Copy 2

TM 11-1335

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

W/C1
W/C2

RADAR SETS

AN/SPN-11X, AN/SPN-11Y AND AN/SPN-11Z

INSTALLATION AND OPERATION

DEPARTMENT OF THE ARMY • OCTOBER 1952

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
TM 11-1335

RADAR SETS

AN/SPN-11X, AN/SPN-11Y AND AN/SPN-11Z

INSTALLATION AND OPERATION

DEPARTMENT OF THE ARMY • OCTOBER 1952

United States Government Printing Office
Washington : 1952

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *20 October 1952*

TM 11–1335 is published for the information and guidance of all concerned.

[AG 413.44 (6 Oct 52)]

BY ORDER OF THE SECRETARY OF THE ARMY:

J. LAWTON COLLINS
Chief of Staff, United States Army

OFFICIAL:
WM. E. BERGIN
Major General, USA
The Adjutant General

DISTRIBUTION:
Active Army:
Tech Svc (1); Tech Svc Bd (1); AFF Bd (ea Svc Test Sec) (1); AFF (5); AA Comd (2); OS Maj Comd (5); Base Comd (5); Log Comd (5); A (20); MDW (5); CHQ (2); FT (2); Sch (5) except 11 (25); PMS & T 11 (1); Gen Dep (2); Dep 11 (20) except Sig Sec, Gen Dep (10); Tng Div (2); POE (10), OSD (2); Lab 11 (5); Mil Dist (3); 4th & 5th Ech Maint Shops 11 (3); Two (2) copies to each of the following T/O & E's: 11–107; 11–127A; 11–128; 11–500, CA, CB, CC, CD; 11–587; 11–592; 11–597.
NG: Same as Active Army except one copy to each unit.
ORC: Same as Active Army except one copy to each unit.
For explanation of distribution formula, see SR 310–90–1.

CONTENTS

WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if operating personnel fail to observe safety precautions.

Be careful not to contact high-voltage connections or any power connections when working on or near this equipment. When working inside the radar set, after all the power has been turned off, always short-circuit the high-voltage capacitors.

EXTREMELY DANGEROUS VOLTAGES

exist in the following units:
Radar Receiver-Transmitter RT–268/SPN–11
Azimuth and Range Indicator IP–193/SPN–11

First Aid for Electric Shock

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only,* remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

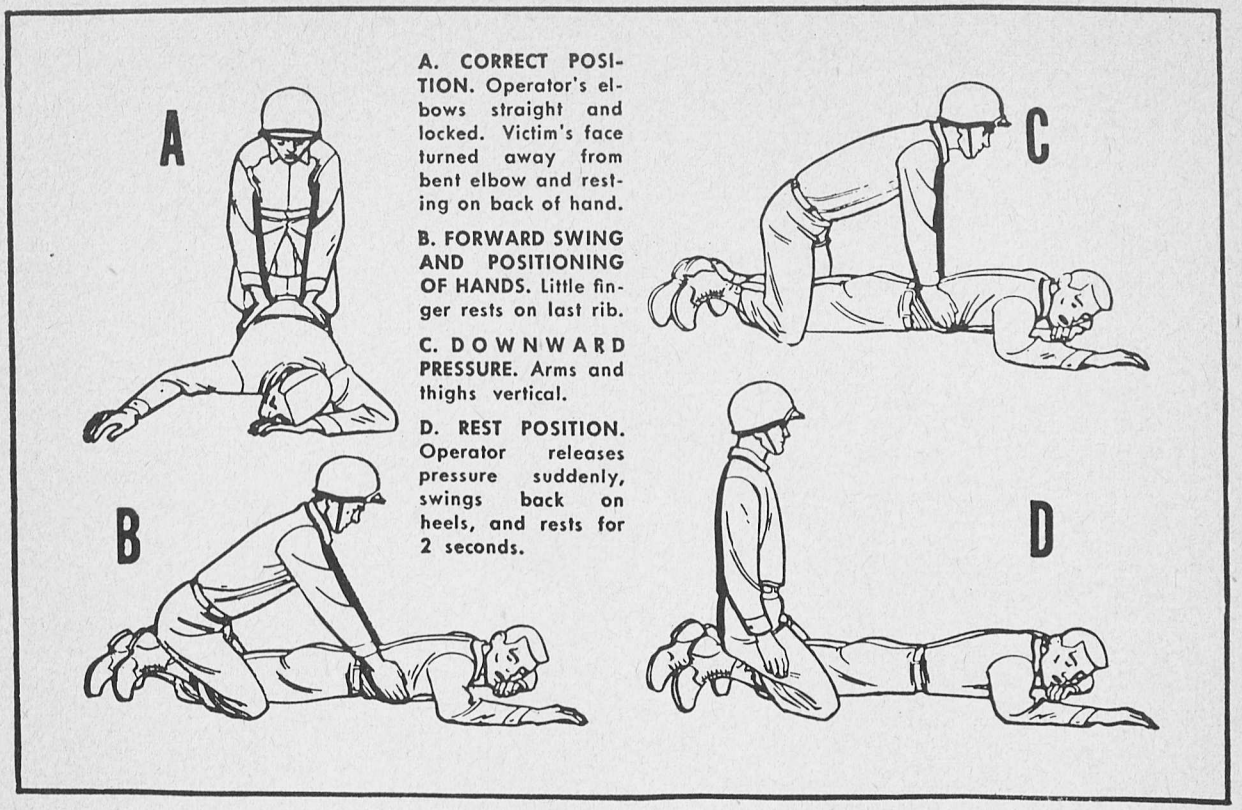
f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit up on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4



A. CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.

B. FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.

C. DOWNWARD PRESSURE. Arms and thighs vertical.

D. REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

TL 15338-E

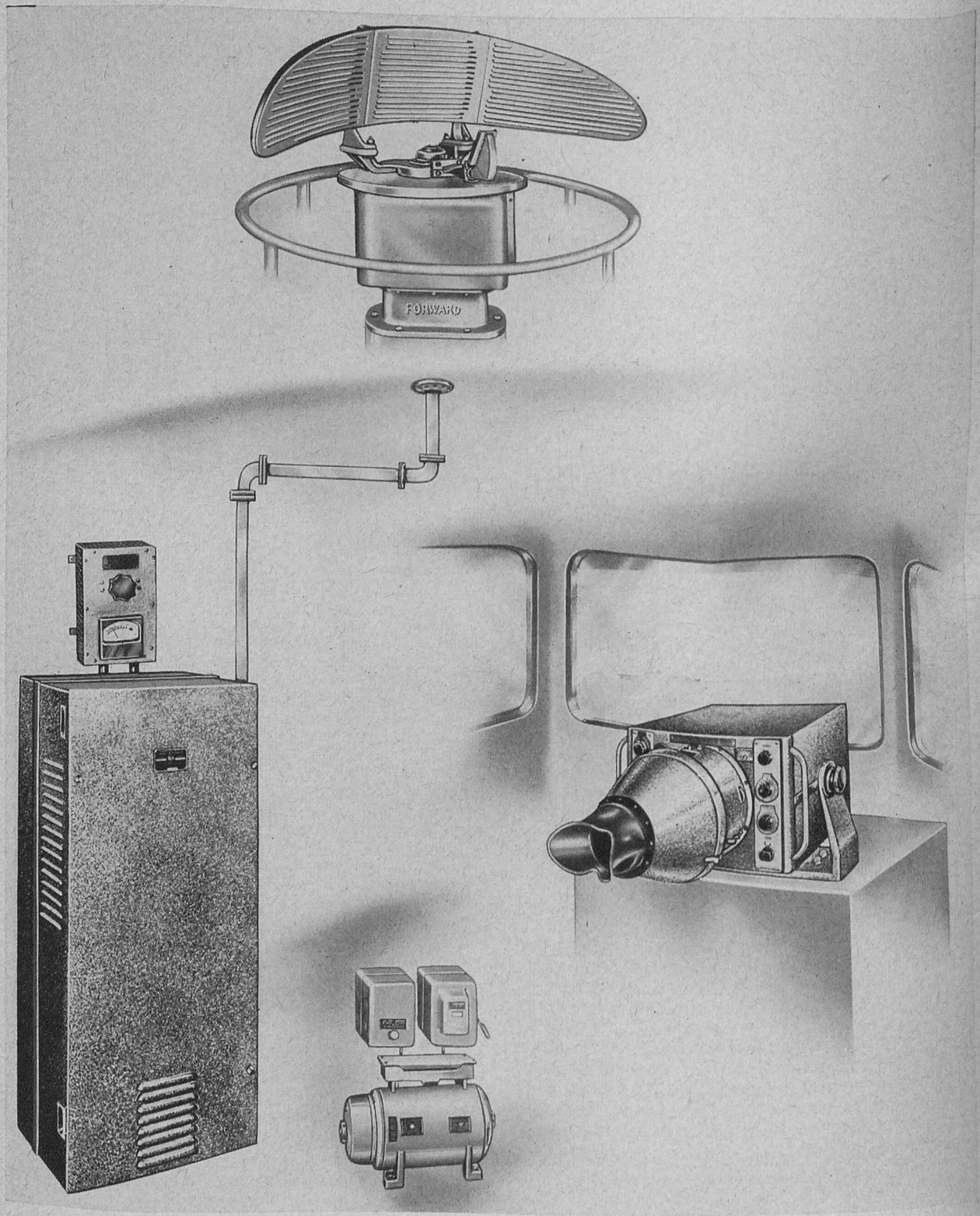


Figure 1. Radar Set AN/SPN–11(*).

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains instructions for the installation, operation, preventive maintenance, and trouble shooting (at organizational maintenance level) of Radar Sets AN/SPN–11X, AN/SPN–11Y, and AN/SPN–11Z.

b. Official nomenclature followed by (*) is used to indicate all models of the item of equipment included in this manual. Thus Radar Set AN/SPN–11(*) represents Radar Sets AN/SPN–11X, AN/SPN–11Y, and AN/SPN–11Z.

c. The basic nomenclature Radar Set AN/SPN–11 is used in this manual to indicate the group of components common to all models of Radar Set AN/SPN–11(*) (par. 17).

2. Forms and Records

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

a. DD Form 6, Report of Damaged of 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. USAF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel 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. 62).

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

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Radar Set AN/SPN–11(*) (fig. 1) is a shipboard navigational aid which provides position data on vessels and landmarks that are not visible because of fog or darkness. Over a range of 75 yards to 20 nautical miles, the radar set is used for the following purposes:

a. Anticollision data are obtained by observing the positions and courses of vessels on the open sea.

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

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

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

4. Technical Characteristics

a. Power Supply Requirements.

Radar Set:	*Shipboard supply*
AN/SPN–11X	115 volts, dc, at 1,000 watts.
AN/SPN–11Y	32 volts, dc, at 1,000 watts.
AN/SPN–11Z	24 volts, dc, at 1,000 watts.

227432—52——2

b. Radar Receiver-Transmitter RT–268/SPM–11.

Transmitter:	
Frequency	One preset channel in the 9,320- to 9,430-mc band. (3.22–3.18 cm.)
Modulation	Pulse.
Pulse width	0.4 usec.
Pulse repetition rate	1,000 cps.
Power output (peak)	30 kw.
Power output (average)	12 watts.
Source of r-f power	Magnetron, type 725A.
Range (approximate)	75 yards to 20 nautical miles.
Blower motor (input)	115, 32, or 24 volts, dc, from shipboard supply.
Number of tubes	18.
Radar Receiver R–480/SPN–11:	
Frequency	One preset channel in the 9,320- to 9,340-mc band.
Receiver type	Superheterodyne.
Intermediate frequency	30 mc.
Bandwidth	5 mc.
Type of signal	Pulse.
Number of tubes	16.
Duplexer CU–311/SPN–11:	
T/R tube	1B24A.
Anti-T/R tube	1B35.
Frequency Mixer Stage CV–239/SPN–11:	
Afc crystal	1N23B.
Mixer crystal	1N23B.
Oscillator (Klystron)	2K25 or 723A/B.
Intermediate frequency	30 mc.

c. Azimuth and Range Indicator IP–193/SPN–11.

Ranges	1, 3, 8, and 20 nautical (or statute) miles.
Azimuth	Relative bearings, 0° to 360°.
Indicator	7-inch cathode-ray tube.
Type of presentation	Plan position indicator.
Number of tubes	10.

d. Antenna AS–599/SPN–11.

Type of feed	Horn.
Reflector	Parabolic.
Frequency range	9,320 to 9,430 mc.
Input impedance	400 to 500 ohms.
Beam width:	
Horizontal	1.9°.
Vertical	20°.
Bearing resolution	2°.
Attenuation of back and side lobes.	25 db.
Rotation speed	17 rpm.
Synchro gearing to antenna	10 to 1.
Drive motor (input)	115, 32, or 24 volts, dc, from shipboard supply.

e. Motor Generator.

Motor:	
Input	115, 32, or 24 volts, dc, from shipboard supply.
Field	Compound wound.
Speed of rotation	1,715 rpm.
Generator:	
Input (to field)	115, 32, or 24 volts, dc, from shipboard supply.
Output	115-volt, 400-cycle, single-phase ac at 6.5 amperes (750 va). (For all radar set components, except heaters and blower and drive motors.)

5. Packaging Data

a. General. When packed for shipment, the components of Radar Set AN/SPN–11(*) are placed in moistureproof-vaporproof containers and packed in nine wooden crates. A cutaway view of a typical shipping crate and its contents is shown in figure 23.

b. Packaging Data Chart.

Note. Items may be packed differently from that shown, depending on supply channel.

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1	53	30	24	22. 1	350	Receiver-transmitter (less blower motor).
2	31	30	23	12. 4	160	Indicator.
3	72	31	26	33. 5	280	Reflector, horn, hood, magnifying glass, switch box, voltage regulator, and technical manuals.
4	33	32	30	18. 3	245	Antenna pedestal (less drive motor and heaters).
5	25	18	14	3. 6	200	Motor generator.
6	146	10	10	8. 5	150	Waveguides and accessories.
7	53	31	24	22. 8	250	Cables.
8	34	23	23	10. 4	76	Antenna drive motor, blower motor, and antenna heaters.
9	34	23	23	10. 4	168	Running spares.
Total weight (lb.)					1, 879	

6. Nomenclature Assignments

The letter suffixes X, Y, and Z are used as voltage designators. Thus basic nomenclature followed by X, Y, or Z indicates that the component or radar set operates on a d-c (direct-current) supply source of 115, 32, or 24 volts, respectively. A list of the nomenclature assignments for the components of Radar Set AN/SPN–11(*) is given below. A common usage name is indicated after each component.

Nomenclature	*Common name*
Radar Receiver-Transmitter RT–268/SPN–11	Receiver-transmitter.
Radar Receiver R–480/SPN–11	Receiver.
Antenna AS–599/SPN–11	Antenna.
Duplexer CU–311/SPN–11	Duplexer.
Azimuth and Range Indicator IP–193/SPN–11	Indicator.
Junction Box J–497/SPN–11	Junction box.
Resistance Element HD–123/SPN–11	Heater (24- or 32-volt).
Resistance Element HD–124/SPN–11	Heater (115- or 230-volt).
Switch Box SA–283/SPN–11	Switch box (24- or 32-volt).
Switch Box SA–284/SPN–11	Switch box (115- or 230-volt).
Motor-Generator PU–243/SPN–11	Motor generator (115-volt input).
Motor-Generator PU–244/SPN–11	Motor generator (24-volt input).
Motor-Generator PU–245/SPN–11	Motor generator (32-volt input).
Motor Starter SA–285/SPN–11	Starter (24-volt).
Motor Starter SA–286/SPN–11	Starter (32-volt).
Motor Starter SA–287/SPN–11	Starter (115-volt).
Frequency Mixer Stage CV–239/SPN–11	Mixer.
Voltage Regulator CN–192/SPN–11X	Voltage regulator (115-volt).
Voltage Regulator CN–193/SPN–11Y	Voltage regulator (32-volt).
Voltage Regulator CN–194/SPN–11Z	Voltage regulator (24–volt).

7. Table of Components

a. Radar Set AN/SPN–11X (115 VOLTS DC).

Component	Reqd No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Radar Receiver-Transmitter RT–268/SPN–11	1	43 5/8	13 3/4	20 5/8	7. 15	215
Azimuth and Range Indicator IP–193/SPN–11	1	16 3/8	18	19	3. 24	60
Antenna AS–599/SPN–11	1	33 3/4	22 1/2	50	21. 97	155
Drive motor (115 v dc)	1					
Blower motor (115 v dc)	1					
Resistance Element HD–124/SPN–11	2					
Motor-Generator PU–243/SPN–11	1	13 3/4	19 1/2	9 1/4	1. 43	170
Motor Starter SA–287/SPN–11	1	9 1/2	6 13/16	6 29/32	. 255	13
Voltage Regulator CN–192/SPN–11X	1	11 1/2	5 1/2	8 3/8	. 30	8
Junction Box J–497/SPN–11	1	14 1/8	3 3/4	6 3/4	. 21	5
Switch Box SA–284/SPN–11	1	7	4	6 3/4	. 109	4 1/4
Waveguide sections (fig. 16)						
Cables (par. 14).						
Technical manual	1	10 1/4	1/8	7 7/8	. 01	3/4
Total					34. 674	631

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

b. Radar Set AN/SPN–11Y (32 Volts DC).

Component	Reqd No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Radar Receiver-Transmitter RT–268/SPN–11	1	43⅝	13¾	20⅝	7. 15	215
Azimuth and Range Indicator IP–193/SPN–11	1	16⅜	18	19	3. 24	60
Antenna AS–599/SPN–11	1	33¾	22½	50	21. 97	155
Drive motor (32 v dc)	1					
Blower motor (32 v dc)	1					
Resistance Element HD–123/SPN–11	2					
Motor-Generator PU–245/SPN–11	1	13¾	19½	9¼	1. 43	170
Motor Starter SA–286/SPN–11	1	11 11/16	7⅛	8¾	. 410	19
Voltage Regulator CN–193/SPN–11Y	1	11½	5½	8⅜	. 30	8
Junction Box J–497/SPN–11	1	14⅛	3¾	6¾	. 21	5
Switch Box SA–283/SPN–11	1	11	5¼	10¼	. 343	8
Waveguide sections (fig. 16)						
Cables (par. 14)						
Technical manual	1	10¼	⅛	7⅞	. 01	¾
Total					35.063	640¾

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

c. Radar Set AN/SPN–11Z (24 Volts DC).

Component	Reqd No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Radar receiver-Transmitter RT–268/SPN–11	1	43⅝	13¾	20⅝	9. 15	215
Azimuth and Range Indicator IP–193/SPN–11	1	16⅜	18	19	3. 24	60
Antenna AS–599/SPN–11	1	33¾	22½	50	21. 97	155
Drive motor (24 v dc)	1					
Blower motor (24 v dc)	1					
Resistance Element HD–123/SPN–11	2					
Motor-Generator PU–244/SPN–11	1	13¾	19½	9¼	1. 43	170
Motor Starter SA–285/SPN–11	1	12	7⅛	8¾	. 432	19
Voltage Regulator CN–194/SPN–11Z	1	11½	5½	8⅜	. 30	8
Junction Box J–497/SPN–11	1	14⅛	3¾	6¾	. 21	5
Switch Box SA–283/SPN–11	1	11	5¼	10¼	. 343	8
Waveguide sections (fig. 16)						
Cables (par. 14)						
Technical manual	1	10¼	⅛	7⅞	. 01	¾
Total					35. 085	640¾

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

8. Antenna AS–599/SPN–11

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

a. Pedestal. The pedestal is a two-section, cast-aluminum housing which contains the azimuth drive components.

(1) The upper section (drive housing) has two removable covers and contains the following components:

(*a*) An antenna drive motor (fig. 3) to drive the rotating assembly.

(*b*) A synchro transmitter, also called a synchro generator (fig. 4), to synchronize rotation of the PPI sweep with rotation of the antenna.

(*c*) An antenna cam assembly (fig. 4) to actuate heading flash circuits in the indicator.

(*d*) Heater strips (figs. 3 and 4), capacitor C502 (fig. 4), and a thermostat (fig. 4) to maintain a reasonably constant temperature within the pedestal.

(*e*) Terminal board TB501 (fig. 3) for the drive motor switch, a telephone jack, and terminal stud screws (for cable W702).

(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 filter pipe extends into the upper section (fig. 4), and the oil gage can be checked by removing one of the covers from the upper section of the pedestal. 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) to which the antenna horn and reflector are bolted (fig. 2).

(1) The antenna horn is a special waveguide section with a sealed, rectangular plastic window. During transmission, the horn radiates r-f (radio-frequency) energy to the reflector; during reception, the horn receives r-f signal energy from the reflector.

(2) The parabolic reflector is made of cast aluminum, and the reflecting surface is protected by an anodized coating. During transmission, the reflector concentrates r-f energy into a narrow beam in the direction that the antenna is facing; during reception, the reflector picks up and directs signal energy into the antenna horn.

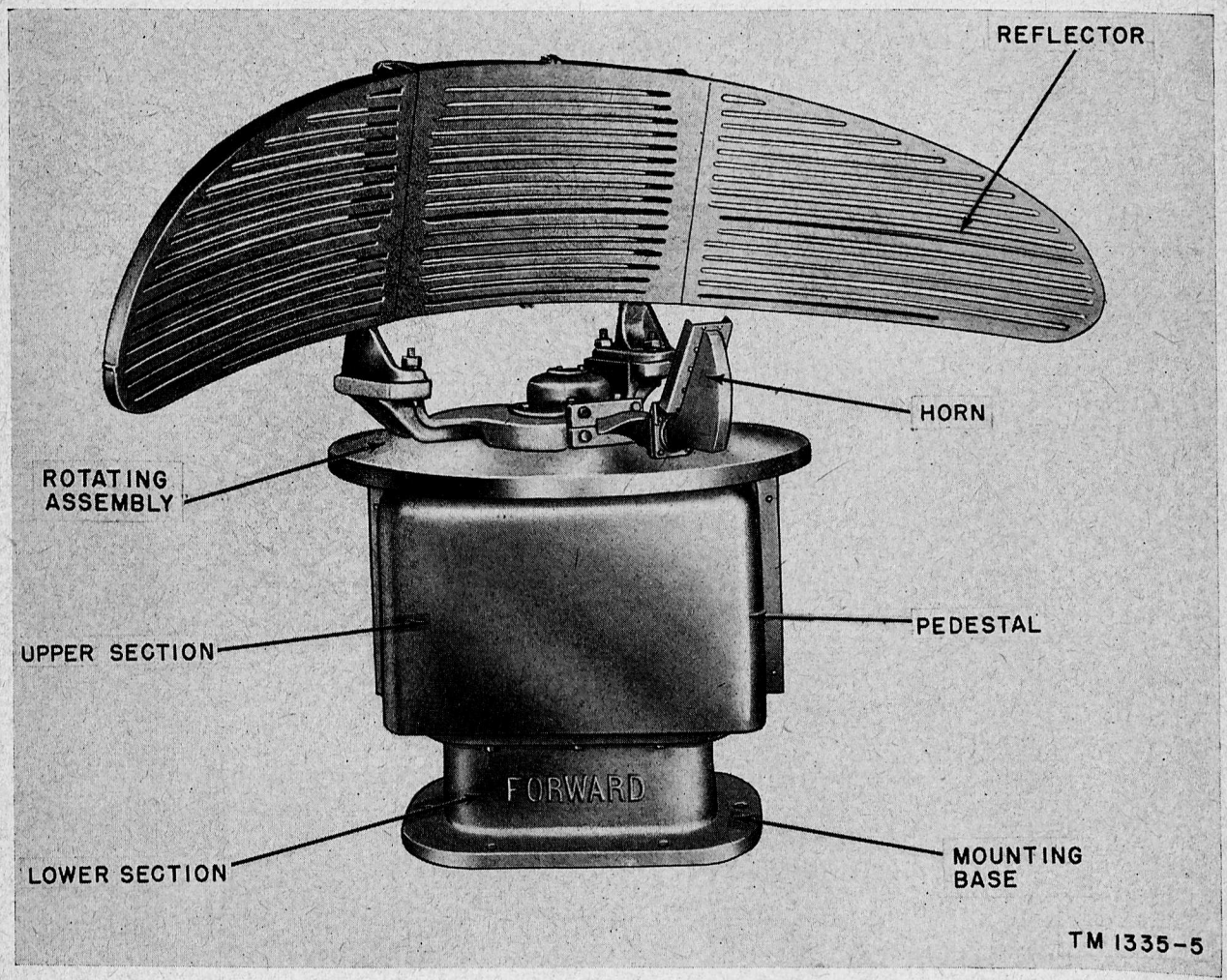


Figure 2. Antenna AS-599/SPN-11.

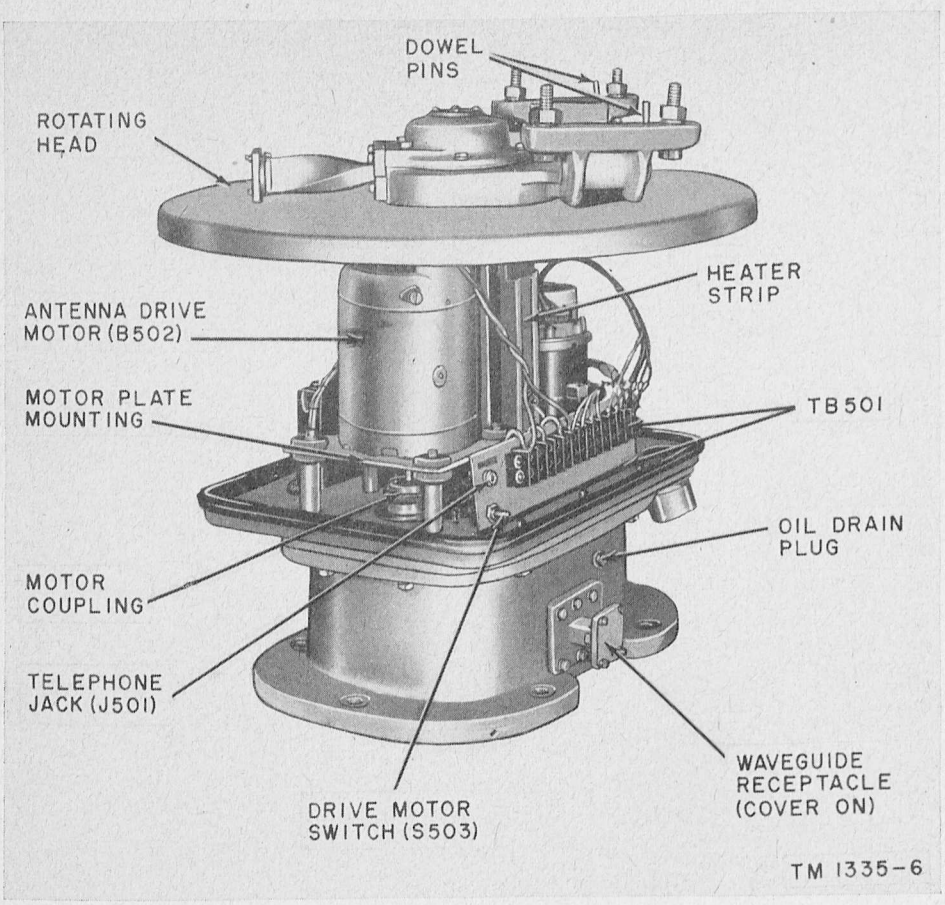


Figure 3. Antenna pedestal with covers removed, rear view.

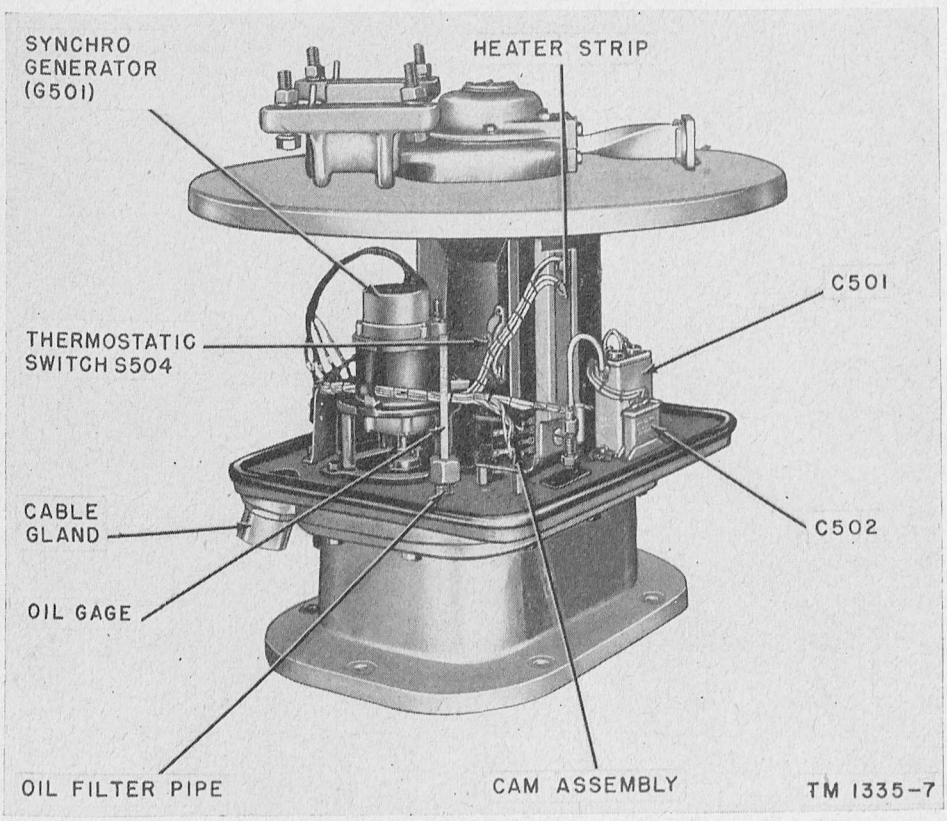


Figure 4. Antenna pedestal with covers removed, front view.

9. Radar Receiver-Transmitter RT-268/SPN-11

a. Receiver-Transmitter Cabinet. This cabinet contains the transmitter, receiver, power supplies, duplexer, transmitter test panel, convenience panel, and ventilating system components (figs. 5 and 6). The receiver, transmitter, duplexer, and power supply components are mounted on the front and back of a hinged panel. A convenience panel, a-c (alternating-current) outlets, and the air filter and blower motor are mounted on a subchassis just below the hinged panel, and terminal boards are mounted on the lower section of the back cover.

b. Transmitter. The magnetron assembly, hv, (high-voltage) transformer, filament transformer-pulse transformer, and certain l-v (low-voltage) power supply components are mounted on the front of the hinged panel. Other power supply and transmitter components are mounted on the rear of the hinged panel (fig. 6). The transmitter components, including the modulator components, on the rear of the panel are inclosed in a shielded compartment. The modulator components are mounted on a horizontal subchassis shelf within the shield, as shown in figure 7.

c. Radar Receiver R-480/SPN-11. The radar receiver chassis is mounted on the front of the hinged panel as shown in figure 5. Supply voltages

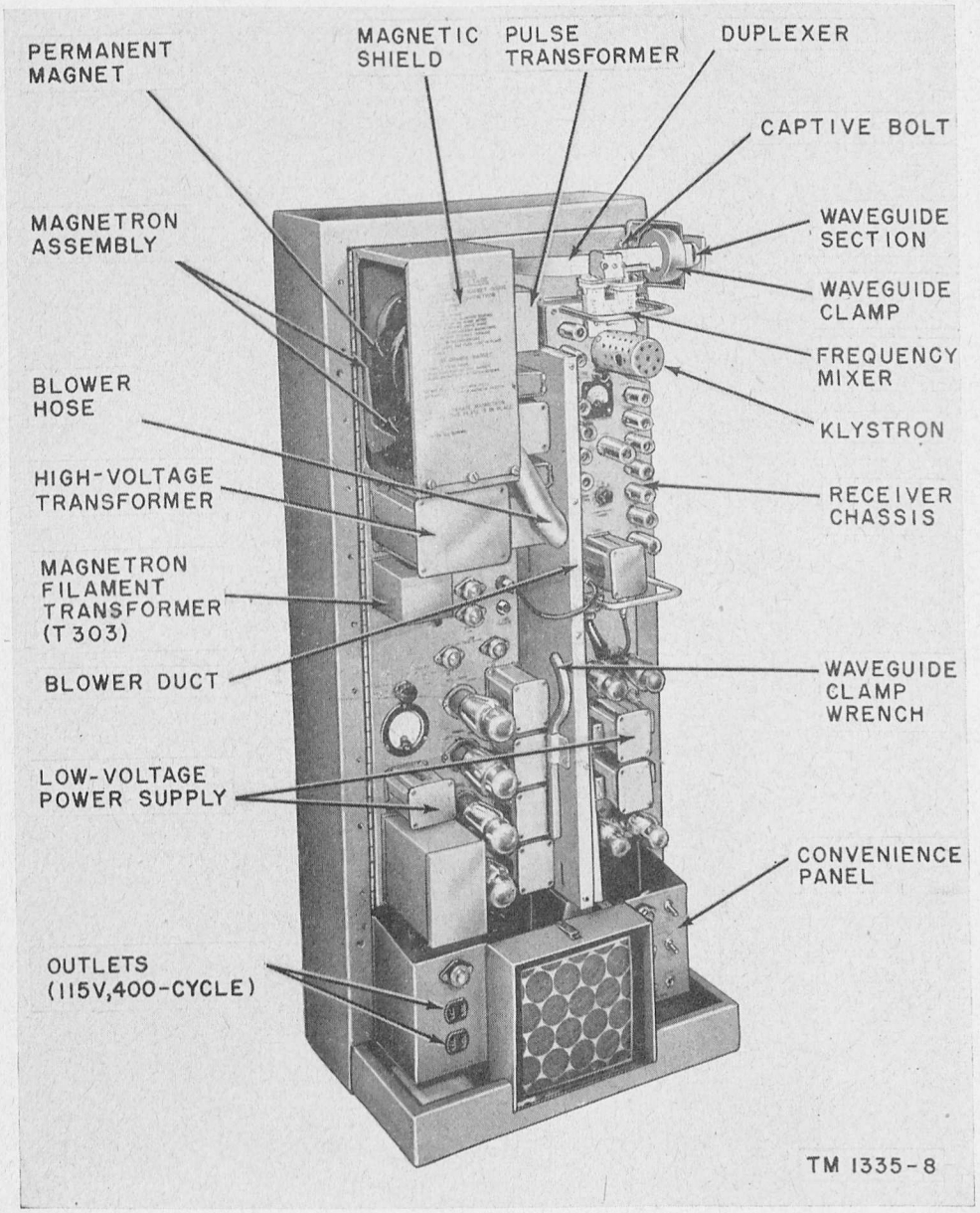


Figure 5. Receiver-transmitter, front cover removed.

for the receiver are obtained from the l-v power supplies.

d. Duplexer CU–311/SPN–11. The duplexer (fig. 5) contains the T/R (transmit-receive) and the anti-T/R tubes. The keep-alive voltage supply and T/R tube V202 are mounted on the rear of the hinged door (figs. 6 and 7).

Note. The T/R and the anti-T/R 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 frequency mixer stage includes the afc (automatic frequency control) and signal mixer crystals and the klystron oscillator (fig. 5). The unit is bolted to the duplexer and provides 30-mc (megacycle) input for the receiver i-f (intermediate-frequency) stages.

10. Azimuth and Range Indicator IP–193/SPN–11

The azimuth and range indicator includes a deflection coil assembly, synchro receiver (also called a synchro motor), PPI (plan position indicator), h-v supply for the cathode-ray tube and the operating controls for the radar set (figs. 8 and 9).

a. The top and bottom covers (fig. 8) are removed by loosening captive screws at the rear of the unit. A cast-aluminum trunnion is used to mount the indicator on a table, to an overhead bulkhead, or on the receiver-transmitter. Two adjustable knobs, one on each side of the unit, permit tilting and locking the indicator at an angle convenient for the operator. The operat-

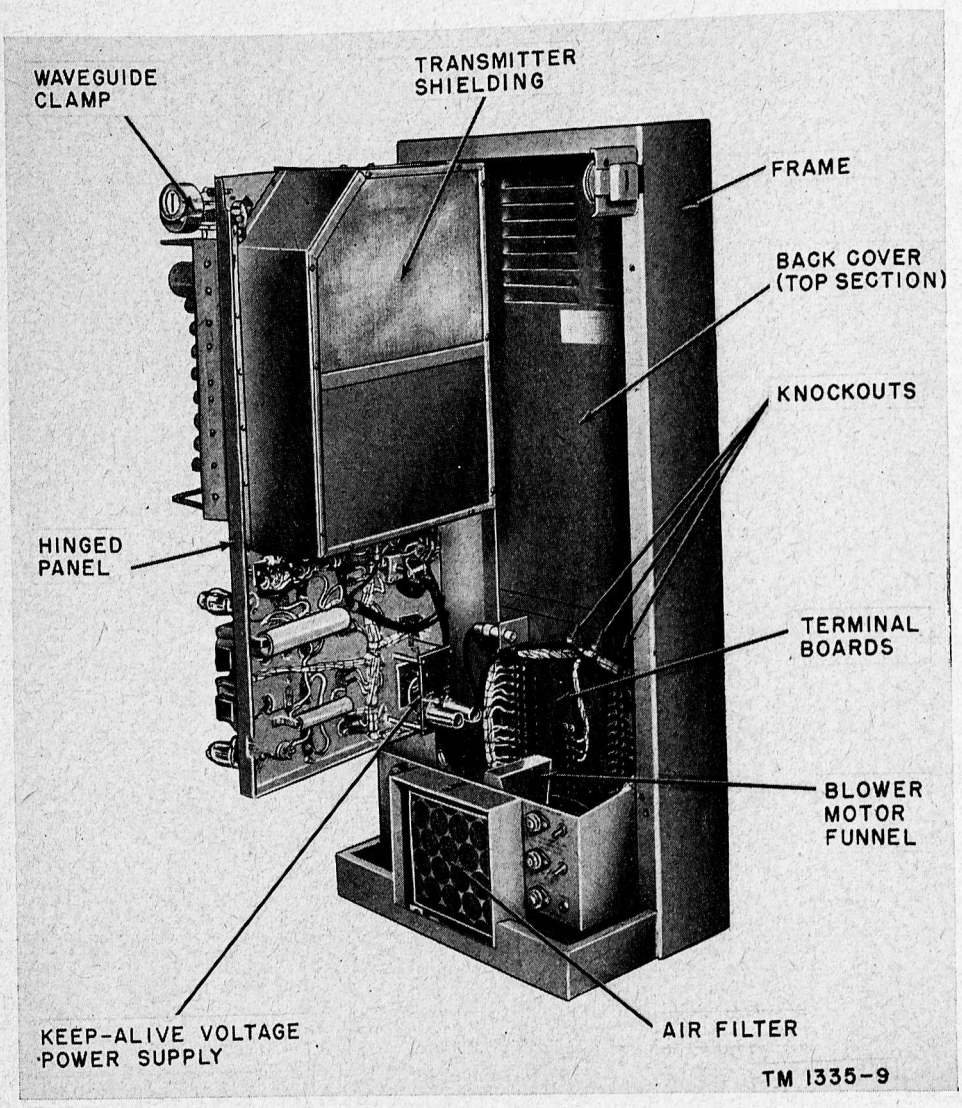


Figure 6. Receiver-transmitter, hinged panel open.

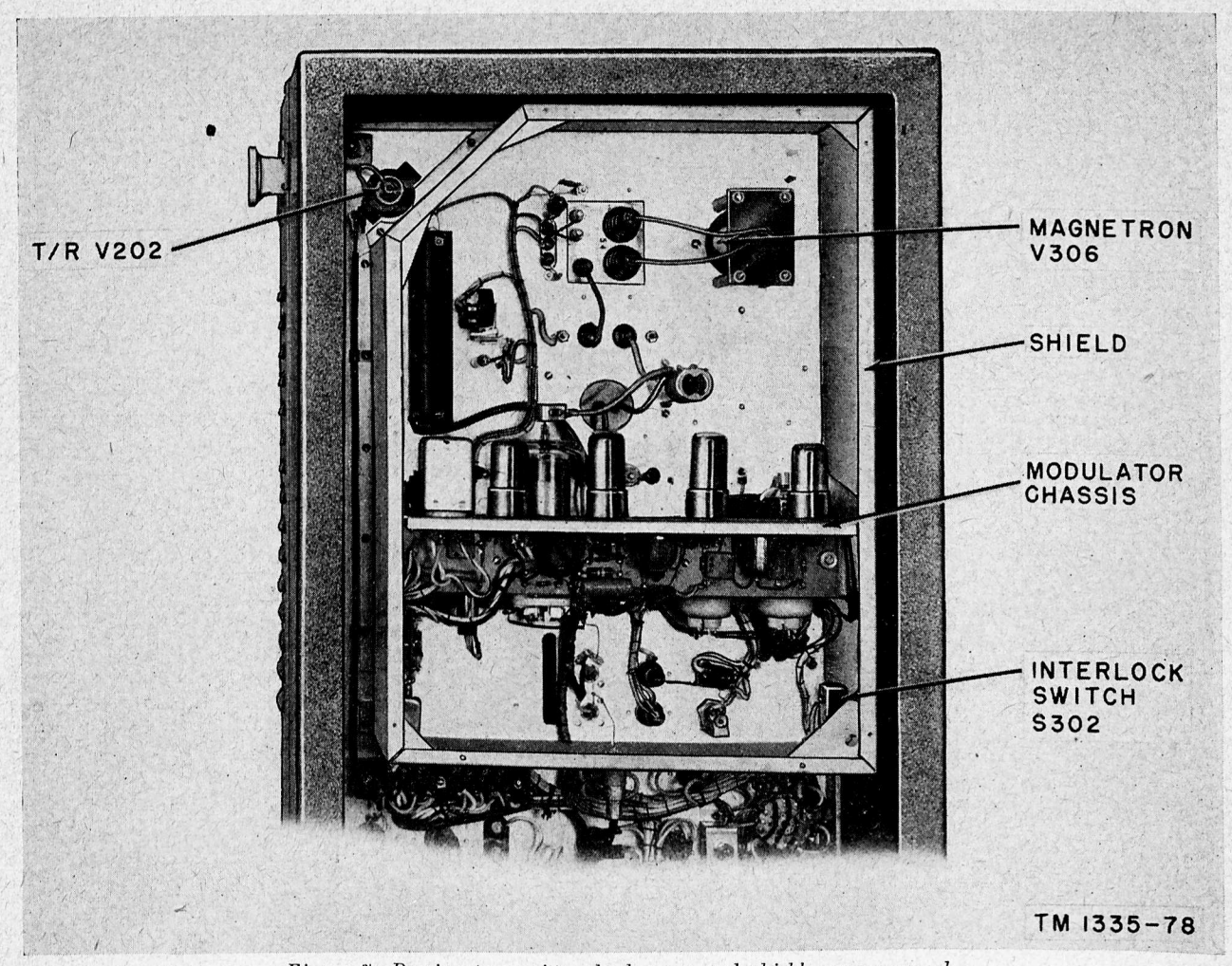


Figure 7. Receiver-transmitter, back cover and shield cover removed.

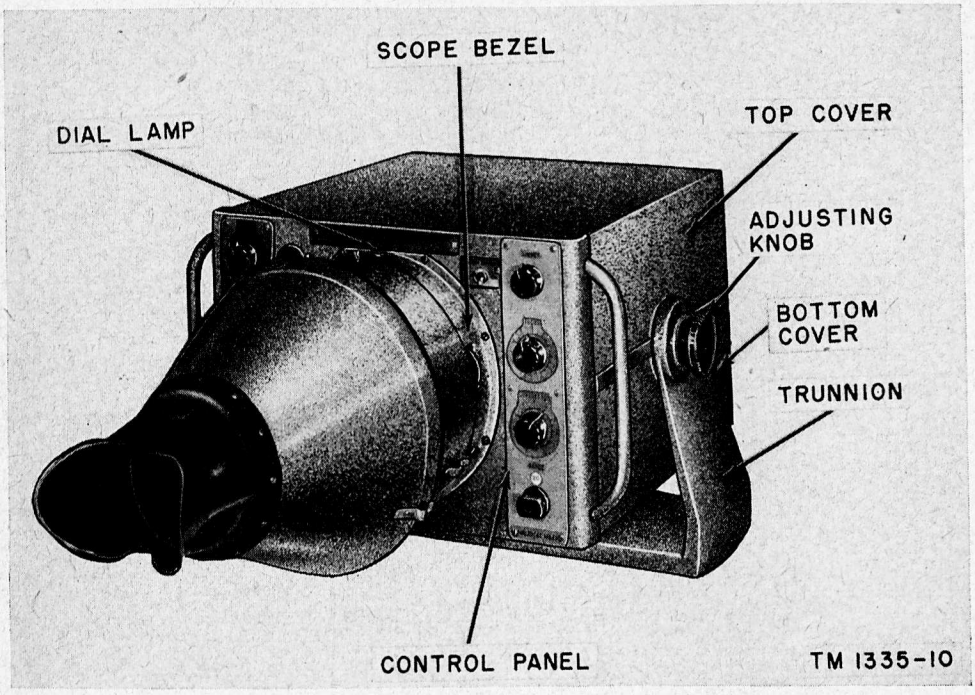


Figure 8. Azimuth and range indicator, front view.

ing controls of the radar set are mounted on the front panel. A fixed azimuth scale and an adjustable bearing cursor are mounted close to and in front of the PPI tube face. Three removable dial lamps are located on the outer rim of the scale housing. A detachable viewing hood and magnifying glass (fig. 10) are furnished for attachment to the scope bezel (fig. 8).

b. Two signal input jacks, a plug, a fuse, and a phone jack are mounted on the rear external panel of the indicator chassis (fig. 43). Two 400-cycle, 115-volt, a-c outlets are mounted on the left side of the indicator chassis. These outlets are accessible when the top cover of the unit is removed.

11. Power Components

The power components required for a given installation of Radar Set AN/SPN–11(*) depend on the available power source. The correct power components for operation from a 24-, 32-, or 115-volt, d-c source are furnished with Radar Set AN/SPN–11Z, Radar Set AN/SPN–11Y, or Radar Set AN/SPN–11X, respectively. The required components are a motor generator, motor starter, line switch box, voltage regulator, fuses, and connecting cables.

a. Motor Generators. Except for electrical differences required by their individual input voltage ratings, the d-c motor generators are alike (fig. 11). Each motor generator consists of a d-c

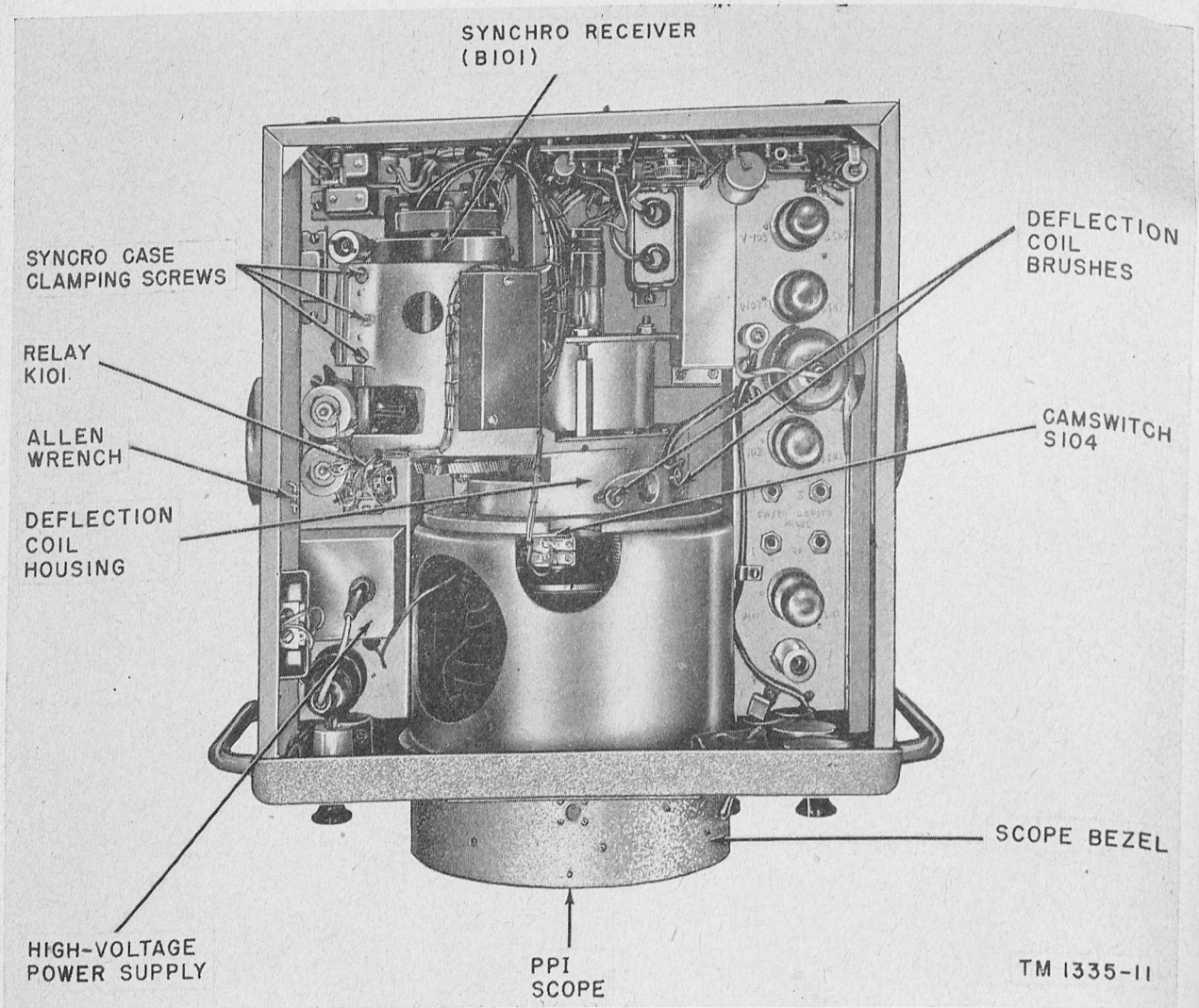


Figure 9. Azimuth and range indicator, top cover removed.

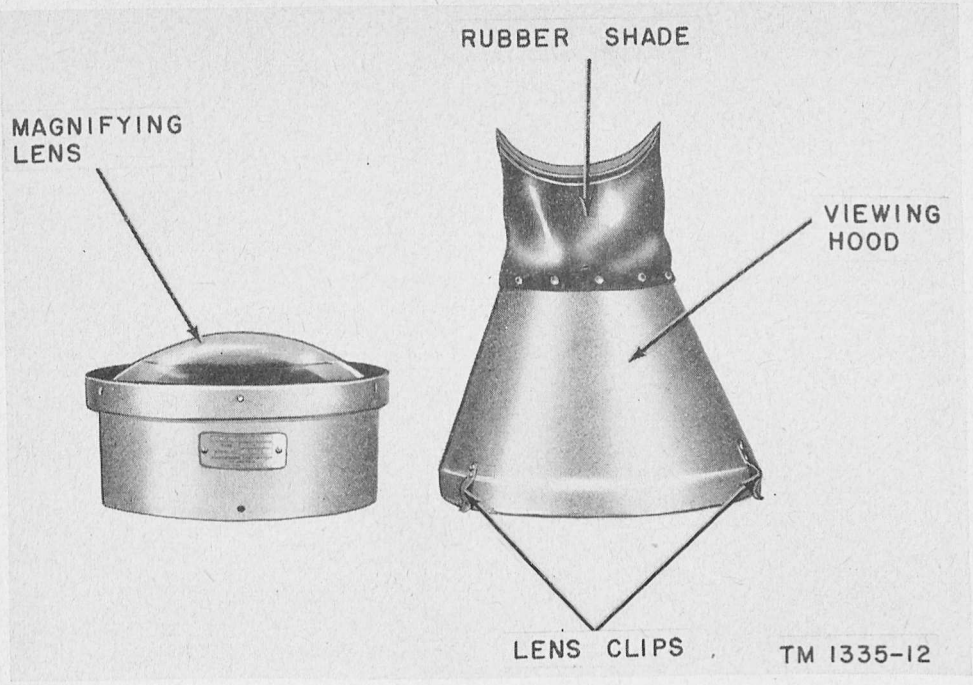


Figure 10. Magnifying lens and hood.

motor and an a-c generator on a common shaft within a single frame. Each motor generator converts the available d-c supply voltage (24, 32, or 115 volts) to 115-volt, single-phase, 400-cycle a-c. At each end of the common shaft, permanently sealed bearings are inclosed by removable access covers. The commutator and four motor brushes are inclosed by a removable brush access cover at the motor end of the frame (fig. 71.). Terminal board TB601 is mounted on top of the motor-generator frame.

b. Motor Starters. Except for electrical differences due to their individual voltage ratings of 24, 32, and 115 volts, respectively, Motor Starters SA–285/SPN–11, SA–286/SPN–11, and SA–287/SPN–11 are alike (fig. 12). The motor starter automatically starts and stops the motor generator when the POWER switch on the azimuth and range indicator is turned on or off. Each starter is housed in a sheet-steel, wall-mounting case. A ratchet-type mechanical timer is mounted in the lower left corner of the starter panel. A

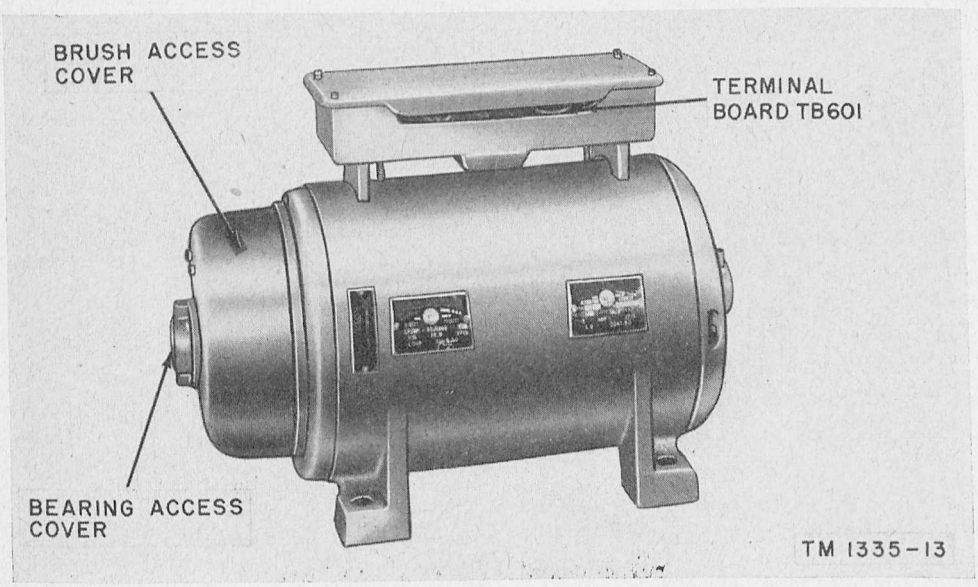


Figure 11. Motor-generator PU–243/SPN–11.

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 is included to prevent damage to the equipment. The relay automatically opens the circuit whenever an overload occurs.

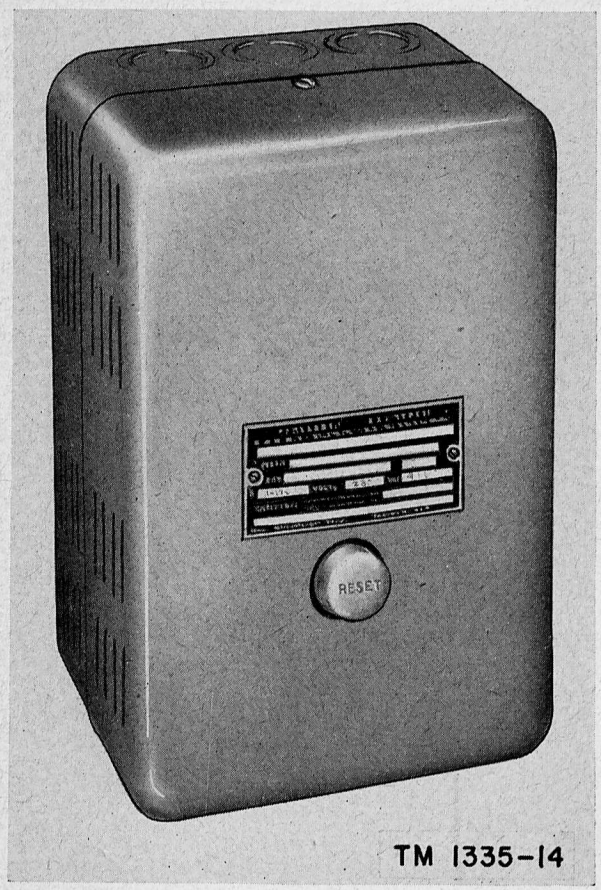


Figure 12. Motor starter SA-287/SPN-11.

c. Switch Boxes. Two line switch boxes are available for d-c power components.

(1) Switch box SA-284/SPN-11 (fig. 13) may be used on a ship line voltage of 115 or 230 volts, d-c or a-c. The switch box is connected in the ship supply line to the radar set motor generator, antenna heaters, antenna drive motor, and blower motor. The switch box contains a double-pole, heavy copper, knife switch and two cartridge fuse clips. The knife switch is operated by a control lever.

(2) Switch Box SA-283/SPN-11 (fig. 14) is used on 24- or 32-volt, d-c supply lines. Its use is identical to that of Switch Box SA-284/SPN-11.

d. Voltage Regulators. Voltage Regulator CN-194/SPN-11Z, Voltage Regulator CN-193/SPN-11Y, or Voltage Regulator CN-192/SPN-11X (fig. 15) is furnished for operation on a 24-, 32-, or 115-volt d-c supply line. The voltage regulator has a rheostat for adjusting the motor-generator a-c output voltage and a voltmeter to indicate the output voltage. The voltage regulators are alike, except that the resistance of the rheostat is determined by the d-c supply voltage on which the regulator is to be used.

12. Junction Box J-497/SPN-11

This junction box (fig. 46) is used to connect the azimuth and range indicator to the receiver-transmitter; it is not used when the indicator is mounted on the receiver-transmitter cabinet. The junction box contains terminal boards TB701 and TB702; jacks and cable glands must be installed as shown in figure 46.

13. Waveguides

Waveguide sections for use with Radar Set AN/SPN-11(*) are illustrated in figure 16. 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. 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 ½-, 1-, 2-, 3-, 4-, 8-, and 12-foot lengths. Curved sections are furnished with E or H bends of 45° or 90°, respectively. E bends are curved on the wide surface (90E, fig. 16); H bends are curved on the narrow surface (45H and 90H, fig. 16). A waveguide deck fitting, a waveguide ceiling dress plate (fig. 40), and waveguide clamps also are furnished.

14. Cables

Cables W707, W708, and W709 are ready to install. All other cables must be cut to the required length and fitted with terminal connectors.

a. W701 is a 19-conductor cable which connects the motor generator to the receiver-transmitter.

b. W702 is a 19-conductor cable which connects the antenna to the receiver-transmitter.

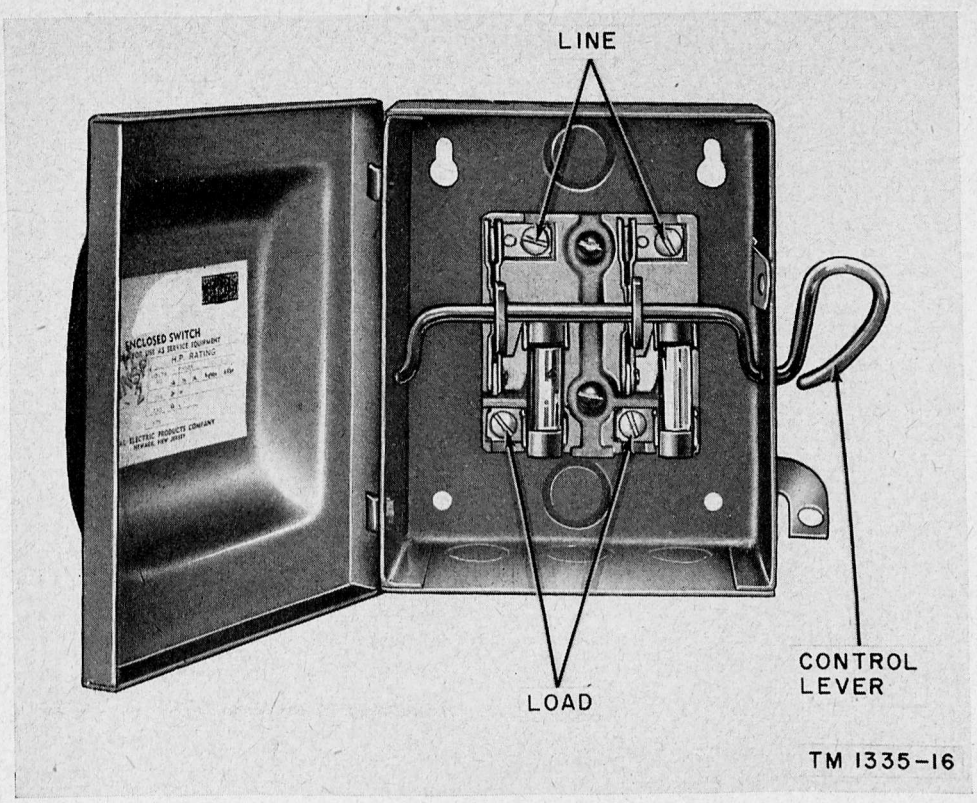


Figure 13. Switch Box SA–284/SPN–11, front view.

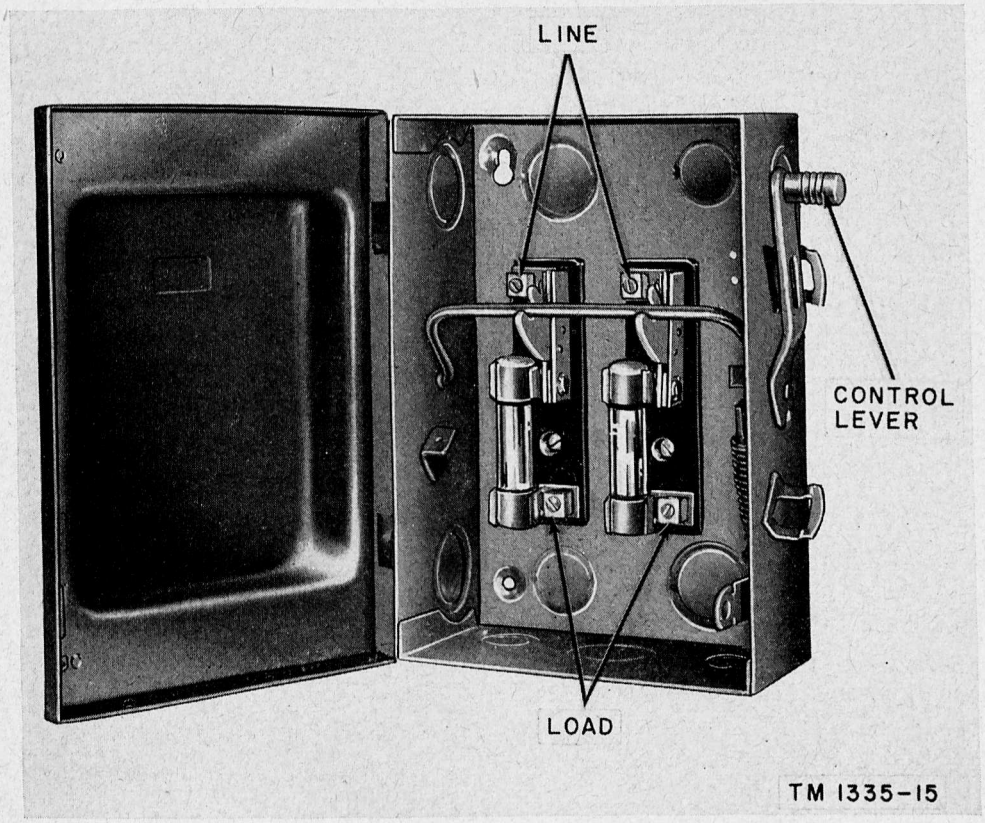


Figure 14. Switch Box SA–283/SPN–11, front view.

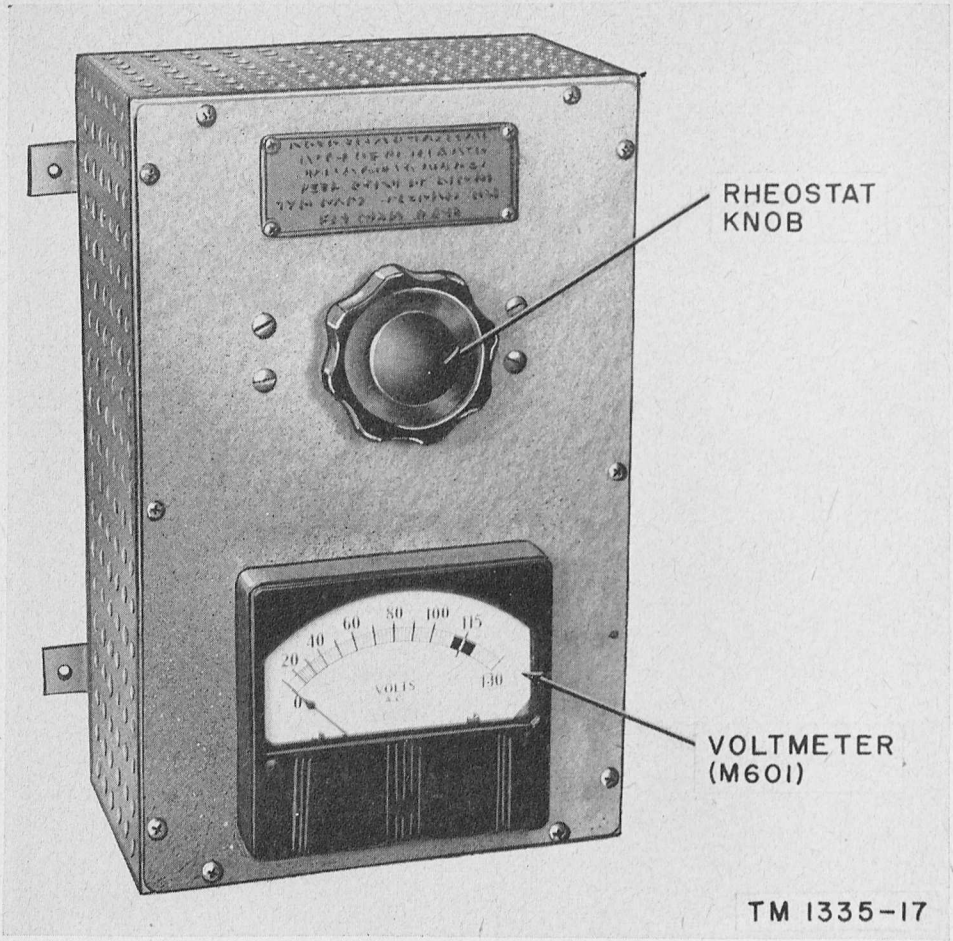


Figure 15. Voltage Regulator CN–192/SPN–11X.

c. W703 is a four-conductor cable which connects the voltage regulator to the receiver-transmitter.

d. W704 is a 19-conductor cable which connects the junction box to the receiver-transmitter.

e. W705 is a coaxial cable which connects the junction box to the receiver-transmitter.

f. W706 is a coaxial cable which connects the junction box to the receiver-transmitter.

g. W707 is a coaxial cable which connects the indicator to the junction box or receiver-transmitter.

h. W708 is a 19-conductor cable which connects the indicator to the junction box or receiver-transmitter.

i. W709 is a coaxial cable which connects the indicator to the junction box or receiver-transmitter.

j. W710 is a two-conductor cable which connects the switch box to the motor generator.

k. W711 is a seven-conductor cable which connects the motor starter to the motor generator.

l. W712 is a two-conductor cable which connects the switch box to the power source.

15. Running Spares

The following items are supplied as running spares for Radar Set AN/SPN–11(*).

1 tube, type 1B24A.
1 tube, type 1B35.
1 tube, type 1V2.
1 tube, type 2X2A.
1 tube, type 3B24W.
1 tube, type 4C35.
2 tubes, type 5R4WGY.
3 tubes, type 5654/6AK5.
2 tubes, type 5726/6AL5W.
1 tube, type 6AQ5W.
1 tube, type 5725/6AS6W.
1 tube, type 6BG6G.
3 tubes, type 6J6.
2 tubes, type 6SN7GT.
1 tube, type 6V6GT.

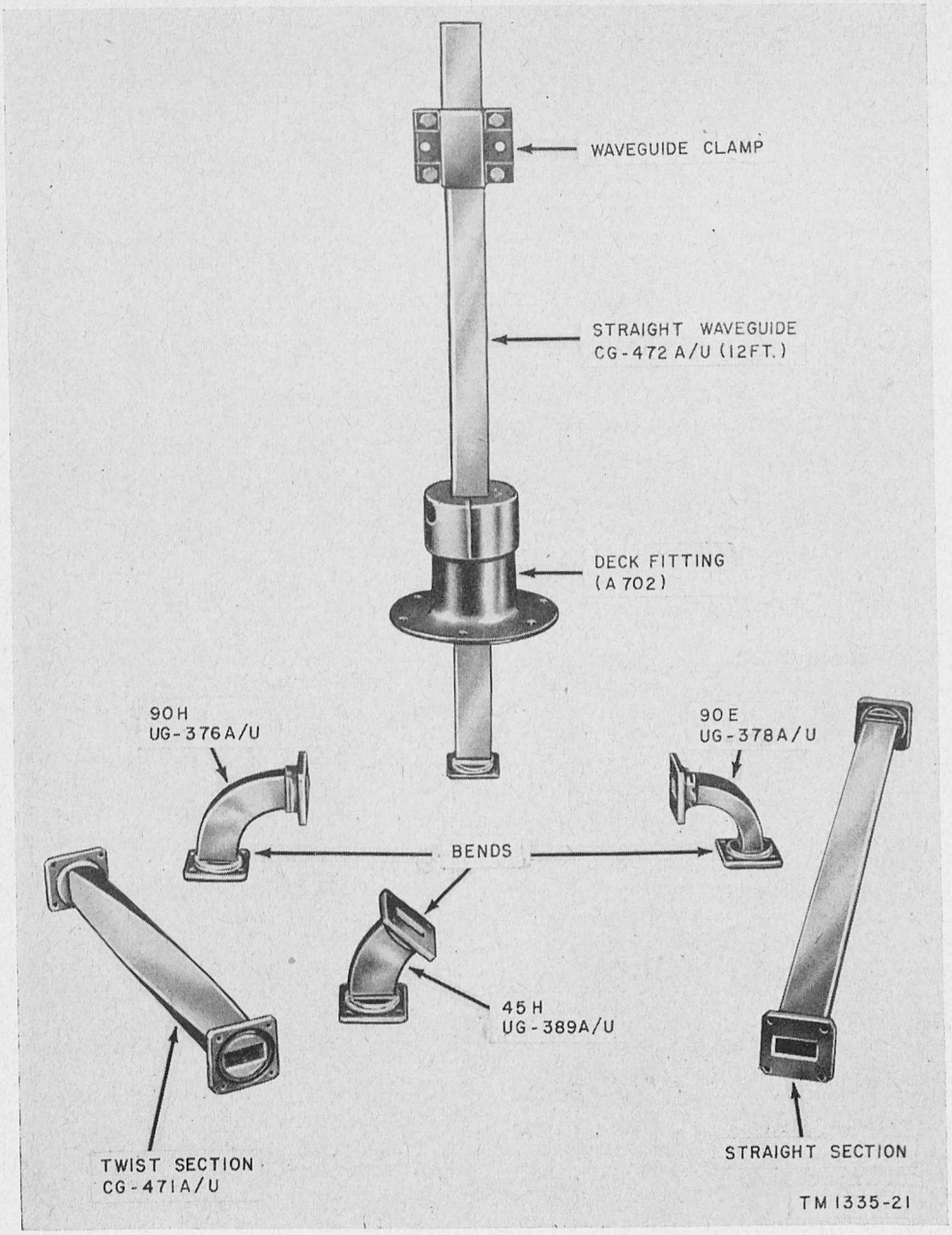


Figure 16. Waveguide sections.

1 tube, type 7MP7.
1 tube, type 12AU7.
1 tube, type 723AB/2K25.
1 tube, type 725A.
1 tube, type 0D3W.
4 crystals, type 1N23B.
12 fuses, cartridge type, 2 amperes, 250 volts.
6 fuses, cartridge type, ¼ ampere, 250 volts.
6 fuses, cartridge type, 3 amperes, 250 volts.
2 fuses, cartridge type, 25 amperes, 250 volts (Radar Set AN/SPN–11X).
2 fuses, cartridge type, 60 amperes, 250 volts (Radar Sets AN/SPN–11Y and –11Z).
6 fuses, cartridge type, 2½ amperes, 250 volts.
12 fuses (Radar Set AN/SPN–11X) or 4 fuses (Radar Set AN/SPN–11Y or Z), cartridge type, 10 amperes, 250 volts.
8 fuse links, 25 amperes, 250 volts (Radar Set AN/SPN–11X).
8 fuse links, 60 amperes, 250 volts (Radar Sets AN/SPN–11Y and AN/SPN–11Z).
2 lamps, Mazada #323.
2 lamps, Mazda #47.
1 lamp, glow type, NE–32.
1 cleaner, air element, 8 inches square by ¾ inch thick.

16. Additional Equipment Required

The following material is not supplied as part of Radar Set AN/SPN-11(*); it is required for installation and operation.

Quantity	Name and description	Sig C stock No.
2	BLADE: hack-saw; 12″; 32 teeth.	6Q8012–32
4	BLOCK: triple sheave; loose hook; w/becket; 5/8″ dia x 1 7/8″ circum.	19–B24995
1	BURNISHER TL–557/U	6R4106JC
1	DRILL: electric; 3/4″ cap; 120 v ac or dc.	40–D346
1	DRILL TL–331/U: hand: 3/8″ cap.	6Q3Z00–5
1	DRILL SET: 1/16″ to 1/2″ by 64ths.	6Q35814
1	DRILL SET: twist; Nos. 1 through 60.	6Q36160
1	FILE: half-round; 2d cut; 8″	6Q38123–8
1	FILE; flat; smooth; 8″	6Q38134–8
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; 1/2″ sq drive; 16″ lg.	6Q51205–15
1	HANDLE: flex; 3/8″ sq drive	41–H–1502–85
1	KNIFE TL–29; electrician's	6Q60229
6	PAPER: sand; flint, No. 000	6Z7500–000
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	SCREW DRIVER TL–21: 7″ lg.	6R15310
1	SCREW DRIVER TL–456/U 6″ lg; 1/8″ bit.	6R14990
1	SCREW DRIVER: 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; 100 w.	6R24617
1	SOCKET WRENCH: 1/4″, 12 point; 3/8″ sq drive.	41–W–2999
1	SOCKET WRENCH: 5/16″, 12 point; 3/8″ sq drive.	41–W–2999–35
1	SOCKET WRENCH: 3/8″, 12 point; 3/8″ sq drive.	41–W–2999–50
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	6R24017/1–1
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.	6R5512–14.1
1	WRENCH: double; open-end; 1/2″ x 9/16″ cap.	6R5516–18.3
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: socket; Spintite; 3/16″ 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.	None
1	WELDING EQUIPMENT: electric arc.	None
1	BRUSH: paint; 2″ wd	6Z1582
1	HANDLE: 3/8″ drive; flex	41–H–1502–85
1	OILER	6Z7308.4
1	PLIERS: 8″ comb	6R4745–8
1	SCREWDRIVER: 7″ lg; 3/16″ wd bit.	6R15693
1	WRENCH TL–476/U: adjustable.	6R55018.1
1	WRENCH: single; open-end; 11/16″ opening.	6R57034
1	WRENCH: socket; 5/16″; 3/8″ drive.	41–W–2999–35

17. Differences in Models

The basic nomenclature Radar Set AN/SPN–11 is used in this manual to refer to the group of components (*a* below) common to all models of Radar Set AN/SPN–11 (*). The common components operate from the 400-cycle, 115-volt a-c output of the radar set motor generator. The letter suffix X, Y, or Z is added to the basic nomenclature to indicate that the particular radar set includes the additional components (*b* below) for operation from a d-c supply source of 115 volts, 32 volts, or 24 volts, respectively. Some vessels have an a-c, 115- or 230-volt, single-phase, 60-cps power source; other vessels have a 230-volt, d-c power source. Subparagraph *c* lists the components which must be changed or added to the common components for operation from these sources.

a. Common Components.

(1) Radar Receiver-Transmitter RT–268/SPN–11, including Radar Receiver R–480/SPN–11, but less blower motor.
(2) Antenna AS–599/SPN–11, less drive motor and heaters.
(3) Duplexer CU–311/SPN–11.
(4) Azimuth and Range Indicator IP–193/SPN–11.
(5) Junction Box J–497/SPN–11.
(6) Frequency Mixer Stage CV–239/SPN–11.
(7) Cables (except W710 and W712).
(8) Waveguide sections.

b. Table of Additional Components.

Item	Radar Set		
	AN/SPN–11X	AN/SPN–11Y	AN/SPN–11Z
Supply voltage	115 v dc	32 v dc	24 v dc.
Motor-Generator	PU–243/SPN–11	PU–245/SPN–11	PU–244/SPN–11.
Motor Starter	SA–287/SPN–11	SA–286/SPN–11	SA–285/SPN–11.
Antenna drive motor	115 v dc	32 v dc	24 v dc.
Blower motor	115 v dc	32 v dc	24 v dc.
Resistance Elements	HD–124/SPN–11	HD–123/SPN–11	HD–123/SPN–11.
Switch Box	SA–284/SPN–11	SA–283/SPN–11	SA–283/SPN–11.
Voltage Regulator	CN–192/SPN–11X	CN–193/SPN–11Y	CN–194/SPN–11Z.
Fuse (F601)	250 v 25 amp	250 v 60 amp	250 v 60 amp.
Fuse (F602)	250 v 25 amp	250 v 60 amp	250 v 60 amp.
Fuse (F801)	125 v 10 amp	125 v 15 amp	125 v 15 amp.
Cable W710	DHFA–23	DHFA–23	DHFA–40.

c. Changes and Additions (A-C or 230-VOLT D-C Supply).

Item	Power source		
	230 v dc	115 v ac, 60 cps	230 v ac, 60 cps
Motor generator:			
Input	230 v dc	115 v ac, 60 cps	230 v ac, 60 cps.
Exciter output	No exciter	115 v dc	115 v dc.
Motor starter (K601)	3-step constant accelerator type; heater element 8.64–7.3 amp; 1½ hp rating.	A-c magnetic starter; heater element 13.5–14.8 amp.	A-c magnetic starter; heater 8.1–8.7 amp.
Antenna drive motor (B502)	Input: 230 v dc	Input: 115-v, single-phase, 60-cps, ac.	Input: 230 v, single-phase, 60-cps ac.
Starting capacitor (C801 for antenna motor).	None	53 μf, 115 v, 60 cps	53 μf, 115 v, 60 cps.
Blower motor (B801)	Input: 230 v dc	Same as in Radar Set AN/SPN–11X (connects to 115-v d-c output of excitor).	Same as in Radar Set AN/SPN–11X (connects to 115-v d-c output of excitor).

c. Changes and Additions (A-C or 230-VOLT D-C Supply—Continued

Item	Power source		
	230 v dc	115 v ac, 60 cps	230 v ac, 60 cps
Resistance elements	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.
Switch box (S601)	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.
Voltage regulator	600-ohm rheostat (R601)	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.
Capacitor (C504)	Same as in Radar Set AN/SPN–11X,	Same as in Radar Set AN/SPN–11X.	Same as in Radar Set AN/SPN–11X.
Fuses F601 and F602	15 amp, 230 v	30 amp, 230 v	20 amp, 230 v.
Fuse F801	5 amp, 230 v	10 amp, 115 v	5 amp, 230 v.
Fuse F802	5 amp, 230 v	10 amp, 213 v	5 amp, 230 v.

Section III. BASIC PRINCIPLES

18. Introduction

Radar Set AN/SPN–11(*) radiates pulsed h-f (high-frequency) energy in a beam which is very narrow (1.9°) horizontally and relatively wide (20°) vertically. When the beam strikes a reflecting object, such as a ship or buoy, energy is reradiated or reflected from the object. A very small part of the reflected energy returns to the radar system. The reflected energy is known as an *echo*, and the object from which the energy is reflected is called a *target* (A of fig. 17). The radar antenna and, hence, the beam are rotated horizontally by an antenna drive motor to provide continuous scanning. The velocity of the transmitted radio waves (186,000 miles per second) is much greater than the velocity at which the antenna is rotated (17 rpm (revolutions per minute)). Consequently, the radar antenna does not move appreciably during the time interval between the transmission of a pulse and the return of its echo to the antenna.

19. Determination of Direction and Range

a. Because of the extremely narrow radar beam, an echo is produced and received only when the antenna is pointed directly at the target (A of

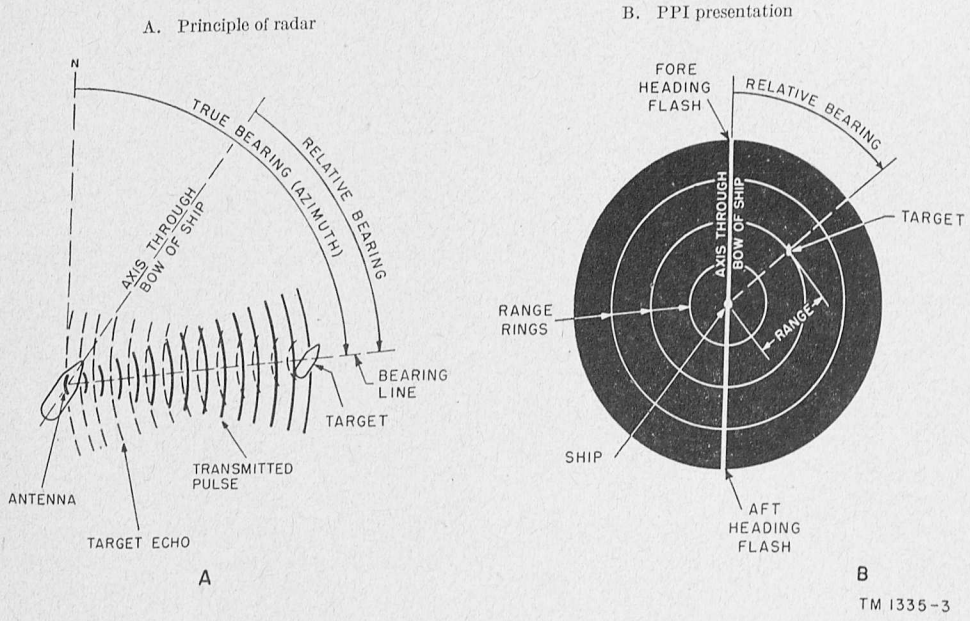


Figure 17. Radar patterns.

fig. 17). The direction in which the antenna is facing is then an indication of the direction in which the target would be seen from the antenna. This direction is read directly from the azimuth scale of the indicator scope in the radar set.

b. The determination of distance to the target is based on the fact that radio waves travel at a constant velocity approximately equal to the speed of light. In other words, the time interval between the transmission of a pulse and the return of its echo is a measure of the distance or range (fig. 18) between the target and the radar antenna. (Strictly speaking, this time interval is a measure of *twice* the distance between the radar antenna and the target. However, the radar set indicating device is calibrated to read the range distances directly (B of fig. 17)).

20. Bearings

From a point on the earth's surface, the *bearing* of another point is the direction in which the second point is seen from the first. The line connecting the two points is called the *bearing line.*

a. True Bearing. The true bearing of a point on the earth's surface from the position of an observer is the angle which the bearing line makes with the north-south line through the position of the observer. In A of figure 17, 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 these 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 to the head 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 of fig. 17) is an extension of the fore-and-aft line of the ship. Therefore, the relative bearing is the angle which the bearing line makes with the fore-and-aft line of the ship.

c. Plan Position Indicator. On the PPI scope (B of fig. 17) the center of the scope represents the radar antenna, and the heading flashes coincide with the fore-and-aft line of the ship. The *relative bearing* is the angle, measured in the clockwise direction, between the heading flash and the bearing line from the center of the PPI to the target. The *true bearing* cannot be read directly on the PPI of Radar Set AN/SPN–11(*), because the azimuth scale is fixed with 0° coincident with the fore-heading flash.

d. Azimuth. The *azimuth* of a celestial body such as the sun is its direction from the ship, measured from 0° at north to 360° *clockwise.* Azimuth is another term for bearing, and the two terms may be used interchangeably without confusing the meaning of either (figs. 17 and 18).

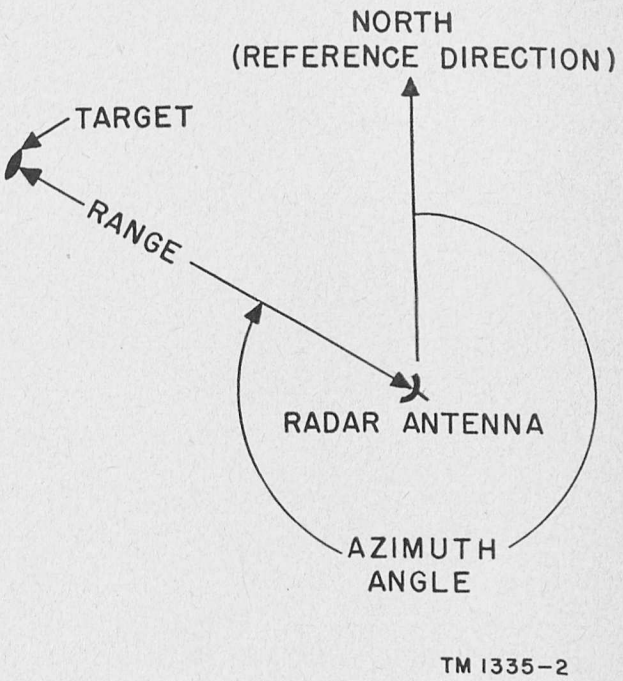


Figure 18. Azimuth angle and range.

21. Range

The range of a target (distance from the radar antenna to the target) is measured by the time required for the transmitted pulse (radio waves) to travel from the radar antenna to the target, plus the time required for the echo to return from the target to the antenna (A of fig. 17). It takes 1 μsec (microsecond) for a radar signal to make a *round trip* between an antenna and a target 164 yards distant. The time is measured and converted by the radar set into visual information which is presented on the PPI scope. Thus, if the round trip requires 24.73 μsec, the range to the target is 4,053.4 yards, and this distance is indicated on the PPI as 2 nautical miles. (Range also may be indicated in statute miles.)

22. Target Information Indicator

a. Information concerning the range and azimuth of targets within 20 nautical miles of the radar set is displayed on a cathode-ray tube. This tube is called the PPI and produces a radar map of the surrounding area (fig. 19). A fixed azimuth scale from 0° to 360°, calibrated in 2° divisions, is mounted in front of the PPI scope. Zero on this scale corresponds to a dead-ahead bearing and, therefore, all bearings are taken relative to the bow. A plastic disk, inscribed with a cursor line, is placed in front of the PPI. This line is used as an aid to determine target bearing.

b. Extending from the center to the edge of the PPI is a fine line of light which rotates like the spoke of a wheel, synchronized with the rotation of the antenna. This line is called the rotating

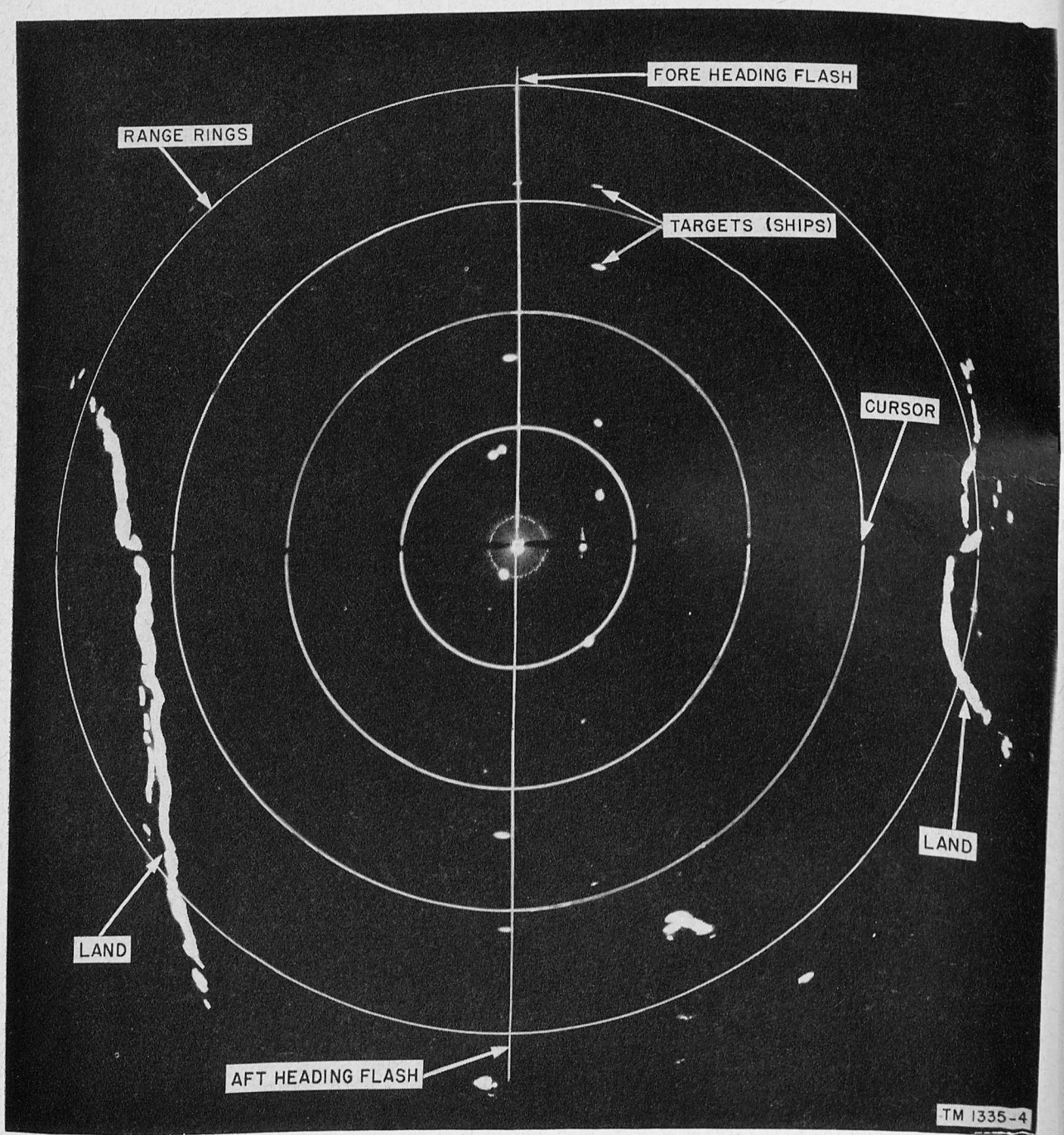


Figure 19. Typical PPI presentation.

sweep, and it 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. The rotating sweep also produces a series of concentric rings about the center of the PPI face. These rings are *range rings* (fig. 19). Each time the rotating sweep passes through the 0° and 180° calibration points of the azimuth scale, it is intensified sharply. This leaves a visible trace line for a relatively long interval as the rotating sweep continues its rotation. The lines which appear as a result of this intensification are called the fore-heading flash (0°) and the aft-heading flash (180°). 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 again intensifies the spot.

c. The relative bearing of a target, determined by noting on the PPI the angular position of the target relative to the fore-heading flash, can be read directly on the fixed aximuth scale as the rotating sweep passes over the target. The cursor can be rotated manually to cross the spot at which a target appears.

d. The range of a target, determined by the distance between the center of the PPI and the spot that marks the target, can be read by noting the position of the target with respect to the range rings.

Section IV. FUNCTION OF COMPONENTS

23. Grouping of Components

For purposes of discussion the components of Radar Set AN/SPN–11 (*) are divided into the following groups or systems.

a. Transmitting System. This system is considered to consist of the components, including power supplies, which produce the transmitted pulses.

b. R-F System. The r-f system includes the antenna, waveguides, and duplexer.

c. Receiving System. The receiving system consists of the frequency mixer and the radar receiver.

d. Synchronizing and Indicating System. This grouping includes all synchronizing components and the azimuth and range indicator.

e. Heater and Ventilating Units. This group of components is used to maintain satisfactory operating temperatures in the antenna pedestal and in the receiver-transmitter.

f. Power System. This grouping includes the components required to convert the d-c supply to 400-cycle, single-phase, 115-volt ac.

24. Transmitting System
(fig. 20)

a. Function. The transmitting system develops high power pulses of r-f energy and provides trigger pulses for synchronization of the radar set as a whole.

b. Description. Modulator circuits (fig. 7) are triggered by a master oscillator and supply rectangular voltage pulses to trigger the magnetron (fig. 20). The magnetron delivers .4-μsec pulses of r-f energy at a prf (pulse repetition frequency) of 1,000 pulses per second. This pulse energy is coupled through a duplexer and waveguide to the antenna.

25. R-f System
(fig. 20)

a. Function. The r-f system transmits r-f energy from the magnetron through a duplexer and waveguide to the antenna. The antenna radiates the transmitted energy in a narrow beam. The antenna also picks up signal energy from echoes, and the waveguide conducts this signal energy to the radar 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, it reflects a portion of the energy back to the antenna. The received echo signals enter the horn and travel through the waveguide and duplexer to the radar receiver.

(2) At the instant that the transmitter produces an r-f pulse, a T/R tube in the duplexer allows the transmitted pulse to

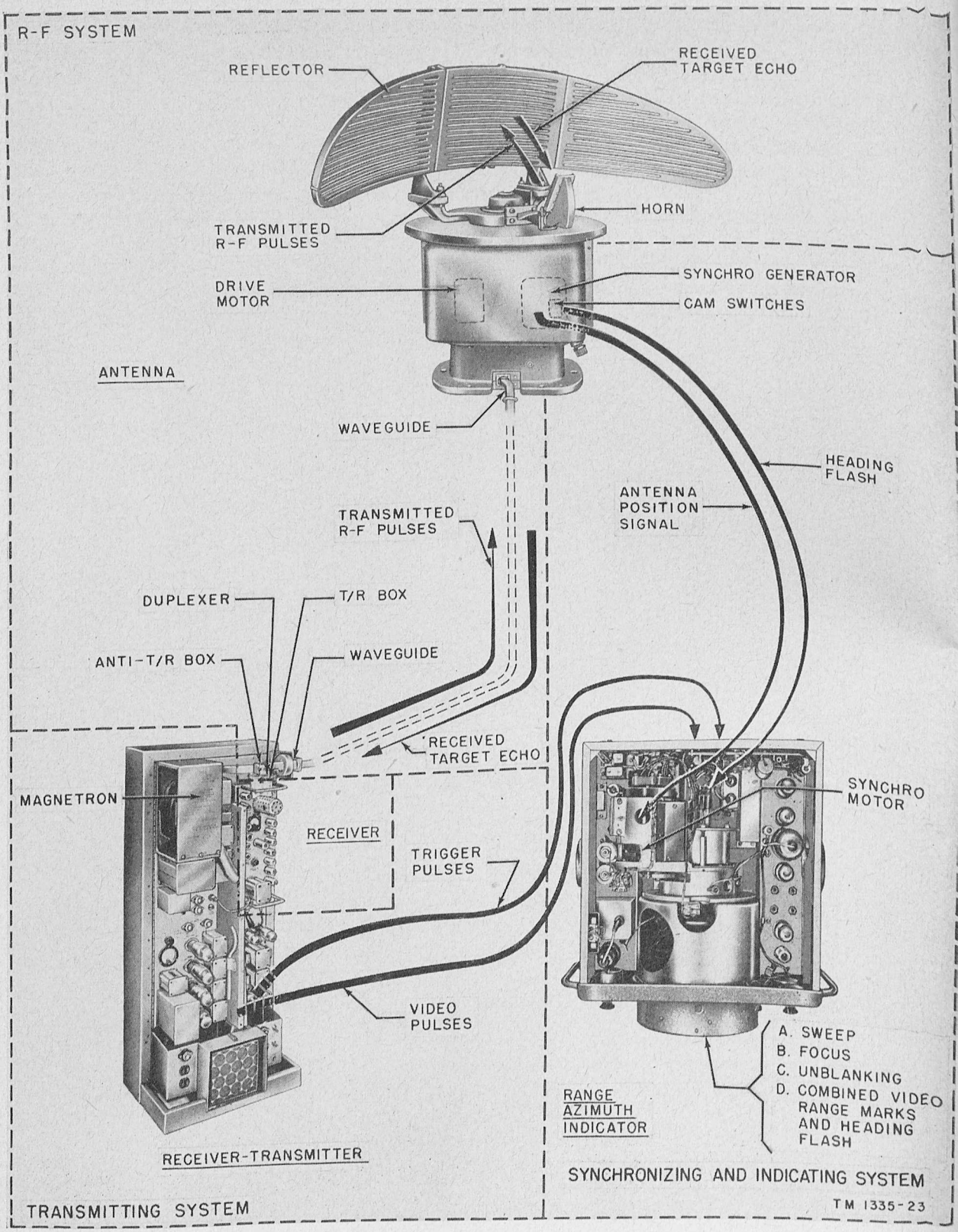


Figure 20. Radar Set AN/SPN–11(*), system breakdown.

pass to the waveguide, but prevents any of the transmitted energy from entering the receiver. Between transmitted pulses, an anti-T/R tube allows echo signal energy to travel to the receiver, but prevents it from being wasted in the transmitter circuits.

26. Receiving System

(fig. 20)

a. Function. The receiving system receives target echo signals from the r-f system, amplifies them, and converts them to video signals which are coupled to the azimuth and range indicator circuits.

b. Description.

(1) The output of the klystron local oscillator tube in the frequency mixer stage (fig. 5) 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. This circuit picks up a small portion of the transmitted signal and develops an afc voltage which is applied 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 radar receives i-f stages amplify the 30-mc output of the frequency mixer stage. 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 azimuth and range indicator.

27. Synchronizing and Indicating System

(fig. 20)

a. Function. The receiver video output is applied to the PPI scope in the indicator. These signals, together with the rotating sweep and range rings that are developed in the indicator, produce on the PPI scope a map of the surrounding area (fig. 19).

b. Description.

(1) The indicator (fig. 20) receives the timing (trigger) pulses generated by the master oscillator in the transmitter. This trigger voltage controls the following circuits:

(*a*) The waveshaping circuits that produce a saw-tooth current through the deflection coils of the PPI.

(*b*) The range marking circuits.

(*c*) The unblanking circuits of the PPI.

(2) The indicator also contains the circuits which amplify the video signals from the receiver, the h-v power supply for the PPI tube, 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 figure 19.

(4) The synchro system keeps rotation of the PPI sweep in synchronism with rotation of the antenna. The deflection coils in the PPI are coupled to the antenna through the indicator synchro receiver and the antenna synchro transmitter. Consequently, rotation of the antenna results in a corresponding rotation of the deflection coils, 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.

28. Heating and Ventilating Units

a. The antenna pedestal has two resistance elements (heaters) that are connected through a thermostat to the d-c line. These heaters prevent the antenna gearing assembly oil from becoming

too thick during extremely cold weather. The heater circuit is controlled by a thermostat (fig. 4). The circuit is closed and power is applied whenever the temperature within the pedestal below 40° F; the circuit is opened whenever the inside air temperature is approximately 45° F. The temperature differential of approximately 5° prevents unnecessary intermittent operation of the circuit.

b. There is a blower motor and blower at the bottom of the receiver-transmitter cabinet (fig. 6). The blower draws air through a filter and forces it through ducts (fig. 5) to the magnetron, the modulator compartment, the receiver, transformers, and other components. This provides adequate cooling under adverse climatic conditions.

29. Power System

(fig. 21)

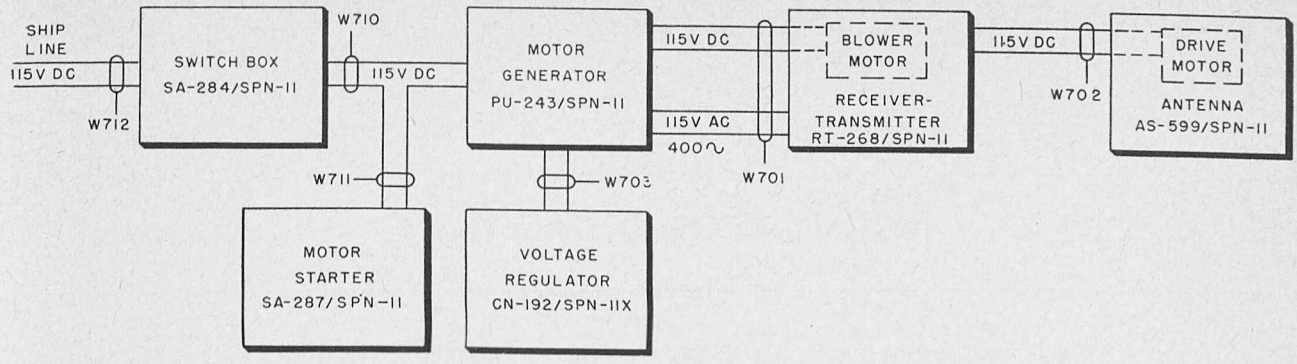
The components of the basic Radar Set AN/SPN–11 (par. 17) are designed to operate from a 400-cycle, single-phase, 115-volt, a-c power source. Most vessels have d-c or 60-cycle, a-c power sources. The power system of Radar Set AN/SPN–11(*) includes equipment to convert d-c power to the required 115-volt, 400-cycle, a-c power.

a. Motor Generator. The motor generator consists of a d-c motor and an a-c generator on a common shaft within a single frame (fig. 11). The motor is connected to the ship supply line and drives the a-c generator. Consequently, the motor generator acts as a converter; its input is dc, and its output is the required ac. Since the ship supply voltage may be 115 volts, 32 volts, or 24 volts, the corresponding motor generator is furnished with Radar Set AN/SPN–11X, AN/SPN–11Y, or AN/SPN–11Z.

b. Motor Starter. The resistance of the armature windings of a d-c motor is very low, practically a short circuit. Consequently, if power were applied directly to start the motor, the armature would be burned out. To prevent this damage, a motor starter is used. The starter palaces a resistance in series with the motor armature to limit the starting current to a safe value. This starting resistance is reduced, either manually or automatically, as the motor speed increases. The motor starters (fig. 12) for Radar Set AN/SPN–11(*) are automatic. In the lower left corner of the starter is a ratchet-type, mechanical timer. This timer is actuated by a solenoid, so that three sets of contacts close one after the other. As they close, the contacts short-circuit sections of the starting resistance (mounted on the rear of the starter panel), finally reducing the resistance to zero as the motor generator reaches its normal running speed.

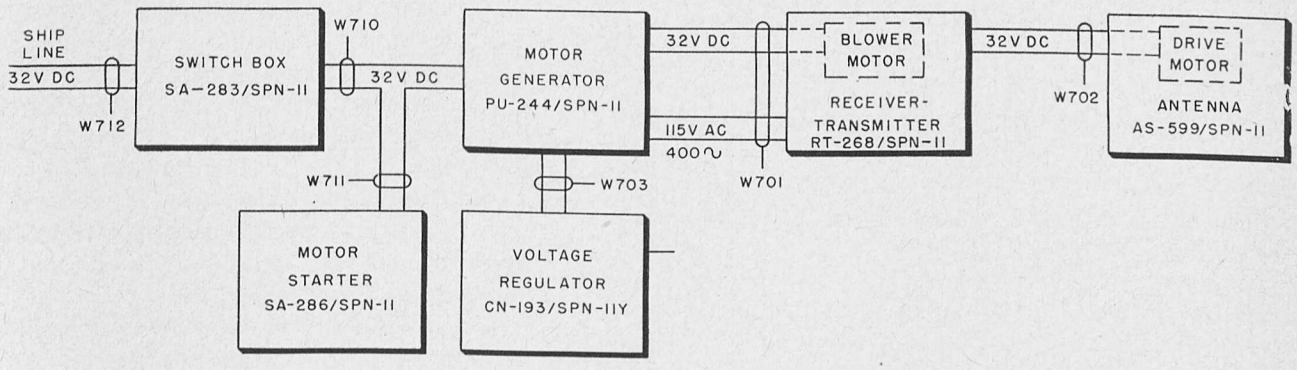
c. Voltage Regulator. The voltage regulator (fig. 15) is used to adjust the a-c output voltage of the motor generator to the correct value. The voltage regulator rheostat is connected in series with the generator field winding; therefore, the generator field strength and, hence, the a-c output voltage vary with the setting of the rheostat. The regulator voltmeter is connected across the motor generator a-c output terminals, and it indicates the amplitude of the a-c output voltage. The correct model of the regulator is furnished with each Radar Set AN/SPN–11(*).

d. Switch Box. The switch boxes (figs. 13 and 14) contain a heavy, double-pole, copper, knife switch and clips for two cartridge-type line fuses. The switch is connected in the ship supply line. When the switch is open, the radar set is disconnected from the source of d-c voltage. The correct switch box is furnished with each model of Radar Set AN/SPN-11(*).



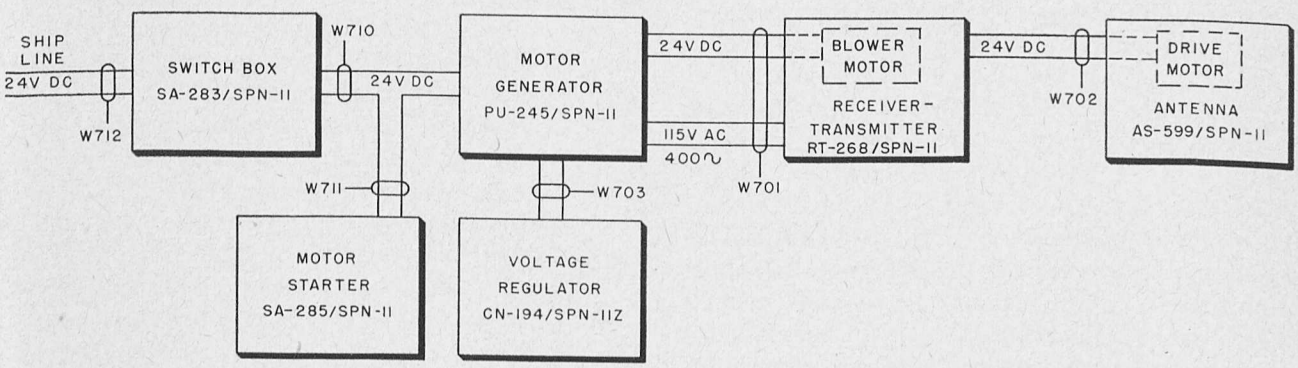
RADAR SET AN/SPN-11X

A



RADAR SET AN/SPN-11Y

B



RADAR SET AN/SPN-11Z

C

TM 1335-22

Figure 21. Radar Set AN/SPN-(*), power systems

CHAPTER 2

INSTALLATION INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF RADAR SET AN/SPN-11(*)

30. Siting

The best shipboard location for the radar set is usually a compromise between electrical requirements and local conditions. For example, the electrical requirement that the waveguide run should be extremely short is often in conflict with the requirement that the components must be located conveniently for the operators and the technicians. Refer to the simplified siting and installation diagram (fig. 22).

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

b. Receiver-Transmitter. Place the receiver-transmitter as close to the indicator as possible. On the right side of the receiver-transmitter, allow sufficient clearance for entrance of the waveguide on a horizontal plane. Allow enough clearance, also, for removal of the front cover and for a hinged panel swing of approximately 2 feet.

c. Indicator. Place the indicator in the wheel house so that radar observations may be forwarded quickly to the navigator and helmsman. Orient the unit so that the operator always faces forward when he is viewing the PPI. Allow sufficient clearance for connecting the cables to the panel board at the rear of the unit. Also, allow enough clearance on each side of the unit for maintenance purposes. Refer to paragraph 34*b* for information on installing the indicator on top of the receiver-transmitter.

d. Antenna. The best position for the antenna depends on such factors as height, reflections, and permissible waveguide run. The antenna should be high enough to permit the radar beam to clear large shipboard structures. If a high antenna support is impractical, a lower support may be used provided the beam is blocked only when the antenna points aft. Increasing the antenna height merely to increase the range is not practical, because only a slight range increase is obtained by adding several feet to the height of the antenna support. In general, it is advantageous to locate the antenna on one side or the other of the fore-and-aft line, so that the radar beam will not be blocked by the foremast or other structures when the antenna points dead ahead.

e. Power Group.

(1) Install the motor generator in a well ventilated space where it is not exposed to moisture or salt spray. To avoid excessive line losses, place the motor generator as close as possible to the receiver-transmitter. The switch box and motor starter should be mounted on a bulkhead directly above the motor generator. This provides a short cable length between the motor generator terminal board and the main line switch.

(2) Always mount the motor starter close to the motor generator. The only consideration is that the leads between the starter and the motor generator must be as short as possible.

(3) Install the voltage regulator on a bulkhead convenient to the indicator, so that the operator may read the voltmeter readily and adjust the rheostat.

(4) Install the junction box close to the indicator, so that the standard length cables to the indicator will permit it to swing on its trunnion. The junction box is not required when the indicator is mounted on top of the transmitter.

31. Uncrating, Unpacking, and Checking New Equipment

Note. For information on used or reconditioned equipment, refer to paragraph 45.

a. General. When new equipment is received

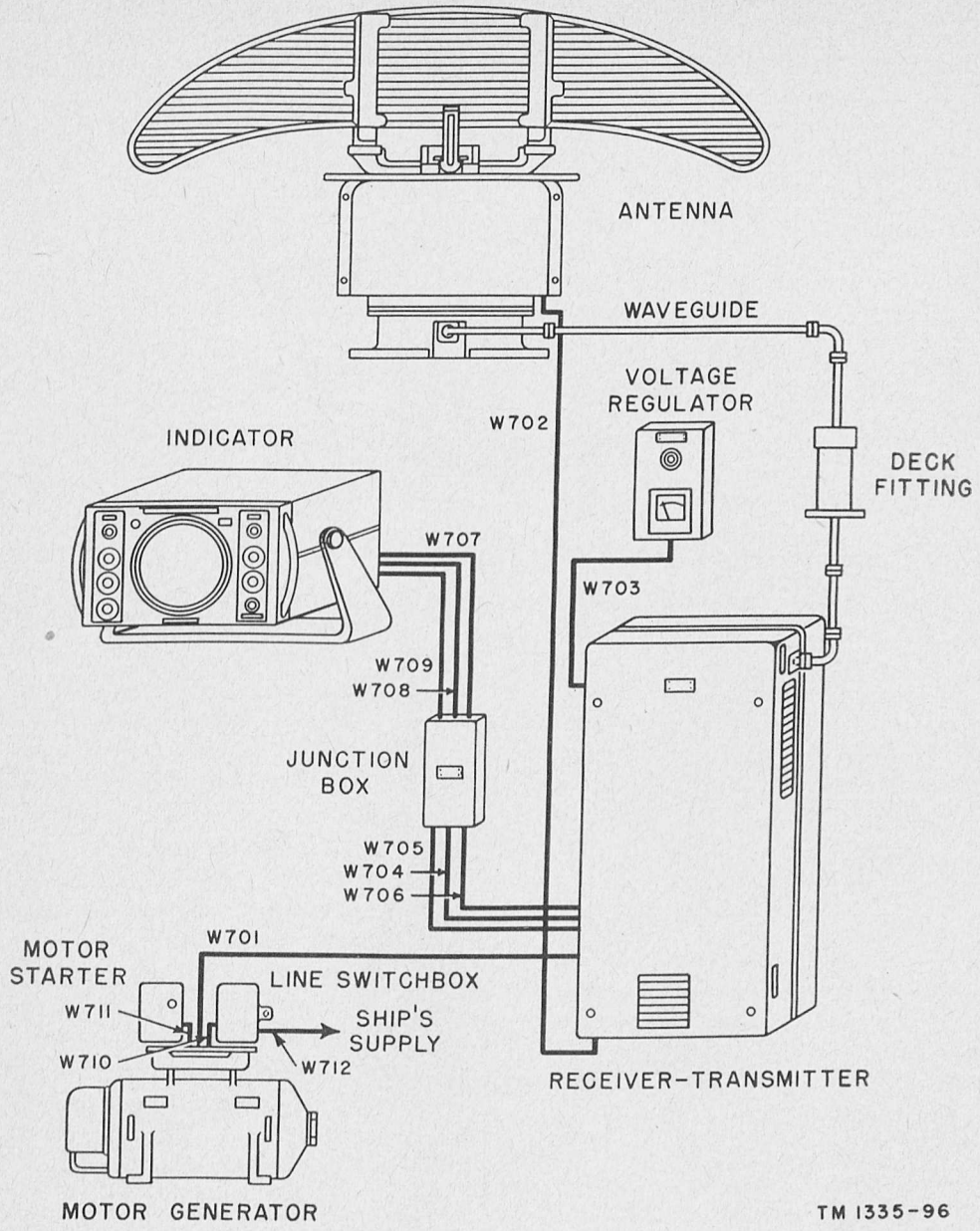


Figure 22. Simplified siting and installation diagram.

uncrate, unpack, and check it in a location which is convenient to the point of installation and sheltered from the elements. The following instructions apply to equipment shipped in either export or domestic packing cases.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is damaged easily and may be rendered useless.

b. Step-by-Step Instructions for Uncrating and Unpacking. Figure 23 illustrates typical packaging of a radar set component. Eight of the nine packing cases are similar, but the motor generator is bolted to the bottom of its packing case and is braced by two boards (fig. 24).

(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, excelsior, and corrugated paper covering the

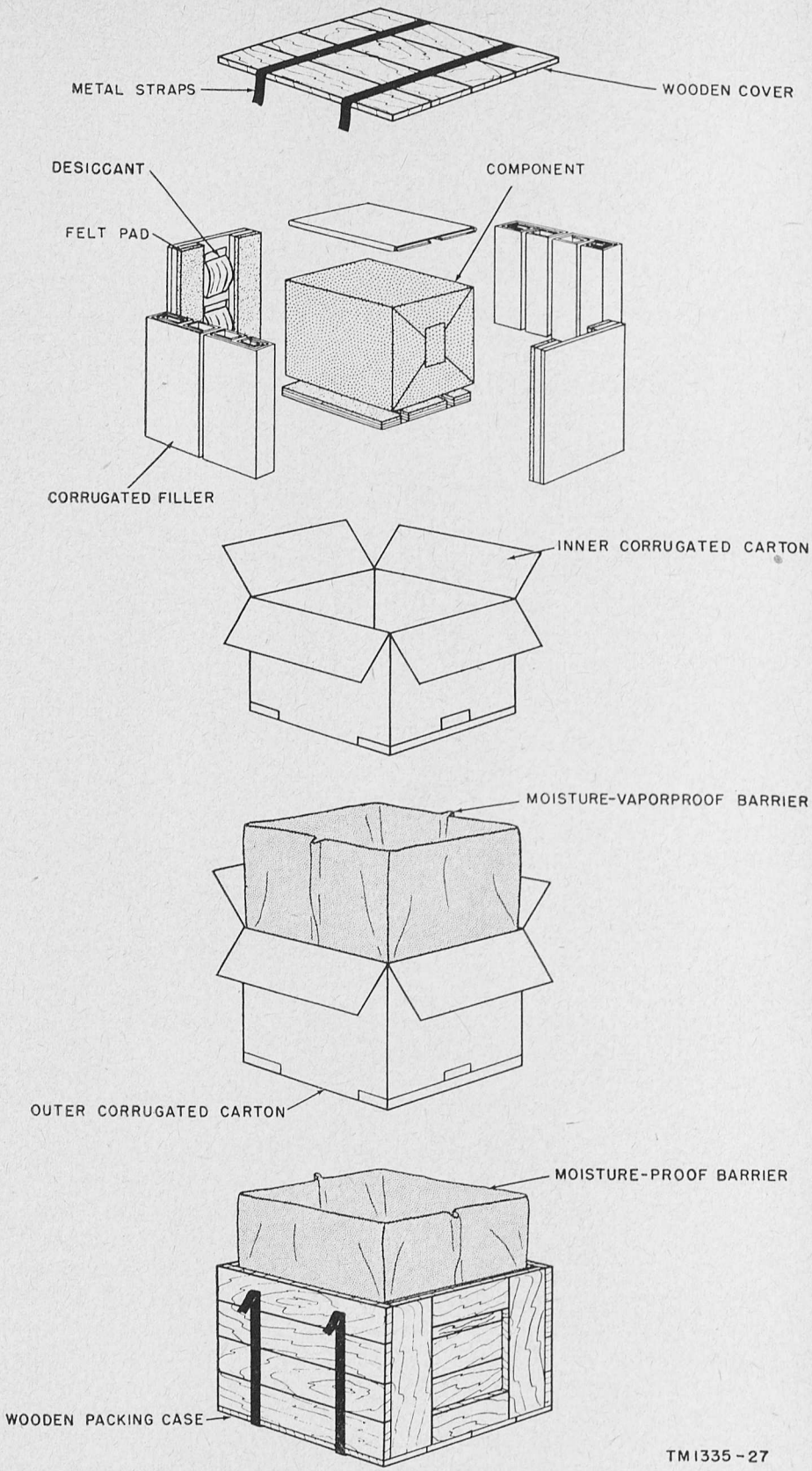


Figure 23. Typical packaging of a component.

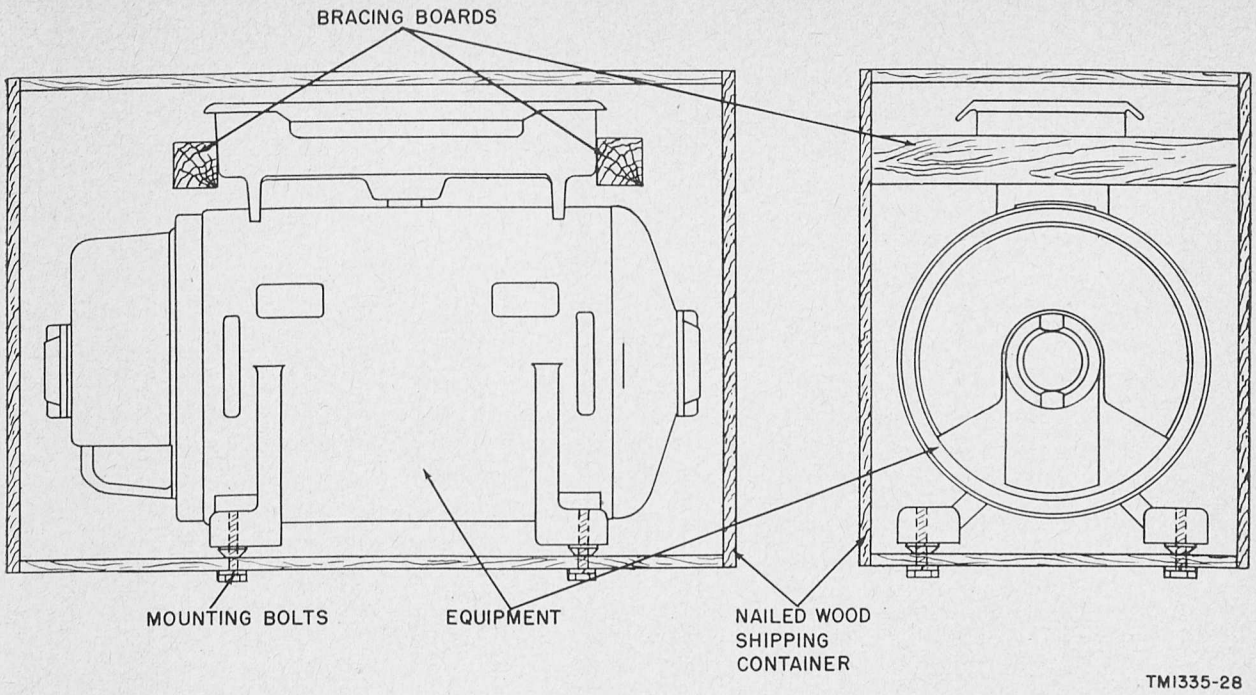


Figure 24. Motor-generator packaging.

equipment within 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 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.

32. 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 NAVSHIPS 900171, Electronic Installation Practices Manual.

b. 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.

33. Receiver-Transmitter

The following instructions give the procedures for installing the receiver-transmitter and its blower motor.

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. 25). This crib usually is supplied by the agency or the shipyard which installs the unit. The thickness of the wooden crib must be considered when the waveguide run is planned.

c. Select the deck position for the base of the receiver-transmitter and mount the wooden crib. Drill four $\frac{5}{8}$-inch mounting holes in the wooden crib as indicated in the base and kick pipe location diagram of figure 25.

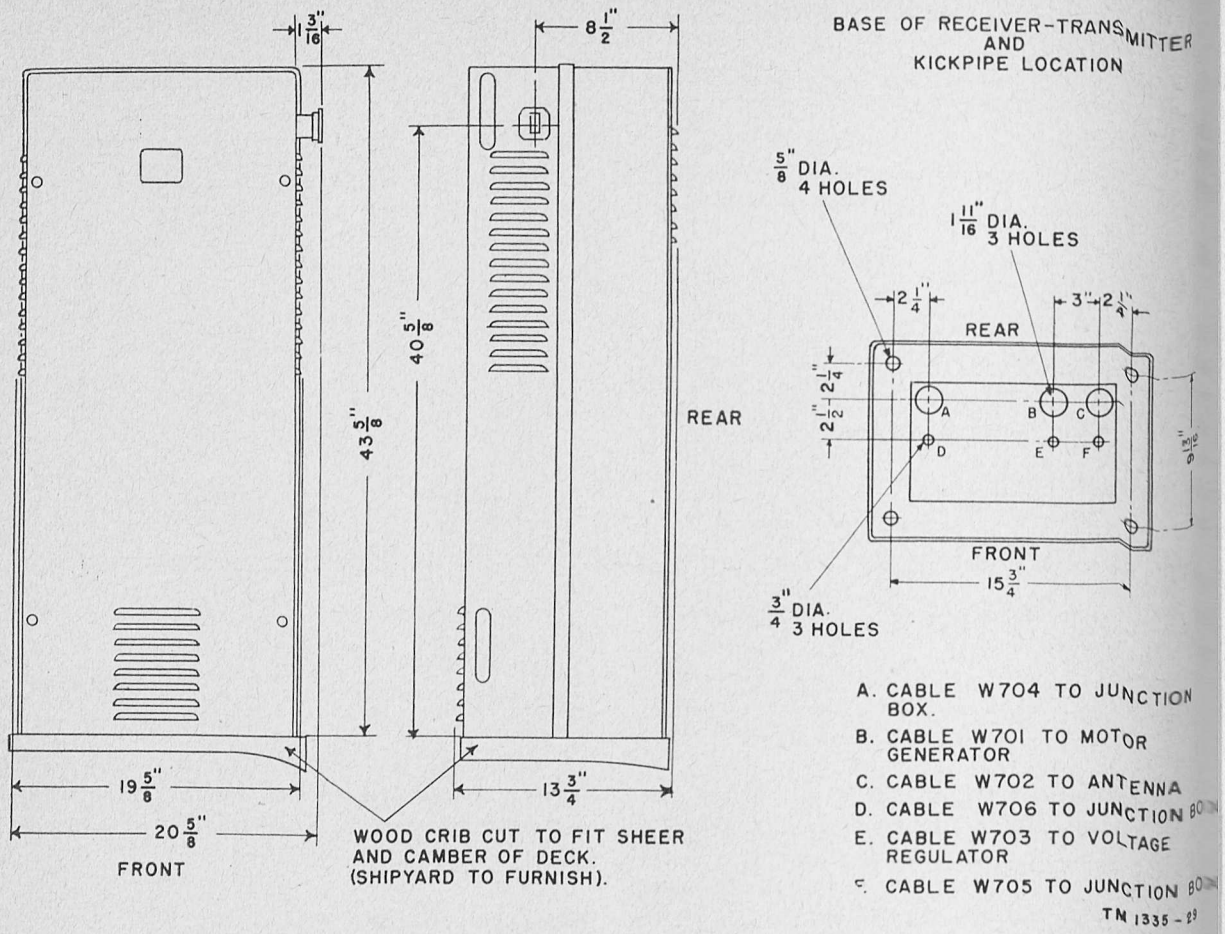


Figure 25. Receiver-transmitter, dimensional drawing.

d. In the deck, drill three $1\frac{11}{16}$-inch kick pipe holes (A, B, and C, fig. 25) and three $\frac{3}{4}$-inch kick pipe holes (D, E, and F, fig. 25).

Note. Holes A, D, and F are not required when the indicator is mounted on the receiver-transmitter.

e. Install the proper kick pipe in each hole. Use approved cable glands to secure cables in kick pipes. Refer to paragraph 39 for information on installing cables.

f. Use four ½-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 40 through 43 and to figure 72 for information on preparing and connecting cables to the four terminal boards (fig. 42). Also, connect the two coaxial cables to their respective jacks (fig. 72).

h. To install the blower motor in the receiver-transmitter, proceed as follows:

(1) Open the hinged panel and remove the air funnel from its shipping position within the unit.

(2) Remove the air filter by pulling up the tension spring.

(3) Aline the three mounting holes of the blower with the three clearance holes made visible by removal of the air filter.

(4) Use three No. 8–32 screws to bolt the blower to the air filter frame. Ground the blower by connecting the shielded cable (provided with the blower) to the center 8–32 mounting view.

(5) Mount the air funnel to the top of the blower assembly. Make certain that the air funnel lines up with the air duct (fig. 5).

(6) Tighten the clamp to secure the junction of the blower assembly and the air funnel.

(7) Refer to figures 72 and 76 and connect the blower cables to terminals MG6 and MG7 of terminal board TB803.

i. Install fuses F801, F802, F803, and F804. Refer to paragraph 44 for the correct values of F801 and F802. F803 is a 2½-ampere fusetron; F804 is a 10-ampere fuse.

34. Indicator

The indicator unit may be mounted to an overhead, a bulkhead, or on top of the receiver-transmitter unit. Reinforce the bulkhead or overhead with angle iron and suitable brackets to minimize the effects of vibration. Leave at least 15 inches of free space above, below, and at the rear of the unit, so that the top and bottom covers can be removed.

a. Installation on bulkhead or overhead (fig. 26). The trunnion mounting base should rest on a wooden crib at least 1 inch thick. This crib usually is supplied by the shipyard.

(1) Select the position for the trunnion mounting base on the bulkhead or overhead and mount the wooden crib.

(2) Drill four ⅜-inch holes (fig. 26) in the wooden crib.

(3) Fasten the trunnion mounting base to the wooden crib with four 5/16-inch bolts. Use suitable lockwashers and nuts.

(4) Connect the cables at the rear of the unit. (Refer to paragraphs 40 through 43 for cabling information.)

b. Installation On Receiver-Transmitter. To install the indicator on the receiver-transmitter, proceed as follows:

(1) Refer to the trunnion mounting dimensions diagram (fig. 26) and drill four ⅜-inch holes in the *top* of the *frame* of the receiver-transmitter cabinet.

(2) Fasten the trunnion mounting base to the top of the receiver-transmitter cabinet with four 5/16-inch bolts. Use suitable lockwashers and nuts.

Note. If the hinged chassis and the front cover of the receiver-transmitter do not close properly, adjust the four trunnion mounting boits by first loosening and then retightening them evenly.

(3) Connect the cables to the receiver-transmitter unit as described in paragraph 41 and indicated in figure 72.

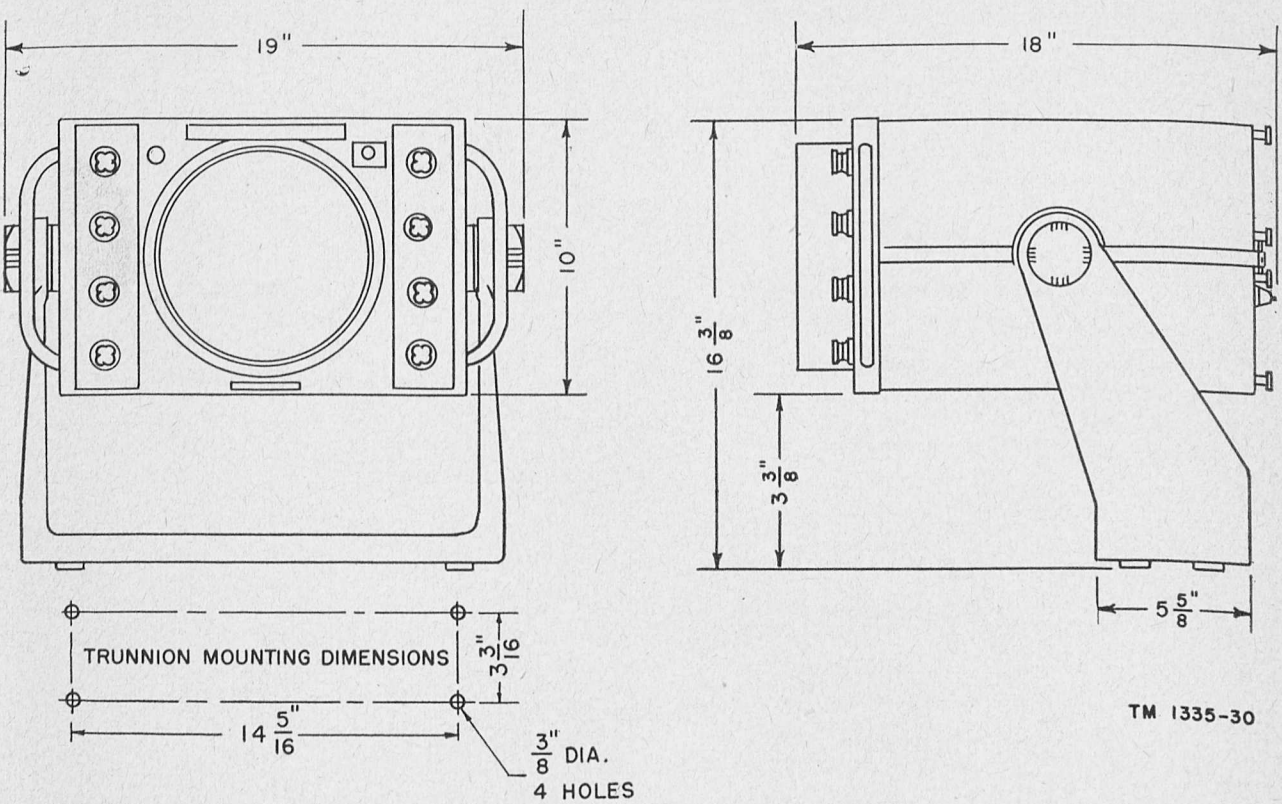


Figure 26. Indicator, dimensional drawing.

35. Antenna

Mount the antenna as high as possible to avoid reflections from the ship structure in the forward and beam directions. The supporting structure should be guyed with ⅜-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 reflector and antenna horn are shipped as separate items. Determine whether or not the antenna must be completely assembled (fig. 2) *before it is placed on the antenna mounting.*

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

a. Reflector Assembly.

(1) As the reflector is lowered on the antenna base, carefully insert into the two holes at the base of the reflector mounting brackets the two dowel pins (fig. 3) of the rotating head. (Also refer to figs. 27 and 28.)

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

b. Horn Assembly.

(1) Remove the cover plate from the waveguide flange on the rotating assembly.

(2) Mount the horn to the waveguide flange (fig. 28). Make certain that the red paint mark on the horn is alined with the red mark on the wing under the two upper flange screws.

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

c. Antenna Feed Horn and Reflector Adjustments. The spacing between the horn and the reflector must be checked and adjusted to assure satisfactory performance. It can be checked with an

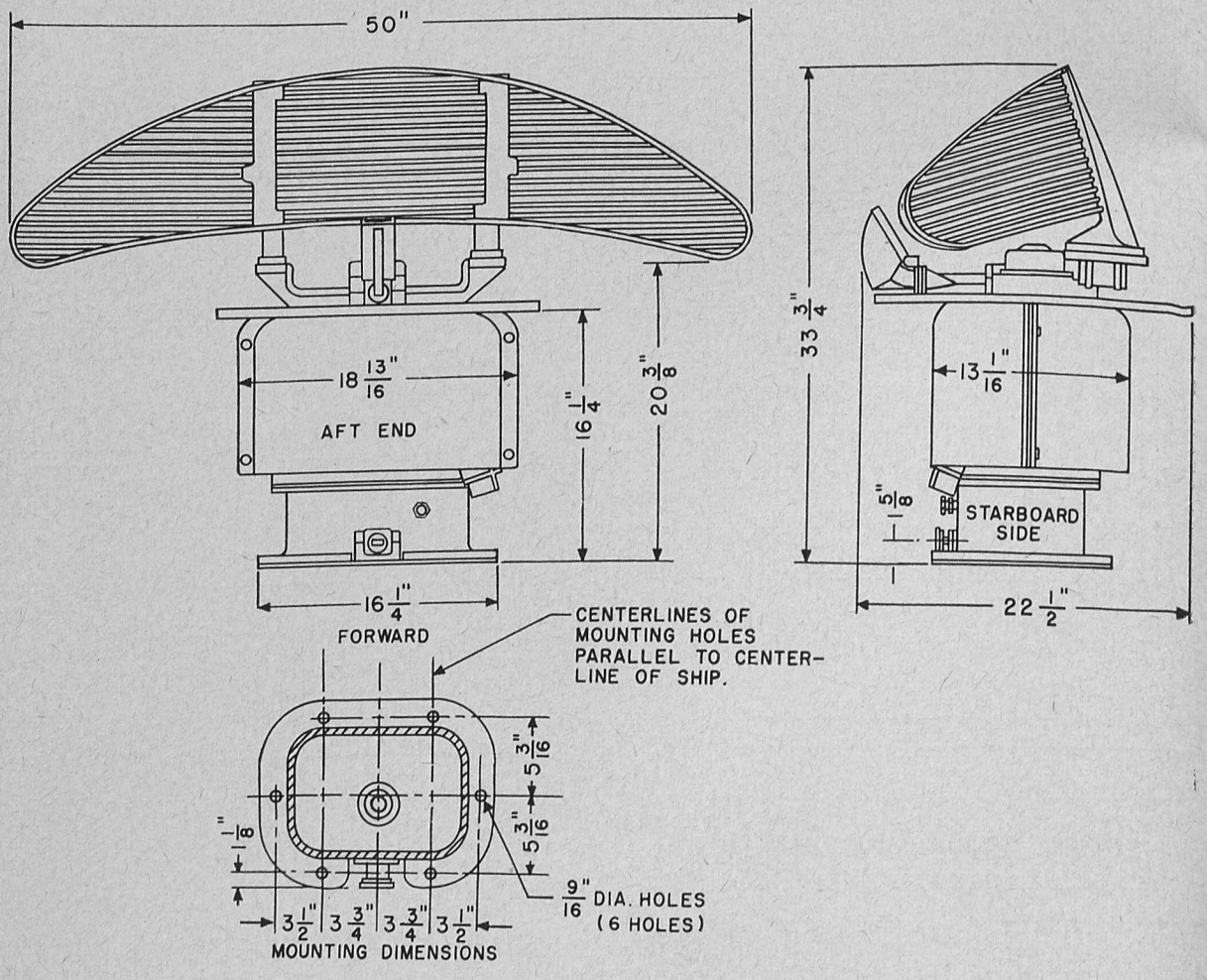


Figure 27. Antenna, dimensional drawing.

antenna gage or with a 6-foot steel rule. Pips on the center and ends of the reflector (fig. 28) identify the correct points for measurement. The ends are marked by a single pip. The center of the reflector lies between two pips on the top and bottom of the reflector.

(1) *Antenna gage check.*

(*a*) Make certain that the antenna feed horn is fastened securely to the waveguide.

(*b*) Loosely bolt the reflector to the rotating head so that the reflector position may be shifted.

(*c*) Place the antenna gage between the two pips in the center of the reflector and over the antenna horn (fig. 28).

(*d*) Move the reflector to obtain an exact fit. The gage must fit to within one-thirty-second inch at all points on the reflector.

(*e*) Shift the reflector to make the horn equidistant from the ends of the reflector.

(*f*) Measure the distances (X in figure 28) from the pip on each end of the reflector to each edge of the horn flange.

(*g*) When both distances are the same within one-thirty-second inch, the antenna gage fits exactly and the horn is centered in the reflector.

(*h*) Bolt the reflector securely to the rotating head.

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

(*a*) Measure $15\frac{7}{16}$ inches, $\pm\frac{1}{32}$ inch, from the top center pips of the reflector to the top center of the flat flange on the horn.

(*b*) Measure $12\frac{15}{16}$ inches, $\pm\frac{1}{32}$ inch, from the center pips of the reflector to the bottom center of the flat flange on 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 inch.

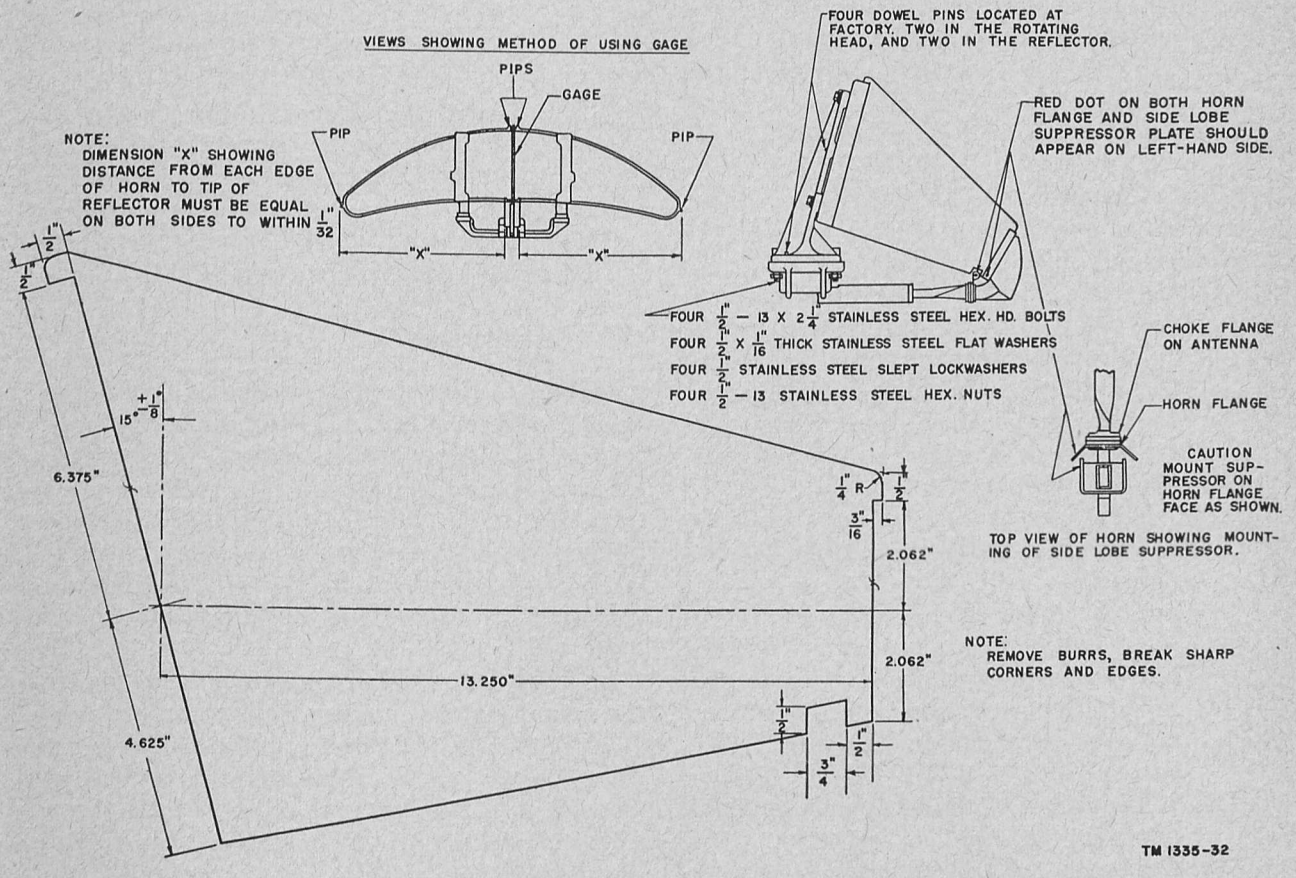


Figure 28. Antenna horn and reflector adjustments.

d. Antenna Drive Motor Installation.

(1) Remove the four captive bolts on the pedestal and remove the drive housing cover plates.

(2) Remove the drive motor mounting plate (fig. 3) by removing the hexagonal-head bolts.

(3) Bolt the drive motor to the mounting plate so that the nameplate of the drive motor will face the observer when the mounting plate is replaced. (Use the bolts and lockwashers which are supplied with the equipment).

(4) Mount the drive motor by replacing the mounting plate. The drive motor coupling should engage the antenna worm-gear shaft.

Caution: Do not use force to engage the drive motor coupling. If the drive motor is not alined accurately, it will not seat properly.

(5) Replace and tighten the hexagonal-head bolts that secure the mounting plate.

(6) The connections for the drive motor depend on the supply line voltage. Refer to the intraconnection diagram for the antenna unit (fig. 29). For a 24-, 32-, or 115-volt d-c drive motor, connect the green lead to terminal No. 5, and the grey lead to terminal T of terminal board TB501.

e. Heater Installation. Refer to figure 29 for information on which heater units to use with the available supply line voltage.

(1) Aline the holes in the heater strips with the holes provided in the fore-and-aft antenna mounting (figs. 3 and 4). Mount the forward heater strip with the connecting terminals on top. Mount the aft heater strip with the connecting terminals at the bottom.

(2) Use the hexagonal-head bolts provided to secure the heater strips to the antenna mounting.

(3) Bolt the thermostatic switch (fig. 4) to the mounting flange located to the left of heater the forward strips. Use the two round head screws provided. (Holes are provided for mounting the thermostatic switch.)

(4) Bolt capacitor C502 (fig. 4) to the antenna mounting in front of capacitor C501. Use two No. 6–32 machine screws. (Holes are provided for mounting the capacitor.)

f. Heater Connections (fig. 29). For 115-volt, d-c installations, connect heater strips HR501 and HR502 (Resistance Elements HD–124/SPN–11) in parallel; for 24- or 32-volt, d-c installations, connect heater strips HR503 and HR504 (Resistance Elements HD–123/SPN–11) in parallel. Connect one common terminal of the heater strips to terminal T of terminal board TB501; connect the other common terminal to thermostatic switch S504. Connect capacitor C502 across the thermostatic switch.

Caution: Make certain that there are no loose wires.

g. 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 $\frac{9}{16}$-inch holes through the selected mounting base. (See fig. 27 for the location and spacing of these holes.)

Note. Be sure that the center lines of these holes are parallel to the center line 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 ½-inch bolts. Use suitable lockwashers and nuts.

(4) Connect the proper cable through the cable gland (fig. 4) to the antenna terminal board (par. 41 and fig. 3).

36. Junction Box

Locate the junction box within 62 inches of the indicator so that the indicator can swivel freely on its trunnion when the standard cables are connected. Leave at least 8 inches of free space on all sides of the box for maintenance purposes. (When the indicator is mounted on top of the receiver-transmitter unit, the junction box and cables W704, W705, and W706 are not required (par. 41)).

a. With a No. 9 drill, drill four holes (fig. 30) for mounting the junction box to the bulkhead.

b. Fasten the junction box to the bwlkhead with four No. 10 screws. The screws must be long enough to extend at least one-half inch beyond the opposite side of the bulkhead. Use suitable lockwashers and nuts.

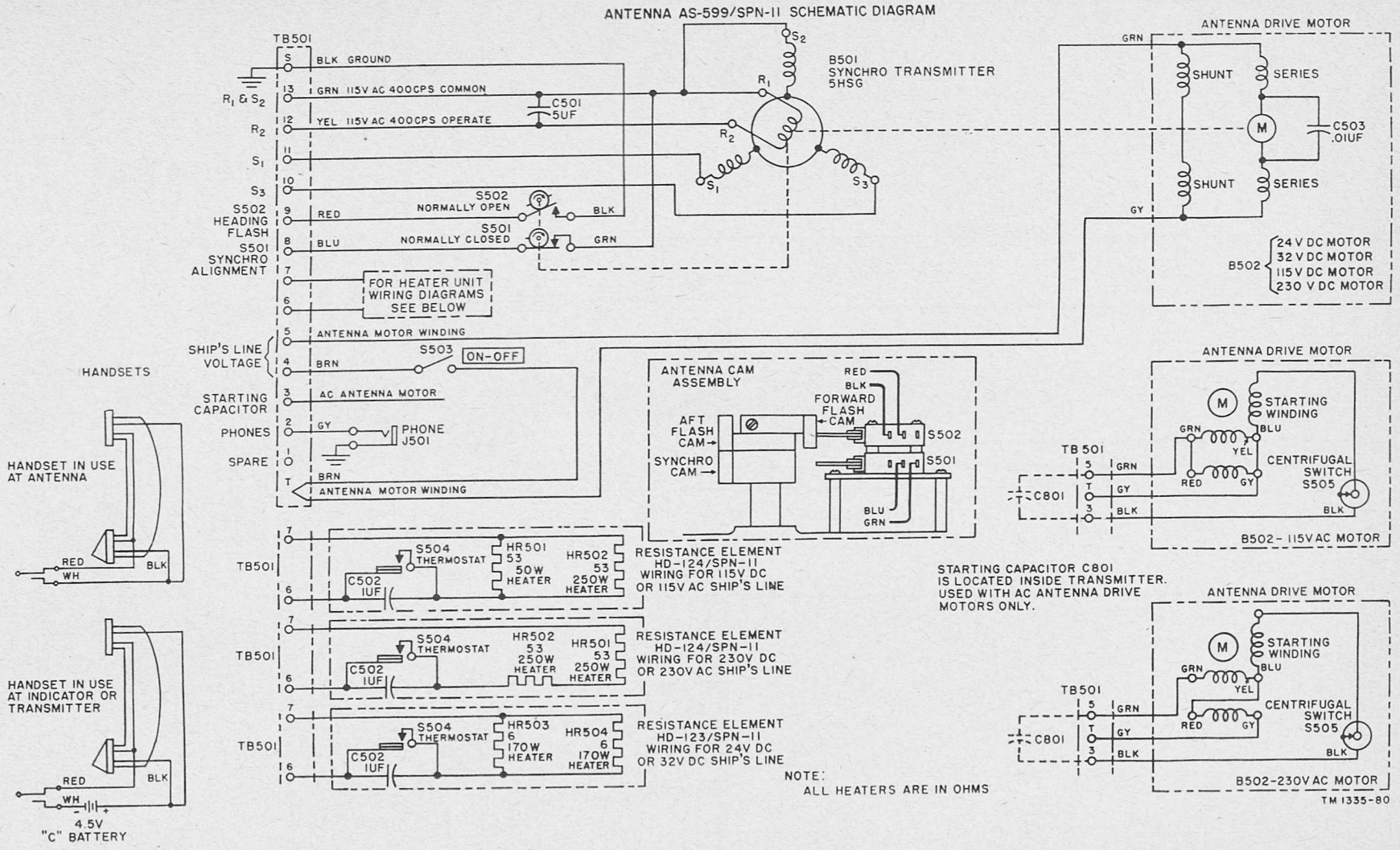


Figure 29. Antenna intraconnection diagram.

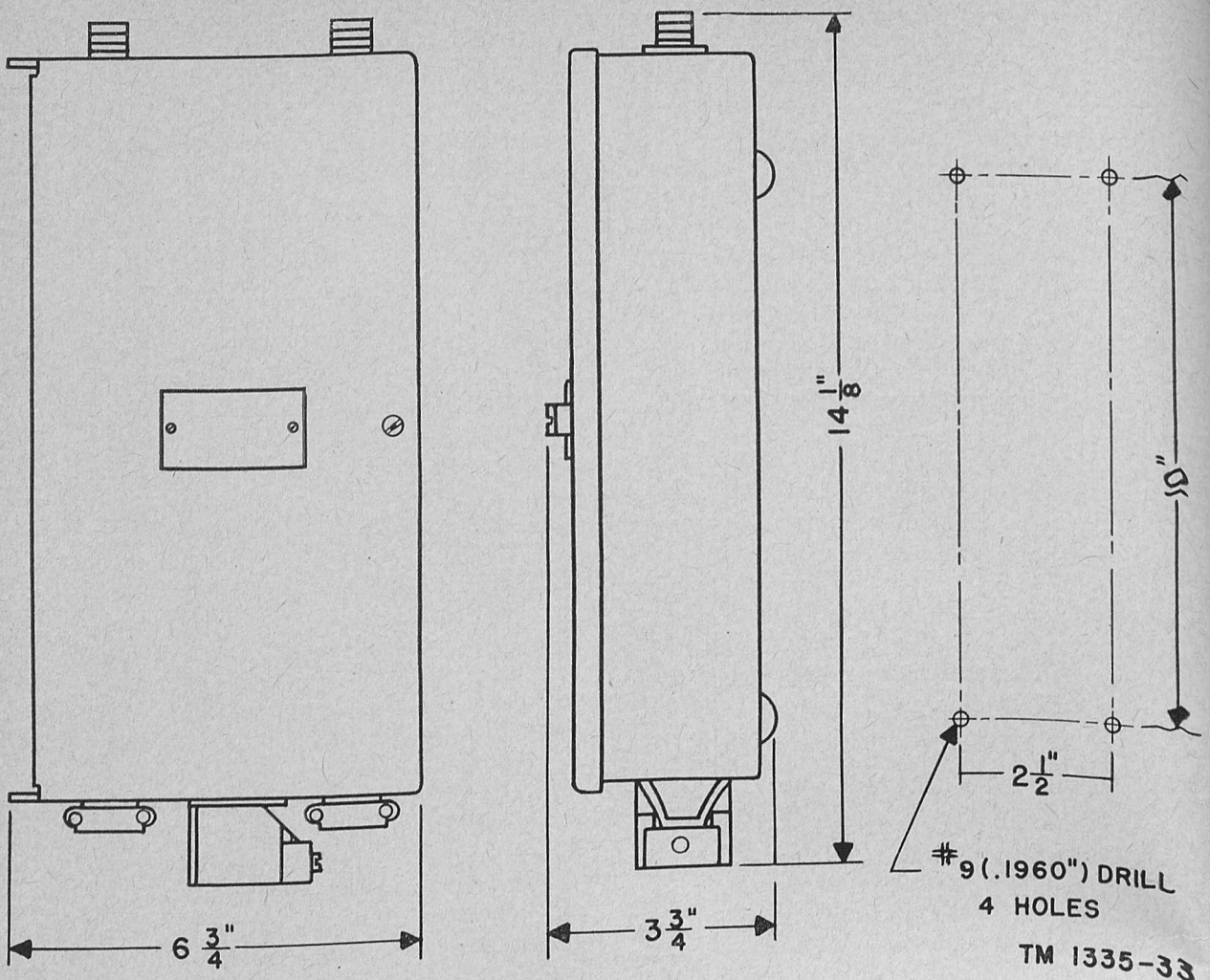


Figure 30. Junction box, dimensional drawing.

37. Power Components

This paragraph covers installation instructions for the motor generator, line switch box, motor starter, and voltage regulator. Refer to the block diagram of figure 21 for information on the power system of each model of Radar Set AN/SPN–11(*).

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

(1) Drill four 5/16-inch holes in the deck (fig. 31).

(2) 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 inch on the other side of the deck.

b. Switch Box. Leave enough clearance space for the hinged front cover to swing open (fig. 32 or 33). The exact dimensions of the front cover depend on the switch box in use. Install the switch box as close as possible to the motor starter and motor generator.

(1) Drill four 1/4-inch holes in the bulkhead (fig. 32 or 33). Locate the lower pair of holes approximately 62 inches above the deck level.

(2) Fasten the switch box to the bulkhead with four 3/16-inch roundhead screws. These screws must be long enough to extend at least one-half inch beyond the opposite side of the bulkhead plate.

(3) Remove the two knock-out plugs which

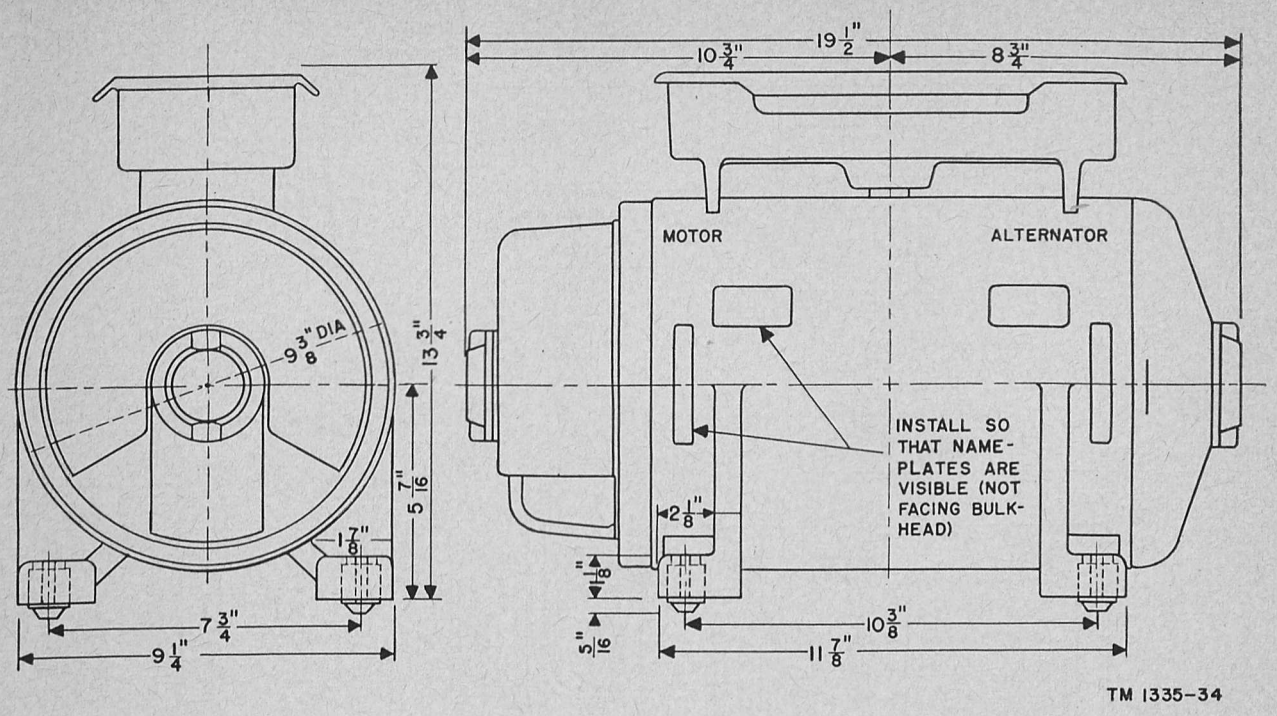


Figure 31. D-c motor-generator, dimensional drawing.

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 knock-out plug by striking it sharply with a screw driver at a point on the side opposite the lip (fig. 34) and then twisting it free.

Note. Before removing the knock-outs examine the cables and cable clamps to determine whether a large entrance hole (entire knock-out) or a small entrance hole (center portion only of knock-out) is required.

c. Motor Starter. Locate the motor starter as close as possible to the motor generator and switch box. Leave at least 6 inches of clearance in front of the unit for the removal of the front cover.

(1) Loosen the retaining screw at the bottom of the starter case and remove the front cover.

(2) Remove the two screws and lockwashers that hold the starter mechanism to the rear of the case.

(3) Lift out the starter mechanism and carefully place it to one side.

(4) Drill four 5/16-inch holes in the bulkhead (fig. 35 or 36). Locate the lower pair of holes approximately 62 inches above the deck level.

(5) Fasten the 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 inch beyond the opposite side of the bulkhead.

(6) Remount the starter mechanism in the case, reinstall the two mounting screws and lockwashers, and tighten securely.

(7) See *b* above for removal of knock-out plugs.

(8) Refer to figure 35 or 36 for dimensions of the unit.

Note. The mounting dimensions for the 24-volt and the 32-volt motor starters are identical.

d. Voltage Regulator. Locate the voltage regulator as close as possible to the indicator so that the operator can read the meter and adjust the rheostat easily. Leave at least 24 inches of free space in front of the voltage regulator for removal of the front mounting panel.

(1) Drill four holes (fig. 37) in the bulkhead with a No. 9 drill.

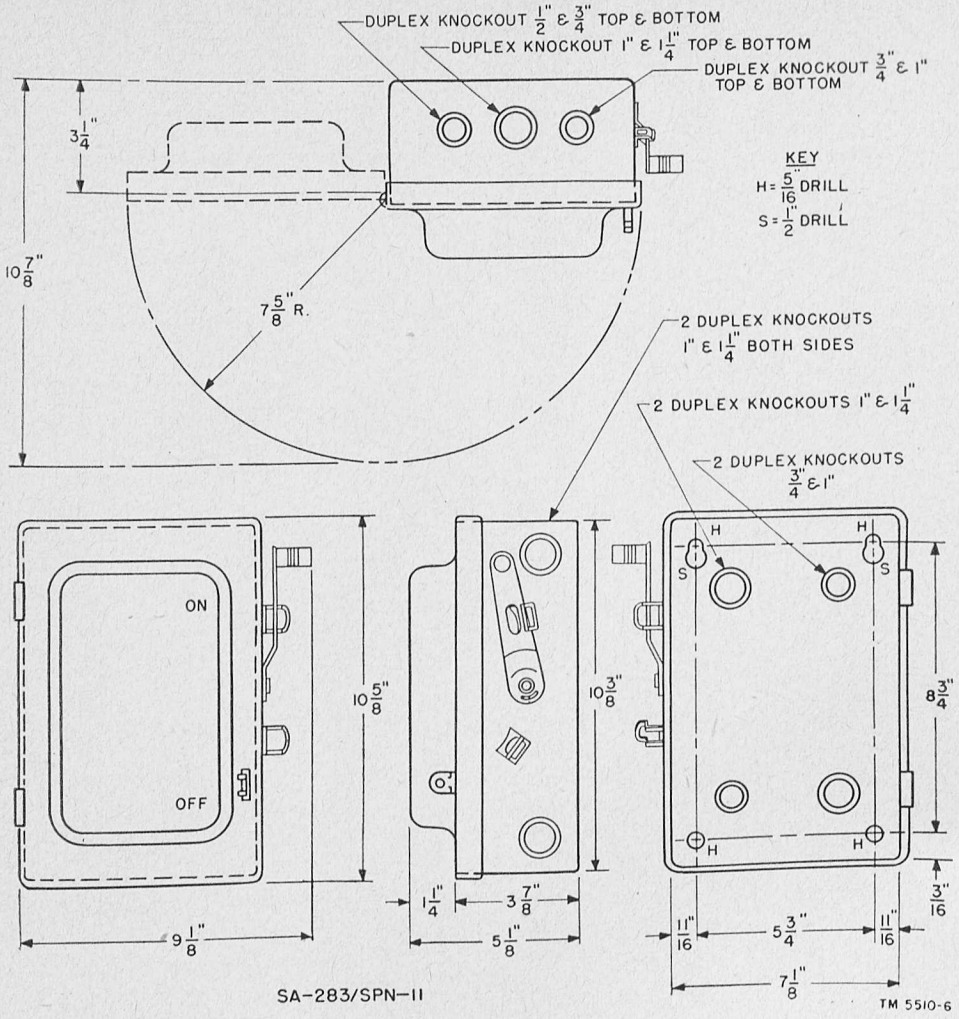


Figure 32. Switch Box SA-283/SPN-11, dimensional drawing.

(2) Fasten the voltage regulator to the bulkhead with four No. 10 screws.
(3) Connect the cables (par. 41).

38. Waveguides

Waveguides must be installed in accordance with shipboard standards. (Refer to NAVSHIPS 900171, Electronics Installation Practices Manual.) 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 (fig. 16). 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) Make certain 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. 38), 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.

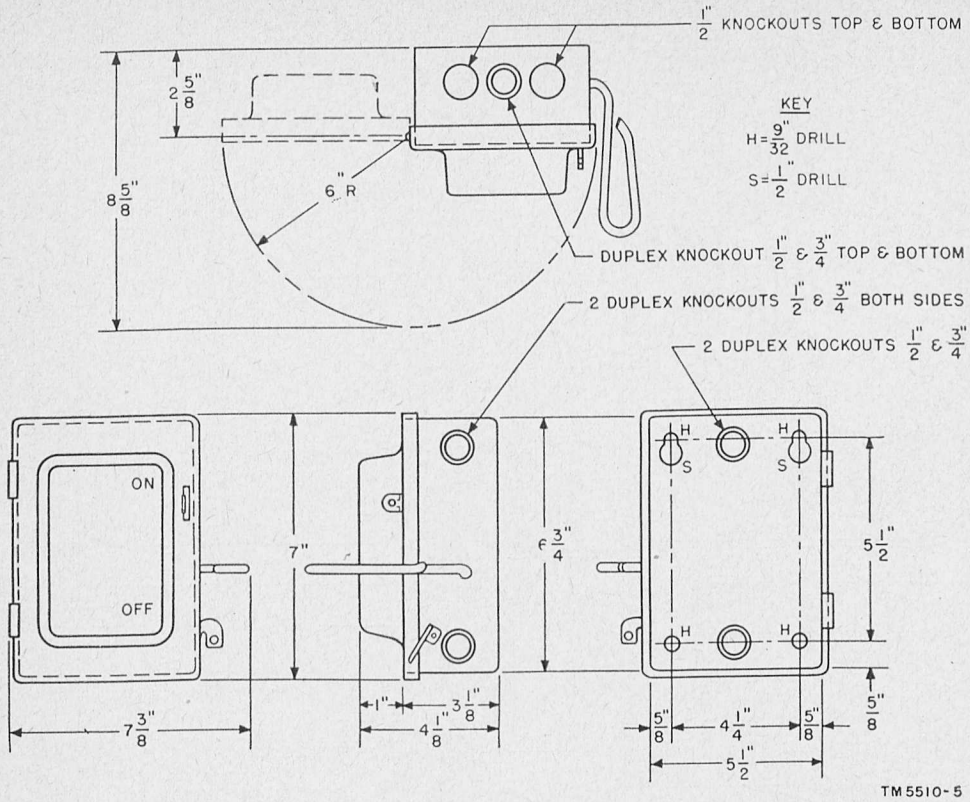


Figure 33. Switch Box SA-284/SPN-11, dimensional drawing.

(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 bring the waveguide downward to the side of the receiver-transmitter.

Note. Always place a 1-foot section as close as possible to the receiver-transmitter. This permits insertion of a bidirectional coupler for test purposes.

(8) Either a twist section or a straight section may be required to bring the waveguide to the receiver-transmitter. 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.

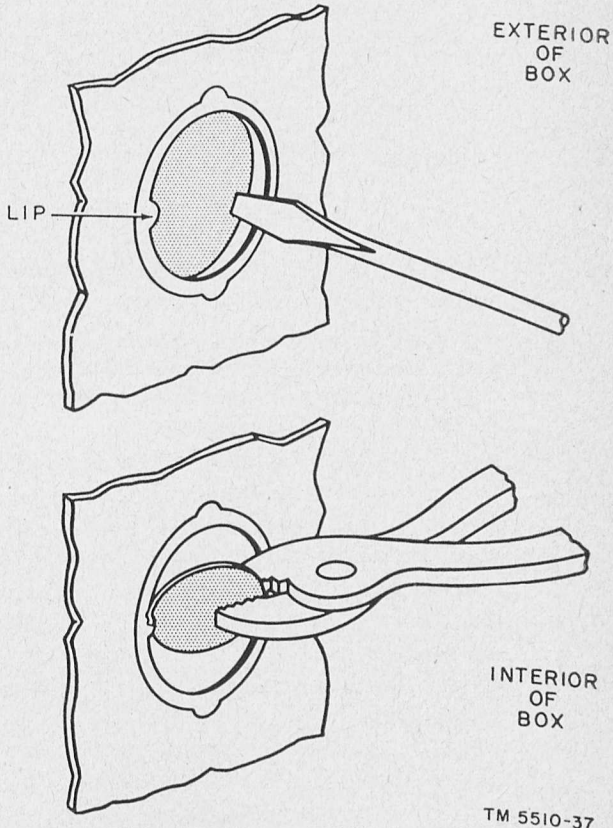


Figure 34. Removal of knock-out plugs.

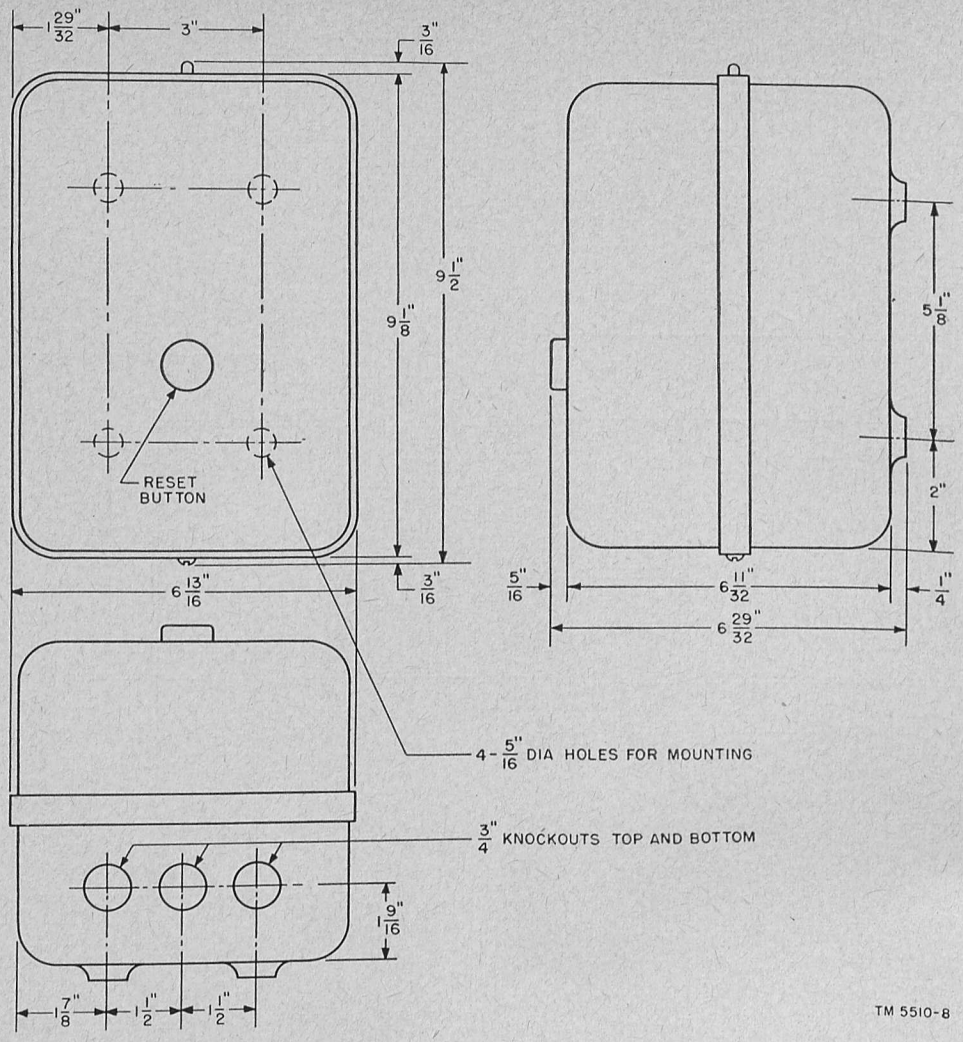


Figure 35. Motor Starter SA-287/SPN-11, dimensional drawing.

(9) Use a 90° H bend to connect the waveguide to the duplexer waveguide (fig. 38).

Note. For purposes of illustration, numerous bends are shown in figure 38. 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 48 inches apart for proper waveguide support. The installation procedure is as follows:

(1) Bolt the waveguide clamp base (fig. 39) to the deck with two ⅜-inch bolts.

(2) Mount the waveguide in the waveguide clamp base.

(3) Place the waveguide clamp (fig. 39) over the waveguide.

(4) Bolt the waveguide clamp to the waveguide clamp base with four ¼-inch bolts. Use suitable nuts and lockwashers.

d. Waveguide Deck Fitting.

(1) Weld the deck fitting base (fig. 39) to the deck.

(2) Remove the two clamping bolts, which hold the flange ring, at the top of the deck fitting.

(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. 40) to hold

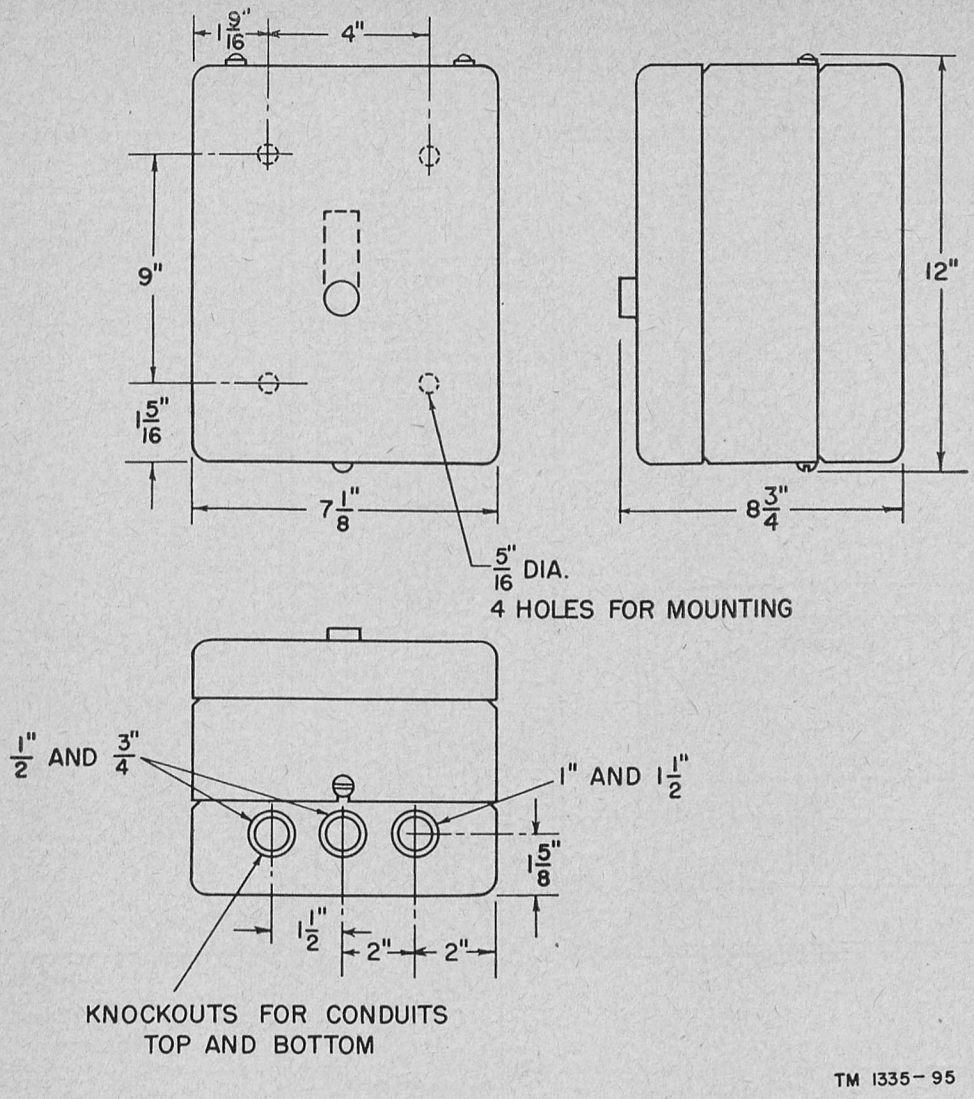


Figure 36. Motor Starter SA–285/SPN–11, dimensional drawing.

the waveguide on the underside of the deck (ceiling of house).

e. Cutting and Brazing Waveguide Sections.

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

Caution: Do not scratch the silvered surface. Cut a waveguide section near a 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 burrs.

(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 carbon tetrachloride. 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 surface of the cut section to the surface of the plain flange; hold the surfaces firmly in contact until the solder has set.

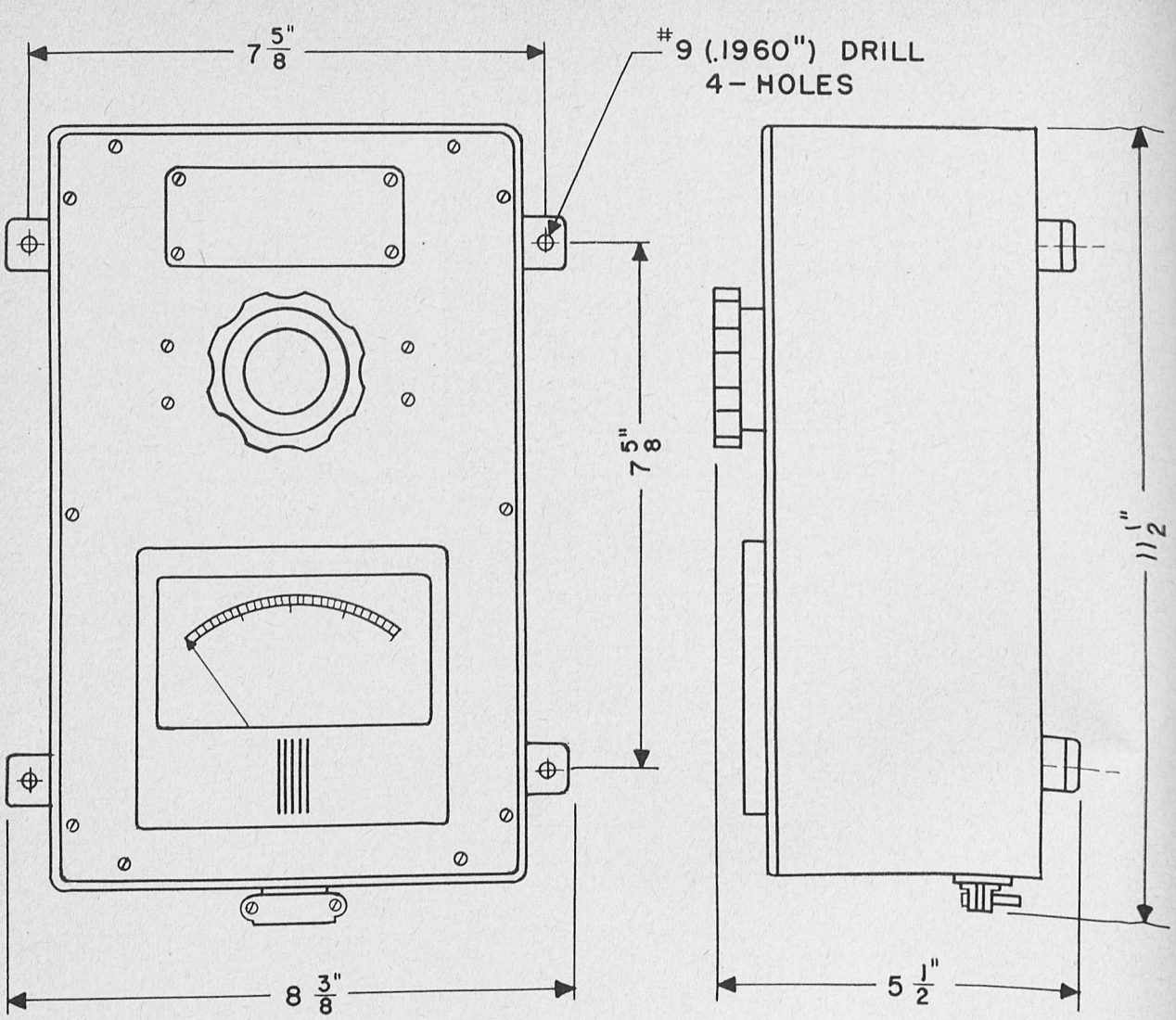


Figure 37. Voltage regulator, dimensional drawing.

(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 1¼-inch side of the *lowest* horizontal section. The hole is for drainage of condensed moisture.

39. Cable Installation

Because of the differences among vessels on which Radar Set AN/SPN–11(*) will be installed, it is impossible to give here exact installation instructions. Each installation must be made in accordance with shipboard requirements and standards. For information on these requirements refer to NAVSHIPS 900171, Electronic Installation Practices Manual. The following general information is given to assist in planning the required cable runs.

a. Preparation of cables. Cables W707, W708,

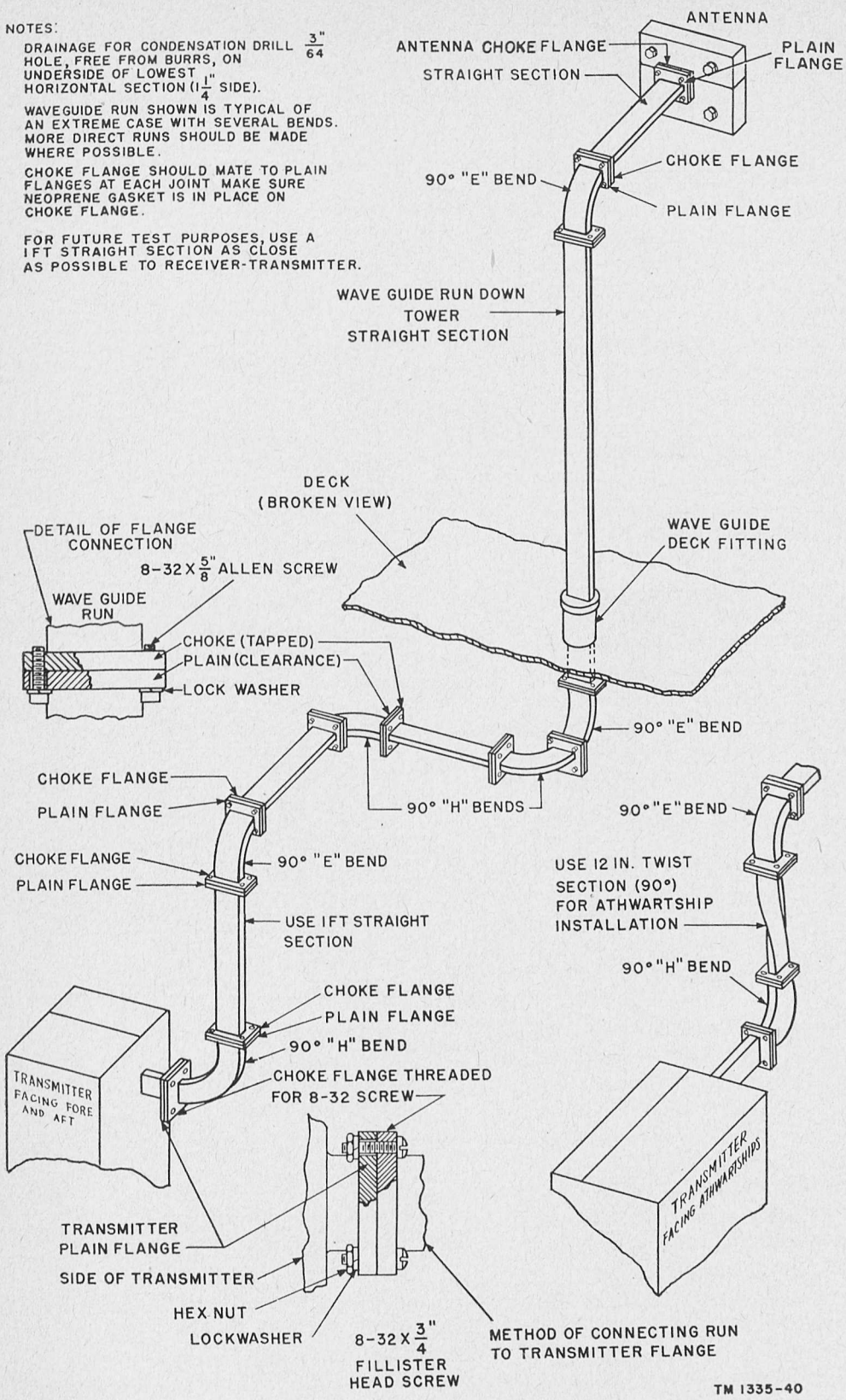


Figure 38. Typical waveguide run.

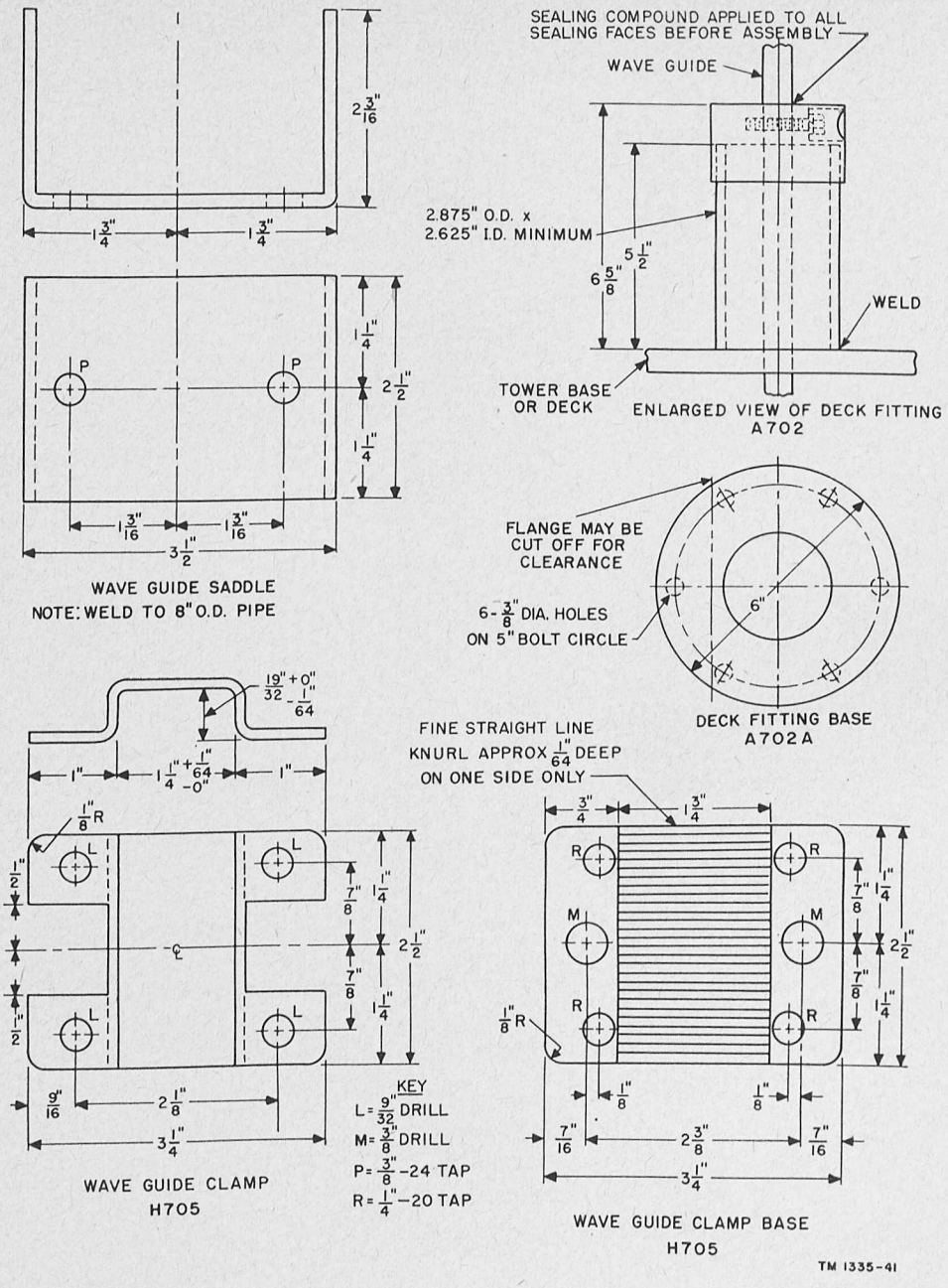


Figure 39. Waveguide accessories.

and W709 are shipped ready to install. All other cables must be cut to the required lengths and fitted with suitable connectors. When determining cable lengths, remember that each length must include the amount of cable needed to reach from component to component, *plus the lengths required to make insulated leads at both ends of the cable.* In certain installations it may be advantageous to cut a cable to the required length and install it before preparing the leads and connectors. In other installations it may be better to complete preparation of the cable before installing it. Paragraph 40 contains instructions for preparing the cables. The cable chart (par. 42) lists the cables in numerical order (by reference symbols), gives the type of each cable, the number of its conductors, and the points between which it is connected. The locations of terminal boards, jacks, and plugs are listed in paragraph 43. Figure 72 is a complete cabling diagram.

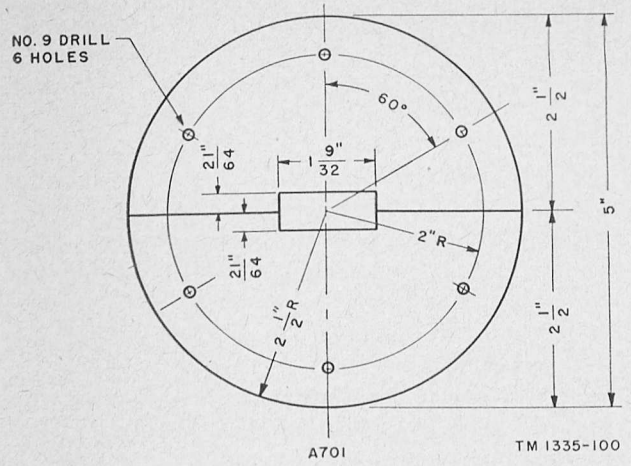


Figure 40. Ceiling plate.

b. Routing Cables. Each cable should be run over the shortest possible route. In particular, cables 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 avoid 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 kick pipes 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.

40. Preparation of Cables

a. Cable W701. This cable must be cut to the required length and a terminal lug must be attached to each end of 16 of its 19 conductors. To prepare this cable proceed as follows:

(1) Determine the required length of cable. This length must *include* the following lengths.

(*a*) Fourteen inches at one end for making insulated leads for connections to terminal board TB803 in the receiver-transmitter.

(*b*) Ten inches at the other end for making insulated leads for connections to terminal board TB601 on the motor generator.

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

(3) 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.)

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

(5) Use a wire stripper, wire cutter, or other suitable tool to remove ¼ inch of insulation from both ends of each insulated conductor.

(6) Tin the bare conductor ends with solder.

(7) Insert the tinned end of one 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.

(8) 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.

(9) Attach a Burndy terminal lug to the end of each conductor.

(10) Refer to paragraph 41 for information on connecting the cable.

b. Cables W702, W703, and W704. These cables run from the receiver-transmitter to the antenna, voltage regulator, and junction box, respectively. The instructions of *a*, above, also apply to these cables, except for the lengths of insulated leads. The insulated lead lengths are as follows:

(1) *Cable W702.* Include 14 inches for connections to TB804 in the receiver-transmitter and 12 inches for connections to terminal board TB501 in the antenna pedestal.

(2) *Cable W703.* Include 17 inches for connections to terminal board TB803 in the receiver-transmitter and 4 inches for connections to the voltage regulator.

(3) *Cable W704.* Include 14 inches for connections to terminal boards TB801 and TB802 in the receiver-transmitter and 12 inches for connections to terminal boards TB701 and TB702 in the junction box.

c. Cable W705. This cable must be cut to the

length required for installation. One end of the cable must be terminated by a coaxial connector plug and the other end must be terminated by a 9/32-inch diameter and a 3/8-inch diameter ferrule. To prepare the cable, proceed as follows:

(1) At one end of the cable, remove the outer armor and resin insulation from three-quarter inch of the cable end. Do not damage the exposed copper braid.

(2) Cut the copper braid and polyethylene insulation one-quarter inch from the cable end. Do not damage the inner copper conductor.

(3) Cut the copper braid five-sixteenths inch from the end of the remaining braid.

(4) Place the 9/32-inch diameter ferrule *under* the copper braid. The ferrule should be flush against the steel armor and resin insulation end.

(5) Place the 3/8-inch diameter ferrule *over* the copper braid.

(6) Cut a strip of 1/4-inch diameter braid approximately 1 inch in length.

(7) Insert the 1-inch strip of braid between the copper braid and the outer ferrule.

(8) Crimp the ferrule and braid.

(9) Place one wrap of friction tape around the outer steel armor to prevent it from fraying.

(10) Insert the bare copper conductor into the pin of jack J702 and solder the conductor to the pin.

(11) Solder the strip of braid to the solder lug on jack J702.

(12) Refer to *i* below, for instructions on installing a coaxial connector at the other end of the cable.

d. Cable W706. The instructions of *c* above, also apply to this table.

e. Cables W707, W708, and W709. Cables W707 and W709 are 62 inches long and cable W708 is 72 inches long. The three cables are furnished with terminations attached.

f. Cable W710. Refer to *a* above, for instructions on cutting this cable. A modified Sherman 7/16-inch terminal lug must be attached to the insulated leads of the two cable conductors. To attach these lugs, proceed as follows:

(1) Remove armor and insulation from each end of the cable as required to make leads into the switch box and motor generator.

(*a*) For connections to Switch Box SA–284/SPN–11, 3-inch insulated leads are required; for connections to Switch Box SA–283/SPN–11, 4-inch leads are required.

(*b*) For connections to the motor generator, 8-inch leads are required.

(2) Cut three-quarters of an inch of the insulation from each end of the insulated conductors.

(3) Tin the exposed copper conductors with solder.

(4) Insert a tinned conductor into the terminal lug and solder the conductor to the lug.

(5) Similarly, solder terminal lugs to the other conductor ends.

g. Cable W711. Refer to *a* above, for instructions on cutting this cable. To prepare the cable, proceed as follows:

(1) Allow the following lengths for insulated conductors.

(*a*) At the motor generator end, 7 inches.

(*b*) At the motor starter end, 11 inches for connections to Motor Starter SA–287/SPN–11, or 13 inches for connections to Motor Starters SA–285/SPN–11 and SA–286/SPN–11.

(2) Measure the lead armor the required distance from the end.

(3) Nick the 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 hack saw to cut *through* the armor; the conductor insulation beneath the armor will be damaged.

(4) Bend the nicked armor back and forth until the 3/8-inch piece is freed. Remove this piece from the end of the cable.

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

(6) Remove the conductor insulation with a wire stripper.

(7) Tin the ends of the copper conductors with solder.

(8) Insert a tinned conductor into a terminal lug, Burndy type No. YAV–10. The tip of the conductor should not extend beyond the small hole at the tongue of the lug.

(9) Crimp the lug with a pair of pliers.

(10) Similarly, attach a lug to each end of each conductor.

h. Cable W712. The cable instructions of *f* above, apply to this cable, except that one end of the cable must be terminated in connectors that are suitable for making connections to the ship power supply. The required lengths of insulated leads are as follows:

(1) For connection to Switch Box SA–284/SPN–11, 3-inch leads are required.

(2) For connections to Switch Box SA–283/SPN–11, 5-inch leads are required.

(3) The required lead lengths for connections to the ship d-c line must be determined at the time of installation.

i. Coaxial Connectors. To terminate coaxial cables with male connectors refer to figure 41 and follow the instructions given below.

(1) Loosen the setscrew in the protective sleeve of the connector.

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

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

(4) Cut the outer insulation 1⅛ inches from the cable end and remove it.

(5) Cut the copper braid five-eighths inch from the end of the outer insulation. Be careful not to damage the insulation.

(6) Cut the inner insulation three-eighths inch from the end of the conductor and remove it.

(7) Tighten the strands of the center conductor by twisting it.

(8) Tin the bare end of the conductor.

(9) Slide the plug body over the cable and guide the tinned conductor into the hollow tip on the plug body. Use a screw driver to spread the slot at the base of the plug body.

(10) Solder the center conductor to the tip of the plug body. Also, run solder into the body at the point indicated in figure 39. This will solder the body to the braid.

(11) Slide the clamping nut and the protective sleeve back into place. Tighten the setscrew.

j. Motor-Generator Jumper Connections. Refer to figure 72 for jumper connections.

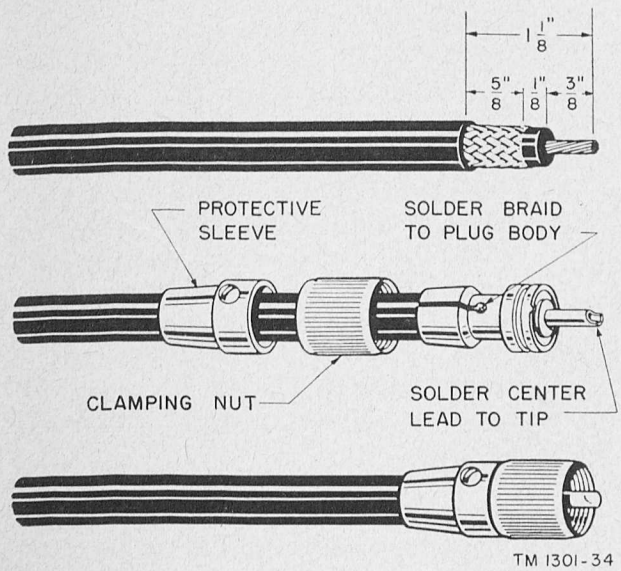


Figure 41. Coaxial connector.

41. Cable Connections

All connections must be made in accordance with the color coding or other designation given in the external wiring diagram (fig. 72). Note that this diagram indicates both the color coding and the *destination* of each conductor. For an example of this indication refer to terminal MG1 of terminal board TB803. The BLK (black) conductor of cable W701 is connected to this terminal and the figure 4 indicates that the other end of the BLK conductor goes to terminal 4 of terminal board TB601 on the motor generator.

Note. For information on supporting cables on decks, bulkheads, ceilings, and channels, refer to NAVSHIPS 900171, Electronic Installation Practices Manual.

a. Receiver-Transmitter.

(1) Connect 14 of the 19 conductors of cable W704 to terminal board TB801 (fig. 42). Connect the remaining five conductors of cable W704 to terminal board TB802. If the indicator is mounted on the receiver-transmitter, use cable W708 instead of cable W704. Run cable W708 through the center gland on top of the transmitter and connect its 19 conductors to terminal boards TB801 and TB802, as indicated for cable W704.

(2) Connect the four conductors of cable W703 to terminals MG6, MG8, MG9, and MG11 of terminal board TB803.

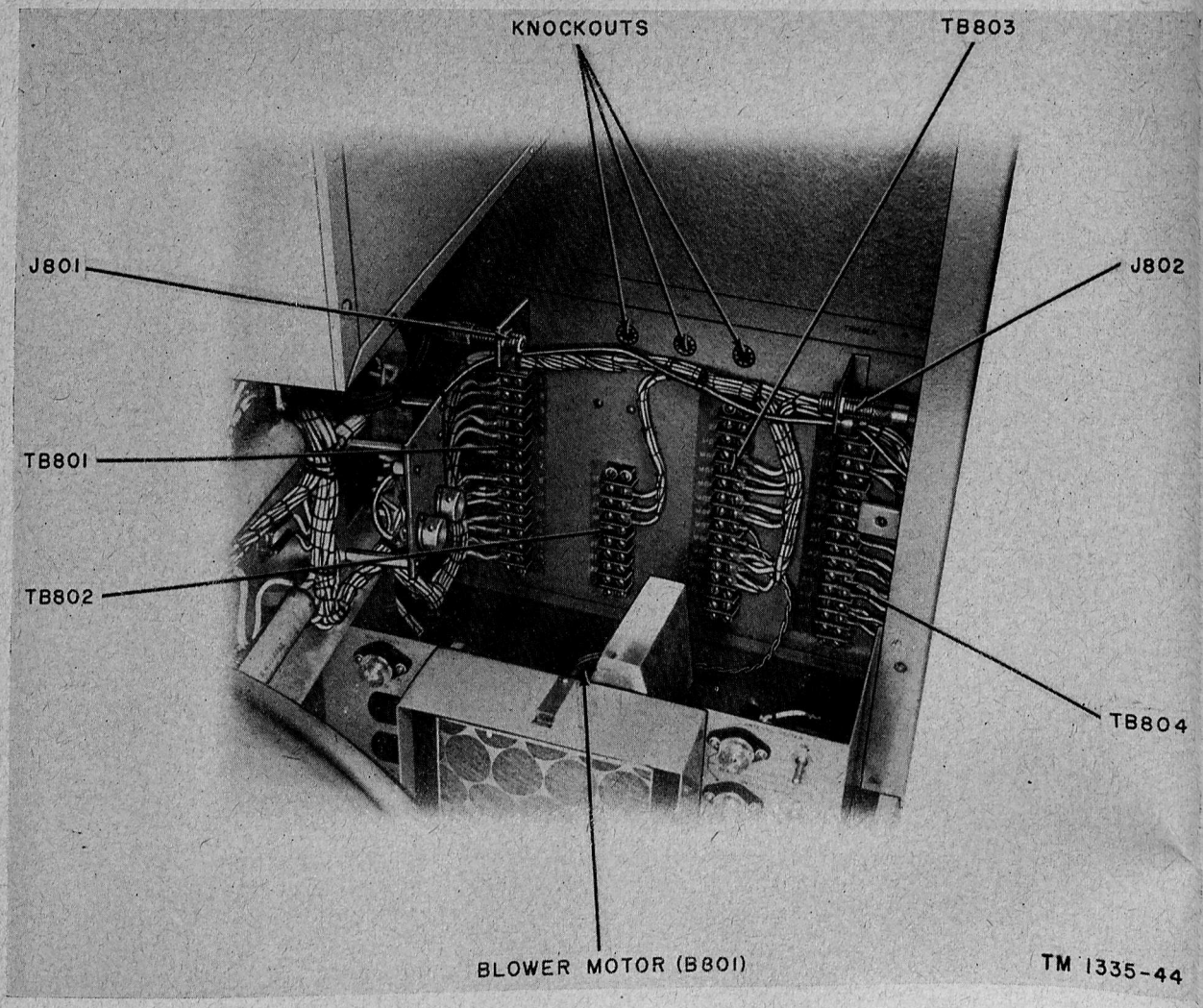


Figure 42. Terminal boards in receiver-transmitter.

(3) Connect 16 of the 19 conductors of cable W701 to terminals MG1 through MG8 and to terminals MG10 and MG11 of terminal board TB803. For long runs of cable W701 connect the spare leads in *parallel* with the 115-volt, 400-cycle line between the motor generator and terminal board TB803. (The 400-cycle line is connected to terminals MG8 and MG10 on terminal board TB803 and to terminals 8 and 9 of terminal board TB601.) For short runs of cable W701 connect the spare leads to spare terminals on the terminal boards.

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

(5) Connect coaxial cable W705 to trigger jack J802. If the junction box is not used, cable W709 is fed to trigger jack J802 through the right gland at the rear of the receiver-transmitter.

(6) Connect coaxial cable W706 to video jack J801. If the junction box is not used, cable W707 is fed to trigger jack J801 through the left gland at the rear of the receiver-transmitter.

b. Indicator.

(1) Connect cable W708 to male plug P101 located at the rear of the indicator (fig. 43).

(2) Connect coaxial cable W709 to trigger jack J101.

(3) Connect coaxial cable W707 to video jack J103.

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

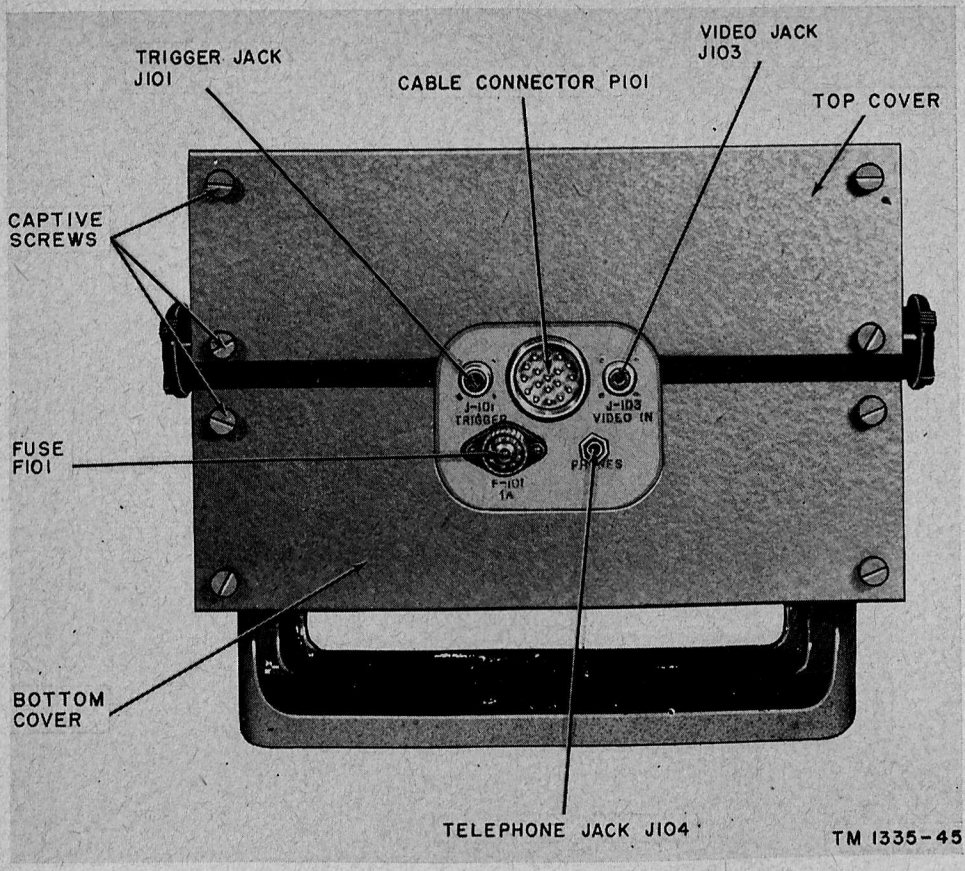


Figure 43. Indicator connector panel.

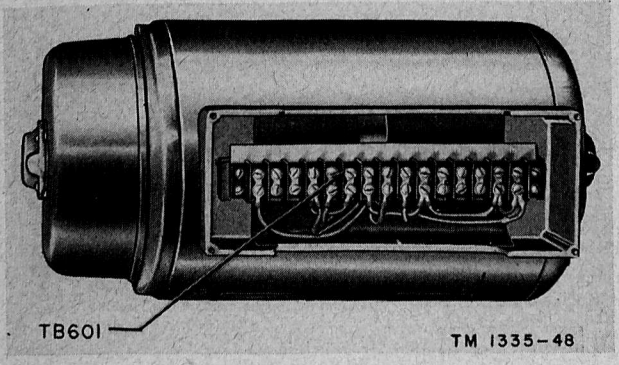


Figure 44. D-c motor-generator, terminal board TB601.

d. Motor Generator.

(1) Connect 16 of the 19 conductors of cable W701 to terminal board TB601 (fig. 44). For long cable runs connect the spare conductors in parallel with the 400-cycle line (*a*(3) above).

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

(3) Connect cable W711 to terminals 1, 4, 11, 12, and 14 of terminal board TB601.

e. Motor Starter. Connect the seven conductors of cable W711 to the starter (fig. 72).

f. Switch Box.

(1) Connect the two conductors of cable W710 to the output terminals of the switch box (fig. 13 or 14).

(2) Connect the two conductors of cable W712 to the input terminals of the switch box.

g. Voltage Regulator. Connect the four conductors of cable W703 to the voltage regulator (fig. 45).

h. Junction Box.

(1) Connect the first 14 conductors of cable W704 to terminal board TB701 (fig. 46).

(2) Connect conductors 15 through 19 to terminal board TB702.

(3) Connect cable W709 to trigger jack J701.

(4) Connect cable W707 to video jack J702.

(5) Connect cable W706 to video jack J702.

(6) Connect cable W705 to trigger jack J701.

Note. Preparation of cables W705 and W706 is discussed in paragraph 40.

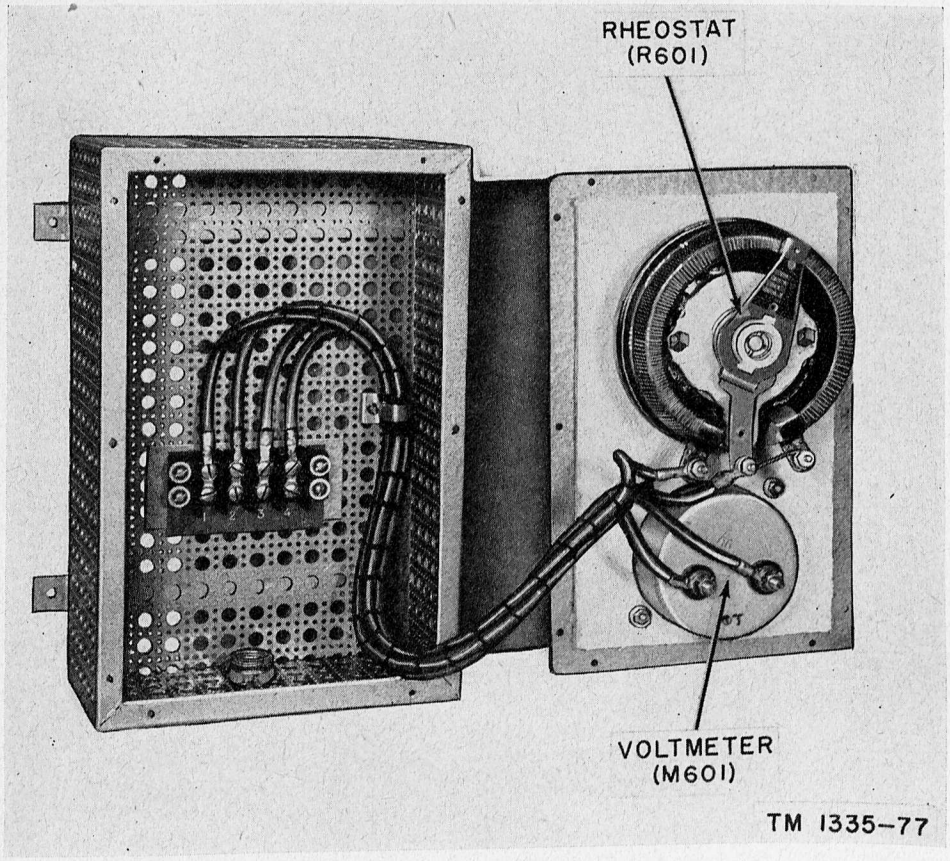


Figure 45. Voltage regulator terminal board, rheostat, and meter.

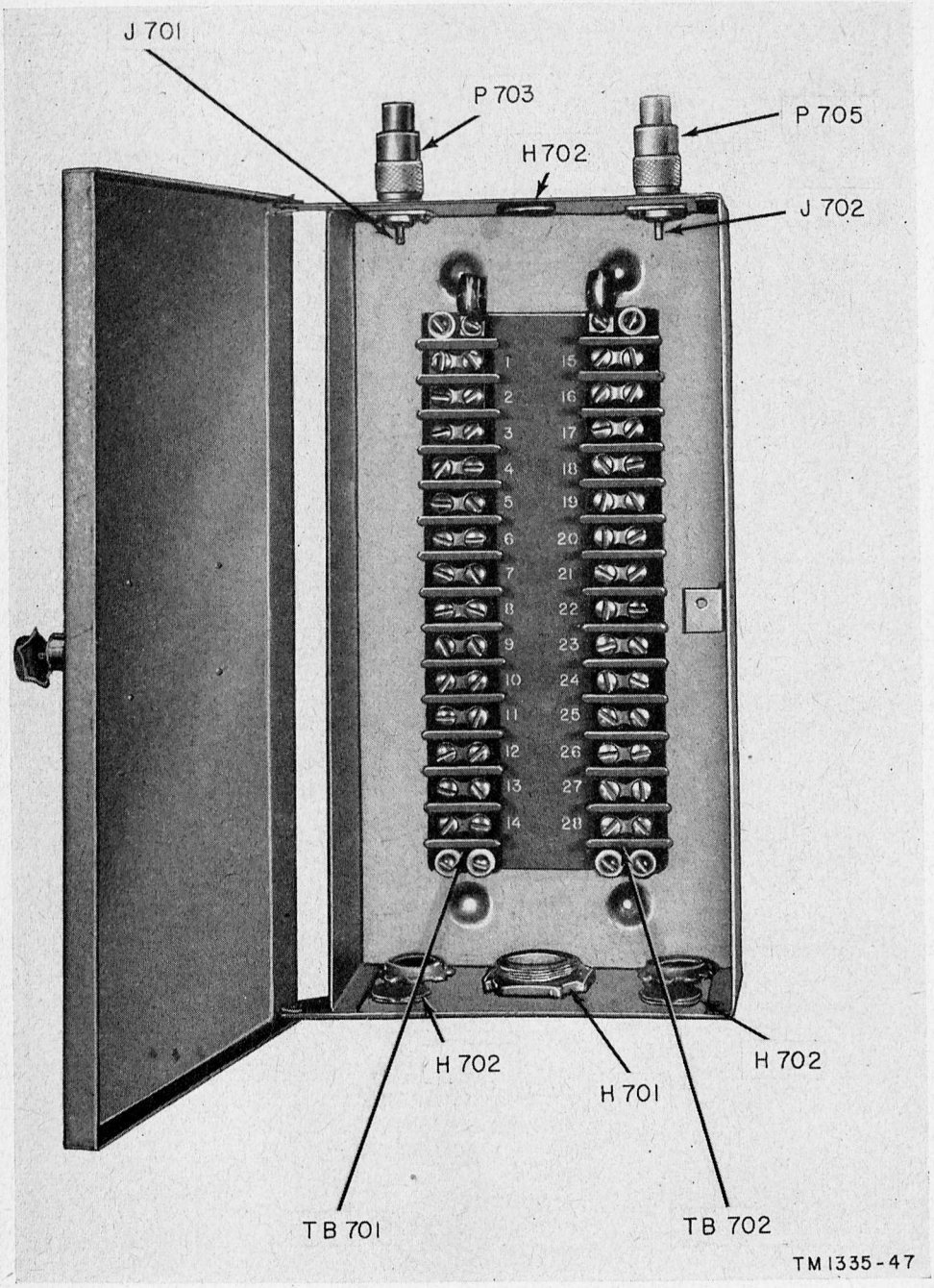


Figure 46. Junction box, showing terminal boards and cable clamps.

42. Cable Chart

Cable reference symbol	Type of cable	Number of conductors	Connect	
			From	To
W701	MHFA–19	19	Motor-generator TB601	Receiver-transmitter TB803.
W702	MHFA–19	19	Receiver-transmitter TB804	Antenna TB501.
W703	FHFA–3	4	Receiver-transmitter TB803	Voltage regulator.
W704	MHFA–19	19	Receiver-transmitter TB801 and TB802.	To junction box TB701 and TB702. Not required when junction box is not used.
W705	RG–12/U	1	Transmitter trigger jack J802	Junction box trigger jack J701. Not required when junction box is not used.
W706	RG–12/U	1	Receiver video jack J801	Junction box video jack J702. Not required when junction box is not used.
W707	RG–11/U	1	Junction box video jack J702. (Connect to receiver video jack J801, when the junction box is not used.)	Indicator video jack J103.
W708	MHFA–19	19	Junction box TB701 and TB702. (Connect to receiver-transmitter TB801 and TB802, when junction box is not used.)	Indicator male plug P101.
W709	RG–11/U	1	Junction box trigger jack J701. (Connect to transmitter trigger jack J802, when junction box is not used.)	Indicator trigger jack J101.
W710	DHFA–23, or L & A cable No. 2 (for 32 or 24 volts, d-c line).	2	Switch box	Motor-generator TB601.
W711	L & A cable No. 12	7	Starter	Motor-generator TB601.
W712	DHFA–23, or L & A cable No. 2 (for 32 or 24 volts, d-c line).	2	Power source	Switch box.

43. Location of Terminal Boards, Jacks and Plugs

Component	Item	Fig. No.
Receiver-transmitter	Terminal board TB801	42
	Terminal board TB802	42
	Terminal board TB803	42
	Terminal board TB804	42
	Video jack J801	42
	Trigger jack J802	42
Antenna	Terminal board TB501	3
Indicator	Plug P101	43
	Trigger jack J101	43
	Video jack J103	43
Junction box	Terminal board TB701	46
	Terminal board TB702	46
	Trigger jack J701	46
	Video jack J702	46
D-c motor generator	Terminal board TB601	44

Note. All connections are to be made in accordance with the color-code indications in figure 72.

44. Fuse Rating and Location Chart

Fuse			Location	
Ref. symbol	Rating		Component	Circuit
	Volts	Amp.		
F101	250	1	Indicator	A-c line.
F102	250	¼	Indicator	Transformer T101.
F301	250	2	Receiver-transmitter	Transformer T301.
F302	250	2	Receiver-transmitter	Transformer T302.
F401	250	3	Receiver-transmitter	Transformer T401.
F402	250	2	Receiver-transmitter	Transformer T402.
F601	250	25	Switch box	115-v d-c line.
F601	250	60	Switch box	24- or 32-v d-c line.
F602	250	25	Switch box	115-v d-c line.
F602	250	60	Switch box	24- or 32-v d-c line.
F801	250	10	Receiver-transmitter	Antenna heater (115 v).
F801	125	15	Receiver-transmitter	Antenna heater (24 or 32 v).
F802	250	10	Receiver-transmitter	Antenna motor (115 v).
F802	125	30	Receiver-transmitter	Antenna motor (24 or 32 v).
F803	250	25	Receiver-transmitter	Synchro.
F804	250	10	Receiver-transmitter	Motor-generator output.

45. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 31 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 change in this manual.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in chapter 4.

d. Perform the installation and connection procedures given in paragraphs 30 through 44. Refer to paragraphs 46 through 51 for installation alinement procedures.

Section II. INSTALLATION ALINEMENT PROCEDURES

46. General

This section covers checking and alinement procedures which must be performed before the equipment is ready for use by operators. Qualified personnel should make the installation, operating, and alinement checks given in paragraphs 47 through 51.

47. Checking the Installation

Before applying power to the radar set, check the entire installation carefully.

a. Antenna.

(1) Refer to the lubrication instructions (par. 73) and fill the lower drive assembly with the correct amount of oil (2135).

(2) Check the terminal board connections for proper color-coding and tightness (fig. 72).

(3) Check to see that all bolts and nuts are secured properly.

(4) Make sure that the window of the antenna horn is free from corrosion, dirt, and paint.

(5) Determine that all possible obstructions have been cleared from the path of the antenna rotation.

b. Receiver-Transmitter.

(1) See that the hinged panel is closed properly.

(2) Tighten the waveguide clamp to the waveguide; use the wrench supplied (fig. 5).

(3) Make sure that the air filter is in place (fig. 6).

(4) Check the terminal board connections for proper color-coding and tightness (fig. 72).

(5) See that the two white flexible leads from

the top caps of tubes V303 and V304 do not touch the metal panel behind the tubes.

(6) Do not allow metal objects to come in contact with the magnetron magnet.

Caution: Do not wear a wrist watch while working on the receiver-transmitter; the magnetic field of the magnetron magnet will ruin the watch.

c. Indicator.

(1) Ascertain that the PPI gears are not obstructed by wiring.

(2) Check all terminal board connections for proper color-coding and tightness.

d. Power Components.

(1) Check all power cables at the motor generator, switch box, starter, and voltage regulator for proper connections and tightness.

(2) Check to see that the correct fuse has been inserted in each fuseholder.

(3) Refer to the lubrication instructions (par. 73) and check to see that the blower motor is lubricated properly.

48. Operating Check

Refer to the operating instructions (ch. 3) and to the equipment performance checklist (par. 82). Operate the radar set and check its performance against the equipment performance checklist. Also make the alinement checks given in *a* through *c* below.

a. Duplexer and Mixer Stage Alinement. The duplexer and mixer are adjusted carefully at the factory. To assure maximum operating efficiency, however, the mixer stage and duplexer should be checked and, if necessary, realined at the time of installation. The alinement procedures are given in paragraph 49. The proper tool (H825, fig. 47) must be used to remove and replace defective crystals.

b. Bearing Alinement. Using the cursor, take radar bearings on targets. Check the radar bearings against pelorus bearings. If the radar bearings are inaccurate, refer to paragraph 50 for instructions on realinement of the synchro system.

Note. The synchro system is alined at the factory. Careless orientation of the antenna may necessitate complete realinement of the synchro system.

c. Heading Flash Alinement. Check to verify that the fore-and-aft heading flashes coincide with 0° and 180°, respectively, on the fixed azimuth scale of the indicator. If the heading flashes are inaccurate, refer to paragraph 51 for information on the required adjustments.

Note. The bearing alinement (*a* above) must be checked first; readjustments for bearing alinement affect the heading flash alinement.

49. Alinement of Duplexer and Mixer

a. General. There are two LO frequencies that produce the 30-mc intermediate frequency; the LO may be tuned to a frequency 30 mc above the magnetron frequency or to a frequency 30 mc below the magnetron frequency. For proper operation of the radar set, the LO *must* be tuned to a frequency 30 mc *higher* than the magnetron frequency. It is also extremely important that the final tuning strut adjustment produces simultaneously a peak in crystal current and maximum signal output. The necessary adjustments should be made with a test oscilloscope (*b* below), but may be made without an oscilloscope (*c* below).

b. Alinement With Oscilloscope. The following instructions are based on tests made with Oscilloscope TS–34A/AP. However, any equivalent oscilloscope may be used. Before using an oscilloscope other than Oscilloscope TS–34A/AP, refer to its technical manual and ascertain that it is designed to operate from a *400-cycle*, 115-volt, a-c source. Refer to chapter 3 and put the radar set in operation.

(1) Plug the line cord of the test oscilloscope into one of the 400-cycle, 115-volt outlets on the receiver-transmitter convenience panel (fig. 5).

(2) 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 trigger jack J303 on the receiver-transmitter test panel (fig. 50) and clip the ground lead to the frame of the receiver-transmitter.

(3) Connect the male connector of the SIGNAL INPUT coaxial test lead to the SIGNAL INPUT connector on the oscilloscope. Attach the probe of this lead to video jack J201 on the receiver and clip the ground lead to the frame.

(4) Adjust the controls on the left side of the

test oscilloscope according to the following table:

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

(5) Adjust the controls on the right side of the oscilloscope according to the following table:

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

(6) With the test scope FINE SWEEP SPEED control fully counterclockwise, 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.

(7) Adjust the FOCUS control to obtain the smallest and sharpest spot possible.

(8) Adjust the HORIZONTAL and VERTICAL POSITION CONTROLS to put the spot in the lower left portion of the scope screen.

(9) Turn the FINE SWEEP SPEED control clockwise until the sweep line extends across the screen.

(10) Advance the receiver GAIN control (on the indicator front panel) to obtain noise on the test scope.

(11) Set the receiver A. F. C.-OPERATION—MAN. TUNE switch to MAN. TUNE.

(12) Set both crystal adjusting screws (A and B, fig. 47) about four turns from their fully clockwise positions. (This step is required only for *initial* adjustments; readjustments can be made as required.)

(13) Turn the klystron tuning strut adjustment to its completely closed (clockwise) position. (This adjustment is required only for *initial* adjustments.)

(14) *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 XTAL current (A. F. C. XTAL I—SIGNAL XTAL I switch pressed). The crystal currents must not exceed .75 ma (milliampere). If either crystal current becomes excessive, adjust the corresponding crystal adjusting screw (A or B, fig. 47) as required to reduce the current to approximately .50 ma.

(15) While slowly opening the tuning strut (14 above), watch for the *first* signals to appear on the test scope.

(16) Use the ANTENNA MOTOR ON—OFF switch (fig. 50) to stop antenna rotation with the antenna on targets.

(17) Adjust the SYNC VOLTAGE control of the test scope to obtain a steady picture of targets on the test scope.

(18) Readjust the test scope FOCUS, BRIGHTNESS, and IMAGE SIZE controls to obtain a test signal of the required sharpness, intensity, and size. (A ½-inch image is satisfactory.)

(19) Tune the TR adjustment (fig. 47) for maximum amplitude of the test image on the test scope.

(20) Adjust the REFLECTOR TUNING control for peak crystal current with the A. F. C. XTAL I—SIGNAL XTAL I PUSH switch pressed. As peak crystal current is approached, the signals probably will decrease and may even disappear.

(21) Carefully readjust the klystron tuning strut for maximum signals.

(22) Repeat steps given in (20) and (21) above until maximum signals and peak signal crystal current are obtained together. Note the crystal current.

(23) Check the A. F. C. XTAL I reading and adjust the crystal adjustment screw (B,

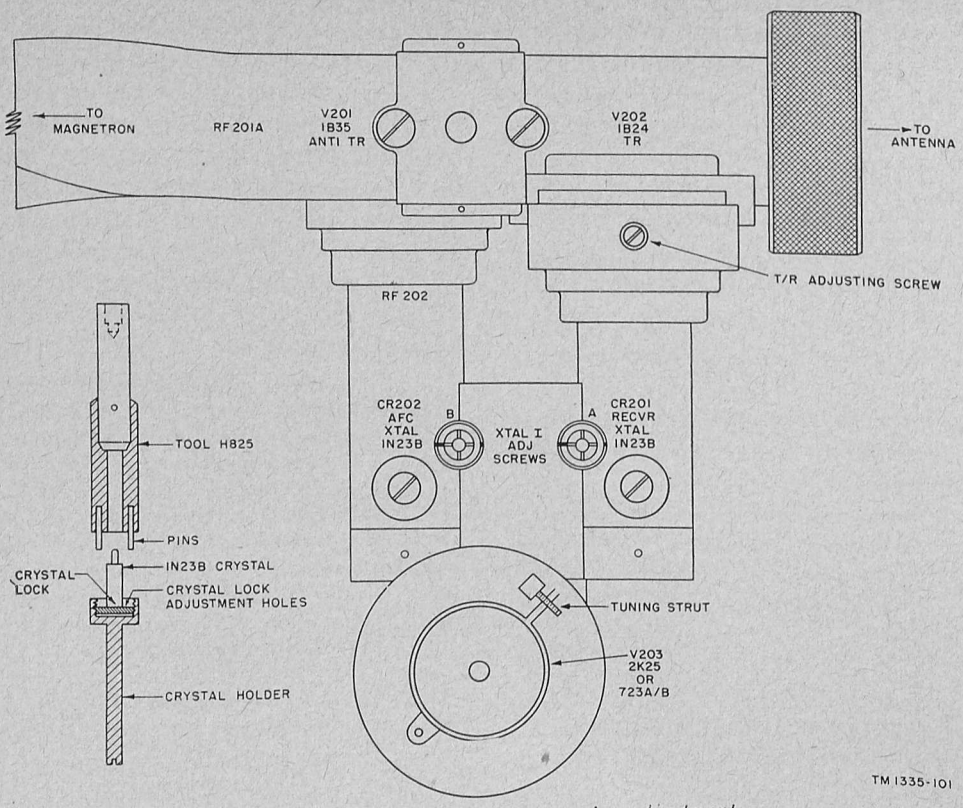


Figure 47. Mixer and duplexer tuning adjustment.

fig. 47) to obtain a meter reading between .4 and .5 ma. *Do not touch any other control.*

(24) Push switch S201 and check the signal crystal current. If the SIGNAL XTAL I reading is lower than that given in (22) above, readjust crystal tuning screw A to increase the reading to that obtained in (22) above.

(25) Make the following checks to determine that the LO is operating on the frequency which is 30 mc above the magnetron frequency.

(*a*) Open the kylstron tuning strut *slowly*. A slight adjustment should produce a second set of signals, indicating that the LO is now 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 (*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 klystron is operating at the correct frequency (30 mc higher than the 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.

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

(27) Check for proper operation of the afc circuits by throwing the A. F. C. OPERATION—MAN. TUNE switch to A. F. C. OPERATION. The amplitude of the signals should not change. Repeat the alinement procedure if necessary.

(28) 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 HIGH VOLTAGE switch is thrown back to ON, the crystal current should again become steady. Repeat the alinement procedure if necessary.

Caution. The alinement is incorrect

if maximum signals and maximum crystal current do not occur together. The alinement is also incorrect if the LO is not adjusted to the *high side* of the magnetron frequency. The *first* signals to appear as the klystron tuning strut is opened are obtained with the proper LO tuning.

c. Alinement Without Oscilloscope. The alinement procedure of *b* above should be used whenever possible. However, 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 and stop the antenna rotation with the antenna pointed at targets.

(2) Advance the receiver GAIN control (on the indicator panel) to the point at which some noise appears on the PPI scope.

(3) Adjust the REFLECTOR TUNING control so that the LO oscillates, and adjust the crystal adjustment screws, A and B (fig. 47), so that the crystal currentreadings are the same (about .5 milliampere) for both positions of the A. F. C. XTAL I—SIGNAL XTAL I switch.

(4) Throw the A. F. C. OPERATION—MAN. TUNE switch to A. F. C. OPERATION. (Assuming that the LO is tuned improperly, the crystal current will rise and fall periodically.)

(5) Close the klystron tuning strut and then *slowly* open it. As the strut is opened the crystal current will rise and fall.

(6) 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 klystron operating mode.*

(7) Throw the A. F. C. OPERATION—MAN. TUNE switch to MAN. TUNE and adjust the REFLECTOR TUNING control for peak crystal current. Note the current amplitude.

(8) Now set the A. F. C. OPERATION—MAN. TUNE switch to its A. F. C. OPERATION 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 (7) above.

(9) Repeat the procedures of (7) and (8) above, until there is no change in crystal current as the A. F. C. OPERATION—MAN. TUNE switch is alternately switched from one position to the other.

(10) Readjust the crystal adjustment screws (§A and B, fig. 47), so that both crystal currents are between .4 and .5 milliampere.

(11) Adjust the TR tuning for maximum target signals on the PPI scope.

(12) Make a very 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 as the A. F. C. OPERATION—MAN. TUNE is alternately switched from one position to the other. Repeat the alinement procedure if necessary.

50. Bearing Alinement

The synchro system is alined carefully at the factory. With perfect alinement of the antenna base in the fore-and-aft direction, radar bearings will be identical to sight bearings. Assume, however, that the antenna base is installed 5° off the ship center line, so that a dead-ahead target appears at 355° on the indicator azimuth scale (fig. 48). Because of the 10-to-1 gear ratio between the synchro receiver and the deflection coils 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 *a* below.

a. Alinement Procedure.

(1) Stop the radar antenna so that a dead-ahead target (or a target only a few degress off the bow) may be observed.

(2) Use the indicator RANGE setting that puts the target near the outer edge of the PPI and 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 is clamped in its mounting by three screws. Loosen the case by *loosening* the two outer screws and tightening the center screw.

(4) Rotate the synchro receiver case so that

227432—52——5

the PPI sweep line travels in the right direction and amount to compensate for the error.

(5) The indicator cam is adjusted at the factory so that when the cam is rotated clockwise and the switch just operates, the PPI sweep is at 176° on the azimuth scale (A of fig. 48). Readjust the position of the cam as follows:

(*a*) Remove the synchro fuse (F803) on the transmitter, so that the synchro gearing may be moved by hand.

(*b*) Use the Allen wrench (in clip at left of synchro receiver) to loosen the cam setscrew which holds the cam to the deflection coil housings.

(*c*) Rotate the cam slowly until the cam switch just closes with the PPI sweep 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 of fig. 48), the switch should be set to operate at 176° *plus the error* (B of fig. 48); if the dead-ahead target appeared to the right of 0° the switch should be set to operate at 176° *minus the error*.

(*d*) Tighten the cam setscrew and replace the Allen wrench in its clip.

(*e*) Reclamp the synchro receiver case in its mounting by *loosening* the center mounting screw and tightening the two outer mounting screws.

b. Rechecking Alinement and Operation. Replace the synchro fuse (F803) and set the ANTENNA MOTOR switch to ON. Radar bearings should now agree with pelorus bearings. Make the following checks on alinement action:

(1) When the radar set is first turned on, the synchro relay K101 will operate to aline the PPI sweep with the antenna rotation. After this initial alinement cycle, there should be no jerkiness in operation of the sweep in the vicinity of 180° on the azimuth scale.

(2) To check the alinement action, push the armature of the synchro relay (K101) with a pencil to close the relay for about 1 second. When the relay contacts are released, the system should realine itself and operate smoothly.

(3) Repeat the procedure in (2) above several times to make sure that all settings are correct. If operation is unstable or if fuse F803 blows out, it may be necessary to repeat the entire alinement procedure (*a* above) to correct the trouble.

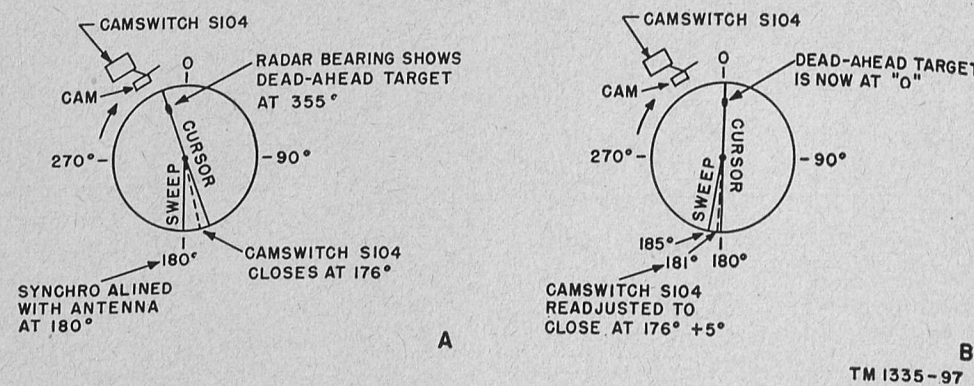
51. Heading Flash Alinement

Any adjustment of the synchro receiver to compensate for bearing errors (par. 50) will shift the fore-and-aft heading flashes.

a. Refer to figures 29 and 72 for information on connecting handsets to jack J501 in the antenna pedestal and to jack J104 on the indicator. Refer to figure 49 for information on identifying the aft and forward flash cams. Note that each cam can be adjusted by loosening its setscrews and shifting the cam in the required direction. Be sure to retighten the setscrews after making the necessary adjustment.

b. To readjust the heading flashes proceed as follows:

(1) Station a man at the indicator and a second man at the antenna.



A. Original adjustment.

B. Readjustment.

Figure 48. Camswitch.

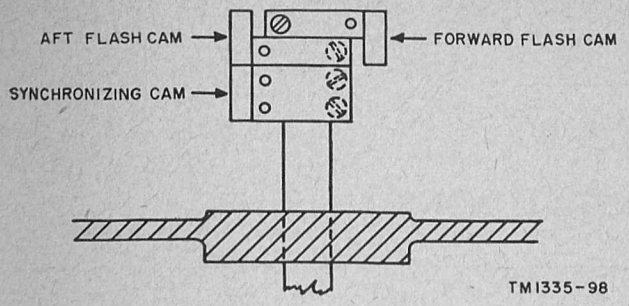


Figure 49. Location of heading flash cams.

(2) Remove the covers from the antenna pedestal.

(3) Place the radar set in operation and make the required adjustments to obtain clear, sharp heading flashes.

(4) If the heading flashes are inaccurate, inform the antenna man of the error and its direction.

(5) Stop rotation of the antenna by throwing the antenna drive motor switch (S503, fig. 3) to OFF.

(6) Loosen the setscrews in the forward flash cam and shift the cam. Then recheck the forward flash by restarting the antenna rotation and observing the heading flashes.

(7) Repeat steps given in (3), (4), and (5) above until the forward heading flash is accurate.

(8) Adjust the aft flash cam by following the procedure outlined for adjusting the forward flash cam.

(9) Whenever possible, observe dead-ahead targets and ascertain that they coincide with the forward heading flash. Similarly check the aft heading flash against targets that are directly astern.

(10) Before replacing the antenna pedestal covers, make sure that the cam setscrews are tight and that the drive motor switch S503 is in its ON position.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INSTRUMENTS

52. General

a. Operating Controls. The operating controls of Radar Set AN/SPN–11(*) are grouped on two panels of the azimuth and range indicator (fig. 8). The voltage regulator (fig. 15) is mounted close to the indicator, so that the operator may readily adjust the 115-volt, 400-cycle motor generator output to compensate for variations because of changes in the supply line voltage.

b. Other Controls. Most of the controls which normally do not require adjustment by the operator are mounted on the receiver-transmitter (figs. 5 and 50). The main line switch (switch box) and the motor starter are mounted as close as possible to the motor generator. ANTENNA MOTOR switch S802 and ANTENNA HEATERS switch S801 on the receiver-transmitter convenience panel are used for normal operation; for convenience in servicing the antenna, an auxiliary antenna drive motor switch (S503) is mounted on terminal board TB501 in the antenna pedestal (fig. 3).

c. Instruments.

(1) The 0–130 volt, a-c voltmeter on the voltage regulator (fig. 15) indicates the amplitude of the 400-cycle a-c voltage from the motor generator.

(2) The crystal CURRENT meter M20 (fig. 50) on the receiver-transmitter panel normally indicates the A. F. C. XTAL current, but indicates the REC'R XTAL (SIGNAL XTAL) current when the A. F. C. XTAL I—SIGNAL XTAL PUSH switch is pushed. These readings are used to check operation and to align the T/R and crystal circuits. Since the receiver-transmitter cover is in place during normal operation, this meter and its switch are not generally available to the operator.

(3) The test meter (M401, fig. 50) is also behind the receiver-transmitter cover; therefore, it is not generally available to the operator. The meter is used to check the transmitter for normal operation.

53. Controls and Their Functions

The following tables list the controls of Radar Set AN/SPN–11(*) and give the function of each control. The built-in test meters and their controls also are listed.

a. Receiver-Transmitter (fig. 50).

Control	Function
HIGH VOLTAGE OFF–ON switch (S301).	This switch is not used during normal operation; it controls the modulator high-voltage (h-v) supply. The transmitter operates only when this switch is in its ON position.
Meter switch S401 and meter M401	This switch is not used during normal operation; it is a 7-position wafer switch on the receiver-transmitter test panel.

a. Receiver-Transmitter—Continued

Control	Function
Meter switch S401 and meter M401—Continued	The positions of the switch and the corresponding functions of the meter are as follows: *Switch position* — *Meter function* MAG. I.: 4–5 MA, 400–500 — Indicates plate current of magnetron tube V306. MOD HV: 3000V (300) — Indicates output voltage of modulator h-v supply. +140V — Indicates unregulated output voltage of low-voltage (l-v) power supply. +320V — Indicates unregulated output voltage of l-v power supply. +300V REG. — Indicates regulated output voltage of l-v power supply. −300V REG. — Indicates regulated negative output voltage of l-v power supply. 115V AC — Indicates amplitude of 400-cycle a-c input power to the receiver-transmitter.
ANTENNA HEATER ON–OFF switch S801	Controls application of power supply voltage to antenna heater units.
ANTENNA MOTOR ON–OFF switch S802	Controls application of power supply voltage to antenna drive motor.
A.F.C. OPERATION–MAN. TUNE switch S202	This switch is not used during normal operation; it shifts receiver circuits from A. F. C. OPERATION to MAN. TUNE and it normally is left in the A. F. C. OPERATION position.
REFLECTOR TUNING (R250)	This control is not used during normal operation; it adjusts the reflector voltage of the klystron oscillator and, therefore, it is an oscillator frequency control.
A.F.C. XTAL I–SIGNAL XTAL I PUSH switch S201 and CRYSTAL CURRENT meter M201.	This push-button switch is not used during normal operation; its positions and the corresponding functions of the meter are as follows: *Switch position* — *Meter function* Normal — Indicates the A. F. C. XTAL current. Pushed — Indicates the REC'R XTAL current.

b. Azimuth and Range Indicator (fig. 51).

Control	Function
Cursor control	Rotates cursor line over face of PPI tube. Used in conjunction with fixed azimuth scale to provide accurate readings of relative bearings between ship and targets.
POWER OFF switch S105 on HEADING FLASH control	When the HEADING FLASH control is rotated from its maximum counterclockwise position, this switch is turned to its ON position and power is applied to the operating components of the radar set.
HEADING FLASH	Clockwise rotation increases intensity of the fore-and-aft heading flashes.
CONTRAST (R160)	This potentiometer adjusts the amplitude of the video input to the indicator. Use this in conjunction with the (receiver) GAIN control to adjust the intensity of targets on the PPI scope screen.
RINGS (R165)	A potentiometer control for adjusting the intensity of the range rings on the PPI scope.
GAIN (R177)	This potentiometer is actually the *receiver* gain control; it adjusts the receiver sensitivity and, hence, the amplitude of the video input to the indicator.

b. Azimuth and Range Indicator—Continued

Control	Function
CENTER EXPAND OFF—ON switch S102.	Normally set to OFF position. When the RANGE switch is set for 1-mile range, switch S102 may be set to ON to show the distance between the ship and targets on an expanded PPI scale.
DIMMER (R179)	This control adjusts the amount of illumination on the fixed azimuth scale and cursor line.
FOCUS (R138)	This potentiometer control provides sharp focusing of the range rings and targets.
SUPPRESSOR (R181)	This potentiometer is used to reduce interference.
RANGE switch S101 (NAUTICAL MILES)	This is a 4-position switch for selecting the desired range. The ranges in nautical miles and corresponding range rings for each position of the switch are given below:

Switch position (NAUTICAL MILES)	*Range rings on PPI*
1	2 rings, ½ mile apart.
3	3 rings, 1 mile apart.
8	4 rings, 2 miles apart.
20	4 rings, 5 miles apart.

c. Power Group Controls.

Control	Function
Switch box (main line switch, fig. 13)	Controls application of power supply voltage to radar set. With the control handle down, the main line switch is open.
POWER OFF switch S105 on indicator HEADING FLASH control (fig. 51).	Starts motor generator when initial clockwise rotation of HEADING FLASH control (on indicator) turns POWER switch to its ON position.
RESET button on motor starter (fig. 12)	Pushing this button resets the thermal overload relay in the starter.
Rheostat (R601) and meter (M601) on voltage regulator (fig. 15).	The rheostat adjusts current through the generator field of the motor generator; therefore, it adjusts the 400-cycle, a-c output voltage of the motor generator. The a-c output voltage is indicated by meter M601.
ANTENNA HEATER switch S801 (fig. 50)	See *a* above.
ANTENNA MOTOR switch S802 (fig. 50)	See *a* above.
Antenna drive motor ON—OFF switch S503 in antenna pedestal (fig. 3).	Auxiliary switch in antenna pedestal; for controlling antenna drive motor. During normal operation this switch is left in its ON position (operator controls antenna drive motor by means of ANTENNA MOTOR switch S802).

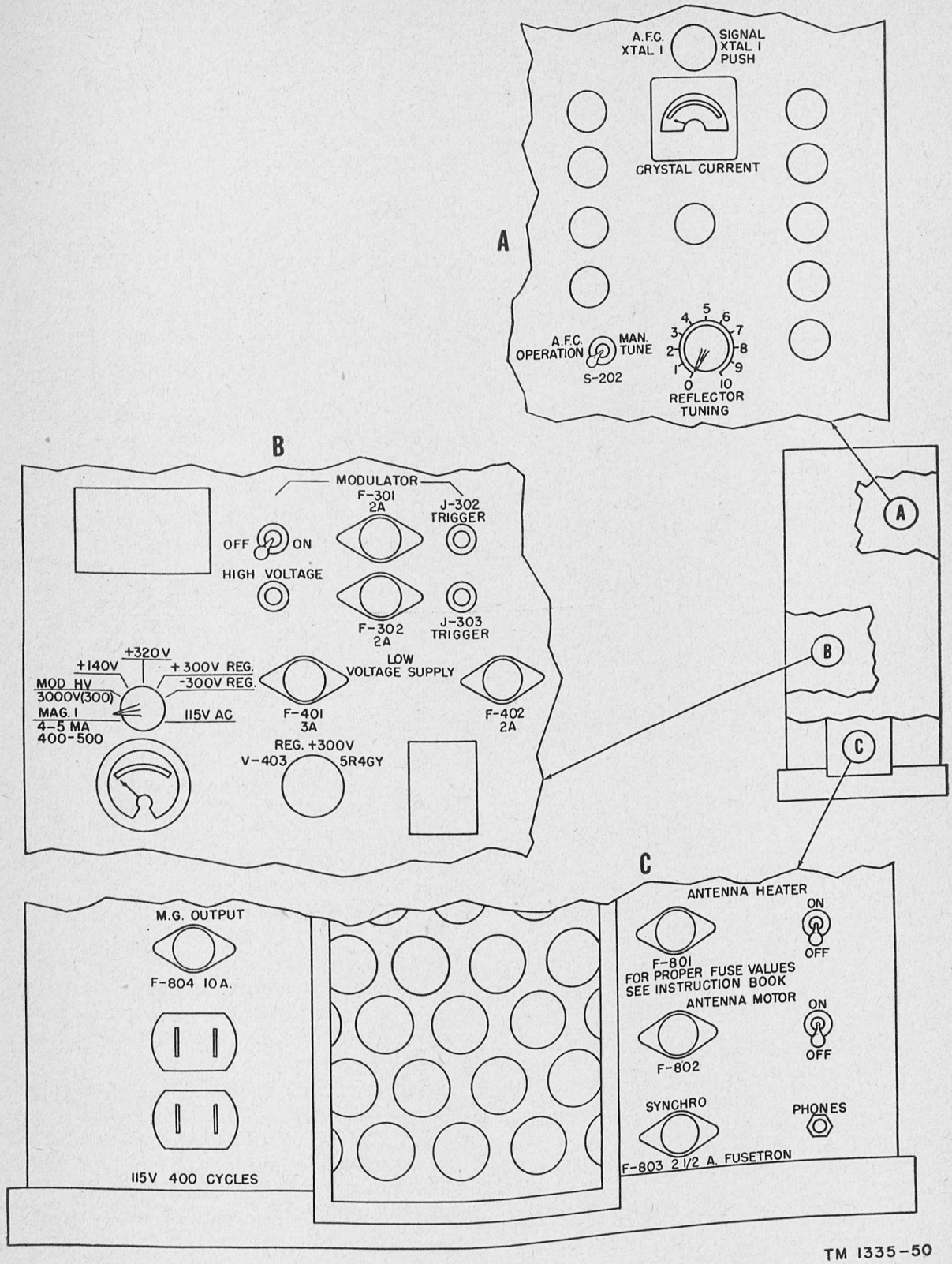


Figure 50. Receiver-transmitter control panels.

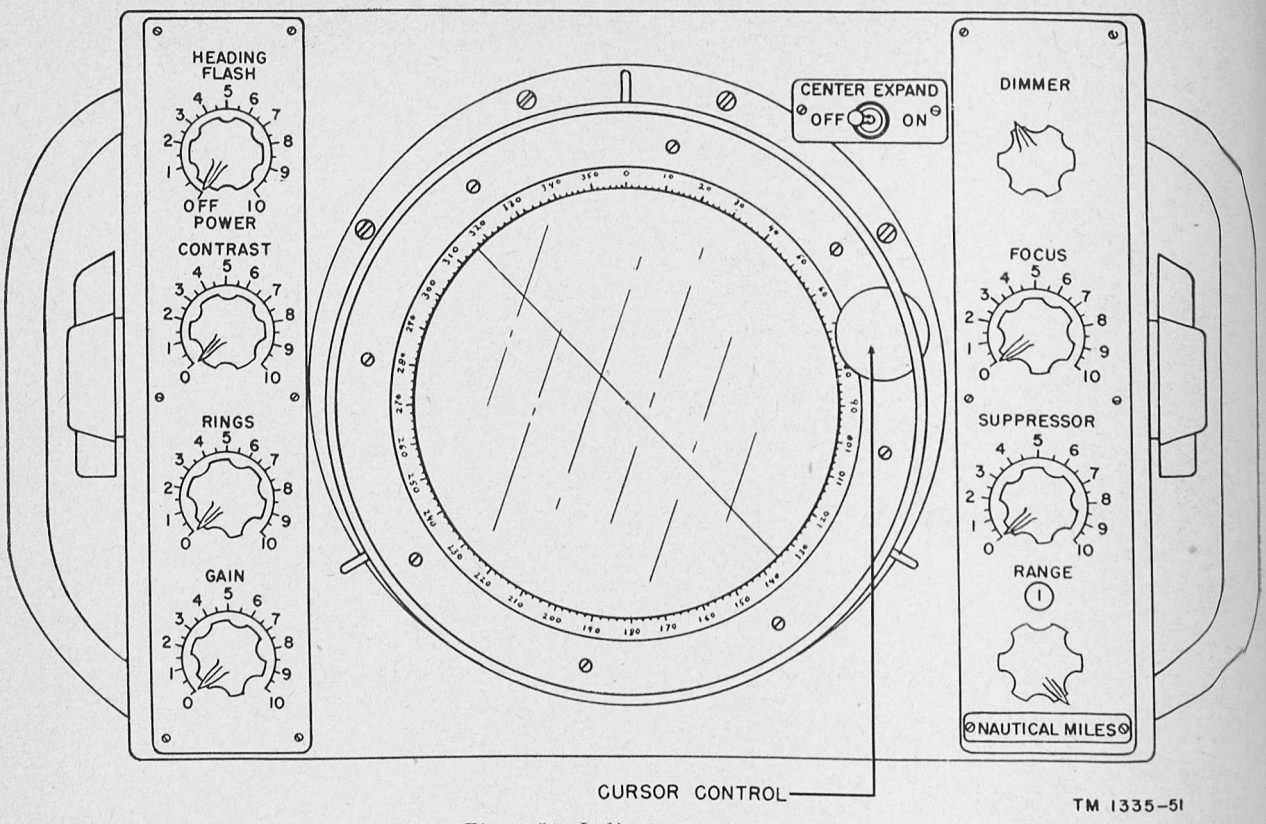


Figure 51. Indicator control panels.

Section II. OPERATION UNDER USUAL CONDITIONS

54. Initial Starting Procedure

a. General. Before starting the radar set for the first time, it is necessary to set all operating controls to the initial positions given in *b* below. This preliminary setting of the radar set controls provides for an orderly initial starting procedure and prevents damage that might be caused by incorrect settings.

Note. If the ship has been laid up, it is advisable to perform the preliminary starting procedure before again starting the radar set.

b. Initial Settings of Controls.

(1) Make sure that the switch box control handle is in its down position (main line switch open).

(2) Set the indicator controls (fig. 51) to the following positions:

(*a*) HEADING FLASH control fully counterclockwise so that the POWER switch is OFF.

(*b*) RANGE switch to any range.

(*c*) CONTRAST control to 8, if the RANGE switch is set to the 1-mile range. For other ranges, use a lower setting of the CONTRAST control.

(*d*) SUPPRESSOR control to 0.

(*e*) GAIN control to 0.

(*f*) RINGS control to 0.

(*g*) FOCUS control to 0.

(*h*) CENTER EXPAND switch to OFF.

(3) Remove the front cover from the receiver-transmitter and set the receiver-transmitter controls (fig. 50) to the following positions:

(*a*) A. F. C. OPERATION—MAN. TUNE switch to A. F. C. OPERATION.

(*b*) HIGH VOLTAGE switch to OFF.

(*c*) Meter switch to 115V AC.

(*d*) ANTENNA MOTOR switch to OFF.

(*e*) ANTENNA HEATER switch to OFF.

Caution: All other receiver-transmitter controls are adjusted at the factory or during installation; do not touch them.

(4) Set the voltage regulator rheostat control to its extreme counterclockwise position.

(5) Remove the covers from the antenna pedestal (fig. 3) and set antenna drive motor switch S503 to its ON position. Also be sure that there are no obstacles in the path of the antenna rotation. Replace the pedestal cover.

c. Initial Starting.

(1) Throw the switch box control handle to its ON position. This connects the radar set to the ship supply voltage.

(2) Set the ANTENNA HEATER switch to ON. This applies ship power to the antenna heaters.

(3) Turn the HEADING FLASH control clockwise to turn the POWER switch to its on position. This applies ship power to the motor generator. If the motor generator starts, the voltage regulator voltmeter will indicate the a-c output voltage and the indicator dial lamps will light. If the motor generator fails to start, press the RESET button on the motor starter. If the motor generator still fails to start, check the line fuses in the switch box.

Note. For additional information on normal indications, refer to the equipment performance checklist. For additional trouble-shooting information, refer to the radar set field maintenance manual.

(4) After allowing sufficient time for the motor generator to reach its normal running speed, adjust the voltage regulator rheostat to bring the a-c output voltage up to 115 volts, as indicated by the voltage regulator voltmeter.

(5) Throw the ANTENNA MOTOR switch handle to its ON position. This applies ship power to the antenna drive motor and the antenna should rotate. If the drive motor fails to start, check antenna motor fuse F801. Also check to see that antenna drive motor switch S503 in the pedestal is ON.

(6) Set the HIGH VOLTAGE switch to ON.

(7) Check the reading of meter M401 for each position of the meter switch. 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 table:

Switch position	Observed reading (scale)	Actual value
MAG. I. 4–5MA	400–500	4–5 ma.
MOD H V 3000V	300	3,000 v.
+140	140	+140 v.
+320	320	±320 v.
+300V REG	300	+300 v.
−300V REG	300	−300 v.
115V AC	115	115 v ac.

(8) If the meter readings (7 above) are normal, replace the receiver-transmitter front cover.

(9) Rotate the RINGS control on the indicator clockwise until the rotating sweep and range rings appear.

(10) Adjust the FOCUS control for the clearest and sharpest possible inner ring.

(11) Rotate the HEADING FLASH control clockwise until the heading flashes appear.

(12) Rotate the GAIN control clockwise until noise begins to appear on the PPI scope.

55. Normal Operating Procedures

This paragraph contains general operating instructions. Information on stopping and restarting the radar set is given in paragraph 56. Information on uses of the radar set, disturbances, bearing and range resolution, long distance targets, and radar plotting is given in paragraphs 58 through 62.

a. Range.

(1) *Choice of range.* Use the 8- and 20-mile ranges to search large areas when the vessel is in open waters. Use the 1- and 3-mile ranges whenever greater accuracy is needed to determine the distance between the radar-equipped vessel and nearby vessels. When using the 1- and 3-mile ranges, adjust the GAIN and SUPPRESSOR controls to minimize sea return, so that nearby targets, such as channel markers and buoys, stand out clearly on the PPI. The following table

227432—52——6

lists the RANGE switch positions and the range data for each position:

RANGE (switch position)	Number of rings	Distance between rings (nautical miles)
1	2	½
3	3	1
8	4	2
20	4	5

(2) *Use of center expand.* To observe targets that are very close to the radar-equipped vessel, use the CENTER EXPAND (fig. 52) on the 1-mile range. With the CENTER EXPAND switch at ON, the bright spot normally at the center of the PPI is expanded into a bright circle or disk, the ½-mile range ring is moved toward the outer edge of the PPI scope, and the 1-mile range ring is moved off the scope. Targets within the ½-mile range ring also are moved toward the edge of the scope.

Caution: When using the CENTER EXPAND, measure distances from the *edge* of the expanded center to targets and remember that the *total* distance from the *edge* of the expanded center to the range ring is ½ mile.

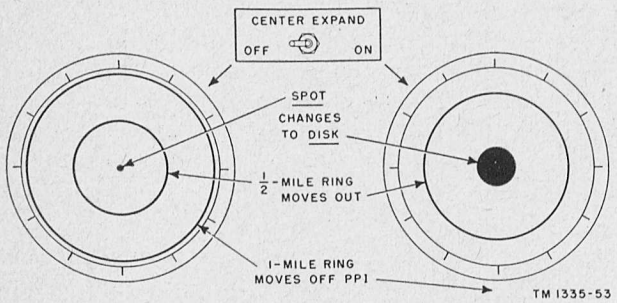


Figure 52. Center expand.

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 background on the PPI scope.

c. Suppressor. To eliminate excessive sea return on 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. Dimmer. Adjust the DIMMER control so that the cursor line and the azimuth scale are just visible. Excessive illumination reduces the apparent brightness of targets and makes it difficult to see weak target echoes.

e. Ring and Heading Flash. Adjust the RING and HEADING FLASH controls to obtain clear, but not excessively bright, rings and heading flashes. Excessive brightness will obscure targets on the rings and flashes.

f. Gain and Contrast. Make final adjustments of GAIN and CONTRAST controls to obtain the best PPI picture. Readjust the CONTRAST control each time that the RANGE switch is changed, so that the targets are as bright and clear as possible.

g. Voltage Regulator. While using the radar set, check the voltage regulator voltmeter reading frequently. Readjust the voltage regulator control to keep the motor generator output at exactly 115 volts.

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

56. Stopping and Restarting

After the radar set has been placed in operation for the first time (par. 54), most of the controls are left in their operating positions. Stopping and restarting then is accomplished by means of a single control.

a. Stopping. To stop the radar set, rotate the HEADING FLASH control fully counterclockwise so that it actuates the POWER switch to its OFF position. This stops the motor generator, the antenna drive motor, and the blower motor.

b. Restarting. To restart the radar set, rotate the HEADING FLASH control clockwise to actuate the POWER switch to its ON position.

Note. When the vessel is in warm climates, the ANTENNA HEATER switch should be left in its OFF posi-

tion. When the vessel is in cold climates, the ANTENNA HEATER switch should be left in its ON position, except when the vessel is in port or laid up.

57. Complete Shut-down

a. When the vessel is in port, the radar set should be shut down completely to prevent unauthorized use and possible damage.

(1) Rotate the HEADING FLASH control fully counterclockwise to actuate the POWER switch to its OFF position.

(2) Throw the ANTENNA MOTOR switch on the convenience panel to its OFF position.

(3) Throw the ANTENNA HEATER switch on the convenience panel to its OFF position.

(4) Open the main line switch by throwing the switch box control handle to its down (off) position.

b. If the vessel is to be laid up, remove the antenna pedestal covers and throw the antenna drive motor switch (S503) to its OFF position. Also remove the front cover from the receiver-transmitter and throw the HIGH VOLTAGE switch to its OFF position. Replace the covers.

c. To restart the radar set after a complete shut-down, follow the initial starting procedure (par. 54).

58. 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–11(*) is 1.9° at half-power points. For purposes of discussion, assume that the beam width is 2° and refer to figure 53 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° 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° 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° 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 53 shows that as the range increases, the bearing resolution decreases. The following table gives the approximate span of a 2° beam at various ranges from the radar-equipped vessel:

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

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 PPI by the scope beam.

(1) *Short range.* In Radar Set AN/SPN–11 (*), the transmitted pulse is 0.4 microsecond in length. During this period of time, the beam travels 65.6 yards (round trip). Theoretically, a target separation of only 32.8 yards, one-half of 65.6 yards, will provide adequate range resolution. However, the shadowing of one target by another also must be considered, and a 75-yard separation of targets will just provide range resolution on the 1-mile range. Refer to figure 54 which shows two targets on the same bearing with different spacings (range) between them.

(*a*) Point A shows two targets, 125 yards apart; separate echoes appear on the PPI since the target spacing exceeds 75 yards.

(*b*) Point B shows two targets, 75 yards apart; the echoes just touch one another on the PPI since the target spacing is exactly 75 yards.

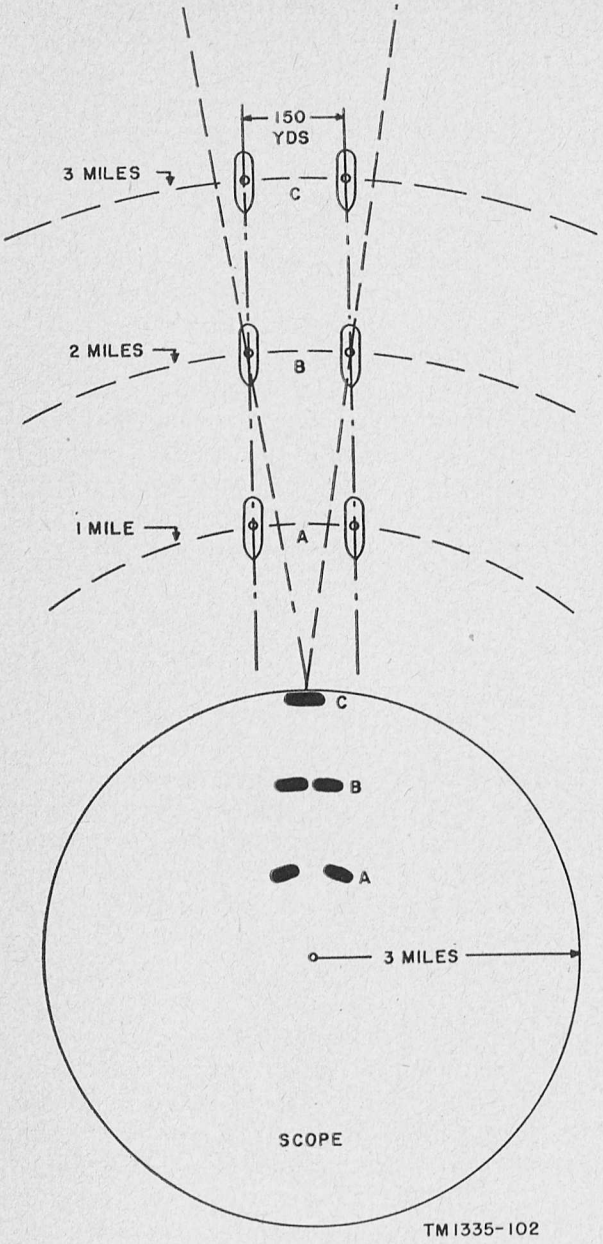


Figure 53. Bearing resolution.

(*c*) Point C shows two targets, 50 yards apart; the echoes merge into one echo on the PPI since the target spacing is less than 75 yards.

(2) *Long range.* On the long ranges, such as 20 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.

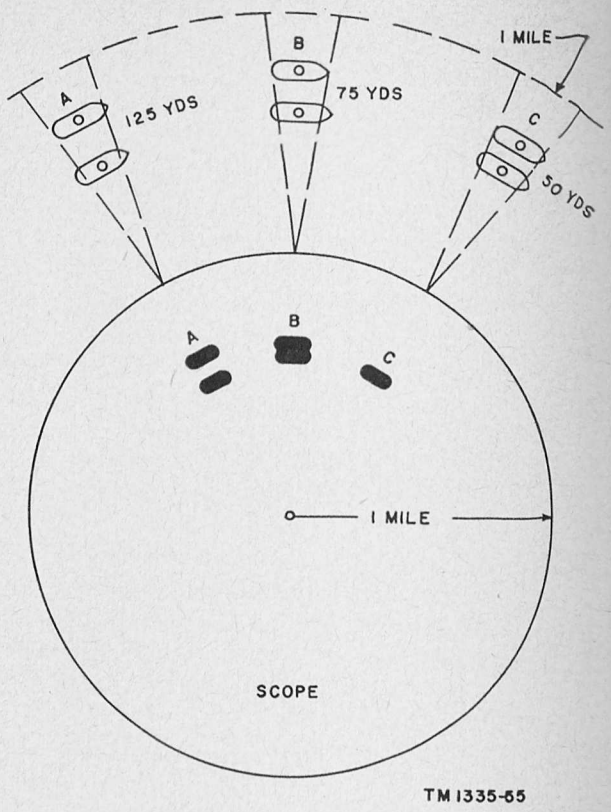


Figure 54. Range resolution.

59. Long Distance Targets

a. The ability of the radar to pick up targets on the 20-mile range 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. Line-of-sight distances are given in Bowditch (H. O. No. 9), part II, table 8 and table 9. From table 8, 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.

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.

c. When superpropagation does not exist, the target echoes show correct ranges. With superpropagation, 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–11(*), such targets must be more than approximately 81 nautical miles distant (fig. 55). For example, if a target is 82 nautical miles away, it may show on the scope as a 11-mile target (82 minus 81 equals 1 mile). If the distant target is 91 nautical miles away, it will show on the scope with a range of 10 miles (91 minus 81). These long-range effects may be recognized by noting changes in bearing as your vessel proceeds. These changes will be very small compared to those observed on normal range targets.

60. False or Displaced Targets

a. Figure 56 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 57 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 58 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.

61. Interference

a. Interference caused by another shipborne radar shows on the PPI as a series of spiral lines starting at the center of the scope (fig. 59). 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 which returns a weak echo, bring the target into view by adjusting the GAIN and SUPPRESSOR controls and readjusting the FOCUS control.

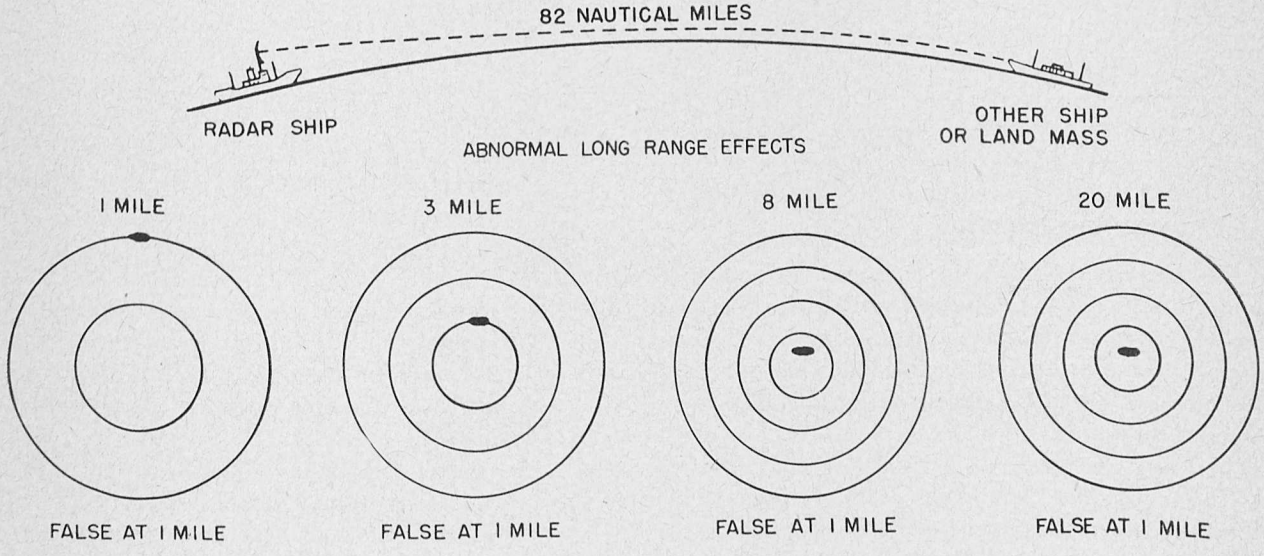


Figure 55. Presentation of 82-mile target at 1 mile.

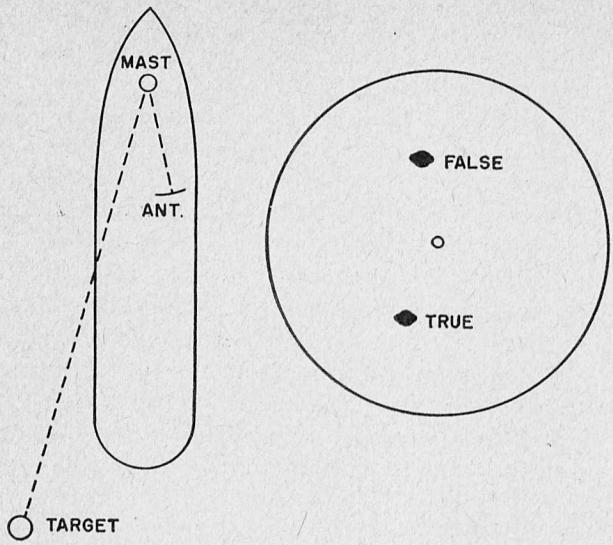


Figure 56. False target in forward position.

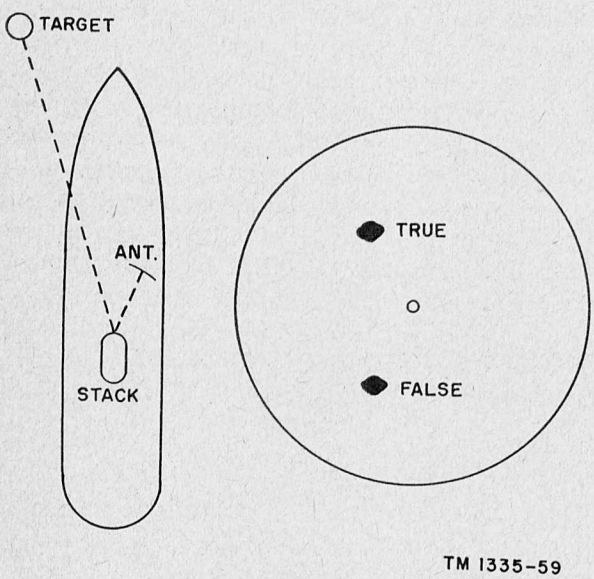


Figure 57. False target in aft position.

62. Types of Operation

Radar Set AN/SPN–11(*) is used primarily to obtain anticollision, piloting, position finding, and storm warning data. Typical examples of these applications are given in the following subparagraphs. Typical PPI presentations are shown in figures 60 and 61.

a. Anticollision.

(1) Assume that your vessel is proceeding through fog on the open sea. The radar set is operating with the RANGE switch set to its 20 NAUTICAL MILES position and the RINGS control has been adjusted 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.

(2) 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 to determine the need for avoiding action.

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

b. Piloting.

(1) If your ship is entering a harbor or channel, set the range switch to 3 NAUTICAL MILES and examine the scope for targets due to 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.

(2) 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.

(3) For close targets on the 1-mile range, consider that the distance to the target is measured from the *antenna* position of your ship. The bow of your ship may be 25 yards or more ahead of the antenna and this distance must be considered.

c. Positioning.

(1) Assume that your ship is within radar range of an object whose position is shown on charts. For best bearing accuracy, adjust the RANGE switch so that the target appears at the edge of the PPI scope.

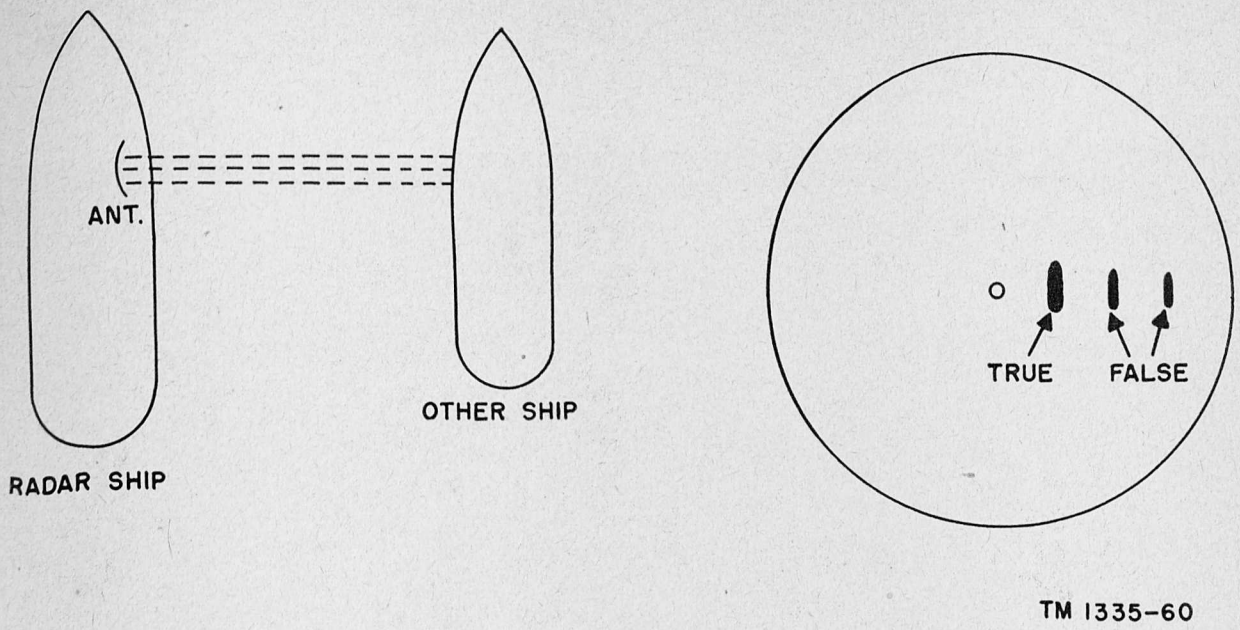


Figure 58. False targets in beam position.

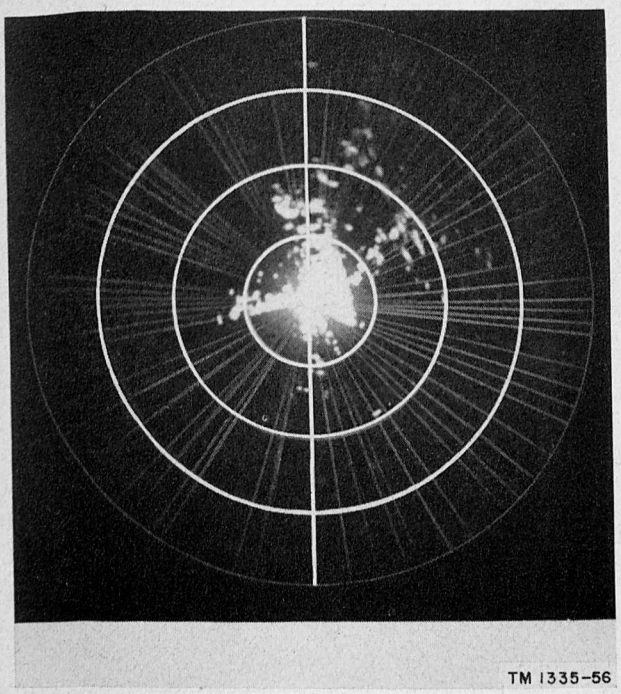


Figure 59. Typical radar interference.

(2) Observe the target and, as it passes under a range ring, use the cursor to take a relative bearing. Convert this to a true north bearing. This gives a one-point fix, since range and bearing are known, and the position can be plotted on the chart.

(3) To check the one-point fix, take bearings and ranges on two or more targets which can be identified on the scope. The cross bearings intersect to show the position of the ship. Range can be *estimated* when the targets fall between range rings, or *measured* with considerable accuracy when the targets fall on a range ring. Lightships or other charted targets that stand out clearly on the scope give the best bearings and ranges.

d. Storm Warning. Heavy rainfall usually shows up on the PPI as a bright mass. If a squall is detected early, usually on the 20-mile range, 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.

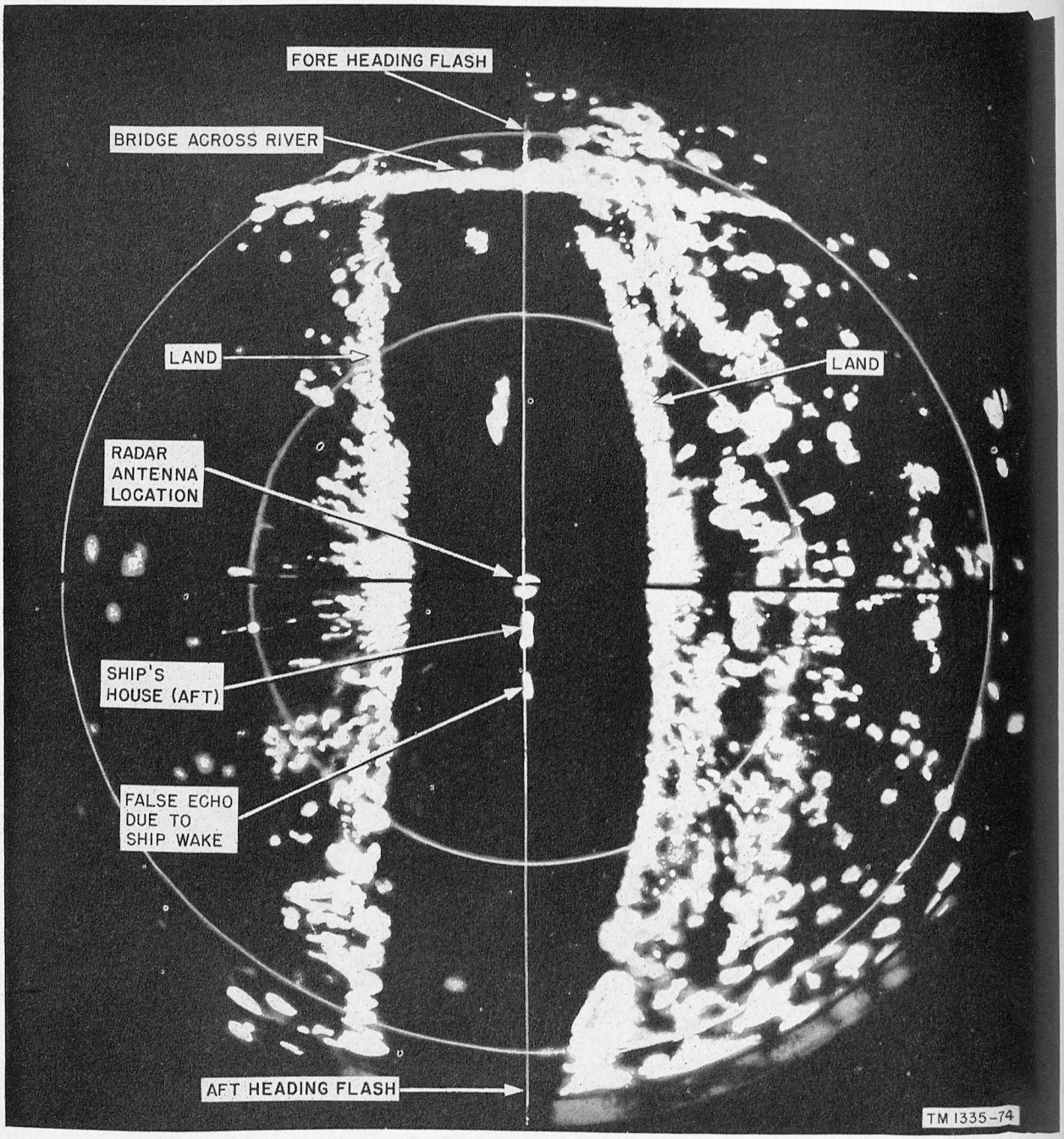


Figure 60. PPI presentation, ship in river.

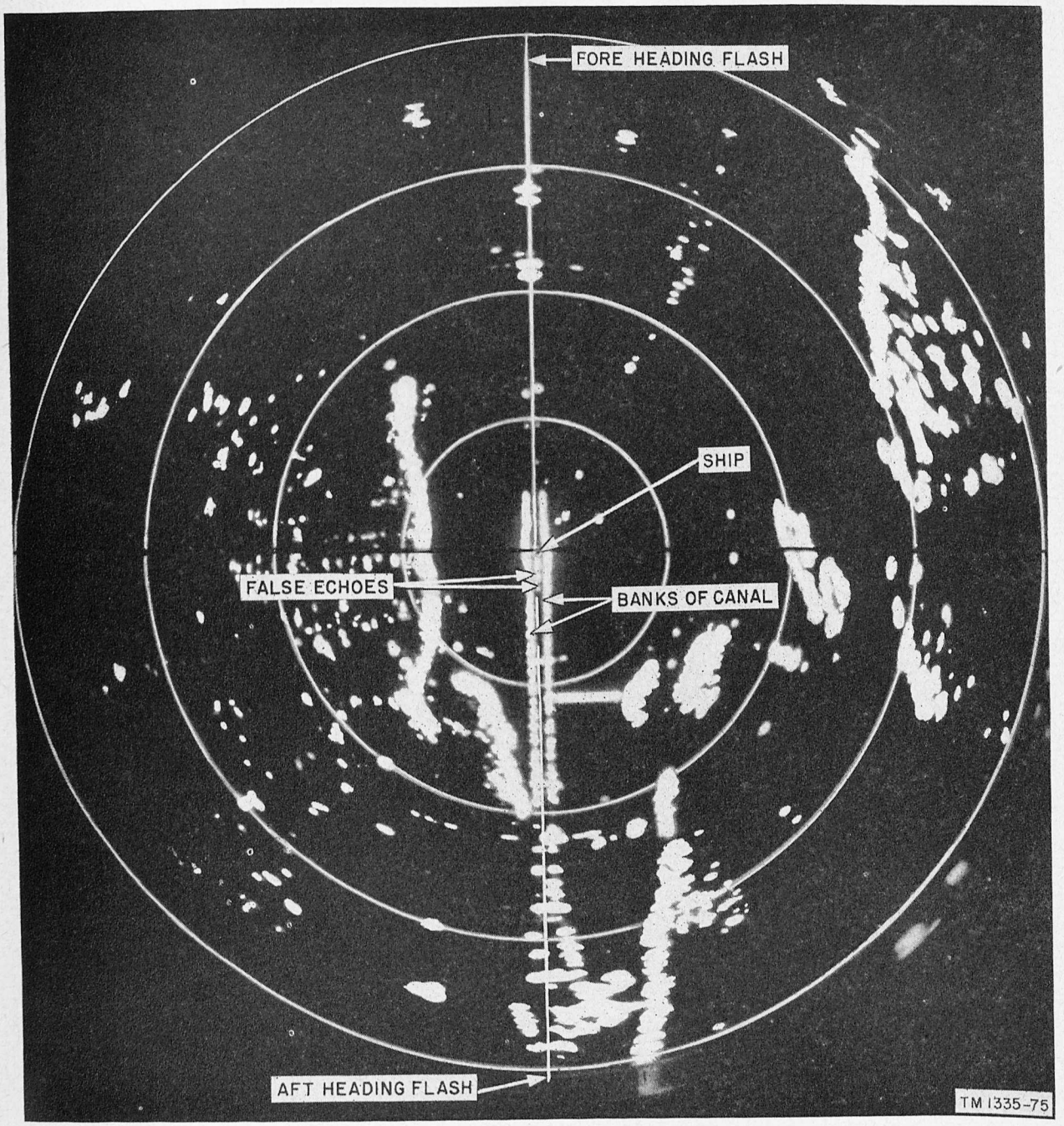


Figure 61. PPI presentation, ship in canal.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

63. General

Radar Set AN/SPN–11(*) may not operate properly in regions where extreme cold, heat, humidity and moisture conditions prevail. In paragraphs 64 and 65, instructions at given on procedures for minimizing the effect of these unusual operating conditions.

64. 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:

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.

65. Operation in Tropical Climates

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

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

66. General

a. The tools, materials, and tool equipment required for installation and maintenance of Radar Set AN/SPN–11(*) are listed in paragraph 16. Special tools supplied with the equipment are listed in paragraph 67.

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

67. Special Tools Supplied with Equipment

a. A spanner wrench for use on the waveguide clamp is located in the receiver-transmitter cabinet (fig. 5).

b. An Allen wrench is located in the indicator unit (fig. 9). It is used to adjust the indicator synchro cam.

c. A crystal locking wrench (fig. 47) is furnished for removing and replacing mixer crystals CR201 and CR202.

Section II. PREVENTIVE MAINTENANCE SERVICES

68. 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 break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair, since its object is to prevent certain troubles from occurring (AR 750–5).

69. 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, Dry Cleaning (SD); then wipe the parts 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 that 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.

70. Use of Preventive Maintenance Form (fig. 62)

a. The information in paragraph 71 is presented as a guide to the individual making an inspection of the equipment in accordance with instructions on DA AGO Form 11–238. 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 communications officer/chief or his designated representative. Instructions for the use of the form appear on the reverse side.

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. 71(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. 71(b)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 71(c)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 71(d)							
6	CHECK FOR NORMAL OPERATION.							

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. 71(e)		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. 71(f)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 71(k)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 71(g)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 71(l)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 71(h)		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR. 71(i)		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 71(m)	
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. 71(j)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE. PAR. 71(n)	

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

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

TM1335-103

Figure 62. DA AGO Form 11–238.

b. Circled items in figure 62 are partially or totally applicable to the equipment. References in the ITEM block refer to paragraphs in text that contain additional maintenance information.

71. Performing Preventive Maintenance

The following preventive maintenance operations should be performed 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 general condition of the radar set antenna, receiver-transmitter, indicator, motor generator, switch boxes, cabling, and starter.

b. Clean dirt and moisture from exterior of all component panels, cabinets, terminal boards, and exposed cabling.

c. Inspect seating of the following readily accessible *pluck-out* items: receiver-transmitter convenience panel fuses; indicator fuse and cable connections; switch box fuses; antenna cable connections; and cable clamps.

d. Inspect the following controls for binding, scraping, excessive looseness, and positive action: indicator panel controls; receiver-transmitter convenience panel controls, including swtiches; switch box control levers; and starter reset button.

e. Check the radar set for normal operation. (Refer to the equipment performance checklist (par. 82) and place the radar set in operation.)

f. Clean and, if necessary, tighten the following exterior parts: waveguide clamps; cable clamps; indicator mounting to bulkhead or overhead; component cover fasteners; and cable glands.

g. Inspect the antenna, the antenna mount, and all exposed surfaces for rust, corrosion, and moisture.

h. Inspect cables, wires, and cable connectors for cuts, breaks, deterioration, kinks, and undue strain.

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

j. Inspect the following accessible items for looseness: switch boxes, starter, motor generator mounting, indicator mounting, cable connections, fuses, cable glands, and component covers.

k. Clean the window of the voltage regulator meter, the magnifying glass for the indicator, the window of the range dial, and the cursor plate in front of the PPI tube.

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

m. Inspect the antenna guy wires (if used) for looseness and proper tension.

72. Procedure

a. Tools and Materials. Shortly before the maintenance period begins, arrange tools and materials in a convenient working place.

b. Power Input. Before starting preventive maintenance, always turn off the power to the equipment by throwing the switch box control handle to its OFF position.

c. Cathode-Ray Tube. The cursor plate, in front of the tube, may become covered with a coating of dust after a period of time. Remove the viewing hood and the magnifying glass and clean the cursor plate with a soft cloth. Be careful not to damage the tube nor to allow tools to fall on it.

Section III. LUBRICATION

73. Lubrication Charts for Radar Set AN/SPN–11(*)

Lubrication charts for Radar Set AN/SPN–11(*) are shown in figures 63 and 64.

74. General Lubrication Instructions

a. The type of lubricant to be used, lubrication intervals, and specific instructions for each part of Radar Set AN/SPN–11 are given in figures 63 and 64.

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 in the following cases: on electrical equipment where inflammable solvents cannot be used because of fire hazard, and for cleaning electrical contacts, including relay contacts, plugs, commutators, etc.

Caution: Repeated contact of carbon tetra-

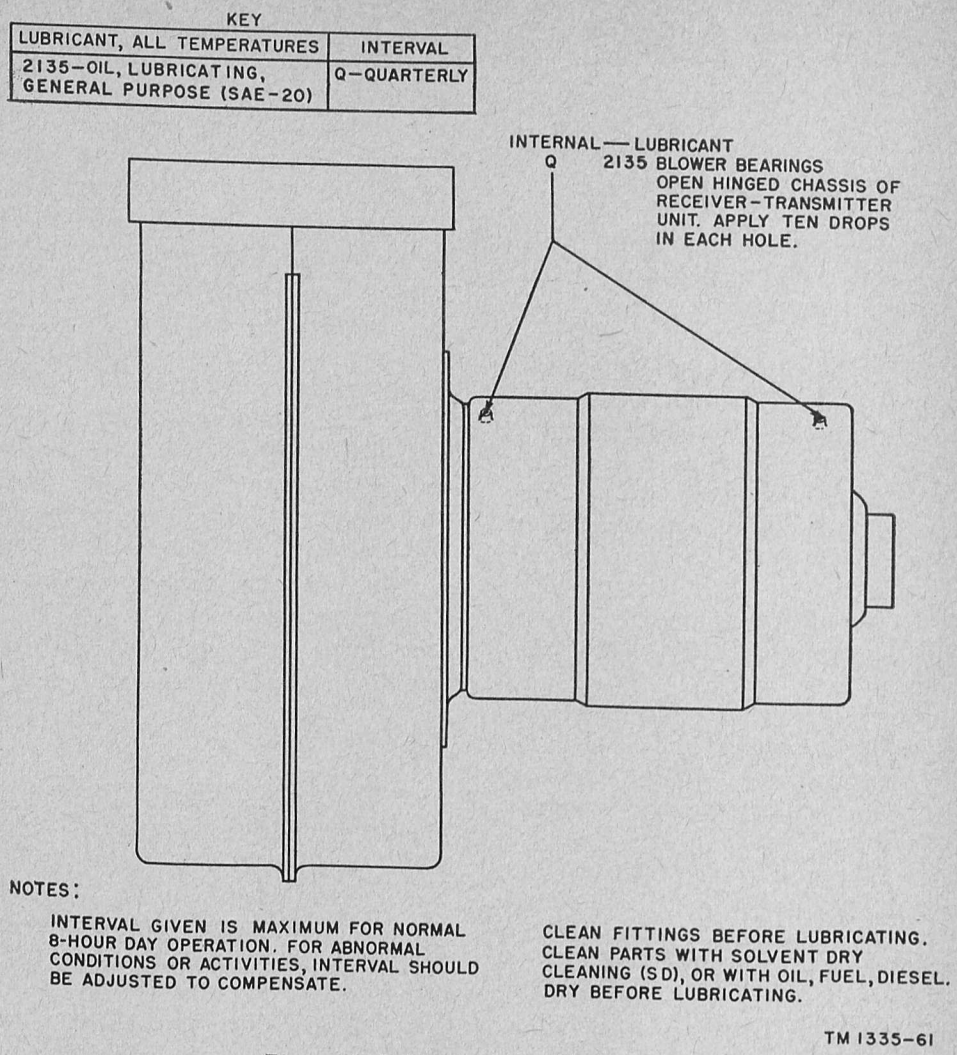


Figure 63. Lubrication chart, blower motor.

chloride with the skin or prolonged breathing of the fumes is dangerous. Make sure that adequate ventilation is provided.

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

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

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

75. Detailed Lubrication Instructions

a. Blower Motor (fig. 63).

(1) Remove the receiver-transmitter front cover and open the hinged panel (fig. 6).

(2) Place 10 drops of oil (2135) in the oilholes at each end of the blower motor.

(3) Close the hinged panel and replace the receiver-transmitter front cover.

b. Antenna Gearbox (fig. 64).

(1) Remove the two-piece pedestal cover by loosening the four captive bolts that hold it to the antenna pedestal.

(2) Remove the oil gage from the upper end of the filler pipe and check the level of the oil in the gearbox.

(3) If the oil level is below the FULL mark on the gage, add just enough oil (2135) to bring the oil level to the FULL mark.

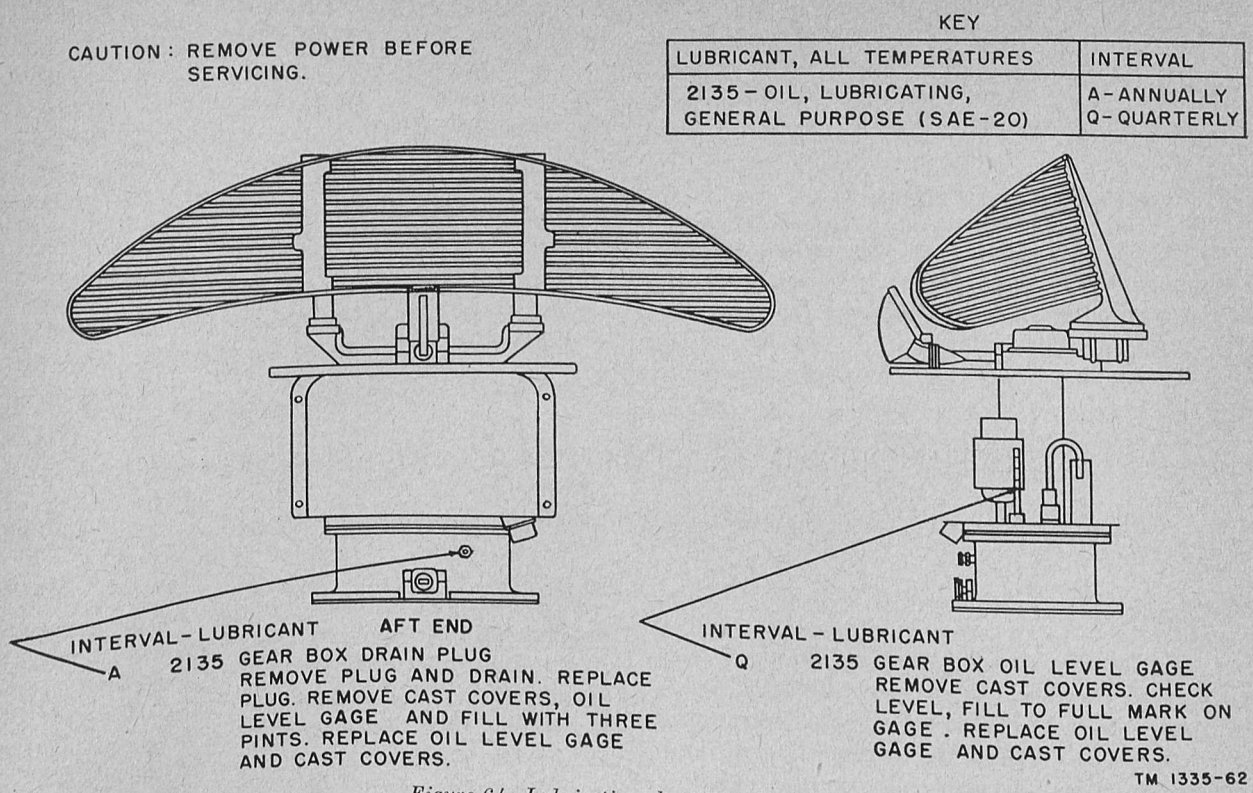


Figure 64. Lubrication chart, antenna gearbox.

(4) Once a year, drain all oil from the gearbox by removing the drain plug on the antenna pedestal (fig. 64).

(5) Replace the drain plug and tighten it securely.

(6) Refill the gearbox with 3 pints of oil (2135).

(7) Replace the oil gage in the upper end of the filler pipe and replace the pedestal covers.

c. Motor Generator. The motor generator has sealed bearings which should provide 7,200 hours of operation. It may be necessary to replace the bearings after about 2 years of normal operation. For information on replacing the motor generator bearings refer to the field maintenance manual.

Section IV. WEATHERPROOFING

76. Weatherproofing Procedures and Precautions

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

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72. 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. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures and low humidity are explained in TB SIG 75.

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 and TB SIG 219.

d. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained

in TB SIG 69. 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.

77. Rustproofing and Painting

a. When the finish on the covers of any component of the radar set 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 components and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the covers 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. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

Note. Trouble shooting performed by field maintenance personnel will be published in a field maintenance manual for this equipment.

78. Scope

a. The trouble shooting 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, trouble shooting 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. Paragraphs 79–91 help in determining which of the components, such as the receiver-transmitter or the indicator, is at fault and in localizing the fault in that component to the defective stage or item, such as a tube or a fuse.

79. Inspection

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

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

b. When failure is encountered and the cause is not immediately apparent, check as many of these items 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 the trouble occurred.

c. Inspect the antenna system and waveguide system for obvious abnormalities.

80. System Sectionalization of Trouble to Component

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

a. Operate the radar set and observe its performance. See the equipment performance checklist (par. 82) for normal operating indications.

b. 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.

c. Check the output of the motor generator by the meter in the voltage regulator unit. Power to the blower motor in the receiver-transmitter and to the heating elements and drive motor in the antenna is supplied directly from the ship line. Therefore, proper functioning of these units does not indicate necessarily proper functioning of the motor generator.

d. After checking the fuses, check the meters (fig. 50) for clues to the location of the trouble.

e. The transmitter is operating correctly if a normal reading is observed on the MAG. I. and

MOD HV positions of meter M401. Since the transmitter blocking oscillator tube stage, V307(A), supplies the entire radar set with timing voltage, a defective transmitter may cause improper operation of other units.

f. Proper operation of the duplexer is indicated by normal reading of A. F. C. XTAL and SIGNAL XTAL currents on the CRYSTAL CURRENT meter.

g. Proper operation of the indicator is indicated by correct patterns on the PPI scope.

Note. First check the transmitter and duplexer for proper operation.

(1) Since the video signals and range marks pass through the same channel, the indicator is operative if either the range marks or the video signals appear on the PPI scope.

(2) The indicator may be defective if there is nothing on the PPI; that is, if no sweep, range marks, or echoes appear.

h. Proper operation of the receiver is indicated by targets on the PPI scope.

81. Trouble Shooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 82) will help the operator to locate trouble in the equipment. The list gives the item to be checked, the condition under which the item is checked, the normal indications and tolerances of correct operation, 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 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 are those the operator can make without turning in the equipment for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires continued operation, and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

Note. If the corrective measure calls for checking tubes, refer to the tube trouble-shooting chart (par. 83*b*).

82. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
START	1	All controls	Set to initial starting positions (par. 54); leave hinged panel open.		
	2	POWER-HEADING FLASH control.	Rotate clockwise to turn POWER switch on.	Voltage regulator voltmeter indicates a-c output of motor generator; indicator scale lamps and RANGE dial lamp light; blower motor starts.	If no voltage reading: Check to see that switch box (line) switch is closed; press RESET on motor starter; check fuses F301 and F302 in switch box. If lamps do not light, check fuse F101 at rear of indicator.

82. Equipment Performance Checklist—Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	3	Voltage regulator rheostat	Adjust for correct motor-generator output.	Voltmeter reads 115	Check ship line voltage. (Low supply voltage will not run motor generator at normal speed.)
	4	ANTENNA MOTOR switch on convenience panel.	Set to ON position	Antenna rotates	Check fuse F802; check to see that drive motor switch S503 in pedestal is at ON position; check for possible obstructions in path of antenna.
	5	HIGH VOLTAGE switch	do	HIGH VOLTAGE pilot lamp lights. (Because of the time delay circuit, the lamp will not light until the radar set has been on approximately 3 minutes.)	Check fuse F301; check lamp I301; replace tube V301; check operation of relay K301.
	6	Meter switch S401 for meter M401.	Set to MAG. I. position.	Reading between 400 and 500 on meter scale.	Check fuse F302. (See indications for other positions of switch S401).
			Set to MOD HV position.	Reading of 300 on meter scale.	Check fuse F302; check tubes V303, V304, and V305.
			Set to +140V position	Reading of 140 on meter	Check fuses F401 and F402; check tube V401.
			Set to +320V position	Reading of 320 on meter	Check fuses F401 and F402; check tube V402.
			Set to +300V REG. position.	Reading of 300 on meter	Check fuses F401 and F402; check tubes V403, V404, and V405.
			Set to −300V REG. position.	do	Check fuses F401 and F402; check tubes V406, V407, and V408.
			Set to 115V AC position.	Reading should agree with reading on voltage regulator meter.	Adjust R412 (behind panel and close to switch) so that meter readings agree.
	7	A. F. C. OPERATION—MAN. TUNE switch.	Set to A. F. C. OPERATION.	CRYSTAL CURRENT meter reading is between .4 and .5 milliampere.	Refer to installation alinement instructions in chapter 2.
			Set to MAN. TUNE	do	Do.
	8	A. F. C. XTAL I—SIGNAL XTAL I PUSH switch.	Push	CRYSTAL CURRENT meter now indicates REC'R XTAL current.	Refer to alinement instructions in chapter 2.
	9	REFLECTOR TUNING control.	Rotate over entire range (with A. F. C. OPERATION—MAN. TUNE switch at A. F. C. OPERATION).	CRYSTAL METER current reading varies. *This control must be reset for maximum current, after this test.*	Refer to installation alinement instructions in chapter 2.
	10	Receiver-transmitter cover	Close hinged panel and replace cover.		

82. Equipment Performance Checklist—Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	11	RINGS control	Advance (clockwise)	Rotating sweep and range rings appear.	Check indicator tubes V107 through V110.
	12	FOCUS control	Adjust for sharpest inner range ring.	Sharpness of scope images changes with adjustment of control.	If necessary, readjust R137 (inside indicator) to bring focusing within range of FOCUS control.
	13	HEADING FLASH control.	Advance (clockwise)	Heading flashes appear	Refer to field maintenance manual.
	14	GAIN control	do	Noise and signals appear	Advance contrast control; check cables between indicator and receiver; check indicator tubes V109 and V110. Trouble may be in receiver. Refer to field maintenance manual.
	15	SUPPRESSOR control	do	Screen darkens near center of PPI tube.	Check tube V219 in receiver.
	16	RANGE switch	Set to each position	Range rings change in accordance with table (par. 55).	Check setting of RINGS control; check indicator tubes V107, V108, V109, and V110.
	17	CONTRAST control	Advance (clockwise)	Increased intensity of noise and targets on PPI scope.	Check indicator tubes V109 and V110.
	18	DIMMER control	Vary	Brightness of indicator scale lamps varies.	
	19	CENTER-EXPAND switch.	Set to ON position (with RANGE switch at 1-mile position).	Spot at center of PPI changes to disk, and 1-mile range ring moves off scope.	Refer to field maintenance manual.
STOP	20	POWER—HEADING FLASH control.	Fully counterclockwise to actuate POWER switch to OFF.	Radar set off and antenna rotation stops.	

83. Tube and Crystal Trouble-Shooting Charts

a. General. Experience shows that from 40 to 50 percent of the troubles encountered in the radar set are caused by defective tubes. Except for the magnetron (V306), the T/R tube (V202), and the local oscillator tube (V203), tube replacements (par. 84) do not necessitate retuning or readjustment of other components in the radar set. The following charts list trouble symptoms, including test meter (M401) readings, and the tubes or crystals most likely to be causing the trouble. Figures 65 through 69 are tube location diagrams, and the normal readings of test meter M401 are given in paragraph 54. Figure 72 is the cabling diagram and figures 73 through 75 are schematic diagrams.

b. Tube Trouble-Shooting Chart.

Picture symptom	Test meter (M401)	Additional indication	Tube		Tube location
			Symbol	Type	
Blank			V101	6SN7	Indicator (fig. 65).
			V101	2X2A	
			V105	7MP7	
Blank		Bright spot in center	V102	6AL5	
			V103	6SN7	
			V104	6BG6	
Blank	No reading at MAG. I. position.		V307	6SN7	Transmitter (fig. 66).
Blank	No voltage at +300V REG. position.	Fuse F401 blown	V403	5R4GY	Power supply (fig. 67).
Blank	−300V REG. reads high.		V407	OD3	
			V408	OD3	
No range rings			V107	6SN7	Indicator (fig. 65).
			V108	6SN7	
No range rings		No echoes, or weak echoes.	V109	6J6	
			V110	6AQ5	
First range ring-nonlinear on all ranges.			V102	6AL5	
Range rings brighter than usual with dark areas after each mark.		Weak echoes	V109	6J6	
Weak echoes			V204 through V212.		Receiver (fig. 69).
			V201 (not likely).	1B35	Duplexer (fig. 47).
Weak echoes	Low MAG. I, or current drops as a-c voltage is increased.	Afc erratic. Targets fuzzy.	V306	725A	Transmitter (fig. 7).
Weak echoes		Defective receiver crystal and/or blacked out ring around center of scope.	V202	1B24	Duplexer (fig. 47).
			V409	1V2	Keep-alive power supply (figs. 68 and 6).
			V410	1V2	
Weak echoes	+300V REG. reads high.	Bright sweep does not focus.	V404	OD3	Power supply (fig. 67).
			V405	OD3	
No echoes			V204 through V212.		Receiver (fig. 69).
No echoes	No MAG I		V305	4C35	Transmitter (fig. 66)
			V308	6V6	
Normal	Normal	No suppressor action	V219	12AU7	Receiver (fig. 69).
Normal	Normal	Transmitter time delay considerably more or less than 3 minutes.	V301	6N7	Transmitter (fig. 66).
			V302	NE–32	
Alternate sectors of light and dark areas on crt.	Meter M201 sweeps		V203	2K25	Receiver (fig. 69).
			V213 through V218.		
No echoes	No MAG. I.; no MOD. HV.		V309	6V6	Transmitter (fig. 66).
			V306	725A	
			V301	6SN7	
			V303	3B24	
			V304	3B24	

b. Tube Trouble-Shooting Chart—Continued

Picture symptom	Test meter (M401)	Additional indication	Tube		Tube location
			Symbol	Type	
No echoes	No voltage at +140V position.		V401	5R4GY	Power supply (fig. 67).
No echoes	No voltage at −300V REG. position.	Bright sweep will not focus; fuse F301 blown.	V406	5R4GY	
No echoes	No voltage at +300V REG. No MAG. I. position; no MOD. HV.	Fuse F401 blown	V402	5R4GY	
No echoes	No MAG. I. and MOD. HV reads low or zero.		V303 V304	3B24 3B24	Transmitter (fig. 66).

c. Crystal Diode Trouble-Shooting Chart.

Picture symptom	Remarks	Crystal diode		Crystal diode location
		Symbol	Type	
Blank	No echoes, range markers	CR101	1N34	Indicator.
Sweep line only	No echoes, range markers, or heading flash.	CR104	1N34	Do.
Weak echoes or no echoes		CR201	1N23B	Mixer.*
Abnormal picture	Picture gets dimmer as RANGE switch is advanced.	CR101	1N34	Indicator.
Abnormal picture	Range rings bloom when passing over echoes.	CR103	1N34	Do.
No range rings		CR103	1N34	Do.
Alternate bands of light and dark	Receiver meter M201 sweeps	CR202	1N23B	Mixer.*
Abnormal heading flash	Heading flash has dark area following flash.	CR104	1N34	Indicator.
Poor or no SUPPRESSOR action		CR204	1N34	Receiver.
Bright spot on crt which moves as SUPPRESSOR control is rotated.		CR203	1N34	Receiver.

*Refer to paragraph 49 for information on alinement.

84. Tube Replacement

The tube complement, tube location diagram, and instructions for replacing tubes in each major component are given in paragraphs 85 through 88.

a. To locate trouble resulting from a defective tube, refer to the tube trouble-shooting chart and substitute a known good tube for the suspected tube. Do not replace more than one tube before checking for proper operation.

b. If it is necessary to replace the magnetron (V306), the T/R tube (V202), or the local oscillator, refer to the installation alinement instructions (ch. 2) for information on retuning.

c. If it is necessary to replace the mixer diodes (CR201 and CR202), refer to the crystal alinement procedure (ch. 2).

85. Indicator Tube Replacement

(fig. 65)

a. Tube Complement.

Symbol	Type	Function
V101	6SN7G/T	One-shot multivibrator.
V102	6AL5	Sweep generator and d-c restorer.
V103	6SN7G/T	Sweep-voltage amplifier.
V104	6BG6G	Sweep-current amplifier.
V105	7MP7	Cathode-ray tube.
V106	2X2–A	Cathode-ray tube 5 KV supply.
V107	6SN7G/T	Ringing oscillator and range mark amplifier.
V108	6SN7G/T	Range mark peaking and inverter amplifier.
V109	6J6	Video mixing amplifier.
V110	6AQ5	Video output amplifier

b. Removal of Cover. Loosen the top four captive screws (fig. 43) at the rear of the unit. Slide the top cover back until its front edge clears the indicator front panel and then lift up. Do not remove the bottom cover.

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

c. Replacement of PPI Tube V105. Be very careful when handling the cathode-ray tube. Use both hands when lifting the tube and never lay it down on hard surfaces. Do not drop tools on the face of the tube. Proceed as follows:

(1) Throw POWER switch S105 to its OFF position.

(2) Remove the 12-pin female socket from the base of the tube.

(3) Disconnect the 5,000-volt anode lead on the left side of the cathode-ray tube. Short the lead to the chassis.

(4) Tilt the indicator unit slightly upward and tighten the trunnion knobs.

(5) Remove the eight machine screws from the outer bezel rim (fig. 8). Take out the scale and cursor assembly.

(6) Remove the cathode-ray tube by gently pushing at the tube base while another person gently pulls at the face of the tube. Do not force the tube. If binding occurs, investigate the reasons before continuing.

(7) Remove the rubber shock ring from around the face of the tube.

(8) Reverse the procedure above when inserting the new cathode-ray tube.

(*a*) Be sure that the 45° cutaway on the tube neck yoke is facing toward the upper left corner. This precaution will provide clearance for the high-voltage cap of the cathode-ray tube.

(*b*) Be sure that the dial-light contact finger engages the mating contact in the upper right section of the housing.

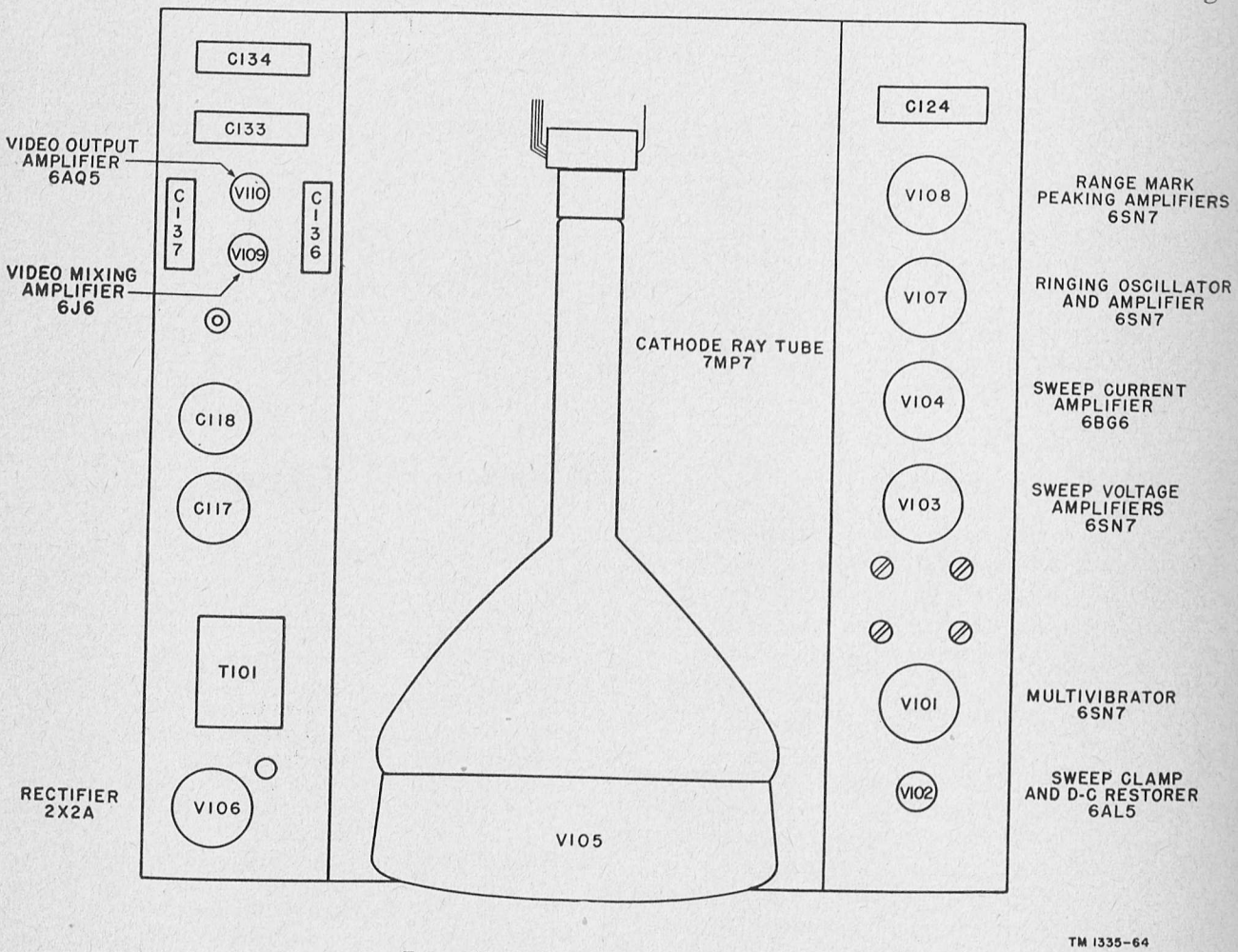


Figure 65. Indicator, tube location diagram.

(c) When installation is completed, apply power to the radar set. Check the centering with the sweep rotating.

(9) Place the defective tube in the carton supplied with the new tube.

86. Transmitter Tube Replacement

(fig. 66)

a. Tube Complement.

Symbol	Type	Function
V301	6SN7	Three-minute time delay.
V302	NE 32	V301 cathode (3-minute) time-delay circuit.
V303	3B24	H-v rectifier.
V304	3B24	H-v rectifier.
V305	4C35	Hydrogen thyratron.
V306	725A	Magnetron (fig. 7).
V307	6SN7	Blocking oscillator and amplifier.
V308	6V6	Blocking oscillator.
V309	6V6	Cathode follower.

b. Cover and Hinged Panel. Remove the front cover and open the hinged panel (fig.6).

c. Replacement of Magnetron V306.

(1) Shut off all power.

(2) Remove the forward half of the magnetic shield (fig. 5).

(3) Remove the hose bracket.

(4) Loosen the waveguide on the clamping screws.

(5) Loosen the three screws above the hinge and tip the magnet down.

(6) Remove the six screws holding the magnetron.

(7) Pull the magnetron straight forward. (Filament pins will disengage from socket behind panel.)

(8) To install a new magnetron, engage the filament plugs in the magnetron tube socket and then push the tube into the socket.

(9) Reassemble the shield and reconnect the hose bracket.

(10) Retune the local oscillator and the T/R tube (ch. 2).

d. Replacement of Magnet.

(1) Shut off all power.

(2) Remove the forward half of the magnetic shield.

(3) Remove the hose bracket.

(4) Remove the four screws holding the magnet.

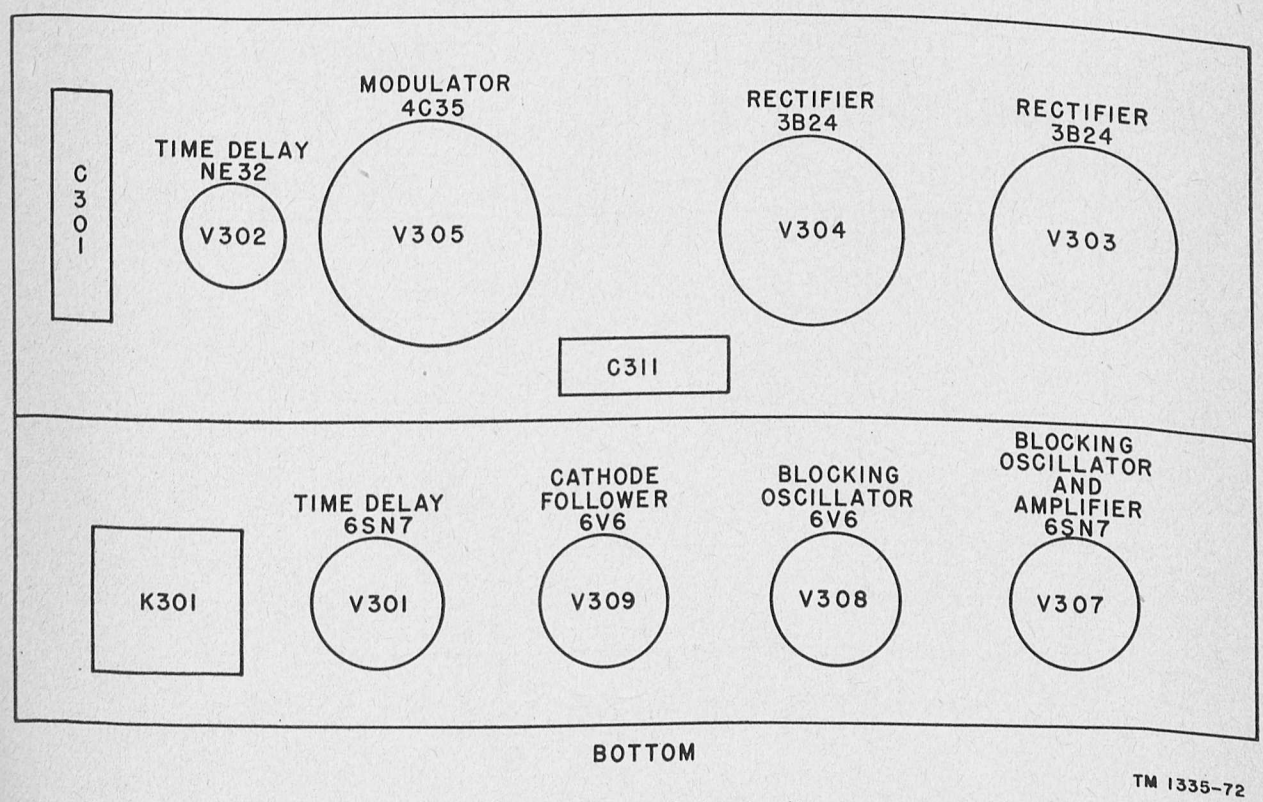


Figure 66. Transmitter, tube location diagram.

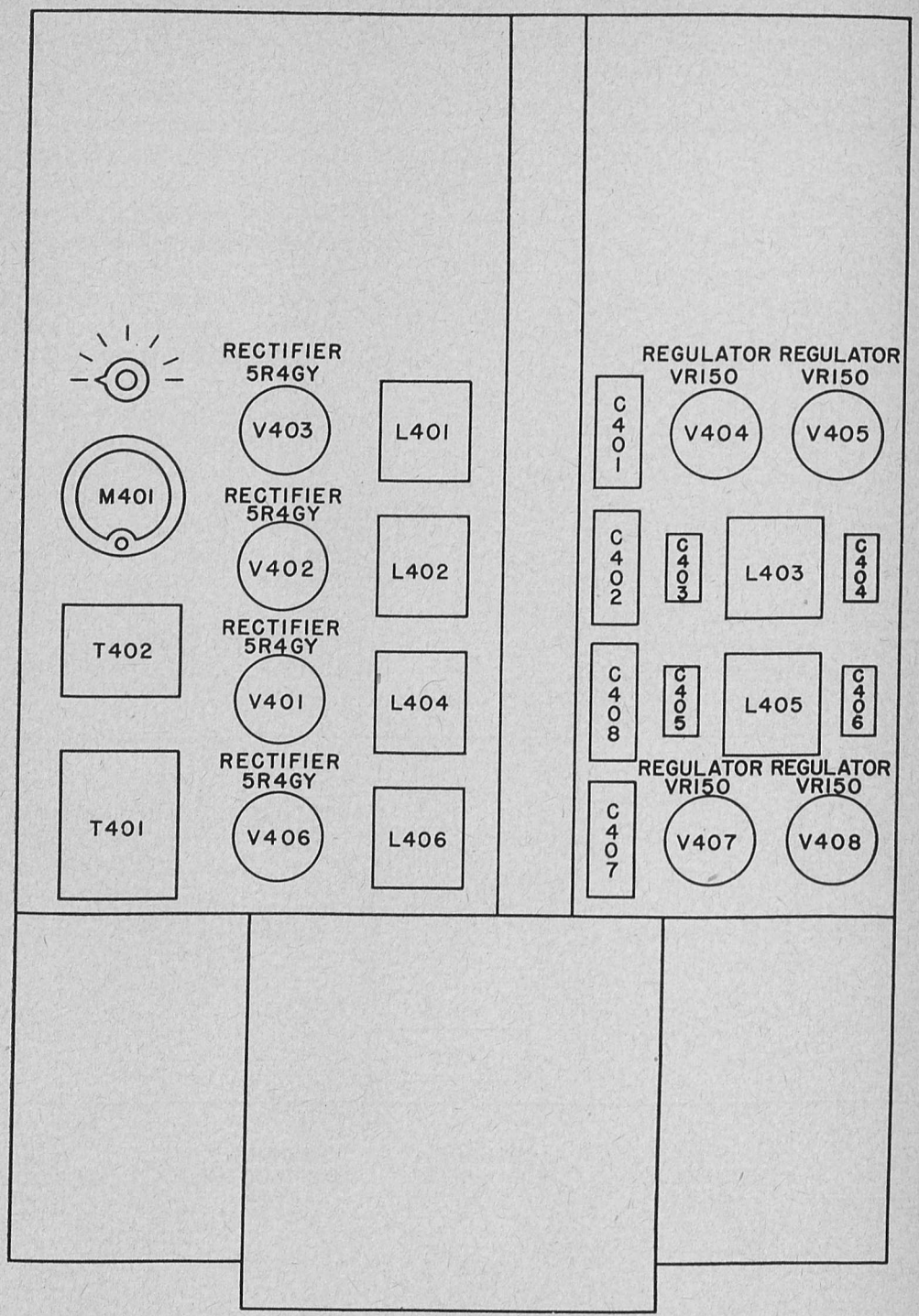


Figure 67. Power supply, tube location diagram.

(5) Remove and replace the magnet.
(6) Center and tighten the four holding screws.

Caution: Do not touch the magnet with a screw driver or other magnetic material. Do not operate the magnetron unless the magnetic shield is in place.

(7) Replace the magnetic shield and hose bracket.

e. Power Supply Tube Complement (fig. 67).

Caution: Shut off power to unit before removing tubes.

Symbol	Type	Function
V401	5R4GY	Rectifier.
V402	5R4GY	Rectifier.
V403	ODS/VR150	Regulator.
V404	OD3/VR-150	Regulator.
V405	5R4GY	Rectifier.
V406	OD3/VR-150	Regulator.
V407	OD3/VR-150	Regulator.
V408	1V2	Rectifier.
V409 (figs. 9 and 68)	1V2	Rectifier.
V410		

87. Receiver Tube Replacement (*fig. 69*)

a. Tube Complement.

Symbol	Type	Function
V203	2K25 or 723A/B	Signal oscillator.
V204	6AK5	Intermediate frequency.
V205	6J6	Intermediate frequency.
V206	6AK5	Intermediate frequency.
V207	6AK5	Intermediate frequency.
V208	6AK5	Intermediate frequency.
V209	6AK5	Intermediate frequency.
V210	6AK5	Intermediate frequency.
V211	6AK5	Second detector.
V212	6J6	Cathode follower-limiter.
V213	6AK5	Intermediate frequency.
V214	6AK5	Intermediate frequency.
V215	6AL5	Discriminator.
V216	6J6	Video.
V217	6AL5	Charging diode.
V218	6AS6	Sweep generator and d-c amplifier.
V219	12AU7	STC generator and cathode follower.

b. Realinement. If tube V203 is replaced, refer to paragraph 49 for realinement instructions.

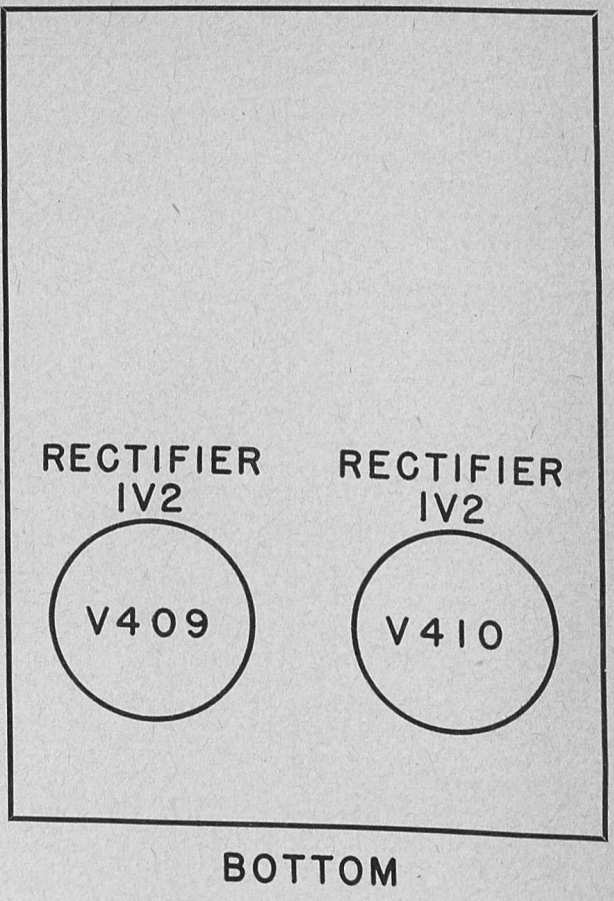


Figure 68. Keep-alive power supply, tube location diagram.

88. Mixer and Duplexer Tube Replacement (fig. 47)

a. Tube Complement.

Symbol	Type	Function
V201	1B35 (duplexer)	ANTI-T/R.
V202	1B24 (duplexer)	T/R.
V203	2K25 or 723A/B (mixer)	LO.

b. Replacement of T/R Tube V202.

(1) Throw POWER switch S105 to its OFF position.

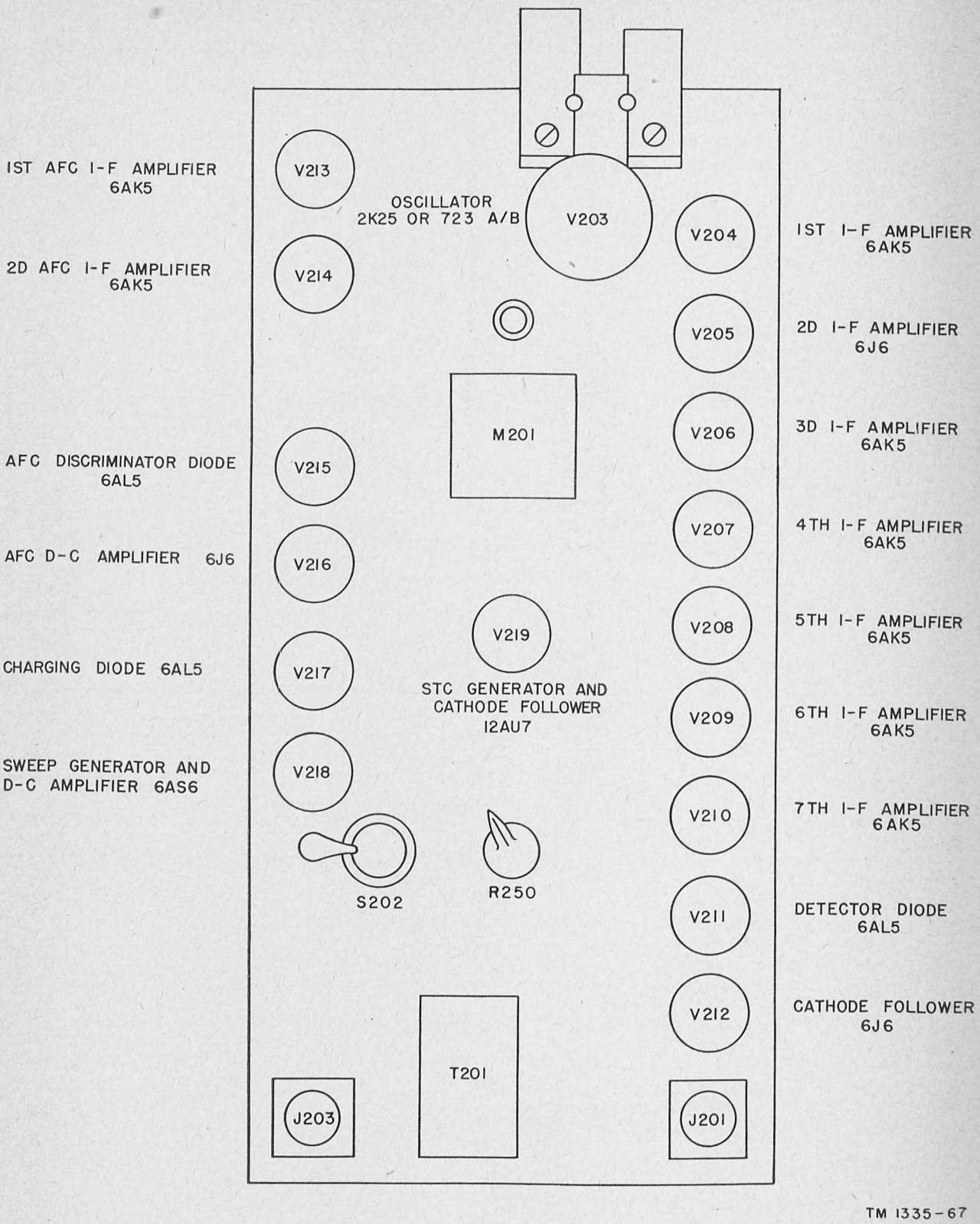


Figure 69. Receiver, tube location diagram.

(2) Open the hinged panel of the receiver-transmitter.
(3) Remove the four machine screws holding the T/R tube.
(4) Grasp the glass envelope of the tube and pull the tube until it clears the waveguide and the hole in the hinged panel.
(5) Insert the new T/R tube and refer to paragraph 49 for realinement instructions.

c. Replacement of Anti-T/R Tube V201.

(1) Throw POWER switch S105 to its OFF position.
(2) Remove the two machine screws and the cover plate.
(3) Replace the Anti-T/R tube.

89. Motor-Generator Trouble 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 connections at switch box, motor starter box, voltage regulator, and motor generator.
		Check fuses F601, F602, in the switch box. Refer to paragraph 44 for proper fuse ratings.
		Check cable connections at indicator unit, receiver-transmitter unit, and antenna unit.
		Check fuses F301, F302, F401, F402, F801, F802, F803, and F804 in receiver-transmitter unit and F101 in indicator unit. Refer to paragraph 44 for proper fuse rating.
	Brush not making contact with commutator.	Check for weak or broken brush tension spring (fig. 71). Clean brushes and brush holder (par. 91).
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 box.
Motor attempts to start, but thermal overload operates.	Motor is started with weak field	Check connections at switch box motor starter, 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. 91).
	Short circuit in power group	Check connections at switch box, motor starter box, 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. 90 and 91).
	Excessive vibration	Check brushes to make sure they ride freely in brush holders.

89. Motor-Generator Trouble Chart—Continued

Trouble	Probable cause	Remedy
Excessive sparking at commutator	Broken or weak brush tension spring	Check brush tension spring (fig. 71).
	Brushes too short	Replace brushes (par. 91).
	Poor brush fit on commutator	Seat brush properly (par. 91).
	Dirt on commutator	Clean commutator (par. 93).
	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 louvers 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 louvers 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.
	Dirty commutator	Clean commutator (par. 90).

90. 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. A commutator cleaning tool (fig. 70) may be constructed as follows:

(1) Cut a strip of wood 6 inches long, approximately 5/16 inch thick, and 1½ inches wide.

(2) Cut several strips of canvas the same width and length as the strip of wood.

(3) Wrap the canvas strips around the end of the strip of wood.

(4) Rivet the canvas strips to the strip of wood. If rivets are not available, use wire, cord, or several strong rubber bands to hold the canvas strips on the strip of wood.

c. To clean the commutator, proceed as follows:

(1) Remove the brush access cover (fig. 71).

(2) Insert the cleaning tool and rub the canvas surface against the exposed commutator surface.

(3) Rotate the armature to expose and clean the next commutator surface.

(4) Repeat the steps in (2) and (3) above, until all commutator surfaces have been cleaned.

d. When commutator surfaces are pitted badly, proceed as follows:

(1) Cut a strip of No. 0000 sandpaper 6 inches long and 1½ inches wide.

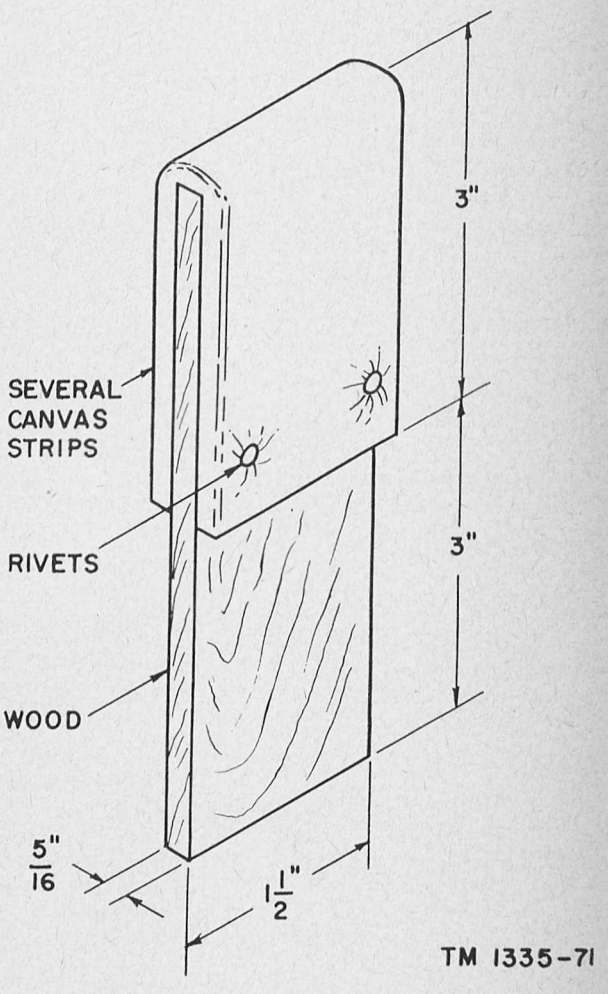


Figure 70. Commutator cleaning tool.

Caution: Never use emery cloth or a file for this cleaning procedure.

(2) Fold the sandpaper over the cleaning tool.

(3) Repeat the procedure in (2), (3), and (4) above.

(4) After using sandpaper, apply carbon tetrachloride to remove dirt and sandpaper dust from between the commutator segments.

91. Brushes

New or old brushes must be seated to conform with the surface of the commutator. Perform the following operations to seat a brush properly:

a. Cut a long strip of No. 0000 sandpaper slightly wider than the width of the brush.

b. Remove all brushes from brush holders.

c. Place the strip of sandpaper around the commutator, with the sanded side toward the brush.

d. Lower one brush into contact with the sandpaper and draw the sandpaper in the direction of normal rotation.

e. Lift the brush; return the sandpaper to its original position.

f. Repeat the steps in *d* and *e* above until the brush is seated properly.

g. Perform this procedure for each brush.

Caution: Never use emery cloth. Emery dust will short-circuit commutator segments.

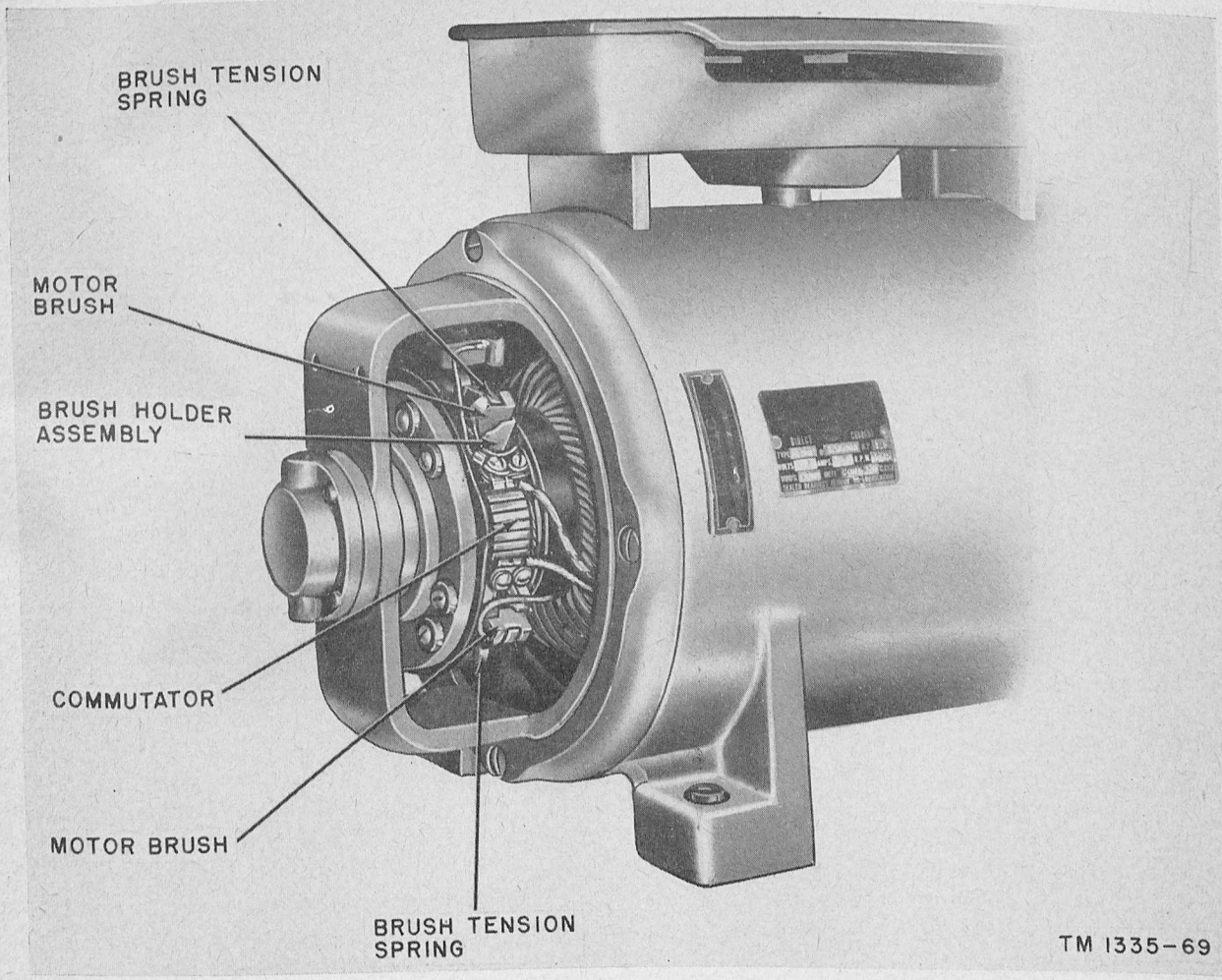


Figure 71. Motor end of motor generator.

CHAPTER 5

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

92. Disassembly

a. Radar Set AN/SPN–11(*) 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 plate (used with original factory shipment) to seal the waveguide 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 nonhygroscopic 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.

93. Limited Storage or Repacking

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 waterproof sealing compound or tape.

94. Domestic Shipment

When the shipment is to be removed from its mounting and transported to a remote point, proceed as follows:

a. Remove access covers.

b. Clean the interior of each unit.

c. 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.

d. Seal all openings with nonhygroscopic tape.

e. Wrap each unit in moistureproof paper or other moistureproof wrapping. Seal the edges of the wrapping.

f. Place each unit in its original packing crate, or equal. Refer to the typical packaging illustration (fig. 23).

95. Preparation for Extended Periods of Non-use

a. This paragraph contains storage procedure for periods when the ship is laid up but equipment is left in place.

b. When the equipment is not to be used for a period of 30 days or more, prepare each unit as follows:

(1) Remove the access cover.
(2) Clean the interior of the unit.
(3) Apply a light coating of compound (CL) to all exposed, unpainted surfaces.

Caution: Do not allow the compound to come in contact with rubber parts and wires.

(4) Seal all openings with nonygroscopic tape.
(5) Cover the unit with a tarpaulin or other suitable covering.
(6) Remove the antenna horn and seal the waveguide assembly with the cover plate.
(7) Cover the antenna assembly with a tarpaulin.

Section II. DEMOLITION OF MATÉRIEL TO PREVENT ENEMY USE

96. General

The demolition procedures outlined in paragraph 97 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.

97. Methods of Destruction

a. Smash. Smash magnetron, duplexer, relays, cam switches, meters, controls, capacitor, transformers, and tubes, using sledges, axes, hammers, crowbars, or heavy tools.

Caution: Place a tarpaulin or a suitable cover over cathode-ray tube to protect personnel against shattering glass.

b. Cut. Cut cables, cord, and wiring, using 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, using gasoline, kerosene, oil, or incendiary grenades.

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 Everything.

APPENDIX

REFERENCES

Note. For availability of items listed, check SR 310–20–3, SR 310–20–4, and SR 310–20–5. Check Department of the Army Supply Catalog SIG 1 for Signal Corps Supply Catalog pamphlets.

1. Army Regulations

AR 380–5	Military Security (Safeguarding Military Information).
AR 750–5	Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation).

2. Supply Bulletins

SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11–76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Auxiliary Equipment and Test Equipment

TM–11–1067A	Oscilloscope TS–34A/AP.
TM 11–5527	Multimeter TS–352/U.

4. Painting, Preserving, and Lubrication

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69	Lubrication of Ground Signal Equipment.
TM 9–2851	Painting Instructions for Field Use.

5. Other Publications

NAVSHIPS 900171	Electronic Installation Practices Manual.
SR 310–20–3	Index of Training Publications.
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
SR 310–20–5	Index of Administrative Publications.
SR 700–45–5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD–247).
SR 745–45–5 Navy Shipping Guide, Article 1850–4 AFR 71–4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD–66 (Army), S and A–70–6 (Navy), and AF–MC–U2 (Air Force)).
TB SIG 25	Preventive Maintenance of Power Cords.
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TB SIG 225	Radioactive Tube Handling.

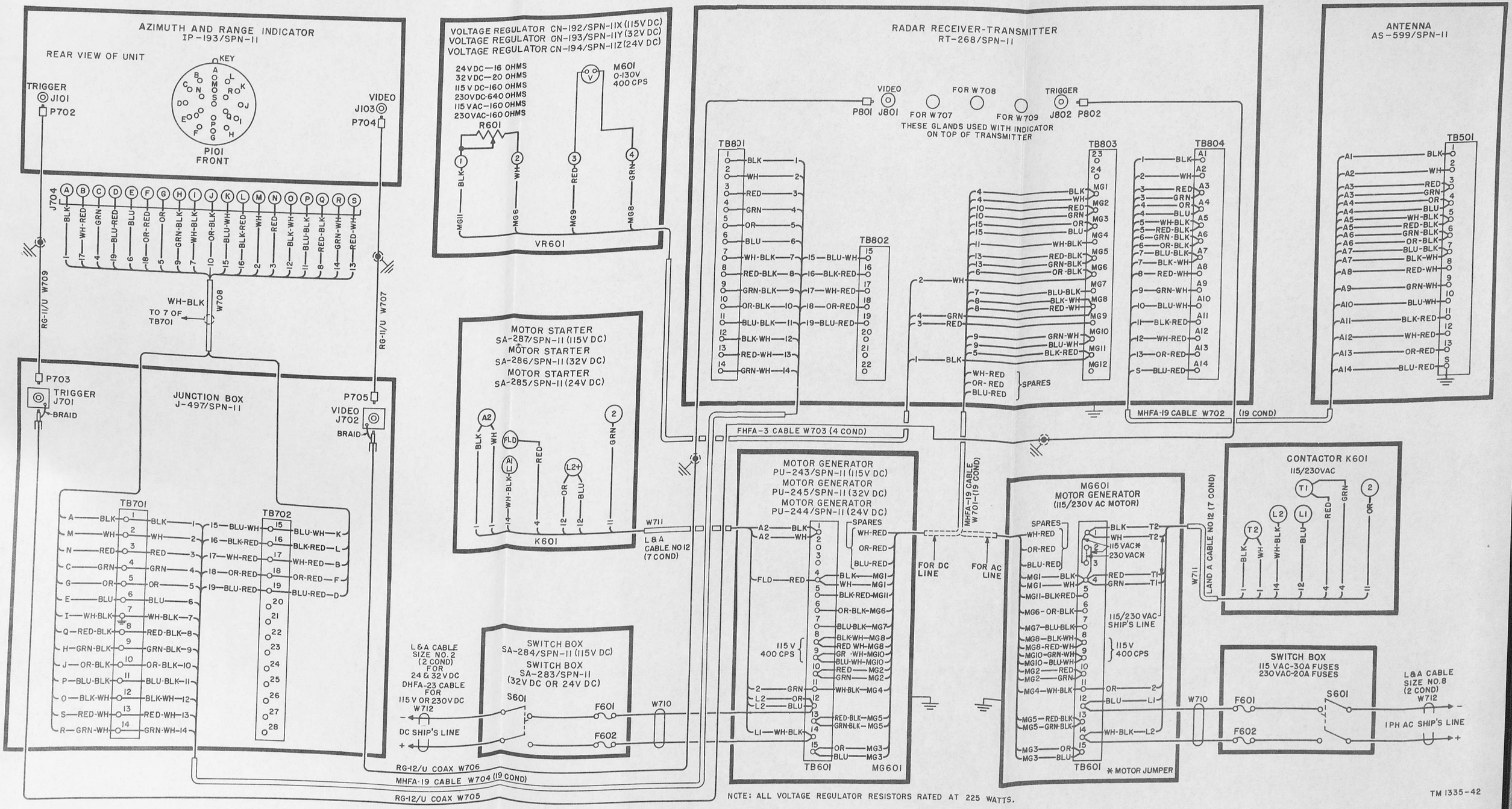


Figure 72. Radar Set AN/SPN-11(*), cabling diagram.

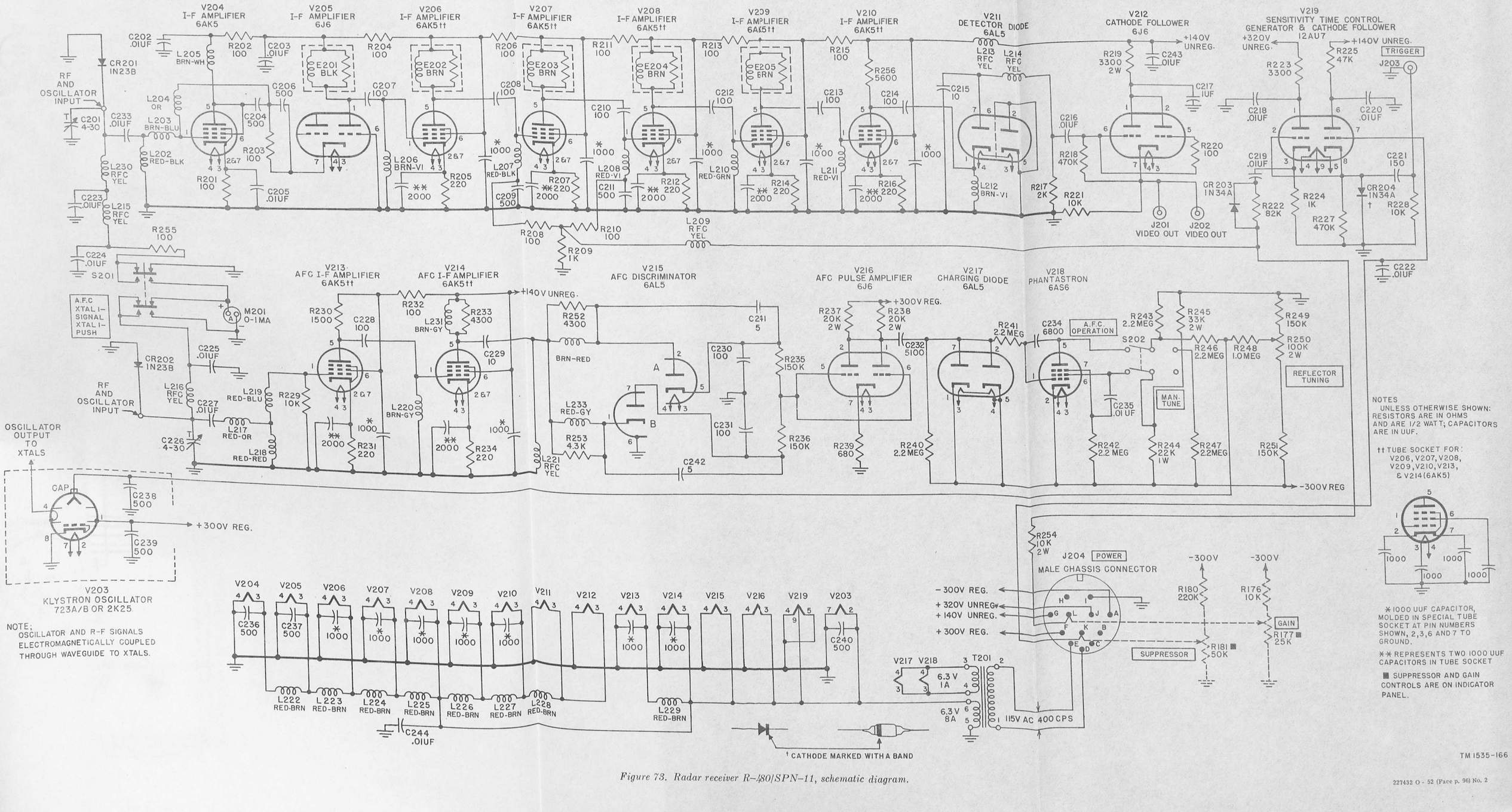


Figure 73. Radar receiver R-480/SPN-11, schematic diagram.

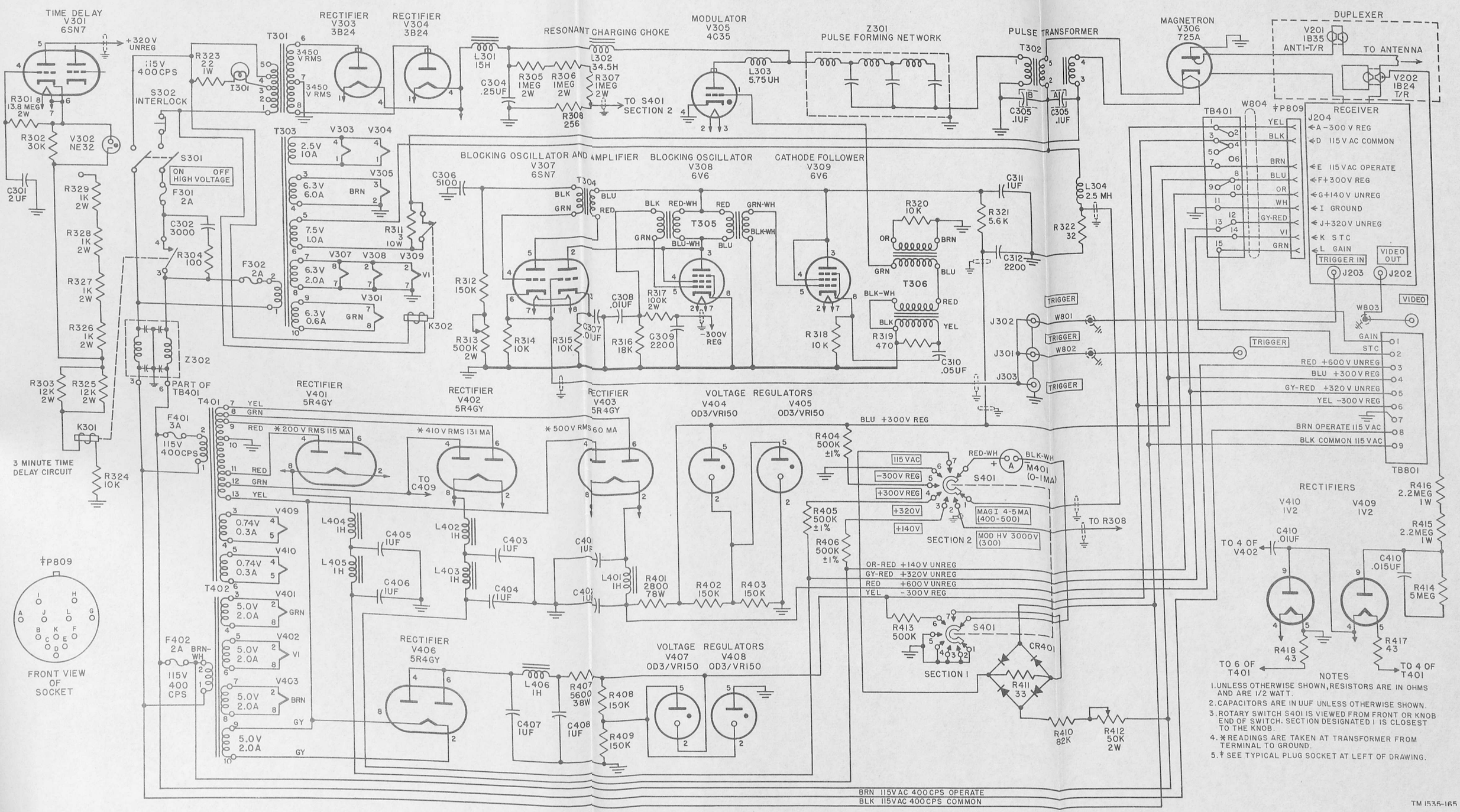


Figure 74. Radar transmitter, schematic diagram.

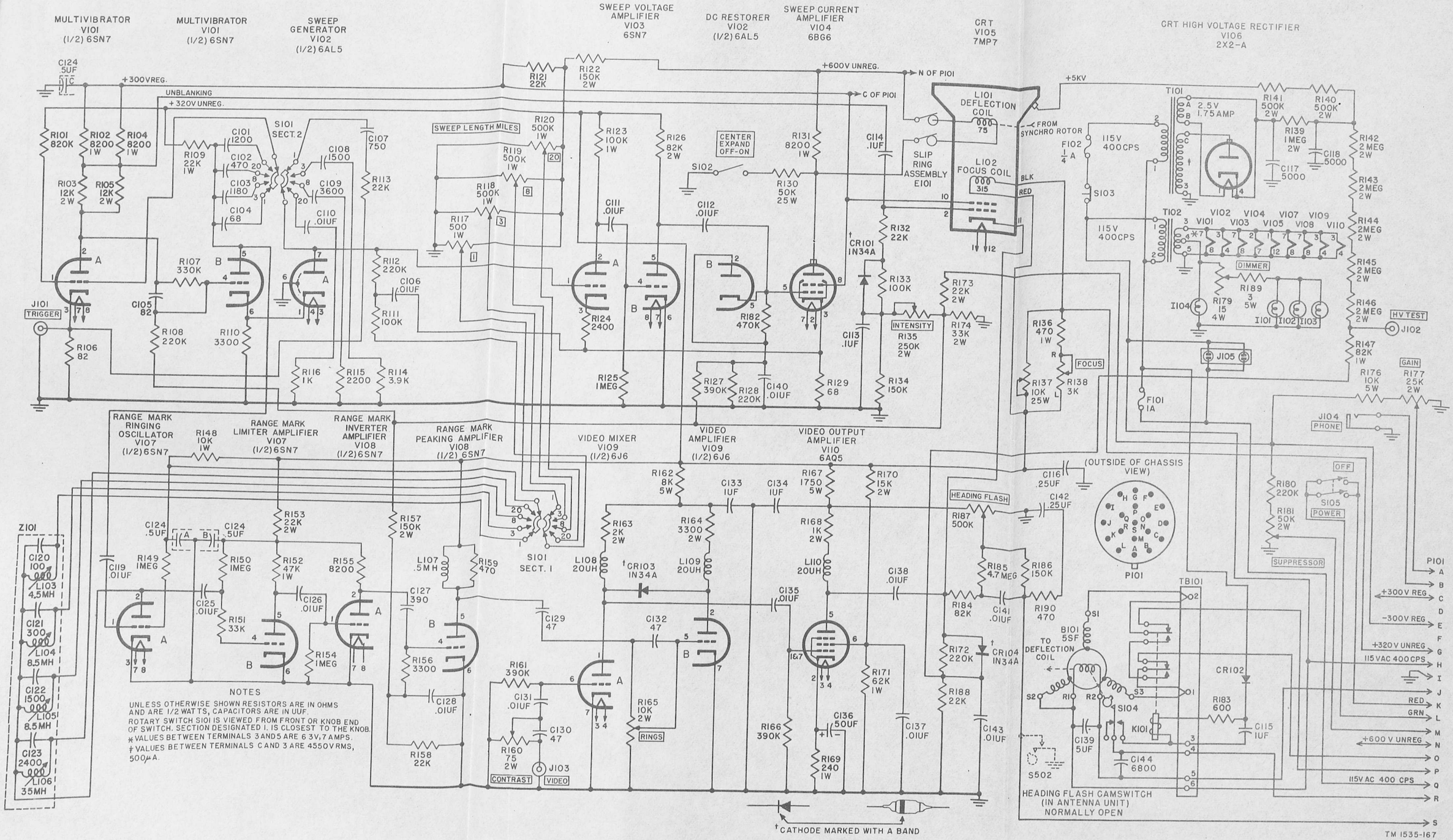
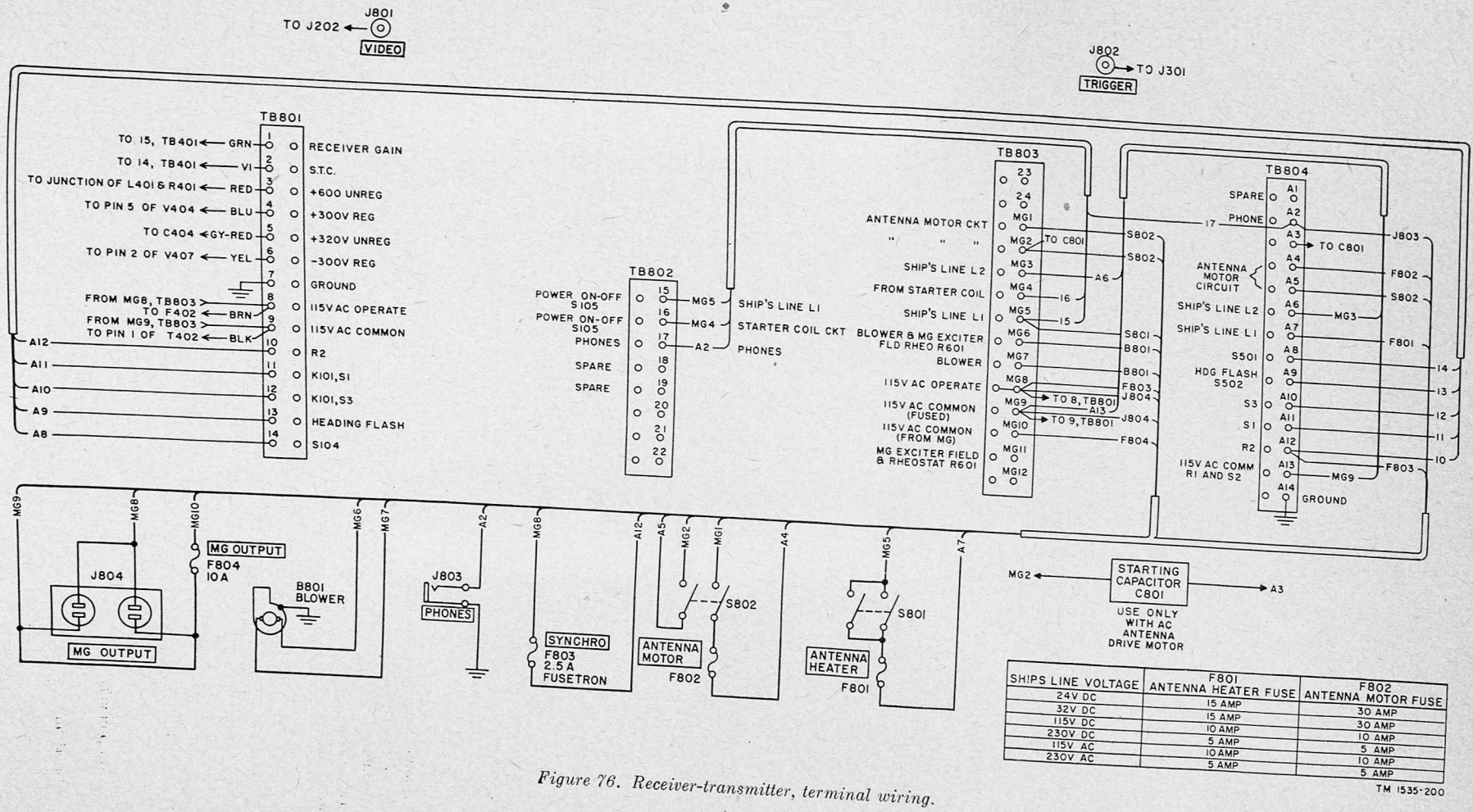


Figure 75. Azimuth and range indicator IP-193/SPN-11, schematic diagram.



SHIPS LINE VOLTAGE	F801 ANTENNA HEATER FUSE	F802 ANTENNA MOTOR FUSE
24V DC	15 AMP	30 AMP
32V DC	15 AMP	30 AMP
115V DC	10 AMP	10 AMP
230V DC	5 AMP	5 AMP
115V AC	10 AMP	10 AMP
230V AC	5 AMP	5 AMP

TM 1535-200

Figure 76. Receiver-transmitter, terminal wiring.

INDEX

U. S. GOVERNMENT PRINTING OFFICE: 1952