CHAPTER 6

RADAR EQUIPMENT

The modern warship has several radars. Each radar is designed to fulfill a particular need, but it also may be capable of performing other functions. For example, most height-finding radars can be utilized as secondary air-search radars; in emergencies, fire control radars have served as surface-search radars. To familiarize you with some of the capabilities and limitations of radars and radar accessories, this chapter is devoted to describing the characteristics and uses of various shipboard radar equipment.

Because there are so many different models of radar equipment, the radars and accessories described herein are limited to those common to a large number of ships in the active fleet, and to those that are replacing older equipment currently installed in the fleet.

SURFACE-SEARCH RADARS

As you learned in the preceding chapter, the principal function of surface-search radars is the detection of surface targets and low-flying aircraft and the determination of their range and bearing. A common surface-search radar in use today is the AN/SPS-10( ).

RADAR SET AN/SPS-10( )

Designed for installation aboard destroyers and larger ships, the AN/SPS-10( ) is a medium-range, two-coordinate (bearing and range) surface-search and limited air-search radar (fig. 6-1). Its maximum range when detecting surface targets is greater, normally, than the optical horizon as viewed from the antenna reflector. Actual detection range depends on a number of conditions, including antenna height, target size and composition, weather conditions, and the density of the atmosphere. You can normally expect to detect targets 1 1/4 times the optical horizon, due to the refraction of RF energy near the earth's surface. In some instances, targets have been detected at distances exceeding 100 miles.

The AN/SPS-10( ) operates in the frequency range 5450 to 5825 MHz, with a peak power output of 285 KW. Its magnetron is tunable over the entire frequency range. This feature is desirable so that its operating frequency can be changed to minimize interference from other radar sets operating at the same frequency.

Two pulse widths are available. The long pulse (1.3μsec) provides a longer detection range than the short pulse (0.25μsec). In addition, the pulse repetition rate (PRR) can be varied between 625 and 650 pulses per second (PPS), which will enable the operator to check for "second time around echos".

The antenna used with the AN/SPS-10( ) is a horn-fed, truncated parabolic reflector, which rotates in a clockwise direction at an average speed of 16 RPM. Radiated signals have a beam width of 1.5° in the horizontal plane and between 12° and 16° in the vertical plane.

The major units of the AN/SPS-10( ) are shown in figure 6-1. These units are typical of those employed in most surface-search radar systems.

RADAR SET AN/SPS-5( )

The AN/SPS-5( ) radar set is used on ships of escort size and smaller. Classed as a medium-range surface-search radar, the AN/SPS-5( ) has a tunable magnetron that permits selection of any operating frequency between 6275 and 6575 MHz. (Later models of the AN/SPS-5 have a frequency range of 5450 to 5825 MHz.) Power output varies between 170 and 285 KW, depending mostly on the operating frequency selected. A pulse length of 0.37μ sec is used as a compromise between long

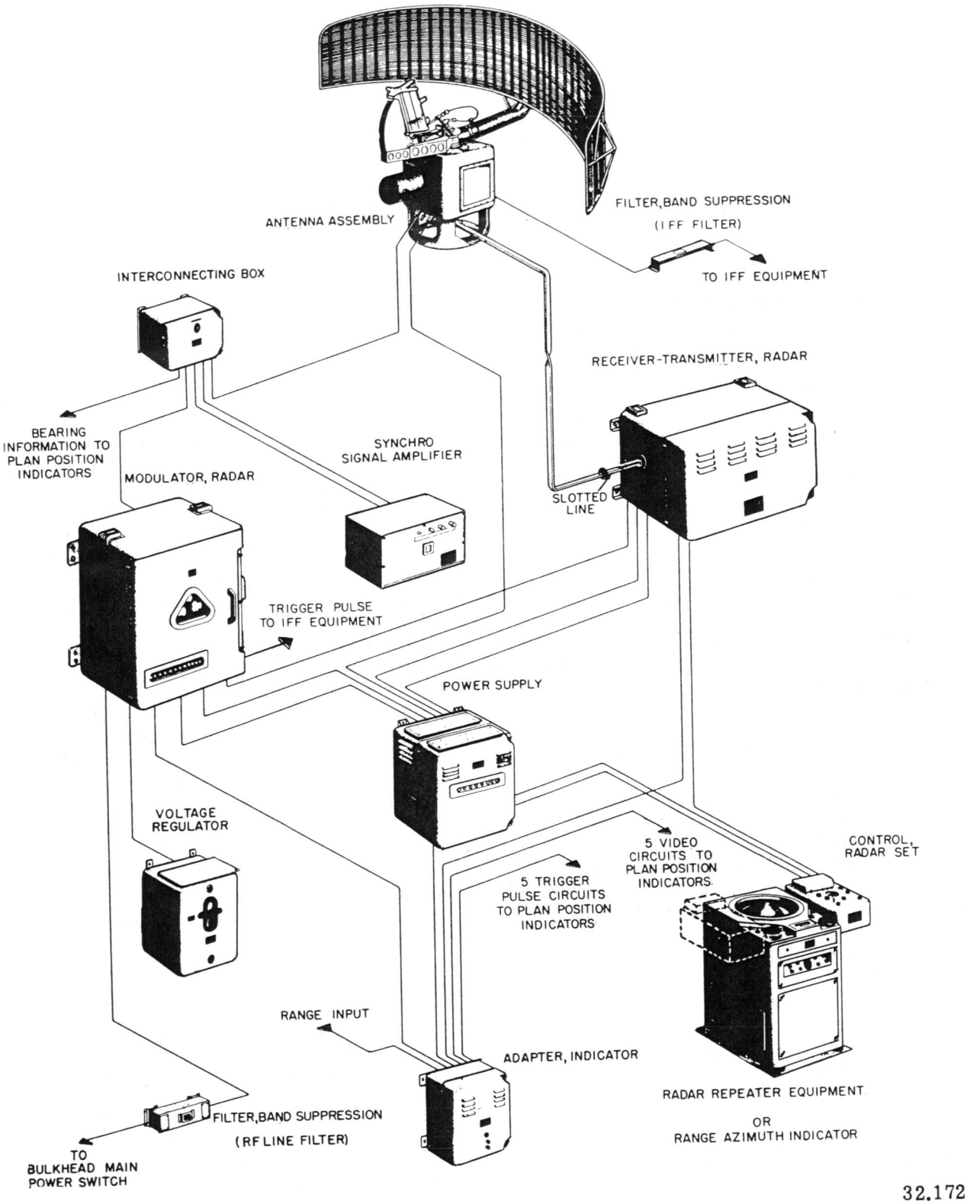

Figure 6-1.—Surface-search Radar Set AN/SPS-10( ) system.

and short ranges. The antenna is similar to that of the AN/SPS-10( ).

RADAR SET AN/SPS-21( )

The AN/SPS-21( ) is a short-range, compact surface-search radar designed principally for installation aboard small ships. It also is installed on some of the larger auxiliary ships for use as a close-range navigational radar. Being a short-range equipment (75 yards to 16 miles), the set has a narrow pulse width of 0.2 μ sec and a low power output of 10 KW. Its operating frequency is selectable within the frequency range 5500 to 5600 MHz, and it employs a parabolic antenna that radiates a beam 2° wide in the horizontal plane and 15° high in the vertical plane.

RADAR SET AN/SPS-53A

Radar Set AN/SPS-53A (fig. 6-2) is a surface-search radar operating in the 9345 to 9405 MHz band and is capable of detecting surface targets up to maximum range of 32 miles. The set operates from a 115-volt, 60 hertz power source.

The antenna rotates at 15 RPM to provide search facilities for both surface and low-flying targets. The feed assembly, containing the slotted-array radiating element, produces a vertical beam width of 20 degrees and a horizontal beam width of 1.6 degrees. The vertical plane beamwidth allows enough latitude to keep the target in the beam pattern during ship's pitch and roll.

AIR-SEARCH 2-COORDINATE RADARS

The primary function of air-search radars is the long-range (greater than 50 miles) detection of aircraft targets and the determination of their ranges and bearings. These radars search 360° in azimuth from surface to high elevation angles.

Some of the most widely used 2-coordinate air-search radars in the fleet are: AN/SPS-6C; AN/SPS-29( ); AN/SPS-40; -40A; AN/SPS-37, -37A; and AN/SPS-43, -43A. These radar sets use the PPI display indicators for determining range and azimuth.

The main design features of the 2-coordinate air-search radars are basically the same. They may, however, vary in frequency, range, type of antenna, and in design techniques. All of these radar sets, except the AN/SPS-6C use a Moving Target Indicator (MTI) to discriminate against clutter of stationary objects and to emphasize only moving targets.

All of the above 2-coordinate radars, except the AN/SPS-6C and -29, transmit long pulses from a generated narrow pulse and then receive and compress the long pulse back into a narrow pulse. This minimizes the peak power requirements of the radar set without impairing the range resolution. These modified shaped pulses also reduce interference with other shipboard electronic equipments.

RADAR SET AN/SPS-6C

The AN/SPS-6C is a ship-borne, air-search, 2-coordinate radar for target bearing and ranging. This high-power (500 KW) long-range set is used in the fleet for detecting, ranging, and tracking both conventional and jet aircraft.

A description of the AN/SPS-6C radar set follows. The power transformer (fig. 6-3) steps down the ship's voltage to the 115 volts required for operation of the radar set. The line disconnect switch is bulkhead mounted. The electrical filter assembly prevents any RF pickup of the main power circuits from entering the radar transmitter-receiver.

The radar transmitter-receiver console (fig. 6-3) has the operating controls in the top compartment. The echo box is used to measure frequency. The transmitter-receiver is tunable to any operating frequency within the range of 1250 to 1350 MHz, and provides a choice of pulse lengths (1 or 4 μ sec). The transmitter RF signal is transmitted through the rectangular waveguide to the antenna. The directional coupler permits a sample of transmitted RF energy to be coupled to the echo box.

The antenna is a unidirectional transmitting and receiving type with a 30° vertical beam width and a 3 1/2° horizontal beam width. The reflecting surface is a section of a parabola. The feed horn is a dual frequency radiator for radiating RF energy for both radar and IFF recognition sets. The antenna control unit supplies DC power to rotate the antenna pedestal.

The radar set control contains the remote controls used for operation. Antijamming controls are also located here in recess behind a small door.

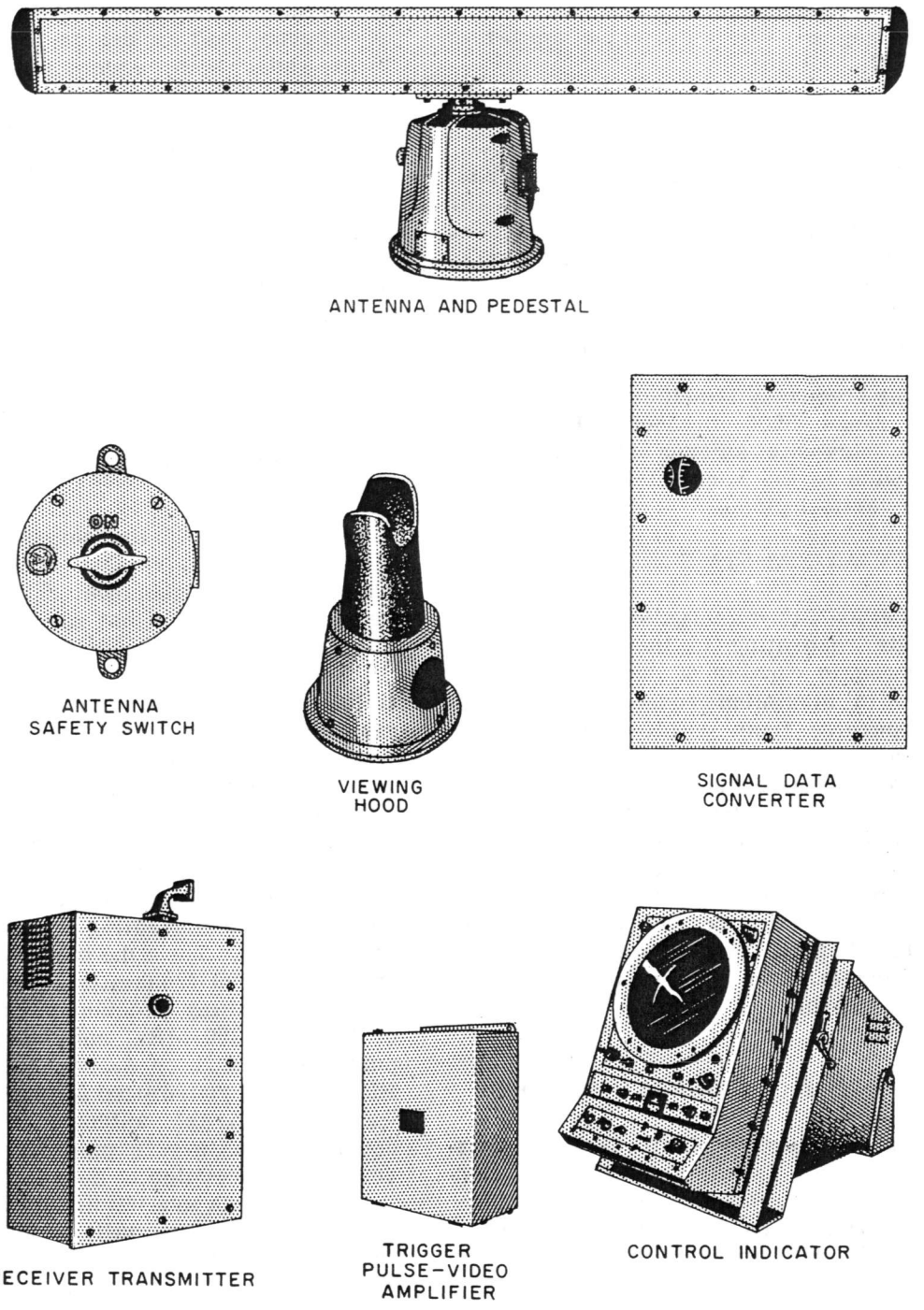

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Figure 6-2.—Surface-search Radar Set AN/SPS-53A units.

The video amplifier amplifies signals from the radar receiver and supplies video outputs to the PPI indicator. This cabinet is designed for bulkhead mounting.

The range indicator is used to indicate target range information. The 5-inch screen is accompanied with a viewing hood.

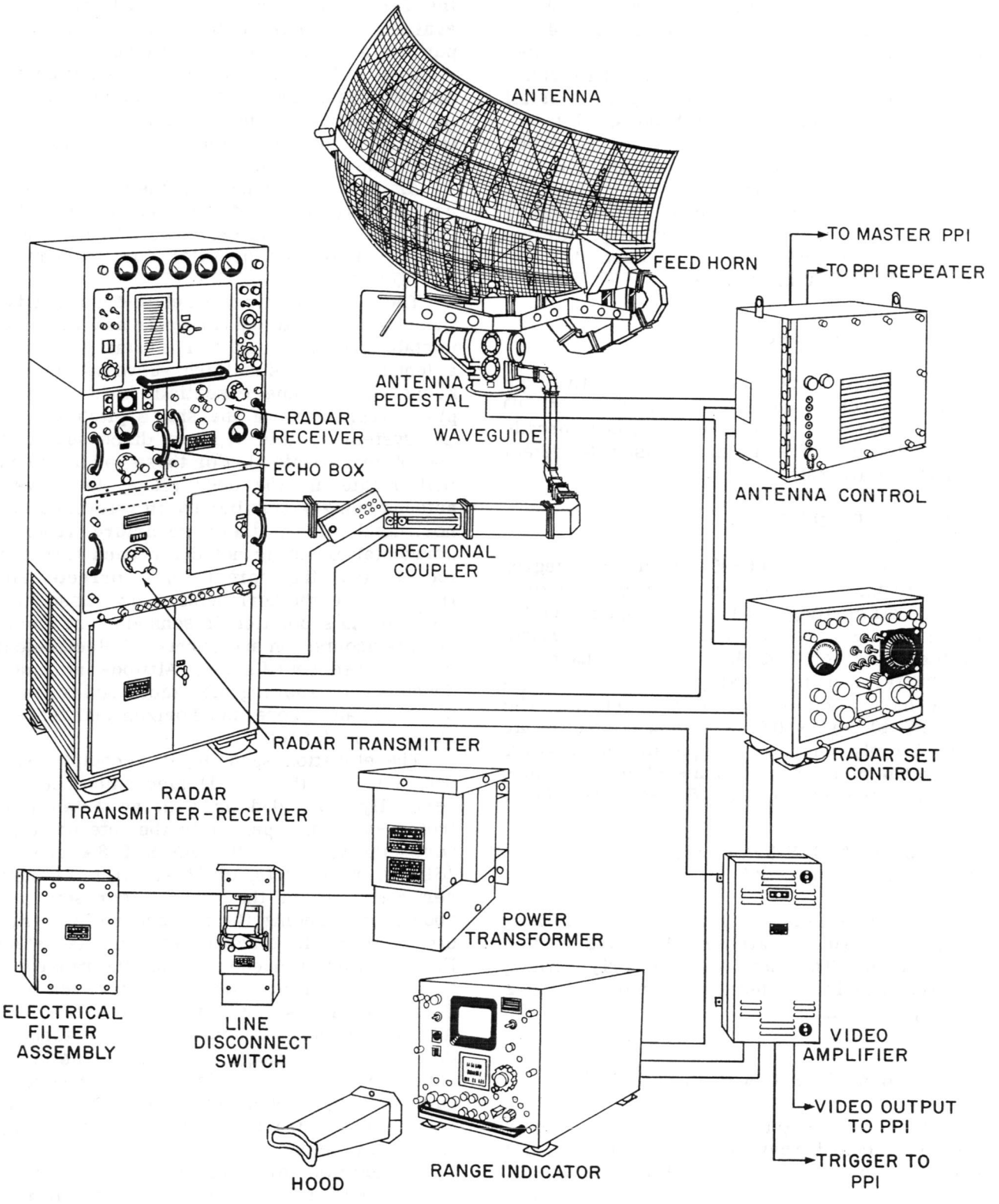

Figure 6-3.—Air-search Radar Set AN/SPS-6C system.

The AN/SPS-6C is an older set but still being used on destroyers and auxiliary ships. The set is capable of tracking aircraft at low altitudes. It also is suitable for limited surface tracking and navigation. This radar excels, however, in detecting targets of small reflective surface at high altitudes. Jet aircraft are detected at altitudes up to 40,000 feet and at distances as far out as 60 miles. Large conventional aircraft flying at high altitudes normally are picked up in the range of 70 to 140 miles, whereas smaller targets (such as fighters) are detected when they are between 60 and 80 miles away.

RADAR SET AN/SPS-29( )

The AN/SPS-29( ) is a representative type of air-search radar found on ships of DD size and larger. It uses the co-linear broadside antenna. The radar is used to detect high flying aircraft.

RADAR SET AN/SPS-40

The AN/SPS-40 and -40A feature an integral IFF antenna and radar antenna combination, thereby eliminating the need for separate units. Being a light weight and a smaller radar system, the AN/SPS-40 and -40A have the capability of being installed on smaller ships which have a 2-dimensional requirement. The AN/SPS-40 and -40A is a long-range radar used largely on escort ships and destroyers. A general pictorial and nomenclature of units are included on the AN/SPS-40 (fig. 6-4).

Radar Sets AN/SPS-37 or -37A
And AN/SPS-43 or -43A

Both radar sets are high power, very long range, 2-coordinate air search radars used on large ships. They are used for early warning and are capable of detecting fast moving targets at very long range.

AIR SEARCH 3-COORDINATE RADARS

Among the height-finding radars currently installed aboard Navy ships, some of the most common are the AN/SPS-8A, AN/SPS-30, AN/SPS-42, AN/SPS-39A, AN/SPS-52, and AN/SPS-48(V).

The 3-coordinate radar functions much like the 2-coordinate system, but will provide elevation, in addition to a horizontal search pattern, a vertical search pattern.

Most radars present only range and bearing, so their beams are narrow in azimuth and broad in the vertical plane. The beams of height-finding radars are quite narrow vertically, as well as in the horizontal plane.

Azimuth is provided as the antenna rotates continuously at speeds varying up to 15 RPM or selected data rates. The antenna may be controlled by the operator for searching in a target sector.

There are two types of height-finding radars, those with stabilized antennas and those with unstabilized antennas. The stabilized radar antennas have a stabilized servosystem which keeps the antenna essentially in a horizontal plane regardless of the ship's pitch and roll. (A system of this type is discussed at the end of this chapter.) For those radar antennas that rotate in the deck plane, the physical antenna being unstabilized with reference to the horizontal plane, their departure from the horizontal plane is noted for each target detected and the target data corrected electronically to the horizontal plane. Essentially, the antenna's position is sensed at the moment of data acquisition and corrected electronically to stabilized coordinates. Altitude information depends upon knowing the exact angular position of the beam above the horizon and the slant range to the target.

The elevation scanning is accomplished by one of two methods: (1) mechanical scanning vertically up-and-down with an antenna-feed (rotary-switch) type, while the antenna rotates horizontally, as in the AN/SPS-8A and AN-/SPS-30 radar sets, or (2) electronic scanning vertically, as in the other radar sets listed above, by changing the frequency of the transmitted beam in discrete increments (steps). Each applied frequency causes the radar beam to be radiated at a different elevation angle. Each step has its own particular scan frequency. As the frequency increases or decreases, so does the slant range conversion factor. A computer can electronically synchronize the radiated frequency and give electronic scanning 3-coordinate radars a high data rate and high angle conversion.

In addition to radar indicators used for 2-coordinate radar systems, the 3-coordinate systems also employ a RHI (range height

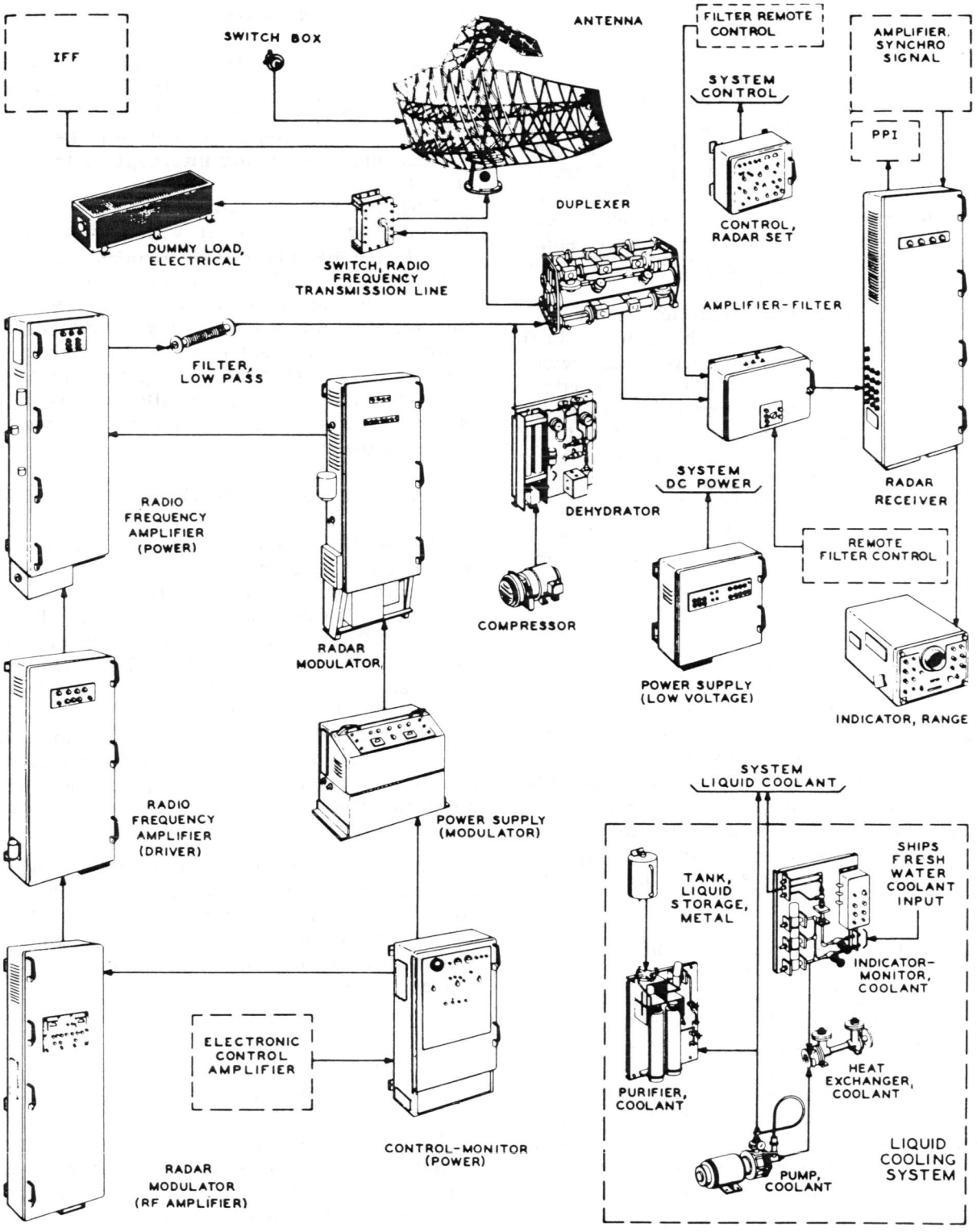

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Figure 6-4.—Air-search Radar Set AN/SPS-40 system.

indicator) for air search and interceptor direction. These radars may use noise clutter and pulse compression techniques.

RADAR SET AN/SPS-8A

Radar Set AN/SPS-8A is a high-power, shipboard, height-finding radar system, and may be used for fighter aircraft direction. The set presents target height, slant range, bearing, and beacon (IFF) information on remote radar repeaters and range-height indicators. The AN/SPS-8A radar is found on large ships (cruisers and carriers mostly) and many destroyer radar picket ships.

The operational characteristics of the AN-/SPS-8A are: frequency in the 3430 to 3550 MHz range, peak power 650 KW, pulse width 1 or 2 μ sec, PRR 500 to 1000 PPS, vertical beam width 1.1° , and horizontal beam width 3.5° scanning any vertical 12° sector from 0 - 36°. Antenna rotation rates are 1, 2, 3, 5, or 10 RPM. The antenna may be made to scan any sector from 30° to 200° horizontally, or it may be trained manually. Maximum range using 1-μ sec pulse is 83 miles; with 2-μ sec it is 165 miles. Minimum range is approximately 4,500 yards.

RADAR SET AN/SPS-30

The AN/SPS-30 (fig. 6-5) is a high-power, long-range shipboard radar system for air search and interceptor direction of aircraft. It provides information for individual and multiple targets at a fast data rate and presents the information on PPI and RHI indicators. The AN/SPS-30 uses a stabilizing servosystem and mechanical scan, the same as the AN/SPS-8A.

RADAR SETS AN/SPS-42 AND -39A

The AN/SPS-42 with minor modifications became the AN/SPS-39A radar set. These 3-coordinate radar sets provide three-dimensional position data under all weather conditions on surface and airborne targets. The radar sets provide a means for detecting moving targets in the presence of obscuring echoes and for detecting targets that would be obscure due to large antenna side lobe return. The main functional sections are: the synchronizing, transmitting, receiving, side lobe suppression, antenna positioning, indicating, power distribution, waveform converting, and testing.

RADAR SET AN/SPS-52

The AN/SPS-52 (fig. 6-6) is a long-range and short-range radar. It is largely installed on guided missile destroyers. It provides the target input data required to support the missile system and employs air intercept control techniques.

The AN/SPS-52 radar utilizes a general-purpose digital computer with both automatic and off-line diagnostic test routines. In addition, it is possible to change the radar programs by use of the input/output radar printer. To enhance detection and accuracy, a digital display indicator is furnished with the radar set.

The radar set employs a planar high gain antenna radar system which allows a larger part of the radar system to be located in compartments below deck.

RADAR SET AN/SPS-48(V)

The AN/SPS-48(V) is a very versatile radar with many modes of operation. It provides the necessary target input data required to support the Navy surface missile systems (Tartar, Terrier, Talos) and also fills the requirement for air intercept control. The system is installed on guided missile destroyers, frigates, cruisers, and aircraft carriers.

The radar is composed of six major units: antenna, transmitter, receiver, two computers and frequency control group, plus a number of small auxiliary power units, data converters, and a control console.

The equipment uses solid state, modular construction techniques extensively and operates on 400 hertz primary power. The below decks weight of the radar is approximately 17,000 pounds and the antenna weights 4,500 pounds.

FIRE CONTROL AND MISSILE GUIDANCE RADARS

Electronic equipment in the fire control and missile guidance systems is closely related to mechanical and optical equipment both physically and electrically. Although the use of radar is merely a part of a whole fire control or missile

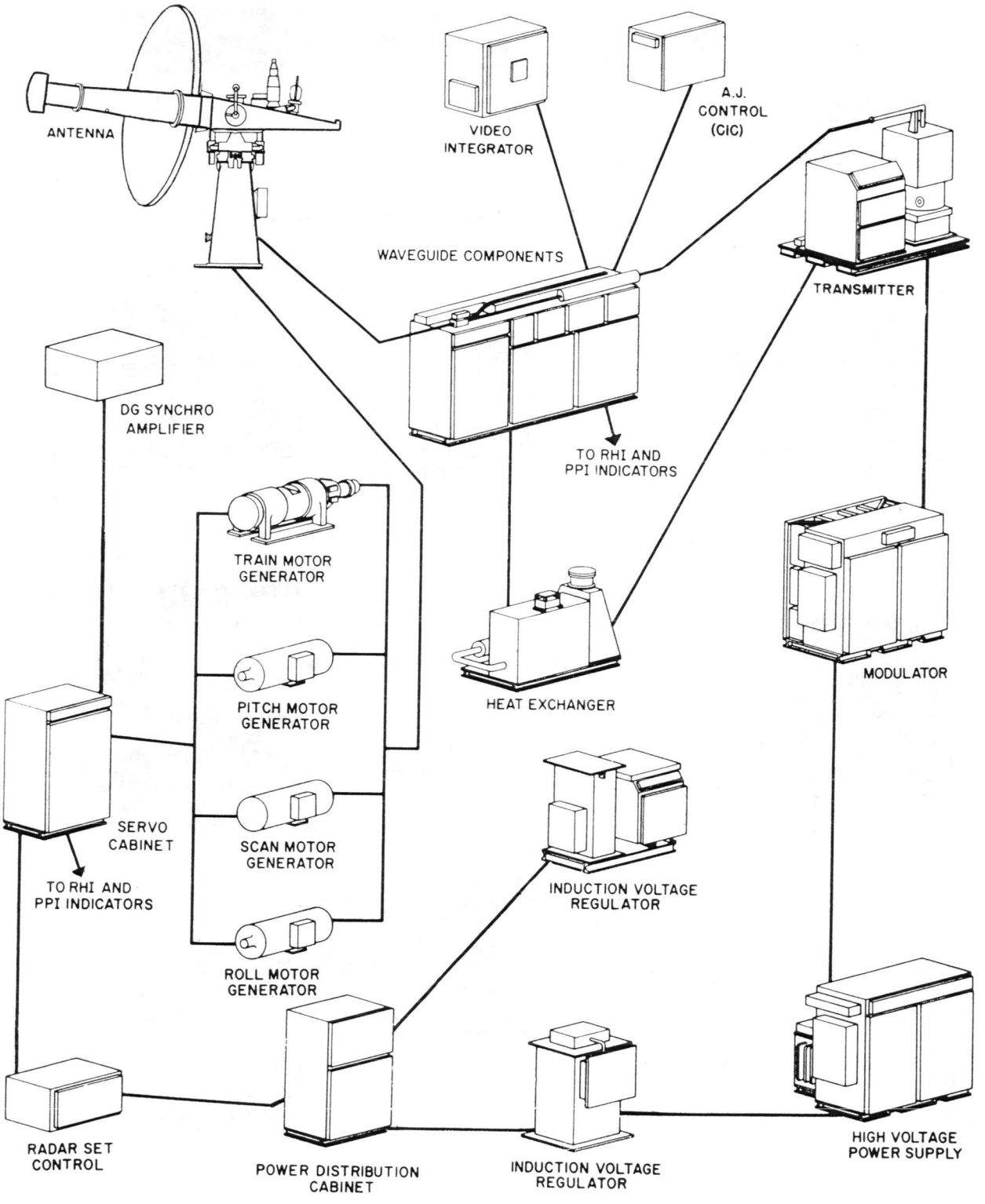

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Figure 6-5.—Air-search Height-finding Radar Set AN/SPS-30 system.

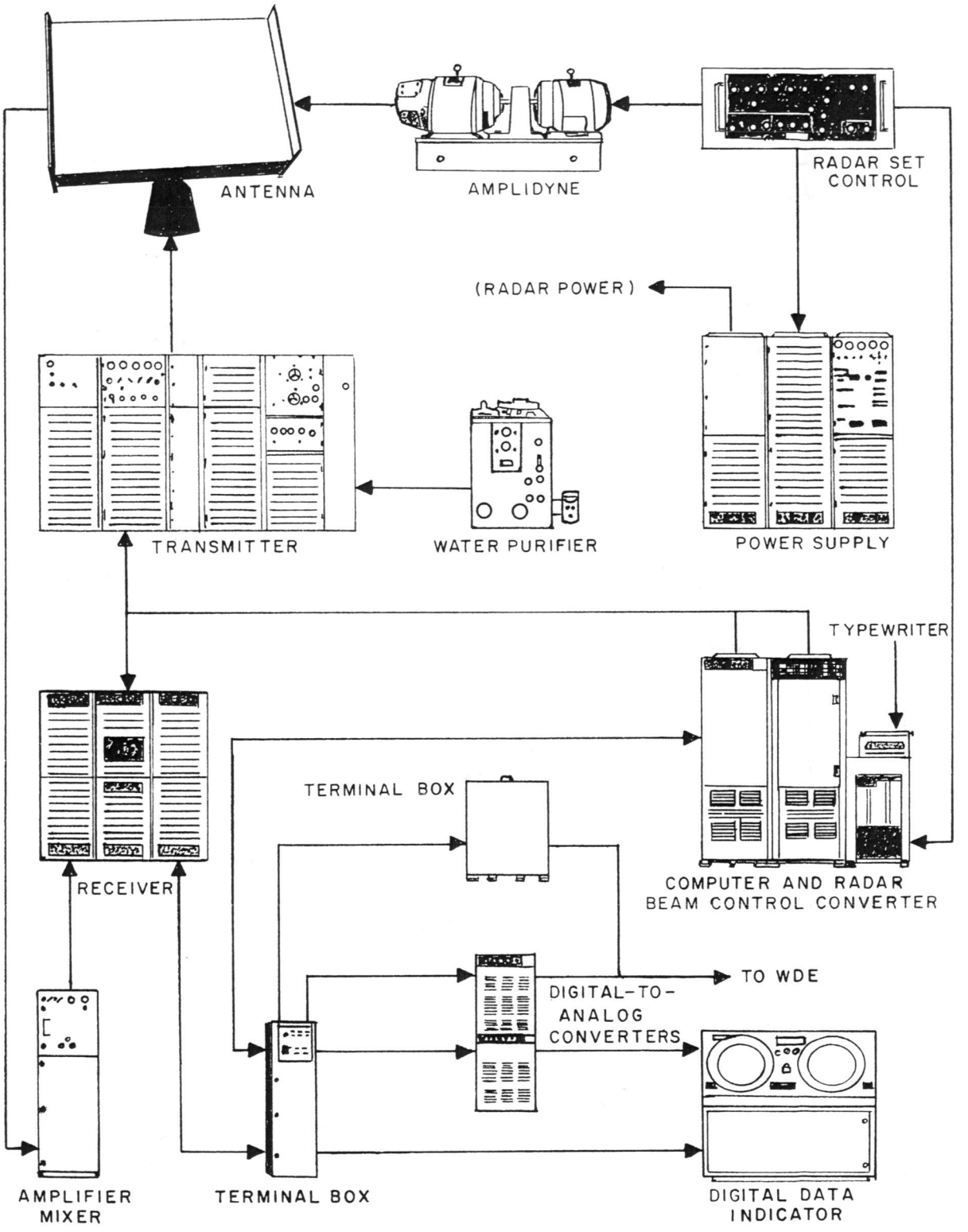

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Figure 6-6.—Air-search Height-finding Radar Set AN/SPS-52 system.

guidance problem, only the radar is discussed in this text.

FIRE CONTROL RADARS

Among the radars used for gun fire control are radar sets Mk 25, Mk 34 (also designated AN/SPG-34), Mk 35, AN/SPG-50, and AN/-SPG-52. The Mk 25 and Mk 34 are described here.

Mk 25 Mod-( )

The Mk 25 radar (fig. 6-7 an extremely accurate equipment, is capable of tracking either surface or air targets. It is used principally in 5-inch 38-caliber gun fire control systems, but serves equally well for controlling guns of other calibers.

This equipment operates on 5200 to 10,900 MHz frequency band, with a peak power output of 50 KW and a pulse width of 0.2μsec. Its accuracy in bearing is $\pm 0.1^{\circ}$; range in yards is ± 15 yards to ± 0.1 percent of the range; and elevation is $\pm 0.1^{\circ}$.

Early models of the Mk 25 has a maximum range of 50,000 yards. Those now in use can track targets at distances up to 100,000 yards.

Mk 34 Mod-( )

Another fire control radar capable of tracking either surface or air targets is the Mk 34. It was designed for heavy machinegun batteries, but its most common use today is in the Mk 63 fire control system that controls our 3-inch guns. When used in this system, the radar usually is listed as the AN/SPG-34.

Operating in the 5200 to 10,900 MHz frequency band with a peak power output of 32 KW and a pulse width of 0.5μ sec, the Mk 34 can track targets at distances greather than 30,000 yards. Its maximum range, however, is considerably less than the range of the Mk 25.

The antenna for this radar may be found on the gun platform itself (Mk 63 system) or on a separate director.

MISSILE GUIDANCE RADARS

Missile guidance radars currently installed in the fleet are listed here for the purpose of making the reader aware of their existence and use. The Tartar missile weapons system utilizes Radar Set AN/SPG-51. This radar provides a continuous wave radiofrequency output for the Tartar homing missle.

The Terrier missile weapons system uses 1 of 4 radar models. The AN/SPQ-5 and AN/-SPG-55 models are for beam riding Terrier missiles only. The AN/SPG-55A have dual capabilities. It can be used with Terrier beam rider or Terrier homing missiles.

The Talos missile weapons system uses two radar sets: the AN/SPW-2 for beam riding guidance; and the AN/SPG-49 for tracking.

AUXILIARY EQUIPMENT

The equipment covered in the remainder of this chapter is used with the various radars we have discussed. In some instances, this auxiliary equipment is in a system that facilitates the use of radar; in others, it is in the radar system itself.

REPEATERS (INDICATORS)

As the tactics of warfare became more sophisticated, there was more and more evidence that the information obtained from radar would have to be displayed at any one of several physically separated stations. The size and weight of the relatively bulky and complex radar console made it unsuitable for remote installations. The need was for a smaller and lighter general-purpose unit, capable of accepting inputs from more than one type of radar. To fulfill this need, the present-day remote indicator (repeater) was developed.

Several types of radar repeaters currently installed on Navy ships are described in the following topics.

Remote Indicator AN/SPA-4( )

The AN/SPA-4( ) range-azimuth general-purpose indicator (fig. 6-8), a remote PPI type of repeater, is used chiefly for surface search and station keeping. It utilizes a standard 10-inch, flat-face cathode-ray tube to show range and azimuth of a target. It is a self-contained unit designed for operation with any standard Navy search radar system having a pulse repetition frequency between 140 and 3000 PPS. This repeater may be employed to select radar information from any one of several radar systems. A

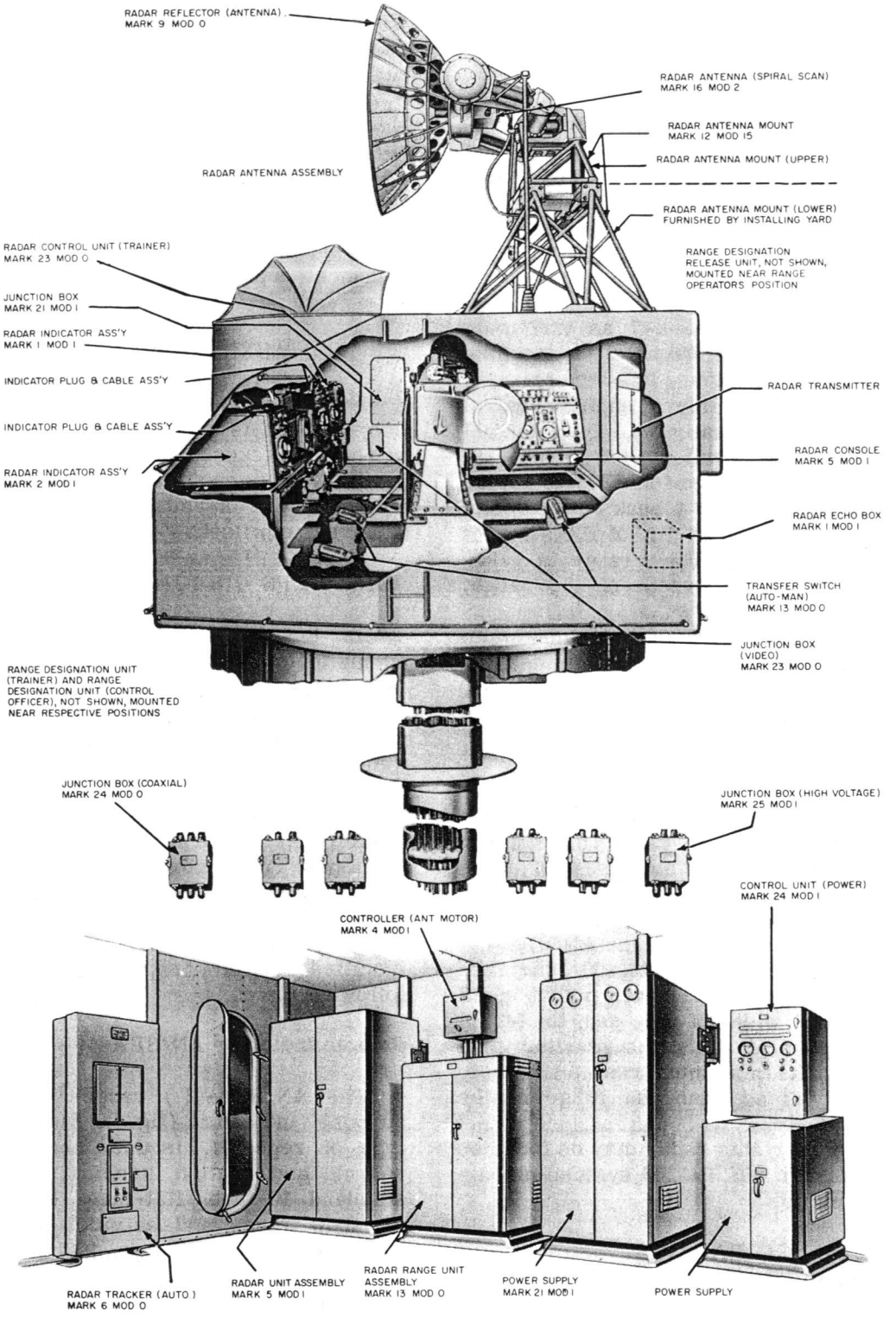

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Figure 6-7.—MK 25 radar system.

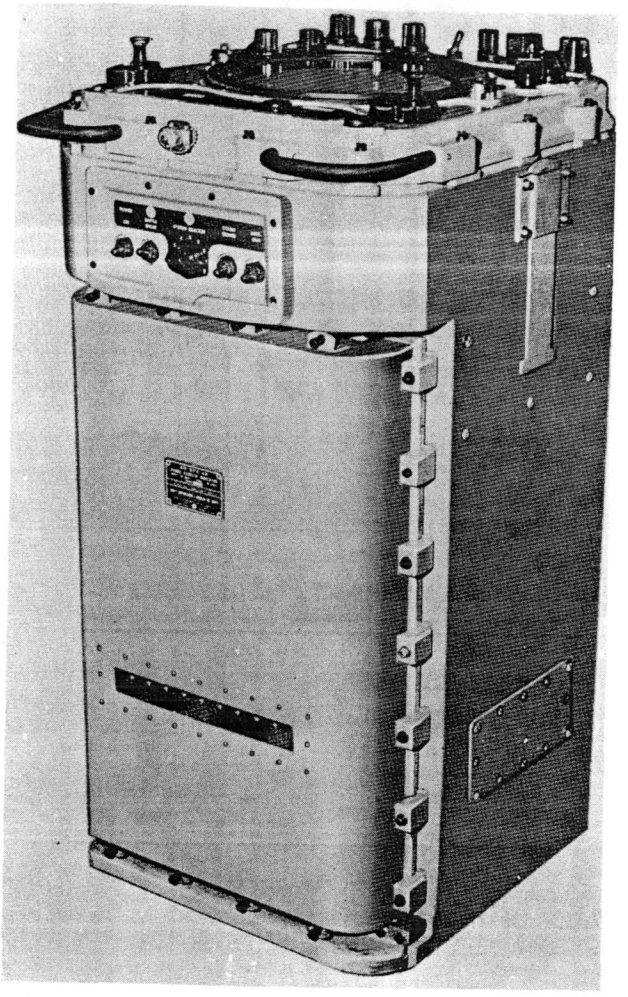

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Figure 6-8.—Range-Azimuth Indicator AN/SPA-4( )

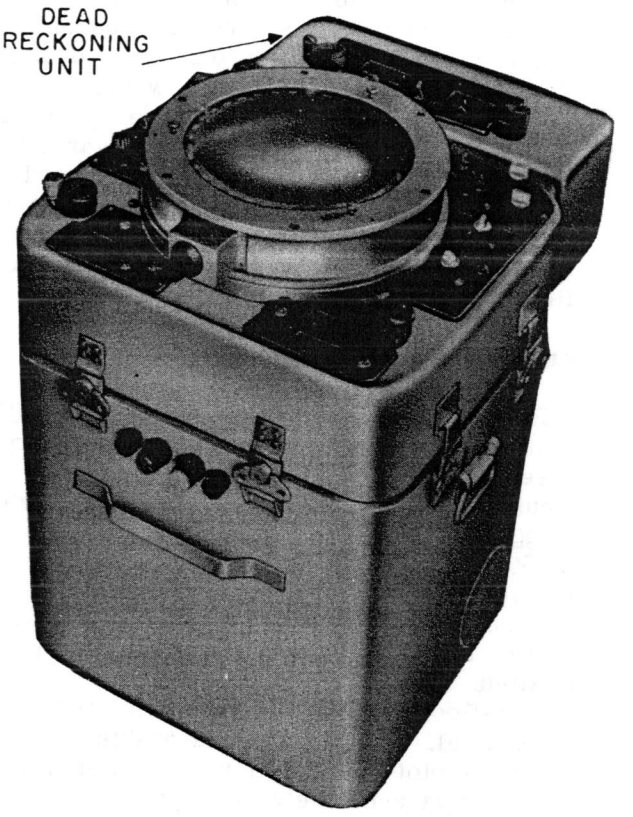

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Figure 6-9.—Range-Azimuth Indicator AN/SPA-25 with dead reckoning auxiliary unit attached.

variable (rubber) range control is incorporated, whereby the range may be varied continuously from 1 to 300 miles.

Remote Indicator AN/SPA-25

The Range-Azimuth Indicator AN/SPA-25 (fig. 6-9) is a light-weight transistorized general-purpose plan position indicator with a standard 10-inch screen designed for operation with any standard Navy search radar system having a pulse repetition frequency of 10 to 5000 PPS (pulse per second). The indicator can be employed to display radar information from any one of up to seven radar systems, depending on the installation. The AN/SPA-25 incorporates continuous range variation from 1 to 300 miles, time sharing of the electronic cursor sweep with the video sweep, and a sweep offset capability when a Dead Reckoning Auxiliary Unit is employed. Without the dead reckoning unit, the indicator does not have the offset capability.

Range may be determined in two ways: by using the range rings, which occur at 1/2-, 1-, 2-, 5-, 10-, 20-, or 50-mile intervals for the operator's selection, or by using the electronic range strobe and a direct-reading mechanical counter.

Bearing (azimuth) may be determined in two ways: by using the electronic cursor and azimuth scale or by using the electronic cursor and a direct reading mechanical counter.

Remote Indicator AN/SPA-18

The AN/SPA-18 is a small, compact, remote PPI that presents range and bearing information on a 7-inch screen. It is designed for installation on small ships where space is limited. The unit is sealed in a sprayproof cabinet, and can be mounted in unprotected areas either on the bulkhead or on a shelf.

This repeater has a continuously variable range scale of 2 to 30 miles. It can be operated with any standard Navy search radar having a PRR of 57 to 3000 PPS.

Remote Indicator AN/SPA-50A

Range-Azimuth Indicator AN/SPA/50A (fig. 6-10) is a transistorized, direct-view, large-screen (22-inch) PPI designed to display the output of any standard search-radar system having a pulse rate frequency between 15 and 5000 PPS. The indicator unit will display the signals from any standard search radar.

It normally uses only the electronic bearing cursor, although a mechanical cursor can be installed.

A reflector plotter is shown separately in figure 6-10. A plotting head enables the operator to plot the position and motion of a radar target accurately on a planned position indicator.

The foregoing AN/SPA-4, -25, -18, and -50 remote indicators are used primarily with surface search radars. The following Remote Indicators AN/SPA-8, -33, -59, -34, -66, -40, -41, and -43 are used more with air search radars.

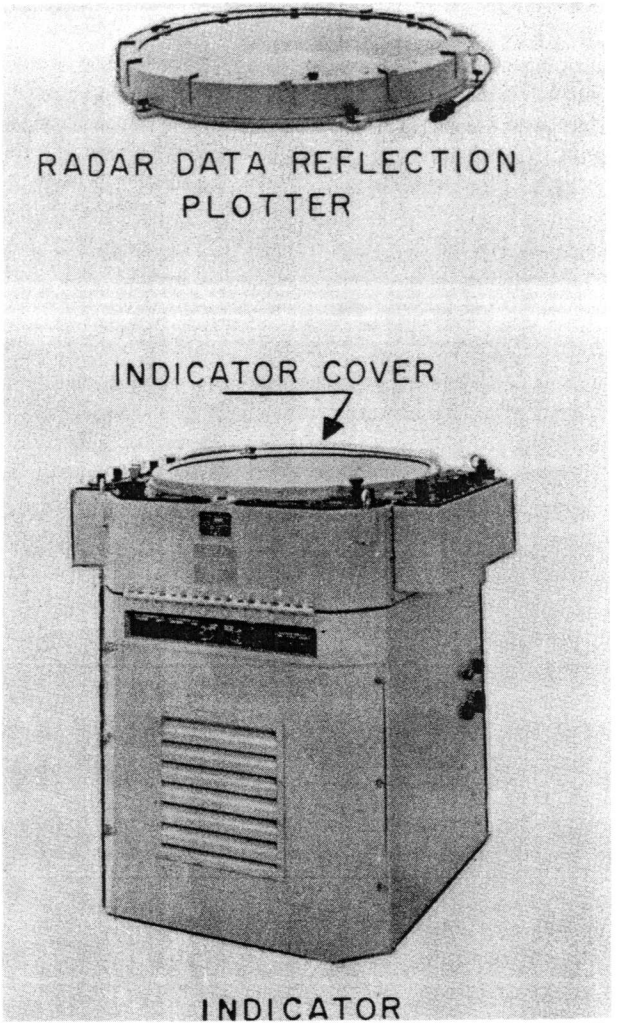

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Figure 6-10.—Range-Azimuth Indicator AN/SPA-50A.

AN/SPA-8( ) Remote Indicator

The AN/SPA-8, -8A, -8B, -8C, are general-purpose PPIs employed with shipboard radars to display range and bearing information. These repeaters have offcentering capabilities and may be used as master or remote PPI indicators, as relay search repeat indicators, or as radar relay search repeat indicators, or as radar relay search tracking indicators. They have the capability for being utilized as tracking and repeat indicators with the shipboard section of the airborne early warning (AEW) system.

This equipment features (1) continuous-range sweep variation without loss of target, (2) time sharing of the electronic cursor and range sweeps or the strobe and range sweeps, and (3) sweep and cursor offcentering, which make target identification possible without geographic distortion. All these features are incorporated in the indicators. The AN/SPA-8 cannot be used for tracking but is used for a repeater (sometimes called a slave.) The AN/SPA-8A, -8B, and -8C are single indicators used either for tracking purposes or as slaves. Some of its special features follow.

1. Manual offcentering: Any target within 250 miles may be centered on the scope.

2. DRA offcentering: Information from the ship's dead reckoning analyzer (DRA) may be fed to the repeater. This DRA information cancels own ship's motion, and shows all targets

(including own ship) moving on their true courses.

3. Electronic cursor and range strobe: Provided with a centered or offcentered electronic cursor and range strobe. Origin of offcentered cursor and strobe may be controlled independently from sweep by tracking cranks.

4. Range scale: Rubber range, 4 to 300 miles, continuously variable, with a choice of six different scale spacings between range rings.

5. Tracking cranks: Used to position origin of strobe or electronic cursor. The tracking cranks may be locked so that the repeater can be used as a final (repeat) AEW indicator.

Remote Indicators AN/SPA-33 and AN/SPA-59

The AN/SPA-33 and -59 are remote indicators (fig. 6-11) which have offcenter capabilities and may be operated either as a general-purpose PPI or as a part of an AEW system. The only difference between these two sets is that the AN/SPA-33 has a 300-mile range and the AN/SPA-59 has a 400-mile range.

They have practically the same controls and capabilities as the AN/SPA-8A, -8B, -8C. At first glance they look alike, but a closer check shows that the AN/SPA-33 and AN/SPA-59 have two joysticks (switches) in place of the range and bearing cranks on the AN/SPA-8( ). The joystick on the left is for the cursor orgin; the one on the right is for the range strobe and cursor bearing line. Another difference between the two repeaters is that the AN/SPA-8A, -8B, 8C has provision for a DRA (dead reckoning analyzer) input, whereas the AN/SPA-33 and AN/SPA-59 do not.

Remote Indicators AN/SPA-34

The AN/SPA-34 remote indicator incorporates into a single console the desirable features of the AN/SPA-8( ) and the AN/SPA-33. Depending on the mode of operation selected, it functions as a general-purpose off-centering type PPI, as an AEW tracking indicator, or as an AEW repeat indicator. Because of its size and weight, the AN/SPA-34 is installed only on ships of DD size and larger.

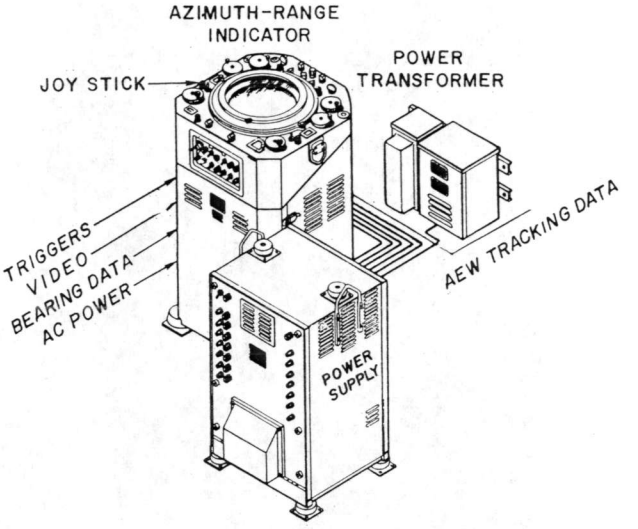

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Figure 6-11.—Range-Azimuth Indicators AN/SPA-33( ) or AN/SPA-59( ) system.

Remote Indicator AN/SPA-66

The AN/SPA-66 (fig. 6-12) has improved capabilities with respect to accuracy and will replace the AN/SPA-34. The Remote Indicators AN/SPA-8A, -33, -59, -34, and -66 are all long range and all perform the same function. They differ somewhat in range scales and accuracies, however.

Remote Indicator AN/SPA-40

The AN/SPA-40 is shipboard equipment used with various height-finding radar systems (fig. 6-13). The range-height indicator (RHI) displays target information by the sweep trace on the screen. The height of the radar beam is presented vertically to a maximum of 150,000 feet. The range is presented horizontally to a maximum of 300 nautical miles. The RHI supplies the third-dimension for a PPI's two-dimension target range and azimuth.

The general-purpose indicator AN/SPA-40 displays a height-line cursor. This cursor is a straight line painted across the width of the screen. The vertical position of the cursor is controlled by the joystick which is centrally located a few inches below the bottom of the screen. The indicator provides an angle mark

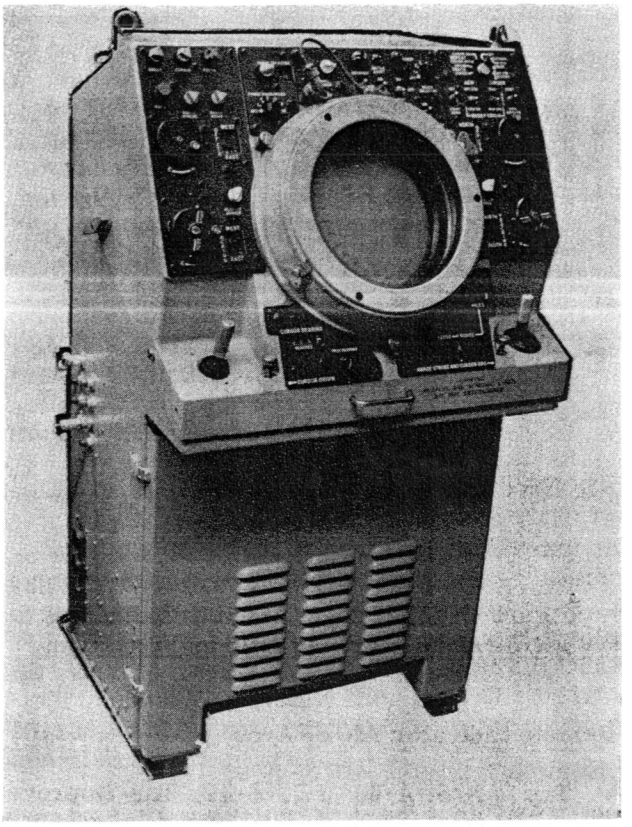

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Figure 6-12.—Range-Azimuth Indicator AN/SPA-66.

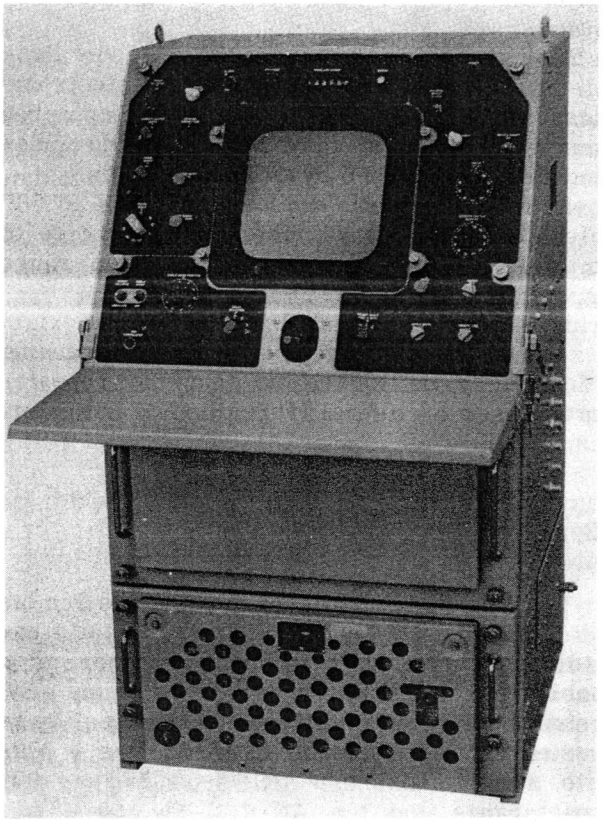

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Figure 6-13.—Height-finding Indicator AN/SPA-40.

cursor used to determine the elevation angle of the target.

The operator may select a delayed sweep of a traverse 30-mile range segment to heights (above sea level) of 0 to 150,000 feet, 50,000 to 150,000 feet, or 0 to 70,000 feet. The center of the range segment may be adjusted anywhere between 15 and 285 miles.

The height-determining capabilities of the indicator are produced by an analog computer. After calibration, this computer solves equations to provide the target height above sea level which is accurate within $\pm$ 200 feet. The errors due to earth curvature and refraction of the radar beam are adequately corrected.

Remote Indicator AN/SPA-41

The height-finding Indicator AN/SPA-41 is replacing the AN/SPA-40. The AN/SPA-40 displays either target traces or angle-mark cursor, but not both simultaneously as does the AN/SPA-41.

Intercept Tracking and Control Group AN/SPA-43

The AN/SPA-43 intercept tracking and control computer is designed to aid the air controller in conducting air intercepts.

AEW TERMINAL EQUIPMENT

The purpose of the AEW system is (1) to obtain an extended radar horizon by operating search radar equipment in an aircraft at high altitude, and (2) to make available to surface ships in the vicinity the extended radar and IFF information thus obtained. This action is accomplished by transmitting to the surface

craft radio signals containing the radar and IFF information. From these signals the original display at the airborne radar is reproduced on the shipboard indicators.

Two radio receiving sets and a video decoder currently used in shipboard AEW installations are the AN/SRR-4, the AN/WRR-1, and the KY-71/UPX. A description of each follows.

Radio Receiving Set AN/SRR-4

One or two radio receivers, a video decoder, and a data converter make up the AN/SSR-4 radio receiving set. These units are mounted one above the other in a framework rack. The number of receivers is governed by the type of antenna available. If an omnidirectional antenna is used with the set, only one radio receiver is required.

Because a satisfactory location for an omnidirectional antenna is unavailable on most surface ships, the usual installation of this equipment includes two radio receivers and two antennas operating as a diversity system. The antennas are mounted on opposite sides of the ships's superstructure so that each antenna covers half of the azimuth circle. The antenna and receiver arrangement that intercepts the strongest signal takes control of the system automatically. With this arrangement, reception of the strongest possible signal is assured at all times.

In either type of installation, the receivers provide video outputs that are used for display on the indicators. They also supply decoded synchronizing pulses for further processing and use in the control of the indicator sweeps and associated IFF and beacon equipment.

Radio Receiving Set AN/WRR-1

The AN/WRR-1 radio receiving set is a refinement of the AN/SRR-4. Although the two sets perform the same functions, they have somewhat different components. The AN/WRR-1 consists of a signal generator, a radio receiver, a signal converter, and a power supply mounted one above the other in the same equipment cabinet.

For diversity operation, the AN/WRR-1 employs a single receiver and two directional antennas. Each antenna covers half of the azimuth circle. The antenna that intercepts the strongest signal is connected automatically to the receiver by means of an antenna switching device.

Video Decoder KY-71/UPX

The KY-71/UPX is a video decoder used in conjunction with the shipboard AEW equipment. Radar data and the identification information (IFF) are transmitted on a common link, and it is the function of this unit to separate the data into separate circuits.

By using this unit in conjunction with other standard identification data distribution accessories, an operator may display the identification data with or without the radar information. He also may display radar information without the identification data. Simultaneously, the other operators are able to select and display identification and/or radar data as they desire.

IFF EQUIPMENT

Today's high-speed aircraft present a critical problem in detection, identification, tracking, and evaluation. When enemy aircraft are approaching, they must be detected and identified at the greatest possible distance in order to provide ample time for initiating appropriate action.

The Selective Identification Feature (SIF) is a recent development that makes the system of identifying friendly units much more secure and more positive. The SIF operates in conjunction with the Mk X system but is a separate piece of equipment.

Currently, the Mk X IFF system is in common worldwide use by both civilian and military. It received wide distribution during and after World War II. Today, pursuit effort is directed to the Mk XII system that provides greater flexibility and security by use of more extensive and complicated interrogations and replies.

Among the various models of IFF equipment currently installed aboard ships are the AN/UPX-1( ), AN/UPX-11, AN/UPX-12( ), AN/UPX-17, AN/UPA-24 ( ), and AN/UPA-38( ). Of these six models, only the AN/UPX-1( ) and the AN/UPA-24( ) are discussed in this text.

Radar Recognition Set AN/UPX-1( )

The AN/UPX-1( ) radar interrogator-recognition set (fig. 6-14) is designed to operate in conjunction with shipboard radar equipment.

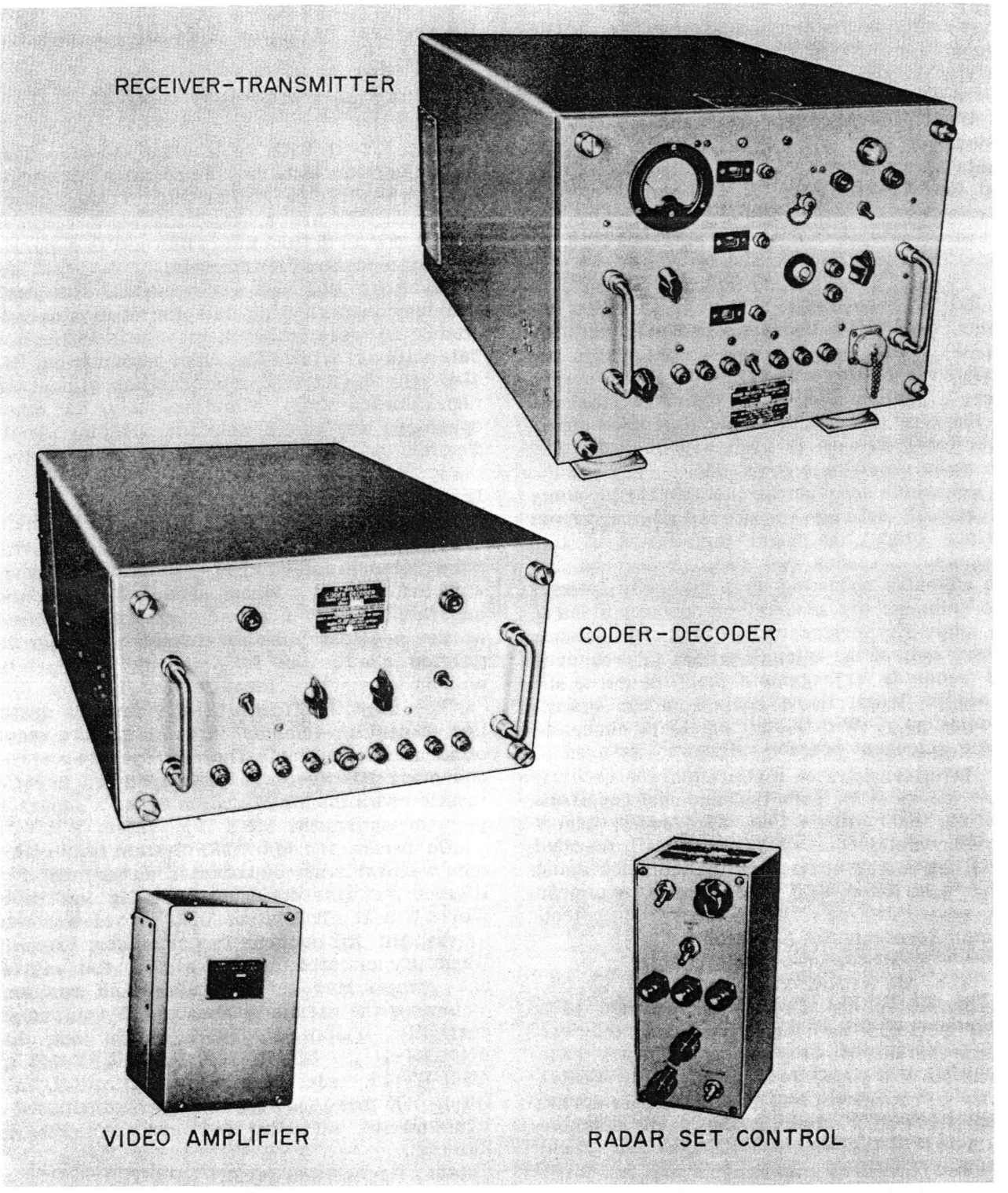

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Figure 6-14.—Radar Recognition Set AN/UPX-1( ).

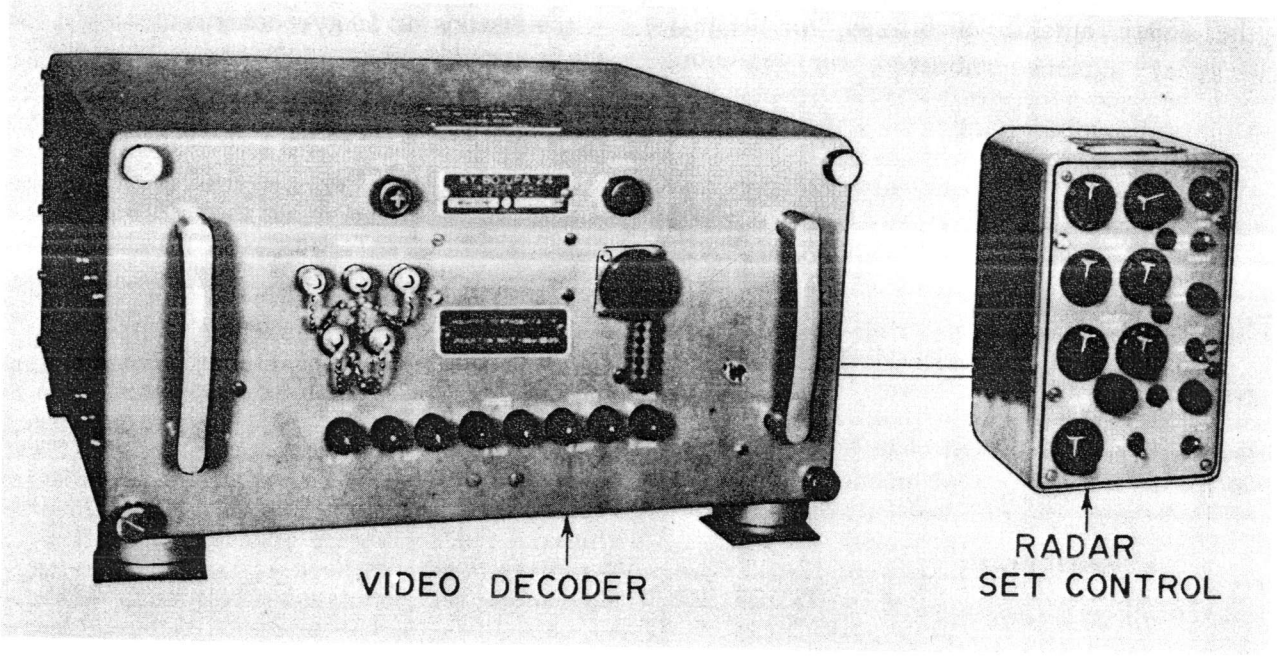

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Figure 6-15.—Decoder Group AN/UPA-24( ).

It uses the radar display for presentation of its IFF data. Its antenna is either integral to or slaved with the associated radar antenna.

The AN/UPX-1( ) is used chiefly for challenging unidentified radar targets. It also can be used to further identify friendly targets as specific aircraft or ships, thereby providing additional security and useful tactical information.

Although it is not discussed in detail in this text, the AN/UPX-12( ) is the shipborne quipment that responds to the challenges transmitted by the AN/UPX-1( ).

Decoder Group AN/UPA-24( )

The AN/UPA-24( ) decoder group, shown in figure 6-15; facilitates the interpretation of coded IFF signals received from a radar recognition set. It selects a coded video pulse-train from the recognition set and presents the coded signal to a decode network. If the pulse-train is coded correctly, an indication in the form of a single decode pulse is displayed on the radar indicator. If the pulse-train is coded incorrectly, a decode pulse is unavailable for presentation.

The AN/UPA-24( ) permits the presentation of the coded or decoded IFF signal alone, the radar signal alone, or the radar signal mixed with either coded or decoded IFF signals. It also provides the means for controlling the operation of the recognition set.

ANTENNA STABILIZATION DATA EQUIPMENT

The AN/SSQ-14 stabilization data set is a vital link in establishing a stabilized antenna platform. It supplies a synchro signal indication of the angular displacement of the ship's deck, with respect to the horizontal, as the ship pitches and rolls. Two gyro units, one associated with pitch and the other with roll, are mounted on a horizontal platform, their output axes vertical. Output of these gyro units—with their associated servo loops—maintain this platform in a horizontal position. By means of transmitting synchros, geared to the pitch and

roll axes of the stabilized platform, the pitch and roll angular correction is sent to the desired destination (the system that keeps the radar antenna stabilized, for example).

Other equipment furnishing stabilization data (roll and pitch signals) are the AN/SSQ-4, Mk 8 (Mods 2 and 4) stable elements, and the Sperry Mk 19 gyrocompass.