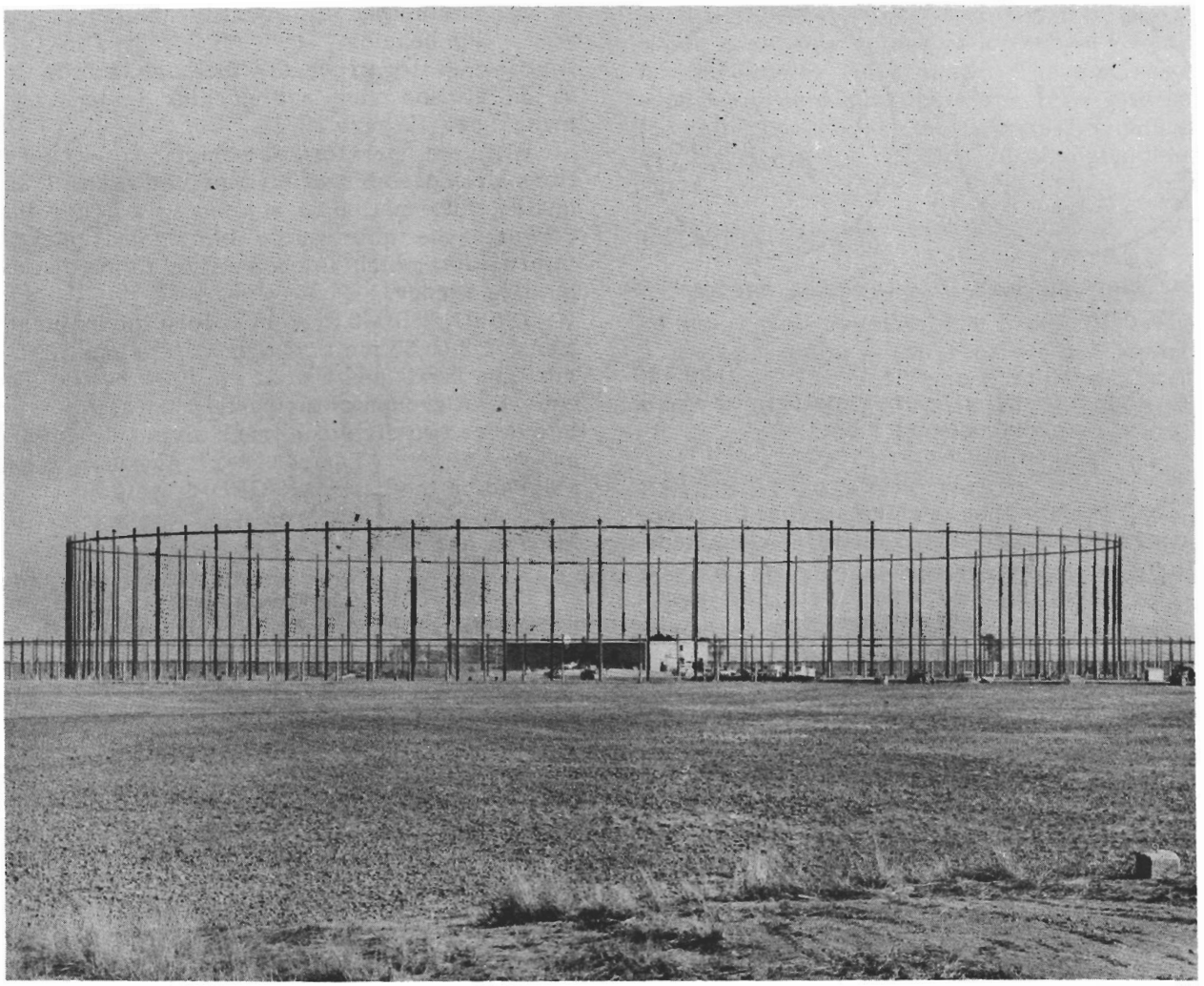


25.117

Figure 18-19.—Circularly Disposed Antenna Array (Wullenweber System).

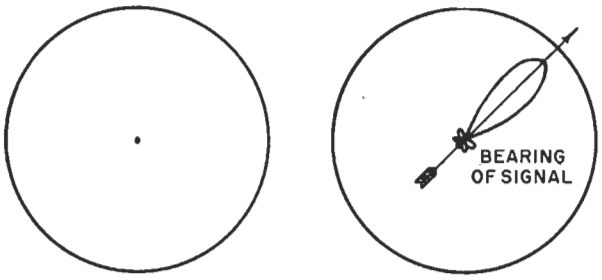
DIRECTION FINDER CENTRAL, AN/GRD-6

This section includes a description of an HFDF system. The AN/GRD-6 is used as an example to illustrate the equipments which are included in a direction finding installation. Because of the complexity of the equipments involved, this discussion is limited to a general, functional description. When a CT M is required to perform maintenance on the equipment, he will need to study carefully the instruction manual.

The AN/GRD-6 is a direction finder radio receiving system which automatically furnishes azimuth indications of radio signals within the frequency range of 2 to 32 mc.

BASIC SYSTEM OPERATION

In the AN/GRD-6 system, the direction of arrival of the signal is measured by utilizing the characteristic response of U-Adcock antennas. The actual sense of direction of the sources of r-f radiation is determined from a combined response of the U-Adcock antennas and an omnidirectional monopole "sense" antenna. The resultant antenna signals are automatically converted into visual indications by the associated operating equipment.



25.119

Figure 18-20.—DF presentations on a cathode-ray tube.

The operator then performs some simple operations to interpret and evaluate the visual indication. These operations, in general terms, are:

1. Lining up a cursor with the visual pattern on the indicator.
2. Determining the "sense"
3. Evaluating the quality (reliability) of the bearing.

Actual operator procedure includes the rotation of an alidade ring and pushing buttons on a switchbox. (Figure 18-26.)

When the operator has performed the operations in a prescribed manner, the azimuth and quality information is applied to a coder that converts the information into coded teletype information which is transmitted to the central plotting agency.

The AN/GRD-6 system covers the frequency band of 2 to 32 mc in two band divisions, 2 to 8 mc (low band) and 8 to 32 mc (high band). The equipment groups of the system are also divided into these two divisions, each division requiring an operator. Figure 18-27 shows a block diagram of the basic AN/GRD-6 system.

MAJOR SYSTEM GROUPS

The AN/GRD-6 system has three equipment groups that correspond directly to the three

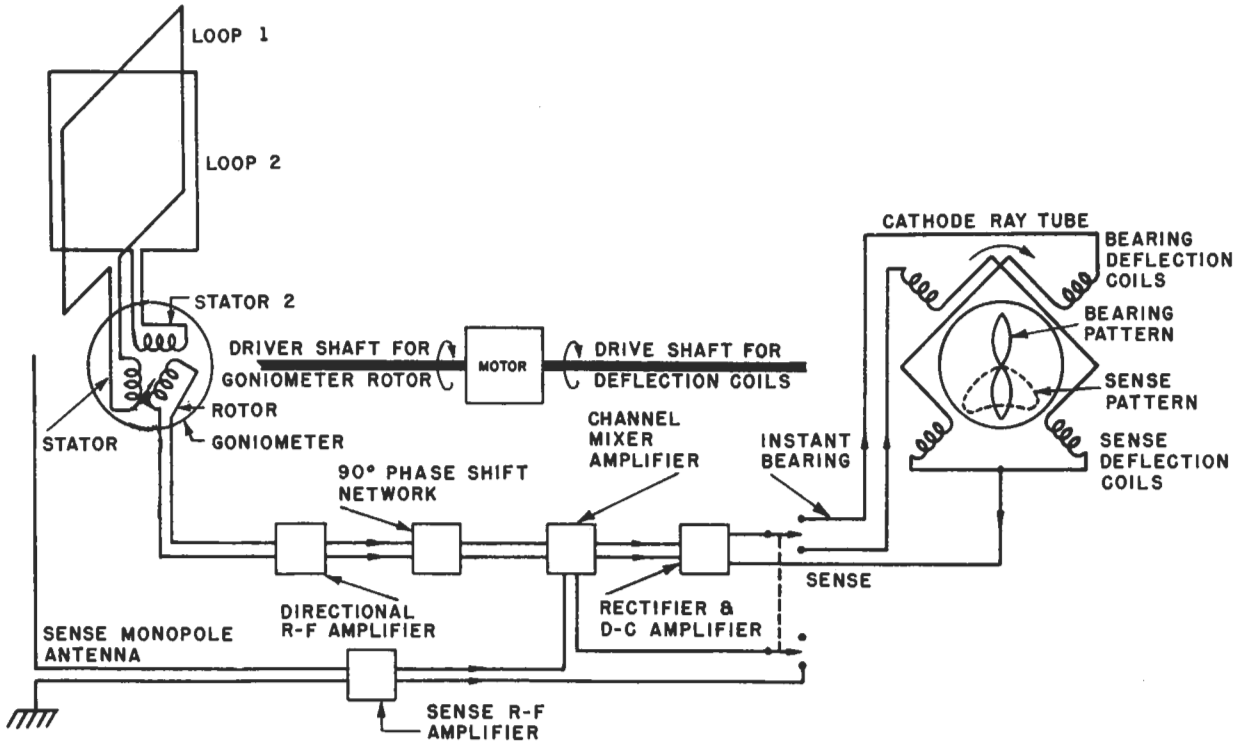


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Figure 18-21.—Block diagram of an automatic-bearing-indicator system.

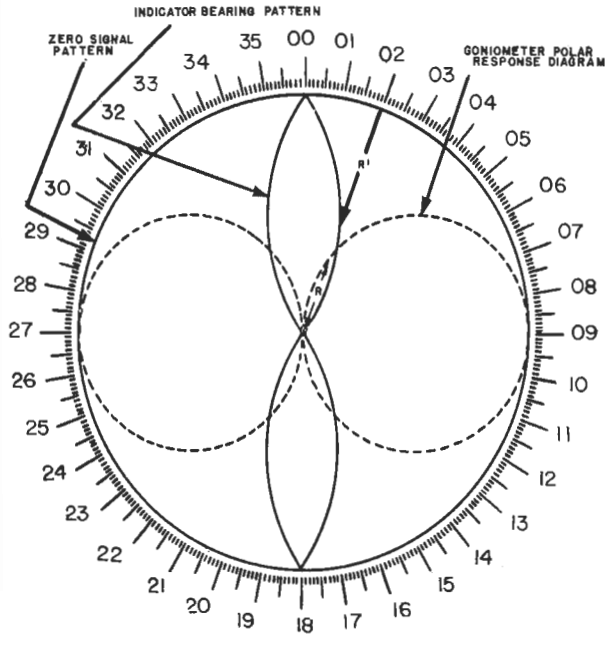

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Figure 18-22.—Figure-of-eight pattern inverted to give the indicator bearing pattern.

basic components of any radio direction finding system: a directional antenna array, a radio receiver, and a bearing indicator. In addition, the AN/GRD-6 system has a bearing coder group. As each of the groups is discussed, refer to figure 18-28 to associate the group's functional relationship to the system.

ANTENNA GROUP

The Antenna Group of the AN/GRD-6 system consists of two antenna arrays, one for low band (2 to 8 mc) and one for high band (8 to 32 mc) operations. The antenna elements used for both arrays are vertical monopoles forming U-Adcock antennas. The low-band elements are terminated, folder monopoles. The high-band elements are broad-band sleeve or cage-type antennas. To eliminate "loop effect," each of the individual low-band antenna elements is arranged with symmetrically disposed down leads (figure 18-29) which cause currents to be equal and opposite, thus eliminating the loop effect of the down leads while still allowing the element to operate in the normal manner.

The other component of the antenna array used with the AN/GRD-6 is a pulse generator which generates pulses at a frequency equal to the goniometer rotor speed. These pulses are used for synchronization of the drive system of the deflection coils in the cathode-ray indicator to the speed of rotation of the goniometer rotor.

RECEIVING GROUP

The receiving group for each band is made up of a tunable receiver (the R-665/GRD-6) and a power supply. The receiver r-f tuning is divided into 4 bands. Band 1, 2 to 4 mc; band 2, 4 to 8 mc; band 3, 8 to 16 mc; and band 4, 16-32 mc.

BEARING INDICATOR GROUPS

The bearing indicator groups are ordinary magnetic deflection cathode-ray tube displays with circular sweeps. The sweep speed is synchronized with the goniometer rotor speed. The deflection is adjusted in such a manner that for

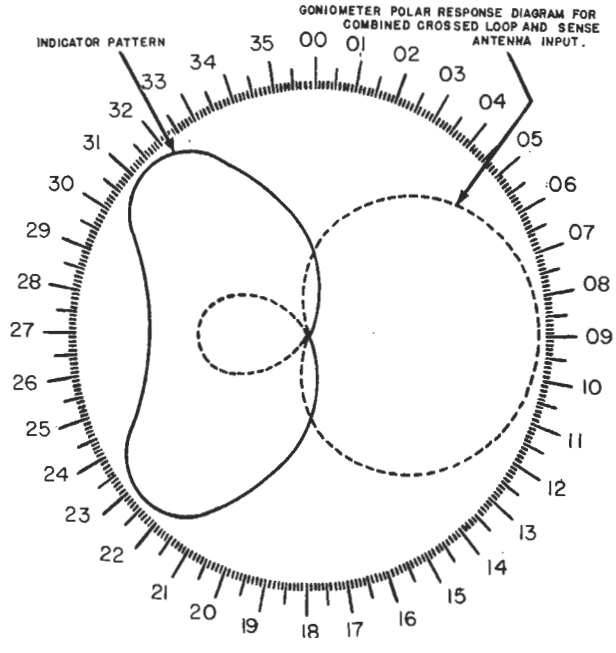

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Figure 18-23.—Cardioid pattern of combined loop and monopole antennas, and inverted indicator pattern.

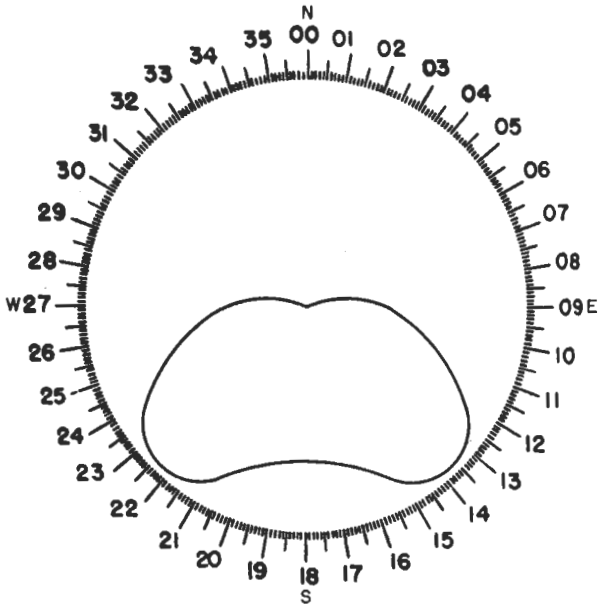

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Figure 18-24.—Sense pattern after a rotation of 90° on indicator screen.

no signal the spot is traveling around the edge of the screen; and when the signal is maximum, the spot is at the center of the screen. With this arrangement, the familiar propeller pattern develops from the Adcock antenna system response.

Bearing Coder Group

Visual bearing azimuth indications and relative bearing information as to quality and sense determination of the bearing are observed and interpreted by the operator. This bearing data is then translated into teletype code and automatically transmitted to recording equipment by the Bearing Coder Group.

Bearing information, as observed by the operator, is set up by rotation of the alidade ring on the indicator to correspond with the bearing of the signal. This operation rotates coded disks within the alidade reader which are used to set up the resultant teletype code. After the alidade ring has been positioned, the operator pushes the sense switch on the indicator panel and notes whether the alidade pointer is pointed in the correct direction. Depending on the sense, he pushes one of two buttons (RECIPROCAL or DIRECT) on the bearing coder switch box. He next pushes one of four pushbuttons which correspond to the operator's evaluation of the quality of the determined bearing. Upon pushing the QUALITY pushbutton, the following cycle occurs:

1. A relay in the bearing sender corresponding to the quality pushbutton depressed locks up.
2. The relay contacts provide ground to the five-wire quality circuit according to the teletype code for the quality letter selected.
3. At the same time, a magnetic brake assembly stops rotation of the bearing translator (alidade reader) shaft and the alidade.
4. The alidade reader motor starts to rotate a multi-track cam against which followers are held by spring pressure.
5. The followers drop in order and allow the half-degree, the degree, and the one set of the tens and hundreds degree fingers to successively engage the slotted discs in the alidade reader.
6. The teletype distributor starts to rotate and sends out bearing information until the bearing, derived from open and closed circuits on switches associated with the half, units,

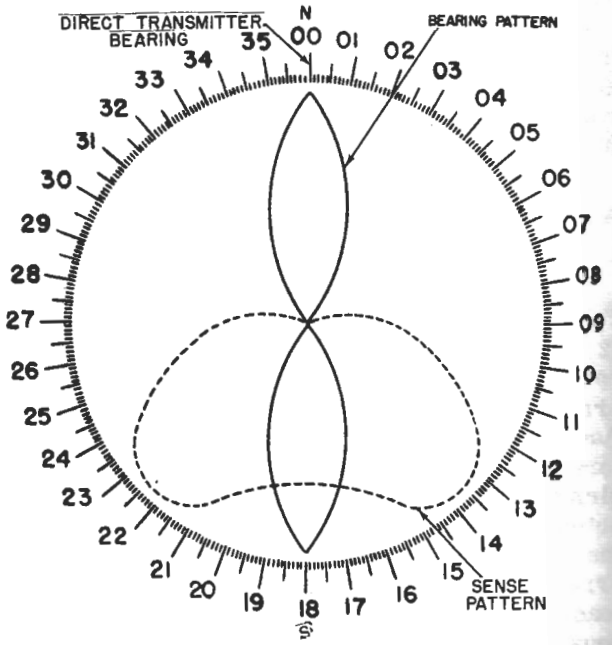

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Figure 18-25.—Bearing and sense patterns.

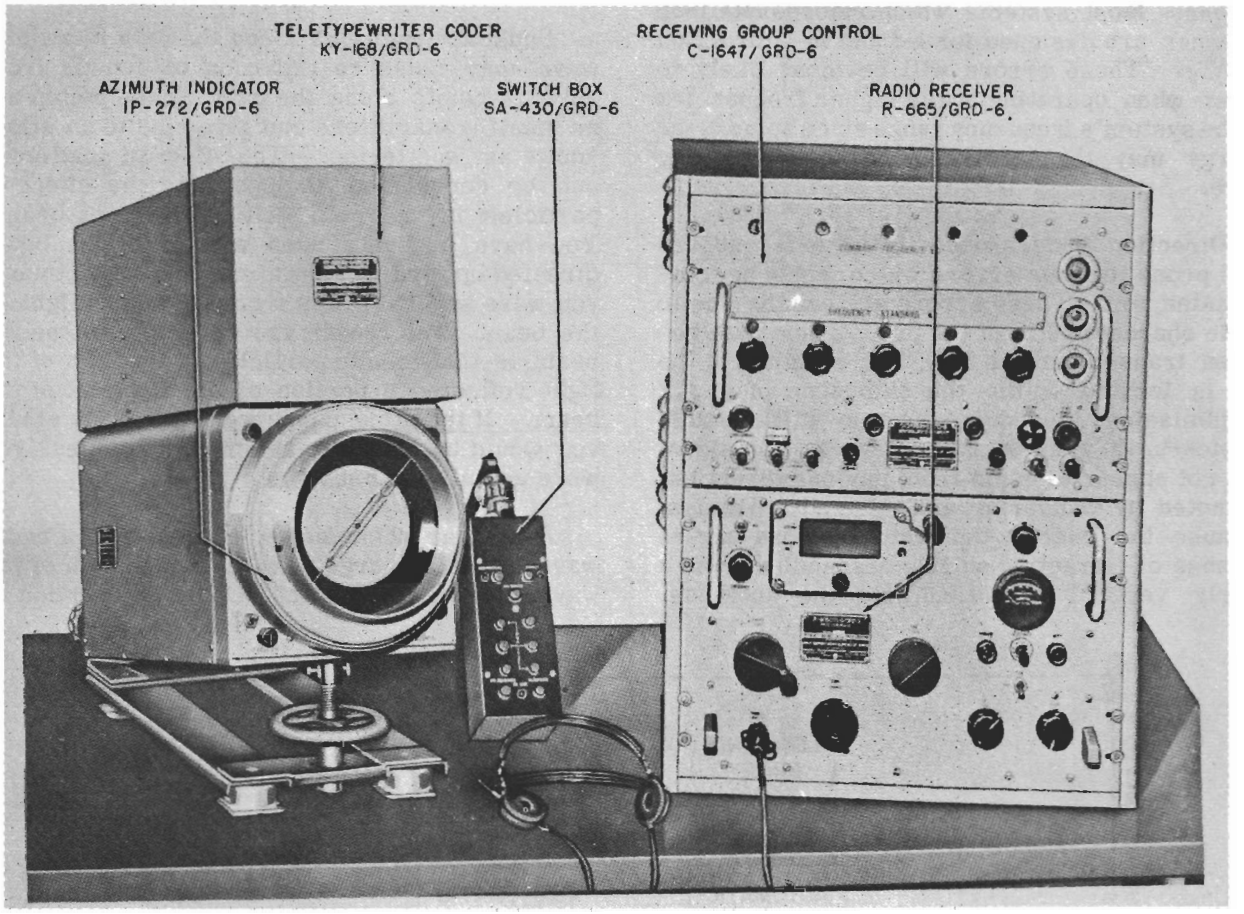

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Figure 18-26.—Typical operating position (AN/GRD-6)

tens, and hundreds fingers, and the quality letter derived from the quality relay has been sent out.

This concludes the discussion of the AN/GRD-6. Because of the complexity of the equipment, it has been impossible to outline the details of electrical and mechanical operation. When corrective maintenance is required on the AN/GRD-6, the procedures outlined in chapter 7 of the instruction manual should be carefully studied and followed. Chapter 7 includes charts to assist the technician in localizing the faulty portion of the equipment and charts to assist in analyzing the probably cause of the fault. The procedures for routine preventive maintenance, as outlined in chapter 6 of the instruction manual, should be performed at least as frequently as called for in the manual. In addition to assuring proper performance of the equipment, the routine maintenance checks are valuable to the maintenance technician in that they will familiarize him with the equipment—and familiarization is a prerequisite to competent performance of corrective maintenance.

DIRECTION FINDER ERRORS AND CALIBRATION

Some of the errors of direction finders have already been discussed; for example, loop effects. If the direction finder antenna system has horizontal components, polarization error or night effect will cause erroneous DF bearings. The susceptibility of a DF system to

polarization errors is a result of its design; little can be done to compensate for these errors. Most systems which incorporate loop antennas are designed for l-f and m-f direction finding. These errors will be most likely to occur when operating at the higher frequencies of the system's frequency range since some of the energy may then arrive by means of the sky wave.

Direction finders used in the h-f band are also prone to some errors which cannot be compensated for. These errors are usually due to some characteristic of the propagation path between transmitter and DF. For example, if the DF is located within the skip zone of an HF transmission, the equipment may still be able to pick up a weak signal. However, the signal will not appear to come from any one direction, as noted by wandering and unsteady displays, because the energy that actually does arrive because of refraction will be descending from a nearly vertical direction onto the antennas. Thus, the angle of incidence in the horizontal plane is extremely difficult to determine.

Unusual conditions along the path of a radio wave may cause re-radiation of signals from various points along the path. These points act as small transmitters and give rise to an effect known as "scattering." The effect of scattering can be considered analogous to the effect of particles in the path of a searchlight beam. You have probably seen a searchlight beam directed upward into the atmosphere even though you were several miles from the searchlight or the beam. The reason you were able to see the beam is that minute particles in the path of the light reflected a portion of the light out of the beam. If the atmosphere were perfectly clear, you would be unable to see the beam unless you were actually within it.

A similar phenomenon occurs with a radio wave. Small charged areas in the path of the wave tend to reflect or "scatter" a portion of

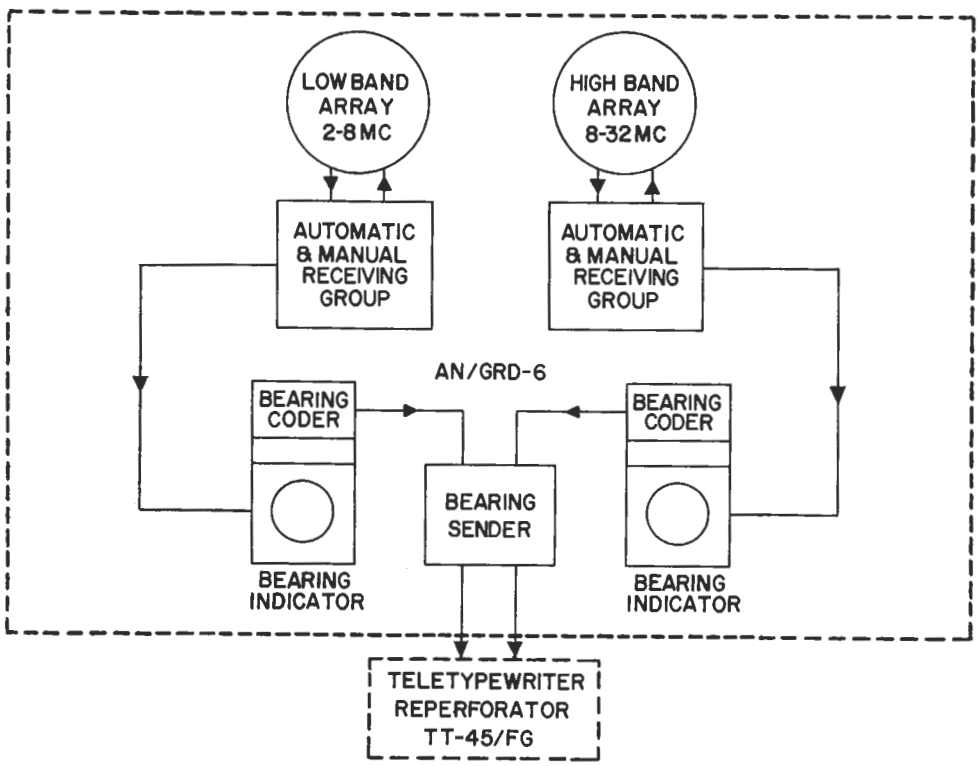

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Figure 18-27.—Direction finder central AN/GRD-6, function block diagram.

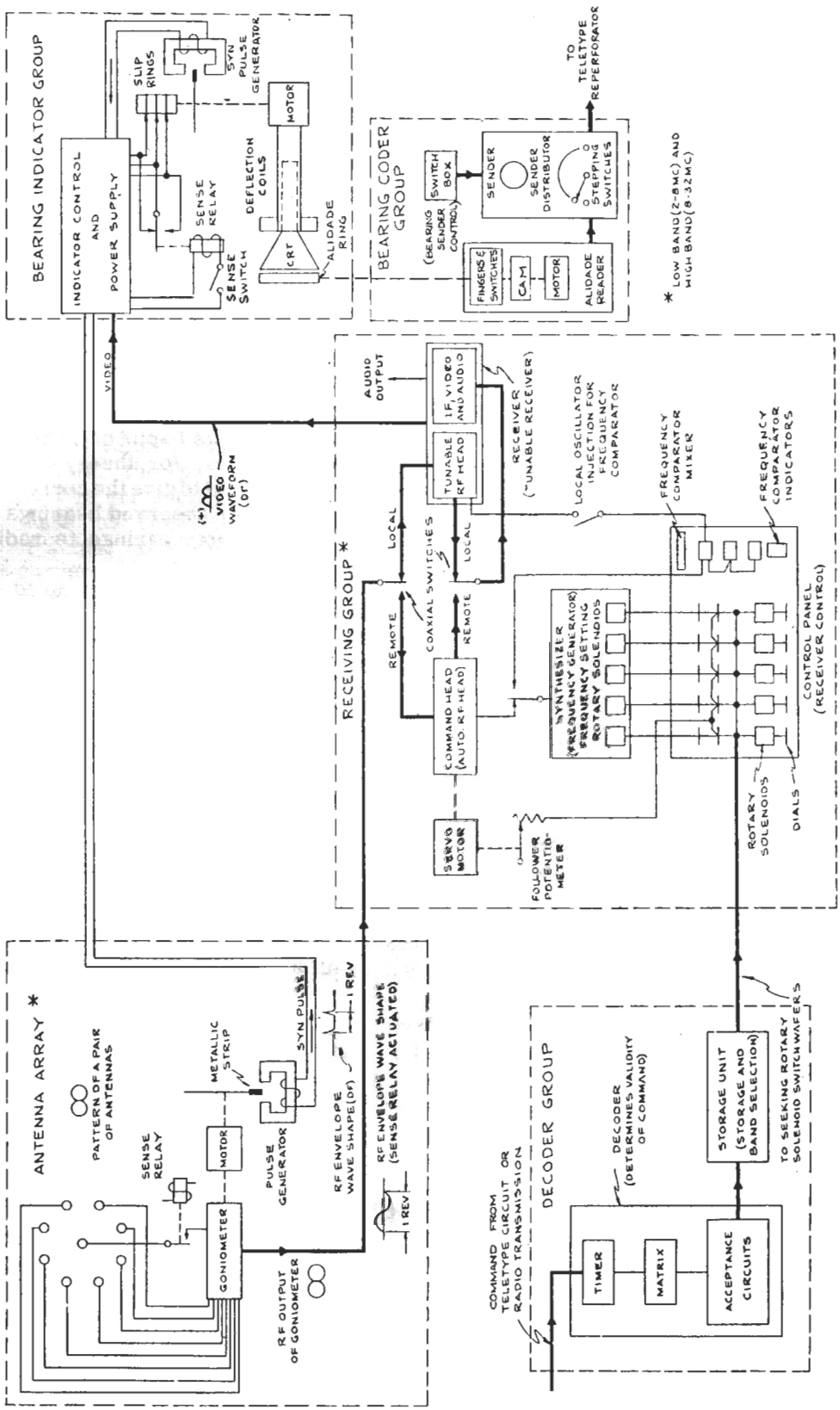

Figure 18-28.—Direction finder central AN/GRD-6, simplified over all block diagram.

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