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TM 11-1561

WAR DEPARTMENT TECHNICAL MANUAL

SERVICE MANUAL
FOR
RADIO SET SCR-682-A

THEORY, TROUBLE SHOOTING, AND REPAIR

[redacted]

WAR DEPARTMENT 31 AUGUST 1944

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This manual, together with TM 11-1361 and TM 11-1461, supersedes TM 11-1061, 6 November 1943.

SERVICE MANUAL
FOR
RADIO SET SCR-682-A

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WAR DEPARTMENT 31 AUGUST 1944

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TM 11-1561, Radio Set SCR-682-A, Service Manual, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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

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IC 11: T/O and E 11-107, 11-237, 11-592, 11-587, 11-597, 11-617, 11-500, (EC) Sig SV Orgn Inst, and Maint Team.

For explanation of symbols see FM 21-6.

QUICK INDEX

CONTENTS

CONTENTS (contd)

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment.

DEATH ON CONTACT

may result if personnel fail
to observe safety precautions.

Be careful not to contact high-voltage plate circuits or 115-volt a-c input connections while checking or servicing the equipment. Make certain that the power is turned off before disassembling any part of the equipment.

Dangerously high voltages are present in the power supplies of this equipment. High-voltage capacitors in these power supplies must be discharged manually when service checks are made after the a-c power has been removed from the components.

EXTREMELY DANGEROUS POTENTIALS

exist in the following units:

Spark Gap GA–9–A (Rotary)
Power Supply Unit RA–101–A
Indicator Panel BD–123–A
Power Supply Unit RA–100–A
Radio Frequency Unit BC–1224–A

FIRST AID TREATMENT FOR ELECTRIC SHOCK

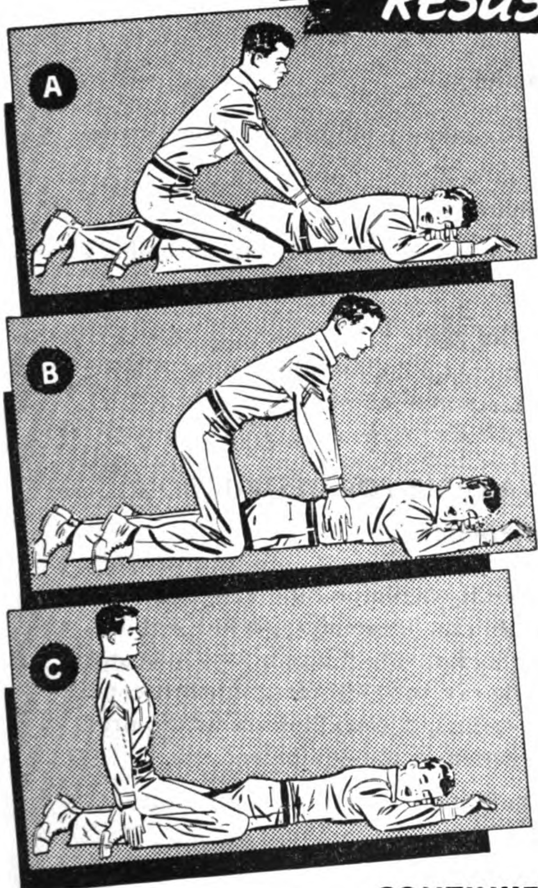
I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not **immediately** possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

RESUSCITATION



POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up forhours

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

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, local oscillator tube and assembly, crystal mixer assemblies, r-f transmission line, antenna dipole, parabolic reflector, rotary spark gap, indicator panel gears, cathode-ray tube, motors, synchroscope, and all other components. Use explosives as required for complete destruction of the equipment.

2. Cut — Antenna pulse cable and other interconnecting cables.

3. Burn — Transmitter tube (including spare). Use thermite powder, incendiary grenade. Scrape schematic drawings from inside panel of components, spray with gasoline and ignite.

4. Bury or scatter — Transmitter tube, all other equipment.

DESTROY EVERYTHING

REFERENCE NOTICE

TM 11–1561, Service Manual, is one of three technical manuals on Radio Set SCR–682–A. It is used in conjunction with TM 11–1361, Technical Operation Manual, and TM 11–1461, Preventive Maintenance Manual. TM 11–1561 contains two general types of information. First, it explains the theory of operation of Radio Set SCR–682–A; and second, it supplies practical procedures to be followed when the equipment fails to function properly. The Service Manual serves as a guide for locating the source of trouble, indicates the proper repair or replacement necessary, and in general assists the technician in charge to get the radar set back into service.

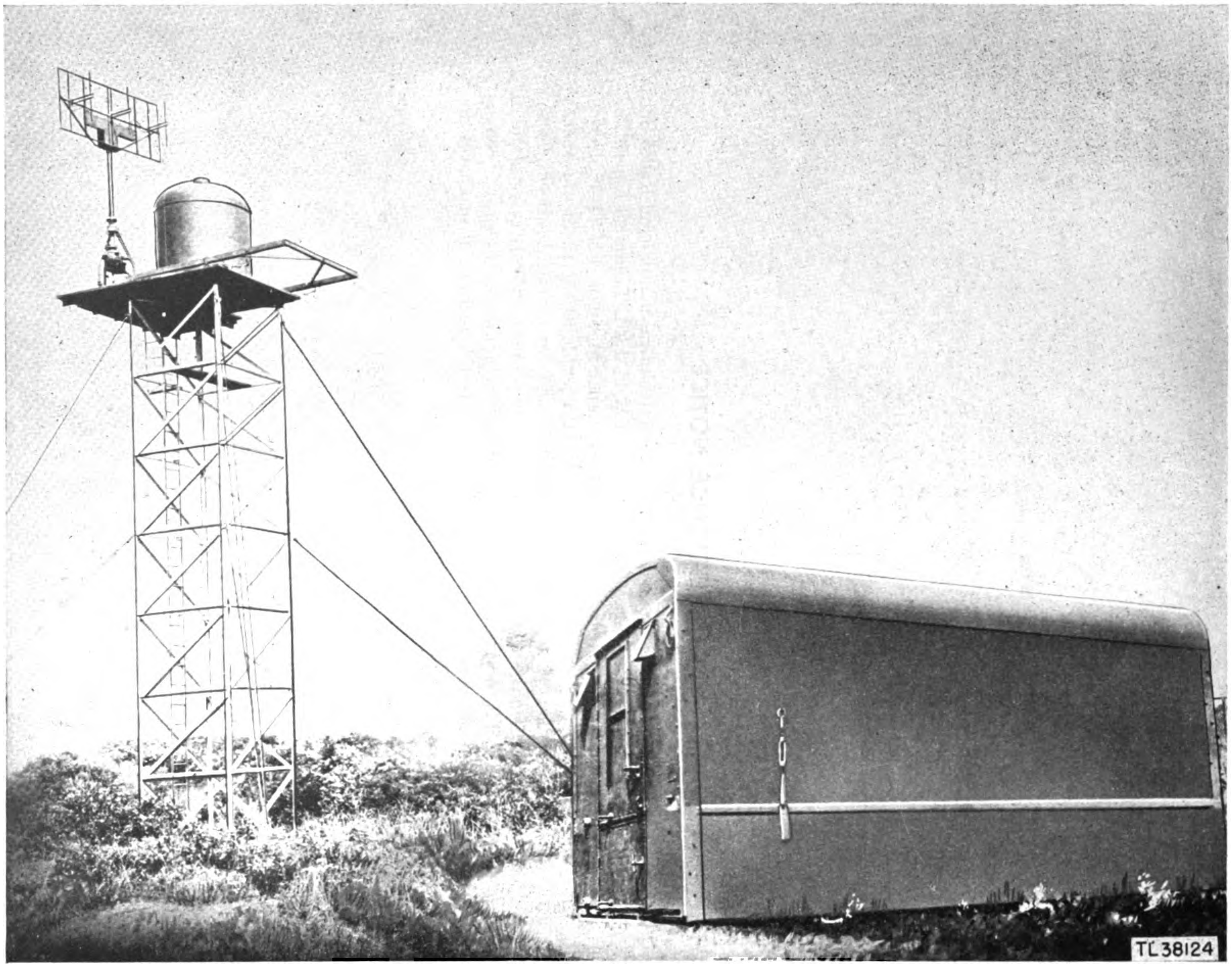


Figure 1. Radio Set SCR-682-A, general view including IFF equipment.

[redacted]

This manual, together with TM 11-1361 and TM 11-1461, supersedes TM 11-1061, 6 November 1943.

CHAPTER 1

THEORY

Section I. ELEMENTARY PRINCIPLES OF RADAR

1. Introduction

The purpose of this technical manual is to present the electrical and mechanical theory of Radio Set SCR-682-A (fig. 1) and to summarize the available information on the repair of the set. The manual has three chapters, the first two contributing directly toward understanding the functioning of the equipment. The chapters are as follows:

a. Chapter 1. Theory.

b. Chapter 2. Trouble-shooting Procedures.

c. Chapter 3. Maintenance Parts List.

2. Fundamentals of Radar

a. PRINCIPLE. Detection of an object or target by the radar set is accomplished by directing a beam of radio-frequency energy over the region to be searched. When the beam strikes an object, part of the transmitted energy is reflected or reradiated by the target and is returned to the radar set. A sensitive receiver which is part of the set detects this reflected energy and, therefore, the presence of the object or target.

b. PULSE TRANSMISSION. The transmitter sends out short bursts or pulses of radio-frequency energy. When this energy strikes a target, part of the energy is reflected and is returned to the radar set. If the transmitter is turned off before the reflected energy, or echo, returns from the target, the radar set distinguishes between the transmitted pulse and the reflected pulse (echo). After all reflections have returned, the transmitter is again turned on and the cycle repeated. Sufficient time must be allowed between transmitted pulses for an echo to return from any target within the maximum workable range of the radar set. Otherwise the reception of echoes from the more distant targets will be obscured by successive transmitted pulses.

(1) *Pulse width.* The duration of each transmitted pulse is commonly referred to as ***pulse width.*** The minimum range at which a target can be detected is determined largely by the width of the transmitted pulse. If a target is so close to the transmitter that the echo is returned to the radar set before the transmitter is turned off, the reception of the echo will be masked by the transmitted pulse.

(2) *Pulse-repetition (recurrence) frequency.* The desired maximum workable range of the system will determine the minimum elapsed time between successive pulses as explained above. The number of pulses transmitted per second, which is determined by the time elapsed between successive pulses, is called the ***pulse-repetition frequency.***

c. ANTENNA DIRECTIVITY. The radar antenna must be directional; that is, it must be constructed so that the radio-frequency energy is transmitted in a concentrated beam. Otherwise targets at several directions from the antenna would return echoes for a single transmitted pulse, and there would be no means of determining the directions of the various targets. The antenna must be rotatable so that the operator can control the direction in which the energy is being sent out.

(1) A single radiating element (a dipole) will send out more energy in some directions than in others. A system of reflectors will further concentrate the energy. These principles are utilized in the construction of radar antennas to produce a single unidirectional narrow beam of energy. The pattern produced in this manner permits the beaming of maximum energy in the desired direction.

(2) The transmitting pattern of an antenna system is the same as the receiving pattern (fig. 2). One antenna, therefore, can be used both to

transmit and to receive energy effectively.

d. Determination of Azimuth or Bearing. The measurement of the direction of a target from the radar system is usually given as an angular position, measured from some reference direction. In the case of Radio Set SCR–682–A, the reference direction is true south. The angle at which the echo signal returns can be measured because of the directional characteristics of the radar antenna system. The antenna rotates in azimuth, directing energy over the region to be searched. Reflected energy will be received from the target through a sector of angular positions of the antenna. In the position in which maximum reflected energy is received, the antenna points directly at the target, and the position of the antenna is an indication of the azimuth or bearing of the target.

(1) Figure 2 shows the receiving (or transmitting) pattern for a typical radar antenna system. The relative signal strength is shown plotted against the angular position of the antenna with respect to the target. A maximum signal is received only when the axis of the lobe passes through the target.

(2) The accuracy with which the direction of a target can be determined depends on the angular

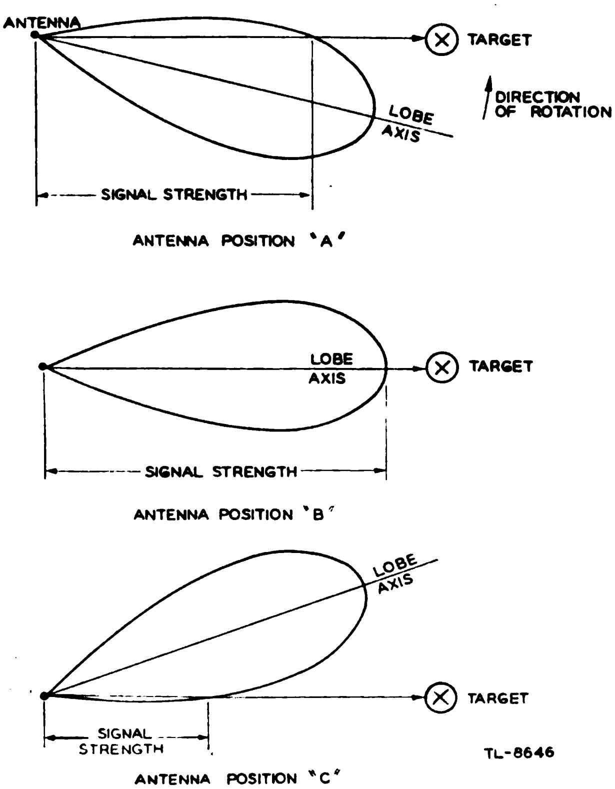


Figure 2. Relationship between beam axis and target bearing.

width of the lobe pattern. If the signal strength changes rapidly when the antenna is rotated a small amount, the on-target position can be selected with a greater degree of accuracy. Figure 3 illustrates the determination of the direction of a target, using first a wide beam and then a narrow beam. The direction of the target is determined by observing the direction of the antenna for which signal strength is maximum. For purposes of illustration it is assumed that the signal strength must drop to one-half its maximum value before the change can be noted. As the wide beam is swept past the target, the return signal strength varies as shown in figures 3①, 3②, and 3③. In the position shown in figure 3① the signal strength has one-half its maximum value; in figure 3②, when the antenna is pointed directly at the target, the signal is maximum; and in figure 3③ the signal strength has dropped back to one-half its maximum value. The observer then knows that the target lies within the 90° sector that the antenna swept through while the signal strength was varying as described above. Figures 3④, 3⑤, and 3⑥ show the corresponding variation of signal strength as the narrow beam is swept past the target. In the case of the narrow beam the signal strength varies from one-half its maximum value to maximum and back to one-half of maximum, as the antenna moves through a 20° sector. With the narrow beam the observer knows that the target lies within a 20° sector. Therefore the narrower the beam the more accurately the direction of the target can be determined.

e. Determination of Range. The measurement of range depends upon a conversion from time to distance which is possible because of the known velocity of radio waves.

(1) Radio-frequency energy which has been radiated into space travels at a known constant velocity. When the energy strikes a reflecting object there is no loss of time. The reflected energy is redirected and continues to travel at the same constant velocity. Its velocity is the same as that of light, 186,000 land miles per second, 162,000 nautical miles per second, or 328 yards per microsecond (millionth of a second).

(2) The radar system measures range by measuring the time required for a pulse of energy to travel to a target and return. For example, assume that a 1-microsecond pulse is transmitted toward an object which is 32,800 yards away. When the pulse reaches the target, it has traveled 32,800

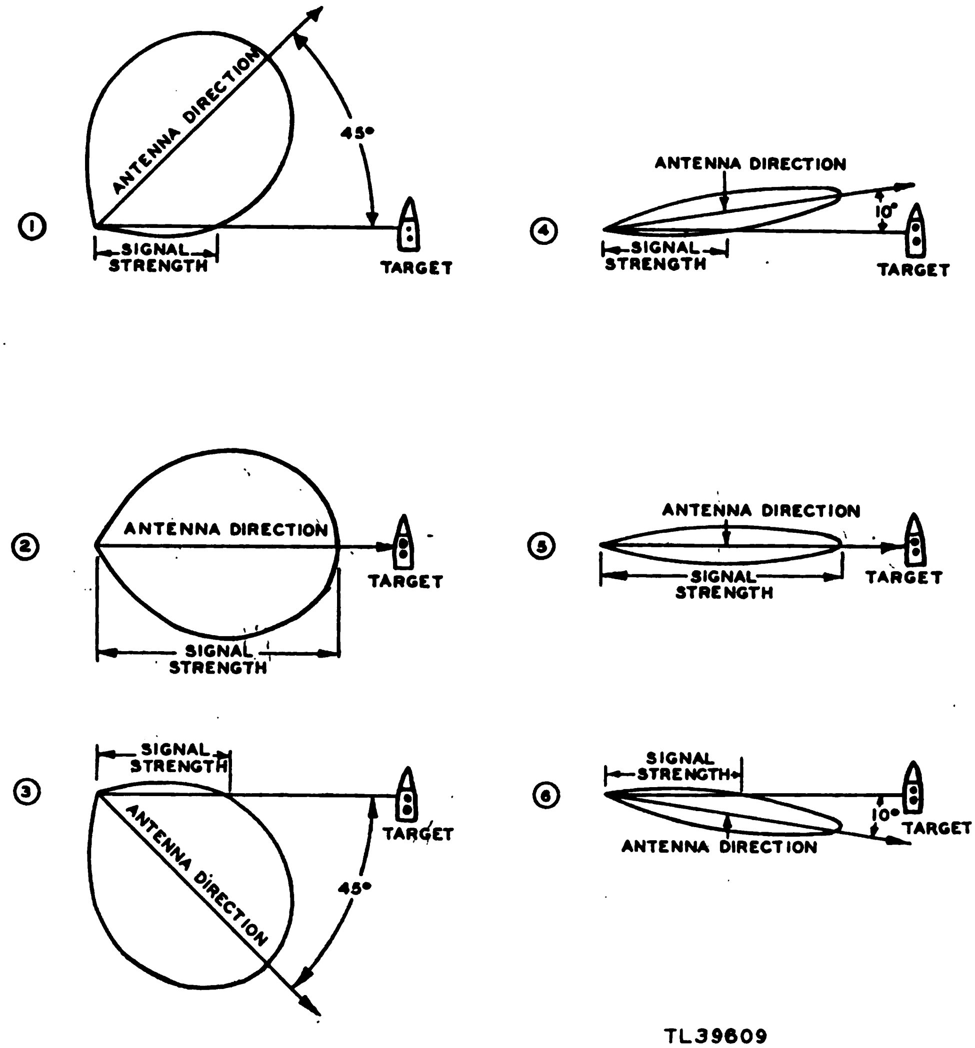


Figure 3. Accuracy of single lobe.

yards at 328 yards per microsecond, and therefore 100 microseconds have elapsed. The pulse is then reflected, and energy is returned over the same path. Since the return trip is also 32,800 yards, it takes 100 microseconds for the reflected pulse to return to the radar set. The total elapsed time is 200 microseconds, but the total distance traveled is twice the actual range of the target. Since it is desired to know only the range of the target, the velocity is commonly considered to be one-half of its true value, or 164 yards per microsecond. In this example, range = time × 164 = 200 × 164 = 32,800 yards.

f. Determination of Time. In order to utilize the time-range relationship discussed in *e* above, the radar system must have a time-measuring device. In addition, since there may be more than one target in the region being searched, some means of separating and identifying pulses must be provided. The cathode-ray oscilloscope is well suited to such a task, because it not only retains the information on its screen but also provides a time scale. The time scale is produced by using a linear sweep to produce a known rate of motion of the electron beam across the screen of the cathode-ray tube.

(1) The measurement of time is illustrated in the following example: Assume that a cathode-ray tube is used with a radial linear sweep which produces a beam whose velocity across the screen is 1 inch per 100 microseconds. The echo signals received from a target at a range of 32,800 yards are applied to the oscilloscope as a brightening of a point on the sweep. Following the same sequence of events as discussed in *e*(2) above, figure 4① illustrates the radio-frequency pulse

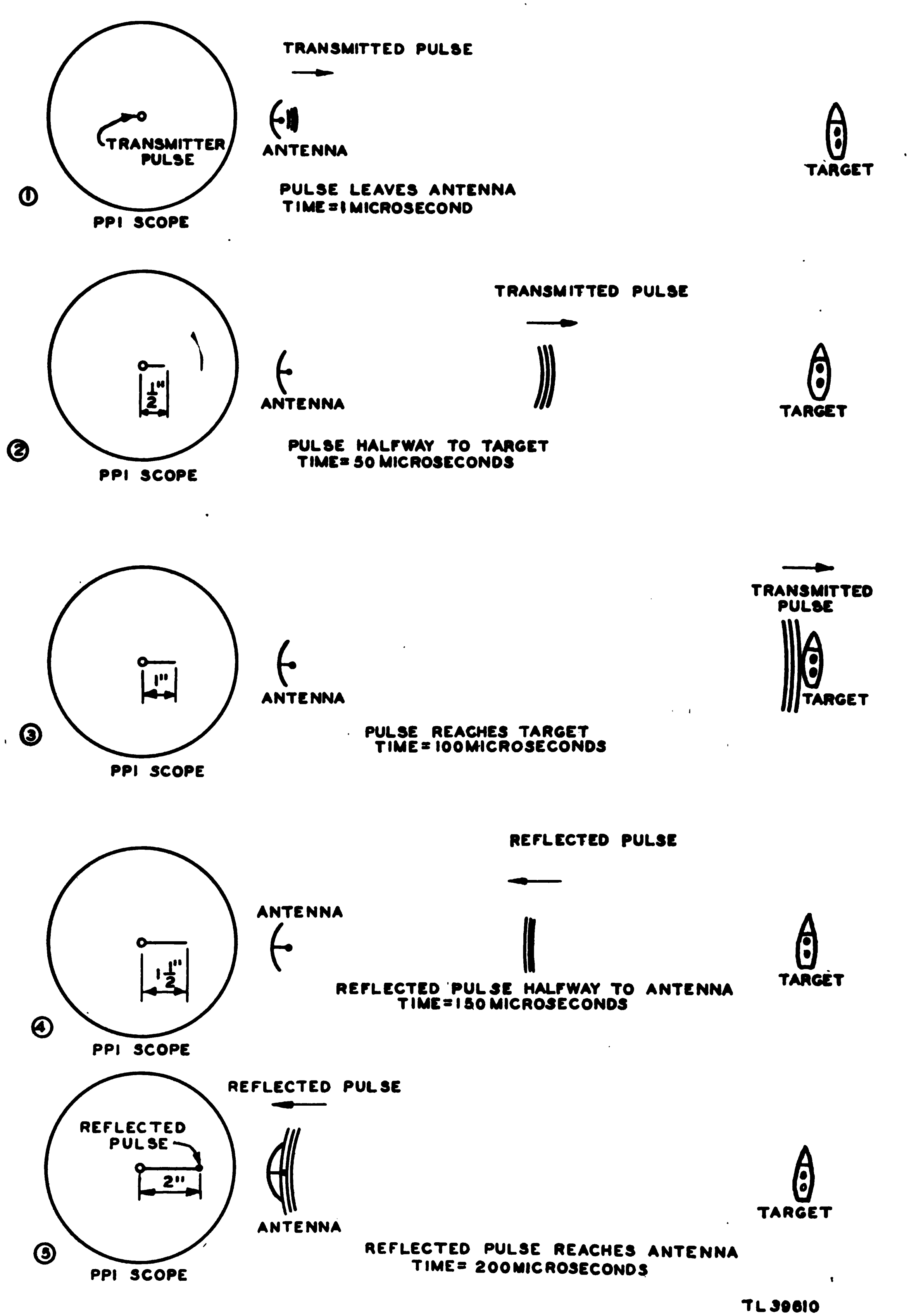


Figure 4. Measurement of time with PPI scope.

leaving the radar antenna and the horizontal sweep just starting across the screen. Since 1 microsecond has elapsed, the leading edge of the pulse has moved 328 yards from the antenna, and the sweep trace has moved 0.01 inch across the screen. The receiver detects the transmitted pulse, which shows on the screen of the oscilloscope (scope) as a bright spot. Fifty microseconds after being generated, the transmitted pulse has traveled half the distance to the target, and the sweep trace has moved ½ inch (fig. 4②). After 100 microseconds have elapsed the pulse reaches the target 32,800 yards away, and the sweep trace has moved 1 inch. The reflected pulse returns to the radar antenna 100 microseconds later. Figure 4④ shows the reflected pulse halfway back to the antenna, and figure 4⑤ shows the reflected pulse and the sweep trace at the time that the pulse arrives at the antenna. A total time of 200 microseconds has elapsed from the time the transmitted pulse was sent out. During this 200-microsecond period the sweep trace has moved a total distance of 2 inches. For a distance representing the duration of the received pulse (1 microsecond) the trace on the face of the scope is brightened. Thus, with a constant sweep-trace velocity of 1 inch per 100 microseconds, a time scale is produced which is equivalent to 100 microseconds per inch times 164 yards per microsecond or 16,400 yards per inch of trace. If another target returned the transmitted pulse in 300 microseconds, the return signal would be indicated 3 inches from the start of the sweep, and the range of this target would be $3 \times 16{,}400 = 49{,}200$ yards.

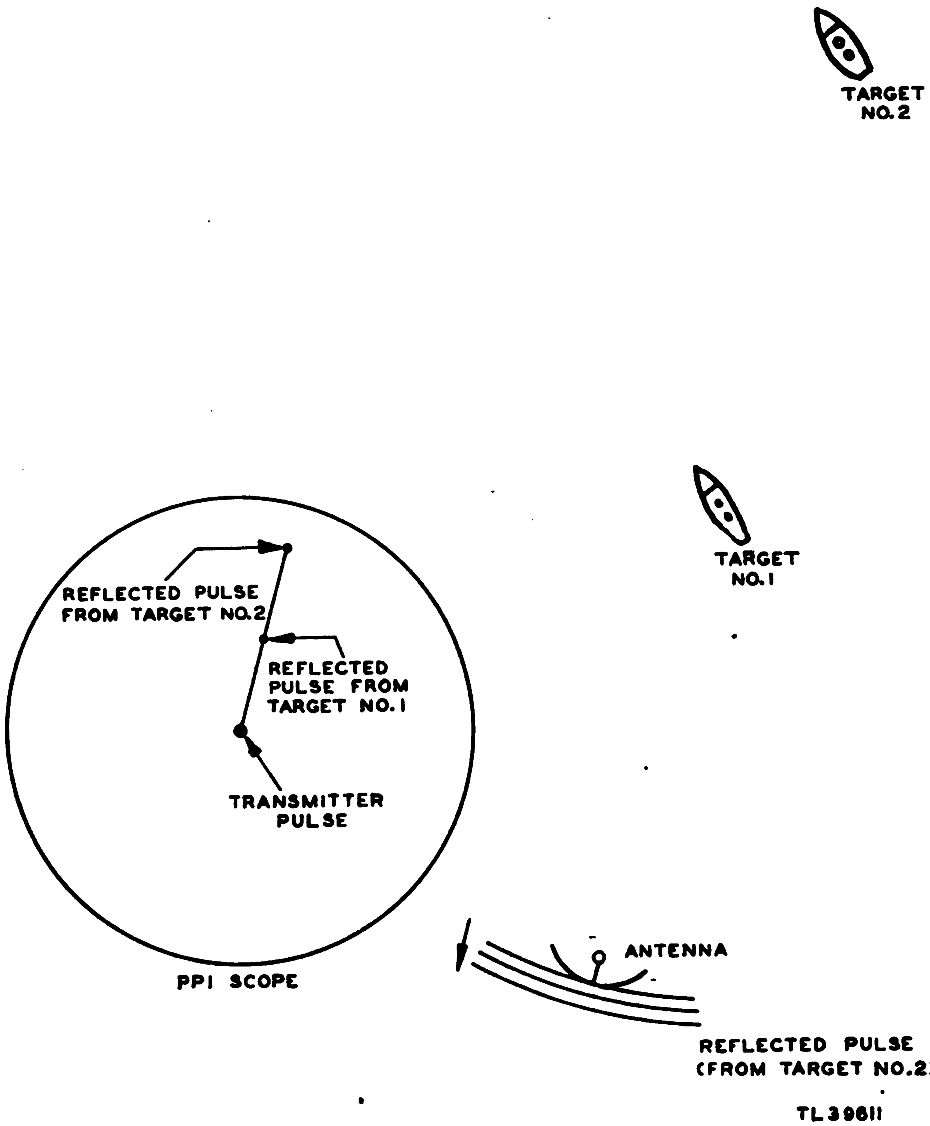


Figure 5. Range indication of two targets.

(2) The single sweep trace described in the above illustration persists on the oscilloscope for only a short time. It is therefore necessary to repeat the pulse transmission and the sweep trace periodically. If the two operations are correctly synchronized, signals returned from a target will be superimposed on each other by successive sweep traces. The echo signals from all targets will be shown on the oscilloscope (fig. 5) in their proper range positions.

3. Description of Radio Set SCR–682–A

a. Radio Set SCR–682–A is a transportable, general-surveillance radar unit. The equipment is designed so that it may be disassembled and moved from one location to another with a minimum of difficulty. Its basic function is RAdio Detection And Ranging (RADAR). In common with other radar sets it is capable, within certain limits, of spotting surface craft and low-flying aircraft under any weather or light conditions. As normally used with harbor defense and coastal defense installations, the functions of the set are:

(1) To search for aircraft or surface vessels within the maximum range of the set.

(2) To supply continuous data on the range (distance) and azimuth (direction) of all targets detected.

b. To perform its functions adequately, the set operates in the microwave frequency range rather than at longer wavelengths. Microwaves can be sharply focused and are not subject to the limitations which ground reflections place upon longer waves.

c. A general view of the components of Radio Set SCR–682–A is shown in figure 6. The set is composed of three main units: Modulator Unit BC–1194–A, Indicator Unit BC–1225–A, and the spinner assembly, each of which contains several components.

d. In the theory and trouble shooting chapters of this manual, the various circuits of the set are not divided according to the components shown in figure 6, but are divided into functional systems as discussed in paragraph 4.

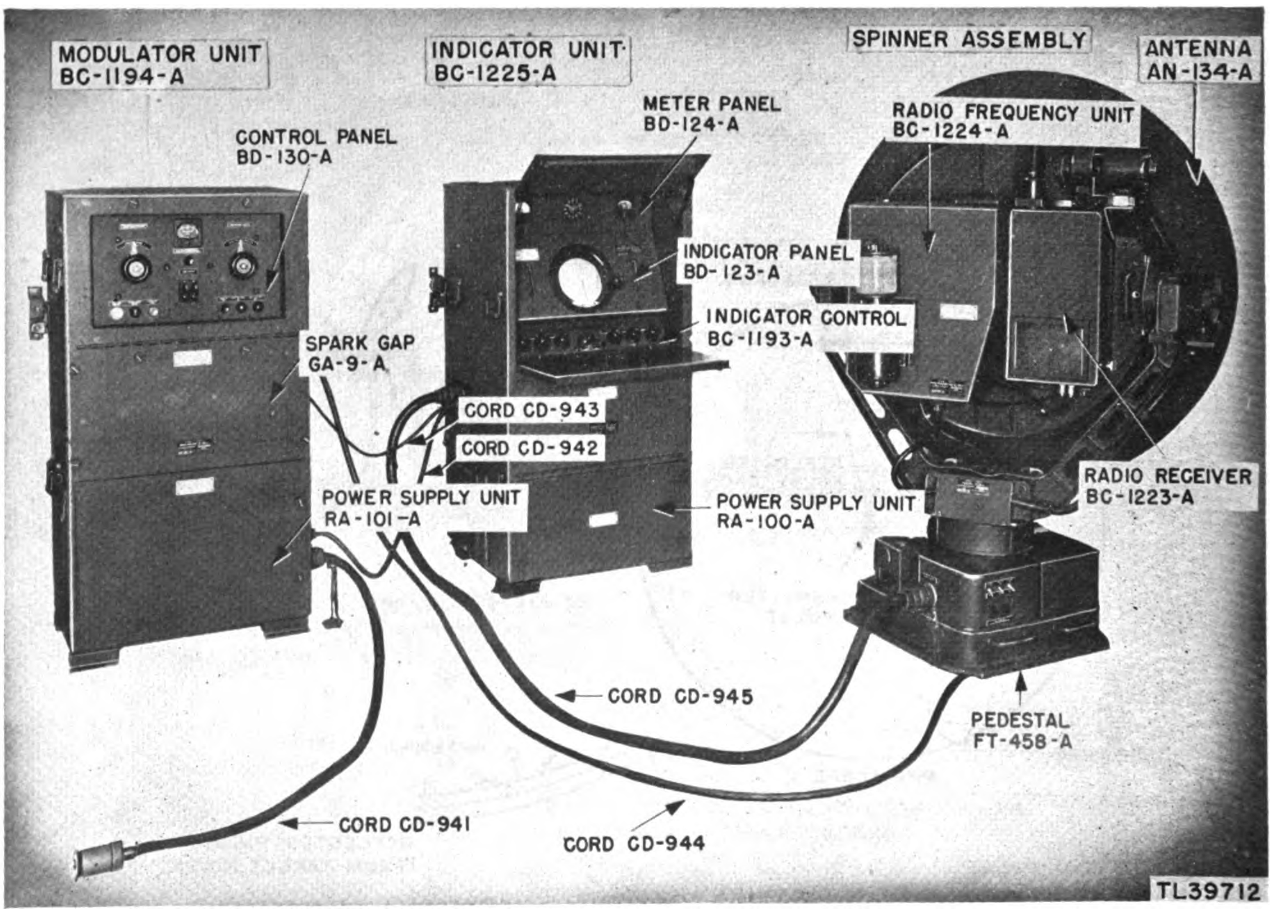


Figure 6. Radio Set SCR–682–A, general view of components.

4. Simplified Block Diagram of Radio Set SCR–682–A

The various systems of Radio Set SCR–682–A are shown in figure 7. In brief, the transmitter system is activated by a spark gap and generates radio-frequency (r-f) pulses. The r-f pulses are conducted to the antenna and are radiated in the form of a focused beam. Target echoes are amplified and detected in the receiver system. The output of the receiver system is then fed into the indicator system (PPI scope and associated circuits). When the spark gap pulses the transmitter, it also triggers the sweep circuit and the range marker circuits at the same instant. Thus all circuit actions (trigger pulses, sweep pulses, "gates," etc.) are synchronized. The azimuth rotation control and the azimuth indication system are also shown in the block diagram. The functions of the various systems are shown in figure 7. Circuit details will be discussed in succeeding sections. Before and during the reading of the next subparagraphs, a thorough study of the block diagram is recommended.

a. Transmitter System. The transmitter system of the radar set generates r-f pulses of narrow width (1 microsecond) and high power (225 kw. peak) at a frequency of approximately 2,800 megacycles. At 2,480-microsecond intervals, the spark-gap modulator applies a negative voltage of 20 kilovolts to the transmitter tube (magnetron) for a period of 1 microsecond. The major parts of the transmitter system are a high-voltage rectifier which produces d-c voltage of the required amplitude, a spark-gap modulator which generates the pulse, and a magnetron oscillator which produces the radio-frequency power.

b. Radio-frequency System. The r-f system of Radio Set SCR–682–A consists of the transmission line, the transmit-receive (T-R) box, the antenna, reflector, and all auxiliary elements which are involved in the conduction, radiation, and interception of pulses. The transmission line couples the antenna to the transmitter and receiver systems. The T-R box keeps transmitted pulses out of the receiver system and passes reflected signals on to the receiver. The antenna, a specially designed dipole, is used for both transmitting and receiving. It is mounted at the focal point of a 4-foot parabolic reflector which revolves in azimuth at a speed of 10 rpm (6 rpm in sets with serial numbers 1 to 6). The entire antenna assembly may be rotated to the left or right, reversed, or halted at any point. Although an elevation tilt adjustment is provided, this is usually set near zero elevation to facilitate detection of ships or low-flying aircraft. The range of the set is considerably increased by mounting the antenna on a tower. Since radio waves travel in a straight line, neglecting refraction, and are tangent to the earth's surface at the horizon as seen from the set, they tend to pass over an object which lies under the radar set's horizon. The tower increases the distance to this horizon.

c. Receiver System. The receiver system of Radio Set SCR–682–A amplifies and detects target echoes. A McNally oscillator generates a signal at a frequency of 2,770 megacycles (2,800 mc less 30 mc). This signal is combined with the received r-f echoes to produce an intermediate frequency of 30 megacycles. The video-detection and amplifying channels included in the system provide signals for the indicator system. Gain variation is accomplished by varying the amount of the bias in the grid circuits of the second and third i-f stages; the receiver gain control is mounted on the indicator operating shelf. An automatic frequency control circuit is included in the receiver system to provide stability of the intermediate frequency.

d. Indicator System. The heart of the indicator system is the cathode-ray oscilloscope, the electron beam movement of which is controlled by a voltage developed in the sweep circuit. The controlled voltage variations cause the spot or beam to move outward from the center of the screen at uniform speed. Because the screen face is treated with a fluorescent material which has the property of retaining an impression for a period of time (persistence), the moving beam or spot gives the impression of being a fine line. This line moves around the scope face like the spoke of a wheel, rotating synchronously with the antenna. When the antenna receives a reflected signal from a target, the received signal appears on the moving line as a bright spot. The direction of the spot from the tube center indicates the target position in azimuth. Range is indicated by the distance of the spot from the tube center. Range and azimuth are determined quickly and accurately, therefore, by direct readings.

e. Range Marker System. Although a part of the indicator unit, the range marker system is presented on the block diagram as a separate functional unit. The system provides markers which

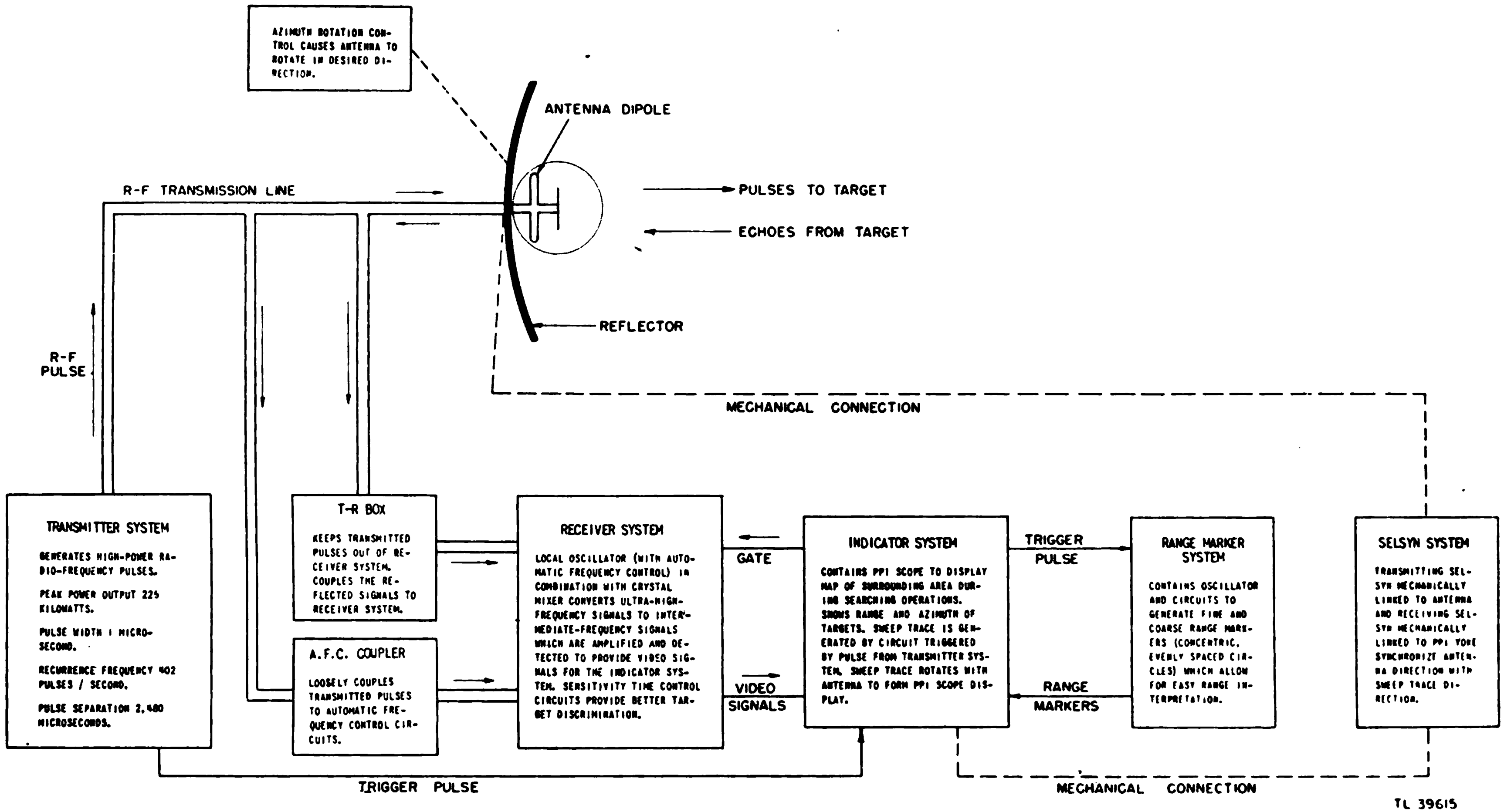


Figure 7. Radio Set SCR-682-A, functional block diagram.

appear as concentric, evenly spaced circles on the face of the PPI scope. The range of a target is then measured by observing the position of the target with respect to the range marker circles.

j. Selsyn System. The selsyn system synchronizes the azimuth position of the trace on the PPI tube with the azimuth position of the antenna. The principal parts of the system are a transmitting selsyn geared to the antenna and a receiving selsyn geared to the PPI yoke.

5. Technical Characteristics of Radar Set

The principal technical characteristics of Radio Set SCR–682–A are as follows:

GENERAL

RANGE:	
Maximum	240,000 yards (approx).
Minimum	500 to 2,000 yards (approx) depending upon ground clutter range.
Accuracy of range:	
10,000-yard range scale	±100 yards.
40,000-yard range scale	±500 yards.
160,000-yard range scale	±2,500 yards.
240,000-yard range scale	±5,000 yards.
Determination	By interpretation of time difference between instant of transmission of main pulse and arrival of echo pulse.
AZIMUTH:	
Mechanical	360 degrees.
Operational	360 degrees.
Accuracy	±1 degree.
Scanning	Continuous rotation of spinner assembly at 10 rpm (6 rpm for units serially numbered 1 to 6).
Determination of direction	Read on PPI scope azimuth dial in number of degrees from true south.
ELEVATION	Manually adjustable from —5 degrees to +25 degrees.
TYPE OF PRESENTATION	7-inch cathode-ray tube for PPI presentation of azimuth and range.
ECHO INTERPRETATION	Examination of echoes on screen of indicator enables approximation of number of targets.
FREQUENCY	Approximately 2,800 megacycles.
WAVELENGTH	10.7 centimeters.
TRANSPORTATION	Three 2½-ton, 6 x 6, LWB cargo trucks or two 2½-ton, 6 x 6, LWB cargo trucks, and two 1-ton trailers are necessary to transport the set in one trip.
SHELTERS AND TOWER	Two shelters provided for set. Antenna Shelter HO-22, a prefabricated pressed canvas and plastic shelter is 68 inches in diameter, 77 inches high, and weighs 105 pounds. Shelter HO-23 is a complete house 11½ feet long, 6¼ feet wide, 5½ feet high, and weighs 1,890 pounds. Tower TR-42-A, a portable adjustable-height steel tower, is 30 feet high, 6 feet square with an 8-foot square platform and a hoist assembly.
ASSEMBLY TIME	Approximately 6 hours with trained crew.

TRANSMITTER SYSTEM

PEAK POWER	225 kw.
AVERAGE POWER	90 watts.
PULSE-RECURRENCE FREQUENCY	402 cycles per second.
PULSE WIDTH	1 microsecond.
SOURCE OF R-F POWER	Magnetron oscillator.
H-V RECTIFIER OUTPUT	6,000 volts, 50 milliamperes.

RECEIVER AND INDICATOR SYSTEMS

TYPE OF INDICATOR:	
PPI scan oscilloscope	7-inch type-7BP7 cathode-ray tube with long persistency screen and suitable color filter.
OPERATING RANGES	0 to 240,000 yards, divided into 4 ranges of from 0 to 10,000 yards, 0 to 40,000 yards, 0 to 160,000 yards, and 0 to 240,000 yards.
RANGE CALIBRATING FREQUENCY	327,868 cycles per second.

R–F SYSTEM

TRANSMISSION LINE	⅞-inch coaxial line.
ANTENNA	One dipole antenna mounted at focal point of parabolic reflector used for transmitting and receiving.
ANTENNA SWITCHING	Switching from transmitting to receiving systems automatically controlled by T-R (transmit-receive) box.
BEAM WIDTH	6 degrees at half-power points.
ANTENNA POWER GAIN	900.

POWER SUPPLY SYSTEM

TYPE OF POWER UNIT	Gasoline engine driven generator.
RATING	6 3-kva, 0.8 power factor, 120-volt, single-phase, 52.5-ampere, 60-cycle.

6. Major Components

a. A listing of the major components is given in table I below. Included are the descriptive names of the components, the common usage names, and the official Signal Corps designations.

Table I. Nomenclature of major components

Descriptive name	Name in common usage	Signal Corps designation
Antenna	Antenna	Antenna AN–134–A*
Indicator control unit	Indicator control unit	Indicator Control BC–1193–A
Indicator power supply	Indicator power supply	Power Supply Unit RA–100–A
Indicator unit	Indicator	Indicator Unit BC–1225–A
Meter panel	Meter panel	Meter Panel BD–124–A
Modulator power supply	Modulator power supply	Power Supply Unit RA–101–A
Modulator unit	Modulator	Modulator Unit BC–1194–A
Operating shelter	Shelter	Shelter HO–23
Pedestal	Pedestal	Pedestal FT–458–A*
PPI scope	PPI	Indicator Panel BD–123–A
Power-control panel	Control panel	Control Panel BD–130–A
Power-generating unit	Power unit	Power Unit PE–183–A
Radio-frequency unit	R-F unit	Radio Frequency Unit BC–1224–A*
Receiver	Receiver	Radio Receiver BC–1223–A*
Rotary spark-gap modulator	Spark gap	Spark Gap GA–9–A (Rotary)
Spinner housing	Blister	Antenna Shelter HO–22

* The combination of Pedestal FT–458–A, Radio Frequency Unit BC–1224–A, Antenna AN–134–A, and Radio Receiver BC–1223–A is commonly called the *spinner assembly* or *spinner*.

b. The complete and simplified schematic diagrams for these components use the following system for part designation.

Prefix	*Location*
1	Pedestal FT–458–A, Radio Frequency Unit BC–1224–A, and Antenna AN–134–A (spinner)
2	Radio Receiver BC–1223–A (spinner)
3	Control Panel BD–130–A and Spark Gap GA–9–A (Rotary) (modulator unit)
4	Power Supply Unit RA–101–A (modulator unit)
5	Meter Panel BD–124–A (indicator unit)
6	Indicator Panel BD–123–A (indicator unit)
7	Indicator Control BC–1193–A (indicator unit)
8	Power Supply Unit RA–100–A (indicator unit)
9	Indicator Unit BC–1225–A (upper cabinet)

Example: Resistor 2–R–43 is resistor No. 43 located in Radio Receiver BC–1223–A (mounted on spinner assembly).

c. The abbreviations listed below are standard in all schematic diagrams.

Unit	*Abbreviation*
Ohms	Ω
Thousand ohms	KΩ
Megohms	MΩ
Microfarads	MF
Micromicrofarads	MMF
Millihenrys	MH
Microhenrys	ΩH

Section II. CONTROL SYSTEM

7. Introduction

The control system of Radio Set SCR–682–A consists of those parts and circuits which are incorporated for the primary purpose of controlling the a-c power supplied to the various components. Parts such as switches, relays, pilot lights, meters, powerstats, rheostats, and fuses are used in the control circuits to insure the correct application of power, indication of applied power, regulation of voltage and current, and protection against

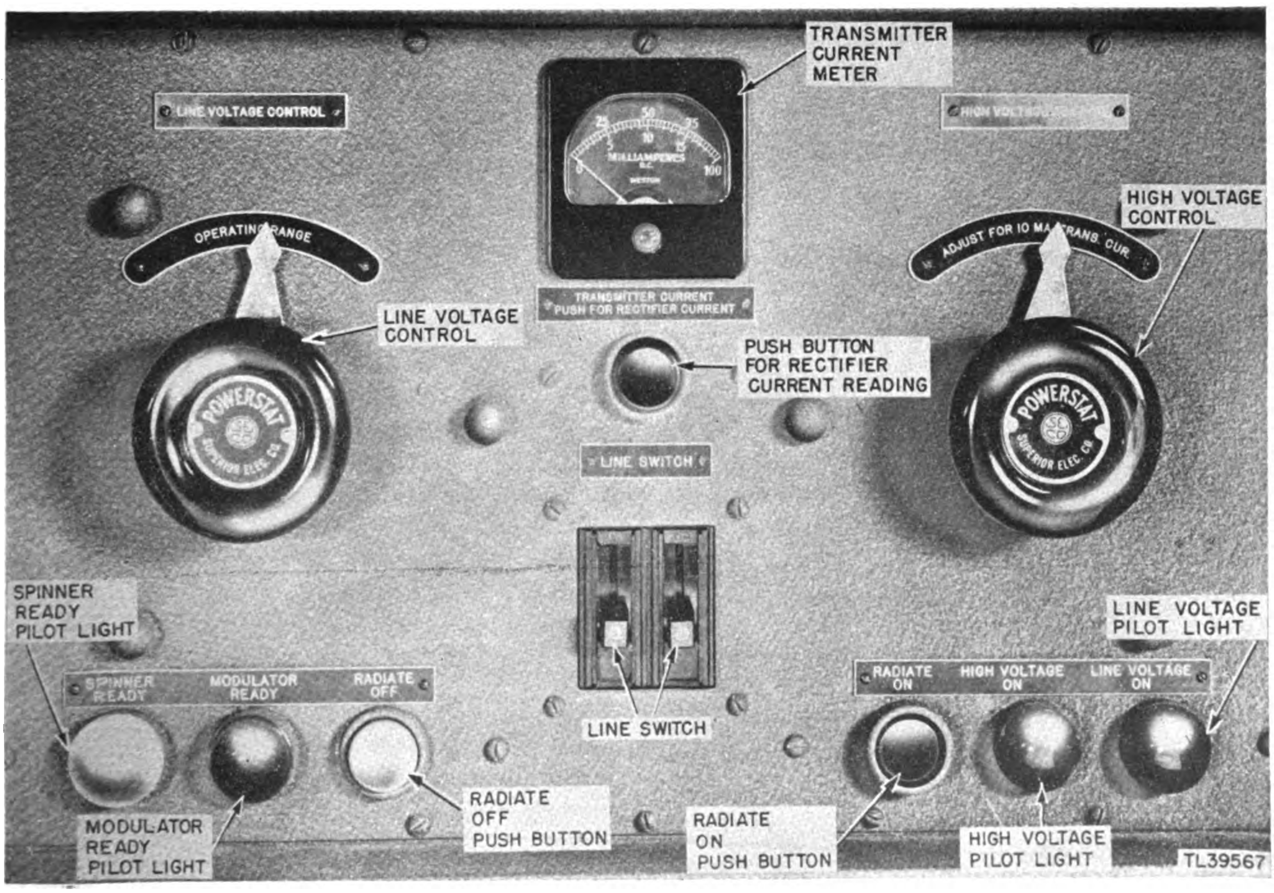


Figure 8. Control Panel BD–130–A, front view.

overload and underload. The control panel (fig. 8) of the modulator unit is the control board, or operations center, for most of the control circuits. The control system of Radio Set SCR–682–A is divided into eight basic circuits, each of which in turn may be subdivided into several individual circuits. The eight basic circuits are listed below and are described in paragraphs 8 through 16.

a. Power supply circuit.
b. Shelter circuit.
c. Green pilot light circuit.
d. Unregulated supply circuit.
e. Regulated supply circuit.
f. Red pilot light circuit.
g. Spinner drive motor control circuit.
h. Selsyn circuit.

8. Power Supply Circuit

Radio Set SCR–682–A operates with a power source having the characteristics listed below:

Nominal voltage ....120 volts
Instantaneous regulation. ± 5 volts maximum
Slow time variation......± 15 volts maximum
Supply frequency........60 cycles ± 2 cycles
Minimum power output..1.6 kilowatts
Minimum kva output.... 2.1 kva

a. LIMITS. Radio Set SCR–682–A is designed to operate with a power source supply voltage between 115 and 125 volts. However the LINE VOLTAGE CONTROL and HIGH VOLTAGE

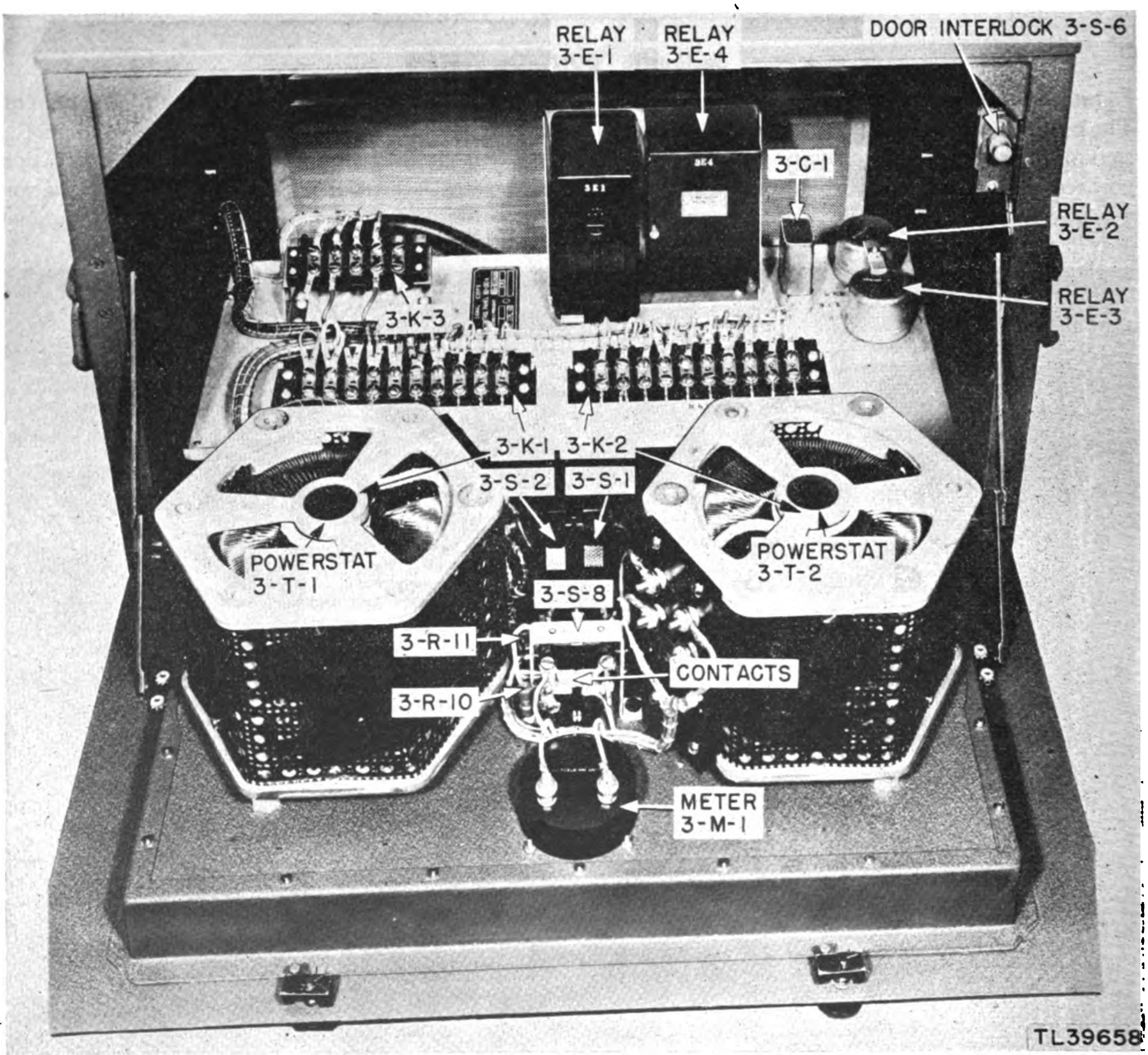


Figure 9. Control Panel BD–130–A, general view of interior.

CONTROL regulating transformers or powerstats (figs. 8 and 9) will permit operation within limits of 105 to 135 volts.

(1) If the equipment is operated outside the 115-volt to 125-volt range, there is a possibility that the control circuit for the spinner drive motor will not function properly,

(2) When operating with the maximum input of 135 volts and with a high ambient temperature, the possible number of reversals of the spinner drive motor before the protective cut-out switch operates will be considerably decreased.

b. ACCESSORIES. The power supply output-capacity figures given in the listing above do not include accessories such as lights, soldering irons, or other auxiliary equipment power loads.

c. PEDESTAL CONVENIENCE OUTLET. **The 115-volt** a-c convenience outlets 1–K–3 (fig. 10) in Pedestal FT–458–A is limited to a load of 15 amperes (maximum) with the spinner drive motor not running.

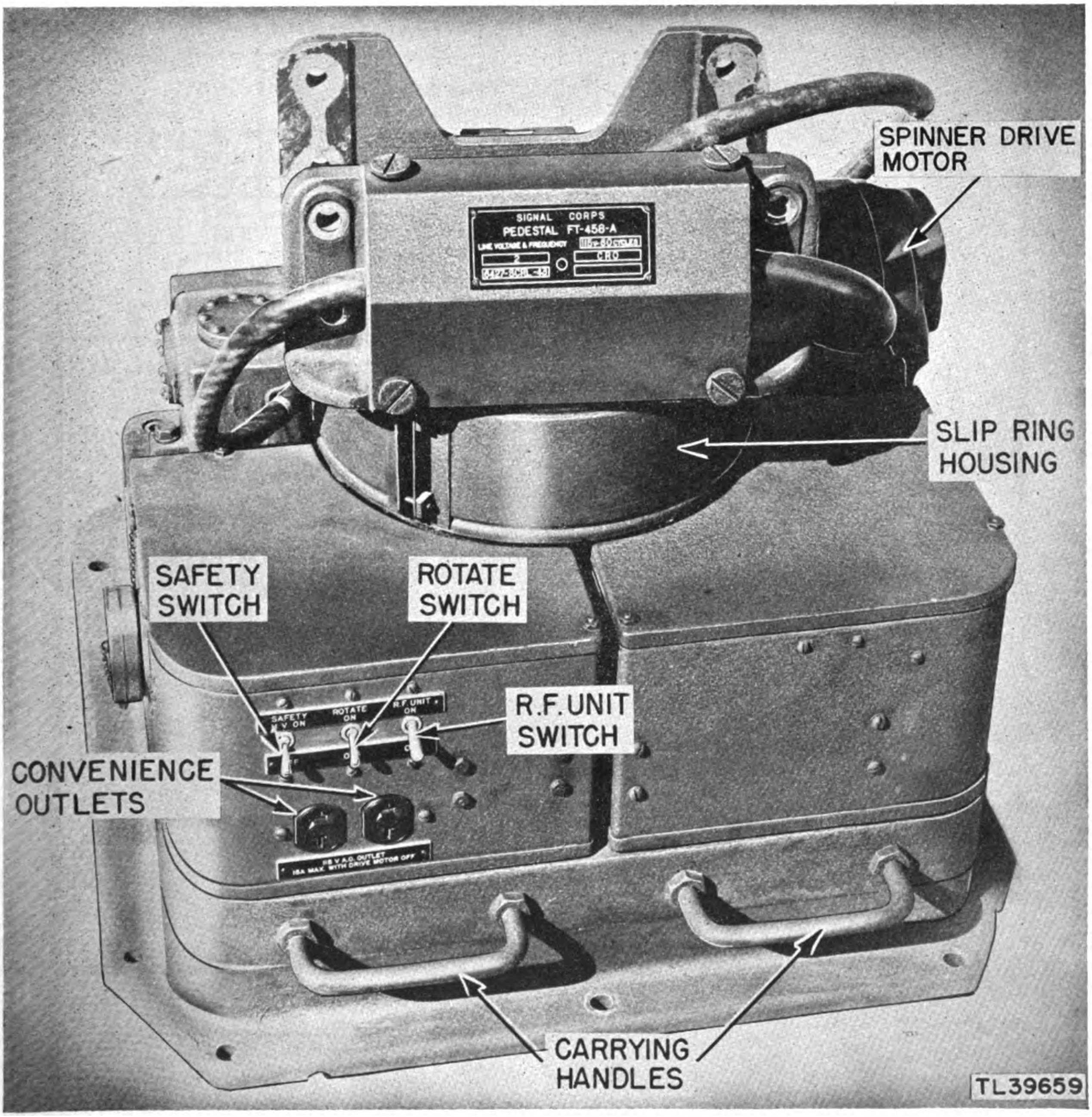
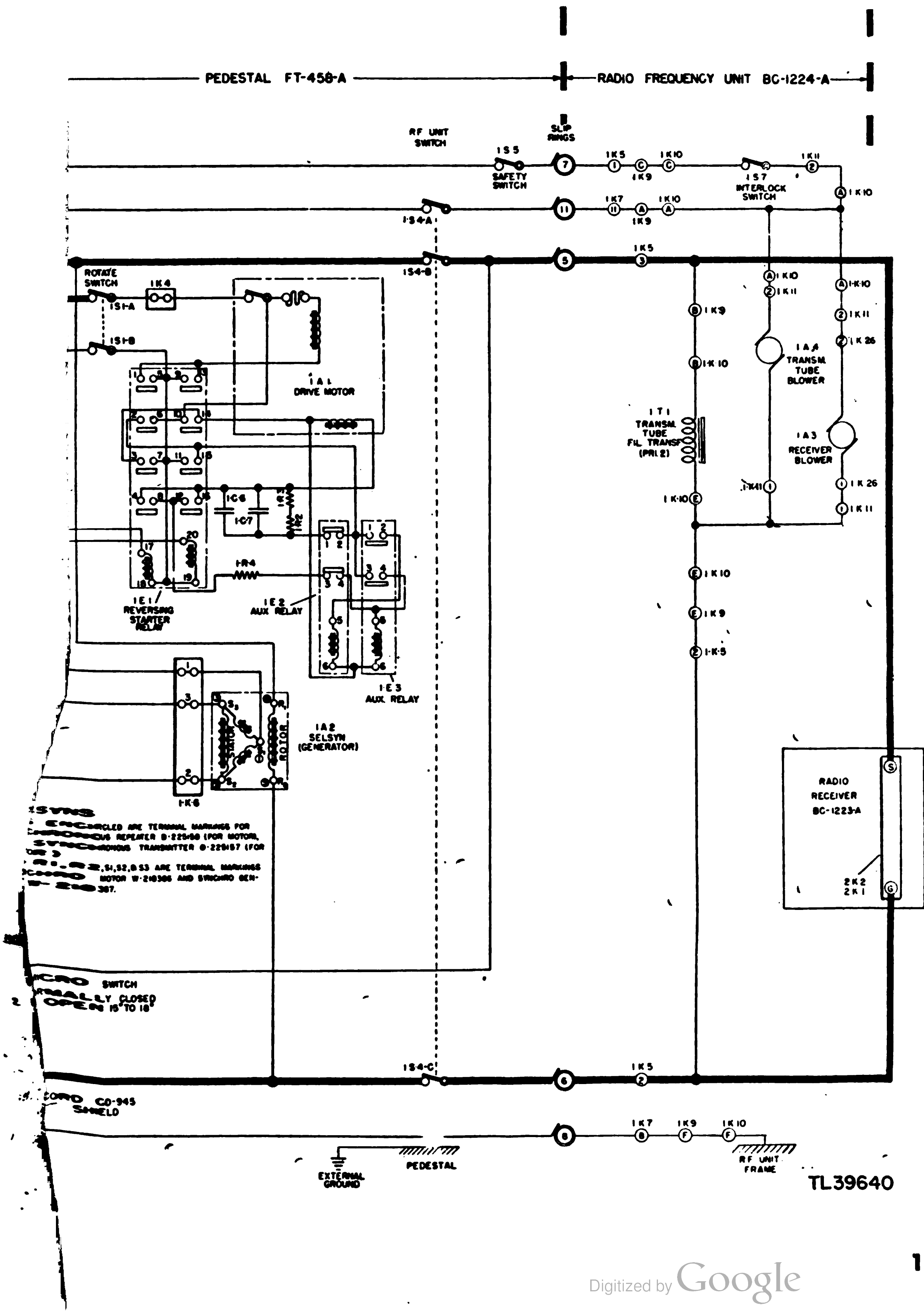


Figure 10. Pedestal FT–458–A, base.


PEDESTAL FT-458-A
RADIO FREQUENCY UNIT BC-1224-A
RF UNIT SWITCH
SLIP RINGS
SAFETY SWITCH
INTERLOCK SWITCH
ROTATE SWITCH
DRIVE MOTOR
REVERSING STARTER RELAY
AUX RELAY
SELSYN (GENERATOR)
TRANSM. TUBE FIL. TRANSF. (PRI. 2)
TRANSM. TUBE BLOWER
RECEIVER BLOWER
RADIO RECEIVER BC-1223-A
CORD CD-945 SHIELD
SWITCH
EXTERNAL GROUND
PEDESTAL
RF UNIT FRAME
TL39640

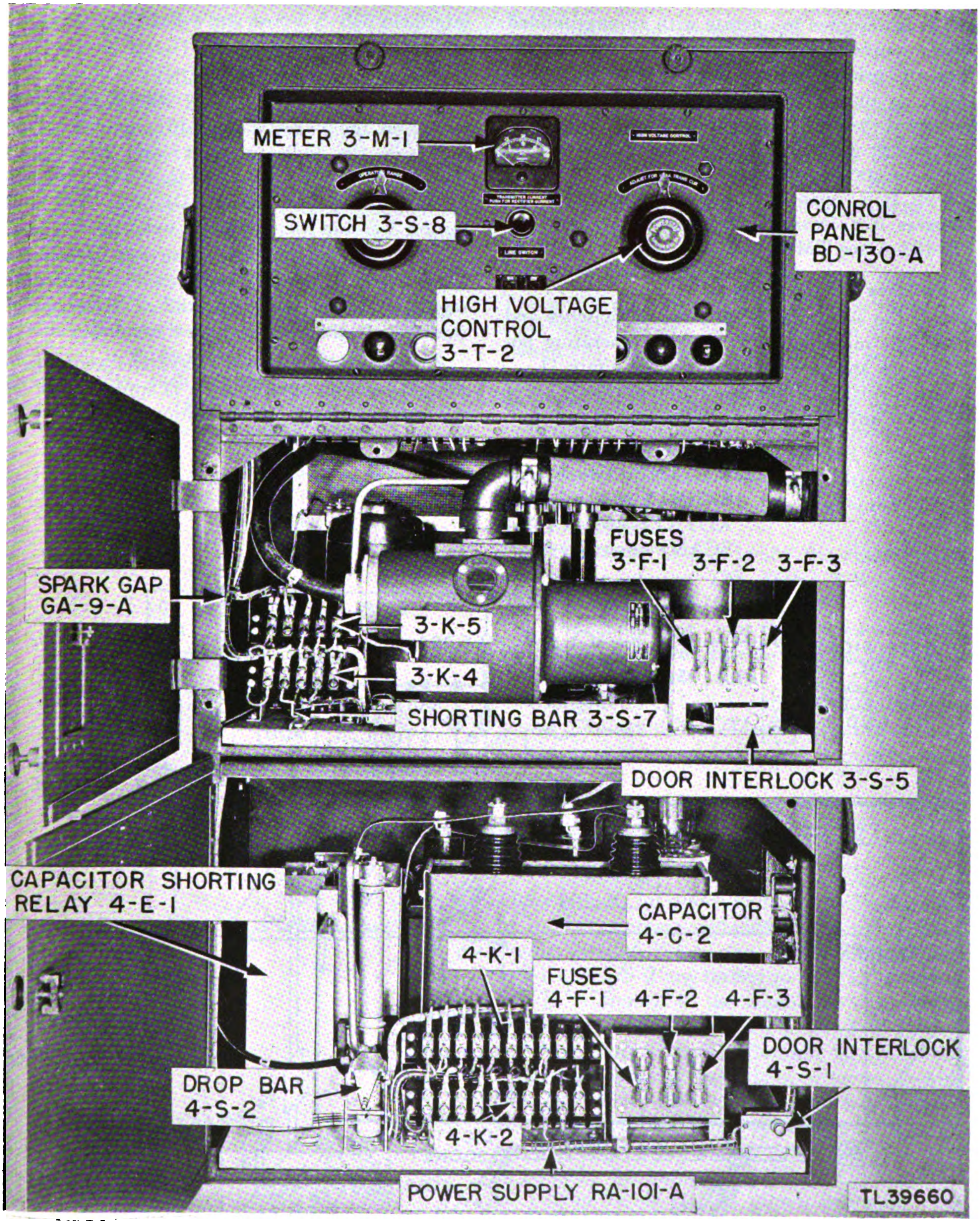


Figure 12. Modulator Unit BC-1194-A.

d. Grounding of Power Source. Radio Set SCR–682–A is designed to operate with an ungrounded power source. However, there are no connections from the primary wiring to ground in the equipment, so that it is possible to operate from a grounded system if desired.

e. Power Unit PE–183–A. Power Unit PE–183–A meets the requirements of Radio Set SCR–682–A. It is capable of supplying a load up to 56 amperes if necessary. For data on Power Unit PE–183–A see TM 11–937.

9. Switches and Interlocks

Before the set can be turned on, all switches and interlocks must be in their proper operating positions, as shown in the diagram of figure 11.

a. Interlocks include one cover interlock 1–S–7 in the r-f unit, three door interlocks 7–S–5, 8–S–1, and 9–S–1 in the indicator unit, and three door interlocks 3–S–5, 3–S–6, and 4–S–1 (figs. 9 and 12) in the modulator unit.

b. Switches include R. F. UNIT switch 1–S–4, SAFETY switch 1–S–5, and ROTATE switch 1–S–1 on the pedestal (fig. 10); SCAN switch 7–S–4 in the indicator unit; and two LINE SWITCHES 3–S–1 and 3–S–2, RADIATE ON push button 3–S–4, and RADIATE OFF push button 3–S–3 in the modulator unit (fig. 8).

c. In the modulator unit are two powerstats (figs. 8 and 9), one of which, 3–T–1, controls a regulated output, while the other, 3–T–2, controls the input to the high-voltage transformer 4–T–2.

d. Figure 11 shows all relays and switches in normal position before power is applied. The following table lists these positions.

All interlocks	Closed
R.F. UNIT switch 1–S–4	ON
SAFETY switch 1–S–5	ON
ROTATE switch 1–S–1	ON
SCAN switch 7–S–4	OFF

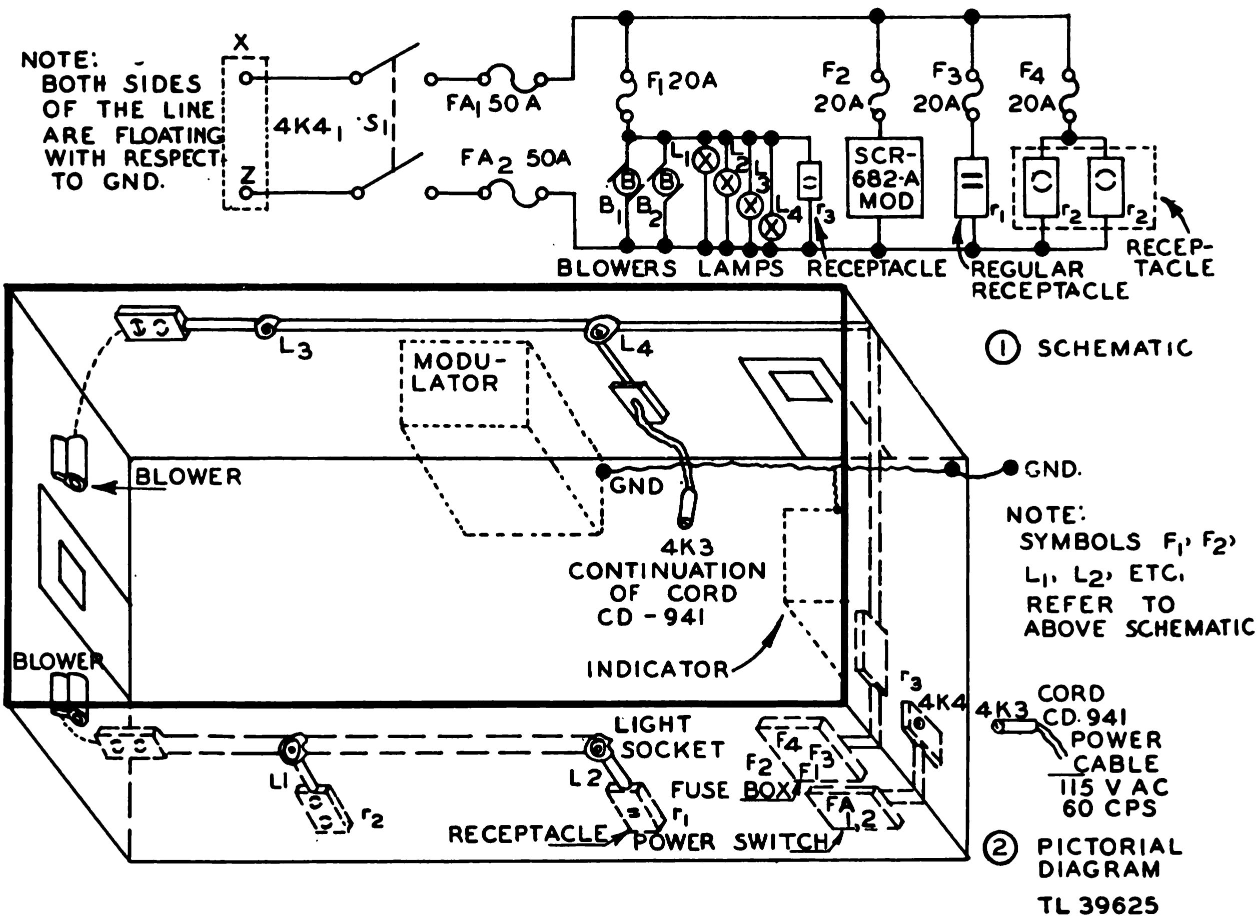


Figure 13. Shelter HO–23, schematic and pictorial diagrams of a-c power circuit.

LINE SWITCHES 3–S–1 and 3–S–2.......OFF
LINE VOLTAGE CONTROL 3–T–1......Normal operating position
HIGH VOLTAGE CONTROL 3–T–2.....Normal operating position

10. Shelter Circuit

Figure 13 shows the wiring of Shelter HO–23. A heavy, insulated, flexible power Cord CD–941 connects the output of Power Unit PE–183–A to the shelter by means of a receptacle mounted on the rear wall of the shelter. This receptacle also connects to the power switch (which has self-contained, nonrenewable cartridge-type fuses F–A–1 and F–A–2). The power switch (fig. 14) is mounted on the inside wall of the shelter. When the switch is thrown on, power is sent into different circuits, each of which is fused by nonrenewable screw-in type fuses located in the fuse box (fig. 14) above the power switch. One of these circuits is for the radar equipment, the others being used for the wall lights, convenience outlets (receptacles), and the shelter ventilating blowers. Conduits and condulets are built in as standard equipment and contain the various connecting wires.

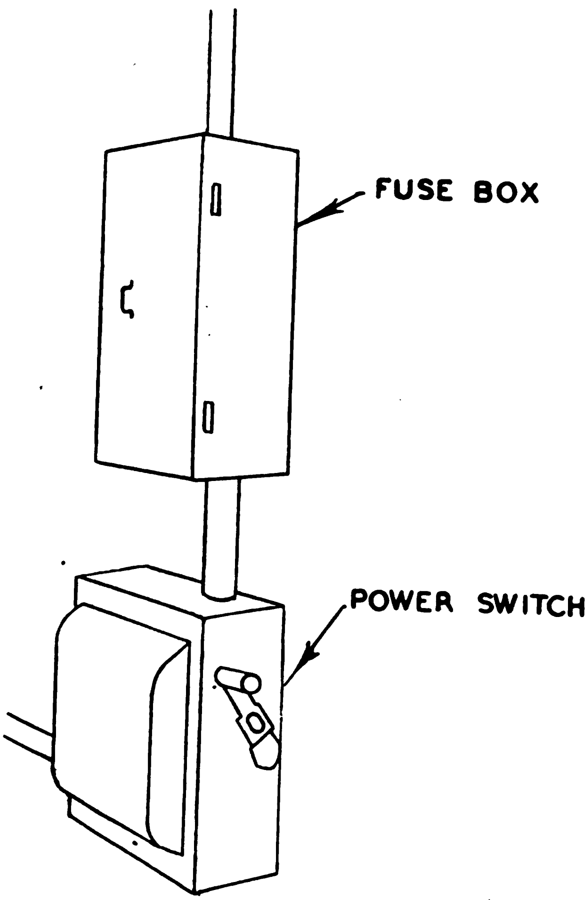


Figure 14. Shelter HO–23, power switch and fuse box.

11. Green Pilot Light Circuit (fig. 15)

The green pilot light circuit includes those circuits which receive a-c power when the power switch (fig. 14) is thrown on and the power cord is connected to the POWER IN receptacle 4–K–4 on the modulator unit. The following normal results occur when this circuit is energized:

a. The green LINE VOLTAGE ON light 3–A–2 (fig. 8) glows. This light with its series resistors 3–R–1 and 3–R–2 is connected across the 120-volt line.

b. The heater 3–A–1 inside the rotary spark gap receives power. This heater 3–A–1 is protected by fuse 3–F–3 (fig. 12).

c. The modulator unit convenience outlets 4–K–5 are energized. Fuse 4–F–1 (fig. 12) is connected in this circuit.

d. Capacitors 4–C–1–1 and 4–C–1–2 are also across the 120-volt line. These capacitors are connected in series and have their common leads grounded.

e. Power is fed to one side of LINE SWITCHES 3–S–1 and 3–S–2.

12. Unregulated Supply Circuit (fig. 16)

Those circuits for which voltage is not controlled by a powerstat are included in the unregulated supply circuit. When the LINE SWITCHES 3–S–1 and 3–S–2 are turned to the ON position, voltage is applied to the modulator unit blower motor 3–A–3, spark-gap drive motor 3–A–4, spinner drive motor circuits (through SCAN switch 7–S–4), transmitter tube blower motor 1–A–4, and the receiver blower motor 1–A–3. Voltage is also applied to the white pilot lamp 3–A–6 and the time delay relay 3–E–4. After approximately 45 seconds, the amber MODULATOR READY pilot lamp 3–A–5 (fig. 8) glows, indicating that the set can be put into operation by pressing the RADIATE ON button. The following circuits are energized as soon as the LINE SWITCHES are turned on:

a. Modulator Unit Blower Motor. The modulator unit blower motor 3–A–3 operates since it is connected directly across the 120-volt line through fuse 3–F–1.

b. Spark-gap Drive Motor. Voltage is applied to the spark-gap drive motor through fuse 3–F–2.

c. Powerstat 3–T–1. The LINE VOLTAGE CONTROL powerstat 3–T–1 is energized. The output voltage from this powerstat feeds several circuits which are explained in paragraph 13.

d. SCAN Switch. The circuits for the spinner drive motor are fed through the SCAN switch 7–S–4 on the indicator unit and ROTATE switch 1–S–1 on the spinner. As explained in paragraph 15, the spinner drive motor is inoperative until the SCAN switch is turned to either FORWARD or REVERSE.

e. Transmitter-tube Blower and Receiver Blower. Blower motors 1–A–3 and 1–A–4 operate as soon as the LINE SWITCHES are thrown ON. Fuses 9–F–3 and 9–F–2 protect these motors as well as other equipment in the unregulated supply circuit. Power is fed to them through slip rings Nos. 6 and 11 in the pedestal.

f. White Pilot Light Circuit. The unregulated 120-volt source also feeds through interlock switch 1–S–7, pedestal slip ring No. 7, and the SAFETY switch 1–S–5 and is then applied across the series combination of two parallel resistors 3–R–5 and 3–R–6, the plate relay contacts 3–E–1–2, and the white SPINNER READY pilot lamp 3–A–6, thus causing the white light to glow.

g. Time Delay Relay Coil. At the time that the white pilot lamp glows, the coil in the time delay relay 3–E–4 (fig. 9) is energized. After this relay coil has been energized for approximately 45 seconds, the time delay relay contacts 3–E–4–1 close. This causes the amber MODULATOR READY pilot light 3–A–5 (fig. 8) to glow. This lamp is connected across the 120-volt unregulated source through the time delay relay contacts, the interlock switches 3–S–6, 3–S–5, and 4–S–1, the parallel resistors 3–R–3 and 3–R–4, and the plate relay contacts 3–E–1–1. See paragraph 18 for a discussion of the time delay relay.

h. Line Switches. The LINE SWITCHES are of the circuit breaker type. In the event of an overload, self-contained thermal units heat and automatically cause the LINE SWITCHES to open.

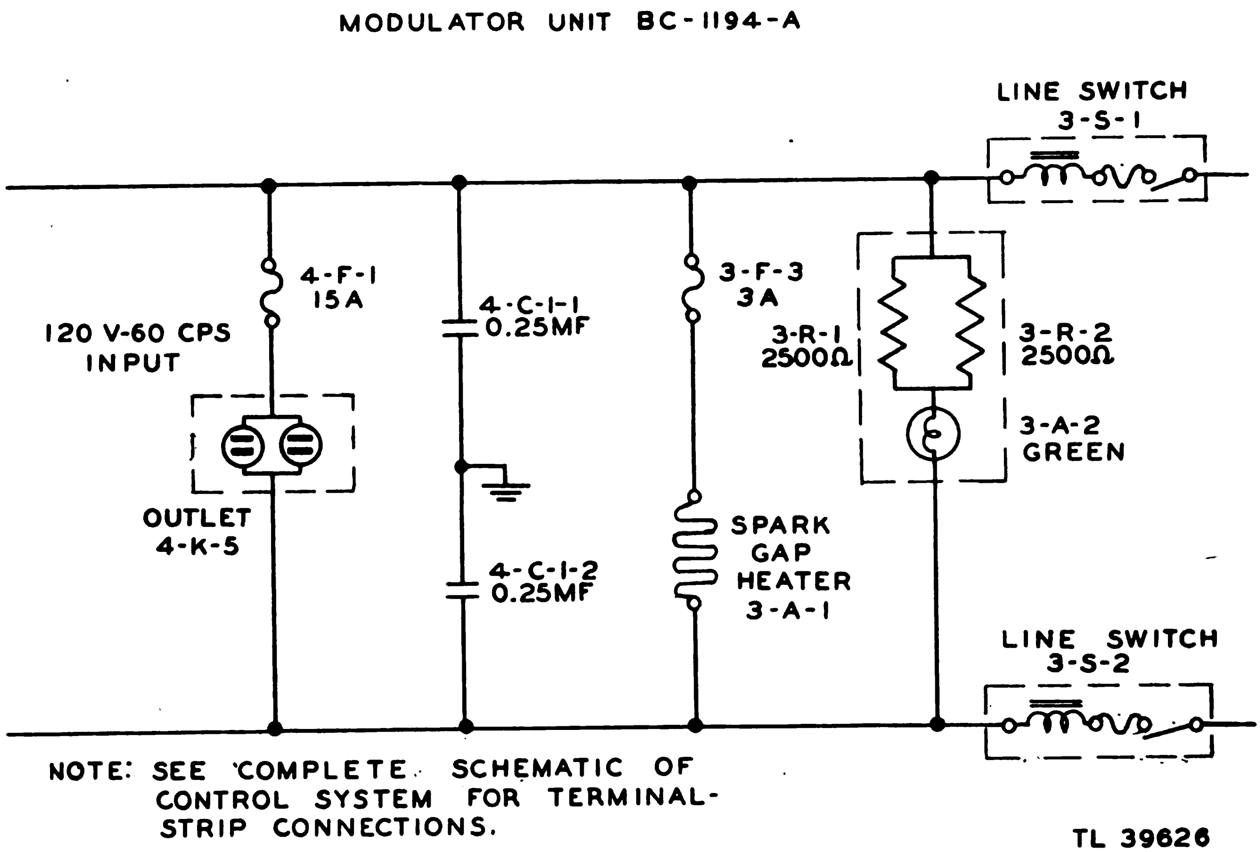


Figure 15. Green pilot light circuit, simplified schematic diagram.

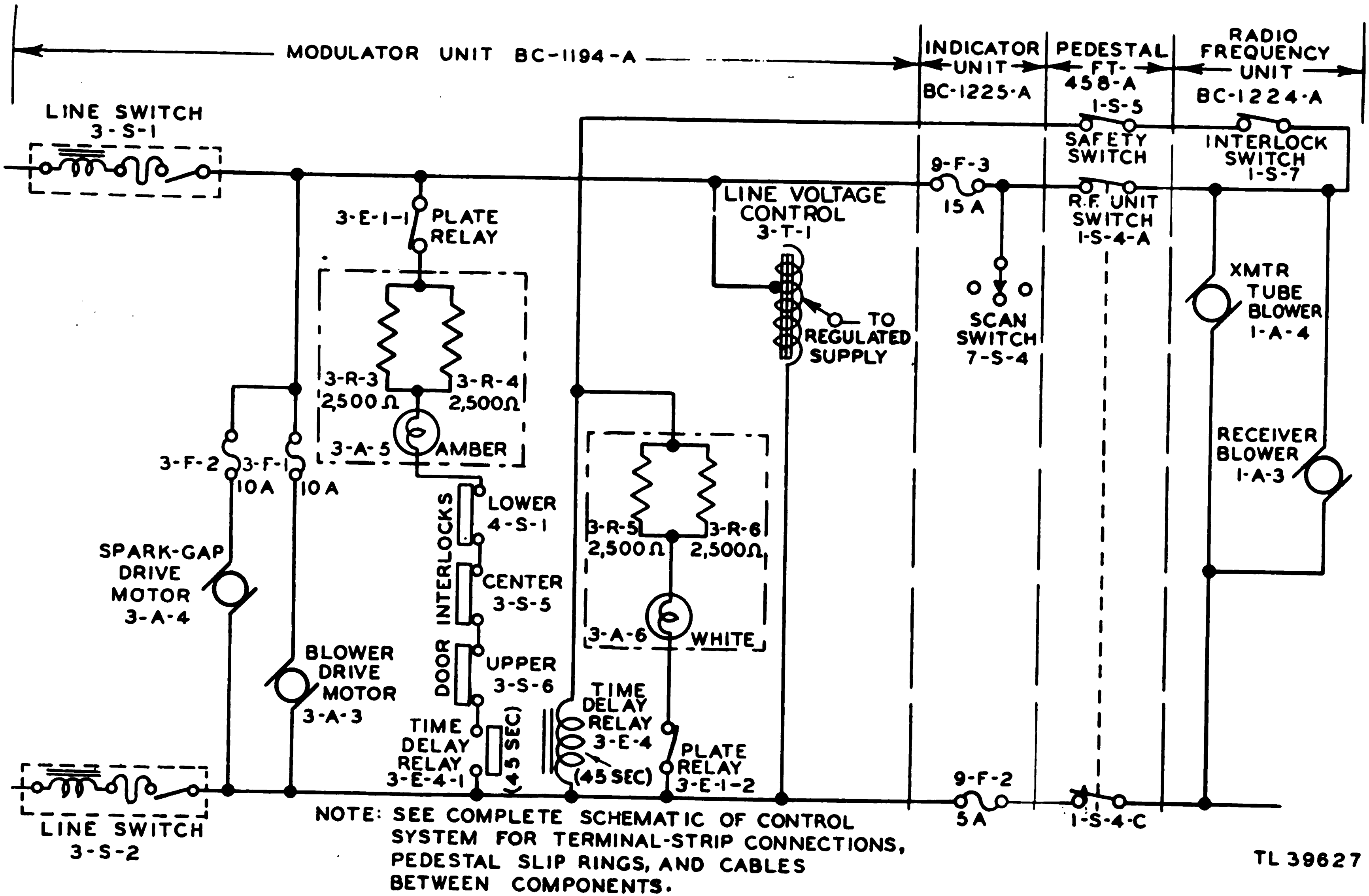


Figure 16. Unregulated supply circuit, simplified schematic diagram.

13. Regulated Supply Circuit (fig. 17)

Those circuits which are fed from the output of powerstat 3–T–1 are included in the regulated supply circuit. The voltage output of this powerstat can be adjusted by means of the LINE VOLTAGE CONTROL (fig. 8). When the LINE SWITCHES are thrown to the ON position, regulated voltage is applied across the filament transformer (4–T–1) of the rectifier tubes of Power Supply Unit RA–101–A, transmitter tube filament transformer 1–T–1, line voltmeter 5–M–1, running time meter 5–M–2, and the indicator control panel lamps 7–A–1, 7–A–2, and rectly across the regulated supply and operate when the LINE VOLTAGE CONTROL is in its normal position and the LINE SWITCHES are thrown to the ON position. A description of these circuits follows:

a. Filament Transformer of Rectifier Tubes. Transformer 4–T–1 supplies power for heating the filaments of the WE–705–A rectifier tubes in Power Supply Unit RA–101–A.

b. Line Voltmeter and Running Time Meter. Meters 5–M–1 and 5–M–2 are connected across the output of the powerstat and are protected by fuses 9–F–5 and 9–F–6.

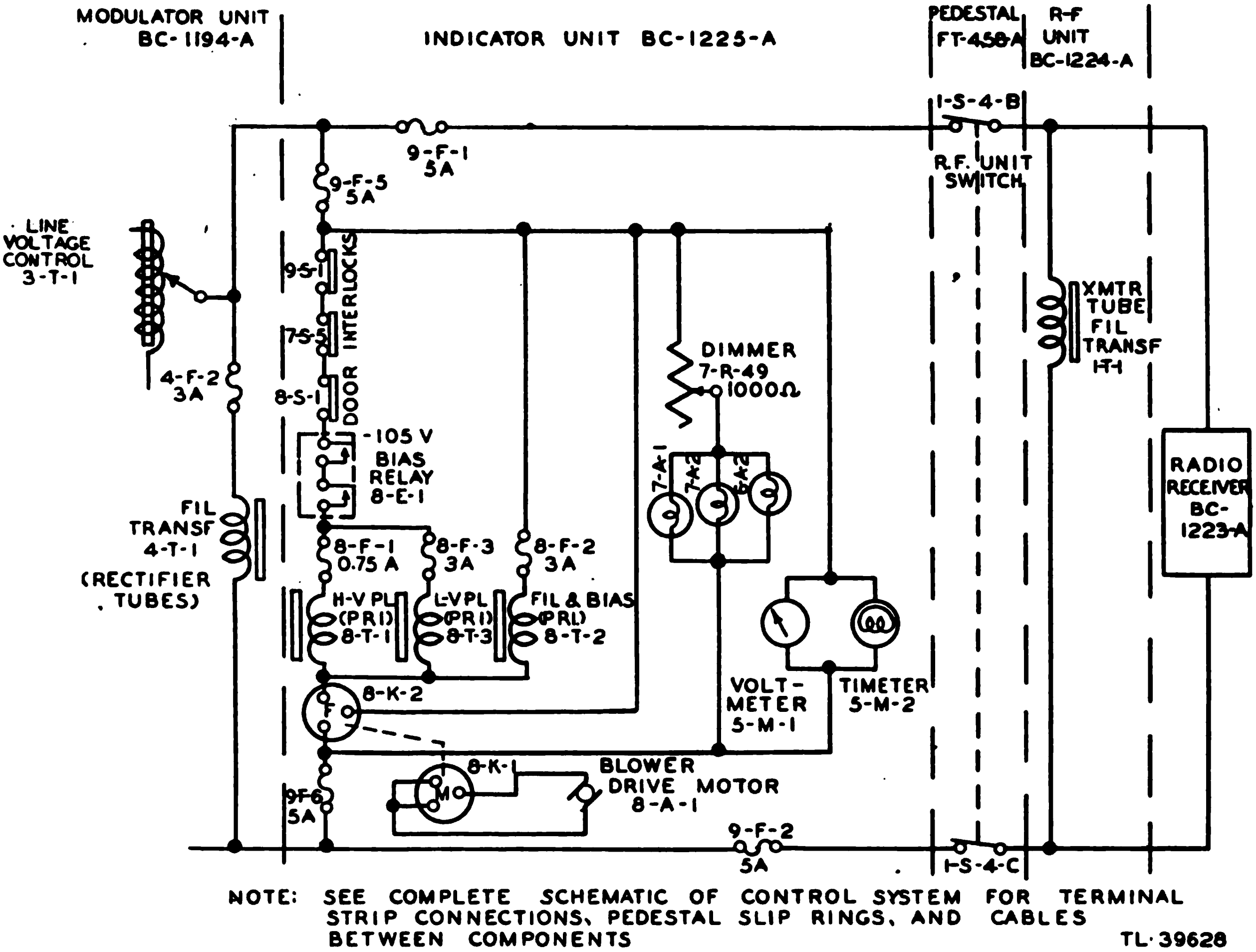


Figure 17. Regulated supply circuit, simplified schematic diagram.

6–A–2. Voltage is applied to the filament and bias transformer 8–T–2 of Power Supply Unit RA–100–A. Voltage is also applied through bias relay 8–E–1 to the high-voltage plate transformer 8–T–1 and the low-voltage plate transformer 8–T–3. The indicator blower motor, the rotors of selsyn motor 6–A–1 and selsyn generator 1–A–2, and Radio Receiver BC–1223–A are connected di-

c. Indicator Lamps. The indicator lamps illuminate the control knobs on the indicator control and the azimuth index of the azimuth dial. Lamps 7–A–1 and 7–A–2 supply light for the indicator control knobs, and lamp 6–A–2 supplies the light for the azimuth dial. All three lamps are in parallel as shown in figure 17. They are connected in series with the dimmer LIGHTS control 7–R–9, and this series combination is placed across the regulated supply through fuses 9–F–5 and 9–F–6.

d. Range Control Light. Another lamp (not shown in fig. 17) is located behind the RANGE switch to illuminate the range setting. This lamp, 7–A–4, is supplied by a 7-volt secondary winding of transformer 8–T–2 in Power Supply Unit RA–100–A. It normally lights when the regulated supply a-c input is fed to this unit. Figure 17 shows the regulated supply a-c input to transformer 8–T–2 of Power Supply Unit RA–100–A through fuses 9–F–6, 9–F–5, and 8–F–2, and receptacle 8–K–2. This receptacle acts as a safety device since the Power Supply Unit RA–100–A cannot receive power until connector 8–K–1 is inserted. In this way, the blower motor must be connected before power is applied.

e. Circuits in Power Supply Unit RA–100–A. The primary of transformer 8–T–2 in Power Supply Unit RA–100–A is supplied with power as explained under subparagraph *d* above. This transformer has three secondaries, one of which supplies a 7-volt source for the filaments of the indicator control tubes. The other two secondaries supply the heater voltage and high voltage for the bias rectifier tube 8–V–2, and heater voltage for the voltage regulating tube 8–V–9. In series with the cathode circuit of rectifier tube 8–V–2 is the coil of the bias relay 8–E–1. Thus, when transformer 8–T–2 receives power, the bias rectifier is operative, the bias relay coil is energized, and the relay contacts close. These contacts (fig. 17) in turn close another circuit which allows power to be applied to transformers 8–T–1 and 8–T–3. The complete circuit which places the regulated supply voltage across transformers 8–T–1 and 8–T–3 comprises the series combination of the bias relay contacts 8–E–1, interlocks 8–S–1, 7–S–5, and 9–S–1, fuses 9–F–5 and 9–F–6, and receptacle 8–K–2.

f. Indicator Blower Motor. As shown in figure 17, this motor is connected across the regulated supply through fuses 9–F–5 and 9–F–6 and receptacle 8–K–2. The connector 8–K–1 when inserted into receptacle 8–K–2 completes the circuit.

g. Rotors of Selsyn Motor and Generator. The rotors of selsyns 6–A–1 and 1–A–2 are connected directly across the regulated supply source through fuses 9–F–1 and 9–F–2. The operation of the selsyns is explained in detail in section VIII of this chapter, Selsyn System. Included in this section are the operation of the selsyn relay 6–E–1 and of microswitches 1–S–6 and 6–S–1.

h. Transmitter Tube Filament Transformer. The primary of transformer 1–T–1 is also sup-

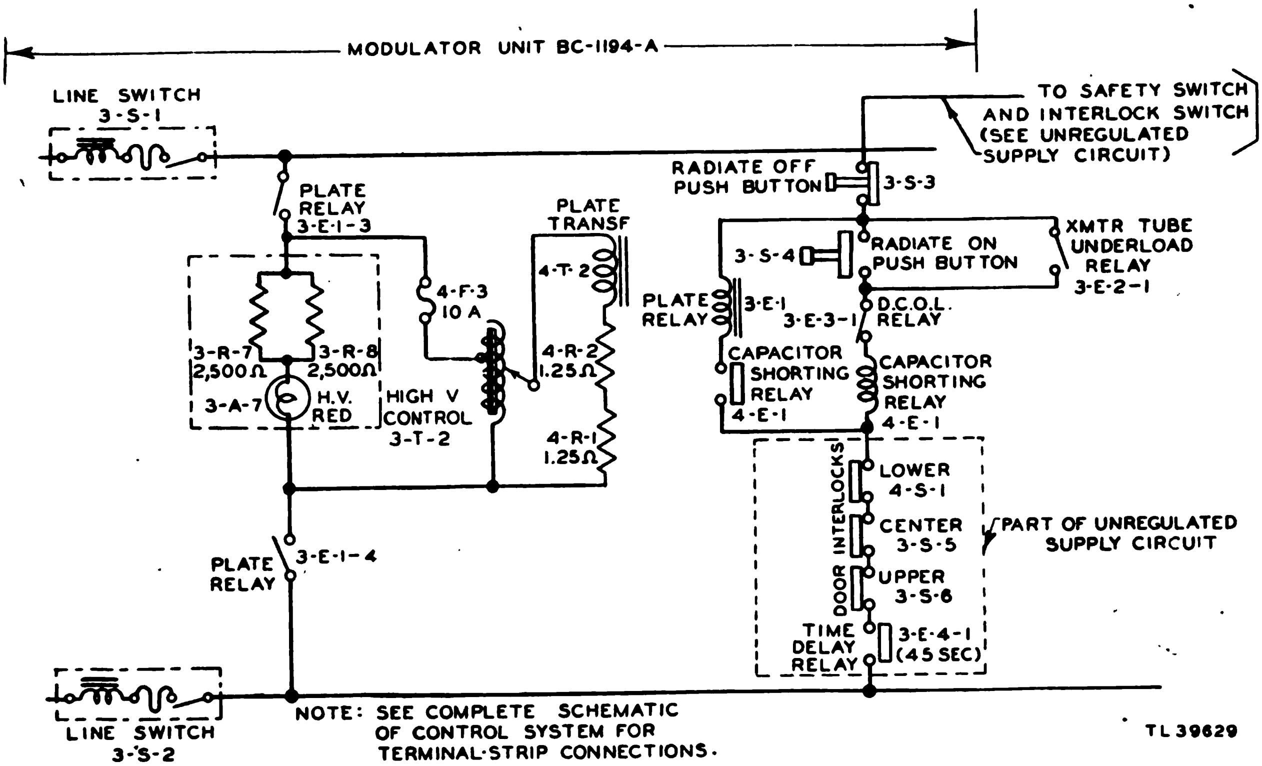


Figure 18. Red pilot light circuit, simplified schematic diagram.

plied by the regulated supply source through fuses 9–F–1 and 9–F–2, R. F. UNIT switches 1–S–4–B and 1–S–4–C, and slip rings Nos. 5 and 6.

i. Circuits in Radio Receiver BC–1223–A. The receiver is supplied by the same circuit that feeds the transmitter tube filament transformer primary.

14. Red Pilot Light Circuit (fig. 18)

The red pilot light circuit provides a visual indication of the presence of high voltage applied to the transmitter system. The transmitter system is placed in operation by pressing the RADIATE ON push-button switch 3–S–4 after the white and amber lights are on (pars. 12*f* and 12*g*). The RADIATE ON button, when pressed, causes the unregulated supply source to be applied to the coil of the capacitor shorting relay 4–E–1 (fig. 18), through the contacts of the direct-current overload relay 3–E–3–1.

a. Action of Capacitor Shorting Relay (fig. 12). When the capacitor shorting relay contacts 4–E–1–1 close, the coil of the plate relay 3–E–1 (fig. 9) receives power and operates four sets of contacts, 3–E–1–1, 3–E–1–2, 3–E–1–3, and 3–E–1–4. The operation of these contacts causes the following actions:

(1) ***White pilot light goes out.*** Plate relay contacts 3–E–1–2 open the circuit which supplies power to the white pilot light.

(2) ***Amber pilot light goes out.*** Contacts 3–E–1–1 of the plate relay open the circuit to the amber pilot light.

(3) ***Red pilot light goes on.*** Plate relay contacts 3–E–1–3 and 3–E–1–4 close and complete the circuit which places the unregulated supply source across the series combination of resistors 3–R–7 and 3–R–8 in parallel and lamp 3–A–7, thereby causing the red pilot light to glow. Simultaneously, power is also applied to the HIGH VOLTAGE CONTROL powerstat through fuse 4–F–3. The powerstat furnishes an adjustable power source for the high-voltage plate transformer 4–T–2 in Power Supply Unit RA–101–A. Applying power to transformer 4–T–2 places the rotary spark gap in operation. The sound of the sparking is audible. Simultaneously, relay contact 3–E–2–1 closes and shorts out the push-button switch 3–S–4, causing the set to continue in operation after pressure is removed from the push button.

b. Protection in Modulator Unit. Relay contacts 3–E–3–1 and 3–E–2–1 in series protect the modulator spark gap and power supply units against overload and underload, respectively. A third relay 4–E–1 is used to short the high-voltage filter capacitor 4–C–2 through resistor 4–R–3 in Power Supply Unit RA–101–A when the power is removed.

(1) Relay 3–E–3 (fig. 9), called the direct-current overload relay (D.C.O.L.) is connected in series with the ground return of the high-

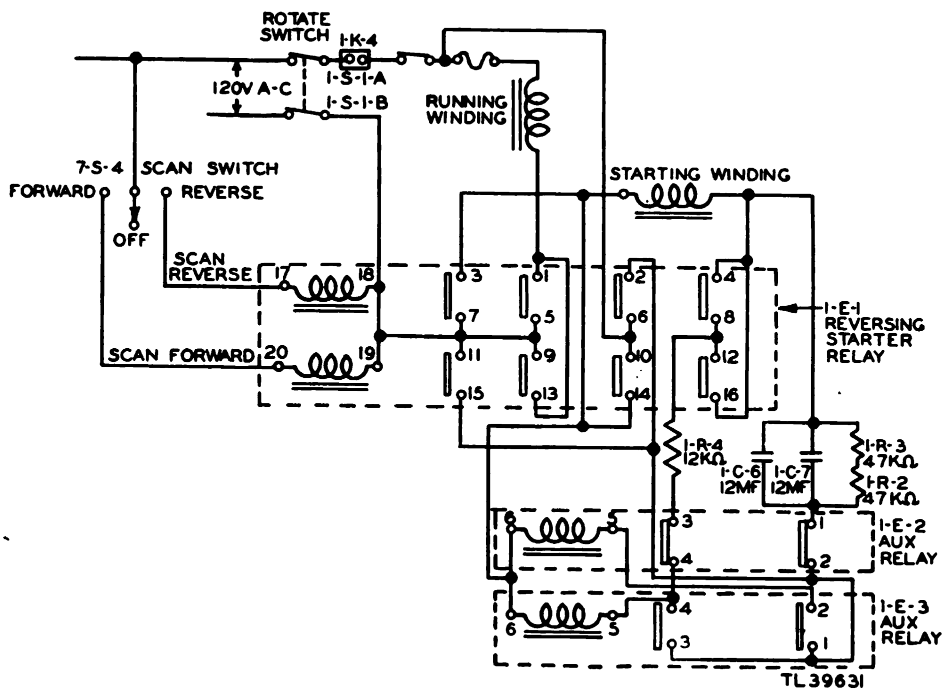


Figure 19. Spinner drive motor control circuit, position of relays, SCAN switch OFF.

voltage rectifier. Its characteristics are shown in the chart below.

Operation	*Current*
Normal	[illegible]0 Milliamperes
Pull out.......	[illegible] Milliamperes + 10%, — 20%
Drop in.......	[illegible]5 Milliamperes ± 20%

(2) The transmitter tube underload relay 3–E–2 (fig. 9) operates when 6 milliamperes or more of transmitter current flows in the circuit. The contacts short out the RADIATE ON switch, keeping the circuit closed after the push button is released.

(3) The capacitor shorting relay 4–E–1 (fig. 12) has a set of contacts which remove the short from capacitor 4–C–2 when power is applied by pressing the RADIATE ON button. A further explanation of the operation of these relays, contacts, spark gap, etc., is given in section III of this chapter, Transmitter System.

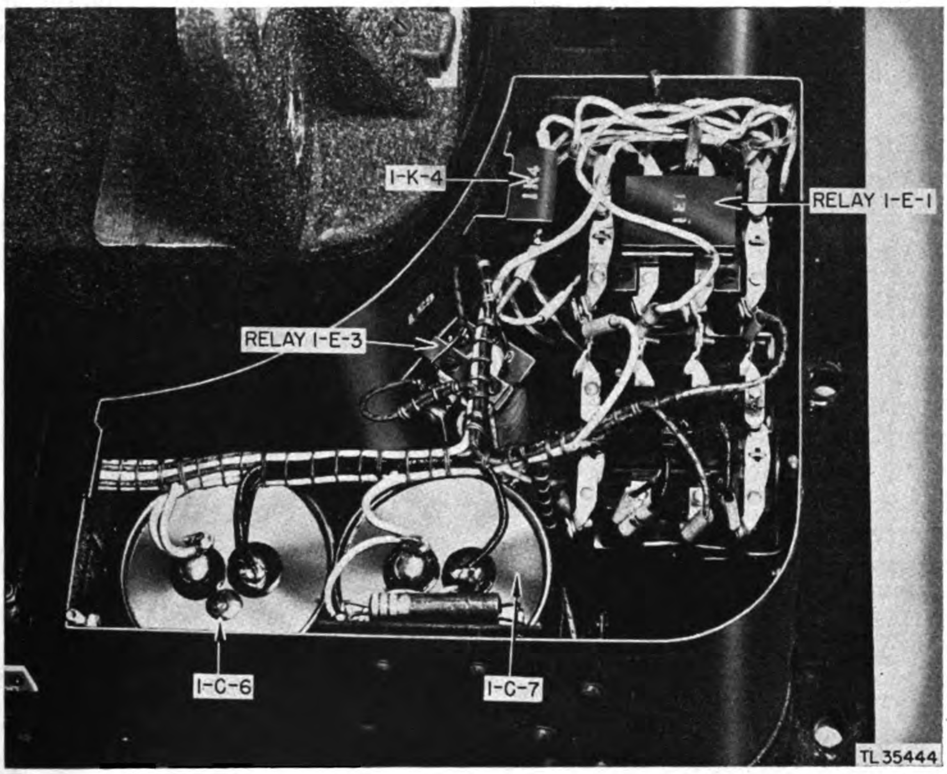


Figure 20. Pedestal FT–458–A, cover removed showing motor relays.

15. Spinner Drive Motor Control Circuits (figs. 19, 20, and 21)

a. Theory of Operation. Spinner drive motor 1–A–1 (fig. 10) supplies the mechanical power to rotate the antenna. It is a standard induction motor with starting capacitors (1–C–6 and 1–C–7) and a separate starting winding. Reversal of direction is obtained by changing the polarity of the voltage across the starting winding with respect to that across the running winding. Since operating characteristics of available motors with centrifugal starting switches are not suitable, use is made of relays 1–E–1 and 1–E–2 for connecting and disconnecting the starting winding at the proper time.

(1) Rapid reversal of the motor is obtained by using the starting winding as a brake. When the controlling switch is reversed, the relays connect the starting winding in opposite phase so that it bucks the field of the running winding, thus bringing the motor to a quick stop and then starting it in the reverse direction.

(2) The possibility that an operator might interrupt the power and then reapply it so as to attempt to continue rotation in the same direction makes a sensing system necessary. After a momentary interruption of power, if it is desired to continue rotation in the same direction, the relays should not connect the starting winding. On the other hand, if a reversal of direction is desired, the starting winding should be connected as a brake, and then as a mechanism for starting in the desired direction.

(3) The starting winding itself is used to furnish the information as to whether or not a reversal is wanted. When the motor is running, there appears across the starting winding a potential of about 265 volts induced from the running winding. If external power is applied so as to continue rotation in the same direction, the induced voltage and the applied voltage add almost in phase, producing across the starting winding a voltage of about 360 volts. If power is applied so as to reverse direction, the induced voltage and the applied voltage are in opposite directions so that the voltage across the starting winding is about 150 volts.

(4) The coil of relay 1–E–3 is connected across the starting winding through a 12,000-ohm resistor (1–R–4). It is adjusted so that its contacts operate when the starting winding voltage is approximately 250 volts. The contacts on relay 1–E–3 close, energizing relay 1–E–2 which breaks the circuit supplying external power to the starting winding. Thus if, when the motor is coasting, power is applied so as to continue rotation in the same direction, relay 1–E–3 operates (360 volts across the starting winding) and disconnects the starting winding. If power is re-applied so as to reverse direction, the relay does not operate (only 150 volts across the starting winding); the starting winding remains connected and brakes the motor. Relay 1–E–3 must be very sensitive with a light movement and consequently with a low current-carrying capacity. Because of these characteristics, better results are obtained when relay 1–E–3 is used to actuate a second relay connected to the circuit carrying current to the starting winding.

b. Operation of Relays. Figure 19 is a simplified diagram of the spinner drive motor and relay control circuits. With no power applied to the motor, relay 1–E–3 is open and relay 1–E–2 is closed. One coil of the reversing relay 1–E–1

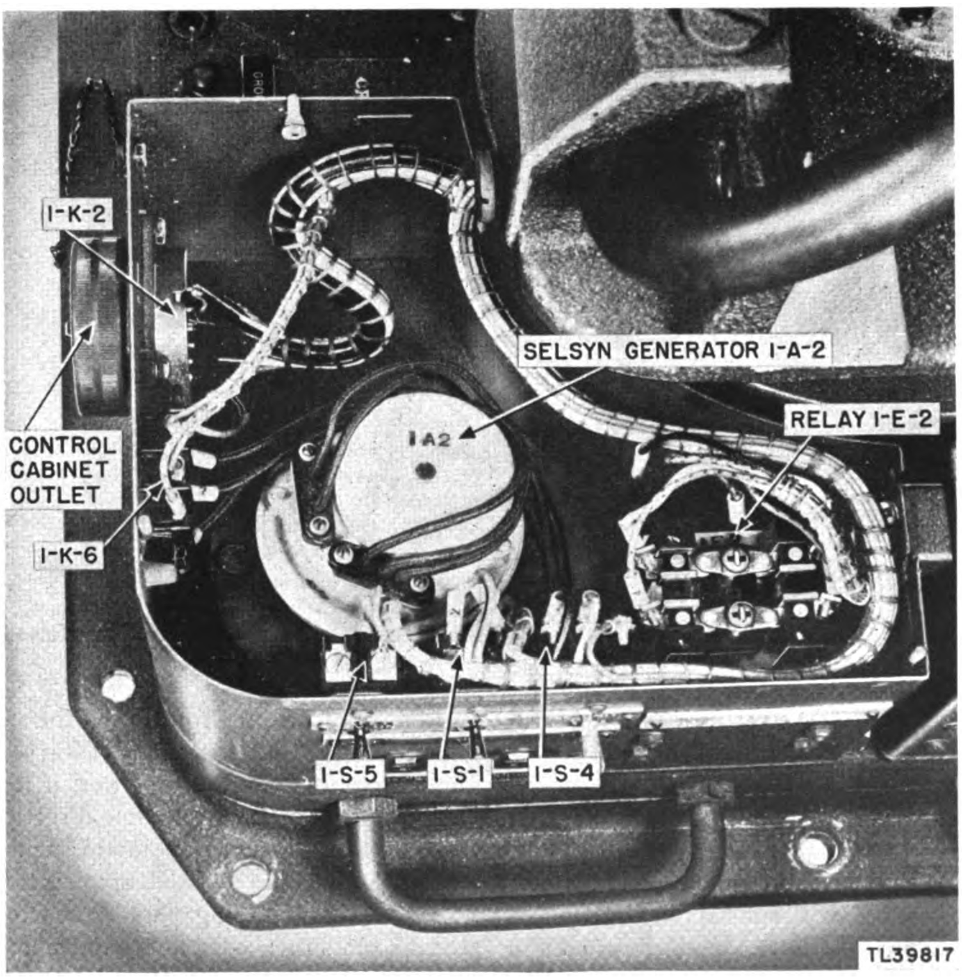


Figure 21. Pedestal FT–458–A, cover removed showing selsyn and relay.

(fig. 20) is operated by turning the SCAN switch to the proper position. This relay (1–E–1) is provided with a mechanical interlock which prevents the two sets of contacts from being closed at the same time.

(1) When power is first applied, both running and starting windings are energized (fig. 22) in the proper phase. As soon as the motor gets up to speed so that approximately 250 volts appear across the starting winding (sum of induced and applied voltages), relay 1–E–3 operates thus energizing relay 1–E–2. Contacts of relay 1–E–2 open, disconnecting the starting winding from the power source and connecting relay 1–E–3 across the power source (fig. 23). Relay 1–E–3 is thus held closed.

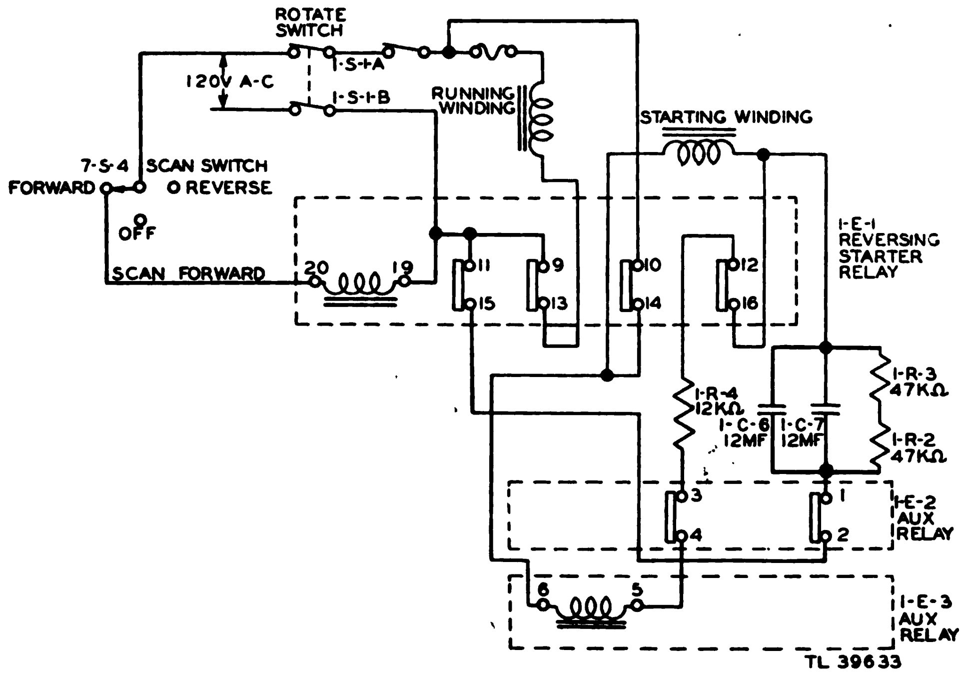


Figure 22. Spinner drive motor control circuit, position of relays, starting forward.

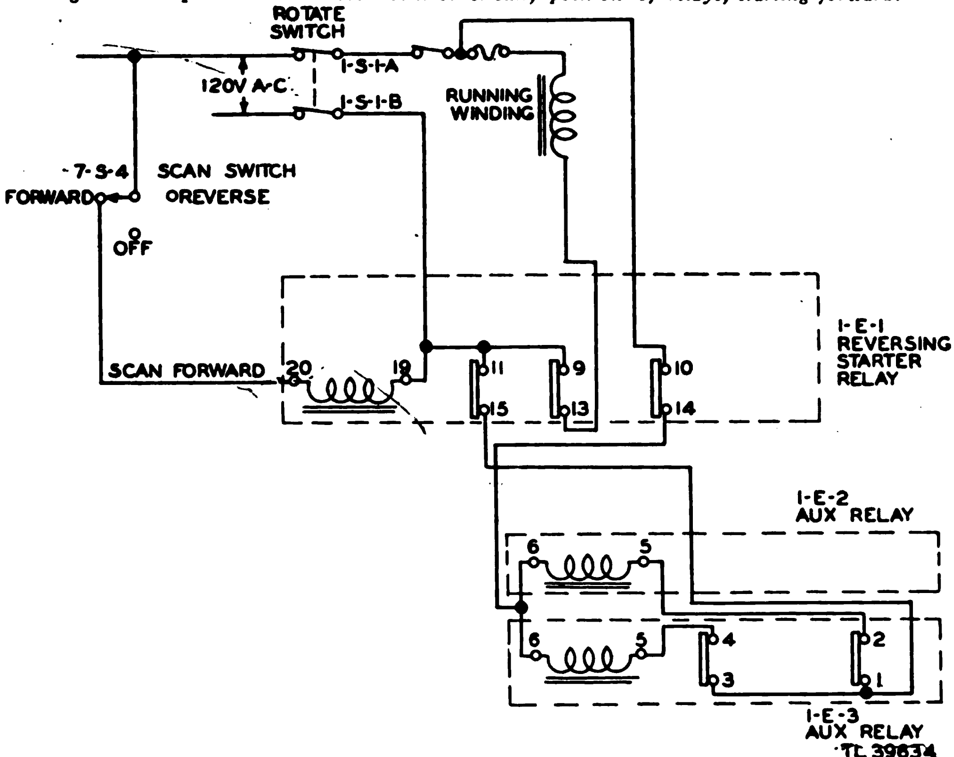


Figure 23. Spinner drive motor control circuit, position of relays, running forward.

(2) If power is removed and then re-applied in the same direction before the motor speed drops appreciably, enough voltage is still present across the starting winding to energize the relays and disconnect the starting winding.

(3) If power is re-applied in the opposite direction (fig. 24), the voltage across the starting winding is too low to operate relay 1–E–3, so the starting winding remains connected, acting first as a brake to stop the motor and then as a starting winding in the opposite direction (fig. 25). If a centrifugal switch were used to connect the start-

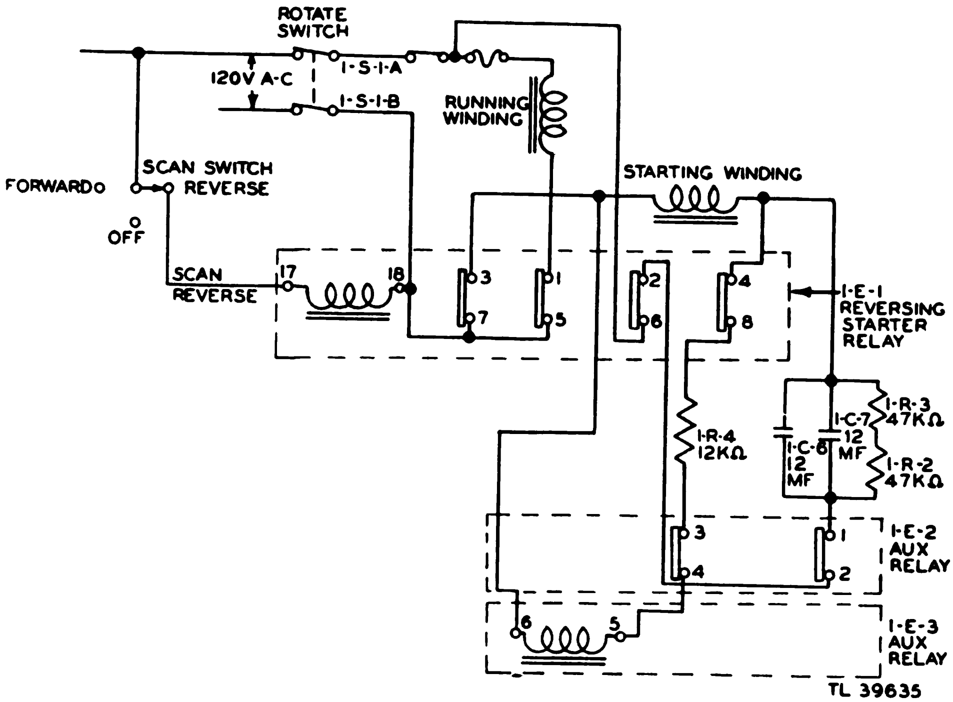


Figure 24. Spinner drive motor control circuit, position of relays, starting reverse.

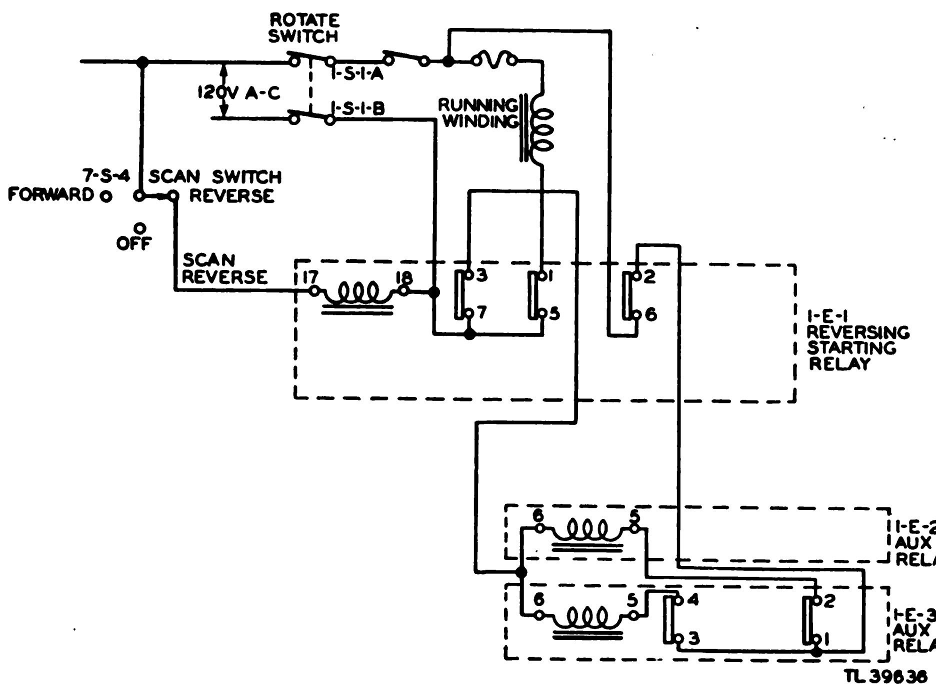


Figure 25. Spinner drive motor control circuit, position of relays, running reverse.

ing winding, the switch would not operate until the motor had coasted almost to a stop. The use of relays thus allows more rapid reversal of direction.

(4) With this arrangement, it is possible to switch from forward to reverse and back again to cause the spinner to scan back and forth over any desired sector. Sector scanning may cause the thermal overload relay to operate and shut off the power to the motor in as little as 30 seconds if ambient temperature is high. If the thermal overload relay kicks out, it will be necessary to wait a short time for the motor to cool off.

16. Selsyn Circuit

As explained in paragraph 13, the rotors of the selsyn motor 6–A–1 and selsyn generator 1–A–2 receive power from the regulated power source. The balance of the selsyn circuit is explained in section VIII of this chapter, Selsyn System. Figure 11 shows the selsyn circuit.

17. Fuses

a. Fuses 9–F–1 to 9–F–6 inclusive are located inside Indicator Unit BC–1225–A. Access to these fuses may be had by removing the operating shelf and swinging forward the indicator unit.

b. Fuses 9–F–1 and 9–F–2 carry the regulated a-c line voltage for Pedestal FT–458–A and Radio Frequency Unit BC–1224–A. If replacement of these fuses is necessary, use only a 5-ampere fusetron. A fusetron differs from an ordinary cartridge-type fuse in that it will carry high momentary currents without blowing. It is used where the normal running current is low and the starting current high.

c. Fuses 9–F–3 and 9–F–4 carry the unregulated line voltage for the convenience outlet 1–K–3 and the drive motor, blowers, and relays on Pedestal FT–458–A. For replacement, use 15-ampere superlay or equivalent.

18. Time Delay Relay (figs. 26 and 27)

When the line switch on the modulator is turned to the ON position, 120 volts a-c is put across the coil of the magnet of the time delay relay 3–E–4. The alternating magnetic field causes the large induction disk at the front of the relay to rotate in the same manner as a watt-hour meter disk. The armature pulls toward the core, engaging the drive pinion with a gear of the timing mechanism. The timing mechanism consists of three gears and pinions which are driven by the rotation of the induction disk. It takes approximately 45 seconds for the timing mechanism to rotate the slowest moving gear so that the insulated pin closes the contacts of the relay. The closing of these contact points completes the a-c path across the 120-volt line and causes the amber MODULATOR READY lamp to light, indicating that high voltage will be available if the RADIATE ON button is pressed. The contact points are held closed by the torque on the induction disk. When the LINE SWITCH is turned to the OFF position, power is removed from the relay coil, the drive pinion is released with the collapsing of the magnetic field, and the timing mechanism is forced to rotate back to its starting position by the spring on the shaft of the slowest moving gear.

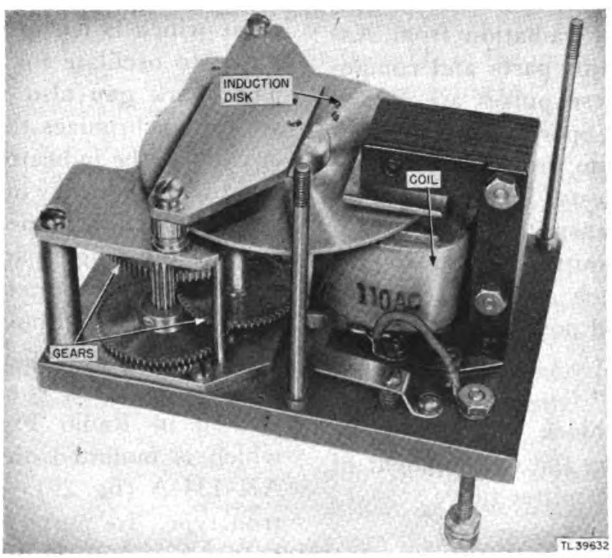


Figure 26. Time delay relay, cover removed.

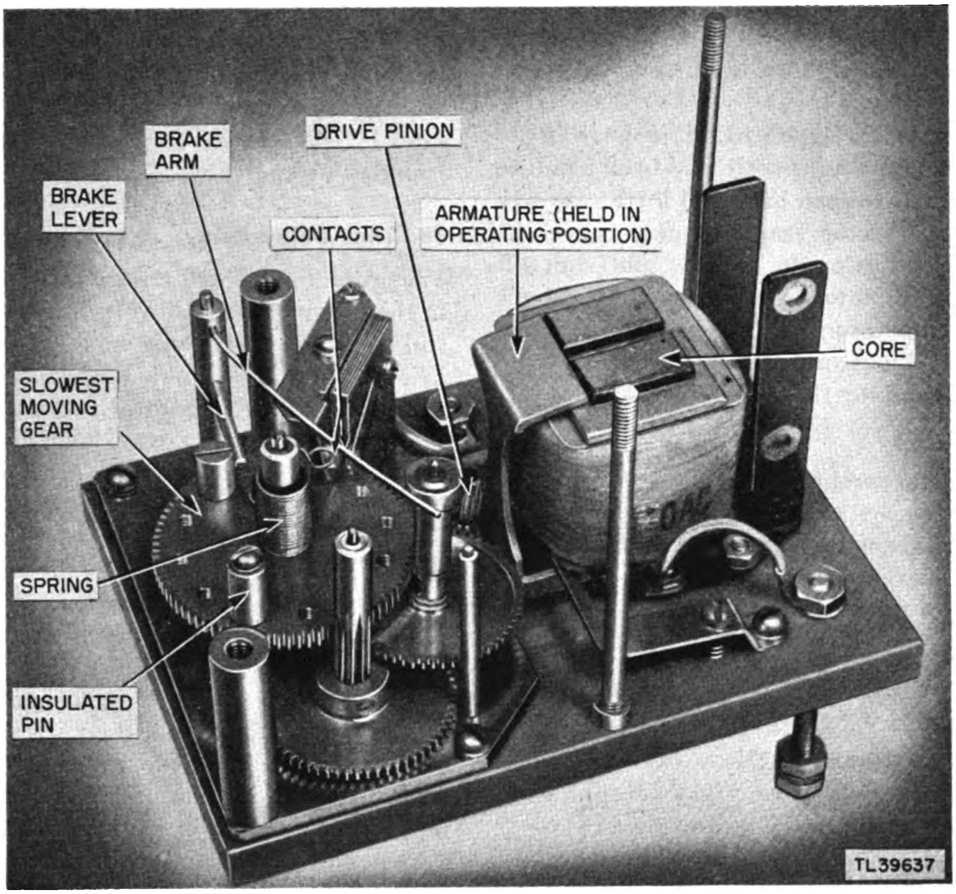


Figure 27. Time delay relay, disassembled to show moving parts.

Section III. TRANSMITTER SYSTEM

19. Introduction

The purpose of the transmitter system is to generate microwave pulses for radiation from Antenna AN–134–A. The major parts and components used to generate these pulses are Power Supply Unit RA–101–A, Spark Gap GA–9–A (Rotary), Cord CD–944 from the modulator unit to the rotating joint of Pedestal FT–458–A, pulse transformer 1–T–2, and transmitter tube 1–V–1. Also included in the transmitter system are the necessary smaller parts such as connectors, capacitors, relays, meters, and power transformers.

20. Simplified Block Diagram

Figure 28 is a simplified block diagram of the transmitter system, showing the development of the keying pulse to the transmitter tube.

a. Spark Gap GA–9–A (Rotary). Spark Gap GA–9–A (Rotary) is located in the center compartment of the modulator unit as shown in figure 12. The spark gap provides the short high-voltage pulse which is fed to the transmitter tube, causing it to oscillate for the duration of the pulse. The spark gap also supplies the trigger pulse which synchronizes the sweep and range marker circuits of the indicator control unit at the pulse-repetition frequency of the transmitter tube. This synchronization is necessary to enable the circuits in the range marker system to measure accurately the time interval between the generation of the transmitted pulse and the reception of the echo from the target.

b. Transmitter Tube. The transmitter tube is located in Radio Frequency Unit BC–1224–A which is mounted on the back of the Antenna AN–134–A (fig. 29). This tube is of the magnetron type. Its purpose is to generate r-f oscillations when the pulse from the spark gap is applied to its cathode.

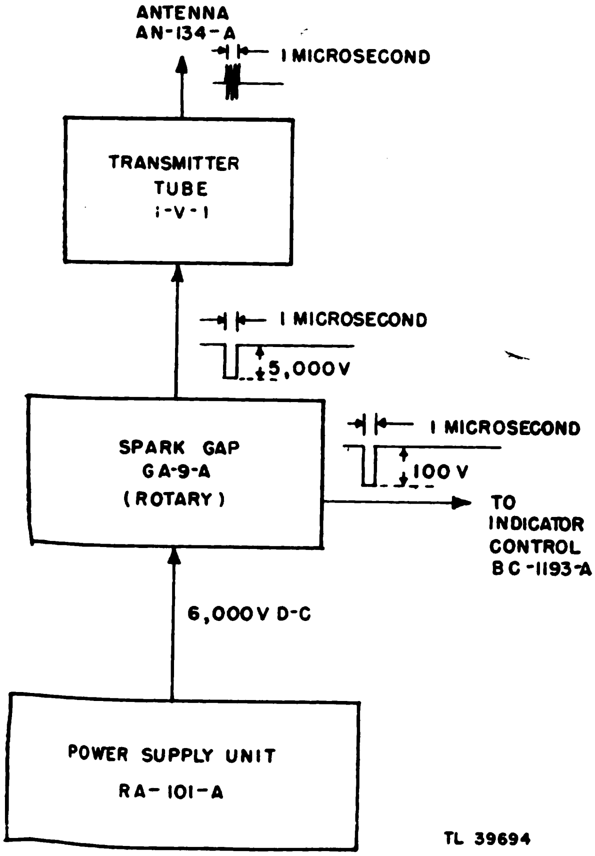


Figure 28. Transmitter system, simplified block diagram

c. Power Supply Unit RA–101–A. Power Supply Unit RA–101–A is located in the bottom cabinet of the modulator unit shown in figure 12. The power supply unit provides the high voltage for the operation of the spark gap. Doors are located in the spark-gap and power-supply cabinets to provide access to the parts inside these cabinets.

d. Controls and Meters. The powerstat 3–T–2, which controls the high-voltage output of the rectifier, and meter 3–M–1, which measures the amount of rectifier current to the transmitter system and the amount of transmitter tube current, are located on Control Panel BD–130–A as shown in figure 12. The meter is connected so that it normally indicates the amount of transmitter tube current. When the push-button switch 3–S–8 is pushed, the meter indicates the amount of rectifier current.

21. Complete Block Diagram

Figure 30 is the complete block diagram of the transmitter system, showing the circuits in greater detail than in figure 28. In the remainder of the paragraph the purpose, input, and output of each of the circuit groups shown in the block diagram will be discussed.

a. Spark Gap GA–9–A (Rotary) (fig. 31). The various circuits contained in the spark-gap cabinet are designed to form a short, negative, high-voltage pulse. The pulse has a duration of approximately 1 microsecond and a magnitude of approximately —5,000 volts.

(1) *D-c resonant choke.* The input to the d-c resonant choke is the 6,000-volt output of the high-voltage rectifier, and the output is a voltage that varies between zero and 12,000 volts as shown in figure 30. It is used to double the voltage output of the high-voltage rectifier.

(2) *Rotary spark gap.* The rotary spark gap is connected between ground and the point where the output of the d-c resonant choke is connected to the input of the pulse-forming line. Just as the voltage on the ungrounded side of the spark gap reaches its maximum value the rotary spark gap effectively grounds the input to the pulse-forming line.

(3) *Pulse-forming line.* The pulse-forming line has as its input the voltage wave developed by the d-c resonant choke and rotary spark gap. The abrupt change in voltage at one end of the line causes it to form the short negative pulse shown in figure 30. The output of the pulse-forming line is carried to the pulse transformer by the pulse cable. This cable is of a special design that will attenuate the pulse very little. Figures 32 and 33 show the connections of the pulse cable to the modulator unit and the pedestal base respectively.

b. Pulse Transformer. The pulse transformer performs the dual function of matching the impedance of the pulse cable to the impedance of the transmitting tube and increasing the magnitude of the voltage pulse to approximately 20,000 volts. It also makes it possible to operate the filament transformer for the transmitter tube near ground potential.

c. Transmitter Tube. The 20,000-volt pulse from the pulse transformer is applied to the cathode of the transmitter tube (fig. 30) and causes it to oscillate for the duration of the pulse. These r-f pulses are fed to the antenna.

d. Power Supply Unit RA-101-A. The high-voltage power supply (fig. 34) operates from the 120-volt, 60-cycle power supply and has a voltage output of approximately 6,000 volts d-c.

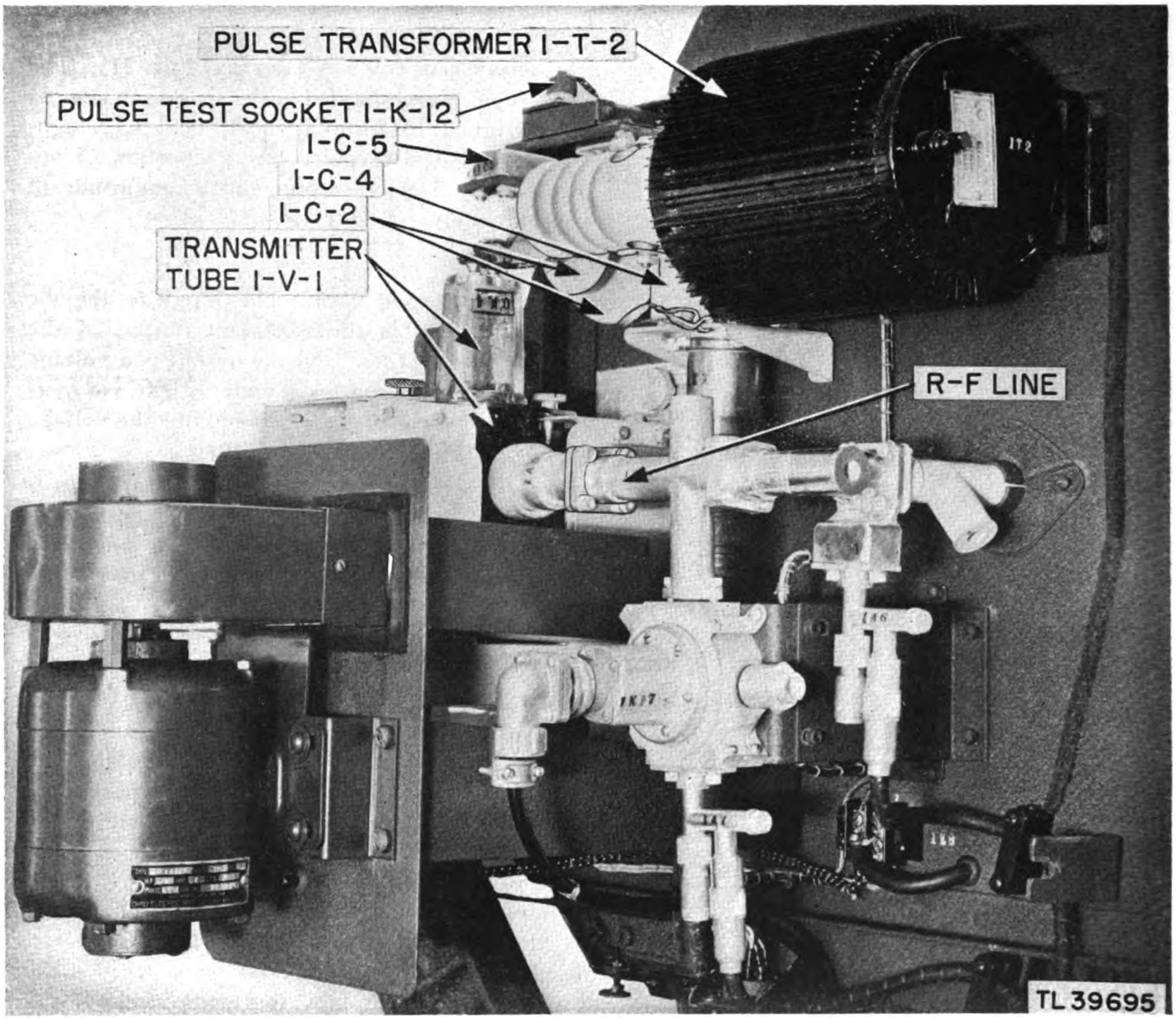


Figure 29. Radio Frequency Unit BC-1224-A, transmitter system parts.

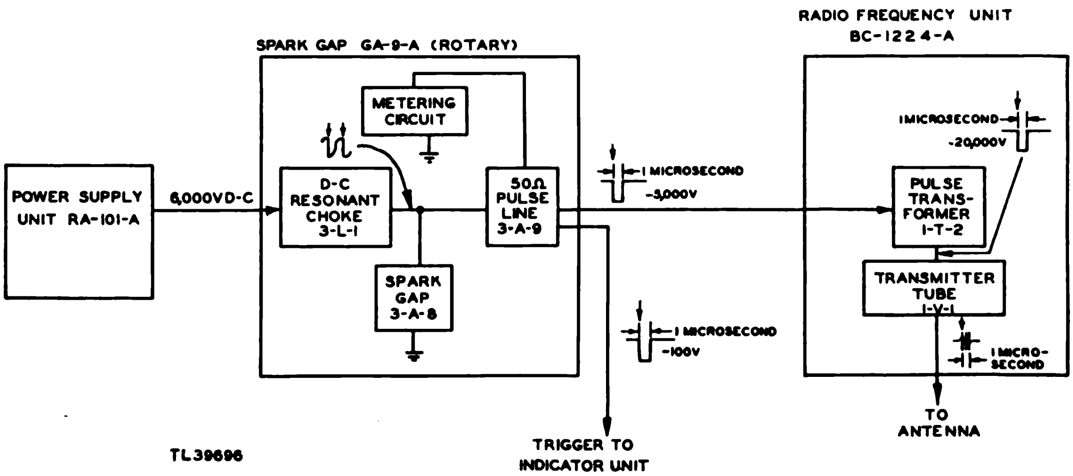


Figure 30. Transmitter system, complete block diagram.

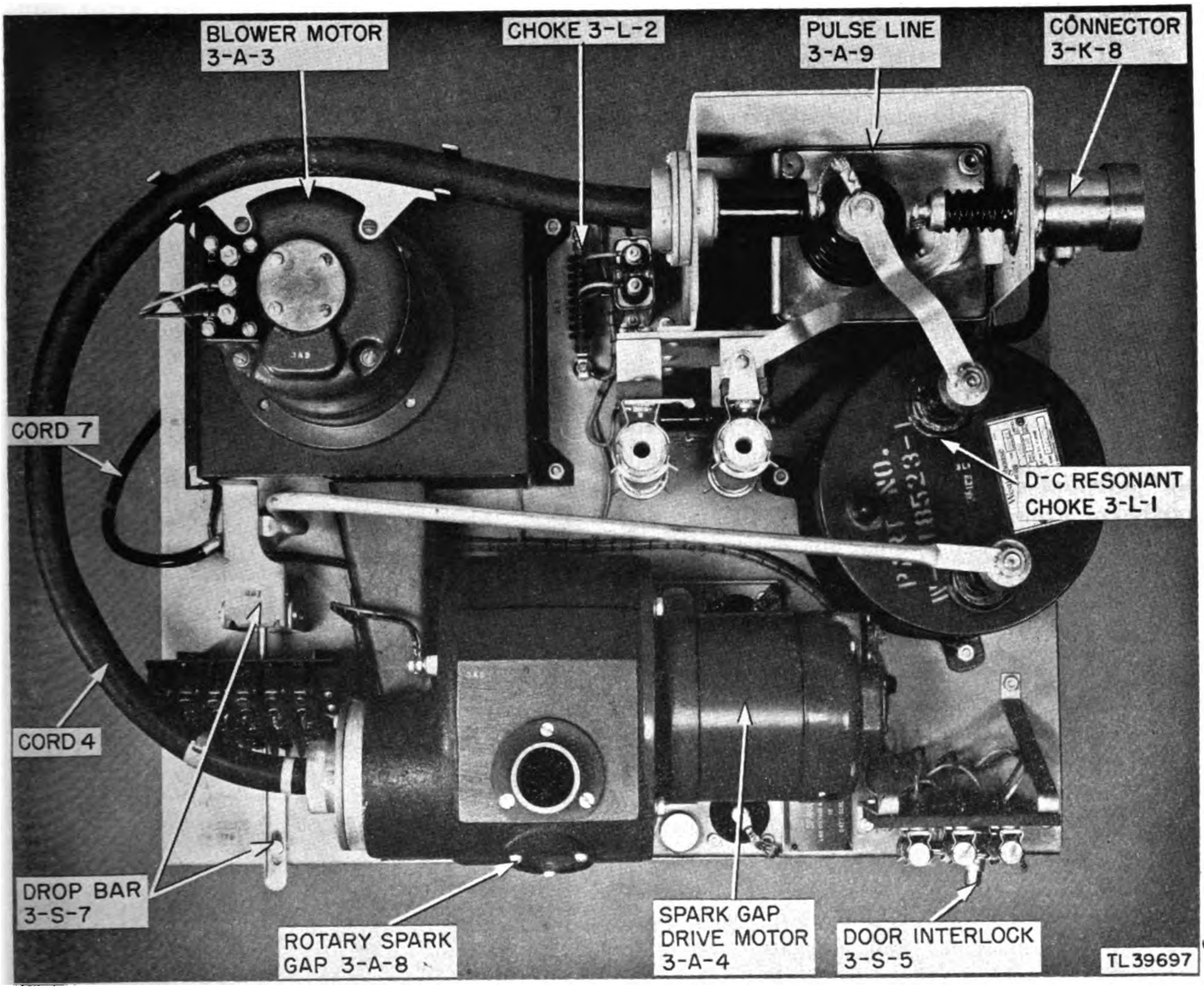


Figure 31. Spark Gap GA-9-A (Rotary), top view of chassis.

22. Circuit Details

a. Simplified Charging And Discharging Circuits. Figure 35① shows a simplified charging and discharging circuit which is the equivalent of the actual circuit used in the unit. This circuit is used for the purpose of explaining the action of the unit. The pulse-forming line 3–A–9 (fig. 31) is shown as a simple capacitance, since this is its external appearance as far as the charging and discharging circuit is concerned.

(1) *Charging of pulse-forming line.* At the start of the charging cycle, point Ⓐ is at a potential of + 6,000 volts, and points Ⓑ and Ⓒ are at ground potential. The difference in potential across the d-c resonant choke 3–L–1 (fig. 31) will cause a large current to flow into the pulse-forming line. The complete charging path is from ground through capacitor 1–C–4 (fig. 29), the pulse transformer, the pulse-forming line, the d-c resonant choke, and back through the power supply to ground. Some charging current will also flow up through the metering circuit. These charging paths are shown by the arrows in figure 35②. When the voltage at Ⓑ has been raised to 6,000 volts there no longer will be any difference of potential across the choke, but the inertia effect of the choke will cause the current to continue to flow until the potential at Ⓑ has been raised as far above the potential at Ⓐ as it originally was below it (fig. 36). Since the potential at Ⓑ was originally 6,000 volts below the potential at Ⓐ, the voltage at Ⓑ will now be 6,000 volts above that at Ⓐ, or 12,000 volts.

(2) *Discharging of pulse-forming line.* Figure 36 shows that as soon as the voltage at the input of the pulse-forming line reaches its maximum

value the spark gap (fig. 31) fires, lowering the input of the pulse-forming line to ground potential. While the recurrence frequency of a rotary spark gap is relatively unstable, an average value may be used for computation. The rotary gap contains seven electrodes, and the speed of the drive motor is 3,450 rpm; therefore the average recurrence frequency is 402.5 cycles per second. In order to complete its charging cycle between pulses, the resonant frequency of the charging circuit must be very close to 200 cycles per second. When the spark gap arcs to ground, the potential at Ⓑ is quickly lowered to very close to ground potential. Since the voltage across the pulse-forming line cannot change immediately, the potential at point Ⓒ is lowered to a value far below ground potential. If the pulse-forming line were a pure capacitance, the potential at Ⓒ would be lowered to —12,000 volts. However, the internal construction of the line is such that the voltage at point Ⓒ is dropped to —5,000 volts. The action of the pulse-forming line is discussed in more detail later in this paragraph. Pulse transformer 1–T–2 is an autotransformer having a voltage ratio of approximately 4 to 1. Therefore, when the potential at Ⓒ is lowered to —5,000 volts, the potential at Ⓓ is lowered to approximately —20,000 volts. This causes the transmitter tube to conduct. The discharge path of the pulse-forming line is down through the pulse transformer and capacitor 1–C–4 to ground, and back up from ground through the spark gap to the other side of the pulse-forming line. There is also another path through the upper part of the pulse transformer and the transmitter tube to ground. The discharge paths are shown by the arrows in figure 35③. The discharge of the pulse-forming line through capacitor 1–C–4 places a small voltage across the capacitor that is removed by the current flow during the charging cycle of the pulse-forming line.

(3) *Summary of charging and discharging of pulse-forming line.* In (1) and (2) above the discussion was based on consideration of the current flow in each part of the circuit during, first, the charging and then the discharging of the pulse-forming line. Considering these flows of current from the viewpoint of a full operating cycle, there are two types of current flow. There is the a-c flow through the lower part of the pulse transformer and capacitor 1–C–4 and the d-c flow through the upper half of the pulse transformer, the trans-

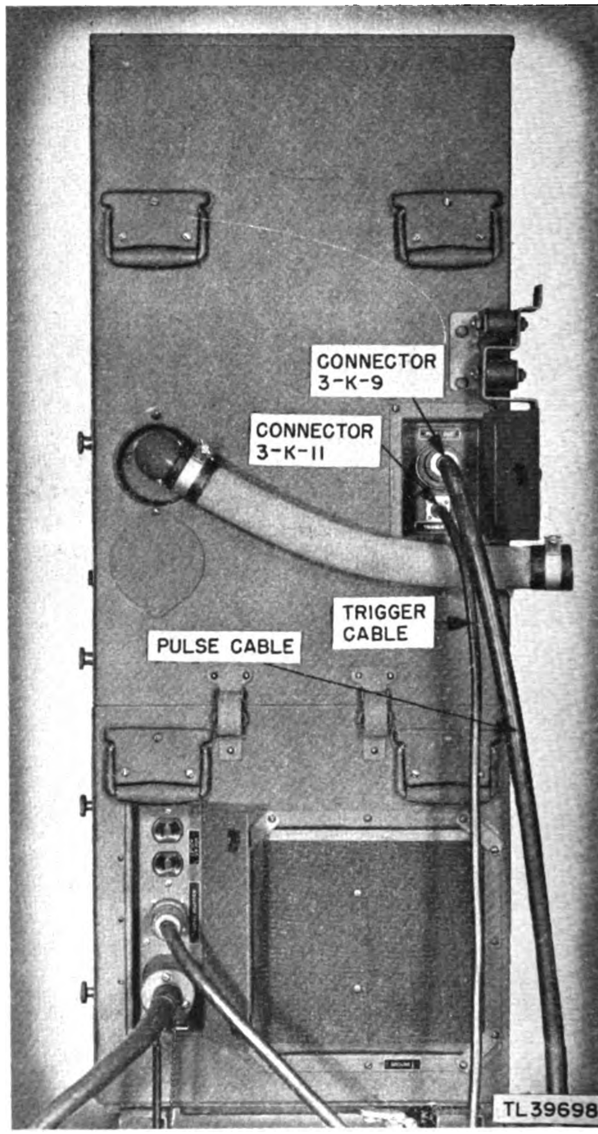


Figure 32. Modulator Unit BC–1194–A, side view.

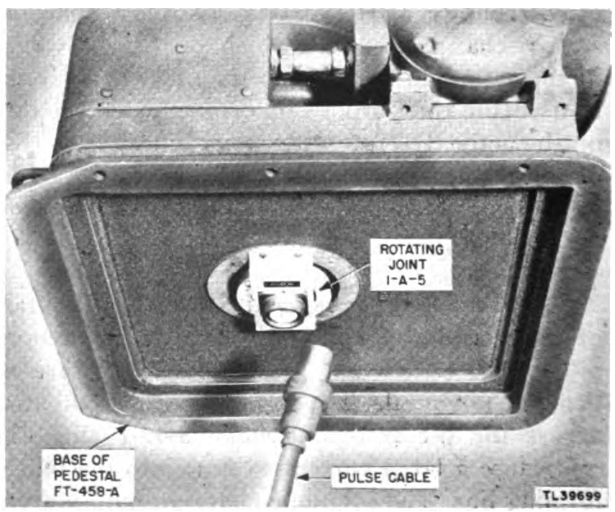


Figure 33. Pedestal FT–458–A, connection of pulse cable Cord CD–944.

mitter tube, and the metering circuit. The a-c flow is so called because the current flow in one direction during the charging portion of the cycle is equal to the current flow in the other direction during the discharge portion of the cycle. The d-c flow results from the fact that the magnetron will pass current in one direction only. In order to recharge the pulse-forming line to the voltage which existed across it before the pulse, as much current must flow back to © during the charging portion of the cycle as flowed away from © through the transmitter tube during the discharge cycle. The only path which can pass this d-c flow is the metering circuit. The metering circuit therefore has an average value of current through it which is equal to the average current through the transmitter tube. When the meter switch 3–S–8 is in the position shown in figure 35, the meter will indicate the transmitter tube current.

b. Pulse-forming Line. The circuit of the pulse-forming line is shown in the simplified schematic of the transmitter system (fig. 37). The line is made up of several tuned circuits. These circuits are tuned to frequencies such that, when their output is added, the output of the line as a whole is a reasonably square, negative pulse. When the spark gap fires it effectively grounds the input side of the pulse-forming line. This action suddenly lowers the voltage applied to the input of the pulse-forming line by 12,000 volts. The sudden change in voltage causes the various tuned circuits within the pulse-forming line to start oscillating, and the square negative pulse of voltage is formed. This voltage pulse lasts for approximately 1 microsecond and has an amplitude of approximately —5,000 volts. The pulse is applied to the pulse transformer through the pulse cable, Cord CD–944.

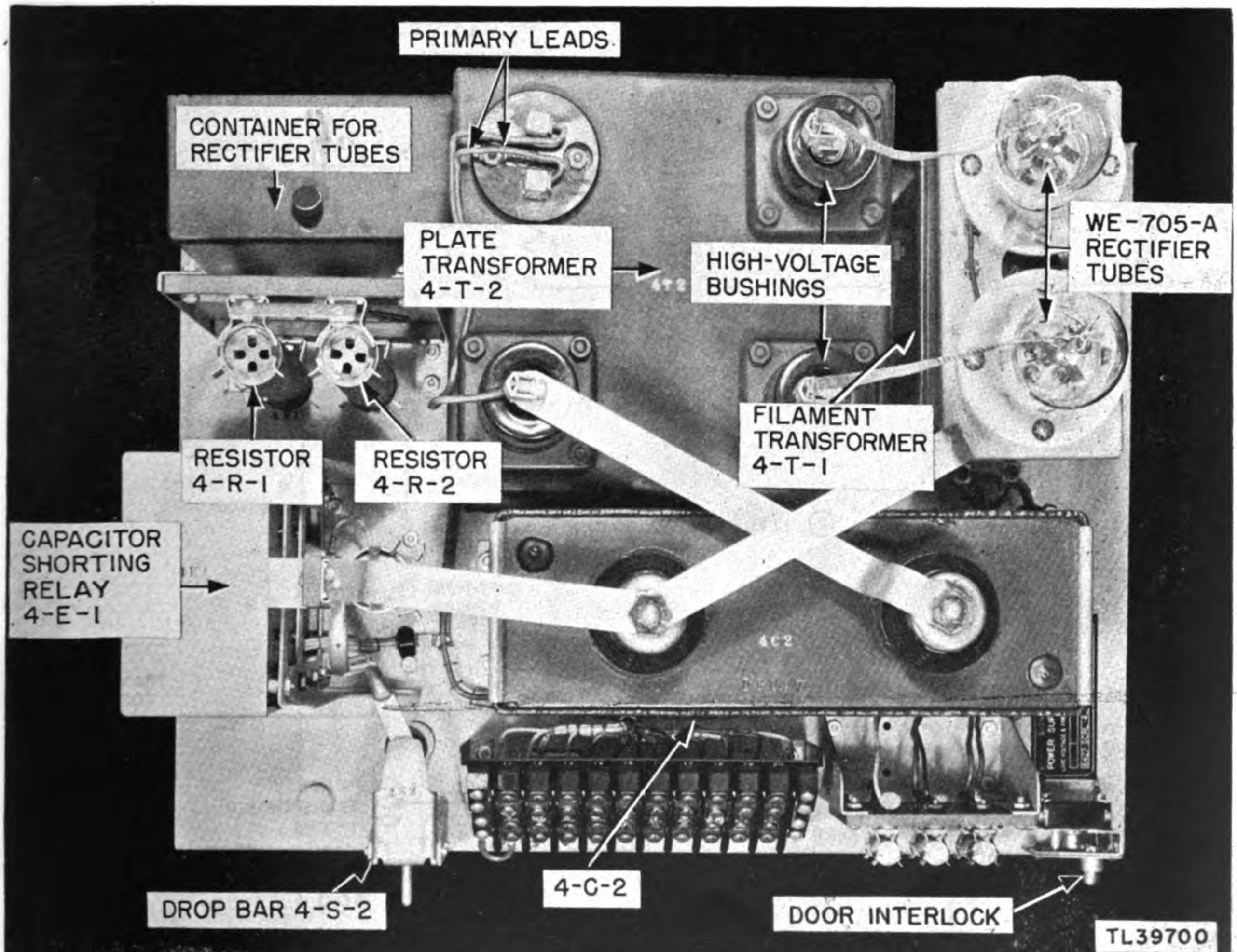


Figure 34. Power Supply Unit RA–101–A, top view.

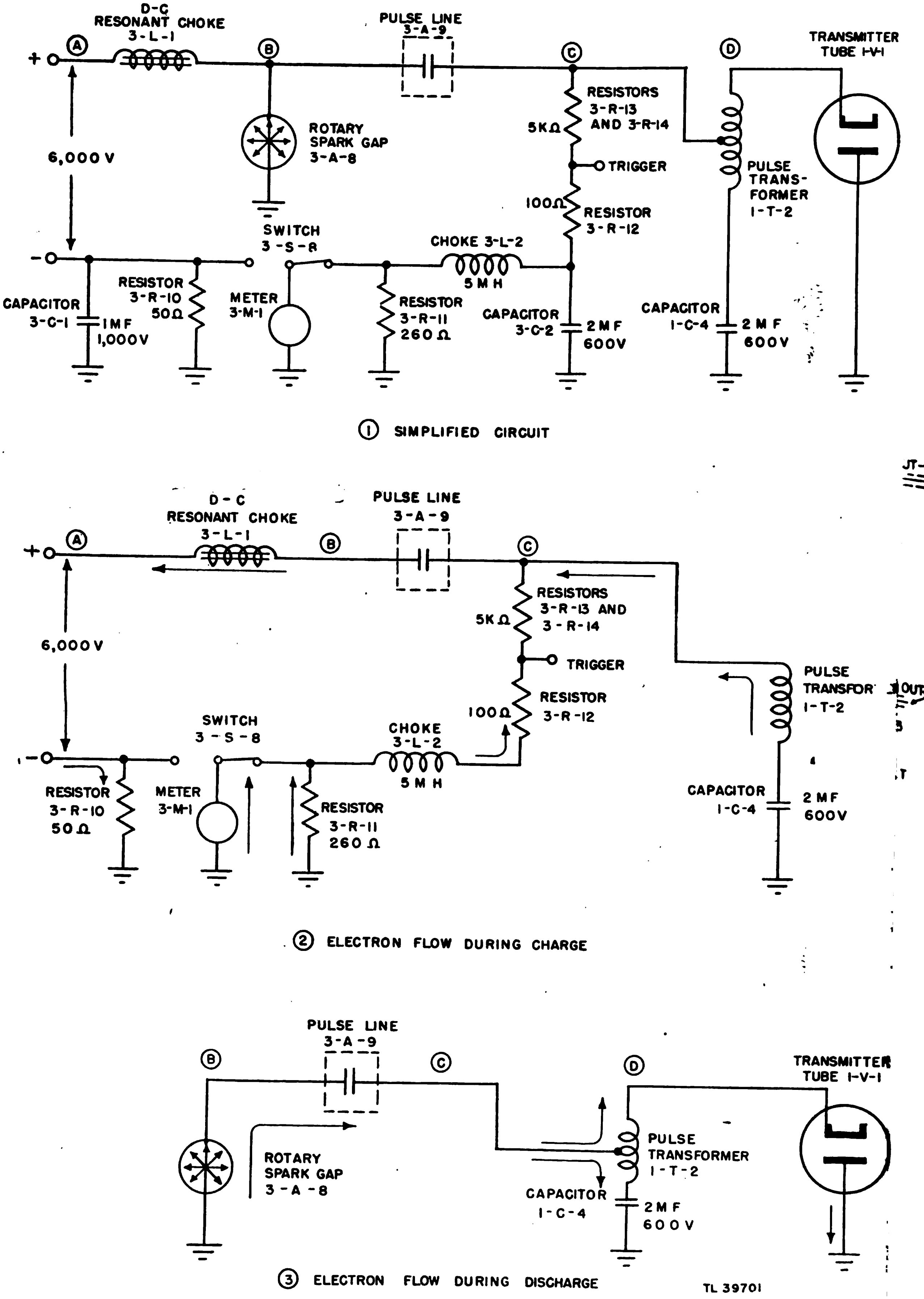
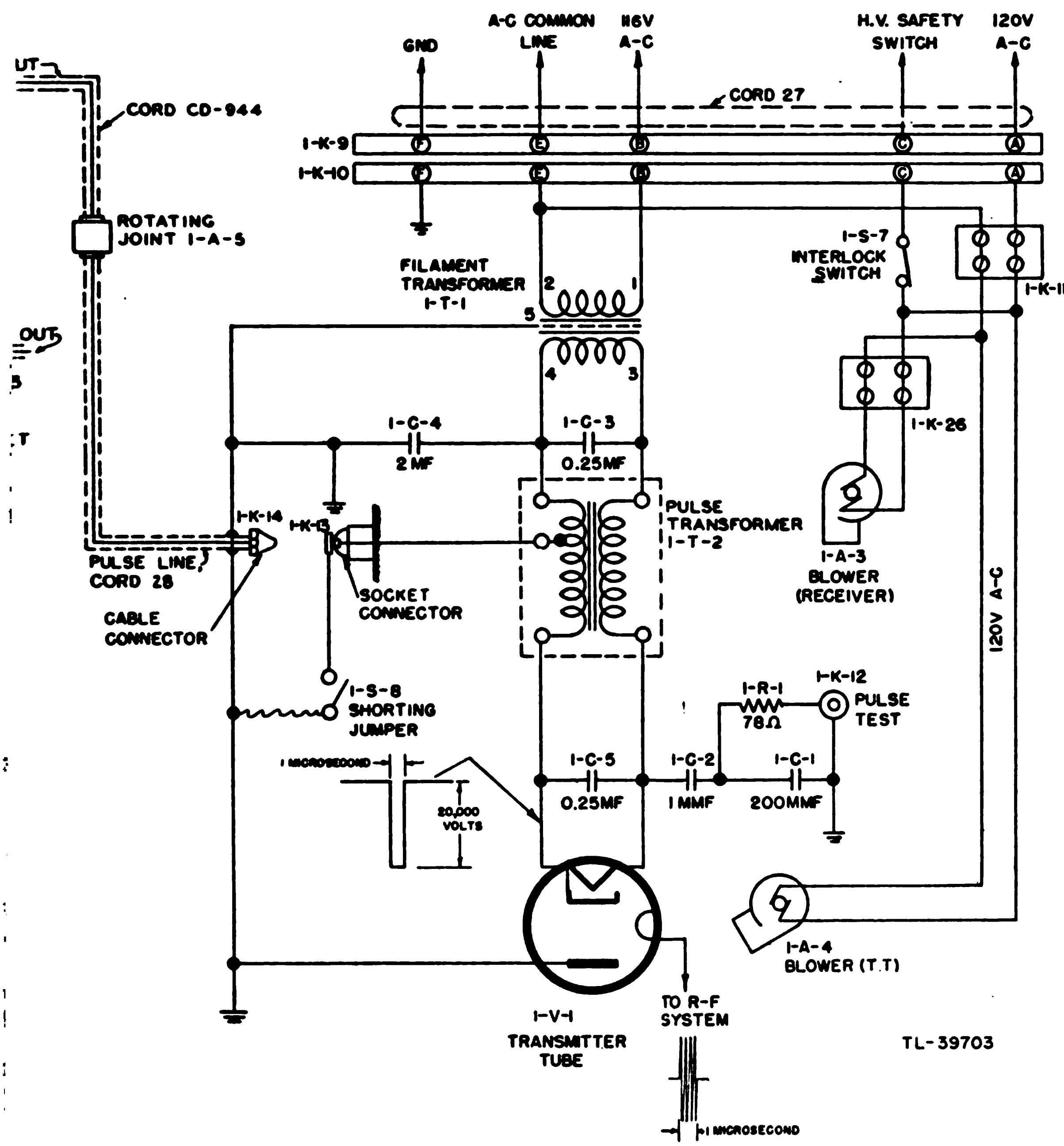


Figure 35. Transmitter system, simplified charging and discharging circuits.


GND
A-C COMMON LINE
116V A-C
H.V. SAFETY SWITCH
120V A-C
CORD 27
CORD CD-944
1-K-9
1-K-10
ROTATING JOINT 1-A-5
1-S-7 INTERLOCK SWITCH
1-K-11
FILAMENT TRANSFORMER 1-T-1
1-K-26
1-C-4
2 MF
1-C-3
0.25MF
PULSE TRANSFORMER 1-T-2
1-A-3 BLOWER (RECEIVER)
1-K-14
1-K-13
PULSE LINE, CORD 28
SOCKET CONNECTOR
CABLE CONNECTOR
120V A-C
1-S-8 SHORTING JUMPER
1-R-1
78Ω
1-K-12
PULSE TEST
1 MICROSECOND
20,000 VOLTS
1-C-5
0.25MF
1-C-2
1 MMF
1-C-1
200MMF
1-A-4 BLOWER (T.T)
1-V-1 TRANSMITTER TUBE
TO R-F SYSTEM
TL-39703
1 MICROSECOND

c. TRIGGER OUTPUT. The circuit from the output of the pulse-forming line to ground (fig. 37) has a voltage divider composed of 3–R–12, 3–R–13, and 3–R–14. The trigger for the indicator control circuits is taken off this voltage divider between 3–R–12 and 3–R–13. The trigger is a negative pulse of approximately 100 volts amplitude.

d. PULSE TRANSFORMER. The pulse transformer (fig. 37) is wound with two secondaries, each producing the same pulse voltage and connected in the same polarity. The two secondary windings also furnish the a-c path between the filament transformer 1–T–1 and the filament of the transmitting tube. Two 0.25-microfarad (mf) bypass capacitors 1–C–3 and 1–C–5 connect the two secondaries at each end of the transformer, preventing pulse voltage from appearing across the transmitter tube filament and secondary of the filament transformer. The 5,000-volt pulse on the primary of the transformer is amplified to approximately 20,000 volts on the secondary by the 1-to-4 turns ratio of the transformer. Figure 38 shows the pulse which is applied to the cathode of the transmitter tube. The characteristic impedance of the pulse cable is 50 ohms. The input impedence of the transmitter tube is 800 ohms. Since a transformer with a 1-to-4 turns ratio gives an impedance transformation of 1 to 16, the pulse transformer matches the characteristic impedance of the line to the input impedance of the transmitter tube.

e. TRANSMITTER TUBE. A diagram of the equivalent circuit of the transmitter tube 1–V–1 is shown in figure 39; its physical location in the r-f unit is illustrated in figure 29. Because a magnetic field is required for oscillations to take place, this type of tube is commonly called a ***magnetron***.

Note. The stability of operation of the magnetron depends on the field strength of the magnet. It is important, therefore, that the field strength not be reduced by touching the magnet with any magnetic material or by dropping or jarring the magnet.

The essential parts of the magnetron are shown in figure 39. A copper shell forms the outside of the tube. The plate of the magnetron is connected to this shell which is grounded. The cathode of the tube is indirectly heated and connected to one side of the heater. A built-in tuned circuit determines the frequency of oscillation. No adjustment is provided; to shift the frequency a new magnetron must be installed. Seven magnetrons are supplied with the equipment. The output is taken through a pick-up loop which is inductively coupled to the tuned circuit inside the magnetron. The pick-up loop connects to the inner conductor of the r-f transmission line (fig. 29) which feeds the r-f output to the antenna.

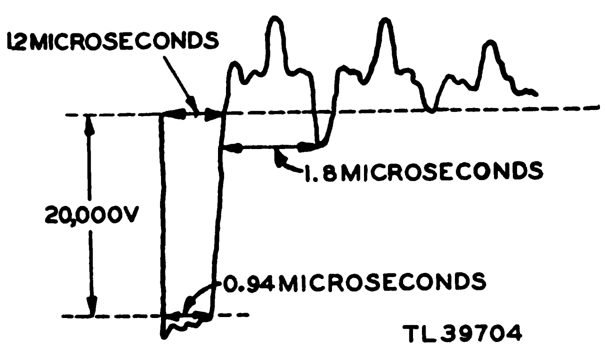


Figure 38. Waveform of pulse input to transmitter tube.

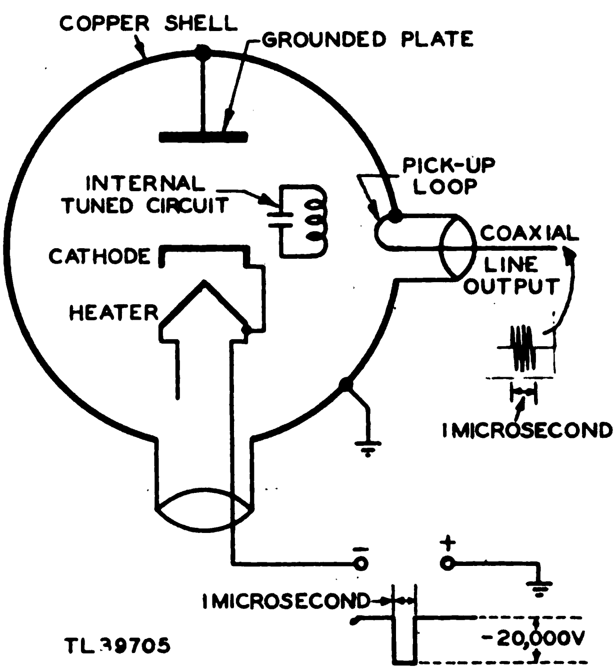


Figure 39. Transmitter tube, simplified equivalent circuit.

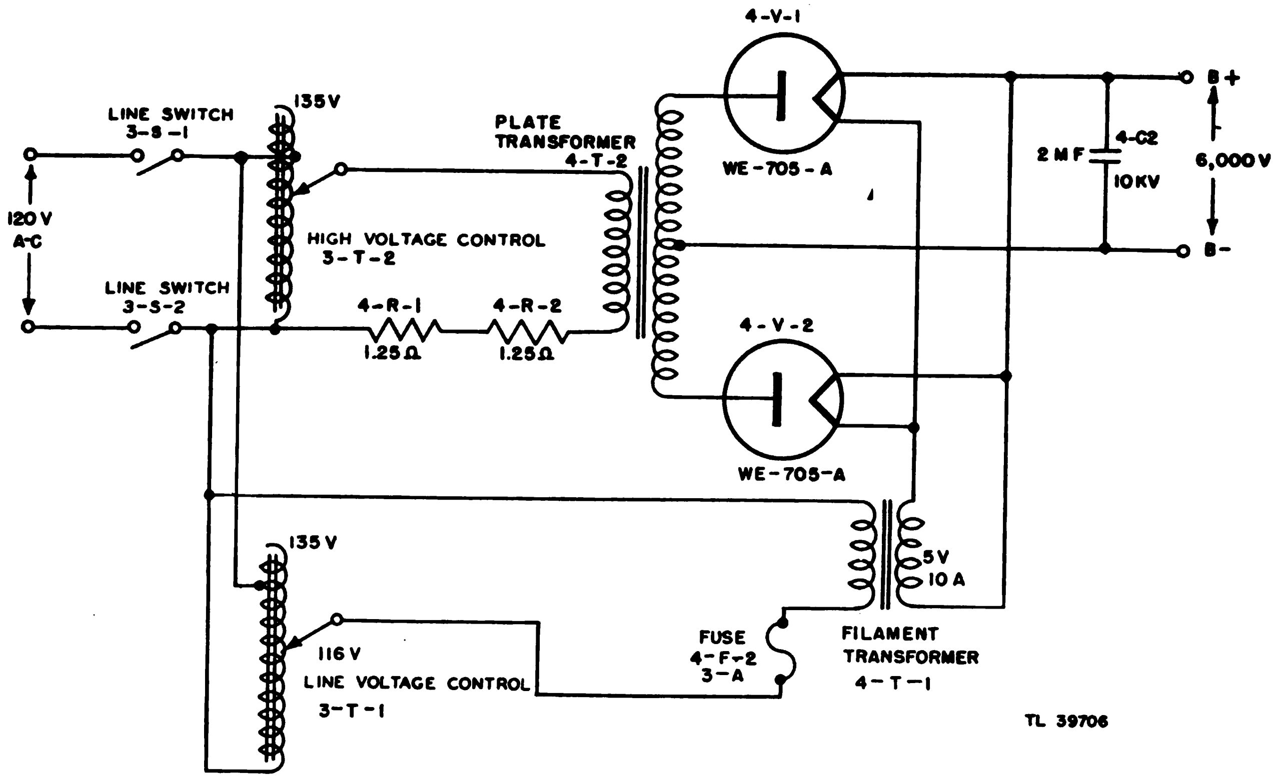


Figure 40. Power Supply Unit RA–101–A, simplified schematic diagram.

(1) *Operation of magnetron.* The complete theory of operation of the magnetron is beyond the scope of this manual. The elementary facts, however, are as follows: when a magnetic field of the proper strength is supplied (the tube is mounted between the pole faces of a permanent magnet) and the cathode of the tube is made sufficiently negative with respect to the plate (ground), the tube will oscillate at a frequency which depends upon the internal construction of the tube. No external tuning circuits are required. Note that making the cathode sufficiently negative permits electrons to flow between the cathode and plate. The magnetron is capable of operating in a number of different modes. In order that the magnetron may operate in an efficient and stable mode, a peak pulse voltage of the required value must be applied by the modulator to the cathode of the magnetron. This pulse is the 20,000-volt negative pulse applied to the cathode of the magnetron by the pulse transformer. As long as this voltage is applied to the cathode of the magnetron, it will oscillate. Since the duration of the pulse is approximately 1 microsecond, the magnetron generates r-f oscillations for this length of time out of each cycle.

(2) *Power output.* Although the magnetron is very small, it is capable of a peak power output of approximately 225 kilowatts. The current which flows while the magnetron is oscillating is approximately 25 amperes. The average current drawn by the magnetron is only about 10 milliamperes, as the magnetron draws current for only 1 microsecond out of each 2,500 microseconds.

f. Pulse Test Socket. The waveform of the pulse (fig. 38) applied to the cathode of the transmitter tube may be viewed by connecting the output of PULSE TEST socket 1–K–12 (fig. 29) to an oscilloscope. The 20,000-volt pulse is reduced in amplitude by the capacitor voltage divider composed of 1–C–1, 1–C–2, and 1–R–1. Since 1–C–1 is 200 mmf and 1–C–2 is 1 mmf, only a small fraction of the pulse voltage will appear across 1–C–1.

g. Power Supply Unit RA–101–A. The high-voltage rectifier (fig. 34), a simplified schematic of which is shown in figure 40, furnishes the power to the transmitting system for the operation of the transmitter oscillator tube. The output of this rectifier is normally about 6,000 volts at 50 milliamperes (ma). The input is single-phase power at 120 volts, 60 cycles. The rectifier uses two type 705–A rectifier tubes, 4–V–1 and 4–V–2. The high value of voltage available from the rectifier and the possible danger to personnel and equipment require protective control circuits.

The following discussion considers the rectifier circuit which develops the high output voltage. The control circuits are discussed later in this section.

(1) *Circuit operation.* Power is applied to the primary of the plate transformer 4–T–2 (fig. 34) through two 1.25-ohm surge resistors 4–R–1 and 4–R–2. These resistors are required because the transformer primary, having almost negligible resistance with zero field strength, draws high current at the instant the power is turned on. By use of the surge resistors, the starting current is limited to a safe value until sufficient field strength is built up for the reactance of the primary to limit the current to a value corresponding to the load on the secondary. The turns ratio of the plate transformer is approximately 75 to 1, and the secondary is center-tapped. Thus, there is developed between center tap and end taps an alternating voltage of 4,500 volts root mean square (rms) when the input is 120 volts, or 4,300 volts rms when the input is 115 volts. During each half-cycle one or the other of the rectifier tubes will conduct and charge the 2-mf capacitor 4–C–2 to the peak voltage which is 1.41 times the rms value at the center tap. When the input is 120 volts this charge will be 6,350 volts, and 6,000 volts when the input is 115 volts, neglecting the 50-volt drop in the rectifier tubes. Thus it can be seen that, by changing the input voltage with the powerstat 3–T–2, the output can be adjusted to 6,000 volts d-c. No filter is required in this circuit, because the charge on the 2-mf capacitor is sufficiently large that the current drawn during a transmitting cycle will be less than 1.5 percent of its total charge. Since the charging frequency is 120 cycles per second (cps) and the pulsing frequency is 400 cps there are approximately three transmitting cycles per charging cycle. Therefore the total discharge of the 2-mf capacitor will be less than 5 percent. This is a relatively small ripple ratio and compares favorably with conventional power supplies.

(2) *Filament supply.* A separate filament transformer 4–T–1 has been provided to supply 5 volts a-c to the rectifier tube filaments which are connected in parallel. Since the secondary of this transformer is connected directly to the high-voltage side of the power supply and the primary has 116 volts regulated a-c on it, the secondary is necessarily heavily insulated.

(3) *Safety devices.* Three safety devices have been provided for shorting out the 2-mf capacitor 4–C–2. One short is through the capacitor shorting relay contacts 4–E–1–2 which are normally closed, constituting a direct short across the capacitor through the 10,000-ohm resistor 4–R–3. These contacts open only when power is applied to the set through the interlock circuit. There are two shorting bars from the positive side of the capacitor to ground, one of which (3–S–7, fig. 31) is actuated by the spark-gap door, while the other (4–S–2, fig. 34) is actuated by the opening of the door to the power supply chassis.

23. Transmitter System Control Circuits

There are various circuits within the transmitting system for the purpose of controlling the operation of the system or indicating whether or not the system is operating normally. These circuits are known as control circuits.

a. PLATE TRANSFORMER POWERSTAT. The plate transformer powerstat 3–T–2 (fig. 12) is located in Control Panel BD–130–A. Its purpose is to provide a variable voltage input to the plate transformer so that the output voltage of Power Supply Unit RA–101–A may be adjusted to the desired value. The setting of this powerstat is adjusted so that the transmitter tube current is 10 ma.

b. RECTIFIER-TRANSMITTER TUBE CURRENT METER. The meter 3–M–1 (fig. 12) located on Control Panel BD–130–A is used for measuring either the rectifier or the transmitter tube current. In its normal position the meter reads the current through the transmitter tube. When in this position the meter is in series with the 5-millihenry choke 3–L–2 and is shunted by the 260-ohm resistor 3–R–11 and the 2-mf capacitor 3–C–2 (fig. 37). The value of the shunt resistor is such that the meter will read 20 ma full scale. The combination of shunt capacitor and series choke bypasses the meter to sudden surges of current. As explained in the discussion of the charging and discharging of the pulse-forming line, the average current which flows up from ground through resistors 3–R–12, 3–R–13, and 3–R–14 is equal to the current flowing through the transmitter tube. Since the meter is in series with 3–R–12, 3–R–13, and 3–R–14, it will read the transmitter tube current. With the meter in this normal position the negative side of the power supply is grounded through the 50-ohm resistor 3–R–10. When the PUSH FOR RECTIFIER CURRENT button (fig. 12) is pressed, the meter is connected between the negative side of the power supply and ground, and the return path for the rectifier current is through the parallel combination of resistor 3–R–10 and meter 3–M–1.

The resistance is such that the meter will read 100 ma full scale. The meter now reads the rectifie. current. The 1-mf capacitor 3–C–1 bypasses the meter to surges of current.

c. Capacitor Shorting Relay. Contacts 4–E–1–2 of the capacitor shorting relay are connected, in series with the 10,000-ohm resistor 4–R–3, across the 2-mf high-voltage capacitor 4–C–2 (fig. 12). These contacts serve to short out the high-voltage capacitor when the set is turned off. Other functions of this relay are discussed in section II.

d. Overload Relay. The direct-current overload relay 3–E–3 (fig. 9) is located between the negative side of the rectifier and ground (fig. 37). When the rectifier current exceeds 80 ma. the relay removes the input voltage to the rectifier. A more detailed description of the operation of this relay is given in section II.

e. Underload Relay. The transmitter tube underload relay 3–E–2 (fig. 9) is located in the metering circuit of the spark gap (fig. 37). If for any reason the transmitter current is 6 ma or less this relay opens and the high voltage to the transmitter tube is removed. The various functions of this relay are discussed in more detail in section II.

f. Door and Panel Interlock Switches. There are door or panel interlock switches on all of the components containing high voltage. These interlocks turn off the high voltage if the door or panel is opened or removed. The complete interlock circuit is shown and discussed in section II.

24. Complete Schematic Diagrams

Figures 41 through 45 are complete schematic diagrams of the components which are included, in whole or in part, in the transmitter system.

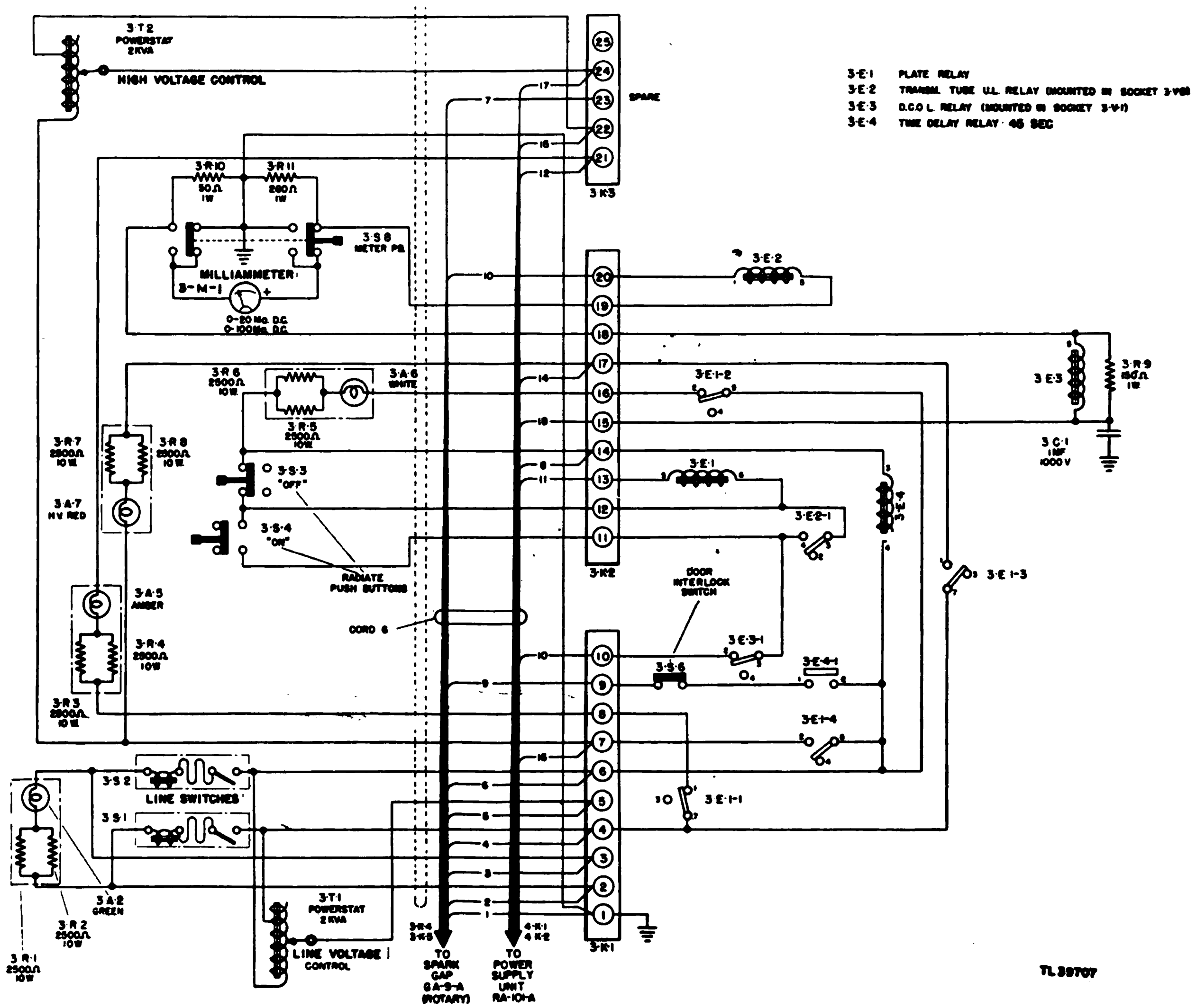


Figure 41. Control Panel BD–130–A, complete schematic diagram.

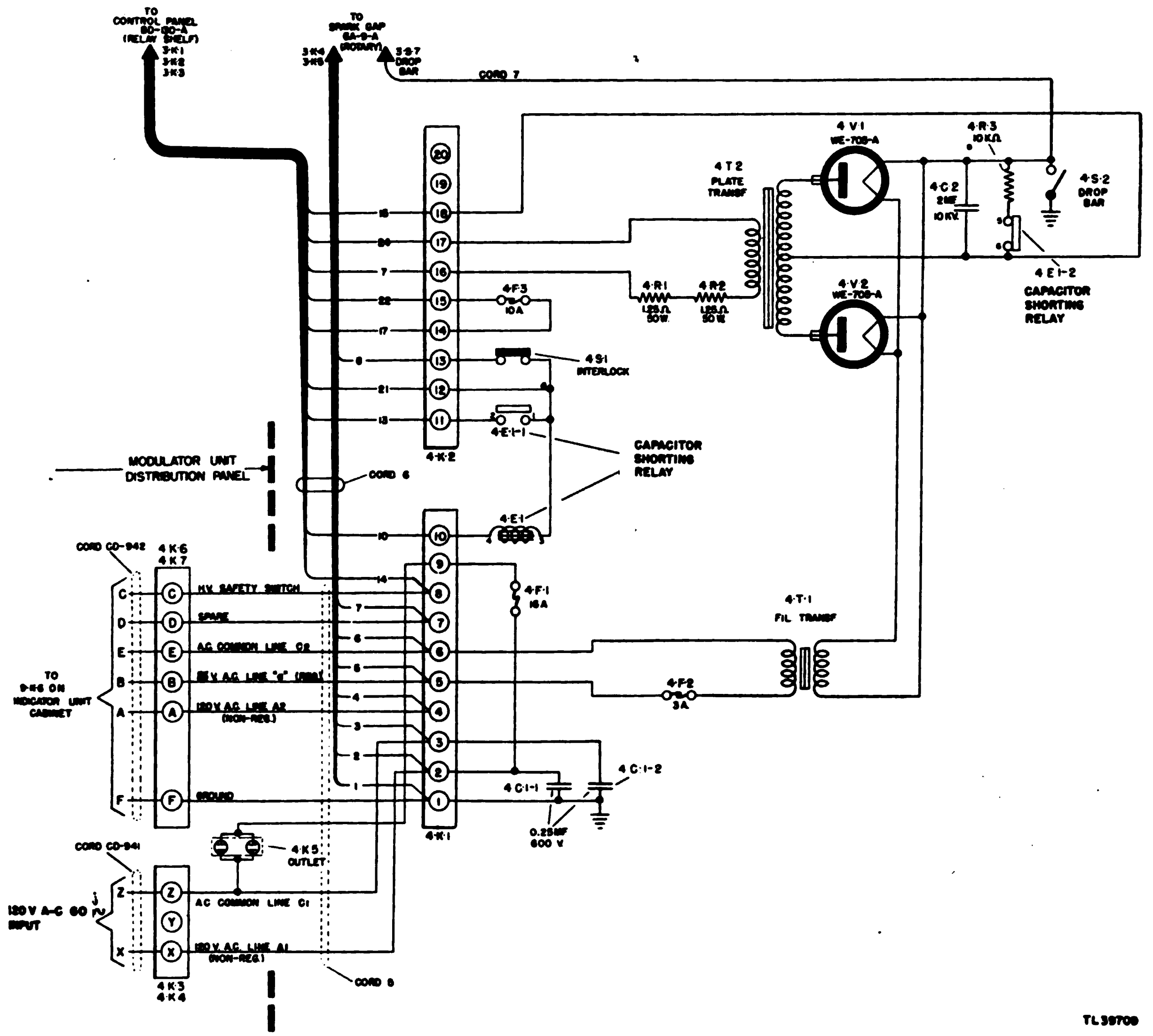


Figure 43. Power Supply Unit RA-101-A, complete schematic diagram.

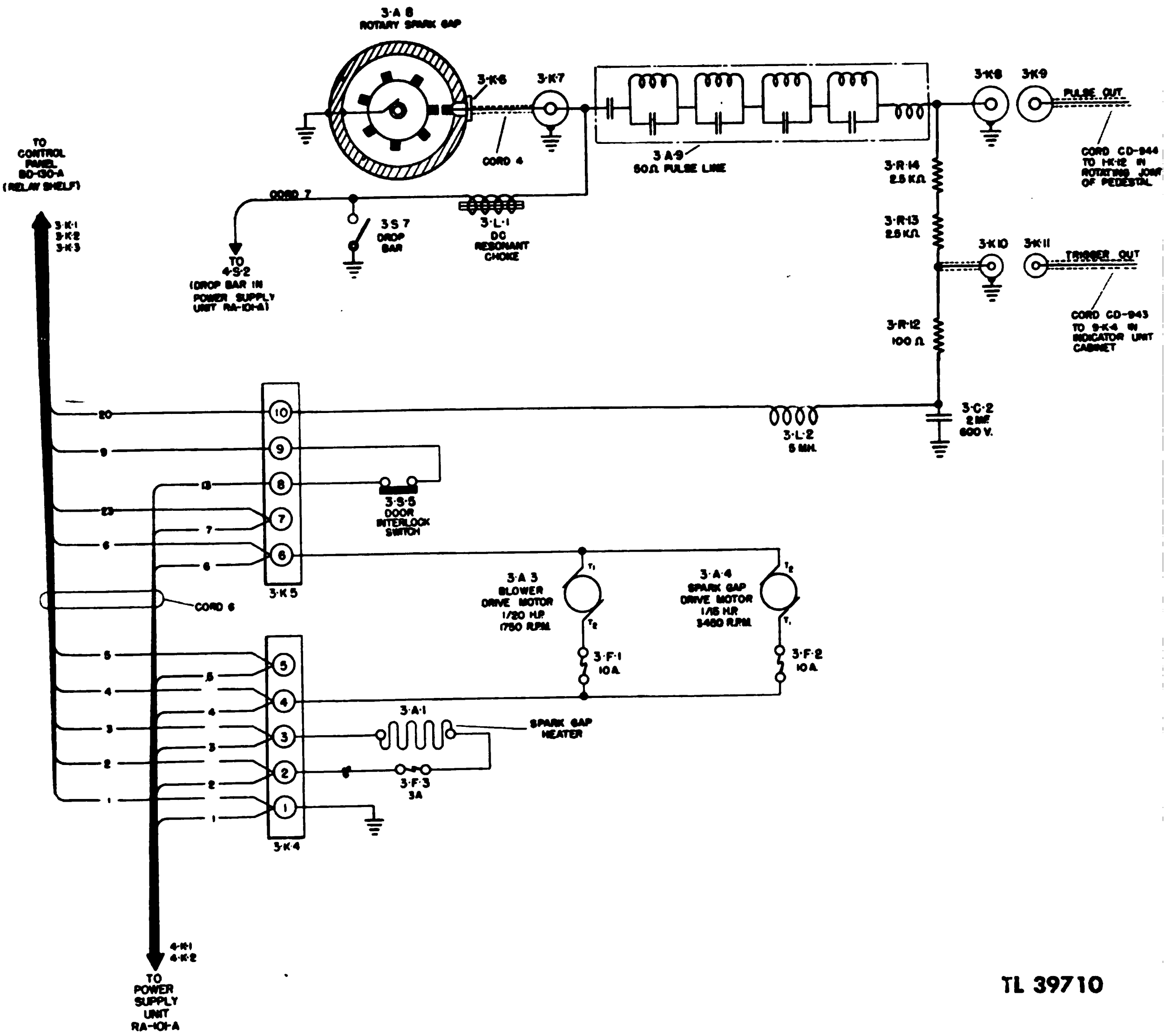


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Figure 44. Spark Gap GA–9–A (Rotary), complete schematic diagram.

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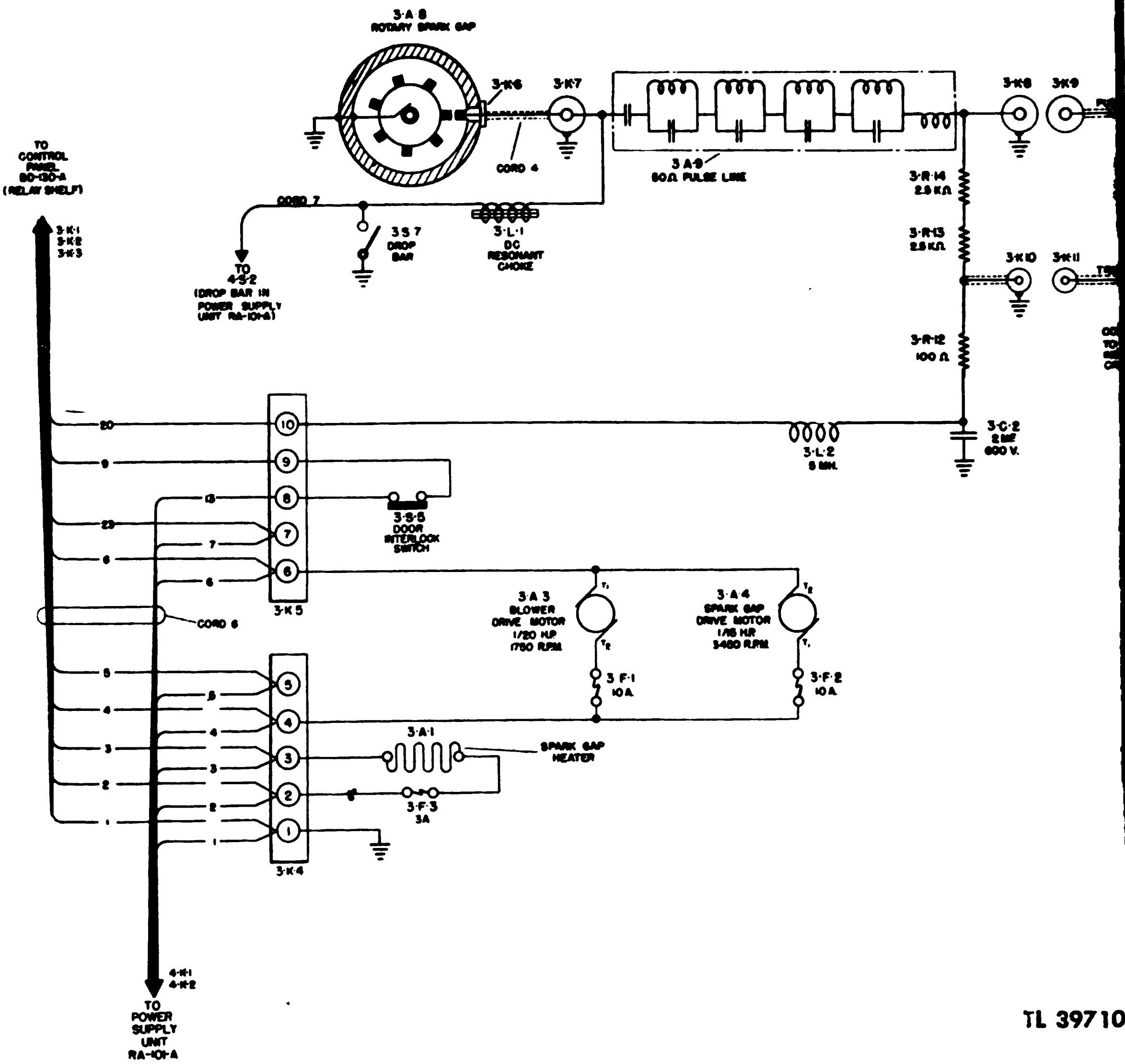

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Figure 44. Spark Gap GA-9-A (Rotary), complete schematic diagram.

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25. Introduction

The radio-frequency system is that part of the equipment which carries the outgoing pulse from the transmitter tube to the antenna, and carries back from the antenna to the receiving system any target echo picked up by the antenna. The system also couples a small part of the energy of the transmitted pulse into the A.F.C. crystal mixer. The principal parts of the r-f system are the transmitter tube coupling, the r-f transmission line, the T-R box, the automatic frequency control coupler, and the antenna. The construction and theory of the r-f system are discussed in this section. The basic ideas involved in the use of the same antenna for both transmitting and receiving are described in section I.

26. Block Diagram of R-F System

The simplified diagram in figure 46 shows the elements of the r-f system and their relationship to the transmitter and receiver systems. Each of the elements described briefly below is considered in detail later in this section.

a. TRANSMITTER TUBE COUPLING. The transmitter tube coupling connects the r-f output of the transmitter tube to the r-f line.

b. R-F TRANSMISSION LINE. The r-f transmission line interconnects the transmitter tube coupling, the antenna, the T-R box, and the A.F.C. coupler. The line conducts the transmitted pulses from the transmitter tube coupling to the antenna, and conducts the received pulses from the antenna to the T-R box.

c. T-R BOX. This unit is located in the branch line to the receiver system closest to the transmitter tube coupling. The T-R box functions as an electronic transmit-receive switch. During the passage of the transmitted pulses it blocks the line to the receiver. In the interval between transmitted pulses when echoes may be intercepted, it serves as an efficient coupling unit from the main r-f line to the receiver system.

d. AUTOMATIC FREQUENCY CONTROL COUPLER. This unit is in the second branch line to the receiver system. It provides a loose coupling between the r-f transmission line and the A.F.C. crystal mixer.

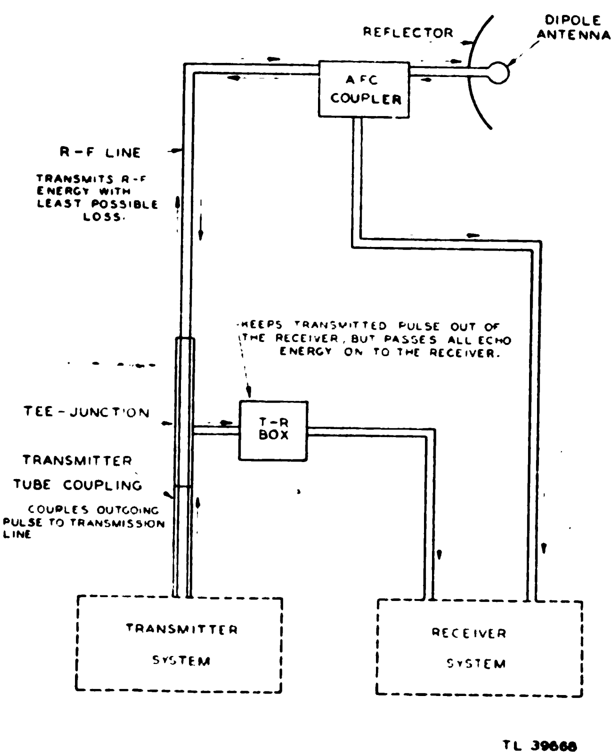


Figure 46. R-f system, simplified block diagram.

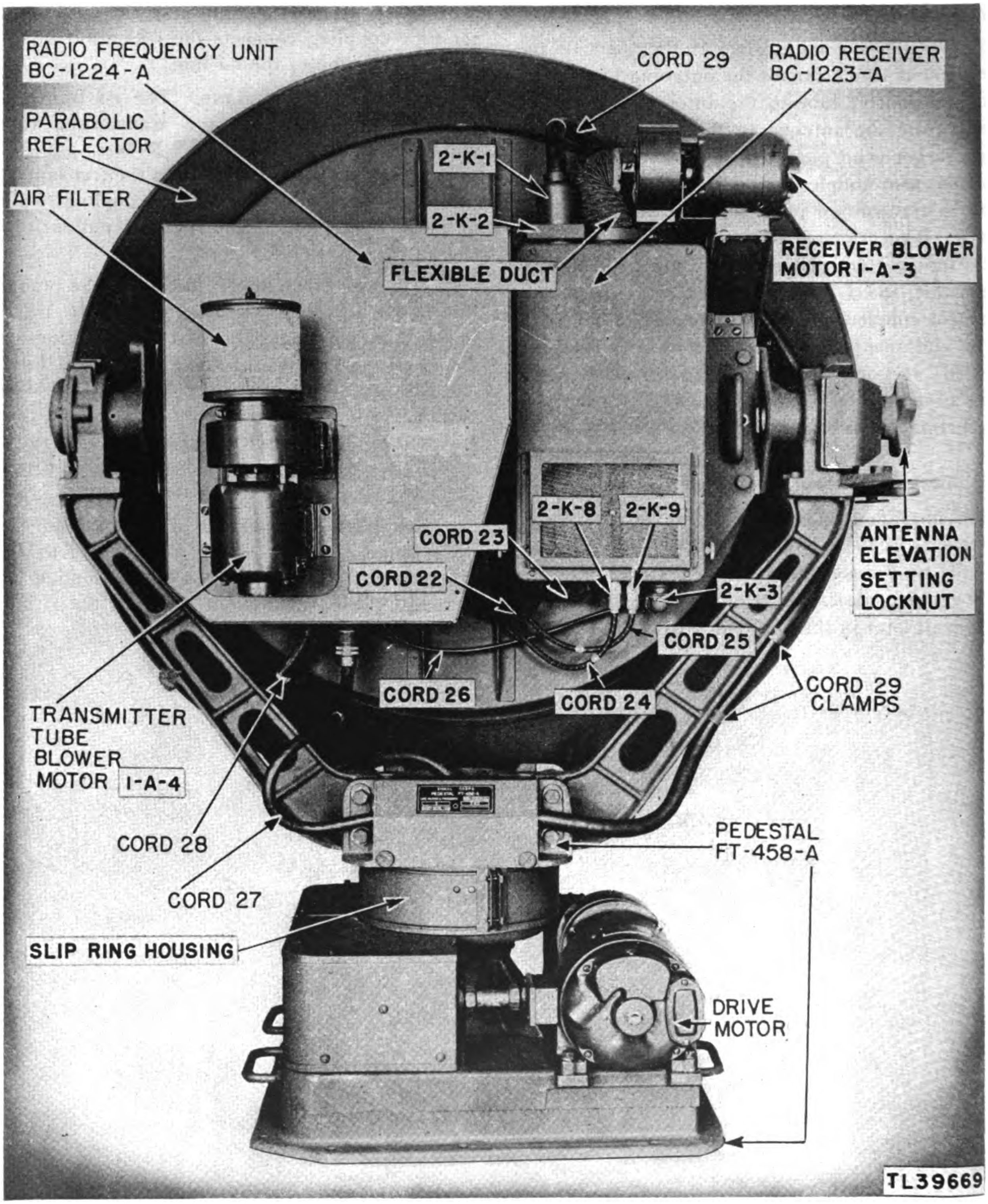


Figure 47. Spinner assembly, rear view.

e. ANTENNA. The antenna connects to the r-f transmission line through an opening in the center of the reflector. The antenna is a dipole, the over-all length of which is approximately one-half the wavelength of the r-f waves. The antenna is placed at such a point inside the reflector that the transmitted waves are focused by the reflector into a narrow beam, and the echo waves are intercepted by the reflector and focused on the dipole.

27. Location of Parts

The various parts of the r-f system are located in Radio Frequency Unit BC-1224-A and an Antenna AN-134-A, as shown in figures 47 and 48. The transmitter tube is mounted as shown in figure 49 at the left side of the r-f unit. Joined directly to the output of the transmitter tube is the transmitter tube coupling. Connected to the coupling is a tee-junction from which a branch line goes to the T-R box.

a. T-R Box. The T-R box is in one of the branch lines to the receiver (fig. 49). It is located close to the transmitter tube coupling, and receives its input connection from the tee-junction. The output of the T-R box goes to the signal crystal mixer, which also receives the output of the local oscillator. Figures 50 and 51 illustrate the elements of the r-f system. The crystal mixer and the local oscillator are a part of the receiver system, and are described in section V.

b. AUTOMATIC FREQUENCY CONTROL COUPLER. The A.F.C. coupler is coupled into the r-f transmission line at the point where the line changes direction to go through the reflector to the antenna dipole (fig. 49). The output of the coupler goes to the A.F.C. crystal mixer which also receives the output of the local oscillator. The A.F.C. crystal mixer is a part of the receiver system and is described in section V.

c. ANTENNA. The antenna is located in front of the reflector as illustrated in figure 48. The antenna sphere is supported by the r-f transmission line which runs through the center of the reflector. The dipole is placed at the focal point of the parobolic reflector so that the radio beam is focused into a narrower, more powerful beam. This action can be compared to the focusing of light rays by a reflector placed back of the light source, and is illustrated in figure 52.

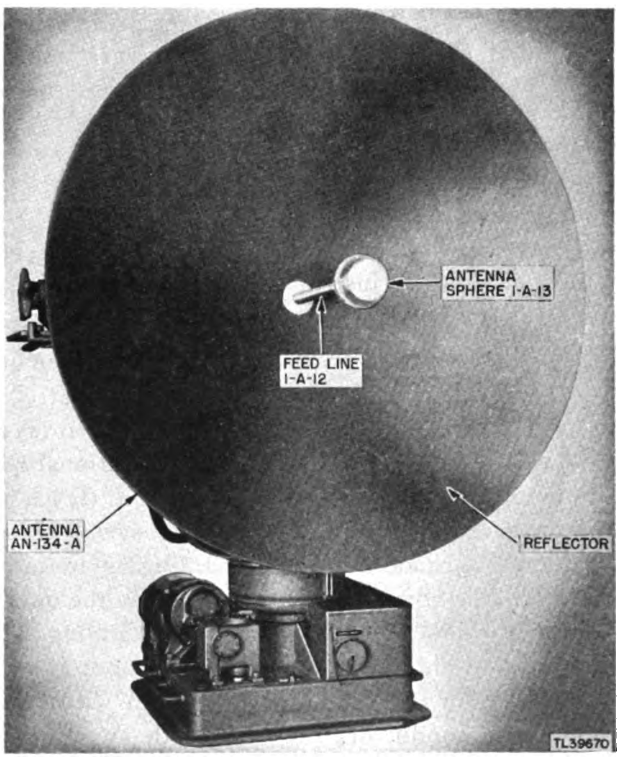


Figure 48. Spinner assembly, front view.

28. R-f Transmission Line

The r-f transmission line is made of ⅞-inch brass tubing containing a smaller coaxial brass tube which is supported by stub supports placed at intervals along the line. The inside diameter of the outside conductor is 0.811 inch; the outside diameter of the inside conductor is 0.375 inch. Figure 53 is a cutaway drawing showing a typical section of the r-f line, including a stub support. Both the inner and outer tubes act as conductors which guide the r-f waves along the line. The average characteristic impedance of the line is 48 ohms.

29. Supporting Stubs

The presence of a support at intervals along the line is necessary to keep the inner conductor properly centered within the outer conductor. At first glance, a metal stub of the type shown in figure 53 looks like a short circuit between the inner and outer conductors. However, a quarter-wavelength section of transmission line shorted at one end appears as an open circuit from the other end of the quarter-wavelength section. Because the length of the stub is approximately equal to one-fourth wavelength, the radio waves travel past the stub support without any appreciable interruption or loss of energy. The large diameter of the inner conductor near the stub makes the stub function efficiently over a band of frequencies. At several places along its length, the r-f line makes sharp right-angle turns. Where these turns occur, other supports will be found which function in the same manner as those just described. A typical right-angle stub is shown in figure 54.

30. Line Connectors

In joining together two sections of r-f transmission line, it is necessary to connect both outer conductors and both inner conductors as smoothly and closely as possible. These connections are illustrated in figure 55. The inner conductor is end-butted with a slotted half-bullet machined on the end of one section to fit a recess in the end of the adjoining section. The outer conductors are connected by means of a misfitted ball and socket joint. This method of junction allows some flexibility while maintaining all around contact. This flexibility allows the inner conductor to be drawn up tightly since the outer conductor will spring enough to seat the inner conductor firmly.

31. Coupling of Transmitter Tube to R-f Transmission Line

The transmitter tube is coupled to the r-f transmission line so that the output of the tube is passed on efficiently to the r-f line.

a. Transmitter Coupling. A cross-sectional view of the transmitter coupling is shown in figure 56. The center conductor of the output head of the transmitter tube, a ⅛-inch tungsten rod approximately 1 inch long, is directly connected to the center conductor of the r-f transmission line. The output head of the transmitter tube is provided with a threaded fitting over which the coupling ring of the coupler is screwed down to make the connection. The outer concentric conductor of the transmitter is connected to the outer conductor by a half-wavelength section of transmission line. A half-wavelength section of line which is shorted at one end presents a very low impedance to r-f energy applied to the other end of the line. Therefore the half-wavelength section of line from ① to ② to ③ presents a low impedance to the r-f energy leaving the outer concentric conductor of the transmitter tube at ①. Thus there is the equivalent of a short circuit between ① and ④. This type of coupling is used instead of a direct connection for two reasons. The use of the coupler minimizes the effect of variations of contact resistance between the coupler and the transmitter tube at ⑤. Since the shorted section of line from ② to ③ appears as an open circuit at ② any additional resistance in series with the open circuit at ② has no effect on the impedance at ①. The second reason for the use of this type of coupling is to prevent the r-f energy from leaking out to the outside of the transmitter tube. There are standing waves of voltage on the line between ① and ② and ③. Since the r-f voltage at ① is high with respect to ground; a quarter-wavelength away at ⑤, the r-f voltage is very near ground potentional. The voltage at ⑤ with

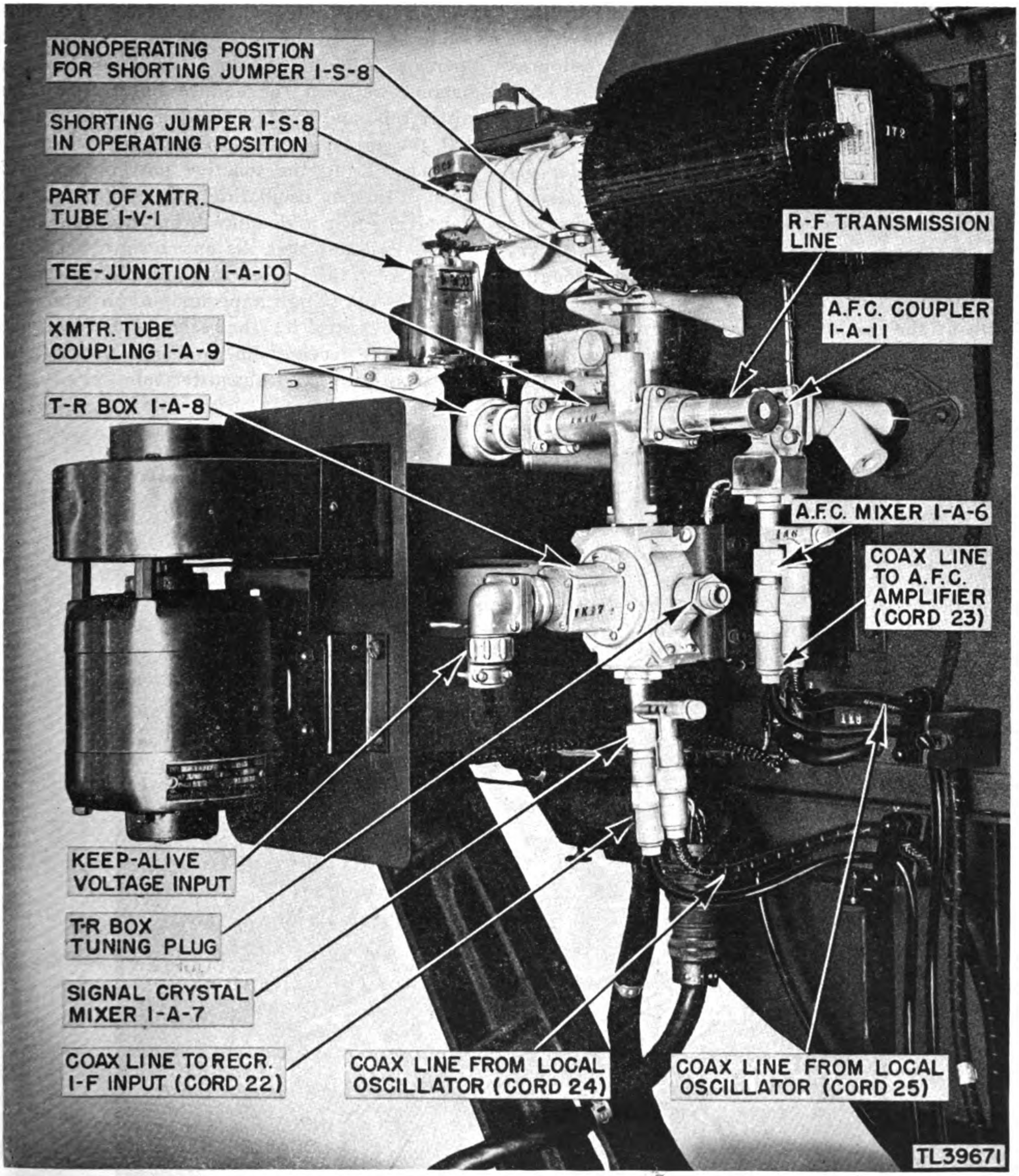


Figure 49. Radio Frequency Unit BC-1224-A, cover removed.

respect to ground being very low, there is little leakage of r-f energy to the outside of the transmitter tube in the event of poor electrical connection at ⑤.

b. Matching of Transmitter Tube to R-f Line During Transmission. That part of the inner conductor designated as the transformer in figure 56 is used to match the impedance of the r-f line as seen from the transmitter tube to the output impedance of the tube. This is done to make certain that there is the most efficient transfer of energy between the tube and the line. This section is one-quarter wavelength long. Because of its increased diameter, its impedance is lower than that of the r-f line. The quarter-wavelength transformer, in conjunction with the matching stub at the tee-junction, transforms the impedance of the r-f line to a value which is a proper matching impedance for the magnetron. The effect of the matching stub on the impedance transformation depends on the length of the stub and its distance from the transmitter tube.

c. Impedance of Transmitter Tube During Reception. The impedance of the transmitter tube as seen from the tee-junction is such as to cause practically all of the energy of an echo to go into the receiver line. This action depends on the exact distance between the connection to the transmitter tube and the tee-junction, and on the fact that the transmitter tube has a very high impedance during the inactive part of the cycle when it is not oscillating. The tee-junction is placed at such a distance from the connection to the oscillator that the entire short section of line between the tee-junction and the transmitter tube presents a high impedance to an echo wave trying to enter it; the echo, therefore, goes through the receiver line and into the T-R box instead of into the transmitter tube.

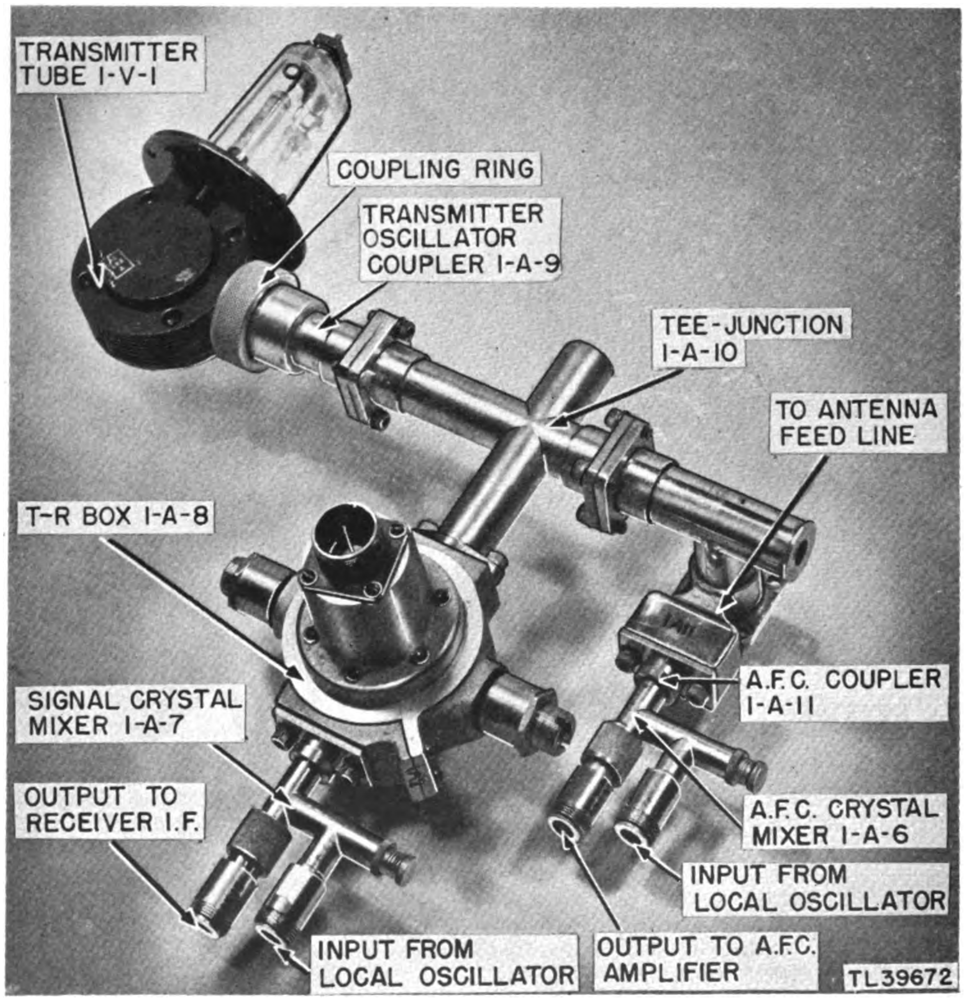


Figure 50. Transmitter oscillator, coupler, T-R box, tee-junction, A.F.C. coupler, and crystal mixers.

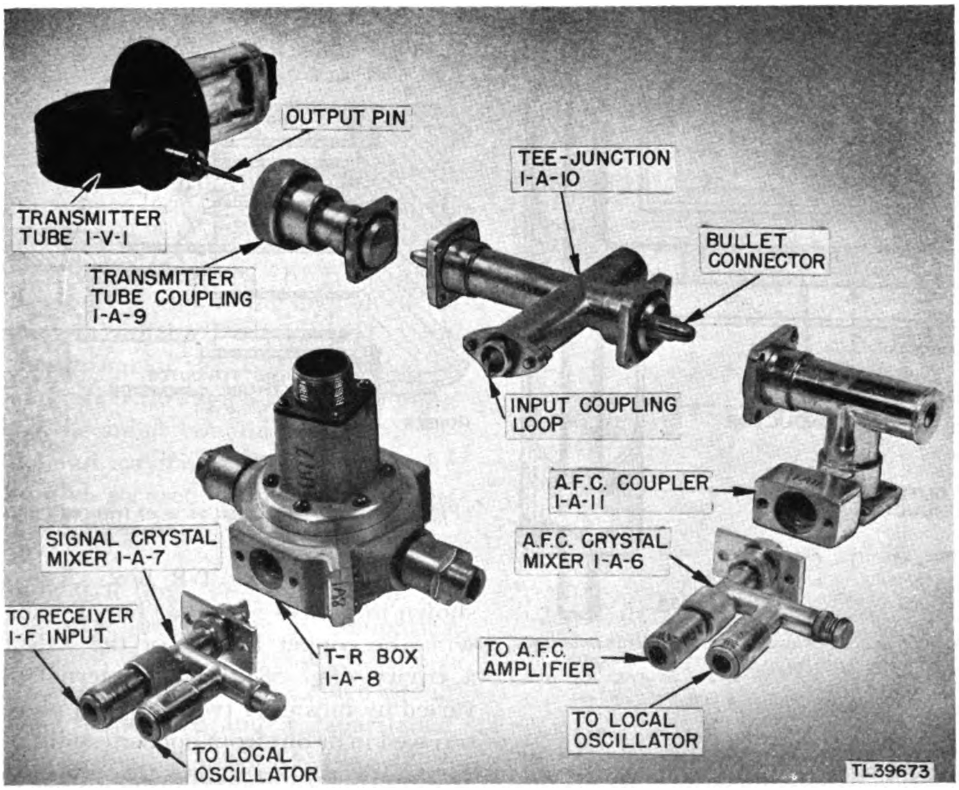


Figure 51. Transmitter oscillator, coupler, T-R box, tee-junction, A.F.C. coupler, and crystal mixers; disassembled.

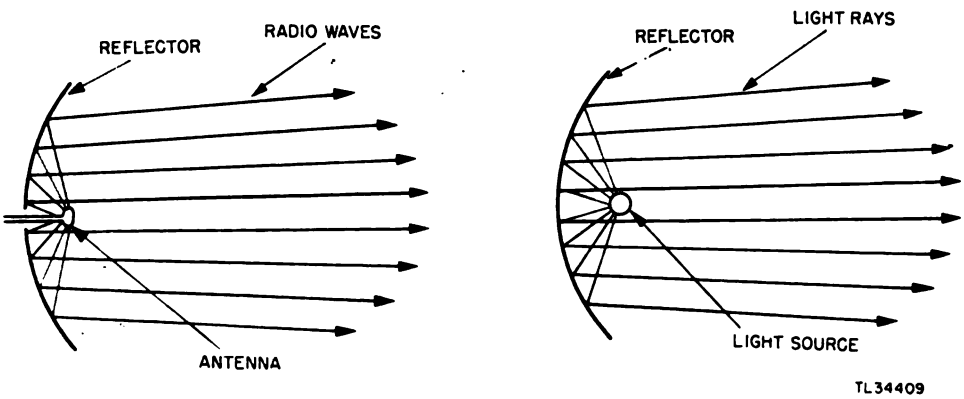


Figure 52. Focusing of microwaves with reflector.

32. T-R Box

The T-R box serves as a high-speed electronic valve or switch which permits the passage to the receiver of all of the energy of any received echo, but prevents the passage to the receiver of the high energy of the transmitted pulse. The T-R box is located in the branch of the r-f line that leads to the receiver at a point only a short distance from the tee-junction (fig. 49).

a. **T-R Tube.** The T-R tube is a partly evacuated glass tube. Sealed into it are two copper disks which project outside the tube in the form

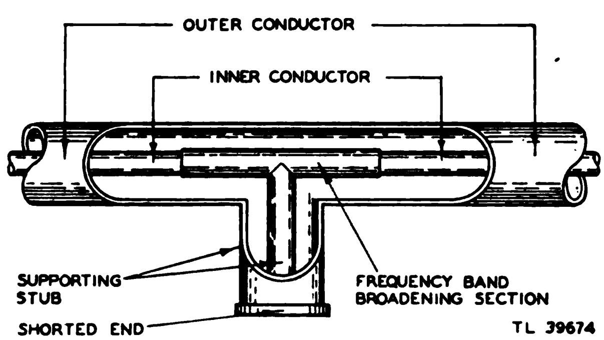


Figure 53. Cutaway view of straight transmission-line stub support.

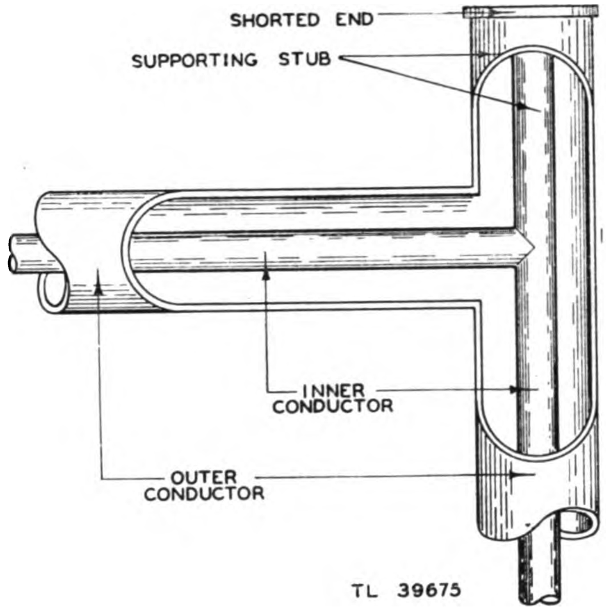


Figure 54. Cutaway view of typical right-angle transmission-line stub support.

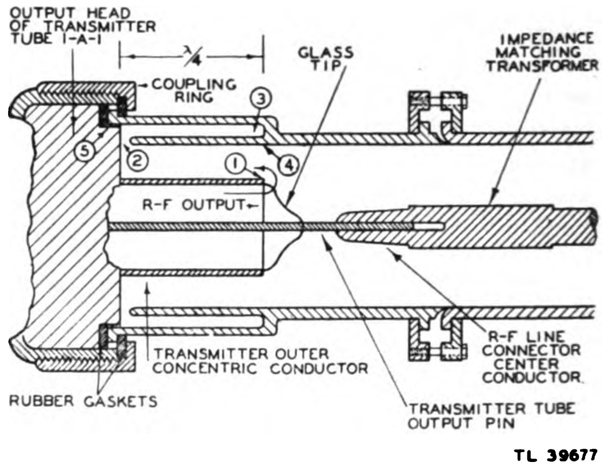


Figure 56. Cross-sectional view of transmitter tube coupling.

of two parallel circular flanges (fig. 57). Inside the tube, these two copper disks are drawn into opposing hollow cones separated at their tips by a small gap. Inside one of the cones is an electrode, called the ***keep-alive*** electrode. When a sufficiently negative potential is applied to this electrode, the space near the tips of the cones becomes filled with electrically charged particles or ions, and provides an easy conducting path for the discharge of any voltage applied across the cones.

l. **Description of T-R Box.** The T-R box is shown in figures 58 to 63. The T-R box, together with the copper flanges of the T-R tube, forms a cavity (fig. 58) whose internal size can be varied by means of two threaded plugs which are screwed in or out from opposite sides of the cavity. These are used in tuning the cavity to the transmitter tube frequency, a process which is explained later in this description. The input to

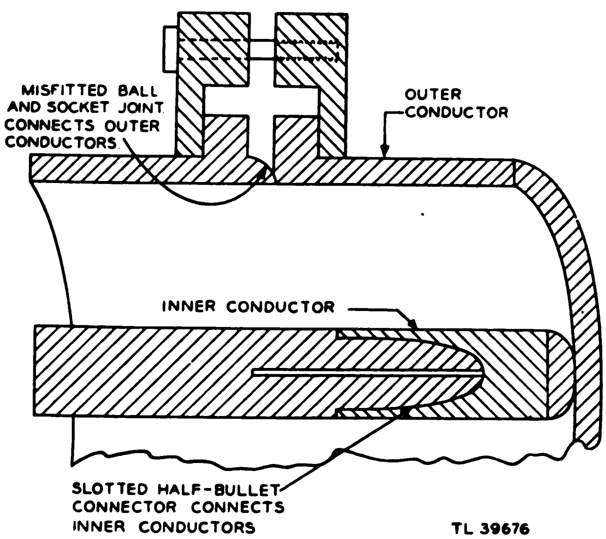


Figure 55. R-f transmission-line connector.

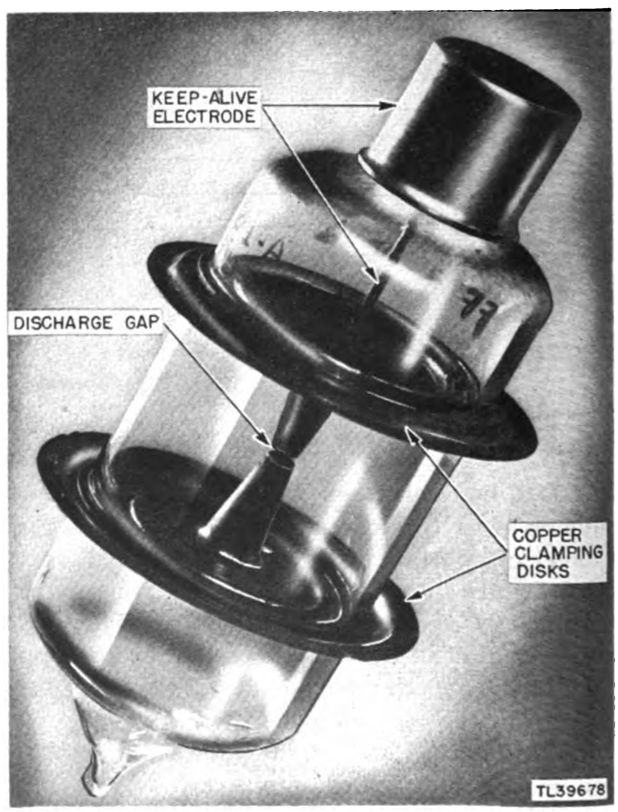


Figure 57. T-R tube.

the T-R box is through the short section of r-f line leading to the tee-junction. This may be seen in figure 49. The end of this line which connects to the T-R box terminates in a coupling loop, made by joining the inner and outer conductors of the line by a copper loop. This input coupling loop is inserted into the T-R cavity at the factory, and tightly secured in place by screws which pass through a flange on the end of the section of r-f line. The loop is part of the T-section and is not adjustable. The output of the T-R box is fed to the signal crystal mixer through a second coupling loop, similar to the input coupling loop, but inserted into the T-R cavity at the diametrically opposite point and secured in place by means of screws and a flange.

c. **Operation of T-R Box.** The operation of the T-R box can be explained simply by comparing it with its equivalent electrical circuit. As shown in figure 64, a T-R box behaves like a tuned circuit consisting of an inductance and a capacitance. If an alternating voltage is applied to the circuit, strong electrical oscillations are built up in the circuit, provided the applied frequency equals the resonant frequency of the tuned circuit. This condition is called resonance. Simple resonant circuits are commonly used as highly efficient coupling circuits in radio receivers. An important point to note is that the effectiveness of the

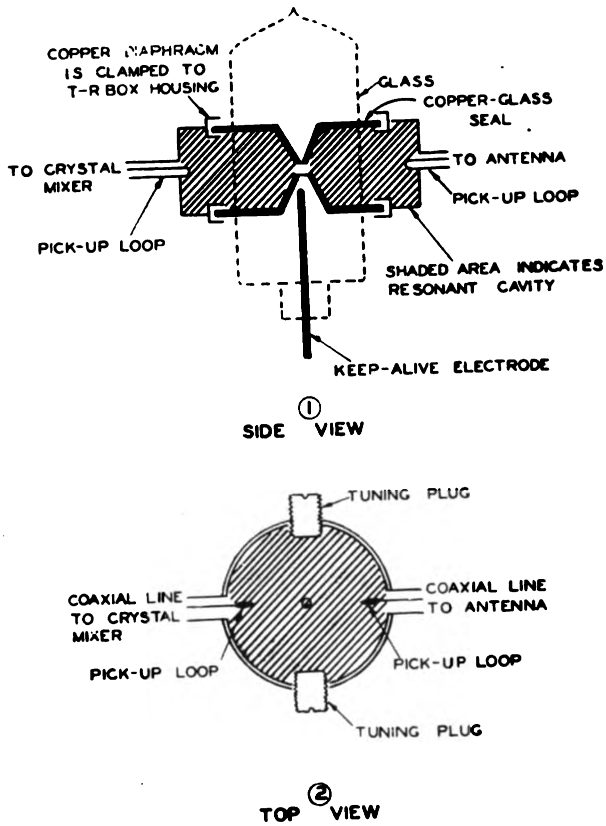


Figure 58. T-R box, simplified diagram showing resonant cavity.

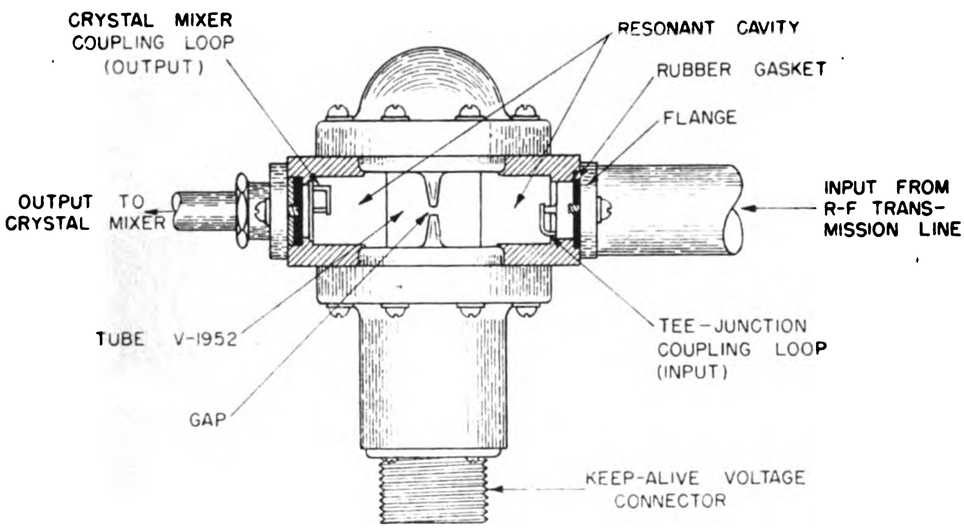


Figure 59. T-R box, showing coupling loops.

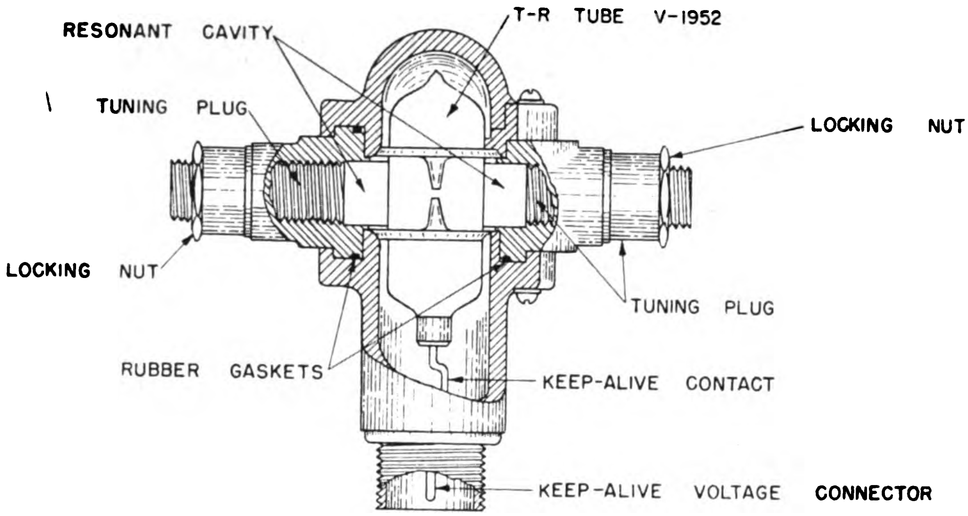


Figure 60. T-R box, showing tuning plugs.

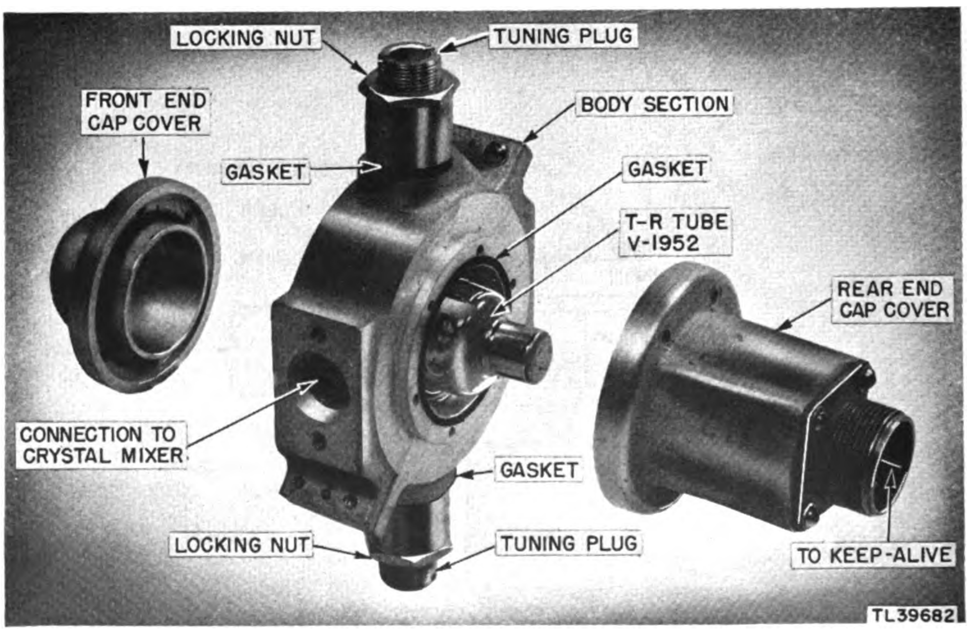


Figure 61. T-R box, end caps removed.

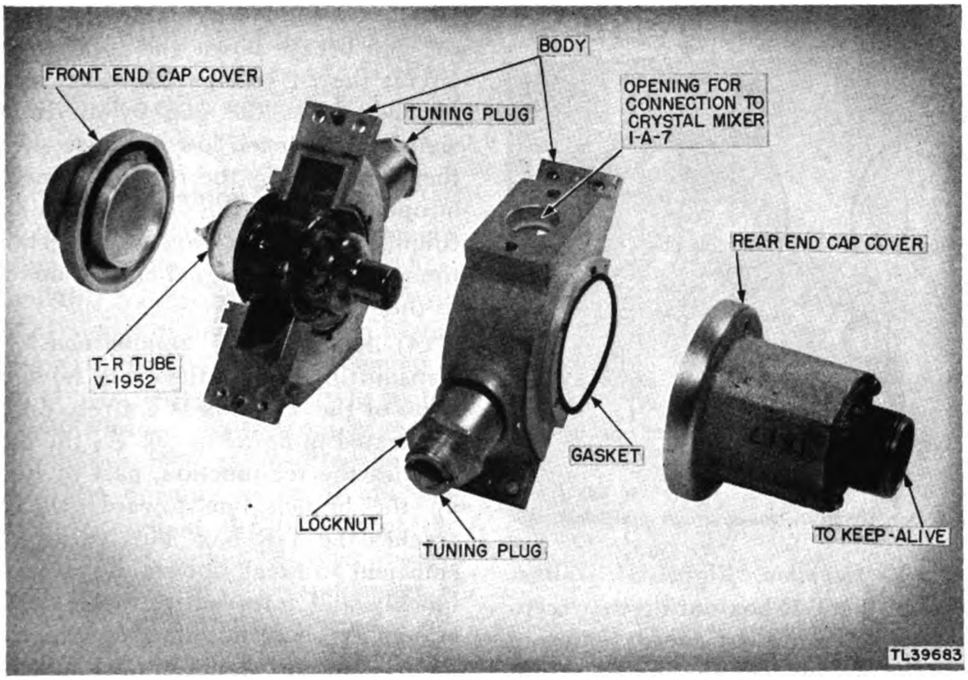


Figure 62. T-R box, partially disassembled.

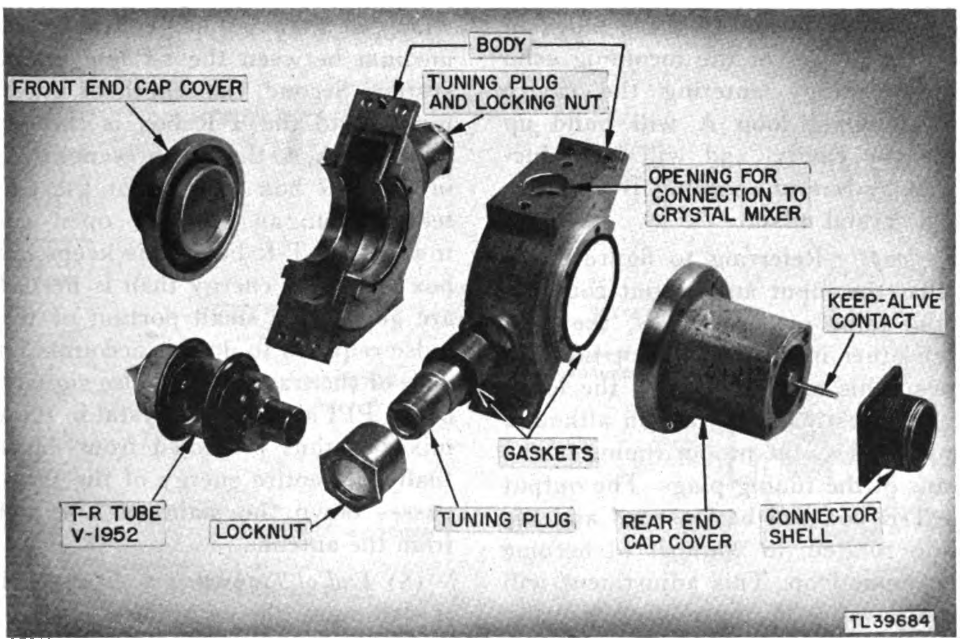


Figure 63. T-R box, completely disassembled.

coupling action depends on having the circuit accurately tuned to the frequency of the radio signal. The similarity between this action and that of the T-R box is explained below.

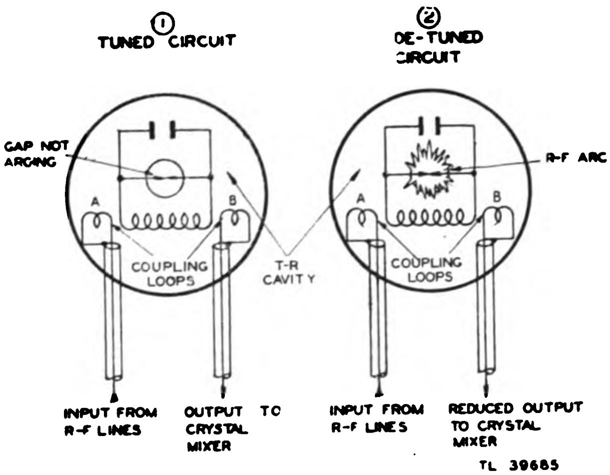


Figure 64. T-R box, simplified tuned circuit equivalent.

(1) *Action during reception.* Figure 64 ① illustrates the action of the T-R box during the reception of echo signals. To any r-f energy entering it through input coupling loop A, the cavity of the T-R box resembles a tuned circuit with the gap between the cones inside the cavity represented by the spark-gap shown in the drawing. The cavity has a definite resonant frequency, which can be changed by varying the settings of the tuning plugs in the side of the cavity. If the cavity is tuned by means of these plugs to resonate at the frequency of the incoming echo signal, the echo energy entering the cavity through input coupling loop A will build up strongly inside the cavity, and will be inductively picked up by output coupling B and sent on to the signal crystal mixer.

(2) *Coupling loops.* Referring to figure 59, it will be seen that the input and output coupling loops lie in the same plane; that is, they are parallel to each other in space, and not tilted at different angles. This arrangement of the loops produces the strongest coupling action although it is not as important as the proper tuning of the cavity by means of the tuning plugs. The output fitting on the T-R box can be loosened and the output coupling rotated, to allow it to become parallel to the input loop. This adjustment will be necessary in the tune-up procedure whenever the T-R box is taken apart for any purpose, such as for the replacement of a faulty T-R tube.

(3) *Break-down o' gap between cones.* As long as the keep-alive voltage from the receiver is applied to the special electrode inside the T-R tube, the space between the tips of the cones in the tube is partially ionized; if a sufficiently strong r-f voltage is applied across these cones, the gap breaks down and forms an arc to short circuit the r-f voltage. However, the r-f voltage applied across the gap by an incoming target signal is much too low to cause such an arc and therefore, during the receiving part of the cycle of operation, the T-R box acts simply as a tuned coupling device to transfer the echo signal from the r-f line to the signal crystal mixer and thence to the receiver.

(4) *Action during transmission.* During the transmitting part of the cycle, however, the operation of the T-R box is entirely different; this is illustrated in figure 64 ②. As the outgoing pulse reaches the tee-junction, part of its energy goes up the branch line towards the receiver and reaches the T-R box. This energy is more than sufficient to break down the gap in the T-R tube quickly and form an arc across the gap which effectively short circuits the voltage and prevents damage to the signal crystal mixer and the receiver. The arc continues for the entire duration of the transmitted pulse.

(5) *Effect of arc between cones.* The presence of the arc between the cones in the T-R tube produces two effects. First it completely detunes the resonant circuit represented by the T-R cavity which is then no longer an effective coupling medium between the r-f line and the receiving system. Second, the length of line from the tee-junction to the T-R box is three-quarters of a wavelength, so that the presence of a short circuit in the T-R box creates, for the r-f pulse at the tee-junction, an effective open circuit looking toward the T-R box. This keeps out of the T-R box any more energy than is needed to keep the arc going; the small portion of the transmitted pulse required to do this accounts for the appearance of the transmitted pulse signal on the screen of the PPI scope. The crystal in the signal crystal mixer is thus protected from damage, and virtually the entire energy of the transmitted pulse passes down the main r-f line and is radiated from the antenna.

(6) *End of Transmission.* At the end of the transmitted pulse, the r-f arc between the cones in the T-R tube goes out, and the cavity automatically returns to its tuned condition, ready to accept the received echo signal. With the short circuit in

the tube is removed, the line in the T-R box (looking from the tee-junction) presents the correct *matched* impedance to the passage of the received echo signal. Because of the high impedance presented by the line leading to the *inactive* transmitter tube, practically all of the echo signal passes into the line to the T-R box and is effectively coupled through to the signal crystal mixer and the receiver.

33. Automatic Frequency Control Coupler

The automatic frequency control coupler provides a loose coupling into the r-f transmission line. The purpose of this loose coupling is to feed a small portion of the transmitted pulse into the A.F.C. mixer. Figure 65 shows the construction of the coupler. It consists of an opening in the r-f transmission line into which the coupler cavity connects. A coupling loop is inserted in the coupler cavity. The opening is small and the coupling loop is located at the bottom of the coupler cavity so the coupling between the r-f line and the line to the A.F.C. crystal mixer is very small.

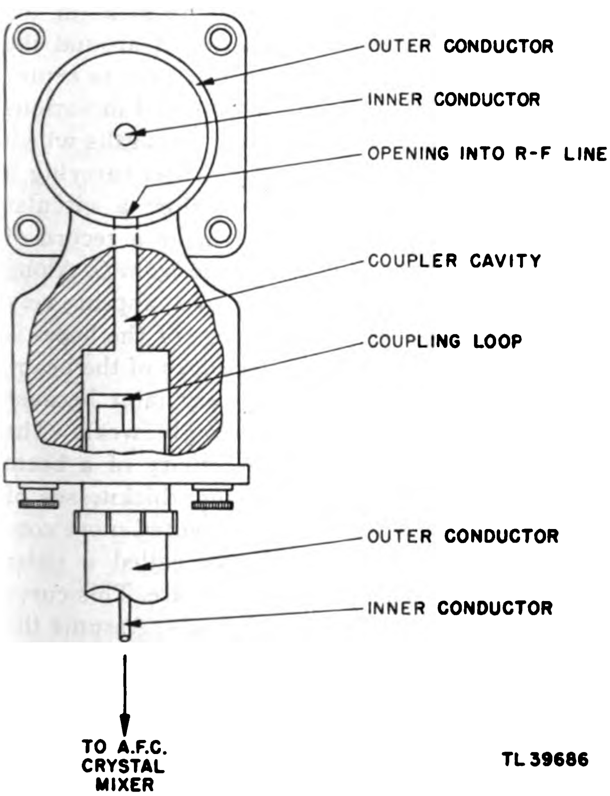


Figure 65. A.F.C. coupler, cross-sectional view.

34. Antenna AN–134–A

Antenna AN–134–A is illustrated in figures 66, 67, and 68. The part of the transmission line attached to the antenna is inserted through the reflector and connects to the r-f line just in front of the A.F.C. coupler. The transmission line then continues forward to the antenna proper which is inclosed in the spherical shell (figs. 67 and 68).

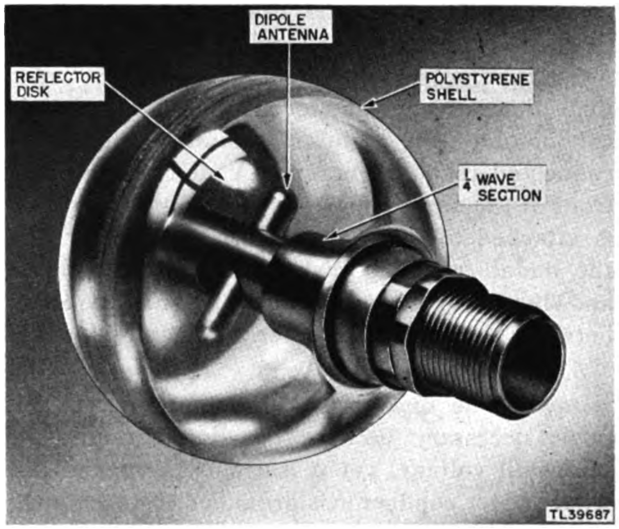


Figure 66. Antenna AN–134–A, shell, dipole, and reflector disk.

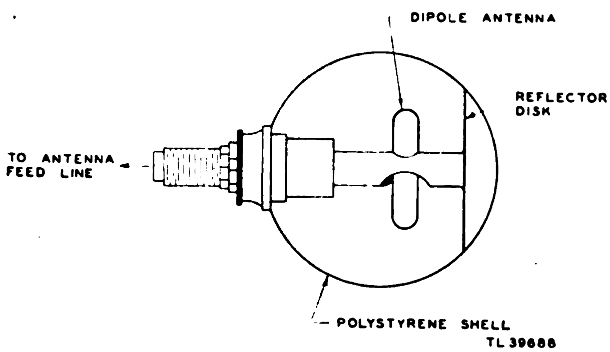


Figure 67. Antenna sphere.

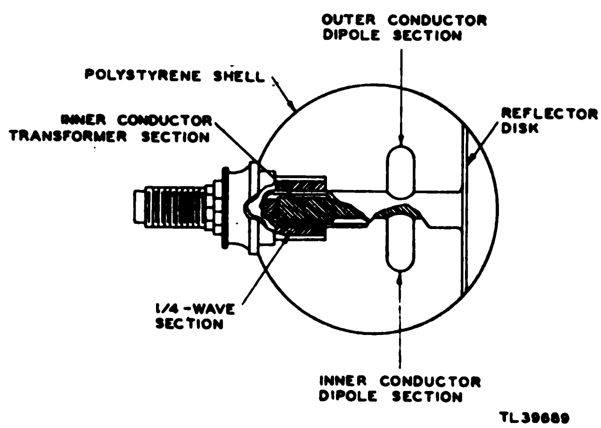


Figure 68. Antenna sphere, cutaway view showing construction details.

a. Mechanical Construction. The details of construction are shown in figure 68. The antenna dipole is in two halves which are soldered to the inner and outer conductors of the transmission line. One half of the dipole is soldered to the outer conductor; the other half passes through a large opening cut in the outer tubular conductor and is soldered to the inner conductor. A one-fourth wave tubular section having a diameter larger than the outer conductor surrounds the outer conductor of the main transmission line and is connected to it at one end. A short distance in front of the dipole is a small reflecting disk which is attached to the main transmission line. Near the metal reflecting disk, the r-f line is closed and shorted by a copper plug which fills the space between the inner and outer conductors.

b. Functioning of Parts. (1) *Quarter-wave section.* The quarter-wave section (fig. 68) is made necessary because the dipole requires a push-pull voltage, yet it is fed by a coaxial line whose outer conductor is grounded. By surrounding this outer conductor with the one-fourth wave section and grounding the one-fourth wave section to the transmission line at one end only, both halves of the dipole are made to receive a push-pull output. The reason for this follows: At one end of the one-fourth wave section, a high impedance exists. This allows radio frequency to appear on the outer conductor of the main transmission line. The inner and outer conductors now tend to assume a balanced condition with respect to ground so that the dipoles in effect are fed from a balanced push-pull line. Note that the outer conductor of the coaxial transmission line is grounded along its entire length to the transmitter except between the point of connection of the one-fourth wave section and the outer end of the antenna.

(2) *Shorting plug.* The transmission line extends beyond the dipole for a short distance and is then shorted by a metal plug. This short length of transmission line between the dipole and the plug thus constitutes a stub, the length of which is such that the dipole does not "see" a direct short but instead "sees" the correct values of impedance at the point where it is connected to the transmission line.

(3) *Reflecting disk.* The reflecting disk is soldered to the shorting plug at the end of the coaxial line. If it were not for this reflecting disk, about half the energy radiated from the dipole would travel directly out from the dipole in a very broad beam. The reflecting disk sends most of this forward energy back into the main reflector (sometimes called the parabola) where it is focused to strengthen and narrow the beam. This same type of reflecting disk is used in the case of a searchlight beam to make certain that all of the light which leaves the searchlight has been focused into a narrow beam by the reflector.

(4) *Transformer.* That part of the inner conductor designated as the transformer in figure 68 is used to match the transmission line to the dipole; that is, to make certain that there is the most efficient transfer of energy between the line and the dipole. This section is similar to that used at the transmitter tube.

c. Meaning of Beam and Polar Diagram. In describing how Radio Set SCR–682–A operates, it is necessary to discuss in some detail the beam which is prdouced. In figure 69 it is assumed that at origin *O* there is a reflector and dipole similar to the one used in this set. This arrangement focuses the energy radiated by the dipole into a narrow beam in the direction indicated by the axis of the reflector. The inset shows the reflector at *O* and its dipole near the focus of the reflector. The heavy arrows shown around the circumference of a circular trace with *O* as center indicate the relative strengths radiated in various directions. These are the signal strengths which would be observed if a surface vessel carrying a *signal strength meter* were to follow a circular course about *O* as center, and make a record of the strength of the pulses received from *O*. Along the axis of the beam the arrows appear very heavy because most of the energy of the beam is along the axis. Near the outer edges of the beam, however, the arrows become very faint because the signal becomes correspondingly weak. The information regarding the directivity of a beam which is represented by varying thicknesses of arrows in figure 69 can be represented more conveniently by means of a curve called a polar diagram, illustrated in the same figure. This curve or polar diagram is used as follows: Assume the relative strength of the beam in the direction *OX* is required. Then draw the line from *O* in the required direction and measure the length *OX* to the point *X* where the line meets the curve. If *OX*. for example, is half of *OA*, then the beam is only half as strong in the direction *OX* as it is in the direction *OA*. The sample principle applies for any other direction that is of interest. Toward the edge of the beam where the arrows thin out to zero width, the polar diagram indicates that the intensity is zero because the polar diagram curve returns to origin *O*. The simple polar diagram shown in figure 69 is often referred to as a lobe. Do not confuse the oval-shaped curve designated as polar diagram in figure 69 with the exact shape of the beam. The polar diagram does not represent the shape of the beam except indirectly, in that it shows the relative strength of the signals in any desired direction.

d. **Beam of Radio Set** SCR-682-A. In the case of Radio Set SCR-682-A, the beam produced is approximately 6° wide. The meaning of a 6° beam is made clear in figure 70 which shows how the signal received at the set is effected by the angle which the target makes with the axis of the beam. Thus when the target is lined up with the axis of the beam, the maximum signal is returned to the set. When the target is outside the 6° beam, that is, more than 3° beyond either side of the axis, the signal received at the set is very weak. As the line of the target approaches the line of the beam at *C*, the echo returned to the set increases to a maximum.

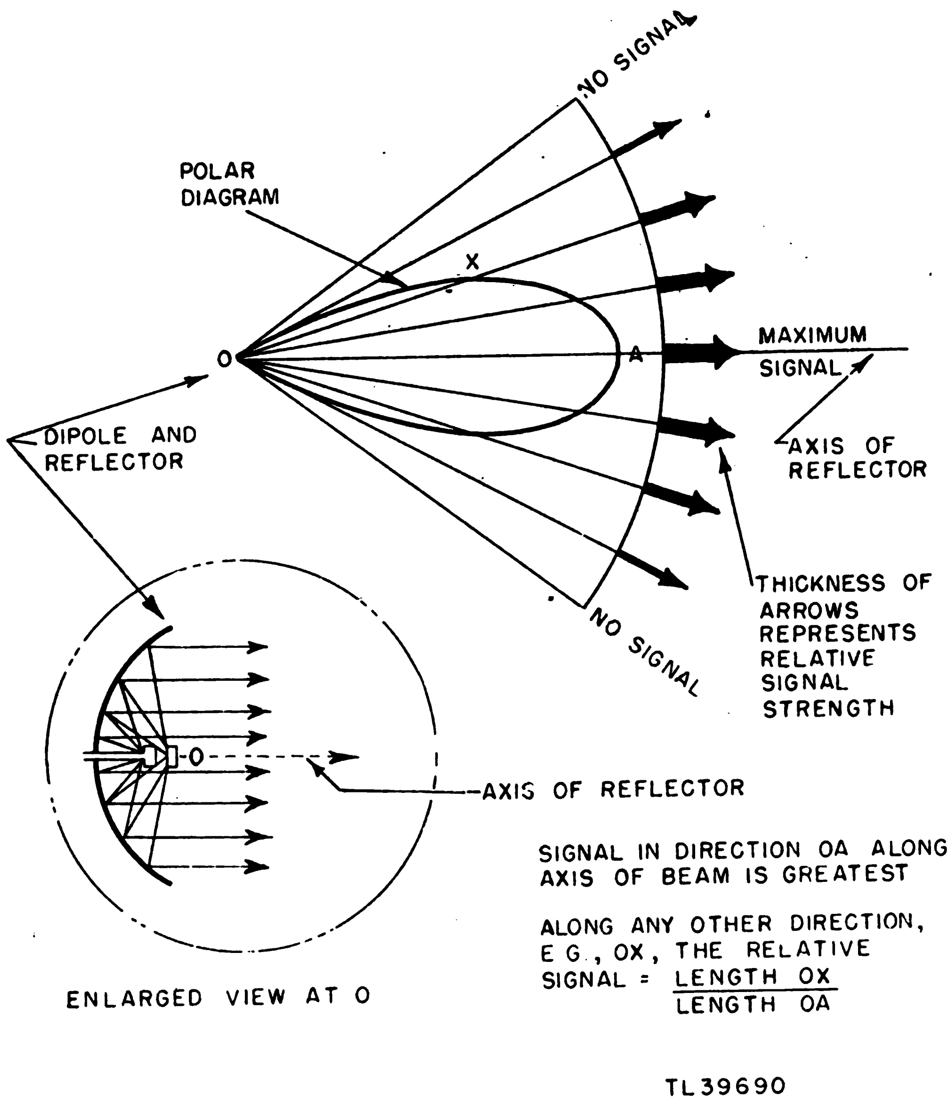


Figure 69. Use of polar diagram to represent beam of radio waves.

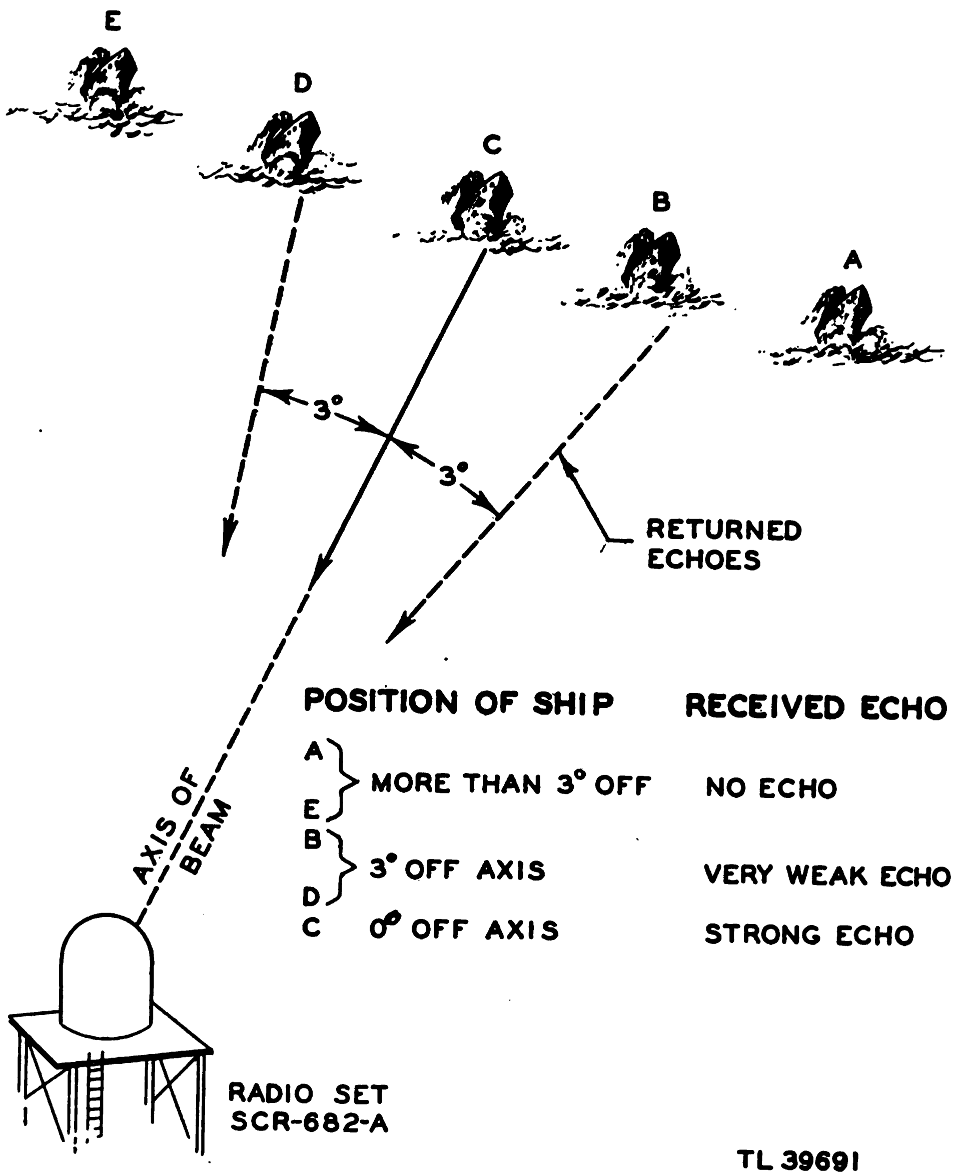


Figure 70. Effect of beam width on returned echo.

Section V. RECEIVER SYSTEM

35. Introduction

The function of the receiver system is to amplify and detect the received echo signals and feed them to the indicator system. The receiver system is basically of the superheterodyne type. It is made up of seven components. A brief description of each of these components is given in connection with the simplified block diagram.

36. Simplified Block Diagram

Figure 71 is the simplified block diagram of the receiver system. Each of the components shown in figure 71 is described briefly in this paragraph and in detail later in this section.

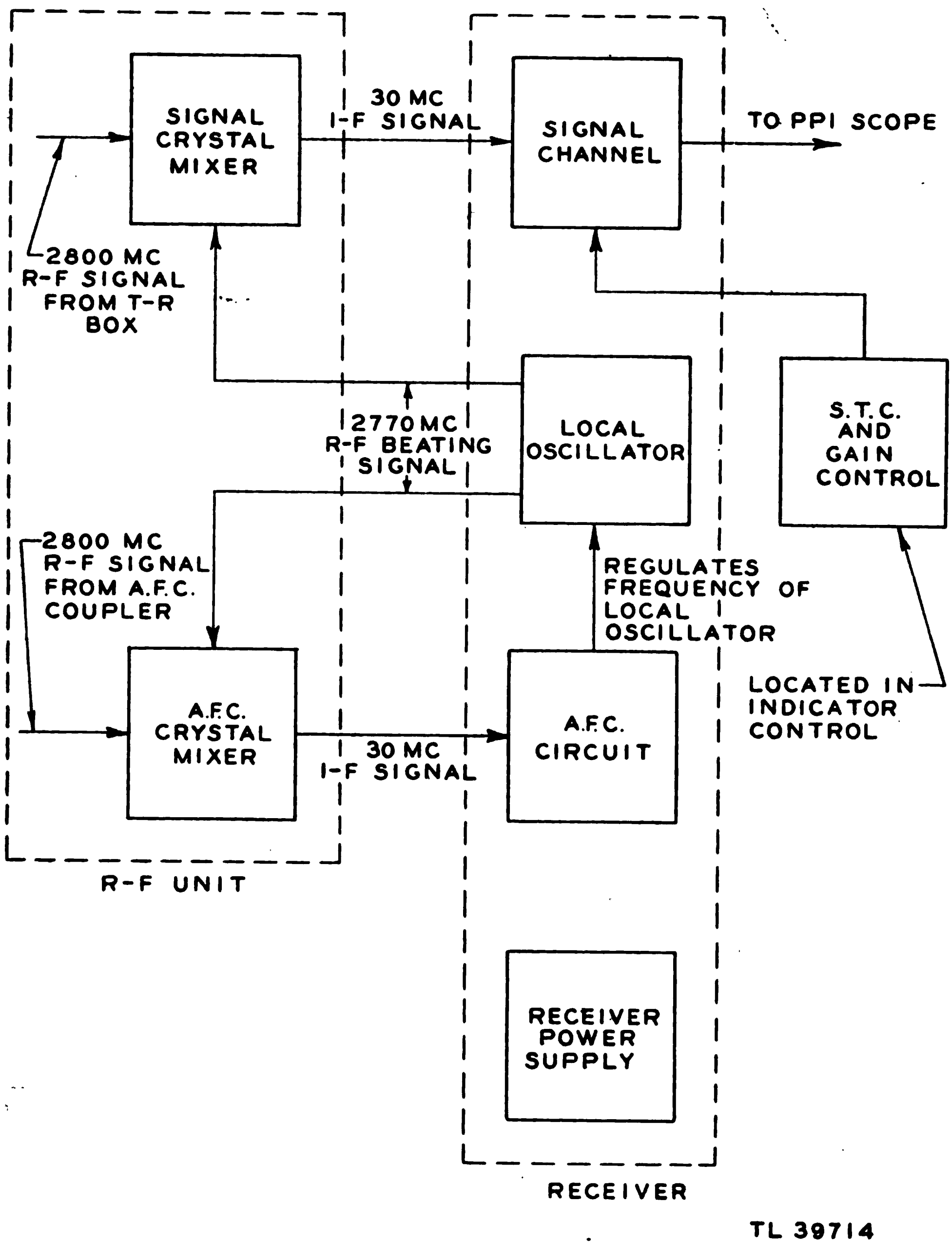


Figure 71. Receiver system, simplified block diagram.

a. Local Oscillator. This receiver uses a McNally reflex klystron as a local oscillator. The frequency of the oscillator is 30 megacycles (mc) below that of the transmitter tube. The output of the oscillator is mixed with the incoming signal voltage in the crystal mixers to produce the 30-mc intermediate frequency. The frequency of the oscillator is regulated by adjusting the potential applied to the reflector plate. The local oscillator is located in Radio Receiver BC–1223–A which is mounted on the back of Antenna AN–134–A as shown in figure 47.

b. A.F.C. Crystal Mixer. The automatic frequency control (A.F.C.) crystal is located in the radio-frequency unit (fig. 49). The input to the A.F.C. crystal mixer is the output of the local oscillator and the output of the A.F.C. coupler. These two signals are heterodyned in the crystal, and the output is a signal whose frequency is the difference between the two input signals. This output is fed to the A.F.C. circuit.

c. A.F.C. Circuit. The A.F.C. circuit is located in the receiver. It receives the output of the A.F.C. crystal and, depending on the frequency of this signal, makes the voltage on the reflector plate of the local oscillator more or less negative. In other words, if the frequency of the local oscillator is not exactly 30 mc below the frequency of the transmitting tube, the A.F.C. system will correct the frequency of the local oscillator by changing the voltage applied to the reflector plate of the local oscillator tube.

d. Signal Crystal Mixer. The signal crystal mixer is located in the radio-frequency unit (fig. 49). The input to the signal crystal mixer is the output of the local oscillator and the output of the T-R box. As explained in section IV, the output of the T-R box consists of the received echo signals. These voltages are mixed in the crystal, and the output is the intermediate frequency which is 30 mc.

e. Signal Channel. The signal channel is located in the radio receiver. It receives the i-f output of the signal crystal mixer, amplifies and detects this voltage, and delivers an output voltage which is a series of negative pulses.

f. Sensitivity Time Control and Gain Control. The sensitivity time control (S.T.C.) and the receiver gain control are located in Indicator Control BC–1193–A (fig. 104). The gain control varies the gain of the receiver by varying the steady d-c bias on the control grids of the second and third i-f tubes. The sensitivity time control generates a voltage whose magnitude varies with the time from the start of the sweep. Its purpose is to decrease the sensitivity of the receiver system during the first part of the sweep. Without this control the echoes received from near-by targets would saturate the receiver, and it would be difficult to distinguish between targets. The decreased sensitivity of the receiver during the first part of the sweep prevents this saturation of the receiver and enables the operator to distinguish between near-by targets. The output of the sensitivity time control is fed, with the steady d-c voltage of the gain control, to the grids of the second and third i-f stages.

g. Receiver Power Supply. The receiver power supply is located in the radio receiver. It supplies all of the power required by the radio receiver itself.

37. Complete Block Diagram

Figure 72 is the complete block diagram of the re-

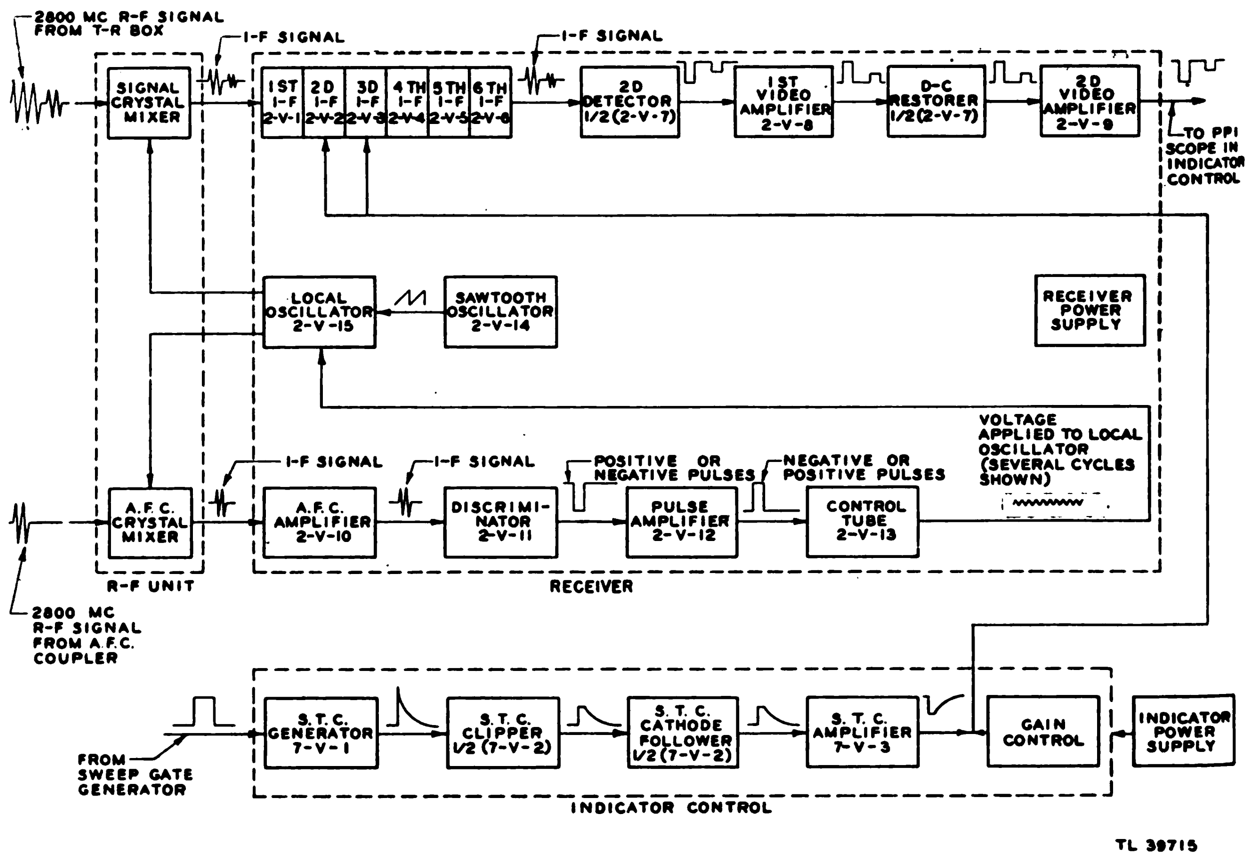
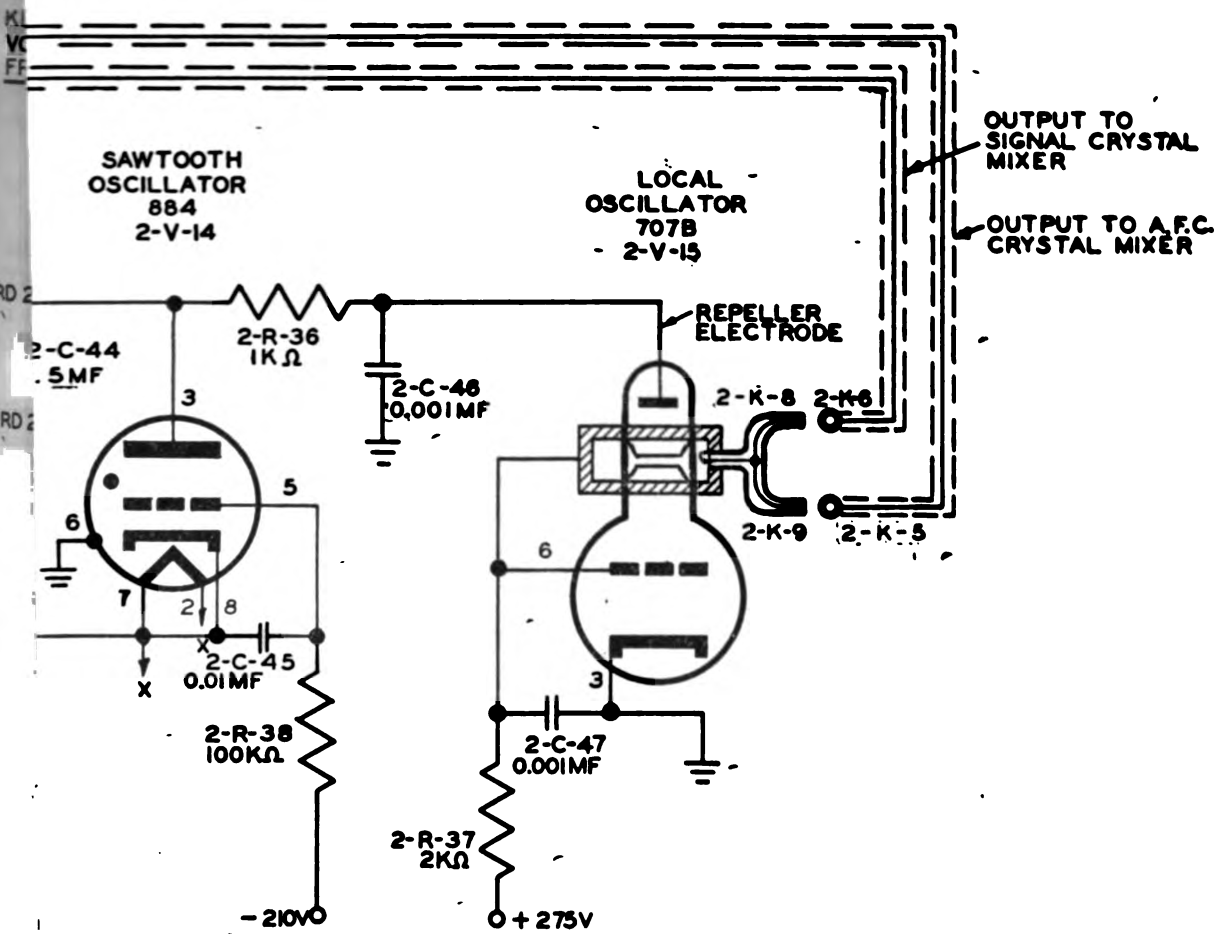


Figure 72. Receiver system, complete block diagram.



SAWTOOTH
OSCILLATOR
884
2-V-14
LOCAL
OSCILLATOR
707B
2-V-15
OUTPUT TO
SIGNAL CRYSTAL
MIXER
OUTPUT TO A.F.C.
CRYSTAL MIXER
2-R-36
1KΩ
REPELLER
ELECTRODE
2-C-44
.5MF
2-C-46
0.001MF
2-K-8
2-K-6
2-K-9
2-K-5
2-C-45
0.01MF
2-R-38
100KΩ
2-C-47
0.001MF
2-R-37
2KΩ
−210V
+275V
TL 39692

ceiver system. It shows each circuit group and its input and output waveform. The local oscillator, A.F.C. crystal mixer, and signal crystal mixer are described in paragraph 36. The waveforms at the various parts of the circuit are shown on the diagram.

a. A.F.C. CIRCUIT. (1) *A.F.C. amplifier.* The A.F.C. amplifier amplifies the output of the A.F.C. crystal mixer.

(2) *Discriminator.* The output of the A.F.C. amplifier is applied to the discriminator. If the output of the A.F.C. crystal is above 30 mc (the frequency of the i-f channel), the output of the discriminator is a negative pulse. If the output of the A.F.C. crystal is below 30 mc, the output of the discriminator is a positive pulse.

(3) *Pulse amplifier.* The pulse amplifier is used to amplify the pulses from the discriminator.

(4) *Control tube.* The output of the pulse amplifier is applied to the grid of the control tube. The plate of the control tube is connected through a filter system to the reflector electrode of the McNally oscillator tube (2–V–15). Every time a positive pulse causes the control tube to conduct, the voltage at its plate will be lowered, thus regulating the voltage on the reflector electrode of the local oscillator tube. A change in the reflector electrode voltage changes the frequency of the McNally oscillator tube. This system maintains the voltage on the reflector electrode of the local oscillator at about —100 volts and maintains its frequency at about 2,770 mc.

(5) *Sawtooth oscillator.* The output of the sawtooth oscillator is a sawtooth voltage wave which varies between —160 volts and —80 volts at a rate of approximately 1 cycle per second. This voltage is applied to the reflector electrode of the local oscillator, thus varying its frequency over a wide range. At one particular frequency within this range, the A.F.C. circuit starts functioning, after which the sawtooth oscillator is effectively removed from the circuit.

b. I-F CHANNEL. The i-f channel amplifies the signal from the signal crystal mixer. There are six i-f stages. The second and third i-f stages differ slightly from the others in that the S.T.C. and gain voltages are fed into the grids of these stages.

c. SECOND DETECTOR. The second detector follows the i-f channel in the receiver. It receives the i-f output of the i-f channel and rectifies it, forming the negative video pulses.

d. FIRST VIDEO AMPLIFIER. The first video amplifier receives and amplifies the negative video pulses from the second detector.

e. D-C RESTORER. The d-c restorer following the first video amplifier returns the grid of the second video amplifier to normal bias following any signal. This is necessary to prevent any small signal from being lost because of abnormal bias on the tube.

f. SECOND VIDEO AMPLIFIER. The second video amplifier amplifies the positive pulses received from the first video amplifier. Negative pulses from this stage are fed to the indicator control.

g. SENSITIVITY TIME CONTROL (S.T.C.). This circuit is located in Indicator Control BC–1193–A but is considered a part of the receiver system.

(1) *S.T.C. generator.* In order to start the action of the S.T.C. circuit with the beginning of the sweep, a gate from the sweep circuit is the input to the S.T.C. generator. The output of the S.T.C. generator is the exponential waveform shown on the block diagram. This wave starts at approximately 80 volts and decays exponentially to about zero volts in approximately 90 microseconds. The output of this stage can be adjusted by means of the control marked S.T.C. WIDTH. Changing the position of the control changes the rate of fall of the output waveform. The S.T.C. WIDTH control is shown in figure 105.

(2) *S.T.C. clipper.* This stage clips a portion of the top of the waveform from the S.T.C. generator. The level at which the clipping takes place depends on the position of the S.T.C. DEPTH control, shown in figure 105.

(3) *S.T.C. cathode follower.* The S.T.C. cathode follower is a conventional cathode follower, the output of which is variable from zero to 95 percent of the input. This variation is controlled by the S.T.C. AMPLITUDE control shown in figure 104.

(4) *S.T.C. amplifier.* The S.T.C. amplifier amplifies the output of the S.T.C. cathode follower. The output of this stage is the S.T.C. waveform which is fed to the grids of the second and third i-f stages.

h. GAIN CONTROL. The RECEIVER gain control shown in figure 104 varies the value of the d-c voltage which is mixed with the S.T.C. waveform and applied to the grids of the second and third i-f stages. This control can vary the d-c voltage of the S.T.C. waveform between zero and approximately —10 volts.

38. Circuit Details

This paragraph gives a detailed discussion of each stage in the receiver system. Figure 73 is a simplified schematic diagram of the A.F.C. circuit; figure 90 represents the simplified schematic diagram of the signal channel and S.T.C. circuit. A complete schematic diagram of the receiver is shown in figure 99. Figure 74 shows the location of the tubes on the receiver chassis.

(1) *Movement of electrons.* The electrons emitted by the cathode of the tube are formed into a beam in much the same manner as in a cathode-ray tube. This beam of electrons passes through the two cavity grids and continues toward the reflector electrode. The negative voltage on the reflector electrode, however, repels the electrons, slows them up, turns them around, and sends them back through the cavity grids on a return trip. The beam of electrons thus passes through the cavity grids twice.

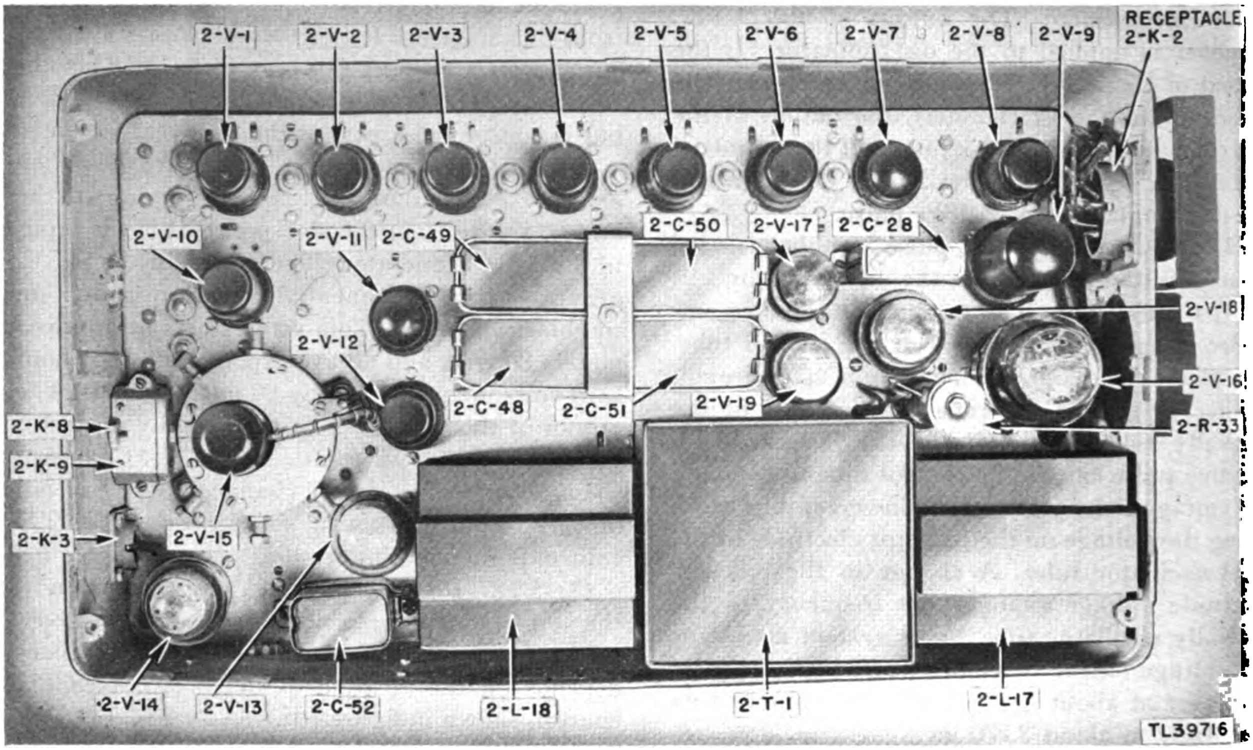


Figure 74. Radio Receiver BC–1223–A, top view of chassis.

a. Local Oscillator. Figure 74 shows the local oscillator tube 2–V–15 mounted in the receiver. Figures 75 and 76 show assembled and disassembled views respectively. The tube is a McNally 707B of the velocity-modulated type. It is a low-powered oscillator designed for a wavelength range of 8 to 12 cm. The tube is used with a resonant cavity, most of which is external to the vacuum of the tube. The cavity may be removed and used with any tube of the same type. A cross-section diagram of the McNally tube is shown in figure 77. Note that the tube contains an indirectly heated cathode, an accelerating grid, part of the resonant cavity (space), two cavity grids, and a reflector electrode. The voltages applied to the electrodes are indicated in the diagram. The output of the oscillator is taken from the coupling loop which projects into the cavity.

(2) *Action of cavity and cavity grids.* The oscillations of the cavity are produced as the result of electrons in the walls of the cavity surging back and forth approximately 2,770,000,000 times a second (2,770 mc). During these oscillations, the electrons in the wall of the cavity pile up first on one cavity grid and then on the other cavity grid, thus producing an electric field between the two grids of the cavity which alternately speeds up and slows down the beam of electrons as it passes through the cavity grids. This action results in a grouping or bunching of the electrons in the beam. The bunches of electrons are turned back by the reflector, and on their way back the

bunches arrive at the proper instant to reinforce the oscillations of the electrons in the walls of the cavity.

(3) *Start of oscillation.* In the preceding paragraph, it was stated that the oscillation of the electrons in the wall of the cavity produces an oscillating field between the cavity grids which is responsible for the bunching of the electrons. A question which is sometimes puzzling is this: What *starts* this oscillating field? The answer is that actually a weak oscillation is started in the cavity by the approach of the very first electrons in the beam. From this point on the oscillations rapidly build, because the returning bunches of electrons reinforce the oscillation of the electrons in the walls of the cavity. Whether or not the oscillations are reinforced and maintained depends upon the tuning of the cavity, the spacing between the cavity grids, and the voltages applied to the various electrodes of the tube. The control grid voltage has an important effect on whether the tube will oscillate, because it determines the speed of the electrons in the beam. The reflector grid voltage is also important because it determines how long the bunches of electrons take to return to the cavity grids, where they give up

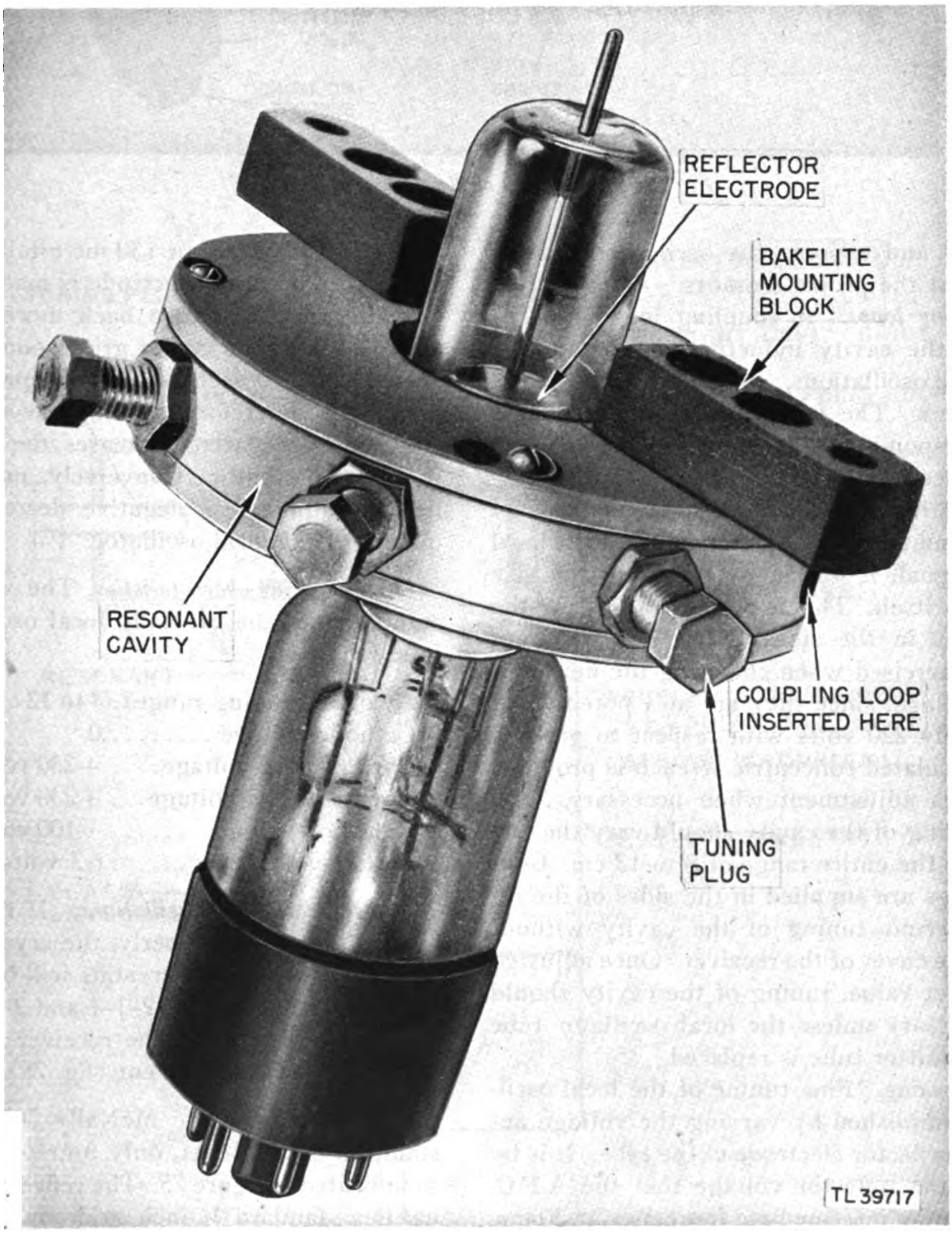


Figure 75. Local oscillator, assembled.

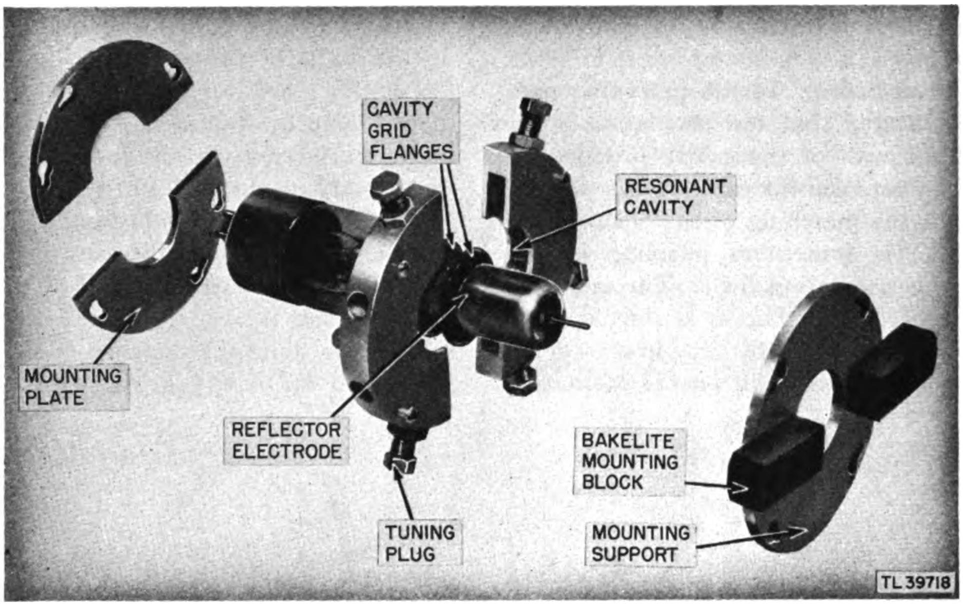


Figure 76. Local oscillator, disassembled.

their energy and support the oscillation only if they arrive at the proper instants.

(4) *Coupling loops.* A coupling loop (fig. 77) inserted in the cavity inductively picks up the energy of the oscillations, which is then fed to the crystal mixers. The frequency of the oscillator output corresponds to the frequency at which the cavity has been set.

(5) *Coarse tuning.* The resonant frequency of the cavity, and therefore the frequency of the local oscillator signal, is varied by changing the size of the cavity itself. This is done by adjusting the tuning plugs in the sides of the cavity. Care should be exercised when changing the mechanical tuning plugs, since they are at a potential of approximately 220 volts with respect to ground. A special insulated concentric wrench is provided to make this adjustment when necessary. Mechanical tuning of the cavity should vary the frequency over the entire range of 8 to 12 cm. Covered openings are supplied in the sides of the receiver to permit tuning of the cavity without removing the cover of the receiver. Once adjusted to the correct value, tuning of the cavity should not be necessary unless the local oscillator tube or the transmitter tube is replaced.

(6) *Fine tuning.* Fine tuning of the local oscillator is accomplished by varying the voltage applied to the reflector electrode of the tube. It is by controlling the reflector voltage that the A.F.C. circuit holds the intermediate frequency at 30 mc. The A.F.C. tuning range of the reflector voltage is approximately ±15 mc (30 mc total). If the voltage on the reflector electrode is made more negative, the electrons turn back more quickly and arrive back at the cavity grids sooner. Since the period has been decreased, the frequency has been increased. Therefore, making the reflector electrode more negative increases the frequency of the local oscillator. Conversely, making the reflector voltage less negative decreases the frequency of the local oscillator.

(7) *Operating characteristics.* The operating characteristics of the McNally local oscillator are as follows:

Available tuning range	8 to 12 cm wavelength
Cathode voltage	0
Control grid voltage	+230 volts
Cavity (shell) voltage	+230 volts
Reflector voltage	−100 volts
Heater voltage	6.3 volts a-c

(8) *Indications of oscillations.* If the local oscillator is operating properly, the crystal current in the A.F.C. and signal crystals will be between 0.3 and 0.4 ma. Test jacks 2–J–1 and 2–J–2 are available at the bottom of the receiver for the measurement of crystal current (fig. 78).

(9) *Mounting.* The McNally 707B tube fits a standard octal socket, only four pins being used, as indicated in figure 75. The reflector plate terminal is a standard ⅜-inch grid cup, located at the top of the tube. The r-f outputs are taken from

two cable connectors, 2–K–8 and 2–K–9, leading to the coupling loop inside the cavity. The attached cords 24 and 25 are dielectric-filled flexible coaxial lines. These cords lead to the signal mixer and the A.F.C. mixer in the r-f unit.

(10) *Power supply.* The 230 volts is applied to the control grid and the resonant cavity from the 275-volt supply in the receiver (fig. 73) through resistor 2–R–37. Capacitor 2–C–47 is a bypass or decoupling capacitor. It filters out r-f variations in voltage.

b. A.F.C. Crystal Mixer. The function of the A.F.C. crystal mixer is to combine the attenuated transmitter pulses from the A.F.C. coupler with the output of the local oscillator to produce an intermediate-frequency signal which is applied to the A.F.C. circuit of the receiver. When two signals are mixed in a nonlinear device such as the crystal mixer, the output is the sum and difference frequencies as well as the original input frequencies. In most mixers the output used is the difference frequency, and therefore the others are no longer required and are usually filtered out. An example of such a mixer circuit is shown in figure 79. The frequency of the McNally oscillator tube 2–V–15 is adjusted to 30 mc below the frequency of the transmitting oscillator, and in the crystal mixer the two frequencies are combined to produce a difference frequency of 30 mc. The crystal mixer contains a specially designed silicon crystal detector. Figures 80 and 81 are photographs of the disassembled crystal mixer, showing the major features of its construction. Figure 82 is a cross-section drawing of the mixer with

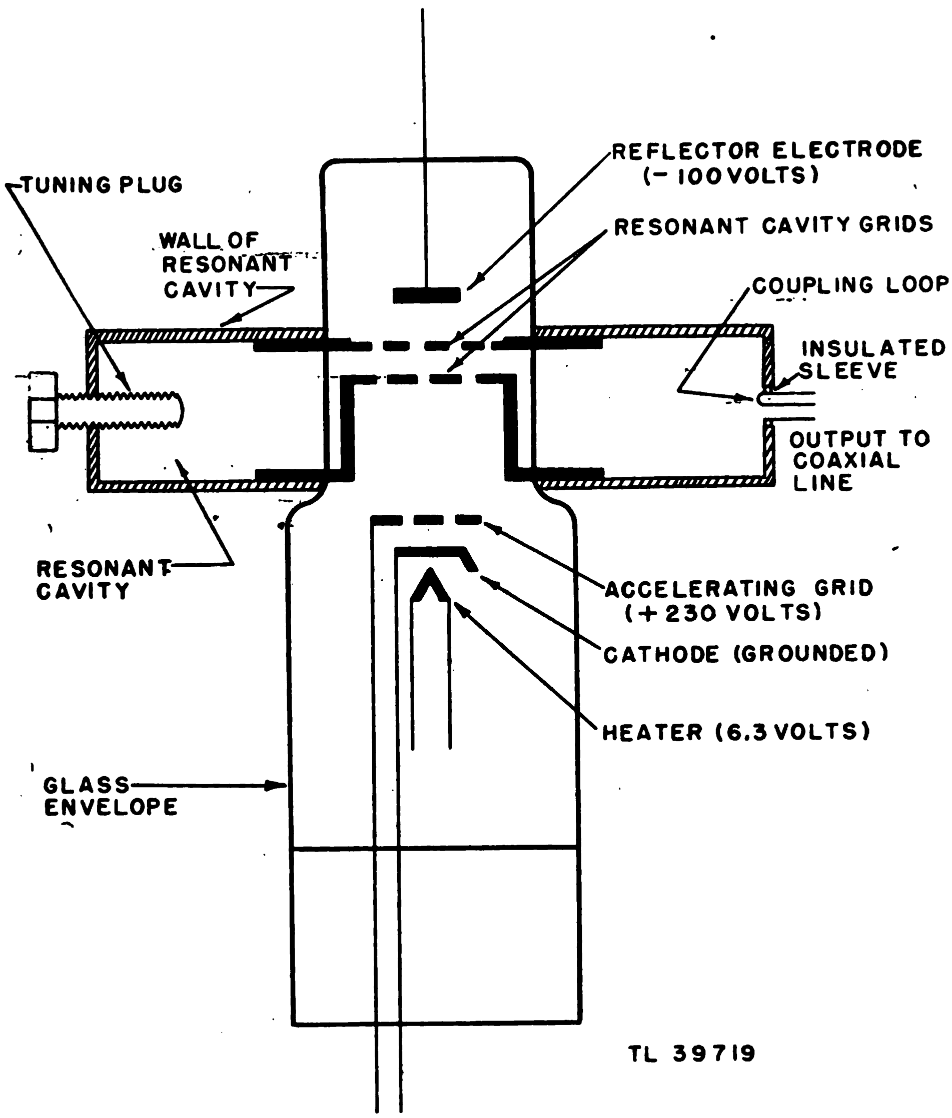


Figure 77. Local oscillator, cross-sectional diagram.

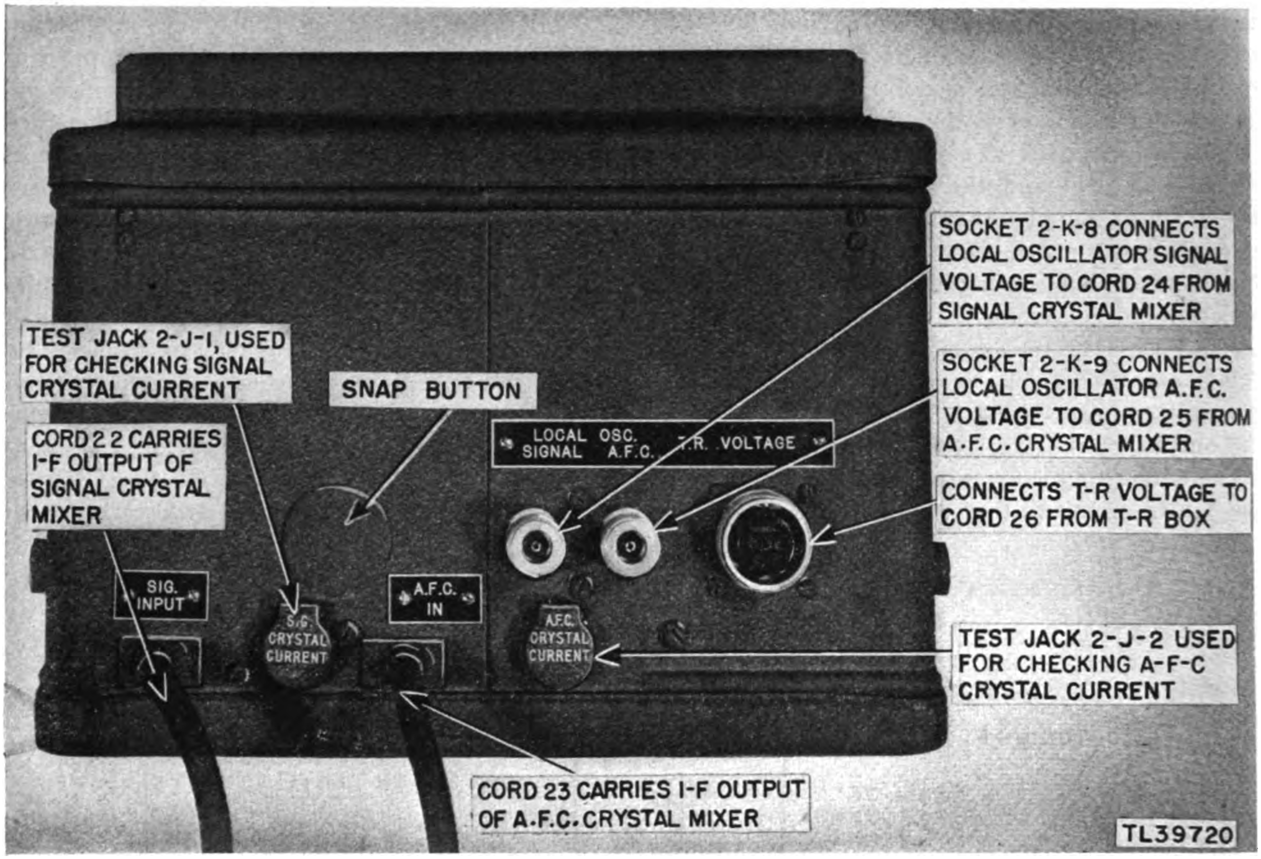


Figure 78. Radio Receiver BC–1223–A, end view of chassis.

the crystal cartridge in place, showing the interior details of construction. The entire unit is attached directly to the A.F.C. coupler by means of the mounting plate. The input r-f voltage from the local oscillator enters the crystal mixer at the connection indicated, and the output signal from the crystal mixer is taken from the second coupling through a flexible cord to the A.F.C. amplifier.

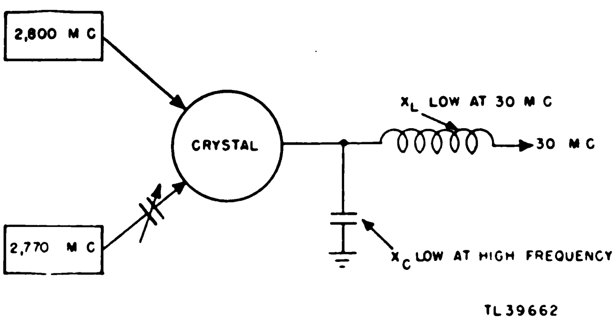


Figure 79. Crystal mixer circuit, simplified diagram.

(1) *Operation of A.F.C. crystal mixer.* The operation of the crystal mixer will be explained with the aid of figures 82 and 83. The r-f signal from the A.F.C. coupler enters a cavity made by the hollow shell of the mixer itself, with the coupling loop at the input end and the crystal at the output end. This cavity is designed to be resonant at the frequency (approximately 2,800 mc) of the input signal from the A.F.C. coupler. The loop at the input end has a low impedance, while the output end of the mixer cavity is open except for the crystal load, and so presents a relatively high impedance. The cavity is designed to act as a step-up transformer and therefore applies a high r-f voltage to the crystal. The local oscillator voltage from the McNally tube is capacitively coupled into the mixer cavity by means of the rod-and-disk coupling shown, through a sliding sleeve connection to the input line. The amount of coupling is made variable by means of a knurled thumbscrew.

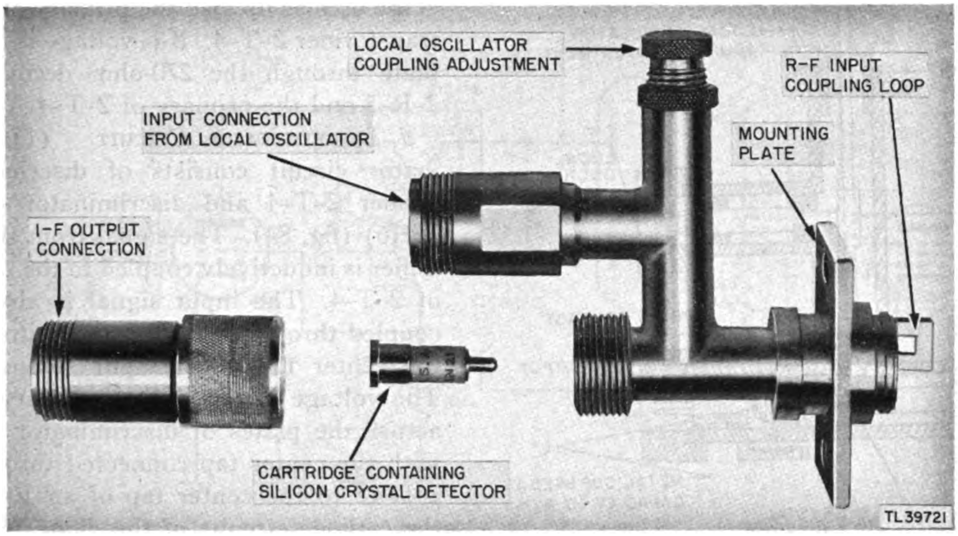


Figure 80. A.F.C. crystal mixer, partially disassembled.

(2) ***Mounting of crystal.*** The crystal cartridge is clamped in place by means of an insulating washer. A short metal stub at one end of the cartridge is tightly gripped by spring fingers which make contact with the inner conductor of the coaxial resonant mixer cavity. The metal base of the cartridge makes contact with the inner conductor of the coaxial output line which carries the i-f output of the A.F.C. crystal mixer to the A.F.C. amplifier. The cartridge contains a silicon crystal which acts as an r-f rectifier, to produce the 30-mc output signal. The base contact on the cartridge connects to a special ¼-wave r-f choke (fig. 83). The r-f choke consists of a cylindrical metal cup very closely spaced to, but insulated from, the outer wall of the mixer. The r-f choke is approximately ¼ wavelength at 2,800 mc. Thus to 2,770 or 2,800 mc it offers a theoretically infinite impedance at the open end, since the other end is shorted (zero impedance). The close spacing between the r-f choke and the outer wall of the mixer serves as a capacitor to ground to bypass

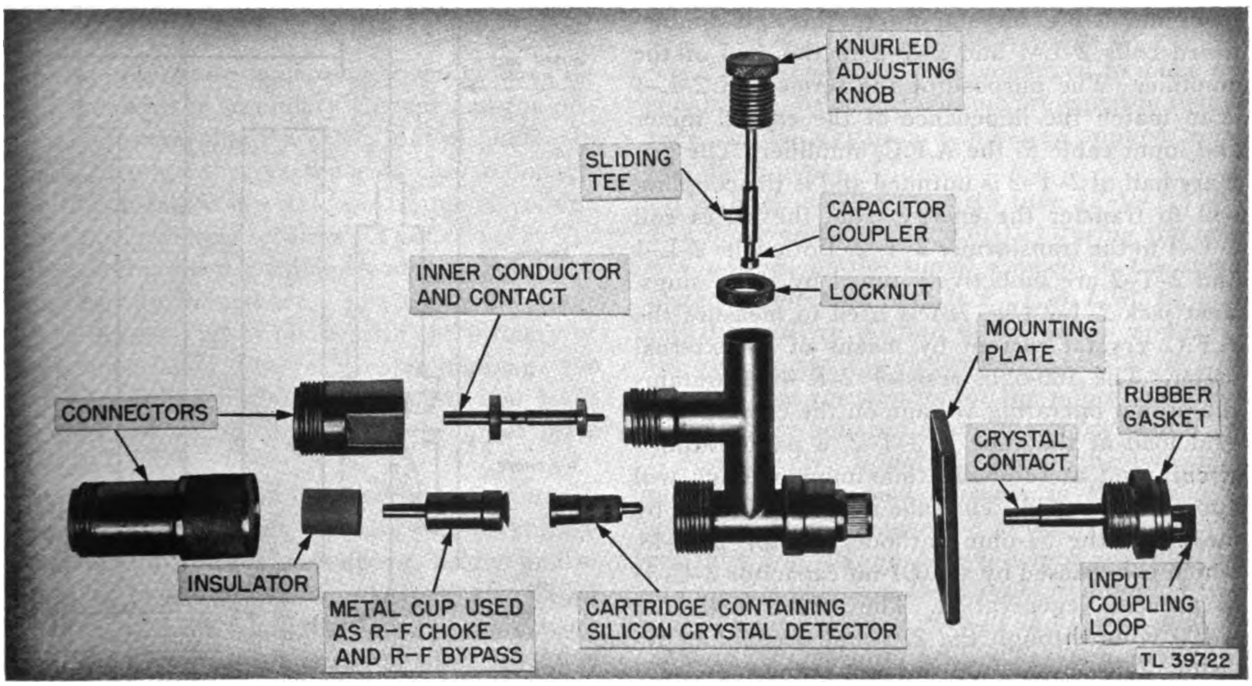


Figure 81. A.F.C. crystal mixer, completely disassembled.

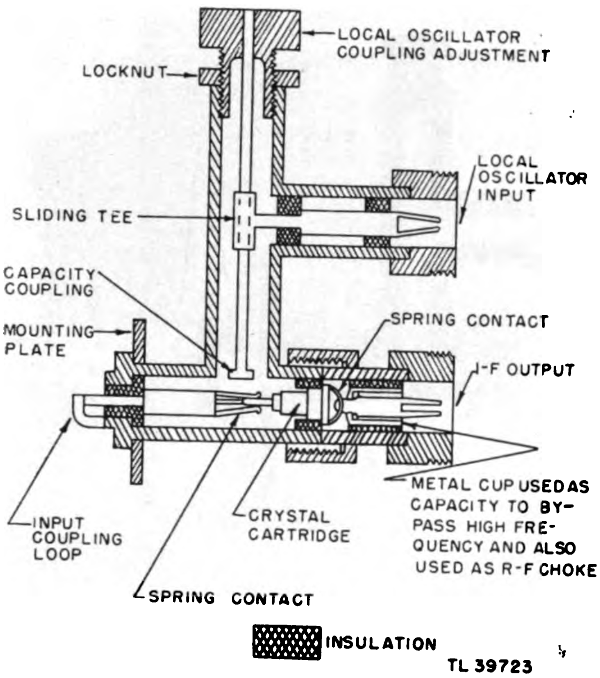


Figure 82. A.F.C. crystal mixer, cross-sectional diagram.

the higher frequencies. The ¼-wave choke offers almost no impedance to the 30-mc frequencies, while the capacitor offers a high impedance; thus signals at the intermediate frequency will be passed and all others rejected.

c. A.F.C. Amplifier. The input of the A.F.C. amplifier 2–V–10 (6AC7) (figs. 73 and 84) is coupled through a 72-ohm coaxial cord (cord 23) from the A.F.C. crystal mixer through double-tuned coils 2–L–1 and 2–T–2 to the grid of the amplifier. The purpose of the series coil 2–L–1 is to match the impedance of the crystal mixer and input cable to the A.F.C. amplifier. The primary half of 2–T–2 is untuned and is the coupling coil to transfer the energy from the series coil 2–L–1 to the transformer 2–T–2. Both coils 2–L–1 and 2–T–2 are inductively tuned by brass slugs. Test jack 2–J–2 (fig. 78) is used to measure the A.F.C. crystal current by means of an external meter. The 100-ohm resistor 2–R–49 maintains the proper operating voltage on the crystal. The grid load of the tube is 2–T–2, a parallel-tuned circuit, and at resonance maximum voltage will appear at the grid. The tube is biased Class A by means of the 51-ohm cathode resistor 2–R–48, which is bypassed by a 0.001-mf capacitor 2–C–34 to prevent degeneration. The screen is tied to +100 volts through the 270-ohm decoupling resistor 2–R–5. A 0.001-mf capacitor (2–C–35) serves as the screen bypass. The plate of this stage uses as its load the primary of discriminator transformer 2–T–4. B+ voltage is applied to this plate through the 270-ohm decoupling resistor 2–R–5 and the primary of 2–T–4.

d. Discriminator Circuit. (1) The discriminator circuit consists of discriminator transformer 2–T–4 and discriminator diode 2–V–11 (6H6) (fig. 84). The signal from the A.F.C. amplifier is inductively coupled to the split secondary of 2–T–4. The input signal is also capacitively coupled through a 22-mmf capacitor (2–C–36) to the center tap of the split secondary winding. The voltage of this split secondary is impressed across the plates of discriminator diode 2–V–11 with the center tap connected through r-f choke 2–L–15 to the center tap of an R-C network in the cathode circuits of the diode. Both tank circuits are sharply tuned to 30 mc. The circuit constants of the tuned tank circuits are so adjusted that, when the frequency fed to the tuned tank circuits is exactly 30 mc, there will be a 90° difference of phase between the signal reaching the plates of the 6H6 tube by means of the coupling capacitor and the signal reaching the plates due to the voltage transfer between the coils.

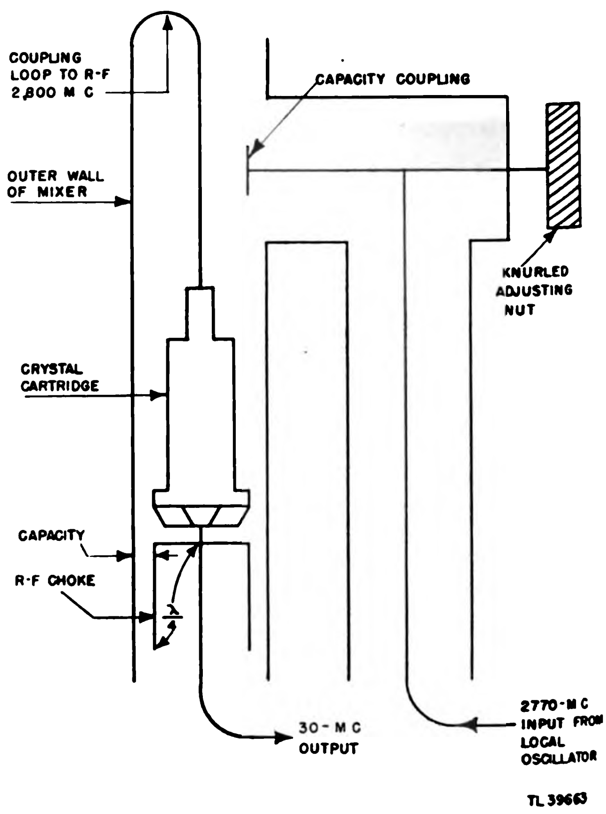


Figure 83. Crystal mixer, simplified cross-sectional diagram.

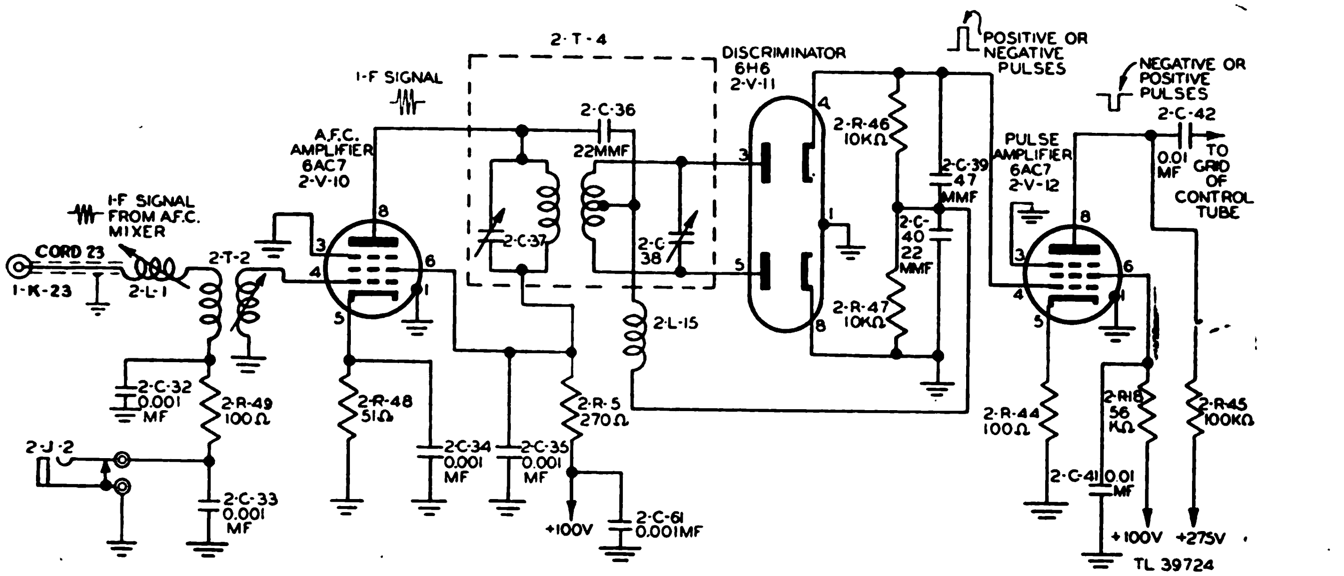


Figure 84. A.F.C. amplifier, discriminator, and pulse amplifier, simplified schematic diagram.

(2) The signal voltages reaching either plate of the 6H6 tube by means of the coupling capacitor are in phase with each other and also in phase with the voltage across the primary coil. These voltages are used as a *reference* voltage in the following discussion (since they are all in phase). The induced voltage in the secondary coil is 180° out of phase with the reference voltage in the primary coil. This induced voltage is small but causes a large current to flow in the series circuit formed by the secondary tank circuit, when the circuit is resonant. At series resonance the induced voltage and the secondary current are in phase, since the inductive and capacitive reactances cancel; therefore, the secondary current and the primary reference voltage are 180° out of phase. In flowing through the reactance of the secondary, the current builds up a large resonant voltage which appears across terminals *A* and *C* (fig. 85 ①). In the coil this *reactive* voltage leads the current by 90°, as in any inductance. The reactive voltage is therefore 90° out of phase with the primary or reference voltage. The reactive voltage lags the reference voltage by 90° at one plate and leads the reference voltage by 90° at the other plate of 2–V–11.

(3) Figure 85 shows the discriminator circuit, its equivalent r-f circuit, and the various voltage relationship for frequencies above, below, and at resonance. In the equivalent r-f circuit (fig. 85 ②) note that only the r-f signal voltages are considered. These voltages are represented as signal generators. The voltage applied between the upper diode plate and cathode is the drop between *A* and *D*. This is the *vector* sum of the reactive voltage across the upper half of the secondary *A* to *B*, and the reference voltage of the primary *B* to *D*. Similarly the voltage applied to the lower diode plate is the reactive voltage across the lower half of the secondary, *C* to *B*, plus the primary reference voltage, *B* to *D*.

(4) When the i-f signal is exactly 30 mc, the reactive voltage across the secondary, *A* to *C*, is 90° out of phase with the reference voltage across the primary, *B* to *D* (fig. 85 ③). Thus E_{CB} leads E_{BD} by 90°, while E_{AB} lags E_{BD} by 90°. Since the secondary is center-tapped to make E_{AB} equal to E_{CB}, the vector sums are equal in magnitude. Equal signals are therefore applied to the two diode plates.

(5) Each half of the 6H6 tube (2–V–11) acts as a diode rectifier (fig. 85 ①). During the positive portion of the signal applied to the upper plate, the electron path is *E, A, B, L, F, E*. During the positive portion of the signal applied to the lower plate, the electron path is *G, C, B, L, F, G*. The load resistances for the upper and lower rectifiers are between *E* and *F* and between *F* and *G* respectively. Equal signals on the two diode plates produce equal currents in the cathodes, which in turn produce d-c voltage drops across resistors 2–R–46 and 2–R–47 which are equal but of opposite polarity. Both resistors together with the 22-mmf capacitor 2–C–40 and the 47-mmf capacitor 2–C–39, form a filter network to convert the rectified voltage to 1-microsecond video

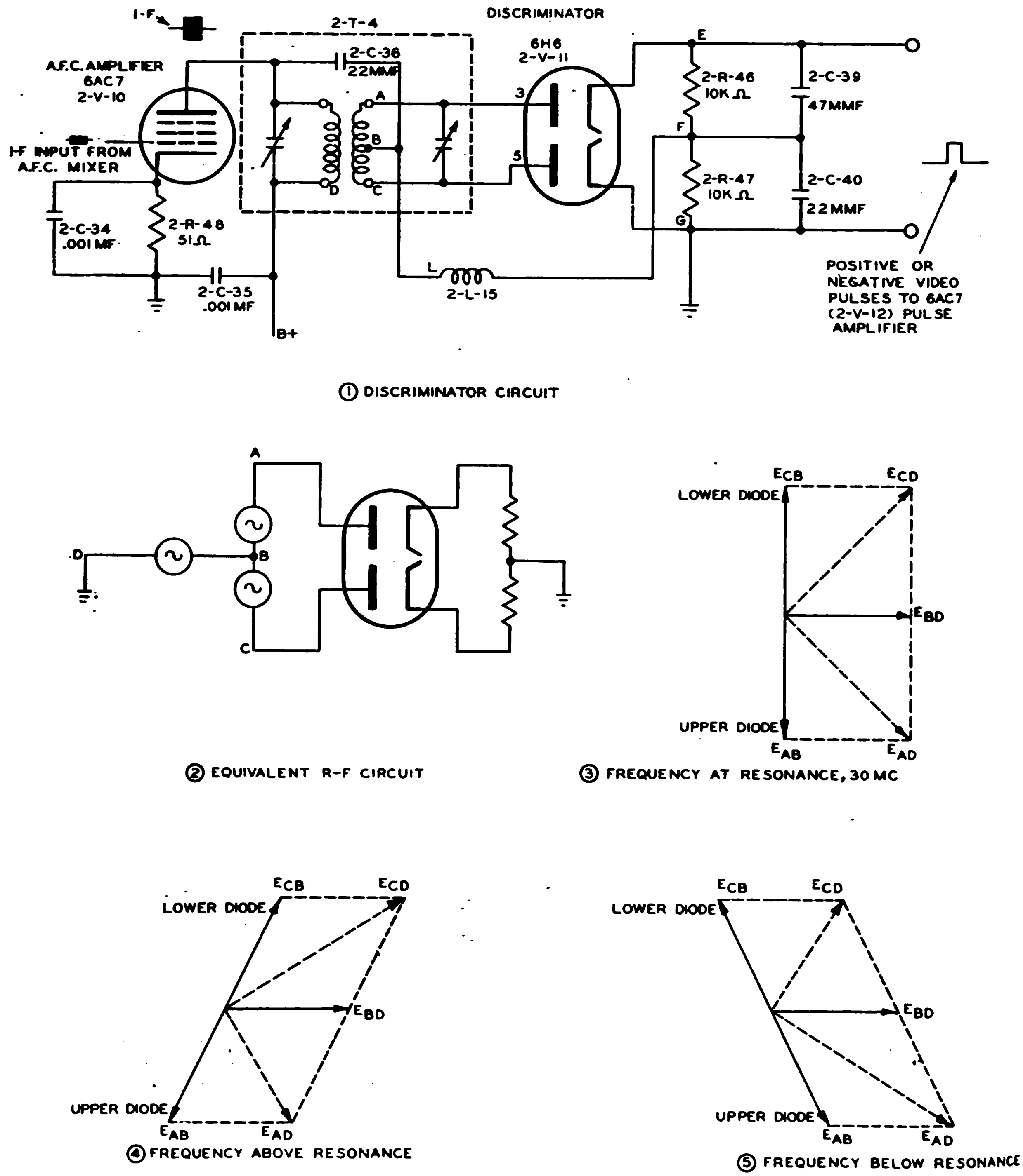


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Figure 85. Discriminator circuit; schematic, equivalent r-f circuit, and vector diagrams.

pulses. The two voltages tend to buck or cancel each other. The final rectified votlage present across the resistors from point *E* to *G* (ground) is zero. The output to the pulse amplifier 2–V–12 is therefore zero.

(6) If the i-f signal fed to the tank circuits varies from 30 mc one way or the other, the secondary tank circuit across the plates of the 6H6 tube will appear either as an inductance or capacitance. From the viewpoint of internal current, the secondary tank circuit is a series resonant circuit. A series resonant circuit appears as pure resis-

tance at the resonant frequency, as capacitive reactance below the resonant frequency, and as inductive reactance above the resonant frequency. Off the resonant frequency the secondary tank circuit is no longer tuned to resonance, and the reactive voltage (*A* to *C*) no longer differs from the reference voltage *D* to *B* by 90°. If the frequency increases, the voltage *induced* across the secondary coil is still 180° out of phase with the primary reference voltage *B* to *D*; however, because of the increased inductive reactance in the secondary tank circuit, the current in this tank circuit lags the induced voltage. The reactive voltage developed across terminals *A* to *C* (fig. 85 ①) therefore lags the reference voltage *B* to *D*. In figure 85 ④, E_{AB} lags E_{BD} by more than 90°. If the frequency decreases, the additional capacitive reactance causes E_{AB} to lag E_{BD} by less than 90° (fig. 85 ⑤). In the former case the voltage applied to the lower diode plate is greater (fig. 85 ④), and the d-c output to the pulse amplifier 2–V–12 is negative pulses. In the latter case conditions are reversed (fig. 85 ⑤), and the d-c output will be positive pulses.

(7) Note that the filter capacitors 2–C–39 and 2–C–40 are not of the same value. This is to compensate for stray capacitance in the discriminator circuit, and because capacitors 2–C–40 and 2–C–36 (both 22 mmf) are effectively in parallel.

(8) The output of this discriminator diode then is either positive or negative pulses, depending upon whether the intermediate frequency is below or above 30 mc; these are then applied directly to the grid of pulse amplifier 2–V–12.

e. Pulse Amplifier. Pulse amplifier tube 2–V–12 (fig. 84) is used to amplify the d-c pulses from the discriminator. It uses as its grid load the R-C network in the output of discriminator diode 2–V–11. Plate voltage for this tube is supplied through the 100,000-ohm plate-load resistor 2–R–45 from the + 275-volt source. The screen voltage is applied through the 56,000-ohm screen resistor 2–R–18 from the + 100-volt source. The tube is biased by means of the 100-ohm cathode resistor 2–R–44. This resistor is not bypassed and allows degeneration to limit the output of the tube should the input from the discriminator be too large. The output is taken from the plate

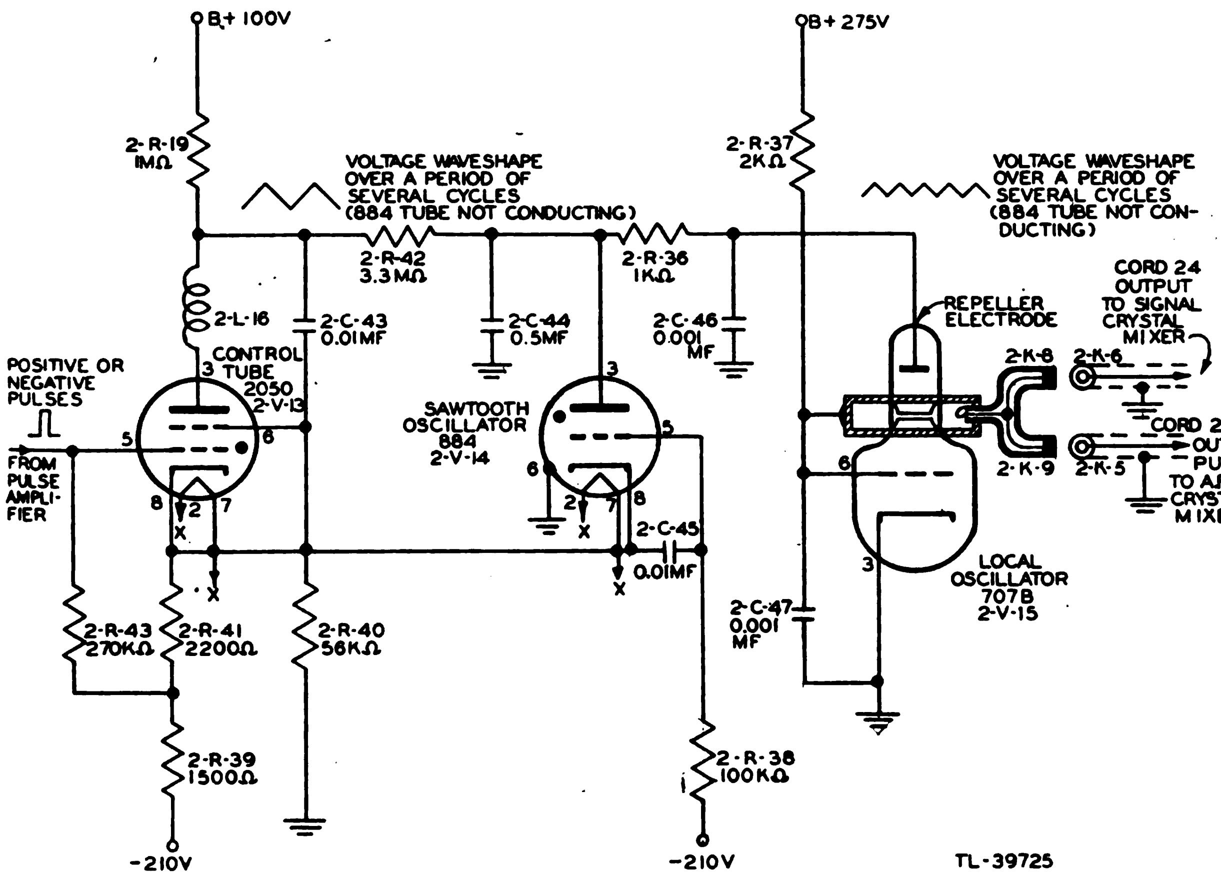


Figure 86. A.F.C. control tube, sawtooth oscillator, and local oscillator, simplified schematic diagram.

through the 0.01-mf coupling capacitor 2–C–42 to the grid of the 2050 control tube 2–V–13.

f. CONTROL TUBE AND SAWTOOTH OSCILLATOR. Both the 2050 control tube 2–V–13 and the 884 sawtooth oscillator 2–V–14 (fig. 86) are normally biased to cut-off.

(1) *Control tube*. The 2050 control tube 2–V–13, a gas tetrode, has its grid connected through the 270,000-ohm resistor 2–R–43 and the 1,500-ohm decoupling resistor 2–R–39 to —210 volts. The cathode and grid shield are tied together and have a voltage slightly more positive than the grid. This cathode voltage is supplied by the — 210-volt supply through the 1,500-ohm resistor 2–R–39 and is dropped through the voltage divider resistors of 2,200 ohms (2–R–41) and 56,000 ohms (2–R–40) to ground. Plate voltage is applied from the + 100-volt source through a 1-megohm resistor (2–R–19) and an r-f choke (2–L–16). Choke 2–L–16 is used to limit the current when the tube is conducting and discharging the 0.01-mf capacitor 2–C–43.

(2) *Sawtooth oscillator*. The 884 gas triode 2–V–14 has the same cathode voltage as the 2050 since both cathodes are tied together. The grid of the 884 is connected to — 210 volts through a 100,000-ohm resistor (2–R–38). Plate voltage for the type 884 tube (2–V–14) is from the + 100-volt source through the 1-megohm resister 2–R–19 and the 3.3-megohm resistor 2–R–42. The 3.3-megohm resistor in connection with the 0.5-mf capacitor 2–C–44 has a long time constant. The 1,000-ohm resistor 2–R–36 and the 0.001-mf capacitor 2–C–46 constitute a filter network to help filter out any sawtooth ripple of voltage applied to the reflector of the local oscillator.

(3) *Circuit operation*. When the set is first turned on, the B + voltage is applied to the 884 tube, and it fires, placing a potential of approximately —-160 volts on 0.5-mf capacitor 2–C–44 and the reflector of the local oscillator. The 884 then cuts off and the 0.5-mf capacitor discharges slowly through the 3.3-megohm resistor 2–R–42 and the 1-megohm resistor 2–R–19. This discharging of the capacitor sweeps the voltage on the local oscillator from — 160 volts up to approximately — 80 volts. At this time, the cycle is repeated unless the A.F.C. circuit operates and causes 2050 tube 2–V–13 to fire. This cycle takes approximately 1 second. As the sawtooth voltage sweeps the local oscillator voltage from — 160 volts to — 80 volts, the frequency of the local oscillator will change ± 15mc. At approximately the middle of the sweep, the frequency of the local oscillator is 2,770 mc. Since the transmitter frequency is 2,800 mc, the intermediate frequency is 30 mc. As the sweep continues to rise, the frequency of the local oscillator decreases, therefore increasing the intermediate frequency above 30 mc. At this time the A.F.C. circuit starts to function as explained below.

(*a*) When the intermediate frequency is higher than 30 mc (fig. 87), the output of the discriminator is a negative pulse (see *d* above). The negative pulse after passing through the pulse amplifier becomes a positive pulse and is applied to the grid of the 2050 tube 2–V–13. When the bias on the grid of the 2050 tube goes above — 3

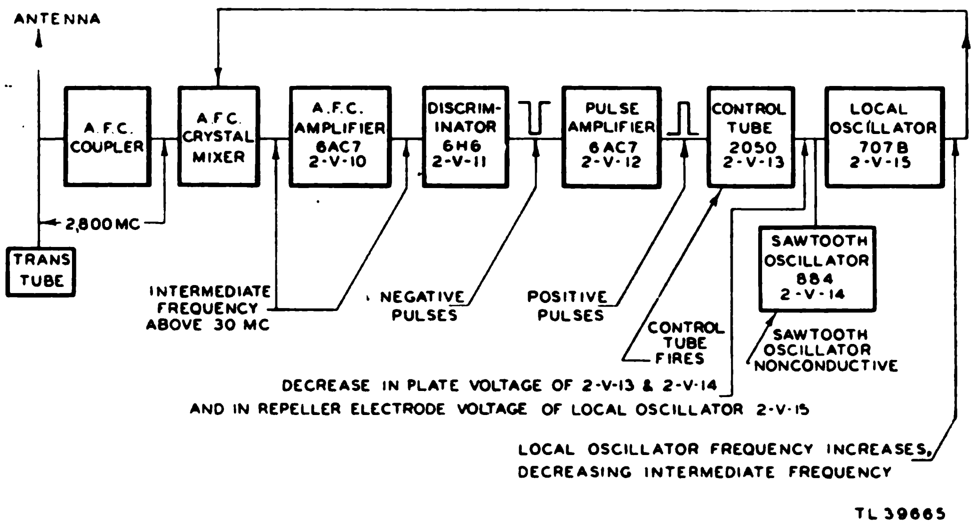


Figure 87. A.F.C. circuit, effect of high intermediate frequency.

volts, the tube will fire, capacitor 2–C–43 will discharge, and the plate voltage will go highly negative and cut the tube off. The 884 tube 2–V–14 is also cut off and remains cut off during normal operation. The 0.01-mf capacitor 2–C–43 across the 2050 tube 2–V–13 takes a fairly long time to charge through the 1-megohm resistor 2–R–19. The decrease in voltage at the plate of the 2050 tube lowers the voltage at the repeller electrode of the local oscillator tube 2–V–15 and causes its frequency to increase above 2,770 mc. The output of the local oscillator tube is then mixed with the transmitter signal voltage, 2,800 mc, and thus lowers the intermediate frequency (i.f.) to slightly below 30 mc. Summing up, it is evident that a high intermediate frequency causes the A.F.C. circuit to change the intermediate frequency to lower than 30 mc.

(*b*) The A.F.C. circuit operation when the intermediate frequency is lower than 30 mc is illustrated in figure 88. The low i-f signal voltage is passed through the A.F.C. amplifier tube 2–V–10, and causes the discriminator to apply while at the plate of the 884 and at the repeller electrode of the local oscillator it is only a fraction of 1 volt, because of the large filter circuit to the local oscillator reflector. This small increase in voltage, however, is sufficient to decrease the frequency of the local oscillator 2–V–15 to slightly below 2,770 mc. When the output of the local oscillator is mixed with the transmitter signal voltage (2,800 mc) in the A.F.C. crystal mixer, the intermediate frequency increases to slightly above 30 mc. The foregoing shows that a low intermediate frequency causes the A.F.C. circuit to raise the intermediate frequency.

(*c*) The action covered in (*a*) and (*b*) above then repeats itself. The A.F.C. circuits will therefore continually vary the intermediate frequency back and forth through 30 mc (fig. 89). Actually the frequency variation is relatively small, about ± ½ mc. If the magnetron frequency varies slightly, the intermediate frequency goes above or below 30 mc, therefore causing the same action described in (*a*) and (*b*) above. The magnitude of the pulse from the pulse amplifier 2–V–12 when

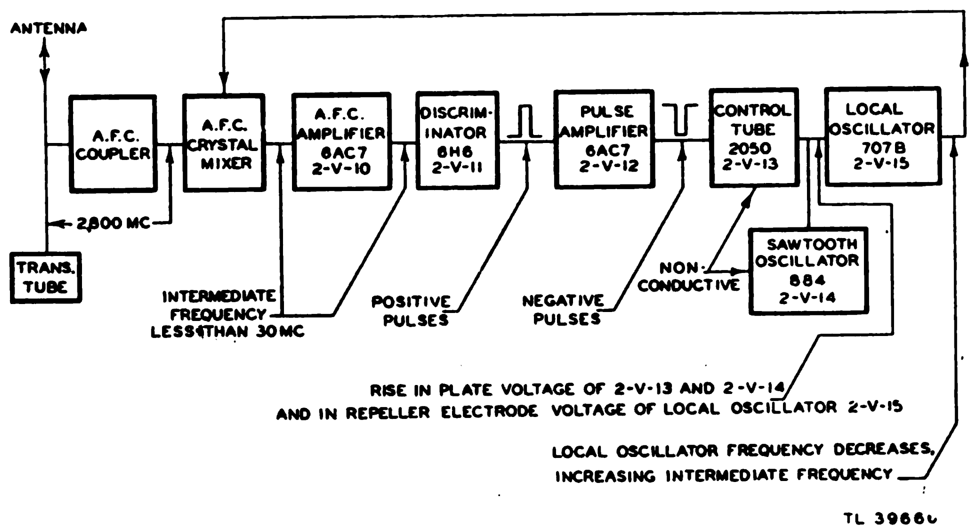


Figure 88. A.F.C. circuit, effect of low intermediate frequency.

positive pulses to the pulse amplifier tube 2–V–12. Since the output of 2–V–12 is a negative pulse, the control tube 2–V–13 remains nonconductive. The 2–V–14 also remains cut off. The 0.01-mf capacitor 2–C–43, which was previously discharged by the firing of the 2050 tube 2–V–13, slowly charges through the 1-megohm resistor 2–R–19. This causes the plate voltage to vary slowly over a range from low to high. The change in voltage at the plate of the 2050 is considerable, the intermediate frequency is slightly higher than 30 mc is such that the 2050 fires approximately 200 times per second. This is sufficient to maintain the local oscillator reflector voltage at a fixed negative value of approximately — 100 volts, thus holding the frequency of the local oscillator at a fixed value to give an almost perfect i-f output. The slight variation of voltage on the reflector of the local oscillator during normal operation is not enough to cause a frequency variation that would decrease the over-all sensitivity of the receiver. The 884 tube 2–V–14 is inactive as long as signals are received through the pulse amplifier to operate the 2050 tube 2–V–13, since the plate voltage will remain too negative to allow 2–V–14 to fire.

(*d*) If the magnetron frequency suddenly shifts to give an intermediate frequency beyond the range of the i-f amplifier, there will be no i-f pulse to cause the discriminator to supply a pulse to the 2050 tube 2–V–13. The 0.5-mf capacitor 2–C–44 then discharges, and the 884 tube 2–V–14 fires again. The repeller plate voltage falls, then gradually increases in a positive direction until the correct intermediate frequency is reached. The previously described 2050 control action is then repeated.

(4) *Emergency tuning.* If the A.F.C. fails to work, a potentiometer can be connected from cathode to plate of the 884 tube 2–V–14 and the reflector voltage set manually. This is the function of an emergency tuner supplied with the set. It plugs into the 884 socket, and the local oscillator is tuned by varying the position of the dial on the end of the emergency tuner.

g. Signal Crystal Mixer. The function of the signal crystal mixer is to combine the received echo signals with the output of the local oscillator to produce an i-f signal which can be amplified in the i-f circuits of the receiver.

(1) *Operation and mounting of signal crystal mixer.* The operation and mounting of the signal crystal mixer is identical with that of the A.F.C. crystal mixer, discussed in *b* above. For this reason these aspects of the signal crystal mixer will not be discussed here.

(2) *Coupling to signal crystal mixer.* Since the input echo signal is always weak, the coupling of the signal crystal mixer to the T-R cavity is as tight as possible. On the other hand, since the output of the McNally local oscillator is very much stronger, it is only loosely coupled to the signal crystal mixer; as a result of this loose coupling, only a very small part of the echo signal is lost in the oscillator coupling. To prevent overload and damage to the crystal, the disk coupling the output of the local oscillator into the crystal mixer cavity must be kept well out of the cavity initially, and then screwed in carefully until the normal current flows through the crystal. This is indicated by a reading of approximately 0.4 ma. A test jack 2–J–1 (fig. 78) is

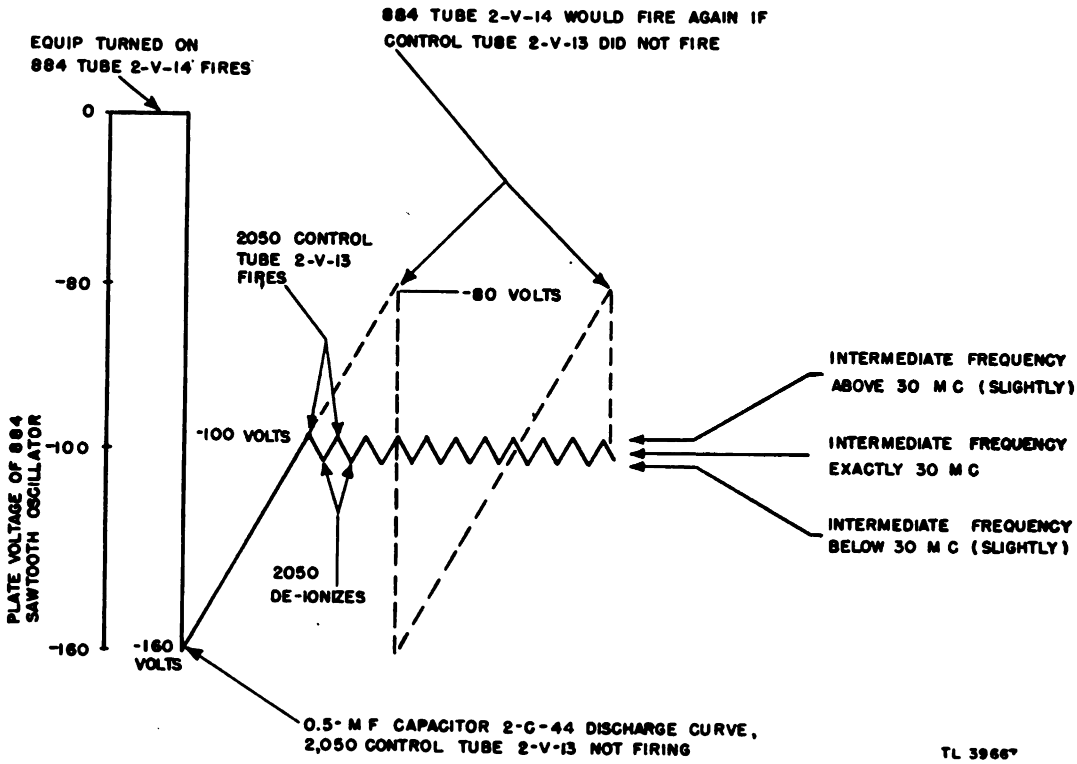
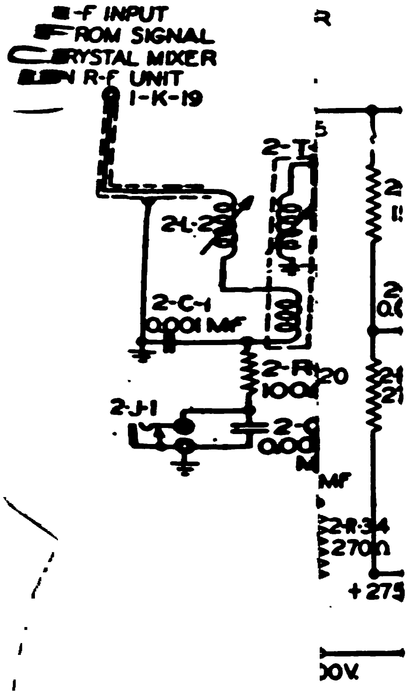


Figure 89. A.F.C. voltage at plate of 884 tube.



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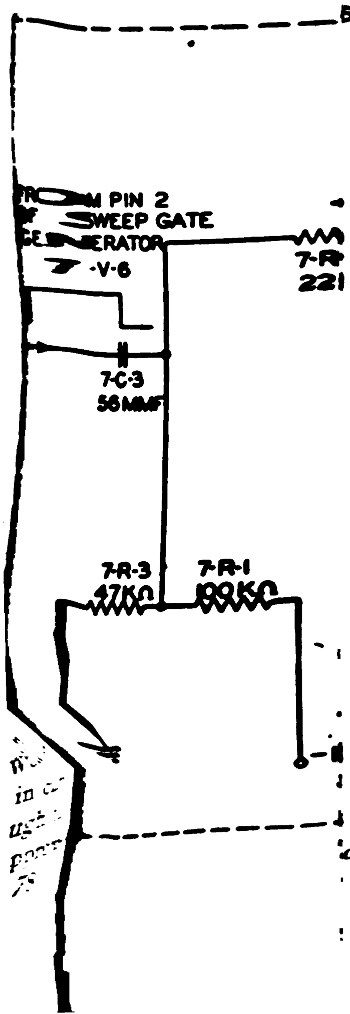
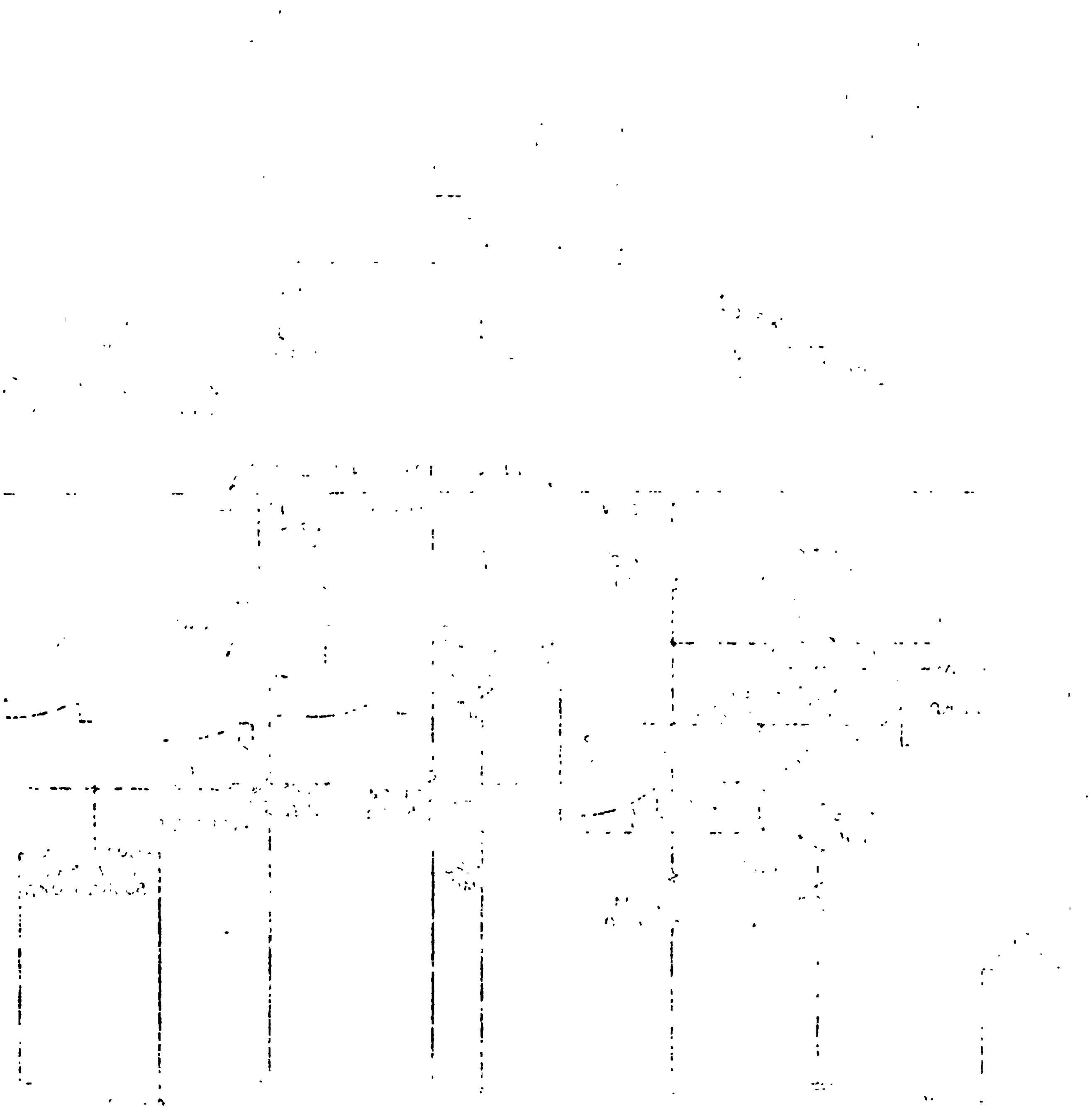


circuit.



provided for the measurement of signal crystal current. Adjustment of the position of the coupling disk may be made with all lines connected, by loosening the locknut and turning the knurled head of the adjusting screw. This operation is recommended only when absolutely necessary.

h. First I-f Stage. The input of the first i-f stage is coupled through a 72-ohm coaxial cable (cord 22) from the crystal mixer through double-tuned i-f coils 2–L–2 and 2–T–3 into the grid of the first i-f amplifier 2–V–1 (6AC7) (figs. 90 and 91). The purpose of series coil 2–L–2 is to match the impedance of the crystal mixer and the input cable to that of the first i-f stage. The lower half of 2–T–3 is untuned and is the coupling coil used to transfer energy from 2–L–2 to the i-f transformer 2–T–3. Both 2–L–2 and 2–T–3 are inductively tuned by means of brass slugs. Since 2–T–3 is a parallel-resonant-tuned circuit, the maximum voltage will appear at the input of the first i-f amplifier. This stage operates Class A self-bias by means of the 51-ohm cathode resistor 2–R–2. output is taken from the plate with an L-R parallel network (2–L–3) as the plate load. The coil is wound around a resistor of 1,200 ohms and is broadly resonant at 30 mc. The low d-c resistance of the coil tends to keep the plate voltage up, and the resistance in parallel with the coil tends to broaden the bandwidth of the i-f stage. The gain of this stage is approximately 10, and the signal from the plate is capacitively coupled to the grid of the second i-f amplifier by means of the 0.0001-mf capacitor 2–C–6. Test jack 2–J–1 (figs. 78 and 91) is used to measure the signal crystal current when connected to an external meter. The 100-ohm resistor 2–R–1 in series with the test jack gives a small voltage drop to keep the crystal operating at the proper level.

i. Second and Third I-f Stages. The inputs to the second and third i-f stages (2–V–2 and 2–V–3, 6AC7's, fig. 91) are capacitively coupled through 0.0001-mf capacitors 2–C–6 and 2–C–10 from the preceding tubes. Both tubes operate Class A self-bias by means of 51-ohm cathode resistors 2–R–7 and 2–R–9. The grids are tuned by parallel-

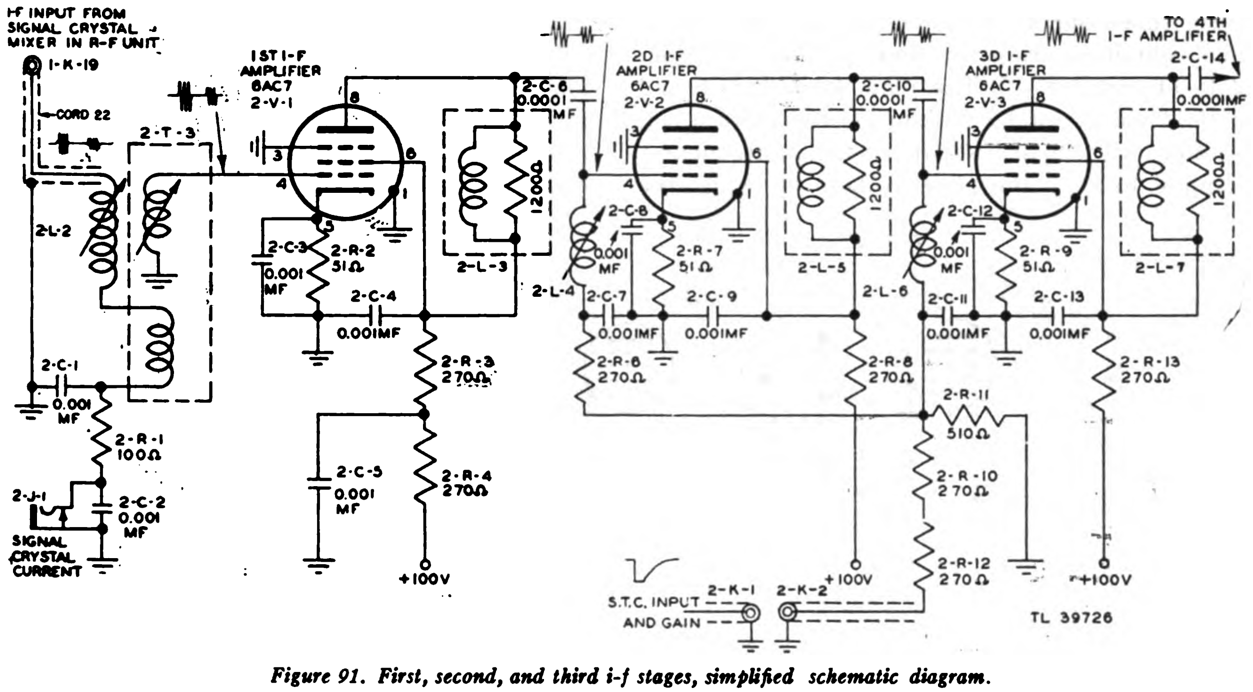


Figure 91. First, second, and third i-f stages, simplified schematic diagram.

The cathode is bypassed with the 0.001-mf capacitor 2–C–3 to prevent degeneration. The screen and plate voltage is from the + 100-volt source through the decoupling network of two 270-ohm resistors (2–R–4 and 2–R–3) and the 0.001-mf capacitor (2–C–5). The screen bypass capacitor is a 0.001-mf capacitor (2–C–4). The tuned i-f coils 2–L–4 and 2–L–6, peaked at 30 mc to develop the i-f signals on the grids. The plate loads 2–L–5 and 2–L–7 are L-R parallel networks to give a wide bandpass with low loss of plate voltage. The second i-f grid return is to ground through the 270-ohm and 510-ohm resistors 2–R–6 and 2–R–11, while the third i-f grid return is through the 510-ohm resistor 2–R–11 alone. The 510-ohm resistor 2–R–11 acts as a voltage divider to reduce the S.T.C. (sensitivity time control) and gain voltages at this point approximately 60 percent. The 270-ohm resistor 2–R–6 also serves to decouple the two stages. The S.T.C. and gain control voltage is applied through two 270-ohm decoupling resistors 2–R–12 and 2–R–10 to the junction of 2–R–6 and 2–R–11. This S.T.C. voltage varies from zero (ground potential) to —15 volts and is applied to the grids of the second and third i-f amplifiers 2–V–2 and 2–V–3 as bias voltage. The S.T.C. voltage adds to the gain voltage which may be varied from —5 volts to zero. The gain is operated manually by means of the RECEIVER gain control located on the indicator control (fig. 104).

j. Fourth and Fifth I-f Stages. The inputs to the fourth and fifth i-f stages (2–V–4 and 2–V–5, 6AC7's, fig. 92) are capacitively coupled through 0.0001-mf capacitors 2–C–14 and 2–C–17, from the plates of the preceding tubes. The parallel-tuned coils 2–L–8 and 2–L–10, peaked at 30 mc, serve as the grid loads with their return to ground. Both tubes operate Class A self-bias with their bias obtained from 51-ohm cathode resistors 2–R–14 and 2–R–16. The plate loads 2–L–9 and 2–L–11 consist of 1,200-ohm resistors with a coil wound on them to resonate at the i-f frequency, tending to keep the plate voltage up while the resistance broadens the response. The gain of each of these i-f stages is approximately 10.

k. Sixth I-f Stage. The input to the sixth i-f amplifier (2–V–6, 6AC7, fig. 92) is from the plate of the fifth i-f tube through the 0.0001-mf coupling capacitor 2–C–20 to the grid. The grid load consists of parallel-tuned circuit 2–L–12 with the return to ground. The tube operates Class A self-bias from the 150-ohm cathode resistor 2–R–20. This resistor is approximately three times as large as the cathode resistors used in the preceding five i-f stages in order to develop more bias in this stage. The plate circuit of this last i-f stage is also different from that of the other i-f stages. The plate load consists of 1,500-ohm resistor 2–R–21. The plate voltage is obtained from the + 275-volt source and is applied to the plate load through the 270-ohm decoupling resistor 2–R–22. The increased plate load and plate voltage boosts the signal to provide enough drive for the diode detector 2–V–7 (6H6). The over-all gain of the six i-f stages is approximately 1,000,000 or an average of 10 per stage.

l. Second Detector. The input to the second detector (2–V–7, 6H6, fig. 93) is through the 0.0001-mf coupling capacitor 2–C–23, from the plate of the sixth i-f stage, to the cathode of one section of 2–V–7. The second section of this tube is used in another circuit and will be discussed later. The detector input is the parallel-

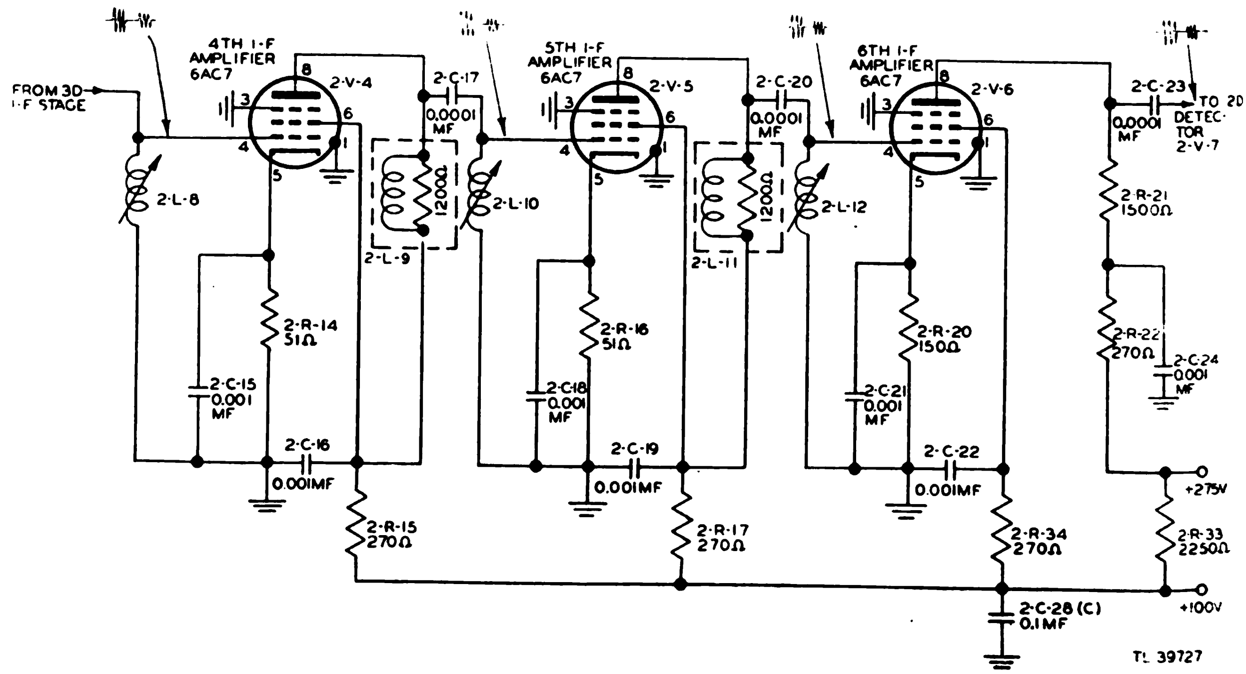


Figure 92. Fourth, fifth, and sixth i-f stages, simplified schematic diagram.

tuned coil 2–L–13 in the cathode. The plate load for this detector consists of r-f choke 2–L–14 in series with 4,700-ohm resistor 2–R–23 to ground. The r-f choke in conjunction with the 10-mmf plate bypass capacitor 2–C–25 keeps the intermediate frequency out of the video stages by bypassing it to ground, without material loss of frequencies that go to make up the video pulses (400 cycles to 1 mc). The output is a negative pulse taken at the junction of the choke and the 4,700-ohm resistor 2–R–23 through the 0.01-mf coupling capacitor 2–C–26 to the grid of the first video stage.

m. First Video Stage. The negative pulse from the detector is applied to the grid of the first video amplifier (2–V–8, 6AC7, fig. 93). The grid is returned to ground through the 270,000-ohm grid resistor 2–R–24. The first video is biased by the 100-ohm cathode resistor 2–R–25. The cathode is bypassed by a 0.001-mf capacitor (2–C–27) to prevent degeneration. The screen is bypassed by a 0.1-mf capacitor ("A" in 2–C–28). Screen voltage for this tube is obtained from the +275-volt source and is dropped approximately 60 percent through the voltage divider network of 68,000 ohms and 47,000 ohms (2–R–26 and 2–R–35). The positive pulse output is taken from the plate through the 0.01-mf coupling capacitor 2–C–30 to the second video stage. Note that the values of coupling capacitors in the video stages are much larger than those used in the i-f stages, since the frequency is now video and much lower than the intermediate frequency. The plate load of this tube is the 3,900-ohm resistor 2–R–27, and the gain of the stage is approximately 40. The maximum signal from the detector is approximately 1 volt, and the maximum signal from the first video will then be 40 volts.

n. D-c Restorer. The second half of the 6H6 (2–V–7) is connected across the grid load of the second video tube with the cathode going to the grid (fig. 93). The normal input to the grid of the second video is positive pips. After a series of positive pulses the 0.01-mf coupling capacitor 2–C–30 will hold a small charge, and it is the purpose of the d-c restorer to discharge this capacitor. Following a large video pulse, the capacitor tends to drive the grid more negative than the applied bias, but at this time the diode conducts, lowering the resistance in the grid circuit, effectively stopping any pulse from swinging negative following a positive rise on the

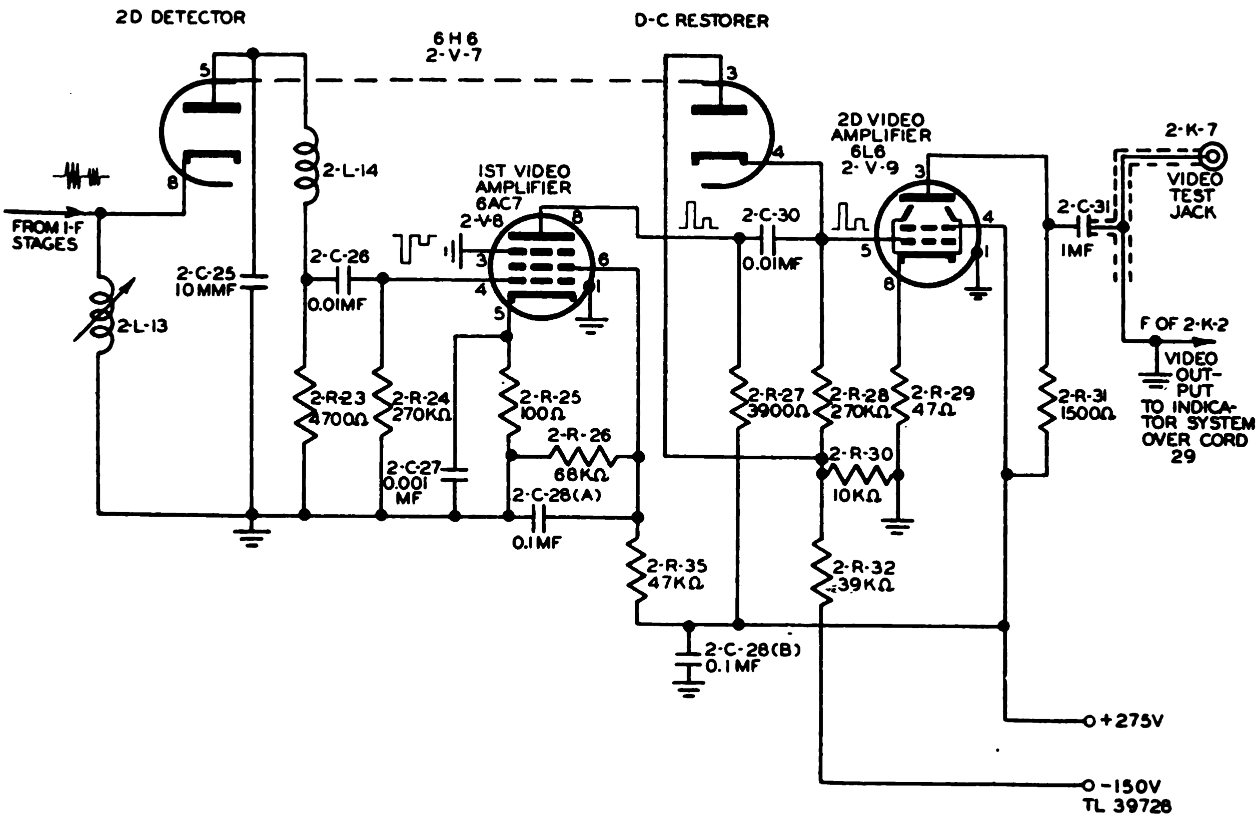


Figure 93. Second detector, d-c restorer, and video stages, simplified schematic diagram.

grid. The main purpose of the d-c restorer then is to return the grid of the second video to its normal bias immediately following any signal applied to the grid; then any small signal that might follow a large signal will not be lost since the restorer keeps the bias at the normal level.

o. SECOND VIDEO STAGE. The positive pulse from the first video is applied to the grid of the second video amplifier (2–V–9, 6L6, fig. 93). The tube is operated Class AB, getting its bias through a 270,000-ohm grid load resistor (2–R–28) and a 39,000-ohm resistor (2–R–32) connected in the negative 150-volt source in the power supply. The 10,000-ohm resistor 2–R–30 is used as a voltage divider to lower the grid bias approximately 25 percent. The cathode is returned to ground through 47 ohms (2–R–29) which allows some degeneration to maintain a linear pulse. The screen is tied directly to the +275-volt source, and is bypassed by a 0.1-mf capacitor ("B" of 2–C–28). The plate load of the second video is 1,500 ohms (2–R–31), and the gain of the stage is approximately one-half. The small load resistor and the use of the 6L6 tube (as a power amplifier) forms a means of impedance matching to the 72-ohm output cable through the 1-mf coupling capacitor 2–C–31. The output of the last video stage is applied to a 72-ohm coaxial cable in cord 29 by means of connector 2–K–2 (fig. 94) and is then fed to the indicator control. The VIDEO TEST jack 2–K–7 is provided to facilitate examination of the video waveforms by the synchroscope.

p. S.T.C. GENERATOR. The first stage in the S.T.C. (sensitivity time control) circuit is the S.T.C. generator, and 884 thyratron tube (7–V–1, figs. 90, 95, and 106). The grid of this tube is normally at —34 volts, and the plate at +91 volts. The positive gate output from pin 2 of the sweep gate generator is applied through a differentiating network, consisting of the 56-mmf input coupling capacitor 7–C–3 and the 47,000-ohm resistor 7–R–3 shunted by the 100,000-ohm resistor 7–R–1, in the grid circuit. The network develops a positive pip at the start of the gate that is used in the S.T.C. generator, and a negative pip at the end of the gate that is not used in the stage. The positive pip raises the grid voltage and allows the gas in the tube to ionize. The current at ionization is approximately 300 ma, and most of this cur-

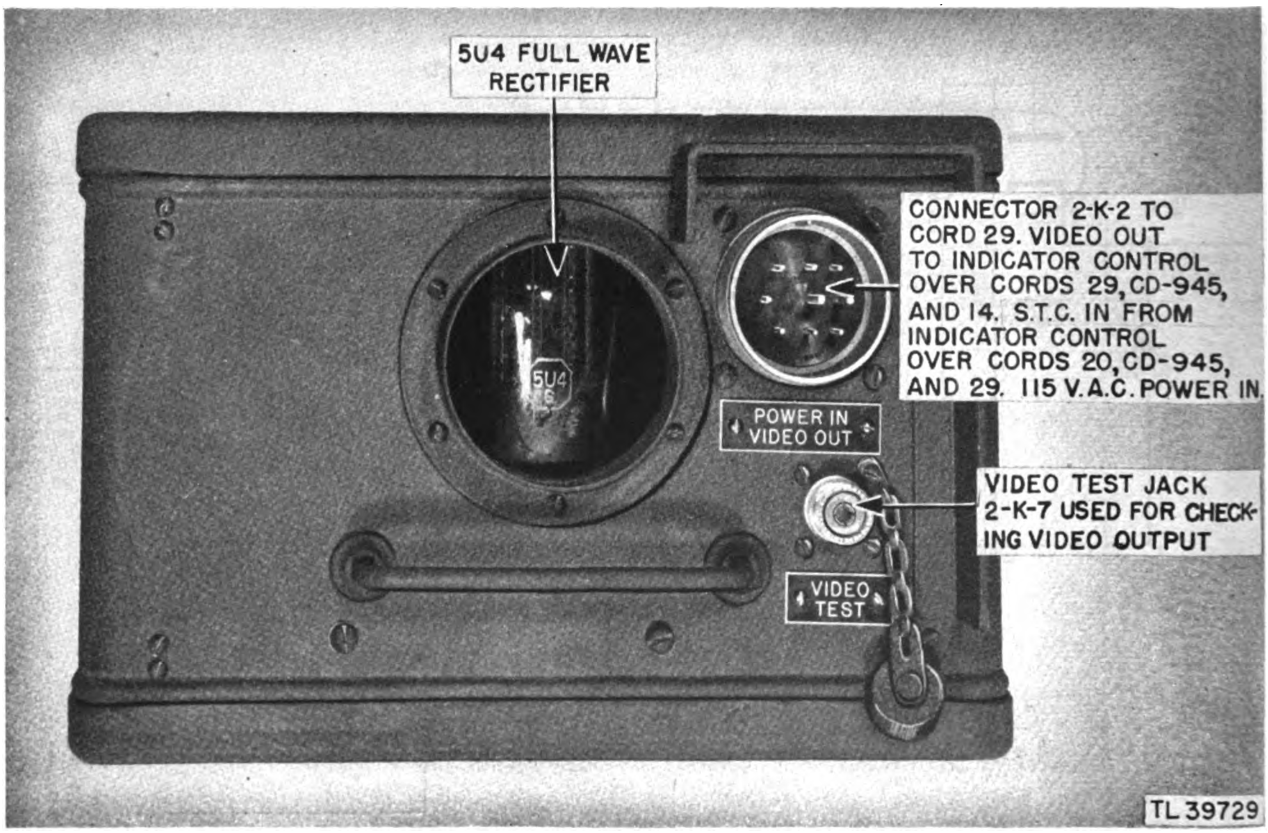


Figure 94. Radio Receiver BC–1223–A, end view of chassis.

rent comes from the 1,500-mmf capacitor 7–C–1 in the plate circuit through the 270-ohm resistor 7–R–11 to the cathode of the tube. The 300-ma current through the 270 ohms develops about 80 volts, so the cathode of the tube goes immediately to +80 volts. Since the plate of the tube is only at +91 volts, the tube then de-ionizes, and the 1,500-mmf capacitor 7–C–1 begins to charge. The charging time is dependent upon the R-C constant where the *C* is 1,500 mmf, and the *R* is 30,270 ohms. Therefore, if it is desired to change the S.T.C. time, it is necessary to change the size of the capacitor in the R-C network. The waveshape at the cathode of the tube is one that goes sharply positive to 80 volts at the transmitter pulse time and then decays exponentially to about zero volts in approximately 90 microseconds. The ouput of the generator may be varied from approximately 27 to 54 volts by means of the 10,000-ohm potentiometer in the cathode circuit. The 47-mmf capacitor 7–C–46 decreases the time of rise of the cathode voltage and maintains a steep front on the output wave by coupling the high cathode voltage to the output to overcome shunting capacity in the following stage. The 6,800-ohm resistor 7–R–15 in the output limits the load on the generator and has been determined experimentally to give the best output waveshape. The output of this stage can be adjusted by means of the control marked S.T.C. WIDTH (figs. 105 and 95). The reason for calling this control S.T.C. WIDTH becomes apparent when the limiting action of the next stage, S.T.C. clipper, is considered. For any particular limiting value, the width of the cut-off portion of the wave depends upon the amplitude of the wave applied.

q. S.T.C. CLIPPER. The second stage in the S.T.C. circuit is the S.T.C. clipper (fig. 96), one-half of a 6SN7 tube (7–V–2). This section of the tube is connected as a diode, and the cathode potential can be varied by means of the 50,000-ohm potentiometer 7–R–24 from zero to approximately +83 volts. The exact cathode voltage determines the level at which the output signal from the S.T.C. generator will be clipped, so the potentiometer is called S.T.C. DEPTH (figs. 105 and 96). This control is adjusted to remove completely the little pip that appears at the start of the S.T.C. above the normal exponential curve with the S.T.C. WIDTH set at a minimum. Then, as S.T.C. WIDTH is increased, the horizontal section of the cut-off section, called the ***width*** of the curve, is actually increased. The 0.25-mf capacitor 7–C–11 in the cathode circuit is a bypass capacitor to maintain constant voltage on the cathode during the pulse period.

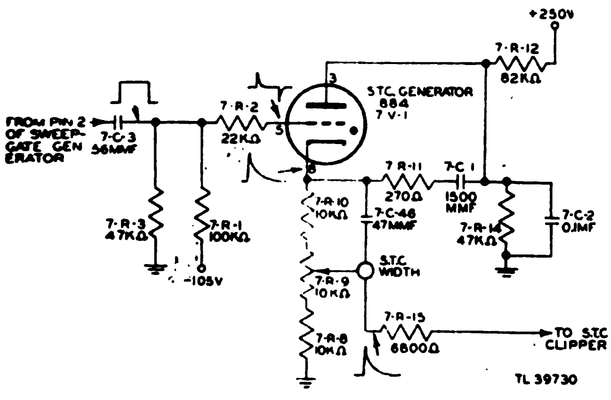


Figure 95. S.T.C. generator, simplified schematic diagram.

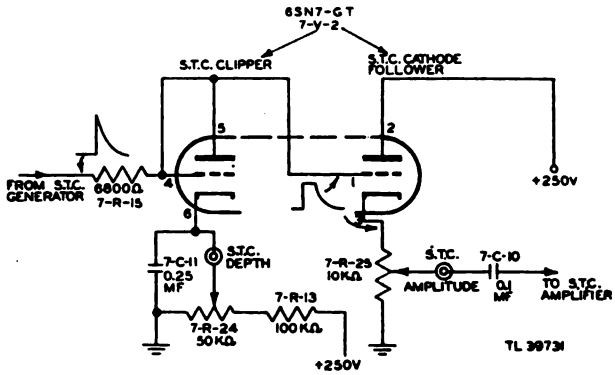


Figure 96. S.T.C. clipper and cathode follower, simplified schematic diagram.

r. S.T.C. CATHODE FOLLOWER. The output of the S.T.C. clipper is directly coupled to the grid of the S.T.C. cathode follower (fig. 96), the second section of the 6SN7 tube (7–V–2). The stage is a conventional cathode follower, the output of which is variable from zero to approximately 95 percent of the input and is coupled through a 0.1-mf capacitor 7–C–10 to the grid of the S.T.C. amplifier.

s. S.T.C. AMPLIFIER. The last stage in the S.T.C. circuit is the S.T.C. amplifier (fig. 97), a 6V6 tube (7–V–3). The tube is operated as a conventional pentode with the screen connected directly to +250 volts and the plate connected through 5,000 ohms to +250 volts. The grid voltage is approximately —22 volts, obtained across the divider network from —105 volts.

The tube is therefore biased near cut-off, so that the positive input from the S.T.C. cathode follower

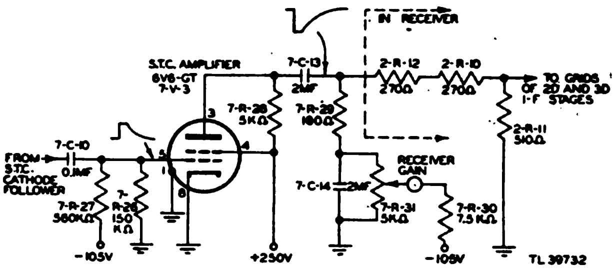


Figure 97. S.T.C. amplifier, simplified schematic diagram.

is properly amplified to give a negative wave that is used in the receiver. The output of the stage is coupled to the S.T.C. coaxial line through a 2-mf capacitor 7–C–13. The coaxial line also receives the d-c bias voltage from a divider network attached to —105 volts. It is necessary to consider the remainder of the biasing circuit (fig. 90) in the receiver in order to see that the RECEIVER gain control can vary the receiver bias from zero volts down only to about —5 volts. The two voltages, the d-c bias and the S.T.C., are mixed in the 180-ohm resistor 7–R–29 and fed into the coaxial line. The maximum amplitude of the S.T.C. voltage across resistor 2–R–11 (fig. 90) is approximately —15 volts, so the ***maximum*** bias on the second and third stages in the receiver at the instant of transmission is about —20 volts, and this voltage increases exponentially for about 90 microseconds, after which time the maximum d-c bias remains constant at —5 volts until the next pulse. At minimum setting, the S.T.C. amplitude potentiometer 7–R–25 (fig. 104) prevents the S.T.C. voltage from reaching the receiver. When the S.T.C. amplitude potentiometer is set at maximum, the S.T.C. voltage applied to the receiver is effective over the entire 10,000-yard range, and approximately the first 14,700 yards on the 40,000-, 160,000-, and 240,000-yard ranges. The power supply for the S.T.C. circuits is in the indicator unit and is discussed in paragraph 43.

t. Receiver Power Supply. (1) The receiver power supply (figs. 98 and 99) consists principally of one transformer, two filter chokes, and four tubes. Other than the filament supply, the outputs furnish only four main voltages. They are as follows:

(*a*) T-R box, —600 volts.

(*b*) A.F.C. voltage, —210 volts.

(*c*) Bias voltage, —150 volts.

(*d*) Receiver B+ voltage, +275 volts.

(2) The T-R box supply furnishes a negative keep-alive voltage for the T-R tube by means of a 6X5 half-wave rectifier, 2–V–19. Both plates of this tube are tied together, since no use is made

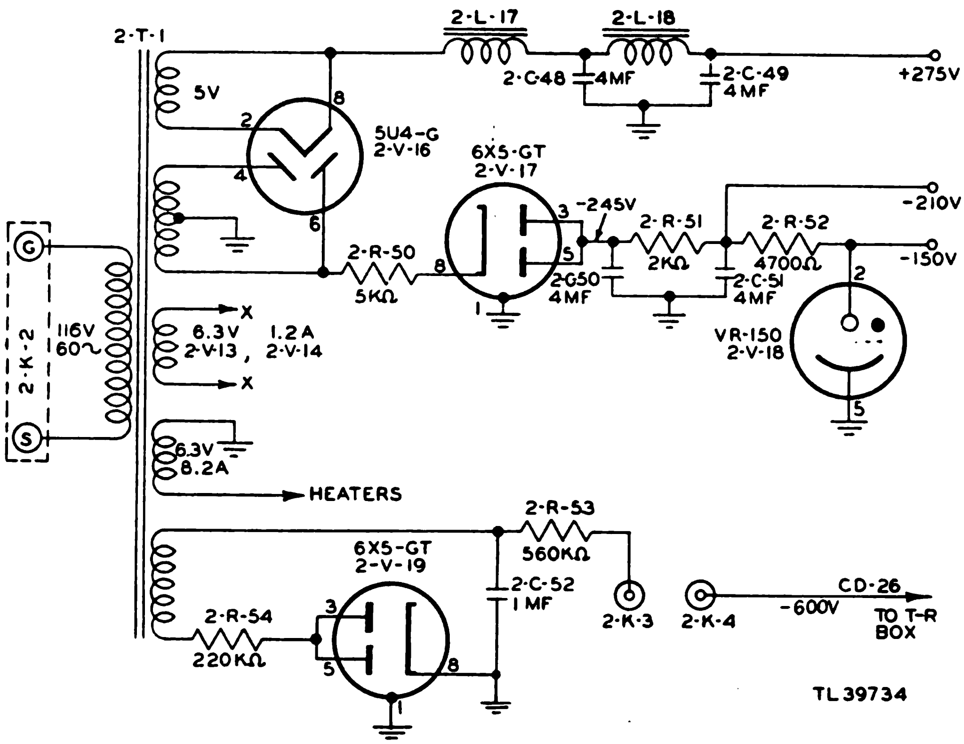


Figure 98. Power supply for Radio Receiver BC–1223–A, simplified schematic diagram.

of the extra plate and the tube will then handle more current. The output is taken from the plates through a 220,000-ohm resistor 2–R–54 and the transformer winding to the 1-mf filter input capacitor 2–C–52. The 220,000-ohm resistor 2–R–54 is used to limit the peak current drawn from the supply and to protect the transformer 2–T–1. Good regulation is not necessary in this part of the supply, and capacitor input is used to give a greater voltage output. The voltage is applied to the keep-alive electrode in the T-R box through a 560,000-ohm resistor (2–R–53). This resistor in conjunction with the 1-mf capacitor (2–C–52) forms a filter network to convert the half-wave rectified pulses into direct current. As manufactured, no bleeder resistor is provided to bleed off the capacitor 2–C–52 when the receiver is turned off. This capacitor should be discharged before performing maintenance work on the receiver with the case removed.

(3) The B+ 275-volt supply utilizes a 5U4G tube (2–V–16) in a full-wave rectifier circuit. Good regulation is desired here since this voltage supplies the plates and screens of the receiver tubes. Input choke 2–L–17 in conjunction with choke 2–L–18 and the two 4-mf capacitors 2–C–48 and 2–C–49, make up the filter network for the full-wave supply. Although this type of regulation is not as good as an electronic regulated supply, it is sufficient where the load is nearly constant.

(4) The negative bias supply utilizes one-half of the transformer secondary winding that is used for the B+ supply. The 6X5 tube (2–V–17) has both plates tied together, and the output taken from them gives a half-wave rectified negative voltage. The purpose of the 5,000-ohm resistor 2–R–50 between cathode of the rectifier and the transformer is to limit current and to protect the transformer. This negative output uses capacitor input filtering with two 4-mf capacitors (2–C–50 and 2–C–51) and a 2,000-ohm resistor (2–R–51), making up the filter network. At the junction of the 2,000-ohm resistor 2–R–51 and a 4,700-ohm resistor (2–R–52), a tap is provided for approximately —210 volts for the A.F.C. circuit. The 4,700-ohm resistor 2–R–52 is a current-limiting resistor for the VR–150/30 tube 2–V–18. The 150-volt negative output from the VR–150/30 provides a stable bias for the second video stage.

(5) The 6.3-volt winding at 1.2 amperes is used for heater voltage on gas tubes 2–V–13 and 2–V–14. Since these tubes have their cathodes at a high negative potential, it is necessary to have them on a separate winding to prevent flash-overs which would damage the tubes.

(6) The 6.3-volt winding at 8.2 amperes supplies voltage to the heaters of all tubes in the receiver except the 2–V–13 and 2–V–14, and the power supply rectifier 2–V–16.

(7) The heaters on 2–V–1 and 2–V–2 have an r-f choke 2–L–19 (fig. 105) in series and are bypassed with 0.001-mf capacitors 2–C–53 and 2–C–54. They have the hot side shielded to prevent pick-up. Tubes 2–V–3, 2–V–4, 2–V–5, and 2–V–6 are shielded and bypassed as above. Tubes 2–V–7 and 2–V–10 are bypassed while 2–V–8, 2–V–9, 2–V–11, 2–V–12, 2–V–15, 2–V–17, and 2–V–19 have no bypass or shielding. The shielding of leads, bypassing, and the use of r-f chokes tends to keep out or bypass any radio frequency that may be present on the filament leads, thus preventing degeneration.

(8) The input to power transformer 2–T–1 is from the 115-volt a-c regulated source into its primary. This input is not fused and is connected in parallel with other units using alternating current. Therefore, receiver power supply troubles will not be indicate at the source, but may burn out either of the 5-ampere fuses, 9–F–1, or 9–F–2, located in the indicator unit.

39. Complete Schematic Diagrams

The complete schematic diagram of Radio Receiver BC–1223–A is represented by figure 99. The signal mixer and A.F.C. mixer are both illustrated in figure 45. The S.T.C. circuit is shown in the complete schematic diagram of Indicator Control BC–1193–A (fig. 106).

Section VI. INDICATOR SYSTEM

40. Introduction

The indicator system provides a visual indication on the PPI-scope screen of the range and azimuth of targets within a 240,000-yard radius of the radar set. Sweep and scope circuits necessary for target presentation are contained in Indicator Control BC–1193–A. Sensitivity time control (S.T.C.) and range marker channels, also physically located within Indicator Control BC–1193–A, are not considered functionally in this section.

a. Persistence of Targets on the PPI Scope. The PPI scope is useful in searching because of the long persistence of the screen. When searching, the radio beam passes across targets very rapidly. On the PPI scope the signal from the target increases the beam intensity thus causing a bright spot on the screen of the scope. Even though the beam intensity decreases immediately, the coating on the face of the PPI scope continues to remain luminous. This effect, called *persistence,* makes the bright dot corresponding to the target remain visible on the screen long enough to determine range and azimuth.

b. Appearance of PPI Scope. Figure 100 shows the physical appearance of the PPI scope. The sweep is radial from the center of the outside edge of the tube. The radar set is considered to be at the center of the face of the scope. The distance radially from the center of the scope to the bright dot is proportional to the range of the target. The angular position of the sweep is synchronized with the azimuth position of the antenna so that the sweep rotates as the azimuth of the antenna is changed. The angular position of the bright spot representing the target therefore corresponds to the azimuth of the target.

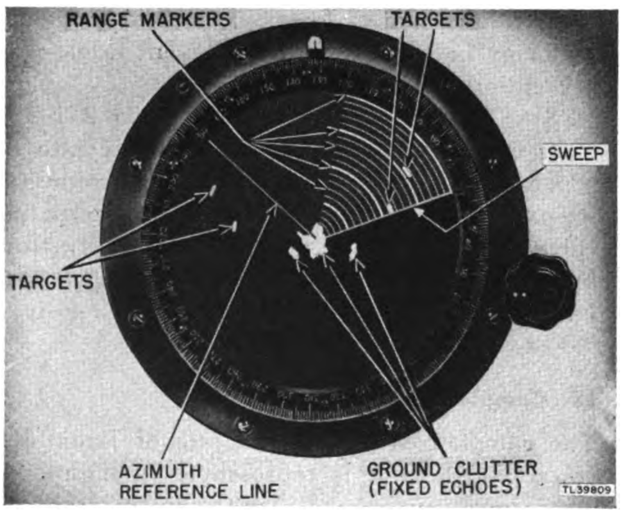


Figure 100. PPI scope, general appearance.

c. Sweep Ranges. Search ranges of 10,000, 40,000, 160,000, and 240,000 yards are provided. The proper sweep for a given range is selected by the RANGE selector switch. Range markers, which are bright dots on the sweep, are provided to assist the operator in estimating the range of the target. These range markers form bright circles as the sweep rotates. The range marker system is described in section VII of this chapter.

41. Simplified Block Diagram

Figure 101 represents the simplified block diagram of the indicator system.

a. Range Determination. For accurate range determination, the sweep line must start at the same instant the transmitter fires. This is done by using a portion of the same pulse which triggers the transmitter to start the sweep action. A negative 100-volt pulse, tapped off a voltage divider in the spark-gap output circuit, simultaneously triggers both sweep and range-marker circuits. The sweep circuit (part of Indicator Control BC–1193–A) when triggered as described above, provides the sweep for the linear magnetic deflection of the PPI-scope electron beam and also delivers a square-topped pulse to the scope. When this pulse is applied to the first anode of the scope, it unblanks and intensifies the beam at the proper intervals.

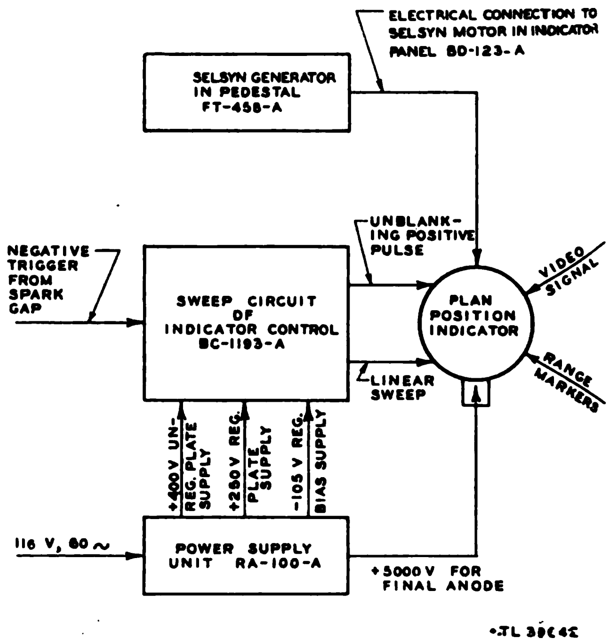


Figure 101. Indicator system, simplified block diagram.

b. Power Supply Unit RA–100–A. This supply is a group of individual power supplies built on a single chassis, designed to deliver the proper a-c and d-c voltages to Indicator Control BC-1193–A and to its associated scope circuits. The following voltages are developed:

(1) The unregulated final anode voltage for the PPI scope: +5,000 volts d-c.

(2) The filament voltage for the PPI scope and all other tubes in Indicator Control BC–1193–A: 7 volts a-c.

(3) The regulated bias supply for the sweep channels, the S.T.C., and the range marker channels: —105 volts d-c.

(4) The unregulated plate supply for some of the sweep and marker channels: +400 volts d-c.

(5) The regulated plate supply for the balance of the sweep, marker, and S.T.C. channels: +250 volts d-c.

c. Selsyn System. To coordinate the action of the sweep with the rotations of the antenna, a selsyn system is used. A transmitting selsyn is mechanically geared to the antenna drive shaft and electrically transmits information on the azimuth position of the antenna. At the PPI tube a receiving selsyn is mechanically geared to the sweep deflection coils, which in turn control the positioning of the sweep trace. Thus the sweep trace points in the same direction as the antenna at any given instant.

42. Complete Block Diagram

Figure 102 represents the complete block diagram of the indicator system showing the circuit action in detail. A front view of Indicator Unit BC–1225–A is illustrated in figure 103. Operating and adjusting controls for Indicator Control BC–1193–A are indicated in figures 104 and 105. Placement of parts on the chassis of Indicator Control BC–1193–A and Power Supply Unit RA–100–A are shown in figures 106 and 107. Each component section of the group is discussed below.

a. Trigger Buffer. The input stage of the indicator control is known as the trigger buffer stage, tube 7–V–5. Irregularities in the negative pulse from the spark-gap discharge are eliminated in this stage.

b. Sweep-gate Generator. The negative pulse from the trigger buffer stage triggers the sweep-gate generator, tube 7–V–6. The tube is connected as a start-stop multivibrator, the output of which is a straight-sided square pulse (gate voltage) with an approximate amplitude of 155 volts. The output signal developed in this stage is used to control the action of the sweep generator and blanker.

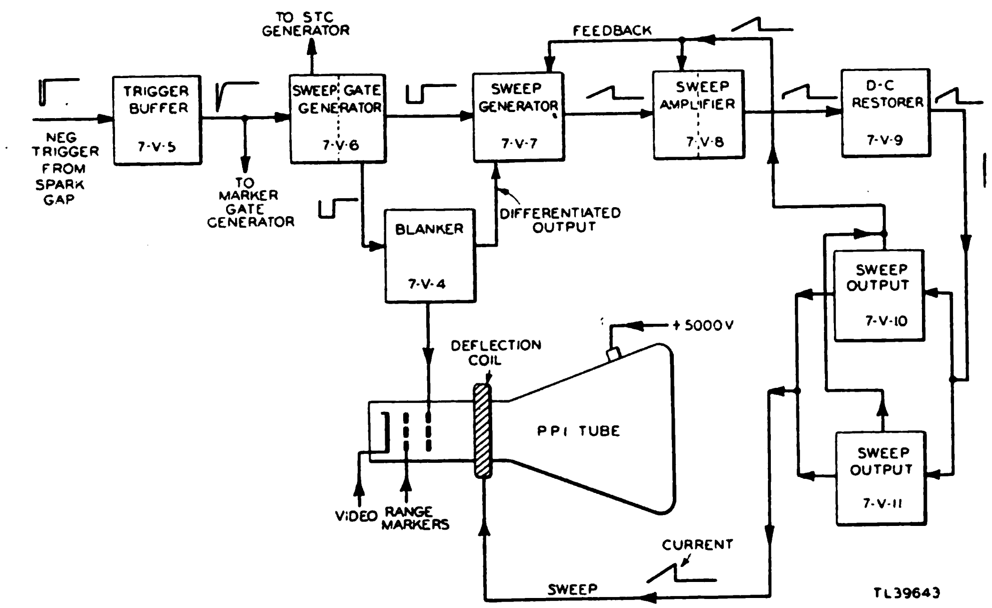


Figure 102. Indicator system, complete block diagram.

c. Sweep Generator. (1) For accurate echo interpretation it is necessary to develop a linear sweep trace, or time baseline, on the scope face. This is done by passing a linear current sawtooth waveform through the deflection coil, thus producing a magnetic field, which in turn deflects the electronic beam in a linear manner. At the termination of the deflection current sawtooth waveform the beam returns to the point of origin.

(2) To obtain a linear sawtooth wave of current for the lower ranges, the inductive and capacitive reactance of the coil must be overcome. The sawtooth voltage, therefore, is combined with an auxiliary pip of voltage, which is used to

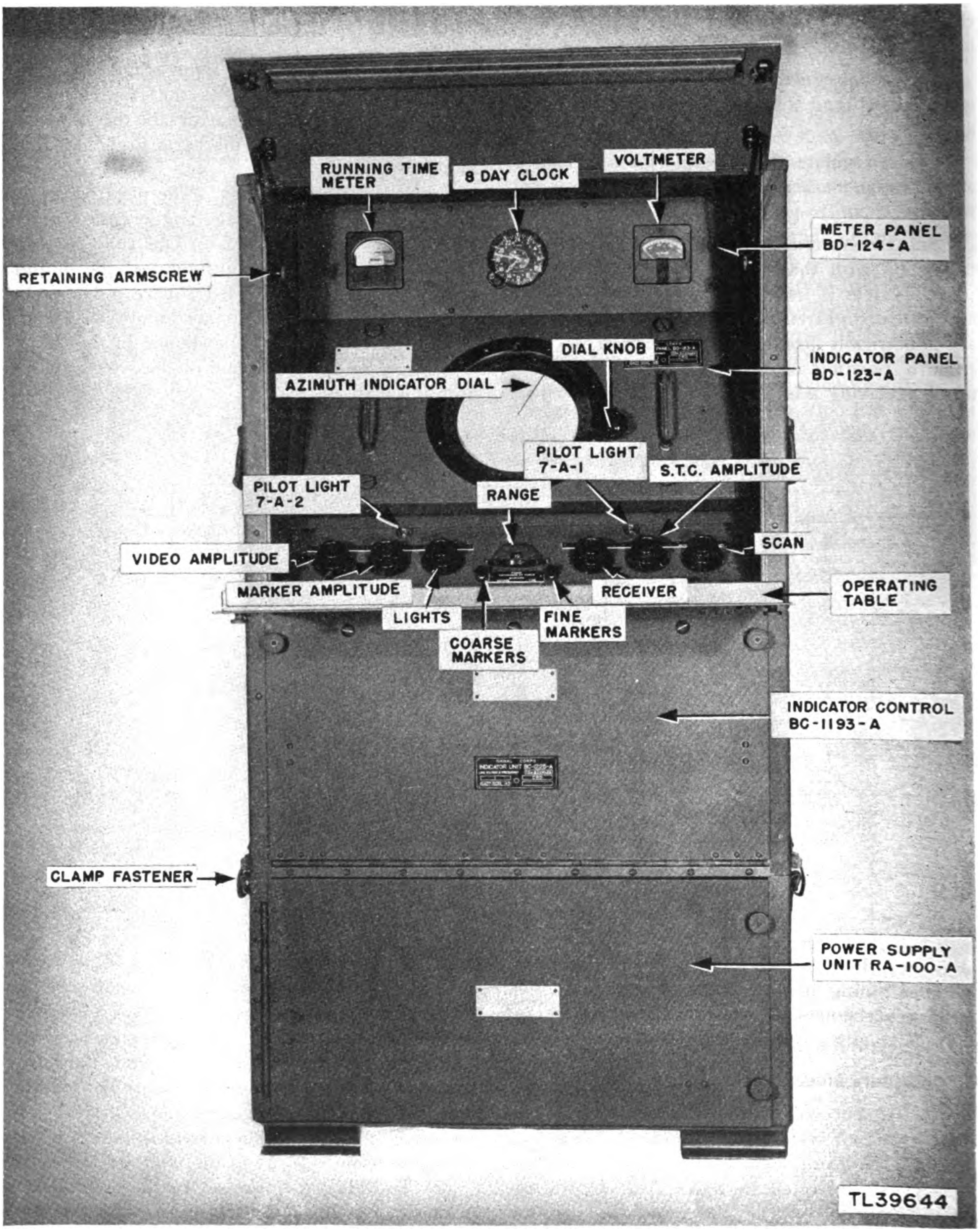


Figure 103. Indicator Unit BC–1225–A, front view.

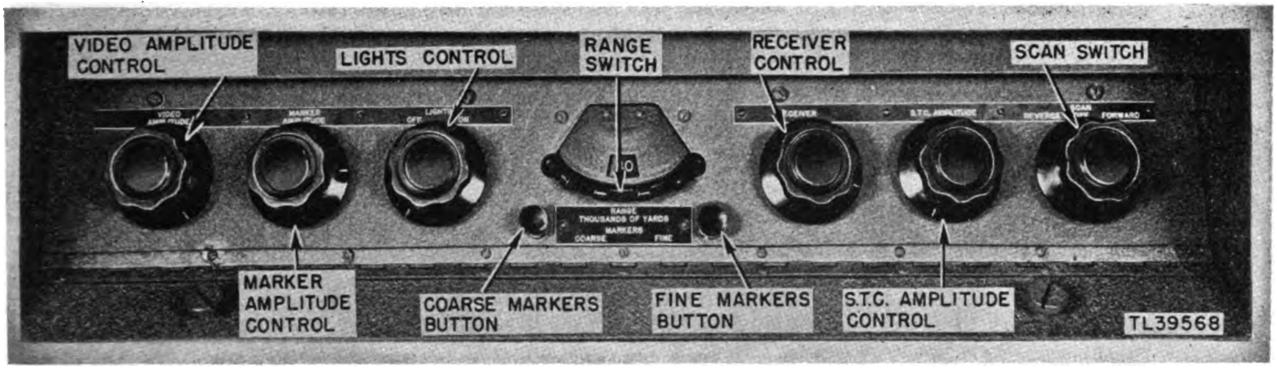


Figure 104. Indicator Control BC-1193-A, operating controls.

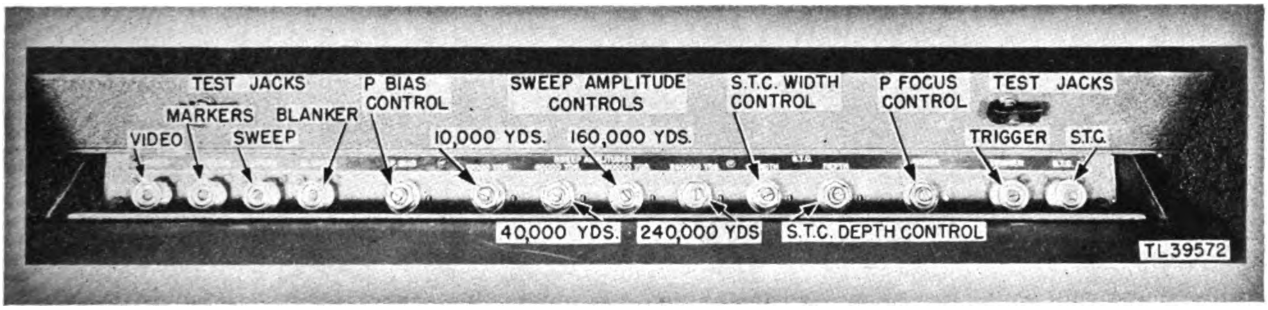


Figure 105. Indicator Control BC-1193-A, adjustment controls.

charge the distributed capacitance across the coil. The additional kick supplied by the added voltage pip tends to keep the developed sweep linear. The voltage waveform generated, a trapezoidal wave, is produced by the action of the sweep generator, tube 7–V–7. To produce the same effect on the longer ranges the voltage wave produced is almost triangular.

d. Sweep Amplifier. The function of the sweep amplifier tube 7–V–8 is to stabilize the sweep generator stage output. Both sections of the twin triode tube are utilized to achieve this purpose. The tube normally has a gain of 400, but as used in this particular instance, it develops a gain of only 2. Degeneration, which is introduced at the cathode of the first section of the tube by the sweep output tubes 7–V–10 and 7–V–11, is responsible for the small gain.

e. D-c Restorer. The d-c restorer stage, tube 7–V–9, produces a leveling action which maintains the grid voltage of the two sweep output tubes at a constant level, thereby causing sweep action to start at the same point at all times.

f. Sweep Output. The sweep output tubes, 7–V–10 and 7–V–11, apply a linear current sawtooth wave to the deflection coil. The strong magnetic field which results causes the linear sweep of the beam on the scope face. This linear beam sweep is known as a timebase.

g. Blanker. Since the pulse recurs at the rate of 402 cycles per second, the period between pulses is approximately 2,500 microseconds. Thus there is a considerable interval between the return of one sweep trace and the start of the succeeding trace. To prevent scope screen damage and signal confusion, it is necessary to eliminate scope signals on the return trace. The blanking effect is achieved by reducing the first anode voltage during the non-sweep periods.

43. Circuit Details

a. Trigger Buffer. The trigger buffer (fig. 108), the first stage in the indicator circuit, receives a negative triggering pulse with an approximate amplitude of 100 volts from the modulator. The trigger is fed through receptacle 7–K–2 to the tube cathode. The tube, held at cut-off because of the —53 volts applied to its grid from a voltage divider (resistors 7–R–6 and 7–R–7), begins to conduct when the triggering voltage drops the cathode voltage a sufficient amount. A clipping action takes place, and the stage output, taken off resistor 7–R–4, has the form of a square negative pulse which is one

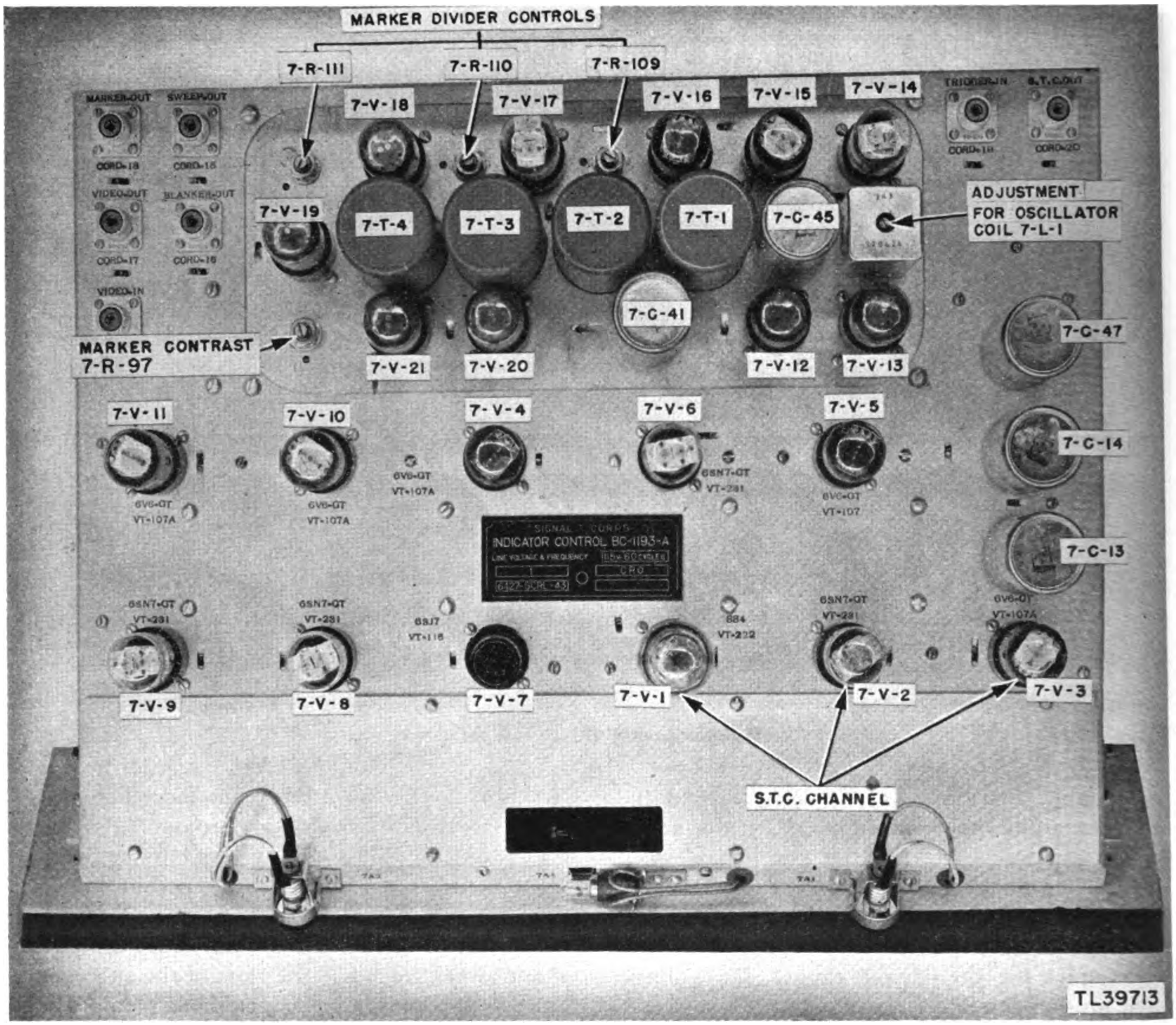


Figure 106. Indicator Control BC–1193–A, top view of chassis.

microsecond wide and approximately 100 volts in amplitude.

b. Sweep-gate Generator. (1) A twin triode (fig. 108) is used to follow the trigger buffer stage and is used as a sweep-gate generator. Both triode sections are used individually. The first section conducts between pulses since it has no bias applied and has a plate voltage of about 95 volts. The second section is biased to cut-off. The bias applied to the grid of the second section is tapped off a voltage divider network which consists of 7–R–21 and 7–R–23 connected between —105 volts and +95 volts. The cut-off bias on the grid of the second section is therefore about —35 volts. The plate voltage of the second section at cut-off is +250 volts.

(2) When the square 100-volt negative pulse developed by the trigger buffer is applied to the grid of the first section through capacitor 7–C–4, this section is driven below cut-off. Current ceases to flow, and the voltage at the tube plate rises to 250 volts. A positive voltage, therefore, is impressed on the grid of the second section and this section reaches current saturation. At saturation increased current in the plate-load resistor 7–R–20 causes a voltage drop which decreases the plate voltage of the second section from 250 to about 95 volts. The 155-volt drop is coupled back through one of four feedback capacitors, 7–C–6, 7–C–7, 7–C–8, or 7–C–9, to the grid of the first section thus holding it at cut-off. The feedback capacitor discharges to ground through its asso-

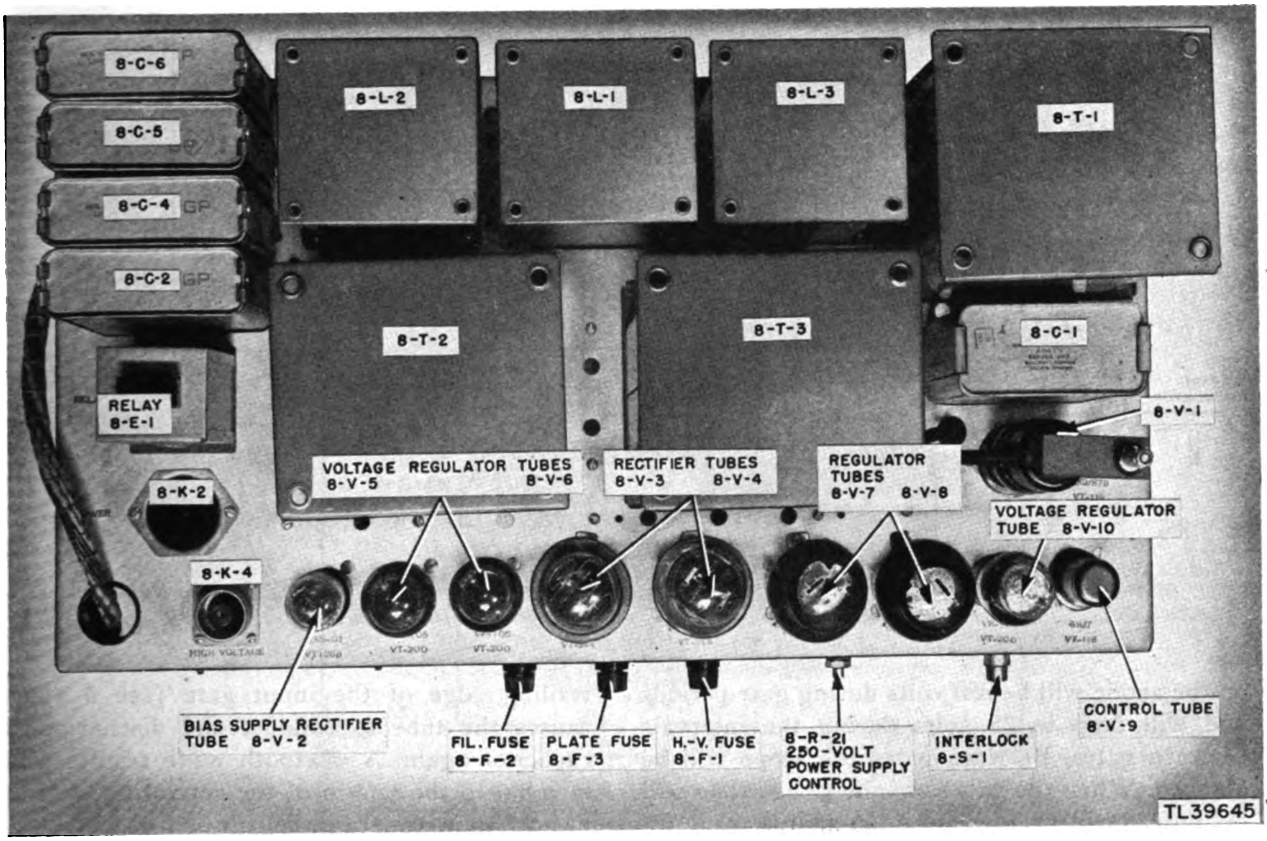


Figure 107. Power Supply Unit RA-100-A, top view of chassis.

ciated grid resistor, 7-R-16, 7-R-17, 7-R-18, or 7-R-19. The voltage drop across this resistor holds the grid of the first section below cut-off for a period of time depending on the resistance-capacitance (RC) constant of the feedback circuit. The gate is variable and depends upon the range desired, which in turn is determined by the feedback circuit RC constants. The proper size of capacitor for the desired range is selected by RANGE switch 7-S-1. The actual gate developed is larger than required, to compensate for the 10 percent allowable resistor and capacitor value tolerances.

(3) The plate voltage of both sections of tube 7-V-6 remains constant until the first section begins conducting again. When the first section starts to conduct its plate voltage decreases, developing a negative voltage on the second section grid and increasing the voltage at the second section plate. The increase at the plate is transferred to the first section grid through a capacitor, causing it to conduct even more heavily. The above action then repeats itself until the first section is back at saturation and the second section is again at cut-off. The complete cycle repeats itself with each triggering pulse. The output of the stage consists of straight-sided square pulses with an approximate amplitude of 155 volts, the width of which depends upon the RANGE switch position. The minimum width for the various ranges is 61, 244, 977, or 1,465 microseconds. The positive output of the first section which is taken off resistor 7-R-22, is used to trigger the S.T.C. channel. The negative output, taken from the second section at resistor 7-R-20, is used in the sweep generator and blanker stages of the indicator system.

c. Blanker. (1) Blanking and unblanking of the scope screen during the proper intervals is controlled by the blanker stage, tube 7-V-4 (fig. 109). The negative gate output of the sweep-gate generator tube 7-V-6 second section is applied to the grid of a type 6V6-GT tube through capacitor 7-C-15. Between sweep periods tube 7-V-4 conducts heavily, dropping its plate voltage to approximately 25 volts. When a negative gate is applied to the grid, the tube is driven to cut-off. At cut-off the tube plate voltage rises to 250 volts. Since the output of this tube is directly coupled to the first anode of the PPI scope, the voltage

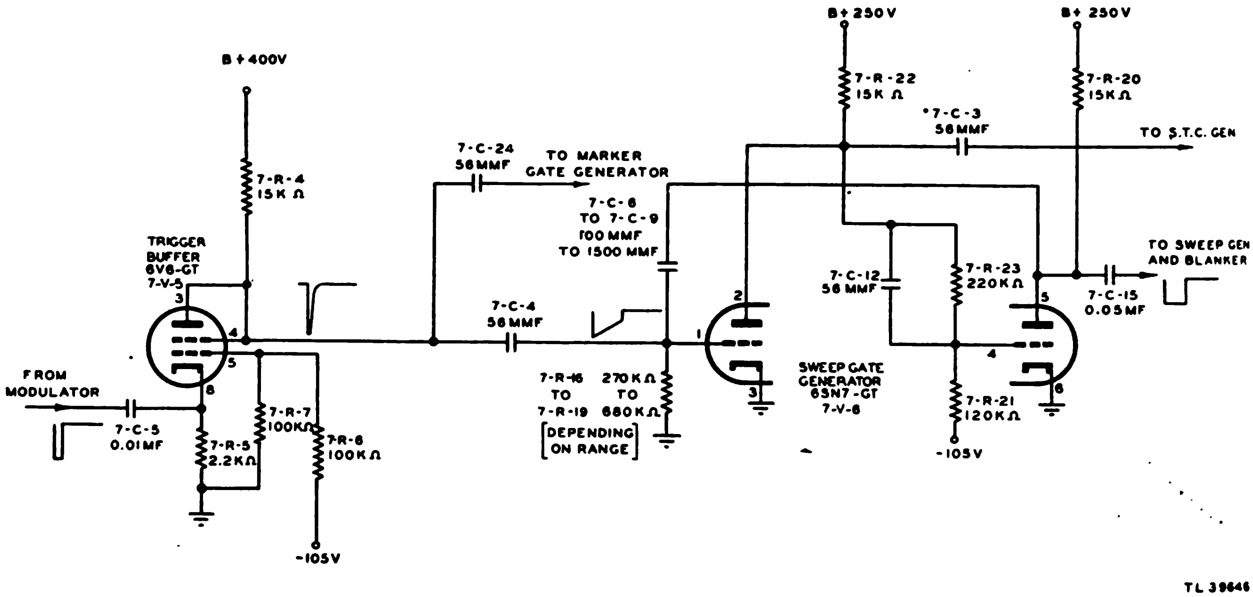


Figure 108. Trigger buffer and sweep gate generator, simplified schematic diagram.

on the anode will be 250 volts during gate periods and will drop to 25 volts during the intervals between gates. Between gates the scope will be blanked. When the gate is applied, the scope will be unblanked, but since a 0.6-microsecond interval occurs before the rise of the voltage to full value, the signal intensity at the start of the sweep will automatically be reduced.

(2) A 22,000-ohm resistor, 7–R–32, is inserted in the grid circuit of the blanker tube to decouple it from the gate circuit. The pip voltage applied to the trapezoidal voltage wave on the 10,000- and 40,000-yard ranges (see *d* below) also originates in the output circuit of this tube.

d. Sweep Generator. (1) The sweep generator tube 7–V–7 is basically a switching device, the action being controlled by the gate developed in the second section of the sweep-gate generator tube. Tube 7–V–7 normally conducts. Any one of four capacitors, 7–C–18, 7–C–19, 7–C–20, or 7–C–21, may be selectively switched across the tube (plate to ground). The choice of capacitors is dependent upon the setting of the RANGE switch 7–S–1. The selected capacitor will normally be discharged. The negative gate previously mentioned is fed through capacitor 7–C–15 (fig. 109) to the input grid and drives the tube to cut-off. The capacitor which has been switched across the output now charges exponentially. The rate of charge is dependent upon the size of the selected capacitor and its associated series resistor. The charging voltage is 250 volts. The trailing edge of the input gate (see *b* above) causes the tube to conduct and discharges the capacitor again. A sawtooth wave results which is equal to the length of the activating gate and has an approximate peak value of 43 volts.

(2) During the generation of the sawtooth voltage, two other actions take place simultaneously. On the lower ranges (10,000 yards and 40,000 yards) a small auxiliary voltage pip is impressed upon the sawtooth voltage at its beginning. The pip is developed by differentiating the positive square wave at the output of the blanker circuit, tube 7–V–4. The differentiating action is caused by the small time constants of capacitor 7–C–17 and resistors 7–R–104 and 7–R–105. This pip appears on the sawtooth voltage only on the two ranges mentioned above. The effect is used to overcome the capacitive and inductive reactance of the scope deflection coil. The resultant effect is the excellent linearity of the sawtooth current developed in the deflection colis. Since the rate of current change is much more gradual on the longer ranges, no starting pip is required. The positive square-wave differentiation also results in a negative pip from the trailing edge of the gate. This is combined with the end of the voltage sawtooth and sharpens the cut-off action helping to reduce the deflection-coil flux to zero.

(3) The second action also aids in maintaining a linear sweep. A capacitor charges exponentially because the charging rate decreases as the ca-

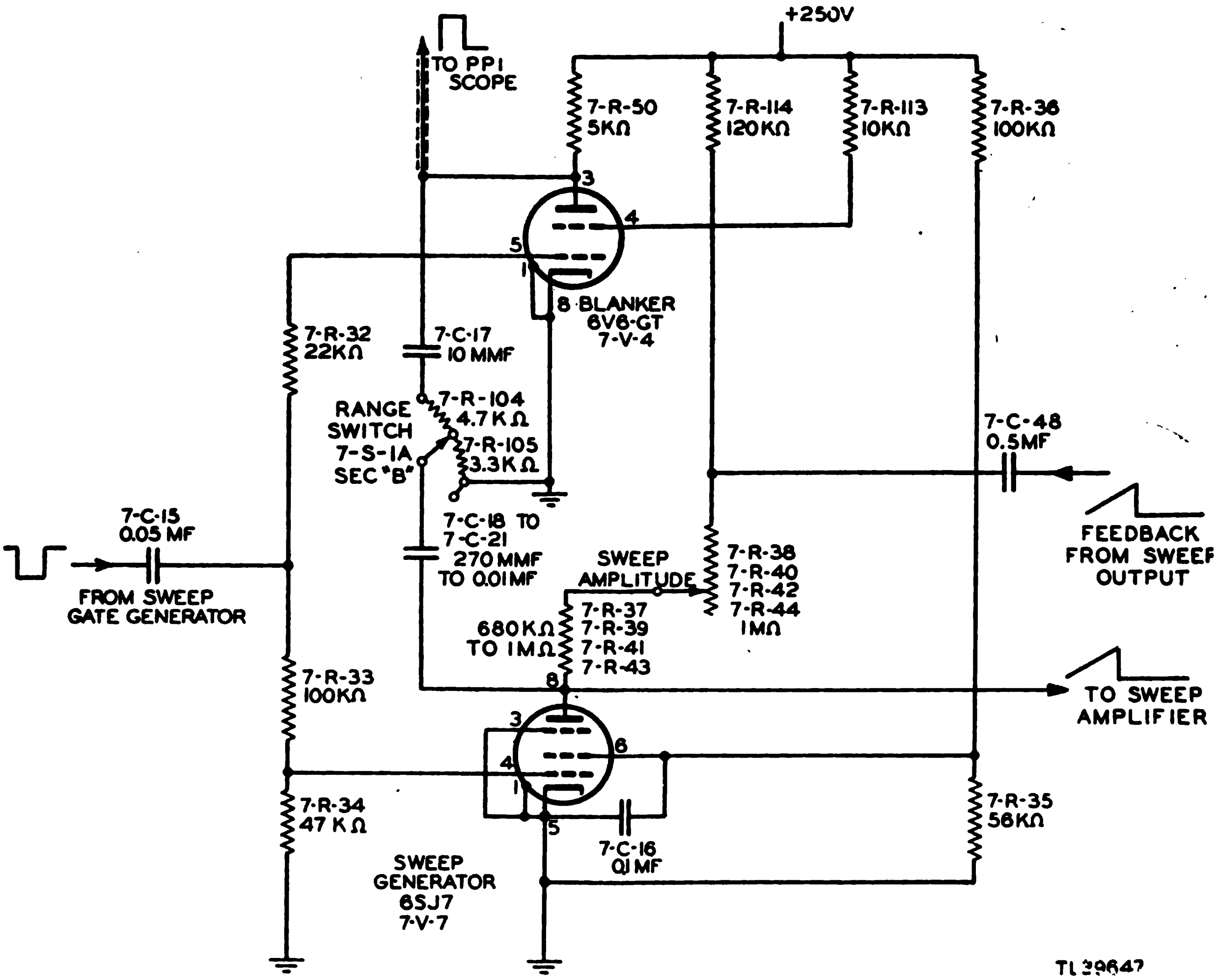


Figure 109. Blanker and sweep generator, simplified schematic diagram.

pacitor approaches the charging potential. It is possible to charge a capacitor linearly if the charging rate is held constant. If this can be done, the resulting sawtooth will also be linear. This is accomplished in the equipment under discussion by feeding back a positive linear sawtooth voltage from the sweep output tubes 7–V–10 and 7–V–11 (fig. 102) to the plate resistor of the sweep generator stage (fig. 109). This action maintains a constant voltage drop across the appropriate pair of charging resistors, 7–R–37 to 7–R–44. The current flow through these resistors remains constant over the sweep period and therefore maintains a constant charging rate on the capacitor. The result is a voltage sawtooth waveform that is highly linear.

(4) Resistor 7–R–33, a 100,000-ohm resistor in the grid circuit of the sweep generator stage, serves to decouple the stage from the gate circuit.

(5) The length of the individual sweeps for a given range is adjusted by varying the SWEEP AMPLITUDE controls 7–R–38, 7–R–40, 7–R–42, and 7–R–44. Each control varies the sweep for a different range. The adjustments may be varied with a screwdriver and are located in a recess directly below the operating controls (fig. 105).

e. Sweep Amplifier. (1) The sweep amplifier stage (fig. 110) must help maintain a linear voltage sawtooth and provide sufficient gain to operate effectively the sweep output tubes 7–V–10

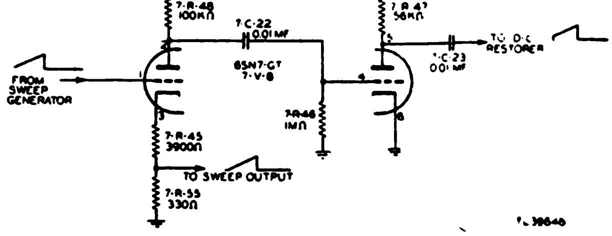


Figure 110. Sweep amplifier, simplified schematic diagram.

and 7–V–11. The first section of tube 7–V–8 operates as an amplifier with cathode degeneration until feedback starts. The second section operates as an amplifier with a gain of about 20. Gain of the whole stage is relatively high when there is no feedback, but with feedback the gain drops to about 2. Feedback cannot start until the grids of the sweep output stage are driven above their cut-off voltage. This requires at least 10 volts output from the sweep amplifier.

(2) When a signal is applied to the sweep amplifier, the initial high gain of this stage causes the output voltage to rise immediately to the cut-off voltage of the tubes in the sweep output stage. The sweep output tubes conduct, and the feedback voltage is developed across the common cathode resistance 7–R–55. This voltage causes the gain of the sweep amplifier to fall to about 2, and the input wave is amplified without distortion in the sweep amplifier.

f. D-c Restorer. The d-c restorer, tube 7–V–9, is a twin triode which in this instance is connected as a diode. The tube is connected between the grids of the sweep output tubes and ground (fig. 111). The design of the circuit is such that the tube conducts current on the fly-back portion of the sawtooth sweep voltage, thus causing the coupling capacitor 7–C–23 to return to its normal voltage in almost zero time. Two 15,000-ohm resistors, 7–R–53 and 7–R–54, are in series between —105 volts and ground and provide a bias of —52.5 volts on the grids of the sweep output tubes 7–V–10 and 7–V–11, during the interval between sweeps. This same bias is imposed on the plate of the d-c restorer. It is obvious, therefore, that the restorer will not conduct unless the cathode goes below —52.5 volts. The resistance of grid resistor 7–R–52 is of the order of 560,000 ohms during the sweep time, but when the sweep returns to zero the diode conducts. The parallel resistance offered by the diode at this point causes the effective grid resistance to fall considerably below its original value. The bias on the sweep output tubes, therefore, immediately falls below cut-off at the completion of the sawtooth.

g. Sweep Output. (1) The final or output stage of the sweep circuit consists of a pair of type 6V6–GT tubes (7–V–10 and 7–V–11) connected in parallel, so that a 110-milliampere peak current is developed. This provides adequate current for the full magnetic deflection of the PPI-scope beam. The tube plate load is composed of the deflection coil (fig. 114) connected in series with a 180-ohm resistor 7–R–56. The entire arrangement is shunted by a 15,000-ohm resistor 7–R–57 and connected to a +250-volt source. Parasitic effects are suppressed in both plate and grid circuits by the insertion of resistors 7–R–58, 7–R–59, 7–R–69, and 7–R–70. The cathode resistor 7–R–55, with a value of 330 ohms, provides degenerative control of current in the stage and also develops feedback voltage for the sweep generator and sweep amplifier stages, tubes 7–V–7 and 7–V–8 respectively. With full magnetic deflection, the feedback voltage peak is approximately 45 volts.

(2) The positive sawtooth voltage waveform from the sweep amplifier tube, 7–V–8, which is impressed on the grids of the sweep output tubes 7–V–10 and 7–V–11, allows the plate-load current to increase linearly to the desired peak current of 110 milliamperes. The 180-ohm resistor, in series with the deflection coil, develops a voltage across it proportional to the current flowing through it. This voltage provides a convenient means of

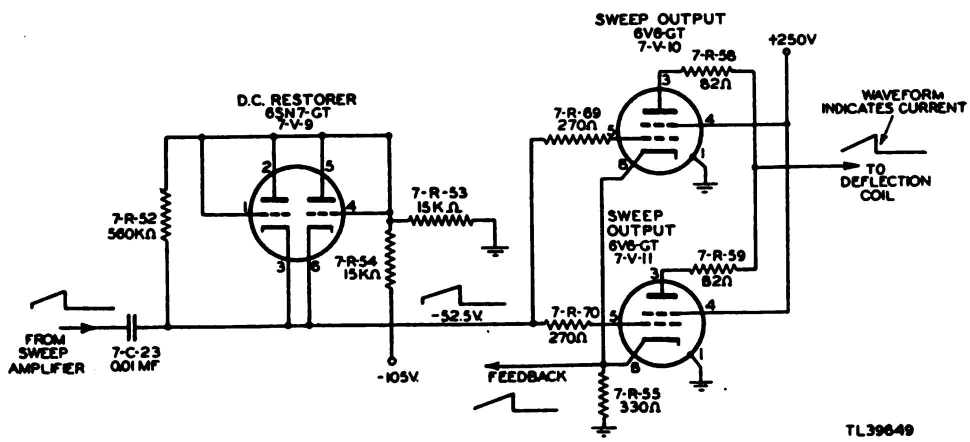


Figure 111. D-c restorer and sweep output, simplified schematic diagram.

testing the output and is fed to sweep test jack 7–K–11. Synchroscope checks can be made by inserting the instrument test probe at this point. The 15,000-ohm shunt resistor tends to damp out any oscillatory action which might occur at the end of each sawtooth sweep because of the action of the collapsing deflection-coil field.

(3) The plate current of the sweep output tubes flows through the cathode-ray deflection coils, setting up a strong magnetic field. This magnetic field causes the beam path to move away from the center of the tube toward the periphery. The distance moved is in direct proportion to the strength of the applied field. Since the deflection coils are coupled to the antenna through a selsyn synchronizing system, the coils rotate at the same speed as the spinner assembly. Thus the trace line appears as a straight line, one end pivoted at the center of the scope screen, the other end free to rotate in either direction.

(4) It is necessary for each sweep trace to start at the center of the scope for accurate echo interpretation. This means the flux in the deflection coil must collapse to zero before the next sweep starts. If trouble is experienced on the 160,000- and 240,000-yard ranges, where there is less time for the coil field to collapse, resistors 7–R–66 and 7–R–67 may be added. These resistors take a current from the 400-volt source and pass it through the deflection coil, opposing the sweep current and hastening the collapse of the coil flux. Final resistor values are determined experimentally, but approximate values of 220,000 ohms for 7–R–66 and 82,000 ohms for 7–R–67 are recommended. Do not add these resistors unless absolutely necessary for operation of a particular set.

h. PPI Scope. (1) A simplified schematic of the scope circuit proper is illustrated in figure 112. The cathode-ray tube used in this equipment is a type 7BP7. The indicating device is the electron beam developed and magnetically focused and deflected. The effect of the focusing field is varied by adjusting the current through the focusing coil 6–L–2 by varying focus control 7–R–51. Deflection is controlled by varying the field around deflection coil 6–L–1 which is wound on an iron yoke that slips over the neck of the tube. Initial electron beam acceleration is supplied by applying 250 volts from the blanker stage to the first anode. Further acceleration is produced by applying +5,000 volts to the No. 2 or accelerating anode. The accelerating anode in the type 7BP7 tube is a thin coating of conducting material (graphite) deposited on the inner surface of the evacuated glass tube. The coating extends from a point about ½ inch from the fluorescent screen to another point just beyond the deflection-coil yoke. The +5,000 volts is applied through jack 6–K–2.

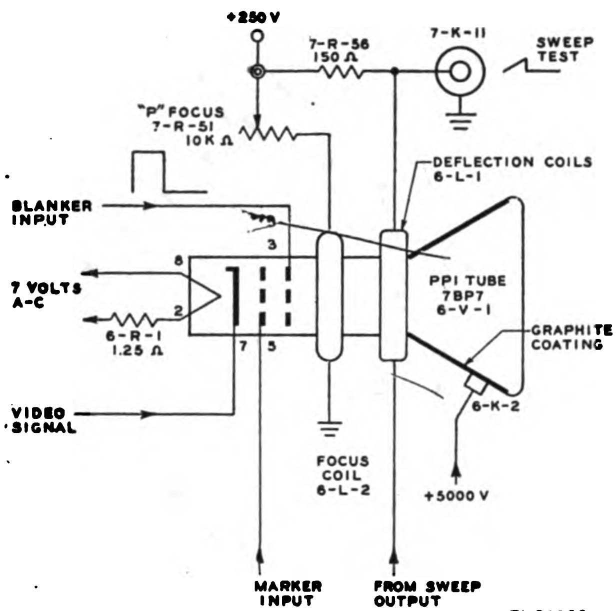


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Figure 112. PPI scope, simplified schematic diagram.

(2) Examination of the PPI scope face (fig. 113) reveals a reference line extending from the center of the scope face to the 180° mark on the azimuth dial. The azimuth angle is read on the azimuth dial under the azimuth index. Reference direction for azimuth is south as indicated by the reference line at 180°. To obtain the azimuth of a target, the azimuth dial control knob is turned until the reference line bisects the target trace.

(3) Range is estimated by pressing the COARSE markers button placing coarse range markers on the scope face. A more accurate range determination is made by pressing the FINE markers button placing both coarse and fine range markers on the scope face. Range of targets that lie between two markers must be interpolated.

i. Indicator System Diagram. Schematic diagrams of individual stages are assembled into a simplified schematic diagram for the indicator system (fig. 114).

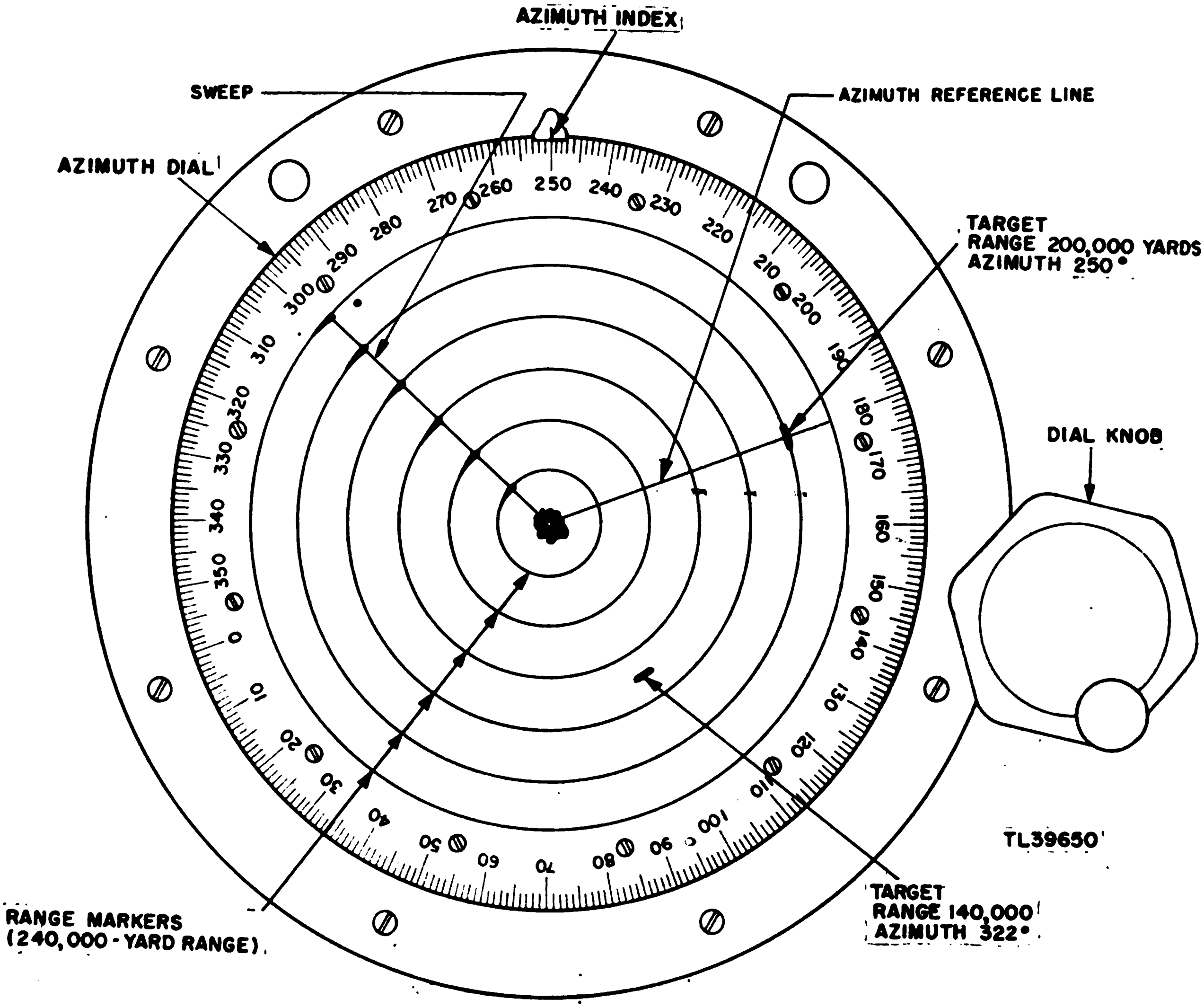


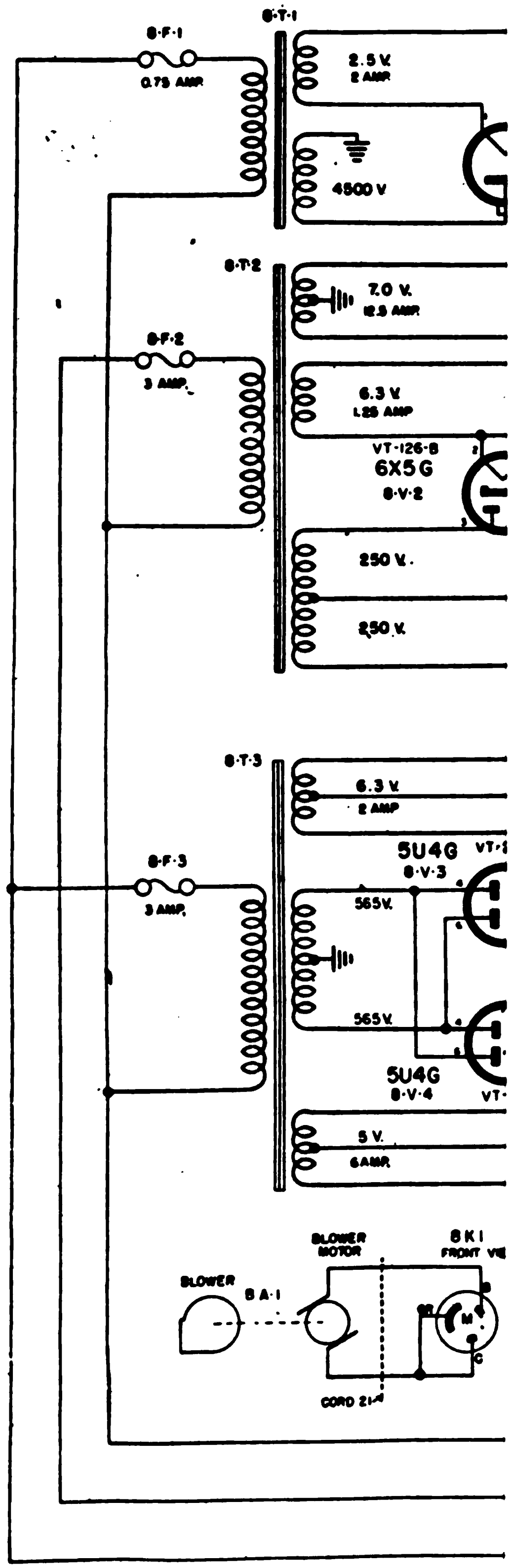
Figure 113. PPI scope, range and azimuth determination.

j. Power Supply Unit RA–100–A. This power supply unit (fig. 115) actually consists of a series of power supplies, which are built into the same chassis. The individual components of the supply are as follows:

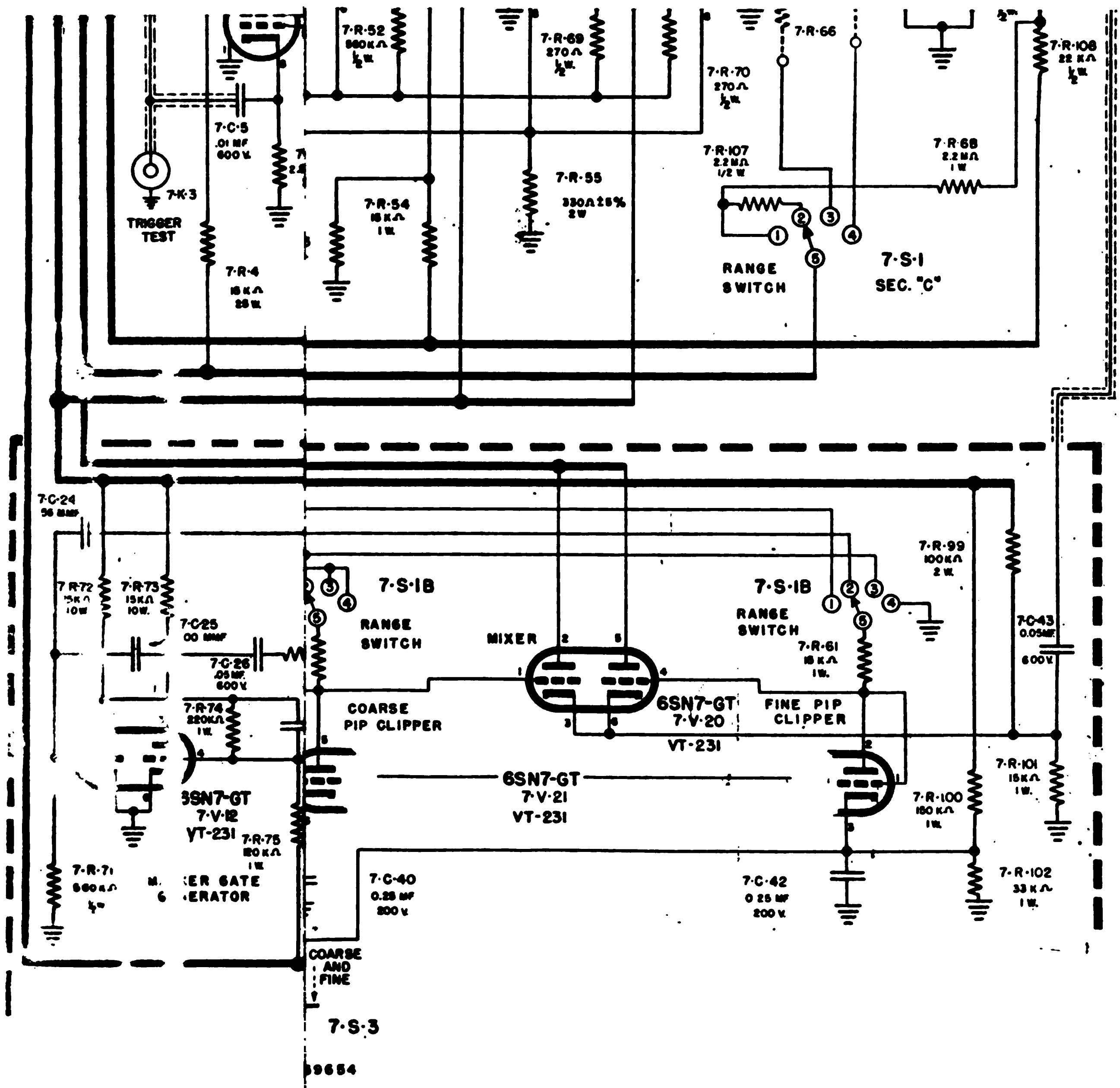
(1) *5,000-volt d-c supply circuit.* The 5,000-volt or high-voltage section of the supply is rectified by a type-2X2/879 half-wave rectifier whose output is smoothed by an RC filter of standard design. Since the peak output from the filter system is greater than 5,000 volts, two 250,000-ohm resistors, 8–R–28 and 8–R–29, are used to drop the voltage down to the required value. The 10-megohm bleeder across the output is a safety device which discharges filter capacitor 8–C–1 when the set is shut down. The bleeder consists of ten 1-megohm resistors connected in series (8–R–5 to 8–R–14). In this arrangement, since there is only a 500-volt drop across each resistor, small low-cost commercial resistors may be used. The current requirements for the entire system is very small.

(2) *7.0-volt a-c supply.* A step-down winding on the bias transformer 8–T–2 provides filament voltage to the PPI tube and to all the tubes in the indicator control.

(3) *—105-volt d-c bias supply.* The —105-volt d-c supply circuit consists of a full-wave rectifier unit with two output channels, one output supplying bias to the marker channel and the other supplying bias to the S.T.C. and sweep channel of the indicator control. Since the output must be made negative with respect to ground the cathode of the type-6X5G tube is grounded. The output is taken from the center tap of the plate transformer 8–T–2. The cathode ground conne



B-T-1
B-F-1
0.75 AMP.
2.5 V.
2 AMP.
4500 V
B-T-2
7.0 V.
12.5 AMP.
B-F-2
3 AMP.
6.3 V.
1.25 AMP.
VT-126-B
6X5G
B-V-2
250 V.
250 V.
B-T-3
6.3 V.
2 AMP.
5U4G
B-V-3
B-F-3
3 AMP.
565 V.
565 V.
5U4G
B-V-4
5 V.
6 AMP.
BLOWER MOTOR
B K I
FRONT VIE
BLOWER
B A-1
CORD 21-


7-R-52 560KΩ ½W
7-R-69 270Ω ½W
7-R-66
7-R-108 22KΩ ½W
7-R-70 270Ω ½W
7-C-5 .01 MF 600V
7-R-107 2.2MΩ 1/2 W
7-R-68 2.2MΩ 1W
7-R-55 330Ω 25% 2W
7-K-3
TRIGGER TEST
7-R-54 15KΩ 1W
7-R-4 15KΩ 25W
RANGE SWITCH
7-S-1 SEC. "C"
7-C-24 56 MMF
7-R-72 15KΩ 10W
7-R-73 15KΩ 10W
7-S-1B
RANGE SWITCH
7-S-1B
RANGE SWITCH
7-R-99 100KΩ 2W
7-C-25
7-C-26 .05 MF 600V
MIXER
7-R-61 15KΩ 1W
7-C-43 0.05MF 600V
7-R-74 220KΩ 1W
COARSE PIP CLIPPER
6SN7-GT 7-V-20 VT-231
FINE PIP CLIPPER
6SN7-GT 7-V-21 VT-231
6SN7-GT 7-V-12 VT-231
7-R-75 120KΩ 1W
7-R-100 180KΩ 1W
7-R-101 15KΩ 1W
7-R-71 560KΩ ½W
7-C-40 0.25 MF 200V
7-C-42 0.25 MF 200V
7-R-102 33KΩ 1W
COARSE AND FINE
7-S-3
59654


TO 1-K-2 ON PEDESTAL
TO 3 K 10 ON MODULATOR
TO 4 K 8 ON MODULATOR

tion is made through three type-VR–105 tubes, 8–V–5, 8–V–6, and 8–V–10, and bias relay 8–E–1. Input to the other transformers in the power supply is applied when the bias relay holding coil functions. If a type VR–105 tube is removed or the bias voltage supply fails, the relay will not close and the entire power supply will not operate. This assures that bias will be present before the plate voltage is applied and eliminates the possibility of power-supply failure due to excessive current drain. The 8-microfarad capacitor 8–C–2, which is connected between the tube cathode and the transformer secondary center tap, acts as a storage capacitor and gives higher voltage output. It charges during each half-cycle to the pulse voltage at the center tap. Resistors 8–R–15 and 8–R–16 are current-limiting resistors for the VR tubes.

(4) *250- and 400-volt supplies* (fig. 115). *(a)* Two type-5P4G tubes, 8–V–3 and 8–V–4, are connected in parallel in a full-wave rectifier circuit. The rectifier output is fed into two choke-input filters, one of which is a 2-section inductance-capacitance (LC) filter consisting of two 15-henry chokes, 8–L–1 and 8–L–2, and two 8-microfarad capacitors (8–C–4 and 8–C–5). The output from this system is 400 volts unregulated.

(b) The voltage is also fed to a second choke-input filter consisting of a single 15-henry choke, 8–L–3, and one 8-microfarad capacitor, 8–C–6.

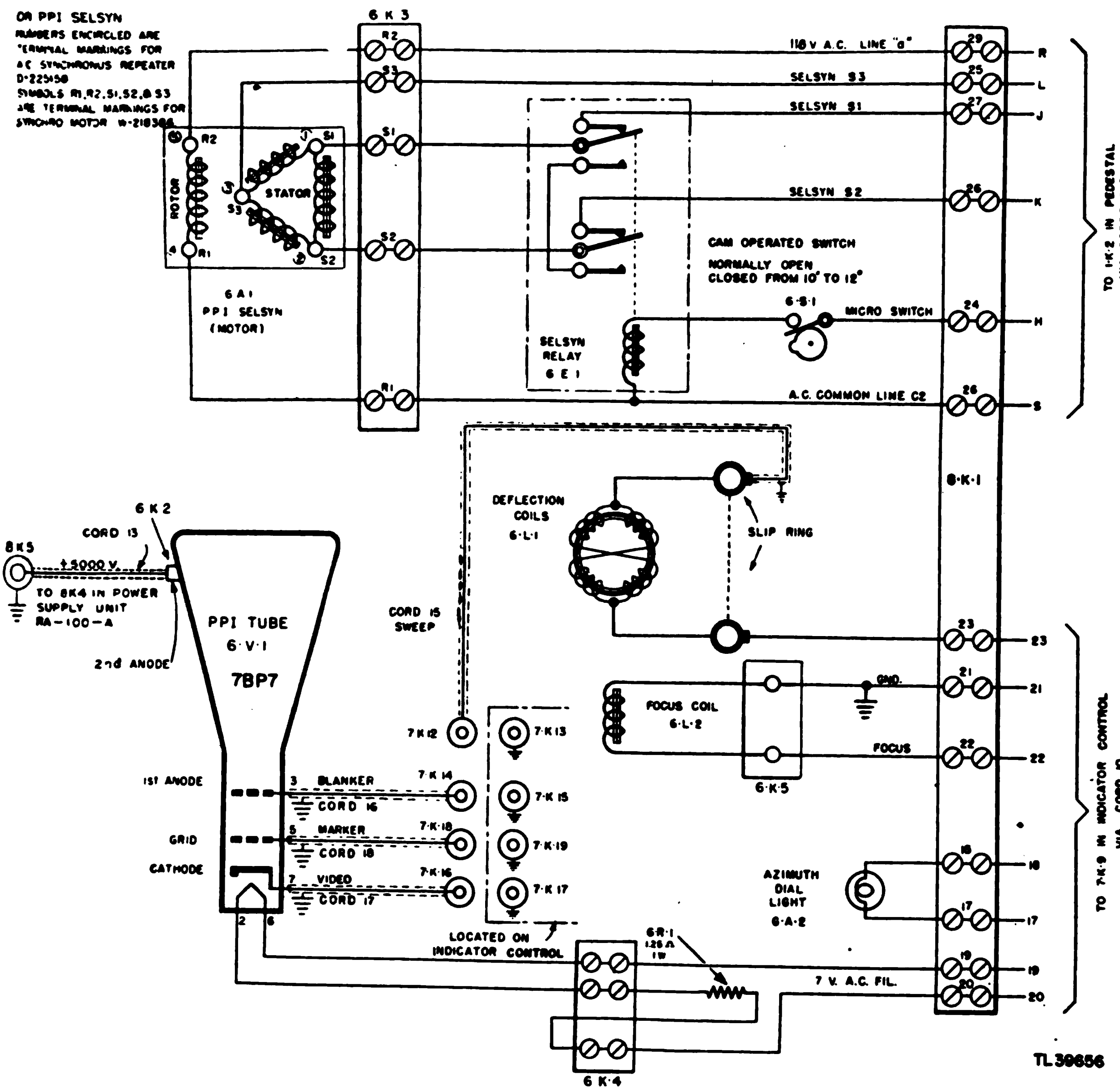


Figure 118. Indicator Panel BD–123–A, complete schematic diagram.

The 400-volt output is applied to the plate of two type-6B4G regulator tubes, 8–V–7 and 8–V–8. Because of the internal resistance of the tubes, a 250-volt output is taken off the 6B4G filament winding center tap. Regulation and maintenance of the 250-volt value is maintained in the following manner. The type-6SJ7 tube is used as a control device. Cathode and screen voltage for the type-6SJ7 tube are obtained from a voltage divider connected from the 250-volt output to ground, the voltage regulator tube 8–V–10 maintaining the cathode voltage at +105 volts. The plate supply is taken from the 400-volt output with 560,000-ohm resistor, 8–R–26, in the plate load. Grid voltage is obtained from the center arm of a 50,000-ohm potentiometer which is part of another voltage divider across the 250-volt supply. Variation of the bias on the type-6SJ7 control tube varies the bias in the regulator tubes, increasing or decreasing their output. Assume that the load demand calls for a higher current. The output voltage of tubes 8–V–7 and 8–V–8 decreases. The decreased output voltage causes a lower grid voltage on the control tube 8–V–9 and consequently a lower plate current. The smaller plate current causes a lower voltage drop across the 560,000-ohm plate-load resistor and a higher effective plate voltage. The increased voltage is applied to the grids of regulator tubes 8–V–7 and 8–V–8, causing them to conduct more heavily, and hence creating a lower voltage drop through them. The effect is to restore the original 250-volt output. If the current through tubes 8–V–7 and 8–V–8 decreases, an opposite action to the one described above will take place, and the output voltage will still remain at 250 volts. In effect, the 6B4G tubes may be considered as several variable resistors which vary with current load changes. The net effect of any vairation will be to compensate automatically for the changes, so that a constant voltage of 250 volts is maintained.

44. Complete Schematic Diagrams

Figures 116 to 118 inclusive represent complete schematic diagrams for the indicator system. Indicator Control BC–1193–A is illustrated in figure 116; the complete schematic of Indicator Unit BC–1225–A is shown in figure 117. Figure 116 includes the schematic diagrams of the indicator system, the range marker system, and the S.T.C. circuit of the receiver system. Figure 118 represents the complete schematic diagrams of Indicator Panel BD–123–A and Meter Panel BD–124–A. These schematics may be used as supplements to the simplified schematics in this section as well as ready references for the trouble-shooting section on this system (chap. 2, sec. VIII).

Section VII. RANGE MARKER SYSTEM

45. Introduction

The function of the range marker circuit is to produce an electron-developed range measuring device on the PPI scope. Markers are produced when voltage is applied to the grid of the cathode-ray tube at timed intervals. This voltage causes an increased flow of current in the cathode-ray tube, creating points of increased intensity on the screen. As the sweep revolves, the points of increased intensity leaves circular traces, because of the persistency of the screen (fig. 100). These circular traces (spaced at equal intervals) are used as range markers.

46. Simplified Block Diagram

Figure 119 is a simplified block diagram of the range marker system. A trigger pulse from the spark gap modulator starts the range marker

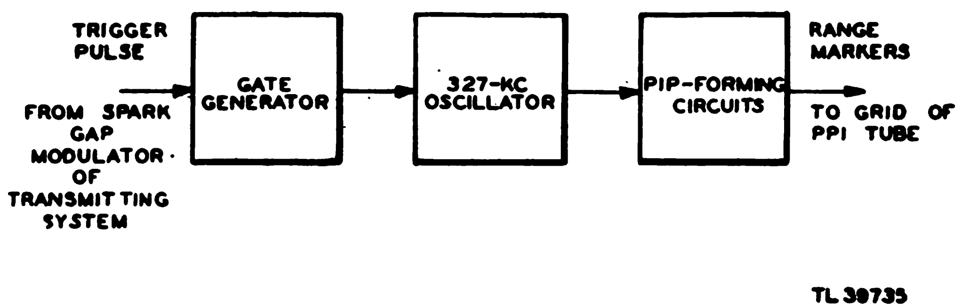


Figure 119. Range marker system, simplified block diagram

action simultaneously with the activation of the transmitter and indicator systems. The output of the range marker system is fed directly to the grid of the PPI scope.

47. Complete Block Diagram

Figure 120 is a complete block diagram of the range marker system. A brief discussion of each circuit group follows.

a. MARKER GATE GENERATOR. The marker gate generator (fig. 121), tube 7–V–12, is a start-stop multivibrator. It is triggered by a negative pulse developed at the output of the trigger buffer stage. It produces a steep-sided square negative gate with an amplitude of about 140 volts, the width of which is the same as the sweep width on the longest (240,000-yard) scope range.

b. SWITCH TUBE AND PIP MARKER OSCILLATOR. In the development of the electronic range markers, a series of oscillatory waves of equal amplitude is used. Since the velocity of radio waves is known, an oscillator with the necessary characteristics can be constructed to measure the signal travel-time to and from a target. The pip marker oscillator, the second section of tube 7–V–13, is kept inoperative by the conducting action of

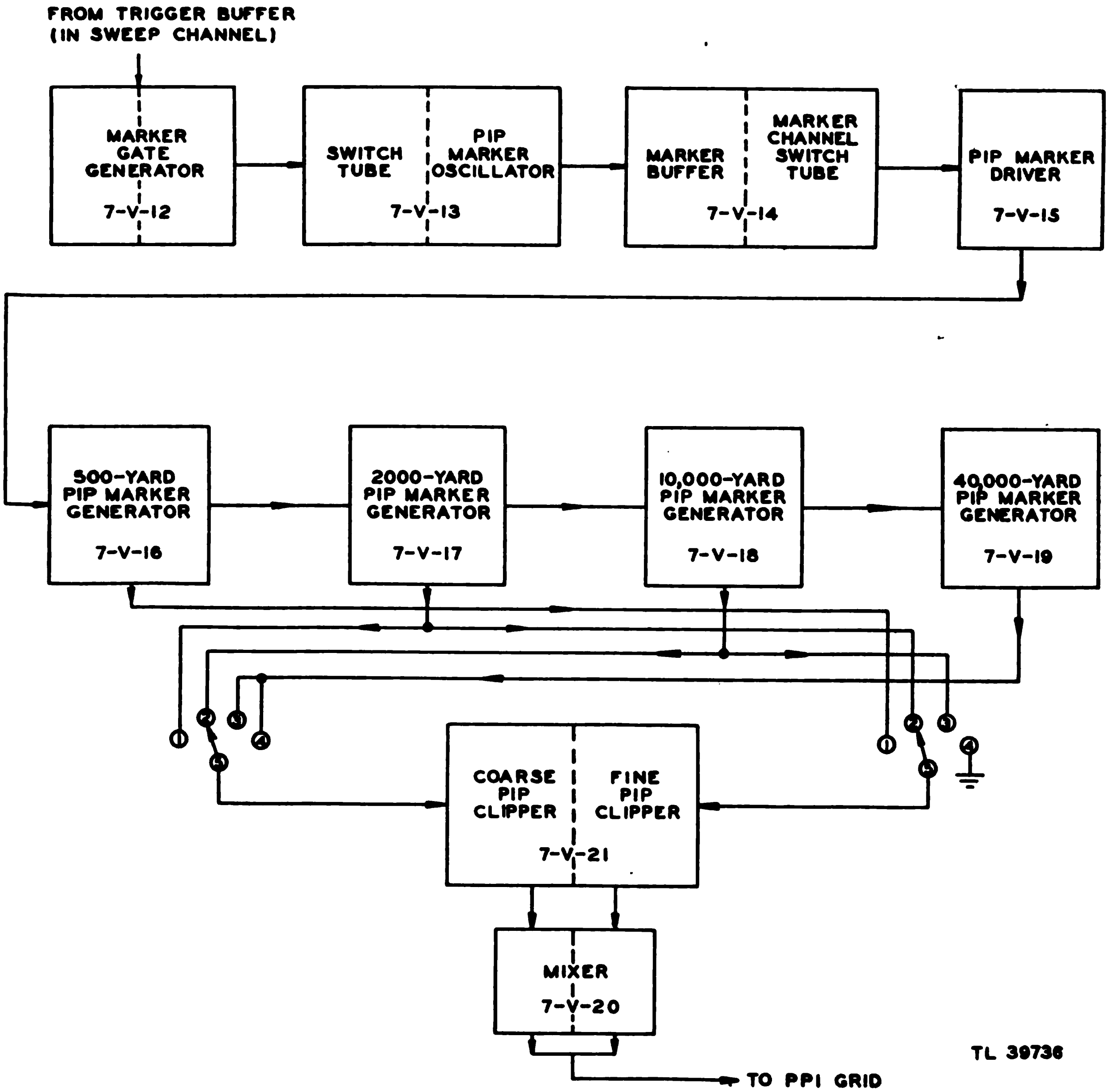


Figure 120. Range marker system, complete block diagram.

the switch tube, the first section of tube 7–V–13 (fig. 122). When the negative gate is applied to the switch tube, the pip marker oscillator produces a sine wave voltage of a frequency of 327.868 kilocycles. The time of one cycle is approximately 3 microseconds. This output is used to develop markers on the 10,000-yard range which allow measurement of 500-yard intervals.

c. Marker Buffer and Marker Channel Switch Tube. The marker buffer half, 7–V–14, of the stage (fig. 123) isolates the oscillator described above from the balance of the circuit and thus acts as a stabilizing influence. The marker channel switch tube, the second section of tube 7–V–14, provides an electronic means of switching on and off the pip markers that appear on the PPI-scope screen. The output waveform of this stage is distorted because of the slightly positive potential on the cathode. This series of negative pulsations with an amplitude of 12 to 15 volts is directly coupled to the grid of the pip marker driver.

d. Pip Marker Driver. The action of the pip marker driver stage, 7–V–15 (fig. 124), is to invert and amplify the negative pulses developed in the preceding stage. The inverted or positive pulses appearing in the output have an amplitude of approximately 125 volts.

e. 500-yard Pip Marker Generator. The 500-yard pip marker generator, 7–V–16 (fig. 125), develops sharp positive pips with amplitudes of approximately 160 volts which are fed to the fine pip clipper stage. The output of the stage also triggers the 2,000-yard range marker stage.

f. 2,000-, 10,000-, and 40,000-yard Pip Marker Generators. These stages, 7–V–17, 7–V–18, and 7–V–19 (fig. 126), of the unit are triggered by the stage immediately preceding it. Each in turn develops the required range marker pips for the selected range. In brief, the result is as follows:

(1) The 10,000-yard range displays 500-yard fine pips and 2,000-yard coarse pips.

(2) The 40,000-yard range displays 2,000-yard fine pips and 10,000-yard coarse pips.

(3) The 160,000-yard range displays 10,000-yard fine pips and 40,000-yard coarse pips.

(4) The 240,000-yard range displays 40,000-yard coarse pips.

g. Fine and Coarse Pip Clipper. Pips for the corresponding range setting are fed to the coarse and fine pip clipper stage, 7–V–21 (fig. 127), through selector switches. The fine markers (light lines) appear between the coarse markers (heavy lines), as described in *f*, on the PPI-scope screen. The stage clips the markers at a selected level, and feeds them to the mixer stage which follows.

h. Mixer. The mixer stage, 7–V–20 (fig. 127), feeds the markers to the grid of the cathode-ray tube at the proper intervals. As the spinner assembly rotates, the markers appear on the PPI-scope screen as evenly spaced concentric circles, the interval being dependent upon the setting of the RANGE switch. The range markers constitute a rapid and accurate index for determination of target range.

48. Circuit Details

a. Marker Gate Generator. A 6SN7–GT dual triode tube, 7–V–12 (fig. 121), is used in the first stage of the range marker system as a marker gate generator. A negative square pulse, 1 microsecond wide and 100 volts in amplitude, is taken from the plate load resistor, 7–R–4, of the trigger-buffer stage, 7–V–5, and applied to the grid of the first section of 7–V–12 through capacitor 7–C–24. The marker gate generator is a start-stop multivibrator which functions in the same way as the sweep gate generator, 7–V–6 (par. 43*b*). The time constants of the multivibrator coupling circuits are so chosen that the output pulse length assures sufficient range markers for all four scope ranges. The output of the first section of 7–V–12 is applied to the grid of the second section through resistor 7–R–74 in parallel with capacitor 7–C–39, this combination sharpening the sides of the pulse.

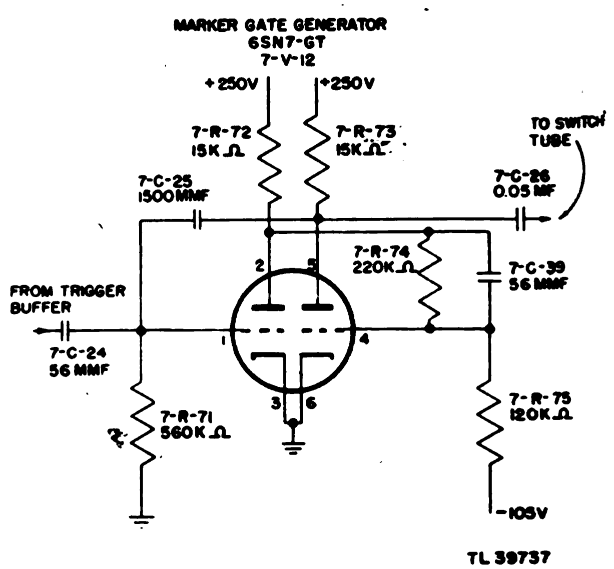


Figure 121. Marker gate generator, simplified schematic diagram.

The output of the second section of 7–V–12 is a sharp-sided, negative marker gate, the amplitude of which is 140 volts.

b. Switch Tube and Pip Marker Oscillator. The second stage of the range marker system is a 6SN7–GT tube, 7–V–13 (fig. 122). During the period between marker gates, the first section of the 6SN7–GT is conducting heavily. When the negative 140-volt gate reaches the grid of the tube through capacitor 7–C–26, the tube is driven far beyond cut-off, causing the current flow in the first section of the tube to cease. As the current flow decreases to zero, the effective resistance across the tank circuit, 7–A–3, increases, thereby raising the effective *Q* of the tank circuit to a point where the circuit will begin to oscillate. The frequency of oscillation (327.868 kc) is set at the factory and should not be adjusted unless there is a definite error in frequency. When the gate is removed from the grid allowing plate current to flow, the effective resistance across the tank circuit decreases causing the effective *Q* to be reduced to a point where oscillations cease. The tube, therefore, may be considered as a switching device which controls the starting and stopping of circuit oscillations. Isolation from the marker generator tube, 7–V–12, is effected by a 22,000-ohm resistor, 7–R–77, inserted in the grid circuit of 7–V–13. The oscillator tank, a slug-tuned system mounted in can 7–A–3, may have its resonate frequency varied over a limited range by adjusting the position of the slug in its inductive field. The basic frequency at which the oscillator is set is 327.868 kc, the proper value for obtaining 500-yard markers. The variation arrangement is necessary, because although properly set at the factory, shift of frequency for any reason will result in a percentage of error in range measurements. It is important that, if tube replacement becomes necessary, the tube replaced should be of same manufacture as the one removed. The second section of 7–V–13 completes the oscillatory circuit and helps maintain the oscillations at a comparatively even amplitude. Bias for the second section is obtained from the voltage drop across the 22,000-ohm cathode resistor, 7–R–79. Coupling from the cathode of 7–V–13 to the grid of the succeeding stage, 7–V–14, is through capacitor 7–C–30.

c. Marker Buffer and Marker Channel Switch Tube. (1) The output of the pip marker oscillator is coupled to the grid of the first section of the 6SN7–GT tube, 7–V–14. This stage, a cathode

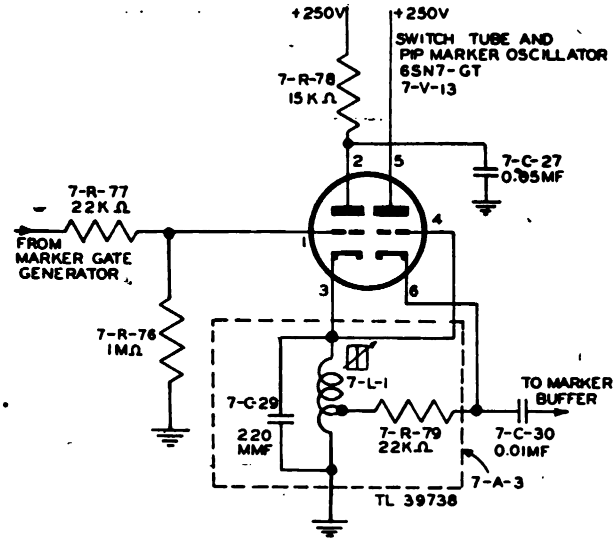


Figure 122. Switch tube and pip marker oscillator, simplified schematic diagram.

follower, is referred to as a marker-buffer; it isolates the pip marker oscillator from the succeeding stages. A divider network, 7–R–80 and 7–R–119, places —9.5 volts on the grid. The plate of the tube is connected directly to +250 volts and the cathode to —105 volts through 22,000-ohm resistor 7–R–81. The resulting 5-milliampere current flow causes a 106-volt drop across the cathode resistor. The cathode potential, therefore, is approximately 1-volt positive, and the effective bias on the grid is —10.5 volts. The tube action tends to improve the stability of, and isolate the following stages from, the pip marker oscillator. A stable sine wave with an amplitude of approximately 40 volts is developed across common cathode resistor 7–R–81. This voltage is effectively applied to the grid-cathode circuit of the second section of the tube (fig. 123).

(2) The second section of 7–V–14, the marker channel switch tube, is connected as a diode by tying plate and grid together. Normally, the MARKERS switch, 7–S–2 or 7–S–3 (fig. 127), is open so that the plate voltage is held at —105 volts through resistors 7–R–82 and 7–R–88. In this condition the second section of 7–V–14 does not conduct, therefore no signal is passed to the grid of 7–V–15. When the MARKERS switch is closed, the plate is connected to ground through resistor 7–R–82. The tube conducts only on the negative half-cycle of the incoming sine wave. When the tube conducts, the voltage drop across plate resistor 7–R–82 increases. The output, therefore, is a series of negative (with relation to ground) pulses, with an amplitude of approxi-

mately 10 volts that are 1½ microseconds wide and 1½ microseconds apart. The output of this stage is coupled directly to the grid of the pip marker driver.

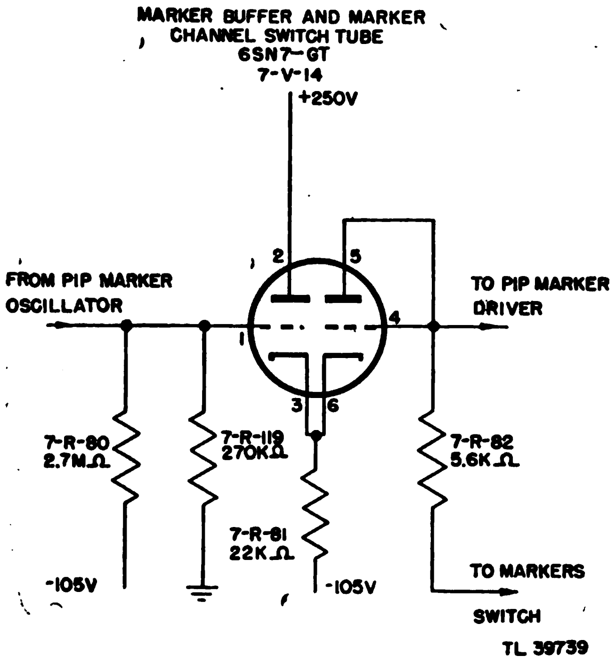


Figure 123. Marker buffer and marker channel switch tube, simplified schematic diagram.

d. Pip Marker Driver. A 6V6–GT tube, 7–V–15 (fig. 124), is used in this stage. The cathode is connected directly to ground, the screen is connected to a +250-volt source through 56,000-ohm resistor 7–R–83, and held at a constant potential by the action of bypass capacitor, 7–C–31. With the MARKERS switch open, the grid voltage applied through resistors 7–R–82 and 7–R–88 is —105 volts; therefore the tube is at cut-off. When

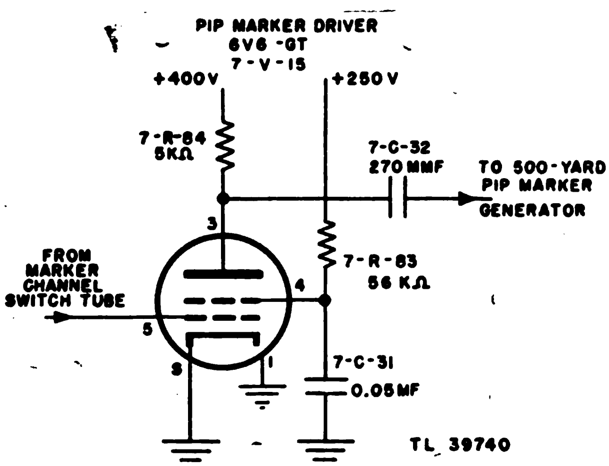


Figure 124. Pip marker driver, simplified schematic diagram.

the MARKERS switch is closed, the grid of the tube as well as the plate of the marker channel switch tube is connected to ground through resistor 7–R–82. The driver plate is connected to a +400-volt source through 5,000-ohm resistor 7–R–84. Under these conditions, 55 milliamperes of current will flow through the tube leaving a voltage of 125 volts on the plate. Due to the 10-volt negative pulse applied to the grid from 7–V–14, the output taken off plate load resistor 7–R–84, is a series of positive pulsations of approximately 125 volts amplitude. Coupling to the grid of the succeeding tube, 500-yard pip marker generator 7–V–16, is through capacitor 7–C–32.

e. The 500-yard Pip Marker Generator. (1) A 6V6–GT tube, 7–V–16, is used as the 500-yard pip marker generator (fig. 125). The grid and plate are connected to a specially constructed transformer, 7–T–1. The transformer has three windings: grid, plate, and output. The core is made up of extremely thin iron laminations (0.003 inch thick). Thin laminations are used because the current changes in the transformer are very large, and occur very rapidly; therefore, high eddy current and hysteresis losses occur in the core material. During no-signal periods the grid voltage of this tube is —52.5 volts, obtained from a divider network, consisting of resistors 7–R–86 and 7–R–87, connected between —105 volts and ground. This biases the tube well below cut-off. Each positive pulse from the pip marker driver allows the 500-yard pip marker generator tube to conduct. During the conduction period, plate current flows in the transformer plate winding. This current induces a voltage across the grid winding such that the grid goes highly positive causing the plate current of the tube to rise almost instantaneously to saturation. When the tube reaches saturation, there is no further change in current through the plate winding, hence no voltage is induced across the grid winding. Capacitor 7–C–34 which charges as the grid goes positive, starts to discharge and drive the grid negative. The current in the plate winding decreases, inducing a voltage across the grid winding, driving the grid still more negative. The increase in negative grid voltage rapidly decreases the plate current inducing a greater voltage across the grid winding. This causes the grid to go still more negative, and be driven almost instantaneously beyond cut-off, blocking the tube. This blocking action occurs so rapidly that only the sharp wave front of the triggering pulse passes through the transformer. Capacitor 7–C–34 keeps the grid blocked until the capacitor can discharge exponentially through resistors 7–R–85 and 7–R–87. The RC constant has been so arranged that the capacitor will discharge to the original —52.5 volts before the next triggering pulse from the driver is applied.

(2) The sharp wave front that passes through the transformer causes a 350-milliampere current surge through the tube. A positive, 160-volt, ¼-microsecond pip appears at terminal 4 of the transformer. The output from terminal 4 of 7–T–1 goes to switch 7–S–1. At the tube plate or at terminal 1 of the transformer, there appears a sharp negative pip that is coupled through attenuating resistor 7–R–89 to the plate of the following generator, and to terminal 2 of the transformer 7–T–2.

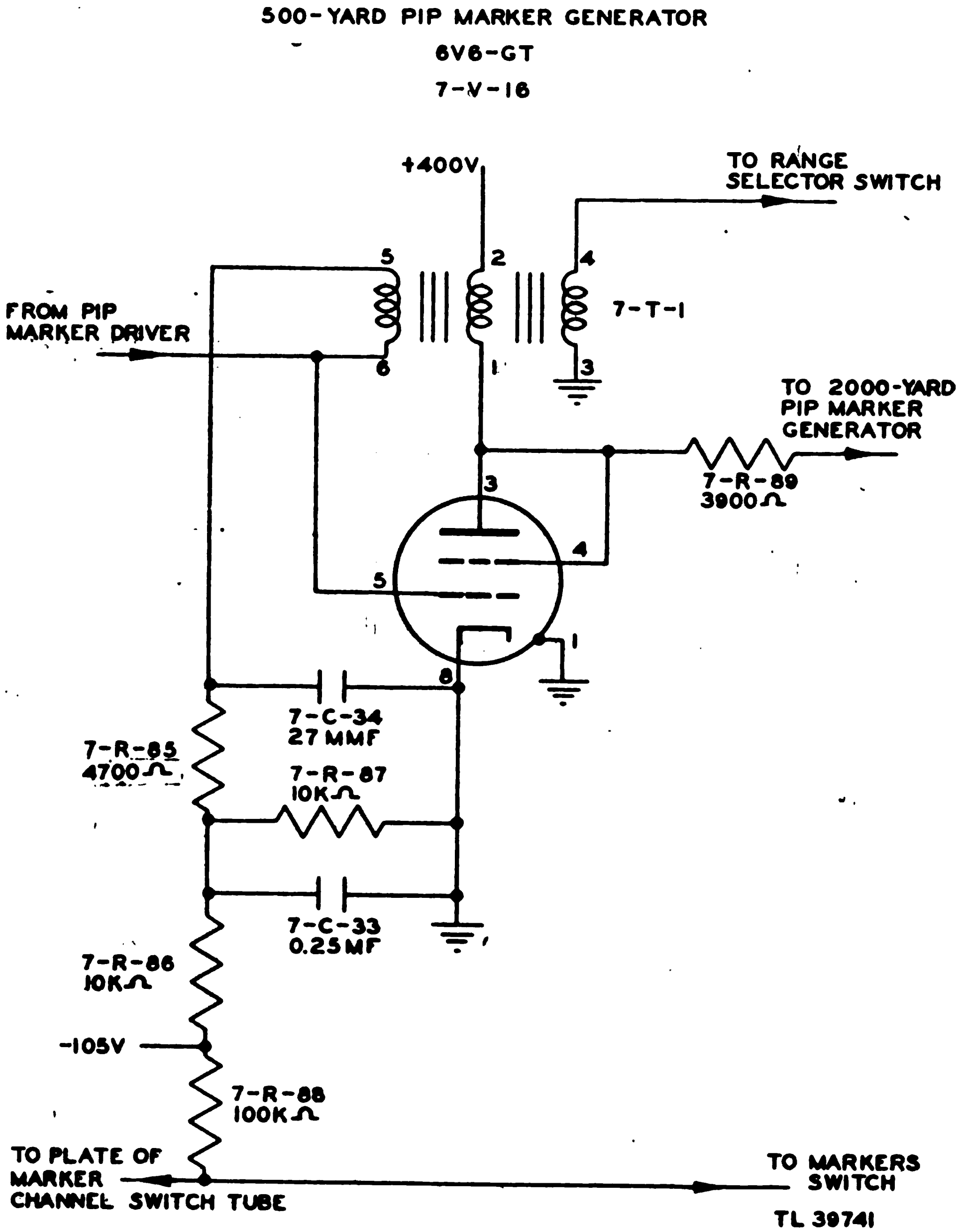


Figure 125. Pip marker generator (500-yard), simplified schematic diagram.

f. 2,000-, 10,000-, AND 40,000-YARD PIP MARKER GENERATORS. These generators, 7–V–17, 7–V–18, and 7–V–19, supply range marker pips to the PPI-scope grid in such a way that 2,000-, 10,000-, and 40,000-yard range markers appear on the scope screen when it is desired to determine accurately the range of a target (fig. 126).

(1) The 160-volt pulse from the 500-yard pip marker generator is applied to terminal 2 (plate winding) of the 2,000-yard pip marker generator transformer, 7–T–2, through resistor 7–R–89. The grid of 7–V–17 is connected through the grid winding of the transformer to the junction of resistors 7–R–103 and 7–R–95, the voltage divider connected between —105 volts and ground, thus biasing the tube beyond cut-off. Current, due to the negative pip marker pulse impressed across the plate winding of transformer 7–T–2, causes a voltage to be induced across the grid winding of the transformer such that the grid is driven sharply above cut-off. Plate current flows through the transformer causing a still higher grid voltage; this voltage in turn causes the plate current to increase further. This cumulative effect results in plate-current saturation in an extremely short time. It also results in a flow of grid current, this current charging capacitor 7–C–35 to a value equal to the peak grid voltage. As soon as plate-current saturation occurs, no further increase in current through the plate winding of the transformer takes plate; therefore, the induced positive voltage across the grid winding falls to zero. As the grid voltage decreases, the plate current also decreases, this decrease causing a voltage to be induced in the grid winding such that the grid is driven further in a negative direction. This cumulative action drives the tube beyond cut-off in an extremely short time. As soon as plate current ceases flowing, no further voltage is induced in the grid winding. The grid will now be held well beyond cut-off by the action of capacitor 7–C–35, previously charged through 7–V–17, discharging through resistor 7–R–90 and potentiometer 7–R–109. The time constant of this RC circuit is so adjusted by means of potentiometer 7–R–109 that the pip generator tube is held cut off until the fourth pulse from the 500-yard pip marker generator again drives the grid above cut-off. A sharp negative pulse will appear at the plate of tube 7–V–17. The output,

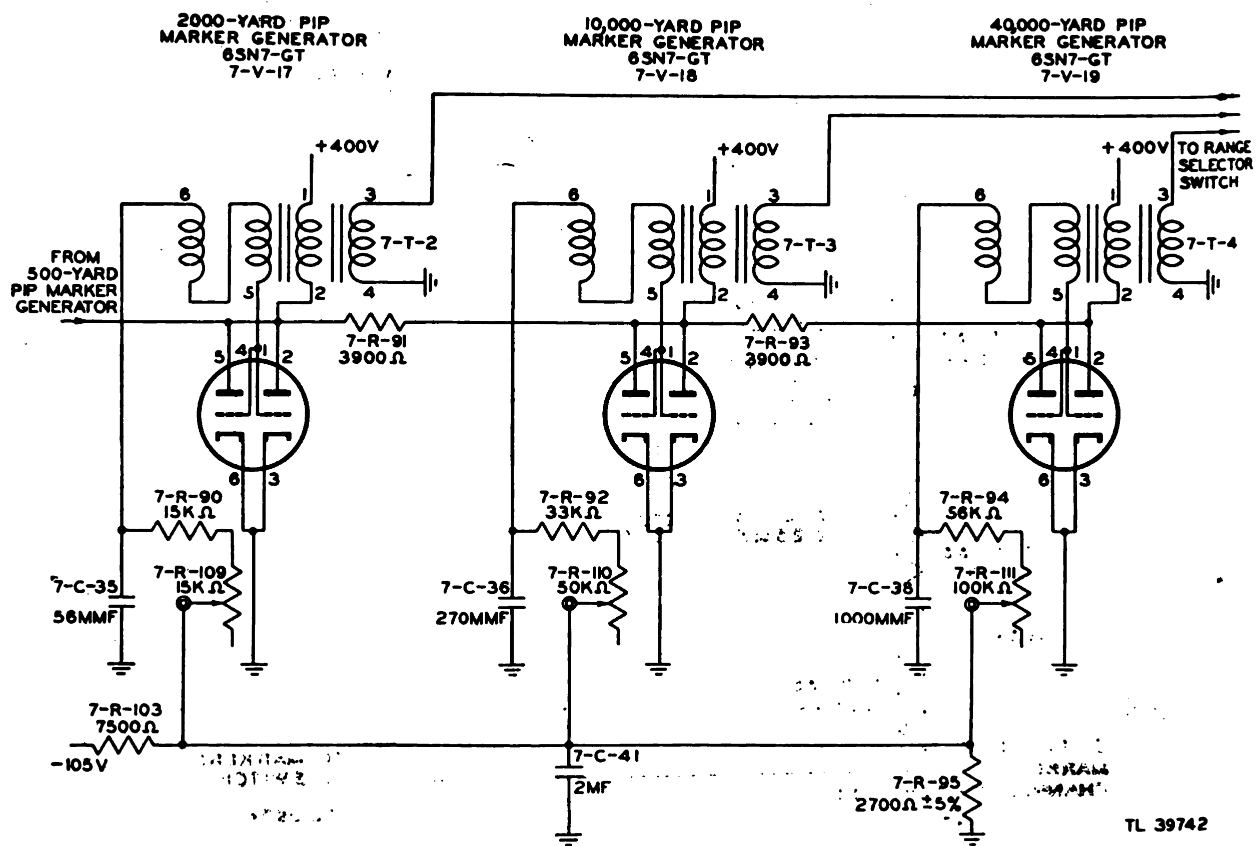


Figure 126. Pip marker generator (2,000-, 10,000-, and 40,000-yard), simplified schematic diagram.

taken from the output winding of the transformer, will consist of positive pulses. The time interval between positive pulses corresponds to a range of 2,000 yards. Sufficient pips are generated to provide markers every 2,000 yards of the 40,000-yard range. The output of the 2,000-yard generator is taken to switch 7–S–1.

(2) The negative pulse appearing at the plate of the 2,000-yard pip marker generator is applied to terminal 2 (plate winding) of the 10,000-yard pip marker generator transformer, 7–T–3, through attenuating resistor 7–R–91. The action of this stage in supplying 10,000-yard pip markers is exactly the same as that of the 2,000-yard pip marker generator in supplying 2,000-yard markers. The RC circuit in the grid of 7–V–18 is so adjusted that the tube bias will be raised above cut-off on every fifth pulse supplied by the 2,000-yard generator. The output is taken to switch 7–S–1 and consists of sufficient pips to provide markers every 10,000 yards of the 160,000-yard range.

(3) The 40,000-yard pip marker generator is triggered by the output of the 10,000-yard generator. It functions in the same manner as do the 2,000- and 10,000-yard generators. The RC circuit in the grid of 7–V–19 is adjusted so that the stage triggers on every fourth pulse supplied through attentuating resistor 7–R–93 to the transformer 7–T–4. The output is taken to switch 7–S–1 and is used to supply 40,000-yard markers for the 160,000- and 240,000-yard ranges.

g. Pip Clippers. (1) All of the range markers are not used on all the ranges. The 500-yard genrator is used only as a source of fine pips, and the 40,000-yard generator only as a source of coarse pips. The combinations appearing for a given range setting are as follows:

(*a*) 10,000-yard range: 500-yard fine pips and 2,000-yard coarse pips.

(*b*) 40,000-yard range: 2,000-yard fine pips and 10,000-yard coarse pips.

(*c*) 160,000-yard range: 10,000-yard fine pips and 40,000-yard coarse pips.

(*d*) 240,000-yard range: 40,000-yard coarse pips.

(2) The 160-volt signal from the fine pip selector section of the RANGE selector switch is coupled through 15,000-ohm resistor 7–R–61 to the plate of the fine pip clipper, 7–V–21 (fig. 127), the second triode section of a 6SN7–GT connected as a diode. When the coarse and fine range markers switch 7–S–3 is operated, the voltage on the cathode is +45 volts, obtained from a divider network of resistors 7–R–100 and 7–R–102 between +250 volts and ground. As the plate voltage increases above the cathode voltage, the flow of current through the tube and 15,000-ohm resistor 7–R–61 increases; consequently, the plate voltage does not rise much above +45 volts. The remainder of the positive 160-volt input signal appears across plate load resistor 7–R–61. With the introduction of the signal pulse, the plate voltage rises until plate and cathode voltages are equal at which time the tube conducts. The result is a clipping action at a +45-volt level, so that the output of the fine pip clipper applied to the mixer is a series of positive 45-volt, ¼-microsecond pips.

(3) The 160-volt signal from the coarse pip selector in the RANGE selector switch is coupled through 15,000-ohm resistor 7–R–60 to the plate of the coarse pip clipper, 7–V–21 (fig. 127), the first triode section of 6SN7–GT connected as a diode. When switch 7–S–2 or 7–S–3 is operated the voltage on the cathode can be varied from +23 volts to +94 volts by means of 100,000-ohm marker contrast potentiometer 7–R–97, connected in a divider network consisting also of resistors 7–R–96 and 7–R–98 from +250 volts to ground. Degenerative effects are minimized by bypassing the cathode to ground, through capacitor 7–C–40. The action of this tube is very similar to that of the fine pip clipper, with the exception of the variation of the clipping level in the coarse pip clipper. The clipping level variation is the means used to create contrast between fine and coarse pip indications. The marker contrast control, which is located on the tube shelf of the indicator control chassis, is the means used to control the effect.

(4) Normally MARKER switches 7–S–2 and 7–S–3 are in the positions illustrated in figure 127. With the switches in these positions no pulses are fed into the pip marker driver 7–V–15, and the marker generators remain inactive (see *c* and *d* above). In addition to the above action the switches ground the cathodes of the pip clippers, preventing any positive signal from appearing on the plates of these stages. When COARSE MARKERS switch 7–S–2 is pressed, the plate and grid of the marker channel switch tube and the grid of the pip marker driver are grounded through resistor 7–R–82, allowing the marker channel to operate. The cathode of the fine pip clipper remains grounded, clipping the fine pips

at the zero volt level. The voltage on the cathode of the coarse pip clipper rises to a value determined by the setting of MARKER CONTRAST potentiometer, 7–R–97. Thus the pips are clipped at a level determined by the setting of potentiometer 7–R–97 and fed to the mixer 7–V–20. When FINE MARKERS switch 7–S–3 is pressed, the action is the same as when the COARSE MARKERS switch is pressed, except that the cathode of the fine pip clipper is ungrounded and connected to a point of positive potential. This allows both positive and negative markers of the proper voltage to be fed to the mixer.

Emphasis is again placed on the fact that there will be no pip or indication on the PPI-scope screen when the MARKERS switches are open.

network consisting of resistors 7–R–99 and 7–R–101 is connected between 250 volts and ground. The tube cathodes are tied together and connected to a 33-volt tap on the divider. Since the tube is used as a cathode follower, the output is taken off at resistor 7–R–101, and coupled to the MARKER AMPLITUDE control, 7–R–63, through capacitor 7–C–43. The output from the MARKER AMPLITUDE control is coupled to the PPI-tube control grid through a matching coaxial line. When the signals from the pip clipper are applied to the PPI grid, sharp positive voltage pips are superimposed on the normal d-c bias of the PPI-tube grid. This creates the change necessary to impose range marker combinations on the PPI-scope screen. As the sweep revolves,

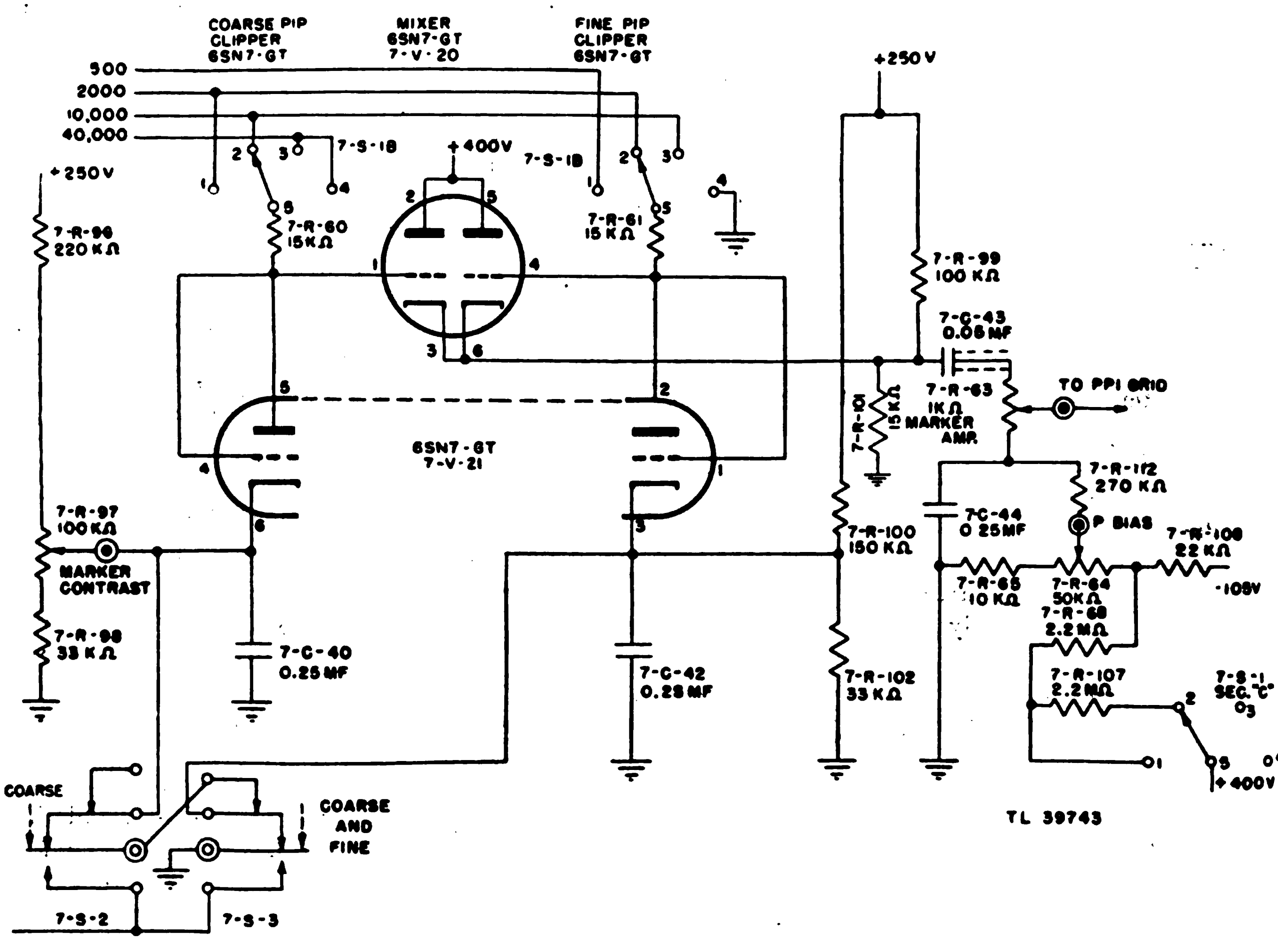
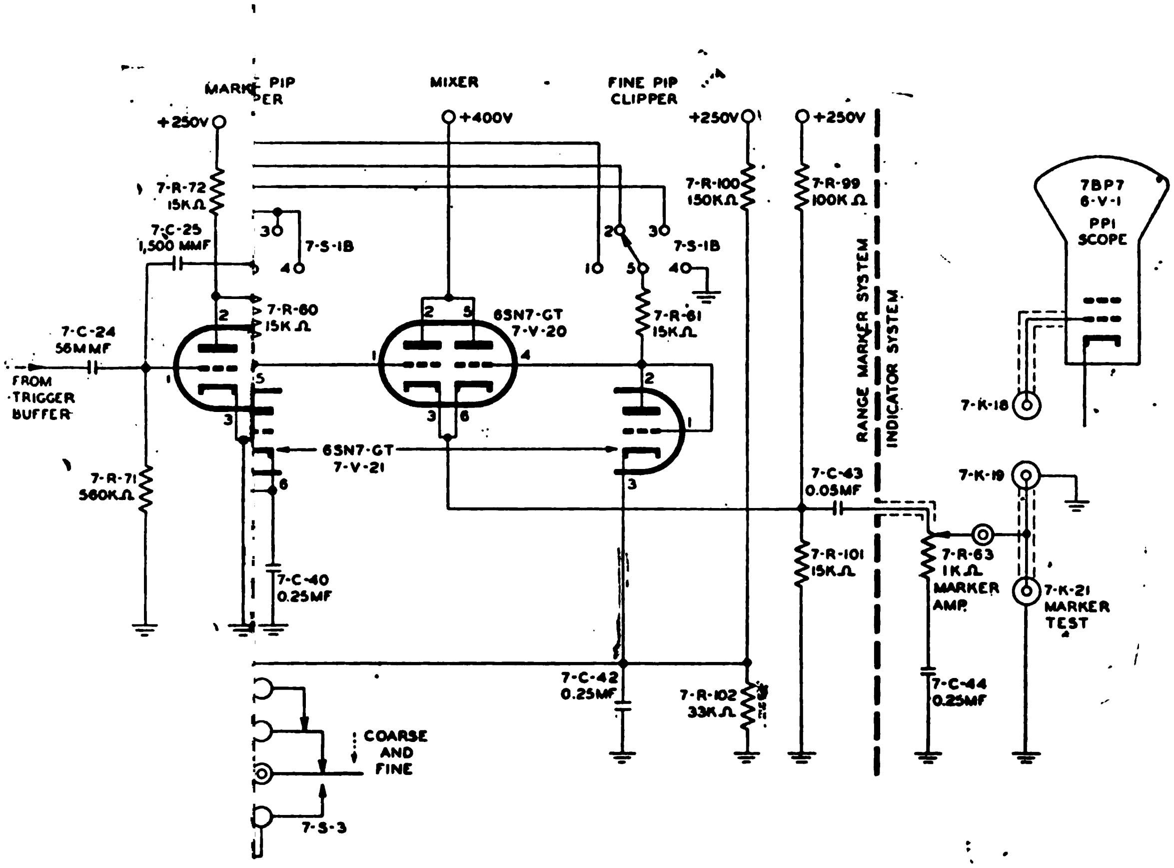


Figure 127. Pip marker mixer and clippers, simplified schematic diagram.

h. MIXER. The last stage of the range marker system is the signal mixer, 7–V–20 (fig. 127), a 6SN7–GT tube. The signals from the clippers are directly coupled to the grids of the tube; the plates are connected to +400 volts. A divider

the points of increased intensity leave circular traces. The normal d-c bias of the scope is varied between —13 and —77 volts by P BIAS control 7–R–112, the range marker amplitude is varied by means of MARKER AMPLITUDE control


MARKER PIP
MIXER
FINE PIP CLIPPER
+250V
+400V
+250V
+250V
7-R-72 15KΩ
7-C-25 1,500 MMF
7-S-1B
7-R-60 15KΩ
7-C-24 56MMF
FROM TRIGGER BUFFER
7-R-71 560KΩ
6SN7-GT 7-V-20
6SN7-GT 7-V-21
7-C-40 0.25MF
7-R-61 15KΩ
7-R-100 150KΩ
7-R-99 100KΩ
RANGE MARKER SYSTEM
INDICATOR SYSTEM
7-C-43 0.05MF
7-R-101 15KΩ
7-C-42 0.25MF
7-R-102 33KΩ
COARSE AND FINE
7-S-3
7-R-63 1KΩ MARKER AMP.
7-C-44 0.25MF
7BP7 6-V-1 PPI SCOPE
7-K-18
7-K-19
7-K-21 MARKER TEST

TL 30760

potentiometer 7–R–63, which is in the output circuit of the mixer stage.

49. Complete Schematic Diagrams

For the complete schematic diagram of the range marker system see figure 115, Power Supply Unit RA–100–A and figure 116, Indicator Control BC–1193–A. The simplified schematic diagram of the range marker system is shown in figure 128.

Section VIII. SELSYN SYSTEM

50. Introduction

The range and azimuth determination of all targets within range of the set is possible only if the sweep trace rotates around the face of the scope in exact step with the rotation of the antenna on the spinner assembly. The selsyn system is designed for this purpose. The basic principle of the selsyn system is to cause a selsyn motor, mounted in the indicator panel, to operate in unison with a selsyn generator, mounted on the spinner assembly. (Although both selsyn units are motors which are almost identical in characteristics, the spinner selsyn is usually known as a *generator* because the selsyn control voltage is generated there.) The rotor of the selsyn generator is mechanically driven by a gear train which rotates with the spinner, so that the angular position of the selsyn rotor always corresponds with the azimuth position of the antenna. The selsyn generator is electrically connected to the selsyn motor in the indicator unit. The selsyn motor, geared to the deflection yoke of the PPI scope, rotates the deflection coils in exact step with the rotation of the antenna. Thus any angular motion of the spinner causes the same amount of angular motion of the deflection coils. The sweep trace, rotating thus in synchronism, permits an accurate determination of the range and azimuth of targets.

51. Circuit Details

a. Theory of Operation of Simple Selsyn System. Figure 129 shows a schematic diagram of a simple selsyn system. As shown in the diagram, the selsyn motor or generator consists of a motor with three field windings which are 120° apart and a rotor with a single winding on it. The coil on the rotor is excited by the 116-volt a-c power supply. With the rotor resting in any given position, the three field coils of the selsyn generator have voltages induced in them whose magnitude is proportional to the position of the rotor coil with respect to the three field coils. The amount of voltage that is induced in any of the field windings is entirely dependent upon the angular relationship of the winding to the rotor winding. If the rotor winding is parallel to a field coil winding, maximum voltage is induced in that field coil winding. If the rotor winding is perpendicular to a field coil winding, minimum voltage is induced. Any angular position of the rotor in between these two points causes a voltage between the maximum and minimum values to be induced in the winding. The three field coils of the selsyn generator are electrically connected to the three field coils of the selsyn motor. This means that the coils of the motor have the same voltages at their terminals that the generator coils have at their terminals. The resultant magnetic field of the motor coils is therefore the same as the resultant magnetic field of the generator coils. The rotor of the motor is excited by the same a-c source that supplies the rotor of the generator. The rotor of the motor thus assumes the same position as the rotor of the generator at any given time. If the position of the rotor of the selsyn generator is changed (as it is when the spinner assembly is rotating), the direction of the resultant fields of the generator and motor stator coils changes, and the rotor of the motor moves

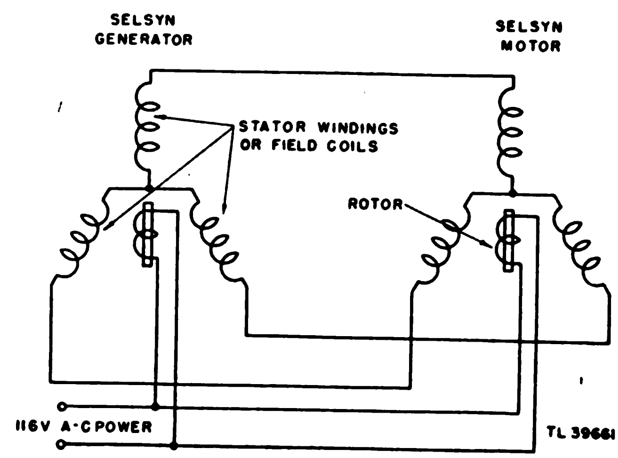


Figure 129. Simple selsyn system, schematic diagram.

so that its position corresponds to the position of the generator rotor. Since the deflection coil is geared to the motor rotor, it too rotates. Thus any angular rotation of the spinner assembly causes an immediate and corresponding rotation of the sweep trace on the PPI scope screen.

b. Operation of Selsyn System of Radar Set. (1) The operation of the selsyn system of Radio Set SCR–682–A is similar to that described above. The selsyn generator 1–A–2 (fig. 21) is geared to the spinner in such a way that the selsyn rotates 10 times for each spinner revolution. The

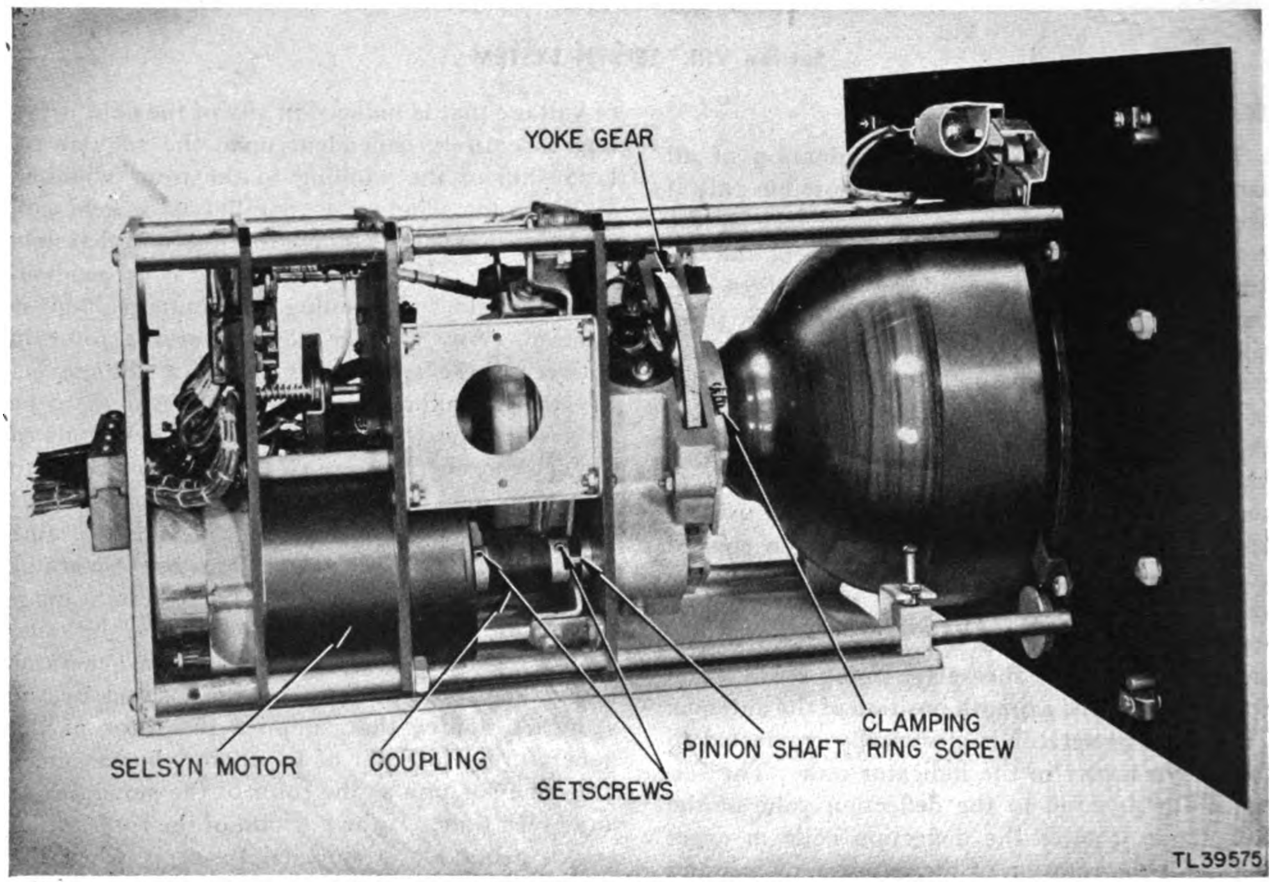


Figure 130. Indicator panel, showing location of selsyn motor.

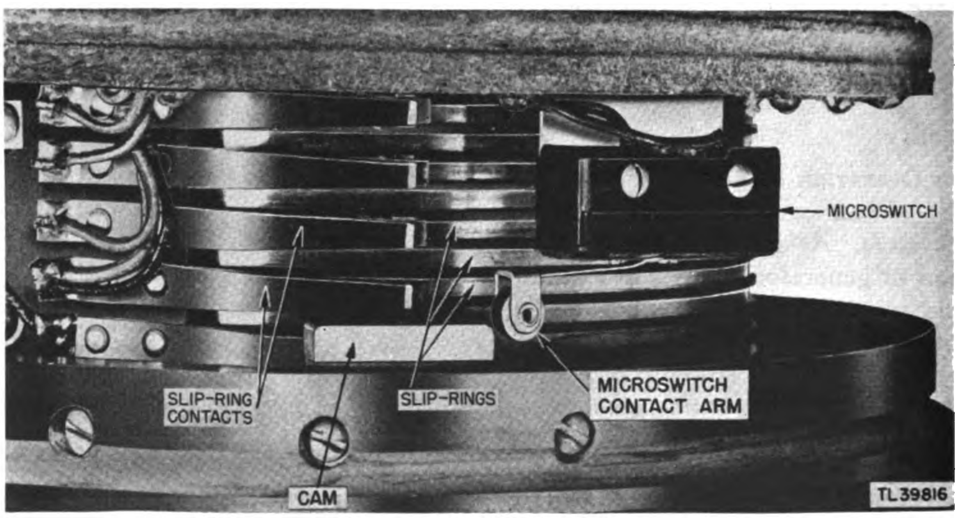


Figure 131. Pedestal base, showing slip rings and cam.

selsyn generator is connected electrically to selsyn motor 6–A–1 in the indicator panel (fig. 130). The selsyn motor is geared through a 10 to 1 gear ratio to the PPI yoke assembly. Because of the gearing ratio, there are 10 possible positions for the PPI yoke assembly motor for any position of the selsyn motor. Thus there are 10 different positions for the deflection yoke at any given spinner position. A system of cams and relays has been incorporated to select the proper position of rest so the set will remain in orientation. The cam (fig. 131) in the spinner assembly is about 18° wide. The cam in the indicator unit deflection yoke assembly (fig. 132) is about 12° wide. Thus there is a 6° difference between the width of the two cams. Each cam operates a microswitch (figs. 131 and 132) in series with selsyn relay coil 6–E–1.

cam) the cam of microswitch 6–S–1 closes the a-c line at that point. However, the open circuit at microswitch 1–S–6, keeps relay 6–E–1 from being energized. After 12° of rotation, microswitch 6–S–1 opens, while 3° later, microswitch 1–S–6 closes the circuit. At no time in the operation was there a complete a-c circuit to energize relay 6–E–1. Therefore, in normal operation relay 6–E–1 does not function. Now assume a misalignment whereby the spinner rotates out of synchronism with the indicator yoke. At this time relay 6–E–1 will be energized. The indicator yoke rotates until its cam closes the microswitch. Since the spinner cam has not opened its microswitch relay 6–E–1 is energized. This situation is illustrated in figure 134. When the relay is energized, note in figure 134 that two wires of the three field coil windings of selsyn motor 6–A–1

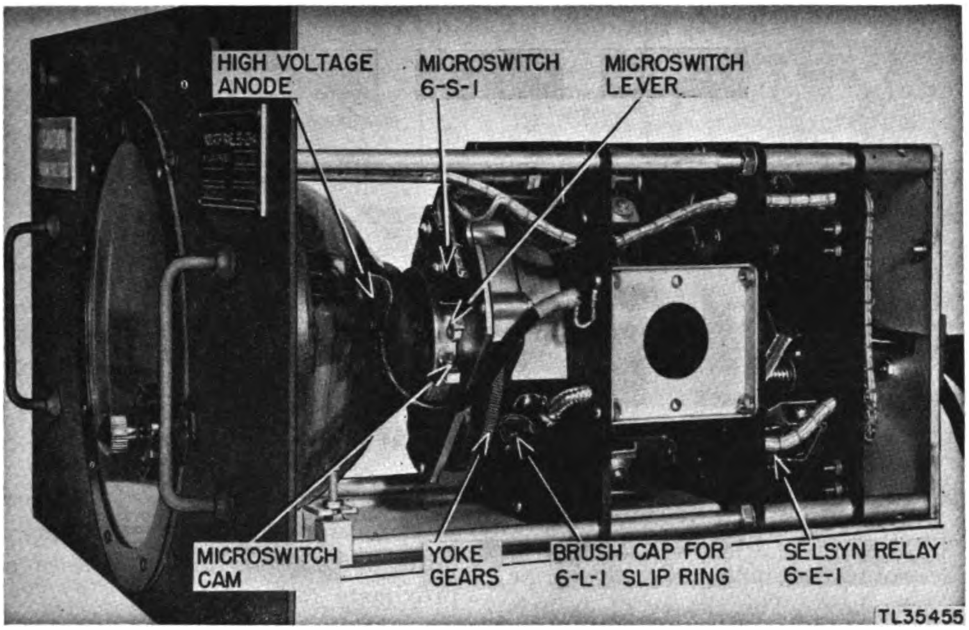


Figure 132. Indicator panel, showing cam, microswitch, and relay.

(2) A simplified schematic diagram of the selsyn system is shown in figure 133. Note that the two microswitches and the selsyn relay are all in series between the a-c common and 116-volt lines. Microswitch 6–S–1 is normally open. Thus, no complete circuit exists and relay 6–E–1 is not energized. Assume proper orientation of the microswitches. The cycle of operation is as follows: As the spinner unit rotates, microswitch 1–S–6 opens the a-c circuit (when the cam presses against the switch). Three degrees later (the spinner cam is 6° wider than the indicator unit

are disconnected from the selsyn generator and shorted. This causes the selsyn motor to lock and wait until the spinner rotates far enough so that its cam opens the spinner microswitch and de-energizes the relay. Selsyn motor 6–A–1 then assumes normal operation and drives the deflection yoke in synchronism with the spinner. The cam and relay arrangement assures that the sweep trace and spinner will rotate in synchronism. It is important, therefore, to match the selsyns so that the relay is ***not*** energized when the two selsyns are in synchronism. The two cams must be centered on the two microswitches when the system is operating normally. Failure to do this will cause the yoke and sweep to "jump" on each revolution. The deflection yoke cam (fig. 132) can be moved in position to permit adjustment and proper matching with the spinner cam.

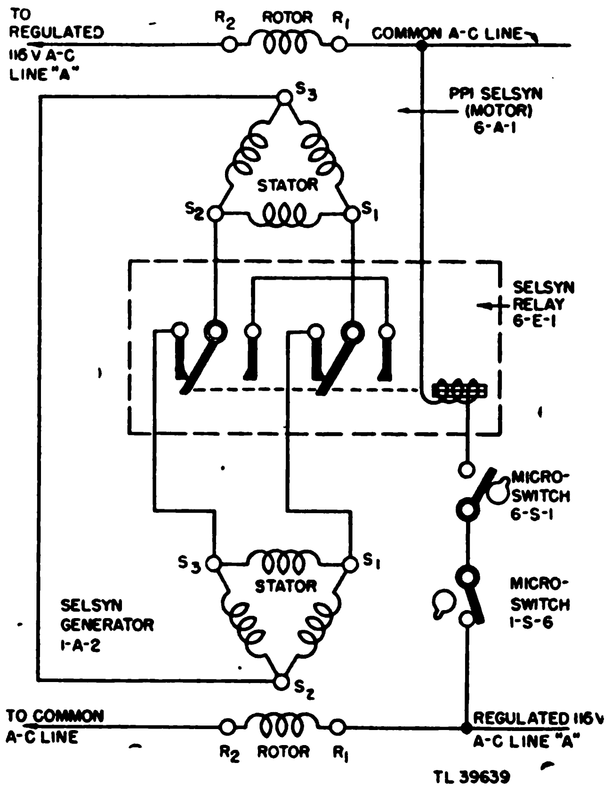


Figure 133. Selsyn system, simplified schematic diagram showing correct alignment of microswitch cams.

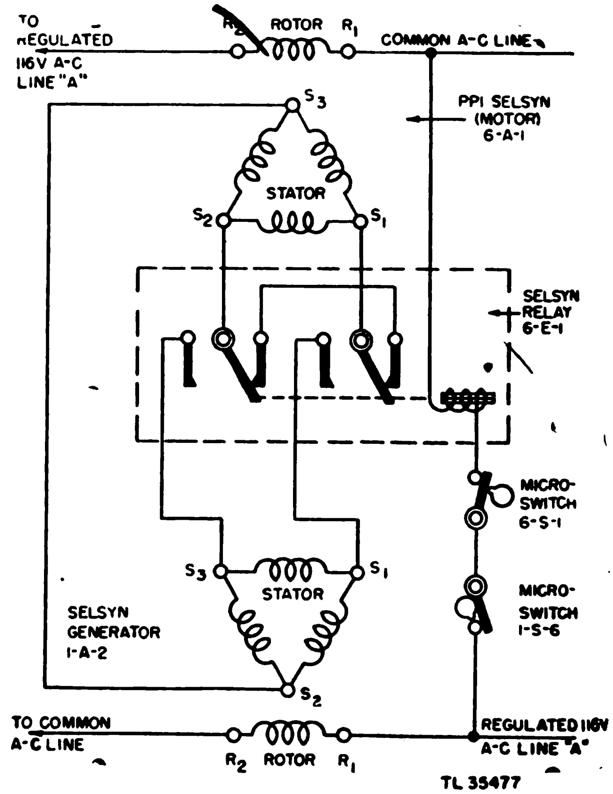


Figure 134. Selsyn system, simplified schematic diagram showing misalignment of microswitch cams.

Section IX. SPECIALIZED TEST EQUIPMENT

52. Introduction

Supplied with Radio Set SCR–682–A are two specialized pieces of test equipment, Synchroscope I–212 and an echo box. The theory of each is presented in this section.

53. Synscroscope I–212

a. Purpose. Synchroscope I–212 is a combination gated fast sweep and conventional cathode-ray oscilloscope used primarily for making adjustments and field tests on Radio Set SCR–682–A. It uses a cathode-ray tube 2 inches in diameter with a calibration scale 1 inch square divided into tenths. Sufficient accuracy is thus provided for most field measurements. The range of sweep speeds is suitable for viewing pulses of 1-microsecond duration or longer and cyclic waveforms having a frequency of from 50 to 2,000 cycles per second. The instrument may also be used as an A-scope with the radar set. In the latter application, it is capable of providing approximate range data up to 82,000 yards. The synchroscope may also be used as a pulse generator for triggering external circuits.

b. Brief Description of Operation. Synchroscope I–212 functions as an oscilloscope presenting a fixed image of the input signal waveshape as a means for interpreting signal waveforms visually. The internal pulse generator produces a 3-microsecond pulse having a steep wave front suitable for triggering the fast sweep circuit of the instrument or for triggering external circuits. The fast gated sweep circuit may also be triggered by the incoming signal or by an external trigger; thus making the instrument suitable for viewing rapidly recurring waveshapes of extremely short duration. A thyratron relaxation oscillator is also incorporated in the instrument to provide slow sweep speeds suitable for reviewing cyclic waveshapes similar to a conventional oscilloscope. Provision is also made for synchronizing the sweep frequency with the signal frequency when the instrument is operated in this manner.

c. CHARACTERISTICS. The signal input sensitivity using the internal video amplifier at maximum gain is approximately 21 volts per inch. A vertical deflection of approximately seven screen divisions (0.7 inch) is obtained with a 5-volt rms. input. The cathode-ray tube sensitivity without the video amplifier is, for the vertical axis, 220 volts per inch, and for the horizontal axis, 200 volts per inch. These figures may vary by ∓10 percent. The fast sweep speeds for the four switch positions are:

Position	Microseconds	Maximum yards
1	5	820
2	25	4,200
3	100	16,400
4	500	82,000

The slow sweep speed ranges for the four sweep switch positions are:

Position	Cycles per second
5	650 to 2,000
6	225 to 670
7	80 to 240
8	50 to 125

Sweep frequency is continuously adjustable over each of the slow sweep ranges. The internal trigger pulse generator develops a steep wave front pulse approximately 3 microseconds wide at the base and with a recurrence rate of from approximately 200 to 2,000 cps continuously variable and calibrated. A calibration chart is attached to the side of the synchroscope cabinet. For all work with Radio Set SCR–682–A, the recurrence frequency should be set at 400 cps.

d. BLOCK DIAGRAM. (1) The operation of the synchroscope can be traced on the block diagram (fig. 135). When used as an oscilloscope, the initial pulse originates in the trigger generator, 10–V–4(A), or from an external pulse from the

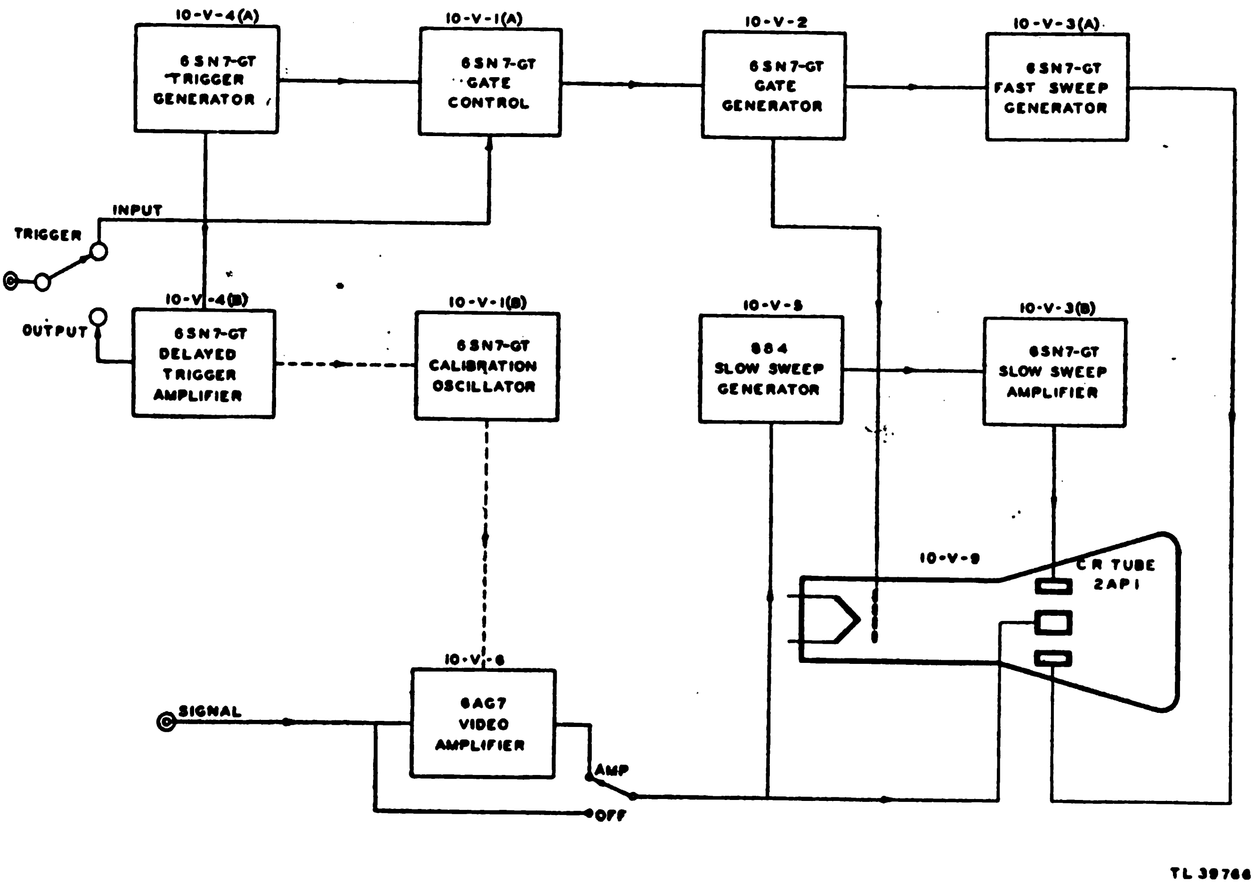


Figure 135. Synchroscope I–212, block diagram

trigger terminal, 10–K–1. When using the internally produced pulse from the trigger generator, the pulse recurrence frequency may be varied from 125 to 2,400 cycles per second.

(2) Gate control 10–V–1(A) receives its operating pulse from the trigger generator or from an external source. Gate control 10–V–1(A) can accept either a negative or a positive pulse but its output is always negative. It acts as a buffer to the trigger generator.

(3) Delayed trigger amplifier 10–V–4(B) receives its operating pulse from the trigger generator and delivers it to the trigger terminal so that the internally produced pulse may be used to trigger an external circuit under test. It also acts as a buffer to the trigger generator.

(4) The output of the gate control is used to operate the gate generator which in turn produces an intensifying pulse to brighten the electron beam during the sweep on the four fast sweeps.

(5) Fast sweep generator 10–V–3(A), is pulsed by the gate control and produces a sweep voltage used to move the electron beam across the cathode-ray tube screen. The speed of this sweep is selected on the positions 1 to 4 of the SWEEP SPEED switch.

(6) On positions 5 through 8 of the SWEEP SPEED switch, the fast sweep generator is grounded and the slow sweep generator (10–V–5), is used. This tube produces a sweep continuously variable from 50 to 2,000 cycles per second. Variable synchronization is obtained through SYNC control either to an external pulse or to the internal pulse produced by the trigger generator.

(7) This slow speed sweep pulse from the slow sweep generator is amplified by slow sweep amplifier 10–V–3(B), and fed to the cathode-ray tube.

(8) A signal may be fed to the signal plates of the cathode-ray tube directly, or if it is not of sufficient amplitude, it may be amplified through video amplifier 10–V–6, and then fed to the signal plates.

(9) Calibration oscillator 10–V–1(B) generates a damped oscillation at a frequency of 1 megacycle for calibrating the length of sweep in the fast sweep position (SWEEP SPEED switch positions 1 to 4).

e. Description of Circuits. (1) *Trigger generator* (fig. 136). This stage, 10–V–4(A), is one section of a 6SN7 tube used as a blocking oscillator. The plate load transformer (10–T–1) is designed to pass very high frequencies, allowing generation of a narrow pulse of approximately 3-microseconds duration. The pulse recurrence frequency

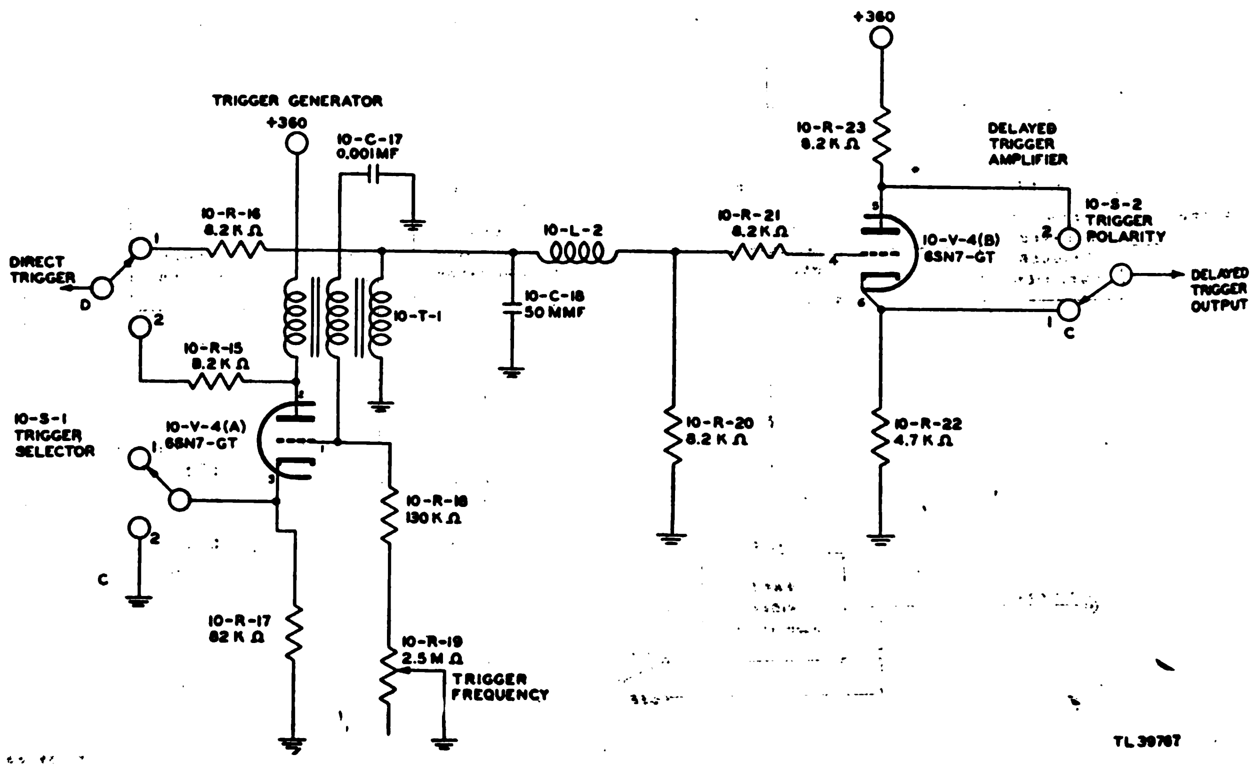


Figure 136. Trigger generator and delayed trigger amplifier, simplified schematic diagram.

is determined by the time constant of the grid circuit, the 130,000-ohm resistor (10–R–18), the 2.5-megohm TRIG FREQ potentiometer (10–R–19), and the 0.001-mf capacitor (10–C–17). The 2.5-megohm grid resistor (10–R–19) is made variable to change the frequency over the range from 125 to 2,400 cycles. The plate transformer has a third winding which produces a positive pulse output of approximately 330 volts in amplitude. This permits taking either a positive trigger pulse from the output winding or a negative trigger pulse from the plate of the oscillator.

(2) *Delayed trigger amplifier* (fig. 136). A 6SN7 tube, 10–V–4(B), is used for amplifying and isolating the output of the blocking oscillator. A delay is introduced in this stage by the inductance (10–L–2) and the 50-mmf capacitor (10–C–18) in the grid circuit. This delay allows the sweep to start approximately 1 microsecond before the external circuit under test is triggered. The trigger output pulse is slightly wider than the pulse from the oscillator since the delay introduces some distortion. A positive pulse of approximately 170 volts is applied to the grid of tube 10–V–4(B), permitting a positive pulse of 150 volts to be taken from the cathode and a negative pulse of 120 volts to be taken from the plate circuit.

(3) *Gate control* (fig. 137). The 6SN7 tube (10–V–1(A)) is used for coupling the trigger pulse into the gate generator. This tube is biased to just below cut-off by a voltage divider composed of a 12,000-ohm resistor (10–R–28) in the cathode and a 150,000-ohm resistor (10–R–1) connected to +150 volts. The input signal can be either positive or negative in polarity. A positive signal applied to the grid causes a negative pulse to appear at the plate. A negative pulse coupled into the cathode drives it negative which also produces a negative pulse on the plate.

(4) *Gate generator* (fig. 138). *(a)* The 6SN7 gate tube (10–V–2) is a cathode-coupled multivibrator requiring a negative trigger pulse at the beginning of each cycle of operation. Section one (pins 1, 2, and 3) is normally held at cut-off due to the positive potential on the common cathode circuit created by current flow in section two. A large plate current flows in section two (pins 3, 4, and 5) since the grid is returned to a positive potential of 150 volts through any one of four resistors; 160,000-ohm (10–R–4), 1.2-megohm (10–R–5), 10 megohm (10–R–6), or 390,000-ohm (10–R–61). The plate current must be at least 16 ma, which together with a small grid current will create a voltage drop of 9 volts across the parallel combination of 680-ohm (10–R–26) and

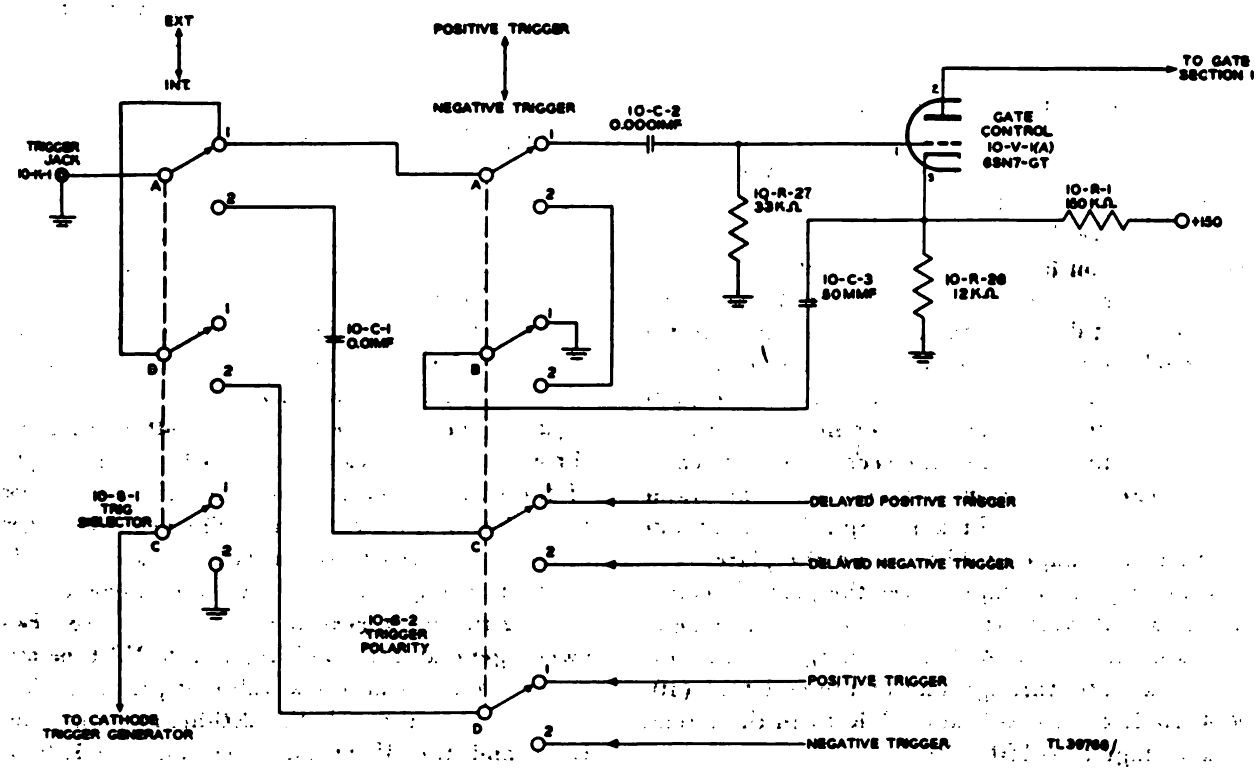


Figure 137. Trigger switching and gate control, simplified schematic diagram.

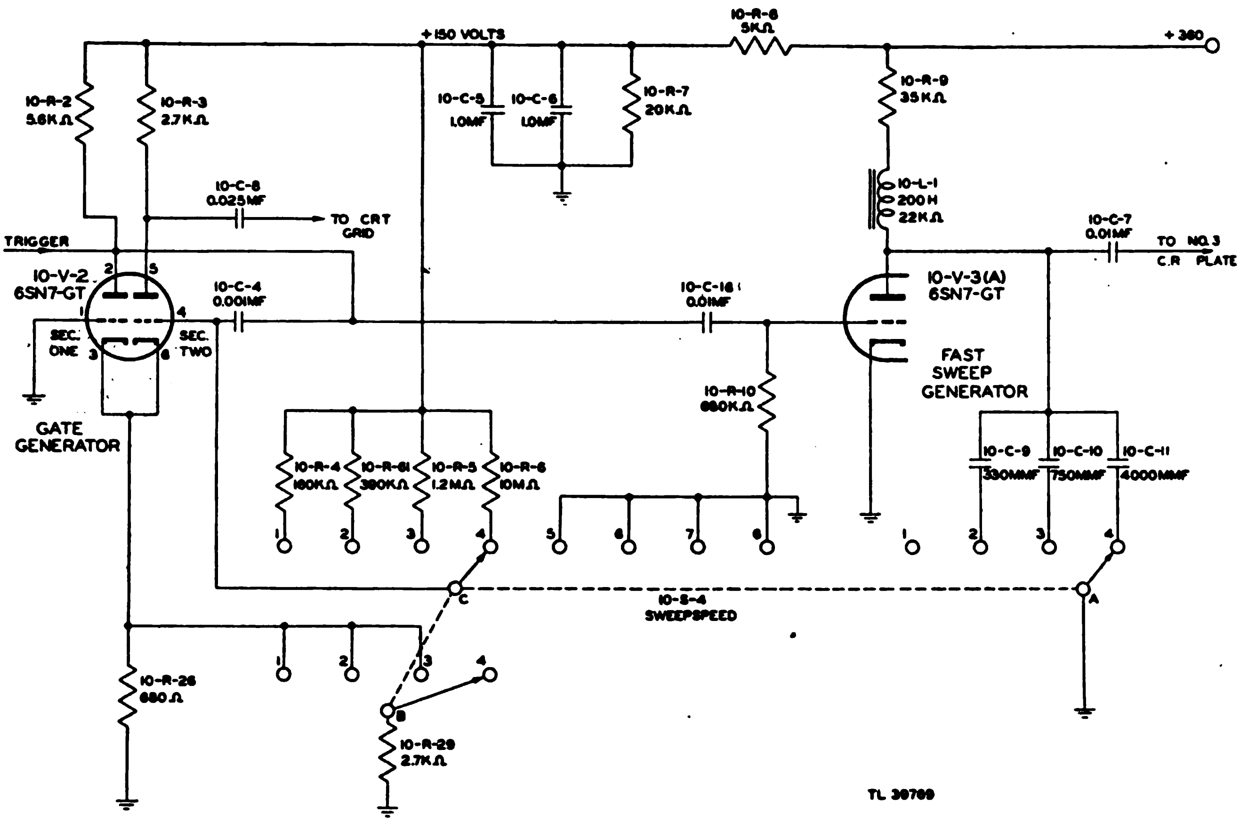


Figure 138. Gate generator and fast sweep generator, simplified schematic diagram.

2,700-ohm (10–R–29) cathode resistors. This is the minimum allowable voltage on the common cathode circuit which will keep section one at cut-off.

(b) The 5,600-ohm plate load resistance (10–R–2) of the first section is common to the plate of the gate control tube; thus, when the trigger pulse is applied, both plates are driven negative. This negative drive is coupled to the grid of the second section by a 0.001-mf capacitor (10–C–4), causing the current in this section to decrease. Less current drives both cathodes negative to the point where the first section is no longer at cut-off, and, therefore, begins to conduct. The plate current drives the plate further negative; this is fed back into the grid of the second section, causing regenerative action to take place. This value of current is about 5.5 ma, giving a 3-volt cathode bias and a change of 30 volts on the plate. The change in plate voltage drives the grid of section one to a —20 volts at which time the grid side of the capacitor (10–C–4) begins charging, at an exponential rate, through one of the resistors (10–R–4, 10–R–61, 10–R–5, and 10–R–6) in the circuit to a voltage of +150 volts.

(c) When the charge on the capacitor has risen to —6 volts with respect to ground, the grid causes the second section to start conducting again, bringing the cathode voltage up and decreasing the static current in section one. The positive feed-back from the plate of section one to the grid of section two causes a very rapid rise of cathode potential (back to the condition prevailing before the trigger pulse was applied). The exponential RC rate of rise on the grid of the second section may be varied by using any one of the resistors (10–R–4, 10–R–61, 10–R–5, or 10–R–6) to provide four gate widths of 5, 25, 100, and 500 microseconds, controlled by the SWEEP SPEED switch.

(d) The positive output of 40 volts is fed through 0.025-mf capacitor (10–C–8) to the grid of the cathode-ray tube to intensify the electron beam during the sweep time. The negative output of 30 volts is fed through 0.01 mf capacitor (10–C–16) to the grid of the fast sweep generator.

(5) ***Fast sweep generator*** (fig. 138). *(a)* **Fast** sweep generator 10–V–3(A) is a 6SN7 tube normally operating at a low value of grid bias. The plate current through the 200-henry choke (10–L–1) and the 35,000-ohm resistor (10–R–9) is high, creating a low voltage at the plate of the

tube. The negative signal from the gate generator runs the grid negative beyond cut-off, thus interrupting the plate current flow. The rapidly collapsing field of choke 10–L–1 begins to create a large damped oscillation at a frequency determined by the value of capacity from plate to ground. This frequency will be low because of the large value of inductance and capacitance. Only a small portion of the beginning of the first oscillation is used to provide sweep voltage, so that an approximately linear rise of voltage is obtained at the plate of the tube. A separate value of capacity is used on each sweep in order to give the same rise in voltage for the different gate width or time. The result is almost the same physical length of sweep on the screen for all four fast sweep positions. The sweep voltage actually developed is about 220 volts on the 5- and 25-microsecond settings, giving a sweep length of 1 inch, and about 300 volts for the 100- and 500-microsecond settings, giving a length of 1½-inches.

(b) Sweep time is adjusted by varying the plate supply voltage on the gate generator as well as the fast sweep generator. Adjustment of this voltage changes the sweep time on all four fast sweep ranges. It has been found, however, that the voltage which will produce a sweep duration of exactly 5 microseconds on the fastest sweep setting will cause the other three sweep times to be accurate enough for use with the set.

(6) *Slow sweep generator* (fig. 139). A standard sweep circuit using an 884 thyratron tube (10–V–5) generates a sweep continuously variable from 50 to 200 cycles. Four ranges are provided: 50 to 125, 80 to 240, 225 to 670, and 650 to 2,000 cycles, controlled by the SWEEP SPEED switch, and varied by the 2-megohm SLOW SWEEP control (10–R–34). Variable synchronization voltage is provided by taking a portion of the vertical signal voltage through the 250,000-ohm SYNC control (10–R–25), 100,000-ohm resistor (10–R–24), and 10-mmf capacitor (10–C–19). The amplitude of the sweep voltage fed through the 0.25-mf capacitor (10–C–20) to the sweep amplifier is approximately 15 volts.

(7) *Slow sweep amplifier* (fig. 139). This circuit uses a 6SN7 tube (10–V–3(B)) in a conventional Class A amplifier stage with some cathode degeneration to reduce the amplitude of the sweep. The tube gain would normally be about 20, but the degeneration reduces the stage gain to about 13; thus, the 15-volt sweep voltage input will produce approximately a 200-volt signal on the deflection plate of the cathode-ray tube. Since the horizontal sensitivity of the cathode-ray tube is 200 volts per inch, the sweep length will be about 1 inch for all slow sweep positions.

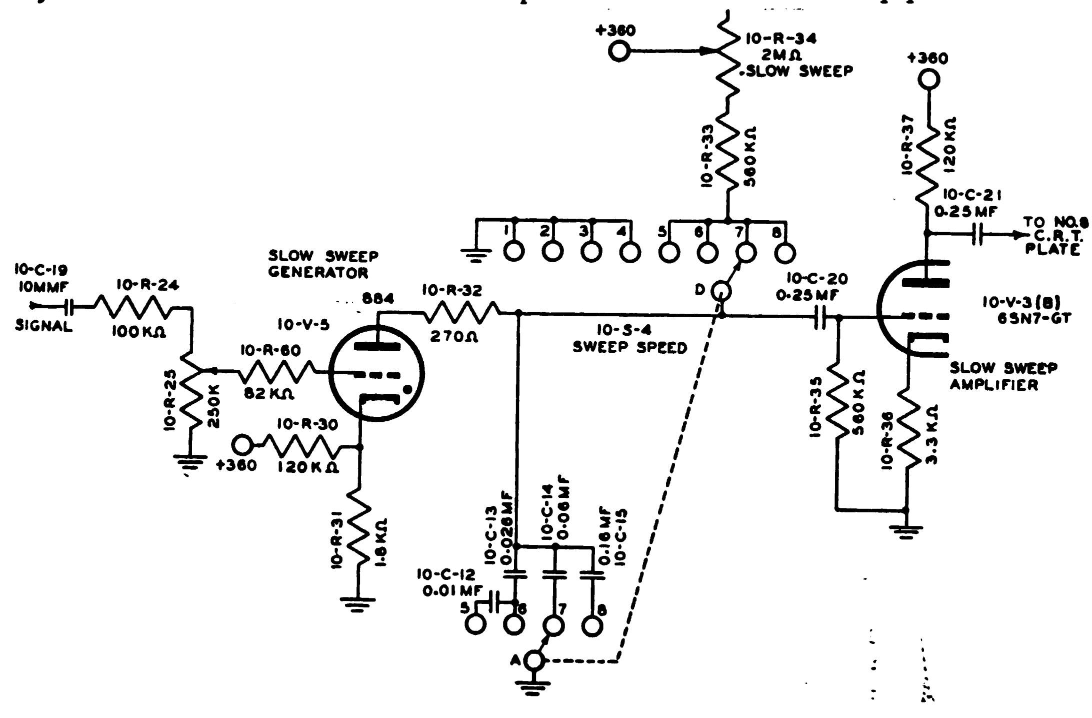


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Figure 139. Slow sweep generator and slow sweep amplifier, simplified schematic diagram.

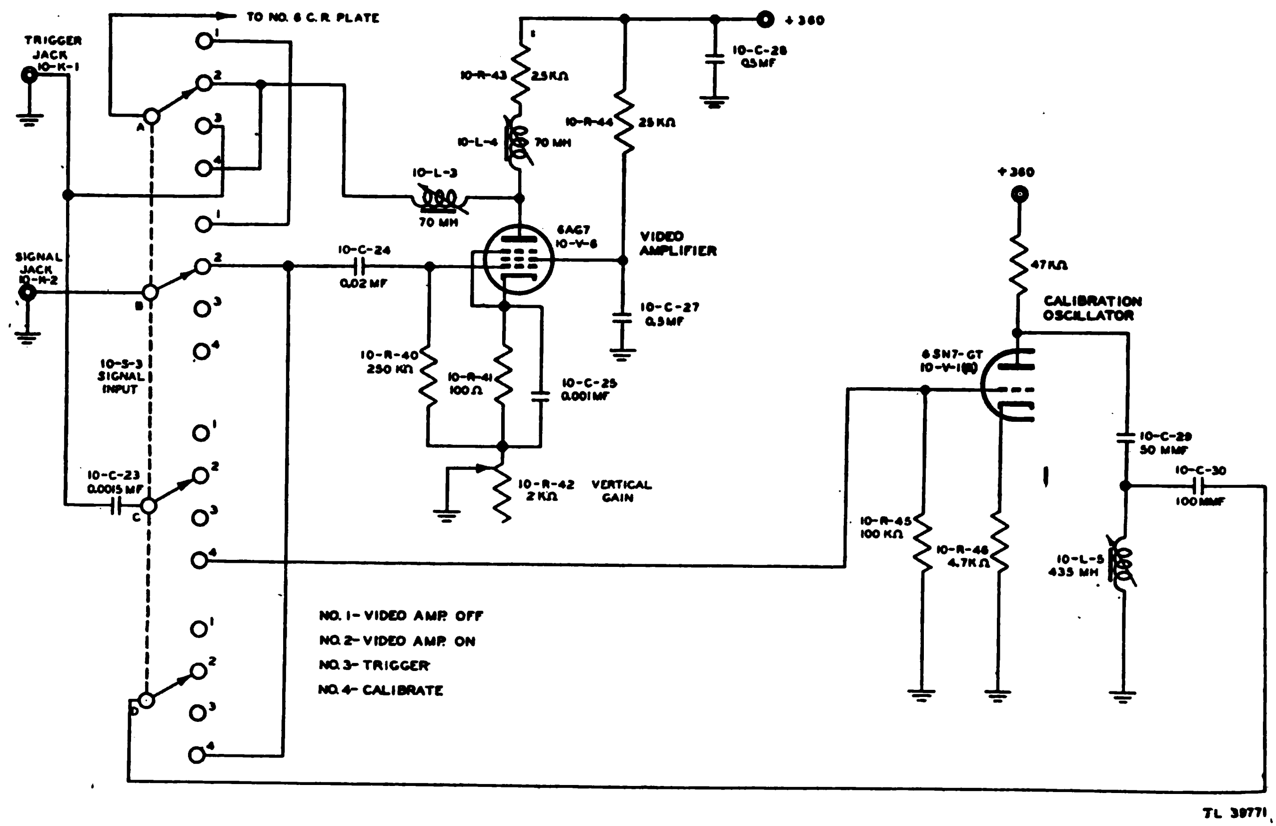


Figure 140. Video amplifier and calibration oscillator, simplified schematic diagram.

(8) *Calibration oscillator* (fig. 140). This stage is provided for generating a damped oscillation at a frequency of 1 megacycle for calibrating the length of sweep in the fast sweep position. The 6SN7 tube 10–V–1(B) is normally conducting, with approximately 3 milliamperes of plate current flowing. Coupling either a positive or negative trigger pulse into the grid circuit causes a sudden change in plate current. This change causes a surge of current flow through the 50-mmf capacitor (10–C–29) and 435-microhenry inductance (10–L–5), which make up a series resonant circuit tuned to 1 megacycle. After the initial shock, the circuit will continue to oscillate until the energy in the circuit is dissipated by the resistances associated with the circuit. The 1-megacycle signal is coupled into the video amplifier by a 100-mmf capacitor (10–C–30) where it is amplified, then applied to the vertical plate of the oscilloscope.

(9) *Cathode-ray tube* (fig. 141). The cathode-ray tube used in the synchroscope is a type 2AP1 (10–V–9). The tube is somewhat shorter than the usual oscilloscope tube, allowing a short electron travel distance, and is operated with high negative cathode-to-anode potential resulting in a very high electron speed. This helps to give good picture definition since the electron beam can be kept more sharply focused than in standard tubes. Due to the high electron speed, the deflection sensitivity of this type tube is rather low, being about 220 volts per inch on the vertical axis, and about 200 volts on the horizontal axis.

(a) The cathode of the tube is supplied with approximately 1,000 volts negative from the 1,100-volt power supply output through the 200,000 ohms INT control (10–R–56). The movable center control allows a variable negative potential to be applied to the arm of this grid so that the electron beam can be adjusted to give the desired intensity on the screen. The 1-megohm resistor (10–R–38) in series with the grid allows a positive gate voltage to be developed. This gate voltage, present only in the four fast sweep positions, intensifies the electron beam during the period of sweep; by proper adjustment of the intensity control, the beam will be cut off during the no-sweep time.

(b) The 200,000-ohm FOCUS control (10–R–58) is provided with a range of —600 to —420 volts by the 180,000-ohm (10–R–57) and 470,000-ohm (10–R–59) bleeder resistors. This allows the

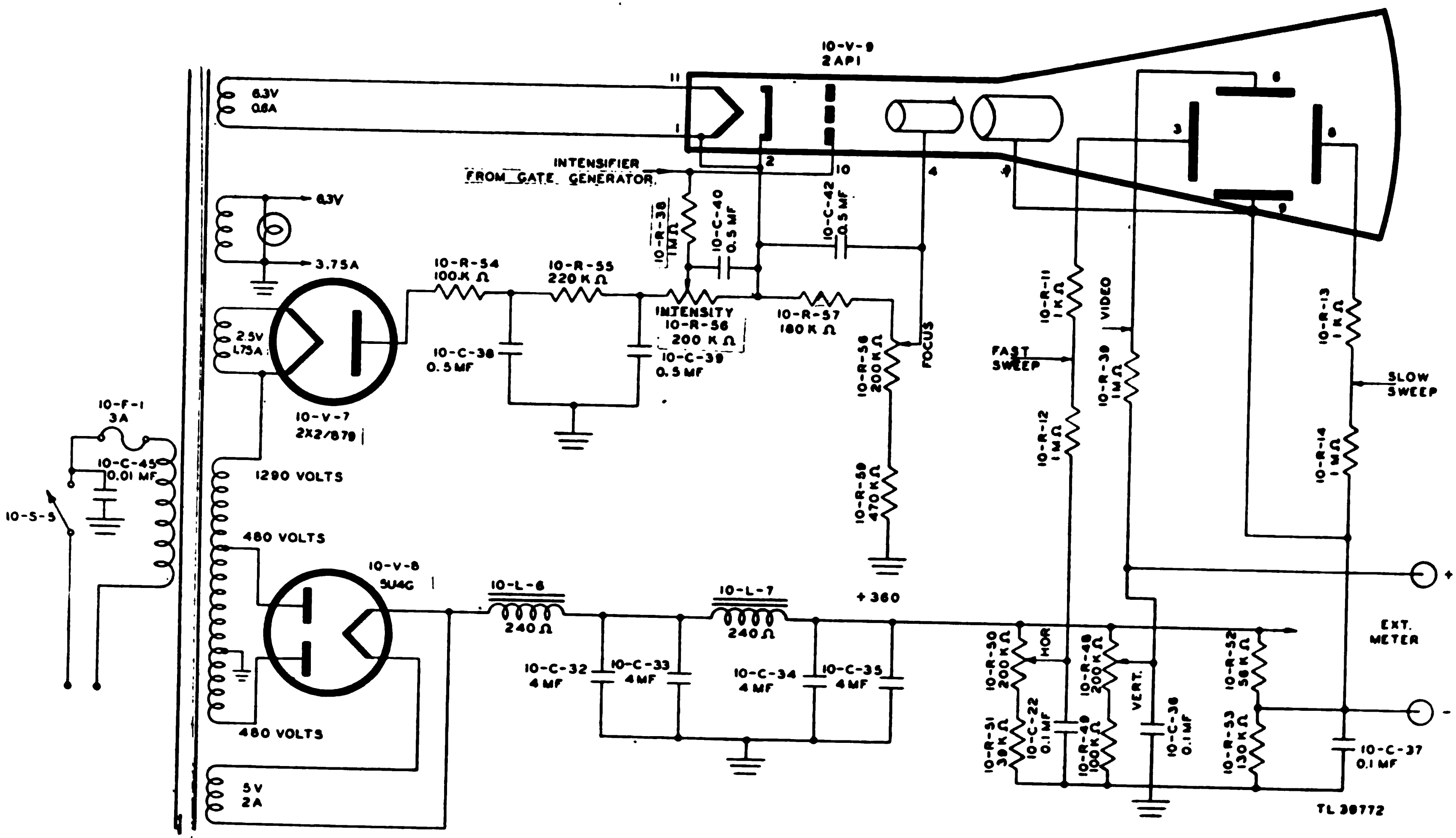


Figure 141. Power supply and cathode-ray tube circuits, simplified schematic diagram.

center arm of the control, which is connected to the first anode of the tube, to be set at the voltage which will give proper focusing of the electron beam. Deflection plates numbers 8 and 9 are connected to +250 volts provided by the voltage divider of 56,000-ohm resistor (10–R–52) and 130,000-ohm resistor (10–R–53) bypassed by a 0.1-mf capacitor (10–C–37). No. 3 deflection plate is supplied with +60 to +360 volts by the 200,000-ohm HOR positioning control (10–R–50). No. 6 deflection plate is supplied with +120 to +360 volts by the 200,000-ohm VER positioning control (10–R–48). Vertical sweep voltages are developed across the 1-megohm resistor (10–R–39), and are fed directly to vertical deflection plate No. 6.

(c) Shield 10–A–2 (fig. 143) is used around the tube to prevent any stray electrostatic or magnetic pick-up from interfering with deflection of the electron beam.

(10) *Power supply.* *(a)* All a-c voltages used in the power supply are furnished by one transformer (10–T–2). The primary is fed with 115 a-c from the line cord through switch (10–S–5) mounted on the intensity control. All filament voltages, except for the cathode-ray tube which obtains its filament voltage from another winding, are furnished from a 6.3-volt winding rated at 3.75 amperes.

(b) To supply plate voltage for all stages in the synchroscope, a secondary winding developing 480 volts on each side of a grounded center tap is used to feed a type 5U4G tube (10–V–8), full-wave rectifier. Choke input (10–L–6) is used with two 4-mf capacitors (10–C–32 and 10–C–33) in parallel to give good voltage regulation. Choke (10–L–7) and two 4-mf capacitors (10–C–34 and 10–C–35) provide sufficient filtering of the +360-volt output.

(c) To supply high voltage for operation of the cathode-ray tube, an additional 770-volt winding is added in series with the 480-volt winding to provide 1,250 volts to the filament side of a 2X2/879 (10–V–7) half-wave rectifier. The 110,-000-ohm resistor (10–R–54) limits peak current through the tube to a safe operating value. The 220,000-ohm resistor (10–R–55) together with the two 0.5-mf capacitors (10–C–38 and 10–C–39) make up an RC filter of sufficient size to reduce the ripple on the negative 1,000-volt output to a small value.

(11) *Signal input switch* (figs. 140 and 143). *(a)* In the OFF position, the video stage is not used for amplification of the signal; a direct connection is made from the SIGNAL input jack to the vertical deflection plate.

(b) In the AMP position, the input signal is fed through the video stage to the vertical deflection plate.

(c) In the TRIG position, either an internal or external trigger is fed directly to the vertical deflection plate.

(d) In the CALIB position, an internal or external trigger is fed to the calibration stage to shock excite the oscillator. The 1-megacycle signal thus generated is fed through the video amplifier and to the vertical deflection plate.

(12) *Trigger polarity switch* (figs. 137 and 143).

(a) In the POS position, the switch connects a positive signal into the grid of the gate control tube. A delayed positive trigger is connected into the TRIG SELECTOR switch for external triggering.

(b) In the NEG position, the switch connects a negative signal into the cathode of the gate control, and a delayed negative trigger into the TRIG SELECTOR switch for starting the internal sweep.

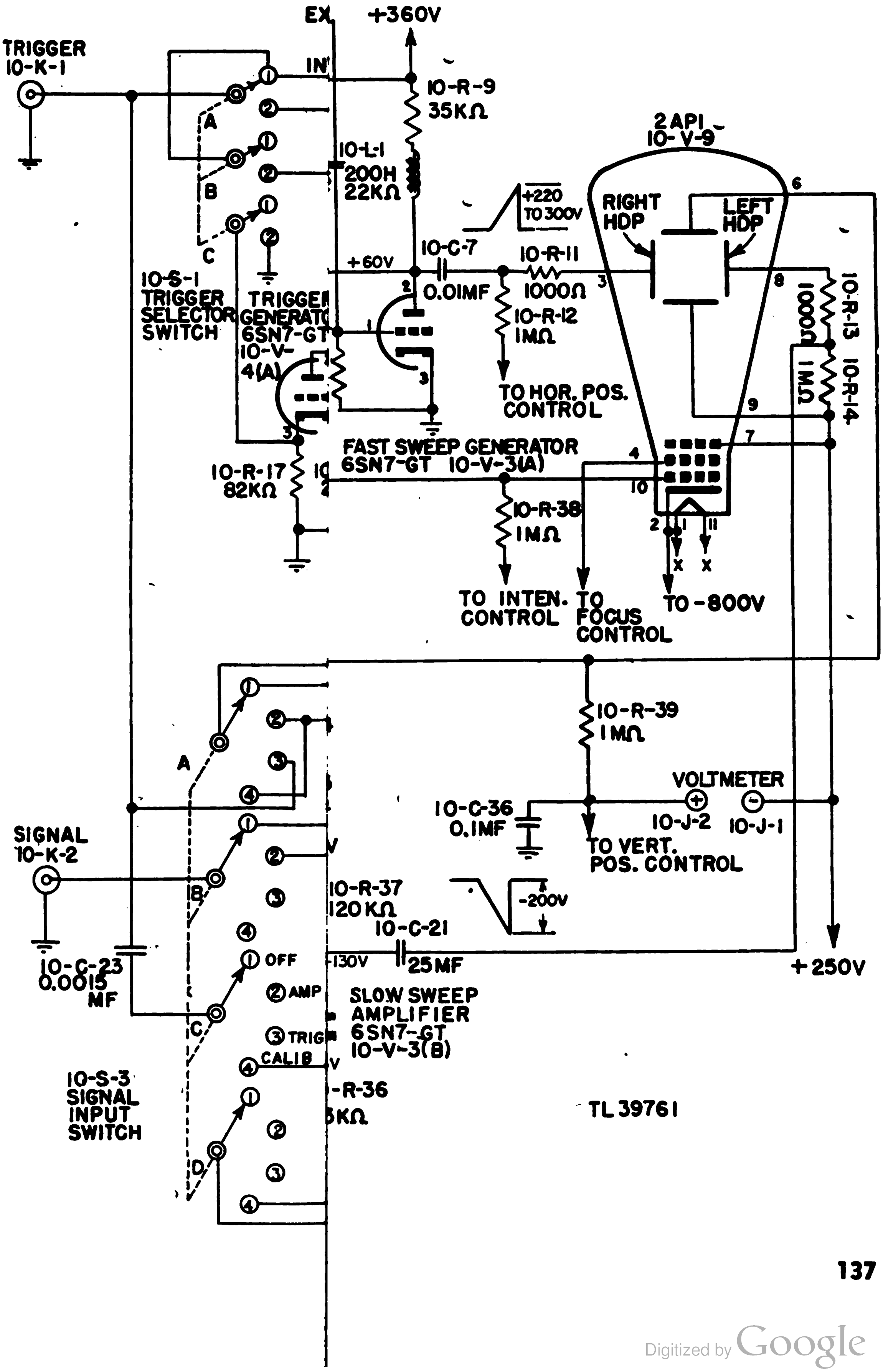
(13) *Trigger selector switch* (fig. 137). The INT position allows use of the internally generated trigger to start the internal sweep, at the same time providing a trigger at TRIGGER jack 10–K–1 to start the operation of an external circuit under test. In the EXT position, the cathode circuit of the trigger generator is opened so that it does not operate. The sweep is then triggered by an external voltage which must be fed into the TRIGGER jack from the external circuit under test.

(14) *Remarks.* Operation and trouble shooting of the synchroscope are discussed in chapter 2, section II.

54. Echo Box

a. Purpose. The echo box consists of a high-Q, tunable resonant cavity that can be loosely coupled to the transmitter output. This unit produces an artificial or phantom target echo which may be used to tune the receiver to the transmitter. The echo box may also be used to give an approximate indication of the transmitter output relative to some arbitrary standard; if accurately calibrated, it may be used to measure frequency.

b. Description of Operation. Energy from the radar antenna is fed into the resonant cavity to make it oscillate. Since the Q is very high (on



EX
+360V
TRIGGER
10-K-1
IN
10-R-9
35KΩ
2API
10-V-9
10-L-1
200H
22KΩ
+220
TO 300V
RIGHT
HDP
LEFT
HDP
+60V
10-C-7
0.01MF
10-R-11
1000Ω
10-R-12
1MΩ
10-R-13
1000Ω
1MΩ
10-R-14
A
B
C
10-S-1
TRIGGER
SELECTOR
SWITCH
TRIGGER
GENERATOR
6SN7-GT
10-V-4(A)
TO HOR. POS.
CONTROL
FAST SWEEP GENERATOR
6SN7-GT 10-V-3(A)
10-R-17
82KΩ
10-R-38
1MΩ
TO -800V
TO INTEN.
CONTROL
TO
FOCUS
CONTROL
10-R-39
1MΩ
VOLTMETER
10-C-36
0.1MF
10-J-2
10-J-1
TO VERT.
POS. CONTROL
SIGNAL
10-K-2
10-R-37
120KΩ
-200V
10-C-21
25MF
+250V
10-C-23
0.0015
MF
OFF
AMP
TRIG
CALIB
-130V
SLOW SWEEP
AMPLIFIER
6SN7-GT
10-V-3(B)
-R-36
KΩ
10-S-3
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the order of 35,000), the cavity oscillates or rings for several microseconds after the end of the transmitted pulse. During the time that the echo box is ringing, it feeds energy back into the radar antenna which produces an echo pulse on the indicator screen. The length of time that the echo box oscillates is dependent on the tuning and losses in the cavity, the pulse shape and peak power of the transmitter, and the tuning of the r-f and receiver systems. Since the echo box can be tuned to the transmitter under a given set of operating conditions, the r-f and receiver systems may be tuned by watching for maximum width of the pulse that appears on the indicator screen (fig. 145).

c. Characteristics. (1) The cavity is of closed cylindrical construction approximately 6 inches in diameter and 5 inches long, allowing a mode of oscillation in the 10-centimeter band. In this mode, the magnetic lines of force move longitudinally along the inside surface from one end, and return past the center to the opposite end of the cavity. The electrical field contours form circles coaxial with the axis of the cavity.

(2) The cavity goes smoothly from this cylindrical mode to the coaxial mode when a rod is introduced into its center. The change from cylindrical to coaxial is accompanied by a small increase in resonant frequency due to a slight shortening of the magnetic lines of flux. This permits the use of a threaded coaxial rod as a tuning device. The tuning control is micrometer-graduated in reference numbers which can be converted to frequency by means of the calibration chart provided.

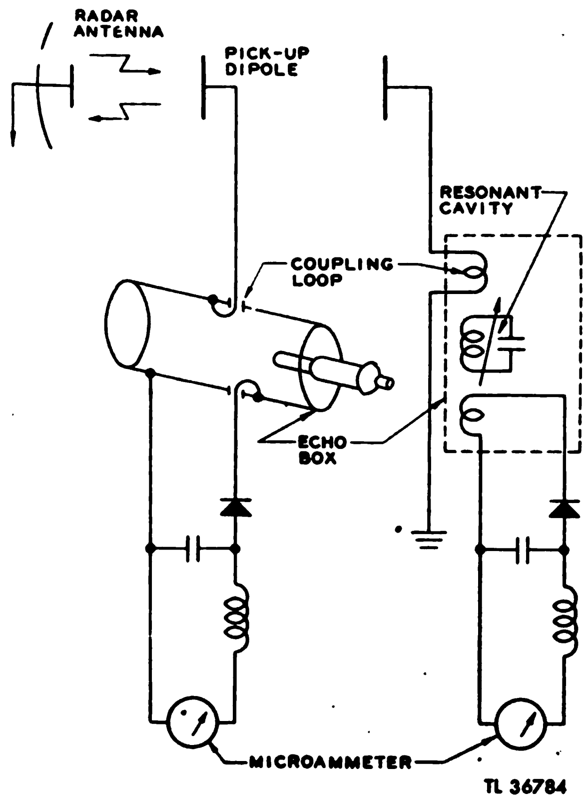


Figure 144. Echo box circuit and equivalent circuit.

(3) Coupling loops are used to introduce and remove energy from the echo box. The coupling loops are midway between the ends of the cylinder and are polarized in a plane perpendicular to the cylinder axis in order to link the maximum lines of magnetic flux. These loops are made with locating pins to insure proper polarization; the distance the loop protrudes into the cavity is fixed so the same fractional part of the energy is always introduced and removed.

(4) As one loop is used to introduce energy to the echo box, the second loop may be used to remove some of this energy. If this r-f energy is rectified through a crystal detector, its comparative strength can be measured on a microammeter. By this means the frequency and power output of the transmitter may be measured. A calibrated chart accompanies the equipment for this purpose.

d. Theory of Operation. (1) Electrically, the echo-box cavity is equivalent to a sharply tuned L-C resonant circuit (fig. 144). It is not correct, however, to consider any particular part of the box as either the capacitance or inductance of the equivalent circuit. The frequency to which the box is resonant is dependent upon the physical size of the cavity which is changed by moving the plunger. When the size of the cavity is decreased, the resonant frequency is raised; when the size of the cavity is increased, the resonant frequency is lowered.

(2) R-f energy from the radar antenna is picked up by the small test dipole and is fed into the echo-box cavity through r-f cable and a coupling loop (fig. 144). During the radar pulse, the resonant cavity of the echo box accepts r-f energy, and oscillations build up for the duration of the radar pulse. After the radar pulse, the oscillations in the echo box continue but gradually die out (fig. 145) because some of the energy is dissipated in the resonant cavity, some is coupled out to the crystal rectifier and microammeter, and some is coupled out to the pick-up dipole. This latter energy is radiated from the pick-up dipole and detected in the radar receiver, appearing on the PPI or synchroscope screens. The echo box,

therefore, acts as a miniature transmitter which begins sending immediately after the radar pulse has been transmitted.

(3) Because of the large amount of power received and returned by the echo box, the received signals will, for the most part, appear on the synchroscope as a solid block with a flat top at the receiver-saturation amplitude, as shown in figure 145. On the PPI scope, the signal appears as a bright bar with its outer end diminishing in intensity. The oscillations dies out exponentially; this portion of the curve can be seen from the end of the flat top to the noise or grass level on the synchroscope. The time from the beginning

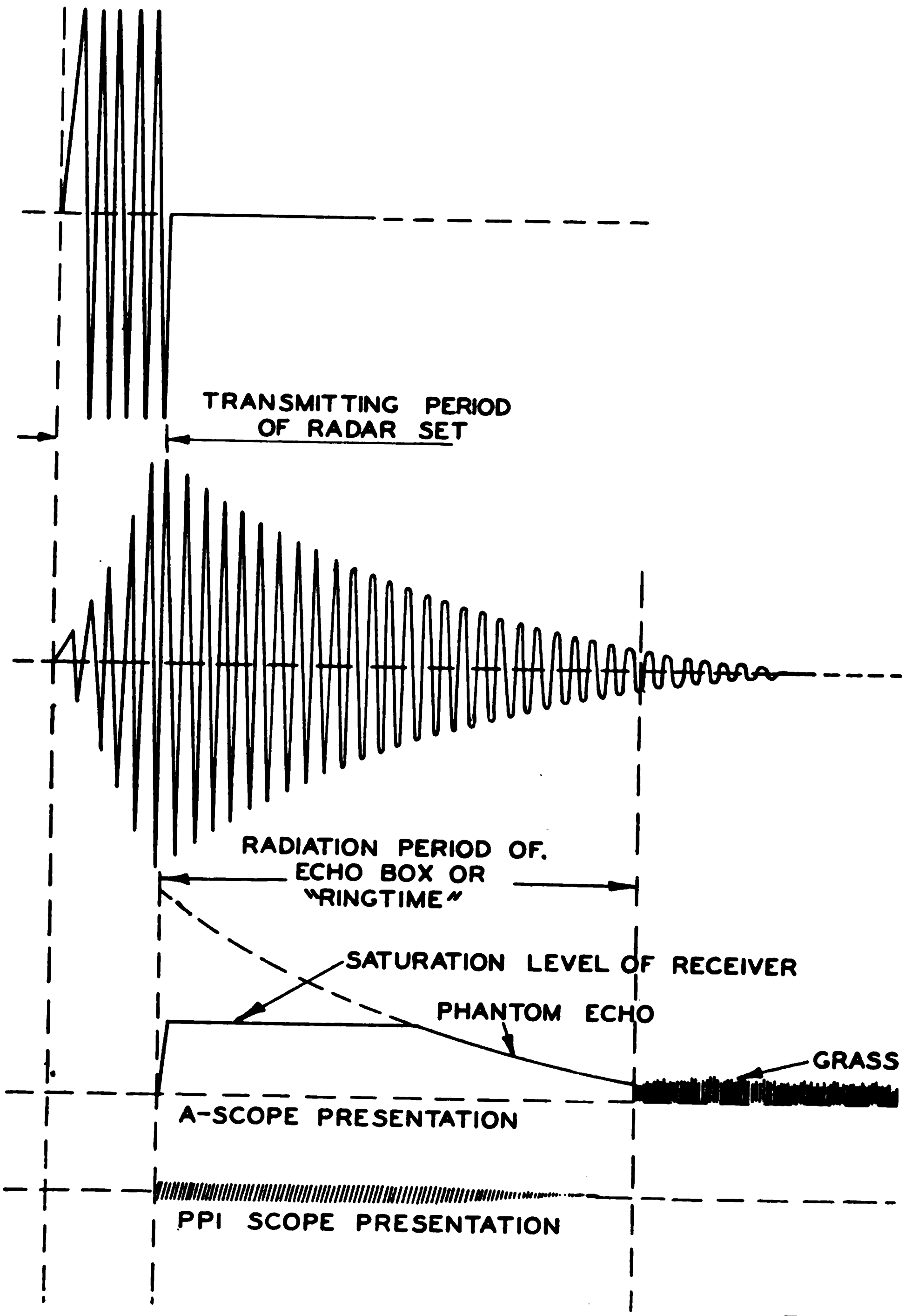


Figure 145. Echo box oscillations and scope presentation.

of the transmitted pulse to the point where the signal from the echo box fades into the noise level is known as the ***ringing time*** of the box. The ***ringing time*** is measured in terms of range in yards on the scopes.

(4) When the box is turned to reasonance, energy may be coupled out of the cavity into the crystal rectifier. The crystal current, filtered by a capacitor, is measured by a microammeter. The crystal current measured by the microammeter indicates the amount of r-f pulse energy absorbed by the echo box. Thus, the microammeter indication will serve to indicate the radar power output.

(5) The observed ***ringing time*** is dependent upon several factors. Some of the constant factors, such as characteristics of the echo box, pickup dipole, cabling, and coupling loops in the echo box, are a part of the construction; they do not enter into any of the comparative measurements or indications. Other factors, such as power output of the transmitter, pulse duration, frequency spectrum, and receiver condition and tuning, vary with the performance of the radar system. Therefore, if all factors external to the radar system are standardized, the ***ringing time*** will depend only upon the performance of the radar system.

Section X. COMPLETE BLOCK DIAGRAM OF RADIO SET SCR–682–A

55. Purpose of Block Diagram

a. The block diagram of Radio Set SCR–682–A shown in figure 146 is a complete functional presentation of the electrical circuits of the equipment. Following the separate descriptions of the circuits given in the preceding sections of this chapter, it shows the relationship of these circuits and their individual functions in the over-all operations of the equipment.

b. The block diagram is useful while making a quick review of the operation of the equipment, or when instructing others in the broad details of its performance. In trouble shooting it also enables the radar officer or technician to follow the course of a signal from circuit to circuit without having to bother with the detailed circuit tracing which would be necessary if this were done with the schematics. Then, when trouble is suspected in an individual circuit, reference can easily be made to the proper schematic and trouble shooting data for accurate location of the source of trouble .

56. Reading Diagram

a. Figure 146 represents the various circuits of the equipment as blocks marked with the name of the circuit. A chassis or major component is represented by a large block (dotted lines), and the circuits within it are represented by smaller blocks. Interconnections have been simplified and are indicated by solid lines with arrowheads which show the direction in which the signal is progressing. The various blocks representing major components have been arranged in groups so that each group represents a system. For example, the components in the first column are the transmitter system components, while those in the second column are the r-f system components.

b. The signal leaving a major component opposite one of the smaller blocks within it indicates that the signal leaves the component from the circuit identified by the smaller blocks; the signal entering a major component opposite a smaller block indicates that the signal is applied to the circuit represented by this block. The a-c distribution system has been omitted from the block diagram for simplification. Also, filament connections and d-c connections within the various units have been left out for the same reason. The latter voltages are shown applied to the entire major component, and their distribution within the component is to be assumed. Since the purpose of the diagram is to emphasize the functional, or signal-carrying connections, any other connections which might confuse the diagram and defeat its main purpose have not been included.

57. Review of Theory with Block Diagram

a. FUNCTIONS. (1) Radio Set SCR–682–A, in common with other radar equipment, has as its primary functions:

(a) The transmission of a short pulse of radio-frequency energy.

(b) The reception of echo signals caused by the reflection of this pulse of energy when it strikes a surface vessel, aircraft, or other target.

(c) The measurement of the time interval between the transmission of the pulse and the reception of the echo.

(*d*) The presentation of this time factor as linear distance between the radar set and the target.

(2) In addition to these basic detection and ranging functions, Radio Set SCR–682–A presents visual indications of azimuth based upon the position of the antenna when it is pointed accurately towards the target. The following summary of these actions with reference to the block diagram, figure 146, will show how the equipment operates.

b. TRANSMITTER SYSTEM. (1) The components of the transmitter system are shown in the left-hand column in the block diagram. They are Power Supply Unit RA–101–A and the rotary spark-gap modulator which are part of the modulator unit, and the pulse transformer and transmitter tube which are part of the r-f unit.

(2) The various circuits contained in the rotary spark-gap modulator are designed to form a high-voltage pulse of approximately —5,000 volts in magnitude and 1-microsecond-duration. The rotary spark gap, driven at 3,450 rpm, contains seven electrodes; therefore, the transmitter system will transmit an r-f voltage pulse 402.5 times per second, and will remain inactive during the period between these pulses.

(3) Power Supply Unit RA–101–A supplies the 6,000 volts to the d-c resonant choke in the spark-gap modulator. The resonant choke doubles the voltage and charges the pulse forming line in the modulator to a full 12,000 volts which is discharged through the spark gap electrodes across a voltage divider circuit. Two outputs are taken off the voltage divider. A negative pulse of approximately —100 volts is used to trigger the indicator system. A —5,000-volt pulse output, shaped to a 1-microsecond rectangular wave by the action of the pulse forming line, is fed to the primary of a 1 to 4 step-up pulse transformer located in the r-f unit. The negative output of the transformer, a steep-sided 20,000-volt pulse, is applied to the cathode of the transmitter tube during the 1-microsecond period, and the transmitter tube emits its pulse of r-f voltage delivered by the coaxial r-f line to the antenna.

c. R-F SYSTEM. The r-f system is composed of the coaxial r-f line, the A.F.C. coupler, the T-R box, and the antenna. The r-f line accepts the pulse of r-f energy from the transmitter tube and conveys it to the antenna. The antenna radiates the r-f energy from the transmitter system and receives the energy from the reflected echo signal. The T-R box acts as an electronic switch to disconnect the receiver from the line while the transmitter is operating, and to connect the receiver to the line during the time the transmitter is off. The A.F.C. coupler feeds part of the transmitter signal to the A.F.C crystal mixer in the receiver system for automatic frequency control.

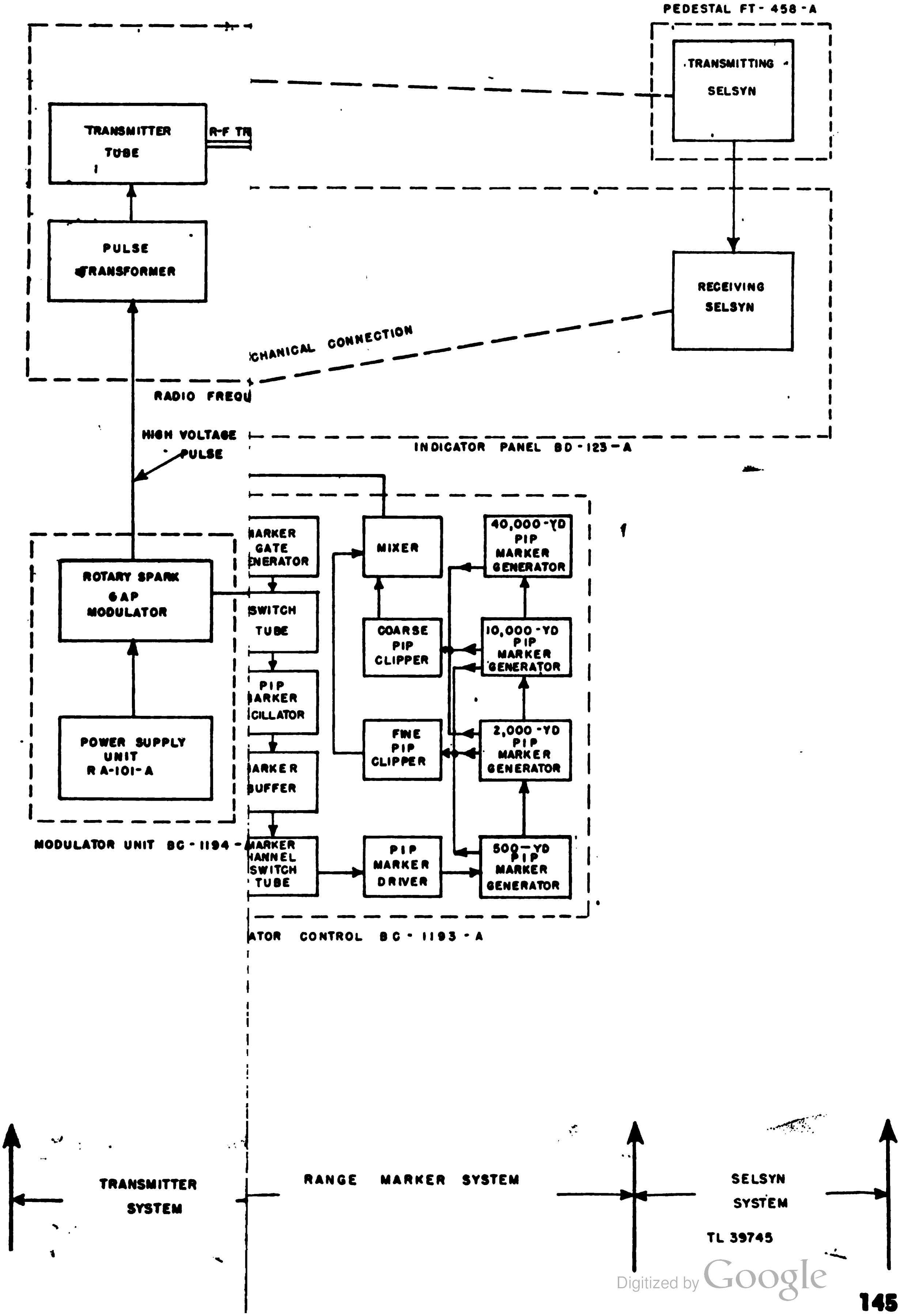
d. RECEIVER SYSTEM. (1) The receiver system comprises the component necessary to accept the incoming echo signals from the T-R box and to amplify and convert them into video signals for amplification to the PPI scope of the indicator system. These components are the A.F.C. and signal crystal mixers, the local oscillator, the automatic frequency control circuit, the i-f channel, the video amplifiers, the S.T.C and gain control circuits, and the receiver power supply.

(2) The signal crystal mixer and local oscillator, form a heterodyne conversion circuit which functions on the same principle as the conversion circuits of a standard superheterodyne receiver. They convert the 2,800-megacycle echo signal to an intermediate frequency of 30 magacycles. The A.F.C. crystal mixer, amplifier, discriminator, pulse amplifier, control tubes, and sawtooth oscillator comprise the automatic frequency control circuit which maintains the local oscillator at a stable frequency by changing the voltage applied to the reflector plate of the local oscillator tube. This circuit serves to prevent frequency drift of the local oscillator, allowing an accurate and stable intermediate frequency of 30 megacycles.

(3) The 30-megacycle i-f signal is applied to the i-f channel where it is passed through six stages of amplification, after which it is detected. The video pulse is amplified in two video amplifier stages. The output of these stages is fed to the cathode of the PPI-scope tube through a video amplifier control circuit in the indicator system.

(4) The sensitivity time control (S.T.C.) generates a voltage whose magnitude varies with time from the start of the sweep. Its purposes is to decrease the sensitivity of the receiver system during the first part of the sweep in order to facilitate interpretation of and distinguishing between nearby targets. A gate from the sweep circuit in the indicator system is used to trigger the S.T.C. circuit. The gain control varies the gain of the receiver by varying the steady d-c bias on the control grids of the second and third i-f tubes.

e. INDICATOR SYSTEM. (1) The indicator system



PEDESTAL FT-458-A
TRANSMITTING SELSYN
RECEIVING SELSYN
TRANSMITTER TUBE
R-F TR
PULSE TRANSFORMER
CHANICAL CONNECTION
RADIO FREQU
HIGH VOLTAGE PULSE
INDICATOR PANEL BD-123-A
ROTARY SPARK GAP MODULATOR
POWER SUPPLY UNIT RA-101-A
MODULATOR UNIT BC-1194-
ARKER GATE ENERATOR
SWITCH TUBE
PIP ARKER CILLATOR
ARKER BUFFER
ARKER HANNEL SWITCH TUBE
MIXER
COARSE PIP CLIPPER
FINE PIP CLIPPER
PIP MARKER DRIVER
40,000-YD PIP MARKER GENERATOR
10,000-YD PIP MARKER GENERATOR
2,000-YD PIP MARKER GENERATOR
500-YD PIP MARKER GENERATOR
ATOR CONTROL BC-1193-A
TRANSMITTER SYSTEM
RANGE MARKER SYSTEM
SELSYN SYSTEM

TL 39745

includes the PPI sweep circuits, the PPI indicator (scope), and the indicator power supply.

(2) The PPI sweep circuit provides the sweep line which starts at the center of the PPI-scope tube and extends radially outward. The sweep line must start at the same instant that the transmitter fires. Therefore, a portion of the same pulse which triggers the transmitter is used to inaugurate the sweep action. This 100-volt negative pulse, tapped off a voltage divider in the spark gap modulator circuit of the transmitter system, is fed through a trigger buffer stage to the sweep gate generator. This tube, a multivibrator, develops a straight-sided square pulse which drives a sawtooth sweep generator. The sawtooth is amplified by the sweep amplifier and sweep output tubes and applied to the deflection coils of the PPI-scope circuit. The deflection coil yoke is geared to the rotor of a selsyn motor which, by synchronized action, rotates in step with the rotation of the spinner assembly. This action causes the sweep to rotate around the face of the scope so that the direction of the sweep line in azimuth is an accurate indication of the direction in which the antenna is pointed.

(3) The sweep-gate generator square-wave pulse is also applied as a positive wave through the blanker stage to the first anode of the PPI scope. This pulse unblanks the scope and intensifies the electron beam only during the time that the sweep-forming dot is on its outward trip. The first anode voltage is reduced during the no-sweep period so that possible scope damage is prevented.

(4) The indicator system power supply contains regulated and unregulated rectifiers which provide operating voltages for the system. It also contains the high-voltage supply for the beam-forming element of the PPI scope.

f. Range Marker System. As the sweep revolves, the range marker system creates points of increased intensity on the sweep trace. Because of the persistency of the PPI-scope screen, these points appear as circular traces. The range of a signal may thus be more easily determined. The marker gate generator stage, triggered by the same pulse which triggers the sweep circuit of the indicator system, is a multivibrator which develops a steep-sided square pulse. The width of this —140-volt pulse is the same as the sweep width on the longest (240,000-yard) range. The switch tube and pip marker oscillator, pulsed by this square-wave pulse, develop a series of oscillatory waves of equal amplitude. The sine wave voltage, oscillating at a frequency of 327.9 kilocycles, is fed through a marker buffer stage to the marker channel switch tube. This stage provides an electronic means of switching the pip markers that appear on the PPI scope *on* and *off*. The ouput of this stage is directly coupled to the grid of the pip marker driver which inverts and amplifies the negative pulses. The output positive pulses of approximately 125-volt amplitude are fed to the 500-yard pip marker generator where sharp positive 160-volt pips are developed. These are fed to the fine pip clipper stage. The output of the 500-yard pip marker generator also triggers the 2,000-yard range marker stage which in turn triggers the 10,000-yard range marker stage, etc. The pips for the corresponding range setting are fed to the coarse and fine pip clipper stages through selector switches. These stages clip the markers at a selected level. The markers are then fed to the mixer stage which feeds the markers (at the proper intervals) to the grid of the PPI scope in the indicator system. The range markers constitute a rapid and accurate index for immediate determination of the target location.

g. Selsyn System. The selsyn system makes it possible to determine accurately the azimuth of targets by keeping the rotation of the sweep trace in step with the rotation of the spinner assembly. The rotor of the transmitting selsyn (or selsyn generator) is mechanically geared to the spinner so that the angular position of the rotor corresponds with the azimuth position of the antenna. The transmitting selsyn is electrically connected to the receiving selsyn (the selsyn motor in the indicator panel). The receiving selsyn, mechanically geared to the deflection coils of the PPI scope, rotates the deflection yoke in exact step with the rotation of the antenna.

58. Cording Diagram

Figure 147 represents the cording diagram for Radio Set SCR-682-A. The individual components are indicated by blocks. Together with the complete block diagram, figure 147 indicates the interrelation between components.

Chapter 2

TROUBLE-SHOOTING PROCEDURES

Section I. GENERAL INFORMATION

59. Introduction

No matter how well equipment is designed and manufactured, faults are bound to occur in service. When such faults do occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting. (Remember, however, that preventive maintenance will minimize the necessity of trouble shooting.)

a. TROUBLE-SHOOTING DATA. Take advantage of the material supplied in this manual to help in rapidly locating faults. Consult the following trouble-shooting data when necessary:

(1) *Block diagram of the system.*

(2) *Complete schematic diagrams.* These diagrams include all components and show all the connections (power, input, and output) to other units.

(3) *Simplified and partial schematics.* These diagrams are particularly useful in trouble shooting, because they enable the electrical functioning of the circuits to be followed more clearly than on the regular schematics, thus speeding trouble locations.

(4) *Voltage and resistance data at all socket connections.*

(5) *Voltage, resistance, and waveform data at test jacks.* Blocking capacitors are omitted from most leads to the test jacks, to enable measurement of the d-c voltage at the plate or other points to which the test jacks connect. For this reason, be careful not to touch the measuring instruments which carry high voltage when connected to the test jacks.

(6) *Illustrations of components.* Front, top, and bottom views aid in locating and identifying parts.

(7) *Pin connections.* Pin connections on sockets, plugs, and receptacles are numbered or lettered on the various diagrams.

(a) Seen from the bottom, pin connections are numbered in a clockwise direction around the sockets. On octal sockets the first pin clockwise from the keyway is pin No. 1. Pin numbers appears on both the schematic diagrams and the wiring diagrams, so that any tube element can be readily located.

(b) Plugs and receptacles are numbered. To avoid confusion, some individual pins are identified by letters which appear directly on the connector.

b. TROUBLE-SHOOTING STEPS. The first step in servicing a defective radar set is to sectionalize the fault. Sectionalization means tracing the fault to the component responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition.

(1) Use of Equipment Performance Log (EPL) and the Starting Procedure aids in tracing the fault to the defective component. The procedures to be followed are explained in *c* and *d* below.

(2) Some faults such as burned-out resistors, r-f arcing, etc., can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage, resistance, and waveforms.

c. EQUIPMENT PERFORMANCE LOG SECTIONALIZATION. The Equipment Performance Log sheet is a record of the normal and abnormal operation of the station. In the event of station failure or abnormal operation, references to the Equipment Performance Log will usually aid in sectionalizing the defect. When a station failure occurs, refer to the log sheet and note the operation of the station for the past 24 hours. The failure may be the result of a previous abnormal condition not serious enough in itself to have caused the station to go off the air at the time it occurred. The abnormal condition will have been entered in the station log. Check the log entry to obtain direct information leading to the cause of the failure.

d. STARTING-PROCEDURE SECTIONALIZATION. The starting procedure is the systematic method used to put the station on the air. This procedure is used in sectionalization when the cause of the station failure is not known. In most cases it will trace the defect to a particular component. The steps of the starting procedure are performed in sequence until an abnormal result is obtained. As each step is performed, the visible and audible results of the action are noted. The use of the starting procedure is described in detail in section III of this chapter.

e. LOCALIZATION. Localization is the tracing of the fault to a particular part. Sections IV to X of this chapter describe the method of localizing faults within the individual components. These sections contain trouble-shooting charts which list abnormal symptoms and their causes. The charts also give the procedure for finding out which of the probable locations of the faults is the exact one. The sections also tell what waveforms should be obtained at the test points. In addition, there is a drawing which shows the resistance and the voltage at every socket-pin connection. The method of using the voltage and resistance data in checking a circuit is described in detail in paragraphs 60*d* and 61*c* of this section.

f. TEST EQUIPMENT AVAILABLE FOR TROUBLE SHOOTING. The following test equipment is provided with radio Set SCR-682-A for use in maintenance and trouble shooting. Figures 148 and 149 show pictures of the test equipment.

(1) Synchroscope I-212.
(2) Echo box.
(3) Analyzer, Simpson, model No. 260.
(4) Tube tester, Hickok, model No. 530.
(5) Emergency receiver tuner.
(6) Voltmeter multiplier.
(7) Crystal current cable and plug.
(8) Meter shunt.
(9) Coaxial tee connector set.
(10) Ten neon lamps, type T-2.

Note. The synchroscope and echo box are discussed fully in section II of this chapter.

60. Voltage Measurements

a. GENERAL. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages. Voltage measurements are made easily, because they are always made between two points in a circuit and the circuit need not be interrupted.

(1) Complete information on normal operating voltages is given in the trouble-shooting section. Unless otherwise specified, these voltages are measured between the indicated points and ground.

(2) Always begin by setting the voltmeter on the highest range, so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

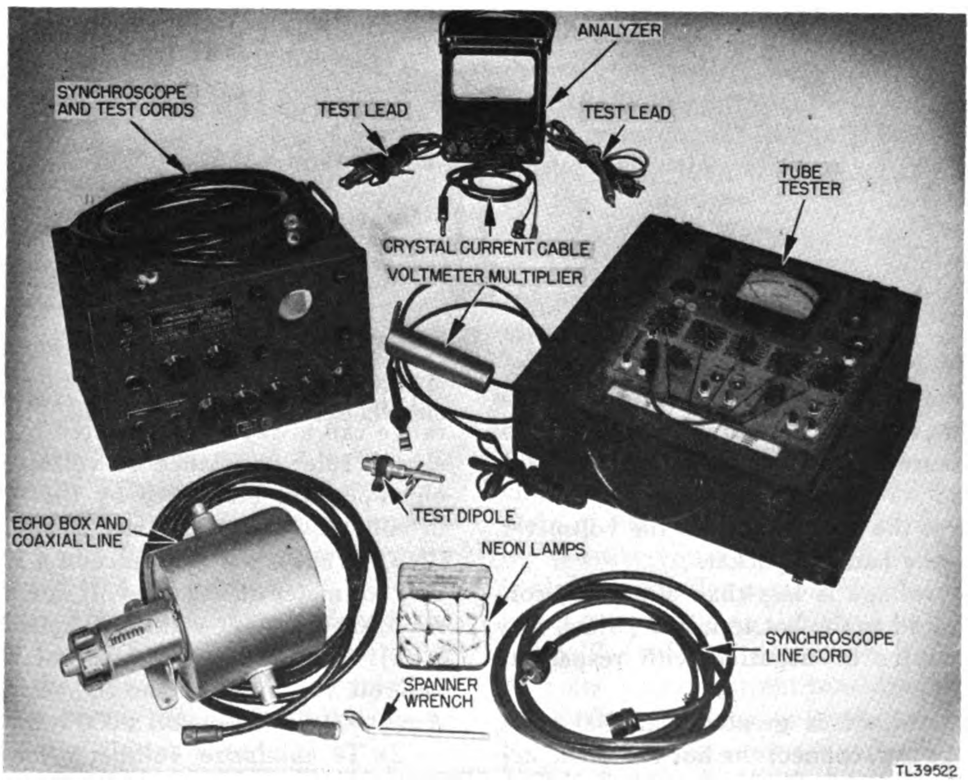


Figure 148. Test equipment.

(3) In checking cathode voltage, remember that a reading can be obtained when the cathode resistor is actually open. The resistance of the meter may act as a cathode resistor. Thus, the cathode voltage may be approximately normal only as long as the voltmeter is connected between cathode and ground. Before the cathode voltage is measured, a resistance check should be made with the circuit cold to determine if the cathode resistor is normal.

b. Precautions Against High Voltage. Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages are dangerous, and can be fatal. When it is necessary to measure high voltages, observe the following rules:

(1) Connect the ground lead to the voltmeter.

(2) Place one hand in pocket.

(3) If the voltage is less than 300 volts, connect the test lead to the hot terminal (which may be either positive or negative with respect to ground).

(4) If the voltage is greater than 300 volts, shut off the power, connect the hot test lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points, both of which are above ground.

c. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a lower voltage than the actual voltage present when the voltmeter is removed from the circuit.

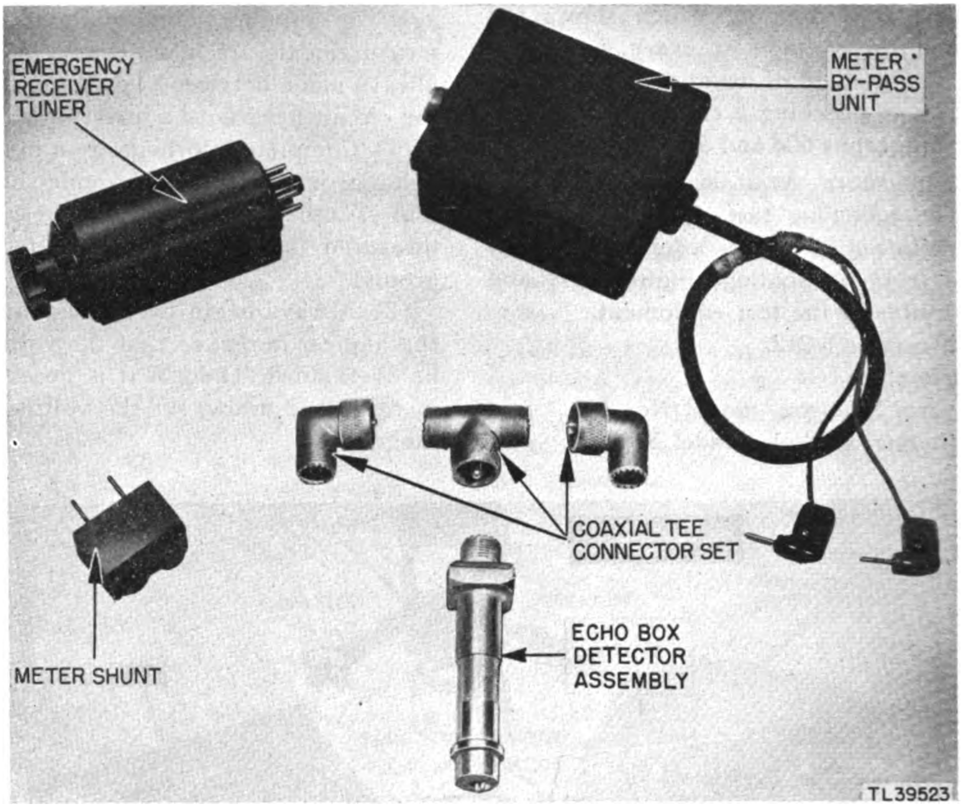


Figure 149. Test equipment.

(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: resistance of voltmeter equals the ohms-per-volt multiplied by the full-scale range in volts. Two examples are shown below:

(a) What is the resistance of a 1,000-ohms-per-volt voltmeter on the 300-volt range?

R=1,000 ohms-per-volt x 300 volts=300,000 ohms

(b) What is the resistance of a 20,000-ohms-per-volt voltmeter on the 300-volt range?

R=20,000 ohms-per-volt x 300 volts = 6 megohms

(2) To minimize voltmeter loading in high-resistance circuits, use the highest voltmeter

range. Although only a small deflection is obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement is increased. The decreased loading of the voltmeter more than compensates for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the higher range is greater than on the lower range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

(4) The voltage and resistance drawings used in this manual are based on readings taken with the Simpson analyzer (fig. 148). The trouble shooter should use a meter having the same ohms-per-volt sensitivity. Because the meter used in testing for the voltage produces the same amount of loading as the meter used in measuring the voltage, it is unnecessary to consider the effect of loading.

d. Practical Example of Voltage Analysis. Figure 150 illustrates a typical amplifier stage. The values of the various parts are labeled as well as the input voltages. The normal voltages at the V3 tube socket pins are:

Pin No.	1	2	3	4	5	6	7	8
Voltage	7.2	6.3 ac	0	0	7.2	195	0	185

Note. All voltages are d-c unless otherwise specified. The d-c readings were taken with a 1,000-ohms-per-volt voltmeter. Drawings for each component, giving the voltage at each socket connection, can be found in the section on trouble shooting in the component.

To check the stage shown in figure 150 for an abnormal voltage measurement, measure the voltages between the socket contacts and the chassis.

(1) The voltage between contact 1 and the chassis is normally 7.2 volts (see above chart). This voltage should be the same as that between socket contact 5 and the chassis, since they are directly connected (see (3) below).

(2) The voltage between contact 2 and the chassis should be 6.3 a-c volts, since contact 2 is one side of the filament. On the diagram no connections are shown, because the filaments of amplifier tubes are always connected to a low-voltage a-c source. If this voltage is abnormal,

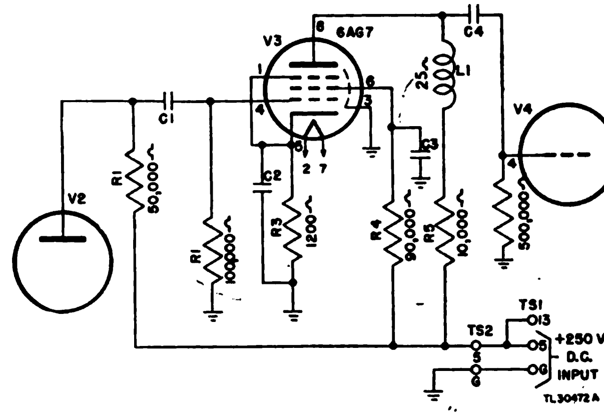


Figure 150. Schematic diagram for voltage analysis.

check the voltage across the winding of the transformer which supplies the voltage.

(a) If the voltage of the transformer is normal, the trouble is a broken connection between the transformer and the contact.

(b) If the voltage of the transformer winding is abnormal, measure the voltage of the transformer primary winding.

(c) If the primary voltage is normal and the voltage on the winding that delivers the filament voltage is abnormal, either the transformer is 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. However, if the voltage on the transformer primary is abnormal, the source of this voltage must be checked.

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

(4) The voltage between contact 4 and the chassis should be zero, since this is a Class A amplifier and normally no grid current flows through resistors R2. If capacitor C1 short-circuits, however, the high positive voltage on the plate of tube V2 is delivered to contact 4 and a d-c positive-voltage reading will be obtained. It is also possible for a short circuit inside the tube to cause a reading on this contact.

(5) The voltage on contacts 1 and 5 should be 7.2 volts. (An important consideration in measuring cathode voltage is explained in paragraph 60*a*(3).) The plate-cathode voltage and the grid-cathode voltage normally cause a current to flow

through the cathode resistor R3. This current is normally 0.006 ampere, since the resistor is rated at 1,200 ohms and the voltage across it is 7.2 volts.

$$I = \frac{E}{R} = \frac{7.2}{1,200} = 0.006 \text{ ampere}$$

(a) If no voltage is obtained, the trouble may be a lack of plate-supply voltage, a burned-out tube V3, a shorted resistor R3, a shorted capacitor C2 (this capacitor, if shorted, connects the cathode to the chassis), or a broken connection.

(b) If the voltage is low, the trouble may 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 plate-supply voltage, an open-circuited coil L1, a poor connection, or a change in the resistance value of any of the resistors.

(c) If the voltage is too high, the trouble may be a gassy tube, a short-circuited resistor, too high an applied voltage or a connection in either the plate-cathode or screen-grid-cathode circuits shorted by an external circuit.

(6) The screen voltage is checked as follows:

(a) The voltage on contact 6 is normally 195 volts. The voltage drop across the resistor is normally 55 volts, since the voltage is 195 volts on one side of the resistor and 250 volts on the other side. The normal current through this resistor is 0.0006 ampere.

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

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

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

Note. A gassy tube, or lowering of the grid bias of tube V3, increases the screen-grid current. Increasing this current increases the voltage drop across resistor R4. If capacitor C3 is leaky or shorted, the screen grid of tube V3 will be connected near or at ground potential, lowering the voltage on contact 6. The current through resistor R4 rises if capacitor C3 is shorted. Resistor R4 is then the only resistance between the applied voltage and the chassis ground. Resistor R4 probably will burn out because of the high current flow unless the resistor has a high power rating. Any fault that makes high current flow through the screen-grid-cathode circuit may burn out either resistor R3 or R4.

(7) The voltage between contact 7 and ground is normally zero, according to the chart above, since this contact is connected directly to the chassis ground.

(8) The plate voltage is checked as follows:

(a) The voltage between contact 8 and the chassis is normally 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 resistor R5 and coil L1 in series is 65 volts (250 volts −185 volts). The current through resistor R5 and coil L1 is 0.0064 ampere.

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

(b) If no voltage is obtained on contact 8, the trouble may be a lack of applied voltage, an open-circuited resistor R5 or coil L1, or a broken connection between terminal 5 on terminal strip TS1 and contact 8.

(c) If the voltage on contact 8 is too low, the trouble may 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 causes the current through the plate-cathode circuit to rise, increasing the voltage drop across resistor R5 and coil L1. This lowers the voltage on contact 8. Increased current through this circuit may also burn out resistor R3 or R5, unless their power rating is ample.

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

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

61. Resistance Measurements

a. General. (1) *Normal resistance values.* When a fault develops in a circuit, its effect will very often show up as a change in the resistance values. To assist in the localization of such faults, trouble-shooting data includes the normal resistance values, as measured at the tube sockets and at the test jacks. These values are measured between the indicated points and ground, unless otherwise stated. Often it is desirable to measure the resistance from other points in the circuit, in order to determine whether the particular points in the circuit are normal. The normal resistance values at any point can be determined by referring to the resistance values shown in the schematic diagram. Figure 151 represents the standard resistor color code.

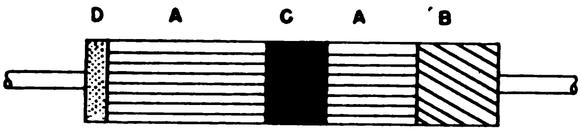
(2) *Precautions.* *(a)* Before making any resistance measurements, turn off the power. An ohmmeter is essentially a low-range voltmeter and battery. If the ohmmeter is connected to a circuit which already has voltages in it, the needle will be knocked off scale and the voltmeter movement may be burned out.

(b) Capacitors must always be discharged before resistance measurements are made. This is very important when checking power supplies that are disconnected from their load. This discharge of the capacitor through the meter will burn out its movement and in some cases may endanger life.

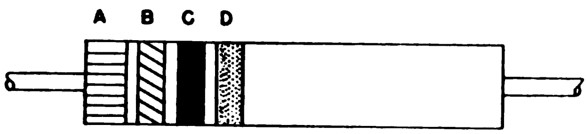
(3) *Correct use of low and high ranges.* It is important to know when to use the low-resistance range and when to use the high-resistance range of an ohmmeter. When checking the circuit continuity, the ohmmeter should be set on the lowest range. If a medium or high range is used, the

RESISTOR COLOR CODE

OLD STYLE



NEW STYLE



OLD STYLE	COLOR	NEW STYLE
BODY A	INDICATES FIRST SIGNIFICANT FIGURE OF RESISTANCE IN OHMS	BAND A
END B	INDICATES SECOND SIGNIFICANT FIGURE	BAND B
BAND OR DOT C	INDICATES MULTIPLIER	BAND C
END D	IF ANY, INDICATES TOLERANCE IN PER CENT OF THE NOMINAL RESISTANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS ± 20%	BAND D

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE PER CENT (IF GIVEN)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1,000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

TL 35620

Figure 151. Standard resistor color code.

pointer may indicate zero ohms, even if the resistance is as high as 500 ohms. When checking high resistances or measuring the leakage resistance of capacitors or cables, the highest range should be used. If a low range is used, the pointer will indicate *infinite* ohms, even though the actual resistance is less than a megohm.

(4) *Parallel resistance connections.* In a parallel circuit the total resistance is less than the smallest resistance in the circuit. This is important to remember when shooting trouble with the aid of a schematic diagram.

(a) When a resistance is measured and the value is found to be less than expected, make a careful study of the schematic to be certain that there are no resistances in parallel with the one that has been measured. Before replacing a resistor because its resistance measures too low, disconnect one terminal from the circuit and measure its resistance again, to make sure that the low reading is not because some part of the circuit is in parallel with the resistor.

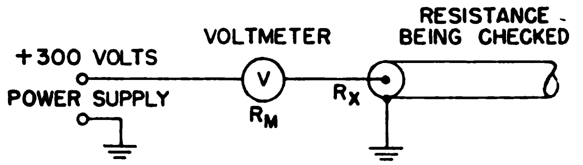
(b) In some cases, it is impossible to check a resistor because it has a low-voltage transformer winding connected across it. If the resistor must be checked, disconnect one terminal from the circuit before measuring its resistance.

(5) *Checking grid resistance.* When checking grid resistance, a false reading may be obtained if the tube is still warm and the cathode is emitting electrons. Allow the tube to cool, or reverse the ohmmeter test leads so that the negative ohmmeter test lead is applied to the grid.

(6) *Tolerance values for resistance measurements. Tolerance* means the normal difference that is expected between the rated value of the resistor and its actual value.

(a) Most resistors that are used in radar circuits have a tolerance of at least 10 percent. For example, the grid resistor of a stage may have a rated value of 1 megohm. If the resistor is measured and found to have a value between 0.9 megohms and 1.1 megohms, it will be considered normal. As a rule, the ordinary resistors used in circuits are not replaced unless their values are off more than 20 percent. Some precision resistors and potentiometers are used. When a resistor is used whose value must be very close to its rated value, the tolerance is usually stated on the diagram.

(b) The tolerance value for transformer windings is generally between 1 and 5 percent. As a rule, suspect a transformer which shows a resistance deviating more than 5 percent from its rated value. Allow the transformer to cool off before the resistance test is made.



$$R_X = \frac{300}{V} R_M \text{ (APPROX.)}$$

EXAMPLE

V = 5 VOLTS. THE METER IS USED ON ITS 300 VOLT RANGE AND HAS A RESISTANCE OF 1,000 OHMS-PER-VOLT.

$$R_M = 300 \times 1{,}000 = 300{,}000 \text{ OHMS.}$$

$$R_X = \frac{300}{5} \times 300{,}000 = 18 \text{ MEGOHMS.}$$

TL 35530

Figure 152. High resistance measurement.

b. HIGH-RESISTANCE MEASUREMENTS. Many leakages will not show up when measured at low voltages. Most ohmmeters use a maximum test voltage of 15 volts on the highest resistance range. Where it is necessary to measure resistance above a few megohms or the leakage resistance between conductors of a cable, the test should be made using an applied voltage of 100 volts or more. Where it is possible to ground one end of the resistance being checked, one of the low-voltage power supplies in the equipment can be used to provide about 300 volts for making these high-resistance measurements. The manner in which such measures are made is indicated in figure 152. This method should be used only when the resistance being measured is very high. Be careful not to handle the meter after the circuit has been completed. The meter used should have an ohms-per-volt sensitivity of 1,000 ohms or more. The resistance of the meter is equal to the ohms-per-volt sensitivity multiplied by the range to which the meter is set. The derivation of the formula $Rx = \frac{300Rm}{V}$ is shown below. *Rx* is the unknown resistance, *Rm* is the meter resistance, and *V* is the voltmeter reading.

$$\frac{Rx}{Rm} = \frac{300-V}{V}$$

If *Rx* is very large *V* will be small in comparison to 300. Assuming that $300-V$ can be replaced by 300, the formula $\frac{Rx}{Rm}=\frac{300}{V}$ is obtained.

When solved for Rx this gives $Rx=\frac{300\ Rm}{V}$.

When making the measurement, the meter should first be put on the 300-volt scale to protect it in case Rx is very low. If the voltage used is not 300 volts, the correct value should be inserted in the formula in place of 300.

c. Practical Example of Resistance Analysis. The low-voltage power supply shown in figure 153 will be used in this sample analysis. Suppose that a fuse in the primary circuit of the power transformer has blown out. The cause is obviously an overload. The overload may be a short circuit in the unit to which the power supply furnishes power, a short circuit in the power supply, or a short circuit in the primary circuit of the power transformer.

(1) Points 1, 2, 3, 4, 5, and 6 represent connections to a plug which takes power away from the power supply. Disconnect the plug and replace the blown fuse. (Since this is a low-voltage circuit, it is not likely that any damage will be done by blowing another fuse.) Turn the power on. If the fuse blows again, the trouble is not in the unit to which power is supplied.

(2) If the fuse blows the second time, the resistance between point 2 and ground should be checked. If this resistance is within 10 percent of 12,400 ohms (the sum of the resistances in the bleeder chain equals 12,400 ohms), the trouble is in the secondary or primary of the transformer. For this analysis, it will be assumed that the resistance is found to be much less than 12,400 ohms.

(3) If the resistance between point 2 and ground is found to be zero, capacitor C3 must be shorted. In order to test the capacitor, disconnect its lead from point *M*. The actual resistance of the capacitor can then be measured.

(4) A resistance between point 2 and ground of 550 ohms indicates that capacitor C2 is shorted, since coil L1 has a resistance of 550 ohms. Test capacitor C2 by disconnecting it from ground and measuring its resistance.

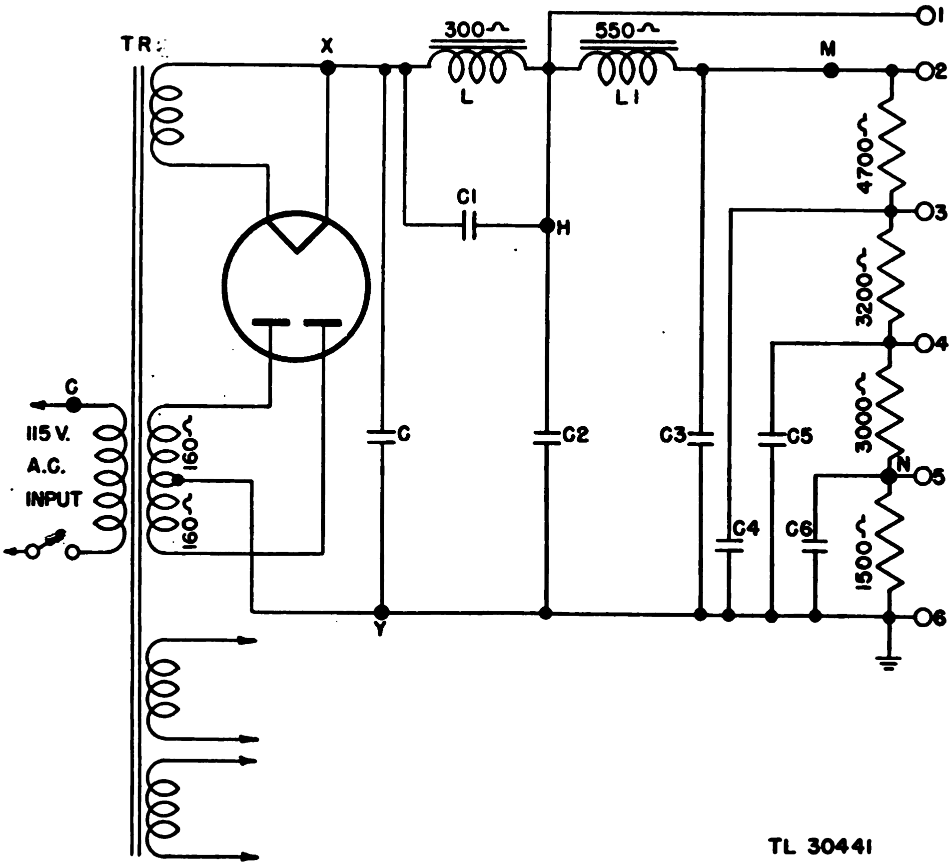


Figure 153. Schematic diagram for resistance analysis.

(5) A resistance between point 2 and ground of 850 ohms indicates a short circuit in the rectifier tube, the filament winding, or capacitor *C*. To discover which is shorted, remove the tube from its socket and again measure the resistance between point 2 and ground. If the fault is still present, it is either in capacitor *C* or in the filament winding. If the fault disappears when the tube is removed, the fault is in the tube.

(6) If the resistance between point 2 and ground is about 1,000 ohms, the trouble is in the circuit either to the right or to the left of point *M*. To isolate the trouble disconnect the circuit at *M*. If the resistance between point 2 and ground is still much less than 12,400 ohms, the fault is in the bleeder chain. To check the chain, proceed as follows:

(a) Measure the resistance between points 2 and 3. If it is not close to 4,700 ohms, the resistor between these points should be replaced.

(b) If the above check is satisfactory, the resistance between point 3 and ground should be checked. From figure 153 it is seen that the reading should be 7,700 ohms. If the reading is zero, first disconnect capacitor C4 and check it. If capacitor C4 is normal, check the 3,200-ohm resistor. If the resistance between point 3 and ground is greater than zero but much less than 7,700 ohms, disconnect capacitors C4, C5 and C6 from the circuit. Then check the capacitors and the 1,500-ohm and 3,000-ohm resistors individually.

62. Capacitor Tests

Capacitors which are leaky or shorted can be found by resistance checks of the stage. A capacitor which is suspected of being open can best be checked by shunting a good capacitor across it. In i-f circuits, keep the lead to the capacitor as short as the original capacitor leads. In video and low-frequency circuits (less than 1 megacycle), the test capacitor leads may be several inches long. Figure 154 illustrates the standard capacitor color code.

63. Current Measurements

Current measurements other than those indicated by the panel meters are not ordinarily required in trouble shooting the radar set. Under special circumstances where the voltage and resistance measurements by themselves are not sufficient to localize the trouble, a current measurement can be made by opening the circuit and connecting an ammeter to measure the current. This procedure is not recommended except in very difficult cases.

a. When the meter is inserted in a circuit to measure current it should always be inserted away from the r-f end of the resistance. For example, when measuring plate current, do not insert the meter next to the plate of a tube, but insert it next to the end of the resistor which connects to the power. This precaution is necessary to keep the meter from upsetting the r-f voltages.

Caution: A meter has least protection against damage when it is used to measure current. Always set the current range to the highest value. Then, if necessary, decrease the range to give a more accurate reading. Avoid working close to full-scale reading because this increases the danger of overload.

b. In most cases, the current to be measured flows through a resistance which is either known or can be measured with an ohmmeter. The current flowing in the circuit can be determined by dividing the voltage drop across the resistor by its resistance value. The drop across the cathode resistor is a convenient method of determining the cathode current. For an example see paragraph 60*d*.

64. Tubes

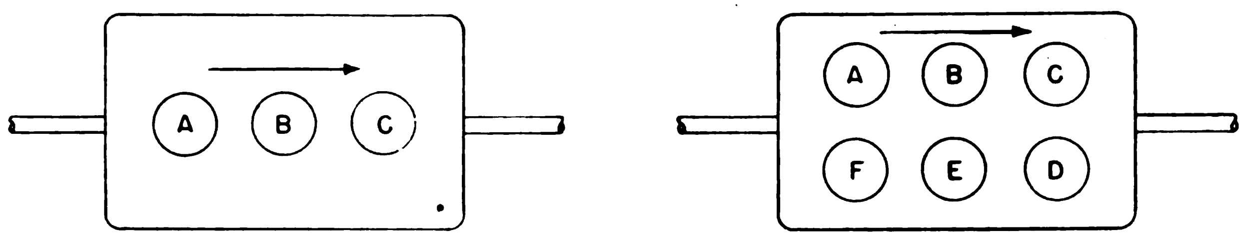
a. Tube Failures. Tube failures are responsible for a large percentage of the faults which occur in radar sets. There are, however, too many tubes in a radar set for a trouble shooter to attempt to find a fault by indiscriminate tube changing. Do not resort to tube changing until the fault has been traced to a particular stage.

(1) When putting a new tube into a circuit, note the position of all controls before making any changes. If retuning the controls with the new tube in the circuit does not correct the abnormal condition, return the controls to their original positions and put the old tube back in the circuit, unless a tube test shows the tube to be definitely bad.

Caution: In many radar circuits the interelectrode capacitance of a tube is a part of a tuned circuit. When tubes are switched, the tuning of the circuits is upset. If too many tube substitutions are made, the set may become seriously misaligned.

(2) When replacing a tube in a circuit, decide at once whether or not to keep the old tube. Do not change the tubes indiscriminately, or the

CAPACITOR COLOR CODE



ONE ROW DOTS	COLOR	TWO ROWS OF DOTS
DOT A	INDICATES FIRST SIGNIFICANT FIGURE OF CAPACITANCE VALUE IN MICROMICROFARADS	DOT A
DOT B	INDICATES SECOND SIGNIFICANT FIGURE	DOT B
	INDICATES THIRD SIGNIFICANT FIGURE	DOT C
DOT C	INDICATES MULTIPLIER	DOT D
USUAL TOLERANCE ±20%	INDICATES TOLERANCE IN PER CENT OF THE NOMINAL CAPACITANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS 20%	DOT E
RATED VOLTAGE USUALLY 500 VOLTS	INDICATES THE RATED VOLTAGE	DOT F

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE PER CENT (IF GIVEN)	RATED VOLTAGE (IF GIVEN)
BLACK	0	1		
BROWN	1	10	1	100
RED	2	100	2	200
ORANGE	3	1000	3	300
YELLOW	4	10,000	4	400
GREEN	5	100,000	5	500
BLUE	6	1,000,000	6	600
VIOLET	7	10,000,000	7	700
GRAY	8	100,000,000	8	800
WHITE	9	1,000,000,000	9	900
GOLD		0.1	5	1,000
SILVER		0.01	10	2,000
NO COLOR			20	500

TL 35619

Figure 154. Standard capacitor color code.

spares box will become full of tubes whose exact age and condition is uncertain.

b. Tube Checking. Tube checkers (fig. 148) are used to check the emission of electrons from the cathode and to test for shorted elements. Tube checkers will not test the performance of high-voltage tubes or rectifiers or of some special tubes in the modulator and rectifier. Tube checkers are useful, however, for checking receiving-type tubes used in the various components.

(1) Results obtained from a tube checker are not always conclusive, because the conditions are

not the same as those under which the tube operates in the set. For this reason, the final test of a tube must be its replacement with a tube which is known to be good. In many cases it is quicker and more reliable to replace a suspected tube with a good one than to check it with the tube checker.

(2) An operating chart and an instruction book are provided with the tube checker. This chart indicates the setting of the tube checker for each tube type. The number of controls, their arrangement, and their settings vary with different types of tube checkers.

65. Checking Waveforms

a. Signal Tracing. Basically, ***signal tracing*** means following the progress of a signal through a circuit. By ***signal*** is meant a video signal, a sweep voltage, a wide-gate voltage, or any other waveform which appears in the various parts of the equipment. A departure from the normal waveform indicates a fault located between the point where the waveform is last normal and the point where it is observed to be abnormal. For example, if a waveform is observed to be normal at the grid of a stage and abnormal at the plate of the same stage, this indicates that the trouble lies in that stage or in the succeeding stage.

(1) When the waveform of a multivibrator, a blocking oscillator tube, or a similar circuit is found to be abnormal, replace the tube before making any further tests. If replacing the tube does not correct the waveform of the original tube, place it back in the socket.

(2) When a component does not give the expected waveform, the fault is not necessarily in the component. The abnormal waveform may be due to the absence of a synchronizing or triggering pulse from another component. The point at which to start signal-tracing a component is at the input trigger plug.

(3) It is sometimes desirable to know definitely whether any signal voltage is getting to the grid of the first tube in a channel. To determine this when a test jack is not provided, remove the first tube in the channel involved so as to make the grid connection of the tube available from the top of the chassis. Then insert the test lead of the oscilloscope in the grid connection of the tube socket in order to see the waveform.

b. Use of Test Oscilloscope. Waveforms are the basis of radar operation. The outstanding advantage of the oscilloscope or synchroscope (fig. 148) is that it can be used to observe and to measure waveforms at the various test jacks and other points in the equipment. By comparing the observed waveform with the actual reference waveform shown in the data, the fault can be rapidly localized. However, if waveforms are measured at random, without a logical procedure such as that originating with the starting procedure, the result may be a loss of time in finding the fault. The measurement of waveforms with the test oscilloscope involves several essential points:

(1) ***Initial adjustments.*** The oscilloscope must be set up in accordance with the manufacturer's instructions.

(2) ***Sweep frequency.*** Adjust the sweep frequency to a frequency lower than the repetition frequency of the waveform being observed. For ordinary measurements, adjust the sweep frequency so that 2 or 3 cycles of the waveform appear on the screen. If more detail is desired, increase the sweep amplitude to spread the waveform.

(3) ***Sixty-cycle waveforms.*** Some of the waveforms have a fundamental or repetition frequency of 60 cycles. In observing these waveforms the sweep frequency can be set so that 2 cycles of the waveform are observed.

(4) ***Synchronization.*** Avoid excessive synchronizing voltage. If the SYNC control is advanced too far, the sweep will become nonlinear with the result that the waveform will be distorted. Be sure that the fine frequency control on the oscilloscope is properly set so as to obtain a nearly stationary image. Then advance the SYNC control only far enough to make the trace stationary.

(5) ***Sixty-cycle pick-up.*** If some fault is present, it may be impossible to obtain a stationary pattern, even though the oscilloscope frequency control is properly adjusted. This effect is usually due to the presence of 60-cycle modulation or 60-cycle pick-up combined with the observed waveform. To check, turn the oscilloscope sweep frequency to 30 cycles. If the effect is due to line pick-up, a stationary pattern will be observed. The inside of this pattern will, of course, be more or less *filled,* because of the much higher frequency of the waveform being observed.

(6) ***Reactions of oscilloscope on waveform.*** Remember that the oscilloscope, because it shunts capacitance and resistance across the circuit, modifies the actual operating waveforms present in the circuit. This does not affect the usefulness of waveform measurements. The reference waveforms shown in this manual were taken with a

typical oscilloscope under the conditions which prevail when the repairman takes the waveforms.

(7) *Test leads. (a)* Keep the ungrounded oscilloscope test lead away from other circuits to avoid introducing feedback. The test leads should be brought from the test points in a way which introduces the minimum amount of coupling to other stages.

(b) The leads to the oscilloscope must be kept short when measuring grid voltages from circuits where the grid capacitors are small. The smallest reaction on the waveform is introduced when measuring the voltage across the output (cathode) of a cathode follower or of any low-impedance circuit.

(c) In measuring waveforms in high-impedance circuits, do not handle the ***hot*** test lead. If this precaution is not observed, the waveform will be distorted as a result of loading the circuit and picking up 60-cycle voltage.

(d) If a signal voltage is picked up on the test leads, the oscilloscope indication may be misleading. For example, a signal may appear on the oscilloscope even when a plate-to-grid coupling capacitor is open. This effect occurs most often in circuits carrying narrow-pulse waveforms. It can be recognized by the fact that the waveform is reduced in amplitude below the normal and is distorted because the high-frequency components are overemphasized.

(8) *R-f and i-f circuits.* Do not attempt to measure voltages or waveforms in any of the r-f or i-f circuits. These frequencies are beyond the range of ordinary test oscilloscopes, and no indications useful in trouble shooting can be obtained.

(9) *Reversing line plug.* In some instances a more stable pattern may be obtained by reversing the a-c line plug of the oscilloscope circuit. This may reduce the amount of 60-cycle pick-up, if they happen to be troublesome.

(10) *Relative amplitude.* In following the path of the signal through a component, the amplitude of the waveform usually increases as the checking point is advanced from the input stage toward the output stage. However, this is not always true. For example, when going from the grid to the cathode of the cathode-follower stage, there is a loss in signal amplitude of about 10 percent. This is a normal condition. Another example is in connection with waveshaping circuits, where a decrease in the width of a signal is sometimes accompanied by a decrease in amplitude (as in differentiating circuits).

(11) *Calibration.* If it is necessary to measure the actual voltage of the waveform, the oscilloscope must be calibrated. Calibrate the oscilloscope by finding how many volts correspond to a 1-inch deflection on the screen. This is the sensitivity of the scope.

(12) *High-voltage measurements.* When voltages above a few hundred volts are measured, connect the test lead with the power turned off.

Caution: Some test jacks do not have blocking capacitors. The capacitors are left out so that d-c voltages can be measured at the test jacks.

c. Comparison of Waveforms. If there is no fault in the circuit or equipment, an actual waveform taken at a point in the equipment should closely resemble the reference waveform. In some cases, however, differences in shape may occur for the following reasons:

(1) The test leads to the oscilloscope may not be placed in the same manner.

(2) A different oscilloscope may be used, having values of input resistance and capacitance which differ from those of the oscilloscope used in taking the reference waveforms.

(3) The various controls in the equipment may not be in the same positions as when the reference waveforms were taken. Note the conditions specified in the reference waveform.

(4) The same number of cycles may not be present.

(5) The vertical or horizontal amplitudes of the reference and the test patterns may not be proportional. This will produce apparent differences in the shapes of the two waveforms, when there is actually no real difference.

(6) Whether or not a waveform is regarded as abnormal will depend upon the symptom accompanying the fault which is being traced. The discrepancy should be considered significant if the fault could be caused by a minor difference in waveform at the point under test. Otherwise time should not be spent in hunting down the cause of relatively minor differences between the shapes of the reference waveforms and the test waveforms.

66. Use of Signal Generator

Signal generators are used to locate defective stages in radar receivers. The signal generator output is fed to the first i-f stage, and the progress of the signal is then traced through the receiver. The procedure is as follows:

a. The signal generator frequency should be set to the i-f frequency of the radar receiver. The output of the signal generator should be amplitude-modulated at an audio-frequency rate of between 400 and 10,000 cycles per second. For information concerning the setting up of the signal generator, refer to the manufacturer's handbook accompanying the signal generator.

b. Make the leads from the signal generator to the receiver as short as possible. Insert a coupling capacitor in the hot lead. For frequencies above 20 megacycles the capacitance of the coupling capacitor should be around 0.005 microfarad.

c. The i-f signal should be coupled by means of the coupling capacitor to the grid of the first i-f stage. If no output is shown on the radar oscilloscopes, connect a test oscilloscope to the plate of the detector. If no output is seen on the test oscilloscope, the fault lies in or between the first i-f amplifier and the detector (see (1) below). If a sinusoidal waveform is seen which has the same frequency as the chosen modulating frequency, the i-f stages and the detector are operating. In that case, the test oscilloscope should be connected to the plate of the output stage of the receiver. If no output is seen there, the fault lies in or between the first video amplifier and the output stage (see (1) below).

(1) If the fault is found to be in the i-f stages or in the detector, connect the signal generator to the grid of the middle stage of the i-f amplifier. If there is a normal output from the detector, the fault is in one of the first i-f stages. If the detector has no output, the fault is in or between the middle stage and the detector. By moving the signal generator output either forward or backward, stage by stage, the faulty stage can be rapidly located. In order to locate the defective part in the stage, change the tube. If replacing the tube does not clear up the fault, make resistance and voltage checks of the stage.

(2) If the fault is found to be in the video amplifiers, leave the signal generator connected to the first i-f stage and move the test oscilloscope from the grid to the plate of each video stage until the defective stage is located. If changing the tube does not correct the fault, make resistance and voltage checks to locate the defective part.

67. Replacement of Parts

Careless replacement of parts often makes new faults inevitable. Note the following points:

a. Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections to it, tag each of the leads.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Do not allow drops of solder to fall into the set, since they may cause short circuits.

d. A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.

e. When a part is replaced in r-f or i-f circuits, it must be placed exactly as the original one was. A part which has the same electrical value but different physical size may cause trouble in high-frequency circuits. Give particular attention to proper grounding when replacing a part. Use the same ground point as in the original wiring. Failure to observe these precautions may result in decreased gain, or possibly in oscillation of the circuit.

Section II. USE OF SPECIALIZED TEST EQUIPMENT

68. Synchroscope I–212.

a. GENERAL. The description and the theory of the Synchroscope I–212 (fig. 148) are given in chapter 1, section IX. This section discusses the use of the synchroscope and trouble-shooting procedures.

b. SYNCHROSCOPE ACCESSORY EQUIPMENT. (1) *Test cables.* Two coaxial test cables (fig. 148) are provided. They terminate at each end in Signal Corps type PL–259 coaxial plug connectors. These plugs fit Signal Corps type SO–239 coaxial receptacles used on the synchroscope and test points jacks on Radio Set SCR–682–A components. Adaptors may be used if it is desired to use the synchroscope in testing a circuit which does not have a receptacle matching the test plugs.

(2) *Power cable.* A two-conductor rubber covered power cable (fig. 148) is furnished with the synchroscope. One end is terminated with a standard appliance plug; the other end has a twist-lock connector matching the receptacle at the rear of the synchroscope cabinet.

(3) *Viewing hood.* The hood is a fiber cone equipped with a spring catch. It may be attached to the front of the oscilloscope over the viewing

window and held in place by the catch. It is used to shade the viewing screen when light conditions prevent the image on the screen from standing out clearly.

(4) *Calibration chart*. A calibration chart is attached to the right end of the synchroscope cabinet.

(5) *Schematic circuit diagram*. A schematic diagram of the synchroscope is cemented on the inside of the cabinet. Standard resistor and capacitor color code charts are also shown inside this cabinet.

c. **Preparing Synchroscope for Use** (fig. 155). (1) Be sure knob marked INT (intensity and power switch) is turned to its extreme counterclockwise position.

(2) Insert the synchroscope power cable twistlock connector into the receptacle at the rear of the instrument and lock it by turning it to the right. Connect the other end to a source of primary power (115 v ±5 percent, 60-cycles, single-phase).

(3) Turn the INT knob clockwise about 30° to turn ON the power. The red pilot lamp will light. Wait 30 seconds for the filaments to heat before advancing the knob beyond 30°.

(4) Turn the TRIG SELECTOR (trigger selector) switch to the EXT (external trigger) position.

(5) Turn the TRIGGER POLARITY switch to the NEG (negative trigger) position.

(6) Leave the trigger input and signal input cables disconnected from the TRIGGER and SIGNAL jacks.

(7) Turn the SIG INPUT (signal input) switch to OFF position and the SWEEP SPEED selector switch to position 1, thus adjusting for a 5-microsecond sweep. A spot will appear on the screen of the cathode-ray tube.

(8) Adjust INT control for a suitable intensity; focus clearly by adjusting the FOCUS control.

(9) Deflect the spot from the extreme left to extreme right of the screen by use of the HOR (horizontal) control, and from bottom to top by

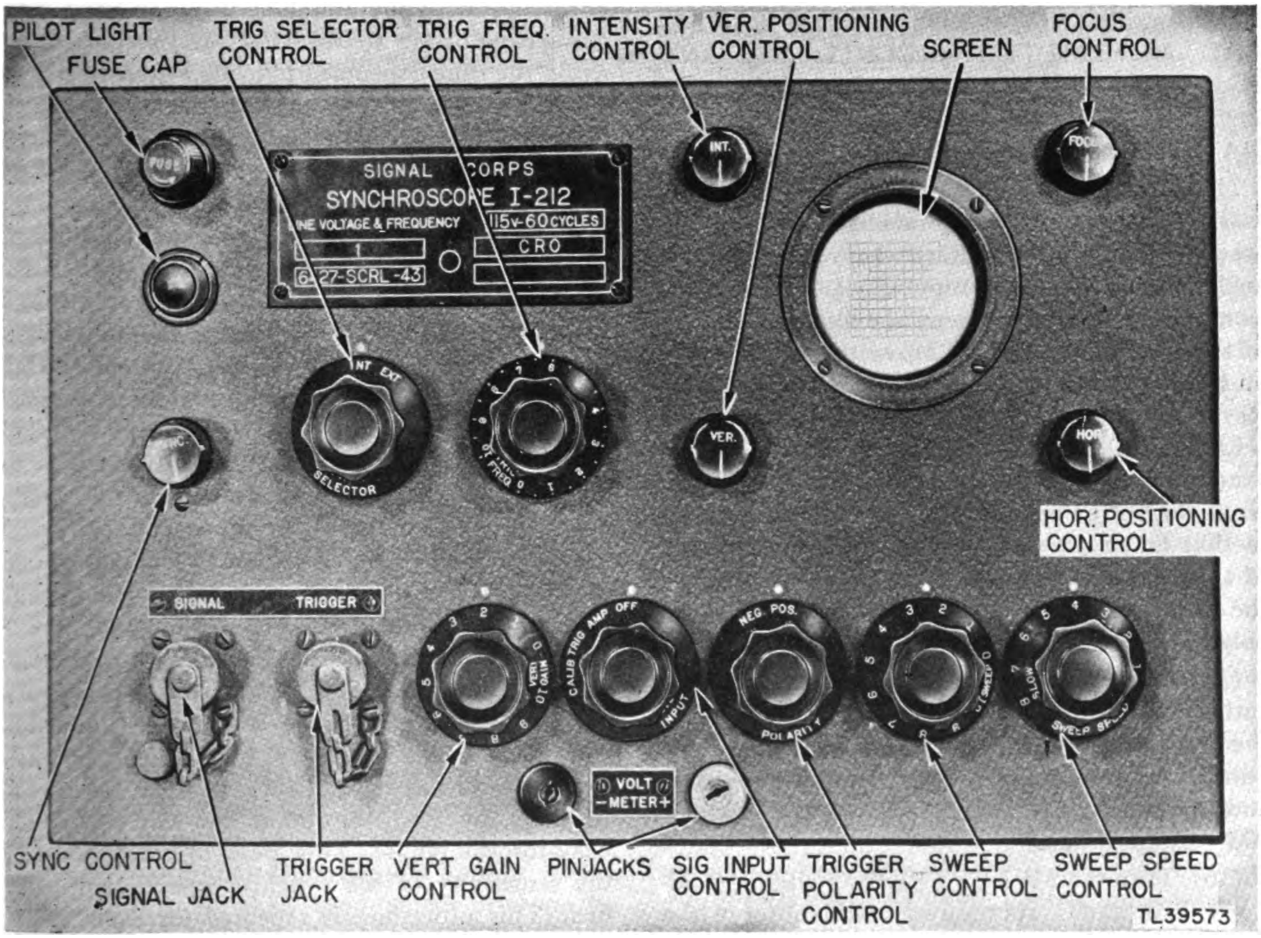


Figure 155. Synchroscope I–212, front panel.

use of the VER (vertical) control. Spot travel should be well across the screen. If the spot travels in an angular direction with respect to the horizontal plane of the cabinet, the 2AP1 cathode-ray tube should be oriented until the deflection course is level.

(10) Turn the TRIG SELECTOR switch to INT (internal trigger) position. A sweep line approximately 1 inch in length will appear.

(11) Turn the SIG INPUT control from OFF to CALIB (calibrate) position. Five waves should appear, denoting 5-microsecond sweep time. The amplitude of the calibrating signal may be adjusted by means of the VERT GAIN (vertical gain) control.

(12) Turn the SIG INPUT switch to TRIG position, and the SWEEP SPEED switch to number 4 position for a 500-microsecond sweep. The internal trigger will now be viewed on the screen.

(13) Set the Simpson Analyzer at 250-v, d-c range; connect the analyzer to the synchroscope VOLTMETER jacks, using the test leads with needlepoint prods.

Caution: DO NOT GROUND THE EXTERNAL VOLTMETER CIRCUIT AT ANY POINT. DO NOT COME IN CONTACT WITH THIS CIRCUIT. IT IS APPROXIMATELY 250 VOLTS ABOVE GROUND.

(14) By means of the VER control, move the axis of the image until it coincides with the highest line on the screen. Read the voltage on the analyzer and note the number of vertical divisions on the screen between the axis and the tip of the peak of the image. Move the image down on the screen until the voltmeter reading is zero. Reverse the voltmeter leads and continue to move VER control until the image axis has moved the exact number of vertical divisions noted above. Note the voltmeter reading and add this reading to that taken previously. The voltage amplitude of the peak of the waveform equals the sum of the two voltages and will be approximately 120 volts.

(15) The vertical sensitivity of the 2AP1 cathode-ray tube may be determined by dividing the voltage found in subparagraph (14) by the number of vertical divisions between the axis and the peak of the image. This should be about 200 volts per inch.

(16) Turn the SWEEP SPEED switch to positions 3, 2, and 1 successively, and observe the trigger waveform. The horizontal width of the image will become longer at each successive position.

(17) Turn the TRIG SELECTOR switch to EXT position and turn SWEEP SPEED switch to positions 5, 6, 7, and 8 successively. A horizontal sweep line about 1 inch long should appear with each of these positions.

d. SENSITIVITY CALIBRATION OF SYNCHROSCOPE I–212. The actual voltage of test waveforms must be known to compare them with reference waveforms. This is accomplished by calibrating the VERTICAL GAIN control of the synchroscope. Calibration determines the voltage input necessary to give a standard deflection. When the deflection is 1 inch, the input voltage is the sensitivity of the scope in volts per inch.

(1) *Without amplifier.* When the amplifier is not used the sensitivity figures given for the cathode-ray tube are sufficiently accurate for general use. The type 2AP1 tube used in Synchroscope I–212 has a vertical sensitivity of approximately 200 volts per inch.

(2) *With amplifier.* The sensitivity of the synchroscope with the amplifier ON will vary with the setting of the VERTICAL GAIN control. To avoid the time consumed figuring sensitivity each time the scope is used, a table or coordinate plot is made showing the scope sensitivity corresponding to each of the numbered settings of the VERTICAL GAIN control.

(3) *Calibration procedure. (a)* A suitable voltage for calibrating the scope can be obtained from the 120-volt a-c line. A potentiometer voltage divider of at least 120,000 ohms is shunted across the line. The voltage between the potentiometer contact arm and one side of the line is then continuously variable from zero to the line voltage. This variable voltage is fed to the SIGNAL jack. The Simpson Analyzer, set to measure a-c voltage, is used to measure the input voltage.

(b) Set the VERTICAL GAIN control to one of the marked divisions and adjust the potentiometer until the waveform on the scope is exactly 1 inch peak-to-peak. The a-c voltage input necessary to give the 1-inch deflection is read on the voltmeter. Since the a-c voltmeter indicates rms values, it is necessary to convert the readings to peak-to-peak values. Multiply the meter readings by 2.83 to obtain the corresponding peak-to-peak value. This peak-to-peak value is the sensitivity of the synchroscope in volts per inch. This procedure is repeated for each VERTICAL GAIN control setting. A table or co-

ordinate plot is then made using values of sensitivity corresponding to each VERTICAL GAIN control settings.

e. HOW TO OPERATE SYNCHROSCOPE. (1) *General.* When used as a synchroscope in making adjustments and tests on components of Radio Set SCR-682-A, this instrument requires that TRIG SELECTOR switch remain at EXT position and the TRIG POLARITY switch at the NEG position. ***This is important.***

(2) *Viewing waveform at pulse transformer 1-T-2 on Radio Frequency Unit BC-1224-A.* *(a)* Connect the synchroscope power cable from the synchroscope to the a-c outlet on Pedestal FT-458-A.

(b) Connect the test cable between the TRIGGER input connector on the synchroscope and the PULSE TEST connector on top of the radio-frequency unit.

(c) Switch and control settings should be as follows:

1. TRIG SELECTOR at EXT position.

2. TRIGGER POLARITY at NEG position.

3. SWEEP SPEED at position 1.

(d) Turn on the synchroscope and observe the waveform of the pulse transformer.

(3) *Use of synchroscope for adjustment of T-R Box and as A-scope at Antenna AN-134-A.* See paragraph 92*b*.

(4) *Use of synchroscope as A-scope with Indicator Unit BC-1225-A.* *(a)* Connect the power input plug of the synchroscope power cable to the a-c outlet on the modulator unit.

(b) Connect synchroscope TRIGGER jack to TRIGGER on the indicator control under the hinged door below the control knobs.

(c) Connect SIGNAL jack on the synchroscope to the VIDEO jack on the indicator control.

(d) Switch and control settings should be as follows:

1. SIG INPUT switch at AMP (amplifier) position.

2. TRIG SELECTOR switch at EXT position.

3. SWEEP SPEED switch at position 1, 2, 3, or 4.

4. TRIGGER POLARITY at NEG position.

(e) Turn on the synchroscope, focus and adjust the pattern for position on the screen. The familiar A-scope pattern will now appear.

(f) Calibration when used as an A-scope is shown below:

Sweep Speed Selector position	Maximum Sweep Length (yards)
1	800
2	4,000
3	16,000
4	80,000

(g) Vertical amplitude of the signal may be adjusted by means of theVERT GAIN control. This amplitude will also be affected by the RECEIVER gain control and the VIDEO amplitude control on the indicator unit. Both VERT GAIN and VIDEO AMPLITUDE controls will affect the amplitude of the pattern, while the RECEIVER gain control will affect the noise and weak signals without disturbing the amplitude of saturated signals. Noise will appear on the synchroscope screen as grass, while targets will appear as pips.

(h) To observe the pulse waveform from the modulator unit to the indicator unit, leave the synchroscope set up as in *(d)* above, but shift the SIG INPUT switch to TRIG position.

(i) To observe S.T.C., SWEEP, or MARKER waveforms on the indicator unit, transfer the cable from the SIGNAL jack on the synchroscope to the proper connector on the indicator unit. When viewing any of these waveforms, the SIG INPUT switch should be at AMP position. The amplitude may then be adjusted by means of the VERT GAIN control.

(5) *Use of synchroscope to trigger indicator.* The indicator unit may be triggered by the synchroscope when the transmitter is not operating. Set the switches and make connections as follows:

(a) Connect the TRIGGER connector of the synchroscope to the TRIGGER jack on the indicator unit.

(b) Turn the TRIGGER SELECTOR switch to INT position.

(c) Turn TRIGGER POLARITY switch to NEG TRIGGER position.

(d) Turn on the synchroscope in the usual manner.

(e) Adjust TRIG FREQ control for the proper repetition rate by referring to the calibration chart.

(6) *Use of synchroscope as conventional oscilloscope.* The slow sweep is used primarily in checking waveforms in circuits where the repetition frequency is between 50 and 2,000 cycles per second.

(a) TRIG SELECTOR switch should be in EXT position.

(b) If the signal is between 3 and 15 volts rms, amplification is necessary; SIG INPUT switch should be placed in AMP position. If the signal is between 40 and 100 volts rms, the amplifier cannot be used; SIG INPUT should be turned to OFF position.

(c) Turn on the power by means of the INT control.

(d) Locate the image as required with the HOR and VER controls.

(e) When the amplifier is in use, advance the VERT GAIN control until the signal has a useful amplitude for viewing on the screen.

(f) Select the required frequency by first switching to position 5, 6, 7, or 8 on the SWEEP SPEED switch.

(g) Adjust the SLOW SWEEP control for a finer frequency setting.

(h) Adjust the SYNC control to fix the pattern in a stable position on the screen.

f. CALIBRATION OF SYNCHROSCOPE. Calibration of the synchroscope can be checked quite accurately by viewing the MARKER waveform as developed by the indicator unit.

(1) Connect the SIGNAL jack of the synchroscope to the MARKER jack on the indicator unit.

(2) Set the SWEEP SPEED control to the position corresponding to 4,000 yards.

(3) Set the RANGE switch on the indicator unit at the 10,000-yard position.

(4) Depress the FINE markers button on the indicator unit.

(5) Coarse marker pips should appear at the left edge, middle, and right edge of the calibrated screen of the synchroscope, corresponding to zero, 2,000, and 4,000 yards. Three fine marker pips, corresponding to 500-yard increments, should appear between each two coarse marker pips.

69. Reference Data

The following figures are included in this manual to assist maintenance personnel in trouble shooting in the synchroscope.

a. Figure 135, Synchroscope I–212, block diagram.

b. Figure 136, Trigger generator and delayed trigger amplifier, simplified schematic diagram.

c. Figure 137, Trigger switching and gate control, simplified schematic diagram.

d. Figure 138, Gate generator and fast sweep generator, simplified schematic diagram.

e. Figure 139, Slow sweep generator and slow sweep amplifier, simplified schematic diagram.

f. Figure 140, Video amplifier and calibration oscillator, simplified schematic diagram.

g. Figure 141, Power supply and cathode-ray tube circuits, simplified schematic diagram.

h. Figure 142, Synchroscope I–212, simplified schematic diagram.

i. Figure 143, Synchroscope I–212, complete schematic diagram.

j. Figure 159, Synchroscope I–212, electrical connection diagram.

k. Figure 156, Synchroscope I–212, side view, cover removed.

l. Figure 157, Synchroscope I–212, rear view, cover removed.

m. Figure 158, Synchroscope I–212, bottom view, cover removed.

70. Behavior Analysis

When trouble develops, make a thorough inspection of the unit before resorting to voltage and resistance measurements. If no spot appears on the scope screen, make sure that the INT knob is turned clockwise. Visually examine the tubes to see if all the filaments are glowing. Faults can usually be traced to a particular stage of the synchroscope by changing the controls and noting the effect. For example, if a sweep is obtained on the fast sweep speed positions 1 through 4, but not on the slow sweep speed positions 5 through 8, the fault is probably in stages 10–V–5 and 10–V–3(B). Within a particular stage, voltage measurements (table II) and resistance measurements (table III) can be used to locate the fault.

71. Trouble-Shooting Chart

In the following charts the synchroscope is externally triggered by Radio Set SCR–682–A.

A. SYMPTOM:

Waveform appears on scope screen when SIG INPUT switch is set to OFF, but does not appear when switch is set to AMP.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Video signal amplifier stage 10–V–6.	1*a*. Vary the VERT GAIN control; if no effect is observed, replace tube 10–V–6. *b*. Make a voltage and resistance check of the stage if the fault is still present. *c*. Check for mechanical trouble in the SIG INPUT switch.

B. SYMPTOM:

Damped sine wave does not appear on scope screen when SIG INPUT switch is set at CALIB.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Video signal amplifier stage 10–V–6.	1*a*. Apply a test signal to SIGNAL jack; set SIG INPUT switch to AMP. *b*. If pattern appears on scope, stage 10–V–6 is normal. *c*. If no pattern appears, either stage 10–V–6 or stage 10–V–1(B) is faulty.
2. Calibration oscillator stage 10–V–1(B).	2*a*. Replace tube 10–V–1(B). *b*. Check coil 10–L–5 for continuity. *c*. If previous steps have not revealed fault, take voltage and resistance readings.

C. SYMPTOM:

No sweep baseline appears on sweep speeds 1 through 4; only a stationary bright spot appears.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. TRIGGER POLARITY switch.	1. Set switch to corresponding polarity of input trigger.
2. Fast sweep generator stage 10–V–3(A).	2*a*. If spot is at far right of screen with HOR knob at correct setting, replace tube 10–V–3. *b*. If spot is at left side of screen, turn SWEEP SPEED switch to position 5. If baseline appears, tube 10–V–3 is good.
3. Gate generator 10–V–2.	3. Replace tube.
4. Gate control 10–V–1(A).	4. Replace tube. If none of these steps has corrected the fault, take voltage and resistance readings in the above stages.

D. SYMPTOM:

No sweep baseline appears on sweep speeds 5 through 8; only a stationary bright spot appears.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Slow sweep amplifier 10–V–3(B).	1. Turn SWEEP SPEED switch through positions 1 to 4. If baseline is present, tube 10–V–3 is probably good.
2. Slow sweep generator 10–V–5.	2. With SWEEP SPEED switch on positions 5 through 8, a soft blue glow should appear inside tube 10–V–5; if not, replace the tube. If steps 1 and 2 are unsuccessful, make voltage and resistance tests in above stages.

Table II. D-C voltages to ground for synchroscope I-212

All controls are set as listed below unless otherwise indicated.

TRIG SELECTOR	INT
TRIGGER POLARITY	NEG
TRIG FREQ	4
SIG INPUT	OFF
VERT GAIN	0
SYNC	Max counterclockwise
SLOW SWEEP	0
VER position	Max counterclockwise
HOR position	Max counterclockwise
INT	Max counterclockwise with switch on.
SWEEP SPEED	1
Line voltage	115 volts

TUBE NO. 10-V-1

Pin No.	Sweep Speed											
	Internal								External			
	1	2	3	4	5	6	7	8	1	2	3	4
1	—0.1	—.01	—.01	—0.1	0	0	0	0	0	0	0	0
2	170	175	180	185	190	190	190	190	175	180	180	190
3	13	14	15	16	17	17	17	17	13	14	14	15
4	0	0	0	0	0	0	0	0	0	0	0	0
5	225	225	225	225	225	225	225	225	225	225	225	225
6	10	10	10	10	10	10	10	10	10	10	10	10

TUBE NO. 10-V-2

1	0	0	0	0	0	0	0	0	0	0	0	0
2	170	175	180	185	190	190	190	190	170	175	180	190
3	11	10	9	8	7	7	7	7	11	10	9	11
4	14	10	6	—4	1	1	1	1	14	11	10	11
5	115	130	150	180	200	200	200	200	115	130	135	142
6	11	10	9	8	7	7	7	7	11	10	9	11

TUBE NO. 10-V-3

1	—0.8	—2	—5	—20	—0.5	—0.5	—0.5	—0.5	—0.3	—0.3	—0.3	—0.3
2	60	65	100	150	60	60	60	60	60	60	60	60
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	—1	—0.5	—0.4	—0.1	0	0	0	0
5	125	125	125	125	150	150	150	145	125	125	125	125
6	5	5	5	5	4.3	4.3	4.3	4.6	5	5	5	5

TUBE NO. 10-V-4

1	—80	—80	—80	—80	—80	—80	—80	—80	0	0	0	0
2	325	325	325	325	325	325	325	325	325	325	325	325
3	0	0	0	0	0	0	0	0	16	16	16	16
4	—0.1	—0.1	—0.1	—0.1	—0.1	—0.1	—0.1	—0.1	0	0	0	0
5	300	300	300	300	300	300	300	300	300	300	300	300
6	15	15	15	15	15	15	15	15	15	15	15	15

TUBE NO. 10-V-5

3	0	0	0	0	40	40	40	40	0	0	0	0
5	0	0	0	0	0.2	0.2	0.2	0.2	0	0	0	0
8	5.5	5.5	5.5	5.5	6	6	6	6	5.5	5.5	5.5	5.5

Table III. Resistances to ground for synchroscope I–212

Note. K = 1,000 ohms.

TUBE NO. 10–V–1

Pin No.	Sweep Speed											
	Internal								External			
	1	2	3	4	5	6	7	8	1	2	3	4
1	30K	30K	30K	30K	30K	30K	30K	30K	30K	30K	30K	30K
2	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K
3	12K	12K	12K	12K	12K	12K	12K	12K	12K	12K	12K	12K
4	100K	100K	100K	100K	100K	100K	100K	100K	100K	100K	100K	100K
5	55K	55K	55K	55K	55K	55K	55K	55K	55K	55K	55K	55K
6	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500

TUBE NO. 10–V–2

1	0	0	0	0	0	0	0	0	0	0	0	0
2	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K	20K
3	500	500	500	650	650	650	650	650	500	500	500	650
4	170K	400K	1.3M	10M	0	0	0	0	170K	400K	1.3M	10M
5	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K
6	500	500	500	650	650	650	650	650	500	500	500	650

TUBE NO. 10–V–3

1	700K	700K	700K	700K	700K	700K	700K	700K	700K	700K	700K	700K
2	70K	70K	70K	70K	70K	70K	70K	70K	70K	70K	70K	70K
3	0	0	0	0	0	0	0	0	0	0	0	0
4	600K	600K	600K	600K	600K	600K	600K	600K	600K	600K	600K	600K
5	130K	130K	130K	130K	130K	130K	130K	130K	130K	130K	130K	130K
6	3K	3K	3K	3K	3K	3K	3K	3K	3K	3K	3K	3K

TUBE NO. 10–V–4

1	650K	650K	650K	650K	650K	650K	650K	650K	650K	650K	650K	650K
2	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K
3	0	0	0	0	0	0	0	0	75K	75K	75K	75K
4	8K	8K	8K	8K	8K	8K	8K	8K	8K	8K	8K	8K
5	25K	25K	25K	25K	25K	25K	25K	25K	25K	25K	25K	25K
6	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600

TUBE NO. 10–V–5

3	250	250	250	250	3M	3M	3M	3M	250	250	250	250
5	80K	80K	80K	80K	80K	80K	80K	80K	80K	80K	80K	80K
8	2K	2K	2K	2K	2K	2K	2K	2K	2K	2K	2K	2K

TUBE NO. 10–V–6

Pin No.	Voltage		Resistance	
	Gain maximum	Gain minimum	Gain maximum	Gain minimum
1	3.6	48	100	2100
3	0	0	0	0
4	0.2	34	250K	252K
5	3.6	48	100	2100
6	152	180	40K	40K
8	265	280	20K	20K

72. Echo Box Test Outfit

a. Description. The echo box test outfit (fig. 148) consists of an echo box, a test antenna, and associated cables, fittings, and tools.

(1) *Echo box.* The echo box has been described previously in paragraph 54. It may be permanently mounted on the floor of Shelter HO–22 by means of its mounting flanges.

(2) *Test antenna.* The test antenna is a dipole (fig. 148) equipped with a reflector suitable for reception of signals in the 10-centimeter band. The test antenna is mounted on a bakelite base and may be mounted permanently on the wall of Shelter HO–22. It is recommended that it be located in a line with the axis of the antenna feed line when the antenna is tilted to an angle of 25°. The test antenna dipole should be located as nearly as possible in a position parallel to the antenna of Radio Set SCR–682–A when the radar set antenna is pointed directly at the test antenna.

(3) *Associated equipment.* *(a)* The echo box to test antenna cable is a 10-foot coaxial cable provided with type-N connectors on both ends for connection between the echo box and the test antenna.

(b) The echo box detector assembly is a coaxial fitting provided with a coupling loop on one end that may be inserted in place of one of the loops already in the cavity. A type SO–239 connector is attached to the other end for connection to the meter bypass unit (fig. 149). A type IN–21 crystal detector is mounted concentrically inside the fitting and an r-f bypass capacitor is built into it.

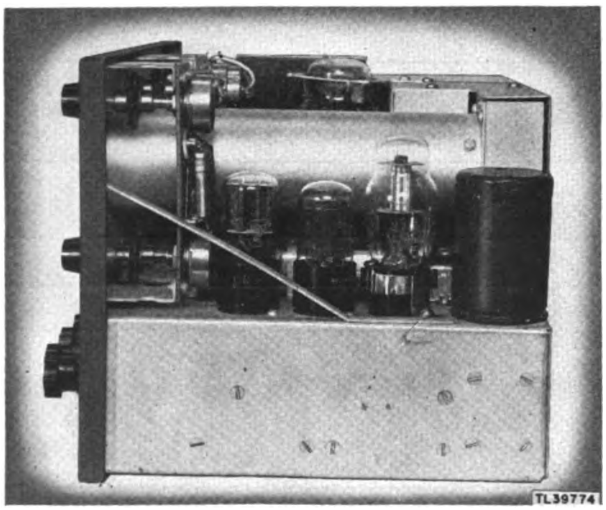


Figure 156. Synchroscope I–212, side view, cover removed.

(c) The detector to bypass unit cable is a 2-foot coaxial cable with type PL–259 connectors on each end.

(d) The meter bypass unit consists of a case containing a 2-mf capacitor and an SO–239 connector on one end, and on the other end a length of twin conductor cable terminated with phone tip plugs.

(e) The meter shunt (fig. 149) is a 500-ohm fixed resistor mounted in a housing, and equipped with phone tip plugs and jacks.

(f) The spanner wrench is used to fasten the fittings to the echo box.

b. Checking Radar Set Transmission Performance. (1) *Preparation for use.* *(a)* Locate the echo box and the test antenna in the positions recommended in *a*(1) and (2) above.

(b) Tilt the transmitting antenna to a 25° angle.

(c) Connect the echo box to test antenna cable.

(d) Remove the remaining type N receptacle and pick-up loop from the echo box. Use the echo box spanner wrench.

(e) Unscrew the body supporting the SO–239 connector from the threaded barrel of the echo box detector assembly.

(f) Mount the pick-up loop section of the detector assembly on the echo box, by means of the threaded collar.

(g) Tighten, by hand only, to insure contact on the crystal.

(h) Connect the detector to bypass unit cable between the detector unit and the meter bypass unit.

(i) Set the Simpson Analyzer range switch to the 100-microampere scale.

(j) Connect the phone tip plugs on the cable leading from the meter bypass unit to the jacks in the Simpson Analyzer.

(k) Place Radio Set SCR–682–A in operation. Be sure ROTATE switch on the pedestal base is in OFF position.

(2) *Wavelength measurement.* Tune the echo box to obtain a maximum reading on the analyzer. There are a number of minor peaks on both sides of one major peak, but tune the echo box to the major peak. Convert the reading of the micrometer-type scale on the echo box to wavelength in centimeters by means of the calibration chart.

(3) *Power measurement.* The peak reading obtained on the analyzer in subparagraph (2) above is a measure of the power output of the radar set. The reading should be recorded to serve as a con-

tinual check on the system power output. However, if the type 1N–21 crystal in the echo box detector assembly is changed or deteriorates, a new reference reading must be taken.

(4) *Spectrum measurement.* An indication of the frequency spectrum of the transmitted energy can be obtained by tuning the echo box over a considerable range and plotting the analyzer meter readings versus the micrometer scale readings.

(a) A symmetrical pattern consisting of a major peak with a deep null separating a small peak of each side of the major peak indicates that the transmitter tube is satisfactory.

(b) A spectrum without deep minima adjacent to the main peak is indicative of frequency modulation of the transmitter tube. This can be caused by a voltage pulse whose sides are not steep or whose top is not flat.

(c) If two distinct maxima are observed in the spectrum, the transmitter tube is double-moding.

(5) *Ringing time measurement.* The ringing time is the time in yards on the PPI scope, or scale divisions on the synchroscope, from the beginning of the transmitted pulse to the point where the signal from the echo box fades into the noise level. The ringing time and power measurements are used to check performance as follows:

(a) Ringing time and power both low means that trouble exists in the transmitter or r-f systems or both, but probably not in the receiver system.

(b) Erratic ringing time and power readings indicate transmitter or r-f system trouble, such as a double-moding transmitter tube or loose r-f line joints.

c. CHECKING RADAR SET RECEPTION PERFORMANCE. Set up test equipment as directed in paragraph 72*b*(1).

(1) *T-R box tuning.* Maximum ringing time, preferably measured on the synchroscope, indicates that the T-R box is tuned properly.

(2) *Local oscillator coupling adjustment.* The local oscillator coupling adjustment on signal mixer 1–A–7 should be set to secure the highest signal-to-noise ratio. This adjustment can be made easily by varying the knob on signal mixer 1–A–7 to obtain maximum ringing time (preferably measured on the synchroscope).

(3) *Local oscillator frequency measurement.* *(a)* Remove cord 24 from the receiver.

(b) Remove the test antenna to echo box cable from the test antenna and connect it to the local oscillator SIGNAL socket.

(c) Place the radar set in operation, making certain that the ROTATE switch is in the OFF position.

(d) Tune the echo box until a peak reading is obtained on the analyzer. Determine the wavelength of the local oscillator by referring to the

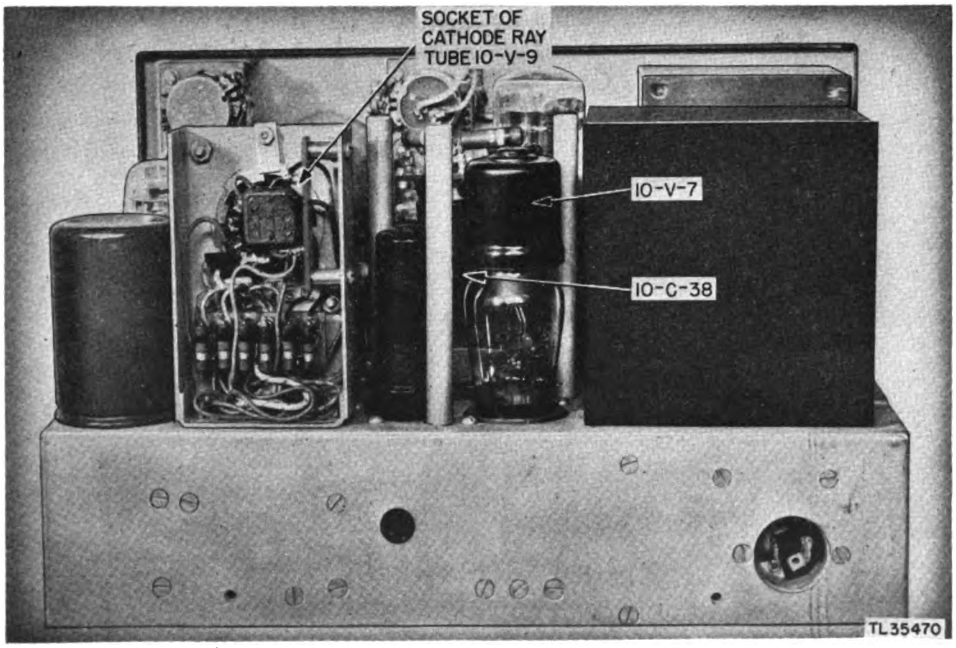


Figure 157. Synchroscope I–212, rear view, cover removed.

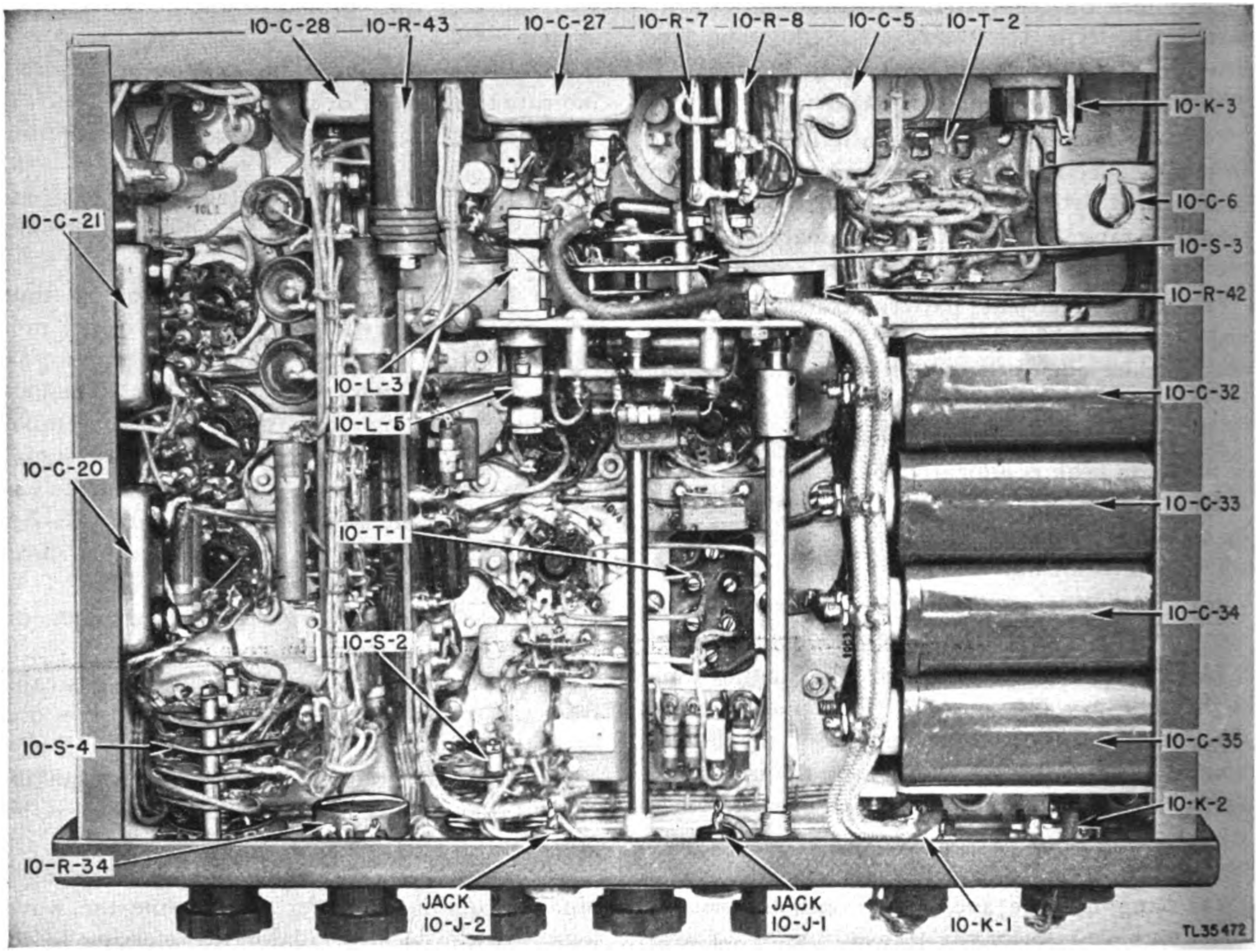


Figure 158. Synchroscope I–212, bottom view, cover removed.

calibration chart on the echo box. It should be approximately .115 centimeters longer than that of the transmitting tube.

(*e*) If a single peak cannot be obtained by tuning the echo box, it is likely that the A.F.C. system is not functioning, and the local oscillator is sweeping through a band of frequencies. The reading on the analyzer will probably be unsteady and of low amplitude in this case. If so, it will be necessary to tune the local oscillator.

Section III. TROUBLE SHOOTING BASED ON STARTING PROCEDURE

> **Warning:** *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this radar set. Do not place hands or arms within any system with high voltage ON. Do not make any connections which will bring high voltage out to an exposed point. Make all tests with high voltage OFF. Always ground high-voltage capacitors before touching them or their associated parts.*

73. Reference Data

The following figures are provided to assist maintenance personnel in trouble shooting by the use of the starting procedure:

a. Figure 14, Shelter HO–23, power switch and fuse box.

b. Figure 13, Shelter HO–23, schematic and pictorial diagrams of a-c power circuit.

c. Figure 15, Green pilot light circuit, simplified schematic diagram.

d. Figure 11, Control system, complete schematic diagram.

e. Figure 16, Unregulated supply circuit, simplified schematic diagram.

f. Figure 17, Regulated supply circuit, simplified schematic diagram.

g. Figure 116, Indicator control, complete schematic diagram.

h. Figure 27, Time delay relay, disassembled to show moving parts.

i. Figure 160, Plate relay.

j. Figure 18, Red pilot light circuit, simplified schematic diagram.

k. Figure 162, Starter reversing relay.

l. Figure 163, Auxiliary relay 1–E–2.

m. Figure 19, Spinner drive motor control circuit, position of relays, SCAN switch off.

n. Figure 164, Auxiliary relay 1–E–3.

o. Figure 166, Control Panel BD–130–A, electrical connection diagram.

p. Figure 167, Control Panel BD–130–A, relay shelf, electrical connection diagram.

q. Figure 161, Capacitor shorting relay.

74. Introduction

Radio Set SCR–682–A has been carefully designed to give trouble-free operation; but, as in all electronic apparatus, faults will occur. The analysis of symptoms and the trouble-shooting information which follow have been prepared to aid the repairman in isolating such troubles as may occur, so that the set may be placed back in operation as quickly as possible.

75. Procedures

The most logical procedure for discovering and isolating trouble is to start the set in logical steps and to observe all indications carefully until an improper indication appears. On starting the set, the procedure given in chapter 3 of TM 11–1361 should be followed. The information in this section is presented in a sequence which follows the steps of the starting procedure. Proper indications are given, as well as most of the improper indications which indicate trouble occurring at any particular step of the starting procedure. The explanations of the improper indications are such that, in most cases, the improper indication will enable the operator to know quickly in which component the trouble has occurred. This should enable the faulty component to be repaired or replaced and operation to be continued with minimum delay. If a replacement component is not available, reference should be made to the following sections of this manual, where more detailed tests and procedures and all reference data are collected by systems. The following tabulation of normal and abnormal conditions is based on the 16 steps of the starting procedure (after performing the steps of the preliminary starting procedure), beginning with paragraph 69 of TM 11–1361.

A. STEP 1. Start power unit.
NORMAL INDICATIONS: For normal and abnormal indications and corrective measures, see TM 11-937.

B. STEP 2. Adjust voltage for 120 volts, frequency for 60 cycles, and then throw circuit breaker on control panel of Power Unit PE-183-A to the ON position.
NORMAL INDICATIONS: For normal and abnormal indications and corrective measures, see TM 11-937.

C. STEP 3. Throw power switch on wall of Shelter HO-23 to the ON position.
NORMAL INDICATIONS: 1. Wall lamps light when cord is pulled.
2. Green LINE VOLTAGE ON pilot light on modulator unit glows.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. No normal indications present.	1*a*. Burned-out fuse in power fuse box or power switch box (fig. 14). *b*. No output from power unit. *c*. Defective Cord CD-941 between power unit and Shelter HO-23. *d*. Defective Cord CD-941 connector or receptacle. *e*. Defective power switch. *f*. Broken or shorted connection (fig. 15).
2. Green pilot light does not light, other indications normal.	2*a*. Defective lamp 3-A-2. *b*. Defective power cord or power-cord connector 4-K-3 or receptacle 4-K-4. *c*. Burned-out resistors 3-R-1, 3-R-2. *d*. Broken connection in green pilot light circuit (figs. 11 and 15).

D. STEP 4. Throw both LINE SWITCH controls on modulator control panel to the ON position.

NORMAL INDICATIONS:

1. Blower motor in modulator unit starts operating and is audible.
2. Spark-gap drive motor starts operating. The sound of the motor is not audible.
3. Line voltmeter on indicator panel reads approximately 116 volts.
4. Pilot lights on indicator control and azimuth dial illuminate control knobs and dial.
5. Blower motor in indicator unit starts operating and is audible.
6. Pilot light for RANGE switch on indicator unit glows.
7. White SPINNER READY pilot lamp on modulator control panel lights.
8. Transmitter tube blower and receiver blower on spinner operate and are audible.
9. After approximately 45 seconds have elapsed, time delay relay operates. The click is not audible.
10. Amber MODULATOR READY pilot lamp on modulator control panel lights when time delay relay operates.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. No normal indications present.	1*a*. Defective circuit breaker on modulator control panel (LINE SWITCH) 3–S–1, 3–S–2. *b*. Broken connection in wiring (figs. 11 and 16).
2. Blower drive motor in modulator unit does not operate, but other indications normal.	2*a*. Burned-out fuse 3–F–1. *b*. No a-c input to motor 3–A–3. *c*. Broken connections in blower drive motor circuit between terminal 4 on terminal strip 3–K–4 and terminal 6 on terminal strip 3–K–5 (figs. 11 and 16). *d*. Defective motor 3–A–3.
3. Spark-gap drive motor inoperative but other indications normal.	3. See symptom C, trouble shooting in the control system.

4. Line voltmeter, pilot light for RANGE switch, pilot lights for indicator control knobs and azimuth dial light, and indicator unit blower abnormal, but other indications normal.	4*a*. LINE VOLTAGE CONTROL on modulator unit control panel in wrong position. *b*. Burned-out fuse 9–F–5, 9–F–6. *c*. Broken connection in wiring for these circuits (figs. 11 and 17). *d*. Defective powerstat 3–T–1.
5. Pilot light for RANGE switch does not glow, but other indications normal.	5*a*. Defective fuse 8–F–2. *b*. Defective lamp 7–A–4 or lamp socket. *c*. No a-c input to terminals 2 and 3 of Power Supply Unit RA–100–A. *d*. Defective receptacle 8–K–2 or connector 8–K–1. *e*. Broken connection in pilot light circuit. See figures 11 and 116.
6. Indicator unit blower inoperative, but other indications normal.	6*a*. No a-c input to motor 8–A–1. *b*. Defective receptacle 8–K–2 or connector 8–K–1. *c*. Broken connection in blower motor circuit (figs. 11 and 17). *d*. Defective motor 8–A–1.
7. Line voltmeter does not register or registers improper voltage, but other indications normal.	7*a*. LINE VOLTAGE CONTROL not adjusted properly. *b*. Broken connection in meter circuit (figs. 11 and 17). *c*. Defective meter 5–M–1. *d*. Defective powerstat 3–T–1.
8. Pilot lights for indicator control knobs and azimuth dial do not light, but other indications normal.	8*a*. Defective lamps 7–A–1, 7–A–2, 6–A–2. *b*. Defective rheostat 7–R–9. *c*. Broken connection in pilot light circuit (figs. 11 and 17).
9. White SPINNER READY pilot light does not blow, time delay relay does not operate, amber MODULATOR READY pilot light does not glow, and transmitter tube and receiver blowers do not operate, but other indications normal.	9*a*. Burned-out fuse 9–F–3. *b*. Open or defective switch 1–S–4 (R.F. UNIT switch). *c*. Broken connections in wiring for circuit (figs. 11 and 16). *d*. Poor contact on slip ring No. 11.
10. White SPINNER READY pilot light does not glow, time delay relay does not operate, amber MODULATOR READY light does not glow, but other indications normal. (Transmitter tube and receiver blower operate.)	10*a*. Open or defective switch 1–S–7, 1–S–5. *b*. Broken connection in wiring for this circuit between terminal A on terminal strip 1–K–10 and terminal 6 on terminal strip 3–K–1 (figs. 11 and 16). *c*. Poor contact on slip ring No. 7.
11. White SPINNER READY pilot light does not glow, but all other indications normal.	11*a*. Defective lamp 3–A–6. *b*. Open on defective plate relay contacts 3–E–1–2. *c*. Defective resistors 3–R–5, 3–R–6. *d*. Broken connection in white pilot light circuit (figs. 11 and 16).
12. Time delay relay does not operate, amber MODULATOR READY pilot light does not glow, but all other indications normal.	12*a*. Open or defective relay 3–E–4 (fig. 27). *b*. Broken connection in relay wiring (figs. 11 and 16).

13. Amber MODULATOR READY light does not glow, but time delay relay operates and all other indications normal.

13*a*. Defective lamp 3–A–5.
b. Open or defective interlock switch 3–S–6, 3–S–5, 4–S–1.
c. Defective or open relay contacts 3–E–1–1 or 3–E–4–1. (figs. 27 and 160).
d. Defective resistor 3–R–3, 3–R–4.
e. Broken connection in pilot light between terminal 4 on terminal strip 3–K–1 and terminal 6 on strip 3–K–1.

14. Transmitter tube blower motor or receiver blower motor or both do not operate, but all other indications normal.

14*a*. Burned-out fuse 9–F–2.
b. No a-c input to motor 1–A–4 or 1–A–3.
c. Defective contact on slip ring No. 6.
d. Broken connection in motor circuit (fig. 11).
e. Defective motor 1–A–4 or 1–A–3.

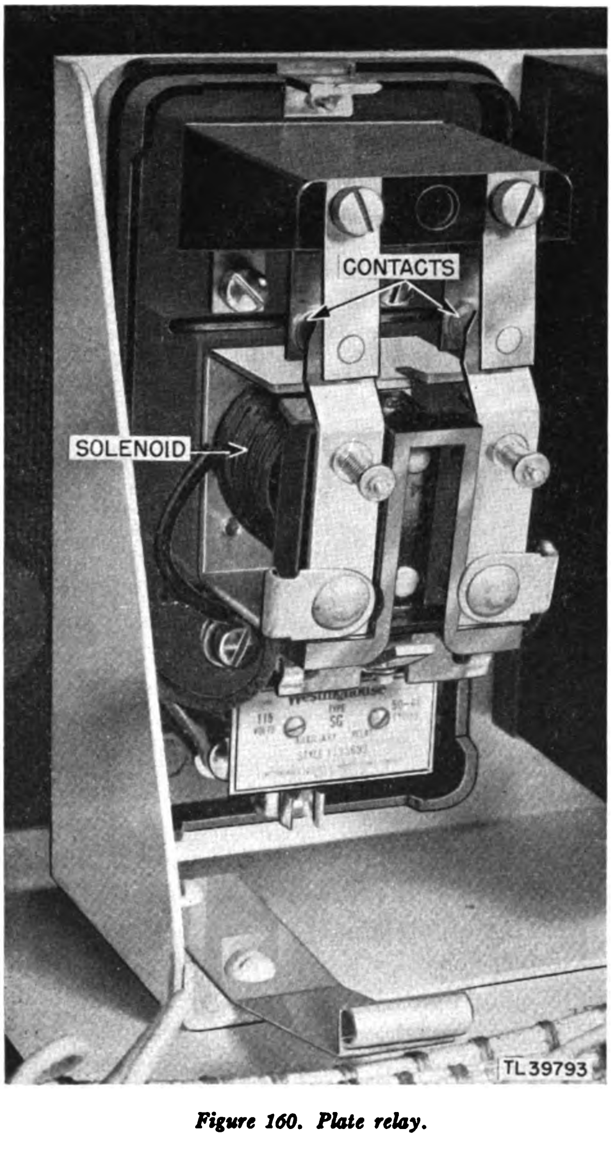


Figure 160. Plate relay.

E. STEP 5. Adjust **LINE VOLTAGE CONTROL** to bring reading of line voltmeter on meter panel of indicator unit to 116 volts.

NORMAL INDICATION: Reading of voltmeter increases as control is turned clockwise, and vice versa.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Voltmeter reading cannot be made to read 116 volts by adjustment of control.	1. See step 4 (same abnormal indication).

F. STEP 6. Press RADIATE ON button which is located on modulator unit control panel.

NORMAL INDICATIONS:
1. Capacitor shorting relay, plate relay, and transmitter tube underload relay operate. The sound can be heard.
2. White SPINNER READY and amber MODULATOR READY pilot lamps go out.
3. Red HIGH VOLTAGE ON pilot lamp lights.
4. Spark gap is heard operating.
5. TRANSMITTER CURRENT meter reads approximately 10 ma.
6. Sweep line of low intensity is observed on PPI scope.

ABNORMAL INDICATIONS	PROBABLE LOCATION OF FAULT
1. No normal indications present. (When button is pushed, ***no*** audible or visible indications.)	1*a*. HIGH VOLTAGE CONTROL not set at normal operating position. (Setscrews on knob may be loose.) *b*. Open or defective push-button switches 3–S–3, 3–S–4. *c*. Open-circuited coil in capacitator shorting relay 4–E–1 (fig. 161). *d*. Open or defective relay contacts 4–E–1–1. *e*. Open or defective contacts in D.C.O.L. relay 3–E–3–1. *f*. Open relay coil 3–E–1. *g*. Plate relay contacts not operating. *h*. Broken connection (figs. 11 and 18).
2. Normal indications appear momentarily, then disappear.	2. This trouble is usually caused by an overload or underload in the transmitter system. See section V, Trouble Shooting in Transmitter System.
3. White SPINNER READY PILOT light stays on, but other indications normal.	3. Defective contacts or short circuit in plate relay 3–E–1–2.
4. Amber MODULATOR READY pilot light stays on, but other indications normal.	4. Defective contacts or short circuit in plate relay 3–E–1–1.
5. Red HIGH VOLTAGE ON pilot light does not light, but other indications normal.	5*a*. Defective lamp 3–A–7. *b*. Defective resistors 3–R–7, 3–R–8. *c*. Broken connection in red pilot light circuit between terminal 17 on terminal strip 3–K–2 and terminal 7 on terminal strip 3–K–1.
6. Spark-gap operation is not regular, but other indications normal.	6. See section V, Trouble Shooting in Transmitter System.

7. Meter (TRANSMITTER CURRENT) does not register approximately 10 ma (lower scale), but other indications normal.

7a. Improper adjustment of HIGH VOLTAGE CONTROL.
b. See section V, Trouble Shooting in Transmitter System.

8. No sweep line on PPI scope, but other indications normal.

8a. Improper adjustment of P. BIAS control 7-R-64.
b. Improper setting of S.T.C. AMPLITUDE control when RANGE switch is on 10,000-yard setting.
c. Cord CD-943 not connected or defective.
d. See section VIII, Trouble Shooting in Indicator System.

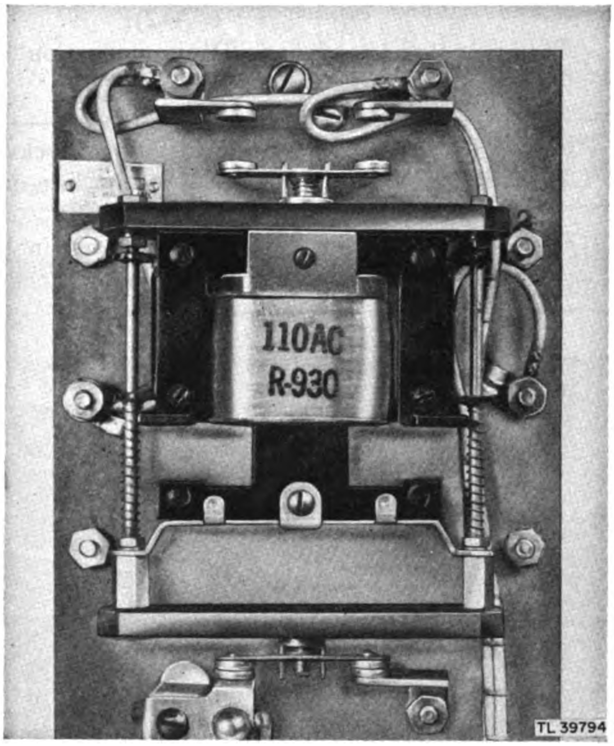


Figure 161. Capacitor shorting relay.

G. STEP 7. Adjust HIGH VOLTAGE CONTROL to obtain a 10-ma reading (lower scale) on TRANSMITTER CURRENT meter on modulator unit control panel.
NORMAL INDICATION: Reading of meter increases as control is turned clockwise and vice versa.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Adjustment of control does not bring meter reading to 10 ma.	1. See step 6 (same abnormal indication).

H. STEP 8. Press button marked PUSH FOR RECTIFIER CURRENT on modulator unit control panel.
NORMAL INDICATION: Meter on control panel reads between 46 and 54 ma (upper scale) when transmitter current is normal (10 ma).

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Meter reading not normal.	1. See section V, Trouble Shooting in Transmitter System.

I. STEP 9. Adjust LIGHTS control on indicator control panel.
NORMAL INDICATION: Intensity of pilot lights for control knobs and azimuth dial increases as LIGHTS control is rotated clockwise and vice versa.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Illumination does not change uniformly and illuminate all control knobs as LIGHTS control is rotated.	1*a*. Knob on LIGHTS control loose. *b*. Defective rheostat 7-R-9. *c*. Pilot lamps burned out (7-A-1, 7-A-2, or 6-A-2). *d*. Poor connection in pilot light circuit (figs. 11 and 17).

J. STEP 10. Rotate RECEIVER gain control one-half turn clockwise and turn VIDEO AMPLITUDE control clockwise until sweep line on PPI scope is clearly seen.
NORMAL INDICATION: Sweep line on PPI scope increases in brightness as VIDEO AMPLITUDE control is rotated clockwise, and vice versa.

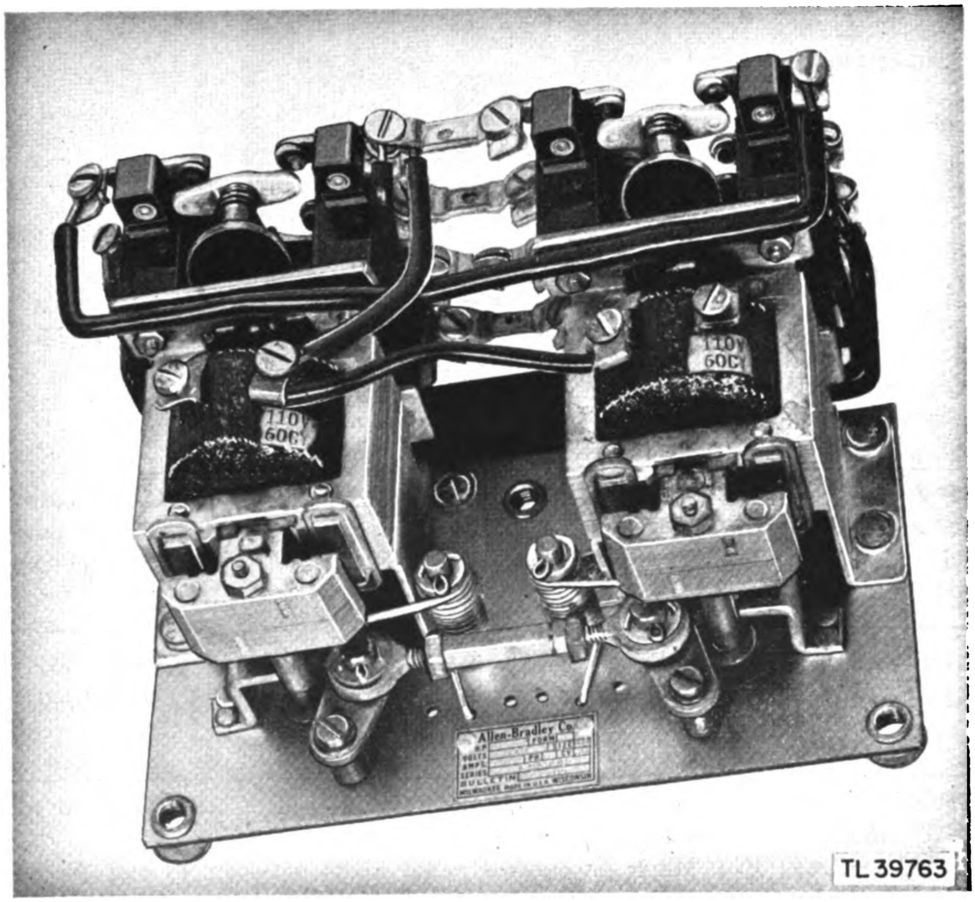


Figure 162. Starter reversing relay.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Rotation of VIDEO AMPLITUDE control has no effect on brightness of sweep line.	1*a*. Improper setting of S.T.C. AMPLITUDE control when RANGE switch is on 10,000-yard setting. *b*. Loose control knob. *c*. Defective potentiometer 7-R-106, 7-R-31. *d*. See section VIII, Trouble Shooting in Indicator System.

K. STEP 11. Turn SCAN switch to FORWARD position. Then turn SCAN switch to REVERSE position.

NORMAL INDICATIONS:
1. Antenna rotates clockwise steadily with SCAN switch in FORWARD position.
2. Antenna rotates counterclockwise steadily with SCAN switch in REVERSE position.
3. Speed of rotation is approximately 10 revolutions per minute (6 rpm on Radio Set SCR-682-A units 1 through 6).
4. Sweep line on PPI scope rotates in synchronism with antenna.

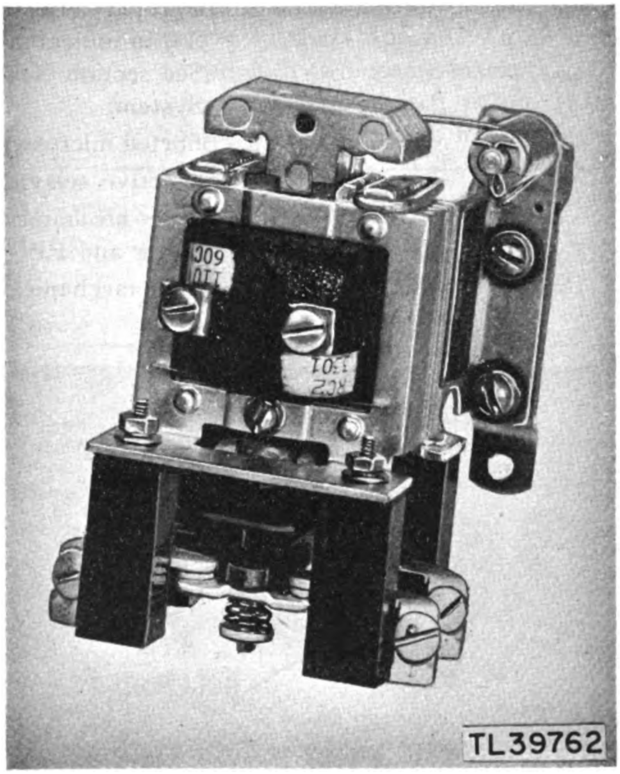


Figure 163. Auxiliary relay 1-E-2.

ABNORMAL INDICATIONS	PROBABLE LOCATION OF FAULT
1. Antenna does not rotate when SCAN switch is in either FORWARD or REVERSE position.	1*a*. Burned-out fuse 9-F-4. *b*. No a-c input to motor 1-A-1. *c*. Open or defective switch (ROTATE or SCAN) 1-S-1, 7-S-9. *d*. Defective (open) contacts on relay 1-E-2

	e. Open coil on relay 1–E–1 (fig. 162). *f.* Defective contacts on relay 1–E–1. *g.* Broken or shorted connection in spinner drive motor control circuit (fig. 19). *h.* Defective motor 1–A–1.
2. Antenna does not rotate but drive motor makes a muffled sound louder than usual.	2*a.* Open capacitors 1–C–6, 1–C–7. *b.* Open contacts Nos. 1 and 2 on relay 1-E-2. *c.* Open contacts on relay 1–E–1. *d.* Broken connection in circuit for drive motor 1–A–1 start winding. *e.* Defective motor 1–A–1 (start winding).
3. Drive motor 1–A–1 overheats and eventually stops or spinner does not change direction when SCAN switch is quickly reversed.	3. Improper adjustment of auxiliary relay 1-E–3 (fig. 164). See paragraph 79, section IV, Trouble Shooting in Control System.
4. Antenna rotates normally but sweep line does not rotate.	4*a.* No a-c input to rotor (terminals R1 and R2) of selsyn generator 1–A–2 in pedestal. *b.* No a-c input to rotor (terminals R1 and R2) of selsyn motor 6–A–1 in indicator panel. *c.* Improper adjustment of microswitches (6-S–1 in indicator unit and 1–S–6 in pedestal). See section X, Trouble Shooting in Selsyn System. *d.* Shorted microswitch in selsyn control circuit. *e.* Defective selsyn 6–A–1, 1–A–2. *f.* Loose mechanical coupling between selsyn motor and PPI yoke gear. *g.* Other mechanical faults.

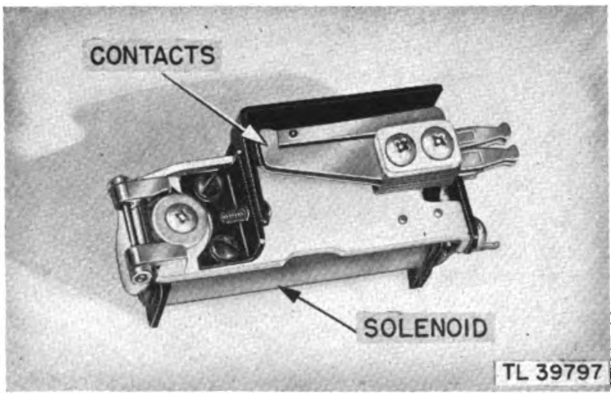


Figure 164. Auxiliary relay 1–E–3.

L. STEP 12. Rotate RECEIVER gain control clockwise until signals and noise indications are observed on PPI tube.

NORMAL INDICATIONS: As control is advanced:

1. Noise appears as a granular indication on PPI tube.
2. Echo signals appear as bright spots or areas.

ABNORMAL INDICATIONS	PROBABLE LOCATION OF FAULT
Noise and signals do not appear or do not appear as bright as usual as RECEIVER gain control is advanced.	1*a*. Improper setting of VIDEO AMPLITUDE control. *b*. Improper setting of S.T.C. AMPLITUDE control. *c*. See section VII, Trouble Shooting in Receiver System.
2. Noise appears greater than usual (poor signal-to-noise ratio).	2*a*. Crystal current too high. *b*. See section VII, Trouble Shooting in Receiver System.

M. STEP 13. Press FINE MARKERS button and ADVANCE MARKER AMPLITUDE control clockwise until marker circles appear on PPI scope.

NORMAL INDICATIONS:
1. When RANGE switch is on 10,000-yard position, five coarse markers appear. Three fine markers appear between each two coarse markers.
2. When RANGE switch is on 40,000-yard position, four coarse markers appear. Four fine markers appear between each two coarse markers.
3. When RANGE switch is on 160,000-yard position, four coarse markers appear. Three fine markers appear between each two coarse markers.
4. When RANGE switch is on 240,000-yard position, six coarse markers and no fine markers appear.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Range markers do not appear or do not appear normally.	1. See section IX, Trouble Shooting in Range Marker System.

N. STEP 14. Set RANGE switch at desired operating range.

NORMAL INDICATION: See step 13.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Operation of RANGE switch is abnormal.	1. See section VIII, Trouble Shooting in Indicator System.

O. STEP 15. Rotate S.T.C. AMPLITUDE control clockwise *slowly* while observing pattern on PPI scope.

NORMAL INDICATION: Intensity of illumination near center of PPI scope decreases as control is rotated clockwise. (Illumination near center of PPI scope disappears on 10,000-yard range when control is completely clockwise.)

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. S.T.C. AMPLITUDE control does not cause any change in intensity of illumination on PPI scope, or causes an otherwise abnormal indication.	1. See section VII, Trouble Shooting in Receiver System.

P. STEP 16. 1. Turn ON two ventilation blowers which are located on wall of Shelter HO-23.
2. Open inside and outside louvers of blower duct assembly.
3. Open the four wall louvers on back wall of Shelter HO–23.

NORMAL INDICATIONS: 1. Motors start and are audible.
2. Air is sucked into blower intake louvers.
3. Air is exhausted from louvers on outside of Shelter HO-23 behind blower.
4. Air passes through four wall louvers when both doors of Shelter HO-23 are closed.

ABNORMAL INDICATIONS	PROBABLE LOCATION OF FAULTS
1. Motor does not operate.	1*a*. Burned-out fuse in power fuse box on wall of shelter. *b*. Broken connection (fig. 13).
2. Air is not felt passing through louvers of blower duct assembly.	2*a*. Make sure both inside and outside louvers are open. *b*. Look into blower chamber through intake louver and ascertain ***visually*** if blower is operating. ***Do not place fingers into blower.***

Section IV. TROUBLE SHOOTING IN CONTROL SYSTEM

Warning: ***Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in the radar equipment. Do not place hands or arms within components with the high voltage ON. Do not make any connections into this system which will bring high voltage out to an exposed point. Make all tests with high voltage OFF. Always ground high-voltage capacitors before touching them or their associated parts.***

76. Reference Data

The following figures are included to aid maintenance personnel engaged in trouble shooting the control system. See also references in paragraph 73.

a. Figure 11, Control system, complete schematic diagram.

b. Figure 15, Green pilot light circuit, simplified schematic diagram.

c. Figure 16, Unregulated supply circuit, simplified schematic diagram.

d. Figure 17, Regulated supply circuit, simplified schematic diagram.

e. Figure 164, Auxiliary relay 1-E-3.

f. Figure 165, Control Panel BD-130-A, voltages and resistances.

g. Figure 166, Control Panel BD-130-A, electrical connection diagram.

h. Figure 167, Control Panel BD-130-A, relay shelf, electrical connection diagram.

77. Introduction

The theory of operation of the circuits of the control system has been explained in chapter 1, section II. In addition, the section on trouble shooting based on the starting procedure covers a majority of possible troubles in this system and gives the probable location of the fault. Section IV explains the location of troubles in the control system which are not covered by the various abnormal condition symptoms in section III.

78. Centrifugal Motor Switch

a. The spinner drive motor is equipped with a single-pole double-throw centrifugal switch which is normally not used. However, if emergency arises wherein control relays 1-E-2 or 1-E-3 are defective and replacements are not available, then the motor can be made to operate by connecting the centrifugal switch into the circuit as follows:

(1) Turn off switches 1-S-1, 1-S-5, and 1-S-4.

(2) Disconnect motor lead marked 3 and connect it to motor lead 22. (Since these wires are not rigidly held, exposed lugs and wire should be insulated with tape.)

(3) Connect motor lead 23 to terminal 3 on relay 1-E-1.

(4) Tape the exposed portion of motor lead 24.

(5) Connect a temporary jumper between terminals 1 and 2 on relay 1-E-2.

b. The motor will then be ready to run either forward or reverse as desired. However, narrow sector search cannot be accomplished because the motor cannot reverse until the centrifugal switch closes. The switch will close after the motor has coasted to approximately one-third of full speed.

79. Motor Control Relay

a. Adjustment of relay 1-E-3 (fig. 164) is somewhat critical, and care should be exercised to avoid altering its value of pull-in current.

b. Misadjustment of relay 1-E-3 may be noted when:

(1) The relay does not pull in with the motor running. (As a result of the relay not pulling in, the starting winding remains connected and causes the motor to overheat and eventually to stop because of the operation of the thermal overload relay.)

(2) After the motor has started and is running normally, it does not change direction when the SCAN (forward-reverse) switch is quickly changed for opposite rotation.

c. The relay may be adjusted by changing the tension of the springs. Use long-nose pliers and slightly bend the springs at the point where they are secured to the frame. Final adjustment of the relay should be such that:

(1) The relay pulls in on starting with the lowest expected value of voltage applied to the motor.

(2) On rapid reversals, the relay will not pull in until the motor has reversed.

80. Trouble-shooting Chart

A. SYMPTOM:

Convenience outlet 4–K–5 on modulator unit is not hot although green pilot light glows.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Convenience outlet circuit of modulator unit.	1*a*. Check fuse 4-F-1. *b*. Check for broken, loose, or shorted connection in Power Supply Unit RA-101-A between terminal 2 on terminal strip 4-K-1 and terminal Z on terminal strip 4-K-4 (fig. 11). *c*. Check outlet 4-K-5.

B. SYMPTOM:

Spark-gap heater inoperative although green pilot light glows.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Spark-gap heater circuit in modulator unit.	1*a*. Check fuse 3-F-3. *b*. Check spark-gap heater element 3-A-1. *c*. Check for broken, loose, or shorted connection in modulator unit between terminal 2 on terminal strip 3-K-4 and terminal 3 on terminal strip 3-K-4 (figs. 11 and 15).

C. SYMPTOM:

Spark-gap drive motor inoperative although modulator unit blower motor operates.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Spark-gap drive motor circuit of modulator unit.	1*a*. Check fuse 3-F-2. *b*. Check for broken, loose, or shorted connection between terminal 4 on terminal strip 3–K–4 and terminal 6 on terminal strip 3–K–5 (figs. 11 and 17). *c*. Check drive motor 3–A–4 and replace it if defective (par. 88).

D. SYMPTOM:

No output voltage from Power unit RA–100–A, although indicator control knobs, including RANGE switch, are lighted by pilot lights.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Indicator system.	1. See section VIII, Trouble Shooting in Indicator System.

E. SYMPTOM:

RUNNING TIME METER on indicator meter panel inoperative, although LINE VOLTMETER reading is normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. RUNNING TIME METER circuit of indicator unit.	1*a*. Check for broken, loose, or shorted connection between terminal 13 on terminal strip 5–K–1 and terminal 12 on terminal strip 5–K–1 (figs. 11 and 17). *b*. Replace meter 5–M–2 if defective.

F. SYMPTOM:

RUNNING TIME METER indicating inaccurately.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. RUNNING TIME METER circuit of indicator unit.	1*a*. See procedure for symptom E above. *b*. Check frequency of output voltage of power unit. It should be 60 cycles per second ± 0.5 cycle. *c*. Replace meter 5–M–2 if defective, after a 24-hour check.

G. SYMPTOM:

Convenience outlet 1–K–3 in Pedestal FT–458–A not hot, although equipment operates normally otherwise.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Outlet circuit in pedestal.	1*a*. Check for broken, loose, or shorted connection in wiring of outlet (fig. 11). *b*. Check outlet 1–K–3.

H. SYMPTOM:

LINE SWITCHES on modulator control panel snap off without being operated.

PROBABLE LOCATION OF FAULT

1. Excessive current flow through switches. (These switches are circuit-breaker type which open automatically on overload.)

PROCEDURE

1*a*. Try throwing LINE SWITCHES on again to see if symptom repeats.

b. Turn set off, using recommended stopping procedure given in chapter 3 of TM 11–1361. (Leave gasoline power unit on and power switch on wall of shelter on.)

c. Remove fuses 9–F–1, 9–F–2, and 9–F–3 from clip holders temporarily to remove power from selsyn system, spinner drive motor system, circuits excited by action of time delay relay, etc.

d. Try throwing on LINE SWITCHES again.

(1) If switches stay on, proceed with test *e* below.

(2) If switches snap off, trouble has been isolated to a shorted condition in the equipment supplied with power without the above fuses in (figs. 11 and 16). Make resistance tests to localize short.

e. Re-insert fuses 9–F–2 and 9–F–3.

f. Throw LINE SWITCHES on again.

g. (1) If switches snap off ***immediately***, trouble has been isolated to circuits fed through fuses 9–F–2 and 9–F–3 or to circuits excited by action of time delay relay.

(2) If switches snap off approximately 45 seconds (time required for time delay relay contacts to close), check for a short in circuits fed through action of time delay relay (figs. 11 and 18).

h. If in step *g* above, the switches snapped off immediately, remove fuse 9–F–2 and turn ROTATE and SCAN switches off.

i. Throw LINE SWITCHES on again.

j. If switches snap off immediately, trouble has been isolated to circuits which are fed through fuse 9–F–3 when ROTATE and SCAN switches are off.

k. If in step *j* switches do not snap off immediately, throw on ROTATE and SCAN switches.

l. Throw LINE SWITCHES on again.

m. If switches snap off, trouble has been isolated to antenna drive motor and its control circuits. Check these for shorted condition (fig. 11).

n. Press RADIATE ON push button. If LINE SWITCHES snap off, trouble has been isolated to circuits fed by action of plate relay contacts.

Note The above material shows one method of attempting to isolate a shorted condition. Various other methods may be used, but the general procedure is always fundamentally the same as that given. ***Use resistance measurements in high-voltage circuits.***

I. SYMPTOM:
No input to a particular circuit.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Blown fuse.	1. Fuses are used to protect the equipment in case of an overload such as is caused by a shorted condition. Most of the major circuits include fuse protection. The general procedure in the event of a blown fuse may be summed up as follows: *a.* Try replacing fuse to see if a second fuse also burns out. *b.* If second fuse also blows, study schematic diagram to isolate those circuits to which power is applied through fuse which has blown. *c.* Inspect wiring and parts included in the circuit for evidence of burning, shorted wires, soldered connections, frayed insulation, etc. *d.* Check circuit by means of resistance tests. *e.* Check for ***loose connections*** as well as shorts.

NOTE:
1. ALL VOLTAGES D-C UNLESS OTHERWISE SHOWN.
2. D-C MEASUREMENTS MADE WITH 20,000 OHMS PER VOLT METER.
3. ALL VOLTAGES MEASURED TO GROUND, UNLESS OTHERWISE SHOWN, WITH POWER CORD CONNECTED AND INTERLOCK SWITCH 3-S-6 OPEN.
4. ALL VOLTAGES MEASURED WITH INPUT OF 117 VOLTS, A-C LINE VOLTAGE, AND WITH MAIN CIRCUIT BREAKERS 3-S-1 AND 3-S-2 CLOSED.
5. ALL RESISTANCES MEASURED TO GROUND, UNLESS OTHERWISE SHOWN, WITH POWER INPUT CORD, TRANSMITTER, AND RECEIVER DISCONNECTED.
6. NC DENOTES NO CONNECTION.

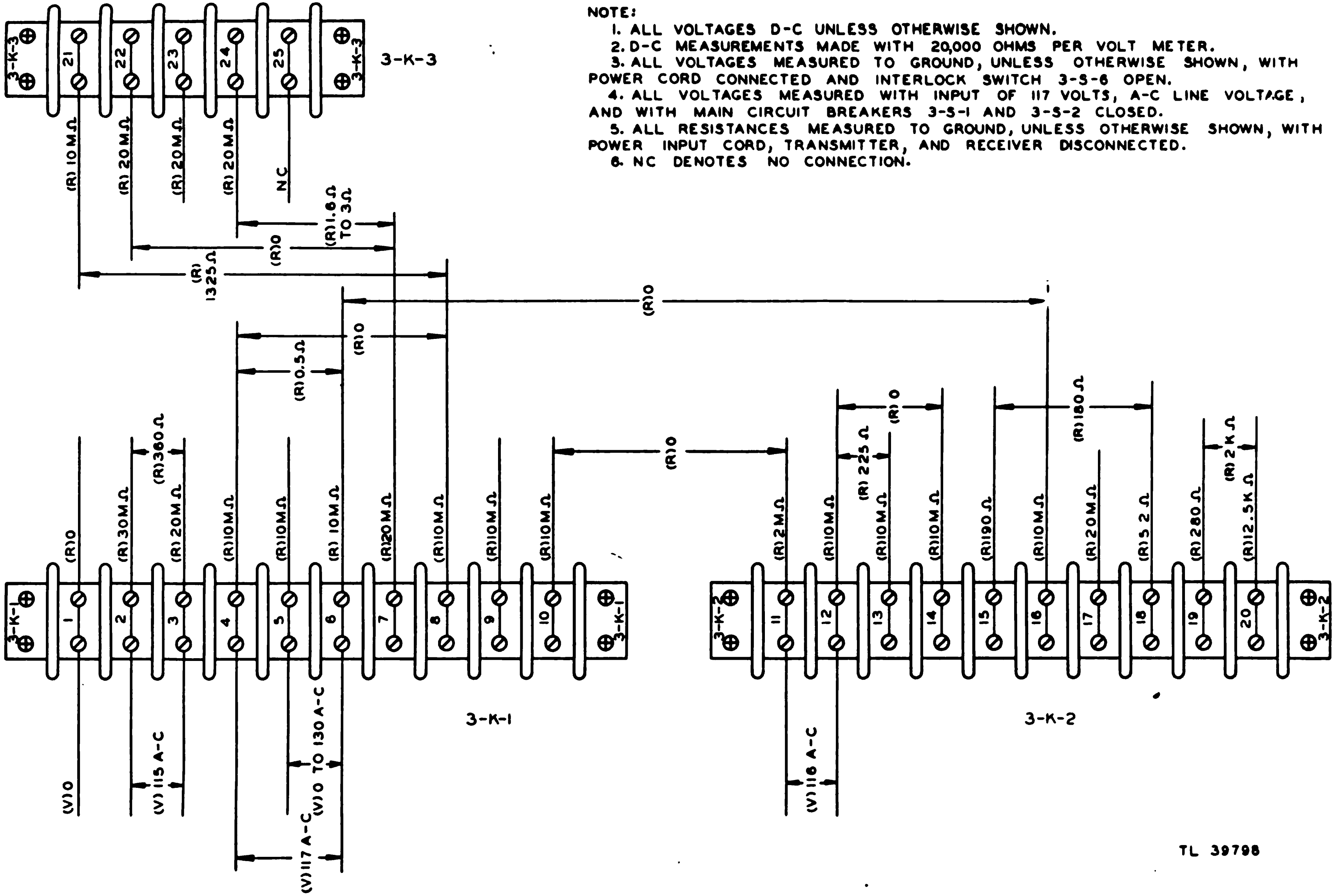
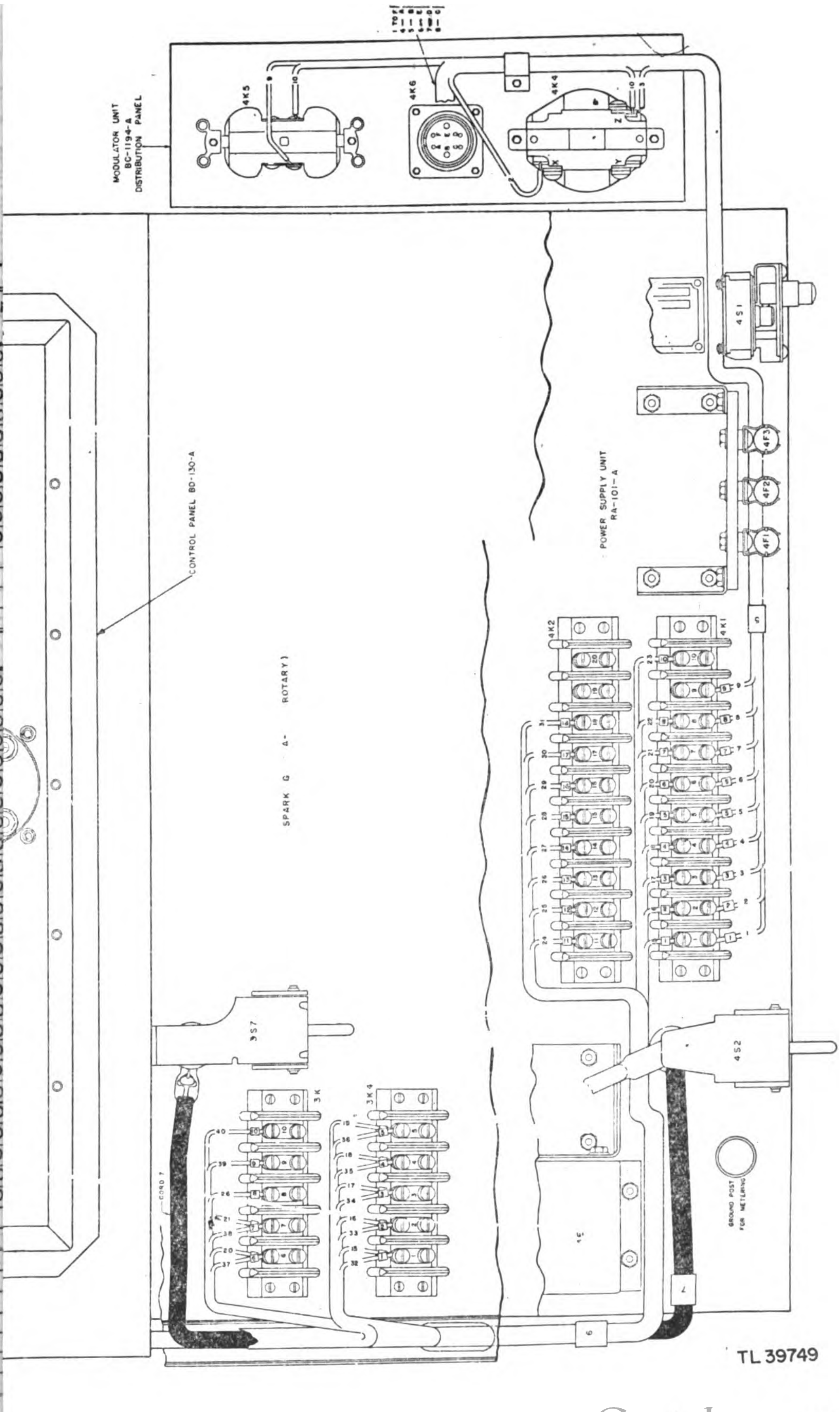


Figure 165. Control Panel BD–130–A, voltages and resistances.

WIRE	FROM	TO	
	DISTRIBUTION PA		
	CORD 5		
1	4K1- 1	4K6-F	NO
2	4K1- 2	4K4-X	NO
3	4K1- 3	4K4-Z	NO
4	4K1- 4	4K6- A	NC
5	4K1- 5	4K6- B	NO
6	4K1- 6	4K6- E	NO
7	4K1- 7	4K6- D	NO
8	4K1- 8	4K6- C	NO
9	4K1- 9	4K5	NO
10	4K4- Z	4K5	NO
11			
12			
13			
14			
	INTRA CONNECTING		
	CORD 6.		
15	4K1- 1	3K4- 1	NO
16	4K1-2	3K4-2	NO
17	4K1-3	3K4-3	NO
18	4K1-4	3K4-4	NO
19	4K1-5	3K4-5	NO
20	4K1-6	3K5-6	NO
21	4K1-7	3K5-7	NO
22	4K1-8	3K2-14	NO
23	4K1-10	3K1-10	NO
24	4K2-11	3K2-13	NO
25	4K2-12	3K3-21	NO
26	4K2-13	3K5-8	NO
27	4K2-14	3K2-17	NO
28	4K2-15	3K3-22	NO
29	4K2-16	3K1-7	NO
30	4K2-17	3K3-24	NO
31	4K2-18	3K2-15	NO
32	3K4-1	3K1-1	NO
33	3K4-2	3K1-2	NO
34	3K4-3	3K1-3	NO
35	3K4-4	3K1-4	NO
36	3K4-5	3K1-5	NO
37	3K5-6	3K1-6	NO
38	3K5-7	3K3-23	NO
39	3K5-9	3K1-9	NC
40	3K5-10	3K2-20	NO
41			
42			
43			
44			
45			
46			
47			
48			
49			



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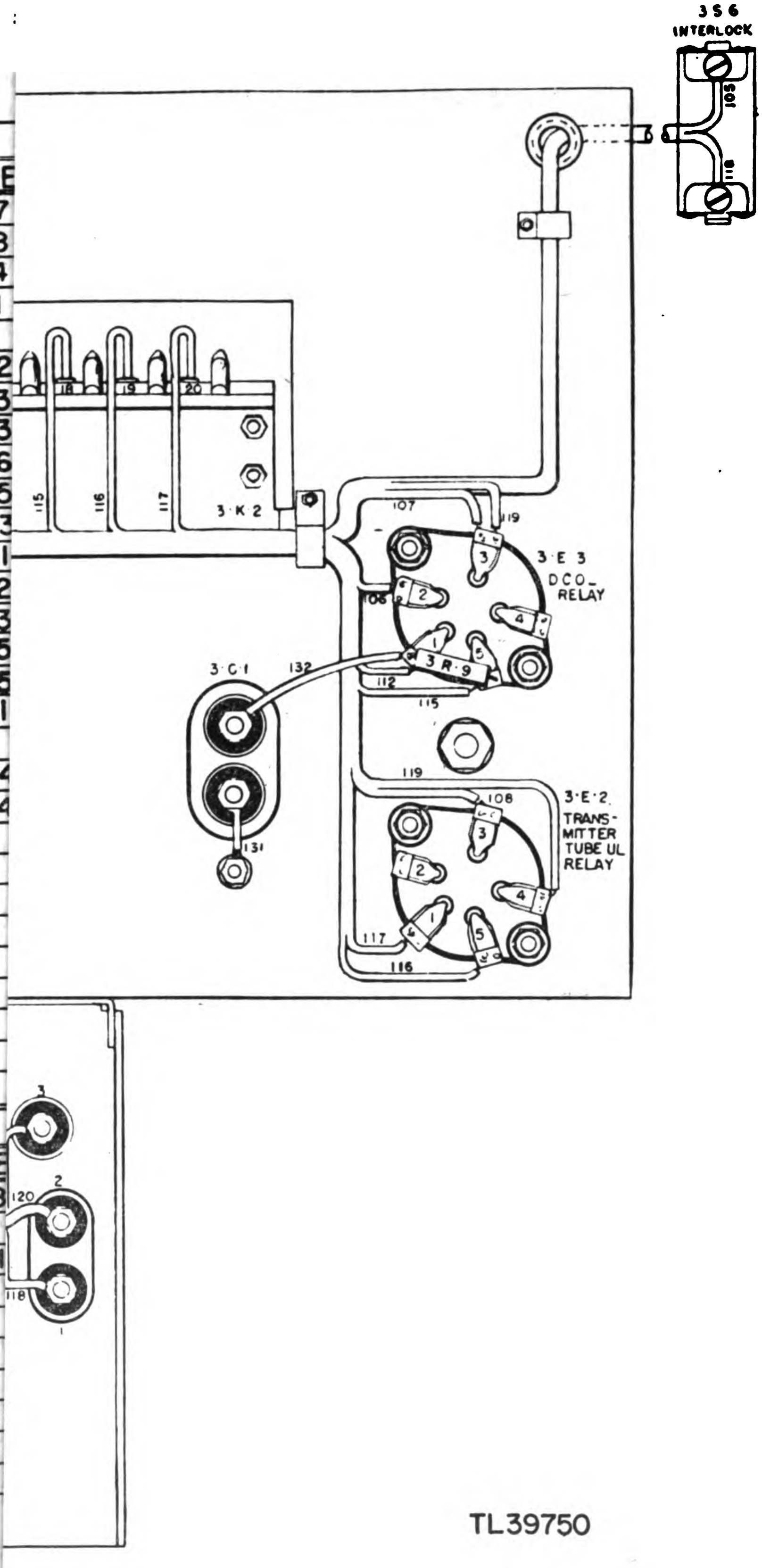
WIRE	FROM	TO
	CABLE HARNE	
101	3·K·1-4	3·E·1-7
102	3·K·1-6	3·E·1-8
103	3·K·1-7	3·E·1-4
104	3·K·1-8	3·E·1-1
105	3·K·1-9	3·S·6
106	3·K·1-10	3·E·3-2
107	3·K·2-11	3·E·3-3
108	3·K·2-12	3·E·2-3
109	3·K·2-12	3·E·1-6
110	3·K·2-13	3·E·1-5
111	3·K·2-14	3·E·4-3
112	3·K·2-15	3·E·3-1
113	3·K·2-16	3·E·1-2
114	3·K·2-17	3·E·1-3
115	3·K·2-18	3·E·3-5
116	3·K·2-19	3·E·2-5
117	3·K·2-20	3·E·2-1
118	3·E·4-1	3·S·6
119	3·E·3-3	3·E·2-4
120	3·E·4-2	3·E·4-4
121		
122		
123		
124		
125		
126		
127		
128		
129		

WIRE	FROM	TO
	JUMPE	
130	3·E·4-4	3·E·1-8
131	3·C·1	GND.
132	3·C·1	3·E·3-1
133	3·K·1-1	GND.
134		
135		
136		
137		
138		
139		



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Warning: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this system. Do not place hands or arms within the modulator unit or on any of the high-voltage connections between the modulator unit and the transmitter tube while the high voltage is ON. Do not make any connections which will bring high voltage to an exposed point. Except on specific output tests, make all tests with the high voltage OFF. Always short out high-voltage capacitors before touching them or their associated circuits.*

81. Reference Data

The following figures are included to assist maintenance personnel in trouble shooting the r-f system.

a. Section VI, Trouble shooting in the r-f system.

b. Figure 12, Modulator Unit BC–1194–A.

c. Figure 29, Radio Frequency Unit BC–1224–A, transmitter system parts.

d. Figure 31, Spark Gap GA–9–A (Rotary), top view of chassis.

e. Figure 32, Modulator Unit BC–1194–A, side view.

f. Figure 33, Pedestal FT–458–A, connection of pulse cable Cord CD–944.

g. Figure 34, Power Supply Unit RA–101–A, top view.

h. Figure 37, Transmitter system, simplified schematic diagram.

i. Figure 38, Waveforms of pulse input to transmitter tube.

j. Figure 40, Power Supply Unit RA–101–A, simplified schematic diagram.

k. Figure 41, Control Panel BD–130–A, complete schematic diagram.

l. Figure 42, Modulator Unit BC–1194–A, complete schematic diagram.

m. Figure 43, Power Supply Unit RA–101–A, complete schematic diagram.

n. Figure 44, Spark Gap GA–9–A (Rotary), complete schematic diagram.

o. Figure 45, Pedestal FT–458–A, Radio Frequency Unit BC–1224–A, and Antenna AN–134–A, complete schematic diagram.

p. Figure 46, R-f system, simplified block diagram.

q. Figure 168, Multiplier IE–41, schematic diagram.

r. Figure 169, Rotary spark gap, exterior view.

s. Figure 170, Stationary pin of rotary spark gap.

t. Figure 171, Spark-gap housing, showing brushes.

u. Figure 172, Brushes of rotary spark gap.

v. Figure 173, Rotary spark gap disassembled, showing rotating pins and slip ring.

w. Figure 174, Cord 28 and high-voltage rotating joint.

x. Figure 175, Rotating joint, disassembled for replacement of brushes.

y. Figure 176, Rotating joint, completely disassembled.

z. Figure 177, Spark Gap GA–9–A (Rotary), voltages and resistances.

aa. Figure 178, Pedestal FT–458–A, resistances.

ab. Figure 179, Radio Frequency Unit BC–1224–A, resistances.

ac. Figure 180, Power Supply Unit RA–101–A, voltages and resistances.

ad. Figure 181, Spark Gap GA–9–A (Rotary), electrical connection diagram.

ae. Figure 182, Pedestal FT–458–A, Radio Frequency Unit BC–1224–A, and Antenna AN–134–A, electrical connection diagram.

af. Figure 183, Power Supply Unit RA–101–A, electrical connection diagram.

82. Introduction

It is assumed that the trouble has been localized to the transmitter system by observing the indications given by the starting procedure. In other words, indications are all normal up to the point at which the RADIATE ON button is pressed. An idea of the cause of a fault may often be obtained by noting what abnormal indication appears when the RADIATE ON button, which starts the operation of the transmitter system, is pressed. Note especially the reading on the TRANSMITTER CURRENT meter.

83. Proper Setting of Controls

a. The LINE VOLTAGE CONTROL should be set so that the line voltmeter on the indicator panel shows a line voltage reading of 116 volts.

b. The HIGH VOLTAGE CONTROL should be set at its normal operating position or near the center of the nameplate.

Note. Make certain that the setscrews on knobs are tight, and check to see whether or not knob has slipped on shaft, making the pointer indicate incorrectly.

84. Behavior Analysis

Normally the transmitter system is placed in operation when the RADIATE ON button on the modulator unit control panel is pressed. The normal indications (audible and visible) obtained when this button is pressed are discussed in section III, Trouble Shooting Based on Starting Procedure. Oten when a failure occurs in the transmitter system, the indications obtained when the RADIATE ON button is pressed may be used to advantage.

a. NO NORMAL INDICATIONS. In the event *no* audible or visible indications are present when RADIATE ON button is pressed, the trouble is not in the transmitter system proper but in the control system. See section III, Trouble Shooting Based on Starting Procedure, and section IV, Trouble Shooting in the Control System.

b. OVERLOAD IN SYSTEM. When normal indications appear momentarily, but disappear immediately after the RADIATE ON button is pressed, the trouble may be an overload in the transmitter system. Relay 3-E-3 is a direct current overload relay and automatically causes the power to be removed from Power Supply RA-101-A if the current drain on the high-voltage rectifier reaches 80 milliamperes. Since the balance of the transmitter system is the load for this rectifier, the trouble will have been isolated to any condition which would cause an overload, such as a shorted connection or part, gassy transmitter tube, shorted transformer winding, or loss of magnetic flux for transmitter tube.

c. UNDERLOAD IN SYSTEM. An underload relay, 3-E-2, is also incorporated as a protective device. In the event of an underload in transmitter current, this relay operates to remove the power from Power Supply Unit RA-101-A. This relay closes when the transmitter current reaches 6 milliamperes and opens when the current falls below this value.

d. RELAY CHATTER. If underload relay 3-E-2 chatters, erratic operation of the spark gap discharge may be the cause. Check the pins and brushes of rotary spark gap 3-A-8. Also see *e*(2) below.

e. DETERMINING UNDERLOAD OR OVERLOAD. Since only momentary indications appear when the RADIATE ON button is pressed, it is necessary to determine whether an underload in transmitter current or an overload in rectifier current is at fault. A simple way of doing this is to press the RADIATE ON button in for several seconds, but not longer. At the same time observe the reading of transmitter current and rectifier current on the control panel TRANSMITTER CURRENT meter. (Press the button beneath the meter to read rectifier current.)

(1) If the transmitter current is low, this underload is indicated by a low reading on the meter.

(2) If an overload exists, the relays will continue to open and close as long as finger is held on the RADIATE ON button.

f. LOW RECTIFIER AND TRANSMITTER CURRENT. When RADIATE ON button is pressed and both meter indications are abnormally low but the transmitter current is not under 6 milliamperes, the trouble may usually be traced to low supply voltage to the high-voltage rectifier, poor rectifier tubes, or some other abnormal condition in the transmitter system. Meter 3-M-1 may be defective.

g. HIGH RECTIFIER AND TRANSMITTER CURRENT. When both meter indications are abnormally high but not sufficient to cause operation of the overload relay, the trouble will be similar to that which exists in case of an overload which actuates the overload relay.

h. OTHER READINGS. Various other combinations of transmitter current and rectifier current may be encountered, such as high rectifier current and normal transmitter current, normal rectifier current and low transmitter current. The trouble shooting chart includes most of these symptoms and gives the probable location of fault, and trouble shooting procedures for each symptom.

i. DOUBLE-MODING. Double-moding is the name given to that condition which, if present, causes the major output of the transmitter tube to occur at two fundamental frequencies. Erratic transmitter current may be an indication of double-moding. Double-moding occurs when the transmitter tube operating potential or field strength is abnormal or the tube is defective. This fault may sometimes be caused by an abnormal condition in the r-f plumbing. A procedure for checking to find out if this condition exists (by means of the echo box) is given in section II, paragraph 72*b*. An additional method is outlined in paragraph 85*d*.

j. LOW POWER OUTPUT. The output power of the transmitter system, after passing through the r-f plumbing, is radiated into space by the dipole. Procedures on measurement of relative power output by means of the echo box are explained in paragraph *72b*.

85. Tests

a. CHARTS. Resistance charts showing normal values of resistance in the transmitter system are given in this section (figs. 177, 178, 179 and 180).

b. WAVEFORMS. Jacks are provided in the equipment for checking the waveform of the pulse and trigger developed in the transmitter system. These waveforms may be affected by practically any fault in the transmitter or r-f systems. One jack, located on the indicator unit (at operating shelf), is labeled TRIGGER. The trigger pulse is applied to the circuits of the indicator control for synchronizing. Another jack is located in the r-f unit on top of pulse transformer 1–T–2 and represents the pulse input to transmitter tube 1–V–1.

c. OUTPUT VOLTAGE OF RECTIFIER. A method is provided for measuring the output voltage of Power Supply Unit RA–101–A. This is checked by the following procedure:

(1) Make certain that all power and high-voltage switches are off.

(2) Open the door on Power Supply Unit RA–101–A. Remove air filter on side of cabinet.

(3) Slide metal base of the 0 to 7 kv multiplier (fig. 168) under the thumbscrew located at the front of chassis on the left side. Tighten securely.

(4) Clip the black handle (attached to the lead extending from the top of the multiplier) to the ⅜-inch high-voltage bus bar (Tubing 32) connected to the mechanical grounding switch (fig. 183). This connection should be made carefully so that the lead does not touch ground at any point.

(5) Set range switch on Simpson model 250 analyzer to the 250 v (—40 DB) position. Set the DC–AC output switch to the DC position.

(6) Connect the black alligator clip test lead between NEG tip jack and ground terminal on right side of cabinet.

(7) Feed the bottom connection from multiplier across the chassis between the high-voltage capacitor and terminal board, and out through air filter opening. Connect this lead to red POS tip jack on the analyzer.

(8) Start the system in normal manner.

Caution: Do not reach into the air filter opening with the equipment operating. The rectifier tube shelf at the top of the opening operates at the rectifier output potential.

(9) Adjust the HIGH VOLTAGE CONTROL to give 10 ma TRANSMITTER CURRENT and note reading on 10-volt, d-c scale of analyzer. The reading is then direct in kilovolts; the meter reads 10 kv full-scale. This voltage should read approximately 6.8 kv. If the reading deviates appreciably from this value, there are two probable causes. The load on the rectifier may have changed due to defective components in the balance of the circuit; this may be checked by operating the PUSH FOR RECTIFIER CURRENT button and noting rectifier current which should be approximately 50 ma. The other probable reason for a large change in output voltage is defective rectifier tubes; this can be checked by substituting new tubes.

d. DOUBLE-MODING. As explained in paragraph *84i*, double-moding is checked by means of the echo box. Observation of the VIDEO and pulse waveforms on the synchroscope will also show if this condition exists. Proceed as follows:

(1) Connect the power input plug on the syn-

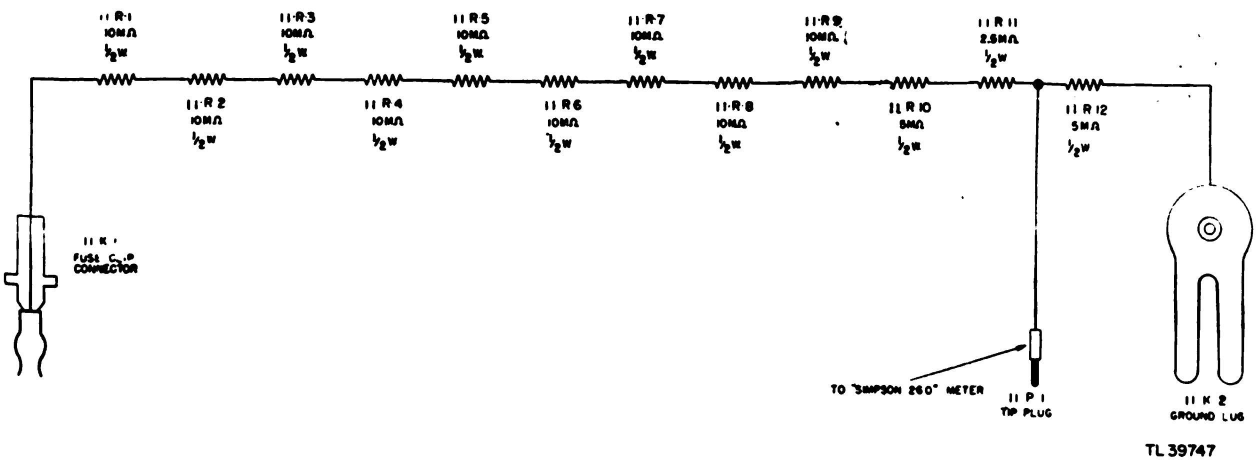

Figure 168. Multiplier IE–41, schematic diagram.

chroscope power cable to the a-c outlet on the modulator unit.

(2) Connect synchroscope TRIGGER jack to TRIGGER on the indicator control under the hinged door below the control knobs.

(3) Connect SIGNAL jack on the synchroscope to the VIDEO jack on the indicator unit.

(4) Switch and control setting of the synchroscope should be as follows:

(a) SIG INPUT switch at AMP position.

(b) TRIG SELECTOR switch at EXT position.

(c) SWEEP SPEED switch at position 3 or 4.

(d) Turn on the synchroscope, focus, and adjust the pattern for position on the screen. An A–scope pattern will now appear.

(e) Adjust the vertical amplitude of the pattern by means of VERT-GAIN control. This amplitude will also be affected by the setting of the RECEIVER gain and VIDEO AMPLITUDE controls on the indicator unit.

(f) Observe the waveform of a strong echo signal, which should be clear and stable. If it appears fuzzy or erratic or gives the effect of superimposed pulses, double-moding may be the cause.

(g) Move the synchroscope to Antenna Shelter HO–22 to make a check of the pulse waveform.

(h) Connect the PULSE jack located at the top of the r-f unit to TRIGGER jack on the synchroscope.

(i) Set the synchroscope SIG INPUT to TRIG.

(j) Set the synchroscope SWEEP SPEED to the No. 1 position.

(k) Set the synchroscope TRIGGER POLARITY to NEG.

(l) Set the synchroscope TRIG SELECTOR to EXT.

(m) Connect the power input cord on the synchroscope power cable to the 115 v A.C. OUTLET on the pedestal.

(n) Turn on the synchroscope, focus, and adjust the pattern for position on the screen. An A–scope pattern should be observed.

(o) Study the appearance of the waveform to substantiate the presence of double-moding. The PULSE waveform normally should be observed as a clean pulse with an unbroken outline (fig. 38). The presence of double-moding is evidenced by amplitude variations at the peak of the pulse waveform.

86. Trouble-shooting Chart

A. SYMPTOM:

No normal indications observed when RADIATE ON push-button is pressed, although white and amber pilot lamps glow.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Defective switch 3–S–3 or 3–S–4.	1*a*. Check mechanical operation of switches. *b*. Make continuity check across switches with switches closed and LINE SWITCH in OFF position.
2. Defective overload relay 3–E–3.	2. Check contacts on relay 3–E–3.
3. Open circuit in coil of relay 4–E–1, or mechanical fault preventing closing of contacts.	3*a*. Check continuity with voltage off. *b*. Inspect mechanical operation and contacts of relay 4–E–1.
4. Broken or loose connection between terminal 12 on terminal board 3–K–2 and terminal 12 on terminal board 4–K–2.	4*a*. Make continuity check between these points. *b*. Repair any loose or broken connection.

B. SYMPTOM:

When RADIATE ON button is pressed, red light glows but rectifier and transmitter currents read zero, no sweep is observed on PPI scope, and spark gap is not heard operating; when RADIATE ON button is released, red light goes out.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Filaments of rectifier tubes not operating.	1*a*. Check fuse 4–F–2. *b*. Check visually to see if filaments of rectifier tubes 4–V–1 and 4–V–2 are glowing. To do this look through air filter opening after removing this filter, but as a safety precaution, ***do not place hands inside filter opening.*** *c*. If they are not lighted, turn off power and open door of Power Supply Unit RA–101–A. Short capacitor 4–C–2 with capacitor shorting tool. *d*. Check voltage across filament contacts of tube sockets (this should be 5 volts) by turning power ON after test leads are connected. ***Do not press RADIATE ON button while making this check.*** *e*. If abnormal, check transformer 4–T–1 and wiring in filament circuit. If voltage is normal, the rectifier tubes are probably burned out. *f*. Make resistance checks on spark gap and power supply units before replacing these tubes if they have been burned out.
2 Blown fuse.	2. Check fuse 4–F–3.
3. Power Supply Unit.	3*a*. Make resistance measurements in power supply unit. *b*. Check powerstat 3–T–2. *c*. Check transformer 4–T–2. *d*. Check resistors 4–R–1, 4–R–2. *e*. Check the output voltage of Power Supply Unit RA–101–A as explained in paragraph 85.
4. Rotary Spark Gap.	4*a*. Check the overlap between the moving and stationary pins, and the condition of the pins. *b*. Check for an open circuit between the moving pins and ground. The brushes may be worn, or not making good contact with the slip ring.
5. Spark Gap Unit.	5. Make resistance measurements in spark gap unit.

C. SYMPTOM:

The red light glows when RADIATE ON button is pressed but transmitter and rectifier currents are low. When RADIATE ON button is released, underload relay causes power to shut off and red light goes out.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of HIGH VOLTAGE CONTROL 3–T–2.	1. Adjust to proper setting near center of nameplate.
2. Low output voltage from Power Supply Unit RA–101–A or defect in Spark Gap GA–9–A (Rotary).	2*a*. Check voltage using procedure explained in paragraph 85. *b*. Make resistance checks in spark gap and power supply unit.

3. Defective pulse transformer or transmitter tube.
4. Cords CD–944 or CD–28.

6. Rotating joint 1–A–5 not making good contact.

3a. Make resistance checks in r-f unit.
b. Check transmitter tube by trying a new one.
4a. Check to see that connections at ends of cables are good.
b. Replace cord if found defective. Do not attempt repair.
6. If currents vary when antenna is rotated (antenna may be rotated by hand), joint 1–A–5 is probably at fault.

D. SYMPTOM:

Transmitter and rectifier currents are high when RADIATE ON button is pressed, causing power to shut off and red light to go out.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper setting of HIGH VOLTAGE CONTROL 3–T–2.	1. Set correctly at point near center of nameplate.
2. Defective part or connection.	2a. Make resistance check of Power Supply Unit RA–101–A.
	b. Check spark gap compartment resistances.
	c. Check resistance in r-f unit.
3. Defective transmitter tube.	3. Replace transmitter tube.
4. Defective transmitter tube magnet.	4. Transmitter tube magnet may have less than 1,950 gauss. Check by replacement.

E. SYMPTOM:

The firing of spark gap is irregular (in some cases this may cause underload relay 3–E–2 to chatter).

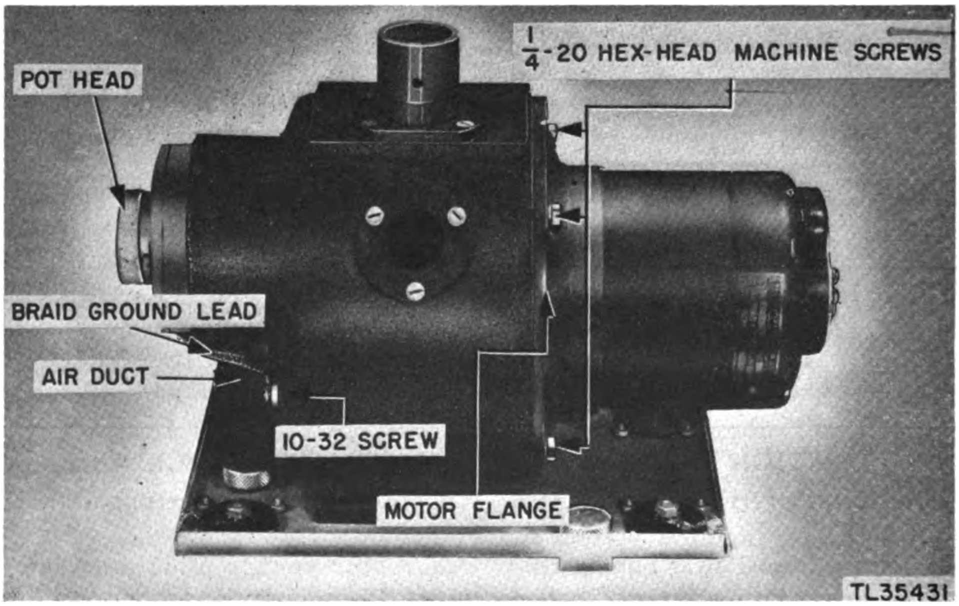

Figure 169. Rotary spark gap, exterior view.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Rotary spark gap.	1*a*. Check the overlap between the moving and stationary pins.
	b. Check the condition of pins.
	c. Adjust if necessary as explained in paragraph 87.
	d. Check slip ring and brushes.
2. Spark gap motor 3–A–4.	2*a*. Check for a loose connection to motor.
	b. Check connection 4 on 3–K–4 and 6 on 3–K–5.
3. Intermittent open or short circuit anywhere in system.	3. Make complete visual and resistance checks until defect is found.

F. SYMPTOM:

Rectifier current high and transmitter current normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Defective part or connection.	1. Make resistance measurements in spark gap and power supply units, and r-f unit.

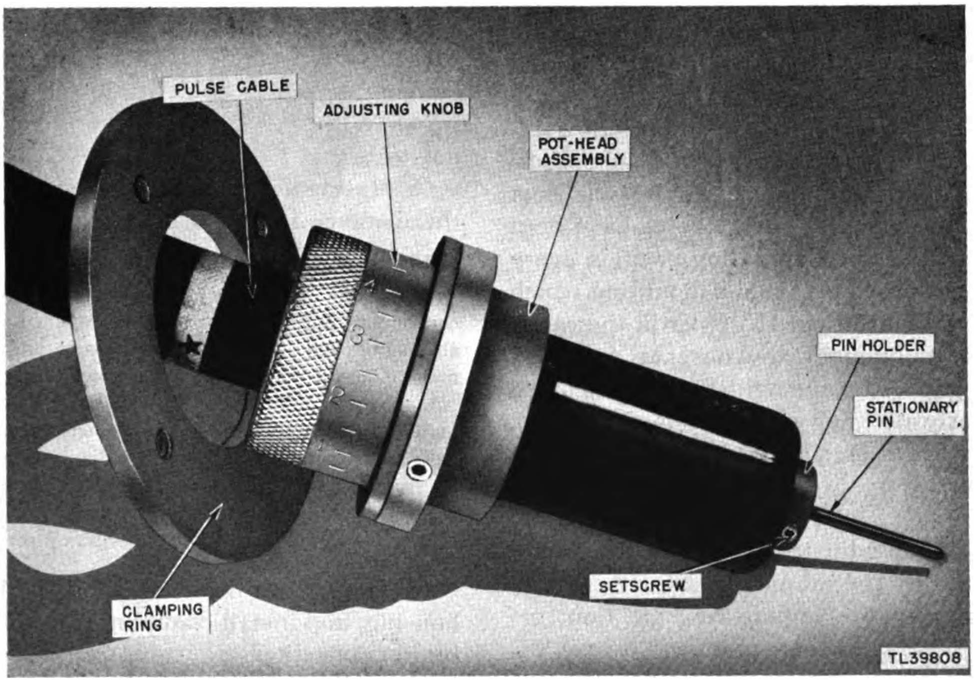

Figure 170. Stationary pin of rotary spark gap.

87. Adjustment of Spark Gap

Caution: Do not attempt to make any adjustment of the spark gap with the wheel revolving.

a. Remove viewer window by removing three 8–32 screws in the window retaining ring (fig. 169).

b. Check the pin overlap. Pins should overlap approximately ¼ inch. If the pins overlap too much, the gap may fire to the wheel or fan, or it may fire erratically. If the overlap is too small, the pin life for a given setting will be decreased. If it is necessary to adjust the overlap, follow the procedure described in paragraph 88*c*, but change the protrusion of the pin from the pin holder by the amount necessary to provide about ¼ inch overlap.

c. Loosen the four 10–32 screws in the clamping ring (fig. 170) around the adjusting knob sufficiently to allow the knob to be turned.

d. Remove the four screws which mount the pot-head on the other end of the pulse cable to the pulse forming line bracket at the rear of the chassis.

e. Rotate the wheel slowly with the finger through the viewer window opening; at the same time rotate the adjuster knob slowly counterclockwise (toward graduation 0) until the pins just touch. Slowly rotate the wheel one full revolution and adjust the knob so that the stationary pin just touches the highest rotating pin. Turn the spark adjuster knob one-half division clockwise, that is, one half the distance between the numbered calibration pins on the knob. This will give a gap spacing of between 0.008 and 0.012 inch.

f. Tighten the four 10–32 screws in the clamping ring, being careful to avoid changing the setting of the adjuster knob.

g. Rotate the wheel again by hand to make sure no pins touch. If any pin touches when the wheel is rotated by hand, the screws in the clamp ring are probably too loose. Repeat steps *c*, *d*, *e*, *f*, and *g* if any pin touches.

h. Install the viewer window and window retaining ring, and replace the four pot-head mounting screws in the position which requires the least twist in the pulse cable. Twelve holes have been provided which permit a mounting position every 30° and make it possible to find a mounting which will not require more than 15° twist in the cable.

i. Start the equipment and observe operation of the spark gap. After the adjustment is changed and particularly after new pins have been installed, the gap may fire somewhat erratically for about 12 to 24 hours.

j. Do not under any circumstances attempt to turn the spark gap adjuster knob while the wheel is being driven by the motor. Be sure the screws in the adjuster knob clamping ring are tight before starting the spark gap motor.

88. Replacement of Parts

a. Changing Rectifier Type WE–705–A Tubes.

(1) Make certain that all power and high-voltage switches are OFF.

(2) Open the front panel door. Make sure high-voltage capacitor is shorted out.

(3) Remove air filter from side of cabinet. Tubes may be changed from the front, but it is easier to work from the air filter opening.

(4) Unclip plate connectors.

(5) Using a short screwdriver, turn the retaining hooks counterclockwise to release the tubes.

(6) Remove the old tubes and replace with new tubes.

(7) Turn the retaining hooks to lock the tubes. Replace the plate connectors and install the air filter.

b. Removing Spark Gap GA–9–A (Rotary).

(1) Disconnect Cords CD–944 and CD–943.

(2) Remove well into which these cords fit.

(3) Disconnect the numbered terminal leads on cord 6 from terminal boards 3–K–4 and 3–K–5.

(4) Remove Cord 7 from switch 3–S–7.

(5) Remove the four Allenhead screws along the front edge of the chassis.

(6) Slide Spark Gap GA–9–A (Rotary) from the cabinet.

c. Replacing Stationary Pin in Spark Gap.

(1) Remove the 10-32 screws from the pot-head clamping ring (fig. 170).

(2) Carefully withdraw pot-head from spark gap housing. (The pins are made of tungsten and are very brittle. Be careful.)

(3) Loosen the 6–32 Allenhead setscrew which fastens the pin in holder.

(4) Withdraw pin from the holder. Be careful not to break it off.

(5) Insert new pin and tighten setscrew so that the distance from pot-head face to end of pin is 1$\frac{1}{16}$ inches.

Note. The stationary pins are rounded on both ends; consequently, a worn pin may be reversed. These pins are also somewhat longer than necessary, and the worn end may be cut off making the pin usable. These pins should be cut off by grinding; the end should be ground approximately to a hemisphere. In an emergency, ordinary iron nails approximately 0.1 inch in diameter may be cut to length and ground for a tungsten substitute. The iron pin life will be quite short, but with careful maintenance, iron pins will be satisfactory for emergency service.

(6) Insert pot-head assembly with spark gap housing, and install clamping ring screws and the braid connection.

(7) Adjust the gap spacing as outlined in paragraph 87, Adjustment of Spark Gap.

d. Replacing Spark-gap Brushes. (1) Tag for replacement and remove connections from the spark-gap motor.

(2) Remove the ¼-20 hex-head machine screws from the motor flange.

(3) Carefully withdraw the motor and wheel assembly from the spark-gap housing. This can be accomplished without removing the chassis if the motor is moved straight back until the flange fit clears the pilot on the housing. (It may be

necessary to wedge the motor flange loose with a screwdriver.) Tilt the end of motor up and withdraw the spark-gap wheel in the same motion. This should be done carefully to avoid breaking the pins. Figure 171 shows spark-gap brushes in the spark-gap housing after the motor and wheel assembly are withdrawn.

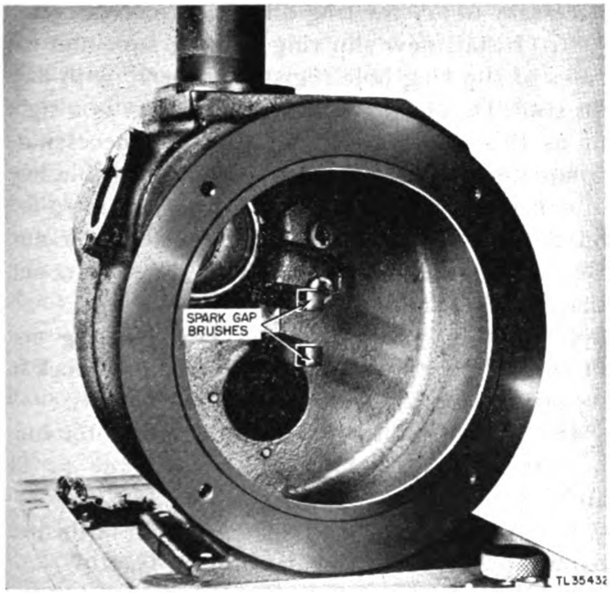

Figure 171. Spark-gap housing, showing brushes.

(4) Remove the 10-32 screw holding the braid ground lead to the pot head on the left side of the spark-gap assembly.

(5) Remove the three 10-32 screws holding the air duct to the spark-gap housing. Remove the air duct.

(6) Remove the brush-holder bracket through the air intake opening. Slide the bracket vertically downward as far as it will go and withdraw straight to the left. Figure 172 shows a picture of brushes and holder bracket.

(7) Remove the 6-32 screws that hold the brush spade terminal.

(8) Withdraw the brush assembly from the brush guide.

(9) Replace brushes if they are worn down so that they extend less than ⅛ inch beyond the brush holder. Insert a new brush assembly with the spade lug in the proper position and replace the 6-32 screws.

(10) Make sure that the brush does not bind in the brush guide. The brush spring should return the brush to the fully extended position without delay when the brush is pushed into the guide. If there is any tendency for the brush to stick, remove it from the guide; and if the inside of the guide is smooth, remove a small amount of brush material by rubbing the brush on a flat piece of fine sandpaper. (Do not take off too much; the brush must fit snugly in the guide but must not bind.)

(11) Reassemble by reversing the above procedure.

(12) Adjust the spark-gap spacing by the procedure given in paragraph 87.

e. Replacing Rotating Pins in Spark Gap.

Caution: The spark-gap pin holes are drilled after the wheel and hub are assembled to insure concentricity. This assembly should be taken apart only when it becomes absolutely necessary. When it is necessary to disassemble the wheel, the hub, bakelite block, and the wheel should be marked so that they may be reassembled in the same relative position. Three scratch marks at 120° intervals around the circumference of mating parts will assist in reassembling in the proper position. If suitable equipment is available, mount the hub on a mandrel in a lathe (or on the motor shaft) and check the eccentricity of the pin circle. Some correction for eccentricity may be made by loosening the screws and tapping lightly.

(1) Tag for replacement and remove connections from spark gap drive motor.

(2) Remove the ¼-20 hex-head machine screws from motor flange.

(3) Carefully withdraw motor and wheel assembly (fig. 173) from spark gap housing. This can be accomplished without removing the chassis if the motor is moved straight back until the flange fit clears pilot on housing. It may be necessary

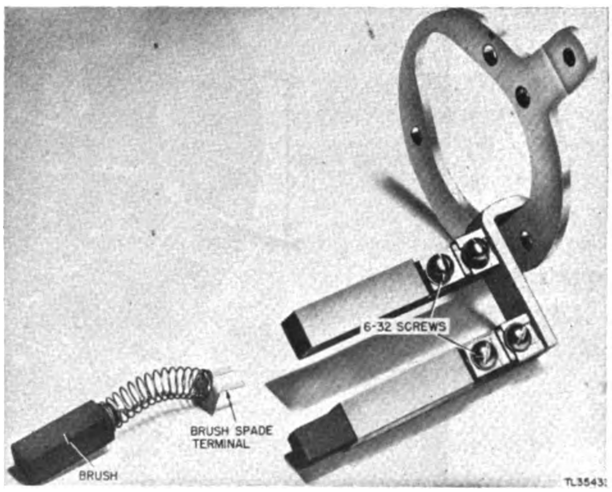

Figure 172. Brushes of rotary spark gap.

to wedge the motor flange loose with a screwdriver. Tilt the end of the motor up and withdraw spark gap wheel in the same motion. This should be done carefully to avoid breaking the pins.

(4) Loosen the 6-32 Allenhead setscrews in the periphery of the wheel.

(5) Pull out the pins carefully so that they are not broken off.

(6) Insert new pins with the rounded end pointing away from the wheel and with the square end flush with the back of the wheel. Tighten the setscrews.

(7) Carefully insert wheel into housing and fit motor flange to housing with terminal block in its original position. Avoid damage to pins.

(8) Replace motor flange bolts and motor connections. Be sure connections are made to T1 and T2.

(9) Adjust spark gap spacing as described in paragraph 87, Adjustment of Spark Gap.

f. REPLACING SPARK GAP SLIP RING. (1) Tag for replacement, and remove connections from spark gap drive motor.

(2) Remove the ¼-20 hex-head machine screws from motor flange.

(3) Carefully withdraw motor and wheel assembly from spark gap housing. This can be accomplished without removing the chassis if motor is moved straight back until flange fit clears pilot on housing. It may be necessary to wedge the motor flange loose with a screwdriver. Tilt the end of motor up and withdraw spark gap wheel in the same motion. This should be done carefully to avoid breaking the pins.

(4) Remove shoulder nut at center of slip ring (fig. 173).

(5) Remove slip ring from stud. It may be necessary to pry the ring off with a screwdriver.

(6) Install new slip ring making sure that flat sides of slip ring hole register properly with flats on stud. Do not drive slip ring on if it is a tight fit as this may loosen the stud and necessitate complete disassembly of wheel and possible loss of concentricity of pins. Draw slip ring down flat on the rotor face by means of the shoulder nut. Be sure the slip ring is drawn down flat, and that it will run true.

(7) Carefully insert wheel into housing and fit motor flange to housing with terminal block in its original position. Avoid damage to pins.

(8) Replace motor flange bolts and motor connections. Be sure connections are made to T1 and T2.

(9) Adjust spark gap spacing as described in paragraph 87, Adjustment of Spark Gap.

(10) Run the spark gap motor without firing the gap for at least a half hour to permit brushes to seat to the new ring.

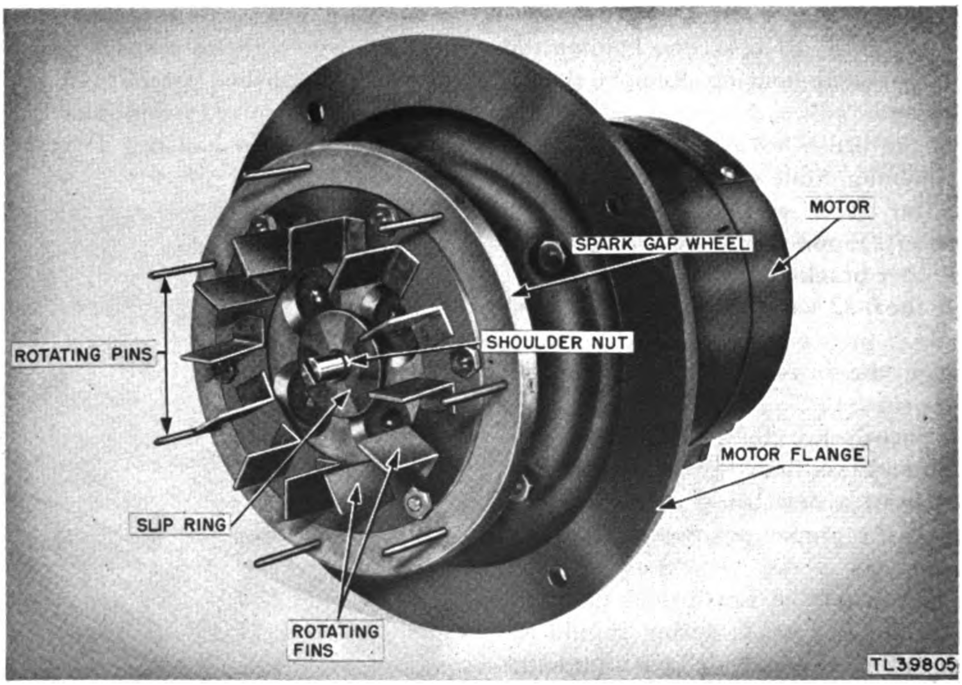

Figure 173. Rotary spark gap disassembled, showing rotating pins and slip ring.

g. **Replacement of Transmitter Tube.** In general, the necessity of replacement of transmitter tube 1–V–1 may be indicated by a reduction in system sensitivity or by a change in the voltage required to give normal transmitter tube plate current. Since both of these symptoms may be indicative of trouble elsewhere, before making any replacement, take a measurement of the radio-frequency output power and spectrum. If either the maximum current reading or the shape of the spectrum curve deviates greatly from normal, the transmitter tube should be changed. Replace as follows:

(1) On Pedestal FT–458–A, turn the three switches (ROTATE, SAFETY, and R.F. UNIT) to their OFF positions.

(2) Set elevation of Antenna AN–134–A to about —5° (pointing slightly downward).

(3) Remove air filter on transmitter tube blower 1–A–4, then remove outside cover from Radio Frequency Unit BC–1224–A.

(4) Connect shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2.

(5) Remove filament connector 1–K–15 from transmitting tube 1–V–1.

(6) Loosen thumbscrews holding the two clamps for transmitting tube 1–V–1 through one full turn.

(7) Loosen only the two knurled head screws which hold outer magnet bracket to base of the radio-frequency unit.

(8) Slide this bracket to the left as far as possible. It may not slip easily because of the weight upon the supporting screws; partially support the weight with one hand.

(9) Uncouple T.T. coupling 1–A–9 from tee-junction 1–A–10 by removing the four cap screws and lockwashers.

(10) Loosen the two thumbscrews referred to in subparagraph (6) above, and rotate the two clamps which they hold through 90°.

(11) Slide transmitter tube 1–V–1 and T.T. coupling 1–A–9 to the left as far as possible, then swing this assembly counterclockwise before lifting it out. Unscrew the knurled screw on T.T. coupling 1–A–9 and pull it off carefully with a straight line motion. Remove the gasket from the tube.

Caution: THE R-F INNER CONDUCTOR ON TRANSMITTER TUBE 1–V–1 IS GLASS SUPPORTED. THE GLASS WILL BREAK VERY EASILY.

(12) Remove a new tube from its box and carefully unscrew the fibre cylinder.

(13) Insert the gasket on the new tube.

(14) Assemble T.T. coupling 1–A–9 on the new tube, and screw the fibre cylinder on the old one.

(15) Place the transmitter tube and T.T. coupling assembly on the mounting plates, swinging it into position with a clockwise motion.

(16) Hold the tube in the left hand and the spring inner conductor lightly in the right hand, then move the tube over until the two inner conductors barely touch. Center the transmitter tube inner conductor in the spring conductor; gently slip the spring conductor over the tube conductor.

(17) Couple T.T. coupling 1–A–9 to tee-junction 1–A–10 and tighten the four screws.

(18) Slide outer magnet bracket to the right until transmitter tube 1–V–1 is centered between the pole faces of magnet 1–A–14. Tighten the two knurled screws which hold this bracket to the base of the radio-frequency unit.

(19) Turn the two clamps holding the transmitter tube to the normal position; tighten the thumbscrews.

(20) Replace filament connector 1–K–15 on transmitter tube 1–V–1.

(21) Remove shorting jumper 1–S–8 from the strap and clip it on to ground.

(22) Reset Antenna AN–134–A to normal position.

(23) Connect a temporary jumper across the terminals of cover interlock switch 1–S–7.

(24) Turn r–f unit switch 1–S–4 and SAFETY switch 1–S–5 ON.

Caution: CLOSING SAFETY SWITCH 1–S–5 PERMITS HIGH VOLTAGE TO BE APPLIED TO MODULATOR UNIT BC–1194–A. EXTREME CARE MUST BE EXERCISED WHEN EQUIPMENT IS OPERATED WITH COVER REMOVED FROM RADIO-FREQUENCY UNIT. TERMINALS OF TRANSMITTER TUBE 1–V–1, SOCKET CONNECTOR 1–K–13, AND PULSE TRANSFORMER 1–T–2 OPERATE AT PEAK VOLTAGES AS HIGH AS 20,000 VOLTS. AS A SAFETY MEASURE, TWO MEN MUST BE PRESENT WHENEVER THE EQUIPMENT IS OPERATED WITH COVER REMOVED FROM THE RADIO-FREQUENCY UNIT.

(25) Place equipment in operation.

(26) Check the crystal current (par. 97*b*).

(27) Since the new transmitter tube may be slightly different in frequency from the old one,

local oscillator tube 2–V–15 of Radio Receiver BC–1223–A may have to be retuned (par. 97*c*).

(28) Remove the analyzer lead from the receiver.

(29) Follow the procedure of finding a target and tuning the T–R box as described in paragraph 92*b*.

h. Magnet Replacement. Magnet 1–A–14 used in Radio Set SCR–682–A is adjusted to a flux density of 1,950 gauss. Replacement normally will be unnecessary except in cases of rough handling. An appreciable reduction in the air gap flux density of magnet 1–A-14 will reduce the plate voltage necessary to give 10 milliampere transmitter current. Since this same effect may be caused by a poor transmitter tube, change the transmitter tube before the magnet is replaced.

Caution: The flux density of the magnet will be reduced by mechanical shocks. Handle it carefully. Steel tools or parts should not be brought close to the air gap. Note that the flux field intensity is high enough to magnetize nearby watches.

(1) On Pedestal FT–458–A, turn the three switches (SAFETY, ROTATE and R.F. UNIT) to their OFF positions.

(2) Set elevation of Antenna AN–134–A to about —5° (pointing slightly downward).

(3) Remove air filter on transmitter tube blower 1–A–4, then remove outside cover from the radio-frequency unit.

(4) Connect a shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2.

(5) Remove filament connector 1–K–15 from transmitter tube 1–V–1.

(6) Loosen the thumbscrews holding the two clamps for transmitter tube one full turn.

(7) Loosen only the two knurled head screws which hold outer magnet bracket to base of the radio-frequency unit.

(8) Slide this bracket to the left as far as possible. It may not slip easily because of the weight upon the supporting screws. Partially support the weight with one hand.

(9) Uncouple T.T. coupling 1–A–9 from tee-junction 1–A–10 by removing the four cap screws and lockwashers.

(10) Loosen the two thumbscrews referred to in subparagraph (6) above, and rotate the two clamps which they hold through 90°.

(11) Slide the transmitter tube and T.T. coupling to the left as far as possible, then swing this assembly counterclockwise before lifting it out.

(12) Remove the ground wire from the inner magnet bracket.

(13) Tighten the top knurled thumbscrew. Remove the other three screws holding outer magnet bracket to the base of the radio-frequency unit.

(14) Hold the bracket in one hand while removing remaining thumbscrew.

(15) Tilt the bracket to left, and lift out.

(16) Remove the four screws holding magnet to inner bracket, and lift it out.

(17) Remove the cylindrical keeper from new magnet 1–A–14. This requires application of considerable force. Hold the base of the magnet firmly, and pull the keeper out with a rolling motion.

(18) Mount the new magnet in the bracket with the pole marked north (N) nearest the back mounting plate of the outer bracket.

(19) Carefully replace the keeper in the old magnet. Hold the keeper between the thumb and first two fingers in such a way that no part of the hand can be caught between the keeper and pole faces as the magnet field pulls keeper in center.

i. Replacing Pulse Transformer 1–T–2. (1) On Pedestal FT–458–A, turn the three switches (SAFETY, ROTATE, and R.F. UNIT) to their OFF positions.

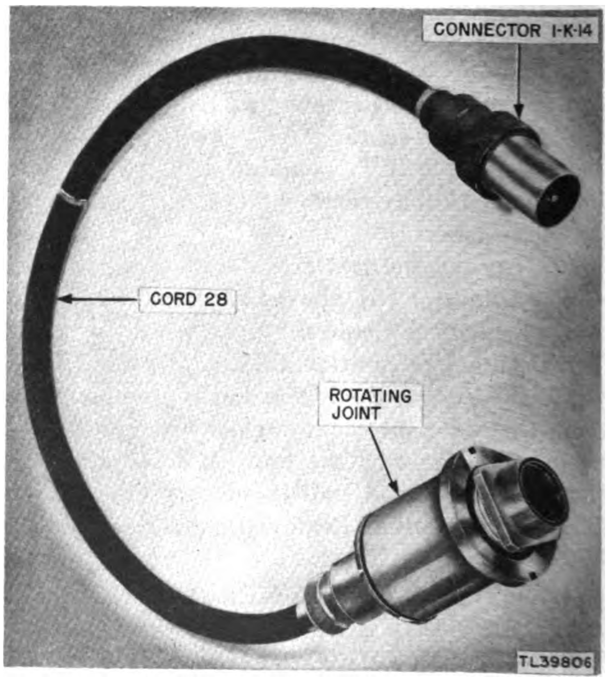

Figure 174. Cord 28 and high-voltage rotating joint.

(2) Set the elevation of Antenna AN–134–A to about —5° (pointing slightly downward).

(3) Remove the air filter on transmitter tube blower 1–A–4, then remove outside cover from the radio-frequency unit.

(4) Connect shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2.

(5) Remove filament connector 1–K–15 from transmitter tube 1–V–1. Disconnect the three remaining leads from the pulse transformer.

(6) Remove the four mounting screws at the base of the pulse transformer and carefully lift it out. (Remove the top left screw last.)

(7) Remove assembly from end of pulse transformer bushing.

(8) Carefully mount this assembly on new pulse transformer 1–T–2.

Caution: Solderseal bushings are fragile. The assembly must not be forced on the bushings, and care must be exercised when mounting nuts are tightened.

(9) Insert left top screw first, and mount new transformer on base of radio-frequency unit.

(10) If necessary, set the two plates of air capacitor 1–C–2 so they are parallel. (The top circular plate is mounted on a swivel to permit adjustment.)

(11) Remove shorting jumper 1–S–8 from the strap and clip it on the ground.

(12) Reset Antenna AN–134–A to normal elevation.

(13) Connect a temporary jumper across terminals of cover interlock switch 1–S–7.

(14) Replace cover and air filter on the radio-frequency unit.

(15) Set up synchroscope for observation of voltage pulse at transmitter tube 1–V–1.

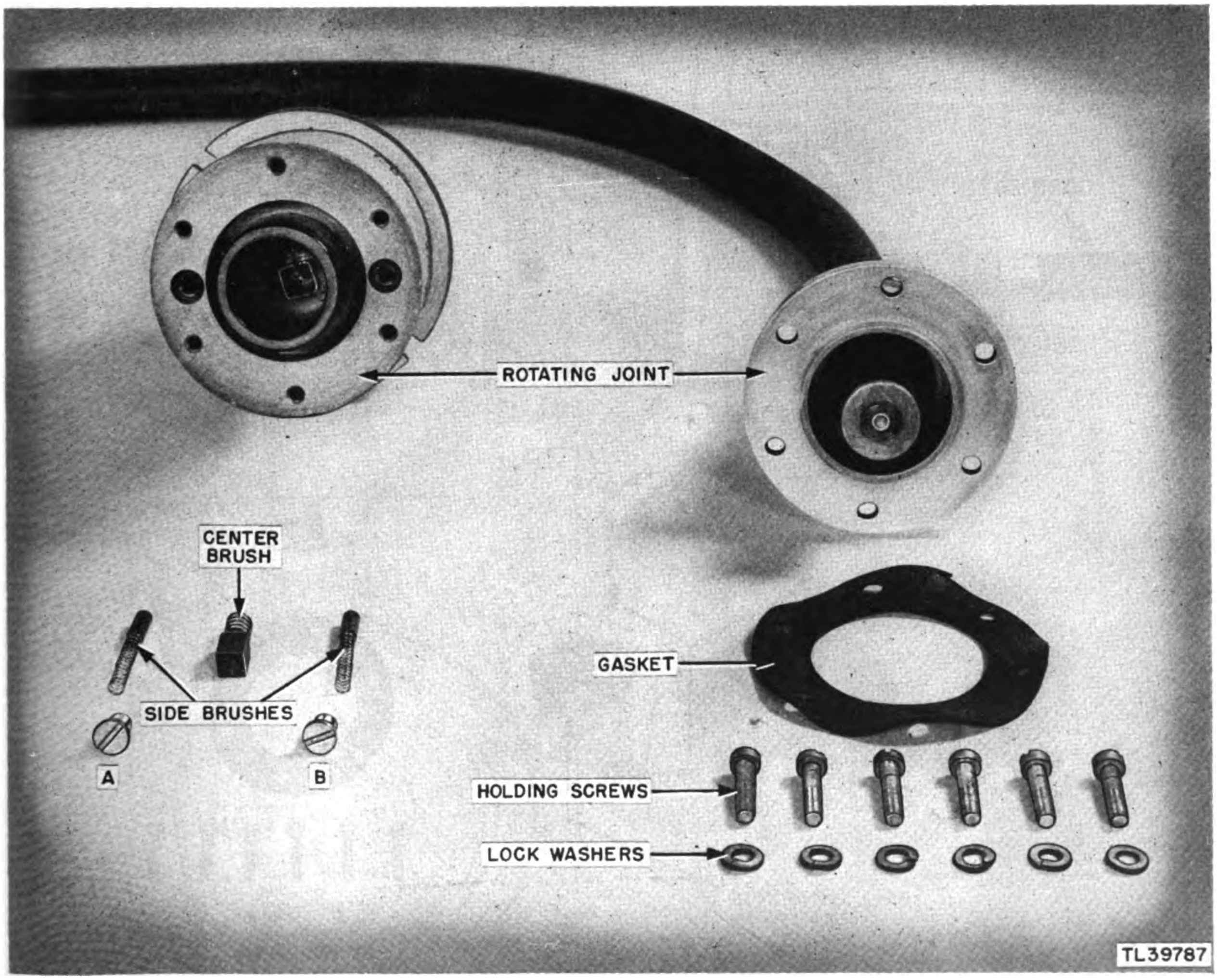

Figure 175. Rotating joint, disassembled for replacement of brushes.

(16) Turn ON only the R.F. UNIT and SAFETY switches on base of the pedestal and place equipment in operation.

(17) Check the voltage pulse at the transmitter tube for normal shape (par. 85*d*).

(18) Turn off the equipment.

(19) Disconnect and remove synchroscope.

j. Replacement of Capacitor 1–C–1 or Resistor 1–R–1. (1) On Pedestal FT–458–A, turn the three switches (SAFETY, ROTATE and R.F. UNIT) to the OFF position.

(2) Remove air filter on transmitter tube blower 1–A–4; then remove outside cover from radio-frequency unit.

(3) Connect shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2.

(4) Remove the two screws mounting the assembly containing the lower circular plate of air capacitor 1–C–2 (fig. 29) from the top base channel of the radio-frequency unit.

(5) Remove the metal cover plate from the assembly after taking out the two screws.

(6) Remove the two end screws holding the mycalex plate to the painted bracket.

(7) Carefully pull the mycalex plate away from this bracket so that the resistor and capacitor are exposed.

(8) Replace faulty component.

(9) Replace the mycalex plate, and press bodies of resistor and capacitor against it.

(10) Check for shorts and continuity.

(11) Replace metal cover plate.

(12) Mount assembly to channel.

(13) Remove shorting jumper from strap and clip it to ground.

(14) Replace cover and air filter on the radio-frequency unit.

(15) Set up the synchroscope for observation of voltage pulse at transmitter tube 1–V–1 (par. 85*d*).

(16) Turn on only the R.F. UNIT and SAFETY switches on base of the pedestal, and place equipment in operation.

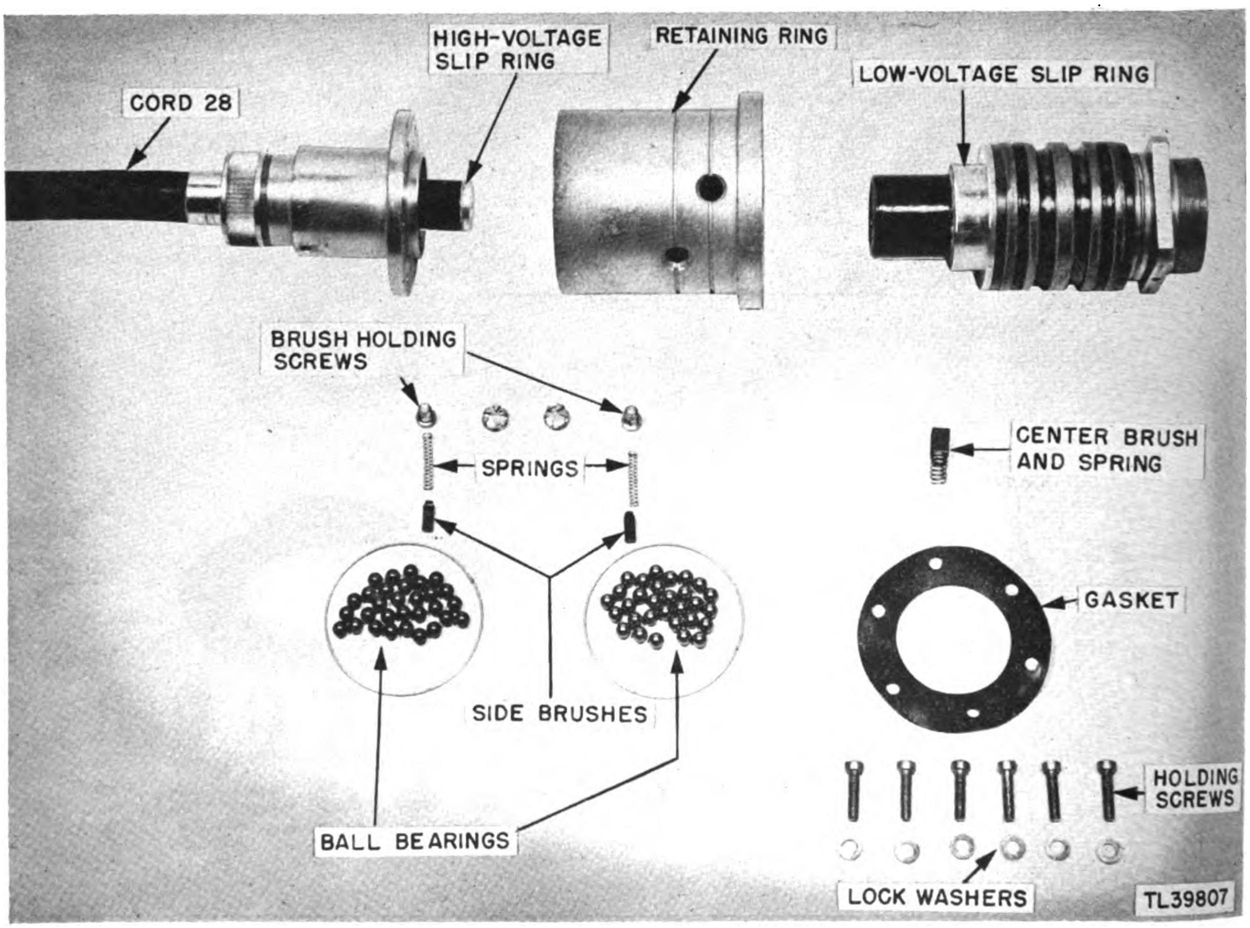

Figure 176. Rotating joint, completely disassembled.

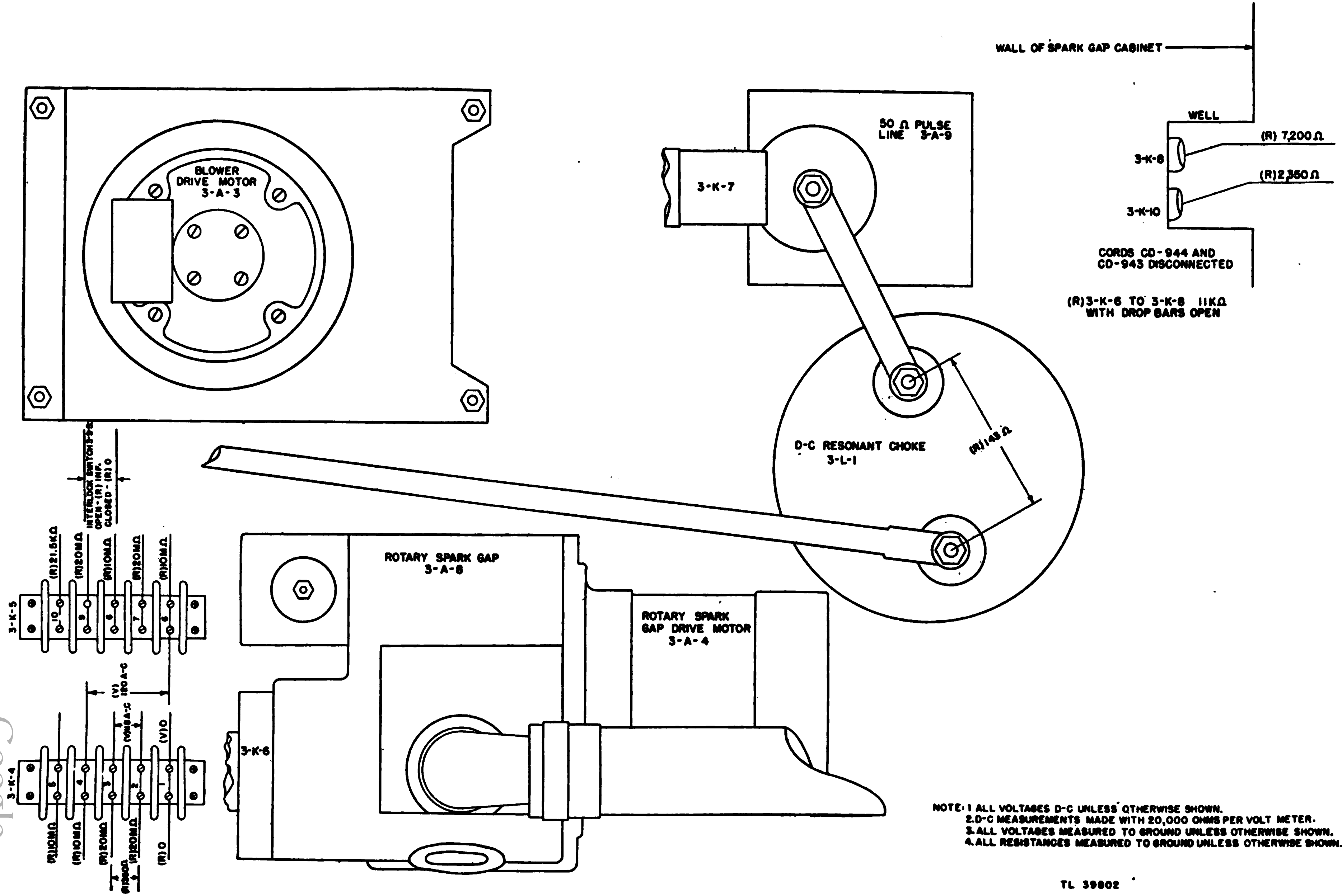

Figure 177. Spark Gap GA–9–A (Rotary), voltages and resistances.

(17) Check voltage pulse at transmitter tube for normal shape.

(18) Turn off equipment.

(19) Disconnect and remove synchroscope.

k. ROTATING JOINT, REPLACEMENT OF BRUSHES. To inspect or replace these brushes, proceed as follows:

(1) Remove the guide bracket (fig. 33) on the under side of the pedestal by taking out the four holding screws. This guide may be reached through the opening in the center of the tower platform, making the disassembly of the spinner unnecessary.

(2) Remove the retaining ring by taking out the three holding screws. The rotating joint 1–A–5 will now be free to fall clear of its sleeve in the pedestal after cord 28 has been disconnected. To do this, take the following steps:

(*a*) Have one person hold the rotating joint so that it will not fall, or tie it in a secure position.

(*b*) Remove the clamp holding cord 28 to the r–f unit.

(*c*) Disconnect connector 1–K–14 from socket connector 1–K–13.

(3) *Slowly* allow the rotating joint to lower from the pedestal. *Be careful not to damage the connection between cord 28 and connector 1–K–14* while removing the rotating joint (with cord attached, fig. 174) from the pedestal.

(4) After carrying the rotating joint assembly

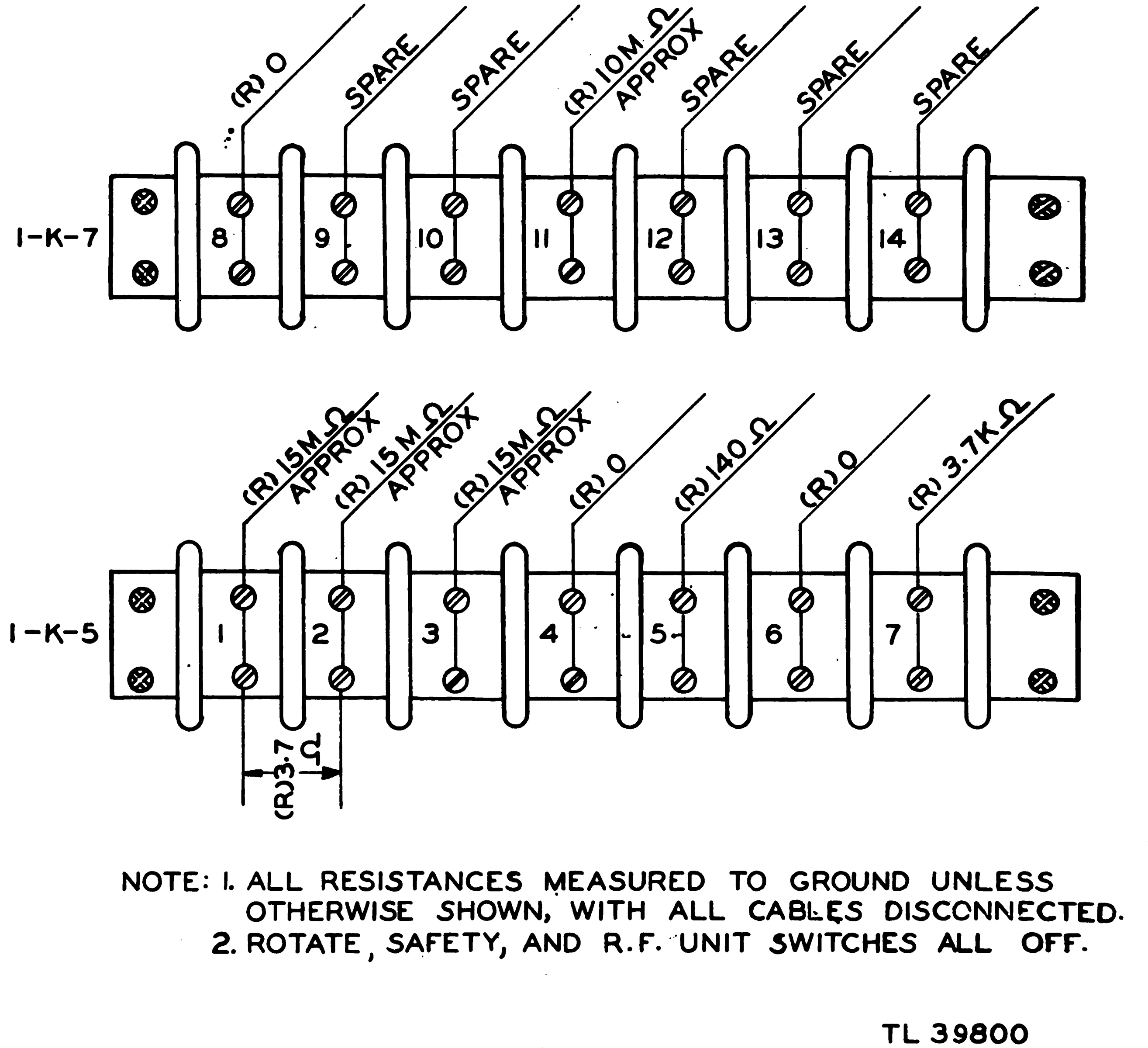

Figure 178. Pedestal FT–458–A, resistances.

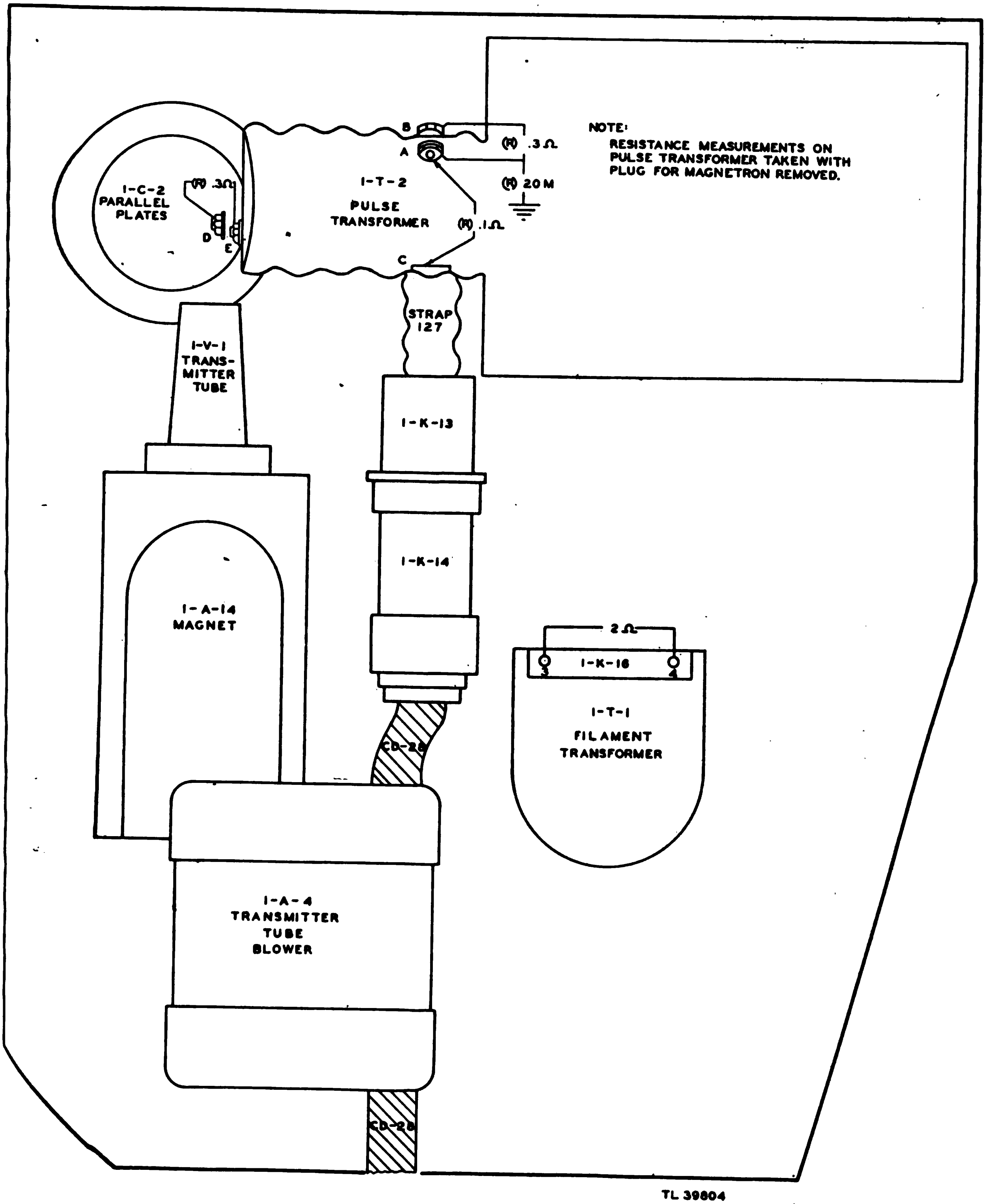

Figure 179. Radio Frequency Unit BC-1224-A, resistances.

to a convenient working space, proceed to remove the center brush. Do this by removing the six holding screws on the bottom of the assembly. The ring and brush will then fall out (fig. 175).

(5) Remove the two side brushes by unscrewing the two holding screws (*A* and *B* in fig. 175).

(6) The brushes may now be replaced, if necessary, and the rotating joint inspected. A reverse procedure may be used for reassembly and replacement. Make certain that the gasket clamping ring is securely tightened to avoid seepage of moisture into the joint. A leaky gasket accompanied by moisture in the rotating joint will lower the operating efficiency of the equipment.

(7) Figure 176 shows rotating joint 1–A–5 completely disassembled.

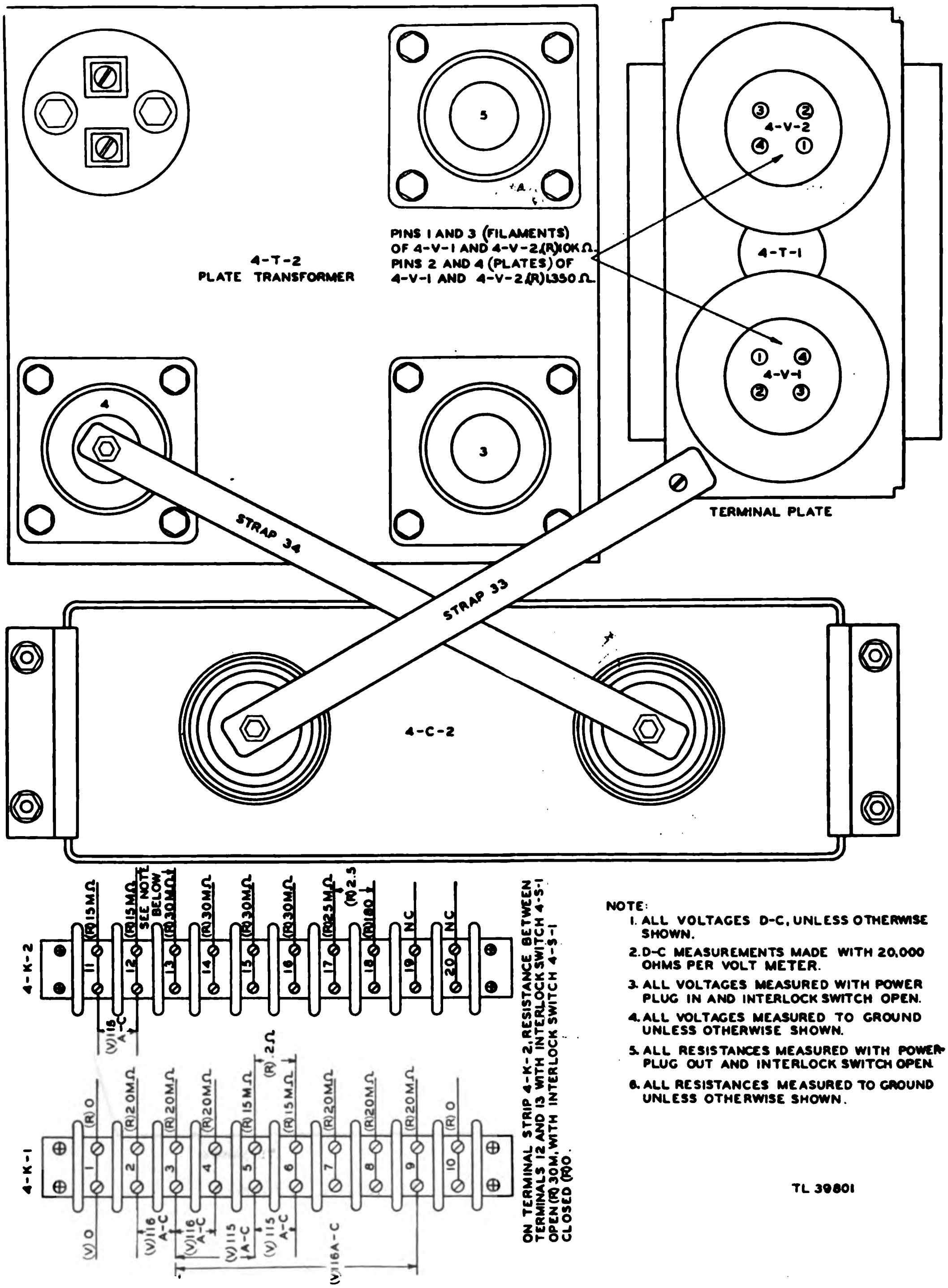

Figure 180. Power Supply Unit RA–101–A, voltages and resistances.

WIRE	FROM
CABLE HA	
140	3K4-2
141	3K4-3
142	3K4-4
143	3K5-6
144	3K5-8
145	3K5-9
146	3K5-10
147	3F3 (BOT.)
148	3F1 (BOT.)
149	3F2(BOT.)
150	3L2
151	3C2
152	3R12
153	3K3-6
154	
155	
156	
157	
158	
159	
DIRECT LEA	
160	3A9
161	3A9
162	3A9
163	3K10
164	3A9
165	3R14(BOT)
166	3L1
167	
168	3K4-1
169	3F1(TOP)
170	3R12
171	3K6
172	3A8 FRAME
173	3A8 FRAME
174	3A8 FRAME
175	3A8 FRAME
176	
177	
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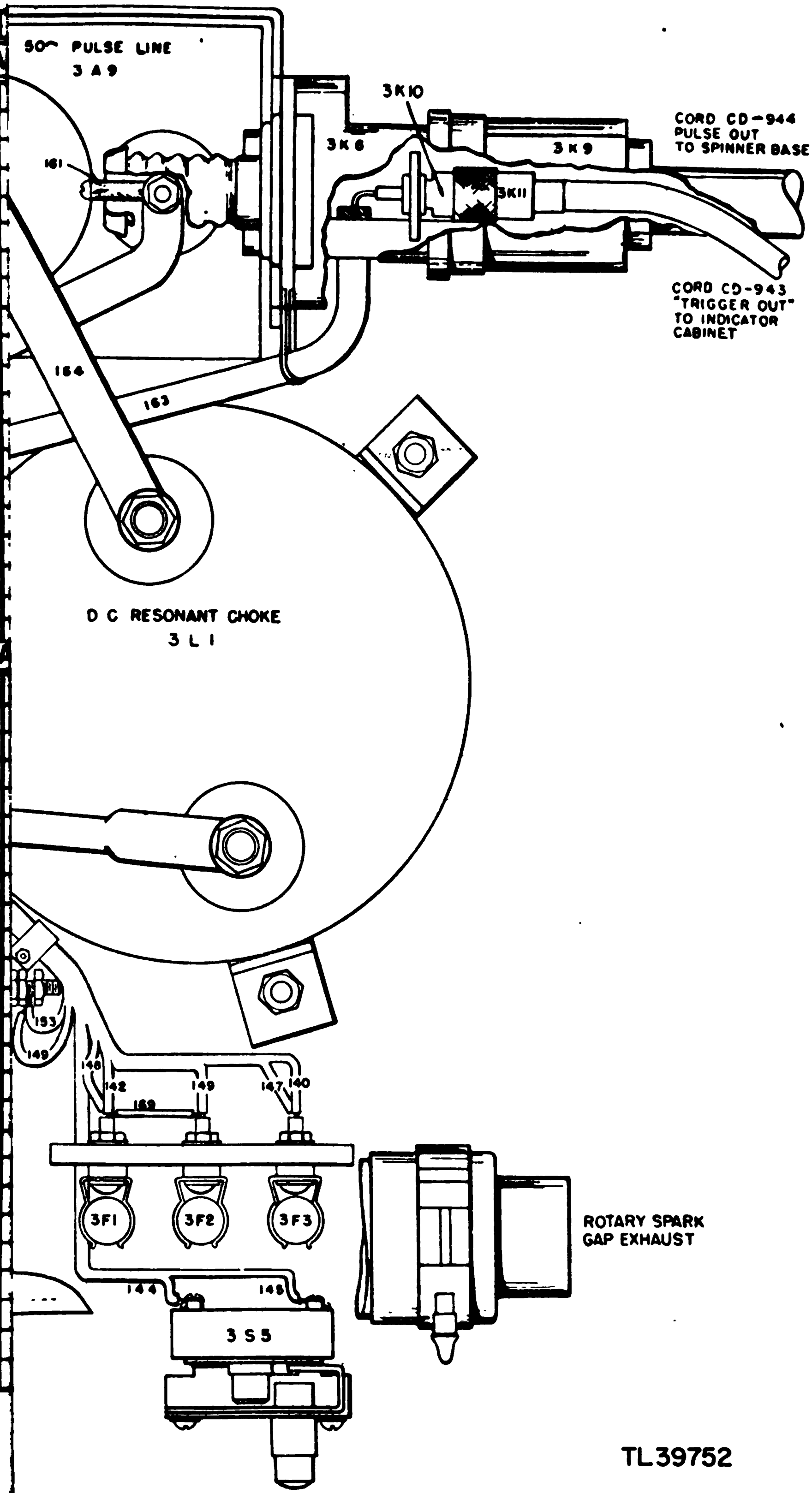
184	



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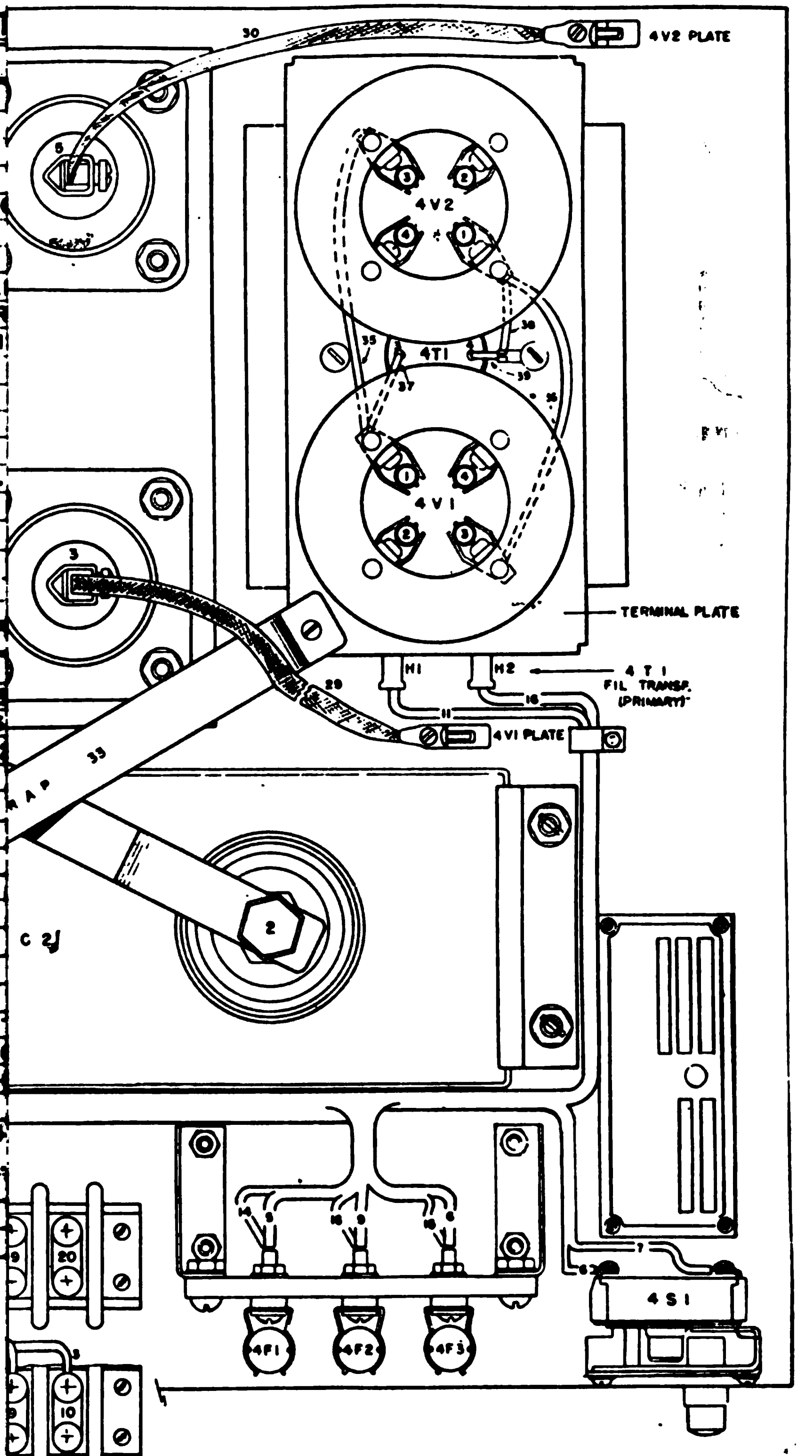
to a convenient working space, proceed to remove the center brush. Do this by removing the six

procedure may be used for reassembly an placement. Make certain that the gasket c

WIRE	FROM	TO	DESCRIPTI
CABLE HARNESS NO. 6			
1	4K2-12	4E1-1	YEL. NO.16
2	4K2-11	4E1-2	YEL. NO.16
3	4K1-10	4E1-4	YEL. NO.16
4	4K2-18	4E1-6	YEL. NO.16
5	4K1-2	4F1 (TOP)	WHITE NO.1
6	4K2-12	4S1	YEL. NO.16
7	4K2-13	4S1	YEL. NO.16
8	4K2-14	4F3 (TOP)	BROWN NO.
9	4K1-5	4F2 (TOP)	BLK.-RED TR
10	4K2-16	4R1 (BOT)	BROWN NO.1
11	4K1-6	4T1-H1	BLACK NO.
12	4K2-17	4T2-H2	BROWN NO.
13	4K2-18	4T2-4	BROWN NO.
14	4K1-9	4F1 (BOT)	BROWN NO.
15	4K2-15	4F3 (BOT)	BROWN NO.
16	4F2 (BOT)	4T1-H2	BROWN NO.
17	4R2 (BOT)	4T2-H1	BROWN NO.
18			
19			
20			
DIRECT LEAD (JUMPER)			
21	4C1-1	4K1-2	WHITE NO.16
22	4C1-2	4K1-3	BLACK NO.16
23	4C1-C	GROUND	BARE NO.16
24	4K1-1	GROUND	BROWN NO.1
25	4E1-1	4E1-3	YEL. NO.16
26	4E1-5	INSULATOR NO.1-1	YEL. NO.16
27	INSULATOR NO.1-2	4R3 (BOT)	YEL. NO.16
28	4R1 (TOP)	4R2 (TOP)	STRAP
29	4T2-3	4V1 PLATE	BRAID
30	4T2-5	4V2 PLATE	BRAID
31	4C2-1	4R3 (TOP)	STRAP
32	4R3 (TOP)	INSULATOR NO.2 TOP	TUBING
33	4C2-1	TERM. PLATE	STRAP
34	4C2-2	4T2-4	STRAP
35	4V1-1	4V2-3	BROWN NO.1
36	4V1-3	4V2-1	BROWN NO.1
37	4V1-1	4T1-3	BARE NO.14
38	4V2-1	TERM. PLATE	BARE NO.14
39	TERM. PLATE	4T1-4	BARE NO.14
40			
41			
42			



TL 39751

Warning: *Voltages sufficient to cause DEATH ON CONTACT are exposed in R. F. Unit BC-1224-A. Tests and adjustments may be necessary which require power to be applied. Do not place hands, arms, or other parts of body near high-voltage points located in upper left area of this unit. Test leads must not come in contact with high voltage points while power is applied. With power removed, short out high-voltage capacitors and clip shorting jumper to strap on pulse transformer before working in the unit.*

89. Reference Data

The following figures are included to assist maintenance personnel in trouble shooting the r-f system.

Figure 10, Pedestal FT-458-A, base.

Figure 47, Spinner assembly, rear view.

Figure 48, Spinner assembly, front view.

Figure 49, Radio Frequency Unit BC-1224-A, cover removed.

Figure 50, Transmitter oscillator, coupler, T-R box, tee-junction, A.F.C. coupler, and crystal mixers.

Figure 51, Transmitter oscillator, coupler, T-R box, tee-junction, A.F.C. coupler, and crystal mixers; disassembled.

Figure 55, R-f transmission-line connector.

Figure 56, Cross-sectional view of transmitter tube coupling.

Figure 57, T-R tube.

Figure 58, T-R box, simplified diagram showing resonant cavity.

Figure 59, T-R box, showing coupling loops.

Figure 61, T-R box, end caps removed.

Figure 62, T-R box, partially disassembled.

Figure 63, T-R box, completely disassembled.

Figure 65, A.F.C. coupler, cross-sectional view.

90. Behavior Analysis

Faults within the r-f system may make themselves known by weak signals or the lack of signals on the PPI scope, abnormal pulse waveform, or by erratic transmitter current. Since the r-f lines are pre-plumbed and very short (figs. 50 and 51), troubles within the lines should occur infrequently and corrective measures will usually consist of replacing a section of the line.

a. R-F ARCS IN TRANSMISSION LINE. R-f arcs within the transmission line can be most easily located by finding the origin of the sound of the arc and by feeling the r-f line for warm spots, especially near the transmitter tube. R-f arcs are most likely to be found at the coupling connection between two sections of line (fig. 51).

b. IMPROPER OPERATION OF T-R BOX. Improper operation of the T-R box may be determined by measuring the crystal current and noting the effects of changing the position of the pick-up loop within the T-R box (fig. 59). If the T-R box is not operating properly, it may pass a large portion of the transmitted pulse and cause excessive crystal current. This may be the result of a defective T-R tube (fig. 57), improper tuning of the T-R cavity, or the lack of *keep-alive* voltage on the T-R tube. If the pick-up loop within the T-R box is not positioned properly, or if the T-R tube is defective, the T-R box will not pass the received signals effectively and the strength of the signals on the PPI scope will be reduced.

91. Trouble-shooting Chart

A. SYMPTOM:
High-pitched singing noise coming from the general direction of the r-f line.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. R-f arc at some point inside the transmission line.	1*a*. Locate the origin of the sound by ear and by feeling near the transmitter tube. R-f arcs are most likely to be at the following places: (1) Coupling connections between two sec-

tions of line (bullet connector not properly spread).

(2) The bullet connector to the transmitter tube output lead.

(3) Unsoldered input coupling loop inside the T–R box (fig. 59).

b. When the location of the arc is found, turn off the set and remove the section of line containing the arc.

c. Examine the interior of the r–f line for signs of burning or pitting.

d. Replace entirely the faulty section unless the damage is very slight and can be corrected by spreading the tip of a bullet connector or by cleaning. If signs of burning are found on the output lead of the transmitter tube, it may be desirable to replace the tube as well as the connector bullet.

e. The proper procedure for replacing the transmitter tube is given in paragraph 88*g*.

B. SYMPTOM:

High signal crystal current (above 0.5 ma); A.F.C. crystal current normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Local oscillator coupling adjustment screwed in too far on crystal mixer.	1*a*. Reduce local oscillator coupling to crystal mixer by turning mixer coupling screw counterclockwise.
	b. If crystal current cannot be reduced by local oscillator input coupling, the T–R tube is probably faulty; if so, it must be replaced at once.
2. Bad T–R tube, permitting transmitted pulse to get past the T–R box.	2. Replace T–R tube. See replacement of T–R tube in paragraph 93.
3. No ionizing voltage on T–R box.	3*a*. Check keep-alive voltage connector for faulty connection.
	b. If connection is good, check keep-alive voltage.
	c. If keep-alive voltage is not approximately —600 volts, check the power supply for the keep-alive voltage. Tube 2–V–19 (6X5–GT) in Radio Receiver BC–1223–A supplies the keep-alive voltage.

C. SYMPTOM:

Noticeably weakened echoes on the PPI scope, from known fixed targets.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. T–R box out of tune.	1. Check tuning of T–R box cavity (par. 92*b*).
2. Defective T–R tube.	2. Replace T–R tube, using the procedure explained in paragraph 93. Visual inspection

of a T–R tube will often determine if it is defective. Check for discoloration of the glass envelope, which is a sign of a defective tube. This discoloration is caused by a thin coating of metal on the glass walls of the tube which creates low resistance paths and detunes the T–R cavity. The formation of this metal coating on the glass walls occurs during normal operation and necessitates frequent replacement of the T–R tube.

3. System out of tune or abnormal condition in receiver system.	3. See section VII, Trouble Shooting in the Receiver System.
4. Moisture in r–f line.	4. When all other tests on the equipment fail to locate the cause of weak signals and the weak signals are not caused by atmospheric conditions, check for moisture in the r–f line. Proceed by disassembling sections of the line and checking for presence of water or condensation. If moisture exists, dry all parts of the line out thoroughly before reassembling. See paragraph 92 for details on assembly and alignment procedures.

92. Alignment and Adjustments

a. Alignment of Plumbing. The coaxial line components such as 1–A–10 and 1–A–11 are normally referred to as "plumbing." Three plane adjustments have been provided for aligning the rigid plumbing carefully. Misalignment generally is evidenced by bends in the line or poor mating at the joints. Note particularly the alignment of transmitter tube coupling 1–A–9 where it connects to transmitter tube 1–V–1 (fig. 50). Since the body of the transmitter tube coupling is cushioned on rubber at the point of connection to the transmitter tube, it is possible for it and the rest of the plumbing to be out of line with the axis of tube output connection. Likewise, since part of the inner conductor of tee-junction 1–A–10 is mounted on a ball and socket joint, it is possible for this inner conductor to be eccentric with the body of the transmitter tube coupling. Mismatching of impedances and possible arcing between inner and outer conductor may result. The proper way to assemble the plumbing is to work from feed line 1–A–12 and antenna sphere 1–A–13 (fig. 48) to transmitter tube 1–V–1 (fig. 49). T–R box 1–A–8 with signal mixer 1–A–7 should not be connected to tee-junction 1–A–10 until step (20) given below is reached. The procedure for assembly or alignment of the plumbing follows:

(1) On Pedestal FT–458–A, turn the three switches (SAFETY, ROTATE, and R.F. UNIT) to their OFF positions (fig. 10).

(2) Set elevation of Antenna AN–134–A to about —5° (pointing slightly downward).

(3) Remove air filter on transmitter tube blower 1–A–4 and then remove outside cover from the radio-frequency unit (fig. 47).

(4) Connect shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2 (fig. 49).

(5) Remove filament connector 1–K–15 from transmitter tube 1–V–1.

(6) Make certain all gaskets are in place before fastening any parts together.

(7) Mount feed line 1–A–12 with antenna sphere 1–A–13 to the parabolic reflector, and tighten screws.

(8) Mount A.F.C. mixer 1–A–6 to A.F.C. coupler 1–A–11 with the plane of the loop in the mixer parallel to the axis of the male bullet connector in the A.F.C. coupler.

(9) Connect A.F.C. coupler 1–A–11 to feed line without tightening the four screws beyond the point where it is possible to turn the A.F.C. coupler by hand.

(10) Couple tee-junction 1–A–10 only to A.F.C. coupler, and tighten the four screws.

(11) Place transmitter tube coupling 1–A–9 on transmitter tube 1–V–1. Make certain that a gasket is in place on the tube and inside the knurled nut of transmitter tube coupling.

(12) The outer magnet bracket must be located in a vertical position as far to the left as possible.

(13) Mount tube and coupling. In the left hand hold the tube; in the right hand lightly hold the spring inner conductor; then move the tube over until the two inner conductors barely touch. Center the transmitter tube inner conductor in the spring conductor and gently, but firmly, slip the spring conductor over the tube conductor.

(14) Couple transmitter tube coupling 1–A–9 to the tee-junction, and tighten the four screws.

(15) Slide tube and coupler to the right far enough to check alignment.

(16) Tighten the two flange screws holding the flanges of the transmitter tube.

(17) Movement of the assembly of magnet 1–A–14, transmitting tube 1–V–1, and transmitter tube coupling 1–A–9 is possible in both the vertical and horizontal direction, toward or away from the base of the radio-frequency unit. Adjustments may be made by loosening the three knurled cap screws on each side of the outer magnet bracket, and moving the inner bracket.

(18) Angular movement in the horizontal plane is possible by loosening the four screws under the inner magnet bracket.

(19) After all necessary adjustments and checks have been made, loosen the two thumbscrews holding the transmitter tube and connect transmitter tube coupling to tee-junction 1–A–10.

(20) Move magnet brackets to the right until the transmitter tube is centered in the pole faces. Tighten screws holding this bracket.

(21) Mount signal mixer 1–A–7 to T–R box 1–A–8.

(22) Slightly loosen the coupling between the tee-junction and the A.F.C. coupling; swing the tee-junction out.

(23) Mount the assembly of the T–R box and the signal mixer to the tee-junction.

(24) Swing the T–R box back to the mounting brackets. It may be necessary to adjust these brackets. If so, adjustment is possible in all three planes.

(25) Tighten all screws and clamp T–R box with the ring retainer bracket provided.

(26) Replace cords 22 to 26 inclusive.

(27) Remove shorting jumper 1–S–8 from the strap and clip it to ground.

(28) Reset the antenna to normal elevation.

(29) Connect a temporary jumper across terminals of cover interlock switch 1–S–7.

(30) Replace cover and air filter on radio-frequency unit.

(31) Place the unit in operation.

b. Tuning T-R Box. (1) Set the SIG INPUT switch on the synchroscope to the AMP position. Set the TRIG-SELECTOR to EXT, and set TRIGGER POLARITY to NEG. Set VERT-GAIN control to maximum clockwise position. Set SWEEP SPEED to the range corresponding to the distance to a selected fixed target as indicated on the PPI tube. The numbered positions 1, 2, 3, and 4 on the SWEEP SPEED switch correspond to the four approximate maximum time-base ranges of 800, 4,000, 16,000, and 80,000 yards, respectively.

(2) Set the VIDEO AMPLITUDE control located on the indicator control unit so that no signal is more than ½ inch high (five divisions on the screen of the synchroscope). The RECEIVER control on the indicator control unit should be set so that the vertical pulse on the synchroscope representing the signal under observation is about three divisions high. If, during the course of the T–R box adjustment, the signal amplitude increases until it is more than four divisions high, the RECEIVER control should be reset for a maximum signal height of three divisions.

Note. Units with serial numbers above 90 are provided with a small door permitting access to T-R box and crystal mixer adjustments, making it unnecessary to remove the cover of the radio frequency unit.

(3) After loosening the proper locknut, adjust either of the tuning plugs on the sides of the T–R box to produce maximum signal amplitude as indicated on the screen of the synchroscope.

Caution: This operation involves making adjustments with the equipment operating. Extreme care must be observed to KEEP CLEAR OF ALL HIGH-VOLTAGE POINTS.

(4) Ordinarily, tuning can be accomplished with either plug. If there is a great difference in the position of the plugs, however, adjust them to nearly equal positions.

Note. It is also possible to adjust the T-R box, using the echo box instead of a fixed target (par. 72). The echo-box method has the advantage of giving a relative indication of the over-all performance of the system over a period of time.

93. T-R Tube Replacement

Failure of T–R tube 1–V–2 (fig. 57) may be evidenced by repeated "burn-outs" of crystals in the signal mixer, or by reduced sensitivity of the system for short range targets.

a. On Pedestal FT–458–A, turn the three switches (SAFETY, ROTATE, and R.F. UNIT) to their OFF position (fig. 10).

b. Remove air filter on transmitting tube blower 1–A–4, then remove outside cover from the radio-frequency unit (fig. 47).

c. Connect shorting jumper 1–S–8 to rolled edge of strap connecting socket connector 1–K–13 to pulse transformer 1–T–2.

d. Remove ring which clamps T–R box 1–A–8 to the mounting bracket by taking out the two screws and lockwashers.

e. Disconnect 600-volt keep-alive connector 1–K–16 from T–R box connector 1–K–17 (fig. 49).

f. Remove type N connectors 1–K–19 and 1–K–21 from 1–K–18 and 1–K–20, respectively, at signal mixer 1–A–7.

g. Loosen the four screws on each of the two couplings at the ends of tee-junction 1–A–10 just enough to permit the joined flanges to be turned easily.

h. Loosen the two screws holding tee-junction 1–A–10 to T–R box 1–A–8 until the screws can be turned by hand.

i. Swing T–R box 1–A–8 away from mounting bracket, and remove completely the two screws which were loosened.

j. Pull the T–R box from tee-junction 1–A–10.

k. Remove front cover from the T–R box by taking out the six screws. This cover fits tightly; it may require forcing (fig. 61).

l. Remove back cover in a similar manner, and take out the two circular gaskets if they still remain.

m. Remove the remaining four screws, and carefully pull the two halves of the cavity apart (fig. 62).

n. Remove the tube.

o. Remove a new T–R tube (type 721–A) from the box.

p. With the left hand, pick up the half-cavity to which signal mixer 1–A–7 is connected, with the signal mixer at the bottom and the open end of the half-cavity away from the hand. Pick up the new tube and insert it into the half-cavity with the electrode cap facing the keep-alive voltage end of the cavity. Be careful that the fins of the tube inclose flanges of the half-cavity.

q. Take the other half of the cavity in the right hand, making sure that the two right-angle gaskets are properly positioned in the face. The opening for tee-junction 1–A–10 should be at the top, and the open end of the cavity away from the hand.

r. Carefully bring the two cavities together, again making certain that all parts of the tube fins inclose the half-cavity mounting flanges.

s. Insert the four screws holding the two halves of the cavity together, and pull up tight.

t. Replace front and back circular gaskets.

u. Replace the rear end cap. If cavity and cap are stamped with locating numbers, the cap should be positioned so that the two numbers are together.

v. Replace front end cap in such a way that the locating key on the A–N type connector is less than 30° counterclockwise from the down position.

w. Connect the T–R box to tee-junction 1–A–10 and, after tightening the two screws, swing into position.

x. Clamp T–R box 1–A–8 to mounting bracket.

y. Tighten screws on coupling at ends of tee-junction.

z. Replace keep-alive connector 1–K–16.

aa. Replace type N connectors 1–K–19 and 1–K–21.

ab. Connect a temporary jumper across terminals of cover interlock switch 1–S–7.

ac. Follow procedure of tuning T–R box as outlined in paragraph 92*b* above.

Warning: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this system. The radio-frequency unit operates with peak voltages as high as 20,000 volts. Voltages in excess of 700 volts exist in the radio receiver power supply. Do not make any connections which will bring high voltage to an exposed point. Except on specific tests make all tests with the high voltage OFF. Always short out high-voltage capacitors before touching them or their associated circuits.*

94. Reference Data

The following figures are included to assist maintenance personnel trouble shooting the receiver system.

a. Figure 74, Radio Receiver BC–1223–A, top view of chassis.

b. Figure 75, Local oscillator, assembled.

c. Figure 76, Local oscillator, disassembled.

d. Figure 78, Radio Receiver BC–1223–A, end view of chassis.

e. Figure 81, A.F.C. crystal mixer, completely disassembled.

f. Figure 82, A.F.C. crystal mixer, cross-sectional diagram.

g. Figure 94, Radio Receiver BC–1223–A, end view of chassis.

h. Figure 99, Radio Receiver BC–1223–A, complete schematic diagram.

i. Figure 148, Test equipment.

j. Figure 149, Test equipment.

k. Figure 184, Radio Receiver BC–1223–A, video output waveform.

l. Figure 185, Receiver system, waveforms for S.T.C. circuit.

m. Figure 186, Radio Receiver BC–1223–A, under side of chassis.

n. Figure 187, Radio Receiver BC–1223–A, electrical connection diagram.

o. Figure 188, Radio Receiver BC–1223–A, voltages and resistances.

p. Figure 189, Emergency receiver tuner, circuit diagram.

q. Figure 193, Indicator Control BC–1193–A, voltages and resistances.

95. Behavior Analysis

When the receiver is not operating normally the signals of the PPI scope will be of reduced strength, or the signals will not appear on the PPI scope at all. Signals of reduced strength indicate that some part of the receiver system may be detuned or functioning abnormally. Absence of signals and grass indicate that considerable detuning exists or that some part of the circuit is completely inoperative.

a. System Localization. Before attempting to localize the fault within the receiver system it must first be localized to that system. The trouble-shooting procedure outlined in paragraph 75 may have indicated that the receiver system is at fault. This may be verified by an over-all check of the receiver, r-f, and transmitter systems as follows:

(1) *Video output test.* Connect the synchroscope to the VIDEO TEST jack (fig. 187) and arrange the synchroscope to obtain the video waveform shown in figure 184. The waveform is taken with the S.T.C. AMPLITUDE control turned to maximum counterclockwise position. If the waveshape shown in figure 184 is not obtained, the trouble may be in the transmitter, r-f, or receiver systems, in which case make the transmitter test below.

(2) *Transmitter test.* The method of testing the transmitter system for proper functioning is described in paragraph 72*b*. If the transmitter is operating satisfactorily and there is no output or a poor output from the receiver in step (1) above, the trouble is localized to the r-f or receiver systems.

b. Circuit Localization. The following general methods, in addition to the trouble-shooting chart in paragraph 96, can be used to localize the fault to a particular circuit in the receiver system.

(1) *Crystal current tests. (a)* By measuring the current at SIG. CRYSTAL CURRENT jack 2–J–1 and A.F.C. CRYSTAL CURRENT jack 2–J–2, most troubles in the receiver system can be localized to an individual circuit. The method of measuring the crystal current is described in paragraph 97*b*. The current reading at either jack should be between 0.3 and 0.5 ma. If both current readings are normal, the local oscillator, the A.F.C. circuit, and the crystal mixers are operating properly. Then the trouble is probably in the signal channel.

(b) If the crystal current at either jack sweeps from a low value to about 0.4 ma and the 884 tube 2–V–14 is firing at a rate of once a second, the trouble is in the A.F.C. circuit. Tube 2–V–14 (fig. 74) may be exposed by raising the receiver air filter.

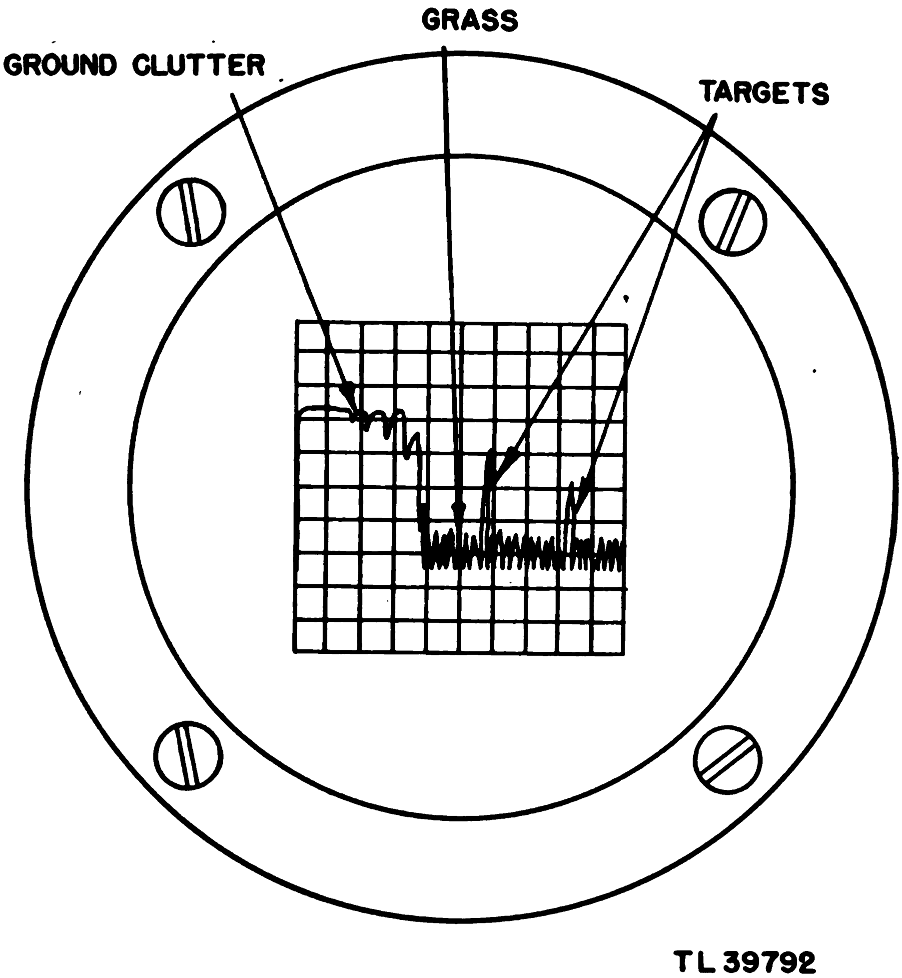


Figure 184. Radio Receiver BC–1223–A, video output waveform.

(c) It is possible for the local oscillator to become so detuned that the A.F.C. circuit loses control. If the crystal currents are zero and tube 2–V–14 is firing, the local oscillator is probably defective.

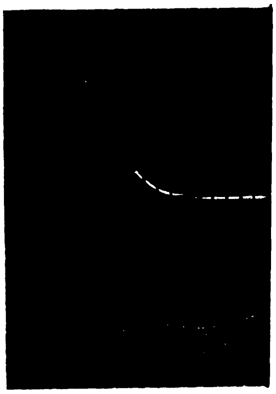
(d) If the SIGNAL MIXER crystal current is zero and the A.F.C. MIXER crystal current is normal, the SIGNAL MIXER crystal is probably burned out and should be replaced. Check T–R tube before installing new crystal (par. 91*c*.). Normal SIGNAL MIXER crystal current and zero A.F.C. MIXER crystal current is likewise probably caused by a burned-out A.F.C. MIXER crystal.

(e) If the current at either jack is low, the coupling from the local oscillator input to the crystal mixer is probably too little and should be increased.

(2) *S.T.C. circuit tests.* Improper operation of the S.T.C. circuit will not usually cause signals to disappear throughout the entire range of the set. However, troubles may develop within this circuit which will affect the strength of the signals at the shorter ranges.

(a) Troubles can be quickly isolated to the S.T.C. circuit by observing the waveform at the S.T.C. TEST plug 7–K–8 (fig. 105) with the synchroscope. If the waveform at this plug is abnormal, trouble exists within the S.T.C. circuit. The proper output waveforms are shown in figure 185, ⑧ to ⑭.

① *S.T.C. GENERATOR 7*
Test point, grid pin 5.
Range, 10,000 yards.
Scope sensitivity, 200 volts
Sweep setting, No. 4.
Amplifier off.



⑥ *S.T.C. AMPLIFIER 7-*
Test point, grid pin 5.
Range, 10,000 yards.
S.T.C. width setting, extre
S.T.C. depth setting, extre
S.T.C. amplitude setting, e
wise.
Scope sensitivity, 200 volt
Sweep setting, No. 4.
Amplifier off.

⑪ *S.T.C. OUTPUT TO*
7-K-7.
Test point, S.T.C. test jac
Range, 10,000 yards.
S.T.C. width setting, ext
clockwise.
S.T.C. depth setting, extr
S.T.C. amplitude setting,
Scope sensitivity, 133 vo
Sweep setting, No. 4.
Amplifier on (waveform

(b) Another method of checking the S.T.C. circuit is to connect the synchroscope to the VIDEO TEST jack in the receiver (fig. 94) so as to obtain a video pulse (fig. 184). By varying the S.T.C. AMPLITUDE control (fig. 104) it should be possible to cause the main pulse to appear and disappear.

(3) *Visual checks.* *(a)* Inspect the cabling between the r-f unit and the receiver.

(b) Remove the air filter on the receiver and observe whether the filaments of the tubes are glowing. This will indicate whether or not power is being supplied to the receiver.

c. STAGE LOCALIZATION. Once localized to a particular circuit in the receiver system, troubles may be localized to a defective stage by systematic voltage and resistance measurements and waveform examination. However, since the under side of the receiver (fig. 186) is not easily accessible, it is expedient to check all other possible sources of trouble before removing the receiver chassis. When trouble is definitely localized to the receiver, the receiver may be removed from the spinner assembly as outlined in paragraph 98*a*. It will be necessary to improvise test connections in order to supply power to the receiver at the test bench. Figure 187 is a diagram of the electrical connections in the receiver. Figure 188 shows the normal voltages and resistances at the pins of the tubes within the receiver.

(1) *Signal Channel.* When the trouble has been localized to the signal channel, voltage and resistance checks should be made throughout the channel. A quick though not a thorough check of the i-f stages can be made by measuring the voltage on the plate of the second detector. If the i-f stages are functioning properly, the noise picked up will cause a negative voltage of approximately 10 volts on this plate. If the resistance and voltage checks indicate proper operation of the receiver, the fault may be in the S.T.C. circuit (fig. 90) since the voltage on the grids of the second and third i-f stages is controlled by the RECEIVER gain control in the indicator control panel (fig. 104).

(2) *A.F.C. circuit.* Trouble in the A.F.C. circuit may be best located through the use of voltage and resistance checks as described above. It must be remembered that the voltages within this circuit with the local oscillator out of operation are quite different from those obtained with the local oscillator operating. The voltages shown in figure 188 were taken with the local oscillator not operating.

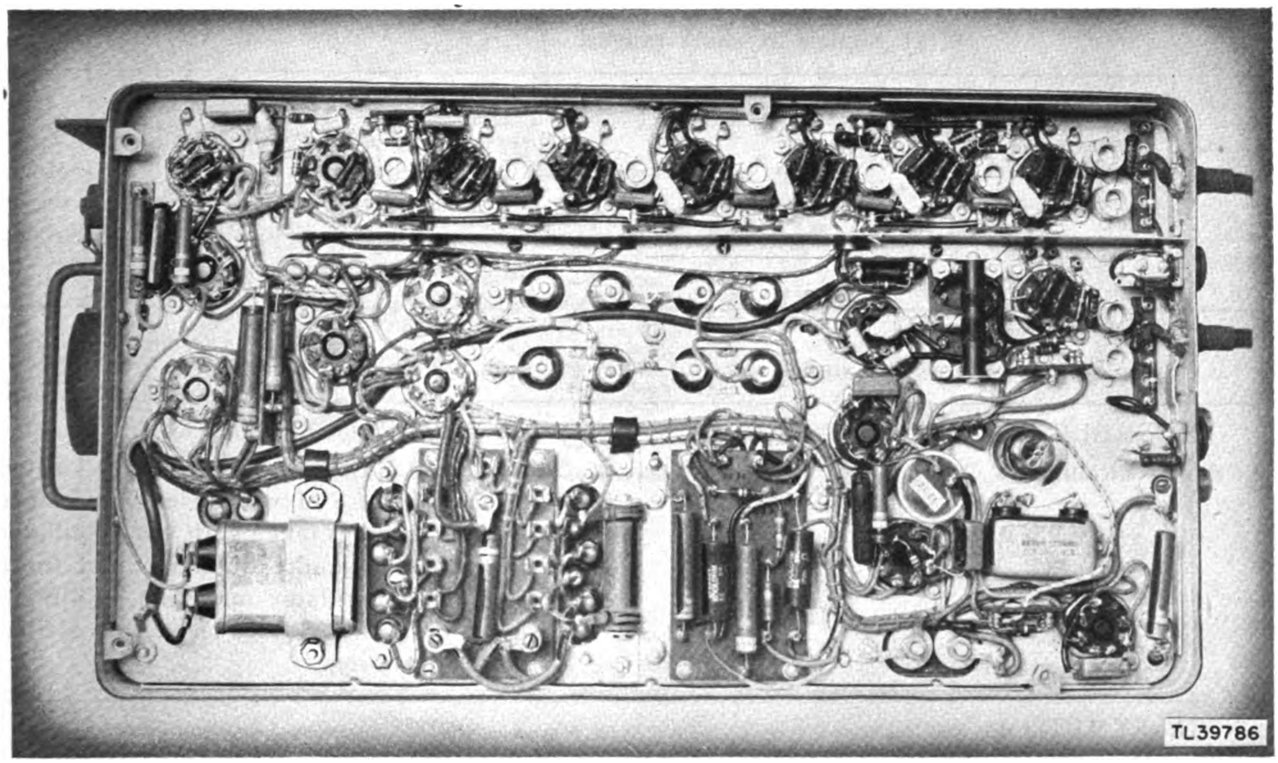


Figure 186. Radio Receiver BC–1223–A, under side of chassis.

(3) *Local oscillator.* Before replacing the local oscillator as defective, attempt to make it operate by tuning the cavity. The voltages and resistances at the electrodes of the tube should be checked to make sure that the trouble is not the result of improper power supply to the tube. The sawtooth oscillator (2–V–14) should be replaced by the emergency tuner (fig. 149) and an attempt made to produce oscillation by manual variation of the voltage on the reflector electrode of the tube. The method of using the emergency receiver tuner is described in paragraph 97*d*.

(4) *S.T.C. circuit.* Once the trouble is isolated to the S.T.C. circuit it can be traced to a defective stage by taking waveforms within the circuit and comparing the waveforms with those shown in figure 185. The defective element within the stage then can be located by taking voltage and resistance measurements and comparing the readings with those given in figure 188.

(5) *Receiver power supply.* When tests or observations indicate that trouble exists within the receiver power supply, make a visual inspection first to ascertain whether the rectifier tubes are operating. If the visual check indicates that the tubes are not defective, voltage and resistance readings should be made and compared with figure 188 to locate the trouble. See warning notice at beginning of this section.

96. Trouble-shooting Chart

A. SYMPTOM:
Weak signal and weak grass or no signal or grass, crystal current normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Signal channel.	1. Check tubes in signal channel. If tubes are satisfactory voltage and resistance checks should be made throughout channel, starting at first i-f stage and going through second video stage.

B. SYMPTOM:
Weak signals at short ranges.

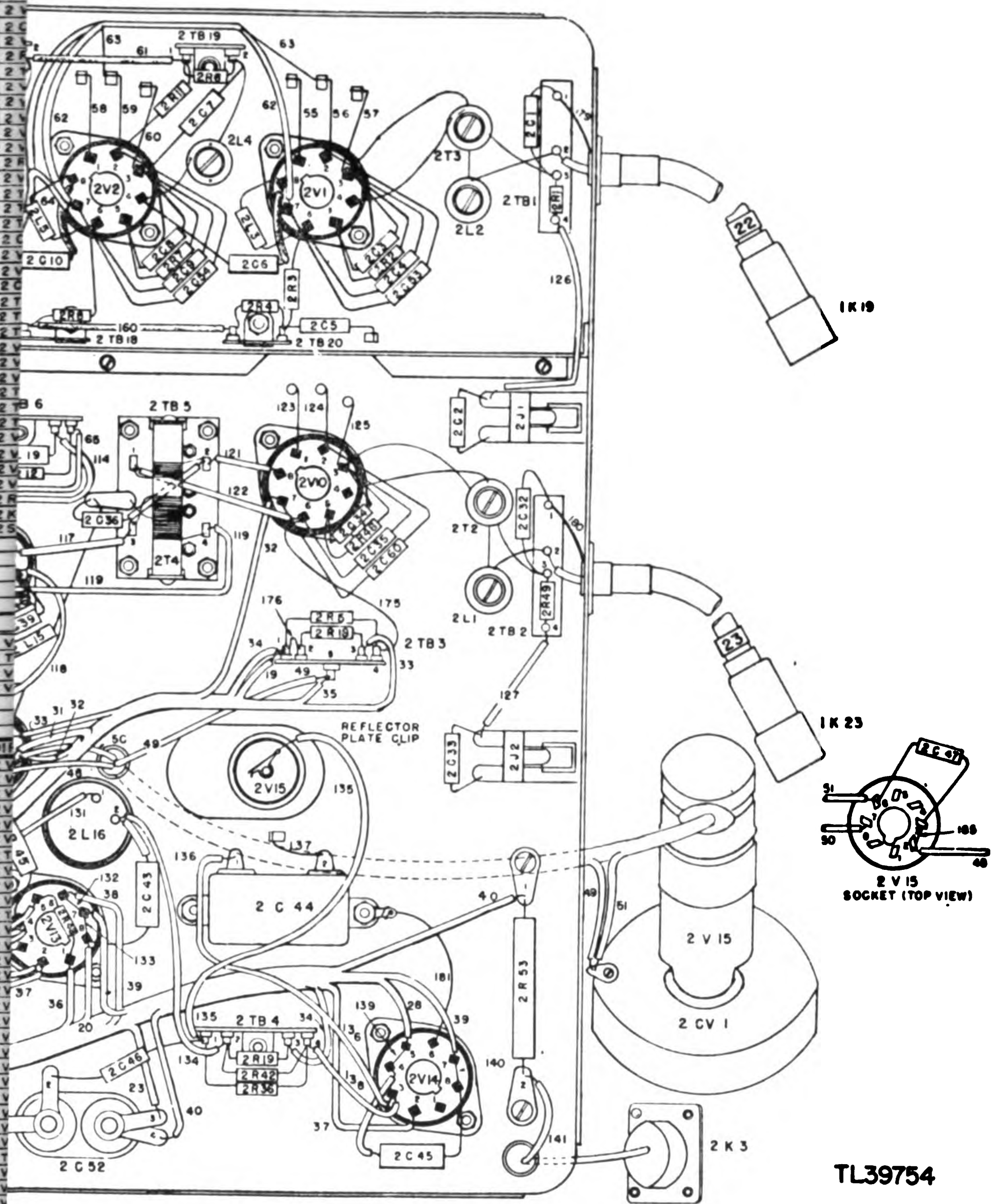
PROBABLE LOCATION OF FAULT	PROCEDURE
1. S.T.C. circuit.	1. Observe waveform at S.T.C. TEST plug 7-K-8 with synchroscope (fig. 185). If waveform is abnormal, locate stage by taking waveforms within the circuit. Locate element by voltage and resistance checks (fig. 193).

C. SYMPTOM:
Grass, no signal, varying meter currents.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. A.F.C. circuit.	1. Trouble in A.F.C. circuit may be best located through the use of voltage and resistance checks. Voltages taken with local oscillator inoperative are quite different from those taken with oscillator operating. Voltages shown in figure 188 were taken with oscillator not operating.

D. SYMPTOM:
Grass, no signal, no crystal current.

WIRE	
1	2 T
2	2 V
3	2 V
4	2 V
5	2 V
6	2 T
7	2 C
8	2 V
9	2 C
10	2 V
11	2 R
12	2 T
13	2 V
14	2 V
15	2 V
16	2 V
17	2 V
18	2 R
19	2 V
20	2 T
21	2 T
22	2 T
23	2 C
24	2 V
25	2 V
26	2 C
27	2 T
28	2 T
29	2 T
30	2 V
31	2 V
32	2 V
33	2 T
34	2 T
35	2 T
36	2 V
37	2 V
38	2 V
39	2 V
40	2 R
41	2 K
42	2 S
43	
44	
45	
46	
47	
48	2 V
49	2 T
50	2 V
51	2 V
52	
53	
54	
	DI
55	2 V
56	2 V
57	2 V
58	2 V
59	2 V
60	2 V
61	2 T
62	2 V
63	2 V
64	2 V
65	2 T
66	2 V
67	2 V
68	2 V
69	2 V
70	2 V
71	2 V
72	2 V
73	2 V
74	2 V
75	2 V
76	2 V
77	2 V
78	2 V
79	2 V
80	2 V
81	2 T
82	2 V
83	2 V
84	2 V
85	2 V
86	2 V
87	2 V
88	2 V
89	2 V
90	2 V
91	2 V
92	2 V
93	2 V
94	



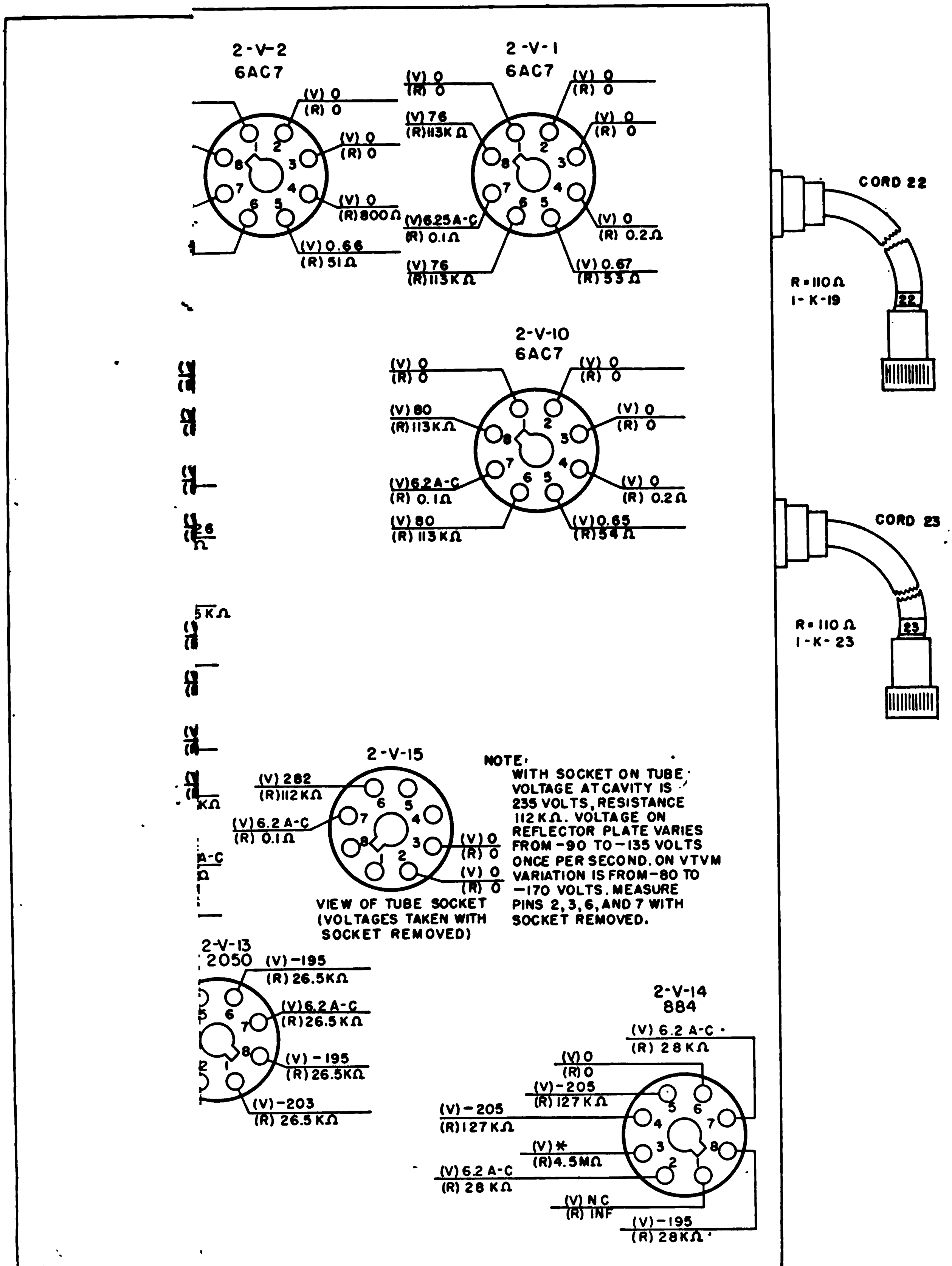
TL39754

233

235

237

Grass, no signal, no crystal current.


2-V-2
6AC7
(V) 0
(R) 0
(V) 0
(R) 0
(V) 0
(R) 800Ω
(V) 0.66
(R) 51Ω
2-V-1
6AC7
(V) 0
(R) 0
(V) 76
(R) 113K Ω
(V) 6.25 A-C
(R) 0.1Ω
(V) 76
(R) 113KΩ
(V) 0
(R) 0
(V) 0
(R) 0
(V) 0
(R) 0.2Ω
(V) 0.67
(R) 53Ω
CORD 22
R = 110Ω
1-K-19
22
2-V-10
6AC7
(V) 0
(R) 0
(V) 80
(R) 113KΩ
(V) 6.2 A-C
(R) 0.1Ω
(V) 80
(R) 113KΩ
(V) 0
(R) 0
(V) 0
(R) 0
(V) 0
(R) 0.2Ω
(V) 0.65
(R) 54Ω
CORD 23
R = 110Ω
1-K-23
23
2-V-15
(V) 282
(R) 112KΩ
(V) 6.2 A-C
(R) 0.1Ω
(V) 0
(R) 0
(V) 0
(R) 0
VIEW OF TUBE SOCKET
(VOLTAGES TAKEN WITH
SOCKET REMOVED)
NOTE:
WITH SOCKET ON TUBE VOLTAGE AT CAVITY IS 235 VOLTS, RESISTANCE 112 KΩ. VOLTAGE ON REFLECTOR PLATE VARIES FROM -90 TO -135 VOLTS ONCE PER SECOND. ON VTVM VARIATION IS FROM -80 TO -170 VOLTS. MEASURE PINS 2, 3, 6, AND 7 WITH SOCKET REMOVED.
2-V-13
2050
(V) -195
(R) 26.5KΩ
(V) 6.2 A-C
(R) 26.5KΩ
(V) -195
(R) 26.5KΩ
(V) -203
(R) 26.5KΩ
2-V-14
884
(V) 6.2 A-C
(R) 28KΩ
(V) 0
(R) 0
(V) -205
(R) 127KΩ
(V) -205
(R) 127KΩ
(V) *
(R) 4.5MΩ
(V) 6.2 A-C
(R) 28KΩ
(V) NC
(R) INF
(V) -195
(R) 28KΩ

TL 39765

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Local oscillator.	1*a*. Attempt to make tube oscillate by tuning cavity (par. 97*c*). *b*. If tube is still inoperative, attempt to produce oscillation by manual variation of voltage on reflector electrode by use of emergency tuner (par. 97*d*).

97. Alignment and Adjustments

a. Tune-up with Echo Box. The over-all sensitivity of the receiver system may be checked with the echo box (par. 72*c*). The echo box is also useful in obtaining a comparative check of the tune-up at periodic intervals. In making this comparison, be sure to have the antenna aimed directly at the echo-box dipole, the drive motor stopped, and the antenna dipole parallel to the echo-box dipole. Comparisons should ***not*** be made using different transmitting oscillators, as the ringing time of the box varies greatly with frequency.

b. Measuring Currents in A.F.C. and Signal Crystals. (1) Set the analyzer to the 0-100-microampere scale. Insert the meter shunt (fig. 148) into the POS and NEG jacks in the Simpson analyzer model 260 (fig. 148) and insert the test leads into the meter shunt.

(2) Insert the phone plug analyzer lead into the A.F.C. CRYSTAL CURRENT test jack 2–J–2 of Radio Receiver BC–1223–A (fig. 78).

(3) If the transmitter is on, the crystal current should be 0.3 to 0.5 ma. With the transmitter off, the current should sweep from zero to approximately 0.4 ma at a rate of about 1 cycle per second.

(4) Connect the meter to SIGNAL CRYSTAL CURRENT jack 2–J–1 (fig. 78). The current readings should be the same as described in (3) above.

(5) If an adjustment of either crystal current is necessary, take the following steps:

(a) Turn the safety switch to the OFF position, remove the air filter from the transmitting tube blower 1–A–4 and then remove the outside cover of the r-f unit.

Caution: CLOSING SAFETY SWITCH 1–S–5 PERMITS HIGH VOLTAGE TO BE APPLIED TO MODULATOR UNIT BC–1194–A. EXTREME CARE MUST BE EXERCISED WHEN EQUIPMENT IS OPERATED WITH COVER REMOVED FROM RADIO-FREQUENCY UNIT. TERMINALS OF TRANSMITTING TUBE 1–V–1, SOCKET CONNECTOR 1–K–13, AND PULSE TRANSFORMER 1–T–2 OPERATE AT PEAK VOLTAGES AS HIGH AS 20,000 VOLTS. AS A SAFETY MEASURE, TWO MEN MUST BE PRESENT WHENEVER THE EQUIPMENT IS OPERATED WITH COVER REMOVED FROM THE RADIO-FREQUENCY UNIT.

(b) Connect a temporary jumper across interlock switch (1–S–7).

(c) Turn on the power to place the transmitter in operation.

(d) Loosen the locknut on the side of the proper crystal mixer (figs. 45 and 82).

(e) Turn the adjustment screw of the mixer to bring the crystal current to the proper value.

Note. The signal mixer 1–A–7 is to the left of the A.F.C. mixer 1–A–6 (fig. 49). Units with serial numbers above 90 are provided with a small door permitting access to T–R box and crystal mixer adjustments, making it unnecessary to remove the cover of the radio-frequency unit.

c. Tuning Local Oscillator Cavity. (1) Throw R.F. UNIT switch on Pedestal FT–458–A to ON position. Leave the SAFETY and ROTATE switches off.

(2) Check crystal currents as described in paragraph 97*b*.

(3) Turn on the SAFETY switch and start in normal manner.

(4) If the crystal current continues to sweep after the transmitter is turned on, it may be assumed that the local oscillator 2–V–15 is being swept through a band of frequencies none of which beats with the transmitter frequency to produce 30 megacycles, the intermediate frequency of Radio Receiver BC–1223–A. To correct this condition, remove the snap button (fig. 78) covering the tuning hole in the right side of Radio Receiver BC–1223–A as viewed from the cover, and using the ***insulated*** concentric wrench supplied with the tool equipment, engage the plug and locknut in the side of the local oscillator cavity.

(5) Loosen the locknut slightly and screw the plug in or out until the crystal current becomes steady. Continue in the same direction, counting the number of turns required to tune through the stable range until the crystal current starts to sweep again. Back the plug halfway through this

range and tighten the locknut. This is usually, but not always, the position giving approximately the maximum crystal current. If the frequency is too far removed from the one required, it may be necessary to adjust the tuning plug reached through the hole in the end of the receiver case. All the tuning plugs may be considered to be in parallel. The local oscillator cavity normally needs to be retuned only if the transmitter tube has been replaced with one of slightly different frequency or if the local oscillator tube itself is replaced. Never use any tool other than the insulated concentric wrench supplied for tuning the cavity, as it is 240 to 275 volts above ground.

(6) The local oscillator should be tuned to a wavelength about 0.115 cm longer than that of the transmitter in order to produce the proper 30-mc beat frequency. It is possible for the local oscillator to lock in at a shorter wavelength than that of the transmitter. This false locking will be evidenced by some instability of the crystal currents. In case of instability, measure the local oscillator wavelength and the transmitter tube wavelength with the echo box (fig. 148) as described in paragraph 72.

(7) Adjust the A.F.C. and SIGNAL MIXER crystal currents to approximately 0.4 ma as described in paragraph *97b* (5).

c. USE OF THE EMERGENCY TUNER. (1) *Purpose.* The emergency receiver tuner (fig. 149) is used to provide a manual means of adjusting the local oscillator frequency. When this manual tuner is used, the sweeping and locking characteristic of the A.F.C. circuit does not function. The emergency receiver tuner performs the function of setting the reflector voltage of the local oscillator tube and thus controls its frequency. It is equipped with an octal base so that it may replace the 884 gas triode 2–V–14 which normally performs this function. The tuner consists of a 250,000-ohm potentiometer and a fixed 200,000-ohm resistor (fig. 189). The resistance is connected from pin 5 to ground in such a manner that the movable arm of the potentiometer connects to the reflector of the local oscillator. The voltage on the reflector can be varied by the potentiometer over approximately the voltage range covered by the A.F.C. circuit when sweeping.

(2) *Use.* *(a)* To use the emergency receiver tuner, remove the cover from Radio Receiver BC–1223–A and remove the 884 and 2050 tubes. The emergency receiver tuner is then placed in the 884 tube socket. Insert Plug PL–55 on the crystal current cable into the SIG CRYSTAL CURRENT jack on Radio Receiver BC–1223–A. Insert the meter shunt into the jacks of the Simpson meter. Set the Simpson meter to the 100-microampere range and insert the phone tips on the crystal current cable into the jacks on the meter shunt. As the emergency receiver tuner is adjusted, the Simpson meter will indicate crystal current over a portion of the range. A definite rise and fall of crystal current will be observed. When a reading is obtained, the local oscillator is in a mode of oscillation. With the system in operation, using a fixed target on the synchroscope or using the echo box, adjust the tuning knob for maximum returned signal. When the maximum occurs, the tuning knob reading should be approximately in the center of the scale. If the maximum signal occurs with the tuning knob at either end of the scale, or if no signal is obtained, the correct operating frequency for the local oscillator is not included in the range over which it can be controlled by the emergency tuner. This range can be shifted by referring to the instructions for tuning the local oscillator cavity (par. *97c*).

(b) When using the emergency receiver tuner, it is possible to measure the local oscillator wavelength while observing targets. Remove cord 25 from Radio Receiver BC–1223–A and insert Plug PL–259 on the r-f cable into the LOCAL OSC. A.F.C. socket. Proceed as described in the instructions for using the echo box to determine the wavelength of the local oscillator (par. *72c*). Using the emergency receiver tuner, it is also possible to measure the frequency range over which the local oscillator can be tuned by the reflector voltage.

e. ADJUSTMENT OF SIGNAL MIXER 1–A–7 OR A.F.C. MIXER 1–A–8. Mixers 1–A–7 and 1–A–8 will normally require no replacement. However, it is possible that the coupling-loop holder at top of the mixer may loosen. This is often the result of pulling the mounting flange too tight against T–R box 1–A–8 or A.F.C. coupler 1–A–11, and then turning the body of mixer. The coupling-loop holder is held by friction against the knurled end of the mixer trunk. This design permits the loop to be positioned in any plane relative to the plane of the mixer proper. The proper relative angle is approximately 70°, so that the mixer can be put back in position with the main plane approximately 20° from the plane of the base of the radio-frequency unit. This allows the plane of the coupling loop to be set roughly perpendicular to the base of the radio-frequency unit without the necessity of rotating the body of the mixer after the coupling flange is tightened.

Note. **Before the mixer is mounted to either the T–R box or the A.F.C. coupler, the circular nut holding the coupling-loop holder should be pulled wrench-tight. The coupling-loop holder should always be put on or removed with a straight-line motion and never more frequently than necessary, in order to retain the friction of the knurling.**

f. **Emergency I-f Alignment in the Field.** The i-f stages of the receiver and video amplifier circuits are all accurately aligned to 30 megacycles at the factory. Since a signal generator is not

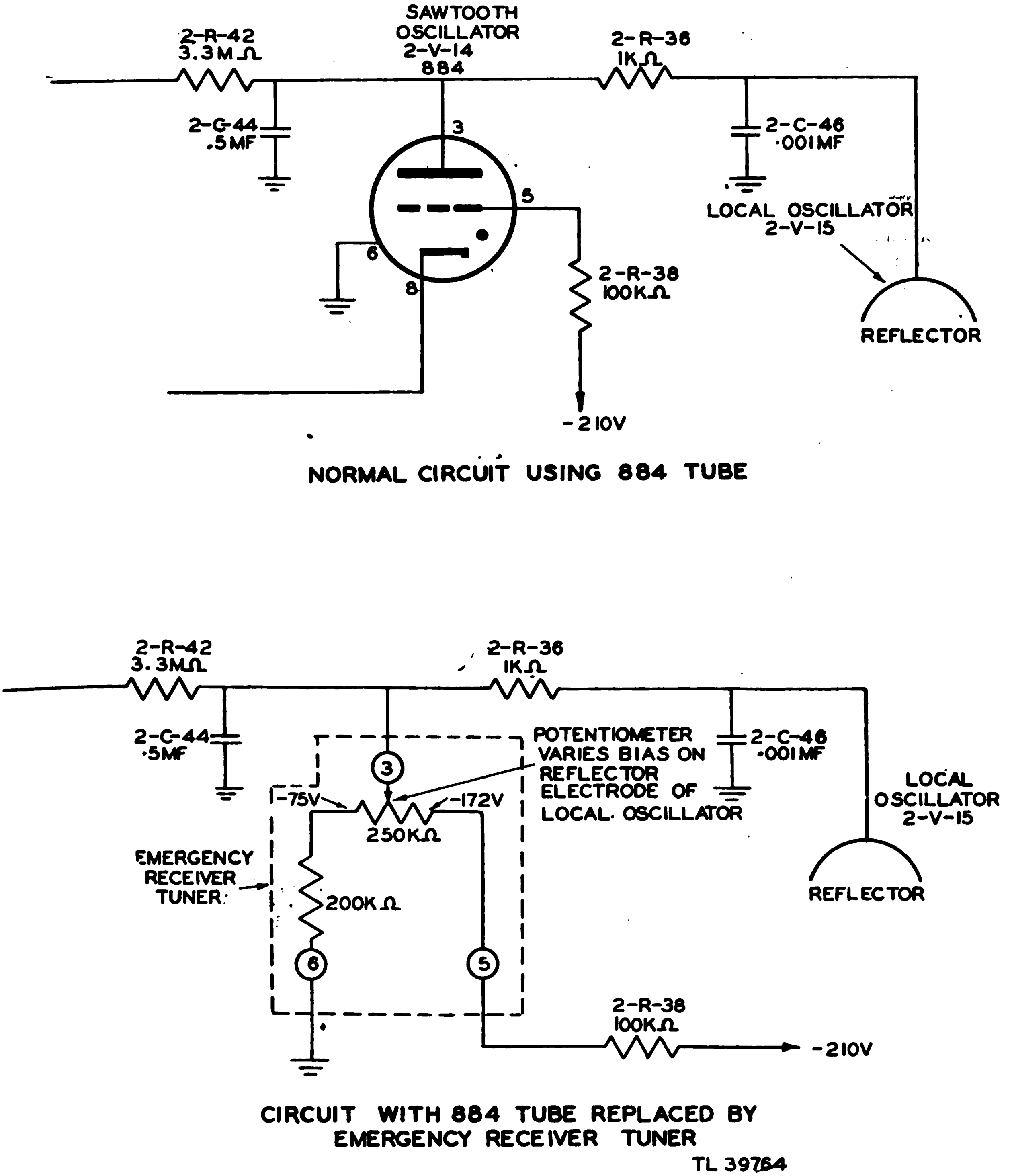


Figure 189. Emergency receiver tuner, circuit diagram.

supplied with the test equipment and these units must be matched and interchangeable, it is not recommended that they be aligned in the field unless alignment is absolutely essential to keep the equipment in operation. In the tuned circuits, the grid and plate capacitances are part of the tuned circuits. When necessary to replace tubes, try several from the spare parts to obtain one which produces the brightest signal on the scope.

Note. **The fact that one tube produces a brighter signal than another does not indicate that it is superior to the others. It simply means that its plate and grid capacitance are proper for the present tuning of the circuit inductances. Matching tubes this way often makes it unnecessary to tune the inductances to the tube.**

If it is necessary to align the receiver, and an accurately calibrated 30-mc signal generator using a-f modulation is available, proceed as follows:

(1) Remove the receiver to a test bench as described in paragraph 98*a* and improvise test connections to an a-c power supply.

(2) Connect the synchroscope into VIDEO TEST jack 2–K–7.

(3) Connect the output of the signal generator to the input of the i-f stages.

(4) Set the frequency of the signal generator to 30 mc. Adjust the a-f modulation and output of the signal generator and also the synchroscope controls so as to secure a sine wave.

(5) Adjust the tuning coils in the following order for maximum signal: 2–L–13, 2–L–12, 2–L–10, 2–L–8, 2–L–6, 2–L–4, 2–T–3, and 2–L–2. Reduce the signal generator output and the synchroscope gain control as necessary to keep the sine wave below saturation.

(6) Readjust the tuning coils in the reverse order 2–L–2, 2–T–3, 2–L–4, etc.

98. Replacement of Parts

a. Removal of Receiver Chassis from the Spinner Assembly. (1) Remove the cover plate by taking out the four holding screws.

(2) Remove the flexible duct between the blower motor and the receiver.

(3) Stretch back the protective rubber covering over connector 2–K–1. Remove connector from receptacle 2–K–2.

(4) Tag cords found on the lower side of the receiver and remove cords 24, 25, and 26 from receptacles 2–K–8, 2–K–9, and 2–K–3 respectively. Note that receptacle 2–K–3 is labeled T.R. VOLTAGE, receptacle 2–K–9 is labeled LOCAL OSC. A.F.C. and receptacle 2–K–8 is labeled LOCAL OSC. SIGNAL.

(5) Remove the cover from the radio-frequency unit.

(a) Remove cord 27 from receptacle 1–K-10.

(b) Remove the r-f unit air filter by loosening the clamp and lifting the filter off.

(c) Loosen the six knurled knobs around the cover.

(d) Lift the cover off ***with care.***

(6) Remove cord 22 from receptacle 1-K-18 (under cover).

(7) Remove cord 23 from receptacle 1-K-22 (under cover).

(8) Remove screws from clamps which hold cords 22 and 23 in position. Cords 22 and 23 will now fall free.

(9) Remove two knurled knobs found on the lower sides of the radio receiver.

(10) Slide the receiver to the left as far as it will go (a fraction of an inch). Lift out carefully; place on floor.

(11) Remove the rear cover from the unit by removing the four holding screws.

b. Replacement of Crystals 1–A–15 and 1-A-16. (1) Failure of either signal crystal 1–A–15 or A.F.C. crystal 1–A–16 may be indicated by an appreciable drop in crystal current. If both crystal currents are abnormally low, the trouble is probably elsewhere. However, if only one current is low, reverse local oscillator cords 24 and 25 at the mixers. If the respective magnitudes of the crystal currents do not change appreciably, the crystal with the low current should be replaced. A change in respective magnitudes may indicate that either cord 24 or cord 25 is faulty.

(2) A faulty crystal in signal mixer 1–A–7 will result in poor system sensitivity. A faulty crystal in A.F.C. mixer 1–A–6 may result in the failure of the A.F.C. system to lock in, as evidenced by very weak fluctuating signals and sweeping crystal currents.

(3) A rough check of the condition of a crystal may be made by measuring the d-c resistance. Since crystals are nonlinear elements, this resistance varies in general with the direction and magnitude of the current. The measurements should be made with the analyzer set to the R X 100 position. The forward resistance of a good crystal should be approximately 300 ohms. The back resistance should be at least five times the forward resistance. One front-back reading means nothing. However, if the front-back ratio decreases with use, the crystal is getting weaker.

Caution: THE R X 10,000 SCALE SHOULD

NEVER BE USED FOR CRYSTAL MEASUREMENTS BECAUSE IT MAY APPLY MORE THAN 1.5 VOLTS TO THE CRYSTAL.

(4) To replace either crystal, proceed as follows:

(a) Turn the SAFETY switch to the OFF position.

(b) Remove the air filter from the transmitting tube blower 1–A–4 and then remove the outside cover of the radio-frequency unit.

(c) Remove the connector from the trunk of the proper mixer. This is 1–K–19 for the signal mixer or 1–K–23 for the A.F.C. mixer.

(d) Loosen the knurled screw holding the lowest piece on the trunk of the mixer and remove this piece. This exposes the end of the crystal.

(e) Remove crystal 1–A–15 or 1–A–16 and replace it with a new one (type IN–21).

Caution: The crystal should not be exposed to strong electric fields such as exist near the antenna during transmission. Likewise, a static discharge to ground from the body of a person will damage a crystal if the current passes through the crystal.

(f) Replace the lowest piece on the trunk of the mixer.

(g) Replace connector 1–K–19 or 1–K–23 on the trunk of the mixer.

(h) Check the crystal current as indicated in paragraph 97*b*.

(i) Replace the cover and the air filter on the radio-frequency unit.

(j) Set the system in operation and check for normal operation.

c. Replacing Local Oscillator Tube 2–V–15. (1) Remove the octal plug from the end of the tube (figs. 74, 75, and 76).

(2) Remove the screw holding the plate lead from cable to cavity.

(3) Hold the tube in place and remove the mounting screws which hold the bakelite mounting blocks to the chassis.

(4) Remove the two adjacent tubes, and carefully slide the oscillator tube and cavity directly away from the end of the case until the r-f pickup is disengaged. Lift and tilt slightly until the reflector pin on the bottom of the tube is visible. Do not force.

(5) Remove the clip from the reflector pin and lift out the tube and cavity.

(6) Loosen the small roundhead screws holding top and bottom plates to the cavity, and rotate mounting plates until the large holes are under the screw heads. Lift off the mounting plates. Do not disturb the tuning plugs which extend radially from the cavity.

(7) Note the position of the octal base with respect to each half of the cavity, then carefully separate the two halves from the tube.

(8) Place the cavity on the new tube, being sure to maintain proper relation between it and the key on the octal base.

(9) Replace the bottom mounting plate and then the top mounting plate. Tighten the screws.

(10) Hold the assembly of the tube and cavity in the receiver and carefully replace the reflector clip. Push the clip toward the tube envelope as far as it can go.

(11) Carefully insert the end of the pick-up loop in the hole in the cavity and slide the tube and cavity into position.

(12) Replace and tighten the mounting screws.

(13) Replace the plate lead from cable to cavity.

(14) Replace the octal plug on the base of the tube.

(15) Replace the cover on Radio Receiver BC–1223–A.

Section VIII. TROUBLE SHOOTING IN INDICATOR SYSTEM

> **Warning:** *Voltages sufficient to cause death on contact are exposed within the indicator panel and power supply unit. Do not place hands or arms within Indicator Panel BD–123–A or Power Supply Unit RA–100–A while the high voltage is ON. Do not make any connections into unit which will bring high voltage out to an exposed point. If it is necessary to measure voltage within the units, turn all power OFF, connect the voltmeter, and turn the power ON. Do not handle the voltmeter or leads when the power is applied.*

99. Reference Data

The following figures are supplied to assist maintenance personnel in trouble shooting in the indicator system.

a. Figure 104, Indicator Control BC–1193–A, operating controls.

b. Figure 105, Indicator Control BC–1193–A, adjustment controls.

c. Figure 114, Indicator system, simplified schematic diagram.

d. Figure 115, Power Supply Unit RA–100–A, complete schematic diagram.

e. Figure 116, Indicator Control BC–1193–A, complete schematic diagram.

f. Figure 117, Indicator Unit BC–1225–A, complete schematic diagram.

g. Figure 118, Indicator Panel BD–123–A, complete schematic diagram.

h. Figure 190, Indicator system, test waveforms.

i. Figure 191, Indicator Control BC–1193–A, under side of chassis.

j. Figure 192, Bias relay.

k. Figure 193, Indicator Control BC–1193–A, voltages and resistances.

l. Figure 194, Indicator Panel BD–123–A, voltages and resistances.

m. Figure 195, Operating Controls, rear view.

n. Figure 196, Power Supply Unit RA–100–A, underside of chassis.

o. Figure 197, Indicator Panel BD–123–A, right side.

p. Figure 198, Indicator Panel BD–123–A, left side.

q. Figure 199, Removing PPI focusing coil assembly.

r. Figure 200, Removing PPI deflection coil assembly.

s. Figure 201, Meter Panel BD–124–A, electrical connection diagram.

t. Figure 202, Power Supply Unit RA–100–A, electrical connection diagram.

u. Figure 203, Indicator Panel BD–123–A, electrical connection diagram.

v. Figure 204, Indicator Control BC–1193–A, electrical connection diagram.

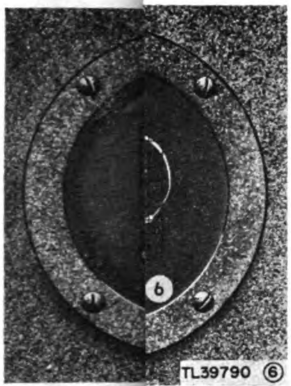
100. Behavior Analysis

The indicator system of Radio Set SCR–682–A may be divided for purposes of trouble shooting, into three distinct circuits: the sweep channel, the power supply unit, and the PPI-scope circuit. When trouble which has developed within the equipment is traced to the presentation system, the following checks should be made to localize the defect to the particular circuit within the system.

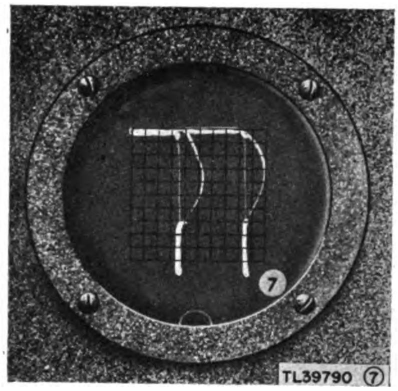
a. Localizing Trouble to a Particular Circuit. (1) *Visual indications.* The power for the indicator system is supplied by Power Supply Unit RA–100–A. To determine if the power unit is defective, several visual indications may be advantageously used. Note whether pilot lights 7–A–1 and 7–A–2 on the operating shelf are lit. Proper operation indicates that 120 volts a-c is being supplied to the unit. Open the door to the power supply unit, depress interlock switch 7–S–5, and note the condition of the voltage regulator tubes, 8–V–5, 8–V–6, and 8–V–10. These tubes should glow with a blue haze. Lack of this visual indication means some difficulty within the power unit. The checks made will give evidence whether or not the low-voltage power supply unit is at fault. There is a possibility that the +5,000-volt output from the power supply is defective. Trouble in this power supply will result in loss of intensity on the PPI scope and complete failure of the trace, if the power supply voltage drops to a low value or fails completely. If it is necessary to check this power supply, resistance measurement with the power OFF should be used.

(2) *Waveshapes.* If the power unit supply has been found satisfactory by visual check, the next step in the trouble shooting procedure involves determining whether the defect lies in the sweep channel. Waveform analysis can best be used for this purpose. Check the input and output waveforms as seen on the synchroscope against the waveforms shown in figure 190. The input waveform, a negative trigger pulse, can be taken off jack 7–K–3, the TRIGGER TEST jack, in the adjustment shelf of the indicator unit. The output waveform, a sawtooth voltage waveform, can be taken off jack 7–K–11, the SWEEP TEST jack, also located in the adjustment shelf of the indicator unit. Check also the waveform at jack 7–K–10, the BLANKER TEST jack in the adjustment shelf. This waveform should be a positive steep-sided square wave. If these three waveforms are correct, the sweep channel may be considered in satisfactory operating condition. The fault will then lie in the PPI scope or its associated circuit. If the input pulse to the sweep channel is incorrect, check the connecting cord between the modulator and indicator, cord 19. Check also the input receptacle, 7–K–2. If the input waveshape is correct and the output waveshape is incorrect, the sweep circuit is defective.

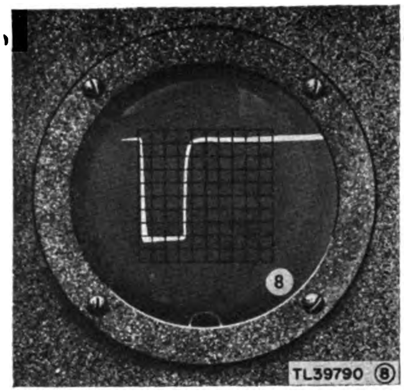
(3) *Voltage checks.* Although the visual indications help determine whether the power unit is defective, faulty visual indications do not necessarily mean the fault lies within the power unit. Pilot lights may be burned out. Wires between power unit and pilot lights may be defective. Also, no check has been made on the power unit plate voltage outputs. Therefore, if the fairly simple usual checks and waveform checks do not



① *TRIGGEI GENERATOR*
Test point, tri
Scope sensitiv
Sweep setting
Amplifier off.lts/inch.

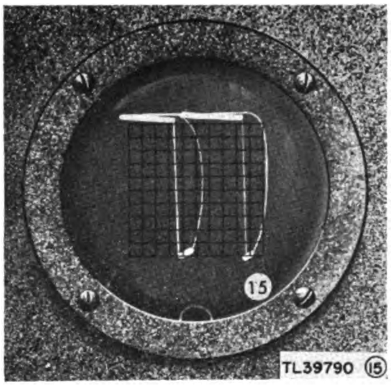


⑦ *SWEEP GATE GENERATOR 7–V–6.*
Test point, plate pin 2.
Range, 240,000 yards.
Scope sensitivity, 200 volts/inch.
Sweep setting, No. 7.
Amplifier off.

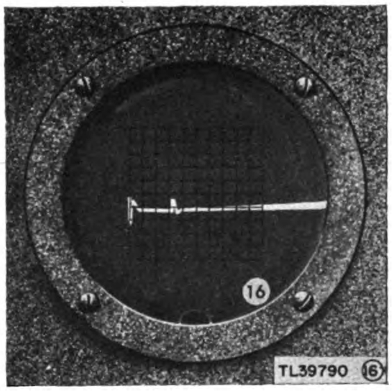


⑧ *SWEEP GATE GENERATOR 7–V–6.*
Test point, plate pin 5.
Range, 10,000 yards.
Scope sensitivity, 200 volts/inch.
Sweep setting, No. 4.
Amplifier off.

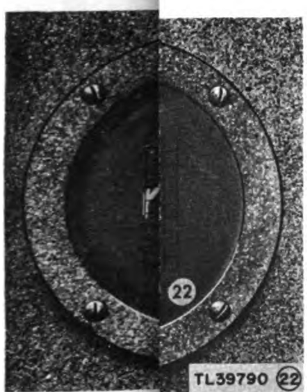
⑨ *SWEEP G*
Test point, grick 7–K–10.
Range, 10,000
Scope sensitivts/inch.
Sweep setting,
Amplifier off.



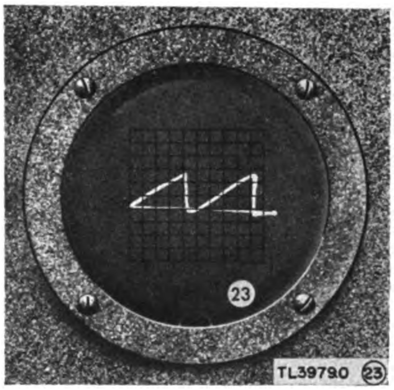
⑮ *BLANKER 7–V–4.*
Test point, blanker test jack 7–K–10.
Range, 240,000 yards.
Scope sensitivity, 200 volts/inch.
Sweep setting, No. 7.
Amplifier off.



⑯ *SWEEP GENERATOR 7–V–7.*
Test point, plate pin 8.
Range, 10,000 yards.
Tube 7–V–7 out of tube socket.
Scope sensitivity, 25 volts/inch.
Sweep setting, No. 4.
Amplifier on (waveform inverted).



⑰ *SWEEP A*
Test point, pls.
Range, 10,000k 7–K–11.
Scope sensitiv
Sweep setting,/inch.
Amplifier off.
nverted).



㉓ *SWEEP OUTPUT TO DEFLECTION COILS.*
Test point, sweep test jack 7-K-11.
Range, 240,000 yards.
Scope sensitivity, 67 volts/inch.
Sweep setting, No. 6.
Amplifier on (waveform inverted).

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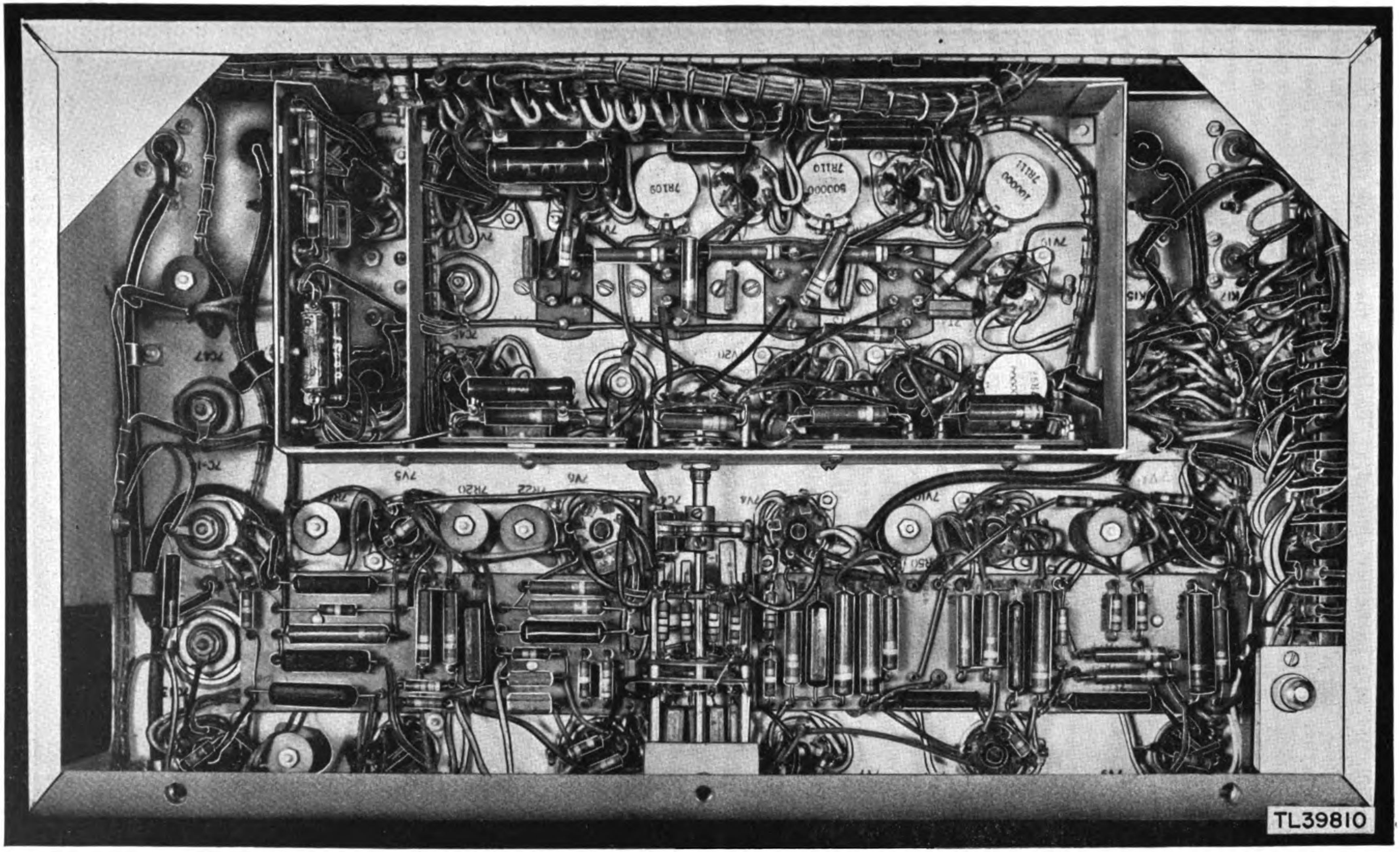


Figure 191. Indicator Control BC-1193-A, under side of chassis.

help trace the difficulty to a particular channel, perform the following voltage checks to determine definitely whether the power unit is defective. The output voltage of the power supply can be read at terminal board 7–K–5 in the under side of the indicator control tube shelf (fig. 191). Make sure a jumper is connected across door interlock switch 7–S–5 while making the following checks on terminal board 7–K–5.

(*a*) Measure the —105-volt output at terminal 7 or 8.

(*b*) Measure the +400 volts (approximately) at terminal 10.

(*c*) Measure the +250 volts at terminal 9.

(*d*) Measure the 7 volts a-c across terminals 5 and 6.

(4) *General.* The preceding series of checks and tests has helped the maintenance man localize the trouble to a particular circuit within the indicator system. The following information is offered to help the maintenance man localize the trouble to the particular stage or stages within the unit which may be responsible for the defect.

b. LOCALIZING TROUBLE TO A PARTICULAR STAGE. (1) *Power supply unit RA–100–A.* The best way of checking the power supply is by means of resistance measurements with the power off. Make sure that all the VR tubes 8–V–5, 8–V–6, 8–V–10 are securely in place, since the entire power supply will be shut down and remain inoperative if any one of these tubes is out of place (par. 43*j*). To locate the defective part or parts within the power supply, proceed to take the necessary resistance measurements as described in section I of this chapter for a typical rectifier circuit. Should voltage measurements be necessary, be *careful.* Note that there are four basic power supplies within the one unit. The bias supply output, as measured at terminals 7 and 8 of terminal board 8–K–3, is basic for the rest of the power supplies within the unit. When the bias supply operates, the bias relay 8–E–1 (fig. 192) is energized, and 115 volts is applied to the primaries of the remaining transformers through the bias relay contacts. Relays in units with serial numbers 1 to 75 use tungsten contacts. Relays in units with serial numbers above 75, and replacements, use micro switch contacts. Should it be necessary to check the high-voltage output (observe WARNING notice at head of section), see instructions in section I for special instructions in measuring the high voltage. The output of the high-voltage rectifier can be measured indirectly by measuring the voltage drop across the first of the 10 resistors which make up the bleeder. The voltage across 8–R–14 should be approximately 500 volts. Make certain that one side of the resistor across which the voltmeter is to be connected is grounded before connecting the voltmeter. The output of a step-down winding on bias supply transformer 8–T–2 provides filament voltage to all tubes in the indicator control and the PPI tube. This out-

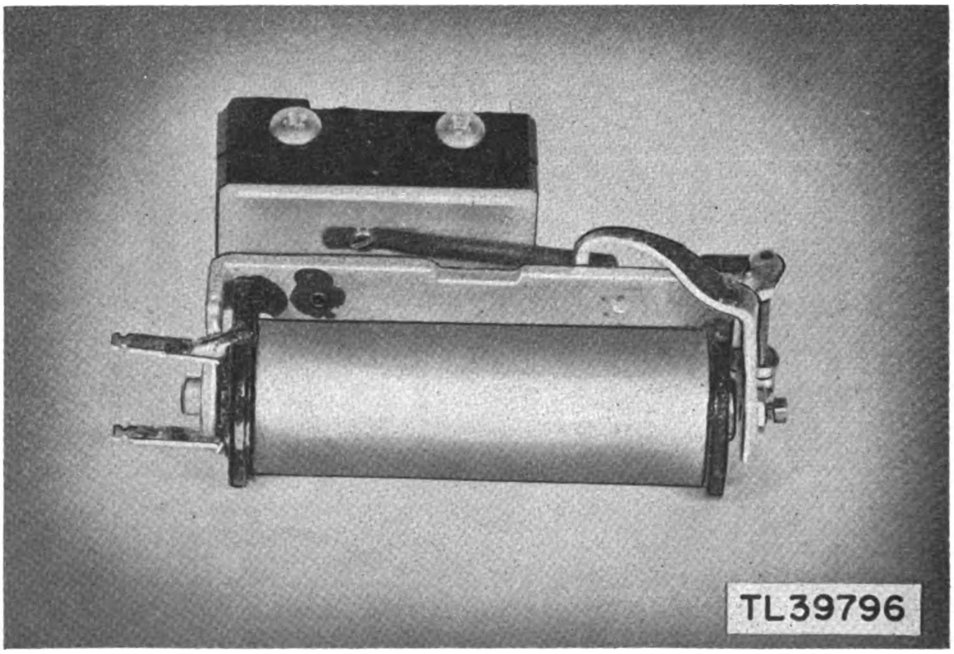
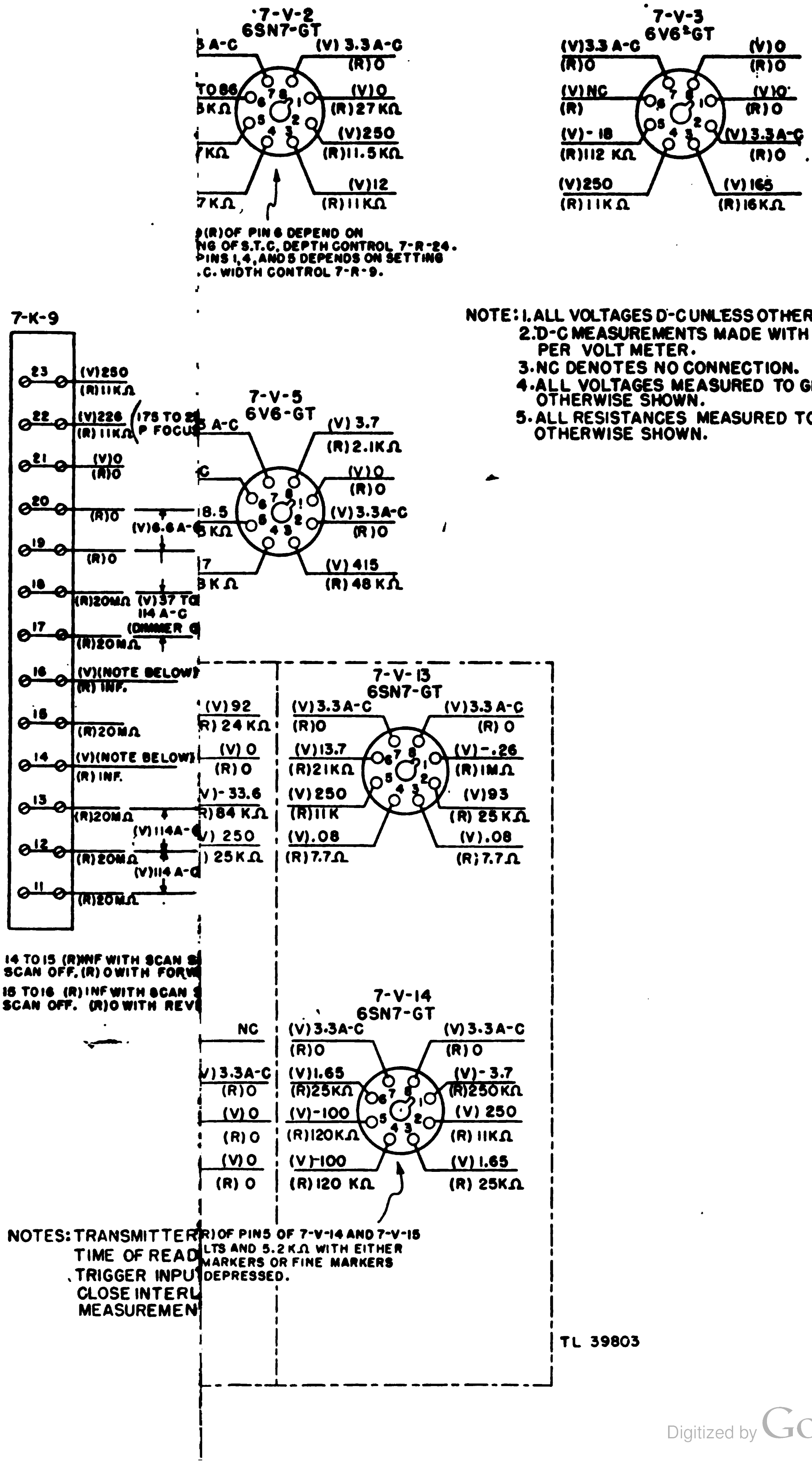


Figure 192. Bias relay.



NOTE: 1. ALL VOLTAGES D-C UNLESS OTHERWISE SHOWN
2. D-C MEASUREMENTS MADE WITH 20,000 OHMS PER VOLT METER.
3. NC DENOTES NO CONNECTION.
4. ALL VOLTAGES MEASURED TO GROUND UNLESS OTHERWISE SHOWN.
5. ALL RESISTANCES MEASURED TO GROUND UNLESS OTHERWISE SHOWN.

put can be checked at terminals 5 and 6 of terminal board 8–K–3. No output here indicates defective windings on transformer 8–T–2 or an open fuse 8–F–2. Check a-c input at terminal 3 of terminal board 8–K–3. The +250 and +400 voltage supply can be measured at terminals 9 and 10 respectively. If the proper reading is not obtained, check the parts within the circuit (fig. 115).

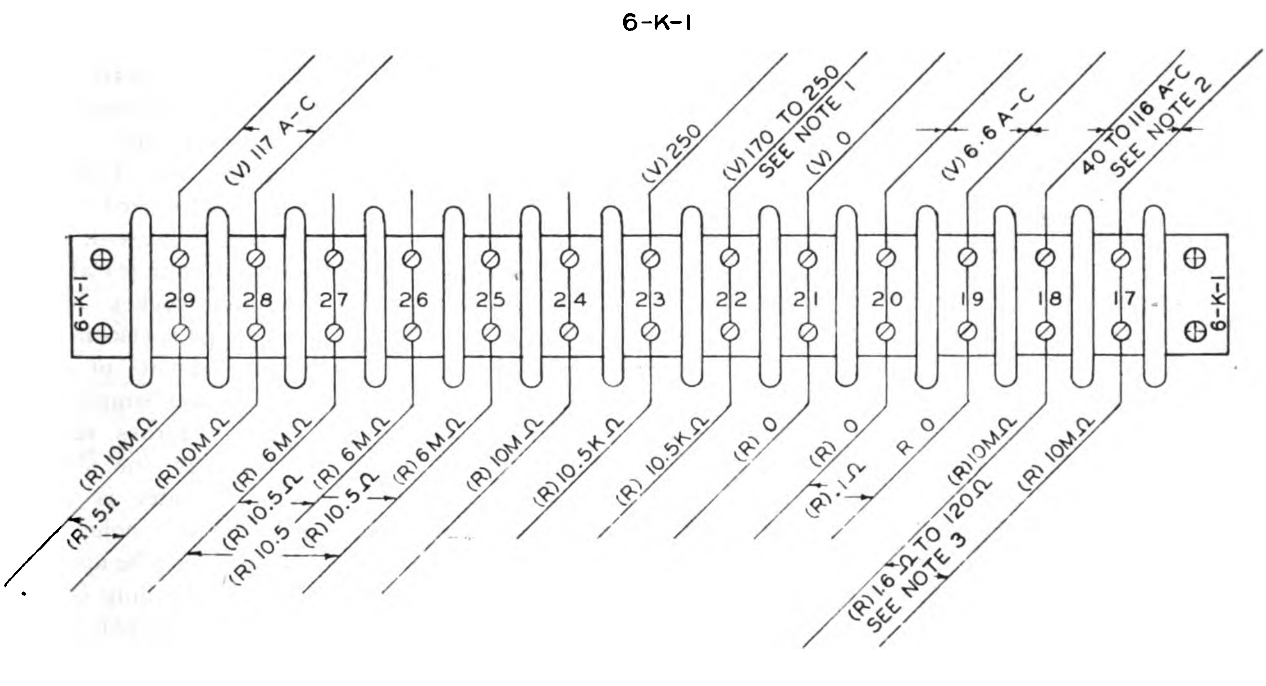
(2) *Sweep circuit.* The best way of checking the sweep circuit is by means of waveshapes. The input (or output) of each stage is pictured in figure 190. Place the test lead of the synchroscope at the proper tube socket pin, and note the waveshape. Begin with the triggering pulse and work toward the output positive sawtooth waveform. When a stage is reached where the waveform indicates a defect, take the necessary voltage or resistance measurements (fig. 193) to pick out the part or parts responsible for the defective operation. Make sure that the tube of the defective stage is checked.

(3) *PPI scope circuit.*

Warning: *Be careful.* A potential of 5,000 volts exists at the high-voltage anode attached to the glass envelope of the cathode-ray tube. Observe the warning listed at the head of the section. Should voltage checks be made, be sure that the power is OFF when connecting the voltmeter. Do not handle the voltmeter or leads when the power is applied. Keep clear of the rubber-covered connector 6–K–2 and cord 13 when the power is on.

(*a*) When trouble is localized to the PPI scope or its associated circuit and no trace appears, an attempt should be made to secure an indication on the PPI scope. Examine the high-voltage cord 13 and the rubber-covered connector 6–K–2 to make sure that adequate contact is made to the glass envelope of the cathode-ray tube.

Warning: MAKE SURE THE POWER IS OFF.



NOTE

1 INTERLOCK SWITCH 9-S-1 HELD CLOSED, PPI FOCUS CONTROL 10-R-58 EXTREME CLOCKWISE-(V) 250, EXTREME CONTERCLOCKWISE-(V) 170.
2 (V) OF TERMINAL 17 DEPENDS ON POSITION OF DIMMER CONTROL 7-R-49.
3 (R) BETWEEN TERMINALS 17 AND 18 DEPENDS ON POSITION OF DIMMER CONTROL 7-R-49
4 ALL VOLTAGES D-C UNLESS OTHERWISE SHOWN.
5 D-C MEASUREMENT MADE WITH 20,000 OHMS PER VOLT METER.
6 ALL VOLTAGES MEASURED TO GROUND UNLESS OTHERWISE SHOWN.
7 ALL RESISTANCES MEASURED TO GROUND UNLESS OTHERWISE SHOWN.
8 ALL MEASUREMENTS MADE WITH TRANSMITTER AND RECEIVER DISCONNECTED, PPI PANEL OUT OF CABINET, INTERLOCK OPEN.

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Figure 194. Indicator Panel BD–123–A, voltages and resistances.

The P. BIAS control should be advanced to determine whether this adjustment will produce a visible trace.

(*b*) To ascertain whether the input waveforms are being fed to the scope, check the waveforms as seen on the synchroscope against the waveforms shown in figure 190. The input waveform at jack 7–K–20, the VIDEO TEST jack located in the adjustment panel of the indicator unit (fig. 105), is a sweep trace showing transmitter pulse and probable target echoes similar to the picture on a typical A-scope. A sawtooth voltage waveform can be taken off jack 7–K–11, the SWEEP TEST jack. If these waveforms are satisfactory, examine the waveshapes at the socket of the cathode-ray tube. The video pulse can be tested at pin 7. Make sure that the positive "unblanking" steep-sided square wave exists on the first anode (pin 3). If these do not exist, examine the cords (16 and 17) for tightness of connections. If necessary, check the continuity of the cords. In a similar manner, using voltage or resistance measurements, trace the defect to the part or parts within the scope circuit responsible for the trouble. Voltage and resistance measurements at 6–K–1 are given in figure 194.

101. Trouble-shooting Chart

A. SYMPTOM:

No spot on PPI scope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Indicator circuit or power supply.	1*a*. Turn S.T.C. AMPLITUDE control completely counterclockwise. Turn up P. BIAS control. If no spot or trace appears, leave P. BIAS control turned up and proceed to item *b*. If a spot or trace appears, control may have been improperly set. Leave P. BIAS control turned up and proceed according to whatever indication is present.
	b. Check filament voltage (a-c voltage) at pins 2 and 8 of cathode-ray tube socket. If this is normal, see item *c*. If not, perform continuity checks between filaments of scope to transformer 8–T–2 in power supply unit.
	c. Check high-voltage output across resistor 8–R–14. (Make certain that one side of resistor across which voltmeter is to be connected is grounded before connecting voltmeter.) This voltage should be approximately +500 volts. If this reading is normal, proceed with item *d*. If not, check power supply half-wave rectifier high-voltage circuit by resistance measurements.
	d. Check high-voltage cord 13 from power supply to connector 6–K–2 on second anode of scope for continuity. If normal, proceed to item *e*.
	e. Check positive steep-sided square wave at pin 3 of scope socket.
	f. Voltage at pin 5 of cathode-ray tube depends upon setting of P. BIAS control. Normal values lie between —9 volts and —63 volts.
	g. Cathode return circuit is checked at pin 7 of

cathode-ray tube. Resistance will be between 2 and 150 ohms as VIDEO AMP control is varied. Cord 14 should be removed. If trouble is not cleared, substitute a new cathode-ray tube.

B. SYMPTOM:
PPI sweep is dim, distorted, or blurred.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. PPI circuit or power supply.	1*a*. Check P. FOCUS control and attempt to clear up blurring of sweep. *b*. Check high-voltage output. Lower than normal voltages will cause dimming of sweep. *c*. Check voltage waveform at jack 7–K–11 (SWEEP TEST jack). If this is abnormal, proceed with item ***d***. *d*. Check trigger input waveform at jack 7–K–3 (TRIGGER TEST jack). If this is normal, proceed with item *e*. If this is abnormal, check operation of spark-gap modulator. *e*. Check waveshapes of sweep circuit. Where an abnormal indication is noted, proceed to item *f*. *f*. Make resistance and voltage analysis of stage found defective (in item *e*) to locate part or parts responsible for trouble. *g*. Check operation and continuity of focus coil and 7–R–51, P. FOCUS control.

C. SYMPTOM:
Intermittent PPI trace during rotation of spinner assembly.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Poor contact at slip rings to deflection coil.	1*a*. Remove brushes and examine for wear. Test brush springs for tension. Unscrew two retaining screws and remove brush holder. Clean both slip rings with lint-free cloth. *b*. If this does not remedy trouble, check all connections. If all connections are tight, replace selsyns 1–A–2 (in pedestal) and 6–A–1 (in indicator unit).

D. SYMPTOM:
Intensity of PPI sweep cuts out intermittently or completely.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Break-down in high-voltage cord 13 or connectors which carry 5-kv supply for second anode of PPI scope.	1. See if there is any visible sign of break-down in cable or connectors. If no sign can be found, see paragraph 100*b*. ***Caution**: Do not touch meter or test leads while making checks with power on.*

E. SYMPTOM:
No video signal on PPI scope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Video input or receiver circuit.	1*a*. Turn up VIDEO AMPLITUDE control to its full clockwise position. Check video signal at input to PPI circuit by checking waveshape at jack 7–K–20 (VIDEO TEST jack). If this is normal, check cord 17 and connectors between input jack and cathode of tube. If abnormal, proceed to item *b*. *b*. Check cord 14 from receptacle 7–K–22 in indicator through cord CD–945 to receptable 2–K–2 in receiver for continuity. If normal, proceed to item *c*. *c*. Check receiver as described in paragraph 95.

F. SYMPTOM:
Sweep off center.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Shift in position of focusing coil.	1. Adjust position of focusing coil by centering screen pattern through adjustment of two slotted shafts on indicator panel.

G. SYMPTOM:
Sweep short on all ranges, outer portion condensed.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Weak sweep output, tubes 7–V–10 and 7–V–11.	1*a*. Test emission of 7–V–10 and 7–V–11. Replace defective tube. If normal, proceed with *b*. *b*. Check waveforms and proceed as indicated.

H. SYMPTOM:
Sweep is short but markers are evenly spaced and drift slightly.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. D-c restorer 7–V–8 is not functioning.	1. Replace tube 7–V–8. This will probably clear up fault. If symptom persists, check voltage and resistance measurements for this stage.

102. Removal and Replacement of Parts

a. Indicator Panel BD–123–A. To gain access to the inner part of the unit, loosen the four knurled knobs on the front panel and pull out the unit by grasping the two handles provided. Pull it out slowly. Allow the unit to rest on the operating shelf. Do not pull it out too far.

b. Indicator Control BC–1193–A. To permit access to the tube shelf and rear of operating controls, lift the operating shelf from the unit and place it aside. Loosen the two knurled knobs on the third panel of the unit, pull on these knobs, and allow the unit to lower. Rear view of operating controls is shown in figure 195. To permit access to the under side of the tube shelf, replace

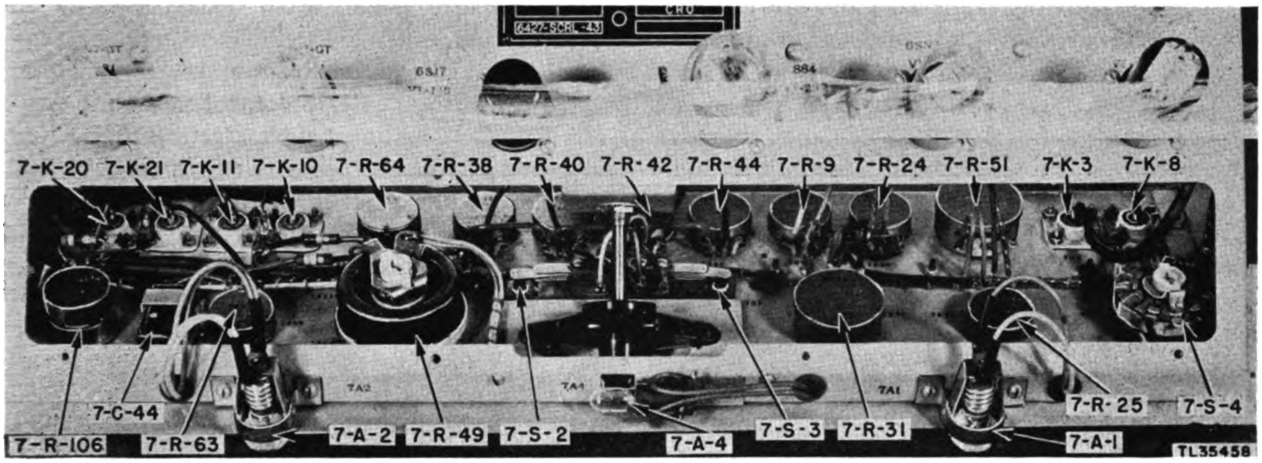


Figure 195. Operating controls, rear view.

the tube shelf in its normal position, loosen three holding screws in the middle of the third panel, and lower it to a horizontal position.

c. Power Supply Unit RA–100–A. To permit access to the power supply unit, do the following:

(1) Loosen the two knurled knobs located on the right side of the lowest panel door of the indicator and swing the door open.

(2) Pull out cord 21.

(3) Unscrew the connector on cord 13.

(4) Remove the two screws on the front part of the power unit chassis.

(5) Pull the unit forward carefully. Do not place undue strain on cable 12.

(6) Pull the unit out on the floor by lifting the front end carefully and allowing the unit to rest on its rear end. Reattach cords 13 and 21. The bottom view of Power Supply Unit RA–100–A is given in figure 196.

d. Replacement of PPI Tube 6–V–1 (figs. 197 and 198). (1) Remove Indicator Panel BD–123–A by loosening the four thumbscrews which hold it

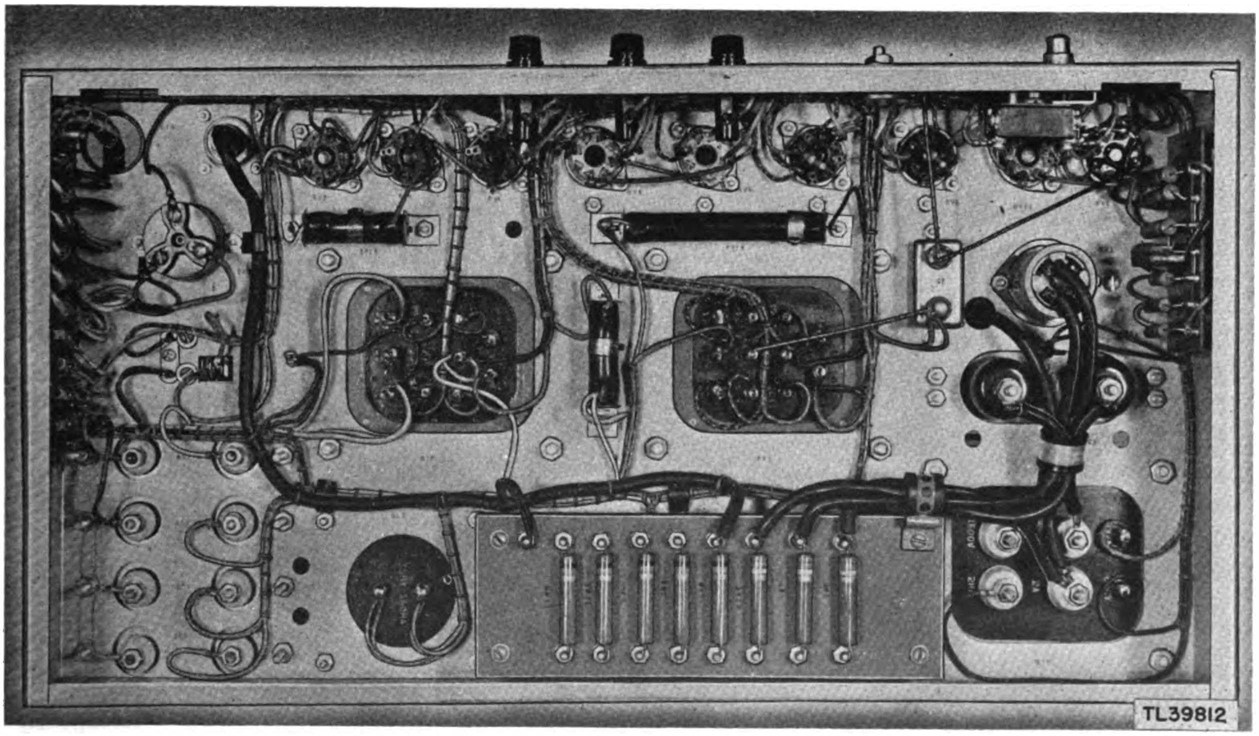


Figure 196. Power Supply Unit RA–100–A, under side of chassis.

in place and drawing it forward and upward.

(2) Unclip azimuth dial lamp-socket assembly 6–A–2.

(3) Remove the four 10-32 roundhead machine screws in the front of the indicator panel. Remove the panel from the tube mount assembly by pulling it gently forward.

Caution: CARE MUST BE EXERCISED TO PREVENT DAMAGE TO THE NECK OF THE CATHODE-RAY INDICATOR TUBE AS THE PANEL AND TUBE-SUPPORTING SHELL ARE WITHDRAWN; HOLD THE TUBE FIRMLY TO PREVENT DROPPING.

(4) Disconnect high-volage connector 6–K–2 from the side of tube 6–V–1. Remove the tube by pulling it forward carefully.

(5) Insert a new tube (type 7BP7) with the socket key in the proper position. Press gently inward on the RIM of the tube. DO NOT PUSH ON THE TUBE FACE.

(6) Replace panel, lamp socket 6–A–2, and high-voltage lead 6–K–2. Slide the indicator panel into place and tighten the thumbscrews.

(7) Turn the P. BIAS control to the full counterclockwise position before starting the system, to prevent damage to the scope screen.

(8) Start the system and adjust the P. BIAS for proper brilliance. Adjust the P. FOCUS control and center the screen pattern if necessary.

(9) Resistor 6–R–1 is a filament voltage dropping resistor for the cathode-ray tube. This is necessary because the voltage is approximately 6.8 volts measured at terminals 19 and 20 on 7–K–9. Excessive filament voltage on the type-7BP7 cathode-ray tube materially reduces its life. However, should an old or defective tube show evidence of insufficient cathode emission, resistor 6–R–1 may be shunted to increase filament voltage.

e. Adjustment of Azimuth Dial Drive Roller.

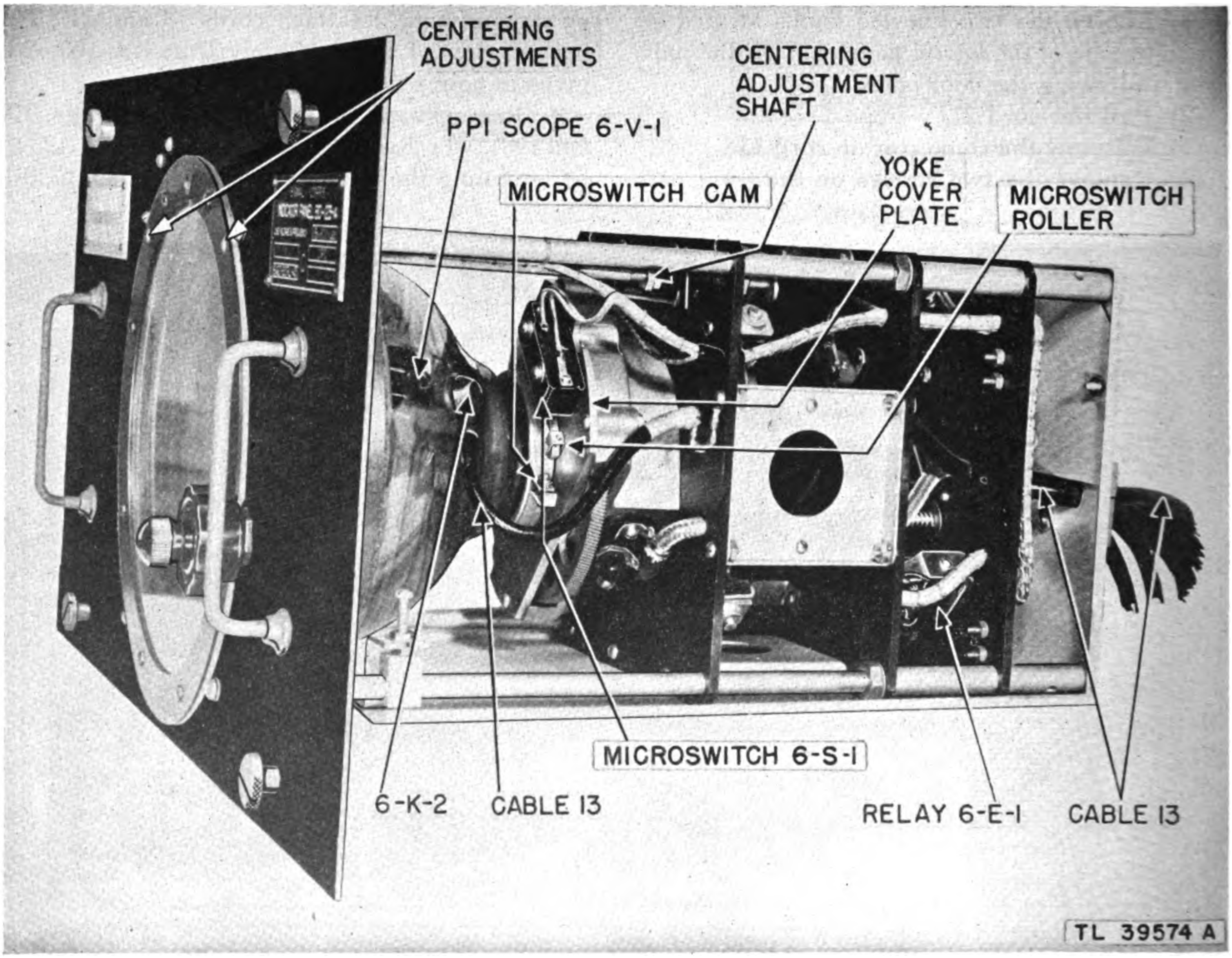


Figure 197. Indicator Panel BD–123–A, right side.

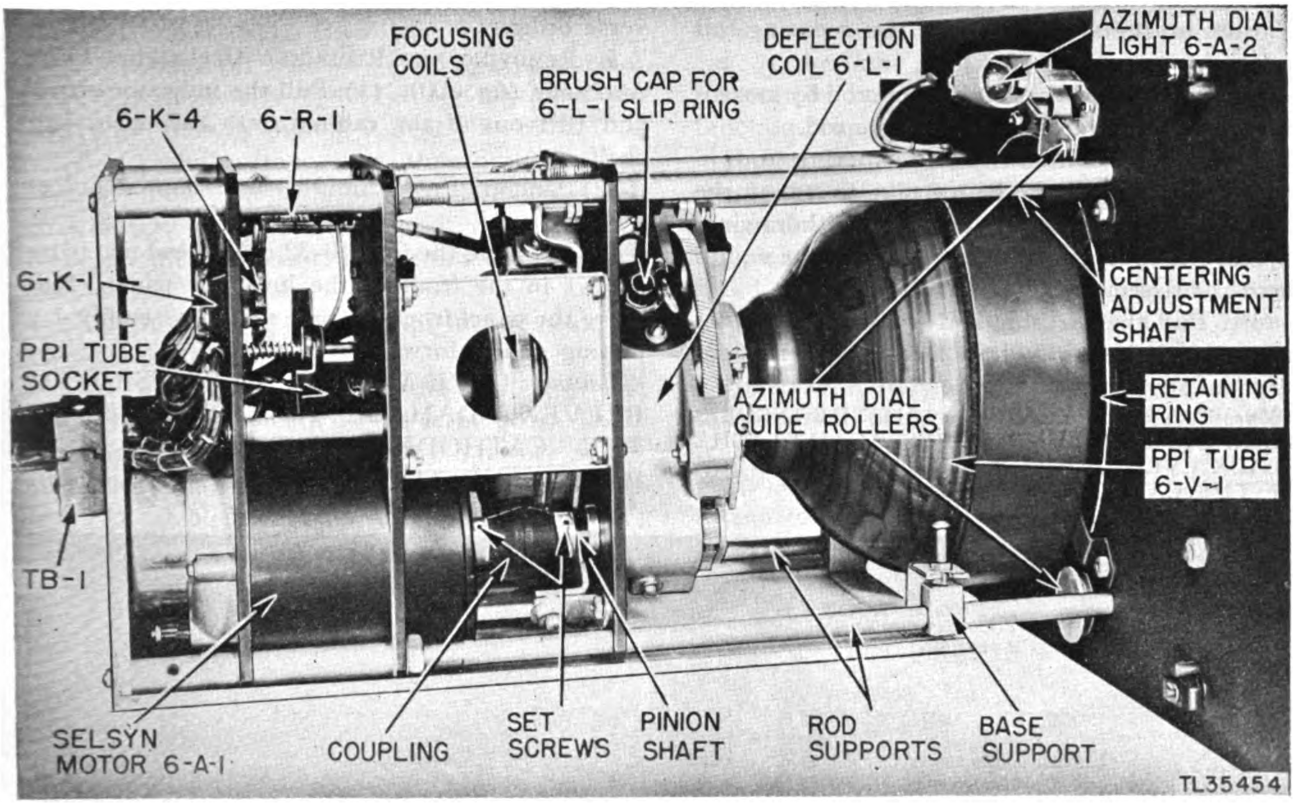


Figure 198. Indicator Panel BD–123–A, left side.

(1) The azimuth dial is driven by a rubber ring mounted in a metal roller. This roller assembly is mounted on a shaft and is rotated by a knob located at the lower right of the azimuth dial. The bushing through which this shaft passes is eccentric so that the position of the drive roller may be adjusted. If the rubber ring in drive roller assembly should wear so that there is insufficient friction or the azimuth dial does not center properly, adjustment may be made as follows:

(2) Remove Indicator Panel BD–123–A and loosen the setscrew which holds the drive roller assembly to the shaft. Pull the drive knob forward and remove the drive roller assembly. Loosen the bushing locknut in the rear of the panel and rotate the bushing to secure the desired adjustment. Tighten the bushing locknut securely. Replace the drive roller assembly on the shaft and tighten the setscrew. Check the dial assembly for satisfactory operation.

f. **Replacement of Microswitch.** (1) Remove slip-ring dust cover and then remove the microswitch. (Retain nuts and washers on rear side of microswitch.)

(2) Install the replacement microswitch and adjust its height so the roller is depressed approximately 3/64 to 1/16 inch when the bumper strikes it.

g. **Removing and Replacing Focusing Coil Assembly** (fig. 199). (1) Pull the indicator panel and PPI out of the cabinet onto the operating shelf.

(2) Unclip the azimuth dial lamp socket 6–A–2.

(3) Remove the four 10-32 roundhead machine screws in the front of the indicator panel. Remove the panel from the tube mount assembly by pulling gently forward.

Caution: CARE MUST BE EXERCISED TO PREVENT DAMAGE TO THE NECK OF THE CATHODE-RAY TUBE AS THE PANEL AND TUBE-SUPPORTING SHELL ARE WITHDRAWN; HOLD THE TUBE FIRMLY TO PREVENT DROPPING.

(4) Disconnect the high-voltage connector 6–K–2 from the side of the cathode-ray tube. Remove the tube by pulling it gently forward.

(5) Remove the four bolts holding the square spacer plate above the focusing coils. Remove the plate on the left side above the selsyn by the same method.

(6) Remove the two coil springs which hold the focusing-coil cradle against the centering rods.

(7) Remove the four screws holding the two bearing brackets which hold the focusing-coil frame.

(8) Remove the upper-left frame rod by loosening the locknut and unscrewing the rod.

(9) Partially withdraw the centering rod in the upper-left corner. Be certain to count the number of turns this rod is turned in withdrawing, so that the spot will be centered when the equipment is reassembled.

(10) Pull the focusing-coil frame out from its mounting and unsolder the leads from the fiber terminal strip.

Note. TAKE CARE NOT TO CUT THE INSULATION ON THE LEAD WIRES AGAINST THE BLACK CYLINDRICAL GUIDE FOR THE NECK OF THE CATHODE-RAY TUBE.

(11) To reassemble, follow these steps in reverse order.

h. **Removing and Replacing Deflection Coil Assembly** (fig. 200). (1) Pull the indicator panel and PPI out of the cabinet onto the operating shelf.

(2) Unclip the azimuth dial lamp socket 6–A–2.

(3) Remove the four 10–32 roundhead machine screws in the front of the indicator panel. Remove the panel from the tube mount assembly by pulling gently forward.

Caution: CARE MUST BE EXERCISED TO PREVENT DAMAGE TO THE NECK OF THE CATHODE-RAY TUBE AS THE PANEL AND TUBE-SUPPORTING SHELL

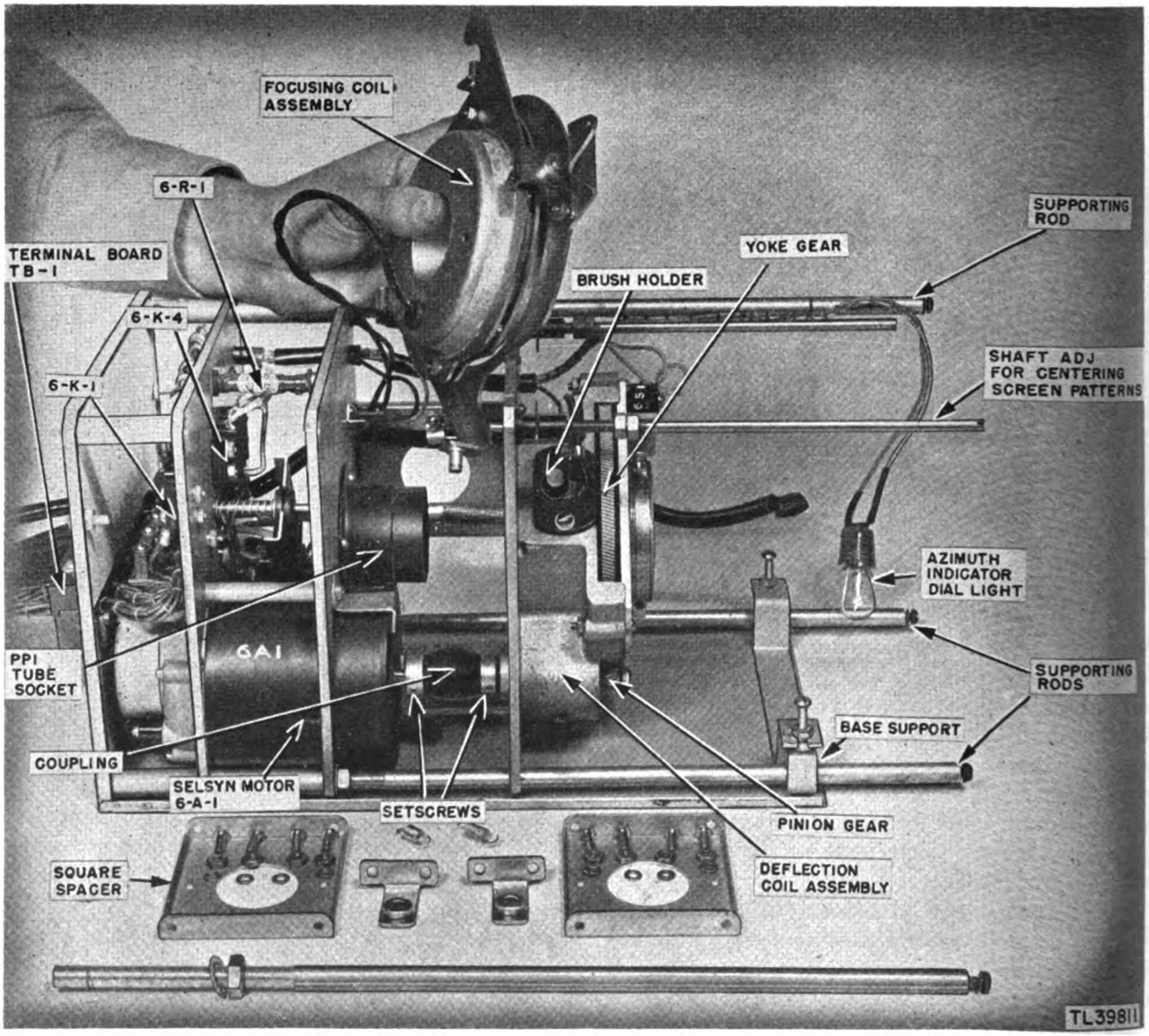


Figure 199. Removing PPI focusing coil assembly.

ARE WITHDRAWN; HOLD THE TUBE FIRMLY TO PREVENT DROPPING.

(4) Disconnect the high-voltage connector 6–K–2 from the side of the cathode-ray tube. Remove the tube by pulling it gently forward.

(5) Carefully draw the outline of the microswitch on the gear cover plate so the microswitch can be returned to the same position later. Then unscrew the two screws and remove microswitch 6–S–1.

(6) Unscrew the plastic caps and remove the two carbon brushes.

(7) Put a radial mark on the small gear and mark directly opposite on the large gear. These two lines must be made exactly opposite so the same teeth can be made to mesh when the gears are reassembled. Then remove the four screws on the gear cover plate.

(8) Remove the deflection coil assembly by sliding forward.

(9) In replacing the deflection coil assembly, be careful to reassemble the gears so that the same teeth mesh, and replace the microswitch in exactly the same position. If these parts are not reassembled correctly, the selsyn system will not function properly.

i. Emergency Operation. (1) In emergency the following substitutions may be made for the recommended tube types: A type 6F6 or a type 6L6 may be used in place of the 6V6 recommended for 7–V–3, 7–V–4, or 7–V–5. The sweep output amplifiers 7–V–10 and 7–V–11 will operate with one 6V6, providing the emission of this tube is high. One or two 6L6 tubes may be used in this position, or two 6F6 tubes. (One 6F6 tube will not give sufficient sweep amplitude.)

(2) The sweep generator 7–V–7 will operate satisfactorily with any of the following tubes: 6SJ7 (recommended), 6SK7, 6AB7, 6AC7, or 6AG7.

(3) The S.T.C. tubes 7–V–1, 7–V–2, and 7–V–3 may be removed from their sockets without affect-

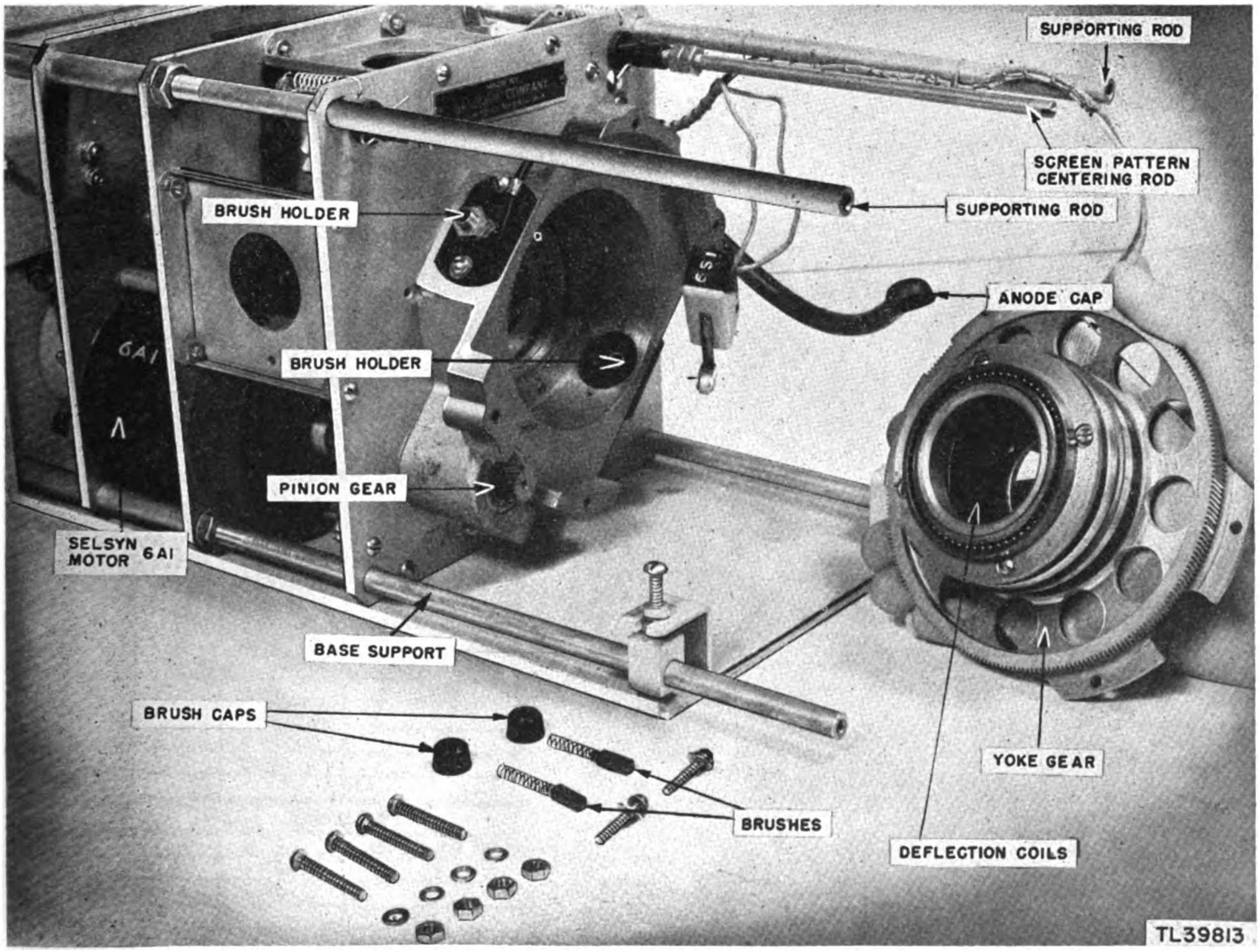
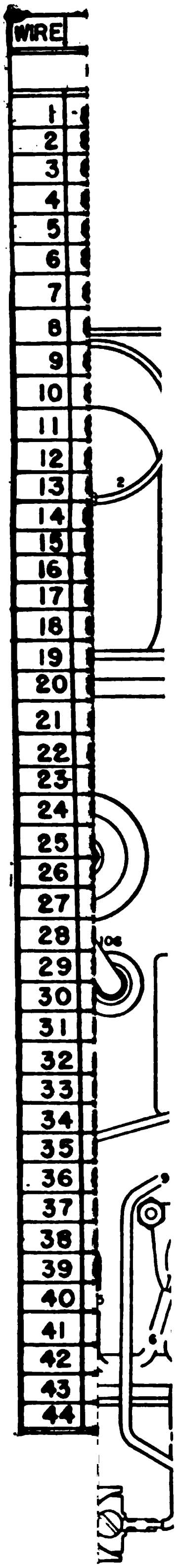


Figure 200. Removing PPI deflection coil assembly.

WIRE	FROM	TO	DESCRIPTION
IND. UNIT DIST. PANEL CABLE HARNESS			
1	9F6	9K7-12	AN-JC-48 NO.1
2	9F5	9K7-13	"
3	9F4	9K2-N	"
4	9F3	9K2-M	"
5	9F3	9K6-A	"
6	9F3	9K7-15	"
7	9F2	9K2-S	"
8	9F2	9K7-28	"
9	9F2	9K6-E	"
10	9F1	9K2-R	"
11	9F1	9K6-B	"
12	9F1	9K7-29	"
13	9K7-27	9K2-J	AN-JC-48-NO.1
14	9K7-26	9K2-K	"
15	9K7-25	9K2-L	"
16	9K7-24	9K2-H	"
17	9K7-16	9K2-O	"
18	9K7-14	9K2-P	"
19	9K7	9K2-U	"
20	9K6-C	9K2-I	"
21	9K6-D	9K2-G	"
22	9K6-F	9K2-T	"
23	9K2-E	9K2-A	NO.20 BARE
24	9K2-F	9K2-C	"
25	9K2-E	9K2-F	"
26	9K2-z	9K2-a	"
27	9K2-c	9K2-z	"
28	9K2-a	9K2-e	"
29	9K2-T	9K2-U	"
30			
31			
32			
33			
34			
CORD 8			
35	9K7-11	9S1	AN-JC-48 NO.14
36	9K7-12	5K1	"
37	5K1	9S1	"
38	9K 7-13	9S1	"
39			
CORD 9			
40	9K7-29	6K1-29	AN-JC-48 NO.18
41	9K7-28	6K1-28	"
42	9K7-27	6K1-27	"
43	9K7-26	6K1-26	"
44	9K7-25	6K1-25	"
45	9K7-24	6K1-24	"
CORD 11			
53	9K7-16	7K9-16	AN-JC-48 NO.14
54	9K7-15	7K9-15	"
55	9K7-14	7K9-14	"
56	9K7-13	7K9-13	"
57	9K7-12	7K9-12	"
58	9K7-11	7K9-11	"
METER PANEL CABLE HARNESS			
70	5M2	5K1	AN-JC-48 NO.18
71	5M1	5K1	"
72	5M2	5K1	"
73	5M1	5K1	"
74			
DIRECT JUMPERS			
75	9F1	9F5	AN-JC-48 NO.14
76	9F2	9F4	"
77	9F4	9F6	"
78			
79			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iagram.

ing the operation of the rest of the indicator control panel. The RECEIVER gain control 7–R–31 will continue to function in the normal manner, but there will be no sensitivity-time correction. The 500-yard marker generator 7–V–16 may be operated with a 6F6 tube in place of the recommended 6V6. Because of space limitations, a 6L6 cannot be used. The driver tube 7–V–15 will not operate with a 6F6, but a 6L6 may be used if necessary.

Section. IX. TROUBLE SHOOTING IN RANGE MARKER SYSTEM

103. Reference Data

The following figures and figure references are supplied to assist maintenance personnel in trouble shooting in the range marker system:

a. Figure 104, Indicator Control BC–1193-A, operating controls.

b. Figure 105, Indicator Control BC–1193–A, adjustment controls.

c. Figure 106, Indicator Control BC–1193–A, top view of chassis.

d. Figure 115, Power Supply Unit RA–100–A, complete schematic diagram.

e. Figure 116, Indicator Control BC–1193–A, complete schematic diagram.

f. Figure 128, Range marker system, simplified schematic diagram.

g. Figure 193, Indicator Control BC–1193–A, voltages and resistances.

h. Figure 205, Range marker system, test waveforms.

104. Behavior Analysis

The range marker system may be considered, for purposes of trouble shooting, as a separate channel. When trouble which has developed within the equipment is traced to the range marker system, the following checks should be made to help localize the defect to the particular circuit within the system responsible for the trouble:

a. Visual Indications. (1) The range marker system is operating normally if, when the FINE MARKERS switch 7–S–3 is pressed, the following indications are seen on the PPI-scope screen:

(*a*) On the 10,000-yard range: 500-yard fine marker pips and 2,000-yard coarse pips.

(*b*) On the 40,000-yard range: 2,000-yard fine pips and 10,000-yard coarse pips.

(*c*) On the 160,000-yard range: 10,000-yard fine pips and 40,000-yard coarse pips.

(*d*) On the 240,000-yard range: 40,000-yard coarse pips.

(2) Absence of the above results indicates a defect or defects in the range marker or associated systems.

(3) The power for the range marker system is supplied by Power Supply Unit RA–100–A (fig. 115). By checking to see that the indicator system is clear of defects, the indicator power supply can be assumed to be in a satisfactory condition. A check on whether pilot lights 7–A–1 and 7–A–2 on the operating shelf are lighted will indicate the presence or absence of 120 volts ac in the unit. Proper operation of the RANGE switch pilot light, 7–A–4, shows that 7 volts ac is being supplied to the filament circuits of the unit.

b. Marker Test. A convenient means of observing the output waveform of the range marker system is made available at MARKERS test jack 7–K–21, located on the adjustment panel of the indicator unit (fig. 105). A check, with the aid of Synchroscope I–212, at this jack will isolate Indicator Control BC–1193–A from Indicator Panel BD–123–A.

c. Supply Voltage Checks. Although the indicator power supply may be supplying the required voltages, it cannot be assumed that the proper voltages are reaching the range marker system. Connections between the power supply and range marker circuit may be defective. The input voltages to the circuit can be measured at terminal board 7–K–5 on the under side of the indicator control tube shelf. Make sure a jumper wire is connected across door interlock switch 7–S–5 while making the following checks on terminal board 7–K–5.

(1) Measure the —105-volt input at terminal 7.

(2) Measure the +250 volts at terminal 9.

(3) Measure the approximate +400 volts at terminal 10.

(4) Measure the approximate 7 volts ac across terminals 5 and 6. If the input voltages are abnormal check continuity of wires from terminal board 7–K–5 to 8–K–3 through cord 12.

d. Waveforms. (1) Using Synchroscope I–212, check the waveforms shown in figure 205, starting with the input to the range marker system and progressing toward the MARKERS test jack, 7–K–21. Accurate waveforms will be obtained only at the points in the stages indicated in figure proper range marker on proper range is correctly positioned. One full turn of adjustment screw will change marker spacing by approximately 1.6 percent or 640 yards at 40,000 yards.

I. SYMPTOM:

Spurious range markers on PPI-scope screen.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Push-button switches 7–S–2 and 7–S–3.	1. If contacts of MARKERS push-button switches 7–S–2 and 7–S–3 are improperly adjusted so that clipper diodes are released from ground before bias circuit is closed, spurious range markers will be seen on PPI-scope screen. Adjust these switches for proper operating sequence (par. 107).

106. Adjustment of Marker Divider Controls

It is important that the following adjustments be made in the exact order outlined:

a. Turn the RANGE switch to the 10,000-yard position.

b. With the spinner assembly rotating, press the FINE MARKERS button and advance the MARKER AMPLITUDE control until fine and coarse markers are visible. Five coarse markers should be observed with three fine markers between each two coarse markers. If the number of fine markers between coarse markers is wrong, correct by adjusting the 2,000-yard marker divider control 7–R–109 (fig. 106).

c. Switch to the 40,000-yard range. Four coarse markers should be observed with four fine markers between each two coarse markers. If the number of fine markers between coarse markers is wrong, correct by adjusting the 10,000-yard marker divider control 7–R–110 (fig. 106).

d. Switch to the 160,000-yard range. Four coarse markers should be observed with three fine markers between each two coarse markers. If the number of fine markers between coarse markers is wrong, correct by adjusting the 40,000-yard marker divider control 7–R–111 (fig. 106).

e. Check the correctness of the marker divider adjustment for each range by varying the line voltage between 105 and 125 volts. All range circles should remain correct. If any instability is noted, the entire marker divider adjustment procedure should be repeated.

107. Adjustment of Markers Switches

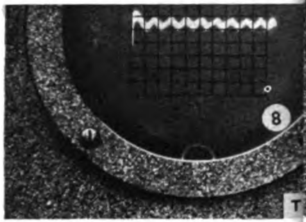
Adjust MARKERS switches 7–S–2 and 7–S–3 by carefully bending the contact springs to secure the following conditions:

a. When COARSE MARKERS button is pressed lightly, the first action to occur is the grounding of the grid bias circuit of tube 7–V–14. At this same time, all contacts of switch 7–S–2 must be closed.

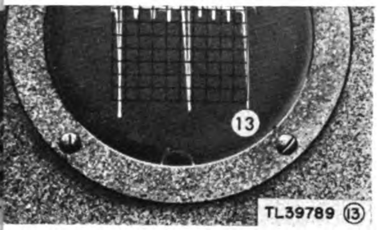
b. When the button is pressed further, coarse mixer diode (7–V–21) pin 6 circuit is removed from ground.

c. When FINE MARKERS button is pressed lightly, the first action is again to ground the grid bias circuit of tube 7–V–14. At the same time, all contacts of switch 7–S–3 must be closed.

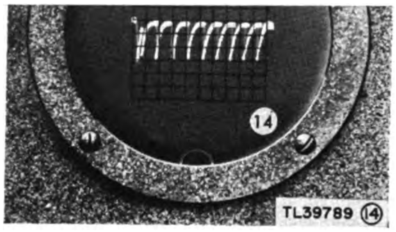
d. When the button is pressed further, pins 3 and 6 of tube 7–V–21 are disconnected from ground.



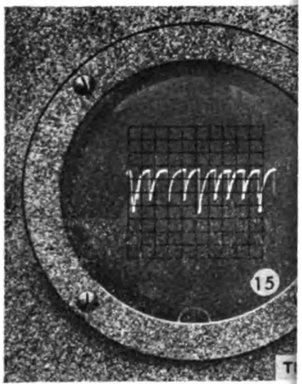
Ⓡ MARKER CHANNEL
TUBE 7–V–14.
Test points: grid and plate, pi
Scope sensitivity, 25 volts/inc
Sweep setting, No. 2.
Amplifier on (waveform inve



2,000-YARD PIP MARKER GEN-
RATOR 7–V–17.
st points, plates pins 2 and 5.
NE MARKERS switch, depressed.
ope sensitivity, 200 volts/inch.
eep setting, No. 2.
mplifier off.



⑭ RANGE MARKER CIRCUIT OUT-
PUT 7–K–19.
Test point, marker test jack 7–K–21.
Range, 10,000 yards.
FINE MARKERS switch, depressed.
Marker contrast setting, extreme counterclockwise.
MARKER AMPLITUDE setting, extreme clockwise.
Scope sensitivity, 67 volts/inch.
Sweep setting, No. 2.
Amplifier on (waveform inverted).



⑮ RANGE MARKER CIRC
PUT 7–K–19.
Test point, marker test jack
Range, 10,000 yards.
FINE MARKERS switch, d
Marker contrast setting, ½
wise.
MARKER AMPLITUDE s
treme clockwise.
Scope sensitivity, 67 volts/in
Sweep setting, No. 2.
Amplifier on (waveform inv

TL39789 ① TO ⑲

> **Warning:** *Voltages sufficient to cause DEATH ON CONTACT are exposed in Indicator Panel BD–123–A. Tests and adjustments may be necessary which require power to be applied. Do not place hands, arms, or other parts of body near high voltage points with the power applied. If possible, always turn off power and short high-voltage capacitors when making tests or adjustments.*

108. Reference Data

The following figures are supplied to assist maintenance personnel in trouble shooting the selsyn system:

a. Figure 130, Indicator panel, showing location of selsyn motor.

b. Figure 131, Pedestal base, showing slip rings and cam.

c. Figure 132, Indicator panel, showing cam, microswitch, and relay.

d. Figure 11, Control system, complete schematic diagram.

e. Figure 206, Selsyn motor, disassembled.

f. Figure 207, Selsyn relay.

g. Figure 21, Pedestal FT–458–A, cover removed showing selsyn and relay.

109. Behavior Analysis

Troubles in the selsyn system will be indicated by the improper orientation of the sweep trace with the revolving spinner assembly, or by the failure of the sweep trace to rotate when the spinner is known to be rotating. Once the set is properly oriented, the cam on the yoke gear of deflection coil 6–L–1 (fig. 132) in the indicator panel should not be disturbed. The complete procedure involved in orientation of the sweep trace with the rotation of the spinner is outlined in paragraph 111 of this section.

110. Trouble-shooting Chart

A. SYMPTOM: Sweep not properly orientated but rotates with spinner.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Selsyn motor 6–A–1 not properly oriented with respect to deflection coil yoke and cam in indicator panel.	1. Orient sweep. Refer to paragraph 111 for detailed procedure.

B. SYMPTOM: Sweep jumps every time it passes a particular azimuth.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Indicator cam closes before spinner cam opens.	1. Orient sweep. Refer to paragraph 111 for detailed procedure.

C. SYMPTOM: Sweep on PPI scope remains stationary while spinner is rotating.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Indicator cam keeps microswitch closed for more than 12°.	1*a*. Check angle through which microswitch is closed as described in paragraph 111. *b*. Adjust position of microswitch if angle is found to be too large. If angle is found to be normal proceed as follows:
2. Open circuit between selsyn generator and selsyn motor.	2*a*. Check continuity between terminals S1, S2, and S3 on selsyn generator and terminals S1, S3, and S2, respectively, on selsyn motor.

b. If circuit is open between S1 on generator and S1 on motor, or S3 on generator and S2 on motor, inspect contacts of selsyn relay 6–E–1 to see that they are in proper position (fig. 207).

c. If any of the circuits is open but selsyn relay contacts are in proper position, continue continuity check on each section of line until "open" is found.

d. Repair or replace defective connection or cable.

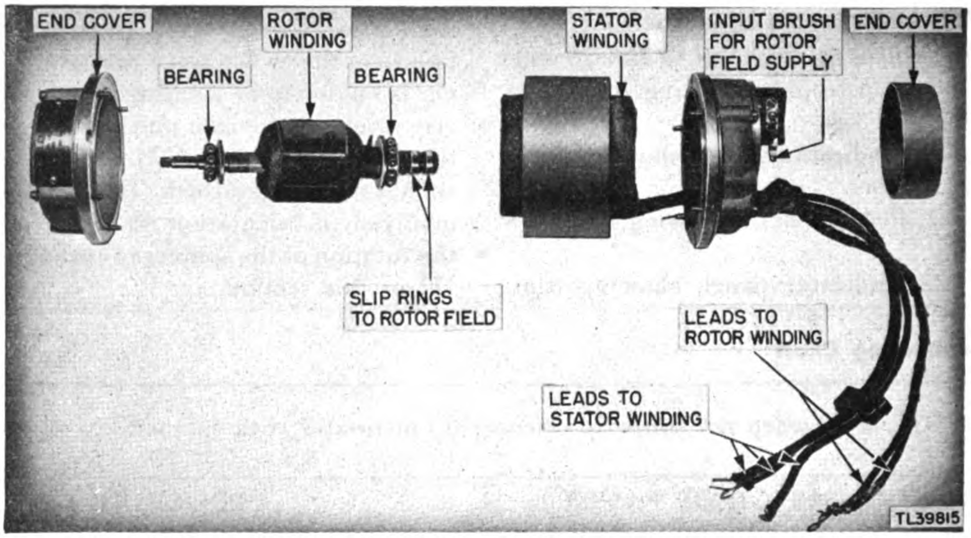


Figure 206. Selsyn motor, disassembled.

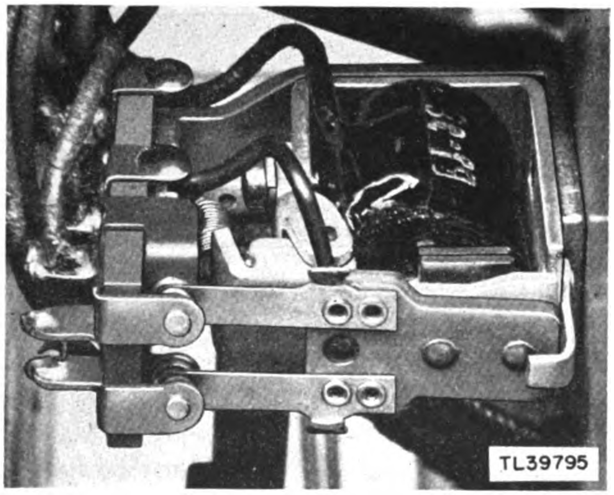


Figure 207. Selsyn relay.

3. Defective selsyn motor or generator.

3*a*. If circuit between selsyns does not have an open, disconnect leads 25, 26, and 27, on terminal strip 6–K–1 in indicator panel.

b. Turn on power to set.

c. Test selsyn motor 6–A–1 by connecting voltmeter across terminals of each stator coil in turn and turning shaft of motor. If motor is operating properly, voltage across each stator coil will range between zero and a maximum value as shaft is turned.

d. If motor is defective, relace entire indicator panel mount with spare provided. Send defective unit to depot.

e. If motor is not defective, perform same test on generator 1–A–2 (fig. 21). Rotate spinner by hand to vary voltage on stator coils. Replace generator if found defective.

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111. Orienting Procedure

a. ORIENTATION OF SPINNER AND PPI SWEEP. (1) Loosen the four thumbscrews which hold Indicator Panel BD–123–A in place. Remove the indicator panel by drawing it forward and upward. Leave all cables connected. Place unit on the operating shelf.

(2) Set SCAN switch to FORWARD, depress the interlock switch (9–S–1), and allow the antenna to turn several revolutions. This permits any static charge on the screen of the indicator tube to be equalized and the selsyns to assume their correct relative positions.

(3) Center the screen pattern accurately by means of the two slotted shaft adjustments on the indicator panel. Figure 132 shows one of the shafts within the indicator panel and the actual location of the two adjustments.

(4) Align the antenna on a target of known azimuth by means of the SCAN control switch. To make this alignment accurately, reduce receiver gain until the target echo on the indicator is a small spot.

(5) Mark the location of the microswitch cam (fig. 132) by making a pencil mark opposite the cam on the yoke cover plate. Loosen one of the clamping screws until the cam is free to rotate.

(6) Loosen the setscrews in both ends of the coupling (fig. 130) between the selsyn motor and the pinion shaft. If the setscrews happen to be on the inside and inaccessible, proceed as follows:

(*a*) Insert a strip of paper or other thin insulating material between the open contacts of the selsyn relay, 6–E–1 (fig. 132).

(*b*) Close the relay armature manually. Leads S1 and S2 to the selsyn stator are now entirely disconnected and the selsyn armature is free to revolve.

(*c*) Rotate the coupling until the setscrews are accessible.

(*d*) Loosen the setscrews and then release the relay armature. The selsyn will then assume its original position.

(*e*) Remove the insulating strip mentioned in subparagraph (*a*) above.

(7) Rotate the large yoke gear (fig. 130) until the line on the indicator tube screen points to the exact known bearing of the target chosen in (4) above. Tighten the setscrews in the coupling between the selsyn motor and pinion shaft taking care that the position of the yoke gear is not disturbed.

(8) Rotate the microswitch cam (fig. 132) to position indicated by pencil mark (see (5) above) and tighten the clamping screw. Correct setting of this cam may be checked as follows:

(*a*) Turn the SCAN control switch to the FORWARD position and allow the antenna to turn several revolutions. After not more than two revolutions, the indicator yoke should revolve smoothly and the selsyn relay should not operate when the cam closes the microswitch.

(*b*) With the SCAN switch in the REVERSE position, the yoke should rotate smoothly as before and the selsyn relay should not close.

(*c*) Stop rotation of the spinner assembly with the cam exactly centered on the microswitch roller (fig. 132).

(*d*) Close the selsyn relay (6–E–1) momentarily by pressing on the armature. This short circuits one of the selsyn stator windings and causes the rotor to lock. As the relay is closed, the deflection yoke should not move more than 2° as indicated on the azimuth dial. If there is more than 2° shift, loosen the clamping ring screw (fig. 130) farthest from the microswitch sufficiently to allow the cam to be moved slightly. Move cam to reduce shift to less than 2°, and tighten clamping ring screw. During this operation do not disturb the position of Antenna AN–134–A.

(9) Slide the indicator panel into place in the cabinet and tighten the thumbscrews. Recenter the pattern if necessary, (subpar. *a*(3) above) and check the accuracy of the azimuth indication on the known target.

(10) Sets with serial numbers above 90 are supplied with an adjustable azimuth index. Azimuth index kit 682–ID–7 is provdied for modification of sets with serial numbers below 91. Check bearing of known target. If bearing is in error more than 1/4° and less than 5° adjust azimuth index by withdrawing the indicator panel from the indicator unit and loosening the knurled-head screw behind indicator panel. Remove hole plug near the top of the window retaining ring at the front of the panel, insert hex. wrench, and adjust index line to exact target bearing. Carefully tighten knurled-head screw.

b. ADJUSTMENT OF MICROSWITCH CAMS. By the following procedure the proper operating sequence for the selsyn cams can be checked: (1) turn off all power on the set.

(2) Remove the indicator panel and place it on the operating shelf.

(3) Remove the cover plate on terminal strip 6–K–1 at the back of the indicator panel.

(4) Disconnect lead 24 of cord 9 from terminal 24 on terminal strip 6–K–1.

(5) Connect a 6-watt lamp from lead 24 of cord 9 to terminal 28 on terminal strip 6–K–1.

(6) Connect a 6-watt lamp from terminal 24 to terminal 29 on 6–K–1.

(7) Place a short circuit across the energizing coil of selsyn relay 6–E–1. (Check connection diagram, fig. 11, to find the coil connections.)

(8) Short out the indicator panel-door interlock switch 9–S–1.

(9) Turn on power to the set.

(10) Slowly rotate the antenna with the SCAN switch and watch the operation of the two lamps. The lamp in series with the indicator microswitch (between terminals 24 and 29) should light when the switch is operated, and the lamp in series with the antenna microswitch (between terminals 24 and 28) should go out when the switch is operated.

(11) By means of the sweep on the PPI tube, read the azimuth sector over which each switch operates.

(12) The antenna switch should remain open approximately 18°, and the indicator switch should remain closed approximately 12°.

(13) If the microswitch cams are properly adjusted, the center of both azimuth sectors as read on the PPI tube should coincide.

(14) If the electrical operating centers of the two cams do not coincide, loosen the indicator cam and rotate it on the shaft until the condition in (13) above is true.

(15) Remove the lamps, relay coil short, and reconnect the leads on the terminal strip.

112. Removal and Replacement of Parts

a. SELSYN MOTOR 6–A–1 IN INDICATOR PANEL BD–123–A. (1) Remove the front panel of the indicator panel and take out the PPI scope.

(2) Remove all amphenol connector cables from the rear of the unit so that the indicator panel can be removed to a work table.

(3) Unsolder the selsyn leads (fig. 130).

(4) Uncouple the selsyn from the yoke gear of deflection coil 6–L–1 (fig. 130). Use Allen wrenches to loosen the setscrews in the coupling.

(5) Loosen the screws and remove the PPI chassis from the mounting plate extending along the bottom and rear of the unit.

(6) Remove the rear plate which holds the selsyn in place.

(7) Pull the selsyn out carefully through the rear of the unit.

Note. A complete PPI mount is provided with the spares. It will often be more expedient to substitute PPI mounts rather than to attempt repairing the selsyn motor. The defective motor and its accompanying mount may then be sent to a higher echelon for repair. Refer to *b*, below, for information on how to replace the PPI mount.

b. INDICATOR PANEL BD–123–A. (1) Remove the front panel of the indicator panel and take out the PPI scope.

(2) Remove all amphenol connector cables from the rear of the unit.

(3) Remove the entire PPI mount from the indicator unit.

(4) Insert the spare PPI mount.

(5) Reconnect the cables and replace the front panel.

c. SELSYN GENERATOR 1–A–2 IN PEDESTAL FT–458–A. (1) Make sure all power is removed from the set.

(2) Throw ROTATE, SAFETY, and R.F. UNIT switches on the pedestal base to their OFF positions.

(3) Remove cover from left-side compartment of pedestal base (fig. 21).

(4) Disconnect the rotor and stator leads from their terminals. Tag all wires.

(5) Remove the six bolts located around the base of the selsyn generator. Use a socket wrench.

(6) Pull the selsyn out carefully.

d. GEARS IN BASE OF SPINNER ASSEMBLY. (1) Remove the r-f unit and the receiver unit from the yoke assembly. (Refer to paragraph 98*a* for information on removal of receiver.) After the receiver is removed, the r-f rack can be easily removed by loosening the bolts around the rack.

(2) Lower the spinner assembly to the ground (TM 11–1361).

(3) Place the pedestal base on its side.

(4) Remove the large setscrews located around the base of the pedestal unit. Use the Allen wrenches.

(5) Lower the bottom plate of the assembly. Access is now permitted to the gear network in the base of the spinner assembly.

e. DISASSEMBLY OF SELSYN MOTORS. The procedure in disassembling the motors will be evident when the motors are removed from their units. Figure 206 is a picture of the selsyn motor disassembled. Lower echelon repair may include lubrication of bearings, cleaning of windings, etc. The motor may be sent to a higher echelon for servicing.

CHAPTER 3

Maintenance Parts List for Radio Set SCR-682-A

113. Index of Major Components

This index is a key to column 4 in the following pages.

Major Component	*Reference No.*
Indicator Unit BC-1225-A..........	(1)
a. Indicator Control BC-1193-A...	(2)
b. Indicator Panel BD-123-A.....	(3)
c. Power Supply Unit RA-100-A..	(4)
d. Meter Panel BD-124-A........	(5)
Modulator Unit BC-1194-A.........	(6)
a. Spark Gap GA-9-A (Rotary)...	(7)
b. Control Panel BD-130-A.......	(8)
c. Power Supply Unit RA-101-A..	(9)
Antenna AN-134-A	(10)
Radio Frequency Unit BC-1224-A...	(11)
Pedestal FT-458-A	(12)
Radio Receiver BC-1223-A..........	(13)
Test Equipment IE-41..............	(14)
Tool Equipment TE-118............	(15)
Antenna Shelter HO-22.............	(16)
Synchroscope I-212 (See Maintenance Lists for I-212)..................	(17)
Shelter HO-23	(18)
Cables	(19)

Note. Radio Set SCR-682-A uses Power Equipment PE-183-A, therefore reference should be made to the maintenance list for Power Equipment PE-183-A for maintenance parts in manual TM 11-937.

114. Maintenance Parts List for Radio Set SCR–682–A

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
1-V-1 to 1-T-2	2Z7112.17	11	CABLE: ass'y, filament and plug, Dwg. #B-223101-1		1	*			*
2-V-15	3E4505-3	13	CABLE: ass'y, L.O. Dwg. #C-220514-2		1	*			*
3-K-10 to 3-R-12, Lead 163.	1F4B6-2	6.1	CABLE: coaxial; Dwg. #W-220679-1		196				*
Cord 24, 25	1F4W1-3.19	19	CABLE: coaxial; 50 ohms, type D-163296. Dwg. #W-218404-1		41 in.				*
3-K-6 to 3-K-7 and Cord 4.	1F4C9-37	6	CABLE: coaxial; spark gap to line pulser cable, part #220344-8		1	*			*
Cord 7	1B3015-1	19	CABLE: H.V. #15 AWG, single stranded, flexible, Dwg. #220741-11		94	*			*
Cord 28	3E4505-6	11	CABLE: rotary joint, Dwg. #C-222366-5		1	*			*
1-A-3 to 1-K-26, 1-A-4 to 1-K-11.	1B816.22	9	CABLE: service cord, 2 conductor, Dwg. #W-220340-2		8				*
	1B3020-1.1	13,12,1	CABLE: shielded, 1 conductor stranded, Dwg. #W-218803-1			*			*
Cord 27, CO-942	1B3046-6	19	CABLE: 6 conductor, Dwg. #W-218518-2		4				*
Cord 1	3E4505-2	6	CORD: ass'y, CD-7 H.V. coaxial, Dwg. #W-217572		1				*
CD-22	1F4W1-1.15.4	13	CORD: ass'y, coaxial; CD-22 Dwg. #B-224043-1		1				*
CD-23	1F4W1-1.17A	13	CORD: ass'y, coaxial; 72 ohms, CD-23, Dwg. #B-224035-1		1				*
CD-24	1F4W1-3.17	11	CORD: ass'y, coaxial; CD-24 Dwg. #B-223525-1		1	*			*
CD-27	3E4505-4	11	CORD: ass'y, CD-27, R.R.P. Dwg. #C-222783-1		1	*			*
CD-29	1F4B6-1.6.50		CORD: ass'y, coaxial; CD-29, #14 AWG Dwg #C-220218		1	*			*
Cord 25	1F4W1-3.19	11	CORD: coaxial; CD-25, AFC, Dwg. #B-223524-1		1	*			*
CD-943	3E1943	19	CORD: coaxial; CD-943, trigger, Dwg. #C-218962-7		1				*
BC-1194, A to F1, 458-A.	3E1944	19	CORD: coaxial; CD-944, H.V. single conductor, type B-2 Dwg. #D-222374-5		1	*			*
CD-26	3E4505-5	11	CORD: CD-26, Dwg. #C-223873-1		1	*			*
CD-941	3E1941	19	CORD: CD-941, 2 conductor, Dwg. #C-218971-7		1				*
CD-942	3E1942	19	CORD: CD-942, 6 conductor, Dwg. #C-218990-9		1				*
CD-945	3E1945	19	CORD: CD-945, Dwg. #C-218994-10		1	*			*
	1F7C1-4.10	9	WIRE: braided lead, Dwg. #W-217572		20 in.				*
	1A802.1	9	WIRE: #2 copper, bare, Dwg. #W-220861-2		43 ft.				*
	1B1312.7	19	WIRE: #12 hook-up, black, Dwg. #W-220787-1		55 ft.	*			*
	1A812.3	19	WIRE: #12, tinned, bare copper, Dwg. #39209-12		10 ft.				*
	1B2012	19	WIRE: #12 L.T. aircraft, Dwg. #W-222262-1		400				*
	1B1314.4	19	WIRE: #14, Lenz Aerolac, yellow, Dwg. #W-218797-2		400	*			*
	1B2014		WIRE: #14, rubber covered, Dwg. #W-222262-2		35 ft.				*
	1B1316.4	19	WIRE: #16, hook-up, yellow, type S-12-CL		233 ft.	*			*
	1B2016	19	WIRE: type AN-#16, Dwg. #222262-3		400	*			*
	1B1318.2	13	WIRE: #18, Lenz Aerolac, red, Dwg. #218842-1		400	*			*
	1A818.1	19	WIRE: #18, solid, bare copper, Dwg. #3900-18		400				*
	1B2018	19	WIRE: type AN-#18, Dwg. #W-222262-4		71 ft.	*			*
	1B1320.7	2, 4	WIRE: #20, hook-up, black, stranded, Dwg. #218505-2		441 ft.	*			*
	1A107	13	WIRE: #20, solid copper, bare, Dwg. #39209-20		120 in.	*			*
	1B1120.2	19	WIRE: grid; shielded, tinned copper 41 in. long, Dwg. #W-218446-1		10				*
2-C-25	3D9010-15	13	CAPACITOR: 10 mmf, ceramic, ±10%, 500 volts, #W218452-1		1	*	*		*
2-C-17	3D9010-3	2	CAPACITOR: 10 mmf, mica, ±10%, 500 volts, #39283-1		1	*	*		*
2-C-36, 2-C-40	3D9022-4	13	CAPACITOR: 22 mmf, ceramic, ±20%, 500 volts, #W218453-1		2	*	*		*
7-C-34	3D9027-6	2	CAPACITOR: 27 mmf, mica, ±10%, 500 volts, #39283-6		1	*	*		*
7-C-46	3D9047-4	2	CAPACITOR: 47 mmf, mica, ±10%, 500 volts, #39283-9		1	*	*		*
2-C-39	3D9047-5	13	CAPACITOR: 47 mmf, ceramic, ±10%, 500 volts, #W218454-1		1	*	*		*
7-C-3, 4, 12, 24, 35, 39.	3K2056031	2	CAPACITOR: 56 mmf, mica, ±10%, 500 volts, #39283-10		6	*	*		*
7-C-6	3D9100-25	2	CAPACITOR: 100 mmf, mica, ±10%, 500 volts, #39283-13		1	*	*		*

2-C-6, 2-C-10, 14, 17, 20, 23.	3D9100-79	13	CAPACITOR: 100 mmf, mica, ±10%, 500 volts, #GC-210685-4		6	*	*		*
1-C-1	3D9200-23.2	11	CAPACITOR: 200 mmf, mica, ±10%, 250 volts, #W222365-1		1	*	*		*
7-C-7	3D9220-4	2	CAPACITOR: 220 mmf, mica, ±10%, 500 volts, #39283-17		1	*	*		*
7-C-18, 7-C-32, 36	3D9270-3	2	CAPACITOR: 270 mmf, mica, ±10%, 500 volts, #39283-18		3	*	*		*
7-C-8	3D9820-1.1	2	CAPACITOR: 820 mmf, mica, ±10%, 500 volts, #39286-4		1	*	*		*
7-C-38	3DA1-66	2	CAPACITOR: 1,000 mmf, mica, ±10%, 500 volts, #39286-5		1	*	*		*
2-C-1, 2-C-2, 2-C-3, 2-C-4, 2-C-5, 2-C-7, 2-C-8, 2-C-9, 2-C-11, 2-C-12, 2-C-13, 2-C-15, 2-C-16, 2-C-18, 2-C-19, 2-C-21, 2-C-22, 2-C-27, 2-C-32, 2-C-33, 2-C-34, 2-C-35, 2-C-46, 2-C-53, 2-C-54, 2-C-55, 2-C-56, 2-C-57, 2-C-58, 2-C-59, 2-C-60.	3DKA1-108	13	CAPACITOR: 1,000 mmf, ceramic, ±20%, 300 volts, #W-218536-2		31	*	*		*
2-C-24, 2-C-47	3DA1-58	13	CAPACITOR: 1,000 mmf, mica, ±20%, 500 volts, #W218768-1		2	*	*		*
7-C-19	3K3012231	2	CAPACITOR: 1,200 mmf, mica, ±10%, 500 volts, #39286-6		1	*	*		*
7-C-1, 7-C-9, 7-C-25	3DA1.500-1	2	CAPACITOR: 1,500 mmf, mica, ±10%, 500 volts, #39286-7		3	*	*		*
7-C-20	3DA4-700	2	CAPACITOR: 4,700 mmf, mica, ±10%, 500 volts, #39286-13		1	*	*		*
7-C-21, 7-C-30	3DKA10-175	2	CAPACITOR: 10,000 mmf, mica, ±10%, 300 volts, #GC-210685-8		2	*	*		*
2-C-26, 2-C-41, 43, 45.	3DA10-53	13	CAPACITOR: 10,000 mmf, mica, ±20%, 300 volts, #GC-210685-63		4	*	*		*
7-C-5, 7-C-22, 7-C-23, 8-C-7.	3DA10-124	2, 4	CAPACITOR: 10,000 mmf, paper, ±20%, 600 volts, #GB210630		4	*	*		*
2-C-30, 2-C-42	3D353	13	CAPACITOR: 10,000 mmf, paper, ±10%, 800 volts, #W-218789-1		22	*	*		*
2-C-15, 2-C-27, 2-C-26, 2-C-31, 2-C-43.	3DA50-57	2	CAPACITOR: 50,000 mmf, paper, +30% 10%, 600 volts, #GB-210630-6		5	*	*		*
7-C-2, 7-C-10, 7-C-16.	3DA100-112	2	CAPACITOR: 100,000 mmf, paper, +20%—10%, 400 volts, #GB-210630-1		3	*	*		*
2-C-28A, 2-C-28B, 2-C-28C.	3DA100-36	13	CAPACITOR: 3x100,000 mmf, +30%—20%, paper, 600 volts, #ES-690308-6		1	*	*		*
7-C-11, 7-C-33, 7-C-40, 7-C-44, 7-C-42.	3DA250-43	2	CAPACITOR: 250,000 mmf, paper, +20%—10%, 200 volts, #GB-210630-3		5	*	*		*
1-C-3, 1-C-5	3DA250.21	11	CAPACITOR: 2,500,000 mmf, paper, +20%—10%, 600 volts, #W-220875-1		2	*	*		*
4-C-1A, 4-C-1B	3DA250-49	9	CAPACITOR: 2x250,000 mmf, +10%, 200 volts, #W-218483-2		1	*	*		*
2-C-44	3DA500-97	13	CAPACITOR: 500,000 mmf, paper, +20% −10%, 600 volts, #W-218490-1		1	*	*		*
7-C-48, 8-C-3	3DA500-27	2, 4	CAPACITOR: 500,000 mmf, oil filled, +20% −10%, 600 volts, #W-218784-2		2	*	*		*
8-C-1	3DA100-172	4	CAPACITOR: 2x100,000 mmf, oil filled, +20%—10%, 7,000 volts, #W-218712-2		1	*	*		*
2-C-31	3DB1.428	13	CAPACITOR: 1 mf, oil filled, +20% −10%, 600 volts, #W-218428-2		1	*	*		*
2-C-52	3D333	13	CAPACITOR: 1 mf, oil filled, —20%+10%, 1,000 volts, #W-218429-1		1	*	*		*
3-C-1	3DB1-2538	8	CAPACITOR: 1 mf, +20%—10%, 1,000 volts, #W-218426-4		1	*	*		*
3-C-2, 1-C-4	3DB2.425	7, 11	CAPACITOR: 2 mf, paper, +14%—6%, 600 volts, #W-218425-3		2	*	*		*
4-C-2	3DB2.10020-3	9	CAPACITOR: 2 mf, paper, +15% −5%, 10,000 volts, #W-218478-1		1		*		*

*Indicates stock available.

114. Maintenance Parts List for Radio Set SCR-682-A (contd.)

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
7-C-13, 7-C-14, 7-C-41, 7-C-45, 7-C-47.	3DB2-6020	2	CAPACITOR: 2 mf, paper, +10%—20%, 600 volts, #W-218540-1	....	5	*	*	....	*
2-C-48, 2-C-49, 2-C-50, 2-C-51.	3DB4-85	13	CAPACITOR: 4 mf, oil filled, +20%—10%, 600 volts, #W-218430-2	....	4	*	*	....	*
8-C-2, 8-C-4, 8-C-5, 8-C-6.	3DKB8-57	4	CAPACITOR: 8 mf, paper ,+25%—10%, 1,000 volts, #W-220963-2	....	4	*	*	....	*
1-C-6, 1-C-7	3DB12-17	12	CAPACITOR: 12 mf, 220 volts, #W-220-977-2	....	2	*	*	....	*
2-L-14, 2-L-15	3Z1891-4	13	CHOKE: assembly, 75 turns 2 crosses per turn, wire wound on 1 megohm resistor, Dwg. #W-2183821	....	2	*	*	....	*
2-L-19	3Z1891-4.2	13	CHOKE: assembly, filament, 36 turns of #23 enamel wire, Dwg. #W-218383-1	....	1	*	*	....	*
2-L-17, 2-L-18	3C323-5A	13	CHOKE: filter, 12 henrys, 150 ma, 2,000 volt, a-c type #1308, Dwg. #D-222495-2	....	2	*	*	....	*
2-L-3, 2-L-5, 2-L-7, 2-L-9, 2-L-11.	3Z1891-4.1	13	CHOKE: plate assembly, 55 turns #30 DSC wire wound on 1,200 ohm resistor, ½ watt, type BT-½RC, Dwg. #W-218384-1	....	5	*	*	....	*
3-L-2	2C2500-1194 A/C1	6	CHOKE: 5 mh±10%, 50 ma, d-c, 10,000 volts, Dwg. #W-216490-1	....	1	*	*	....	*
2-L-13	2C5066-1223 A/C2	13	COIL: assembly, diode, Dwg. #W-218394-1	....	1	*	*	....	*
2-L-4, 2-L-6, 2-L-8, 2-L-10, 2-L-12.	2C5066-1223 A/C1	13	COIL: assembly, interstages, Dwg. #W-218397-1	....	5	*	*	....	*
2-L-1, 2-L-2	2C5066-1223 A/C3	13	COIL: assembly, Dwg. #W-218396-1	....	2	*	*	....	*
7-A3 includes 7-L-1, 7-R-79, 7-C-29.	2C1557-1193A/C2	2	COIL: oscillator, assembly, Dwg. #C-220624-2	....	1	*	*	....	*
3-E-1	2Z7590-34/8	8	COIL: relay, style #1155693, Dwg. #W-218579	....	1	*	*	....	*
2-L-16	3C307-7	13	COIL: d-c, resistance 10 ohms ±20%, type #12697, Dwg. #218535-1	....	1	*	*	....	*
4-E-1	2Z7590-32/4	9	COIL: 115 volts, 60 cycles, Dwg. #W-218827-1	....	1	*	*	....	*
1-E-1	2Z7590-35/4	12	COIL: for reversing contactor, 115 volts, 60 cycles, Dwg. #W-222631-1	....	1	*	*	....	*
8-L-1, 8-L-2, 8-L-3.	3C338-4	4	REACTOR & FILTER: 15 henrys, 150 ma, 200 ohms, ±10%, 2,000 volts, Dwg. #W-218667-1	....	3	*	*	....	*
3-L-1	3C338-2	7	REACTOR: resonant choke, 64 henrys, 50 ma, 26,000 volts, oil filled ceramic, Dwg. #W-218523-1	....	1	*	*	....	*
1-K-2, 9-K-2	2Z8799-149	12, 6	CONNECTOR: AN-3102-40-1S, Dwg. #C-220213-12	....	2	*	*	....	*
1-K-16, 2-K-4	2Z7111.37	11	CONNECTOR: AN-3108-16S-3P, Dwg. #GC-220224-11	....	2	*	*	....	*
1-K-10, 4-K-6, 9-K-6.	2Z8799-208	11, 9, 2	CONNECTOR: AN-3102-22-SP, Dwg. #C-220213-9	....	2	*	*	....	*
2-K-2	2Z7119.2	13	CONNECTOR: AN-3102-28-4P, Dwg. #C-220213-10	....	1	*	*	....	*
2-K-3	2Z8671.5	13	CONNECTOR: AN-3102-16S-3S, Dwg. #C-220213-11	....	1	*	*	....	*
4-K-7, 9-K-5	2Z8676.23	19	CONNECTOR: female, AN-3106-22-5S, Dwg. #C-220218-4	....	2	*	*	....	*
3-K-11, 9-K-3, 7-K-1, 7-K-6, 7-K-12, 7-K-14, 7-K-16, 7-K-18, 7-K-22.	2Z7226-259	1, 8, 2	CONNECTOR: type PL-259, Dwg. #W-218477-1	....	9	*	*	....	*
8-K-4	2Z7111.38	4	CONNECTOR: AN-3106-18-16P, Dwg. #W-22066-1	....	1	*	*	....	*
1-K-12, 7-K-2, 2-K-7, 3-K-10.	2A8799-239	11, 2 13, 7	CONNECTOR: Signal Corps type SO-239, Dwg. #W-218434-2	....	17	*	*	....	*
1-K-13, 3-K-8	2Z8671.32	11, 7	CONNECTOR: socket for B2 Cable, type #118114, Dwg. #C-222277-2	....	2	*	*	....	*
CO-941, K-1, 4-K-3	6Z3150-7	19	CONNECTOR: Twist Lock, type #7398, Dwg. #W-218600-1	....	2	*	*	....	*
Lead #32, 4-S-2 to 4-R-3 & 4-C-2.	3H4496-101A/C20	9	CONNECTOR: cord to ground, Dwg. #C-217991-1	....	1	....	*	....	*

1-K-2	2Z1612.5	12, 11	CONNECTOR: cover to fit connector AN-3102-40-15, Dwg. #W-218836-3		1		•		•
	6Z3147-2	11	CONNECTOR: T and B, for thin wall conduit, type #5221, Dwg. #W-222236-1		2		•		•
2-J-1-2	2Z5540	13	JACK: phone, P.R. type A.2., Dwg. #W-218381-1						
1-K-3, 4-K-5	6Z1727	9	PLUG: cap. #7057, Dwg. #W-218522-1		2		•		•
8-K-2	6Z7591-12.1	1	PLUG: lockcap twist, 15 amp. 125 volts, type #7554, Dwg. #W-218548-1		1	•	•		•
1-K-3, 4-K-5	2Z3010.11	6	RECEPTACLE: duplex, 15 amp., 125 volts, Cat. #9595, Dwg. #W-218463-1		2		•		•
4-K-4	6Z7778	9	RECEPTACLE: 3 poles, 50 amp., 600 volts, Cat. #7380, Dwg. #W-218891-2		1		•		•
8-K-1	3Z7813-1	4	RECEPTACLE: twist lock, 15 amp., 125 volts, type #7557, Dwg. #W-218537-1		1		•		•
8-F-1	3Z2600A7	4	FUSE: 0.75 amperes, 250 volts, type 3AG, Dwg. #W-218554-1		1	•	•		•
4-F-2, 3-F-3	3Z1901-3	6, 7, 9	FUSE: 3 amperes, cartridge, Cat. #1003, Dwg. #W-218484-2		2	•	•		•
8-F-2, 8-F-3, 10-F-1	3Z1950	4	FUSE: 3 amperes, 250 volts, type 3AG, Dwg. #W-218555-1		2	•	•		•
9-F-1, 2, 9-F-5, 6	3Z2605.4	1	FUSETRON: 5 amperes, 250 volts, type #405, Dwg. #W-220777-1		4	•	•		•
4-F-3, 3-F-1, 3-F-2	3Z1931	9-6	FUSE: 10 amperes, 250 volts, renewable cartridge, Cat. #1010, Dwg. #W-218468-2		3	•	•		•
9-F-3, 4; 4-F-1	3Z2615.1	1-9	FUSE: 15 amperes, 250 volts, renewable cartridge, Cat. #1012, Dwg. #W-218485-2		3	•	•		•
4-F-2, 3-F-3	3Z3003		FUSE-LINK: 3 amperes, 250 volts, Cat. #1103, Dwg. #W-218583-1		2	•	•		•
3-F-1, 2; 4-F-3	3Z3010		FUSE-LINK: 10 amperes, 250 volts, Cat. #1103, Dwg. #W-218583-1		3	•	•		•
4-F-1, 9-F-3, 4	3Z3015.1		FUSE-LINK: 15 amperes, 250 volts, Cat. #1112, Dwg. #W-218582-1		3	•	•		•
8-F-2, 3; 10-F-1	3Z3275-1	4	FUSE EXTRACTOR POST: type HOM, Dwg. #W-218553-1		3	•	•		•
	2Z1404-2	13	BUSHING: brass, 164 in. I.D. x ¼ x 0.395 long, #W-210996-1		4		•		•
	2Z1404-3	3	BUSHING: cam, brass, 0.625 in. I.D. x 0.250 in. I.D. x 0.656 long, #W-217390-1		1		•		•
	2Z1404-4	11	BUSHING: guide, brass, ¼ in. long, #W-220655-3		2		•		•
	3G1050-16	9	BUSHING: lead-in, porcelain #W-21847601		1	•	•		•
	2Z1404-1	3	BUSHING: stainless steel, 0.346 in. long, #W-218906-1		1		•		•
3-A-1	6N8701	7	INSULATION: asbestos listing #W-218465-1		4		•		•
	3G1838-33.2	7-9	INSULATION: block, rectangular, 1 x 2$\frac{1}{16}$ in., #W-217573-1		4		•		•
	3G1838-86.1	9	INSULATION: block, rectangular, 1$\frac{3}{16}$ x 5$\frac{3}{8}$ in., #W-218207-1		2		•		•
	3G1838-33.1	9	INSULATION: block, ⅜ base, #W-217656-1		1		•		•
	3G1838-64.2	7	INSULATION: block, fabric, 4 in. long, #W-220885-1		1		•		•
4-E-1	3G1450-20.7	9	INSULATOR: relay, type P1728, #W-218567-1		1		•		•
	3G1838-59	13	INSULATOR: $\frac{1}{32}$ in. fabric base 2¼ x 3$\frac{11}{16}$ in., #W-222755-1		1		•		•
	3G1838-41.2	2	INSULATOR: junction block, 0.078 in. fabric base, #W-217608-1		1		•		•
	3G1838-152	2	INSULATOR: junction block, $\frac{1}{32}$ in. fabric base, #W-217605-2		1		•		•
	3G1838-49	2	INSULATOR: junction block, 2½ x 3$\frac{1}{32}$ in. rectangular, #W-217599-2		1		•		•
	3G1838-50	2	INSULATOR: junction block, 2½ x 3⅛ in. rectangular, #W-217603-2		1		•		•
	3G1350-58	7	INSULATOR: feed through, $\frac{13}{32}$ in. diam., $\frac{23}{32}$ in. long, #W-216221-1		2	•	•		•
	3G1837-19	13	INSULATOR: phenolic, tubular, $\frac{19}{32}$ in. long, #W-217305-2		1	•	•		•
	3G1837-8.5	13	INSULATOR: polystyrene, 0.267 x ¼ in. thick, #W-217307-1		1	•	•		•
	3G1450-16.7	7-9	INSULATOR: square post, 1 x 1 x 1 in. long, #W-218467-1		6	•	•		•
	3G1837-8.4	13	INSULATOR: polystyrene, 0.89 in. I.D. x 2.98 O.D. x ¼ in. thick, #W-217308-1		2	•	•		•
	3G1838-86.2	2	INSULATOR: junction block, 2½ x 5⅜ in., #W-217600-2		1		•		•
1-A-3, 1-A-4, 3-A-3, 3-A-4, 8-A-1.	3G1839-14	11, 7, 4	INSULATOR: switch arm, type #W-222584-1, #1704		5		•		•
	3G1838-120.2	12	INSULATOR: slip ring, 2 slots ⅜ x $\frac{5}{32}$ in. deep, #W-217906-3		14		•		•
	3G1838-120.1	12	INSULATOR: top, fabric base, 6 holes, 2 slots 1⅛ in. w., #C-217913-1		1		•		•
	3G1250-48.8	7-9	SPACER: ceramic, 1 in. O.D. x 3 in. long, #W-132947-20		2	•	•		•
	3G1250-10.5	7	SPACER: ceramic, ½ in. O.D. x ⅝ in. long, #W-132947-21		2	•	•		•

*Indicates stock available.

114. Maintenance Parts List for Radio Set SCR-682-A (contd.)

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
	6L50424	12	SPACER: felt, gray, type F11, #W-222496-1		1		*		*
	3G1250-10.6	13	SPACER: ceramic, 3/8 in. O.D. x 5/8 in. long, #W-132947-9		5	*	*		*
	3G1838-13.1	2	SPACER: insulating, washer, #W-220680-2		7		*		*
	2Z8804-13	9-4	SPACER: std. steel tubing, 3/4 in. long, #W-217693-1		8		*		*
	3G1838-25	13	SPACER: natural bakelite, 1 9/16 in. long, #W-217251		1		*		*
	3G1838-30.3	13	SPACER: natural bakelite, 1 7/8 in. long, #W-218290-1		3		*		*
	3G1250-10.5	9	SPACER: ceramic, 1/2 in. O.D. x 5/8 in. long, #W-132947-19		6	*	*		*
	2Z8804-14	7	SPACER CONNECTOR: 6 slots, 0.210, #W-220886-1		1		*		*
7-A-4	2Z5925	2	LAMP: range switch, 6-8 volt, type T13, #W-211125-2		1	*	*		*
3-A-2, 5-6-7	2Z5935.1	8	LAMP: dial, 55 volts, type #55 BT-2, base #902, #W-222577		4	*	*		*
7-A-1, 2; 6-A-2	2Z5941-1	2, 3	LAMP: dial, 120 volts, 6 watt, #W-218455-1		3	*	*		*
3-A-5, 3-A-2, 3-A-6, 3-A-7, 3-R-1, to 8.	2Z5886-2	8	LIGHT ASSEMBLY: pilot, 55 volts, #W-220996-2		4	*	*		*
	6Z1957	5	CLOCK: aircraft, 24 hr. dial, civil date indicator, 2 3/4 in. round dial, Aeronautics Spec. #SQ-115, #870-SK, Waltham Watch Co. BWG, #W-218496-1		1				*
3-M-1	3F910-30	6	METER: milliameter, rectangular case, 0-1.0 ma. with 0-100 ma. and 0-20 ma. scale, radium dial, Dwg. #W-218474-3		1		*		*
5-M-2	3F3358	5	METER: total time, rectangular case, 115 volt, 60 cycle a-c, Dwg., #W-218494-2		1				*
5-M-1	3F8150-68	5	METER: voltmeter, a-c, 0-150 volt, 60 cycles, rectangular case 3 1/2 in. Ad-25, Graybar Cat. #93 x 474, Dwg., #W-218493-1		1		*		*
1-E-1	2Z7593-20	12	CONTACTOR: reversing, 115 volts, 60 cycles, Dwg., #B-222415-2		1		*		*
1-E-3	2Z7587-29	12	RELAY: motor control; 115 volts, 60 cycles, type A, Dwg. #B-222477-4		1	*			*
8-E-1	2Z7590-33	4	RELAY: dust tight; 120 volts a-c, 60 cycles, 2 contacts. Dwg. #218543-2		1	*			*
3-E-4	2Z7656-9	8	RELAY: time delay; 110 volts a-c, 60 cycles, type 92. Dwg. #218411-1		1		*		*
3-E-3	2Z7599-7	8	RELAY: overload; 50 ma, 5 prong mtg. Dwg. #W-218458-3		1	*			*
3-E-1	2Z7590-34	8	RELAY: switchboard type; 115 volts a-c, 0.087 amps, type SG. Dwg. #W-218401-2		1	*			*
3-E-2	2Z7599-8	8	RELAY: underload; T.T. 10 M.R. 5 prong mtg. Dwg. #218459-3		1	*			*
4-E-1	2Z7590-32	9	RELAY: panel mtg; 115 volts, 60 cycles, 2 pole, open type, Dwg. #B-222416-2		1	*			*
1-E-2	2Z7590-35	12	RELAY: 2 pole N.C. open; type B-020. Dwg. #B-222416-2		1	*			*
1-S-7, 8-S-1, 4-S-1, 3-S-6, 3-S-5, 7-S-5, 9-S-1.	3Z9560-3	6, 9, 11, 1	SWITCH: momentary, interlock; type 8870. Dwg. #W-218680-2		7	*	*		*
1-S-6	3Z9588-19	11	SWITCH: spring and roller; S.P.D.T. Dwg. #W-218534-1		1	*			*
1-S-1, 1-S-5	3Z9849-48	12	SWITCH: toggle, D.P.S.T. Dwg. #W-218552-2		2	*	*		*
1-S-4	3Z9849.49	12	SWITCH: 3 pole heavy duty; S.T.; Dwg. #W-218901-2		1	*	*		*
3-S-8	3Z9824-37.1	8	SWITCH: push button, momentary; 2 circuit, Dwg. #W-218482-1		1	*	*		*
3-S-3	3Z9824-37.4	8	SWITCH: push button, momentary; 2 double break. Dwg. #W-218479-1		1	*	*		*
3-S-4	3Z9824-37	8	SWITCH: push button, momentary; 2 double break. Dwg. #W-218480-1		1	*	*		*
3-S-1, 3-S-2	3H900-20-6	8	SWITCH: circuit breaker; 120 volts a-c, 25 amp. Dwg. #B-222284-1		2	*	*		*
7-S-4	3Z9824-43.1	2	SWITCH: 3 taps; type 111-3, (modified) 10 amps, 150 volts a-c, #W-220652-1		1	*	*		*
7-S-2, 7-S-3	3Z9825-69.2	2	SWITCH: 2 contact N.C.; bias control. Dwg. #W-218196-2		2	*	*		*
7-S-1-A	3Z9825-63.9	2	SWITCH: 4 position; range, type H. Dwg. #B-218444-2		1	*	*		*
7-S-1-B	3Z9825-63.8	2	SWITCH: 4 position; range, type H. Dwg. #B-218443-3		1	*	*		*

7-R-106	2Z7284.47	2	POTENTIOMETER: dual, 500 ohms; +20%, linear, type 35. Dwg. #W-218439-2		1	•	•		•
7-R-63	2Z7279.13	2	POTENTIOMETER: 1,000 ohms; ±20%, linear, type 35. Dwg. #W-220388-2		1	•	•		•
7-R-49	2Z7262	2	POTENTIOMETER: 1,000 ohms; ±20%, linear, type 0.237. Dwg. #W-218412-3		1	•	•		•
7-R-31	2Z7280-26	2	POTENTIOMETER: 5,000 ohms; ±20%, linear, type 25. Dwg. #W-218435-1		1	•	•		•
7-R-9	2Z7269.34	2	POTENTIOMETER: 10,000 ohms; ±20%, linear, type 35. Dwg. #W-218441-3		1	•	•		•
7-R-25	2Z7269.22	2	POTENTIOMETER: 10,000 ohms; ±20%, linear, type 35. Dwg. #W-218436-3		1	•	•		•
7-R-51	2Z7269.2	2	POTENTIOMETER: 10,000 ohms; ±20%, linear, type 25. Dwg. #W-218436-1		1	•	•		•
7-R-109	2Z7270.31	2	POTENTIOMETER: 15,000 ohms; ±20%, linear, type 35. Dwg. #W-220569-2		1	•	•		•
7-R-24, 7-R-64, 7-R-110, 8-R-21.	2Z7270.32	2, 4	POTENTIOMETER: 50,000 ohms; ±20%, linear, type 35. Dwg. #W-218442-2		4	•	•		•
7-R-97, 7-R-111	2ZK7262-100M.2	2	POTENTIOMETER: 100,000 ohms; ±20%, linear, type 35. Dwg. #W-220568-2		2	•	•		•
7-R-38, 7-R-40, 7-R-42, 7-R-44.	2Z7273-12	2	POTENTIOMETER: 1 megohm; ±20%, linear, type 35. Dwg. #W-218440-3		4	•	•		•
4-R-1	3Z5991-17	9	RESISTOR: 1.25 ohms, 100 watts, ±5%, wirewound		2	•	•		•
2-R-29	3ZK6004A7-5	13	RESISTOR: 47 ohms, ½ watt, ±10%, carbon		1	•	•		•
2-R-2, 2-R-7, 2-R-9, 2-R-14, 2-R-16, 2-R-48.	3Z6005-31.1	13	RESISTOR: 50 ohms, ½ watt, ±5%, carbon		6	•	•		•
3-R-10	3Z6005-71	8	RESISTOR: 50 ohms, 2 watts, ±2.5%, wirewound		1	•	•		•
1-R-1	3Z007H8	11	RESISTOR: 78 ohms, ½ watt, ±3%, carbon		1	•	•		•
7-R-58, 7-R-59	3Z6008B2-8	2	RESISTOR: 82 ohms, ½ watt, ±10%, wirewound		2	•	•		•
2-R-1, 2-R-25, 2-R-44, 2-R-49.	3Z6010-18	13	RESISTOR: 100 ohms, ½ watt, ±10%, carbon		4	•	•		•
3-R-12	3Z6010-80	7	RESISTOR: 100 ohms, 2.5 watts, ±10%, carbon		1	•	•		•
2-R-20	3Z6015-1	13	RESISTOR: 150 ohms, ½ watt, ±10%, carbon		1	•	•		•
3-R-9	3Z6015-29	8	RESISTOR: fixed, 150 ohms, 1 watt, ±10%, insulated		1	•	•		•
7-R-56	3Z6015-23	2	RESISTOR: 150 ohms, BW-2, ±10%, wirewound		1	•	•		•
7-R-29	3Z6018-13	2	RESISTOR: 180 ohms, BW-1, ±10%, wirewound		1	•	•		•
3-R-11	3Z6026-2	8	RESISTOR: 260 ohms, 2 watts, ±2.5%, wirewound		1	•	•		•
2-R-3, 2-R-4, 2-R-5, 2-R-6, 7, 2-R-8, 2-R-10, 1-R-12, 2-R-13, 2-R-15, 2-R-17, 2-R-22, 2-R-34.	3Z6027-14	13	RESISTOR: 270 ohms, ½ watt, ±10%, carbon		12	•	•		•
8-R-24, 8-R-25	3Z6027-1	4	RESISTOR: 270 ohms, ½ watt, ±10%, carbon		3	•	•		•
7-R-11, 9, 70	3Z6027-10	2	RESISTOR: 270 ohms, ½ watt, ±10%, wirewound		3	•	•		•
7-R-55	3Z6033-17	2	RESISTOR: 330 ohms, 2 watts, ±5%, wirewound		1	•	•		•
7-R-62	3Z6039-5	2	RESISTOR: 390 ohms, ½ watt, ±10%		1	•	•		•
3-A-1	3Z6047ES-1	7	RESISTOR: 475 ohms, 25 watts		1	•	•		•
2-R-11	3Z6015-2	13	RESISTOR: 510 ohms, ½ watt, ±5%, carbon		1	•	•		•
2-R-36	3Z6010-36	13	RESISTOR: 1,000 ohms, ½ watt, ±10%, carbon		1	•	•		•
2-R-39	3Z6150-7	13	RESISTOR: 1,500 ohms, ½ watt, ±5%, carbon		1	•	•		•
2-R-21, 2-R-39	3Z6150-29	13	RESISTOR: 1,500 ohms, ½ watt, ±10%, carbon		2	•	•		•
2-R-31	3Z6150-74	13	RESISTOR: 1,500 ohms, 10 watts, ±5%, wirewound		1	•	•		•
2-R-37, 2-R-51	3Z6200-70	13	RESISTOR: 2,000 ohms, 5 watts, ±5%, wirewound		2	•	•		•
2-R-41	3Z6220-4	13	RESISTOR: 2,200 ohms, ½ watt, ±5%, carbon		1	•	•		•

*Indicates stock available.

114. Maintenance Parts List for Radio Set SCR-682-A (contd.)

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
7-R-5	3Z6220-18	2	RESISTOR: 2,200 ohms, 2 watts, ±10%, carbon	......	1	*	*	......	*
2-R-33	3Z6225-2	13	RESISTOR: 2,250 ohms, 18 watts, ±5%, wirewound	......	1	*	*	......	*
2-R-33	2Z5424-2	8	RESISTOR: 2,500 ohms, 10 watts, ±10%, wirewound	......	1	*	*	......	*
2-R-13, 2-R-14	3Z6250-44	6	RESISTOR: 2,500 ohms, 20 watts, ±10%, carbon	......	2	*	*	......	*
7-R-93	3Z6270-10	2	RESISTOR: 2,700 ohms, 2 watts, ±5%, carbon	......	1	*	*	......	*
7-R-105, 11-R-36	3Z6330-1	2	RESISTOR: 3,300 ohms, ½ watt, ±10%, carbon	......	1	*	*	......	*
2-R-27, 7-R-45, 7-R-89, 7-R-91, 7-R-93.	3Z6390-7	2, 13	RESISTOR: 3,900 ohms, 1 watt, ±10%, carbon	......	5	*	*	......	*
7-R-85, 7-R-104, 2-R-23.	3Z6470-2	13, 2	RESISTOR: 4,700 ohms, ½ watt, ±10%, carbon	......	3	*	*	......	*
2-R-52	3Z6470-21	13	RESISTOR: 4,700 ohms, 2 watts, ±5%, carbon	......	1	*	*	......	*
2-R-50	3Z6500-141	13	RESISTOR: 5,000 ohms, 8 watts, ±5%, wirewound	......	1	*	*	......	*
7-R-84	3Z6500-142	2	RESISTOR: 5,000 ohms, 20 watts, ±5%, wirewound	......	1	*	*	......	*
7-R-28, 7-R-50, 8-R-15, 8-R-16.	3Z6500-109	4, 2	RESISTOR: 5,000 ohms, 20 watts, ±5%, wirewound	......	4	*	*	......	*
7-R-82	3ZK6506-9	2	RESISTOR: 5,600 ohms, ½ watt, ±10%, carbon	......	1	*	*	......	*
7-R-15	3Z6568	2	RESISTOR: fixed 6,800 ohms, ½ watt, ±10%, carbon	......	1	*	*	......	*
7-R-103	3Z6575-39	2	RESISTOR: 7,500 ohms, 10 watts, ±5%, carbon	......	1	*	*	......	*
7-R-30	3Z6575-40	2	RESISTOR: 7,500 ohms, 20-25 watts, ±5%, wirewound	......	1	*	*	......	*
2-R-30, 2-R-46, 2-R-47, 7-R-8, 7-R-10, 7-R-65.	3Z6610-57	13	RESISTOR: 10,000 ohms, ½ watt, ±10%, carbon	......	6	*	*	......	*
7-R-86, 7-R-87, 7-R-113, 8-R-17, 8-R-19, 8-R-23.	3Z6610-88	2, 4	RESISTOR: 10,000 ohms, 2 watts, ±10%, carbon	......	6	*	*	......	*
4-R-3	3Z6610-106	9	RESISTOR: 10,000 ohms, 50 watts, ±15%, wirewound	......	1	*	*	......	*
1-R-4	3Z6612-33	12	RESISTOR: 12,000 ohms, 25 watts, ±5%, wirewound	......	1	*	*	......	*
7-R-53, 7-R-54, 7-R-60, 7-R-61, 7-R-90, 7-R-101.	3Z6615-14	2	RESISTOR: 15,000 ohms, 1 watt, ±10%, carbon	......	6	*	*	......	*
7-R-72, 7-R-73, 7-R-78.	3Z6615-6	2	RESISTOR: 15,000 ohms, 10 watts, ±5%, wirewound	......	3	*	*	......	*
7-R-4, 7-R-20, 7-R-22, 7-R-57.	3Z6615-88	2	RESISTOR: 15,000 ohms, 20 watts, ±5%, wirewound	......	4	*	*	......	*
7-R-2, 7-R-32, 7-R-77, 7-R-79, 7-R-108.	3Z6622-2	2	RESISTOR: 22,000 ohms, ½ watt, ±10%, carbon	......	5	*	*	......	*
7-R-81	3Z6622-6	2	RESISTOR: 22,000 ohms, 2 watts, ±10%, carbon	......	1	*	*	......	*
7-R-92, 7-R-98, 7-R-102.	3Z6633-1	2	RESISTOR: 33,000 ohms, 1 watt, ±10%, carbon	......	3	*	*	......	*
8-R-18	3Z6635-11	4	RESISTOR: 35,000 ohms, 50 watts, ±10%, wirewound	......	1	*	*	......	*
2-R-32, 10-R-51	3Z6639-10	13	RESISTOR: 39,000 ohms, 1 watt, ±10%, carbon	......	1	*	*	......	*
7-R-3, 7-R-14, 7-R-34.	3Z6647-1	2	RESISTOR: 47,000 ohms, ½ watt, ±10%, carbon	......	3	*	*	......	*
8-R-22	3Z6647-8	4	RESISTOR: 47,000 ohms, 1 watt, ±10%, carbon	......	1	*	*	......	*
2-R-35, 1-R-2, 1-R-3, 10-R-47.	3Z6647-20	3, 12	RESISTOR: 47,000 ohms, 2 watts, ±10%, carbon	......	3	*	*	......	*
2-R-18	3Z6656-1	13	RESISTOR, 56,000 ohms, ½ watt, ±10%, carbon	......	1	*	*	......	*
7-R-35, 7-R-94, 10-R-52.	3Z6656-12	2	RESISTOR: 56,000 ohms, 1 watt, ±10%, carbon	......	2	*	*	......	*

2-R-40	3Z6656-14	13	RESISTOR: 56,000 ohms, 2 watts, ±5%, carbon		1	*	*		*
7-R-47, 7-R-83	3Z6656-2	2	RESISTOR: 56,000 ohms, 2 watts, ±10%, carbon		2	*	*		*
2-R-26, 8-R-20	3Z6668-1	13, 4	RESISTOR: 68,000 ohms, 1 watt, ±10%, carbon		2	*	*		*
7-R-12	3Z6682-5	2	RESISTOR: 82,000 ohms, 1 watt, ±10%, carbon		2	*	*		*
7-R-38, 7-R-16, 7-R-7, 7-R-33, 7-R-88, 10-R-24, 10-R-45.	3Z6700-54	2	RESISTOR: 100,000 ohms, ½ watt, ±10%, carbon		6	*	*		*
2-R-45, 7-R-13, 7-R-48, 10-R-49, 10-R-54.	3Z6700-30	13, 2	RESISTOR: 100,000 ohms, 1 watt, ±10%, carbon		3	*	*		*
7-R-36, 7-R-89	3Z6700-32	2	RESISTOR: 100,000 ohms, 2 watts, ±10%, carbon		2	*	*		*
7-R-21 7-R-75, 7-R-114.	3Z6712-9	2	RESISTOR: 120,000 ohms, 1 watt, ±10%, carbon		3	*	*		*
7-R-26, 10-R-1	3Z6715-1	2	RESISTOR: 150,000 ohms, ½ watt, ±10%, carbon		1	*	*		*
7-R-100	3Z6715-18	2	RESISTOR: 150,000 ohms, 1 watt, ±10%, carbon		1	*	*		*
8-R-12	3Z6720-5	4	RESISTOR: 200,000 ohms, 2 watts, ±10%, carbon		2	*	*		*
7-R-23, 7-R-74, 7-R-96, 10-R-55.	3Z6722-6	2	RESISTOR: 220,000 ohms, 1 watt, ±10%, carbon		3	*	*		*
2-R-54	3Z6722-23	13	RESISTOR: 220,000 ohms, 2 watts, ±10%, carbon		1	*	*		*
8-R-3, 8-R-4, 8-R-28, 8-R-29.	3Z6725-3	4	RESISTOR: 250,000 ohms, 2 watts, ±10%, carbon		4	*	*		*
2-R-24, 2-R-28, 2-R-43, 7-R-16, 7-R-112, 7-R-119.	3Z6727-6	2, 13	RESISTOR: 270,000 ohms, ½ watt, ±10%, carbon		6	*	*		*
7-R-17, 7-R-19, 7-R-27, 7-R-52, 7-R-71, 10-R-35.	3Z6756-1	2	RESISTOR: 560,000 ohms, ½ watt, ±10%, carbon		5	*	*		*
8-R-26	3Z6756-8	4	RESISTOR: 560,000 ohms, 1 watt, ±10%, carbon		1	*	*		*
2-R-53	3Z6756-10	13	RESISTOR: 560,000 ohms, 2 watts, ±10%, carbon		1	*	*		*
7-R-18, 7-R-43	3Z6768	1	RESISTOR: 680,000 ohms, ½ watt, ±10%, carbon		2	*	*		*
7-R-37, 7-R-39, 7-R-41, 7-R-46, 7-R-76, 10-R-12, 10-R-14, 10-R-38, 10-R-39.	3Z4534	2	RESISTOR: 1 meg., ½ watt, ±10%, carbon		5	*	*		*
8-R-5 to 8-R-14	3Z6801-15	2	RESISTOR: 1 meg., 2 watts, ±10%, carbon		10	*	*		*
7-R-107	3Z6802A2-6	2	RESISTOR: 2.2 meg., ½ watt, ±10%, carbon		1	*	*		*
7-R-68	3Z6802A2-14	2	RESISTOR: 2.2 meg., 1 watt, ±10%, carbon		1	*	*		*
7-R-80	3Z6802A7	2	RESISTOR: 2.7 meg., ½ watt, ±10%, carbon		2	*	*		*
2-R-42	3Z6803A3-1	13	RESISTOR: 3.3 meg., ½ watt, ±10%, carbon		1	*	*		*
	2Z5883-34	2	SOCKET-LIGHT: dial type B-310-G, #W-218542-2		1	*	*		*
7-A-1, 7-A-2, 6-A-2	2Z5884-11	2	SOCKET ASSY: candelabra style, type #19VC-SP, #W-218413-2		3	*	*		*
8-V-1	2Z8674.15	4	SOCKET-H. V.: cylindrical, type #77A-4T, #W-218542.2		1	*	*		*
4-V-12	2Z8674.16	9	SOCKET-TUBE: 4 prong, type #115-034, #W-220357-1		2	*	*		*
3-V-1, 3-E-3, 3-V-2, 3-E-2.	2Z3763.8	6	SOCKET: 5 prong, type #XC5, #W-211912-2		4	*	*		*
2-V-15	2Z8678.27	13	SOCKET: type #PF8-7, #W-218447-1		1		*		*
	2Z8678-1	2, 4	SOCKET: tube, octal, phenolic, #W-210860-6		21	*	*		*
	2Z8678.35	2, 4	SOCKET: tube, octal, ceramic, #W-210860-5		9	*	*		*
1-T-2	2Z9614-22	11	TRANSFORMER: auto-fixed; 60,000-20,000 volts. Dwg. #C-218668-2		1		*		*
3-T-1, 3-T-2	2C2263B/T9	8	TRANSFORMER: auto-variable; 2kva, 115 volts to 0/315 volts, 60 cycles, type 100Q. Dwg. #216271-2		2	*	*		*
4-T-1	2Z9611.83	9	TRANSFORMER: filament; Pri. 115 volts, 60 cycles; Sec. 5 volts, 10 amps. Dwg. #W-218473-2		1	*	*		*

*Indicates stock available.

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
8-T-3	2Z9613.85	4	TRANSFORMER: power; Pri. 115 volts, 60 cycles; Sec. 6.3 volts, 5.0 volts, 540-0 540 volts. Dwg. #W-218610-3		2	*	*		*
8-T-2	2Z9613.88	4	TRANSFORMER: filament; Pri. 115 volts, 60 cycles; Sec. 7.0V, 6.3 volts, 500 volts CT. Dwg. #W-218551-3		1	*	*		*
1-T-1	2Z9611.82	11	TRANSFORMER: filament; Pri. 110 volts, 60 cycles, Sec. 7.2 volts, 1.5 amps. Dwg. #W-218607-4		1	*	*		*
2-T-4	2Z9643.21	13	TRANSFORMER: assembly, disk; Dwg. #B-22-417-3		1	*	*		*
2-T-2, 2-T-3	2C5066-1223A/T1	13	TRANSFORMER: assembly, input; Dwg. #W-218395-1		2	*	*		*
7-T-2, 7-T-3, 7-T-4	2Z9638-6	2	TRANSFORMER: marker amplifier; Dwg. #C-218194-3. (Type VX-8204-A)		3	*	*		*
4-T-2	2Z9612.41	9	TRANSFORMER: H. V., 115 volts, Pri. Sec. 7,500 volts, 0.060 amp.; Dwg. #W-218521-1		1	*	*		*
8-T-1	2Z9613.89	4	TRANSFORMER: H. V.; 115 volts, Pri. Sec. 4,500 volts. Sec. 2.5 volts. Dwg. #W-218608-2		1	*	*		*
2-T-1	2Z9613.32	13	TRANSFORMER: power; Type 1309-B, Dwg. #D-222493-3		1	*	*		*
7-T-1	2Z9638-9	2	TRANSFORMER: blocking osc.		1	*	*		*
8-V-5-6-10	2JVR105-30	4	TUBE: VR—105-30; voltage regulator, Dwg. #GB-211146-65		3	*			*
2-V-18	2JVR150-30	13	TUBE: VR—150-30; voltage regulator, Dwg. #GB-211146-57		1	*			*
10-V-9	2J2AP1	17	TUBE: 2AP1; Dwg. #W-218811-1		1	*			*
1-V-1	2J32	11	TUBE: 2J32; Dwg. #W-218602-1						
8-V-1, 10-V-7	2V2X2/879	4	TUBE: 2X2/879; Dwg. #GB-211146-66		2	*			*
8-V-3-4, 2-V-16, 10-V-8.	2V5U4G	4, 13	TUBE: 5U4G; rectifier, Dwg. #GB-211146-56		4	*			*
	2J5Y3GT	14	TUBE: 5Y3GT; rectifier, Dwg. #GB-211146-71		1	*			*
2-V-1 to 6-8-10-12	2J6AC7	13	TUBE: 6AC7; R. F. amplifier. Dwg. #GB-211146-52		9	*			*
10-V-6	2V6AG7	17	TUBE: 6AG7; Dwg. #GB-211146-67		1	*			*
8-V-7-8	2J6B4G	4	TUBE: 6B4G; Dwg. #GB-211146-64		2	*			*
2-V-7, 2-V-11	2J6H6	13	TUBE: 6H6; diode, Dwg. #GB-211146-54		2	*			*
2-V-9	2J6L6	13	TUBE: 6L6; beam power amplifier, Dwg. #GB-211146-53		1	*			*
7-V-7, 8-V-9	2J6SJ7	2, 4	TUBE: 6SJ7; Dwg. #GB-211146-63		2	*			*
7-V-2-6-8-9-12-13-14-17-18-19-20-21 10-V-1A-1B-2-3A 3B-4A-4B.	2V6SN7GT	2	TUBE: 6SN7GT; triode amplifier, Dwg. #GB-211146-61		16	*			*
7-V-3-4-5-10-11-15-16.	2J6V6GT	2	TUBE: 6V6GT; beam power amplifier, Dwg. #GB-211146-62		7	*			*
8-V-2, 2-V-17-19	2J6X5GT	4, 13	TUBE: 6X5GT; rectifier, Dwg. #GB-211146-55		3	*			*
6-V-1	2J7BP7	2	TUBE: 7BP7; Dwg. #W-218495-1		1	*			*
	2J83	14	TUBE: 83; rectifier, Dwg. #GB-211146-69		1	*			*
4-V-1, 2	2J705A	9	TUBE: 705A; Dwg. #W-218456-1		2	*			*
2-V-15	2V707B	13	TUBE: 707B; Dwg. #GB-211146-60		1	*			*
1-V-2	2J721A	11	TUBE: 721-A; Dwg. #218604-1		1	*			*
7-V-1, 2-V-14, 10-V-5.	2J884	2, 13	TUBE: 884; Dwg. #GB-211146-59		3	*			*
2-V-13	2J2050	13	TUBE: 2050; Dwg. #GB-211146-58		1	*			*
	3Z12029	11, 6, 4	LUG: ground, #W-220860-4		7				*
	3Z12059-30	13	LUG: type "Birdie," #W-5741		1				*
	3Z12059-12	13	LUG: shakeproof, #W-2049		1				*
	3Z12059-29	13	LUG: #2006-12, #W-21633-1		5				*
	3Z12012-4	1	LUG: binding post, #W-217791-1		12				*
	3Z12072-34	11	LUG: solder type, #207, #W-218573-1		6				*

	3Z12066	6	LUG: #93, #W-220803-1		8				*
	3Z12012-2	9, 6	LUG: for #10 screw, #W-220804-1		85				*
	3Z12072-30	9, 6	LUG: #28, #W-220805-1		22				*
	3Z12072-29	9, 6	LUG: #28, #W-220805-2		46				*
	3Z12072-31	9, 6	LUG: #28, #W-220805-3		60				*
	3Z12059-27	13	LUG: #206-10, #W-7218A		1				*
	3Z12026-2	1	LUG: #6 ring type, #W-210703-4		3				*
	3Z12031-9	9	LUG: type #202, #W-220397-1		3				*
	3Z12026-3	6	LUG: "Notch," #W-223065-1		2				*
	3Z12072-26	2	LUG: Code # "Equator," #W-134214-2		4				*
	3Z12026-4	2	LUG: Code # "External," #W-134214-1		2				*
	3Z12059-28	4	LUG: #2006, #W-4229-2		1				*
	3Z12059-9		LUG: #8 type A, #W-2047-2		7				*
	3Z12072-33	1	LUG: terminal, type #83, #W-7953		15				*
	3Z12012-3	6	TERMINAL: #W-217983-1		7				*
	3Z12030	6	TERMINAL: binding post, #W-216439-1		14				*
	3Z12072	11, 1, 6, 13, 9	TERMINAL: clip, type #105, #W-33488-A		47				*
	3Z12004-6	13	TERMINAL: lug, #WB-218367-1		9				*
	3Z12072-32	11, 1, 4	TERMINAL: lug, type #205, Dwg. #20007		67				*
	3Z12073-1	11, 1	TERMINAL: type #142, Dwg. #W-218295-1		42				*
	2ZK9402.29	1	TERMINAL: type #W150, Dwg. #W-217789-2		12				*
	2Z12012-1	4	TERMINAL: #W-220621-1		17				*
	3Z12050-5.4	4	TERMINAL: type #1GB132, #W-7087-1		5				*
1-K-4	2Z9401.19	12	TERMINAL: strip, single, #W-222512-1		1		*		*
	2ZK9402.29	11	TERMINAL: strip, 2 circuit, #B-218367-12		2		*		*
5-K-1	2Z9402.44	5	TERMINAL: strip, 2 circuit, #B-218367-4		1		*		*
1-K-6	2Z9403.28	12	TERMINAL: strip, 7 circuit, #B-218367-13		1		*		*
3-K-3, 3-K-4-5	2Z9405.21	6	TERMINAL: strip, 5 circuit, #B-218367-11		3		*		*
	2Z9407.8	12	TERMINAL: strip, 7 circuit, #B-218367-6		2		*		*
3-K-1-2, 4-K-1-2	2Z9410.9	6	TERMINAL: strip, 10 circuit, #B-218367-9		4		*		*
7-K-5, 8-K-3	2Z9410.11	2, 4	TERMINAL: strip, 10 circuit, #B-218367-11		2		*		*
9-K-7	2Z9412.2	1	TERMINAL: strip, 12 circuit, #B-218367-03		1		*		*
On PPI Mount 6-K-1, 7-K-9.	2Z9413.1	2	TERMINAL: strip, 13 circuit, #B-218367-1		2		*		*
	2Z3600-13	4, 9	ADAPTER: shockmount; Dwg. #W-217343-1		8				*
	2Z3600-14	4, 9	ADAPTER: shockmount; Dwg. #W-217342-2		8				*
1-A-13	3A3215	10	ANTENNA: sphere, polystyrene. Dwg. #B-218701-4		1	*			*
1-E-1	2Z7593-20/3	12	BAR: cross (relay); Dwg. #W-222632-2		1		*		*
1-E-2	2Z7590-35/3	12	BAR: cross (relay); Dwg. #W-222626-1		1		*		*
1-A-1	3H304-7	12	BEARING: motor (front); Dwg. #W-222599-1		1		*		*
	3H304-4	12	BEARING: ball (yoke spindle); Dwg. #B-216119-12		1				*
	3H304-2	12	BEARING: ball; yoke, Dwg. #B-216119-11		2				*
	3H304-3	12	BEARING: ball (yoke spindle); Dwg. #B-216119-9		1				*
3-A-3, 3-A-4	3H304-5	7	BEARING: set (motors); Dwg. #B-216119-13		4		*		*
1-A-1	3H4575A/199	12	BEARING: motor (rear); Dwg. #W-222600-1		1		*		*
1-A-1	3H304-6	12	BEARING: motor (gear head); Dwg. #W-222601-1		1		*		*
	2Z735-1	4	BLOCK: standoff; resistor, Dwg. #W-217244-4		4				*
	3G1838-120	2	BOARD: fuse mtg., Dwg. #B-217784-2		1				*
1-A-8	2C3734A/B2	11	BOX: T.R., metal, Dwg. #B-218547-3		1				*
1-A-3, 1-A-4, 3-A-3, 3-A-4, 8-A-1.	3H3000A06-1/B10	12 7, 2	BRUSH: arm ass'y (motor); Dwg. #W-222583-1		10		*		*
3-A-8	3H3000A06-1/B11	7	BRUSH: ass'y; (spark gap), Dwg. #W-222486-1		2		*		*
	2C3734A/B3	12	BRUSH: ass'y; (slip rings), Dwg. #B-217927-4		1		*		*
	2C3734A/B4	12	BRUSH: ass'y; (slip rings), Dwg. #B-217928-3		1		*		*
3-A-4	2C7709A/B2	7	BRUSH: ass'y; (spark gap), Dwg. #B-222538-2		1		*		*

*Indicates stock available.

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
3-T-1, 3-T-2	2C2263B/T9/1	8	BRUSH: powerstat; Dwg. #W-220442-1		2	*	*		*
1-L-1	2C1557-1193A/B1	5	BRUSH: (deflection coil)		2	*	*		*
	2Z559-99	7	BUS: bar (grounding), Dwg. #C-220899-3		1				*
3-A-1	2C2500-1194A/H1	7	CAN: heater ass'y; Dwg. #B-218228-2		1	*	*		*
3-A-5	2Z5891-22	8	CAP: color cap (amber); Dwg. #W-220997-3		1	*	*		*
3-A-6	2Z5891-23	8	CAP: color cap (white); Dwg. #W-220997-1		1	*	*		*
3-A-2	2Z5891-21	8	CAP: color (green); Dwg. #W-220997-5		1	*	*		*
3-A-7	2Z5891-20	8	CAP: color (red); Dwg. #W-220997-6		1	*	*		*
2-J-1, 2-J-2	2Z1612.6	13	CAP: jack; Dwg. #W-218815-1		1		*		*
	2Z2638-3	4	CAP: tube clamp; Dwg. #W-220541-1		1		*		*
8-V-1	2Z1605-1	4	CAP: tube H.V. tube cap, Dwg. #W-218525-3		1	*	*		*
	2Z2638-4	12	CLAMP; Dwg. #W-220907-1		1				*
	2Z2636-15	12	CLAMP: Dwg. #W-220906-1		1				*
	2Z2636-1	11	CLAMP: cable; Dwg. #W-218457-1		2				*
	2Z2636-2	13	CLAMP: cable; type #AN-3057-16, Dwg. #W-218457-6		1				*
	2Z2600	2, 6	CLAMP: cable; Dwg. #W-211141-1		8				*
	2Z2636-16	2	CLAMP: cable; Dwg. #W-218804-2		1				*
	2Z2636-6	4, 13, 11, 6	CLAMP: cable; Dwg. #W-211140-1		9				*
	2Z2636-13	13	CLAMP: cable; Dwg. #W-210991-2		2				*
	2Z2636-17	2	CLAMP: cable; Dwg. #W-218804-3		1				*
	2Z2636-18	11	CLAMP: cable (upper); Dwg. #W-220911-1		1				*
	2Z2636-19	11	CLAMP: cable (lower); Dwg. #W-220912-1		1				*
	2Z2636-20	11	CLAMP: cable (lower); Dwg. #W-220903-2		1				*
	2Z2636-21	11	CLAMP: cable (upper); Dwg. #W-220904-1		1				*
	2Z2636-22	9, 4	CLAMP: cable; Dwg. #W-212388-3		14				*
	2Z2636-23	11	CLAMP: cable (lower); Dwg. #W-220864-1		2				*
	2Z2636-24	11	CLAMP: cable (upper); Dwg. #W-220863-1		2				*
	6Z1915-2	9	CLAMP: ground wire; Dwg. #W-220862-1		1				*
	6Z1928-6	11	CLAMP: hose; Dwg. #W-218235-3		1				*
	6Z1928-5	6	CLAMP: hose; Dwg. #W-222678-1		4				*
	2Z2636-14	4, 13	CLAMP: tube; Dwg. #W-218597-1		5				*
1-S-8	2Z2721	11	CLIP: antenna; type "Peewee" #45C, part #W-211846-2		1		*		*
	2Z2735-4	4	CLIP: cable, Dwg. #B-223177-3		1		*		*
	2Z2735-5	4	CLIP: cable, Dwg. #B-223178-6		1		*		*
	2Z2726.5	13	CLIP: Fahnstock #15, Dwg. #W-218445-1		1		*		*
	2Z2735-2	9	CLIP: Fahnstock #146, Dwg. #W-220715-1		2		*		*
	3Z1028	2, 7, 9	CLIP: resistor; brass, Dwg. #W-216528-1		34		*		*
	2Z2726.6	6	CLIP: resistor; 0.059 steel, Dwg. #W-222955-1		4		*		*
	3Z1101-1	7, 9	CLIP: resistor; brass, Dwg. #W-216528-2		10		*		*
6-A-2	2C1557-1193A/S3	3	CONDUCTOR: light glass shade, Dwg. #B-220947-1		1		*		*
7-A-1, 7-A-2	2C1557-1193A/S4	2	CONDUCTOR: light glass shade, Dwg. #B-220825-1		2		*		*
1-A-6, 1-A-7	2C3734A/C10	11	C. N. ASSEMBLY: copper tubing, Dwg. #W-218574-3		2	*			*
	6Z3174	7	CONNECTOR: hose, steel tubing, Dwg. #W-220484-3		1		*		*
3-E-4	2Z7656-3/4	7	CONTACT: flexible, Dwg. #W-218577-1		1		*		*
3-E-1	2Z7590-34/7	8	CONTACT: moving L.H., style #1155693, Dwg. #W-218580-2		2		*		*
3-E-1	2Z7590-34/1	8	CONTACT: moving R.H., style #1155693, Dwg. #W-220990-1		1		*		*
1-E-1	2Z7684/3	12	CONTACT: moveable, part #X-68996, Dwg. #W-22634-1		10		*		*
4-E-1	2Z7590-32/4	9	CONTACT: moveable, part #P-810, Dwg. #W-218569-1		4		*		*
1-E-1	2Z7684/1	12	CONTACT: stationary L.H., Dwg. #W-222636-1		2		*		*
1-E-1	2Z7684/2	12	CONTACT: stationary R.H., Dwg. #W-222635-1		2		*		*

1-E-2	2Z7590-35/2	12	**CONTACTS: stationary R.H., Part #X-53380, Dwg. #222627-1**		1		•			•
1-E-2	2Z7590-35/1	12	**CONTACT: stationary L.H., part #X-53310 Dwg., #W-222628-1**		1		•			•
3-E-1	2Z7590-34/2	8	CONTACT: stationary; break, Dwg. #W-218585-2		2		•			•
3-E-1	2Z7590-34/3	8	CONTACT, STATIONARY: make, style #1155693, Dwg. #W-218584-2		2		•			•
4-E-1	2Z7590-32/1	9	CONTACT, STATIONARY: R.H., Dwg. #W-218571-1		2		•			•
4-E-1	2Z7590-32/6	9	CONTACT, STATIONARY: type #122, Dwg. #W-218570-1		1		•			•
4-E-1	2Z7590-32/5	9	CONTACT, STATIONARY: L.H., Dwg. #W-218572-1		2		•			•
3-E-4	2Z7656-3/1	8	CONTACT, STATIONARY: Dwg. #W-218578-1		1		•			•
1-A-11	2C3734A/C6	11	COUPLER: AFC, Dwg. #B-220525-1		1	•				•
1-A-9	2C3734A/C8	11	COUPLING, ASSEMBLY: T.T., Dwg. #B-218565-3		1	•				•
	2Z3270-9	2	COUPLING: flexible, type "FC", Dwg. #W-218530-1		1	•	•			•
	2C3734A/C7	12	COUPLING: roller chain, Dwg. #B-220747-2		1		•			•
1-A-15, 1-A-16	2Z3417-1	11	CRYSTAL: type IN-21, Dwg. #W-218603-1		2	•	•			•
	2Z3714-5	3	DIAL: (plastic), Dwg. #C-217479-1		1		•			•
	2A275-134A/1	10	DISH & PAN ASSEMBLY: Dwg. #C-222494-1		1					•
1-C-2	2C3734A/D3	11	DIVIDER, CAPACITY: assembly, Dwg. #C-220586-4		1					•
1-A-10	2C3734A/D4	11	DUPLEX: assembly, Dwg. #B-218734-6		1					•
	6Z3812-2	2	FELT: cable clamp; black, Dwg. #W-223191-1		2					•
	6Z3812-2.1	2	FELT: cable clamp; black, Dwg. #W-223191-2		2					•
	6Z3812-2.2	2	FELT: cable clamp; black, Dwg. #W-223191-3		1					•
	6Z3812-2.4	2	FELT, CUSHION: 1/16 in. felt, Dwg. #B-217759-1		1					•
	6Z3812-2.3	2	FELT: dial, green, 2 Dwg. #W-218665-3		1					•
	6Z3812-3	2	FELT: lining, dark gray, Dwg. #W-217760-2		1					•
	6Z3812-2.5	11	FELT: pipehole cover; green, Dwg. #W-220649-1		2					•
	6Z3812-2.6	2	FELT, STRIP: (cable block), Dwg. #W-220770-2		1					•
	6Z3812-3.1	11	FELT: strip, gray, 5½ in. long, Dwg. #W-2209434-1		1					•
	6Z3812-3.2	11	FELT: strip, gray, 10 in. long, Dwg. #W-220943-2		1					•
	6Z3856-29	1-6	FILTER-AIR PANEL: bronze, Dwg. #B-217389-3		2					•
	6Z3856-31	13	FILTER-AIR: aircraft type, bronze, Dwg. #B-217427-2		1	•	•			•
	6Z3856-30	11	FILTER-AIR: bronze screen, Dwg. #B-222773-1		1	•	•			•
	2Z3014-3	13	FITTING: 50 ohm "T", Dwg. #B-217326-8		1	•				•
	6Z3880	7	FLANGE, HOSE CONNECTOR: cast iron, Dwg. #W-217875-5		1		•			•
	2Z4868.12	11	**GASKET: 7/8 in. coupling, neoprene, Dwg. #**W-218559-2		1	•	•			•
	2Z4868.9	12	**GASKET: antenna, neoprene**		2	•	•			•
	2Z4868.10	11	GASKET: T.R. box, Duplex neoprene, Dwg. #218820-2		1	•	•			•
	2Z4868.8	11	GASKET: T.T. coupling, neoprene, Dwg. #W-218564-2		1	•	•			•
	2Z4868.11	11	GASKET: C.M. neoprene, Dwg. #W-218819-2		2	•	•			•
	3G1625-16	9, 6	GASKET-INSULATOR: Dwg. #W-218941-1		10	•	•			•
	2Z4867.11	12	GASKET, DUST COVER: felt, Dwg. #W-218263-2		2		•			•
	2Z4867.12	12	GASKET-DUST COVER: felt, Dwg. #W-218262-2		2		•			•
	2Z4867.13	2	GASKET, REAR COVER: Dwg. #W-220736-2		1		•			•
	2Z4672	12	GEAR: 16 teeth, Dwg. #W-218995-1		1	•				•
	6Z4880	11	GROMMET, CABLE: rubber, Dwg. #W-222791-1		1					•
	6Z4882	4	GROMMET: black spauldite fibre, Dwg. #W-214257-1		1					•
	6Z4876-3	2, 11	GROMMET: rubber, type #1975, Dwg. #W-133608-1		3					•
	6Z4883	11	GROMMET: (blower tube), black rubber, Dwg. #W-22096-1		1		•			•
	2C1557-1193A/H1	3	HANGER ASSEMBLY: Dwg. #C-220603-1		1	•				•
9-K-4	2Z5041	1	HOOD: CSK-49193, type #2.53PT-2, Dwg. #W-218721-1		1					•
	6Z6019	6	HOSE, EXHAUST: neoprene, Dwg. #B-222659-1		1		•			•
	6Z6019-1	6	HOSE, EXHAUST: neoprene, Dwg. #B-222659-2		1		•			•
	2C7709A/H1	7	HOUSING, CAST IRON: Dwg. #D-217888		1					•
	2C2500-1194A/H3	3	HUB: cast red brass 5AE40, Dwg. #B-218911-2		1					•
	2C3734A/K2	12	KEY: steel, Dwg. #W-220618-1		2		•			•
	2C3734A/K3	12	KEY: Dwg. #W-220618-4		1		•			•
	2Z5822-34	2	KNOB: control; type #S-311-3L, Dwg. #W-217795-2		6					•
	2Z5824.15	2	**KNOB, DIAL LIGHT: Dwg.** #W-212407-1		2					•

*Indicates stock available.

114. Maintenance Parts List for Radio Set SCR-682-A (contd.)

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
	2Z5824.16	2	KNOB: range switch, Dwg. #W-4-217384-3		1				*
	6Q63005	12	LEVEL: bench; Dwg. #W-222520-1		1				*
3-A-9	2Z1009-4	6	LINE: 50 ohms, type A, Dwg. #W-218406-1		1	*			*
1-A-12	2C3734A-L1	12	LINE: feed ass'y; Dwg. #C-217775-2		1	*			*
1-A-3, 1-A-4, 3-A-3, 3-A-4, 8-A-1.	2Z6193-2	11, 7, 4	LINK: switch, 0.031 in. steel wire, Dwg. #W-222582-1		1		*		*
3-F-1, 3-F-2, 3-F-3, 4-F-1, 4-F-2, 4-F-3.	3Z3840	7, 9	LOCK: fuse clip; Dwg. #W-216113-2		12		*		*
1-A-14	2C3734A/M1	11	MAGNET: no pole pieces, type #443-MS, Dwg. #C-218735-3		1		*		*
	2C1557-1193A/M4	3	MOUNT: P.P.I. ass'y, for sets up to and including serial #45, Dwg. #D-218898-3		1	*			*
	2C1557-1193A/M4	3	MOUNT: P.P.I. ass'y for sets above serial #45		1	*			*
	2Z6756-2	1, 6	MOUNT: shock; #12 U.S.S. Ga steel, Dwg. #B-217459-1		8		*		*
	2Z8501-4	6-1	MOUNT: shock rubber; type #B310, Dwg. #W-218362-2		8		*		*
	2Z8403.3	6	MOUNT: shock, type #153 P-8, Dwg. #W-218433-3		4				*
2-V-15, 2-K-8, 9	2C5066-1223A/02	13	OSCILLATOR: local, Dwg. #MG-218328-9		1				*
3-A-8	2C500-1194A/P1	6	PLATE: contact, copper, Dwg. #W-222417-1		1	*	*		*
3-F-1, 2, 3; 4-F-1, 2, 3	3Z2842	9, 7	PLATE: fuse, Dwg. #B-218192-2		2				*
4-E-1	2Z7094-1	9	PLATE: relay; mycalex, Dwg. #B-217575-2		1				*
	2Z1480.5	3	PLUG: button; (blank knock-out), Dwg. #W-215540-3		2				*
	2Z7104-3	13	PLUG: hole; brass, Dwg. #W-33510-2		2				*
	2Z7586-2.3	12	PLUG: pipe; Dwg. #W-22489-1		2				*
	2Z7258.9	12	POINTER: dial; Dwg. #W-220766-1		1				*
	6L17110-12K	9	POST: groundsteel, Dwg. #W-220928-1		1				*
	2Z7259-10	4	POST: tube clamp, Dwg. #W-220539-1		1				*
	2C1557-1193A/P4	3	PULLEY: brass, Dwg. #W-218908-1		2				*
	2C1557-1193A/P5	3	PULLEY: long life rubber, Dwg. #W-218907-3		1				*
	2C1557-1193A/R1	3	RETAINER: window, steel, Dwg. #C-217494-1		1				*
	2C3734A/R1	12	RING: clamping, Dwg. #B-217926-1		2				*
	2C3734A/R2	12	RING: contact; coin silver		14		*		*
	2C373A/D2	11	ROD: assembly; Dwg. #W-220566-1		1				*
	1A814.4	7	ROD: buss, Dwg. #W-220927-1		1				*
	3Z3332.8	9	ROD: ground, Dwg. #W-220859-2		1				*
	2C7709A/E1	7	ROD: tungsten, 1½ in. x 0.100 in., Dwg. #W-217816-3		7	*	*		*
	2C500-1194A/E1	7	ROD: tungsten, 2 1/16 in. x 0.100 in., Dwg. #W-217816-5		1	*	*		*
	2Z8273	12	SEAL: dust; ½ felt, SAE-11, Dwg. #B-217763-1		1				*
	2Z8273-1	12	SEAL: oil; type #2091, Dwg. #W-21898-6		1				*
	2Z8273-2	12	SEAL: oil, type #1005, Dwg. #W-218981-4		1				*
	2Z8273-3	12	SEAL: oil, Dwg. #W-218981-3		1				*
	2Z8308-3	12	SHIELD: cable, black neoprene, Dwg. #B-222344-2		1				*
	2Z8551-1	12	SLEEVE: slip ring; Dwg. #C-217914-4		1				*
	3G2517-9	13	SLEEVING: cambric, black, Dwg. #W-35701-6920		36				*
3-E-1	2Z7590-34/6	8	SPRING: armature, Dwg. #W-220987-1		1		*		*
3-A-8	2Z8876.17	7	SPRING: brush; Dwg. #W-217284-1						
4-E-1	2Z7590-32/3	9	SPRING: contact, Dwg. #218568-1		2		*		*
1-E-1	2Z7590-35/5	12	SPRING: contact, Dwg. #W-222635-1		10		*		*
4-E-1	2Z7590-32/2	9	SPRING: guide rod, Dwg. #W-218566-1		2		*		*
3-E-1	2Z7590-34/5	8	SPRING: inner contact, Dwg. #W-220989-1		4		*		*
1-E-1	2Z7593-20/1	12	SPRING: Kick-off; L.H., Dwg. #W-222630-1		1		*		*
1-E-1	2Z7593-20/2	12	SPRING: Kick-off; R.H., Dwg. #W-222629-1		1		*		*
1-E-2	2Z7590-35/2	12	SPRING: Kick-off; #B-10424, Dwg. #W-222625-1		1		*		*

3-E-1	2Z7590-34/4	8	SPRING: outer contact, Dwg. #W-220986-1		4		*		*
3-E-4	2Z7656-3/2	8	SPRING: reset, Dwg. #W-218576-1		2		*		*
3-E-1	2Z8878-9	8	SPRING: retainer; relay, Dwg. #W-222127-1		1		*		*
	2Z8878-11	2	SPRING: steel, Dwg. #W-217534-1		6				*
3-A-3	3H3000A06-1/S21	7	SPRING: switch; Dwg. #W-222580-1		2		*		*
3-A-4	3H3000A06-1/S20	7	SPRING: switch; Dwg. #W-222580-2		2		*		*
8-V-1	2Z8878-10	4	SPRING: tube clamp; Dwg. #W-220542-1		1		*		*
3-E-2, 3	6L31141	8	STUD: relay hold down; Dwg. #W-218219-1		1		*		*
	6L31250	12	STUD: slip ring, Dwg. #W-217915-1		6				*
	6L31171	13	STUD: ¼ hex., Dwg. #W-217315-2		1				*
	6L31151	13	STUD: steel, Dwg. #W-217318-2		1				*
	2C3734A/T1	11	TUBE: brass, Dwg. #C-220511-2		1				*
	6Z6017-3	11	TUBING: blower, rubber, Dwg. #W-222357-3		1				*
	3G2400-2	9, 2	TUBING: flex., Dwg. #G-39138-18B		16 in.				*
	3G2400-2.1	9, 2	TUBING: Dwg. #39138-16B		20 in.				*
	3G2550-4	9, 2 13, 6, 11	TUBING: vartex, Dwg. #W-215535-1		32 in.		*		*
	3G2425-9	2	TUBING: black, flexible, Dwg. #G-39138-23B		48 in.		*		*
	3G2400-6	4	TUBING: flex., Dwg. #G-39138-7		7 in.				*
	3G2400-1	4	TUBING: flex., Dwg. #G-39138-19B		36 in.				*
3-A-8	2Z4880-14	7	VIEWER: window; circular, Dwg. #W-217299-1		1				*
	2ZA1344	13	WEDGE: cover; Dwg. #W-38935		91	*	*		*
3-A-8	2C22500-1194A/W2	7	WHEEL & Hub Ass'y.; Dwg. #C-218923-4		1				*
	2Z4880-15	3	WINDOW: plastic; Dwg. #C-217493-1		1		*		*
	6R55214	12	WRENCH: binder; Dwg. #C-222694-1		1		*		*
	6L80015 (Temp.)		KIT: misc. hardware		1	*			*
1-A-3-4	3H389	11	BLOWER: ventilating; 1/40 H.P., 1,750 r.p.m., 115 volts, flange mounted, Dwg. #C-218866-4		2				*
	3H391	7	BLOWER: ventilating; 1/20 H.P., 1,750 r.p.m., 115 volts, Dwg. #G-218546-4		1				*
	3H391-1	4	BLOWER: ventilating; 1/20 H.P., 1,725 r.p.m., 115 volts, Dwg. #D-220641-4		1				*
	3H3000A06-1	7	MOTOR: spark gap; 115 volts, 60 cycles, 1 phase, 1/15 H.P., 3,450 r.p.m., flange mounted		1				*
	3H3121	12	MOTOR: synchro-generator; 115-90 volts, 60 cycles, Mark 1, model 2, size 5G, Ordnance Dwg. #109659. Crosly Dwg. #W-218387-1. (For sets up to and including serial #45.)		1				*
	3H3121	12	MOTOR: synchro-generator, (for sets above serial #45)		1				*
	3H3000A16-5	12	MOTOR: 1/6 H.P., 1,725 r.p.m., 115 volts, 3 amperes, 60 cycles, 1 phase, Dwg. #C-220998-5		1				*
	2A275-134A	11	ANTENNA: AN-134-A		1				*
	2C650-130A	8	CONTROL PANEL: BD-130-A		1				*
	2C1590-123A	3	INDICATOR PANEL: BD-123-A		1				*
	2C1557-1193A	2	INDICATOR CONTROL: BC-1193-A		1	*			*
	2Z6965-124A	5	METER PANEL: BD-124-A		1				*
	2A2699-458A	12	PEDESTAL: FT-458-A		1				*
	3H4496-100A	4	POWER SUPPLY UNIT: RA-100-A		1				*
	3H4496-101A	9	POWER SUPPLY UNIT: RA-101-A		1				*
	2C5066-1223-A	13	RADIO RECEIVER: BC-1223-A		1	*			*
	2C3734A	11	R. F. UNIT: BC-1224-A		1				*
	2C7709A	7	SPARK GAP (rotary): GA-9-A		1				*
	3F3910-212	17	SYNCHROSCOPE: I-212[1]		1				*
	3F3933-41		TEST EQUIPMENT		1				*
	3F3933-118		TOOL EQUIPMENT		1				*

*Indicates stock available.

[1] Since the Synchroscope (I-212) normally considered as test equipment may be used as an "A" scope it is listed as a Major Item; however, Maintenance Parts are shown on a separate list (I-212) as it will be used as a separate item for test purposes in the higher maintenance echelons.

115. Maintenance Parts List for Synchroscope I–212

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
10-C-44	3D9003-11	17	CAPACITOR: 3 mmf±10%, 500 volts		1		*		*
10-C-19	3D9010-32	17	CAPACITOR: 10 mmf, ceramic ±20%, 500 volts		1		*		*
10-C-18	3D9050-49	17	CAPACITOR: 50 mmf, ceramic ±10%, 500 volts		1		*		*
10-C-29, 10-C-3	3D9050-13	17	CAPACITOR: 50 mmf, silver mica, ±20%, 500 volts		2		*		*
10-C-2, 10-C-30	3D9100-63	17	CAPACITOR: 100 mmf, silver mica, ±5%, 500 volts		2		*		*
10-C-9	3K2033132	17	CAPACITOR: 330 mmf, silver mica, ±5%, 500 volts		1		*		*
10-C-10	3D9750-8	17	CAPACITOR: 750 mmf, silver mica, 500 volts		1		*		*
10-C-4, 10-C-17, 10-C-25.	3K3010232	17	CAPACITOR: 1,000 mmf, silver mica, ±5%, 500 volts		3		*		*
10-C-23	3DA.500-5	17	CAPACITOR: 1,500 mmf, silver mica, ±10%, 500 volts		1		*		*
10-C-11	3DA4-28	17	CAPACITOR: 4,000 mmf, silver mica, ±5%, 300 volts		1		*		*
10-C-12	3DA10-87	17	CAPACITOR: 10,000 mmf, mica, ±5%, 300 volts		1		*		*
10-C-1, 10-C-7, 10-C-16, 10-C-25, 10-C-43, 10-C-45.	3DKA10-175	17	CAPACITOR: 10,000 mmf, mica, ±10%, 300 volts		6		*		*
10-C-13	3DA20-75.1	17	CAPACITOR: 20,000 mmf, tubular oil, ±20%, 600 volts		1		*		*
10-C-24	3DA20-71.1	17	CAPACITOR: 20,000 mmf, oil tubular, ±20%, 600 volts		1		*		*
10-C-8	3DA50-17	17	CAPACITOR: 50,000 mmf, oil tubular, ±5%, 1,600 volts		1		*		*
10-C-14	3DA60-4	17	CAPACITOR: 60,000 mmf, oil tubular, ±5%, 600 volts		1		*		*
10-C-22, 10-C-36, 10-C-37.	30KA100-92.3	17	CAPACITOR: 3 x 100,000 mmf, oil, +20%—10%, 600 volts		3		*		*
10-C-15	3DA160-1	17	CAPACITOR: 160,000 mmf, tubular oil, ±5%, 600 volts		1		*		*
10-C-20, 10-C-21	3DA250-11	17	CAPACITOR: 250,000 mmf, oil, +30%—20%, 600 volts		2		*		*
10-C-26, 10-C-27	3DA500-27	17	CAPACITOR: 500,000 mmf, oil, +20%—10%, 600 volts		2		*		*
10-C-38, 10-C-39	3DKA500-108	17	CAPACITOR: 500,000 mmf, oil, ±10%, 2,000 volts		2		*		*
10-C-40, 10-C-42	3DA500-70	17	CAPACITOR: 2 x 500,000 mmf, oil, +30%—20%, 600 volts		2		*		*
10-C-5, 10-C-6	3DB1.308	17	CAPACITOR: 1 mf, oil, +30%—20%, 600 volts		2		*		*
10-C-32, 10-C-33, 10-C-34, 10-C-35.	3DB4-34	17	CAPACITOR: 4 mf, oil, ±10%, 600 volts		4		*		*
10-L-6	3F3910-212/R1	17	REACTOR: 12-12 henry, 80 ma, 220521-3 choke		1		*		*
10-L-1	3C338-3	17	REACTOR: 220 henry, choke, 4 ma, #W-218700-3		1		*		*
10-F-1	3Z1950	17	FUSE: 3 amp, 250 volts, glass body, type 3-AG, 1043, RCA, Dwg. #K-850339		1		*		*
10-A-1	2Z5927	17	LIGHT: pilot, 6.8 volts, 25 amp, clear mazda 44		1		*		*
10-S-1	3Z9825-62.41	17	SWITCH: 3-pole, 2-position rotary, non-shorting, #B-218728		1		*		*
10-S-2	3Z9825-62.40	17	SWITCH: 4-pole, 2-position rotary, non-shorting, #B-218729		1		*		*
10-S-3	3Z9825-62.39	17	SWITCH: 4-pole, 4-position rotary, non-shorting, #B-218731-8		1		*		*
10-S-4	3Z9825-62.38	17	SWITCH: range, 4-pole, 8-position, rotary, non-shorting, #B-2189267		1		*		*
10-R-42	2Z7268.19	17	POTENTIOMETER: 2,000 ohms, ±10%, ½ watt, #W-21869-3-3		1		*		*
10-R-56	2Z7271.4	17	POTENTIOMETER: 2,000 ohms, ±10%, ½ watt, RCA #K-864780.1		1		*		*
10-R-48, 10-R-50, 10-R-58.	2Z7271-32	17	POTENTIOMETER: 200,000 ohms, ±10%, ½ watt, carbon		1		*		*
10-R-25	2Z7272-18	17	POTENTIOMETER: 250,000 ohms, ±20%, ½ watt, +20%, variable		1		*		*
10-R-34	2Z7274-9	17	POTENTIOMETER: 2 meg, ±10%, ½ watt, carbon, #W-218695-6		1		*		*
10-R-19	2Z7274-9	17	POTENTIOMETER: 2.0 meg, ±10%, ½ watt, carbon, #W-218695-6		1		*		*
10-R-41	3Z6010-46	17	RESISTOR: 100 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-32	3Z6027-1	17	RESISTOR: 270 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-26	3Z6068-10	17	RESISTOR: 680 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-11, 10-R-13	3Z4525	17	RESISTOR: 1,000 ohms, ½ watt, ±10%, insulated composition		2		*		*

10-R-31	3Z6190-4	17	RESISTOR: 1,800 ohms, ½ watt, ±5%, carbon		1		*		*
10-R-43	3Z6250-56	17	RESISTOR: 2,500 ohms, wire wound, ±10%, 10 watts		1		*		*
10-R-3	3Z6270-7	17	RESISTOR: 2,700 ohms, 2 watts, ±10%, insulated composition		1		*		*
10-R-29	3Z6270-6	17	RESISTOR: 2,700 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-36	3Z6330-1	17	RESISTOR: 3,300 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-46	3Z6470-2	17	RESISTOR: 4,700 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-22	3Z6470-3	17	RESISTOR: 4,700 ohms, 1 watt, ±10%		1		*		*
10-R-8	3Z6500-58	17	RESISTOR: 5,000 ohms, 10 watts, ±10%, wire wound		1		*		*
10-R-2	3Z6506-10	17	RESISTOR: 56,000 ohms, 2 watts, ±10%, insulated composition		1		*		*
10-R-22, 10-R-23	3Z6582-6	17	RESISTOR: 8,200 ohms, 1 watt, ±10%, insulated composition		2		*		*
10-R-15, 10-R-16, 10-R-20, 10-R-21.	3Z6582-3	17	RESISTOR: 8,200 ohms, ½ watt, ±10%, insulated composition		4		*		*
10-R-28	3Z6612-1	17	RESISTOR: 12,000 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-7	3Z6620-35	17	RESISTOR: 20,000 ohms, wire wound, ±10%, 10 watts		1		*		*
10-R-44	3Z6625-35	17	RESISTOR: 25,000 ohms, wire wound, ±10%, 10 watts		1		*		*
10-R-27	3Z6630-5	17	RESISTOR: 33,000 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-9	3Z6635-2	17	RESISTOR: 35,000 ohms, 2 watts, ±10%, carbon		1		*		*
10-R-51	3Z6639-10	17	RESISTOR: 39,000 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-47	3Z6647-20	17	RESISTOR: 47,000 ohms, 2 watts, ±10%, insulated composition		1		*		*
10-R-52	3Z6656-12	17	RESISTOR: 56,000 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-17, 10-R-60	3Z6682	17	RESISTOR: 82,000 ohms, ½ watt, ±10%, insulated composition		2		*		*
10-R-49, 10-R-54	3Z6700-59	17	RESISTOR: 100,000 ohms, 1 watt, ±10%, insulated composition		2		*		*
10-R-24, 10-R-45	3Z6700-15	17	RESISTOR: 100,000 ohms, ½ watt, ±10%, insulated composition		2		*		*
10-R-30, 10-R-37	3Z6712-1	17	RESISTOR: 120,000 ohms, 2 watts, ±10%, insulated composition		2		*		*
10-R-53	3Z6713-4	17	RESISTOR: 130,000 ohms, 1 watt, ±5%, carbon		1		*		*
10-R-18	3Z6713-5	17	RESISTOR: 130,000 ohms, ½ watt, ±5%, carbon		1		*		*
10-R-1	3Z6715-1	17	RESISTOR: 150,000 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-4	3Z6716-2	17	RESISTOR: 160,000 ohms, 1 watt, ±5%, carbon		1		*		*
10-R-57	3Z6718-1	17	RESISTOR: 180,000 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-55	3Z6722-6	17	RESISTOR: 220,000 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-40	3Z6725-17	17	RESISTOR: 250,000 ohms, ½ watt, ±10%, carbon		1		*		*
10-R-61	3Z6739-6	17	RESISTOR: 390,000 ohms, ½ watt, ±15%, insulated composition		1		*		*
10-R-59	3Z6747-12	17	RESISTOR: 470,000 ohms, 1 watt, ±10%, insulated composition		1		*		*
10-R-33	3Z6756	17	RESISTOR: 560,000 ohms, ½ watt, ±5%		1		*		*
10-R-35	3Z6756-1	17	RESISTOR: 560,000 ohms, ½ watt, ±10%, insulated composition		1		*		*
10-R-10	3Z6768-11	17	RESISTOR: 680,000 ohms, ½ watt, ±5%, carbon		1		*		*
10-R-12, 10-R-14, 10-R-38, 10-R-39.	3Z4534	17	RESISTOR: 1 meg, ½ watt, ±10%, insulated composition		4		*		*
10-R-5	3ZK6801A2-1	17	RESISTOR: 1.2 meg, ½ watt, carbon		1		*		*
10-R-6	3Z6810-22	17	RESISTOR: 10 meg, ½ watt, ±5%, carbon		1		*		*
	2Z8657-8	17	SOCKET: 11 contact, Dwg. #5802		1		*		*
	2Z8674.15	17	SOCKET: H.V. 4 contact anph. 77A-4T		1		*		*
	2Z8678-1	17	SOCKET: tube, octal Meissner, 25-8209		1		*		*
10-T-2	2Z9613.84		TRANSFORMER: power, pri. 115 volts, sec. 1,250 volts, 480 volts, 2.5 volts, 5 volts, 63 volts, #W-218855-4		1		*		*
10-T-1	3Z9638-5		TRANSFORMER: (3) windings		1		*		*
	2Z5837-3		KNOB: focus, #W-220563-1		1				*
	2Z5837-4		KNOB: Hor, #W-220562-1		1				*
	2Z5837-5		KNOB: Int, #W-220563-1		1				*
	2Z5824.8		KNOB: Sig. Input, #B-220591-1		1				*
	2Z5824.9		KNOB: Slo-Sweep, #B220587-1		1				*
	2Z5824.10		KNOB: Sweep-Speed ,#B-220598-1		1				*
	2Z5837-6		KNOB: Sync., #W-220-565-1		1				*
	2Z5824.11		KNOB: Trigger-Freq., B-220592-1		1				*
	2Z5824.12		KNOB: Trigger Polarity, #B-220588-1		1				*
	2Z5824.13		KNOB: Trig. Selector, #S-220590-1		1				*

*Indicates stock available.

115. Maintenance Parts List for Synchroscope I–212 (contd.)

Reference symbol	Signal Corps stock No.	Major comp	Name of part and description	Running spares	Quantity per unit	Organization stock	3d echelon	4th echelon	Depot stock
	2Z5837-7		KNOB: Vertical, #W-220564-1		1				*
	2Z5824.14		KNOB: Vertical, Gain, #B-220693-1		1				*
	3F3910-212/S1		SCREEN: Cathode Ray Tube, #B-216491-2		1		*		*
	2Z8304.16		SHIELD: tube (2AP1), #B-217-771-2		1		*		*

*Indicates stock available.

☆—601439—1944

RESTRICTED

TM 11-1562

WAR DEPARTMENT TECHNICAL MANUAL

RADIO EQUIPMENT RC-384

SERVICE MANUAL

THEORY, TROUBLE SHOOTING, AND REPAIR

CONFIDENTIAL

WAR DEPARTMENT 16 APRIL 1945

Stock No. 6D13577

[redacted]

THIS ADDENDA WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL WAR DEPARTMENT PUBLICATION.

ADDENDA

27 APRIL 1945

ADDENDA TO

TM 11-1562

RADIO EQUIPMENT RC-384, SERVICE MANUAL

The following information, published on Order No. 3047-MPD-44, corrects portions of TM 11-1562, 16 April 1945.

Personnel using the equipment and having custody of this technical manual will enter suitable notations beside each affected paragraph or illustration in the technical manual to indicate the presence of this supplementary information.

SUMMARY OF EQUIPMENT CHANGES. The design of Radio Equipment RC-384 as described in TM 11-1562 has been changed as follows:

Resistor 43 in Control Unit BC-1378 has been changed from 39,000 ohms, ±10%, ½ w, to 27,000 ohms, ±5%, ½ w. This resistor is connected in series with the 75 K YD. sweep calibration potentiometer 92-B in the sweep multivibrator circuit.

CHANGES TO TM 11-1562. Make the following changes and additions to TM 11-1562:

Page 47, Fig. 44. Change the value of resistor 43 from 39K to 27K.

Pages 63 and 64, Fig. 57. Resistor 43 is shown attached to potentiometer 92-B in the circuit wired to terminal 5 of section 1, range switch 124-A. Change the value of resistor 43 from 39K to 27K.

Page 151, Fig. 108. Change resistance reading at grid T1 (pin 4) of tube 9 from 46,000 to read: Variable between 28,800 and 48,800.

Page 155. Change resistance reading at terminal 23 from 46K to read: Variable between 28,800 and 48,800. Change resistance reading at terminal 52 from 5K to read: Variable between 1.8K and 21.8K.

Page 159, Fig. 113. Change "SYNCH TERMINAL BOARD" to read: TERMINAL BOARD A OF FIG. 106. Change "NOTCH TERMINAL BOARD" to read: TERMINAL BOARD B OF FIG. 106. Change "VIDEO TERMINAL BOARD" to read: TERMINAL BOARD C OF FIG. 106.

Page 192. Change Signal Corps stock No. and description of resistor 43 to read: 3RC20BF273J RESISTOR: fixed; carbon; 27,000 ohm ±5%; JAN type No. RC20BF273J; Belrad dwg/part #A-9B1-193 (2 axial wire leads).

[redacted]

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ADDENDA

16 APRIL 1945

ADDENDA TO

TM 11-1562

RADIO EQUIPMENT RC-384, SERVICE MANUAL

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Personnel using the equipment and having custody of this technical manual will enter suitable notations beside each affected paragraph or illustration in the technical manual to indicate the presence of this supplementary information.

SUMMARY OF EQUIPMENT CHANGES. The design of Radio Equipment RC-384 as described in TM 11-1562 has been changed as follows:

a. The fasteners for the waterproof covers of Rack FM-93 and Control Unit BC-1378 have been changed from captive wing-nut type to luggage-type clasps (fig. 126).

b. The a-c convenience outlets on the side of Rack FM-93 have been moved to the lower left-hand side of the front of the rack (fig. 126).

c. The BLOWERS pilot light and switch has been moved from the left-hand side of the lower front panel of Rack FM-93 to the right-hand side (fig. 126).

d. The receptacle for the seven-conductor cable which connects the control unit to the rack has been moved from the right-hand side of the lower front panel of Rack FM-93 to the left-hand side (fig. 126).

e. Ventilation in Rack FM-93 has been improved by eliminating the louver on the bottom front panel of the rack and substituting larger air vents (fig. 126).

f. Ventilation of Control Unit BC-1378 has been improved by providing vents in the back of the inner case of the control unit.

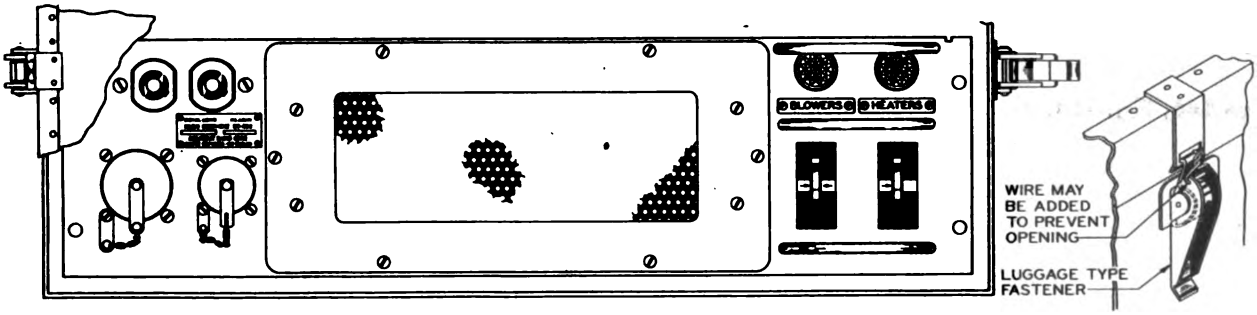

Figure 126. Rack FM-93, lower front panel.

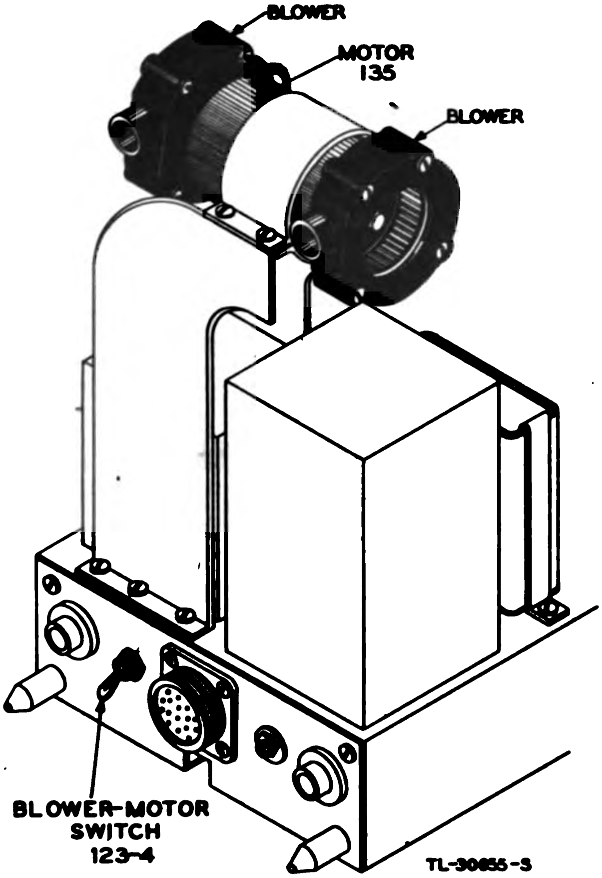

Figure 127. Control Unit BC-1378, rear view.

CHANGES TO TM 11-1562. Make the following changes and additions to TM 11-1562:

Figures 1, 2, 120, and 124. The lower front panel of Rack FM-93 as shown in these figures, has been rearranged as shown in figure 126 and described in paragraphs **b c d** and **e** above.

Figures 2 and 104. The captive wing-nut fasteners shown on the waterproof covers of the equipment in these figures have been changed to luggage-type clasps. These clasps are shown in figure 126.

Page 146, Fig. 104. Two air vents have been provided in the upper part of the rear panel of the control unit. Toggle switch 123-4 (fig. 122) for the control unit blower motor has been mounted between the multiple cable receptacle and the TRIGGER IN connector (fig. 127).

Page 149, Par. 104. After paragraph 104, add the following paragraph:

104.1 REPLACEMENT OF BLOWER MOTOR BRUSHES.*

The control unit blower motor brushes require replacement after approximately 300 hours of service. To replace the brushes, proceed as follows:

a. Disconnect the cords at the rear of the control unit.

b. Loosen the three captive knurled screws on the front panel of the control unit. There is one in each upper corner and one in the bottom center of the front panel. Grasp the handle on the front panel, and pull the chassis from the inner case.

c. Remove the blower motor from its mounting clamp by removing the two screws at each end of the mounting clamp (fig. 127).

d. Remove the four screws which hold the phenolic housing around air impeller on the left end of the motor (fig. 128). (The end of the motor where the two leads go through the metal grommet.)

e. With a No. 8 Allen wrench loosen the two setscrews which hold the air impeller onto the motor shaft.

f. Remove the impeller from the shaft and then remove the two screws which hold the bakelite plate on the end of the motor. Remove the bakelite plate.

g. Remove the aluminum end cap from the motor. This cap is sometimes difficult to remove. It should be carefully pried off the end of the motor with a screwdriver.

h. Remove the brushes by removing the two screws which hold the brushholder to the brush mounting (fig. 128). To reassemble the motor reverse the disassembling procedure.

***See Figures 128 and 129 on pages 215 and 216.**

WAR DEPARTMENT TECHNICAL MANUAL
TM 11-1562 CONFIDENTIAL

RADIO EQUIPMENT RC-384
SERVICE MANUAL

THEORY, TROUBLE SHOOTING, AND REPAIR

WAR DEPARTMENT 16 APRIL 1945

WAR DEPARTMENT,
WASHINGTON 25, D.C., 16 APRIL 1945

TM 11-1562, Radio Equipment RC-384, Service Manual, is published for the information and guidance of all concerned.

[A. G. 300.7 (3 Oct 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff,

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

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

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LIST OF ILLUSTRATIONS

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WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

Be careful not to contact high-voltage plate circuits or 117-volt a-c input connections while checking or servicing the equipment. Make certain that the power is turned off before disassembling any part of the equipment.

Dangerously high voltages are present in the power supplies of this equipment. High-voltage capacitors in these power supplies must be discharged manually when service checks are made after the a-c power has been removed from the components.

EXTREMELY DANGEROUS POTENTIALS

exist in the following units:

Rack FM-93
Control Unit BC-1378
Radio Receiver and Transmitter BC-1267-A
Power Supply RA-105-A
Signal Generator I-222-A

FIRST AID TREATMENT FOR ELECTRIC SHOCK

I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

Resuscitation

A

B

C

POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

TL37451

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—All tubes, taking special care to destroy completely the tubes in the transmitter oscillator; all coil forms, transformers, chassis.

WARNING: Destroy the cathode-ray tube with small arms fire from a shielded position behind the tube, because the socket is expelled through the front of the tube when the glass envelope is broken.

2. Cut—All cables, coil windings.

3. Burn—All parts of the equipment that cannot be completely demolished by other means.

4. Bend—The dipoles and Lecher bars in the transmitter circuit.

5. Bury or scatter—Nameplates, smashed tubes, all other parts of the equipment.

DESTROY EVERYTHING

REFERENCE NOTICE

TM 11-1562, SERVICE MANUAL, is one of three technical manuals on Radio Equipment RC-384. It is used in conjunction with TM 11-1362, TECHNICAL OPERATION MANUAL, and TM 11-1462, PREVENTIVE MAINTENANCE MANUAL. TM 11-1562 contains two general types of information. First, it explains the theory of operation of Radio Equipment RC-384; and second, it supplies practical procedures to be followed when the equipment fails to function properly. The SERVICE MANUAL serves as a guide for locating the source of trouble, indicates the proper repair or replacement necessary, and in general assists the technician in charge to get the equipment back into service.

The theory section of this manual is written for personnel who have a general knowledge of radar. Less experienced personnel will be assisted in the use of the manual by reference to TM 11-466, which covers the fundamental principles of radar and the electronic theory necessary for a further study of radar, and to TM 11-467, which covers common radar systems in use.

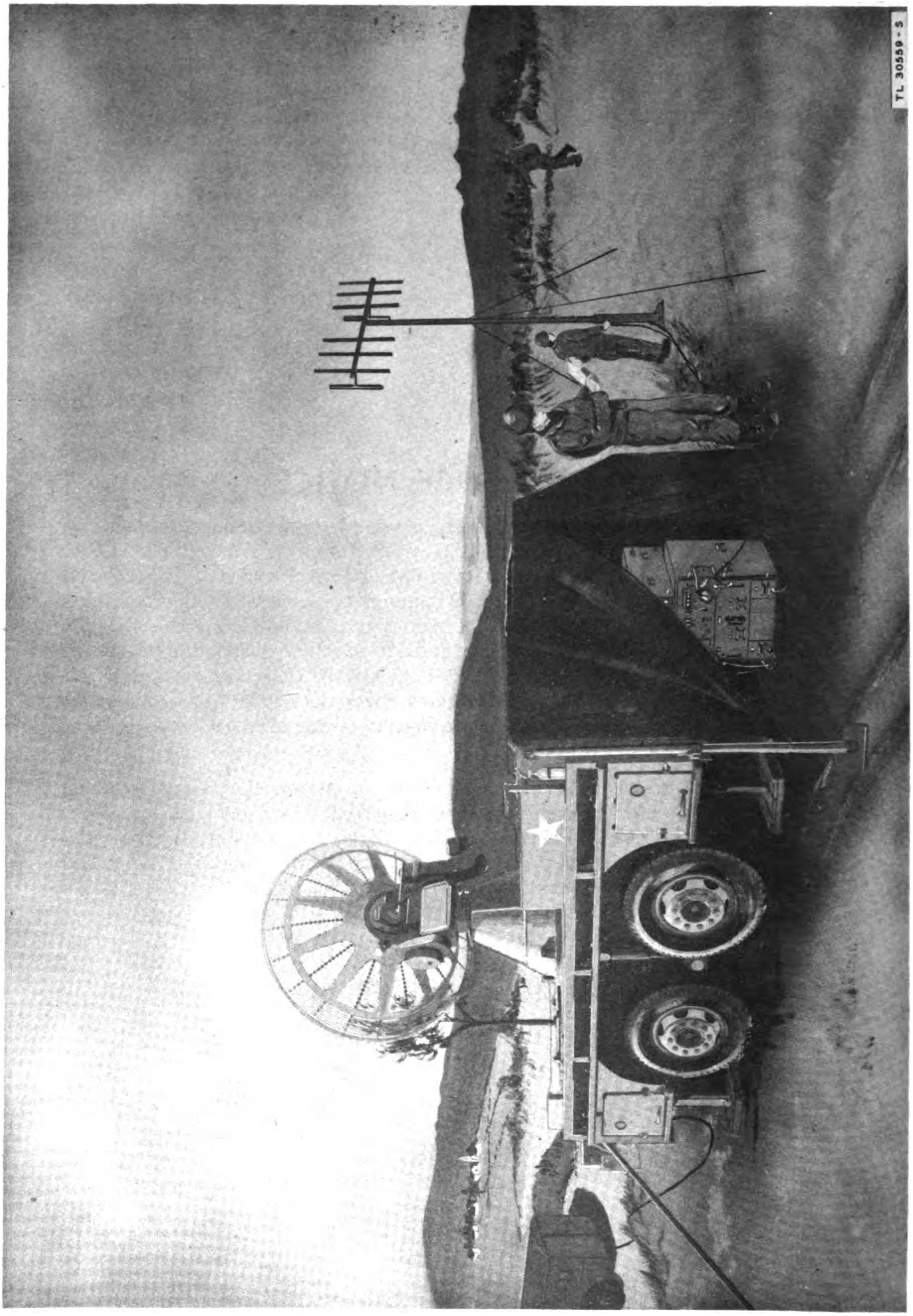


Figure 1. Radio Equipment RC-384 set up for operation with Radio Set SCR-784.

[redacted] RESTRICTED

PART ONE

THEORY OF RADIO EQUIPMENT RC-384

CHAPTER 1

INTRODUCTION

1. PURPOSE OF MANUAL.

The purpose of this technical manual is to present the electrical and mechanical theory of Radio Equipment RC-384 and to aid the repairman in the maintenance, repair, and most efficient operation of the equipment.

2. CONTENTS OF MANUAL.

a. Part One, Theory of Radio Equipment RC-384. Chapter 1 of this part describes briefly the purpose and fundamentals of an identification-friend-or-foe (IFF) system. Chapters 2 through 7 contain both a general and a detailed description of the function and operation of the components of Radio Equipment RC-384.

b. Part Two, Trouble-Shooting Procedures. Part two deals with the techniques and methods of finding trouble in Radio Equipment RC-384. It discusses the use of the starting procedure in trouble shooting, the significance of abnormal indications while the set is in operation, voltage and resistance measurements of the specific stages and circuit components, the methods of signal tracing and signal substitution where applicable, and any other practical techniques. It also includes information on the replacement of defective electrical parts.

c. Part Three, Maintenance Parts. This is a complete list of all replaceable parts of the radio equipment and includes such information as reference numbers, names of parts and their descriptions, names or symbols of manufacturers, and Signal Corps stock numbers.

3. FUNDAMENTALS OF IFF.

a. Need for IFF. When the presence of an aircraft or surface vessel is detected by radar or other means, it is necessary to determine whether the target is friendly or hostile. This may be accomplished either by *recognition*, which implies that the target is established as friendly or hostile by visual observation; or by *identification*, which implies that the friendliness or hostility of the target is determined by means other than visual.

b. Identification Methods. Several methods of identification are now in use. One method involves the coordination of reports from radar equipment and from observers who have been able to recognize the target. Another method is by a process of elimination, based on the knowledge of the movements of friendly aircraft and surface vessels. In another method, an aircraft identifies itself to a direction-finding system of radio telegraphy usually by use of a simple code. All such methods involve coordination and consequent time delay. It has been found essential to avoid this time delay by providing means of direct identification at the point where the target is detected by radar. Radar sets are not capable of determining whether a target is friendly or hostile. Therefore, various systems have been developed whereby aircraft and surface vessels are provided with equipment which allows them to establish their friendly character, either directly to the radar search set or to additional apparatus associated with the radar set. Such systems of identification are known as identification friend or foe (IFF).

c. Development of IFF. Early types of IFF equipment made use of the radar signal, but this was soon found to be inadequate. Radar sets now operate on such a large number of widely separated frequencies that it has become impracticable to produce a single IFF set capable of tuning and responding to all of them. To provide an adequate identification service operating in this manner, it would be necessary for aircraft and ships to carry simultaneously several different types of IFF sets. It would also be necessary to introduce additions and modifications to this equipment each time

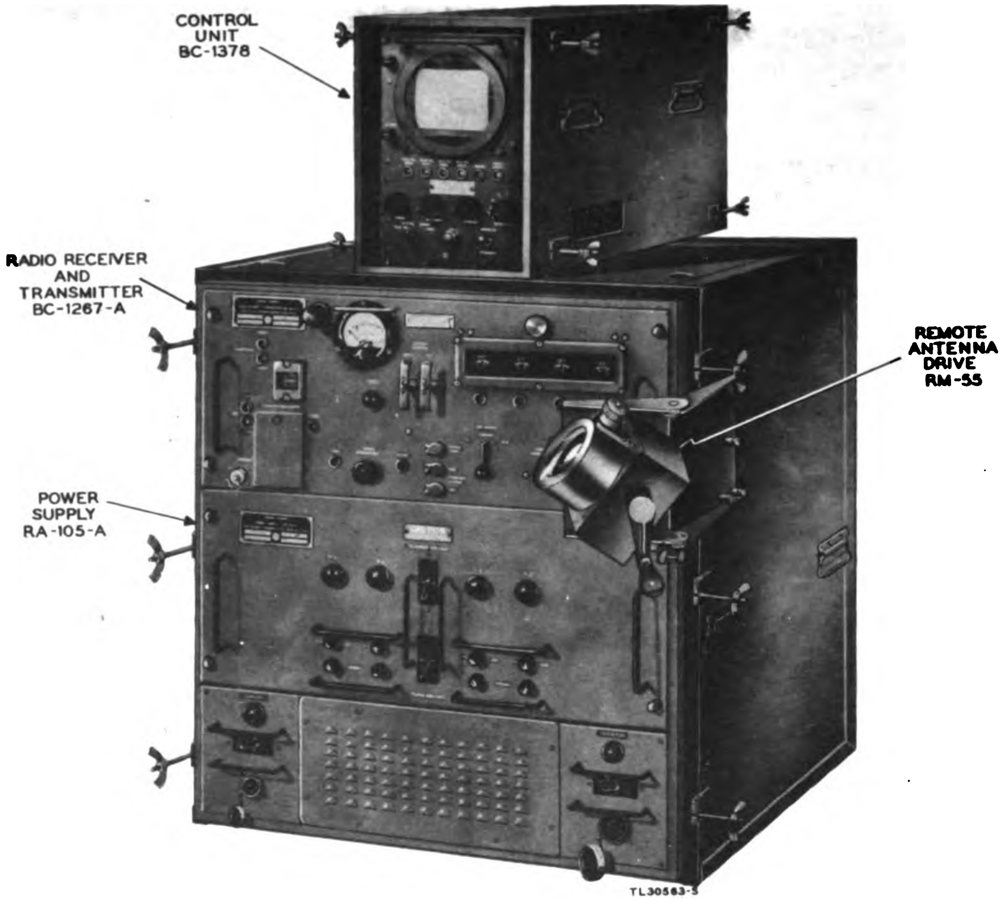


Figure 2. Rack FM-93, all components installed.

radar equipment on a new frequency was introduced. Such increases in the amount of equipment carried, particularly in aircraft, could not be accepted. The difficulty has been overcome by the introduction of a universal IFF frequency band separate from that of the radar sets. Though the need for extra equipment still exists, it may be installed in the ground radar set instead of in the aircraft.

4. MARK III IFF.

a. Description. The complete Mark III IFF system consists of two separate units (fig. 3): the ground unit, called the interrogator-responsor, located near the search set; and the airborne equipment, called the transpondor, located in the friendly aircraft. The radar operator challenges the unidentified aircraft by operating the interrogator-responsor. As shown in figure 3, pulses of r-f (radio-frequency) energy are radiated toward the aircraft. If the aircraft is friendly, it contains a transpondor; the interrogation pulses received by the transpondor are amplified, altered, and transmitted with sufficient power to present an intelligible signal at the interrogator-responsor. Here the pulses are detected, amplified, and presented on a cathode-ray tube display. The necessary identification information is obtained from the coding of the pulses and comparison of the range and azimuth with that reported by the radar set. The following subparagraphs describe the system components and coding.

b. Interrogator-responsor. The ground equipment consists of transmitter and modulator units (interrogator), receiver and display units (responsor), associated antenna, and power units. A synchronizing voltage from the radar unit controls the circuits which supply pulses to operate the transmitter and display unit. The r-f pulses from the transmitter are fed to a directional antenna. By rotating this antenna, the operator is able to examine space with radio waves in the same manner as with any radar set and thus interrogate the unidentified aircraft. Usually one antenna is used for both transmitting and receiving purposes. The returned coded pulses are detected and amplified by the receiver circuits and then supplied to the display unit. Since there is little delay in the transpondor, the time lapse between the transmission of the interrogation pulse and the reception of the coded reply pulse can be used to measure the range accurately.

c. Transpondor. The airborne equipment consists of receiver, coding unit, transmitter unit, antenna, and power supply. The sensitive receiver detects the interrogation pulses and passes them to the coding unit. The pulse width is varied in the coding unit, but the repetition rate is unchanged. These coded pulses are used to actuate the transmitter which transmits the coded return pulses. It is because of this additional *push* given to the original pulses that the IFF equipment with its very low power will have the same range as the larger and more powerful radar set. The transpondor normally uses one antenna for both receiving and transmitting.

d. Allocation of IFF Frequencies. The tuning of the transpondor receiver and transmitter is swept periodically through a band of frequencies (157-187 mc), and spot frequencies are allocated to the interrogator-responsor equipments associated with the various types of radar sets. Use of a frequency band in this manner has important advantages over the use of a single frequency for IFF purposes. These advantages include a reduction in the amount of mutual interference, and the risk of *over-interrogation* (or swamping) of the transpondor in operational areas having a high density of radar interrogation requirements. The wide bandpass characteristic of the receiver (4 mc) insures adequate time during the sweep of the transpondor frequency through the receiver band to permit easy identification of the pulse coding. The transpondor is actuated by the interrogator transmission. This system permits additional security because the interrogator is switched on only when IFF is desired, thus avoiding continuous transmissions from the transpondor.

e. Display Systems. The identification signals received by the responsor may be displayed either

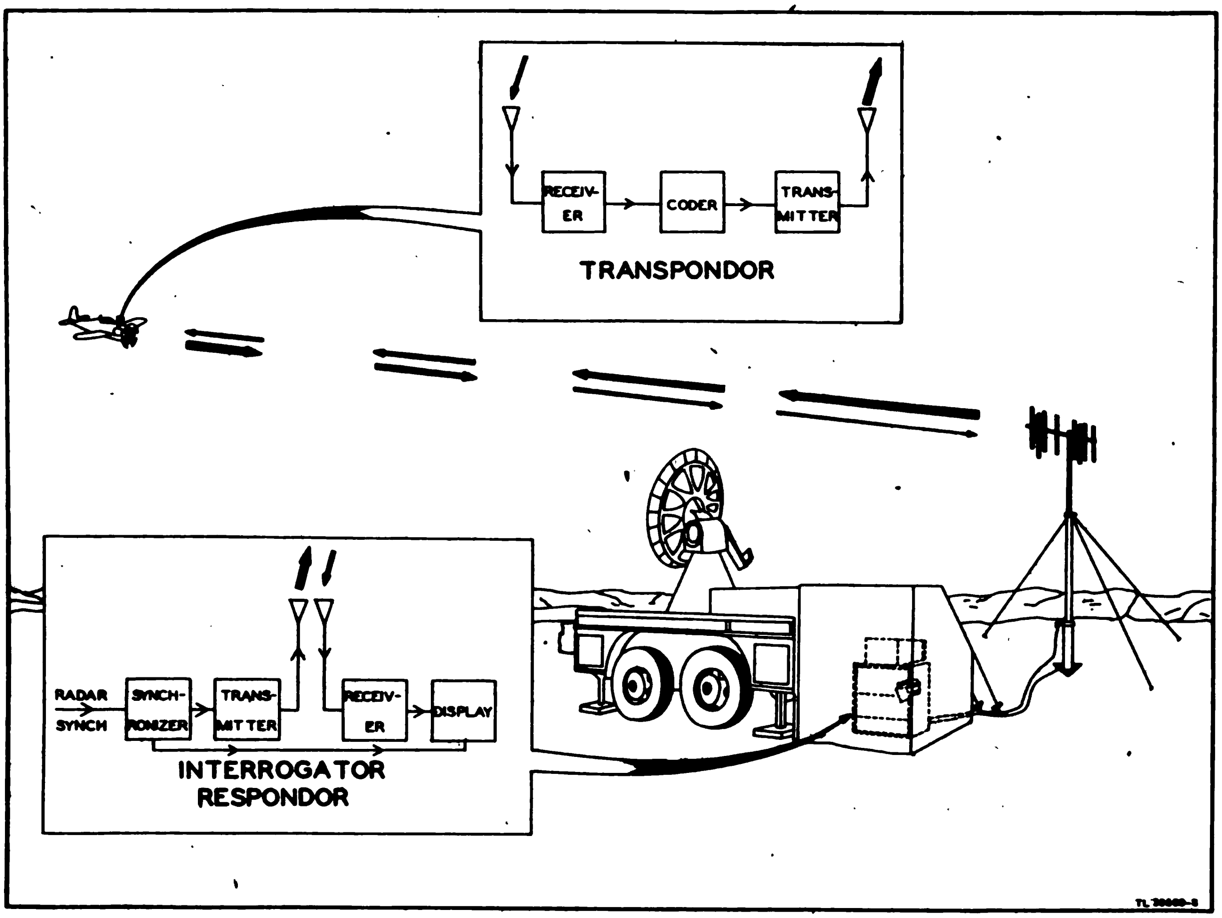


Figure 3. IFF, block diagram.

on the display unit of the radar set or on a separate display unit which is part of the identification equipment. In this way, the identification signal is promptly correlated with the correct target.

f. Coding.

(*1*) The transpondor sweeps the frequency band in approximately 2½ seconds, and therefore sweeps through any interrogator frequency at intervals of 2½ seconds. Coding is accomplished by arranging the transpondor so that, during consecutive sweeps, it may return to the interrogator-responsor equipment: either no reply, a narrow pulse, or a wide pulse (table I).

TABLE I
CODING POSITIONS, SEQUENCES, AND PULSE DURATIONS

Coding position	1st sweep	2d sweep	3d sweep	4th sweep
1	N	N	N	N
2	N	——	N	——
3	N	N	N	——
4	N	N	W	W
5	N	——	W	——
6	N	N	W	——
Emergency	VW	VW	VW	VW

N—Narrow transmitted pulses, from 5 to 12 microseconds.
W—Wide transmitted pulses, from 17 to 30 microseconds.
VW—Very wide transmitted pulses, from 60 to 100 microseconds (used when the friendly aircraft is in distress).
——No transmission.

NOTE: Ratio of wide pulse to narrow pulse (W/N) must be 2.5 or larger.

(*2*) The basic coding cycle consists of four sweeps, after which all codes are repetitive. In this way, six distinct codes have been provided which are selected by a switch on the transpondor control unit. The minimum time required to establish the identity of the code used is about 10 seconds.

(*3*) The various codes provide means of discriminating between different types of aircraft as an additional security measure. In addition to the six codes just described, a further code is available in which a wide pulse is returned during each sweep. The code is distinguished easily and is intended as a universal distress code.

5. RADIO EQUIPMENT RC-384.

a. Description. Radio Equipment RC-384 is a transportable IFF unit designed for use with Radio Set SCR-784. Radio Equipment RC-384 is capable of identifying, within certain limits, the aircraft detected by the associated radar search set. The maximum effective range of Radio Equipment RC-384 is 75,000 yards.

b. Block Diagram of Radio Equipment RC-384 (fig. 4). Radio Equipment RC-384 is a typical Mark III IFF equipment. The synchronizing voltage from the associated radar search set is processed through the control unit which establishes the recurrence rate of transmission. The transmitter generates pulses of r-f energy which are fed to a directional antenna and radiated into space. The radiated pulses reaching a friendly aircraft are detected, amplified, coded, and transmitted by the transpondor. The transpondor pulses are picked up by the antenna of Radio Equipment RC-384 and fed into the receiver where they are detected and amplified. The output of the receiver is fed into the control unit (display oscilloscope). The control unit is the master unit; it supplies all the necessary trigger pulses, and sweep voltages. Figure 4 shows the basic aspects of Radio Equipment RC-384 and also the main principles of its functioning. The details of the circuits used in the equipment are described in the chapters which follow. Study the block diagram before, and during, the reading of the following paragraphs which give additional facts of general interest on the different units.

c. Transmitter Unit. The transmitter unit consists of several separate circuits: an amplifier and blocking oscillator, which shapes the sync pulses; a modulator triggered by the blocking oscillator that acts as an electronic switch to turn the high voltage to the oscillator tubes on and off; and an r-f oscillator, which produces the r-f energy. The transmitter receives a trigger pulse from the control unit approximately 213 times a second, dependent upon the frequency of the radar synchronizing voltage. The transmitter contains circuits for shaping and amplifying the trigger pulse to a value of 3,000 volts, which is applied to the plates of the transmitter oscillator tubes for a period of 4 to 10 microseconds.

d. Receiver Unit. The receiver of Radio Equipment RC-384 receives and amplifies the return pulse of the transpondor. The receiver is a conventional superheterodyne using a video amplifier as the output stage. The receiver has a double channel detector to supply the video amplifier and the tuning indicator with a portion of the detected i-f output signal.

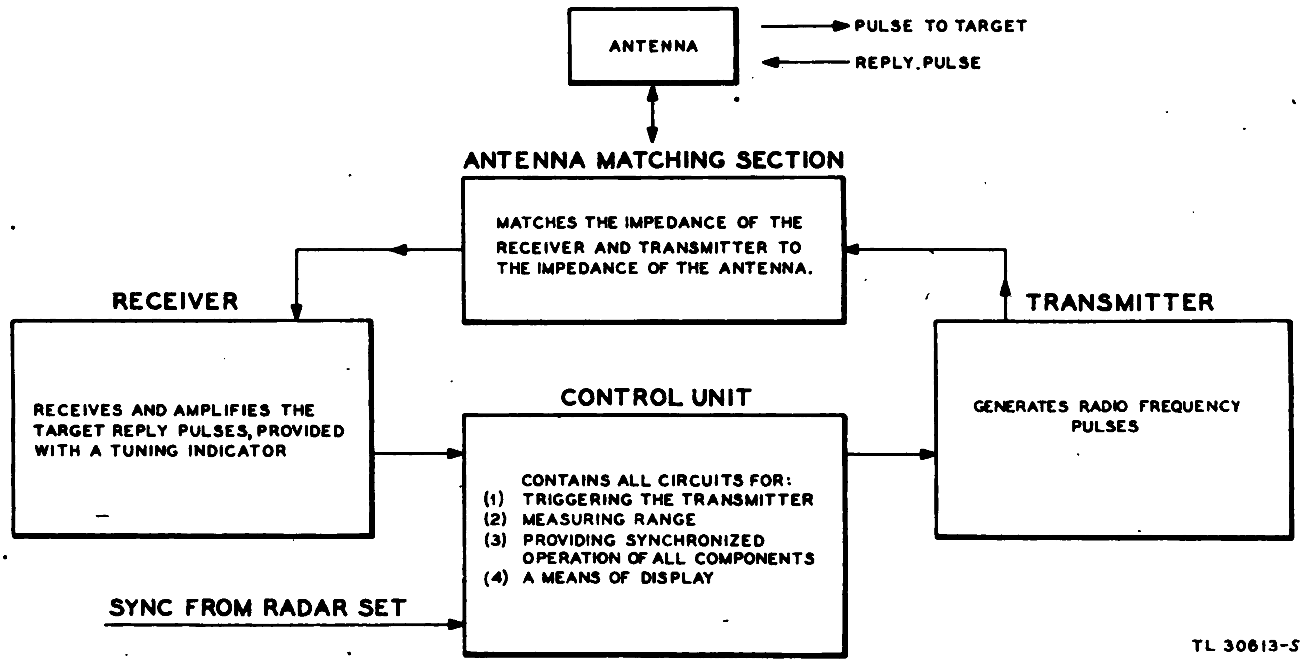


Figure 4. Radio Equipment RC-384, simplified block diagram.

e. Control Unit. The control unit contains all the essential trigger circuits and a display oscilloscope. This unit can be called the *timer* of the complete equipment because it produces all of the trigger pulses and provides the ranging circuits for the proper display of the received signals. The operation of the control unit is initiated by the synchronizing voltage from the associated radar search set. This synchronizing voltage is used in the control unit to synchronize the operation of the IFF and radar equipments.

f. Remote Antenna Drive. The remote antenna drive, mounted on the side of the rack, is a hand-operated gearbox which controls the rotation of the antenna through two 25-foot sections of flexible drive cable. The gear drive ratio is 1 to 2½ so that 20 rotations of the hand crank produce 50 rotations of the flexible drive shaft which in turn produces one rotation of the antenna.

g. Antenna. The antenna consists of two folded vertical dipoles with three reflector elements behind each dipole. The antenna is mounted on a 16-foot rotatable mast. The azimuth position of the antenna is controlled by the remote antenna drive which rotates the mast by means of a flexible drive cable. The antenna is used for both transmitting and receiving.

6. TECHNICAL CHARACTERISTICS OF RADIO EQUIPMENT RC-384.

FREQUENCY......... 157 to 187 megacycles.

PEAK POWER
OUTPUT............ 1.0 kilowatt.*

AVERAGE POWER
OUTPUT............ 0.8 watt

PULSE RECURRENCE
FREQUENCY

Synchronized by Radio
Set SCR-784....... 213 (pulses per second) (pps).

Allowable recurrence
frequencies......... 200 through 240 pps.

*In operation, the power output is reduced to 0.25 kw to increase the azimuth selectivity of the antenna and to avoid triggering transpondors far beyond the range of the display circuits (75,000 yards).

PERMISSIBLE RANGE OF INPUT SYNCHRONIZING SIGNALS

To TRIGGER IN jack on Control Unit BC-1378

Pulse width	0.5 to 15 μsec.
Frequency	1,000 to 2,000 pps.
Peak voltage	
Positive pulse	25 to 160 volts.
Negative pulse	15 to 160 volts.

(Sine wave sync cannot be used.)

To RANGE SYNC jack on Control Unit BC-1378

Pulse width	0.5 to 15 μsec.
Frequency	1,000 to 2,000 pps.
Peak voltage	
Positive pulse	15 to 160 volts.
Negative pulse	15 to 160 volts.

(Sine wave sync cannot be used.)

POWER REQUIREMENTS	113 to 117 volts, 60 cycles, single phase.
POWER CONSUMPTION	1,228 watts.
TYPE OF PRESENTATION	A-type cathode-ray oscilloscope.
CALIBRATION OF BASELINE (During adjustment procedure)	75,000-yard sweep calibrated by means of calibration pips from radar set; 10,000-yard sweep calibrated by waveform from control unit.
RANGE	Maximum: 75,000 yards. Minimum: Approximately 800 to 1,700 yards depending upon pulse width.
RANGE OF PRESENTATION SYSTEM	Zero to 75,000 yards; expanded precision range for any 10,000 yard portion of the first 42,000 yards.
AZIMUTH CONTROL	Hand-driven remote drive mechanism rotates antenna by means of flexible drive cable.
AZIMUTH PRESENTATION	Azimuth position indicated on mil scale on remote drive mechanism.
ANTENNA	Two folded vertical dipoles with three parasitic reflector elements behind each dipole. Antenna is mounted on a 16-foot rotatable mast.
TRANSMISSION LINE	RG-8/U flexible coaxial cable.
BEAM WIDTH	46° at the half-power point.
AZIMUTH ACCURACY	Not used for accurate azimuth determination.
ASSEMBLY TIME	Approximately 15 minutes with trained crew.
SOURCE OF R-F POWER	Two 2C26A tubes in tuned-plate, tuned-grid, push-pull oscillator circuit.
R-F PULSE WIDTH	4 to 10 μsec.
TYPE OF MODULATOR	Blocking oscillator output amplified by power tube, transformer-coupled to r-f oscillator plate circuit.
HIGH-VOLTAGE RECTIFIER	One 2X2 tube in half-wave rectifier circuit.
RECEIVER	
Sensitivity	16-microvolt input to produce 5-volt peak-to-peak video output with signal-plus-noise to noise ratio of 2:1.
Over-all bandwidth	4 mc at half-voltage points.
Local oscillator frequency	11 mc below rf.
Intermediate frequency	Staggered above and below 11 mc.

7. MAJOR COMPONENTS OF RADIO EQUIPMENT RC-384.

Radio Equipment RC-384 consists of several separate components listed below:

a. Rack FM-93.

b. Radio Receiver and Transmitter BC-1267-A.

c. Control Unit BC-1378.

d. Power Supply RA-105-A.

e. Antenna Assembly AS-109/TP.

f. Tower TR-29.

g. Remote Antenna Drive RM 35.

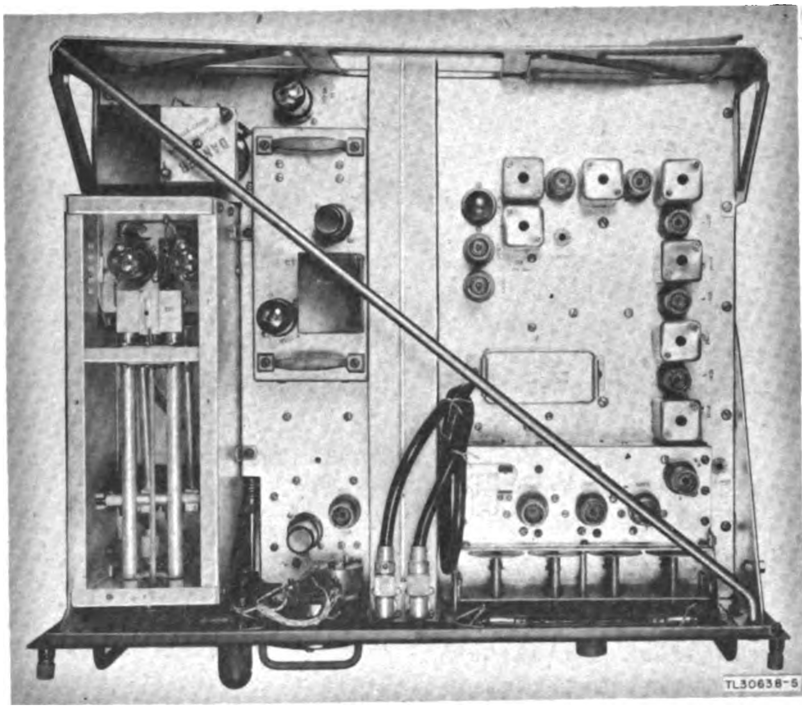
h. Signal Generator I-222-A.

CHAPTER 2
TRANSMITTING SYSTEM

8. GENERAL.

The function of the transmitter is to generate a radio-frequency interrogation pulse in proper synchronization with the radar transmitter pulse. The transmitter system consists of the modulator section, the r-f oscillator, and the testing or monitoring circuits (fig. 6). This paragraph contains a general description of the main sections of the transmitter. Paragraphs 9 through 16 contain a detailed description of the individual stages that make up the transmitting system.

a. The modulator section consists of five stages: the sync amplifier, the limiter, the cathode follower, the blocking oscillator, and the modulator



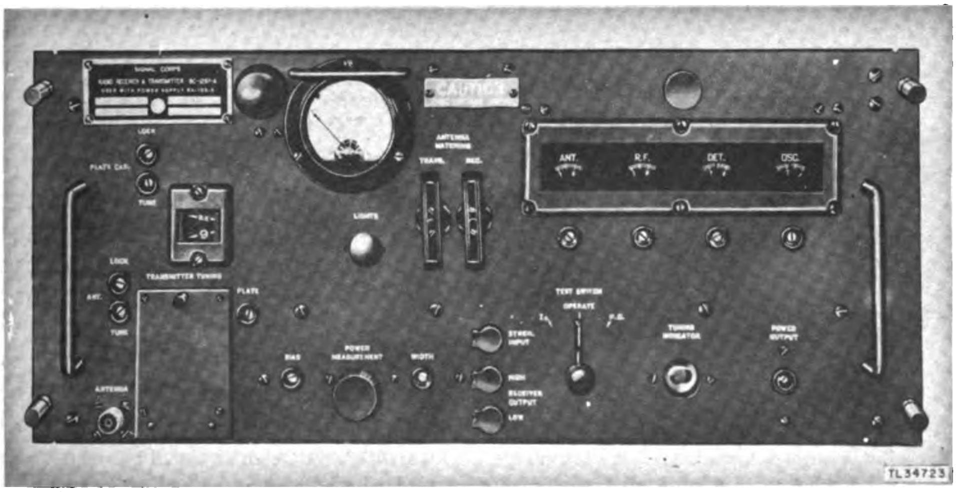


Figure 5. Radio Receiver and Transmitter BC-1267-A, front panel and top view of chassis.

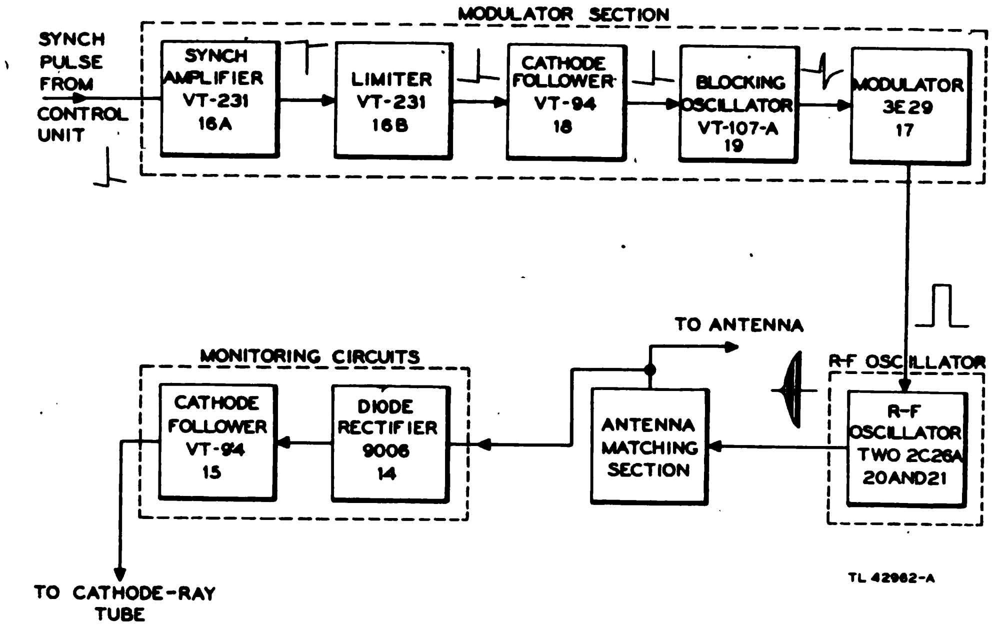


Figure 6. Transmitter, block diagram.

stage. The function of the modulator section is to shape and amplify the pulse which keys the r-f oscillator. The input to the modulator section is a pulse from the control unit which has a repetition rate of 213 pps; the output is a sharp narrow pulse of high voltage which is applied to the plates of the r-f oscillator.

b. The r-f oscillator generates r-f energy at a frequency between 157 and 187 mc (megacycles). This r-f energy is radiated from the antenna in the form of pulses which have a repetition rate of 213 pps.

c. The monitoring circuit (a diode rectifier and a cathode follower) in conjunction with the display tube provides a means of viewing and checking the power output of the transmitter. The input to the monitoring circuit is a portion of the output pulse of the r-f oscillator. The output as displayed on the display scope is the envelope of the r-f pulse.

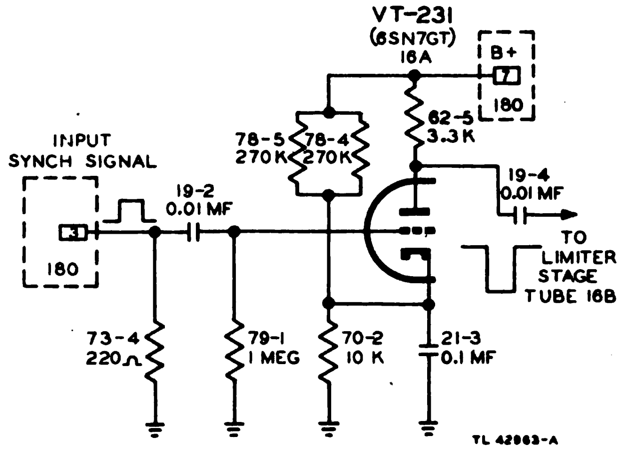


Figure 7. Transmitter, sync amplifier circuit.

9. SYNC AMPLIFIER, 16-A.

The input circuit of the modulator section is a conventional amplifier, one-half of Tube VT-231 (6SN7GT) (fig. 7). The synchronizing pulse from the control unit is applied through pin 3 of the multiple connector 180 and coupled through capacitor 19-2 to the grid of the amplifier tube 16-A. Resistor 73-4 is the impedance matching load for the cathode-follower stage and cable which carries the synchronizing signal from the control unit to the transmitter; resistor 79-1 is the grid leak. The positive trigger voltage is applied to the grid and produces an amplified, inverted pulse in the plate circuit. This pulse is coupled through capacitor 19-4 to the limiter stage.

10. LIMITER, 16-B.

Tube 16-B, the second half of Tube VT-231, is a limiter amplifier (fig. 8). This stage operates at zero bias and is normally conducting. When the negative output pulse of the sync amplifier is applied to the grid, the tube is cut off and a positive pulse is developed in the plate circuit. A positive pulse of 10 volts or more on the grid of the sync amplifier is amplified sufficiently to cut off the limiter tube and create a square positive pulse in its plate circuit. The amplitude of the output pulse of the limiter, therefore, will be of the same

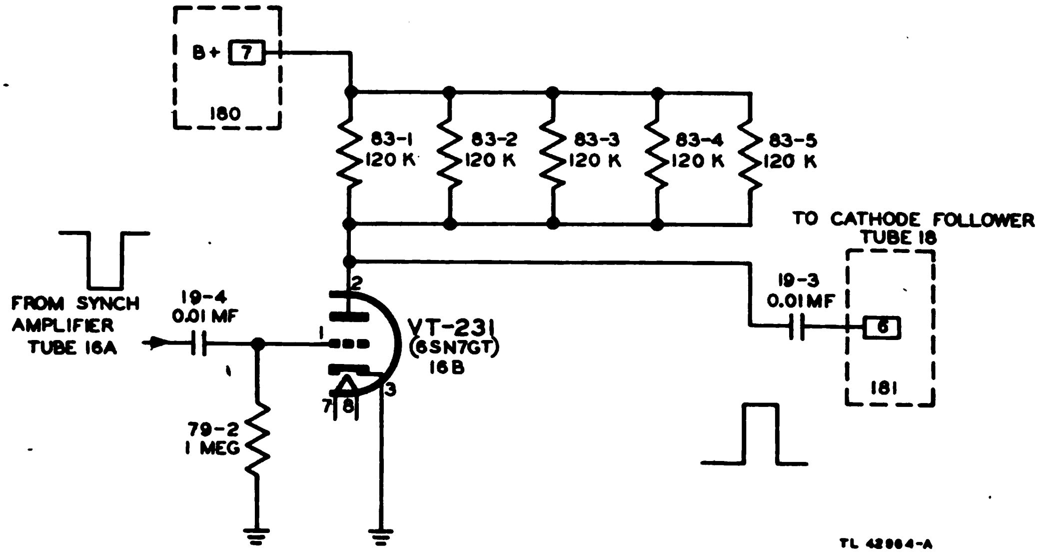


Figure 8. Transmitter, limiter circuit.

fixed value whenever the input to the synch amplifier exceeds 10 volts. The output of this stage is coupled through capacitor 19-3 to pin 6 of the modulator connector, male plug 181 and female plug 182.

11. CATHODE FOLLOWER, 18.

The cathode-follower tube, VT-94 (6J5) (fig. 9), is used to isolate the blocking oscillator from the input circuit. The positive pulse output of the limiter stage comes through pin 6 of the modulator connector and is applied to the grid of the cathode follower. The operation of the cathode follower is conventional. Resistor 79-3 is the grid leak and capacitor 33 is the plate bypass. The output voltage taken across the cathode resistor 62-4 is of the same shape and polarity as the input voltage, but slightly less in magnitude. The output is applied to the grid of the next stage, the blocking oscillator.

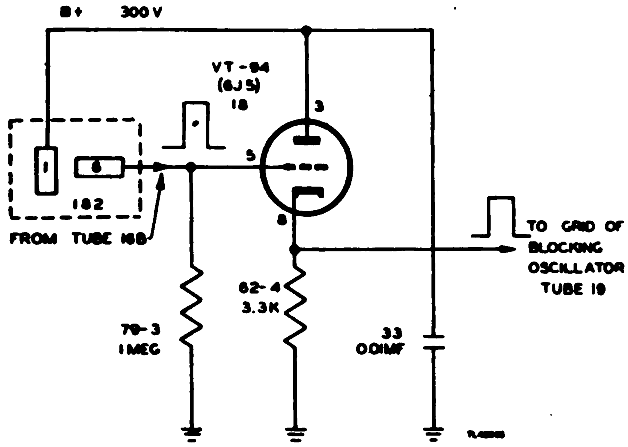


Figure 9. Transmitter, cathode-follower circuit.

12. BLOCKING OSCILLATOR, 19.

a. General. Tube VT-107-A (6V6GT) is a blocking oscillator (fig. 10). It is a triggered regenerative oscillator with a transformer supplying the required feedback from the plate to the grid. The oscillator is arranged, however, so that it will not operate continuously but will become blocked or inoperative after a definite length of time determined by the constants of the transformer and of the grid circuit. The cathode of the blocking oscillator has a fixed bias supplied by the voltage divider network consisting of resistors 95-3, 78-2, and 78-3 connected between the 300-volt supply and ground. This bias is approximately 40 volts and is sufficient to cut off the tube when a trigger pulse is not present on the grid. When the positive trigger pulse from the cathode follower is applied to the blocking oscillator grid, it triggers the blocking oscillator and sets it into oscillation. The oscillator generates one pulse and then stops until the next triggering pulse arrives. The details of this operation are explained in the following subparagraphs.

b. Rise of Current. When the positive triggering pulse is impressed upon the grid of the blocking oscillator, it causes the grid to become more positive with respect to the cathode and charges capacitors 30-1 and 30-2. This positive grid voltage causes an increase of plate current to flow through the plate winding of the blocking oscillator transformer which, in turn, induces a voltage in the grid winding of the transformer. Because of the polarity of the windings, the induced voltage causes the grid to become more positive which,

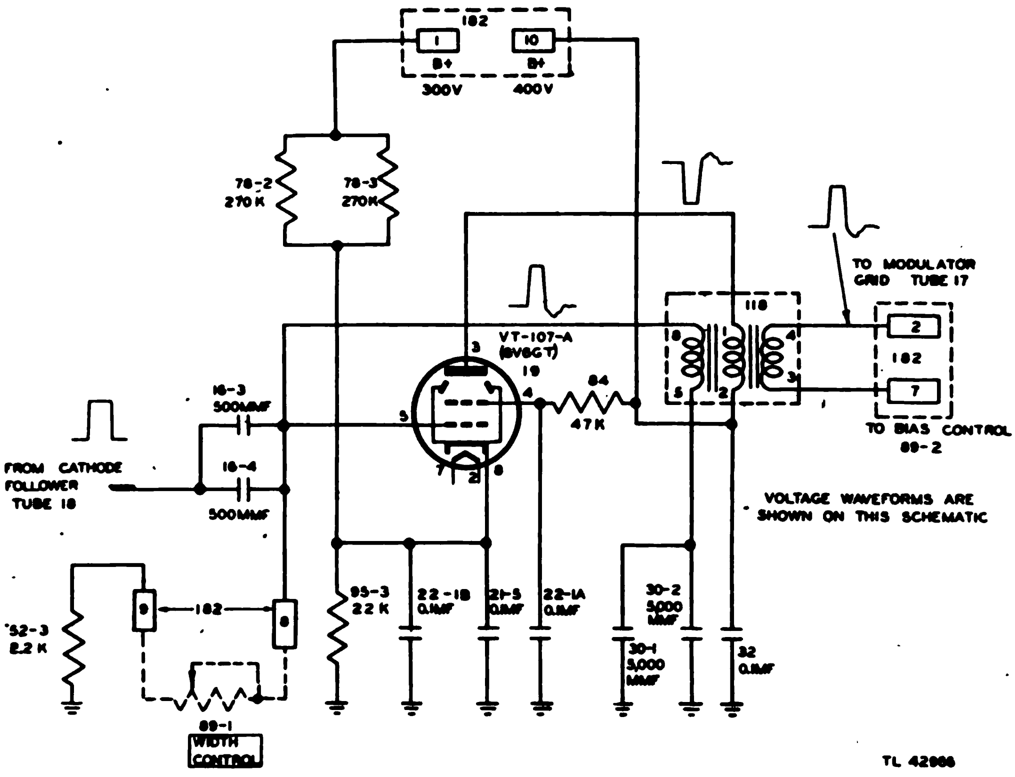


Figure 10. Transmitter, blocking-oscillator circuit.

in turn, causes more plate current to flow. Because of this regenerative action, the plate current rises very rapidly to saturation. Although the plate voltage can change instantaneously, the current through the plate winding, an inductance, cannot. The plate voltage, therefore, drops to its minimum value very rapidly and remains there while the plate current is rising to saturation.

c. Fall of Current. At saturation, the field about the plate winding ceases to increase and for an instant there is no induced voltage in the grid winding. Grid capacitors, 30-1 and 30-2 in parallel, immediately begin to discharge. This discharge causes the positive potential on the grid to become less positive, thereby causing a decrease in plate current in the plate winding; the field around the plate coil starts to collapse. This collapsing field, in turn, induces a voltage in the grid winding in the reverse direction, causing the grid to become more and more negative. This process continues until the grid is driven beyond cut-off, thus completing a cycle of operation.

d. Recurrence Frequency. Because of the action described above (subpars. **b** and **c**) sharp pulses are generated in the plate curcuit. Since the bias is fixed, the rate of recurrence of the operating cycle depends only upon the synchronizing pulses from the control unit.

e. Pulse Width. The width of the pulse produced by the blocking oscillator is determined by the electrical constants of the transformer and the time constant of the grid circuit. Capacitors 30-1 and 30-2 and resistors 52-3 and 89-1, in parallel with 95-3 therefore, determine the width of the pulse produced. Variable resistor 89-1, WIDTH control on the front panel, varies the width of the pulse over a range of approximately 4 to 10 microseconds.

f. Output Coupling. The output pulse of the blocking oscillator is coupled to the next stage, the modulator, by means of the third winding of the blocking oscillator transformer and appears as a narrow positive pulse. The 180° phase inversion is due to the polarity of the windings. The use of a three-winding transformer in this circuit has a decided advantage in that it isolates the blocking oscillator stage from the modulator stage and prevents any undesired interaction.

13. MODULATOR, 17.

a. General. Tube 17 (3E29) is used as a modulator or driver tube to trigger the r-f oscillator (fig. 11).

b. Bias, Plate, and Screen Voltage. The modulator tube is biased by means of a negative 150-volt source which is applied to the grid through the output winding of the blocking oscillator transformer 118. Variable resistor 89-2, BIAS control, and fixed resistor 53-3 are connected across the negative 150-volt power supply to ground. By means of the potentiometer 89-2, the bias voltage can be varied from −95 to −135 volts. Varying the potentiometer varies the load on the bias power supply (tube 1, fig. 60) and changes the voltage drop across the two 120K resistors, 22-1 and 22-2, in the power supply. This amount of variation is necessary because the cut-off bias is not the same for all commercial 3E29 tubes. The plate voltage of 2,300 volts is applied through the primary winding of the modulator transformer 119. Screen voltage is obtained from a 600-volt source. Dual variable-control resistor 91, labeled POWER OUTPUT, is connected across the 600-volt supply and makes it possible to vary the screen voltage from zero to 600 volts. This affords a smooth variation in output power from 50 watts to 1 kw (kilowatt). Capacitor 25 is the storage capacitor which furnishes the energy to the r-f oscillator. Resistors 82-1, 82-2, 82-3, and 82-4 form the bleeder. Capacitors 23 and 24 are the screen and cathode bypass capacitors, respectively.

c. Operation. The modulator performs the function of a switch which discharges a storage capacitor through the r-f oscillator tubes. Figure 12-A is a block diagram of the modulator circuit. Figure 12-B and -C is a simplified schematic of the modulator circuit of both phases of operation.

(*1*) *Switch Open.* The modulator tube is represented by a switch which is open while the tube is not conducting. While the switch is open, electrons flow around the circuit in the direction of the arrows, placing a charge on the storage capacitor 25. Since the switch remains open for a sufficiently long time (greater than 5 time constants), capacitor 25 becomes completely charged. During the pulse it loses only a portion of its charge and consequently requires an even shorter time to regain the full charge. Capacitor 25 has a potential across it of the entire B+ supply or 2,300 volts.

(*2*) *Switch Closed.* When the positive pulse output of the blocking oscillator is applied to the grid of the modulator, its voltage is sufficient to overcome the bias, and the tube conducts. This is represented by the closed switch. A low-impedance discharge path for the storage capacitor is provided, and the capacitor discharges through the transformer and the modulator tube.

d. Output. The output is taken from the pulse transformer 119. Because of the polarity of the windings and the step-up action of the transformer, the output is a pulse of approximately 3,000 volts amplitude. The pulse transformer is a specially constructed type that can pass the pulse with a minimum of frequency distortion.

e. Meter Circuit. Resistor 86 (fig. 11) is the d-c return path for the modulator tube and it is bypassed for the pulse by capacitor 24. Resistor 86 also serves as a shunt for meter 160 (0-1 ma). This meter can be connected into the cathode circuit by means of TEST SWITCH 140 (fig. 14).

14. R-F OSCILLATOR.

a. General. The r-f oscillator uses two 2C26A tubes, 20 and 21, in a tuned-plate, tuned-grid circuit operated in push-pull (fig. 13). At the frequency of operation, conventional inductors or capacitors would have to be so small in size that their use would not be practical. In addition, the skin effect in the coils introduces resistance which reduces the Q of the oscillator. To overcome these difficulties, the tuned circuits in the r-f oscillator are made of transmission lines. The inductance of a transmission line, a quarter wavelength or less, shorted at the end away from the tube, together with its distributed capacity and the interelectrode

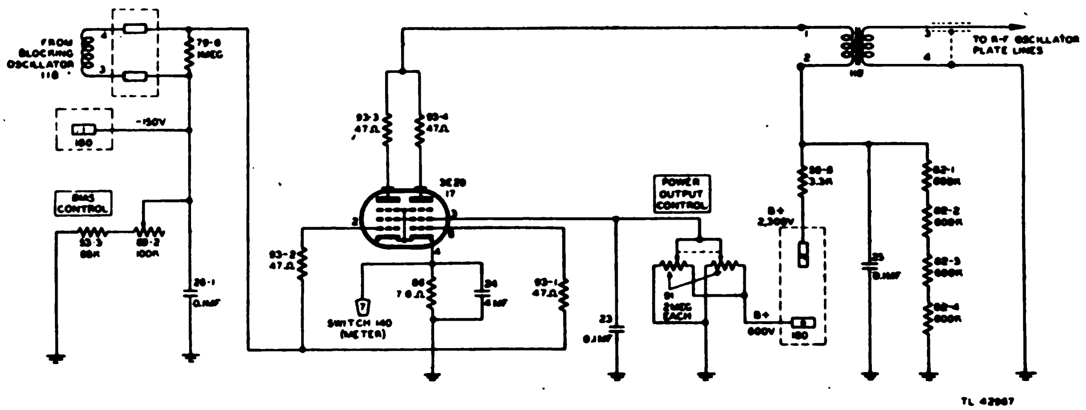


Figure 11. Transmitter, modulator circuit.

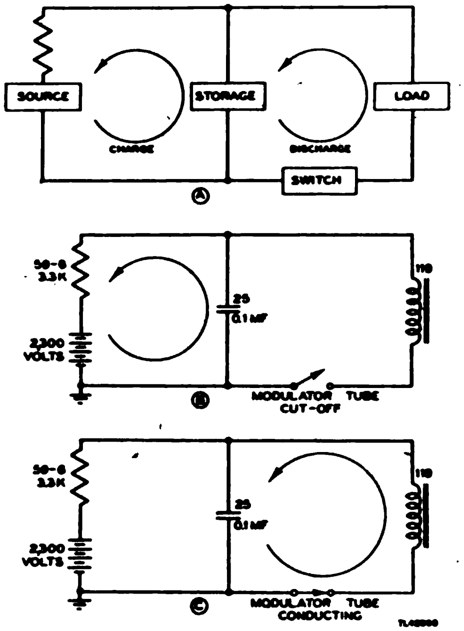


Figure 12. Modulator, equivalent circuit.

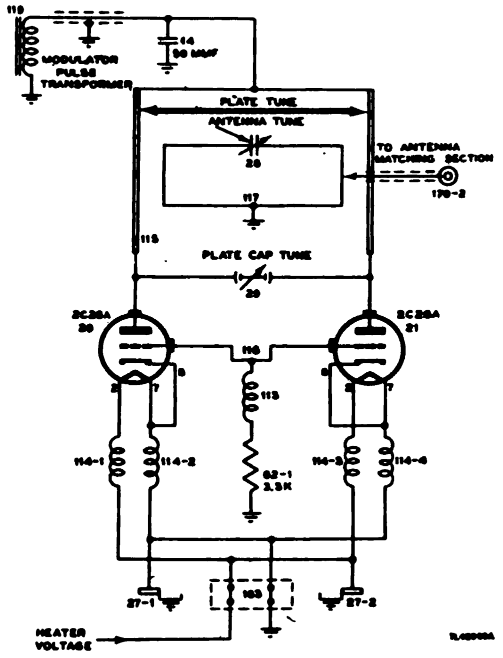


Figure 13. Transmitter, r-f oscillator circuit.

capacitance of the tube, acts like a parallel resonant circuit. The Q of this tuned circuit is high because the resistance due to the skin effect is minimized by using large-diameter, silver-plated rods for the quarter-wave line.

b. Filament and Cathode Circuit. The filament voltage for the tubes comes from the power supply through terminal board 183. Chokes 114-1, 114-2, 114-3, and 114-4 are used to keep radio frequencies out of the power supply. The cathodes of the tubes are connected to one side of the heaters and are grounded through r-f chokes 114-2 and 114-4 and spark plates 27-1 and 27-2. Spark plates are small capacitors riveted to the chassis; they are used throughout the equipment to ground stray r-f voltages.

c. Operation. The operation of this oscillator is similar to that of any tuned-grid, tuned-plate oscillator. The high-voltage pulse from the modulator is applied directly to the plate circuit and causes the circuit to oscillate at radio frequency for the duration of the pulse. When the pulse is removed, plate voltage to the oscillator tubes is removed until the next pulse appears. The feedback necessary to maintain oscillations is obtained by the interelectrode capacitance between the plate and grid of the tube. Resistor 62-1 and the grid-to-cathode capacitance of the tube provide bias for the oscillator. The oscillator is operated with two tubes in push-pull in order to get a large power output. By connecting the tubes in push-pull rather than in parallel, the interelectrode capacitances of the tubes are not added. Therefore the tendency to generate parasitic oscillations is minimized and the frequency range at which the oscillator may be operated is extended.

d. Tuning. The tuning of the lines in the grid and plate circuits determines the frequency of oscillation.

(*1*) *Grid Lines.* The grid lines are broadly resonant over the entire range of operating frequencies. Line 116 (fig. 74) is the inductance of the grid tank circuit. As in the plate tank circuit, the capacitance required is supplied by the distributed capacity of the line and the interelectrode capacitance of the tubes.

(*2*) *Plate Lines.* The electrical length of the plate line is adjusted by means of the adjustable shorting bar. Varying the distance of the shorting bar from the end of the line varies the electrical length of the line and therefore the resonant frequency. This is accomplished by the PLATE adjustment control on the front panel of the transmitter. By means of the shorting bar in the plate line, the frequency of the r-f oscillator can be varied over its entire range of 30 mc; that is, from 157 to 187 mc.

(*3*) *Plate Capacitance Adjustment.* The plate-to-grid capacity of tubes 20 and 21, as explained in subparagraph **a** above, serves to tune the plate line. Since this capacity will vary with individual tubes, variable capacitor 29 has been provided to compensate for these variations. The adjustment is made by means of the screwdriver adjustment on the front panel labeled PLATE CAP. This adjustment makes the actual transmitted frequency correspond with the setting of the PLATE dial as indicated by the calibration chart.

e. Output Coupling. The energy in the plate tank circuit is inductively coupled to the r-f system by the tuned antenna output coupling line which is approximately 1/8 wavelength long. The magnetic field that is set up by the r-f current in the plate tank circuit induces an r-f voltage in the coupling line. Therefore, the coupling line is the tuned secondary of a transformer whose primary is the tuned plate tank circuit. The capacitor placed across the open end of the coupling line is variable and permits the line to be adjusted to the transmitter frequency for maximum transfer of energy. This control is on the front panel and is labeled ANT.

f. R-f Output Cable. The r-f output cable is a coaxial line tapped to the antenna output coupling line by means of a clamp. This clamp is adjusted by the manufacturer for a correct impedance match in order to obtain maximum transfer of energy. The other end of the output cable goes to connector 170-2 from which point it is fed to the antenna-matching section and the r-f system.

15. MONITOR CIRCUITS AND TEST SWITCH 140 (fig. 14).

The monitoring circuits and the TEST SWITCH make it possible to measure the cathode current of modulator tube 17, measure the power output and observe the pulse width of the transmitter, and observe the receiver output.

a. Test Switch in Operate Position. The test switch is spring-loaded so that it remains in the OPERATE position. Part of section 2 of the switch connects the high-impedance output of the receiver to jack 150-3. The low-impedance receiver output is connected to jack 150-2 and, via pin 6 of connector 180 and the video amplifier, to the cathode-ray tube in the control unit. Diode 14 and cathode follower 15 are not used.

b. Test Switch in Ic Position. In this position of the test switch, meter 160 is connected to the cathode of modulator tube 17 by part of section 3 of the test switch and measures the voltage developed across cathode resistor 86. The meter is calibrated in milliamperes so that its deflection indicates the cathode current of tube 17. Part of section 2 of the test switch connects the high-impedance output of the receiver to jack 150-3. The low-impedance output is connected to jack 150-2 and to the video circuits of the control unit via pin 6 of connector 180. Diode 14 and cathode follower 15 are not used.

c. Test Switch in P.O. (Power Output) Position. In this position of the switch, diode 14 rectifies the transmitter output and passes the rectified pulse to cathode follower 15. The output

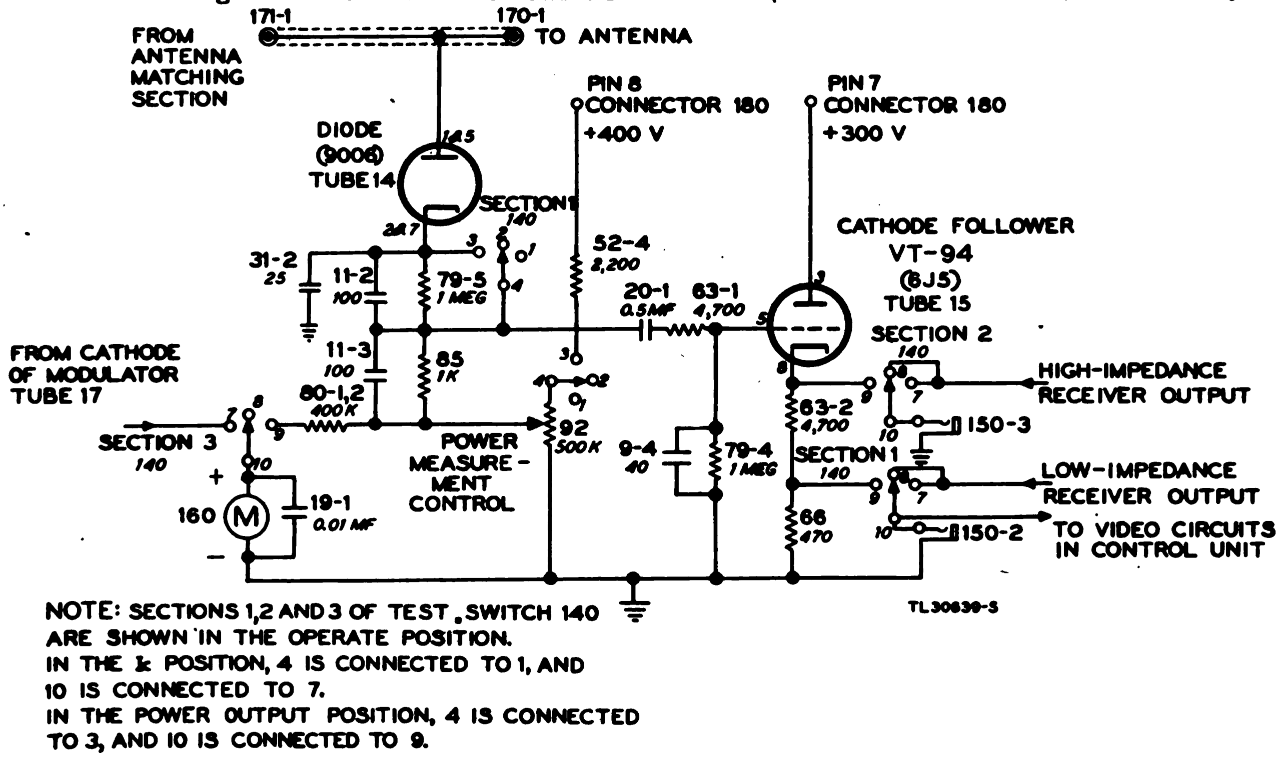


Figure 14. Transmitter, monitoring circuits.

of the cathode follower is fed to jack 150-3, jack 150-2 and through the video circuits to the deflection plates of the cathode-ray tube in the control unit. POWER MEASUREMENT control 92 adjusts the bias on diode 14; when the control is adjusted properly, the diode is biased to cut-off and the transmitter pulse disappears from the cathode-ray tube. Meter 160 reads the voltage across control 92 and is calibrated in kilowatts so that it indicates the power output of the transmitter. The details of the circuit are explained below.

(*1*) In the P.O. position, part of section 1 shorts out resistor 79-5 and capacitor 11-2. The purpose of this resistor and capacitor is to protect the diode and prevent the monitoring circuits from loading the transmitter output when the switch is in the OPERATE or Ic position. This resistor and capacitor have a time constant (RxC) of 100 microseconds. A positive bias voltage is built up across them which limits the conduction of diode 14.

(*2*) With resistor 79-5 and capacitor 11-2 shorted, the detection network for the diode is resistor 85 and capacitor 11-3, which have a 0.1-microsecond time constant. The time constant is long enough to permit rectification of the r-f of the transmitter pulses, but is short enough to preserve the envelope of the pulses.

(*3*) The rectified pulse is fed via capacitor 20-1 and resistor 63-1 to the grid of cathode follower 15. The purpose of capacitors 31-2, 20-1, resistors 63-1, 79-4, and capacitor 9-4 is to filter out r-f ripple in the rectified pulse. The purpose of the cathode follower is to supply a low-impedance output for the rectified pulse so that the pulse can be measured without loading diode 14.

(*4*) Part of section 2 of the test switch connects jack 150-3 to the cathode of tube 15. Part of section 1 of the test switch connects jack 150-2 and the video circuit in the control unit to the junction of resistors 66 and 63-2 in the cathode circuit of tube 15. One-eleventh of the cathode-follower output is available at this point; the output is taken at this low level so that it will not overload the video amplifier in the control unit.

(*5*) The width of the transmitter pulse, as rectified by tube 14, is observed on the oscilloscope in the control unit. The amplitude of the pulse is an indication of the peak power output of the transmitter and is measured with meter 160 and POWER MEASUREMENT control 92.

(*a*) Diode 14 rectifies only when its plate is at a higher potential than its cathode. By measuring and gradually increasing the cathode voltage until the diode no longer conducts, as indicated by the disappearance of the transmitter pulse from the oscilloscope, the peak voltage at the plate of the diode can be measured and thus the peak r-f voltage output of the transmitter is obtained.

(*b*) In the P.O. position a part of section 3 of the test switch connects meter 160, through resistors 80-1 and 80-2, to the movable arm of the POWER MEASUREMENT control. The remainder of section 3 applies 400 volts through resistor 52-4 to the control. As the control is turned clockwise the meter reading increases, the bias on tube 14 increases, and the transmitter pulse disappears from the oscilloscope screen.

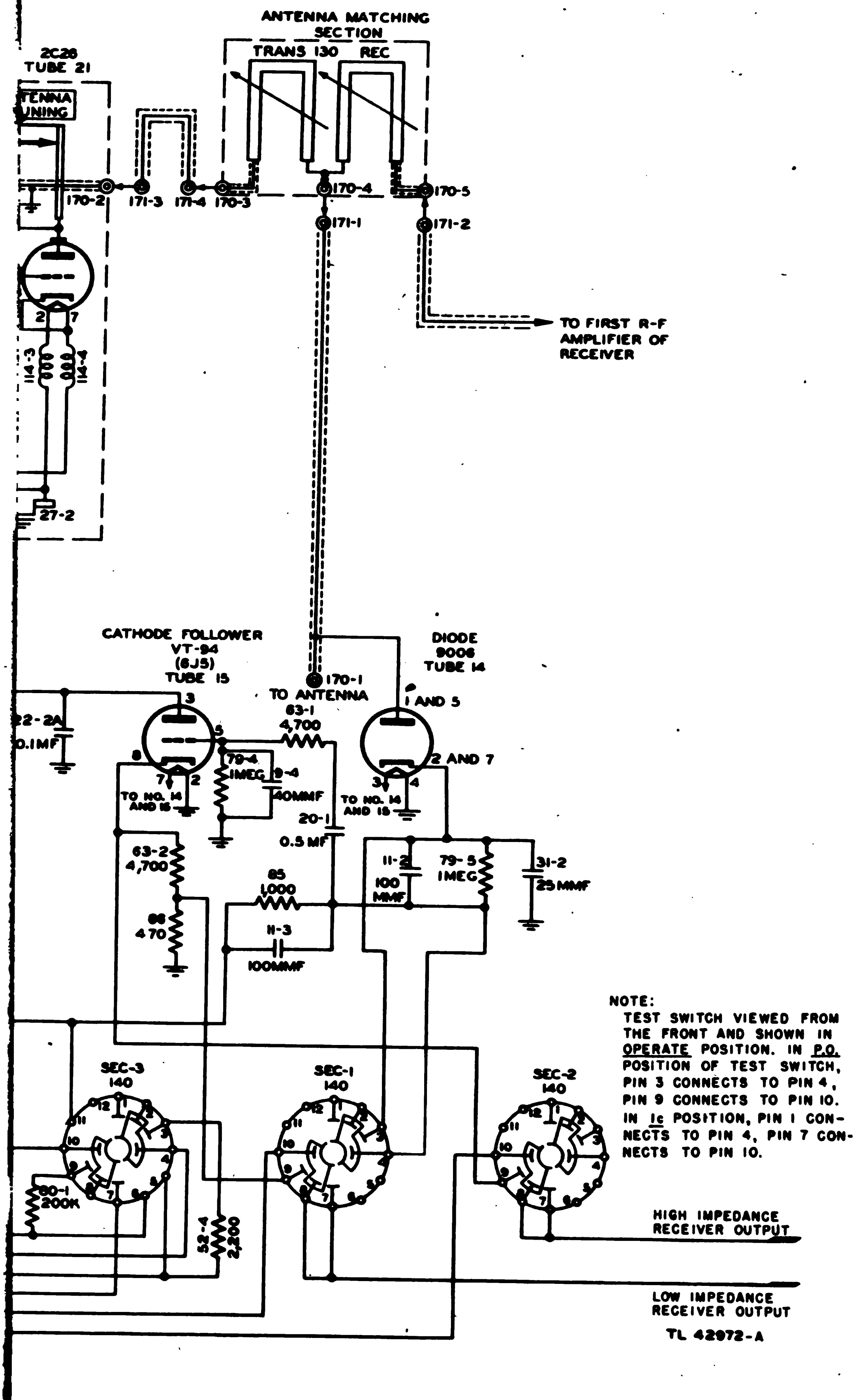
(*c*) The peak power output of the transmitter is proportional to its voltage output and the resistance of its load. The resistance of the transmitter load is known to be 50 ohms. Meter 160 measures the peak r-f voltage output of the transmitter; its scale is calibrated to indicate the peak power output of the transmitter.

16. TEST JACKS.

a. Jack 150-1. SYNC INPUT jack 150-1 (fig. 15) provides a means for observing the synchronizing pulse from the control unit applied to grid 4 of sync amplifier tube 16.

b. Jack 150-2. RECEIVER OUTPUT LOW jack 150-2 is connected by pin 6 of connector 180 to the video circuits of the control unit and provides a means for observing the receiver-transmitter output to the control unit. In the Ic and OPERATE positions of the test switch, part of section 1 of the switch connects the low-impedance output of the receiver to the jack. In the P.O. position of the test switch, part of section 1 of the switch connects the low-impedance output of cathode follower 15 to the jack. The rectified transmitter pulse from diode 14 can then be observed at the jack.

c. Jack 150-3. RECEIVER OUTPUT HIGH jack 150-3 is connected to the high-impedance output of the receiver when the test switch is in the Ic and OPERATE positions. In the P.O. position of the switch, jack 150-3 is connected to the high-impedance output of cathode follower tube 15. The same waveform is always obtainable at jacks 150-2 and 150-3; however, the waveform always has a much greater amplitude at jack 150-3.



e 15. Radio Receiver and Transmitter BC-1267-A, schematic diagram, transmitter section.

CHAPTER 3
RADIO-FREQUENCY SYSTEM

17. INTRODUCTION.

The r-f system carries the outgoing pulses from the transmitter to the antenna which radiates the energy into space. The r-f system also carries back to the receiving system any return pulses picked up by the antenna. The components of the r-f system are the antenna-matching section, the flexible coaxial transmission line, and the antenna system. The antenna system includes the Remote Antenna Drive RM-55 and its associated flexible drive cable, Tower TR-29, and Antenna Assembly AS-109/TP. The components of the r-f system are shown in figures 17, 18, 22, and 23.

18. BLOCK DIAGRAM OF R-F SYSTEM.

The simplified block diagram (fig. 16) shows

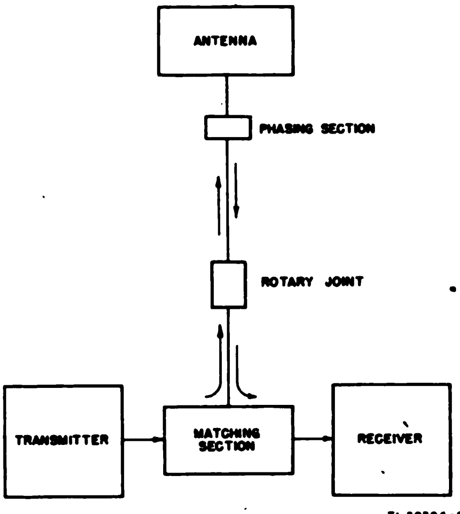


Figure 16. R-F system, block diagram.

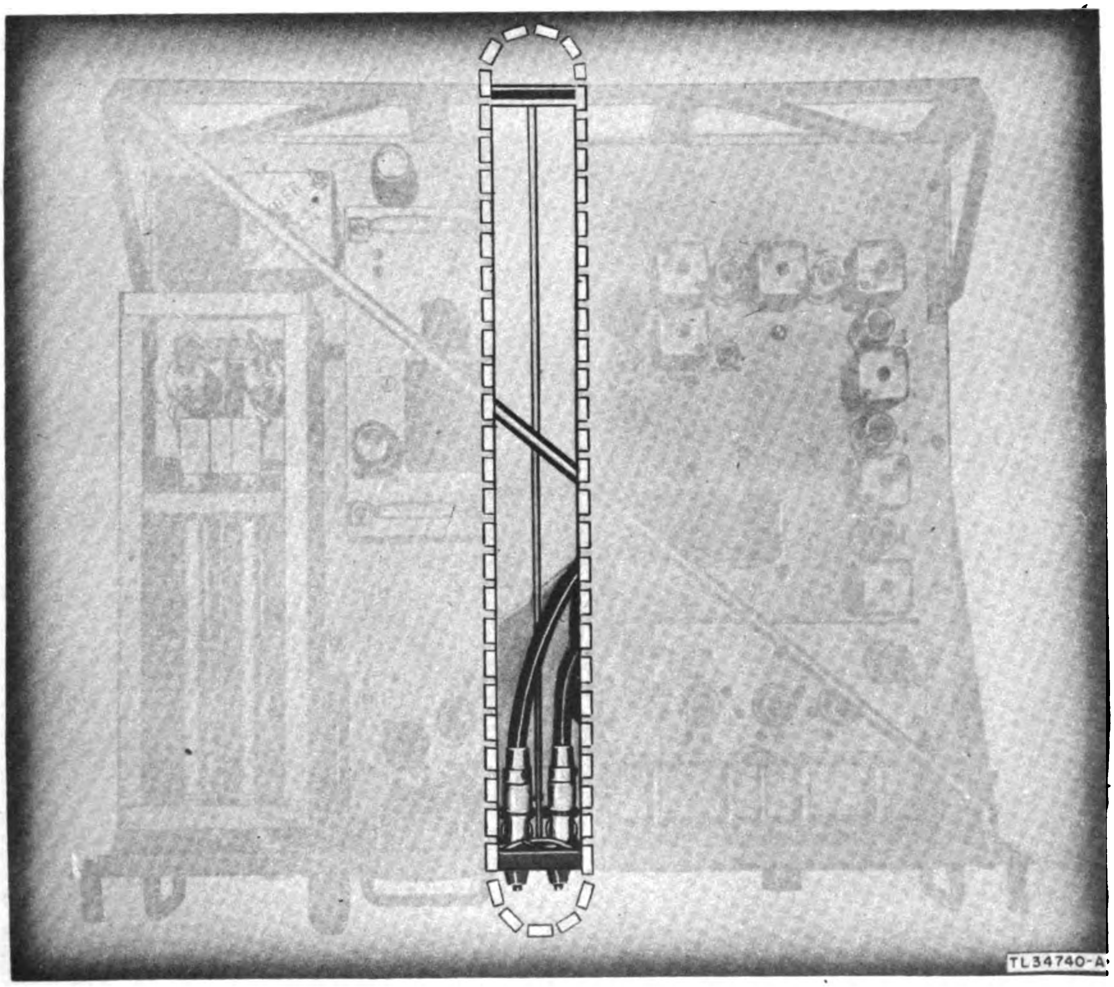


Figure 17. Radio Receiver and Transmitter BC-1267-A, top view, antenna-matching section.

the elements of the r-f system and their relationship to the transmitting and receiving systems.

a. Antenna-matching Section. The antenna-matching section (fig. 17) consists of two folded lines so arranged that their lengths may be varied. The purpose of the antenna-matching system is not only to match the impedance of the receiver and transmitter to the impedance of the transmission line, but also to keep the transmitted energy out of the receiver and to prevent received energy from being lost in the transmitter. The two latter functions allow the use of a single antenna for both receiving and transmitting.

b. Phasing Section. The phasing section or J-section is a loop of flexible coaxial cable 1 wavelength long (fig. 18). It is used to connect the flexible coaxial transmission line to the two dipole feed lines and to maintain proper phase relationship between the two parallel feeders.

c. Antenna Assembly. Antenna Assembly AS-109/TP (fig. 18) is a directional array composed of two folded vertical half-wave dipoles fed by the phasing section. Three reflectors are mounted behind each dipole. The dipoles are so designed that they transmit and receive efficiently throughout the frequency range (157 to 187 mc) of the IFF equipment. All coaxial cable connections on the antenna assembly are inclosed in small polystyrene blocks for moistureproofing. The antenna assembly is mounted on a 16-foot tower (Tower TR-29), which is rotated by means of a flexible drive cable and a hand-driven gearbox (Remote Antenna Drive RM-55).

19. FUNCTIONING OF PARTS.

a. Antenna-matching Section (fig. 19).

(*1*) To effect a maximum transfer of energy between the receiver and transmitter and the transmission line, the impedance of the receiver and transmitter must be matched to the impedance of the transmission line. This is done by the antenna-matching section which consists of two adjustable quarter-wave folded lengths of line. The 52-ohm coaxial transmission line is connected to the closed end of the antenna-matching section and the receiver and transmitter are connected, one to each open end (fig. 19), points B and A respectively. The antenna-matching section is made adjustable by a sliding rod arrangement so

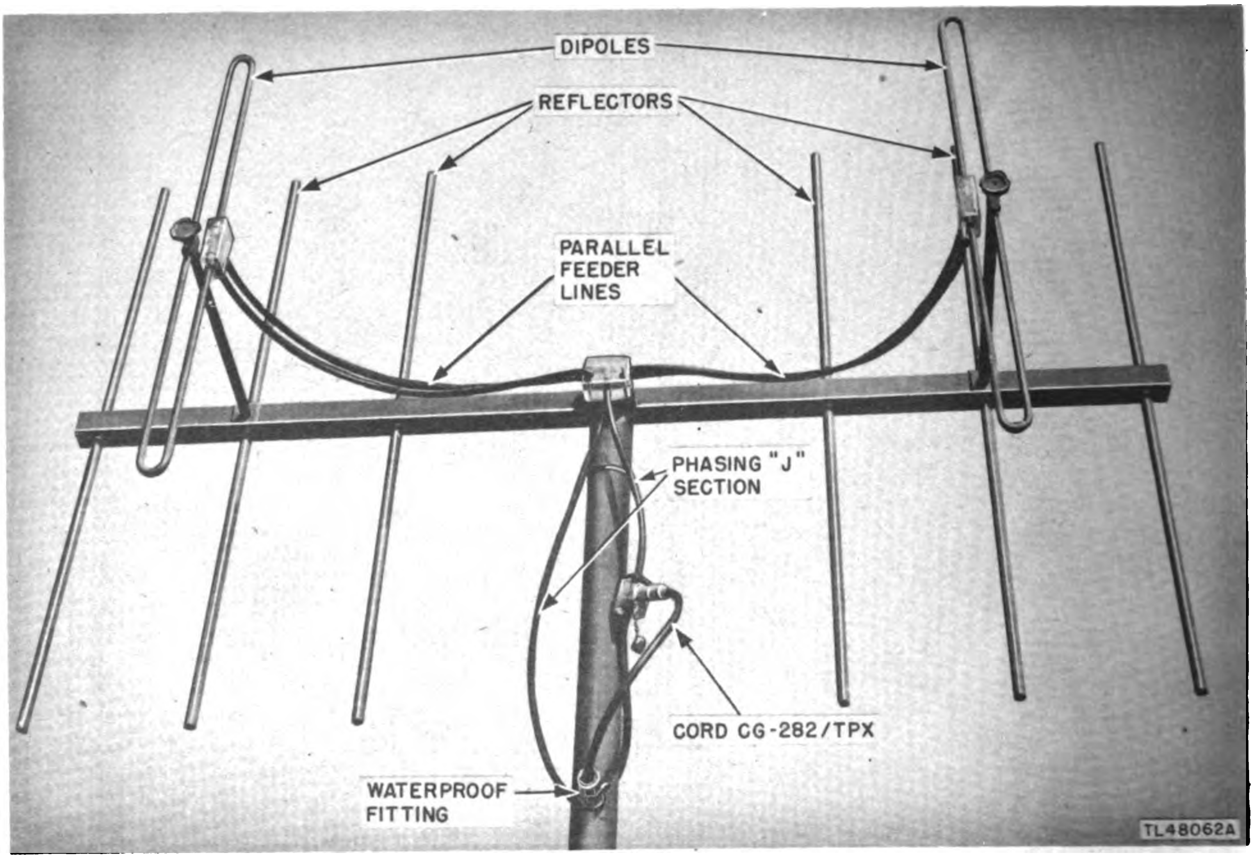


Figure 18. Antenna Assembly AS-109/TP.

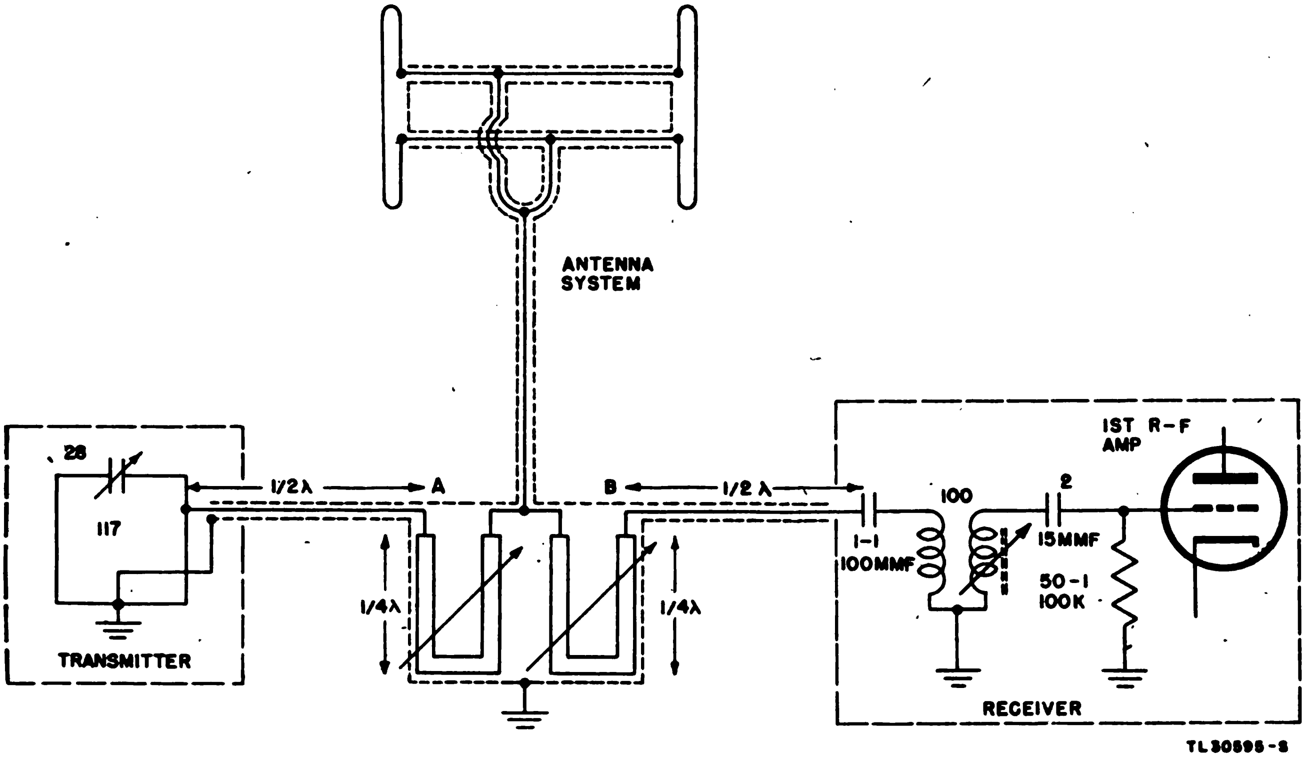


Figure 19. R-F system, schematic diagram.

that the impedance which appears at the common end of the matching section can be varied to match the impedance of the transmission line at any frequency between 157 and 187 megacycles. The variable section has sufficient range of adjustment to keep the total length of the fixed flexible coaxial cable plus the variable matching section approximately 1 wavelength long for any frequency from 157 through 187 mc. This variation requires a change of approximately 12 inches in length, but because the sections are folded, a 6-inch change is sufficient. To insure ample adjustment range, the antenna-matching section permits a variation slightly greater than 7 inches in length.

(*2*) Because a common antenna is used for both transmitting and receiving, the transmitter and receiver are connected into a common transmission line through the antenna-matching network. To prevent the high-power transmitter pulse from being conducted directly into the receiver during the transmitting cycle and damaging the receiver, and to prevent the received energy from being lost in the transmitter during the receiving cycle, some means must be provided to block alternately the receiver and transmitter from the transmission line. This is effectively accomplished by the half-wavelength of flexible coaxial line and the folded half-wavelength of the matching section which are connected between the receiver and transmitter and the transmission line. During the receiving cycle the output impedance of the transmitter is high because the oscillator tubes are not conducting. This high impedance is reflected ½ wavelength away to point A (fig. 19) and an additional ½ wavelength to the point where the transmission line joins the common end of the matching section. This causes the impedance, looking into the transmitter side of the matching section, to appear high so that the received energy is shunted to the receiver portion of the matching section where it is conducted to the input circuit of the receiver.

(*3*) When the transmitter fires, the r-f energy appearing at the grid of the first r-f amplifier stage in the receiver (fig. 19) causes grid current to flow. Capacitor 2 charges rapidly, biasing the grid near cut-off. This occurs at the start of the transmitter pulse and the bias is maintained for the remainder of the pulse because the capacitor discharge path is through the relatively high resistance of resistor 50-1. Thus the tube presents a high input impedance which is reflected through the receiver portion of the matching sections so that the receiver appears as a high impedance at the common antenna junction. The antenna and transmitter are therefore matched while the transmitter and receiver are mismatched so that most of the r-f energy goes to the antenna.

b. Transmission Line. The r-f transmission line consists of two 25-foot lengths of RG-8/U flexible coaxial cable. The cable is made up of a stranded copper inner conductor and a layer of insulating material covered with a flexible copper braid which serves as an outer conductor. The outer conductor is covered with neoprene insulation. The characteristic impedance of the line is approximately 52 ohms. This impedance value is matched to the antenna by connecting it to the 52-ohm J phasing section. The other end of the line is matched to the receiver-transmitter through the antenna-matching section (subpar. a (*1*) above). Thus the line operates as an efficient low-loss nonresonant line.

CAUTION: In cold weather, be sure the flexible coaxial transmission line is at room temperature before uncoiling or handling. At low temperature the insulating material becomes less flexible and may crack.

c. Phasing Section. The parallel feeder line of the antenna assembly is fed through a phasing section or J section (fig. 20), which is a loop of coaxial cable 1 wavelength long. The phasing section is fed at point A, ¼ wavelength from one end. The maximum voltage difference that can be obtained between two equal voltages is obtained when the voltages are 180° out of phase. The phasing section is used to produce this desired condition. The distance from point A to C is ¾ wavelength, or ½ wavelength longer than the distance from point A to B. Consequently, the signal traveling the path from A to C will lag the signal traveling from A to B by 180°. Thus the voltages produced at points B and C with respect to ground will be 180° out of phase. The voltage between B and C is therefore at a maximum and the greatest amount of energy is applied to the balanced 104-ohm coaxial line.

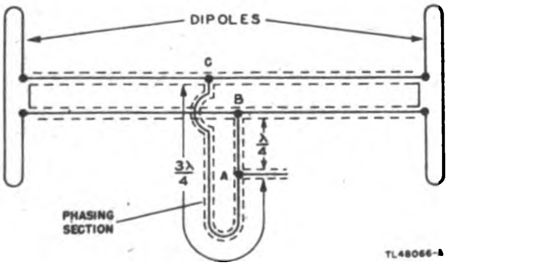


Figure 20. Antenna Assembly AS-109/TP, schematic diagram.

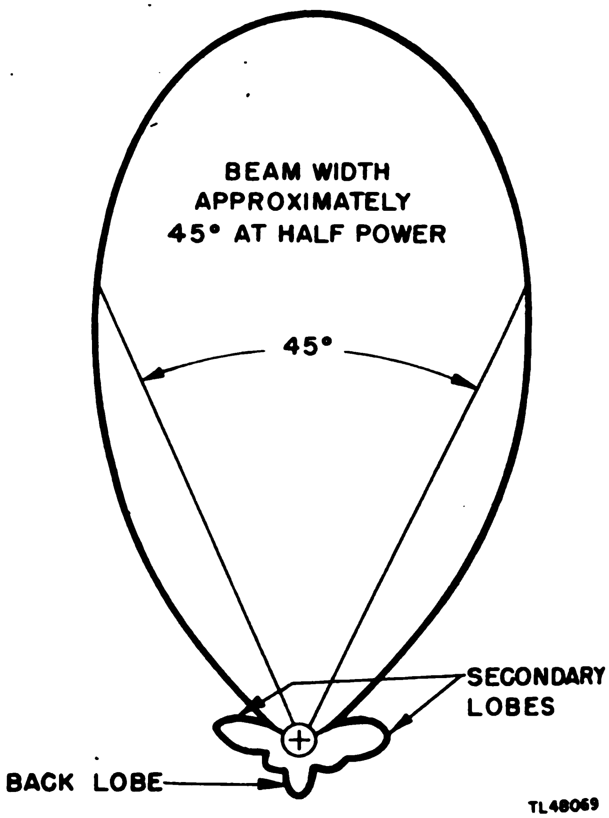


Figure 21. Antenna Assembly AS-109/TP, lobe pattern.

d. Antenna Assembly (fig. 20). The folded dipoles of the antenna assembly are approximately 31 inches long and are vertically mounted 42 inches apart. The six reflector rods are approximately 39½ inches long and are mounted in two groups, three behind each dipole. The two dipoles are fed in parallel by a 104-ohm coaxial line which is made up of two 52-ohm coaxial lines. Since the impedance between the center conductor and the outer conductor of each line is 52 ohms, and the outer conductors of both lines are connected together, the series impedance between the two center-conductors is 104 ohms. The phasing section connects to the 104-ohm line at the exact center and consequently the dipoles are fed in phase. This phase relationship in conjunction with the spacing between all parts of the assembly provides the directional characteristic of the antenna. The directional characteristics of the antenna are shown in figure 21 and are listed below:

(*1*) *Beamwidth.*
Horizontal plane—approx. 45°.
Vertical plane—approx. 70°.

(*2*) *Amplitude of Secondary Lobes.*
172 mc—approx. 12 percent of main lobe.
187 mc—approx. 21 percent of main lobe.

(3) *Amplitude of Back Lobes.*
172 mc—approx. 8 percent of main lobe.
187 mc—approx. 24 percent of main lobe.

e. Tower TR-29 (fig. 22). The tower consists of a three-section 16-foot mast mounted on a triangular base and supported by three guy cables. The guy cables fasten to a floating-type bearing on the top mast section and are secured to the ground with screw-in anchors. The base is staked to the ground and has a hinge pin and wingnut for fastening the mast in place. Rotation of the tower is controlled by a remote antenna drive.

f. Remove Antenna Drive RM-55 (fig. 23). The remote antenna drive is a hand-operated gearbox which is mounted on the side of Rack FM-93. The gear drive ratio is 1:2½, so that 20 rotations of the hand crank produce 50 rotations of the flexible shaft and one rotation of the antenna. The antenna end of the flexible drive is connected to a 50:1 worm and gear drive which turns the antenna mast. A 20:1 worm and gear drive is also contained in the remote drive to turn the azimuth indicating dial once for each rotation of the antenna. A dial lamp is included in the box to illuminate the dial for about 50 mils on each side of the azimuth pointer. Zero adjustment of the azimuth dial is made by removing the metal cap over the zero adjustment knob and by depressing and turning the knob until the azimuth pointer indicates the correct reading (fig. 23).

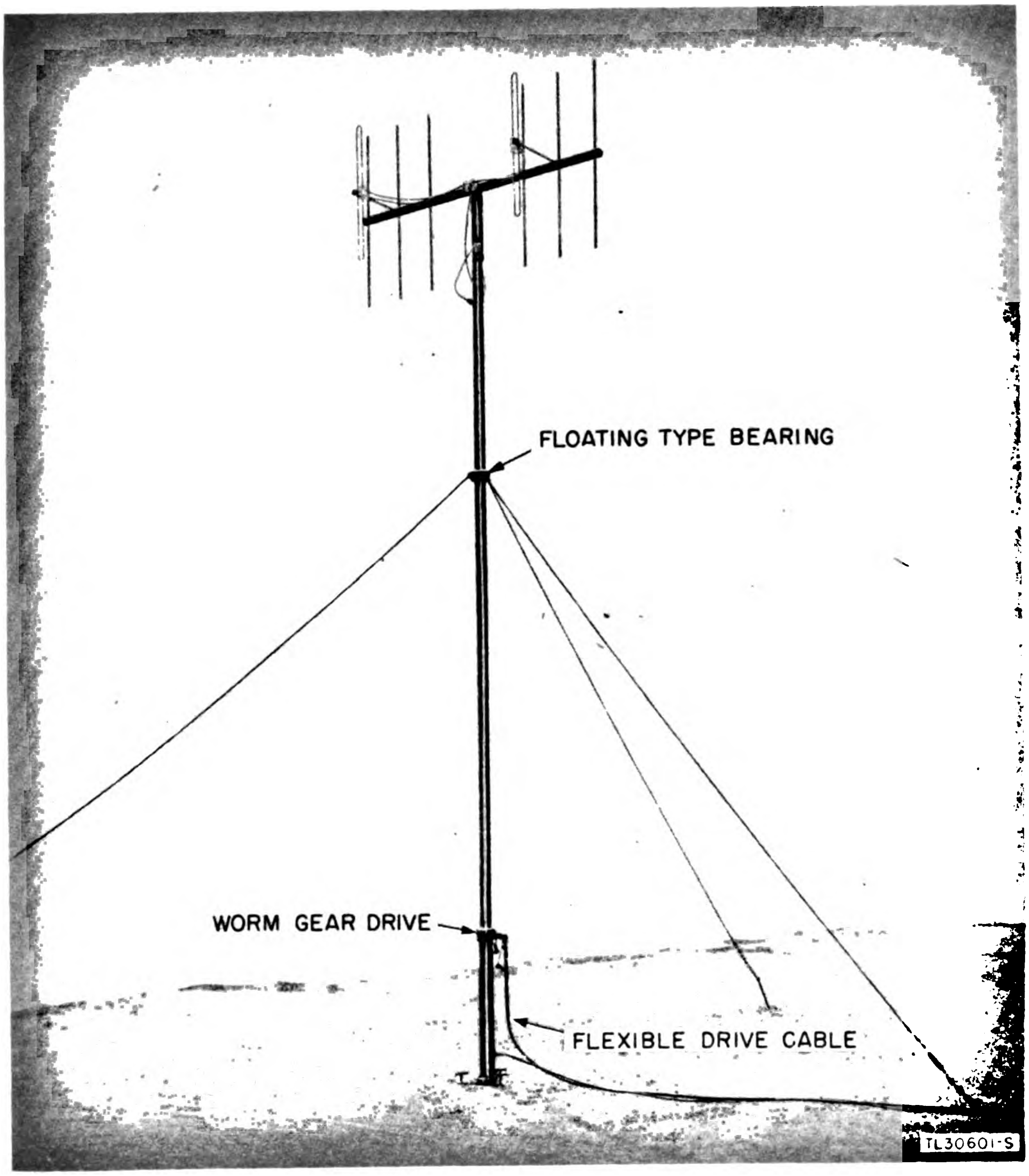


Figure 22. Tower TR-29, antenna in place.

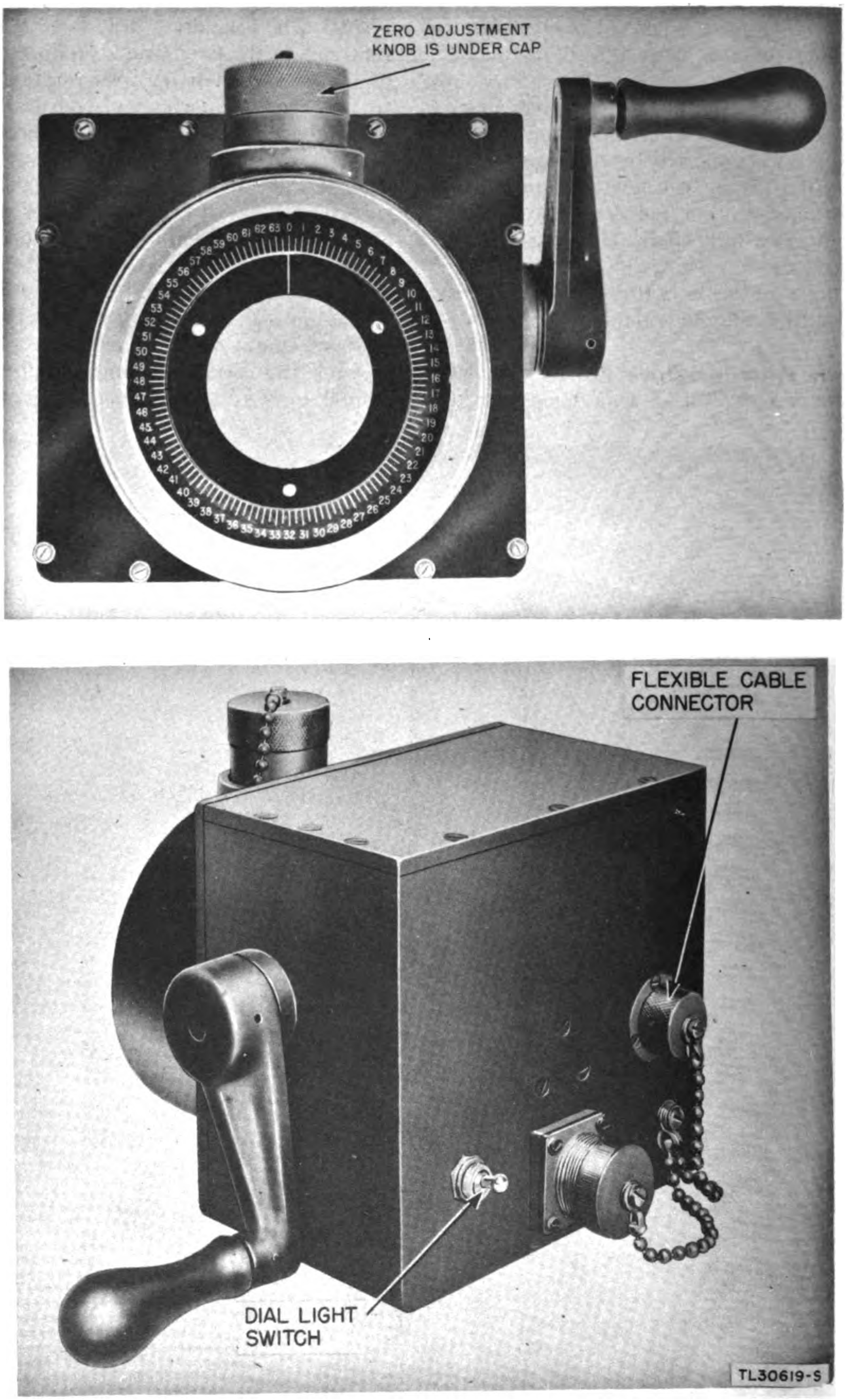


Figure 23. Remote Antenna Drive RM-55, front and rear views.

CHAPTER 4
RECEIVER SYSTEM

20. PURPOSE.

The function of the receiver is to detect and amplify signals picked up by the antenna and to apply them to the display tube of the control unit.

21. GENERAL DESCRIPTION.

The receiver is a 13-tube superheterodyne consisting of five sections: r-f section, i-f (intermediate-frequency) section, detector section, video section, and tuning indicator section. All d-c and filament voltages for the receiver are supplied by Power Supply RA-105-A. The following discussion is based on the block diagram (fig. 25). Circuit details are described in paragraphs 22 through 28.

a. R-f Section. The r-f section consists of two r-f amplifying stages, local oscillator and mixer. Reply signals from the transpondor picked up by the antenna are fed through the antenna-matching section to the r-f section of the receiver. Here the signals are amplified and mixed with the heterodyning signal from the local oscillator to obtain an 11-mc intermediate frequency.

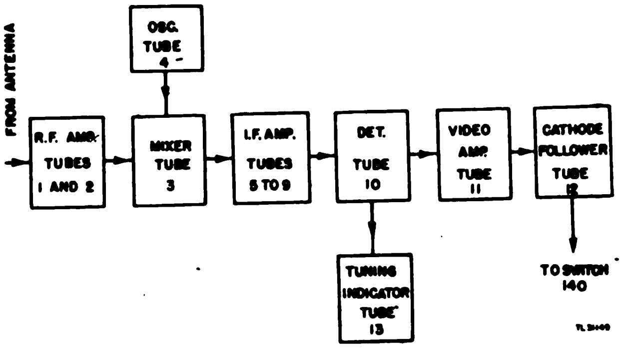


Figure 25. Receiver system, block diagram.

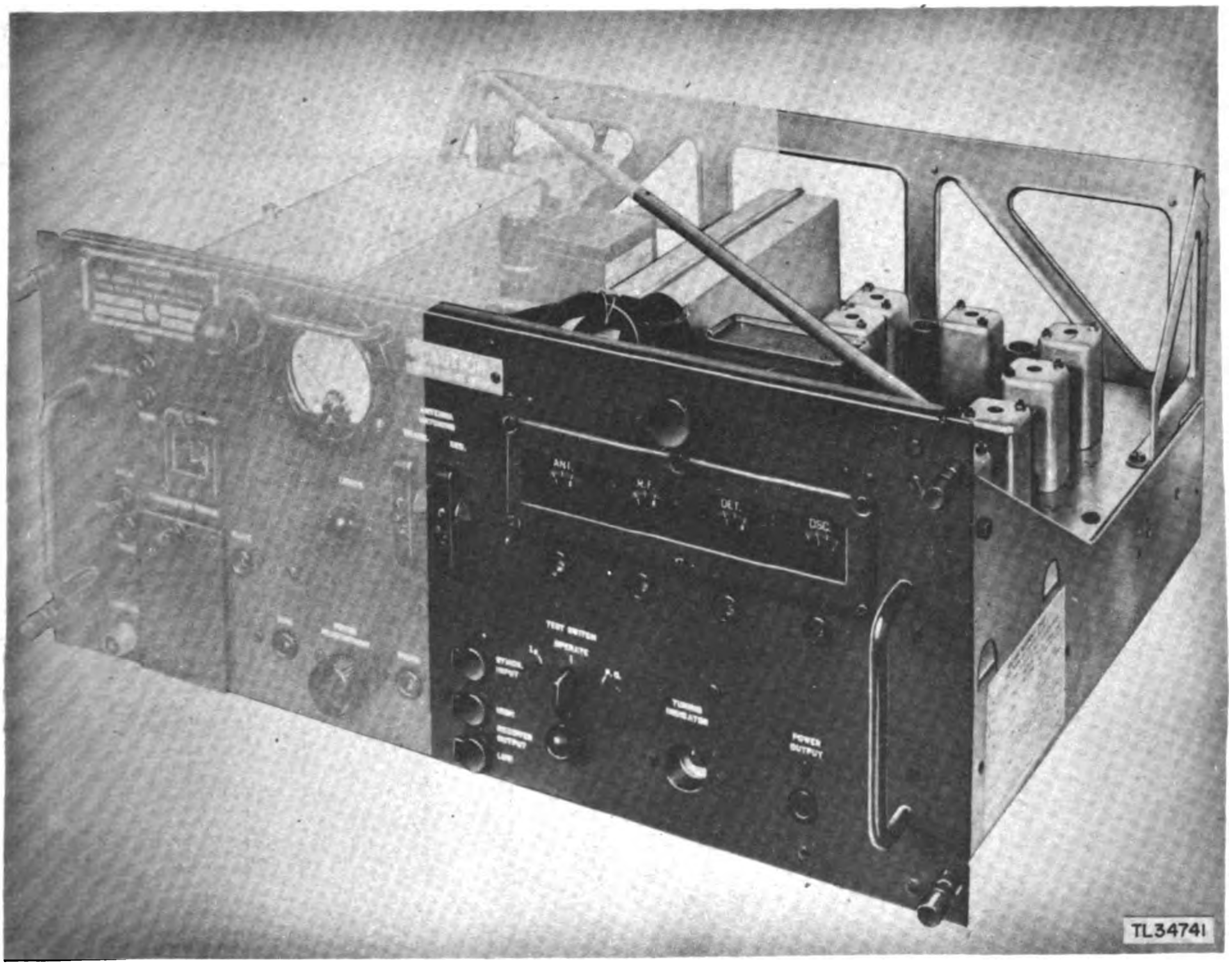


Figure 24. Radio Receiver and Transmitter BC-1267-A, front oblique view, receiver section.

b. I-f Section.

(*1*) This consists of five i-f amplifiers which amplify the 11-mc signal from the r-f section.

(*2*) The i-f amplifiers are stagger-tuned, that is, they are aligned or tuned to frequencies slightly above and below the middle frequency of 11 mc. The over-all bandwidth of the i-f section is 4 mc.

c. Detector Section. The output of the i-f section is fed to a double-diode detector. One of the diodes functions as a detector for the signal output which is further amplified by the video section. The other diode is used to detect a part of the signal and operate the tuning indicator section of the receiver.

d. Video Section. The video section consists of a video amplifier and a cathode follower. This section inverts and amplifies the signal pulses from the detector section and feeds its output to the control unit video stage.

e. Tuning Indicator Section. The tuning-eye indicator tube receives the output of the tuning indicator section detector. Proper over-all tuning of the r-f and i-f sections is indicated by obtaining as narrow a shadow on the tube as possible.

22. FIRST AND SECOND R-F STAGES.

a. Input Circuit. The r-f signal from the antenna is coupled to the grid of the first r-f amplifier, tube 1, through the antenna-matching section, connector 171-2, the antenna coupling capacitor 1-1, and antenna tuning transformer 100 (fig. 26). The coaxial line from the antenna-matching section is soldered directly to capacitor 1-1. The input impedance of the line is approximately 50 ohms. The primary of antenna tuning transformer 100 consists of a half turn of silver wire placed around the secondary of the transformer. One end of the primary is grounded; the other end is in series with capacitor 1-1, forming a series resonant circuit broadly tuned to the middle of the 157-187-mc band. The secondary of antenna tuning transformer 100 is coupled through capacitor 2 and grid leak resistor 50-1 to the first r-f amplifier. This coil is permeability tuned by means of ANT. control on the front panel. The cathode of the first r-f amplifier is connected to the gain control (par. 25*c*) through resistor 51-1.

b. Permeability Tuning. Tuning coils in the receiver are reactance or permeability tuned. In the r-f section, the powdered-iron cores inside

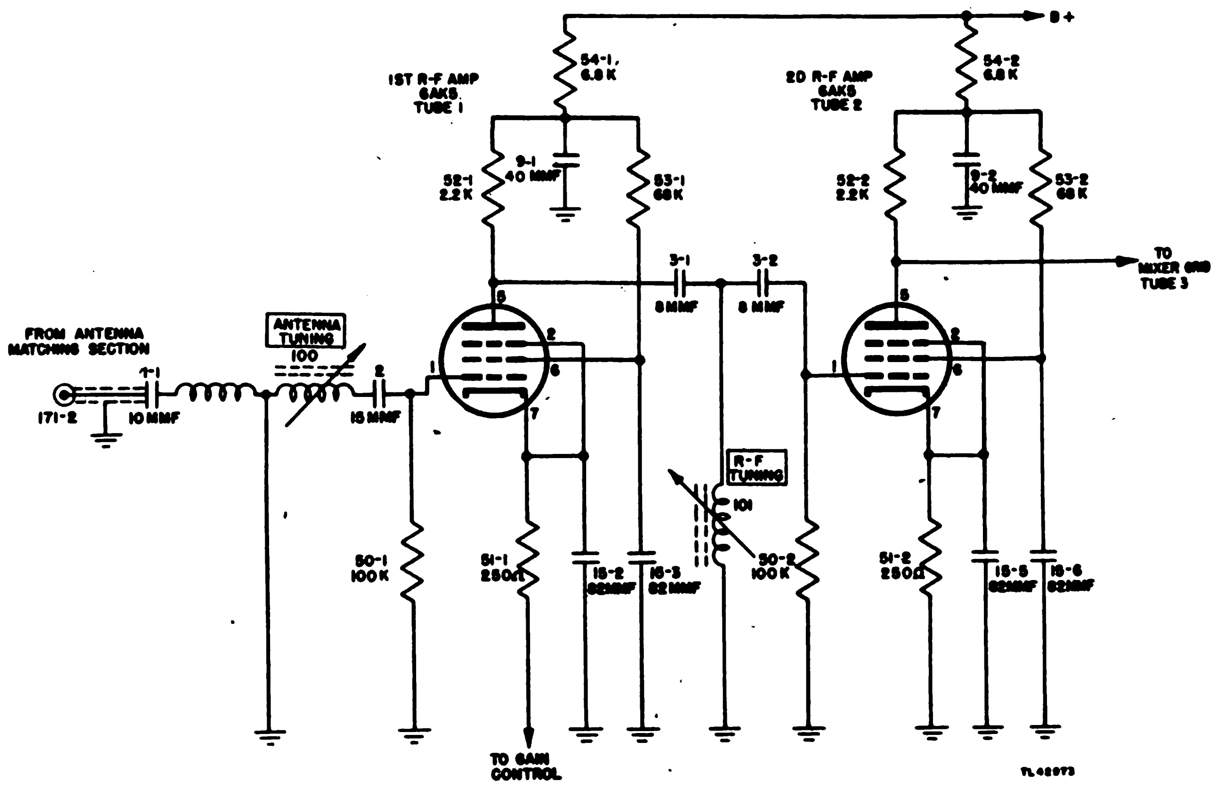


Figure 26. Receiver system, r-f amplifier circuit.

coils 100, 101, 102, and 103 are mechanically adjusted at the front panel by the controls below ANT., R.F., DET., and OSC. dials. Coils 106, 107, 108, 109 and 110 in the i-f section and coils 111 and 112 in the detector section are manually tuned from the top side of the chassis. The inductance of these coils is increased as the tuning slug or core is inserted further into the coil winding. The capacitance in the circuit is the distributed capacity of the coil windings and the inter-electrode capacity of the tube.

c. Output Circuit. Capacitors 3-1 and 3-2 couple the output of the first r-f stage to the grid of the second r-f amplifier. Tuning coil 101 is the plate load for the first r-f stage. Resistor 50-2 is the grid leak for tube 2; tuning coil 102 is its plate load. Capacitors 3-3 and 3-4 (fig. 27) couple the stage to mixer tube 3.

23. LOCAL OSCILLATOR.

The local oscillator is a modified Colpitts oscillator circuit. Coil 104 is resonant below the lowest operating frequency of the oscillator and therefore can be considered a capacitor, as shown in the equivalent circuit (fig. 28). The frequency of the oscillator is determined by the capacities of

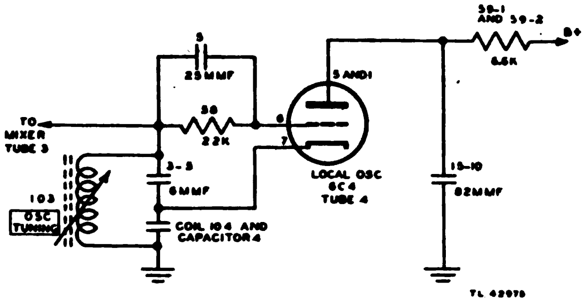


Figure 28. Receiver system, equivalent Colpitts oscillator circuit.

coil 104 and capacitors 4 and 3-5 in parallel with OSC. TUNING 103 which is permeability tuned. Capacitor 5 and resistor 58 form the bias circuit. Capacitor 5 has no appreciable effect on the resonant circuit because of its relatively large capacity. Resistors 59-2, 59-1, 59-3 and 59-4 are voltage dropping resistors and capacitor 15-10 is the plate bypass capacitor. At the low-frequency end of the band, it is possible to tune the oscillator to two frequencies, one above and the other below the signal frequency. Therefore, the tuning dials on the front panel should always be set to the same numbers when tuning the other receiver circuits. The output of the local oscillator is capacitively coupled to DET. TUNING coil 102 (fig. 27).

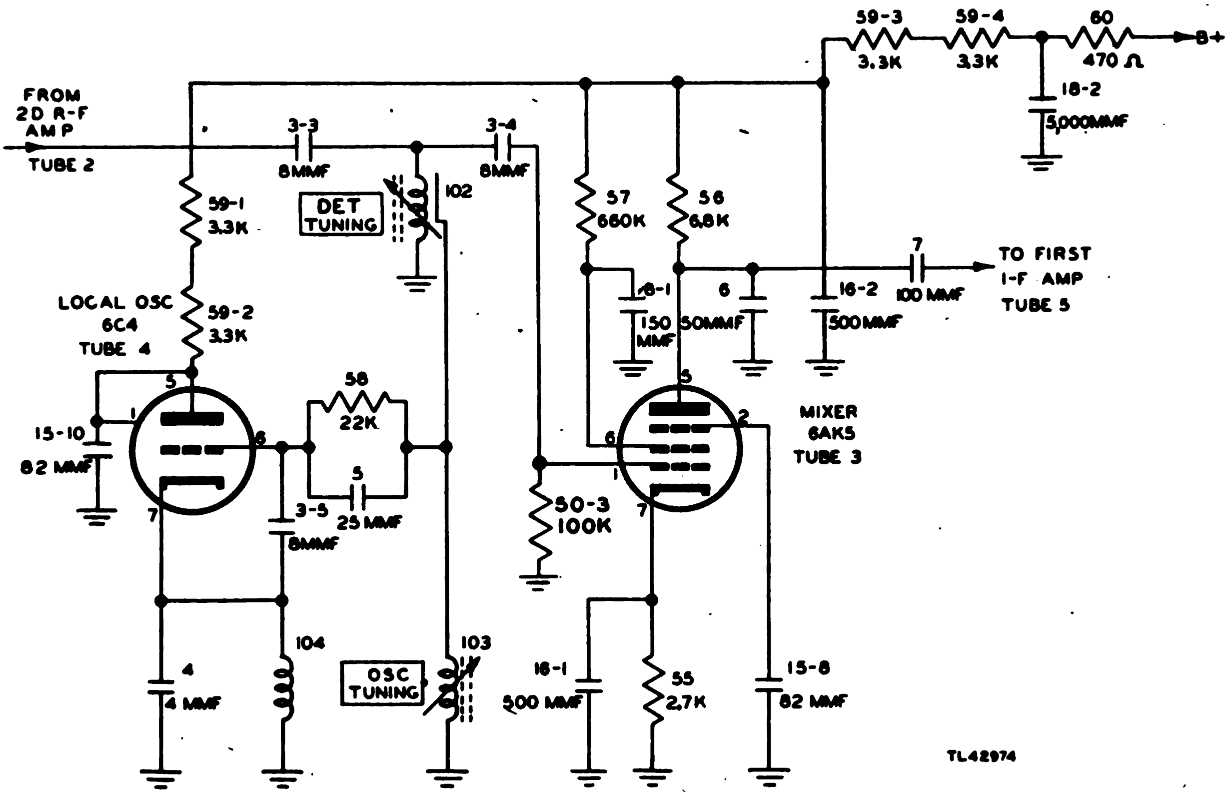


Figure 27. Receiver system, local oscillator and mixer circuits.

24. MIXER STAGE.

a. General. The mixer stage (fig. 27) uses a 6AK5 pentode (tube 3) for heterodyning the local oscillator and the r-f signal. The two signals are mixed on the control grid and filtered in the plate circuit to obtain the intermediate frequency of 11 mc. The output of the mixer tube is coupled to the grid of the first i-f amplifier tube 5.

b. Operation. The output of the second r-f amplifier is coupled to the grid of mixer tube 3 through coupling capacitors 3-3 and 3-4 (fig. 27). The local oscillator signal is capacitively coupled through coil 102 and capacitor 3-4 to the grid of the mixer. Resistor 50-3 is the grid leak resistor. The two frequencies are mixed in the tube and filtered at the plate by r-f choke 121 (fig. 29) and capacitors 6 and 16-2 (fig. 27) to give the 11-mc intermediate frequency in the first i-f tuning coil 106. Resistor 56 is the mixer plate load resistor.

c. Intermediate Frequency. The 11-mc intermediate frequency is the difference frequency obtained by beating the r-f input signal (157 to 187 mc) against the output (146 to 176 mc) of the local oscillator. R-f filter choke 121 (fig. 29), together with capacitors 6 and 16-2 (fig. 27), filters all components from plate to ground except the 11-mc intermediate frequency. For example, if the incoming signal is 167 mc, the local oscillator is tuned to 156 mc. This signal combines with the incoming r-f signal and produces a difference frequency of 11 mc.

25. I-F SECTION.

a. General. All the i-f stages are similar except for the gain control in the first three stages, the fixed bias in the fourth and fifth stages, and the resistive plate load in the fifth stage. The stages are all permeability tuned by coils 106, 107, 108, 109, and 110 (fig. 29). Capacitance for the tuned circuits is obtained from capacitors 1-2, 1-3, 10-1, 10-2 (fig. 29), and 10-3 (fig. 30) across the coils in conjunction with the distributed capacitance of the circuit. The i-f signal is impressed on the grid of the first i-f amplifier through filter choke 121, and is amplified by the five i-f stages. Capacitors 17-1, 17-2, 17-3, 17-4 (fig. 29), and 17-5 (fig. 30) are interstage coupling capacitors. Capacitors 18-3, 18-4, 18-5, 18-6, and 18-7 are plate bypass capacitors used to keep the i-f out of the B+ supply.

b. Broad Bandpass. The coupling and plate bypass capacitors have negligible reactance at the intermediate frequency and therefore act as low resistance paths for the i-f signal. This effectively places the grid leak resistors 61, 76, 77, 64, and 87 (fig. 29) across the i-f tuning coils, tending to dampen the sharpness of tuning and broaden the response of the tuned circuit. This detuning and staggered tuning arrangement of the i-f stages gives a broad bandpass to the i-f section. The alignment frequencies for the i-f coils are given in paragraph 74**d**, table IV.

c. Gain Control. The receiver output is manually controlled by SENSITIVITY control 98 on the front panel of the control unit (fig. 29). This is a variable resistor connected in parallel with resistor 50-5 in the cathode circuit of the first r-f and first three i-f amplifiers (fig. 32). Increasing the resistance (rotating the SENSITIVITY control counterclockwise) puts relatively large positive voltages on the cathodes of tubes 1, 5, 6, and 7, reducing the amplification of these stages. Decreasing the resistance (rotating the SENSITIVITY control clockwise) reduces the grid bias and increases the gain of the stages. The gain of each i-f stage is approximately 12, but because of staggered tuning, the effective over-all gain of the individual stages is about 8 per stage.

d. Fourth and Fifth I-F Stages. The fourth and fifth i-f stages (tubes 8 and 9) are essentially the same as the three preceding i-f stages with the following exceptions: resistors 73-2 and 73-3 (fig. 29) provide a fixed bias of 1.5 volts d-c on the cathode of both stages whereas the bias of the first three stages is controlled by the gain control; the fifth i-f amplifier is resistance loaded by resistors 62-2 and 62-3. Tuning coil 111 and tuning capacitor 10-3 are in the cathode circuit of the diode detector. Capacitor 17-5 (fig. 30) is the coupling capacitor between the fifth i-f amplifier and the detector section.

26. DETECTOR SECTION.

a. General. A double diode, tube 10, is used as a detector (fig. 30). One section of the diode supplies the signal output to the video stage; the other section detects a part of the i-f signal for the tuning indicator.

b. Video Section Detector. The input to the double diode consists of pulses of i-f signal from the output of the fifth i-f amplifier. Capacitor 17-5 (fig. 30) is the coupling capacitor between the fifth i-f amplifier and the cathode of the detector. The tuned circuit consisting of coil 111 and capacitor 10-3 is in the detector section cathode circuit. Alternations of polarity of i-f signals make the cathode alternately positive and negative, allowing the detector section to conduct on negative half-cycles only. Sharp negative video output pulses at the plate are developed across diode detector load resistor 54-3 and capacitor 9-3. The output to the video amplifier is taken off at the plate through resistor 70-1 in series with the plate, damping parasitic oscillations in the diode output. I.F. OUTPUT jack 151-2, in series with load resistor 54-3 and bypassed by capacitor 12-17, is used to measure the output of the i-f section.

c. Tuning Indicator Section Detector. Resistor 50-4 is a dropping resistor that taps off a part of the incoming i-f signal at the cathode of the video section detector. Tuning coil 112 and capacitor 1-4 comprise a tuned circuit for the tuning section of the diode. The output is fed directly to the tuning-eye grid (tube 13).

27. TUNING INDICATOR SECTION.

The output from the plate of the tuning indicator section detector is essentially a d-c voltage of negative polarity. The R-C network, resistor 69 and capacitor 13-5 (fig. 30), has a very high time constant so that a d-c potential is obtained which is an indication of the amplitude of the video signal. Tuning-eye tube 13 is essentially a triode with a fluorescent target placed around an upper extension of the cathode. Between cathode (pin 5) and target (pin 4), there is a small ray-control electrode connected to the plate (pin 2) and held at target potential when no plate current is flowing. The target glows green as electrons passing the plate strike the fluorescent screen. With plate current flowing, the ray-control electrode between cathode and target has a lower potential than the target because of the voltage drop across resistor 75. This impedes electron flow to the target causing a shadow on the fluorescent screen. More negative voltage applied to the grid of the tuning eye from the tuning-eye section of the detector results in less electron flow through the tube, a smaller drop across resistor 75, and a smaller shadow on the screen. Therefore, an increased i-f signal will result in a very small shadow or no shadow, and the target will be completely green. Tuning adjustments are made to get as narrow a shadow as possible.

28. VIDEO AMPLIFIER AND CATHODE FOLLOWER.

a. Video amplifier tube 11 is a conventional resistance-coupled amplifier using a 6AG5 tube to give a broad frequency response of 100 to 250,000 cycles per second. Sharp negative pulses from the video-section detector are coupled to the grid through capacitor 20-2 (fig. 31). Resistor 88-1 is the grid leak resistor and resistor 73-1 is the cathode resistor for the tube. Resistor 95-1 in parallel with resistor 95-2 are the plate load resistors.

b. Amplified positive pulses from the plate of the video amplifier are coupled to the control grid of cathode follower tube 12 (6AG5) through coupling capacitor 20-3 (fig. 31). Resistor 88-2 is the grid leak for the cathode follower. The cathode load consists of two resistors 94 and 59-5, so that two values of output impedance are available. The high-impedance output signal, taken directly from the cathode, is used for monitoring purposes only. It is connected to RECEIVER OUTPUT HIGH jack through TEST SWITCH 140 (section 2, fig. 31) and through pin 17 of receptacle 180 when the switch is in the Ic or OPERATE position. The low-impedance output is taken at the junction of resistors 94 and 59-5. It is coupled to the grid of video amplifier tube 13 in the control unit, through section 1, switch 140 (fig. 31), pin 6 of receptacle 180, and pin B of receptacle 127 in the control unit when the switch is in the Ic or OPERATE position. Capacitor 8-2 between pins 6 and 5, receptacle 180, bypasses any stray high-frequency components above the video level before the signal leaves the receiver chassis. The low-impedance output signal can be checked at RECEIVER OUTPUT LOW jack 150-2 on the receiver front panel or at VERT. INPUT jack 144-6 on the control unit front panel. The low side of resistor 94 is grounded through pin 20, receptacle 180 (receiver).

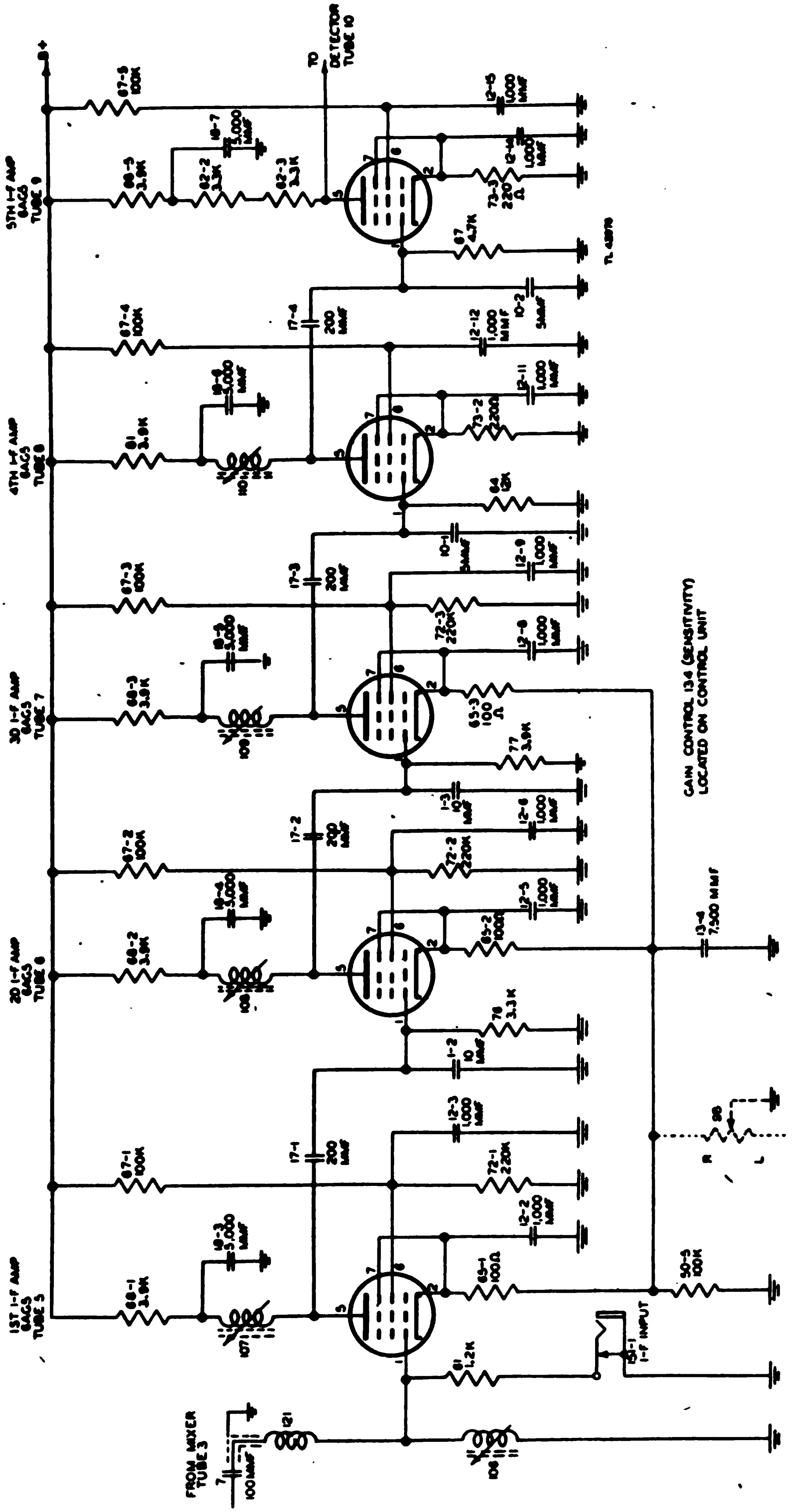


Figure 29. Receiver system, i-f amplifier circuit.

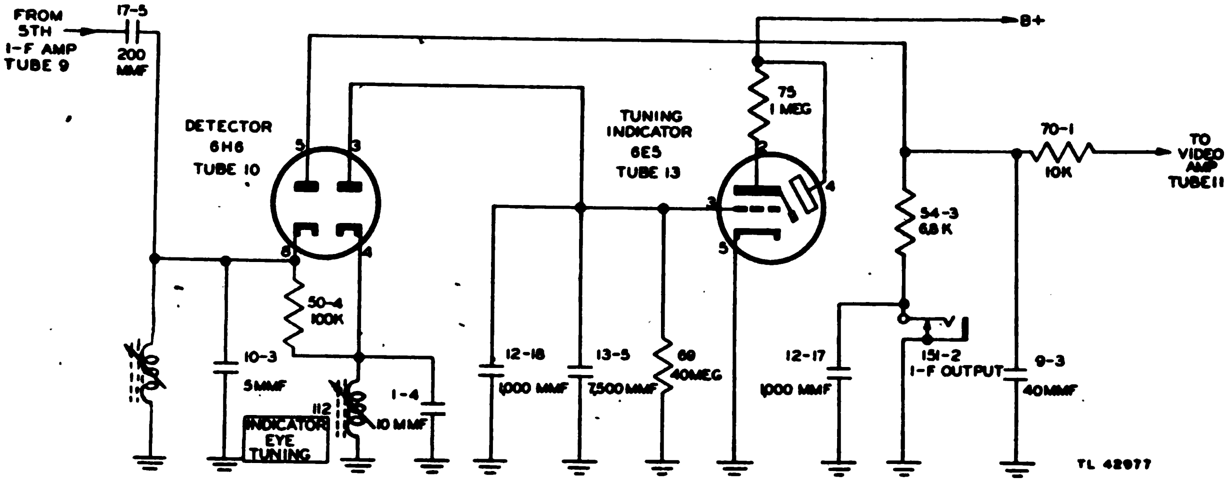


Figure 30. Receiver system, detector and tuning indicator circuits.

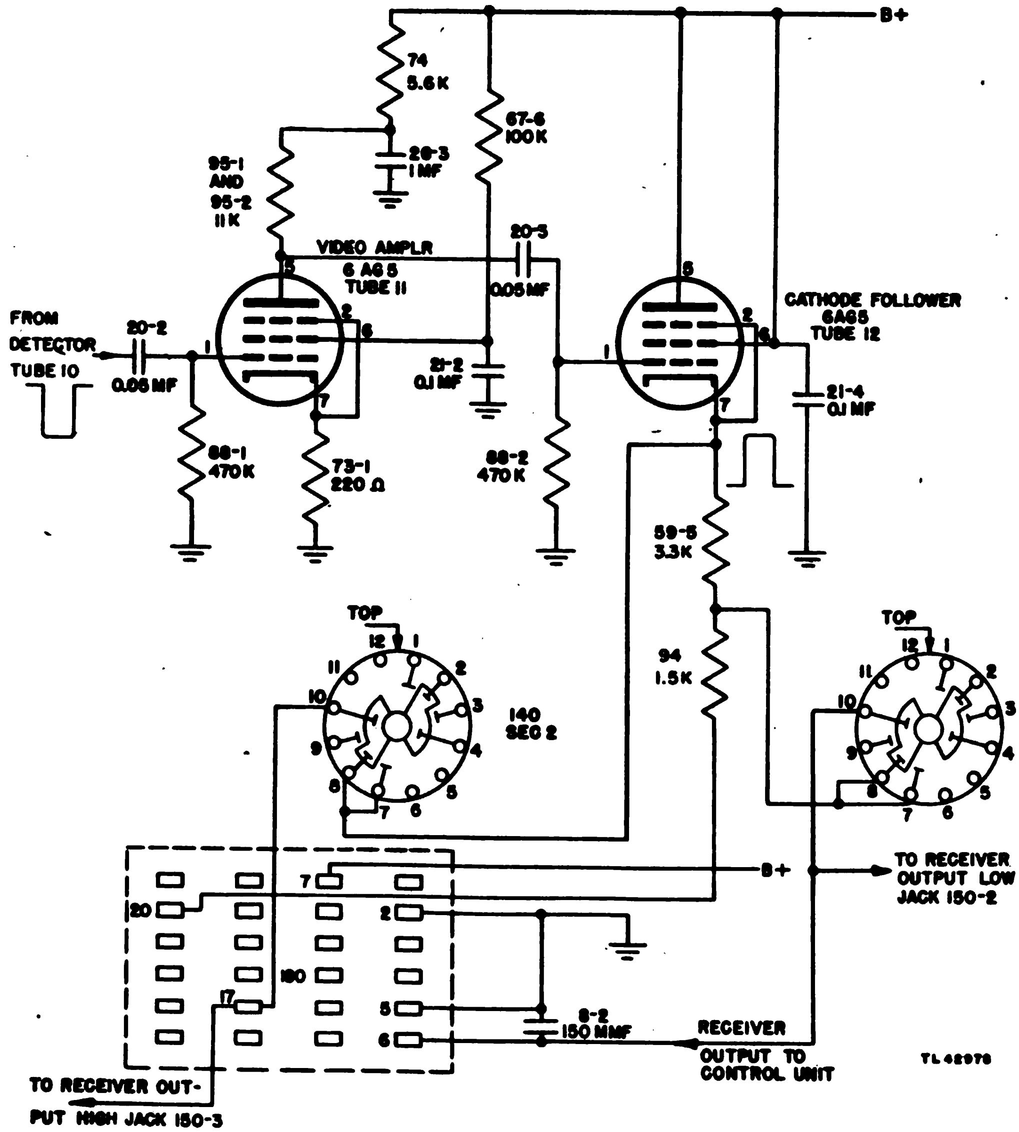
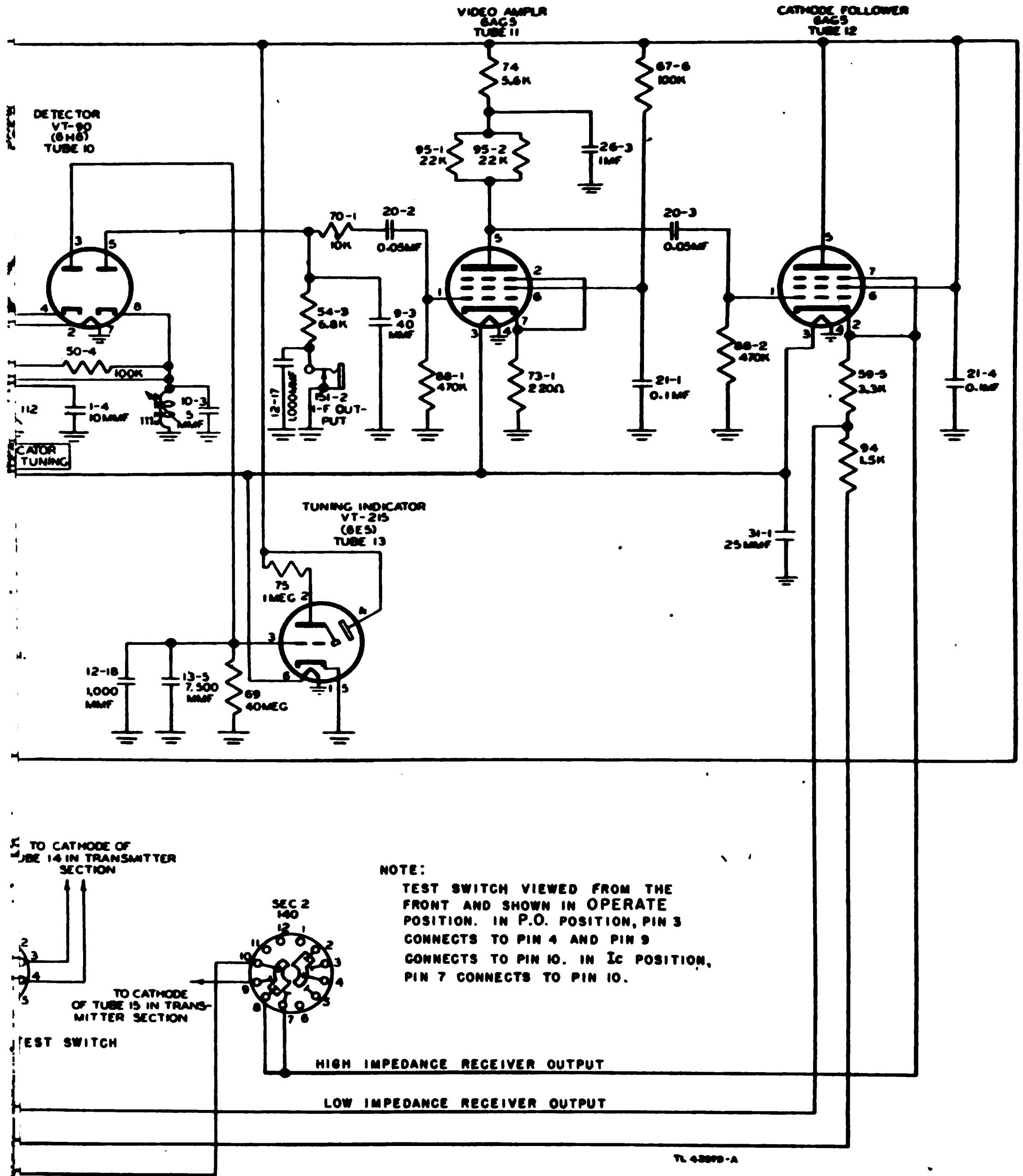


Figure 31. Receiver system, video output circuits.



VIDEO AMPLR 6AG5 TUBE 11
CATHODE FOLLOWER 6AG5 TUBE 12
DETECTOR VT-90 (6H6) TUBE 10
TUNING INDICATOR VT-215 (6E5) TUBE 13
74 5.6K
67-6 100K
95-1 22K
95-2 22K
26-3 1MF
70-1 10K
20-2 0.05MF
20-3 0.05MF
54-3 6.8K
9-3 40 MMF
88-1 470K
88-2 470K
73-1 220Ω
21-1 0.1MF
21-4 0.1MF
59-5 3.3K
94 1.5K
31-1 25MMF
50-4 100K
1-4 10MMF
10-3 5 MMF
12-17 1000MMF
151-2 I-F OUT-PUT
12-18 1,000 MMF
13-5 7,500 MMF
69 40MEG
75 1MEG
CATOR TUNING
TO CATHODE OF TUBE 14 IN TRANSMITTER SECTION
SEC 2 140
TO CATHODE OF TUBE 15 IN TRANS-MITTER SECTION
TEST SWITCH
NOTE:
TEST SWITCH VIEWED FROM THE FRONT AND SHOWN IN OPERATE POSITION. IN P.O. POSITION, PIN 3 CONNECTS TO PIN 4 AND PIN 9 CONNECTS TO PIN 10. IN Ic POSITION, PIN 7 CONNECTS TO PIN 10.
HIGH IMPEDANCE RECEIVER OUTPUT
LOW IMPEDANCE RECEIVER OUTPUT
TL 43979-A

CHAPTER 5.
RANGE AND TIMING SYSTEM

Section I. Block Diagrams.

The range and timing functions of Radio Equipment RC-384 are performed by Control Unit BC-1378. Section I of this chapter presents the various circuits in the control unit as blocks and describes the function of each block, its coordination with the other blocks, and the interrelationship of all the blocks. Section II describes the electrical operation of each circuit but makes no attempt to correlate the various circuits; this is done in Section I.

29. PURPOSE OF CONTROL UNIT BC-1378.

The purpose of the control unit is to:

a. Coordinate the functions of the IFF equipment with those of the radar set.

b. Provide circuits for measuring the range of targets which furnish IFF reply pulses.

c. Provide an indicator for displaying these reply pulses.

d. Provide a single panel containing all the electrical controls necessary during IFF operation.

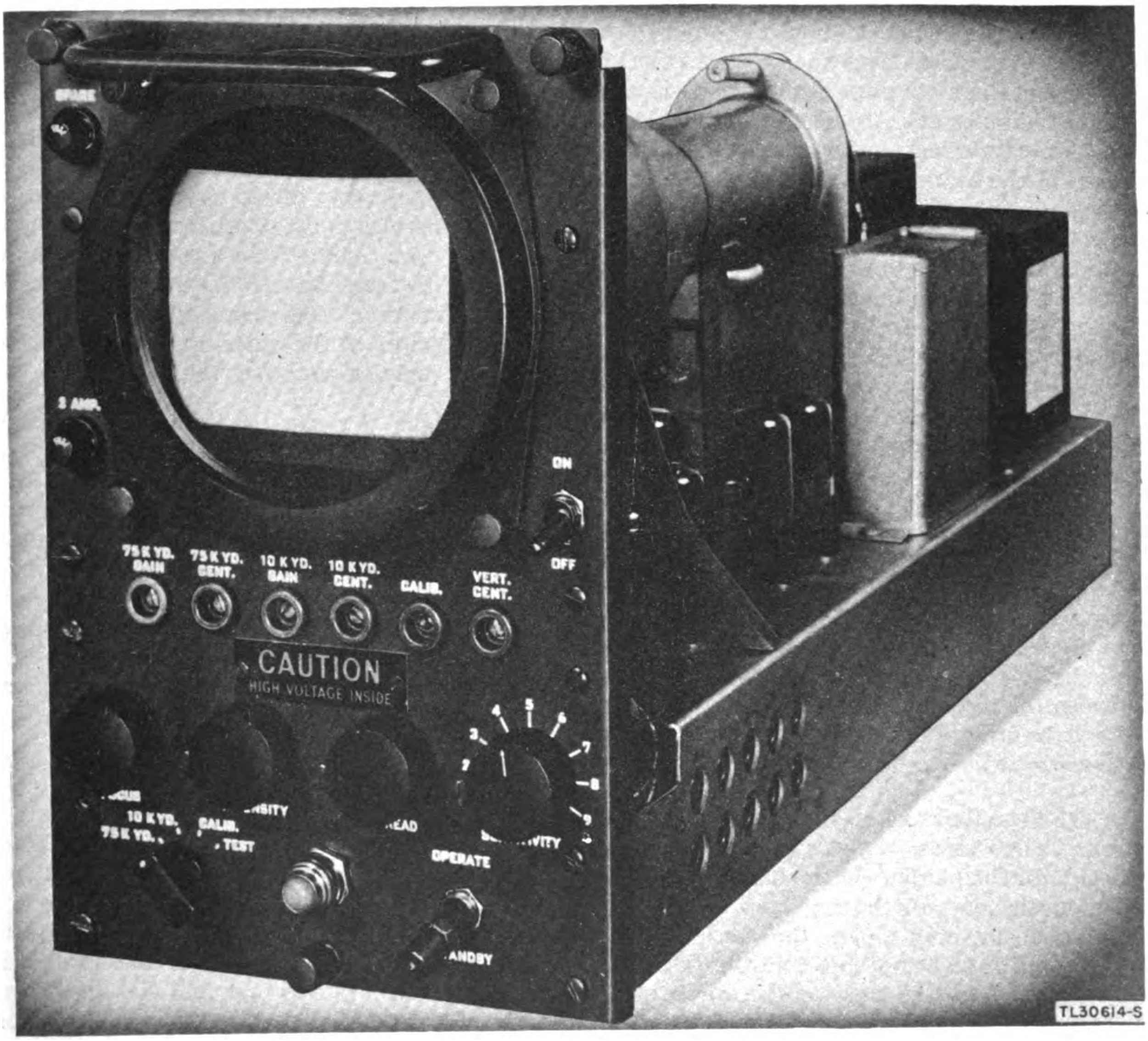


Figure 33. Control Unit BC-1378 removed from inner case.

e. Provide the split pattern necessary for azimuth determination with a lobe-switching antenna if such an antenna is substituted for the single-beam antenna system normally furnished with Radio Equipment RC-384.

30. SIMPLIFIED BLOCK DIAGRAM (fig. 34).

The various functions of the control unit depend on *synchronization* (sync) and *division* and are performed in the different *channels* shown in figure 34. Each channel is composed of groups of circuits; each circuit is identified in figure 34 by the circuit tube number.

a. Synchronization. Sync pulses from the radar equipment time both the firing of the IFF transmitter and the start of the IFF display tube sweep.

(*1*) Line Ⓐ of figure 34 shows the origin of the two radar sync pulses. This line shows the start of the radar transmitter pulse at a time designated as T1. Simultaneously, a *trigger sync* pulse is fed by cable from the radar equipment to the *division channel* in the control unit. It is this pulse which determines when the IFF transmitter fires. When the control unit range switch is in the 75 K YD. position, the starting time of the IFF sweep trace is also determined by the *trigger sync* pulse. In the 75 K YD. position, the control unit display circuits provide a 75,000-yard timebase (458 microseconds) for viewing reply pulses, and the operator estimates the target range from the position of the reply pulses on the timebase line (fig. 34Ⓒ).

(*2*) The radar ranging circuits incorporate a small fixed delay which is compensated for by the radar display circuits. In order to use the radar ranging circuits for IFF ranging, compensation must also be included in the IFF circuits. Therefore the *transmitter trigger* channel in the control unit (fig. 34) introduces a 3¼-microsecond delay between the reception of the *trigger sync* pulse at T1 and the firing of the IFF transmitter. This delay is shown greatly exaggerated in lines Ⓑ, Ⓒ, and Ⓓ.

(*3*) When the radar operator discovers a target within 32,000 yards, he turns his SLEWING handwheel until the hairline on the 32,000-yard radar A-scope coincides with the target pip. The SLEWING handwheel not only moves the hairline on the 32,000-yard A-scope but also controls a delay circuit which times the start of the sweep on the 2,000-yard radar A-scope and the start of the brightening pulse on that sweep. When the hairline coincides with the target pip on the 32,000-yard scope, that portion of the range which contains the target is presented on the 2,000-yard scope, greatly expanded, and illuminated by the movable brightening pulse.

(*4*) The starting time of the movable brightening pulse is designated as T2 in figure 34 and is the time at which the *range sync* pulse is fed by cable from the radar equipment to the *range sync channel* in the control unit. When the control unit range switch is in the 10 K YD. position, the starting time of the IFF sweep trace is determined by the *range sync* pulse although the IFF transmitter is still timed by the *trigger sync* pulse (fig. 34Ⓓ). The control unit display circuits then provide a 10,000-yard timebase (60 microseconds) to present any 10,000-yard portion of the range up to 42,000 yards, as determined by the radar ranging circuits. The radar target return occurs a little after T2 (line Ⓐ), and IFF reply pulses from the target (if it is friendly) must appear a little after the start of the 10,000-yard sweep (line Ⓓ). In the 10 K YD. position, therefore, the IFF operator does not have to determine the range of the aircraft which is replying. If the reply pulses appear a little to the right of the start of the sweep, the operator knows that they are coming from a source at the same range as the target selected by the radar operator. If the azimuth of the replying aircraft is the same as the azimuth of the radar target, it is assumed that the replying aircraft is the radar target.

(*5*) Line Ⓓ shows the timing of the 10,000-yard IFF sweep in relation to T1 and T2. Its appearance on the display screen, however, is the same as the appearance of the 75,000-yard sweep. The electron beam which generates the sweep move the same distance on the screen but at 7½ times the speed that it moves in the 75 K YD. range switch position. IFF reply pulses therefore appear 7½ times wider in the 10 K YD. position (line Ⓔ) than they do in the 75 K YD. position (line Ⓒ) and are more easily observed.

b. Division.

(*1*) The repetition rate of Radio Set SCR-784 is 1,706 pulses per second (pps), and both the *trigger sync* pulse and the *range sync* pulse occur at this repetition rate. The transpondor used in the Mark III IFF system would be "swamped" if interrogated at a rate as high as 1,706 pps. This is especially true in areas with many interrogators. Therefore, the *division channel* divides the repeti-

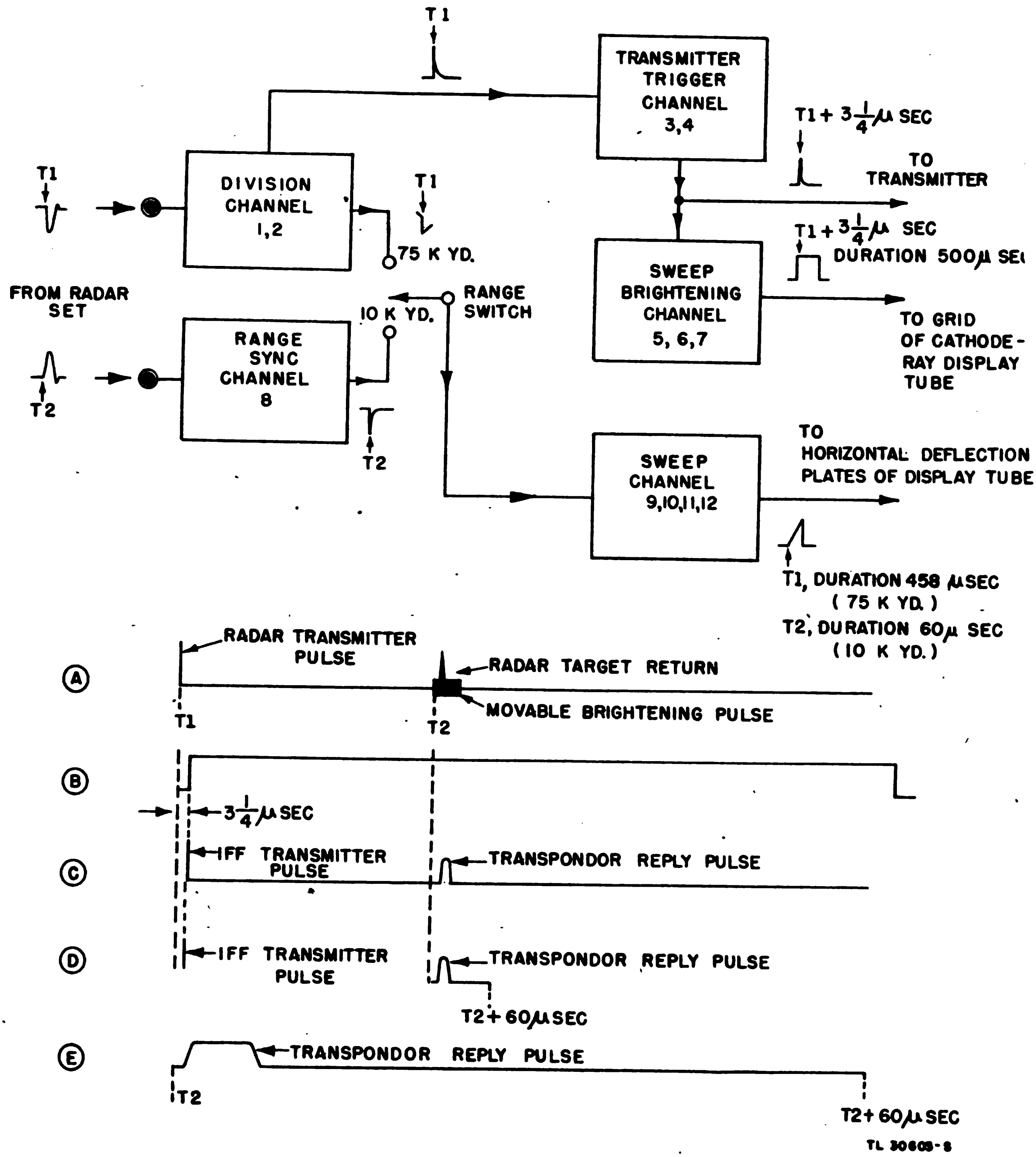


Figure 34. Control unit, simplified block diagram.

tion rate by eight and sends its output to the *transmitter trigger channel* at a repetition rate of 213 pps. If Radio Equipment RC-384 is used with some other radar set having a repetition rate different from 1,706 pps, the division ratio can be changed by a simple adjustment to keep the IFF transmitter repetition rate somewhere between 200 and 240 pps inclusive.

(*2*) Figure 34 shows that when the range switch is in the 75 K YD. position, the ***sweep channel*** is triggered at the divided frequency of 213 pps; but when the range switch is in the 10 K YD. position, the ***sweep channel*** is triggered at 1,706 pps and eight display-tube sweeps occur for every one IFF transmitter pulse. If all of these sweeps were allowed to appear on the display tube, the base line would be much more brilliant than a reply pulse and would be unbroken by the reply pulse. Both of these conditions are undesirable and are avoided by allowing only that sweep which coincides with the IFF transmitter pulse to appear on the display tube; the other seven sweeps are kept below the level of visibility by bias on the display tube grid. The ***sweep brightening channel,*** which is triggered by the same pulse which triggers the IFF transmitter, reduces this bias in time to allow every eighth sweep to appear on the display tube.

(*3*) When the radar operator cranks the SLEWING handwheel to zero yards range, T2 corresponds to T1, and both the 75,000-yard and the 10,000-yard sweeps start at T1. Line Ⓑ (fig. 34) shows the positive brightening pulse to the grid of the display tube. It will be seen that the first 3¼ microseconds of the 75,000-yard sweep, and of the 10,000-yard sweep on zero range, are not brightened, but this cannot interfere with IFF operation because the IFF transmitter pulse also occurs 3¼ microseconds after T1.

(*4*) The limit of T2 is T1 plus 32,000 yards and, therefore, the farthest possible end of the 10,000-yard sweep is T1 plus 42,000 yards (256 microseconds). The end of the 75,000-yard sweep is T1 plus 458 microseconds. The brightening pulse duration is about 500 microseconds, which is long enough to brighten either sweep as can be seen by comparing line Ⓑ with lines Ⓒ and Ⓓ, respectively.

(*5*) At zero yards range, the 10,000-yard sweep starts at T1 and the next sweep, ***which must not be brightened,*** starts at T1 plus 586 microseconds (the period of 1,706 pps is 586 microseconds). The brightening pulse duration of 500 microseconds, starting at T1 plus 3¼ microseconds, brings the end of the pulse to 503¼ microseconds, enough short of 586 microseconds to insure that only one out of every eight 10,000-yard sweeps will be brightened. It can be seen from this discussion that the brightening pulse (which is necessary because division of the radar repetition rate is necessary) is long enough to brighten all of the sweep which must be brightened but short enough to produce perfect apparent division of the 10,000-yard sweeps even under the most extreme condition of zero yards range.

c. Channels.

(*1*) *Division Channel.* The purpose of this channel is to produce negative and positive pulses at a repetition rate between 200 and 240 pps inclusive and at times coinciding with radar *trigger sync* pulses. By setting a toggle switch on the chassis to either − or +, the channel can use either a negative *trigger sync* pulse (as from Radio Set SCR-784) or a positive *trigger sync* pulse (if some other radar set is used). By adjusting a potentiometer, radar repetition rates from 1,000 to 2,000 pps can be divided to furnish the desired IFF repetition rate.

(*2*) *Range Sync Channel.* The purpose of this channel is to produce a sharp negative pulse at a time coinciding with each ***range sync*** pulse. As in the case of the ***division channel,*** a toggle switch makes it possible to use either a positive ***range sync*** pulse (as from Radio Set SCR-784) or a negative ***range sync*** pulse (if some other radar set is used).

(*3*) *Transmitter Trigger Channel.* Three and one-quarter microseconds after receiving its input, this channel produces a sharp positive pip of the required amplitude to trigger both the IFF transmitter and the ***sweep brightening channel.***

(*4*) *Sweep Channel.*

(*a*) This channel produces the saw-tooth voltage waves which cause the sweep to appear on the display tube. Although only a positive output waveform is shown in figure 34, the channel produces equal positive and negative outputs which are applied to opposite deflection plates of the display tube. The negative voltage repels the electron beam and the positive voltage attracts the electron beam; because of this "push-pull" action, each waveform need have only half the amplitude which would be required if a single action were used. It is possible to produce a linear low-amplitude saw-tooth wave but almost impossible to produce a linear high-amplitude saw-tooth wave; therefore, the "push-pull" action makes for uniform speed as the electron beam sweeps across the scope screen.

(*b*) In the 75 K YD. range switch position, the *sweep channel* receives its input from the *division channel* and sweeps are produced at the divided repetition rate. Another section of the range switch selects circuit constants which produce a 458-microsecond sweep (75,000 yards).

(*c*) In the 10 K YD. range switch position, the *sweep channel* receives its input from the *range sync channel* and sweeps are produced at the radar repetition rate. Circuit constants are automatically switched to produce a 60-microsecond sweep (10,000 yards).

(*5*) *Sweep Brightening Channel.* This channel produces the 500-microsecond positive pulse which brightens only that sweep which occurs during the pulse. The input to this channel is the transmitter triggering pulse, at the divided repetition rate, and therefore sweeps are brightened at the divided repetition rate.

31. COMPLETE BLOCK DIAGRAM OF OPERATION (fig 35).

The tubes used in the various stages are identified by their symbol numbers in the blocks of figure 35.

a. Trigger Sync Stages.

(*1*) The *trigger sync* pulses from the radar equipment are a continuous series of pulses at a relatively high repetition rate. When the radar equipment is Radio Set SCR-784, the *trigger sync* pulses are negative, about 1.2 microseconds wide, and the repetition rate is 1,706 pps. Figure 35 Ⓣ shows any group of nine consecutive pulses from Radio Set SCR-784.

(*2*) The sync selector input circuit contains a polarity selector switch (TRIGGER SYNC POLARITY) which is set according to the polarity of the input pulses. When the switch is set correctly, the output of the sync selector stage is a series of positive pulses. The stage both amplifies and clips so that the output pulses are square waves of approximately uniform amplitude regardless of input amplitude.

(*3*) The sync selector output is differentiated and fed to the sync amplifier which amplifies only the positive differentiated pips. The sync amplifier output is a series of sharp negative pips coinciding in time to the leading (left) edges of the *trigger sync* pulses.

b. Range Sync Stages. The same circuit and values are used in the range sync stages (8A, differentiating circuit, and 8B), as are used in the trigger sync stages and the action of each range sync stage is the same as that of the corresponding trigger sync stage. The *range sync* pulses from Radio Set SCR-784 are positive and the RANGE SYNC POLARITY selector switch is set accordingly. The important differences between the two circuits are that each *range sync* pulse occurs at a variable time after a *trigger sync* pulse (fig. 34), and the two sync amplifier outputs are used for different purposes.

c. Dividing Stages.

(*1*) The negative pips from the sync amplifier stage 1B affect the division multivibrator stage in the following manner:

(*a*) The first pip starts the action which results in the sharp vertical rise in pulse Ⓤ (fig. 35) and the sharp vertical drop in pulse Ⓧ.

(*b*) The next seven pips have no effect on the circuit and the outputs during this interval are shown as the long horizontal line in Ⓤ and the long slanting line in Ⓧ.

(*c*) Some time between the eighth and ninth pips, the stage recovers. The recovery is shown in Ⓤ as the sharp vertical drop at the right end of the horizontal line and continues as the short horizontal line following the drop; the recovery is shown in Ⓧ as the short vertical rise at the right end of the long slanting line and continues as the short slanting line following the rise.

(*d*) The ninth pip starts a repetition of the previous action; the start of the repetition is shown as the sharp vertical rise at the right end of Ⓤ and the sharp vertical drop at the right end of Ⓧ.

(*2*) The division multivibrator cycle described above is for the division ratio of 8:1; this is the ratio used with Radio Set SCR-784. The division multivibrator "fires" on pips 1, 9, 17, 25, etc., once for each successive eight pips. This ratio divides the radar sync repetition rate of 1,706 pps to produce the IFF sync repetition rate of approximately 213 pps. If a radar set which has a different repetition rate is used, the division can be adjusted for another division ratio which will keep the IFF repetition rate between 200 and 240 pps inclusive.

(*3*) Output Ⓧ is fed to the sweep multivibrator stage when the range switch is set at 75 K YD. Output Ⓤ is fed to the differentiating circuit which produces the output as shown at Ⓥ. The negative portion of output Ⓥ occurs sometime between the eighth and ninth pips and has no effect on the following stage. The positive portions of output Ⓥ occur at 213 pps; the interval between pulses is 4,695 microseconds.

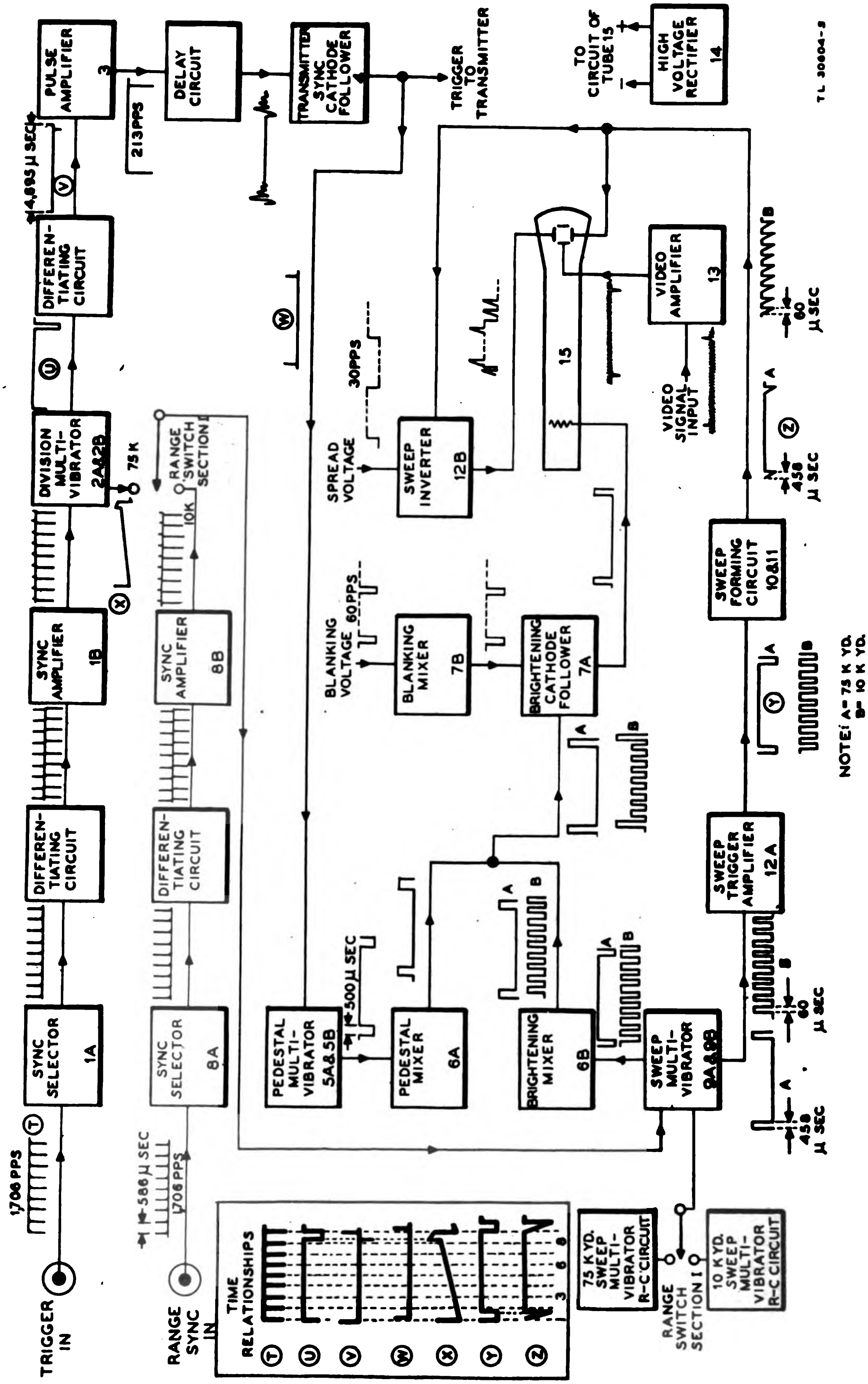


Figure 35. Control unit, complete block diagram of operation.

d. Transmitter Triggering Stages.

(*1*) The waveform shown as Ⓥ is fed to the pulse amplifier stage which amplifies only the positive portions to produce negative pips at 213 pps. Each negative pip starts a damped oscillation in the delay circuit. The oscillations start negative, complete the negative half of a sine wave, continue to form the next positive half of the sine wave, and quickly damp out. The first positive half of each damped wave attains an amplitude which is not subsequently reached by the remainder of the damped wave. The time between the start of the damped wave in the negative direction and the upper portion of the first positive rise is about 3¼ microseconds.

(*2*) The damped waves are fed to the transmitter sync cathode follower stage which is so biased that only the upper portion of the first positive half-wave appears in the output (fig. 35Ⓦ) as a very short pulse occurring at 213 pps but starting 3¼ microseconds after the *trigger sync* pulse which initiated all the preceding circuit action.

(*3*) Output Ⓦ is fed by cable to the IFF transmitter and by the control unit wiring to the pedestal multivibrator stage.

e. Sweep Stages.

(*1*) Two inputs and two conditions of operation are available to the sweep multivibrator stage:

(*a*) When the range switch is at 75 K. YD., waveform Ⓧ is selected by one portion of section 1 of the range switch as the input to the stage. The other portion of this range switch section selects the 75,000-yard R-C circuit for the stage operation. Each of the sharp vertical drops of waveform Ⓧ, that is, the long vertical lines occurring at 213 pps, triggers the sweep multivibrator stage into producing two outputs: a positive rectangular pulse 458 microseconds (75,000 yards) long and a negative rectangular pulse with the same duration. The pulses occur at 213 pps and their leading edges coincide in time with the leading edges of *trigger sync* pulses 1, 9, 17, 25, etc. (T1 in fig. 34).

(*b*) When the range switch is at 10 K YD. the output of sync amplifier stage 8B is the trigger for the sweep multivibrator stage and the 10,000-yard time-constant cicuit is selected for the stage operation. Each negative pip from sync amplifier stage 8B triggers the sweep multivibrator stage into producing two outputs: a positive rectangular pulse 60 microseconds (10,000 yards) long and a negative rectangular pulse with the same duration. The pulses occur at 1,706 pps, and their leading edges coincide in time with the leading edges of the *range sync* pulses (T2 in fig. 34).

NOTE: The "A" waveforms in figure 35 are produced when the range switch is in the 75 K YD. position. The "B" waveforms are produced in the 10 K YD. range switch position.

(*2*) The positive output of the sweep multivibrator stage is fed to the sweep trigger amplifier stage which amplifies and inverts the rectangular pulses. The "A" output of the sweep trigger amplifier stage is shown as Ⓨ to indicate its time relationship to the other waveforms.

(*3*) The negative output of the sweep trigger amplifier stage is fed to the sweep-forming circuit which produces negative saw-tooth voltage pulses which have the same duration and which occur at the same time as the rectangular pulses which trigger the sweep forming circuit. The "A" output of the sweep-forming circuit is shown as Ⓩ to indicate its time relationship to the other waveforms.

(*4*) The negative saw-tooth voltage pulses are fed to the left horizontal-deflection plate of the display tube and to the sweep inverter stage which produces positive saw-tooth voltage pulses for application to the right horizontal-deflection plate. The sweep is thus applied to the display tube in "push-pull."

(*5*) Although the antenna system furnished with Radio Equipment RC-384 does not switch lobes, circuits are provided in the control unit to form the split pattern necessary if a lobe-switching antenna system is substituted. To form a split pattern, it is necessary to shift the starting point of the sweep at regular intervals. For example, three or more sweeps must start at the left edge of the screen. The next three or more sweeps must start ½ inch to the right, the next group of sweeps must start at the left edge, etc. This is done by applying a symmetrical rectangular voltage wave to one of the horizontal deflection plates; the rectangular voltage wave acts as automatically changing positioning voltage and is called *spread voltage*. The positive saw-tooth voltages are shown in figure 35 superimposed upon the symmetrical rectangular wave which would be present *only* if a lobe-switching antenna were used and if the SPREAD control were turned counterclockwise. The rectangular wave is shown dotted to indicate that its period is far greater than the time scale shown in figure 35. The frequency shown, 30 pps, is a typical frequency with lobe-switching antennas. **When Radio Equipment RC-384 is used with Antenna Tower Kit AS-134-TPX, which is**

normally furnished, the SPREAD control is left in its extreme counterclockwise position, no spread voltage is present, and the positive saw-tooth voltage pulses have an unvarying base-line, as shown for the negative saw-tooth pulses.

f. Sweep Brightening Stages.

(*1*) Each positive pulse of waveform Ⓦ triggers the pedestal multivibrator stage into producing a negative rectangular pulse 500 microseconds long. The leading edge of the rectangular pulse coincides in time with the leading edge of the pulse of waveform Ⓦ. The negative 500-microsecond *pedestals* are fed to the pedestal mixer stage which amplifies and inverts the pedestals.

(*2*) The negative rectangular pulses from the sweep multivibrator stage are fed to the brightening mixer stage which amplifies and inverts them.

(*3*) The outputs of the two mixer stages are combined and sent as input to the brightening cathode follower stage. Whenever a sweep-duration rectangular pulse from the brightening mixer occurs during the interval of a pedestal rectangular pulse from the pedestal mixer, the input to the brightening cathode follower stage is reinforced. The two pulses coincide 3¼ microseconds after the leading edges of *trigger sync* pulses 1, 9, 17, 25, etc.

(*4*) The brightening cathode follower stage is so biased that only the reinforced input appears in the output as a positive rectangular pulse which is sent to the grid of the display tube.

(*a*) in the 75 K YD. range switch position, the positive rectangular pulse at the grid of the display tube brightens all but the first 3¼ microseconds of the sweeps which start at the same time as the leading edges of *trigger sync* pulses 1, 9, 17, 25, etc.

(*b*) When the range switch is set at 10 K YD., and the radar range is greater than about 530 yards (3¼ microseconds), the positive pulse at the display tube grid brightens all of the sweeps which start at the same time as the leading edges of *range sync* pulses 1, 9, 17, 25, etc. When the radar range is at zero yards, the first 3¼ microseconds of these 10,000-yard sweeps are blanked. In either case a 10,000-yard sweep appears only once for each firing of the IFF transmitter.

(*5*) If lobe-switching is used (subpar. e(*5*) above), some means must be provided to blank the sweeps which occur at the time of switching, that is, at the times when the vertical portions of the spread-voltage wave occur. At these times a negative rectangular pulse of *blanking* voltage, resulting from lobe switching, is formed by the

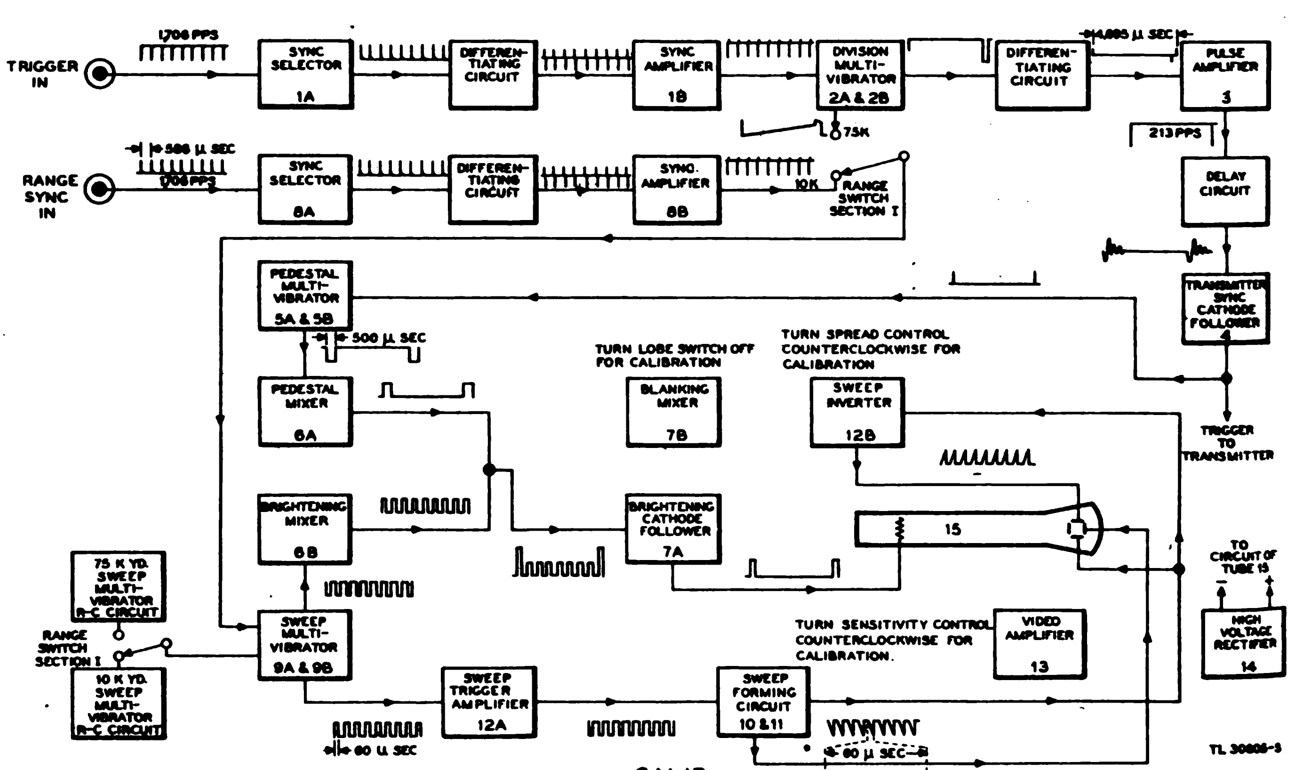


Figure 36. Control unit, block diagram of CALIB. connections.

blanking mixer stage and is fed to the brightening cathode follower stage. No brightening pulse can come from the brightening cathode follower stage during the interval of the blanking voltage.

g. Video Amplifier Stage. To counteract the attenuation of the video pulse in the wiring from the receiver to the rack receptacle and in the cable from the rack receptacle to the control unit, a video amplifying stage is included in the control unit. Positive video signals are amplified, inverted, and fed as negative video signals to the bottom vertical-deflection plate of the display tube. The electron beam is pushed upward by the negative video signals.

h. High-voltage Rectifier Stage. The control unit contains its own power supply to provide the negative and positive high voltages required by the display tube. The primary voltage is 117 volts 60 cycles and is switched by the ON-OFF toggle switch on the front panel.

32. CALIBRATION OF 10 K YD. SWEEP (figs. 36 and 37).

The range switch wiring is complex. It is therefore desirable to present an over-all picture (fig. 36) in block diagram form of the circuit relationships when the range switch is turned to the CALIB. position. This is the position used to adjust the duration of the 10,000-yard sweep to 60 microseconds.

a. In the CALIB. position of the range switch, the range sync circuits provide the trigger to the sweep multivibrator and all other conditions are set up for the 10,000-yard sweep. The only difference in the complete circuit from the conditions set up by the range switch in the 10 K YD. position (fig. 35) is that a connection is made automatically between the top vertical-deflection plate of the display tube and a ringing oscillator in the circuit of tube 10. The ringing oscillator is in the tube 10 circuit permanently, but its output does not affect the circuit operation in any way because it is used only during the 10,000-yard calibration.

b. Coincident with the start of each sweep, this oscillator starts producing a damped sine wave at a frequency of 200 kc. The period of 200 kc is 5 microseconds. All that is necessary, then, is to adjust the sweep duration until exactly 12 complete sine-wave cycles appear on the screen (fig. 37). The sweep duration necessary to present exactly 12 cycles at 5 microseconds per cycle is 60 microseconds, which is the approximate timebase for a 10,000-yard sweep.

c. To avoid complicating the display tube screen during the calibration, video signals are kept off the screen by turning the SENSITIVITY control down. If a lobe-switching antenna is used, the lobe switch is turned off and the SPREAD control turned down for the same reason. These conditions are shown by the absence of the corresponding signal lines in figure 36.

33. CALIBRATION OF 75 K YD. SWEEP.

No internal measuring circuit is provided for the calibration of the 75,000-yard sweep. The range switch is set to 75 K YD. and a measuring circuit in the radar equipment is used. Radio Set SCR-784

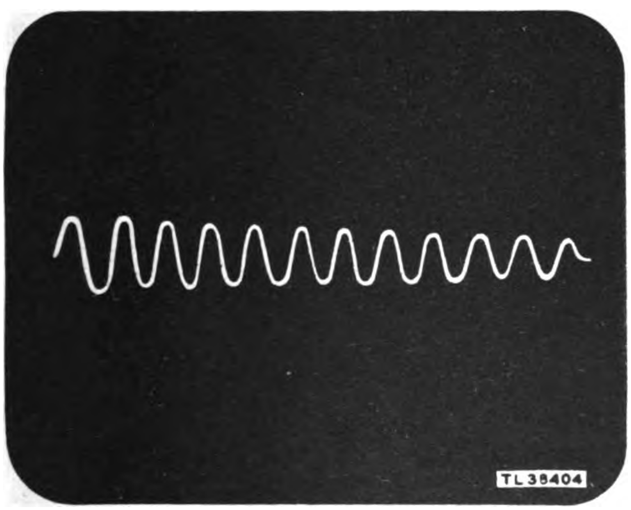


Figure 37. Control unit display pattern, 10 K YD. calibration.

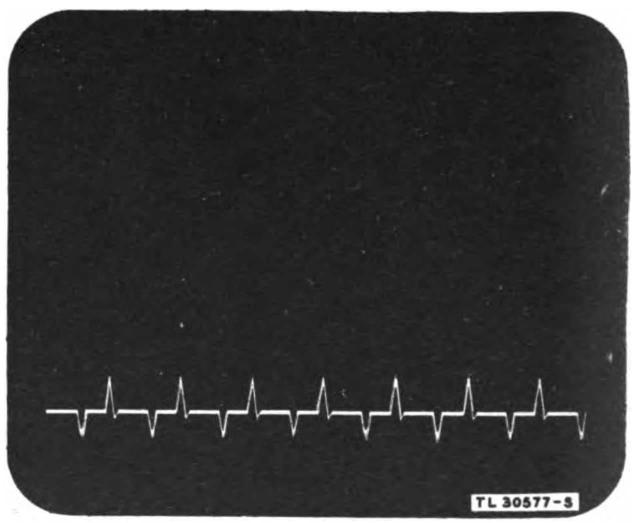


Figure 38. Control unit display pattern, 75 K YD. calibration.

has a connector (RANGE MARKER) from which positive pips, spaced 10,000 yards apart, are available.

a. One end of Cord CD-1347 is connected to the RANGE MARKER receptacle on the radar set; the other end is connected to jack 120 on the control unit (jack 120 connects to the top vertical-deflection plate). The range switch is turned to 75 K YD. and the sweep duration is adjusted until the waveform on the screen is as shown in figure 38. Figure 38 shows seven 10,000-yard spaces between the positive RANGE MARKER pips and is about a half a space longer, to add up to a total duration correct for a 75,000-yard timebase.

b. To avoid complicating the display tube screen during the 75 K YD. calibration, the same conditions are set up as are described in paragraph 32*c* and illustrated in figure 36.

34. DIVISION ADJUSTMENT (figs. 39 and 40).

The range switch wiring is complex. It is therefore desirable to present an over-all picture (fig. 39) in block diagram form of the circuit relationships when the range switch is in the TEST position. This is the position used to adjust and test the division action.

a. To avoid complicating the display tube screen during TEST, the video output is removed from the screen by turning down the SENSITIVITY control. If a lobe-switching antenna is used, the lobe switch is turned off and the SPREAD control is turned down. The brightening pedestal duration is far too short for the long sweep used during TEST and would only complicate the appearance of the pattern on the screen. The pedestal mixer stages and brightening mixer stages are therefore disabled automatically by the range switch connections, and the INTENSITY control is turned up to eliminate the need for brightening pedestals. The sweep multivibrator stage receives no input and therefore produces no output. These conditions are shown by the absence of the corresponding signal lines in figure 39.

b. In all other switch positions the sweep multivibrator stage furnishes the sweep trigger amplifier stage with positive rectangular pulses; the duration of these pulses determines the duration of the sweeps. In the TEST position the positive rectangular pulses to the sweep trigger amplifier are furnished by the division multivibrator stage and are shown as waveform Ⓑ in figure 39. Waveform Ⓒ shows the duration of the saw-tooth sweep-forming

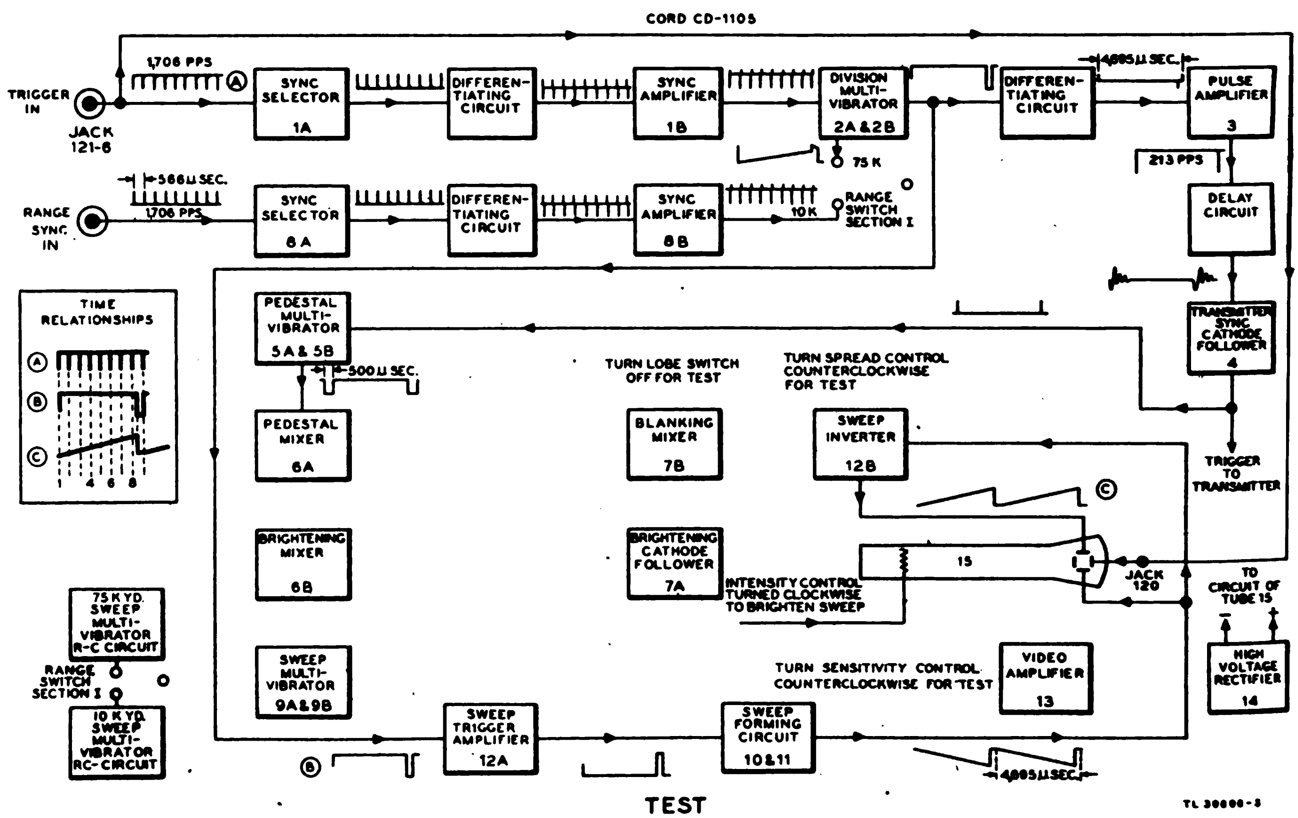


Figure 39. Control unit block diagram of TEST connections.

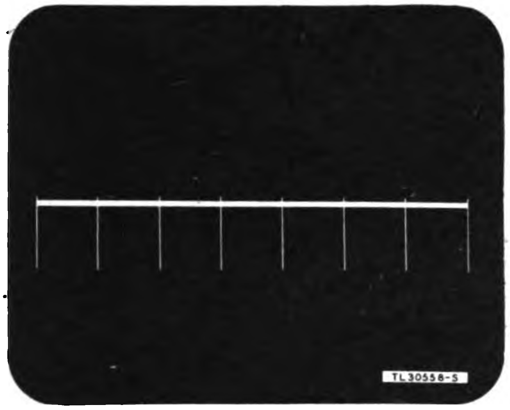


Figure 40. Control unit display pattern, 8:1 division ratio, negative trigger sync pulses.

voltage wave in time relationship to the division multivibrator output.

c. To divide the *trigger sync* pulses (waveform Ⓐ) by eight, the division multivibrator must "fire" on *trigger sync* pulse 1 to form the positive rise of the square pulse; this rise is shown as the vertical line at the left end of waveform Ⓑ and corresponds in time with *trigger sync* pulse 1. The division multivibrator must be adjusted to allow the next seven trigger pulses to go by without affecting it. This period is shown as the long horizontal line which forms the top of waveform Ⓑ. The multivibrator must recover sometime between the eighth and ninth pulses. The recovery is the vertical drop from the right end of the long horizontal line in waveform Ⓑ and the short horizontal line to the right of the vertical drop. The multivibrator is then in condition to be fired again by *trigger sync* pulse 9 to repeat the cycle.

d. The division adjustment varies the length of the long horizontal line; this length is the duration of the rectangular pulse. When the adjustment is correct for a division ratio of 8:1, as shown in the TIME RELATIONSHIPS part of figure 39, the sweep duration, shown as the slanting line of waveform Ⓒ, is long enough to include eight *trigger sync* pulses (waveform Ⓐ).

e. The *trigger sync* pulses are fed by Cord CD-1105, connected between jacks 121-6 and 120, to the top vertical deflection plate of the display tube where they produce eight downward pips (fig: 40) on the sweep for a division ratio of 8:1. If the radar set is different from Radio Set SCR-784, and requires a different division adjustment, 6:1 for example, the division multivibrator is adjusted to recover at some time between *trigger sync* pulses 6 and 7, and only six pulses appear on the screen. The *trigger sync* pulses from a radar set other than Radio Set SCR-784 may be positive instead of negative, In this case, the pulses appear up from the sweep line, instead of downward.

f. By comparing figure 39 with figure 35, it will be seen that the division multivibrator output which produces the rectangular pulse feeds into a different impedance in the TEST position of the range switch than it does in either of the two operating positions (75 and 10 K YD.). In the TEST position the multivibrator feeds two circuits instead of one. Therefore the adjustment made in the TEST position does not hold for the operating positions. The method of correcting the adjustment to the impedance in the operating positions is explained in paragraph 101c.

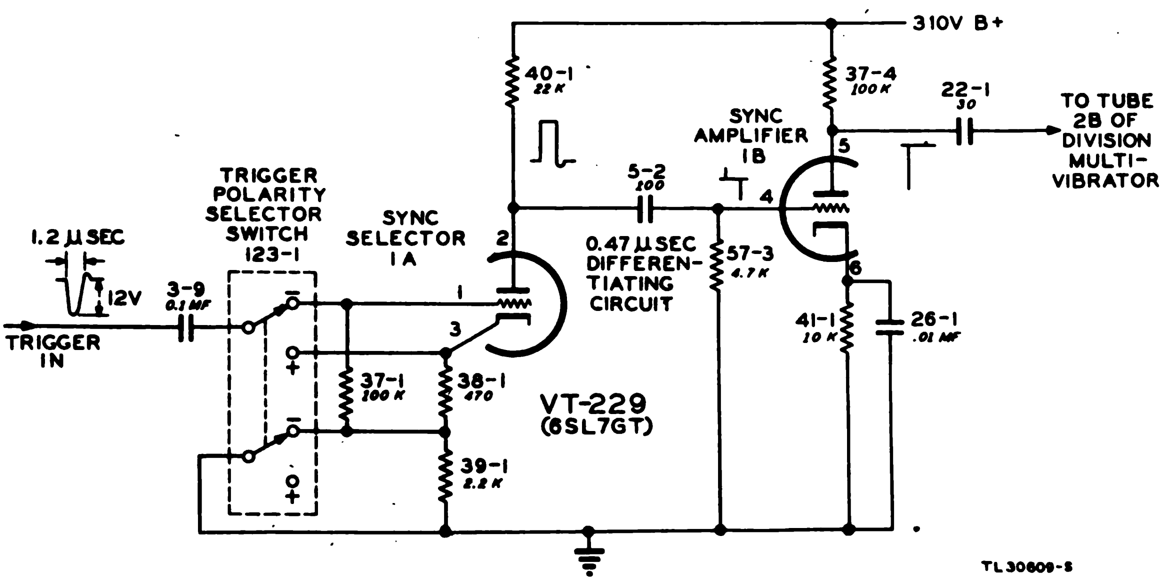


Figure 41. Trigger input circuits.

The functional schematic diagrams given in the text show the circuits in simplified form with parts values and approximate waveforms. For a complete schematic, refer to figure 57. Accurate waveforms, identified by tube numbers, are shown in figures 55 and 56 at the end of this chapter. The following paragraphs discuss the circuits used in the control unit.

35. TRIGGER INPUT CIRCUITS (fig. 41).

a. *Trigger sync* pulses from the radar set are coupled by capacitor 3-9 either to the grid or cathode of sync selector tube 1A, depending upon the position of the TRIGGER POLARITY SELECTOR switch. The input pulse shown is the pulse from Radio Set SCR-784; because it is negative, the switch is shown set to minus (−) and the pulse is fed to the grid. Cathode resistor 39-1 is shorted out and the tube is self-biased by cathode resistor 38-1. The grid is returned to ground through resistor 37-1. The negative input signal swings the grid below cut-off and the rounded bottom of the trigger pulse is not reproduced in the plate circuit. A trigger pulse with greater amplitude will drive the grid farther below cut-off and the increase in amplitude will not affect the circuit operation.

b. If a radar set is used which furnishes positive trigger sync pulses, the switch would be set to plus (+). The tube is still self-biased by cathode resistor 38-1, but resistor 39-1 is added to the input circuit to prevent overloading the radar circuit which furnishes the pulse. A positive input signal at the cathode has an effect similar to a negative input signal at the grid. With the grid tied to ground a positive pulse to the cathode increases the grid-to-cathode potential in the same direction that would result from a negative pulse to the grid with the cathode tied to ground; although the degeneration is greater with the signal at the cathode, the plate pulse is still positive, squared, and limited.

c. The squared pulse at the plate of tube 1A is differentiated by the circuit of capacitor 5-2 and resistor 57-3 because the R-C time constant is considerably shorter than the pulse; the differentiated pips are fed to the grid of sync amplifier tube 1B. This tube is self-biased near cut-off by the 10,000-ohm cathode resistor 41-1 which is bypassed by capacitor 26-1. Only the positive differentiated pips are amplified and appear at this plate as negative pips. The tube cannot bias itself all the way to cut-off, but the gain for the negative portion of the input is so small that the output shows only a very-low-amplitude positive portion which has no effect on the following circuit. The output of tube 1B is coupled by capacitor 22-1 to the grid of division multivibrator tube 2B.

36. RANGE SYNC INPUT CIRCUITS.

The range sync input circuits are exact duplicates of the trigger sync input circuits. The operation is exactly the same in both circuits with the following two exceptions:

a. When the radar set is Radio Set SCR-784, the range sync input is positive and the polarity selector switch is therefore set at plus (+).

b. The output is coupled to sweep multivibrator tube 9B in the 10 K YD. and CALIB. positions of the range switch; the output is not used in the 75 K YD. and TEST positions.

37. DIVISION MULTIVIBRATOR (fig. 42).

a. Tubes 2A and 2B are used in a cathode-biased multivibrator circuit to count down the trigger sync repetition rate to the IFF repetition rate. When Radio Set SCR-784 is used, its trigger sync rate of 1,706 pps is divided by eight to produce an IFF rate of 213 pps.

b. Tube 2B has no bias because its grid is returned to the cathode at the cathode end of biasing resistor 54-1. This tube therefore conducts heavily, and the steady-state voltage at its plate is comparatively low. The plate load resistance (resistors 79-1, 79-2, and 79-3 in parallel) is made small, only 11,000 ohms, in order to allow the tube to conduct heavily. Capacitor 20 is normally charged to the low voltage between the plate of tube 2B and ground.

c. Tube 2A is biased beyond cut-off by the voltage drop across cathode resistor 54-1 caused by the current through tube 2B. The steady-state voltage at the plate is therefore equal to the plate supply voltage at the junction of B+ dropping resistor 73-1 and decoupling capacitor 6. Capacitor 24 is charged to the high plate voltage of this tube in the normal (steady-state) condition.

d. Subparagraphs b and c above describe the operating conditions that the circuit tends to return to after it is triggered out of its steady-state condition. The trigger which changes this condition is the output of sync amplifier tube 1B. Nine consecutive negative pips from tube 1B are considered to occur at time 0 through time 8 for purposes of this discussion; time 8 is 4,695 microseconds after time 0.

(1) The pip at time 0 cuts off tube 2B and the voltage at the plate of tube 2B rises to the plate supply voltage. These grid and plate voltage changes are shown in the waveforms at time 0.

(2) Capacitor 20 had been charged to a low potential. The voltage across the capacitor cannot change instantaneously; therefore, when the plate voltage of tube 2B rises, the grid of tube 2A also rises. The amount the grid rises is determined by the flow of the charging current through resistor 64-2 (and 54-1 after the grid of tube 2A rises above cathode potential). The purpose of resistor 66 is to limit the capacitor charging current and the voltage developed across resistor 64-2 thereby limiting the grid potential and the grid current drawn by tube 2A. Grid current is undesirable because it rounds off the corner of the pulse at the plate of tube 2B by causing a voltage drop across resistors 79-1, -2, and -3.

(3) The plate voltage of tube 2A therefore drops sharply at time 0 and this drop, coupled by capacitor 24, reinforces the negative voltage at the grid of tube 2B.

(4) The steady-state condition of the two tubes is thus reversed; tube 2A is conducting and tube 2B is cut off. The regenerative feedback from the plate of tube 2A to the grid of tube 2B is sufficient to keep tube 2B cut-off even after capacitor 20 charges, as explained below:

(a) The time constant of capacitor 20 in series with resistors 66 and 64-2 is so short that at approximately time 2½ there is no more feedback from the plate of tube 2B to the grid of tube 2A because capacitor 20 has charged up to the new value. This condition is shown by the plate voltage wave at the plate of tube 2A in figure 55.

(b) However, the voltage at the plate of tube 2A, even after capacitor 20 has charged to the new value, is still far lower than in the steady-state condition. At time 2½, the tube is conducting and the voltage drop across the 56,000-ohm plate load resistor 88 is large. The lowered plate voltage, coupled to the grid of tube 2B by capacitor 24, is all the feedback that is necessary to keep the grid of tube 2B below cut-off.

(5) The time constant of capacitor 24, in series

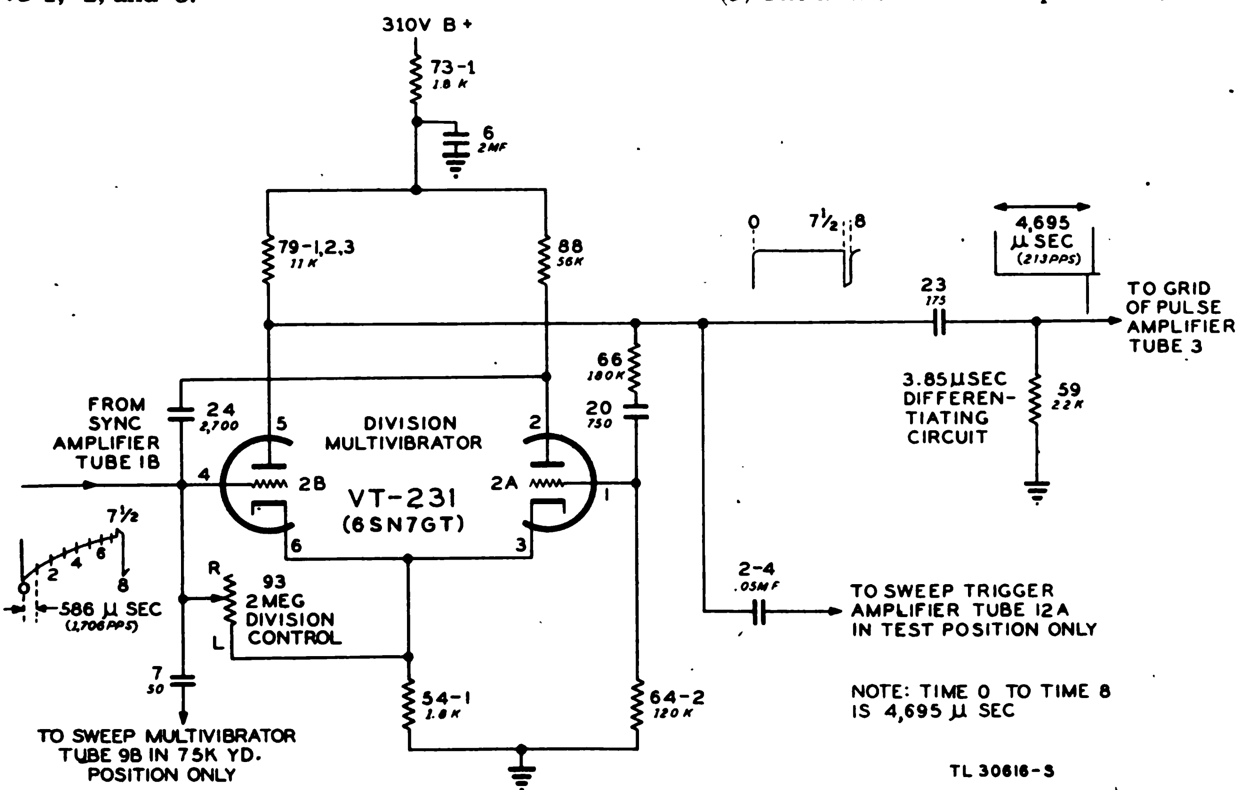


Figure 42. Division multivibrator.

with variable resistor 93 (the DIVISION control) and the plate resistance of tube 2A, thus becomes the factor which determines how long tube 2B remains below cut-off. When capacitor 24 discharges sufficiently, it stops feeding back the reduced plate voltage of tube 2A to the grid of tube 2B. For a division ratio of eight to one, the DIVISION control 93 is set to allow the grid of tube 2B to rise to cut-off at time 7½.

(*6*) As soon as tube 2B starts to conduct, the circuit operation reverses. The plate voltage of tube 2B drops; the drop is fed back to the grid of tube 2A, and the plate voltage of tube 2A rises. This rise is fed back to the grid of tube 2B, reinforcing the plate-voltage drop of tube 2B.

(*7*) Any time after time 7½ the circuit is ready to be again triggered out of the steady-state condition by the next negative pip at the grid of tube 2B. At time 8 a negative pip arrives from sync amplifier tube 1B and the action repeats itself.

e. Two outputs are taken from the division multivibrator.

(*1*) The voltage waveform at the grid of tube 2B is coupled by capacitor 7 and through the range switch to the grid of sweep multivibrator tube 9B when the range switch is in the 75 K YD. position only. In other switch positions capacitor 7 leads to an open switch contact.

(*2*) The voltage waveform at the plate of tube 2B is differentiated by capacitor 23 and resistor 59 (fig. 42). The differentiated pulse is used by the grid of pulse amplifier tube 3 (fig. 43).

38. TRANSMITTER TRIGGERING CIRCUITS (fig. 43)

a. The transmitter triggering circuits produce an amplified and delayed positive pulse from the differentiated output of the division multivibrator. The sharp positive and negative voltage pulses from the differentiating circuit are applied to the grid of tube 3. Tube 3 is biased below cut-off by a voltage divider between B+ and ground consisting of resistors 42 and 52; therefore only the positive differentiated pulses are amplified and appear as negative pulses at the plate of tube 3.

b. The sharp drops in plate voltage at the plate of tube 3 are coupled to the following circuit by capacitor 8. The capacitor shifts the reference level of the pulses at the plate of tube 3, applying sharp negative voltage pulses to the tuned circuit consisting of coil 130 and capacitor 5-1. The tuned circuit is shocked into a heavily damped oscillation by each negative pulse; the oscillations start in the negative direction because they are started by negative pulses, and appear at the grid of tube 4 as sinusoidal swings above and below a zero voltage axis.

c. Tube 4 is a cathode follower biased below cut-off by a voltage divider (between B+ and ground) consisting of resistors 87-7 and 87-8 in parallel and resistor 60-2. The first half-cycle of the damped wave produced by the tuned circuit is negative and has no effect on the tube operation. The portion of the positive grid rise which starts the plate cur-

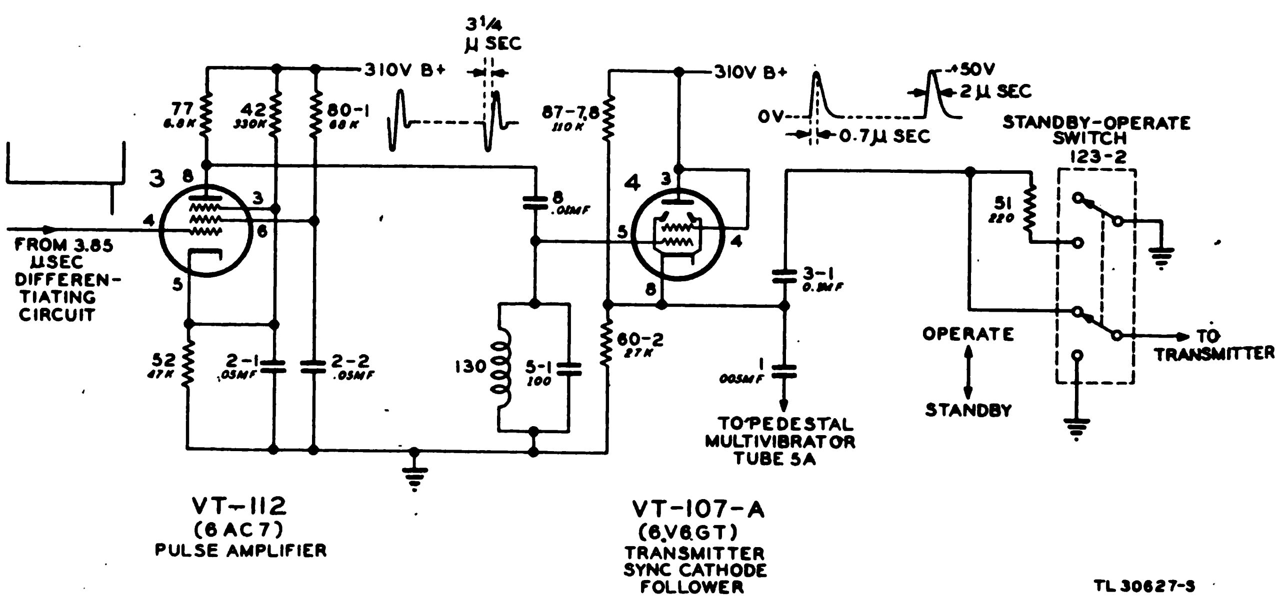


Figure 43. Transmitter triggering circuits.

rent swing of tube 4 is reached 3¼ microseconds after the oscillation starts. The voltage produced across the cathode load of tube 4 is therefore a positive voltage pulse, the leading edge of which is delayed 3¼ microseconds after the trigger sync pulse from the radar set.

d. The output of tube 4 is coupled by capacitor 1 to pedestal multivibrator tube 5A and by capacitor 3-1 to STANDBY-OPERATE switch 123-2. In the OPERATE position of switch 123-2 the output signal is applied to the transmitter synchronizing circuits. In the STANDBY position one section of the switch grounds the signal through load resistor 51; this resistor keeps approximately the same impedance conditions at the junction of capacitors 3-1 and 1 in either position of the STANDBY-OPERATE switch. The other section of the switch grounds the transmitter input circuit to prevent triggering of the transmitter by stray transients.

39. SWEEP MULTIVIBRATOR (fig. 44).

a. The purpose of the sweep multivibrator is to produce rectangular pulses of duration equal to the duration of the sweep desired. The input may come either from the grid of division multivibrator tube 2B (75 K YD. switch position) or from the plate of range sync amplifier tube 8B (10 K YD. and CALIB. switch positions). In both cases, the input which affects the operation of the sweep multivibrator is a sharp negative pip. The negative pip inputs, in the case of the 75 K YD. switch position, correspond in time with the leading edges of the 1st, 9th, 17th, 25th, etc., trigger sync pulses, because of the action of the division multivibrator. The negative pip inputs, in the case of the 10 K YD. and CALIB. switch positions, correspond in time with the leading edges of each range sync pulse. The waveform shown at the grid of tube 9B (fig. 44) is that which appears on a test oscilloscope and is a result of the sweep multivibrator action. This waveform is not the waveform of the negative triggering pips.

b. The sweep multivibrator action is similar to the action of the division multivibrator explained in paragraph 37.

(*1*) Tube 9B normally conducts heavily and tube 9A is cut off.

(*2*) The negative input pip reverses the normal operation.

(*3*) No feedback from the plate of tube 9B to the grid of tube 9A is necessary for two reasons:

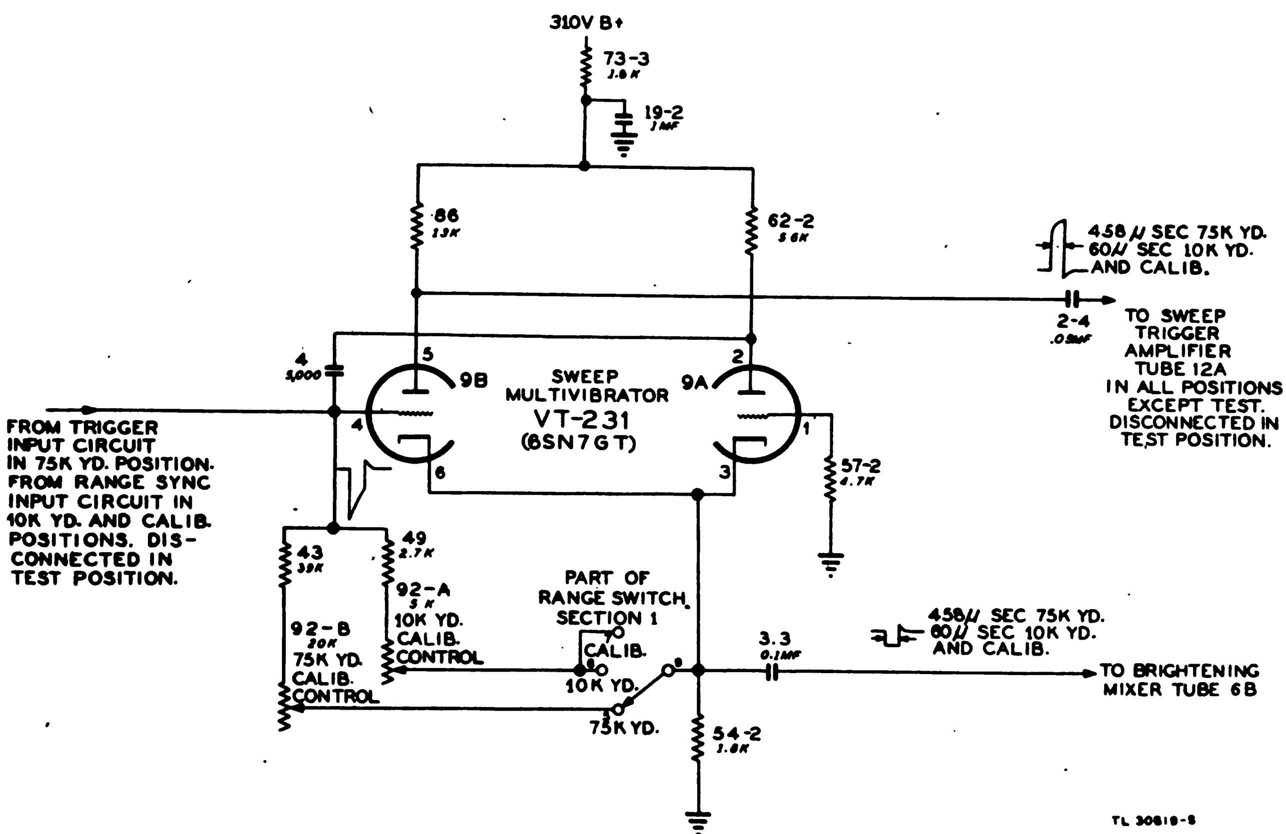


Figure 44. Sweep multivibrator.

(*a*) The duration of reversed operation need only be 458 microseconds at the most, whereas in the case of the division multivibrator the duration has to be more than 7/8 of 4,695 microseconds, or 4,108 microseconds. Additional sustaining feedback from the plate of tube 9B to the grid of tube 9A is therefore unnecessary.

(*b*) The comparatively high value of plate load resistor 62-2 sets the self-biased operation of tube 9A at a level which maintains a reduced voltage at the plate of tube 9A. The feedback of this lowered voltage to the grid of tube 9B through capacitor 4 is sufficient to produce the cycle desired.

(*4*) The time constant of capacitor 4 in series with the plate resistance of tube 9A and the resistance network selected by part of section 1 of the range switch (fig. 44) determines the duration of the reversed condition of operation.

c. The range switch can select resistance values to produce either a 458-microsecond pulse (75 K YD.) or a 60-mocrosecond pulse (10 K YD. and CALIB.).

d. The plate current through tube 9A during the reversed condition of the circuit is less than the plate current through tube 9B during the steady-state condition. The reduced plate current through cathode resistor 54-2 during the reversed condition lowers the cathode voltage and makes a negative rectangular pulse output available at the cathode in addition to the positive pulse output at the plate of tube 9B.

e. After the circuit recovers and returns to the steady-state condition, the next negative pip at the grid of tube 9B repeats the reversal action. In the 75 K YD. range switch position these pips are 4,695 microseconds apart, and therefore the output pulses from the sweep multivibrator appear at the divided repetition rate. In the 10 K YD. and CALIB. positions, the output pulses appear at the radar repetition rate (1,706 pps).

f. The positive output is coupled by capacitor 2-4 to sweep trigger amplifier tube 12A in all range switch positions except TEST. In the TEST position the sweep multivibrator is disabled because the time-constant resistance networks are disconnected from the cathode. Other sections of the range switch disconnect the input and the positive output.

g. The negative output, which appears in all range switch positions except TEST, is coupled by capacitor 3-3 to the brightening mixer tube 6B.

40. SWEEP-FORMING CIRCUITS (fig. 45).

a. Introduction.

(*1*) The sweep-forming circuits have two functions:

(*a*) They generate the negative saw-tooth voltage pulses.

(*b*) They provide a series of sine waves at 200 kc for an interval equal to the sweep interval. These sine waves, each of which has a 5-microsecond period, are used for calibrating the duration of the 10,000-yard sweep and for measuring the duration of the IFF transmitter pulse.

(*2*) The circuit input is a positive rectangular pulse obtained from the division multivibrator in the TEST position of the range switch and from the sweep multivibrator in all other positions of the range switch. The duration of the input pulse sets the duration of the saw-tooth output pulse. The positive input pulse is applied to the grid of the

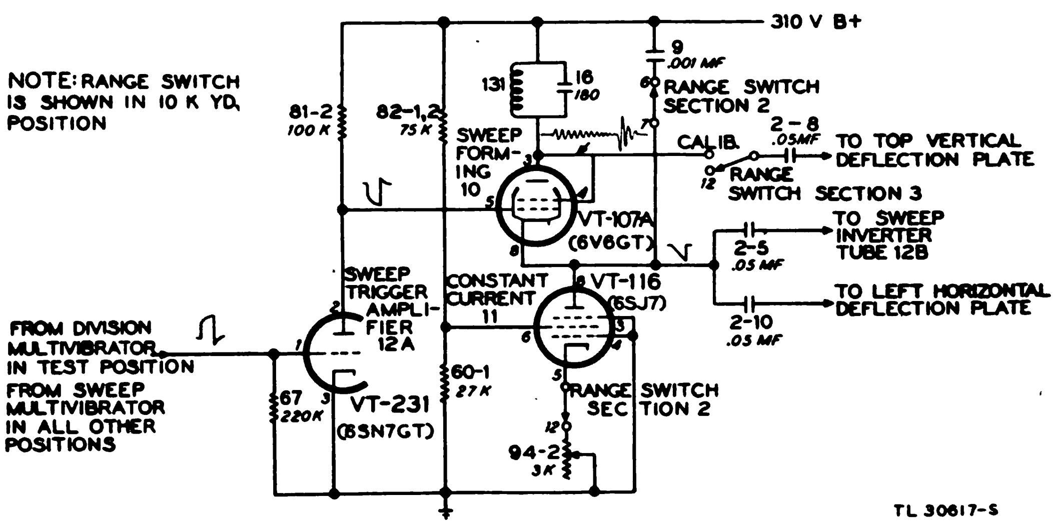


Figure 45. Sweep-forming circuits.

sweep trigger amplifier tube 12A which amplifies and inverts it. The negative pulse at the plate of tube 12A appears across load resistor 81-2 and is fed directly to the grid of sweep forming tube 10.

b. Circuit Description.

(*1*) Tube 10 is connected in series with constant current tube 11, which, together with the cathode resistor of tube 11, forms the cathode circuit of tube 10. Load resistor 81-2 in series with tube 12A forms a voltage-dividing network from B+ which helps set the correct bias on tube 10. The voltage divider from B+ consisting of resistors 82-1 and 82-2 in parallel and 60-1 in series, sets the correct screen voltage for tube 11. The bias on tube 11 is also dependent to a great extent on the plate current drop across its cathode resistor, 94-2 (3,000 ohms) in the 10 K YD. and CALIB. switch positions or 94-1 (3,000 ohms) in the 75 K YD. and TEST switch positions (fig. 57).

(*2*) A 200-kc ringing circuit, consisting of coil 131 and capacitor 16, is in series with B+ and the plate of tube 10. The ringing circuit is of no importance to the sweep-forming function of the circuit and its operation is incidental to the sweep-forming operation although the time of ringing is set by the sweep-forming operation.

(*3*) Tube 10 normally conducts and the voltage drop from B+ to the cathode of tube 10 is normally low. This same low voltage drop also appears across one of three capacitors (as selected by the range switch), wired in parallel with tube 10 and the ringing circuit. Figure 45 shows the range switch set at 10 K YD. when capacitor 9 (0.001 microfarad) is connected between B+ and the cathode of tube 10. The same capacitor is in the circuit in the CALIB. position of the range switch. It is replaced by capacitor 10 (0.015 microfarad) in the 75 K YD. position, or by capacitor 2-6 (0.05 microfarad) in the TEST position (fig. 57).

c. Sweep Formation.

(*1*) In its sweep-forming function, tube 10 acts simply as a switch across the parallel capacitor (capacitor 9 in the switch position chosen for fig. 45). The negative voltage pulse from the plate of tube 12A cuts off tube 10, keeps it cut off for the duration of the pulse, and quickly brings it back to the conducting state at the end of the pulse.

(*2*) If tube 11 were to be considered as a fixed resistor, the sweep-forming action would be as follows: As soon as tube 10 is cut off, capacitor 9 starts to charge to a higher value. As the voltage builds up across the capacitor, the charging current decreases through the capacitor (and therefore through the hypothetical series resistor) and the voltage at the capacitor end of the resistor decreases in a saw-tooth manner. At the expiration of the negative pulse at the grid of tube 10, the capacitor is shunted by the low-resistance circuit of tube 10, and the current through the hypothetical series resistor increases immediately; the voltage at the capacitor end of the resistor swings up to form the vertical line of the saw tooth.

(*3*) The drawback to the fixed-resistor sweep-forming system described above is that charging current through a capacitor does not decrease at a uniform rate because the impedance offered by the capacitor does not increase at a uniform rate, and the sloping part of the saw tooth would be curved. Such a saw tooth would not move the electron beam across the face of the display tube at a uniform rate of speed. If, however, the hypothetical resistor could be made to decrease in value as the capacitor impedance increases, the current would be kept fairly constant. The voltage waveform across a gradually decreasing resistance for a constant current is similar to the voltage waveform across a constant resistance for a gradually decreasing current. In the case of the constant current, if the resistance decreases at a uniform rate, the sloping part of the saw tooth is a straight line. This is the ideal resistor.

(*4*) Tube 11 is a compromise between the ideal resistor and a fixed resistor and furnishes a much better saw-tooth wave than a fixed resistor would. All the electrodes in tube 11 have fixed voltages with the exception of the plate and cathode; because the tube is a pentode with a fixed screen-grid potential, variations in plate voltage have very little effect on the resistance offered by the tube. Variations in cathode voltage, however, have a large effect on the resistance of the tube.

(*5*) As the charging current through the capacitor, tube, and cathode resistor 94-2 tends to decrease, the voltage drop across resistor 94-2 decreases, the cathode becomes less positive with respect to the grids, the tube resistance decreases, and the charging current is kept more constant. Moreover, the nonlinearity of the capacitor charging curve is compensated by the nonlinearity of the tube's change of resistance with change of bias; because the nonlinearities are in opposite directions, the result is an almost perfectly linear saw-tooth pulse at the capacitor end of the tube.

(*6*) Varying the setting of control 94-2 (10 K

YD. GAIN) varies the amount of bias change which the tube experiences as charging current changes, and therefore varies the total voltage change across the tube. With more total voltage change the amplitude of the saw-tooth pulse and the length of the sweep trace is increased. When the range switch is in the 75 K YD. and TEST positions, control 94-1 (75 K YD. GAIN) is substituted for 94-2 so that individual sweep length adjustments can be made. Note that these controls have no effect on the *duration* of the sweep; the duration is fixed by the duration of the pulse from the sweep multivibrator.

d. Calibrating Waves. As tube 10 is cut off by the negative sweep trigger pulse, plate current through coil 131 suddenly stops, and the tuned circuit is shocked into slowly damped oscillation. As soon as conduction begins again, a new oscillation is set up, more violent than the previous one because of the added energy of the plate current. The d-c plate current, however, quickly damps the new oscillation. These conditions are shown in the waveform at the plate of tube 10 (fig. 45). The reason that the straight line at the left and the violent oscillations at the right of the waveform (fig. 45) are not seen on the display screen (fig. 37) is that there is no sweep on the screen at these times. The sweep trigger start is synchronous with the first positive sinusoidal rise at the left end; the sweep trigger finish causes the violent oscillations at the right end.

e. Outputs.

(*1*) The negative saw-tooth pulse is coupled by capacitor 2-5 to sweep inverter tube 12B and by capacitor 2-10 to the left horizontal-deflection plate of the display tube.

(*2*) The calibrating waves are coupled by capacitor 2-8 to the top vertical-deflection plate of the display tube in the CALIB. position of the range switch only. In all other positions the waves are not used.

41. SWEEP INVERTER AND SPREAD CIRCUITS (figs. 46–49).

a. Sweep Inversion. Antenna Tower Kit AS-134/TPX is normally furnished as part of Radio Equipment RC-384. This antenna system has no provisions for lobe switching. The circuit of figure 46 will therefore first be described as though no rectangular voltage wave (spread voltage) were present. In this case the SPREAD control 100 (fig. 46) is left in the counterclockwise position, that is, with the moving arm at the grounded end of resistor 100. The negative saw-tooth pulse from the sweep forming circuits is attenuated by the voltage divider consisting of resistors 70 and 48. The voltage divider applies the negative saw-tooth pulse at one-eleventh the original amplitude to the grid of sweep inverter tube 12B. The tube is self-biased by cathode resistor 53-2. This resistor is not bypassed by a capacitor and the resulting degenerative feed back reduces the gain of the stage to a ratio of 11:1. The output appears across the plate load resistors (81-3 and 81-4 in parallel) as a positive saw-tooth pulse with the original amplitude. This pulse is coupled to the right horizontal-deflection plate of the display tube by capacitor 12. Simultaneously, an equal-amplitude but negative saw-tooth pulse is applied to the left horizontal-deflection plate by the sweep-forming circuits. The negative pulse *pushes* the electron beam from left to right and the positive pulse *pulls* the electron beam from left to right; because of the "push-pull" action, each pulse need have only half the amplitude necessary when a single pulse is used. The advantage of low-amplitude pulses is that they can be formed and preserved with more linearity than high-amplitude pulses.

b. Lobe Switching.

(*1*) Circuits are provided in the control unit to view separately the signals received from each of the two antenna patterns if a lobe-switching

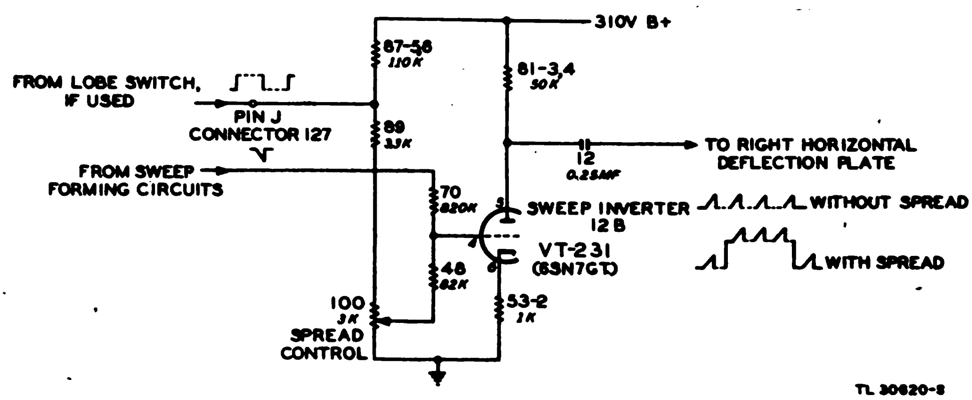


Figure 46. Sweep inverter and spread circuits.

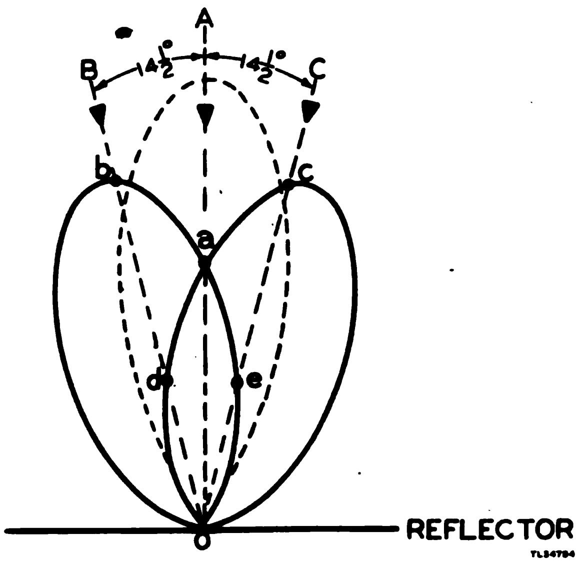


Figure 47. Typical lobe displacement with a lobe-switching antenna.

antenna is substituted for Antenna System AS-134/TPX. A lobe switch, mounted in the housing of the lobe-switching antenna, alternately selects either of two antenna patterns displaced from the normal with respect to the reflector. The typical lobe-switching antenna system described here displaces the antenna patterns about 14½° from the normal to the reflector (fig. 47). Direction *A* to *O* is normal (90°) to the reflector. If a signal is received from a direction such as *B* to *O* and the left-hand lobe is switched to the input of the receiver, the intensity of the received signal is proportional to the distance *b* to *O*. With the right-hand lobe connected to the receiver input, the signal is proportional to the distance *d* to *O*. Similarly, when a signal is coming in from a point *C*, the right- and left-lobe signal intensities are proportional to distances *c* to *O* and *e* to *O*, respectively. A signal coming in from a position perpendicular to the reflector (as at *A*) would intercept both lobes at equal amplitudes.

(*2*) To determine the direction from which a signal is coming, the receiver input is alternately switched from one lobe to the other. Simultaneously, the sweep on the control unit display tube screen is made to start from two different points. Figure 48 shows the appearance of reply pulses on the display screen as the antenna is rotated from right to left. With respect to the antenna, figure 48-A shows the target at bearing *B* (fig. 47); figure 48-B shows the target at bearing *A* (fig. 47); and figure 48-C shows the target at bearing C (fig. 47).

(*3*) The typical lobe-switch motor turns at a speed that is synchronous with the line frequency

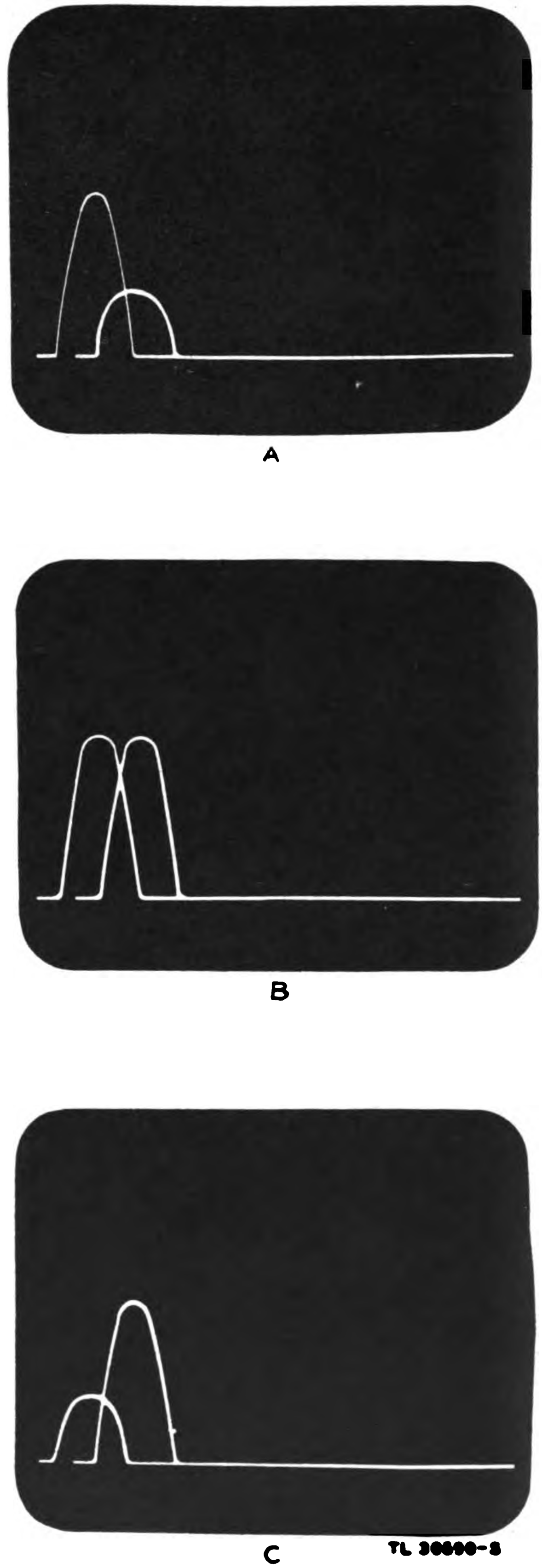


Figure 48. Azimuth determination with a lobe-switching antenna, 10 K YD. switch position.

and makes 30 complete revolutions per second. Each lobe is on for 1/60 second, 16,667 microseconds. The IFF recurrence rate is between 200 and 240 pps. With Radio Set SCR-784 and a division ratio of 8:1, the IFF recurrence rate is 213 pps, and the time between successive IFF transmitter pulses is 4,695 microseconds. This is also the time between successive brightened sweeps. For every half-cycle of lobe switch operation (16,667 microseconds), three complete sweeps appear on the screen of the display tube.

(*4*) The mechanism for producing a displaced pattern for either lobe is a combination of mechanical switching in the lobe switch and a process of changing the sweep-positioning voltage on the right horizontal-deflection plate of the display tube. Figure 49 shows the d-c connections in a typical lobe switch for three possible combinations of cam contacts during any cycle.

(*5*) If a lobe-switching antenna is used, Cord CD-1382, which connects the control unit to the rack, would have to be discarded because it makes no connection to pins G and J of control unit receptacle 127; another cord is substituted which connects pin G (fig. 52) and pin J (fig. 46) with the lobe switch (fig. 49). (The pin G connection is explained in paragraph 44.)

(*6*) Pin J (fig. 46) is connected to the junction of resistors 87-5 and 87-6 in parallel and resistor 89. When contact L is open (fig. 49-C), this junction point is also connected, through pin G, to the cathode circuit of tube 7B (fig. 52). The voltage dividers from B+ to ground in both circuits (figs. 46 and 52) combine to apply about 21 volts of positive dc to the pin J connection point (fig. 46). This voltage is reduced by the voltage divider consisting of resistor 89 and SPREAD control 100 so that about 10 volts appear across the SPREAD control. Any portion of the 10 volts can be picked off by the moving arm of the SPREAD control and applied to the grid of tube 12B. When the grid potential is raised by voltage from the SPREAD control, the plate voltage is lowered. When contact L is closed (fig. 49-A and -B), the pin J connection point (fig. 46) is at ground potential, no voltage appears across the SPREAD control, and the plate voltage of tube 12B is raised.

(*7*) Thus two operating levels of plate voltage are established. These levels can be considered as *platforms of voltage*, the lower platform appearing for 46 percent (fig. 49-C) of the 33,333-microsecond duration of each lobe-switch cycle, and the higher platform appearing for 54 percent (fig. 49-A and -B) of the cycle. The saw-tooth pulses are superimposed on these voltage platforms (fig. 46).

(*8*) Coupling capacitor 12 is large enough (0.25 microfarad) to pass the comparatively long voltage platforms to the right horizontal-deflection plate

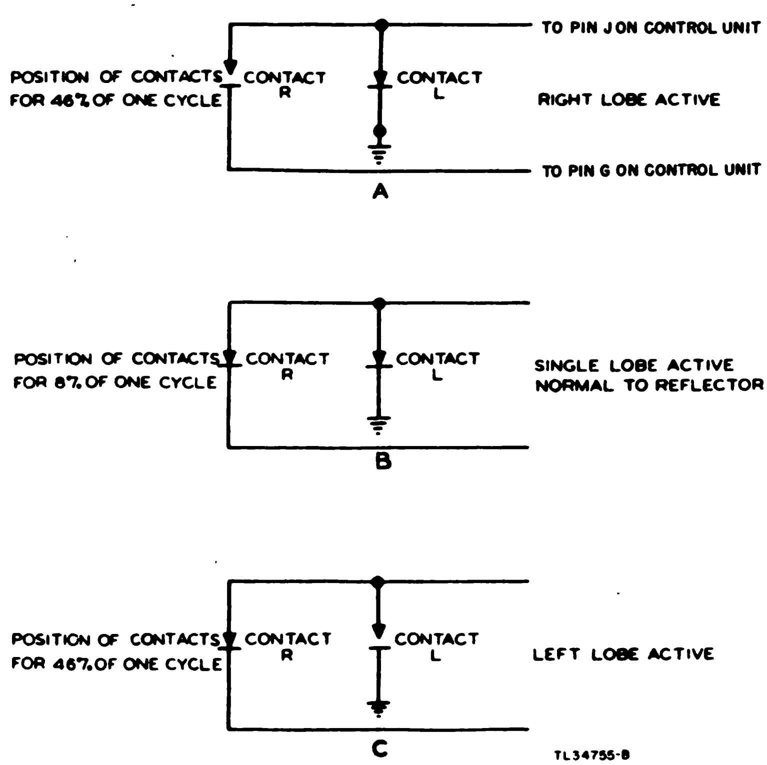


Figure 49. Typical cam operation with a lobe-switching antenna.

of the display tube. The coupling capacitor shifts the axis of the rectangular wave so that the higher platform adds to the sweep-positioning potential and shifts the trace positioning to the right, and the lower platform subtracts from the positioning potential and shifts the trace positioning to the left. A total separation of ½ inch can be obtained by turning the SPREAD control to its maximum clockwise position.

42. PEDESTAL MULTIVIBRATOR (fig. 50).

The same positive pulse output (fig. 43) which is used to trigger the IFF transmitter is also used to trigger the pedestal multivibrator. The purpose of the pedestal multivibrator is to produce a negative rectangular pulse 500 microseconds wide and with leading edge coinciding in time with the leading edge of the transmitter triggering pulse. The pedestal pulse is used in the sweep brightening mixer circuit to insure that only one out of every eight 10,000-yard sweeps is brightened.

a. The circuit is a cathode-biased multivibrator. The plate supply voltage is reduced by B+ dropping resistor 73-2 which is decoupled from the circuit by capacitor 19-1. Resistor 57-1 is a grid-current limiting resistor. Tube 5A is normally cut off by the bias developed across cathode resistor 74. Tube B5 normally conducts heavily because its grid is returned to the cathode and is at the same potential as the cathode. The plate voltage of tube 5A is normally high and capacitor 21 is charged to this high voltage. The plate voltage of tube 5B is normally low because of the comparatively high plate current through tube 5B.

b. The leading edge of the positive input pulse reverses the normal condition by causing tube 5A to conduct. The plate voltage of tube 5A drops and because the voltage across capacitor 21 cannot change instantaneously, the grid of tube 5B drops an equal amount, and tube 5B is cut off.

c. Capacitor 21 discharges through PEDESTAL WIDTH control 101 and the internal resistance of tube 5A. As the voltage drop across the capacitor decreases, the grid voltage of tube 5B rises. When the grid voltage rises above cut-off, the circuit immediately returns to the normal condition of operation because of the following regenerative action: plate current through tube 5B increases the voltage drop across cathode resistor 74 and thus increases the bias on tube 5A; the plate voltage of tube 5A rises and the rise is coupled back to the grid of tube 5B by capacitor 21; this regenerative action quickly restores the normal condition.

d. The R-C time constant of capacitor 21 in series with the PEDESTAL WIDTH control and the internal resistance of tube 5A determines the duration of the reversed condition of operation. The PEDESTAL WIDTH control is adjusted for a duration slightly longer than the 458-microsecond duration of the 75,000-yard sweep. The adjustment procedure (par. 101**f**) is such as to set the duration to about 500 microseconds.

e. Less plate current flows through cathode resistor 74 in the reversed operation than in the normal operation because tube 5A conducts less in the reversed operation than tube 5B did during normal operation. The conduction of tube 5A is limited by

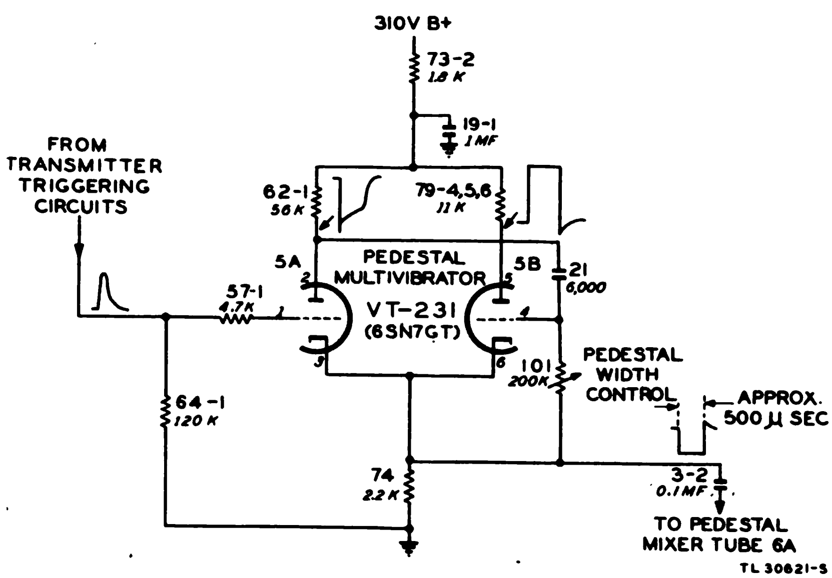


Figure 50. Pedestal multivibrator.

the biasing voltage developed across cathode resistor 74 and by the comparatively large value of plate load resistor 62-1. The reduced current through cathode resistor 74 lowers the cathode voltage and makes a negative output pulse available at the cathode; the duration of the negative pulse is equal to the duration of the reversed condition of operation. The output pulse is coupled by capacitor 3-2 to pedestal mixer tube 6A.

43. SWEEP BRIGHTENING MIXERS (fig. 51).

Pedestal mixer 6A and brightening mixer 6B mix and amplify the outputs of the pedestal multivibrator and sweep multivibrator to provide a brightening pedestal to the grid of the cathode-ray tube.

a. The 500-microsecond negative rectangular pulse from the pedestal multivibrator is applied to the grid of pedestal mixer tube 6A. The output at the plate is an amplified positive pulse. The leading edge of this pulse coincides in time with the leading edge of the delayed transmitter sync pulse.

b. The negative output of the sweep multivibrator is applied to the grid of brightening mixer tube 6B. In the 75 K YD. position of the range switch the negative output of the sweep multivibrator is an undelayed rectangular pulse 458 microseconds in duration. In the 10 K YD. switch position the pulse is 60 microseconds in duration. Either of these two outputs, as determined by the position of the range switch, is amplified in the brightening mixer. The output at the plate is a positive pulse.

c. Because the pedestal mixer and the brightening mixer have a common plate load resistor, the output of the two stages is the combined waveform shown in figure 51. This waveform is applied to the grid circuit of brightening cathode-followed tube 7A.

d. In the TEST position of the range switch the low end of common cathode resistor 53-1 is disconnected from ground, the entire circuit is disabled, and no output pulses are applied to the brightening cathode-follower tube 7A.

44. BLANKING AND BRIGHTENING OUTPUT CIRCUITS (figs. 49 and 52).

a. Brightening Output Circuit. The circuit of figure 52 will first be described as though a lobe-switching antenna is not used.

(*1*) Although tube 7A is connected as a cathode follower, its output is not a faithful reproduction of its input because its grid is driven positive with respect to its cathode. The circuit operation is as follows:

(*a*) The positive pulse from the sweep brightening mixers has an amplitude of more than 125 volts. High cathode current flows during the pulse, but cathode resistor 76 is small (1,500 ohms), and the cathode voltage cannot rise sufficiently to prevent grid current.

(*b*) With grid current flowing, the resistance from grid to ground is equal to the low grid-to-cathode resistance in series with resistor 76 and both in parallel with resistor 69-3. During the pulse the charging circuit of capacitor 2-3 is this low grid-to-ground resistance in series with the 34,000-ohm plate load resistance of the sweep brightening

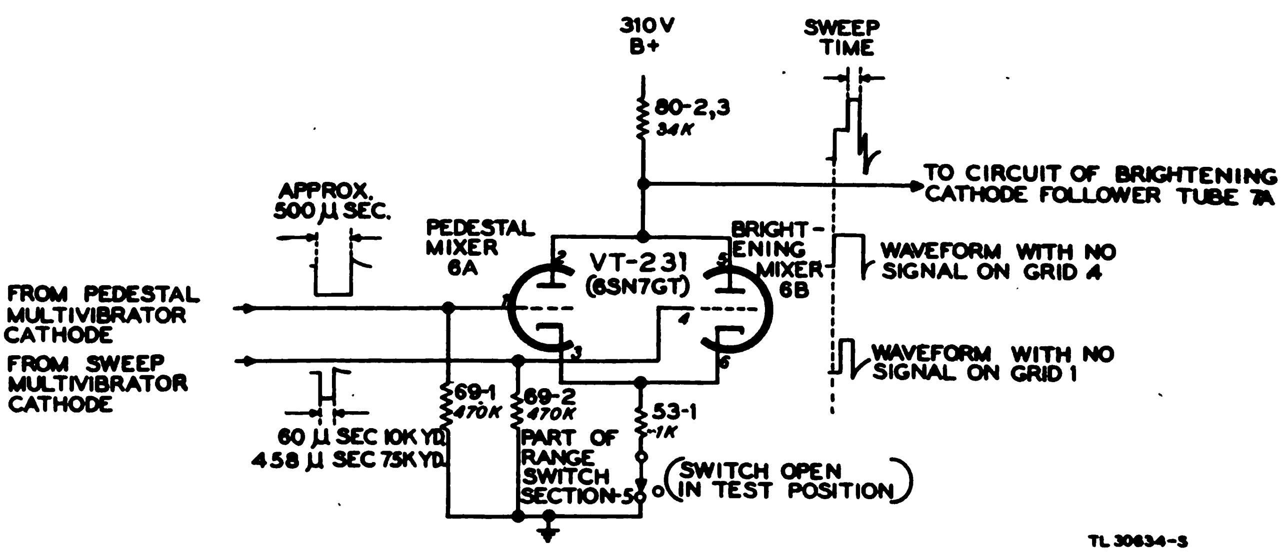


Figure 51. Sweep brightening mixers.

mixers (fig. 51). The R-C time constant of this circuit is about 2,000 microseconds.

(*c*) In the period between pulses the grid-to-cathode resistance of tube 7A is infinite, and the time constant of the circuit is about 25,000 microseconds.

(*d*) With no pulses, capacitor 2-3 is charged to the voltage at the plates of tube 6, approximately 150 volts. The pulse amplitude is about 125 volts; that is, the voltage at the plate side of the capacitor rises to 275 volts. During the first pulse the 150-volt capacitor charge is increased by a fixed percentage of the 125-volt difference in potential levels; the percentage is determined by the pulse duration and by the 2,000-microsecond time constant of the charging circuit. The time between the first and second pulses is insufficient to allow the capacitor to discharge to the original 150-volt level for two reasons: the difference in potential levels is only a *percentage* of 125 volts, and the time constant of the discharge circuit is 25,000 microseconds. The second 125-volt pulse is opposed by the residual charge (above 150 volts) in the capacitor, but the difference in potential levels is still large enough to allow the pulse to add to this residual charge. Similarly, each successive pulse adds to the charge until a condition of equilibrium is reached when the charging potential difference is so small and the discharging potential difference is so large that the capacitor discharges between pulses as much as it charges during pulses. This condition of equilibrium is not reached, however, until a comparatively high voltage (above the 150-volt level) exists across the capacitor.

(*e*) The polarity of the voltage across capacitor 2-3 is negative on the grid side and this voltage applies a negative bias to the grid of tube 7A; because of this negative bias, only the upper portion of the input pulse appears in the output at the cathode of tube 7A; the lower portion of the input pulse is clipped.

(*2*) In the 75 K YD. range switch position the leading edge of this pulse occurs 3¼ microseconds after the start of the 75,000-yard sweep, and the trailing edge coincides with the end of the 75,000-yard sweep. Although the output of the pedestal multivibrator has greater duration than the 75,000-yard sweep, the "adding" action of the sweep brightening mixer circuit, as shown in the waveforms of figure 51, the clipping action of the brightening cathode follower stage, and the setting of the INTENSITY control result in an effective brightening pulse coinciding with all but the first 3¼ microseconds of the 75,000-yard sweep.

(*3*) In the 10 K YD. range switch position the output pulse corresponds in time and duration with the one in every eight 10,000-yard sweeps which is to be brightened. This is true at all ranges beyond about 530 yards (3¼ microseconds); if the radar range were set to zero yards, the first 3¼ microseconds of the 10,000-yard sweep would be blanked.

(*4*) In either position of the range switch, the brightening pulse terminates soon enough to eliminate sweep flyback on the display screen and also to prevent the appearance at the beginning of the sweep of a bright spot caused by the electron beam lingering at the left end of the screen between sweeps.

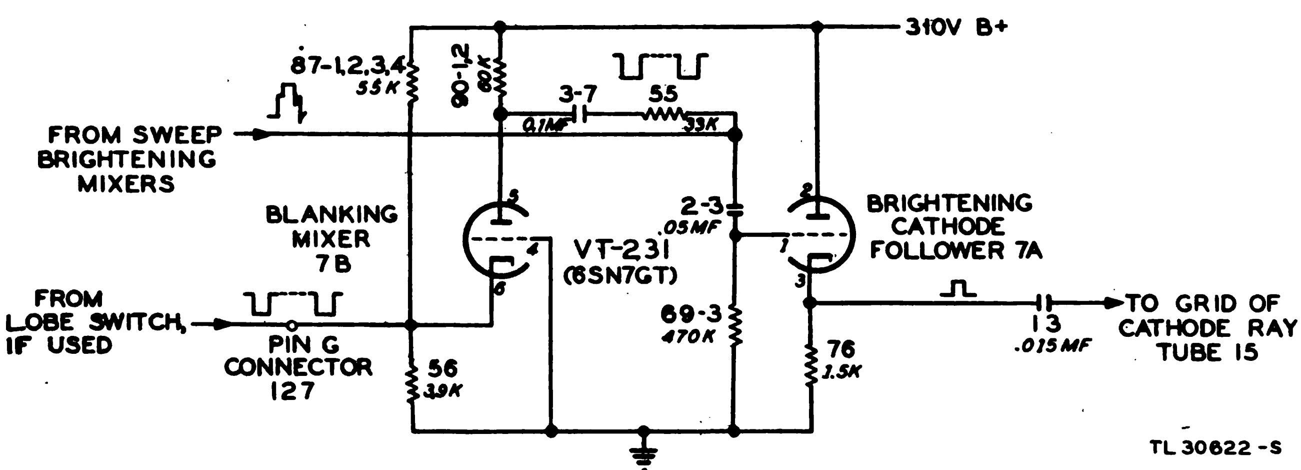


Figure 52. Blanking mixer and brightening output circuits.

(*5*) The output pulse, which is coupled to the grid of the display tube by capacitor 13, reduces the bias on the display tube grid, sufficiently to brighten the sweep.

b. Blanking. When a lobe-switching antenna is not used, blanking mixer tube 7B contributes nothing to circuit operation. When a lobe-switching antenna is used, means must be provided to blank the sweep during the transition period from one lobe to the other. If this is not done, the output of a single lobe normal to the reflector (fig. 47) appears on the display tube screen and complicates the pattern.

(*1*) Tube 7B is biased to cut-off by the voltage divider consisting of resistors 87-1 through 87-4 in parallel and the cathode resistor 56. The cathode is connected to the blanking cam of the lobe switch (contact R, fig. 49) through pin G of connector 127 when a cable suitable for use with a lobe-switching antenna is substituted for Cord CD-1382.

(*2*) During the 8 percent of each lobe-switch cycle when the lobe switch is shifting from one lobe to the other (fig. 49-B), the cathode of tube 7B is grounded and the tube conducts. Its plate voltage drops and remains lower for 8 percent of the lobe-switch cycle. When the contact opens, the tube is again cut off and the plate voltage rises. The result is a negative rectangular pulse at the plate of tube 7B.

(*3*) The typical lobe switch represented in figure 49 makes 30 complete revolutions per second and each revolution takes 33,333 microseconds. The duration of each blanking pulse at the plate of tube 7B is 8 percent of each revolution (2,667 microseconds). The repetition rate of the blanking pulses is 60 pps because two pulses occur for each lobe switch revolution.

(*4*) The negative pulses are coupled to the grid of brightening cathode-follower tube 7A by coupling capacitor 3-7, isolating resistor 55, and coupling capacitor 2-3. They are of sufficient amplitude to prevent any positive output at the cathode of tube 7A during their presence. Thus no sweeps can appear on the display tube during the lobe-switching transition period.

45. VIDEO AMPLIFIER AND SENSITIVITY CONTROL (fig. 53).

a. Although the video amplifier is located in the control unit, it actually constitutes the final stage of video amplification of the receiver.

b. The video amplifier is a conventional resistance-coupled amplifier. Resistor 72 is a B+ dropping resistor; capacitor 19-3 is a decoupling capacitor. The negative output of the stage is coupled by capacitor 2-7 to the lower vertical-deflection plate of the cathode-ray tube. The negative output repels the electron beam of the display tube upward and IFF reply pulses are therefore displayed above the baseline.

c. For the convenience of the operator the gain control (SENSITIVITY) of the receiver is located on the front panel of the control unit. This control (98 in fig. 53) is part of the cathode circuit of the first r-f and the first three i-f tubes in the receiver. Varying the control changes the bias on these tubes. Because of the "variable mu" characteristic (amplification dependent upon bias) of these tubes, varying their bias controls the gain of the receiver.

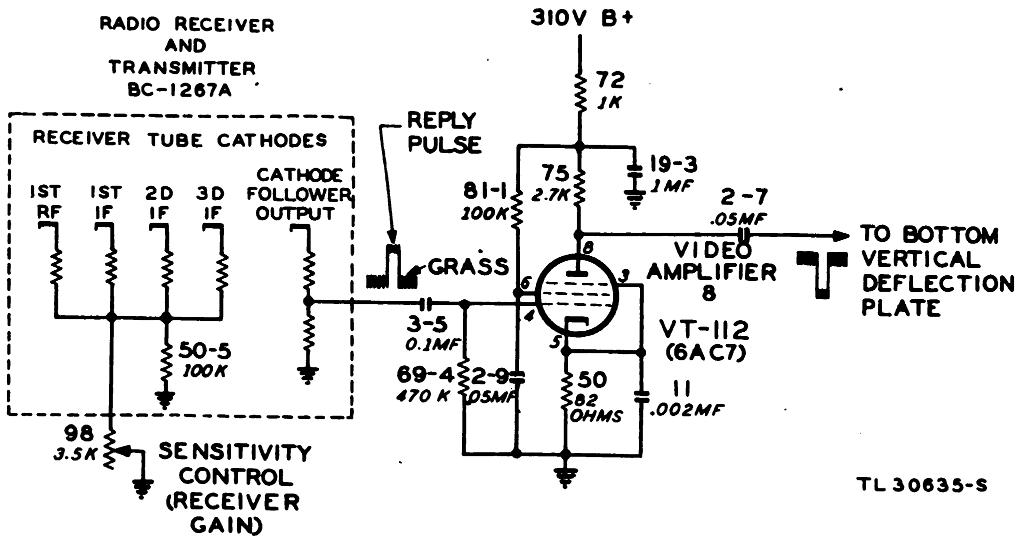


Figure 53. Video amplifier and sensitivity control.

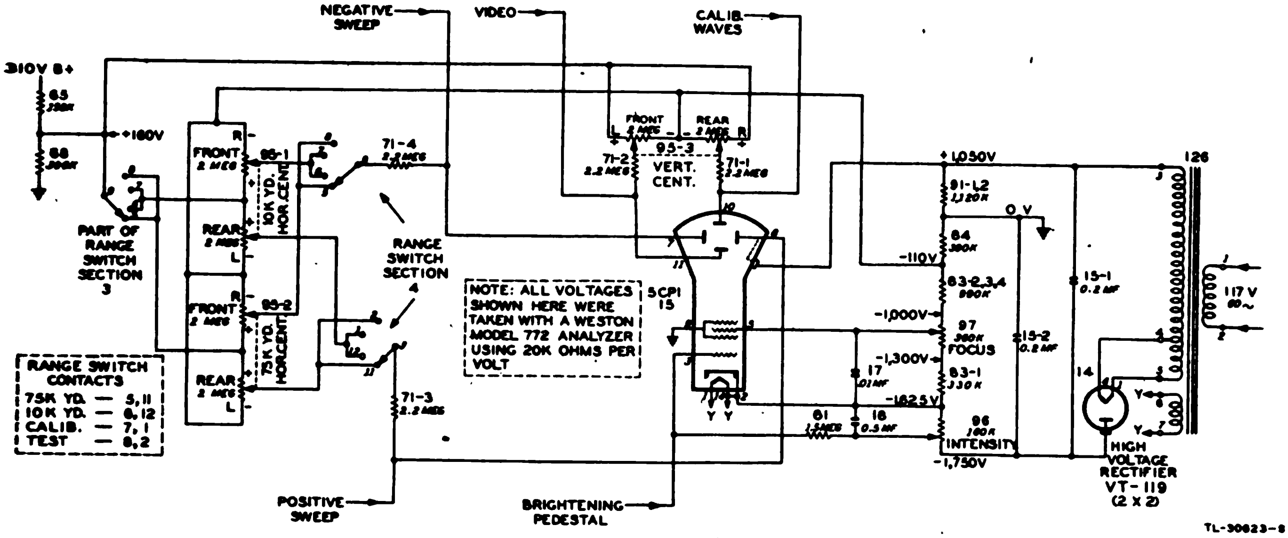


Figure 54. Control unit display tube circuits.

46. DISPLAY TUBE CIRCUITS (fig. 54).

a. The cathode ray tube is a 5CP1 tube used in a conventional manner. The operating voltages are supplied by transformer 126 and rectifier tube 14. A voltage divider across the output of the rectifier circuit provides voltages at the proper potentials for the electrodes of the display tube. Capacitors 15-1 and 15-2 across the voltage divider are filter capacitors. Potentiometer 97 in the voltage divider varies the voltage applied to the focusing anode. Potentiometer 96 varies the negative potential applied to the grid of the tube and therefore controls the intensity of the electron stream. Resistor 61 limits grid current. Capacitors 17 and 18 bypass any stray transients which might cause defocusing or intensity modulation. Resistors 71-1 through 71-4 isolate pulse voltages from the positioning controls.

b. Dual controls 95-1 and 95-2, either of which is selected by the range switch, supply d-c positioning voltage for centering the baseline horizontally. Separate controls are used so that individual adjustments can be made, one for the 75 K YD. and TEST positions, and another for the 10 K YD. and CALIB. positions of the range switch. D-C positioning voltage for centering the baseline vertically is controlled by dual control 95-3. The operation of this control is typical of all three of the dual controls. When the control is turned to the right, the potential on the lower deflection plate becomes more negative and the potential on the upper deflection plate becomes more positive. This positions the trace upward on the screen of the cathode ray tube. When the control is turned to the left, the potentials are reversed, and the trace is shifted downward.

47. MISCELLANEOUS CIRCUIT INFORMATION (figs. 57 and 122).

a. The 310-volt B+ voltage for the control unit is furnished by Power supply RA-105-A and is brought from Rack FM-93 through Cord CD-1382 to pin M of connector 127. The B+ voltage is on all the time that the PLATE VOLTAGE circuit breaker on the power supply is at ON; it is *not* controlled by the ON-OFF switch on the control unit.

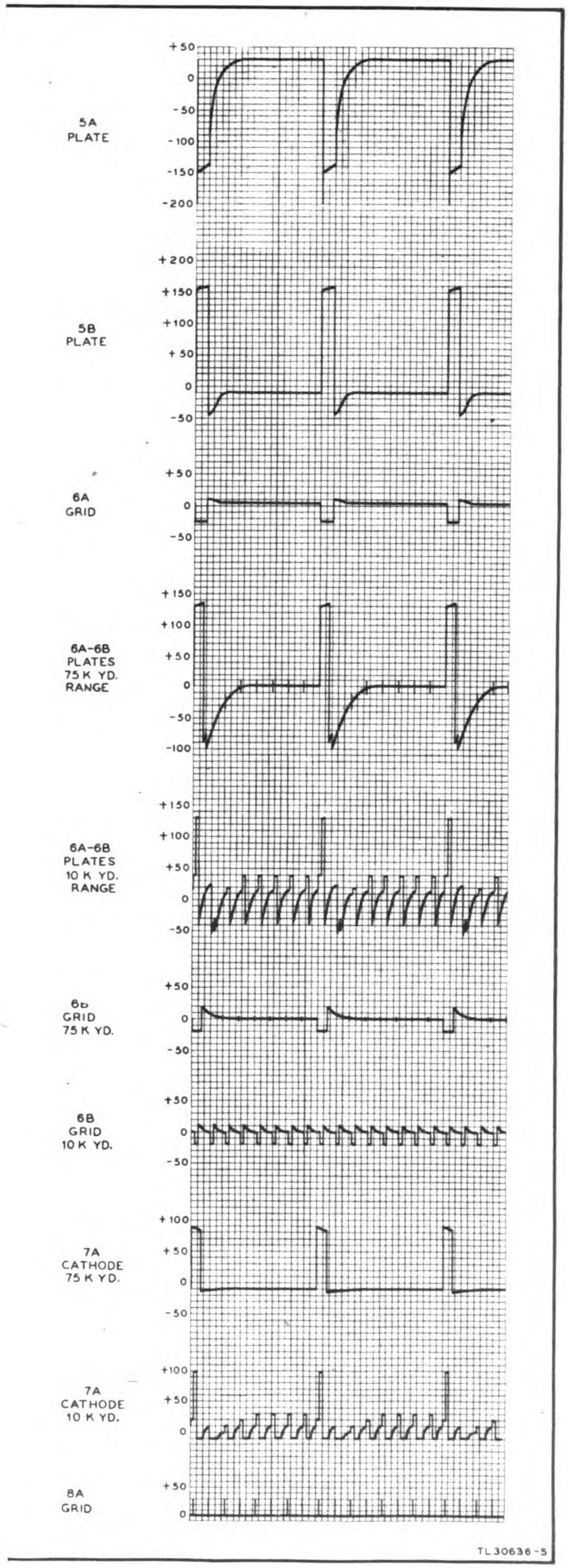
b. The 117-volt, 60-cycle line voltage is brought from the rack to pins D and E of connector 127. Fuse 129 and ON-OFF switch 122 are in series with one side of the 60-cycle line. The line voltage supplies power to transformers 125 and 126. Transformer 126 is shown in figure 54 and its use is explained in paragraph 46. Transformer 125 supplies 6.3 volts ac to all the receiving-type tubes in the control unit and to the pilot light 134.

c. Resistor 133, connected between pins C and E of connector 127, is a heater. It is wired into the rack circuit through Cord CD-1382 so that it is in parallel with the rack heaters. Whenever the HEATERS and BLOWERS switches at the bottom of the rack are at ON, pin C of connector 127 is connected to pin D and line voltage is applied across resistor 133; (the heaters cannot go on unless the rack blowers are on).

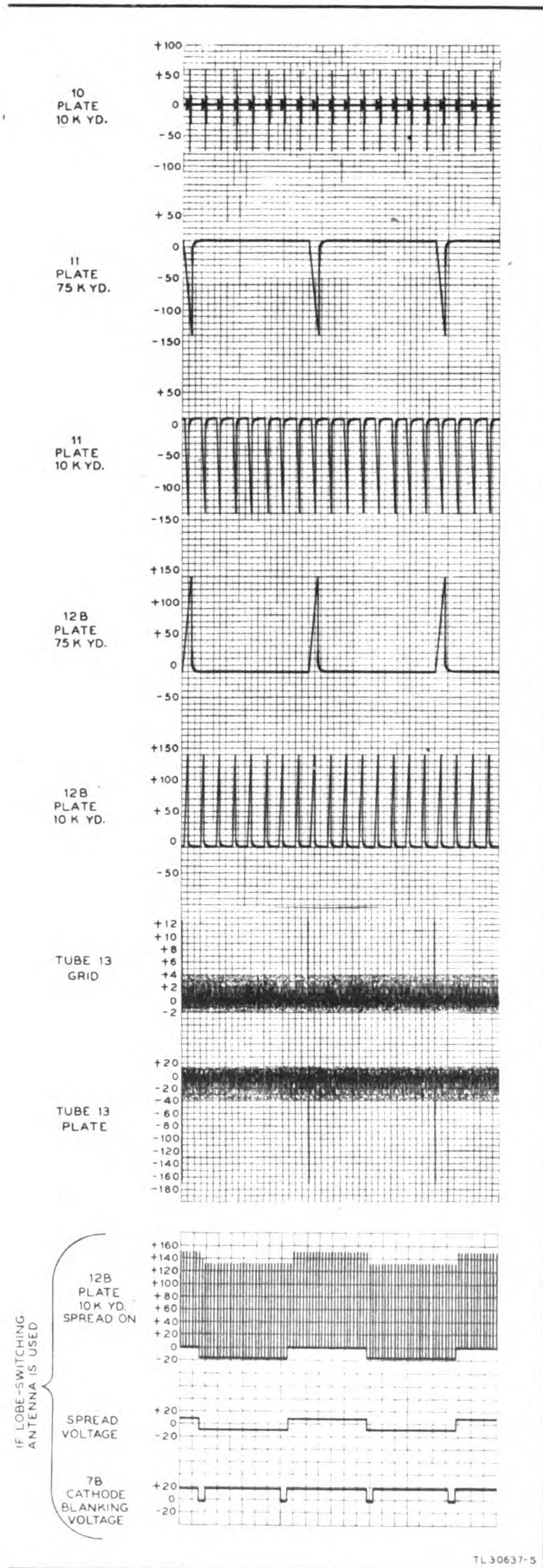
d. Blower moter 135, used to prevent overheating, is controlled by switch 123-4 on the back panel of the control unit inner case. This switch makes the control unit blower independent of the rack blowers. However, whenever the heaters are turned on, the control unit blower is also turned on (fig. 122) even if switch 123-4 is in the OFF position. This wiring arrangement eliminates the possibility of too much heat concentration around control unit heater 133.

e. Ten test jacks are provided at various points in the circuit for test purposes. Their circuit location is shown in figures 57 and 100. Note that input test jack 120, which connects to the top vertical-deflection plate of the display tube, is a switching-type jack. When an external signal is connected, the 10,000-yard calibration waves are automatically disconnected even if the range switch is at CALIB. In other positions of the range switch the jack switch is of no importance because there is no signal voltage in the jack-switch line.

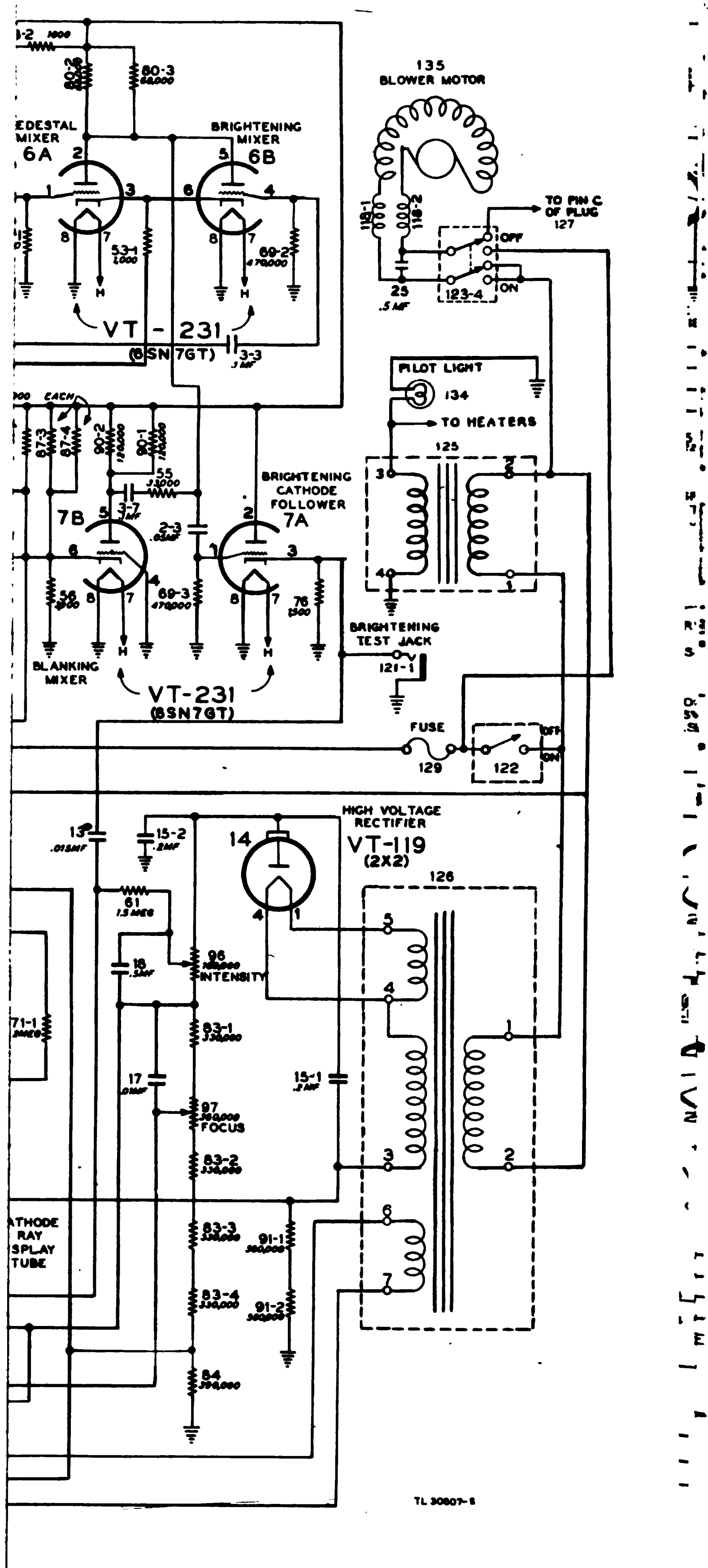
f. Spark plates 132-1 through 132-4 are bypass capacitors with extremely low series inductance. They are used to ground out pick-up of the high-powered r-f impulses from the radar transmitter.



rol unit waveforms.



ol unit waveforms.



ol Unit BC-1378, complete schematic diagram.

CHAPTER 6.
POWER-SUPPLY SYSTEM

48. INTRODUCTION.

a. Power Supply RA-105-A supplies all voltages to Radio Receiver and Transmitter BC-1267-A and B+ voltages to Control Unit BC-1378. High-voltage d-c for the cathode-ray tube and filament voltages for all tubes in the control unit are supplied by a separate power supply circuit in the control unit. This separate power supply is discussed in chapter 5, Range and Timing System.

b. Power Supply RA-105-A consists of seven rectifier tubes and associated filter circuits, transformers, circuit breakers, pilot lamps, fuses, and an interlock switch. A detailed discussion of the circuit elements is given in the following paragraphs.

49. FUNCTIONING OF PARTS.

a. Protective Devices (fig. 59).

(*1*) FILAMENT VOLTAGE circuit breaker 44 is a 10-ampere, 117.5-volt magnetic breaker, containing a current coil which opens the circuit if a current greater than 10 amperes is drawn by the primaries of transformers 56, 57, 58, and 59. Circuit breaker 44 is also connected in the circuit so that PLATE VOLTAGE circuit breaker 43 cannot supply power to trqnsformers 58 and 59 unless circuit breaker 44 is closed. This prevents the application of plate voltage to the rectifier tubes until after the filament voltage has been applied and therefore prevents injury to the cathodes of the rectifier tubes. The primaries of transformers 56 and 57 are further protected by fuses 70-1 and 72, respectively. Pilot lamps 35-1 and 35-2 light when transformers 56 and 57 are energized. Circuit breaker 43 controls the two plate-voltage transformers 58 and 59. This circuit breaker contains a current coil in series with the secondary of transformer 58. If the current supplied by the two high-voltage rectifiers becomes excessive, circuit breaker 43 opens the primary circuits of transformers 59 and 58, which are further protected by fuses 70-2 and 71, respectively. Pilot lamps 35-3 and 35-4 light when transformers 59 and 58 are energized.

(*2*) Radio Receiver and Transmitter BC-

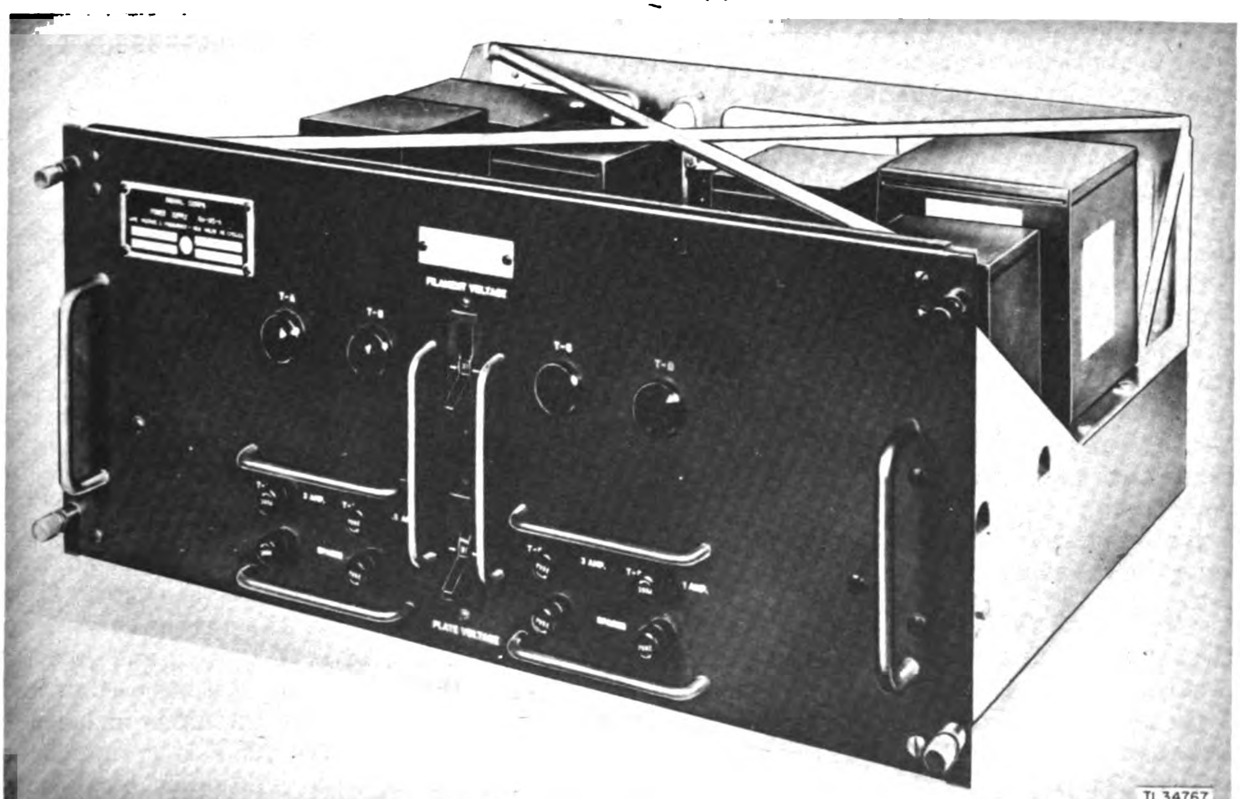


Figure 58. Power Supply RA-105-A, front oblique view.

1267-A and interlock switch 40 on the power supply chassis are in series with the primary winding of transformer 58. Therefore, if the receiver-transmitter is removed from the rack, or if interlock switch 40 is open, power is removed from transformer 58 and consequently the high voltage is removed from tubes 6 and 7. Interlock switch 9 on the wiring channel of the rack is in series with the a-c input to the power supply so that if the rear panel of the rack is removed the a-c input to the power supply is removed. (This interlock switch also removes the a-c input to the control unit, blowers, and heaters.)

b. Filament Transformers (fig. 60). A-C power enters the power supply through pins 17 and 23 of the multiple receptacle 30; this power is applied to transformers 56 and 57 through circuit breaker 44. Secondary windings of transformer 56 supply the filament voltage for the five low-voltage rectifier tubes. Terminals 5 and 6 are the filament winding which supplies filament voltage to the receiver and transmitter. Transformer 57 has three secondary windings, two of which supply filament voltage for the two high-voltage rectifier tubes. The third winding is not used in Radio Equipment RC-384.

c. Plate Transformers (fig. 60).

(*1*) When circuit breakers 44 and 43 are closed, power is applied to transformers 59 and 58. The tapped secondary of transformer 59 supplies the five low-voltage rectifiers. Tube 1 (VT-126-B) is used as a half-wave rectifier. The output of this tube supplies approximately −150 volts for biasing the modulator tube in the transmitter of Radio Receiver and Transmitter BC-1267-A. The a-c voltage is supplied from terminal 3 of transformer 59 through a voltage divider consisting of resistors 22-1 and 22-2 in parallel and resistor 25. Note that the output of the circuit is drawn through the 60,000-ohm resistance of resistors 22-1 and 22-2. The BIAS CONTROL (89-2) in the receiver-transmitter varies the current drawn from the power supply and therefore varies the voltage drop across resistors 22-1 and 22-2 and the output voltage of the supply.

(*2*) Tube 2 (VT-244) is a full-wave rectifier. The a-c voltage is applied to the two plates from terminals 3 and 5 of transformer 59. The output of the rectifier is filtered by dual choke 62 and capacitors 2-3 and 3-1. Resistor 21 is the bleeder resistor. The positive 300-volt d-c output is supplied to the control unit.

(*3*) Tube 3 (VT-244) is a full-wave rectifier. The a-c voltage is applied to the two plates from terminals 3 and 5 of transformer 59. Since the requirement of this output is mainly voltage rather than current, a resistance-capacitance (R-C) type filter is used. Resistors 18 and 23, together with capacitors 1 and 2-2, provide the filtering; resistors 19-2 and 19-3 in parallel are the bleeder resistors. The positive 400-volt d-c output is supplied to the transmitter.

(*4*) Tube 4 (VT-244) is a full-wave rectifier supplied with a-c voltage from terminals 3 and 5 of transformer 59. Choke 63 and capacitors 3-2 and 2-1 form a choke and capacity filter; resistor 19-1 is a bleeder resistor. Resistor 24 is a part of the filter network. The positive 300-volt d-c output is supplied to the receiver and transmitter.

(*5*) Tube 5 (VT-119) is a half-wave rectifier. The a-c plate voltage is supplied from terminal 6 of transformer 59. This rectifier is primarily a voltage source; therefore, the filter circuit is a resistance-capacitance type. The filter consists of resistor 15 and capacitor 4 with resistor 15 serving as the bleeder resistor. The positive 600-volt d-c output is supplied to the screen grid of the modulator tube in the transmitter.

(*6*) Tube 6 (VT-119) is a half-wave rectifier. The plate is supplied with a-c voltage from terminal 4 of transformer 58. The filter circuit for this rectifier tube, consisting of capacitor 25 and resistor 59-6, is located in the receiver and transmitter (fig. 15). The bleeder network is also located in the receiver and transmitter and consists of resistors 82-1, 82-2, 82-3, and 82-4. The positive 2,300-volt d-c output is applied to the plate of the modulator in the transmitter.

> **NOTE:** When the power supply is removed from the rack, the output of tube 6 consists of unfiltered half waves. A d-c voltmeter will then read only the half-wave average, 850 volts. When installed in the rack, filter capacitor 25 (in the receiver-transmitter) charges and raises the d-c output level to 2,300 volts.

(*7*) Tube 7 (VT-119) is a half-wave rectifier with a negative 2,000-volt output. The a-c voltage is applied to the cathode from terminal 4 of transformer 58. The filter consists of resistor 17 and capacitors 6-1 and 6-2. The bleeder network consists of resistors 16-1, 16-2, 16-3, and 16-4. The output of this rectifier circuit is not used in Radio Equipment RC-384. The circuit is included because Power Supply RA-105-A is an interchangeable component used with other identification equipments.

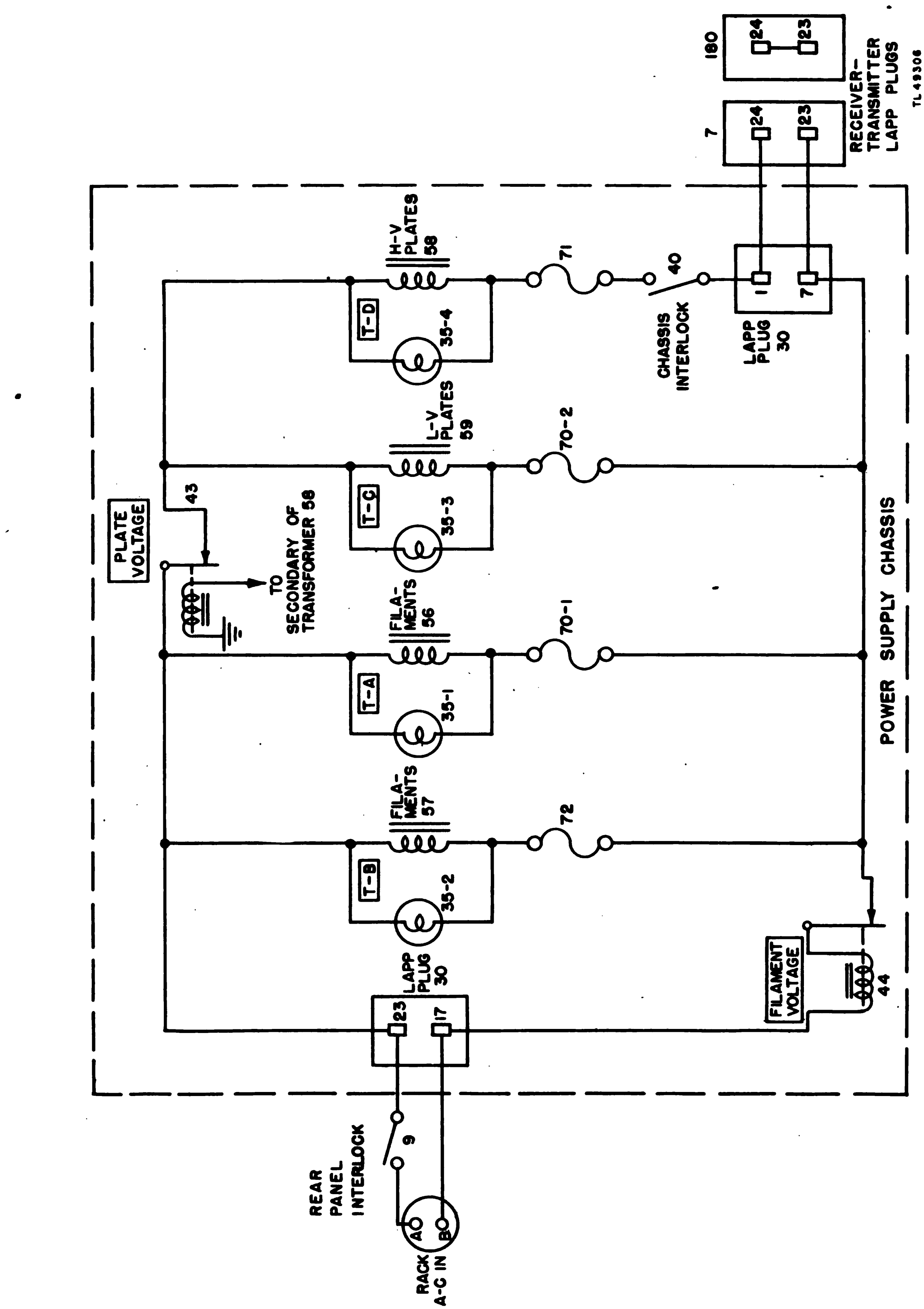


Figure 59. Power Supply RA-105-A, a-c input and interlock circuit.

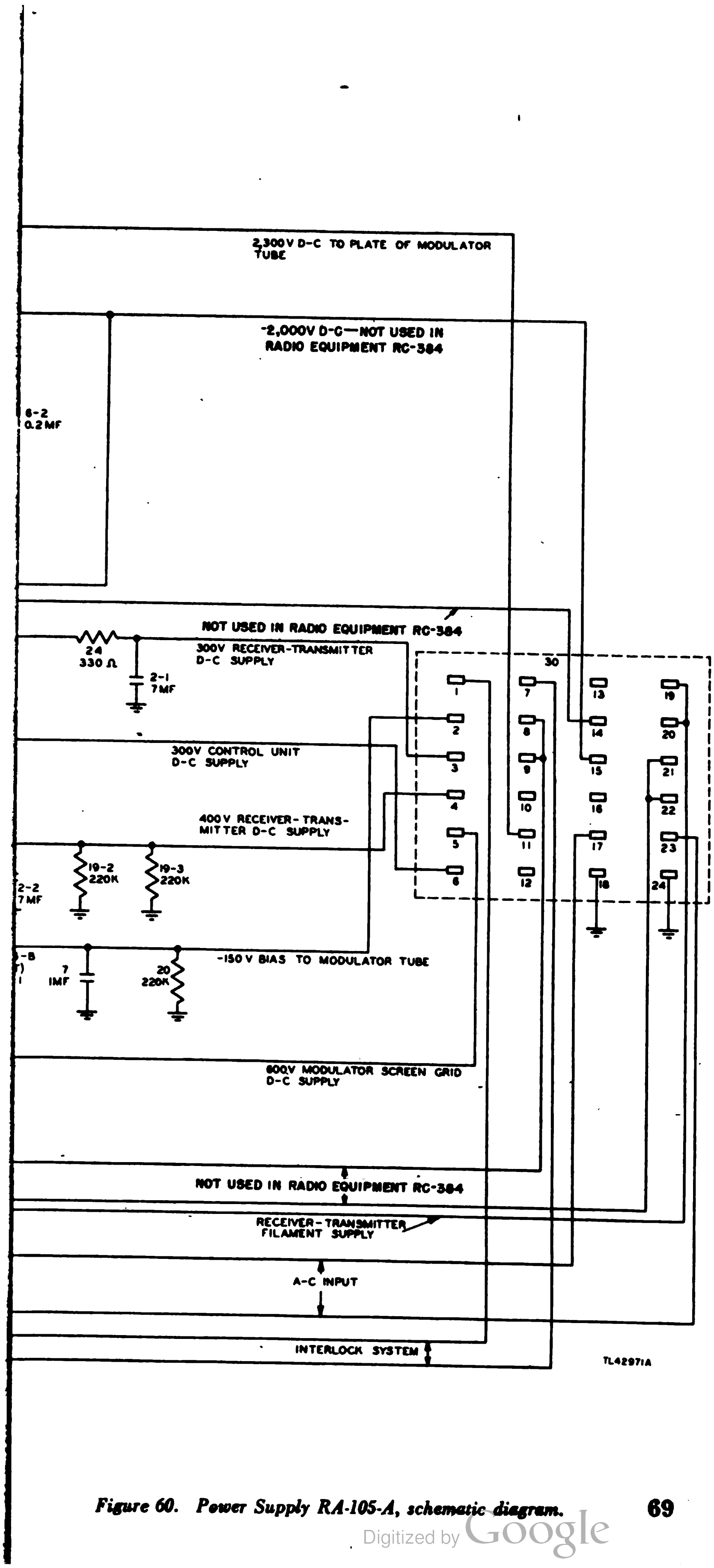


Figure 60. Power Supply RA-105-A, schematic diagram.

CHAPTER 7.
BLOCK DIAGRAM OF RADIO EQUIPMENT RC-384

50. PURPOSE OF DIAGRAM.

The block diagram of Radio Equipment RC-384 (fig. 61) is a complete functional presentation of the electrical circuits of the equipment. The diagram shows the relationship of the individual circuits and their function in the over-all operation of the equipment.

51. READING THE DIAGRAM.

a. Figure 61 represents the various circuits of the equipment as blocks marked with the name of the circuit. A chassis or major component is represented by a large block, and the circuits within it are indicated by smaller blocks. Interconnections have been simplified and are indicated by solid lines with arrowheads pointing in the direction in which the signal is progressing. The various blocks representing major components have been arranged in groups so that each group represents a system.

b. A signal leaving a major component opposite one of the smaller blocks within it indicates that the signal leaves the component from the circuit identified by the smaller block. A signal shown entering a major component opposite a smaller block indicates that the signal is applied to the circuit represented by this block. The a-c and d-c distribution systems have been simplified on the block diagram in order to place emphasis on the functional or signal-carrying connections.

52. REVIEW OF THEORY WITH BLOCK DIAGRAM.

Radio Equipment RC-384, in common with other IFF equipments, has the following primary functions: the transmission of a short pulse of r-f energy, the reception of *identification signals* transmitted by the challenged aircraft, the measurement of time intervals between the transmission of the pulse and the reception of the identification pulse, and the presentation of this time factor as linear distance between the equipment and the target. In addition to these basic functions, Radio Equipment RC-384 presents an approximate indication of the azimuth based upon the position of the antenna when it is pointed toward the target. The following summary of these actions, with reference to the block diagram (fig. 61), will show how the equipment operates.

a. Transmitter System.

(*1*) The transmitter system shown in the transmitter section of the block diagram consists of the following components: the sync amplifier, limiter, cathode follower, blocking oscillator, modulator, r-f oscillator, and monitoring circuit. The main power supply furnishes both a-c and d-c power for the transmitter. A positive trigger pulse is supplied by the control unit to the transmitter sync amplifier stage 16 A. This pulse causes the transmitting system to transmit a 4- to 10-microsecond r-f pulse approximately 213 times per second and to remain inactive during the period between these pulses.

(*2*) The sync amplifier amplifies and inverts the trigger pulse. The negative pulse output of the sync amplifier is amplified, clipped, and inverted by the limiter. The cathode follower takes the positive pulse output of the limiter and applies it to the grid of the blocking oscillator. The blocking oscillator is triggered by this positive sync pulse, and supplies a positive pulse to the grid of the modulator. The modulator delivers a positive high-voltage pulse to the plates of the transmitting oscillator. Upon application of this pulse, the r-f oscillator breaks into oscillation and emits a pulse of r-f energy which has the same duration as the modulator pulse (4 to 10 microseconds). The r-f energy developed by the oscillator is fed through a transmission line to the antenna. A portion of the r-f energy is fed to the monitoring circuit to provide means of determining peak power output.

b. Radio-frequency System. The r-f system is composed of the antenna-matching section, r-f lines, and the antenna. The rotating joint in the base of the antenna mast, which houses the line-coupling plug, is included in the line. It is not shown in the block, however, because its function is primarily mechanical. R-f pulses from the transmitting system travel to the antenna-matching section, then through the r-f transmission line to the antenna. Received signals picked up by the antenna travel back through the transmission line and the antenna-matching system to the receiver. The antenna-matching section serves two purposes: it provides a means for proper impedance matching of the line when receiving and transmitting, and it isolates the transmitter and identification pulses to their own particular systems.

c. Receiver System.

(*1*) The receiver system is comprised of the components necessary to receive the incoming *identification* signals from the antenna-matching section, and to convert them into video signals for application to the display oscilloscope. These components are the r-f amplifier stages, mixer, local oscillator, i-f amplifiers, detector, and video amplifier.

(*2*) The receiver is a conventional superheterodyne. Two stages of r-f amplification are used before the mixer. The local oscillator is of the Colpitts type and can be varied over a range of 146 to 176 mc. The mixer stage produces an intermediate frequency of 11 mc, which is amplified by five stagger-tuned i-f stages. A double diode is used as the detector to develop the input to the video amplifier and also to supply the signal which operates the tuning indicator. The video amplifier inverts and amplifies the signal taken from the detector. The positive pulse output of the video amplifier is applied to the grid of a cathode follower which is used to provide a low-impedance output for cable connection to the video amplifier in the control unit. The power used in the receiver is supplied from the main power supply.

d. Control Unit.

(*1*) The control unit is comprised of the components necessary to develop a synchronizing pulse for the identification transmitter and to measure the distance between the identification equipment and the interrogated target. The various functions of the control unit are performed in different *channels* or groups of circuits.

(*2*) The division channel consists of sync selector 1A, sync amplifier 1B, and the division multivibrator. The sync selector provides an output pulse of the proper polarity so that either positive or negative synchronizing pulses can be used to trigger the control unit. The sync amplifier amplifies and inverts the sync pulses and applies them to the division multivibrator which divides the incoming sync signal to the desired pulse-recurrence frequency.

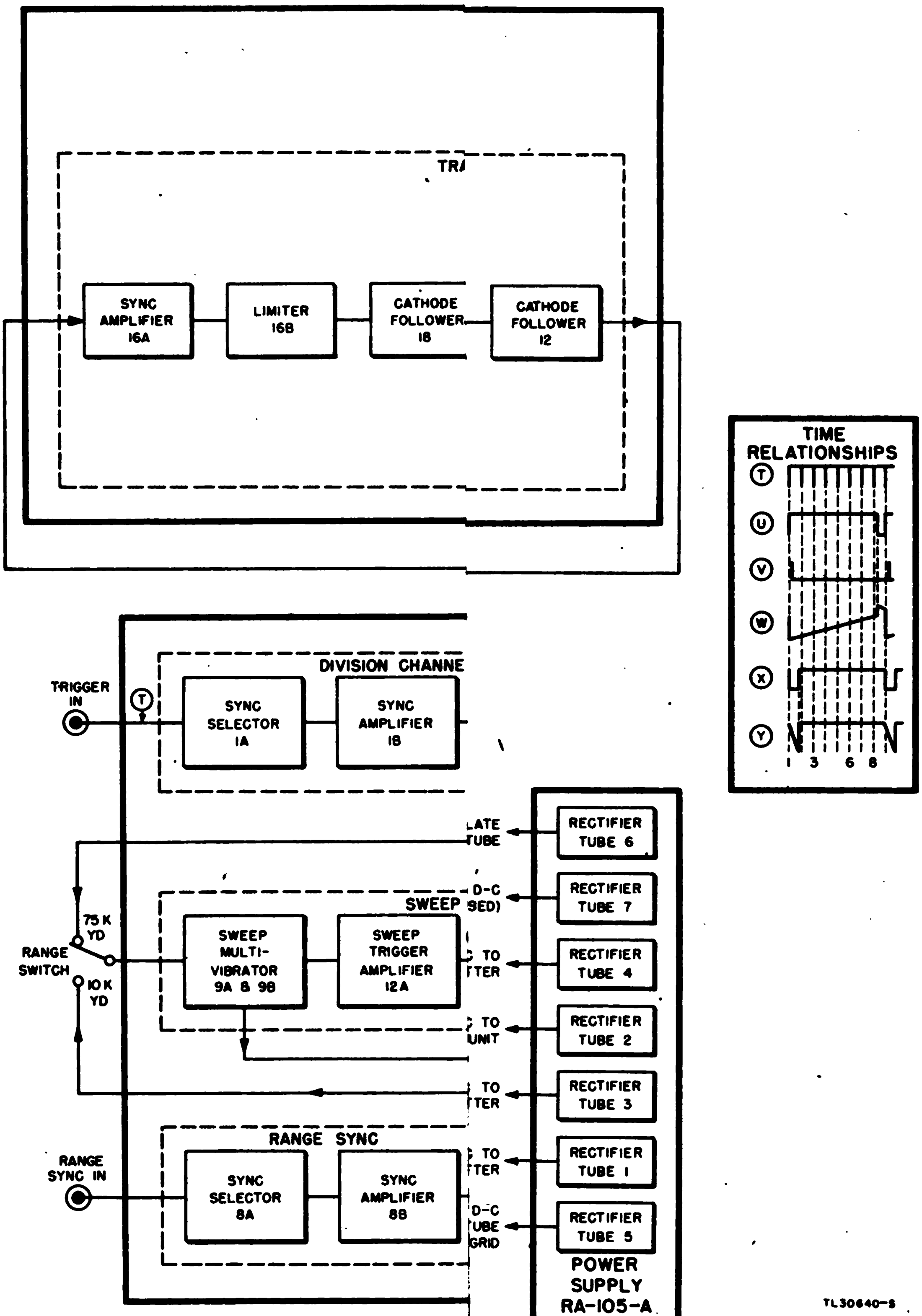
(*3*) The transmitter trigger channel consists of the pulse amplifier, the delay circuit, and the transmitter sync cathode follower. These circuits amplify and delay the transmitter sync pulse 3¼ microseconds and apply it to the transmitter circuits through the cathode follower.

(*4*) The sweep channel consists of the sweep multivibrator, the sweep trigger amplifier, sweep-forming tubes 10 and 11, and the sweep inverter. The sweep multivibrator produces a square wave which determines the sweep duration. The square wave is amplified in the sweep trigger amplifier and formed into a saw-tooth wave in sweep-forming tubes 10 and 11. The output of the sweep-forming tubes is applied to one horizontal-deflection plate of the oscilloscope and to the sweep inverter. The saw-tooth output of the sweep inverter is applied to the other horizontal plate to produce a push-pull horizontal sweep.

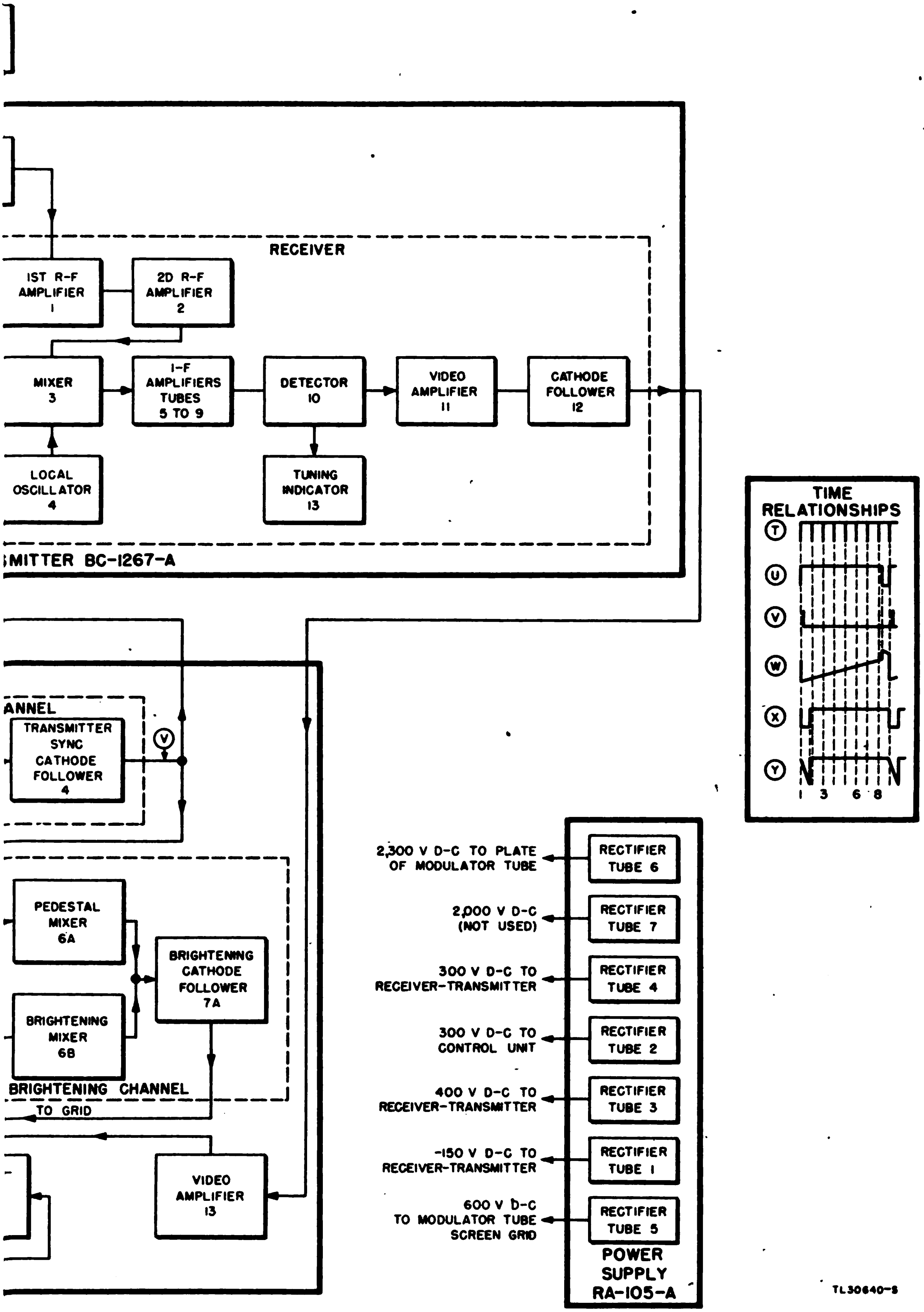
(*5*) The sweep multivibrator, which controls the action of the sweep generating channel, is triggered by the division channel when the range switch is in the 75K YD. position. The sweep-generating channel can also be triggered by the range sync channel by placing the range switch in the 10K YD. position. The range sync channel consists of sync selector 8A and sync amplifier 8B. The sync selector provides a means of changing the polarity of its output so that a range sync pulse of either positive or negative polarity can be applied to the range sync channel. The range sync amplifier amplifies and clips the output of the sync selector. The output of the sync amplifier is applied through the range switch to the sweep multivibrator which triggers the sweep-generating channel. When the sweep-generating channel is triggered by the range sync channel, a 10,000-yard sweep is generated instead of the 75,000-yard sweep which is generated when the sweep-generating channel is triggered by the division multivibrator.

(*6*) The sweep-brightening channel consists of the pedestal multivibrator, the pedestal mixer, the brightening mixer, and the brightening cathode follower. The pedestal multivibrator is triggered by a pulse from the transmitter sync cathode follower. The output of the pedestal multivibrator is amplified in the pedestal mixer and mixed with the output of the sweep multivibrator. This mixed output is applied to the grid of the cathode-ray tube so that each time the transmitter fires the sweep trace becomes visible on the screen of the tube. This brightens each 75,000-yard sweep; in the 10K YD. position, however, only every eighth sweep is brightened.

(*7*) The video amplifier amplifies the output of the receiver and applies the amplified signal to one of the vertical-deflection plates of the display oscilloscope.



RC-384, complete block diagram.


RECEIVER
IST R-F AMPLIFIER 1
2D R-F AMPLIFIER 2
MIXER 3
I-F AMPLIFIERS TUBES 5 TO 9
DETECTOR 10
VIDEO AMPLIFIER 11
CATHODE FOLLOWER 12
LOCAL OSCILLATOR 4
TUNING INDICATOR 13
MITTER BC-1267-A
TIME RELATIONSHIPS
T
U
V
W
X
Y
1 3 6 8
ANNEL
TRANSMITTER SYNC CATHODE FOLLOWER 4
V
PEDESTAL MIXER 6A
BRIGHTENING CATHODE FOLLOWER 7A
BRIGHTENING MIXER 6B
BRIGHTENING CHANNEL
TO GRID
VIDEO AMPLIFIER 13
2,300 V D-C TO PLATE OF MODULATOR TUBE
RECTIFIER TUBE 6
2,000 V D-C (NOT USED)
RECTIFIER TUBE 7
300 V D-C TO RECEIVER-TRANSMITTER
RECTIFIER TUBE 4
300 V D-C TO CONTROL UNIT
RECTIFIER TUBE 2
400 V D-C TO RECEIVER-TRANSMITTER
RECTIFIER TUBE 3
-150 V D-C TO RECEIVER-TRANSMITTER
RECTIFIER TUBE 1
600 V D-C TO MODULATOR TUBE SCREEN GRID
RECTIFIER TUBE 5
POWER SUPPLY RA-105-A
TL30640-S

PART TWO
TROUBLE-SHOOTING PROCEDURES

CHAPTER 8.
GENERAL INFORMATION

53. INTRODUCTION.

The purpose of this chapter is to aid personnel in locating and correcting faults as rapidly as possible.

a. Trouble-shooting Data. Take advantage of the material supplied in this manual. Use the following trouble-shooting aids:

(1) *Block Diagrams* indicate graphically the electrical functioning of the circuit.

(2) *Complete Schematic Diagrams* indicate all components and show all electrical connections to other units.

(3) *Simplified and Partial Schematic Diagrams* are particularly useful in trouble-shooting. They facilitate the analysis of the electrical functioning of the circuit.

(4) *Voltage and Resistance Measurements at All Socket Connections* are listed in this part.

(5) *Voltage, Resistance, and Waveform Measurements at Test Jacks* are listed in this part and in part one.

(6) *Illustrations of Components* (front, top, and bottom views) aid in locating and identifying parts.

b. Trouble-shooting Steps. The first step when servicing a defective radar set is to *sectionalize* the fault. Sectionalization means tracing the fault to the *component* responsible for the abnormal operation of the set. The second step is to *localize* the fault. Localization means tracing the fault to the *part* responsible for the abnormal operation of the set. Although some faults, such as burned-out resistors and r-f arcing, can be found easily by sight, smell, or hearing, the large majority of them must be found by systematic voltage checks, resistance measurements, and waveform comparisons. The procedures to be followed are explained in subparagraphs c and d below.

c. Equipment Performance Log (EPL). The Equipment Performance Log is a record of the operation of the IFF equipment. In the event of equipment failure or abnormal operation, reference to the EPL aids in sectionalizing the defect. Note particularly any remarks in the EPL concerning the operation of the station within the previous 24 hours. Failure may be the result of a previous abnormal condition not serious enough in itself to have caused the station to go off the air at the time. This condition and the equipment or parts affected by it are entered in the log book. Always check the log before trouble shooting.

d. Starting-procedure Sectionalization. The systematic method used to put the set on the air may be used as a trouble-shooting aid. Perform the steps of the starting procedure in sequence until an abnormal condition is obtained. Note the visible and audible results as each step is performed. The use of the starting procedure is described in detail in Chapter 2 of this part.

e. Localization. Chapters 3 through 7 of this part describe the method used in localizing faults within the individual components. These sections contain trouble-shooting charts which list abnormal symptoms, their causes, and the procedure for finding the exact location of the fault.

54. VOLTAGE MEASUREMENTS.

a. General. Most equipment failures are the direct result of abnormal voltages. Since voltage measurements are easily made and require no elaborate equipment, they are an indispensable aid to the repairman. Use all available data.

CAUTION: When measuring voltage in any r-f circuit, *always* shunt the meter with a small mica capacitor (approximately 0.00025 mf). R-f can damage a meter beyond repair.

(1) To prevent overloading and damaging the voltmeter, set the meter on its highest range.

Decrease the setting for accuracy.

(2) When checking very low voltages, such as cathode bias, remember that a reading is obtained when the cathode circuit is open. Internal meter resistance may act as a bias resistor. The cathode voltage may be approximately normal only so long as the voltmeter is connected between the cathode and ground. Before measuring cathode voltage, check the resistance of the circuit (with power off) to make sure that the cathode resistance is normal.

b. High-voltage Precautions. High voltages are dangerous and can easily prove fatal. When measuring voltages above a few hundred volts, observe the following precautions:

(1) Connect the ground lead to the voltmeter.

(2) Put one hand in your pocket and keep it there.

(3) Connect the test lead to the hot terminal.

(4) If the voltage is greater than 300 volts:

(a) Shut the power *off*.

(b) Connect the hot test lead.

(c) Step away from the voltmeter and turn the power on.

(d) Do not touch *any part* of the meter.

(e) Note the reading and shut off the power.

(f) Discharge any capacitors in the circuit and remove the meter.

c. Voltmeter Loading. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a lower voltage than the actual voltage present.

(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: Resistance of the voltmeter equals the ohms-per-volt value multiplied by the full-scale range in volts. Two examples are shown below:

(a) Find the total resistance of a 1,000-ohms-per-volt voltmeter on the 300-volt range:

$$R = 1{,}000 \text{ ohms per volt} \times 300 \text{ volts} = 300{,}000 \text{ ohms.}$$

(b) Find the total resistance of a 20,000-ohms-per-volt voltmeter on the 30-volt range:

$$R = 20{,}000 \text{ ohms per volt} \times 30 \text{ volts} = 0.6 \text{ megohm.}$$

(2) To minimize voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection is obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement is increased. The decreased loading of the voltmeter more than compensates for the inaccuracy resulting from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage readings on two successive ranges. If the voltage readings on the two do not agree, voltmeter loading is excessive. The reading, ***not the amount of needle deflection***, on the highest range may be greater than that on the lowest range. If the voltmeter loads the circuit heavily, the pointer deflection may remain nearly the same when the voltmeter is shifted from one range to another.

(4) The voltage and resistance charts used in this manual are based on readings taken with an actual meter. The ohms-per-volt sensitivity of the meter used is given in each chart. When shooting, use a meter having the same sensitivity.

d. Voltage Analysis. Figure 62 illustrates a typical amplifier stage. The values of the various parts and the input voltages are labeled. The normal voltages at the socket pins of tube V3 are:

Pin No.	1	2	3	4	5	6	7	8
Voltage	6.36	6.3 ac	0	0	6.36	150	0	208

NOTE: All voltages are d-c unless otherwise specified. The d-c readings were taken with a 1,000 ohms-per-volt voltmeter. Charts for each component giving the voltage and resistance at each socket connection, can be found at the end of each chapter on trouble shooting the component.

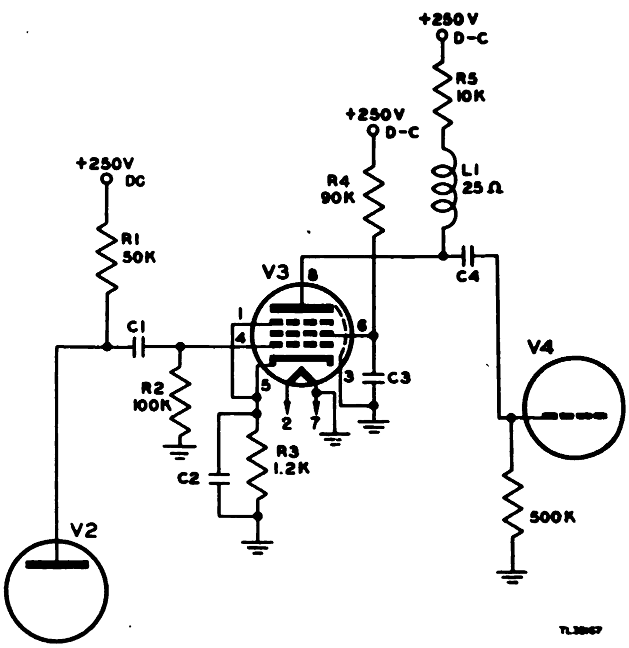


Figure 62. Schematic diagram for voltage analysis.

(1) The voltage between pin 1 and the chassis is normally 6.36 volts (note chart above). This voltage should be the same as the voltage between pin 5 and the chassis (subpar. (4) below).

(2) The voltage between pin 2 and the chassis should be 6.3 volts a-c. Pin 2 is one side of the filament.

NOTE: No connections are shown on the diagram because the filaments of amplifier tubes are always connected to a low-voltage a-c source. If this voltage is abnormal, check the voltage across the filament transformer.

(3) Since a Class A amplifier does not normally draw grid current, the voltage between pin 4 and the chassis should be zero. If capacitor C1 short-circuits, the high positive voltage on the plate of tube V2 is delivered to pin 4, and a positive d-c voltage reading is obtained. An internal short circuit in the tube may cause a reading on this contact.

(4) The voltage on pins 1 and 5 should be 6.36 volts (see chart above). The plate-cathode voltage, the screen-cathode voltage, and the grid-cathode voltage cause a current to flow through cathode resistor R3. This current is normally 0.0053 ampere, because the resistor is rated at 1,200 ohms, and the voltage across it is 6.36 volts:

$$I = \frac{E}{R} = \frac{6.36}{1{,}200} = 0.0053 \text{ ampere.}$$

(a) If there is no reading, check the plate-supply voltage, tube V3, resistor R3, capacitor C2, and circuit wiring.

(b) If the voltage reading is low, the trouble may be low electron emission of tube V3, leaky capacitor C2, open-circuited resistors R4 or R5, shorted capacitor C3 or C4, low plate-supply voltage, open-circuited coil L1, a poor connection, or a change in the value of any of the resistors.

(c) If the voltage reading is high, the trouble may be a gassy tube, a short-circuited resistor, too high an applied voltage, or a connection in either the plate-cathode or screen grid-cathode circuits shorted by an external circuit.

(5) Check the screen-grid voltage as follows:

(a) The voltage at pin 6 should normally be 150 volts, and the voltage drop across the resistor should be 100 volts. (Voltage is 150 volts on one side of the resistor and 250 volts on the other side.) The normal current at this point is 0.0011 ampere:

$$I = \frac{E}{R} = \frac{100}{90{,}000} = 0.0011 \text{ ampere.}$$

(b) If no voltage reading is obtained at pin 6, check the applied voltage, resistor R4, capacitor C3, and associated circuit wiring.

(c) If the voltage reading at pin 6 is low, check capacitor C3, the applied voltage, and the grid bias voltage. Low voltage may be the result of a gassy tube.

NOTE: A gassy tube or low grid bias of tube V3 increases the screen grid current. Increasing this current increases the voltage drop across resistor R4. If capacitor C3 is leaky or shorted, the screen grid of tube V3 is connected at or near ground potential, lowering the voltage on pin 6. The current through resistor R4 rises if capacitor C3 is shorted. Resistor R4 is then the only resistance between the applied voltage and the chassis ground and may burn out because of the high current flow. Any fault that causes a high current flow through the screen grid-cathode circuit burns out either resistor R3 or R4.

(6) The voltage between pin 7 and ground normally is zero, because this pin is connected directly to the chassis ground.

(7) The plate voltage is checked as follows:

(a) The voltage between pin 8 and the chassis is normally 208 volts. This measurement is one of the points in the plate-cathode circuit comprising resistor R3 and R5, coil L1, and plate resistance of tube V3. The applied voltage in this circuit is +250 volts. The voltage drop across resistor R5 and coil L1 in series is 42 volts (250 volts minus 208 volts). The current through resistor R5 and coil L1 is =0.0042 ampere.

$$I = \frac{E}{R} = \frac{42}{10{,}025} = 0.0042 \text{ ampere.}$$

(b) If there is no voltage reading at pin 8, check the applied voltage, resistor R5, coil L1, and connections between the B+ supply line and pin 8.

(c) If the voltage on contact 8 is low, the trouble may be a gassy tube V3, too low an applied voltage, a shorted or leaky capacitor C2, or a shorted resistor R3, causing the current through the plate-cathode circuit to rise, and increasing the voltage drop across resistor R5 and coil L1. This increase lowers the voltage at pin 8. Increased current through this circuit may burn out resistor R3 or R5.

(d) If the voltage is high, check tube V3, resistor R3, resistor R5, and the applied voltage.

If the tube is burned out or resistor R3 is open, no current can flow through the plate-cathode circuit, and there is no voltage drop between the applied voltage and the plate of the tube.

(8) Check capacitor C4 (coupling capacitor to the grid of tube V4) for a shorted or leaky condition by measuring the voltage between pin 4 on tube V4 and the chassis ground: If positive d-c voltage is present at pin 4 of tube V4, the capacitor is leaky or shorted.

55. RESISTANCE MEASUREMENTS.

a. General. A fault developing in a circuit very often appears as a change in the resistance values in the circuit. To assist in the localization of such faults, trouble-shooting data includes normal resistance values, as measured at the tube sockets and at the test jacks. Unless otherwise stated, these values are measured between indicated points and ground. It is often desirable to measure the resistance from other points in the circuit, to determine whether the particular points in the circuit are normal. To find the normal resistance value at any point, refer to the resistance values on the schematic diagrams.

(1) *Correct Use of Low and High Ranges of Ohmmeter.* Set the voltohmmeter at its *lowest* range when checking for circuit continuity. To check high resistance or leakage in capacitors or cables, use the highest range.

(2) *Parallel Resistance.*

(a) When trouble-shooting with a schematic diagram, remember that the total resistance of a parallel circuit is less than the smallest resistor in the network. If the value of a resistor is less than it should be, make a careful study of the schematic diagram, and be sure that there are no parallel resistances. Before replacing a resistor, disconnect one terminal from the circuit and measure its resistance again.

(b) In some cases it is impossible to check a resistor that has a low-voltage transformer winding connected across it. To measure a resistor in this type of circuit, disconnect one terminal from the circuit.

(3) *Checking Grid Resistance.* A false resistance reading may be obtained if a tube is still warm and the cathode is emitting electrons. Allow the tube to cool or reverse the ohmmeter test leads so that the negative ohmmeter test lead is applied to the grid.

(4) *Tolerance Values for Resistance Measurements.* *Tolerance* means the normal difference or variation that is expected between the rated value of the resistor and its actual value.

(a) Most resistors used in radar circuits have a maximum tolerance of 10 percent. For example, the grid resistor of a stage might have a rated value of 1 megohm. If the resistor is measured and found to have a value between 0.9 megohm and 1.1 megohms, it is considered normal. The ordinary resistors used in circuits are not replaced unless their values are off more than 20 percent. Precision resistors and potentiometers may be used. To check tolerance values, refer to part three, Maintenance Parts.

(b) The tolerance value for transformer windings is generally between 1 and 5 percent. Suspect a transformer which shows a resistance deviating more than 5 percent from its rated value. Allow the transformer to cool before the resistance test is made.

b. High-resistance Measurements. Many leakages will not show up when measured at low voltages. Most ohmmeters use a maximum test voltage of 15 volts on the highest resistance range. When it is necessary to measure resistance above a few megohms, or the leakage resistance between conductors of a cable, the test should be made using a *voltmeter* and an applied voltage of 100 volts or more. When it is possible to ground one end of the resistance being checked, one of the low-voltage power supplies in the equipment can be used to provide about 300 volts for making these high-resistance measurements. The manner in which such measurements are made is indicated in figure 63. Use this method only when the resistance being measured is very high. Do not touch the meter after the circuit has been completed. An ammeter (plus the application of Ohm's law) can be used to make the same measurement. The device being measured, however, may break down and short out during the test, destroying the meter. The method shown (fig. 63) protects the meter. Use a meter with an ohms-per-volt sensitivity of 1,000 or more. The resistance of the meter is equal to the ohms-per-volt sensitivity multiplied by the range to which the meter is set.

The derivation of the formula $R_x = \frac{300R_m}{V}$ is shown below. R_x is the unknown resistance, R_m is the meter resistance, and V is the voltmeter reading:

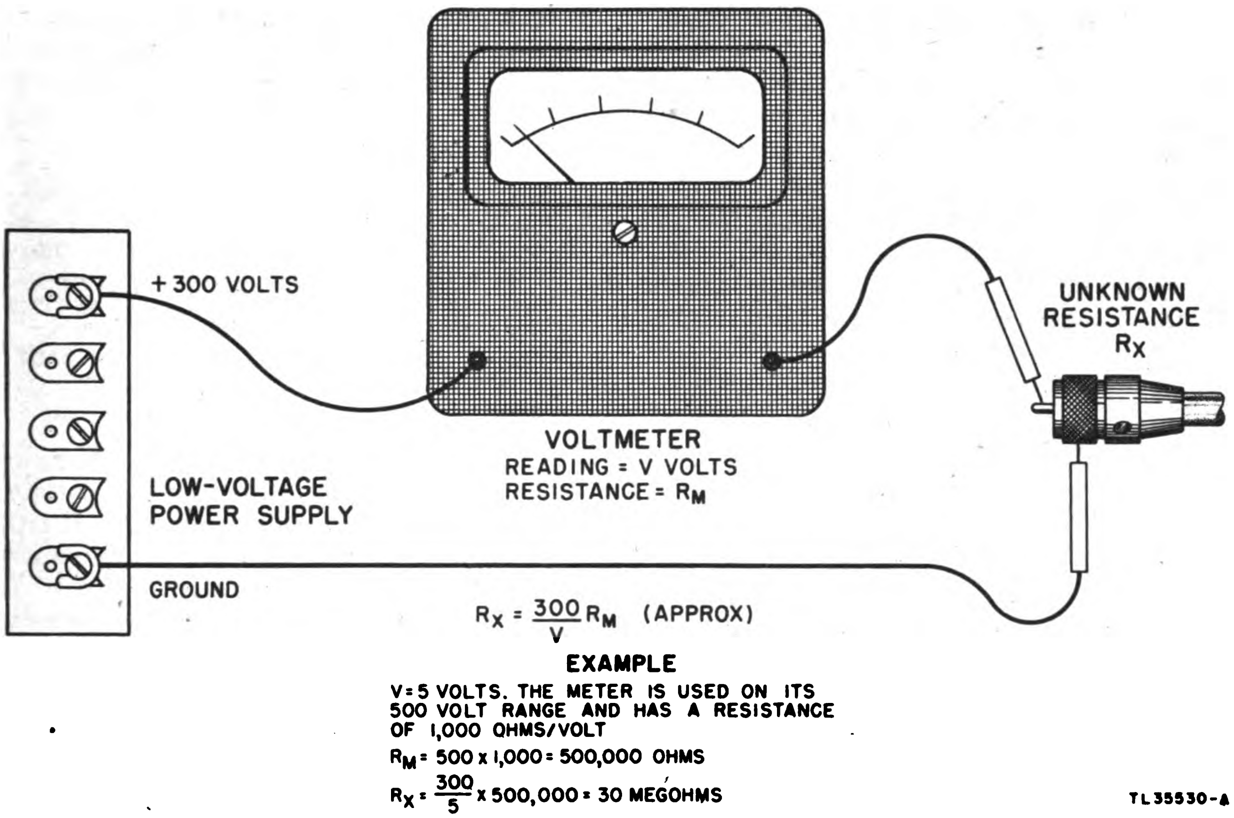


Figure 63. Measurement of high resistance.

$$\frac{R_x}{R_m} = \frac{300\text{-}V.}{V}$$

If R_x is very large, V is small in comparison to 300. Assuming that 300-V can be replaced by 300, the formula $\frac{R_x}{R_m} = \frac{300}{V}$ is obtained. Solving for R_x gives $R_x = \frac{300R_m}{V}$. When making the measurement, first put the meter on the 300-volt scale to protect it in case R_x is very low. If the voltage used is not 300 volts, the correct value should be inserted in the formula in place of 300.

c. Resistance Analysis. The low-voltage power supply shown in figure 64 is used as a sample of resistance analysis. If the fuse in the primary circuit of the power transformer blows, the cause is obviously an overload or short circuit in the unit, in the power supply itself, or in the primary circuit of the power transformer.

(*1*) Points 1, 2, 3, 4, 5, and 6 represent connections to the output plug. Disconnect the plug and replace the blown fuse. It is unlikely that any damage will be done by blowing another fuse. Turn the power on. If the fuse blows again, the trouble is *not* in the unit to which power is applied.

(*2*) If the fuse blows a second time, check the resistance between point 2 and ground. If this resistance is within 10 percent of 12,400 ohms (the sum of the resistance in the bleeder chain equals 12,400 ohms), the trouble is in the second-

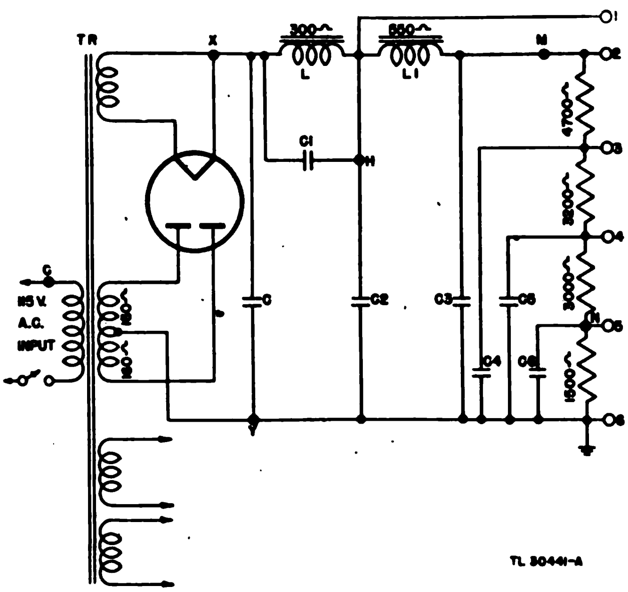


Figure 64. Schematic diagram for resistance analysis.

ary or primary of the transformer. For the purposes of this analysis, assume that the resistance is found to be much less than 12,400 ohms.

(*3*) If the resistance between point 2 and ground is found to be zero, capacitor C3 is shorted. To test the capacitor disconnect its lead from point M. The actual resistance of the capacitor can then be measured.

(*4*) A resistance of 550 ohms between point 2 and ground indicates that capacitor C2 is shorted; coil L1 has a resistance of 550 ohms. Test capacitor C2 by disconnecting it from ground and measuring its resistance.

(*5*) A resistance of 850 ohms between point 2 and ground indicates a short circuit in the rectifier tube, the filament winding, or capacitor C. To find the short remove the tube from its socket and again measure the resistance between point 2 and ground. If the fault is still present, it is either in capacitor C or in the filament winding. If the fault disappears when the tube is removed, the trouble is in the tube.

(*6*) If the resistance between point 2 and ground is approximately 1,000 ohms, the trouble is in the circuit either to the right or to the left of point M. To isolate the trouble disconnect the circuit at M. If the resistance between point 2 and ground is still much less than 12,400 ohms, the fault is in the bleeder chain. Measure the resistance of the individual resistors in the bleeder network:

(*a*) Measure the resistance between points 2 and 3. If it is not reasonably close to 4,700 ohms, the resistor between these points should be replaced.

(*b*) If the above check is satisfactory, the resistance between point 3 and ground should be 7,700 ohms (fig. 98). If the reading is zero, disconnect and check capacitor C4. If capacitor C4 is normal, check the 3,200-ohm resistor. If the resistance between point 3 and ground is greater than zero but much less than 7,700 ohms, disconnect capacitors C4, C5, and C6 from the circuit. Check the capacitors and the 1,500-ohm and 3,000-ohm resistors individually.

56. CURRENT MEASUREMENTS.

Current measurements, other than those indicated by the panel meters, are not ordinarily required in trouble shooting the radar set. A current measurement can be made by opening the circuit and connecting an ammeter in series with the circuit. This procedure is not recommended except in very difficult cases.

a. When the meter is inserted in a circuit to measure current, always insert it away from the r-f end of the resistance; for example, when measuring plate current, connect the meter at the power supply end of the resistor.

> **CAUTION:** A meter has least protection against damage when it is used to measure current. *Always* set the current range to the highest value. Then decrease the range to give a more accurate reading. Avoid working close to full-scale reading; this increases the danger of overload. When measuring current in any r-f circuit, *always* shunt the meter with a small mica capacitor (approximately 0.00025 mf). R-f can damage a meter beyond repair.

b. In most cases current can be easily figured from Ohm's law. The current to be measured usually flows through a resistance which is either known or can be measured with an ohmmeter. The current flowing in the circuit can be determined by dividing the voltage drop across the resistor by its resistance value. The drop across the cathode resistor is a convenient method of determining the cathode current.

57. CAPACITOR TESTS.

Leaky or shorted capacitors can be found by resistance checks. An open capacitor can best be checked by shunting a good capacitor across it. In r-f circuits keep the lead to the capacitor as short as the original capacitor leads. In video and low-frequency circuits (less than 1 mc) the test capacitor leads may be several inches long.

58. TUBES.

a. Tube Failures. Tube failures are responsible for a large percentage of the faults which occur. There are, however, too many tubes in the equipment for a trouble shooter to attempt to find a fault by indiscriminate tube changing. Do not resort to tube changing until the fault has been traced to a particular stage.

(*1*) Before inserting a new tube in a circuit, note the position of all controls before making any changes. Retune the controls with the new tube in the circuit. If this does not correct the abnormal condition, turn the controls to their original position and put the old tube back in the circuit, unless a tube test proves that the tube is definitely bad.

> **CAUTION:** In many radar circuits the interelectrode capacitance of a tube is a part of a tuned circuit. Tube switching upsets the tuning of a circuit. The set may become seriously misaligned if too many tube substitutions are made.

(2) When a tube is replaced, decide at once whether or not to keep the old tube. The result of indiscriminate tube changing is a spare tube box full of tubes whose exact age and condition are uncertain.

b. Tube Checking. Tube testers are used to check the emission of electrons from the cathode and to test for shorted elements; a tester is not used to check the performance of high-voltage tubes, rectifiers, and some special tubes in the modulator. Tube testers are useful for checking receiving-type tubes.

(1) Results obtained from a tube tester are not always conclusive because the conditions are not the same as those under which the tube operates in the set. The final test of a tube is its replacement with a tube known to be good. It is quicker and more reliable to replace a suspected tube with a good one than to check it with the tube tester.

(2) An operating chart and an instruction book are provided with the tube tester. This chart indicates the setting of the tube tester for each tube type. The number of controls, their arrangement, and their settings vary with different types of tube testers.

c. Pin Connections. Pin connections on tube sockets are numbered in a clockwise direction around the sockets when viewed from the bottom. The first pin clockwise from the keyway is pin 1. Any tube element can be readily located by the pin numbers appearing on both the schematic diagrams and the wiring diagrams.

59. CHECKING WAVEFORMS.

a. Signal Tracing. Following a voltage through a circuit is known as signal tracing. The term *signal* means a sweep voltage, a step voltage, or any other waveform which appears in the various parts of the equipment. A departure from the normal waveform indicates a fault located after the point where it was last observed to be normal. For example, a waveform observed to be normal at the grid of a stage and abnormal at the plate of the same stage indicates trouble in that stage.

(1) When the waveform of a multivibrator, a blocking-oscillator tube, or a similar circuit is found to be abnormal, replace the tube before making any further tests. If replacing the tube does not correct the trouble, put the original tube back in the circuit.

(2) If a component does not give the proper waveforms, the fault may be the result of the absence of a synchronizing or triggering pulse from another component. Start signal tracing at the signal input to the component.

(3) It is sometimes desirable to know definitely whether a signal voltage is getting to the grid of the first tube in a channel. If a test jack is not provided, remove the first tube in the channel to make the grid connection of the tube available from the top of the chassis. Insert the test lead of the oscilloscope in the grid connection of the tube socket.

b. Use of Test Oscilloscope. The outstanding advantage of the oscilloscope is that it can be used to observe and to measure waveforms at the various test jacks and other points in the equipment. By comparing the observed waveforms with the actual reference waveform shown in the data, the fault can be rapidly localized. If waveforms are measured at random, without logical procedure, loss of time results. Measuring waveforms with the test oscilloscope involves the following essential points:

> **NOTE:** DuMont type 208 oscilloscope, supplied with Radio Set SCR-784, is used when trouble shooting Radio Equipment RC-384. The terminology in this manual for test oscilloscope controls applies to this oscilloscope. See figure 65 for description of the controls.

(1) *Initial Adjustments.* Plug the power cord into an a-c outlet, snap the POWER switch ON, and allow the oscilloscope to warm up for 5 minutes. Before using the oscilloscope, snap the BEAM switch ON.

(2) *Sweep Frequency.* Adjust the sweep frequency to a frequency *lower* than the repetition frequency of the waveform being observed. For ordinary measurements adjust the sweep frequency so that two or three cycles of the waveform appear on the screen. If more detail is desired, increase the sweep amplitude to spread the waveform.

(3) *Synchronization.* Avoid excessive synchronizing voltage. If the SYNC. SIGNAL AMPLITUDE control is advanced too far, the sweep will become nonlinear, and the waveform will be distorted. Be sure that the FINE FREQUENCY control on the oscilloscope is set to obtain a nearly stationary image. Advance the SYNC. SIGNAL AMPLITUDE only far enough to make the trace stationary.

(4) *Sixty-cycle Pick-up.* If there is a fault, it may be impossible to obtain a stationary pattern, even though the oscilloscope frequency control is properly adjusted. This effect is usually the result of a 60-cycle modulation or 60-cycle pick-up com-

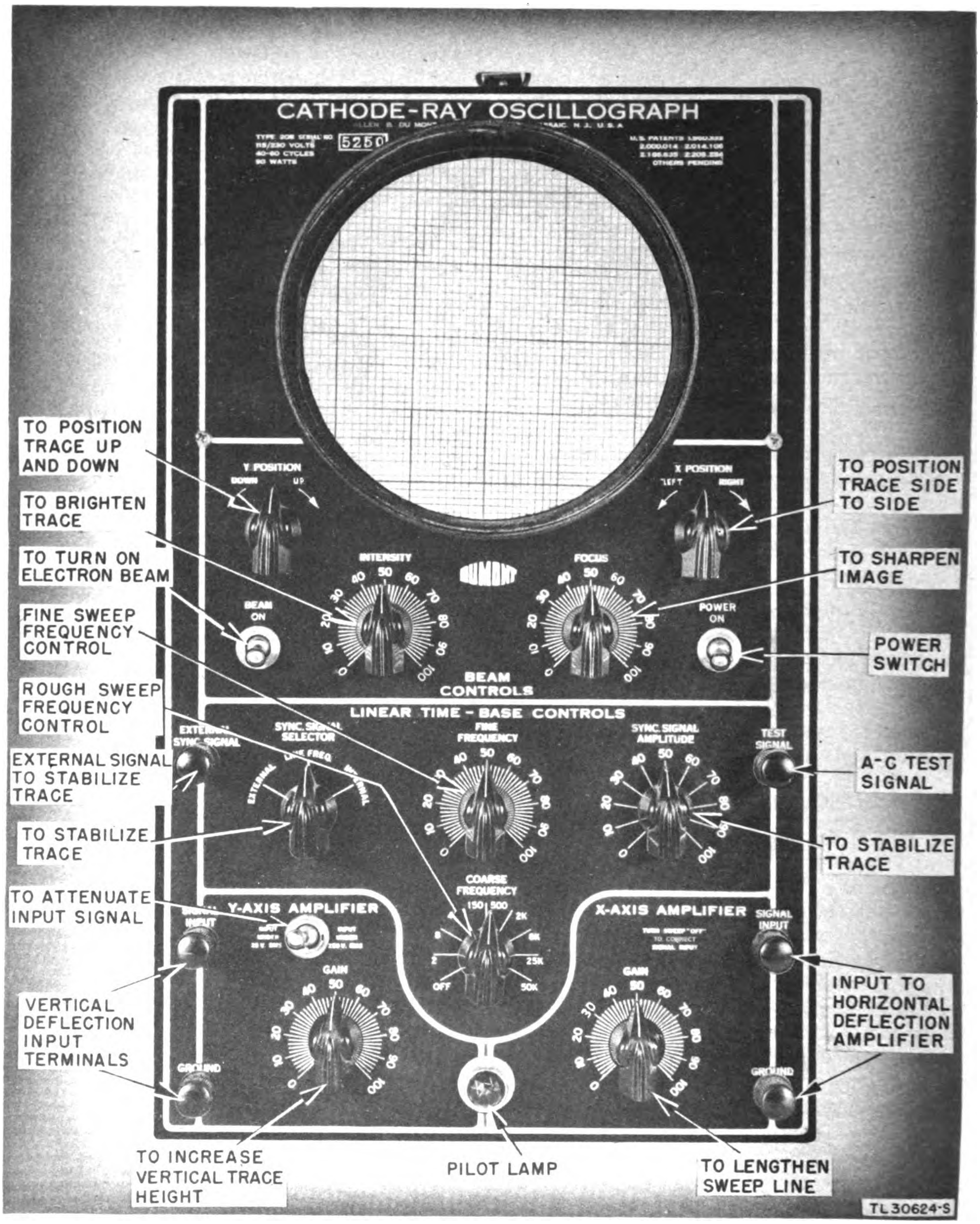


Figure 65. DuMont type 208 oscilloscope.

bined with the observed waveform. To avoid 60-cycle pick-up make sure that the test lead attached to the GROUND terminal of the oscilloscope is connected to a ground point in the chassis being tested. Keep the test leads away from power transformers and a-c lines.

(5) *Reactions of Oscilloscope on Waveform.* The oscilloscope, because it shunts capacitance and resistance across the circuit, modifies the actual operating waveform which is present in the circuit. This does not affect the usefulness of waveform measurements. The reference waveforms shown in this manual were taken with a typical oscilloscope under the same conditions as those under which the repairman takes the waveforms.

(6) *Test Leads.* Avoid the use of a shielded test lead or twisted leads when taking waveforms. Either of these shunts a capacitance across the circuit under test, causing distortion. The waveforms shown in the test data were taken with an unshielded lead. The ground lead must be connected at all times.

(*a*) To avoid feedback keep the ungrounded oscilloscope test lead away from other circuits. Bring the test leads from the test point to the oscilloscope in a way which introduces a minimum amount of coupling from other circuits.

(*b*) Keep the leads to the oscilloscope short when measuring grid voltages. The smallest reaction on the waveform is introduced when measuring the voltage across the output (cathode) of a cathode follower or of any low-impedance circuit.

(*c*) When measuring waveforms in high-impedance circuits, do not handle the *hot* test lead. This action causes the waveform to be distorted as a result of loading the circuit and picking up 60-cycle voltage.

(*d*) If a signal voltage is picked up on the test leads, the oscilloscope indication may be misleading. For example, a signal may appear on the oscilloscope even when a plate-to-grid coupling capacitor is open. This effect occurs most often in circuits carrying narrow-pulse waveforms. The waveform will be reduced in amplitude below normal and will be distorted because the high-frequency components are overemphasized.

(7) *R-F and I-F Circuits.* Never measure waveforms in any of the r-f or i-f circuits. These frequencies are beyond the range of ordinary test oscilloscopes and no useful indications can be obtained.

(8) *Reversing Line Plug.* In some instances a more stable pattern may be obtained by reversing the a-c line plug of the oscilloscope circuit. This may reduce the amount of 60-cycle pick-up.

(9) *Relative Amplitude.* The amplitude of the waveform usually increases as the checking point is advanced from the input stage toward the output stage; however, this is not always true. For example, there is a loss of about 10 percent signal amplitude between the grid and the cathode of the cathode-follower stage. This is a normal condition. Another example is in connection with waveshaping circuits, when a decrease in the width of a signal is sometimes accompanied by a decrease in amplitude (differentiating circuits).

(10) *Calibration.* If it is necessary to measure the voltage of the waveform, calibrate the oscilloscope by finding how many volts correspond to a 1-inch deflection on the screen. This is the *sensitivity* of the oscilloscope.

(11) *High-voltage Measurements.* To measure voltages above a few hundred volts, turn the power off at the source before connecting the test lead.

CAUTION: Some test jacks do not have blocking capacitors. The capacitors are not included so that d-c voltages can be measured at the test jacks.

c. Comparison of Waveforms. If there is no fault in the circuit or equipment, an actual waveform taken at a point in the equipment should closely resemble the reference waveform. In some cases the differences in shape may occur for the following reasons:

(1) The test leads to the oscilloscope are not properly placed.

(2) The test oscilloscope used has values of input resistance and capacitance differing from those of a Dumont type 208 oscilloscope which was used to take reference waveforms.

(3) The various equipment controls are in a position different from the settings used when taking the reference waveforms. Note the conditions specified in the reference waveform.

(4) The frequency is different.

(5) The vertical or horizontal amplitudes of the reference and the test patterns are not proportional. This produces apparent differences in the shape of the two waveforms, although there is no real difference.

(6) Whether or not a waveform is regarded as abnormal depends upon the sympton accompanying the fault which is being traced. The discrepancy should be considered significant only if the fault can be caused by a slight difference in

waveform at the point under test. Do not waste time checking relatively minor differences between the shape of the reference waveforms and the test waveforms.

60. USE OF SIGNAL GENERATOR.

Signal generators are used to signal trace defective stages in radar receivers and to align the i-f amplifiers.

a. Signal Tracing. Signal Generator I-222-A supplied with Radio Equipment RC-384 does not have a modulated output and therefore cannot be used for signal tracing. If a signal generator with a modulated output is available, the following procedure is applicable.

(*1*) Set the signal-generator frequency to the i-f of the receiver. The output of the signal generator is amplitude-modulated at an audio-frequency rate. For information concerning the setting up of the signal generator, refer to the technical manual supplied with it.

(*2*) Make the leads from the signal generator to the receiver as short as possible. Insert a coupling capacitor in the hot lead. For frequencies above 20 mc, the capacitance of the coupling capacitor should be around 0.005 microfarad.

(*3*) Connect a test oscilloscope to the video output of the receiver. Set the sweep speed for one-half the frequency of the audio modulating signal.

(*4*) Couple the modulated signal to the grid of the first i-f stage with a coupling capacitor. If no output is shown on the test oscilloscope, move it to the plate of the detector. If there is no output on the oscilloscope, the fault lies in or between the first i-f amplifier and the detector (subpar. (*a*) below). If a sinusoidal waveform having the same frequency as the chosen modulating frequency is seen, the i-f stages and the detector are operating properly. Connect the test oscilloscope to the plate of the output stage of the receiver. If there is no output, the fault lies in or between the first video amplifier and the output stage (subpar. (*b*) below).

(*a*) If the fault is found in the i-f stages or in the detector, connect the signal generator to the grid of the middle stage of the i-f amplifier. Normal output from the detector indicates that the fault is in one of the first i-f stages. No output from the detector indicates that the fault is in or between the middle stage and the detector. By moving the signal generator output either forward or backward, stage by stage, the faulty stage can be rapidly located. After locating the defective stage, replace the tube. If replacing the tube does not clear up the fault, make resistance and voltage checks of the stage.

(*b*) If the fault is found in the video amplifiers, leave the signal generator connected to the first i-f stage and move the test oscilloscope lead from the grid to the plate of each video stage until the defective stage is located. If replacing the tube does not correct the fault, make resistance and voltage checks to locate the defective part.

b. I-F Alignment. Use Signal Generator I-222-A to align the i-f stages. The i-f stages in this equipment are stagger-tuned, and special procedure must be used. This procedure is described in paragraph 74.

61. REPLACING PARTS.

Careless replacement of parts makes new faults inevitable. Note the following points:

a. Before a part is unsoldered, tag each of its leads.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Drops of solder falling into the set cause short circuits. A carelessly soldered connection is a very difficult fault to find.

d. Replace parts in r-f or i-f circuits exactly as they were originally. A part having the same electrical value, but different physical size, may cause trouble in high-frequency circuits. Give particular attention to proper grounding. Use the same ground point as in the original wiring. Failure to observe these precautions results in decreased gain or in oscillation of the circuit.

62. REPLACING CABLE CONNECTIONS.

a. Introduction. When insulation at a cable connector becomes frayed, cracked, or cut, or when leads have pulled loose, repair or replacement is necessary. If the cord is long enough to permit cutting the wire back to where the insulation is in good condition, remove the connector and clean it carefully with crocus cloth and dry-cleaning solvent. If necessary, re-tin those surfaces to which the wires are to be soldered. Prepare the wire and replace the connector. Figures 66 and 67 are self-explanatory instructions in the assembly of the various connectors used with the equipment and in the wire preparations required. Use the two tables on the following page to determine the connector type and which panel of the illustrations applies.

WARNING: Be extremely careful to attach the proper wire to the correct pin number on the multiwire assemblies. Use an ohmmeter to determine continuity and to test for absence of shorts and cross connections. Ground connections must be electrically and mechanically secure. An OPEN GROUND CONNECTION OR A MISPLACED WIRE CAN CAUSE DEATH OR DESTROY THE EQUIPMENT.

b. Soldering. When soldering, remember that *flux cannot clean a dirty terminal.* The primary considerations in soldering are a clean tinned terminal, a clean tinned wire, and a hot tinned soldering iron tip of the proper size.

(*1*) Use only rosin-core solder.

(*2*) Do not permit the melted flux or solder to flow around the pins or insulated part of the connector.

(*3*) Do not try to remove individual prongs from the connectors.

(*4*) Avoid excessive heating of the pins and insulated parts of the connector.

(*5*) A firm mechanical connection is necessary before beginning to solder. Clasp wire firmly to terminal to be soldered.

(*6*) Do not touch clean terminal with fingers otherwise an oily film will be deposited.

(*7*) Apply the solder to the terminal, not to the iron. If the terminal is heated sufficiently, the solder will melt readily upon contact and adhere to the work; whereas when the solder is applied to the iron, it will cool when it hits the terminal and form a cold soldered joint which can be dislodged easily.

(*8*) If the solder forms globules and runs off the surface of the terminals, dirt, oil, or improper tinning of the surface is indicated.

(*9*) Be careful not to move the terminal or wire when withdrawing the iron or before the solder has cooled to a bright hard joint. Any movement of the solder while it is solidifying will cause it to crystallize into a granular mass which will not adhere properly and which will make a high-resistance connection.

(*10*) Remove excess rosin and particles of solder and clean these surfaces carefully with dry-cleaning solvent because even a microscopic film of rosin changes the characteristics of high-frequency circuits.

(*11*) When soldering in difficult places, see that no damage or short circuits have been caused by contact of the iron with surrounding wiring. Use the proper soldering iron tip to avoid burning the insulation of near-by wires.

TABLE II
INTERCONNECTING CABLES FOR RADIO EQUIPMENT RC-384

Signal Corps type No.	*Function*	*Type and length*	*Terminal A and fig. No.*	*Terminal B and fig. No.*
CD-1342	A-C to rack	2-conductor, #14 stranded, 10 ft	AN-3106-22-8S (to rack) fig. 66B	AN-3106-22-8P (to radar) fig. 66B
CD-1343	Radar sync to control unit	RG-8/U coaxial, 10 ft (2 supplied)	P-201-3/8 (Jones) (to control unit) fig. 67H	Plug PL-259 (to radar) fig. 66D
CD-1382	Control unit to rack	7-conductor, 8 ft	AN-3106-28-8S (to control unit) fig. 66B	AN-3106-28-1P (to rack) fig. 66B
CG-55/U (25 ft 0 in)	R-F from tower base to receiver-transmitter	RG-8/U coaxial, 25 ft (2 supplied)*	Connector UG-21/U** fig. 66E	Connector UG-21/U (to tower) fig. 66E
CG-282/TPX	Antenna to rotary joint in tower	RG-8/U coaxial. 10 ft 10 in.	Plug UG-21/U (to antenna) fig. 66E	Lapp 26243 (to rotary joint in tower) fig. 67G
CX-596/TPX	A-C power to illuminate azimuth dial on remote indicator	2-conductor, rubber-covered, 6 ft	AN-3108-18-3P (change to two-prong a-c cap for rack outlet) (to rack a-c outlet) fig. 66B	AN-3106-18-3S (to remote antenna drive) fig. 66B
MX-363/TPX	Rotates antenna from remote drive box	Flexible shaft, 25 ft (2 supplied)†	Straight flexible shaft connector (to remote antenna drive).	Right-angle flexible shaft connector (to base of tower)

*2 Cords CG-55/U (25 ft 0 in.) are joined by straight connector UG-29/U to make 50-ft length.

**Connects to straight Adapter UG-83/U, which is in turn connected to right angle Adapter M-359 for attachment to ANTENNA receptacle on receiver-transmitter.

†Cords MX-363/TPX are joined by straight mechanical connector to make 50-ft. length.

TABLE III
TEST CABLES FOR RADIO EQUIPMENT RC-384

Signal Corps type No.	*Function*	*Type and Length*	*Terminal A and fig. No.*	*Terminal B and fig. No.*
CD-1099	General utility test cord	Low-capacity shielded microphone cable, 6 ft	Plug PL-55 fig. 66A	Two spade lugs
CD-1102	General utility test cord	Single-conductor, 4 ft	Alligator clip	Spade lug
CD-1103	Signal generator output to i-f input test jack on receiver chassis	Low-capacity, shielded microphone cable, 33 in.	Plug PL-259 fig. 66D	Plug PL-55 fig. 66A
CD-1104	Signal generator output to receiver input	Low-capacity, shielded microphone cable, 5 ft	Plug PL-259 fig. 66D	Plug PL-259 fig. 66D
CD-1105	Interconnects jacks at control unit jack panel	Low-capacity, shielded microphone cable, 1 ft	Plug PL-55 fig. 66A	Plug PL-55 fig. 66A
CX-572/CPX (8 ft. 0 in.)	Lapp receptacle in rack to Lapp plug on receiver-transmitter	21-conductor, 8 ft	Special connector fig. 67F	Special connector fig. 67F
CD-1141	A-C to power supply Lapp plug	2-conductor, 6 ft	2-prong, a-c plug	Special connector
CD-1347	Radar calibration pips to control unit	RG-54/AU coaxial, 10 ft	Plug PL-55 fig. 66A	Plug PL-259 with special adapter UG-176/U (Amphenol)

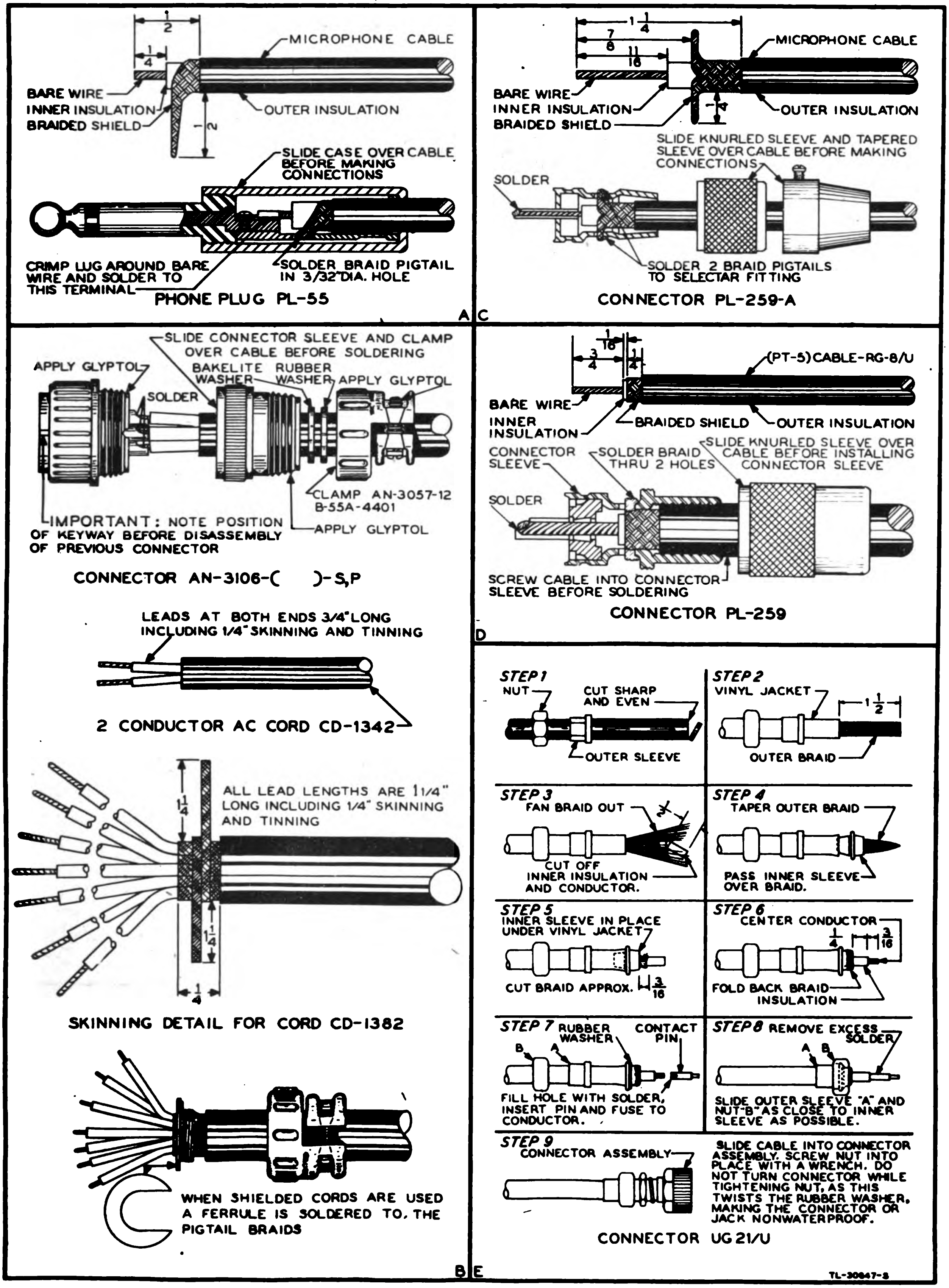


Figure 66. Assembling connectors to cables.

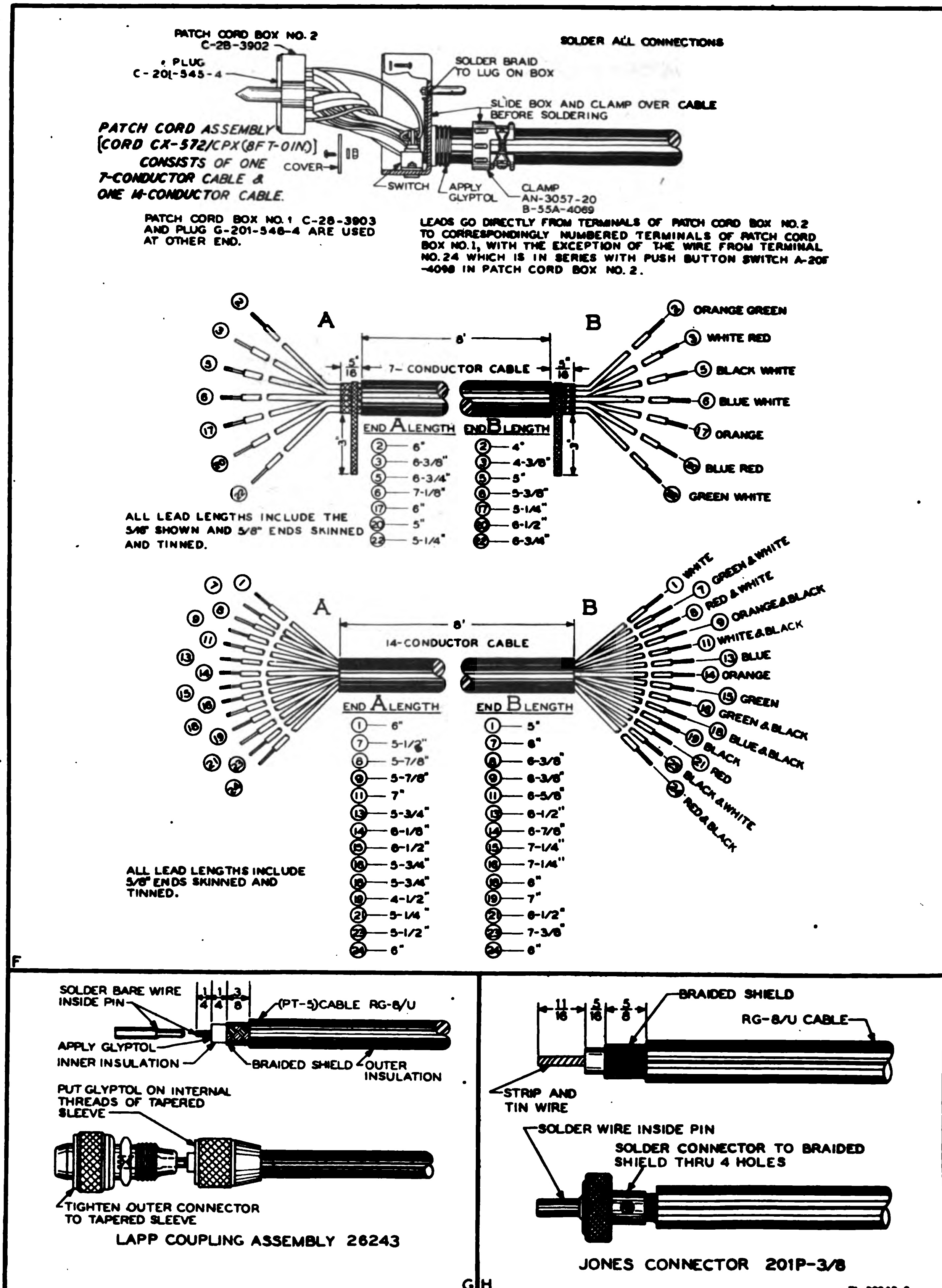


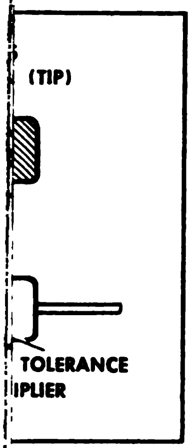
Figure 67. Assembling connectors to cables.

R

DES

FOR

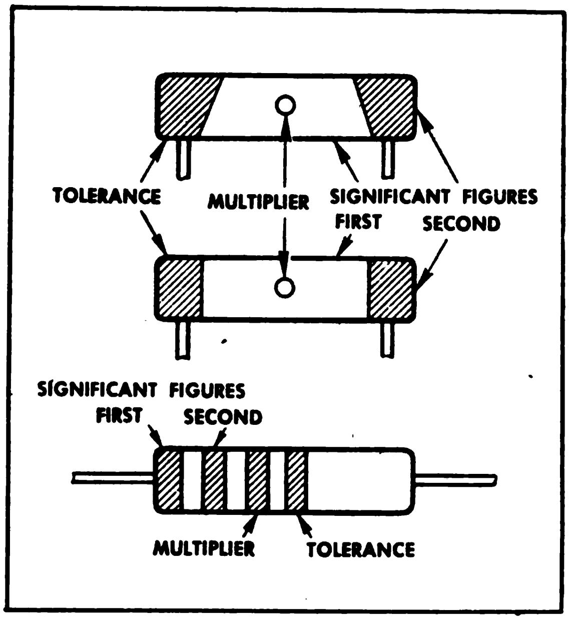
SISTORS



tors with axial
tan background
n resistors with
ack background

IER	TOLERANCE (PERCENT)
0	
0	
0	
00	
00	
000	
000	
,000	
0,000	
0	5
0	10
0	20

AWS COLOR CODE FOR
FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

TL 13418

Figure 68. Capacitor color code.
Figure 69. Resistor color code.

CHAPTER 9

TROUBLE SHOOTING BASED ON STARTING PROCEDURE

63. TROUBLE-SHOOTING CHART BASED ON STARTING PROCEDURE.

The trouble-shooting charts in this section are based on the starting procedure contained in TM 11-1362. Start the equipment according to this procedure and watch carefully for abnormal indications. The charts are designed to enable the repairman to locate quickly the faulty component so that the trouble can be cleared as rapidly as possible by replacing the component with a spare. If a replacement for a component is not available, refer to the trouble-shooting chapter for that component (chs. 10 through 14).

STEP 1. Place BLOWERS switch in ON position.

NORMAL INDICATIONS: 1. Pilot light near switch glows if jewel is turned counterclockwise.

2. Air intake can be felt at lower front panel of rack.

Abnormal Indications	Probable Location of Fault
1. Pilot lamp does not light.	1. Bad pilot lamp.
2. No air intake.	2*a*. No line voltage being delivered to rack (fig. 122).
	b. Rack interlock switch open (fig. 122).
3. Switch will not remain closed.	3*a*. Short in blower circuit (fig. 122).
	b. Short in blower motor (fig. 122).
	c. Blower motor rotor locked.

STEP 1. 1. Place BLOWER switch on rear of control unit in ON position.

NORMAL INDICATION: Air flow can be felt at air vents in upper part of rear panel of control unit.

Abnormal Indication	Probable Location of Fault
No air flow.	*a*. Control unit fuse blown (fig. 122).
	b. Defective control unit BLOWER switch (fig. 122).
	c. Open choke 118-1 or 118-2 (fig. 122).
	d. Bad brushes in control unit blower.
	e. Defective control unit blower.

STEP 2. Place HEATERS switch in ON position.

NORMAL INDICATION: 1. Pilot light near switch glows if jewel is turned counterclockwise.
2. Control unit blower goes on; air current can be felt at vents in rear of control unit case.

CAUTION: Do not allow heaters to operate for more than 30 minutes.

Abnormal Indications	Probable Location of Fault
1. Pilot lamp does not light.	1*a*. Bad pilot lamp. *b*. Overload in blowers circuit has opened BLOWERS switch (indication 3 of step 1 above).
2. Switch will not remain closed.	2*a*. Short in heaters circuit or heater in control unit (fig. 122). *b*. Short in heater circuit in Cord CD-1382 (fig. 122). *c*. Short in heaters circuit or heaters in rack (fig. 122). *d*. Short in control-unit blower circuit (fig. 122).
3. No air current at rear of control unit.	3. Same as for Step 1.1 above.

STEP 3. Snap ON-OFF toggle switch on control unit to ON position.

NORMAL INDICATION: Control unit pilot light glows if jewel is turned clockwise.

Abnormal Indications	Probable Location of Fault
Pilot lamp does not light.	*a*. Bad pilot lamp. *b*. Blown fuse in control unit. *c*. Bad connections at receptacles at either end of Cord CD-1382. *d*. Defective a-c circuit in control unit (fig. 57).

STEP 4. Switch FILAMENT VOLTAGE circuit breaker of power supply to ON position.

NORMAL INDICATIONS: Pilot lights T-A and T-B glow if jewels are turned counterclockwise.

Abnormal Indications	Probable Location of Fault
1. Pilot lamp T-A or pilot lamp T-B does not light.	1. See symptoms C, D, and H, par. 108.
2. FILAMENT VOLTAGE circuit breaker will not remain closed.	2. Defective power supply (shorted filament circuit, par. 108, symptom A).

STEP 5. Wait 45 seconds; then switch PLATE VOLTAGE circuit breaker on power supply to ON position.

NORMAL INDICATION: Pilot lamps T-C and T-D glow if jewels are turned counterclockwise.

Abnormal Indications	Probable Location of Fault
1. Pilot lamp T-C or pilot lamp T-D does not light.	1. See symptoms E, F, and G, par. 108.
2. PLATE VOLTAGE circuit will not remain closed.	2. Defective power supply (shorted plate-supply circuit, par. 108, symptom B).

STEP 6. Turn SENSITIVITY knob on control unit to its maximum counterclockwise position.
NORMAL INDICATION: None.

STEP 7. Turn range switch on the control unit to 10 K YD position.
NORMAL INDICATION: Correctly positioned sweep line with no grass on it appears on control unit screen.

Abnormal Indications	**Probable Location of Fault**
1. No sweep trace or dot on the screen.	1*a*. Improper adjustment of INTENSITY control. *b*. No B+ voltage from Tube 2 in Power Supply RA-105-A. See par. 96**b**.
2. Only a dot or vertical line appears on display tube. **NOTE:** When this condition exists, reduce the intensity to prevent screen damage.	2. Defective control unit (par. 100, symptom B).
3. Trace present but not clear and sharp.	3*a*. Improper adjustment of FOCUS control. *b*. Defective control unit (par. 100, symptoms I, K, and L).

STEP 8. Turn SENSITIVITY control clockwise.
NORMAL INDICATION: Noise signals (grass) appear on the sweep line.

Abnormal Indication	**Probable Location of Fault**
Grass does not appear.	*a*. Defective Cord CD-1382. *b*. Defective receiver (par. 69, symptoms G and H). *c*. Defective control unit (par. 100, symptom E, fault 3). *d*. Defective rack wiring between receiver-transmitter and connector to Cord CD-1382 (fig. 125).

STEP 9. Turn SENSITIVITY knob on control unit to its maximum counterclockwise position.
NORMAL INDICATION: Grass disappears from sweep line.

Abnormal Indication	**Probable Location of Fault**
Grass does not disappear.	Defective sensitivity control 98.

STEP 10. Turn range switch on control unit to 75 K YD position.

NORMAL INDICATIONS: Correctly positioned sweep line with no grass on it appears on control unit screen.

Abnormal Indications	Probable Location of Fault
Same as for step 7.	Same as for step 7. See also par. 100 Symptom D.

STEP 11. Turn SENSITIVITY control clockwise until grass is about 1/16 inch high.

NORMAL INDICATION: Grass appears on sweep about 1/16 inch high.

Abnormal Indications	Probable Location of Fault
1. Grass does not appear.	1. Same as for step 8.
2. Grass height is not controllable.	2. Same as for step 9.

STEP 12. Hold TEST SWITCH on receiver-transmitter in Ic position and read current on lower scale of meter. Then release TEST SWITCH.

NORMAL INDICATION: Reading is between zero and 2 milliamperes.

Abnormal Indication	Probable Location of Fault
Meter reading incorrect.	*a.* Improper adjustment of BIAS control (par. 66). *b.* Defective receiver-transmitter (par. 69, symptom A)

STEP 13. Snap STANDBY-OPERATE switch on control unit to OPERATE position.

NORMAL INDICATION: Envelope of r-f transmitter pulse appears on screen as thin vertical line at left end of sweep.

Abnormal Indication	Probable Location of Fault
Pulse does not appear.	*a.* Defective Cord CD-1382 (pars. 96*d* and 96*e*). *b.* Defective receiver-transmitter (par. 69, symptoms A, B, and D). *c.* Defective control unit (no sync voltage to transmitter, par. 100, symptom E). *d.* Defect in rack wiring between receiver-transmitter and connector to Cord CD-1382 (fig. 125).

STEP 14. Hold TEST SWITCH on receiver-transmitter in Ic position and read current on lower scale of meter.
NORMAL INDICATION: Reading is between 3.5 and 7.5 milliamperes.

Abnormal Indications	Probable Location of Fault
1. Meter reading higher than step 12 reading but not between 3.5 and 7.5 milliamperes.	1*a*. Improper adjustment of BIAS control (par. 66). *b*. Improper adjustment of WIDTH control (par. 67). *c*. Improper DIVISION adjustment (causing wrong transmitter recurrence rate) (par. 101*c*).
2. Meter reading same as in step 12.	2*a*. Defective Cord CD-1382 (no sync voltage to transmitter, par. 96*d*). *b*. Defective receiver-transmitter (par. 69, symptom B). *c*. Defective control unit (no sync voltage to transmitter, par. 100, symptom E). *d*. Defect in rack wiring between receiver-transmitter and connector to Cord CD-1382 (fig. 125).

STEP 15. Hold TEST SWITCH on receiver-transmitter in P.O. position and observe control unit display screen.
NORMAL INDICATIONS: 1. Grass and ground return disappear from sweep.
2. Envelope of transmitter pulse appears on sweep.

Abnormal Indications	Probable Location of Fault
1. Grass and ground return do not disappear from sweep.	1. Defective receiver-transmitter (measuring circuit' fig. 14).
2. Envelope of transmitter pulse does not appear on sweep.	2. If step 14 shows normal indications, fault is in receiver-transmitter measuring circuit (fig. 14) or in r-f oscillator (par. 69, symptom D).

STEP 16. While holding TEST SWITCH in P.O. position, turn POWER MEASUREMENT control clockwise.
NORMAL INDICATIONS: 1. Transmitter pulse grows shorter.
2. Transmitter pulse finally disappears.
3. Power output reading on upper scale of meter at the point in rotation where pulse disappears is 0.25 kilowatt or as specified by person in charge (par. 68).

Abnormal Indications	Probable Location of Fault
1. Pulse does not grow shorter as POWER MEASUREMENT control is turned.	1. Defective receiver-transmitter (power measurement circuit, fig. 14).
2. Pulse cannot be made to disappear.	2. POWER OUTPUT adjustment control is turned too far clockwise (too much power output, par. 68).

3. Wrong power output reading.	3*a*. Improper adjustment of POWER OUTPUT control (par. 68). *b*. Incorrect adjustment of antenna-matching section (par. 72). *c*. Improper adjustment of ANT. TUNE control (par. 71**h**). *d*. Incorrect adjustment of BIAS control (par. 66). *e*. Faulty receiver-transmitter (par. 69, symptom E.)

STEP 17. Snap switch on remote antenna drive box to ON position.

NORMAL INDICATION: Portion of remote azimuth dial near indicating mark lights up.

Abnormal Indication	Probable Location of Fault
Lamp does not light.	*a*. Cord CX-596/TPX is not connected properly between convenience outlet on rack and a-c connector on remote drive box (fig. 124). *b*. Bad lamp in remote antenna drive box. *c*. Defect in Cord CX-596/TPX.

STEP 18. Rotate crank of remote antenna drive box until dial makes one complete revolution.

NORMAL INDICATIONS:
1. Crank turns fairly freely.
2. Crank turns fairly smoothly.
3. Unless surrounding terrain is uniform in all directions, ground return on the display screen changes in appearance during rotation.

Abnormal Indication	Probable Location of Fault
1. Crank binds.	1*a*. In cold climates, grease is stiff (par. 92**b**). *b*. In cold climates, ice forms in bearings (par. 92). *c*. Defect in mechanical assembly between crank and antenna (par. 91).

CAUTION: Do not force the rotation. Forcing will damage the flexible shaft.

STEP 19. Snap STANDBY-OPERATE switch to STANDBY position.

NORMAL INDICATION: Transmitter pulse and ground return disappear from display screen, but sweep and grass remain.

Abnormal Indications	Probable Location of Fault
Transmitter pulse and ground return do not disappear.	Defective STANDBY-OPERATE switch.

CHAPTER 10

RADIO RECEIVER AND TRANSMITTER BC-1267-A

WARNING: Voltages sufficient to cause death on contact are exposed at many points in this unit. Do not place hands or arms within the component when the high voltage is on. Always ground high-voltage capacitors before touching them or their associated circuits.

Section I—Introduction

64. REFERENCE DATA.

The figures listed below appear in other chapters of this manual and will assist maintenance personnel in trouble shooting in the receiver-transmitter.

Fig. No.	*Subject*
14	Transmitter, monitoring circuits.
15	Schematic diagram of transmitter section.
32	Schematic diagram of receiver section.
60	Schematic of Power Supply RA-105-A.
61	Complete block diagram of Radio Equipment RC-384.
125	Rack wiring diagram.

65. GENERAL.

a. Locating Faults in Transmitter.

(*1*) Before attempting to locate a fault in the transmitter circuit, it must be established that the fault is not in some other circuit. Operation of the transmitter can be checked by measuring its power output (par. 68). The inoperation of the transmitter may result from an absence of the trigger pulse. The trigger pulse can be checked at the SYNCH INPUT jack on the receiver-transmitter panel. If the pulse is present, the fault is in the transmitter circuit or in Power Supply RA-105-A.

(*2*) Most of the faults that occur in the transmitter can be localized by means of the monitoring circuits and test jacks. The results that can be obtained from their use are discussed in paragraphs 66, 67, and 68 which follow.

b. Locating Faults in Receiver Section.

(*1*) Faults in the video amplifier (tube 13) of the control unit and in the video circuits of the receiver often produce the same symptoms. The operation of the receiver can be checked by observing the output at the RECEIVER OUTPUT HIGH jack. The waveform at this jack should be the same as that normally observed on the display oscilloscope—grass plus the transmitter pulse.

(*2*) A failure of the 300-volt power supply (tube 4) may result in the same symptoms as a failure in the receiver. The power supply can be checked by noting whether or not the tuning eye indicator is dark.

(*3*) The presence of the transmitter pulse and the amount of grass on the oscilloscope screen, with the SENSITIVITY control fully clockwise, is an indication of the functioning of the receiver.

(*a*) A failure in the i-f stages will cut out most of the grass on the oscilloscope. If the grass is not reduced more than half, the fault is probably in the r-f amplifiers, the mixer, or the local oscillator.

(*b*) If all the stages which precede the detector are defective, the transmitter pulse will still be seen since it will be picked up by the detector. If the transmitter pulse is not seen and the transmitter power output is normal (par. 68), the fault is known to be in the detector circuit (tube 10) or in one of the circuits of the video channel (tubes 11 and 12).

(*c*) A failure in the i-f stages will not prevent the transmitter pulse from being seen but will cut out almost all the grass. Therefore, almost complete disappearance of the grass with the transmitter pulse present indicates a failure in the i-f stages.

(*4*) When the sensitivity of the set goes down slightly because of misalignment of the i-f stages, a shift in the value of a part, or a partial failure of a stage, the fault is difficult to locate. After the r-f stages have been tuned and the voltages have been checked at each stage, the i-f stages should be aligned (par. 74) and the sensitivity of each stage should be checked (par. 74f).

c. Operation of Receiver-Transmitter while Removed from Rack. Patch Cord CX-572/CPX (8 ft. 0 in.) can be used to connect connector 180 on the back of the chassis to connector 7 in the rack. All circuits except the modulator plate voltage circuit will be completed. To complete this circuit, push the button on the patch cord connector that fits onto the receiver-transmitter chassis.

66. MODULATOR CATHODE CURRENT.

a. Use the following procedure in checking and adjusting the modulator cathode current.

(*1*) Place the challenge switch in the STANDBY position.

(*a*) Hold the TEST SWITCH in the Ic position.

(*b*) The test meter should read between 0.2 and 2 milliamperes. If it does not, adjust the BIAS control to obtain the proper reading.

(*2*) Place the challenge switch in the OPERATE position.

(*a*) Hold the TEST SWITCH in the Ic position.

(*b*) The test meter should read between 3.5 and 7.5 milliamperes. If it does not, adjust the WIDTH control (par. 67).

b. If the procedures above cannot be carried out successfully, trouble is indicated and should be located by using the following information.

(*1*) If the cathode current is abnormally high with the challenge switch in the STANDBY position and cannot be lowered by adjusting the BIAS control, the bias voltage applied to the grid of modulator tube 17 has probably decreased. Bias control 89-2 and resistor 53-3 in the receiver-transmitter, and the bias rectifier circuit, tube 1, in Power Supply RA-105-A (fig. 60) should be checked.

NOTE: If the modulator tube burns out, the bias circuit should be checked. A loss of bias voltage will allow tube 17 to conduct continuously and will either cause the tube to burn out or cause the PLATE VOLTAGE circuit breaker to open.

(*2*) If the modulator cathode current is zero, the fault is a failure in tube 17, an increase in the bias voltage (resistor 22-1 or 22-2 in the power supply shorted), or a failure in the 2,300-volt plate power supply for the modulator tube.

(*3*) If the cathode current does not increase when the challenge switch is thrown from STANDBY to OPERATE, the modulator tube is not being triggered. To isolate the fault, follow the procedure given below:

(*a*) Using the test oscilloscope, check the waveform at SYNCH INPUT jack 150-1 on the receiver-transmitter panel. If the sync pulse is at jack 150-1, the fault is in the modulator channel, tubes 16, 18, and 19. If the waveform is not at jack 150-1, check it at jack 121-4 on the control unit.

(*b*) Plate voltage for sync amplifier tube 16 and cathode-follower tube 18 is supplied by the same power supply (tube 4) that supplies plate voltage for the receiver and for tuning indicator tube 13. Failure of this supply is indicated by the TUNING INDICATOR eye remaining dark and an absence of grass on the oscilloscope.

(*c*) When trouble in the blocking oscillator is suspected, hold the TEST SWITCH in the P.O. position and turn the POWER MEASUREMENT control clockwise. If the test meter reading increases, it is indicated that the 400-volt power supply (tube 3 in Power Supply RA-105-A) for the block-

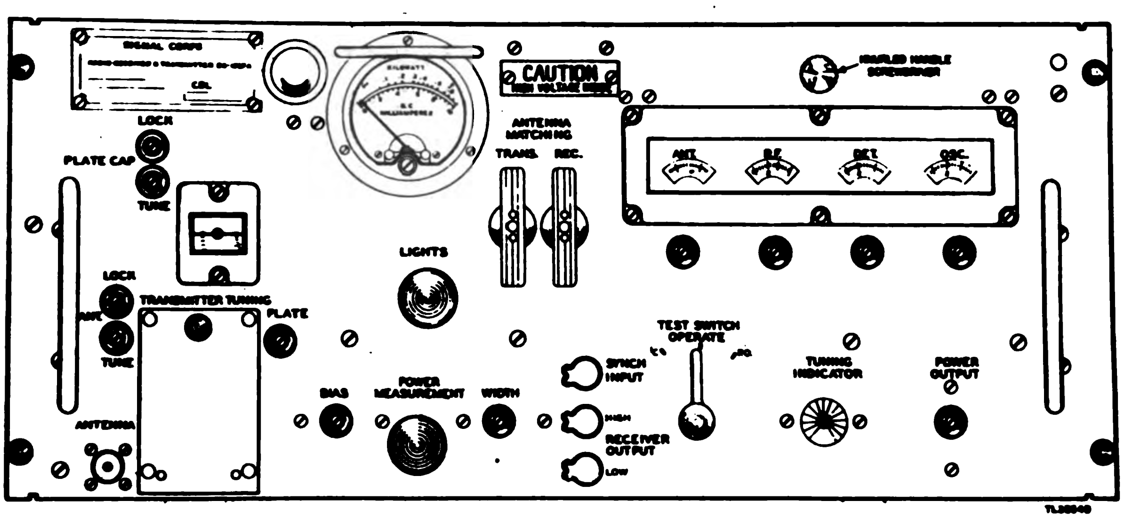


Figure 70. Radio Receiver and Transmitter BC-1267-A, front panel view.

ing oscillator is functioning. Ad additional check of the blocking oscillator is obtained by listening for a buzzing sound coming from transformer 118. The buzzing noise indicates that the blocking oscillator is functioning.

(4) If the cathode current increases when the challenge switch is thrown to the OPERATE position but does not increase to at least 3.5 milliamperes, the division circuits in the control unit should be checked because a low sync frequency is indicated. If the cathode current increases beyond 7.5 milliamperes, the sync frequency may be too high. Abnormal cathode current may also be caused by improper adjustment of the WIDTH control, a fault in the grid circuit of the blocking oscillator, or a fault in the modulator circuit.

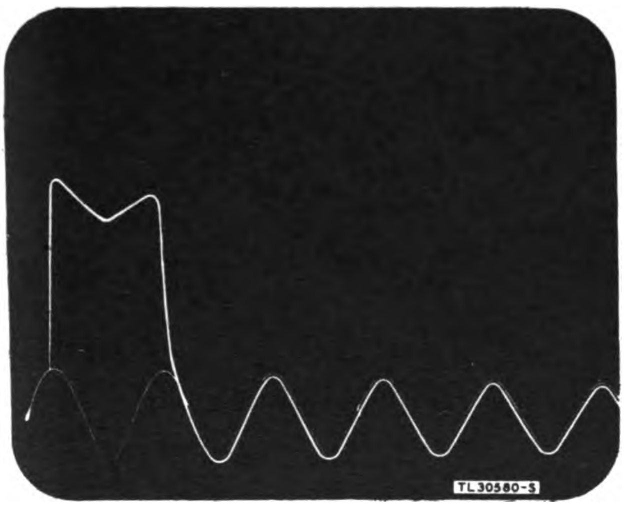


Figure 71. Pulse width measurement waveforms.

67. PULSE WIDTH ADJUSTMENT.

a. Follow the procedure below in checking and adjusting the WIDTH control (fig. 70).

(1) Place the challenge switch in the OPERATE position and turn the range switch to the CALIB. position.

(2) Turn the 10 K YD. GAIN screwdriver control completely clockwise and then adjust CENT. to set the left edge of the pattern on the display oscilloscope to about ½ inch from the left of the screen. The calibrating waves are now spread out on the screen (fig. 71). Each cycle of the calibrating sine wave represents 5 microseconds. (A cycle is the distance from any point on the wave to the corresponding point on the next wave.)

(3) Turn the INTENSITY control clockwise until the pattern on the screen is very bright but not bright enough to be too fuzzy.

(4) Request the radar operator to turn the SLEWING handwheel on the radar range indicator until the radar range pointer is at zero yards. Hold the test switch on the receiver-transmitter in the P.O. position. The envelope of the transmitter pulse will appear superimposed on the calibrating wave (fig. 71).

(5) Adjust the WIDTH control on the receiver-transmitter to obtain the desired pulse width. The width is measured at a point halfway up the power output pulse. The pulse width selected must be between 4 and 10 microseconds; that is, the power output pulse can vary from slightly less than one calibrating cycle up to two cycles wide.

(6) After the pulse width has been adjusted, check the modulator cathode current. Set the challenge switch to the OPERATE position and hold the TEST SWITCH on the receiver-transmitter in the Ic position. The cathode current must be less than 7.5 milliamperes. If it is more than 7.5 milliamperes, decrease the pulse width.

b. If the pulse width cannot be set to between 4 and 10 microseconds, trouble is indicated in blocking oscillator tube 19. The pulse width is determined principally by transformer 118 and tube 17. A large variation in the values of capacitors 30-1, 30-2, 21-5, 22-16, 16-3, and 16-4 or resistors 52-3, 89-1, 62-4, and 95-3 in the grid circuit of tube 19 and the cathode circuit of tube 18 also affects the pulse width.

c. If the cathode current is greater than 7.5 milliamperes when the desired pulse width is obtained, adjust the modulator BIAS control to lower it; if adjustment of the BIAS control does not correct the abnormal cathode current, the fault is in the circuits associated with the modulator tube 17.

68. TRANSMITTER POWER OUTPUT.

a. Use the following procedure in checking the power output of the transmitter.

(1) Place the challenge switch in the OPERATE position.

(2) Hold the TEST SWITCH in the P.O. position.

(3) Rotate the POWER MEASUREMENT control (fig. 70) clockwise meanwhile observing the pulse on the screen of the cathode-ray tube, until the pulse decreases to a minimum. Do not turn the POWER MEASUREMENT control past the point where the pulse ceases to decrease or an erroneous reading will be obtained.

(4) Read the power output on the test meter.

The power output should be 0.25 kilowatt (kw). Turn the POWER OUTPUT control clockwise to increase the power, counterclockwise to decrease it.

NOTE: The power output reading on the test meter is a measure only of the r-f power being generated by the r-f oscillator; it is not a measure of the power being radiated by the antenna. With no abnormal losses in the r-f transmission lines, and in a normal site, the power required to match the coverage of Radio Set SCR-784 is 0.25 kw as read on the power output meter. Because of tolerances in the meter circuit, it may be found that the coverage of Radio Set SCR-784 can be matched by using a lower reading. In that case decrease the power reading to that value. It is desirable to operate at the lowest possible power level, first, to avoid interrogation of aircraft outside the range of the display circuits (75,000 yards) and, second, to avoid interrogating planes at the wrong azimuth.

b. If the test described above cannot be completed, trouble is indicated in the circuits associated with the POWER MEASUREMENT control, TEST SWITCH 140, or tubes 14 and 15. If the power output cannot be set to 0.25 kw, check the cathode current of tube 17. Check the voltage applied to the screen grid of tube 17, the r-f oscillator tubes, and the measuring circuit.

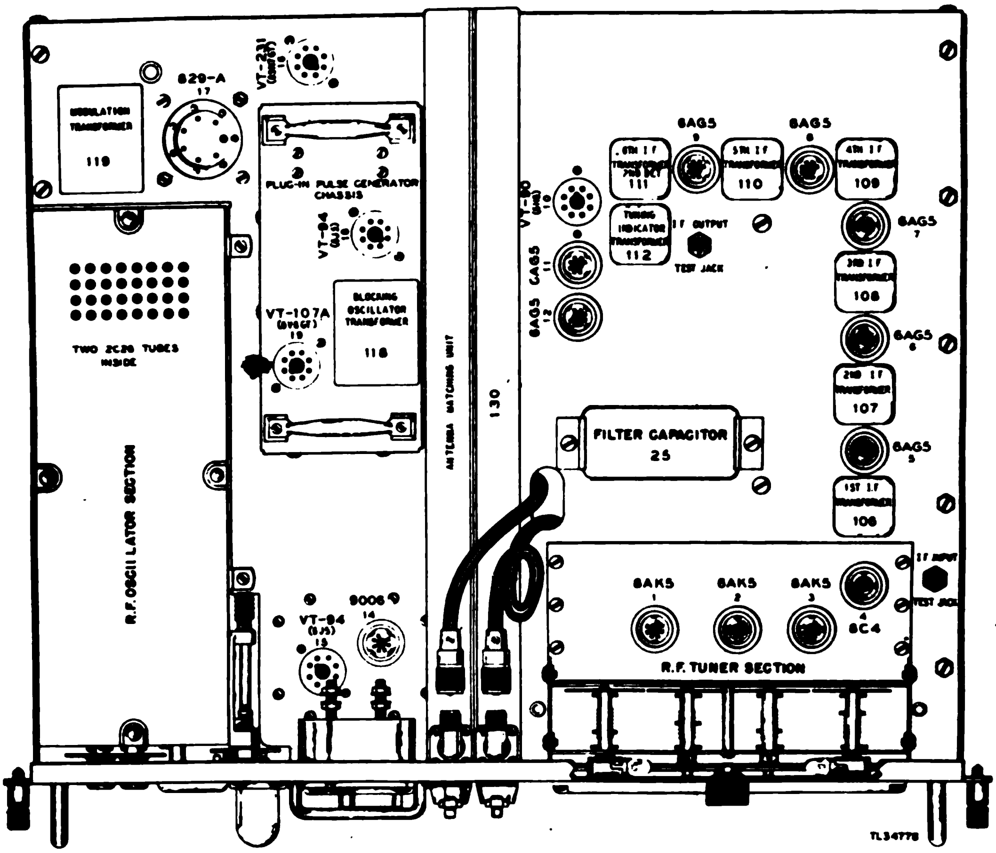


Figure 72. Radio Receiver and Transmitter BC-1267-A, top view showing location of parts.

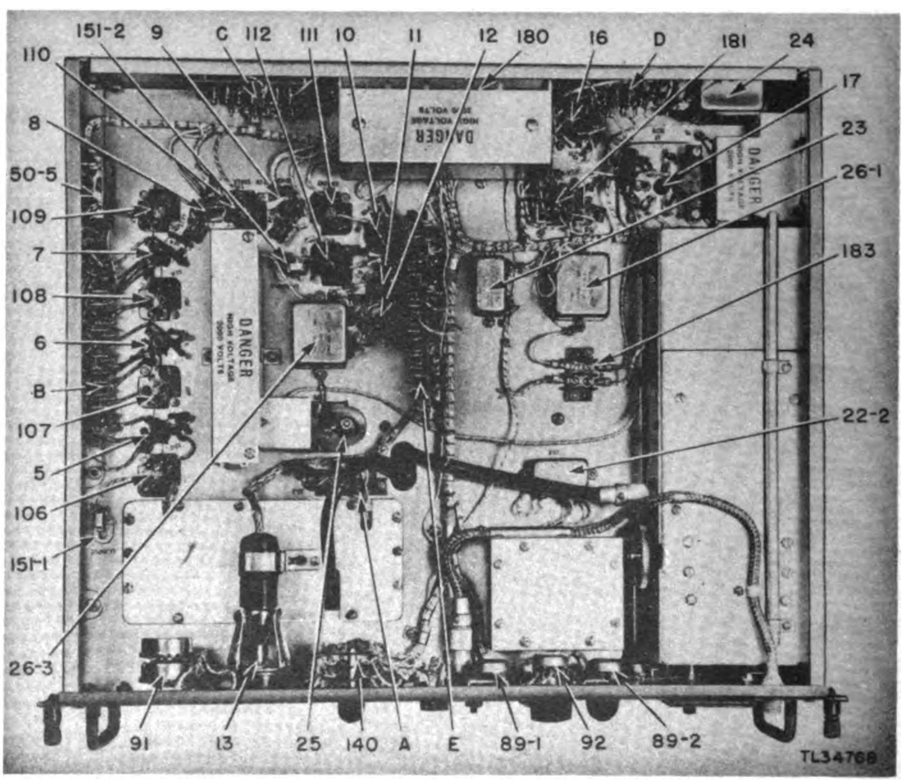


Figure 73. Radio Receiver and Transmitter BC-1267-A, bottom view showing location of parts.

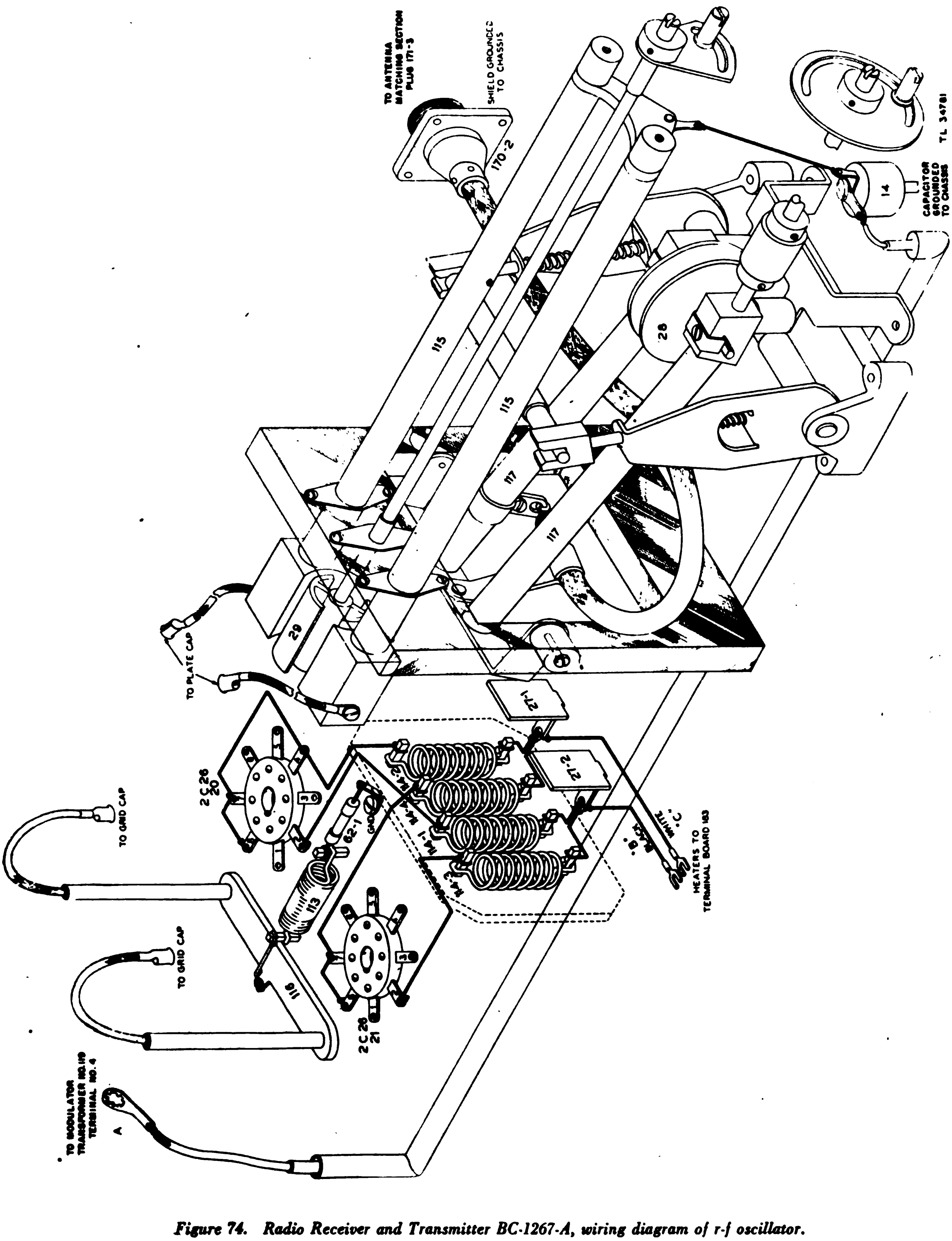


***Figure 74.** Radio Receiver and Transmitter BC-1267-A, wiring diagram of r-f oscillator.*

Section II—Trouble-Shooting Chart

69. RADIO RECEIVER AND TRANSMITTER BC-1267-A, TROUBLE-SHOOTING CHART.

A. SYMPTOMS:

1. No transmitter pulse on display oscilloscope.
2. No modulator cathode current indication on test meter with challenge switch in STANDBY or OPERATE position. Varying BIAS control does not result in cathode current indication.

Probable Location of Fault	Procedure
1. No plate voltage on modulator tube 17 (fig. 15).	1*a*. If pilot light T-D on panel of Power Supply RA-105-A is not glowing, see symptoms F and G of power supply trouble-shooting chart. If pilot light is glowing see *b*.
	b. Remove receiver-transmitter chassis. Short pins 23 and 24 of connector 7 and measure voltage at pin 11 of connector 7. This voltage should be 850 volts. (1) If voltage is not 850 volts, check circuit of tube 6 in power supply (fig. 60) and rack wiring between pin 11 on connector 8 and pin 11 on connector 7. (2) If voltage is present at pin 11 of connector 7, check continuity to plate of modulator tube 17. Check resistor chain 82-1, 82-2, 82-3, 82-4 and capacitor 25 (fig. 15).
2. Modulator tube defective, defective part in modulator circuit, or a failure in bias power supply.	2*a*. Check tube 17 by replacement.
	b. Check bias on cathode of tube 17. If bias is high (greater than 135 volts) check resistors 22-1, 22-2, and 25 in bias power supply (fig. 60). Check BIAS control 92, cathode resistor 86, and plate resistors 93-3 and 93-4.

B. SYMPTOMS:

1. No transmitter pulse on display oscilloscope.
2. Modulator cathode current normal with challenge switch in STANDBY position. Cathode current does not increase when challenge switch is thrown to OPERATE position.

NOTE: If there is no grass on the display oscilloscope, the fault is in the 300-volt circuit (tube 4) of Power Supply RA-105-A or in the wiring between pin 7 of rack connector 7 and pin 3 of rack connector 8.

Probable Location of Fault	Procedure
1. No sync pulse from control unit.	1*a*. Check sync pulse at SYNCH INPUT jack 150-1 on receiver-transmitter panel (fig. 70). If pulse is present, the fault is in receiver-transmitter (see 2).
	b. If pulse is not present at jack 150-1, check pulse at jack 121-4 in control unit. If pulse is present at jack 150-1, check rack wiring between pins 3 of connector 180 on receiver-transmitter and pin H of connector 127 on control unit.
	c. If pulse is not present at jack 121-4 on control unit, fault is in control unit. See symptoms D and E in par. 100.

Probable Location of Fault	Procedure
2. Fault in modulator channel, tubes 16, 18, and 19.	2*a*. Check plate voltage for blocking oscillator tube 19 by holding TEST SWITCH in the P.O. position and turning POWER MEASUREMENT control clockwise. If test meter reading increases, the 400-volt supply is operating. If reading is zero, check circuits associated with tube 3 in Power Supply RA-105-A.
	b. Check tubes 16, 18, and 19 by replacement.
	c. If the fault is not in any of the above tubes, check progressively the waveforms at pin 2 of tube 16, pin 3 of tube 18, and pin 3 of tube 19. It will be necessary to turn up the intensity control of the oscilloscope in order to see these waveforms; because of their short duration, a vertical line is all that will be seen. Make a voltage and resistance check of the stage at which the sync pulse disappears.

C. SYMPTOM:

PLATE VOLTAGE circuit breaker opens when challenge switch is thrown to OPERATE position.

Probable Location of Fault	Procedure
1. Distorted pulse from blocking oscillator; pulse width is too great.	1*a*. Check modulator cathode current with challenge switch in STANDBY position. If current is normal, 0.2 to 2 ma, see *b*. If current is high, see 2 below.
	b. Turn POWER MEASUREMENT control counterclockwise until challenge switch can be held in OPERATE position without causing circuit breaker to open.
	c. Observe transmitter pulse width on display scope (par. 67).
	d. If pulse width is too wide, check blocking oscillator tube 19 by replacement. Check resistors and capacitors in grid circuit of tube 19. Check modulator tube 17 by replacement. As a last resort, check blocking oscillator transformer 118 by replacement.
2. Low bias on modulator tube 17 or gassy tube; cathode current high in STANDBY position of challenge switch.	2*a*. Check modulator tube 17 by replacement.
	b. Check bias voltage on grids of tube 17. Voltage should vary between −95 and −135 volts as BIAS control is varied. If voltage is low, check resistor 53-3, BIAS control 89-2, and capacitor 26-1. Check bias supply circuits (tube 1) in Power Supply RA-105-A.

D. SYMPTOMS:

1. No transmitter pulse on display oscilloscope.
2. Modulator cathode current normal in both positions of challenge switch.
3. No transmitter pulse on oscilloscope with TEST SWITCH in P.O. position and POWER MEASUREMENT control fully counterclockwise.

Probable Location of Fault	Procedure
1. R-F oscillator circuit (fig. 74).	1*a*. Check tubes 20 and 21 by replacement. *b*. Check continuity between terminals 4 and 3 of transformer 119. Check terminal 4 for a short to ground. *c*. Check grid line 116 and plate line 115 for shorts to ground. Check resistance of all components (figs. 15 and 89).

E. SYMPTOMS:

1. Power output low.
2. Antenna-matching section aligned and POWER OUTPUT control fully clockwise.

Probable Location of Fault	Procedure
1. R-F oscillator circuit.	1*a*. Check modulator cathode current. If cathode current is abnormal, fault is in modulator circuit (see 2). *b*. If cathode current is normal, follow procedure indicated for symptom D. *c*. If display scope picture is normal, see 3.
2. Modulator screen grid circuit.	2. Check screen grid voltage by varying POWER MEASUREMENT control. If power output does not vary, check voltage at pin 3 of modulator tube 17. Voltage should vary from zero to 600 volts as POWER MEASUREMENT control 91 is varied. If it does not, check control 91 and 600-volt supply (tube 5) in Power Supply RA-105-A (fig. 60).
3. Modulator tube defective, defective part in modulator circuit, or a fault in bias power supply.	3. Follow procedure 2 of symptom A.
4. Monitoring circuits. If normal results are obtained from operation of equipment, fault is probably in monitoring circuits (fig. 14).	4*a*. If modulator cathode current is normal, check tubes 14 and 15 and their associated circuits. *b*. If modulator cathode current is abnormal, check meter 160 and TEST SWITCH 140.

F. SYMPTOMS:

1. Transmitter pulse on display oscilloscope.
2. Grass reduced by approximately 50 percent with SENSITIVITY control fully clockwise.

Probable Location of Fault	Procedure
1. Defective tuning of r-f tuner.	1. Check adjustment of ANT., R.F., DET., and OSC. dials (par. 73).

Probable Location of Fault	Procedure
2. Defective r-f amplifier, local oscillator, or mixer tube.	2*a*. Check tubes 1, 2, 3, and 4 in receiver to see if their filaments are glowing. *b*. Check each tube by replacement.
3. Defect in above circuit.	3. Make voltage and resistance analysis of circuits associated with tubes 1, 2, 3, and 4 (fig. 32).
4. Defective SENSITIVITY control 98 in control unit.	4. Check resistance of SENSITIVITY control. Resistance should vary from zero to 3,500 ohms as control is rotated.
5. A defective part in i-f stages, or i-f stages misaligned.	5*a*. Make voltage and resistance check of each stage (figs. 89 and 90). *b*. Align each stage and check its sensitivity (par. 74).

G. SYMPTOMS:

1. Transmitter pulse on display oscilloscope.
2. No grass or very little grass with SENSITIVITY control fully clockwise.

Probable Location of Fault	Procedure
1. Defective i-f amplifier tubes.	1*a*. Check i-f tubes 5, 6, 7, 8, and 9 to see if their filaments are glowing. *b*. Check each tube by replacement.
2. Defective SENSITIVITY control.	2. See procedure 4 of symptom F.
3. Defective part in i-f circuits.	3. See procedure 5 of symptom F.

H. SYMPTOMS:

1. No transmitter pulse and no grass on display oscilloscope with SENSITIVITY control fully clockwise.
2. Normal sweep on display oscilloscope.

NOTE: If the tuning eye remains dark, the fault is in the 300-volt circuit (tube 4) of Power Supply RA-105-A or in the wiring between pin 7 of rack connector 7 and pin 8 of rack connector 8.

Probable Location of Fault	Procedure
1. Defect in video amplifier tube 13 in the control unit.	1*a*. Check waveform at RECEIVER OUTPUT HIGH jack 150-3 (fig. 70). If transmitter pulse and grass are not seen, see 2. *b*. If expected waveform is seen in above test, check tube 13 by replacement. Make voltage and resistance check of the stage (figs. 107 and 108). *c*. Check continuity from pin B of connector 127 on control unit to pin 6 of connector 180 on receiver-transmitter chassis.
2. Defective tube in video channel of receiver.	2*a*. Check tubes 10, 11, and 12 to see if their filaments are glowing. *b*. Check tubes 10, 11, and 12 by replacement.
3. Defective part in video channel of receiver.	3*a*. Check waveforms at pins 3 and 5 of tube 10, 1 and 5 of tube 11, and 1 and 5 of tube 12. Transmitter pulse and noise should be seen. *b*. Make voltage and resistance check of defective stage (figs. 89 and 90). *c*. If normal waveform is obtained at pin 5 of tube 5 but not at RECEIVER OUTPUT HIGH jack 150-3, check TEST SWITCH 140.

Section III
Alignment Procedure

70. INTRODUCTION.

The procedures to be used in aligning the receiver and transmitter are given in the following paragraphs. It should be noted that none of the procedures is entirely independent of the others. This is especially true of the alignment of the antenna-matching section. Whenever this section is aligned, it will be necessary to check the transmitter and receiver frequency.

71. TRANSMITTER FREQUENCY ADJUSTMENT.

Tune the transmitter to the chosen operating frequency by use of the wavemeter section of Signal Generator I-222-A (fig. 75). As a preliminary step, calibrate the signal generator (see section II of TM 11-1082 supplied with the signal generator).

a. Disconnect Cord CG-55/U from the ANTENNA connector. Connect the T-connector to the ANTENNA connector (fig. 76) and connect the dummy antenna to the T-connector.

b. Unfasten the cover plate over the calibration chart on the receiver-transmitter front panel and, from the calibration chart obtain the transmitter setting for the desired frequency. Set PLATE control to obtain the proper setting in the TRANSMITTER TUNING dial.

c. Pull out the antenna-matching section handles (fig. 77) until the rods are engaged. Set the rods to the positions corresponding to the desired frequency (par. 72a).

d. Place the radio transmitter in operation.

e. Pull the antenna pick-up rod on the signal generator all the way up. Slide the rod back in until a weak signal, suitable for monitoring purposes, is heard over the earphones.

f. Set the dial of the wavemeter to the desired frequency.

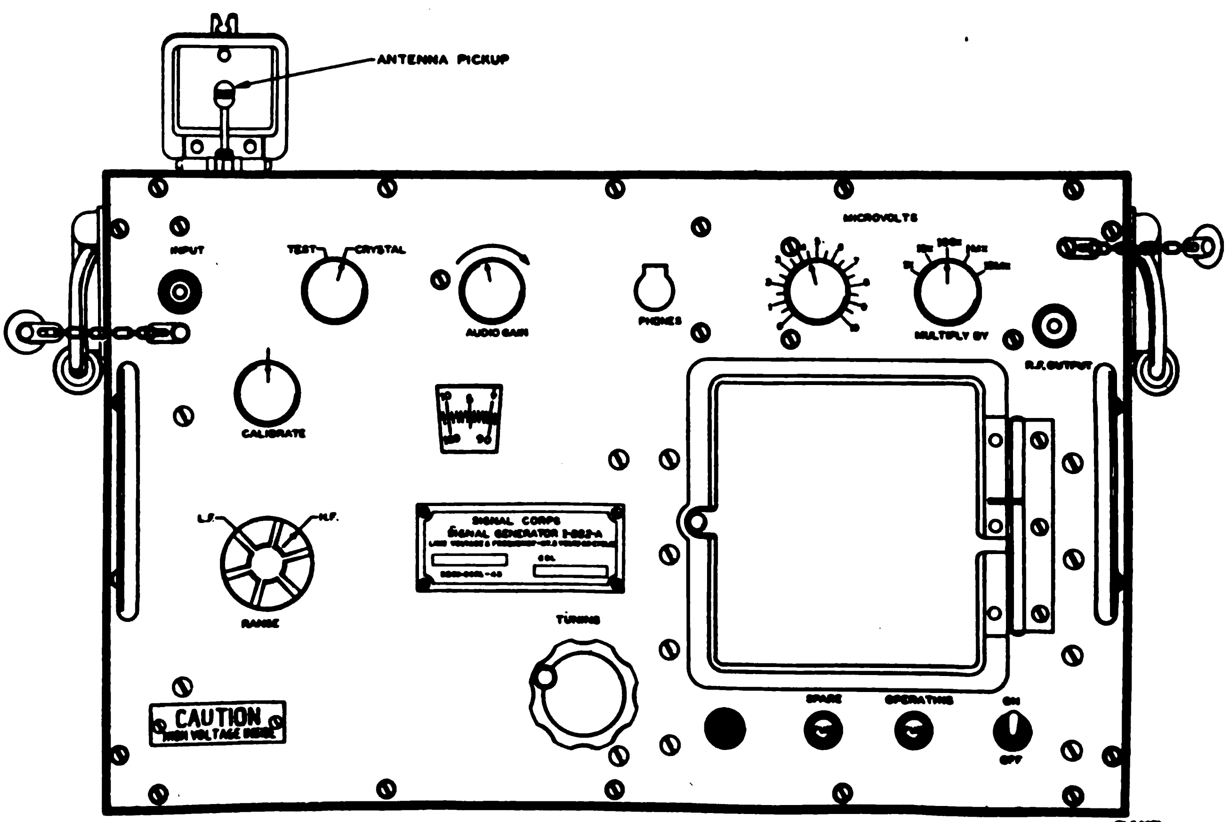


Figure 75. Signal Generator I-222-A, front panel.

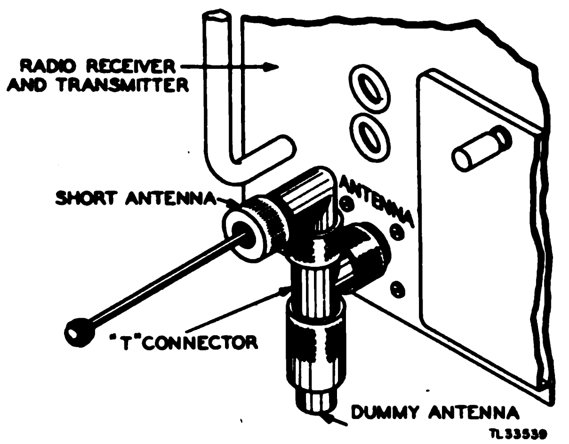


Figure 76. Radio Receiver and Transmitter BC-1267-A, antenna test installation.

g. Readjust the PLATE control until the buzzing noise gets louder and changes to a rasping noise. Be sure that the tuning is sharp and that the change in tone can be approached from both directions by rotation of the PLATE control.

> **NOTE:** If the setting of the TRANSMITTER TUNING dial obtained in subparagraph **b** above is much different from that indicated by the calibration chart, set the dial to the value indicated by the chart, loosen the PLATE CAP. LOCK control, and tune the transmitter with the PLATE CAP. TUNE control rather than the PLATE control. This procedure will ordinarily be required when an r-f oscillator tube, 20 or 21, is replaced.

h. Hold the TEST SWITCH in the P.O. position and adjust the ANT. TUNE control for maximum amplitude of the transmitter pulse. After this adjustment is made, check the transmitter frequency with the signal generator, because the ANT. TUNE adjustment sometimes shifts the frequency of the transmitter.

72. ALIGNMENT OF ANTENNA-MATCHING SECTION.

The antenna-matching section must be aligned every time the operating frequency of the equipment is changed. Improper alignment of the section will reduce the efficiency of the equipment and in some cases will result in arc-overs in the receiver-transmitter.

a. Set the rods to the position corresponding to the desired frequency as indicated in the chart below. These settings are approximately correct for the indicated frequencies. (The setting corresponding to a given frequency can be obtained by adding 0.25 to a known setting for each additional megacycle.) To set the rods, pull out the handle and set it to the position corresponding to the operating frequency as indicated in the chart. Then push the button in the center of the handle and at the same time push the rod in as far as it will go.

Frequency (mc)	*Rod setting*
157	0
160	0.75
165	2.00
170	3.25
175	4.50
180	5.75
185	7.00
187	7.50

b. After the rods have been set roughly to the correct frequency, follow the procedure below for the final adjustment. (In this procedure it is assumed that the receiver and transmitter have been tuned to the correct frequency.) It will be noted that the REC. rod is used to adjust for maximum transmitter output and the TRANS. rod is used to adjust for maximum receiver output. Interchanging the adjustments in this manner minimizes interaction between the receiver and transmitter and provides the best compromise between receiver sensitivity and transmitter power output.

(*1*) Disconnect Cord CG-55/U from the ANTENNA connector.

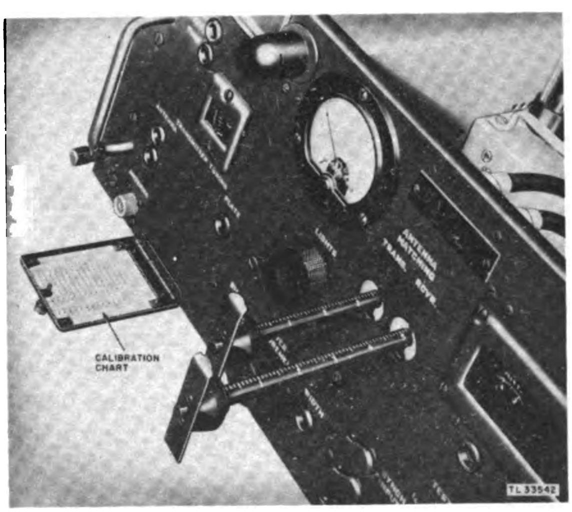


Figure 77. Calibration chart and antenna-matching section adjusting rods.

(2) Connect the r-f output of the signal generator to the ANTENNA connector with Cord CD-1104.

(3) Tune the signal generator to the same frequency as the transmitter and receiver. Set the MULTIPLY BY control on the signal generator to the 1Mx position. (Complete information on the use of the Signal Generator I-222-A is furnished in TM 11-1082, supplied with the signal generator.)

(4) Adjust the TRANS. rod of the antenna-matching section to obtain maximum closure of the TUNING INDICATOR eye.

(5) Disconnect the signal generator and reconnect Cord CG-55/U or the dummy load to the receiver-transmitter.

(6) Turn the challenge switch to OPERATE and hold the TEST SWITCH in the P.O. position.

(7) Adjust the REC. rod for maximum transmitter output as indicated by maximum amplitude of the transmitter pulse.

73. TUNING RECEIVER R-F CIRCUITS.

a. Disconnect Cord CG-55/U from the ANTENNA connector.

b. Connect the r-f output of the signal generator to the ANTENNA connector with Cord CD-1104.

c. Tune the signal generator to the same frequency as the transmitter frequency. Set the attenuator dial (marked MULTIPLY BY, fig. 75) to the 1 Mx position.

d. Adjust the receiver ANT., R.F.., DET., and OSC. dials (fig. 70) until maximum closure is obtained. If the tuning eye closes completely, open it by turning the SENSITIVITY control counterclockwise to reduce the gain of the receiver. If necessary, reduce the signal generator output by means of the left-hand attenuator control.

e. Repeat the above procedure until maximum eye closure is obtained.

74. I-F ALIGNMENT.

The following procedure is applicable when using Signal Generator I-222-A or any other signal generator which has an unmodulated output.

a. Plug the power cord of Signal Generator I-222-A into an a-c outlet, turn the power switch ON, and set the selector switch to the CRYSTAL position. The signal generator should warm up for 15 minutes before use.

NOTE: Complete information on the use of Signal Generator I-222-A is contained in TM 11-1082, supplied with the signal generator.

b. Remove the receiver-transmitter from the rack and place it on a test bench. Connect the receiver-transmitter to the rack with Cord CX-572/CPX (8 ft. 0 in.).

c. On the control unit, place the challenge switch in the STANDBY position and turn the SENSITIVITY control to 9. Calibrate the signal generator at 11 megacycles and adjust both MICROVOLTS controls to 300 microvolts. With Cord CD-1103 connect the R.F. OUTPUT terminal of the signal generator to the I.F. INPUT jack on the receiver-transmitter chassis (fig. 72). Turn on Power Supply RA-105-A. (All d-c and filament voltages for the receiver-transmitter are furnished by the power supply through the rack wiring.)

d. The i-f stages are *stagger-tuned;* that is, each stage is tuned to a different frequency to provide a broad bandpass. Each i-f coil must therefore be aligned to its own frequency. Table IV gives the frequency for each of the six i-f coils.

TABLE IV
ALIGNMENT FREQUENCIES FOR I-F AMPLIFIERS

Coil No.	*Alignment frequency (mc)*
111	9.5
110	8.8
109	13.2
108	8.8
107	12.5
106	11.0

e. To align the i-f stages, connect the signal generator as described above and start with the last i-f coil (coil 111). Set the signal generator to the frequency indicated in table IV and adjust the i-f coil for maximum closure of the tuning eye. If the eye closes or overlaps, turn the SENSITIVITY control slightly counterclockwise and continue aligning the stage until maximum closure is obtained. Use the alignment tool to adjust the slug on the coil being tuned. The tuning slug is accessible from the bottom of the chassis. Tune the stages beginning with the last i-f stage (coil 111) and work back to the first i-f stage (coil 106). Be sure that the input frequency for each coil is that shown in table IV.

NOTE: When aligning one coil, never go back to a previously aligned coil to tune for maximum gain. Greater gain is obtained by doing this but at the expense of reducing the overall bandwidth.

After aligning each of the i-f coils, repeat the entire process.

f. If, after alignment, the over-all gain of the i-f section is still unsatisfactory, a weak or defective stage may be isolated by using the information contained in table V. Connect a milliammeter with a 0.1 ma scale to the i-f output jack and apply the microvolt input specified in the table to the grid of each successive stage. (The microvolt output of Signal Generator I-222-A is controlled by the two knobs marked MICROVOLTS.) The microvolt input specified for each stage should produce a 0.75-ma output with the SENSITIVITY control turned completely clockwise. If a stronger signal is necessary to produce this output, realign the stage at the frequency specified in table IV. If alignment has no effect on the gain, trouble shoot the stage. The gain checks should be traced back by starting with the last i-f stage and working back to the first i-f stage.

TABLE V
AVERAGE I-F GRID SENSITIVITIES
(For 0.75-ma output)

Grid of i-f tube No.	*Frequency (mc)*	*Microvolt input*
I.F. INPUT jack	11	300
1	11	280*
2	11	2,500
3	11	15,000
4	11	100,000
5	9.5	500,000

*The first sensitivity reading is greater than the second because the I.F. INPUT jack is connected in series with resistor 61.

NOTE: With a signal input of 300 μv at 11 mc applied to the grid of the first i-f stage, an output of 0.75 ma at the i-f output jack indicates proper gain in the i-f section; but because of the stagger-tuning, it does not indicate proper alignment. It is possible to align the stages for proper gain at one frequency while the gain throughout the entire bandwidth is inadequate. To insure adequate bandwidth, each stage must be aligned to a different frequency as specified in table IV.

75. ALIGNMENT OF RECEIVER R-F CALIBRATION DIALS.

The alignment of the receiver r-f calibration dials by means of the calibration chart usually is not necessary unless an r-f coil is replaced. The alignment procedure is written for all four stages; however, it may be used to align just one stage without aligning the others.

a. Place the challenge switch in the OFF position. Disconnect the coaxial cable from the antenna receptacle on the transmitter. Use Cord CD-1104 to connect the r-f output of the signal generator to the antenna receptacle. Use the tuning eye for a resonance indicator. Set the signal generator to the transmitter frequency and tune the receiver for resonance. If the dial readings on all the r-f stages of the receiver, with the exception of the ANT., read within one division of the reading on the calibration chart for the frequency being used, the dial alignment may be considered normal. A much greater tolerance is allowed for the ANT. tuning dial because there are great deviations in antenna characteristics. If the dials do not read correctly, follow the procedure below:

(*1*) Turn each tuning shaft to its maximum clockwise position and check the zero position of each dial. If the dial does not read zero in this position, loosen the dial setscrew (fig. 78) and rotate the dial until zero coincides with the hairline.

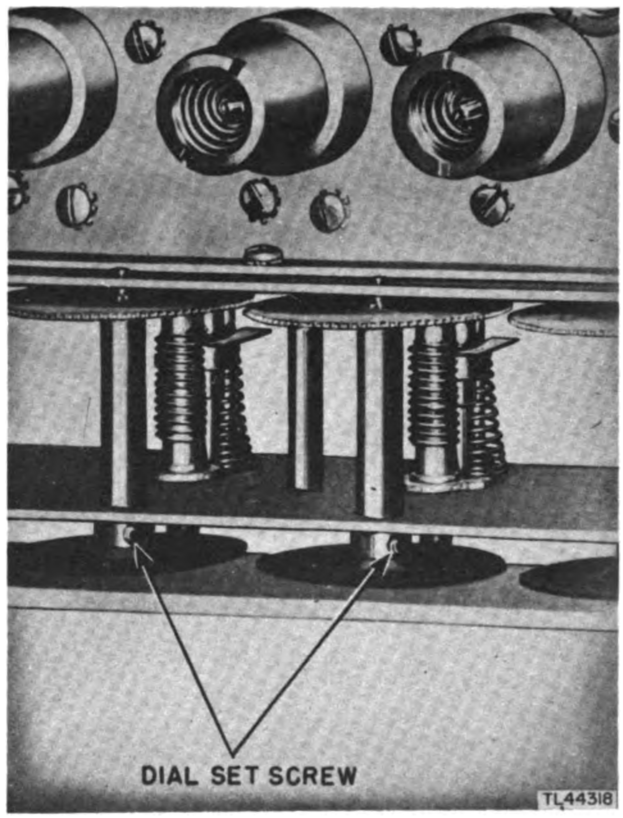


Figure 78. Receiver r-f tuning section, top view.

(*2*) Loosen the setscrew on the slug drive assembly and adjust the tuning cores until their shafts extend 1/16 inch from the tuner front plate (fig. 79). To do this, remove the tuner from the chassis.

b. Set the signal generator at 156 mc and tune the OSC. dial to maximum eye closure.

> **NOTE:** The desired response in this receiver occurs with the heterodyning oscillator tuned below the incoming signal. This condition is checked by first tuning the signal generator to 156 mc and adjusting the OSC. control for maximum eye closure. (Use a moderate signal input to avoid high image response.) Next, tune the signal generator to 134 mc and then to 178 mc. If the eye closes at 134 mc but not at 178 mc, the local oscillator is tuned correctly.

If the OSC. dial fails to check against the calibration point for 156 mc, adjust the outside turn and the center turn (fig. 79) on the OSC. coil until the correct dial setting is obtained. (The inside turn is next to the front panel.) The spacing should be adjusted by bending the inside turn of the coil away from or toward the center turn.

c. Repeat the above procedure for the DET., R.F., and ANT. stages.

d. To check and adjust for correct dial calibration over the entire IFF band, set the signal generator at 186 mc and tune the OSC. dial to resonance, as indicated by maximum eye closure. If the OSC dial fails to check with the calibration chart, adjust the spacing between the inside turn and the center turn until the correct dial reading is obtained.

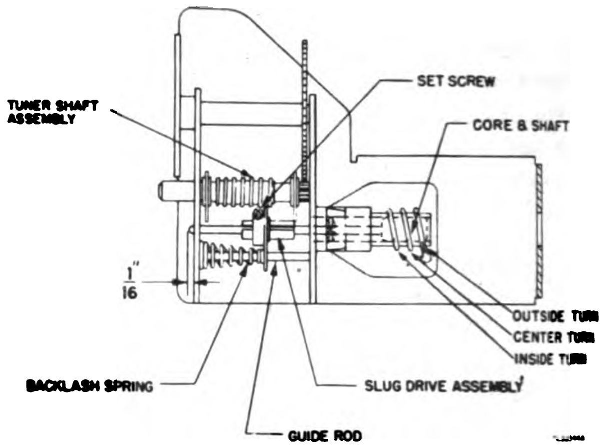


Figure 79. Receiver r-f tuning section, side view.

e. Repeat this process for the DET., R.F., and ANT. stages.

> **NOTE:** Tuning on a fixed echo is a useful over-all check of system performance. The fixed echo should be used only to obtain an optimum setting of the antenna-matching section and of the ANT. and R.F. dials of the receiver. Never use a fixed echo to set the OSC. and DET. dials because of the danger of setting the oscillator at a peak on either side of the band thereby sacrificing over-all bandwidth. Always use the tuning eye and a simulated signal to set the local oscillator and mixer.

76. PULSE GENERATOR CHASSIS.

To remove the plug-in pulse generator chassis, remove the two screws which hold it on the main chassis. Grasp the pulse generator chassis by the two handles and pull upward to disengage the connector on the plug-in pulse generator chassis from the main chassis receptacle.

77. ADJUSTING RODS.

To replace an adjusting rod of the antenna-matching section, engage the rod and set it to zero on the calibrated scale; then remove the handle (two screws on either side of release button), press the inner rod to release the spring lock, and remove the adjusting rod through the hole in the rear of the case which houses the antenna-matching section (fig. 80).

78. ANTENNA-MATCHING SECTION.

To remove the antenna-matching section, disconnect the three cables from their right-angle fittings and set the adjustment rods to zero; then remove the handles and center rods, the four screws which hold the case to the chassis, and the crossbar brace which is mounted from the front panel to the rear fence. The antenna-matching section can now be removed (fig. 81). To disassemble the antenna-matching section, remove the four screws which hold the front of the case. Unsolder the three coaxial fittings. Now the entire assembly may be slid out of the case (fig. 81). To reassemble, reverse the above procedure.

79. POWER MEASUREMENT CIRCUIT.

To reach the wiring of the power measurement circuit tubes, remove the eight screws which hold the cover of the shield box in place (fig. 82). To remove the shield box, unsolder the wire at terminal 1 of tube 14, and disconnect the two leads to capacitor 20-1. Remove the eight screws which hold the shield box to the chassis.

80. R-F OSCILLATOR BOX.

To reach the r-f oscillator unit box, loosen the four captive screws which hold the cover in place and remove the cover. The side of the r-f oscillator

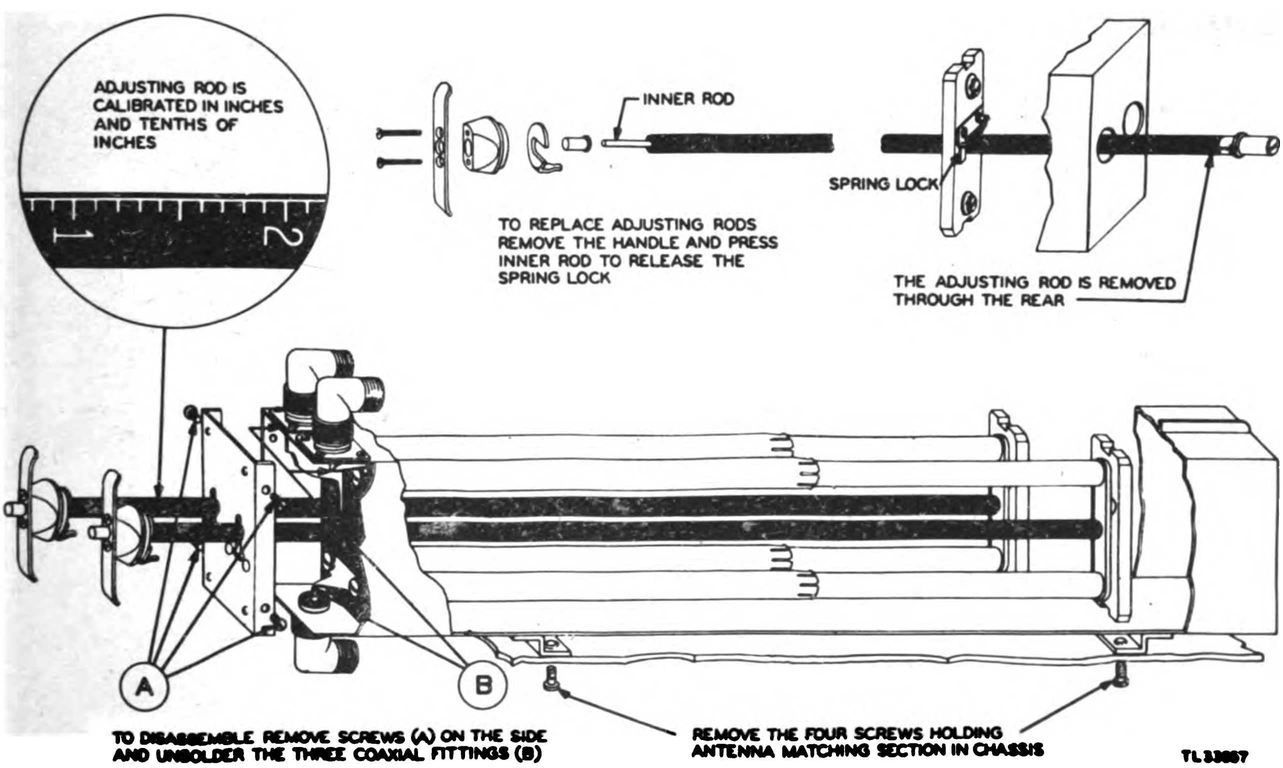


Figure 80. Disassembly of antenna-matching section.

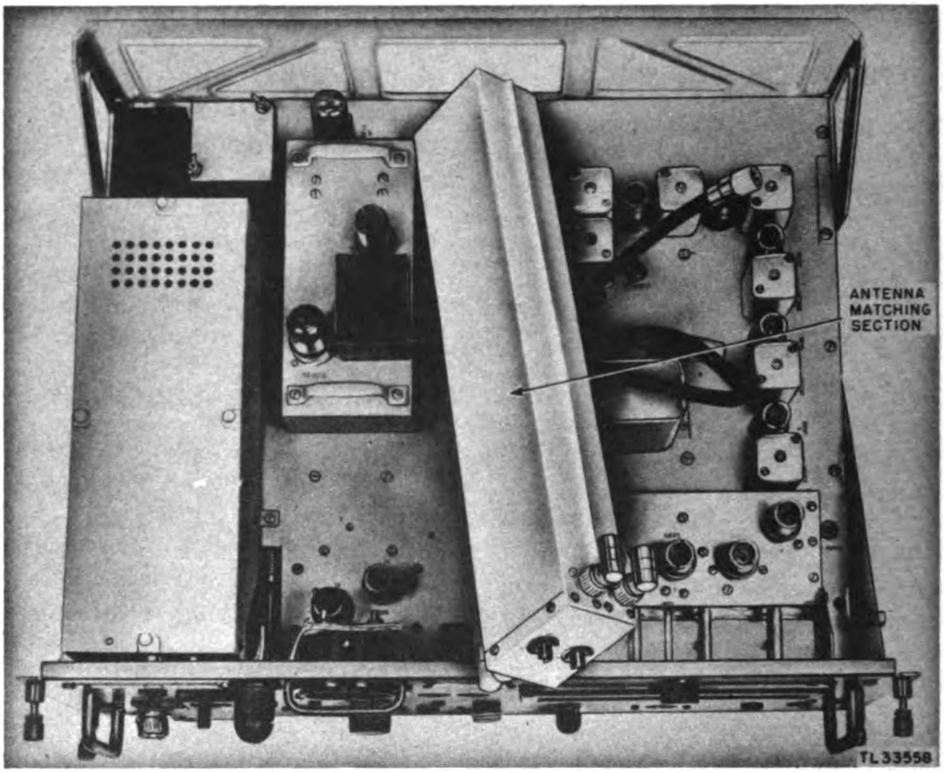


Figure 81. Removal of antenna-matching section.

unit box may be taken off. Remove the 16 screws which hold the side of the oscillator box to the chassis and front panel. This allows the entire side to be removed (fig. 84).

81. CHOKES AND SPARK PLATES.

To replace heater chokes 114-1 to 114-4 and heater spark plates 27-1 and 27-2, remove the bottom shield cover. Remove the two screws from the clamps which hold the high-voltage shield tubing to the bottom of the r-f oscillator unit box. Remove the two screws which hold the shield for the high-voltage terminals on modulator transformer 119. Disconnect the high-voltage lead from terminal 4 on modulator transformer 119. Remove the three screws on the side of the oscillator box which hold the shield for the tube sockets and the chokes to the oscillator box. (fig. 84).

82. INTERCONNECTOR PLUG.

To reach the connector on the rear of the chassis, remove the two screws which hold the shield in place (fig. 85). To remove the connector, disconnect all the wires to its terminals and remove the four screws which hold it to the frame of the chassis.

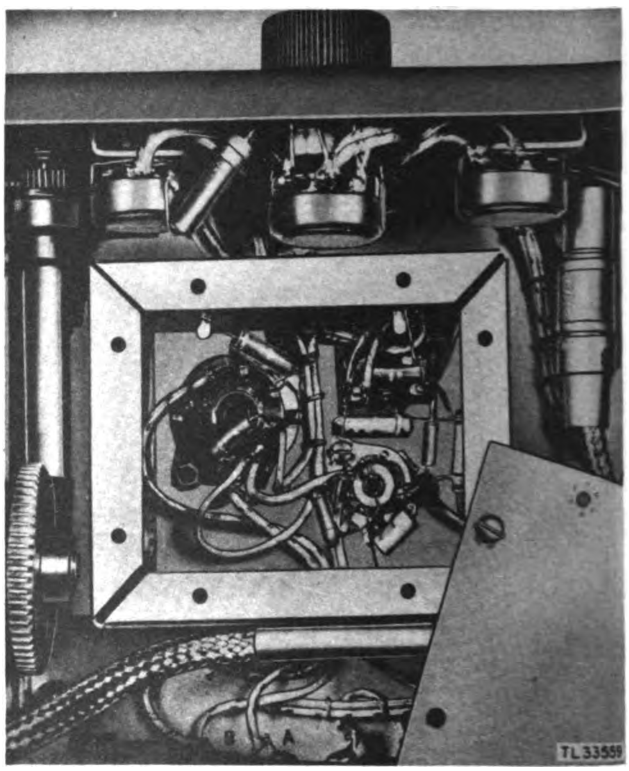


Figure 82. Power measurement circuit, shield cover removed.

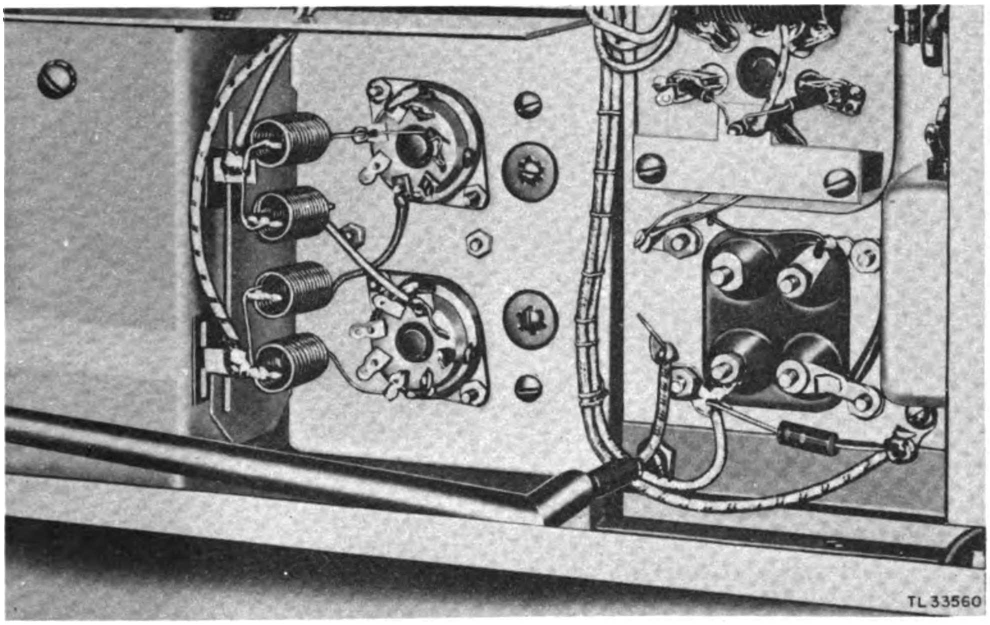


Figure 83. Transmitter oscillator tube compartment, shield removed.

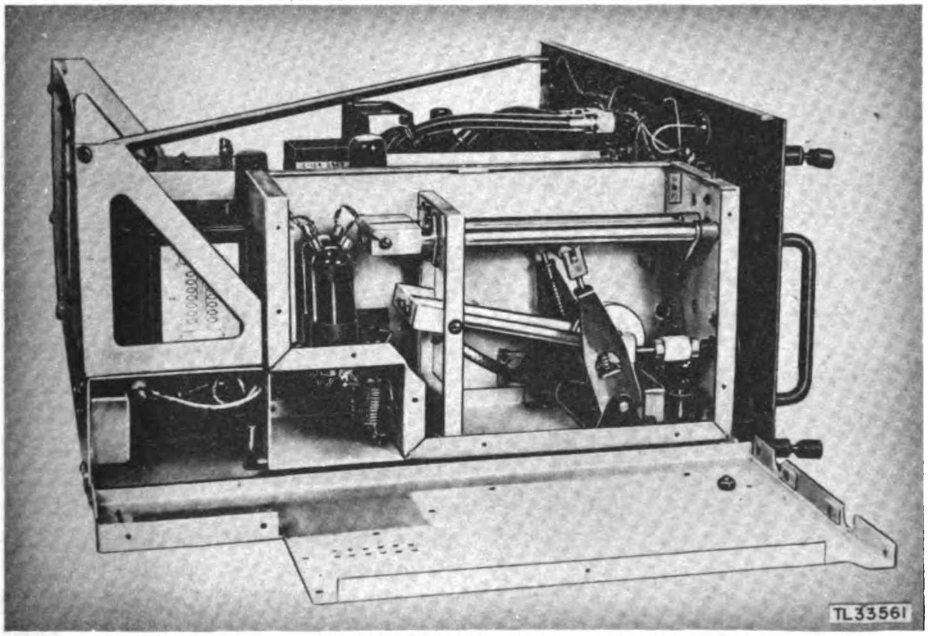


Figure 84. Transmitter oscillator box, side removed.

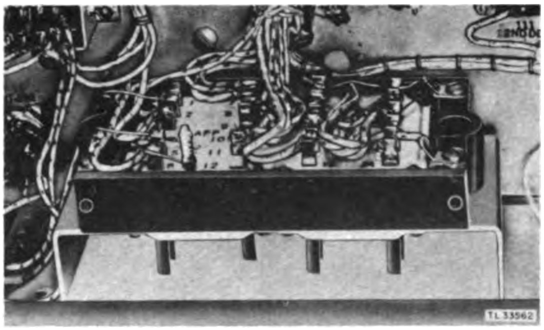


Figure 85. Lapp plug 180, shield removed.

83. CAPACITOR 25 AND TERMINAL BOARD.

To replace capacitor 25 or the ceramic terminal board containing resistors 82-1, 82-2, 82-3, and 82-4, remove the shield which covers the board and the positive terminal of capacitor 25. This shield is fastened to the chassis with two screws and to the ceramic terminal board supports with two screws. Remove the four screws and lift off the shield (fig. 86). Ground the capacitor with a screwdriver. Remove the capacitor or the terminal board.

84. TUBES 2C26A.

To replace the 2C26A tubes, remove the cover of the r-f oscillator unit. Remove the plate and grid caps. To remove the tubes, rock them gently from side to side and pull upward.

85. MODULATOR TUBE 17.

To remove tube 17 (3E29), remove the shield

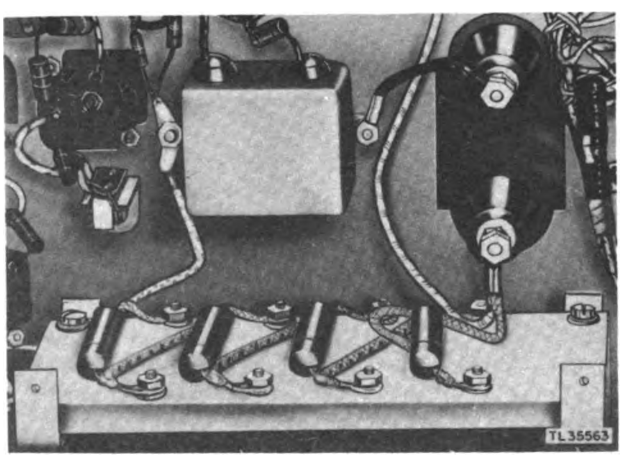


Figure 86. Capacitor 25 and terminal board, high-voltage shield removed.

covering it. Remove the crossbar brace mounted between the front panel and the rear fence. Remove the wingnuts and springs which hold the cover in place. These springs are under considerable tension and may fly off when the nuts are removed. Remove the shield and the ceramic terminal board then remove the tube by pulling upward. This tube has no base; be very careful when handling to prevent damage or breakage to seals where the pins leave the glass envelope.

86. TUBE 14.

To remove the shield from tube 14 (9006), use the key fastened to the chassis next to tube 1 on the receiver section and turn in a counterclockwise direction. After the shield has been taken off the tube can be removed easily.

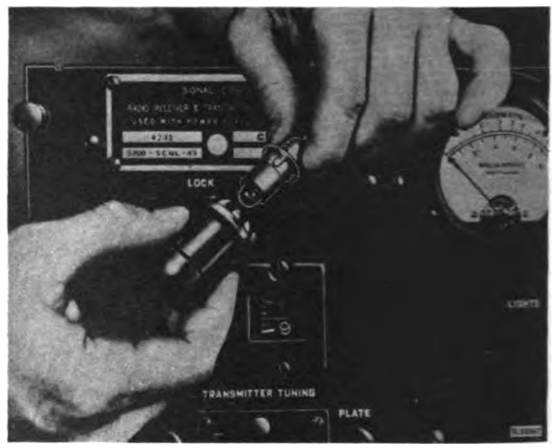


Figure 87. Meter pilot light removed from housing.

87. METER PILOT LIGHT.

The meter pilot light is in a special housing fastened to the front panel. Press down on the housing to remove it from the panel. Grasp the socket in one hand and the housing in the other hand (fig. 87). Exert a strong steady pull to separate the external housing from the pilot light socket. Push the pilot light gently into the socket and turn it counterclockwise until it releases.

88. TRANSMITTER DIAL LIGHT.

The transmitter dial light is mounted in a standard bayonet socket. Push the dial light in and turn it counterclockwise until it releases.

89. R-F COILS.

a. In order to replace an r-f coil or core in the r-f tuner, remove the complete tuner in the fol-

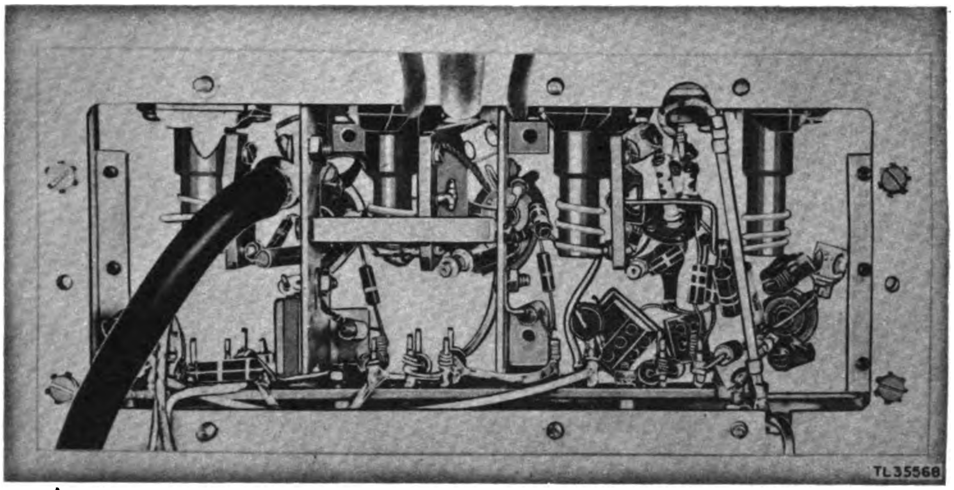


Figure 88. R-F tuner, cover plate removed.

lowing manner: Remove the crossbar. Pull the trombone handles out 1 inch. Loosen all the screws which fasten the front panel to the chassis except the four screws on the left side of the panel which hold the r-f oscillator box. About ⅛ inch of play in the screws is necessary because the tuning screws on the tuner fit into shoulder washers on the front panel. Remove the tuning-eye tube from its bracket and remove the plate which covers the r-f tuning head. Take off the cover plate when the six nuts on the spade lugs are removed (fig. 88). Unsolder the three wires connected to terminals 1, 2, and 3 on the terminal board at the edge of the tuner cut-out. Unsolder the shielded lead from terminal 5 of i-f transformer 106. Remove the four screws which hold the r-f tuner to the main chassis. Pull the front panel forward ⅛ inch to clear the screwdriver tuning rods and lift the tuner upward until it is clear.

b. After the tuner has been removed, take out the cores. Turn the tuning screw clockwise until the dial reads zero. Measure the distance the core shaft protrudes through the front panel. This distance should be 1/16 inch (fig. 79). When the core is replaced, set it to the same distance. Insert a No. 6 Allen wrench in the setscrew holding the core shaft (fig. 79). Turn the setscrew counter clockwise until the core shaft slides freely.

c. Slide the core through the holes in the terminal board and the rear of the tuner chassis. To remove the oscillator stage core, it is necessary to unsolder capacitor 5 and bend choke coil 104 downward to provide an unobstructed path for the core. Unsolder the leads connected to the coil assembly. Be sure to unsolder the ground connection which has been made to a bracket fastened to the chassis. Check the dial calibration (par. 75) after a coil replacement.

d. To replace the core, slide it into the coil through the holes in the chassis and terminal board. Place the slug drive assembly in position on the sleeve by compressing the spring and engaging the bottom edge with the screw thread tuning rod. Compare this unit with another assembly that has been set at zero. Slide the core shaft through the sleeve until it protrudes 1/16 inch through the front panel. Tighten the setscrew. When the unit is assembled correctly, rotate the tuning screw throughout its entire range; the stops should engage at exactly zero and 9 on the dial. If the stops are incorrect, loosen the setscrew and adjust the sleeve position.

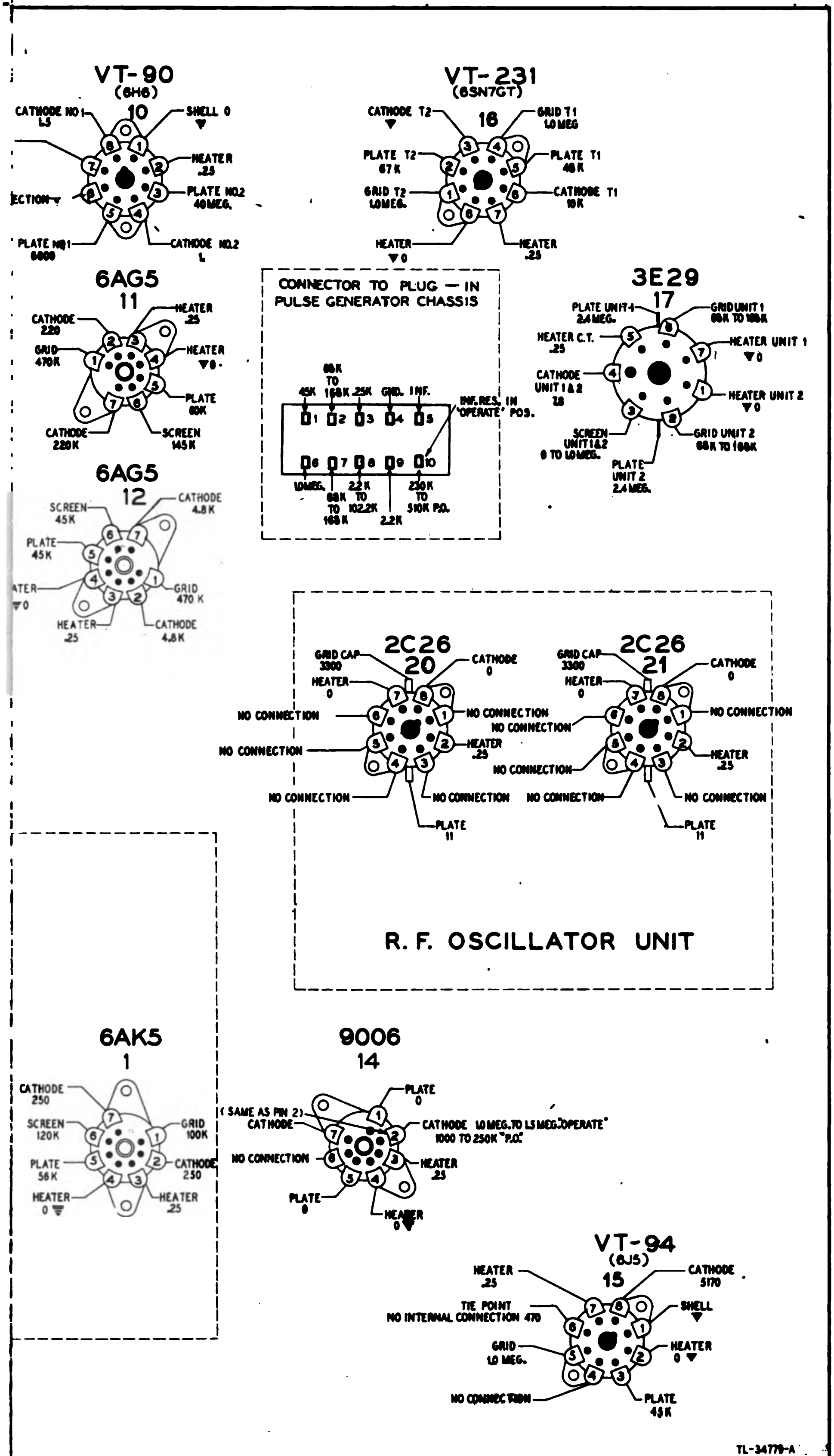


Figure 89. Radio Receiver and Transmitter BC-1267-A, resistance chart.

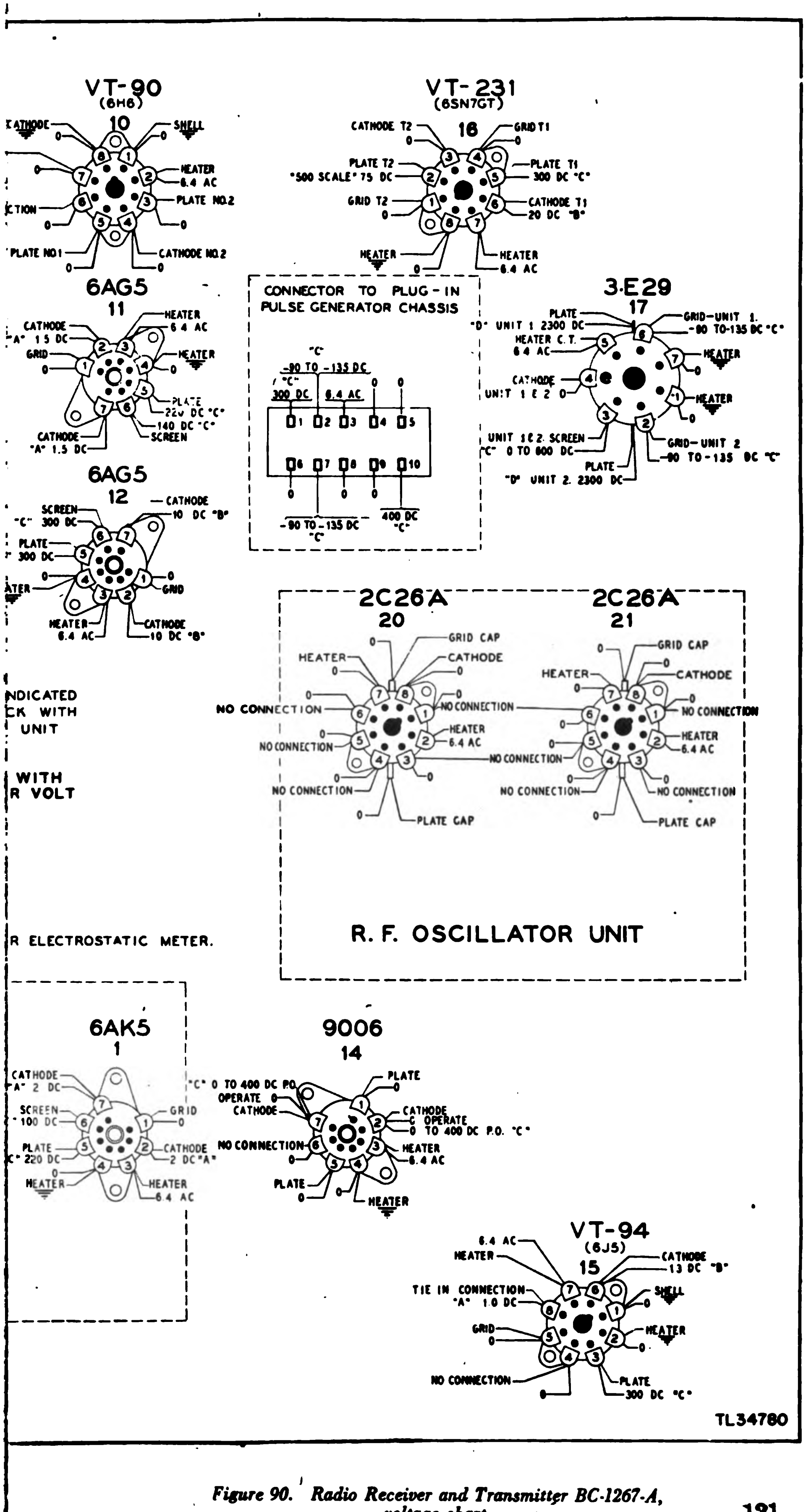


Figure 90. Radio Receiver and Transmitter BC-1267-A, voltage chart.

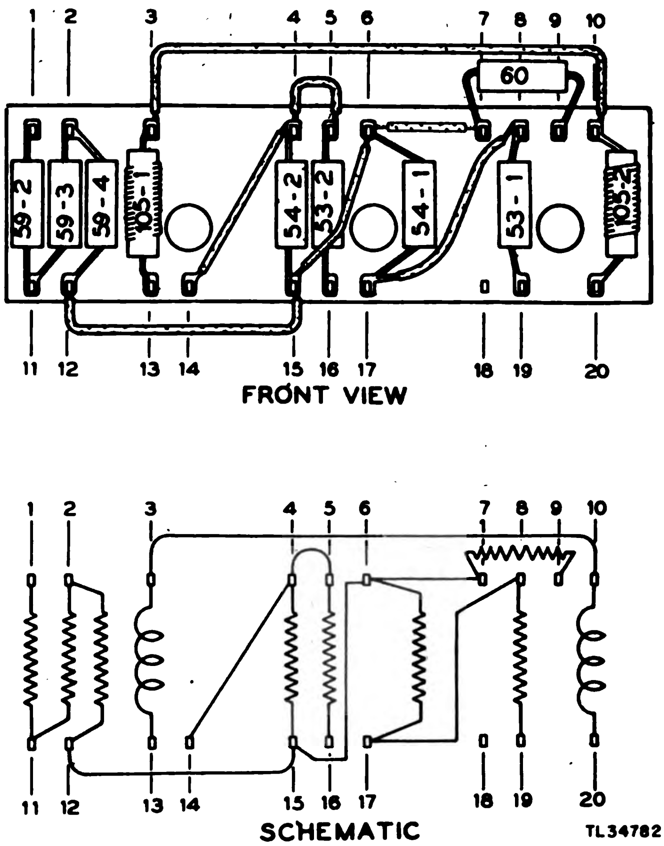


Figure 91. R-F tuner unit terminal board.

Voltage and Resistance Chart of R-F Tuner Unit Terminal Board (figs. 73-A and 91)

Terminal	*Volts*	*Ohms (K = 1,000)*	*Terminal*	*Volts*	*Ohms (K = 1,000)*
1	180.0 dc	56.0 K	11	215.0 dc	53.0 K
2	250.0 dc	49.0 K	12	290.0 dc	45.5 K
3	6.3 ac	0.2	13	6.3 ac	0.2
4	230.0 dc	52.0 K	14	230.0 dc	52.0 K
5	230.0 dc	52.0 K	15	290.0 dc	45.5 K
6	290.0 dc	45.5 K	16	100.0 dc	120.0 K
7	290.0 dc	45.5 K	17	230.0 dc	52.0 K
8	230.0 dc	52.0 K	18	0	0
9	300.0 dc	45.0 K	19	100.0 dc	120.0 K
10	6.3 ac	0.2	20	6.3 ac	0.2

Test Conditions

Voltage Measurements:

1. Measurements made between indicated points and chassis with a 1,000-ohms-per-volt meter.
2. Chassis connected to rack with Cord CX-572/CPX (8 ft. 0 in.).
3. Line voltage 117.5 volts a-c.
4. SENSITIVITY control on control unit in extreme clockwise position.
5. Control unit connected to rack.

Resistance Measurements:

1. Measurements made between indicated points and chassis.
2. Chassis disconnected from rack.
3. Pins No. 20 and 22 on rear plug grounded.

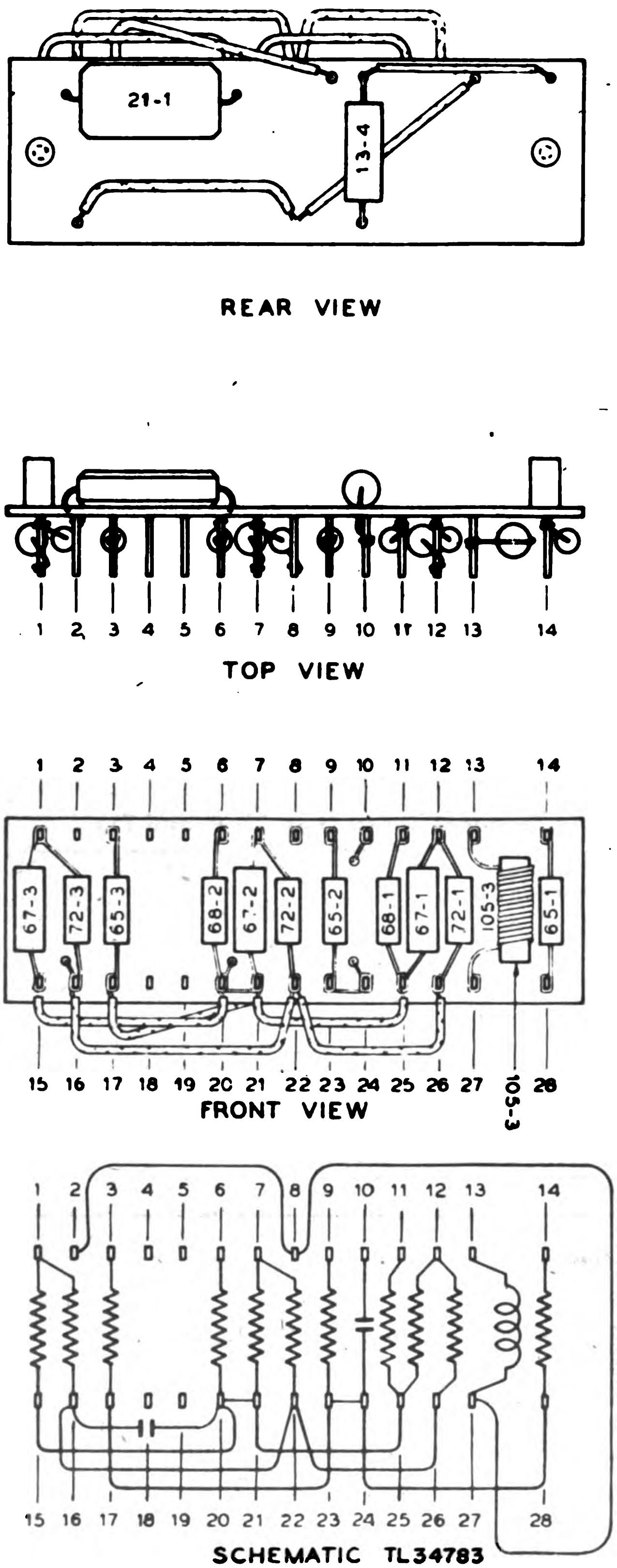


Figure 92. First i-f terminal board.

Voltage and Resistance Chart of First I-F Terminal Board (figs. 73-B and 92)

Terminal	*Volts*	*Ohms (K = 1,000)*
1	90.0 dc	90 K
2	6.3 ac	0.2
3	1.0 dc	100.0
4	0	Infinite
5	0	Infinite
6	280.0 dc	49 K
7	90.0 dc	90 K
8	6.3 ac	0.2
9	1.0 dc	100.0
10	0	0
11	280.0 dc	49 K
12	90.0 dc	90 K
13	6.3 ac	0.2
14	1.0 dc	100.0
15	300.0 dc	45 K
16	0	0
17	0	0
18	0	Infinite
19	0	Infinite
20	300.0 dc	45 K
21	300.0 dc	45 K
22	0	0
23	0	0
24	0	0
25	300.0 dc	45 K
26	0	0
27	6.3 ac	0.2
28	0	0

Test Conditions

Voltage Measurements:

1. Measurements made between indicated points and chassis with a 1,000-ohms-per-volt meter.

2. Chassis connected to rack with Cord CX-572/CPX (8 ft. 0 in.).

3. Line voltage 117.5 volts a-c.

4. SENSITIVITY control on control unit in extreme clockwise position.

5. Control unit connected to rack.

Resistance Measurements:

1. Measurements made between indicated points and chassis.

2. Chassis disconnected from rack.

3. Pins No. 20 and 22 on rear plug grounded.

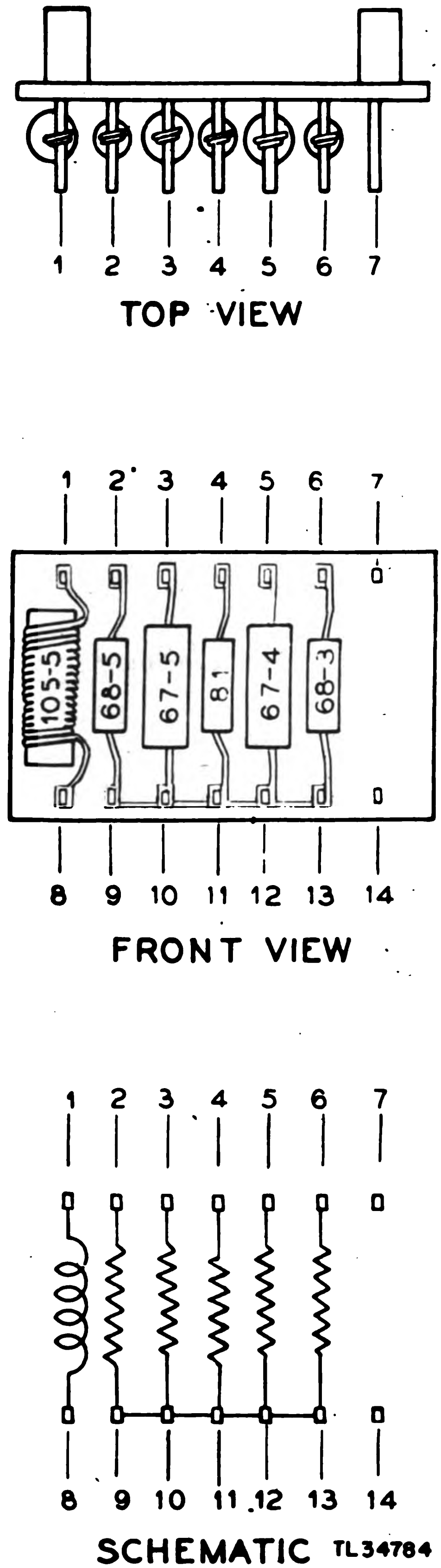


Figure 93. Cable terminal board.

Voltage and Resistance Chart of Cable Terminal Board (figs. 73-C and 93)

Terminal	*Volts*	*Ohms (K = 1,000)*
1	6.3 ac	0.2
2	280.0 dc	49 K
3	120.0 dc	145 K
4	280.0 dc	49 K
5	140.0 dc	145 K
6	280.0 dc	49 K
7	0	Infinite
8	6.3 ac	0.2
9	300.0 dc	45 K
10	300.0 dc	45 K
11	300.0 dc	45 K
12	300.0 dc	45 K
13	300.0 dc	45 K
14	0	Infinite

Test Conditions

Voltage Measurements:

1. Measurements made between indicated points and chassis with a 1,000-ohms-per-volt meter.

2. Chassis connected to rack with Cord CX-572/CPX (8 ft. 0 in.).

3. Line voltage 117.5 volts a-c.

4. SENSITIVITY control on control unit in extreme clockwise position.

5. Control unit connected to rack.

Resistance Measurements:

1. Measurements made between indicated points and chassis.

2. Chassis disconnected from rack.

3. Pins No. 20 and 22 on rear plug grounded.

Voltage and Resistance Chart of Pulse Amplifier Terminal Board (figs. 73-D and 94)

Terminal	*Volts*	*Ohms (K = 1,000) (meg = 1,000,000)*
1	0	1 meg
2	20 dc	10 K
3	20 dc	10 K
4	300 dc	48.3 K
5	75 dc	69 K
6	75 dc	69 K
7	75 dc	69 K
8	0	220
9	0	0
10	300 dc	45 K
11	0	1 meg
12	300 dc	45 K
13	300 dc	45 K
14	0	1 meg

Test Conditions

Voltage Measurements:

1. Measurements made between indicated points and chassis with a 1,000-ohms-per-volt meter.

2. Chassis connected to rack with Cord CX-572/CPX (8 ft. 0 in.).

3. Line voltage 117.5 volts a-c.

4. SENSITIVITY control on control unit in extreme clockwise position.

5. Control unit connected to rack.

Resistance Measurements:

1. Measurements made between indicated points and chassis.

2. Chassis disconnected from rack.

3. Pins No. 20 and 22 on rear plug grounded.

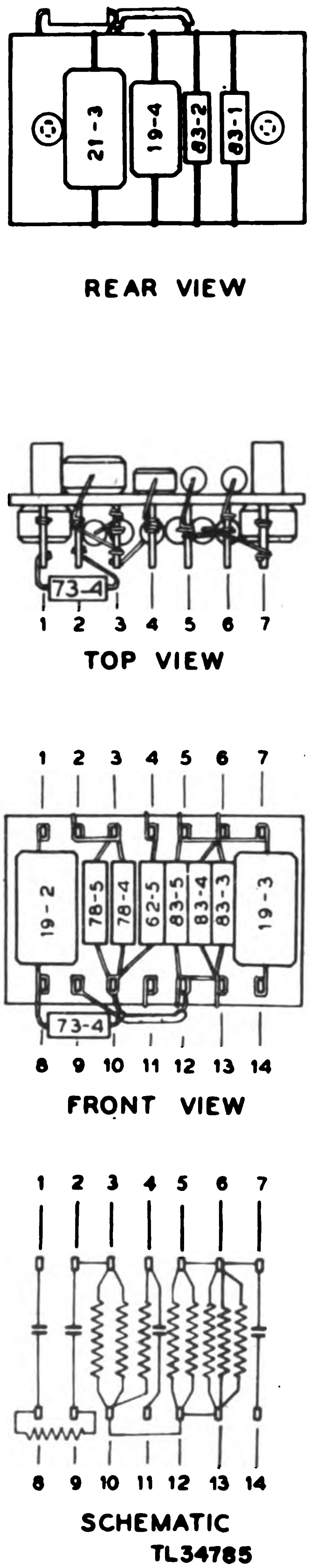


Figure 94. Pulse amplifier terminal board.

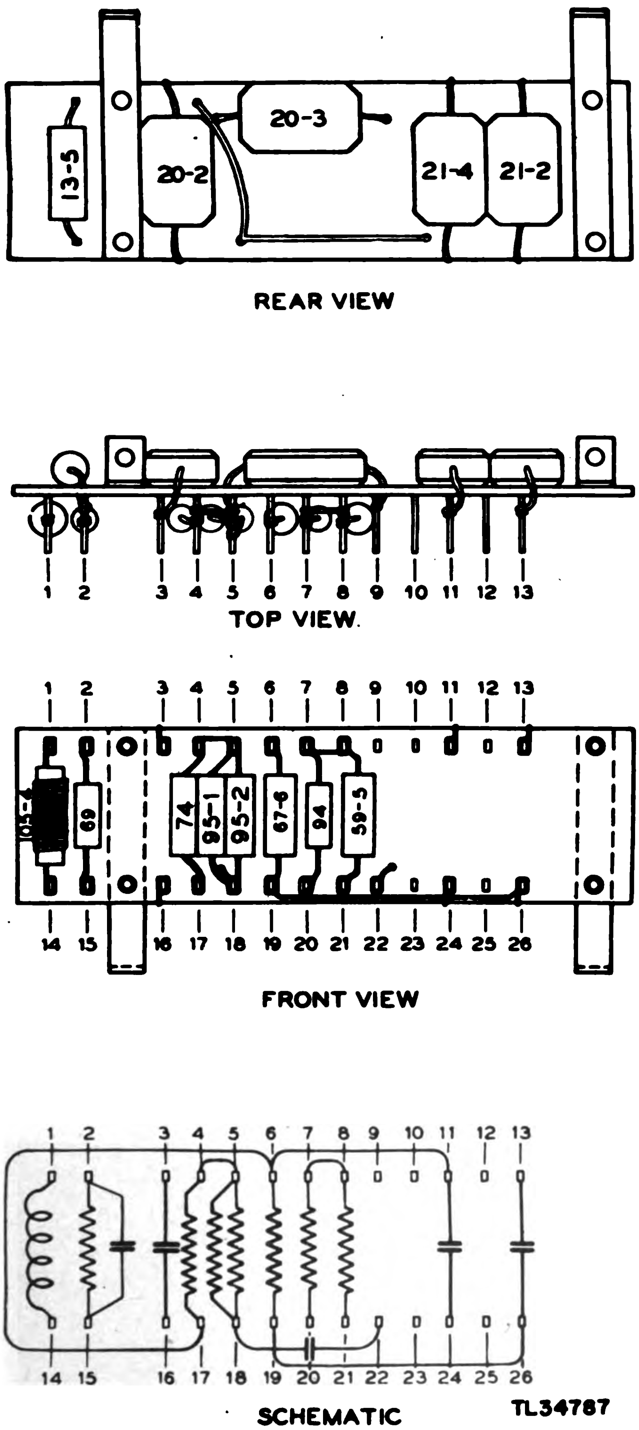


Figure 95. Second detector terminal board.

Voltage and Resistance Chart of Second Detector Terminal Board (figs. 73-E and 95)

Terminal	*Volts*	*Ohms (K = 1,000) (meg = 1,000,000*
1	6.3 ac	0.1
2	0	0
3	0	470 K
4	270.0 dc	50 K
5	270.0 dc	50 K
6	300.0 dc	45 K
7	3.3	1500
8	3.3	1500
9	0	Infinite
10	0	Infinite
11	300.0 dc	45 K
12	0	Infinite
13	0	0
14	6.3 ac	0.2
15	0	40 meg
16	0	17 K
17	300.0 dc	45 K
18	220.0 dc	60 K
19	140.0 dc	145 K
20	0	0
21	10.0 dc	4800
22	0	470 K
23	6.3 ac	0.1
24	0	0
25	0	Infinite
26	140.0 dc	145 K

Test Conditions

Voltage Measurements:

1. Measurements made between indicated points and chassis with 1,000-ohms-per-volt meter.

2. Chassis connected to rack with Cord CX-572/CPX (8 ft. 0 in.).

3. Line voltage 117.5 volts a-c.

4. SENSITIVITY control on control unit in extreme clockwise position.

5. Control unit connected to rack.

Resistance Measurements:

1. Measurements made between indicated points and chassis.

2. Chassis disconnected from rack.

3. Pins No. 20 and 22 on rear plug grounded.

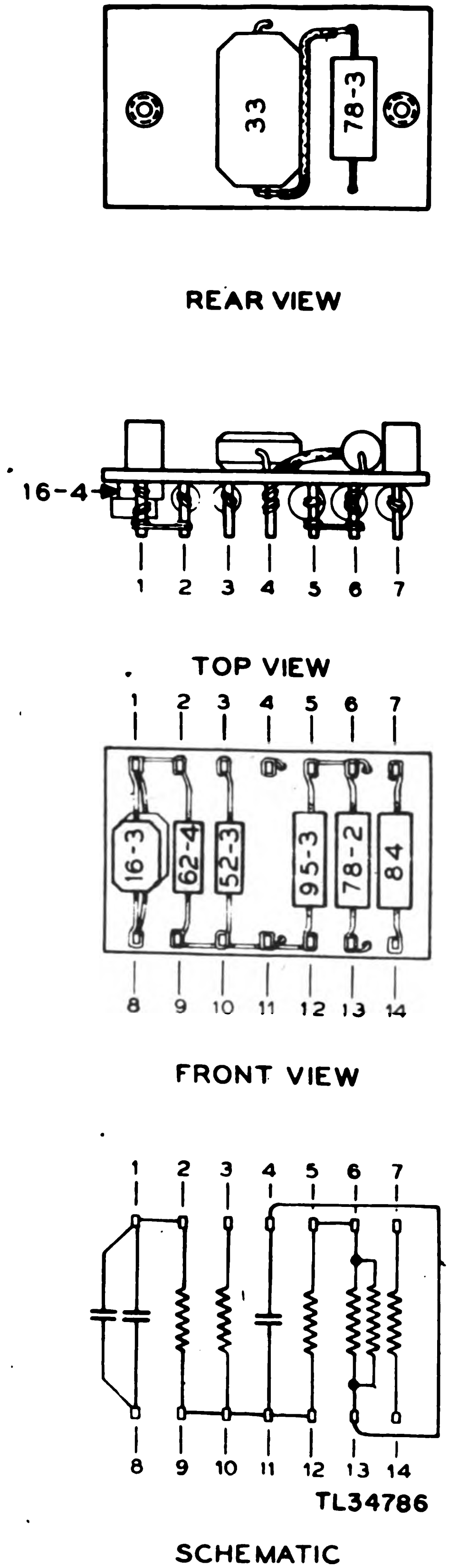


Figure 96. Blocking-oscillator terminal board.

Resistance Chart of Blocking Oscillator Terminal Board (fig. 96)

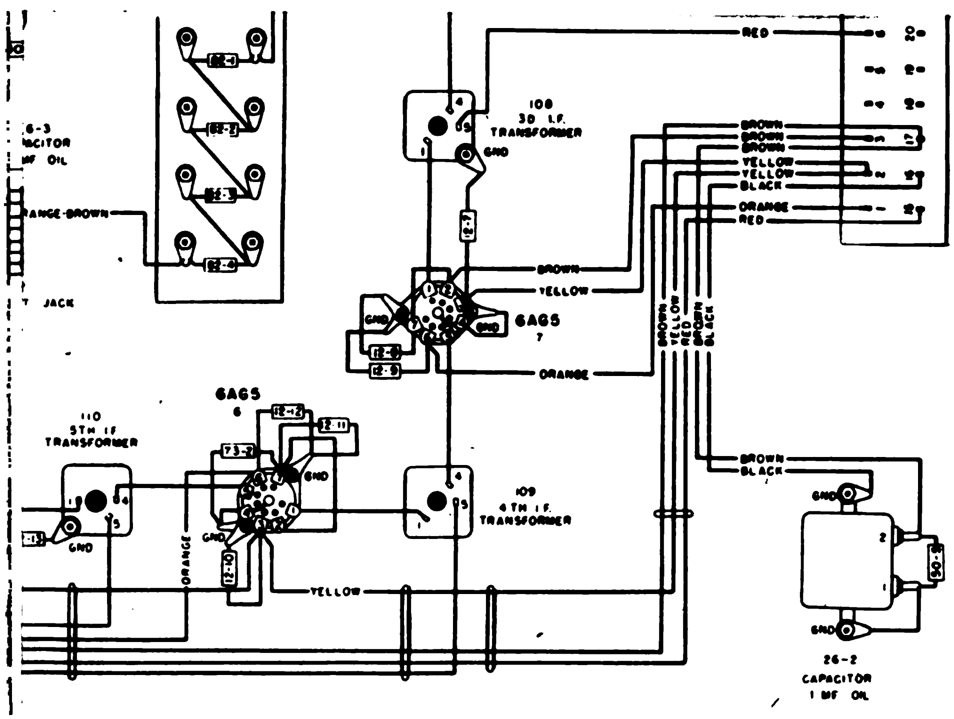
Terminal	*Ohms* (*K* = *1,000*)
1	3.3 K
*2	3.3 K
3	2.2 K
4	135.0 K
5	10.0 K
6	10.0 K
7	Infinite
8	Infinite
9	0
10	0
11	0
12	0
13	135.0 K
14	Infinite

*See figure 90 for voltages at pulse generator chassis connector.

Test Conditions

1. Measurements made between indicated points and chassis.

2. Blocking-oscillator subchassis removed from transmitter chassis; no voltage measurements possible.



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g diagram.

CHAPTER 11
ANTENNA TOWER KIT AS-134/TPX

90. REFERENCE DATA.

The following figures will assist maintenance personnel in trouble shooting the components of Antenna Tower Kit AS-134/TPX.

Figure No.	*Title*
16	R-F system, block diagram.
19	R-F system, schematic diagram.
20	Antenna Assembly AS-109/TP, schematic diagram.

91. GENERAL.

a. The components of Antenna Tower Kit AS-134/TPX used with Radio Equipment RC-384 are: Antenna Assembly AS-109/TP (fig. 18), Tower TR-29 (fig. 22), Remote Antenna Drive RM-55 (fig. 23), flexible drive Cord MX-363/TPX, Cord CG-282/TPX, and Cord CX-596/TPX. The complete kit is shown in figure 98.

b. Troubles which may develop in Antenna Tower Kit AS-134/TPX are of two types: r-f short or open circuits which may occur in the flexible coaxial cables or rotary joint, and mechanical troubles which may occur in the remote antenna drive, flexible drive cable, or mast drive gear. Both types of trouble can be localized by sectionalizing the systems.

(*1*) If an r-f short or open circuit is suspected in the coaxial line or antenna system, turn off the equipment and disconnect Cord CG-55/U (25 ft 0 in.) from the ANTENNA connector on the radio receiver and transmitter. In place of the cord connect to the ANTENNA connector the tee-connector and dummy load (fig. 76). (Do not connect the test antenna.) If the transmitter works normally with the dummy load connected, the trouble is in the coaxial cable or antenna system. Disconnect the other end of the coaxial cable from the antenna tower and check with an ohmmeter for open or short circuits. If no faults are found in the cable, lower the antenna and check the section of cable inside the tower mast: disconnect Cord CG-282/TPX from the coaxial dipole harness and check

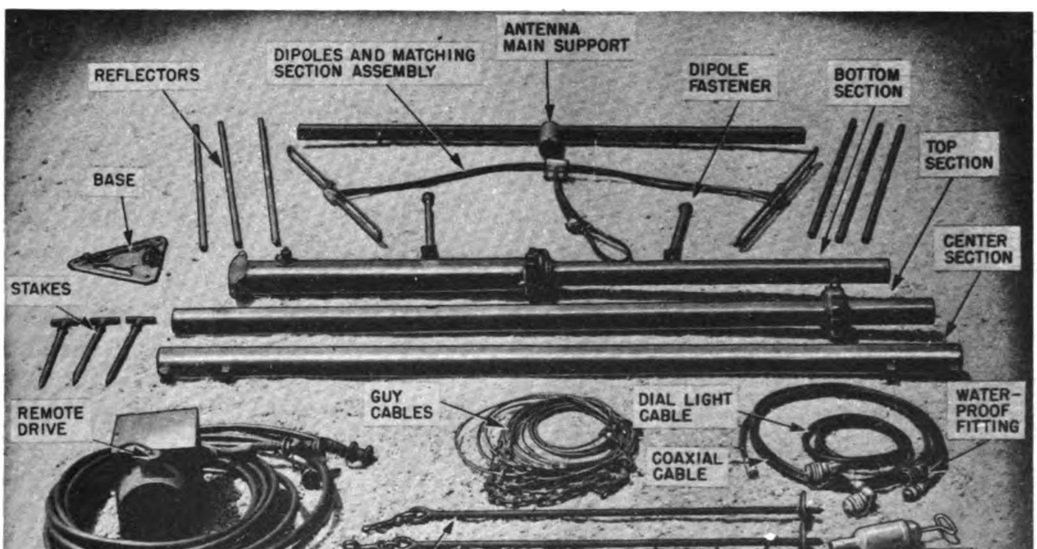

Figure 98. Antenna Tower Kit AS-134/TPX, disassembled.

for open or short circuits from the coaxial connector at the base of the antenna to the end of Cord CG-282/TPX. If an open or short circuit is found, remove the cord from the mast and check it again. If no faults are found, check the section of line from the coaxial connector on the base of the mast through the rotary joint to the top of the bottom section of the mast (fig. 99).

(2) Mechanical faults in the antenna rotating system can be localized by disconnecting the flexible drive cable from the base of the antenna mast and operating the remote antenna drive. If the remote antenna drive and flexible drive cable operate normally, the trouble is in the mast or mast gear drive. If the remote antenna drive and flexible drive cable do not operate normally with the drive cable disconnected from the mast, disconnect the drive cable from the remote drive box. If the drive box now operates normally, the trouble is in the drive cable.

92. REMOTE ANTENNA DRIVE RM-55 AND TOWER TR-29.

a. Improper operation of the antenna drive system is sometimes caused by having the guy cables pulled too tight. This overloads the guy-wire bearing on the mast and causes the antenna to turn hard. Improper operation is also caused by not having the tower mounted perpendicular to the ground. This loads the guy-wire bearing unevenly and causes the mast to rotate erratically.

b. In cold weather the drive system should be warmed up by disconnecting the flexible drive cable at the tower and attaching the hand crank (fig. 99). Turn the tower rapidly several times in each direction until it turns easily. Before reconnecting the flexible drive cable, turn the hand crank on the remote drive box until it turns easily. Then reconnect the drive cable to the mast.

c. When Cord MX-363/TPX has been coiled up and packed for any length of time, the outer shield shrinks and does not cover the inner flexible drive shaft completely. In this case lay the cable out on the ground and stretch the outer shield by pulling on each end until it covers the inner conductor completely.

93. DISASSEMBLY OF ROTARY JOINT (fig. 99).

It may be necessary to remove the rotary joint, which is located at the top of the bottom mast section, for cleaning or repair. The disassembly procedure is as follows:

a. Remove the two upper mast sections and disconnect Cord CG-282/TPX from the rotary joint assembly.

b. Disconnect Cord CG-55/U from the connector at the base of the bottom mast section and unscrew the N-type fitting from the rigid coaxial line which is composed of a copper tube approximately 54 inches in length terminating at the base of the rotary joint assembly.

c. Pull the complete rotary joint assembly out far enough from the top of the mast section to facilitate further disassembly.

d. Unscrew the hex nut from the coaxial connector on the top of the rotary joint.

e. Remove the six screws which hold the brass collar in place. Little by little loosen each screw in turn to maintain an even pressure all around the collar. The pressure is exerted by a coil spring beneath the collar.

f. Remove the brass collar and spring.

g. Remove the inner section of the rotary joint carefully. This inner section is composed of the N-type connector and an extended inner conductor pin which makes a friction coupling with the inner conductor of the rigid coaxial line (fig. 99).

h. To reassemble the rotary joint, replace the inner section, the spring, the brass collar, and the hex nut. Note that a small pin located on the inside of the brass collar must engage a slot on the connector portion of the inner section before it fits properly. A similar slot on the lower flange of the outer case of the rotary joint assembly must line up and engage a pin on the inside of the mast section before the complete assembly drops down into the mast. Replace the N-type fitting at the base of the rigid coaxial line, connect the two cables, and reassemble the mast.

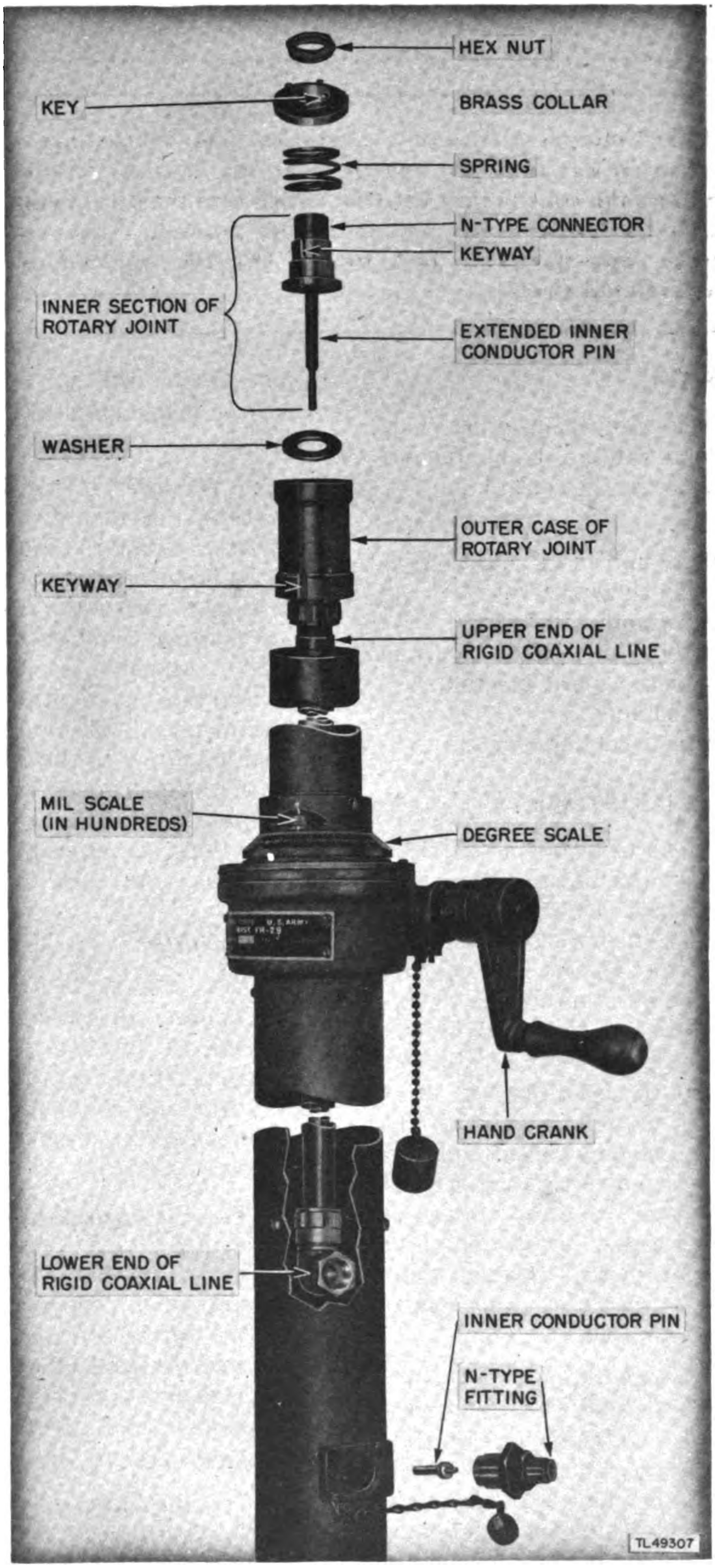

Figure 99. Tower TR-29, rotary joint, exploded view.

CHAPTER 12
CONTROL UNIT BC-1378

WARNING: Voltages sufficient to cause death on contact are exposed at many points in this unit. Do not place hands or arms within the component unless the control unit ON-OFF switch and the power supply PLATE VOLTAGE circuit breaker are both in the OFF position. Always ground the high-voltage capacitors 15-1, 15-2, and 17 (fig. 106) before touching them or their associated circuits.

94. REFERENCE DATA.

The figures listed below appear in other chapters of this manual and will assist maintenance personnel in trouble shooting the control unit.

Fig. No.	*Subject*
35 and 39	Control unit block diagrams.
37, 38, and 40	Display tube patterns.
55 and 56	Control unit waveforms.
57	Control Unit BC-1378, complete schematic diagram.
122 and 125	Rack circuits.
124	Complete cabling diagram.

95. PRELIMINARY ADJUSTMENTS.

a. Field maintenance for Control Unit BC-1378 requires only occasional adjustment of the sweep. The sweep positioning and length controls are labeled 75 K YD. GAIN, 10 K YD. GAIN, 75 K YD. CENT., 10 K YD. CENT., and VERT. CENT. The controls labeled CALIB. adjust the durations of the 10,000-yard and 75,000-yard sweeps. If a fault is indicated, *do not* adjust the controls at random because this will aggravate the condition and make readjustment very difficult. For example, if the right half of the sweep line suddenly disappears, it is possible that the sweep inverter tube 12B has failed, cutting out the positive sweep voltage at the right deflection plate and leaving only the negative sweep voltage at the left deflection plate. In this case, increasing the sweep gain control will only cover up the symptom.

b. If a sweep trace does not appear on the display screen, adjust *only* the INTENSITY and VERT. CENT. controls. The sweep voltage is developed by one of the last circuits in the control unit, and the absence of a sweep is a common symptom indicating trouble. Manipulation of the positioning controls may move the sweep off the screen after the fault in a circuit has been remedied, and the trouble shooter will not know that he has completed the repair because the sweep does not appear.

c. If it is suspected that the fault is simply that the sweep positioning controls are out of adjustment, try to obtain the sweep by mainpulating the controls; however, if a control is turned and the fault is not corrected, ***return the control to its former position***. Similarly, if it is suspected that the CALIB., DIVISION, or PEDESTAL WIDTH controls have been put out of adjustment, and that their readjustment will clear up the apparent trouble, proceed according to the adjustment instructions (par. 101), ***but note carefully the original position of each control before turning it.*** If readjustment of controls does not clear the trouble, ***return each control to its former position.***

96. ISOLATING TROUBLE TO CONTROL UNIT.

The cabling diagram (fig. 124) for Radio Equipment RC-384 shows the dependence of the control unit on the rest of the equipment. Before trouble shooting in the control unit, make sure that none of the external circuits discussed below is at fault.

a. Is Trouble Caused by A-C Failure? If the control unit pilot light glows, the control unit is receiving a-c power. If it does not glow but the power supply lights do glow, check the fuse in the front panel of the control unit. If the fuse is not blown, remove Cord CD-1382 from the back of the control unit and check for 117 volts a-c between pins D and E of the connector at the control unit end of Cord CD-1382.

b. Is Trouble Caused by Lack of B+ Supply? If the TUNING INDICATOR eye tube (on the front panel of the receiver-transmitter) glows, the power supply is at least partially operative. Turn up

INTENSITY to eliminate the need for brightening pulses. If a spot appears on the display tube and can be positioned with the sweep-positioning controls (par. 95a), B+ is present in the control unit (fig. 54). If the spot cannot be positioned, remove Cord CD-1382 from the back of the control unit and check for +300 to +330 volts between pin M and the shell of the connector at the control unit end of Cord CD-1382.

c. Is Trouble Caused by Lack of Radar Sync Pulses?

CAUTION: Do not clamp headphones over the ears when signal checking because the signal may be uncomfortably loud; hold them near the ears.

(*1*) Plug the headphones (which come with Signal Generator I-222-A) into jack 121-6 (fig. 101) to check the trigger sync pulses from the radar set. A rather high-pitched (1,706 pps) tone should be heard if the trigger sync pulses are coming in.

(*2*) Plug the headphones into jack 121-7 (fig. 101) to check the range sync pulses. If these pulses are coming in, a 1,706-pps tone should be heard. (When the radar set is Radio Set SCR-784, the range sync signal should be much louder than the trigger sync signal. The range sync pulse amplitude is 50 volts, and the pulses are 12 microseconds wide. The trigger sync pulse amplitude is only 12 volts, and the pulses are 1.2 microseconds wide.)

d. Is Transmitter Failure Caused by Lack of Sync from Control Unit? Plug the headphones into jack 121-4 (fig. 101). A loud, low-pitched tone (213 pps) should be heard if the transmitter trigger circuits are delivering sync pulses to the STANDBY-OPERATE switch. To check the sync pulses through the STANDBY-OPERATE switch, Cord CD-1382, and the rack wiring, snap the STANDBY-OPERATE switch to OPERATE and plug the headphones into the SYNCH. INPUT jack on the front panel of the receiver-transmitter.

e. Is Lack of Video Display Caused by Fault in Control Unit? Plug Cord CD-1105 between jacks 121-3 and 120 (fig. 101). This puts the video input directly on the top vertical-deflection plate. Turn up SENSITIVITY. If video signals do not appear, none are being delivered to the control unit. Check the receiver-transmitter and Cord CD-1382.

97. TROUBLE SHOOTING WITH PANEL CONTROLS.

Many troubles can be traced to specific circuits by interpreting the results of panel-control manipulations. The discussion below assumes that the fault has been isolated to the control unit (par. 96). The first thing to look for is a spot or sweep on the display screen. If there is neither, turn up INTENSITY to eliminate the need for brightening pulses. If a spot appears, the circuits of high-voltage rectifier tube 14 and display tube 15 are operating. If a vertical line can be obtained by turning up SENSITIVITY, the video circuit (tube 13) is operating. After these preliminary checks are made, proceed with the detailed procedure which follows:

a. No CALIB. Waves. Turn up INTENSITY. If fault is in the sweep-brightening channel, the waves should appear when INTENSITY is turned up because this control, when turned clockwise, decreases the display-tube grid bias to the point where brightening pulses are not needed. If the waves do not appear, turn INTENSITY to the original position and turn the range switch to 10 K YD. If the sweep appears, the trouble is isolated to the ringing circuit (coil 131 and capacitor 16) or the coupling and connecting circuits between the ringing circuit and pin 10 of the display tube (fig. 57).

b. No 10 K Yd. Sweep. Turn up INTENSITY. If sweep appears, fault is in the sweep-brightening channel (subpar. d below). If sweep does not appear, turn the range switch to 75 K YD. If the 75 K YD. sweep appears, the fault is either in the range sync circuits (tube 8) or in capacitor 9. (Capacitor 9 is connected to pins 6 and 7 of range switch section 2, fig. 57, and is the capacitor used to form the sweep in the 10 K YD. and CALIB. switch positions, as described in par. 40.)

c. No. 75 K Yd. Sweep. Turn up INTENSITY. If sweep appears, the fault is in the sweep-brightening channel (subpar. d below). If sweep does not appear, leave INTENSITY turned up and turn the range switch to 10 K YD. If sweep appears, the fault is in the trigger sync circuits (tube 1) or capacitor 10. (Capacitor 10 is connected to pin 5 of range switch section 2, fig. 57, and is the capacitor used to form the sweep in the 75 K YD. position as described in par. 40.) If the 10 K YD. sweep does not appear, turn the range switch to TEST. If a long sweep appears, the fault is probably in the sweep multivibrator circuit (tube 9) because in the TEST position tube 9 is bypassed (fig. 39). If neither the TEST sweep nor the 10 K YD. sweep appears, the trouble is probably in the sweep circuits (tubes 12A, 10, and 11).

d. Checking the Brightening Circuits. If the sweeps appear only with the INTENSITY control turned up an apparently abnormal amount, it can be definitely established whether or not the brightening circuits are operating by proceeding as follows:

(*1*) Turn range switch to 75 K YD.

(*2*) Reduce INTENSITY until sweep is visible but not bright.

(*3*) Turn range switch to TEST (this disconnects the brightening circuits).

(*a*) If sweep disappears, the brightening circuits are operating.

(*b*) If sweep remains on screen, the brightening circuits (tubes 5, 6, and 7A) are not operating correctly.

e. Checking Delay. If the sweep brightening circuits are operating (subpar. **d** above), check the 3¼-microsecond delay operation as follows:

(*1*) Turn range switch to CALIB.

(*2*) Reduce INTENSITY until the sine waves on the screen (fig. 37) are visible but not bright.

(*3*) Ask the radar operator to turn the SLEWING handwheel to zero yards range.

(*a*) If slightly more than the first half-cycle of the first sine-wave cycle blanks out, the delay is present. The blanking is caused by the delay in the start of the brightening pedestal.

(*b*) If no blanking occurs, the ringing oscillator (fig. 43) is defective; capacitor 5-1 is probably disconnected.

f. No Transmitter Sync. If the check described in paragraph 96**d** reveals no transmitter triggering output, the fault is in the circuit of tube 1, 2, 3, or 4 (fig. 35). Isolate the trouble as follows: Turn up INTENSITY to eliminate the need of brightening pulses. Turn the range switch to 75 K YD. If the sweep does not appear, the circuits of tube 1 are at fault and there is no need to seek further. If the sweep appears, the circuits of tube 1 (fig. 35) are operating. (The sweep multivibrator will be triggered at 1,706 pps by the output of tube 1B even if tube 2 is inoperative.) Turn the range switch to TEST. If a long sweep appears, the circuits of tube 2 are also operating (fig. 39). Next, check the brightening circuits (subpar. **d** above). If there is no brightening output, the trouble is in one of the four last blocks (fig. 35), before the transmitter trigger output. If the brightening circuits operate, the fault is narrowed down to capacitor 3-1 (fig. 57, cathode output of tube 4).

g. Right Half of Sweep Missing. This symptom indicates clearly that the negative saw-tooth pulse is being applied to the left horizontal-deflection plate but the positive saw-tooth pulse is missing from the right horizontal-deflection plate. The sweep inverter circuit (tube 12B) is defective.

h. Locating Tube Failures. A cross-reference compilation of trouble location procedures, listed by tube symbol numbers, may be helpful in isolating trouble to tubes without internal trouble shooting.

(*1*) *Tube 1.* See subparagraph **f** above.

(*2*) *Tube 2.* See subparagraph **f** above.

(*3*) *Tubes 3 or 4.* See subparagraph **f** above.

(*4*) *Tubes 5, 6, or 7A.* See subparagraph **d** above.

(*5*) *Tube 8.* See subparagraph **b** above.

(*6*) *Tube 9.* See subparagraph **c** above.

(*7*) *Tubes 10, 11, 12A.* See subparagraph **c** above.

(*8*) *Tube 12B.* See subparagraph **g** above.

(*9*) *Tube 13.* See paragraph 96**e**.

(*10*) *Tubes 14 or 15.* See introduction to paragraph 97 above.

98. USE OF DISPLAY TUBE AS A SYNCHROSCOPE.

a. An ordinary oscilloscope is not the best instrument to use when it is necessary to study a very short pulse which is repeated at an audio recurrence frequency. For example, the transmitter triggering pulse (cathode of tube 4) in figure 55 is shown as it appears on an ordinary test oscilloscope. Very little pulse shape detail can be seen. If the sweep frequency had been higher, the pulse would be spread out more, but the base line would be unbroken because many sweeps with no vertical deflection would appear for every one sweep which has a vertical deflection; moreover, it is very difficult to obtain a stationary pattern under these conditions.

b. A synchroscope is a special test oscilloscope with a very fast sweep synchronized to the signal to be studied. For example, the pulse at the cathode of tube 4 would be seen on a synchroscope sweep which occurs once each time the pulse occurs and which is fast enough to spread the pulse out horizontally.

c. With certain limitations, the display tube in the control unit can be made to serve as a syn-

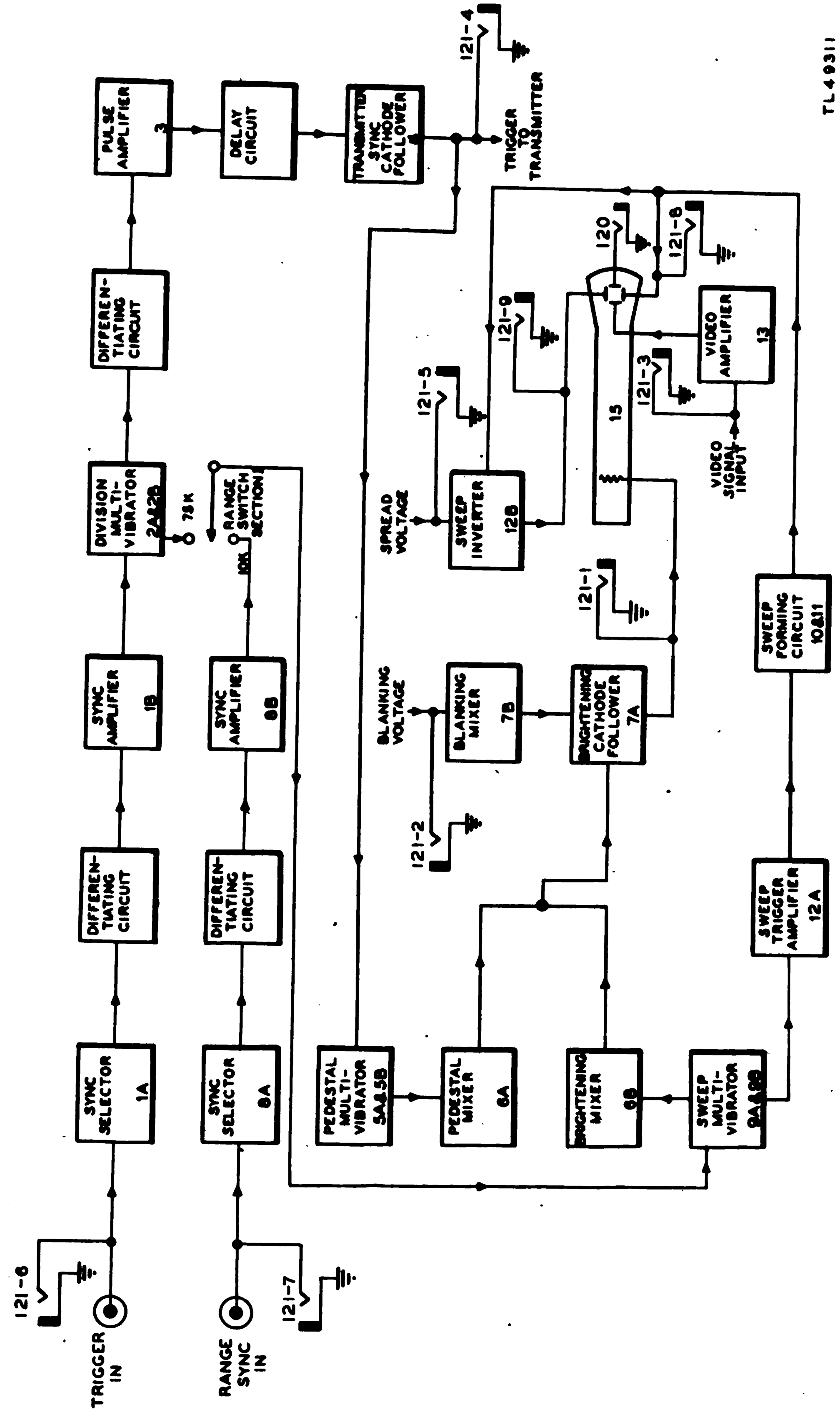

Figure 100. Block diagram of test-jack locations.

chroscope. For example, if it is desired to study the pulse at the cathode of tube 4 in detail, proceed as follows:

(*1*) Turn SENSITIVITY all the way down to keep other signals off the screen.

(*2*) Apply the pulse to the top vertical-deflection plate by connecting Cord CD-1105 between jacks 121-4 and 120 (figs. 100 and 101).

(*3*) Provide a 60-microsecond sweep by turning the range sweep to 10 K YD.

(*4*) Spread the sweep out by turning 10 K YD GAIN all the way up.

(*5*) Have the radar operator turn the SLEWING handwheel to zero yards range; this will cause the sweep to start ahead of the pulse. The pulse starts 3¼ microseconds after zero yards, and the sweep is brightened at the instant the pulse starts. If the left edge of the pulse is not clearly visible, brighten the entire sweep by turning up INTENSITY. The sweep base line will fill in under the pulse because eight sweeps become visible for every one transmitter pulse; however, this should not cause too much difficulty.

d. The procedure for measuring the width of the r-f transmitter-pulse envelope, given in paragraph 67 and illustrated in figure 71, is another example of the use of the control unit display tube as a synchroscope. In this case, the sweep is calibrated by the 5-microsecond sine waves.

99. TROUBLE SHOOTING WITH TEST JACKS.

Figure 100 shows the circuit location of the 10 control unit test jacks in block diagram form. These jacks are mounted in the side panel of the control unit (fig. 101). The table below lists the waveforms (figs. 55 and 56) which should be seen when Cord CD-1099 is used to connect the test jacks to a test oscilloscope set for a sweep frequency of approximately 60 sweeps per second.

TABLE VI
CONTROL UNIT TEST JACKS

Jack No.	*Name in fig. 57*	*Waveform illustration*
120	Input test jack	No waveform available at this jack.
121-1	Brightening test jack	7A cathode, fig. 55.
121-2*	Blanking test jack*	7B cathode, fig. 56.*
121-3	Video test jack	13 grid, fig. 56.
121-4	Transmitter sync test jack	4 cathode, fig. 55.
121-5*	Spread test jack*	Spread voltage, fig. 56 (SPREAD control turned down)*
121-6	Trigger input	1A grid, fig. 55.
121-7	Range sync input	8A grid, fig. 55.
121-8	Negative sweep test jack	11 plate, fig. 56.
121-9	Positive sweep test jack	12B plate, fig. 56.

*Waveform available only when a lobe-switching antenna is used.

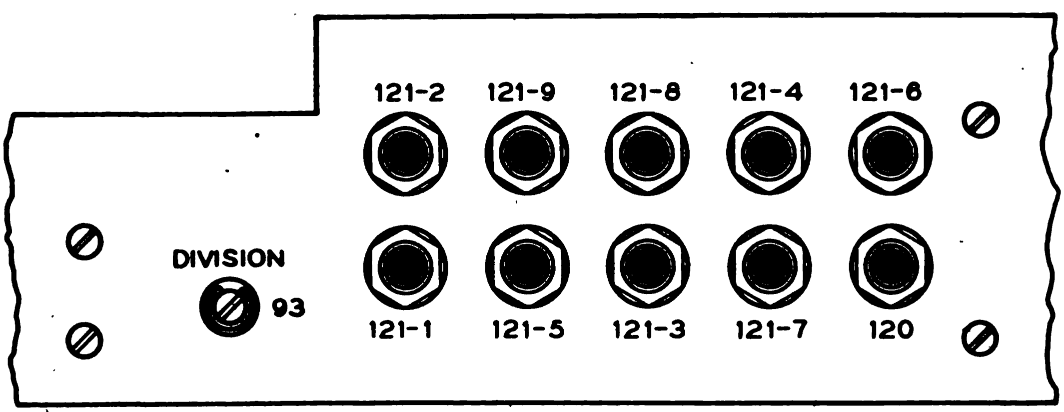

Figure 101. Control Unit BC-1378, side panel.

a. Jack 120. This jack is used to apply signals to the top vertical-deflection plate of the oscilloscope.

b. Jack 121-1. This jack is used to check the brightening pulse to the grid of the display tube.

c. Jack 121-2. This jack is used to check the blanking operation (par. 52**b**) when a lobe-switching antenna is used.

d. Jack 121-3. This jack is used to check for the presence of video signal from the receiver.

e. Jack 121-4. This jack is used to check the trigger pulse to the IFF transmitter either with headphones (par. 96**d**) or by the synchroscope method (par. 98**c**). Trouble indicated by lack of output at this jack can be traced as described in paragraph 97**f**.

f. Jack 121-5. This jack is used to check for the presence of spread voltage when a lobe-switching antenna is used.

g. Jack 121-6. This jack is used to check for the presence of trigger sync pulses from the radar set (par. 96**c**). The trigger sync pulse can be studied on the display tube by using a procedure similar to that described in paragraph 98**c**. The jack is also used to check and adjust the division action (par. 101**c**).

h. Jack 121-7. This jack is used to check for the presence of range sync pulses from the radar set (par. 96**c**). The range sync pulse can be studied on the display tube by using a procedure similar to that described in paragraph 98**c**. To see this pulse, it is not necessary to set the radar SLEWING handwheel to any particular range. The left edge of the pulse will always coincide with the start of the sweep and may not be clearly visible.

i. Jack 121-8. This jack is used to check the output of the sweep-forming circuit either with the headphones or the test oscilloscope.

(*1*) If jack 121-4 shows output but jack 121-8 does not, the trouble lies between the moving arm of range switch section 1 (fig. 100) and jack 121-8.

(*2*) If jack 121-8 shows output but no sweep is present on the display tube, the trouble is in the circuit of display tube 15 or high-voltage rectifier tube 14.

j. Jack 121-9. This jack is used to check the output of the sweep inverter circuit either with the headphones or the test oscilloscope.

(*1*) If jack 121-8 shows output but jack 121-9 does not, the trouble is in the sweep inverter circuit. This condition is also indicated by a sweep on the left half of the display screen only.

(*2*) If neither jack shows output, the trouble is probably ahead of the jack 121-8 point (fig. 100). See subparagraph **i**(*1*) above.

100. CONTROL UNIT TROUBLE-SHOOTING CHART.

NOTE: To remove the control unit from its case, disconnect the cords at the back of the unit, loosen the three captive knurled screws, one in each upper corner and one in the bottom center of the front panel, grasp the handle on the front panel, and pull the chassis from the inner case. It is rarely necessary to remove the inner case from the waterproof outer case.

The procedure below is based on the assumption that the trouble has been isolated to the control unit (par. 96).

A. SYMPTOMS:

1. No 75 K YD. sweep.
2. No 10 K YD. sweep.
3. No spot on the display tube.
4. Both a-c and B+ power switched on.

Probable Location of Fault	Procedure
1. Defective brightening channel.	1. Proceed as in paragraph 97**d**.
2. Defective circuit, tube 14 or tube 15.	2*a*. If neither sweep nor spot appears when INTENSITY is turned up, make voltage, resistance, and tube checks of the circuits of tubes 14 and 15 (fig. 54).
	b. If sweep does not appear when INTENSITY is turned up but a spot does appear, fault 2 is not indicated. See symptom B below.

B. SYMPTOMS:

1. No 75 K YD. sweep.
2. No 10 K YD. sweep.
3. A spot or vertical line appears on display tube when INTENSITY is turned up.

Probable Location of Fault	**Procedure**
1. Defective sweep multivibrator circuit.	1. Turn range switch to TEST. If a long sweep appears, make waveform, voltage, resistance, and tube checks of sweep multivibrator circuit (tube 9).
2. Defective sweep circuits (tubes 10, 11, or 12).	2. If no sweep appears in TEST position, make waveform, voltage, resistance, and tube checks of circuits of tubes 10, 11, and 12.

C. SYMPTOMS:

1. 75 K YD. sweep appears.
2. No 10 K YD. sweep.
3. INTENSITY turned up.

Probable Location of Fault	**Procedure**
1. Defective range sync circuits (tube 8).	1. Make waveform, voltage, resistance, and tube checks of the circuits of tube 8.
2. Defective capacitor 9 (connected to pins 6 and 7 of range switch section 2).	2*a*. Bypass capacitor 9 with another 0.001-mf capacitor. *b*. If trouble is not cleared, check capacitor 9 for short.
3. Defective range switch.	3. Make continuity checks of range switch.

D. SYMPTOMS:

1. 10 K YD. sweep appears.
2. No 75 K YD. sweep.
3. INTENSITY turned up.

Probable Location of Fault	**Procedure**
1. Defective trigger sync circuits (tube 1).	1. Check output of jack 121-4 with phones and by using display tube as synchroscope (par. 98*c* and fig. 43). If output is absent or abnormal, make waveform, tube, voltage, and resistance checks of circuit of tube 1.
2. Defective capacitor 10 (connected to pin 5 of range switch section 2).	2. If output of jack 121-4 is normal, turn range switch to TEST. If sweep appears, check capacitor 10.
3. Defective range switch.	3. Make continuity checks of range switch.

E. SYMPTOMS:

1. 10 K YD. sweep appears.
2. 75 K YD. sweep appears.
3. INTENSITY turned up.
4. STANDBY-OPERATE switch at OPERATE.
5. Transmitter pulse does not appear on display tube.

Probable Location of Fault	Procedure
1. Defective triggering circuits.	1*a*. Check input to transmitter at SYNCH. INPUT jack on receiver-transmitter. Use phones; if tone is heard, check waveform by using display tube as synchroscope (par. 98**c** and fig. 43). Make the long test cord which is required as described in paragraph 102**b**. If pulses at SYNCH. INPUT jack are normal, fault 1 is not indicated. Skip to fault 2.
	b. If no pulses or abnormal pulses are present at SYNCH. INPUT jack, snap STANDBY-OPERATE switch to STANDBY and repeat test at jack 121-4 on control unit. If pulses are present and normal, fault is in STANDBY-OPERATE switch or in cabling between units. Make continuity checks of cabling first, because it is a more likely source of trouble than the switch.
	c. If output of jack 121-4 is absent or abnormal (procedure 1*b* above), check action of brightening circuits (par. 97**d**). If brightening circuits operate, check capacitor 3-1 (connected to cathode of tube 4).
	d. If sweep brightening circuits do not operate, turn range switch to TEST. If no long sweep appears, division multivibrator circuit (tube 2, fig. 39) is at fault. Make tube, waveform, voltage, and resistance checks of this circuit.
	e. If long sweep appears, make waveform, tube, voltage and resistance checks of circuits of tubes 3 and 4, starting with plate (pin 5) of tube 2B.
2. Defective receiver-transmitter.	2. If input to SYNCH. INPUT jack is normal (procedure 1*a* above), check receiver output at RECEIVER OUTPUT LOW jack on receiver-transmitter; use phones and oscilloscope. Make sure that STANDBY-OPERATE switch is at OPERATE. If output is absent or abnormal, fault is in receiver-transmitter (par. 69) or may be a short in cabling and wiring to video stage in control unit. Check for short between pin B and ground both at control unit receptacle 127 and at control unit end of Cord CD-1382.
3. Defective video circuit (tube 13 and wiring to it).	3*a*. If output of RECEIVER OUTPUT LOW jack on receiver-transmitter is normal, check video input at jack 121-3 (on control unit) with phones. If video input is absent, fault is due to open circuit in wiring between units (fig. 125).
	b. If video input is present at jack 121-3, connect Cord CD-1105 between jacks 120 and 121-3 and turn up SENSITIVITY. If transmitter pulse appears, trouble is in video stage. Make tube, voltage, and resistance checks of tube 13 circuit.

F. SYMPTOMS:

1. IFF reply pulses do not break base line of 10 K YD. sweep.
2. INTENSITY must be turned up abnormally to make sweep appear.

Probable Location of Fault	Procedure
Defective sweep brightening circuits.	Check sweep brightening circuits (par. 97*d*). If defective, make waveform, tube, voltage, and resistance checks of circuits of tubes 5, 6, and 7.

G. SYMPTOMS:

1. Sweep appears only on left half of display tube.
2. GAIN controls cannot make right end of sweep go off the screen.

Probable Location of Fault	Procedure
Defective sweep inverter circuit.	*a.* Check for pulse at jack 121-9 with headphones. *b.* If tone is heard, check at jacks 121-9 and 121-8 with test oscilloscope (fig. 56, plates of 11 and 12B). *c.* If results of procedures *a* and *b* above are abnormal, make voltage, resistance, and tube checks of sweep inverter circuit (tube 12B). *d.* If results of procedures *a* and *b* above are normal, check capacitor 25 and connections to pin 8 of tube 15.

H. SYMPTOMS:

1. Horizontal instability; sweep shifts and shortens intermittently.
2. 75 K YD. range.

Probable Location of Fault	Procedure
Defective division multivibrator (circuit of tube 2).	*a.* Check division ratio (par. 101*c*). If division is at either limit of division possibilities of circuit, operation is unstable. *b.* If division ratio is correct, try replacing the tube. If this does not correct trouble, make resistance and voltage checks of circuit components.

I. SYMPTOM:

Extremely bright and badly focused display.

Probable Location of Fault	Procedure
1. High-voltage supply (fig. 54).	1*a.* Check grid voltage of tube 15. *b.* If there is no grid voltage, check continuity of resistor 61.
2. Abnormal grid bias, tube 15 (fig. 54).	2*a.* Check for potential difference between grid and cathode (fig. 54). *b.* If grid bias is absent, check for shorted capacitor 18 and for shorted potentiometer 96 (INTENSITY). *c.* Check for a short in tube 15 or socket of tube 15 between pins 2 and 3 (figs. 54 and 105).

J. SYMPTOM:

Intermittent flashes on screen.

Probable Location of Fault

Leaky capacitor 13 (connected to cathode of tube 7A).

Procedure

a. Disconnect the capacitor lead at either end and turn up INTENSITY.

b. If fault is cleared, replace capacitor 13.

K. SYMPTOM:

Sweep does not focus properly at all points ("astigmatism").

Probable Location of Fault

Defective cathode-ray tube 15.

Procedure

Adjust FOCUS control. If a portion of the trace goes out of focus and another portion is brought into focus, replace tube 15 if symptom is sufficiently annoying.

L. SYMPTOM:

FOCUS control does not affect sweep trace.

Probable Location of Fault

1. High-voltage supply.
2. Defective tube 15.

Procedure

1*a.* Check negative high voltage (fig. 54).

b. Check for defective potentiometer 97 (FOCUS) or capacitor 17 (fig. 54).

c. Make complete voltage and resistance checks of the high-voltage voltage-divider network (fig. 112).

2*a.* Check for shorted elements.

b. If no circuit defect can be found, replace tube.

M. SYMPTOM:

INTENSITY control does not affect display.

Probable Location of Fault

Defective potentiometer 96 (INTENSITY).

Procedure

Check mechanical and electrical action of potentiometer 96 with a voltmeter (fig. 54).

N. SYMPTOM:

CENT. controls do not affect display.

Probable Location of Fault

Defect in display-tube circuits (fig. 54).

Procedure

Make voltage and resistance checks of circuit (fig. 54).

O. SYMPTOM:

GAIN controls do not produce sufficient change in display.

Probable Location of Fault

Defective tube 11 circuit.

Procedure

Make tube, voltage, and resistance checks of the tube 11 circuit (fig. 45).

P. SYMPTOMS:

1. No spread action or continuous spread action.
2. Lobe-switching antenna used and lobe switch turned on.
3. SPREAD control turned up.

Probable Location of Fault

Defective tube 12B circuit.

Procedure

Make waveform (jack 121-5), tube, voltage, and resistance checks of tube 12B circuit (fig. 46).

Q. SYMPTOMS:

1. Reply pulses occasionally appear greater in amplitude during pip-matching process.
2. Lobe-switching antenna used and lobe switch turned on.

Probable Location of Fault

Defective tube 7B circuit.

Procedure

Make waveform (jack 121-2), tube, voltage, and resistance checks of tube 7B circuit (fig. 52).

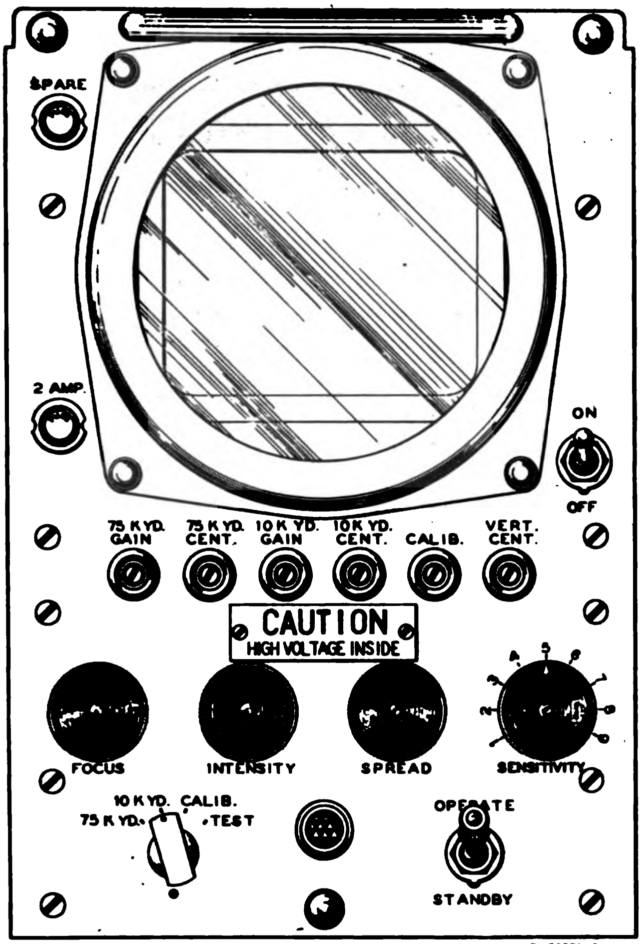

Figure 102. Control Unit BC-1378, front panel controls.

101. ADJUSTMENT PROCEDURE.

a. Sync Polarity Switch Settings. If the associated radar equipment is Radio Set SCR-784, its trigger sync pulses are negative and its range sync pulses are positive. Make sure that the two POLARITY SELECTOR switches on the top of the chassis are set correctly, as shown in figure 105. If another radar equipment is used, determine the trigger and range sync pulse polarities and set the POLARITY SELECTOR switches accordingly, negative (−) for a negative pulse and positive (+) for a positive pulse.

b. Sweep Trace Adjustments. Allow at least 1 minute for the equipment to warm up after the ON-OFF switch on the control unit and the PLATE-VOLTAGE circuit breaker on the power supply have been snapped to ON. The STANDBY-OPERATE switch should be at STANDBY, and the SENSITIVITY and SPREAD controls should be in their extreme counterclockwise positions. Turn the range switch to 75 K YD. and manipulate the FOCUS, INTENSITY, VERT. CENT., 75 K YD. GAIN, and 75 K YD. CENT. controls (fig. 102) for a sharply defined sweep trace about midway up the screen, starting about ¼ inch from the left edge and ending about ¼ inch from the right edge of the screen. Then turn the range switch to 10 K YD. and adjust the 10 K YD. CENT. and 10 K YD. GAIN controls until the 10,000-yard sweep has the same appearance as the 75,000-yard sweep.

c. Division Adjustment.

(*1*) After adjusting the sweep trace, turn the range switch to TEST. The sweep will disappear because the range switch in the TEST position disconnects the brightening circuits. Make the sweep reappear by turning up the INTENSITY control. The sweep duration on TEST is in the order of 4,000 microseconds instead of 60 microseconds (10 K YD.) or 458 microseconds (75 K YD.) On TEST, the saw-tooth sweep pulses have more time to build up to a large amplitude, and the sweep will end far off the right edge of the screen. Reduce the sweep length with the 75 K YD. GAIN control and, if necessary, reposition the sweep with the 75 K YD. CENT. control. Feed the radar trigger sync pulses to the top vertical-deflection plate by connecting Cord CD-1105 between jacks 120 and 121-6 on the side panel of the control unit (fig. 101). If the radar set is Radio Set SCR-784, the division ratio must be eight to one, and eight negative pips should appear on the screen; adjust the DIVISION control (fig. 101) until eight pips appear as shown in figure 40. As the DIVISION control is rotated, it may be necessary to readjust the 75 K YD. GAIN control to keep the pattern on the screen.

(*2*) If the associated radar set has a recurrence rate other than 1,706 pps, a different division ratio may be required. The IFF recurrence rate must be kept between 200 and 240 pps inclusive. For example, if the radar recurrence rate is 1,400 pps, a division ratio of six to one will make the IFF recurrence rate 233 pps, and a division of seven to one will make the IFF recurrence rate 200 pps. Choose the six-to-one ratio because the 233-pps recurrence rate is farther away from the extremes of 200 and 240. If the radar recurrence rate is 1,200 pps, it is necessary to choose between division by five, which gives 240, and division by six, which gives 200 pps for the IFF recurrence rate. Choose the six-to-one ratio; the lower of the two extremes (200 and 240) is preferable because it reduces the danger of over-interrogation. When adjusting the DIVISION control for the six-to-one ratio, for example, six pips must be made to appear on the screen instead of the eight pips shown in figure 40. If the trigger sync pulse from the radar set is positive, the pips will appear up from the sweep line. Figure 40 shows the pips below the sweep line because the trigger sync pulses from Radio Set SCR-784 are negative.

(3) In the TEST position of the range switch, the output of division multivibrator tube 2 is fed to two circuits instead of the one circuit it feeds in the operating positions of the range switch. When the range switch is turned back to 10 K YD. or 75 K YD., the changed impedance condition may change the division ratio. To compensate for this changed impedance condition, the transmitter modulator cathode current is used as a criterion of correct division. If the division ratio increases, the IFF recurrence rate decreases and the average current through the modulator tube decreases. The reverse is true for a lowered division ratio. After the division adjustment has been made on the basis of the number of pips on the sweep trace, as described above, and while the range switch is still in the TEST position, snap the STANDBY-OPERATE switch to OPERATE. (If this adjustment is being made in the operating location and it is not desired to put the equipment "on the air," use the test and dummy antennas at the ANTENNA connector of the receiver-transmitter.) Hold the receiver-transmitter TEST SWITCH in the Ic position and note the modulator cathode current on the lower scale of the meter in the front panel of the receiver-transmitter. This reading is the criterion for correct division. Turn down the INTENSITY control, remove Cord CD-1105, and turn the range switch to 75 K YD. Again hold the receiver-transmitter TEST switch in the Ic position and see if the division ratio has changed. If the Ic reading on the meter is different from the criterion reading, readjust the DIVISION control until the criterion reading is obtained.

(4) A slight rotation of the DIVISION control can be made before the meter needle jumps to a different value. It is desirable to *center* the adjustment; that is, get the moving arm of the DIVISION potentiometer to a point where the amount of clockwise rotation necessary to raise the division ratio equals the amount of counterclockwise rotation necessary to lower it. A slight change in circuit constants due to aging or temperature will not change the division ratio if the adjustment is centered. Hold the TEST SWITCH in the Ic position, watch the meter, and slowly turn the DIVISION control counterclockwise until the meter needle jumps to a value *higher* than the criterion value.

Figure 103. Special screwdriver for the CALIB. controls.

Then slowly turn the DIVISION control clockwise until the meter needle jumps twice, first to the criterion value and then to a *lower* value. Repeat a few times to get the feel of how much rotation is necessary to move the needle between the two wrong values. Then set the control to the midpoint of this rotation. Snap the STANDBY-OPERATE switch to STANDBY.

d. 75 K YD. Calibration. After the division adjustment is made, the sweep durations can be adjusted. Turn the range switch to 75 K YD., insert the phone-plug end of Cord CD-1347 into jack 120; connect the other end of the cord to the RANGE MARKERS receptacle on the radar set (fig. 124). The range marker pips will appear on the screen as a series of positive and negative pips. Disregard the negative pips. The positive pips are

Figure 104. Rear view of control unit.

10,000 yards apart. Use the special screwdriver (fig. 103) provided with the control unit and adjust the *shaft* of the CALIB. control until the sweep length includes seven spaces between the positive pips and is, in addition, about one-half space longer (fig. 38). It may be necessary to readjust the 75 K YD. CENT. and 75 K YD. GAIN controls during the calibration adjustment. The sweep duration is now correct for a 75,000-yard timebase. Remove Cord CD-1347 from jack 120.

e. 10 K YD. Calibration. Adjust the duration of the 10,000-yard sweep by turning the range switch to CALIB. and adjusting the *bushing* of the CALIB. control until 12 complete sine-wave cycles appear on the screen (fig. 37). Each cycle represents 5 microseconds, and a 12-cycle (60 microsecond) sweep duration is correct for the 10,000-yard timebase. It may be necessary to readjust the 10 K YD. CENT. and 10 K YD. GAIN controls during the calibration adjustment.

f. Pedestal Width Adjustment. The pedestal multivibrator must next be adjusted to furnish a pulse (pedestal) approximately 500 microseconds in duration (width). This pulse is used by the sweep brightening circuits to brighten the sweep. Two methods of adjusting the pedestal duration are given below. Both methods require the services of an assistant. One man observes the control unit screen and instructs the second man, who turns the PEDESTAL WIDTH control on the back of the control unit (fig. 104).

(1) *Method Given in TM 11-1362.* Turn the range switch to 75 K YD. Slowly turn the PEDESTAL WIDTH control down until told that the sweep line (which is 458 microseconds long) is beginning to shorten from the right-hand end. This means that the pedestal duration has become less than 458 microseconds. Continue turning down until told that 1/8 inch is clipped from the end of the line. Then turn the control clockwise until told that the 1/8 inch of length is restored to the line; carefully note the amount of rotation necessary. Continue with the same amount of clockwise rotation from this point; that is, turn the control clockwise enough to brighten an imaginary sweep which is 1/8 inch longer than the actual sweep.

(2) *Alternate Method.* Turn the range switch to 75 K YD. Turn the PEDESTAL WIDTH control all the way clockwise. Connect Gord CD-1347 between the RANGE MARKERS receptacle on the radar set (fig. 124) and jack 120 on the side panel of the control unit (fig. 101). With the special screwdriver (fig. 103), turn the *shaft* of the CALIB. control until the sweep line shows eight spaces between positive radar pips and is, in addition, a half space longer. It may be necessary to readjust the 75 K YD. CENT. and 75 K YD. GAIN controls to keep the entire sweep on the screen. Since there are 10,000 yards between positive radar calibration pips, the sweep line is now 85,000 yards, or about 520 microseconds long. Slowly turn the PEDESTAL WIDTH control counterclockwise until told that the sweep is beginning to shorten from the right-hand end. This means that the pedestal width has become about 520 microseconds or slightly less, which is the desired duration. Readjust the sweep duration to 75,000 yards by turning the *shaft* of the CALIB. control until the sweep shows 7½ spaces between positive radar pips (fig. 38). Remove Cord CD-1347 from jack 120. Readjust the 75 K YD. CENT. and 75 K YD. GAIN controls for a correctly positioned sweep.

g. Vertical Positioning. All of the adjustments described above were made with the sweep midway up the screen for greater ease in observation. For operation, the sweep should be about ½ inch from the bottom. Move the sweep down to about ½ inch above the bottom of the screen by turning the VERT. CENT. control.

102. EMERGENCY REPAIRS.

There are very few emergency repairs that can be made on the control unit, but a few operational hints are worth mentioning for use when a spare unit is not available.

a. If the 10 K YD. sweep cannot be obtained, use the 75 K YD. sweep and estimate range.

b. If the video stage is defective, bypass it by connecting Cord CD-1105 between jacks 121-3 and 120, and turn up the SENSITIVITY control. If the video amplitude is insufficient, connect the two test Cords CD-1099 together to make a single long cord with a phone plug at each end; remove Cord CD-1105 from jack 120, and use the long cord to connect jack 120 with the RECEIVER OUTPUT HIGH jack on the front panel of the receiver-transmitter.

c. If the brightening circuits are defective, turn up the INTENSITY control.

103. REPLACEMENT OF RECEIVER-TYPE TUBES.

A defective tube is often the cause of faulty operation. If the symptoms indicate that a tube may be defective, replace the tube and adjust

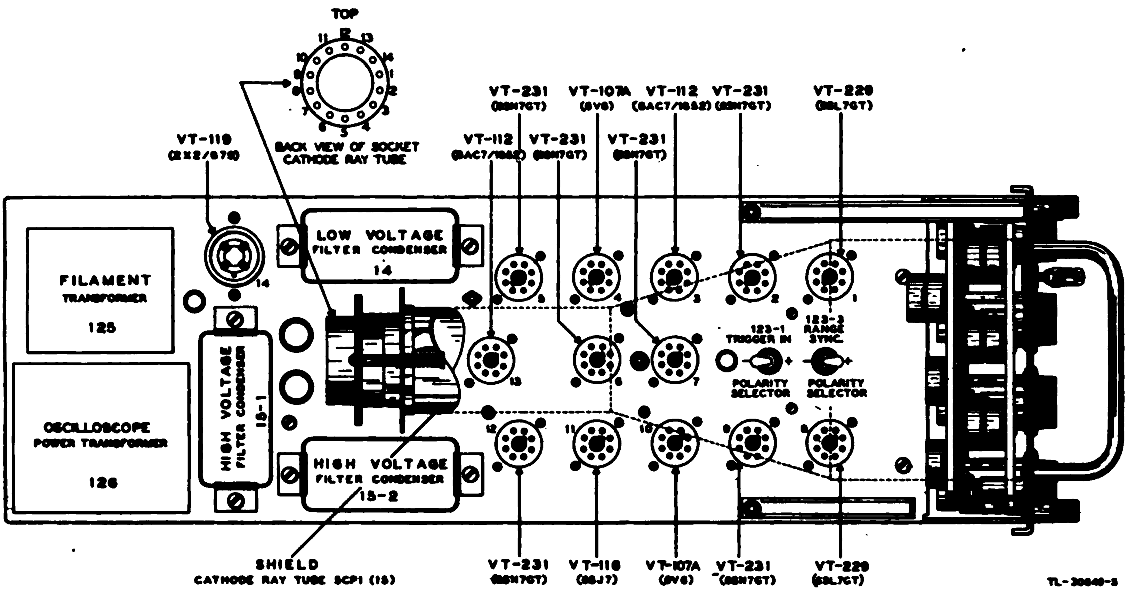

Figure 105. Control unit, top view showing location of parts and pin arrangement of cathode-ray tube socket.

only those controls directly associated with the circuit in which the replacement was made. If the fault is not cleared, return the controls to their original settings in order that additional complications are not introduced. All tubes used in the control unit are easily accessible when the unit is removed from its case. The usual procedure is followed when removing the tubes.

104. REMOVAL AND REPLACEMENT OF CATHODE-RAY TUBE.

CAUTION: Voltages of over 1,500 volts are used in the operation of the control unit cathode-ray tube. Do not attempt to remove or replace the cathode-ray tube without first disconnecting all cables from the control unit and removing the control unit from its case. Observe the high-voltage warning which appears at the beginning of this chapter.

CAUTION: If the cathode-ray tube is broken, the glass will shatter and the socket will be expelled with great force through the front of the tube. While handling the tube, wear heavy gloves, goggles, and an overcoat for protection.

a. To remove the cathode-ray tube, loosen the four captive screws which hold the escutcheon plate against the front panel and at the same time push the escutcheon against the panel. (Spring pressure on the cathode-ray tube tends to push the escutcheon forward.) When the captive screws have been completely disengaged from the panel (but not removed from the escutcheon), allow the escutcheon to come forward and remove it. The tube extends forward far enough to allow it to be pulled from its socket. If it is difficult to get sufficient hold on the rim of the tube, a rocking motion of the cathode-ray tube socket will help loosen it. When the tube has been disengaged from the socket, it should be carefully brought forward until the high-voltage clip lead attached to the side of the tube can be reached. Pull the rubber-covered clip off the terminal and remove the tube. Do this carefully to avoid unnecessary jarring of the tube.

b. To install a cathode-ray tube, first pull out the high-voltage clip lead until slack is taken up and insert the tube far enough to allow the connection to be made. Snap the metal clip over the pin in the center of the side terminal of the cathode-ray tube. Rotate the tube so that this connection is at the bottom (nearest the chassis) and push the tube back into the socket. Further rotation of the tube will allow the key on the large center pin of the tube to engage the keyway in the socket.

c. When a new cathode-ray tube is intalled, it will usually be necessary to align it so that the sweep is horizontal. With the escutcheon removed, loosen the four screws around the rim of the cathode-ray tube socket and thus allow the tube and socket to be rotated together. To make the adjustment, have the unit operating. Turn the sweep range switch to the 10 K YD. position and the STANDBY-OPERATE switch to the STANDBY position. Turn the SENSITIVITY control to its extreme counterclockwise position. Rotate the tube and socket to line up the pattern with the top and bottom of the panel.

CAUTION: While making these adjustments, be careful not to contact the high-voltage lead or connections at the tube socket.

Turn the unit off. Carefully avoid further rotation of the tube and tighten the four screws on the socket rim. Replace the escutcheon, making sure that the hole in the rim, which holds the light shield in place, is at the top. Push the escutcheon back to the panel and tighten the captive screws.

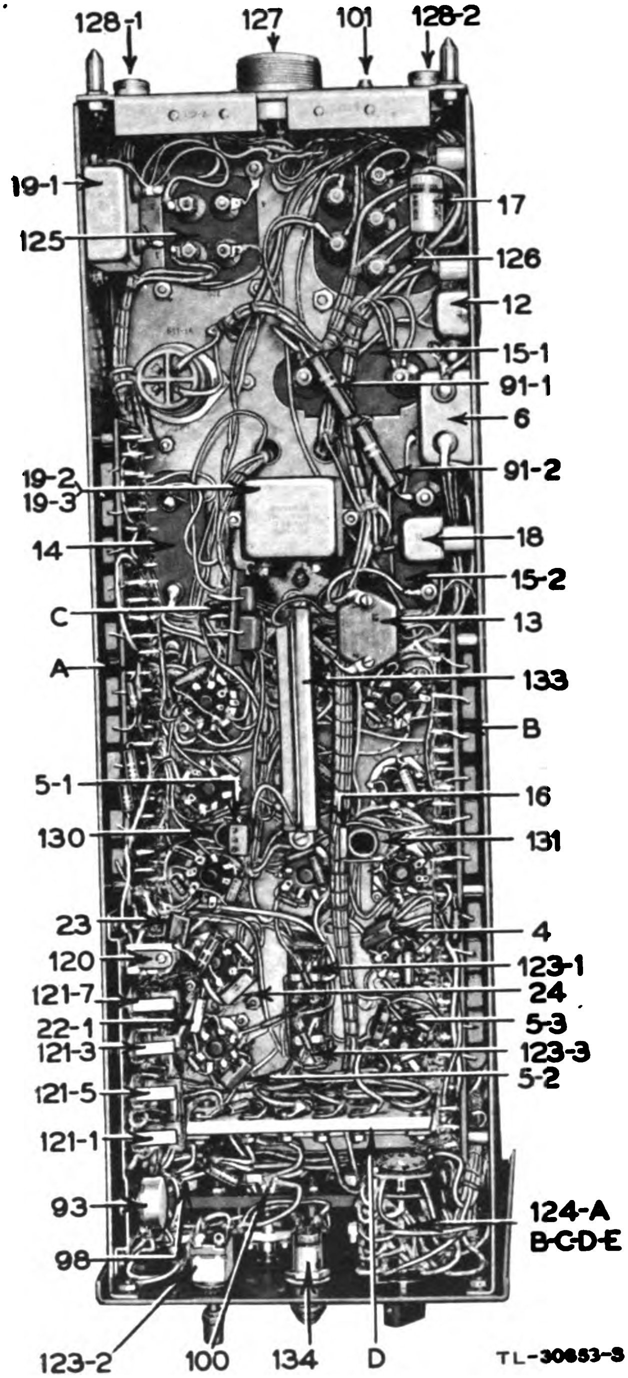

Figure 106. Control unit, bottom view showing location of parts

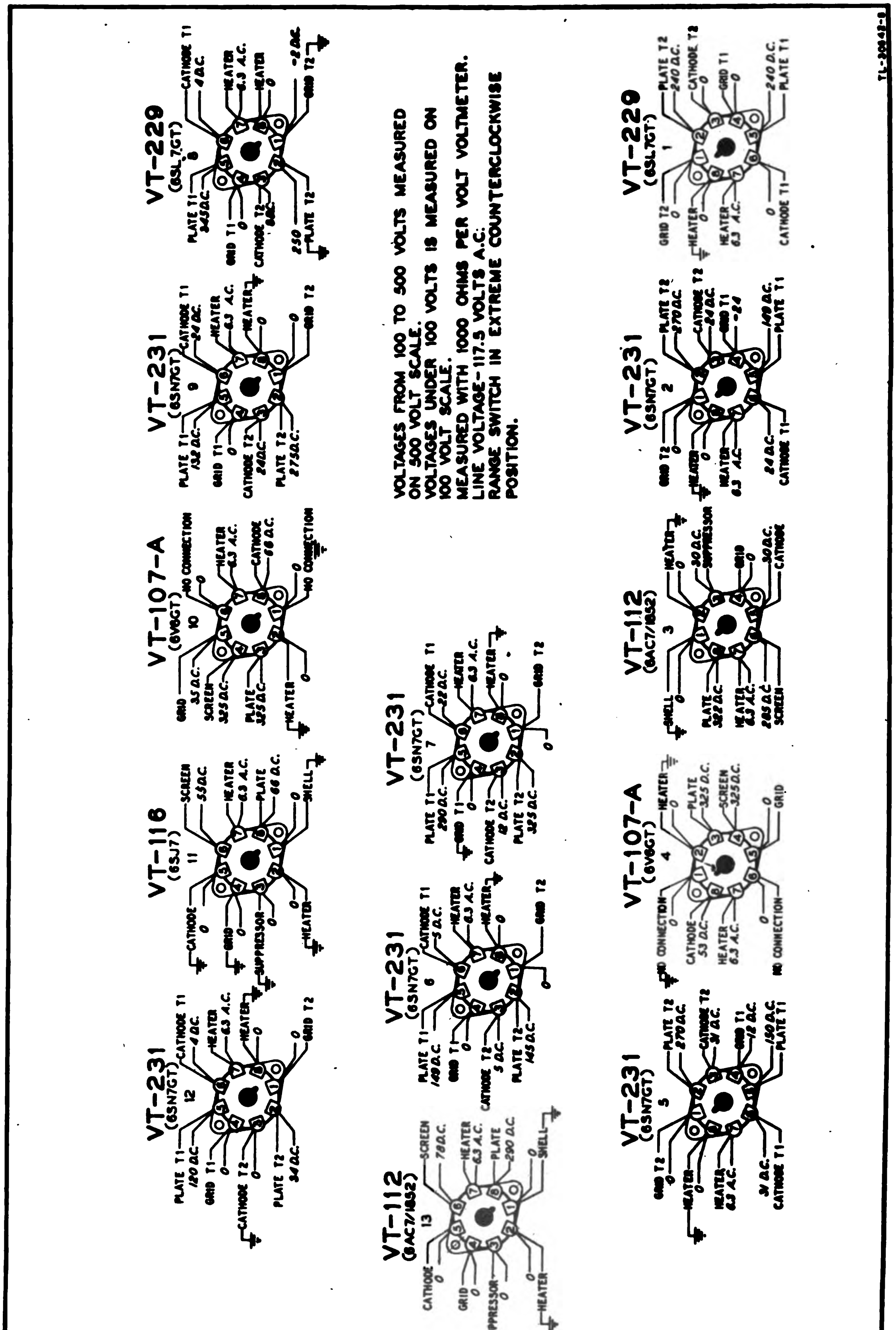

Figure 107. Control unit, socket voltage chart.

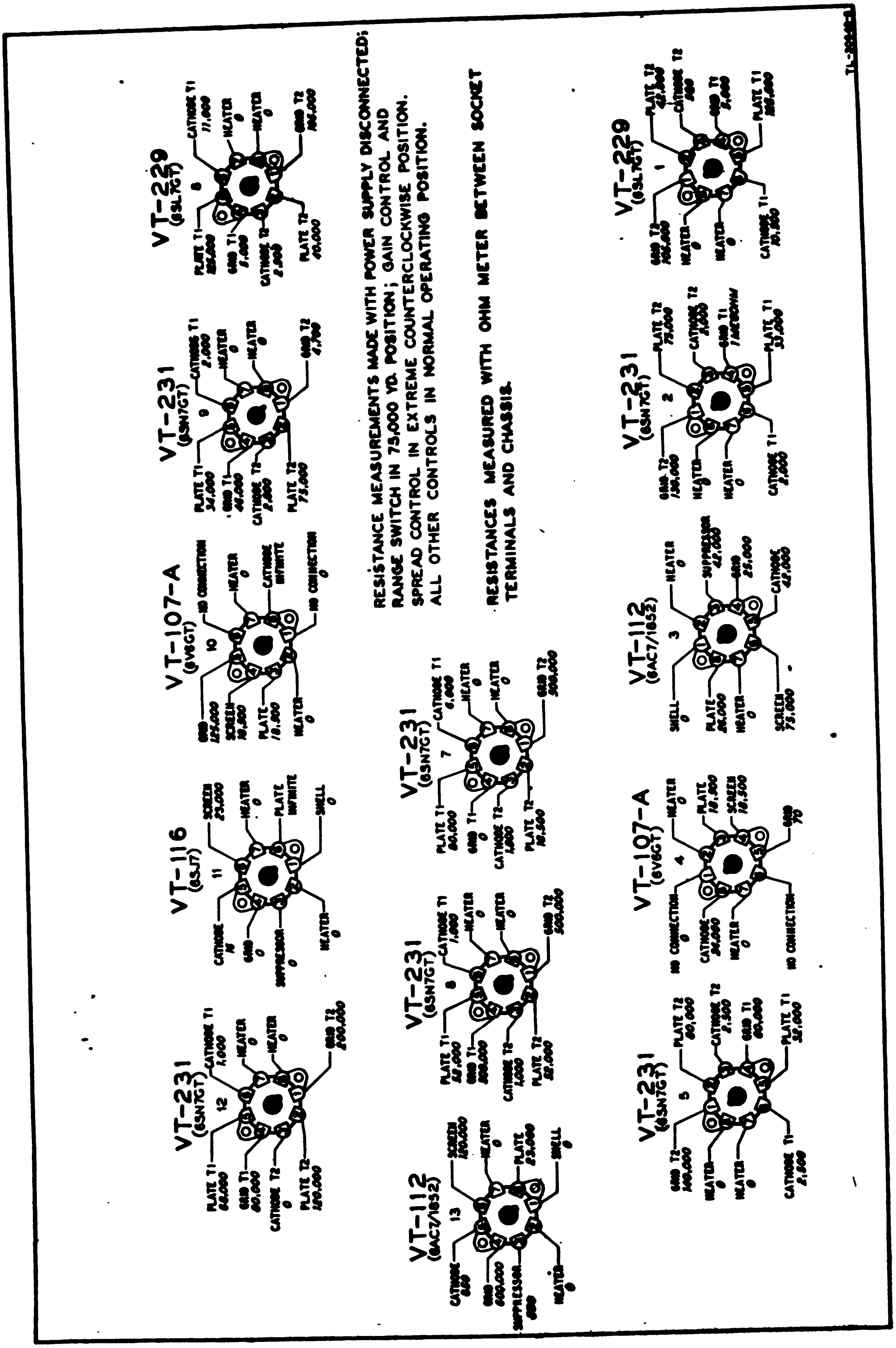

Figure 108. Control unit, socket resistance chart.

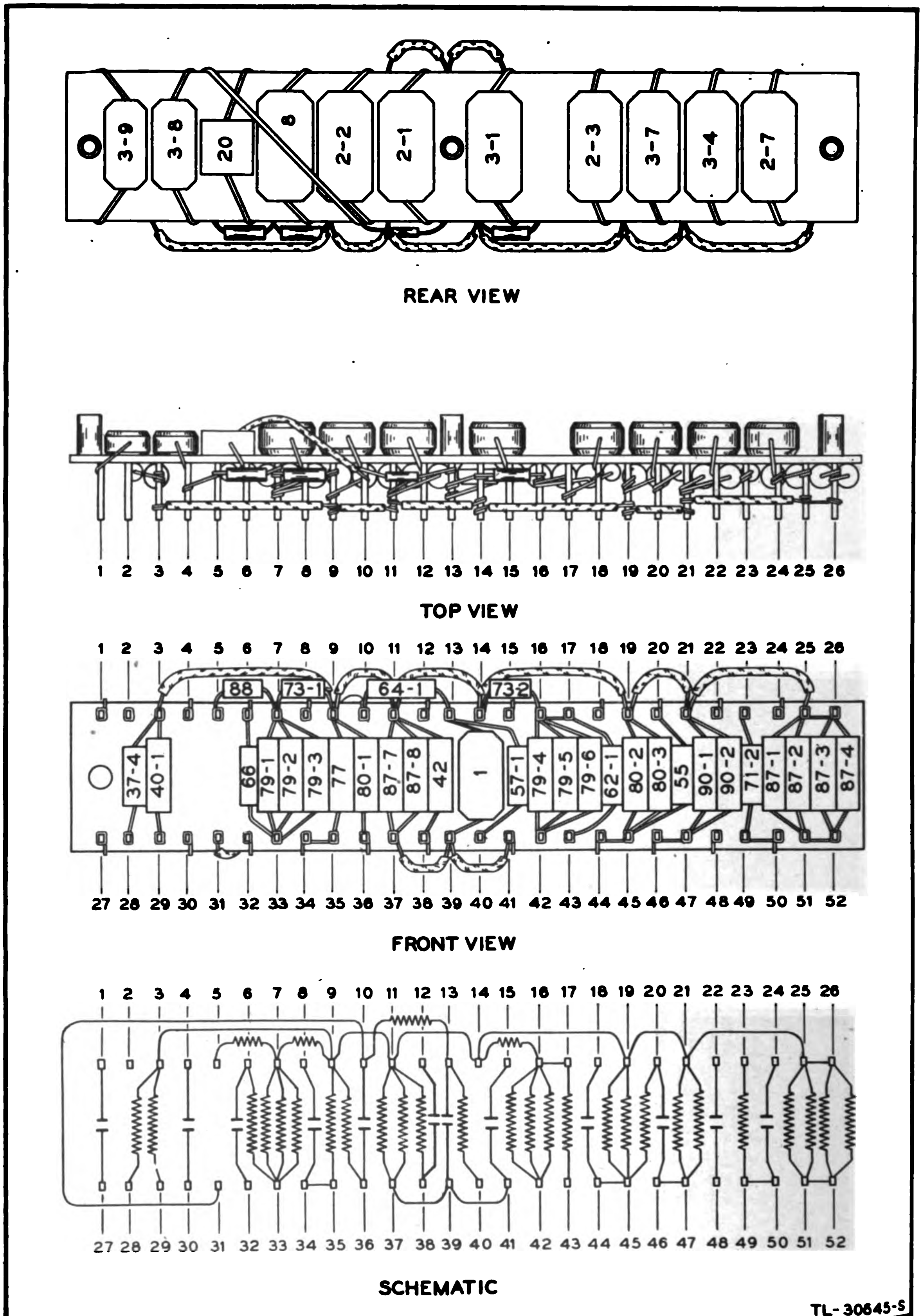

Figure 109. Control unit, terminal board A (detail A of figure 106).

Voltage and Resistance Readings at Terminal Board A (figs. 106, 109)

Terminal	*Volts*	*Ohms (K = 1,000)*	*Terminal*	*Volts*	*Ohms (K = 1,000)*
1	0	Inf.	27	0	110K
2	N.C.	N.C.	28	240	125K
3	325	18.5K	29	242	41K
4	8	2.8K	30	0	Inf.
5	272	75K	31	0	0
6	110	200K	32	0	130K
7	302	20K	33	150	32K
8	0	700	34	325	25K
9	325	18.5K	35	325	25K
10	0	0	36	270	90K
11	325	18.5K	37	53	24K
12	0	0	38	30	41K
13	0	130K	39	53	24K
14	325	18.5K	40	0	140K
15	0	230	41	53	24K
16	302	20K	42	150	32K
17	302	20K	43	272	80K
18	0	500K	44	150	51K
19	325	18.5K	45	150	51K
20	140	85K	46	290	75K
21	325	18.5K	47	290	75K
22	0	Inf.	48	120	51K
23	8	500K	49	0	3 meg
24	290	22K	50	0	3 meg
25	325	18.5K	51	22	4K
26	325	18.5K	52	22	4K

Test Conditions

General:

1. Both rack units in rack and rack connected to control unit.
2. STANDBY-OPERATE switch at STANDBY.
3. Range switch at 75 K YD.
4. SENSITIVITY knob in extreme counterclockwise position. All other controls in normal position.

Voltage Measurements:

1. Equipment operating and receiving synchronizing pulses from the radar set.
2. Line voltage of 117.5 volts, 60 cycles.
3. Measurements made between terminals indicated and chassis.
4. Voltage measurements made with a meter having a resistance of 1,000 ohms per volt.
5. Voltages measured as follows:
   0 — 100 volts on 100-volt scale.
   100 — 500 volts on 500-volt scale.

Resistance Measurements:

1. Measurements made between points indicated and chassis.
2. Resistance measurements made with power turned off.

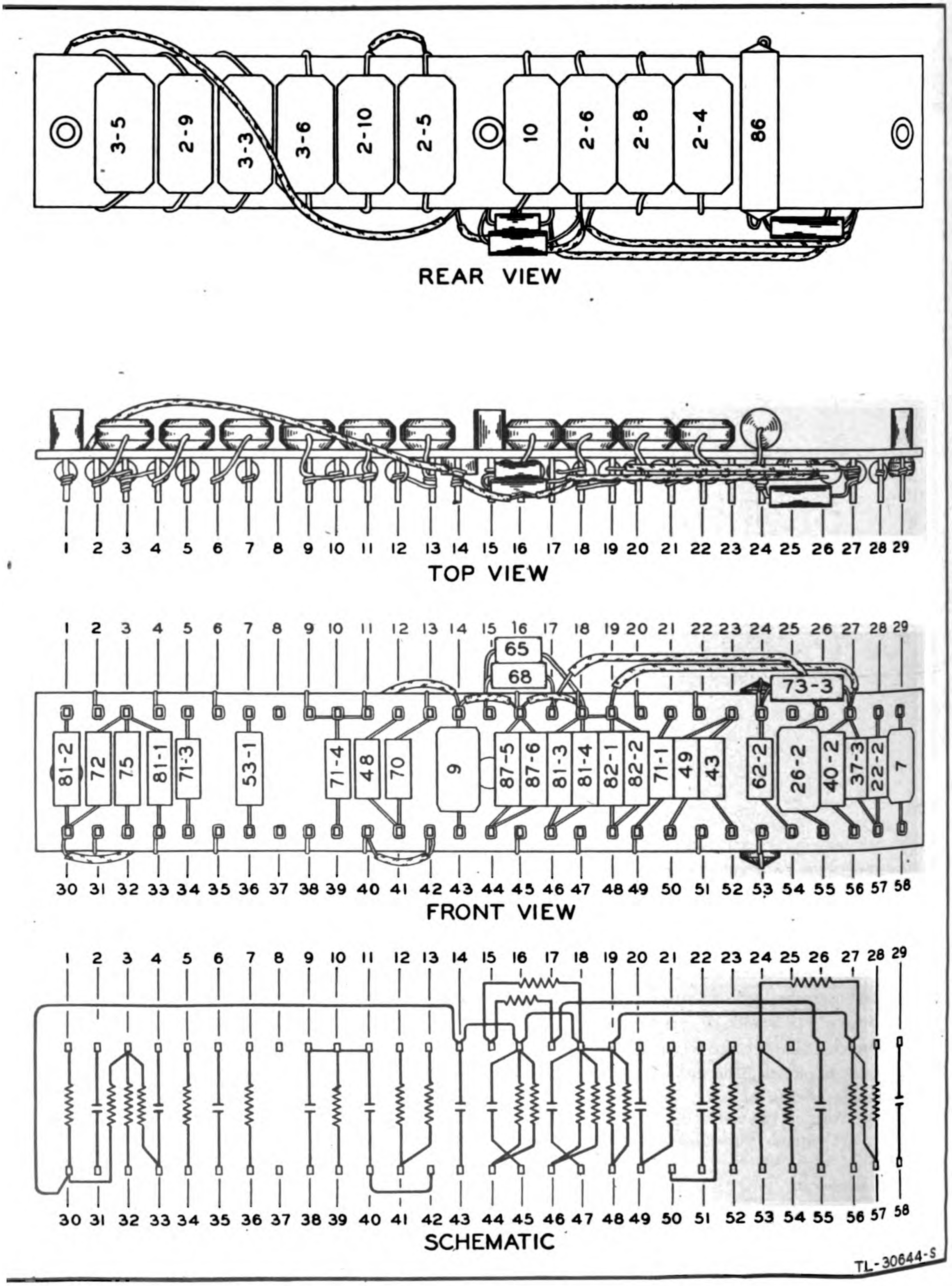

Figure 110. Control unit, terminal board B (detail B of figure 106).

Voltage and Resistance Readings at Terminal Board B (figs. 106, 110)

Terminal	*Volts*	*Ohms (K = 1,000)*	*Terminal*	*Volts*	*Ohms (K = 1,000)*
1	35	120K	30	325	18.5K
2	0	1.5K	31	0	600K
3	320	20K	32	290	22K
4	0	0	33	78	120K
5	−5	500K	34	0	3 meg
6	25	2K	35	0	500K
7	0	0	36	5	1K
8	N.C.	N.C.	37	0	Inf.
9	3	2.5 meg	38	0	Inf.
10	3	2.5 meg	39	14	500K
11	3	2.5 meg	40	66	Inf.
12	0	11	41	0	80K
13	0	1 meg	42	66	Inf.
14	325	18.5K	43	0	Inf.
15	135	100K	44	18	6K
16	325	18.5K	45	66	Inf.
17	0	0	46	120	70K
18	325	18.5K	47	0	Inf.
19	325	15.5K	48	12	23K
20	0	0	49	0	3 meg
21	0	600K	50	9	50K
22	0	200K	51	130	34K
23	10	46K	52	22	5K
24	302	21K	53	130	34K
25	N.C.	N.C.	54	275	75K
26	0	0	55	3	5K
27	325	18.5K	56	250	40K
28	0	Inf.	57	245	125K
29	10	46K	58	−24	1 meg

Test Conditions

Same as for terminal board A.

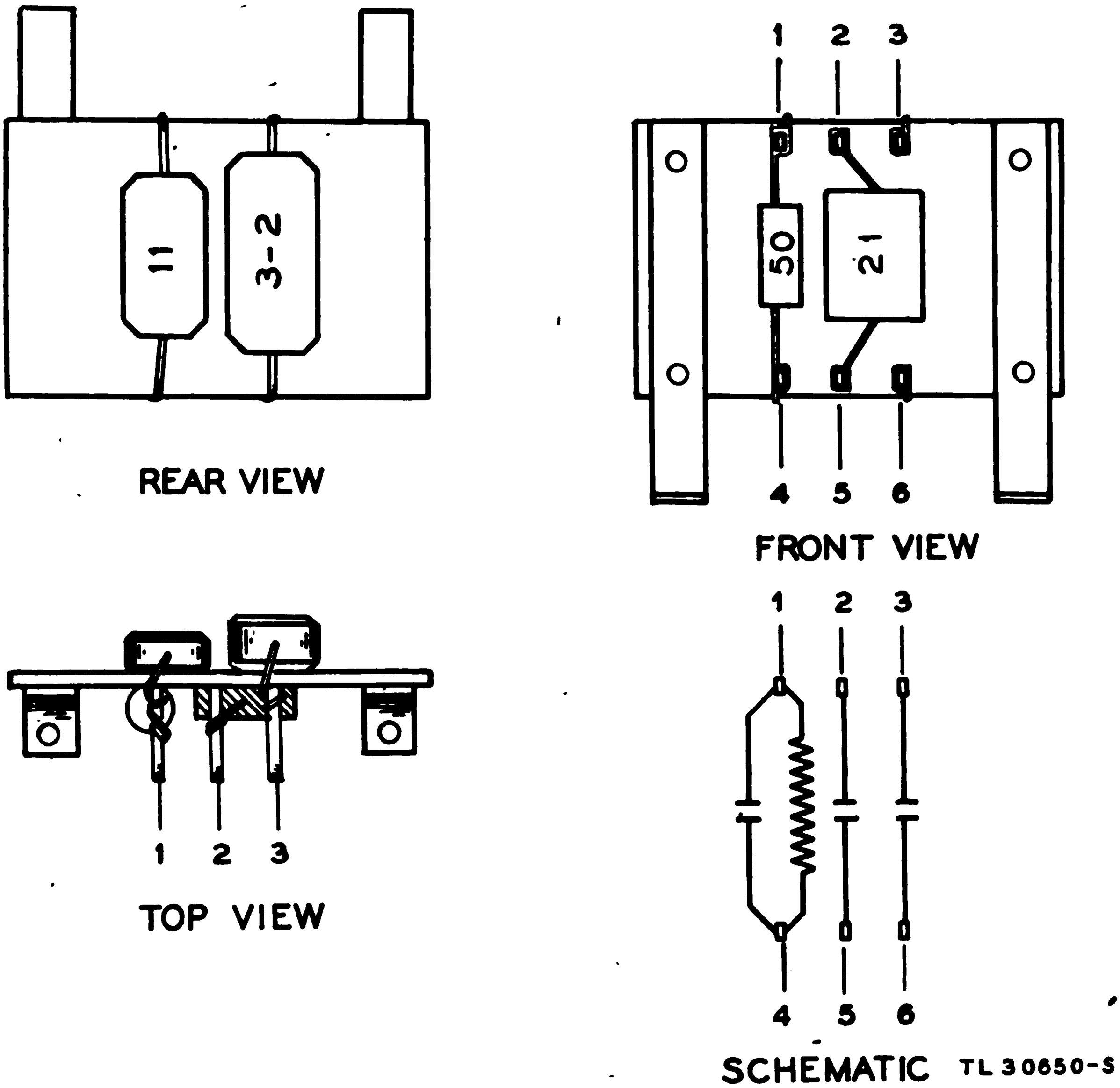

Figure 111. Control unit, terminal board C (detail C of figure 106)

Voltage and Resistance Readings at Terminal Board C (figs. 106, 111)

Terminal	*Volts*	*Ohms (K = 1,000)*	*Terminal*	*Volts*	*Ohms (K = 1,000)*
1	0	82	4	0	0
2	272	82K	5	12	175K
3	0	470K	6	31	2.2K

Test Conditions

Same as for terminal board A.

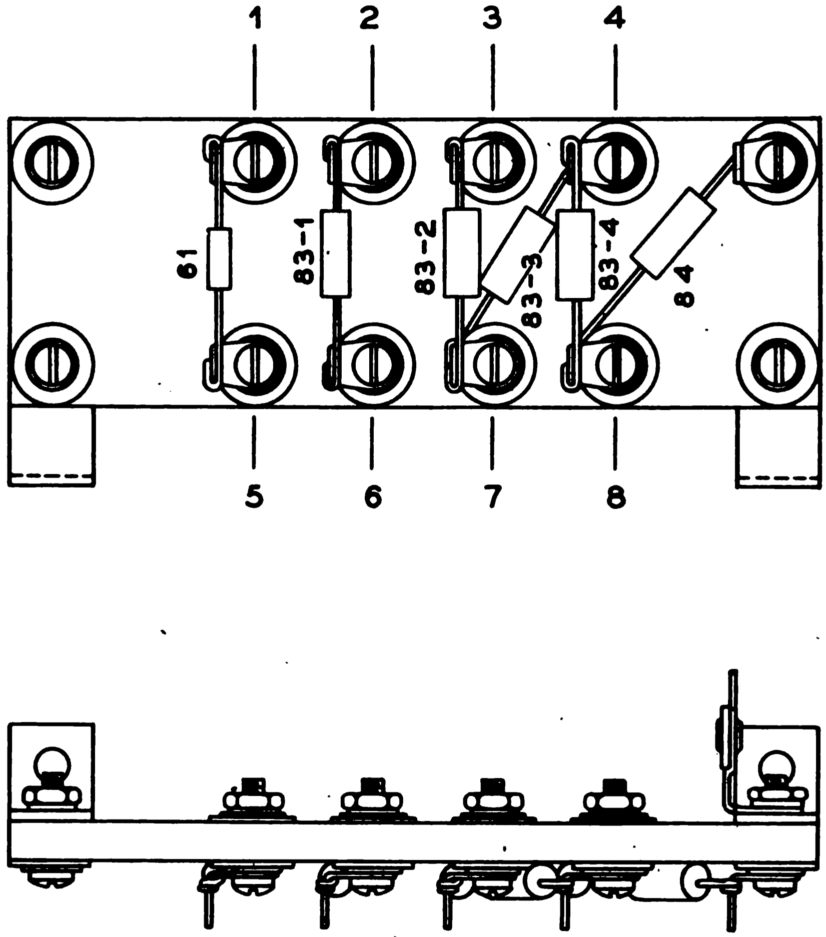

Figure 112. Control unit, high voltage terminal board (detail D of figure 106).

Voltage and Resistance Readings at High-Voltage Terminal Board D (figs. 106, 112)

Terminal	*Volts*	*Ohms (K = 1,000)*	*Terminal*	*Volts*	*Ohms (K = 1,000)*
1	−770	3.5 meg	5	−910	2 meg
2	−710	1.5 meg	6	−890	2 meg
3	−570	1.2 meg	7	−430	900K
4	−280	560K	8	−90	240K

Test Conditions

Same as for terminal board A except that voltmeter is set to 1,000-volt scale for all readings.

WIRING DIAGRAM
OF CONTROL UNIT BC-1378

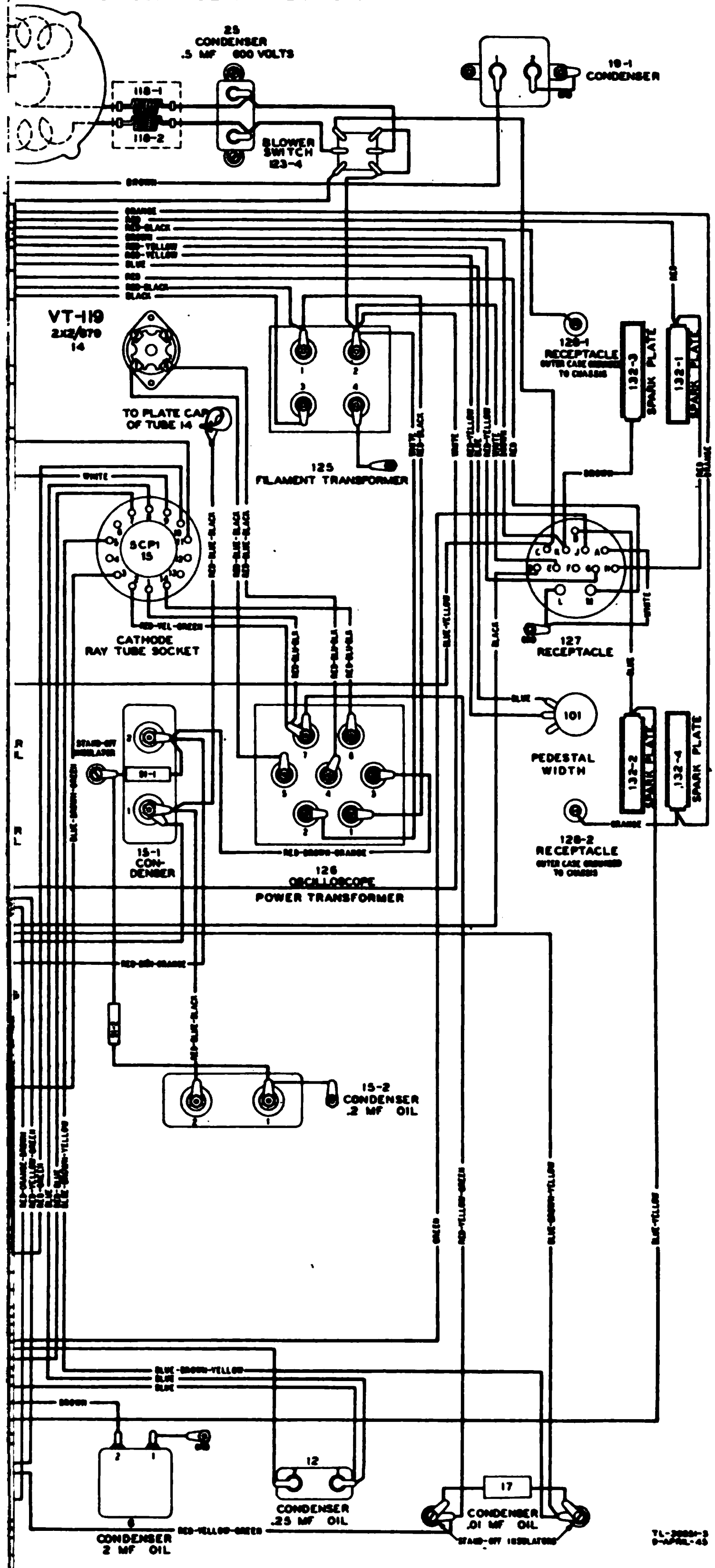

Figure 113. Control unit wiring diagram.

CHAPTER 13

POWER SUPPLY RA-105-A

WARNING: Voltages sufficient to cause death on contact are exposed at many points in this component. Do not place hands or arms within component with the high voltage on. Always ground high-voltage capacitors before touching them or their associated circuits. Do not depend on bleeders.

105. REFERENCE DATA.

In addition to the illustrations in this chapter, the illustrations listed below will be of assistance to maintenance personnel in trouble shooting in the power supply.

Fig. No.	*Subject*
15	Schematic diagram of transmitter section of Radio Receiver and Transmitter BC-1267-A.
32	Schematic diagram of receiver section of Radio Receiver and Transmitter BC-1267-A.
57	Schematic diagram of control Unit BC-1378.
59	Schematic diagram of primary circuits of Power Supply RA-105-A.
60	Schematic diagram of Power Supply RA-105-A.
61	Complete block diagram of Radio Equipment RC-384.
125	Rack wiring diagram.

106. PRIMARY CIRCUITS OF POWER SUPPLY.

Figure 59, primary circuits of the power supply, will be of considerable assistance in locating faults.

a. Interlocks.

(*1*) Interlock 9, the rack rear panel interlock, is in series with the input line of the equipment. If the interlock is open, no a-c power is supplied to any part of the equipment except the convenience outlets on the front of the rack.

(*2*) Interlock 40, at the rear of the power supply chassis, is in series with the primary of modulator plate voltage transformer 58. If the interlock is open, no transmitter pulse will be obtained.

(*3*) Connector 180, in the rear of the receiver transmitter chassis, has two pins, 23 and 24, connected together. These pins are in series with interlock 40 and primary transformer 58. Consequently, the modulator plate voltage supply will be inoperative unless the receiver-transmitter chassis is in the rack.

b. Circuit Breakers.

(*1*) The FILAMENT VOLTAGE circuit breaker, which is in series with the a-c input of the power supply, will remove all power from the power supply when it opens.

(*2*) The PLATE VOLTAGE circuit breaker is opened by an overload on modulator plate voltage transformer 58. The contacts of the breaker are in series with the primaries of plate voltage transformers 58 and 59. Consequently, when the circuit breaker opens, it removes all plate voltages, except those of the cathode-ray tube and the high-voltage rectifier in the control unit.

NOTE: Control Unit BC-1378 contains a separate power supply which supplies operating voltages to the cathode-ray tube and filament voltages to all tubes in the control unit.

c. Fuses and Pilot Lights. Each of the four transformers in the power supply have a pilot light across their primaries and a fuse in series with their primaries. The panel designation for the pilot light and fuse for each transformer have the same designation; T-A for filament voltage transformer 56, T-B for high-voltage filament transformer 57, T-C for low-voltage plate transformer 59, and T-D for high-voltage plate transformer 58.

107. LOCATING FAULTS IN RECTIFIERS.

a. There are seven different rectifier circuits in Power Supply RA-105-A. A failure in any one circuit gives symptoms different from those of a fault in any other circuit. The symptoms resulting from failures of the various rectifier circuits are given below.

Rectifier stage	*Function*	*Symptom of failure*
Tube 1	−150-volt bias to grid of modulator tube in transmitter.	Modulator tube 17 in transmitter will conduct continuously causing tube to burn out or PLATE VOLTAGE circuit breaker to open.
Tube 2	300-volt supply to control unit.	Control unit inoperative except for cathode-ray tube. No sweep or spot appears on screen.
Tube 3	400-volt supply to blocking oscillator in transmitter and to power measurement circuit.	No transmitter pulse with TEST METER SWITCH in P.O. position and POWER MEASUREMENT control completely clockwise; no reading on test meter.
Tube 4	300-volt supply to receiver-transmitter.	No grass on display scope; tuning eye remains dark.
Tube 5	600-volt supply to screen grid of modulator tube.	Power output of transmitter cannot be varied by POWER OUTPUT control.
Tube 6	2,300-volt supply to plate of modulator tube in transmitter.	Ic reading of test meter is zero in both positions of challenge switch.
Tube 7	−2,000 volts.	Not used in Radio Equipment RC-384.

b. When a fault has been isolated to one rectifier, check the resistance to ground at the plate and cathode of the tube (fig. 116). Check the tube by replacement and if fault is not cleared up, check the filament voltage for the tube.

(*1*) To supply a-c power to the power supply after it has been removed from the rack, connect one end of Cord CD-1141 to the power supply and plug the other end of the cord into the a-c outlet on the front of the rack.

(*2*) Figure 117 gives the tube socket voltages, and table VII gives the open-circuit voltages at the pins of the Lapp connector.

CAUTION: When making high-voltage measurements, exercise all the safety precautions outlined in paragraph 54.

TABLE VII

POWER SUPPLY RA-105-A, OPEN CIRCUIT VOLTAGES*

Conditions

1. Power supply chassis removed from rack. Power supplied to chassis with Cord CD-1141.
2. Pins 1 and 7 on rear of chassis connected together (par. 106a (*3*), fig. 59).
3. Chassis interlock switch 40 held closed while taking high-voltage measurements.
4. D-C voltages taken with 1,000-ohm-per-volt meter.
5. A-C measurements made with PLATE VOLTAGE circuit breaker OFF.

Pin connections	*D-C voltage*	*A-C voltage*	*Pin connections*	*D-C voltage*	*A-C voltage*
11 to ground	850		2 to ground	−178	
15 to ground	−2,350		4 to ground	438	
15 to 14		6.85	6 to ground	502	
17 to 23		117.5	3 to ground	505	
9 to 21		6.7	5 to ground	620	
20 to ground		6.7			

*Voltages taken at pins of Lapp connector on rear of power supply chassis.

108. POWER SUPPLY RA-105-A TROUBLE-SHOOTING CHART.

A. SYMPTOM:
Filament circuit breaker opens.

Probable Location of Fault	Procedure
1. Short or overload in transformer 57 or associated circuits.	1*a*. Remove fuse T-B. If fault does not clear, see 2 below.
	b. If fault cleared, replace fuse; remove tubes 6 and 7. If fault does not clear, check transformer 57 for shorts. If fault clears, replace tubes one at a time to locate faulty tube.
2. Short or overload in transformer 56 or associated circuits.	2*a*. Remove fuse T-A. If fault clears, see *b* below. If fault does not clear, check wiring between circuit breaker, transformer 56, and 57, and pin 23 of connector 30 for shorts.
	b. Remove the receiver-transmitter from the rack. If fault clears, it is in the receiver-transmitter (see 4 below).
	c. If fault did not clear in *b* above, check each winding of transformer 56 for shorts to ground. Note that terminal 5 is connected to ground.
	d. Remove all power supply tubes except 6 and 7; replace tubes one at a time, with the power on, until the defective tube is located.
3. Short in rack wiring.	3. Check pins 14 and 15 of connector 7 and pins 19 and 20 of connector 8 for shorts to ground.
4. Fault in receiver-transmitter filament circuits (fault disappears when receiver-transmitter chassis is removed from rack).	4*a*. Check pin 14 of connector 180 for a short to ground. This resistance is normally 0.25 ohms.
	b. As a last resort, remove all tubes in the receiver-transmitter. Check resistance as in *a* above. Resistance to ground should be infinite. If it is not, make a visual inspection of wiring to locate the short. Check spark plates 27-1 and 27-2, terminal board 183, and pin 3 of connectors 181 and 182 for shorts to ground.
	c. If removing tubes cleared fault, replace tubes one at a time until the defective tube is located.

B. SYMPTOMS:
1. Plate voltage circuit breaker opens and will not remain closed. 2. Pilot lights T-A and T-B remain lighted.

Probable Location of Fault	Procedure
1. Overload in receiver-transmitter on 2,300-volt power supply (tube 6 and transformer 58).	1*a*. Check modulator cathode current. If it is high, check the bias voltage (95 to 135 volts) on pins 2 and 6 of modulator tube 17. If bias is low, check bias power supply (tube 1).

	b. If modulator current is normal, check modulator tube 17 by replacement. Check resistance to ground of pin 11 of connector 180 on the receiver-transmitter; resistance should not be less than 2 megohms.
2. Short in power supply or rack wiring.	2*a.* Remove tube 6. If fault persists, it is not in the 2,300-volt d-c circuit. Remove tube 7. If fault persists, it is in secondary of transformer 58 or between terminals 6 and 5 of transformer 57.
	b. If fault cleared when tube 6 was removed, check tube 6 socket pins 1 and 4 for a short to ground. Check pin 11 of connector 30 and pin 11 of connector 8 for a short to ground.
	c. If fault cleared when tube 7 was removed, check pin 15 of connector 30 and pin 15 of conector 8 for a short to ground.

C. SYMPTOMS:

1. Pilot light T-A does not light.
2. Fuse T-A blown.

Probable Location of Fault	**Procedure**
1. Short or overload in circuits supplied by transformer 56.	1. See symptom A procedures 2*b*, *c*, and *d*.
2. Primary circuit of transformer 56.	2. Check primary of transformer 56 and pilot light T-A for shorts.

D. SYMPTOMS:

1. Pilot light T-B does not light.
2. Fuse T-B blown.

Probable Location of Fault	**Procedure**
1. Short or overload in circuits supplied by transformer 57.	1. See symptom A procedure 2*b*.
2. Primary circuit of transformer 57.	2. Check primary of transformer 57 and pilot light T-B for shorts.

E. SYMPTOMS:

1. Pilot light T-C does not light.
2. Fuse T-C blown.

Probable Location of Fault	Procedure
1. Overload or short in Power Supply RA-105-A or rack wiring.	1*a*. Remove receiver-transmitter from rack; put in new fuse. If fuse does not blow, see 2 below.
	b. Remove input cable from connector 127 on control unit. Put in new fuse. If fuse does not blow, see 3 below.
	c. Check resistance to ground at plate and filament pins of tubes 1, 2, 3, 4, and 5 in the power supply.
	d. Check primary of transformer 56 for a short.
	e. With power supply and receiver-transmitter removed, check pins 2, 3, 4, 5, and 6 of connector 8 for shorts to ground.
2. Overload or short in receiver-transmitter plate circuits.	2*a*. Check resistance (45K) from pin 7 of connector 180 to ground.
	b. Check resistance (infinite) from pin 8 of connector 180 to ground.
	c. Check resistance (1 megohm) from pin 9 of connector 180 to ground.
	d. If fault cleared in 1*a* above but was not located in 2*a*, *b*, or *c*, it must be a gassy or shorted tube. Remove all tubes except diode 14, r-f oscillators 20 and 21, and modulator tube 17. Put in new fuse. Replace tubes one at a time until defective tube is found.
3. Control unit.	3*a*. Check resistance from pin 4 of connector 127 to ground.
	b. If fault cleared in 1*b* above but was not located in 3*a*, it must be a shorted or gassy tube. Remove all tubes except the cathode-ray tube and rectifier tube 14. Put in new fuse. Replace tubes one at a time until the defective tube is located.

F. SYMPTOMS:

1. Pilot light T-D does not light.
2. Fuse T-D blown.

Probable Location of Fault	Procedure
1. Overload or short in circuits supplied by transformer 58.	1. See symptom B procedure 1.

G. SYMPTOMS:

1. Pilot light T-D does not light.
2. Fuse T-D not blown.
3. No transmitter pulse, no modulator cathode current.

Probable Location of Fault	**Procedure**
1. Interlock circuit in receiver-transmitter open.	1*a*. Push receiver-transmitter in firmly. *b*. Pull out power supply; check continuity between pins 1 and 7 of connector 8.
2. Interlock 40 on rear of power supply chassis open.	2*a*. Inspect the interlock to see that it closes properly *b*. Check the continuity of the interlock.

H. SYMPTOMS:

1. One pilot light does not light.
2. Equipment operates normally.

Probable Location of Fault	**Procedure**
1. Pilot light burned out.	1. Replace the light.
2. Open circuit at light socket.	2. Check the voltage at the socket.

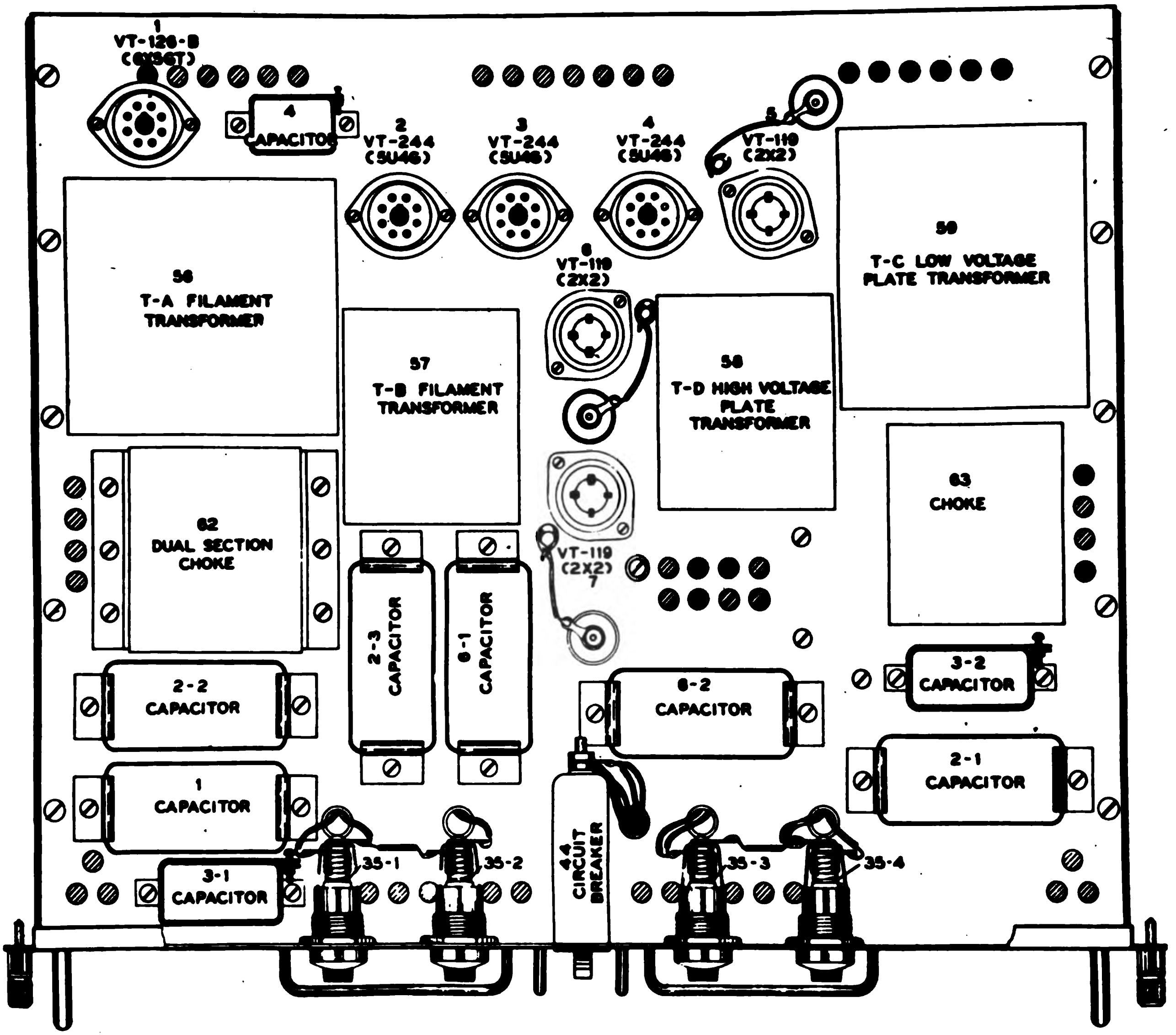

Figure 114. Power Supply RA-105-A, top view showing location of parts.

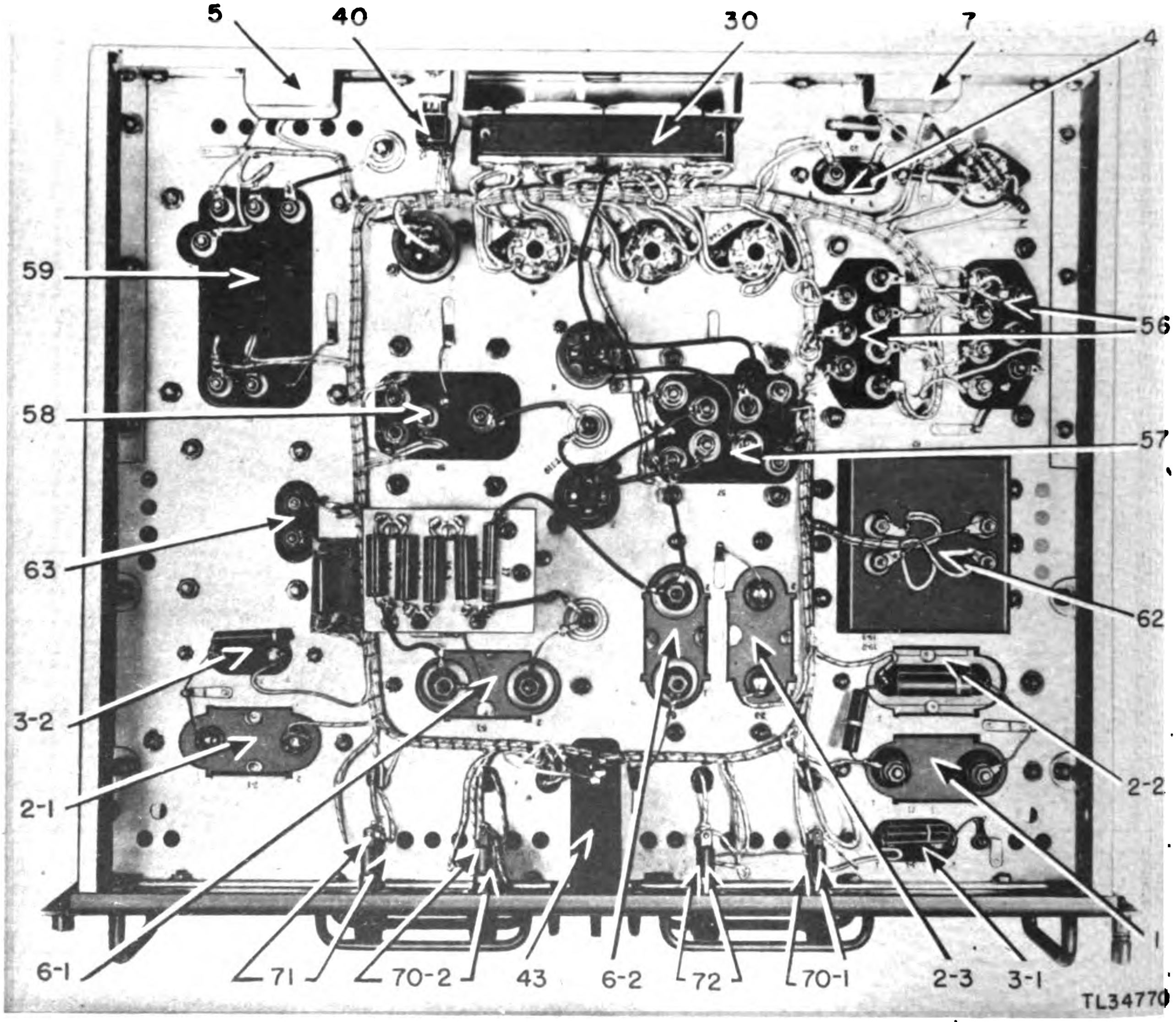

Figure 115. Power Supply RA-105-A, bottom view showing location of parts.

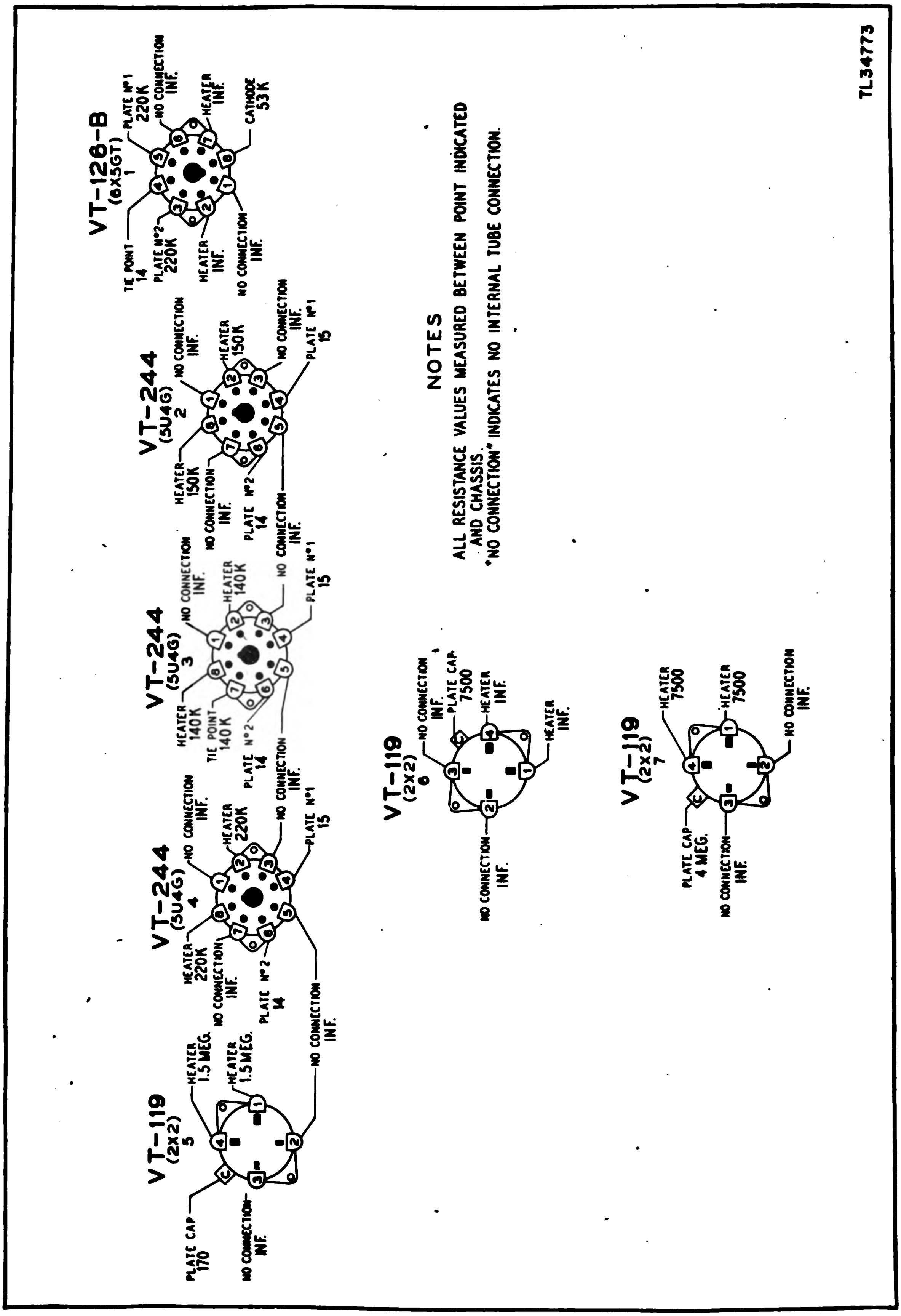

Figure 116. Power Supply RA-105-A, resistance chart.

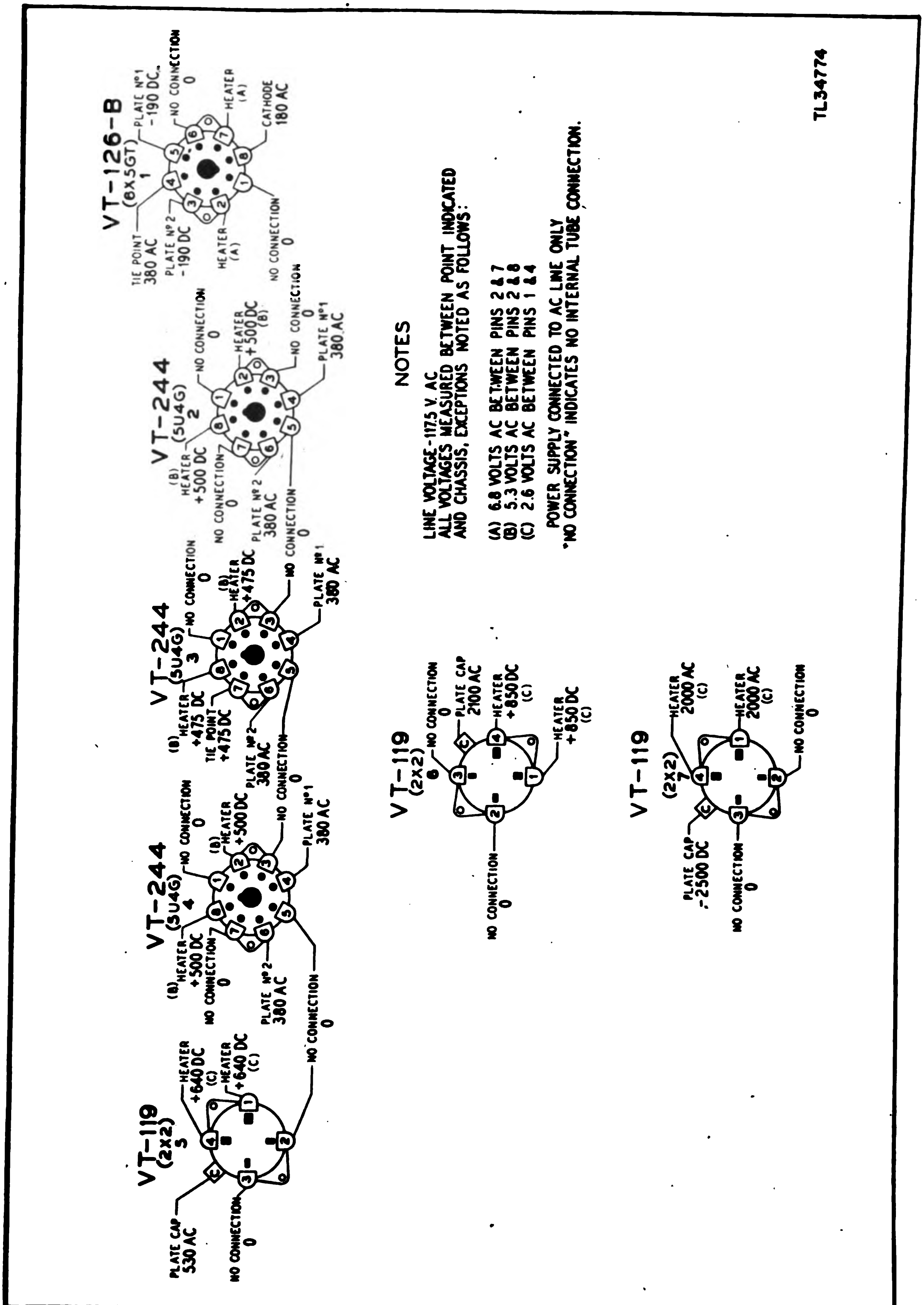

Figure 117. Power Supply RA-105-A, voltage chart.

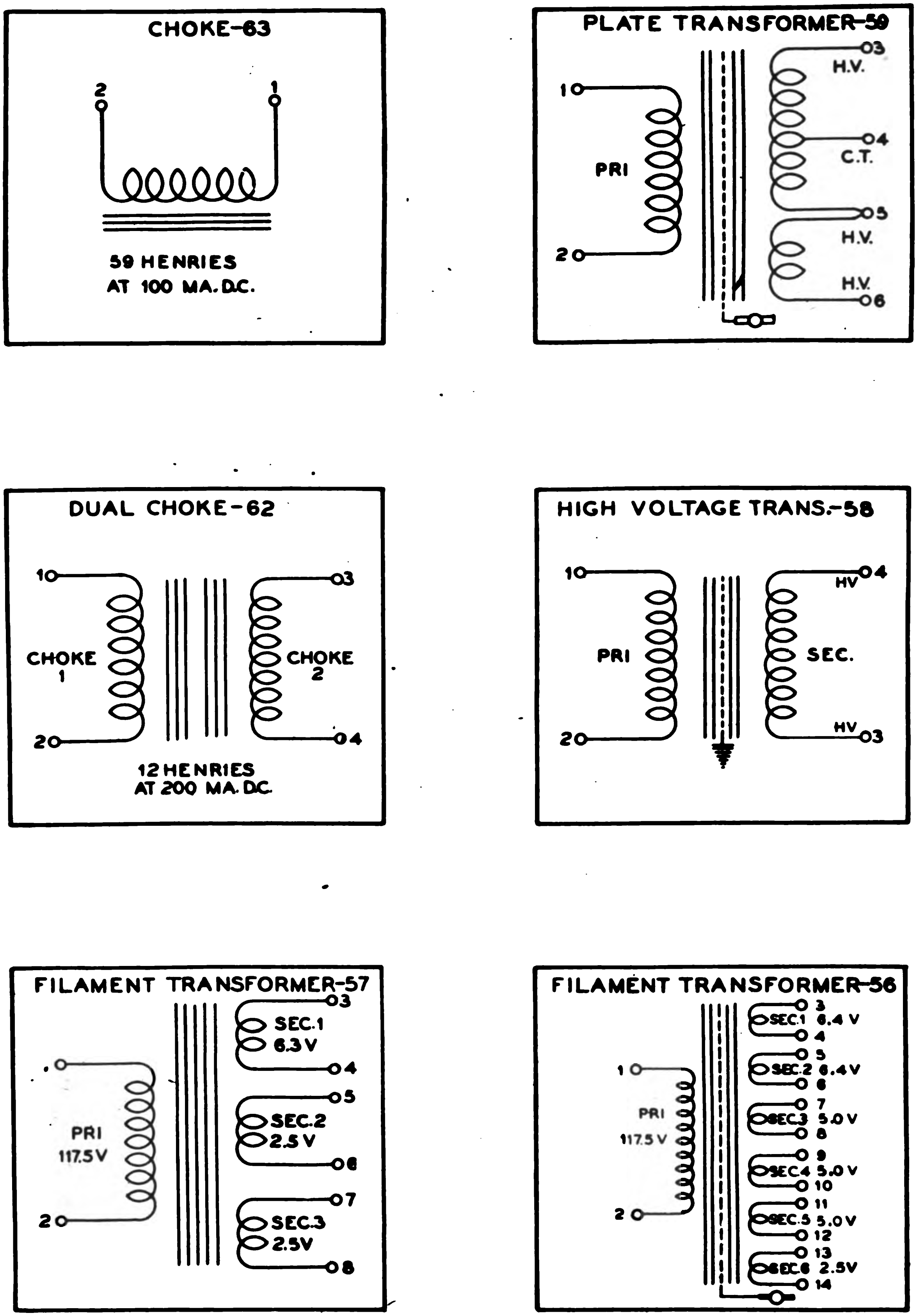

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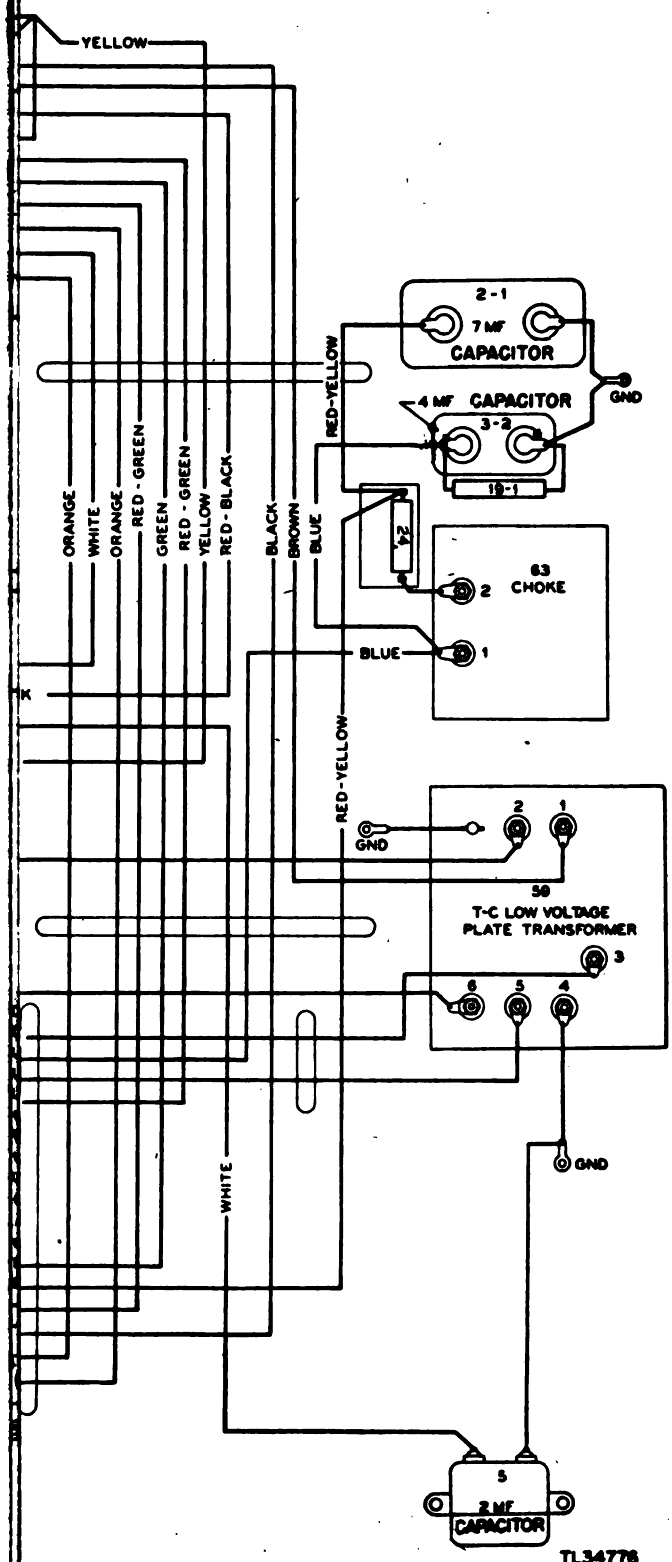
Figure 118. Power Supply RA-105-A, transformer schematic diagrams.



ly RA-105-A, wiring diagram.

CHAPTER 14
RACK FM-93

WARNING: When the rear panel of Rack FM-93 is removed, potentials in excess of 2,000 volts are exposed. Make sure that the panel interlock switch is opened. Discharge high-voltage capacitors in the various units with an insulated screwdriver. Do not depend on bleeders.

109. REFERENCE DATA.

a. The following schematics will be found useful in trouble shooting Rack FM-93.

Figure No.	*Title*
15	Radio Receiver and Transmitter BC-1267-A, schematic diagram, transmitter section.
32	Radio Receiver and Transmitter BC-1267-A, schematic diagram, receiver section.
59	Power Supply RA-105-A, primary and interlock circuits.
60	Power Supply RA-105-A, schematic diagram.
57	Control Unit BC-1378, complete schematic diagram.

110. GENERAL.

Field maintenance of the rack requires only an occasional replacement of pilot lamps and a check of the wiring. The troubles encountered within the rack are treated generally in the following paragraphs.

a. If power is supplied to the convenience outlet but no power is supplied to the blowers or heaters, check the interlock switch in the wiring channel for mechanical operation and improper connections.

b. If the pilot lamps do not light, check the blowers for improper operation by feeling for air flow through the ventilator panel at the bottom of the rack. If the blowers are normal, the pilot lamp is probably defective.

c. If power is not supplied to the components in the rack, check the units for insecure mounting and the rack wiring for improper connections.

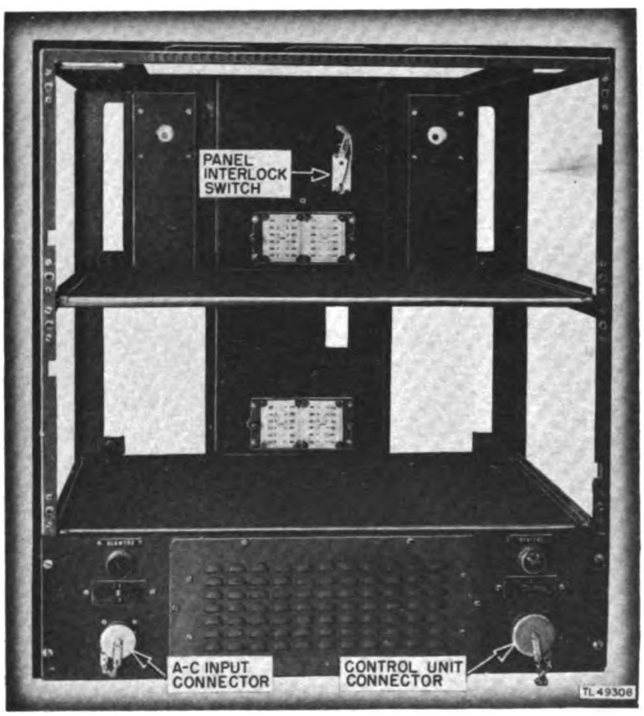


Figure 120. Rack FM-93, front view.

111. DISASSEMBLY OF RACK FM-93.

If trouble has been localized to the rack wiring, it will be necessary to remove the rack framework from its waterproof outer case. The procedure for this operation is covered step by step in the following subparagraphs.

a. Remove Radio Receiver and Transmitter BC-1267-A and Power Supply RA-105-A from the rack.

CAUTION: Two men are needed to remove Power Supply RA-105-A from the rack. It weighs 120 pounds.

b. Remove the panel in the front bottom of the rack.

c. Unbolt the four shockmounts at the bottom and the two shockmounts at the top back of the framework from the outer case.

d. Remove the framework from the outer case.

e. Remove the screws mounting the cover plate on the wiring channel on the rear of the rack framework.

f. The rack wiring is now exposed, and repair work can be accomplished.

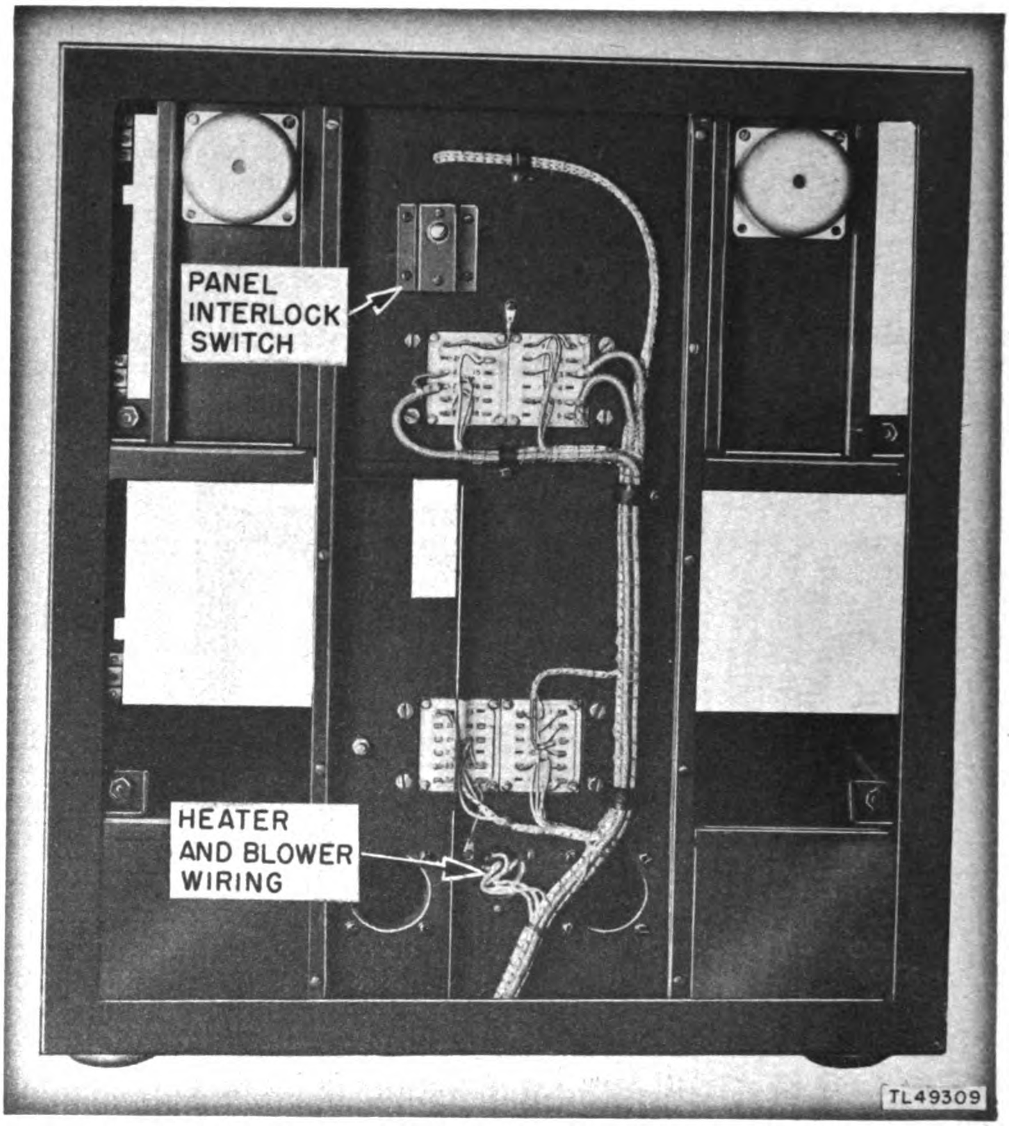


Figure 121. Rack FM-93, rear view.

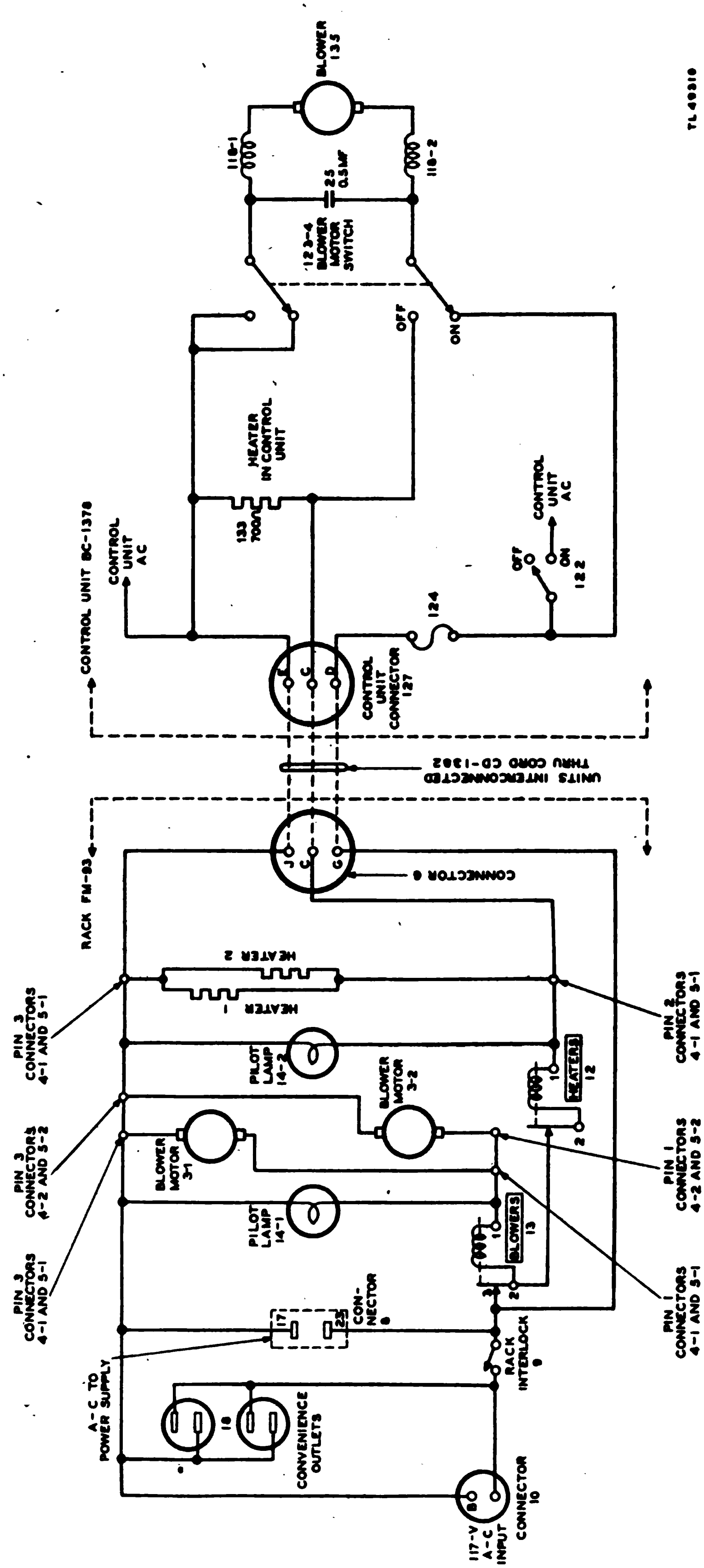


Figure 122. Rack FM-93, a-c input circuits, schematic diagram.

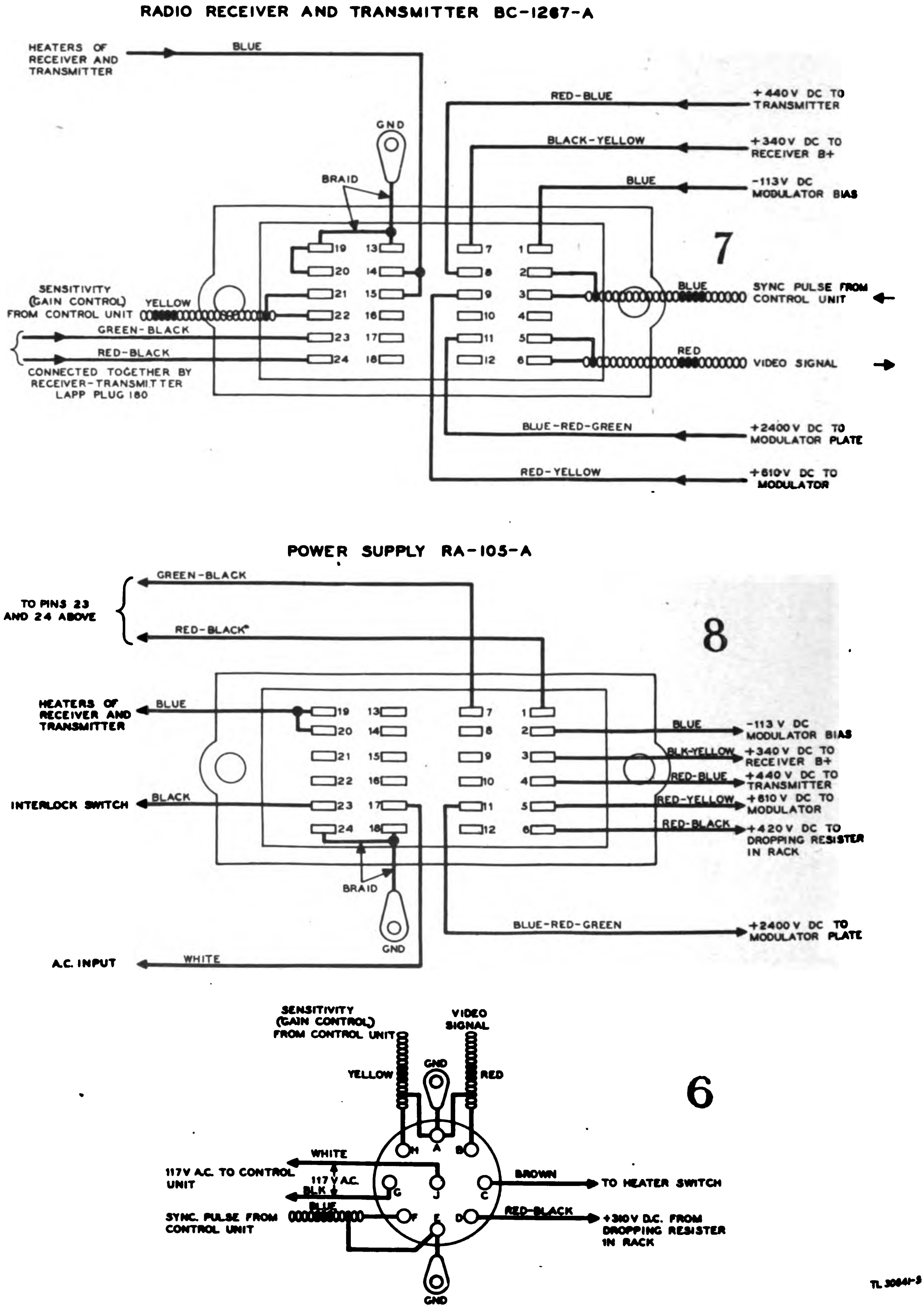


Figure 123. Rack FM-93, connector voltages and wiring.

TABLE VIII
RACK FM-93
VOLTAGES AT PINS OF CONNECTORS

GENERAL CONDITIONS

NOTE: Rack must be removed from waterproof case to take these readings.

1. All measurements taken in wiring channel at rear of Rack FM-93 and at connector for Cord CD-1382 on the bottom panel of rack.
2. 117 volts a-c line voltage.
3. Both units in rack and connected to control unit.
4. D-C voltages taken with a 1,000-ohms-per-volt meter.
5. STANDBY-OPERATE switch in STANDBY position.
6. Range switch in 75K YD. position.
7. SENSITIVITY knob on control unit in extreme counterclockwise position. All other controls in normal position.

Location	*Pin connections*	*D-C voltage*	*A-C voltage*	*Remarks*
Level 1, Power Supply RA-105-A	11 to ground	+2,400		**CAUTION:** High voltage. All measurements in this bracket are at potentials in excess of 1,000 volts to ground.
	14 to ground	−High voltage		
	15 to ground	−High voltage		
	14 to 15		6.5	
	5 to ground	+610		
	4 to ground	+440		
	6 to ground	+420		
NOTE: When power supply is removed from rack and powered by Cord CD-1141, voltages at chassis connector are different from voltages shown here. See paragraph 107, table VII.	3 to ground	+340		
	2 to ground	−113*		BIAS control on receiver-transmitter in extreme counterclockwise position for this measurement only.
	1 to ground	0		
	7 to ground	0		
	17 to 23		117	
	8 or 9 to 21 or 22		6.5	
	19 or 20 to gnd.		6.5	
Level 2, Radio Receiver and Transmitter BC-1267-A	11 to ground	+2,400		**CAUTION:** High voltage.
	9 to ground	+610		
	8 to ground	+440		
	7 to ground	+340		
	1 to ground	−113*		BIAS control on receiver-transmitter in extreme counterclockwise position for this measurement only.
	22 to ground	+9.2		
	17 to ground	+7.5		
	6 to ground	+1.5		
	3 to ground	0		
	16 to ground	0		
	18 to ground	0		
	23 to ground	0		
	24 to ground	0		
	14 or 15 to ground		6.5	
Connector for Cord CD-1382 on the bottom panel of rack	B to ground	+1.5		
	D to ground	+310		
	F to ground	0		
	G to J		117	
	H to ground	+9.2		

*This reading varies, depending on voltmeter scale used.

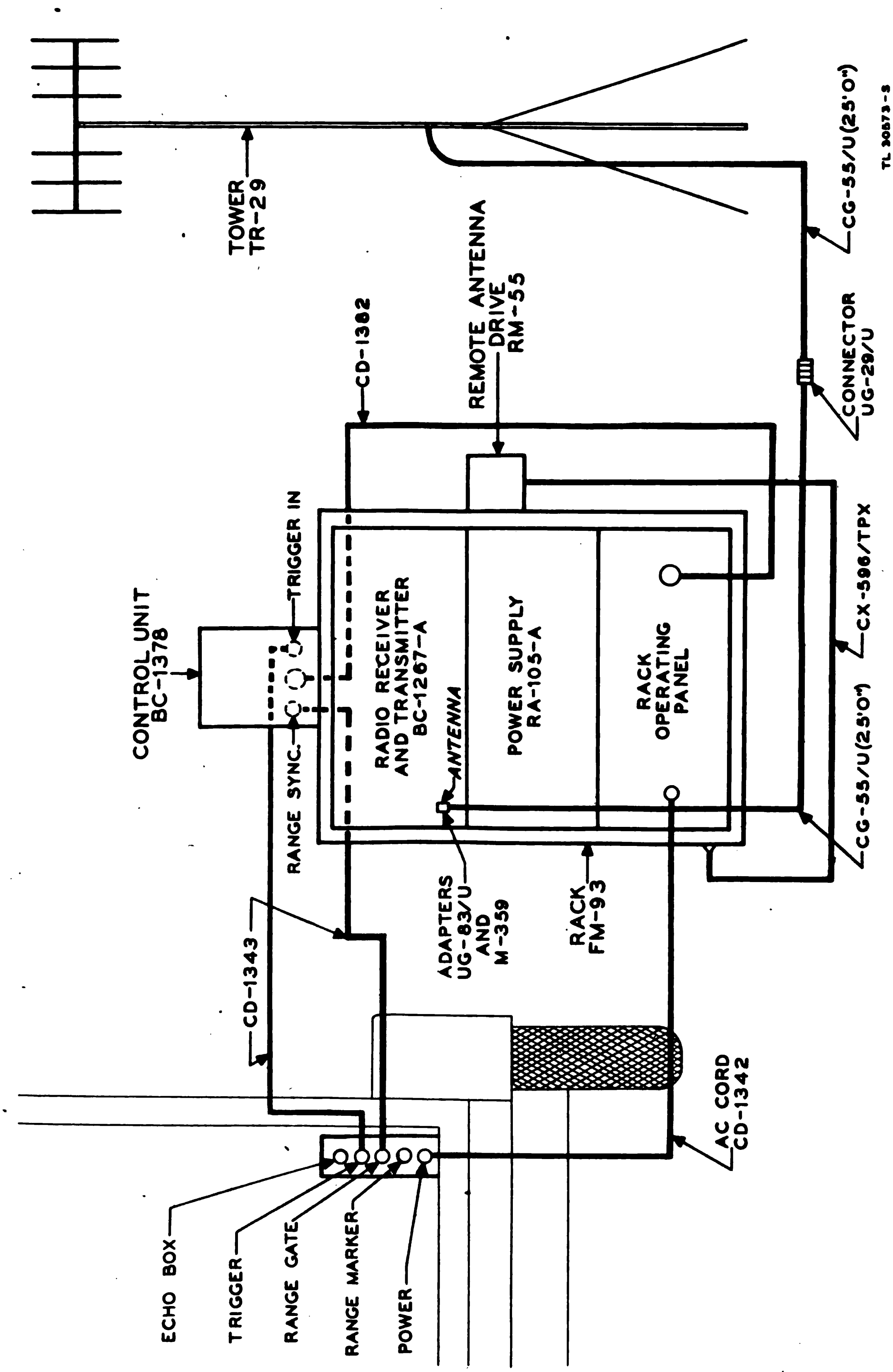


Figure 124. Radio Equipment RC-384, cabling diagram.

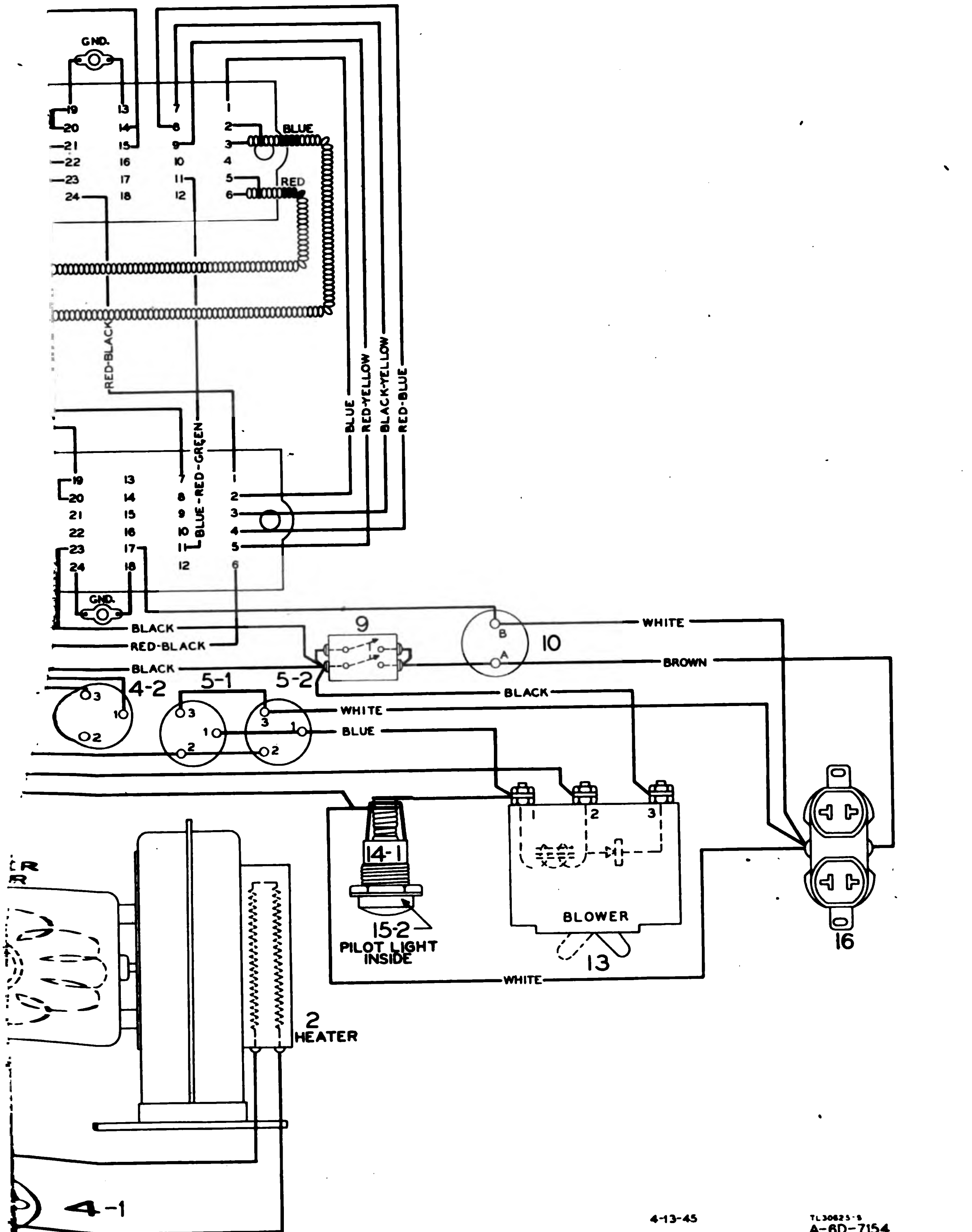


Figure 125. Rack FM-93, wiring diagram.

CHAPTER 15

SUMMARY OF ADJUSTMENTS AND ALIGNMENT

112. GENERAL.

The adjustment and alignment chart presents a step-by-step procedure for the over-all alignment of Radio Equipment RC-384. This chart is arranged to give a systematic procedure for an initial adjustment of the equipment when it is first installed. It may also be used when misalignment of a separate component occurs. Refer to the sections of the chart which applies to that component and make the prescribed adjustments. The paragraphs listed in the last column of the chart should be referred to when additional information is desired on an adjustment or when the adjustment of a control does not produce the desired results. If a component cannot be brought to normal operating condition by making the adjustments prescribed in this chart, refer to the trouble-shooting chart which applies to that component.

TABLE IX

ADJUSTMENT AND ALIGNMENT CHART*

	Control	*Position*	*Reference*
a. Preliminary Steps.			
1	Power supply PLATE VOLTAGE switch	OFF.	
2	Control unit ON-OFF switch	OFF.	
3	Power supply FILAMENT VOLTAGE switch	OFF.	
4	Connect signal generator to a-c outlet on rack.		
5	Signal generator ON-OFF switch	ON.	
6	Signal generator TEST-CRYSTAL switch	CRYSTAL.	
7	Rack BLOWERS switch	ON.	
8	Rack HEATERS switch	ON (leave on for 30 minutes).	
b. Control Unit Preliminary Adjustment.			
1	PEDESTAL WIDTH (on rear of control unit)	Extreme clockwise.	
2	75 K YD. CENT.	Turn to middle of rotational range.	
3	10 K YD. CENT.	Turn to middle of rotational range.	
4	VERT. CENT.	Turn to middle of rotational range.	
5	75 K YD. GAIN	Turn one-third of the way up from its extreme counterclockwise position.	

*Words in CAPITAL LETTERS represent labels on controls on the front panel of the components.

	Control	Position	Reference
6	10 K YD. GAIN	Turn one-third of the way up from its extreme counterclockwise position.	
7	CALIB. inner control	Extreme clockwise.	
8	CALIB. outer control	Extreme clockwise.	
9	SPREAD	Extreme counterclockwise.	
10	SENSITIVITY	Extreme counterclockwise.	

c. Receiver-Transmitter Preliminary Adjustment.

1	ANTENNA connector	Remove r-f cable; attach T-connector, dummy antenna and test antenna.	
2	WIDTH	Turn halfway clockwise.	
3	POWER MEASUREMENT	Extreme counterclockwise.	
4	BIAS	Extreme counterclockwise.	
5	POWER OUTPUT	Extreme clockwise.	
6	Calibration Chart	Read receiver and transmitter dial settings for desired frequency.	fig. 77
7	OSC., DET., R.F., and ANT.	Set to reading shown on calibration chart.	
8	ANTENNA MATCHING, TRANS.	Set to position corresponding to desired frequency.	par. 72
9	ANTENNA MATCHING, REC.	Set to position corresponding to desired frequency.	par. 72

d. Control Unit Sweep-line Adjustment.

1	FILAMENT VOLTAGE (on power supply)	ON (wait 45 secs. before next step).	
2	PLATE VOLTAGE (on power supply)	ON.	
3	STANDBY-OPERATE	STANDBY.	
4	Range switch	75 K YD.	
5	ON-OFF switch	ON.	
6	INTENSITY	Adjust for sharply defined sweep trace.	par. 101b
7	FOCUS		

e. Control Unit Division Adjustment.

1	STANDBY-OPERATE	STANDBY.	par. 101c (1)
2	Range switch	TEST.	
3	INTENSITY	Turn clockwise until sweep reappears.	
4	75 K YD. CENT.	Adjust to center sweep.	
5	75 K YD. GAIN		

	Control	Position	Reference
6	Test jacks	Connect Cord CD-1105 between jack 120 and 121-6.	
7	DIVISION	Adjust to obtain 8 stationary pips on base line.	fig. 40, par. 101c(*2*)
8	INTENSITY	Turn counterclockwise until pattern disappears.	par. 101c (*3*)
9	Test jacks	Remove Cord CD-1105.	
10	STANDBY-OPERATE	OPERATE.	
11	TEST SWITCH (on receiver-transmitter)	Ic (note reading on lower scale and release switch).	
12	Range switch	75 K YD.	
13	TEST SWITCH	Ic (reading on lower scale should correspond with reading obtained in step 11; if it does not, adjust DIVISION control until reading corresponds).	
14	DIVISION	Hold TEST SWITCH in Ic position, turn DIVISION control slowly counterclockwise until meter reading jumps to a slightly higher value; then turn DIVISION control slowly clockwise until the meter reading jumps, first to the correct value, and then to a lower value. Set the DIVISION control in the middle of the rotational range between the high value and low value.	par. 101c(*4*)
16	STANDBY-OPERATE	STANDBY.	
17	INTENSITY	Turn clockwise until pattern is plainly visible.	par. 101b
18	75 K YD. CENT.	Adjust to center sweep.	
19	75 K YD. GAIN		

f. Calibration of 75,000-Yard Sweep.

1	Range switch	75 K YD.	
2	STANDBY-OPERATE	STANDBY.	
3	Cord CD-1347	Insert phone-plug end into jack 120 on side of control unit; other end to RANGE MARKERS receptacle on Radio Set SCR-784.	par. 101d
4	CALIB. (inner shaft)	Adjust to obtain 7½ spaces between positive pips.	fig. 38
5	Cord CD-1347	Remove from test jack and RANGE MARKERS receptacle.	
6	75 K YD. CENT.	Adjust to center sweep.	
7	75 K YD. GAIN		

	Control	*Position*	*Reference*
g. PEDESTAL WIDTH Control Adjustment.			
1	Range switch	75 K YD.	
2	STANDBY-OPERATE	STANDBY.	
3	PEDESTAL WIDTH (on rear of control unit)	Slowly turn counterclockwise until ⅛ inch is clipped from right-hand end of sweep line. Turn clockwise until ⅛ inch is restored to line; carefully note amount of rotation necessary to restore line. Continue with the same amount of clockwise rotation; that is, turn the control clockwise enough to brighten an imaginary sweep which is ⅛ inch longer than the actual sweep.	par. 101f
h. Calibration of 10,000-Yard Sweep.			
1	Range switch	CALIB.	par. 101e
2	STANDBY-OPERATE	STANDBY.	
3	CALIB. (outer bushing)	Adjust for 12 complete cycles on display tube screen. (It may be necessary to readjust 10 K YD. CENT and GAIN controls to keep the pattern on the screen.)	fig. 37
4	Range switch	10 K YD.	
5	10 K YD. CENT.	Adjust to center sweep.	
6	10 K YD. GAIN		
7	VERT. CENT.	Position sweep line ½ inch from bottom of screen.	par. 101g
i. Transmitter Modulator Cathode Current Adjustment.			
1	STANDBY-OPERATE	STANDBY.	
2	TEST SWITCH	Hold in Ic position.	
3	BIAS	Adjust until lower scale of meter reads more than zero but less than 2 milliamperes.	par. 66
4	STANDBY-OPERATE	OPERATE.	
5	TEST SWITCH	Hold in Ic position. Meter reading must be between 3.5 and 7.5 milliamperes.	par. 66

	Control	*Position*	*Reference*

j. Antenna Tuning and Matching.

1	STANDBY-OPERATE	OPERATE.	
2	Range switch	75 K YD.	
3	TEST SWITCH	Hold at P.O. for steps 4, 6, and 7 below.	
4	POWER MEASUREMENT	Adjust until envelope of transmitter pulse is about half screen height.	
5	LOCK	Loosen so ANT. control may be adjusted.	par. 72
6	ANT.	Adjust for maximum height of transmitter pulse envelope.	
7	ANTENNA MATCHING rods.	Adjust for maximum height of transmitter pulse envelope.	par. 72

k. Pulse Width Adjustment.

1	STANDBY-OPERATE	OPERATE.	
2	Range switch	CALIB.	
3	10 K YD. GAIN	Extreme clockwise.	
4	10 K YD. CENT.	Turn clockwise until left edge of pattern is about ½ inch from left edge of screen.	
5	INTENSITY	Turn clockwise until pattern is very bright, but not bright enough to be too fuzzy.	
6	Radar range control	Turn SLEWING handwheel on radar range indicator to bring range pointer to zero yards.	
7	TEST SWITCH	Hold at P.O.	par. 67, fig. 71
8	WIDTH	Adjust until pulse width is between 4 and 10 microseconds.	
9	TEST SWITCH	Move to Ic position. Meter must read between 3.5 and 7.5 milliamperes.	
10	INTENSITY	Turn counterclockwise to normal brilliance.	
11	STANDBY-OPERATE	STANDBY.	
12	10 K YD. CENT.	Readjust for correctly positioned sweep trace.	
13	10 K YD. GAIN		

	Control	*Position*	*Reference*
l. Power Output Adjustment.			
1	STANDBY-OPERATE	OPERATE.	
2	Range switch	75 K YD.	
3	TEST SWITCH	Hold at P.O.	
4	POWER MEASUREMENT	Turn clockwise until transmitter pulse stops decreasing; then stop turning. Note the power reading on the meter. It should be 0.25 kw.	par. 68
5	TEST SWITCH	Release the switch.	
6	POWER OUTPUT	Turn clockwise to increase power, or counterclockwise to decrease power.	par. 68
7	POWER MEASUREMENT	Turn to middle of rotational range.	
m. Transmitter Frequency Adjustment.			
1	Signal generator	Warm up for 15 minutes, calibrate, and set to desired operating frequency.	par. 71
2	STANDBY-OPERATE.	OPERATE.	
3	PLATE	Adjust for zero beat.	par. 71
n. Receiver Frequency Adjustment.			
1	MICROVOLTS (signal generator)	5.	
2	MULTIPLY BY (signal generator)	1 Mx.	
3	ANTENNA connector (receiver)	Remove T-connector, dummy antenna, and test antenna.	
4	Cord CD-1104	Connect between ANTENNA connector on receiver and R.F. OUTPUT on signal generator.	
5	SENSITIVITY	Extreme clockwise.	
6	OSC. } Receiver dials	In order indicated, tune for maximum closure of the tuning eye. If eye overlaps, turn SENSITIVITY control slightly counterclockwise.	par. 73
7	DET. } Receiver dials		
8	R.F. } Receiver dials		
9	ANT. } Receiver dials		

PART THREE

MAINTENANCE PARTS

113. INDEX TO MAJOR COMPONENTS.

*The maintenance parts for Antenna Tower Kit AS-134/TPX are listed in TB SIG 144. The maintenance parts for Signal Generator I-222-A are listed in TM 11-1082.

**The hardware kit may be ordered as a complete unit.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384.

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			CONTROL UNIT BC-1378	
		2C680-1378	CONTROL UNIT BC-1378: azimuth; similar in design and appearance to Control Unit BC-1266-A; in aluminum case approx 9½" wd x 14⅞" h x 29⅛" d; Belmont dwg/part #205-1578.	
		2Z9411.12	BOARD, terminal: 11 Shakeproof term lugs; Belmont dwg/part #B-201-831.	
		2Z9406.176	BOARD, terminal: six stud terminals; laminated phenolic board; 2" lg x 1⅞" wd x 0.093" thk; Anchor Tool & Die Co; Belmont dwg/part #A-201-1664; (two L-shaped steel brackets with two 0.187" diam holes on 1½" mtg/c; legend No. stamped on board 50-2, 21, 3-2, and 11).	
		2Z9440-78	BOARD, terminal: 58 copper stud term, hot tin dipped; laminated phenolic; 11⅛" lg x 1⅞" wd x 0.093" thk; fungus-resistant varnish coating and impregnation; Anchor Tool & Die Co, Chicago; three mtg studs on 5¼" mtg/c, tapped for #8-32 screw; Belmont dwg/part #B-201-1580.	
		2Z9440-79	BOARD, terminal: 52 copper stud term, hot tin dipped; laminated phenolic; 10⅛" x 1⅞" x 0.093" thk; fungus-resistant varnish coating and impregnation; Anchor Tool & Die Co, Chicago; (three mtg studs on 4 11/16" mtg/c, tapped for #8-32 screw); Belmont dwg/part #B-201-1582.	
		2Z5991-30	CAP, lens: brass; over-all dimen approx 1" lg x 27/32"; shutter type; plain red glass jewel; p/o indicator light assem Gothard #1115; Belmont dwg/part #A-55A-6804-1.	
	C-17	3DA10-214	CAPACITOR, fixed: oil-filled; 10,000 mmf +30% −10%; 1,000v; Belmont dwg/part #A-8B-3628.	
	C-12	3DA250-21.3	CAPACITOR, fixed: oil-filled; 250,000 mmf ±20%, 600v; Belmont dwg #A-8B-3512.	
	C-15-1 to C-15-2	3DA200-14	CAPACITOR, fixed: oil-filled; 200,000 mmf +20% −10%; 5,000v; Belmont dwg/part #C-8B-2784.	
	C-18	3DA500-133	CAPACITOR, fixed: oil-filled; 500,000 mmf +40% −10%; 200v; Belmont dwg/part #A-8B-3191.	
	C-19-1	3DB1.34	CAPACITOR, fixed: oil-filled; 1 mf +40% −10%; 600v; Belmont dwg/part #A-8B-3770.	
	C-19-2 C-19-3	3DB1.1988	CAPACITOR, fixed: oil-filled; 1 mf ±20%; 600v; Belmont dwg/part #A-8B-1988.	
	C-14	3DB7-2	CAPACITOR, fixed: oil-filled: 7 mf +30% −10%; 600v; Belmont dwg/part #B-8C-1139.	
	C-6	3DB2-23	CAPACITOR, fixed: oil-filled: 2 mf +40% −10%; 600v; Belmont dwg/part #A-8B-3513.	
	C-13	3DA15-20	CAPACITOR, fixed: mica; 15,000 mmf ±20%; 2,500v; Belmont dwg/part #A-8L-3678.	
	C-7	3DK9050-103	CAPACITOR, fixed: mica; 50 mf ±10%; 500v; Belmont dwg/part #B-8F-1554.	
	C-5-1 thru C-5-3	3K2010122	CAPACITOR, fixed: mica; 100 mmf ±5%; 500v; Belmont dwg/part #B-8F-1938.	
	C-16	3D9180-1	CAPACITOR, fixed: mica; 180 mmf ±3%; 500v; Belmont dwg/part #B-8F-1850.	
	C-4-3	3DA5-9	CAPACITOR, fixed: mica; 5,000 mmf ±5%; 500v; Belmont dwg/part #B-8F-3779.	
	C20	3D9750-11	CAPACITOR, fixed: mica; 750 mmf ±10%; 500v; 51/64" lg x 13/32" wd x 7/32" thk; JAN Spec JAN-C-5; (molded bakelite case); two wire leads 1⅛" lg; Belmont dwg/part #B-8F-4854.	
	C-9	3DA1-142	CAPACITOR, fixed: paper; 1,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-3981.	

C-3-1 to C-3-9	3DA100-112.1	CAPACITOR, fixed: paper; 100,000 mmf ±20%; 400v; Belmont dwg/part #A-8J-1626.
C-2-1 to C-2-10	3DA50-57.1	CAPACITOR, fixed: paper; 50,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-1995.
C-10	3DA15-22	CAPACITOR, fixed: paper; 15,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-3982.
C-1-2	3DA5-73	CAPACITOR, fixed: paper; 5,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-3654.
24	3K3027222	CAPACITOR, fixed: mica; 2,700 mmf ±5%; 500v; 3/4" x 3/4" x 1 1/4"; Belmont part #B-8F-3467.
21	3DA6-45	CAPACITOR, fixed: paper; 6,000 mmf ±20%; 600v; molded case; 1/4" x 5/8" x 1 5/32"; Micamold type 340-24; Belmont part #B-8J-1851.
8-1 and 8-3	3DA10-140.2	CAPACITOR, fixed: paper; 10,000 mmf ±20%; 400v; molded case; 1 5/32" x 5/8" x 1/4"; Micamold type 340-21; Belmont part #B-8J-1627.
22-1 to 22-2	3D9030-15	CAPACITOR, fixed: ceramic; 30 mmf ±0.3 mmf; 500v; 7/16" lg x 7/32" diam; type N-750K Erie; Belmont part #A-8G-3422.
23	3K2018121	CAPACITOR, fixed: mica; 175 mmf ±10%; 500v; 11/16" lg x 7/16" wd x 3/16" thk; JAN type case CM20; characteristic B; (molded bakelite case; two wire leads 1 5/16" lg); Micamold type OXM; Belmont part/dwg #B-8F-7080.
C-8	3DA10-124.1	CAPACITOR, fixed: paper; 10,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-3424.
C-11	3DA2-111	CAPACITOR, fixed: paper; 2,000 mmf ±20%; 600v; Belmont dwg/part #A-8J-3980.
	2Z2724	CLIP: tube cont; Belmont dwg/part #A-26D-757-2.
L-130	2C680-266A/C2	COIL: delay line; Belmont dwg/part #B-207-898.
L-131	2C680-266A/C3	COIL: timer; Belmont dwg/part #B-204-382.
J-128-1 J-128-2	2Z8671.62	CONNECTOR: female; Belmont dwg/part #A-55A-3493.
P-127	2Z7122.2	CONNECTOR: male; Belmont dwg/part #A-55A-3495.
F-129	3Z1927	FUSE: cartridge; Belmont dwg/part #A-46B-2717.
	2Z4866.215	GASKET: Buna "S" synthetic rubber; to obtain a waterproof fit for cover to outer case; rectangular; over-all dimen 14 13/16" lg x 9 31/32" wd x 3/8" thk with groove 1/2" x 1/8"; opening 13 9/16" x 8 23/32" Belmont part/dwg #C-25H-6855.
	2Z4866.214	GASKET: Buna "S" synthetic rubber; to obtain a waterproof fit for cover plate to outer case; rectangular; over-all dimen 6 21/32" lg x 3 7/32" wd x 3/8" thk; groove 1/4" x 1/8"; opening 5 29/32" x 2 15/32"; Belmont dwg/part #B-25H-6854.
	2Z4880-21	GLASS: scope: Belmont dwg/part #A-55F-2837.
	3Z3275-1	HOLDER, fuse: Belmont dwg/part #A-55A-2716.
	3G1250-10.4	INSULATOR: stand-off; ceramic; Belmont dwg/part #A-5F-1120.
	3G2300-08	INSULATION: spaghetti tubing; black; fibronized plastic; 0.053" ID; IVICO #16 IRV-O-LITE XTE-30.
J-121-1 to J-121-9	2Z5534A	JACK: telephone; Belmont dwg/part #A-44A-300.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			CONTROL UNIT BC-1378 (contd)	
	J-120	2Z5531.2	JACK: telephone; Belmont dwg/part #A-44A-2850.	
		2Z5821-15	KNOB: round; Belmont dwg/part #A-4B-1110.	
		2Z5821-8.1	KNOB: round; with arrow; Belmont dwg/part #A-4B-1110-A.	
		2Z5821-9	KNOB: bar; Belmont dwg/part #A-4B-1489.	
	E-134	2Z5927	LAMP: Mazda #44; incandescent; Belmont dwg/part #A-46A-1621.	
		3G1100-112	PLATE: mycalex; Belmont dwg/part #A-7A-3688.	
	R-133	3Z6070-18	RESISTOR: fixed; heater strip, 700 ohm ±10%; 20w; Belmont dwg/part #A-9D-4185.	
	R-50	3Z6008B2-6	RESISTOR: fixed; carbon; 82 ohm ±10%; ½w; Belmont dwg/part #A-9B1-49.	
	R-51	3RC20BE221K	RESISTOR: fixed; carbon; 220 ohm ±10%; ½w; Belmont dwg/part #A-9B1-54.	
	R-53-1 to R-53-3	3RC20BE102K	RESISTOR: fixed; carbon; 1,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-62.	
	R-76	3RC20BE152K	RESISTOR: fixed; carbon; 1,500 ohm ±10%; ½w; Belmont dwg/part #A-9B1-64.	
	R-89	3RC20BE332K	RESISTOR: fixed; carbon; 3,300 ohm ±10%; ½w; Belmont dwg/part #A-9B1-68.	
	R-56	3RC20BE392K	RESISTOR: fixed; carbon; 3,900 ohm ±10%; ½w; Belmont dwg/part #A-9B1-69.	
	39-1 to 39-2	3RC20BE222K	RESISTOR, fixed: carbon; 2,200 ohm ±10%; ½w; AWS type RC20BE222K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B1-66.	
	43	3RC20BE393K	RESISTOR: fixed; carbon; 39,000 ohm ±10%; ½w; AWS type RC20BE393K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B1-81.	
	42	3RC30BE334J	RESISTOR: fixed; carbon; 330,000 ohm ±5%; 1w; AWS type RC30BE334J; AWS spec C-75.7-1943; Belmont dwg/part #A-9B2-219.	
	40-1 to 40-2	3RC30BE223K	RESISTOR: fixed; carbon; 22,000 ohm ±10%; 1w; AWS RC30BE223K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B2-78.	
	52	3RC20BE473J	RESISTOR: fixed; carbon; 47,000 ohm ±5%; ½w; 9/16" lg x 1/8" diam; AWS type RC20BE473J; AWS spec C-75.7-1943; (bakelite insulation; two axial wire leads 1½" lg); Belmont part #A-9B1-199.	
	37-1 to 37-4	3RC20BE104K	RESISTOR: fixed; carbon; 100,000 ohm ±10%; ½w; AWS type RC20BE104K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B1-86.	
	41-1 41-2	3RC20BE103K	RESISTOR: fixed; carbon; 10,000 ohm ±10%; ½w; AWS type RC20BE103K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B1-74.	
	38-1 to 38-2	3RC20BE471K	RESISTOR: fixed; carbon; 470 ohm ±10%; ½w; AWS type RC20BE471K; AWS spec C-75.7-1943; Belmont dwg/part #A-9B1-58.	
	R-57-1 thru R-57-4	3RC20BE472K	RESISTOR: fixed; carbon; 4,700 ohm ±10%; ½w; Belmont dwg/part #A-9B1-70.	

R-59	3RC20BE223K	RESISTOR: fixed; carbon; 22,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-78.
R-60-1 R-60-2	3RC20BE273K	RESISTOR: fixed; carbon; 27,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-79.
R-55	3RC20BE333K	RESISTOR: fixed; carbon; 33,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-80.
R-62-1 R-62-2	3RC20AE563K	RESISTOR: fixed; carbon; 56,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-83.
R-48	3RC21BE823K	RESISTOR: fixed; carbon; 82,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-85.
R-49	3RC20BE272K	RESISTOR: fixed; carbon; 2,700 ohm ±10%; ½w; Belmont dwg/part #A-9B1-67.
R-64-1 R-64-2	3RC21BE124K	RESISTOR: fixed; carbon; 120,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-87.
R-65	3RC20BE154K	RESISTOR: fixed; carbon; 150,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-88.
R-66	3RC20BE184K	RESISTOR: fixed; carbon; 180,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-89.
R-67	3RC20BE224K	RESISTOR: fixed; carbon; 220,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-90.
R-68	3RC20BE394K	RESISTOR: fixed; carbon; 390,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-93.
R-69-1 to R-69-4	3RC20BE474K	RESISTOR: fixed; carbon; 470,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-94.
R-70	3RC21BE824K	RESISTOR: fixed; carbon; 820,000 ohm ±10%; ½w; Belmont dwg/part #A-9B1-97.
R-61	3RC21AE155K	RESISTOR: fixed; carbon; 1.5 meg ±10%; ½w; Belmont dwg/part #A-9B1-100.
R-71-1 to R-71-4	3RC20BE225K	RESISTOR: fixed; carbon; 2.2 meg ±10%; ½w; Belmont dwg/part #A-9B1-102.
R-72	3RC30BE102K	RESISTOR: fixed; carbon; 1,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-62.
R-73-1 to R-73-3	3RC31BE182K	RESISTOR: fixed; carbon; 1,800 ohm ±10%; 1w; Belmont dwg/part #A-9B2-65.
R-54-1 R-54-2	3RC30BE182J	RESISTOR: fixed; carbon; 1,800 ohm ±5%; 1w; AWS type RC30BE182J; AWS spec C-75.7-1943; bakelite insulation; two axial wire leads 1½" lg; Belmont dwg/part #A-9B2-165.
R-74	3RC31AE222K	RESISTOR: fixed; carbon; 2,200 ohm ±10%; 1w; Belmont dwg/part #A-9B2-66.
R-75	3RC31BE272K	RESISTOR: fixed; carbon; 2,700 ohm ±10%; 1w; Belmont dwg/part #A-9B2-67.
R-77	3RC30BE682K	RESISTOR: fixed; carbon; 6,800 ohm ±10%; 1w; Belmont dwg/part #A-9B2-72.
R-79-1 to R-79-6	3RC31BE333K	RESISTOR: fixed; carbon; 33,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-80.
R-88	3RC31BE563K	RESISTOR: fixed; carbon; 56,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-83.
R-80-1 to R-80-3	3RC30BE683K	RESISTOR: fixed; carbon; 68,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-84.
R-81-1 R-81-4	3RC30BE104K	RESISTOR: fixed; carbon; 100,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-86.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			CONTROL UNIT BC-1378 (contd)	
	R-90-1 R-90-2	3RC30BE124K	RESISTOR: fixed; carbon; 120,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-87.	
	R-82-1 R-82-2	3RC30BE154K	RESISTOR: fixed; carbon; 150,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-88.	
	R-87-1 to R-87-8	3RC30BE224K	RESISTOR: fixed; carbon; 220,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-90.	
	R-83-1 to R-83-4	3RC30BE334K	RESISTOR: fixed; carbon; 330,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-92.	
	R-84	3RC30BE393K	RESISTOR: fixed; carbon; 39,000 ohm ±10%; 1w; Belmont dwg/part #A-9B2-93.	
	R-91-1 R-91-2	3RC41BE564K	RESISTOR: fixed; carbon; 560,000 ohm ±10%; 2w; Belmont dwg/part #A-9B4-95.	
	R-86	3Z6613-6	RESISTOR: fixed; WW; 13,000 ohm ±5%; 10w; Belmont dwg/part #A-9C-3736.	
	R-93	3Z7499-2.4	RESISTOR: variable; single sect; carbon; 2 meg ±20%; 1/2w; three term; body 1 1/8" diam x approx 1/2" d, shaft 1/4" diam x 1/8" lg; CTS type #35; taper, linear; inclosed body; washer and hex nut included for mtg; bushing 3/8"-32 x 1/4" lg; Belmont dwg/part #B-10B-6796.	
	R-100	2Z7269.100	RESISTOR: variable; 3,000 ohm ±20%; 1/2w; Belmont dwg/part #A-10B-3096.	
	R-97	2Z7272-88	RESISTOR: variable; 360,000 ohm ±20%; 2w; Belmont dwg/part #A-10B-3097.	
	R-98	2Z7269.110	RESISTOR: variable; 3,500 ohm ±20%; 1/2w; Belmont dwg/part #A-10B-3098.	
	R-96	2Z7271-101	RESISTOR: variable; 160,000 ohm ±20%; 2w; Belmont dwg/part #A-10B-3099.	
	R-94-1 R-94-2	2Z7269.84	RESISTOR: variable; 3,000 ohm ±20%; 1w; Belmont dwg/part #A-10B-3095.	
	R-95-1 to R-95-3	2Z7284.60	RESISTOR: variable; 2 meg ±20%; 1/2w; Belmont dwg/part #A-10B-2767.	
	101	2Z7271-42	RESISTOR: variable; pedestal width control; 200,000 ohm ±20%; 1/2w; Belmont part #B-10B-2772.	
	R-92A R-92B	3Z7420-13	RESISTOR: variable; two sect; carbon; 5,000 ohm, 20,000 ohm ±20%; 1/2w; three term ea sect; body 1 1/8" diam x 0.945"; 1 shaft 0.265" diam x 1 9/16"; one shaft 0.202" diam x 1 3/8" lg; both slotted for screwdriver adjustment; CTS type C2-35; linear taper; inclosed body; washer and hex nut included for mtg; bushing 3/8-32 x 3/8" lg; Belmont dwg/part #B-10B-6828.	
		6L7920-4-19.81C	SCREW CAP: hex head; steel; iridite on zinc plate; 1/4"-20, NC; 1 11/64" lg over-all, 3/4" lg of thd; head 7/16" across flats; 3/16" thk; (shoulder 7/16" diam x 1/64" lg; Belmont dwg/part #A-3F-7088).	
		2Z5991-30	SOCKET, indicator light: bakelite socket; brass body; nickel-plated; holder for Mazda #44 bayonet type lamp; over-all lg 1 7/16" x 15/16" diam; p/o indicator light assem Gothard #1115; Belmont dwg/part #A-55A-6804-2; (furnished with fibre washer 11/16" ID x 15/16" OD; aluminum split lockwasher 11/16" ID x 15/16" OD; aluminum hex nut 11/16" ID x 15/16" across flat; two solder lugs; mts on panel in 11/16" diam hole).	

	2Z8650.5	SOCKET: tube; octal; molded bakelite; Belmont dwg/part #A-15B-1462.
	2Z8674.15	SOCKET: tube; bakelite; Belmont dwg/part #A-15B-2779.
	2Z8684-18	SOCKET: tube; bakelite; Belmont dwg/part #B-15B-3864.
	2Z8878-18	SPRING: compression; Belmont dwg/part #A-49A-2975.
S-123-1 to S-123-3	3Z9849.60-1	SWITCH, toggle: Belmont dwg/part #A-20C-3100.
S-124	3Z9825-62.108	SWITCH, rotary: Belmont dwg/part #B-20A-3669.
S-122	3Z9849.39	SWITCH, toggle: Belmont dwg/part #A-20C-3663.
T-125	2Z9611.197	TRANSFORMER: filament; Belmont dwg/part #C-12A-3155.
T-126	2Z9613.198	TRANSFORMER: power; Belmont dwg/part #D-12A-3527.
	2J6SJ7	TUBE, electron: 6SJ7.
	2J2X2	TUBE, electron: 2X2.
	2J5CP1	TUBE, electron: 5CP1
	2J6SL7GT	TUBE: 6SL7GT (VT-229).
	2J6V6GT/G	TUBE, electron: 6V6GT/G.
	2J6SN7GT	TUBE, electron: 6SN7-GT.
	2J6AC7	TUBE, electron: 6AC7.
		RADIO RECEIVER AND TRANSMITTER BC-1267-A
	2Z8050-6	ADJUSTMENT ROD ASSEMBLY: used in antenna-matching section; size, 18⅝" lg x ⅜" diam; type BRC; Belmont dwg #A-202-552.
	2Z1409-11	BUSHING: handle; zamak; 1" OD x 0.343" ID x ⅝" lg; type BRC; Hudson Screw Machine Co; Belmont dwg #A-3B-2817.
	2Z1409-12	BUSHING: steel; headed; head dimen 5⁄16" diam x 3⁄16" lg; shank dimen 0.216" diam x 1 1⁄16" lg; 0.147" diam through hole; type BRC; Aurora Precision Devices Co; Belmont dwg #A-3B-4165.
	2Z1480.6	BUTTON: release; steel; headed bushing; head dimen 0.320" diam x 3⁄64"; shank dimen 0.245" diam x 0.328" lg; blind hole in head end 0.147" diam x 3⁄16" d; type BRC; Hudson Screw Machine Co, Chicago Belmont dwg #A-3B-2820.
104	3C323-4C	CHOKE: cathode; #18 TCW; 7 turns of #26 SSE wire; #18 TCW used in two loop shapes near ends of coil form; coil ¼" diam and ⅝" lg; legs of loops extend 1⅛" off center of coil; type BRC; Belmont dwg #A-17A-1194.
114-1 to 114-4	3C323-4E	CHOKE COIL: #18 tinned copper wire, bare; 0.040" diam; 12 turns; 0.455" OD; ¾" lg w/⅝" lg ends; type BRC; Belmont dwg #A-17A-3565.
113	3C323-4F	CHOKE: #20 enameled copper wire; 0.031" diam; 18 turns; 0.437" OD; winding close wound w/½" lg ends; type BRC; Belmont dwg #A-17A-3566.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			RADIO RECEIVER AND TRANSMITTER BC-1267-A (contd)	
		2Z3351-30	CAP AND CHAIN ASSEMBLY: Belmont dwg #A-202-885.	
	105-1 to 105-5	3C323-4B	CHOKE, RF heater: #18 TCW; 25 turns of #24 SSE wire, close wound; #24 SSE diam 0.020"; #18 TCW diam 0.040"; #18 TCW used in two loop shapes near ends of coil form; coil form 5/16" diam x 7/8" lg; ends of loops extend 1" off ends of coil; type BRC; Belmont dwg #A-17A-1195.	
	120	3C323-4G	CHOKE, RF heater: #16 ga enameled wire; bare; 0.050" diam; 18 turns; 0.475" diam; coil form 1 3/8" lg; type BRC; Belmont dwg #A-204-812.	
	101	3C1084N	COIL ASSEMBLY: RF tuning; coil wound w/2½ turns of #14 ga bare silver wire; wire diam 0.064"; OD of winding 17/32"; lg of winding ½"; space wound; permeability tuned; coil mtd on a coil base assembly, size 1¼" x 1½" x 2¼"; type BRC; Belmont dwg #B-204-534.	
	102	3C392	COIL ASSEMBLY: mixer tuning; coil wound w/2½ tuns of #14 ga bare silver wire; wire diam 0.064"; OD of winding 17/32", lg of winding ½"; space wound; permeability tuned; coil mtd on a coil base assem, size 1¼" x 1½" x 2¼"; type BRC; Belmont dwg #B-204-535.	
	100	3C302-R	COIL ASSEMBLY: antenna tuning; coil wound w/2½ turns of #14 ga bare silver wire looped over this first winding; wire diam 0.064", OD of first winding 17/32"; lg of winding ½"; space wound; radius of hoop coil 13/32"; lg of legs 11/16"; permeability tuned; coil mtd on a coil base assem, size 1¼" x 1½" x 2¼"; type BRC; Belmont dwg #B-204-536.	
	103	3C1081-12B	COIL ASSEMBLY: oscillator tuning; coil wound with 2½ turns of #14 ga bare silver wire; wire diam 0.064"; OD of winding 17/32"; lg of winding ½"; space wound; permeability tuned; coil mtd on a coil base assembly, size 1¼" x 1½" x 2¼"; type BRC; Belmont dwg #B-204-543.	
	24	3DB4-93	CAPACITOR: oil-filled; 4 mf +30% −10%; 100v; 2" x 2" x 1¼"; type 8413 BA, Industrial Condenser Corp, Chicago, or equal; Belmont dwg #A-8B-3267.	
	26-1 to 26-3	3DB1.1104	CAPACITOR: oil-filled; 1 mf +20% −10%; 400v; 2" x 1¾" x 7/8"; type BM-306-78, Micamold Radio Corp, New York, or equal; Belmont dwg #A-8B-1104.	
	22-1A & B to 22-2A & B	3DA100-133.4	CAPACITOR: oil-filled; 0.1 mf +20% −10%; 600v; 1 27/32" x 1" x ¾"; type 8416 BA, Industrial Condenser Corp; Belmont dwg #A-8B-3268.	
	23	3DA100-184	CAPACITOR: oil-filled; 0.1 mf +30% −10%; 1,000v; 1 27/32" x 1" x 13/16"; type 8405 BA, Industrial Condenser Corp, Chicago, or equal; Belmont dwg #A-8B-3269.	
	25	3DB1.3062	CAPACITOR: oil-filled; 1 mf +40% −10%; 3,600v; 3¾" x 1¾" x ¾"; type 8412-SAL, Industrial Condenser Corp, Chicago, or equal; Belmont dwg #C-8B-3062.	
	32	3DA100-182	CAPACITOR: oil-filled; 0.1 mf +30% −10%; 600v; 1 27/32" x 1" x 13/16"; type 2528-1, Sprague Specialties Co, North Adams, Mass, or equal; Belmont dwg #A-8B-3730.	
	15-1 to 15-10	3D9082-3	CAPACITOR: mica; 82 mmf ±10%; 300v; 33/64" x 0.365" x 5/32"; type A-7614, John E. Fast Co, Chicago, or equal; Belmont dwg #A-8M-2662.	
	14	3D9050-94	CAPACITOR: ceramic; 50 mmf ±20%; 5,000v; 49/64" diam x 13/16" lg; type 850, Centralab, Milwaukee Wis, or equal; Belmont dwg #A-8M-3185.	
	16-1 to 16-4	3DK9500-99	CAPACITOR: mica; 500 mmf ±10%; 500v; 11/16" x 7/16" x 3/16"; type 0, Micamold Radio Corp, New York, or equal; Belmont dwg #B-8F-2715.	

18-1 to 18-7	3DA5-32	CAPACITOR: mica; 5,000 mmf ±10%; 500v; 3/4" x 3/4" x 1/4"; type W, Micamold Radio Corp, New York, or equal; Belmont dwg #B-8F-312.
30-1 to 30-2	3DA5-9	CAPACITOR: mica; 5,000 mmf ±5%; 300v; 3/4" x 3/4" x 1/4"; type W, Micamold Radio Corp, New York, or equal; Belmont dwg #B-8F-3779.
13-3 to 13-5	3DA7.500-3	CAPACITOR: ceramic; 7,500 mmf ±20%; 300v; 3/8" diam x 1 1/2" lg; type 3167, Muter Co, Chicago, or equal; Belmont dwg #A-8G-3265.
12-1 to 12-19	3DA1-116	CAPACITOR: ceramic; 1,000 mmf ±20%; 400v; 5/32" diam x 5/8" lg; type 3165, Muter Co, Chicago, or equal; Belmont dwg #A-8G-3264.
11-2 to 11-3	3D9100-118	CAPACITOR: ceramic; 100 mmf ±10%; 500v; 0.225" diam x 0.600" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-3402.
9-1 to 9-4	3D9040-14	CAPACITOR: ceramic; 40 mmf ±10%; 500v; 7/32" diam x 7/16" lg; type N750K-40, Erie Resistor Corp, Erie, Pa, or equal; Belmont dwg #A-8G-2657.
31-1 to 31-2	3D9025-39	CAPACITOR: ceramic; 25 mmf ±10%; 500v; 7/32" diam x 7/16" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-3081.
2	3D9015-36	CAPACITOR: ceramic; 15 mmf ±10%; 500v; 0.225" diam x 0.600" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2710.
3-1 to 3-5	3D9008-5.1	CAPACITOR: ceramic; 8 mmf ±6%; 500v; 7/32" diam x 7/16" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2711.
4	3D9004-3	CAPACITOR: ceramic; 4 mmf ±12.5%; 500v; 7/32" diam x 7/16" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2712.
7	3D9100-150	CAPACITOR: ceramic; 100 mmf ±10%; 500v; 0.225" diam x 1" lg; type C, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2306.
8-1 to 8-2	3D9150-23.1	CAPACITOR: ceramic; 150 mmf ±10%; 500v; 0.225" diam x 1" lg; type C, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2713.
6	3D9050-107	CAPACITOR: ceramic; 50 mmf ±10%; 500v; 0.225" diam x 0.600" lg; type D, Centralab, Milwaukee, Wis, or equal; Belmont dwg #A-8G-2714.
1-1 to 1-4	3D9010-24	CAPACITOR: ceramic; 10 mmf ±10%; 500v; 7/32" diam x 7/16" lg; type NPOK-10, Erie Resistor Corp, Erie, Pa., or equal; same as Erie N680KS; Belmont dwg #A-8G-2658.
5	3D9025-41	CAPACITOR: ceramic; 25 mmf ±10%; 500v; 7/32" diam x 11/16" lg; type NPOL-25, Erie Resistor Corp, Erie, Pa, or equal; Belmont dwg #A-8G-2659.
20-1 to 20-3	3DA50-57.1	CAPACITOR: molded case; 0.05 mf ±20%; 600v; 3/8" x 3/4" x 1 1/16"; type 345-22, Micamold Radio Corp, New York, or equal; Belmont dwg #A-8J-1995.
21-1 to 21-5	3DA100-112.1	CAPACITOR: molded case; 0.1 mf ±20%; 400v; 3/8" x 3/4" x 1 1/16"; type 345-21, Micamold Radio Corp, New York, or equal; Belmont dwg #A-8J-1626.
19-1 to 19-4	3DA10-140.1	CAPACITOR: molded case: 0.01 mf +30% −10%; 400v; 1/4" x 5/8" x 1 5/32"; type 340-21, Micamold Radio Corp, New Yorp, or equal; Belmont dwg #A-8J-696.
33	3DA10-140.2	CAPACITOR: molded case; 0.01 mf ±20%; 600v; Belmont dwg #A-8J-3424.
170-1 to 170-5	2Z7111.61	PLUG: connector; coaxial; straight; female; 1 1/16" lg; American Phenolic Corp, Chicago, #83-1R, or equal; Belmont dwg #A-55A-2071.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			RADIO RECEIVER AND TRANSMITTER BC-1267-A (contd)	
	171-1 to 171-4	2Z7226-259A	PLUG: connector; coaxial; straight; male; 15/64" diam x 1 37/64" lg; type 83-1SP, American Phenolic Corp, Chicago, or equal; Belmont dwg #B-55A-2162.	
		2Z299-359	CONNECTOR: right-angle; male and female; 3/4" diam one leg from C/L of diam is 13/16" lg, other leg is 15/16" lg; type AN-M-359, American Phenolic Corp, Chicago, or equal; Belmont dwg #A-55A-3367.	
		2Z5040-360	HOOD: connector; 0.020" brass; funnel-shaped; base 1" x 1"; base diam 0.635"; tip diam 11/32"; type AN-M-360, American Phenolic Corp, Chicago, or equal; Belmont dwg #A-55A-3519.	
	92	2Z7284.61	POTENTIOMETER: control; dual variable; power measurement 1 meg per sect ±10%; 1 1/4w; shaft diam 1/4" x 0.671" lg; 1/4 threaded, #3/8-32; linear taper; type J; Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #B-10A-3172.	
	91	2Z7284.62	POTENTIOMETER: control; dual variable; power 2 meg per sect ±10%; 1 1/4w; shaft diam 1/4" x 1/8" lg; 1/4 threaded, #3/8-32; linear taper; type C; Stackpole Carbon Co, St. Marys, Pa, Belmont dwg #B-10A-3108.	
	89-1 to 89-2	2Z7271-43	POTENTIOMETER: control; variable; pulse and bias; 100,000 ohm ±10%; 1/2w; shaft diam 1/4" x 1/8" lg; 1/4 threaded, #3/8-32; linear taper; type 35, Chicago Telephone Supply Co, Elkhart, Ind, or equal; Belmont dwg #A-10A-3147.	
	90	3Z7006-3	RHEOSTAT: control; variable; dial light; 6 ohm ±10%; 25w, shaft diam 1/4" x 23/64" lg; 1/4 threaded, #3/8-32; linear taper; type H, Ohmite Mfg Co, Chicago, or equal; Belmont dwg #B-10A-3109.	
		2Z4880-18	DIAL GLASS: 7 7/8" x 1 1/2" x 1/8"; Commercial; Belmont dwg #A-55A-3065.	
		2Z4880-19	DIAL GLASS: has inner surface olive drab for a portion of its lg on both ends; 1 1/2" x 1 1/8" x 1/8"; type BRC, Crowe Nameplate, Chicago, or equal; Belmont dwg #A-55A-3066.	
		2Z4880-20	DIAL GLASS: opaque except for four dial openings, which have hairline indicators; 1 55/64" x 9 1/8" x 1/8"; type BRC, Crowe Nameplate, Chicago; Belmont dwg #A-55A-1055.	
		2Z4928-8	HANDLE: tuning; 0.083" CRS; 1/2" wd x 12 1/2" lg; type BRC; Belmont dwg #A-23A-2821.	
		3G1250-8.15	INSULATOR: stand-off; Belmont dwg #A-5F-3296.	
		3G1100-110.2	INSULATOR: stand-off; porcelain; 6 7/8" x 2 5/8" x 7/16"; strip has twelve 5/32" dial holes; type BRC, Lapp Insulator Co, LeRoy, New York; Belmont dwg #A-7A-4108.	
		3G1838-26.3	INSULATION STRIP: polystyrene; 1 5/8" x 1/8"; strip has three holes; two holes are 5/32" diam, one hole is 0.035" diam; type BRC, American Phenolic Corp, Chicago, or equal; Belmont dwg #A-7A-3439.	
		3G1100-54.1	INSULATOR: grid line; micalex; 1/2" x 3 3/8" x 1/4"; strip has four holes; two holes are 0.147" diam, two are are 0.128" diam; type BRC, Colonial Kolonite Co, Chicago, or equal; Belmont dwg #A-7A-3163.	
		3G1100-101	INSULATOR: ceramic; 4" x 6 5/16" x 1/2"; piece has an opening 3" x 3 3/8"; type BRC, General Ceramics Co, Chicago; Belmont dwg #C-5H-3139.	
		3G1250-10.4	INSULATOR: stand-off; ultra steatite, or equal; 1/2" OD x 5/8" lg; #6-32 tapped both ends 5/16" d; type BRC, General Ceramics Co, Chicago; Belmont dwg #A-5F-1120.	

	3G1838-10.5	INSULATOR: laminated phenolic; 3/8" x 5/8" x 1/32"; has a 0.144" diam hole; type BRC, Lamicoid Fabricators, Chicago; Belmont dwg #A-7A-4145.
150-1 to 150-3	2Z5534A	JACK, telephone: open circuit; bushing lg 1/4 threaded #3/8-32; over-all size, 3/4" diam x 1 13/16" lg; complete with hardware; type J-300, Chicago Telephone Supply Co, Elkhart, Ind; Belmont dwg #A-44A-2960.
151-1 to 151-2	2Z5531.2	JACK: closed circuit; bushing lg 5/16 threaded 3/8-32; over-all size, 1 1/2" x 5/8" x 1 1/16"; complete with hardware; type J-307, Chicago Telephone Supply Co, Elkhart, Ind; Belmont dwg #A-44B-2850.
	2Z5821-16	KNOB: black molded bakelite; 27/32" OD, 1 1/32" lg, 0.252" diam shaft hole; type BRC, Industrial Molded Products, Chicago; Belmont dwg #A-5B-3986.
	2Z5821-15	KNOB: zamak; 1 1/4" OD x 9/16"; shaft hole 0.251" diam x 11/32" d; hole for setscrew is tapped #8-32; type BRC, Central Die Casting Co, Chicago; Belmont dwg #A-4B-1110.
	2Z3095.5	JUMPER: Belmont dwg #A-26D-3597.
	2Z5821-14	KNOB: zamak; has arm projecting from 3/4" diam hub; shaft hole 0.251" diam x 11/32" d w/a 5/8" diam x 5/32" d counterbore; over-all dimen 1 7/8" x 3/4" x 5/8"; holes for setscrews are 120° apart, tapped #8-32; type BRC, Central Die Casting, Chicago, Belmont dwg #A-4B-1553.
	2Z5821-13	KNOB: screwdriver type; steel; knurled; OD 1", lg 1/2", shank 33/64" lg; diam is 3/8" except for 0.143" of its lg which is 1/2 x 20 thd; screwdriver tip is 1/16" x 7/32" x 0.045"; over-all lg is 1 9/16"; type BRC, Hudson Screw Co, Chicago; Belmont dwg #B-3F-2849.
	2Z5698	KEY: tube; shield; steel; T-shaped; arm of T is 3/4" x 2 1/4"; stem is 7/8" x 1"; material is 0.059"; type BRC; Belmont dwg #A-2H-4236.
190-1 to 190-4	2Z5927	LAMP: pilot light; bayonet base; 6.3v, 0.4w; type 44 Mazda; GE, Chicago, or equal; Belmont dwg #A-16A-1621.
	3F25025	METER: head dimen, 3 1/2" diam x 1 9/64"; body dimen, 2 13/16" diam x 1 1/2" w/two 1/4"-28 studs protruding out 1"; bakelite case; scale limits are 0-10 ma and 0-1 kw; type DO 41-44-46, General Electric, Chicago, or equal; Belmont dwg #B-55A-3530.
180	2Z7131.6	PLUG ASSEMBLY: 21 cont; high-voltage; type BRC; Lapp Insulator Co; Belmont dwg #C-201-546-4.
181	2Z7120.8	PLUG ASSEMBLY: 10 cont; pulse connector; male; type BRC; Potter-Brumfield Mfg Co; Belmont dwg #B-201-579.
182	2Z8680-6	SOCKET ASSEMBLY: 10 cont; pulse connector; female; type BRC; Potter-Brumfield Mfg Co; Belmont #B-201-578.
	2Z8050-3	ROD, release: black linen bakelite; 0.140" diam x 18.323" lg; type BRC; Micarta Fabricators & Co, Chicago; Belmont dwg #A-3P-2819.
71-1 to 71-3	3RC20BE224K	RESISTOR: carbon; 220,000 ohm ±10%; 1/2w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-90.
62-2 to 62-3	3RC20BE332K	RESISTOR: carbon; 3,300 ohm ±10%; 1/2w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-68.
58	3RC20BE223K	RESISTOR: carbon; 22,000 ohm ±10%; 1/2w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-78.
B1	3RC30BE392K	RESISTOR: fixed; carbon; 3,900 ohm ±10%; 1w; 9/16" lg x 7/32" diam; AWS type #RC30BE392K; AWS spec C-75.7-1943; bakelite insulation; two axial wire leads 1 1/2" lg; Belmont dwg/part #A-9B2-69.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			RADIO RECEIVER AND TRANSMITTER BC-1267-A (contd)	
	73-1 to 73-4	3RC20BE221K	RESISTOR: carbon; 220 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-54.	
	70-1 to 70-3	3RC20BE103K	RESISTOR: carbon; 10,000 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-74.	
	50-1 to 50-5	3RC20BE104K	RESISTOR: carbon; 100,000 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-86.	
	79-1 to 79-6	3RC20BE105M	RESISTOR: carbon; 1 meg ±20%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, equal; Belmont dwg #A-9B1-31.	
	63-1 to 63-2	3RC20BE472K	RESISTOR: carbon; 4,700 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-70.	
	88-1 to 88-2	3RC20BE474K	RESISTOR: carbon; 470,000 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-94.	
	93-1 to 93-4	3RC20BE470K	RESISTOR: carbon; 47 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-46.	
	69	3Z6850-4	RESISTOR: carbon; 50 meg ±20%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-3253.	
	52-1 to 52-4	3RC20BE222K	RESISTOR: carbon; 2,200 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-66.	
	65-1 to 65-3	3RC20BE101K	RESISTOR: carbon; 100 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-50.	
	68-1, 68-2, 68-3, 68-5	3RC20BE392K	RESISTOR: carbon; 3,900 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-69.	
	54-1 to 54-3	3RC30BE682K	RESISTOR: carbon; 6,800 ohm ±10%; 1w; 3/16" diam x 1¼" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-72.	
	85	3RC30BE102K	RESISTOR: carbon; 1,000 ohm ±10%; 1w; 3/16" diam x 1¼" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-62.	
	51-1 to 51-2	3Z6025-63	RESISTOR: carbon; 250 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-2709.	
	55	3RC20BE272K	RESISTOR: carbon; 2,700 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-67.	
	56	3RC20BE682K	RESISTOR: carbon; 6,800 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-72.	
	57	3RC20BE684K	RESISTOR: carbon; 680,000 ohm ±10%; ½w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-96.	

66	3RC20BE471K	RESISTOR: carbon; 470 ohm ±10%; 1/2w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee Wis, or equal; Belmont dwg #A-9B1-58.
94	3RC20BE152K	RESISTOR: carbon; 1,500 ohm ±10%; 1/2w; 3/16" diam x 5/8" lg; type EB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B1-64.
59-1 to 59-6	3RC30BE332K	RESISTOR: carbon; 3,300 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-68.
74	3RC30BE562K	RESISTOR: carbon; 5,600 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-71.
67-1 to 67-6	3RC30BE104K	RESISTOR: carbon; 100,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-86.
78-2 to 78-5	3RC30BE274K	RESISTOR: carbon; 270,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-91.
80-1 to 80-2	3Z6720-19	RESISTOR: carbon; 200,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-3755.
84	3RC30BE473K	RESISTOR: carbon; 47,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-82.
53-1 to 53-3	3RC30BE683K	RESISTOR: carbon; 68,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-84.
60	3RC30BE471K	RESISTOR: carbon; 470 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-58.
95-1 to 95-3	3RC30BE223K	RESISTOR: carbon; 22,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-78.
83-1 to 83-5	3RC30BE124K	RESISTOR: carbon; 120,000 ohm ±10%; 1w; 5/16" diam x 1 1/4" lg; type GB, Allen Bradley Co, Milwaukee, Wis, or equal; Belmont dwg #A-9B2-87.
82-1 to 82-4	3Z6768-14	RESISTOR: carbon; 600,000 ohm ±20%; 2w; 3/8" diam x 1 7/16" lg; type #2, Speer Resistor Corp, or equal; Belmont dwg #A-9B4-3219.
86	3Z5997-9	RESISTOR: WW; 7.8 ohm ±2%; 1/2w; 23/32" diam x 3/4" lg; type WW-7, International Resistance Corp, Philadelphia, Pa; Belmont dwg #A-9C-3532.
	6L17504-28Z2	SCREW, thumb: steel; captive; knurled; over-all lg 1 1/8"; head is knurled, 1/2" diam x 5/8" lg; shank is 7/8" lg and has 5/16" of lg threaded #1/4-28; shank has 0.203" diam; type BRC; Hudson Screw Machine, Chicago, Belmont dwg #A-3F-2782.
	6L4766-13-1N	SCREW, thumb: brass; captive; knurled; over-all lg 27/32"; head is knurled, 3/8" diam x 3/32" lg; shank is 3/4" lg and has 1/4" of its lg threaded #6-32 thd; shank has 0.099" diam; type BRC; Rentscher Tool & Machine Works, Chicago; Belmont dwg #A-3C-554.
	2Z5883-19	LAMP SOCKET ASSEMBLY: pilot light and bracket; bayonet type; socket has one term; over-all of assem 1/4" diam x 1 1/4" lg; type BRC; Micarta Fabricators, Chicago; Belmont dwg #A-17A-3220

2Z8650.5	SOCKET: bakelite; for mtg std octal tubes; type 9950, Cinch Mfg Co, Chicago, or equal; Belmont dwg #A-15B-1462.
2Z8678.93	SOCKET: mica-filled bakelite for mtg std octal tubes; 8 cont; 1½ NC, Cinch Mfg Co, Chicago, or equal; Belmont dwg #A-15B-1142.
2Z8677.30	SOCKET: mica-filled bakelite; midget type; 7 cont; type BRC; Cinch Mfg Co, Chicago; Belmont dwg #A-15C-3746.
2Z8677.5	SOCKET: mica-filled bakelite; midget type; 7 prong; type 78-7 P; American Phenolic Corp; Belmont dwg #A-15C-1041.
2Z8877.11	TUBE SHIELD: spring; spiral; music wire; 0.035" thd; ¾" diam tapering to 9/16" diam; ⅝" lg; type BRC; Cinch Mfg Co, Chicago; Belmont dwg #A-49A-1269.
2Z8878-24	SPRING: music wire; compression; 0.292" diam x ⅞" lg; type BRC; International Spring Co, Chicago; Belmont dwg #A-49A-4166.
3Z9825-60.2	SWITCH, rotary: test; three-position; three-wafer; dimen of body, 2" diam x 1⅝" lg; shaft ¼" diam x 15/16"; ¼ threaded #⅜-32 thd; type QH3; Oak Mfg Co, Chicago, or equal; Belmont dwg #B-20D-3260.
2Z9428-4	TERMINAL BOARD ASSEM: wiring; 28 lugs, plus two mtg studs 0.437" lg and tapped for #8-32 screw, 0.281" d; cloth base laminated phenolic; dimen 5⅞" x 1½" x 0.093"; mtg/c 5¼" apart, Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #B-201-697.
2Z9401.25	TERMINAL BOARD ASSEM: wiring; one lug, w/0.147" diam mtg hole, 3/16" from edge of board; cloth base laminated phenolic; dimen 13/16" x 9/16" x 3/32" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-439.
2Z9403.42	TERMINAL BOARD ASSEM: wiring; three lugs, w/two 0.136" diam mtg holes 9/16" apart; cloth base laminated phenolic; dimen 1 1/16" x ¾" x 0.093" thk; stamped B5; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-896.
2Z9401-27	TERMINAL BOARD ASSEM: wiring; one lug, w/two 0.56" diam mtg holes 1⅞" apart, 3/16" from edge of board; cloth base laminated phenolic; dimen 2¼" x ⅞" x 0.093" thk; stamped 33-1, 33-2; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-803.
2Z9414.15	TERMINAL BOARD ASSEM: wiring; 14 lugs, plus two mtg studs 0.437" lg and tapped for #8-32 screw, 0.281" deep; mtg/c 3" apart; cloth base laminated phenolic; dimen 3½" x 1⅞" x 0.093" thk; stamped 105-5, 68-5, 67-5, 81, 67-4, 68-3; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-718.
2Z9404.45	TERMINAL BOARD ASSEM: wiring: four lugs w/two 0.156" diam mtg holes 1¾" apart; ¼" from edge of board; cloth base laminated phenolic; dimen 2¼" x ½" x 0.93" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-687.
2Z9426-1	TERMINAL BOARD ASSEM: wiring; 26 lugs, plus two mtg brackets w/0.156" diam hole, mtg/c 4 3/16" apart; dimen 6⅜" x 1⅞" x 0.033" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #B-201-501.

	2Z9402.73	TERMINAL BOARD ASSEM: wiring: 14 lugs, plus two mtg studs 0.437" lg and tapped for #8-32 screw, 0.281" d; mtg/c 2¼" apart, 15/16" from edge of board; cloth base laminated phenolic; dimen 3" x 1⅞" x 0.093" thk; stamped 19-2, 73-4, 78-5, 78-4, 62-5, 83-5, 83-4, 83-3, 10-3; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-823.
	2Z9409.12	TERMINAL BOARD ASSEM: wiring; three lugs and two tube socket cont; triangular in shape; dimen 1¾" x 15/16" x 5/16" thk; ceramic material; stamped 93-3, 93-4; plate connection for 3E29 tube; Belmont dwg #A-201-850.
	2Z9402.25	TERMINAL BOARD ASSEM: wiring; two lugs, w/two 0.147" diam mtg holes ¼" from edge of board; mtg holes 2½" apart; cloth base laminated phenolic; dimen 2⅞" x ½" x 0.093" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-101.
	2Z9414.13	TERMINAL BOARD ASSEM: wiring; 14 lugs, plus two mtg studs 0.437" lg and tapped for #8-32 screw, 0.281" deep; mtg/c 2¼" apart and 15/16" from edge of board; cloth base laminated phenolic; dimen 3" x 1⅞" x 0.093" thk; stamped 16-3-4, 62-4, 52-3, 95-3, 78-2, and 84; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-580.
	2Z9408.27	TERMINAL BOARD ASSEM: wiring; eight lugs, w/two 0.128" diam mtg holes 15/16" from edge of board; mtg holes 3⅜" apart; cloth base laminated phenolic; dimen 3¾" x 1⅝" x 0.093" thk; stamped 114-3, 114-1, 114-4, 114-1; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-657.
	2Z9420.8	TERMINAL BOARD ASSEM: wiring; 20 lugs, w/three 0.136" diam mtg holes 15/16" from edge of board; cloth base laminated phenolic; dimen 6⅜" x 1⅜" x 0.093" thk; stamped 105-1, 54-2, 53-2, 105-2; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-540.
108	2Z9643.40	TRANSFORMER: 3d IF; permeability tuned; housing dimen 3⅝" x 1½" x 1½"; type 41-382, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13H-3134.
109	2Z9643.39	TRANSFORMER: 4th IF; permeability tuned; housing dimen 3¾" x 1½" x 1½"; type 41-383, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13H-3129.
110	2Z9643.38	TRANSFORMER: 5th IF; permeability tuned; housing dimen 3¾" x 1½" x 1½"; type 41-384, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13B-3128.
111	2Z9643.43	TRANSFORMER: IF; 2d detector; permeability tuned; housing dimen 3¼" x 1½" x 1½"; type 41-385, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13H-3130.
112	2Z9643.44	TRANSFORMER: eye tuning; permeability tuned; housing dimen 3⅞" x 1½" x 1½"; type 41-386, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13H-3133.
	2Z9401.26	TERMINAL BOARD ASSEM: wiring; one lug, w/0.144" diam mtg hole 5/16" from edge of board; cloth base laminated phenolic; dimen ⅝" x ⅜" x 0.093" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-556.
	2Z9402.64	TERMINAL BOARD ASSEM: wiring; two lugs, w/two 0.110" diam mtg holes ½" from edge of board; mtg holes 115/16" apart; cloth base laminated phenolic; dimen 127/32" x ½" x 0.093" thk; Anchor Tool & Die Co, Chicago, or equal; Belmont dwg #A-201-89.
118	2Z9638-14	TRANSFORMER: blocking oscillator with tertiary winding; turns ratio: pri to secd No. 1, 1 to 0.503 ±5%,

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			RADIO RECEIVER AND TRANSMITTER BC-1267-A (contd)	
	107	2Z9643.41	TRANSFORMER: 2d IF; permeability tuned; housing dimen, 3⅜" x 1½" x 1½"; type 41-381, Aladdin Radio Industries, Inc, Chicago; Belmont dwg #B-13H-3131.	
		6L58504	WASHER: locking; special OD 13/16" slot, 0.281" wd; projection 15/32" at right angle to its face; material 0.078"; type BRC; Craft Mfg Co, Chicago; Belmont dwg #A-29H-2822.	
		2J6SN7GT	TUBE: 6SN7-GT (VT-231).	
		2J6V6GT	TUBE: 6V6-GT (VT-107-A).	
		2J2C26	TUBE: 2C26.	
		2J3E29	TUBE: 829A (3E29).	
		2J6J5	TUBE: 6J5 (VT-94-D).	
		2J9006	TUBE: 9006.	
		2J6AK5	TUBE: 6AK5.	
		2J6C4	TUBE: 6C4.	
		2J6AG5	TUBE: 6AG5.	
		2J6H6	TUBE: 6H6 (VT-90).	
		2J6E5	TUBE: 6E5 (VT-215).	
			POWER SUPPLY RA-105-A	
	63	3C323-4H	CHOKE: #32 enamel; 0.00795" diam; 162 turns per layer; 51 layers; 1 27/32" wd coil; 466-001-143, Jefferson Electric Co; case 4⅜" lg x 1 35/64" wd x 3 15/16"; Belmont dwg #C-17A-2841.	
	62	3C323-4J	CHOKE: dual; #28 enamel; 0.012641" diam, 3,450 turns; 1 27/32" wd; 466-001-117, Jefferson Electric Co; case 7¾" x 3 15/16" x 3 35/64"; 4.416" mtg/c; Belmont dwg #D-17A-2785.	
	43	3H900-0.04	CIRCUIT BREAKER: one pole; single throw; 117v working, 50 to 60 cycles, 0.040 to 0.050 amps, max resistance 5,000 ohms; curve special; type AM-1515-RS-PU.01, Heinemann Electric Co, or equal; Belmont dwg #B-20C-2826.	
	44	3H900-10-4	CIRCUIT BREAKER: one pole; single throw; 117.5v, 50 to 60 cycles, 10 amps; curve No. 1; type AM-1515-10, Heinemann Electric Co, or equal; Belmont dwg #B-20C-3591.	
	6-1 to 6-2	3DA200-14	CAPACITOR: oil-filled; 200,000 mmf +20% −10%; 5,000 vdcw; 5" lg x 3¾" wd x 1¾" thk; 4⅜" mtg/c; type 2-1416 as made by John E. Fast & Co, or equal; Belmont dwg #C-8B-2784.	
	5	3DB2.3044	CAPACITOR: oil-filled; 2 mf +20% −10%; 400 vdcw; 2" sq x 1⅛" thk; 2⅜" mtg/c; type x DM RAW-2, made by Solar Mfg Corp; Belmont dwg #A-8B-1254.	
	7	3DB1.1104	CAPACITOR: oil-filled; 1 mf +20% −10%; 400 vdcw; 2" wd x 1¾" h x ¾" thk; 2⅜" mtg/c; type x DM RAW-1 as made by Solar Mfg Corp; Belmont dwg #A-8B-1104.	

3-1 to 3-2	3DB4-87	CAPACITOR: oil-filled; 4 mf +20% −10%; 600 vdcw; 4⅝″ lg x 2¼″ wd x 1¼″ thk; 3″ mtg/c; type P-3040, Sprague Specialties Co, or equal; Belmont dwg #B-8B-1253-1.
1	3DB7-3	CAPACITOR: oil-filled; 7 mf +20% −10%; 800 vdcw; 4¼″ lg x 3¾″ wd x 1¾″ thk; 4⅝″ mtg/c; type 6848; Sprague Specialties Co, or equal; Belmont dwg #C-8B-2842.
4	3DB2.3042	CAPACITOR: oil-filled; 2 mf +20% −10%; 1,000 vdcw; 4⅝″ lg x 1⅞″ wd x 1⅛″ thk; 2¼″ mtg/c; type P-3042, Sprague Specialties Co, or equal; Belmont dwg #B-8B-1252-1.
2-1 to 2-3	3DB7-2	CAPACITOR: oil-filled; 7 mf +30% −10%; 600 vdcw; 4⅝″ lg x 3¾″ wd x 1¾″ thk; 4⅜″ mtg/c; type BM-324-19, Micamold Radio Corp; Belmont dwg #B-8C-1139.
72-1 to 72-2	3Z1946	FUSE: cartridge; 5 amp, 250v; catalog #3-Ag., Littelfuse Inc, or equal; Belmont dwg #A-46B-2719.
71-1 to 71-2	3Z1926	FUSE: cartridge; 1 amp, 250v; catalog #3-Ag., Littelfuse Inc, or equal; Belmont dwg #A-46B-2718.
70-1 to 70-4	3Z1950	FUSE: cartridge; 3 amp, 250v; catalog #3-Ag., Littelfuse Inc, or equal; Belmont dwg #A-46B-1109.
	3Z3275-1	FUSE HOLDER: 2⅜″ lg x 1¹⁄₁₆″ diam; two term; type #3-Ag., Littelfuse Inc, or equal; Belmont dwg #A-55A-2716.
	2Z2724	GRID CLIP: brass; 0.375″ wd x 0.875″ lg; cat. No. 24, National Radio Products; Belmont dwg #A-26D-757-2.
	3G1300-46	INSULATOR: feed-through; ceramic; ⅜″ OD x 2⅞″ lg; cat. No. 40, E. F. Johnson Co; Belmont dwg #A-55E-2778.
	3G1250-24.10	INSULATOR: ceramic; ½″ OD x 1½″ lg; Centralab; Belmont dwg #A-5G-2777.
	2Z3095.5	JUMPER: formed; 0.375″ centers; 0.312″ h x 0.125″ wd; 0.008″ spring temp; phosphor bronze; BRC; Crescent Tool & Die; Belmont dwg #A-26D-3597.
35-1 to 35-4	2Z5941	LAMP: pilot light; candelabra base; 117v, 6w; (preferred) 117v, 3w; type S-6, Westinghouse Electric & Mfg Co, or equal; Belmont dwg #A-46A-1622 or A-46A-4189.
5	2Z6125-53	CAP, indicator light: brass; over-all dimen approx 1³⁄₁₆″ lg x 1⅛″ diam; shutter to dim-out light; red glass faceted jewel; p/o indicator light assem; Gothard #1504; Belmont dwg/part No. A-55A-6945-3.
6	2Z6125-52	CAP, indicator light; brass; over-all dimen approx 1³⁄₁₆″ lg x 1⅛″ diam; shutter to dim-out light; amber glass faceted jewel; p/o indicator light assem; Gothard #1504; Belmont dwg/part #A-55A-6945-4.
7	2Z5882-50	SOCKET, indicator light: bakelite socket; brass body; nickel-plated; holder for Mazda 6-3-6 screw type lamp; 75w, 125v; over-all dimen approx 2⅜″ lg x 1⁹⁄₃₂″; p/o indicator light assem; Gothard #1504; Belmont dwg/part #A-55A-6945-5; (furnished w/fibre washer 1″ ID x 1¼″ OD; steel hex nut 1″ ID x 1⅛″ across flat; two straight term lugs w/two #6-32 x ³⁄₁₆″ brass machine screws; mts on panel in 1″ diam hole).
30	2Z8690-7	SOCKET ASSEMBLY: plug assembly; 20 cont; high-voltage; type BRC; Lapp Insulator Co; Belmont dwg #C-201-546-1.
18	3RC20BE152K	RESISTOR: fixed; carbon; 1,500 ohm ±10%; ½w; ⅝″ lg; ³⁄₁₆″ diam; type EB, Allen Bradley Co, Belmont dwg #A-9B1-64.
25	3RC30BE184K	RESISTOR: fixed; carbon; 180,000 ohm ±10%; 1w; 1¼″ lg; ⁵⁄₁₆″ diam; type GB, Allen Bradley Co; Belmont dwg #A-9B2-89.
20	3RC20BE224K	RESISTOR, fixed: carbon; 220,000 ohm ±10%; 1w; 1¼″ lg; ⁵⁄₁₆″ diam; type GB, Allen Bradley Co; Belmont dwg #A-9B2-90.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			POWER SUPPLY RA-105-A (contd)	
	15	3RC30BE155M	RESISTOR: fixed; carbon; 1.5 meg ±20%; 1w; 1¼" lg; 5/16" diam; type GB, Allen Bradley Co, Belmont dwg #A-9B2-32.	
	22-1 to 22-2	3RC30BE124K	RESISTOR: fixed; carbon; 120,000 ohm ±10%; 1w; 1¼" lg; 5/16" diam; A.B., Allen Bradley Co; Belmont dwg #A-9B2-87.	
	21	3RC40AE154M	RESISTOR: fixed; carbon; 150,000 ohm, ±20%; 2w; 1 7/16" lg; 3/8" diam; S2, Speer Resistor Corp; Belmont dwg #A-9B4-26.	
	19-1 to 19-3	3RC40AE224M	RESISTOR: fixed; carbon; 220,000 ohm ±20%; 2w; 1 7/16" lg; 3/8" diam; S2, Speer Resistor Corp; Belmont dwg #A-9B4-27.	
	23	3RC40AE682K	RESISTOR: fixed; carbon; 6,800 ohm ±10%; 2w; 1 7/16" lg; 3/8" diam; S2, Speer Resistor Corp; Belmont dwg #A-9B4-72.	
	16-1 to 16-4	3RC40AE105M	RESISTOR: fixed; carbon; 1 meg ±20%; 2w; 1 7/16" lg; 3/8" diam; S2, Speer Resistor Corp; Belmont dwg #A-9B4-31.	
	17	3RC40AE684K	RESISTOR: fixed; carbon; 680,000 ohm ±10%; 2w; 1 7/16" lg; 3/8" diam; S2, Speer Resistor Corp; Belmont dwg #A-9B4-96.	
	24	3Z6033-20	RESISTOR: WW; 330 ohm ±10%; 5w; 1 27/32" lg; x 15/32" diam; Koolohm 5K, Sprague Specialties Co; Belmont dwg #A-9C-3668.	
		2Z8678.91	SOCKET: tube; ceramic; for mtg standard octal tubes; type 40C-uie, National Fabricated; Belmont dwg #A-15A-2739.	
		2Z8674.15	SOCKET: molded; for high-voltage rectifiers; type 77 A4T, American Phenolic Corp; Belmont dwg #A-15B-2779.	
	40	3Z9824-275.2	SWITCH: interlock; used on rear of chassis; 3 amp, 250v, or 5 amp, 125v; type C.H.-7190, Cutler Hammer, Inc; Belmont dwg #A-20F-2776.	
		3G1100-62	TERMINAL BOARD: ceramic; 3⅛" lg x 2¾" wd x ⅜" thk; 7 holes 0.187" diam; Centralab; Belmont dwg #A-7A-3618.	
		2Z9402-75	TERMINAL BOARD ASSEMBLY: wiring; two lugs, plus two mtg studs 0.437" lg; tapped for an #8-32 screw; cloth base, laminated phenolic insulation; dimen 2¼" x 1" x 0.093" thk; mtg/c of studs 1½" apart; Anchor Tool & Die Co; Belmont dwg #A-201-743.	
	56	2Z9611.126	TRANSFORMER: filament: low-voltage; 464-001-110, Jefferson Electric Co; Belmont dwg #D-12A-2838.	
	57	2Z9611.127	TRANSFORMER: filament; high-voltage; 464-001-111, Jefferson Electric Co; Belmont dwg #D-12A-2792.	
	58	2Z9612.64	TRANSFORMER: plate; high-voltage; 465-001-142, Jefferson Electric Co; Belmont dwg #D-12A-2786.	
	59	2Z9612.61	TRANSFORMER: plate; low-voltage; 465-001-141, Jefferson Electric Co; Belmont dwg #D-12A-2811.	
		2J2X2	TUBE: 2X2 (VT-119).	
		2J5U4G	TUBE: 5U4G (VT-244).	

	2J6X5GT	TUBE: 6X5-GT (VT-126-B).
	1B1120.3	WIRE: #20 solid aeroglas; white.
	1B1316.9	WIRE: #16 strand, #30 aeroglas; white Tr.
	1B1114.1	WIRE: #41 strand, #30 aeroglas; white.
	1A814.5	WIRE: #14 solid tin; copper.
	1A107	WIRE: #20 solid tin; copper.
		RACK FM-93
12	3H900-7-1	BREAKER, circuit: magnetic type; single pole; 7 amp, 117.5v, resistance 0.02 ohms max; bakelite case; $3\frac{23}{32}$" lg x 0.990" wd x $2\frac{39}{64}$" h; Heinemann; Belmont part/dwg #B-20C-2783.
13	3H900-1.5-1	BREAKER, circuit: magnetic type; single pole; 117.5v, 1.0 amp, 0.85 ohms; bakelite case; $3\frac{23}{32}$" lg x 0.990" wd x $2\frac{39}{64}$" h; Heinemann; Belmont part/dwg #B-20C-3590.
	2Z1612.13	CAP AND CHAIN: connector; aluminum; sand blast; $1\frac{1}{2}$" OD x $\frac{7}{16}$" thk x $1\frac{3}{8}$" ID; #18 thd; chain $3\frac{1}{2}$" lg; Amphenol #9760-22; Belmont dwg/part #B-55A-1276.
	2Z1612.21	CAP AND CHAIN: connector; sand blasted; $1\frac{7}{8}$" OD, $\frac{1}{2}$" wd, $1\frac{3}{4}$" ID, #18 thd; chain $3\frac{15}{16}$" lg; link $\frac{1}{2}$" between centers; Amphenol #9760-28; Belmont dwg/part #B-55A-4198.
2A	3Z1003-4	CLAMP, cable: steel; iridite; $\frac{11}{16}$" OD, 0.032" thk, $\frac{1}{2}$" wd; two 0.199" diam mtg holes; Tinnerman A3046S-11; Belmont #A-2M-7155 (extruded, synthetic channel for cable approx $\frac{5}{8}$" OD).
3A	3Z1003-4.1	CLAMP, cable: steel; iridite; $\frac{7}{16}$" OD, 0.032" thk, $\frac{3}{8}$" wd; two 0.173" diam mtg holes; Tinnerman A3046S-7; Belmont #A-2M-7156 (extruded, synthetic channel for cable approx $\frac{3}{8}$" OD).
5	6Z7784.2	CONNECTOR: female cont; three spring polarized cont; straight type; $2\frac{3}{16}$" diam of base, $\frac{15}{16}$" h, $1\frac{11}{16}$" diam of shell; Amphenol #60-F18; Belmont dwg/part #A-19B-4086.
8	2Z7134.5	CONNECTOR: 18 rectangular male cont; two female cont; straight type; over-all dimen $5\frac{15}{16}$" lg x $2\frac{15}{16}$" wd, approx $2\frac{23}{32}$" h; Lapp; Belmont part/dwg #C-201-545-1.
7	2Z8694.2	CONNECTOR: female cont; 24 spring female cont; straight type; over-all dimen $5\frac{15}{16}$" lg x $2\frac{15}{16}$" wd, approx $2\frac{23}{32}$" h, Lapp; Belmont part/dwg #C-201-545-4.
5	2Z7113.8	CONNECTOR: male cont; three rectangular polarized cont; straight type; $2\frac{1}{8}$" lg over-all x $1\frac{3}{16}$" diam; Amphenol #60-M11; Belmont part/dwg #A-19A-4085.
10	2Z7112.6	CONNECTOR: two round male cont; straight type; 1.343" lg x 1.250" diam, mtg base 1.625" x 1.625"; #18 thd; Amphenol #AN-3102-22-8P; Belmont dwg/part #A-55A-1275.
6	2Z8799-190	CONNECTOR: female cont; six small female cont, three large female cont; straight type; over-all lg $1\frac{11}{32}$"; $1\frac{3}{4}$" OD on thd end, $1\frac{5}{8}$" on other end; #18 thd; Amphenol #AN-3102-28-1S; Belmont dwg/part #A-55A-6946; cylindrical die cast body; molded black bakelite insert; mtg base $\frac{7}{16}$" from end 2" x 2"; $1\frac{9}{16}$" mtg/c; four holes 0.147" diam.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			RACK FM-93 (contd)	
	9	2Z4866.205	GASKET, rubber: to waterproof rack; 1" wd x 3/8" thk; rectangular; 27.890" x 24.890" wd; Belmont part/dwg #C-25H-7018.	
		2Z3095.5	JUMPER: rectangular shape; 0.125" wd x 0.008" thk x 0.375" lg x 0.312" h; phosphor bronze; Crescent; Belmont part/dwg #A-26D-3597.	
	15-2	2Z5941	LAMP, incandescent; 115 to 120v, 6w; clear bulb; 1 7/8" lg, candelabra base; Wemco S-6; Belmont part/dwg #A-46A-4189.	
	1 2 3	3H3000-50	MOTOR, blower and heater unit: type L, shaded pole induction motor; iron; inside finished w/red iron oxide primer; external finish lusterless olive drab enamel; 117.5v, 0.38 amp, 50 to 60 cycles, 1,425 rpm; over-all lg 10 15/16", over-all wd 6 19/64", over-all h 5 13/16"; two heating units and two 28-blade blowers in unit; AG Redmond & Co; Belmont dwg #D-55A-4080.	
	11	3Z6075-62	RESISTOR, fixed: WW; 750 ohms ±10%; 25w; 23/32" diam x 2 7/8" lg; Sprague #25KT, type Y797; Belmont #A-9C-7181; ceramic insulation; ceramic core; (two straight copper tinned term 5/8" lg).	
	9	3Z9824-275.3	SWITCH, interlock: DPST; bakelite; 117.5v; 7 amp; 2 1/4" lg x 1" wd x 2 5/32" h; Cutler-Hammer part #M-75957W3; Belmont part/dwg #A-20F-3866.	
		6Z7809-5	RECEPTACLE: dual outlet; black bakelite; power outlet; 15 amp, 125v; Hubbell #9200; Belmont part/dwg #A-5E-3868.	
	10	2Z6125-53	CAP, indicator light: brass; over-all dimen approx 1 5/16" lg x 1 1/8" diam; shutter to dim-out light; red glass faceted jewel; p/o indicator light assem; Gothard #1504; Belmont dwg/part #A-55A-6945-3.	
	11	2Z5882-50	SOCKET, indicator light: bakelite socket; brass body; nickel pl; holder for Mazda 6-3-6 screw type lamp; 75w; 125v; over-all dimen approx 2 7/8" lg x 1 9/16"; p/o indicator light assem; Gothard #1504; Belmont dwg/part #A-55A-6945-5; (furnished w/fibre washer 1" ID x 1 1/4" OD; steel hex nut 1" ID x 1 1/8" across flats; two straight term lugs w/two #6-32 x 3/16" brass machine screws; mounts on panel in 1" diam hole).	
			INSTALLATION CABLES AND MOUNTING HARDWARE	
		3E1999-342	CABLE ASSEMBLY: rack to a-c supply; type S portable cable; flexible; approx 10 ft lg; two #14 stranded cond; Sig C CD-1342; insulated w/type WB rubber compound; color coded; jacketed with WPB, type WD rubber compound; 9/16" max OD; Amphenol #AN-3106-22-8S connector at one end and Amphenol #AN-3106-22-8P connector at other end; Belmont dwg #C-201-1395.	
		2Z8672.9	CONNECTOR, female; two #12 cont, 1/8" spacing; straight; 2 7/8" lg over-all x 1 19/32" diam at insertion, 23/32" insertion; Amphenol AN-3106-22-8S; aluminum body; cable opening 1 13/16"; p/o cable assem Belmont C-201-1395, Belmont dwg #C-55A-2328.	
		2Z7112.42	CONNECTOR, male: two #12 cont, 1/8" spacing; straight; 2 1/8" over-all lg x 1 19/32" OD; AN-3106-22-8P; Belmont dwg #C-55A-1695.	
		2Z2636-3	CLAMP, cable: aluminum; sand blast; over-all lg 1 5/16" x 1 3/8" OD x 15/16" ID; with saddle clamp for cable with max OD of 1"; Amphenol #AN-3057-12; Belmont dwg #B-55A-4401-1.	
		3G-1837-21	SLEEVE, cable: fibre; varnish coated; 21/32" wd, 15/32" outer radius x 1/4" inner radius; Belmont dwg #A-3C-1791.	

13	1F4B8-10.300	CABLE ASSEMBLY: antenna; RG-8/U cable; coaxial; flexible; approx 25 ft lg; single cond #12; 7 strands of #21 bare copper wire; SigC CG-55/U; polyethylene dielectric; single braid copper shield; vinyl outer covering; 0.405" max OD; AN Plug UG-21/U at ea end; Belmont dwg #B-201-1556.
	2Z7390-21	CONNECTOR, female; single cont pin; straight; 2" lg over-all x 3/4" OD at insertion; AN Plugs UG-21/U; p/o cable assembly Belmont #B-201-1556; Belmont dwg #A-55A-6741.
	1F432-1343	CABLE ASSEMBLY: synch input to rack; RG-8/U cable; coaxial; flexible; approx 10 ft lg; single cond #12; 7 strands of #21 bare copper wire; Belmont SigC CD-1343; polyethylene dielectric; single braid copper shield; vinyl outer covering; max OD 0.405"; w/Belmont #B-55A-2244, SigC PL-259, male connector at one and and Belmont A-55A-3494, SigC #2Z7111.102; Jones type P-201, male connector at other end; Belmont dwg #B-201-1394.
	1C814-2	CABLE, flexible: covered with WPB type W.D. rubber compound; OD 0.530"; two #14 AWG stranded conductors; 84 strands of 0.0071" copper wire; GE cordx type 8; (conductors insulated with WPB type WB rubber compound, color-coded); Belmont dwg/part #B-145; used in cable assembly; Belmont dwg #C-201-1395.
	1F425-8	CABLE, RF: RG-8/U; coaxial; flexible; impedance 52 ohms; single-stranded conductor #12 AWG; 7 strands of #21 bare copper wire; polyethylene dielectric; single braid copper shield; vinylite outer covering; OD 0.405"; 10 ft used in cable assembly Belmont dwg #B-201-1394; 25 ft used in cable assembly Belmont dwg #B-201-1556.
	2Z7226-259	CONNECTOR, male: Plug PL-259; straight; over-all lg approx 1 37/64" x 23/32" diam; Amphenol p/o cable assembly Belmont dwg/part #B-201-1394; Belmont dwg #B-55A-2244.
	2Z7111.102	CONNECTOR, male: straight; single prong; over-all lg 1 3/16" x 7/8" OD; Jones P-201; p/o cable assem Belmont dwg/part #B-201-1394; Belmont dwg #A-55A-3494.
	3E7144-27	CABLE ASSEMBLY: rack to control unit; 7-cond; flexible; approx 8 ft lg; #16 stranded, 0.085" rubber insulation; vinyl outer covering; max OD 1"; AN-3106-28-8S connector at one end and AN-3106-26-1P connector at other end; ea connector fastened w/cable clamp AN-3057-16; Belmont dwg #C-201-1634.
	1B3L18-7.2	CABLE, power: jacketed within a cotton wrap and a vinylite jacket over-all w/a wall thickness of 0.062" to 0.080"; 1" OD; seven shielded stranded conductors, each comprised of 7 strands of #26 AWG bare copper wire (insulated with polyethylene dielectric, covered w/a color-coded lacquered cotton braid and an 85% tin copper braid); used in cable assembly Belmont dwg #C-201-1634.
	2Z7122.27	CONNECTOR, female: two #12 cont 3/16" spacing and ten #16 cont 1/8" spacing; straight; 2 1/4" lg over-all, 1 31/32" diam at insertion, 23/32" insertion; Amphenol #AN-3106-28-8S; aluminum body; cable opening 1 7/16"; p/o cable assembly #C-201-1634; Belmont dwg #55A-6951.
	2Z7119.13	CONNECTOR, male: six #12 cont and three #8 cont w/1/8" spacing; straight; over-all lg 2 1/4" x 1 31/32" OD at insertion; #AN-3106-28-1P; Belmont dwg #55A-6952.
	2Z2636-2	CLAMP, cable: aluminum; over-all lg 1 5/16" x 1 5/8" OD x 1" ID; with saddle clamp for cable max OD 1 1/8"; Amphenol #AN-3057-16; Belmont dwg #B-55A-1709.
	6Z5084	GEARBOX HINGE ASSEMBLY: steel; olive drab; fastens to Rack FM-93 and holds gearbox; over-all dimen approx 9" lg x 8" wd x 2 1/4" h when closed; Belmont dwg/part #D-202-1658; consists of gearbox index arm, Belmont dwg #C-2D-7059, with five bushings staked to it; captive screws go through bushings and fasten to rack; gearbox swivel arm, Belmont dwg #C-2D-7058, has four 0.386" diam mtg holes on

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			TEST CABLES AND ACCESSORIES	
		3E7144-28	CABLE ASSEMBLY, RF: Cord CD-1347; connects radar calibration pips to Control Unit BC-1378 input test jack; coaxial; flexible; RG-54A/U cable; one stranded conductor of seven strands of .0152" copper wire; solid dielectric; single braid copper shield; polyethylene outer covering; 0.250" OD x 10 ft lg; Plug PL-259, Belmont #A-55A-2244, with special adapter UG-176/U on one end and plug PL-55, Belmont #A-19A-3304-1, on the other end; Belmont dwg/part #B-201-1555.	
		2Z7226-259	CONNECTOR, male contact: Plug PL-259; one round male cont, over-all dimen 1½" x 23/32"; Amphenol #83-1SP; Belmont #A-55A-2244.	
		2Z7155.1	PLUG PL-55: telephone; straight; male; 2⅞" lg x ½" diam, type 55A-CTS, Belmont dwg/part #A-19A-3304-1.	
		2Z8050-2	ROD, cable support: ⅜" steel; over-all dimen 28" lg; one end bent to U-shape; other end pointed to go into ground; used to suspend cable above ground; Belmont dwg/part #A-3P-3880.	
		2Z299-359	CONNECTOR, SigC M-359; right angle: Amphenol 83-1AP; Belmont dwg/part #A-55A-3367.	
		6R19055-1	SCREWDRIVER: steel; iridite zinc plate; shank round; heavy diamond knurl; 3/16" diam x 3/16" wd; blade tapered to 0.035" on one end; blade tapered 0.035" thk by 13/64" wd on other end; over-all lg 3"; u/w Control Unit BC-1378; Belmont dwg/part #A-55K-6782.	
		2Z8301-4	EYE SHIELD ASSEMBLY: steel; over-all dimen 12" lg x 8 29/64"; u/w Control Unit BC-1378; Belmont dwg/part #C-202-883.	
		2Z7390-29	CONNECTOR, cable: type UG-29/U; over-all dimen 2.1895" lg x ⅝" diam; ⅝-24 thd on ea end; one male cont on ea end for Connector UG-12/U; Astatic #B-7540; Belmont dwg/part #B-55A-6742.	
		2Z308-83	ADAPTER, connector: UG-83/U; one end female, other male cont; one fits UG-21/U connector; other end fits SO-239 receptacle, approx over-all dimen 1 25/32" lg x ¾" OD; Astatic #B-7850; Belmont dwg/part #B-201-1627.	
		2Z308-176	ADAPTER, connector: UG-176/U; straight; used to connect RG-54A/U cable and PL-259 Plug; brass; silver-plated; 1" lg; one end 7/16" OD x 3/16" lg, other end .312" OD x 3/16" lg with 7/16"-14 NC-2 special thd x ¼" lg on .312" diam end; .257" ID; Amphenol #83-168; Belmont dwg/part #A-3B-7280.	
		3E1999-102	CABLE ASSEMBLY CD-1102: 41 strands #34 single cotton wrap, outer covering 3/64" thk blk rubber; 4 ft lg w/spade lug on one end and alligator clip on other end; Belmont dwg/part #A-201-864.	
		3Z1087-6	CLIP: alligator; type #85, Mueller Elec Co, Cleveland, Ohio; Belmont dwg/part #A-26D-4073; p/o Cable CD-1102.	
		3G1790-28	INSULATOR: stock rubber type #87 Mueller Elec Co. Cleveland, Ohio; Belmont dwg/part #A-25E-4074; p/o Cable CD-1102.	
		3E1999-99	CABLE ASSEMBLY CD-1099: microphone cable; 6 ft lg; w/two spade lugs on one end and male Plug PL-55 on other end; Belmont dwg/part #B-201-843.	
		2Z7155.1	PLUG PL-55: male; Belmont dwg/part #A-19A-3304-1; p/o CD-1099.	
		1FK425-54	CABLE RG-54/U; flexible: single stranded cond; 7 strands of #26 AWG bare copper wire; polyethylene dielectric; single braid copper shield; vinylite outer covering; max diam 0.275"; cable assemblies: 6 ft used in B-201-843; 32¾" used in B-201-857; 5 ft used in B-201-856; 9¼" used in B-201-869.	

1F425-54A	CABLE RG-54A/U; coaxial; flexible; nominal impedance 58 ohms; single stranded cond; 7 strands of .0152" copper wire; solid dielectric; single braid copper shield; polyethylene outer covering; 0.250" OD; JAN spec JAN-C-17; mfd by Amphenol; Belmont dwg/part #B-14DA; 10 ft used in cable assembly #B-201-1555.
1C818-1	CABLE, flexible: 41 strands of #34 tinned copper wire; single cotton wrap; 3/64" outer covering of WPB-60-40 black rubber; 4 ft used in ea clip lead assem; Belmont #A-201-864.
1C818-2	CABLE, flexible: WPB rubber covered; OD 0.390"; 2 #18 AWG stranded copper cond; 40 strands #34 copper wire; GE Cordx; type 8; used in Cable Assembly B-201-728.
2Z7385	RADIATOR ASSEMBLY: transmitter; consisting of connector, cap, and radio; Belmont dwg #A-201-868.
2A271-4	ANTENNA ASSEMBLY: dummy; simulates the antenna for adjusting the transmitter; Belmont dwg #A-201-886.
3E1999-141	CORD ASSEMBLY: AC line; Cord CD-1141; Belmont dwg #B-201-865.
6Z7592	PLUG: two prong AC male; type A & H; Belmont dwg #A-19A-2347.
3E1999-106	CABLE ASSEMBLY: patch cord, CD-1106; Belmont dwg #D-201-729.
2Z8694.2	PLUG, female: 21 cont; BRC Lapp; Belmont dwg #C-201-545-4.
2Z7131.6	PLUG, male: 21 cont; type BRC Lapp; Belmont dwg #C-201-546-4.
3Z9824-250	SWITCH: momentary contact; 1 amp, 125v a-c; single pole; type 3391 AH&H; Belmont dwg #A-20F-4098.
3E1999-103	CABLE ASSEMBLY: i-f; CD-1103; Belmont dwg #B-201-857.
2Z8671-41	INSERT: bakelite; 29/64" OD x 5/16" ID x 1/8" thk; Belmont dwg #A-3B-3972.
2Z7155.1	PLUG, male: 2 7/8" lg x 1/2" diam; type 55 CTS; Belmont dwg #A-19A-3304-1; p/o Cord CD-1099.
2Z7226-259A	CONNECTOR: 1 37/64" lg x 45/64" diam; type #CSX-4195 Selectar; Belmont dwg #B-55A-2162.
3E1999-104	CABLE ASSEMBLY: output; CD-1104; Belmont dwg #B-201-856.
2Z8671-41	INSERT: bakelite; 29/64" OD x 5/16" ID x 1/8" thk; Belmont dwg #A-3B-3972.
2Z7111.60	CONNECTOR: 1 37/64" lg x 45/64" diam; type #CSX-4195 Selectar; Belmont dwg #B-55A-2162.
3E7144-5	CORD ASSEMBLY: line; one end two-pole male plug; other end one two-pole female plug; Belmont dwg #B-201-728.
6Z7592	PLUG, male: two poles; 110v AC; clamp type; AH&H; Belmont dwg #A-19A-2347-1.
6Z7567-1	PLUG, female: two poles, 110v AC; clamp type; type No. 61-F11 Amphenol; Belmont dwg #A-19A-3671.
3E1999-105	CABLE ASSEMBLY: CD-1105; Belmont dwg #B-201-869.
2Z7155.1	PLUG, male: SigC PL-55; straight; 2 7/8" lg x 1/2" diam; CTS; Belmont dwg #A-19A-3304-1.
2Z299-358	CONNECTOR: T; 13/16" x 1 5/16" x 5 7/64", type 83-IT Amphenol; Belmont dwg #A-55A-4041.
2B935	HEAD SET: max voltage 500v dc; complete with cord, head band, plugs, and rubber cushions; Radio Speakers Inc; Belmont dwg #44C-0545.
6M211-1	NOTE BOOK: #38 Boorum & Pease Co; Belmont dwg #55A-1953.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			HARDWARE KIT	
		6Z4858-4	GROMMET, rubber: 7/16" OD, 5/16" ID, 7/32" thk; Belrad dwg and part No. A-25A-3580.	
		6Z4856-23	GROMMET, rubber: 1 3/4" OD, 1" ID, 7/16" thk; Belrad dwg and part No. A-25A-3748.	
		6L3408-32.2B	NUT, knurled: round; brass; black nickel; #8-32; Class 2 fit; 7/16" OD, 5/16" thk; Belrad dwg and part No. A-43E-3586.	
		6L3706-32E1	NUT, wing: steel; cronak zinc plate; #6-32; 11/16" across wings; 11/32" h; Belrad dwg and part No. A-43E-3930.	
		6L3604-40E-A4	NUT, hex: steel; cronak zinc plate; #4-40 NC; 1/4" across flats, 3/32" thk; Belrad part No. 43A-267.	
		6L3606-32E-A4	NUT, hex: steel; cronak zinc plate; #6-32; NC; 1/4" across flats, 3/32" thk; Belrad part No. 43A-27.	
		6L3606-32E-A5	NUT, hex: steel; cronak zinc plate; #6-32; NC; 5/16" across flats, 7/64" thk; Belrad part No. 43A-1331.	
		6L3608-32E-A5	NUT, hex: steel; cronak zinc plate; #8-32; NC; 3/8" across flats, 1/8" thk; Belrad part No. 43A-2730.	
		6L3608-32-4.3	NUT, hex: steel; cronak zinc plate; #8-32; NC; 1/4" across flats, 1/8" thk; Belrad part No. 43A-117.	
		6L3610-32E-A6	NUT, hex: steel; cronak zinc plate; #10-32; NC; 3/8" across flats; 1/8" thk; Belrad part No. 43A-1326.	
		6L3504-20E-A7	NUT, hex: steel; cronak zinc plate; #3/4-20; NC; 7/16" across flats, 3/16" thk; Belrad part No. 43A-1330.	
		6L3612-24E-A7	NUT, hex: steel; cronak zinc plate; #12-24; NC; 7/16" across flats, 5/32" thk; Belrad part No. 43A-1652.	
		6L3504-28E-A1	NUT, hex: steel; cronak zinc plate; #1/4-28; NC; 7/16" across flats, 3/16" thk; Belrad part No. 43A-3141.	
		3Z8902	SETSCREW: Allen head; steel; #8-32; NC; 5/16" lg; Belrad part No. A-52A-463.	
		6L4768-17	SCREW, captive: steel; #8-32; NC; 1 1/16" lg; Belrad part and dwg No. A-3F-3487.	
		6L18604-16.31S	SCREW, steel: headless setscrew; screwdriver slot; iridite on zinc plate; #1/4-20; NC; 1" lg; Belrad dwg and part No. A-52A-3865.	
		6L18506-2.39DE	SETSCREW: Allen head; steel; #6-32; NC; 1/8" lg; Belrad dwg. and part No. A-52A-87C.	
		6L6440-17.1Z-2	SCREW, machine: bind H; steel; iridite; #4-40; NC; 1 1/16" lg; Belrad 32F4-3186.	
		6L6440-13.2Z-2	SCREW, machine: OH; steel; #4-40; NC; 13/16" lg; iridite; Belrad #32D4-2831.	
		6L6460-8SE1	SCREW, machine: FH; steel; cronak; #4-40; NC; 1/4" lg; Belrad #32B4-4554.	
		6L6640-48Z-2	SCREW, machine: FH; steel; iridite; #4-40; NC; 3/4" lg; Belrad #32B4-3307.	
		6L4450-5.3SE-1	SCREW, machine: Fil. H; steel; cronak; #4-40; NC; 5/16" lg; Belrad #32C4-4661.	
		6L6632-7.8SE-1	SCREW, machine: Bind H; steel; iridite on zinc plate; #6-32; NC; 7/16" lg of thd; Belrad #32F6-2939.	
		6L6632-6SE-1	SCREW, machine: FH; steel; electro gal #6-32; NC; 3/8" lg of thd; Belrad #32B6-3387.	
		6L6832-32.8SE1	SCREW, machine: Bind H; steel; cronak; #8-32; NC; 2" lg; Belrad #32F8-4128.	

6L6832-6.8Z-2	SCREW, machine: Bind H; steel; iridite; #8-32; NC; 3/8" lg; Belrad #32F8-2725.
6L6832-6.1SE-1	SCREW, machine: FH; steel; cronak; #8-32; NC; 3/8" lg; Belrad #32B8-2678.
6L7032-8.8Z-2	SCREW, machine: Bind H; steel; iridite; #10-32; NC; 1/2" lg; Belrad #32F10-3915.
6L7024-8.8Z-2	SCREW, machine: Bind H; steel; iridite; #10-24; 1/2" lg; Belrad #32F10-3061.
6L7224-14Z-1	SCREW, machine: FH; steel iridite; #12-24; 7/8" lg; Belrad #32B12-3576.
6L7928-4-12.8Z2	SCREW, machine: RH; steel iridite; #1/4-28; 3/8" lg; Belrad #32A15-3861.
6L15008-12	SCREW, steel: captive; knurled; #8-32; NC; thd; 25/32" lg; Belrad A-3C-3437.
3Z12059-4	TERMINAL, lug: phos bronze; Shakeproof type #2104-8; Belrad A-26D-3241.
3Z12059-12	TERMINAL, lug: phos bronze; Shakeproof #2103-10; Belrad A-26A-3357.
3Z12025-9.15	TERMINAL, lug: Sherman #98; Belrad A-26D-2861.
3Z12059-40.1	TERMINAL, lug: phos bronze; Shakeproof #2124-6; Belrad A-26D-3514.
3Z12031-12.1	TERMINAL, lug: brass; Stewart #907; Belrad A-26C-1670.
3Z12059-22	TERMINAL, lug: Shakeproof #2101-10; Belrad A-26A-2462.
3Z12025-9.14	TERMINAL, lug: spade; brass; Sherman #1; Belrad #A-26D-3936.
6L71004Z2	WASHER, lock: steel; split type; iridite; 1/4" ID; Belrad #A-28C-323.
6L71004E1	WASHER, lock: steel; split type; cronak; 1/4" ID; Belrad #A-28C-323.
6L72214E1	WASHER, lock: steel; Shakeproof #1214; cronak; Belrad #28B-2302.
	WASHER, lock: steel; cronak; Shakeproof #1212-2; Belrad #28B-3731.
6L72210Z2	WASHER, lock: steel; iridite; Shakeproof #1210; Belrad 28B-644.
6L72206Z2	WASHER, lock: steel; iridite; Shakeproof #1206; Belrad 28B-55.
6L72114E1	WASHER, lock: steel; cronak; Shakeproof #1114; Belrad #28A-990.
6L72110E1	WASHER, lock: steel; cronak; Shakeproof #1110; Belrad #28A-347.
6L72106E1	WASHER, lock: steel; cronak; Shakeproof #1106; Belrad #28A-16.
	WASHER, flat: steel; cronak; 1/4" ID, 0.437" OD, 0.031" thk; Belrad #B-29A-3528.
6L58023-3E1	WASHER, flat: steel; cronak; 0.173" ID, 5/16" OD, 1/32" thk; Belrad #B-29A-3507.
6L58023-4E1	WASHER, flat: steel; cronak; 0.173" ID, 0.375" OD, 0.031" thk; Belrad #B-29A-2165.
6L58002-6E1	WASHER, flat: steel; cronak; 0.147" ID, 3/8" OD, 1/32" thk; Belrad #B-29A-3216.
6L58024E1-2	WASHER, flat: steel; cronak; 1/4" ID, 0.437" OD, 0.062" thk; Belrad #B-29A-3776.
6L50102-4	WASHER, flat: brass; 0.128" ID, 0.278" OD, 0.025" thk; Belrad B-29B-237.

114. MAINTENANCE PARTS FOR RADIO EQUIPMENT RC-384 (contd.)

Major component	Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
			HARDWARE KIT (contd.)	
			WASHER, flat: steel; 0.390" ID, 0.718" OD, 0.031" thk; cronak; Belrad #B-29A-3670.	
			WASHER, flat: brass; 0.149" ID, 0.265" OD, 0.064" thk; white nickel; Belrad #B-29B-316.	
		3G1625-8.2	WASHER, flat: vellutex; 0.169" ID, 1/2" OD, 0.050" thk; Belrad #A-41A-2592.	
		3G1625-6	WASHER, flat: vellutex; 0.171" ID, 3/8" OD, 0.031" thk; Belrad #B-29G-3659.	
		3G1625-6.1	WASHER, flat: vellutex; 0.147" ID, 3/8" OD, 0.031" thk; Belrad #B-29G-3217.	
		3G1625-8.3	WASHER, flat: vellutex; 0.147" ID, 1/2" OD, 0.031" thk; Belrad #B-29G-3236.	
		6L58023-12.2	WASHER, flat: vellutex; 0.173" ID, 0.500" OD, 0.031" thk; Belrad #B-29G-3390.	
		6L71014B	WASHER, spring: phos bronze; Shakeproof #3559; Belrad A-29E-466.	
			WASHER, flat: steel; 0.687" ID, 1.093" OD, 0.031" thk; cronak; Belrad #B-29A-2574.	
			WASHER, flat: black rubber; 1/2" ID, 1 1/16" OD, 3/32" thk; Belrad #A-25G-6319.	
			WASHER, flat: brass; 0.131" ID, 1/4" OD, 0.020" thk; white nickel; Belrad #B-29B-531.	
		6L6832-4Z-2	SCREW, machine: FH; iridite; #8-32; NC; 1/4" lg; Belrad #32B8-3308.	
		6L7928-4-8.1SK1	SCREW, machine: RH; steel; iridite on zinc; 1/4-28; NC; 3/8" lg; Belrad part No. 32A15-4813.	
		3Z12056/1	TERMINAL, straight: hole for #6 screw; 0.812" lg; 3/32" hole for wire; Shakeproof #2108-6 or equal; Belrad part No. A-26A-2035.	

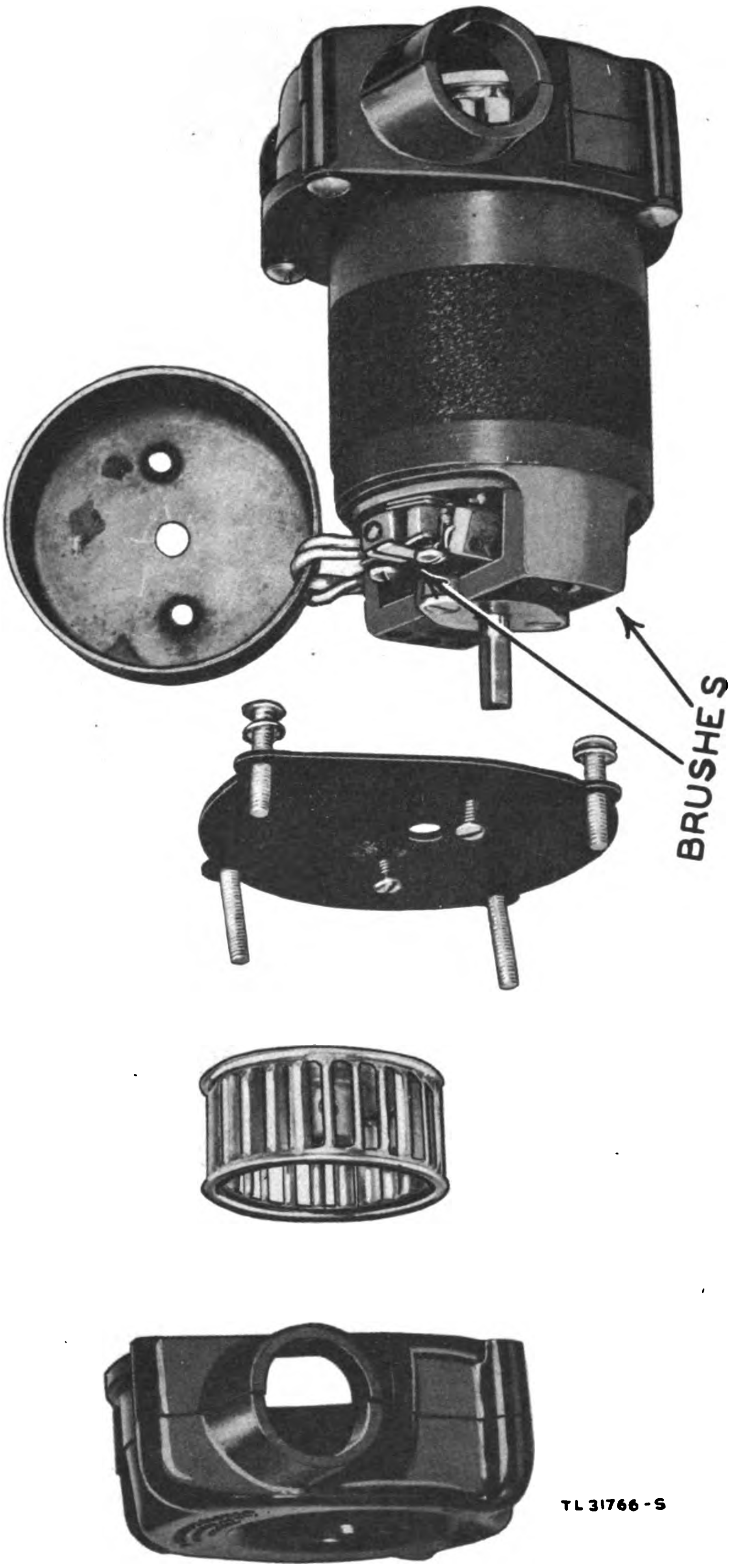


Figure 128. Control unit blower disassembled.

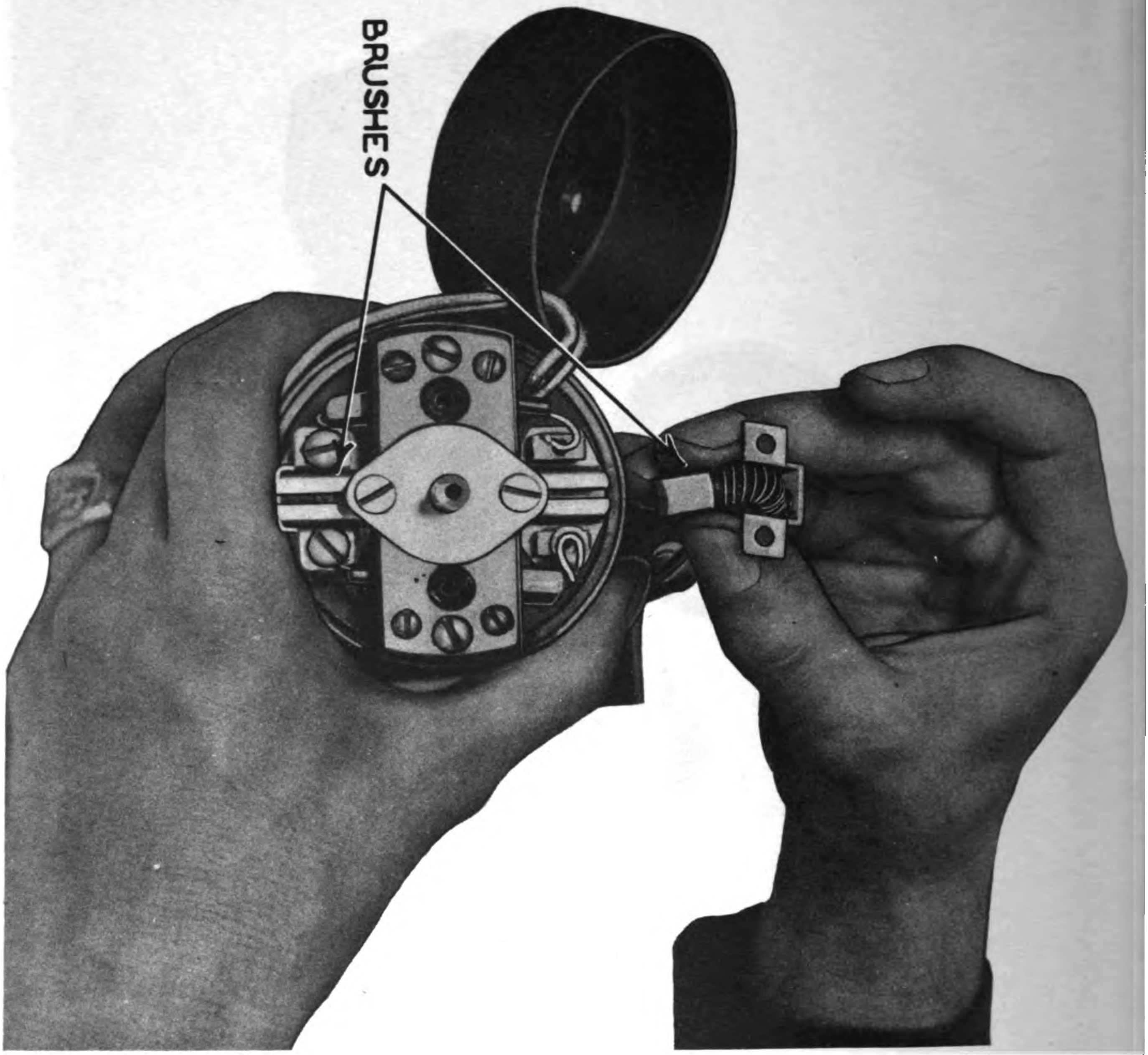


Figure 129. Control unit blower disassembled, showing brushes.

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