RESTRICTED

FM 4–95

WAR DEPARTMENT

COAST ARTILLERY FIELD MANUAL

SEACOAST ARTILLERY

SERVICE OF THE RADIO SET SCR-296-A

15 September 1943

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The Army Field Printing Plant, C.A.S., Fort Monroe, Va.

WAR DEPARTMENT,
WASHINGTON, 15 September 1943.

FM 4–95, Coast Artillery Field Manual, Service of the Radio Set SCR–296–A, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

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The Adjutant General.

DISTRIBUTION:
IBn and H 4 (5), IC 4 (10).
(For explanation of symbols see FM 21–6.)

CHAPTER 1

GENERAL

SECTION I

GENERAL

■ 1. SCOPE.—*a.* The object of this manual is to furnish in brief form the essentials of all available reference material now on hand for the Radio Set SCR-296-A, to the exclusion of detailed diagrams, drawings, and intricate adjustments or repairs. This manual is intended as a guide for those charged with the employment of a fire control radar set. The problem of position finding is the same as that discussed in FM 4-10, *Gunnery,* and FM 4-15, *Fire Control and Position Finding,* for the vertical base system.

b. The matter contained herein is intended only as a guide in the assignment of individuals and duties. Minor changes in procedure may be made to fit local conditions.

■ 2. DEFINITIONS.—An explanation of the meaning of various words and terms used throughout this manual will be found in the glossary in appendix I.

■ 3. REFERENCES.—This manual should be studied in connection with the various references listed in appendix II for

best results. Detailed instructions for operation and maintenance of Radio Set SCR-296-A will be found in instruction manuals issued with the set.

■ 4. STYLE.—The lettering which appears on name plates, controls, and dials of the Radio Set SCR-296-A when used in this manual will be capitalized. The lettering on these name plates, controls, and dials may be an abbreviation of a word or words. In these cases the references in the manual may contain the abbreviated word or words in capitals, or may contain the abbreviated word or words in capitals plus the remainder of the word or words in lower case such as MODulation or CATHode.

■ 5. WARNING.—Voltages sufficient to cause serious injury or death on contact are used in the Radio Set SCR-296-A. Safety devices have been incorporated in the set so that in normal operation no high-voltage circuits are or can be exposed. Servicing or adjustments within the equipment should be made only by experienced maintenance personnel. Servicing should not be attempted unless another person capable of rendering aid in case of injury is present. The interlock switches should not be shorted or closed except as prescribed for certain tests. When working on the equipment the power should be removed even though the safety switches are provided.

SECTION II

THE INSTRUMENT

■ 6. GENERAL.—The Radio Set SCR-296-A is assigned to modern seacoast batteries of 6-inch caliber or larger. Its function is to provide present azimuth and range of surface marine craft with sufficient accuracy for direction of gunfire. Each set normally will be assigned to one battery of a

harbor defense but may be required to furnish data to one or more additional batteries as a secondary assignment when necessary. The operation of this set is not limited by darkness, haze, fog, smoke, or other atmospheric characteristics that render optical methods of observation ineffective. The set utilizes short pulses of high-frequency radio energy. The time interval from the emission of the pulse to the reception of the reflected energy from a target determines the range to the target. A highly directive antenna is used to determine the azimuth of the target.

■ 7. RANGE INDICATION.—The complete range of the set appears as a horizontal line or sweep on an oscilloscope. The center portion of the sweep may be expanded, so that 4 inches represent about 5,000 yards (see fig. 1), thus allowing accurate determination of target range and facilitating discrimination between targets differing slightly in range.

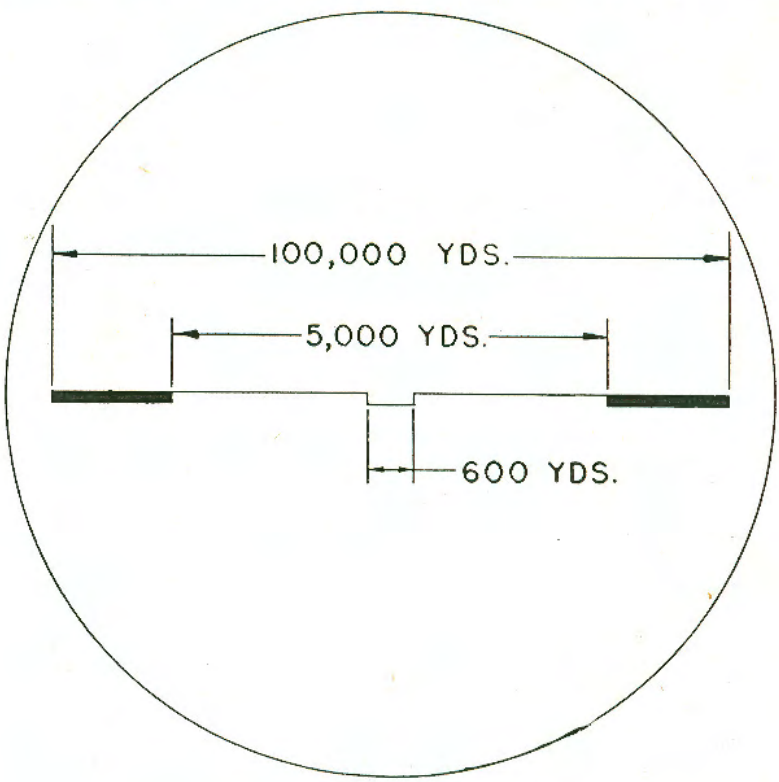


FIGURE 1.—Range oscilloscope screen (no signals).

Echoes, called "pips," appear as vertical deflections on the sweep line; the transmitted pulse appears as a large pip (see fig. 2). In the center of the expanded portion of the sweep a section of the base line, having a width which represents about 600 yards, is lowered to form a notch. The range to any target centered in the notch may be read from range dials.

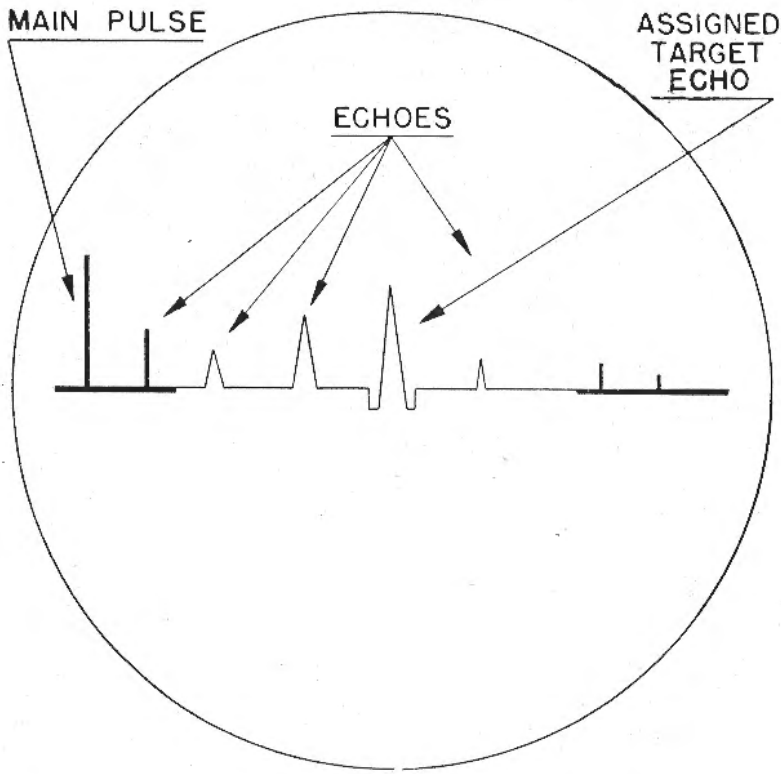


FIGURE 2.—Range oscilloscope screen (desired signal in notch).

■ 8. AZIMUTH INDICATION.—The echo in the notch, and only this echo, appears on the azimuth oscilloscope. The echo, at the same time that it appears on the azimuth oscilloscope, also affects the position of the pointer on the azimuth tracking meter. This echo is made to appear as two pips side by side. When the antenna is directed at the target, the pips are of equal height and the pointer of the azimuth tracking meter is at the center of the dial. The azimuth of the target is now read from azimuth dials. If the antenna is

directed off the target, one side or the other, the pip heights are unequal (see fig. 3) and the pointer of the azimuth tracking meter is off center.

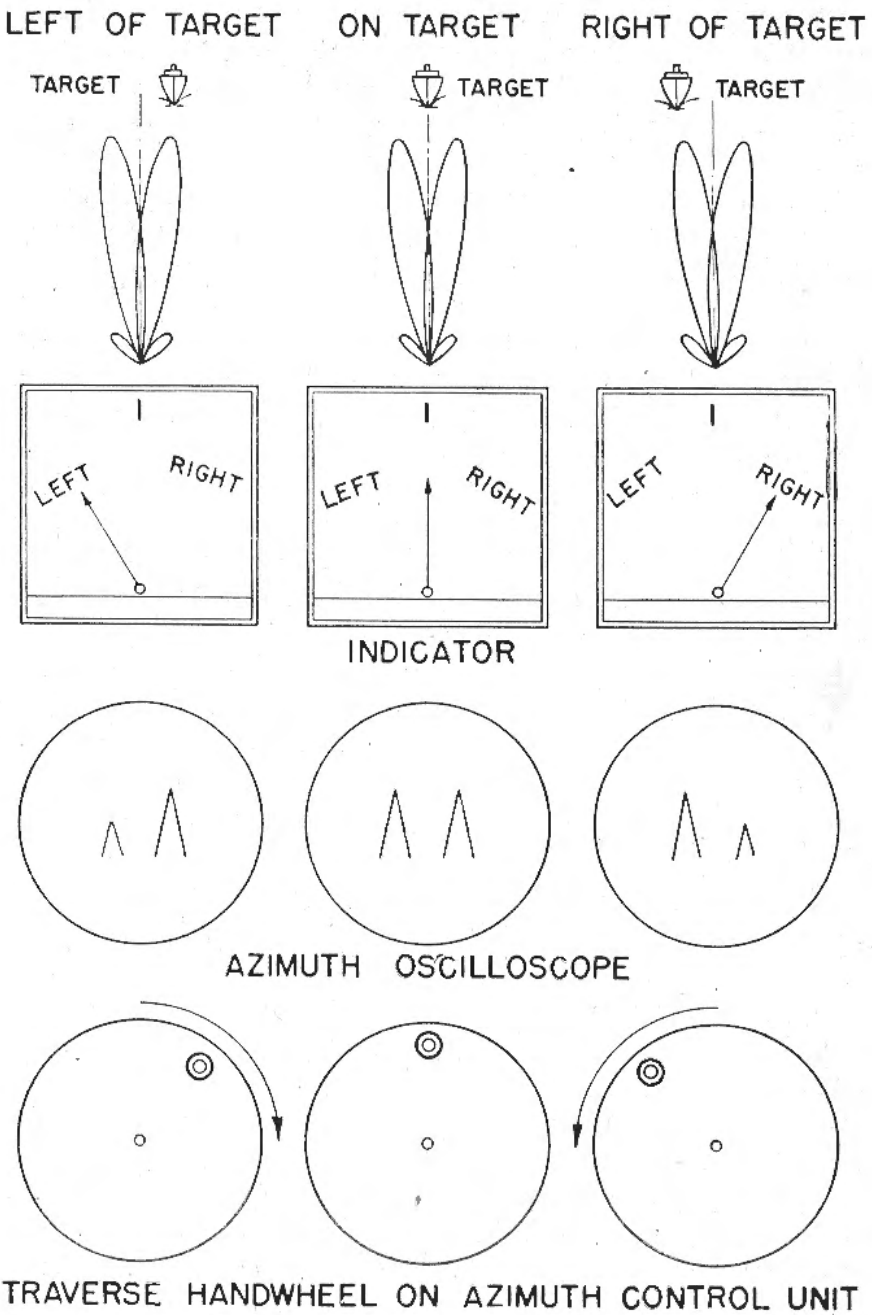


FIGURE 3.—Azimuth indications.

■ 9. EMPLOYMENT.—The SCR-296-A is a precision fire control instrument assigned to a particular firing battery. As such, it should be incorporated in the fire control system of the battery and employed so as to furnish most effectively the data required for accurate fire control, particularly during periods when visual observation is unsatisfactory or impossible. Station centers, station arms, and couplers must be provided for the M3 and M4 plotting boards of 6-inch and 16-inch batteries for each SCR-296-A from which data are to be received. In keeping with its role as a fire control instrument, the SCR-296-A normally will be operated only for tracking during training periods and during combat under orders of the battery commander. Various states of readiness, defined in section III, chapter 5, will be prescribed to fit the tactical situation. As a general rule, the set will be in full operation only a few hours each day. An exception to this rule may be necessary in those few cases where no surveillance radar is operated in the same locality. Under such circumstances, it may be necessary to use an SCR-296-A for searching and the period of daily operation may approach 24 hours.

SECTION III

DESCRIPTION OF THE SET

■ 10. GENERAL.—*a.* The Radio Set SCR-296-A, when installed, represents a complete radio station, as both transmission and reception are accomplished. The station is capable of operating independently since it is supplied with its own primary source of power. Sufficient tools, accessories, spare parts, supplies, and test equipment are furnished with the set to equip a complete radio repair shop within the station.

b. The set is composed of three major sections (see fig. 4).

(1) *Operating room.*—Radio House HO-2-A supplied with the set houses the complete transmitting, receiving, and indicating equipment. Operation of the set is accomplished here (see fig. 5).

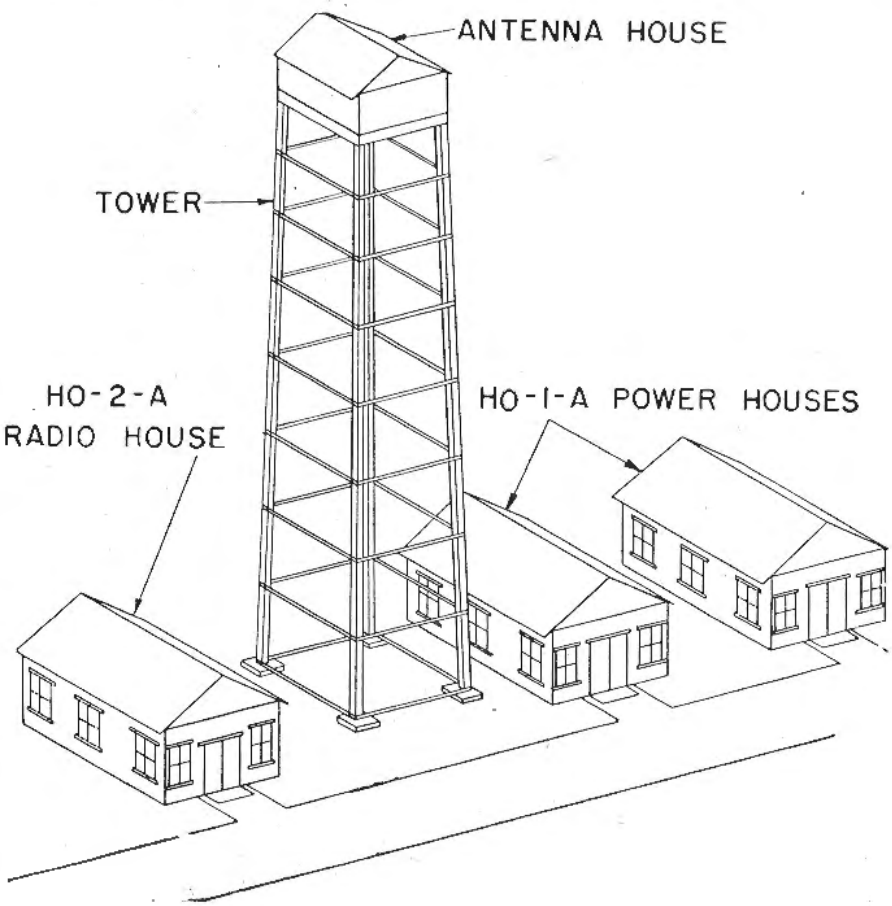


FIGURE 4.—SCR-296-A. Type installation.

(2) *Antenna.*—The SCR-296-A is so designed that one antenna serves for both transmission of the pulses and reception of the echoes. The antenna is mounted on a steel tower.

(3) *Power units.*—Two 25-kv.-a. gasoline-electric power units, each with separate housing (House HO-1-A), are supplied with the radio set.

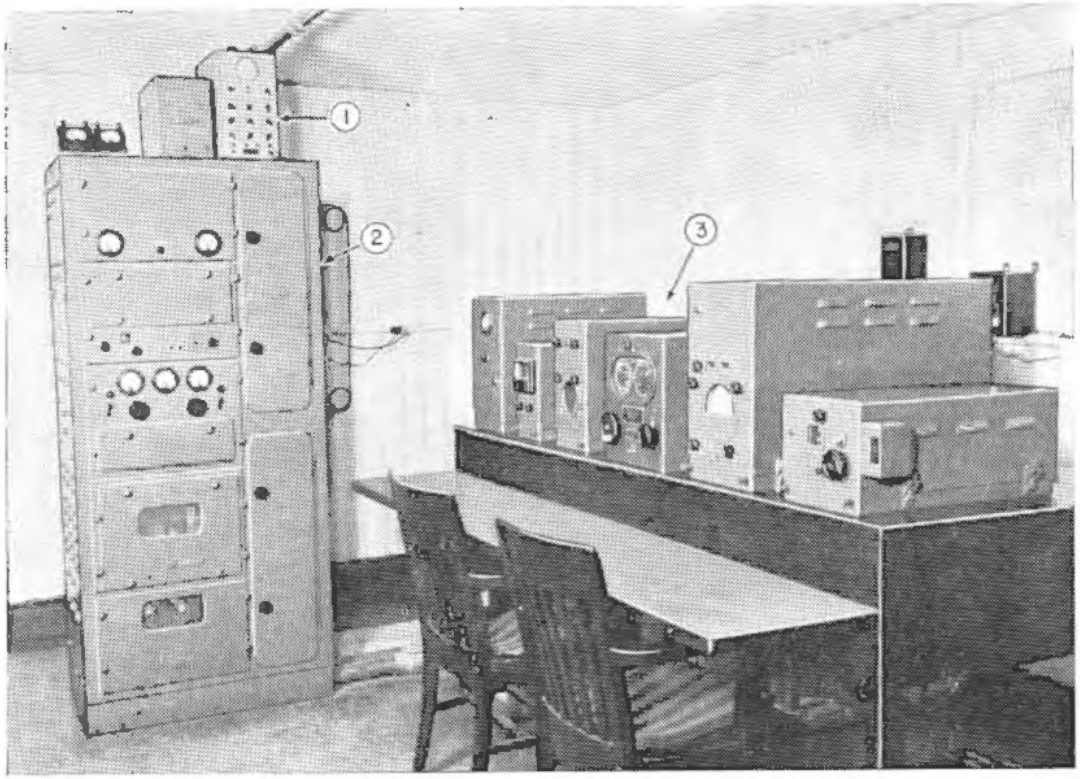
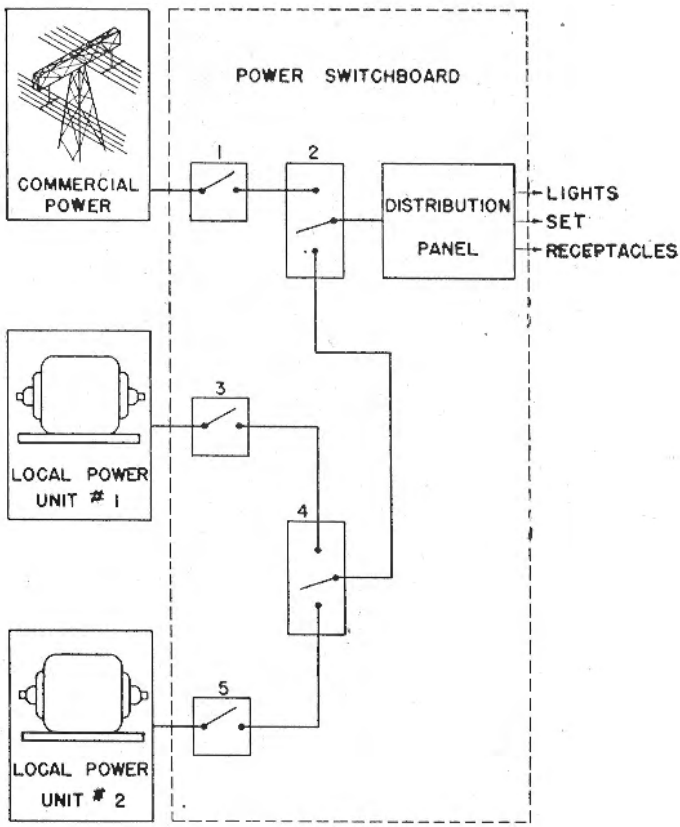


FIGURE 5.—SCR-296-A, operating room.
1. Test equipment. 2. Main unit. 3. Indicating equipment.

■ 11. POWER SWITCHBOARD.—As power may be supplied to the SCR-296-A from any one of three sources, commercial (or post) power, local power unit No. 1, or local power unit No. 2, a switching arrangement is necessary. This is referred to as the power switchboard and is located in the operating room. On this board is also located the power distribution panel which makes power available for the set, for lighting, and for heating. The necessary fusing is accomplished in the various switches (see fig. 6).



1. COMMERCIAL POWER SWITCH
2. LOCAL COMMERCIAL POWER TRANSFER SWITCH
3. POWER UNIT #1 SWITCH
4. POWER UNIT TRANSFER SWITCH
5. POWER UNIT #2 SWITCH

FIGURE 6.—Power switchboard system.

■ 12. MAIN UNIT.—*a.* Located in the operating room is Cabinet BE-82-A. This is a steel cabinet in which are located six components (see fig. 7).

(1) Modulation Generator BC-720-A.
(2) Radio Receiver BC-716-A.
(3) Power Control Panel BD-108-A.
(4) Radio Transmitter BC-717-A.
(5) Rectifier RA-50-A (high voltage).
(6) Duplexing Panel BD-106-A.

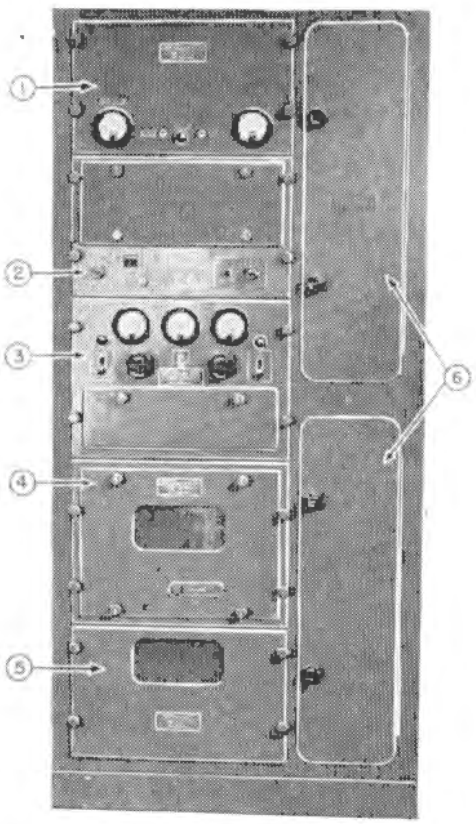


FIGURE 7.—Main unit (Cabinet BE-82-A).
1. Modulation Generator BC-720-A.
2. Radio Receiver BC-716-A.
3. Power Control Panel BD-108-A.
4. Radio Transmitter BC-717-A.
5. Rectifier RA-50-A (high voltage).
6. Duplexing Panel BD-106-A.

b. All units in the cabinet with the exception of Duplexing Panel BD-106-A can readily be removed from the cabinet for ease in servicing. Interlock switches and shorting bars are provided in the main cabinet to remove all high voltage and to discharge all high-voltage condensers when the units are removed or when the transmitter front panel is removed for servicing. Even though these devices are provided for protection of personnel, extreme care should be taken when working on the high-voltage circuits.

■ 13. INDICATING EQUIPMENT.—*a.* Six separate units make up the indicating equipment (see fig. 8).

(1) Rectifier RA-49-A.
(2) Indicator I-110-A (azimuth tracking meter).
(3) Oscilloscope BC-718-A (azimuth).
(4) Control Unit RM-36-A.
(5) Oscilloscope BC-719-A (range).
(6) Range Unit BC-723-A.

b. These units are located in the operating room on an equipment table that is provided with the set. All facilities for directing the antenna at the target and for reading range and azimuth are located in these units.

NOTE.—An automatic gain control unit will be furnished for all Radio Sets SCR-296-A. This unit is added to the indicating equipment and is designed to control the signal output and gain of the receiver in inverse relation to the amplitude of a selected input signal. Included in the automatic gain control unit is a new azimuth indicator circuit which will improve tracking with the meter. The unit will be mounted on an extension of the equipment table.

■ 14. ANTENNA.—The antenna for the SCR-296-A confines the radiated energy to a narrow beam. The antenna proper is a directive array with a cylindrical parabolic reflector. The reflector has an aperture about 6 feet square. This directive array and reflector are mounted on a pedestal which contains the necessary mechanism for rotating them through 360°. The rotating of the antenna is controlled by the azimuth control unit, located with the indicating equipment in the operating room. In order that the operator of the azimuth control unit may know the direction in which

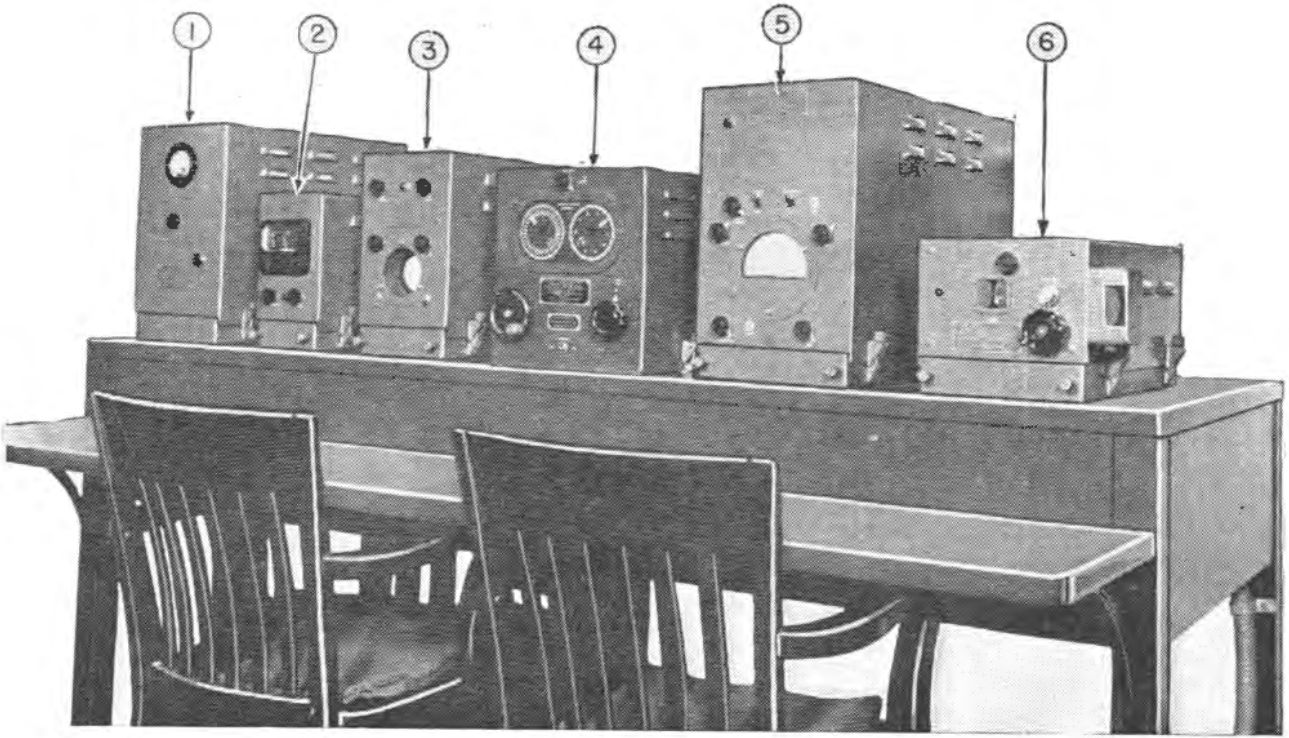


FIGURE 8.—Indicating equipment.

1. Rectifier RA-49-A.
2. Indicator I-110-A (azimuth tracking meter).
3. Oscilloscope BC-718-A (azimuth).
4. Control Unit RM-36-A.
5. Oscilloscope BC-719-A (range).
6. Range Unit BC-723-A.

the antenna is pointed, a selsyn data transmission system is provided between the antenna and operating room. The entire antenna assembly (see fig. 9) is housed in a wooden tanklike shelter on top of a steel tower.

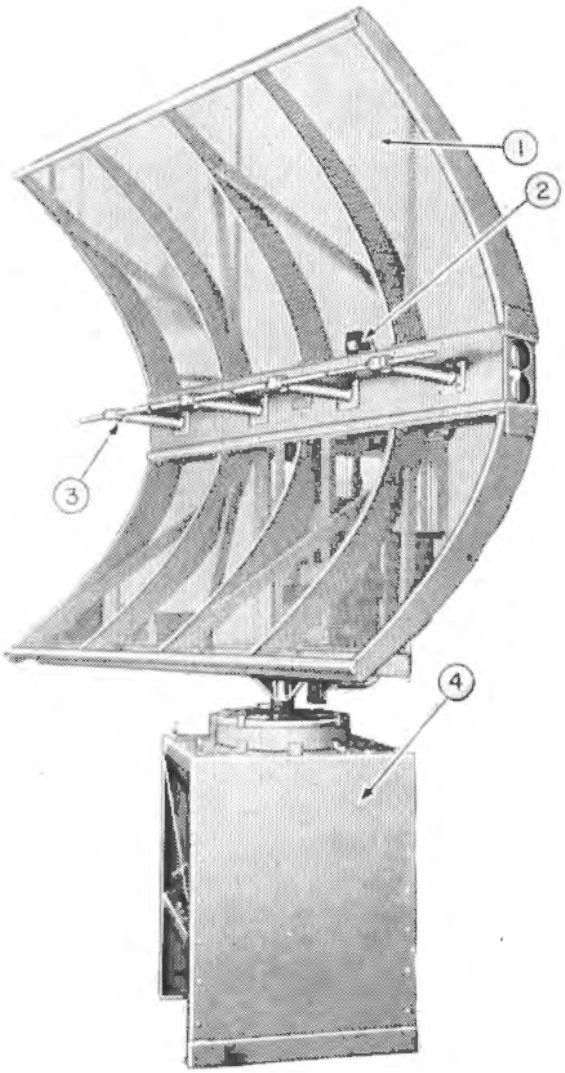


FIGURE 9.—Antenna assembly.

1. Reflector.
2. Lobe-switching mechanism.
3. Antenna.
4. Pedestal.

■ 15. TOWER.—The tower for the SCR-296-A may be obtained in heights of 25, 50, 75, or 100 feet, as required by the local site. The antenna should be at least 100 feet above sea level. Each antenna is equipped with an electric hoist for raising the antenna assembly during construction and overhaul and for raising and lowering tools and supplies during routine maintenance. A ladder is provided for personnel.

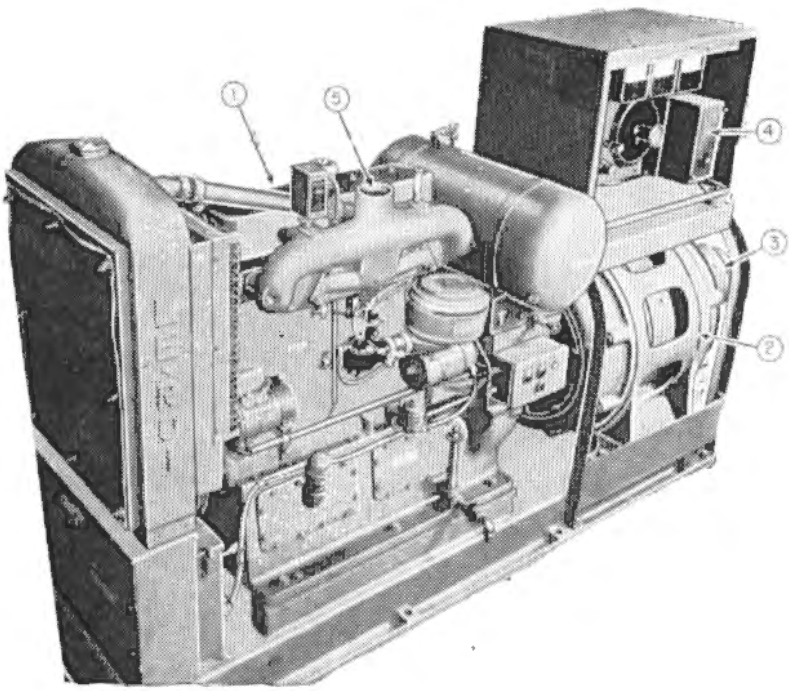


FIGURE 10.—Power Unit PE-84-C.

1. Gasoline engine.
2. Generator.
3. Exciter.
4. Power control board.
5. Connection to exhaust stack.

■ 16. POWER SUPPLY AND POWER PLANTS.—*a*. The Radio Set SCR-296-A is designed for operation either from the local power supplied by one of the two power units, PE-84-C (see fig. 10), or from commercial 115-volt, 60-cycle power where available. The approximate power requirements are as follows:

(1) Radar equipment	2.3 kw. (operating) 350 w. (standby)
(2) Antenna control equipment	1.1 kw. (maximum) 200 w. (standby)
(3) Building lighting	1.4 kw.
(4) Floodlights	800 w.
(5) Motor—hoist	4.5 kw.
(6) Antenna house heater	1.0 kw.

b. When commercial power is used, a minimum of 15 kw. should be available. It is recommended that at least 20 kw. be available for good voltage regulation.

■ 17. UNITS AND WEIGHTS.—The Radio Set SCR-296-A includes the following:

Description	*Approximate weight in pounds*
2—House HO-1-A (power).	
1—House HO-2-A (radio).	
1—Tower TR-18-A (and antenna house).	
1—Antenna AN-70-A	415
1—Pedestal FT-336-A (antenna)	750
2—Power Units PE-84-C (each)	5000
1—Cabinet BE-82-A, which includes the built-in Duplexing Panel BD-106-A and the following units:	1375
1—Modulation Generator BC-720-A	155
1—Radio Receiver BC-716-A	120
1—Power Control Panel BD-108-A	135
1—Radio Transmitter BC-717-A	160
1—Rectifier RA-50-A (high voltage)	155
1—Oscilloscope BC-718-A (azimuth)	80
1—Oscilloscope BC-719-A (range)	145
1—Range Unit BC-723-A	70
1—Rectifier RA-49-A (regulated)	115
1—Indicator I-110-A (azimuth)	30
1—Motor-Amplidyne Generator MG-16-A	50
1—Control Unit RM-36-A	160

SECTION IV

MODE OF OPERATION

■ 18. BASIC ELEMENTS.—The basic elements of the SCR-296-A are shown in the functional diagram, figure 11. The transmitted energy is indicated by heavy solid lines while the received signals are indicated with dotted lines. The function of the remaining lines will be discussed in the ensuing explanation.

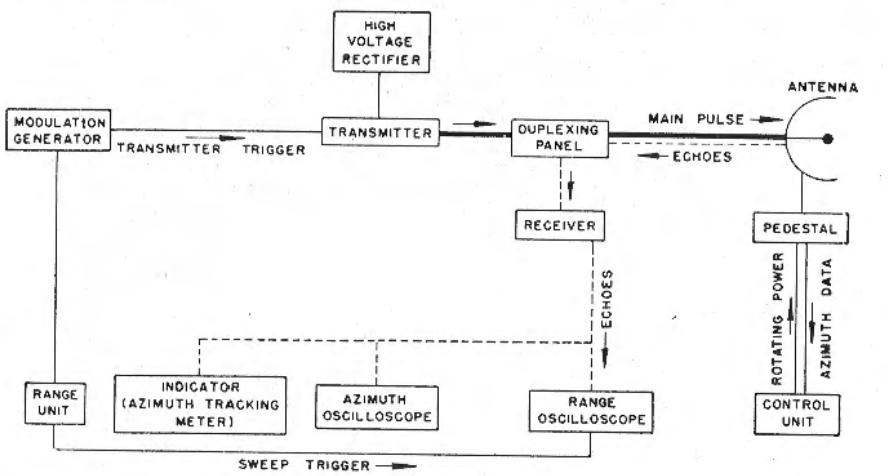


FIGURE 11.—SCR-296-A, functional diagram.

■ 19. TRANSMITTING.—A signal of a definite stable frequency originates in the modulation generator. The output of the modulation generator is fed to the transmitter, causing it to send out at regular intervals high-powered pulses of radio energy. The transmitter receives the required high voltage from the high-voltage rectifier. The pulses of radio energy are fed to the antenna for radiation via the duplexing panel. The duplexing panel makes possible transmitting and receiving with a single antenna. The time between pulses is such that a signal may go to the maximum range and an echo return before another pulse is sent out.

■ 20. RECEIVING.—The returning echoes are fed via the duplexing panel to the receiver, where they are detected, amplified, and fed to the range oscilloscope, the azimuth oscilloscope, and the azimuth tracking meter.

■ 21. TIMING.—A signal from the modulation generator, in phase (occurring at the same time) with the signal that triggers the transmitter, is fed to the range unit. In the range unit the phase relation of this signal to the transmitter pulse can be shifted through 360°. The output of the range unit is used to trigger the sweep line on the range oscilloscope. The phase relation is controlled so that any desired echo signal appearing on the range oscilloscope sweep line may be placed in the marker notch provided. The dials on the range unit are so calibrated that they indicate the range to the target which is proportional to the phase shift necessary to place the echo in the notch.

■ 22. AZIMUTH.—On the azimuth oscilloscope the only signals that appear are those in the notch on the range oscilloscope. The signals in the notch also affect the position of the pointer on the azimuth tracking meter. Two pips appear on the azimuth oscilloscope, one for each of the two lobes sent out from the antenna. The azimuth operator traverses the antenna by use of the azimuth control unit. When the two pips are matched for height, the true azimuth to the target is indicated on the dials on the control unit. An alternative method of tracking is by use of the azimuth tracking meter. If the meter has been adjusted correctly, the pointer is at the center of the dial when the antenna is directed at the target.

■ 23. LOBING.—To increase the accuracy of azimuth determination a principle known as lobing is used on the antenna. The lobing mechanism is located on the rear of the antenna assembly. Its function is to cause the beam from the antenna to be emitted in a direction slightly to one side of the perpendicular bisector of the antenna for a definite short period of time; then to shift the beam a similar distance to the other side of the antenna axis for a like period of time.

This period of time allows a number of pulses to be sent out. Also contained in the lobe-switching mechanism are the necessary cam-operated switches that separate the signals from the two lobes on the azimuth oscilloscope. It can be seen from figure 12 that when a target is to the

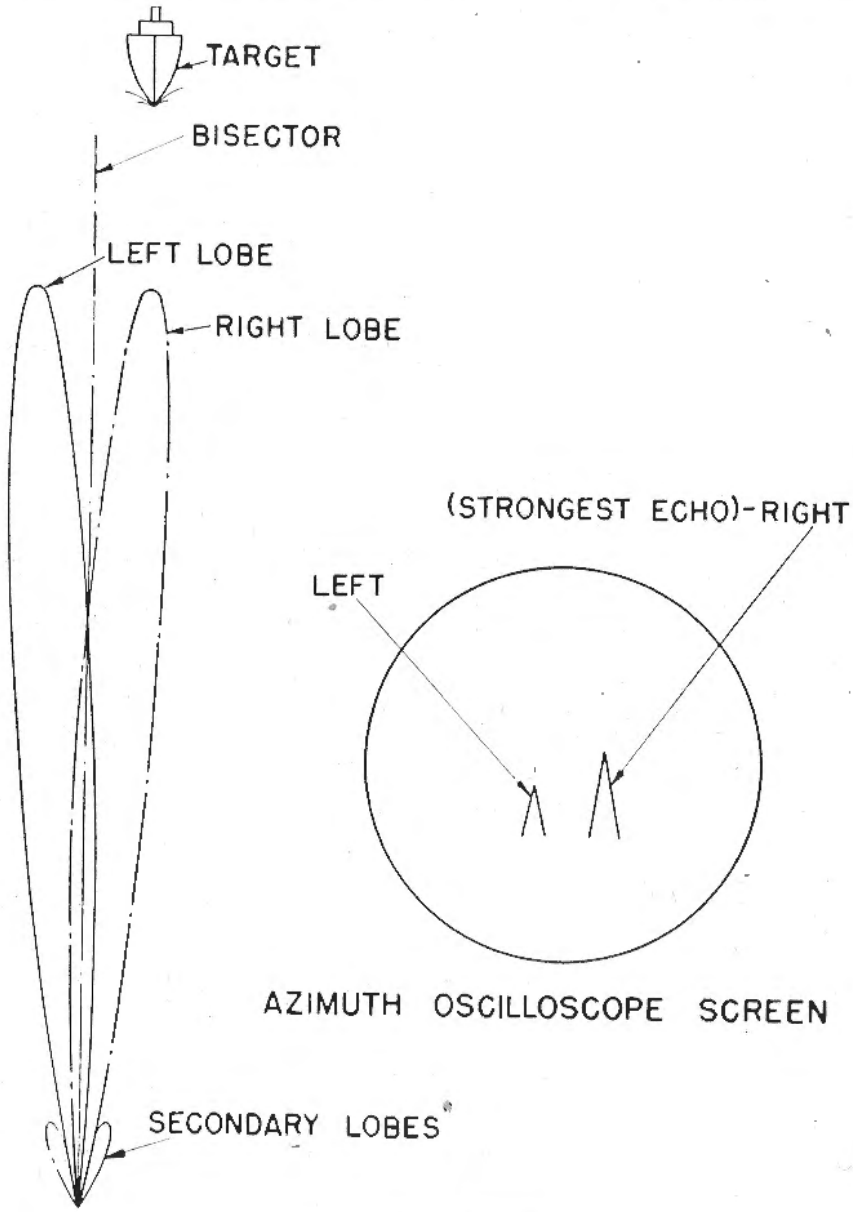


FIGURE 12.—Lobing.

right of the bisector of the angle between the two lobes, the signal returned from the right lobe will be the larger. When the target is to the left of the bisector, the signal returned from the left lobe will be the larger. When the target is exactly on the bisector, the signals returned to the set will be of equal amplitude for both lobes (see fig. 3). The right and left pips on the azimuth oscilloscope screen correspond to the returned signals, the amplitudes being proportional to the strength of the received signal.

SECTION V

DESCRIPTION AND FUNCTION OF COMPONENTS

■ 24. MAIN UNIT.—Located in the Cabinet BE-82-A are:

a. Modulation Generator BC-720-A.—This unit generates what is known as the recurrence frequency. This frequency is such that, during one cycle, time enough will have elapsed for echoes from the previous pulse to have returned from the extreme range of the set. One output from this unit triggers the transmitter on each cycle. Two other outputs, the fundamental and its eighteenth harmonic, are fed to the range unit, where they are used for timing and thus determining the range. Provisions are made for checking the frequency output of this unit against a standard (Calibrator BC-726-A). The frequency output of the modulation generator is variable over a small range and must be kept within one-fifth of a cycle of the standard for accurate range determination. PLATE CURRENT and PLATE VOLTAGE meters are provided for operational checks.

b. Radio Transmitter BC-717-A.—The radio transmitter produces the high-power radio pulse which goes by way of a coaxial transmission line to the antenna for radiation.

Power is supplied to the transmitter by the high-voltage rectifier. The voltage used in the transmitter is 12,000 volts. Located on the transmitter is the field control which controls the current through the transmitter tube. The transmitter tube is kept cool by a small blower located in the transmitter.

c. Rectifier RA-50-A.—The high-voltage rectifier is a full-wave, single-phase vacuum tube rectifier which changes the commercial or local power supply of 115 volts, alternating current, to 12,000 volts, direct current, for use in the transmitter. Safety interlocks and shorting devices are provided here, as in the transmitter, for protection when removing the units from the main cabinet.

d. Radio Receiver BC-716-A.—The radio receiver is a special superheterodyne type. It detects and amplifies the signal for use in the indicating equipment. A preamplifier to increase the received signal is to be supplied as soon as available. Access to various points in the circuit is provided at test jacks to aid in tuning and adjusting the receiver. The power supply for this unit is located within the unit itself. All tubes are shock-mounted and all wiring is well shielded to obtain a maximum signal-to-noise ratio. The gain of the receiver is controlled by either of two sensitivity controls: one is on the receiver itself, the other is on the range oscilloscope. Control is transferred from one control to the other by the REMOTE-LOCAL switch on the receiver.

e. Duplexing Panel BD-106-A.—Located on this panel, which is in the right front section of the main cabinet, are the necessary tuning and protective devices which make possible the use of one antenna for both transmission and reception. On this panel is provided a jack into which a patch cord from the test oscilloscope can be inserted for viewing the strength and shape of the transmitted pulse. The terminal strips for the interconnections between the main unit and indicating equipment and antenna are located on this panel (see fig. 13). Also mounted on this panel

are two time meters: one meter indicates the total time the set has been turned on, the second meter indicates the total time the plate voltage has been turned on.

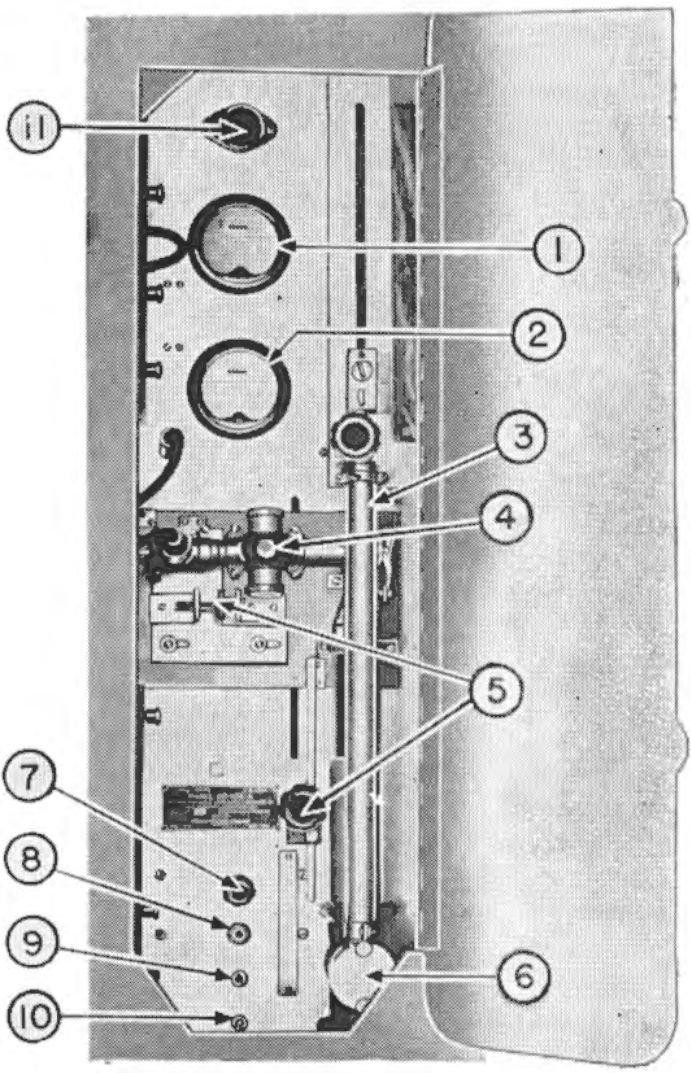


FIGURE 13.—Duplexing panel.

1. PLATE time meter.
2. TOTAL time meter.
3. Wave meter.
4. TR box.
5. Tuning knobs.
6. Monitor tube.
7. SWEEP PHASE control.
8. SWEEP jack.
9. MONITOR jack.
10. Monitor switch (ON—OFF).
11. Convenience outlet.

f. Power Control Panel BD-108-A.—The power control panel contains the fuses, switches, and variable auto-transformers for distributing and controlling the 115-volt alternating current power to all parts of the set. On the front of the panel are located the LOAD VOLTAGE, PLATE CURRENT, and PLATE VOLTAGE meters, the LOAD and PLATE voltage controls, and the RADIO SET—STANDBY HEATERS and PLATE switches. On the subpanel behind the door on the lower part of the panel are located disconnect switches and fuses for the various parts of the set (see fig. 14).

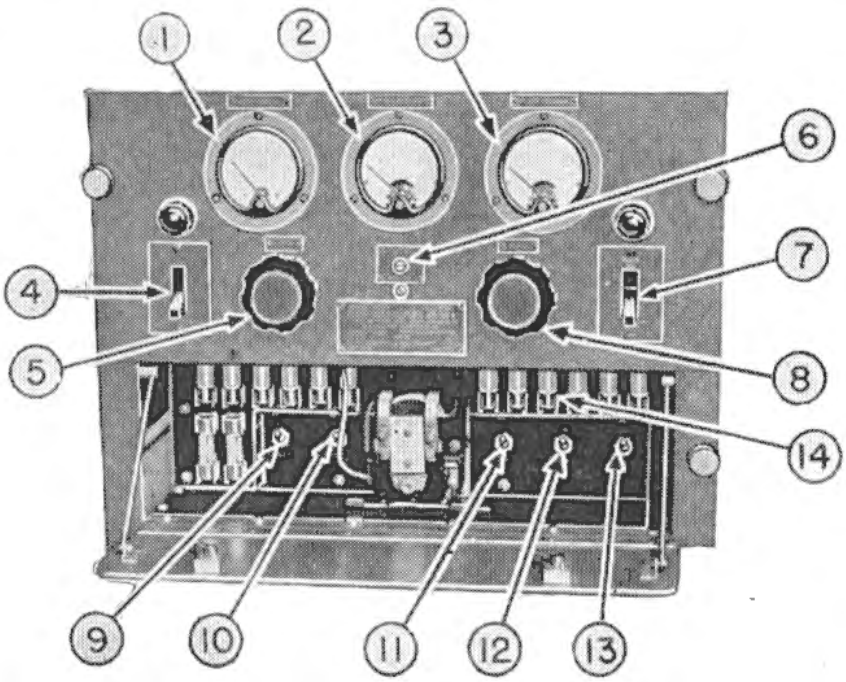


FIGURE 14.—Power Control Panel BD-108-A.

1. LOAD VOLTAGE meter.
2. PLATE CURRENT meter.
3. PLATE VOLTAGE meter.
4. RADIO SET—STANDBY HEATERS switch.
5. LOAD voltage control.
6. MAG FIL control.
7. PLATE switch.
8. PLATE control.
9. INDICating EQUIPment switch
10. RECEIVER switch.
11. MODulation GENerator switch
12. TRANSmitter switch.
13. MAG FIL switch.
14. Fuses.

■ 25. INDICATING EQUIPMENT.—The indicating equipment is located on a table provided in the operating room and consists of the following:

a. Range Unit BC-723-A.—Located on this unit is the range handwheel which turns the phase-shifting condensers and the range dials. The output of this unit controls the starting time of the sweep line on the range oscilloscope. Since the phase change introduced by the condensers is proportional to time, and time, in turn, is proportional to distance, the dials show the range to any target whose echo is placed in the marker notch on the range oscilloscope. A clutch, used in orientation, is provided on the range unit by means of which the range dials can be disconnected from the condensers.

NOTE.—An aided tracking attachment modifying the range unit will be provided when available. When modified by the addition of this attachment, tracking in range will be smooth and continuous. The controls will differ somewhat from those described in this manual. Full instructions will be furnished with the aided tracking kit.

b. Oscilloscope BC-719-A.—This is the range oscilloscope used by the range operator to track the target. This unit includes a 5-inch cathode-ray tube; its necessary power supply; focus, intensity, and positioning controls; and the circuits for producing the sweep, the notch, and radio signals. The output signals from the receiver appear on the sweep line as vertical deflections. The sweep line is triggered by the output from the range unit which is a signal that is synchronous with the transmitted pulses but variable in phase. The sweep line on the screen represents 100,000 yards of range, and the center section of this sweep line is magnified so that a 5,000-yard range can be made to include up to 4 inches of the sweep line. The IMAGE SPREAD control determines the physical length of this 5,000-yard section. In the center of the 5,000-yard section is a notch in which the range operator puts the echoes of the target to be tracked. The echoes move along the sweep line when the range handwheel is turned or when the range to the target changes. Two switches are located on the front of

the oscilloscope along with the control knobs. They are the transmitter switch which is used by the range operator to shut off the transmitter when ordered to do so for tactical reasons, and the LOBING switch which controls the lobing mechanism motor on the antenna.

c. Oscilloscope BC-718-A.—The azimuth oscilloscope indicates to the azimuth operator when the antenna is alined on the target or if not alined on the target, the direction in which it is off. This oscilloscope operates only during the interval corresponding to the voltage that forms the notch of the range oscilloscope. Thus, only the signals appearing in the notch of the range oscilloscope will be on the screen, and the operator sees only the echoes placed in the notch by the range operator. The height of the two pips on the screen indicates the relative strength of the right and left lobe echoes. By traversing the antenna to equalize the two pips, the antenna is accurately directed at the target. Controls are provided whereby the operator may choose the length of the restricted sweep and the spacing between the two patterns. The azimuth oscilloscope is similar to the range oscilloscope in construction. Control knobs for FOCUS, INTENSITY, SWEEP EXPANSION, and IMAGE SPACER; horizontal and vertical positioning controls; and the pilot light are on the front panel.

d. Indicator I-110-A.—The indicator (azimuth tracking meter) provides an alternative method of tracking in azimuth. This meter indicates the deviation of the antenna from the direction to the target, that is, LEFT or RIGHT. Actually it indicates the difference between the returned signal strengths of each lobe for the signal that is in the notch on the range oscilloscope. The indicator will give false indications if more than one echo is in the notch, or if another radar set is working in the vicinity; for this reason it must be used only in connection with the azimuth oscilloscope. A ZERO ADJust control is provided on the meter for orientation purposes.

e. Rectifier RA-49-A.—This full-wave rectifier provides a regulated 250-volt direct current supply for use throughout the indicating equipment. A meter is provided on the unit

for measuring the output voltage and the current in the various regulator tubes. The voltage is kept at 250 volts by use of the adjusting screw on the front panel.

f. Control Unit RM-36-A.—This is the antenna control unit. The traversing of the antenna is accomplished by either of two controls.

(1) *MANUAL.*—By turning this handwheel clockwise the antenna is traversed to the right; the antenna is traversed to the left by counterclockwise rotation.

(2) *RATE.*—This control makes possible the traversing of the antenna in either direction at various rates. This is an aid to smooth tracking and to rapid slewing of the antenna. Associated with the antenna control unit is a motor-amplidyne generator (see fig. 15), which receives the voltage set up by rotating the MANUAL or RATE controls, amplifies it, and causes the antenna to move an amount comparable to the movement of the control. Two dials are located on the panel of the control unit. These are on receiver selsyns, and the transmitters that drive these receivers are located in the antenna pedestal. The dial indicates the

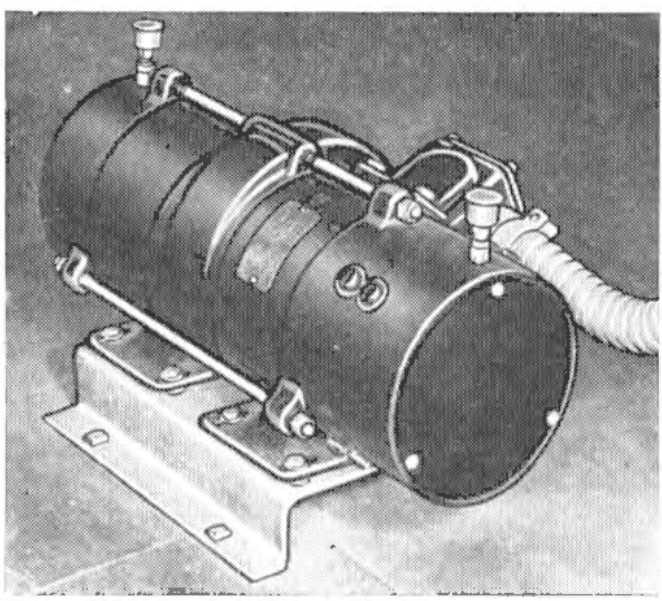


FIGURE 15.—Motor-Amplidyne Generator MG-16-A.

direction the antenna is pointing to the nearest 0.05°. By interpolation, closer readings are possible. The entire antenna traversing circuit, including the motor-amplidyne generator, is turned ON and OFF by the switch on the control unit.

NOTE.—An aided tracking attachment for the Control Unit RM-36-A will be provided when available. After the addition of this attachment, the tracking controls will differ somewhat from those described in this manual.

■ 26. COOLING BLOWER.—A blower and the necessary air ducts are provided to circulate air through the main unit and indicating equipment (see fig. 16). The air intake is through a filter. This filter should be kept clean so that sufficient air can get through to prevent overheating the set. A check should be made to insure that the blower is operating each time the set is turned on.

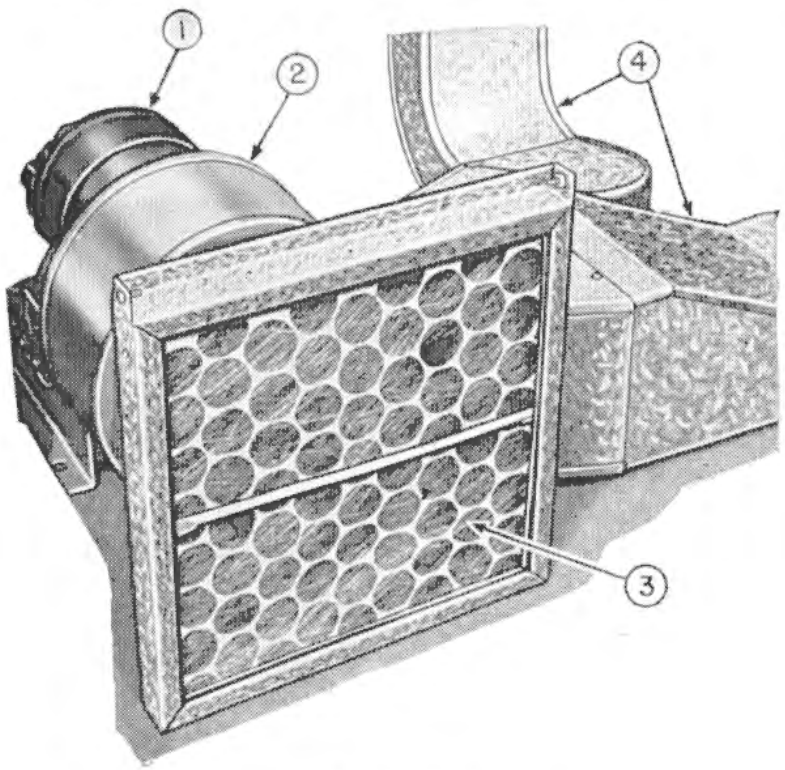


FIGURE 16.—Cooling blower.

1. Blower motor.
2. Blower.
3. Air filter.
4. Air ducts.

■ 27. STANDBY HEATERS.—Electric heating units are located throughout the set (see fig. 17). When the RADIO SET—STANDBY HEATERS switch is in the STANDBY HEATERS position, these heaters are on. They prevent dampness which would be injurious to the set. When the set is on, the heaters are automatically turned off. The heaters can be turned off without starting the set by opening the circuit at the power switchboard.

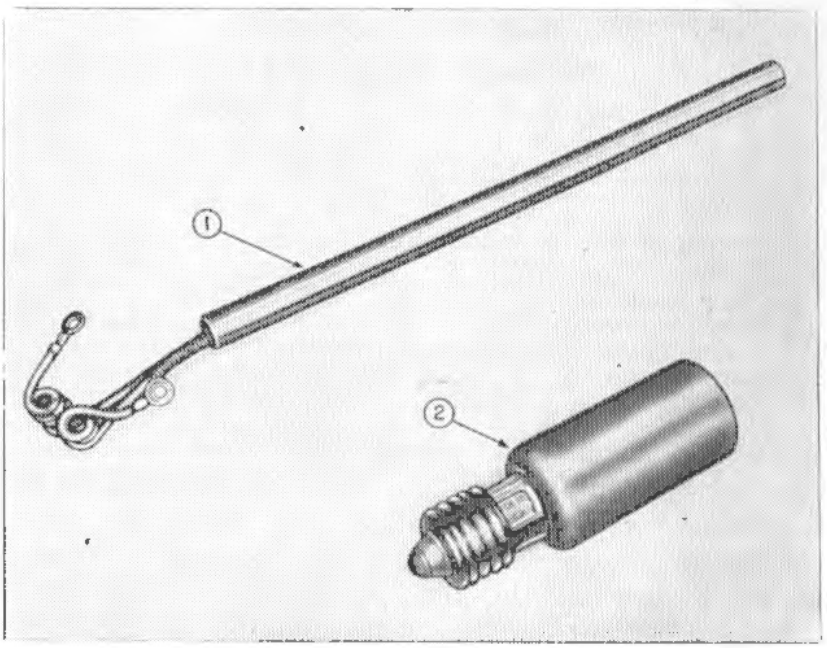


FIGURE 17.—Standby heaters.
1. Tubular type used in the indicating equipment.
2. Socket type used in the main unit, control unit, and antenna pedestal.

■ 28. TRANSMISSION LINE.—*a.* A coaxial transmission line (see fig. 18) of 1⅝-inch diameter connects the main unit to the antenna. A maximum of 250 feet is provided with each set. Nitrogen under a pressure of from 2 to 3 pounds is kept in the line to prevent condensation within the line. The same line is used for both transmitting and receiving. The necessary impedance matching to the transmitter and receiver is accomplished at the duplexing panel.

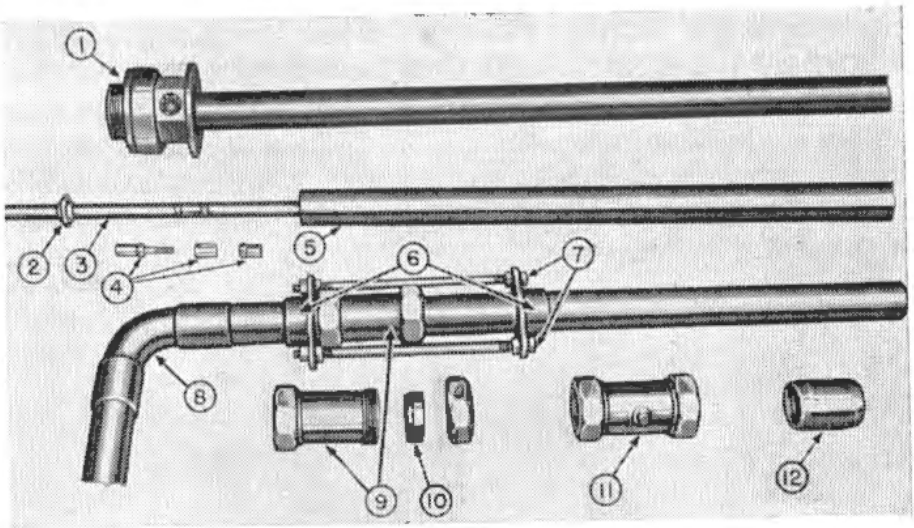


FIGURE 18.—Transmission line and couplings.

1. Rotary joint.
2. Insulator bead.
3. Inner conductor.
4. Inner conductor coupling.
5. Outer conductor.
6. Brackets.
7. Bolts.
8. 90° elbow.
9. Solderless coupling.
10. Synthetic rubber gasket.
11. Gas servicing coupling.
12. Streamline coupling.

b. An air compressor dehydrator, type 2000, kit No. A-96-A1, has been approved for issue to the field, replacing the nitrogen system. The dehydrator should be operated for a period not to exceed 48 hours when the set is first installed to dry out the line thoroughly. After the line has been dried out for the first time the unit should not be used again until there is an indication that moisture has condensed in the line. If there is moisture in the line the dehydrator should be operated until the line is dried out. Continuous operation of this unit may increase rather than decrease the amount of moisture in the line. During the time the unit is operated a dipole plug should be removed at the antenna.

■ 29. INTERLOCK SWITCHES.—Arrangement is made so that power is shut off to the indicating equipment if the cover of any unit is removed. No one but the maintenance man should close these safety switches with the covers off, and

he should do this only when it is necessary for trouble shooting or servicing. One of these interlock switches is shown in figure 19.

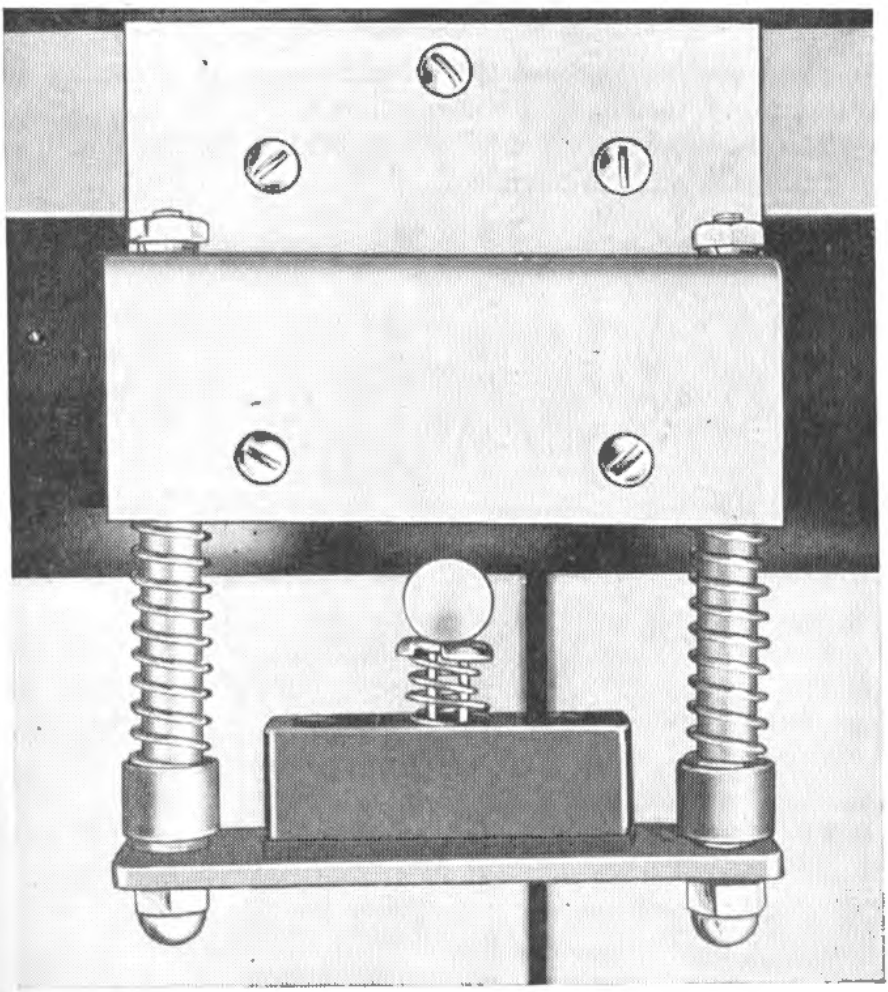


FIGURE 19.—Interlock switch.

■ 30. TESTING EQUIPMENT.—The following testing equipment is furnished, either with each set or to each harbor defense, for servicing the SCR-296-A:

a. Range Calibrator BC-725-A.—Due to tolerances which must be permitted in the manufacture of the range measuring equipment, each range unit may introduce an error in

the measurement of range which varies with the range to the target. The Range Calibrator BC-725-A will be available in each locality where an SCR-296-A is used for determining the value of this error at all ranges. A calibration curve for each range unit at each set may be prepared from these data.

b. Test oscilloscope.—A test oscilloscope is provided for use in tuning, testing, and maintenance.

c. Meters.—Several meters are provided for tuning, testing, and maintenance purposes.

CHAPTER 2

INSTALLATION

SECTION I

LOCATION

■ 31. LOCATION OF THE ANTENNA.—Since the theory of radar involves the reflection of electromagnetic radiation from some reflecting object, and since any solid object, especially metal, is a reflector to a certain degree, it is important, as far as possible, to locate the SCR-296-A antenna so that the beam in tracking normal targets avoids striking tall buildings, towers, water tanks, or hills to prevent unwanted reflections from these objects. Ultrahigh-frequency electromagnetic energy leaving the transmitting antenna is reflected from the target. Although sent out in a narrow concentrated beam, the energy comes back in a widely scattered or diffused beam. Part of the returning or reflected energy may be again reflected from a building or a tower located close to the beam of the antenna. Since the receiving antenna also picks up energy in a narrow solid sector or angle, the receiving antenna in picking up the signal may point falsely in a direction between that of the second reflecting object and that of the target. If it is necessary that the antenna be located with obstructions in the beam, corrections may be applied to compensate for this type of error, but it is the best practice to locate an SCR-296-A antenna so that no large reflecting objects come within 8 to 10 degrees of the

extreme flank limits of the field of fire in which an SCR-296-A will normally operate. Obviously, the more open the selected spot, the less chance there will be for this type of interference. Clearance of from 8 to 10 degrees is desirable below the beam of the antenna.

A second consideration is the matter of range obtainable with height of the antenna above sea level. Because the earth is curved, visual range is limited by the distance to the horizon. However, the visual range can be increased by going to a higher altitude. Radar behaves similarly. Therefore, one way to increase the range of an SCR-296-A is to increase the height of the antenna above sea level. As stated previously, a steel tower is supplied with each set. The tower may be ordered in 25-, 50-, 75-, or 100-foot heights depending on terrain conditions. A height of 100 feet above sea level is the minimum recommended for the SCR-296-A antenna. Increasing the height above 100 feet increases the range obtainable. Experience indicates that from 150 feet to 500 feet is a satisfactory height of site, since with such heights above sea level, the dependable range of the units is usually sufficiently great to permit fire control at the maximum range of large caliber guns.

■ 32. LOCATION OF RADIO HOUSE HO-2-A.—The location of the radio house is limited by the fact that 175 feet is the maximum allowable distance between the main unit and the antenna. Depending on the height of tower used, this distance laterally can vary from 75 to 150 feet. It is desirable to keep this distance at a minimum, although close grouping is not advisable as one bomb might then knock out the two units. Location to take advantage of natural camouflage is recommended. Suitable existing structures may be used if the correct principles of siting are not violated.

■ 33. LOCATION OF POWER UNITS.—The power units should be located within a radius of 150 feet from the main unit to keep the line losses to a minimum. The two units should be separated from each other by at least 50 feet to prevent one bomb or shell from destroying both units. The 1,000-gallon gasoline tanks should be buried in the ground at some distance from the other structures (see fig. 20).

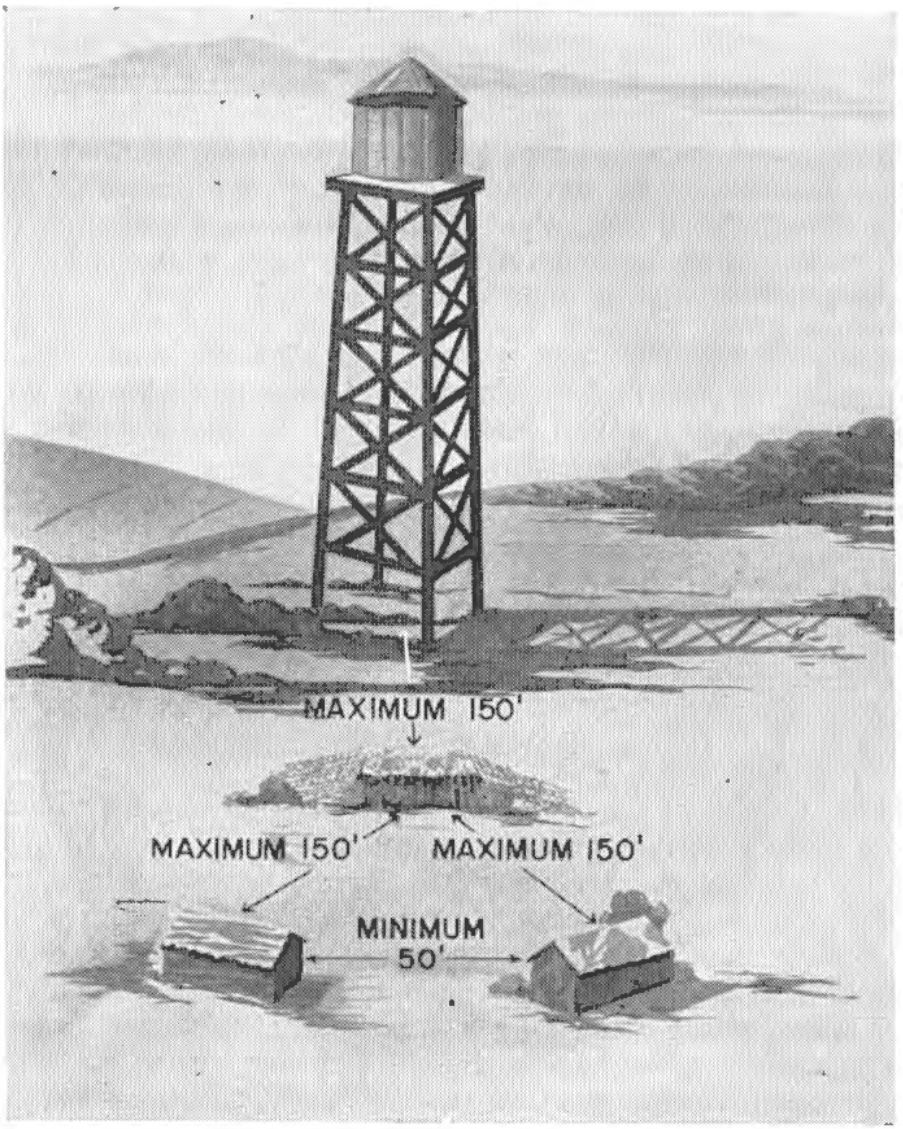


FIGURE 20.—Recommended location of components.

SECTION II

SETTING UP THE SET

■ 34. ERECTION.—The erection of the tower and houses and the installation of the radar equipment are accomplished by Signal Corps personnel. Upon completion the equipment is turned over to Coast Artillery personnel who operate it and perform routine maintenance.

■ 35. INITIAL OPERATION.—When the SCR-296-A is turned over to the assigned battery it is in working order. It has been thoroughly tuned and tested by the installation mechanics.

SECTION III

ADJUSTMENTS

■ 36. GENERAL.—The maintenance personnel assigned to the set will normally tune and adjust the set twice daily for highest efficiency. They are also charged with keeping a log on maintenance and making complete periodic checks on all components of the set. The maintenance sergeant may delegate certain duties of the daily adjustment to competent members of the operating personnel. Since most checks and adjustments are made as the set is being turned on, only those adjustments that are not accomplished then will be mentioned here.

■ 37. THE OSCILLOSCOPES.—*a.* The location of the images on either of the oscilloscopes may be changed by adjustment of two controls on both oscilloscopes. These controls must be adjusted with a screw driver. The one marked HOR

locates the image horizontally, and the one marked VERT locates the image vertically.

b. On the lower front corner of the left side of the azimuth oscilloscope is a screw-driver adjustment that controls the height of the signal on the azimuth oscilloscope in relation to that on the range oscilloscope. This adjustment is set so that when the range operator has his most desirable height of signal, the azimuth operator has pips that are easily matched in height.

■ 38. REGULATED RECTIFIER.—The output of the regulated rectifier should be kept at 250 volts. A meter is provided for measuring the voltage. With the meter switch on VOLTS, the indication is read on the lower scale. In addition to reading the output voltage, a check on the current in each of the six regulator tubes may be made by turning the meter switch to the additional six positions in turn. An adjustment in the voltage is made with a screw driver in the screw marked VOLTAGE ADJUST. The current readings are provided as an aid in locating trouble.

■ 39. ADJUSTMENT OF ANTENNA CONTROL SYSTEM (ANTIHUNT). With the CONTROL switch on the Control Unit RM-36-A in the ON position, the motor generator should be operating. If at any time the antenna should fail to halt smoothly when the MANUAL or RATE controls are stopped, adjustment of the antihunt will probably correct the fault. This adjustment should be accomplished by a qualified maintenance man.

CHAPTER 3

OPERATION

SECTION I

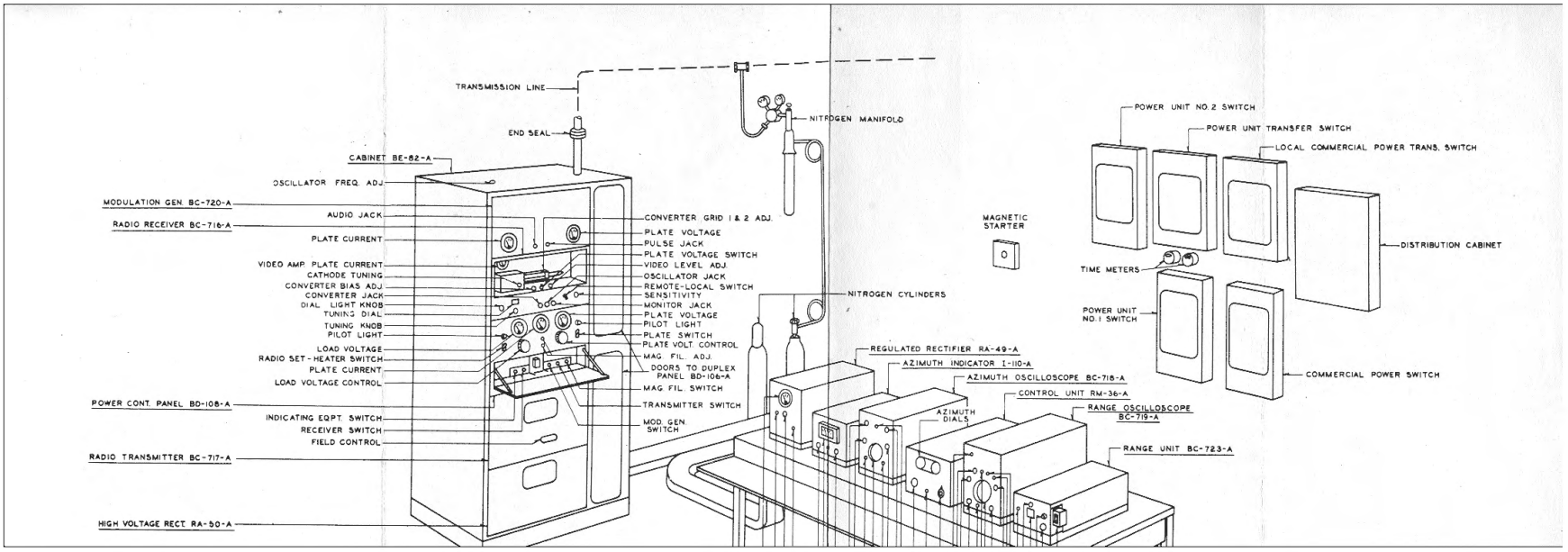
TURNING ON THE SET

■ 40. POWER SWITCHBOARD.—In order to turn on the set the proper switches on the power switchboard must be closed. The arrangement depends on the power source to be used, whether commercial power, power unit No. 1, or power unit No. 2. Closing the proper switches supplies power to the equipment and turns on the standby heaters. Normally the power is not turned off at the power switchboard, as it is desirable to have the standby heaters on whenever the set is off to keep the set dry and to maintain approximately the proper operating temperature.

■ 41. OPERATIONS.—The following operations are then performed (see fig. 21 for location of controls):

a. Cabinet BE-82-A.

Control	*Result of adjustment*
(1) RADIO SET—STAND-BY HEATERS switch to RADIO SET ON.	Transmitter blower and external blowers operate; heaters are off. Pilot light above switch is on.
(2) LOAD control	Adjust this control for LOAD VOLTAGE of 115 volts. The meter must read 115 volts at all times.
(3) MOD GEN switch ON.	About 1 minute after the switch is operated, modulation generator PLATE CUR-


TRANSMISSION LINE
END SEAL
CABINET BE-82-A
OSCILLATOR FREQ. ADJ.
MODULATION GEN. BC-720-A
AUDIO JACK
RADIO RECEIVER BC-716-A
PLATE CURRENT
VIDEO AMP. PLATE CURRENT
CATHODE TUNING
CONVERTER BIAS ADJ.
CONVERTER JACK
DIAL LIGHT KNOB
TUNING DIAL
TUNING KNOB
PILOT LIGHT
LOAD VOLTAGE
RADIO SET-HEATER SWITCH
PLATE CURRENT
LOAD VOLTAGE CONTROL
POWER CONT. PANEL BD-108-A
INDICATING EQPT. SWITCH
RECEIVER SWITCH
FIELD CONTROL
RADIO TRANSMITTER BC-717-A
HIGH VOLTAGE RECT. RA-50-A
CONVERTER GRID 1 & 2 ADJ.
PLATE VOLTAGE
PULSE JACK
PLATE VOLTAGE SWITCH
VIDEO LEVEL ADJ.
OSCILLATOR JACK
REMOTE-LOCAL SWITCH
SENSITIVITY
MONITOR JACK
PLATE VOLTAGE
PILOT LIGHT
PLATE SWITCH
PLATE VOLT. CONTROL
MAG. FIL. ADJ.
DOORS TO DUPLEX PANEL BD-106-A
MAG. FIL. SWITCH
TRANSMITTER SWITCH
MOD. GEN. SWITCH
NITROGEN MANIFOLD
NITROGEN CYLINDERS
MAGNETIC STARTER
POWER UNIT NO. 2 SWITCH
POWER UNIT TRANSFER SWITCH
LOCAL COMMERCIAL POWER TRANS. SWITCH
DISTRIBUTION CABINET
TIME METERS
POWER UNIT NO. 1 SWITCH
COMMERCIAL POWER SWITCH
REGULATED RECTIFIER RA-49-A
AZIMUTH INDICATOR I-110-A
AZIMUTH OSCILLOSCOPE BC-718-A
CONTROL UNIT RM-36-A
RANGE OSCILLOSCOPE BC-719-A
AZIMUTH DIALS
RANGE UNIT BC-723-A

Control	*Result of adjustment*
	RENT rises to 125–200 milliamperes. PLATE VOLTAGE reads 525–600 volts. The modulation frequency tone is audible at the cabinet.
(4) TRANS switch ON...	This applies power to the transmitter filament circuit and transmitter tube field supply.
(5) MAG FIL switch ON.	This applies power to the filament of the transmitter tube. The filament voltage appears on a meter seen through the screen on the transmitter cabinet and is adjusted to 13.5 volts by means of the MAG FIL adjustment on the Power Control Panel BD–108–A.
(6) INDIC EQUIP switch ON.	This applies power to the indicating equipment. Meter on regulated rectifier should indicate 250 volts with TEST METER switch in VOLTS position. All pilot lamps and dial lights on indicating equipment should be illuminated. After a short warm-up period, sweeps should appear on both azimuth and range oscilloscopes. The sweep on the azimuth oscilloscope will not be normal unless the LOBING switch is ON.
(7) PLATE switch ON...	This applies power to the high voltage rectifier. The TRANSMITTER switch on the range oscilloscope must also be ON.

Control	*Result of adjustment*
	The pilot light above the PLATE switch is now illuminated.
(8) PLATE control	One minute after PLATE switch is turned ON, turn the control counterclockwise to the stop. The relay in the power control panel should operate. Turn control clockwise until the PLATE VOLTAGE is 12,000 volts, watching PLATE CURRENT meter carefully. The PLATE CURRENT must not exceed 34 milliamperes. The current will normally be between 25 and 30 milliamperes.
(9) FIELD CONTROL ...	Adjust for PLATE CURRENT of 25 to 30 milliamperes.
(10) RECEIVER switch ON.	This applies power to the radio receiver. The meter in the receiver should indicate about 12.5 milliamperes when the tubes have warmed up. The PLATE VOLTAGE switch on the horizontal panel of the receiver must be on. Noise should appear on the oscilloscopes with the receiver SENSITIVITY control near maximum.
(11) REMOTE - LOCAL switch.	With switch in LOCAL position, the receiver gain is controlled by the SENSITIVITY control on the receiver. In the REMOTE position, receiver gain is controlled by the receiver

Control	*Result of adjustment*
	SENSITIVITY control on the range oscilloscope. Both controls should be checked for appearance of noise on the oscilloscopes.
b. Indicating equipment.	
(1) VOLTAGE ADJ control.	With TEST METER switch in VOLTS position, adjust this control for voltage of 250 volts. The lower of the two voltage scales on the meter is used.
(2) FOCUS and INTENSITY controls.	Adjust these controls for clear, sharp traces on both of the oscilloscope screens.
(3) HOR and VERT controls.	Adjust these controls until the sweeps of both oscilloscopes are centered horizontally and are set slightly below the center of the screens.
(4) SWEEP GAIN control.	Adjust this control so that the sweep line on the range oscilloscope is about 4 inches long.
(5) IMAGE SPREAD control.	Adjust this control for expansion of marker notch on range scope sweep line as desired. The normal setting is for a notch of approximately ¼-inch width.
(6) Receiver SENSITIVITY control.	Adjust this control for amplitude of signals on the range oscilloscope. When tracking, the amplitude of the signal in the notch determines the proper control setting. The signal in the notch should be between ¾ inch and 1 inch in height.

Control	*Result of adjustment*
(7) TRANSMITTER switch ON.	This turns on the high voltage supply for the transmitter. Both the PLATE switch on the power control panel and this switch must be ON. When the set is to be taken off the air temporarily for tactical purposes, this switch is used.
(8) CONTROL switch ON.	This switch, located on the Control Unit RM-36-A, applies power to the antenna traversing circuits. After a warm-up period of about 1 minute the RATE knob and MANUAL handwheel should be rotated individually in both directions. If the system is operating properly the azimuth dials will so indicate. This switch also turns off certain heaters.
(9) LOBING switch ON..	Power is supplied to the lobe-switching motor on the antenna. Two sweep lines should now appear on the azimuth oscilloscope. Operation of the IMAGE SPACER control regulates the distance between the two images.
(10) Range handwheel....	This handwheel, located on the range unit, moves the echoes along the base line, allowing the placing of the desired echo in the notch. This is the control used to track in range.

Control	*Result of adjustment*
(11) ZERO ADJ	This clutch on the range unit is used in orienting the set in range. This allows the turning of the dials without moving the signals on the sweep line.
(12) SWEEP EXPANSION control.	Adjust this control for the desired length of sweep on the azimuth oscilloscope. A short sweep (narrow pips) normally results in more accurate tracking. When an interfering signal is present a wider sweep may facilitate tracking through the interference.
(13) IMAGE SPACER control.	Adjust the control for desired spacing of the two images on the azimuth oscilloscope. This varies with different operators. Normally, the closer the two pips are to each other the easier it is to match them in height.
(14) ZERO ADJ control...	There is a mechanical centering adjustment screw on the meter of the Indicator I-110-A, by means of which the meter needle must be set at the center index prior to making the zero adjustment. This is done with the set off. Adjust the ZERO ADJ control to bring the needle to the center index. While this adjustment is being made, the receiver SENSITIVITY control is turned to minimum.

SECTION II

DETERMINATION OF RANGE

■ 42. GENERAL.—The range unit and range oscilloscope are used in the determination of range. When the approximate range and azimuth of the target are given, the range operator turns the range handwheel until the range reader indicates that he is at the approximate range. If the azimuth operator is on or near the target in azimuth, the target echo should appear near the center of the sweep line.

■ 43. CENTERING IN THE NOTCH.—The range handwheel is rotated until the desired echo is centered in the notch. The receiver SENSITIVITY should be adjusted so that the echo is between ¾ inch and 1 inch in height. Care should be taken not to run the SENSITIVITY to the point where the signal reaches saturation (maximum height), as then the azimuth operator cannot properly match the pips for determination of azimuth. The IMAGE SPREAD control may be adjusted to regulate the size of the notch. The notch should be narrow while searching and ¼ to ⅜ inch wide when tracking.

■ 44. READING THE DIALS.—*a.* When tracking a target and furnishing data to a plotting room, the range reader, on the last of each series of time interval bells, reads the dials on the range unit. There are three dials on the range unit (see fig. 22), reading from left to right: the first dial turns once in every 100,000 yards and is numbered from 0 to 10; the center dial turns once every 10,000 yards and is numbered 0,000 to 10,000; the dial on the right turns once every 1,000 yards and reads 000 to 1,000. Each 100 yards is divided into five intervals, each representing 20 yards. By interpolation, the dials can be read to the nearest 5 yards or less, depending on the ability of the reader. The readings are called over a telephone to the plotter in the plotting room.

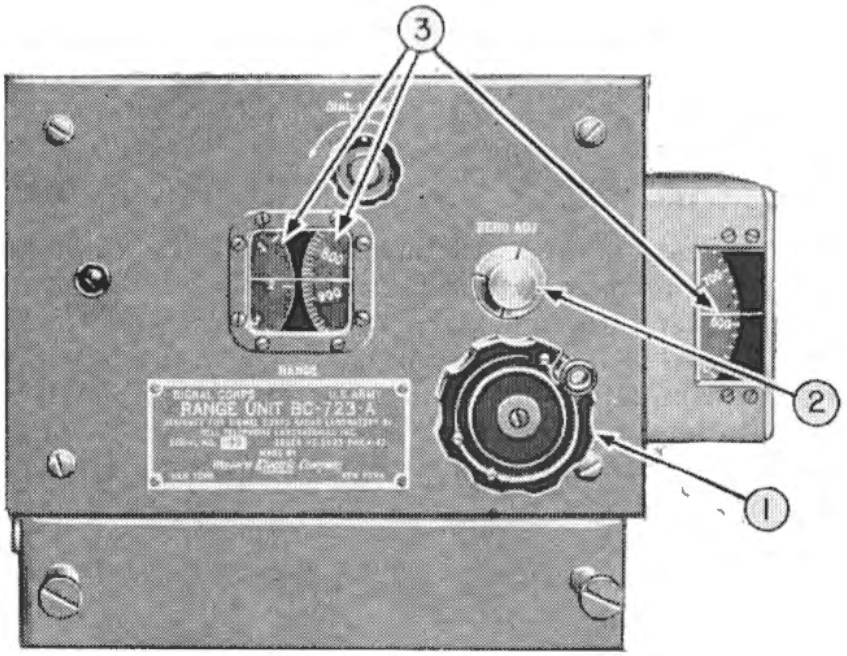


FIGURE 22.—Range unit (reading 18,620 yards).
1. Range handwheel. 2. ZERO ADJustment. 3. RANGE dials.

b. Provision is made in the range unit for the application of a data transmission system. This will be used when the data are to be furnished to a gun data computer. A push button located on the hub of the range handwheel may be used for signaling if desired.

■ 45. SMOOTH TRACKING.—Care should be taken to keep the pip accurately centered in the notch at all times. This requires a continuous slow turning of the handwheel in the case of moving targets. When data are being telephoned to the plotting room, the range operator should stop tracking on the reading bell long enough to permit the reader to read the dials accurately. When the range unit is modified by the addition of the aided tracking attachment, tracking should be smooth and continuous at all times. If it is then necessary to telephone data, readings must be taken while the dials are in motion.

SECTION III

DETERMINATION OF AZIMUTH

■ 46. GENERAL.—Three instruments are at the disposal of the azimuth operator: the azimuth control unit, the azimuth oscilloscope, and the indicator. The oscilloscope and/or indicator are used to indicate the deviation from the target, and the control unit is used to traverse the antenna and indicate the direction in which it is pointed. When the adjustments outlined in section I have been accomplished and a target has been assigned, the azimuth operator, guided by the reader, traverses the antenna to the approximate azimuth. He may use the MANUAL or RATE control. When the range operator has placed the echo in the notch, pips will appear on the sweep lines of the azimuth oscilloscope.

■ 47. MATCHING PIPS.—The azimuth operator matches the two pips on the azimuth oscilloscope screen in height by use of the MANUAL or RATE control. If the pip on the right is larger, the control is turned to the right (clockwise); if the pip on the left is larger, the control is turned left (counterclockwise). When the two pips are exactly matched in height the antenna is pointing directly at the target (see fig. 3). The IMAGE SPACER and SWEEP EXPANSION controls should be adjusted by the operator so that he has images of such size and shape as to permit him to match their heights easily.

■ 48. INDICATOR (AZIMUTH TRACKING METER).—The indicator (azimuth tracking meter) may be used in conjunction with the azimuth oscilloscope to tell when the pips are matched. The needle on the tracking meter will fluctuate equally on each side of zero when the pips are matched. The meter cannot be used when interference from other targets or other radar sets is present.

■ 49. AZIMUTH READING.—On the last bell of each group of time interval bells the azimuth reader reads the azimuth. The azimuth is indicated on 2 dials on the front panel of the control unit (see fig. 23). The full faces of both dials show, and the index is located between the 2 dials. The left dial makes 1 revolution for each 360° traverse of the antenna, and the right dial revolves once for every 10° of traverse. Each degree on the 10° dial is divided into 20 sections, making possible the reading of azimuth to the nearest 0.05°. By interpolation, closer readings can be made. The azimuth reader's telephone is connected to that of the arm setter in the plotting room. For the continuous transmission of azimuth to a gun data computer, a suitable data transmission system will be provided.

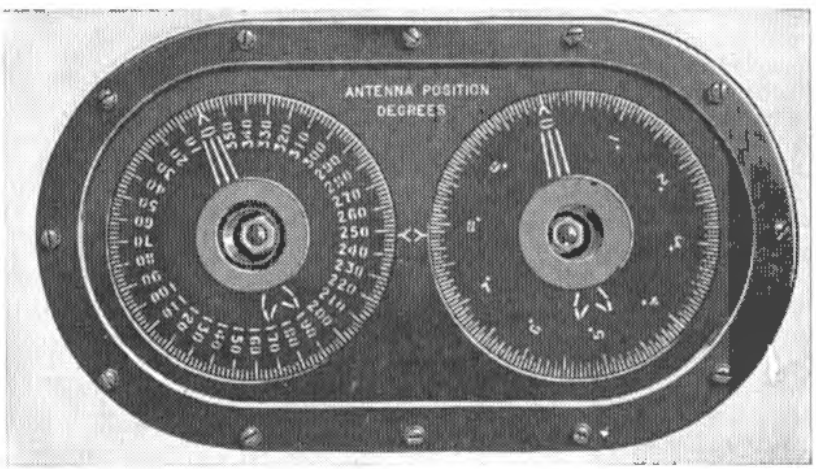


FIGURE 23.—Azimuth dials on control unit. Correct reading 247.85°.

■ 50. SMOOTH TRACKING.—The RATE control is a great aid to smooth tracking in azimuth. Where the angular change of the target is constant or nearly so, the RATE control can be adjusted to keep the pips matched. The MANUAL control may be used in conjunction with the RATE control, giving an additive or subtractive effect when turned with or against the rate. When the Control Unit RM-36-A is modified by the addition of an aided tracking attachment, smooth and continuous tracking will be accomplished by the manipulation of a single control.

CHAPTER 4

ORIENTATION

SECTION I

GENERAL

■ 51. GENERAL.—Although the SCR-296-A is inherently capable of furnishing accurate fire control data, the accuracy actually achieved is dependent to a large degree on careful orientation. The set must be oriented as accurately as possible with the facilities available before adequate data can be furnished to the plotting board or computer. Accurate orientation can be accomplished only by careful control of the recurrence frequency and by the application of appropriate corrections to range data as read on the Range Unit BC-723-A. Control of the recurrence frequency and calibration of the range unit are discussed in succeeding paragraphs. Checks of the accuracy of orientation should be made by the operating personnel each time the set has warmed up after being turned on and every 2 hours during operation. Orientation should be entrusted only to experienced personnel.

■ 52. CALIBRATION OF RANGE UNIT.—The calibration of each range unit is accomplished by the use of the Range Calibrator BC-725-A. From the calibration curves determined in advance, corrections should be applied to the known ranges of orienting points.

■ 53. CHECKING RECURRENCE FREQUENCY.—The checking of the recurrence frequency consists of comparing the output of the modulation generator with that of the Calibrator BC-726-A, which generates an accurate standard signal. The comparison is made by using the test oscilloscope. (See fig. 24.) Prospective minor modification of this set will permit the use of the Calibrator BC-726-A directly to control the recurrence frequency, thus eliminating the need for this check.

■ 54. CONNECTING THE TEST OSCILLOSCOPE.—The two patch cords provided with the equipment are connected to the test oscilloscope: one to the horizontal plates, and one to the vertical plates. The spades marked "T" are connected to the terminals marked "HIGH" and the spades marked "S" to the terminals marked "O." One cord plug is plugged in the AUDIO jack on the modulation generator; the other in the OUTPUT jack of the calibrator. The calibrator and oscilloscope are turned on. Both amplifiers on the oscilloscope are turned on and the GAIN controls adjusted until a figure of a readable size is obtained. A clear, sharp figure is obtained by adjusting the INTENSITY and FOCUS controls on the test oscilloscope.

■ 55. ADJUSTING THE RECURRENCE FREQUENCY.—The recurrence frequency is as desired if a stationary figure, or one that goes through one cycle in not less than 5 seconds, appears on the screen. (See fig. 25.) If the figure goes through one cycle in less than 5 seconds an adjustment is required. Located on top of the main unit is a hole through which a screw driver can be inserted to turn the adjustment screw which regulates the recurrence frequency. A figure as near stationary as possible is obtained on the test oscilloscope screen.

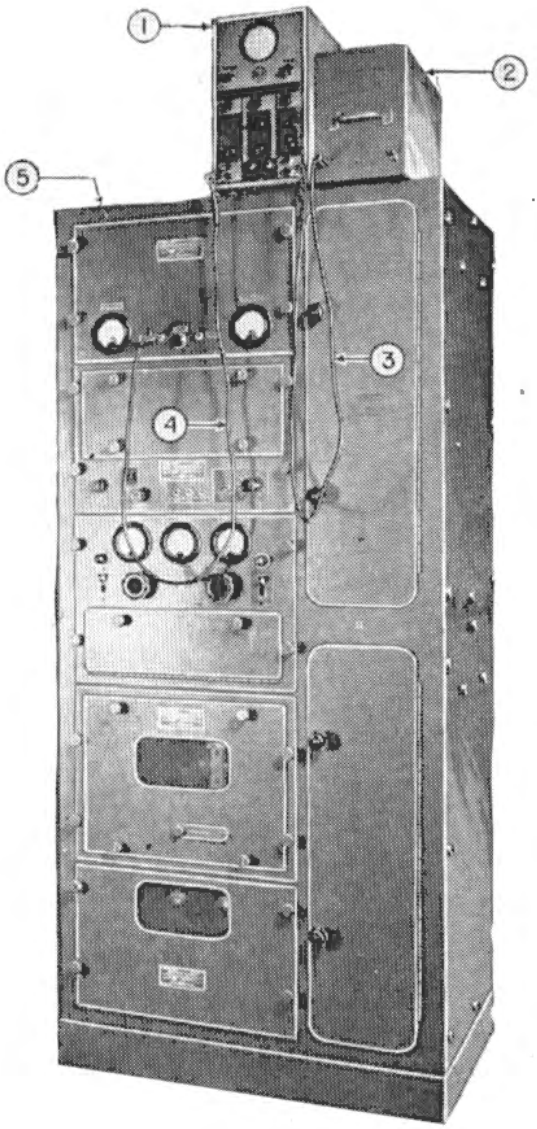


FIGURE 24.—Checking recurrence frequency.

1. Test oscilloscope.
2. Calibrator BC-726-A.
3. Patch cord connected to OUTPUT jack on calibrator.
4. Patch cord connected to AUDIO jack on modulation generator.
5. Hole in top for access to frequency adjustment.

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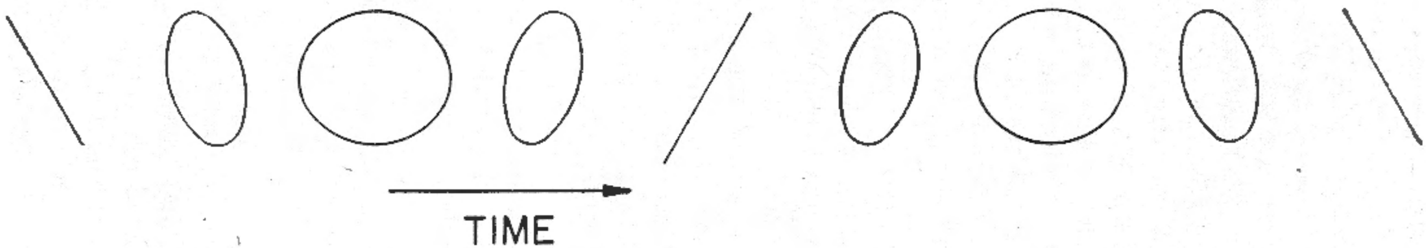

FIGURE 25.—One cycle, as viewed on test oscilloscope.

■ 56. ORIENTING POINTS.—Suitable orienting points within the range of the set should be surveyed accurately and the range and azimuth from the SCR-296-A should be computed. These orienting points should be stationary objects that return perceptible echoes to the set. In general, these orienting points will be found to be constructed of metal, to be high above the ground or surface of the water, and to have no large reflecting object nearby within the width of the antenna beam. When no suitable orienting points are found in the vicinity, it may be necessary to erect suitable reflecting targets such as corner reflectors at ranges and azimuths which permit adequate orientation, such as a right trihedral corner reflector made of small mesh wire, at ranges and azimuths which permit adequate orientation. (See fig. 26.)

■ 57. CHECKING ORIENTATION.—Each time the set is turned on, and every 2 hours during operation, the operators should take readings on at least two orienting points with the range and azimuth dials completely covered during the centering of the range pip and the matching of the azimuth pips. The dials should be uncovered for reading only after all manipulation of the controls has ceased. Ten readings should be taken on each orienting point, five approaching from one direction and five approaching from the other direction. If, after the set is warmed up, the averages of these readings differ from the correct orientation data by more than 0.05° or 10 yards, qualified personnel will reorient the set. Adequate precautions should be taken to insure that the recurrence frequency is accurately set prior to orientation of the range unit. Range readings should be corrected in accordance with the calibration curves of the particular range unit in use.

■ 58. ORIENTATION RECORDS.—Records should be kept of all readings on orienting points. These readings should be made under carefully controlled conditions and any adjustment of the ZERO ADJ control or changes in the azimuth dials should be recorded, stating exactly what range and azimuth corrections were made. After sufficient data are accumulated, the orienting point or points showing average readings

closest to the true orientation data should be chosen for use during subsequent orientation operations. From this time on, range and azimuth adjustments should be made only on the basis of readings on one or more of these points. Every opportunity should be taken to check the validity of orientation data by analysis of SCR-296-A data and horizontal base data on targets tracked simultaneously by the two systems.

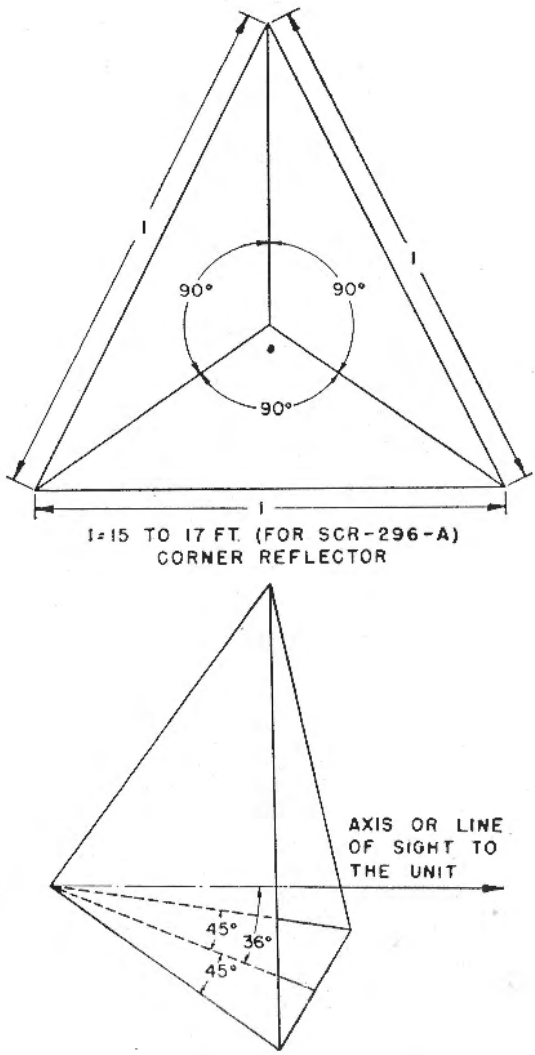

FIGURE 26.—Corner reflector design.

SECTION II

RANGE ORIENTATION

■ 59. ON A TARGET OF KNOWN RANGE.—A suitable reflecting object within the range of the SCR-296-A is chosen. This preferably should be the best of the available orienting points, determined as described in Section I above. If no suitable orienting point is available, a vessel the location of which has been calculated by optical methods may be used. The echo from a target of known range is centered in the marker notch 10 times by operation of the range handwheel. This centering is done 5 times from each direction. The range dials are covered during the centering of the echo and are uncovered only for reading the range while the range handwheel is stationary. The average of the 10 readings is computed and corrected for the error of the range unit at that particular range. The echo from the target of known range is centered in the marker notch by operation of the range handwheel. If the corrected average of the range readings does not correspond to the actual range, the ZERO ADJ clutch is loosened, disconnecting the range dials from the phase-shifting unit. The handwheel is rotated until the dials indicate the true range, noting that the echo is still centered in the notch. The ZERO ADJ clutch is tightened. The set is now oriented in range. It is a good practice to check on other known points at various ranges.

■ 60. ON THE TRANSMITTED PULSE.—Range orientation may occasionally be required when there is no target of known range available, or when it is considered desirable for purposes of security that the set should be silent in certain sectors. Under these conditions, the antenna may be traversed until the transmitted energy is emitted in a noncritical direction. The receiver SENSITIVITY is reduced until the main pulse, which is the only signal appearing on the range oscilloscope with receiver SENSITIVITY near

minimum, is sufficiently narrow to be contained in the notch. The handwheel is rotated until the left edge of this signal is in line with the left edge of the notch. The ZERO ADJ clutch is loosened and the range dials are set to indicate the range of the main pulse. The clutch is then tightened. The range of the main pulse varies slightly with different sets and is determined as follows: after orientation in range on a target of known range, the main pulse is positioned in the notch as noted previously and the range is read from the dials and recorded. This method may be used only when the set has been oriented previously on a known target.

SECTION III

AZIMUTH ORIENTATION

■ 61. TARGET.—For orientation in azimuth an isolated target of known azimuth is necessary. The range of the target must be sufficiently great that the main pulse does not appear in the notch and at such azimuth and range that no echo other than that from the orienting target appears in the notch on the range oscilloscope. If no suitable orienting point determined as described in section I above is available, a vessel whose azimuth is determined by optical methods may be used. The orienting echo is centered in the range notch, and the pip heights on the azimuth oscilloscope are matched by means of the azimuth handwheel. The centering should be checked on the indicator meter. This operation should be repeated 10 times, approaching the target from each direction 5 times, with the azimuth dials covered. The average of the 10 readings is then computed. If the average of the 10 readings does not agree with the true azimuth to the target within 0.05°, an adjustment is required.

■ 62. ADJUSTMENT IN AZIMUTH.—To adjust the azimuth dials, the cover is removed from the Control Unit RM-36-A (see fig. 27) and the safety switch is held in by suitable

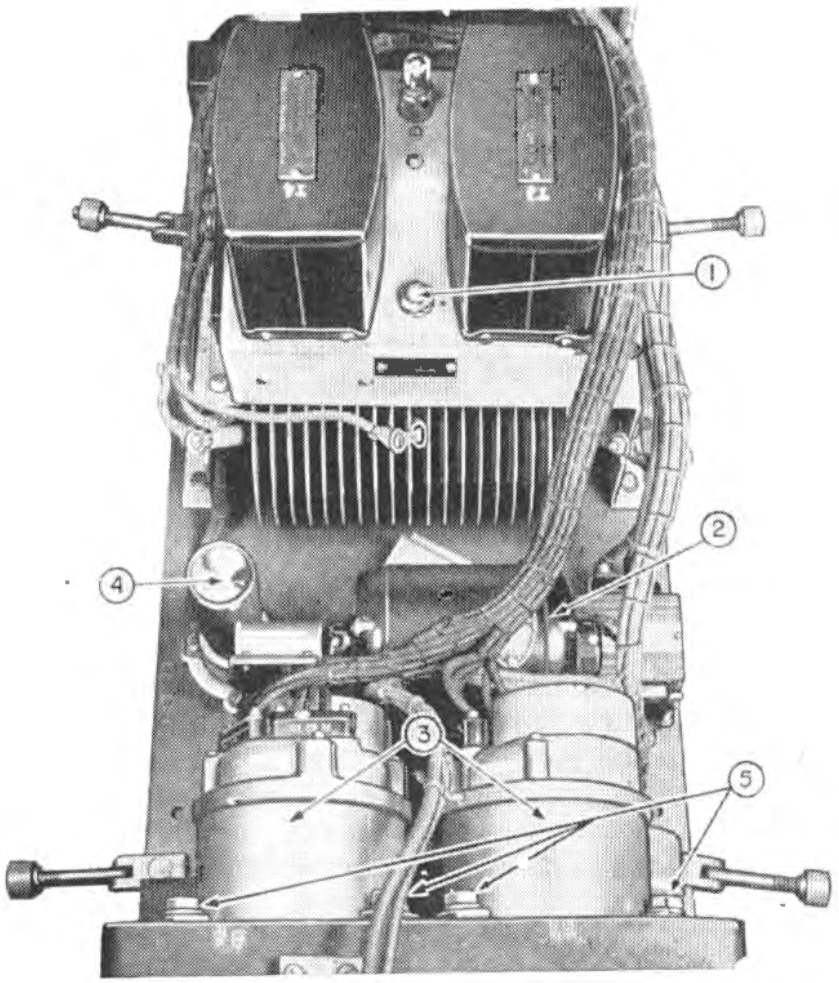

FIGURE 27.—Control Unit RM-36-A (cover removed).

1. Antihunt adjustment.
2. Slewing motor.
3. Azimuth data receiver selsyns.
4. Standby heater.
5. Clamp screws.

means. The three clamp screws holding the azimuth receiver selsyns are loosened, the selsyns are rotated until the azimuth dials indicate the true azimuth to the target and then the clamp screws are tightened. This operation must be performed carefully to avoid damaging the dials and should be accomplished by qualified maintenance personnel. After this adjustment has been made, check readings should be made on other orienting points or targets of known position.

SECTION IV

ERRORS

■ 63. GENERAL.—The SCR-296-A is subject to certain limitations by both its design and the peculiarities of the terrain surrounding the set. Every effort should be made to determine the errors resulting from these limitations as accurately as possible, so that appropriate corrections may be made to orientation and fire control data. These errors and their determination are discussed below.

■ 64. RANGE UNIT.—Due to the tolerances that must be allowed in the manufacture of mechanical parts, each range unit may introduce errors in range; these errors will vary in a regular fashion and will be repeated at regular intervals as the range is increased from the minimum to the maximum. The magnitude of the error so introduced will vary depending on the particular range unit in use at the time. The value of this error for each of the two range units furnished should be determined for all ranges. The Range Calibrator BC-725-A will be available in all harbor defenses and other locations where the SCR-296-A is used for the determination of the error in the range unit. By means of the Range Calibrator BC-725-A, the error of any range unit may be determined within less than plus or minus 5 yards at 360 points within the range limits of the set, 0 to 100,000 yards. By plotting a curve from these 360 points, with range error as ordinates and range as abscissae, a continuous calibration curve may be drawn from which the error at any range may be determined. If the Range Calibrator BC-725-A is not available, a less accurate and less convenient method may be used. It consists of tracking a target simultaneously with the radar set and the two observing instruments of a horizontal base visual system,

plotting corresponding points on a plotting board, and measuring the range differences. From these data a calibration curve for the range unit can be obtained.

■ 65. AUDIO FREQUENCY.—If the audio (recurrence) frequency is not maintained at the proper value, errors will be introduced in the measurement of range. This error will increase in direct proportion to the range to the target. Errors from this cause may be avoided by maintaining the audio frequency constant at all times and at the proper value by using the Calibrator BC-726-A. Errors in the recurrence frequency may also affect the cyclical error.

■ 66. AZIMUTH ERROR.—Large reflecting objects in or close to the beam of the antenna may cause a deflection of the beam resulting in erroneous azimuth readings in portions of the field of search. These errors may be sufficiently large to warrant the application of corrections to the radar azimuth data. Whether such obstacles are known to be present or not, checks should be made of radar data against visual data throughout the field of search at various ranges. This is accomplished by plotting and relocating as in the determining of range errors. If a large number of such determinations indicate that an azimuth error exists, a calibration curve should be plotted and correction should be applied to data in the affected area.

■ 67. FALSE TRACKING.—When tracking targets at short ranges, it is possible to introduce an error of about 15°, either right or left, by tracking on a secondary lobe of the antenna. False tracking can be detected immediately by noting that traversing the antenna to the right causes the size of the right echo on the azimuth scope to increase instead of decrease. Similarly, tracking left causes the left echo to increase instead of decrease. When this reverse tracking is noted, traverse right or left about 15° until the true tracking point is found. The true point will return a much stronger echo and give correct tracking sense.

CHAPTER 5

EMPLOYMENT

SECTION I

DUTIES OF PERSONNEL

■ 68. GENERAL.—Men on duty at the SCR-296-A station are in a position of great responsibility. During periods of poor visibility, the battery of which they are a part is dependent primarily upon their efforts for the firing data necessary to attack hostile targets successfully. To assure a high standard of operating efficiency, the battery radar officer should supervise and guide the training and technical employment of operating personnel continuously. Frequent inspection should be made by the harbor defense radar officer.

■ 69. RADAR OFFICER.—A specially qualified officer within the harbor defense will be designated as radar officer on the staff of the harbor defense commander. He will supervise the general administration, supply, and maintenance of all radar sets assigned to the harbor defense. He will be the tactical and technical adviser to the harbor defense commander in matters concerning radar employment. Each battery employing an SCR-296-A will also be assigned an

officer, designated as radar officer, whose primary duty is the supervision of the operation and maintenance of the set.

■ 70. REQUIRED PERSONNEL.—At all times when the SCR-296-A is manned, the operating section will consist of the following men:

a. A noncommissioned officer of the grade of sergeant acting as chief of section.

b. A range operator.

c. An azimuth operator.

d. A range reader.

e. An azimuth reader.

f. A power plant operator.

g. In addition to the section listed, an experienced maintenance sergeant will be available for immediate call should any adjustments be needed or any break-down occur.

■ 71. EXCHANGE OF DUTY.—Every member of the operating section will be trained to perform the duties of each other member of the section. Thus during each member's tour of duty he will take his turn watching the oscilloscopes. Ordinarily, however, the chief of section will not act as an operator, although he may fill that position during an emergency.

■ 72. EXTENDED PERIODS OF OPERATION.—Inasmuch as the SCR-296-A will normally be operated for comparatively short periods of time, either in combat or training, only one complete manning detail will be provided in the tables of organization for each battery equipped with this set. However, there may be times when the SCR-296-A is called on to augment or even substitute for the SCR-582 in the function of surveillance. In these cases of extended hours of operation it will be necessary to provide additional men from the battery, trained as operators, to relieve the regular manning detail.

■ 73. DUTIES OF PERSONNEL.—*a. Chief of section.*—(1) Receives all orders from the battery commander and sees that they are promptly and efficiently carried out by his section.

(2) Makes all entries in the logbook. He will record the maximum tracking range obtained during his tour of duty along with any pertinent comments about the type of echo signal or the functioning of the set. He is responsible for the complete and accurate keeping of the logbook. Upon completion of his tour, he initials the logbook to signify that it is correct.

(3) Normally turns on the SCR-296-A but may entrust this duty to any competent operator.

(4) Is responsible for the police of the operating room. Sees that it is neat and clean before dismissing his section.

(5) Is responsible for the presence of a complete section on duty during the entire tour and for promptly reporting any absentees.

(6) Immediately notifies the officer in charge and the maintenance man when any break-down occurs. If, for any reason, any operator cannot perform his normal tactical duty, he will report, "SCR-296-A OUT OF SERVICE." For example, the maintenance man may be tuning the set so the range operator cannot watch his oscilloscope.

(7) Immediately notifies the officer concerned when the set is back on the air after servicing, maintenance, or repair operations.

(8) Is responsible for the performance of all operational maintenance checks at the designated periods and the accurate recording of results.

(9) Is responsible for the conduct of all persons while in the operating room and the exclusion of all unauthorized persons therefrom.

b. Range operator.—(1) Watches the range oscilloscope and accurately tracks the target when ordered to do so by the chief of section. When searching a given area he will report all targets within the designated range zone.

(2) Maintains the echo signal at a height between ¾ and 1 inch, so that a signal of desirable height will be available on the azimuth oscilloscope.

c. Azimuth operator.—Watches the azimuth oscilloscope or indicator and accurately tracks the designated target that has been placed in the notch on the range oscilloscope.

d. Range reader.—Reads the range dials on the last bell of each time interval group and calls them to the plotting room over the telephone provided. In some cases he will be called on to record the readings.

e. Azimuth reader.—Reads the azimuth dials on the last bell of each time interval group and calls the reading to the plotting room over the telephone provided. Records the azimuth readings when necessary.

f. Power-plant operator.—(1) The power-plant operator is responsible for the maintenance of the two standby power plants, for their readiness for immediate use should the commercial power fail, and for the keeping of an adequate supply of gasoline. Each power plant will be run at least 15 minutes, twice each week, to insure that each is functioning properly.

(2) When not actively engaged in the maintenance or operation of the power plant, he will act as a relief operator or reader.

g. Maintenance man.—(1) The maintenance man must be immediately available should the set go out of operation. It is his responsibility to see that the radar officer and chief of section know where he can be reached at all times during his tour of duty.

(2) He is responsible for keeping the maintenance log up to date and recording daily the number of hours of operation.

(3) He will check the tuning of the set twice daily.

(4) He is responsible for all routine maintenance checks and repairs.

(5) He keeps an inventory of the spare parts, seeing that sufficient parts are always available.

■ 74. TRAINING OF PERSONNEL.—Normally the chief of section and the maintenance sergeant will be men trained at The Coast Artillery School. In some cases operators are also obtained from this source. Where operators are to be trained at the station, this training is undertaken by the chief of section under the supervision of the radar officer. The men trained on the SCR-296-A are included in the range section

of the manning battery and should be familiar with the visual observing equipment used by the battery.

■ 75. SELECTION OF OPERATORS.—Operators should be keen, intelligent men, with a considerable degree of manual dexterity and capable of a high degree of coordination between mind, hand, and eye. Aptitude tests for determining whether enlisted men have the required qualifications should be employed in selecting operators for assignment to the SCR-296-A.

■ 76. ACCURACY.—It should be impressed on all men operating the SCR-296-A that the accuracy of the data furnished is greatly dependent on their skill. Skill in operating comes only with constant and diligent practice. All the accuracy built into the set is of no use if the set is not operated correctly.

SECTION II

COMMUNICATIONS

■ 77. GENERAL.—The communication facilities at the SCR-296-A are fitted into the battery fire control telephone system in much the same manner as any other important element of the battery. This communication system is shown in block schematic form in figure 28. A minimum of nine cable pairs must be provided for the set. Of these, one is for the command line, two are for the reader's telephones, four are required for the automatic transmission of data to gun data computers, one is for time interval signals, and one is for a Post telephone. All of these lines, except that for the Post telephone, terminate in the fire control switchboard for cross connection to lines to the Switchboard BD-95 in the battery commander's station or the plotting room. When the set is required to furnish data to a battery of secondary assignment, switching of the necessary circuits is accomplished at the fire control switchboard room by means of cross patching on the Switchboard BD-74.

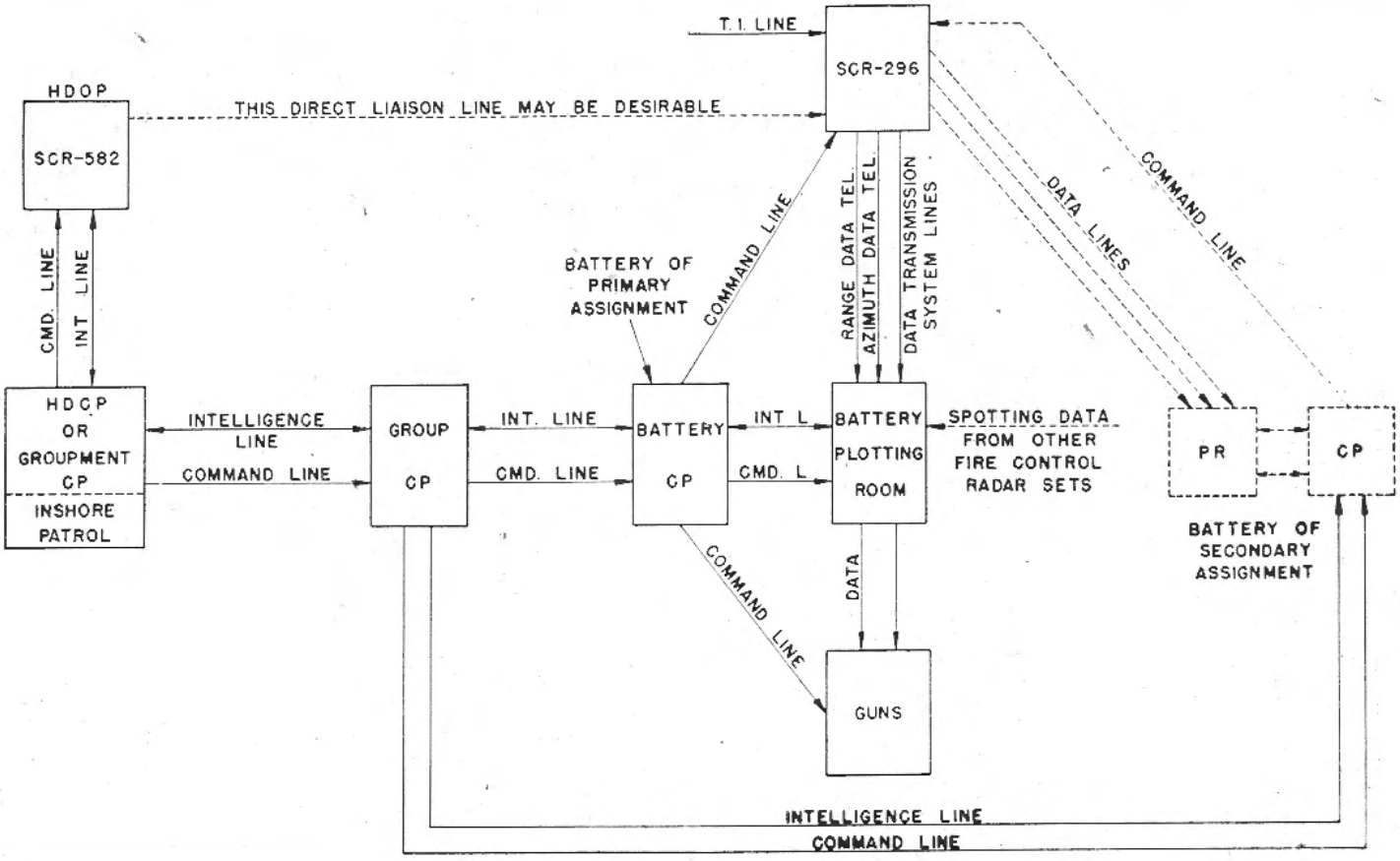

FIGURE 28.—Communications system.

a. Command telephone.—The command telephone is used for the reception of orders from the battery commander's station and the forwarding of information to that station.

b. Azimuth reader's telephone.—This telephone is connected to the Switchboard BD-95 in the plotting room through the fire control switchboard. At the BD-95, it may be connected to either of the plotting board arm setter's telephones. The plotting boards of batteries of primary and secondary assignment must be modified by the addition of station centers corresponding to the exact location of the SCR-296-A antenna.

c. Range reader's telephone.—This telephone is connected to the Switchboard BD-95 in the plotting room through the fire control switchboard. At the BD-95, it may be connected to either of the plotting board arm setter's telephones.

d. Data transmitters.—The range and azimuth data transmitters are connected to receivers on the gun data computer in the plotting room through the fire control switchboard. Two pairs are required for the transmission of range and two for azimuth.

■ 78. TIME INTERVAL.—The time interval line is terminated on the time interval panel in the fire control switchboard room. Any of the time intervals available on the Time Interval Apparatus EE-86-A may be furnished the SCR-296-A by cross patching on the time interval panel.

SECTION III

OPERATING PROCEDURE

■ 79. STATES OF READINESS.—*a.* The set may be in any one of the following conditions with respect to readiness for action:

(1) *ON THE AIR.*—The set is in full operation, transmitting and receiving signals, and either tracking or ready for tracking.

(2) *ALERT.*—All components except the transmitter are in operation. The only additional operation necessary to bring the set to the ON THE AIR status is to throw the TRANSMITTER switch on the range oscilloscope to the ON position.

(3) *STANDBY.*—The RADIO SET—STANDBY HEATERS switch on the Power Control Panel BD-108-A is in the STANDBY HEATERS position and the CONTROL switch on the Control Unit RM-36-A is in the OFF position. All power except that to the heaters is disconnected.

(4) *SHUT DOWN.*—All power is removed from the set, but the set is capable of being put in any higher state of readiness by the operation of appropriate controls.

(5) *OUT OF SERVICE.*—The set is not immediately available for service because routine maintenance operations are in progress or repairs are being made.

b. The state of readiness to be maintained is governed by directives contained in training schedules, standing operating procedures, general and special orders, and commands from appropriate headquarters. In what follows, it is assumed that the set is already in the ALERT status.

■ 80. ASSIGNMENT OF TARGET.—Targets normally are assigned by the battery commander or his direct representative over the command line. In assigning a target, the approximate azimuth and range are given. This information will have been passed down the chain of command and may have originated in reports either by the SCR-582 operator, visual observer, or naval or air patrol. In assigning a target the order will be, "Target, azimuth, two - nine - zero; range, ten thousand. Track."

■ 81. PROCEDURE.—*a.* The chief of section receives this command over the command line and immediately repeats it to the operating section. It will be understood by the entire section that the readings given are approximate.

b. The set being in the state of ALERT, the range operator snaps the TRANSMITTER switch putting the set ON THE AIR.

c. The azimuth and range readers repeat the azimuth and range data received and direct the operators, "Traverse right (left)," "Increase (decrease) range."

d. The operators turn the handwheels as indicated to reach the desired range and azimuth. As the given range and azimuth appear on the dials the readers give, "Steady."

e. The range operator centers the pip at or near the given range in the notch and calls, "On target."

f. When the range operator has reported, "On target," the azimuth operator matches the pips and calls, "On target."

g. When the chief of section hears both operators report, "On target," he verifies that they are on the correct target and reports to the battery commander's station, "296 on target."

h. After reporting, "296 on target," the section remains on target and awaits further orders.

■ 82. TRACKING.—On the order, "Track," the readers read the dials on the last bell of each time interval sequence. If range-aided tracking is not being used, range tracking should be interrupted long enough for the reader to read the dials accurately. Tracking is continued until the target is lost or "Cease tracking" is ordered.

■ 83. REPORT TARGET POSITION AT (FIVE-) MINUTE INTERVALS. Upon receiving the command: REPORT TARGET POSITION AT (FIVE-) MINUTE INTERVALS, the chief of section will report the target position to the battery commander's station at the designated interval. The range and azimuth readers may or may not be required to record the data.

■ 84. CEASE TRACKING.—At this command, the range operator turns the TRANSMITTER switch on the range oscilloscope to OFF. This places the set in the ALERT state. The operators and readers stand by.

■ 85. SEARCHING.—If the battery should be ordered to search a given area with its SCR-296-A the battery commander will give the azimuth and range limits in his command, as in the following example: SEARCH BETWEEN AZIMUTH, ONE - TWO - ZERO AND TWO - ZERO - ZERO; RANGE, TEN THOUSAND AND FIFTEEN THOUSAND.

a. The chief of section receives the command and repeats it to the section.

b. The readers indicate the direction of traverse to the operators. The azimuth operator sets at the lower of the two azimuths; the range operator sets at the center of the range zone.

c. When the azimuth operator is ready and the range operator has called, "Set," the azimuth operator calls, "Commence searching," and traverses the antenna slowly to the right.

d. The range operator will watch his scope intently (the SENSITIVITY control should be set near maximum) and will call, "Target," whenever a signal appears which he believes will fall within the designated range area. When he calls, "Target," the azimuth operator ceases traversing. The range operator places the signal in the notch and the azimuth operator centers on the target and calls, "Set."

e. The readers read the range and azimuth. The operators report the movement of the target in the following manner: "Target coming in (going out)," or, "Target stationary."

f. These data and the time they were taken are recorded. The chief of section reports the information to the battery commander over the command line.

■ 86. STANDBY.—To put the set in the STANDBY state, the load switch is thrown to the STANDBY HEATERS position. The CONTROL switch on the control unit is thrown to the

OFF position. In this way all power except that to the heaters is removed. The PLATE VOLTAGE cannot again be applied until the PLATE control is turned to the extreme counterclockwise position, as explained in section I, chapter 3.

■ 87. INTERFERENCE.—It will happen occasionally that, when a target is being tracked, another vessel will appear in the field of view. If this vessel appears on a course from the flank at very nearly the same range as the target, neither operator will detect it, but the set will track a spot between the target and the object. It is one function of the liaison between the SCR-582 and SCR-296-A to warn of imminent interference which is normally detectable at the SCR-582. Generally the interfering vessel will not be at the same range as the target, and it will be seen by the range operator who will report its approach. The report, "Interference," will be given when the interfering echo drops in the notch (see fig. 29). The azimuth operator should increase his SWEEP EXPANSION and track the target until he can no longer distinguish between the target and the interference.

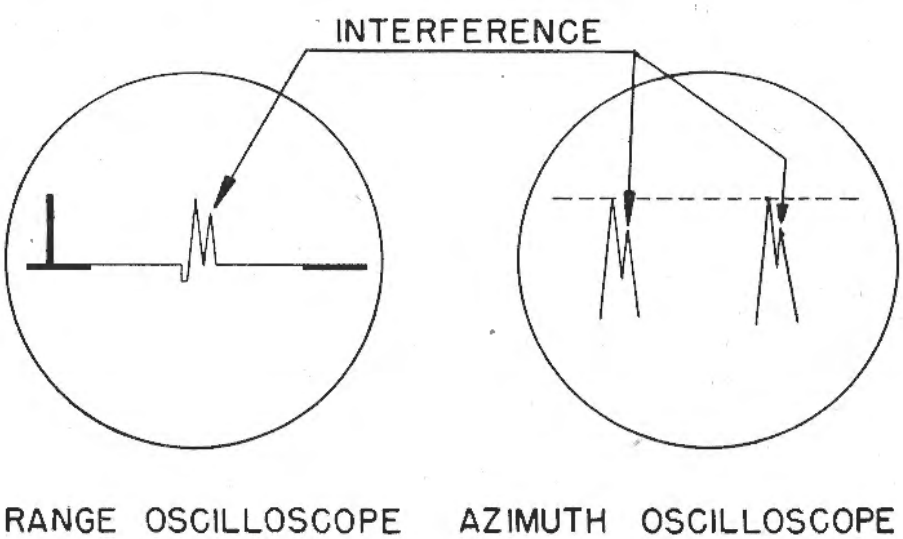

FIGURE 29.—Interference.

He then reports, "Interference," and, disregarding his pips, tries to maintain the tracking rate existing before the interference. If the aided tracking attachments are in use on the set, it is relatively easy to track through interference of the nature described above. When the pips again separate, the azimuth operator reports, "Clear," and resumes pip matching. During the period of interference the indicator (azimuth tracking meter) cannot be used as its data are not accurate. In both cases mentioned the battery commander and plotting room are informed, and the SCR-582 will normally be asked to check the position of the target after accurate tracking is resumed.

■ 88. SPOTTING.—Splashes from guns of 6-inch caliber and larger will appear on the oscilloscope of the SCR-296-A under favorable circumstances. For this reason, every effort should be made to use the set for spotting purposes during target practice and in combat. The echo from a shell in flight appears on the range oscilloscope as a small pip moving along the base line toward the notch, culminating in a large pip from the splash that may persist for several seconds. It will frequently be possible to determine whether the splash is at a longer or shorter range than the target. In this case, the range operator should report, "Over (Short)." If the echo from the splash is distinguishable in the notch, the azimuth tracker may be able to tell from the relative heights of those portions of the pips which are due to the splash whether the splash is to the right or left of the target. In this case, he will report, "Right (Left)." If the SCR-296-A of another battery is located well around to the flank, this set should be used in spotting for range since lateral deviations from the battery will appear as range deviations from the flank set. For effective spotting, a high degree of mental alertness is required on the part of the operators.

SECTION IV

LOGS

■ 89. GENERAL.—Two logbooks will be kept on each SCR-296-A. One is to contain the tactical and operational data. The other is the maintenance log. The maintenance log is kept by the maintenance sergeant and the tactical log is the responsibility of the chief of section.

■ 90. TACTICAL LOG.—The chief of section is responsible for and makes all entries in the logbook. Upon completion of his relief, he initials the logbook to signify that it is correct. The following entries are suggestions of information that should be included in the logbook:

a. Date.

b. Hours relief was on duty.

c. Name of chief of section and number of men on relief.

d. All orders issued to the section by the battery commander and the action taken in compliance with these orders.

e. Weather.

f. Operation checks.

g. Maximum range obtainable.

h. Signal strength checks.

i. Orientation checks, listing orienting points.

j. Time SCR-296-A is OUT OF SERVICE.

k. Data on ships tracked.

(1) Time and range at start and end of course.

(2) Type of ship, name, and tonnage, if possible.

(3) Reason for ending course.

l. Any unusual reception conditions, such as:

(1) Interference from other radars.

(2) Fading of signals.

(3) Interference from electrical storms.

(4) Spotting of shell splashes during firing.

■ 91. MAINTENANCE LOG.—The maintenance sergeant is responsible for this log. In this log should be entered all information pertaining to the maintenance of the entire SCR-296-A. A complete maintenance log will be of great assistance to the maintenance man and future maintenance men. Some suggested entries for the maintenance log are:

a. Record of time set was tuned and various tuning settings: grid 1, grid 2, cathode tuning, tuning dial.

b. Meter reading at daily checks.

c. Record of tube life. Time-meter reading when tubes were installed and various replacement times.

d. Record of break-downs, detailed description of symptoms and corrective steps taken, also list of spare parts used.

e. Inventory of spare parts. This will facilitate keeping sufficient spare parts at hand to facilitate normal repairs.

f. Log on lubrication and 1,000-hour checks.

g. Record of use of local power units.

CHAPTER 6

MAINTENANCE

SECTION I

GENERAL

■ 92. SPARE UNITS.—*a.* To minimize the time lost due to trouble on the SCR-296-A, spare units have been provided for each of the following:

(1) Radio Transmitter BC-717-A.
(2) Radio Receiver BC-716-A.
(3) Oscilloscope BC-719-A (range).
(4) Oscilloscope BC-718-A (azimuth).
(5) Range Unit BC-723-A.
(6) Rectifier RA-49-A (regulated).

b. Replacing one of these units is a comparatively simple job and the shut-down period due to trouble on one of these units should not exceed 20 minutes. Care should be taken to insure that the power is off and all connections have been freed before attempting to remove the unit.

■ 93. SPARE PARTS.—In addition to the aforementioned spare units, sufficient spare parts and tools are provided with the set to make normal repairs. When a unit is rendered

unserviceable, it should be repaired immediately even though the spare unit has been installed. This procedure insures against long inoperative periods should the newly installed unit fail.

■ 94. SIGNAL CORPS REPAIR SERVICE.—A Signal Corps repair depot is located within a short distance of most Radio Sets SCR-296-A. This depot maintains stocks of spare parts, and specially trained Signal Corps men are available for third and fourth echelon maintenance of all sets in the vicinity. The assistance of personnel at these depots should be sought in the event that any maintenance beyond the capabilities of the harbor defense maintenance personnel is required.

■ 95. TUBES.—*a.* Most complaints of ineffective operation of radio equipment arise from the use of old or defective vacuum tubes. As far as possible, tube failure should be avoided by making replacements as soon as the necessity is indicated by the record of the time the tubes have been in service, by various meter readings, or by individual tube tests made at regular intervals. The type of tube and its application in the set are the main determining factors of the tube's life. As there are 82 tubes of 26 different types in the SCR-296-A, various tube lives can be expected. As an aid to anticipating tube failures, two time meters have been installed in the duplexing panel.

b. TOTAL time meter records the total time the set is ON. This will tell the hours all the tubes, with the exception of the transmitter tube, have been on.

c. PLATE time meter tells the time the transmitter tube has been on.

■ 96. TUBE LIFE.—By recording the time-meter reading when a tube is replaced and when it again fails, the probable life of all tubes can be obtained. Thus, replacements can be made before tube failures occur. A bad or weak tube may be the cause of more serious trouble if it is not replaced in time. A chart similar to the one shown in figure 30 will be a great aid in preventing tube failures.

Unit	Tube	Tube Type	Time-meter reading at			Replace at				
			1st replacement	2nd replacement	3rd replacement					
(Example) Range oscilloscope.	V3	6SJ7	900	1700	2700	3500	4300	5100	5900	6700

FIGURE 30.—Tube life chart.

SECTION II

OPERATIONAL MAINTENANCE

■ 97. HOURLY CHECKS.—*a.* Certain checks made each time the set is turned on, and hourly thereafter, aid in the proper operation of the set and are of great assistance in locating troubles should they occur. The following checks can be accomplished by the operating personnel. The enumerated meter readings should be taken and recorded accurately in the logbook.

	Should be
b. Modulation generator.	
(1) Plate current	125–200 ma.
(2) Plate voltage	525–600 volts
c. Receiver.	
(1) Current at OSC jack as measured on 0-25 milliammeter.	18–25 ma.
(2) Current at CONV jack as measured on 0-5 milliammeter.	1–3 ma.
d. Power control panel.	
(1) Load voltage (adjust to)	115 volts
(2) Plate voltage (adjust to)	12 kilovolts
(3) Plate current (adjust to)	18–34 ma.
e. Transmitter.	
Voltage on MAG FIL meter	13–14 volts
f. Indicating equipment.	
Voltage at regulated rectifier	250 volts

■ 98. ADDITIONAL CHECKS.—In addition to the foregoing checks, the orientation, signal strength, and noise level should be checked after the set has warmed up and approximately every 2 hours during operation. The orientation checks should be made at such times that they will not interfere with the tactical employment of the set. Once each day the gas pressure on the transmission line should be checked and regulated to 3 pounds. The recurrence frequency should be controlled or checked continuously. It is advisable for the chief of section and maintenance man to make periodic checks for excessive temperature rises. This can be done by "feeling" external surfaces of all units and by being alert for odors due to overheating. The usual safety precautions should be observed in making touch tests.

■ 99. RECORD OF CHECKS.—Maintenance checks that require more technical knowledge and skill will be accomplished by the maintenance sergeant. It is imperative that a complete record be kept of all maintenance checks, as this record will be of great assistance in obtaining uninterrupted service from the SCR-296-A.

SECTION III

TUNING

■ 100. GENERAL.—To receive echoes from small and distant targets the set must be tuned to optimum. In tuning, the transmission line is tuned so that a minimum of the transmitter power is lost in the line and only a small amount of power goes directly to the receiver. The receiver is tuned for maximum return signals with the smallest possible noise level. The tuning should be checked twice daily by the maintenance personnel. If at any time the operators find the signal strength is abnormally low, the maintenance man should be called to tune the set. The return signal strength will vary slightly from time to time with atmospheric conditions.

■ 101. TUNING THE TRANSMISSION LINE.—*a.* To tune the transmission line, means must be available for viewing the transmitted signal. This is accomplished by connecting a test oscilloscope to the jack provided (MONITOR on the duplexing panel) (see fig. 31). The signal at this jack is obtained from a circuit composed of a half-wave pick-up loop and a detecting diode. The pick-up loop is referred to as the wave meter, as it is so arranged that a determination of the transmitted frequency can be obtained from it.

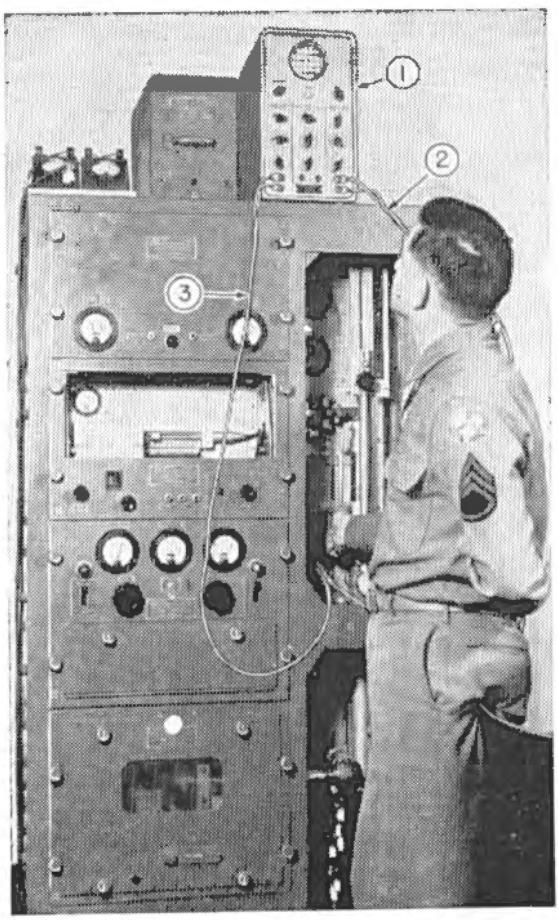

FIGURE 31.—Tuning the transmission line.

1. Test oscilloscope.
2. Patch cord connected to SWEEP jack.
3. Patch cord connected to MONITOR jack.

b. The output of the MONITOR jack is applied to the vertical plates of the test oscilloscope, and the output of the SWEEP jack, which supplies a sweep line that is variable in phase relation to the main transmitted pulse, is connected to the horizontal plates of the test oscilloscope. The test oscilloscope is set with both amplifiers off. The FOCUS and INTENSITY controls are adjusted for a clear sharp sweep. The SWEEP PHASE knob is adjusted for a sweep line of about 1 inch. The monitor switch is turned on. Run the wave meter index to near its lower limit and adjust for a maximum vertical deflection on the test oscilloscope screen. By adjusting the SWEEP PHASE knob, the vertical pip, caused by the transmitted pulse, can be centered on the sweep line.

c. The lower tuning control on the duplexing panel should be adjusted for a maximum height of signal on the test oscilloscope, followed by a similar adjustment of the upper control. The small adjustment near the TR tube should also be adjusted for the same results. Any value over 1 inch in height on the oscilloscope screen, with the vertical amplifier off, is good. The height of the signal should be recorded in the logbook each time the set is tuned.

d. When the lines are tuned for the greatest output signal, the monitor switch should be turned off and the test cords removed. The wave meter should be detuned so the index will be about halfway up the scale.

e. If the SWEEP PHASE knob were moved during the operation the set might require reorientation in range. A good practice is to set the SWEEP PHASE knob once and then not move it unless absolutely necessary.

■ 102. TUNING THE RECEIVER.—*a.* After the set has been turned on, the tuning of the receiver is accomplished by the following procedure:

(1) If the SCR-296-A has been modified with a pre-amplifier, the following operations are performed first (see fig. 32):

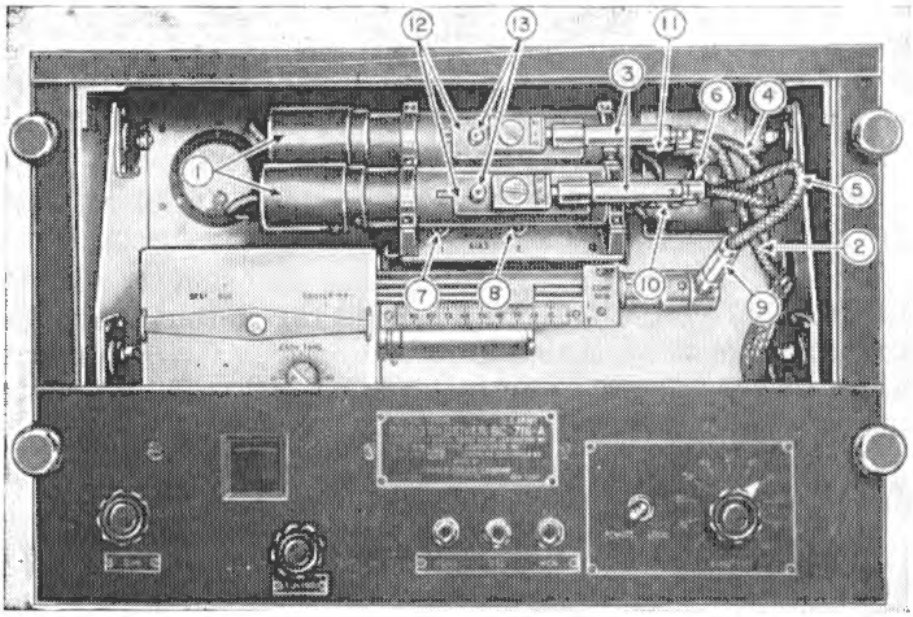

FIGURE 32.—Radio receiver preamplifier.

1. Amplifier socket assemblies.
2. TR box connector.
3. Input connector plugs.
4. Interstage connector.
5. Preamplifier to converter input connector.
6. RF AMPlifier switch.
7. CATHODE BIAS 1 control.
8. CATHODE BIAS 2 control.
9. Converter input.
10. Stage 2 output tuning control.
11. Stage 1 output tuning control.
12. Input connectors.
13. Input tuning locks.

(a) After loosening the clamps, remove the two amplifier socket assemblies (1).

(b) Check the following:

1. Connection (2) between the receiver protector unit (TR box) and the input on stage 1. The input connector plugs (3) for both stages are indicated on figure 32.

2. Connection (4) between the output of stage 1 and the input of stage 2.

3. Connection (5) between the output of stage 2 and the converter input.

(c) Apply power to the receiver and place the radio-frequency amplifier plate switch (6) in the ON position.

(d) Carefully slide the vacuum-tube socket assembly of stage 1 in place and tighten the cylinder mounting strap clamps.

(e) Insert a 0–25 milliammeter in the cathode circuit of the preamplifier and observe the plate current of stage 1.

(f) After an adequate warm-up period (approximately 2 minutes), adjust the CATHODE BIAS 1 control (7) so that the milliammeter indicates 8 milliamperes.

(g) Leaving the socket assembly of stage 1 in place, slide the socket of stage 2 in place and clamp it securely.

(h) After allowing a warm-up period [see step (f) above], adjust the CATHODE BIAS 2 control (8) so that the milliammeter indication is now 16 milliamperes. (With this adjustment the tube of each stage is operating with a plate current of 10 milliamperes.)

(i) Remove the connections checked in (b), and connect the TR box connector to the converter input (9).

(j) Place the transmitter of the equipment in operation in the normal manner.

(k) Tune and adjust the receiver as outlined in subparagraph (2) following.

(l) Remove the TR box connector from the converter input and connect it to the input of amplifier stage 2. Connect the output of stage 2 to the converter input. This connects amplifier stage 2 into the system.

(m) Rotate the output tuning control of stage 2 (10) to adjust for a maximum receiver output as indicated on the monitoring test oscilloscope. The receiver SENSITIVITY control should be adjusted for a convenient signal amplitude below saturation.

(n) Maximize the receiver output by adjusting the input and output tuning of stage 2. The input is tuned by sliding the input connector (12) along the cylinder. To free this control, the input tuning lock (13) should be released by turning the knurled nut counterclockwise.

(o) Withdraw the antenna connector from the input of stage 2 and connect it to the input of stage 1. Connect the output of stage 1 to the input of stage 2. This connects both amplifier stages into the system.

(p) Tune stage 1, following the procedure outlined in steps (m) and (n) for stage 2.

(q) Trim all the tuning adjustments of the amplifier stages and the converter with both stages in the circuit. After trimming, lock the input tuners by means of the input tuning locks.

(r) After the adjustments described have been made, the receiver is ready for service.

(s) The amplifier as a whole or either stage may be bypassed by proper use of the various connectors. Under these conditions, the equipment may be operated with reduced receiver performance.

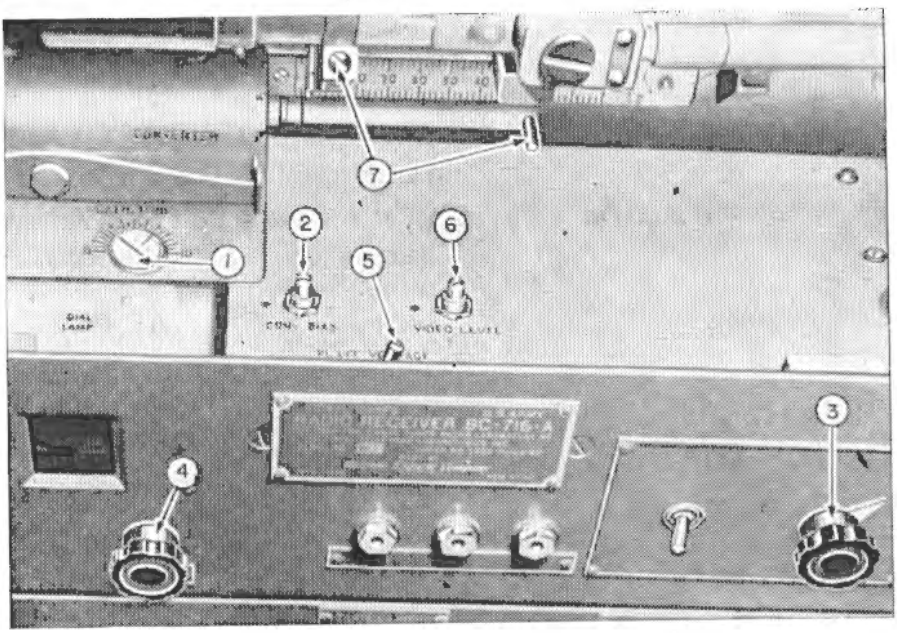

FIGURE 33.—Radio Receiver BC-716-A.

1. CATHode TUNE.
2. CONVerter BIAS control.
3. SENSITIVITY control.
4. TUNING control.
5. PLATE VOLTAGE switch.
6. VIDEO LEVEL control.
7. CONVerter GRID tuning adjustments.

(2) If the SCR-296-A is not modified with a preamplifier, proceed as follows with tuning the receiver (see fig. 33):

Control	*Result of adjustment*
(a) CATH TUNE	Adjust until the 0-5 test milliammeter, connected to the CONV jack with the cord provided, reads maximum.
(b) CONV BIAS	Adjust until the 0-5 milliammeter reads 1.5 ma.
(c) SENSITIVITY control.	With the REMOTE-LOCAL switch in the LOCAL position, the range and azimuth of a known target at close range are set on the range and azimuth dials. Increase this control until the target or a low level of noise appears on the range oscilloscope screen.
(d) TUNING control	Adjust for an echo of maximum height on the range oscilloscope.
(e) CONV GRID 1	Adjust for an echo of maximum height on the range oscilloscope.
(f) CONV GRID 2	Adjust for an echo of maximum height on the range oscilloscope.

b. If at any time during the process of tuning, the signal reaches saturation (maximum height), the SENSITIVITY control should be turned counterclockwise until the signal is just visible and then continue tuning.

c. The process should be repeated two or more times as the adjustment of one control affects that of the others. By careful observation of the range oscilloscope screen, optimum tuning can be accomplished without difficulty.

d. To aid the maintenance men in keeping the set in tune, a periodic check of the return signal strength should be made. This is done by recording the height of the signal from a particular short range target when the set is in perfect tune and the SENSITIVITY is set at some definite setting. By returning to this target and SENSITIVITY setting periodically and recording the resulting signal height, variation in receiver effectiveness can be detected.

SECTION IV

INSPECTION

■ 103. GENERAL.—In general, a thorough periodic inspection of the complete installation at least every 1,000 hours of operation will materially aid in uninterrupted performance. The following details and inspections are recommended.

a. Clean accumulated dust and dirt from all units, paying particular attention to the high-voltage insulators in the main cabinet and to the potentiometers in the control unit. The cleaning should be done with carbon tetrachloride or some similar highly volatile solvent.

b. Make certain that all mounting brackets and supports are rigidly fastened and that all nuts, bolts, and machine screws are tight.

c. Determine that no cords have broken shielding and that all bonding and grounding is in place.

d. Make certain that fuses are held tightly in their clips. A loosely held fuse should be removed and the clips bent until they will hold the fuse tightly. The clips and fuse ends should be kept clean and the contact surfaces kept bright.

e. Check wiring. Make certain that all terminal connections are good and that wire insulation is not frayed or broken, causing a possible short.

f. Inspect and test all vacuum tubes. Replace any tube that does not test satisfactorily. Record all replacements in the tube chart in the logbook. The TR tube should be removed and replaced if the inside of the glass has a coating of copper. When operating in the set, this tube should have a blue glow. Loss of power and blocking of the receiver is an indication that the TR tube needs replacing.

g. The relays should be inspected to see that the contacts are in good working condition. Any rough or pitted contacts should be smoothed with a contact burnisher.

h. Clean the air vents on the underside of both ends of the motor-amplidyne generator. In extremely dusty or dirty places this should be checked frequently. The eight brushes should be checked. If they are worn short or uneven they should be replaced. In replacing the brushes, care should be taken to use brushes of the same grade; they should be carefully fitted to the commutator. This will insure good commutation and guard against sparking at the brushes. If at any time the motor-amplidyne generator fails to start, the most likely cause is that the overload protection has opened the circuit at the magnetic starter. Pushing the RESET button will correct the fault. If the starter continually "kicks out," an overload condition undoubtedly exists on the motor-amplidyne generator.

i. The antenna assembly should be inspected and all loose parts tightened. The glass test tubes of the dipole assemblies should be cleaned. Small plugs are provided on the dipole assemblies for bleeding the gas pressure in cases where it is evident that moisture is present in the transmission line.

j. The antenna tower should be inspected for rust and bare spots. Any rust should be removed, and the bare spots repainted. The hoist motor should be checked and run at this time. The cable and cable drum should be kept well greased to avoid rust. The hoist is intended only for the raising and lowering of tools and equipment and should not be used by personnel.

k. The transmission line should be checked for leaks. These will be indicated by the excessive use of gas from the cylinders. Leaks can be found by testing at the joints with soapy water; escaping gas will be indicated by the formation of bubbles.

l. The power plant should be cleaned and checked at this time. Additional instructions on the power unit are included later in the chapter.

m. The contacts on the lobe-switching mechanism should be checked. However, no adjustment should be made unless definitely necessary.

CAUTION.—Before removing the cover from the lobe-switching mechanism the gas pressure regulator should be closed to prevent the loss of gas from the cylinders.

n. The air filter on the cooling blower will require cleaning periodically, depending on the amount of dirt that is present in the air. The filter should be cleaned in solvent and retreated with light oil. By keeping the filter clean, the inside of the main unit and indicating units need cleaning less often.

■ 104. WARNING.—When working in the antenna shelter, the disconnect switch located there should be opened. This will insure that the antenna will not be traversed while it is being worked on.

SECTION V

LUBRICATION

■ 105. GENERAL.—Lubrication is an important factor in prolonging the life of the set. Lubrication should be sufficient but not excessive. The following recommendations are for average conditions and are intended only as a guide. Various conditions under which the set may be operated will determine the definite procedure for lubrication. A good grade of ball-bearing grease such as Beacon M-285 should be used for all ball bearings, and for gears where the lubrication is merely to prevent corrosion.

a. Motor-amplidyne generator.—This unit is equipped with ball bearings. Normal greasing is accomplished by filling the grease cups on each end and forcing grease into the bearings by screwing down the caps. The fittings should be wiped clean to prevent forcing dirt into the bearings along with the grease, and care should be taken that the amount forced in is not excessive. This normal lubrication should be performed every month. About every 2,500 hours the generator should be disassembled and the bearings cleaned of old and hardened grease by washing in gasoline or some similar solvent. After the bearings have been cleaned in the solvent, they should be further washed in a light mineral oil of SAE-10 grade, and the bearings packed about one-half full with grease.

b. Slewing motor.—The slewing motor in the control unit needs no addition of grease as it has sealed ball bearings. Once each year the motor should be disassembled and the bearings cleaned and repacked.

c. Power motor.—The lubrication of the main gear box at the top of the power motor should be checked every few months and the oil changed every 3 to 6 months. Three and one-half pints of UNIVIS No. 48 oil should be used. One year's supply under normal conditions is furnished with each pedestal. When changing the oil, the gear box should be flushed out with kerosene and drained thoroughly before refilling. The power motor on the antenna assembly should be disassembled and lubricated annually with grease (Beacon M-285). The grease level in the gear box at the commutator end of the power motor should be checked every 1,000 hours. This check should be made with the motor at rest. The compartment should be about one-third full. Be careful not to overfill, as this will cause leakage around the shafts and overheating. The condition of the grease should be checked. Any indication of the presence of water or grit necessitates the flushing and refilling of the gear box.

d. Antenna pedestal (see fig. 34).—Lubrication in the antenna pedestal should include the power drive gears, reduction gears for the selsyns, and the ball bearings at either end of the trunnion tube. Lubrication of the power motor and

gears is discussed in paragraph 105*c*. The exposed gears are lubricated merely to prevent corrosion. A thin coating of grease should be applied to these gears with a brush after they have been cleaned with solvent. The ball bearings should be cleaned and lubricated as described in paragraph 105*a*.

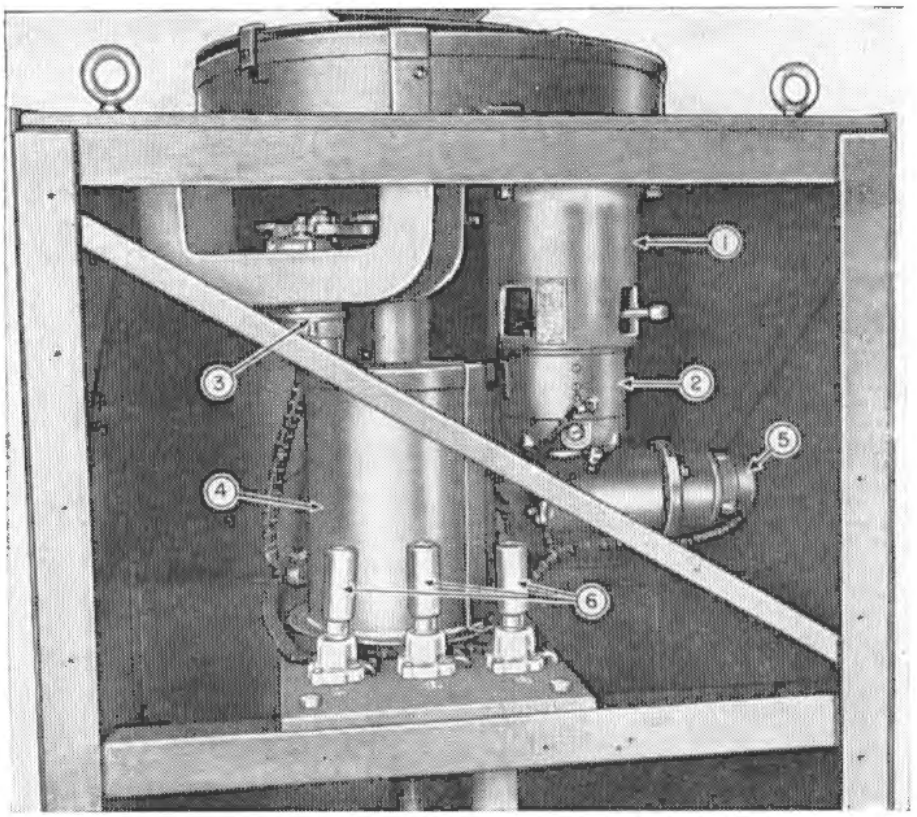

FIGURE 34.—Antenna pedestal.

1. Reduction gear box.
2. Antenna drive motor.
3. Azimuth data transmission selsyns.
4. Slip ring assembly.
5. Antenna traversing control selsyn.
6. Standby heaters.

e. Control unit.—Lubrication of this unit, with the exception of the slewing motor, consists of greasing the gears and ball bearings. Gears are lubricated for the sole purpose of preventing corrosion. A light coating of grease should be applied to these gears, and the ball bearings should be

cleaned and lubricated as described in paragraph 105*a*. Thus the climatic conditions govern the period between lubrications. The period should not exceed 3 months.

f. Range unit.—Greasing of the gears and bearings, as in the control unit, is all that is required here.

g. Lobe-switching mechanism (see fig. 35).—The motor bearings and the bearings on the lobe-switching motor shaft

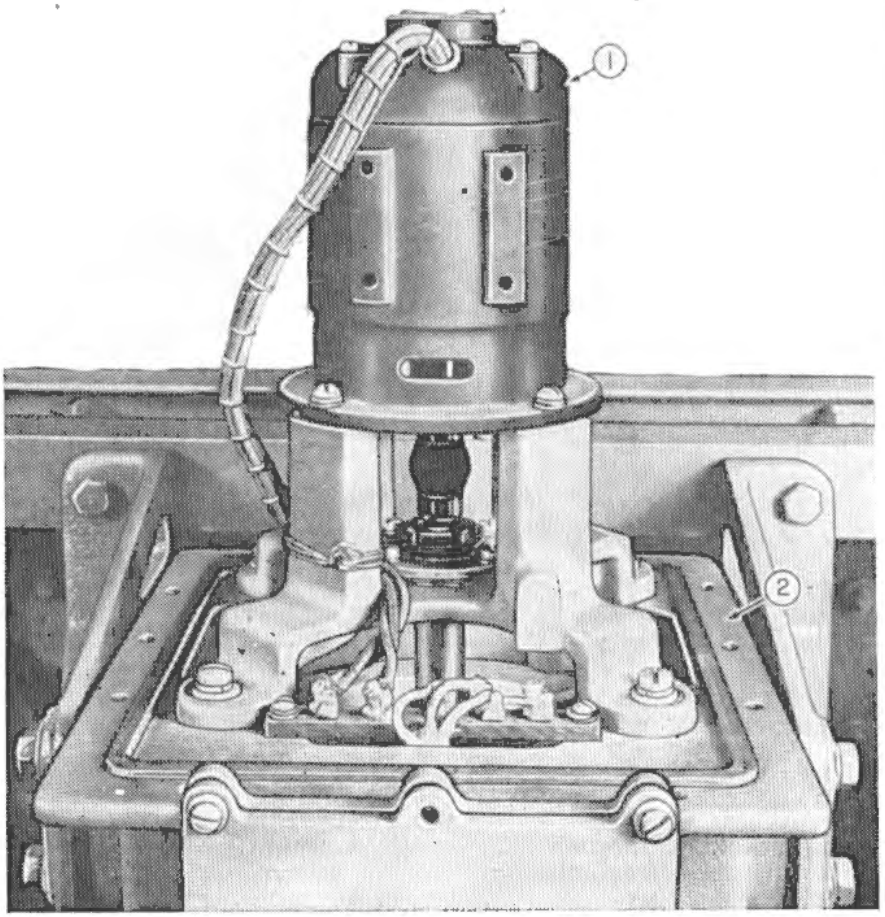

FIGURE 35.—Lobe-switching mechanism (gas-tight cover removed).
1. Lobing motor.
2. Housing for lobe-switching condenser and cams.

are sealed ball bearings and should not require greasing more often than once each year. During each 1,000-hour check, the cams should be wiped clean and a light coating of clean grease applied. The contact pivots should be oiled with a light machine oil.

h. Rotary joint.—This joint is lubricated with a special grease (CHIKSAN grease) provided by the manufacturer. It should be lubricated once every 3 months through the Alemite fitting provided. Overgreasing should be avoided. The unit should be removed and cleaned when there is evidence of a presence of excessive old grease.

i. Cooling blower.—This motor has oil-impregnated, wool-packed bearings. Light machine oil should be added after every 1,000 hours of operation.

SECTION VI

POWER PLANT MAINTENANCE

■ 106. GENERAL.—*a.* The Power Plant PE-84-C is a self-contained gasoline-electric source of power, consisting of a 4-cylinder Le Roi engine, directly connected through a flexible metallic coupling to an alternating current generator. The generator is equipped with a direct-current exciter. The control board is enclosed in a steel cabinet which is mounted on a vibration-proof fitting supported by a steel frame that extends directly over the generator (see fig. 10).

b. The generator is rated at 25 kv.-a. at 80 percent power factor, 900 r.p.m., 120 volts at full load, 60-cycle single phase. The machine should be protected carefully from moisture to prevent the likelihood of insulation break-down.

c. The electrical control panel mounts a main switch, a voltage regulator and field rheostat, ammeter, voltmeter, and frequency meter. (See fig. 36.)

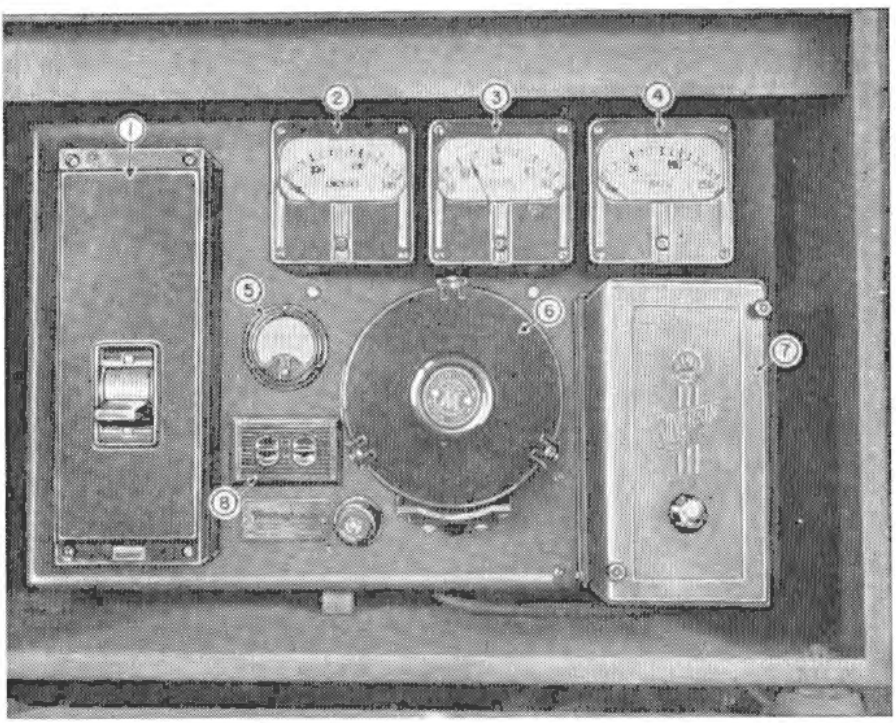

FIGURE 36.—Power control board on Power Unit PE-84-C.

1. Main switch and circuit breaker.
2. Ammeter.
3. Frequency meter.
4. Voltmeter.
5. Time meter.
6. Field rheostat.
7. Voltage regulator (silverstat).
8. Convenience outlet.

d. The fuel supply is kept in a 1,000-gallon tank supplied with each set. This tank should be buried near the House HO-1-A (power). In addition to the large tank, a 15-gallon gravity feed tank is located on the engine itself.

e. The control switch box assembly on the engine mounts two protective devices. These devices cause the set to shut down if the oil pressure drops below 5 pounds or the water temperature rises above 195°. If the engine stops for either of these reasons the RESET button must be pushed after the set has returned to normal before it can be restarted.

■ 107. STARTING AND STOPPING.—*a. Before starting a new engine or an engine that has been standing idle*:

(1) See that the cooling system is full of clean water or antifreeze solution.

(2) See that oil is at the proper level in the crankcase.

(3) Grease water pump.

(4) Remove spark plugs and pour about 2 tablespoons of mixture of one-half oil and one-half gasoline into each cylinder.

(5) Prime fuel pump and carburetor by manipulation of the gasoline pump priming lever.

(6) Examine the battery to see that the electrolyte is approximately one-half inch over the top of the plates.

(7) Make certain that the circuit breaker is in OFF position.

b. Starting the engine.—(1) Move the carburetor shaft lever to the RUN position.

(2) Pull out the choke rod on the engine instrument panel.

(3) Push the start button on the safety control box until engine fires.

(4) Push the choke rod in gradually as the engine warms up. As soon as the engine oil pressure builds up the governor will maintain correct speed.

c. Stopping the engine.—(1) Trip the circuit breaker to OFF position.

(2) Move carburetor shaft lever to STOP position. This cuts off fuel supply and grounds the magneto.

(3) If power unit is to be shut down for any length of time, the fuel supply should be shut off.

■ 108. VOLTAGE REGULATION.—The output of the power unit should be maintained at 120 volts, 60 cycles. The voltage is adjusted to 120 volts by the field rheostat and voltage regulator (silverstat). The frequency is determined by the engine governor. This is set at the factory and should need no adjusting. If the frequency is other than 60 cycles, an adjustment is necessary. Refer to the instruction manual furnished with the set.

■ 109. ROUTINE CHECKS AND LUBRICATION.—*a. Engine* (see fig. 37).—(1) *Fuel.*—Only clean white gasoline from clean containers should be put into the tank. If not obtainable, then other gasolines may be used and those containing the least amount of additive lead should be selected. Continued operations with such gasolines will require a more frequent check on valves and spark plugs. The tanks should be checked daily and the amount used recorded. Sufficient gas should be on hand to meet long emergency runs. In winter, high-test gas should be used for easy starting and tanks should be kept full to prevent moisture from collecting in the tank.

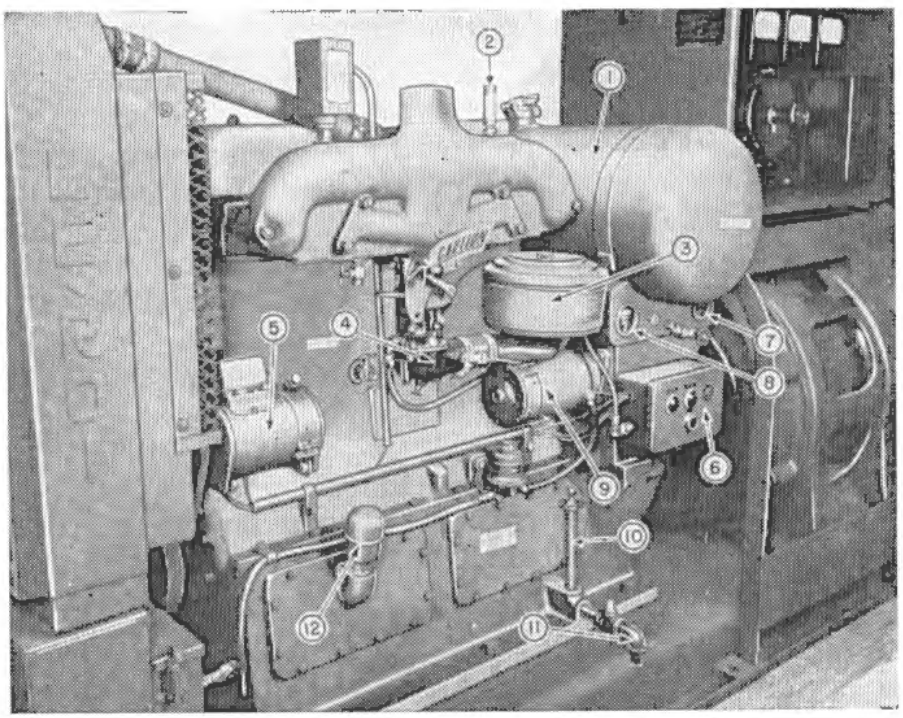

FIGURE 37.—Gasoline engine.

1. 15-gallon gasoline tank.
2. Thermometer.
3. Air cleaner.
4. Carburetor.
5. Charging generator.
6. Control switch box assembly.
7. Ammeter.
8. Oil pressure gage.
9. Starter motor.
10. Oil level gage.
11. Oil drain.
12. Oil filler pipe.

(2) *Oil.*—The level in the crankcase should be checked periodically and kept to the full mark on the dip stick. Oil should be used as recommended in the manual supplied with the set. When the oil becomes badly discolored or diluted it should be changed. The oil filter element should be changed about every 100 to 200 operating hours, depending on the operating conditions.

(3) *Cooling system.*—The radiator should be kept full of clean water. In weather below freezing, antifreeze must be used. The radiator should be drained, flushed, and refilled after about every 200 hours of operation or as indicated by the condition of the water in the radiator. The fan belt should be checked and adjusted as necessary. The spaces between the fins in the radiator should be kept clean to allow the free passage of air. These may be cleaned with air under pressure.

(4) *Air cleaner.*—The bowl of the air cleaner should be removed after each 48 hours of operation and checked for dirt accumulation. The dirty oil should be removed; the cleaner rinsed in fuel oil, gasoline, or some similar solvent; the cleaner thoroughly dried, refilled with clean oil to the level of the bead, and replaced. The same oil that is used in the crankcase should be used in the air cleaner. The oil level must be maintained at all times.

(5) *Water pump.*—The grease cap on the water pump should be turned down snugly after every 8 hours of operation. The grease should be replenished when necessary. Use high temperature or soft, water-pump grease (*example,* Alemite No. 38 or equal). Should the water pump leak after considerable use, it is necessary to replace the seal assembly, as there is no adjustment.

(6) *Magneto.*—The magneto points should be checked and cleaned after each 150 hours of operation. The magneto should be lubricated with a small quantity of SAE 50 or 60 oil at this time.

(7) *Spark plugs.*—Spark plugs should be removed, checked, cleaned, and adjusted after each 150 hours of operation or as indicated by missing or hard starting of the

engine. It may be expected that this operation will be required more frequently if high-leaded gasolines are used. The gap should be set to not more than 0.025 inch. Care should be taken when checking spark plugs to replace the correct wire of each plug. These should be marked as removed.

(8) *Battery.*—To prevent failure of the battery it is important to keep the electrolyte level above the plates. Only distilled water or rain water should be added to the battery. The vent holes in the battery caps should be kept open. The battery water level should be checked weekly. The battery cable terminals should be checked to insure that they are clean and tight.

(9) *Generator.*—After each 100 hours of operation the generator should be oiled. Add 8 to 10 drops of light engine oil to each oil hole. The belt tension should be checked and adjusted at this time. Every 3 months or so the brushes and commutator should be checked.

(10) *Starting motor.*—This unit requires no lubrication but the brushes and commutator should be checked every 3 months or so.

(11) *Valves.*—Adjustment should be checked every 150 hours or so. Compression checks should be taken periodically. Valve adjustments and regrinding will be done by motor maintenance men.

(12) *Nuts and bolts.*—A careful check of all nuts and bolts should be made from time to time. Any loose ones should be tightened.

b. Generator and exciter.—(1) *Bearings.*—Quietness of operation and life of ball bearings depend largely on cleanliness and proper lubrication. Never open the bearing housing under conditions which would permit entrance of dirt. Ordinary cup greases are not satisfactory for the lubrication of the generator bearings. A smooth, clean, low-alkali-content grease with a high melting point is required. Do not overlubricate the bearings as this causes overheating and grease leakage. The bearing housing should be kept one-third to one-half full. The grease sump below the bearing should be kept empty at all times. The bearing

should be greased every 500 hours of operation. After each 5,000 hours the bearing housing should be opened and the bearing checked, cleaned, and repacked as described in paragraph 105*a*.

(2) *Brushes.*—Brushes should be checked every 1,000 hours of operation or so. They should be free in the holders and apply sufficient pressure on the ring and commutator. Worn brushes should be replaced, taking care to fit the brush to the ring or commutator. Brushes of the same grade should be used as replacements.

(3) *Rings and commutator.*—Rings should be maintained smooth and true. They should be kept free of oil and dirt. Pitted or grooved rings or commutator should be turned or ground. This will be done by experienced maintenance men.

APPENDIX I

GLOSSARY

Aided tracking.—That method of control in which movement of the control handwheel causes direct displacement as well as change in the rate of movement of the mechanism being controlled.

Alternating current (a.c.).—A current the flow of which varies periodically in both direction and magnitude.

Amplidyne.—The motor generator set whose output runs the antenna drive motor. It serves to amplify the voltage set up by the turning of the MANUAL or RATE controls and traverses the antenna an amount proportional to the movement of the control.

Amplifier.—A device used for increasing the power of a given signal through the use of electronic tubes.

Antenna.—Element used for the radiation and reception of radio waves.

Antenna drive motor.—Motor located in the antenna pedestal that causes the antenna to rotate as controlled by the control unit.

Antihunt.—Circuit used to prevent hunting of the antenna drive system. (See *hunting.*)

Array.—An assembly of antenna units for the purpose of obtaining directivity.

Audio.—Those frequencies that can be heard by the human ear. Approximately 16 cycles to 15,000 cycles per second.

Azimuth.—An angle measured in a clockwise direction from a fixed reference direction usually taken as south in seacoast artillery operations.

Azimuth operator.—Man who watches the azimuth oscilloscope or indicator and operates the azimuth control unit.

Calibrator.—An oscillator, employing a crystal that produces an extremely stable and accurate signal, used to check the recurrence frequency.

Cathode.—Element in an electronic tube from which the electrons are emitted.

Cathode-ray tube.—An electronic tube containing a fluorescent screen on which indications are obtained by deflection of a stream of electrons emitted from the cathode.

Coaxial line.—Transmission line in which one conductor is a pipe, and the other is a tube or rod spaced in the center of the pipe. Coaxial lines are used because they transmit current of radio frequencies with less power loss than other types.

Condenser.—Two conducting plates separated by air or other insulating material. The condenser can store a charge of electricity.

Converter.—Tube circuit in the receiver where the radio frequencies are converted to intermediate frequencies.

Converter grid.—Element of converter tube where radio frequency is applied. Tuning devices are in this circuit.

Detector.—The circuit employed to obtain the intelligence from a radio frequency carrier.

Diode.—Vacuum tube having only two elements, cathode and plate.

Dipole.—The half wave radiating element of the antenna assembly.

Direct current (*d.c.*).—A current the flow of which is always in one direction.

Focus control.—Control on the oscilloscope that concentrates the electron stream to give a sharp image on the screen.

Frequency.—Number of complete events per second.

Grid.—An element within an electron tube that controls the flow of electrons.

Height of site.—Elevation of the antenna above sea level.

Hunting.—Action in which the antenna oscillates about rather than stops smoothly at the point determined by the setting of the control.

Image spacer.—Control on azimuth oscilloscope that varies the distance between pips on the screen.

Image spread.—Control on range oscilloscope that varies the physical length of the 5,000-yard section of the sweep line. At the same time, it varies the width of the notch.

Impedance matching.—Matching of the characteristics of two circuits or lines for minimum loss in transferring energy.

Intensity.—Brightness of the visual image on the oscilloscope.

Interlock switch.—Safety switch which opens the high voltage circuit when any cover or unit is out of place.

Jack.—Fixture into which a plug is inserted to make electrical contact.

Kilovolt (kv.).—1,000 volts (v.).

Kilowatt (kw.).—1,000 watts (w.).

Lobe.—Pattern formed by joining points of equal power in the beam radiated by the antenna.

Lobe switching.—Causing the energy from the antenna to be transmitted alternately in two slightly different directions.

Milliampere.—One one-thousandth of an ampere.

Modulation.—The process of impressing upon a radio-frequency current, a current of lower frequency.

Orientation.—The process of adjusting the azimuth and range indicating mechanisms of an instrument so that the correct azimuth and range of any point will be indicated when the instrument is laid on that point.

Oscillator.—An electron tube circuit generating alternating current.

Oscilloscope.—Instrument, employing a cathode-ray tube and sweep circuits, used in viewing various electrical wave forms.

Phase.—Electrical position of a point on an electrical wave with respect to the beginning of the cycle. May be used to indicate time and time differences.

Phase-shifting condensers.—Condensers used in the range unit to vary the phase relationship, and hence, the time difference between an electric wave that triggers the transmitter and one that triggers the sweep on the range oscilloscope.

Pips.—Images on the sweep line of the oscilloscope caused by the main pulse or returning echoes.

Range operator.—Man who watches the range oscilloscope and places the desired echo in the notch by operating the range handwheel.

Rectifier.—Electrical circuit in which alternating current is converted to direct current.

Recurrence frequency.—Number of pulses sent out per second by the transmitter.

Regulator tubes.—Tubes whose function is to keep the output voltages of the Rectifier RA-49-A constant.

Relay.—An electric switch operated by an electromagnet.

Secondary lobe.—Lobe radiated by the antenna in a direction different from that of the main lobe.

Selsyn.—Self-synchronous motors. When used to indicate the position of a rotating assembly such as the antenna, one selsyn designated the receiver automatically takes the same position as the other selsyn designated the transmitter.

Sensitivity control.—Controls the gain of the receiver, i.e., ratio of output to input.

Shielded.—Protected by metallic covering to prevent magnetic or electrostatic coupling between two otherwise isolated circuits.

Signal-to-noise ratio.—Relation of the strength of the desired signal to the strength of the noise. High ratio means little noise and large signal.

Slewing motor.—Motor in the control unit that drives the antenna controlling selsyn when the RATE control is used.

Superheterodyne.—Type of radio receiver that is very sensitive and selective.

Sweep expander.—Control that determines the physical length of the two sweep lines on the azimuth oscilloscope.

Sweep gain.—Control that determines the physical length of the entire sweep line on the range oscilloscope.

Sweep line.—Line on the oscilloscope screen caused by the application of a saw-toothed wave from a sweep generator to the horizontal plates of the cathode-ray tube. The sweep line of the range oscilloscope represents a definite period of time corresponding to a range of 100,000 yards.

Time interval bell.—Bell used to sound a signal at regular intervals, depending on the observing or firing interval of the battery; it may be used to synchronize the observing, plotting, and firing sections of the battery.

Time meter (integrating clock).—Electrically operated clock that totals the time of (1) operation of the whole set, (2) the transmitter plate circuit, (3) the two power units.

TR tube.—Transmitter-receiver tube located on the duplexing panel. Protects the receiver from overload when the pulse is sent out.

Wave meter.—Adjustable coaxial line section used in determining the transmitter frequency, and, in connection with the monitoring tube, to provide facilities for observing the wave shape of the transmitted pulse.

Appendix II

REFERENCES

1. GENERAL.

TM 11-455. Radio Fundamentals.

Radio Handbook (Radio Ltd., Santa Barbara, Calif.).

The Radio Amateur's Handbook (American Radio Relay League, West Hartford, Conn.).

Fundamentals of Radio (McGraw-Hill Publishing Co.).

2. SPECIFIC.

Operator's Instruction Manual and Parts List for 25 kv.-a. Single-Phase, 60-Cycle, 120-Volt Engine Generator Power Unit. Signal Corps. Type PE-84-C.

WTB-12. War Training Book. Principles and Operation of Radio Set SCR-296-A.

TM 11-1105. Operating Instructions for Radio Set SCR-296-A.

TM 11-1105A. Technical Manual for Radio Set SCR-296-A.

Preliminary Instructions for Radio Set SCR-296-A. (Issued with the set.)

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RESTRICTED

COAST ARTILLERY FIELD MANUAL

SEACOAST ARTILLERY

SERVICE OF RADIO SET SCR-296-A

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D.C., 10 February 1944.

FM 4-95, 15 September 1943, is changed as follows:

CHAPTER 7 (ADDED)

DESTRUCTION OF MATERIEL

■ 110. GENERAL.—Tactical situations may arise, when, due to the limitations of time or transportation, it will become impossible to evacuate all equipment. In such situations, it it imperative that all materiel which cannot be evacuated be destroyed or damaged to prevent—

a. Its capture intact, which will disclose information of assistance to the enemy in neutralizing this type of equipment by countermeasures.

b. The capture intact of certain portions of the equipment, perhaps unknown to the enemy, which may assist him in the development of similar equipment.

c. Its use by the enemy against our own or allied troops.

■ 111. WORKING PRINCIPLES.—*a.* Methods for destruction of materiel subject to capture or abandonment in the combat zone must be adequate, uniform, and easily followed in the field.

b. Destruction must be as complete as available time, equipment, and personnel permit. Identical parts must be destroyed on all like units to prevent the enemy constructing a complete unit from several damaged ones by cannibalization. Since complete destruction takes some time, priorities

must be set up so that the most important *classified* features are destroyed first. Then, even if the process of destruction is interrupted before its completion, the requirements of paragraph 110 will have been met. Next in priority of destruction are *essential parts not necessarily classified.* As these parts are difficult to procure, the lack of them will prevent the equipment from being reconstructed and operated. Next in priority is the complete destruction of the remaining equipment to prevent its use by the enemy for other purposes. Spare parts and accessories must be given the same priority as the parts installed on the equipment.

c. The destruction of materiel subject to capture or abandonment in a combat zone will be undertaken only upon authority delegated by a harbor defense or higher commander. Dependent upon the tactical situation, such commanders will delegate this authority to lower echelons.

d. The accomplishment of adequate, uniform destruction of materiel makes it necessary that—

(1) All units know thoroughly the plans for destruction, including the priority of destruction.

(2) All echelons be trained in the several procedures for destruction.

■ 112. METHODS OF DESTRUCTION.—*a.* The destruction procedures outlined below are arranged in their order of effectiveness. Method No. 1 shall be used whenever time permits and necessary destroying equipment is available. If method No. 1 is impracticable, method No. 2 or method No. 3, in the order named, shall be used.

b. Regardless of the method used, the order of priority indicated below must be followed. Conformation to this priority will result in uniformity of destruction and prevention of cannibalization even though the destruction is not carried to completion.

c. Certain methods described below require special equipment or materiel which normally may not be items of issue. The issue of these items and the conditions under which

destruction is effected will in each case be command decisions based on the tactical situation.

■ 113. PRIORITY AND METHODS.—*a. Destruction of transmitting tubes.*—The dimensions and internal construction of the transmitting tubes constitute information of extreme importance to the enemy. Their destruction must therefore be as complete as possible. Special care must be taken that they be destroyed sufficiently to render their constructional details unrecognizable. If possible, destruction should be performed under the supervision of a commissioned officer. (Methods of destruction should be presented during the training period. At this time stress should also be laid on the fact that it is as important to destroy spare transmitting tubes as those in operation.) Proceed as follows after removing the tube from the transmitter:

(1) *Method No. 1.*—Scoop a hole in the earth slightly larger in diameter and three inches deeper than a steel helmet. Pour into the hole sufficient thermite to fill a steel helmet heaping full. A minimum of 25 pounds of thermite powder or Thermit per tube is required. Lay the transmitting tube on top of the powder and ignite with an M-14 incendiary grenade laid on top of the transmitting tube. After the thermite is burning well, throw a shovel full of dry sand or earth on top of the hole. After the materiel has cooled sufficiently to handle in a shovel, and if time permits, the remains should be hidden in deep water or in a concealed hole.

(2) *Method No. 2.*—If the incendiary grenade and thermite are not available, or if time does not permit, break the glass seals of the filament leads and the output terminal and hide the remains in deep water or bury in a concealed hole. Hiding places should be chosen and prepared in convenient places for all stations.

b. Destruction of printed and written materiel.—All manuals, charts, and written matter pertaining to the equipment should be destroyed by burning, if possible. The burning should take place in a wire basket or mesh container which

has been made available. Pages should be torn out of books, if time permits, and paper should be saturated with gasoline, kerosene, or other inflammable materiel before being ignited. If time permits, the fire should be stirred after it has burned down to insure complete destruction of all pages.

c. Destruction of radio components.—(1) *Priority of destruction.*—The destruction of radio components must be performed as set up in the following priority, in order to insure uniform partial destruction of all the threatened sets if total destruction is interrupted. The priority of destruction is as follows:

(*a*) Modulation generator, with special attention to nonlinear coils.

(*b*) Transmitter, with special attention to modulator tubes.

(*c*) Range unit, with special attention to phrasing condensers.

(*d*) Receiver, with special attention to the preamplifier, local oscillator, and converter sections.

(*e*) Azimuth and range oscilloscopes.

(*f*) Other components.

NOTE.—The above priority as set up includes destruction of the spare components at the same time that the identical components in the set are being destroyed. This is essential and should be stressed in training.

(2) *Detailed methods for destroying radio components.*—(*a*) *Method No. 1.*—Using a sledge hammer, pickax, crowbar, or other heavy tool, smash the tubes, transformer, and coils and rip out wiring and small parts. Leave the cover plates off the units and pile solid material (wood, waste, coal, straw, or other material) in and around the units to be destroyed. Pour gasoline or other inflammable materiel liberally over the units and the solid material. If available, place an open bucket of gasoline on top of each unit and ignite by throwing a gasoline-soaked torch into the equipment from a safe distance. Make sure the fire extinguisher has been removed and discharged.

(*b*) *Method No. 2.*—Place TNT blocks or other high explosive inside the components and detonate with all cover plates on. Use a detonating cap and detonating cord (Primacord) to obtain simultaneous detonation. (See FM 5-25.) Saturate all components and the building with gasoline and ignite, following method No. 1 as far as possible.

(*c*) *Method No. 3.*—Saturate all radio components and radio house with gasoline or other inflammable liquids. Scatter fragmentation grenades throughout the equipment and ignite the gasoline.

NOTE.—Destruction by burning is considered to be most effective from the standpoint of making the equipment useless. Inflammable liquids should be kept handy at all times.

d. Destruction of antenna and tower.—(1) *Method No. 1.*—The antenna dipoles, antenna harness, and lobe-switching mechanism should be battered with a sledge hammer or other heavy instrument. The tower may be collapsed by fastening explosive charges (TNT or dynamite) to each of the tower legs and detonating. The antenna and housing should then be saturated with gasoline and burned.

(2) *Method No. 2.*—Place a heavy explosive charge on the base of the antenna just below the lobe-switching mechanism and detonate. Burn the remains by the means explained above for other components.

(3) *Method No. 3.*—Saturate the antenna and housing with gasoline and burn.

e. Destruction of power units and accessory motors.—Power units are items of standard manufacture by our enemies, and therefore need be destroyed only sufficiently to prevent their use by the enemy. Electric motors and generators may be destroyed beyond use to the enemy by simply cracking or breaking the bearing cases at each end of the motor or generator. This may be done with a hammer or other heavy instrument. The motor may then be saturated with gasoline and burned. However, it must be remembered that the enemy can rewind the coils, and therefore burning alone is not an effective method for destroying

a motor. Gasoline engines may be destroyed beyond use by cracking cylinder blocks, cylinder heads, and crank cases, and by smashing the carburetors and ignition systems. This may be done with explosives or by sledging the equipment with a heavy tool.

[A.G. 300.7 (21 Jan 44).] (C 1, 10 Feb 44.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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