DEPARTMENT OF THE ARMY TECHNICAL MANUAL

RADAR SETS

AN/SPN-18 AND -18X

INSTALLATION AND OPERATION

DEPARTMENT OF THE ARMY • JANUARY 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 140-volt and 300-volt plate and power supply circuits, on the 870-volt TR and keep-alive power supply circuits, or on the 115-volt ac or dc line connection.

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNITS:

Control-Indicator C-1261/SPN-18	12,000-volt circuits
Radar Receiver-Transmitter RT-290/SPN-18	10,000-volt circuits

TECHNICAL MANUAL
No. 11-1330

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., 7 *January* 1955

RADAR SETS AN/SPN-18 AND -18X, INSTALLATION AND OPERATION

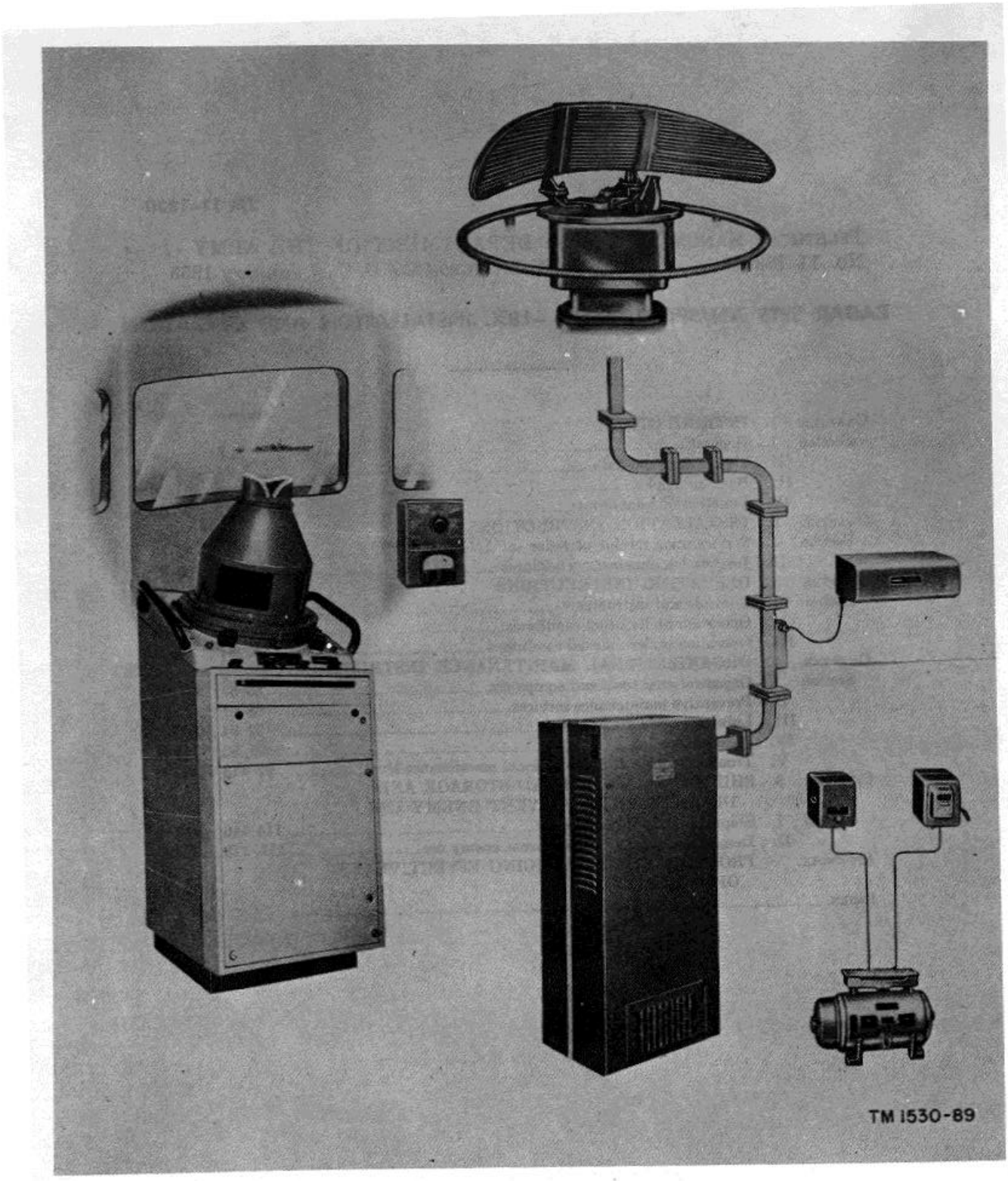

Figure 1. Radar Set AN/SPN-18.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains instructions for the installation, operation, and organizational maintenance of Radar Set AN/SPN-18(*) (fig. 1). It presents an explanation of the chief functions of each major group of components but does not include discussions of circuit theory. A separate instruction book covers the theory, troubleshooting, and repair of this radar set.

b. Official nomenclature followed by an asterisk (*) is used to indicate all models of the equipment included in this instruction book. Thus Radar Set AN/SPN-18(*) represents Radar Sets AN/'SPN-18 and AN/SPN-18X.

2. Forms and Records

The following forms and records will be used for reporting unsatisfactory conditions of Army materiel and equipment and for completing maintenance checks.

a. DD Form 6 (Report of Damaged or Improper Shipment) will be filled out and forwarded as prescribed in SR 745-45-5 (Army), Navy Shipping Guide, Article 1850-4 (Navy), and AFR 71-4 (Air Force).

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

c. DD Form 535 (Unsatisfactory Report) will be filled out and forwarded to Commanding General, Air Materiel Command, Wright Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA Form 11-238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) will be prepared in accordance with instructions on the back of the form (fig. 79).

e. DA Form 11-239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Cairier, Radar)) will be prepared in accordance with instructions on the back of the form (fig. 80).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Radar Set AN/SPN-18(") (fig. 1) is a shipboard navigational radar which provides position data on vessels and landmarks. The radar set operates in the 9,320- to 9,430-mc (megacycle) frequency band, with a range of approximately 55 yards to 40 nautical miles. The radar set is used for the following purposes:

a. Anticollision. Anticollision data are obtained by observing on a PPI scope (plan position-indicator oscilloscope), the range (distance), and azimuth (direction) of vessels on the open sea and plotting their courses on a plotter.

b. Piloting. Piloting information is obtained by observing the positions of shoreline, buoys, and other markers in channels and harbors.

c. Position Finding. The position of the radar-equipped vessel is plotted from bearings and ranges of known landmarks.

d. Storm Warning. Storm warning data may be obtained by observing and plotting the movements of heavy rain or snow squalls.

4. Technical Characteristics

a. General.

Range:
- Maximum ..... 40 miles (nautical).
- Minimum ..... 55 yards.
- Accuracy ..... 2% on all ranges.
- Determination ..... By use of 4 fixed rings on each range, or a variable-range marker from ½ to 20 miles (read on range counter).
- Resolving power ..... 55 yards on 1-, 2-, and 4-mile ranges.

Azimuth:
- Operational ..... 360° continuous rotation.
- Accuracy ..... 1°.
- Determination ..... By use of fixed relative bearing scale and movable true bearing scale.
- Resolving power ..... 1.5°

Antijamming ..... Receiving system equipped with fast time constant and sea return suppressor.

Assembly time ..... 8 hours for three men.

b. Transmitting System.

Frequency ..... 9,320 to 9,430 mcs (megacycles per second).

Wavelength ..... 3.22 to 3.18 cm (centimeters).

Peak Power ..... 40 kilowatts or 76 dbm (decibels above one milliwatt).

Average Power ..... 20 watts.

Pulse repetition rates:
- 1-, 2-, and 4-mile ranges. 2,000 cps (cycles per second).
- 8-, 20-, and 40-mile ranges. 800 cps.

Pulse width:
- 1-, 2-, and 4-mile ranges. 25 usec (microsecond).
- 8-, 20-, and 40-mile ranges. 65 usec.

Source of r-f power..... Magnetron, type 725A.

Modulation ..... Pulse.

c. R-f System.

Type of feed..... Horn.

Reflector ..... Parabolic.

Beam width:
- Horizontal ..... 1.9°.
- Vertical ..... 20°.

Antenna rotation speed..... 9 rpm (revolutions per minute).

Sidelobe attenuation ..... 30 db (decibels).

Transmission line ..... Waveguide.

Synchro gearing to antenna.. 10 to 1.

d. Receiving System.

Receiver type ..... Superheterodyne.

Local oscillator ..... Klystron, type 2K25.

Local oscillator frequency.... 9405 mc.

Intermediate frequency ..... 30 mc.

Bandwidth:
- 1-, 2-, and 4-mile ranges. 8 mc.
- 8-, 20-, and 40-mile ranges. 2.5 mc.

Maximum gain ..... Sufficient to raise noise to limit level.

e. Indicating System.

Type of presentation ..... PPI: 16-inch cathode-ray tube for presentation of echo signals in azimuth and range, with six range scales, four range rings or a variable range marker, and a center expand.

Searching ..... 1-, 2-, 4-, 8-; 20-, and 40-mile ranges.

Tracking ..... 1-, 2-, 4-, 8-, and 20-mile ranges, and on to 20 miles on 40-mile range.

Heading indication ..... Fore and aft flasher.

Plotting ..... By wax-pencil markings on a plotter mounted over the PPI.

f. Power System.

Type of power unit..... Motor generator.

(1) *D-c motor generator.*

Motor:
- Input ..... 115-volt dc (direct current) from shipboard supply.
- Field ..... Compound wound.
- Speed of rotation. 1,715 rpm.

Generator:
- Input to field.... 115-volt dc from shipboard supply.
- Output ..... 115-volt, 400-cycle, single-phase ac (alternating current) at 8.4 amperes (965 va). (For all radar set components except driers, heaters, and antenna drive motor.)

(2) *A-c motor generator.*

Motor:
- Input ..... 115-volt, 60-cycle, single-phase ac from shipboard supply.
- Speed of rotation. 1,750 rpm.

Generator:
- Input to field.... 115-volt dc at 1 ampere from shunt-wound d-c generator (exciter).
- Output ..... 115-volt, 400-cycle, single-phase ac at 8.4 amperes or 965 va. (For all radar set components except driers, heaters, and antenna drive motor.)

5. Packaging Data

a. General. When packed for shipment, the components of Radar Set AN/SPN-18(*) are placed in moisture-vapor proof containers and are packed in nine wooden crates.

b. Packaging Data Chart. The number, size, weight, and contents of each crate are indicated in the following chart. Crate No. 3 and No. 6 differ for Radar Set AN/SPN-18 and AN/SPN-18X; Crate No. 10 is supplied with Radar Set AN/SPN-18X only. An asterisk indicates the differences for Radar Set AN/SPN-18X.

Note. Items may be packed in a manner different from that shown, depending upon the supply channel.

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1	54	35	23	25.2	340	Receiver-transmitter.
2	60	35	32	38.9	405	Indicator.
3	72	29	27	32.6	255 *225	Reflector, horn, plotter hood, echo box, voltage regulator, instruction book. Switch Box SA-284/SPN-11, Motor Starter SA-342/SPN-18, and miscellaneous hardware. Reflector, horn, plotter hood, echo box, instruction book, and miscellaneous installation hardware.*
4	32	23	23	9.8	75	Cathode-ray tube.
5	33	31	31	18.4	230	Antenna pedestal.
6	25 *34	18 *20	14 *18	3.6 *7	200 *290	Motor Generator PU-243A/SPN-11. Motor Generator PU-288/SPN-18X*.
7	148	10	10	8.6	140	Waveguides and accessories.
8	51	33	25	24.4	485	Cables.
9	51	33	25	24.4	200	Running spares.
10*	*32	*23	*23	*9.8	*130	*A-c antenna drive motor, Switch Box SA-368/SPN-18X, Circuit Breaker, SA-369/SPN-18X, and voltage regulator.*
Total weight (lb.)					2315 *2505	

6. Nomenclature Assignments

A list of the nomenclature assignments for the components of Radar Set AN/SPN-18(*) is given below. A common usage name is indicated after each component.

Note. In the following list, an asterisk indicates components used with an a-c shipboard supply in place of Motor Generator PU-243A/SPN-11, Motor Starter SA-342/SPN-18, Radar Set AN/SPN-18, and Switch Box SA-284/SPN-11.

Nomenclature	Common name
Antenna AS-659/SPN-18	Antenna.
Control-Indicator C-1261/SPN-18	Indicator.
Directiohal Coupler CU-356/SPN-18	Directional coupler.
Duplexer CU-311/SPN-11	Duplexer.
Electrical Synchronizer SN-119/SPN-18.	Indicator circuits chassis.
Frequency Mixer Stage CV-239/SPN-11.	Mixer.
Motor Generator PU-243A/SPN-11	D-c motor generator.
* Motor Generator PU-288/SPN-18X	A-c motor generator.
Motor Starter SA-342/SPN-18.	Motor starter.
Powergraph position tracker (Radiomarine Corporation of America Type RM-182).	Plotter.
Radar Receiver R-572/SPN-18.	Receiver.
Radar Receiver-Transmitter RT-290/SPN-18	Receiver-transmitter.
Radar Set AN/SPN-18	Radar set (d-c operation).
*Radar Set AN/SPN-18X,	Radar set (a-c operation).
Radio Frequency Cable Assembly CG-1074/SPN-18	R-f cable W713.
Resistance Element HD-124/SPN-11	Heater unit.
Switch Box SA-284/SPN-11	Switch box.
*Switch Box SA-368/SPN-18X.	Switch box.
Tuned Cavity TN-224/SPN-18	Echo box.
Video Amplifier AM-874/SPN-18	Video circuits chassis.
Voltage Regulator CN-225/SPN-18	Voltage Regulator.

7. Table of Components

The weights and dimensions of the components of Radar Set AN/SPN-18(*) are listed in the following table:

Component	Req. No.	Length (in.)	Width (in.)	Height (in.)	Volume (cu. ft.)	Unit weight (lb.)
Antenna AS-659/SPN-18	1	50	22½	33¾	21.97	160
Control-Indicator C-1261/SPN-18	1	23¼	20½	47⅜	13.06	235
*Circuit Breaker SA-369/SPN-18X	1	6 1/16	5⅛	9 3/16	.17	8
Duplexer CU-311/SPN-11	1					
Frequency Mixer Stage CV-239/SPN-11	1					
Motor Generator PU-243A/SPN-11	1	9¼	20½	13¾	1.51	170
*Motor Generator PU-288/SPN-18X	1	29½	12 9/16	14¾	3.16	250
Motor Starter SA-342/SPN-18	1	7	6 13/16	9⅛	.25	13
Powergraph position tracker (Radiomarine Corporation of America Type RM-182).	1	18¾	17¼	18½	3.5	17.5
Radar Receiver R-572/SPN-18	1					
Radar Receiver-Transmitter RT-290/SPN-18	1	13¾	30⅝	43⅝	7.16	255
Resistance Element HD-124/SPN-11	1					
Switch Box SA-284/SPN-11	1	4⅛	7½	7⅛	.13	4¼
*Switch Box SA-368/SPN-18X	1	4⅛	7½	7⅛	.13	4¼
Voltage Regulator CN-255 SPN-18	1	7⅛	7½	11⅝	.36	14
Electrical Synchronizer SN-119/SPN-18						
Video Amplifier AM-874 SPN-18	1					
Tuned Cavity TN-224/SPN-18	1	6⅛	13⅞	6½	.32	20
Directional Coupler CU-356/SPN-18	1					
Instruction Book	1	11	8½			

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts. An asterisk indicates components used with a-c shipboard supply in place of Motor Generator PU-243A/SPN-11, Motor Starter SA-342/SPN-18, and Switch Box SA-284/SPN-11.

8. Antenna As-659/SPN-18

The antenna assembly (fig. 2) consists of a fixed pedestal and a rotating assembly.

a. Antenna Pedestal. The pedestal (figs. 3 and 4) is a two-section, cast-aluminum housing which contains the azimuth drive components.

(1) The upper section, or upper drive assembly, has two removable covers. It contains the following components.

(a) The antenna drive motor (fig. 3) drives the antenna rotating assembly in azimuth.

(b) The syncho transmitter, also called a synchro generator (fig. 4), synchronizes rotation of the PPI sweep with the rotation of the antenna.

(c) The antenna cam assembly (fig. 4) actuates heading flash circuits in the indicator. The cam assembly is mechanically linked to the synchro generator.

(d) The heater unit (heater strips (figs. 3 and 4), capacitor C502 (fig. 4), and thermostat S504 (fig. 4)) maintain reasonably constant temperature within the pedestal.

(e) Terminal board TB501 (fig. 3) mounts drive motor switch S503, a telephone jack, and terminal stud screws (for cable W702). The drive motor switch permits manual control of the drive motor at the antenna location by maintenance personnel, and the telephone jack allows communication.

(f) An oil filler pipe and gage is used to fill and check the level of the oil in the antenna gear box.

(2) The lower section contains the gear assembly through which power is applied from the drive motor to the rotating assembly. The gears are immersed in oil, and an oil drain plug is located above the waveguide connection (fig. 3). The oil filler pipe and gage extends into the upper section. Above and to the right of the drain plug is a cable gland through which

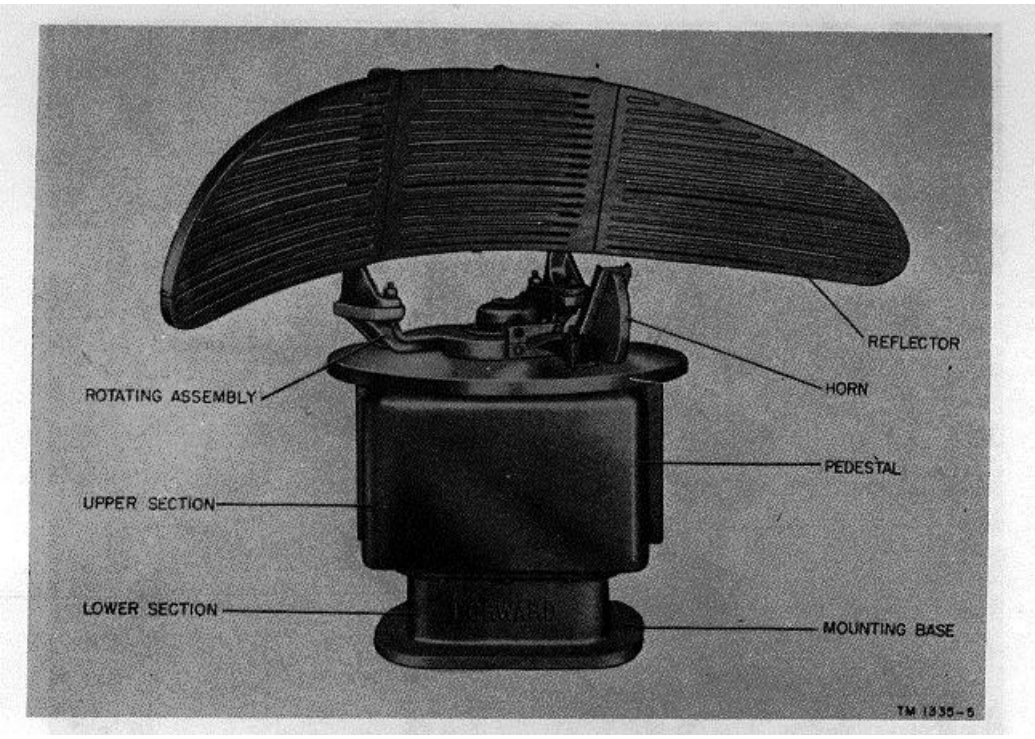

Figure 2. Antenna AS-659/SPN-18

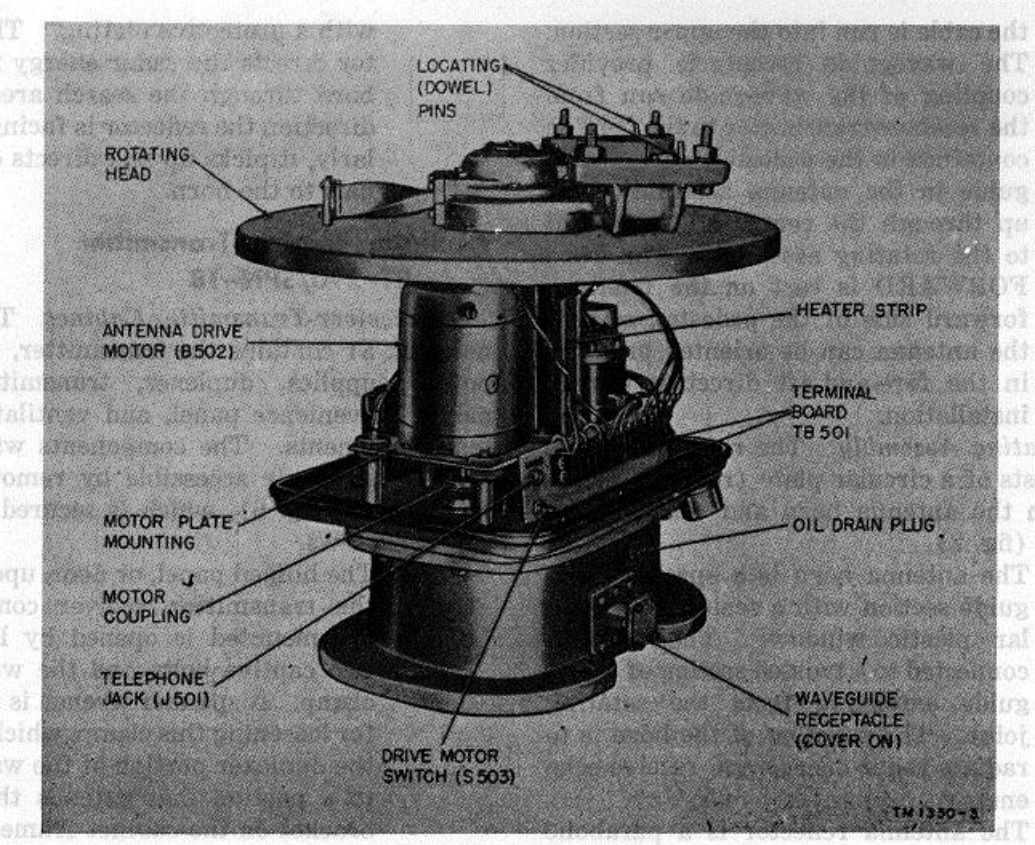

Figure 3. Antenna AS-659/SPN-18, rear oblique view with covers removed.

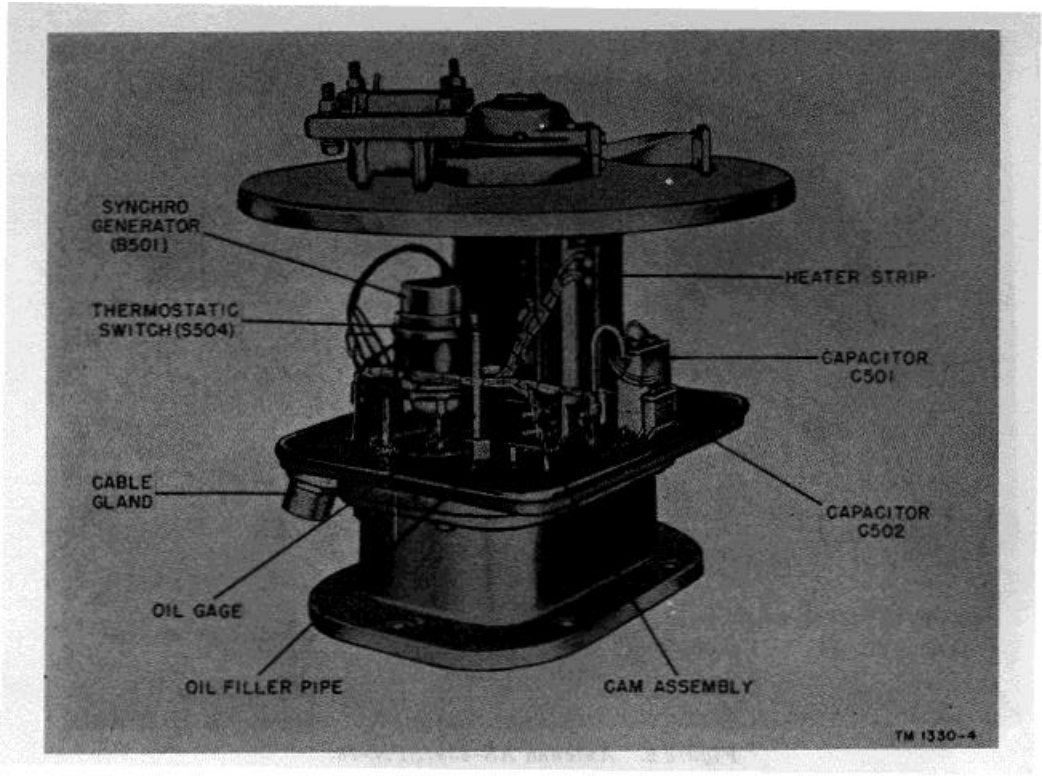

Figure 4. Antenna AS-659/SPN-18, front oblique view with covers removed.

the cable is run into the upper section. The waveguide receptacle provides coupling of the waveguide run from the receiver-transmitter to the portion contained in the pedestal. The waveguide in the antenna assembly runs up through the center of the mount to the rotating assembly. The word FORWARD is cast on the front or forward side of the pedestal, so that the antenna can be oriented properly in the fore-and-aft direction during installation.

b. Rotating Assembly. The rotating assembly consists of a circular plate (rotating head) on which the antenna horn and reflector are mounted (fig**.** 2).

(1) The antenna horn is a special waveguide section with a sealed, rectangular plastic window. The horn is connected to a twisted section of waveguide extending from the rotating joint. The function of the horn is to radiate radar energy and receive echo energy.

(2) The antenna reflector is a parabolic type made of cast aluminum coated with a protective plating. The reflector directs the radar energy from the horn through the search area, in the direction the reflector is facing. Similarly, it picks up and directs echo signals to the horn.

9. Radar Receiver-Transmitter RT-290/SPN-18

a. Receiver-Transmitter Cabinet. This cabinet (fig. 5) contains the transmitter, receiver, power supplies, duplexer, transmitter test panel, convenience panel, and ventilating system components. The components within the cabinet are made accessible by removing the front cover (fig. 6), which is secured by four captive screws.

(1) The hinged panel, or door, upon which the transmitter-receiver components are mounted is opened by loosening two captive bolts and the waveguide clamp. A spanner wrench is provided for loosening this clamp, which couples the duplexer portion of the waveguide to a portion that extends through a bracket on the cabinet frame. When the door is open (fig. 7), the blower

motor, transmitter chassis, terminal boards, and receiver and power supply under-chassis components are accessible.

(2) On a subchassis below the door are a-c outlets, convenience panel, air filter, and blower motor. The blower motor provides ventilation for the equipment by drawing air through the filter and distributing it through a vertical duct. Louvers on the sides of the cover and on the rear of the cabinet permit the warm air to escape. The air filter can be replaced, without removing the front cover, by loosening two captive screws and opening the hinged grille on the front. The convenience panel to the right of the filter contains the switches for the antenna heaters and drive motor and fuses for the antenna heater and blower, On the rear cover, above the terminal boards, there are three knockouts for cable entry.

b. *Transmitter*. The magnetron assembly is mounted on the upper left of the door, under a magnetic shield. Beneath the magnetron assembly and directly under the h-v (high-voltage) transformer is the magnetron filament transformer. To cool the magnetron, a hose attached to the vertical duct directs air from the blower. The transmitter components are inclosed in a shielded compartment (fig. 7) on the rear of the door. Removing the perforated cover to this compartment automatically operates an interlock switch.

c. *Radar Receiver R-572/SPN-18.* The receiver chassis is mounted on the front of the door as shown in figure 6. Since the receiver is a relatively heavy unit, two handles are attached to make it easy to remove. The receiver, whose function is to detect and amplify the echo pulses, uses a klystron local oscillator and a double mixer, both attached to the chassis.

d. *Duplexer CU-311/SPN-11.* The duplexer (fig. 6) contains the TR (transmit-receive) and anti-TR tubes, and is connected to the waveguide at the upper right of the door. The TR tube prevents transmitted pulses from entering and damaging the receiver input circuits; the anti-TR tube prevents received echoes from entering and being dissipated in the magnetron. The TR tube extends through a hole to the rear of the door. The keep-alive power supply for the TR tube is mounted on the bottom rear of the door.

Note. The TR and anti-TR tubes contain radioactive materials and are a radiation hazard. Handle in accordance with instructions given in TB SIG 225.

e. *Frequency Mixer Stage CV-239/SPN-11.* The mixer (fig. 6) includes the afc (automatic frequency control) and signal mixer crystals and the klystron oscillator. The unit is connected to the duplexer. It provides a 30-mc input for the receiver i-f (intermediate-frequency) stages.

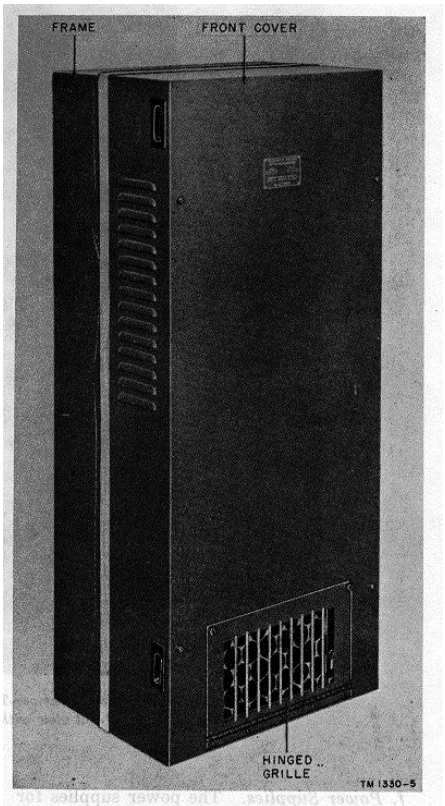

Figure 5. Radar Receiver-Transmitter RT-290/SPN-18.

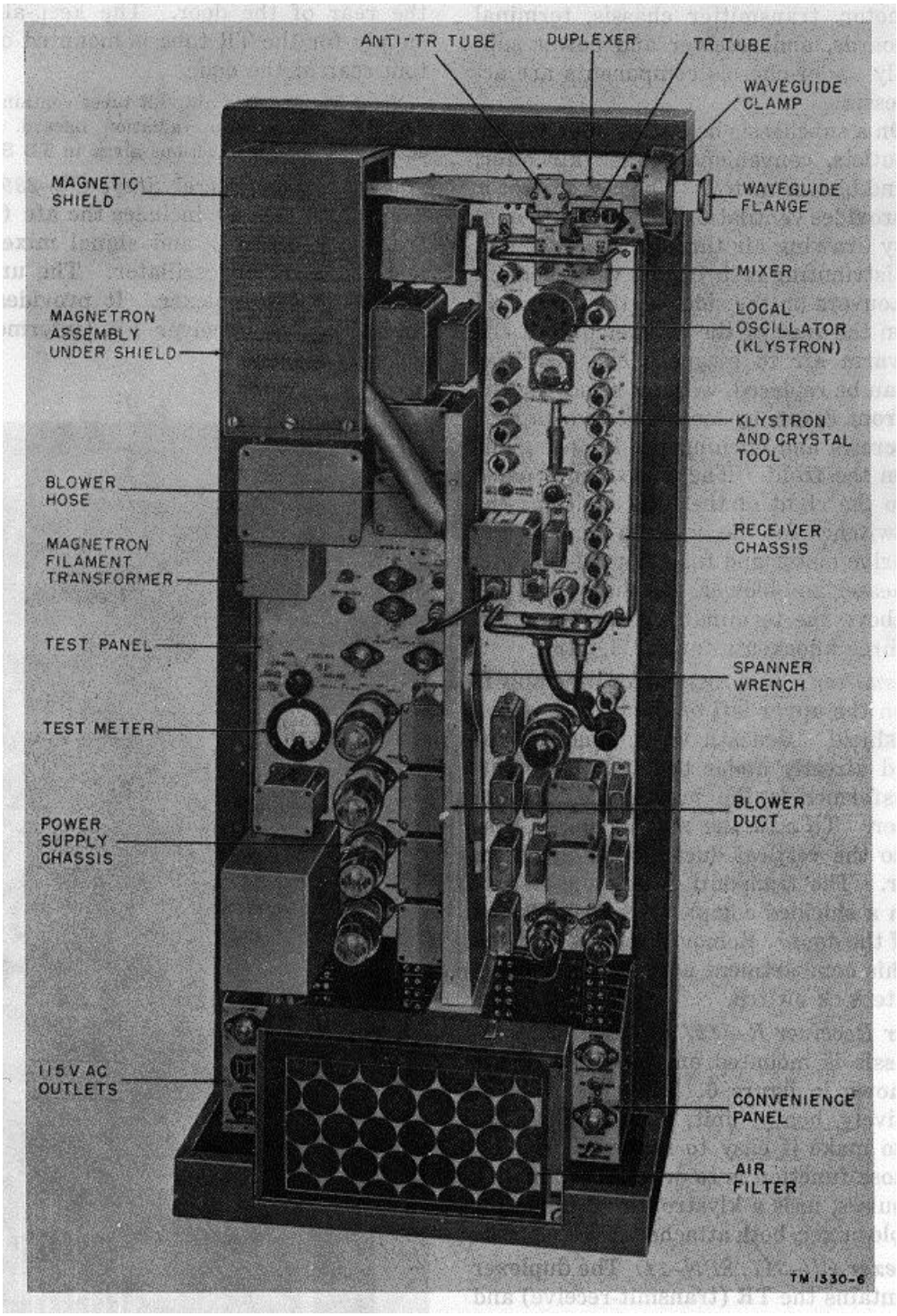

Figure 6. Radar Receiver-Transmitter RT-290/SPN-18, front view with cover removed.

f. Power Supplies. The power supplies for the transmitter, receiver, duplexer, and indicator are located on the front and rear of the door (figs. 6 and 7). A test meter on the panel is used to check the various outputs.

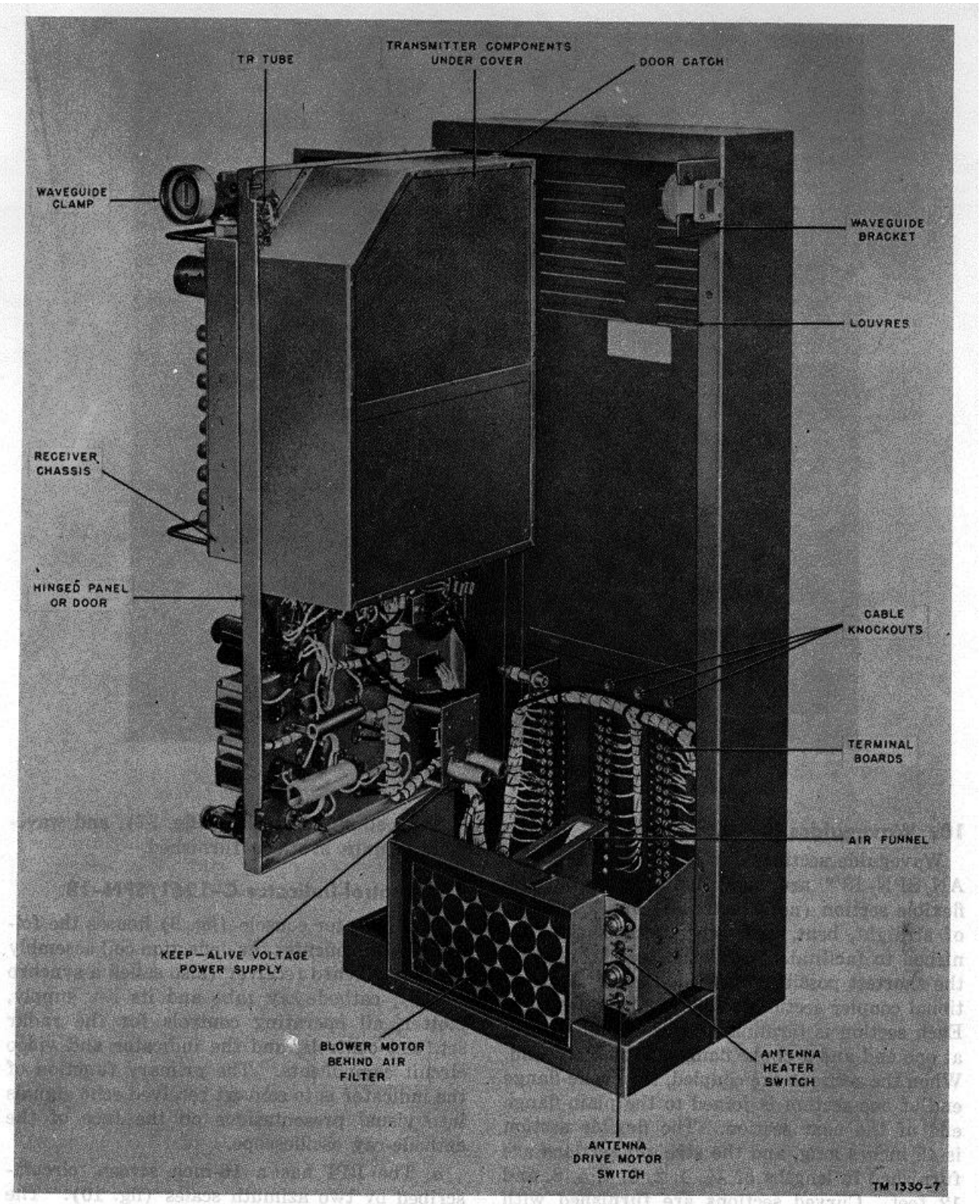

Figure 7. Radar Receiver-Transmitter RT-290/SPN-18, door open

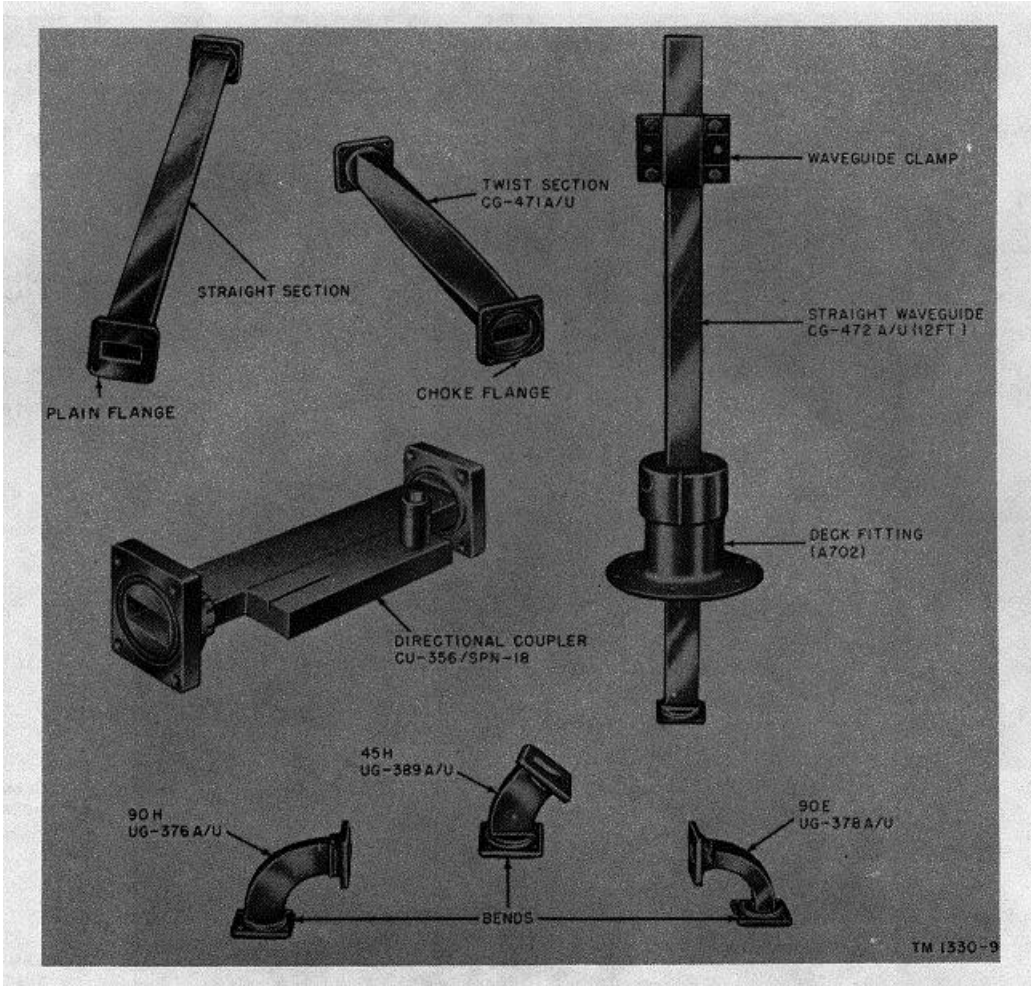

Figure 8. Waveguide sections

10. Waveguides and Accessories

Waveguide sections for use with Radar Set AN/SPN-18(*) are illustrated in figure 8. One flexible section (not illustrated) and a number of straight, bent, and twist sections are furnished to facilitate installation and to provide the shortest possible waveguide run. A directional coupler section is furnished for test use. Each section is terminated with a plain flange at one end and a choke flange at the other end. When the sections are coupled, the choke-flange end of one section is joined to the plain-flange end of the next section. The flexible section is 48 inches long, and the straight sections are furnished in lengths of 1/2, 1, 2, 3, 4, 5, 8, and 12 feet. Curved sections are furnished with E or H bends of 45° or 90°, respectively. E bends are curved on the wide surface (90E, fig. 8); H bends are curved on the narrow surface (45H and 90H, fig. 8). A waveguide deck fitting, ceiling dress plate (fig. 37), and waveguide clamps are also furnished.

11. Control-indicator C-1 261 /SPN-18

The indicator console (fig. 9) houses the following components: the deflection coil assembly (yoke), synchro receiver (also called a synchro motor), cathode-ray tube and its h-v supply, plotter all operating controls for the radar set, test controls, and the indicator and video circuit components. The primary function of the indicator is to convert received echo signals into visual presentations on the face of the cathode-ray oscilloscope.

a. The PPI has a 16-inch screen, circumscribed by two azimuth scales (fig. 10). The inner scale is fixed, while the outer scale is movable and can be controlled either by the operator (using the true bearing knob located near the lower left edge of the screen) or from

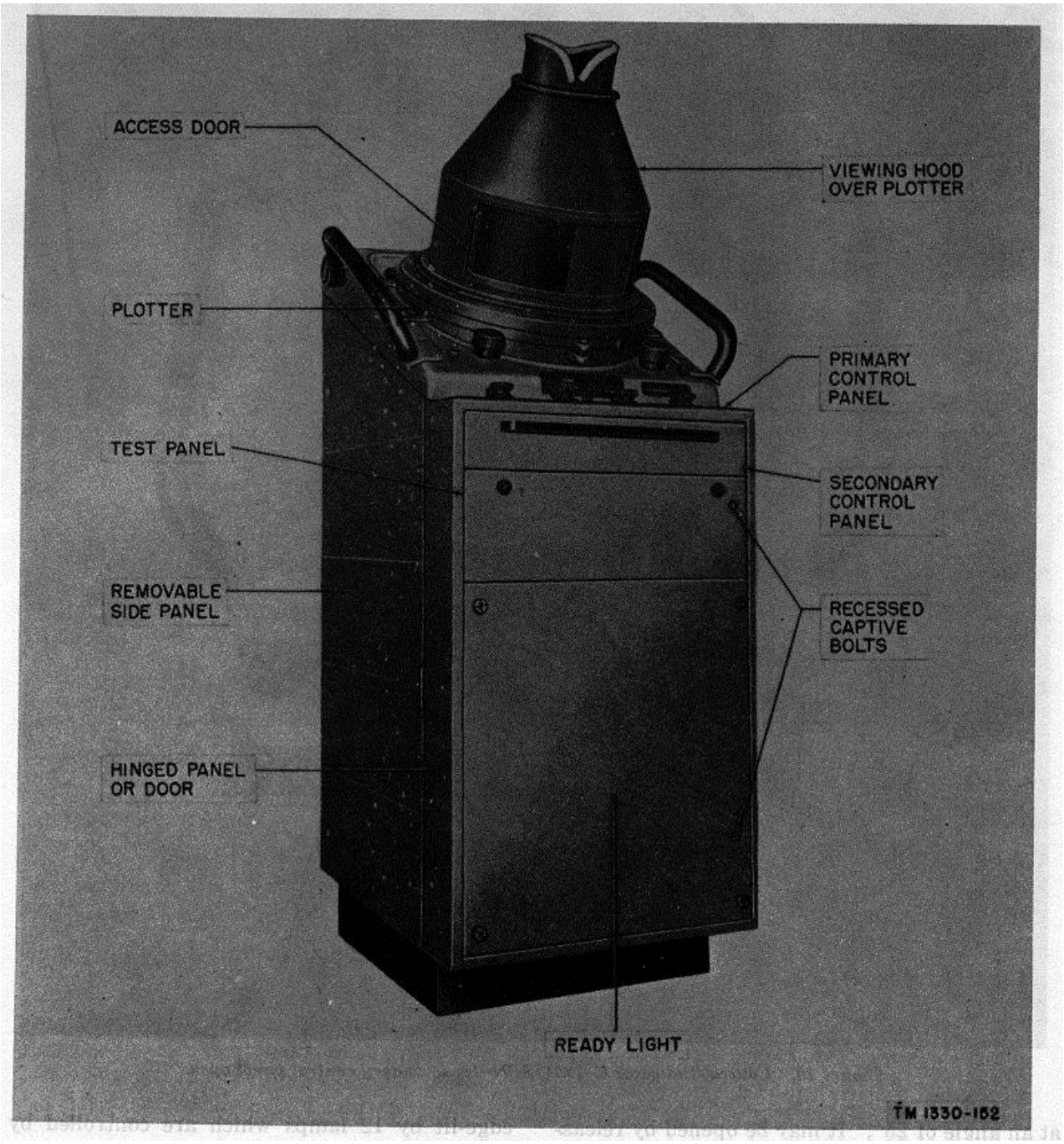

Figure 9. Control-Indicator C-1261/SPN-18, front view with hood.

the gyro compass of the ship (as connected by the switch on the upper left side of the cabinet). However, gyro-compass control is not possible without a true-bearing assembly (not supplied with the equipment). The diametrical cursor lines under the face of the screen are controlled by large knob near the lower right edge of the screen. The scope face is protected by yellow, safety filter glass. Above the screen is a range counter, variable from .5 to 20 miles by means of the range control knob on the right side of the cabinet. Alongside the counter are six windows marked with the fixed ranges; in operation, the window marked with the selected range is illuminated. The top of the console is inclined

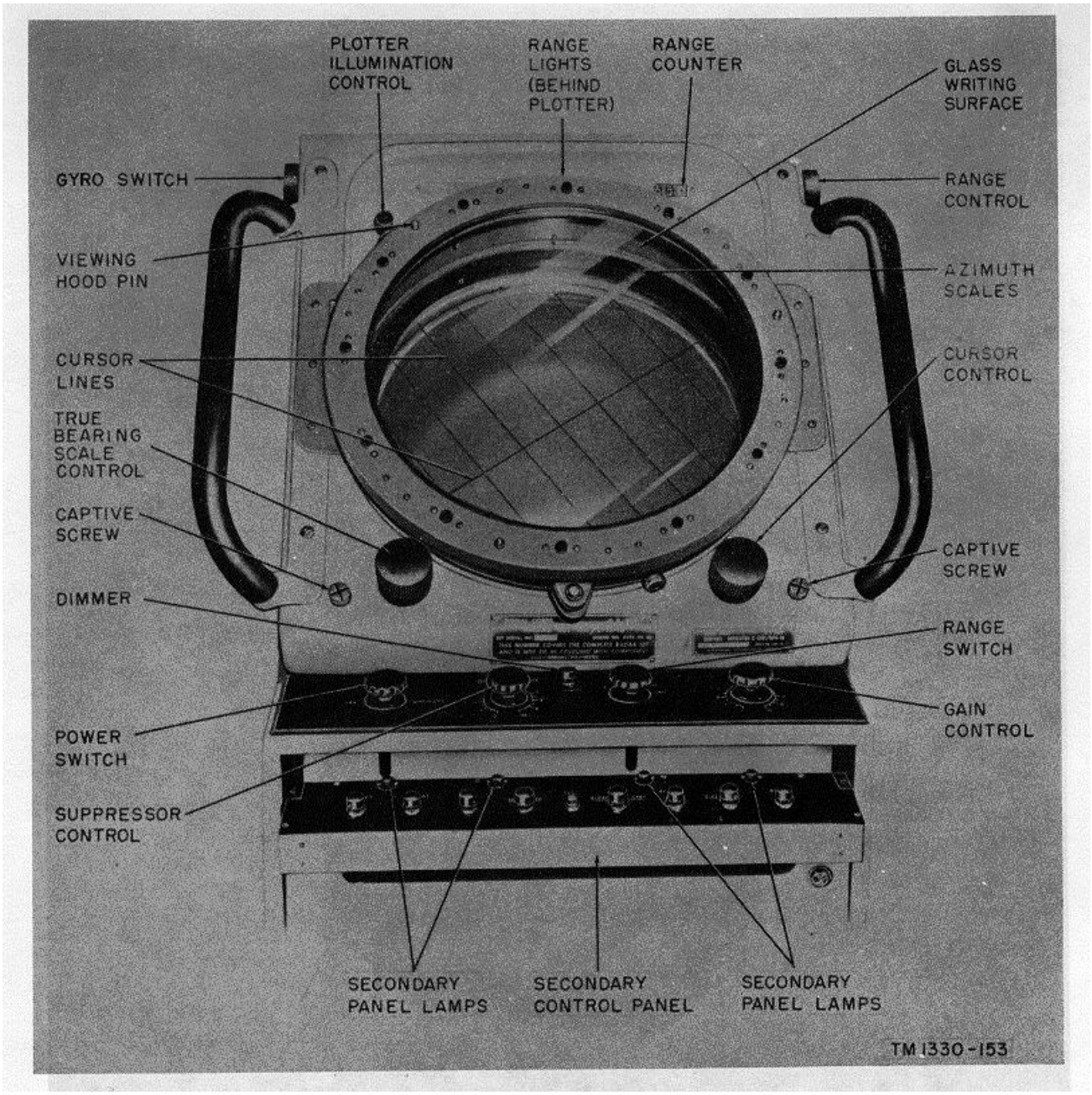

Figure 10. Control-Indicator C-1261/SPN-18, secondary control panel open.

at an angle of 25°. It may be opened by releasing two knurled captive screws and lifting the handles. When the top is opened, an interlock switch shuts off power to the radar set.

b. The plotter is mounted on the console (fig. 10), over the PPI screen. It contains a dichroic (two-color) mirror that enables the operator to see the yellow PPI presentation with red plotting marks superimposed on it. These marks are made by the operator with a wax pencil. The glass writing surface is edge-lit by 12 lamps which are controlled BY a rheostat mounted next to the plotter. A detachable viewing hood (fig. 13) is furnished with the equipment, and is mounted on the plotter (fig. 9) to restrict glow and provide shielding from external light. The viewing hood contains a rernovable eyepiece and a sliding access door (arm hole), and may be rotated to place the arm hole in the most convenient position for marking targets on the plotter writing surface.

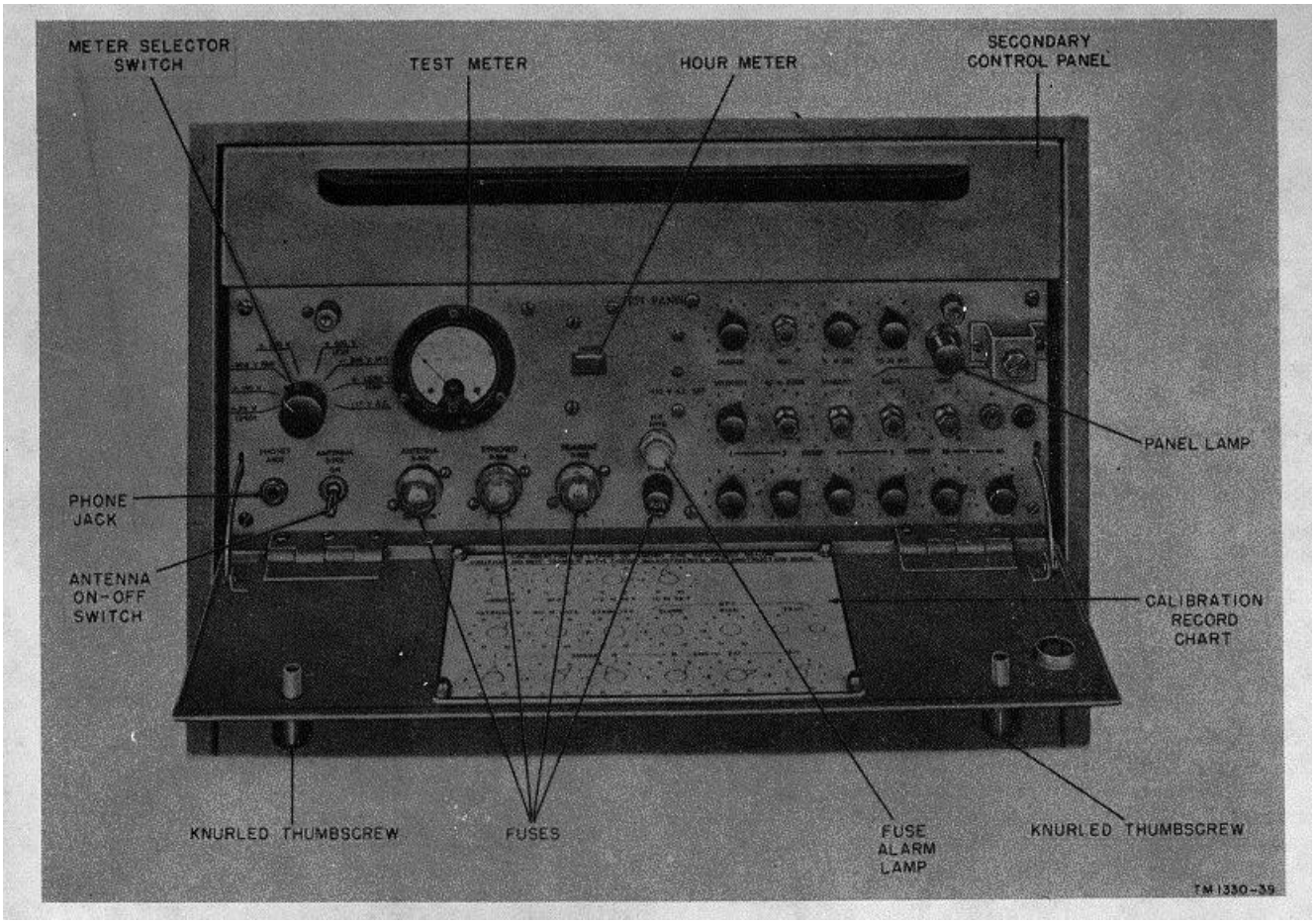

Figure 11. Indicator test panel.

c. Primary controls for the indicator are located on a panel below the screen, and the secondary controls are on a hinged panel (fig. 1*0).*beneath the primary controls. Beneath the .secondary control panel is a test panel. The .hinged cover on the test panel is released by .unscrewing two black, knurled captive screws.. The test panel (fig. 11) contains a test meter,. antenna switch, phone jack, hour meter, fuses,. and adjustments. The proper settings of these .adjustments are shown on a diagram attached. to the inside of the test panel cover..

d. An amber X ready light, which is illuminated shortly after power is turned on, is located on the lower panel. This panel covers. the indicator circuits chassis, and may be taken .off by loosening four knurled captive screws.. Underneath it is another cover over the high-.voltage components. When this second cover. is removed, by loosening four Dzus fasteners, .an interlock turns off cathode-ray tube high. voltage.

. *e.* The entire front of the indicator may be. opened by releasing the two recessed hex-head. bolts and swinging it outward (fig. 12). Opening the door operates a protective interlock.(the same interlock operated by raising the. top). On the rear of the front door are. mounted the indicator and high-voltage power. supply components. The high-voltage tube at. the bottom is inclosed in a shield box. Terminal boards and the video chassis are mounted. on a vertical plate inside the cabinet. Two. 115-volt, 400-cycle a-c outlets, special setscrew .wrenches, and a relay under a transparent. cover are also located on this rear plate. The. cabinet contains a servicing lamp, next to the. PPI rotating deflection yoke assembly. The. yoke assembly can be seen better BY removing. the louvered rear cover. The sides of the indicator cabinet may also be removed to make. servicing and repairs easier..

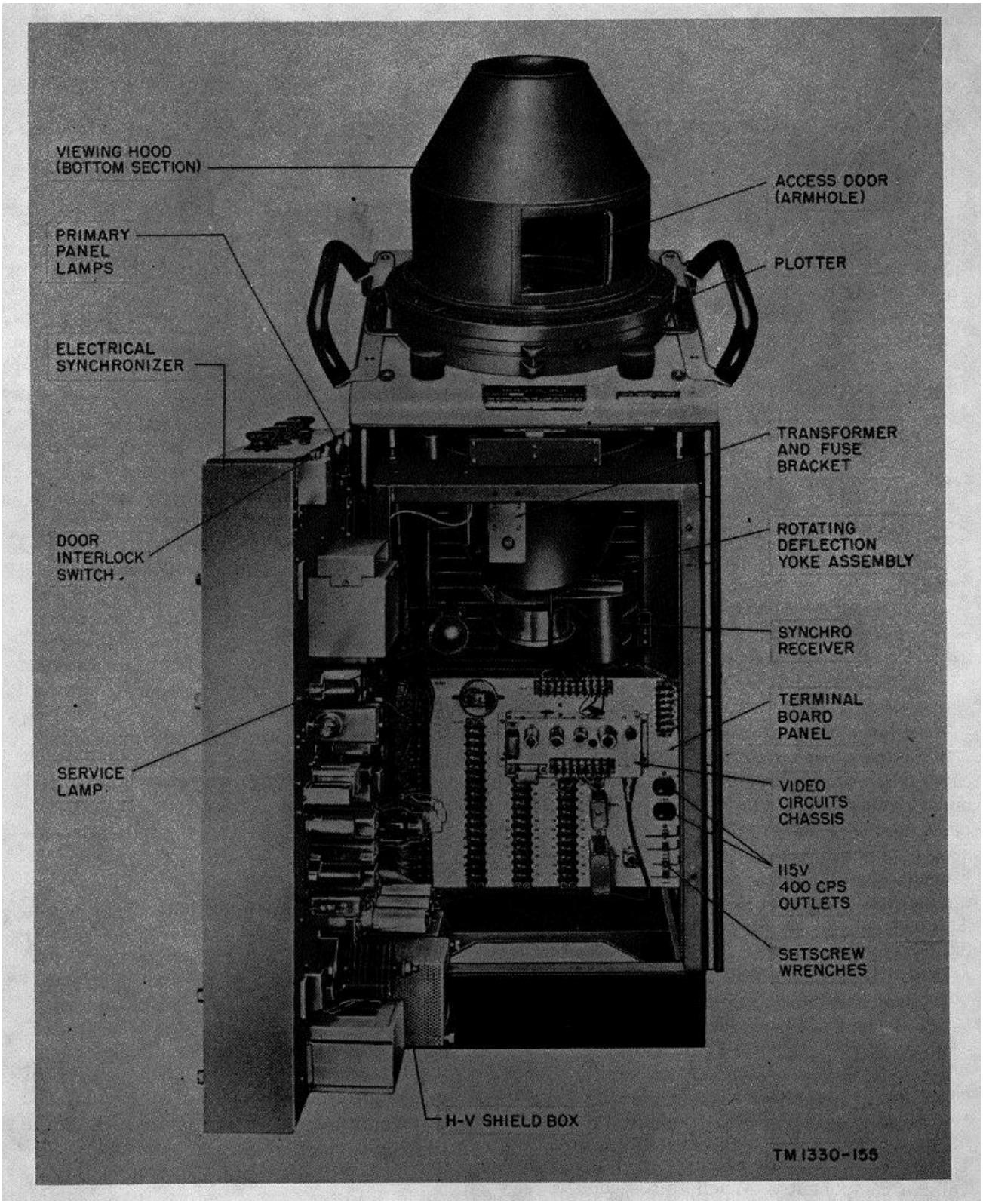

Figure 12. Control-Indicator C-1261/SPN-18, door open.

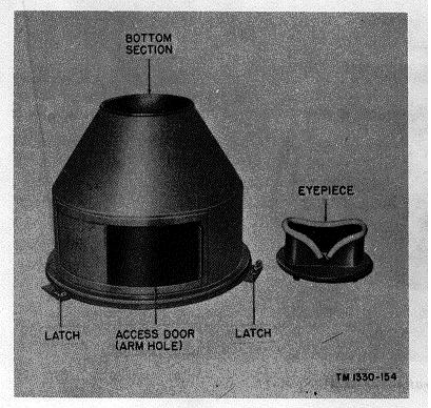

Figure 13. Two-section indicator viewing hood

12. Motor Generator PU-243A/SPN-11

The d-c motor generator (fig. 13) used with. Radar Set AN/SPN-18, converts the available. 115-volt d-c supply voltage to 115-volt, 400-.cycle, single-phase ac, rated 965 va (volt-amperes). It consists of a d-c motor and an a-c. generator on a common shaft within a single. frame. At each end of the shaft, permanently. sealed bearings are inclosed by removable. access covers. The commutator and motor. brushes are inclosed by a removable brush-.access cover at the d-c motor end of the frame.. Terminal board TB601 is mounted on top of .the motor generator frame under a removable. cover..

13. Motor Starter SA-342/SPN-18

The motor starter (fig. 15) automatically. starts and stops the motor generator, and is. controlled by the POWER switch on the indicator. The starter is housed in a steel case.. A ratchet-type mechanical timer is mounted in. the lower left corner of the starter panel. A. solenoid operates the timer to produce gradual. acceleration of the motor by closing three sets. of contacts one after the other. A thermal. overload relay prevents damage to the equipment by opening the circuit to the motor generator whenever an overload occurs. The relay is reset by pressing the RESET button. Motor. Starter SA-342/SPN-18 is used with Radar .Set AN/SPN-18 (d-c operation)..

14. Switch Box SA-284/SPN-11.

The switch box (figs. 16 and 17) closes the. power circuit to the motor generator, driers,. heaters, and antenna drive motor. The switch .box contains a heavy cop per, double-pole, knife. switch and two cartridge fuses held by clips.. The knife switch is operated by a lever on the. side of the box. Switch Box SA-284/SPN-11. is used with a 115-volt d-c shipboard supply. only (Radar Set AN/SPN-18)..

15. Motor Generator PU-288/SPN-18X.

The a-c motor generator (fig. 18), used with .Radar Set AN/SPN-18X, converts the available 115-volt, 60-cycle, a-c supply voltage to. 115-volt, 400-cycle, single-phase ac, rated at. 8.4 amp or 965 va. This motor generator. consists of an a-c motor, an a-c generator and. a d-c exciter mounted on a common shaft with-.in a single frame. Permanently sealed bearings are mounted at each end of the common .shaft. The two exciter brushes and the commutator are enclosed in a housing at the exciter. end of the motor-generator frame. A relay. box, mounted on the front of the frame, contains a starting relay, a starting capacitor, .and a running capacitor. Terminal board. TB601 *is* mounted on top of the motor-generator frame under a removable cover..

16. Circuit Breaker SA-369/SPN-18X.

The circuit breaker (fig. 19) automatically .starts and stops the a-c motor generator, and .is controlled by the POWER switch on the indicator. The circuit breaker is housed in a. steel case. A thermal overload relay prevents. damage to the equipment by opening the circuit to the a-c motor generator whenever an. overload occurs. The relay is reset by pressing the RESET button. Circuit Breaker SA-.369/SPN-18X 'is used with Radar Set AN/.SPN-18X (a-c operation)..

17. Switch Box SA-368/SPN-18X.

This switch box (figs. 16 and 17) is used. with Radar Set AN/SPN-18X (a-c operation).and is the same as Switch Box SA-284/SPN-11. used with Radar Set AN/SPN-18 (d-c operation) except for the rating of the inclosed. fuses.

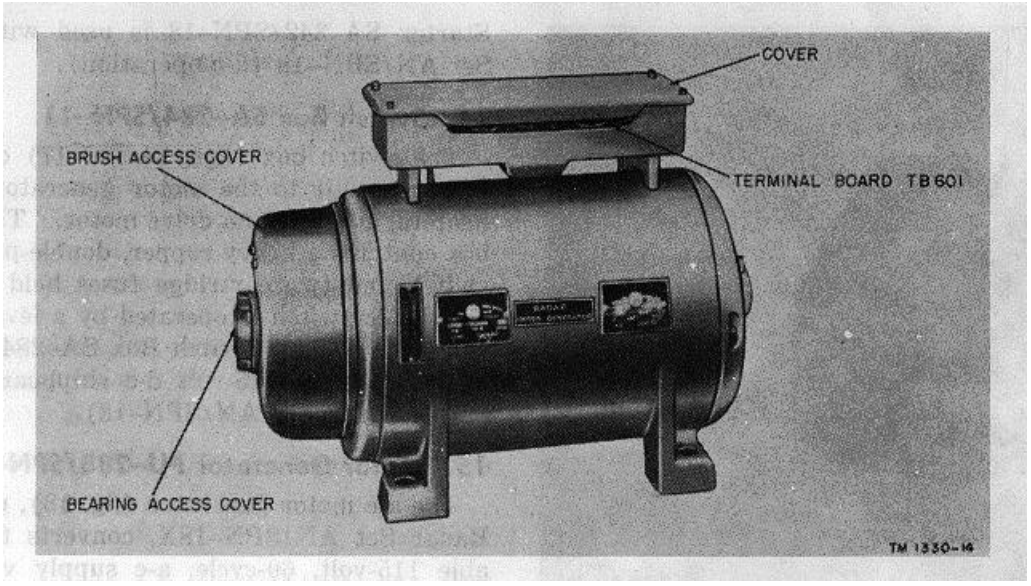

Figure 14. Motor Generator PU-243A/SPN-11.

18. Voltage Regulator CN-225/SPN-18

The voltage regulator (figs. 20 and 21) automatically adjusts the a-c output of the motor generator. The output voltage is indicated on a voltmeter. Meter illumination can be controlled by a dimmer. A toggle switch permits the selection of automatic or manual voltage regulation; if because of failure manual regulation is chosen, the large control knob (rheostat) can be adjusted for the desired voltage level. The voltage regulator is mounted on a bulkhead and can be opened by loosening the knurled screw on the front.

19. Tuned Cavity TN-224/SPN-18

The echo box (fig. 22) is bulkhead-mounted and connected to the receiver-transmitter and to the directional coupler section of the waveguide. The purpose of the echo box is to supply artificial echo signals at the transmitter frequency; for use in tuning the receiver manually and testing it. When the cover is opened, the accessible components are connectors, terminal boards, and the echo box assembly. This assembly is roughly cylindrical in shape, and contains a cavity, 24-volt motor, reciprocating mechanism, microswitch, cavity plunger, and resistors.

20. Cables

All of the following cables must be cut to the required length and fitted with connectors. All other cables in the radar set are already installed and connected, and considered as parts of the components, with one exception- W713 (fig. 22), which is supplied as a 24-inch length of RG-5/U cable (Radio Frequency Cable Assembly CG-1074/SPN-18), must be connected between the echo box (P715 end) and the directional couplet (P7:13 end).

a. W701 is a 19-conductor cable (type MHFA-19) which connects the motor generator (TB601) to the receiver-transmitter (TB803).

b. W702 is a 19-conductor cable (type MHFA-19) which connects the receiver-transmitter (TB804) to the antenna (TB501).

c. W703 is a 14-conductor cable (type MHFA-14) which connects the indicator (TB-904) to the receiver-transmitter (TB802).

d. W704 is a 19-conductor cable (type MHFA-19) which connects the indicator (TB- 903) to the receiver-transmitter (TB801 and TB802).

e. W705 is a coaxial cable (type RG-12/U) which connects the indicator (TRIGGER jack J911) to the receiver-transmitter (TRIGGER jack J802).

f. W706 is a coaxial cable (type RG-12/U) which connects the indicator (VIDEO jack J1152) to the receiver-transmitter (VIDEO jack J801).

g. W707 is a 4-conductor cable (type FHFA-4) which connects the voltage regulator (TB-602) to the indicator (TB905).

h. W708 is not used in this installation.

i. W709 is a 7-conductor, lead and armored cable (size No. 12 wire) which connects the motor starter (K601) or circuit breaker to the motor generator (TB601).

j. W710 is a 2-conductor cable (type DHFA-23 or size No. 4 wire) which connects the switch box (S601) to the motor generator (TB601).

k. W711 is a 2-conductor cable (size No. 8 wire) which connects the switch box (S601) to the main power line of the ship.

l. W712 is a 3-conductor cable (FHFA-4) which connects the echo box (TB101) to the receiver-transmitter (TB801 and TB802).

21. Running Spares

A group of running spares is supplied with each Radar Set AN/SPN-18(*). The list below covers the running spares for all normally expendable items such as tubes, pilot lamps, and fuses.

2 tubes type 0D3/VR150
1 tube type 1B24A
1 tube type 1B35A
2 tubes type 1V2
1 tube type 2K25
1 tube type 3B24W
1 tube type 4C35
4 tubes type 5R4GY
1 tube type 6AG7
20 tubes type 6AK5
6 tubes type 6AL5
2 tubes type 6AQ5
1 tube type 6AS6
1 tube type 6AS7G
1 tube type 6AU6
1 tube type 6BQ7
2 tubes type 6CD6G
2 tubes type 6J6
1 tube type 6SJ7
10 tubes type 6SN7GT
2 tubes type 6V6GT
1 tube type 12AT7
1 tube type 12AU7
1 tube type 5651
1 tube type 5692
1 tube type 725A
3 tubes type 8013A
1 tube type 16ADP7 (16 in. CRT)
1 NE-32 (neon)
2 crystals IN23B
4 lamps, 6-volt Mazda #47
2 lamps, 3-volt Mazda #323
1 lamp, NE-51 (neon)
1 lamp, GE50A/RS
6 fuses, 10-ampere, 250-volt
2 fuses, 25-ampere, 250-volt (Radar Set AM/SPN-18)
6 fuses, 3-ampere, 250-volt
30 fuses, 2-ampere, 250-volt
6 fuses, 1-ampere, 250-volt

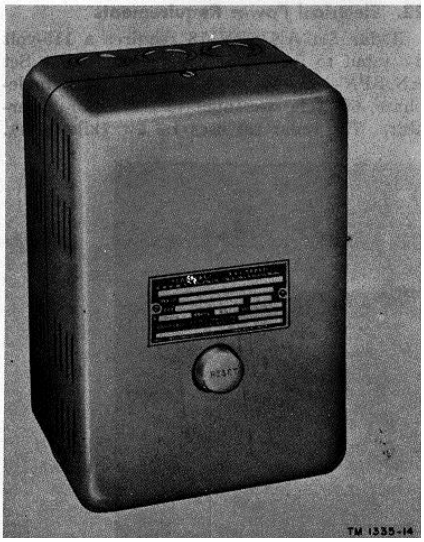

Figure 15. Motor Starter SA-342/SPN-18.

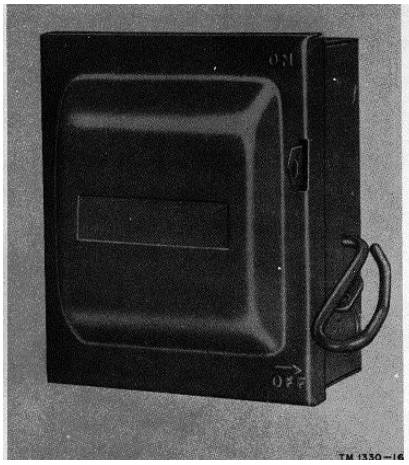

Figure 16. Switch Box SA-284/SPN-11 and SA-368/SPN-18X.

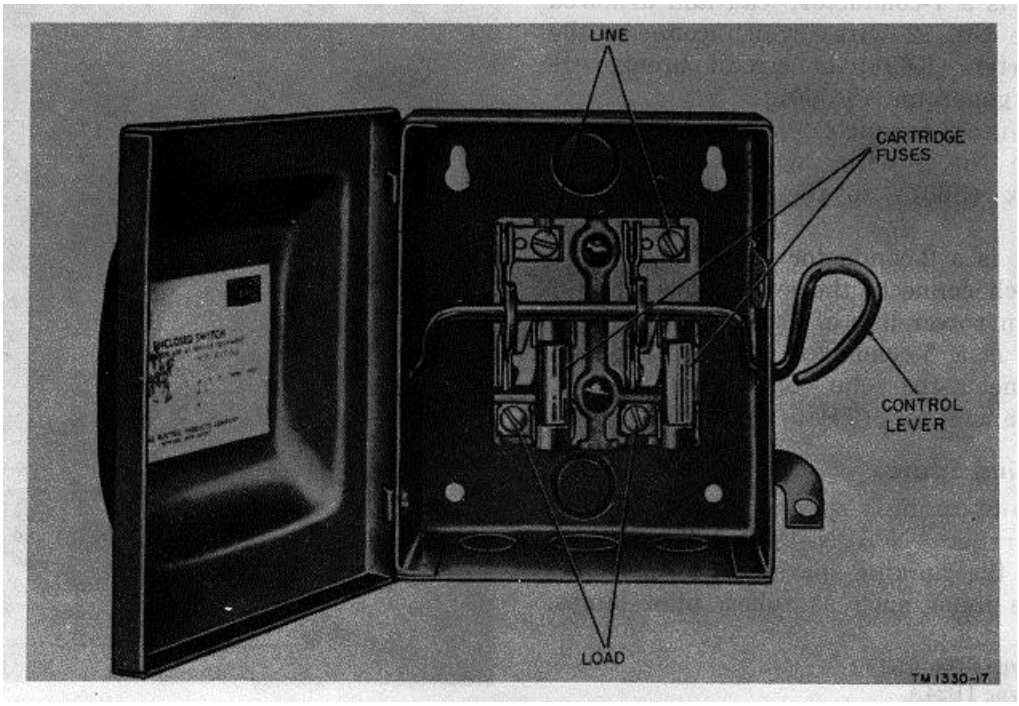

Figure 17. Switch Box SA-284/SPN-11, and SA-368/SN-18X, cover open.

6 fuses, 1/2-ampere, 250-volt
12 fuses, 21/2-ampere, 250-volt
2 fuses, 30-ampere, 250-volt (Radar Set AN/SPN-18X)
10 fuse links, 30-ampere, 250-volt (Radar Set AN/SPN-18X)
10 fuse links, 25-ampere, 250-volt (Radar Set AN/SPN-18)
1 cleaner, air element
1 set motor generator brushes (Radar Set AN/SPN-18)
1 set antenna motor brushes (Radar Set AN/SPN-18)

22. Electrical Power Requirements

Radar Set AN/SPN-18 requires a 115-volt d-c input to the motor generator. Radar Set AN/SPN-18X requires a 115-volt, single-phase, 60-cycle, a-c input to the motor generator. The radar set uses 1.5 kw (kilowatts).

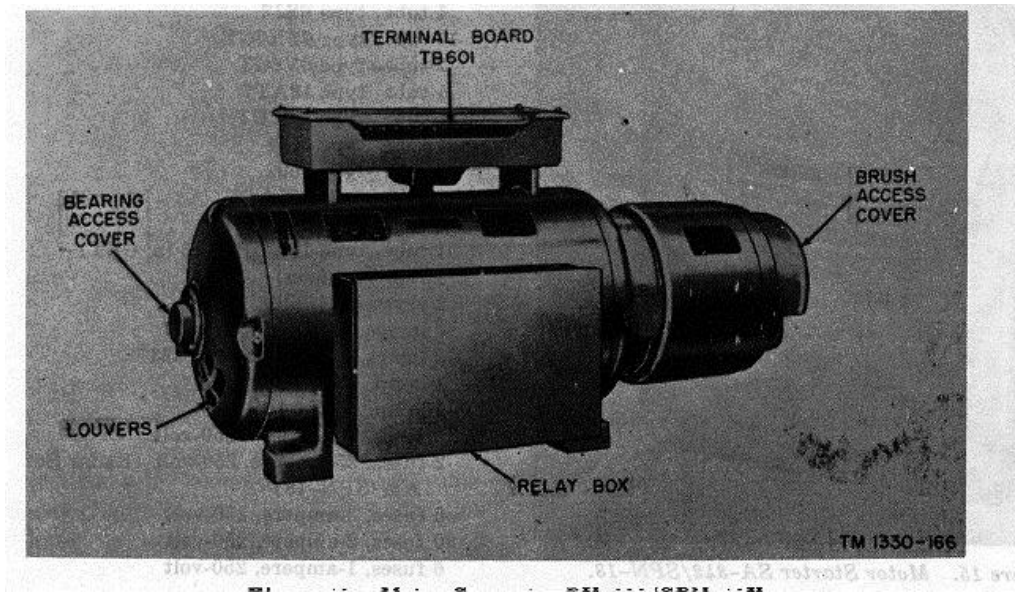

Figure 18. Motor Generator PU-288/SPN-18X.

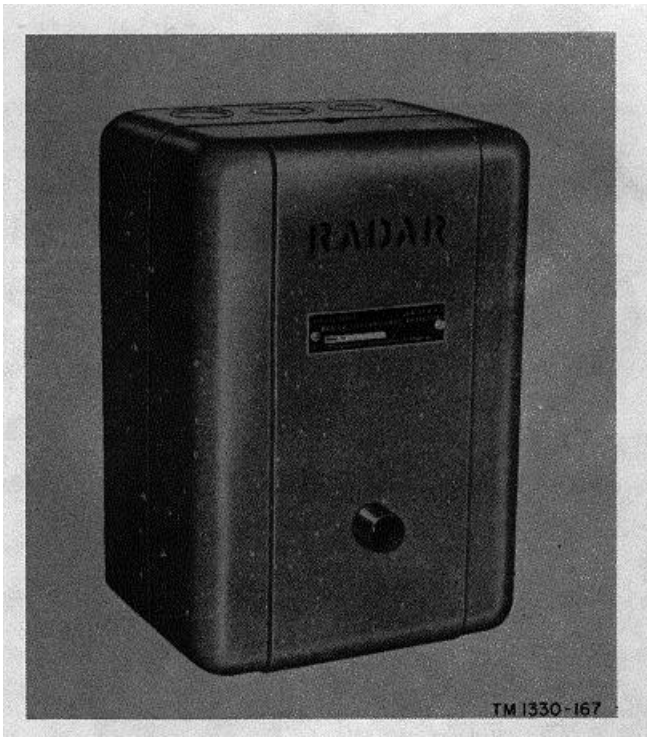

Figure 19. Circuit Breaker SA-369/SPN-18X.

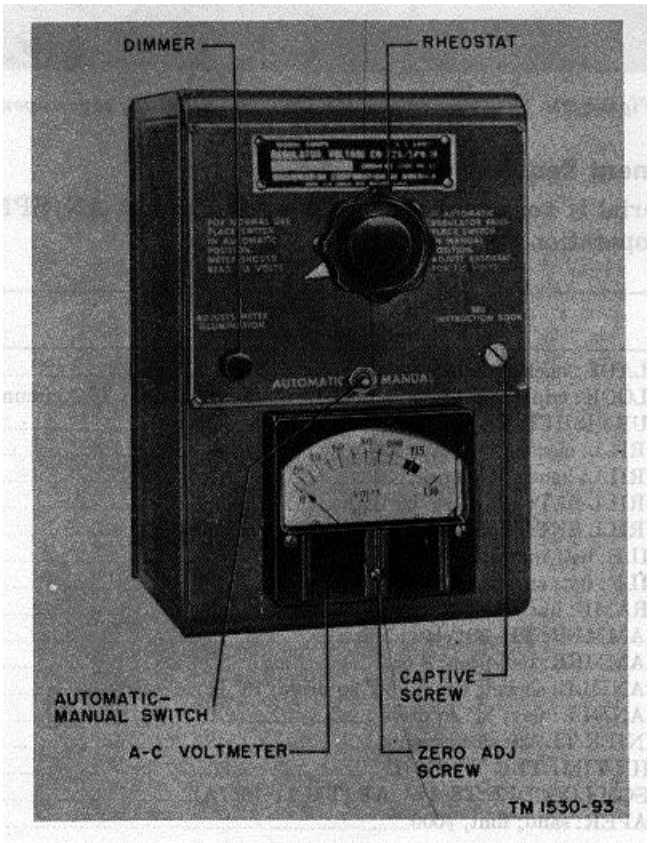

Figure 20. Voltage Regulator CN-225/SPN-18.

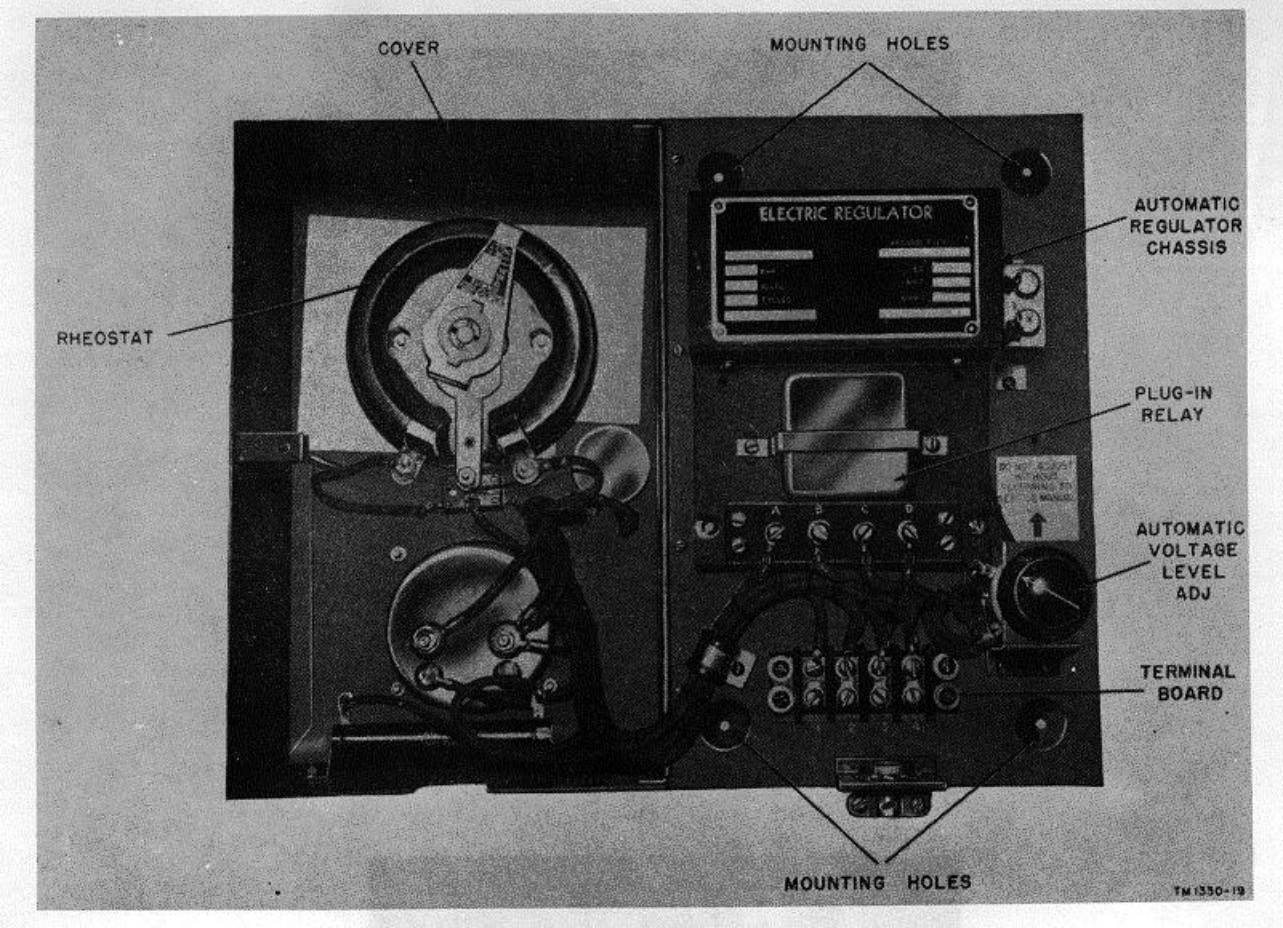

Figure 21. Voltage Regulator CN-225/SPN-18, cover open.

23. Additional Equipment Required

The following material is *not* supplied as part of Radar Set AN/SPN-18(*), but is required for its installation and operation.

2	BLADE: hack-saw, 12″; 32 teeth	6Q8012–32
4	BLOCK: triple sheave; loose hook; w/becket; ⅝″ dia x 1⅞″ circum.	19–B24995
1	BURNISHER TL–557/U	6R41065C
1	DRILL: electric; ¾″ cap; 120 v ac or dc	40–D346
1	DRILL: hand; ⅜″ cap	6Q32005-5.1
1	DRILL SET: 1/16″ to ½″ by 64ths	6Q35814
1	DRILL SET TL–305: twist; Nos. 1 through 60	6Q36160.1
1	FILE: half-round; 2d cut; 8″	6Q38123–8
1	FILE: flat; smooth; 8″	6Q34034–8
1	FRAME: hack-saw	6Q41002
1	HAMMER: TH–39; claw; 1 lb	6Q49139
1	HAMMER: ball-peen; 8 oz	6Q49708
1	HANDLE: socket; flex T; ½″ sq drive; 16″ lg	6Q51202
1	HANDLE: flex; ¼″ sq drive	6Q36881
1	KNIFE TL–29; electrician's	6Q60229
1	MULTIMETER TS–352/U	3F4325–352
1	OSCILLOSCOPE TS–34A/AP (TM 11–1067A)	3F4325–34A
6	PAPER: sand; flint, #000	6Z7500–000

Quantity	Name and description	Sig C stock No.
1	PASTE: soldering; 2 oz	6N4102
1	PLIERS TL–103; diagonal cutters; 5″	6R4603
1	PLIERS TL–125; comb; 8″	6R4525
1	PLIERS TL–126: long-nosed	6R4626
1	PLIERS TL–107: side-cutting	6R4607
1	PUNCH TL–399/U: center	6R7503G
500 ft	ROPE: manila; 5/8″ dia	QM21-R-396
1	RULE: steel; 6″	6R9906
1	SCREWDRIVER TL–21: 7″ lg	6R15310
1	SCREWDRIVER TL–456/U 6″ lg; 1/8″ bit	6R14990
1	SCREWDRIVER: 9 1/2″ lg; 7/32″ bit	6R16001
1	SCRIBER: machinist's	6R20006
1 lb	SOLDER M–30	6N7530
1 lb	SOLDER M–31	6N7531
1	SOLDERING IRON TL–117: 110 v; 80 w	6R24617
1	SOCKET WRENCH: 1/4″, 12 point; 1/4″ sq drive	6R24313–8
1	SOCKET WRENCH: 5/16″, 12 point; 1/4″ sq drive	6R24313–10
1	SOCKET WRENCH: 3/8″, 12 point; 1/4″ sq drive	6R24313–12
1	SOCKET WRENCH: 7/16″, 12 point; 1/2″ sq drive	6R24308–14
1	SOCKET WRENCH: 1/2″, 12 point; 1/2″ sq drive	6R24308–16
1	SOCKET WRENCH: 9/16″, 12 point; 1/2″ sq drive	6R24308–18
1	SOCKET WRENCH: 5/8″, 12 point; 1/2″ sq drive	6R24308–20
1	SOCKET WRENCH: 11/16″, 12 point; 1/2″ sq drive	6R24308–22
1	SOCKET WRENCH: 3/4″, 12 point; 1/2″ sq drive	6R24308–24
1	SOCKET WRENCH: 7/8″, 12 point; 1/2″ sq drive	6R24308–28
1	TANK: prestolite; style B	6Z8631
1	TIP: soldering iron	6R24617/1
1	TAPE: TL–545/U: measuring; 6′ lg	6R9628
1	TAPE: measuring; 100′ lg	6R36026
1	TORCH EQUIPMENT: prestolite	6R42178
1	WRENCH: double; open-end; 1/4″ x 5/16″ cap	6R55508–10.1
1	WRENCH: double; open-end; 3/8″ x 7/16″ cap	6R55512–14.1
1	WRENCH: double; open-end; 1/2″ x 9/16″ cap	6R55516–18.3
1	WRENCH: double; open-end; 5/8″ x 11/16″ cap	6R55520–22
1	WRENCH: double; open-end; 3/4″ x 7/8″ cap	6R55568
1	WRENCH: pipe; 24″	6R56624
1	WRENCH: Allen setscrew; 3/32″	6R55496
1	WRENCH: Allen setscrew; 3/16″	6R57400–1
1	WRENCH: handle; 1/4″ sq drive	6Q36881
1	WRENCH: socket; Spintite; 5/16″ hex	6R57413–5
1	WRENCH: socket; Spintite; 1/4″ hex	6R57413–3
1	WRENCH: socket; Spintite; 5/16″ hex	6R57413
1	WRENCH: socket; Spintite; 11/32″ hex	6R57413–8
1	WRENCH: socket; Spintite; 3/8″ hex	6R57412
1	WELDING EQUIPMENT: oxy-acetylene	6R42205
1	WELDING EQUIPMENT: electric arc	None
1	BRUSH: paint; 2″ wd	6Z1582
1	OILER	6Z7308.4
1	PLIERS: 8″ comb	6R4745–8
1	SCREWDRIVER: 7″ lg; 3/16″ wd bit	TL–358/U
1	WRENCH: TL–476/U: adjustable	6R55018.1
1	WRENCH: single; open-end; 1 1/16″ opening	6R57034

Shipboard supply	115 volts dc	115 volts, 60-cycle ac.
Motor generator	Motor Generator PU–243A/SPN–11	Motor Generator PU–288/SPN–18X.
Motor starter	Motor Starter SA–342/SPN–11	Circuit Breaker SA–369/SPN–18X.
Switch box	Switch Box SA–284/SPN–11	Switch Box SA–268/SPN–18X.
Antenna drive motor in Antenna AS–659/SPN–18.	D-c antenna drive motor	A-c antenna drive motor.

Section III. BASIC PRINCIPLES

25. Introduction

Radar Set AN/SPN-18(*) radiates a beam of pulsed h-f energy which covers a wide angle (20°) vertically and a narrow angle (1.9°) horizontally. When the beam strikes an object, such as a ship within range of the radar set, the object reflects a portion of this energy back to the antenna. The reflected energy is known as an *echo,* and the object from which the energy is reflected is called a target (A, fig. 23). Since the radar beam is only 1.9° wide, an echo will be received by the radar set only when the beam is pointed directly at the target. The antenna and, hence, the beam are rotated through a complete 360-degree circle by the antenna drive motor. This rotation is known as continuous azimuth scanning. The velocity of a radar wave is so much greater than the speed at which the antenna rotates that a transmitted pulse of radio energy can leave the antenna, reach the target, and return to the antenna before the antenna has had time to rotate more than a negligible amount. The direction in which the antenna is facing when the echo is received supplies the radar set with information as to the direction (azimuth) of the target. The length of time which the transmitted pulse takes to travel from the antenna to the target and back to the antenna supplies the radar set with information as to the distance (range) of the target. The range and azimuth data of targets are displayed on the radar indicator unit.

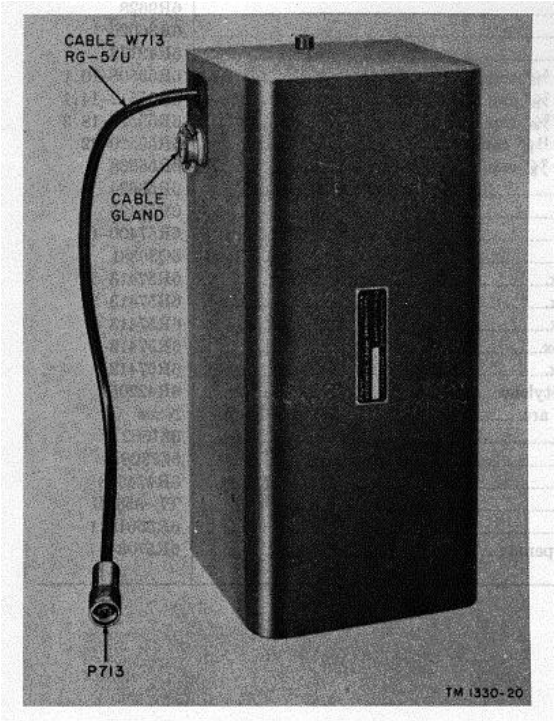

Figure 22. Tuned Cavity TN-224/SPN-18.

26. Range

a. The range of a target is the distance between the target and the radar antenna, as shown in B, figure 23 and in figure 24. Target range is measured in miles (and in steps of 1/10 mile) by Radar Set AN/SPN-18(*).

b. Determination of range is based on the time required for a radio signal to leave the transmitting equipment, travel to the target, and return as an echo from the target to the receiving equipment. A radio wave travels at the speed of light, which is 162,000 nautical miles per second. It therefore takes 12.3 millionths of a second (12.3 microseconds) for a radio wave to make a round trip between an antenna and a target 1 nautical mile apart.

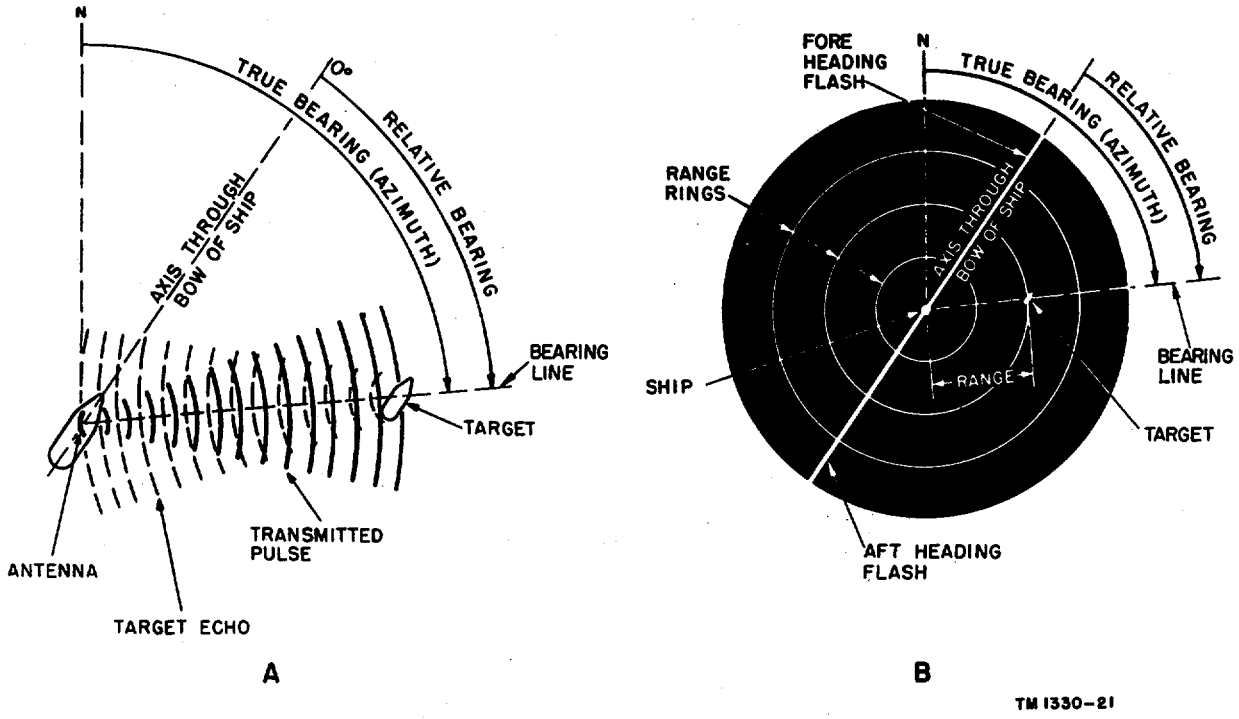

Figure 23. Principles of radar and measurements of bearing and range.

Thus, if the round trip is found to require 123 microseconds, the range (distance) to the target is 10 nautical miles. Actual calculations of the time required for a signal to make the round trip between transmitter and target are made within the equipment by a range-measuring device. In this manner, the exact range of a particular target may be read on the indicating component.

27. Azimuth

The azimuth of a target is its horizontal clockwise angular displacement (fig. 24) with respect to a specific direction. The specific, or reference, direction for Radar Set AN/SPN-18(*) may be either true north or that direction in which the ship is heading.

a. True Bearing. The true bearing of a point on the surface of the earth from the position of an observer is the angle which the bearing line (a straight line connecting the observer and the point observed) makes with the north-south line through the position of the observer. In A, figure 23, the north-south line (marked N) passes through the radar antenna, and the bearing line extends from the antenna to the target. The true bearing is the angle between those two lines, measured in the clockwise direction from the north-south line to the bearing line.

b. Relative Bearing. The relative bearing of an object is its direction from the ship, relative

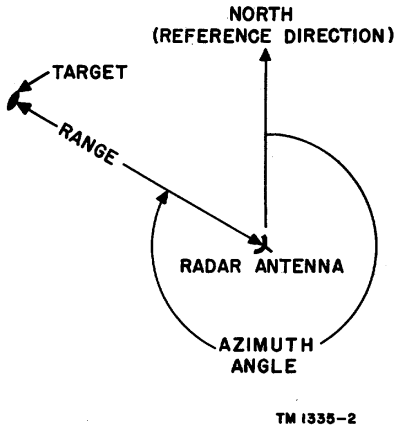

Figure 24. Azimuth angle and range.

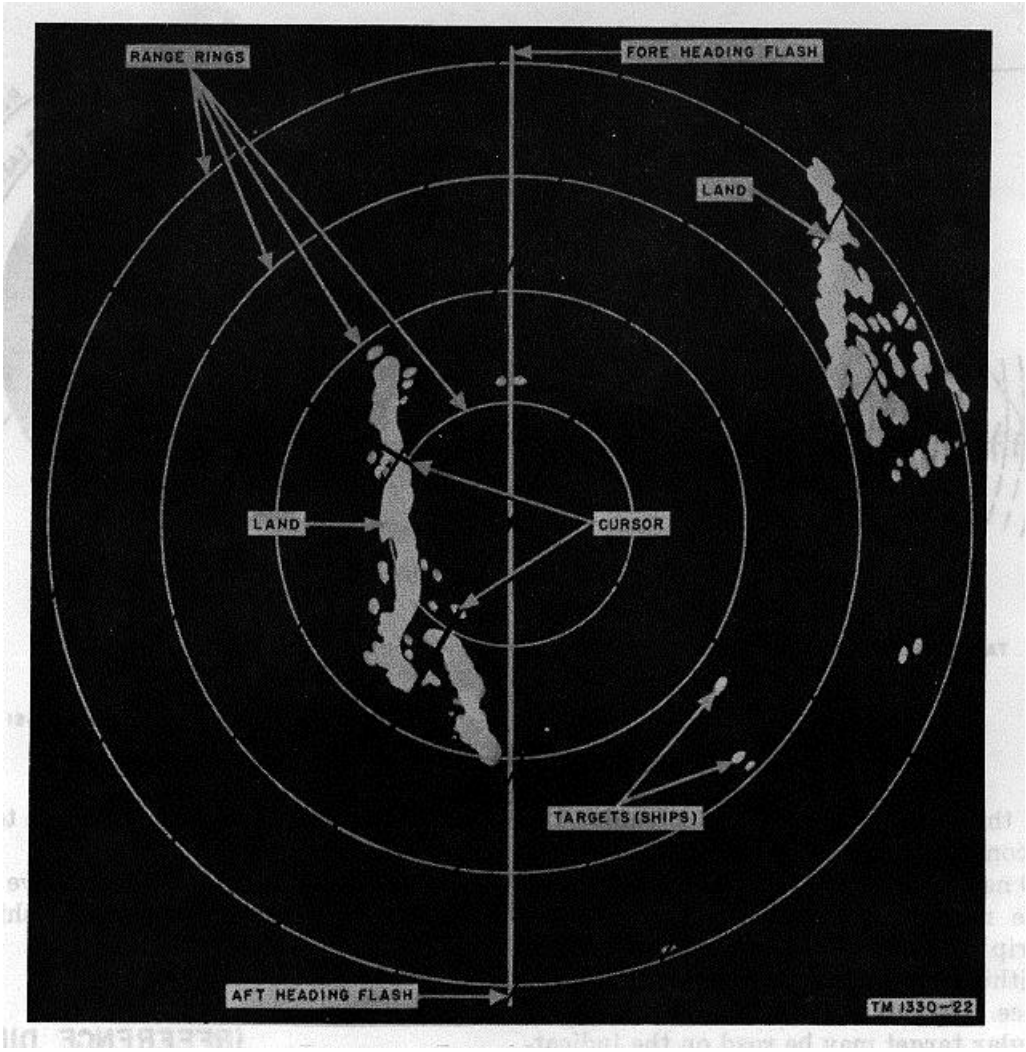

Figure 25. Typical PPI presentation.

to the heading of the ship. The relative bearing equals the angle between the fore-and-aft line of the ship and the bearing line of the object, measured clockwise from 0° to 360°. The line marked *axis through bow of ship* (A, fig. 23) is an extension of the fore-and-aft line of the ship.

28. Searching and Tracking

The main purpose of the radar set is to provide positional data on vessels and landmarks within a range of 40 nautical miles. As the antenna rotates in continuous 360° scan, objects within the range of the radar are presented on the face of the PPI scope. The range of such an object (commonly referred to as a target) is established by the use of range rings or a variable range marker on the face of the scope, and the bearing is found by manually moving the cursor line over the target and reading the azimuth scale. This information, noted at frequent intervals, is used to plot the speed and course of approaching vessels, so as to avoid collision. Storm formations may also be tracked. Piloting and position-finding are similarly accomplished by noting the range and bearing of landmarks.

29. Target Presentation

a. Information concerning the range and azimuth of targets within 40 nautical miles is displayed on a cathode-ray tube. This tube is called the PPI and produces a radar map of the surrounding area (fig. 25), with the ship at the center of the scope. Objects are presented in a map-line manner with polar coordinates,

throughout 360°. An outer, movable, t*rue*-bearing scale and an inner, fixed, *relative*-bearing scale surround the scope. Both scales are calibrated in divisions of 1°. The fixed azimuth scale gives bearings relative to the bow of the ship. The movable azimuth scale is used in conjunction with the fixed scale to give bearings relative to true north. True bearing information may be obtained by alining the course of the ship on the movable scale with the 0° mark on the fixed scale. Bearing is then read by means of a manually controlled cursor. The cursor is moved directly across the target, and its point of intersection with the azimuth scales is the target's bearing.

b. With the radar in operation, a blue-green line, extending from the center to the edge of the PPI, rotates like the spoke of a wheel. The movement of the line is synchronized with the rotation of the antenna. This line is called the rotating sweep, and gives an instantaneous indication of the direction in which the antenna is facing. When read against the fixed azimuth scale, the rotating sweep indicates the *relative* bearing of any target through which it is passing; when read against the movable azimuth scale, it indicates the *true* bearing. Each time the sweep passes through the 0° and 180° points of the relative-bearing (inner) scale, it is sharply intensified. The lines which appear as a result of this intensification are called the fore-heading flash (0°) and the aft-heading flash (180°). The rotating sweep also produces a series of four concentric rings about the center of the PPI face. These are called *range rings* (fig. 25). For more accurate range measurements, a variable range marker may be used instead of the fixed range rings.

c. A target appears as a bright spot along the rotating sweep and remains in the position at which it first appears, gradually fading in intensity until the rotating sweep again passes over the target and intensifies it. The range of a target on the PPI face may be determined by noting the position of the spot that marks the target with relation to the nearest range ring, since each range ring represents a different fixed range. However, since Radar Set AN/SPN-18(*) allows the choice of any of six overall ranges (1, 2, 4, 8, 20, or 40 miles) for PPI coverage, the range of any fixed ring depends on the overall range chosen. If the variable range marker (VRM) is used, the four fixed rings disappear from the scope face. In

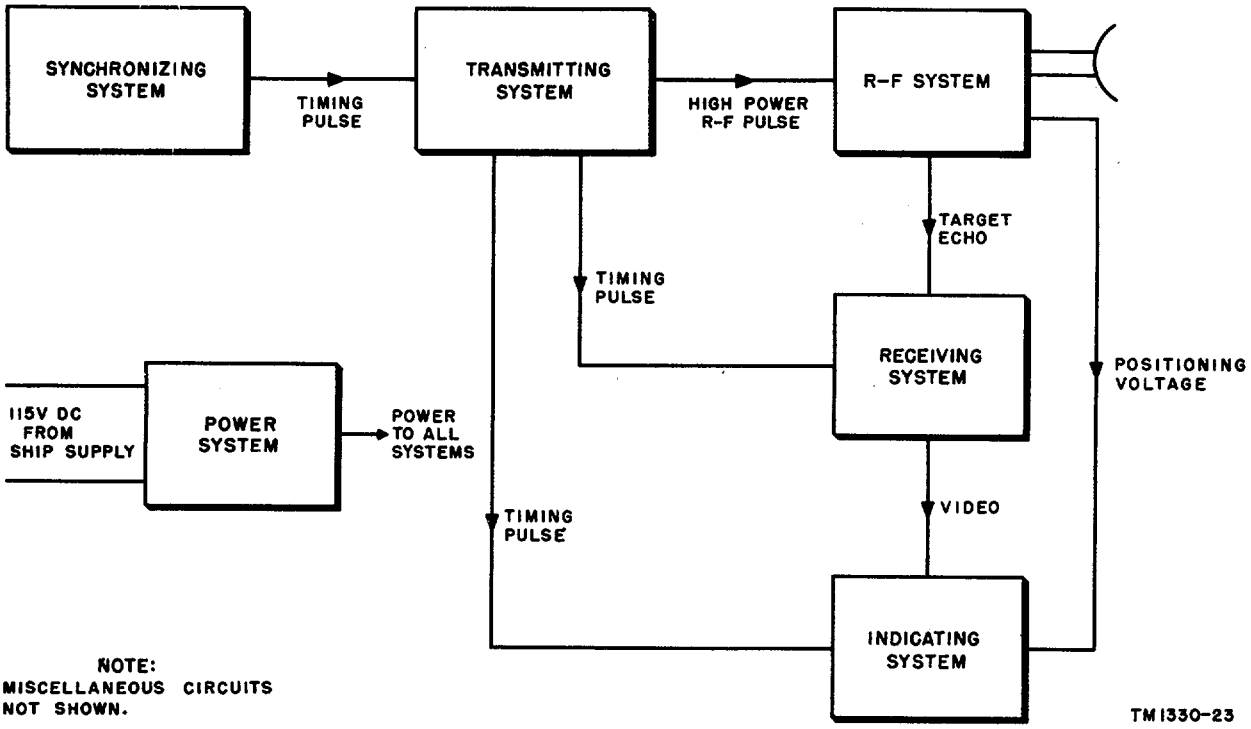

Figure 26. Radar Set AN/SPN-18, functional block diagram showing relation of systems.

their place is a single, movable range ring which is controlled by the operator, and the range is read directly on a mechanical counter in steps of 1/10 mile, up to 20 miles. For very close targets, accurate range reading is made possible by a center expand. The center of the scope can be expanded to a small-diameter circle which serves as a zero range ring, and nearby targets are *pushed out* and appear to be larger.

Section IV. FUNCTION OF COMPONENTS

30. Grouping of Components

a. The components of Radar Set AN/SPN-18(*) may be divided into seven systems or groups according to their functions as related to the function of the radar set as a whole. The grouping of components of the set (fig. 26) is as follows:

(1) Synchronizing system.
(2) Transmitting system.
(3) R-f system.
(4) Receiving system.
(5) Indicating system.
(6) Power system.
(7) Miscellaneous circuits (test meters, blower motor, heaters and driers, panel and azimuth scale lights, phone, and plotter).

b. For detailed theory of the functioning of these components, refer to the appropriate maintenance literature covering Radar Set AN/SPN-18(*).

31. Synchronizing System

a. Function. The synchronizing system (fig. 26) produces the timing pulses for the entire radar set. These timing pulses trigger the modulator circuit in the transmitting system. From there they are delivered to the receiving system, where they actuate the sensitivity time control (STC) circuit, and to the indicating system where they trigger the sweep, range markers, and unblanking circuits.

b. Description. Blocking oscillators in the transmitter provide a timing pulse to trigger the hydrogen thyratron (modulator) tube at a rate of 800 or 2,000 pps (pulses per second). This tube, in turn, generates trigger pulses for the magnetron, the indicator sweep circuits, and the receiver STC circuit. In this way, the transmitted pulses from the magnetron and the beginning of the PPI sweep are coincident.

32. Transmitting System

a. Function. The transmitting system (fig. 26) receives trigger pulses from the sychronizing system and generates high *power* r-f pulses which are delivered to the r-f system.

b. Description. The modulator circuit, triggered by the synchronizing system, supplies rectangular voltage pulses which trigger the magnetron, causing it to produce high power r-f pulses. The pulse supplied by the modulator is either 0.25 or 0.65 microsecond long, depending on the selected range, and is repeated either 2,000 or 800 times per second, respectively. The magnetron supplies r-f power at intervals equal to the intervals of the modulator pulse. The -r-f energy generated by the magnetron is transmitted to the r-f system.

33. R-f System

a. Function. The r-f system receives high power r-f pulses from the transmitting system through a duplexer and waveguide and passes them to the antenna. The antenna radiates these pulses and receives target echoes which are fed back to the receiver.

b. Description.

(1) The electromagnetic waves developed by the magnetron enter the duplexer and are guided through the waveguide and a rotating joint to the antenna horn. The waves then travel to the reflector and are reflected outward in a narrow beam. When a target is struck by the transmitted waves, or pulses, it reflects a portion of the energy back to the antenna. The reflected energy, or echo signal, enters the horn and travels through the waveguide and duplexer to the receiver.
(2) At the instant that the transmitter produces an r-f pulse, the TR tube in the duplexer allows the transmitted pulse to pass to the waveguide, but

prevents any of the transmitted energy from entering the receiver. Between transmitted pulses, an ANTI-TR tube allows echo signal energy to travel to the receiver, but prevents it from being wasted in the transmitter circuit.

34. Receiving System

a. Function. The receiving system (fig. 26) receives target echo signals from the r-f system, amplifies them, and converts them to video signals which are coupled to the video circuit in the indicator. FTC (fast time constant) and STC (sensitivity time control) circuits are used to improve the PPI presentation.

b. Description.

(1) The output of the klystron local oscillator is combined with the echo signal in the mixer crystal circuit. This mixing produces the 30-mc i-f signal. The i-f signal is maintained at 30 mc by an afc circuit, which picks up a small portion of the transmitted signal, develops an afc voltage, and applies it to the LO (local oscillator). If the transmitter frequency shifts, the afc voltage produces an LO frequency shift in the proper direction to keep the frequency mixer output at 30 mc.

(2) The receiver i-f stages amplify the 30-mc output of the frequency mixer. The amplified signals are converted to video signals by a second detector stage. The video output of the receiver is coupled through a coaxial cable to the input of the indicator.

(3) An STC circuit triggered by the synchronizing system reduces the gain of the receiver immediately after the radar pulse is transmitted. Since near targets return a more powerful echo than distant targets, the STC circuit tends to equalize the video out-put of the receiver over different distances. The FTC minimizes sea return by breaking up solid blocks of echo signals.

35. Indicating System

a. Function. The indicating system (fig. 26) receives timing (trigger) pulses from the synchronizing system and video signals from the receiver. These signals are used in the indicator to produce the visual presentation of sweep lines, range rings, and targets on the PPI scope.

b. Description.

(1) The timing pulses generated by the synchronizing system control the following circuits within the indicating system:

(a) The waveshaping circuits that produce a sawtooth current through the deflection coils of the PPI.

(b) The fixed and variable range marker circuits.

(c) The unblanking circuit for the PPI.

(2) The indicating system also includes the circuits which amplify the video signals from the receiver and the range marks, the h-v power supply and focus circuit for the PPI, and the synchro receiver and gearing for rotating the PPI sweep.

(3) An electron beam, originating at the cathode of the PPI tube, strikes the fluorescent screen on the inside of the tube face and produces a spot of light. The sharpness of the spot is controlled by adjusting the current through the focusing coil, and the position of the spot is determined by the current through the deflection coil. The deflection current moves the spot from the center to the edge and back to the center of the scope many times per second. This movement produces a line from the center to the edge of the scope. Since the deflection coil is rotated, the line is also rotated and, therefore, a rotating sweep line is produced on the PPI scope. The fluorescence of the screen is of long persistence, so that each portion of the screen remains fluorescent for some time after the rotating sweep has passed over it. A typical target presentation is shown in figure 25.

(4) The synchro system keeps rotation of the PPI sweep in synchronism with rotation of the antenna. The deflection coil in the PPI is coupled to the antenna through the indicator sel-

syn motor (synchro receiver) and the antenna selsyn *generator* (synchro transmitter). Consequently, rotation of the antenna results in a corresponding rotation of the deflection coil, and the rotating sweep of the PPI always is positioned so that it indicates the direction of the antenna with respect to the fore-and-aft line of the ship.

36. Power System

a. Fu*nction.* The power system (fig. 26) controls and regulates the input power to the radar set.

b. Description.

(1) The power system operates from a shipboard power supply of 115 volts dc (Radar Set AN/SPN-18) or 115 volts, 60 cycles ac (Radar Set AN/SPN-18X), and converts this to 115 volts, 400 cycles, single phase ac. This 400-cycle a-c power is used to obtain supply voltage of +300, regulated +300, +140, +24, and -300 volts, and the receiver filament voltage.

(2) A time delay circuit allows the filaments to warm up before high plate voltage is applied.

(3) The d-c supply line of the ship is connected through the switch box and motor starter to the motor generator. The d-c motor drives an a-c generator, converting the input to ac. The motor is protected by the motor starter against damage from high starting current. The motor starter does this by placing a resistance in series with the motor armature to limit the starting current, and the resistance gradually decreases as the motor reaches normal running speed.

(4) When the shipboard supply is ac, it is connected through the switch box and circuit breaker to the a-c motor generator. The 60-cycle a-c motor drives a 400-cycle a-c generator, converting the 60-cycle input to 400 cycles.

(5) The output of the motor generator is adjusted to a correct value by the voltage regulator, which inserts a variable resistance in series with the generator field winding, and in this way, controls the generator output voltage.

37. Miscellaneous Circuits

a. Function. The miscellaneous circuits are those which cannot properly be said to *function* with any one or more systems even though they may be physically allied with particular systems. These circuits are as follows:

(1) Indicator and receiver- *transmitter* test meters.
(2) Blower motor.
(3) Antenna heaters.
(4) Indicator and receiver - transmitter driers.
(5) Primary and secondary control panel lights.
(6) Azimuth scale lights.
(7) Phone.
(8) Plotter.

b. Description.

(1) The indicator and receiver-transmitter test meters have 0 to 1 ma movements, and are *connected to the* circuits being measured by meter switches, which also insert the proper resistances for the meters. The meters are used to test power supply and input voltages and magnetron current.

(2) The blower motor is a 400-cycle motor with permanently lubricated bearings and no brushes or commutator. Air is drawn through a filter by the blower motor and forced through ducts to the magnetron, transmitter compartment, receiver, transformers, and other components, to cool them during operation.

(3) The antenna heaters are resistance strips which keep the antenna assembly and oil warm during cold weather. A thermostat automatically controls the heater operation to prevent the temperature from falling below 40° F.

(4) The indicator and receiver-transmitter driers are high-wattage resistors. The heat dissipated by these resistors prevents the accumulation of mois-

ture within these two units, especially when the radar set is not being used.

(5) The primary and secondary control panel lights illuminate these control panels. A DIMMER control on the primary control panel can be used to vary the intensity of the panel's lights. The secondary control panel lights go on only when the panel is opened.

(6) The azimuth scale lights illuminate the azimuth scales surrounding the scope face. The DIMMER control on the secondary control panel varies the intensity of these lights.

(7) The antenna, the indicator, and the receiver - transmitter have a phone connection for the use of a handset during maintenance procedures.

(8) The plotter circuit consists of 12 lamps that edge-light the glass writing surface of the plotter, and a transformer, fuse, and rheostat which provide power, protection, and control for these lamps.

CHAPTER 2
INSTALLATION INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF RADAR SET AN/SPN-18(*)

38. Siting

Careful consideration should be given to the selection of a site for the radar set, so that optimum performance will be obtained. However, the best shipboard location may have to be a compromise between the installation specifications for the radar set and the physical limitations of the ship. Some of the siting factors that must be considered are minimum waveguide run, unobstructed antenna transmission, operating convenience, servicing accessibility, weather protection, and minimum cable lengths. These are discussed generally in the following paragraphs. The *complete* installation instructions chapter should be carefully read before any component is installed and before the location of the entire set is decided.

a. Antenna. The location of the antenna depends largely on the superstructure of the ship, and whether stacks, masts, or other structures may be in the path of the radar beam. If possible, the antenna should be placed high enough to clear such structures. Do not increase antenna height merely for the purpose of increasing the range, because the slight range increase is of no practical value and does not justify the additional waveguide. Where a clear 360-degree.view from the antenna results in an impractical height or an overlong waveguide run, it is best to sacrifice the unobstructed view. However, the area forward and off the bow should be clear, since this area is of the greatest navigational importance. Obstructions in the area aft are of lesser concern. To avoid obstacles, such as foremast, in the forward area, it is usually best to locate the antenna to one side or the other of the ship's fore-and-aft line.

b. Waveguide. The waveguide run from the base of the antenna to the *receiver-transmitter* must be as *short* and *straight* as possible.

c. Receiver-Transmitter. Install the receiver-transmitter in a clean, dry, adequately ventilated location. The location should allow a reasonably short waveguide run to the antenna. Allow enough room on the right side of the unit for the entrance of *waveguide* on a horizontal plane. Allow clearance for the removal of the front cover and for a hinged panel swing of approximately 2 feet.

d. Indicator. Install the indicator in the wheelhouse so that scope observations may be reported quickly to the navigator and helmsman. Orient the unit so that the operator always faces *forward* when viewing the PPI. Allow at least 20 inches front clearance for hinged panel swing, at least 4 inches rear clearance for raising the top and, if possible, sufficient side clearance to allow the removal of the side panels for service accessibility.

e. Echo Box. Mount the echo box on the bulkhead within 1 foot of the directional coupler section of waveguide *extending* from the receiver-transmitter.

f. Voltage Regulator. Mount the voltage regulator on a bulkhead in the wheelhouse near the indicator so that the operator may readily observe the voltmeter.

g. Motor Generator, Motor Starter (or Circuit Breaker) and Switch Box. Install these units in a clean, dry, well-ventilated location and near the receiver-transmitter. Mount the switch box and motor starter (or circuit breaker) on the bulkhead directly above the motor generator. Close grouping of these units as necessary to prevent power loss. Allow enough space for the periodic servicing and inspection of the motor generator.

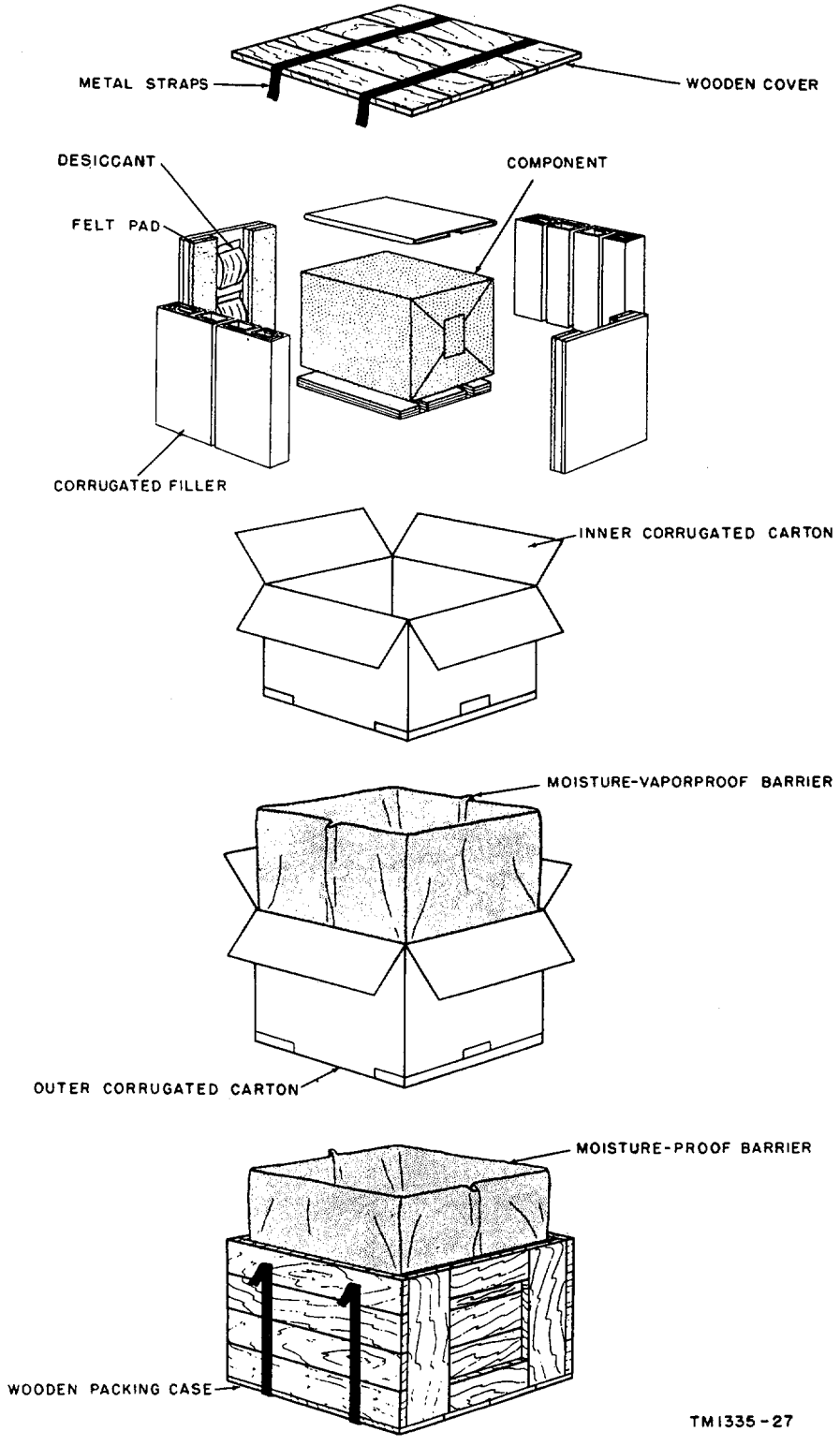

Figure 27. Typical packaging of a component.

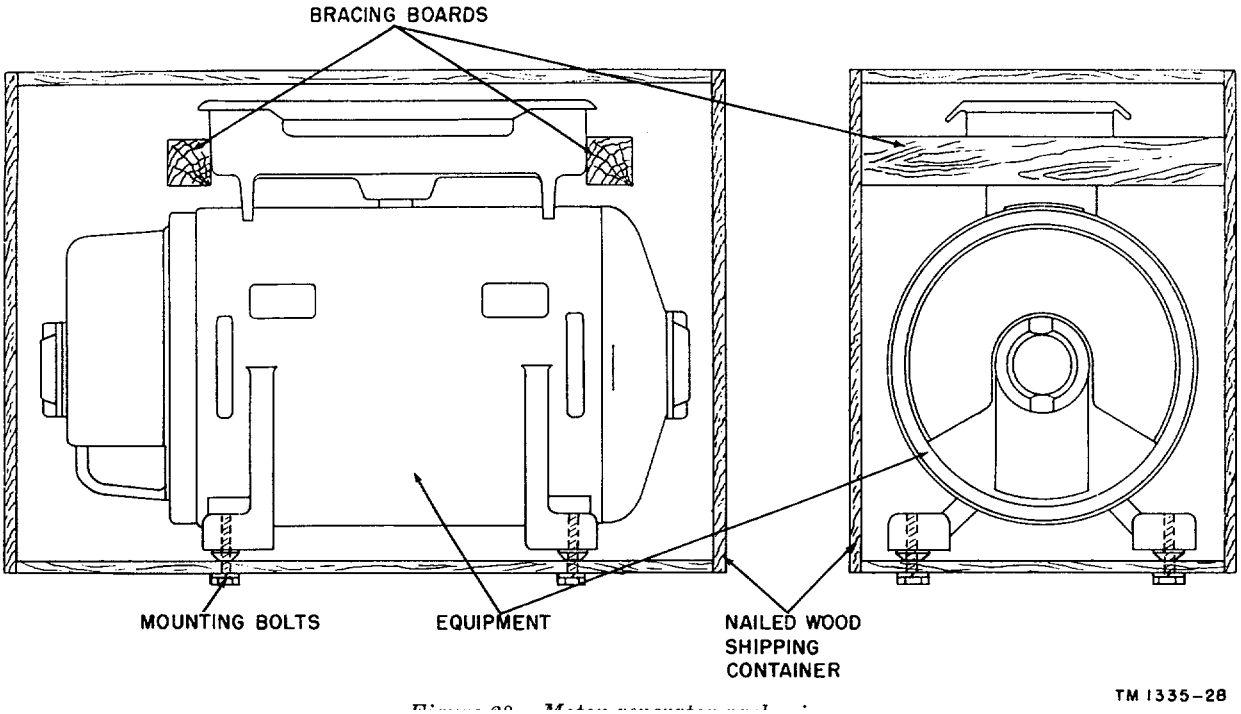

Figure 28. Motor generator packaging.

39. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 55.

a. General. When Radar Set AN/SPN-18 is received, select a location where the equipment may be unpacked without exposure to weather and which is convenient to the permanent or temporary installation of the equipment. The following instructions apply to equipment shipped in either export or domesticpacking cases.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment might be rendered useless. If the plotter is packed separately, use extreme care when unpacking it to avoid breaking or scratching the large glass plates. The bottom glass plate is a specially coated, dichroic mirror a*nd must be kept free from scratches and finger marks.*

b. Step-by-Step Instructions for Uncrating and Unpacking. Figure 27 illustrates the typical packaging of a radar set component. The components of this radar set are similarly packed, except the motor generator which is bolted to its packing case and braced (fig. 28).

(1) Place the packing cases as close to the point of installation as is convenient.
(2) Cut and fold back the steel straps.
(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; the equipment may be damaged.
(4) Remove the moistureproof barrier or heavy wrapping paper, and any excelsior or corrugated paper covering the equipment inside the case. When unpacking the motor generator, remove the bracing boards and the mounting bolts which secure the unit to the bottom boards.
(5) Remove the equipment and place it on the workbench or near its final location.
(6) Inspect the equipment for possible damage incurred during shipment.
(7) Check the contents of the packing case against the master packing slip.
Note. Save the original packing cases and containers. They can be used again when the equipment is repacked for storage or shipment.

40. General Installation Instructions

a. Because of the differences among various vessels, it is impossible to provide in this manual more than a general plan for installation. Each installation should be planned carefully. Choose the most practical location for each component, plan the waveguide and cable runs, and determine as many details as possible *before starting the installation work.*

Note. Every installation must be made in accordance with approved shipboard practices. For detailed instructions, refer to current naval electronic installation practices literature.

b. Three men are required to install Radar Set AN/SPN-18(*). An experienced crew can assemble the set in approximately 8 hours.

c. The units must not be handled roughly or dropped. Do not overtighten screws and bolts. Handle waveguides carefully and tighten waveguide clamps evenly. Waveguides are easily bent and damaged.

41. Installation of Receiver-Transmitter

a. If possible, mount the receiver-transmitter in the fore-and-aft direction to eliminate the twist section from the waveguide run. Leave 24 inches of free space in front of and on the sides of the unit for removal of the front cover and for opening the hinged panel. The rear of the unit must be at least 2 inches from the bulkhead to permit adequate ventilation.

b. The base of the receiver-transmitter should rest on a strong wooden crib (fig. 29). This crib usually is supplied by the agency or the shipyard which installs the unit. The crib is cut to fit the sheer and camber of the deck, and its thickness must be considered when the waveguide is planned.

c. Select the deck position for the base of the receiver-transmitter and mount the wooden crib. Drill four 5/8,-inch mounting holes in the wooden crib as illustrated in figure 29.

d. Drill in the deck four 1 11/16-inch and three 7/8-inch kickpipe holes, as illustrated in figure 29.

e. Install the proper kickpipe in each hole. Use approved cable glands to secure cables in kickpipes. Refer to paragraph 53 for information on installing cables.

f. Use four 1/2-inch bolts and suitable lockwashers and nuts to bolt the receiver-transmitter to the wooden crib.

Note. If the four base mounting bolts are not tightened equally, frame distortion will prevent the hinged panel from closing. Check operation of the hinged panel after tightening the four mounting bolts.

g. Refer to paragraphs 52 and 53 and to figure 92 for information on preparing and connecting cables to the four terminal boards (fig. 48). Also, connect the two coaxial cables to their respective jacks (fig. 48).

42. Installation of Antenna

Mount the antenna as high as possible to avoid reflections from the superstructure in the forward and beam directions. The supporting structure should be guyed with 3/8-inch plow steel cable to minimize the effects of vibration. Allow 36 inches of free space on all sides of the unit for removal of the two-piece drive housing cover. The antenna drive motor, reflector, and antenna horn are shipped as separate items. Before placing the antenna on its mounting, mount the antenna drive motor in the antenna pedestal; then determine whether or not the reflector and horn should be assembled to the antenna *before* or *after* the antenna is mounted.

Note. If an antenna mounting is not provided on the ship, the installation agency or the shipyard should provide one.

a. Antenna Drive Motor.

(1) Remove the antenna pedestal covers by loosening the four captive screws.
(2) Remove the drive motor mounting plate (fig. 3) by removing the four hex- head bolts, lockwashers, and washers.
(3) Use the four machine bolts, lockwashers, and washers supplied, to bolt the drive motor to the mounting plate. Have the nameplate of the drive motor face the narrowest side of the mounting plate with the thicker vibration mounts at the bottom of the mounting plate.
(4) Mount the drive motor and mounting plate in the antenna pedestal so that the two pins on the motor coupling aline with the two holes in the flexible coupling.
(5) Replace the four hex-head bolts; lockwashers, and washers that secure the mounting plate.
(6) The connections for the antenna drive

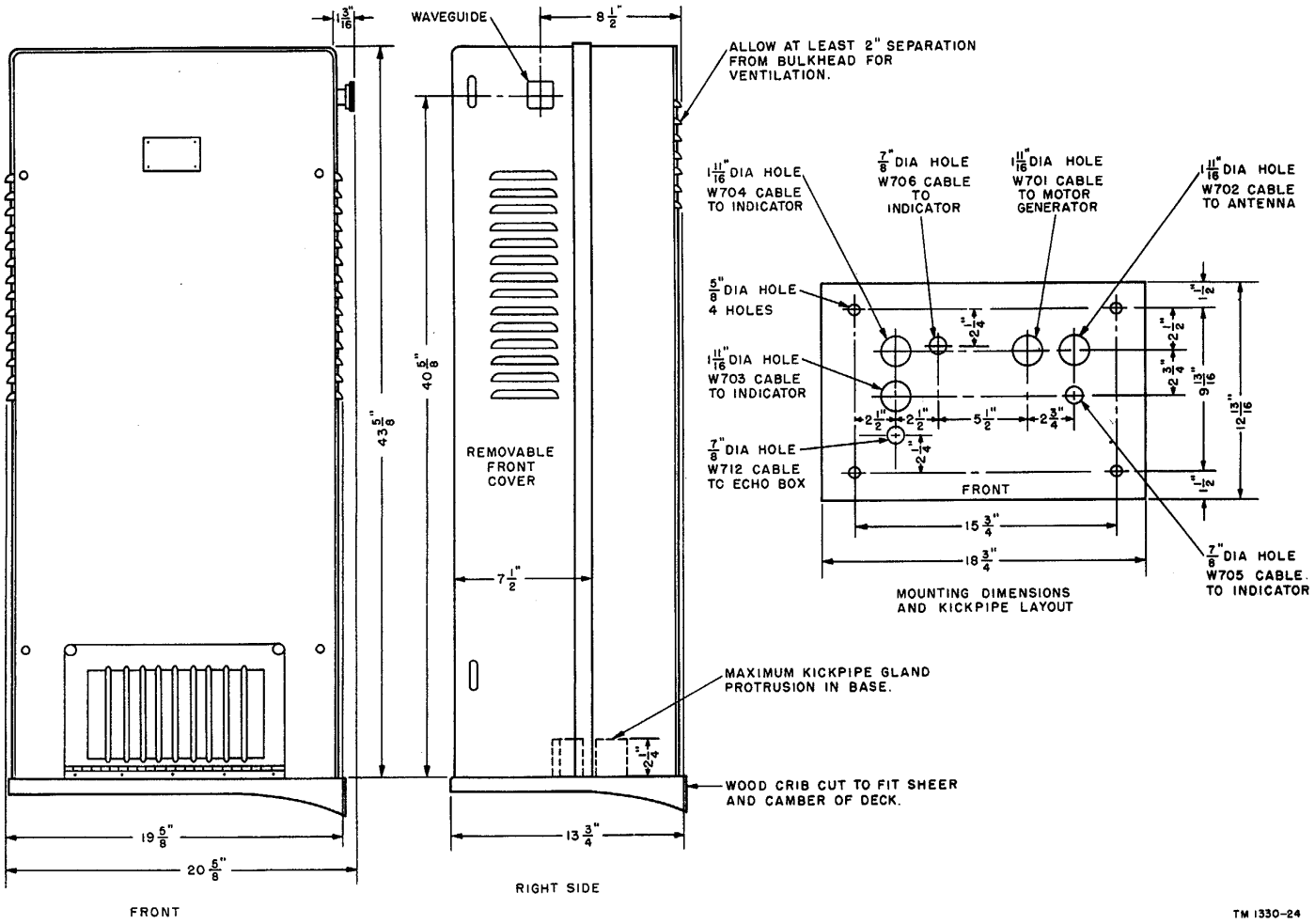

Figure 29. Receiver-Transmitter dimensional drawing.

motor depend on the shipboard supply voltage (fig. 93).

(a) When installing Radar Set AN/ SPN-18 (d-c operation), connect the green lead of the drive motor to terminal 5, and the gray lead to terminal T of TB501.

(b) When installing Radar Set AN/ SPN-18X (a-c operation), connect the green lead of the drive motor to terminal 5, the gray lead to terminal T, and the black lead to terminal 3 of TB501.

b. Reflector Assembly.

(1) Lower the reflector onto the antenna pedestal, carefully inserting the two dowel pins (fig. 3) of the rotating head into the two holes at the base of the reflector mounting brackets. (Also see figures 30 and 31.)
Note. The antenna reflector is matched to the rotating head at the factory, and both are stamped with the same serial number. Check that these serial numbers match.

(2) Fasten the reflector to the rotating head by tightening the two nuts and bolts at the base of each reflector bracket.

c. Horn Assembly.

(1) Remove the cover plate from the waveguide flange on the rotating assembly by unscrewing the four socket-head screws and washers.

(2) Mount the horn to the waveguide flange (fig. 31). See that the red paint mark on the horn flange is

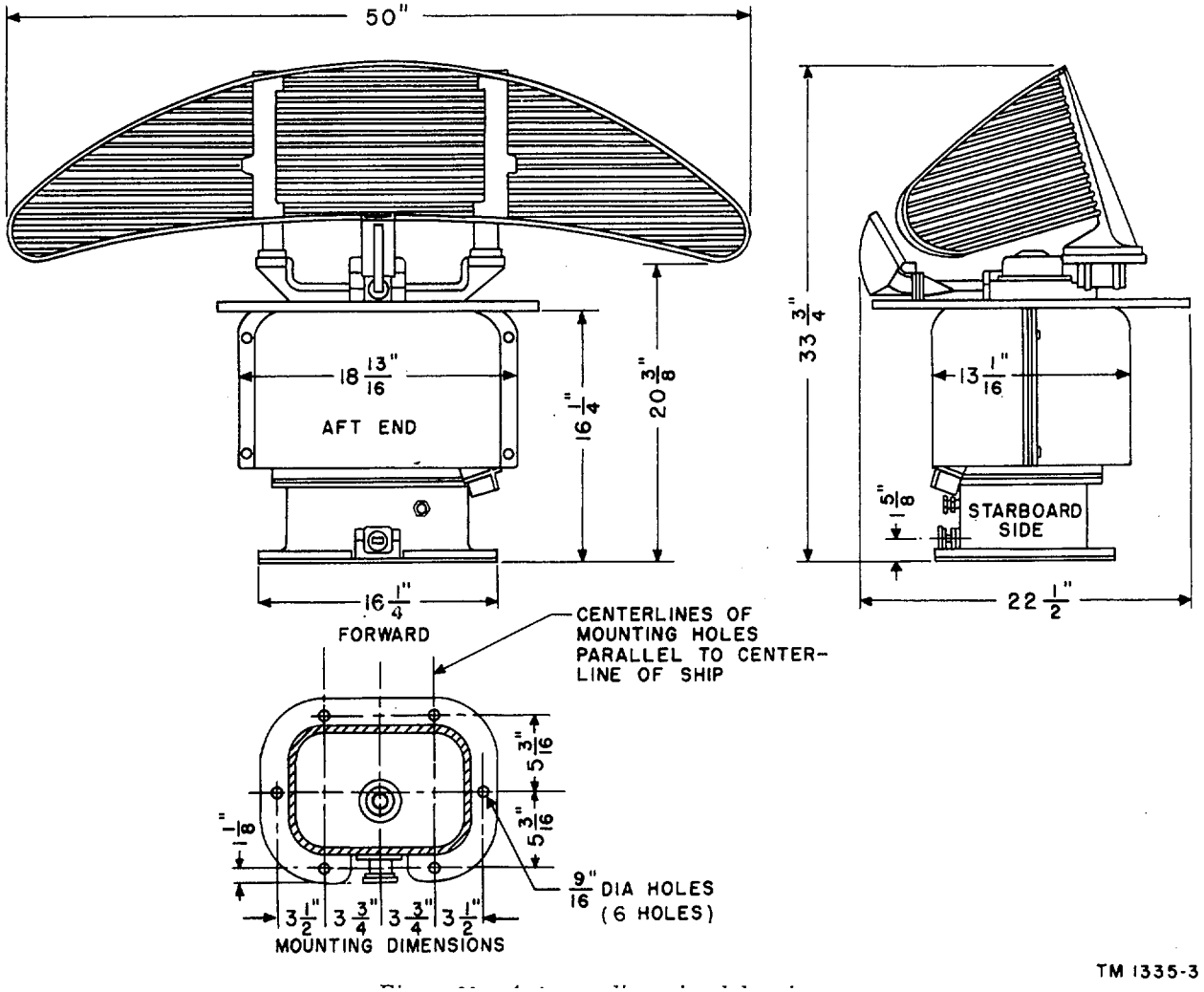

Figure 30. Antenna, dimensional drawing.

alined with the red mark on the wing (side lobe suppressor) which is fastened under the, two upper flange screws.

(3) Fasten the horn to the waveguide flange by tightening the four socket-head screws.

d. Feed Horn and Reflector. Adjustments. The spacing between the horn and the reflector must be checked to assure satisfactory performance. The spacing can be checked with an antenna gage (see note) or a 6-foot steel rule. Measurements are made from pips on the top, bottom, and ends of the reflector (fig. 31). The ends of the reflector each have a single pip. The top and the bottom each have two pips, and the center of the reflector is a line through the center between the top and bottom pips.

Note. The antenna gage is not issued with the equipment; it can be fabricated according to dimensions shown in figure 31.

(1) Antenna gage check.

(a) See that the antenna feed horn is fastened securely to the waveguide.

(b) With the reflector in place, set the antenna gage between the two pips in the center of the reflector and flush over the horn. *The gage must fit within one thirty-second of an inch at all points on the reflector.*

(c) Measure the distance X (fig. 31) from tile pip on each end of the reflector to each edge of the horn flange. Both distances should be the same within one thirty-second of an inch.

*(*d) If, because of the damage during shipment or installation, the measurement is not satisfactory, the reflector position will have to be adjusted as follows:

1. Determine what damage has been done to the reflector. See if the shape of the reflector has been altered, by visual inspection and by means of the gage check.

2. Using a *rubber* hammer, *carefully* hit the reflector into proper shape.

3. Perform the gage check.

*(*e) If the measurements are still unsatisfactory and it is evident that the reflector cannot be hammered into shape, perform the procedures outlined in *1.* through *5*. below.

1. Unbolt the reflector and remove the locating pins on the rotating assembly.

2. Shift the reflector until the gage fits within one thirty-second of an inch at all points on the reflector.

3. If the adjustment cannot be done by merely shifting the reflector, unbolt the reflector proper from the reflector brackets and remove the dowel pins. Rebolt the reflector loosely to its brackets, and shift the reflector with reference to the rotating head, until the spacing conforms to subparagraphs *(b)* and *(c)* above.

4. Tighten all bolts.

5. Relocate the locating pins by drilling new holes for the dowels.

Note. This adjustment should not have to be made because the correct spacing is determined at the factory. However, if the reflector has been damaged during transportation or installation, the spacing may be incorrect. It is essential that the spacing be correct.

(2) Steel rule check. When an antenna gage is not available, use a 6-foot steel rule to check the reflector spacing.

*(*a) Measure 15 7/16 inches ±1/32 inch from the top center pips of the reflector to the top center of the flat flange on the horn.

*(*b) Measure 12 5/16 inches ±1/32 inch from the bottom center pips of the reflector to the bottom center of the flat flange of the horn.

*(*c) Measure the distance from the end pips of the reflector to the corresponding point on each side of the horn flange. Both measurements should be the same within one thirty-second of an inch.

e. Antenna Pedestal. Mount the antenna pedestal with the word FORWARD facing forward and the waveguide outlet facing aft.

(1) Select the mounting base for the antenna pedestal.

(2) Drill six 9/16-inch holes through the

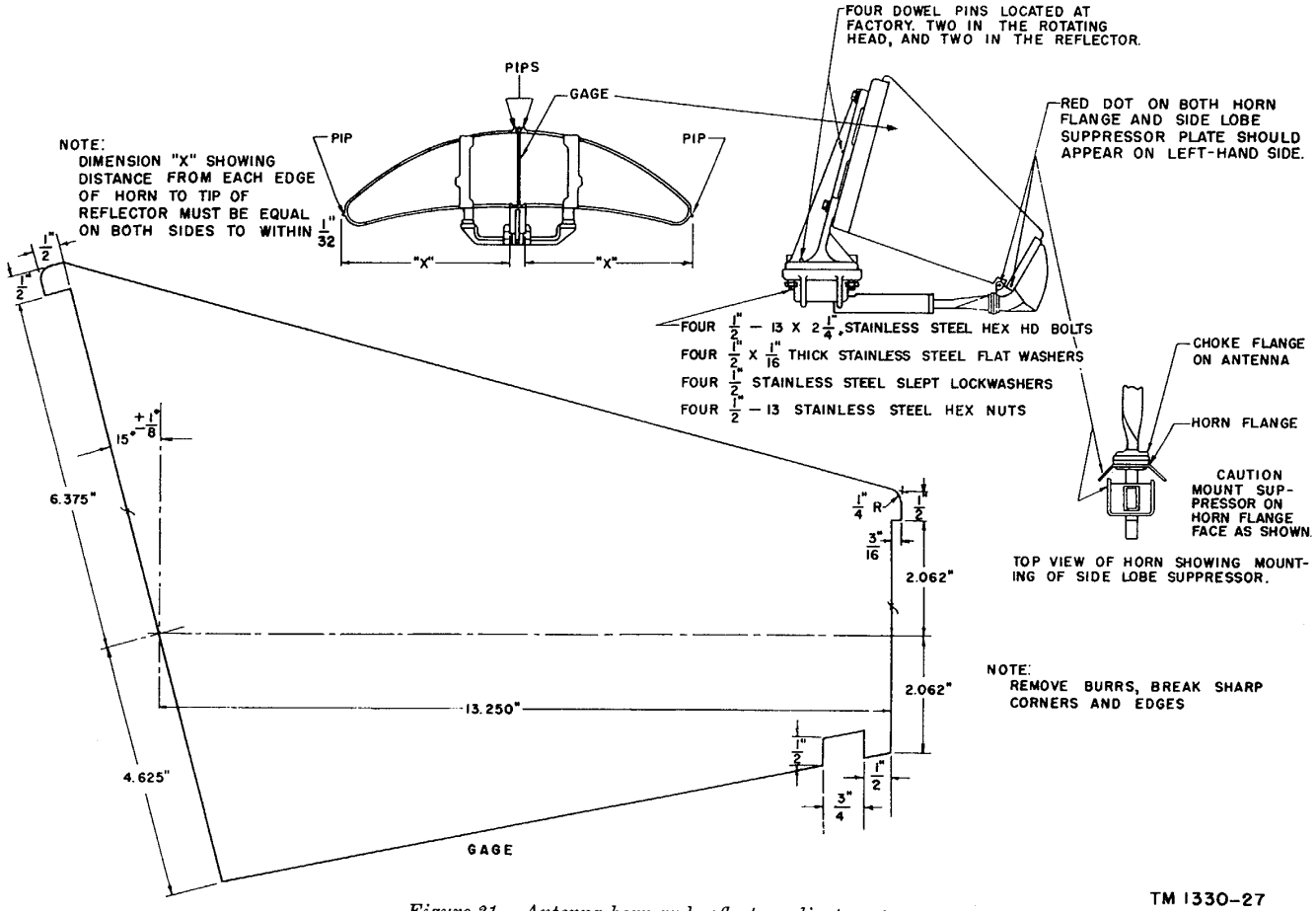

Figure 31. Antenna horn and reflector adjustments.

selected mounting base, as illustrated in figure 30.

Note. Be sure that the center lines of these holes are parallel to the centerline of the ship. Careless alinement of the mounting holes will necessitate complete realinement of the antenna and indicator synchro system.

(3) Fasten the antenna pedestal to the mounting base with six 1/2-inch bolts. Use suitable lockwashers and nuts.

(4) Connect the proper cable through the cable gland (fig. 4) to antenna terminal board TB501 (par. 53c and fig. 3).

43. Installation of Indicator

a. Mount the indicator in the wheelhouse with the front of the unit facing aft. Allow minimum clearance of 4 inches at the rear, 6 inches at the sides, and 20 inches at the front for panel swing. If possible, increase these clearances to allow for easier servicing with the rear and side panels removed.

b. As with the receiver-transmitter, the base of the indicator should rest on a strong wooden crib (fig. 32). This crib is usually supplied by the installation agency or the shipyard. The crib is cut to fit the sheer and camber of the deck.

c. Select the deck position for the indicator and mount the wooden crib. Drill four 5/8-inch mounting holes in the crib as illustrated in figure 30.

d. Drill in the deck two 1 11/16-inch and three 7/8-inch kickpipe holes as illustrated in figure 32.

e. Install the proper kickpipe in each hole. Use approved cable glands to secure cables in kickpipes. Refer to paragraphs 52 and 53 for information on fabricating and installing cables.

f. Use four 1/2-inch bolts and suitable lockwashers and nuts to bolt the indicator to the wooden crib.

Note. If the indicator is furnished with the plotter mounted on it, omit the procedure in paragraph 44. Otherwise, after installing the indicator, install the plotter, transformer and fuse mounting, rheostat, pin jack, and associated wiring.

44. Installation of Plotter

a. Open the top hinged panel of the indicator until it locks.

b. On the right side of the top panel, remove the Phillips oval-head screw and spacer that hold the stay hinge. Lay the top panel back as far as it will go.

Caution: Before swinging the top panel back, make sure there is enough slack in the cable at the left rear corner.

c. Remove the left handle from the top panel by removing the two screws and washers that hold it.

d. Remove the range counter assembly in the following manner:

(1) Remove the screw at the center of the range control knob and remove the knob.

(2) Remove the three screws that mount the range counter assembly.

e. Move the range counter assembly aside so that the handle-mounting screw is accessible.

Note. To make the handle-mounting screw accessible, it may be necessary to remove the pin in the counter shaft extending outside the top panel.

f. Remove the two handle-mounting screws and washers and remove the right handle.

g. Fasten the handle to the handle-mounting brackets supplied with the plotter using the same screws and washers. Mount each handle on the two bent fingers of the bracket, with the fingers pointing down and the handle pointing up.

h. Unscrew the two slide-fastener studs on the top panel.

i. Fasten the handle-mounting brackets to the top panel, using the Phillips oval-head bolts, lockwashers, and nuts supplied with the plotter. The right-hand bracket can be identified by two 1/4-inch holes near the middle of the bracket.

j. Remount the range counter assembly by reversing the procedure given in *d* above.

k. Open the front door of the indicator frame. Mount the transformer and fuse bracket back of the angle (fig. 33), using the two screws and lockwashers supplied.

l. Remove the two knockout plugs on the top of the indicator. Mount the rheostat in the larger hole with the nut supplied. Mount the pin jack in the smaller hole with the nut supplied.

m. Run the four-wire cable from the transformer and fuse down alongside the h-v cable (under the top face of the indicator frame), down the left side of the cabinet, and then over to the terminal board panel. Tie this cable to the other cables that run alongside it.

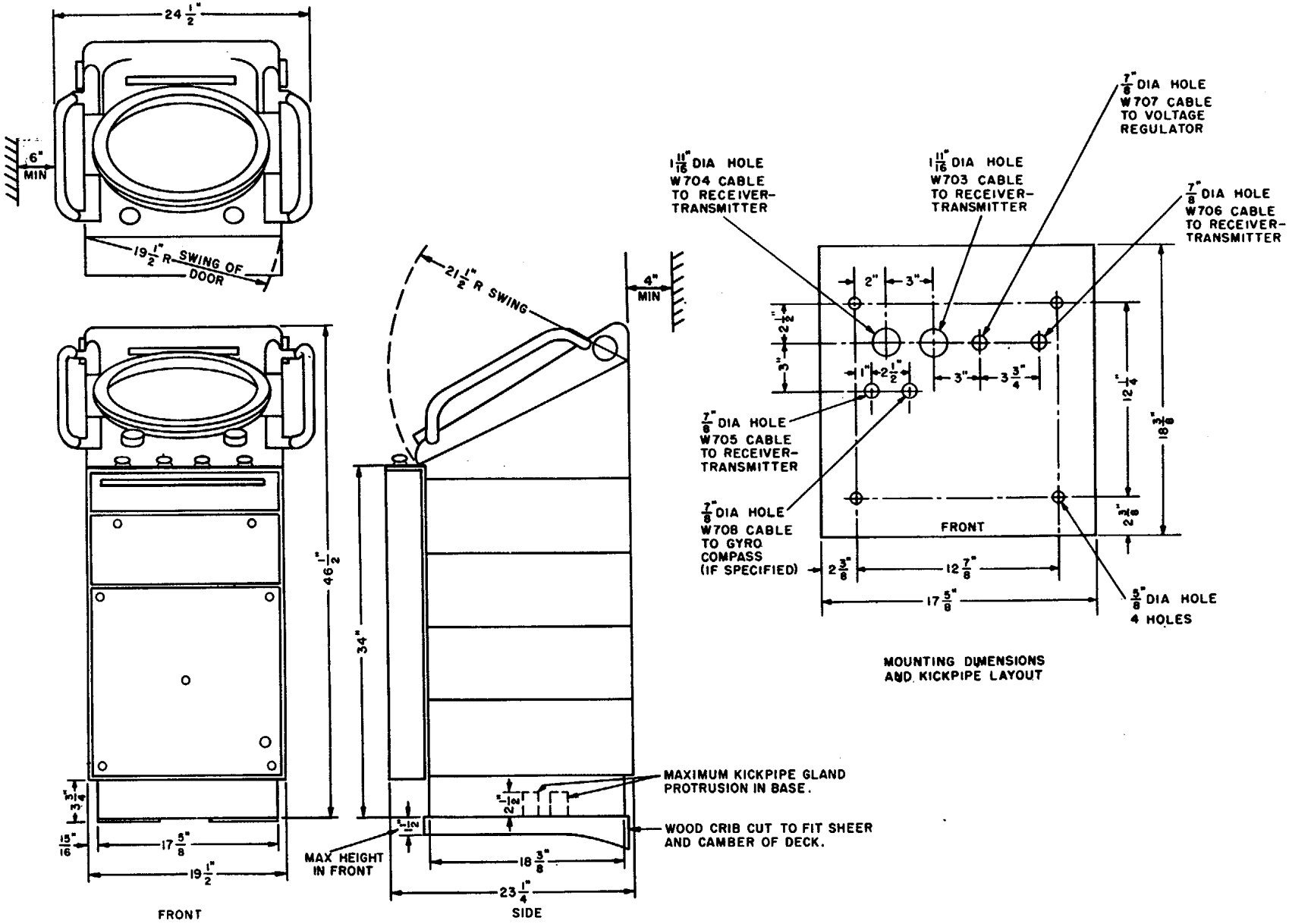

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Figure 32. Indicator, dimensional drawing.

n. Run the brown wire connected to the rheostat alongside the cable that runs down the left rear corner of the indicator and tie it to the cable.

o. Connect the four cabled wires and the brown wire to TB901 and TB903 as shown in figure 34.

Note. If the four-wire cable is not already connected to the transformer and fuse, solder the four leads to the proper terminals (fig. 34). If the brown wire is not already connected to the rheostat, rotate the rheostat shaft fully clockwise and solder the wire to the terminal on which the sliding contact rests.

p. Solder the short brown lead from the pin jack to the middle terminal on the rheostat. If this lead is not already connected to the pin jack, solder it to the pin jack terminal.

q. Replace the stay hinge by replacing the Phillips oval-head screw and spacer (b above), and lower the top panel.

r. Place the black knob supplied with the plotter on the rheostat shaft and tighten the two Allen-head setscrews with the Allen wrench.

s. Place the plotter over the PPI with its right-angle plug on top. Attach it to the handle-mounting brackets with the six screws, flat washers, and lockwashers supplied.

t. Insert the right-angle plug into the pin jack that was installed in the top panel *(1* above).

u. Mount the metal viewing hood on the plotter and lock it into place by means of the three slide fasteners on the rim.

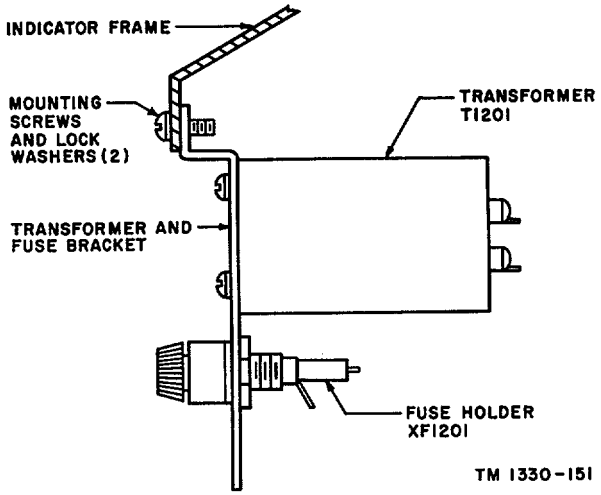

Figure 33. Transformer and fuse bracket installations.

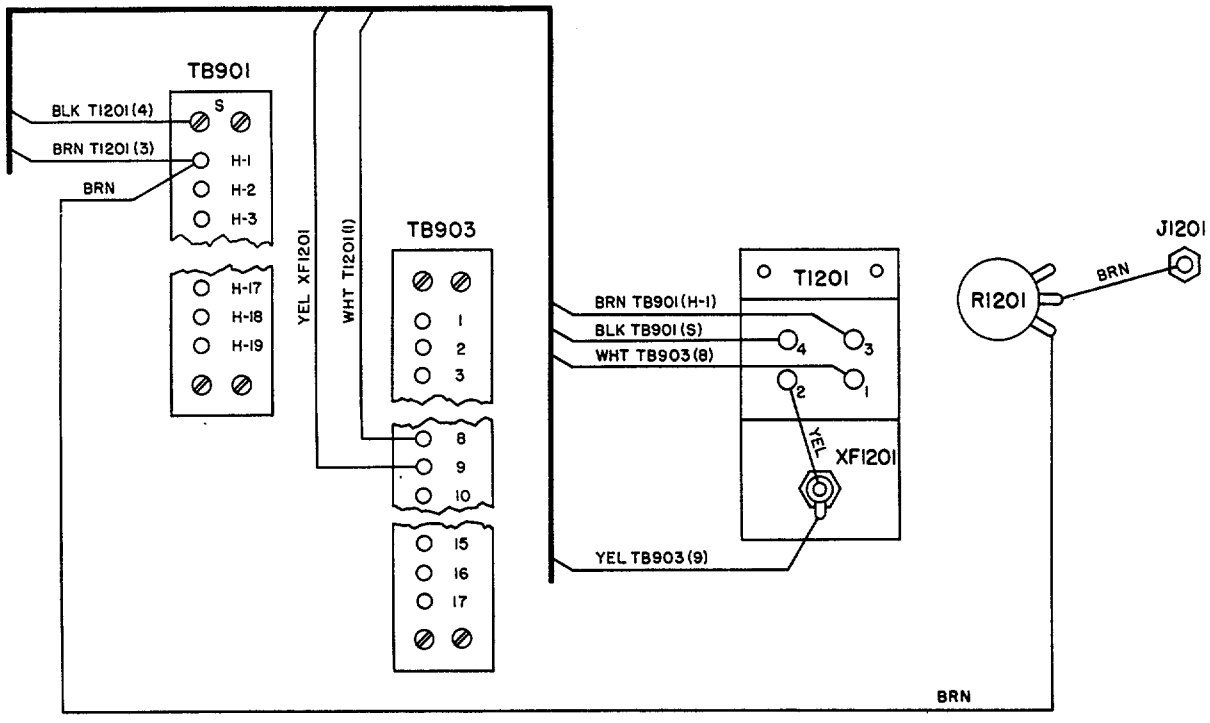

Figure 34. Plotter installation, wiring diagram.

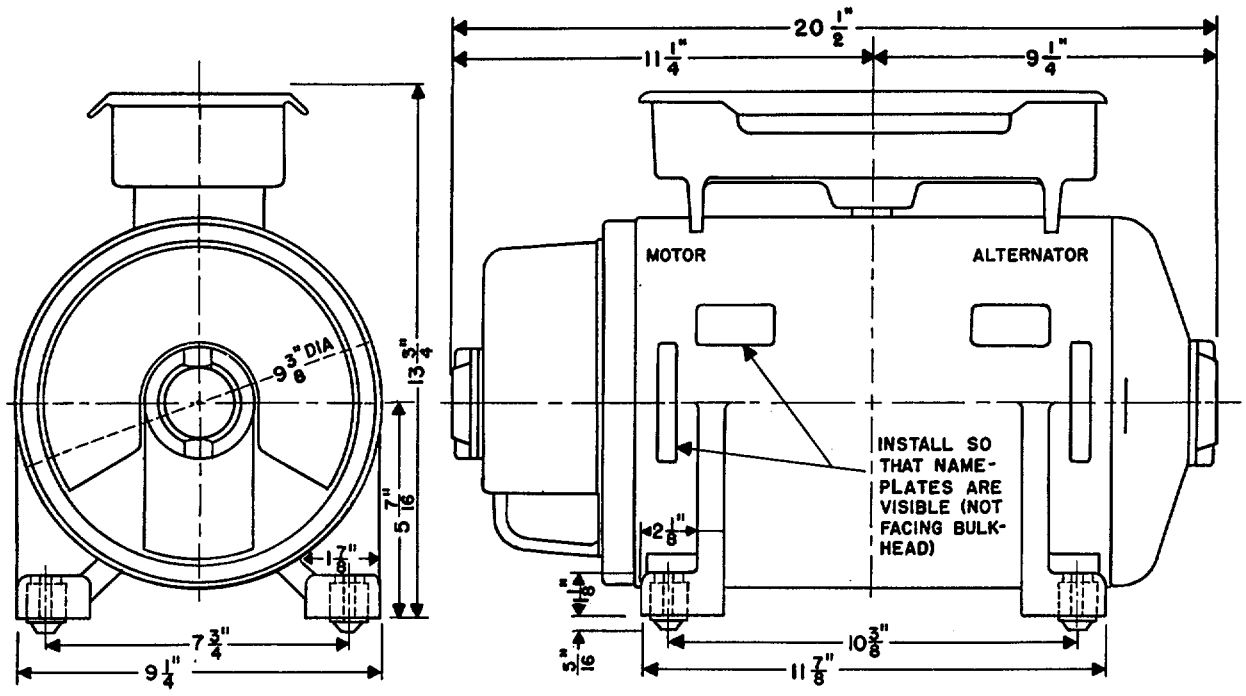

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Figure 35. - Motor generator, dimensional drawing.

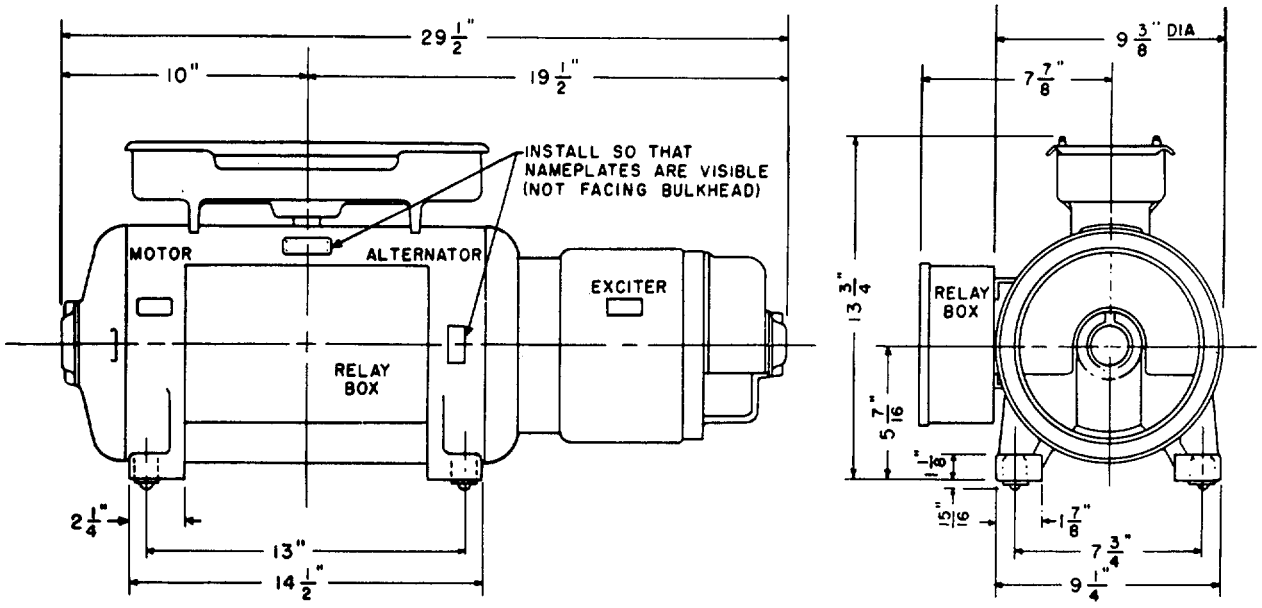

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Figure 36. A-c motor generator, dimensional drawing.

45. Installation of Motor Generator

a. Allow 2 feet of clearance on all sides of the motor generator to permit adequate ventilation and access for servicing. Install the motor generator with the nameplates facing outward.

b. Drill four 5/6-inch holes in the deck. Figure 35 shows the spacing of these holes for the d-c motor generator, and figure 36 for the a-c motor generator.

c. Fasten the motor generator to the deck with four 1/4-inch diameter bolts. These bolts must be of sufficient length to pass through the mounting flange and deck, and to extend at least three-fourths of an inch on the other side of the deck.

46. Installation of Switch Box

a. Mount the switch box on the bulkhead as close as possible to the motor generator and the motor starter (or circuit breaker), but allow at least 6 inches clearance for radial swing of the cover. For unimpeded access to the control lever, the switch box preferably should be mounted to the right of the motor starter (or circuit breaker). Clearance for full cover swing should be allowed so that the motor starter will not be jarred when the switch box cover is opened.

b. Drill four %2-inch holes in the bulkhead (fig. 37). Locate the lower pair of holes approximately 5 feet above the deck level.

c. Fasten the switch box to the bulkhead

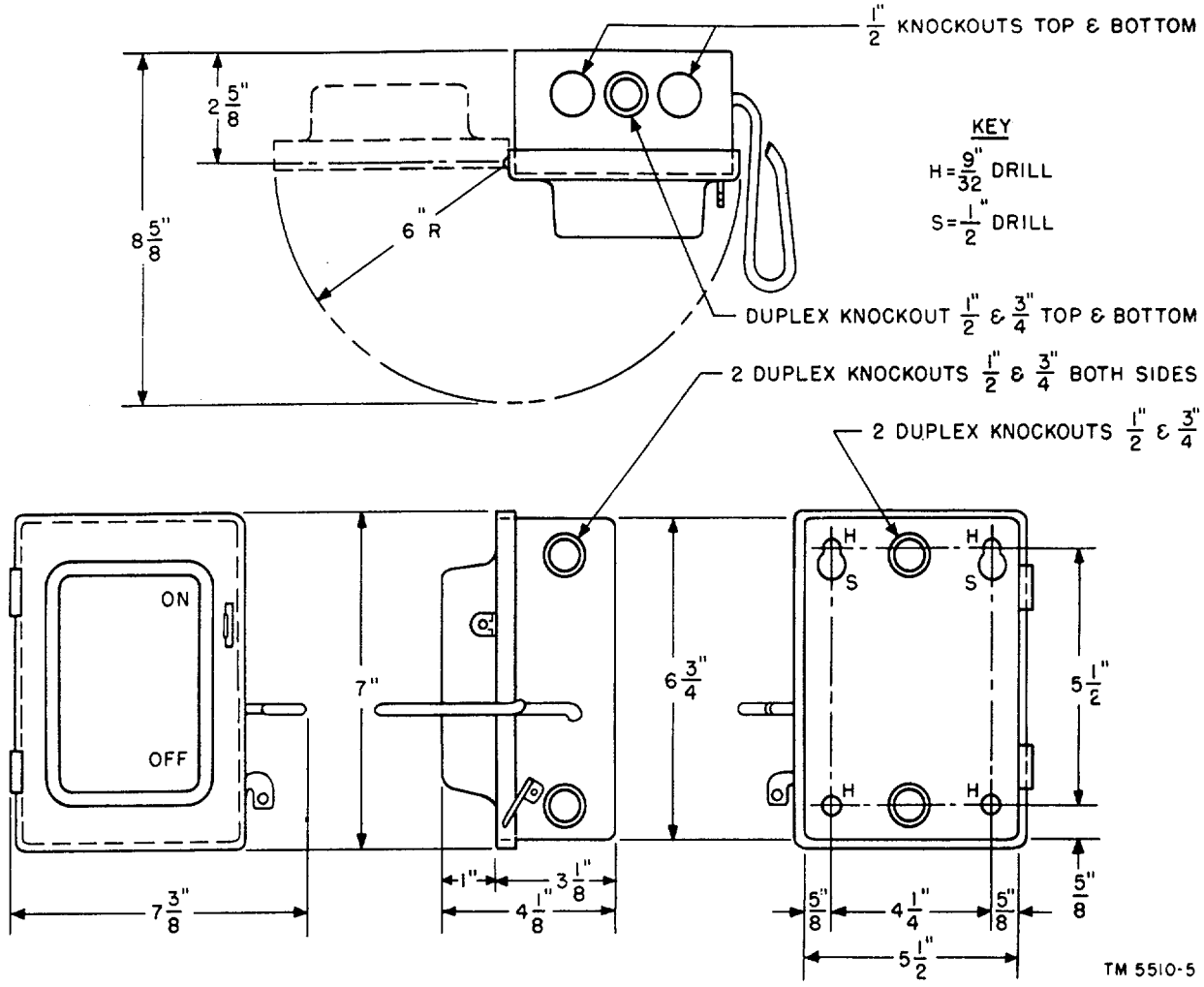

Figure 37. Switch box, dimensional drawing.

with four 1/4-inch roundhead screws. These screws must be long enough to extend at least one-half of an inch beyond the opposite side of the bulkhead plate.

d. Remove the two knockout plugs which are most convenient for the installation and cable connections. The formation of the knock-out rings in the surface of the case is alternately in and out. Rings with surfaces above the outer surface of the box must be bent outward and then twisted free; rings with surfaces lower than the outer surface of the box must be driven inward and then twisted free. Remove the small center knockout plug by striking it sharply with a screwdriver at a point on the side opposite the lip (fig. 38) and then twisting it free.

Note. Before removing the knockouts, examine the cables and cable clamps to determine whether a large entrance hole (entire knockout) or a small entrance hole (center portion only of knockout) is required. (The end knockouts on the top and bottom have no center portion.)

47. Installation of Motor Starter

a. Locate the motor starter as close as possible to the motor generator and switch box, as discussed in paragraph 46. Leave at least 6 inches clearance in front of the unit for removal of the front cover.

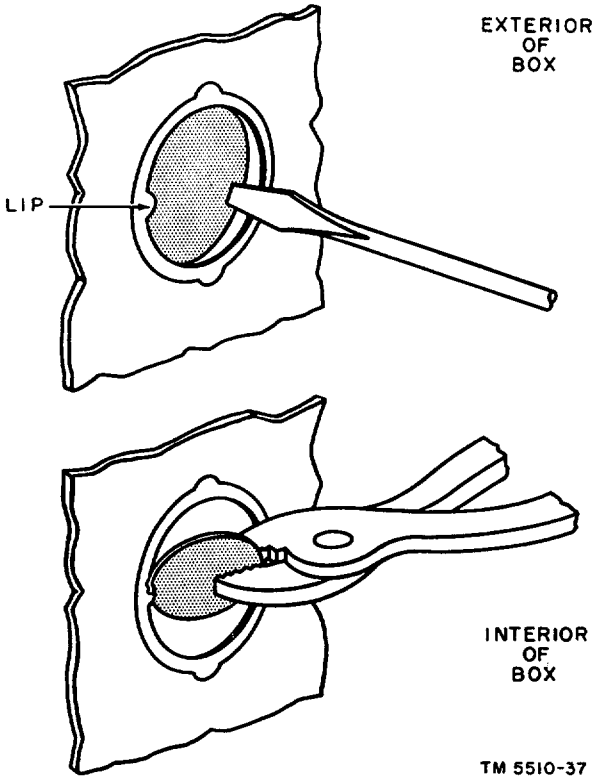

Figure 38. Removal of knockout plugs.

b. Loosen the retaining screw at the bottom of the case and remove the front cover.

c. Remove the two screws and lockwashers (right and left center) that hold the starter mechanism to the case.

d. Lift out the starter mechanism and carefully place it to one side.

e. Drill four 5/6-inch holes in the bulkhead (fig. 39). Locate the lower pair of holes approximately 5 feet above the deck level.

f. Fasten the motor starter case to the bulkhead with four 1/4-inch roundhead screws. These screws must be of sufficient length to extend at least one-half of an inch beyond the opposite side of the bulkhead.

g. Replace the starter mechanism in the case, insert the two mounting screws and lockwashers, and tighten securely.

h. See paragraph *46d* for removal of knockout plugs.

48. Installation of Circuit Breaker

a. Locate the circuit breaker as close as possible to the a-c motor generator and switch box, as discussed in paragraph 46. Leave at least 5 inches clearance in front of the unit for removal of the front cover.

b. Drill three holes in the bulkhead with a No. 10 drill (fig. 40). Locate the lower hole approximately 5 feet above the deck level.

c. Fasten the circuit breaker to the bulkhead with suitable screws, lockwashers, and nuts.

d. See paragraph 46*d* for removal of knock-out plugs.

49. Installation of Voltage Regulator

a. Locate the voltage regulator as close as possible to the indicator so that the operator can read the meter and, if necessary, can adjust the rheostat easily. Leave at least 10 inches clearance for swing of the front cover.

b. Drill four holes (fig. 41) in the bulkhead with a No. 9 drill.

c. Fasten the voltage regulator to the bulk-head with four No. 10 screws. *d*. Connect the cables as instructed in paragraph 53.

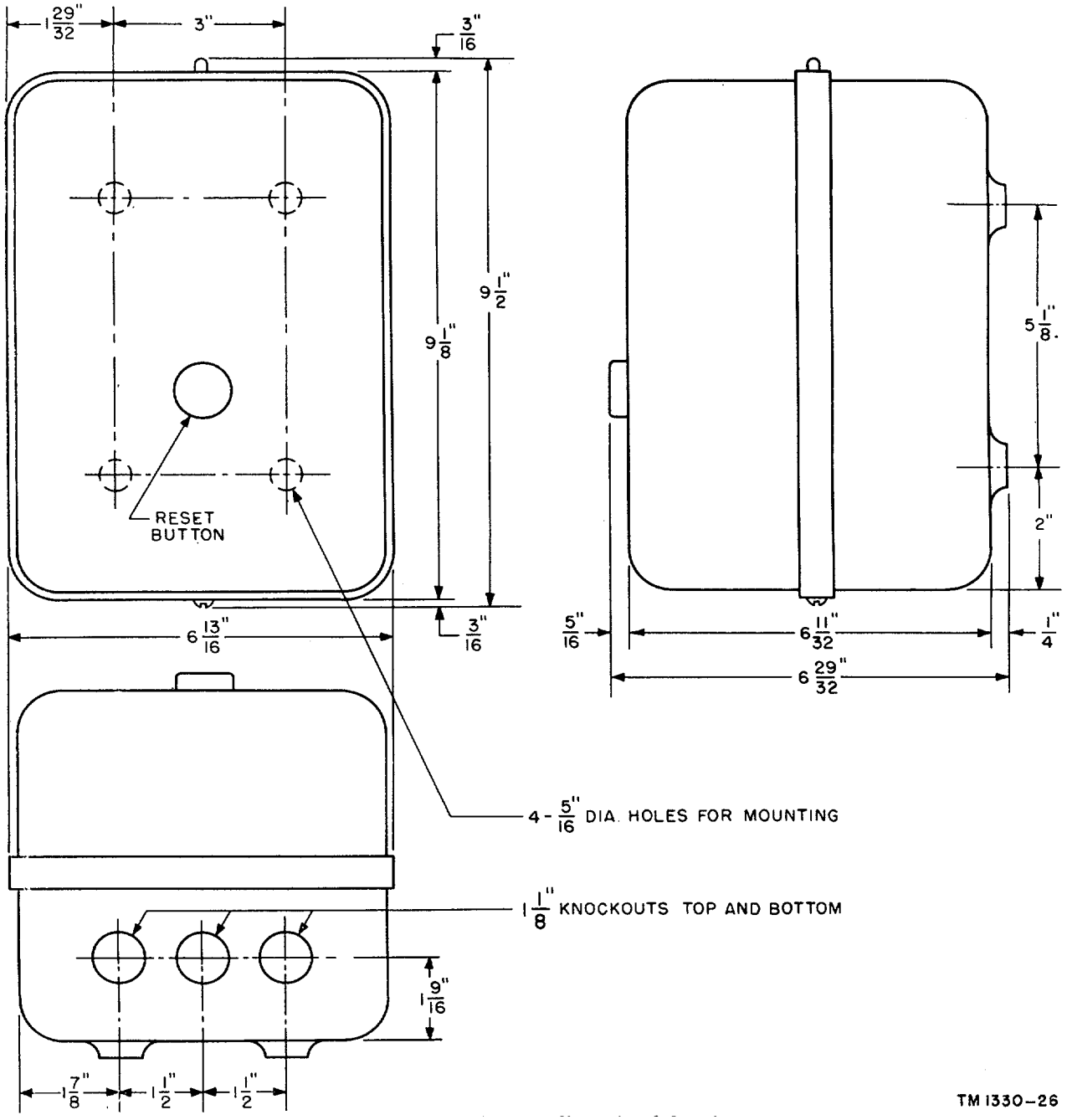

Figure 39. Motor Starter, dimensional drawing.

50. Installation of Waveguide

Waveguides must be installed in accordance with shipboard standards. (Refer to current naval electronics installation practices literature.) Plan the shortest and straightest possible waveguide run. Refer to *b* below for information on a typical waveguide run. If possible, use only standard waveguide sections 46 (fig. 8). If cutting is necessary, follow the cutting and brazing instructions *(e* below) carefully. Information on installing waveguide clamps and the deck fitting is given in *c* and *d* below.

a. Waveguide Flanges.

(1) At the junctions of waveguide sections, always mate a choke flange with a plain flange.

(2) Always mount a choke flange above a plain flange; that is, put the choke flange on the antenna side of the junction.
(3) Be sure that the neoprene gasket in each choke flange is set in Place properly.
(4) Clamp the flanges together with four flange mounting screws. Use a No. 8 Allen socket wrench to tighten the screws.

b. Waveguide Run.

(1) Starting at the antenna (fig. 42), use a straight section to run the waveguide aft horizontally.
(2) Use a 90°E bend to change the direction to downward.
(3) Use straight sections to run the waveguide downward.
(4) Use a 90°E bend to change the direction to forward or aft as required.

Note. A length of flexible waveguide is furnished. Use this only when an elbow cannot be used to change direction.

(5) Use a 90°H bend to run the waveguide athwartships, if necessary.
(6) Run the waveguide forward or aft, as required, by installing a short straight section followed by a 90°H bend.
(7) Install a straight section, followed by a 90°E bend, to direct the waveguide down toward the side of the receiver-transmitter.
(8) A twist or a straight section may be required to bring the waveguide run to the directional coupler. If the front cover of the receiver-transmitter faces forward or aft, install a straight section. If the front cover of the receiver-transmitter faces either beam, install a twist section.
(9) Install the 1-foot directional coupler, close enough to the receiver-transmitter to allow a 90°H bend to be used.
(10) Use a 90°H bend to connect the directional coupler to the duplexer waveguide (fig. 42).

Note. For purposes of illustration, numerous bends are shown in figure 42. In actual installations, the waveguide run must be as short and straight as possible.

c. Waveguide Clamps. Install a waveguide clamp 12 inches below the antenna pedestal. Mount additional waveguide clamps from 36 to

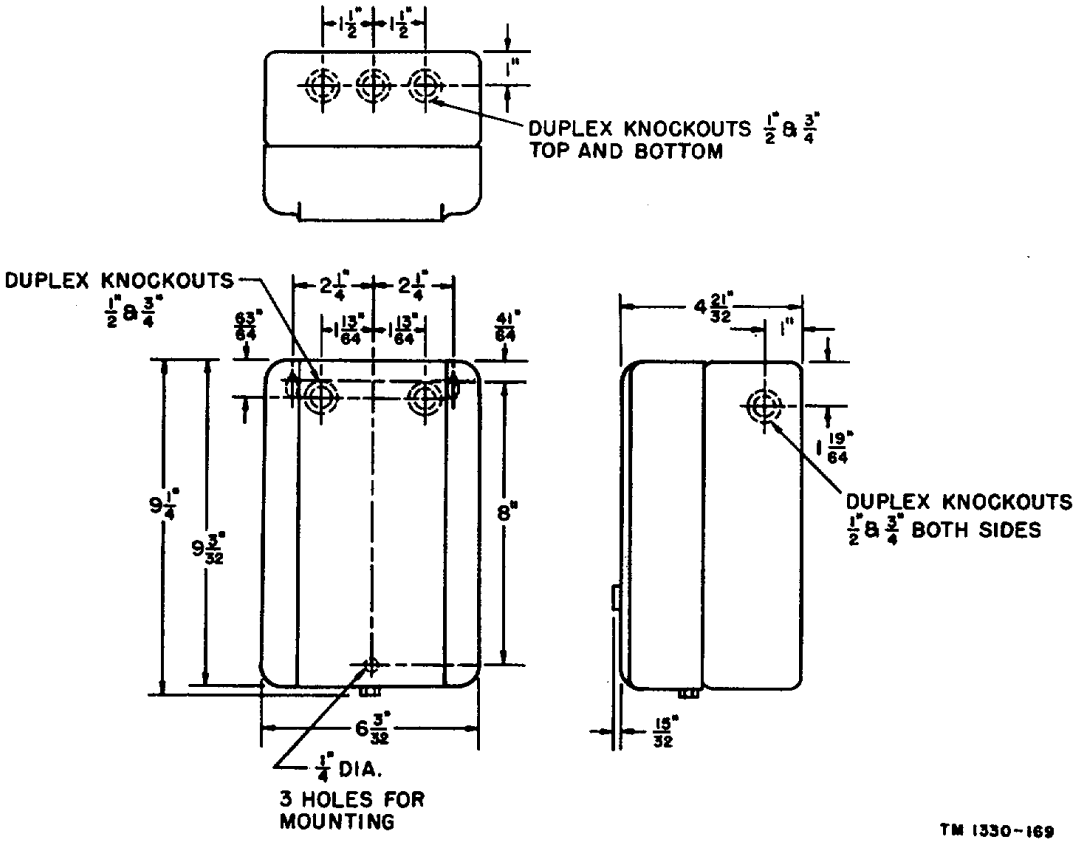

Figure 40. Circuit breaker, dimensional drawing.

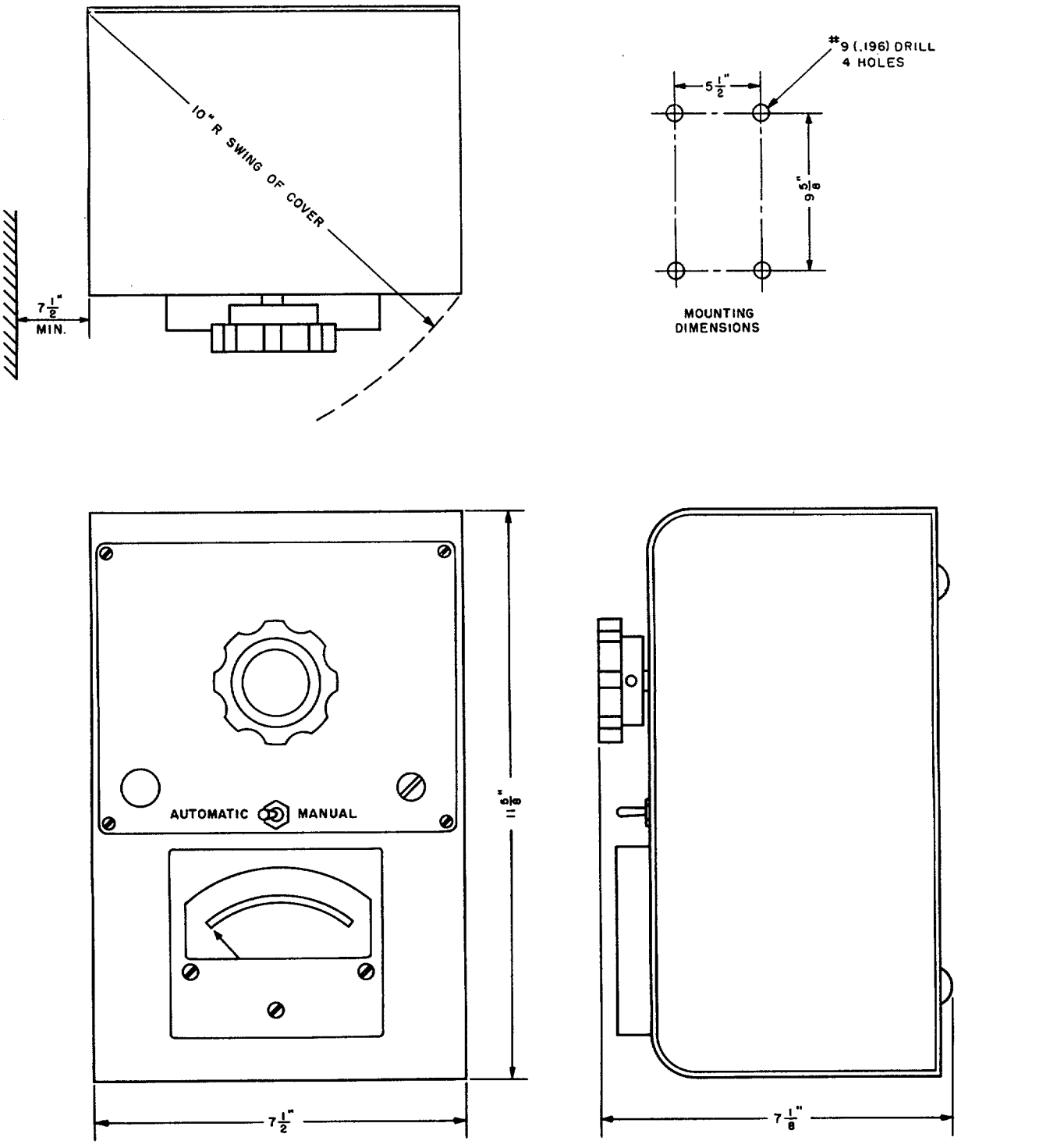

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Figure 41. Voltage regulator, dimensional drawing.

48 inches apart for proper waveguide support. The installation procedure is as follows:

(1) Bolt the waveguide clamp base (fig. 43) to the deck with two 3/8-inch bolts.
(2) Mount the waveguide in the waveguide clamp base.
(3) Place the waveguide clamp (fig. 43) over the waveguide.
(4) Bolt the clamp to the clamp base with four 1/4-inch bolts. Use suitable nuts and lockwashers.

d. Waveguide Deck Fitting.

(1) Weld the deck fitting base (fig. 43) to the deck.
(2) At the top of the deck fitting, remove the two clamping bolts which hold the flanged ring.
(3) Remove the two halves of the flanged ring, and insert the waveguide into the deck fitting.
(4) Place the two halves of the flanged ring over the waveguide, replace the two clamping bolts, and fasten securely.
(5) Apply Permatex No. 2 at the sealing faces of the deck fitting base and the flanged ring.
(6) Install the ceiling plate (fig. 44) to hold the waveguide on the underside of the deck.

e. Cutting and Brazing Waveguide Sections.

(1) Use a hacksaw to make a clean, right-angle cut on the waveguide.

Caution: Do not scratch the silvered surface. Cut a waveguide section near the plain flange, never near a choke flange. This will eliminate the danger of damaging the internal construction of the choke flange.

(2) File off all burs.
(3) Match a separate plain flange to the cut section.
(4) Use a file and Solvent, Dry Cleaning (SD) to clean the surface of the cut section. Clean the surface of the plain flange with Solvent Dry Cleaning (SD). Allow both surfaces to dry thoroughly.
(5) Heat both surfaces with a torch.
(6) Tin each surface with a minimum amount of *soft* solder.

Caution: Use a soft solder, whenever possible, to prevent damage to the silvered surface inside the waveguide. *Never allow solder to enter the interior of the waveguide.*

(7) Carefully solder the surfaces of the cut section to the surface of the plain flange; hold the surfaces in firm contact until the solder has set.
(8) If necessary, run additional solder into the junction.

f. Painting Sections and Drilling Drainage Holes. When the waveguide installation has been completed, perform the following operations:

(1) Paint the waveguide sections which are exposed to the weather. Apply two coats of rust-inhibitive primer before applying the finishing coat of paint.
(2) Drill one 3/64-inch hole near a plain flange in the bottom surface of the 1 1/4-inch dimension of the *lowest* horizontal section. The hole is for drainage of condensed moisture.

51. Installation of Echo Box

a. Mount the echo box on the bulkhead above the receiver-transmitter, approximately 12 inches from the directional coupler portion of waveguide. Allow enough clearance on the side for 14-inch swing of the cover.

b. Drill four holes in the bulkhead with a No. 9 drill, as shown in figure 45.

c. Fasten the echo box to the bulkhead with four No. 10 screws.

d. Connect the cables as instructed in paragraph 53.

52. Cabling

Because of the differences among vessels on which Radar Set AN/SPN-18(*) will be in- stalled, it is not practicable to provide exact installation instructions. Each installation must be made in accordance with shipboard requirements and standards. For information on these requirements refer to current naval electronics installation practices literature.

a. Preparation of Cables. All cables except W713 must be cut to the required lengths and fitted with suitable connectors. When determining cable lengths, remember that each length must include enough cable *to make insulated*

NOTES ---

DRAINAGE FOR CONDENSATION DRILL 3/64" HOLE. FREE FROM BURRS, ON UNDERSICE OF LOWEST, HORIZONTAL SECTION (1 ¼"- SIDE).

WAVEGUIDE RUN SHOWN IS TYPICAL OF AN EXTREME CASE WITH SEVERAL BENDS MORE DIRECT RUNS SHOULD BE MADE WHERE POSSIBLE

CHOKE FLANGE SHOULD MATE TO PLAIN FLANGES AT EACH JOINT. MAKE SURE NEOPRENE GASKET IS IN PLACE ON CHOKE FLANGE.

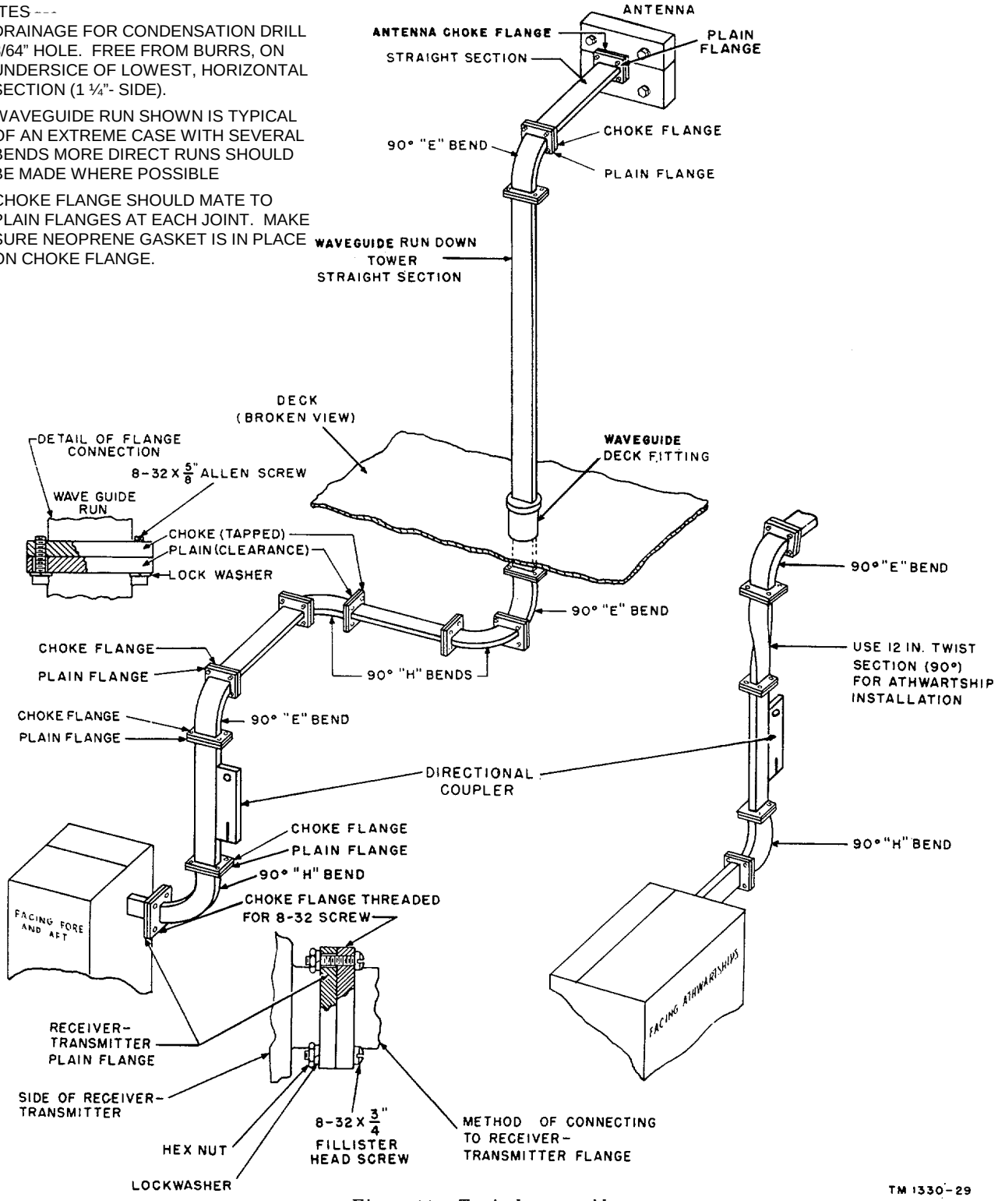

Figure 42. Typical waveguide run.

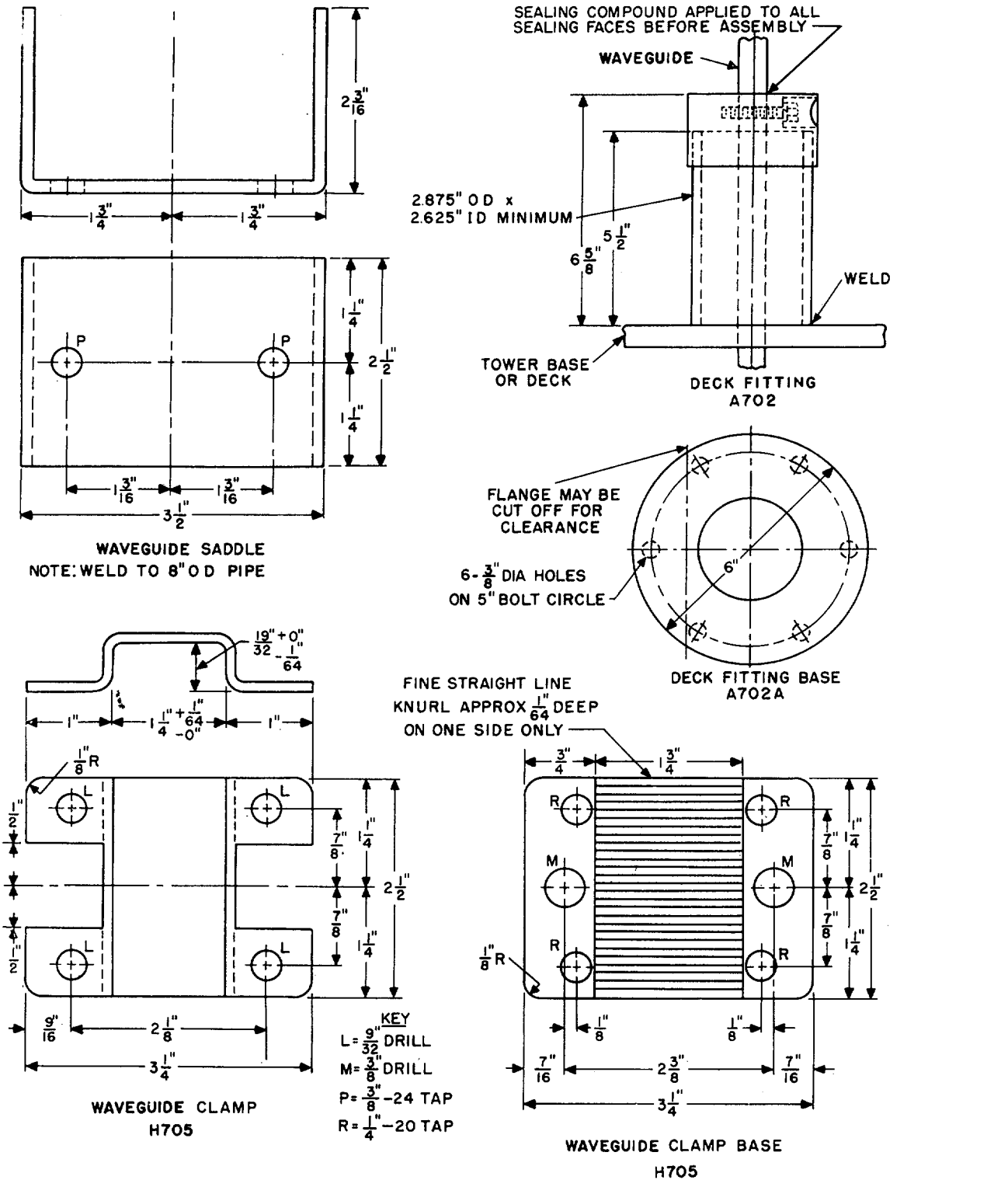

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Figure 43. Waveguide accessories, dimensional drawing.

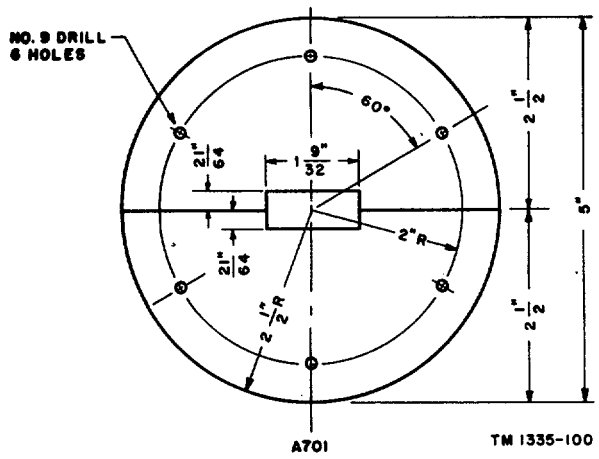

Figure 44. Waveguide ceiling plate, dimensional drawing.

leads at both ends of the cable. In certain installations, it may be advantageous to cut a cable to the required length and to install it before preparing the leads and connectors. In other installations, it may be better to prepare the cable completely before installing it.

(1) *Cable W701.*

(a) Determine the required length of cable. This length must include 14 inches at one end for making insulated leads for connections to terminal board TB803 in the receiver-transmitter, and 10 inches at the other end for similar connections to TB601 on the motor generator.

(b) From each end of the cable, measure a distance equal to the insulated lead length required at that end.

(c) Make a separate wrapping of friction tape on each side of the point at which the cable is to be cut. (The tape is used to prevent fraying of the braided steel armor.)

(d) At each end of the cable, remove the armor and the outer insulation, *but not the conductor insulation,* between the tape and the cable end. *Be careful not to damage the conductor insulation.*

(e) Use a wire stripper, wire cutter, or other suitable tool to remove one-fourth of an inch of insulation from both ends of each insulated conductor.

Note. Prepare *every* conductor in the cable, even if all are not to be used.

(f) Tin the bare conductor ends with solder.

(g) Insert the tinned end of each conductor into a Burndy terminal lug, type YAV-14H. The tip of the conductor must not extend beyond the small hole in the tongue of the terminal lug.

(h) Crimp the split grip of the terminal lug over the conductor insulation. Use a pair of pliers and be careful not to damage the insulation by using excessive force.

(i) Refer to paragraph 53 for information on connecting the cable.

(2) *Cable W702.* The instructions in (1) above also apply to cable W702, except for the lengths of insulated leads. These lengths include 14 inches for connections to TB804 in the receiver-transmitter, and 12 inches for connections to TB501 in the antenna pedestal.

(3) *Cable W703.* The instructions in (1) above also apply to cable W703, except for the lengths of the insulated leads. These lengths include 11 inches for connections to TB904 in the indicator, and 10 inches for connections to TB802 in the receiver-transmitter.

(4) *Cable W704.* The instructions in (1) above also apply to cable W704, except for the lengths of the insulated leads. These lengths include 14 inches for connections to TB903 in the indicator, and 10 inches for connections to TB801 and TB802 in the receiver-transmitter.

(5) *Cable W705.* Both ends of cable W705 must be terminated by a coaxial connector plug. Refer to figure 46.

(a) Loosen the setscrew in the protective sleeve of the body of the connector.

(b) Rotate the clamping nut to separate it from the body of the connector.

(c) Slip the protective sleeve and the clamping nut over the end of the cable and push them away from the cable end.

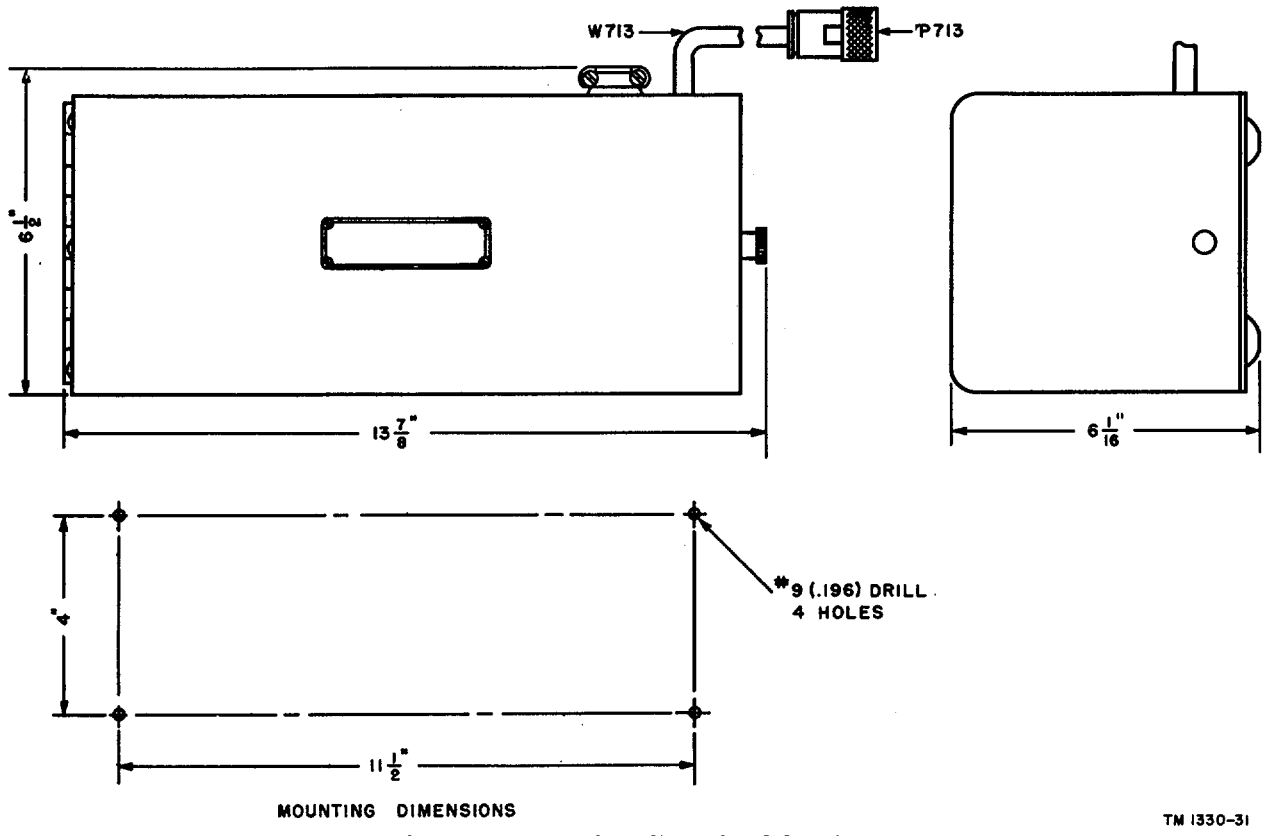

Figure 45. Echo box, dimensional drawing.

(d) Cut the outer insulation 11/8 inches from the cable end and remove it.
(e) Cut the copper braid five-eighths of an inch from the end of the outer insulation. Be careful not to damage the insulation.
(f) Cut the inner insulation three-eighths of an inch from the end of the conductor and remove it.
(g) Tighten the strands of the center conductor by twisting it.
(h) Tin the bare end of the conductor.
(i) Slide the plug body over the cable and guide the tinned conductor into the hollow tip of the plug body. Use a screwdriver to spread the slot at the base of the plug body.
(j) Solder the center conductor to the tip of the plug body. Also, run solder into the body at the point indicated in figure 46. This will solder the body to the braid.
(k) Slide the clamping nut and the protective sleeve back into place. Tighten the setscrew.
(l) Refer to paragraph 53 for information on connecting the cable.

(6) *Cable W706.* The instructions in (5) above also apply to this cable.
(7) *Cable W707.* The instructions in (1) above also apply to cable W707, except for the lengths of the insulated leads. These lengths include 11 inches for connections to TB905 in the indicator, and 2 inches for connections to TB602 in the voltage regulator.
(8) *Cable W708.* Cable W708 is not used in this installation.
(9) *Cable W709.* Refer to (1) above for instructions on cutting this cable. Allow the following lengths for making insulated conductors, and perform the following additional procedures:
(a) Include 7 inches for connections to TB601 on the motor generator, and 11 inches for connections to K601

in the motor starter (or circuit breaker).

(b) To cut the 3/8-inch lead armor under the armor braid, nick the lead armor with two *light* strokes of a hack-saw at the point to be cut. Repeat this procedure around the circumference of the lead armor.

Caution: Do not use the hacksaw to cut *through* the lead armor; the conductor insulation beneath it will be damaged.

(c) Bend the nicked armor back and forth until it breaks, and remove the broken piece from the end of the cable.

(d) Similarly, prepare the other end of the cable.

(e) Prepare the individual leads and attach the terminal lugs as described in (1) above, but use a larger lug, Burndy type YAV-10.

(10) *Cable W710.* Follow the instructions in (1) above to cut this cable. Allow the following lengths for insulated leads and prepare the leads in the following manner:

(a) Allow 3 inches for connections to S601 in the switch box, and 8 inches for connections to TB601 on the motor generator.

(b) After removing armor and outer insulation, cut three-fourths of an inch of the insulation from each end of both conductors.

(c) Tin the exposed ends of the conductors with solder.

(d) Insert each tinned end into a modified Sherman 7/16-inch terminal lug, and solder the conductor to the lug.

(11) *Cable W711.* The instructions in (10) above, also apply to this cable: the length of insulated lead required for connections to the switch box is 3 inches, and the heavier lug must be soldered to the leads. However, the required insulated conductor lengths for connections to the ship power supply must be determined at the time of installation, and the terminal connectors on that end of the cable must be whatever type is suitable.

(12) *Cable W712. (a)* The instructions in (1) above also apply to cable W712, except for the lengths of the insulated leads. These lengths include 10 inches for connections to TB801 and TB802 in the receiver-transmitter, and 4 inches for connections to TB101 in the echo box.

b. Routing Cables. Each cable should be run over the shortest possible route. In particular, cable from the motor generator through the switch box to the ship supply line and from the motor generator to the receiver-transmitter should be as short as possible to prevent excessive line losses.

c. Installation. Each cable must be installed in accordance with approved shipboard wiring practices. Wherever it is necessary to run a cable through a deck or bulkhead, follow approved procedures by running the cable along channels and through conduits and kickpipes as required. Also, be sure that all cable clamping and waterproofing requirements are complied with, particularly when a cable is run through decks and bulkheads (fig. 47).

53. Cable Connections

All connections must be made in accordance with the color coding or other designation given in the interconnection diagram (fig. 92). Note that this diagram indicates both the color coding and the *destination* of each conductor. For example, refer to terminal MGI of receiver-

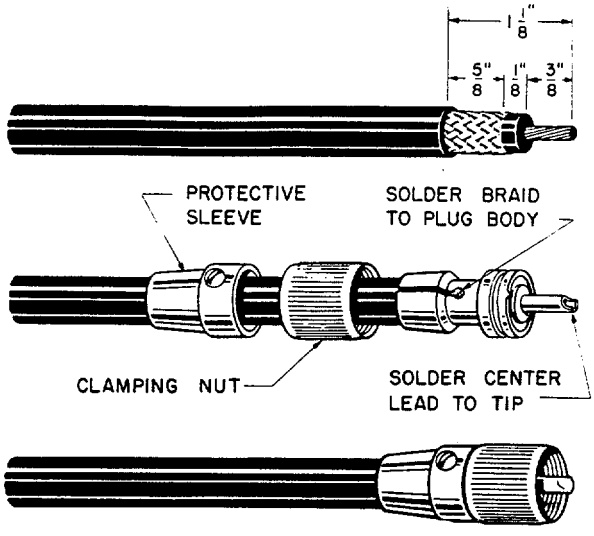

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Figure 46. Coaxial connector.

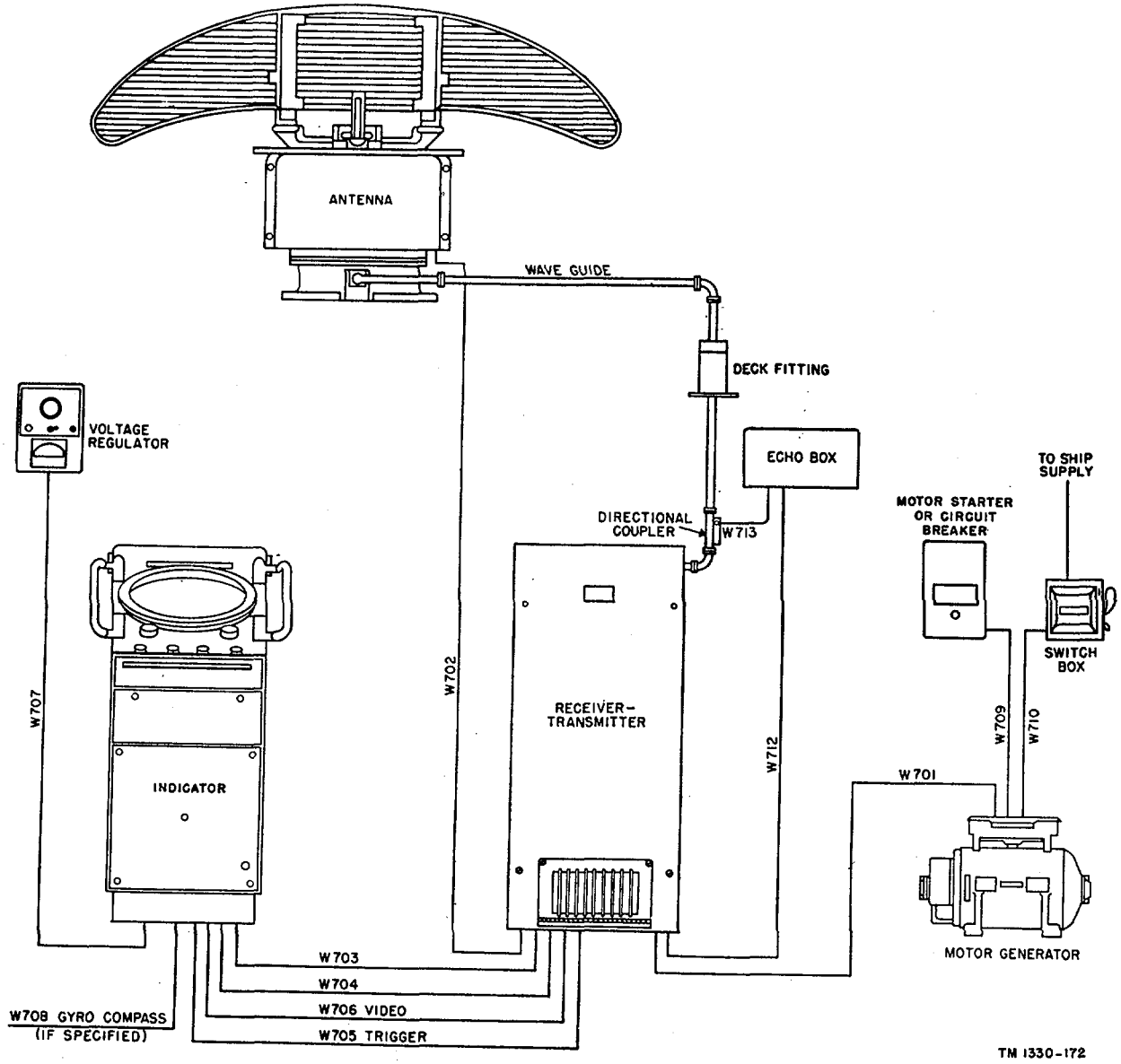


Figure 47. Radar Set AN/SPN-18(*), cabling diagram.

transmitter terminal board TB803. The BLK (black) conductor of cable W701 is connected to this terminal, and the number 4 indicates that the other end of the BLK conductor goes to terminal 4 of TB601 on the motor generator.

Note. For information on supporting cables on decks, bulkheads, ceilings, and channels, refer to current naval electronic installation practices literature.

a. Receiver-Transmitter.

(1) Connect 16 of the 19 conductors of cable W704 to terminal board TB801 (fig. 48) in accordance with the color code. Connect the remaining three conductors of cable W704 to terminal board TB802.

(2) Connect 14 conductors of cable W703 to terminal board TB802, as shown in figure 92. If the cable used has 19 conductors instead of 14 conductors, carefully tape the remaining leads together and bend them so that they can not electrically or physically interfere with other connections or components.

(3) Connect the three conductors of cable W712 to terminal boards TB801 and TB802.

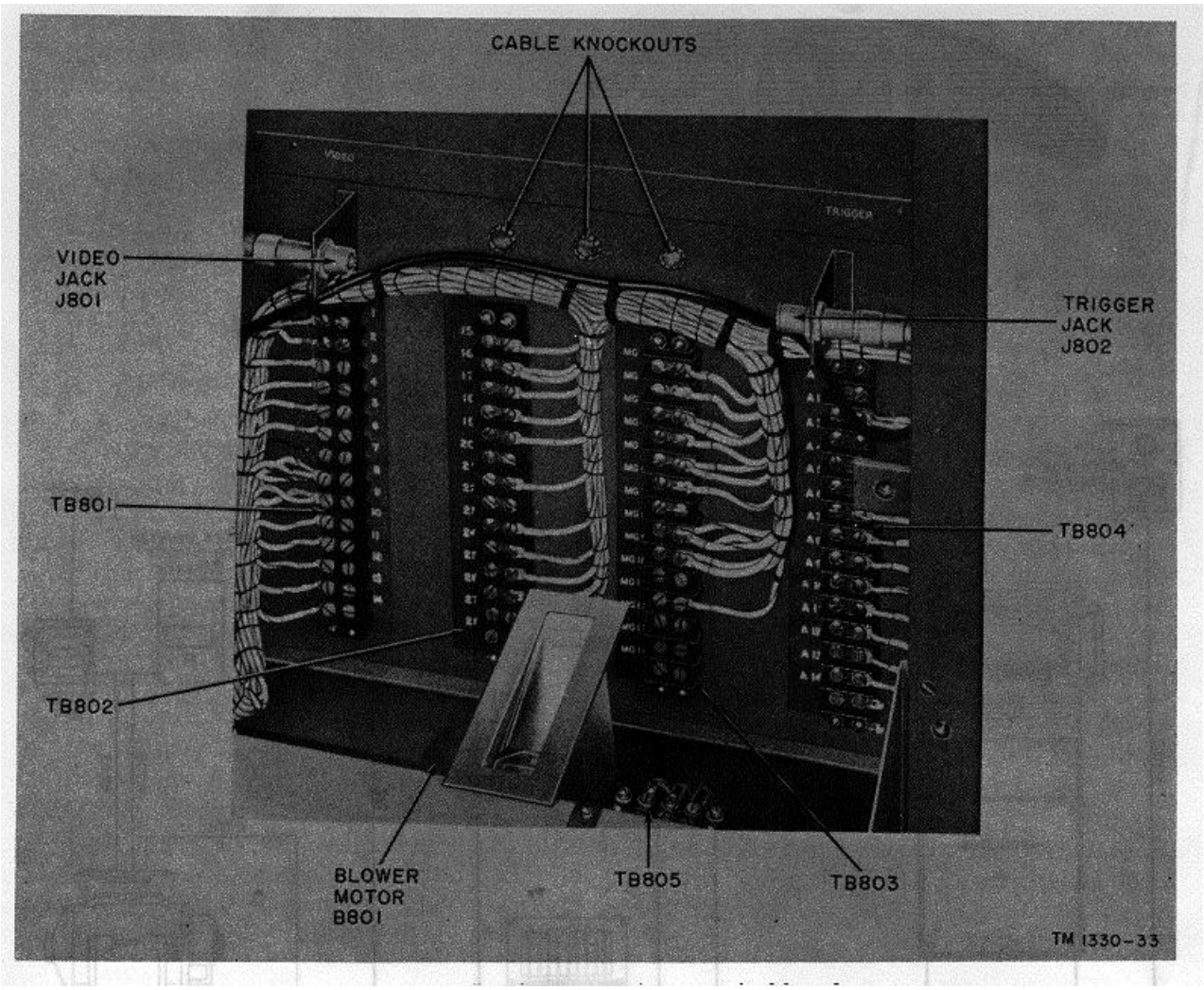


Figure 48. Receiver-transmitter terminal boards.

(4) Connect all but 3 of the 19 conductors of cable W701 to terminals MGI through MG9 and to MG11 of TB803, as shown in figure 92. For long runs of cable W701, connect the three spare leads in parallel with the 115-volt, 400-cycle line between the motor generator and terminal board TB803; to do this, connect the spare leads to terminals MG8 and MG9 on TB803 and to terminals 8 and 9 of TB601. For short runs of cable W701, connect the spare leads to the spare terminals on the terminal boards.

(5) Connect the 19 conductors of cable W702 to terminal board TB804.

(6) Connect coaxial cable W705 to TRIGGER jack J802.

(7) Connect coaxial cable W706 to VIDEO jack J801.

b. Indicator.

(1) Connect the 19 conductors of cable W704 to terminal board TB903 (fig. 49).

(2) Connect 14 conductors of cable W703 to terminal board TB904. If the cable used has 19 conductors rather than 14, carefully tape the remaining leads together and bend them out of the way.

(3) Connect the four leads of cable W707 to terminal board TB905.

(4) Connect coaxial cable W705 to TRIGGER jack J911.

(5) Connect coaxial cable W706 to VIDEO jack J1152.

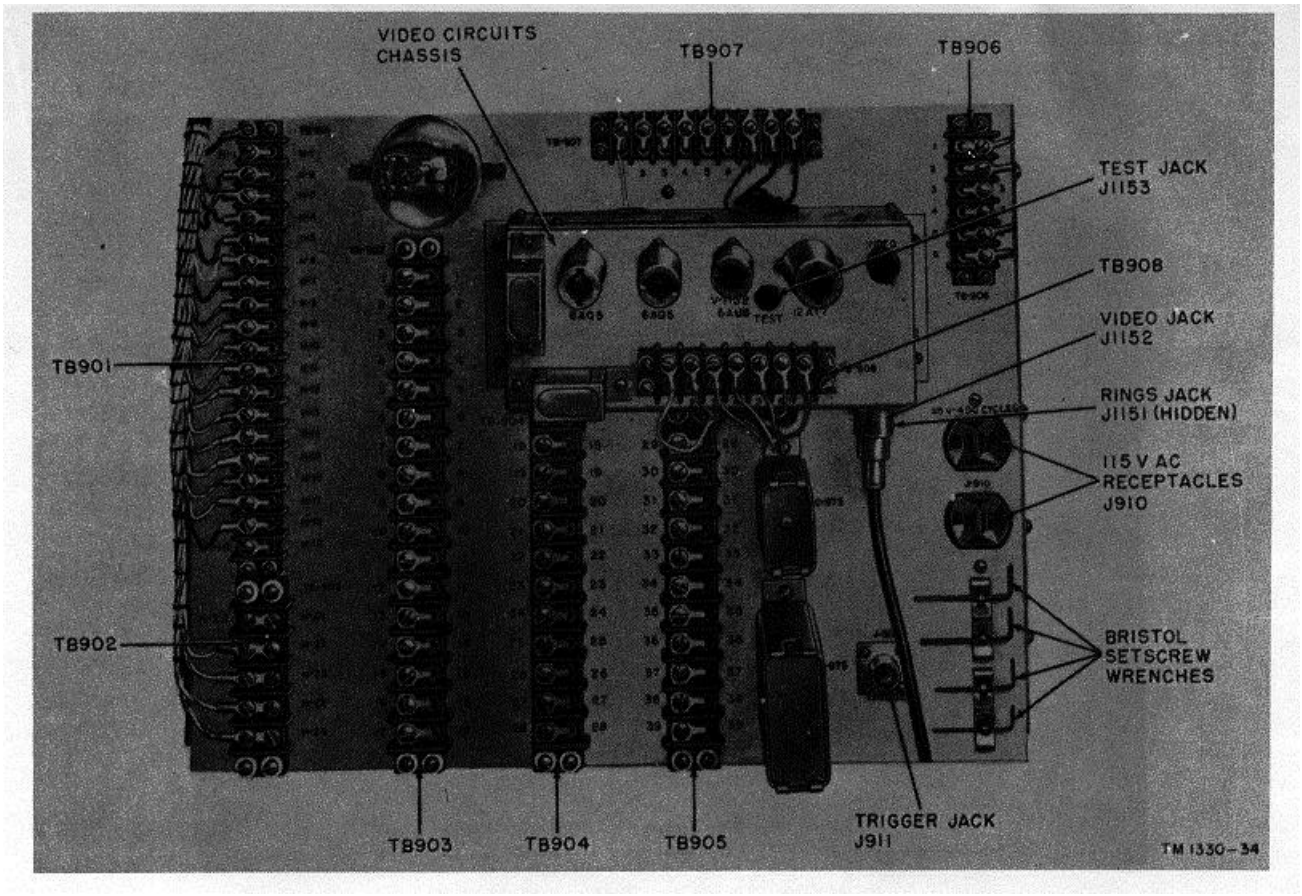


Figure 497. Indicator terminal boards.

c. Antenna.

(1) Remove the side covers of the antenna pedestal and run cable W702 into the upper housing through the cable gland (fig. 4).

(2) Connect the 19 conductors of cable W702 to terminal board TB501 (fig. 3).

d. D-c or A-c Motor Generator.

(1) Remove the cover (fig. 14) over terminal board TB601. Connect 16 of the 19 conductors of cable W701 to terminal board TB601 (fig. 50 or 51), For a long cable run, connect the spare

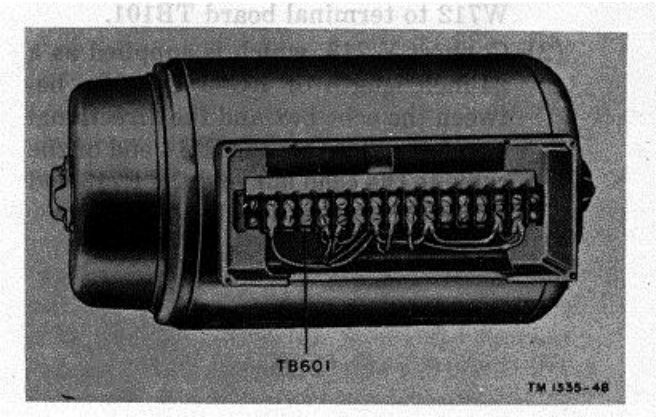


Figure 50. D-c motor generator terminal board.

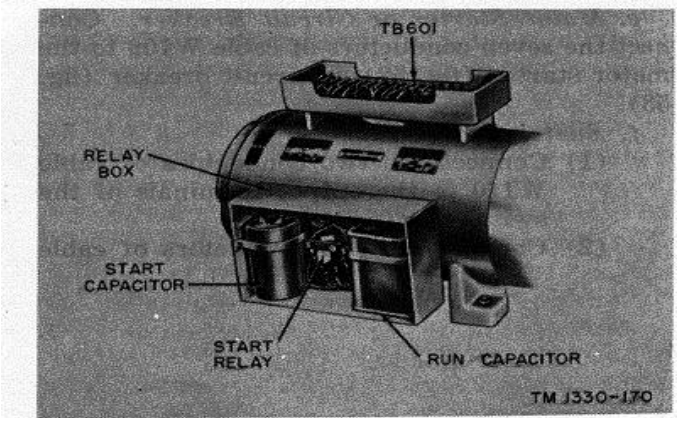


Figure 51. A-c motor generator terminal board.

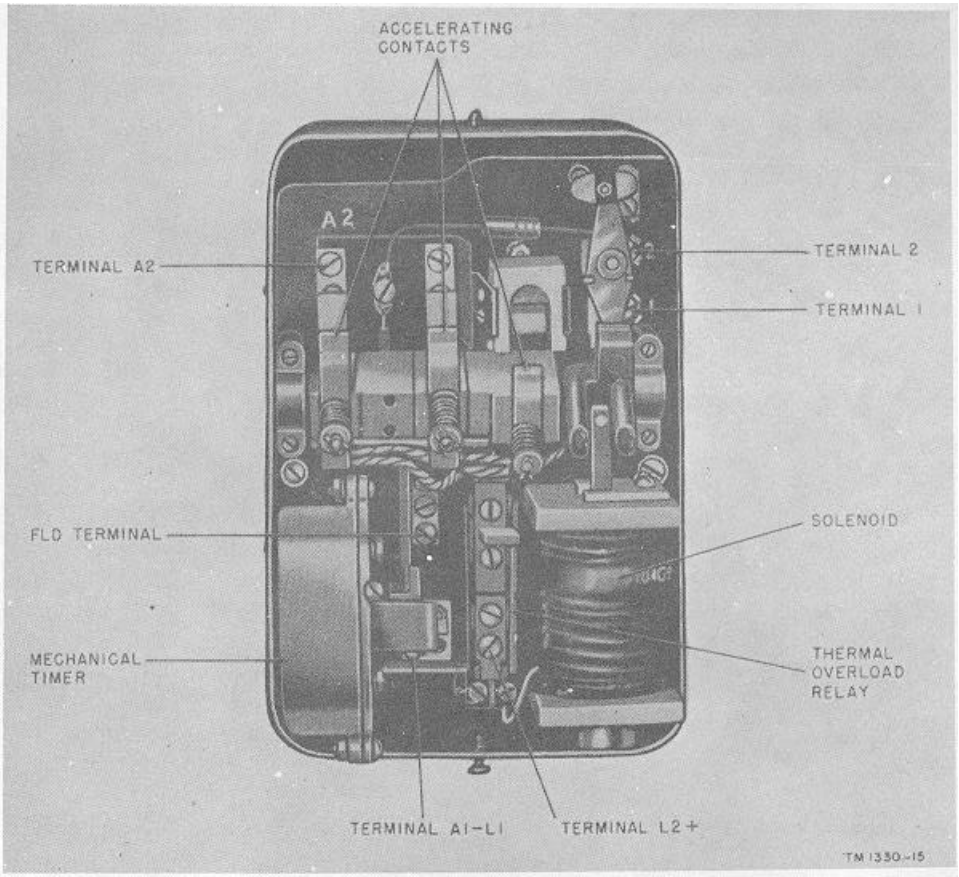


Figure 52. Motor starter terminal board.

conductors in parallel with the 400-cycleline *(a(4)* above).

(2) Connect the seven conductors of cable W709 to terminal board TB601.

(3) Connect cable W710 to terminals 12 and 14 of terminal board TB601.

e. Motor Starter or Circuit Breaker. Connect the seven conductors of cable W709 to the motor starter (fig. 52) or circuit breaker (fig. 53).

f. Switch Box.

(1) Connect the two conductors of cable W710 to the output terminals of the switch box (fig. 17).

(2) Connect the two conductors of cable

W711 to the input terminals of the switch box.

g. Voltage Regulator. Connect the four conductors of cable W707 to terminal board TB602 ;n the voltage regulator.

h. Echo Box.

(1) Connect the three conductors of cable W712 to terminal board TB101.

(2) Connect W713, which is supplied as a 24-inch length of RG-5/U cable, between the echo box and the directional coupler. Connect the P714 end of the cable to the echo box and the P713 end to the directional coupler.

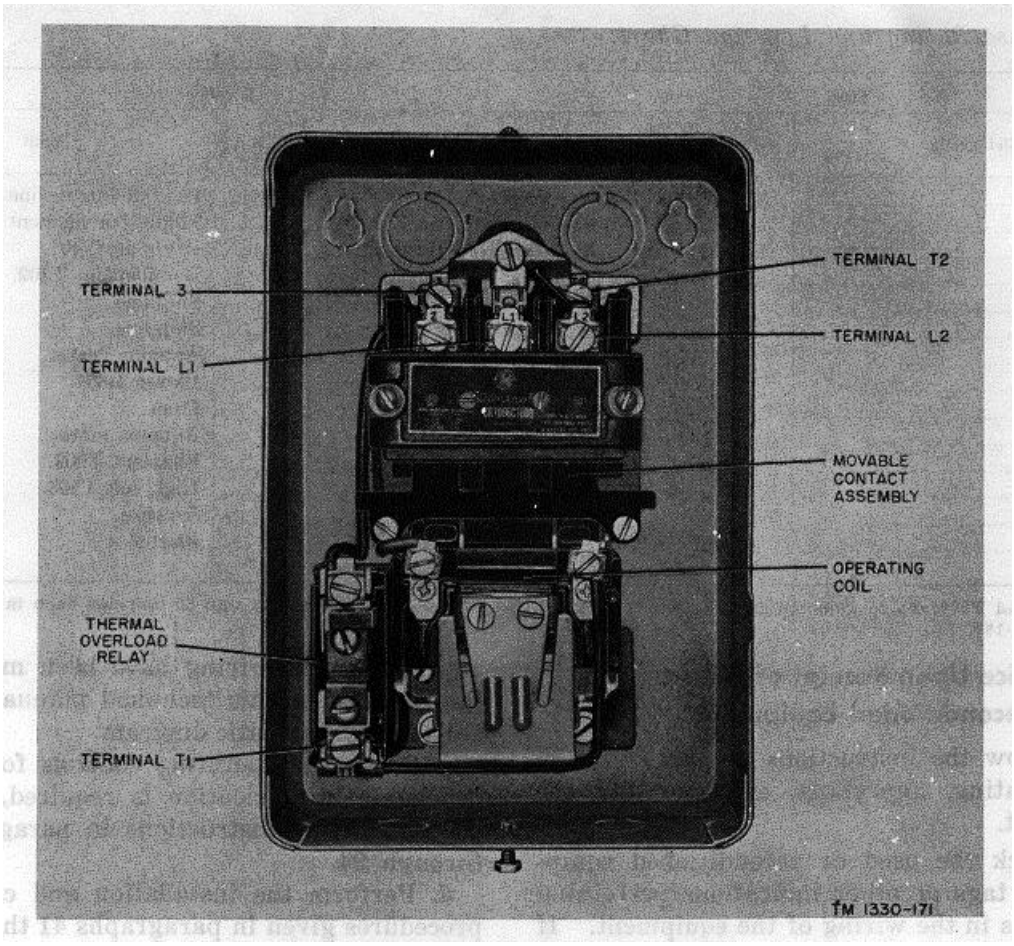


Figure 53. Circuit breaker terminals.

54. Cabling and Fuse Charts

a. Cabling Check. Check the connections between the various units of Radar Set AN/SPN-18(*) with the information given below and in figure 92. The following chart lists the cables in numerical order:

Cable No.	Type of cable	Number of wires	Connects	
			from-	To-
W701.....	MHFA-19.....	19	Receiver-transmitter (TB803).	Motor generator (TB601).
W702.....	MHFA-19.....	19	Receiver-transmitter (TB804).	Antenna (TB501).
W703.....	MHFA-14.....	14	Receiver-transmitter (TB802).	Indicator (TB904).
W704.....	MHFA-19.....	19	Receiver-transmitter (TB801,TB802).	Indicator (TB903).
W705.....	RG-12/U	1	Receiver-transmitter (TRIGGER jack J802).	Indicator (TRIGGER jack J911)
W706.....	RG-12/U	1	Receiver-transmitter (VIDEO jack J802).	Indicator (VIDEO jack J1152)
W707.....	FHFA-19.....	4	Receiver-transmitter (TB803)....	Motor generator (TB601).
W709.....	L & A cable, #12 wire.	7	Motor generator (TB601).....	Motor starter or circuit breaker (K 601)
W710.....	DHFA-23 or #4 wire.	2	Motor generator (TB601).....	Switch box (S601).
W711.....	#8 wire.....	2	Ship supply line.....	Switch box (S601).
W712.....	MHFA-4.....	3	Receiver-transmitter (TB801, TB802).	Echo box TB101.
W7013.....	TG-12/U.....	1	Echo box (P714 end).....	Directional coupler (P713 end).

b. Fuse Rating and Location Chart.

Fuse			Location	
Ref. symbol	Rating			
	Volts	Amp.	Component	Circuit
F301.....	250	2	Receiver-transmitter	H-v modulator line T301.
F302.....	250	2	Receiver-transmitter	Modulator filament line T305.
F401.....	250	3	Receiver-transmitter.....	L-v plate T401.
F402.....	250	2	Receiver-transmitter.....	L-v filament T402.
F601.....	250	(a)	Switch box.....	Ship line.
F601.....	250	(a)	Switch box.....	Ship line.
F801.....	115	1	Receiver-transmitter.....	Antenna heater.
F802.....	250	1	Receiver-transmitter.....	Blower B801.
F803.....	115	2	Receiver-transmitter.....	Drier.
F901.....	115	2 1/2	Indicator.....	Antenna motor.
F902.....	250	2	Indicator.....	Filament T902.
F903.....	250	1/2	Indicator.....	High volt T903.
F904.....	250	2 1/2	Indicator.....	Synchro.
F1201.....	250	1/8	Indicator.....	Platter

"F601 and F602 are 25 amperes each in Switch Box SA-284-11 (d-c operation0 and 30 amperes each in Switch Box SA-368/SPN-18X (a-c operation).

55. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 39 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes in this technical manual, preferably on the schematic diagram.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 92 through 94.

d. Perform the installation and connection procedures given in paragraphs 41 through 54.

Section II. INSTALLATION ALIGNEMENT PROCUDURES

56. General

a. This section covers the initial checks and alinement procedures which must be performed on Radar Set AN/SPN-18(*) after installation and prior to initial operation. Adjustments made during operation are described in chapter 3.

b. Because of the physical location of the various units of the radar set, some of the alinement procedures described in this section require two men. Provisions are made in the equipment for communication between the units by means of a telephone system. The telephone handsets can be plugged into telephone jacks in the indicator (fig. 59), in the receiver-
transmitter (fig. 48), and in the antenna (fig. 3).

c. Before proceeding, carefully read the alinement steps outlined in this section and define clearly the responsibilities of each man.

57. Initial Checks

a. Check all connections at terminal boards (fig. 92) for color coding and tightness.

b. Check all power connections at the switch box, motor starter or circuit breaker, motor generator, and voltage regulator.

c. Check to see that the correct fuse has been inserted in each fuseholder in the switch box.

d. Use a d-c voltmeter to check the power supply input at the line side of the switch box. See that the POWER switch on the indicator (fig. 10) is in the OFF position.

e. Be sure that all tubes are tight in their sockets.

Caution: Do not allow metal objects to come in contact with the magnetron magnet on the receiver-transmitter. Do not wear a wrist watch while working on the unit, or it will be ruined by the strong magnetic field of the magnet.

f. Refer to the lubrication instructions (par. 93) and fill the antenna lower drive assembly with the correct amount of oil (2135).

g. Be sure that the window of the antenna feed horn is free from corrosion, dirt, and paint.

h. Check to see that the bolts and nuts on the antenna are tight.

i. See that all obstructions have been cleared from the path of the antenna rotation.

j. Be sure that the air filter is in place in the receiver-transmitter (fig. 6).

k. Be sure that the hinged panels of the receiver-transmitter and indicator and the hinged top of the indicator are closed properly.

l. Tighten the waveguide clamp in the receiver-transmitter (fig. 6), using the wrench supplied.

58. Duplexer, Mixer, and Local Oscillator Alinement

The duplexer, mixer, and local oscillator are adjusted carefully at the factory, but to assure maximum operating efficiency they should be checked and, if necessary, realined at the time of installation.

a. General. A 30-mc intermediate frequency will be produced when the LO is tuned to a frequency either 30 mc above or 30 mc below the magnetron frequency. However, for proper operation of the radar set, the LO must be tuned to a frequency 30 mc *above* the magnetron frequency. It is also extremely important that the final LO tuning strut adjustment produces simultaneously a peak in crystal current and a maximum signal output. The necessary adjustments should be made with a test oscilloscope *(b* below) but may be made without one (c below).

b. Alinement with Oscilloscope. The following instructions are based on tests made with Oscilloscope TS-34A/AP (TM11-1067A); however, any equivalent oscilloscope may be used. Before using an oscilloscope other than Oscilloscope TS-34A/AP, refer to its technical manual and ascertain whether it is designed to operate from a *400-cycle,* 115-volt, a-c source.

(1) Disconnect the plug from the TRIGGER jack J303 on the receiver-transmitter test. panel (fig. 60) and connect a T-connector in its place. Reconnect the plug to the T-connector.

(2) Put the radar set in operation (ch. 3). Plug the line cord of the test oscilloscope into one of the 400-cycle, 115-volt outlets on the receiver-transmitter -convenience panel (fig. 60).

(3) Two coaxial test leads, each with a male connector at one end and a probe assembly at the other end, are furnished with Oscilloscope TS-34A/AP. Connect the unmarked test lead to the EXT SYNC connector on the oscilloscope. Attach the probe to the T-connector on TRIGGER jack J303 and clip the ground lead to the frame of the receiver-transmitter. Be sure that the cable from the TRIGGER IN jack J204 (fig. 88) is also connected to the T-connector ((1) above).

(4) Connect the male connector of the SIGNAL INPUT coaxial test lead to the SIGNAL INPUT connector on the oscilloscope. Attach the probe to VIDEO OUT jack J203 (fig. 88) on the receiver and clip the ground lead to the frame.

(5) Adjust the controls on the left side of the test oscilloscope according to the following chart:

Control	Initial setting
INPUT IMPEDANCE.....	0.
IMAGGE SIZE.....	Fully clockwise.
ATTENUATION-db.....	0.
BRIGHTNESS.....	Fully clockwise.
FOCUS.....	Any.
POWER.....	ON.

(6) Adjust the controls on the right side of the oscilloscope according to the following chart:

Control	Initial setting
INT SYNC-EXT SYNC.....	EXT SYNC.
SYNC POLARITY.....	Switch down.
SWEEP SELECTOR.....	START-STOP.
NORMAL-H PLATES.....	NORMAL.
COARSE SWEEP SPEED.....	SLOW.
POSITION, HORIZONTAL.....	CENTER.
POSITION, VERTICAL.....	CENTER.

(7) With the FINE SWEEP SPEED control on the test scope fully counter-clockwise, turn the BRIGHTNESS

control counterclockwise to obtain a fairly bright spot on the oscilloscope screen.

Caution: Do not allow the spot to remain stationary on the screen for more than a few seconds.

(8) Adjust the FOCUS control to obtain the smallest and sharpest spot possible.
(9) Adjust the HORIZONTAL and VERTICAL POSITION CONTROLS to place the spot in the lower left portion of the scope screen.
(10) Turn the FINE SWEEP SPEED control clockwise until the sweep line extends across the screen.
(11) Stop the antenna in the direction of targets by means of the ANT. MOTOR ON-OFF switch on the receiver-transmitter.
(12) Advance the receiver GAIN control (on the indicator primary control panel) to obtain noise on the test scope.
(13) Set the receiver A.F.C. OPER.-MANUAL TUNING switch to MANUAL TUNING.
(14) Turn both XTAL I ADJ SCREWS A and B (fig. 54) approximately 4 complete turns from their fully clockwise positions. (This step is required only f*or initial* adjustments; after that, readjustments can be made as required.)
(15) Turn the LO klystron tuning strut to its completely closed (counterclockwise position, using the klystron tool on the receiver chassis. (This adjustment is required only for initial adjustments.)
(16) *Slowly* open the tuning strut and simultaneously adjust the REFLECTOR TUNING control so that the CRYSTAL CURRENT meter indicates crystal current for both positions of the A.F.C. XTAL I-SIGNAL XTAL I PUSH switch.

Note. As the klystron tuning strut is adjusted, the REFLECTOR TUNING control must be readjusted continually to keep the klystron oscillating, as indicated by signal crystal current (A.F.C. XTAL I-SIGNAL XTAL I PUSH switch depressed.) The crystal currents must not exceed .75 ma (milli-ampere). If either crystal current becomes excessive, adjust the corresponding XTAL I ADJ SCREW, A or B (fig. 54), as required to reduce the current to approximately .70 ma.

(17) While slowly opening the tuning strut ((16) above), watch for the *first* signals to appear on the test scope.
(18) Adjust the SYNC VOLTAGE control of the test scope to obtain a steady picture of targets on the test scope.
(19) Readjust the test scope FOCUS, BRIGHTNESS, and IMAGE SIZE controls to obtain a test signal of the required sharpness, intensity, and size. (A 1/2-inch image is satisfactory.)
(20) Tune the TR adjustment (fig. 54) for maximum amplitude of the test image on the test scope.
(21) Adjust the REFLECTOR TUNING control for peak crystal current with the A.F.C. XTAL I-SIGNAL XTAL I PUSH switch depressed. As peak crystal current is approached, the signals probably will decrease and may even disappear.
(22) Carefully readjust the klystron tuning strut for maximum signals.
(23) Repeat the procedures in (21) and (22) above until maximum signals and peak signal crystal current are obtained together. Note the crystal current.
(24) Check the afc crystal current reading, and adjust XTAL I ADJ SCREWS B to obtain a meter reading between .4 and .5 ma. *Do not touch any other control.*
(25) Push the A.F.C. XTAL I-SIGNAL XTAL I PUSH switch and check the signal crystal current. If the reading is lower than that noted in (23) above, readjust XTAL ADJ I SCREW A to increase the rating to its previously noted value (between .4 and .5 ma).
(26) Make the following checks to determine that the LO is operating on a frequency 30 mc above the magnetron frequency.

(a) Open the klystron tuning strut *slowly.* A slight adjustment should produce a second set of signals, in-

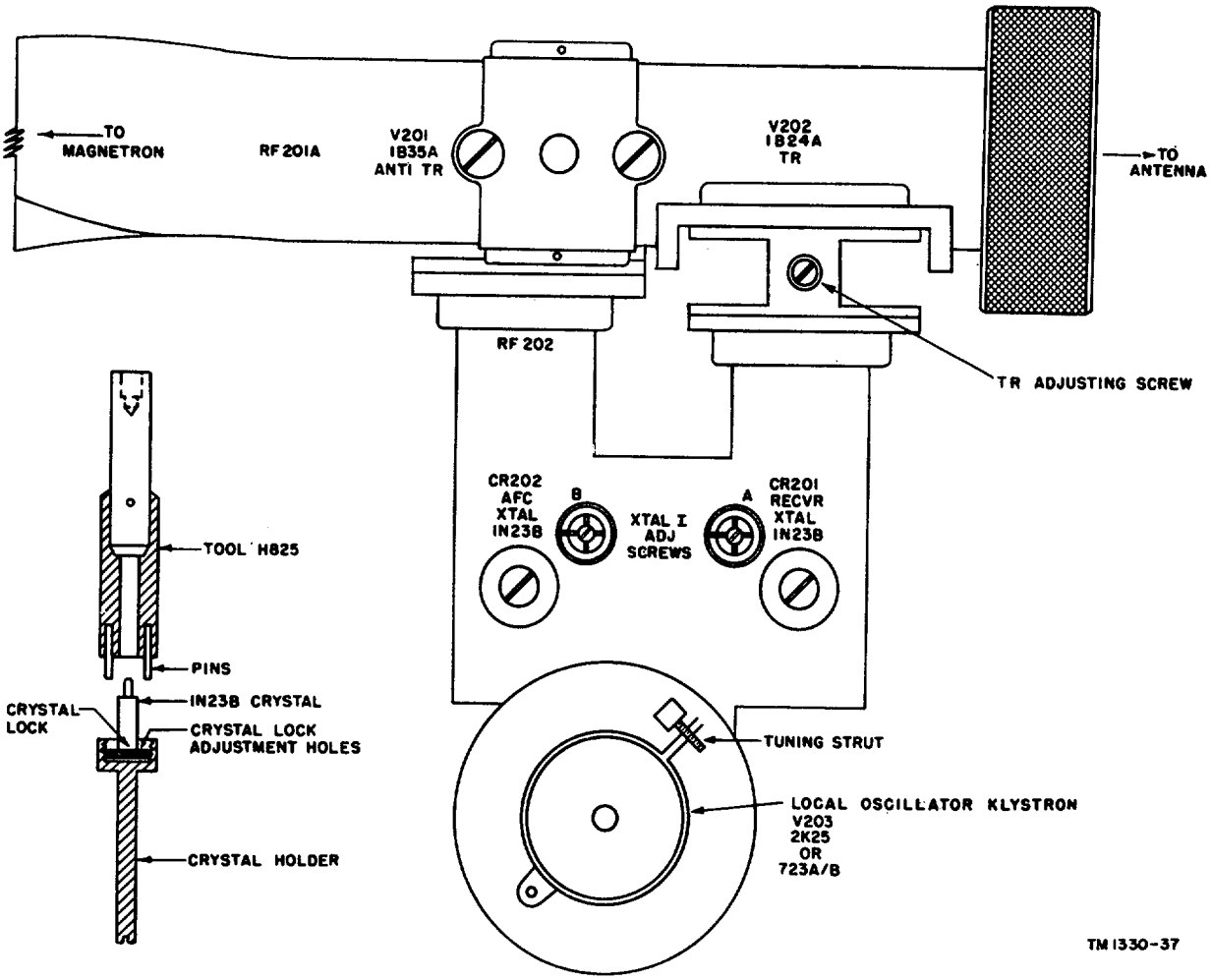


Figure 54. Mixer, duplexer, and LO tuning adjustments.

dicating that the LO now is oscillating at the *wrong* frequency (30 mc *lower* than the magnetron frequency).

(b) Slowly close the tuning strut to its original position, as indicated by maximum signals at the original setting.

(c) If the second set of signals is not obtained in subparagraph *(a)* above, slowly reclose the tuning strut to obtain the original signals. Continue to close the strut to obtain a second set of signals. The second set of signals now indicates that the LO is operating at the correct frequency (30 mc higher than magnetron frequency).

Note. As the tuning strut is opened from its fully closed position, the *first* set of signals is obtained with the LO at the proper frequency.

(27) Readjust the TR tuning adjustment for maximum signal amplitude.

(28) Check for proper operation of the afc circuits by throwing the A.F.C. OPER. -MANUAL TUNING switch to A.F.C. OPER. The amplitude of the signals should not change. If the amplitude changes, repeat the alinement procedure.

(29) As a final check on alinement, throw the HIGH VOLTAGE ON-OFF switch to OFF. The crystal current should rise and fall periodically. When the switch is thrown back to ON, the

crystal current should again become steady. If this does not occur, repeat the alinement procedure.

c. Alinement Without Oscilloscope. The alinement procedure of graph b above should be used whenever possible. If a test oscilloscope is not available, the following procedure may be used as an emergency measure to keep the radar set in operation.

(1) Place the radar set in operation.
(2) Stop the antenna rotation with the antenna pointed at targets.
(3) Advance the receiver GAIN control (on the indicator primary control panel) to the point at which noise appears on the PPI scope.
(4) Adjust the REFLECTOR TUNING control so that the LO oscillates, and adjust the XTAL I ADJ SCREWS A and B (fig. 54), so that the CRYSTAL CURRENT meter readings are the same (about .5 ma) for both positions of the A.F.C. XTAL I-SIGNAL XTAL I PUSH switch.
(5) Throw the A.F.C. OPER.-MANUAL TUNING switch to A.F.C. OPER. (Assuming that the LO is tuned improperly, the crystal current will rise and fall periodically.)
(6) Close the klystron tuning strut and then *slowly* open it. As the strut is opened, the crystal current will rise and fall.
(7) If there is no crystal current when the strut is closed, continue to open the strut slowly while rotating the REFLECTOR TUNING control back and forth. At some setting of the tuning strut a steady crystal current will be obtained. This indicates that the afc has locked in, *but not necessarily on the peak of the kystron operating mode.*
(8) Throw the A.F.C. OPER.-MANUAL TUNING switch to MANUAL TUNING and adjust the reflector tuning control for peak crystal current. Note the current amplitude.
(9) Now set the A.F.C. OPER.-MANUAL TUNING switch to its A.F.C. OPER. position. The crystal current should remain unchanged. If the crystal current changes, readjust the klystron tuning strut slightly to obtain the same current as that obtained in (8) above.
(10) Repeat the procedures in (8) and (9) above until there is no change in crystal current as the A.F.C. OPER.-MANUAL TUNING switch is alternately switched from one position to the other.
(11) Readjust the XTAL I ADJ SCREWS A and E, so that both crystal currents are between .4 and .5 milliampere.
(12) Adjust the TR tuning for maximum target signals on the PPI scope.
(13) Make a careful check to see that the LO is operating on the correct frequency. If the afc is locking in with the LO on the wrong frequency, the crystal current will not remain exactly the same while the A.F.C. OPER. - MANUAL TUNING switch is alternately switched from one position to the other. Repeat the alinement procedure if necessary.

59. Bearing Alinement

a. General. If the antenna is oriented properly in the fore-and-aft direction at the time of installation, bearing alinement should not be necessary because the synchro system has been correctly alined at the factory. However, if the antenna was carelessly oriented, or if it was necessary to install the antenna off center to avoid structural obstacles, it will be necessary to realine the synchro system so that sight bearings will be identical to radar bearings. Assume, for example, that the antenna base is installed so that with the antenna pointing at a dead-ahead target, the PPI sweep is at 355° on the azimuth scale (A, fig. 55). Because of the 10-to-I gear ratio between the synchro receiver and the deflection coil of the PPI, the required *correction* is equal to the error multiplied by the gear ratio. The procedure for making the correction is given in subparagraph c below.

b. Alinement Check.

(1) Turn the ANTENNA switch on the indicator test panel to ON.
(2) As the antenna rotates, use the cursor to take radar bearings of targets on

the PPI scope. The bearings of targets in the *forward* area are especially important.
(3) Check the radar bearings against pelorus bearings.
(4) If the radar bearings are inaccurate, realine as instructed in c below.

c. Alinement Procedure. If the bearing error is very slight, check the antenna base to see if it has been accurately mounted (fig. 30). If the antenna is inaccurately mounted, it may be easier to correct the error by loosening the bolts that secure the antenna base to its mounting and then shifting the whole antenna the correct amount. Otherwise, proceed as follows:

(1) Stop the radar antenna so that a dead-ahead target (or a target only a few degrees off the bow) may be observed.
(2) Use the indicator RANGE setting that puts the target near the outer edge of the PPI. With the cursor, carefully determine the error between the radar bearing and the pelorus bearing of the target. *Make a note of the exact error.*
(3) The synchro receiver case (which is the synchro stator) is clamped in its mounting by three screws. Loosen the case by *loosening* the two outside screws and slightly tightening the center screw.
(4) Support the synchro case with one hand and rotate it so that the PPI sweep line travels in the proper direction and the right amount to compensate for the error. The synchro case must be shifted 10 times the bearing error, because of the 10/1 gearing; that is, if the error is 20, the synchro case will have to be shifted 20°.
(5) Retighten the synchro case in its mounting by *loosening* the center mounting screw and tightening the two outer mounting screws.
(6) The indicator cam (fig. 56) is adjusted at the factory so that at the same time the cam operates the cam switch (S912), the PPI sweep is at 1760 on the azimuth scale (A, fig. 55). Readjust the position of the cam as follows:

*(*a) Temporarily remove the SYNCHRO fuse (F904) on the indicator test panel (fig. 59). This allows the synchro gearing to be moved by hand.

*(*b) Use a No. 6 Allen wrench to loosen the setscrew that holds the cam to the deflection coil housing.

*(*c) Position the cam so that it operates the cam switch just as the PPI sweep is at 176° *plus or minus the erro*r. Make sure of this positioning: Slowly rotate the relocated cam in a clockwise direction and check that the cam switch *just closes* when the PPI sweep is at 176° plus or minus the error. If the dead-ahead target appeared to the left of 0° (dead-ahead) on the azimuth scale (A, fig. 55), the switch should operate at 176° *plus* the error (B, fig. 55); if the dead-ahead target appeared to the right of 0°, the switch should operate at 176° *minus* the error.
*(*d) Tighten the cam setscrew *and replace the wrench in its clip.*

d. Rechecking Alinement and Operation. Replace the SYNCHRO fuse and set the ANTENNA switch on the indicator test panel to ON. Take radar bearings as instructed in subparagraph b above, and check them against pelorus bearings. They should agree. Make the following checks on alinement action:

(1) When the radar set first is turned on, the synchro alinement relay (K903) in the indicator will operate to aline the PPI sweep with antenna rotation. This operation will produce a slight jerk in the sweep in the area of 180° on the azimuth scale. After this initial alinement cycle, there should be no further jerkiness in the movement of the sweep.
(2) To check the alinement, operate the synchro alinement relay by pushing the armature of the relay with a pencil, holding it there about a second, and then releasing it. The synchro system should aline itself and should operate smoothly.
(3) Repeat the procedure in (2) above several times to make sure that all

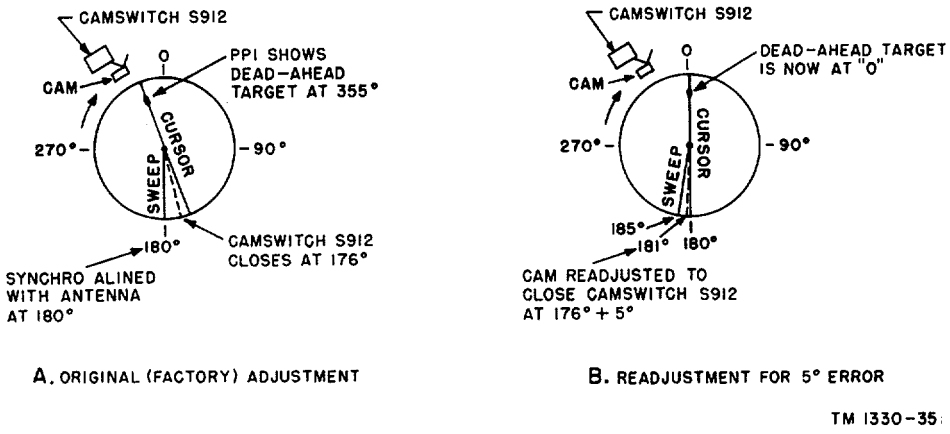


Figure 55. Original adjustment and readjustment of switch cam.

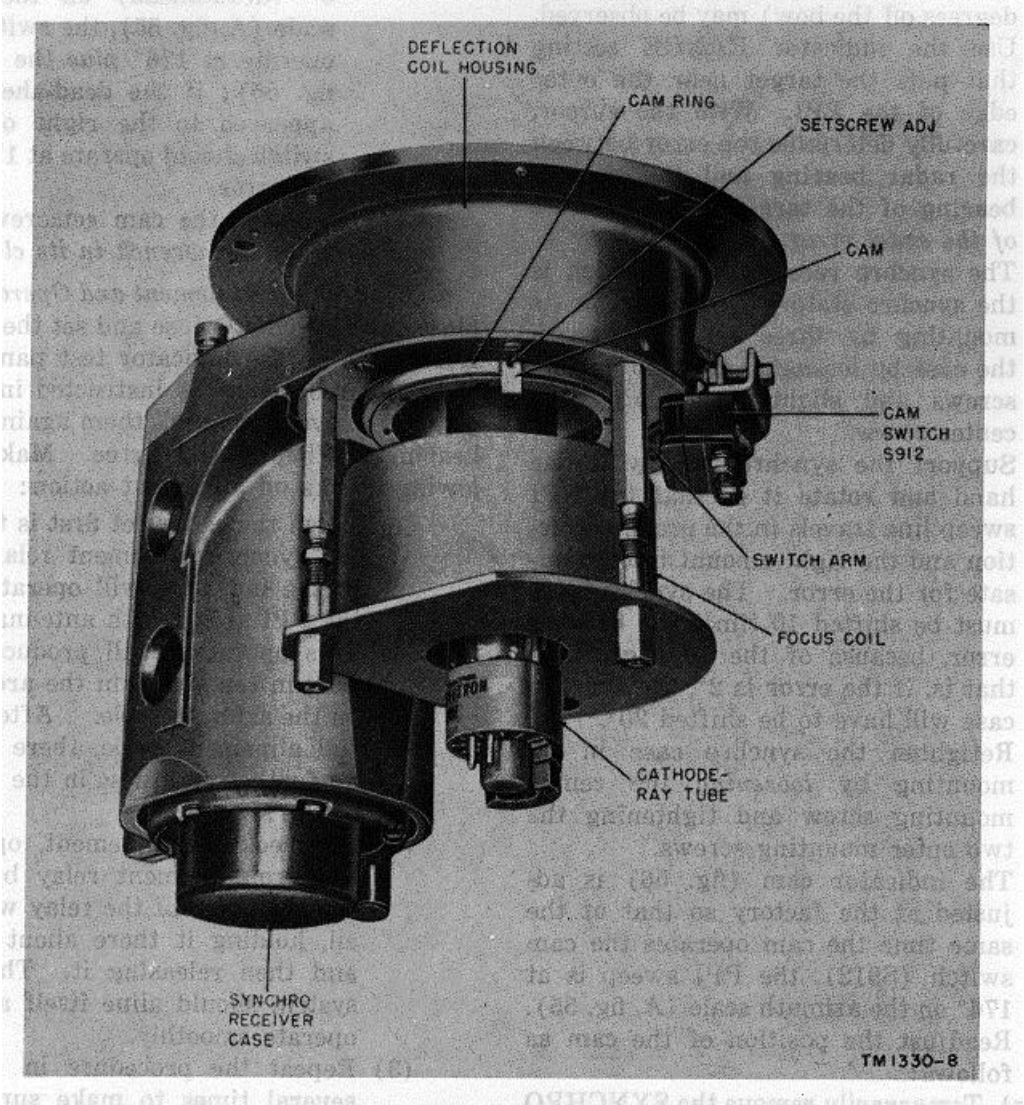


Figure 56. Location of indicator cam.

settings are correct. If operation is unstable or the SYNCHRO fuse blows, it may be necessary to repeat the entire alinement procedure (c above).

60. Heading Flash Alinement

a. General. Any adjustment of the synchro receiver to compensate for bearing errors (par. 59) will shift the fore-and-aft heading flashes. Therefore, always aline for bearing correction first.

b. Alinement Procedure.

(1) Station a man at the indicator and a second man at the antenna. Remove the antenna covers, and connect hand-sets to the PHONES jacks J501 and J909 at the antenna and indicator, respectively, so that the man viewing the PPI scope can direct the adjustments.
(2) Place the radar set in operation and adjust the controls for clear, sharp heading flashes.
(3) If the heading flashes are inaccurate, inform the man at the antenna of the error and its direction.
(4) Stop rotation of the antenna by throwing the antenna drive motor switch (S503, fig. 3) to OFF.
(5) Loosen the setscrews in the forward flash cam (fig. 57) in the antenna. Shift the cam in the proper direction to compensate for the error, and tighten the setscrew.

Note. Be careful not to bend or deform the moving arm on the cam switches.

(6) Recheck the forward flash by restarting the antenna rotation and observing the heading flashes. They should occur at 0°. It will probably be necessary to repeat (2) through (5) above to obtain an accurate forward heading flash.
(7) Adjust the aft flash cam by following the procedure outlined for adjusting the forward flash cam.
(8) Whenever possible, observe targets directly forward and aft and see that they coincide with-the heading flashes.
(9) Before replacing the antenna pedestal covers, make sure that the cam set-screws are tight and that drive motor switch S503 is in its ON position.

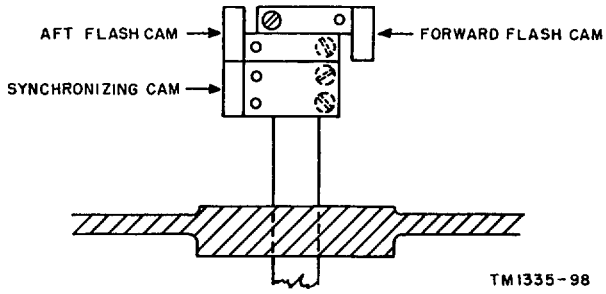


Figure 57. Location of heading flash cams.

61. Plotter Alinement

a. General. The plotter is adjusted at the factory, but to assure maximum operating efficiency it should be checked after installation and, if necessary, readjusted. The three hex-head studs located at the periphery of the plotter are used to raise or lower the glass writing surface with respect to the dichroic mirror. They should be adjusted so that the distance between the dichroic mirror and the glass writing surface is the same as between the mirror and the scope face.

b. Alinement Procedure.

(1) Place the radar set in operation and adjust the controls so that targets may be seen on the scope.
(2) Illuminate the plotter by turning the rheostat on top of the indicator clock-wise.
(3) Using the wax pencil supplied with the plotter, make a few marks on the glass writing surface, some about 1 inch from the center and others toward the outer edge.
(4) Observe the red reflected marks on the scope face. If they appear to be above or below the scope face, adjust the three hex-head studs until the reflected marks appear at the same level as the targets.

CHAPTER 3

OPERATING INSTRUCTIONS

Note. This chapter locates, illustrates, and furnishes the operator sufficient information pertaining to the various controls and instruments provided for the proper operation of the equipment.

Section I. CONTROLS AND INSTUMENTS

62. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 69 through 81.

63. Control Indicator C-1 261 /SPN-18 (figs. 58 and 59)

The chart below lists the controls and instruments of the indicator and the function of each item. Capital letters indicate panel markings.

Control	Function
GYRO ON-OFF switch (S913).....	This switch is not used in this installation. It connects the ship's gyro compass to the true hearing assembly (not used in this installation).
Range control (R106).....	Controls position of variable range marker and mechanical counter from .5 to 20 miles when RINGS switch is set at VAR.
True hearing scale control.....	Controls position of true bearing scale, which can be rotated only when the control is pulled up.
Cursor control.....	Controls position of cursor to provide accurate bearing readings of targets.
Plotter illumination control (R1201).....	Varies brightness of plotter lamps.
POWER switch (SO8).....	STAND BY position: Turns on all power except the two high-voltage supplies and actuates the time delay circuit. OPERATE position: Turns on the high-voltage supplies after the 3-minute time delay has run out, placing the radar in operation.
SUPPRESSOR control (R1039).....	Clockwise rotation increases the suppression of large blocks of signals (sea return)
DIMMER control (R999) on primary control panel.	Varies brightness of primary control panel lamps.
RANG.F. switch (S901).....	Selects desired range and energizes appropriate range light. *Position (Nautical miles)* — *Distance between each of four range rings* 1.....1/4mile 2.....1/2 mile 4.....1 mile 8.....2 miles 20.....5 miles 40.....10 miles
GAIN control (R1047).....	Clockwise rotation increases the sensitivity of the receiver (brightness of echoes on PPI scope).
FLASHER control (R1050).....	Clockwise rotation increases the intensity of heading and aft flashes.
CONTRAST control (R989).....	Clockwise rotation increases the amplitude of video signals delivered to PPI scope (brightness of echoes and range markers).
FOCUS control (RIO90).....	Controls sharpness of PPI presentation.
FTC switch (909).....	Reduces the apparent depth of echoes received from land masses, coastlines, etc.

Control	Function
TEST switch (S904).....	Not used during normal operation; actuates the echo box for testing of the transmitting and receiving system.
CENTER switch (S902).....	Set at OPEN only when navigating in an arrow channel with the indicator on the 1- or 2-mile range. When it is OPEN, the center of the PPI scope is expanded to a small diameter circle which becomes a zero range ring, giving greater bearing accuracy at close ranges.
RING INT control (R1034).....	Clockwise rotation increases the intensity of the variable or fixed range rings.
RING switch (S907).....	FIXED position: Places four fixed range rings on PPI scope. VAR position: Substitutes a variable range ring for the four fixed range rings.
DIMMER control (R1000) on secondary control panel.	Varies brightness of azimuth scale lamps.
Test meter (M901) and meter switch (S903) (fig. 59).	Switch not used during normal operation; it is an eight-position wafer switch that connects the test meter to various circuits as follows: *Position* — *Function* +24V (240)..... Indicates output voltage of +24-volt supply. +140V ..... Indicates output voltage of +140-volt supply. +300V REG..... Indicates output voltage of +300-volt regulated supply. +300V REG..... Indicates output voltage of +300-volt supply. +600V (300)..... Indicates output voltage of +600-volt supply. -300V REG..... Indicates output voltage of -300-volt regulated supply. +1200V (120)..... Indicates output voltage of CRT high-voltage supply. 115V A.C..... Indicates 400-cps output of motor generator.
HOURS meter (M902) (fig. 59).....	Indicates the number of hours the radar set has been in standby or operate condition.
ANTENNA switch (S905) (fig. 59).....	Normally set to ON position. When set to OFF, it removes the power from the antenna drive motor.
INTESITY control (S973) (fig. 59).....	Clockwise rotation increases the amplitude of video signals delivered to PPI

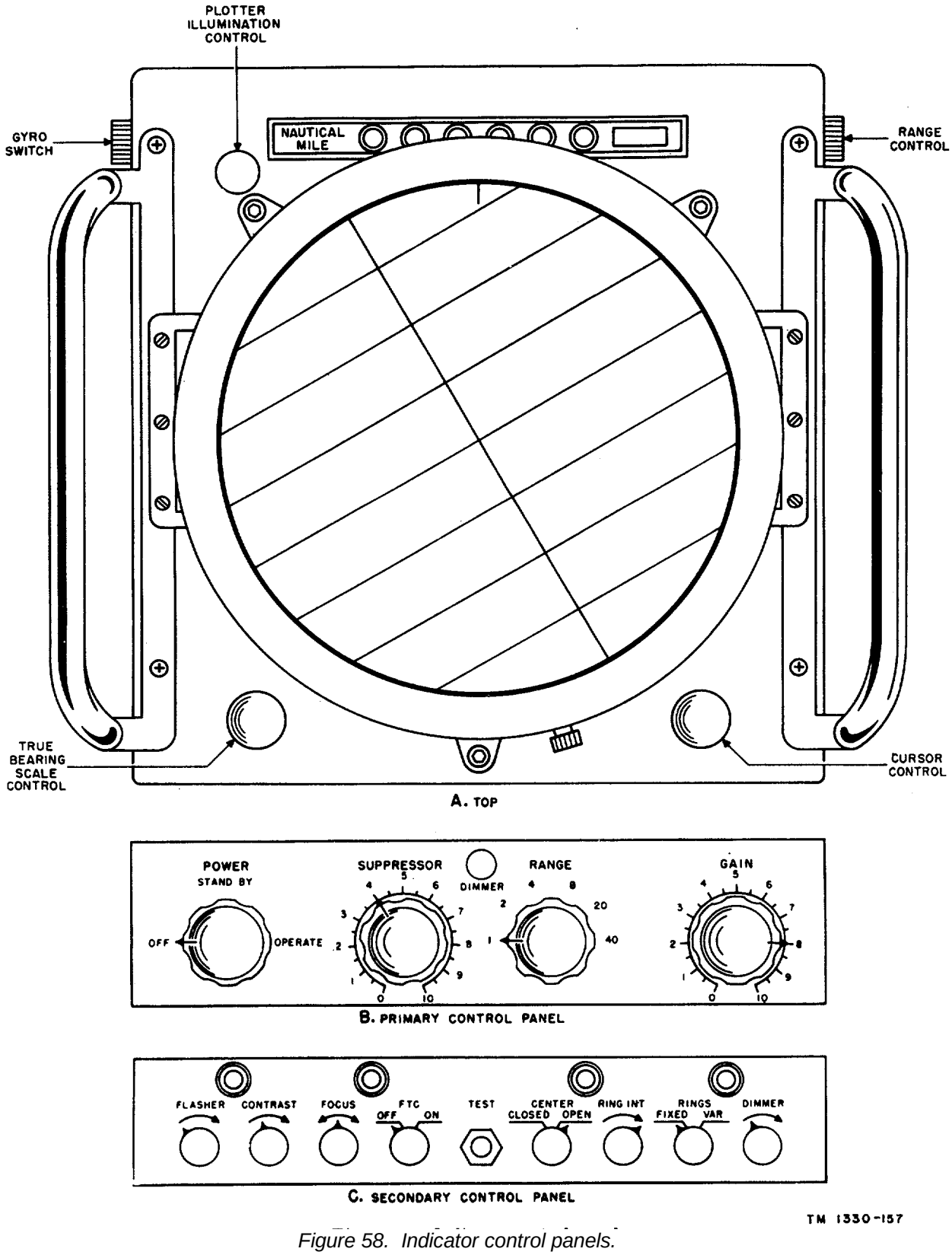


Figure 58. Indicator control panels.

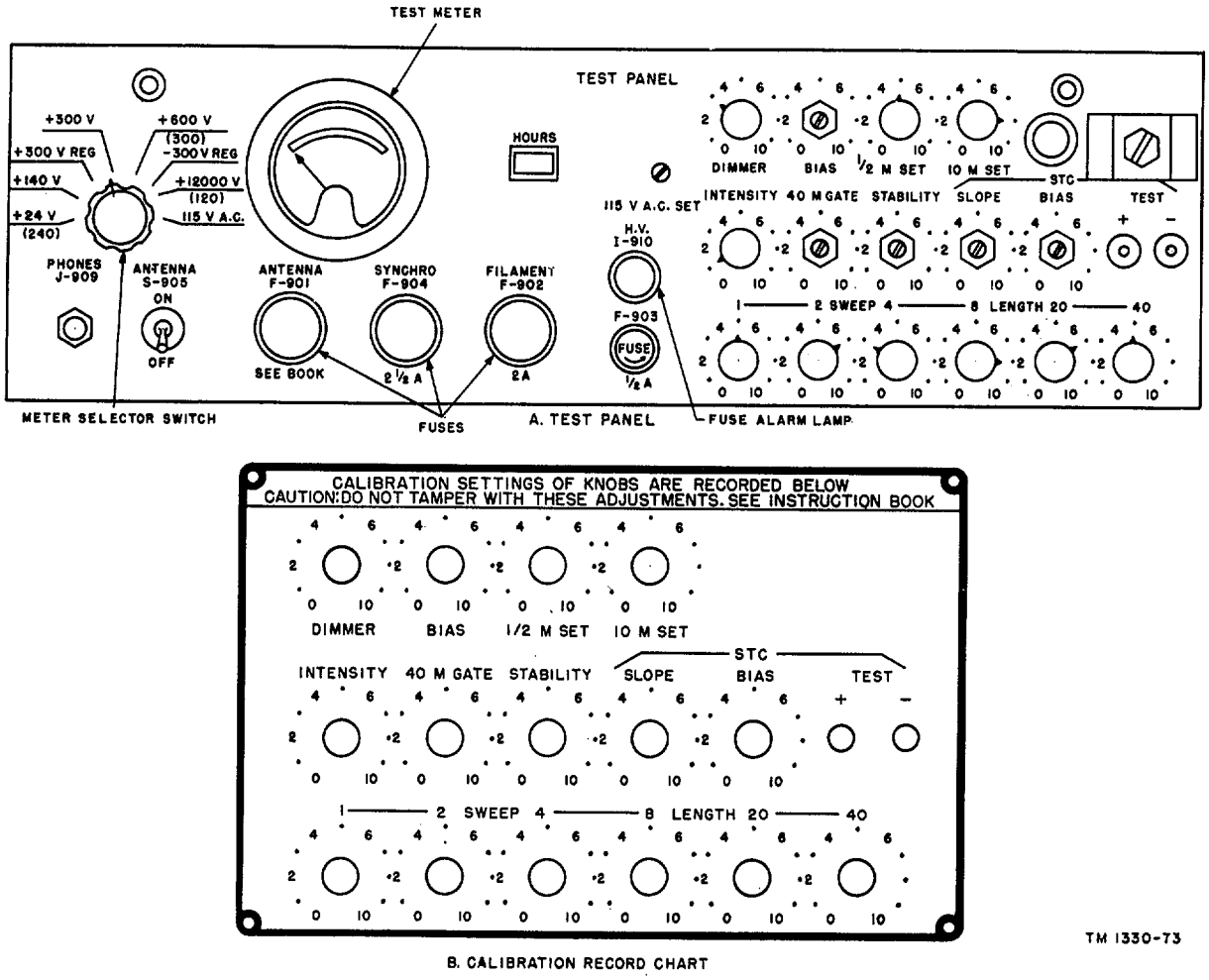


Figure 59. Indicator test panels.

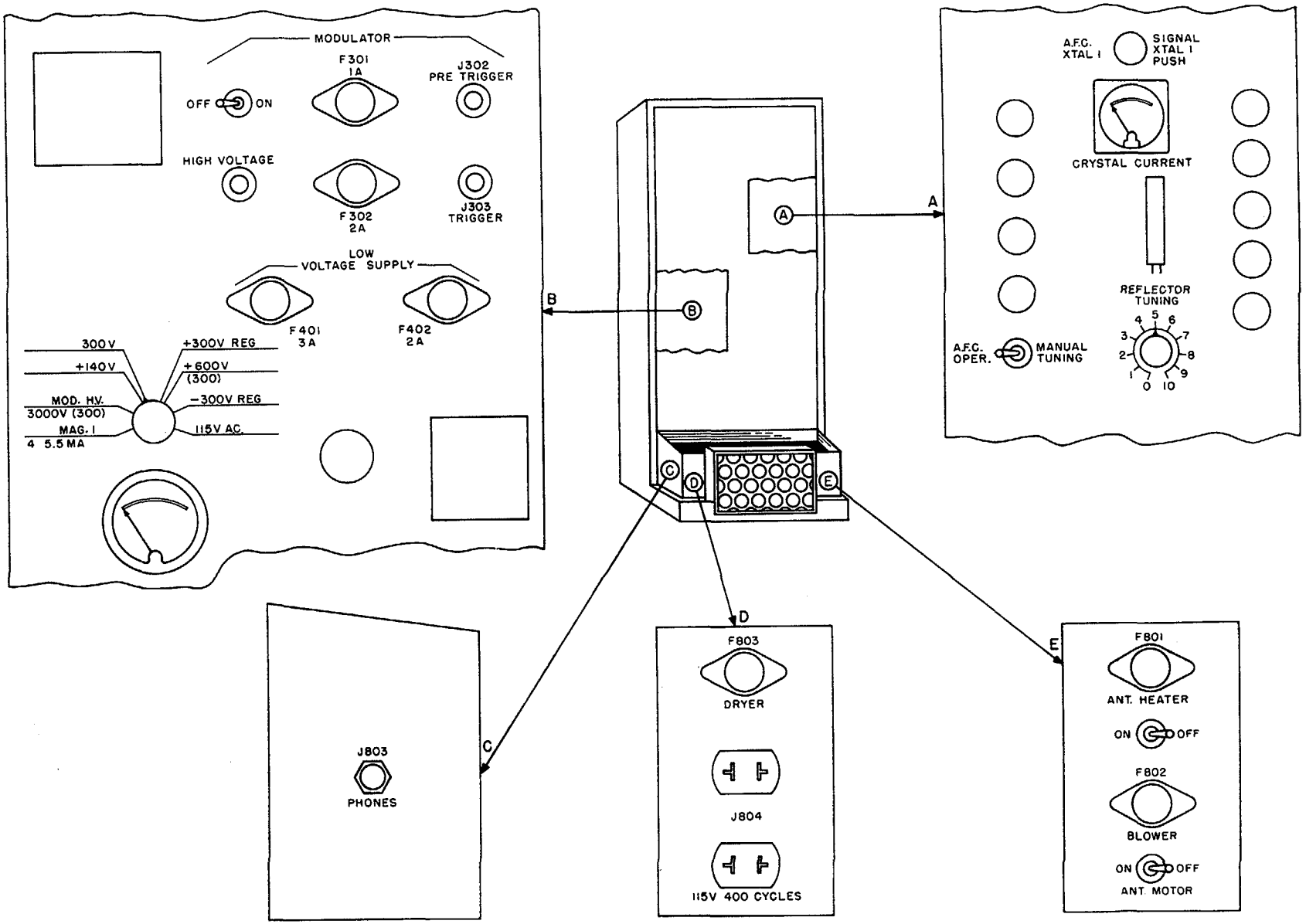


Figure 60. Receiver-transmitter control panels.

64. Radar Receiver-Transmitter RT-290/SPN-18 (fig. 60)

The chart below lists the controls and instruments of the receiver-transmitter and the function of each item. Capital letters indicate panel markings.

Control	Function
A.F.C. XTAL I-SIGNAL, XTAL I PUSH switch (P201) and CRYSTAT, CURRENT meter (N201).	Switch not used during normal operation; it is a push-button switch that connects the CRYSTAL CURRENT meter in series with the crystals, as follows: *Position* — *Function* Normal ..... Indicates the afc crystal current. Pushed..... Indicates the signal crystal current.
A. F. C. OPER.-MANUAL TUNING switch (S202).	Not used during normal operation; it is normally left at A. F. C. OPER. When set at MANUAL TUNING, the LO can he tuned manually.
REFLECTOR TUNING control (R250).....	Not used during normal operation; it adjusts the reflector voltage of the klystron oscillator and, therefore, it is the LO frequency control for manual tuning.
HIGH VOLTAGE switch (S301).....	Controls the modulator h-v supply and is normally left at ON. The OFF position, which is not used in normal operation, renders the transmitter inoperative.
Test meter (M401) and meter switch (S401)	Switch not used during normal operation; it is an eight-position wafer switch that connects the test meter to various circuits as follows: *Position* — *Function* MAG. I 4-5.5 MA..... Indicates plate current of magnetron. MAOD. H.V. 3000V (3CO) ..... Indicates output voltage of modulator high-voltage supply. +140V..... Indicates output voltage of +140-volt supply. 300V..... Indicates output voltage of +300-volt supply. +300V REG..... Indicates output voltage of +300.volt regulated supply. +600V (300)..... Indicates output voltage of +600-volt supply. -300V REG..... Indicates output voltage of -300-volt supply. 115V A.C ..... Indicates 400-cps output of motor generator.
ANT. HEATER switch (S801)	Normally set at ON and left there. When set to OFF, it removes the power from the antenna I-eaters.
ANT. MOTOR switch (S802)	Normally set to ON and left there. When set to OFF, it removes the power from the antenna drive motor.

65. Antenna AS-659/SPN-18 (fig. 3)

Control	Function
Antenna drive motor switch (S503).....	Normally to ON and left there. When set to OFF, it removes the poser from the antenna drive motor.

66. Voltage Regulator CN-225/SPN-18 (fig. 20)

The chart below lists the controls and instruments of the voltage regulator and the function of each item. Capital letters indicate panel markings.

Control	Function
Manual voltage adjustment (R60fS).....	Not used during normal operation; it controls the voltage output of the motor generator.
Meter illumination control (dimmer) (R605).	Varies brightness of meter illuminating lamps.
AUTOMATIC- MANUAL switch (S602).....	Normally set at AUTOMATIC and left there. When set to MANUAL, the manual voltage adjustment can be used to regulate the output of the motor generator.
A-c voltmeter (M601).....	Indicates voltage output of motor generator.

67. Switch Box SA-284/SPN-11 or SA-368/SPN-18X (figs. 16 and 17)

Control	Function
Control (lever) switch (S601).....	Controls application of all power to radar set. When control lever is down (OFF), all power is removed from the radar set.

68. Motor Starter SA-342/SPN-18 or Circuit Breaker SA-369/SPN-18X (figs. 15 and 19)

Control	Function
RIE:SET button.....	Pushing this button resets the thermal overload relay in the motor starter or circuit breaker.

Section II. OPERATING UNDER USUAL CONDITIONS

69. Preliminary Adjustments

Before power is applied to Radar Set AN/SPN-18(i*), perform the following preliminary adjustments:

a. Control Indicator C-1261/SPN-18 (fig. 58).

Control	Position
POVWER switch.....	OFF.
SUPPRESSOR control.....	0.
GAIN control	0.
FLASHER control.....	Fully counterclockwise.
CONTRAST control.....	Fully counterclockwise.
FOCUS control	Fully counterclockwise.
FTC switch.....	OFF.
CENTER switch.....	CLOSED.
RING INT. Control.....	Fully counterclockwise.
RINGS switch.....	FIXED.
ANTENNA switch (fig. 50).....	OFF.
INTENSITY control (fig. 50).....	As indicated on calibration chart.

b. Radar- Receiver - Transmitter RT-290/SPN-18 (fig. 60).

Control	Position
A. F. C. OPER.-MANUAL TUNING switch.	A. F. C. OPER.
HIGH VOLTAGE switch.....	OF.
ANT. HEATER switch.....	OFF.
ANT. MOTOR switch	OFIF.

c. Voltage Regulator- CN-225/SPN-18 (fig. 20). Set the AUTOMATIC-MANUAL switch to the AUTOMATIC position.

d. Switch Box SA-284/SPN-11 or SA-368/SPN-18X (fig. 16). Pull the control lever down to OFF.

e. Antenna AS-659/SPN-18 (fig. 3). Remove the covers from the antenna pedestal and set the antenna drive motor switch to the ON position. Make sure that there are no obstacles in the path of the antenna rotation. Replace the pedestal covers.

70. Starting Procedure

Note. If during the starting procedure an abnormal result is obtained, refer to paragraph 101, Equipment Performance Checklist. See paragraph 69 before following this starting procedure.

Caution: Make sure that all personnel are clear of the antenna before placing the set in operation.

a. Throw the control lever on the switch box to the ON position. This connects the radar set to the ship supply voltage.

b. Remove the receiver-transmitter front cover and set the ANT. HEATER switch (fig. 60) to the ON position. This applies ship power to the antenna heaters.

c. Set the POWER switch to the STAND BY position, to start the motor generator. When the motor generator starts, the voltage regulator voltmeter will indicate the a-c output voltage, and the azimuth scale lamps, primary and secondary control panel lamps, and TEST PANEL lamp will light. If the motor generator fails to start, depress the RESET button on the motor starter (fig. 15) or circuit breaker (fig. 19).

Note. An automatic 3-minute time delay must elapse before the scope and modulator high voltage is applied. The amber READY lamp on the indicator lights when the time delay has run out.

d. Set the POWER switch to the OPERATE position. This applies high voltage to the PPI scope and causes the HIGH VOLTAGE lamp on the receiver-transmitter to light (if the time delay has run out).

Note. The POWER switch may be set to the OPERATE position before the 3-minute time delay has elapsed. When the READY lamp lights the high voltage will be automatically applied.

e. On the receiver-transmitter, set the ANT. MOTOR switch to the ON position.

f. On the indicator test panel set the ANTENNA switch (fig. 59) to the ON position. This energizes the antenna drive motor to rotate the antenna. If the drive motor fails to start, check antenna motor fuse F901. Also check to see that the antenna drive motor switch in the pedestal (fig. 3) is ON.

g. On the receiver-transmitter, set the HIGH VOLTAGE switch (fig. 60) to the ON position.

h. On the receiver-transmitter, check the meter readings for each position of the test meter switch. Refer to paragraph 64 for an explanation of the eight switch positions. Note that the meter scale is calibrated from 0 to 500; therefore, the observed readings must be interpreted in terms of the switch position. The normal scale readings and the corresponding

actual values for each position of the switch are given in the following chart:

Switch position	Observed reading	Actual value
MAG. I	400-500	4-5 ma.
WMOD. HV	300	3,000 v.
+140V	140	+140 v.
300V	300	+300 v.
+300V REG	300	+300 v.
+600V	300	+600 v.
-300V REG	300	-300 v.
115VA.C	115	115 v ac.

i. If the meter readings *(h* above) are normal, replace the receiver-transmitter front cover.

j. Observe the meter reading for each position of the meter switch on the indicator TEST PANEL. The following table lists typical readings that should be obtained. Refer to paragraph 63 for an explanation of the eight switch positions.

Switch position	Observed reading	Actual value
MAG. I	400-500	4-5 ma.
WMOD. HV	300	3,000 v.
+140V	140	+140 v.
300V	300	+300 v.
+300V REG	300	+300 v.
+600V	300	+600 v.
-300V REG	300	-300 v.
115VA.C	115	115 v ac.

k. Rotate the FLASHER control clockwise until the heading and aft flashes appear.

l. Rotate the RING INT control until the four range rings appear on the PPI.

m. Adjust the FOCUS control for the clearest, sharpest possible inner range ring.

n. Rotate the CONTRAST control clockwise to its approximate midposition.

71. Operation

a. General. After completing the starting procedure (par. 70), the radar set is ready for operation. The following controls on the indicator may be used by operating personnel:

(1) All controls on the top hinged panel (fig. 58).

(2) All controls on the primary control panel (fig. 58).

(3) All controls on the secondary control panel (fig. 58).

(4) Only the ANTENNA switch, the test meter switch and the INTENSITY control on the TEST PANEL (fig. 59).

b. GAIN. Adjust the GAIN control until targets appear on the PPI. To search for targets in the immediate vicinity of the vessel, keep the GAIN control at low settings (between 1 and 5). This provides sharp target echoes near the center of the PPI scope. As the GAIN' control is advanced, targets near the center of the scope tend to merge, but targets at greater distances become clearer. When observing distant targets, advance the GAIN control to the point at which receiver noise

begins to appear as a light or mottled back-ground on the PPI scope.

c. SUPPRESSOR. To eliminate excessive sea return or local rain squall interference, adjust the SUPPRESSOR control by slowly turning it clockwise until the PPI picture is clear. The SUPPRESSOR control must be used carefully;

too little SUPPRESSOR action allows sea return to brighten unduly the center of the PPI scope, and too much SUPPRESSOR action darkens the center of the PPI scope and may blank out targets.

d. *CONTRAST*. Adjust the CONTRAST control for good definition of target echoes. Too much contrast will cause the scope to bloom, giving fuzzy definition of targets. At night, in a dark pilot house, the CONTRAST control may be used to reduce the overall glow of the PPI.

e. *DIMMER*. Adjust the DIMMER control on the primary control panel so that the panel markings are visible. Adjust the DIMMER control on the secondary control panel so that the cursor lines and the azimuth scales are just visible. Excessive illumination reduces the apparent brightness of targets and makes it difficult to see weak target echoes.

f. Ring Int. and Flasher. Adjust the RING INT. and FLASHER controls to obtain clear, but not excessively bright, range rings and fore-and-aft flashes. Excessive brightness will obscure targets on the range rings and flashes.

g. *FTC Operation*. The FTC switch is set to the ON position whenever heavy rain or snow clutters the scope, when viewing large masses of land and coastlines, and under some

conditions of sea return. When the switch is ON, large blocks of echoes on the scope will be broken up, allowing objects to be seen through the clutter (B. fig. 61).

h. *Voltage Regulator*. While using the radar set, frequently check the voltage regulator meter reading. If the voltage is incorrect, place the AUTOMATIC-MANUAL switch at MANUAL and adjust the manual voltage adjustment for a meter reading of exactly 115 volts ac.

Note. Low motor generator output (under 115 volts ac) will impair performance; high motor generator output (over 115 volts ac) will shorten tube life and may cause premature breakdown of the radar set.

i. *Azimuth of Targets*. Relative or true bearings of targets may be taken on the PPI. The relative bearing of a target is the angle between the fore-and-aft line of the ship and the bearing line of the target, measured clockwise from 0° to 360° (fig. 23). The true bearing of a target is the angle between the north-south line and the bearing line, measured in the clockwise direction.

(1) To find the relative bearing of a target, rotate the cursor control until one of the heavy cursor lines is directly over the center of the target. Read the relative bearing of this target on the inner (fixed) azimuth scale.

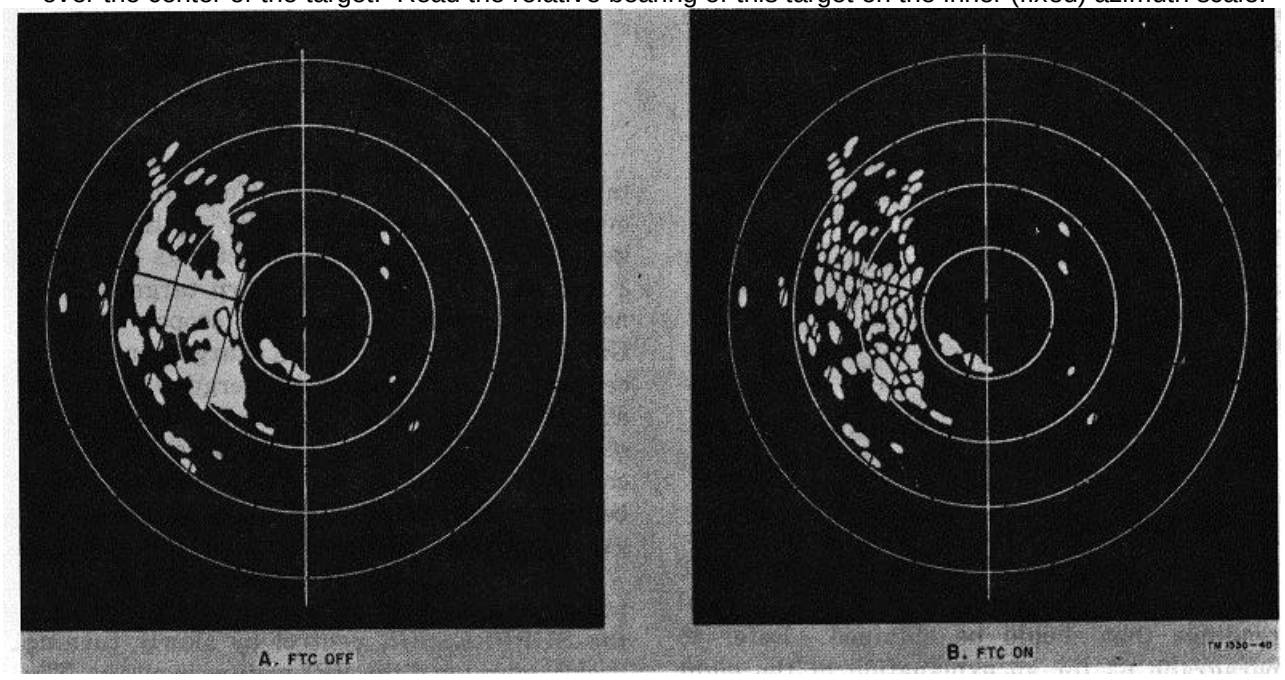


Figure 61. PPI presentation with FTC SWITCH off and ON.

(2) To find the true bearing of a target, set the ship's course on the outer (movable) scale so that it coincides with zero on the inner scale. This can be done by pulling up the true bearing scale control and engaging its internal drive gear to allow manual control of the true bearing scale. Place the cursor exactly over the center of the target and read the true bearing of this target directly on the outer scale.

i. Flange of Targets. The range of a target is the distance between the target and the radar antenna as shown in B. figure 23 and in figure 24. Target range is measured in nautical miles.

(1) *Choice of ranges*. Use the 8- and 20- ranges to search large areas when the vessel is on the open sea. Use the 1-, 2-, and 4-mile ranges whenever greater accuracy is needed to determine the distance between the radar-equipped vessel and nearby vessels. Use the 40-mile range only when long distance targets are required (par. 79). When using the 1-, 2-, and 4-mile ranges, adjust the GAIN and SUPPRESSOR controls to minimize sea return, so that nearby tar gets such as channel markers and buoys stand out clearly on the PPI.

(2) *Measurement of range*. Ranges of targets may be found by using the fixed range rings or the variable range ring. When the RINGS switch is set to the FIXED position, four equally spaced range rings will appear on the PPI scope. The distance between each range ring for the six ranges are as follows:

Range	Distance between range rings
1.....	1/4 mile.
2.....	1 1/2 mile.
4.....	1 mile.
8.....	2 miles
20.....	5 miles.
40.....	10 miles.

Ranges of targets can be estimated by noticing the position of the target in relation to the range rings. Assume the radar set is on the 20-mile range and a target is seen midway between the third (15-mile) and fourth ((20-) range rings. The range of this target is 17.5 miles. On the lower ranges (1, 2, and 4 miles) more accurate ranges are required, and the vari-

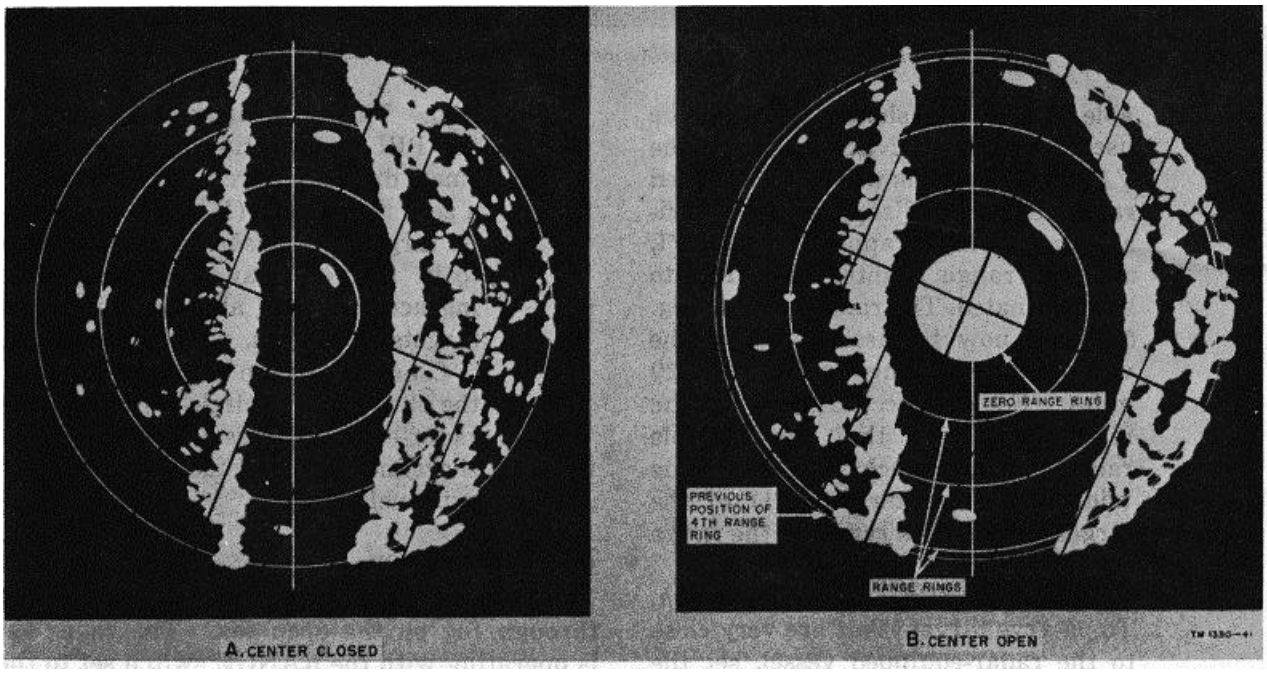


Figure 62. PPI presentation on 1-mile range with center closed and open.

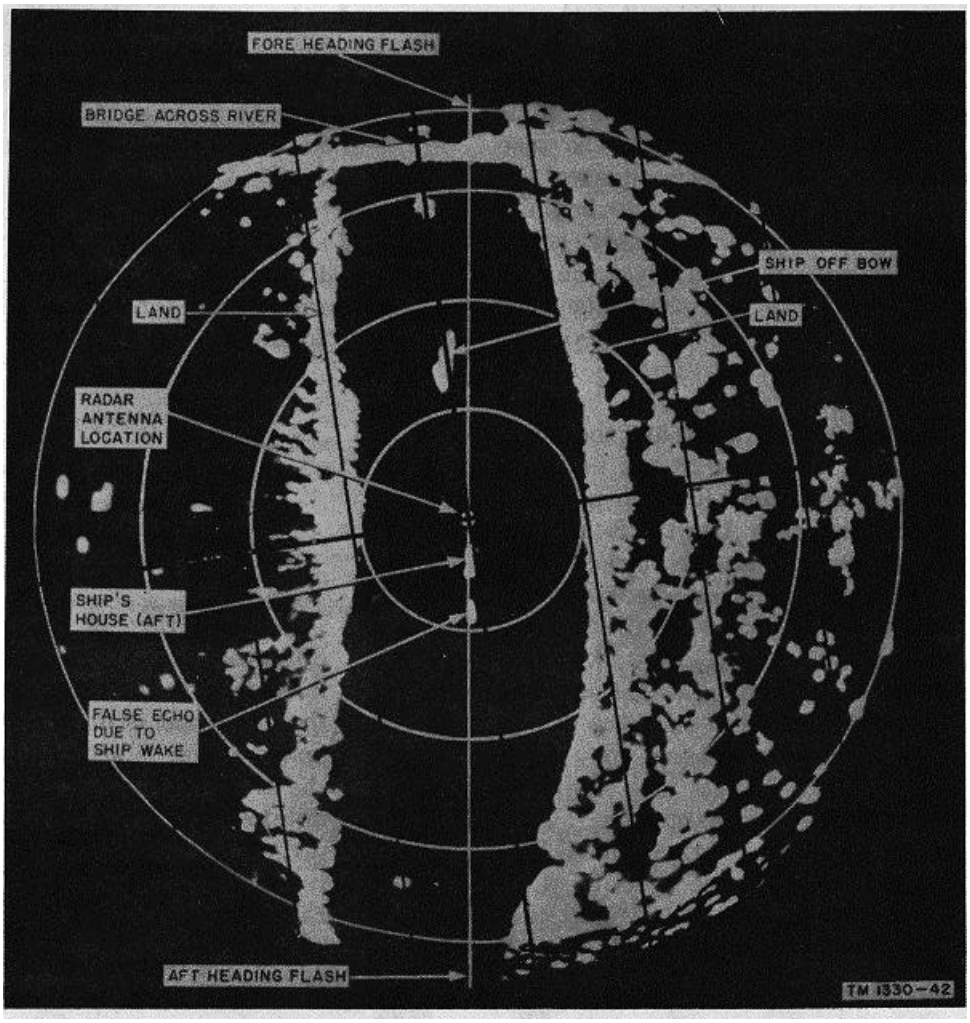


Figure 63. PPI presentation on 2-mile range ship in river.

able range ring should therefore be used. Set the RINGS switch to the VAR position. This will cause the fixed range rings to disappear, the variable range ring to appear on the PPI, and the range counter (fig. 10) to be illuminated. The range control (fig. 58) can now be used to move the variable range ring from .5 to 20 miles. For best accuracy, adjust the range control so that the variable range ring just touches the inner side (side nearest center of PPI) of the target and read its range on the range counter.

(3) *CENTER OPEN-CLOSED switch*. To observe targets that are very close to the radar-equipped vessel, set the CENTER switch to the OPEN position. This will cause the center of the PPI presentation to expand to a small diameter circle which becomes a zero range ring (B. fig. 62). Nearby targets are pushed out and appear to be farther away, improving bearing accuracy and allowing very close targets to be seen.

Caution: When using open center, the entire bright circle represents the radar-equipped vessel; any targets or shorelines just outside this circle are extremely close.

72. Anticollision

a. Assume that your vessel is proceeding through fog on the open sea. The radar set is operating with the RANGE switch set to the 20-mile range and the RINGS control has been

set at FIXED to show the 5-, 10-, 15-, and 20 mile range rings on the PPI scope. Now assume that a target appears to the left of the fore-heading flash and between the second (10-mile) and third (15-mile) range rings. With the cursor over this target, 340° is read on the fixed azimuth scale. The radar set indicates that there is a ship 20° off the port bow and about 12.5 miles distant.

b. To determine whether a meeting, crossing, or overtaking situation exists, keep the target echo under observation and frequently check its bearing and range. If the target moves toward the center of the PPI scope and if the bearing does not change appreciably, a collision course is indicated. Therefore, the range and bearing of the target should be checked continually and plottings of its course and speed should be made frequently (par. 77) to determine the need for an avoiding action.

Caution: Never assume that the other vessel is radar equipped.

73. Piloting

a. If your ship is entering a harbor or channel, set the RANGE switch to 4 MILES and examine the scope for targets caused by known lightships, buoys, or prominent land projections. Adjust the GAIN and SUPPRESSOR controls for best target brightness; be careful not to advance the SUPPRESSOR control sufficiently to blank out nearby targets.

b. As the vessel nears the channel buoys, set the RANGE switch to the 1-mile position. If the heading flash falls on a forward buoy, this buoy may be used as a ranging marker. Check for other ships in the channel and observe on the scope their course and speed.

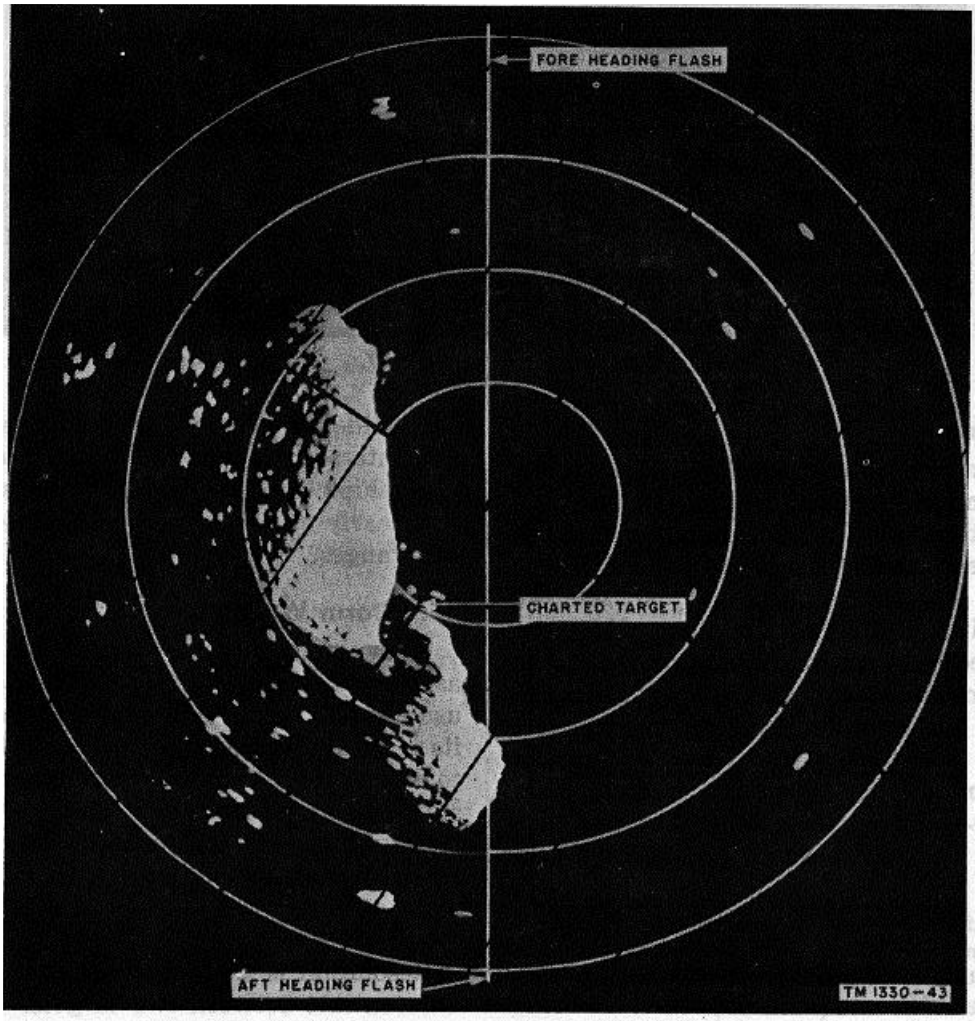


Figure 64. Positioning on a charted target, 8 -mile range.

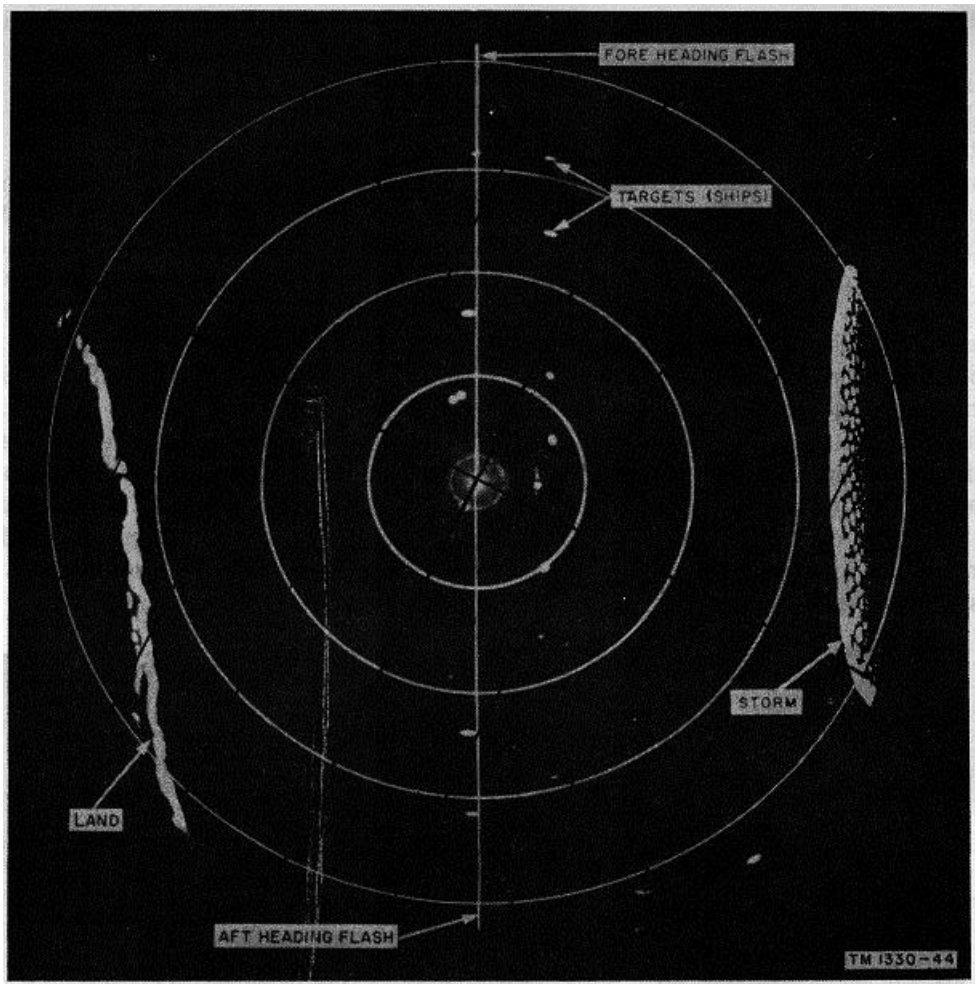


Figure 65. PPI presentation of storm on 20-mile range.

74. Positioning

a. Assume that your vessel is within radar range of an object whose position is shown on charts. Adjust the RANGE switch so that the target appears near the edge of the PPI scope (for good bearing accuracy), and set the RINGS switch to the VAR position. Move the cursor directly over this object and read the true bearing on the outer (movable) scale. Adjust the range control so that the variable range ring just touches the inner side of the object and read the range on the counter. This gives a one-point fix, since range and bearings are known, and your position can be plotted on the chart.
Note. In order to read true bearing directly, the course of the ship must be set on the outer (movable) scale coincident with zero on the inner (fixed) scale.

b. To check the one-point fix, take true bearings and ranges on two or more targets which can be identified on the scope. These bearings will intersect to show the position of the ship. Lightships or other charted targets that stand out clearly on the scope give the best bearings and ranges.

75. Storm Warning

Heavy rainfall usually shows up on the PPI as a bright mass. If a squall is detected early, usually on the 20- or 40-mile range (fig. 65), its general area and movement may be observed to determine if your ship will pass through the storm path. Also locate other ships in the vicinity, so that appropriate action may be taken if visibility becomes poor.

76. Resolution

Resolution is the ability of the radar set to differentiate between two targets. When targets come within certain minimum distances

of one another, their echoes tend to merge and appear as one echo on the PPI scope.

a. Bearing Resolution. The ability of a radar set to separate two closely spaced targets at the same range is a function of the horizontal width of the transmitted beam. The horizontal width of the beam of Radar Set AN/SPN-18 is 1.9° at half-power points. For purposes of discussion, assume that the beam width is 2° and refer to figure 66 which shows two targets at the same range with different spacings (bearings).

(1) Point A shows two targets, 150 yards apart and 1 mile from the vessel. At a distance of 1 mile, the span of a 2-degree beam is approximately 70 yards. Since the two targets are separated by more than the width of the beam, the target echoes appear as separate echoes on the PPI.

(2) Point B shows two targets, 150 yards apart and 2 miles from the vessel. At a distance of 2 miles, the span of a 2-degree beam is 140 yards. Since the separation of the targets is almost equal to the width of the beam, the target echoes almost touch one another on the PPI.

(3) Point C shows two targets, 150 yards apart and 3 miles from the vessel. At a distance of 3 miles, the span of a 2-degree beam is about 210 yards. Since the span of the beam is greater than the separation between the targets, the target echoes merge into a single echo on the PPI.

(4) Examination of figure 66 shows that as the range increases, the bearing resolution decreases. The following table gives the approximate span of a 2-degree beam at various ranges from the radar-equipped vessel:

Range (nautical miles)	0.5	1	2	3	4	5	10	20	40
Span (yards)	35	70	140	210	280	350	700	1,400	2,800

b. Range Resolution. At relatively short ranges, the ability of a radar set to separate two targets on the same bearing depends on the pulse length of the radar transmitter; on longer ranges, the range resolution is a function of the size of the spot produced on the **P**PI by the scope beam.

(1) *Short range.* In Radar Set AN/SPN18(*), the transmitted pulse is .25 microsecond in length on the 1-, 2-, and 4-mile ranges. During this period of time, the beam travels 41 yards (round trip). Theoretically, a target separation of only 20.5 yards, one-half of 41 yards, will provide adequate range resolution. However, the shadowing of one target by another also must be considered, and a 55-yard separation of targets will just provide range resolution on the 1-mile range. Refer to figure 67, which shows two targets on the same bearing with different spacings (ranges) between them.

(a) Point A shows two targets, 125 yards apart; separate echoes appear on the PPI since the target spacing exceeds 55 yards.

(b) Point B shows two targets, 55 yards apart; the echoes just touch one another on the PPI since the target spacing is exactly 55 yards.

(c) Point C shows two targets, 30 yards apart; the echoes merge into one echo on the PPI since the target spacing is less than 55 yards.

(2) Long range. On the long ranges (8, 20, and 40 miles), the range resolution is approximately 300 yards. This resolution is a function of the spot size on the PPI scope; the smaller the spot, the better the resolution.

77. Radar Plotting

When the radar set is used for anticollision, frequent plottings of the course and speed of the target should be made, and the target's crossing point and time should be determined to see if there is need for taking avoiding action. The plot should be made on the plotter (*a* below) or, if the plotter is not used, on a plotting sheet (*b* below).

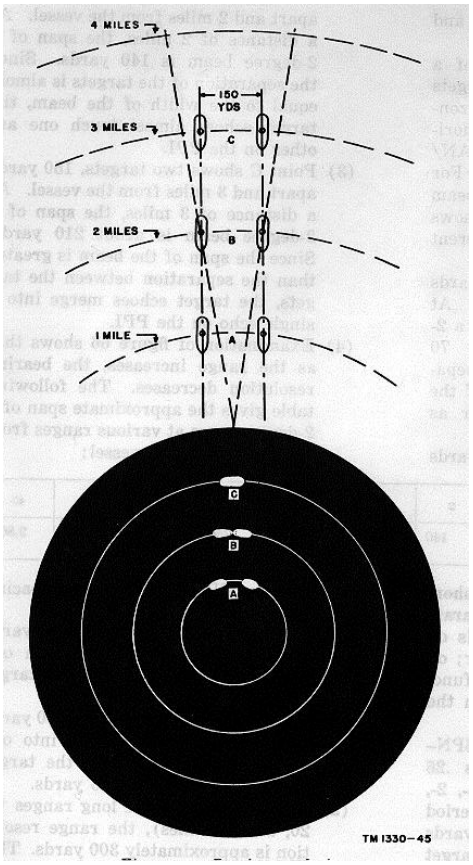


Figure 66. Bearing resolution.

a. Using Plotter. When using the plotter to make a continuous plot of a target, proceed as follows:

(1) Loosen the knurled thumbscrew on the side of the plotter. Rotate the top of the plotter until the index line on the glass writing surface lines up with zero on the fixed azimuth scale.

(2) Adjust the plotter illumination control (fig. 58) for the desired brightness of the plotter lamps.

Note. When the glass writing surface is edge-lit, small bubbles will appear in the glass. These bubbles can be distinguished from target returns because they are smaller, rounder, and of a different color.

(3) If the viewing hood is being used, rotate it so that the arm hole is conveniently located for making marks on the glass writing surface.

(4) Touch the point of the wax pencil to the glass writing surface and note where the red reflection appears on the scope face. Move the pencil so that the reflection is superimposed on the target.

(5) Mark the position of the target with the wax pencil.

(6) Periodically repeat the procedure in

(4) and (5) above. The series of reflected marks indicates the relative course of the target. The actual course of the target must be determined as illustrated in (11) below.

(7) If two targets are to be plotted at the same time, mark one series of marks TARGET A and the second series of marks TARGET B.

(8) If your own ship's course changes while a target is being tracked on the plotter, loosen the knurled thumbscrew at the side of the plotter and rotate the plotter so that the index line on the glass writing surface is shifted an equal number of degrees in the opposite direction of the change in course. For example, if your vessel was moving on true north and the course was changed 450 to north by northeast, the plotter must be rotated 45° counterclockwise to 315° as read on the fixed azimuth scale. The plot of the target may now be continued without erasing any previous marks.

(9) When it is desired to view the scope presentation without the wax pencil marks on the plotter, and where time does not permit erasing the plot, reduce the brightness of the plotter by turning the illumination control (fig. 58) fully counterclockwise.

(10) When *erasing* an old plot, use a soft *clean* cloth, such as cheesecloth.

Caution: Do not use a dirt-em-

bedded cloth because it will scratch the glass writing surface. If cleaning fluids are used, apply the fluid to the cloth and not to the glass writing surface.

(11) The following examples illustrate how to obtain information quickly when using the plotter. All distances in the following examples are measured in nautical miles.

(a) Assume your vessel is moving at a speed of 12 knots and the radar range in use is 8 miles. In figure 68, points A, B, and C represent plots of a target made at intervals of 5 minutes. To determine the crossing point and time, proceed as follows:

1. Draw a line from the first plot (point *A)* in a direction opposite to your own ship's course (parallel to the heading flash). Make the length of this line equal to the distance your vessel traveled during the time it took to plot points *A, B,* and *C.* In this example, line *AX* represents the distance your vessel traveled in 10 minutes. This distance is 2 miles:

$$10 \text{ min} \times \frac{1 \text{hr}}{60 \text{ min}} \times \frac{12 \text{ mi}}{\text{hr}} = 2 \text{ mi.}$$

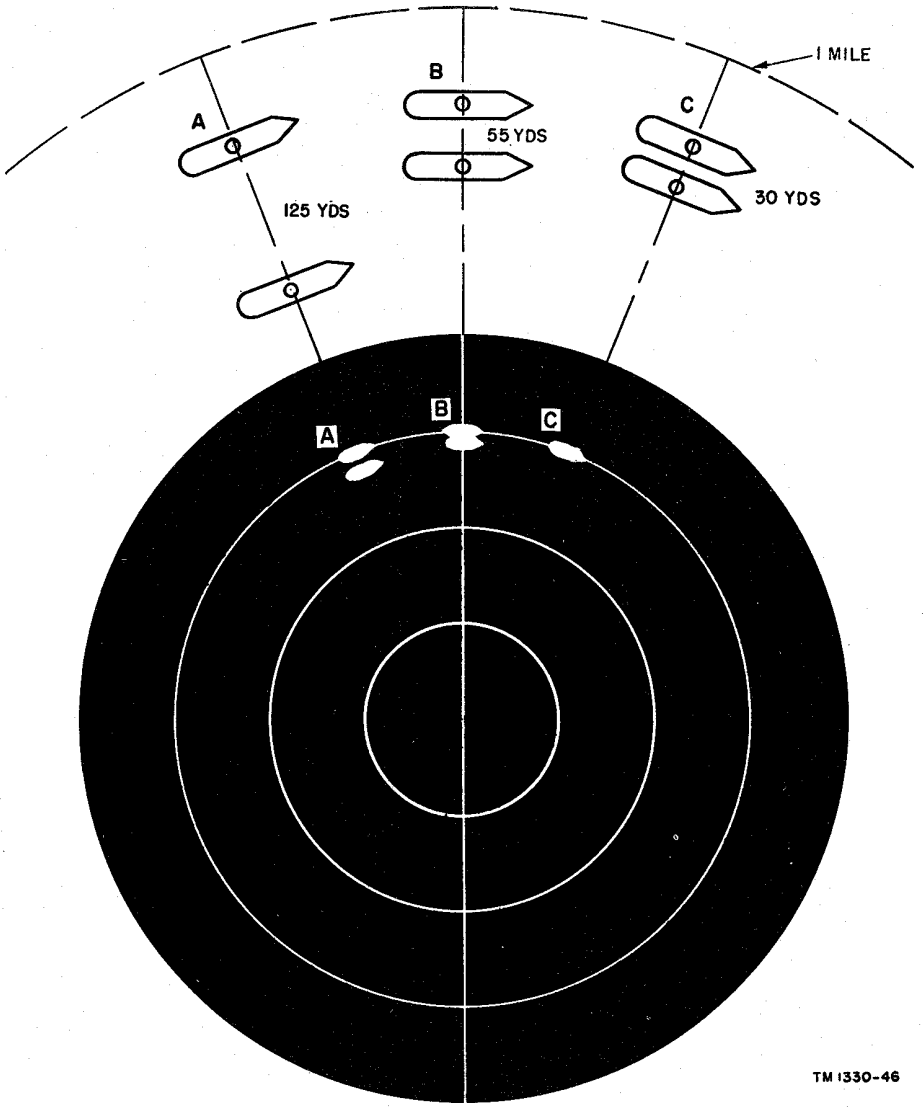


Figure 67. Range resolution.

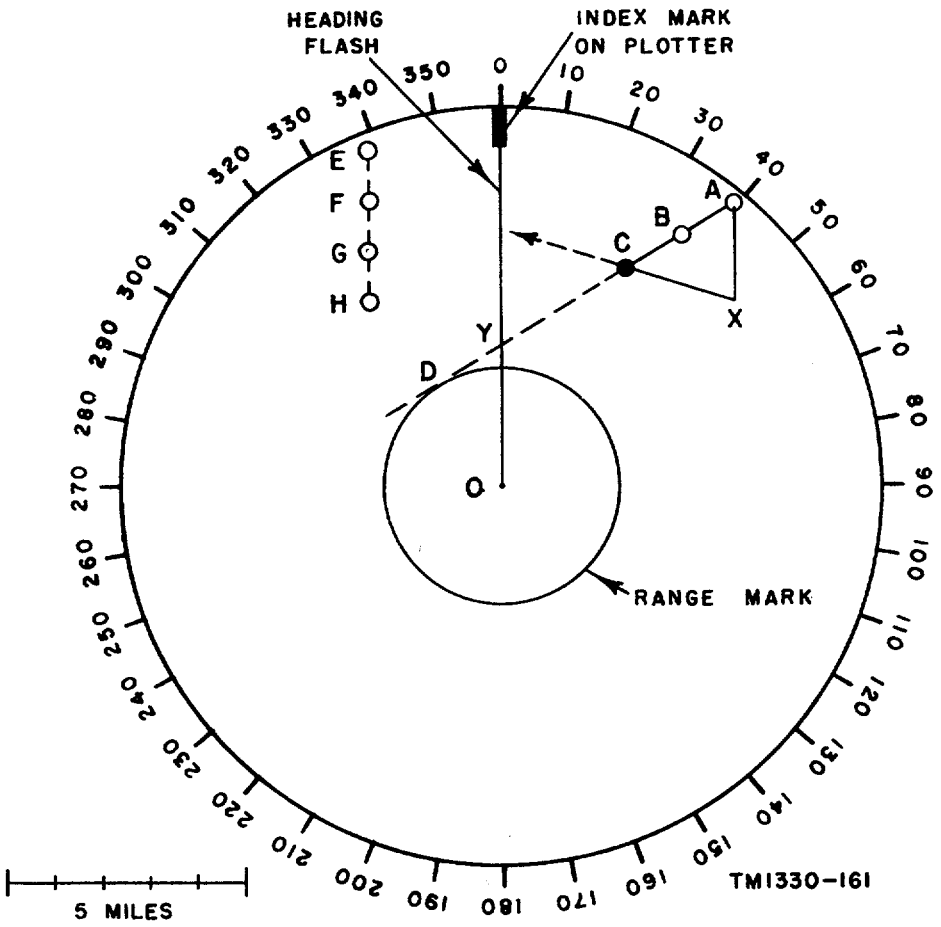


Figure 68. Radar plotting 1.

2. Draw a line through point X and the last plot (point C). Line *XC* indicates the actual course of the target, approximately 287°. Line *A*C represents the relative distance traveled in 10 minutes, approximately 2.25 miles. Therefore, the relative speed is 13.5 knots:

$$\frac{225 \text{ min}}{10 \text{ min}} \times \frac{60 \text{ mi}}{1 \text{hr}} = 13.5 \text{ knots.}$$

3. Extend line *AC* (relative course of target) and determine the distance *OY.* Crossing will occur approximately 3 miles ahead at point Y. The target must travel the distance *CY* (approximately 2.7 miles) before crossing will occur at point Y. The relative speed (2 above) is 13.5 knots. Therefore, it will take 12 minutes for the target to reach point Y:

$$\frac{2.7 \text{ min}}{13.5 \text{ mph}} \times \frac{60 \text{ min}}{1 \text{hr}} = 12 \text{min.}$$

4. Extend line *CY* to determine the point of closest approach, point *D*. This is approximately 2.5 miles.

(b) Assume your vessel is moving at a speed of 12 knots and an object off the port bow on a parallel course is plotted at 5-minute intervals (points *E, F, G,* and *H,* fig. 68). Measure the distance between the first plot (point E) and the last plot (point *H).* In the example, the distance is 3 miles, and the time is 15 minutes. Therefore, the relative speed of the object is 12 knots:

$$\frac{3 \text{ mi}}{15 \text{ min}} \times \frac{60 \text{ min}}{1 \text{hr}} = 12 \text{ knots.}$$

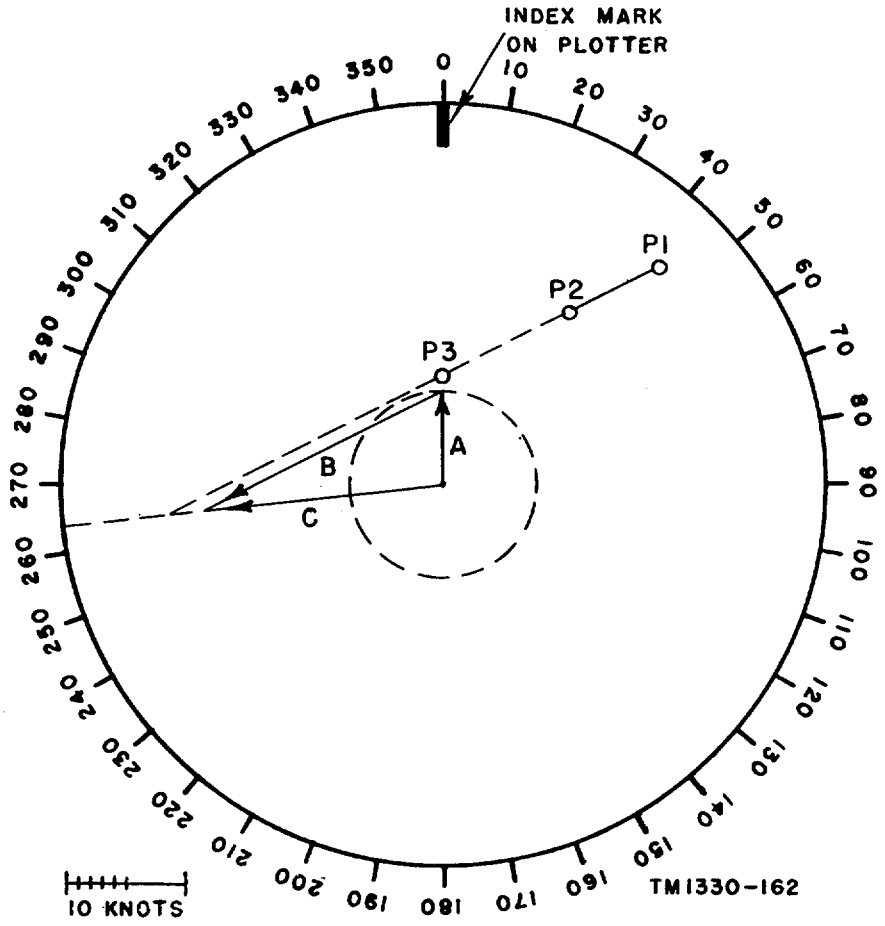


Figure 69. Radar plotting 2.

Since your own ship's speed is 12 knots, the object must be anchored.

(c) When more accurate information is desired, plotting may be done on a larger scale. Assume your own ship's speed is 8 knots and the radar range in use is 8 miles. A target off the starboard bow is plotted at 6.5 miles and 45° (point P_1, fig. 69). Another plot is made 6 minutes later, and the target is at 4.5 miles and 37° (point P_2). To determine the target's course, speed, crossing point and time, and point of closest approach, proceed as follows:

1. Using a calibrated scale, determine the distance in miles between plots P_1 and P_2. In this example, the distance is approximately 2.25 miles. Therefore, the relative speed of the target is 22.5 knots:

$$\frac{2.25 \text{ mi}}{6 \text{ min}} \times \frac{60 \text{ min}}{1 \text{hr}} = 22.5 \text{ knots.}$$

2. Using a convenient scale (in this example, 1/16 inch= 1 knot), draw a vertical line *A* from the center of the scope to represent your own ship's speed of 8 knots.

3. From the end of line *A,* draw line B parallel to the target's plotted course to represent the target's relative speed of 22.5 knots.

4. Close the triangle by drawing line *C*. The direction of line *C* represents the target's relative course of 264°. The length of line C represents the target's speed. Since line C is 14/16 inches long, the speed is 20 knots.

5. Extend the line through points

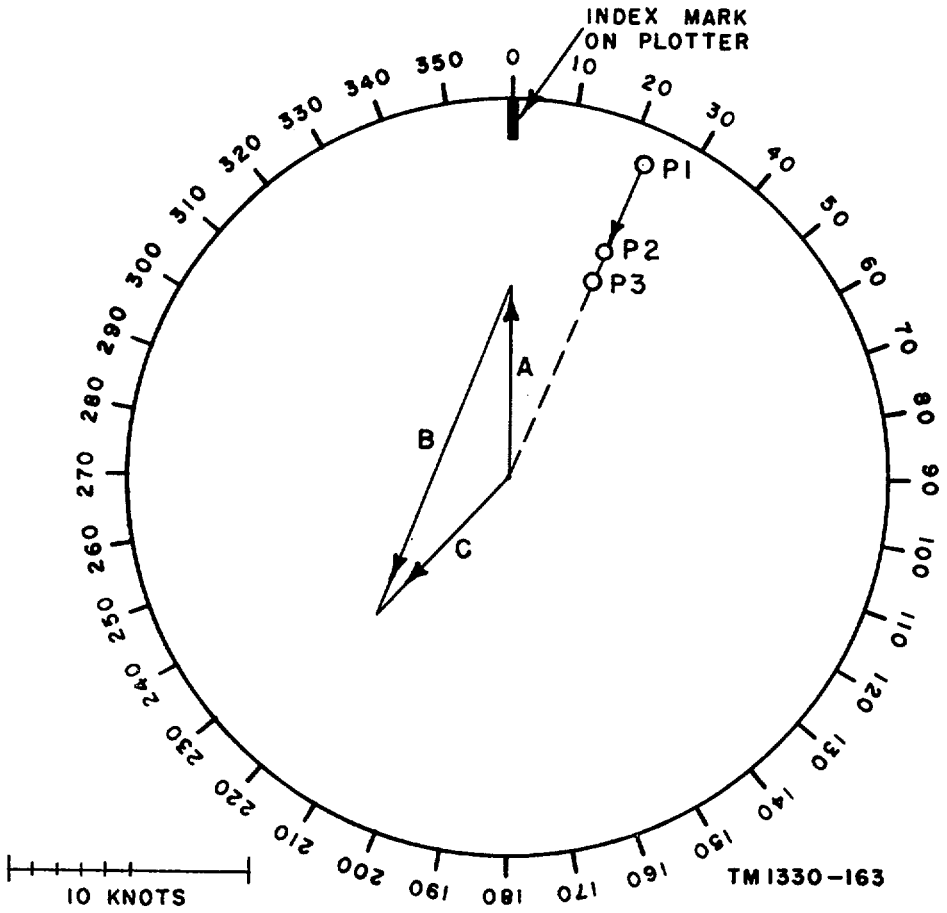


Figure 70. Radar plotting 3.

P_1 and P_2 to determine the crossing point, P_3. The target will cross 2.25 miles ahead.

6. Measure the distance between points P2 and P3 (3 miles) and, using the target's relative speed (3 above), determine the crossing time as 8 minutes:

$$\frac{3 \text{ mi}}{22.5 \text{ min}} \times 60 \text{ min} = \text{min}..$$

7. The point of closest approach is the radius of the dotted circle, which is 2 miles.

(d) When a target is on a collision course, and you are the burdened vessel, the plotter may be rotated as your vessel changes course to allow continuous plotting of the target. Assume your own ship's speed is 8 knots and the radar range in use is 8 miles. A target off the starboard bow is plotted at 7.25 miles and 22° (point P_1, fig. 70). Another plot is made 8 minutes later, and the target is at 5.25 miles with the same relative bearing of 22° (point P_2). To determine the target's course, speed, time of pending collision, new course, passing distance, and time of passing, proceed as follows:

1. The relative speed of the target is 15 knots:

$$\frac{2 \text{ mi}}{8 \text{ min}} \times \frac{60 \text{ min}}{1 \text{hr}} = 15 \text{ knots.}$$

2. If no action is taken, collision may occur in 21 minutes:

$$\frac{5.25 \text{ mi}}{15 \text{ mi}} \times 60 \text{ min} = 21 \text{ min.}$$

3. Using a convenient scale (in this example, 1/8 inch = 1 knot), draw a vertical line *A* to represent your own ship's speed of 8 knots.

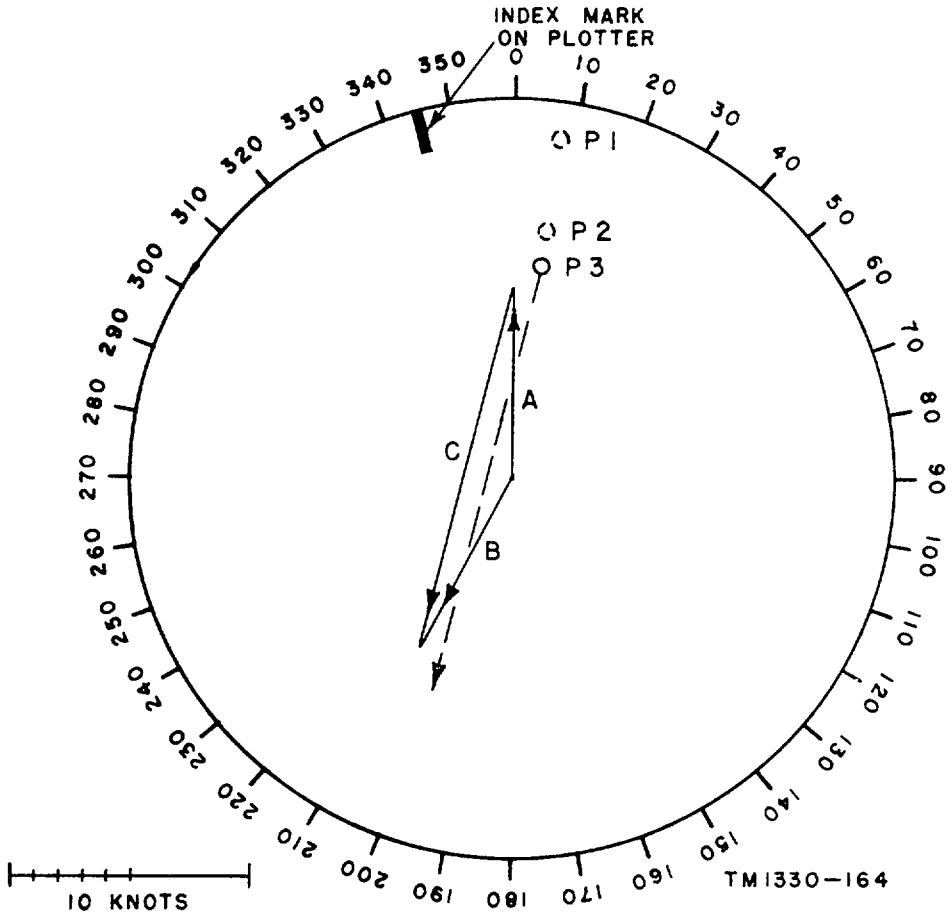


Figure 71. Radar plotting 4.

4. From the end of line *A,* draw line *B* parallel to the target's plotted course to represent the target's relative speed of 15 knots.
5. Close the triangle by drawing line *C.* The direction of line C represents the target's relative course of 222°. The length of line *C* represents the target's speed of 8 knots.
6. Before changing course, mark a new point P_3 on the plotter, representing the latest position of the approaching vessel. Do not erase the former plotting points.
7. Assume that you choose to go to starboard 15°. Loosen the knurled thumbscrew at the side of the plotter and rotate the plotter 15°, in the *opposite direction*, *to port.* At the same time, change course 15° to starboard. The plotted points P_1, P_2, and P_3 will now appear as shown in figure 71.
8. The previous relative bearing of the target was 222°, now it is $2^{07°:}$ 222 -- 15° = 207°.
9. Using the same scale as before (1/8 inch=- 1 knot), lay off your own course and speed (line *A).*
10. Lay off line B in the direction of the target's new course, 207° and speed, 8 knots (1 inch).
11. Close the triangle with line *C*. If the target continues on course at the same speed, further plots should appear on a line parallel to line *C* through point P_3. Previous plots P_1, and P_2 are of no further value. Because it is possible to rotate the plotter, the last plot (point P_3) made before chang-

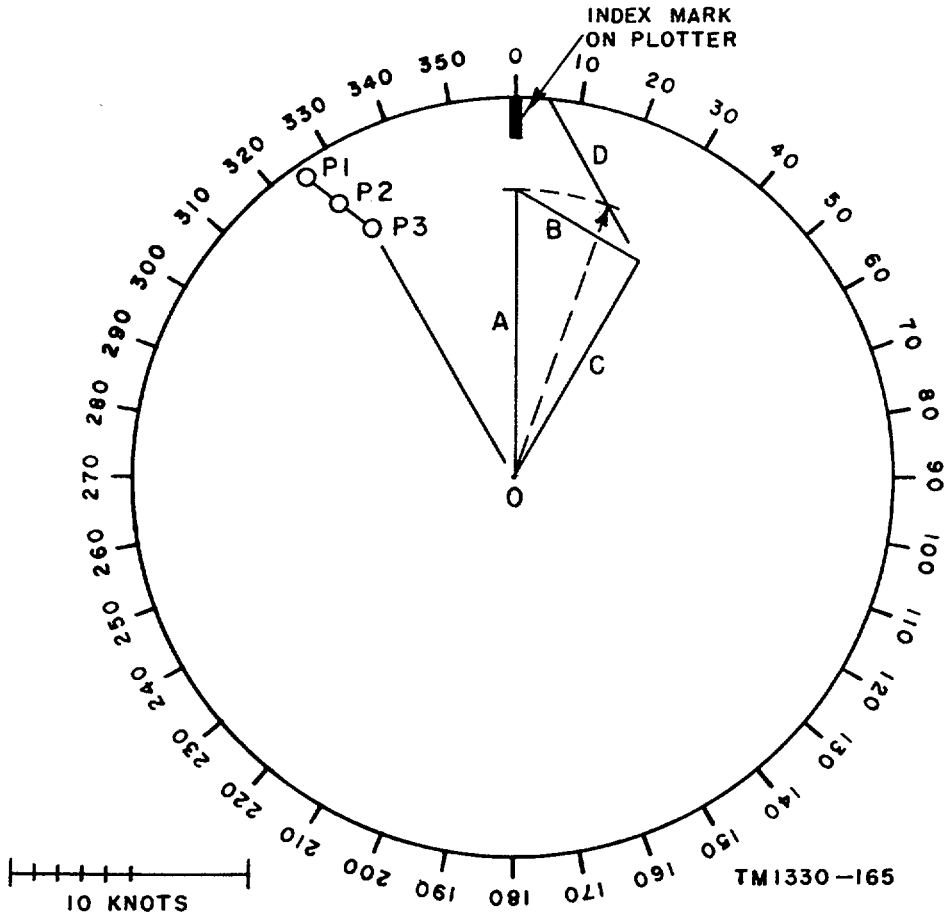


Figure 72. Radar plotting 5.

ing course is saved for further reference.

12. If neither vessel makes any further change in course or speed, the target will pass your vessel about one-half mile on the port side. Since the distance from the last plot (point P_3) to the point of closest approach is 4.5 miles, and the target's relative speed is approximately 16 knots (length of line *C*), the target vessel will pass your own ship in about 17 minutes:

$$\frac{4.5 \text{ mi}}{15.5 \text{ mi}} \times 60 \text{ min} = 17.4 \text{ min.}$$

(e) Figure 72 shows a plot used for determining your ship's course and time when intercepting another vessel. Assume your vessel is moving at a speed of 12 knots and the radar range in use is 8 miles. Points P_1, P_2, and P_3 represent plots of the vessel to be intercepted, made at intervals of 10 minutes. Proceed as follows:

1. The target traveled 2 miles in 20 minutes, and its relative speed therefore is 6 knots:

$$\frac{2 \text{ mi}}{20 \text{ min}} \times \frac{60 \text{ min}}{1 \text{hr}} = 6 \text{ knots.}$$

2. Using a convenient scale, draw a vertical line *A* to represent your own speed of 12 knots.

3. From the end of line *A,* draw line *B* parallel to the target's plotted course, to represent the target's relative speed of 6 knots.

4. Close the triangle by drawing line C. Line *C* represents relative course and speed of target, 30° and 10.5 knots.

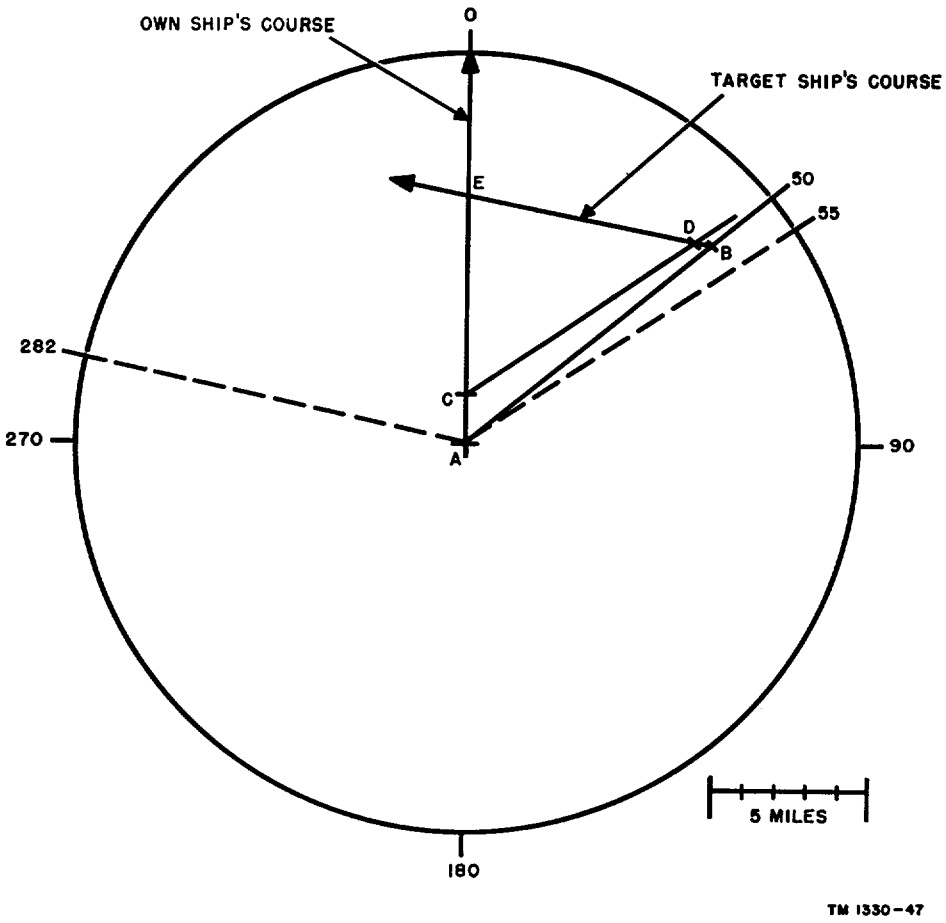


Figure 73. Typical radar plot without plotter.

5. Draw a line from the last plot (point P_3) to the center of the scope. This represents the new collision course.
6. At the end of line *C,* draw line *D* parallel to the new collision course (*5* above).
7. Draw an arc with a radius equal to line *A,* and intersect line *D*. The dotted line from the center of the scope to this intersection on line *D* represents the course your vessel must follow to intercept the target. This new course is 20° to starboard.
8. Before changing course, mark the latest position of the target.
9. Change course to starboard 20°, and rotate the plotter 20° to port.
10. Determine the new relative speed and the distance to the target. In this example, the new relative speed is about 3 knots and the distance to the target is 6 miles. Therefore, the interception time will be 2 hours:

$$6 \text{ mi} \div \frac{3 \text{ mi} = 2}{\text{hr}} \text{ hr.}$$

b. Without Plotter. Assume your vessel is moving on a true north course at a speed of 15 knots, and a target is picked up at a true bearing of 50° and a range of 10 miles. Refer to figure 73 for a radar plot of this target.
(1) Draw a line from the center of the plotting sheet (point *A*) to 0° indicating your true north course.
(2) Draw a line at a true bearing of 50° (line *AB*) from point *A* (bearing line of target).
(3) With the target range at 10 miles, locate point *B* by measuring 10 miles along line *AB.* This will give the location of the target at the moment the range and bearing was taken.

(4) Six minutes later find the bearing and range of the target. Assume that the target is now at a true bearing of 55° and at distance of 8.8 miles.
(5) Your vessel is moving at a speed of 15 knots or 1 mile every 4 minutes. Therefore your vessel has moved ahead 1.5 miles in 6 minutes. Plot your ship's new position at 1.5 miles along your own ship's course (point *C*).
(6) With the target true bearing now at 55° draw a line with this true bearing (line *CD)* through your ship's new position (point C).
(7) With the target range now 8.8 miles, locate point *D* by measuring 8.8 miles along line *CD.* This will give the new location of the target.
(8) Draw a line joining the two positions of the target and extend it until it crosses your own ship's course (line *BE).*
(9) Draw a line parallel to line *BE* through point *A* and read the target's course (282°) on the compass rose.
(10) Measure the distance between points *B* and *D.* During the 6 minutes between plots, the target moved .5 mile. Therefore, the target speed is 5 knots.
(11) Point *E,* where the ships' courses cross, is 6.5 miles from point *C,* your vessel's position at the last plot. If both vessels maintain their courses and speeds, your vessel will arrive at point *E* in 32 minutes after the initial plot, while it will take the other vessel 1 hour and 36 minutes to reach point *E*. Therefore, there is no immediate danger of collision.
(12) After determining the target's course, speed, and crossing point and time, continue to make plottings of the target's course and speed. In the example given above, if the target's speed is increased to 17 knots immediately after the second plot, there is a risk of collision. Unless a continuing plot is made, any change in the situation will not be detected.

78. Interference

a. Interference caused by another shipborne radar shows on the PPI as a series of spiral lines starting or ending at the center of the scope (fig. 74). The effect of this type of interference depends on the range, nearness, and type of shipborne radar. If practical, switching to a lower range will tend to clear the PPI scope and targets can be observed.

b. Sea effect is the reflection of the radar beam by heavy seas. It tends to obscure nearby targets. Targets can be brought into focus through sea effect by turning up the SUPPRESSOR control.

c. When observing a target that returns a weak echo, bring the target into view by adjusting the GAIN and SUPPRESSOR controls and readjusting the FOCUS control.

79. Long Distance Targets

a. The ability of the radar to pick up targets on the 20- and 40-mile ranges depends largely on the height and size of the target and the height of the radar antenna on the ship. As a general rule and with average atmospheric conditions, the maximum range is *line-of-sight.* Accordingly, if the target is below the horizon, or if it is a small vessel or buoy in the trough of the sea, it will not be picked up by the radar. If the radar antenna is 40 feet above water, the line-of-sight distance to the horizon is 7.2 nautical miles. If the distant target is 80 feet high, its line-of-sight distance to the horizon is 10.3 nautical miles. The maximum range at which this target can be observed is, therefore, about 7.2 + 10.3 or 17.5 nautical miles. Line-of-sight distances are given in appropriate tables found on board ship.

b. Under certain atmospheric conditions, the radar beam is bent. This bending is said to be caused by duct or superpropagation effects. When this duct effect occurs, the radar beam and the returning echo can be quite strong over range distances considerably greater than normal. This effect is encountered in the trade wind belt or when warm, dry air from land passes out over the sea. Do not consider the radar to be at fault if these long-range echoes cannot be duplicated. Conversely, other atmospheric conditions may reduce the maximum range. This phenomenon is seldom noticed beyond about 8 miles.

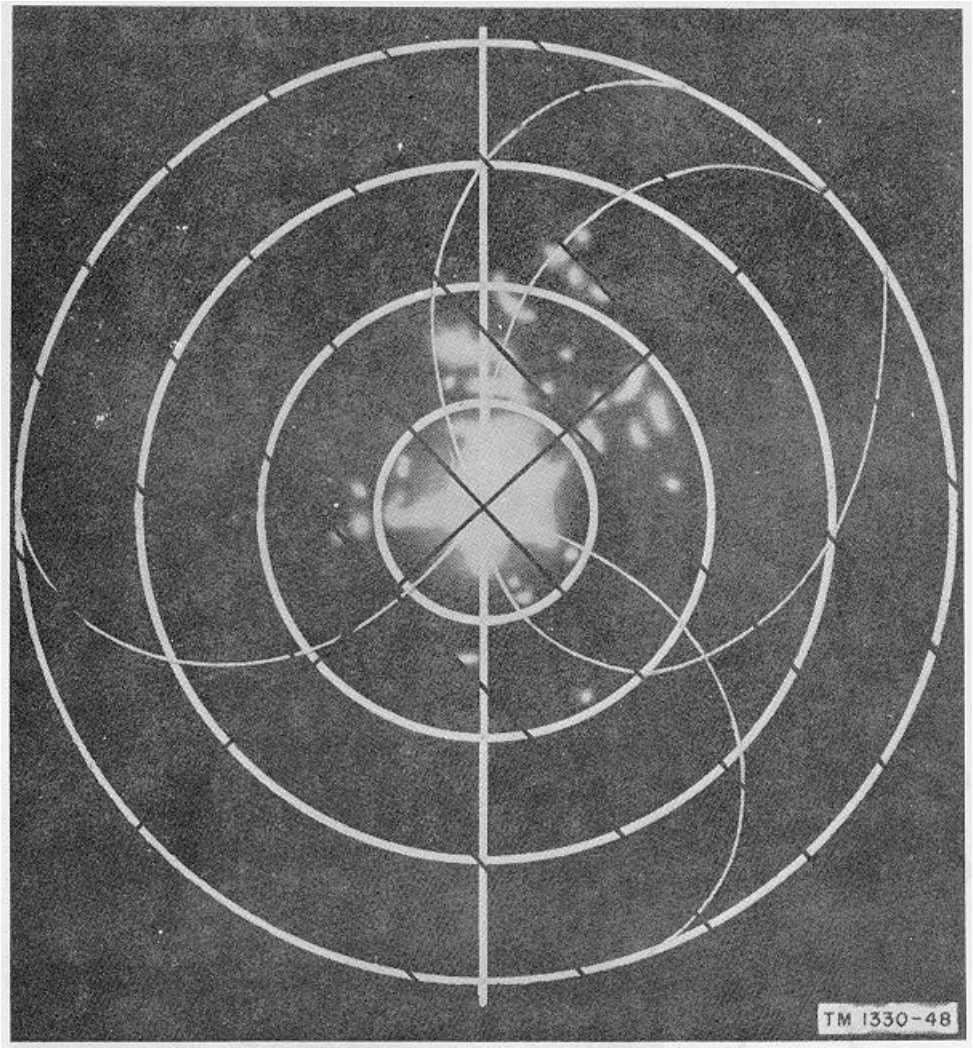


Figure 74. Typical radar interference on 20-mile range.

c. When superpropagation does not exist, the target echoes show correct ranges. With super propagation, the pulses travel out much farther; therefore, targets may be seen which are correct in bearing, but *incorrect* in range. With Radar Set AN/SPN-18(*), this effect can occur only with targets beyond certain distances. These distances change with the pulse repetition rate of the radar set, which is 2,000 pps on the 1-, 2-, and 4-mile ranges and 800 pps on the 8-, 20- and 40-mile ranges.

(1) With the radar set on the 1-, 2-, or 4-mile range, the targets must be more than approximately 41 miles distant to undergo superpropagation. For example, a target at 42 miles will appear at 1 mile on the 1-, 2-, or 4-mile range. A target at 45 miles will appear at 4 miles on these lower ranges. Therefore, the distant target must be not less than 41 or more than 45 miles to appear as long-range echoes.

(2) With the radar set on the 8-, 20-, or 40-mile range, the targets must be more than approximately 100 miles to obtain this effect. For example, a target at 105 miles will appear at 5 miles on these three higher ranges. This case is possible but is very rarely seen.

d. These long-range effects may be recognized by noting changes in bearing as your vessel proceeds. The changes will be very small compared to those observed on normal range targets.

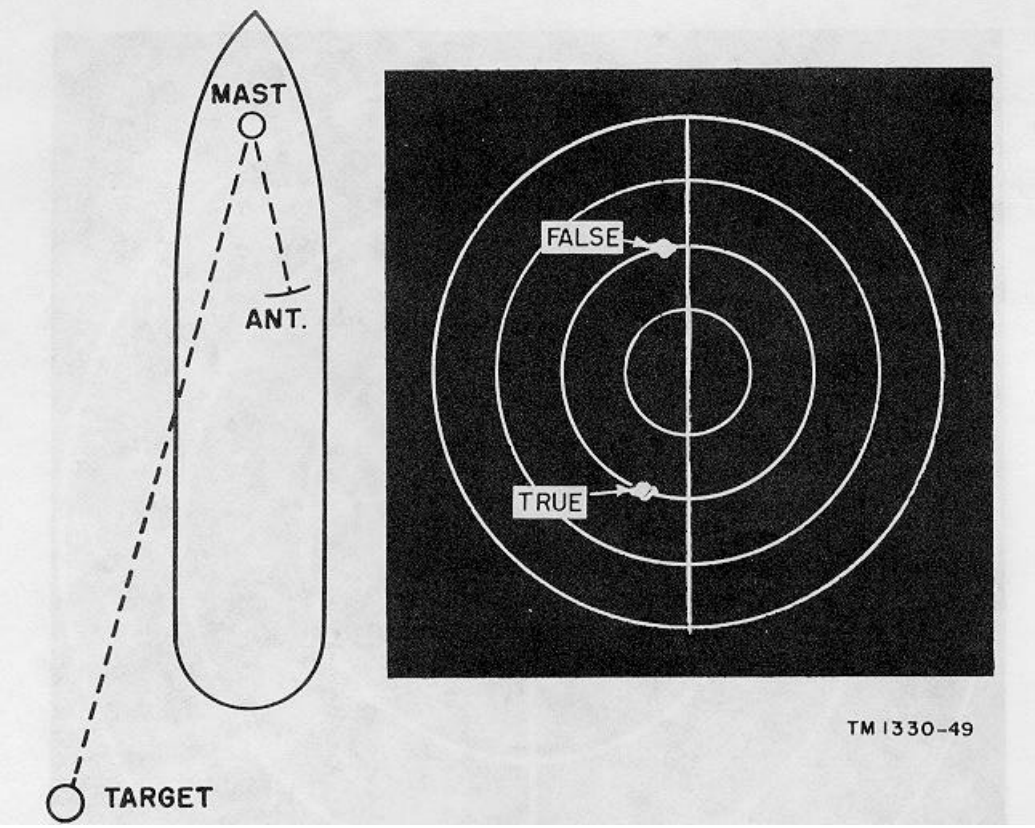


Figure 75. False target in forward position on 20-mile range.

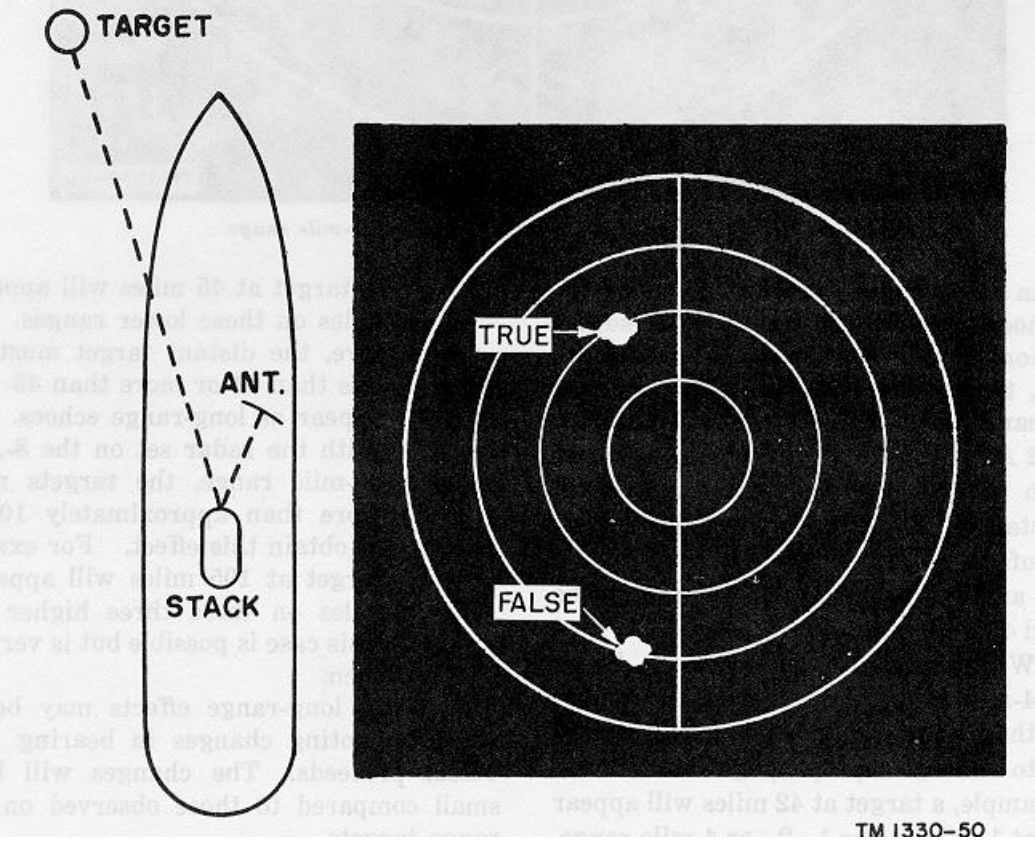


Figure 76. False target in aft position on 1-mile range.

80. False or Displaced Targets

a. Figure 75 illustrates the reflection of the radar beam in an aft direction when the antenna points forward. This causes a target which is astern to appear on the PPI as if it were ahead. A few seconds later, when the antenna does point at the target, its echo will appear at the correct position on the scope. This effect is recognized easily and depends on the structure of the ship, the height of the radar antenna, and the size of nearby targets.

b. Figure 76 illustrates a reflection from the stack aft of the radar antenna. This causes a forward target to appear as if it were astern. A little later when the antenna is pointing at the target, its echo appears at the correct position.

c. Figure 77 illustrates a nearby ship which acts as a very strong reflector. The radar beam bounces back and forth several times, causing additional targets to appear on the same bearing but displaced in range. The correct target is that nearest the ship. This effect also may occur when the vessel is close to a land mass.

81. Stopping procedure

To stop the radar set, set the POWER switch on the indicator to the OFF position. This stops the motor generator, the antenna drive motor, and the blower motor. To remove all power from the radar set, including the antenna heaters and the receiver-transmitter driers, pull down the control lever on the switch box to OFF.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

82. General

The operation of Radar Set AN/SPN-18(*) may be difficult in regions where extreme cold, heat, humidity, and moisture conditions prevail. While every precaution is taken in the design of the equipment to maintain its technical characteristics over a wide temperature and humidity range, adverse conditions may cause very large errors in measurements and target presentations unless additional precautions are taken. Paragraphs 83 and 84 provide procedures that minimize the effects of these unusual climatic conditions.

83. Operation in Arctic Climates

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

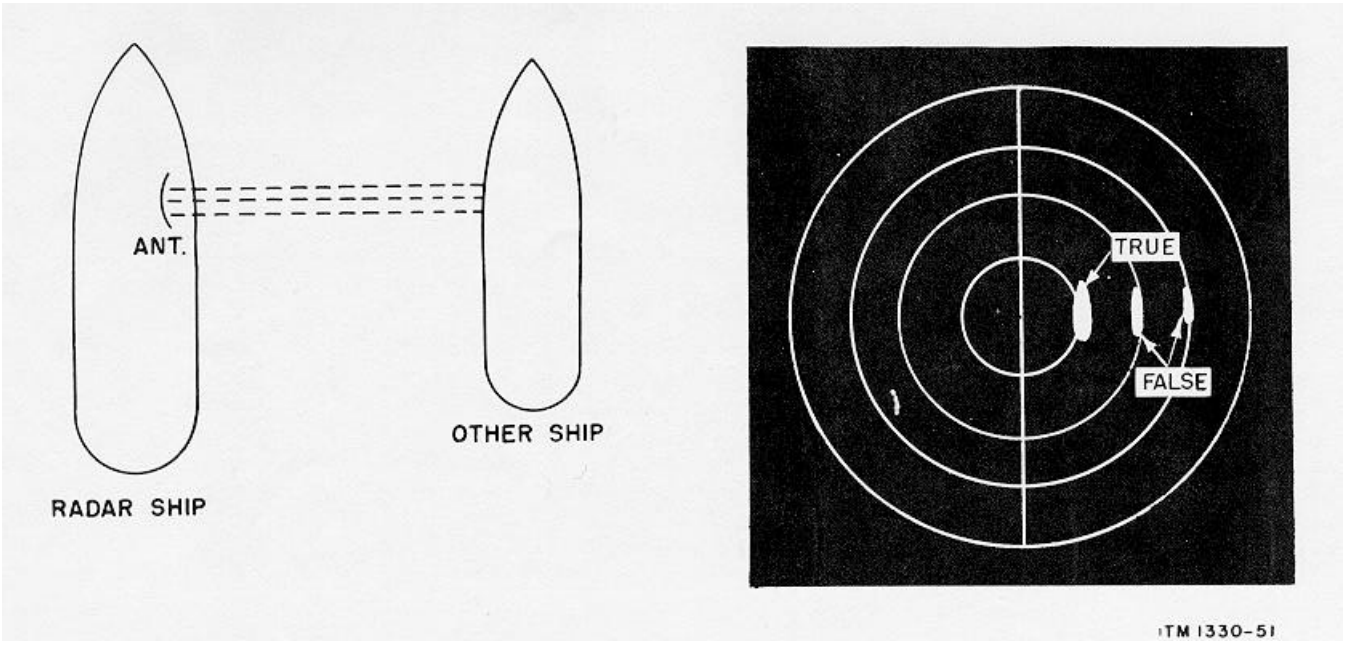


Figure 77. False target in beam position.

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. Keep the antenna heaters turned on.

c. Remove the receiver-transmitter cover only when there is no danger of a cold draft striking the glass tubes. A sudden draft of cold air often is sufficient to shatter the glass envelope of a heated tube. If necessary, place a blanket or other barrier between the source of the draft and the equipment.

d. Heavy coatings of ice and frost will form on the antenna in extremely cold weather. This ice reduces the efficiency of the radar set, and it should be removed carefully. In removing ice from the antenna horn be extremely careful not to damage the horn window.

84. Operation in Tropical Climates

In tropical climates, ventilation usually is very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than that of the surrounding air. To minimize this condition, keep the equipment as dry as possible.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE INSTRUCTION

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

85. General

a. The tools, materials, and tool equipment kit required for maintenance of Radar Set AN/SPN-18(*) are outlined in paragraph 86.

b. The actual allowable organizational maintenance that can be performed is dependent to a large extent on the existing military regulations (standing operating procedure), and the existing tactical situation, and also on the tools and other test equipment issued.

86. Tools and Materials Required for Radar Set AN/SPN-18(*)

Tools and materials required for organizational maintenance of Radar Set AN/SPN-18(*) are listed below. Applicable Signal Corps stock numbers are indicated in parentheses.

Orange stick
Cheesecloth, bleached, lint-free
Carbon tetrachloride
Paper, sand, flint
Solvent, Dry Cleaning (SD) (Fed. Spec No. P-S-661a)
Stone, Electrical Contact Brush Seater (6R29376).

87. Special Tools Supplied with Radar Set AN/SPN-18 *)

a. The following special tools are supplied with each Radar Set AN/SPN-18(*):

(1) Bristol setscrew wrench, size 4 (6RK55232).
(2) Bristol setscrew wrench, size 6 (6R55230).
(3) Bristol setscrew wrench, size 8 (6R55231.1).
(4) Bristol setscrew wrench, size 10 (6RK55230-10).
(5) Spanner wrench (6R57534-1).
(6) Tool (6R38472-1), (klystron and crystal tool).
(7) Funnel (6Z402-5).
(8) Gage (6Q45701.15), (spark gap

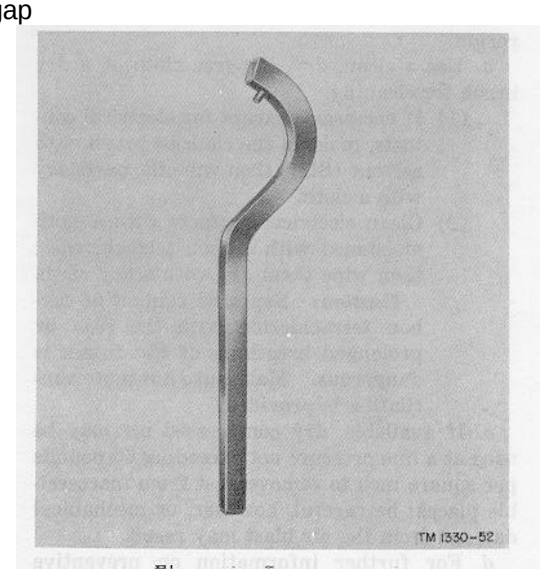


Figure 78. Spanner wrench.

b. The four Bristol setscrew wrenches are used to loosen or tighten parts of the radar set where internal spline setscrews are used. These wrenches are located on the terminal board panel in the indicator (fig. 49). The spanner wrench (fig. 78), which is clipped to the air duct in the receiver-transmitter unit (fig. 6), is used to loosen or tighten the waveguide coupling in the receiver-transmitter. The klystron and crystal tool, which is held in a clip on the receiver chassis (fig. 6), is used to adjust the tuning strut on the local oscillator and to remove the mixer crystals from their holders

Section II. PREVENTIVE MAINTENANCE SERVICES

88. Definition of Preventive *Maintenance*

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good- working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5, Maintenance of Supplies and Equipment, Maintenance Responsibilities and Shop Operation.

89. General Preventive Maintenance Techniques

a Use No. 0000 sandpaper to remove corrosion.

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

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth. ***Caution:*** Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

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

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

90. Use of Preventive Maintenance Forms

(figs. 79 and 80)

a The information in paragraph 91 is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA Forms 11-238 and 11-239. The decision as to which items on the form are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 79 and 80 are partially or totally applicable to the equipment. References in the ITEM block refer to paragraphs in text that contain additional maintenance information.

91. Performing Preventive Maintenance

The following preventive maintenance operations should be performed only by qualified organizational personnel at the intervals indicated, unless these intervals are reduced by the local commander.

Caution: Screws, bolts and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Check for completeness and satisfactory condition of the radar set. The components of the radar set are listed in paragraph 7 and are illustrated in figure 1.

b. Remove dirt and moisture from exterior of all component panels, cabinets, and exposed cabling.

c. Inspect the seating of the following *pluck-o*ut items:

(1) *Indicator.* Four pilot lamps, two multi-conductor connectors, one high-voltage connector, two plate-cap connectors, and all tubes on the inside of the door. Thirteen lamps under the hinged top (five azimuth scale, one gyro, one range scale, and six range lamps). Tubes and tube shields on video circuits chassis, and four Bristol set-screw wrenches on terminal board panel.

(2) *Receiver-transmitter.* Spanner wrench on air duct, klystron wrench on receiver, and all tubes.
Note. Two tubes are located on the back of the receiver-transmitter door.

(3) Switch box fuses (two).

d: Inspect the following controls for binding, scraping, excessive looseness, worn or chipped gears, misalinements, and positive action:

(*1*) *Indicator.* All controls on the hinged top, primary control panel, and secondary control panel; also ANTENNA

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 91 a							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 91 b							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 91 c							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 91 d							
6	CHECK FOR NORMAL OPERATION. PAR. 91 e							

WEEKLY

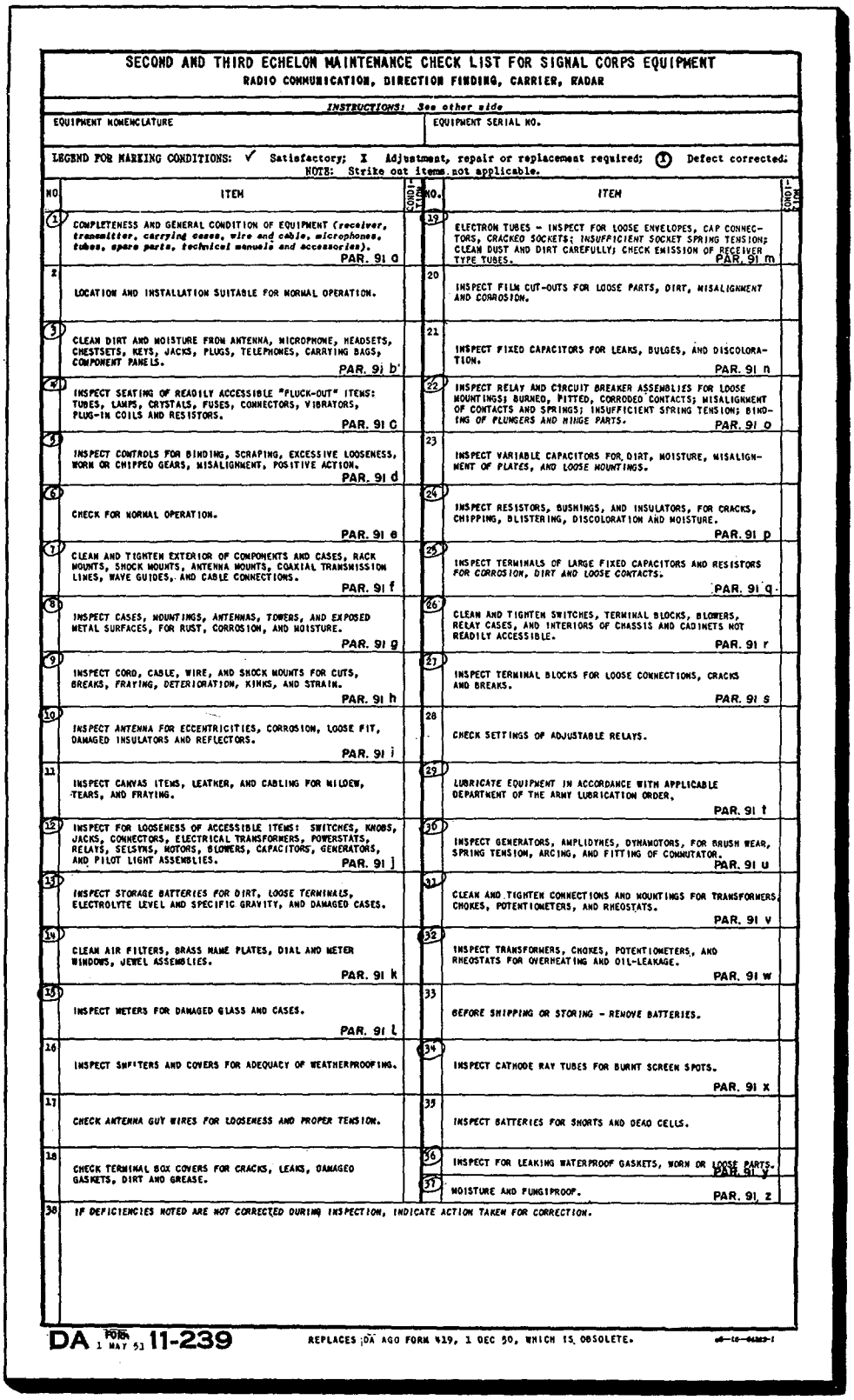
NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 91 f		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 91 g		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 91 k	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 91 h		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 91 l	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 91 i		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 91 j		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 **11-238** REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM1330-53

Figure 79. DA Form 11-233



SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE | EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (1) Defect corrected. NOTE: Strike out items not applicable.

NO	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 91 a	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 91 b	
4	INSPECT SEATING OF READILY ACCESSIBLE "FLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 91 c	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 91 d	
6	CHECK FOR NORMAL OPERATION. PAR. 91 e	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 91 f	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 91 g	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 91 h	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 91 i	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 91 j	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 91 k	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 91 l	
16	INSPECT SHIELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 91 m	
20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 91 n	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 91 o	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 91 p	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 91 q	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 91 r	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 91 s	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 91 t	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR. PAR. 91 u	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 91 v	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 91 w	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS. PAR. 91 x	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. PAR. 91 y	
37	MOISTURE AND FUNGIPROOF. PAR. 91 z	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.	

DA FORM 1 MAY 51 11-239 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM1330-180

Figure 80. DA Form 11-239

ON-OFF switch S905, test meter switch, and DIMMER control on TESTPANEL.

(*2) Receiver-transmitter.* ANT. HEATER ON-OFF switch and ANT. MOTOR ON-OFF switch on the convenience panel. A.F.C. OPER.-MANUAL TUNING switch, A.F.C. XTAL I-SIGNAL XTAL I PUSH switch, HIGH VOLTAGE ON-OFF switch, and test meter switch on the receiver-transmitter. Pushbutton switch at the bottom of the transmitter compartment. (3) Switch box lever.

(4) Starter or circuit breaker RESET button.

e. Check the radar set for normal operation.

(Refer to the equipment performance checklist (par. 101), and place the radar set in operation.)

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

f. Clean and tighten the exterior of all components, including all mountings, waveguide sections and clamps, cable clamps and glands, and component cover fasteners.

g. Inspect the antenna and antenna mounting, exposed waveguide sections, and exposed cable to antenna for rust, corrosion, and moisture.

h. Inspect all cables, wires, and connectors for cuts, breaks, fraying, deterioration, kinks.and strain.

i. Inspect the antenna for corrosion, damage to the reflector, paint or dirt on the antenna feed horn window, and loose mounting bolts.

j. Inspect the following items for looseness:

(*1) Indicator.* ANTENNA, SYNCHRO, and FILAMENT fuses (F901, F904, and F902, respectively) on the TEST PANEL. Four coaxial connectors on the inside of the door, two coaxial connectors on the video circuits chassis, one coaxial connector on the terminal board panel, and the pin jack next to the plotter. Four pilot lamps on the secondary control panel, 12 illuminating lamps on the plotter, and service lamp inside the indicator. High-voltage rectifier shield box, dry metal rectifier, range ring assembly, capacitors, transformers, and interlock switch on inside of door. Video circuits chassis, and capacitors on this chassis, and capacitors on the terminal board panel. Synchro motor and camswitch on the PPI yoke assembly.

(*2) Receiver-transmitter.* MODULATOR fuses F301 and F302, LOW VOLTAGE SUPPLY fuses F401 and F402, DRIERS fuse F803, ANT. HEATER fuse F801, and BLOWER fuse F802. *Trigger* coaxial *connectors,* two connectors at bottom of receiver chassis, one coaxial connector at bottom of transmitter compartment, and two *co*axial connectors near the terminal boards. Magnetron cover, waveguide coupling and bracket, receiver chassis, blower, blower hose, transformers, and capacitors.

(*3) Other units.* Covers, cable connections, and mountings.

k. Clean the air filter in the receiver-transmitter, meter window on the voltage regulator and on the test panels of the indicator and receiver-transmitter, range windows and range counter window on the top of the indicator, and the glass writing surface of the plotter. Clean the glass plate on the *primary and secondary* control panels, and the jewel assembly on the front of the indicator and on the receiver-transmitter.

i. Inspect the voltage regulator meter for damaged glass or case.

m. Inspect all electron tubes for loose envelopes, cap connectors, cracked sockets; insufficient socket spring tension; remove dust and dirt carefully; check emission of receiver type tubes.

n. Inspect fixed capacitors for leaks, bulges, and discoloration.

o. Inspect the motor starter (or circuit breaker) assembly for loose mounting; burned, pitted, corroded contacts; misalinement of contacts and springs; insufficient spring tension; binding of plunger and hinge parts (figs. 52 and 53).

p. Inspect resistors, bushings, and insulators for cracks, chipping, blistering, *discoloration,* and moisture.

q. Inspect terminals of large fixed capacitors

and resistors for corrosion, dirt, and loose contacts.

r. Clean and tighten switches, terminal blocks, relay cases, and interiors of chassis and cabinets not readily accessible.

s. Inspect terminal blocks for loose connections, cracks, and breaks.

t. Lubricate the equipment in accordance with applicable Department of the Army lubrication order (par. 93).

u. Inspect the antenna drive motor and the motor generator for brush wear, spring tension, arcing, and fitting of commutators (par. 112 and 113).

v. Clean and tighten connections and mountings for transformers, chokes, potentiometers, and rheostats.

w. Inspect the voltage regulator for over-heating (par. 18).

x. Inspect the control indicator cathode-ray tube for burned screen spots.

y. Inspect antenna covers and waveguide deck fitting for leaking waterproof gaskets and worn or loose parts.

z. Check adequacy of moisture proofing and fungiproofing treatment (par. 95).

Section III. LUBRICATION

92. Lubrication Chart for Radar Set AN/SPN-18 (*)

A lubrication chart for Radar Set AN/SPN-18(*) is shown in figure 81.

93. Detailed Lubrication Instructions

a. The type of lubricant to be used, the interval, and specific instructions for each part to be lubricated are given in figure 81.

b. Gasoline will not be used as a cleaning fluid for any purpose. When the equipment is overhauled or repairs are made, parts should be cleaned with solvent (SD).

c. Carbon tetrachloride will be used as a cleaning fluid only for electrical contacts, plugs, commutators, etc.

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

d. Do not use excessive amounts of oil or grease and do not allow connections to become greasy.

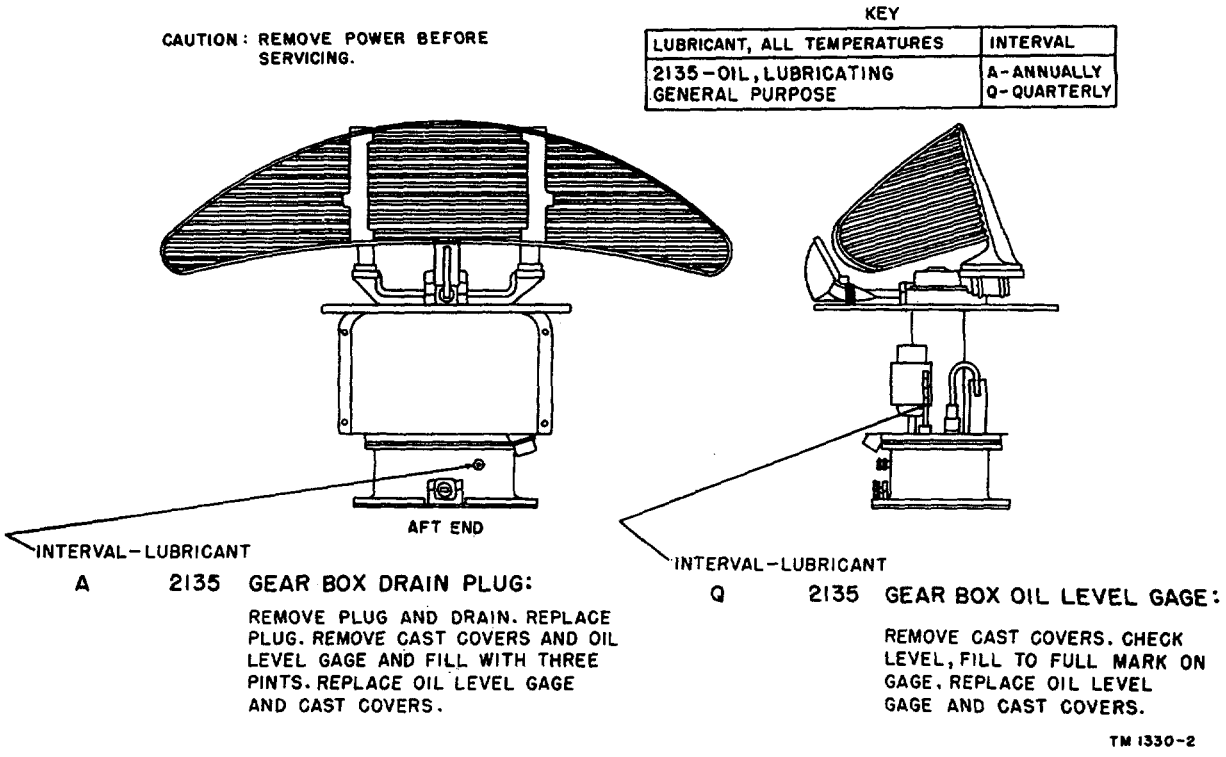


Figure 81. Lubrication chart, antenna gear box.

e. Be sure that lubricants and points to be lubricated are clean and free from grit and dirt. These abrasives are the chief cause of bearing wear and thus often necessitate bearing replacement. Use solvent (SD) to clean all parts. Before lubrication, wipe clean all surfaces to be lubricated; use a lint-free cloth dampened with solvent (SD). Keep solvent off surrounding parts.

f. Lubrication intervals designated are for normal 8-hour day operation. For abnormal conditions or activities, intervals should be shortened.

94. Parts Lubricated by Manufacturer Which Do Not Require Subsequent Lubrication

a. Motor Generator PU-243A/SPN-11 or PU-288/SPN-18X. The motor generator has sealed bearings that should provide 7,200 hours of operation. The bearings may have to be replaced after approximately 2 years of normal operation. Replacement of bearings should be performed by trained maintenance personnel.

b. Antenna AS-659/SPN-18, Drive Motor and Selsyn Generator. The antenna drive motor and selsyn generator contain sealed bearings. Replacement of these bearings should be performed by trained maintenance personnel.

c. Control-Indicator C-1261/SPN-18, Selsyn Motor. The selsyn motor contains sealed bearings. Replacement of these bearings should be performed by trained maintenance personnel.

d. Radar Receiver-Transmitter RT-290/SPN-18, Blower Motor. The blower motor contains sealed bearings. Replacement of these bearings should be performed by trained maintenance personnel.

Section IV. WEATHERPROOFING

95. Weatherproofing Procedures and Precautions

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

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moisture-proofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment. The equipment is given the moistureproofing and fungiproofing treatment at the factory and it is necessary to use this treatment only when parts are replaced or repaired.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to section III of this chapter for detailed instructions.

96. Rustproofing and Painting

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

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or groundings of circuits.

b. When a touchup job is necessary, apply paint with a small brush. Remove rust by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section V. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

97. General

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

b. The paragraphs which follow in this section help in determining which of the components, such as the receiver-transmitter, is at fault and in localizing the fault in that component to the defective stage or item, such as *a tube* or *fuse.*

98. Visual Inspection

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

(1) Worn, broken, or disconnected cables, cords, or plugs.
(2) Burned-out fuses.
(3) Relay contacts burned because of overloads.
(4) Wires broken because of excessive vibration.
(5) Defective tubes.
(6) Inactive (dirty or cracked) crystals.
(7) Open interlocks, due to improperly secured covers.
(8) Loose terminal board connections.

b. When failure is encountered and the cause is not immediately apparent, check as many of the items above as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

c. Visually inspect the antenna system and waveguide for obvious abnormalities.

99. System Sectionalization of Trouble to a Component

System sectionalization consists of determining whether the trouble is in the transmitter, receiver, r-f system, indicator, antenna or power supply units.

a. Operate the radar set and observe its performance. See equipment performance checklist (par. 101) for normal operating conditions.

b. If the entire radar set is dead, the trouble is probably in the ship supply, power cables or switch box.

c Check fuses at an early stage in trouble-shooting. Do not continue to burn out fuses before looking elsewhere to determine the basic source of the trouble.

d. Check the output of the motor generator on the meter on the voltage regulator. Proper functioning of the antenna drive motor, heaters, and driers does not necessarily indicate proper functioning of the motor generator unit, since power *to* these *components is supplied directly* from the ship line through the switch box.

e After checking fuses, check the test meters (figs. 59 and 60) for clues to the location of the trouble.

f. The overall operation of the radar set can be checked by viewing the PPI presentation on all ranges.

g. The transmitter is operating properly if a normal magnetron current (MAG. I) reading is observed on the test meter in the receiver *transmitter* (par. *64). Since the trigger pulse* developed in this unit supplies the entire radar set with a timing pulse, a defective transmitter may cause the indicator unit to be inoperative.

h. Proper operation of the duplexer is indicated by normal afc and signal crystal current readings on the CRYSTAL CURRENT meter.

i. Proper operation of the indicator is evidenced by correct patterns on the PPI.

Note. Check the transmitter and duplexer for proper operation (g and h above) before checking the indicator.

(1) Since both the video signals and range marks pass through the same video channel (video circuits chassis), the indicator is operative if either range marks or video (echo) signals appear on the PPI.
(2) If nothing appears on the PPI, that is, if there is no sweep, range marks, or echoes-the indicator may be defective.

j. Proper operation of the receiver is indi-

cated by the appearance of targets on the PPI scope.

k. Proper operation of the antenna is indicated by a rotating sweep on the PPI scope.

100. Troubleshooting by Using Equipment Performance Checklist

a General. The equipment performance checklist (par. 101) will help the operator to locate trouble in the equipment. The list gives the items to be checked, the conditions under which the item is checked, the normal indications and tolerance of correct operations and the corrective measures the operator can take. To use this list, follow the items *in numerical sequence.*

b .Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indications given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. The phrase "troubleshooting is required" in the table indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the radar set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the tactical situation requires continued operation and if the radar set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

Note. If the corrective measure calls for checking tubes, refer to the tube troubleshooting chart (par. 100).

101. Equipment Performance Checklist

PREPARATORY	1	Covers	Indicator secondary control panel and TEST PANEL open, receiver-transmitter cover removed.		
	2	All controls	Set to initial starting positions (par. 78).		
START	3	Control lever on switch box.	Set to ON position.		
	4	Power switch	Set to STAND BY position.	Motor generator starts	Press RESET button on starter or circuit breaker. Check fuses F601 and F602 in switch box. Check seating of front door and top panel of indicator and interlock S910 on the door.
				Voltage regulator meter reads 115 volts.	Switch to MANUAL operation and adjust rheostat for 115 volts. If 115 volts cannot be attained on the meter in AUTOMATIC or MANUAL, check ship line voltage. (Low line voltage will cause low motor generator speed.)
				Azimuth scale lamps, primary and secondary control panel lamps, and TEST PANEL lamp light.	If all lamps are out, check FILAMENT fuse F902 on TEST PANEL; otherwise check lamp.

START				Blower motor in receiver-transmitter starts.	Check BLOWER fuse F802 on receiver-transmitter convenience panel.
	5	Power switch	Set to OPERATE position.	After 3 minutes, amber *ready* lamp on indicator lights.	Check *ready* lamp and tubes V910 and V920.
				When amber *ready* lamp lights, HIGH VOLTAGE lamp on receiver-transmitter lights.	Check position of HIGH VOLTAGE switch (should be at ON); check MODULATOR fuse F301 in receiver-transmitter.
				Plotter luminating lamps light.	If all lamps are out, check POSITION TRACKER FUSE F1201 in indicator and check tightness of plotter connection at pin jack J1201 on top of indicator; otherwise check lamp.
	6	ANTENNA switch S905 on TEST PANEL.	Set to ON position	Antenna rotates	Check position of ANT. MOTOR switch on receiver-transmitter convenience panel (should be at ON); check ANTENNA fuse F901 on TEST PANEL; check position of antenna motor switch S503 in pedestal (should be at ON); check for possible obstructions in path of antenna.
EQUIPMENT PERFORMANCE	7	Test meter switch on receiver-transmitter.	Set to MAG. I position	Test meter reads between 4 and 5.5 ma.	Check MOD. H.V. position for a meter reading of 300 (3,000 volts). If no MOD. H.V. is present, check MODULATOR fuses F301 and F302 and tubes V301 and V302. If MOD. H.V. is present, check tubes V306, V307, V308, V303, and V304.
			Set to +140V position	Test meter reads 140	Check LOW VOLTAGE SUPPLY fuses F401 and F402 and tube V403.
			Set to 300V position	Test meter reads 300	Check tube V404.
			Set to +300V REG position.	Test meter reads 300	Check tubes V405, V406, V407, and V408.
			Set to +600V position	Test meter reads 300 (600 volts).	Check tube V405.
			Set to −300V REG position.	Test meter reads 300	Check tubes V409, V410, and V411.
			Set to 115V A.C. position.	Test meter reads the same voltage as the voltage regulator meter.	Adjust R424 (back of receiver-transmitter door, adjacent to meter) so that both meter readings agree.

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8	A.F.C. OPER-MANUAL TUNING switch.	Set to MANUAL TUNING.	CRYSTAL CURRENT meter on receiver reads between .4 and .5 ma.	Refer to installation alinement instructions in paragraph 58.
		Set to A.F.C. OPER.....	CRYSTAL CURRENT meter reads between .4 and .5 ma.	Refer to installation alinement instructions in paragraph 58.
9	A.F.C. XTAL I-SIGNAL XTAL I PUSH switch.	Push switch.....	CRYSTAL CURRENT meter reads between .4 and .5 ma.	Refer to alinement instructions in paragraph 58.
10	REFLECTOR TUNING control.	Rotate over entire range. *This control must be reset for maximum current after this test.*	CRYSTAL CURRENT meter reading varies.	Refer to alinement instructions in paragraph 58
11	Receiver-transmitter cover.	Replace and tighten the four captive screws.		
12	Test meter switch on TEST PANEL.	Set to +24 V, +140 V, +300 V REG, +300 V, +600 V, and −300 V REG positions.	Test meter reads selected voltage.	Troubleshooting is required.
		Set to +12000 V position.	Test meter reads 120 (12,000 volts).	If H.V. fuse alarm lamp I 910 on TEST PANEL is on, replace fuse F903 below it. If H.V. lamp does not light, check tube V918.
		Set to 115 V A.C. position.	Test meter reads the same voltage as the voltage regulator meter.	Adjust 115 V A.C. SET on TEST PANEL so that both meter readings agree.
13	INTENSITY control on TEST PANEL.	Advance (clockwise). *This control must be reset to its position indicated on the calibration chart after this test.*	Rotating sweep brightens.	If only a spot is present, check tubes V901, V903, V904, V905, and V906. If sweep is not rotating, check SYNCHRO fuse F904.
14	FLASHER control on secondary control panel.	Advance (clockwise).....	Heading and aft flashes appear on PPI scope.	Troubleshooting is required.
15	RING INT control on secondary control panel.	Advance (clockwise).....	Four range rings appear on PPI scope.	Advance GAIN control (clockwise) and check for targets on scope. If no targets are present, check tubes V1151 through V1154. If targets are present, check position of RINGS switch (should be at FIXED) and tubes V902, V915, V908, V916, V914, and V1151.
16	FOCUS control on secondary control panel.	Adjust for sharp clear range rings.	Sharpness of scope pattern changes with adjustment of control.	Check tube V919.
17	RANGE switch.....	Set to each position and leave on 1-mile range.	Proper range lamp lights.	Check range lamp.
18	GAIN control.....	Advance (clockwise).....	Noise and signals appear on scope.	Advance CONTRAST control; check video cables between receiver and indicator. Receiver may be faulty. Troubleshooting is required.

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EQUIPMENT PERFORMANCE	19	TEST button on secondary control panel.	Push	Eight or ten radial lines appear on the scope, extending from the center of the scope to approximately ½ or ¾ mile.	If radial lines are shorter than normal or if no lines are present, transmitter power output or receiver sensitivity is low. Troubleshooting is required.
	20	SUPPRESSOR control	Advance (clockwise)	Scope darkens near its center, bright areas become mottled or flaky.	Check alinement of STC circuit; check tubes V902 and V917.
	21	CONTRAST control	Vary until noise, range rings, and targets are bright but not fuzzy.	Scope display brightens when control is rotated clockwise and darkens when rotated counterclockwise.	Troubleshooting is required.
	22	FTC switch	Set to ON position	Apparent depth of targets and clutter on scopes decreases.	Troubleshooting is required.
	23	CENTER switch	Set to OPEN position	Center of scope expands to a small diameter circle.	Troubleshooting is required.
	24	RINGS switch	Set to VAR position	Fixed range rings disappear, one new range ring appears, and range counter lamp lights.	Check range counter for a reading within the range of the RANGE switch; check adjustment of RING INT. control; check tubes V911, V912, V909, V913, and V914. If lamp does not light check lamp.
	25	DIMMER control on secondary control panel.	Vary	Brightness of azimuth scale lamp varies.	Troubleshooting is required.
	26	DIMMER control on primary control panel.	Vary	Brightness of primary control panel lamps varies.	Troubleshooting is required.
STOP	27	POWER switch	Set to OFF position	Motor generator stops, radar set is off, and antenna rotation stops.	
	28	Control lever on switch box.	Set to OFF position	Entire equipment inoperative.	

102. Tube Troubleshooting Chart

a General. When replacing tubes, refer to the following figures for tube location.

(1) Figure 82, indicator tube location diagram.
(2) Figure 83, video circuits chassis tube location diagram.
(3) Figure 84, transmitter tube location diagram.
(4) Figure 85, magnetron removal.
(5) Figure 86, power supply tube location diagram.
(6) Figure 87, keep-alive power supply tube location diagram.
(7) Figure 88, receiver and duplexer tube location diagram.

1	PPI blank. Normal reading of test meter with meter switch at +12000 V position	V921 (fig. 12).
2	Range rings brighter than usual with dark areas after each mark. Echoes weak	V1151 (fig. 83).
3	Weak or no echoes	V204 through V214 (fig. 88).
4	Weak echoes. Low MAG. I, or current drops as a-c voltage is increased. aFC erratic	V305 (fig. 85).
5	Weak echoes. Blacked out ring around center of PPI scope	V202 (fig. 88), V401, V402 (fig. 87).
6	Weak echoes and range rings. Test meter reads high at −300 V REG position	V410, V411 (fig. 71).
7	Alternate sectors of light and dark on PPI scope. CRYSTAL CURRENT meter sweeps.	V203, V215 through V220 (fig. 88).
8	PPI scope pattern is bright. Sweep retrace present	V907, V909 (fig. 82).
9	No echoes, range markers, and heading flash on PPI scope. Only sweep line is present.	CR1152.
10	No sweep line on PPI scope	CR901 (indicator).
11	No variable range marker	CR902 (indicator).
12	No range rings	CR1151 (video amplifier).
13	Weak or no echoes. No noise or very little noise appears on PPI scope when GAIN control is advanced.	CR203, CR204 (receiver).
14	Weak or no echoes. Noise level on PPI scope is normal	CR201 (fig. 88).
15	Echoes bloom on PPI scope	CR203, CR204 (receiver).
16	Range rings bloom when passing over echoes	CR1151 (video amplifier).
17	Alternate bands of light and dark appear on PPI scope. CRYSTAL CURRENT meter sweeps.	CR202 (fig. 88).

103. Indicator Tube Replacement

a. General.

(1) All tubes in the indicator (except the cathode-ray tube and four tubes on the video circuits chassis) are located on the inside of the front door (fig. 12). Tubes are held in their sockets by base clamps or removable shields, except V920 which fits into a bayonet socket and V918 which is inclosed in a metal shield box. Always change one tube at a time and make certain that the correct tube is replaced in the proper socket.

(2) To gain access to the indicator tubes, loosen the two hex-head captive screws on the front of the indicator (fig. 9) and slowly swing the front door open until it locks. High-voltage rectifier V918 is enclosed in a metal shield box (fig. 12) which must be removed before V918 can be replaced. The shield box is held to the door by two captive screws.

b. Tube Complement.

Symbol	Tube type	Function
V901	6SN7	Multivibrator.
V902	6SN7	Cathode-follower and STC generator.
V903	6SN7	Sweep generator and d-c restorer
V904	6SN7	Sweep voltage amplifiers.
V905	6CD6G	Sweep current amplifier.
V906	6CD6G	Sweep current amplifier.
V907	6AL5	Clipper and clamper.
V908	6SN7	Cathode-follower and range mark limiter.
V909	6A5	D-c restorer.
V910	6SN'7	Time delay.
V911	6AI5	Charging and pick-off diodes.
V912	6S7	VRM sweep generator and feedback cathode-follower.
V913	6AIK5	VRM amplifier.
V914	6SN'7	Pulse sharpener and range mark blocking oscillator.
V915	6SN7	Range mark oscillator.
V916	6SN7	Range mark inverter and amplifier.
V917	12AIj7	STC cathode-follower.
V918	8013A	High-voltage rectifier.
V919	6AG7	Focus tube.
V920	NE-32	Neon bulb
V921	16ADP7	Cathode-ray tube.

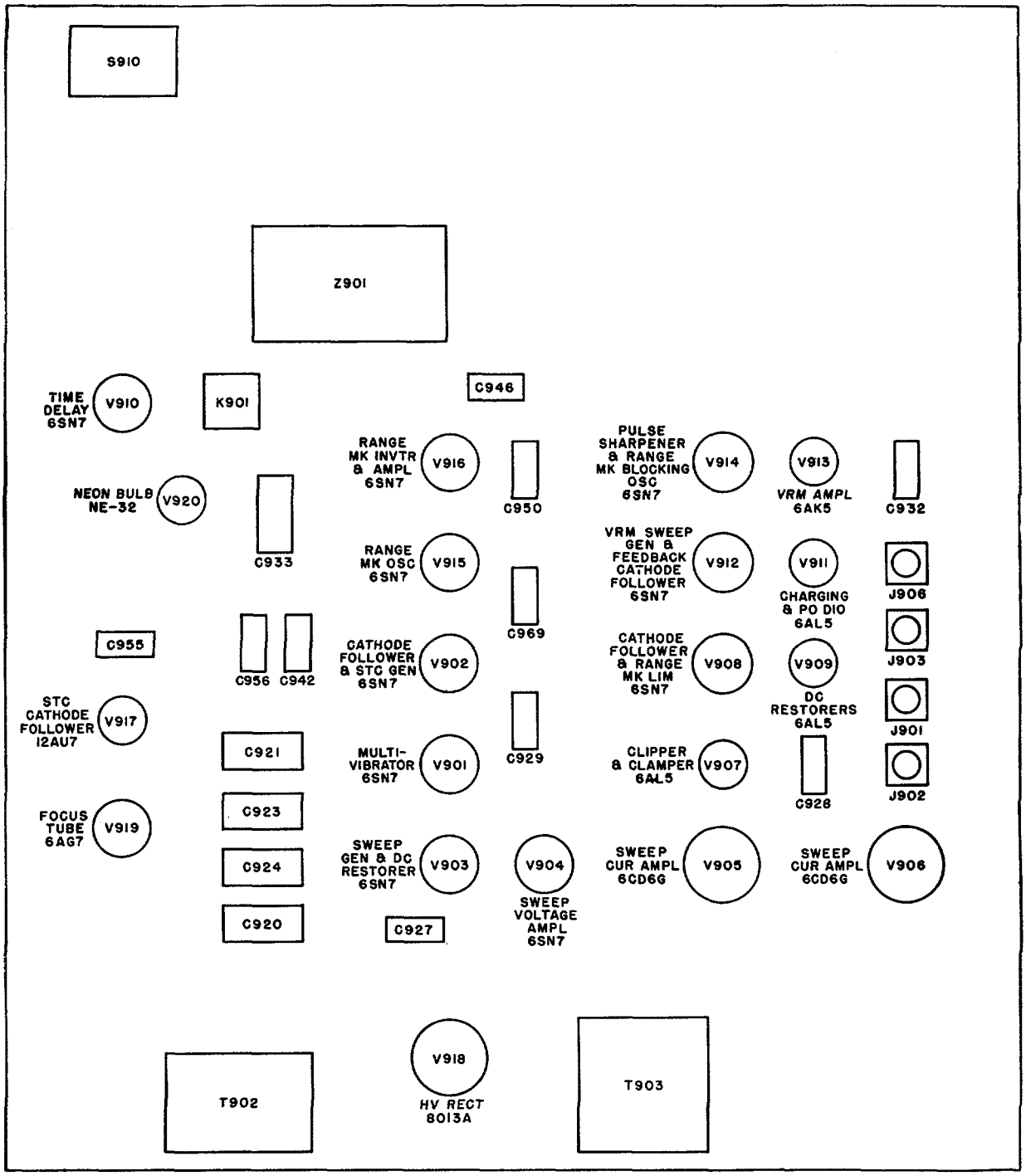


Figure 32. Indicator tube location diagram.

Caution: Shut off all power to unit before removing tubes.

c. Replacement of Cathode-Ray Tube V921. Be extremely careful when handling the cathode ray tube. Use both hands when lifting tube; never lay it down on hard surfaces. Do not drop anything on the face of the tube. To replace V921, proceed as follows:

(1) Set POWER switch on primary control panel to OFF position.

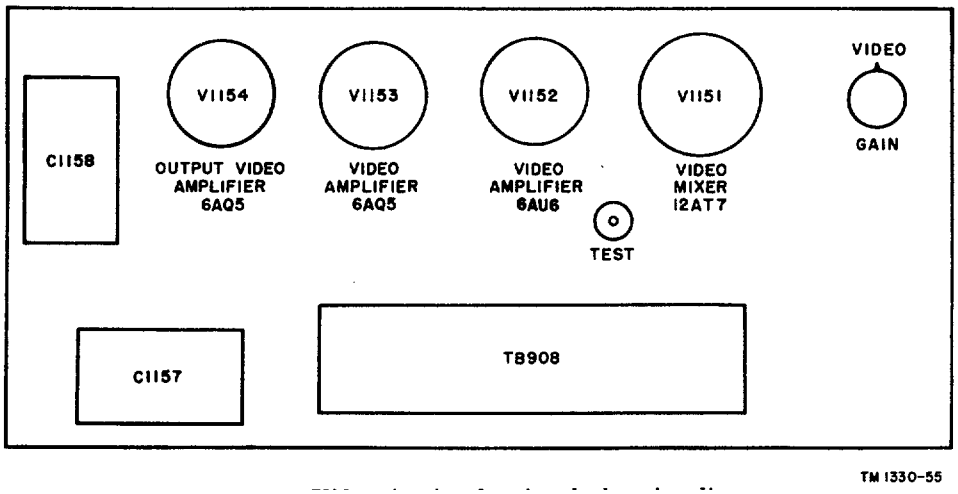


Figure 83. Video circuits chassis tube location diagram.

(2) Loosen the two captive screws on the top of the indicator and lift it until it locks in position.
(3) Remove the left side panel by loosening the four Dzus fasteners.
(4) Remove the semicircular socket at the base of the cathode-ray tube.
(5) Loosen the two screws on each of the three clamps which grip the metal rim of the cathode-ray tube and push the clamps off the rim of the tube.
(6) Keeping a good hold on the rim of the cathode-ray tube, pull it straight out; be careful not to let the narrow glass neck strike the deflection and focus coil mountings.
(7) Gripping the new tube at the rim, carefully insert it into place.
(8) Place the three clamps over the tube rim and tighten them evenly.
(9) To make sure the deflection coil does not rub against the neck of the tube, rotate the deflection yoke by hand. If rubbing exists, shift the tube at the rim and retighten the three rim clamps.
(10) Replace the semicircular socket at the base of the cathode-ray tube.
(11) Replace the side panel and tighten the four Dzus fasteners.
(12) While holding the top, release the supporting bracket by pushing it inward.
(13) Lower the top carefully and tighten the two captive screws.
(14) Apply power to the radar set, and check the operation of the PPI.
(15) Place the defective tube in the carton in which the new tube is supplied

104. Video Circuits Chassis Tube Replacement

a. General.

(1) The video circuits chassis (fig. 83) which is mounted on the terminal tor includes four tubes. These tubes are held in their sockets by removable shields. Always replace one tube at a time and make certain that the correct tube is replaced in the proper socket.
(2) To gain access to the video circuits tubes, swing the front of the indicator open until it locks.

b. Tube Complement.

Symbol	Tube type	Function
V1151	12AT7	Video mixer.
V1152	6ATU6	Video amplifier.
V1153	6AQ5	Video amplifier.
V1154	6AQ5	Output video amplifier.

Caution: Shut off all power to unit before removing tubes.

105. Transmitter Tube Replacement

a. General.

(1) All the tubes in the transmitter (fig. 84) (except the magnetron) are located back of the hinged panel and are enclosed in the transmitter, or

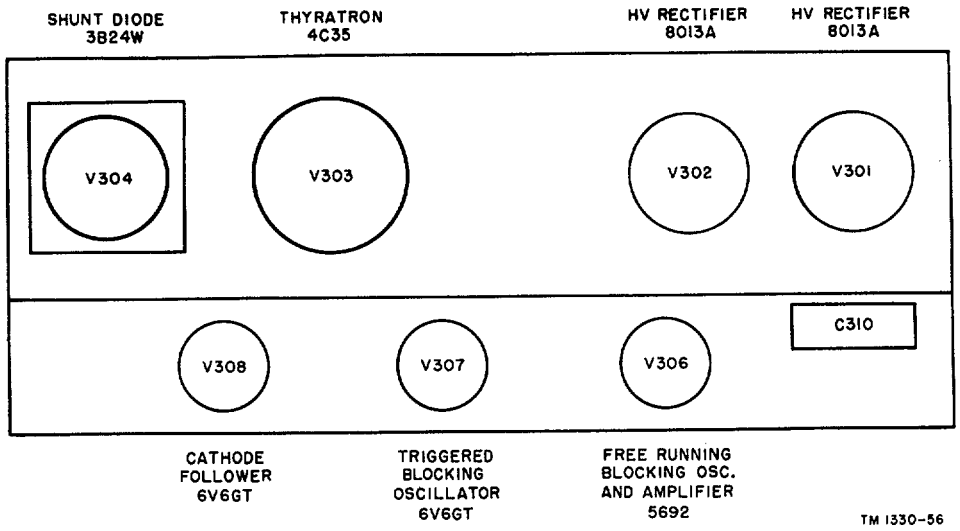


Figure 84. Transmitter tube location diagram

modulator, compartment (fig. 7). The magnetron is located on the front of the hinged panel (fig. 6). Always change one tube at a time and make certain that the correct tube is replaced in the proper socket.

(2) To gain access to the transmitter tubes, loosen the four hex-head captive screws on the main cover (fig. 5) and remove the cover. Disconnect the waveguide coupling, using the spanner wrench (fig. 6), loosen the two knurled captive screws, and swing the hinged panel out until it locks. Remove the 10 machine screws holding the modular compartment cover and remove the cover.

b. Tube Complement.

Symbol	Tube type	Function
V301	8013A	High-voltage rectifier.
V302	8013A	High-voltage rectifier.
V303	4C35	Thyratron.
V304	3B24W	Shunt diode.
V305	725A	Magnetron.
V306	5692	Free-running blocking oscillator and amplifier.
V307	6V6GT	Triggered blocking oscillalor.
V308	GV6GT	Cathode follower.

Caution: Shut off all power to unit before removing tubes.

c. Replacement of Magnetron V305. The hinged panel of the receiver-transmitter does not have to be opened when V305 is replaced.

Be careful not to strike the magnet with a steel screwdriver or other magnetic objects. To replace magnetron V305 (fig. 85), proceed as follows:

(1) Set the POWER switch to OFF position.
(2) Remove the magnetic shield by loosening the three machine screws at the top and the three captive screws at the front of the cover.
(3) Remove the three machine screws holding the hose bracket and remove the hose bracket.
(4) Loosen the four waveguide clamping screws.
(5) Loosen the three screws above the hinge and carefully tip the magnet down.
(6) Remove the six screws holding the magnetron.
(7) Pull the magnetron straight out. (Filament pins will disengage from the socket.)
(8) Carefully insert the new magnetron in place, engaging the socket, and push the magnetron into the socket.
(9) Replace the six screws to hold the magnetron in place.
(10) Tighten the four screws that hold the waveguide clamps.
(11) Tip the magnet into place and tighten the three screws that hold it.
(12) Replace the hose bracket and shield.

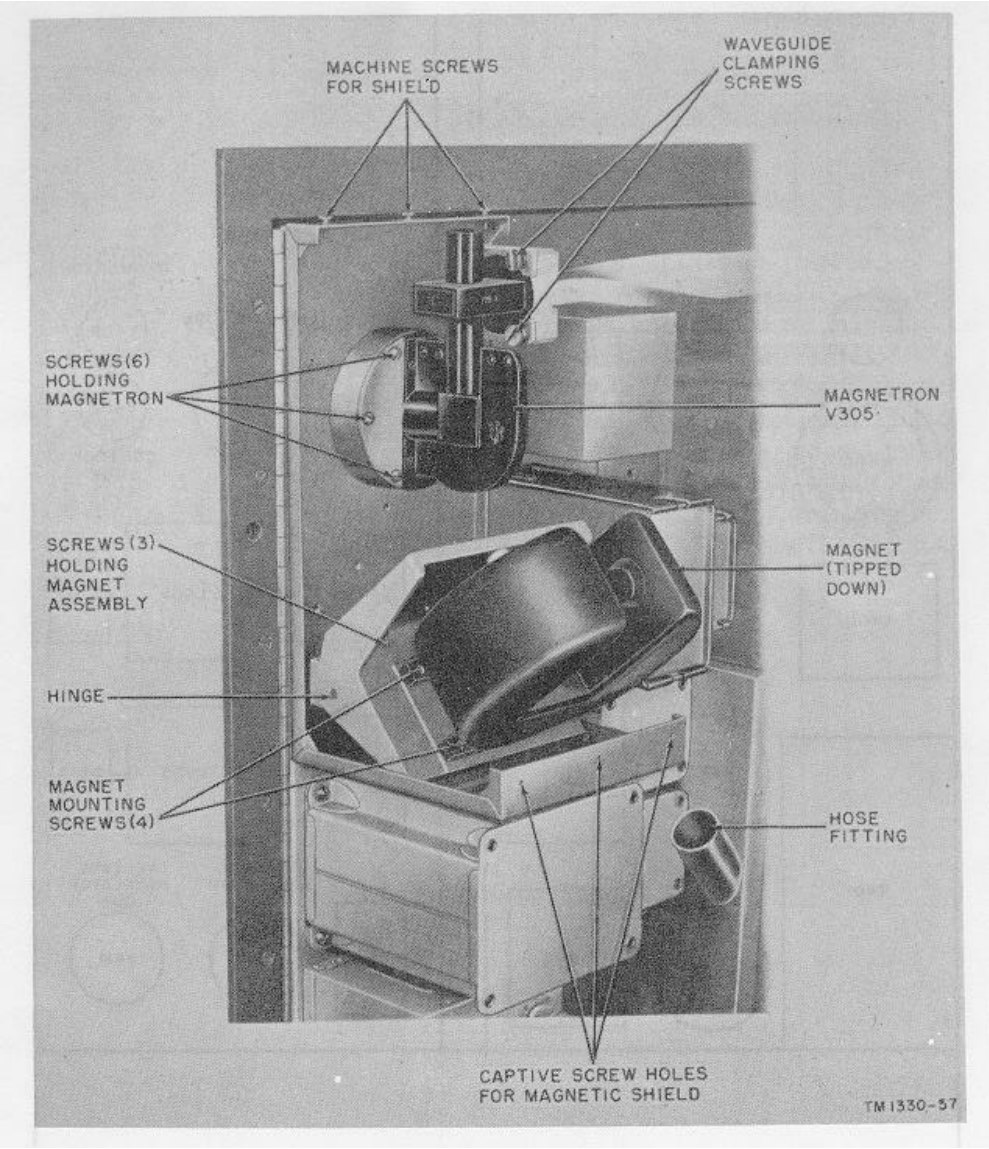


Figure 85. Magnetron removal.

(13) Retune the local oscillator and TR tubes (refer to chapter 2).

d. Replacement of Magnet. Be careful not to strike the magnet with a steel screwdriver or other magnetic objects. To replace the magnet, proceed as follows:

(1) Turn the POWER switch to OFF.
(2) Remove the magnetic shield and hose bracket.
(3) Remove the four screws holding the magnet.
(4) Remove the magnet.
(5) Center the new magnet in position and replace the four screws that hold it.
(6) Replace the hose bracket and magnetic shield.

106. Power Supply Tube Replacement

a. General.

(1) All power supply tubes (fig. 86), except the two keep-alive rectifiers, V401 and V402, are located on the front of the hinged panel. The two keep-alive rectifiers are located at the bottom, on the rear of the receiver-transmitter hinged panel (fig. 87). The keep alive rectifiers are held in their sockets by removable shields, and the rest of

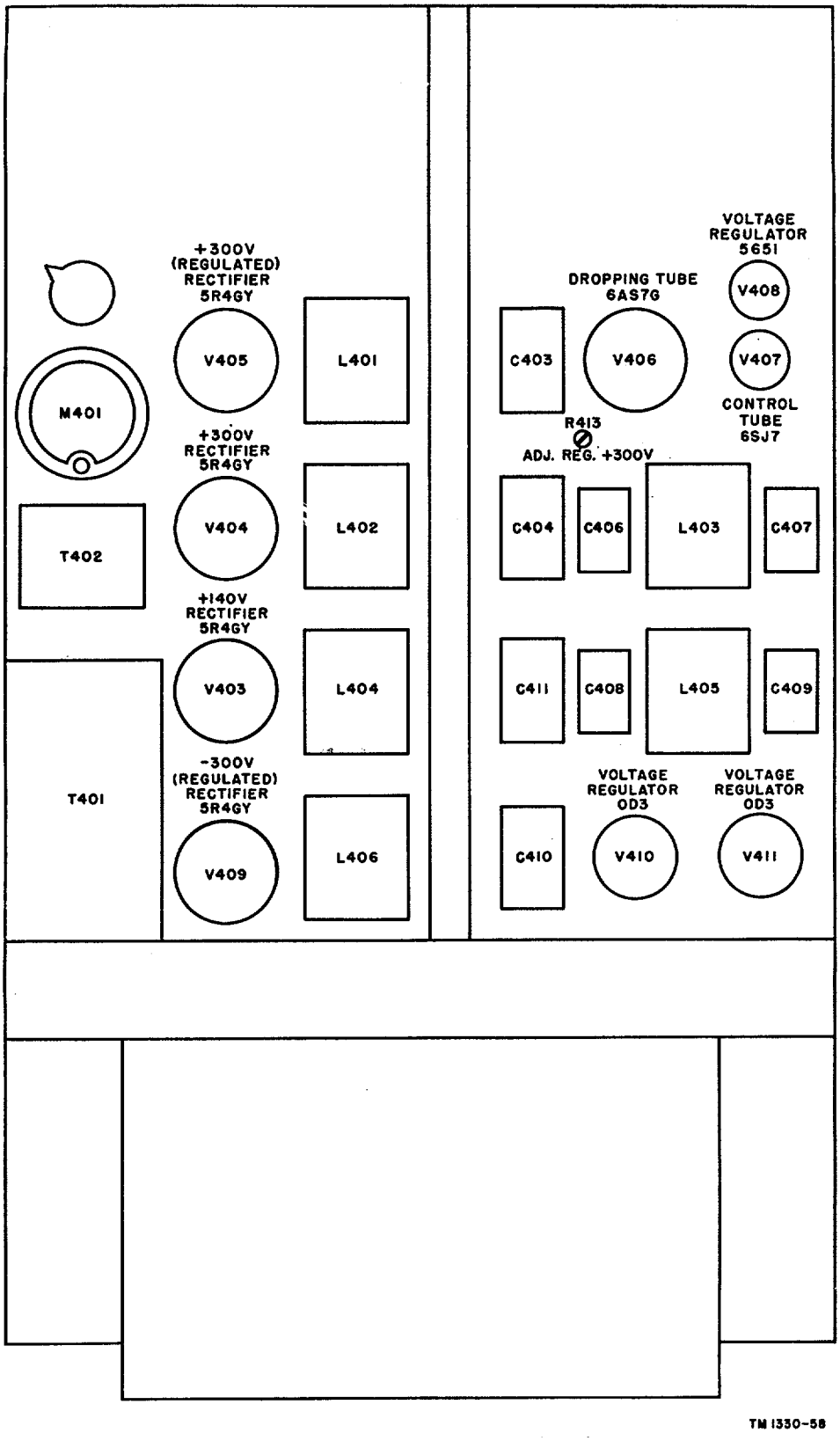


Figure 86. Power supply tube location diagram.

the power supply tubes are held by socket clamps. Always replace one tube at a time and make certain that the correct tube is replaced in the proper socket.
(2) To gain access to the power supply tubes, remove the receiver-transmitter main cover. To reach the keep-alive rectifiers, open the hinged panel.

b. Tube Complement.

Symbol	Tube type	Function
V401	1V2	Keep-alive rectifier.
V402	1V2	Keep-alive rectifier.
V403	5R4GY	+140-volt rectifier.
V404	5R4GY	+300-volt rectifier.
V405	5R4GY	+300-volt (regulated) rectifier.
V406	6AS7G	Dropping tube.
V407	6SJ7	Control tube.
V408	5651	Voltage regulator.
V409	5R4GY	-300-volt (regulated) rectifier.
V410	OD3	Voltage regulator.
V411	OD3	Voltage regulator.

Caution: Shut off all power to unit before removing tubes.

107. Receiver and Duplexer Tube Replacement

a. General.

(1) All the receiver tubes are mounted on the receiver and held in their sockets by removable shields. The two duplexer tubes, V201 and V202, are mounted on the duplexer: ANTI-TR tube V201 is mounted on the front and TR tube V202 is mounted on the rear. Always replace one tube at a time and make certain that the correct tube is replaced in the proper socket. Refer to figure 88 for the location of tubes.

(2) To gain access to the receiver tubes and to V201, remove the main cover of the receiver-transmitter. To reach V202, open the hinged panel.

(3) Whenever V201 and V203 are replaced they must be retuned. Refer to chapter 2 for alinement instructions.

b. Tube Complement.

Symbol	Tube **type**	**Function**
V201	1B35A	ANTI-TR tube.
V202	1B24A	TR tube.
V203	2K25	Local oscillator.
V204	6BQ7	Input i-f amplifier.
V205	6AK5	Second i-f amplifier.
V206	6AK5	Third i-f amplifier.
V207	6AK5	Fourth i-f amplifier.
V208	6AK5	Fifth i-f amplifier.
V209	6AK5	Sixth i-f amplifier.
V210	6AK5	Seventh i-f amplifier.
V211	6AK5	Eighth i-f amplifier.
V212	6AK5	Ninth i-f amplifier.
V213	6AL5	Second detector.
V214	6J6	Cathode-follower.
V215	6AK5	Afc i-f amplifier.
V216	6AK5	Afc i-f amplifier.
V217	6AL5	Afc discriminator.
V218	6J6	Afc pulse amplifier.
V219	6AL5	Charging diode.
V220	6AS6	Afc sweep generator and d-c amplifier.

Caution: Shut off all power to unit before removing tubes.

c Replacement of Anti-TR Tube V201.

(1) Turn POWER switch to OFF.
(2) Remove the two machine screws and the cover plate of the ANTI-TR tube.
(3) Remove the ANTI-TR tube and replace with a new tube.

Caution: The TR and the ANTITR tubes contain radioactive materials and are a radiation hazard. Handle in accordance with instructions given in TB SIG 225, Radioactive Tube Handling.

(4) Replace the cover plate and the two machine screws.

d. Replacement of TR Tube V202.

(1) Turn POWER switch to OFF.
(2) Open the hinged panel of the receiver transmitter.
(3) Remove the platecap clip on the TR tube.
(4) Remove the four machine screws on the top of the duplexer which hold the TR tube.
(5) Slowly pull the tube out of the duplexer and turn it approximately 450 so that it can clear the slot in the hinged panel.

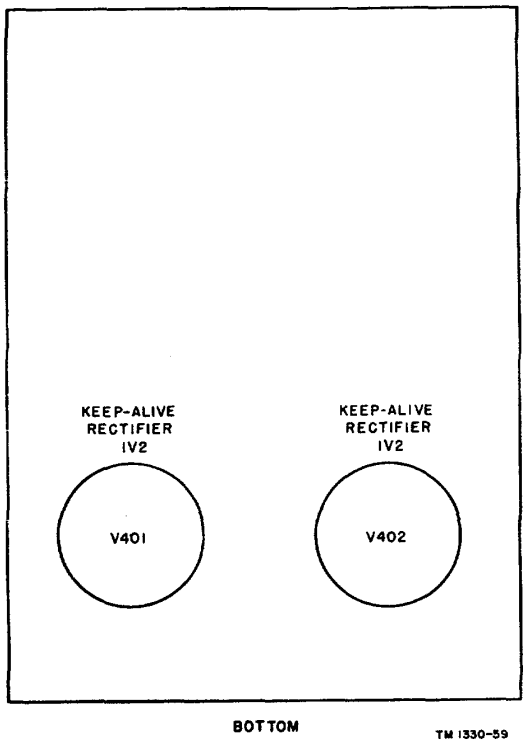


Figure 87. Keep-alive power supply tube location diagram.

Caution: The TR and the ANTI-TR tubes contain radioactive materials and are a radiation hazard. Handle in accordance with instructions given in TB SIG 225, Radioactive Tube Handling.

(6) Insert the new TR tube into the duplexer.

(7) Replace the four machine screws and the plate cap clip.

(8) Retune the TR tube (ch. 2).

108. Use of Receiver-Transmitter Test Meter

Test meter M401 (fig. 60), mounted on the hinged panel of the receiver-transmitter, provides current and voltage readings for key check points in the receiver-transmitter. This meter has a 0-500-volt d-c scale (and 0-10-milliampere scale which is not used). Meter switch S401, located immediately above M401, connects this meter through shunt or series resistors to the appropriate circuit for desired voltage or current readings. Refer to paragraph 63 (starting procedure) for the correct meter readings.

a. Calibration. The 115V A.C. position of the meter switch connects the test meter across the 115 volt a-c output of the motor generator. The voltmeter in the voltage regulator is also across the a-c line. Therefore, the test meter and the voltage regulator meter should show the same reading. To calibrate the test meter, adjust R424 (located in back of the hinged panel, next to the test meter) so that the meter readings agree.

b. Purpose. Receiver-transmitter test meter M401 is used to check eight different circuits, and is connected to the desired circuit by meter

(1) The MAG. I position of the meter switch allows the test meter to read the magnetron plate current. A MAG. I reading of 4 to 5 milliamperes (read between 400 and 500 on the 0-500-volt scale) indicates proper functioning of the synchronizing and transmitting systems.

(2) The MOD. HV position of the meter switch allows the test meter to read the output of the high-voltage supply in the transmitting system. A reading of 3,000 volts (read at 300 on the 0-500-volt scale) indicates proper functioning of the high-voltage supply (including rectifiers V301 and V302).

(3) The +140V position of the meter switch allows the test meter to read the output of the *+140-volt supply* used in the receiving and indicating systems. A reading of 140 volts indicates proper functioning of the +140-volt supply (including rectifier V403).

(4) The +300V position of the meter switch allows the test meter to read the output of the +300-volt supply used in the indicating system. A reading of 300 volts indicates proper functioning of the +300-volt supply (including rectifier V404).

(5) The +-300V REG position reads the voltage output of the +300-volt regulated supply used in the synchronizing, receiving, and indicating systems. A reading of 300 volts indicates proper

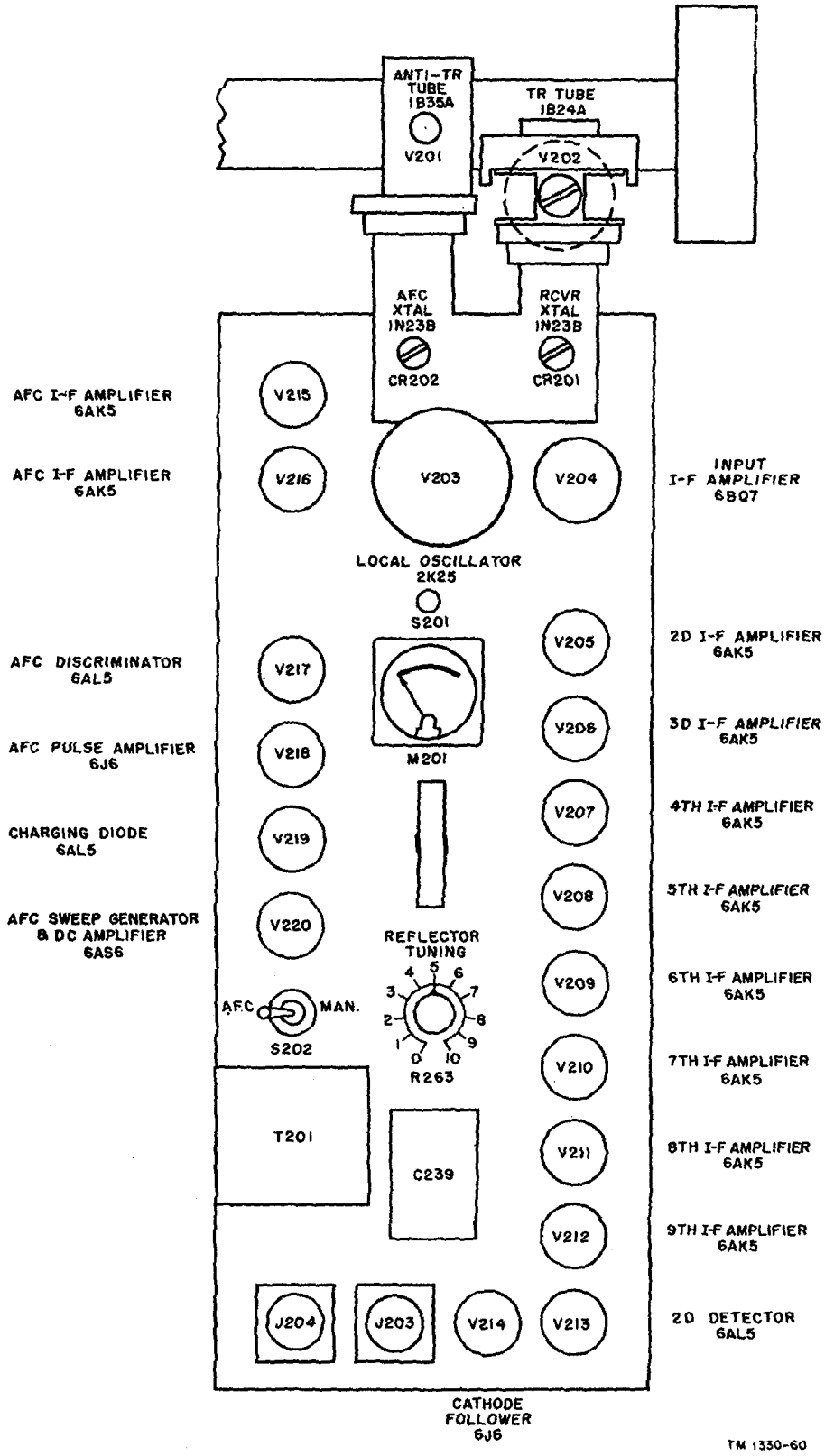


Figure 88. Receiver and duplexer tube location diagram.

functioning of this supply (including V405, V406, V407, and V408).

(6) The +600V position reads the voltage output of the +600-volt supply used in the indicating system. A reading of 300 (600 volts) indicates proper functioning of this supply (including rectifier V405).

(7) The -300V REG position reads the output of the -300-volt regulated supply used in the synchronizing, receiving, and indicating systems. A reading of 300 indicates proper functioning of this supply (including V409, V410, and V411).

(8) The 115V A.C. position reads the 400 cycle input voltage to the receiver transmitter. A reading of 115 volts indicates that a-c input power is present.

109. Use of Indicator Test Meter

Test meter M901 (fig. 59), mounted on the indicator TEST PANEL, provides voltage readings for key check points in the indicator. This meter has a 0-500-volt d-c scale (and a 0-10-milliampere scale which is not used). Meter switch S903, located immediately to the left of M901, connects this meter through series resistors to the appropriate circuit for the desired voltage reading. Refer to paragraph 63 (starting procedure) for the correct meter readings.

a. Calibration. To calibrate the test meter, place the meter switch in the 115V A.C. position, and adjust 115V A.C. SET (R982) so that the test meter reading agrees with the reading on the voltage regulator meter. This calibration is similar to the calibration of the receiver transmitter test meter (par. 108a).

b. Purpose. Indicator test meter M901 is used to check eight circuits and is connected to the desired one by meter switch S903.

(1) The +140V, +300V REG, +300V, +600V, -300V REG, and 115V A.C. positions of the meter switch allow the test meter to read the same voltages as the receiver-transmitter test meter (par. 108b). If any voltage reading is not correct while the corresponding reading on the receiver-transmitter test meter is correct, the cables between the units should be checked.

(2) The +24V position of the meter switch allows the test meter to read the output of the +24-volt supply in the indicator. A reading of 240 (24 volts) indicates proper functioning of this supply.

(3) The +12000V position of the meter switch allows the test meter to read the output of the high-voltage supply in the indicating system. A reading of 120 (12,000 volts) indicates proper functioning of this supply (including rectifier V918).

110. Use of CRYSTAL CURRENT Meter

CRYSTAL CURRENT meter M201 (fig. 60), mounted on the front of the receiver, provides current readings for the afc and signal crystals. This meter has a 0-1-milliampere d-c scale. The A.S.C. XTAL I-SIGNAL XTAL I PUSH switch S201 immediately above the CRYSTAL CURRENT meter connects the meter into the appropriate circuit to read the desired current. Refer to alinement instructions in chapter 2 for the correct meter readings.

a. Calibration. CRYSTAL CURRENT meter M201 does not require calibration.

b. Purpose. The CRYSTAL CURRENT meter is used to check the afc and signal crystal currents and to aline the local oscillator and the afc and signal crystals.

(1) The CRYSTAL CURRENT meter normally reads afc crystal current. A reading of .4 to .5 ma indicates proper functioning of the afc crystal. Refer to alinement instructions in chapter 2 for use of meter when alining the local oscillator.

(2) When S201 is depressed, the CRYSTAL CURRENT meter reads signal crystal current. A reading of .4 to .5 indicates proper functioning of the signal crystal, local oscillator, and mixer. Refer to alinement instructions in chapter 2 for use of meter during receiver alinement.

111. Motor Generator Troubleshooting Chart

This chart indicates various symptoms of trouble, the probable 'cause of the trouble, and the remedy. Follow the sequence given in the *probable cause* column.

Trouble	Probable Cause	Remedy
Motor fails to start	Supply line voltage too low	Check supply line voltage at switch box.
	Open line or short circuit in power group or load circuits.	Check seating of indicator top cover and front door.
		Check connections at switch box, motor starter box or circuit breaker, voltage regulator, and motor generator.
		Check fuses F601, F602, in the switch box (par. 54).
		Check cable connections at indicator, receiver-transmitter, and antenna.
	Brush not making contact with commutator.[a]	Check for weak or broken brush tension spring (fig. 90). Clean brushes and brush holder (par. 113).
Motor stops after running short time	Motor not getting power	Check input voltage at motor terminals on TB601.
		Check fuses F601, F602, and fuse clips in switch box.
		Check thermal overload relay in motor starter or circuit breaker.
Motor attempts to start, but thermal overload operates.	Motor is started with weak field	Check connections at switch box, motor starter or circuit breaker, and motor generator for loose or broken connections.
	Supply-line voltage is too low	Check supply-line voltage at switch box.
Meter M601, on voltage regulator, indicates that generator output voltage is too low.	Brushes not seated properly	Check brushes for uneven wear and seat brushes properly (par. 113).
	Short circuit in power group	Check connections at switch box, motor starter or circuit breaker, voltage regulator, and motor generator.
	Broken or weak brush tension spring	Check brush tension spring.
Meter M601, on voltage regulator, indicates generator output voltage is too high.	Supply-line voltage is too high	Check supply-line voltage at switch box.
Excessive sparking at commutator	Commutator in bad condition	Clean commutator and reseat brushes (pars. 112 and 113).
	Excessive vibration	Check brushes to make sure they ride freely in brush holders.
	Broken or weak brush tension spring	Check brush tension spring (figs. 90 and 91).
	Brushes too short	Replace brushes (par. 113).
	Poor brush fit on commutator	Seat brush properly (par. 113).
	Dirt on commutator	Clean commutator (par. 112).
	Brush sticking in brush holder	Remove and clean sides of brush.
Field coils overheat	Poor ventilation	Check air space around motor generator. Make sure all louvres on unit are clean.
Armature overheats	Excessive sparking at commutator	See checks previously outlined.
	Poor ventilation	Check air space around motor generator. Make sure that all louvres on unit are clean.
Motor generator operation is noisy	Motor generator not firmly mounted, or parts are loose.	Check mountings and tighten all bolts, screws, and connections.
Motor generator operation causes r-f interference.	Excessive sparking at commutator	See checks previously outlined.
	Loose connections at motor generator	Check and tighten all connections at motor generator.
	Dirt commutator	Clean commutator (par. 112).

[a] In d-c motor generator only.

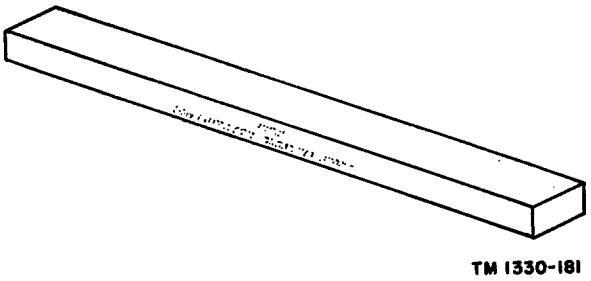


Figure 89. Commutator cleaning stone.

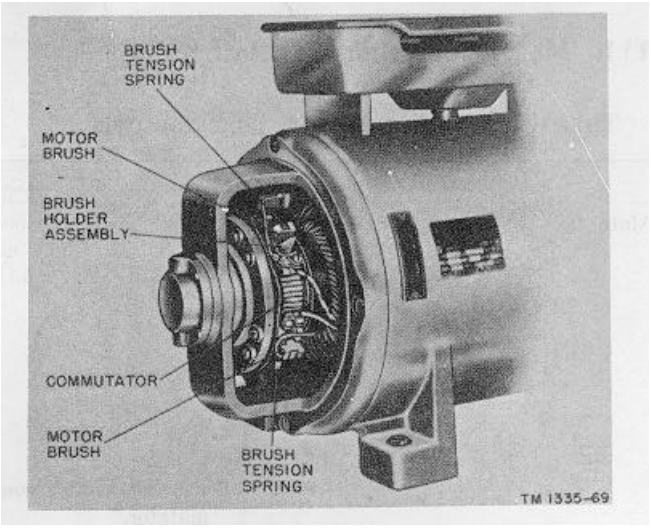


Figure 90. Motor end of d-c motor generator

112. Cleaning Commutator

a. The commutator surfaces should be smooth and free from nicks, pitting, and dirt. A slight discoloration of the commutator surfaces is normal.

b. The commutator cleaning stone (Stone Electrical Contact Brush Seater, 6R29376) is obtained through regular supply channels. The commutator cleaning stone (fig. 89) removes dirt, smudge, and excessive film and brush material from the commutator. Application of the stone also stops excessive sparking and chattering caused by poor brush contact, by reseating the brushes.

c. To clean the commutator, proceed as follows:

(1) Stop the motor generator (par. 74).
(2) Remove the brush access cover (figs.90 and 91).
(3) Start the motor generator (par. 70).
(4) Hold the stone against thecommutator as the motor generator turns and slowly move the stone from side to side, until the commutator looks clean and excessive sparking has stopped.
(5) Stop the motor generator.
(6) Replace the brush access cover.

Caution: Never use emery cloth for cleaning or brush seating procedure. Emery dust will short-circuit commutator segments.

113. Brushes

Seat new or old brushes to conform with the surface of the commutator. Follow the procedure in paragraph 112c(4) until the brushes are seated properly. Proper seating of brushes is indicated by minimum sparking.

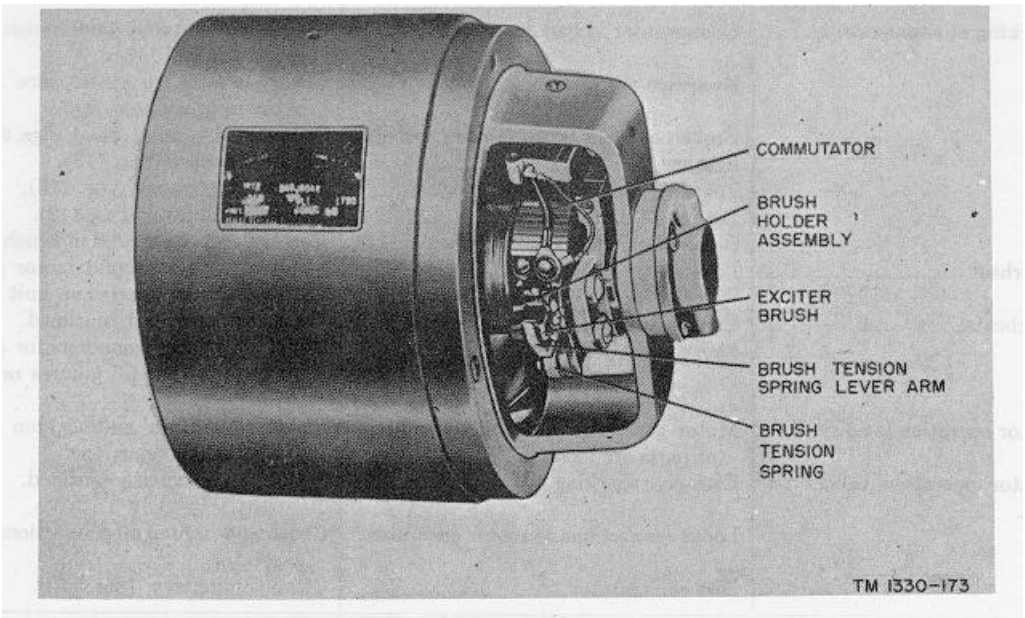


Figure 91. Exciter end of a-c motor generator

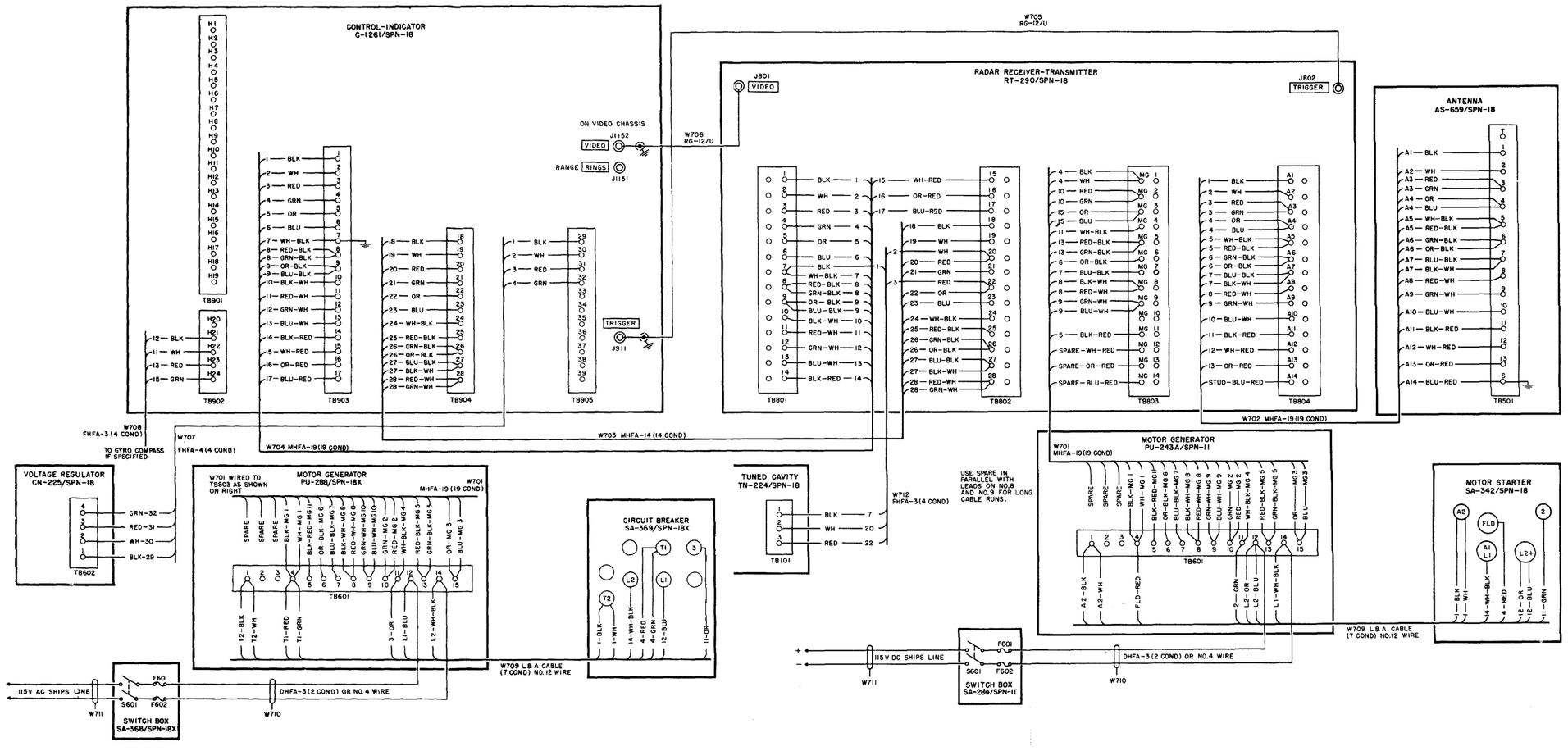


Figure 92. Radar Set AN/SPN-18(*), interconnection diagram.

CHAPTER 5

SHIPMENT AND LIMITED STORAGE AND

DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

114. Disassembly

a. Radar Set AN/SPN-18(*) is disassembled by reversing the installation procedures given in chapter 2.

b. Use the following general instructions as a guide for disassembling each unit.

(1) Carefully disconnect all plugs and connections.
(2) Roll up wires and cables and pile them neatly in a safe place until they are ready to be packed.
(3) Store the removed bolts, screws, nuts, and lockwashers in a suitable bag or box.
(4) Be sure that all tubes are seated firmly in tube sockets.
(5) Fasten the access covers on each unit.

Note. Make sure that no tools have been left inside a unit.

c. Observe the following precautions when disassembling the radar units.

(1) Be careful not to strike the face of the indicator cathode-ray tube with a tool.
(2) Make sure that the front panel knobs are fastened securely.
(3) Remove the antenna horn and replace the cover plates (used, with original factory shipment) to seal the wave- guide assembly. Be careful not to bend the antenna reflector. Do not use the rotating aluminum base as a hold for lifting the antenna unit.
(4) Do not bring metallic tools in contact with the magnetron magnet in the receiver-transmitter. Make sure that the receiver chassis is bolted securely. Fasten the hinged panel and the front cover. Do not scratch or bend the duplexer waveguide and its flange. Seal the face of the flange with water proof tape
(5) Avoid scratching or bending the waveguide sections. Do not damage or lose the gaskets when separating a choke flange from a plain flange.

115. Repacking for Shipment or Limited Storage

a. The exact procedure in repacking for shipment or limited storage depends on the conditions under which the equipment is to be shipped or stored.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the. packing case. Protect the case with a waterproof paper barrier. -Seal the seam of the barrier with water proof sealing compound or tape.

116. Domestic Shipment

When the equipment is to be removed from its mounting and transported to a remote point, proceed as follows:

a. Disassemble the equipment as outlined in paragraph 114.
b. Remove access covers.
c. Clean the interior of each unit.
d. Apply a light coating of Compound, Rust Preventive, Light (CL) to all exposed, unpainted surfaces.
Caution: Do not allow the compound to come in contact with rubber parts and wires.
e. Replace and fasten the access covers on each unit.
f. Seal all openings with waterproof tape.

g. Wrap each unit in moistureproof paper **o**r other moistureproof wrapping. Seal the edges of the wrapping.
h. Place each unit in its original packing crate, or equal. Refer to the typical packaging illustration (fig. 27).

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

117. General

The demolition procedures in paragraph 118 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only when ordered by the captain of the vessel.

118. Methods of Destruction

a. Smash. Smash magnetron, duplexer, relays, cam switches, meters, controls, capacitors, transformers, and tubes; use sledges, axes, hammers, crowbars, or other heavy tools.

Caution: Place a tarpaulin or suitable cover over the cathode-ray tube to protect personnel against shattering glass.

b. Cut. Cut cables and wiring; use axes, handaxes, or wire-cutting tools.
c. Burn. Burn technical manuals, radar charts, schematic and wiring diagrams, log, or any data obtained with radar set, in furnaces or other suitable places.
d. Bend. Bend waveguide, panels, cabinets, and chassis.
e. Explosives. If explosives are necessary, use firearms, grenades or TNT.
f. Disposal. Throw overboard the destroyed parts and spare parts.
g. Destroy. Destroy everything.

APPENDIX

PROCEDURE FOR MINIMIZING THE EFFECTIVENESS OF JAMMING

1. Introduction

Radar jamming is deliberate external interference with the normal operation of a radar set to reduce the effectiveness of the set. Since jamming indications may be similar to indications caused by unintentional interference, the radar operator must learn to distinguish between the two. The operator who shuts down a deliberately jammed set because he thinks the set is defective is accomplishing the very effect
the enemy desires.

a. Unintentional interference may result from the operation of nearby electrical equipment, such as power generators, communications transmitters, or other radar sets. It may also result from natural external sources, such as heavy seas, rain squalls, or clouds. Troubles of various components of the set itself may be a third cause for indications similar to jamming. The operator should therefore become familiar with the indications of unintentional interference and learn to correct or minimize the effects of such interference. The information in paragraphs 78 through 80, and 97 through 113 will aid in recognizing and minimizing unintentional interference.

b. Interference caused by enemy jamming is indicated when the interference pattern remains 'on the scope after interference from all unintentional sources has been minimized or eliminated. The operator must then take all possible action (as indicated in paragraph 4) to minimize the effects of the jamming and to continue effective operation. With training and practice the operator can learn to distinguish between various types of interference and jamming by the scope patterns produced and to take the necessary counteraction.

2. Types of Jamming

Jamming is generally divided into two categories. One is transmission jamming, which is produced by a transmitter radiating modulated or unmodulated radio-frequency signals. The other is reflected jamming, which is produced by reflecting devices intended to produce false targets or to obscure real target signals on the radar scope. The references given in paragraph 5 of this appendix will aid in training the operator.

a. Transmission jamming. Transmission jamming will usually have directional characteristics. The type and strength of the jamming will determine whether strobe lines or sector blanking will occur in the direction from which the jamming is arriving. However, extremely strong jamming signals that come from enemy transmitters close to the radar set may obscure, or completely saturate, the radar scope. The direction from which the jamming is received cannot be determined under such conditions. In counter-countermeasures, it is important to note the *direction of* the jamming
signal whenever it has directional characteristics so that steps can then be taken to reduce the effectiveness of the jammer. Transmission jamming is divided into two categories as follows:

(*1*) *Continuous-wave jamming.* Continuous-wave (c-w) jamming is. the transmission of unmodulated radio-frequency (r-f) signals close to, or at, the frequency used by the radar being jammed, to overload or block the radar receiver. Weak c-w signals appear on the indicator as a moderately bright narrow sector in the direction of the jammer; sometimes, target echoes can be seen through the interference. Stronger *jamming* signals will produce additional bright sectors; the main sector will be wider and brighter. The smaller bright sectors are produced by the side lobes of

the radar set antenna. Target echoes, in directions corresponding to the bright sectors, will be hidden. Very strong c-w signals can block the receiver and thereby remove all target signals from the indicator.

(*2*) *Modulated jamming.* Modulated jamming is the transmission of r-f signals that are modulated to produce interference patterns on the radar scope that is being jammed. F-m and a-m are used, and their effects are similar except that f-m may result in a more weaving pattern. When jammed with a modulated signal, the PPI scope shows strobe lines (thin lines, straight or curved, running from the center to the edge of the scope, or vice versa). The strobe lines, in the direction of the jammer, may be so close together that they may appear as a sector. Noise jamming is another common type of modulated jamming and its effect on the indicator is similar to that of amplitude-modulated jamming, but it shows no regular pattern.

(*3*) *Barrage and spot jamming.* Transmission jamming can be classified ac- cording to the bandwidth occupied by the jamming signal. Barrage jamming operates over a wide band of frequencies and jams all radar sets operating within this band. Since the total available jammer power is used over a wide band, the power per channel is less than that of a spot jammer. Spot jammers produce a jamming signal on only one frequency or over a very narrow band of frequencies. Therefore, spot jammers must operate at, or close to, the frequency of the radar set. To make this possible, the enemy must carefully monitor the radar to be jammed. Because the power of spot jammers is concentrated in a narrow frequency band, smaller transmitters can be used. Noise-modulated and f-m jammers are used for barrage jamming, and c-w and ordinary a-m jammers are used for spot jammers.

b. Reflected Jamming. Reflected jamming is produced by the use of special reflecting devices to return to the radar set large amounts of r-f energy. It is used to create false echoes, or to produce large echoes intended to obscure real target echoes. This type of jamming is divided into two categories.

(*1*) *Window jamming* is produced by the reflection of the energy transmitted from the radar set by a great quantity of metallic material called *window,* or chaff. *Window* is usually dropped from aircraft, though it may be dispersed from artillery shells and guided missiles. When enough *window is* dropped, the false echoes may have the appearance of indications caused by adverse weather conditions, such as clouds and rain squalls. The jamming may be identified as a trail behind the aircraft that is dropping the *window.* The echoes usually beat violently as long as they are visible, and the pattern becomes wider and more ragged as the window floats towards the ground.

(*2*) *Miscellaneous reflected jamming* is produced by corner reflectors, rope, metallized mesh, and either stable, rotating, or oscillating dipoles. These devices produce strong false echoes, which are intended to draw attention from real target echoes or to deceive tracking radar sets. This tactic usually is called *deception* rather than *jamming.*

3. Location of Jamming

When interference is received and appears to the radar operator as deliberate enemy jamming, the operator must immediately report and record the incident, the time and type of jamming, and the direction from which the jamming signals are received. When this information is received from two radar sources, the exact location and movement of the jammer can be determined.- The information can be used by higher authorities to relocate the vessel that is carrying the radar set, or to take the jamming transmitter under active fire with gun, missile, or aircraft. Readings and reports on the jamming should continue as long as jamming is observed.

4. Procedure for Operation Against Radar Jamming

After the type and direction of the interference have been determined, the operator of the radar set should follow the procedures below to reduce the effectiveness of the jamming. Some of the procedures are especially applicable to certain types of jamming signals, but, if feasible, all procedures should be tried to obtain the best performance of the equipment. All controls are on the control-indicator unless otherwise noted.

a. General.

(1) Vary the GAIN control over its entire range to obtain an optimum setting. The GAIN control varies the receiver sensitivity. If the receiver is over- loaded, or blocked by jamming signals, reducing the gain will often help to correct this trouble.

(2) Vary the CONTRAST control over its entire range for an optimum setting. The CONTRAST control varies the brightness of all signals (target echoes and range markers) that are sent to the PPI.

(3) Vary the INTENSITY control for an optimum setting. Normally, this control should remain in the position indicated by the calibration record chart; under certain jamming conditions, varying this control may improve the PPI presentation.

Note. Because the GAIN, CONTRAST, INTENSITY, and FOCUS controls affect the electron stream within the cathode-ray tube, they should be varied simultaneously. For example, if the CONTRAST control is varied after the GAIN control has been set at an optimum condition, the GAIN control should be reset, because a new optimum setting may exist.

(4) Vary the FOCUS control for maximum definition.

(5) Vary the SUPPRESSOR control over its entire range for clearest scope presentation. This control causes a reduction in receiver gain immediately following the transmitter pulse and a gradual increase of gain as the range increases. The SUPPRESSOR is especially useful for viewing tar- gets near the center of the scope. However, this control must be used carefully. Too little SUPPRESSOR action will unduly brighten the center of the scope, while too much SUPPRESSOR action may blank out near- by signals

(6) Turn the FTC switch to the ON position. The FTC switch is normally used to minimize scope clutter (heavy rain- or snow, sea return, and large land masses).

(7) Turn the AFC OPER-MANUAL TUNING switch (located on the receiver) to the MANUAL TUNING position, and vary the REFLECTOR TUNING control (located on the receiver) so that target echoes can be seen easily on the indicator. Use the phone connections supplied in the radar set for intercommunication if the receiver-transmitter and the indicator are widely separated. If target echoes are still difficult to see, retune the receiver.

(8) Depress the TEST switch on the secondary control panel to operate the echo box. Eight to twelve spokes will appear on the PPI to be used for receiver tuning. Turn the GAIN control so that the spokes are clearly seen through the jamming, and then vary the REFLECTOR TUNING (on the receiver) control for maximum spoke length (optimum tuning). Release the TEST switch and adjust the GAIN control until the target echoes can be seen.

(9) Operate the RANGE control to change the range of the radar set for optimum condition. The type of jamming and the range of the target to be observed may determine a different range than that which is normally used, to minimize the effect of the jamming.

(10) Turn the CENTER switch. This control may be used in conjunction with the RANGE control to reduce the effects of jamming without sacrificing accuracy.

b. Transmission Jamming.

(1) Reduce the receiver gain if the jamming signal overloads, or blocks, the receiver. However, if the jamming signal is not strong enough to over- load the receiver, increasing the gain may improve operations. The methods explained in a(2), (3), and (4) should also be applied for optimum performance.

(2) The FTC switch is especially useful against jamming signals which are amplitude modulated at 100 kc or less.

(3) Changing the local oscillator frequency, (a(7) and (8) above) is especially useful against transmission jamming.

(4) Radar sets are difficult to jam unless line-of-sight orientation exists between the jammer and the radar. Whenever possible, ships (upon which the radar set is installed) should take advantage of any artificial or natural barrier. For example, if a land-based jammer is operating against the ship- borne radar and an island lies between the jammer and the ship, it may be possible for the ship to navigate so that the island is always between the ship and the jamming transmitter.

(5) If the jammer is located outside a sector of particular interest, and is jamming through the side lobes of the radar antenna, the effectiveness of the jamming signals may be decreased by erecting a shield of metal screening, backed with a signal-absorbing material between the radar and the jammer. The metal side should face the jammer so that the jamming signals will be reflected. The radar signals will be absorbed by the screen and will not be reflected back into the receiver.

c. Window Jamming.

(1) The FTC switch should be used to break up clutter that is caused by window.

(2) Adjust the FOCUS control for best focusing. Reduce the CONTRAST control to obtain maximum definition. Vary the GAIN and SUPPRESSOR controls to improve the definition. Because window usually appears as many closely spaced targets (clutter), good definition will help to separate targets from the window. Search for targets outside the area filled with window. Carefully examine the speed of a moving target that enters the window-jammed area. The moving target can then be located when it passes through a hole or break in the window, or if it leaves the jammed area.

5. References

For further information on antijamming procedures, refer to TM 11-750, TM 11-751, and field maintenance literature for Radar Set AN/SPN-18(*).

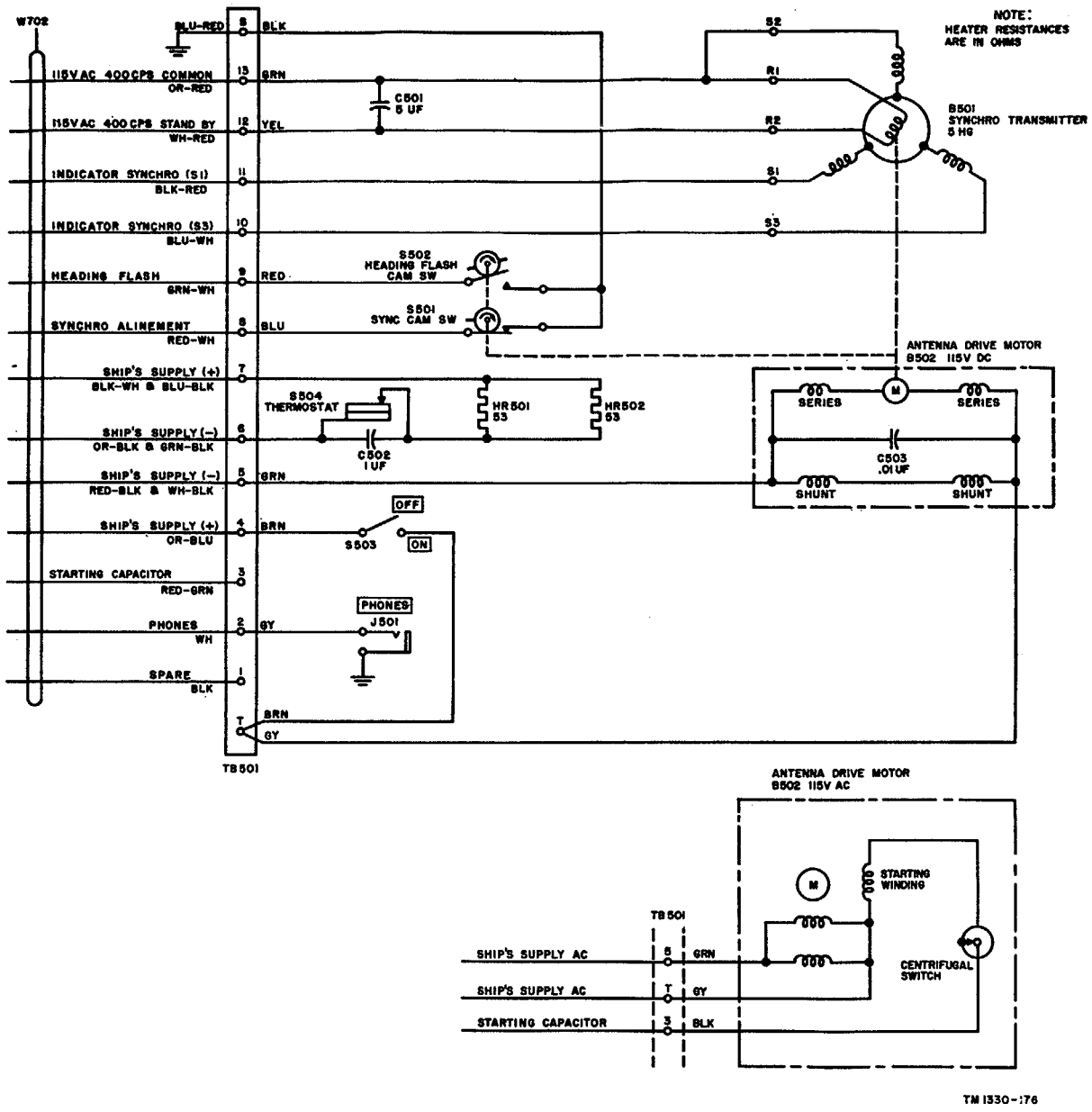


Figure 93. Antenna AS-659/SPN-18, schematic.

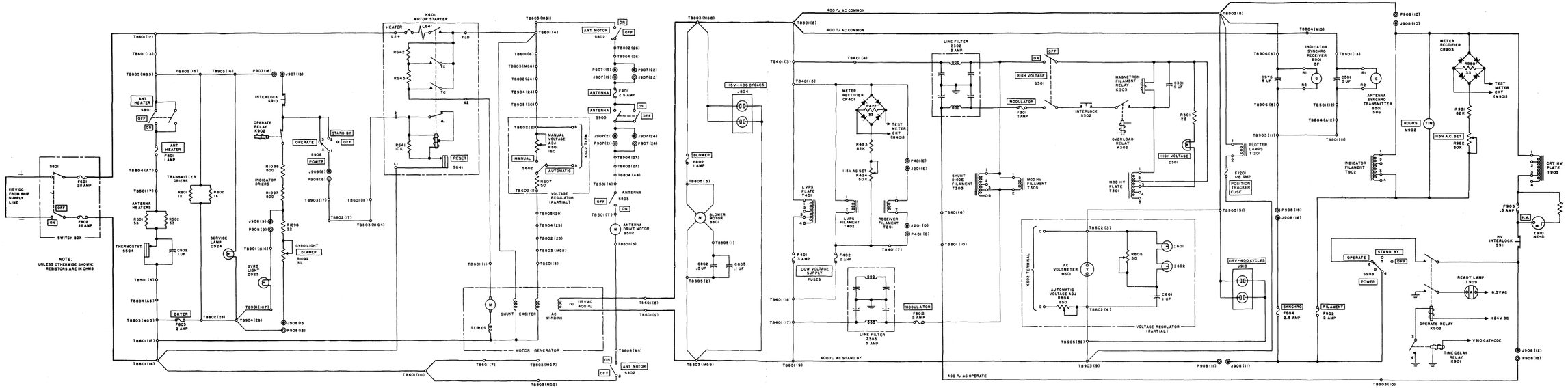


Figure 94. Radar Set AN/SPN-18, primary power distribution schematic

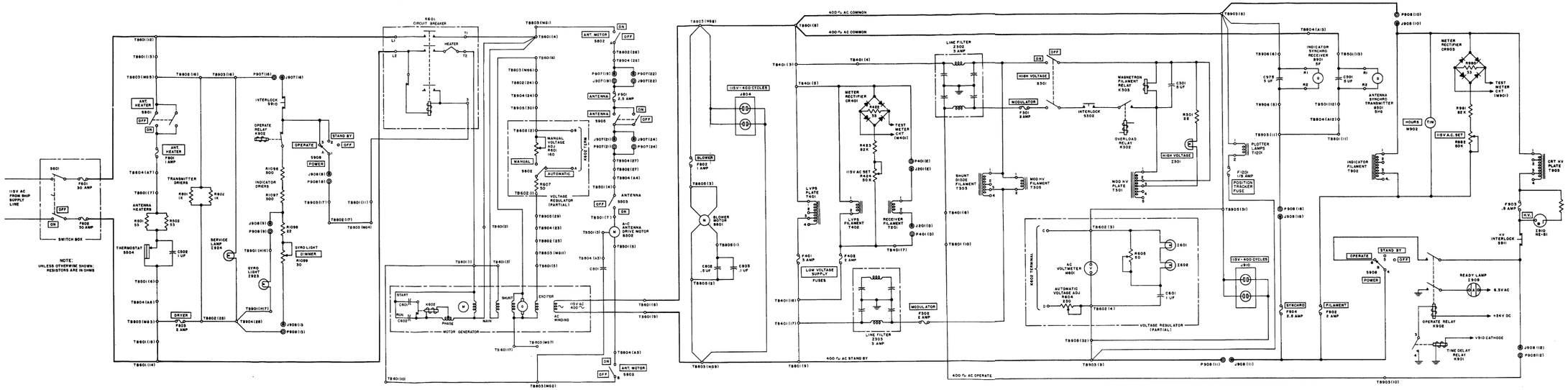


Figure 95. Radar Set AN/SPN-18X, primary power distribution schematic

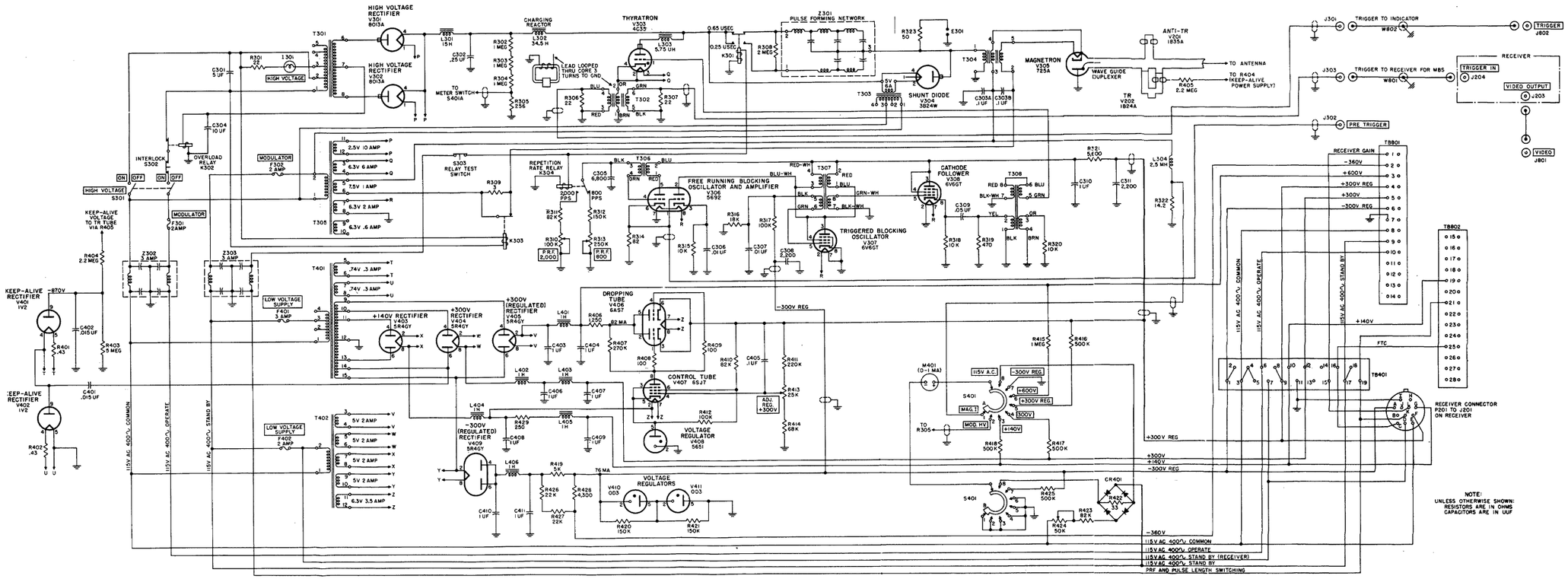


Figure 97. Radar Receiver - Transmitter RT-290/SPN-18, transmitter and power supply schematic.

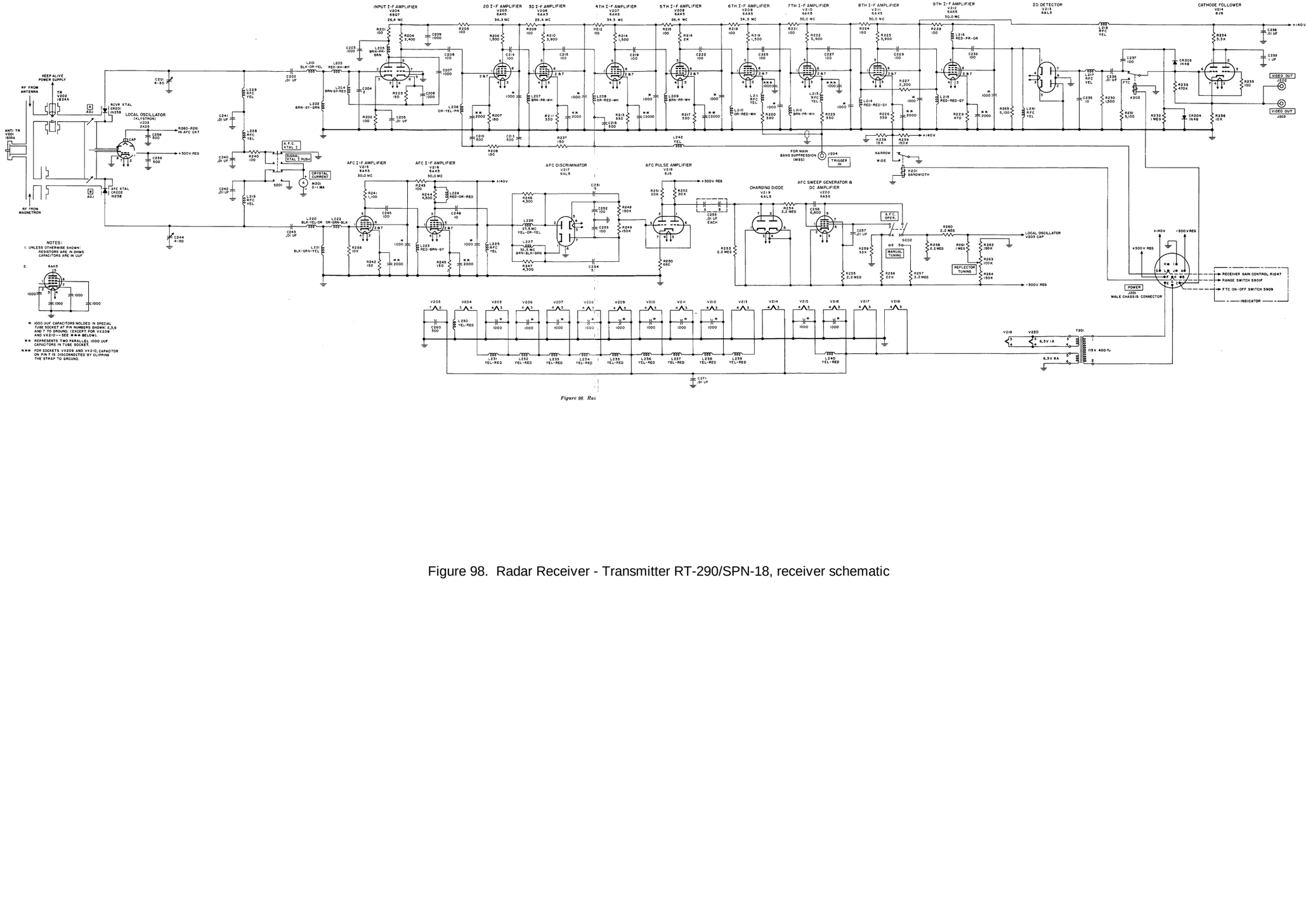
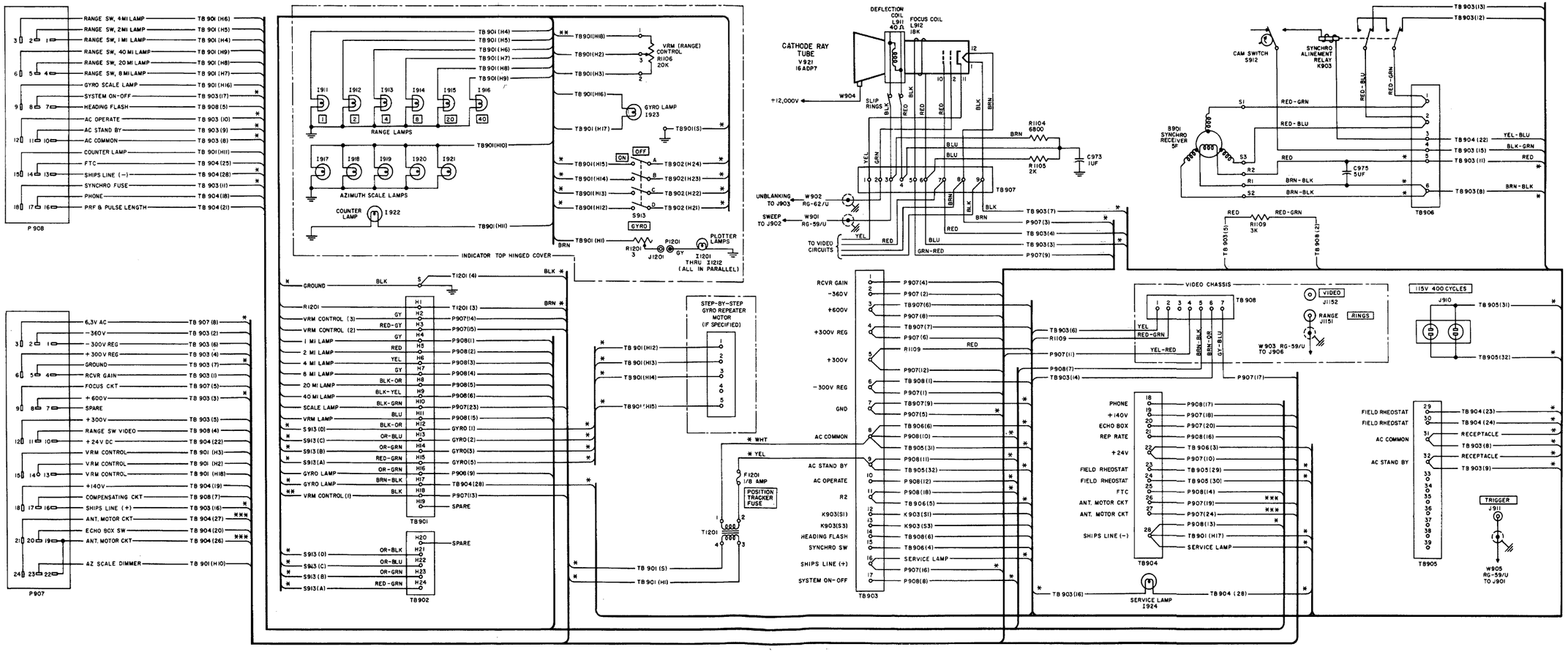


Figure 98. Rad

Figure 98. Radar Receiver - Transmitter RT-290/SPN-18, receiver schematic



NOTES:
1. UNLESS OTHERWISE SHOWN: RESISTORS ARE IN OHMS.
2. * 20 WIRE IS USED, UNLESS OTHERWISE SPECIFIED.
   * INDICATES #16 WIRE.
   ** INDICATES #18 WIRE.
   *** INDICATES #14 WIRE.
3. FOR MATCHING PLUGS AND JACK AND CONTINUATION OF CIRCUITS, SEE INDICATOR SCHEMATIC TM 1530-189.

Figure 99. Control-Indicator C-1261/SPN-18, cabinet schematic and intraconnection diagram.

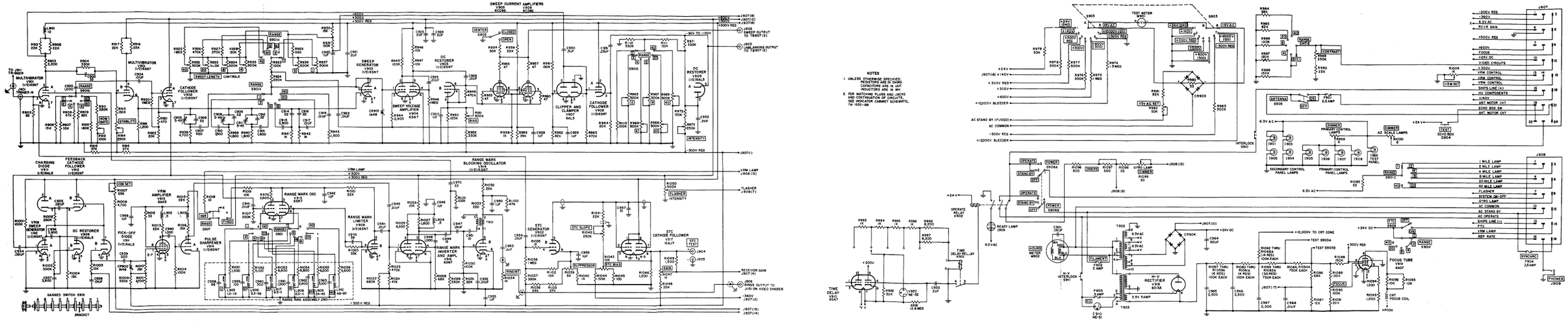


Figure 100. Control-Indicator C-1261/1SPN-18, indicator circuits schematic.

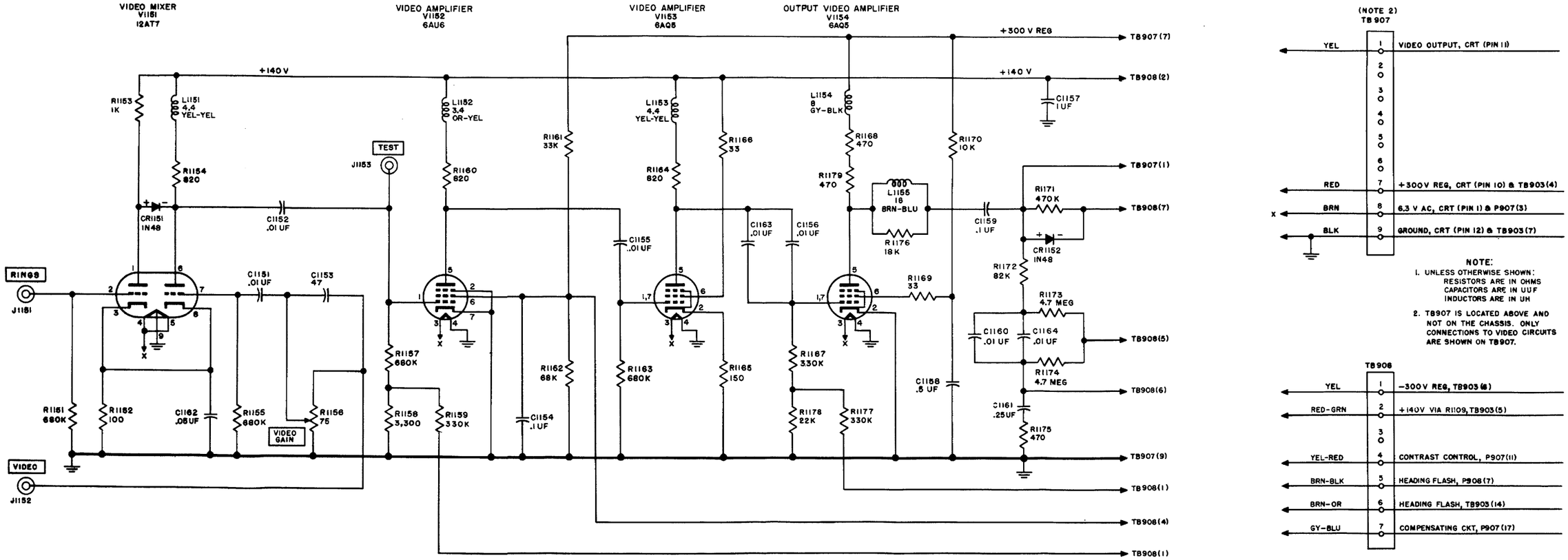


Figure 101. Connector-Indicator C-C-1261/SPN-18, video circuits chassis schematic.

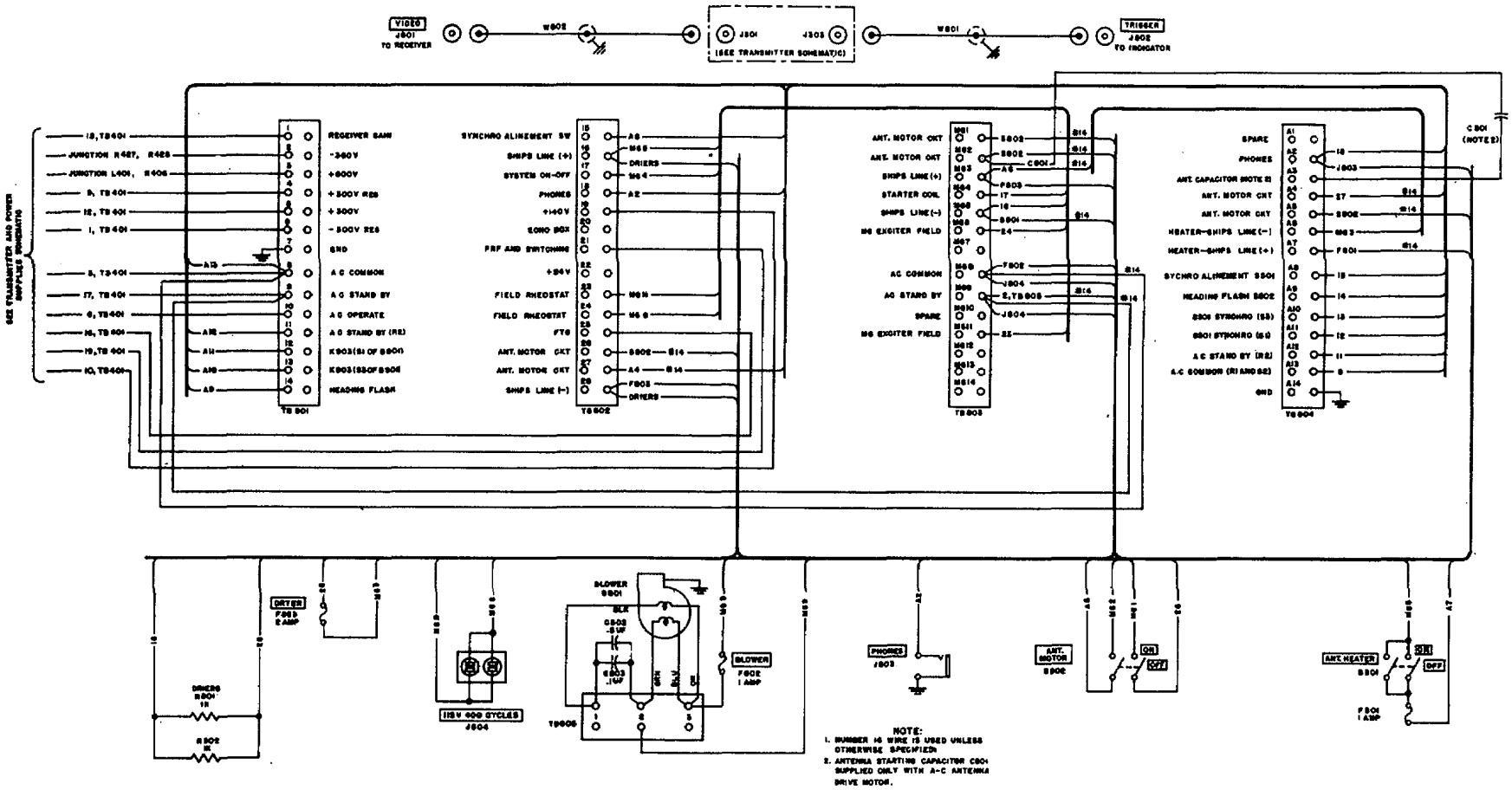


Figure 96. Radar Receiver-Transmitter RT-290/SPN-18, cabinet schematic and intarconnection diagram.

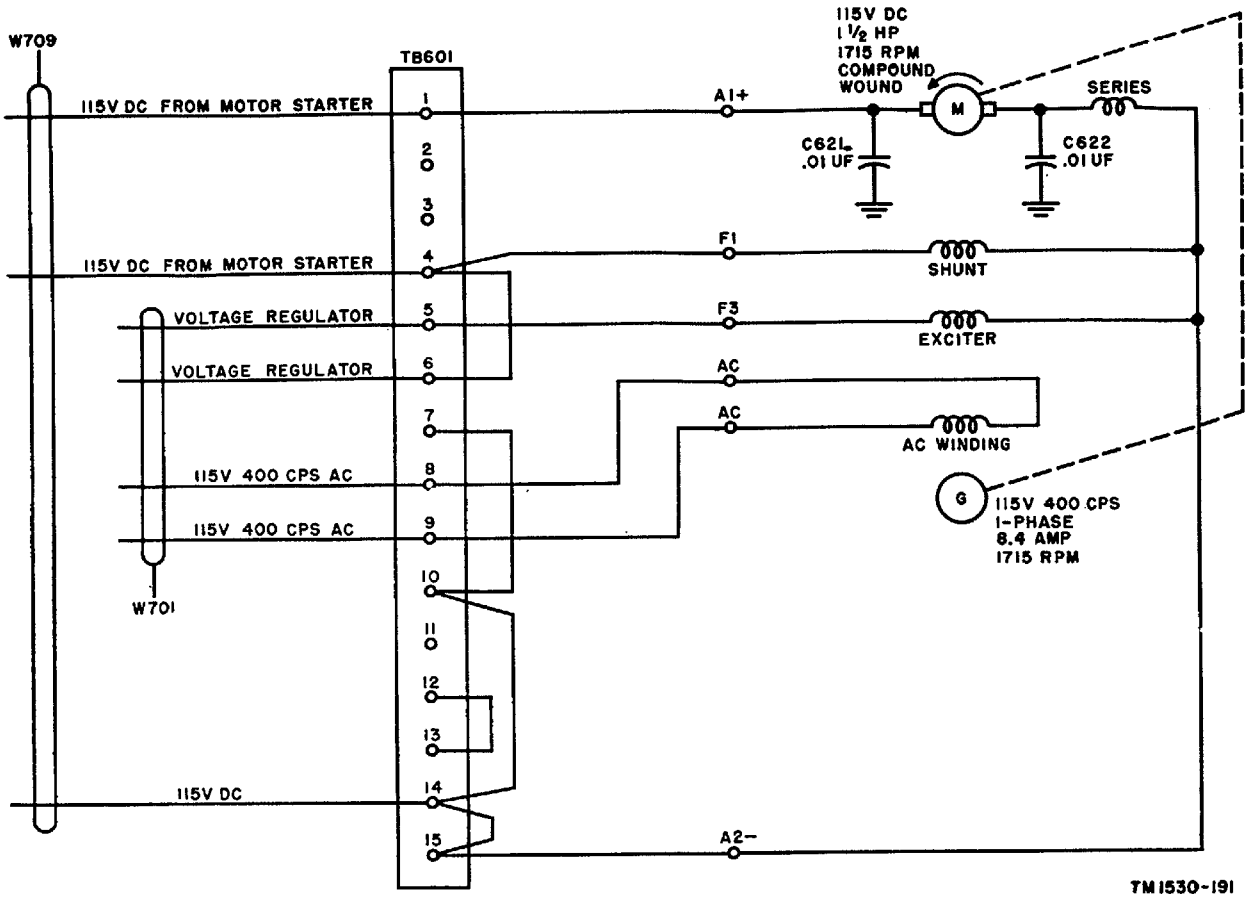


Figure 102. Motor Generator PU-243A/SPN-11, schematic.

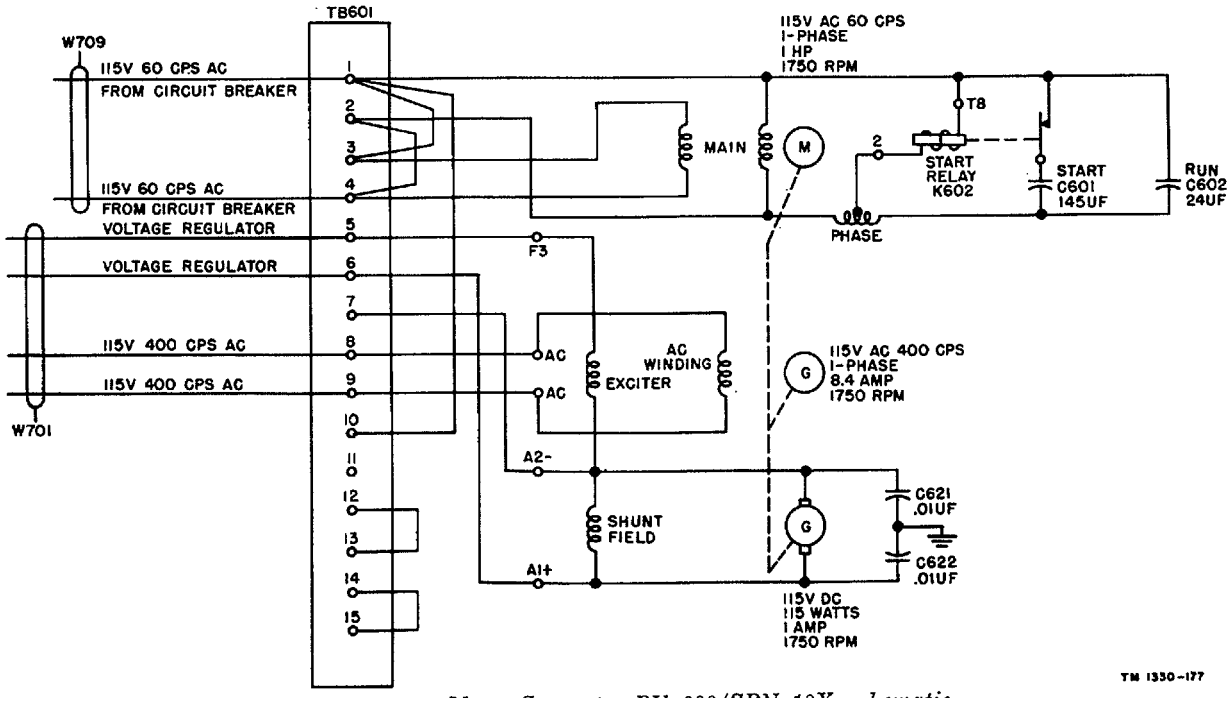


Figure 103. Motor Generator PU-288/SPN-18X, schematic.

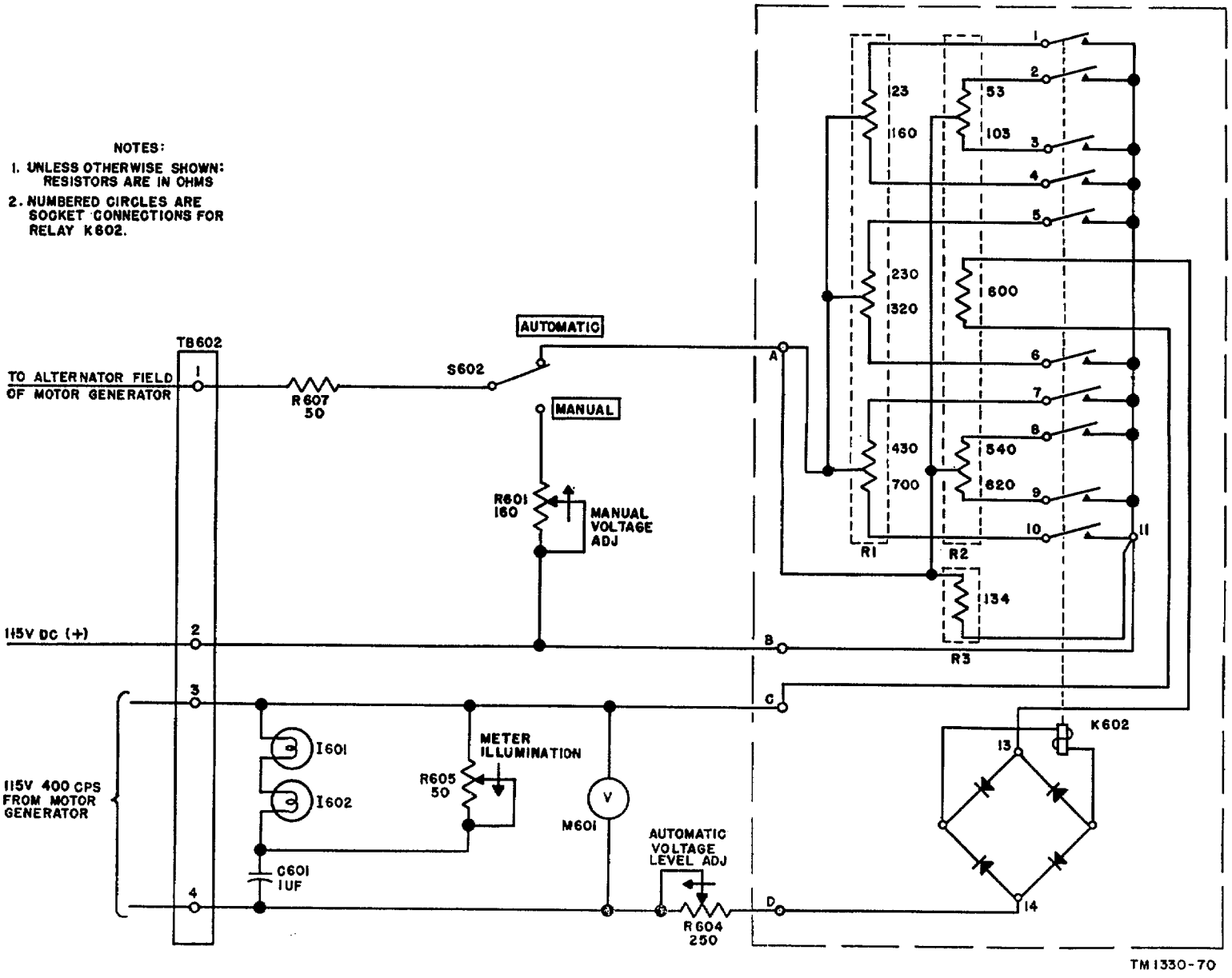


Figure 104. Voltage Regulator CN-225/SPN-18, schematic.

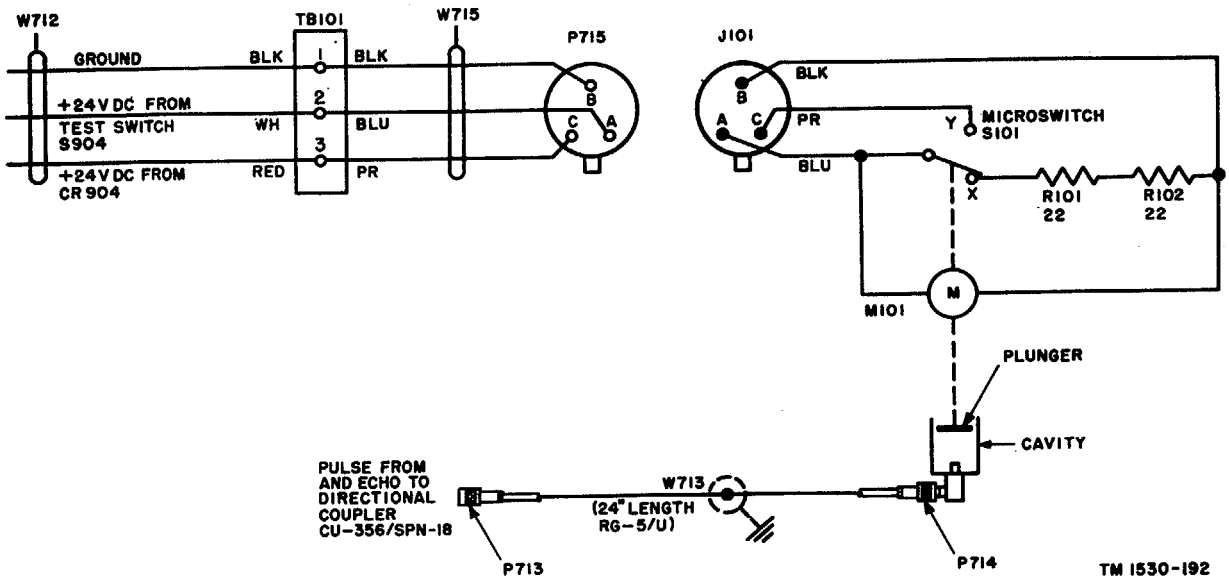


Figure 105. Tuned Cavity TN-224/SPN-18, schematic.

[AG 413.44 (7 Dec 54)]

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