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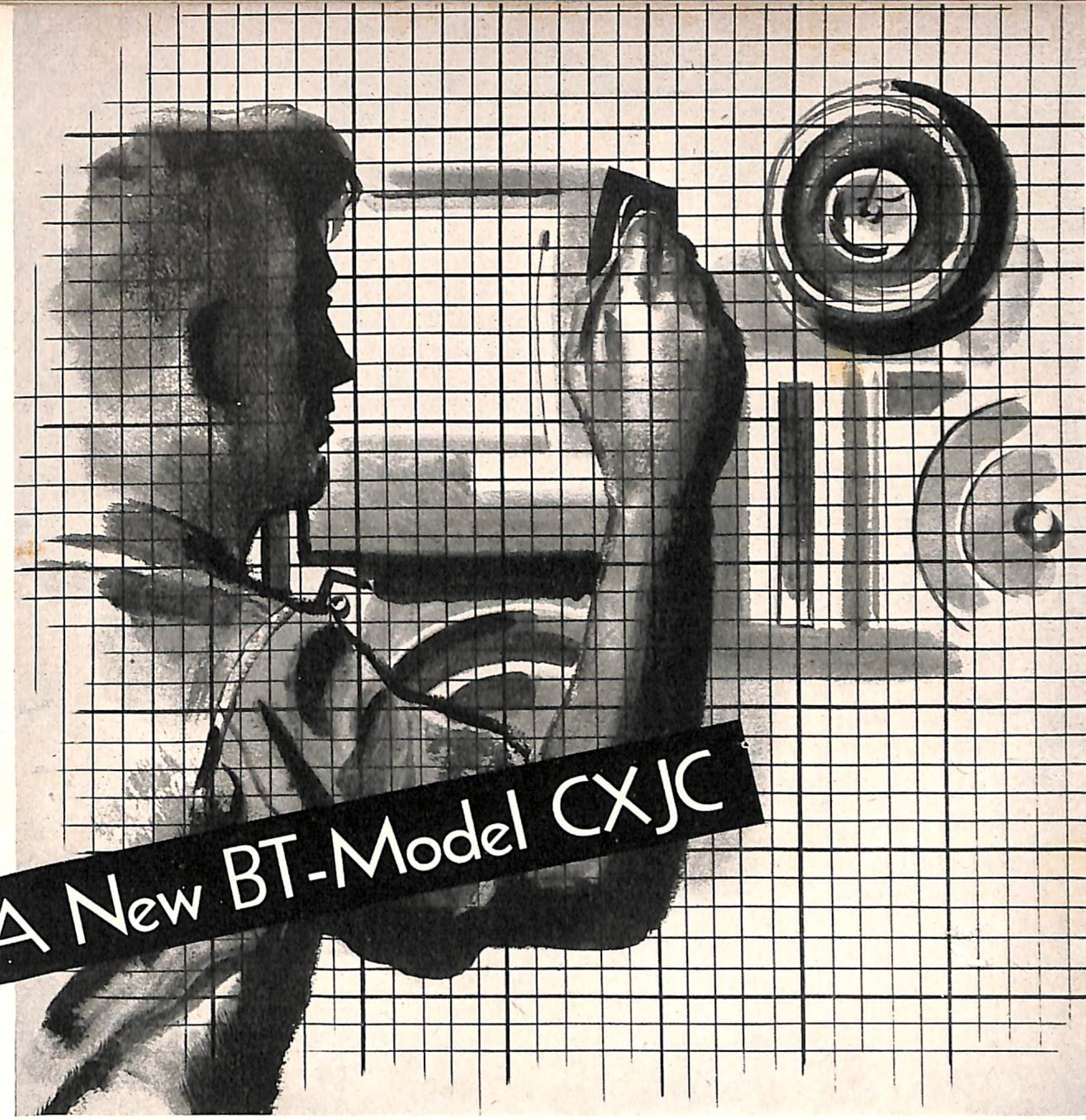


A New BT-Model CXJC

BY LT. MARSTON C. SARGENT, USNR

■ Underwater sound rays do not usually travel in straight lines, but follow curved paths and are bent or refracted away from levels of high velocity (high temperature and salinity) and toward levels of low velocity (low temperature and salinity). As a result, maximum sonar ranges may sometimes be seriously reduced and will in general be very different for submarines at different depths. The range at the surface, the depth at which the range will be least, the range at this depth, and other expected ranges for sonar gear in good condition can usually be predicted from bathythermograph data.

Late in 1941 the first instrument designed to graphically record water temperature and depth was installed in a United States submarine. Since that time, all fleet submarines and most training boats have been equipped with the bathythermograph, as it is called. When first designed, this instrument was considered solely as an aid to the effective use of sonar gear, but it soon became equally valuable as a guide to ballasting and diving operations. Each of the first few models was considerably different from its predecessors, but since the early months of 1943, no major changes in design have appeared in any model which is, as yet, in general use. Although the Model CXJC is unsatisfactory in several ways, repeated trials have indicated that it is much easier to build a worse bathythermograph than a better one.

The buoyancy of a submarine, that is, the weight of the water displaced by the submarine minus the weight of the submarine itself, usually changes with depth of submergence. All submarines are compressible, getting

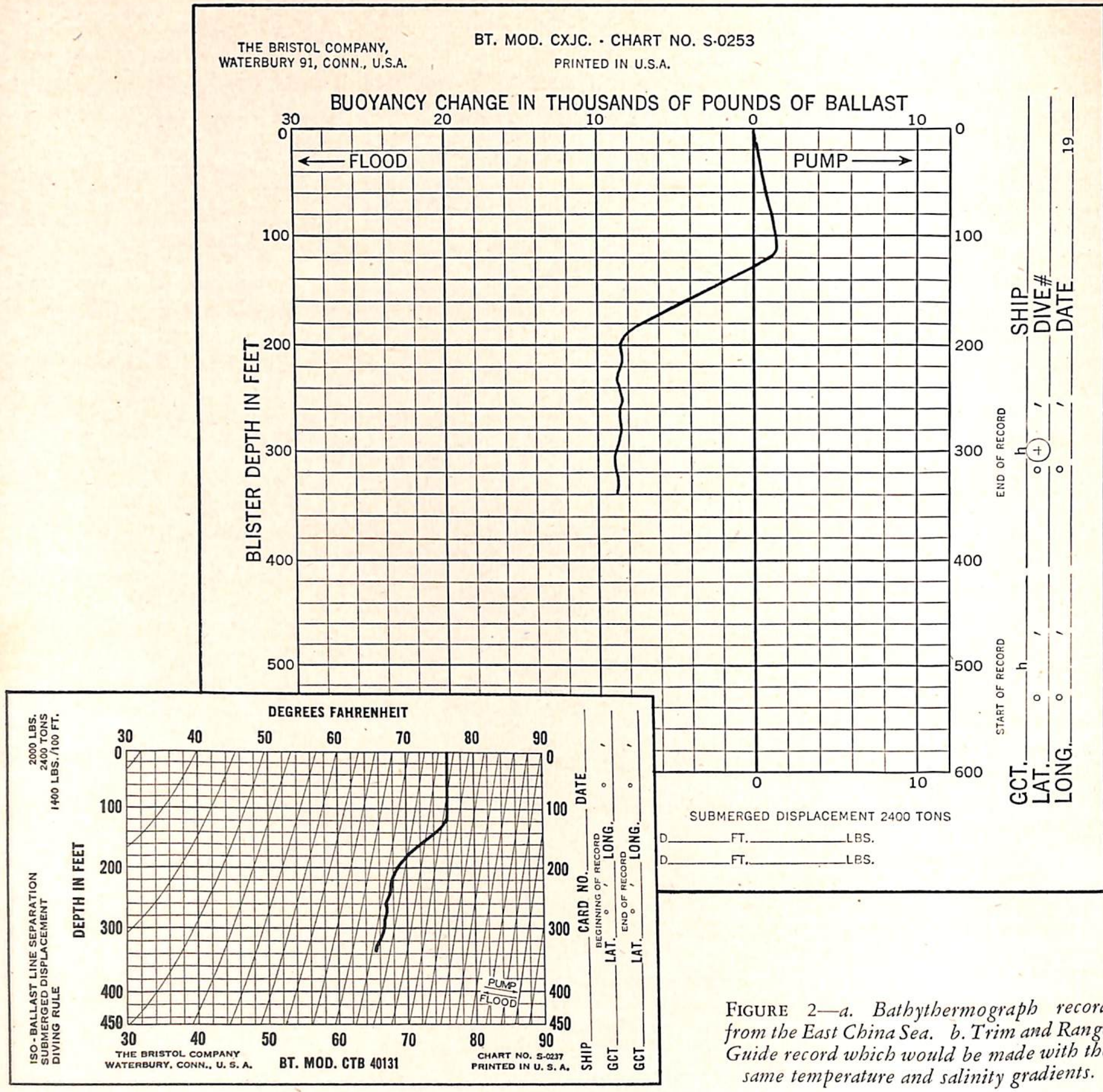


FIGURE 2—*a. Bathythermograph record from the East China Sea. b. Trim and Range Guide record which would be made with the same temperature and salinity gradients.*

smaller and displacing less water as they get deeper. Unless there are temperature or salinity gradients present, the water will have nearly the same density at all operating depths and a diving submarine will have to pump out ballast to maintain neutral buoyancy. Gradients are usually present, however, and the density of the water may sometimes increase so rapidly with depth that a diving submarine actually has to flood in ballast to maintain neutral buoyancy. The trim and range guide and, under most circumstances, the bathythermograph indicate the buoyancy of a submarine at all depths and the changes in ballast which will be necessary for maintaining trim while changing depth.

As submarines began operating closer and closer to the Asiatic Coast, however, it became apparent that any device which estimates buoyancy on the basis of temperature data alone is fundamentally inadequate. In deep water (more than 100 fathoms), the bathythermograph is nearly always a satisfactory indicator of sonar conditions and buoyancy because large salinity gradients in the surface layers are not common over most of the open ocean. In shallow water, sonar ranges are usually determined by the nature of the bottom and other circumstances whose effects can be estimated without a measuring instrument. Ballasting operations, however, in shallow water as well as in the open sea, are determined only by density gradients, and large density gradients due to salinity as well as to temperature are common in waters around the Philippine Islands and Japan (see figure 1). For use in diving and ballasting in such waters, an instrument which measures both salinity and temperature is therefore necessary.

Several other considerations entered into the plans for design of a new instrument. Newer types of submarines have proved to be much less compressible than earlier ships and with changes in design it can be expected that ships will be built which are still more rigid. A comparatively incompressible submarine can balance in a much smaller layer than a compressible submarine, hence an instrument which will accurately and legibly record small layers is required. Furthermore, the provision of several standard types of bathythermograph cards with printed isoballast lines calculated for submarines of several selected compressibilities was abandoned. It was decided instead to furnish means in the instrument by which it could be adjusted after installation in accordance with the measured compressibility to show ballast changes required by that particular ship.

Since electrical measuring and computing devices are necessary for these purposes, it was decided to take advantage of the flexibility of such devices to provide parallel measuring units on the periscope shears and near the level of the center of buoyancy and also to compute and record separately both buoyancy and sound velocity. The two properties of sea water from which the density and the velocity of sound can be derived and which can be measured accurately and continuously are temperature and electrical conductivity. When the compressibility of the submarine has been measured, the buoyancy can be automatically derived from the density of the water and from pressure measurements. To meet these requirements, an experimental Trim and Range Guide, model CXJC, was developed. One of these has been given a two-month service test. Five more will be completed before the end of 1945.

The five major units of the CXJC are the computer, the bottomside measuring unit, the topside measuring unit, the buoyancy recorder and the sonar condition recorder.

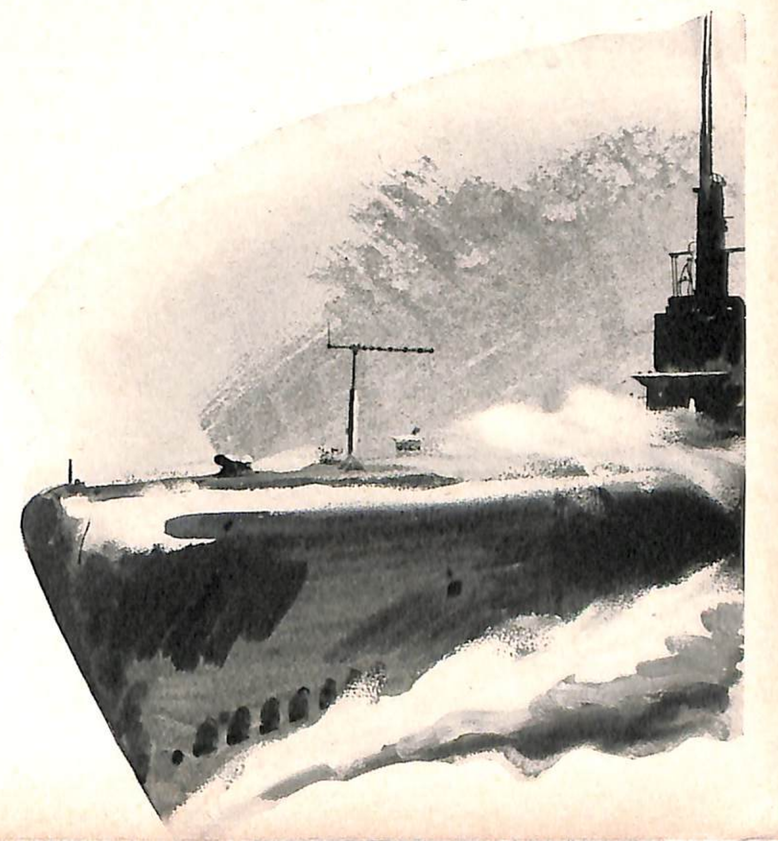
The two measuring units are alike except for the fittings provided for mounting. Each consists of a temperature-sensitive resistance bulb and a conductivity cell; dimensions are 15″ x 4.5″ x 4″. The resistance-sensitive element in the bulb is a helical coil of insulated nickel wire wound on a piece of copper tubing which is fitted inside another piece of tubing just enough larger to accommodate the coil. The space between the tubes is sealed watertight and provision is made for free circulation through the central space in the bulb. This construction combines low temperature lag with compactness and mechanical strength. The conductivity cell is a bakelite tube in which are located three short metal tubes, one in the center and one at each end. The two outer electrodes are connected together and are at ground potential. When a fixed potential is applied between these and the center electrode, the electric current flowing is determined by the specific conductance of the water. The only connection to each measuring unit is a five-conductor cable from the computer.

The bottomside measuring unit is mounted in the lower end of a five-inch pipe extending vertically through a main ballast tank and projecting about six inches below the bilge keel. The unit is exposed to a free flow of sea water through apertures in the projecting end of the pipe and is secured to a ramrod running the length of the pipe so that it may be readily withdrawn for inspection or replacement.

The topside unit has a freely perforated protective shield and a base plate which can be mounted on the periscope shears.

A selector switch is provided on the computer to connect either the bottomside or topside measuring unit as required.

The computer may be mounted on a bulkhead in any convenient place. All switches and sockets are on the right-hand side and access is from the front. The only power connection required for the equipment is the 115 volt, single-phase, 60 cycle supply to the computer. Maximum power consumption is about 250 watts. Other



connections required are one cable to each of the measuring units, two cables to each of the recorders, and a hydraulic connection to any convenient sea pressure line. The dimensions of the computer are 24″ x 22″ x 12″ overall.

The computer contains four identical amplifiers, a conductivity unit, a temperature unit, a hull compression unit, and other components. The amplifiers are used in the temperature measuring circuit, the conductivity measuring circuit, the buoyancy recording circuit, and the sound-velocity recording circuit.

The conductivity unit includes two potentiometers with their moving contacts secured to a common shaft. One of the slide wires forms part of the self-balancing bridge circuit which, with either of the conductivity cells, measures the conductivity. A dial secured to the same shaft and visible through a window in the computer case shows the specific conductance of the sea water and can be used as a check on the operation of the equipment. In the other potentiometer the position of the contact is determined by the rotation of the shaft and also by a cam arrangement which changes the position of the contact with respect to the shaft. The resulting voltage is used in computing the salinity.

The temperature unit of the computer includes five potentiometers with their moving contacts secured to a common drive shaft. One of the slide wires forms part of the self-balancing Wheatstone bridge circuit which, with either of the resistance bulbs, measures the temperature. The contacts on the other potentiometers are automatically positioned by the operation of this bridge. A dial secured to the same shaft and visible through a window in the computer case shows the temperature of the sea water which can be used as a check on the operation of the equipment. Two of the other potentiometers provide voltages for correcting the conductivity unit indications to yield salinity measurements. The other two potentiometers provide voltages which when added to the voltages representing salinity are proportional respectively to the density of the water and to the velocity of sound.

A characteristic common to the four voltages required for the computing circuits is that they are not proportional to the voltage in the measuring circuit and hence are not proportional to the angular position of the shaft and contacts. In order to give the outputs of the four potentiometers this characteristic, the slide wires are tapped at intervals and each section of each slide wire shunted by a separate fixed resistor. This arrangement approximates the curve relating density (or sound velocity, or other desired function) to temperature by a series of straight lines.

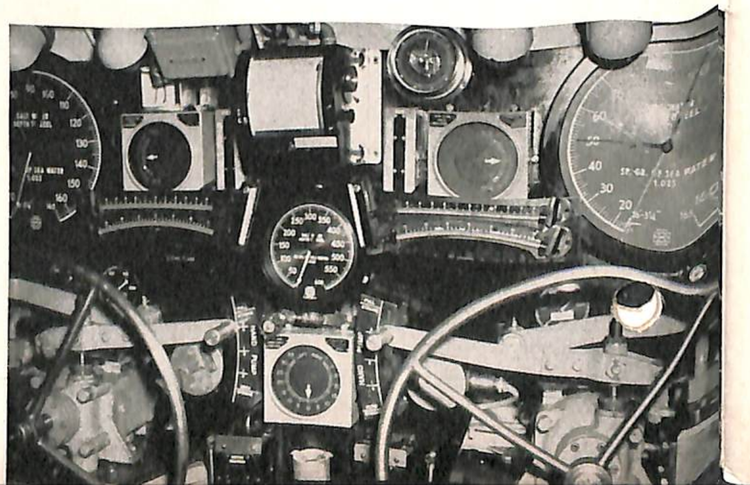
The hull compression unit consists of a Bourdon spring connected to a sea pressure line which controls the contact on a potentiometer. The voltage obtained corrects the density measurement for compression of the submarine. Means is provided in the computer for readily adjusting this voltage to correspond with the measured compression of an individual submarine.

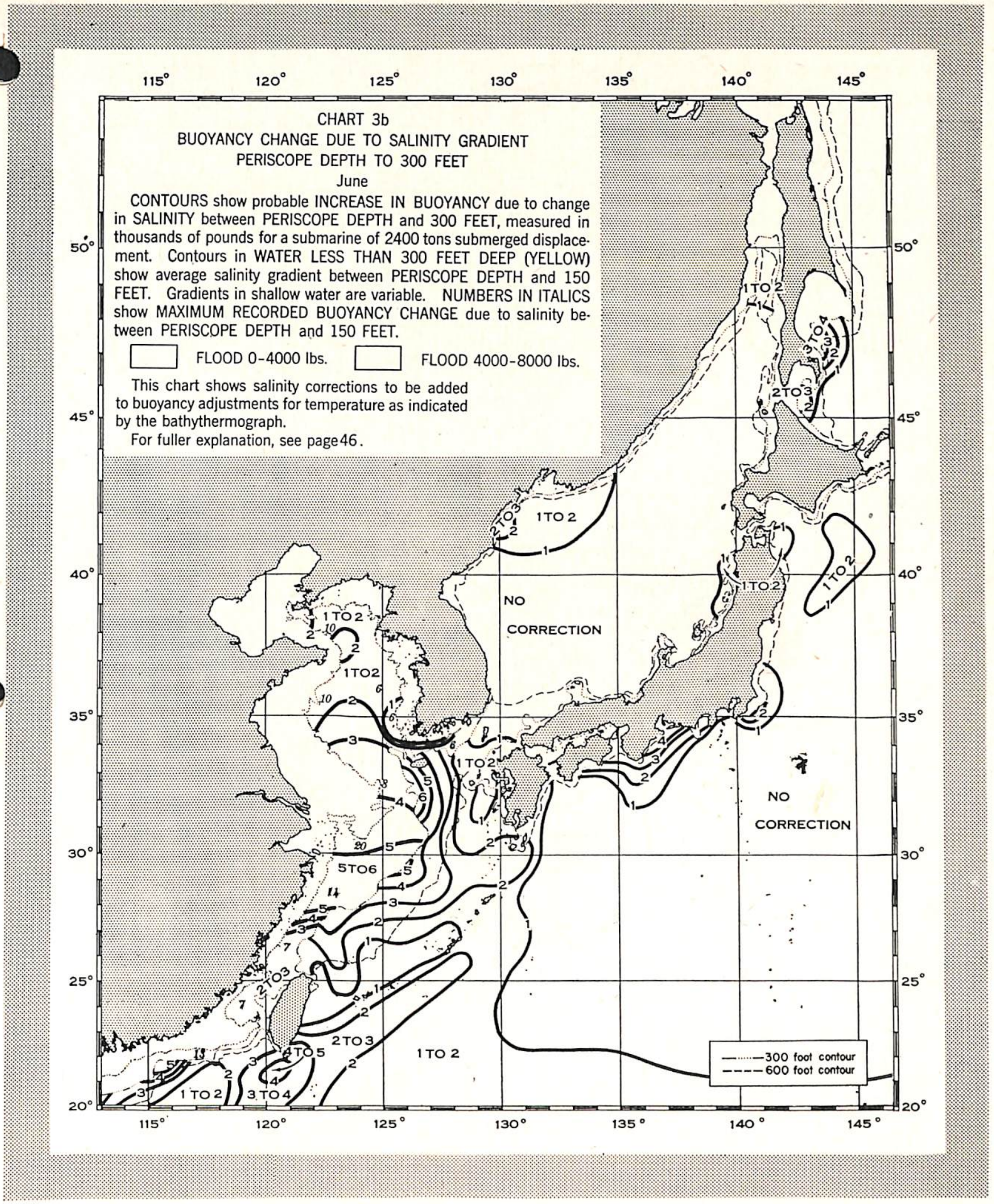
The buoyancy recorder is mounted in the control room in plain sight of the diving officer. Connections required are two cables from the computer and a hydraulic connection to a sea pressure line. A pen, controlled through a servo mechanism by the input from the computer and through the Bourdon spring by the sea pressure, records in ink the buoyancy against depth. The 5″ x 5″ card is graduated in 2000-pound intervals from minus 12,000 pounds to plus 30,000 pounds of buoyancy, and in 20-foot intervals to a depth of 600 feet (see figure 2). When a good trim is obtained, the pen is set by an external knob to indicate zero buoyancy change. Ordinarily this will be done only for a good trim at periscope depth. If the ship is later trimmed at another depth, a short cross line can be drawn on the chart by turning the zeroing knob back and forth for a short distance. Changes in buoyancy thereafter can be read from this line instead of the zero buoyancy line, while the whole curve showing the relative density of the water at all depths is preserved.

The sonar condition recorder is mounted in the conning tower. It is identical in construction with the buoyancy recorder and requires the same number and types of connections. The card is graduated in equivalent temperature (°F) and depth. As all existing manuals for the operational use of the bathythermograph give tables for estimating sonar conditions from temperature data, it is convenient to have the recorder convert salinity changes into the temperature changes which would have the same effect on the velocity of sound.

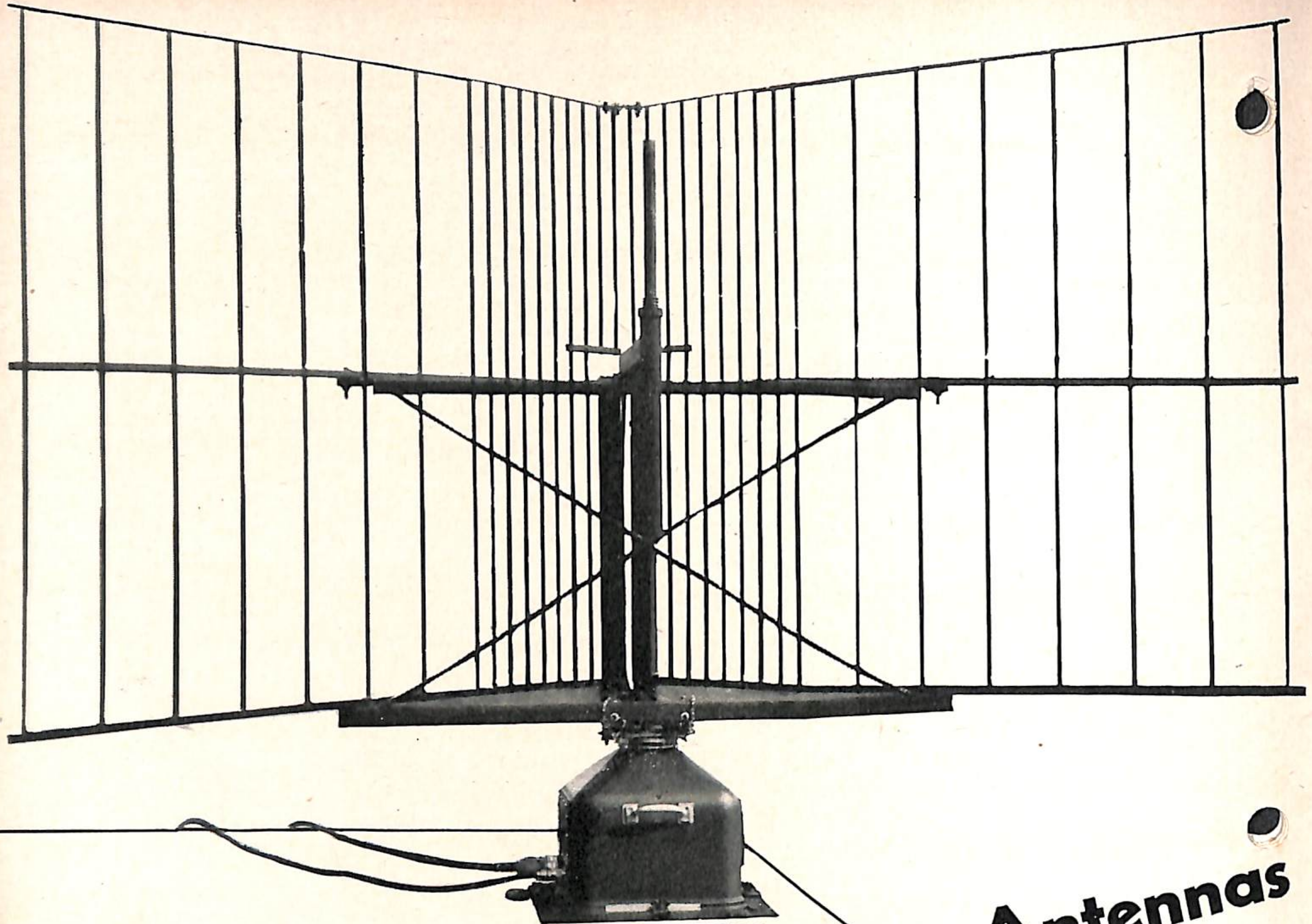
FIGURE 1—*Chart showing average buoyancy change between periscope depth and 300 feet due to salinity distribution. (From H. O. 231, "Submarine Supplement to the Sailing Directions—Japanese Empire Area".)* ▶

FIGURE 3—*CXJC buoyancy recorder installation.* ▼





As an example of the type of information to be obtained from this equipment, figure 2 shows a record obtained in the Yellow Sea by a bathythermograph compared with the record which would be obtained by the Trim and Range Guide at the same time and place. The bathythermograph indicated a 6000 pound layer between 120 and 200 feet. The Trim and Range Guide would show a 10,000 pound layer between the same depths. The extra 4000 pounds of ballast is required because of a salinity gradient existing at the same depth as the temperature gradient. Service tests have shown that the CXJC reliably estimates these ballast changes.



Directional Antennas for IFF Equipments

BY LT. COL. F. A. RAMSEY, JR., USMC

Omnidirectional antennas used with IFF equipment have been criticized in design sections of the Bureau of Ships, and in the field, from two standpoints: (1) lack of adequate range because the radiated power is scattered over a large solid angle and (2) lack of azimuth information.

In order to overcome these limitations, three directional antenna kits were designed and procured for Navy shore and Marine Corps use. Two of these kits replaced "doughnut" antennas on BN-2 equipments used with AN/TPS-1B, Mark 20, SO-7 and SO-12 radars and the third kit was designed for use with the SP-1M.

AS-330–TPX

The AS-330/TPX is a kit designed specifically for use with the AN/TPS-1B and the Mark 20. It is a modification of Army Kit AS-134/TPX. The AS-330/TPX, when used with the AN/TPS-1B or Mark 20, replaces the complete antenna assembly furnished as a part of the original equipment. It is a directional array composed of two folded vertical dipoles. Three reflecting rods are mounted behind each dipole. The antenna is mounted on Tower TR-29, which is a three-section metal mast 16 feet high supported on a triangular base by three guy cables.

Rotation of the antenna is controlled manually by Remote Antenna Drive RM-55 mounted on a tripod inside the radar shelter through two flexible drive cables each 25 feet long. Azimuth is read from an illuminated dial on the drive unit.

The antenna is fed by a coaxial cable, Cord CG-282/-TPX, through a rotary joint in the bottom mast section. The regular r-f cable between the BN-2 and mast base is modified by replacing the connector at the antenna end with Navy Type 49268. Other BN-2 connections are left unchanged. Figure 1 shows the AS-330/TPX installed for use with the AN/TPS-1B radar.

The beam widths, to the half-power points, are approximately 45 degrees in the horizontal plane and 70 degrees in the vertical plane. The horizontal antenna pattern at 172 Mc is shown in figure 2.

In operation, the crank on the remote driver is used to turn the antenna to the position where its azimuth, as indicated by the dial reading on the remote drive, agrees with the azimuth of the bogey as shown on the radar indicator. Challenging procedure is followed as in previous use of the BN equipment with omnidirectional antenna.

The AS-330/TPX kit packed for shipment weighs approximately 214 pounds. It consists of three boxes, the largest of which weighs 74 pounds. Fifty kits were delivered to the Marine Corps in July, 1945.

SO-7M/N AND SO-12M/N

The AS-330/TPX directional IFF antenna kit has been modified to fit the SO-7M/N and SO-12M/N radars, and is known as Field Change No. 110. The antenna AS-109/TP is unchanged, and therefore the same electrical characteristics apply as specified in the portion covering the AS-330/TPX. The mast assembly used in the AS-330/TPX kit has been modified and has been designated Navy Type CBAV-10AGQ. The azimuth control unit is similar to the one used with the AS-330/TPX kit except that the arm for the hand crank is ¾″ shorter and has been designated Navy Type CBAV-23AHN.

Figure 3 shows the directional IFF antenna kit installed on SO-12M equipment. The same kit can be

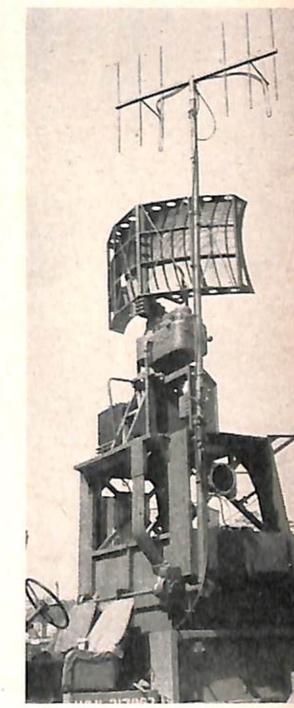


FIGURE 3—*New directional IFF antenna installed on SO-12M equipment.*

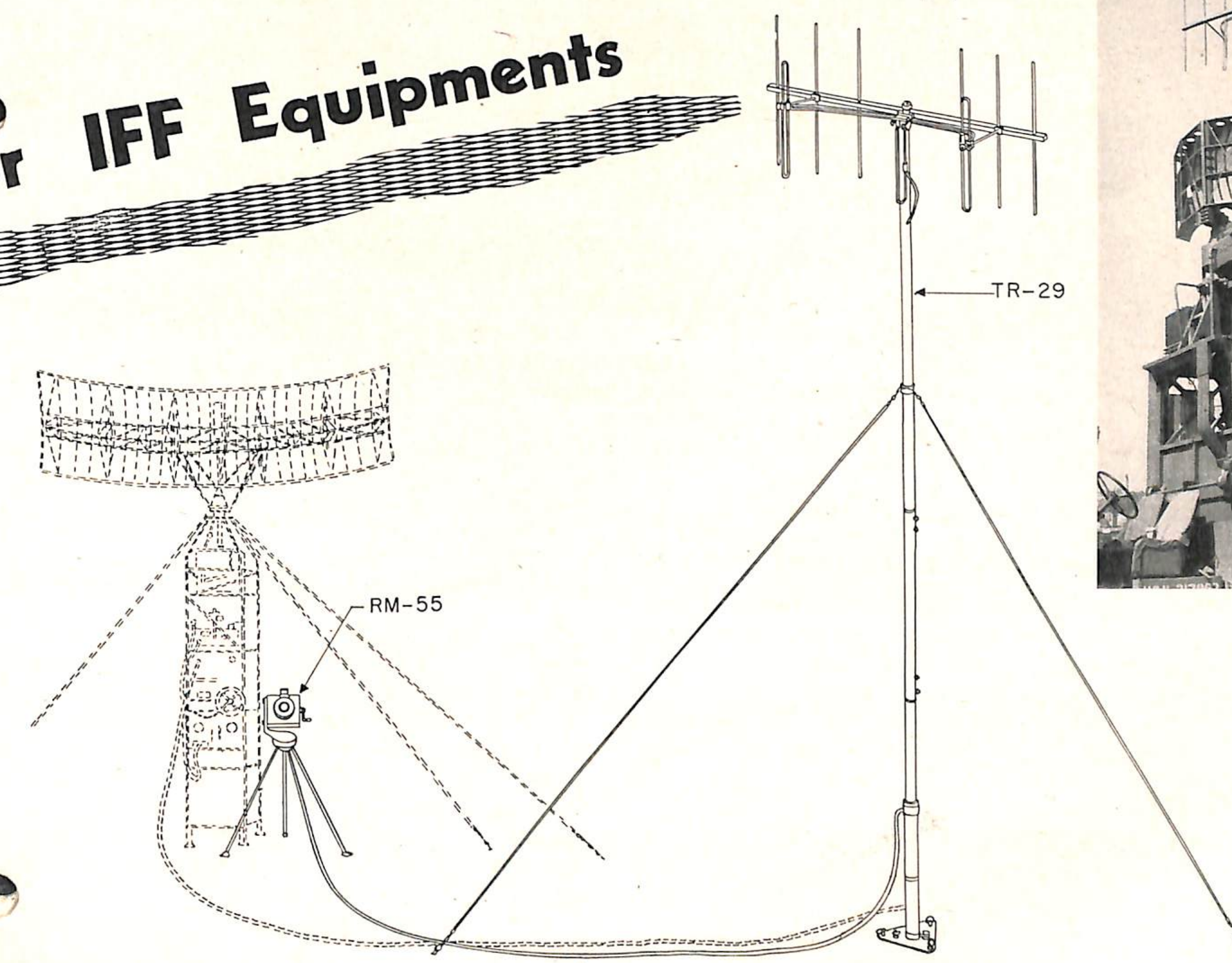


FIGURE 1—*Antenna assembly for use with 1B or Mk20 installed for remote operation about 50 feet from shelter.*

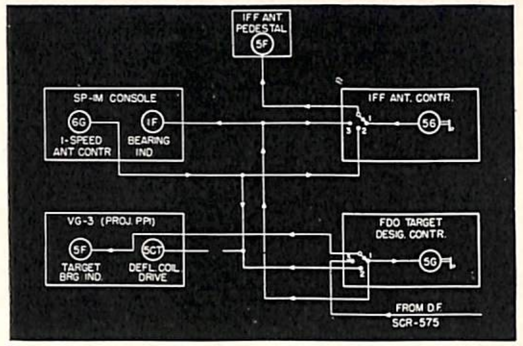


FIGURE 4—*Block diagram showing interconnections of IFF units to the SP-1M.*

installed without any changes on the SO-7M, the SO-7N, or the SO-12N equipments. It will be noted that the azimuth control unit is mounted adjacent to the PPI unit so that the operator can readily control the azimuth of the IFF antenna with his right hand. Operation of the IFF system is identical to the AS-330/TPX, and the IFF response is displayed on the radar PPI.

Examination of figures 1 and 3 reveals that the mast used with the kit for the SO-7M/N and SO-12M/N differs from the AS-330/TPX kit in that the base plate and guy wires have been eliminated, and the coaxial line has been brought down along the outside of the mast and fastened to a connector in the lower mast section just above the rotating joint. This eliminates the need of having to thread the coaxial line through the center of the mast when assembling the upper sections.

When stowed for travel the antenna array and the two upper mast sections are disassembled. The array pieces and associated coaxial cables are packed in a canvas bag. The bag and the mast sections are placed in the spares trailer to which stowing facilities are added when the directional antenna is installed. The kit contains all of the antenna assemblies and stowing facilities, along with the special tools and hardware needed for installing them.

SP-1M ANTENNA

The directional IFF antenna (Type CG-66AKD) for the SP-1M equipment consists of a corner-reflector dipole-fed antenna mounted on a portable pedestal. The pedestal weighs 45 pounds and houses a 5F synchro motor and associated contact follow-up system, double worm gear train, and a 1/8 h-p, 60-cycle, 115 v. a-c induction drive motor. The pedestal mounts on top of the SP-1M operations trailer. For stowing, the corner support can be disassembled and the pedestal and reflector parts stowed within the van.

The reflector is 5′4″ high, 3′8″ deep, and 7′4″ wide across the opening. Interchangeable dipoles are furnished for either Mark III or Mark IV operation. The beam width at the high end of the Mark III band is 52 degrees. The maximum rotational speed for the unit is 3.5 r.p.m., and the bearing accuracy is considered to be 2.5 degrees. All SP-1M equipments are provided with the necessary cabling and IFF antenna control unit. The pedestal and antenna are shipped as SP-1M Field Change No. 42.

The IFF Antenna Control is located directly above the console within reach of the console operators. Referring to figure 4, with the control switch in position 1, the IFF antenna is under control of the console operators. The azimuth is indicated by the dial on the control unit. In position 2, the IFF antenna is slave to the SP-1M radar antenna, and its azimuth is indicated by the SP-1M azimuth scale. In position 3, the IFF antenna is under the control of the FDO, and its azimuth is indicated by the target bearing cursor on the VG-3. Figure 5 shows the actual horizontal field pattern of the corner-reflector antenna.

FIGURE 2—*Calculated directivity pattern of AS-330/-TPX antenna at 172 Mc.*

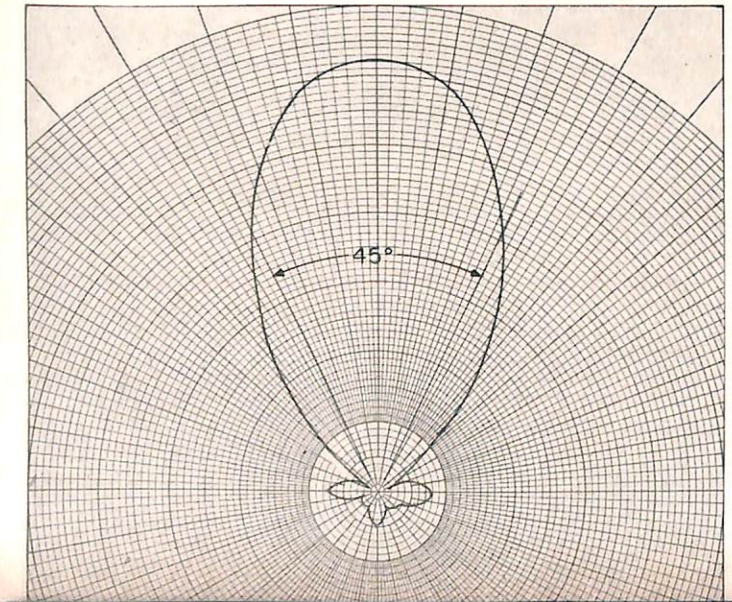
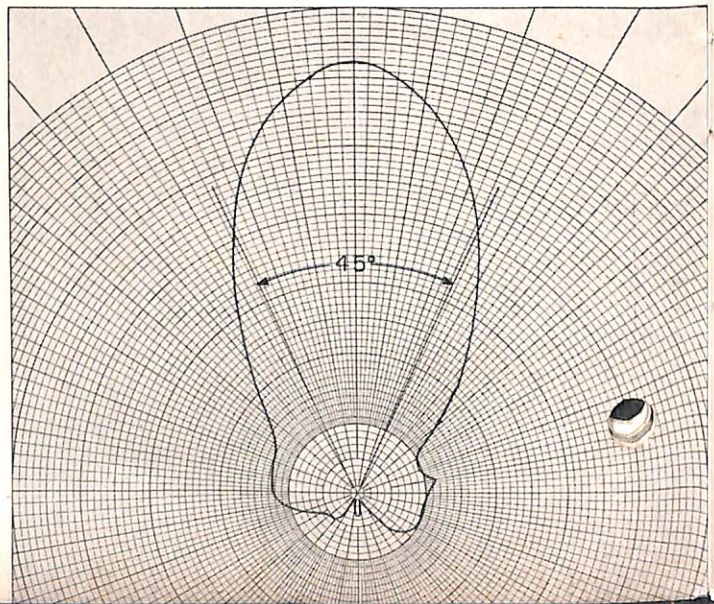
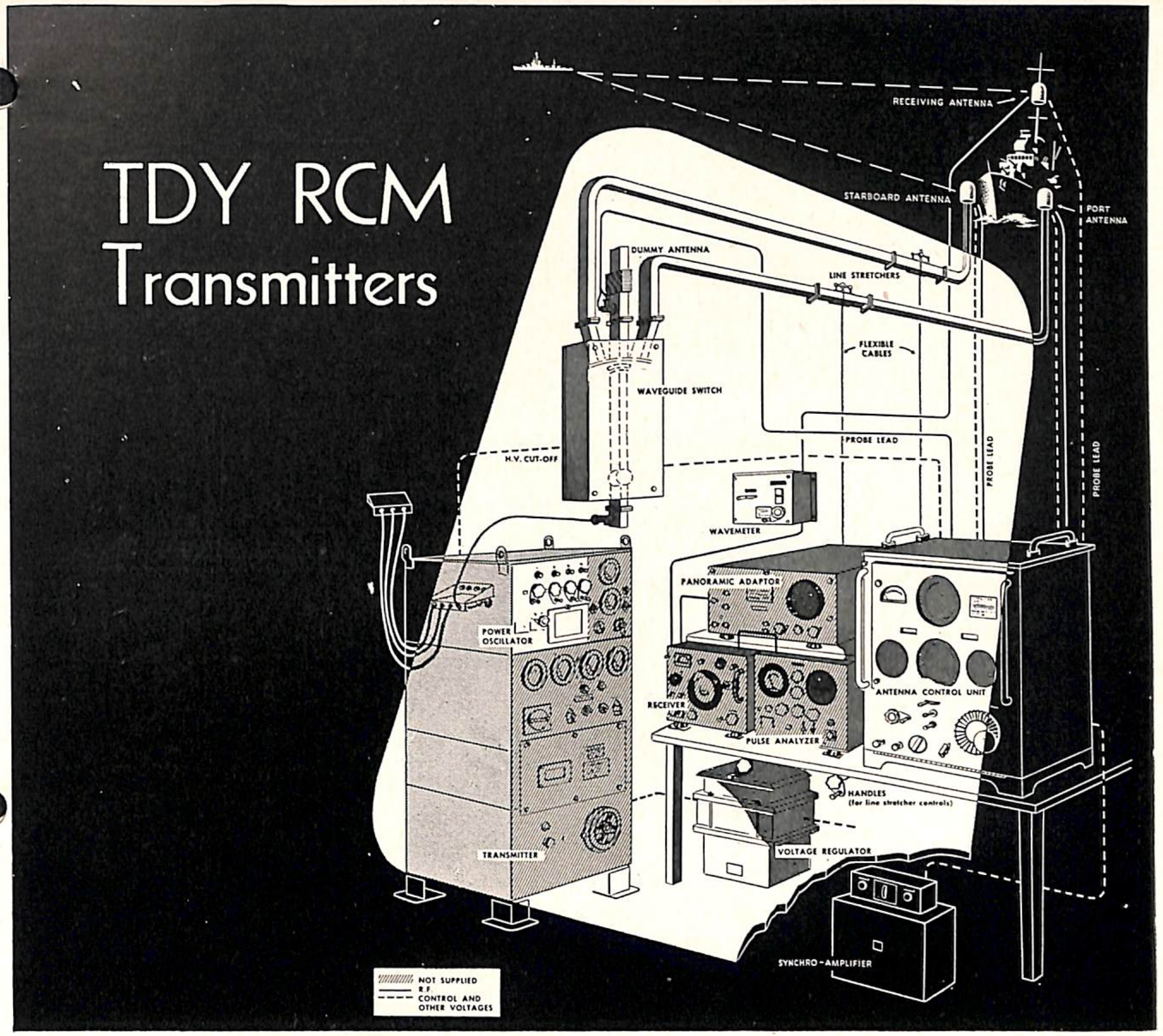


FIGURE 5—*Measured horizontal directivity of corner-reflector antenna at 172 Mc.*



TDY RCM Transmitters

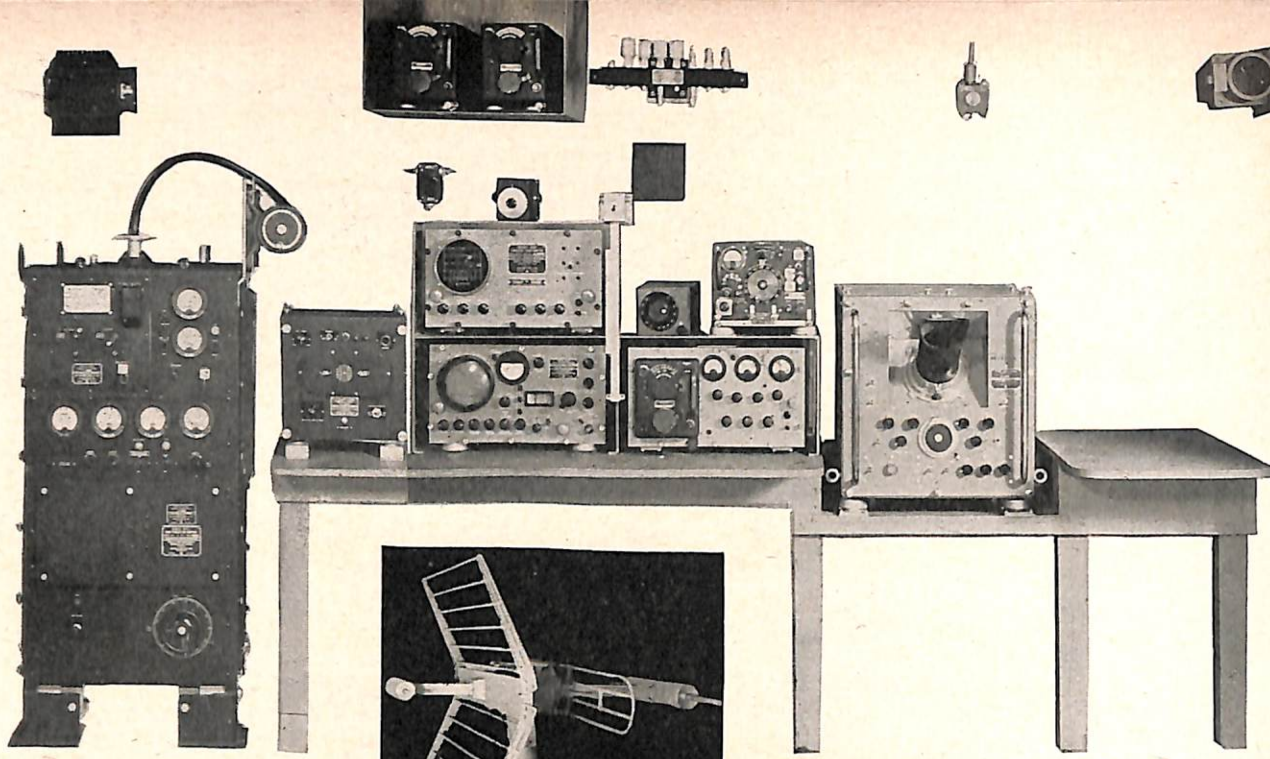


■ Previous to January 1944, a series of low-powered noise-modulated jamming transmitters had been developed. These included the *Dina, Mandrel, Rug,* and *Carpet* transmitters. In order to achieve greater jamming power, research was directed to the split-anode magnetron for use as a power-oscillator tube. The frequency range specified was that of land-based German and Italian gun-laying and surface-search radar. The present 5J29 tube covering the range 350-770 Mc was the initial result of this research. The necessary circuits for noise modulation were devised and a crash program was initiated for a limited number of transmitters using this tube. These crash models were known as the CXFR (60 cycle) and CXFR-1 (for 400- cycle power supply). At the same time the TDY program was initiated for the development of a transmitter using a series of oscillator heads and magnetrons to cover a more extensive frequency range.

General Electric manufactured and delivered 100 standard TDY installations. This equipment was later improved in design and given the designation TDY-1.

Along with 200 TDY-1 equipments was the procurement of a modification kit known as TDY Navy Field Change No. 4. This is a modernization kit designed to be added to all TDY equipments, and when installed will then give the TDY transmitter the same antenna system and transmitter capabilities as the TDY-1.

The TDY-1 equipment provides more satisfactory operation than is possible in the original TDY equipment. A line stretcher has been added to permit maximum transfer of power to the antenna at every frequency in the range. The oscillator tank circuit has been changed to insure stable operation throughout the range, and the tuning control mechanism has been improved. The frequency range is 110-1150 Mc covered by three power-



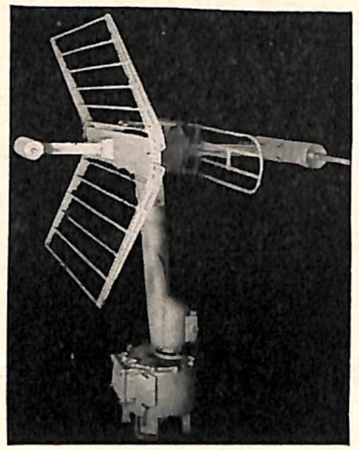


FIGURE 2—*One of several types of TDY antennas. Others vary in size and shape for different frequency-band coverage (right).*

FIGURE 1—*The group of RCM equipments shown above includes TDY-1 Transmitter, Antenna Control Indicator, RDP Panoramic Adapter, RDJ Pulse Analyzer, RDO and AN/SPR-2 Search Receivers, and DBM Direction Finder. A jack box, two RDO tuning heads, and a dummy load are mounted on the bulkhead.*

oscillator tubes, the 5J32, 5J29 and 5J33 magnetrons. The antenna system consists of a rotating antenna mount and control indicator, together with the necessary plug-in type antenna.

Figure 1 shows a standard RCM shipboard installation before cable connections have been made. At the extreme left is a TDY or TDY-1 jamming transmitter with the CG-35ABL oscillator in place. Mounted on brackets extending above the upper right-hand corner is the line stretcher, while on the bulkhead above the transmitter is mounted a dummy antenna. Mounted on the table immediately adjacent to the transmitter is the control indicator for the rotating antenna mount shown in figure 2. On a rack next to the control indicator are the RDJ pulse analyzer and the RDP panoramic adapter. These are display units for the RDO search-intercept receiver shown to the right and on the same level as the pulse analyzer. The *S*-band receiver (AN/APR-5AX or AN/SPR-2), with its associated wave trap, is located above the RDO. On the extreme right is the DBM direction finding equipment used in conjunction with the RDO. Other units shown are supplementary RDO tuning heads, receiver patch panel and intercommunication accessories.

The *S*-band modification is not shown in figure 1 but is pictorially represented in figure 3.

The success of a TDY jamming operation depends upon the use of the associated equipment as shown in the following manner: An enemy radar intercept is made by the search intercept receiver and identified from the panoramic-adaptor and pulse-analyzer displays. From the DBM direction finder the bearing of the enemy radar is found, and this information used to properly orient the jamming transmitter antenna by the use of the antenna-mount control indicator. Meanwhile the transmitter has been fired up and rough tuning adjustments made. Setting exactly on the enemy frequency requires adjustment of the transmitter tuning controls and line stretcher to conform with information given by the RDP and RDJ display units.

In the majority of cases continuous look-through to check any shifting of the enemy frequency is not possible since there is not generally sufficient electrical separation of the receiving and transmitting antennas.

The installation described is not a fully integrated system as compared with higher-powered systems that are now being developed. However, it has had extensive operational use and has demonstrated its value both as a defensive and offensive weapon.

Changes in operational requirements have necessitated sending limited numbers of modification kits to the fleet.

The FSA Frequency-Shift Keyer

■ Following is a detailed discussion of the final production model of a Navy type frequency-shift keyer. This is the second article in a series, and follows the general discussion on the FSK (frequency-shift keying) system which appeared in the September ELECTRON.

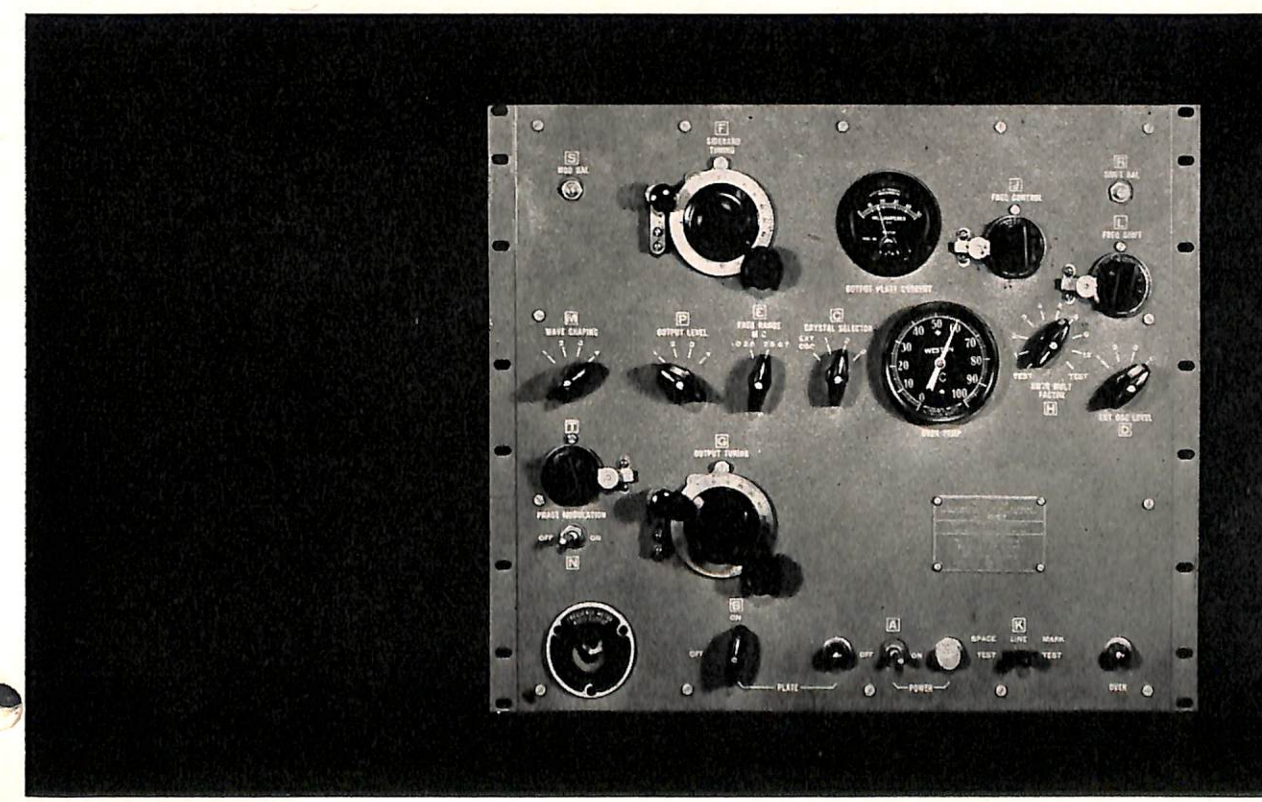
A frequency-shift keyer is the unit which accomplishes frequency-shift keying of a radio transmitter, either by causing the transmitter's master oscillator to shift frequency or, more often, by creating the desired *mark* and *space* frequencies by the heterodyne method; that is, by mixing the output of the master oscillator with signals generated within the keyer. The Model FSA keyer described here is of this second type, and in addition provides a self-contained crystal oscillator to use in place of the transmitter's master oscillator whenever crystals are available.

The accompanying block diagram of the keyer circuits shows location and type of all tubes. The keying signal passes through a reactance modulator circuit and controls the shift of the frequency of a 200 kc oscillator. This output is mixed with the r.f. from the internal crystal oscillator or from the transmitter master oscillator so that the latter frequency is balanced out and only the sum and difference frequencies are fed to an intermediate amplifier. One of these output frequencies is amplified and fed through an auto transformer to the output transmission line.

When an external oscillator is used, the input impedance is 75 ohms, and the input voltage between 2 and 20 volts. The r-f output is 3 watts. Keying speed may be as high as 600 words per minute.

KEYING AND 200 Kc OSCILLATOR

The keying voltage is impressed on one of the grids of the keying tube V-110 and the output plates of the tube are connected to give push-pull action. This out-



put voltage is fed into the injection grids of the balanced reactance modulators V-107 and V-108.

Inserted in the circuit between the keyer tube V-110 and the balanced reactance modulators V-107 and V-108 is a wave-shaping circuit which permits shaping of the keying signal depending upon the speed of keying. This is controlled by the Wave Shaping Switch located on the front of the unit. Also across the same circuit is connected a phase modulation circuit.

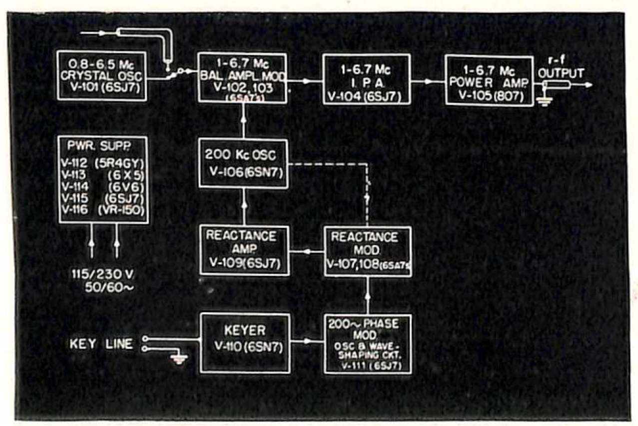
The phase modulator consists of a 200-cycle oscillator whose output can be adjusted to a predetermined value and then turned on and off as required. This is controlled by the Phase Modulation control. Phase modulation makes possible an increase in the average signal-to-noise ratio at the receiving station by reducing selective fading.

A 200-kc voltage is fed into the input grids of the balanced reactance modulators from the 200-kc oscillator V-106, and the plates of the balanced reactance modulators are connected in parallel. Thus if no signal is present from the keyer tube the output of the balanced reactance modulators will be zero, but as the *mark* and *space* voltages are impressed on the injection grids there is a variable voltage present on the output of these tubes.

The output voltage of the balanced reactance modulators is impressed across a potentiometer, the arm of which (XMTR MULT FACTOR) is connected to the grid of the Reactance Amplifier V-109.

The output of the reactance amplifier causes a change in frequency of the 200-kc oscillator, V-106. In order to set the amount of shift of the 200-kc oscillator to allow for transmitter multiplication factor, and still maintain a constant frequency shift at the output of the transmitter (for example 850 cycles), the voltage on the grid of the reactance amplifier must be reduced proportionally as the multiplication factor of the transmitter is increased. This is controlled and adjusted for any given value of shift by the FREQ SHIFT control and the XMTR MULT FACTOR switch. The upper and lower values of the shifted frequency are adjusted to be located symmetrically about the assigned transmitter channel frequency (above and below the carrier by 425 cycles if the total shift is 850 cycles).

Block diagram of the frequency-shift keyer unit.



1.0 TO 6.7 Mc R-F CIRCUITS

The 200-kc oscillator V-106 is of the self-excited, balanced type. The output of this oscillator, which is varied a small amount by the reactance amplifier, is connected into the injection grids of the balanced modulator V-102 and V-103 where it is mixed with the frequency of the crystal or external (transmitter) oscillator.

Most of the circuit elements associated with the crystal oscillator and the 200-kc oscillator circuits, the plate load inductor, and the reactance amplifier are inclosed in an oven, the temperature of which is maintained thermostatically at 60°C (140°F). The close regulation of the temperature of the components in the oven provides more uniform circuit constants to maintain proper frequency stability of the crystal and 200-kc oscillators.

The Pierce-type crystal oscillator V-101 may be used with crystals in the 0.8 to 6.5 Mc frequency range. Any one of three crystals placed in the oven may be selected as desired by a Crystal Selector switch located on the front panel of the unit. When operating with an external oscillator, such as the transmitter oscillator, the internal crystal oscillator is disconnected by turning the Crystal Selector to the external oscillator position.

The balanced modulator V-102 and V-103 functions to combine the output frequencies of the 200-kc oscillator V-106 and the crystal or external oscillator. The crystal or external oscillator output is fed to the input grids of the balanced modulator and when the mixer screen-grid balance potentiometer is properly adjusted, the crystal or external oscillator frequency is balanced out. Only the sum and difference frequencies of the 200 kc-oscillator frequency and the crystal or external oscillator frequencies are present in the output circuit of the balanced modulator.

The plate tank circuit is tuned to the resulting higher sideband frequency (sum of the input frequencies), which in turn is fed into an intermediate r-f amplifier. This amplifier (V-104) serves two functions: (1) it permits a low output of the balanced modulator and (2) acts as a filter to increase the power of the wanted sideband.

The output of the intermediate amplifier is fed into an output or power amplifier, V-105. The output of the power amplifier goes to an auto transformer circuit to permit matching the low impedance of the output transmission line. By selection of output taps on the transformer the output level is also controlled.

The tuned circuits of the balanced modulator, intermediate, and power amplifiers are divided into two bands to permit the unit to cover the total frequency range of 1.0 to 6.7 Mc by means of a switch. The output frequency of the balanced modulator is tuned by a variable capacitor (Sideband Tuning) while the circuits of the intermediate and power amplifiers are tuned by a ganged variable capacitor (Output Tuning).

POWER SUPPLY

The power supply consists of separate positive and negative rectifiers, utilizing a common transformer.

The positive 300-volt rectifier V-112 furnishes plate voltage for the Phase Modulator Oscillator, Reactance Amplifier, Balanced Reactance Modulators, Crystal Oscillator, Balanced Amplitude Modulators, Intermediate Amplifier and Output Amplifier.

The positive 150-volt supply is derived from the 300-volt supply by the use of V-114 which is used as a voltage regulator and its regulation is controlled by V-115. Thus a very stable voltage is available for the screen grid of the Reactance Amplifier, the suppressor grids of the Balanced Reactance Modulators, and the plate voltage for the 200-kc Oscillator.

The negative 150-volt rectifier V-113 is a half-wave rectifier with a resistance-capacity filter and a gas-filled regulator V-116 to furnish bias voltage to the keying-tube circuits.

The FSA frequency shift keyer is given tropicalization treatment in production to render it resistant to the effects of moisture and fungus growth.

EQUIPMENT ARRANGEMENTS

The FSA Frequency Shift Keyer Unit (CW-35060) required for frequency shift keying may be associated with a radio transmitter in one of three ways: (1) permanently installed in the radio transmitter or (2) mounted in a special CW-10389 mobile cabinet for shore stations only, and connected into the radio transmitter circuit by means of flexible cables or (3) mounted in a CW-10390 shock-resisting cabinet for shipboard installation, also connected into the radio transmitter circuit by means of flexible cables. In all cases it is necessary to add a coupling unit in the transmitter to permit the use of the keyer.

The FSB CYV-35062 is another keyer physically the same and electrically similar to the FSA, except that it is designed specifically for shore use. This unit will be discussed in a later article.

ST Field Change

■ ST Field Change No. 14, approved by BuShips, provides a video test outlet at the transmitter-receiver. This obviates the necessity of running a temporary cable each time a test oscilloscope is used at the transmitter for tuning the system. No kits will be furnished, as the material required is readily procurable from navy yard stocks or electronic supply offices.

INSTALLATION

Transmitter-Receiver: Mount a standard coaxial jack on the transmitter-receiver between the two escutcheon plates below the crystal-current meter. Run a shielded lead from this jack to D of J-5. One end of the white-blue-green lead in cable BA (2R-ER-78) is already connected to D in P-5.

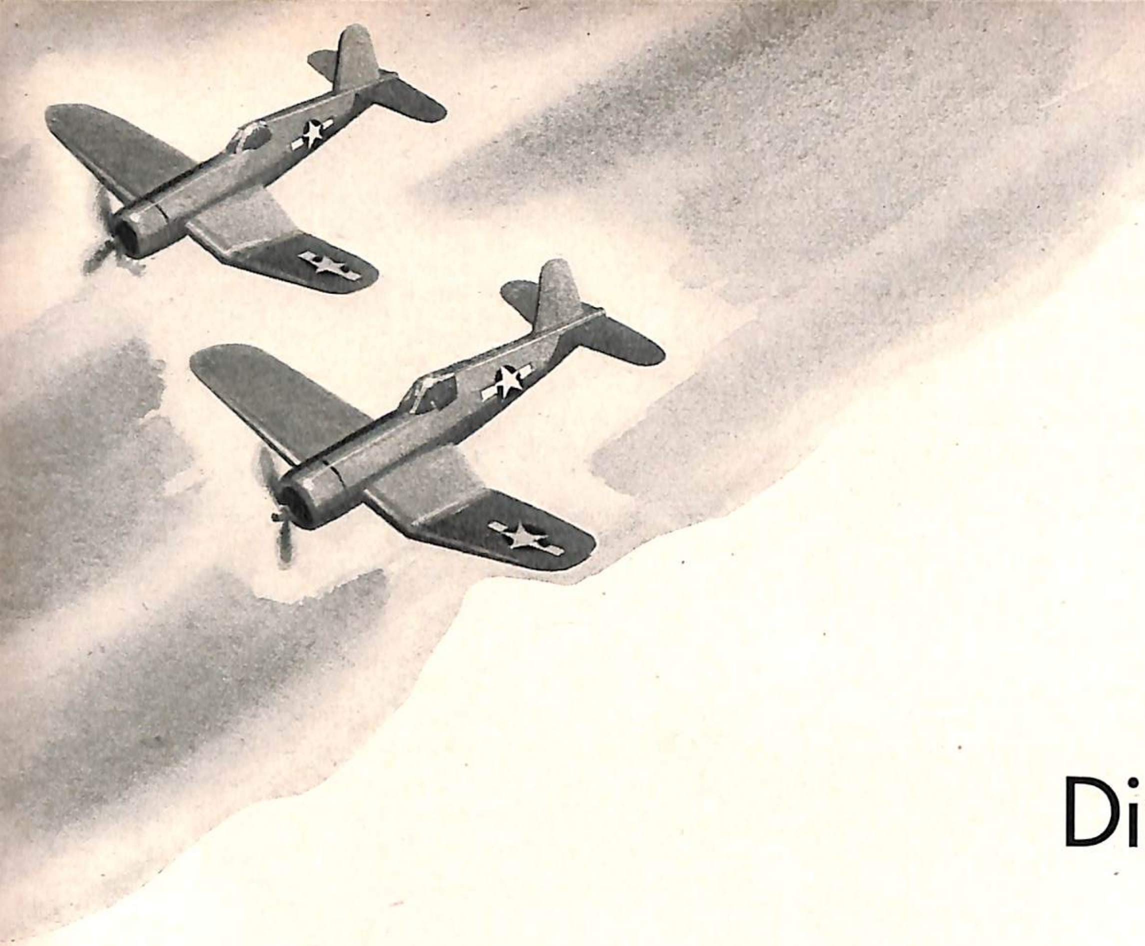
Junction Box: Connect the spare white-blue-green lead in cable BA to terminal 21 together with the spare brown lead in cable BQ (2R-ER-71).

Selector Unit: Connect the spare brown lead of cable BQ and the spare brown lead of cable BN (2R-ER-62) to terminal 76 in this unit.

Range Indicator: Connect the spare brown lead in cable BN to terminal 32. Now mount a coaxial jack on the front panel of the range indicator, and run a shielded lead from the jack to terminal 32. Connect one end of the shielding to the sleeve of the jack and the other to terminal 31.

A short piece of coax should then be fitted with plugs and connect as a jumper between the new jack and the jack designated PPI VIDEO OUTPUT in the range indicator. When this jumper is inserted, video signals for exciting a test oscilloscope are available for tuning purposes at the jack installed in the transmitter-receiver.

The application of this field change should be reported by means of the usual forms and also by entry in the service report.



Fighter Direction Goes High-Hat

■ One of the newest things in radar is the SX. It is a combination of two radar systems in one: an Early Warning Search Radar operating in the S_G band, and a Height Finding Radar operating in the S_W band for fighter director work. The equipment is designed for the same purpose as the SM/SP search and fighter director radars but with several advantages and refinements not possessed by those systems. It will be installed on CVB's and CV's as the equipment becomes available. Due to the number and weight of major units of the system (approximately *fifteen tons,* not including the antenna) it is not feasible to install it in smaller ships. The antenna assembly alone weighs 5,500 pounds, and the necessary cables an additional 10 tons.

To properly discuss the equipment and its characteristics it is deemed necessary to list the major units. A typical shipboard installation on a CVB (USS *Midway*) is used as a reference to show the location of these units. In the forward radar transmitter room and SX power room are located the Main Control Unit, the E.W. (early-warning) Search Driver-Modulator assembly, the H.F. (height-finding) Driver-Modulator assembly, IFF Interrogator-Responsor, DG Amplifier, and other miscellaneous units such as the a-c distribution board, servo amplifier, magnetic controller, 440-volt a-c motor-generator set, and the amplidyne rack. In CIC are four consoles, the Fighter Director Officer's Panel, and two Video Adapters, one for early warning and one for height finding. The Mk 8 Mod 4 stabilization system for the antenna assembly is located in the after main battery plotting room. A fifth console is located in flag plot. The antenna mount is located on a very rugged platform built on the tripod mast. The entire equipment employs over 800 vacuum tubes to perform the various functions required!

One of the outstanding features of the SX is its adaptability for continuous E.W. search train while simultaneously making aircraft height measurements. This was one of the deficiencies in the SM/SP systems, since the precision adjustments necessary in making height measurements required from two to three minutes. During this period the equipment could not be used for early warning search. This difficulty is overcome in the SX by employing two complete antenna assemblies (with associated r-f channels) on the same antenna mount. Interaction between the two antennas is avoided by mounting them at right angles to each other, and by the large difference in frequency.

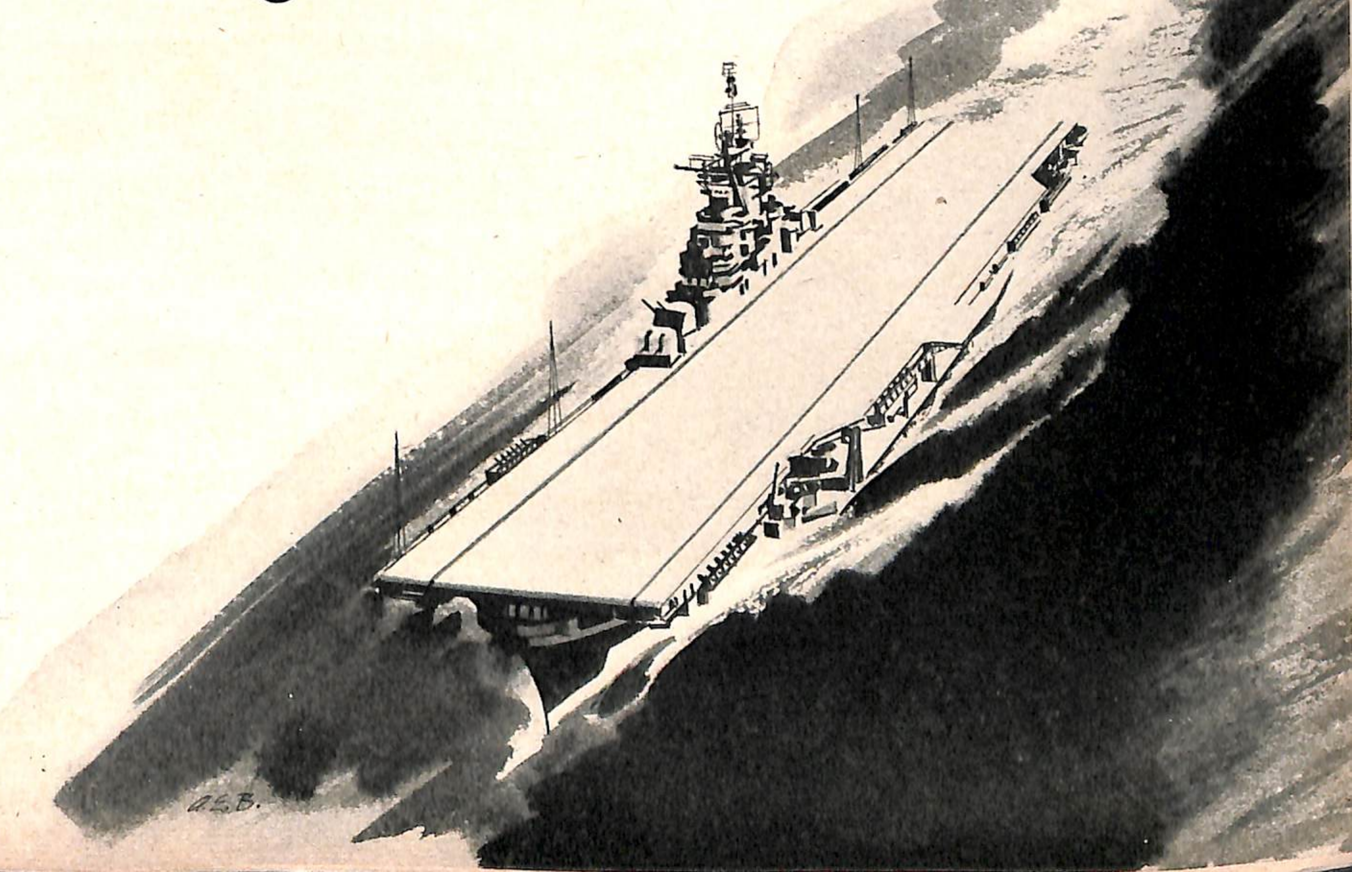
The E.W. search system has two presentations, one a normal PPI and the other an off-center PPI called the *map-sector* scan. Height finding data on planes is presented on a cathode ray tube, called the Range Height Indicator (RHI or *D*-scan) which may operate through 360°, or may be adjusted to respond only over a particular sector. All of these advantages will be discussed in more detail later.

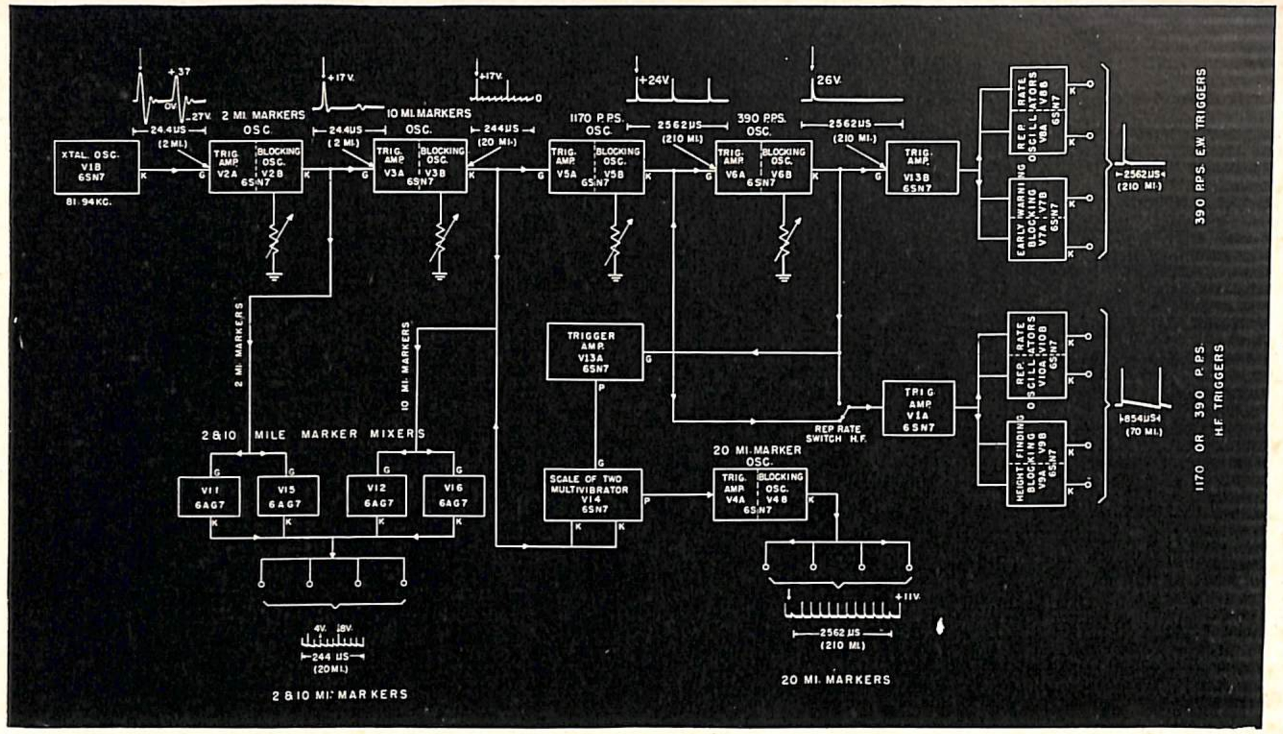
A crystal-controlled unit called the Synchronizer, located in the main control unit, provides pulses for timing all of the units in the system and for measuring ranges on the indicator traces. The timing pulses are used as triggers for initiating the transmitter signals and the associated indicator sweeps, one at a 390-cycle rate and the other at 1170-cycles. The range-measuring pulses, known as range markers, occur at intervals equivalent to two, ten, and twenty radar miles (1 radar mile = 2000 yards). Since all timing or trigger pulses and all range markers are generated by the same oscillator, the problem of synchronization is solved.

The methods used to obtain all trigger pulses and range markers from one oscillator are unique. The basic frequency of the oscillator is 81.94 kc, or equivalent to one cycle per radar mile. This output is divided by two in a divider circuit and the resultant output is used for the two-mile range markers. This output is further divided by five in a second divider circuit and the resultant is used for the ten-mile range markers. The ten-mile range markers are used in producing both the 1170 triggers and the 20-mile range markers. The 1170 triggers are the result of dividing the 10-mile range markers by 7 in a divider circuit. The 390 triggers are obtained by dividing the 1170 markers by 3 in a divider circuit. The 390 triggers and the 10-mile range markers are combined in a scale-of-two multivibrator to produce the 20-mile range markers. Thus, by the use of several divider circuits and the multivibrator, all the necessary timing and range marker pulses are obtained from the output of a single oscillator.

Due to the number of units requiring timing pulses and range markers it is necessary to supply several outputs of the voltages developed in the synchronizer. Generally speaking, the outputs and their destinations will be as shown in the block diagram, although slight variations may appear in different installations.

Both driver-modulator assemblies receive their trigger pulses direct from the synchronizer. When a radar distribution switchboard is employed such as in the *Midway* installation, only two video adapters are used, one in the E.W. system and one in the H.F. system. One E.W. trigger is delivered to the E.W. video adapter and one to the switchboard. The one to the video adapter supplies a trigger output to the IFF system, while the one to the switchboard is connected to feed four outputs, one for





Functional block diagram of the synchronizer located in the main control unit. The synchronizer furnishes all range-mark and trigger voltages for the entire system.

each of the four consoles in CIC. The E.W. video signals from the receiver are first passed through the video adapter then through the switchboard to each of the four consoles. The switchboard has separate video and trigger outputs for a fifth console if used. When no switchboard is installed, a second video adapter is installed to perform the functions normally assigned to the switchboard insofar as the E.W. system is concerned. The H.F. system employs only one video adapter which furnishes four video and four trigger outputs to the consoles in CIC. When a fifth console is employed, separate trigger and video is supplied for it. All range-marks outputs go directly from the synchronizer to the consoles.

The functional block diagram shows the overall picture of the system, including the two individual r-f channels. As stated previously the synchronizer furnishes a 390-cycle trigger for the E.W. system and an 1170 trigger for the H.F. system. Both the 390 and 1170 triggers are positive voltages, the 390 being approximately 105 volts in amplitude and the 1170 being 75 volts. These triggers are delivered to the respective E.W. and H.F. driver-modulator assemblies.

The a-c distribution box is located in the forward radar transmitter room. It is used as a distribution point for power to the various components of the entire system. The main source of 440-volts, 3 phase, 60 cycles, is used for the input to this unit. A motor-generator set located near this unit supplies all units of the equipment which require regulated voltages. The heater units in the modulator assemblies and an outlet in the antenna mount are supplied with 115 volts from transformers located in the cabinet. All 440-volt, 3-phase power for the driver-modulator assemblies is supplied by the distribution box.

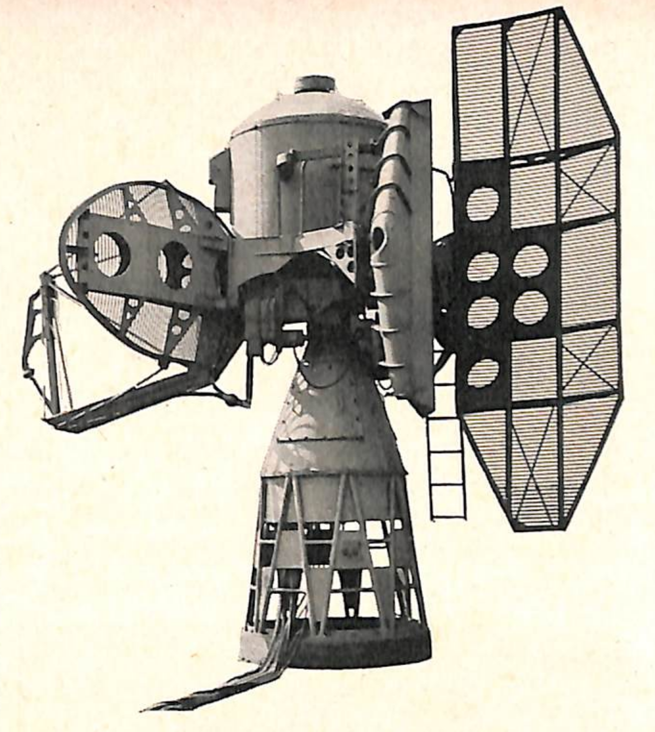
MODULATORS

The E.W. search and H.F. driver-modulators are practically identical except for input and peak output power. The E.W. unit supplies a one-microsecond pulse of 3.5 megawatts peak power at 390 cycles, requiring an input of approximately 3.2 kva at a power factor of 68%. The H.F. unit supplies a one-microsecond pulse of 2.0 megawatts peak power at 1170 cycles, requiring an input of 4.5 kva at a power factor of 69%.

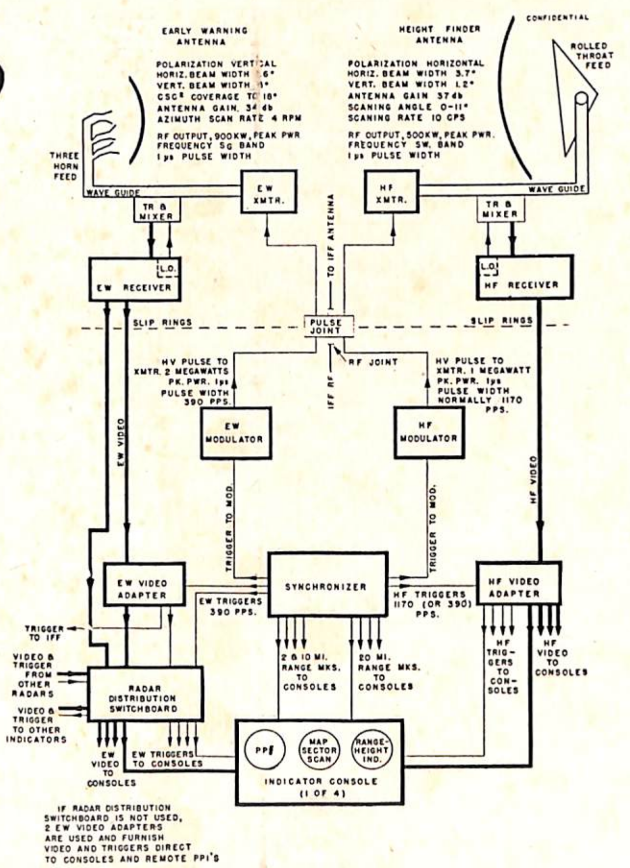
Since the driver-modulator units of both systems are identical in operation, only one will be discussed here. The units are made in two cabinets which are joined together and form one large housing, with forced ventilation of the two sections by blower systems. The power units are contained in the left-hand cabinet, and the right-hand cabinet contains the circuits associated with the driver-modulator assembly proper. The high-voltage rectifier furnishing power for the modulator consists of a Δ-Y-connected transformer using six type 8020 rectifiers to give 15 kw output. Also located in this cabinet are two other rectifier power supplies, one to furnish power for the driver assembly and the other for the trigger amplifier stage.

The positive pulse from the main control unit is passed through a "bootstrap" amplifier, a cathode follower, and applied to the grid of a type 4C35 thyratron. Between pulses the driver power supply has charged a resonant coil and capacitor combination, located in the driver, to a value of 8000 volts. When the pulse is applied to the 4C35 it discharges the capacitor. This discharge is stepped up through a transformer and applied to three spark-gap tubes connected in series. One end of this combination is connected to a pulse-forming network which is charged to a value approaching 30 kv, or double the d-c charging voltage furnished by the modulator power supply. This increase is accomplished by the functioning of a resonant circuit composed of the pulse-forming network and a large choke in series. When the pulse from the driver unit is applied to the spark-gap tubes, it will cause them to arc over, effectively grounding the pulse network. The action of these gap tubes is almost instantaneous and the pulse-forming network thus discharges, creating a high-voltage pulse.

The pulse network is designed so that the discharge cycle will occur in one microsecond, thus delivering a square pulse one microsecond in duration and approximately 10 kv in amplitude. This pulse is delivered to a 1-to-3 pulse transformer which is located in the antenna mount. The output of the pulse transformer, about 28 kv, is applied to the magnetron, causing a pulse of r-f energy to be formed.



Antenna system of the SX showing the two reflectors mounted at right angles to each other. Total weight of the mount is 5500 pounds.

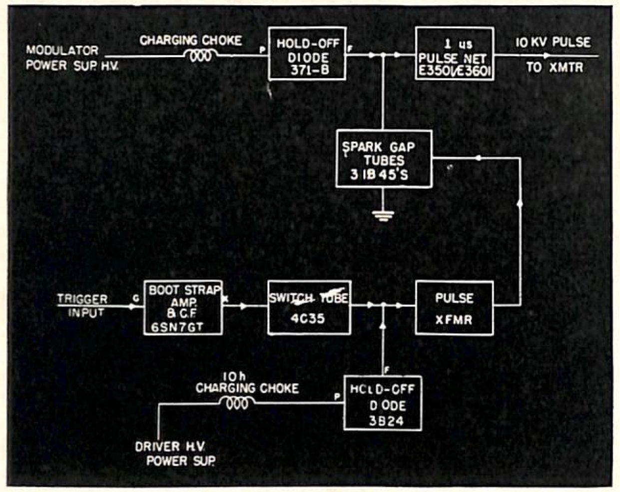


Simplified block diagram of the SX radar, showing the two complete r-f systems and associated units. Note the radar distribution switchboard employed in this installation.

As stated previously, both antennas, transmitters, receivers and associated equipment for complete r-f packages are installed on the same mount. The entire antenna assembly rotates at a speed of 4 rpm. A Mk 8 Mod 4 stable element is employed in the system to provide stabilization.

The E.W. antenna, part of the PPI system, is a horn-fed dish measuring 4 x 14 feet, which gives a *cosecant-squared* (see p. 27) antenna pattern. The beam is very narrow in the horizontal plane, 1.7°, and broad in the vertical plane, 5°. This enables pickup of small planes, such as fighters, at ranges up to 65 miles at 18° elevation due to the cosecant-squared pattern. Larger planes and formations of planes will be picked up at greater ranges. Due to the characteristics of the cosecant-squared pattern, the high-angle short-range coverage is greatly improved. This type of beam pattern, combined with the vertically-polarized antenna, eliminates the nulls which cause fades out to the maximum range on most low-frequency search sets. The range accuracy is approximately 400 yards with a bearing accuracy of 0.5 degrees. The peak power in the pulse is roughly 0.9 megawatt. The overall gain of the antenna is approximately 34 db.

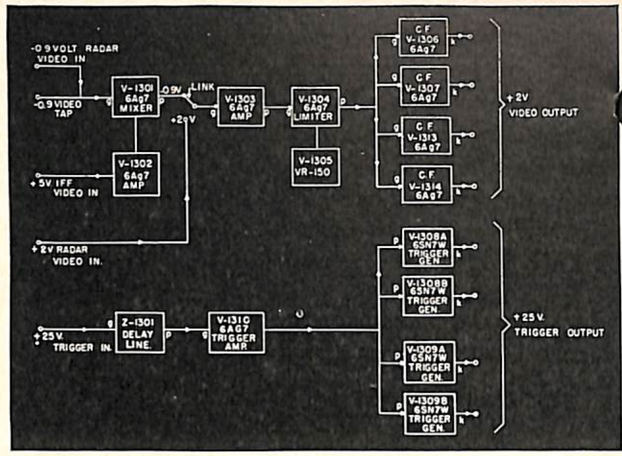
The receivers used in the two r-f packages are identical with the exception of the type of local oscillators used. Both use a type of Shepard-Pierce tube, the E.W. employing a type 726C and the H.F. a 2K29. Both receivers are of the conventional superheterodyne type employing, in addition to the local oscillators just mentioned, a crystal mixer, six stages of i-f amplification using 6AC7's, one-half of a 7F8 (characteristics similar to a 6SN7W) for a detector, and one video amplifier using a 6AC7. The output is taken off a cathode follower composed of two 6AG7's in parallel. A neutralizing stage, using a 6AG7 connected as a triode, is interposed between the output of the mixer and the input to the first i-f amplifier. This circuit is used to lower the noise generated by the first i-f stage. The system employs the latest features in AFC, IAVC, and STC for more efficient and flexible operation.



Functional block diagram of the Driver-Modulator unit of the SX equipment.

The H.F. antenna presents a new development in antennas, both in the reflector and in the method of feeding the energy to the reflector. The 5 x 15 foot vertical dish is fed from the side by a rolled and folded parallel-plate horn. The mouth of this horn measures about 1 x 8.5 feet in cross section. The horn receives its energy from an S_W-band waveguide. The radiation is horizontally polarized. The coverage and accuracy demanded of the H.F. equipment in the solution of the fighter-direction and interception problem led to the development of a rapid-elevation scan, with a beam that is narrow in the vertical plane and comparatively broad in the horizontal plane, the actual widths being about 1.2° by 3.5°.

A rotary scanner is used to make the beam, which has a beaver-tail shape, scan from the "up" to the "down" position. This type of scanning was chosen because it combines good coverage with easy and rapid operation. The base line of the RHI is synchronized with the rotation of the antenna, presenting azimuth information. The vertical sweep of the RHI is synchronized with the ver-



Simplified block diagram of the Video Adapter.

tical scanning of the beaver-tail beam, giving height information which is read directly from the RHI scope.

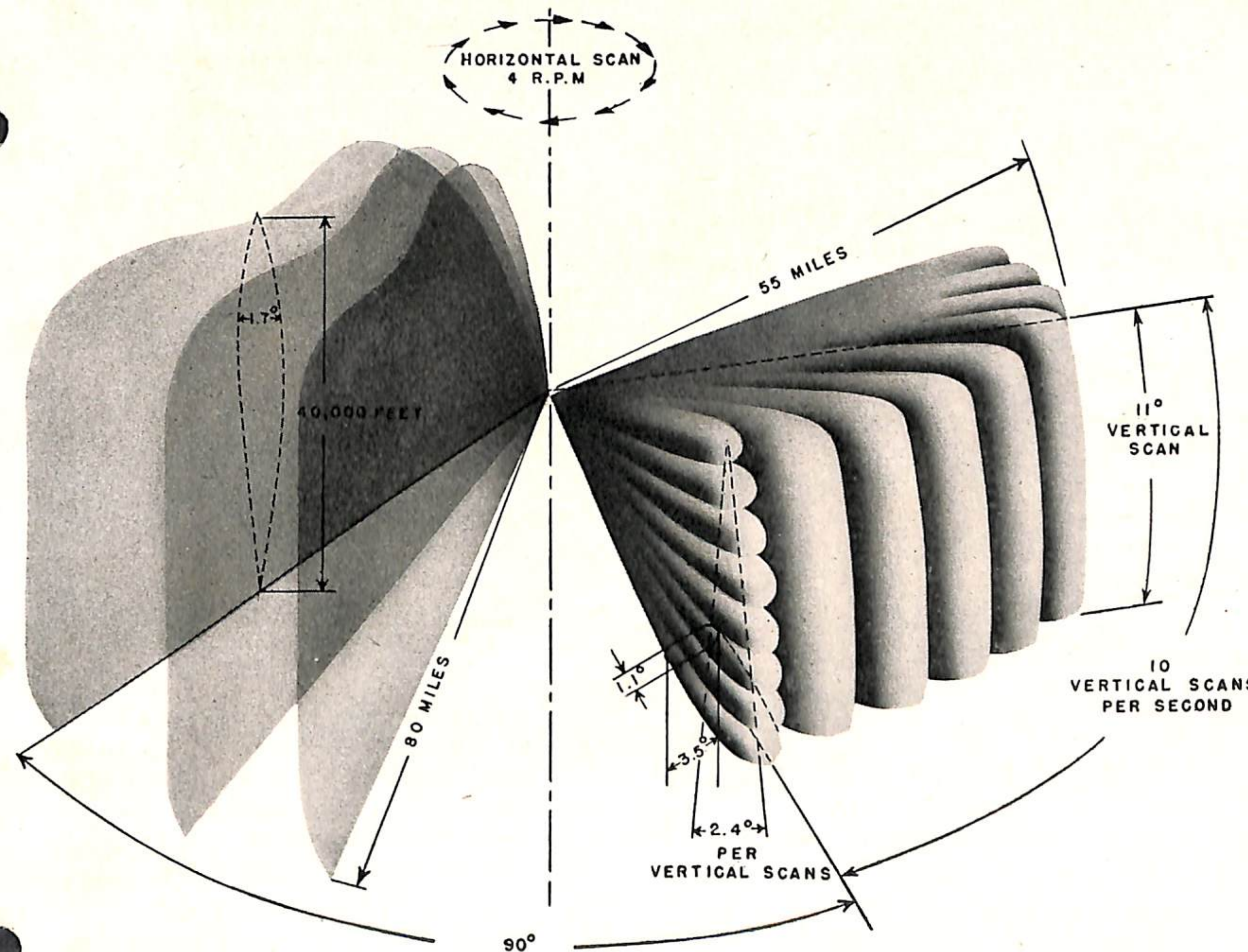
The beam scans 10.5° in elevation ten times per second with 15% time off between scans. The scan is linear to within 0.03°. The gain is 37 db, minus 1 db at the water extreme and 2 db at the air extreme. The antenna consists of a rolled horn feeding a dish. It is of interest to investigate the geometry of the dish and horn feed to understand how the antenna functions electrically.

The dish has such a surface that it will reflect the horn radiation into a true plane wave when the beam is on axis, in the middle of the scan. The radiation from the horn is equivalent to that from a pair of parallel plates fed by the waveguide at one side and flared at the other. In the plane perpendicular to these plates, the wave front has circular sections centered at the flare. Thus the reflector section in this plane is a parabola with focus at the flare. In a plane parallel to the plates and through the center of the waveguide feed, the sections of the wave front are circles with their centers at the waveguide feed. Therefore the section of the surface of the dish in this plane is also a parabola, and its focus is at the waveguide. The two focal lengths are 5 feet and 9 feet respectively. The portion of this surface used as the reflector is not symmetrical, being cut off six inches from the axis of one side and 5 feet six inches from the axis on the other side, so that the horn feed is from one side of the reflector. A new type of horn feed was developed to feed this reflector in such a way that the beam scans vertically. Flared trapezoidal plates are rolled and folded in such a way that the waveguide course becomes a complete circle, while the flared aperture remains straight. For proper radiation, this involves keeping the plates parallel and avoiding stretching while deforming the plates into the horn feed. When a single sheet is folded along the proper curve, it can be rolled up without tearing or stretching into the proper curved surface, which resembles an elongated oval horn with a cylindrical cavity inside it, the two being joined along a horse-collar-shaped region. The energy is fed from the waveguide through a rotary joint and guided into the space between the cylindrical section and the outer horn surface, through torroidal rings which guide the energy from the rotary joint through 90° into the horn.

Although this type of antenna is not easy to build, it is quite good for this application. The *H*-pattern is not beautiful compared to a good non-scanning antenna, but the half-width remains sharp and its motion is accurately linear, so that the antenna can do a good job of height finding. Other methods of scanning were considered, but none led to a design as compact and as light. The rapid scan and saw-tooth coverage are advantages that go with the rotary feed motion. This type lends itself well to large antennas whose beam is fanned in the *E*-plane, and which are to scan less than 12 beam widths in the *H*-plane. For antennas less than 10 feet overall, or with more scan, other designs would probably be preferred.

As has been stated previously the H.F. antenna is mounted at right-angles to the E.W. search antenna, thereby eliminating interaction. This point is to be remembered, because it will become of considerable importance when the presentations on the various scopes in the consoles are discussed later.

Both the E.W. and H.F. systems utilize a Radar Repeater Adapter interposed between the receiver output and the consoles. The arrangement of these adapters together with the Radar Distribution Switchboard has been discussed previously. These adapters are identical, but in this application are used in a different way. However, a brief description of the functions and perform-



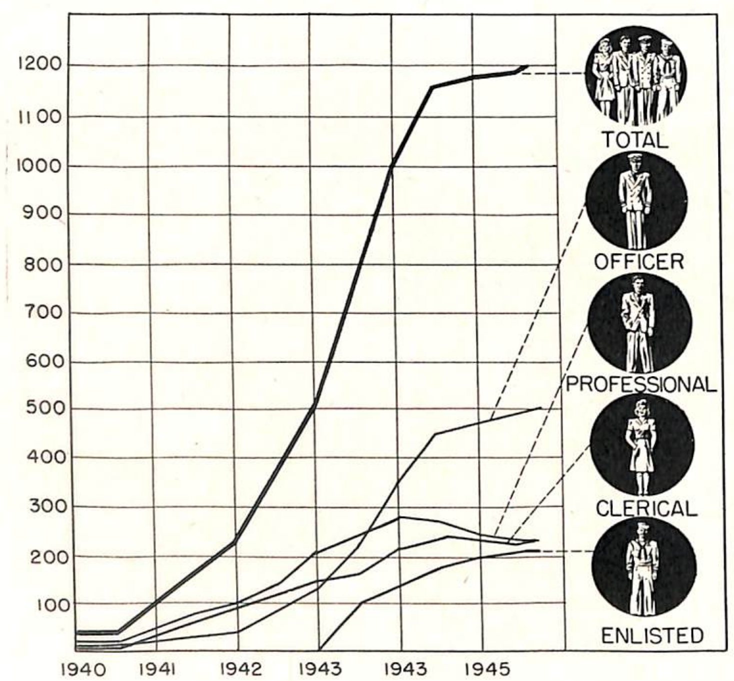
Antenna patterns of the two reflectors showing theoretical coverage and 90° spacing due to reflector arrangement. Note that the height-finding pattern lags the early-warning pattern.

ance of one of them follows: The unit contains its own d-c power supply which operates from any 115-volt 60-cycle source. The unit provides four outputs of video and four outputs of trigger voltage, thus it requires both trigger and video inputs. Facilities are provided to accommodate either a positive or a negative video input voltage, making the unit very flexible in operation. The trigger input should be a positive voltage of approximately 25 volts in amplitude. All outputs, both video and trigger, are taken off cathode-follower stages for delivery to the switchboard or to the consoles as the situation demands.

The trigger input is applied to a delay line. The delay line is arranged in steps equivalent to 25 yards in range, from 0 to 200 yards. The adjustment of the tap on the delay line is made at the time of installation and should not be changed, because the delay time will remain constant for a particular equipment. The output of the delay line is applied to a trigger amplifier using a 6SN7W, triode connected. The output of the amplifier is used to trigger a blocking oscillator consisting of two 6SN7's with all plates tied together and all grids tied together. The output triggers are taken from the four cathodes of the two tubes, one from each cathode, for delivery to the switchboard or the consoles.

The unit is designed to handle either a negative 0.9-volt or a positive 2-volt video input. Switching is accomplished by an easily accessible link inside the unit. Provisions are also made to handle a positive 5-volt IFF video input, but only when the unit is operating from the negative 0.9-volt radar video input position. In the video-amplifier channel, consisting of two 6AG7's, little gain is desired so the value of the plate load resistors is purposely made very low. High-frequency response is improved by the use of small peaking chokes in the plate circuits. The output from the second video amplifier is applied to the grids of four cathode-follower stages using 6AG7's with identical circuit components. The overall amplifier and cathode-follower system is designed to give a constant positive 2-volt video output.

In the preceding paragraphs the reader has been given an overall picture of the SX system. The consoles contain numerous features which are unique, but require a more detailed explanation. This unit will therefore be discussed at length in a later article.



The Electronics Division Grows Up

■ The Electronics Division of the Bureau has grown from 39 employees in January 1940 to 1205 on 1 September 1945. These amazing figures were disclosed in a recent study made by the Division's Personnel Section of the employment record during the war years and the preparatory period which preceded. The accompanying illustration shows graphically how the Division grew, and the breakdown of its various classes of employees. The Bureau's growth during this period is a fair representation of the tremendous enlargement of the electronics program of the entire Naval establishment. It will probably never be reduced to 1940 size.

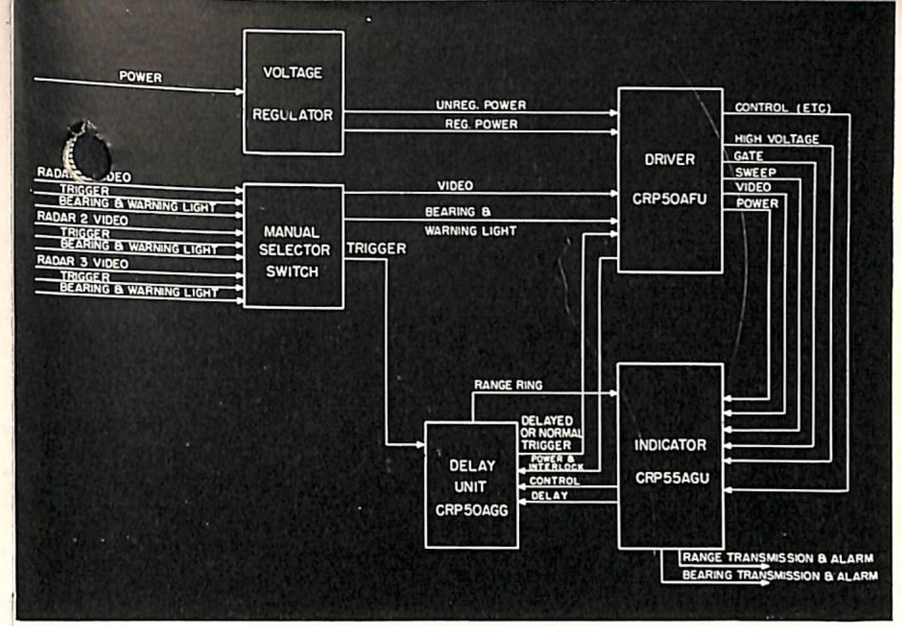


FIGURE 1—*Simplified block diagram of a typical VJ radar repeater installation, employing the delay unit.*

The VJ Radar Repeater

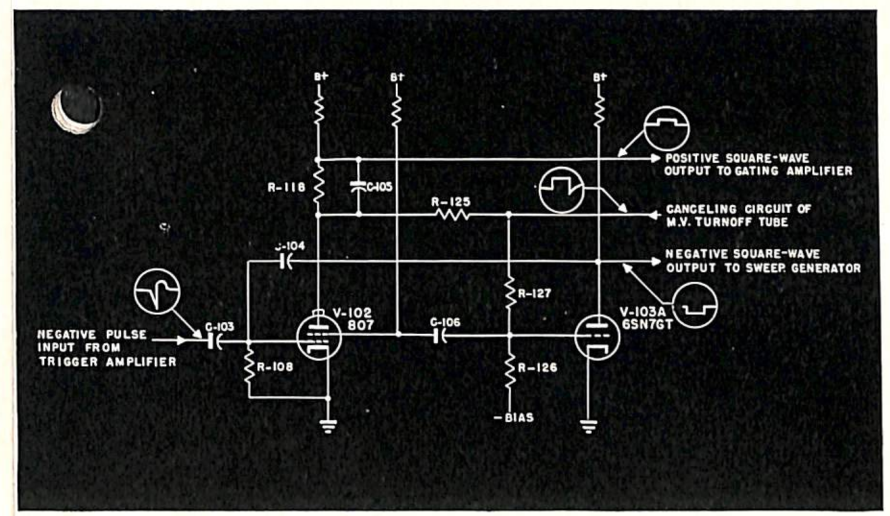
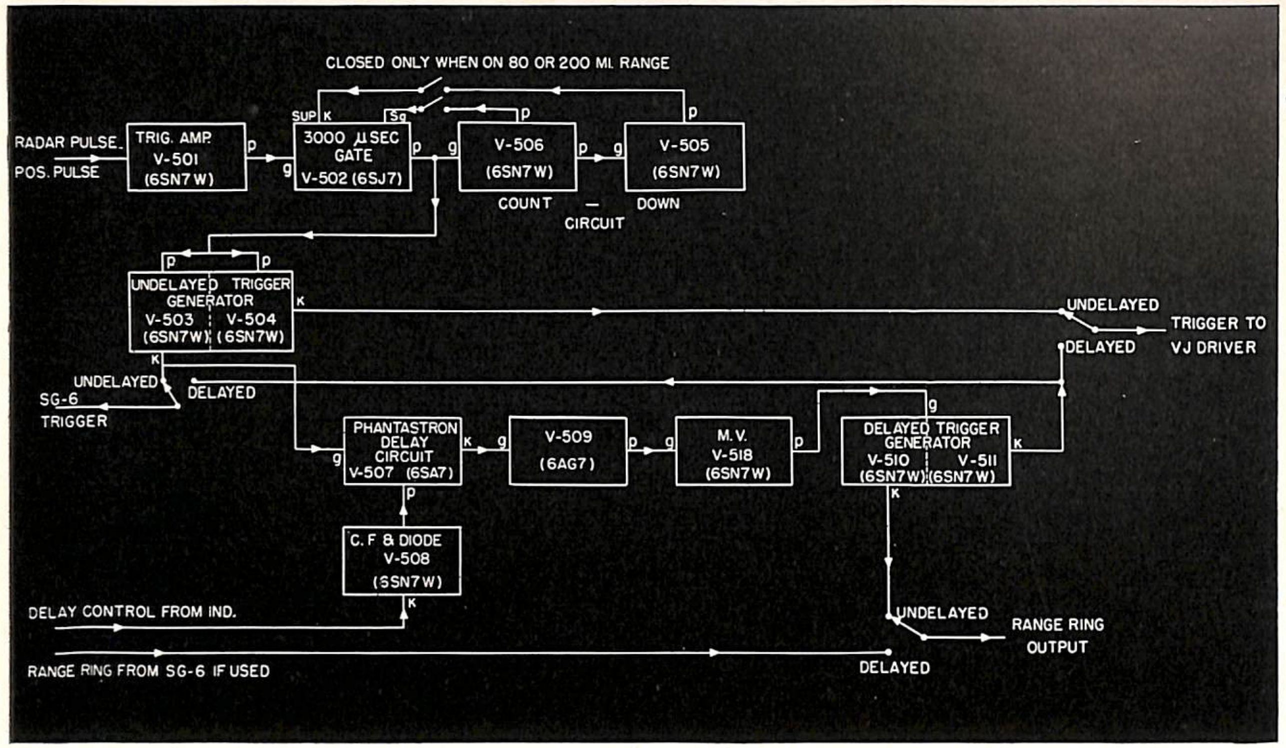


FIGURE 2—*Simplified schematic diagram of the gating multivibrator used in VJ driver unit, showing wave-forms at various points.*

■ Throughout the course of the war different models and types of electronic equipment were developed and produced to meet the demands occasioned by changes in tactical situations. The VJ Radar Repeater consisting of a delay unit, a driver, and indicator, was developed to meet fleet needs for a remote 12-inch indicator for fighter director plotting and station keeping.

In the VH radar repeater (see p. 26, ELECTRON for August) it will be recalled that the driver unit was actuated by the pulse directly from the master radar. In most VJ installations there will be a delay unit added between the master radar and the driver unit as shown in figure 1. This unit will not be included in other systems, contingent on the application of the particular installation.

The system can be used for either NORMAL or DELAYED operation. In normal operation the operator has a choice of six ranges, 2, 4, 10, 20, 80, and 200 miles, measured by a variable range ring. In delayed operation provision is made to expand any ten- or twenty-mile sector of the over-all range (0-180 miles) to cover the entire scope. The operator cranks the range ring out to the vicinity of the echo he desires to expand, then switches to delayed operation. This cuts off the range ring and now utilizes its voltage to trigger off either the 10- or 20-mile sweep, as appropriate. The range of the target can be estimated by the use of the range marks placed on the scope, plus the range dial reading. The



Simplified block diagram of the delay unit, a part of the VJ radar repeater system.

percentage of range accuracy on the 80- and 200-mile ranges is comparable to that of the 2-, 4-, 10-, and 20-mile ranges. When the target range decreases, the accuracy is improved by using one of the four smaller ranges in normal operation. When an SG-6 or comparable radar system is tied in with the VJ, a range ring will be available on either normal or delayed operation, since the SG-6 will furnish this range ring when the VJ is switched to delayed.

A variety of easily removable plotting surfaces will be provided with the VJ. One such cover is curved to fit over the tube face with a ½ inch clearance. Another is the "reflection plotter", a unit developed by the Radiation Laboratory to entirely eliminate the errors caused by parallax. It is essentially a semi-reflecting glass surface interposed equidistant between the PPI tube surface and the edge-lit plotting surface. Markings made on the plotting surface with a china marking pencil are reflected in such a way that they appear to be on the tube surface. This is true regardless of the angle at which the observer views the plotting surface. The pip on the tube face is transmitted through the semi-reflecting mirror to the eye, whereas the marking on the plotting surface is reflected by the semi-reflecting mirror to the eye, so that no matter what the position of the eye, a correctly plotted pip appears to coincide with the pip on the tube surface, and depending on the adjustment of the equal distances involved, both appear to be in the focal plane of the plot. It will be noted that, due to the curvature of the tube, the focal plane of the plot and the tube face will not coincide over the whole surface, but the difference is only slight.

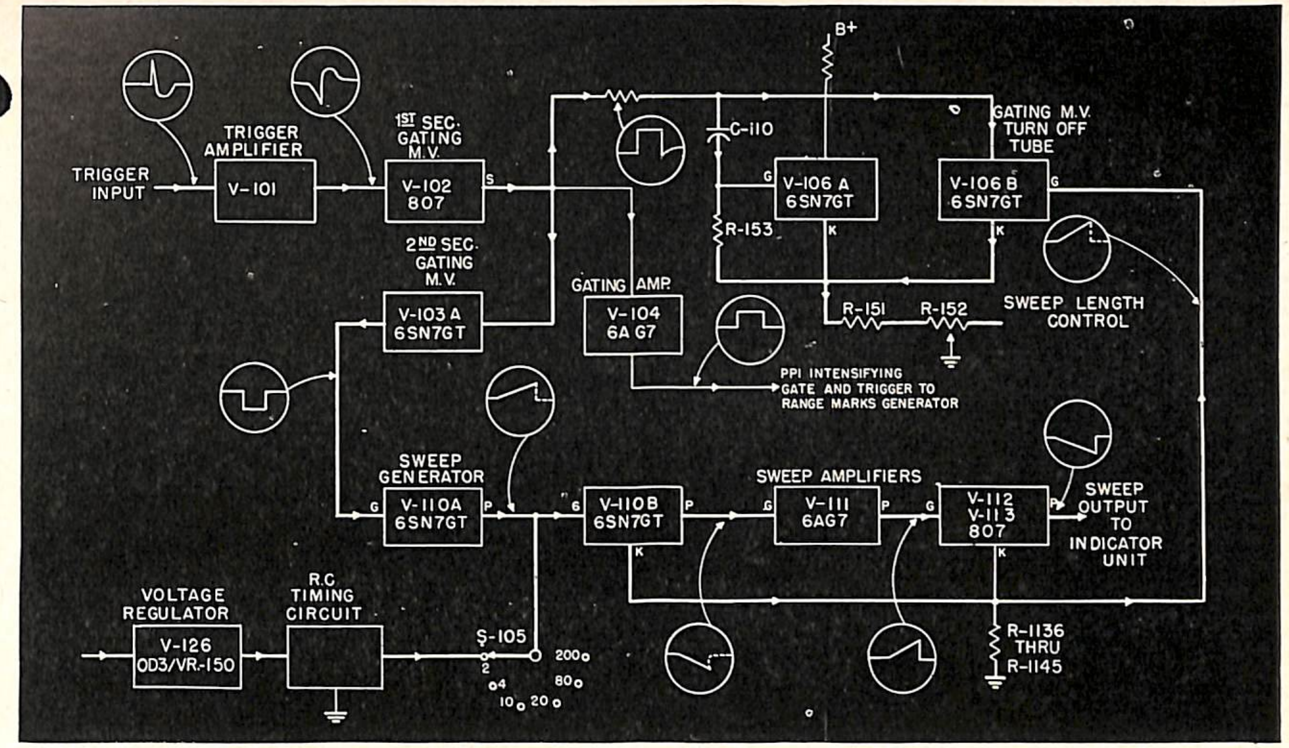
Operation will disclose that the delayed VJ presentation is somewhat distorted since the inside of the ring is contracted while the outside is expanded to transform the ring display into a circular presentation filling the entire scope. This distortion is overcome in a future model, the VK radar repeater, which displays an off-center picture in its expanded presentation. This repeater is now in the developmental stage and delivery is indefinite.

The above is a general description of the system. To provide a better understanding of the actual operation, a more complete investigation of the various units and circuits follow.

DELAY UNIT

To describe a unit of this type it is very helpful first to determine what signal voltages are supplied as input, what signal voltages are desired in the output, what circuits the unit contains, and how the circuits function to produce the desired outputs from the inputs that are available.

The only signal input to the delay unit is the positive trigger from the main radar. The outputs desired are a delayed or normal trigger for the driver unit and a range-ring voltage when in normal operation. If an



Block diagram of the sweep generator circuits, including multivibrator turn-off tube, employed in the VJ driver unit.

SG-6 (or similar radar) is used, the unit will furnish a trigger for it.

The delay unit contains 18 tubes, 6 of which make up the regulated and non-regulated power supplies. The remainder serve useful functions in the signal circuits.

During both normal and delayed operating conditions the incoming positive trigger is amplified in both sections of V-501, a 6SN7 connected in cascade. The positive output is applied to the grid of a 6SJ7 3000 μs gate tube which, together with two 6SN7's connected as multivibrators, forms a count-down circuit. On the 80- and 200-mile ranges this circuit is switched in to lower the repetition rate of incoming trigger pulses.

NORMAL OPERATION

In this condition one output of the 3000 μs gate V-502 is applied to an un-delayed trigger generator, a single-swing blocking oscillator using two 6SN7's (V-503 and V-504) having all four plates tied together and all four grids tied together. The parallelled cathode section of V-503 has two outputs, a positive pulse to trigger the SG-6 (or similar radar) when used, and a positive pulse to trigger V-507, the first tube in a type of delay circuit called a *phantastron* (see p. 38, November Electron). The parallelled cathode section of V-504 has only one output, this being used to trigger the driver unit. The pulse to trigger the SG-6, and the pulse to the VJ driver are used only in normal operation.

The second output from V-502 is applied to a count-down circuit composed of V-505 and V-506, both 6SN7's.

The complete phantastron consists of V-507 and V-508, a 6SN7 having one half connected as a cathode follower and the other half connected as a diode. The pulse width is controlled by a *helipot* located in the indicator unit, which effectively varies the cathode voltage on the diode section of V-508.

The output of the phantastron is taken off the cathode of V-507 and applied to the grid of V-509 (6AG7) which is part of a delayed-trigger generator. The output from V-509 drives a multivibrator V-518 (6SN7). The output from V-518 triggers a single-swing blocking oscillator consisting of V-510 and V-511 (6SN7's) connected in the same manner as the un-delayed trigger generator V-503 and V-504. The parallelled cathode section of V-510 delivers a delayed trigger to a 200-ohm potentiometer, the output of which is delivered to the indicator and forms the range ring. The output from the other parallelled cathode section is not used during normal condition.

The count-down circuit (V-505 and V-506) is in operation only on the 80- and 200-mile ranges. The SG is the only radar which would require its repetition rate to be lowered for correct operation, and then only when using a recurrence rate of 800 cps or more. In the future there may be more equipments with higher recurrence rates, which justifies the inclusion of the count-down circuit in the VJ.

The negative pulse from V-502 starts operation in the first multivibrator of the count-down circuit (V-506). V-506 has two outputs, one from each plate. The output of the second plate, a negative pulse of approximately 3000 μs duration, is applied to the screen grid of V-502, effectively blocking it and allowing no output regardless of the number of triggers appearing on the grid. The output from the first plate, a positive pulse, is applied to the first half of the second multivibrator which is normally conducting. This M. V. is triggered off by the sharp negative swing at the end of the 3000-μs positive pulse. The output from this M. V. is applied to the suppressor and cathode of the 3000 μs gate at the instant the negative voltage is removed from the screen. The circuit is returned to its original condition and ready for the next trigger from the trigger amplifier.

DELAYED OPERATION

In this condition, the trigger is amplified by the trigger amplifier, divided in the count-down circuit (80 and 200 mile ranges only) and applied to the un-delayed trigger generator, the output of which now drives only the phantastron delay circuit. This is because the outputs to the SG-6 and the VJ driver are switched out of the circuit. The delay in the phantastron is controlled as before, and the output from this circuit triggers the delayed-trigger generator circuit. As stated previously, when on delayed operation no range ring is available because the pulse from the delay circuit that was used for the range ring is now used as a trigger voltage for triggering either the 10- or 20-mile sweep in the driver unit. A second output is taken from the delay circuit to trigger the SG-6 if used.

DRIVER UNIT

In any indicator system using the driver unit, such as the VH, VJ, etc., certain inputs are required for correct operation, such as range marks, video signals, sweep voltages, etc. The VH driver (used in the VJ systems) supplies all of these, in addition to power control circuits and to the PPI high voltage. To furnish these voltages the driver must have video input, trigger-pulse input and regulated and non-regulated a-c voltages. These are brought into the driver from the main radar system, the delay unit, or from power circuits.

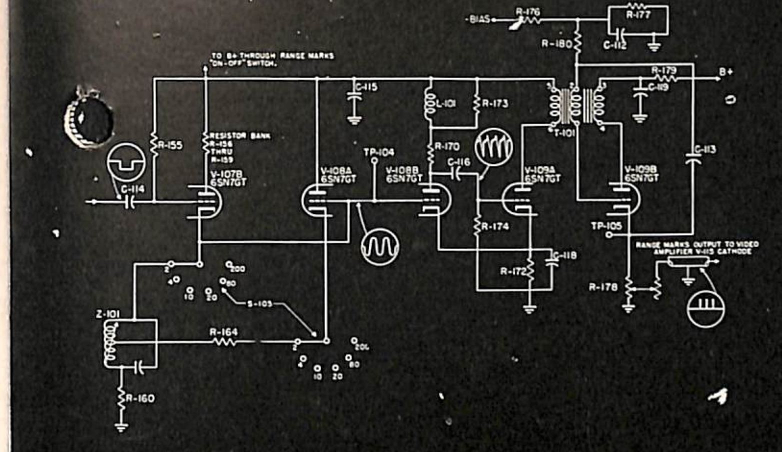
VIDEO CHANNEL

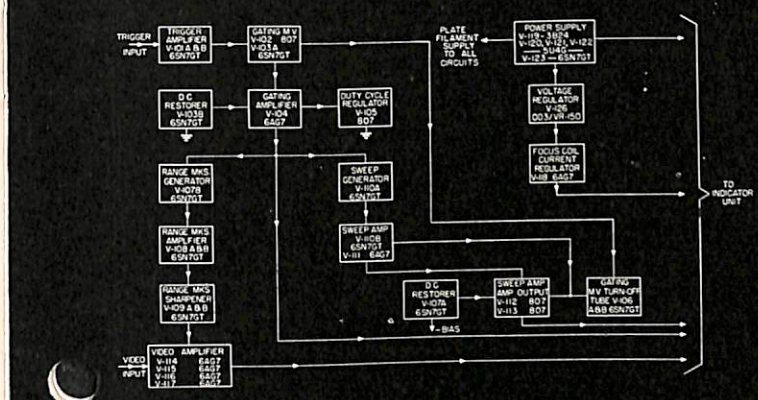
The video amplifier is a conventional two-stage resistance coupled amplifier using two 6AG7's (V-114 and V-115), affording a 6 Mc band width by the use of low value plate load resistors and small peaking inductors. The range marks are mixed with the video in the second video amplifier. The output of this stage is fed to two 6AG7's in parallel and the positive outputs are taken off a common cathode resistor and fed through a coaxial cable to the indicator unit where they are amplified, inverted and applied to the cathode of the PPI as negative voltages.

SWEEP AND RANGE-MARKS GENERATORS

The gating multivibrator (figure 2) consists of an 807 (V-102) and ½ of a 6SN7 (V-103A) connected as a one-kick multivibrator. Normally V-102 is conducting and V-103A is biased to cutoff. The positive trigger from the delay unit is passed through a trigger amplifier V-101 and the negative output is then impressed on the grid of V-102, driving the grid negative. This action allows the screen and plate voltages of V-102 to rise in a positive direction. The rising screen voltage is capacitively coupled to the grid of V-103A creating a negative swing in the plate voltage. This is coupled back to the grid of V-102, driving it into cutoff. The multivibrator employs an unusual method to stop its operation and return it to its original condition before the next pulse is applied. The fixed RC time constant composed of C-104 and R-108 in the grid of V-102 is made greater than the longest range used in the VJ/VH (200 miles), so that its cutoff time must be controlled in another manner. This is done by another multivibrator called the multivibrator turn-off tube V-106. Before discussing the circuit let us examine figure 1, the functional block of the triggering system. Note that the negative square wave from V-103A is used to trigger the sweep generator V-110, the first half of which is normally conducting and the second half is at cutoff. When this negative pulse is applied to the grid, the plate voltage rises exponentially. Its rate of rise is controlled by switch S-105, which changes the RC time constant of the circuit. The negative saw-tooth sweep voltage developed in V-110 is passed through V-111 (6AG7) and V-112 and V-113 (two 807's in parallel) to generate the sweep to be applied to the deflection coils in the indicator.

As stated above, the square wave which was generated in the gating multivibrator has a time equal to or greater than 200 miles; consequently if we do not stop the action of this circuit all sweeps would be of the same length of approximately 200 miles. However, with switch S-105 the sweep length may be selected as desired. Thus when the sweep amplifiers V-112 and V-113 conduct, a positive saw-tooth voltage will be developed across their cathode resistors. This voltage is coupled directly to the grid of V-106B (½ of a 6SN7) which, with V-106A, is a cathode-coupled multivibrator. Potentiometer R-152, the sweep-length control, is common to both cathodes of V-106. The predetermined setting of R-152 determines the point at which V106-B will start





(upper) Schematic of range marks generator in the driver unit, range marks switch in the 2-mile position. (lower) Simplified block diagram of the VJ driver unit. (right) VJ indicator unit showing recessed control panel. Additional controls, not visible, are located on top of the unit.

conducting. The plate output of V-102, a positive voltage, will appear at the grid of V-106A and the plate of V-106B. This will cause V-106A to conduct heavily, thus biasing V-106B to cutoff due to the common cathode resistor R-152. When the saw-tooth voltage from the sweep generator is applied to the grid of V-106B, the tube will come out of cutoff at a time determined by R-152 and the amplitude of the saw-tooth voltage. This change in plate voltage is coupled back to the grid of V-106A, driving it in a negative direction. This action is very fast. V-106A is driven to cutoff, causing the plate voltage to rise rapidly in a positive direction. This change in voltage is coupled to the grid of V-102, which has been cut off due to its RC time constant. The positive rise applied to the grid of V-102 will restore the stage to its original condition and the cycle is completed.

The range mark generator circuit consists of a shock-excited oscillator V-107B, an amplifier V-108, and a range-mark sharpener, V-109.

With a switching arrangement controlled by S-105 any one of six tuned circuits may be switched into the cathode circuit of V-107. The frequency of the tuned circuit will determine the time interval between range marks. These frequencies are so chosen that they will produce four range marks for each sweep selected. For example, if we switch to the 10-mile range on the indicator, a tuned circuit will be connected into the cathode circuit which will produce a series of sine waves, the period of which will be equal to one fourth that of the period of sweep. Thus four range marks will appear on the sweep, equally spaced between each other in time and each representing 2½ miles in range.

The output of the oscillator is fed to a circuit consisting of V-108B and V-109A. The output of this stage is transformer coupled to V-109B, which acts as a single-swing blocking oscillator. The range marks output, a series of positive pips, is taken off the cathode and applied to the cathode of the second video amplifier as explained above.

FEATURES

The driver has two other features which are not too common. One is a duty-cycle regulator, an 807 (V-105, figure 5) with its associated circuit. Its function is to present a compensating load to the power supply when the gating M. V., sweep generator, and range-marks circuits are not operating. It is designed and biased so that it does not conduct when these stages are working but comes into operation when they are quiescent. The current of the 807 is approximately 100 m.a., which is about equal to that of the circuit in question.

The other feature is the employment of a 6AG7 as a focus-coil voltage stabilizer. The tube is placed in series with the focus coil, the plate voltage of the tube being the d-c voltage to the focus coil. The screen and grid voltages are taken from a regulated power supply, and the grid bias is of such a value as to permit plate current of the desired amount to flow. The manual focus control is a potentiometer shunted across the cathode resistor and adjusts the plate current through the tube. Thus any change in focus-coil resistance due to temperature, humidity etc., will have little effect on the plate current. With line voltage changes the anode and grid voltages on the PPI will change. The semi-regulated grid voltage on V-118 causes a change in focus coil current to occur which approximates the change necessary to correct the current value for correct operation.

INDICATOR UNIT

The indicator unit contains only four tubes: a 12-inch cathode ray tube, two 6AG7's, and a 6SN7. The two 6AG7's are connected in parallel and are used as video amplifiers. The range-ring voltage is applied to the screen grids of the video amplifiers. One section of the 6SN7 is connected as a diode and acts as a d-c restorer to avoid any positive excursions in signal-marks voltage from cutting off the PPI trace. The other half is not used.

In addition to tubes, the unit contains the focus- and deflection-coil assemblies, the helipot range control with its associated mechanical tie-up and components for indicating target bearing.

Mark 29 Mod 2

■ The 115-volt distribution diagram in the Mark 29 Mod 2 instruction book shows B-501, the Aided Tracking motor, connected to the "Standby", rather than the "Operate" side of the line. Thus, if the Time Control is not turned off when the equipment is in standby condition, the variable-speed drive is left in continuous operation. This will result in excessive wear of the hardened steel drive balls, especially if the Range Rate is set at zero, where the resulting motion is one of twisting rather than of rolling as is normally experienced.

Wiring B-501 to run only in the Operate condition is accomplished by opening the CW-62090 Junction Box, removing the orange-black lead from T-1618 and re-connecting it to T-1620 in the same box.

RCM Equipment

■ The following data on current RCM equipments is published for general information. These figures are subject to revision by the Bureau.

TDY-1 (Xmtr.)	200 delivered, 100 TDY's converted to TDY-1's.
TDY-2 (Xmtr.)	Contract cancelled, none delivered.
RDP (Adaptor)	Contract cancelled, 1300 delivered.
RDJ (Analyzer)	One contract cancelled, one contract cutback. Expect acceptance of about 500.
REJ (Adaptor)	Contract cancelled, 100 delivered.
SPA-1 (Analyzer)	None on order, 1000 delivered.
SPR-1 (Receiver)	310 on order, 200 delivered.
SPR-2 (Receiver)	Contract cancelled, 776 delivered.
F19 (Wavetrap)	Contract cancelled, 800 delivered.
F20 (Wavetrap)	Contract cancelled, 1060 delivered.
66131 (Antenna)	Production stopped.
66132 (Antenna)	Production stopped.

SO Complaints

■ A number of complaints have been received to the effect that the new TR caps included in the Field Change 58 kit do not clamp the tube and cavity tightly. This results in a condition whereby it is often impossible to tune the TR cavity. Pending investigation of this problem it is suggested that Field Change 58 not be made on SO equipments until further notice.

—*Raytheon.*

CORRECTIONS

October ELECTRON, p. 3: The last line of the caption for the upper picture should read ". . . are shown mounted on a Mk 37 Director."

November ELECTRON, p. 18: The OAW described in figure 2 is pictured at the top of the page, and the OCL is the lower picture.

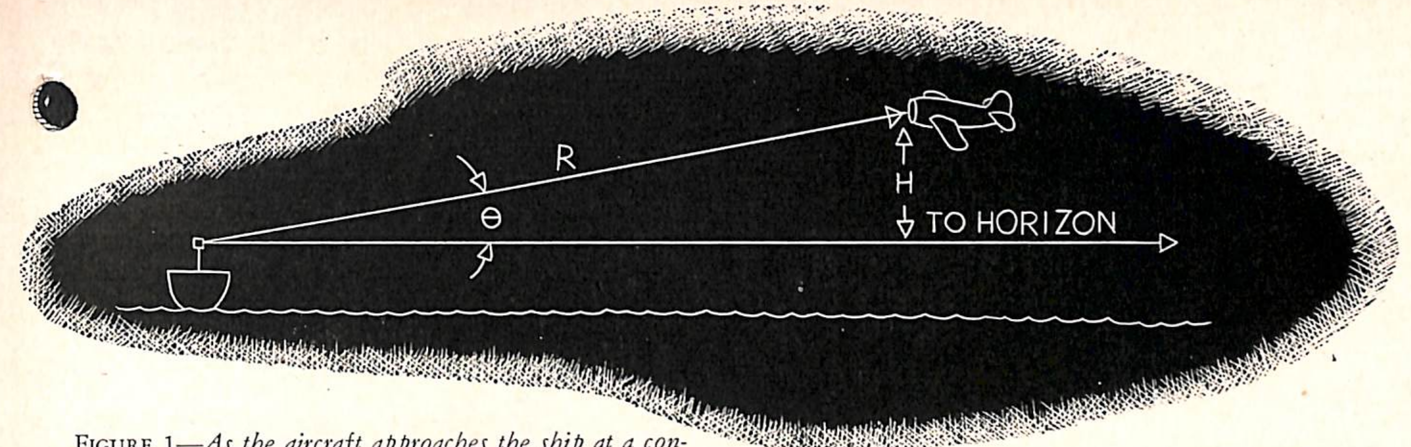


FIGURE 1—*As the aircraft approaches the ship at a constant altitude, the angle θ becomes increasingly larger and a narrow beam pattern would not afford return signals of sufficient strength at the closer ranges.*

Cosecant Squared Antennas

BY W. G. TULLER, RAYTHEON MANUFACTURING CO.

■ One of the undesirable characteristics of microwave antennas has been their lack of coverage at angles greater than a few degrees above the horizon. This has meant that good echoes might be obtained from targets four or five thousand feet in elevation at near maximum range, while the same target might be lost at a range which is too close for comfort, yet too distant for detection by UHF air-search radar. The *cosecant-squared* antenna was designed to relieve such conditions at the expense of a small amount of surface coverage.

Those who are not familiar with this new type of antenna probably wonder why it is called a cosecant-squared antenna. In order to understand this terminology, it first becomes necessary to understand the principles employed to insure continuous detection of the aircraft as it approaches the ship at a constant altitude.

Since there is available only a limited amount of total energy, this energy must be concentrated where it is most needed. The amount of power directed upward should be sufficient to insure a constant amplitude of return signal as the target moves in at a constant height. However, any additional energy expended in this direction is wasted power which is needed on the nose of the beam for increased range. Referring to figure 1, which represents an aircraft at H height approaching a ship, the angle formed by a ray from the ship's antenna to the aircraft and a ray from the antenna to the horizon is defined as θ. When R, the slant range in miles, is very large, θ must be zero for detection at low or medium altitudes. However, as the aircraft approaches and R becomes smaller, θ becomes appreciable, and R is equal to $H/\sin\theta$ or $H \csc\theta$, since the cosecant of an angle is equal to the reciprocal of its sine. If θ is fairly large (greater than a degree or so), so that there is practically free-space propagation, the received power is directly proportional to the square of the antenna gain G and inversely proportional to the fourth power of the slant range R. Where k is used as a constant which takes into account the rest of the system, the formula for received power P_r becomes:

$$P_r = k\frac{G^2}{R^4}$$

Transposing,

$$G^2 = R^4\frac{P_r}{k}$$

Extracting the square root of both sides,

$$G = R^2\sqrt{\frac{P_r}{k}}$$

As stated above, $R = H \csc\theta$. Thus, by substitution,

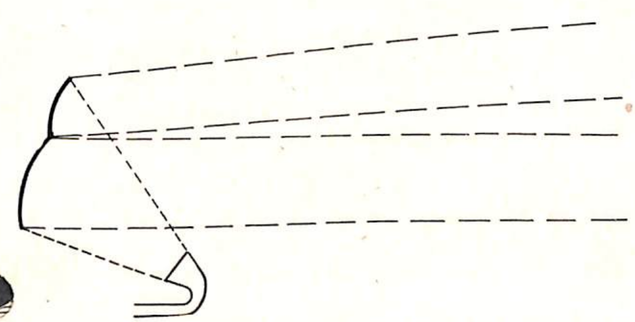


FIGURE 2—*The upper parabola is tilted back slightly to produce the necessary high-angle coverage.*

$$G = H^2 \, cosec^2 \, \theta \sqrt{\frac{P_r}{k}}$$

Since we are assuming a constant height of target and are trying to obtain a constant received power, we may combine these factors into a single constant, C:

$$C = H^2 \sqrt{\frac{P_r}{k}}$$

Then, by substitution,

$$G = C \, cosec^2 \, \theta.$$

Summarizing the above, in order to obtain a constant pip-amplitude from a target approaching at constant altitude, regardless of its range, it is necessary to have an antenna gain in the vertical plane which is proportional to the square of the cosecant of the target elevation angle. Hence, there must be a cosecant-squared pattern, or a "cosecant-squared" antenna.

HOW IT'S DONE

There are several ways of spilling a small amount of power upward, but as the SG-6 system is one of the latest developments, it will be used as an example. Fundamentally the SG-6 dish consists of two sections of a parabola set with respect to each other such that they are wall-eyed in cross section as shown in figure 2. The lower section is a conventional dish which is fed from

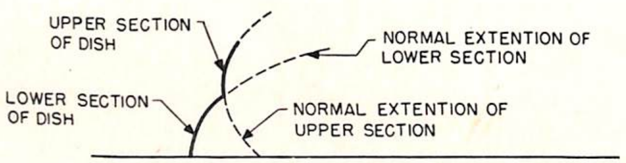


FIGURE 3—*Cross-section showing construction of the theoretical cosecant-squared antenna.*

the lower edge by a horn. This lower-edge feed is used in the SG-3, and in the SG-1 modernized antenna kits, since it keeps the big feed horn out of the way of the beam and improves the side lobes. Some of the radiation from the horn is allowed to miss the lower dish and strike the dish above where it is reflected upward at an angle, due to the fact that this dish is tilted slightly backwards. The combination of the two beams gives sky and surface coverage, with the percentage of each adjusted by varying the amount of power sprayed into each dish.

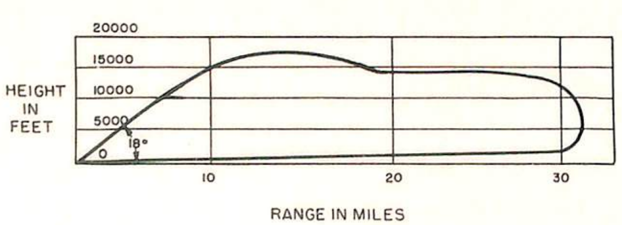


FIGURE 4—*Typical SG-6 antenna coverage and expected range of a twin-engine aircraft.*

This system will work but is difficult to manufacture. Another system, working on the same principle, has been used with success. The antenna is a slatted affair in order to reduce windage. The horizontal slats are all parabolas but the vertical risers that hold these horizontal slats in position are shaped as shown in figure 3. Here a normal parabolic curve extends upward to a point slightly above its axis, then tilts backward and continues on upward in accordance with the new axis created by the tilt.

PIGEONS

Support for the belief that radio waves affect the instincts of homing pigeons has been supplied by a recent series of tests made by the Army Signal Corps. These tests apparently prove that radio transmission confuses the birds and retards them in their flying missions.

Three successive tests were made with three groups of ten birds each, all of similar type and training. The birds were taken to a loft about ten miles from their home lofts. In each test five birds were released while the radio station was transmitting, and the other five with the station silent. The first group seemed bewildered. The birds circled erratically, very close to the station, for 15 or 20 minutes, then took off uncertainly for their lofts, requiring a total of 42 to 52 minutes to complete the 10-mile flight. The birds released while the station was silent took off normally and finished their flight in 18 to 21 minutes. Identical weather and wind condition prevailed throughout the tests.

—*Electrical Engineering.*

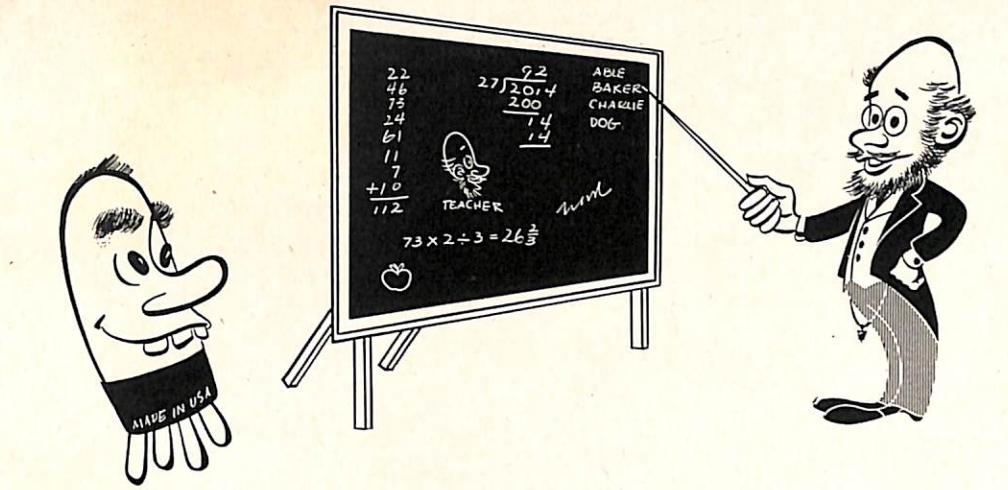
COMMUNICATIONS WITH TOKYO

■ Direct commercial radiotelegraph communication with Tokyo, suspended since Dec. 7, 1941, was restored recently by RCAC and Mackay Radio. For the time being the service is limited to official military and government, press and prisoners-of-war messages.

—*Telephone and Telegraph Age.*

MASS PRODUCTION

■ To give some idea of the size of the radar program, the Western Electric Company is said to have furnished over 52,900 radars of 64 different types during the war. Equipment was valued at over $800 million.



Testing 6AK5 and 6J6 Tubes

■ Tests of 6AK5 and 6J6 tubes in the Hickok models 540 and 550X (Navy type OZ) have been found to be in error when using the settings recommended by the manufacturer. These errors are caused by the tube drawing excessive plate and grid current due to parasitic oscillations.

These oscillations can be eliminated by the use of a Navy type CV-49519 miniature tube adapter, modified as follows: 1—Remove screw and nut which holds the adapter together and pry the socket away from the adapter. 2—Disconnect leads 1, 2, 5, 6, and 7 from the test points. 3—Drill five 1/8″ holes 3/8″ from the bottom of the adapter in such a manner that the five disconnected leads may be brought out externally, then reassemble the adapter. 4—Solder one 47-ohm ±10% resistor in series with each of the five leads. Bend the soldered connection so that the resistor lies parallel to the adapter, then solder the free end of the lead to the correct point on top of the adapter.

After the adapter has been modified, the following settings will be used for testing 6AK5 and 6J6 tubes: *(Red Socket)*

Tube Tester Setting	6 J 6		6AK5
	1st Section	2nd Section	
A	11	1	1
B	8	2	9
FIL	6.3	6.3	6.3
L	52	52	55
R	0	0	20
Notation	Set meter switch at 6,000 micromhos	Set meter switch at 6,000 mciromhos	Set meter switch at 3,000 micromhos

The mutual conductance (G_m) readings on the meter will not be correct but can be used for comparison of tubes of the same type. The color indicated by the needle will be the criterion of the efficiency of the tube. If the meter pointer rests in the *green* area, the tube is good, if in the *red* the tube should be replaced.

The CV-49519 tube adapter may be requisitioned from the nearest Electronics Supply Officer.

REPORTING FIELD CHANGES

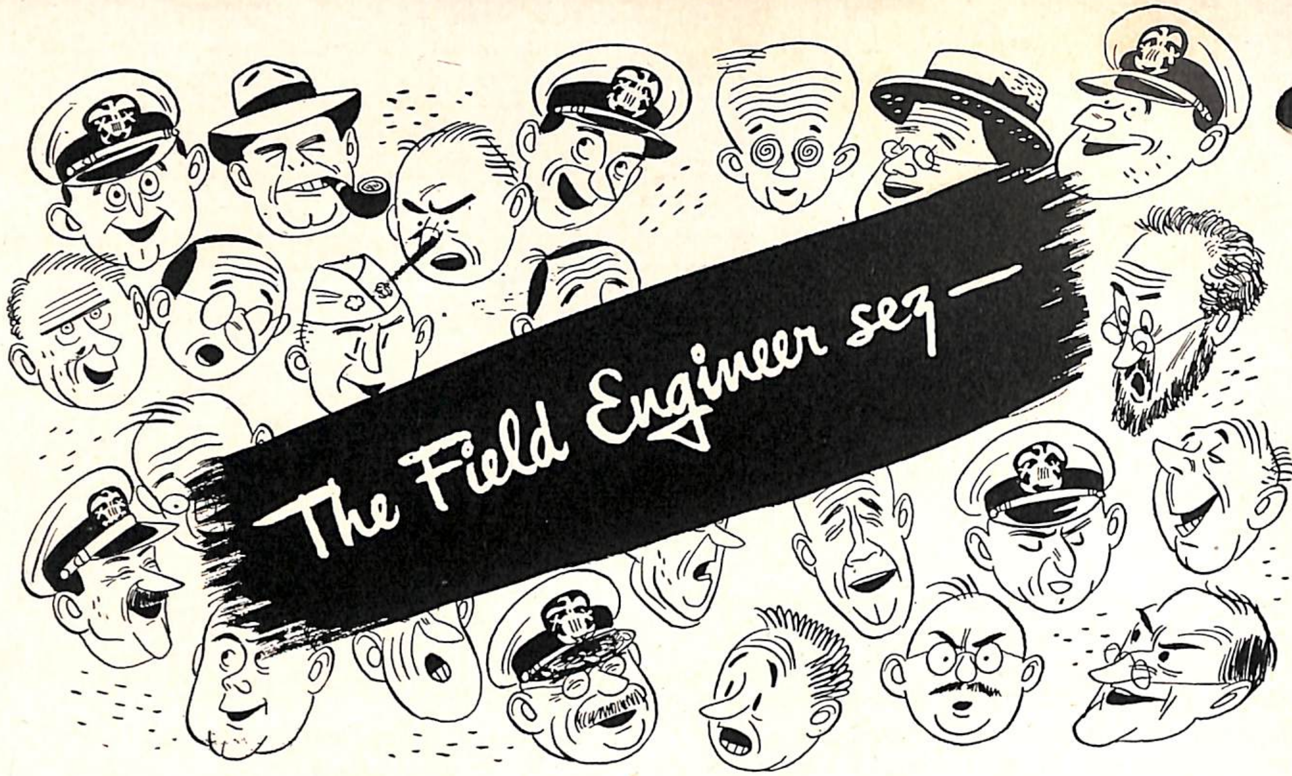
■ For reporting field changes in which no kit is supplied or in which no modification card is available, the Bureau suggests the following easy and convenient procedure:

Fill out the top half of a NavShips 383 (Failure Reports—Electronic Equipment) card and under Remarks note "Navy Field Change No. ...... made".

If properly filled out, the card should contain the following information:

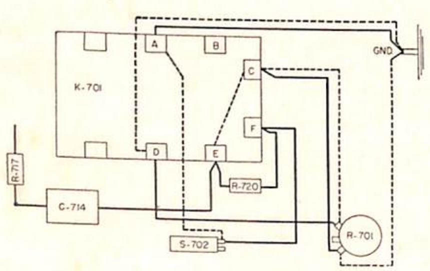
- Equipment Model and Serial Number
- Unit Name and Serial Number
- Navy Field Change Number
- Date Field Change made
- Name and rank, rating, or title of person making change.

When the card is filled out, enclose it in its self-addressed envelope, seal and mail. If no self-addressed envelopes are available, mail the cards to the Bureau of Ships, Code 980, Navy Department, Washington 25, D. C.



FLASH ON VF PPI

■ When a VF repeater is being fed from a radar distribution switchboard a flash may occur on the PPI tube for each operation of the video blanking relay, K-701. Due to the fact that the VF has no coupling capacity in the incoming video line, there is a constant d-c voltage impressed on the input to the VF video amplifier. When the video blanking relay operates, the *B*-tube video gain control is connected in parallel with the PPI video gain control causing a difference in the loading and a resultant change in d-c voltage. This may be sufficient to produce the flash observed on the PPI tube at the beginning and sometimes at the end of the scan period.



If this condition exists in your equipment, the only materials necessary for correcting it are a 1-megohm ½-watt resistor and a .01 μf capacitor. The modification involves rewiring the video blanking relay K-701 as shown. Dotted lines in the sketch indicate wires to be removed, and solid lines indicate new wires to be added.

—*Raytheon.*

CLEANING SILVER-PLATED PLUGS

■ Silver plated plugs such as the *Holmdel* and *Jones* types can be very satisfactorily cleaned of black tarnish by means of "Blitz" cloth, a product obtainable in most Ship's Service stores or Army PX's.

The plug to be cleaned is rubbed with this cloth until the tarnish has disappeared. A soft cotton cloth is then used to remove any chemicals left over from the cleaning process and to finish the polishing operation. The amount of silver removed is apparently negligible compared to that removed by crocus cloth, which has often been used to achieve the same result.

This method is particularly suitable for cleaning the i-f plugs in the SL Indicator and Transmitter as a means of correcting oscillations caused by poor plug contact.

—*Western Electric.*

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MARK 34 MOD 2

■ Apparently some of the junction boxes for the Mark 34 Mod 2 systems are being shipped with jumpers across such terminals as to cause grounding of the feed-back voltage. This may be found by resistance measurement from terminal 10 in the Modulation Generator to ground. The resistance should be about 25 ohms and not zero as will be the case if the jumpers are connected.

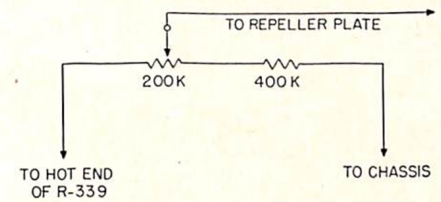
There is also an error in the Mark 34 Mod 2 prints for the Mk 12 Mod 0 junction box connection. BuOrd Print 561754—(for transmitter below deck) shows P1 and P2 reversed from their correct designation. This error is often copied in navy yard blue prints and should be changed if found incorrect.

—*E.F.S.G.*

*

SO Tuning

■ Tuning of SO-1 and SO-8 radars can be accomplished without the use of the indicator or an external scope, and it is possible to make adjustments with the transmitter cover removed without tuning errors being present. This method requires the use of the CW-60ABM Wavemeter. A connection from the wavemeter to the SO can be made up from adapters found in SO-1, SO-8 and SL spares. In order to vary the repeller voltage of the local oscillator at the transmitter, a potentiometer and resistor are fitted with clip leads and connected as shown in the diagram. It is necessary to remove the normal connection to the



repeller plate. Of course, the controls at the indicator must be set to give a higher voltage than normal at the repeller plate in order that the proper range of control of voltage with the potentiometer is obtainable. The tuning procedure is as follows:

Allow the transmitter to operate for at least 30 minutes and then measure the transmitter frequency using the echo box jack as a source of energy for the wavemeter.

Remove the transmitter case and connect the crystal current cable of the wavemeter to the crystal metering jack on the i-f strip. Connect the potentiometer and vary it for maximum crystal current. Remove the output cable from the local oscillator and, by use of the wavemeter, adjust it for the same frequency as the magnetron. (The output of the McNally oscillator is quite low and it may be necessary to couple the output more tightly in order to get sufficient power to operate the wavemeter.)

When the local oscillator is at the magnetron frequency the crystal current is adjusted for a *maximum* by means of the crystal line length. The tuning plugs of the cavity are then adjusted for *minimum* crystal current.

A final touching up of these adjustments is done by connecting the cable with the polystyrene probe to the local oscillator and holding the probe over the open end of the choke joint. In this case, however, both adjustments are made for maximum crystal current. The local oscillator is then tuned 30 Mc above the magnetron frequency. This is approximately 10 divisions lower on the wavemeter micrometer.

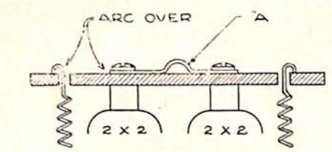
The normal connections are made (except for the repeller plate) and crystal current set for a maximum of .3 ma, since it is assumed that the current will be higher with the meter resistance removed. The repeller plate connections are then returned to normal, the cover replaced, and finally the TUNE SET control at the indicator is adjusted.

—*E.F.S.G.*

*

ARC-Over in BM Equipment

■ The BM IFF equipment was occasionally blowing fuses in the high-voltage circuit. Trouble was traced to a high-voltage arc-cover from the plate cap connector of the 2X2 rectifiers to the retaining spring, which is connected to ground.



The metal strap "A" was longer than necessary, making it too close to the retaining spring, so we cut 1/16″ from the ends and rounded the sharp edges and corners. Fuses stopped blowing. This trouble was very difficult to localize because arc-over was infrequent and did not leave any tell-tale marks.

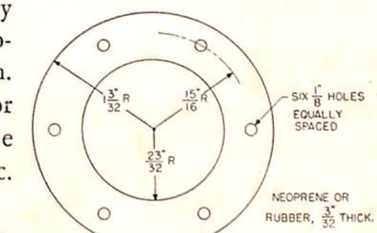
—*E.F.S.G.*

*

SL Tube Centering Washer

■ When performing the 6000-hour lubrication procedure as applied to the oscilloscope tube assembly, the rubber (or neoprene) CRO tube centering washer may be found to be in a deteriorated condition. This washer, per Western Electric Co. ES-692540-2, is a part of the shield assembly that encloses the focus and centering coils. Since the washer is not a spare parts item it may sometimes be necessary to have them made locally as per sketch. Specifications call for A.S.T.M. Neoprene 8003, or Navy Spec. 33R1 (Int.) Rubber.

—*Western Electric*



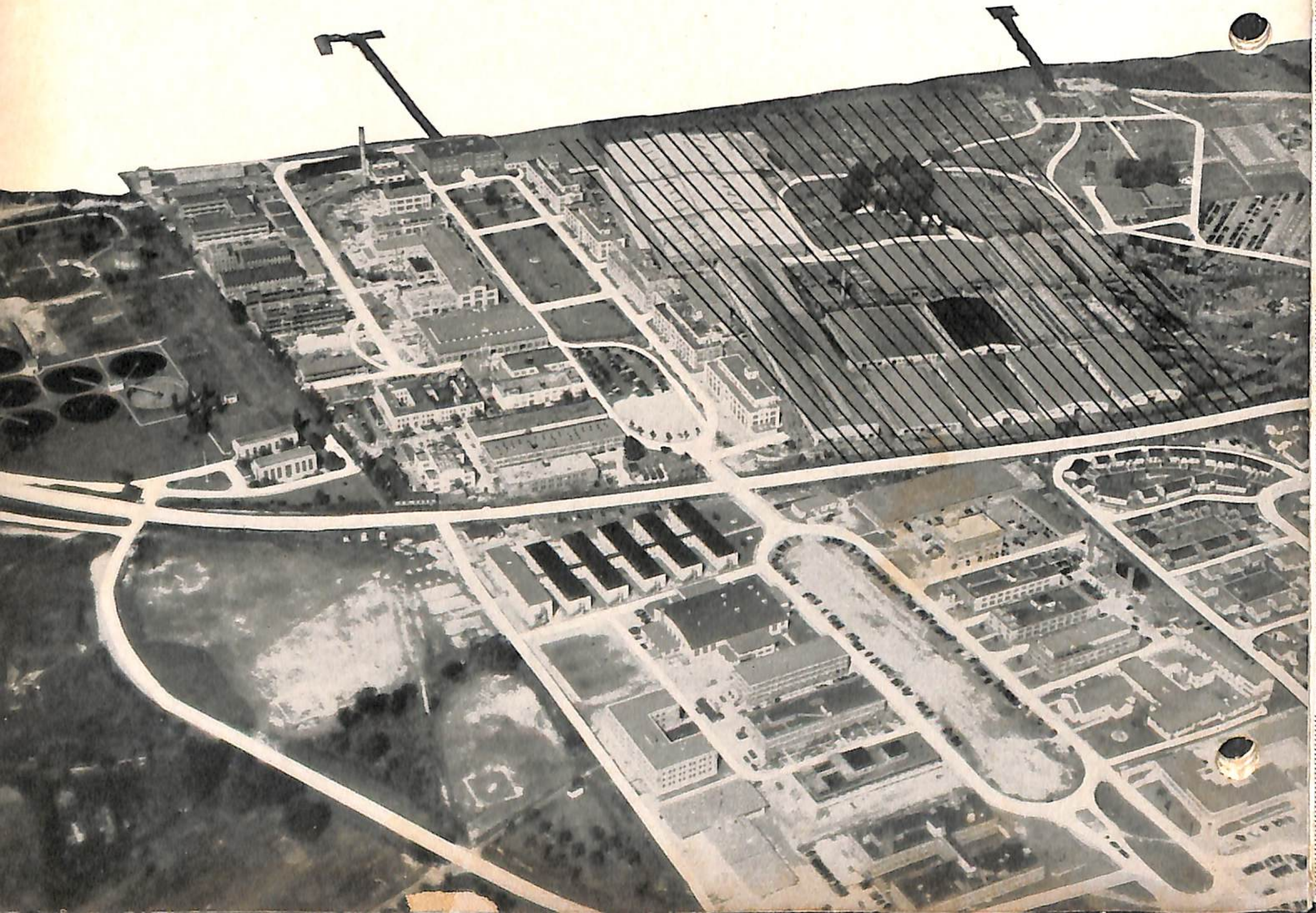
Naval Research Laboratory

■ The Naval Research Laboratory, Washington, D. C., is an activity familiar to a great number of fleet personnel, particularly those engaged in the upkeep and maintenance of electronic equipment. The Radio Matériel School, Airborne Coordinating Group, Combined Research Group, and the Electronics Field Service Group, are some of the major activities located there. These individual activities, in addition to all the permanent divisions of the laboratory, are under the direction of Commodore Henry A. Schade, USN.

The laboratory has grown steadily in size and personnel since its inception in 1923. During the war years just past, the increase was greatly accelerated, with many new buildings being constructed, improvements made on other buildings, and personnel figures mounting to a peak of approximately 7000 military and civilian persons on board in September 1945. Among this number is included about 2000 instructors and students at the Radio Matériel School.

In addition to continual research and consequent advancements in the electronics field, personnel of the laboratory are active in many other fields. A complete photographic laboratory, chemical research division, modern machine shops and foundries are only a few of these activities.

The laboratory is located in a suburb called Bellevue, along the east bank of the Potomac River about 4 miles south of Anacostia, or about 5 miles south of the Capitol. The shaded area in the upper-right corner of the photograph is the Navy's Bellevue Magazine.



In reply refer to Initials and No.

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON

The Chief of Naval Communications appreciates the loyal work of the thousands of officers and enlisted men in communications and electronics who mantained through trying conditions the high standard of the Naval Communication Service. Communications and electronics will have an important part in the post war Naval Reserve, and plans now in preparation will be announced when completed. It is hoped that the communications and the electronics personnel who do not continue in an active status and who played such a vital role in winning the war will work to insure the peace as members of the Naval Reserve.

Rear Admiral J. R. Redman, USN
Chief of Naval Communications

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

ADDRESS NAVY DEPARTMENT, BUREAU OF SHIPS

REFER TO FILE NO.

NAVY DEPARTMENT
BUREAU OF SHIPS
WASHINGTON 25, D. C.

TO ALL ELECTRONICS PERSONNEL:

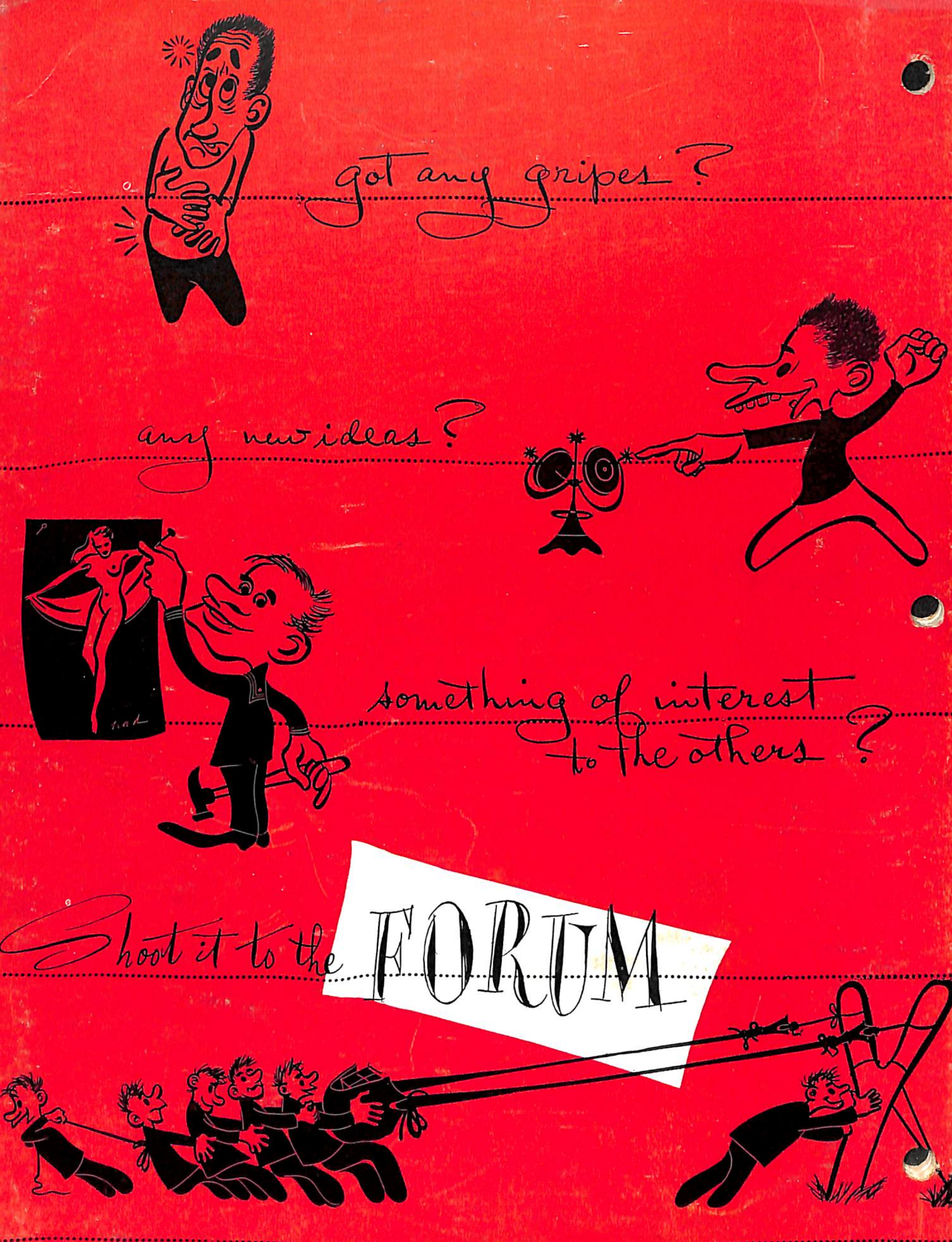
The Director of Electronics welcomes the opportunity to express his personal appreciation to the thousands of men, women, and officers of the United States Navy whose skill and devotion made possible the design, procurement, distribution, installation and maintenance of modern electronic equipment for the Naval Establishment during World War II.

Electronic equipment will play a major role in the operation of the post-war fleet just as it did during the war. I sincerely hope that all electronics personnel who do not remain in active status will continue their interest in Navy Electronics as members of the Naval Reserve. Those of you whose interests are mainly in technical of material matters will have an important place in the Naval Reserve and it is anticipated that the availability of equipment for Naval Reserve Units will be such as to meet the needs on a much better scale than before the war. Many of the major problems confronting the Navy during the present war were solved only by electronic techniques and equipment. They will play an even greater part in any future war, - in fact, the future well-being and safety of the nation will, in all probability, depend upon the development and successful use of electronic weapons and countermeasures against enemy weapons based upon electronic principles. The Navy needs your continuing interest and assistance, both as citizens and members of a trained Naval Reserve.

J. B. Dow

Commodore J.B. Dow, USN
Director of Electronics

FROM BUREAU OF SHIPS, NAVY DEPARTMENT, WASHINGTON 25, D. C.


got any gripes?
any new ideas?
something of interest to the others?
Shoot it to the FORUM