket assembly.

(6) Slide the tube socket assembly to the left (away from the panel meters). In so doing, the new tube will slide into its draw bands and tuned coaxial line, and the base pins of the other tube will go into their contacts on the tube socket assembly. Rock the tube socket assembly slightly during this procedure, to bring mating pieces into alignment. Care should be taken not to damage the wiring on the tube socket assembly, the drawbands, or the tuned coaxial lines.

(7) Replace the two screws which mount the tube socket assembly to the front panel.

(8) Tighten the two draw bands on the tube which was replaced.

(9) Replace the amplifier shield cover.

(10) Put the receiver back in the console and, after allowing two minutes for warming up, set the bias adjusting controls for 0.5 ma., meter reading on positions R-F AMPL #1 and R-F AMPL #2 of the meter switch.

c. Cleaning. If the tuning of the amplifiers becomes "touchy", or they appear to be unstable, remove both tubes, and clean all surfaces of the tubes and drawbands which when assembled make contact. Use crocus cloth or fine emery paper. Slide the inner rod of the tuned coaxial lines, and if necessary squeeze the contact fingers together so that they fit snugly over the plate cap of the tube. Make sure that the set screws holding the coaxial cables in place are tight.

d. Oscillator V203. (1) INDICATION. Failure of the oscillator is indicated by a low or zero meter reading with the meter switch set to X-TAL. However, such meter readings may result from other causes. To determine whether the oscillator is operating correctly, connect the test meter across the 1,200-ohm cathode bias resistor R205. This resistor is next to the oscillator assembly on the under side of the chassis. (fig. 91). The voltage measured should be between 7 and 9 volts. If the oscillator is functioning correctly, the voltage will vary a volt or more as the tuning control is turned from one extreme to the other. If the voltage is zero, or does not vary, or if it exceeds 12 volts, the tube should be replaced.

(2) REMOVAL AND REPLACEMENT. To change the oscillator tube, take out the three screws holding the oscillator tube shield in place, and slide the shield toward the panel, exposing the oscillator tube. Rock the tube slightly while removing it, taking care not to damage the pin connectors on the oscillator assembly. When inserting the new tube, be sure that all five of the pins make good contact with the clips on the oscillator assembly. If necessary, bend the clips so that good contact is made. The oscillator tuning shaft may be removed to make the oscillator assembly more accessible.

> CAUTION: The oscillator will not function normally with its shield removed.

e. Oscillator Coupling Loop. (1) DESCRIPTION. This loop is mounted on the top of the chassis (figs. 21 and 90) within the amplifier shield cover, and is connected by a coaxial cable under the chassis to the oscillator (fig. 91). When properly tuned, the air gap in the loop will be about one thirty-second of an inch. Any dust present should be blown out of this air gap.

(2) ADJUSTMENT. The set will operate best when this loop is adjusted for maximum crystal current, all other elements of the receiver being first tuned to 600 megacycles. This adjustment must be made using a bakelite screwdriver, with the amplifier shield cover in place; it will be necessary only if its original adjustment has been tampered with.

f. Crystal and Associated Circuits. (1) INDICATION. A zero or low crystal current may be caused by the following which are listed in the order of likelihood:

(a) Receiver not properly tuned.

(b) Oscillator not functioning normally.

(c) R-F Amplifier #2 burned out or not operating normally.

(d) Oscillator coupling loop damaged or out of adjustment.

(e) Burned out crystal.

(f) Defect in meter or meter switch circuits, or in contacts of crystal holders.

> NOTE: A high crystal current will result in some decrease in receiver sensitivity, and can be caused by incorrect tuning of the receiver, or by a faulty oscillator tube.

(2) REMOVAL AND REPLACEMENT. To replace the crystal, first remove the i-f shield cover. The crystal holder is mounted directly behind the front panel, within the i-f amplifier enclosure. Unsolder the wire connecting the crystal holder lug to the first coil. Loosen the knurled nut on the crystal holder and slide out the whole assembly. The crystal is held by spring fingers, and will come out of its holder easily. These crystals are fragile and should never be dropped. No attempt should be made to check them with an ohmmeter, as permanent damage may result. In replacing the holder, the crystal must be seated in the spring holding fingers. In tightening the knurled nut, orient the holder so that the connecting wire can be resoldered to the lug on the holder. Avoid heating the crystal holder more than is necessary.

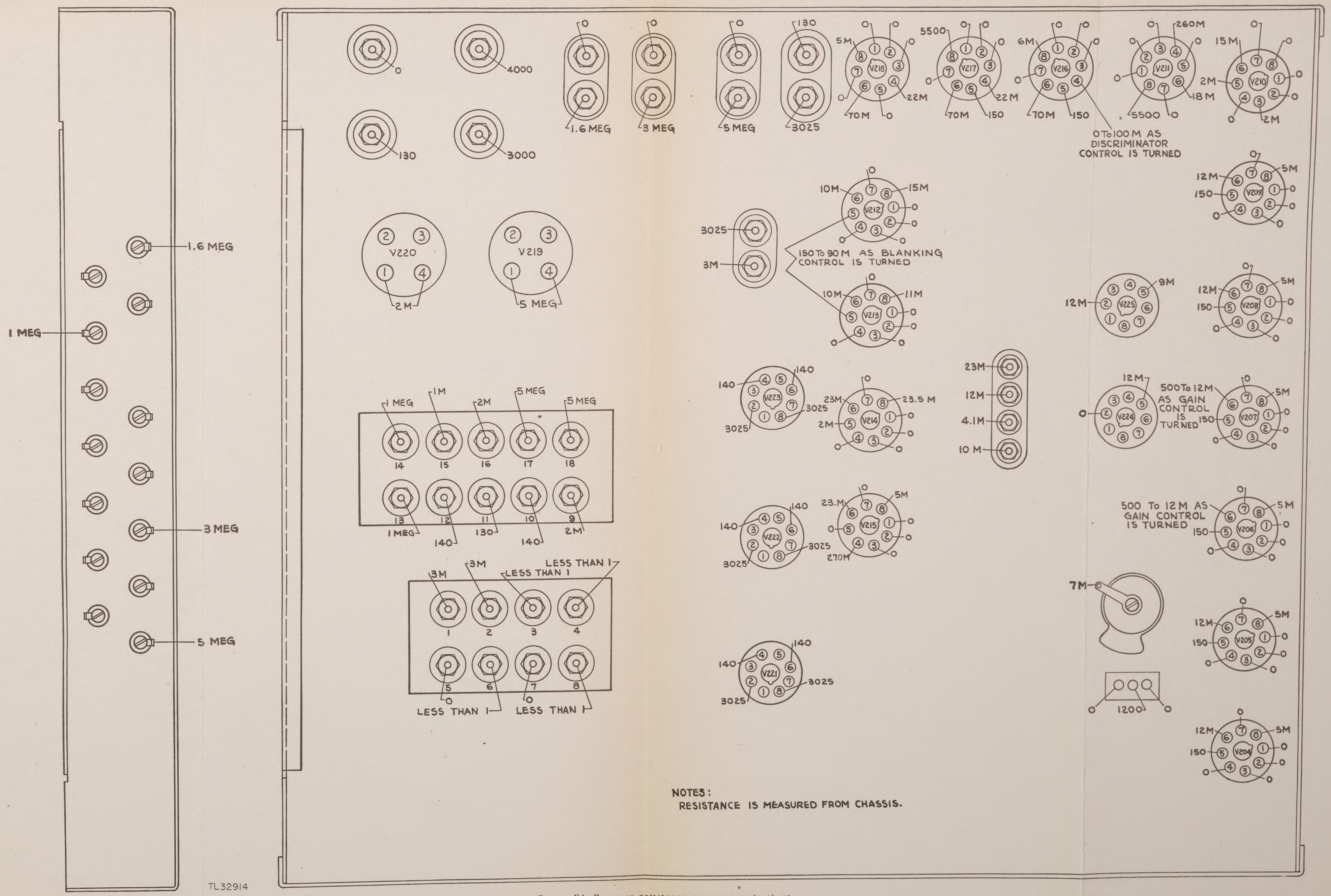

Figure 94. Receiver resistance measurements chart.

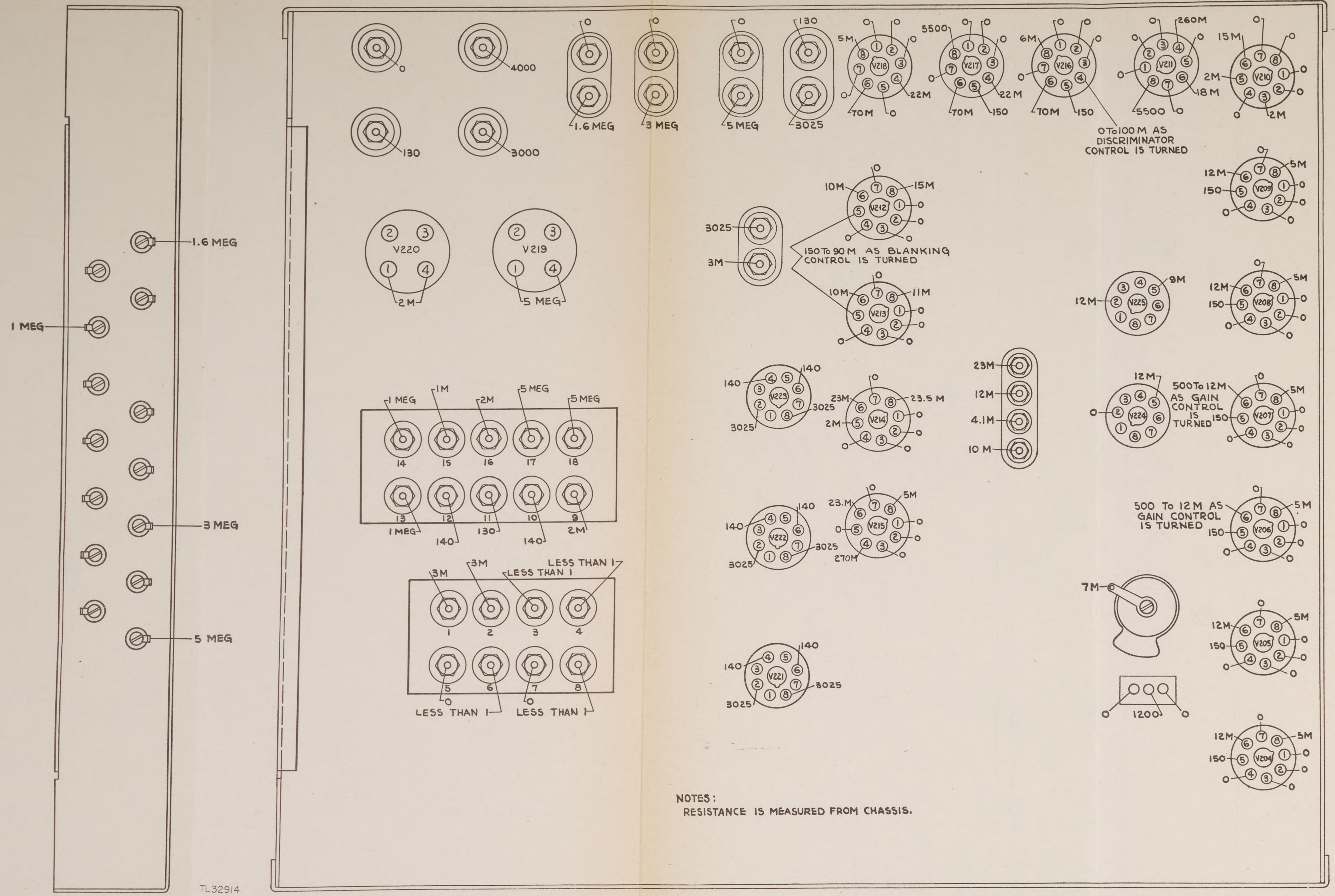

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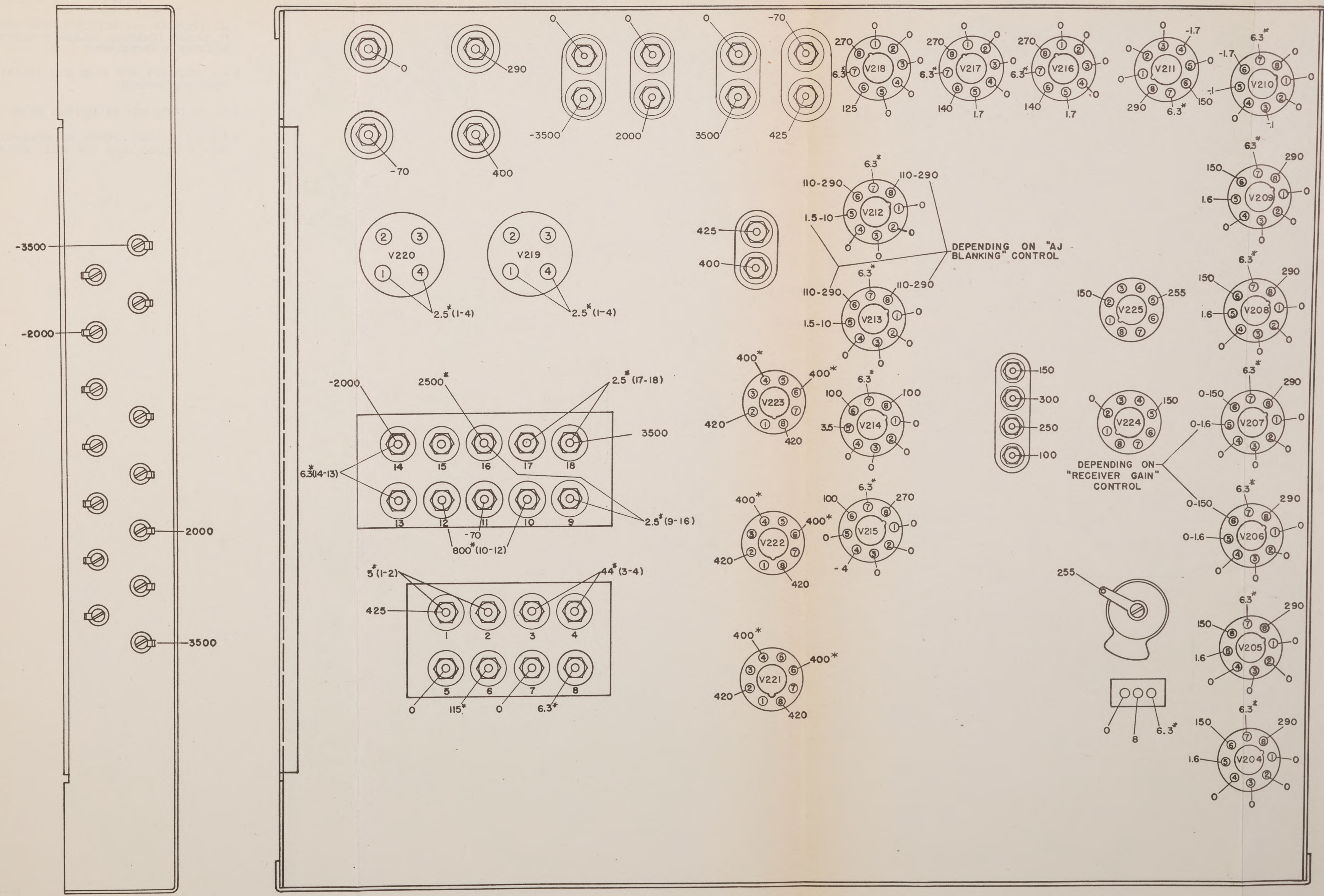
Figure 94. Receiver resistance measurements chart.



NOTES

1. ALL VOLTAGES ARE MEASURED FROM TERMINALS TO GROUND (CHASSIS), UNLESS OTHERWISE INDICATED IN PARENTHESIS.

2. ALL VOLTAGES ARE PLUS (DC) UNLESS OTHERWISE INDICATED.

3. ALL VOLTAGES WITH AN ASTERISK (*) ARE AC.

4. ALL D.C. VOLTAGES SHOULD BE MEASURED WITH A 20,000 OHMS PER VOLT METER.

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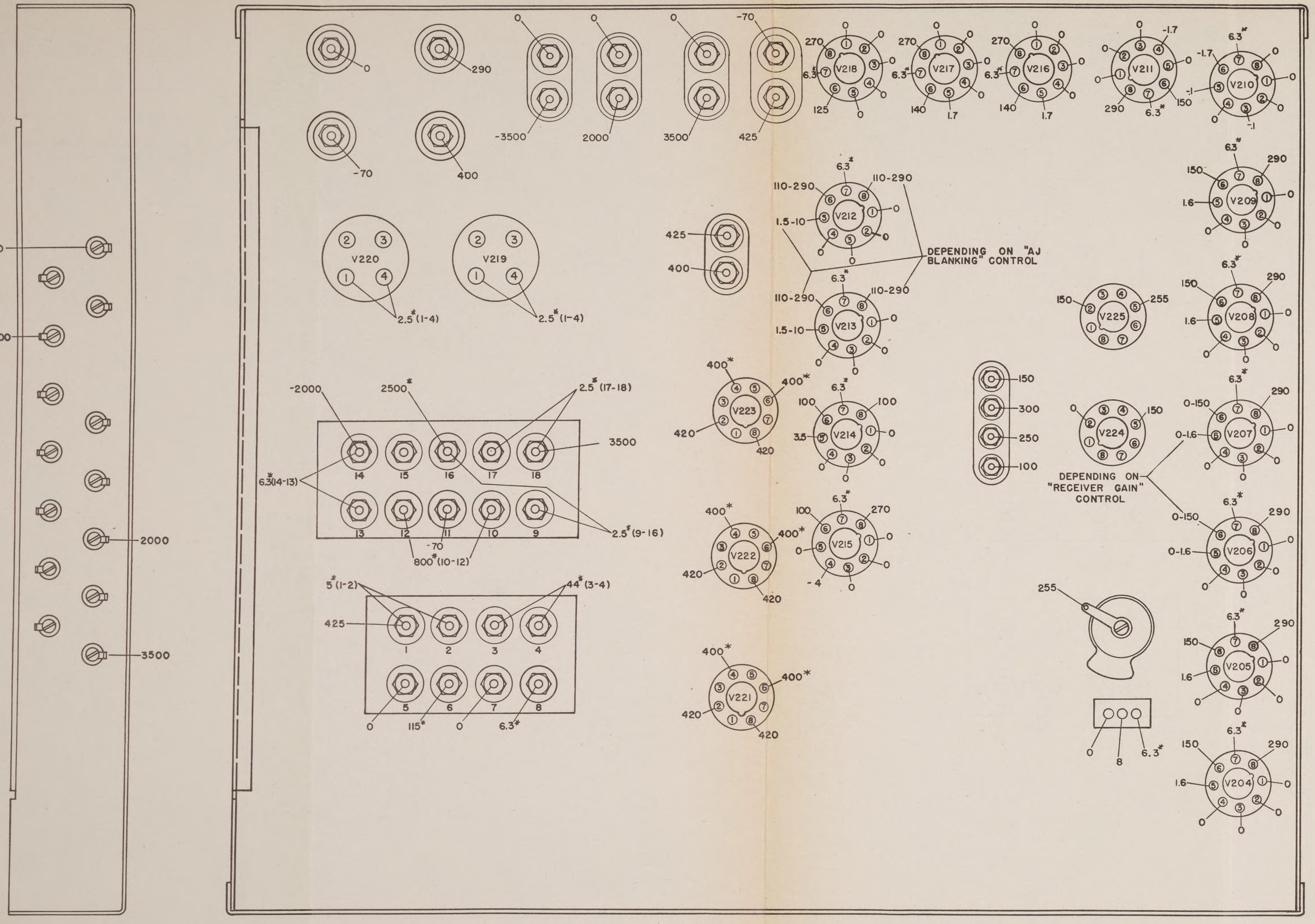
Figure 95. Receiver voltage measurements chart.



NOTES

1. ALL VOLTAGES ARE MEASURED FROM TERMINALS TO GROUND (CHASSIS), UNLESS OTHERWISE INDICATED IN PARENTHESIS.
2. ALL VOLTAGES ARE PLUS (D C) UNLESS OTHERWISE INDICATED.
3. ALL VOLTAGES WITH AN ASTERISK (*) ARE A.C.
4. ALL D.C. VOLTAGES SHOULD BE MEASURED WITH A 20,000 OHMS PER VOLT METER.

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Figure 95. Receiver voltage measurements chart.

CAUTION: NEVER CONNECT THE OHMMETER TO CRYSTAL CURRENT MEASURING CIRCUITS WITHOUT FIRST REMOVING THE CRYSTAL.

g. I-F Amplifiers. (1) INDICATION. If the crystal current is normal, a lack of receiver gain (little or no noise on "A" scope but nearly echoes of normal size) may be caused by one or more faulty i-f amplifier tubes. These i-f tubes are V204 to V209 inclusive. Try a new tube in each stage successively until the faulty tube is found. If no faulty tubes are found, remove the i-f shield cover and check the voltages on the i-f tube sockets. Refer to figure 95 for correct values.

(2) TUNING. The tuning of the i-f amplifier stages is extremely critical. Do not attempt to adjust this tuning, since elaborate test equipment is required for this operation. The tuned circuits of the i-f stages consist of variable inductances in combination with the inter-electrode capacitances of the tubes and the shunt capacitances of the circuit components. Therefore, interchanging or substituting tubes may detune the i-f stages. It is suggested that each tube be identified with its particular stage.

(3) AMPLIFIER REGENERATION. I-F amplifier regeneration can be identified by the noise on the "A" scope coming up prematurely as the gain control is turned clockwise, or by poor signal-to-noise ratio when the gain is turned up near the top. This can result from the following:

(a) Abnormally high crystal current.

(b) Incorrect voltages on amplifier tubes.

(c) Faulty i-f amplifier tube.

(d) An open bypass condenser.

(e) I-F or r-f shield covers not securely in place. The amplifier will regenerate when the receiver is operated with either of the shield covers removed.

h. Detector. A short in either section of the diode detector will destroy the rectifying action. Make voltage and resistance measurements. Figure 93 shows terminal strips across which typical measurements may be made. Replace tube if these measurements do not agree with the correct values (figs. 94 and 95).

i. Video Stage. The amplitude of the signal on the "A" scope is determined by the characteristics of the video tube. If the amplitude, as shown on the "A" scope, is low, replace the tube. If trouble persists, replace detector (V210) and lastly i-f amplifier (V209). If trouble still persists, check the resistances and voltages before proceeding to the indicator video stages. Have anti-jamming switches in OFF position.

j. AJ Circuits. (1) INDICATION. If there is an indication that the AJ circuits are not operating properly, make certain that the set operates properly with the AJ switch SW201 in the OFF position. At this setting, the entire AJ circuit is eliminated from the receiver circuit. If receiver operation is normal at this switch position, set the switch to the #1 position to test the operation of the blanking circuit. With the AJ switch SW201 in the #3 position the discriminator circuit is connected, and in the #2 position, both the blanking circuit and the discriminator circuit are operating in the receiver.

(2) BLANKING CIRCUIT. In the blanking circuit of the AJ circuit, tubes V112, V113, V114 and V115 are employed. If the circuit does not function properly, checking for faulty tubes by removing and replacing them one at a time. Check the AJ BLANKING control on the receiver panel. Make voltage and resistance checks. Refer to figures 94 and 95 for the correct values. Do not attempt to tune the i-f coils in this circuit.

(3) DISCRIMINATOR CIRCUIT. The discriminator circuit employs tubes V216, V217, and V218. Check for faulty operation by removing and replacing one tube at a time. Check the AJ DISCRIMINATOR control located on the panel of the receiver. Make resistance and voltage checks. Refer to figures 94 and 95 for correct values.

SECTION VI

TROUBLE SHOOTING THE INDICATOR

51. INTRODUCTION. Faulty presentations on the two cathode-ray tubes are often the first indications that some defect has appeared in the equipment. In most instances, defects in the equipment are revealed in one form or another on the scope screens. It is possible, however, for the screen indications to be normal even though the equipment may require immediate servicing. Evidence of such a condition is indicated when voltage or current meters show abnormal readings. Generally and most frequently, however, the scope indications constitute the sole warning that something is wrong.

52. PRELIMINARY CHECKS. It is important to make sure the generator, modulator, transmitter, T-R system, and the receiver are operating properly before suspecting defects in the indicator unit. Below are listed some last-minute checks. Before attempting to localize a trouble and attributing it to a specific part in the indicator units, make sure:

a. The a-c line voltage is approximately 115 volts.

b. The spark gap is running regularly and firing properly.

c. The output meter records adequate antenna radiation.

d. The AJ switch is in the OFF position.

e. The RECEIVER GAIN control is turned up approximately half-way.

f. The receiver and indicator units are pushed into the console properly and are engaging all contacts of the multiple plug boards.

g. All connections and plugs are adequately secure.

53. MECHANICAL SERVICING. When defects have been traced to the indicator unit, it is advisable to make a preliminary mechanical check before performing electrical servicing. The complexity of the indicator unit may cause considerable waste of time and effort unless obvious mechanical details are checked BEFORE power is applied to the unit. Remove the indicator chassis from the console and place it on a level surface. When removing the indicator unit from the console, do not use the handles on the front of the panel. The weight of this unit should not be supported by these handles. Grasp the chassis firmly on either side with fingers inserted through the openings in the lower side of the frame and remove the unit.

> CAUTION: Avoid contact with the terminals of all high-voltage capacitors until they are properly short-circuited.

a. Tubes. (1) Check all tubes in the unit. Make sure they are securely in place. Examine the connecting leads to the third anodes of the cathode-ray tubes. Make sure the pins are securely fastened to the glass envelopes of the cathode-ray tubes. For picture of indicator, see figure 97.

(2) The cathode-ray tubes are rugged and are usually in condition unless obvious mechanical damage is evident. The scopes may be considered as failing when the indications on the scope become successively dimmer. Sudden failures of indications, however, can usually be attributed to defective parts in the associated circuits.

b. Wiring. Make a rapid check of the wiring in the indicator unit. Look for connections which may have been ripped out. Make sure that all connections are secure and adequate.

c. Resistors. Examine all high-wattage resistors for evidence of overheating. See figure 98 for picture of underside of indicator chassis.

d. Capacitors. Check the oil-filled capacitors for evidence of oil leakage.

54. ELECTRICAL SERVICING.

a. General. If a rapid mechanical check fails to reveal any defects which might be responsible for the improper operation of the equipment, it is necessary to conduct essential voltage or resistance checks to localize the defects to the particular part of the unit concerned. See sections I and II for detailed instructions on how to perform interstage and intrastage checks. The information given below is intended primarily to suggest the stage or stages in the indicator unit that might be suspected of improper functioning if operation becomes defective.

> WARNING: Dangerously high voltages exist in the scope circuits. Exercise extreme care.

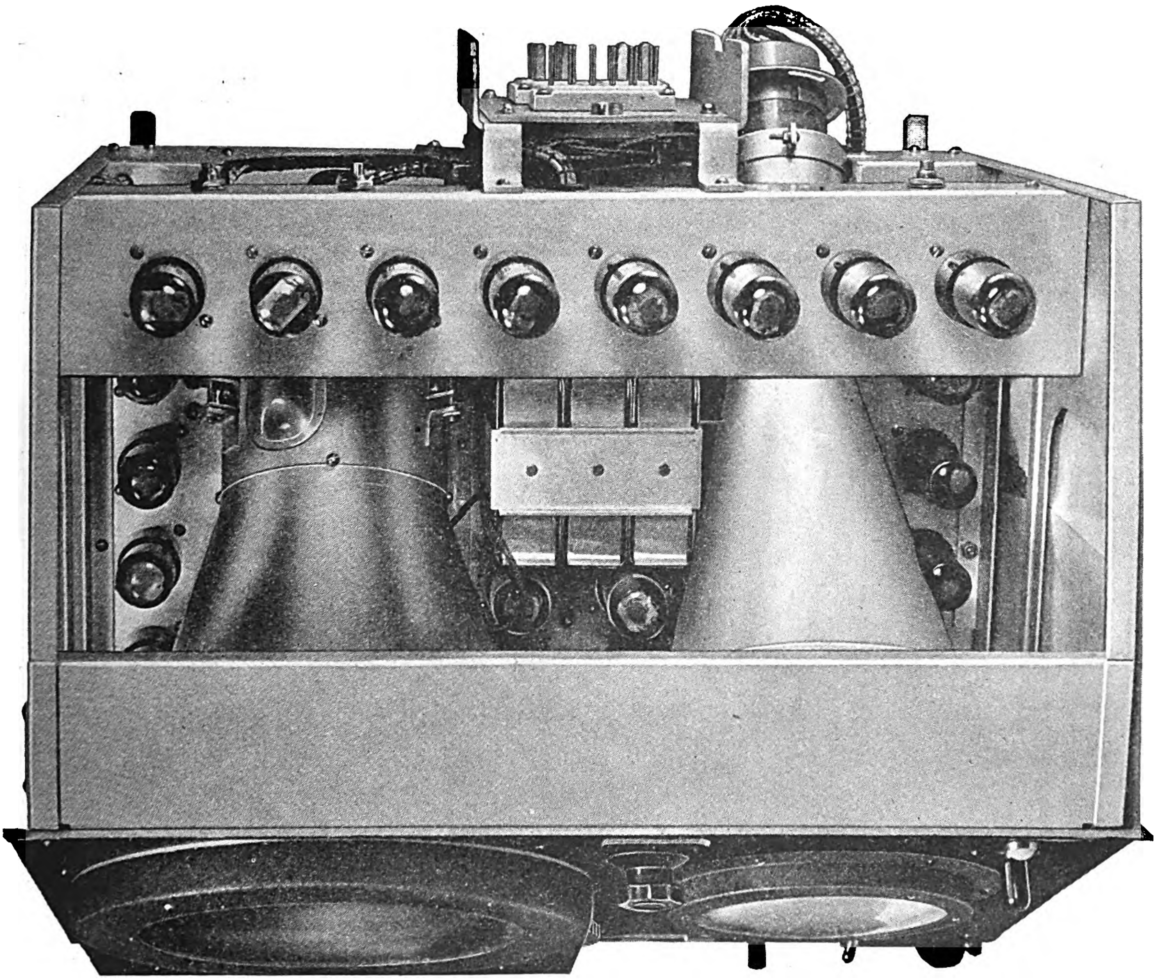

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Figure 96. Indicator chassis, top view.

Connect the indicator extension cord between the console terminal board and the indicator unit. Throw the MAIN POWER SWITCH to the ON position. After 30 seconds, throw the TRANSMITTER switch to the ON position.

b. No Scope Indications. Make sure the PPI INT. and A INT. controls are turned up (clockwise). If no indications appear on the scope, proceed as follows:

(1) TUBES. After a few moments, examine all tubes for filament lighting and tube heating. If a defective tube is suspected, substitute a spare tube known to be good. Through simple substitution of parts, defective components can often be detected and the equipment serviced readily. It is most important to check tubes first. If the substituted tube fails to function, the failure may lie in the filament voltage supply. Measure these voltages as described below under Low Voltage Supply.

(2) LOW VOLTAGE SUPPLY. Make voltage checks at key points of the indicator circuit. Place the indicator chassis topside down on the extended edges of the frame. Refer to the indicator voltage diagram, figure 102, and measure the voltages at the basic reference points as indicated below. These points are correspondingly labeled in figure 102 and can be identified easily. These voltages should be within ±10%, but a deviation of ±20% should not cause complete failure. It is assumed that the voltage output from the power supply in the receiver unit is satisfactory. Failure in the indicator may be a power failure due to an open or short circuit or a defective part. Refer to figure 102. The measured voltages should be ±10%.

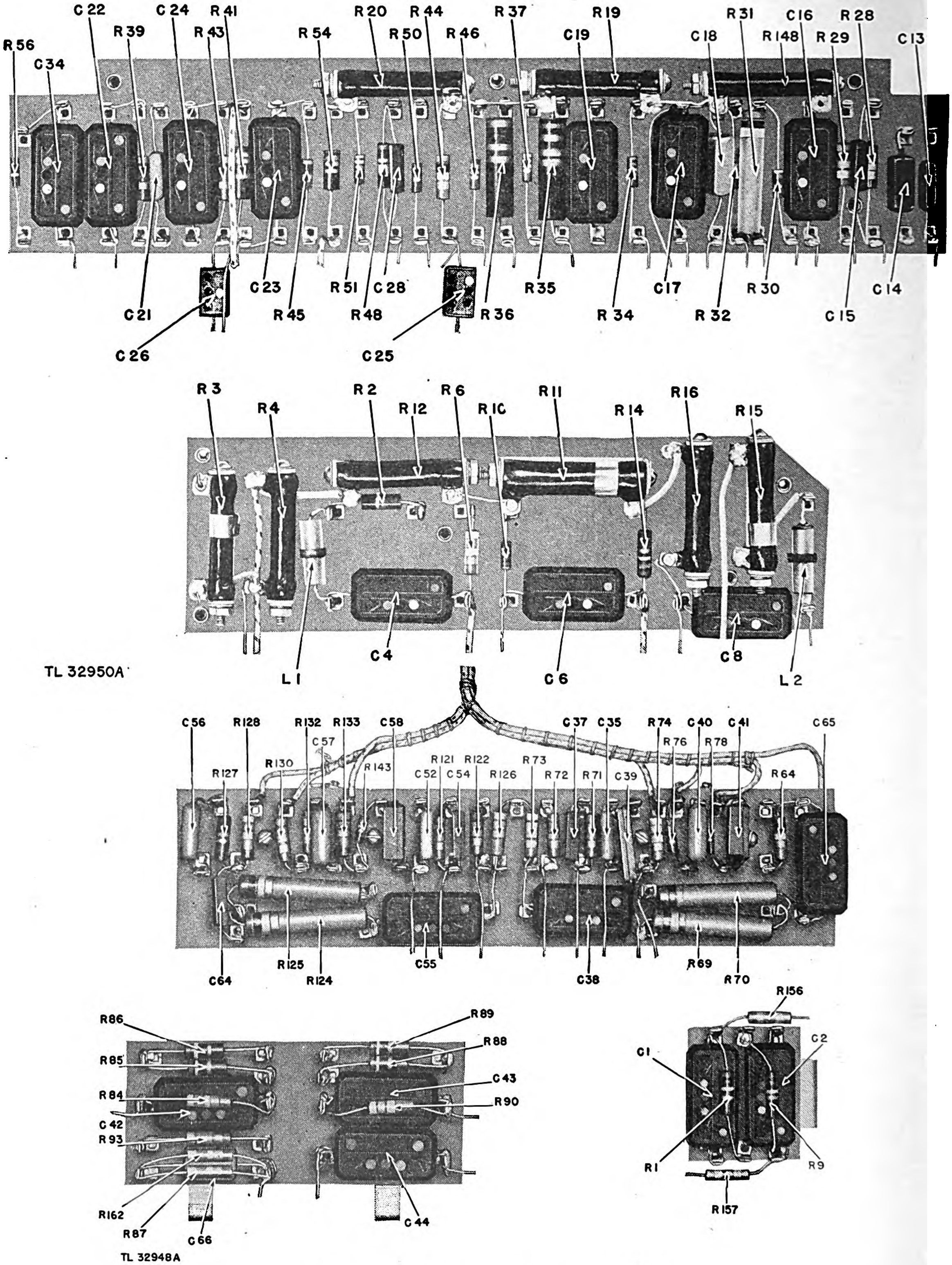


Figure 100. Indicator chassis terminal strips.

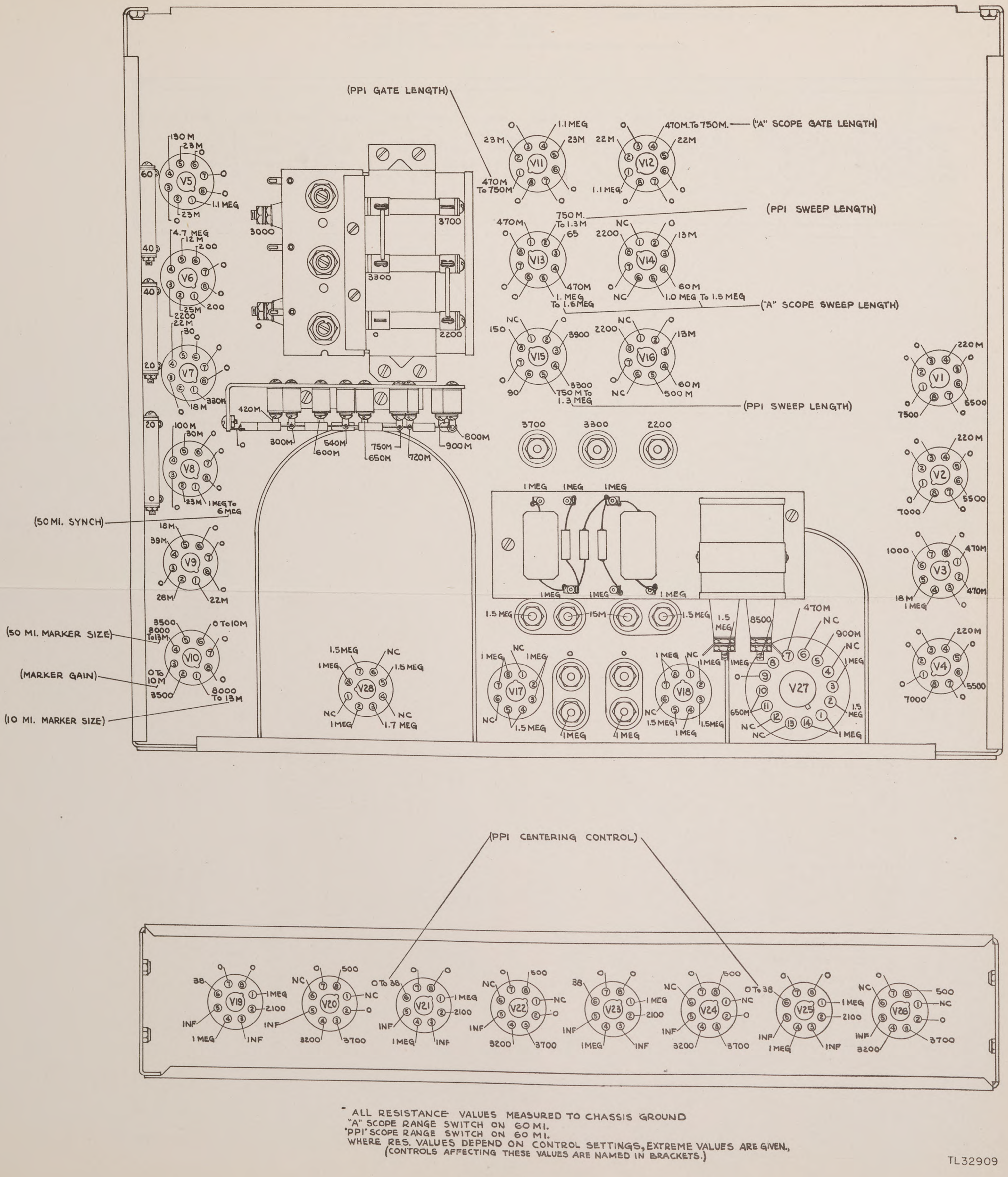
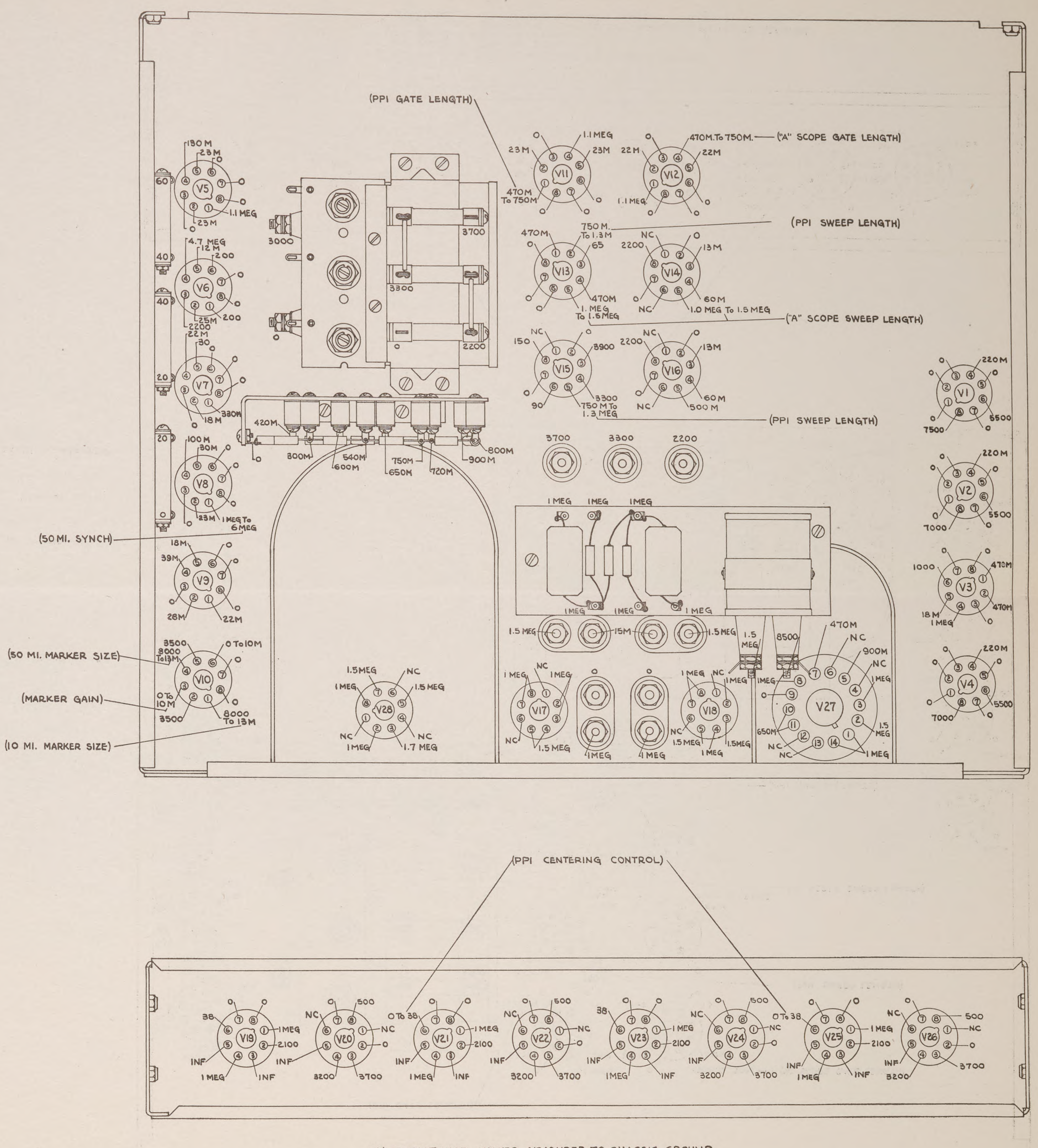


Figure 101. Indicator resistance measurements chart.



ALL RESISTANCE VALUES MEASURED TO CHASSIS GROUND
"A" SCOPE RANGE SWITCH ON 60 MI.
"PPI" SCOPE RANGE SWITCH ON 60 MI.
WHERE RES. VALUES DEPEND ON CONTROL SETTINGS, EXTREME VALUES ARE GIVEN.
(CONTROLS AFFECTING THESE VALUES ARE NAMED IN BRACKETS.)

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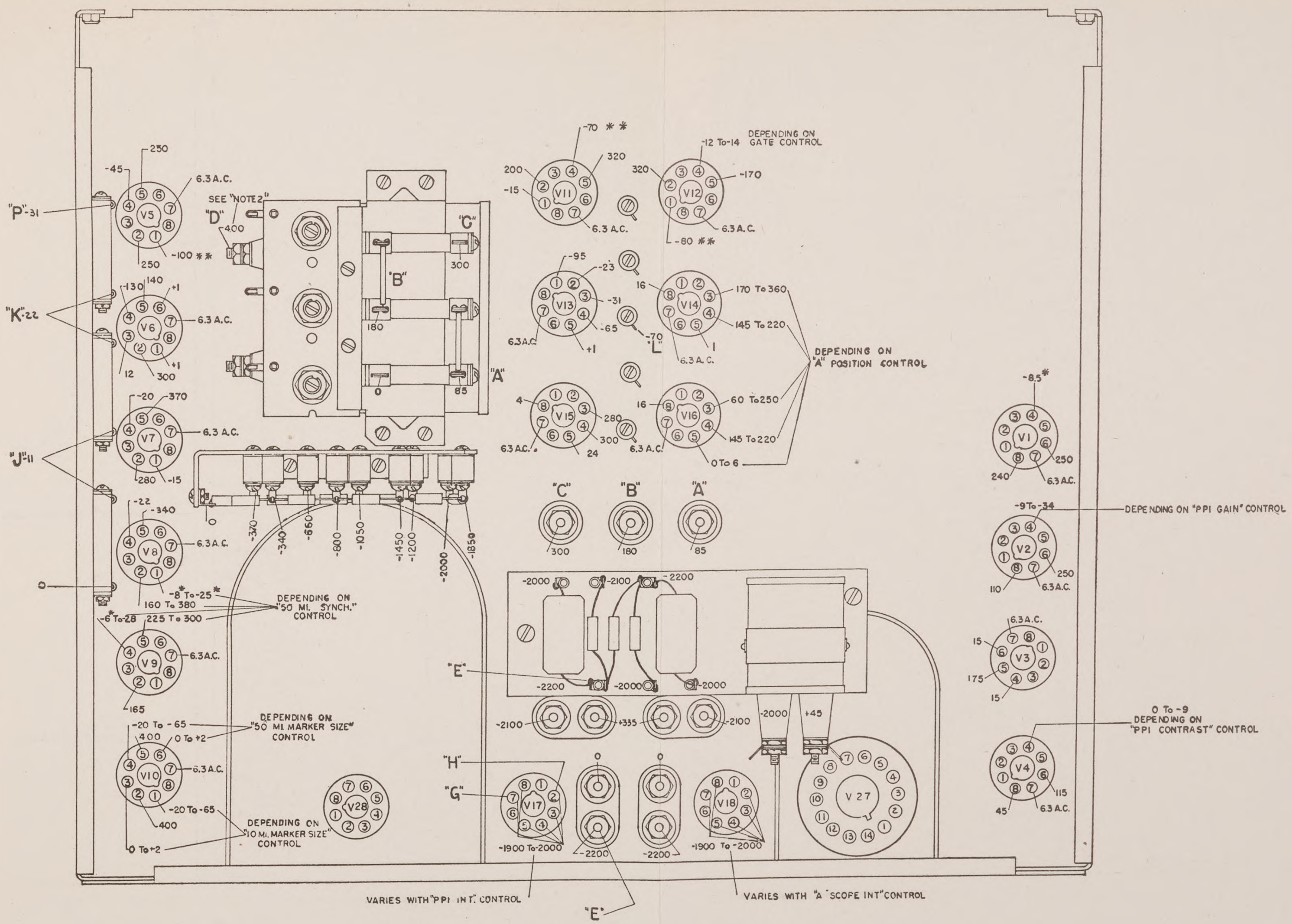
Figure 101. Indicator resistance measurements chart.



1. BOTH "A" SCOPE & PPI RANGE SWITCH IN "60 MI." POSITION BRILLIANCY (INTENSITY) NORMAL. PPI TRACE AT 45° FROM NORTH.
2. GENERATOR ADJUSTED SO THAT 400V. IS MEASURED AT FILTER CONDENSER TERMINAL "D" AFTER 5 MIN. WARM UP PERIOD.
3. ALL VOLTAGES MEASURED ON LOWEST RANGE EXCEPT WHERE OTHERWISE NOTED.
   * MEASURED ON 50 VOLT RANGE.
   ** " " 250 " "
4. ALL VOLTAGES MEASURED TO CHASSIS GROUND USING 20,000 OHM PER VOLT METER ON D.C. AND 1000 OHM P.V. ON A.C. SUCH AS SIMPSON MOD. 260 OR WESTON MOD. 772.
5. 6.3 V. A.C. FOR SCOPE FILAMENTS CAN BE CHECKED BETWEEN "G" & "H". WATCH FOR HIGH VOLTAGE!

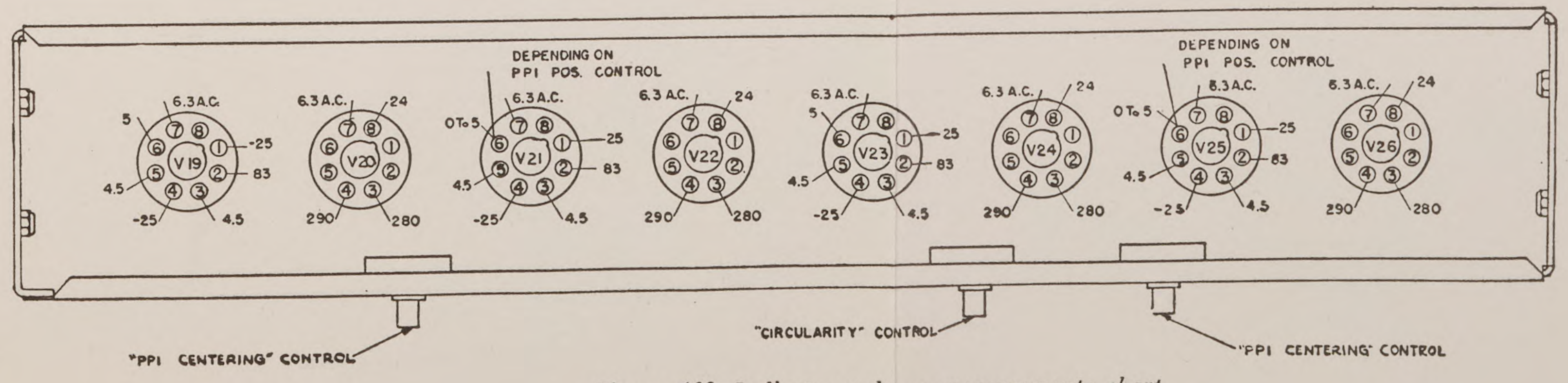


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Figure 102. Indicator voltage measurements chart.

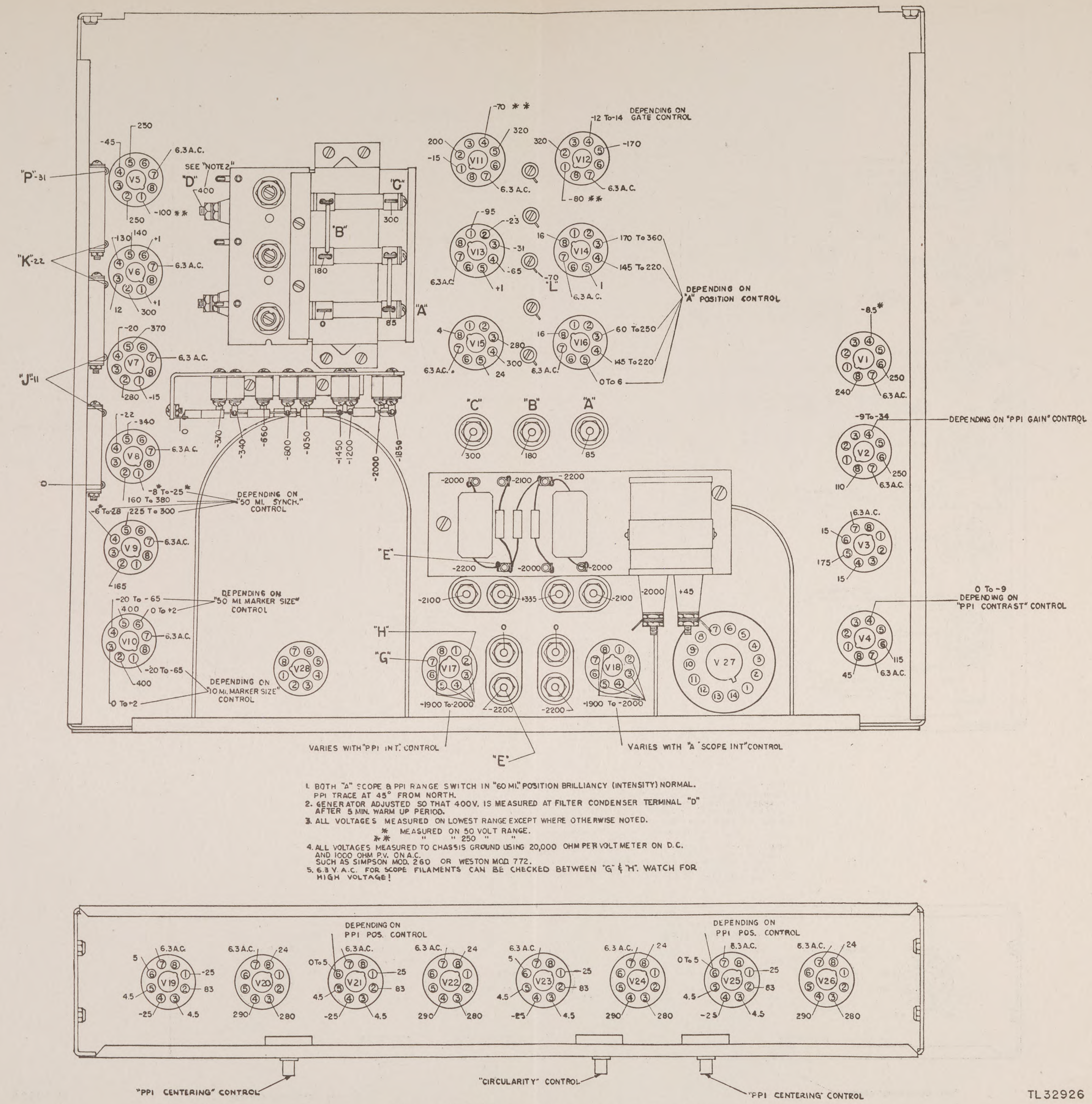

Figure 102. Indicator voltage measurements chart.

(4) RESISTANCE CHECKS. Defective parts in a channel or stage of the indicator unit may be checked by resistance measurement. If the continuity check fails to reveal an open circuit, but the voltage check has localized the defect to a particular stage in the indicator, conduct a resistance check. Refer to figure 101 for the normal resistance values at the various socket pins. Defective parts may be localized by comparing measured values with these normal resistance values. Make sure that all power is off when using the ohmmeter.

c. Improper Scope Indications. If the power supply in the indicator is normal, and if all the tubes have been checked and found operative, the scopes should show indication. A beam of light (or spot) on the screen indicates the voltage is ON and functioning. It is, therefore, necessary to localize the defect to the particular channel or channels within the indicator unit which are responsible for the defective operation.

(1) INPUT TRIGGER PULSE. If the PPI and "A" scope intensity controls are turned up and no light indications appear on the scopes, the absence of the triggering pulse from the pulse transformer may be suspected. An open or shorted interconnecting cable between the console and the indicator may be the cause. It may be due to a poor terminal board connection. Check the continuity of the lead from output of pulse transformer to input of the sweep and range circuits of the indicator.

(2) SCOPE CIRCUITS. Since two scopes are used, one scope sweep circuit can be checked against the second scope sweep circuit so that the channel in which the defect exists may be properly determined. For example, should the sweep and range markers appear normally on the PPI scope, while only a spot of light appears on the "A" scope screen, the "A" scope sweep circuit channel may immediately be suspected as being defective; while, if one scope does not light up at all, the respective gate circuit should be investigated. Should the sweep circuits appear without range marks, the range marker circuit is probably at fault. Interpretation of the indications on one scope against those of the other scope should help to localize the channel in which possible defects exist. There are four separate and distinct channels in the indicator; the PPI sweep, the "A" sweep, the range marker, and the video amplifier circuits.

(3) "A" SCOPE SWEEP CIRCUIT (fig. 33). If analysis up to this point has helped localize the defect to the "A" scope sweep circuit, trace through the circuit until the difficulty is located. It is best to have the functional schematic nearby so that a carefully planned step-by-step, stage-to-stage check can be made. Refer to figures 102 and 101 and check socket voltages and socket resistances of the "A" scope channel. If it is necessary to measure through or across parts, do so. Note that most of the resistors and capacitors are mounted on terminal strips close to the tubes with which they are connected. See figure 100 for layout of components on individual terminal strips.

(4) PPI SCOPE SWEEP (fig. 34) AND RANGE MARKER (fig. 36). These circuits may be checked in similar fashion. It is good practice to substitute good tubes for all tubes in a defective channel so that faulty tubes can be recognized. The range-marker oscillator coil may cause a defect and should be replaced if necessary.

(5) DEFECTIVE SCOPE INDICATIONS. Many scope indications may be such that the very appearance of the scope reveals the stage in which the difficulty may be located. The following comprises a list of *typical* defective "screen pictures" and *possible* causes of these failures:

NOTE: It is assumed that all controls on the indicator are set for optimum operation.

(*a*) *Symptom:* Momentary interruptions or flickers on scope screen which are constant enough to make proper operation of the set difficult.

Cause: Defective spark gap operation.

Remedy: See TM 11-933.

(*b*) *Symptom:* Irregular strong pulses which run across the screen of the scope.

Cause: (External). Noise source or other radar equipment.

Remedy: Operating frequency may have to be set to avoid interference from nearby set. Consult with the person-in-charge.

(*c*) *Symptom:* Irregular trace sweep on PPI scope. Sweep seems to start at different levels and behaves in a jittery fashion.

Cause: Bad clamping tubes or associated circuits.

Remedy: Substitute tubes. Check clamping tube circuits.

(*d*) *Symptom*: Non-circular sweep on PPI scope.

Cause: Defective CIRCULARITY control (fig. 97).

Remedy: Examine potentiometer and associated circuit for possible burned windings, opens, or shorts.

(*e*) *Sypmtom*: Constantly changing intensity of electron beam.

Cause: Irregularities at power unit.

Remedy: Check gasoline supply, mixture, etc., on power unit. See TM 11-933.

(6) REMOVAL OF PARTS. Many parts in the indicator must be removed from the chassis of the indicator for servicing. Resistors, capacitors, and other connections which are soldered need only to be carefully unsoldered and removed.

(*a*) *PPI Dial Light.* The tube must be rotated 90° before it can be snapped out of its socket.

(*b*) "A" Scope. This tube can be taken out of the chassis through the front panel in the following manner.

1. Remove the front escutcheon of the "A" scope.
2. Remove the high-voltage clip from the glass envelope.
3. Remove the tube by pushing on the guide pin through the opening in the tube socket.
4. Remove shield of tube if this becomes necessary for additional servicing. First loosen the mounting bracket around the neck of the shield.

(*c*) *PPI Scope.* This tube may be similarly removed. Be careful not to exert lateral pressure on the neck of the tube while removing it from the yoke and focus coil assembly (fig. 97). Be careful of the fluorescent dial light.

(*d*) *Focus Coil.* If the pattern of the PPI screen cannot be centered with the electrical controls located on the rear of the upper indicator chassis, mechanical adjustment of the focus coil is necessary. Three lead screws are provided on the shield assembly of the tube. These lead screws are accessible from the rear of the chassis. Each screw helps move the position of the coil slightly. Carefully adjust the screws until adequate centering is secured. Keep clear of the high-voltage terminals.

(*e*) *Tracking Switch.* Remove the "A" scope and shield. Access to the tracking switch is thereby permitted.

(*f*) *Panel Controls.* Remove the four screws which fasten the front panel to the side walls of the chassis. Remove the four screws that fasten the panel to the chassis pan.

(*g*) *Vitreous Resistors:* Replace these only if they are 20% greater than the specified values. All vitreous resistors are mounted in long bolts that run through their full length. These bolts must be removed before the resistors can be removed.

(*h*) *Filter Capacitors.* Loosen the strong mounting bracket bolts.

(*i*) *Plug Board.* Remove the large aluminum bracket on which the connectors are mounted. Do not remove any of the individual porcelain connectors unless it is definitely ascertained that they should be replaced.

CHAPTER 3
SUPPLEMENTARY DATA
SECTION I
TABLE OF REPLACEABLE PARTS

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	C-301A, B		CAPACITOR; 2 x .15 Mfd, ±20%, 8000 V. D.C.; unit will operate in oil ambient between %40°C & +85°C; two (2) hot tinned solder lugs to be supplied with each capacitor; overall dimensions 6½ in. x 3¾ in. x 1¾ in.	Filter.	S 2197	22G793
*#1	P301	2Z8799-173	CONNECTOR; Male 4 prong—Type AN3102-20-4P	24 V. D.C. Input.	A2 AN-3102-20-4P	62G54
2	P302		RECEPTACLE & INSULATOR ASSEMBLY; Consisting of the following items: 1—SG3124—Insulator & Cap Assembly 1—SG3125—Receptacle & Shell Assembly 1—SG3127—Cap & Chain Assembly 1—188G46—Lockering 1—196G20—Gasket The contact and shell must be held concentric in assembly to within ±.005; overall dimensions 2½ in. wide x 6 in. long. (special)	Outlet to Motor Generator Gap.	Z SG3126	SG3236
..	P303		Same as P302	Outlet to Pulse Transformer.		
#1	PUL301		PULSE LINE; Type 16-E5-1.5-200-50P; peak operating voltage 16 K.V.; peak operating current 160 amps.; repetition rate 200 P.P.S.; charging capacity 0.015 mfd.±5% at 60 C.R.S.; impedance 50 Ohms ±2%; Satisfactory operation in oil ambient between −40°C and +85°C.	Pulse forming network.	S 16-E5-1.5-200-50P	SG2837
2	V301	2V705A	TUBE; Vacuum, Western Electric & Manufacturing Corp. Type #705A	Rectifier.	W 705A	100G91
..	V302	2V705A	TUBE; Same as V301	Rectifier.		
1	V303		TUBE; Spark Gap, Type 532A	Overpotential safety device.	W1 WL-532A	100G106
*#2	F301		FUSE; 7 Amps. 115 Volt. Type 4 AG; 9/32 in. dia. x 1¼ in. long.	Line Fuse.	12 CH64	136G23
#1	T301		TRANSFORMER; Power, 515 V.A.; Primary; 125 R.M.S. volts 400 Cps Secondary #1: 3400R.M.S. Volts; under load of 0.140 amps. operates at 9000 volts above ground. Secondary #2 & 3: 2.5 R.M.S. Volts; 5.0 amps; operates at 9000 volts above ground. Electrostatic shield between primary and all secondaries; operation in oil ambient between −40°C and +85°C; efficiency at least 95%; Overall dimensions 5¾ in. long x 4¾ in. wide x 2⅞ in. high.	Power Transformer.	W1 L421434	95G47

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

55. MODULATOR UNIT MD-16/TPS-3. (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
#1	CH301		CHOKE; Inductance; 217 Henries ±5% Max. resistance; 1500 Ohms at 20°C; .050 amps. D.C. R.M.S. Current 100 CPS; =.055 amps. Efficiency at least 95% Operation in an oil ambient from −40°C to +85°C. Operating voltage across choke 8000 Volts Operating voltage from coil to ground 16000 Volts.	Charging Choke.	W1	L420800	95G48
*#1	RE301		RELAY; D.P.D.T.; Coil voltage; Nominal 24 V.D.C., maximum 32 V.D.C., minimum 18 V.D.C.; Coil resistance 240 Ohms ±10%; Contacts to handle 7 1/2 amps. 150 A.C. 400 Cycle inductive load; contact insulation linen bakelite "Grade L.E." overall dimensions 2 3/4 in. long x 2 1/8 in. wide x 1 7/8 in. high.	Power Switch.	P1	MRS-58	195G61
#2	306		CLAMP; #22GA (.0299) C.R. Steel; .144 in. dia. mounting hole; overall length 29/32 in.	Cable Clamp.	Z1	79	17G37
#2	307		CLIP; brass, silver plated 1/8 in. wide x 1/2 in. long; spring clamping type.	Retaining Clip.	C2	19-305	19G87
#2	312		SOCKET; ceramic, special, 3 1/4 in. dia. x 5/16 in. thick; four (4) contacts phosphor bronze-silver plated (furnished with one (1) tube retaining clip)	V-301 & V-302 Tube Socket.	U	115061	78G87
#4	323		WASHER; Steel— nickel plated; .031 in. thick x .144 in. I.D. x 3/8 in. O.D.	Socket Mounting Washers.	G2	93G316	93G316
#8	324		WASHER; steel-Zinc plated; .046 in. thick x .261 I.D. x 9/32 in. O.D.	Stud Mounting Washers.	D	93G321	93G321
#4	325		WASHER; fibre; 1/16 in. thick x 5/32 in. I.D. x 3/8 in. O.D.	Socket Mounting Washers.	S7	93G614	93G614
#8	326		WASHER; Acetate; .015 in. thick x 9/64 in. I.D. x 1/2 in. O.D.	Acetate Spacing Washers.	W2	93G629	93G629
#21	327		WASHER; victorite; 1/16 in. thick x .180 in. I.D. x 3/8 in. O.D.	Captive Screw sealing Washer.	E1	93G901	93G901
#3	328		BUSHING; solder seal, porcelain, 7/8 in. dia. x 3 1/8 in. long; one (1) threaded stud 3/8—24 x 1/2 in. at one end.	Solder Seal Bushing.	W1	1014478	94G513
#3	329		BUSHING; solder seal, porcelain; 5/16 in. dia. x 7/8 in. long; one (1) 7/16 in. stud at one end.	Solder Seal Bushing.	W1	S1309164	94G514
#20	331		SCREW; Captive-Slotted round head, 1/2 in. long with 10/32 x 3/16 in. long threaded portion.	Side Cover Captivated Screws.	E1	DC53P67	112G750

#Indicates items furnished in concurrently produced Depot Spares

55. MODULATOR UNIT MD-16/TPS-3. (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
#1	332		SCREW; Fillister head, fibre, $6/32$ x $3/8$ in. long.	Clip Mounting Screw.	S7	114G28	114G28
*#3	337		INSULATOR, STANDOFF; Isolantite, glazed; $1/2$ in. dia. x 1 in. long, tapped at both ends $6/32$ x $5/16$ in. deep; assembled with one (1) brass nickel plated cap and one (1) $6/32$ x $1/2$ in. long brass nickel plated round head screw.	Terminal Insulating Standoffs.	E1	DC53P39	194G46
*#1	338		INSULATOR, STANDOFF; Isolantite, glazed; $3/4$ in. dia. x 4 in. long: tapped at both ends $1/4$-20 x $7/8$ in. deep.	Terminal Standoff.	E1	DC53P29	194G47
*#4	339		INSULATOR STANDOFF; Isolantite, glazed; $1/2$ in. dia. x in. long; tapped at both ends $6/32$ x $5/16$ in. deep.	Tube Socket Mtg. Standoffs.	E1	DC53P38	194G48
#1	340		GASKET, Victorite, $1/2$ in. wide x $1/16$ in. thick stock; $7\,31/32$ in. wide x $13\,31/32$ in. long, twenty (20) $1/4$ in. punched holes spaced $2\,1/4$ in. apart.	Sealing Gasket.	V	196G22	196G22
#1	341		GASKET, Victorite, $1/16$ in. thick stock; $1\,1/2$ in. square x $1\,1/8$ in. inside diameter; four (4) $1/8$ in. punched holes.	Sealing Gasket.	V	196G28	196G28

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

56. RADAR TRANSMITTER T-52/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
1	V-401		TUBE, VACUUM; Type VT-158	Transmitter Tube.	E2 VT-158	100G90
#1	MO404		MOTOR; blower; 20/32 volts D.C., 1/190 wound, 2.306 in. dia. x 2 15/16 in. long, .250 dia. x 1 in. long shaft, four 5/40 tapped holes at shaft end of case for mounting, two conductor #18 stranded motor lead 31 in. long; Type LD3B-27 —Signal Electric Mfg. Co.	Blower Motor.	S6 LD3B-27	141G26
*#1	P405B	2Z7112.24	CONNECTOR; Aluminum alloy, sandblasted; 90° L, 5/8-24 male thread one end, other end 1 in. dia. ferrule and two (2) contact sockets. Type AN-3108-12s-3P.	Connector for M0404.	A2 AN-3108-12S-3P	62G74
#1	407		PLATE LEAD ASSEMBLY; Left hand; Flexible type, consisting of copper braid enclosed in a coil spring; one end terminated to a banana plug, and other end terminated to a connector for tube plate cap. (special)	Plate connection for transmitter tube to transmission line.	Z SG3441	SG3441
#1	408		PLATE LEAD ASSEMBLY; Right hand. Same as Ref. No. 407 except right hand. (special)	Plate connection for transmitter tube to transmission line.	Z SG3442	SG3442
*#1	409	2Z2636-4	CLAMP; Cable; aluminum alloy sandblasted; 5/8-24 threaded hole at one end, other end split, and contains two 5/40 x 1/2 in. Fil. Hd. M.S. for clamping split section to 3/8 in. dia. cable; Type AN-3057-4.	Clamp for P405B.	A2 AN-3057-4	17G109
#1	410		ROTOR; blower fan; steel zinc plated; Cylindrical type; twenty-four vanes; 3 7/32 in. outside dia. x 2 in. wide; .252 dia. mounting hole in hub, supplied with two 1/4-20 x 1/4 in. long Allen Head set screws.	Rotor for MO404.		31G2
#1	411		HOUSING; blower; moulded bakelite, outside dimensions; 5 1/2 in. wide x 6 11/32 in. high x 2 3/8 in. deep; Intake part 2 27/32 in. dia.; exhaust part 2 1/4 in. x 2 1/4 in.; five brass inserts tapped 8/32 thread, moulded into edges of open side opposite intake part to accommodate mounting screws for motor plate.	Blower Housing.		43G74
#1	412		PLATE, Motor mounting; moulded bakelite; overall dimensions 5 1/2 in. x 6 11/32 in. x 3/32 in. thick; four .136 dia. countersunk holes on 1.062 in. radius for motor mounting, five .196 dia. holes for plate mounting.	Mounting for MO404.		57G922

#Indicates items furnished in concurrently produced Depot Spares.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#1	413		RESISTOR; 80 Ohm Koolohm, 10 Watt, 10%, 7/16 in. dia. x 1 27/32 in. long. Has two (2) .032 dia. copper wire, axial leads=2½ in. long. (Part of V-401)	Bias Resistor.	S	63G1206
*#2	414		BRUSH, Motor	Brush for MO404.		213G55

57. RADAR RECEIVER R-59/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#13	C-201		CAPACITOR; Mica; 82 mmfd., ±10%, 500 V.; metal case and terminal to be silver plated or hot tinned dipped; overall dimensions of Capacitor 3/32 in. x 11/32 in. x 3/8 in.	Heater RF By Pass.	F A7614BS	22G980
..	C-202		CAPACITOR; Same as C-201	Cathode RF By Pass.		
..	C-203		CAPACITOR; Same as C-201	Cathode RF By Pass.		
..	C-204		CAPACITOR; Same as C-201	Heater RF By Pass.		
..	C-205		CAPACITOR; Same as C-201	RF Coupling Cond.		
..	C-207		Part of 212	Osc. Tuning Cond.		
..	C-208		CAPACITOR; Same as C-201	Heater RF By Pass.		
..	C-209		CAPACITOR; Same as C-201	Heater RF By Pass.		
..	C-210		CAPACITOR; Same as C-201	Cathode RF By Pass.		

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-211		CAPACITOR; Same as C-201	B + RF By Pass.		
..	C-212		CAPACITOR; built-in, part of R.F. plate line #1 assembly.	Tuning; RF Amp. #1.		
..	C-213		CAPACITOR; built-in, part of R.F. plate line #2 assembly.	Tuning; RF Amp. #2.		
..	C-214		CAPACITOR; Same as C-201	B + RF By Pass.		
..	C-215		CAPACITOR; Same as C-201	B + RF By Pass.		
*#1	C-216		CAPACITOR; Ceramic; 15 mmfd. ±10%, 500 V.; Zero temperature Coefficient; 7/32 in. dia. x 11/16 in. long; axial wire leads; #20 A.W.G. tinned copper wire 1½ in. long.	IF Input Coupling.	E NPOL	22G948
*#34	C-217		CAPACITOR; Mica; .001 mfd., ±10%, 300 V.; low loss mica dielectric sealed case 3/16 in. x 29/64 in. x 25/32 in.; axial wire leads, #20 A.W.G. tinned copper wire 1¼ in. long.	Crystal Current Meter By Pass.	C4 5LS.001 M OXM	22G882
..	C-218		CAPACITOR; Same as C-217	Crystal Current Meter By Pass.		
..	C-219		CAPACITOR; Same as C-217	1st IF Cathode By Pass.		
..	C-220		CAPACITOR; Same as C-217	1st IF Heater By Pass.		
..	C-221		CAPACITOR; Same as C-217	1st IF Heater By Pass.		
*#8	C-222		CAPACITOR; mica; .0001 mfd., ±10%, 500 V.; low loss mica dielectric sealed case 3/32 in. x 29/64 in. x 25/32 in.; axial wire leads, #20 A.W.G. tinned copper wire 1¼ in. long.	Coupling, 1st to 2nd IF.	C4 5LS.0001 M OXM	22G883
*#8	C-223	3D9500-81	CAPACITOR; mica; .0005 mfd., ±10%; 500 V.; low loss mica dielectric sealed case 3/32 in.; axial wire leads #20 A.W.G. tinned copper wire 1¼ in. long.	1st IF plate supply By Pass.	C4 5LS.0005 M OXM	22G884
..	C-224		CAPACITOR; Same as C-217	2nd IF cathode By Pass.		
..	C-225		CAPACITOR; Same as C-217	2nd IF heater By Pass.		
..	C-226		CAPACITOR; Same as C-217	2nd IF screen By Pass.		
..	C-227		CAPACITOR; Same as C-222	Coupling, 2nd to 3rd IF.		
..	C-228	3D9500-81	CAPACITOR; Same as C-223	2nd IF plate supply By Pass.		

#Indicates items furnished in concurrently produced Depot Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-229		CAPACITOR; Same as C-217	3rd IF Cathode By Pass.		
..	C-230		CAPACITOR; Same as C-217	3rd IF Heater By Pass.		
..	C-231		CAPACITOR; Same as C-217	3rd IF Screen By Pass.		
..	C-232		CAPACITOR; Same as C-222	Coupling, 3rd to 4th IF.		
..	C-233	3D9500-81	CAPACITOR; Same as C-223	3rd IF Plate Supply By Pass.		
..	C-234		CAPACITOR; Same as C-217	4th IF Cathode By Pass.		
..	C-235		CAPACITOR; Same as C-217	4th IF heater By Pass.		
..	C-236		CAPACITOR; Same as C-217	4th IF Screen By Pass.		
..	C-237		CAPACITOR; Same as C-222	Coupling, 4th to 5th IF.		
..	C-238	3D9500-81	CAPACITOR; Same as C-223	4th IF Plate Supply By Pass.		
..	C-239		CAPACITOR; Same as C-217	5th IF Cathode By Pass.		
..	C-240		CAPACITOR; Same as C-217	5th IF heater By Pass.		
..	C-241		CAPACITOR; Same as C-217	5th IF Screen By Pass.		
..	C-242		CAPACITOR; Same as C-222	Coupling, 5th to 6th IF.		
..	C-243	3D9500-81	CAPACITOR; Same as C-223	5th IF plate supply By Pass.		
*#1	C-244 A, B, C, D		CAPACITOR; paper dielectric; 2 x .5 mfd., −10% +20% 400 V. (C244A & C244D) 2 x .5 mfd. 600 V. (C244V & G244C) four (4) hot tinned terminals; to be hermetically sealed, oil impregnated; overall dimension of condenser 1 3/16 in. x 2 1/4 in. x 2 1/2 in.	A. IF Channel Screen Supply By Pass. B. Video Amp. Plate Supply By Pass. C. AJ Blanking Circuit Plate and Screen Supply By Pass. D. Screen By Pass, AJ Blanking Circuit Video Amplifier.	S P-6769	22G979
..	C-245	3D	CAPACITOR; Same as C-201.	RF By Pass, heater of det. and Video.		

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-246		CAPACITOR; Same as C-217	6th IF Cathode By Pass.		
..	C-247		CAPACITOR; Same as C-217	6th IF Heater By Pass.		
..	C-248		CAPACITOR; Same as C-217	6th IF Screen By Pass.		
..	C-249		CAPACITOR; Same as C-222	Coupling; 6th IF to det.		
..	C-250		CAPACITOR; Same as C-217	Det. Heater By Pass.		
*#2	C-251		CAPACITOR; ceramic; 10 mmfd., ±10%, 500 V.; Zero temperature coefficient; 7/32 in. dia. x 7/16 in. long; axial wire leads, #20 tinned copper wire 1½ in. long.	Det. Output IF Filter.	E NPOK	22G947
..	C-252		CAPACITOR; Same as C-201	RF By Pass, heater of det. and Video.		
*#1	C-253	3DA100-112.1	CAPACITOR; moulded paper dielectric; .1 mfd., ±20%, 400 V.; sealed case wax impregnated 3/8 in. x 3/4 in. x 1 1/16 in.; axial wire leads, #20 tinned copper wire 1½ in. long.	Coupling, detector to Video.	M 345-21	22G917
..	C-254	3D9500-81	CAPACITOR; Same as C-223	Video amp. plate supply By Pass.		
..	C-255		CAPACITOR; Same as C-217	Video amp. screen By Pass.		
*#1	C-256		CAPACITOR; ceramic; 5 mmfd., ±10%, 500 V.; Zero temperature coefficient; 7/32 in. dia. x 7/16 in. long; axial wire leads, #20 tinned copper wire 1½ in. long.	Input coupling to AJ blanking circuit.	E NPOK	22G946
..	C-257		CAPACITOR; Same as C-217	Cathode By Pass, 1st blanking circuit amp. (V212).		
..	C-258		CAPACITOR; Same as C-217	Heater By Pass, 1st blanking circuit amp. (V212).		
..	C-259		CAPACITOR; Same as C-217	Screen and plate supply By Pass 1st blanking circuit amp. (V212).		
..	C-260		CAPACITOR; Same as C-222	Coupling, 1st to 2nd blanking circuit amp. (V212-V213).		
..	C-261		CAPACITOR; Same as C-217	Cathode By Pass, 2nd blanking circuit amp. (V213).		

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-262		CAPACITOR; Same as C-217	Heater By Pass, 2nd blanking circuit amp. (V213).		
..	C-263		CAPACITOR; Same as C-217	Screen and plate supply By Pass, 2nd blanking circuit amp. (V213).		
..	C-264		CAPACITOR; Same as C-222	Coupling, 2nd blanking circuit amp. to det. (V213-V214).		
..	C-265		CAPACITOR; Same as C-217	Cathode By Pass, blanking circuit det. (V214).		
..	C-266		CAPACITOR; Same as C-217	Heater By Pass, blanking circuit det. (V214).		
..	C-267		CAPACITOR; Same as C-217	Screen and plate supply By pass, blanking circuit det. (V214).		
..	C-268		CAPACITOR; Same as C-251	Blanking circuit det. output IF filter.		
*#4	C-269		CAPACITOR; paper dielectric; .01 mfd. +20%, −10% −400 V.; sealed moulded bakelite case wax impregnated 9/32 in. x 13/16 in. x 13/16 in.; axial wire leads, #20 A.W.G. tinned copper wire 1½ in. long.	Coupling, blanking circuit det. to vid. (V214-V215).	M 336-10	22G1002
..	C-271		CAPACITOR; Same as C-217	Heater By Pass, blanking circuit video amp. (V215).		
..	C-273	3D9500-81	CAPACITOR; Same as C-223	Input coupling to AJ descriminator.		
..	C-274		CAPACITOR; Same as C-269	Cathode By Pass, 1st AJ des. amplifier (V216).		
..	C-275		CAPACITOR; Same as C-222	Screen By Pass, 1st AJ des. amp. (V216).		
..	C-276		CAPACITOR; Same as C-269	Plate supply decoupling By Pass, 1st AJ des. amp. (V216).		
..	C-277		CAPACITOR; Same as C-222	Coupling, 1st to 2nd AJ des. amp. (V216-V217).		

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-278		CAPACITOR; Same as C-269	Cathode By Pass, 2nd AJ des. amp. (V217).		
..	C-279		CAPACITOR; Same as C-222	Screen By Pass, 2nd AJ des. amp. (V217).		
..	C-280		CAPACITOR; Same as C-222	Coupling, 2nd to 3rd AJ des. amp. (V217-V218).		
..	C-282		CAPACITOR; Same as C-222	Screen By Pass, 3rd AJ des. amp. (V218).		
..	C-283		Part of 208	Tuning cond. oscillator coupling loop.		
*#3	C-284		CAPACITOR; paper dielectric; .03 mfd., ±10%, 4000 V.; case to be hermetically sealed; two (2) hot tinned dipped terminals; overall dimensions 1 in. x 1¾ in. x 3½ in.; furnish four (4) 10/32 hex nuts & four (4) shakeproof lockwashers.	Input filter condenser + 2000 volt supply.	S P-6756	22G794
..	C-285		CAPACITOR; Same as C-284	Output filter condenser + 2000 volt supply.		
..	C-286		CAPACITOR; Same as C-284	Input filter condenser −2000 volt supply.		
*#1	C-287		CAPACITOR; paper dielectric; 1 mfd., ±10%, 1000 V.; case to be hermetically sealed; two (2) hot tinned dipped terminals; overall dimensions 1 in. x 1¾ in. x 3 in. four (4) hex nuts and two (2) washers fitted on capacitor.	Input filter condenser 465 volt supply.		22G978
*#2	C-288		CAPACITOR; paper dielectric; 8 mfd., ±10%, 600 V.; two (2) hot tinned dipped terminals; case to be hermetically sealed; overall dimensions 1¼ in. x 3 25/32 in. x 4 9/16 in.; four (4) hex nuts & two (2) lockwashers fitted on capacitor.	Output filter condenser 465 volt supply.	S P-6758	22G795
..	C-289		CAPACITOR; Same as C-288	Filter condenser, plate voltage for receiver.		
..	C-290	3D9500-81	CAPACITOR; Same as C-223	6th IF amp. plate supply By Pass.		
..	C-291		CAPACITOR; Same as C-217	Protective By Pass, power output meter.		

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-292		CAPACITOR; Same as C-217	Heater wind of transformer IF By Pass.		
*#2	R-201		POTENTIOMETER; 500 Ohms, ±15%, 1 W.; D.C. Current through res. approximately 10 M.A.; Linear resistance curve; three (3) hot tinned dipped terminals; one shaft, threaded at one end, 3/8 in. long; one (1) shakeproof lockwasher and one (1) 3/8-32 x 15/32 x 3/32 nut to be furnished with each resistor; overall dimensions. 23/32 wide x 3/4 in. long.	RF amp. #1 bias control.	C 36-010-113	63G1197
*#14	R-202	3RC20BE151K	RESISTOR; fixed, carbon insulated; 150 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	RF amp. #1 minimum bias A limiting res.	A EB1511	63G1039
..	R-203		POTENTIOMETER; Same as R-201	RF amp. #2 bias control.		
..	R-204	3RC20BE151K	RESISTOR; Same as R-202	RF amp. #2 minimum bias limiting resistor.		
*#1	R-205	3RC21BE122J	RESISTOR; fixed, carbon insulated; 1200 Ohms, ±5%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Oscillator self bias res.	I BT-½	63G1072
..	R-206	3RC20BE151K	RESISTOR; Same as R-202	Crystal current meter decoupling.		
..	R-207	3RC20BE151K	RESISTOR; Same as R-202	Bias 1st IF.		
*#18	R-208	3RC20BE471K	RESISTOR; fixed carbon insulated; 470 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Screen decoupling, 1st IF.	A EB4711	63G1021
*#3	R-209		RESISTOR; fixed, carbon insulated; 820 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Plate load, 1st IF.	A EB8211	63G1022
..	R-210	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 1st IF.		
..	R-211	3RC20BE151K	RESISTOR; Same as R-202	Bias, 2nd IF.		
..	R-212	3RC20BE471K	RESISTOR; Same as R-208	Screen decoupling 2nd IF.		
..	R-213		RESISTOR; Same as R-209	Plate load, 2nd IF.		
..	R-214	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 2nd IF.		

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*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	R-215	3RC20BE151K	RESISTOR; Same as R-202	Bias, 3rd IF.		
..	R-216	3RC20BE471K	RESISTOR; Same as R-208	Screen decoupling, 3rd IF.		
..	R-217	3RC20BE471K	RESISTOR; Same as R-208	Plate load, 3rd IF.		
..	R-218	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 3rd IF.		
..	R-219	3RC20BE151K	RESISTOR; Same as R-202	Bias, 4th IF.		
..	R-220	3RC20BE471K	RESISTOR; Same as R-208	Screen decoupling, 4th IF.		
..	R-221	3RC20BE471K	RESISTOR; Same as R-208	Plate load, 4th IF.		
..	R-222	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 4th IF.		
..	R-223	3RC20BE151K	RESISTOR; Same as R-202	Bias, 5th IF.		
..	R-224	3RC20BE471K	RESISTOR; Same as R-208	Screen decoupling, 5th IF		
..	R-225		RESISTOR; Same as R-209	Plate load, 5th IF.		
..	R-226	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 5th IF.		
..	R-227	3RC20BE151K	RESISTOR; Same as R-202	Bias, 6th IF		
..	R-228	3RC20BE471K	RESISTOR; Same as R-208	Screen decoupling, 6th IF.		
*#3	R-229	3RC20BE152K	RESISTOR; fixed, carbon insulated, 1500 Ohms, ±10%, ½ W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Plate load, 6th IF.	A EB1521	63G1023
..	R-230	3RC20BE471K	RESISTOR; Same as R-208	Plate decoupling, 6th IF.		
*#2	R-231	3RC20AE202J	RESISTOR; fixed, carbon insulated; 2000 Ohms, ±5%, ½ W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Detector load.	A EB2025	63G1024
*#3	R-232	3RC20BE274K	RESISTOR; fixed carbon insulated; 270,000 Ohms, ±10%, ½ W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Vid. amp. grid return.	A EB2741	63G1058
*#1	R-233	3RC20BE514J	RESISTOR; fixed, carbon insulated, 510,000 Ohms, ±5%, ½ W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Dropping resistor; part of fixed bias net work for vid. amp.	A EB5145	63G1076

#Indicates items furnished in concurrently produced Depot Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#1	R-234	3RC20BE153J	RESISTOR; fixed, carbon insulated; 15,000 Ohms, ±5%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Part of fixed bias net work for video amp.	A EB1535	63G1077
*#5	R-235	3RC20AE102K	RESISTOR; fixed, carbon insulated; 1,000 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Plate load of vid. amp.	A EB1021	63G1020
..	R-236	3RC20BE151K	RESISTOR; Same as R-202	Plate decoupling, vid. Amp.		
*#2	R-237		POTENTIOMETER; 10,000 Ohms, ±15%; Linear curve; one (1) 1/4 in. dia. shaft and one (1) 3/8 x 32 threaded bushing, overall length of shaft and bushing 4 1/2 in.; three (3) hot tinned terminals; overall dimensions 9/32 in. wide x 5 in. long.	AJ blanking circuit gain control.	C S33-010-361	63G1177
.	R-238	3RC20BE274K	RESISTOR; Same as R-232	Part of blanking circuit gain control net work.		
.	R-239	3RC20AE102K	RESISTOR; Same as R-235	Blanking circuit input loading resistor.		
.	R-240	3RC20BE151K	RESISTOR; Same as R-202	Bias, 1st blanking circuit amp. (V212).		
..	R-241	3RC20BE471K	RESISTOR; Same as R-208	Screen and plate supply decoupling, 1st blanking circuit amp. (V212).		
..	R-242	3RC20BE472K	RESISTOR; fixed, carbon insulated; 4,700 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Plate load, 1st blanking circuit amp. (V212).	A EB4721	63G1036
..	R-243	3RC20BE151K	RESISTOR; Same as R-202	Bias, 2nd blanking circuit amp. (V213).		
..	R-244	3RC20BE471K	RESISTOR; Same as R-208	Screen and plate supply decoupling, 2nd blanking circuit amp. (V213).		
..	R-245	3RC20AE102K	RESISTOR; Same as R-235	Plate load, 2nd blanking circuit amp. (V213).		
*#1	R-246	3RC20BE104K	RESISTOR; fixed, carbon insulated; 100,000 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Part of bias net work, blanking circuit det. (V214).	A EB1041	63G1033

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	R-248	3RC20BE471K	RESISTOR; Same as R-208	Plate load, blanking circuit det. (V214).		
..	R-249	3RC20BE274K	RESISTOR; Same as R-232	Grid return, blanking circuit video amp. (V215).		
*#1	R-250	3RC40AE333K	RESISTOR; fixed, carbon insulated; 33,000 Ohms, ±10%, 2 W.; 3/8 in. dia. x 1 3/8 in. long; axial wire leads, #19 A.W.G. tinned copper wire 1 1/2 in. long.	Dropping resistor, screen of blanking circuit vid. (V215) and screen and plate supply of blanking circuit det. (V214).	S1 S1-2	63G1100
..	R-251	3RC20AE102K	RESISTOR; Same as R-235	Plate load, blanking circuit vid. amp. (V215).		
..	R-252		POTENTIOMETER; Same as R-237	AJ descriminator gain control.		
..	R-253	3RC20BE151K	RESISTOR; Same as R-202	Bias, 1st des. amp. (V216).		
..	R-254	3RC20BE152K	RESISTOR; Same as R-229	Plate load, 1st des. amp. (V216).		
*#3	R-255	3RC20BE683K	RESISTOR; fixed carbon insulated; 68,000 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Screen dropping, 1st des. amp. (V216).	A EB6831	63G1037
*#2	R-256	3RC20BE223K	RESISTOR; fixed carbon insulated; 22,000 Ohms, ±10%, 1/2 W.; 7/32 in. dia. x 5/8 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1 1/2 in. long.	Grid return, 2nd des. amp. (V217).	A EB2231	63G1029
..	R-257	3RC20BE471K	RESISTOR; Same as R-208	Plate supply decoupling, 1st des. amp. (V216).		
..	R-259	3RC20BE683K	RESISTOR; Same as R-255	Screen dropping resistor, 2nd des. amp. (V217).		
..	R-260	3RC20BE152K	RESISTOR; Same as R-229	Plate load, 2nd des. amp. (V217).		
..	R-261	3RC20BE683K	RESISTOR; Same as R-255	Screen dropping resistor, 3rd des. amp. (V218).		
..	R-262	3RC20BE223K	RESISTOR; Same as R-256	Grid return, 3rd des. amp. (V218).		
..	R-264	3RC20AE102K	RESISTOR; Same as R-235	Plate load, 3rd des. amp. (V218).		
*#1	R-265		RESISTOR; fixed, wirewound, insulated; 6000 Ohms, ±10%, 10 W.; two (2) hot tinned terminal; 5/16 in. dia. x 1 13/16 in. long.	Dropping resistor, blanking circuit plate & screen supply.	H 1 3/4T28-6000	63G1143

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	R-266	3RC30BE102K	RESISTOR; fixed, carbon insulated, 1000 Ohms, ±10%, 1 W.; 7/32 in. dia. x 9/16 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Peak current limiting, high voltage rectifiers (V219, V220).	A GB1021	63G1107
*#10	R-267		RESISTOR; fixed, carbon insulated 470,000 Ohms, ±10%, 1 W.; 7/32 in. dia. x 9/16 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Filter, +2000 V. supply.	A GB4741	63G1115
..	R-268		RESISTOR; Same as R-267	Filter, +2000 V. supply.		
..	R-269		RESISTOR; Same as R-267	Filter, +2000 V. supply.		
..	R-270		RESISTOR; Same as R-267	Filter, +2000 V. supply.		
..	R-271		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
..	R-272		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
..	R-273		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
*#3	R-274	3RC30BE224K	RESISTOR; fixed, carbon insulated; 220,000 Ohms, ±10%, 1 W.; 7/32 in. dia. x 9/16 in. long; axial wire leads, #18 A.W.G. tinned copper wire 1½ in. long.	Filter, −2000 V. supply.	A CB2241 I BT-1	63G1121
..	R-275	3RC30BE224K	RESISTOR; Same as R-274	Filter, −2000 V. supply.		
..	R-276	3RC30BE224K	RESISTOR; Same as R-274	Filter, −2000 V. supply.		
..	R-277		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
..	R-278		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
..	R-279		RESISTOR; Same as R-267	Bleeder, +2000 V. supply.		
#2	R-280		RESISTOR; wirewound meter shunt; 20 MA; ¼ in. dia. x 1 1/16 in. long; axial wire leads, #22 tinned copper wire 1½ in. long; Used with M-203.	Meter shunt used in measuring plate current of RF amp. #1.	S4 63G992	63G992
..	R-281		RESISTOR; Same as R-280	Meter shunt used in measuring plate current of RF amp. #2.		
#1	R-282		RESISTOR; wirewound meter shunt; 2 MA; ¼ in. dia. x 1 1/16 in. long; axial wire leads, #22 tinned copper wire 1½ in. long; Used with M-203	Meter shunt used in measuring crystal current.	S4 63G993	63G993
#1	R-283		RESISTOR; wirewound meter shunt; 1 amp.; ¼ in. dia. x 1 1/16 in. long; axial wire leads, #22 tinned copper wire 1½ in. long; Used with M-203.	Meter shunt used in measuring total B+ current.	S4 63G994	63G994

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#1	R-284		RESISTOR; fixed, wirewound, insulated; 4000 Ohms, ±10%; two (2) hot tinned dipped terminals; 5/16 in. dia. x 1 13/16 in. long.	Dropping resistor, for 255 volts.	H 1¾T28-4000	63G1141
*#1	R-285		RESISTOR; fixed, wirewound, insulated; 15,000 Ohms, ±10%, 10 W.; two (2) hot tinned dipped terminal; 5/16 in. dia. x 1 13/16 in. long.	Dropping resistor for 150 volts.	H 1¾T28-15,000	63G1140
*#1	R-286		RESISTOR; fixed, wirewound, insulated; 1000 Ohms, ±10%, 25 W.; two (2) hot tinned dipped terminals; ¾ in. dia. x 2 in. long.	Dropping resistor for 300 volts.	H 2B28-1000	63G1142
*#1	R-288		POTENTIOMETER; wirewound; 30,000 Ohms, ±10%, 4 W.; linear curve; one (1) ⅜ x 32 threaded bushing; one (1) ¼ in. dia. shaft; overall length of shaft and bushing 11/16 in.; three (3) hot tinned dipped terminals; one (1) shakeproof lockwasher & one (1) ⅜ x 32 nut shipped loose; overall dimensions 1⅝ in. wide x 1¾ in. long.	Receiver gain control.	C3 P-10W	63G1198
..	R-289	3RC20BE151K	RESISTOR; Same as R-202	Bias, 3rd des. amp. (V217).		
..	R-290	3RC20AE202J	RESISTOR; Same as R-231	Bias, blanking circuit det. (V214).		
#12	L-201		CHOKE; Radio Frequency, .2 microhenries #26 A.W.G. copper wire, enameled, 18 turns, clockwise wound; .187 dia. x ⅝ in. long. #22 Dead Soft Tinned copper axial leads, 1½ in. long.	Heater RF decoupling RF amp. #1.	B SG3256	SG3256
..	L-202		CHOKE; Same as L-201	Heater RF decoupling RF amp. #1.		
..	E-203		CHOKE; Same as L-201	Cathode RF decoupling RF amp. #1.		
..	L-204		CHOKE; Same as L-201	Heater RF decoupling, RF amp. #2.		
..	L-205		CHOKE; Same as L-201	Heater RF decoupling, RF amp. #2.		
..	L-206		CHOKE; Same as L-201	Cathode RF decoupling, RF amp. #2.		
..	L-207		CHOKE; Same as L-201	Plate RF decoupling RF amp. #1.		

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*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-89/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	L-208		CHOKE; Same as L-201	Plate RF decoupling RF amp. #2.		
#5	L-209		CHOKE; Radio Frequency .3 microhenries #29 A.W.G. Copper Wire, Enameled, 12 turns, clockwise wound, .187 dia. x 5/8 in. long, #22 Dead Soft tinned copper axial Leads, 1 1/2 in. long.	Cathode decoupling, oscillator.	B SG3571	SG3571
..	L-210		CHOKE; Same as L-201	Heater decoupling, oscillator.		
..	L-211		CHOKE; Same as L-209	Heater decoupling, oscillator.		
..	L-212		CHOKE; Same as L-209	Heater decoupling, oscillator.		
..	L-213		CHOKE; Same as L-201	Plate supply decoupling, oscillator.		
#1	L-214		COIL; Intermediate Frequency, 1.2 microhenries #29 A.W.G. copper wire, enameled, 9 turns, clockwise wound, 9/16 dia. x 15/16 in. long, two (2) terminals. (Special)	Primary, mixer to first IF coupling.	B SG3251	SG3251
#1	L-215		COIL; 1.6 microhenries; same as L-214 except number of turns of wire=11 Turns.	Secondary, mixer to first IF coupling.	B SG3252	SG3252
#8	L-216		R.F. CHOKE; I.F. Frequency, 3.4 microhenries, #22 A.W.G. copper Wire Enameled, three (3) layer solenoid winding, First layer=11 turns, Second layer =9 turns, third layer =6 turns, 1/4 in. diameter x 1 in. long. Must be self resonant to 30 M.C. plus-minus 2 1/2 M.C.	Heater decoupling, 1st & 2nd IF amp.	B SG3255	SG3255
#8	L-217		COIL; Intermediate Frequency, 1.9 microhenries #29 A.W.G. copper Wire, Enameled, 11 turns, clockwise wound, 9/16 dia. x 15/16 in. long, two (2) Terminals. (Special)	Grid tuning coil, 2nd IF.	B SG3254	SG3254
#2	L-218		R.F. CHOKE; I.F. Frequency, 43.7 microhenries #37 A.W.G. Copper Wire, enameled, Counter-clockwise wound, .375 dia. x 1 1/4 in. long, two (2) terminals. Must be self resonant to 30 M.C. plus-minus 2 1/2 M.C.	Screen decoupling, 1st IF.	B SG3416	SG3416
..	L-219		COIL; Same as L-217	Grid tuning coil, 3rd IF.		
..	L-220		CHOKE; Same as L-216	Heater decoupling, 3rd & 4th IF.		
..	L-221		CHOKE; Same as L-218	Plate supply decoupling, 1st & 2nd IF.		

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.*		Contractor's Drawing No.
..	L-222		CHOKE; Same as L-217	Grid tuning, 4th IF.			
..	L-223		CHOKE; Same as L-217	Grid tuning, 5th IF.			
..	L-224		CHOKE; Same as L-216	Heater decoupling,5th & 6th IF.			
..	L-225		CHOKE; Same as L-217	Grid tuning, 6th IF.			
#1	L-226		COIL; Intermediate Frequency, 2.6 microhenries #29 A.W.G. copper wire, Enameled, 14 turns, clockwise wound, 9/16 dia. x 15/16 in. long, two (2) terminals. (Special)	Detector input tuning.	B	SG3253	SG3253
..	L-227		CHOKE; Same as L-201	RF decoupling, heater of det. & vid.			
..	L-228		CHOKE; Same as L-201	RF decoupling, heater of det. & vid.			
..	L-230		CHOKE; Same as L-216	IF filter, blanking circuit output.			
..	L-231		COIL; Same as L-217	Grid tuning coil, 2nd blanking circuit amp. (V214).			
#1	T-201		TRANSFORMER; Primary 115 Volt-400 cycle; secondary (1) 2.5 V.-1.75 Amp. (2) 2.5 V-1.75 Amp. (3) 5 V.-9 Amp. (4) 6.3 V-23.5 Amp. (5) 44 V-10 Amp. (6) 6.3 V-1.8 Amp.; output voltages 465 V. and 2000 V., Wound on Hypersil Core, Insulation to withstand test of twice operating voltage plus 1000 volts for one minute, winding to winding, and winding to core, must operate satisfactorily over an ambient temperature range—40° C. to 50° C. Has 18 terminals (Cinch Lugs #1431) insulated by high voltage ceramic bushings. Overall dimensions: 6 in. high x 5½ in. square.	Main power transformer, operating all components of system except motors and modulators.	S2	41P27	95G45
#1	L-238		CHOKE; For use on 400 Cycle Supply, wound on Hypersil Core, inductance 1.5 Hy. ±15% with current of 0.6 amp., insulated for working voltage of 600 V, Test: 1 minute with 2000 volts RMS 60 cycles, between case and coil. Choke to operate satisfactorily over range of ambient temperatures −40° to +50°C. with full load current of .6 Amp. Supplied with tinned cinch Lugs #1431, lockwashers and nuts, insulated by two ceramic bushings. Overall dimensions: 3¼ in. wide x 3⅝ in. long x 4 5/16 in. high. Finish: Flat Black Enamel.	Filter 465 V. supply	S2	41C19	95G46

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	L-232		COIL; Same as L-217	Grid tuning coil, blanking circuit det. (V215).		
..	L-233		CHOKE; Same as L-216	Heater decoupling, blanking circuit amp. (V212, V213).		
..	L-234		COIL; Same as L-217	Grid tuning coil, 1st blanking circuit amp. (V212).		
..	L-235		CHOKE, Same as L-216	Heater decoupling, blanking circuit det. and vid. (V213, V214).		
..	L-236		CHOKE; Same as L-216	Heater decoupling, det. and vid.		
..	L-237		CHOKE; Same as L-216	IF filter blanking circuit det. output.		
..	L-239		CHOKE; Same as L-209	Plate supply decoupling, RF amp. #1.		
..	L-240		CHOKE; Same as L-209	Plate supply decoupling, RF amp. #2.		
2	V-201		TUBE; Vacuum, Type Jan GL446A	RF amp. #1.	G GL446-A R 100G93	100G93
..	V-202		TUBE; Same as V-201	RF amp. #2.		
1	V-203	2J955	TUBE; Vacuum, Type Jan 955/VT-121	Local Oscillator.	R 100G28	100G28
14	V-204	2J6AC7	TUBE; Vacuum, Type Jan 6AC7/1852	1st IF amp.	K 6AC7/1852 R 100G45	100G45
..	V-205	2J6AC7	TUBE; Same as V-204	2nd IF amp.		
..	V-206	2J6AC7	TUBE; Same as V-204	3rd IF amp.		
..	V-207	2J6AC7	TUBE; Same as V-204	4th IF amp.		
..	V-208	2J6AC7	TUBE; Same as V-204	5th IF amp.		
..	V-209	2J6AC7	TUBE; Same as V-204	6th IF amp.		
1	V-210	2J6H6	TUBE; Vacuum, Type Jan 6H6/VT90	Detector.	K 6H6 R 100G92	100G92

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	V-211	2J6AC7	TUBE; Same as V-204	Video amp.		
..	V-212	2J6AC7	TUBE; Same as V-204	1st blanking circuit amp.		
..	V-213	2J6AC7	TUBE; Same as V-204	2nd blanking circuit amp.		
..	V-214	2J6AC7	TUBE; Same as V-204	Blanking circuit det.		
..	V-215	2J6AC7	TUBE; Same as V-204	Blanking circuit Video amp.		
..	V-216	2J6AC7	TUBE; Same as V-204	1st AJ descriminator amp.		
..	V-217	2J6AC7	TUBE; Same as V-204	2nd AJ descriminator amp.		
..	V-218	2J6AC7	TUBE; Same as V-204	3rd AJ descriminator amp.		
2	V-219	2J2X2	TUBE; Vacuum, Type Jan 2X2/878	High voltage rectifier (+2000 V.).	K 2X2/879 R 100G95	100G95
..	V-220	2J2X2	TUBE; Same as V-219	High voltage rectifier (−2000 V.).		
3	V-221	2J5U4G	TUBE; Vacuum, type Jan 5U4G/VT244	Low voltage rectifier.	K 5U4G R 100G96 S3 5U4G	100G96
..	V-222	2J5U4G	TUBE; Same as V-221	Low voltage rectifier.		
..	V-223	2J5U4G	TUBE; Same as V-221	Low voltage rectifier.		
1	V-224	2JVR150-30	TUBE; Vacuum, Type Jan VR-150	Voltage regulator.	R 100G30 S3 003/VR-150	100G30
1	V-225	2JVR105-30	TUBE; Vacuum, Type Jan VR-105	Voltage regulator.	R 100G85 S3 VR-105	100G85
*# 1	SW-201		SWITCH; Single Section Wafer 2 pole—4 throw rotary switch, Non-shorting Type,	AJ selector switch.	O 26815-H1C	85G106
*# 1	SW-202		SWITCH; Single Section Wafer 2 pole—4 throw rotary switch, Non-shorting Type,	Meter selector switch.	O 26993-H1C	85G109
*# 1	SW-203		SWITCH; Toggle, D.P.S.T., 115 volts, 10 amps.; 400 Ohm A.C. (Each Section), 15/32-32 thd. x 15/32 in. long bushing, 3/4 W. x 25/32 D. x 1 5/16 in. long case. (Two (2) nuts and one (1) Lockwasher furnished with switch.)	Main power supply on-off switch.	C7: #8823K4	85G107

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*# 1	SW-204		SWITCH; Toggle, S.P.S.T., 24 volts D.C., 250 MA., 15/32-thd. x 15/32 in. long bushing, 5/8 W. x 21/32 D. x 1 1/8 in. long case. (Two (2) nuts and one (1) lockwasher furnished with switch)	Transmitter on-off switch.	C7:	#8803K5	85G108
*# 2	P-201A		PLUG; Ceramic, 12-pole, Male, 15 amps., 1 7/16 W. x 2 9/16 L. L. x 2 3/32 in. (Four (4) lockwashers, nuts, screws, two (2) gaskets, Eight (8) fishpaper washers and one (1) spacer furnished with each plug.	Connects receiver to console wiring.	L3	28590	58G90
..	P-201B		PLUG, Same as P-201A	Connects receiver to console wiring.			-
*# 1	P-201C		PLUG; Coaxial consisting of one (1) "R" plug shell, one (1) 10 amp. inner socket, two (2) insulating discs, and one (1) insert retaining ring and one (1) solder pot shield	Connects antenna to receiver.	C10	1260-2	23G19
# 1	M-201		VOLTMETER; A.C., 0-150 volts—400 cycles, Bakelite Case, 3 1/2 dia. x 1.66 in. deep. Three (3) screws, nuts and lockwashers furnished with meter. (American War Standard Meter) #MR35W150-ARVV.	Measures Transformer primary voltage.	S4	Model 45	122G7
# 1	M-202		METER; Thermocouple, 3 1/2 dia. x 1 9/16 in. deep, Bakelite Case, 0-1 Ma., 11 Ohms internal resistance. (Three (3) #6-32 screws, nuts, lockwashers and four (4) 1/4-28 nuts and flat washers furnished with meter).	Measures transmitter power output.	S4	Model 25 Spec. 1185	122G12
# 1	M-203	3F891	MILLIAMMETER; 3 1/2 dia. x 2 in. deep, Bakelite Case, 0-1 Ma., D.C. Type, (American or Standard Meter) #MR35W-001 DCMA.	Measures crystal current, RF amp. #1 plate current RF amp. #2 plate current and total B+ current.	S4	Model 25	122G9
*# 2	F-201	3Z1923	FUSE; Cartridge, 10 amps., 25 Volts; type 4AG, (Anti-Vibration Construction, 1/4 dia. x 1 1/4 long.)	In primary input connection to power transformer.	L2:	#1095	136G15
*# 1	X-201		CRYSTAL; .250 dia. x 578 in. long x .046 dia. x .190 in. long. Overall length .768 in. long. Navy type 1N21.	Crystal.	S3	1N21	103G15
# 2	202		FUSE RETAINER ASSEMBLY; Buss Type HCM fuse extractor post (Finger operated) for type 3 AG Fuse. Complete Assembly consists of: 1 Fuse Holder Knob, 1 Fuse Retainer. (Note: Washer and Nut furnished with Retainer)	Fuse Retainer.	B1	HCM	SG1342
# 1	233		KNOB; Black Molded Bakelite; Fuse holder Knob of Buss Type HCM Fuse, extractor post (Finger operated) for type 3AG Fuse. (Part of reference number 202)	Fuse (F201) Retainer Knob.	B1	HCM	15G23

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
# 2	234		CAP; Ceramic, 5/8 in. W. Tapering to 3/8 in. W. x 9/16 in. Deep x 1 1/8 in. long. Has a brass (tinned) metal insert. Clip must fit securely on a standard terminal tube cap of .360 dia.	(V-219 & V-200) Tube Caps.	M1 15G57 N1 17152	15G57
# 2	235	2Z2635.25	CLAMP; .015 H.C. Steel (Hardened & Tempered), "Oval type", 1 19/32 in. O.D. x 1.203 in. I.D. x 2 3/16 in. long. Two (2) .156 dia. mtg. holes.	(V-224 & V-225) Tube Clamps.	C2 8590	17G82
# 3	236		CLAMP; .015 Carbon Steel (Hardened & Tempered), "Oval Type", 1 13/16 in. O.D. x 1.406 in. I.D. x 2 5/32 in. long. Two (2) .143 dia. mtg. holes.	(V-221—V-222—V-223) Tube Clamps.	C2 8597	17G83
# 2	237		CLAMP; #20 (.0359) U.S.S.GA. Cold Rolled Steel, 3/8 in. wide x 1 in. long, having a 9/64 in. rad. band. One (1) #6-32 Tapped mtg. hole.	Tube Clamps.	G2 19G72	19G72
*# 6	239		KNOB; Knurled, Black Bakelite, 7/8 in. O.D. x .250 I.D. x 9/16 in. Thick, tapped #8-32 hole, .030 in. W. x .010 in. deep groove molded in surface and filled white.	Tuning Control Knobs.	CI SM-3646-A	46G27
#11	240		NUT; Hex, Steel Zinc Plate, #12/28 th'd. x 7/16 in. x 5/32 in. thick.	I.F. Coil mounting Nuts.	G2 54G491	54G491
# 1	241		NUT; Hex, Steel-Zinc Plate, 5/8-27 th'd. x 3/4 in. x 3/32 in. thick.	R.F. Plate Line Assembly Mounting Nuts.	R2 54G501	54G501
# 8	242		NUT; Hex, Steel-Zinc Plate, #12/24 th'd. x 7/16 in. 5/32 in. thick.	Power Transformer Mounting Nuts.	C8 54G504	54G504
*#2	250	2Z8403-1	SHOCKMOUNT; Reselient, moulded to C.R. Steel Plate 1.250 in. x 1.250 in. x .032 thick. Four (4) .141 dia. mtg. holes.	Chassis Shockmount (Small).	L1: 102P10	77G36
*#2	251		SHOCKMOUNT; Reselient, moulded to C.R. Steel Plate 1 3/4 in. x 1 3/4 in. x .050 thick. Four (4) .166 dia. mtg. holes.	Chassis Shockmount (Large).	L1: 153P20	77G37
#2	252		SOCKET; Mica Filled Bakelite, Wax impregnated, 4 contact: Two (2) for 5/32 in. prong-two (2) for 1/8 in. prong. 1 7/16 in. O.D. x 1 1/2 in. high. 1.187 I.D. x 29/32 in. deep. Has an oblong metal mounting plate 1 3/4 in. dia. x 2 3/16 in. long x 1/32 in. thick. Two (2) .156 dia. mtg. holes.	(V-219 & V-220) Tube socket.	A2: #774AT	78G88
#20	253		SOCKET; Octal, Mica Filled Bakelite, Wax impregnated, Standard Socket, 1.125 in. dia., 1/32 thick steel mounting bracket; 1 3/16 in. O.D. x 1 7/8 in. long. Two (2) .156 dia. mtg. holes.	Octal Tube Sockets.	C2 9684W.I.	78G90

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57. RADAR RECEIVER R-59/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	263		WASHER; Steel, bright Zinc finish; .144 in. I.D. x 11/16 in. O.D. x 1/16 in. Thick with a 1/16 in. extrusion.	Resistor Mounting Washer (Extruded).	G2 93G501	93G501
#17	264		WASHER; Acetate, .015 in. thick x 9/64 in. I.D. x 3/8 in. O.D.	Resistor standoff (ceramic) Mounting Washer.	F1 93G628	93G628
*#14	265		INSULATOR BUSHING; Ceramic Glazed surface; 3/8 in. dia. x 1/2 in. long; 6/32—3/16 in. tapped hole at each end.	Resistor Insulating Standoff.	C X108E C5 D901	94G309

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58. INDICATOR UNIT ID-51/TPS-3

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#5	R-1	3RC20BE224K	RESISTOR, Carbon (Insulated), 220,000 Ohms, ½ Watt −10%, 7⁄32 dia. x ⅝ long, #18 A.W.G. axial leads = 1½ in. long.	"A" Video (V-4) grid return.	A	EB2241	63G1060
*#1	R-2	3RC30BE152K	RESISTOR, Carbon (Insulated), 1500 Ohms, 1 watt 10%, 7⁄32 dia. x 9⁄16 long, #18 A.W.G. axial leads = 1½ in. long.	"A" Video (V-4) plate load.	A	GB1521	63G1108
*#1	R-3		RESISTOR, Wirewound (Vitreous Enamel), 6000 Ohms, 10 watt −10%, ⅜ dia. x 1¾ long, two (2) terminal lugs.	"A" & "PPI" Video (V-2, V-4) isolating res.	H	1¾T-28	63G1143
*#4	R-4		RESISTOR, Wirewound (Vitreous Enamel), 15,000 Ohms, 10 watt—10%, ⅜ dia. x 1¾ long, two (2) terminal lugs.	"A" Video (V-4) screen bleeder.	H	1¾T-28	63G1140
..	R-5	3RC20BE224K	RESISTOR, Same as R-1.	IFF DC—return.			
*#8	R-6	3RC20BE474K	RESISTOR, Carbon (Insulated), 470,000 Ohm, ½ watt −10%, 7⁄32 dia. x ⅝ in. long, #18 A.W.G. axial leads = 1½ long.	"A" channel DC restorer (V-3) plate load.	A	EB4741	63G1059
*#1	R-7		RESISTOR, Carbon (Insulated), 10,000 Ohm, ½ watt −10%, 7⁄32 dia. x ⅝ long, #18 A.W.G. axial leads = 1½ long.	PPI Video (V-2) bias dropping resistor.	A	EB1031	63G1028
*#2	R-8		POTENTIOMETER, 10,000 Ohm, watt −15%, Linear curve, .250 dia. x 1 7⁄16 long shaft, #8-32 th'd. x 9⁄32 long bushing, 1⅛ dia. x ½ in. deep case. (One (1) Nut, lock-washer & Armite insulating washer furnished with control.)	"PPI gain control" in grid circuit of V-2.	C	S33-010-360	63G1176
..	R-9	3RC20BE224K	RESISTOR; Same as R-1.	PPI Video (V-2) grid return.			
*#1	R-10		RESISTOR, Carbon (Insulated) 820 Ohm, ½ watt −10%, 7⁄32 dia. x ⅝ long, #18 A.W.G. axial leads = 1½ long.	PPI Video (V-2) plate load.	A	EB8211	63G1022
*#1	R-11		RESISTOR, Wirewound (Vitreous Enamel), 6,000 Ohm, 20 Watt−10%, ½ dia. x 2 in. long, two (2) Terminal Lugs.	PPI Video (V-2, V-1) Isolating Resistor.	H	2A-28	63G1145
..	R-12		RESISTOR; Same as R-4.	PPI Video (V-2) screen bleeder.			
*#1	R-13		POTENTIOMETER, Composition, 1,000 Ohm, −15%, Linear Curve, .250 dia. x 1 1⁄16 long shaft, #8-32 th'd. x 9⁄32 long bushing, 1⅛ dia. x ½ in. Deep case. One (1) nut, lockwasher and Armite Insulator furnished with control.	PPI Contrast control in grid circuit of V-1.	C	S33-010-357	63G1173

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
..	R-14	3RC20BE224K	RESISTOR, Same as R-1.	PPI—Video (V-1) grid return.			
*#1	R-15		RESISTOR, Wirewound Vitreous Enamel, 2,500 Ohm, 10 watt −10%, 3/8 dia. x 1 3/4 in. long, two (2) Terminal lugs.	V-1 plate load.	H	1 3/4T-28	63G1144
..	R-16		RESISTOR, Same as R-4.	V-3b plate load.			
*#1	R-17	3RC30BE102K	RESISTOR, Carbon (Insulated), 1000 Ohm, 1 watt −10%, 7/32 dia. x 9/16 long, #18 A.W.G. axial leads = 1 1/2 long.	V-3b Cathode res.	A	GB1021	63G1107
*#1	R-18		RESISTOR, Wirewound (Vitreous Enamel), 75 Ohm, 50 watt −5%, 5/8 dia. x 4 in. long, two (2) terminal lugs.	Bias—Voltage divider.	H	4B-28	63G1146
*#3	R-19		RESISTOR, Wirewound (Vitreous Enamel), 20 Ohm, 10 watt −5%, 3/8 dia. x 1 3/4 in. long, two (2) Terminal lugs.	Bias—voltage divider.	H	1 3/4T-28	63G1147
..	R-20		RESISTOR, Same as R-19.	Bias—Voltage divider.			
*#3	R-21		RESISTOR, Wirewound (Vitreous Enamel), 3,000 Ohm, 10 watt −5%, 3/8 dia. x 1 3/4 in. long, two (2) terminal Lugs.	Bleeder resistor.	H	1 3/4T-28	63G1148
..	R-22		RESISTOR, Same as R-21.	Bleeder resistor.			
..	R-23		RESISTOR, Same as R-21.	Bleeder Resistor.			
*#1	R-24		RESISTOR, Wirewound (Vitreous Enamel) 500 Ohm, 50 watt −5%, 5/8 dia. x 4 in. long, two (2) Terminal Lugs.	Bleeder resistor.	H	4B-28	63G1149
*#1	R-25	3RC20BE134J	RESISTOR, Carbon (Insulated) 130,000 Ohm, 1/2 watt −5%, 7/32 dia. x 5/8 long, #18 A.W.G. axial leads = 1 1/2 long.	V-5a grid leak.	A	EB1345	63G1061
*#5	R-26		RESISTOR, Wirewound (Vitreous Enamel), 20,000 ohm, 10 watt −10%, 3/8 dia. x 1 3/4 in. long, Two (2) Terminal lugs.	V-5a plate load.	H	1 3/4T-28	63G1150
..	R-27		RESISTOR, Same as R-26.	V-5b plate load.			
*#6	R-28	3RC20BE225K	RESISTOR, Carbon (Insulated), 2.2 Megohm, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	Marker gate timing resistor.	A	EB2251	63G1062
*#6	R-29	3RC20BE225K	RESISTOR, Same as R-28.	V-5b grid bias res.			
*#1	R-30	3RC20BE475K	RESISTOR, Carbon (Insulated), 4.7 Megohm, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-6b grid return.	A	EB4751	63G1063

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#5	R-31	3RC40AE103K	RESISTOR, Carbon (Insulated), 10,000 Ohm, 2 watt —10%, 3/8 max. dia. x 1 3/8 in. max. long, #18 A.W.G axial leads = 1 1/2 long.	V-6b plate load.	S1	S1-2	63G1096
*#1	R-32	3RC30BE223K	RESISTOR, Carbon (Insulated), 22,000 Ohm, 1 watt −10%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-6b plate load.	A	GB2231	63G1122
*#1	R-33	3RC20BE222K	RESISTOR, Carbon (Insulated), 2,200 Ohm, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-6b cathode res.	A	EB2221	63G1064
*#5	R-34	3RC20BE223K	RESISTOR, Carbon (Insulated), 22,000 Ohms, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-7a grid return.	A	EB2231	63G1056
*#1	R-35		RESISTOR, Carbon (Insulated), 27,000 ohm, 2 watt −10%, 3/8 Max. dia. x 1 3/8 in. max. long, .036 wire axial leads = 1 1/2 long.	V-7a plate load.	S1	S1-2	63G1102
*#1	R-36	3RC40AE153K	RESISTOR, Carbon (Insulated), 15,000 ohm, 2 watt −10%, 3/8 Max. dia. x 1 3/8 in. max. long, .036 wire axial leads = 1 1/2 long.	V-7b plate load.	S1	S1-2	63G1098
*#1	R-37	3RC20BE334K	RESISTOR, Carbon (Insulated), 330,000 ohm, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-7b grid return.	A	EB3341	63G1065
*#2	R-38		POTENTIOMETER, Composition, 10,000 ohm, −15%, Linear curve, .250 dia. x 11/16 in. long shaft 3/8-32 th'd. x 9/32 in. long bushing, 1 1/8 dia. x 1/2 in. deep case. One (1) nut, lockwasher and Armite Insulator furnished with control.	10-MI Marker Size control.	C	S33-010-354	63G1170
*#2	R-39	3RC20BE822K	RESISTOR, Carbon (Insulated), 8,200 ohm, 1/2 watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-10a grid res.	A	EB8221	63G1066
..	R-40		POTENTIOMETER, Same as R-8.	Mixed Marker Size control.			
*#1	R-41	3RC30BE471K	RESISTOR, Carbon (Insulated) 470 Ohm, 1 watt −10%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	V-10 plate load.	A	GB4711	63G1116
..	R-42		POTENTIOMETER, same as R-38.	50-MI—Marker Size control.			
..	R-43	3RC20BE822K	RESISTOR, Same as R-39.	V-10b grid res.			

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#3	R-44	3RC20BE104K	RESISTOR, Carbon (Insulated), 100,000 ohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	V-8a grid return.	A	EB1041	63G1033
*#9	R-45	3RC20BE105K	RESISTOR, Carbon (Insulated), 1 megohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	"A" scoper vertical deflection plate return.	A	EB1051	63G1042
*#3	R-46	3RC20BE273K	RESISTOR, Carbon (Insulated), 27,000 ohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	V-8a plate load.	A	EB2731	63G1055
..	R-47		RESISTOR, Same as R-26.	V-8b plate load.			
*#1	R-48		RESISTOR, Carbon (Insulated), 160,000 ohm, ½ watt −5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial wire leads = 1½ long.	50-MI circuit bias divider.	A	EB1645	63G1073
*#1	R-49		POTENTIOMETER, Composition, 5 Meg.; −15%, Linear Curve, .250 x 11/16 in. long shaft, #3/8-32 th'd. x 9/32 in. long bushing, 1⅛ dia. x ½ in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"50-MI Synch" control.	C	S33-010-358	63G1174
..	R-50	3RC20BE105K	RESISTOR, Same as R-45.	V-8b grid return.			
*#1	R-51	3RC20BE393K	RESISTOR, Carbon (Insulated), 39,000 ohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	V-9a grid return.	A	EB3931	63G1067
..	R-52		RESISTOR, Same as R-4.	V-9a plate load.			
*#1	R-53		RESISTOR, Wirewound (Vitreous Enamel), 25,000 ohm, 10 watt −10%, 3/8 dia. x 1¾ in. long, two (2) Terminal lugs.	V-9b plate load.	H	1¾T-28	63G1151
..	R-54	3RC20BE223K	RESISTOR, Same as R-34.	V-9b grid return.			
..	R-55	3RC20BE273K	RESISTOR, Same as R-46.	"A" scope supply insulating resistor.			
..	R-56	3RC20BE105K	RESISTOR, Same as R-45.	"A" scope defl.-plate return.			
*#2	R-57	3RC20BE124K	RESISTOR, Carbon (Insulated), 120,000 Ohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	"A" scope supply bleeder.	A	EB1241	63G1068

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#2	R-58		POTENTIOMETER, Composition, 100,000 ohm, —15%, Linear Curve, .250 dia. x 7/8 in. long shaft, #3/8-32 th'd. x 3/8 in. long, 1 1/8 dia. x 1/2 in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope Intensity control.	C S33-010-355	63G1171
*# 2	R-59	3RC20BE154K	RESISTOR, Carbon (Insulated), 150,000 ohm, 1/2 watt—10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" scope supply bleeder.	A EB1541	63G1047
*# 1	R-60		POTENTIOMETER, Composition, 500,000 ohm, 15%, Linear Curve, .250 dia. x 7/8 in. long shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 1/8 dia. x 1/2 deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope focus control.	C S33-010-359	63G1175
..	R-61	3RC20BE154K	RESISTOR, Same as R-59.	"A" scope supply bleeder.		
*# 4	R-62		RESISTOR, Carbon (Insulated), 470,000 ohm, 1 watt—10%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" scope supply bleeder.	A GB4741	
*# 1	R-63		RESISTOR, Carbon (Insulated), 560,000 ohm, 1 watt—10%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" scope supply bleeder.	A GB5641	63G1117
..	R-64	3RC20BE104K	RESISTOR, Same as R-44.	"A" scope gate correcting circuit.		
[*# 2	R-65		RESISTOR, Carbon (Insulated), 150,000 ohm, 1/2 watt—5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" scope gate resistor 20-MI.	A EB1545	63G1057
*# 2	R-66	3RC20BE474J	RESISTOR, Carbon (Insulated), 470,000 Ohm, 1/2 watt 5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 in. long.	"A" scope gate res. 60-MI.	A EB4745	63G1048
*# 2	R-67	3RC20BE105J	RESISTOR, Carbon (Insulated), 1 Megohm, 1/2 watt —5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" scope gate res. 120-MI.	A EB1055	63G1049
..	R-68		RESISTOR, Same as R-26.	V-12a plate load.		
..	R-69	3RC40AE103K	RESISTOR, Same as R-31.	V-12b plate load.		
..	R-70	3RC40AE103K	RESISTOR, Same as R-31.	V-12b plate load.		
..	R-71	3RC20BE225K	RESISTOR, Same as R-28.	V-12b bias divider.		
..	R-72	3RC20BE225K	RESISTOR, Same as R-28.	V-12b grid return.		

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
..	R-73	3RC20BE474K	RESISTOR, Same as R-6.	V-13b grid return.			
..	R-74	3RC20BE474K	RESISTOR, Same as R-6.	"A" scope sweep res. 20 MI.			
*# 8	R-75		POTENTIOMETER, Composition, 500,000 ohm, —15%, Linear Curve, ¼ dia. x ½ in. long slotted shaft, #⅜-32 th'd. x ⅜ in. long bushing, 1⅛ dia. x ½ in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope 20 MI sweep control.	C	S33-010-362	63G1187
..	R-76	3RC20BE105K	RESISTOR, Same as R-45.	"A" scope sweep resistor, 60 MI.			
..	R-77		POTENTIOMETER, Same as R-75.	"A" scope 60 MI sweep length control.			
..	R-78	3RC20BE224K	RESISTOR, Same as R-1.	"A" scope 120 MI sweep resistor.			
..	R-79		POTENTIOMETER, Same as R-75.	"A" scope 120 MI sweep length control.			
*# 1	R-80		RESISTOR, Wirewound (Vitreous Enamel), 2,000 Ohm, 10 watt-10%, ⅜ dia. x 1¾ in. long, two (2) Terminal lugs.	V-14 cathode res.	H	1¾T-28	63G1156
*# 2	R-81		RESISTOR, Wirewound (Vitreous Enamel), 10,000 Ohm, 20 Watt-10%, ½ dia. x 2 in. long, two (2) Terminal Lugs.	V-14 plate load.	H	2A-28	63G1153
*# 1	R-82	3RC20BE333K	RESISTOR, Carbon (Insulated), 33,000 Ohm, ½ Watt-10%, 7/32 dia. x ⅝ in. long, #18 A.W.G. axial leads = 1½ long.	"A" scope sweep-circuit voltage divider.	A	EB3331	63G1069
*# 2	R-83	3RC20BE563K	RESISTOR, Carbon (Insulated), 56,000 Ohm, ½ watt, 10%, 7/32 dia. x ⅝ in. long, #18 A.W.G. axial leads = 1½ long.	"A" scope sweep-circuit voltage divider.	A	EB5631	63G1070
*# 5	R-84	3RC20BE754J	RESISTOR, Carbon (Insulated), 750,000 Ohm, ½ Watt, 5%, 7/32 dia. x ⅝ in. long, #18 A.W.G. axial leads = 1½ long.	"A" scope sweep position bias.	A	EB7545	63G1071
*# 4	R-85		RESISTOR, Carbon (Insulated), 2.4 Megohm, 1 watt-5%, 7/32 in. dia. x 9/16 in. long, #18 A.W.G. axial leads = 1½ long.	"A" scope sweep position bias.	A	GB2455	63G1118
..	R-86		RESISTOR, Same as R-85.	"A" scope sweep position bias.			
..	R-87	3RC20BE563K	RESISTOR, Same as R-83.	V-14 & V-16 screen dropping res.			

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	R-88		RESISTOR, Same as R-85.	"A" scope sweep position bias.		
..	R-89		RESISTOR, Same as R-85.	"A" scope sweep position bias.		
..	R-90	3RC20BE754J	RESISTOR, Same as R-84.	"A" scope sweep position bias.		
..	R-91	3RC20BE224K	RESISTOR, Same as R-1/	V-16 grid bias divider.		
*# 1	R-92		POTENTIOMETER, Composition, 50,000 ohm, —15%, Linear Curve, .250 dia. x 11/16 in. long shaft, #3/8-32 th'd. x 9/32 in. long bushing, 1 1/8 dia. x 1/2 in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope position control.	C S33-010-356	63G1172
..	R-93	3RC20BE474K	RESISTOR, Same as R-6.	V-16 grid return.		
..	R-94		RESISTOR, Same as R-81.	V-16 plate load.		
*# 2	R-95	3RC20BE102J	RESISTOR, Carbon (Insulated) 1,000 ohm, 1/2 watt—5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	Ant. fixed center tap for rotary transformer secondary.	A EB1025	63G1074
..	R-96	3RC20BE102J	RESISTOR, Same as R-95.	Same as R-95.		
*# 2	R-97	3RC20BE472K	RESISTOR, Carbon (Insulated), 4,700 ohm, 1/2 watt—10%, 7/32 in. dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	Circularity control bias.	A EB4721	63G1036
*# 1	R-98		POTENTIOMETER, Composition, 10,000 ohm—15%, Linear Curve, 1/4 dia. x 1/2 in long slotted shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 1/8 dia. x 1/2 in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	Circularity control.	C S33-010-353	63G1167
..	R-99	3RC20BE105K	RESISTOR, Same as R-45.	V-19a grid return.		
..	R-100	3RC20BE105K	RESISTOR, Same as R-45.	V-21a grid return.		
*# 2	R-101		POTENTIOMETER, Wirewound, 100 ohm, 2 watt—10%, Linear Curve, .250 dia. x 1/2 in. long slotted shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 1/4 in. dia. x 9/16 in. deep case. One (1) Nut and Lockwasher furnished with control.	"PPI" centering control.	I W-100	63G1199
*# 2	R-102		RESISTOR, Carbon (Insulated), 51 Ohm, 1 watt—5%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	Clamper biasing resistor.	A GB5105	63G1119
..	R-103		RESISTOR, Same as R-102.	Clamper biasing resistor.		

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*# 4	R-104		RESISTOR, Carbon (Insulated), 390 ohm, 2 watt—10%, 3/8 in. dia. x 1 3/8 in. max. long, .036 wire axial leads = 1 1/2 long.	V-20 Cathode Resistor.	S1	S1-2	63G1101
..	R-105		RESISTOR, Same as R-104.	V-22 Cathode resistor.			
..	R-106		POTENTIOMETER, Same as R-101.	PPI centering control.			
*# 1	R-107		RESISTOR, Wirewound (Vitreous Enamel), 50 ohm, 10 watt—10%, 3/8 dia. x 1 3/4 in. long, two (2) terminal lugs.	Common Cathode resistor of PPI sweep amplifiers.	H	1 3/4T-28	63G1154
..	R-108	3RC20BE474K	RESISTOR, Same as R-6.	V-17a DC-restorer return.			
..	R-109	3RC20BE474K	RESISTOR, Same as R-6.	V-17b DC-restorer return.			
..	R-110	3RC20BE124K	RESISTOR, Same as R-57.	"PPI" supply bleeder res.			
..	R-111		POTENTIOMETER, Same as R-58.	PPI intensity control.			
..	R-112	3RC20BE104K	RESISTOR, Same as R-44.	"PPI" supply bleeder.			
*# 2	R-113	3RC30BE394K	RESISTOR, Carbon (Insulated), 390,000 ohm, 1 watt—10%, 7/32 dia. x 9/16 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"PPI" supply bleeder.	A	GB3941	63G1120
..	R-114		RESISTOR, Same as R-62.	"PPI" supply bleeder.			
..	R-115		RESISTOR, Same as R-62.	"PPI" supply bleeder.			
..	R-116	3RC30BE394K	RESISTOR, Same as R-113.	"PPI" supply bleeder.			
*# 1	R-117		POTENTIOMETER, Wirewound, 25,000 ohms, 4 watts —10%, Linear Curve, .250 dia. x 3/4 in. long shaft, #3/8-32 th'd. x 3/8 in. long Bushing, 1 5/8 dia. x 9/16 in. deep case. One (1) Nut and Lockwasher furnished with control.	PPI focus coil control.	U2		63G1186
..	R-118		RESISTOR, Same as R-65.	PPI gate resistor 20 MI.			
..	R-119	3RC20BE474J	RESISTOR, Same as R-66.	PPI gate Res. 60 MI.			
..	R-120	3RC20BE105J	RESISTOR, Same as R-67.	PPI gate Res. 120 MI.			
..	R-121	3RC20BE225K	RESISTOR, Same as R-28.	V-11b grid return.			
..	R-122	3RC20BE225K	RESISTOR, Same as R-28.	V-11b grid bias divider.			

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58. INDICATOR UNIT ID-51-TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
..	R-123		RESISTOR, Same as R-26.	V-11a plate load.			
..	R-124	3RC40AE103K	RESISTOR, Same as R-31.	V-11b plate load.			
..	R-125	3RC40AE103K	RESISTOR, Same as R-31.	V-11b plate load.			
..	R-126	3RC20BE474K	RESISTOR, Same as R-6.	V-13a grid return.			
*# 1	R-127	3RC20BE683K	RESISTOR, Carbon (Insulated), 68,000 Ohm, ½ watt −10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	PPI sweep resistor 20 MI.	A	EB6831	63G1037
..	R-128	3RC20BE754J	RESISTOR, Same as R-84.	PPI sweep resistor 20 MI.			
..	R-129		POTENTIOMETER, Same as R-75.	PPI sweep length control 20 MI.			
..	R-130	3RC20BE754J	RESISTOR, Same as R-84.	PPI sweep resistor 60 MI.			
..	R-131		POTENTIOMETER, Same as R-75.	PPI sweep length control 60 MI.			
..	R-132	3RC20BE273K	RESISTOR, Same as R-46.	PPI sweep resistor 60 MI.			
..	R-133	3RC20BE754J	RESISTOR, Same as R-84.	PPI sweep resistor 120 MI.			
..	R-134		POTENTIOMETER, Same as R-75.	PPI sweep control 120 MI.			
*# 1	R-135		RESISTOR, Carbon (Insulated), 150 ohm, 1 watt−10%, 7/32 in. dia. x 9/16 in. long, #18 A.W.G. axial leads = 1½ long.	V-15 cathode resistor.	A	GB1511	63G1114
..	R-136	3RC20BE472K	RESISTOR, Same as R-97.	Rotary transformer primary load.			
*# 2	R-137	3RC20BE821J	RESISTOR, Carbon (Insulated), 820 ohm, ½ watt−5%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1½ long.	Artificial center tap for rotary transformer secondary.	A	EB8215	63G1075
..	R-138	3RC20BE821J	RESISTOR, Same as R-137.	Same as R-137.			
..	R-139	3RC20BE105K	RESISTOR, Same as R-45.	V-23a grid return.			
..	R-140	3RC20BE105K	RESISTOR, Same as R-45.	V-25a grid return.			
..	R-141		RESISTOR, Same as R-104.				
..	R-142		RESISTOR, Same as R-104.				

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	R-143	3RC20BE223K	RESISTOR, Same as R-34.	PPI sweep resistor 120 MI.		
..	R-144	3RC20BE223K	RESISTOR, Same as R-34.	Deflection yoke load.		
..	R-145	3RC20BE223K	RESISTOR, Same as R-34.	Deflection yoke load.		
*# 1	R-146		POTENTIOMETER; Wirewound, 10 ohm, 100 watt, ±10%, .250 dia. x 25/32 in. long shaft, #3/8-32 th'd. x 9/32 in. bushing, 3 1/8 dia. x 1 1/2 in. deep case, Linear Curve, one (1) Nut and Lockwasher furnished with control.	Antenna speed control.	H C100	63G1165
*# 1	R-147		POTENTIOMETER, Wirewound, 25,000 ohm, 4 watt—10%, .250 dia. x 1 7/16 in. long, shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 5/8 dia. x 9/16 deep case.	IFF gain control.	U2	63G1185
..	R-148		RESISTOR, Same as R-19.	Bias bleeder resistor.		
..	R-149		RESISTOR, Same as R-62.	"A" scope bleeder resistor.		
*# 2	R-150		POTENTIOMETER, Composition, 100,000 ohm, 15%, Linear Curve, 1/4 dia. x 1/2 in. long slotted shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 1/8 dia. x 1/2 in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope gate control 20 MI.	C S33-010-363	63G1188
*# 2	R-151		POTENTIOMETER, Composition, 250,000 ohm, 15%, Linear Curve, 1/4 in. dia. x 1/2 in. long slotted shaft, #3/8-32 th'd. x 3/8 in. long bushing, 1 1/8 dia. x 1/2 in. deep case. One (1) Nut, Lockwasher and Armite Insulator furnished with control.	"A" scope gate control 60 MI.	C S33-010-364	63G1189
..	R-152		POTENTIOMETER, Same as R-75.	"A" scope gate control 120 MI.		
..	R-153		POTENTIOMETER, Same as R-150.	PPI gate control 20 MI.		
..	R-154		POTENTIOMETER, Same as R-151.	PPI gate control 60 MI.		
..	R-155		POTENTIOMETER, Same as R-75.	PPI gate control 120 MI.		
*# 2	R-156	3RC20BE151K	RESISTOR, Carbon (Insulated), 150 ohm, 1/2 watt — 10%, 7/32 dia. x 5/8 in. long, #18 A.W.G. axial leads = 1 1/2 long.	"A" Video (V-4) anti-parasitic res.	A EB1511	63G1039
..	R-157	3RC20BE151K	RESISTOR, Same as R-156.	V-2 anti parasitic resistor.		
*# 1	R-158		RESISTOR, Wirewound (Vitreous Enamel), 500 ohm, 20 watt — 10%, 1/2 dia. x 2 in. long, two (2) Terminal lugs.	PPI dial light series resistor.	H 2A-28	63G1155

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
..	R-159	3RC20BE474K	RESISTOR, Same as R-6.	"A" scope DC-restorer return.			
*# 1	R-160		RESISTOR, Wirewound (Vitreous Enamel), 2 ohm, 25 watt −10%, $\frac{1}{2}$ dia. x 2 in. long, two (2) Terminal lugs.	Tracking speed limiter.			63G1159
*# 9	C-1	3DA50-57.1	CAPACITOR, Moulded, Paper dielectric, .05 Mfd., (±20%) 600 V., $\frac{3}{4}$ in. W. x $1\frac{7}{16}$ in. L. x $\frac{3}{8}$ in. thick, two (2) .031 tinned wire, axial leads = $1\frac{1}{2}$ long.	V-4 grid coupling.	M	345-22	22G922
..	C-2	3DA50-57.1	CAPACITOR, Same as C-1.	V-1 grid coupling.			
*# 6	C-3		CAPACITOR, Paper Dielectric, 8 mfd., (+30%-10%) 600 V., Hermetically sealed & Oil Impregnated in metal case, $1\frac{1}{4}$ W. x $3\frac{25}{32}$ L. x $3\frac{7}{8}$ in. High. Two (2) lugs (cinch #1431) mounted on ceramic insulators.	V-1, V-2 screen Bypass.	S	P-6758	22G795
..	C-4	3DA50-57.1	CAPACITOR, Same as C-1.	V-3a coupling.			
..	C-5		CAPACITOR, Same as C-3.	V-1 screen bypass.			
..	C-6	3DA50-57.1	CAPACITOR, Same as C-1.	V-1 grid coupling.			
*# 5	C-7		CAPACITOR, Paper Dielectric, .1 mfd., (±10%) 300 V., Hermetically sealed & Oil Impregnated in metal case, 1 in. W x $1\frac{3}{4}$ in. L. x $2\frac{1}{8}$ in. high. Two (2) Lugs (cinch #1431) mounted on ceramic Insulators.	PPI scope video coupling cond.	S	7088	22G976
..	C-8	3DA50-57.1	CAPACITOR, Same as C-1.	B-supply filter.			
..	C-9		CAPACITOR, Same as C-3.	B-supply filter.			
..	C-10		CAPACITOR, Same as C-3.	B-supply filter.			
..	C-11		CAPACITOR, Same as C-3.	B-supply filter.			
..	C-12		CAPACITOR, Same as C-3.	B-supply filter.			
*# 4	C-13	3D9050-50	CAPACITOR, Mica Dielectric, 50 mmfd., (±10%) 500 V., $\frac{29}{64}$ W. x $\frac{25}{32}$ L. x $\frac{3}{16}$ in. thick. Two (2) .031 wire, axial leads = $1\frac{1}{4}$ in. long.	V-5a grid coupling.	C4	5LS	22G850
*# 1	C-14		CAPACITOR, Mica Dielectric, .005 mfd., (±10%) 500 V., $\frac{13}{16}$ x $\frac{13}{16}$ x $\frac{11}{32}$ in. thick. Two (2) .031 wire, axial leads = $1\frac{1}{4}$ in. long.	"A" scope gate timing (V-5a).			22G845

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*# 5	C-15	3DK9025-42	CAPACITOR, Mica Dielectric, 25 mmfd., (±10%) 500 V., 29/64 W. x 25/32 L. x 3/16 in. thick. Two (2) .031 Wire, axial leads = 1¼ in. long.	V-5b grid coupling.	C4	5LS	22G849
*#12	C-16	3DA10-124	CAPACITOR, Moulded Paper Dielectric, .01 mfd., (±20%) 600 V., ¾ in. W. x 1 7/16 L. x 5/16 in. thick. Two (2) .031 wire, axial leads = 1½ long.	V-6a grid coupling.	M	342-17	22G919
*# 6	C-17		CAPACITOR, Moulded Paper Dielectric, .1 mfd., (±20%) 400 V., ¾ in. W. x 1 7/16 in. L. x ⅜ in. thick. Two (2) .031 wire, axial leads = 1½ long.	Marker oscillator tank condenser.	M	345-21	22G917
*# 1	C-18	3DA10-21	CAPACITOR, Mica Dielectric, .01 mfd., (±5%) 300 V., 13/16 x 13/16 x 11/32 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	Same as C-18.	C4	1LS	22G841
..	C-19	3DA10-124	CAPACITOR, Same as C-16.	V-7a grid coupling.			
*# 3	C-20		CAPACITOR, Mica Dielectric, .0004 mfd., (±5%) 500 V., 29/64 W. x 25/32 L. x 3/16 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	V-7b grid coupling.	M	0XM	22G854
*# 2	C-21		CAPACITOR, Mica Dielectric, 50 mmfd., (±20%) 500 V., 29/64 W. x 25/32 L. x 3/16 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	V-10a grid coupling.	M	0XM	22G851
..	C-22		CAPACITOR, Same as C-17.	V-10a grid return filter.			
..	C-23	3DA10-124	CAPACITOR, Same as C-16.	V-3b grid coupling.			
..	C-24		CAPACITOR, Same as C-17.	V-10b grid return filter.			
*# 1	C-25	3D9100-71	CAPACITOR, Mica Dielectric, 100 mmfd., (±10%) 500 V., 29/64 W. x 25/32 L. x 3/16 in. thick. Two (2) .031 wire, axial leads = 1¼ long.	V-8 grid coupling.	M	0XM	22G852
..	C-26		CAPACITOR, Same as C-21.	V-10b grid coupling.			
*# 1	C-27		CAPACITOR, Tubular Ceramic, 5 mmfd., (±10%) 500 V., 7/32 dia. x 7/16 in. long, two (2) #20 Tinned wire, axial leads = 1½ in. long. Temperature coeff. = Zero.	V-8b grid trigger coupling.	E	K	22G946
..	C-28	3DK9025-42	CAPACITOR, Same as C-15.	V-9a grid coupling.			
*# 1	C-29	3D9200-34	CAPACITOR, Mica Dielectric, 200 mmfd., (±10%) 500 V., 29/64 W. x 25/32 L. x 3/16 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	V-8b grid coupling.	C4	5LS	22G853

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	C-30	3D9050-50	CAPACITOR, Same as C-13.	V-9b grid coupling.		
..	C-31		CAPACITOR, Same as C-7.	"A" scope —2000 V. supply filter.		
..	C-32		CAPACITOR. Same as C-17.	"A" scope bias filter.		
..	C-33		CAPACITOR, Same as C-7.	"A" scope cathode coupling.		
..	C-34	3DA10-124	CAPACITOR, Same as C-16.	"A" scope vert. defl. coupling.		
..	C-35	3D9050-50	CAPACITOR, Same as C-13.	V-12a trigger coupling (Grid).		
..	C-36		CAPACITOR, Same as C-20.	V-12a gate timing.		
..	C-37	3DK9025-42	CAPACITOR, Same as C-15.	V-12b grid coupling.		
..	C-38	3DA50-57.1	CAPACITOR, Same as C-1.	V-13b grid coupling.		
*# 1	C-39		CAPACITOR, Mica Dielectric, .0015 mfd., (±10%) 500 V., 13/16 x 13/16 x 11/32 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	"A" scope sweep condenser 20 MI.	C4 1LS	22G847
*# 2	C-40		CAPACITOR, Mica Dielectric, .003 mfd., (±10%) 500 V., 13/16 x 13/16 x 11/32 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	"A" scope sweep condenser 60 MI.	C4 1LS	22G844
*# 2	C-41		CAPACITOR, Mica Dielectric, .006 mfd., (±10%) 500 V., 13/16 x 13/16 x 11/32 in. thick. Two (2) .031 wire, axial leads = 1¼ in. long.	"A" scope sweep condenser 120 MI.	C4 1LS	22G846
..	C-42	3DA50-57.1	CAPACITOR, Same as C-1.	"A" scope horiz. defl. coupling.		
..	C-43	3DA50-57.1	CAPACITOR, Same as C-1.	Same as C-42.		
..	C-44		CAPACITOR, Same as C-17.	V-16 grid bypass.		
..	C-45	3DA10-124	CAPACITOR, Same as C-16.	V-19 grid coupling.		
..	C-46	3DA10-124	CAPACITOR, Same as C-16.	V-20 grid coupling.		
..	C-47	3DA10-124	CAPACITOR, Same as C-16.	V-21 grid Coupling.		
..	C-48	3DA10-124	CAPACITOR, Same as C-16.	V-22 grid coupling.		
..	C-49		CAPACITOR, Same as C-7.	PPI scope supply filter.		

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
..	C-50		CAPACITOR, Same as C-17.	PPI bias filter.			
..	C-51		CAPACITOR, Same as C-7.	PPI cathode coupling.			
..	C-52	3D9050-50	CAPACITOR, Same as C-13.	V-11 trigger coupling.			
..	C-53		CAPACITOR, Same as C-20.	V-11a grid coupling.			
..	C-54	3DK9025-42	CAPACITOR, Same as C-15.	V-11b grid coupling.			
..	C-55	3DA50-57.1	CAPACITOR, Same as C-1.	V13a grid coupling.			
*# 1	C-56	3DKA1-91.1	CAPACITOR, Mica Dielectric, .001 mfd., (±10%) 300 V., $\frac{29}{64}$ x $\frac{25}{32}$ x $\frac{3}{16}$ in. thick. Two (2) .031 wire, axial leads = $1\frac{1}{4}$ in. long.	PPI sweep condenser 20 MI.	C4	5LS	22G842
..	C-57		CAPACITOR, Same as C-40.	PPI sweep cond. 60 MI.			
..	C-58		CAPACITOR, Same as C-41.	PPI sweep cond. 120 MI.			
*# 1	C-59		CAPACITOR, Paper Dielectric, 1 mfd., (±20%) 600 V., Hermetically Sealed & Wax Impregnated in metal case, $1\frac{3}{4}$ in. W. x 2 in. L. x $\frac{13}{16}$ in. deep. Two (2) terminals.	Rotary transf. primary coupling.	C4	DY6100	22G977
..	C-60	3DA10-124	CAPACITOR, Same as C-16.	V-23 grid coupling.			
..	C-61	3DA10-124	CAPACITOR, Same as C-16.	V-24 grid coupling.			
..	C-62	3DA10-124	CAPACITOR, Same as C-16.	V-25 grid coupling.			
..	C-63	3DA10-124	CAPACITOR, Same as C-16.	V-26 grid coupling.			
..	C-64	3DK9025-42	CAPACITOR, Same as C-15.	V-15 Trigger coupling.			
*# 1	C-65	3DKA20-65	CAPACITOR, Moulded Paper Dielectric, .02 mfd., (±20%) 600 V., $\frac{3}{4}$ in. W. x $1\frac{1}{16}$ in. L. x $\frac{3}{8}$ in. thick. Two (2) .031 wire, axial leads = $1\frac{1}{2}$ in. long.	"A" scope gate shaping cond.	M	345-9	22G920
*# 1	C-66	3D9500-81	CAPACITOR, Mica Dielectric, 500 mmfd., (±10%) 500 V., $\frac{29}{64}$ W. x $\frac{25}{32}$ L. x $\frac{3}{16}$ in. thick. Two (2) .031 wire, axial leads = $1\frac{1}{4}$ in. long.	V-14 & 4-16 screen bypass.	M	0XM	22G884
# 1	L-1		COIL CHOKE, #38 Single Silk Enameled wire, 91 Turns, Universal Type-Duo-lateral, Inductance = approx. 74 microhenries ±5%, wound on low-loss "Durez #1601" coil form, $\frac{9}{32}$ in. dia. x $\frac{7}{8}$ in. long, having two (2) #20GA. Tinned Copper wire, axial leads = $1\frac{1}{2}$ in. long.	R-F peaking coil in V-4 plate circuit.			SG3361

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
# 1	L-2		COIL CHOKE, #38 Single Silk Enameled Wire, Approx. 135 Turns, Universal Type-Duo-lateral, Inductance = approx. 157 microhenries ±5%, wound on low loss Durez #1601 Coil dowel, 9/32 in. dia. x 7/8 in. long, having two (2) #20 GA. Tinned Copper wire, axial leads = 1½ in. long.	R-F peaking coil in V-1 plate circuit.		SG3362
# 1	L-3		COIL ASSEMBLY, oscillator, #38 Single Silk Enameled wire, 1495 Turns, Inductance = 35 .16 MH. ±1%, wound on Durez #11863 coil form. ½ dia. x 15/32 in. long, having four special terminals. Complete assembly consist of: 1—Osc. Coil Shield Assembly 2—#¼-28 Hex Nut 1—Tension Spring 1—Coil Form 1—¼ in. Lockwasher 1—Vellutex Washer 1—Coil Bushing 1—Screw & Core Overall length dimensions when assembled; 1⅜ x 1⅜ x 1¼ in. high (Special).	Marker oscillator coil, in circuit of V-6.		SG3351
3	V-1	2J6AG7	TUBE, Vacuum, Type Jan. 6AG7.	"A" scope video amp.	R	100G33
..	V-2	2J6AG7	TUBE, Same as V-1.	1st PPI Video clipper amp.		
14	V-3	2J6SN7GT	TUBE, Vacuum, Type Jan. 6SN7GT.	D.C. Restorer "A" scope PPI Marker amp.	R	100G87
..	V-4	2J6AG7	TUBE, Same as V-1.	2nd PPI video clipper amp.		
..	V-5	2J6SN7GT	TUBE, Same as V-3.	Marker Gate.		
..	V-6	2J6SN7GT	TUBE, Same as V-3.	Osc. Keying—Marker Osc.		
..	V-7	2J6SN7GT	TUBE, Same as V-3.	10 MI Marker clipper amp.		
..	V-8	2J6SN7GT	TUBE, Same as V-3.	Buffer—50 MI Marker Divider.		
..	V-9	2J6SN7GT	TUBE, Same as V-3.	50 MI Divider—50 MI Buffer.		
..	V-10	2J6SN7GT	TUBE, Same as V-3	Marker Mixer.		
..	V-11	2J6SN7GT	TUBE, Same as V-3.	PPI Gate.		
..	V-12	2J6SN7GT	TUBE, Same as V-3.	"A" scope Gate.		

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	V-13	2J6SN7GT	TUBE, Same as V-3.	"A" scope Sweep Fly back PPI Sweep Fly Back.		
7	V-14	2J6V6GT	TUBE, Vacuum, Type Jan 6V6GT.	"A" scope sweep amp.	R	100G53
..	V-15	2J6V6GT	TUBE, Same as V-14.	PPI Sweep pre amp.		
..	V-16	2J6V6GT	TUBE, Same as V-14.	"A" scope sweep amp.		
2	V-17	2J6H6GT	TUBE, Vacuum, Type Jan 6H6GT	D.C. Restorer—PPI focus control.	R	100G58
..	V-18	2J6H6GT	TUBE, Same as V-17.	D.C. restorer.		
..	V-19	2J6SN7GT	TUBE, Same as V-3.	PPI clamper.		
..	V-20	2J6V6GT	TUBE, Same as V-14.	PPI sweep amp.		
..	V-21	2J6SN7GT	TUBE, Same as V-3.	PPI clamper.		
..	V-22	2J6V6GT	TUBE, Same as V-14.	PPI sweep amp.		
..	V-23	2J6SN7GT	TUBE, Same as V-3.	PPI clamper.		
..	V-24	2J6V6GT	TUBE, Same as V-14.	PPI sweep amp.		
..	V-25	2J6SN7GT	TUBE, Same as V-3.	PPI clamper.		
..	V-26	2J6V6GT	TUBE, Same as V-14.	PPI sweep amp.		
1	V-27	2J5CP1	TUBE, Vacuum, C. R. Type Jan. 5CP1.	"A" scope.	R	100G97
1	V-28	2V-1813-P7	TUBE, Vacuum, C. R. Type Jan. 7BP7.	PPI scope.	R	100G98
*#2	SW-1		SWITCH, Rotary, 3 Position, Single Section Wafer, 2 pole—3 throw, Spring Brass Contacts, Isolantite Wafer, .250 dia. x 1½ in. long shaft, ⅜-32 x ⅜ in. L. threaded bushing. Overall dimensions: 1 17/32 in. W. x 1 15/16 in. H. x 3 in. long. Has two #5-40 x 9/32 deep, tapped mounting studs attached.	PPI range rotary switch.	O 26822-H1C	85G103
..	SW-2		SWITCH, Same as SW-1.	"A" Range Rotary Switch.		
*#1	SW-3		SWITCH, Rotary, 2 Position, Single Section Wafer (Isolantite), 2 Pole—2 throw Spring return, Spring Brass Contacts, .250 dia. x 3⅜ in. long shaft, ⅜-32 x ⅜ in. L. Threaded Bushing. Overall dimensions: 1 15/16 in. W. x 1 11/16 in. high. x 4 9/16 in. long.	IFF "Challenge" Switch.	O 26823-QHC	85G101

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#4	SW-5A		SWITCHETTE, Two Circuit switch, one normally open and one closed, air gap between contacts =.020. Each switch section must be capable of controlling an inductive load of 6 amperes (Max.) at 24 volts D.C. (Max.) for single pole double throw operation. Overall dimensions: ½ in. W. x 1¼ in. L. x ½ in. High.	Tracking Switch.			85G104
..	SW-5B		SWITCHETTE, Same as SW-5A (Part of ref. No. 4)	Tracking Switch.			
..	SW-6A		SWITCHETTE, Same as SW-5A (Part of ref. No. 3)	Phase—Anti phase switch.			
..	SW-6B		SWITCHETTE, Same as SW-5A (Part of ref. No. 3)	Phase—Anti phase switch.			
*#1	SW-7A		SWITCH, Toggle, Four (4) Pole-Double throw, 20 amps., 24 V.D.C., BM-120 Molded Black Bakelite Case, 1⁷⁄₁₆ in. W. 2³⁄₃₂ in. L. x ⁶¹⁄₆₄ in. high. Has a nickel Plated, "Bat Type" handle.	Track—PPI switch in Antenna drive circuit.	C7	8885K3	85G102
..	SW-7B		SWITCH, Part of SW-7A.	Track—PPI switch in Antenna drive circuit.			
..	SW-7c		SWITCH, Part of SW-7A.	Track—PPI switch in Antenna drive circuit.			
..	SW-7D		SWITCH, Part of SW-7A.	Track—PPI switch in Antenna drive circuit.			
#1	SW-8		SWITCH, Push Button Type, (Normally open), .75 amps.—125 V. Overall dimensions: ²¹⁄₃₂ in. dia. x approx. 1¹⁵⁄₁₆ in. long. (Black Push-Button).	Fluorescent Light Switch.	C7	8900K29	85G110
#1	SW-9		SWITCH, Same as SW-8, except Push Button is Red, and switch is normally closed.	Fluorescent Light Switch.	C7	8411K2	85G100
*#1	CH-1		CHOKE, #37 Copper Wire, Enameled, 3850 turns, Inductance=10 H ±15%, Current=40 MA., A.C. Voltage 10 V. 60 Ohm, Insulation to withstand 1800 V. D.C. for one minute between coil and core, Sealed in metal case, (Black Lacquer Finished), 1¾ in. W. x 1¾ in. W. x 1⅞ in. L. x 2³⁄₁₆ in. High. Has two terminals mounted on ceramic Insulators.	A-F Plate—Choke in V-15 plate circuit.	C11	8599	95G43
*#3	P-1A		PLUG, 12 pole, male, 15 amps., Ceramic insulation; Brass-Silver Plated contacts. Overall dimensions: 1⁷⁄₁₆ in. W. x 2⁹⁄₁₆ in. L. Two (2) Gaskets, One (1) Cardboard spacer, Four (4) Lockwashers, Nuts and Screws, furnished with Plug.	Connector to Console Wiring.	L3	28590	58G90

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
..	P-1B		PLUG, Same as P-1A.	Connector to console wiring.		
..	P-1C		PLUG, Same as P-1A.	Connector to console wiring.		
*#3	PL-1	2Z5952	LAMP, Pilot Light, 6.3 volts, 150 MA., Bayonet type Base, (G.E. Mazda), .138 in. dia. x 1⅛ in. long.	PAP pilot light.	S3	100G104
..	PL-2		LAMP, Same as PL-1.	Control Panel Light.		
..	PL-3		LAMP, Same as PL-1.	Control Panel Light.		
*#1	PL-4		LAMP, Fluorescent Type "Blacklite", 6 watts, 110 volts, ⅝ in. dia. x 9 in. long, (four contacts).	PPI dial light.	S3	100G105
*#1	1		COIL ASSEMBLY, #38 Copper wire, Enameled, 40,000 turns, 3.375 O.D. x 1.765 I.D. x 1.234 in. wide, #20 stranded wire leads. Complete assembly consists of: 1—Coil Box Back Assembly 1—Focus Coil 4—#4/40 x 3/16 in. Flat Hd. M.S. 1—Grommet 1—Coil Box Front. Overall dimensions: 4½ in. O.D. x 1½ I.D. x 1 15/32 in. wide. Housing made of .062 Armco Iron, cadmium Plated. (Special).	300 V. Focus Coil.	U2	SG-3238
#1	4		PHASE SWITCH ASSEMBLY, (Special) Complete assembly consists of: 1—Mounting Bracket 4—#2/56 Hex Nuts 2—Tubular Rivets 2—#2/56 x 11/16 in. R.H.M.S. 2—#2/56 x ¾ in. R.H.M.S. 1—Switch Shaft 1—Pilot Light Socket 2—Switchette (SW-6A & SW-6B) 4—#2 Lockwashers 1—Spring Washer 1—Switch Bushing 1—Switch Stud 1—Pivot Stud 1—Guide Stud 1—Panel Light Bulb 1—Pivot Arm 1—Color Indicator All necessary hookup wire furnished.	"Lobe" Switch.	Z SG3325	SG3325

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	5		DUAL SWITCHETTE & TOGGLE ASSEMBLY, (Special) Complete assembly consists of: 1—Switch Mtg. Bracket 4—#2/66 Hex Nuts 4—#2/56 x $^{11}/_{16}$ in. R.H.M.S. 1—Shaft 2—Switchettes (SW-5A & SW-5B) 4—#2 Lockwasher 1—Bushing 1—Switch Stud All necessary hook up wire furnished.	"Track" Switch Assembly.	Z SG3326	SG3326
*#1	6		COIL & HOUSING ASSEMBLY, #38 Copper wire, Enameled, four individual coils, 275 turns per layer—4 layers per section—2 sections per coil, must withstand 1800 V. D.C. applied between windings & between windings and core for 1 min. Housing is of .064 Brass-¼ Hard, cadmium plated. Complete assembly consists of: 1—Housing Cover 1—Housing 4—#6/32 Hex Nuts 4—Coil Mtg. Nuts 4—#6/32 x 2¼ in. Flat Hd. M.S. 2—Mounting Strips 4—#6 Lockwashers 4—Mtg. Spacers 1—Delection Coil 1—Gasket Overall dimensions: 4.297 in. O.D. x 1½ in. x 2$^{1}/_{16}$ in. deep. (Special)	Deflection Coil assembly.		SG3328
1	10		BEZEL & LENS ASSEMBLY, Lens is made of .062 clear Lucite, Bezel-.032 (25.0) aluminum, Black Wrinkle Finish. Complete Assembly Consists of: 1—7G2 Bezel 6—64G1213 Tubular Rivets 1—83G588 Strip 6—93G601 Plain Brass Washers 1—171G4 Lens Overall dimensions: 5$^{9}/_{16}$ O.D. x 4⅝ in. I.D. x $^{17}/_{32}$ in. deep x 1$^{5}/_{16}$ in. flange. (Special).	"A" scope Tube Lens.	Z SG3374	SG3374

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
#1	20		COUPLING ASSEMBLY, Brass ½ Hard, Nickel Plated. Complete assembly consists of: 1—Coupling Collar Assembly; 4—Tubular Rivet; 4—Plain Brass Washer; 1—Coupling Link. Overall dimensions: ½ in. O.D. x .252 I.D. x 15/16 in. long. Tapped for two #8-32 Set Screws. (Special).	Switch Shaft Coupling.	Z	SG3567	SG3567
#2	32	2Z2724-9	CAP RUBBER, Gum Rubber (Black), 5/16 in. x 25/64 in. x 1 13/64 in. long. Has one (1) .016 Spring Brass, Hot-Tinned Dip contact sealed within.	PPI Anode Connector.	Cinch	#8657	15G49
#1	33		CLAMP, Brass, .020 thick, cadmium plated, 5/16 in. w. x 17/32 in. long. Has one (1) .157 dia. mtg. hole.	Cable Clamp.	T3	17G2	17G2
#3	34	2Z2600	CLAMP, #22GAC (.0299) C.R. Steel; .144 in. dia. mounting hole; overall length 29/32 in.	Cable Clamp.	Z1	#79	17G37
#2	35	2Z2636-6	CLAMP, C.R. Steel, Cadmium Plated, ⅜ in. wide x 25/32 in. long x 1/16 in. thick. Has a ⅛ in. R. bend, and one (1) .170 dia. mounting hole.	Cable Clamp.	Zeirick	#78	17G128
*#1	39		KNOB, Molded Black Bakelite, 11/16 in. dia. head x .250 I.D. overall length = 1¾ in. L. x 9/16 in. high.	"Challenge" Lever Knob.	K1	8-6844-3	46G72
*#2	40		KNOB, Black Bakelite, ⅞ in. O.D. x 9/16 in. thick. Has a .250 I.D. x .437 in. deep, and .030 wide x .010 deep groove molded in surface & filled white.	Tuning Control Knobs.	C1	46G27	46G27
*#2	43		KNOB, Black Bakelite, Satin Finish, 11/16 in. High x 1⅛ in. long. Engraved .040 in. x .015 deep arrow on top & filled with white.	"PPI" & "A" Range Switch Knobs.	C1	46G75	46G75
#1	44		NUT, hex, Brass-SAE 72, cadmium plated, #7/16-27 th'd. x 9/16 in. x 17/64 in. thick. (Double Chamfer).	Dial Jewel Retaining Nut.	B4	54G527	54G527
*#4	49		SHOCKMOUNT, Rubber, 1 in. dia., moulded on to a C.R. Steel Plate, 1¼ in. x 1¼ in. square x .032 in. thick. Has four (4) .141 dia. mounting holes.	Chassis Shockmount.	L1	100P10	77G36
#2	50	2Z8678.45	SOCKET, Ceramic, for standard octal base tube, Phosphor Bronze contacts. 1/32 in. thick steel saddle x 1 25/32 in. long.	"V-17" & "V-18" tube sockets.	C2	9885	78G42
#1	51	2Z8678.27	SOCKET & CAP, OCTAL, Black Molded Bakelite, for mounting standard octal tube, Phosphor Bronze contacts, Silver Plated, overall dimensions 1 3/16 in. dia. x 1 7/32 in. long.	PPI Tube Socket.	A2	PF8-7	78G89

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58. INDICATOR UNIT ID-51/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#24	52	2ZK8678.28	SOCKET, OCTAL, Durez Grade #11863, Wax Impregnated, Phosphor Bronze Contacts, Silver Plated, for mounting standard octal tube. Furnished with 1/32 in. thick steel mounting plate 13/16 in. wide x 2 in. long, having two (2) .156 in. dia. mounting holes.	Octal Tube Sockets.	C2 9867	78G90
#1	53	2ZK8684-5	SOCKET, Mica Filled Bakelite, 14 contact octal socket, contacts fit standard tube pin of .093 dia., Phosphor Bronze-Silver Plated. Overall dimensions: 2.219 O.D. x 1 in. I.D. x 13/8 in. thick.	Diheptal Tube Socket.	C2 9450	78G91
#2	54		SOCKET, Min. Bayonet type Shell and Bracket of C.R. Steel, Nickel Plated, Has two (2) .156 dia. mtg. holes. Overall dimensions 15/16 in. L. x 7/16 in. x 13/16 in. high.	Control Panel Light Socket.	D3 217SS-A1	78G97
#1	55		SOCKET, Black Bakelite, Non-ferrous Metal Parts, Rating: 75 watts, 250 volts. Has a steel mtg. plate 11/16 in. x 3/4 in. L., nickel plated, one #6-32 tapped hole. Overall dimensions: 17/32 in. x 29/32 in. x 15/64 in. high.	Fluorescent Lamp Socket (Right Hand).	H2 2952	78G98
#1	56		SOCKET, Same as Ref. No. 55, except left hand.	Fluorescent Lamp Socket (Left Hand).	H2 2953	78G99
#13	76		WASHER, Acetate, 3/8 in. O.D. x 9/64 in. I.D. x .015 in. thick.	Ceramic Standoff shock Washer.	W2 93G628	93G628
#2	77		WASHER, Acetate, 1/2 in. O.D. x 9/64 in. I.D. x 9/64 in. I.D. x .015 in. thick.	Ceramic Standoff shock Washer.	W2 93G629	93G629
#2	78		WASHER, Steel, Zinc Plate, 1/2 in. O.D. x .196 in. I.D. x .032 in. thick.		A6 93G788	93G788
#3	79		WASHER, Steel, Nickel Plated, 5/16 in. O.D. x .194 in. I.D. x .020 in. thick.	PPI Shield Adjusting screw washer.	A6 93G789	93G789
#1	80		WASHER, Vellutex, 1/2 in. O.D. x .265 in. I.D. x 1/64 in. thick.	Insulating Washer.	F2 93G875	93G875
*#9	81		INSULATOR, BUSHING, Isolantite, 3/8 in. dia. x 1/2 in. long. Tapped #6/32 x 3/16 in. deep on both ends.	Resistor Standoffs.	C X108E	94G309
#2	84		SPADE LUG, Steel Cadmium plated, #6/32 x 7/16 in. long threaded portion, 1/4 in. wide x 11/32 in. long head, .128 dia. hole.	Small Shield Bracket mounting screws.	R4 6057	112G792
#3	85		SHOULDER SCREW, C.R. Steel, Nickel plated, #6/32 x 1/8 in. long threaded portion, .187 dia. x .244 long shoulder, .359 in. dia. round slotted head.	"PPI" adjusting Bracket Mounting screws.	B4 112G793	112G793

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

58. INDICATOR UNIT ID-81/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#3	86		SCREW, Steel, Nickel Plated, #10-32 x 1 5/16 in. Round Head Mach. Screw, has a .035 slot—1.183 in. from head.	Focusing Coil adjusting Screw.	B4 112G794	112G794
#1	96	2Z7857-14	RING, RETAINING, C.R. Steel, Cadmium plated, 3 3/32 in. O.D. x 2.234 in. I.D. x 1/16 in. thick. Has four .144 in. W. slotted mounting holes.	Diheptal Socket retaining Ring.	C2 8593	188G43
#1	100		JEWEL, Glass to be white S.P., metal portion to be Brass-Nickel Plated. Overall dimensions: .578 dia. x 19/32 long. Has a #7/16-27 x 9/32 in. long threaded portion.	Pilot Light Jewel	D3 16 9/32 CSP White SP	171G3
*#2	101		INSULATOR, Isolantite, Glazed, 1/2 in. dia. x 1 in. long, tapped #6/32 x 5/16 in. deep on both ends.	Terminal Strip Standoffs.	N	194G48
*#4	102		INSULATOR, Isolantite, Glazed, 3/8 in. dia. x 5/8 in. long, tapped, #6/32 x 1/4 in. deep on both ends.	Control Mounting Strip Standoffs.	N	194G52
#1	104		SCALE, .067 Amber Plexiglass; 360° Calibration to be printed in Red-Orange Fluorescent paint, width of stroke 1/64 in.; printing on back of dial to be treated so that even illumination will be had with 6 watt ultra violet bulb; six (6) .093 in. mounting holes; diameter of scale 7.750 in.	Azimuth Calibration dial Scale.	J 26G23	26G23
#1	105		SCALE, .067 Amber Plexiglass; line & circle to be printed with brilliant yellow fluorescent paint 1/64 in. wide; 1/8 in. dia. center circle; six (6) .093 dia. & countersink to .164 diameter x 82° mounting holes; diameter of scale 6.625 in.	Pointer scale.	J 26G24	26G24
#1	106		SCALE, .067 Amber Plexiglass; 1/8 dia. center circle to be printed on this surface with brilliant yellow fluorescent paint circle line to be 1/64 in. wide, six (6) .093 in. dia. & countersink to .164 dia. x 82°; diameter of scale 6.375 in.	Co-ordinate Dial Scale.	J 26G25	26G25

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59. ANTENNA AS-74/TPS-3

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	M401		THERMO COUPLE; Weatherproof, Western Type D-3 with connecting lugs for 3/8 in. dia. dipoles; Adjusted to deliver 10.5 millivolts into nominal 7.8 ohm instrument with 120 M.A. through heater; Resistance between dipole terminals 7 Ohms; two 7/32 in. dia. mounting holes spaced 1 1/4 in.	Antenna Current.	W D3	122G13
*#2	P411B		CONNECTOR; Type AN-3108-16S-8P 5 Contacts	Slip Ring output Cable.	A2 AN-3108-16S-8P	62G82
*#1	P415A	2Z7226-Q264	CONNECTOR; Type AN-3106-16S-8S 5 Contacts	Slip Ring input Cable.	A2 AN-3106-16S-8S	62G85
*#1	P415B		CONNECTOR; Type AN-3100-16S-8P 5 Contacts	Thermo couple Junction. Cable Output	A2 AN-3100-16S-8P	62G84
*#1	P416A		CONNECTOR; Type AN-3102-16S-8S 5 Contacts	Thermo couple Junction Cable Input.	A2 AN-3102-16S-8S	62G82
..	P416B		CONNECTOR; Same as P411B.	Thermo couple Output.		
1	501		SLIP RING ASSEMBLY; Consists of Contact ring assembly, brush holder and brushes, gaskets, bearing and cover plates. (Special)	Thermo Couple Circuit.	J1 SG3455	SG3455
#1	502		CONTACT RING ASSEMBLY, consists of four (4) each collector rings and spacers, center spacer, top and bottom support; assembly secured with four (4) #5/40 x 1 1/2 F.H.M.S.; Collector rings .031 copper x 3 in. O.D.; approx. overall dimensions 3 in. long x 3 1/4 in. dia. (Special) Part of Ref. No. 501	Collector Rings for Ref. No. 501.	J1 SG3511	SG3511
*#4	504		BRUSH; 1/8 in. sq. x 3/8 in. long; Stainless Steel Spring. Part of Ref. No. 501	Brush for Ref. No. 501.		213G52
1	509		GASKET; Victorite, 1/16 in. thick x 1 15/16 in. x 2 in.; four .144 in. dia. mounting holes. Part of Ref. No. 501.	Gasket for Ref. No. 505.	J1 196G37	196G37
#2	511	2Z2636-1	Clamp; Type AN-3057-8	Clamp for P411B & P415A.	A2 AN-3057-8	17G108

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59. ANTENNA AS-74/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#2	512		CLAMP; adjustable; Aero-Seal Clamp No. QS-100-M24 less screw driver guide ferrule as made by aircraft Standard Products Co.	Secures Ref. No. 501 to Transmission Line.	AS	17G127	17G127
..	518	2Z-2636-1	CLAMP; Same as Ref. No. 511	Clamp for P415B.			
..	520		CLAMP; Same as Ref. No. 512	Retains Lower End Trans. Line.			
#4	524		NUT; Wing; cold forged steel, zinc plate; #3/8-16 threads Wing span 3/4 in. high x 1 13/32 in. Part of Ref. No. 513	Nut for Hinge Plate.	U1	54G523	54G523
#1	527		GASKET; felt, 1/8 in. thick 2 1/8 in. I.D. x 3 1/4 in. O.D. Part of Ref. No. 513	Gasket for Deadmen Bracket Bearing.	F2	93G887	93G887
#1	532		TRANSMISSION LINE, Section No. 4; assembly includes inner and outer conductor with two quarterwave support stubs, upper hinge plate and welded structural assembly; Olive drab finish. (Special)	Transmission Line.	E1	DC58P10	SG3239
#1	534		TRANSMISSION LINE: Section No. 5; assembly includes inner and outer conductor with two quarterwave support stubs, coupling nuts and clamps; olive drab finish.	Transmission Line.	E1	DC58P35	SG3240
*#1	537		CONNECTOR; Assembly includes contact pin soldered in each end .625 in. O.D. x 8 in. long x .020 wall brass tube; Approx. overall length 10 3/4 in. silver plated.	Complete transmission Line circuit thru paraboloid hub.	E1	DC58P59	SG3242
#1	538		DIPOLE ASSEMBLY; includes inner & outer conductors, two quarterwave support stubs, driven and parasitic dipoles. Olive Drab finish.	Antenna.	E1	DC58P47	SG3241

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60. CONSOLE UNIT CY-69/TPS-3

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
*#1	C-401		CAPACITOR; paper dielectric; .04 mfd. (—20% + 30%) 1250 V.D.C.W.; mineral oil filled; metal case 11/16 in. dia. x 11/16 in. long: axial wire lead one end 2¼ in. long: solder lug opposite end.	V401 Filament Bypass.	S	526	22G1006
*#1	F401	3Z1923	FUSE, 10 amperes, 25 volt Type 4AG; 9/32 in. dia. x 1¼ in. long.	V401 Filament Line.	L2	1095	136G15
#1	M0401		MOTOR & GEAR BOX; Motor 24 V.D.C.; 50 in. lbs. torque at 16 R.P.M.; solenoid-operated brake on motor shaft to hold with current off, brake to release with 15 volts applied; approx. 120 Ohm solenoid; Gear ratio 560½ to 1; connector AN-3102-16S-8P mounted on motor for external connections; Black Wrinkle Enamel finish; gear box shaft; 1½ in. long with 5/16-24 thread 9/16 in. long. Approx. overall dimensions, 3½ in. x 4½ in. x 9⅛ in.	Antenna Drive.	G	5BA31HJ74	SG3230
#1	M0402		TRANSFORMER; Rotating Type; two phase; Diehl Mfg. Co. type SSFPE43-1; overall dimensions 2½ in. dia. x 3 11/32 in. long; four wire leads for external connection.	Drive for PPI Scope Trace.	D1	441-1005	141G19
#1	M0403		MOTOR; 1/50 H.P. 3000 R.P.M.; 24 V.D.C.; series winding; counter clockwise rotation viewing shaft end; 5/16 in. dia. shaft 1 3/16 in. long; overall dimensions 2⅜ in. dia. x 4⅞ in. long; two conductor #18 Stranded rubber insulated cable 22 in. long for external connections; Olive Drab finish.	Air Filter Intake.	O1	D-8-1	141G27
*#5	P401A		PLUG; female, 12 contacts, phosphor bronze silver plated; ceramic insulators; includes mounting screws, nuts, washers, cardboard spacer and gaskets; overall dimensions 1⅜ in. x 1 7/16 in. x 2 9/16 in.	Indicator Junction.	L3	28589	58G89
..	P401B		PLUG, Same as P401A.	Indicator Junction.			
..	P401C		PLUG, Same as P401A.	Indicator Junction.			
..	P402A		PLUG, Same as P401A.	Receiver Junction.			
..	P402B		PLUG, Same as P401A.	Receiver Junction.			
*#1	P402C		RECEPTACLE COAXIAL; female; Cannon Electric No. 1260-1.	Receiver Antenna.	C10	1260-1	23G17

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60. CONSOLE UNIT CY-69/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*#1	P403	2Z8675.16	CONNECTOR; AN-3108-16S-8S. 5 contacts.	Connector for M0401.	A-2 AN-3108-16S-8S	62G81
#3	P404A	2Z8672.10	CONNECTOR; AN-3102-12S-3S. 2 contacts.	Connector for M0403.	A-2 AN-3108-16S-8S	62G71
*#1	P404B	2Z7112.24	CONNECTOR; AN-3108-12S-3P. 2 contacts.	Connector for M0403.	A-2 AN-3108-12S-3P	62G74
..	P405A	2Z8672.10	CONNECTOR; Same as P404A.	Connector for M0404.		
#1	P406A	2Z8673.9	CONNECTOR; AN-3102-18-5S. 3 contacts.	Connector for T401.	A-2 AN-3102-18-5S	62G75
*#1	P406B		CONNECTOR: AN-3108-18-5P. 3 contacts.	Connector for T401.	A-2 AN-3108-18-5P	62G93
#2	P407		SOCKET; female; A.C. Outlet Amphenol Type MIP61F.	110 V. A.C. Outlet.	A-2 MIP61F	62G72
..	P408		SOCKET; Same as P407.	110 V. A.C. Outlet.		
#1	P409	2Z8799-190	CONNECTOR; AN-3102-28-1S. 9 contacts.	Outlet to I.F.F.	A-2 AN-3102-18-1S	62G46
*#1	P410	2Z8799-173	CONNECTOR; AN-3102-20-4P. 4 contacts.	Power Cable Outlet.	A-2 AN-3102-20-4P	62G54
*#1	P411		CONNECTOR; AN-3102-16S-8S. 5 contacts.	Outlet to Slip Ring.	A-2 AN-3102-16S-8S	62G32
..	P412	2Z8672.10	CONNECTOR; Same as P404A.	Outlet to Tent Fan.		
#1	P413A	2ZK3096-31	CONNECTOR; AN-3102-16S-1S. 7 contacts.	Connector for M0402.	A-2 AN-3102-16S-1S	62G76
#1	P413B	2Z7117.14	CONNECTOR; AN-3108-16S-1P. 7 contacts.	Connector for M0402.	A-2 AN-3108-16S-1P	62G70
*#1	P414A		RECEPTACLE COAXIAL; Male; Cannon Electric No. 1260-2.	Receiver Antenna.	C10 1260-2	23G19
#1	T401		TRANSFORMER; Pulse; phase reversing 1:3 transformer; primary voltage 8KV; primary current 160 amp; pulse width 1.5 microseconds; repetition rate 200 P.P.S.; secondary load impedence 440 Ohms; bifilai secondary for 10 amp; four 3/8 in. dia. mounting holes; mounting centers 5 1/8 in.; approx. overall dimensions, 6 3/4 in. x 8 1/4 in. x 11 3/4 in.; Egyptian Black finish.	Pulse Transformer.	G K-2437C	95G49
1	V402		TUBE, VACUUM; Type 532-A Part of Ref. No. 481.	T.R. Spark Gap.	W1 WL-532A	100G106
*#1	422	6Z3856-1	FILTER; Air fibreglas; Type No. 1, Owens-Corning Fibreglas Corp; overall dimensions 1 in. x 10 in. x 10 in.	Intake Air Filter.	O2 #1	SG3232

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60. CONSOLE UNIT CY-69/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
1	423		CABLE & CONNECTOR ASSEMBLY; Coaxial, Type AN/RG-29/U-51 ohm coaxial cable 12 in. long; male plug (Cannon Electric No. 1260-2) and female plug (Cannon Electric No. 1260-1) connected to opposite ends. (Special)	Transmission Line to Receiver Antenna.	Z SG3435	SG3435
#1	430		FUSE HOLDER; four clips (Littlefuse type 1011) mounted on black bakelite strip, 3/32 in. thick x 1 5/32 in. x 1 21/32 in.; characters "SPARE" stamped on face adjacent one set clips; clip mounting dimension 1 in.; spaced 5/8 in. apart; assembly includes cover snapslide stud; two solder lug terminals for external connections; accommodates spare and circuit fuse. (Special)	Holder for F401 Fuse.	Z SG3570	SG3570
#1	433		CLUTCH & COUPLING; Mechanical assembly consisting of collar, washer, disc, rubber sleeve & set screws. (Special)	Coupling for M0402	Z SG3693	SG3693
#8	435	6Z1923-4	CLAMP; C.R. steel (22GA.) 3/8 in. wide x 29/32 in. long x 9/32 in. high; .144 in. dia. mounting hole; Zierick Mfg. Co. No. 79, Hot tin dip.	Retains Cable.	Z1 79	17G37
#2	437	2Z2636-1	CLAMP; Type AN-3057-8.	Clamp for P410 & P413A.	A2 AN-3057-8	17G108
*#1	438	2Z2636-4	CLAMP; Type AN-3057-4.	Clamp for P404B.	A-2 AN-3057-4	17G109
*#1	439	2ZK2636-2	CLAMP; Type AN-3057-10.	Clamp for P406B.	A-2 AN-3057-10	17G123
#6	441	2Z2639-17	CLAMP; spring steel 5/8 in. wide x 1 5/16 in. high; rubbed synthetic rubber cushion; .203 dia. mounting hole; Tinnerman Products. Type 3044-SF-4.	Retains Cable.	T 3044-SF-4	17G133
#1	446		FAN; Aluminum 8 in. dia.; four blades; center hub 11/16 in. dia. x 1/2 in. long with .314 dia. hole; includes #10/32 x 1/4 cup-point set screw; olive drab finish.	Fan for M0403.	T1	31G3
#2	448		JACK; brass, 1 1/16 in. long; 5/16 in. diameter one end with .166 in. dia. hole 9/16 in. deep, opposite end 3/8 in. hex x 1/4 in. with #10/32 tapped hole 1/2 in. deep; silver plated. (Special).	V401 Filament line lead.	P 44G33	44G33
#4	449		NUT, CAP; Brass, #8/32 top, 5/16 in. hex, 9/32 in. crown; Zinc plate.	Nut for Ref. No. 429.	R2 54G525	54G525
*#8	454		SHOCKMOUNT; 4 lb. max. load at 1/16 in. defection; two .141 in. dia. mounting holes spaced 1.414; overall dimensions 13/32 in. x 1 in. x 1.644.	Shockproof Mounting for P401A-B-C & P402A & B.	P 100PDL-4	77G38
#1	455		WASHER, steel, zinc plate; 1/16 in. thick x 1.975 in. I.D. x 2.475 in. O.D.	Bearing Spacer.	A6 93G912	93G912

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.		Contractor's Drawing No.
#1	456		WASHER, felt; 1/8 in. thick x 3 3/32 in. I.D. x 3 3/4 in. O.D.	Bearing Dust Seal.	F2	93G913	93G913
#1	457		SCREW, captive type; #6/32 x 3/4 in. long; slotted knurled head 1/2 in. dia.; brass, nickel plate. (Special)	V401 Filament Line Shield.	P	112G785	112G785
3	458		SCREW; 1/4-20 x 1 1/4 in. long; head dimensions 1/8 in. thick x 15/32 in. wide x 5/8 in.; Stainless Steel. (Special)	Bracket Retainer.	R2	112G805	112G805
#3	459		SCREW; 1/4-20 x 1 in. long; head dimensions 1/8 in. thick x 9/16 in. square; steel, zinc plate. (Special)	Bracket Retainer.	R2	112G790	112G790
*#2	468		BRUSH; Motor.	Brush for General Electric M0401.			213G53
*#2	469		BRUSH; Motor.	Brush for Ohio Motor M0401.			213G57
*#2	470		BRUSH; Motor.	Brush for Elec. Eng. & Mfg. M0401.			213G58
*#2	471		BRUSH; Motor.	Brush for M0403.			213G56
#1	472		CHAIN; Steel, cadmium plate; 1/2 in. pitch x 1/4 in. wide, .306 dia. single roller; 35 pitches; includes snap-on link & plate; Diamond No. 65 Roller Chain & Connector Link (Manufacturers Standard No. 41).	Antenna Drive.	O2	65	214G6
*#1	476		CONTACT & STUD ASSEMBLY; spark gap; tungsten contact 1/8 in. dia. x 1/4 in. long pressed into brass bushing; #8/32 x 1/2 in. threaded stud opposite end bushing. (Special) Part of Ref. No. 475.	Spark Gap electrode.	T2	SG3451	SG3451
*#1	477		CONTACT & SCREW ASSEMBLY; spark Gap; tungsten contact 1/8 in. dia. x 1/4 in. long pressed into end of 1/4-28 thread x 1 3/8 Knurled head brass screw, silver plated. Part of Ref. No. 475.	Adjustable Spark Gap electrode.	T2	SG3450	SG3450
1	482		CABLE & CONNECTOR ASSEMBLY; Coaxial Type, RG-29/U-51 ohm coaxial cable 10 in. long; female plug (Cannon Electric No. 1260-1) connected on end; receiver loop & plug connected opposite end. Ref. No. 479. (Special)	Connects Receiver to Transmission Line.	E1	SG3551	SG3551
*#2	483	2Z2636-13	CLAMP; adjustable; Aero. Seal Clamp No. QS-100-M24 less screw-driver guide ferrule as made by Aircraft Standard Products Co. Part of Ref. No. 481	Clamp for T.R. Plug.	Z1	139	17G127
..	484	2Z2636-13	CLAMP; Same as Ref. No. 483	Clamp for Ref. No. 489.			

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61. TENT 2-4/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#1	600		MOTOR; 24 V.D.C.; 1/20 H.P.; 3600 R.P.M.; Shunt winding; counter clockwise rotation viewing shaft end; receptacle AN-3102-12S-3P mounted on frame for external connections; 5/16 in. dia. shaft 1 1/2 in. long; four #10/32 tapped holes 1/4 in. deep for mounting space 90° on 1.620 in. dia. circle; Olive drab finish; Ohio Electric Mfg. Co., Type D-26410;	Ventilating Fan.	O3 D-26410	141G28
*#2	601		BRUSH;	Brush for Ref. No. 600.		213G54
#1	602		FAN; four vanes; hub 11/16 in. long x 9/16 in. O.D. x 5/16 in. I.D.; Approx. overall diameter 10 in.; Clockwise rotation facing air discharge; Olive drab finish; Similar to Forrington Mfg. Co., No. 1022.	Ventilating Fan.	T1 1022-10	31G4
*#1	603	2Z-7226-Q175	CONNECTOR; Type AN-3108-12S-3S 2 Contacts	Fan Motor Cable.	A2 AN-3108-12S-3S	62G89
*#1	604	2Z7112.24	CONNECTOR; Type AN-3108-12S-3P 2 Contacts	Fan Motor Cable.	A2 AN-3108-12S-3P	62G74
*#2	605	2Z2636-4	CLAMP; Type AN-3057-4	Clamp for Ref. No.	A-2 AN-3057-4	17G109
*#1	606		BULB; Mazda, inside frosted; 50 W—125 volt.	Bulb for Portable Lamp.	G3 A-19	100G107

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Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
#25 ft.	700		WIRE; #20 AWG, 10 strands #30, tinned copper; Vinylite insulation compound (Halowax Corp. #VE5900); cotton outer braid heavily coated with flameproof lacquer; insulation test voltage 2000 V. Color "WHITE."	Hookup Wire.	P2 #20 Vinylite	91G214
#36 ft.	701		WIRE; Same as Ref. No. 700 except Color—"White with Blue tracer."	Hook up Wire.		91G215
#42 ft.	702		WIRE; Same as ref. No. 700 except: Color—"White with Black tracer."	Hookup Wire.		91G216
#15 ft.	703		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow tracer."	Hookup Wire.		91G217
#26 ft.	704		WIRE; Same as Ref. No. 700 except: Color—"White with Red tracer."	Hookup Wire.		91G218
#26 ft.	705		WIRE; Same as Ref. No. 700 except: Color—"White with Green tracer."	Hookup Wire.		91G219
#8 ft.	706		WIRE; Same as Ref. No. 700 except: Color—"White with Brown tracer."	Hookup Wire.		91G220
#16 ft.	707		WIRE; Same as Ref. No. 700 except: Color—"White with Orange tracer."	Hookup Wire.		91G221
#21 ft.	708		WIRE; Same as Ref. No. 700 except: Color—"White with Red & Brown tracers."	Hookup Wire.		91G222
#12 ft.	709		WIRE; Same as Ref. No. 700 except: Color—"White with Brown-Blue tracers."	Hookup Wire.		91G223
#7 ft.	710		WIRE; Same as Ref. No. 700 except: Color—"White with Red & Orange tracers."	Hookup Wire.		91G224
#16 ft.	711		WIRE; Same as Ref. No. 700 except: Color—"White with Orange & Blue tracers."	Hookup Wire.		91G225
#14 ft.	712		WIRE; Same as Ref. No. 700 except: Color—"White with Black & Blue tracers."	Hookup Wire.		91G226
#21 ft.	713		WIRE; Same as Ref. No. 700 except: Color—"White with Red & Green tracers."	Hookup Wire.		91G227

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*Indicates items included in the Equipment Spares.

62. WIRE AND CORDAGE FOR MODEL AN/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*15 ft.	714		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow & Brown tracers."	Hookup Wire.		91G228
#11 ft.	715		WIRE; Same as Ref. No. 700 except: Color—"White with Blue & Green tracers."	Hookup Wire.		91G229
#32 ft.	716		WIRE; Same as Ref. No. 700 except: Color—"White with Red & Black tracers."	Hookup Wire.		91G230
#10 ft.	717		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow & Blue tracers."	Hookup Wire.		91G231
#11 ft.	718		WIRE; Same as Ref. No. 700 except: Color—"White with Blue & Red tracers."	Hookup Wire.		91G232
#4 ft.	719		WIRE; Same as Ref. No. 700 except: Color—"White with Black & Green tracers."	Hookup Wire.		91G233
#16 ft.	720		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow & Orange tracers."	Hookup Wire.		91G234
#20 ft.	721		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow & Black tracers."	Hookup Wire.		91G235
#11 ft.	722		WIRE; Same as Ref. No. 700 except: Color—"White with Yellow & Green tracers."	Hookup Wire.		91G236
5 ft.	723		WIRE; Same as Ref. No. 700 except: Color—"White with Brown & Green tracers."	Hookup Wire.		91G237
#10 ft.	724		WIRE; #20 A.W.G.; 10 strands #30, tinned copper, insulation, four spiral wraps cellulose acetate butyrate tape; two glass braids having 12 coats of flameproof lacquer; must withstand breakdown test of 15000 volts D.C. after submersion for 100 hours in fresh tap water; Color—"White with Black tracers."	Hookup Wire.	H1 #4662	91G710
# 7 ft.	725		WIRE; Same as Ref. No. 724 except: Color—"White with Brown tracers."	Hookup Wire.		91G711
*# 6 ft.	726		WIRE; Same as Ref. No. 724 except: Color—"White with Red tracer."	Hookup Wire.		91G712
# 1 ft.	727		WIRE; Same as Ref. No. 724 except: Color—"White with Orange tracer."	Hookup Wire.		91G713

#Indicates items furnished in concurrently produced Depot Spares.

62. WIRE AND CORDAGE FOR MODEL AN/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
# 1 ft.	728		WIRE; Same as Ref. No. 724 except: Color—"White with Yellow tracer."	Hookup Wire.		91G714
# 3 ft.	729		WIRE; Same as Ref. No. 724 except: Color—"White with Blue tracer."	Hookup Wire.		91G715
# 2 ft.	730		WIRE; Same as Ref. No. 724 except: Color—"White with Green tracer."	Hookup Wire.		91G716
# 3 ft.	731		WIRE; Same as Ref. No. 724 except: Color—"White with Black & Red tracers."	Hookup Wire.		91G717
# 4 ft.	732		WIRE; Same as Ref. No. 724 except: Color—"White with Red & Brown tracers."	Hookup Wire.		91G718
# 5 ft.	733		WIRE; Same as Ref. No. 724 except: Color—"White with Red & Yellow tracers."	Hookup Wire.		91G719
# 1 ft.	734		WIRE; Same as Ref. No. 724 except: Color—"White with Red & Blue tracers."	Hookup Wire.		91G720
# 3 ft.	735		WIRE; Same as Ref. No. 724 except: Color—"White with Green & Orange tracers."	Hookup Wire.		91G722
# 3 ft.	736		WIRE; Same as Ref. No. 724 except: Color—"White with Brown & Orange tracers."	Hookup Wire.		91G723
# 5 ft.	737		WIRE; Same as Ref. No. 724 except: Color—"White with Brown & Green tracers."	Hookup Wire.		91G724
# 6 ft.	738		WIRE; #18 AWG; 19 strands #30 tinned copper; insulation .030 wall red synthetic thermoplastic resin (Vinylite VE-5900) covered with cotton outer braid and heavily coated with flame resistant lacquer; rating, 5000 volt peak; nominal O.D.-.137; Color—"Grey with Black & Red" tracers.	Hookup Wire.		91G780
# 1 ft.	739		WIRE; #16 AWG, 26 strands # 30 tinned copper wire; Vinylite insulation compound (Halowax Corp. #VE-5900); cotton outer braid heavily coated with flameproof lacquer; insulation test voltage 2000 V. Color—"White with Red tracer."	Hookup Wire.		91G241
# 2 ft.	740		WIRE; Same as Ref. No. 739 except: Color—"White with Black & Blue tracers."	Hookup Wire.		91G242

#Indicates items furnished in concurrently produced Depot Spares.
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62. WIRE AND CORDAGE FOR MODEL AN/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
# 3 ft.	741		WIRE; Same as Ref. No. 739 except: Color—"White with Black & Green tracers."	Hookup Wire.		91G243
# 9 ft.	742		WIRE; Same as Ref. No. 739 except: Color—"White with Black & Brown tracers."	Hookup Wire.		91G244
#11 ft.	743		WIRE; Same as Ref. No. 739 except: Color—"White with Black tracer."	Hookup Wire.		91G245
# 7 ft.	744		WIRE; Same as Ref. No. 739 except color—"White".	Hookup Wire.		91G246
# 3 ft.	745		WIRE; Same as Ref. No. 739 except Color—"White with Green Tracer."	Hookup Wire.		91G247
# 6 ft.	746		WIRE; # 16 AWG. 26 Strands #30 Tinned Copper Wire; insulation, primary dielectric Cellulose Acetate butyrate tape, covered with felted asbestos flameproof glass braid; insulation rating 3000 V; nominal O.D. .199±5%. Color—"White with Red tracer."	Hookup Wire.	R5	91G332
# 7 ft.	747		WIRE; #14 AWG. 41 strands #30 Tinned Copper Wire; vinylite insulation compound (Halowax Corp. #VE5900); Cotton outer braid heavily coated with flameproof lacquer; insulation test voltage 2000 V. Color—"White with Black Tracer."		P2	91G737
# 6 ft.	748		WIRE; Same as Ref. No. 747 except: Color—"White with Green tracer."	Hookup Wire.		91G738
# 5 ft.	749		WIRE; Same as Ref. No. 747 except: Color—"White with Red tracer."	Hookup Wire.		91G739
# 6 ft.	750		WIRE; Same as Ref. No. 747 except: Color—"White."	Hookup Wire.		91G740
# 3 ft.	751		WIRE; #18 AWG. 16 Strands #30 Copper Wire; Tirex Cable 3/16 in. O.D.	Hookup Wire.		91G1
# 2½ ft.	752		WIRE; #16 AWG. Single Conductor, .051 dia. tinned copper wire.	Hookup Wire.	A8	91G44
# 3 ft.	753		WIRE; #18 AWG. Single Conductor, .040 Dia. tinned Copper Wire.	Hookup Wire.	A8	91G45
#14 ft.	754		WIRE; #20 AWG. Single conductor, .032 dia. tinned copper wire.	Hookup Wire.	A8	91G46

#Indicates items furnished in concurrently produced Depot Spares.
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62. WIRE AND CORDAGE FOR MODEL AN/TPS-3 (cont'd).

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
# 2⅞ in.	755		Braided Wire; 16 Carrier, 5 ends, #39 Tinned Copper Wire.	Hookup Wire.	E3	91G65
# 7 in.	756		Braided Wire; double braid of 320 .0076 dia. Tinned Copper Wire, consisting of inner braid 16 carriers—8 ends, Outer braid: 24 Carriers 8 ends; Outer braid ¼ in. O.D.	Hookup Wire.	H1	91G146
# 9½ in.	757		Braided Wire; 12 picks per inch, 24 carrier, 5 ends #36 Tinned Copper Wire, 3/16 in. wide.	Hookup Wire.	E3	91G152
# 2 ft.	758		Braided Wire; 16 picks per inch, 24 carriers, 2 ends #36 tinned Copper Wire, 1/16 in. wide.	Hookup Wire.	D4	91G263
# 7 ft.	759		Coaxial Cable; #20 AWG. Solid Copper Wire conductor, low loss dielectric .116 O.D., Covered with a braided sheath .154 O.D. and outer jacket .179 O.D. Impedence 51 Ohms, Army Navy Type RG-29/U.	Receiver Antenna.	A2 AN/RG-29/U	91G666
# 9 ft.	760		Cable; four conductor; each conductor #20 AWG. 26 strands #34 Tinned Copper Wire, Cotton Wrap, 1/32 in. thick synthetic rubber covered; conductors twisted, cushioned with cotton filler, cotton wrapped and covered with a synthetic rubber jacket .315 O.D. Conductors color coded Red, Black, White and Green respectively.	Thermo Couple Cable.	A3 #1246	91G753
#14 ft.	761		Cable; two conductor, each conductor #18 AWG. 41 strands #34 Copper Wire, 1/64 in. thick Buna S. Synthetic Rubber covered, conductors cushioned with cotton filler, cotton wrapped and covered with .035 thick Neoprene sheath .245 O.D. Conductors color coded Black and White respectively; Belden Mfg. Co. #8452.	Tent Fan Cable.	B2 8452	91G754

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63. CABLE CX-101/TPS-3.

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
*# 1	610	2ZK7234-12	CONNECTOR; Type AN-3106-20-4P 4 Contacts	Connector for Power Cable.	A-2 AN-3106-20-4P	62G55
*# 1	611	2Z8674.56	CONNECTOR; Type AN-3106-20-4S 4 Contacts	Connector for Power Cable.	A-2 AN-3106-20-4S	62G69
*# 2	612	2Z2636-3	CLAMP; Type AN-3057-12	Clamp for Ref. No. 610 & 611.	A-2 AN-3057-12	17G104
#50 ft.	613		CABLE; 4 conductor, each conductor 41 strands #30; cotton wrap each conductor, colored individually—Black-White-Green-Red; Conductor rubber .050 thick Buna S rubber; filler; twisted Seine Twine; outer jacket .605 Buna S Rubber; Simplex Wire & Cable Type S 4 Conductor Tirex Cable No. 14.	Power Unit to Console.	S5 S#14	91G751
*# 1	615	2ZK7234-12	CONNECTOR; Type AN-3106-20-4P 4 Contacts	Connector for Power Cable.	A-2 AN-3106-20-4P	62G55
*# 1	616	2Z8674.56	CONNECTOR; Type AN-3106-20-4S 4 Contacts	Connector for Power Cable.	A-2 AN-3106-20-4S	62G69
# 4 ft.	617		CABLE; 4 conductor, each conductor 41 strands #30; cotton wrap each conductor, colored individually—Black-White-Green-Red; conductor rubber .050 thick Buna S rubber; filler, twisted Seine Twine; outer jacket .605 Buna S rubber; Simplex Wire & Cable Type S4 Conductor Tirex Cable No. 14.	Power Unit to Modulator.	S5 S#14	91G751
# 1	620		CABLE ASSEMBLY; includes single prong male coaxial plug attached to each end of 50 ft. long B2 Pulse Cable; conductor .093 in. O.D. (19 strands of .0185 tinned copper wire); conductor rubber .133 in. O.D. 20 mils thick; dielectric .415 in O.D.; oil base compound; conducting rubber .455 in. O.D. 20 mils thick; copper braid .485 in. O.D. 100% coverage; tape .515 in O.D., rubber filled 12 mil thick 1/4 lap; Steel braid .565 in. O.D.; 70% coverage; overall neoprene sheath .800 in. O.D.; impedance at 1 MC, 50 ohms. (Special)	Pulse Cable-Modulator to Console.	Z SG3228	SG3228
# 1	621		CABLE ASSEMBLY; Same as Ref. No. except cable length of 4 ft. (Special)	Pulse Cable-Modulator to Power Supply.	Z SG3229	SG3229

#Indicates items furnished in concurrently produced Depot Spares.
*Indicates items included in the Equipment Spares.

SUPPLEMENTARY PARTS

Quantity Used Per Component	Drawing Reference Symbol	Stock No.	Name of Part and Description	Function	Actual Manufacturer and Type No.	Contractor's Drawing No.
1	C-67		CAPACITOR; .001 mfd. ±10%, 300 V.		C4 5LS	22G842
1	C-271		CAPACITOR; 10 mmfd. ± 10%, 500 V.	RF By Pass.	E NPOK-10	22G947
1	C-293		CAPACITOR; 10 mmfd. ±10%, 500 V.	RF By Pass.	E NPOK-10	22G947
1	C-294		CAPACITOR; Same as C-293	RF By Pass.	E NPOK-10	22G947
1	L-242		CHOKE; Radio Frequency	Detector Choke.	B SG3255	SG3255
1	R-161		RESISTOR; 1,500 Ohms, ±10%, ½ W.	Cathode Bias Res.	A EB-1521	63G1023
1	R-162		RESISTOR; 100,000 Ohms, ±10%, 1 W.	Screen Dropping Res.	A EB-5631	63G1123
1			AIR FILTER	Air Filter	02 #2	SG4027
1	R-292		RESISTOR; 1,000 Ohms, ±10%, ½ W. Carbon	Plate Decoupling Resistor	A EB-1521	63G1020
1	R-293		RESISTOR; same as R-292	Same as R-292	A EB-1521	63G1020
1	C-294		CAPACITOR; Same as C-293	RF Bypass		

CHAPTER 3. SUPPLEMENTARY DATA

SECTION II

INDEX TO MANUFACTURERS

Mfr.'s Code	*Name & Address*
A	Allen-Bradley Company Milwaukee, Wisconsin
A-1	American Steel Package Company Defiance, Ohio
A-2	American Phenolic Corp. 1830 South 54th Avenue Chicago 50, Illinois
A-3	Alpha Wire Corp. 50 Howard Street New York, New York
A-4	Arrow Pattern & Foundry Company 2720 West Lake Chicago, Illinois
A-5	Aircraft Standards Products Company Rockford, Illinois
A-6	Accurate Die & Stamp 1941 North Maud Chicago, Illinois
A-7	Accurate Engineering 5248 North Clark Chicago, Illinois
A-8	Anaconda Wire & Cable Company 20 North Wacker Drive Chicago 6, Illinois
B	Bangor Electronic Industries Bangor, Michigan
B-1	Bussman Manufacturing Company 9 South Clinton Street Chicago, Illinois
B-2	Belden Manufacturing Company 4647 West Van Buren Chicago, Illinois
B-3	Boston Gear Works 953 West Washington Blvd. Chicago, Illinois
B-4	Robert Bobbins Company 2846 West North Avenue Chicago, Illinois
C	Centralab 900 East Keefe Avenue Milwaukee, Wisconsin
C-1	Chicago Molded Products Corporation 1020 North Kolmar Avenue Chicago, Illinois
C-2	Cinch Manufacturing Corporation 2335 West Van Buren Chicago, Illinois
C-3	Clarostal Manufacturing Co., Incorp. 130 Clinton Street Brooklyn 1, New York
C-4	Cornell-Dubilier Manufacturing Company 333 Hamilton Blvd. South Plainfield, New Jersey
C-5	Crowley & Company Inc., Henry L. 1 Central Avenue West Orange, New Jersey
C-6	Curtis Development & Manufacturing Co. 3266 North 33rd Street Milwaukee 10, Wisconsin
C-7	Cutler-Hammer Company Milwaukee, Wisconsin
C-8	Central Screw 3501 South Shield Avenue Chicago 9, Illinois
C-9	Crown Screw 1534 West Van Buren Chicago, Illinois
C-10	Cannon Electric Development Company 600 West Jackson Blvd. Chicago, Illinois
C-11	Chicago Transformer 3501 Addison Street Chicago, Illinois
D	Delco Radio General Motors Corp. Kokomo, Ind.
D-1	Diehl Mfg. Co. 1019 W. Jackson Blvd. Chicago, Ill.
D-2	Diamond Chain & Manufacturing Co. Martin & Haislip Street Indianapolis, Ind.

Mfr.'s Code	*Name & Address*
D-3	Drake Manufacturing Co. 1713 W. Hubbard St. Chicago, Ill.
D-4	Diamond Wire & Cable Co. Chicago Heights, Ill.
E	Erie Resistor Corporation Erie, Pennsylvania
E-1	Edison General Electric Appliance Co., Inc. 5600 West Taylor St. Chicago, Ill.
E-2	Eitel McCullough, Inc. % G. G. Ryan Co. 549 W. Washington Blvd. Chicago, Ill.
E-3	Essex Wire & Cable Co. 411 South Peoria Chicago, Ill.
F	Fast & Company, John E. 3123 N. Crawford Ave. Chicago 41, Ill.
F-1	Felsenthal & Sons, G. 4110-18 W. Grand Ave. Chicago, Ill.
F-2	Felt Products Manufacturing Co. 1504 W. Cairo Ave. Chicago, Ill.
G	General Electric 840 South Canal St. Chicago 80, Ill.
G-1	General Laminated Products Incorporated 2857 S. Halsted St. Chicago, Ill.
G-2	Grunwald Plating Co., Inc. 2559 West 21st Street Chicago, Ill.
G-3	Graybar Electric Co. 500 South Clinton St. Chicago 7, Ill.
H	Hardwick Hindle Incorporated 1 North Pulaski Road Chicago, Ill.
H-1	Holyoke Wire & Cable Corp. Holyoke, Mass.
H-2	Hubbell Electric 622 W. Randolph St. Chicago, Ill.
I	International Resistance Company 401 North Broad Street Philadelphia 8, Pennsylvania
I-1	Industrial Spring Corp. 1632 North Wells Chicago 14, Ill.
J	Johnston Glass Co. Hartford City, Ind.
J-1	O. D. Jennings 4309 W. Lake St. Chicago, Ill.
K	Ken-Rad Tube & Lamp Corporation Owensboro, Kentucky
K-1	Kurz-Kasch Co. 608 S. Dearborn Chicago, Ill.
L	Lavelle Rubber Company 424 North Wood St. Chicago 22, Ill.
L-1	Lord Manufacturing Co. 1639 West 12th St. Erie, Pennsylvania
L-2	Littlefuse Incorporated 4757 North Ravenswood Ave. Chicago 40, Illinois
L-3	Lapp Insulator Co., Inc. 327 S. La Salle Street Chicago, Illinois
M	Micamold Radio Corporation 1087-95 Flushing Avenue Brooklyn 6, New York
M-1	Millen Mfg. Co., Inc., James 549 W. Washington Blvd. Chicago, Illinois
M-2	Milwaukee Die Casting 1023 North 4th Street Milwaukee, Wisconsin
M-3	Micarta Fabricators, Incorporated 5324 Ravenswood Ave. Chicago 40, Illinois
N	National Union Radio Corporation 4000 West North Avenue Chicago 39, Illinois
N-1	Newark Electronic Company 323 W. Madison St. Chicago 6, Illinois
O	Oak Manufacturing Company 1260 Clybourn Avenue Chicago 10, Illinois
O-1	John Oster Mfg. Co. of Ill. Genoa, Illinois

Mfr.'s Code	*Name & Address*
O 2	Owen & Corning Glass Works 3202-6 Pure Oil Building Chicago, Illinois
O-3	Ohio Electric Manufacturing Co. 5902 Maurice Avenue Cleveland 4, Ohio
P	Pereira, L. A. 106 E. Hubbard St. Chicago, Illinois
P-1	Potter Brumfield Mfg. Co. Inc. 605 W. Washington St. Chicago, Illinois
P-2	Packard Electric Division General Motors Co. Warren, Ohio
R	RCA Victor 151 Westside Avenue Jersey City, N. J.
R-1	Richardson Company, The Lockland, Ohio
R-2	Rolyan Corporation 2330 West 58th Street Chicago, Illinois
R-3	Rome Cable Corp. 208 S. Jefferson St. Chicago 6, Illinois
R-4	Radio Condenser Co. 4447 Armitage Ave. Chicago, Illinois
R-5	Rockbestos Products Corp. 140 S. Dearborn Chicago, Illinois
S	Sprague Specialties Company North Adams, Massachusetts
S-1	Speer Resistor Corporation Saint Marys, Pennsylvania
S-2	Standard Transformer Corporation 1500 North Halsted Street Chicago, Illinois
S-3	Sylvania Electric Products Inc. Chicago, Illinois
S-4	Simpson Electric Company 5216 West Kinzie St. Chicago 44, Illinois
S-5	Simplex Wire & Cable Co. 564 W. Monroe Chicago, Illinois
S-6	Signal Electric Manufacturing Co. 600 W. Jackson Blvd. Chicago, Illinois
S-7	Spaulding Fibre 4757 North Ravenswood Chicago 40, Illinois
T	Tinnerman Products Incorporated 2038 Fulton Road Cleveland, Ohio
T-1	Torrington Manufacturing Co. Torrington, Conn.
T-2	J. O. Tool Co. 1100 W. Washington Chicago, Illinois
T-3	Tuttle & Kift Inc. 1823 North Monitor Ave. Chicago, Illinois
U	United-Carr Fastener Corporation 31 Ames Street Cambridge 42, Mass.
U-1	United Screw & Bolt Corp. 2513 W. Cullerton Chicago, Illinois
U-2	Utah Radio Products Co. 812-20 Arlene Street Chicago 10, Illinois
V	Victor Manufacturing & Gasket 5750 W. Roosevelt Rd. Chicago, Illinois
W	Western Electric Co. Kearny, N. J.
W-1	Westinghouse Electric 20 North Wacker Drive Chicago, Illinois
W-2	Wrought Washer 2100 South Bay Street Milwaukee, Wisconsin
Z	Zenith Radio Corporation 6001 Dickens Avenue Chicago 39, Illinois
Z-1	Zierick Manufacturing Co. 385 Gerard Avenue New York, N. Y.

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