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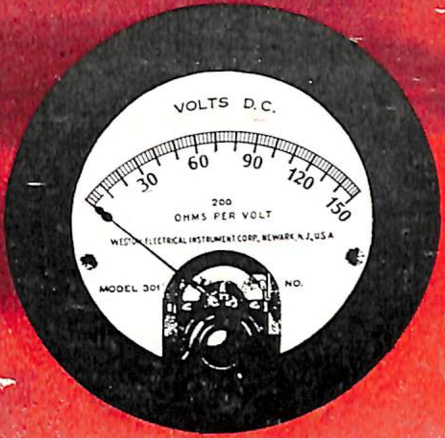
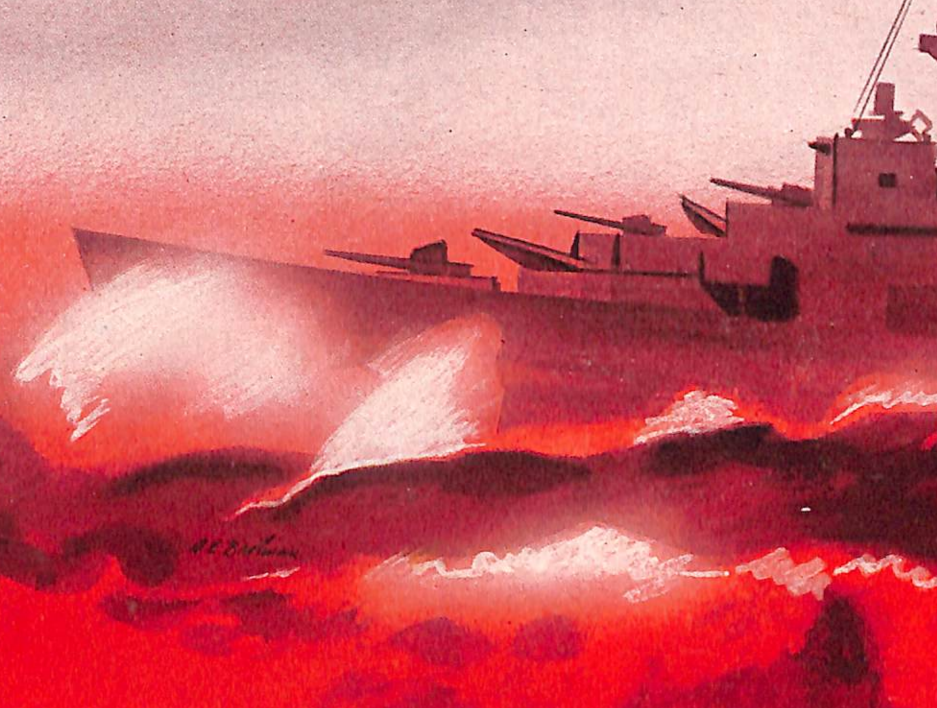
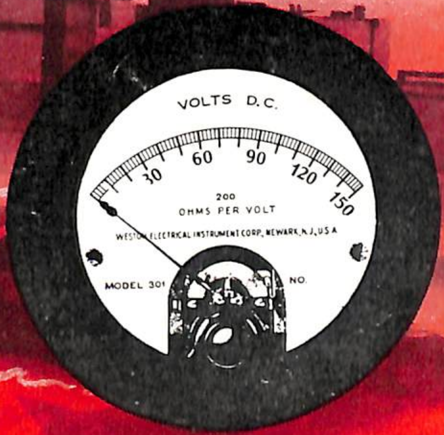
MARCH 1946

BUSHIPS Electron







NavShips 900,100

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BUSHIPS Electron

A MONTHLY MAGAZINE FOR RADIO TECHNICIANS

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and forwarded via the commanding officer. Whenever possible articles should be accompanied by appropriate sketches, diagrams, or photographs (preferably negatives).

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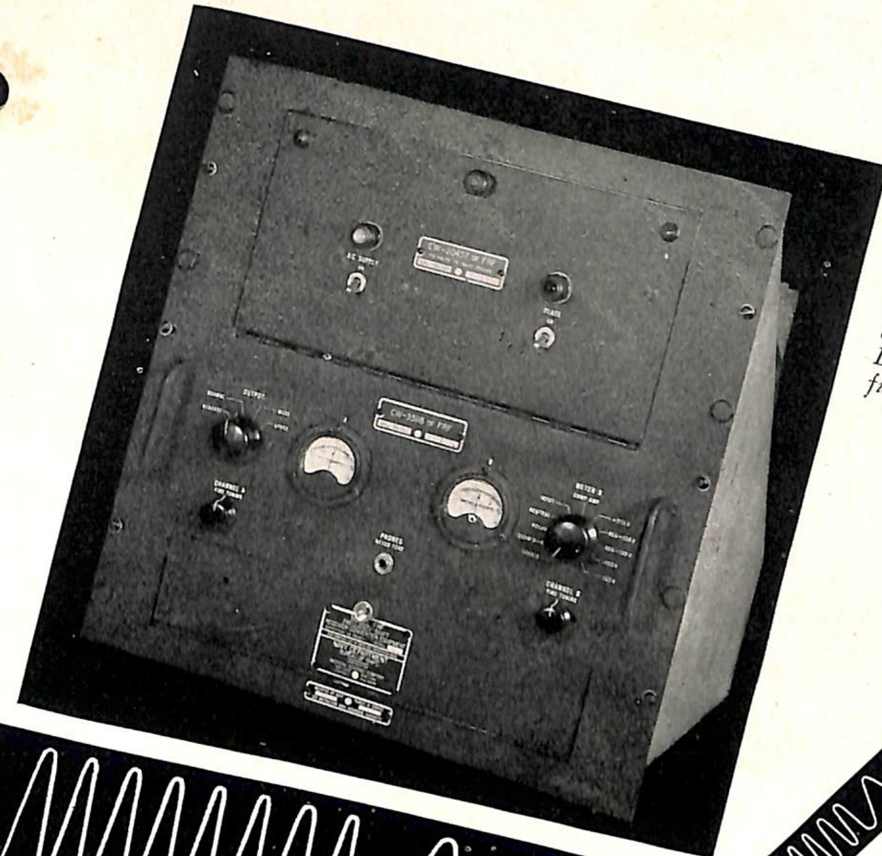
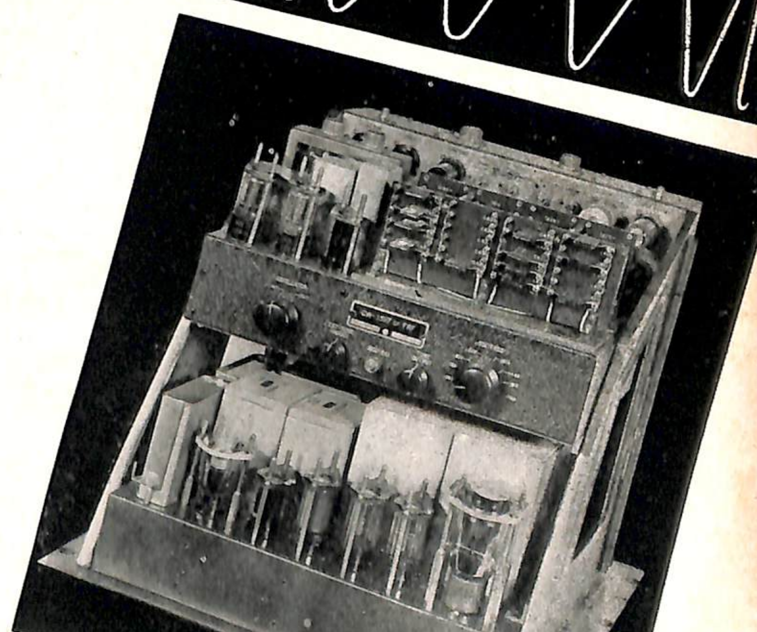


The Model FRF Frequency-Shift Receiver Converter mounts in a standard 19-inch relay rack or cabinet. Principal controls are located on the front panel. Doors provide access to fuses and terminal strips for servicing.

Model FRF Frequency-Shift Receiver Converter



In order to simplify the front panel, and to prevent accidental movement of certain critical controls used only when servicing, these adjustments are made accessible only from the inside of the chasses.

■ This is the third in a series of articles on frequency-shift keying equipments, and describes one model of the terminal equipment needed for receiving the signals.

Since the benefits of FSK are all obtained at the receiving end of the system, one would naturally expect the equipment there to be more complicated than that at the transmitting end. This added receiving equipment is built into one unit and called a frequency-shift receiver-converter or, more simply, a converter.

Converters differ in the manner of obtaining input signals from the receiver. The first converters made use of the two-tone audio output of a conventional receiver. Others use the frequency-modulated signal obtained directly from the i-f output of a receiver modified for this purpose. Although either method may be used, the latter has certain distinct advantages, especially under conditions of frequency drift.

Frequency drift of transmitters and receivers is normally defined in terms of a percentage of the carrier frequency. If it is assumed that a nominal figure for the overall drift of a radio circuit including the transmitter and receiver is .01%/°C of the carrier frequency, a 10-megacycle circuit would be subjected to a drift of 1000 cycles for each degree change in temperature. This drift would appear in the i-f stages by the same amount, and the output audio-frequency would be subjected to a drift of 1000 cycles. However, a drift of 1000 cycles in a 400-kc i-f amplifier represents a .25%/°C shift, while the same drift in the audio amplifier, when the second detector is adjusted to produce a mean frequency-shift signal of 2500 cycles, amounts to 40%/°C. It is obvious that the signal would suffer less telegraph distortion in the i-f channel for a given amount of drift than it would in the audio output.

The Model FRF converter (formerly the FSF) is used principally on long-distance, high-frequency FSK radiotelegraph circuits employing dual space-diversity reception and receivers with an i-f frequency between 400 and 470 kc. Three models of such receivers are the RDM, RBB series, and RBC series.

The FRF takes the frequency-modulated outputs of the i-f stages of the associated receivers and converts them to d-c telegraph signals corresponding to the original *mark* and *space* signals transmitted from the keyer at the distant radio station. These d-c telegraph output signals operate a teletypewriter (or equivalent device) directly on *polar* or *neutral* d-c signals, or indirectly by an on-off keyed tone over a voice-frequency telegraph system. The keyed tone is adjustable in the audible frequency range from about 500 to 2000 cycles.

CIRCUITS

The input circuit of the converter is arranged for dual space-diversity reception. With this method of reception, duplicate incoming telegraph signals are received over two channels (designated *A* and *B*) by two radio receivers connected to antennas separated from each other by a distance of about 3 to 10 wavelengths. This minimizes the effects of fading at one point. These frequency-modulated telegraph signals are both in the range of 400 to 470 kc as they leave the i-f sections of their respective receivers and enter the converter. The frequency around which the signals vary is, of course, dependent on the i-f frequency of the particular type of receiver being used. In the following description, the overall shift between mark and space signals is taken at the customary value of 850 cycles.

To increase the signal-to-noise ratio, i-f signals from the receivers enter the converter through input networks of band-pass filters. Each network may be adjusted to any frequency within the range of 400 to 470 kc. Channels *A* and *B* are separately tuned to the incoming i-f frequencies by means of screwdriver-adjusted capacitors which are mounted within the converter. When once adjusted to the receiver's i-f frequency, readjustment is not necessary.

After the signals have passed through the input filters, each is converted by the heterodyne principle to a lower frequency by means of two 6SA7 pentagrid converter tubes V-101 and V-102. These conversions provide gain and improved selectivity. The incoming signals on Channel *A* are converted by V-101 to 50 kc, and those from Channel *B* are converted by V-102 to 29.3 kc. These particular frequencies are not harmonically related, and were selected to reduce mutual interference.

It is desirable to limit the band width of these circuits to a value not greater than that which is adequate for the particular signals received in order to reject as much noise and interference from nearby transmitting stations as possible. Two degrees of band width may be selected by means of a switch.

Channels *A* and *B* are separate and distinct up to and through the band-pass filters, which have no common components. When these separate signals pass through their individual filters, they are both fed through a common resistor (R-106) to V-103, the first tube in a 3-stage limiter-amplifier.

The original transmitter frequency-modulated telegraph signals vary in frequency in accordance with the original d-c mark and space impulses, and are practically constant in amplitude. In the radio link between the transmitter and the receiver these signals may encounter static disturbances, noise and fading effects which, if they occur, produce variations in signal amplitudes. The purpose of the limiter-amplifiers, V-103, V-107, and V-108, is to eliminate these undesirable amplitude variations before they reach the discriminator for detection. The limiter-amplifier produces relatively square waves of a constant magnitude by tube limiting action and by cutting off the peaks of any signals which are amplified beyond an established limit.

The first limiter-amplifier tube V-103 primarily amplifies, but tends to round off the strong, positive signals due to the limiting action of the grid resistor. Amplification of the negative peaks is limited when the tube is driven beyond cutoff.

The second and third limiter-amplifier stages V-107 and V-108, each in conjunction with half a twin diode limit the amplitude of the positive and negative alternations to a definite value. Some of the output from the first stage of the limiter is fed to the "carrier-control

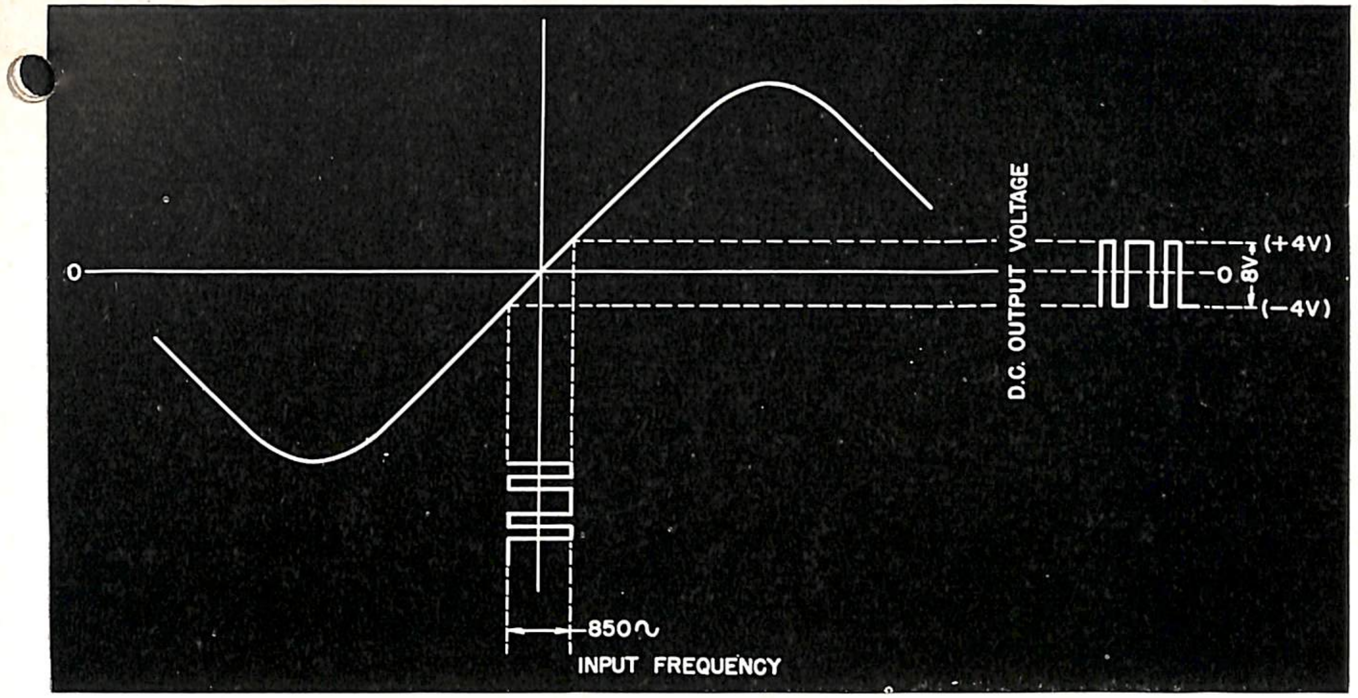


FIGURE 1—*When the signal is tuned to the center of the discriminator operating region, a mark-to-space transition voltage of about 8 volts is produced in the output.*

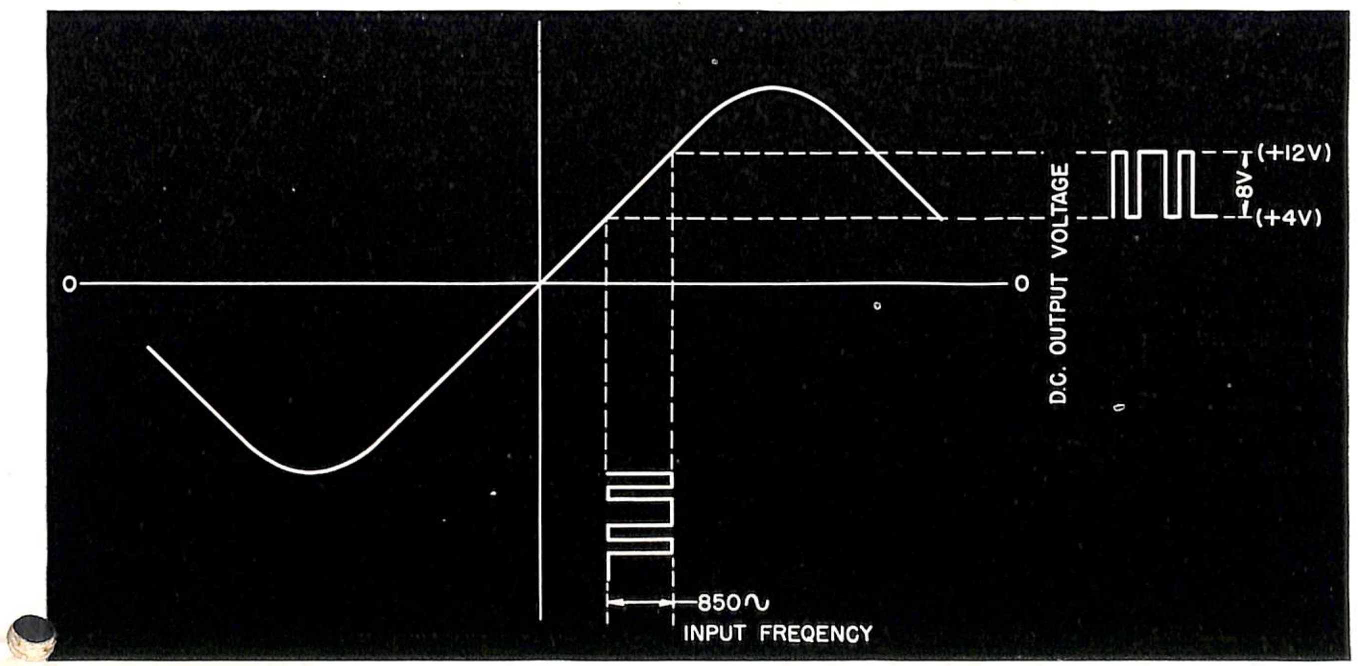


FIGURE 2—*The straight portion of the discriminator characteristic is sufficiently long to permit considerable drift in carrier frequency without changing the voltage difference between the mark and space components.*

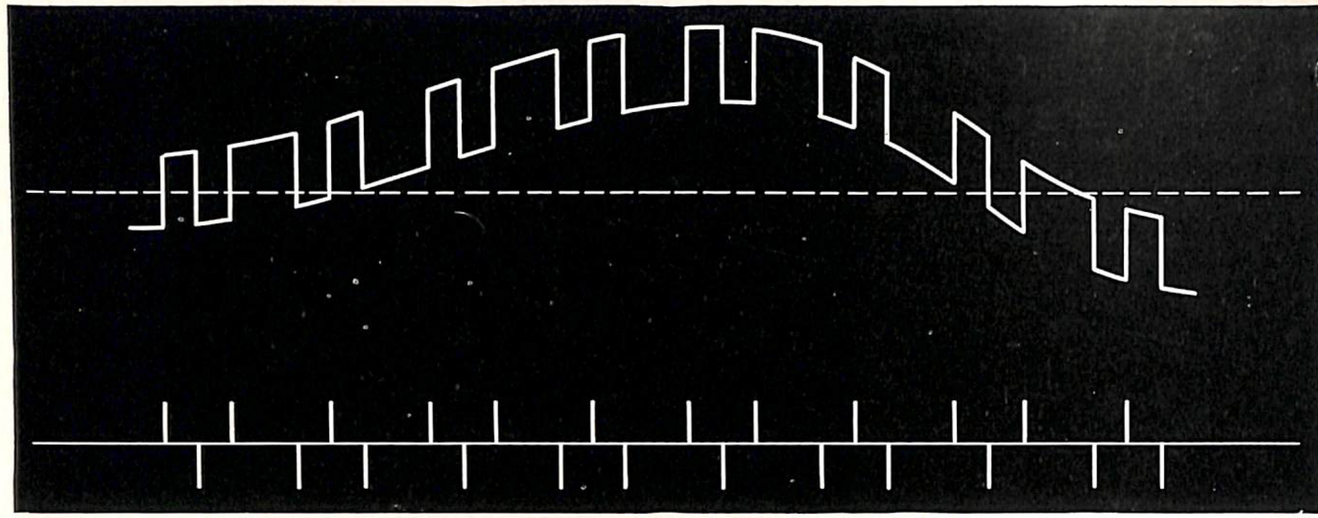


FIGURE 3—*The actual drift between the conditions existing in figures 1 and 2 is shown (upper pattern). Removal of the d-c component of the signals by the differentiating circuit removes all evidence of the drift in carrier frequency (lower pattern). The resulting pulses are then used to trigger the circuits which produce the desired output for the system.*

mark-hold" circuit which will be discussed later.

The output of the limiter is fed to the discriminator section. A discriminator is a circuit which functions so that an input voltage of varying frequency and constant amplitude produces an output voltage varying in *amplitude* in accordance with the *frequency* of the input signal. Its action is shown in figure 1, where it can be seen that a frequency change from 425 cycles below to 425 cycles above the center frequency develops a voltage having the same intelligence characteristics, but varying from —4 volts to +4 volts (average values for certain Navy discriminators). These d-c pulses may be used to control output keying circuits which, in turn, operate teletypewriters or other recording devices.

The characteristic curve of the discriminator is straight over quite a broad band so that any normal drift in the mark and space frequencies will still produce an output voltage which varies the desired 8 volts, as illustrated graphically in figure 2. This is a very important feature of the system, as only the *difference* voltage carries the intelligence. One of the two discriminators interprets the frequency-modulated signals received over Channel *A* and the other interprets those received over Channel *B*. The output from the limiter containing both 50-kc and 29.3-kc signals is passed through the primary of the discriminator transformer for Channel *A*. This transformer contains two secondaries; one is tuned to a frequency a few kilocycles above 50 kc and the other below 50 kc. Each secondary is connected in series with a diode and a resistor (diode detector circuit) across which a voltage may be developed. The resistors are so connected that their voltages tend to cancel each other. The result is that a 50-kc signal would produce equal r-f voltages in each secondary and, therefore, equal d-c voltages of opposite polarity in each resistor and the net result (output voltage) would be zero. A signal of a frequency above 50 kc would develop a larger voltage in the resistor associated with the secondary tuned to the frequency above 50 kc and the net output voltage across the two resistors would be the difference between the two voltages developed across them, and would have the polarity of the larger voltage. Similarly a signal of a frequency below 50 kc would develop a larger voltage across the other resistor, and have the opposite polarity. Thus the discriminator output is a d-c voltage having a polarity and magnitude determined by the frequency of the input voltage.

In a similar manner, the output from the limiter is passed through the primary of the discriminator transformer for Channel *B*. This transformer also has two secondaries, one tuned a few kilocycles above and the other a few kilocycles below 29.3 kc. This transformer is also connected to two diode rectifiers and their associated resistors.

The outputs of these two discriminators are combined so that they reinforce each other and are then passed through a reversing switch, which provides for mark and space output signals of the proper polarities regardless of how they were originally transmitted or subsequently inverted.

The output control circuit consists of a driver circuit, a frequency-drift compensator circuit, and a carrier-control mark-hold circuit. Under operating conditions, the 50- and 29.3-kc carrier frequencies may tend to drift from their normal values. If no compensator equipment were provided under such conditions, the telegraph d-c output signals would be *biased*. Biasing is an undesirable effect whereby the normally equal mark and space intervals become unequal in duration. To minimize the biasing effect, the output control circuit is equipped with a frequency-drift compensator circuit which may be connected to the driver circuit by a switch.

If the drift compensator circuit is not used, the signals pass through a cathode follower V-111A and an amplifier V-113 in the driver. The amplifier has two voltage dividers in its plate circuit. The voltage from one controls the tubes (V-115, V-116, V-117 and V-118) that provide the d-c signals which comprise the output of the converter. The voltage from the other divider controls the tube that keys the modulator of the tone oscillator.

The frequency-drift compensator is a special feature of this equipment. By connecting the output of the 1st amplifier V-104A following the discriminator to the following stage V-111A through a 1 μf capacitor C-128, differentiating of the square waves takes place as shown in figure 3. Note, in the lower drawing, that the output of the capacitor is a pulse whenever the discriminator output voltage *changes,* but that there is no output when a steady-state condition exists. Also the output of the capacitor is constant regardless of the absolute values of the discriminator voltage. In other words, only the differential has been reproduced and since this is constant so long as the frequency shift is held constant, the output remains constant. By applying these pulses to a "flip-flop" triggering circuit so that the first pulse causes plate current to flow and the second pulse cuts it off, square waves of constant amplitude—independent of the drift of the incoming signal—are produced.

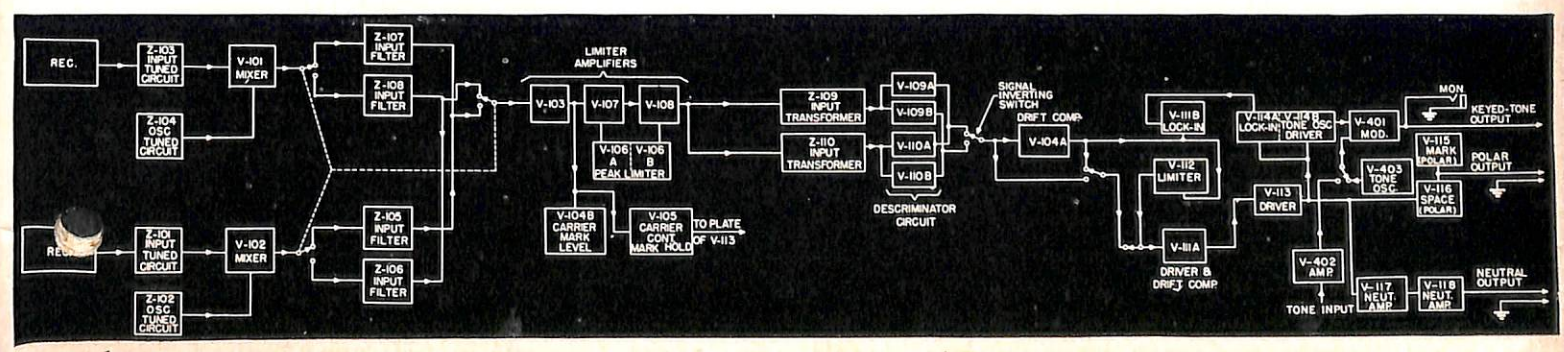
It can be seen from the above description that in response to a momentary pulse of mark signal voltage (for example +15 volts) the feedback path or locking circuit produces a steady-state potential of about +15 volts which "locks in" until the next mark-to-space transition, which would be a space-voltage pulse of the same magnitude but of opposite polarity. The circuit then locks in similarly for the space condition, and awaits a mark pulse to unlock it.

It occasionally would be possible for a transmitted steady-signalling condition to change without unlocking the voltage established by the frequency-drift compensator circuit. This could occur during testing or adjusting procedures if the first voltage pulse should happen to be of the same polarity as the locked-in voltage. The first voltage pulse, therefore, would be ineffective. Due to the time constant of the circuit a comparatively long time would be required to discharge this doubled voltage on the controlling capacitor to a value low enough for a signal-voltage transition to unlock the circuit. Several voltage transitions might be lost if the signalling speed were rapid. A double diode protects the circuit against the condition just described by clipping off the peaks of all voltage pulses exceeding a maximum value as determined by the setting of the LIMITER potentiometer. This arrangement of limiting the maximum voltage of the pulse signals minimizes the length of time required to resume normal keying.

In order to reduce the effects of noise, a filter is purposely introduced into the FRF to limit the amount of drift that can be tolerated to about ±300 cycles. Since this is shore equipment, it is reasonable to assume that the drift can be held that low. For shipboard use, the FRA, to be described later, has a discriminator which is linear for nearly 5000 cycles and the bandwidth is limited to 3000 cycles. This will allow a drift of approximately ±1500 cycles before serious distortion occurs.

The purpose of the carrier-control mark-hold circuit V-104B and V-105 is to hold a marking signal on the telegraph circuits if the incoming carrier fails or is shut off for any reason. As long as an incoming carrier is received over the radio links, a portion of the voltage

Simplified block diagram of the FRF Frequency-Shift Receiver Converter.



appearing in the output of V-103 is fed to the grid of the mark-hold level tube, V-104B. The output from this tube is fed to the grid of the carrier-control mark-hold tube V-105, biasing it so that the circuit is inoperative. If the carrier fails for any reason, there is no input to V-104B and consequently no bias on V-105. Thus the tube conducts, and its output, the equivalent of a mark signal, is fed to the driver V-113 to prevent the TTY printer from running "open".

The output of the driver circuit is fed to the d-c output circuits and the tone oscillator. The tone oscillator V-114 enables the FRF to furnish an on-off keyed audio tone, either for local listening or for transmission over a telephone line to a remote point. It includes an oscillator, a modulator, and an amplifier and phase inverter. Provisions are made for employing an external tone, should it be required in place of the tone produced by the local oscillator. The locally-produced or externally-supplied tone connected to the modulator is on-off keyed as determined by d-c keying signals from the driver unit. The local oscillator produces any one of eight tones, depending upon the setting of an associated OSC FREQ switch.

The rectifier power unit operates from a standard 115-volt 50/60-cycle a-c supply. These circuits are comparatively standard and need not be described here.

The apparatus of the Model FRF converter is assembled on a chassis which can be mounted on a standard 19-inch relay rack, in an available space within a working receiver cabinet, or in a separate cabinet suitable for mounting on a table. No cabinets were furnished with the first FRF's, although later units were furnished with metal cabinets finished in black *morocco* (wrinkle) enamel. These cabinets are approximately two feet high, 21½ inches wide, and 17¾ inches deep. The front opening just accommodates the front panel of the converter.

Physically, the Model FRF converter includes three sub-units, all mounted on the same chassis. The basic unit is mounted at the bottom of the chassis and includes a front panel with operating controls, pilot lamps, meters, a headphone jack for monitoring the keyed-tone output, etc. The unit contains 18 tubes. The tone oscillator containing three tubes is mounted in the upper rear of the chassis. The operating controls at the top of this sub-unit are only used occasionally. The power supply unit is located in the upper front part of the chassis and provides a-c heater voltages and rectified d-c voltages for use with all units of the converter. Six tubes are used in this unit.

Six receptacles mounted at the rear of the chassis are used to connect the converter by cable assemblies with other equipments at the radio receiving station.

Latest Classifications

The following new classifications appeared as changes #5, 6, 7 and 8 to the original security classification letter (CNO restr ltr Op-413-B23/cvk, Ser 203P413, of 20 Nov. 45). These changes and corrections bring the classification list printed on p. 36 of the January ELECTRON up to date as of 27 February:

MODEL	Classifications
AN/TRX-1	C
AN/TXT-1	C
DAH	U
Mk 1 (FA) all Mods	U
Mk 3 (FC) all Mods	U
Mk 4 (FD) all Mods	U
Mk 9 Mod 0	U
Mk 10 all Mods	U
Mk 11 all Mods	U
Mk 13 Mods 2, 4	R
Mk 14 Mod 0	U
Mk 18 Mods 0, 1	U
Mk 19 all Mods	U
Mk 21 Mod 0	U
Mk 23 Mod 0	U
Mk 26 all Mods	U
Mk 27 Mods 0, 1	U
Mk 28 all Mods	U
Mk 29 all Mods	U
Mk 30 Mod 0	U
Mk 38 Mods 0, 1	R
Mk 40 Mods 0, 1	R
Mk 43 all Mods	R
Mk 48 Mods 0, 1	C
Mk 1 Mods 0, 1	U
Mk 3 Mod 0	U
Mk 4 all Mods	U
Mk 5 Mods 0, 1	U
Mk 1 all Mods	U
Mk 4 Mod 0	U
Mk 5 Mod 0	U
Mk 8 Mod 0	U
SWOD Mk 1 All Mods	R
TEH	U
UJ	U
UK	U
UM	U

Remove marks (♦) wherever they appear in the original list. Change AN/APS-15-T3 to read AN/APS-T3.

Nancy

Communication Systems

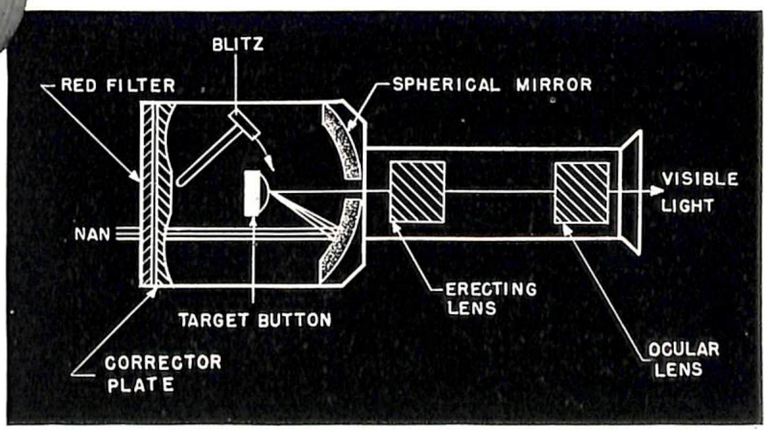
For years the Navy has used lights during the hours of darkness for recognition purposes, station keeping, and communication between ships and shore stations. There are times, however, when any show of light might jeopardize the security of a ship or task force, disclosing its location and giving the enemy a target fix.

In order to carry out these functions under blackout conditions the "Nan" Communication System was developed. After several earlier models, the Nan Type C was developed. This has been shortened to "Nancy", and used to designate all Nan Systems, doing away with the word Nan in the title and thus eliminating confusion between it and the symbol for the letter N.

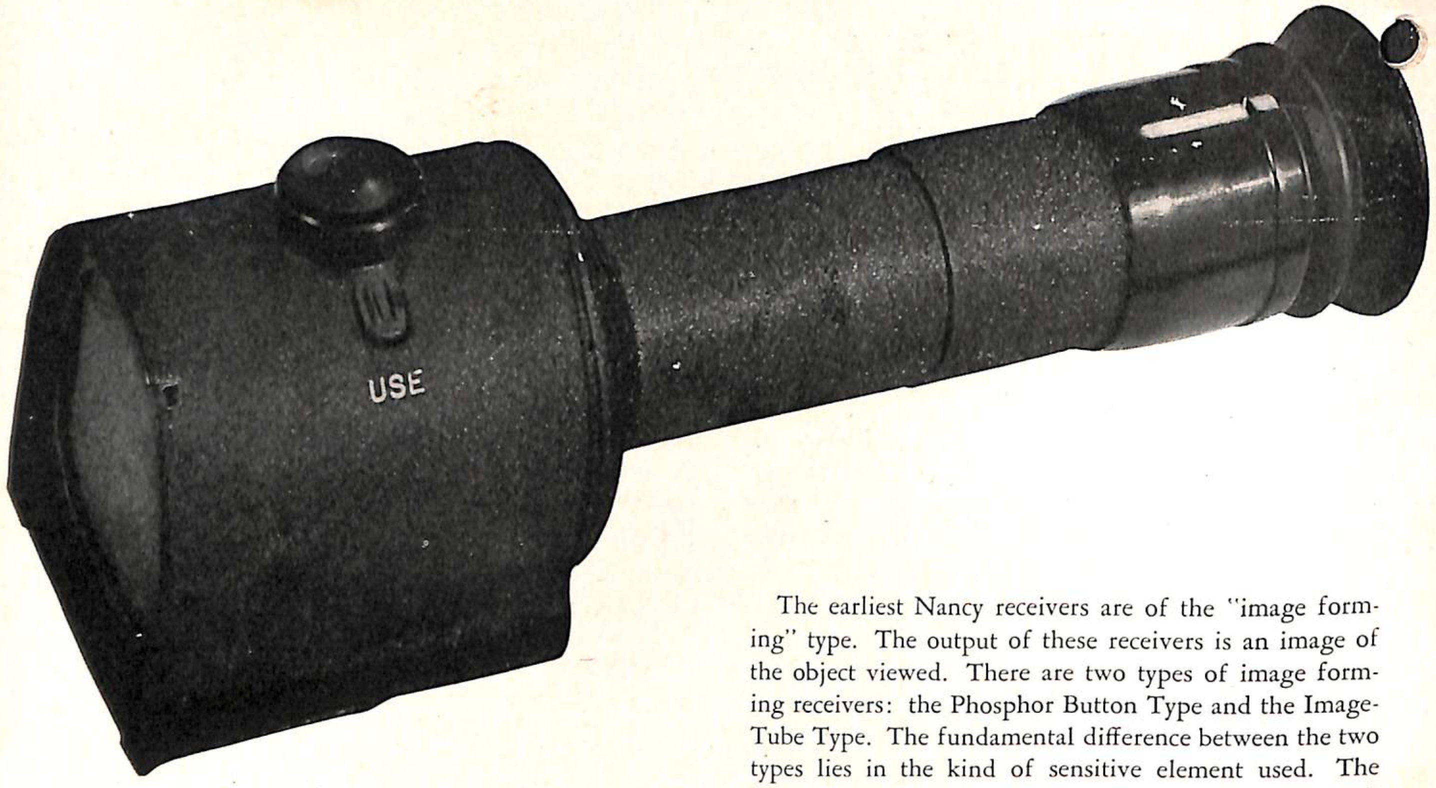
In Nancy Communication Systems infrared radiation instead of visible light is used as the means of communication, since a source emitting infrared radiations can be detected by the naked eye at only very close ranges, and does not violate blackout conditions. The maximum range of the system is about ten miles, if the equipment is mounted about 90 feet above the waterline. Atmospheric conditions, however, cut down the range considerably. The range is adversely affected by such conditions as fog, haze, rain, etc.

A Nancy system consists essentially of a source of infrared radiations and a receiver. The source is basically some type of electric light, a special filter to eliminate all light but the infrared rays, and a power supply. Standard sources are Navy 8-inch signaling searchlights with Type H-1 Hoods, 12-inch signaling searchlights with Type H Hoods, Nancy beacons, Nancy beach-markers, and Nancy course markers,—all with their associated power supplies.

12-inch signalling searchlight, Type-H Hood, and Type C-3 Nancy Receiver in operating position.



Cross-sectional diagram of Type AM Nancy Receiver showing the arrangement of components and operational sequence.

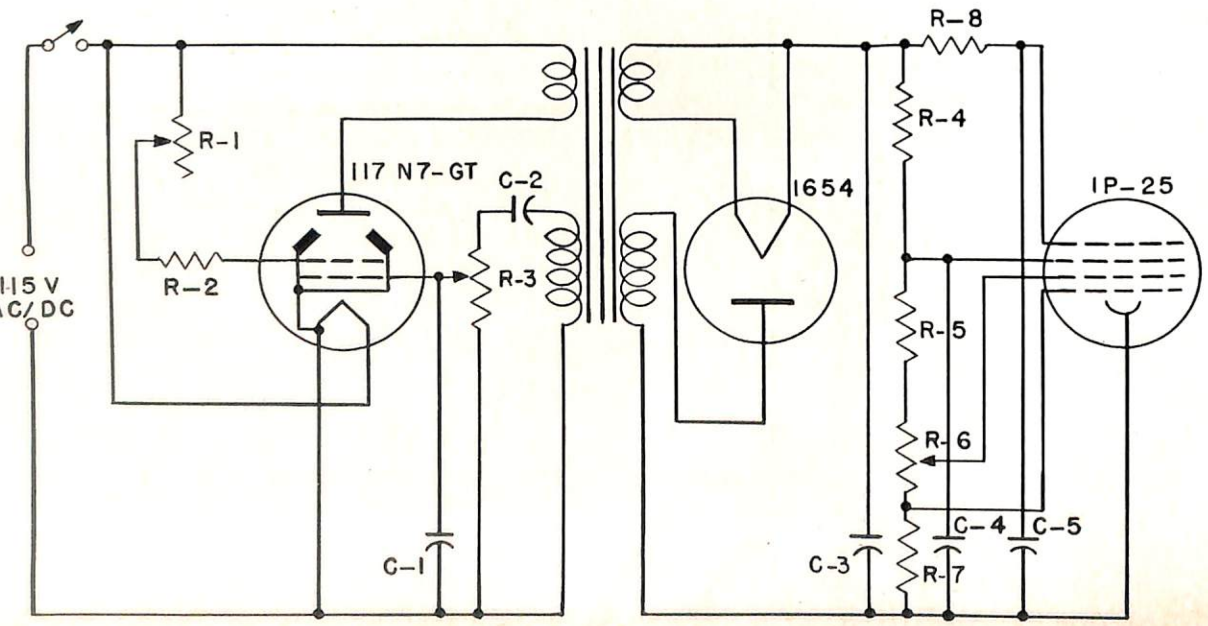


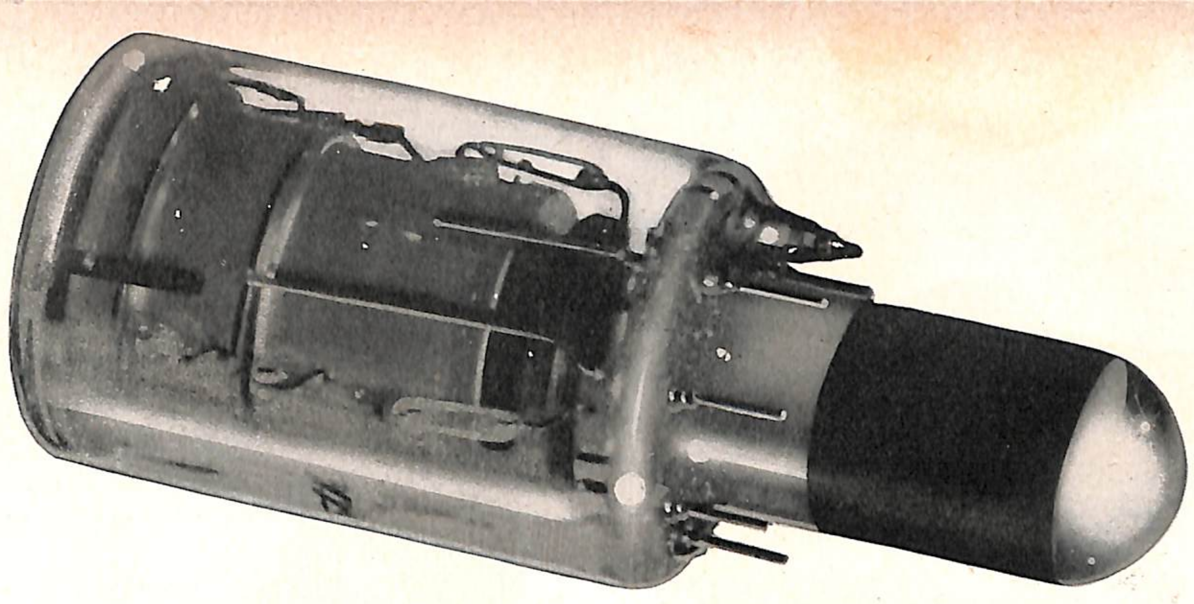
External view of Type AM Nancy Receiver.

The earliest Nancy receivers are of the "image forming" type. The output of these receivers is an image of the object viewed. There are two types of image forming receivers: the Phosphor Button Type and the Image-Tube Type. The fundamental difference between the two types lies in the kind of sensitive element used. The phosphor button type receiver gets its name from a small target button coated with phosphorescent material which is the heart of the receiver; the image-tube type uses a 1P25 electron tube for its sensitive element.

The most recent phosphor button type receiver is the Model AM. Before this receiver can be operated, the phosphorescent face of its target button must be charged or sensitized by the radiations from a minute quantity of radium. This radium is mounted on the surface of a small plate called a *charging blitz*. The charging blitz must be moved close to the target button and left in this position for about twelve hours while the radium on the blitz bombards the button's phosphorescent coating, causing it to glow. To ready the receiver for operation, the blitz is moved away from the button. Fifteen minutes later the button's glow has lessened sufficiently to provide a satisfactory background for viewing Nancy images.

Schematic diagram of the modified Type C-3 Nancy Receiver.





1P25 Electronic Image Tube used in Type C-3 Nancy Receiver.

In operation, Nancy rays enter the instrument through a red contrast filter and are reflected from a spherical mirror and corrector plate to form an image on the face of the target button. The corrector plate lessens distortion of the image by compensating for the spherical aberration of the mirror. The invisible image on the target button is immediately converted into a light green visible picture which can be viewed through an eyepiece. An erecting lens presents the image in an erect position for viewing, and an ocular lens allows the eye to focus on the image.

The principal advantages of the phosphor button type receiver are its light weight (approximately one pound), the fact that it is completely self-contained needing no power supply, and its comparative ease of maintenance.

The most widely used image-tube type receiver is the Model C-3. It is an electronic device for converting invisible infrared light to a visible image by means of a special photoelectric tube. The equipment is a self-contained unit comprising a lens-and-mirror system, an image tube, an eyepiece lens assembly, and a power supply.

The receiver's housing is a die-cast metal case, shaped for holding the unit up to the eye and aiming the lens end at the infrared light source being investigated. The case is a two-piece assembly with the lens, mirror, and image tube suspended inside. It is airtight and filled with dry nitrogen, which prevents moisture condensation on lens and mirror surfaces at low temperatures. The rear portion of the case contains the power supply.

When the telescope unit is pointed toward an infrared light source, the lens-and-mirror system focuses an infrared image on the photosensitive surface of the 1P25 tube. This photosensitive surface emits electrons in proportion to the intensity of the infrared rays striking the surface at that point. These electrons pass through a series of four charged rings and strike a fluorescent screen at the far end of the tube.

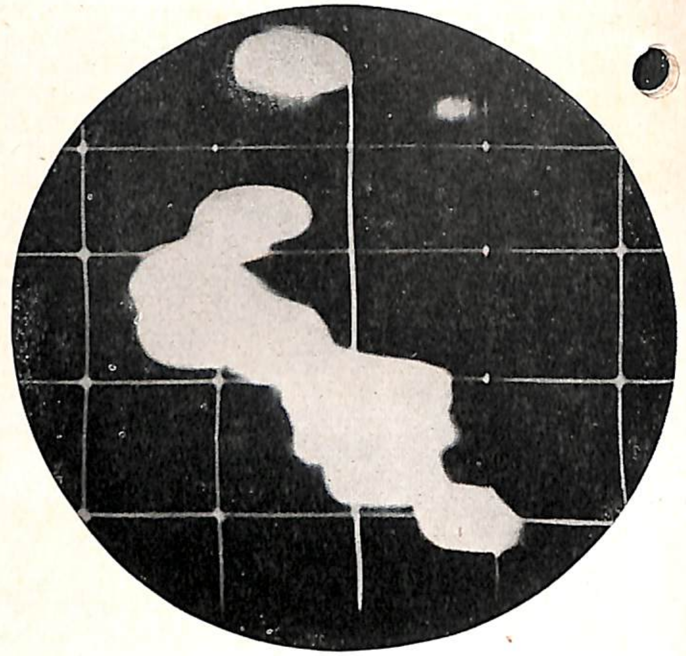
The four rings comprise an electronic lens system, focusing the electrons on the screen. The voltage applied to one of the rings is varied by a potentiometer, providing a means to focus the beam. When the beam strikes the screen, a green image appears, identical to the invisible infrared image at the front end of the tube. An adjustable eyepiece lens assembly at the back of the case enlarges the visible image and brings it into focus for the operator.

In the original C-3 receiver, two dry cells operate a vibrator, the output of which is raised to about 4000 volts by a transformer. This voltage is rectified and used to operate the 1P25 tube. In the modified C-3 receiver, a 115-volt a-c or d-c input and a 117N7GT tube are used to feed the transformer and rectifier. The amplitude and frequency of the voltage input to the transformer are controlled by R-1 and R-3. They are preset at the factory and are not accessible through the case of the receiver.

The principal advantages of the image-tube type receiver are its greater sensitivity, its greater resolving power, and the fact that it is always ready for use. The C-3 receiver weighs about seven pounds.

Future articles will cover Nancy Type D tone-modulated equipment, and Type E tone-modulated and voice-modulated equipment.

PPI screen showing target presentation, range marks, intensified ribbon marker X, and segment selected for enlargement Y.



B-scope showing enlarged presentation of targets seen in the center of segment Y on the PPI screen. The geometric grid is formed by azimuth and range lines.

VF Horizontal Scan

There are many individual circuits in radar equipments whose operating principles are difficult to understand. One such circuit is that used in the VF Indicator *B*-scope for horizontal scan. An explanation of the operation of this circuit has been prepared with the hope it will be of assistance to the technician in circuit analysis.

The horizontal-scan circuit moves the individual vertical sweeps across the *B*-scope during a scan presentation. A sector of about 50° of antenna rotation is represented by this horizontal scan, and the scan must be coordinated with the movement of the antenna. Speed of the horizontal scan is to be determined by the speed with which the antenna revolves, and the direction of movement by the direction of antenna rotation.

The motion of the antenna, as obtained from the azimuth servo which also drives the PPI deflection coils, is transmitted through a mechanical differential into the rotor of a control transformer (CT). To the rotor of this CT is supplied a 600-cycle voltage from a Hartley oscillator. The output voltage from the stator of the CT is determined by the coupling between the rotor and the stator. This coupling, as well as the output voltage, varies with the position of the antenna, rising to a maximum and falling to a minimum twice for each revolution of the antenna. The connections are such that the output of the CT will then be the 600-cycle reference voltage modulated by a sine wave, the frequency of which is the speed of rotation of the antenna. The output of the CT will be in phase with the reference oscillator during one rise and fall, and 180° out of phase during the other as shown in figure 1. This voltage is then coupled through a cathode follower to the sense rectifier which detects the phase and amplitude of the output of the CT. The phase is detected by direct comparison with the oscillator output and will determine the polarity of the output waveform. The amplitude of the input waveform will determine the amplitude of the output, as explained in the following analysis of a simplified sense rectifier.

If two diodes are connected as shown in figure 2, current will be free to flow in either direction through the tubes. Points "A" and "B" are electrically connected through the opposing diodes, and any voltage appearing at "A" will also appear at "B". If, for example, E_{in} were charged in a positive direction, V2 will conduct, charging C, and point "B" will assume the same potential as point "A". Conversely, if E_{in} becomes more negative, V1 will conduct to bring the potential at point "B" down to the potential at point "A".

In figure 3, the diodes have been replaced by triodes and to the grids is applied a high-amplitude 600-cycle reference voltage from the Hartley oscillator. Both grids are driven in phase so that both tubes will be driven into conduction at the same time. As illustrated in figure 4, grid current drawn into the *RC* combinations will develop a high value of self bias so that the tubes will not conduct except during the positive peaks of voltage applied to the grids. During these positive peaks of voltage, point "A" will be shorted to "B", and their potentials will be equal. At all other times there will be an open circuit between "A" and "B", allowing "A" to assume any potential without affecting "B". The voltage applied to "A" during the conducting period will then be the potential appearing at "B". Thus, if a d-c voltage of 70 volts is applied to "A", "B" will soon reach a potential of 70 volts by charging *C* in a series of short pulses.

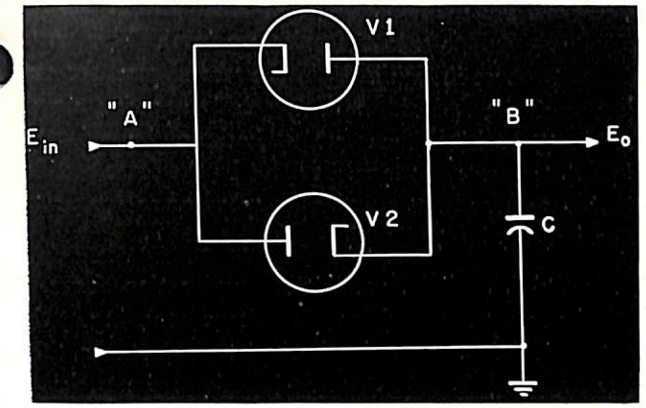


FIGURE 2—*Two diodes connected so that current will be free to flow in either direction through them.*

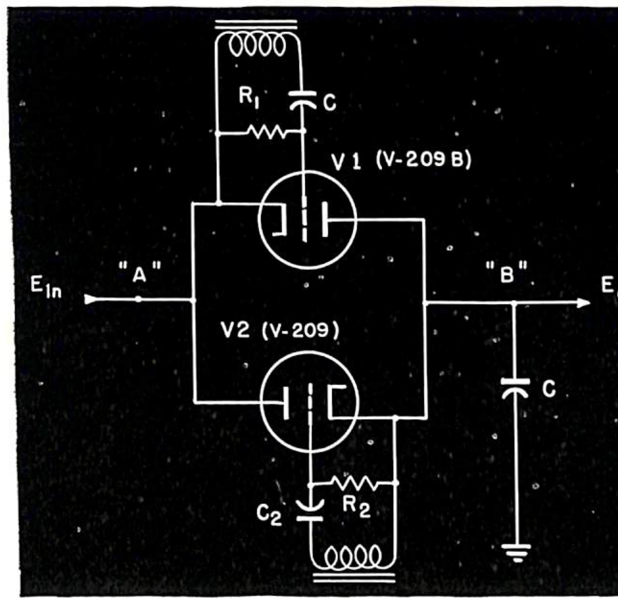


FIGURE 3—*The diodes in figure 2 are replaced by triodes and a reference voltage of 600 cycles is applied to their grids. This is the basic circuit of the Sense Rectifier.*

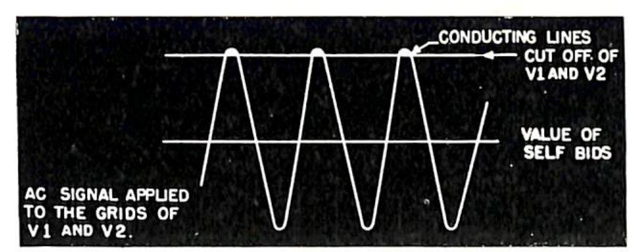


FIGURE 4—*The outline of the reference voltage applied to the grid. Note that the tubes conduct only on the peaks due to self bias in the stages.*

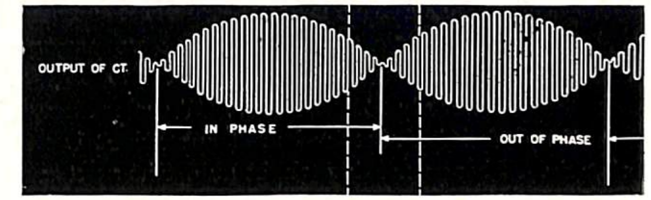


FIGURE 1—*Output of the Control Transformer showing in-phase and out-of-phase portions in respect to the reference oscillator.*

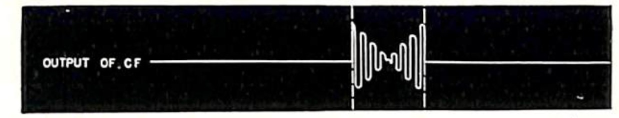


FIGURE 5—*Output of the cathode follower used in the horizontal scan circuit.*

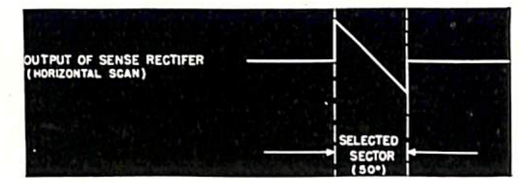


FIGURE 6—*Output of the Sense Rectifier going from an in-phase to an out-of-phase voltage.*

Assume that an a-c voltage is applied in addition to the 70 volts d-c, and that the a.c. is in phase with the voltage applied to the grids of V1 and V2. The voltage at point "A" during the time the tubes can conduct will be the d-c voltage applied plus the peak amplitude of the a.c. applied. The output at point "B" will become more positive by an amount equal to the amplitude of the applied a.c. If the a.c. is slowly reduced to zero, the output at "B" will follow the positive peaks until "B" has fallen back to the d-c level applied. If the a.c. applied were out of phase with the grid voltages, the voltage seen at "A" during the times the tubes can conduct will be the d.c. applied minus the peak value of the a.c. applied. The output at "B" would become less positive, or more negative, by an amount equal to the peak amplitude of the a.c. applied.

Essentially, the above is a description of the actual VF circuit with tubes V1 and V2 corresponding to V-209B and V-209A respectively. The sweep produced in the above simplified description represents the entire 360° rotation of the antenna. On the precision B-scope of the VF only a 50° sector of the antenna revolution is to be presented, so that the output of the CT is connected to the cathode follower and sense rectifier only during the

50° portion selected. This is done by means of a micro-switch-operated relay in conjunction with a cam arrangement which permits the output of the CT to be connected approximately 25° before the CT passes through a null and remains connected until approximately 25° after the CT has passed through the null. The exact midpoint of the sector selected (corresponding to the null) is determined by the position of the cursor which is connected to the mechanical differential, thus varying the positioning of the rotor of the CT with respect to the azimuth information. It can be seen that the output of the cathode follower will correspond to that of figure 5. Since a sine wave has the most linear characteristics as it passes through its axis, the 50° portion selected for the horizontal scan is from that region.

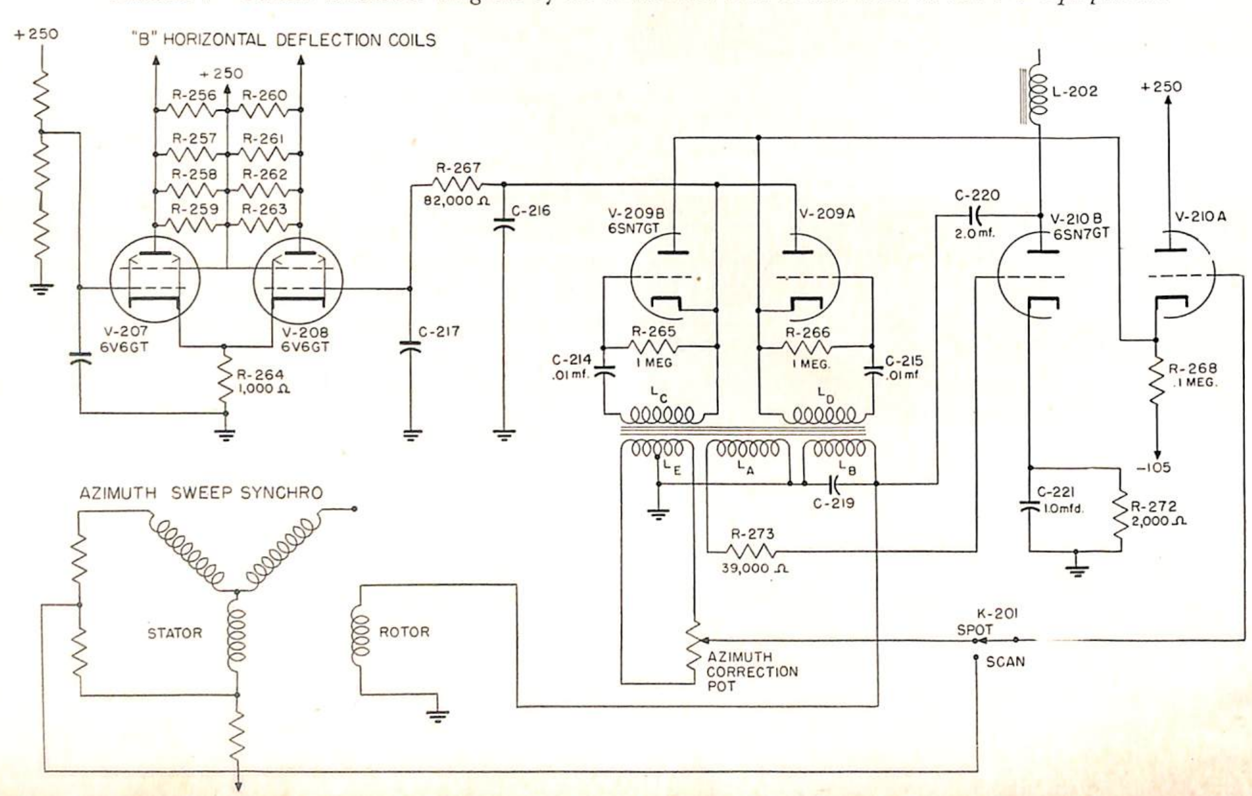
Referring to the waveforms in figures 1, 5, and 6, it will be seen that for one direction of antenna rotation the output of the CT will pass from an in-phase voltage to an out-of-phase voltage with respect to the reference voltage produced by the hartley oscillator. If the direction of rotation were reversed, the direction of phase-change would also be reversed; i.e., from an out-of-phase to an in-phase voltage.

The sense rectifier, as explained above, detects the sine-wave envelope of the CT voltage. However, its output would differ depending upon the direction of antenna rotation. In the first case mentioned above (going from an in-phase to an out-of-phase voltage), its output would rise quickly positive, slowly move to a value which would be negative with respect to the reference voltage, then quickly return to the reference level. This waveform is shown in figure 6. In the second case, the output would be reversed, moving quickly negative, slowly swinging positive, then quickly back to the reference level. The sweep voltage produced by the sense rectifier is thus governed not only by the speed of antenna rotation but also by its direction.

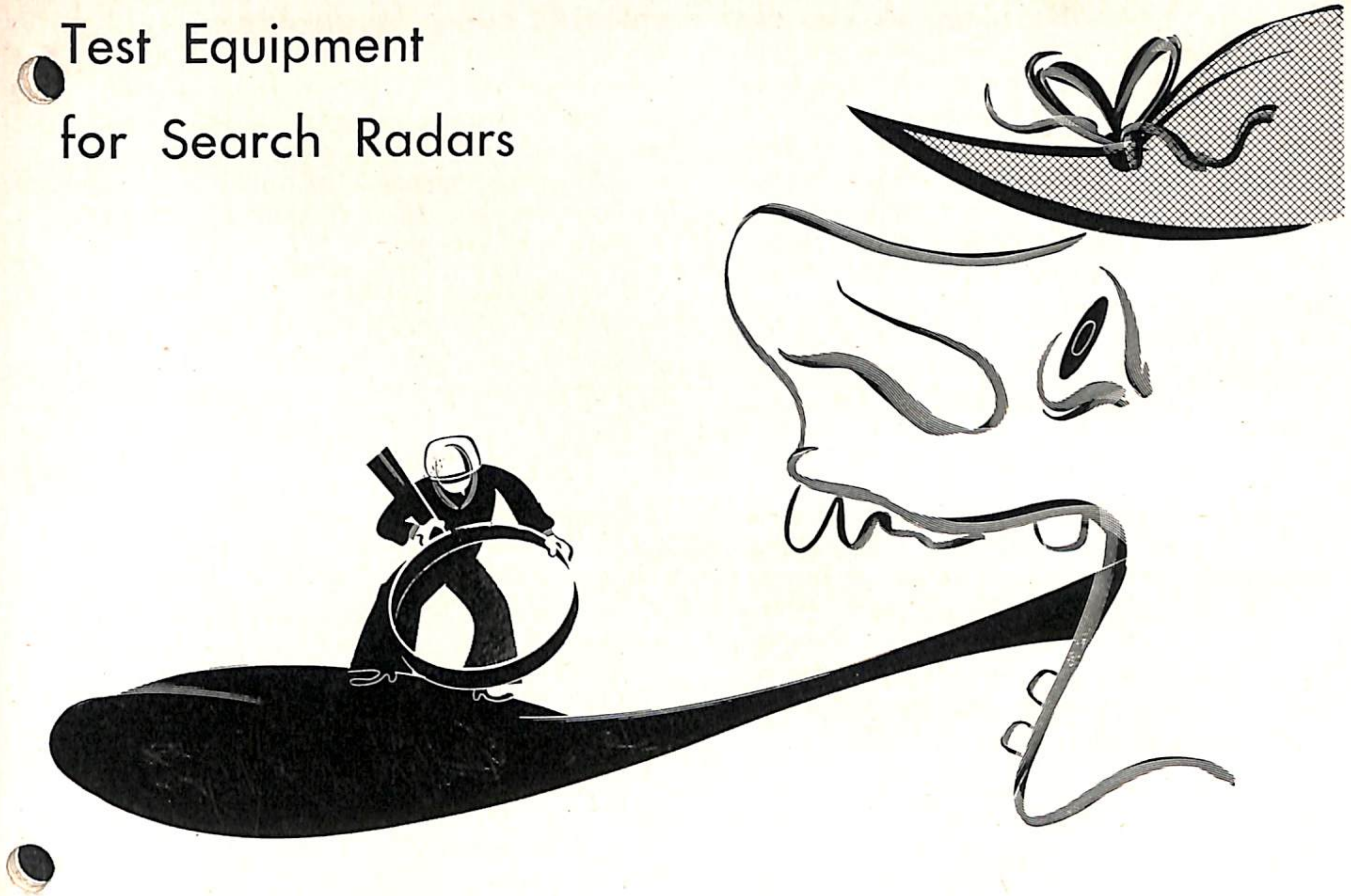
In the simplified sense rectifier explanation above, it will be seen that the change in voltage occurring at the output of the sense rectifier does not take place smoothly, but rises and falls in steps as it follows the peaks of voltage. Before this waveform is suitable for use as a sweep voltage, it must be filtered. Filtering will distort the sweep voltage if the filter components are large compared with the frequency of antenna rotation. For this reason, the exciting frequency for the system is high (600 cycles) when compared with other synchro excitation frequencies. This high frequency enables the circuit to obtain sufficient filtering with small filter components without seriously distorting the sweep voltage.

After filtering, the sweep is applied to the grid of V-208. As the voltage rises and falls on the grid of V-208 the tube draws more or less plate current. This causes V-207 to draw less or more plate current, due to the common cathode resistor. This current difference flows through the *B*-scope horizontal-scan deflection coils and generates a sweep which is proportional to both the speed and direction of rotation of the antenna.

FIGURE 7—*Partial schematic diagram of the horizontal scan circuit used in the VF equipment.*



Test Equipment for Search Radars



■ Is your search equipment just functioning or is it really performing? Is your receiver as sensitive as it should be? Does it compare favorably with others of the same type? Is your transmitter power output down? These are only a few of the questions that plague the technician by day and night, at sea and ashore. To know the answers and have that feeling that his equipments are "hot" should be the goal of every technician.

Many factors contribute to better performance of electronic equipments. One of the most important of these is a knowledge of what test instruments are best suited for a certain performance check. Obviously, no single ship or station will have available all the numerous test units procured by the Navy Department. In view of this fact the Bureau of Ships has compiled a list of many test sets procured for use with search radar equipments. Included are old familiar friends, the echo box and the directional coupler, which are usually considered an integral part of most radars.

The items listed were selected from several sources. Most of them are from "Shipboard Electronic Test Equipment Allowance, RE60Z104E" (just recently replaced by the individual ship allowance lists). Some equipment listed was supplied on earlier allowances; others have been supplied with certain radar gear such as TS-35/AP and TS-34/AP with fire control gear and the TS-295/UP with the SV radar. Others were furnished to field engineers (60ACZ range scope to Raytheon men). The TS-358/U is to be incorporated in the standard remote PPI switchboard on larger vessels.

This list does not necessarily show the best possible equipment for a certain purpose but affords flexibility of selection of the available equipments. The list includes equipments which are in the field, or to be distributed in the near future. The use of any of the equipments listed in lieu of other suitable equipment is not mandatory. In servicing radar equipments correctly, the technician must use common sense and reasoning. Above all, he must know the capabilities and limitations of the radar and of the test instrument in use. The instruction books for both the radar and the test unit should be thoroughly understood *before* actually doing the servicing.

It is pointed out that in most radar receivers the i-f stages are not to be adjusted unless the technician has considerable knowledge, skill and the correct test equipment.

Some of the more general test equipments, usable with practically all radars, are listed in table II. For more information and photographs, attention is invited to the new "Catalog of Electronic Test Equipment", NavShips 900,105, which has just been distributed.

TABLE I—RADAR AND TEST EQUIPMENT CROSS REFERENCE

BASIC RADAR	Directional Coupler for connecting to radar	Echo Box. For check of performance, spectrum pulling, frequency, output (roughly)	R-F Signal Generator for measuring receiver sensitivity	Power Meter for transmitter power VSWR* indicator	Frequency Meter for setting L.O., receiver and transmitter frequencies	Range Calibrator crystal type, for checking range unit	R-F Test Load for testing during radar silence	I-F Oscillator for i-f alignment	Spectrum Analyzer for checking transmitter frequency spectrum	Test Antenna for coupling test equipment	VSWR* Equipment for measuring impedance or checking VSWR
SA series	....	OAA series	LX,LAF OAP-1	....	OAA series	TS-358/U 60ACZ	....	LX,709B LP	....	with OAA-2	OT-1
SC & SK series	....	OAA series	LX,LAF OAP-1	....	OAA series AN/UPM-2	built in	....	LX,709B LP	....	with OAA-2	OT-1
SD series	....	OAO series SD-3 OAF	LX,LAF	....	OAO OAF AN/UPM-2	TS-358/U 60ACZ	....	LX,709B LP	....	....	OT-1
SF & SF-1	CU-90/UP (cancelled)	OBU (14ABA) series	LAG LZ	TS-125/AP 60ABU (part of LZ)	OBU series 60ABM	TS-358/U 60ACZ	....	LX,709B LP,787	....	6AJG	....
SG, SGa SGB,SG-1 to SG-1d	47AAN 47AAM	OBU series	LAG LZ	TS-125/AP 60ABU (part of LZ)	built in, OBU 60ABM	TS-358/U 60ACZ	....	LX,709B LP,787	....	with Echo Box	....
SG-3 & SG-4	built in	built in (or TS-275/UP)	LAG	60124 (built in)	TS-275/UP	60ACV in stock spares	....	LX,709B	....	with Echo Box	built in
SJ series	47AAL (part of OBU-1) 47AAP	OBU-1 OBU series	LAG LZ	TS-125/AP 60ABU (part of LZ)	Echo Box 60ABM	TS-102/AP 60ACZ	....	LX,709B	....	with Echo Box	built in
SL,SLa & SL-1	built in	OBU series	LAG LZ	TS-125/AP 60ABU (part of LZ)	60ABM OBU series	TS-358/U 60ACZ	....	LX,709B	....	with OBU series	....
SM & SM-1	CU-83/UP built in	TS-270/UP	LAD LAG	LAD TS-125/AP	OBA TS-270/UP	built in	....	furnished by Navy LX,709B	....	TS-270/UP (Echo Box)	....
SN	....	....	LAG LZ	TS-125/AP 60ABU (part of LZ)	60ABO 60ABM	....	....	LX,709B	....	(with LZ)	....
SOa, SO-1 SO-2, SO-8 SO-9, SO-13	47AAN-2	OBU series	LAG LZ	TS-125/AP 60ABU (part of LZ)	Echo Box 60ABM	60ACZ TS-102/AP	....	LX,709B	....	with OBU series	....
SO-3 SO-4	SO-3 14ABV SO-4	14AAT built in (or TS-218/AP)	TS-35/AP TS-35A/AP	TS-36/AP TS-230/AP	TS-33/AP	60ACZ TS-102/AP	....	LX,709B	TS-148/UP	with Echo Box	....
SP	built in above ser. No. 100	14AAW built in (or TS-270/UP)	LAD,LZ, LAG	LAD TS-125/AP 60ABU	OBA or Echo Box	built in	....	LX,709B	....	with LAD	built in
SQ	....	....	LAG LZ	TS-125/AP 60ABU (part of LZ)	60ABO 60ABM	TS-358/U 60ACZ	....	LX,709B	....	(with LZ)	....
SR, SRa SR-5	....	OAA-2	LAF	....	built in	TS-358/U 60ACZ	....	LX,709B	....	with Echo Box	....
SR-3 SR-6	built in	built in	LAE	....	Echo Box	TS-358/U 60ACZ	....	LX,709B	....	with radar	built in
SR-2 SR-4	built in	built in	LAE	Reflectometer (built in)	Echo Box built in	TS-358/U 60ACZ	....	LX,709B SR4: NO ADJ	....	....	Reflectometer built in
SS, SS-1 ST, STa ST-1	14ABL (built in)	TS-311/UP TS-311A/UP	TS-35A/AP	TS-230/AP TS-36/AP	TS-33/AP	60ACZ TS-102/AP	66AHT	LX,709B	TS-148/UP	Horn with TS-35A/AP	Bi-direc'l coupler CW-14ABL
SU SU-1	CU-118/UP	TS-218/UP TS-218A/UP	TS-35A/AP	TS-230/AP TS-36/AP	TS-33/AP	60ACZ, TS-102/AP	TS-231/AP	LX,709B fixed-tuned	TS-148/UP	with Echo Box	....
SV,SVa SV-1	built in	14ABG (Built in) (or TS-275/UP)	LAG	TS-295/UP (with each SV series)		60ACZ TS-102/AP	66AJW	LX,709B	....	....	Bi-direc'l coupler built in
SX	built in	TS-270/UP & TS-275/UP	built in noise generator	....	Echo Boxes	60ACZ TS-102/AP	....	LX,709B	....	with TS-270/UP TS-275/UP	....

Notes: TS-125/AP is included with AN-UPM-7 Kit.

* Voltage Standing-Wave Ratio.

TABLE II—Test Equipment for General Radar Use

Equipment	Types	Purpose
Audio Oscillator	LAJ, LO, 205AG	For checking audio systems, checking rep. rate or frequency in conjunction with oscilloscope.
C and R Bridge	60007	For checking resistors and capacitors while applying a voltage.
Crystal Detector Checker	TS-268/U	For estimating performance of 1N21A, 1N21B, 1N23, 1N23A, 1N23B.
Electronic Multimeter	OBQ Series	For use in i-f and discriminator (AFC) alignment and voltage, current, or resistance measurements. It has high input impedance up to 50 Mc.
Fluxmeter	TS-15/AP TS-15A/AP	For checking magnets used with magnetrons.
Heterodyne Frequency Meters: 90-450 Mc.................... 500-1400 Mc.................. (Usable: 100-10,000)	TS-173/UR TS-186/UP	For accurate frequency measurement. Used with signal generato for calibrating absorption-type frequency meters.
Megohmmeters Megger type (500V).........	OCW	0.05-100 megohms
Electronic Type (67.5V)......	60C89	0.05 to 10,000 megohms
Multimeters	OE, OCR	For checking voltages, currents, and resistance.
Oscilloscopes	OBT	For viewing regularly recurring video wave-shapes. If jitters occur use a synchroscope (slave sweep oscilloscope) instead.
	OBL, OCU, 60018	For viewing waves having frequency components under 100 kc.
Range Calibrators (Crystal Controlled)	TS-102/AP TS-120A/AP	For calibrating "close-in" or precision range units. Marker pips every 500 yards—phaseable (Accuracy ±0.1% between pips.)
	TS-358/U	For calibrating remote PPI's and range units. Markers are at multiples of 1, 5, 10, and 50 radar miles (2000 yards = 1 radar mile).
	60 ACZ	For calibrating range. This has an oscilloscope unit incorporated. Similar to TS-100/AP except for marker intervals.
	60 ABZ	(Not crystal controlled.) Liquid tank unit. Accuracy 15 yds. ±0.1%. Similar to range unit of Model SE radar.
Repair Kit, Emergency Electronic	CZY 10223	For simple, on-the-spot checks and repairs.
Synchroscopes	TS-34/AP TS-34A/AP	For viewing 0.25- to 30,000-microsecond pulses and other video waves; also for observing sine waves from 30 cycles to 1 Mc. Has 2-inch tube.
	TS-28/UPN	For viewing wave shapes. Puts out trigger. Frequency range is 1000 cycles to 5 Mc. Has crystal calibrator giving marker pips spaced by 2, 10, and 25 microseconds. IFF video test set. Has 5-inch tube.
	60ACB	For viewing wave shapes. Freq. range 3000 cycles to 1 Mc. Puts out trigger. This is part of LZ equipment furnished to certain yards.
Synchro Tester	Mark 2	Checks selsyn leads to remote PPI's, etc. (TS-417/U PPI checker, a different device, listed on allowance lists, has been cancelled. A buzzer can be used to check video leads.)
Tube Testers (Mutual conductance types)	OD Series	With adapters types 49396, 49397 and 49398. For checking receiving tubes. Characteristic curves may be made using OD Series.
	OQ Series	For checking receiving type tubes. Less elaborate than OD Series.
	OZ Series	For checking receiving tubes in the field. Hickok Model 540-550X.
	OCL	Newest portable tube checker and multi-meter. Temporary books have only partial tube listings. More complete list is forthcoming.
Voltage Dividers	TS-89/AP	For sampling h-v video to allow inspection on synchroscope. Ratio 100-to-1 and 10-to-1. Maximum voltage 20 kw on 100-to-1 range.
	62142 62153	For use with oscilloscope to view video pulse by direct connection to plates of scope.

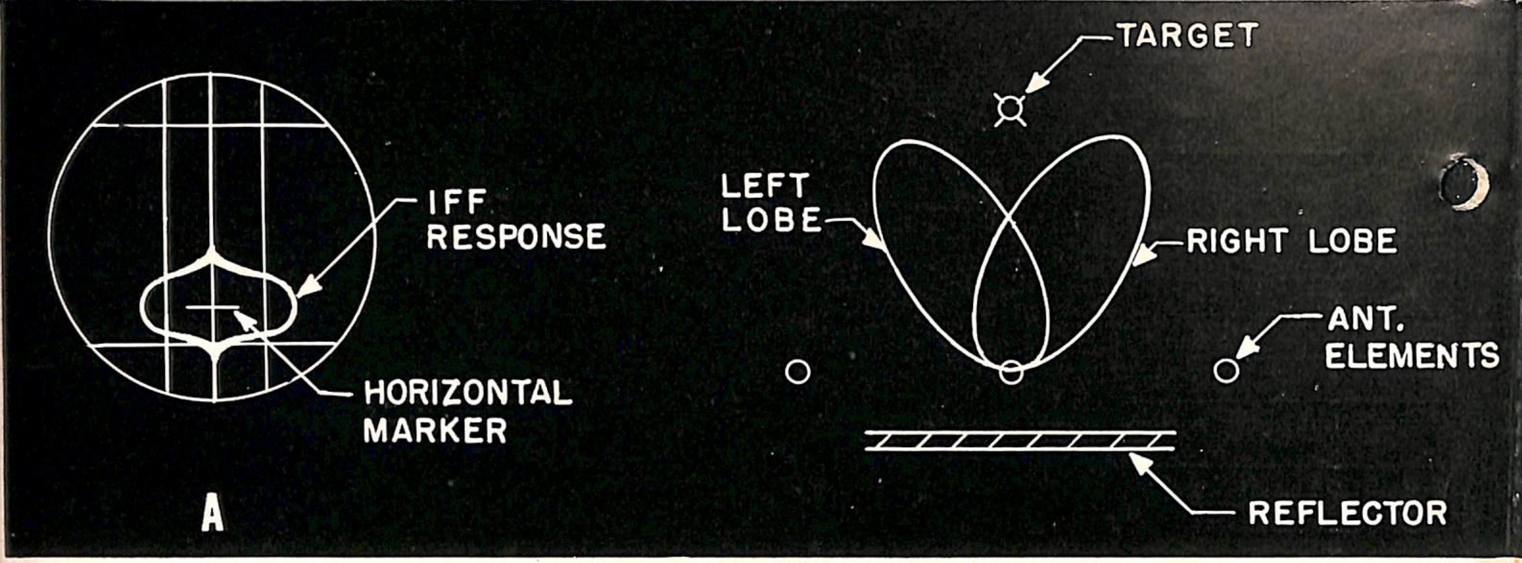


FIGURE 1—*Mark 32 Mod 1 IFF system indicator and antenna lobe patterns showing: A—Target in center line of the two lobes. B—Target to right of center of the two lobes. C—Target to left of center of the two lobes.*

Mark 32 Mod 1 Radar Equipment

Electronics Field Service Group

■ Several inquiries from engineers and ship's personnel indicate a need for additional information on the Mark 32 Mod 1 equipment used for identification purposes with the Mark 4 or Mark 12 fire-control radars. The questions raised indicate a lack of information on installation of the antenna and lober, and the operation of the identification indicator. This is particularly true where the installation work is being carried out by ship's forces. In line with these inquiries, it is hoped that the following will assist engineers and ship's personnel in making installations as well as covering several points which may have proven confusing.

The Mark 32 Mod 1 system consists of a BN Interrogator-Responsor, a Navy Type CTZ-50ACW Duplexer, a Mark 1 Mod 0 Identification Indicator, a Mark 1 Mod 0 Radar Lober, and either a Mark 2 Mod 0 Identification Antenna for Mark 4 Radars or a Mark 3 Mod 0 Identification Antenna for Mark 12 Radars.

The first four of these components are furnished together, but the antenna must be ordered separately, depending on whether the equipment is to be used with a Mark 4 or Mark 12. There are also spare parts boxes, one for the BN and one for the remainder of the equipment. The temporary instruction books (2) and supplements (Ships 350) for Radar Equipment Mark 32 Mod 1 are packed in the latter box. Two instruction books for the antenna system (Ships 353 for Mark 12) are packed with the antenna. Also included with the antenna is the mounting bracket for the lober, since the mounting of the lober assembly differs with the Mark 4 and Mark 12 installations.

BuOrd drawings for installation of the Mark 32 Mod 1 radar are available from Electronics or Ordnance Officers at navy yards. These drawing numbers for various equipments are as follows:

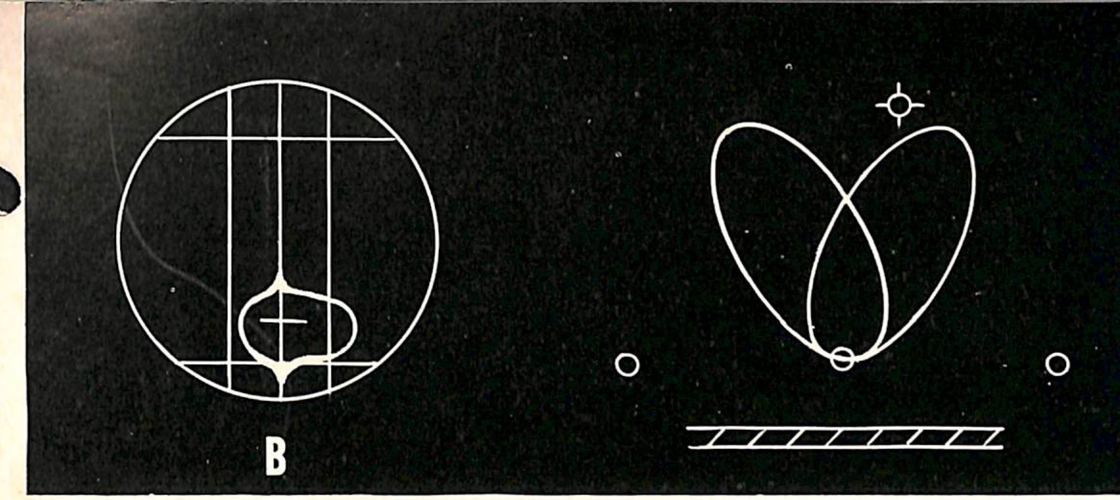
Mark 32 on Mark 4 Radar	423811
Mark 2 Mod 1 Antenna Assembly	591027-33 incl.
Mark 32 on Mark 12 Radar	423812
Mark 3 Mod 1 Antenna Assembly	590961-69 incl.

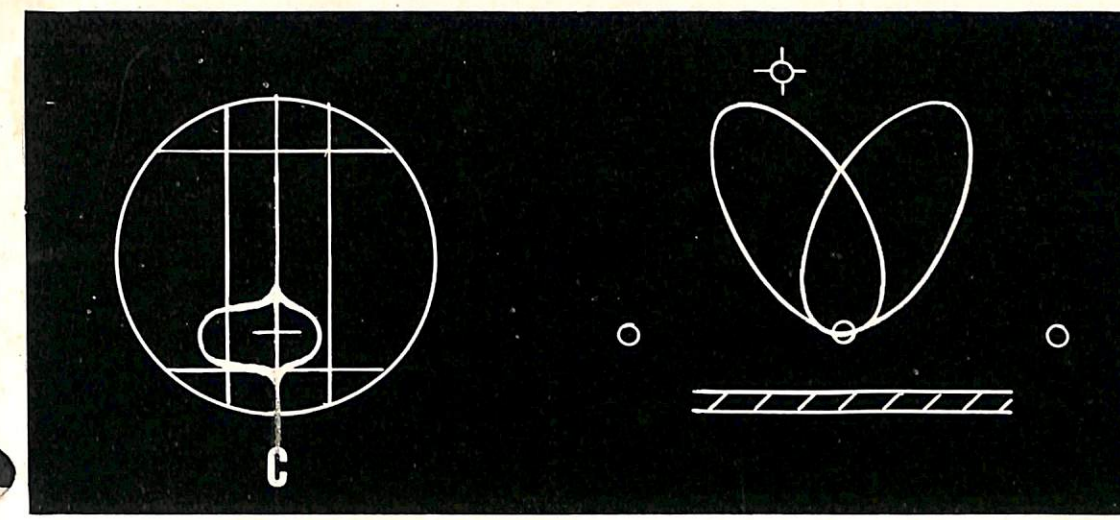
The correct spare parts are supplied with each type of antenna; space is provided in the spare parts box supplied with Radar Equipment Mark 32 for the storage of these parts.

OPERATION

The Mark 32 Mod 1 provides rapid and accurate identification of a target. This is accomplished by using antenna lobe switching and presenting only a small portion of the IFF video beginning with the radar range marker on an expanded sweep of a separate indication. As the antenna lobing is switched from left to right the video is synchronously switched from one horizontal plate to the other. The sweep is applied to the lower vertical plate and deflects the beam in the upward direction. This gives a back-to-back "R" pattern, as shown in the figure. Horizontal and vertical guide lines are provided in front of the indicator scope screen. The upper horizontal line and small horizontal mark are to be disregarded.

The indicator sweep is adjustable between the limits of 30 and 50 microseconds. This sweep and the unblanking-pulse generator are triggered by the fire-control radar range marker. Consequently, only signals from transpondors at or slightly beyond the range of the radar target will be displayed. The radar range marker of the associated radar is in the form of a notch in the radar trace. When the operator ranges on a target he adjusts the range crank so that the target pip will ride inside the notch. The transpondor returns associated with this target will then appear on the IFF indicator. If the target changes range, the operator adjusts the range crank to keep the target pip in the notch. The IFF response in this case will continue to appear in the same position on the IFF indicator sweep.





When the radar antenna is bearing on the target, the IFF signal will also be on the target. This will provide equal signal pickup in each IFF lobe, which in turn will produce equal deflection to either side of the center of the IFF display as shown in figure 1A. The r-f and video switches are so synchronized that during left-lobing of the antenna array the received signal is fed from the receiver through the left video channel, and during right-lobing through the right video channel of the indicator. Each video channel is coupled to a horizontal deflection plate. Consequently a received IFF response produces a dual pattern, one to the right and one to the left of the vertical sweep line. If the target is located in line with the cross-over point of the two antenna-lobe patterns as in figure 1A, the received signal will be of equal strength during right and left lobing. The pattern appearing on the indicator will then be symmetrical on each side of the sweep line, indicating that the IFF antenna is bearing directly on the target. Since the IFF antenna is aligned with the fire-control antenna, this would mean that the IFF signals were being received from the target in the range notch. However, if the replying target is to the right of the center as in figure 1B, or to the left as in figure 1C, the pattern on the indicator scope will be of greater amplitude on the corresponding side of the base line.

CHANGES

During early production of the Identification Indicator, certain modifications were incorporated which are not included in all equipments. These changes are summarized in the following paragraphs as additional information to engineers and ship's personnel. Equipments should be checked to ascertain if the changes have been made.

The plate load resistor (R-11) of V2B should be 4700 ohms instead of 2200 ohms. This increase in resistance is made to increase the amplitude of the unblanking pulse. Mark 32 indicators with serial numbers 1 to 169 inclusive have the wrong type of "IFF-GAIN" potentiometer. It should be replaced with the gain control from the BN spares, item 159.

Ranging With the SU Radar

Electronics Field Service Group

It is true that several calibration procedures may be employed with equally accurate results as long as the same method is also used for ranging. In the interests of uniformity and in order to avoid confusion among operators it is recommended that the following method be employed:

When calibrating the range dial, the MAX and MIN SET controls should be adjusted so that the image appears as in figure 1. In lining up the range step with the echo signal, the center of the range step should be made to coincide with the center of the leading edge of the signal as shown in figure 2.

With the range selector on 8,000 yards and with markers ON, adjust until the first marker coincides with the leading edge of the image of the transmitted pulse on the A scope. The trace from the bottom of the first marker to the top of the transmitted pulse image should be a straight line as shown in figure 1. This pattern must be attained before the equipment can be calibrated accurately on the 8,000 and 40,000-yard scales. The calibration for the SU/SU-1 equipments which is described in the instruction books was established with the assumption that, since the range potentiometer is linear for all practical purposes, the range error at all points on the range dial is so small as to be negligible. It developed that there is some non-linearity in the circuit resulting in a range error which tends to increase with range, regardless of the range scale used. In order to distribute the error more evenly over the entire range of each scale, thereby reducing the error at the mid-point, it has been agreed to standardize on the following calibration procedure, which will appear in the final instruction book for the SU equipments:

Change "Chapter III—Operating Instructions, 3.1 = General Procedure", steps 6 through 16, to read as follows:

6—Set range dial to read 2,000 yards. Adjust 8,000-yard MIN SET control until range marker (drop of trace on range scope) coincides with the second pip.

7—Set range dial to read 6,000 yards. Adjust 8,000-yard MAX SET control until range marker coincides with the fourth pip.

8—Repeat steps above as many times as necessary (3 or 4) to obtain consistent adjustment over entire range.

9—Put RANGE SELECTOR on 40,000 yards.

10—Set range dial to read 10,000 yards. Adjust 40,000-yard MIN SET control until range marker coincides with the sixth pip.

11—Set range dial to read 30,000 yards. Adjust 40,000-yard MAX SET control until range marker coincides with sixteenth pip.

12—Repeat above steps as many times as necessary until adjustment is satisfactory.

13—Put RANGE SELECTOR on 80 miles.

14—Set Range dial to read 19 miles. Adjust 80-mile MIN SET control until range marker coincides with fourth pip visible. (This is actually the fifth pip on the series, as the first pip is not visible on the screen.)

15—Set dial to read 59 miles. Adjust 80-mile MAX SET control until range marker coincides with the twelfth pip.

16—Repeat above steps until adjustment is satisfactory.

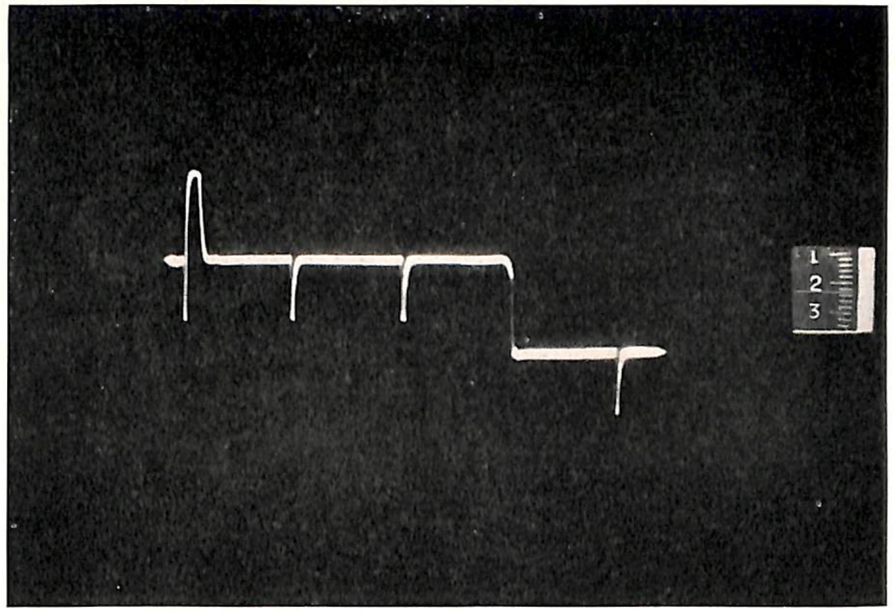


FIGURE 1—*Pattern that should be obtained when adjusting the calibration. Trailing edge of first marker and leading edge of transmitter pulse should form straight line. Note also the appearance of fourth range marker at bottom of step.*

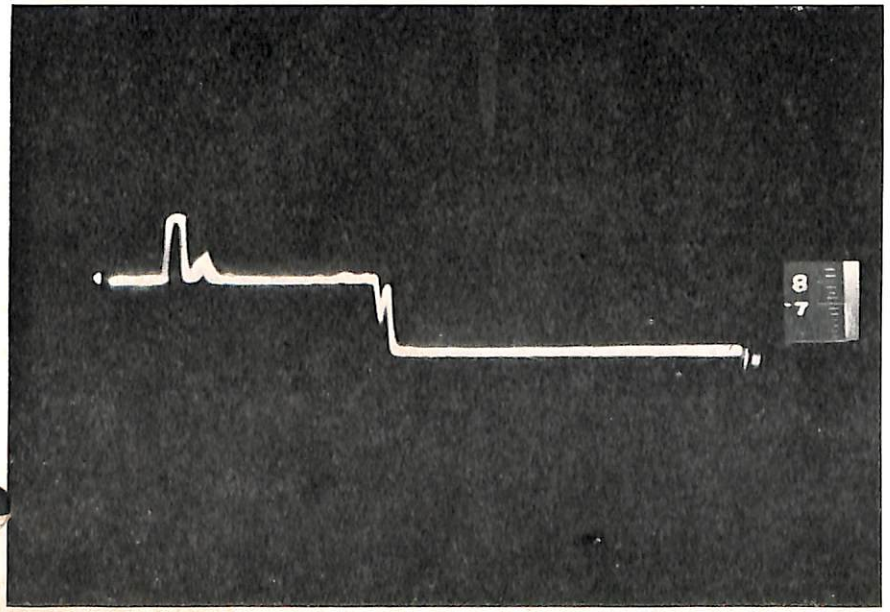
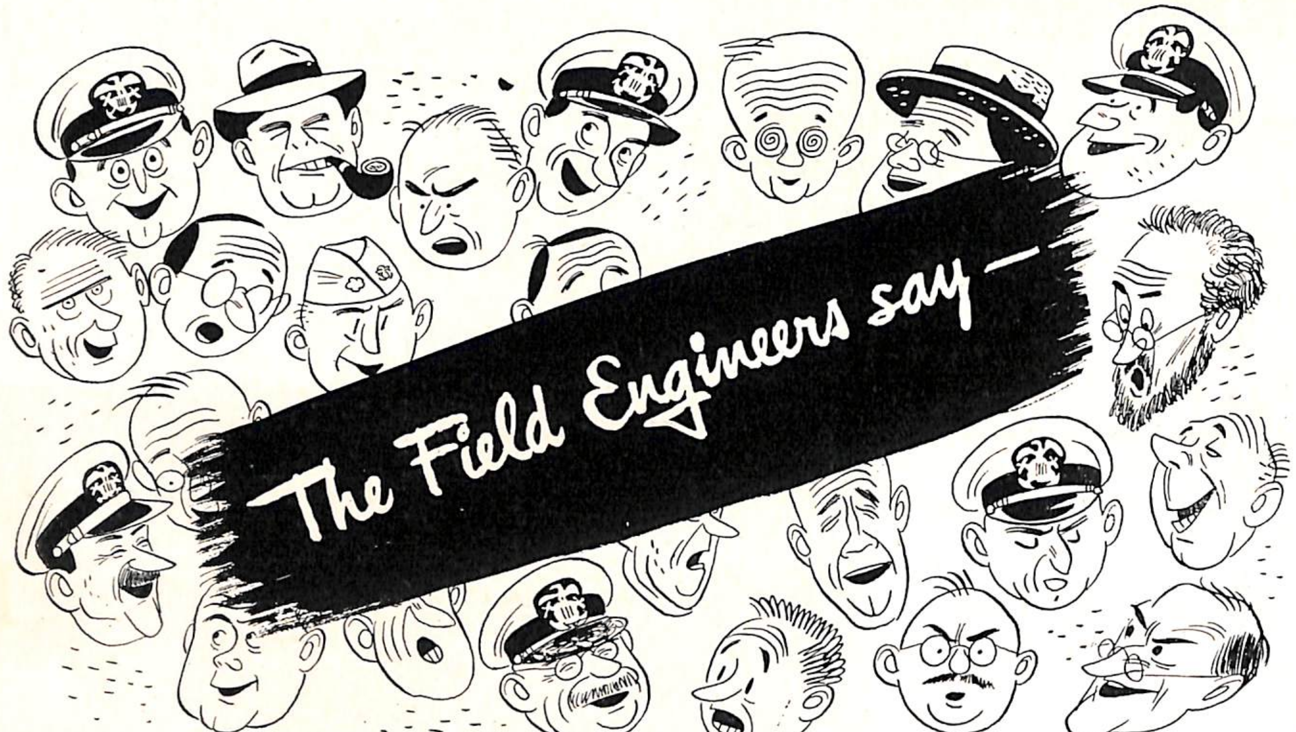


FIGURE 2—*Correct method of measuring range on a target. The middle of the step should coincide with the middle of the leading edge of the echo.*



MARK 12 FIELD CHANGE No. 14

The incorporation of Field Change No. 14 in the Mark 12 radar equipment has resulted in some post-installation difficulties. One difficulty reported as occurring frequently is in the range unit, evidenced by unmeshing of the idler gear under slewing operation. This trouble has been reported by both Western Electric Co. representatives and naval personnel.

It has been found that the idler gear which replaces synchro B1 in field change No. 14 must be locked very securely or else the idler gear will be forced out of mesh by the torque of the slewing operation. To insure that the idler gear will not change position, check to see that the springs and clamps which held the synchro in place were replaced with steel washers. These should be tightened with the socket wrench provided as part of the range unit (mounted in fuse clips on the inside of the cover, lower right-hand side) until the assembly is quite firmly in place. No trouble has been encountered with idler gear assemblies which are known to have been properly tightened on installation. This indicates that the change is adequate for the purpose intended if correctly installed.

If the above procedure does not correct the difficulty, the following procedure is recommended. When a range unit is encountered having the maximum depth of recess in the chassis plate permitted by manufacturing tolerance limits, the clamps mentioned above will fail by 0.002″ to bear on the plate. The clamps will not, therefore, prevent the idler gear bracket from rotating away from its proper position. Also some of the clamping washers supplied may be tapered, or "crowned" by a slight amount instead of being absolutely flat, making the outer edge further away from the mounting plate than the center. A combination of all the tolerances in the wrong direction will cause the method first explained above to be ineffective.

The second remedy for this difficulty is to cut a piece of shim brass stock 0.005″ thick and install it between the idler gear mounting bracket and the chassis. This thickness should be sufficient for the toughest cases. The inside diameter of the shim should be 2 inches while the outside diameter should be 2.5 inches. This method should be used only after the first method described has been tried and failed.

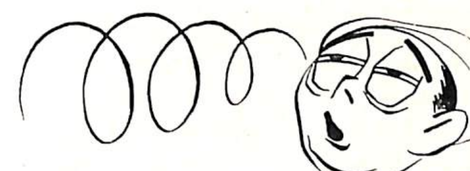
—*Western Electric.*

MK 28/34 DUTY CYCLE ADJUSTMENT

In the Mk 28 and Mk 34 systems, a broader tolerance is now specified for the average current in the 1200-volt supply to the modulation network. The present instruction books specify 175 milliamperes at 1200-volts. This is now revised to between 165 and 200 milliamperes at 1200-volts. With the establishment of these broader limits, the feedback waveshape may show a "break" at a point other than the optimum change in slope. However, this will not appreciably affect the efficiency of the modulator circuit.

The above considerations are of value when the Duty Cycle Monitoring Meter (Mk 28 Field Change No. 15—Mk 34 Field Change No. 3) is installed. The Duty Cycle Adj on the modulation generator unit should then be adjusted so that the DCM Meter needle is midway between the red marks. Then with pulse rate at 1800 cycles (midpoint of potentiometer rotation), and with the HV at 1200 volts (108 volts a.c. on plate supply meter), the average current should be between 165 and 200 milliamperes.

—*Western Electric.*



STACK GAS CAN BE HARMFUL

Regarding the safety of personnel engaged in the installation or maintenance of SX antenna assemblies, as affected by stack gases, the following incidents are reported. Each is claimed to be true, and not just rumor:

1—In Boston Navy Yard, a civilian yard electrician was working at the top of the mast, and the stack exhaust was blowing his way. He worked in it for half an hour and then came down, complaining that he couldn't stand it any more and would have to wait until it cleared. About an hour later he became sick at his stomach and the Yard Dispensary sent him home. He was taken to the hospital that night and died the next day.

2—In Norfolk Navy Yard, a G.E. field engineer was working on the mast with an enlisted man. The engineer went below to get a meter, and when he climbed back up the stack to the top platform he found the Navy man unconscious. The engineer had to go down and get a gas mask and some help. The man was lowered to the flight deck with a rope where, sometime later, he was revived.

3—In Pearl Harbor, an enlisted man was overcome by stack gas and had to be rescued by other members of the crew. He also recovered.

There are probably many other incidents that were not publicized. They show that stack gas sometimes gives no warning and can cause illness and loss of consciousness, or even death as a result of a fall from the mast.

—*General Electric.*

Bureau Comment: Ordinary Smoke Respirators, Bureau of Ships #S-23-R-16900, will filter out smoke particles and obnoxious fumes but offer no protection against carbon monoxide, which is one of the gases prevalent in stack smokes. While the possibility of this gas building up to high concentrations in the open is remote, the results of prolonged exposure to even small concentrations accumulate and can be lethal. Accordingly, if personnel are in confined or poorly ventilated spaces susceptible to the entrance of stack gases, the Type A-1 Oxygen Breathing Apparatus, Bureau of Ships #S-23-B-69850, should be used.

*

WIRING ERROR IN SO-1/SO-8

Attention is invited to the fact that the internal wiring of the SO-1/SO-8 Bearing Control Unit was incorrect. Correction of this error was instituted in production with SO-1 RX-1006 kit No. 1997 and SO-8 RX-1156 kit No. 1117. Earlier kits must be corrected in the field. The change is simple and requires only a few minutes to accomplish.

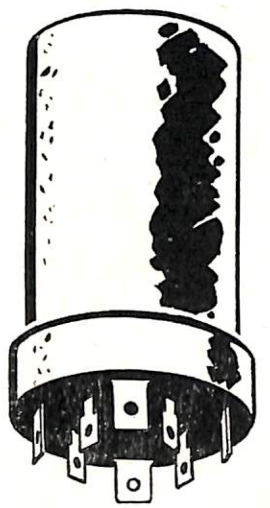
The basic difficulty is that between the Bearing Control Unit step motor and the terminal strip E-1410, the leads 4(214) and 5(215) are reversed. This would normally result in the same polarity at each step-motor coil except for the fact that some current passes through the unused coils in a repeater. A simple test will reveal if the leads have been reversed. Disconnect the external cabling to terminal 214 and 215 on E-1410. Connect one lead of an ohmmeter to terminal 215 and test between the pilot lamp socket and terminal 5 on the terminal strip attached to a direct connection between terminal 215 on E-1410, terminal 5 on the step motor strip, and one side of the pilot lamp. If the connections are not proper, a resistance of several hundred ohms will be indicated between terminal 215 and terminal 5.

If the wiring is reversed, it may be corrected in the following manner:

Remove the can on the step motor side of the Bearing Control Unit, disconnect the external cabling to terminals 214 and 215 on E-1410, remove the marker number strip on E-1410, and remove the second screw in the Jones strip at terminals 214 and 215. Next lift up the Jones strip soldering busses on 214 and 215 and reverse them. Replace screws and marker strip and reconnect the external cabling. Do *not* reverse the external cabling to 214 and 215.

With a pencil, write "4 and 5 ok" on the inside of the cover so that the work will not be duplicated. Then replace the cans on the Bearing Control Unit.

—*Raytheon*



Maintenance of Electrolytic Capacitors

The following information appears in the preventive-maintenance section of the new SV-1 Instruction Book, Ships 341. Technicians should make use of this information in the servicing of any electronic equipment containing electrolytic capacitors.

All electrolytic capacitors should be replaced after a period of 3½ years from the date of manufacture, which is usually stamped on them. If a rectifier unit is not being used in service it should be operated for a period of at least one-half hour every 18 months to restore the film on the plates. Since an electrolytic capacitor not connected to a voltage for more than 18 months may be ruined, the technician should remove these capacitors in spares and connect them across 300 volts for at least one-half hour every 18 months. The positive terminal of the capacitor should be connected to the positive polarity of the supply. This terminal is marked positive or with a red dot. Note the voltage rating on other than high-voltage capacitors so that the process of restoring the film does not ruin a low-voltage unit, and apply a voltage not greater than the rated voltage.

—*Western Electric.*

TS-35A/AP SIGNAL GENERATOR

Since its first appearance in the fleet several changes have been made on the TS-35A/AP Signal Generator both by field modifications and by design changes incorporated at the factory. The more important of these design changes, together with certain changes in the operation of the set, are of particular importance to the technician. It is suggested that this information be incorporated in the instruction book (Ships 339) which accompanies the TS-35A/AP.

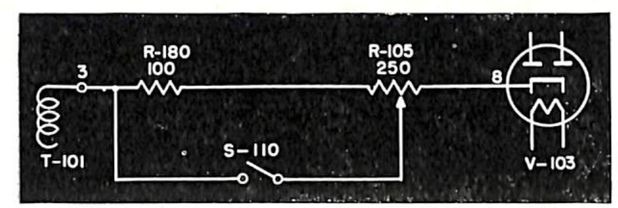
Power Supply Regulating Range Adjustment: In sets having serial numbers lower than 103, R-105 is a fixed 320-ohm resistor and the sets as delivered regulate for a-c inputs from 105 to 125 volts. In a few cases replacement of the 2K25 tube may shift this regulating range slightly and no field adjustment of regulating range was provided. In sets having factory serial numbers from 103 to 1999 inclusive, R-105 is a 250-ohm adjustable resistor and is supplemented by a fixed 100-ohm resistor R-180 and a switch S-110. The circuit arrangement is shown in the figure. R-105 is adjusted at the factory and field adjustment is not recommended. Switch S-110 should be in the HIGH position (open) on a-c line voltages above 115 and in LOW position (closed) for line voltages below 115.

Stabilizing the Oscillator Frequency Adjustment: When the cavity tuning of a 723A/B or 2K25 tube has been readjusted to make a large change in frequency, mechanical stresses in the metal shell may cause frequency drifts unless these stresses are relieved by flexing the tube bows several times around the point of desired adjustment. This is not necessary for small readjustments, but when a major change in frequency is made the procedure given below should be followed after the desired frequency has been found by adjustment of the control setting in accordance with the instruction book:

The setting of the FREQ control which gives the desired frequency is designated "setting A". Turn FREQ control about five full turns clockwise and back again to "setting A". Turn FREQ control about five full turns counter-clockwise and back again to "setting A". Repeat this procedure, but make only four turns in each direction. Continue this process making three turns, two turns, and one turn in each direction. Recheck the frequency and make any small readjustment required.

Frequencies outside 8500-9600 Megacycle Range: The frequency meter calibration card on the panel of TS-35A/AP applies only when the input frequency is between 8500 and 9600 Mc, and false results may be obtained if a frequency outside this range is introduced. The reason for this is that the calibration is based upon adjusting the length of a coaxial line in the frequency meter to 15 quarter-wavelengths of the applied frequency, but the line will resonate also at other odd numbers of quarter-wavelengths such as 13 or 17. For example, a frequency of about 9860 megacycles will give a 17 quarter-wavelengths resonance indication at the same frequency meter setting as the 15 quarter-wavelength indication for 8500 megacycles. This would be mistaken for the latter frequency on the basis of the calibration card.

In general this will cause no difficulty in transmitter frequency measurements since the correct frequency is usually known within about 75 Mc. When adjusting the frequency of Signal Generator TS-35A/AP, the frequency range of some 2K25 tubes is so great that the caution given in the instruction book (Ships 339, Sec. 2, Par. 5h) in exceptional cases may not be sufficient to avoid a false frequency adjustment. To avoid a possible false setting, the oscillator setting should be somewhere within the 8500-9600 megacycle band before starting the frequency adjusting procedure given in the instruction book. This can be assured by first setting the FREQ control in its maximum counterclockwise position, and then rotating it 17 turns in a clockwise direction. Obviously this step will not be required for small readjustments of frequency or if it is known that the control setting has not been moved outside the 8500-9600 megacycle band since the oscillator was last used.



Arrangement for adjusting power supply regulating range in TS-35A/AP units.

Numerical Frequency Values on Calibration Card: On units having serial numbers above 999 the frequency meter calibration chart shows actual frequencies instead of the arbitrary letter symbols formerly used. Steps required to convert letter symbols to frequencies or frequencies to letter symbols are unnecessary when frequencies are shown directly on the chart.

Cord CX-790/U: A ten-inch power cord was furnished with sets having serial number 850 and above. This cord serves as an adapter when operating power for the TS-35A/AP is obtained from an ordinary commercial 115-volt power source. One end is equipped with a standard parallel-blade plug cap (Hubbell No. 7057) and the other end is equipped with an AN-3102-22-10S receptacle which fits the AN-3106-22-10P four-prong male plug on power cord CX-128/AP.

Measurement of Receiver Effective Sensitivity,—Alternate Method: Section 2 paragraph 9a and figure 2-9 of Ships 339 describes a method of receiver sensitivity measurement using a "class A" oscilloscope in which the test signal strength is adjusted to give a signal-plus-noise pattern twice as great in amplitude as the noise pattern. An alternate method preferred by some operators is to adjust the signal to give a signal pattern just barely discernible above the noise pattern. If the 70-db attenuation in the signal generator is not enough to do this the signal can be attenuated further by means of a calibrated cord or attenuator inserted between the signal generator and the receiver. A 10-db reduction can also be obtained by adjusting the output to 0.1 milliwatt (meter reading of 10 instead of 100).

Whether the barely-discernible pattern or the double-height pattern is used must be taken into account in judging the result of the measurement, since the difference between results obtained by the two measurements is of the order of 8 db. The barely-discernible pattern method had some advantage in that the results are more nearly comparable with measurements made with echo-box test sets.

—*Bell Labs.*

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SR/SRa RECEIVER ADJUSTMENT

When the r-f tubes (V-201, V-202, and V-203) in the Monitor Receiver are replaced it may be observed that the performance of the receiver drops below normal. It has been found that when these tubes are replaced it is necessary to readjust the trimmer capacitor C-207 on the r-f sub-chassis. This is particularly true when a type 2C40 is substituted for a type 446A.

Using the echo response on the Monitor Scope as a tuning indication, adjust C-207 with a non-metallic tuning tool. Rock the receiver tune control "F" continuously during the adjustment to keep the echo response maximized.

The change required in the tracking adjustment is usually relatively small for equipments in the *yellow-green* band, and the improvement in performance may not be too noticeable. For those sets in the *blue* band, however, the change may improve the performance by as much as 2:1 in some installations.

—*E.F.S.G.*

*

Prompt submission of the Signal Equipment Failure Report used by Marines is essential to accomplish prompt correction of a defect in Marine Corps signal gear.

WIRING CHANGE IN MK 29 RADAR

Reports and requests from the field for replacement parts indicate that excessive wear is occurring in the aided-tracking section of the range unit in the Mark 29. The wear shows up in scoring of the variable-speed drive ball as well as in the integrator disc and associated gearing. A great deal of the wear occurs when the Time Constant control knob is set at zero range rate, whereupon the unit operates continually with no output.

At present the aided-tracking motor B-501 may run in either the "operate" or "standby" condition of the radar. The following change is recommended to cause the motor to run only in the "operate" condition. The Bureau of Ordnance requests that all ships and activities having installations of Radar Mark 29 Mod 2 effect the wiring change as follows:

In junction box CW-62090, remove lead O-BK from terminal T-1618 and connect it to terminal T-1620 in the same box. (This lead runs from range-rate motor B-201 in the range rate unit to the junction box.) Other leads to these terminals are to remain as before.

Upon completion of this change it should be recorded in the instruction book used with the equipment and reported to the Bureau of Ordnance (code RE4F) by postcard.

—*Western Electric.*

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SPARK WHEEL REMOVAL ON SL

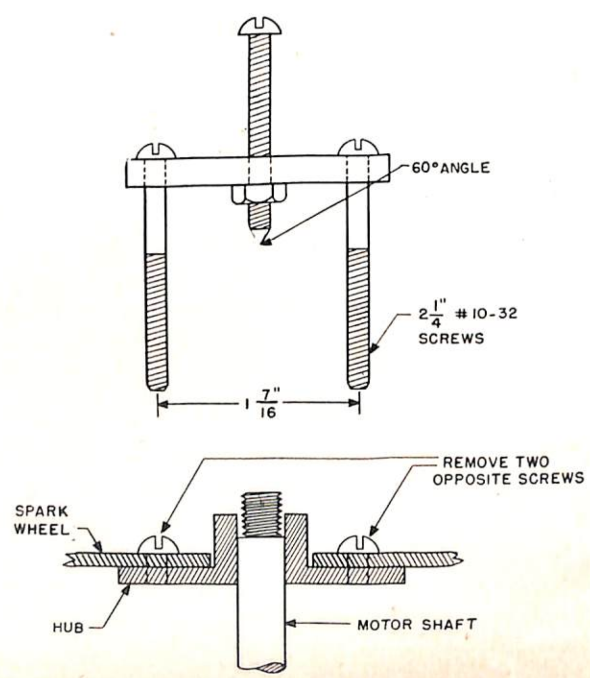
Reports from the field indicate that considerable trouble has been encountered by inexperienced personnel in attempting to remove the spark wheel from the SL radar equipments. In order to avoid unnecessary work and possible damage to the equipment when removing and replacing this component, it is suggested that technicians follow this procedure:

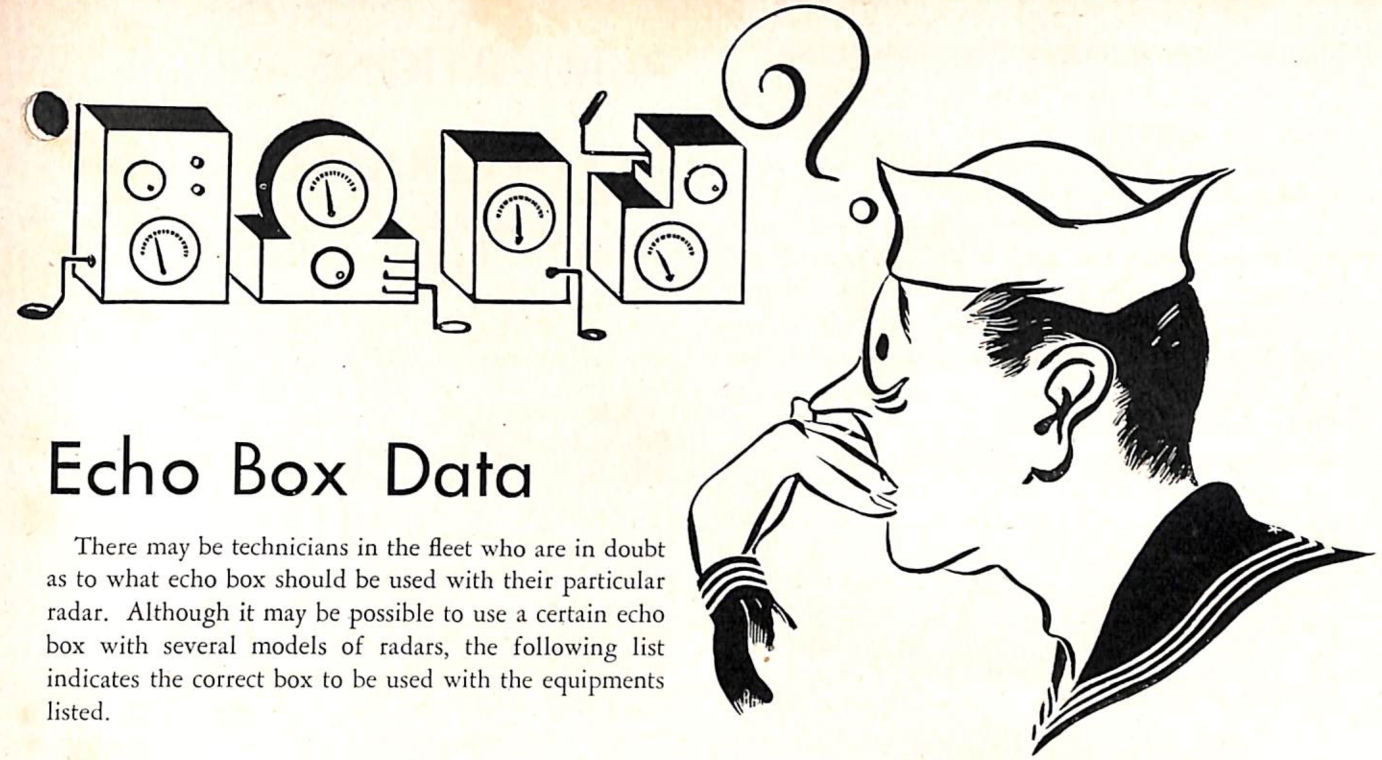
To loosen the motor shaft nut it is necessary that the spark wheel assembly be prevented from turning. To prevent this natural tendency to turn requires patience and the correct method of blocking the assembly. Do not block on the spark wheel pins because they are very brittle and will snap off when pressure is applied to the nut. Use a double open-end wrench with 5/16″ and 13/32″-openings. Place the larger opening of the wrench on one of the round bars that support the stationary electrode assembly. Engage the smaller opening of the wrench with one of the hex nuts in the outer row on the spark wheel.

Ordinary methods of applying pressure oftentimes fail to accomplish the removal of the wheel after the nut has been removed. To meet this situation a wheel puller has been devised. This consists of a piece of steel or brass approximately 1/4″ thick, 1″ wide, and 2 1/2″ long. Three holes are drilled as shown in the figure. The center hole is drilled and tapped for a #10-32 *brass* screw. An alternate method is to use a nut through which the center screw is screwed, thus accomplishing the same purpose—applying pressure on the center of the motor shaft. The two outer holes are a loose fit for the #10-32 screws.

To use the wheel puller, first remove two opposite screws that hold the spark wheel to the hub. Then screw the two 2 1/4″ screws of the wheel puller into these screw holes. The exact depth the screws are inserted is not critical but the puller plate should be parallel with the wheel so that the wheel will have no tendency to bind when pressure is applied. The final step is to screw in the center screw, putting pressure on the center of the motor shaft until the spark wheel is pulled off the shaft.

—*Western Electric.*





Echo Box Data

There may be technicians in the fleet who are in doubt as to what echo box should be used with their particular radar. Although it may be possible to use a certain echo box with several models of radars, the following list indicates the correct box to be used with the equipments listed.

Table I—Preferred Types of Tuned Echo Boxes for Use With Shipboard Fire Control Radars

MODEL	TUNED ECHO BOX	NOTES
Mark 4	....	Obsolete
Mark 8 Mod 2	OBU Series	
Mark 8 Mod 3	TS-311A/UP (or TS-311/UP)	Uses Mark 13 Mod 0 Antenna and ST Antenna.
Mark 12 and Mods 0 to 4	TS-349/UP	Production to begin in February as a retroactive field change.
Mark 12 Mod 0	TS-311A/UP (or TS-311/UP)	
Mark 20 Mod 0	TS-91/TPS-1	Marine Corps (transportable).
Mark 20 Mod 1	TS-172/UP	Marine Corps (Mobile land vehicle).
Mark 22	TS-62/AP	
Mark 25 Mod 2	TS-62/AP, TS-218/UP, and TS-311A/UP	Due to broad band there is a portion of the frequency band not covered by these 3 tuned echo boxes.

MODEL	TUNED ECHO BOX	NOTES
Mark 26	OBU Series	
Mark 27	OBU Series	
Mark 28 Mod 0	OBU Series	
Mark 28 Mod 2	OBU Series	
Mark 28 Mod 3	OBU Series	
Mark 29 Mod 2	TS-62/AP	
Mark 34 Mod 2	TS-311/UP	
Mark 34 Mod 3	TS-311A/Up (or TS-311/UP)	
Mark 34 Mod 4	TS-311A/UP (or TS-311/UP)	
Mark 35 Mod 2	TS-62/AP, TS-218A/UP and TS-311A/UP	Due to broad band there is a portion of the frequency band not covered by these 3 tuned echo boxes.
Mark 39 Mods 0 to 3	TS-218A/UP (or TS-218/UP)	

Table II—Preferred Types of Tuned Echo Boxes for Use With Shipboard Search Radars

RADAR MODEL	ECHO BOX	NOTES
SA Series	OAA-2	
SC and SK Series	OAA-2	
SD Series	OAO-1	
SF Series	OBU Series	
SG to SG-1e	OBU Series	
SG-3, SG-4	TS-275/UP	
SJ Series	OBU Series	
SL Series	OBU Series	
SM Series	TS-270/UP	
(SOa, SO-1, SO-2, SO-8, SO-9, SO-13)	OBU Series	
SO-3, SO-4	TS-218A/AP or TS-218/UP	Built in Echo Box type -14AAT is not suited for comparison of various SO-4's as is the TS-218A/AP or TS-218/AP.

RADAR MODEL	ECHO BOX	NOTES
SP	TS-270/UP	TS-270/UP is more dependable than the Marathon tuned echo box.
SR, SRa, SR5	OAA-2	
SR-3, SR-6	Built in	
SR-2, SR-4	Built in	
SS, SS-1, ST, STa, ST-1	TS-311A/UP (or TS-311/UP	
SU, SU-1	TS-218A/UP (or TS-218/UP)	
SV, SVa, SV-1	CW-14ABG (in RF package or TS-275/UP)	
SX	TS-270/UP and TS-275/UP	TS-270 is in production TS-275/UP is beginning production.

NAVY TYPE NUMBER INFORMATION

For the past few years the Bureau of Ships has been conducting a Parts and Spare Parts Survey. This survey consisted of analyzing all radio, radar and sonar equipments purchased by the Navy since 1939. Trained Naval personnel, supplied by the Electronics Field Service Group, performed the field work, visiting electronic manufacturer's plants and obtaining complete electrical and mechanical data covering 26 different types of components that are ordinarily assigned Navy type designations. This information was sent to the Bureau, and has been prepared for publication in the following manner:

1—Supplemental or revised parts lists for instruction books covering the more popular equipments that will be maintained by the Navy for peacetime use. These supplemental parts lists include all of the Navy type numbers assigned as the result of the Parts and Spare Parts Survey and will be distributed through the various Electronic pools.

The following is a list of revised parts lists which are now being printed:

RBO	RBG, -1, -2
RBO-1, 2	RBK-1 to -14
BM-BO	RCH
BN	RCK
DAE, DAE-1, DAE-2	TCS thru TCS-5, -7, -9 thru -12
NMC	TCS-6
QJB	TCS-8
RBA, -1, -2, -3	TCZ

2—Master catalog sheets showing all electronic components, if assigned Navy type designations, arranged by Navy type number. These master catalog sheets will include as many of the 26 common types of components as is possible. The sheets will be ararnged by component and will include a cross index showing manufacturers part number, Electronic Supply Annex stock number and Aviation Supply Office number. The main section of the sheets will include listings of the components showing dimensions, electrical data and illustrations. These lists will be distributed direct to all ships and shore activities concerned with electronic equipments.

These sheets will not all be published at once. The first group will consist of descriptions of three classes of components and will be distributed in a loose-leaf binder bearing the title "List of Electronic Components arranged by Navy Type Numbers (NavShips 900,113). Other classes will be printed and distributed later and upon receipt can be inserted in the binder.

Comments from the field on the above publications will be appreciated.

PUBLICATIONS DOWNGRADED

■ The Bureau of Ships has completely reviewed its electronics publications in view of recent security directives and as a result has downgraded many of them. These new classifications are officially established in a letter to all Ships and Stations identified by the file "Security-4 EN 28/A2-11 Serial 993b-24".

A large number of the publications which were formerly restricted or confidential are now unclassified. It is hoped that these security reductions will make it easier to handle and use them. However, according to the present Bureau policy, it is still not permissible to issue personal copies of any of these publications even though they are unclassified.

The following is a list of publications issued by the Bureau together with the short title, classification (recent changes indicated by the sign†), and a listing of the type of activities to which the publications are furnished. Activities requiring any of these publications may obtain them by writing the Bureau of Ships.

Short Title	Name	Classification	Distribution
NavShips 943-02	Prediction of Sound Ranges from Bathythermograph Observations	C	To all surface vessels having sonar gear. A/S Schools and other A/S activities
NavShips 903-5	Microwaves and Waveguides	U†	To larger ships, schools, and maintenance activities
NavShips 903-6	SA Instructional Diagrams	U†	To ships having SA Radar, schools and maintenance activities
NavShips 903-7	The Klystron	U†	To all ships and schools
NavShips 900,008	Radio Frequency Transmission Lines	U†	To large ships, schools, and maintenance activities
NavShips 903-9	SC/SK Instructional Diagrams	U†	To ships having SC/SK Radar, schools, and maintenance activities
NavShips 900,011	Radio and Sound Bulletins—Quarterly—Issues 1 to 18 Superseded 7/1/45 by BuShips Electron	R	To all activities concerned with radio
NavShips 900,012	Elements of Electricity and Radio	U†	To larger ships and to schools
NavShips 900,013	Timing Circuits	U†	To radar equipped ships, advanced radar schools, and maintenance activities
NavShips 900,014	Instructions for the Operation of SO Series Radars	U†	To EO's for issue to ships having SO Radar and to schools
NavShips 900,016	Radar Electronic Fundamentals	U†	To all ships having radar and to shore activities concerned with radar training, installation or maintenance.
NavShips 900,017	Radar System Fundamentals	U†	Same as NAVSHIPS 900,016
NavShips 900,020A	Communication Equipment Maintenance Bulletin—monthly	R	To all ships (except landing craft) Type and Force Commanders, advance bases, and major shore activities
NavShips 900,021	Instructions for the Operation of SA Radar	U†	To ships having SA Radar and schools
Navships 900,022	Radio Installation Bulletin—published weekly	R	To installation activities only
NavShips 900,023	Sonar Equipment Log	R	To all ships having sonar
NavShips 900,024	Harbor Detection Bulletin	R	To all Harbor Detection Units, EO'S and harbor defense schools
NavShips 900,025	Sonar Bulletin pub. monthly	R	To all sonar equipped ships, maintenance activities and schools
NavShips 900,026	Maintenance Manual for QCS, QCS-1, QCT, QCT-1, QCQ-1, QCR-1	U†	To all ships having the equipment
NavShips 900,028	Microwave Techniques	U†	To laboratories, advanced material schools and principal maintenance activities
NavShips 900,029	Instructions for the Operation of SF/SF-1 Radars	U†	Ships having SF radar and to schools
NavShips 900,031	Advance Base Teletype Installation and Maintenance Practices	U	To advanced bases
NavShips 900,038	Impedance and Admittance Diagrams for Transmission Lines and Waveguides	U†	To laboratories, schools and EO's
NavShips 900,039	Radio Equipment Log	R	To all ships and stations on the basis of one for each radio space
NavShips 900,041	Instructions for Operations of SA2-PPI Radar	U†	To all SA-2 equipped ships
NavShips 900,042	Maintenance Manual for WEA-2	U†	To all ships having the equipment
NavShips 900,043	Maintenance Manual for JP-1/-2/-3	U†	To all ships having the equipment
NavShips 900,045	Maintenance Manual for WCA/WCA-1	U†	To all ships having the equipment
NavShips 900,046	Maintenance Manual for QCQ-2	U†	To all ships having the equipment
NavShips 900,047	Maintenance Manual for BDI	R	To all ships having the equipment
NavShips 900,048	Servo-Synchro Block Diagrams for Shipboard Radar Equipments	R†	To maintenance activities, repair ships, tenders, and schools
NavShips 900,049	SF/SF-1 Instructional Diagrams	U†	To ships having the equipment and to schools
NavShips 900,050	Instructions for Operation of SA2-PPI with JF Receiver	U†	To all ships having the equipment

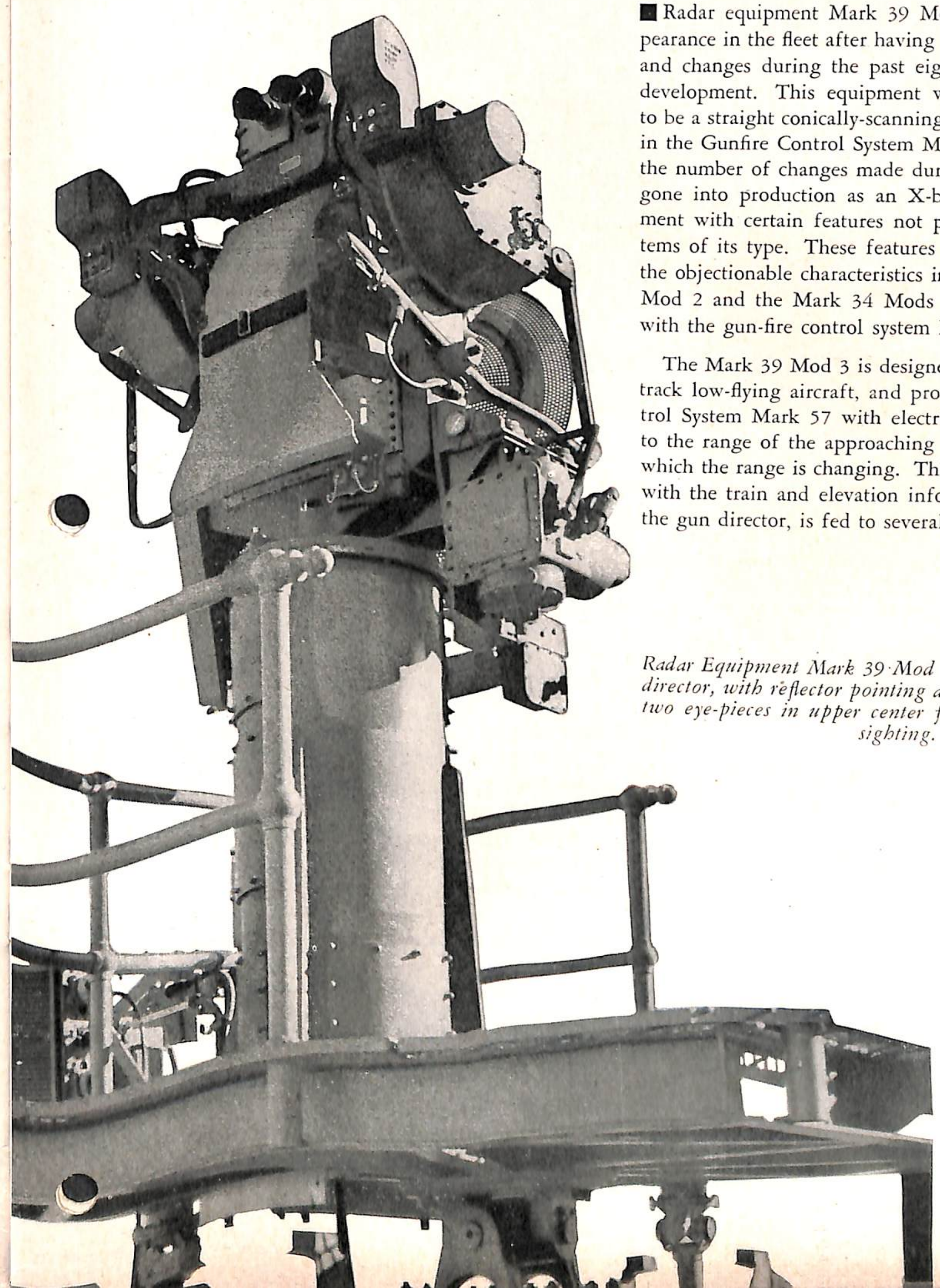
† Indicates recent change.

Short Title	Name	Classification	Distribution
NavShips 900,052	Mechanical Shock	R	To manufacturers
NavShips 900,055	Workbook for Prediction of Maximum Echo Ranges	C	To ASW Training Activities
NavShips 900,056	Instructional Radar Diagrams SGa/SG-1	U†	To all ships having the equipment
NavShips 900,060	Loran Transmitting Station Manual	U†	To activities concerned with Loran Shore Stations
NavShips 900,062	Prototype Radar Beacon Quonset Hut Installation	R†	To concerned activities
NavShips 900,065	Radar Equipment Log	R	To all radar equipped ships. One book per equipment
NavShips 900,069	Use of Submarine Bathythermograph Observations	C	To submarine and submarine activities
NavShips 900,070	Herald Ranges	C	To harbor detection activities
NavShips 900,071	SO Series Maintenance Handbook	U†	To ships having the equipment
NavShips 900,074	Installation and Maintenance of Submarine Cable for U.E.P. System of Harbor Detection	C	To activities concerned with the equipment
NavShips 900,075	Catalogue of Electron Tube Types	U	To all ships, radio stations, and supply activities
NavShips 900,076	VF Operation	U†	To EO's and to ships having equipment
NavShips 900,080	Removing the Mystery from the AN Nomenclature	U	Reprint of article in Radio and Sound Bulletin
NavShips 900,081	Installation and Maintenance of Transmission Lines, Waveguides, and Fittings	U†	To large ships, installation, maintenance activities
NavShips 900,082	SL-a/SL-1 Instructional Diagrams	U†	To ships having the equipment
NavShips 900,084	Installation and Maintenance of Submarine Cable for U.E.P. Net Gate Detection Unit	C	To activities concerned with the equipment
NavShips 900,085	Notes on Servicing Radio and Sound Equipment	R	To all sonar equipped vessels
NavShips 900,086	Installation of the Army-Navy Instrument Approach System SCS-51	R	To activities concerned with the equipment
NavShips 900,095	Trouble Shooting Chart for SO-1/SO-8	U†	Ships having the equipment
NavShips 900,096	Radar Maintenance Bulletin (New edition replacing NAVSHIPS 900,034)—monthly	C	To all radar equipped ships
NavShips 900,097	Shipboard RCM Installations	R†	To commands and installing activities
NavShips 900,099	Mobile Electronic Units	R†	To commands
NavShips 900,100	BuShips ELECTRON	C	All ships and activities concerned with electronics
NavShips 900,101	Calibration of Shipboard Direction Finders	R†	To calibration activities
NavShips 900,102	Index of Army-Navy R-F Transmission Lines and Fittings	R	To installation activities
NavShips 900,104	Servicing IFF Mark 3 Equipment with TS-182/UP Test Set	R†	To maintenance activities
NavShips 900,105	Catalogue of Electronic Test Equipment	C	To installation, maintenance, and planning activities
Ships 242A (and Supplement No. 2)	List of Naval Radio, Radar and Sonar Equipment	C	To commands, schools, tenders, installation and maintenance activities
Ships 275	Catalogue of Naval Radio Equipment	C	To commands, schools, tenders, installation and maintenance activities
Ships 278	Loran Handbook for Shipboard Operators	U†	To all Loran equipped vessels and to schools
	Instructions for the Operation of SG Radar	U†	To ships having SG Radar and schools
	Sound Material Handbook	R	To all sonar equipped vessels
Op 1303	U. S. Navy Synchros	U	To all ships, commands, and major shore activities
NavShips 900,414	Maintenance Manual for WCA-2	U†	To ships having the equipment
NavShips 900,415	Maintenance manual for QBE/-1/-3/-3a	U†	To ships having the equipment

† Indicates recent change.

The Mark 39 Mod 3

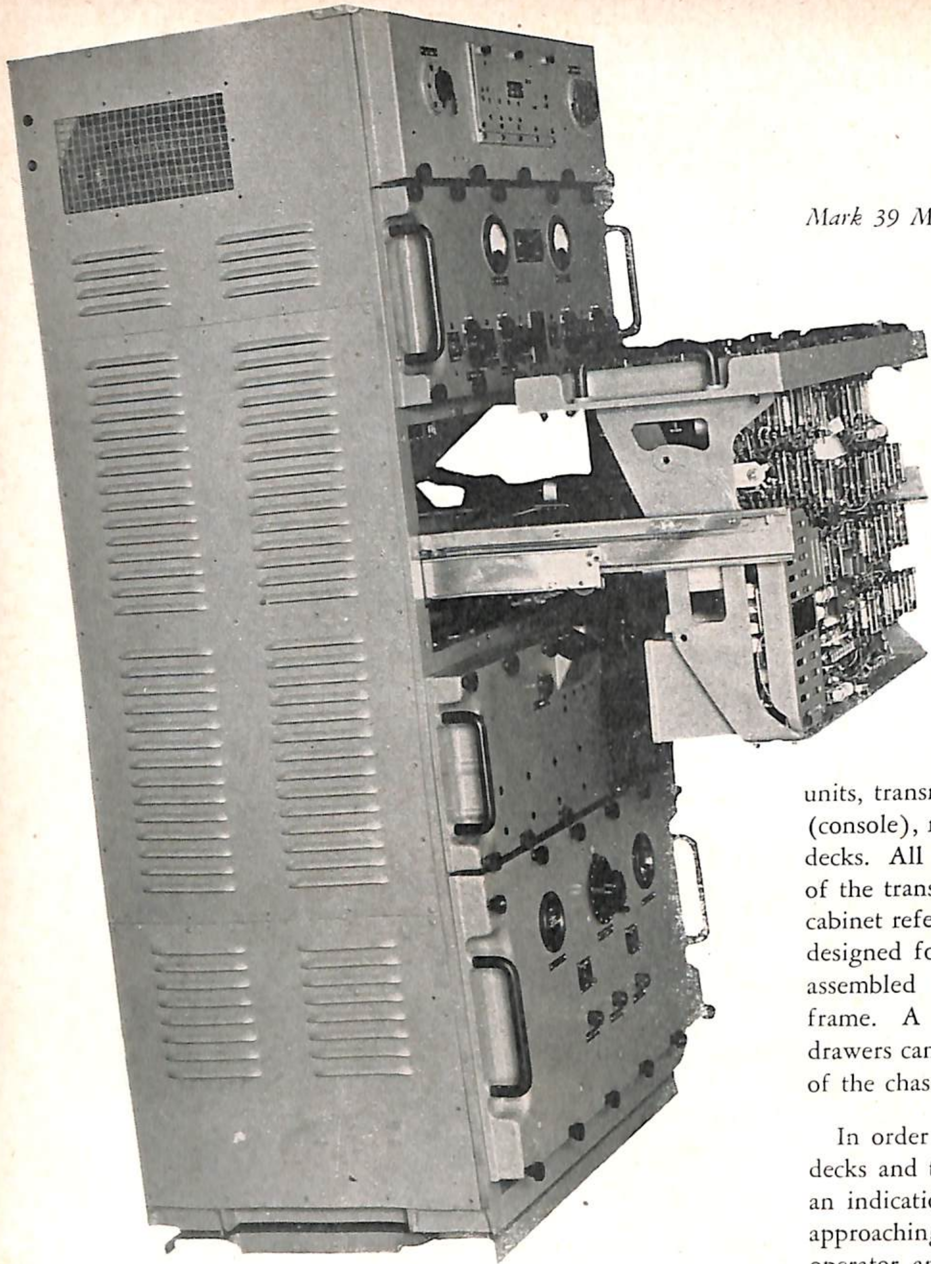
By John A. Rexroth, Lt., *USNR,*
Bureau of Ordnance.



Radar Equipment Mark 39 Mod 3 mounted on Mark 57 director, with reflector pointing away from reader. Note two eye-pieces in upper center for indicator and visual sighting.

■ Radar equipment Mark 39 Mod 3 is making its appearance in the fleet after having undergone various tests and changes during the past eighteen-month period of development. This equipment was originally intended to be a straight conically-scanning radar designed for use in the Gunfire Control System Mark 57 Mod 4. Due to the number of changes made during development it has gone into production as an X-band fire-control equipment with certain features not present in previous systems of its type. These features will eliminate some of the objectionable characteristics inherent in the Mark 29 Mod 2 and the Mark 34 Mods 3 and 4 now installed with the gun-fire control system Mark 57.

The Mark 39 Mod 3 is designed to locate quickly and track low-flying aircraft, and provides the Gunfire Control System Mark 57 with electrical data corresponding to the range of the approaching aircraft and the rate at which the range is changing. This information, together with the train and elevation information obtained from the gun director, is fed to several computing devices, all



Mark 39 Mod 3 Console with one unit withdrawn from frame and tilted for servicing.

part of the Mark 57 system, and is eventually used to direct batteries of either 5″ dual-purpose or 40-mm anti-aircraft guns. The equipment has a mechanism to aid the operator in tracking incoming targets at speeds up to 750 knots and outgoing targets at speeds up to 450 knots. The antenna used in the equipment has two types of scanning; elliptical scanning for the acquisition of targets, and conical scanning for blind-tracking a target after it is acquired. A unit to aid in the acquisition of targets is to be added to the equipment at a later date. Two operators are required for operation of the equipment, one for the above-decks units and one for the below-decks units. This number will be increased to three when the target acquisition unit is added.

Any installation of the equipment divides the units into two groups: The antenna, the director indicator unit, and the filament transformer are mounted on the rotating structure above decks. The remainder of the units, transmitter-receiver, power supply, radar indicator (console), range unit, and modulator are mounted below decks. All of the latter named units with the exception of the transmitter-receiver are enclosed in one frame or cabinet referred to as the console. This console has been designed for easy servicing. Each of the four units are assembled as drawers which slide into the console frame. A unique feature is provided whereby these drawers can be unlocked and tilted so that the underside of the chassis is readily accessible for servicing.

In order that the operator of the gun director above decks and the operator stationed below decks may have an indication of correct pointing of the antenna at an approaching target, an oscilloscope is provided for each operator and indicates the presence of a target in the antenna beam and the approximate angular pointing error. In operation, the antenna is made to *nutate* either conically or elliptically and scans the area in accordance with the motion of the antenna feed in front of the reflector. If the target is not in the center of the beam, the received echoes will be modulated at the frequency of nutation. The antenna unit contains a small generator which turns in synchronism with the antenna radiating element, generating reference voltages which are compared to the phase of modulation of the received echoes. In this way deflection voltages are obtained which are applied to the scopes to deflect the pointing spot. In this type of presentation, known as *T-and-E* (Train and Elevation), an oscilloscope with cross-hairs on its face is used, and the position of the bright dot on the face of the scope is an indication of the position of the target in the nutating antenna beam with respect to the center of the beam. When the spot is in the center of the cross-hairs, the antenna and, therefore, the director, is pointing directly at the target.

The equipment provides circuits which will allow a method of target acquisition to be added at a later date. This system consists of a new unit, Target Acquisition Unit, Mark 5 Mod 0, and will allow a below-decks operator to take control of the deflection of the pointing spot on the *T-and-E* scope of the director-indicator unit, thus indicating the direction in which the director must be pointed to find a target which has been located by other radar sets.

Radar information is presented on two oscilloscopes in the indicator (console) located below decks. One is the 5-inch *A* (range) scope and the other a 2-inch *T-and-E* scope which monitors the director indicator *T-and-E* scope. The range scope utilizes two sweeps simultaneously, a main sweep of 30,000 yards which presents the range information, and a precision sweep of 2000 yards to increase the accuracy of range measurement. Provision is made for "gating" and tracking a single target, whether one or more targets is picked up by the antenna. The width of this range gate is approximately 165 yards.

The range-tracking controls are located in the range unit below decks. A mechanical range counter located in the front of the range unit reads the range in yards, and a range-rate dial indicates the rate at which a target is approaching, provided the target is "gated" and is being tracked. A servo amplifier system provides aided tracking of targets. It may be set to drive the range notch which appears on the range scope of the Indicator at any constant speed between 0 and 750 knots for incoming targets and between 0 and 450 knots for outgoing targets. To aid in the procedure of gating a target, the range notch may be moved rapidly by means of a slewing system controlled by a switch on the front panel.

The Mark 39 Mod 3 operates in the X band with a pulse repetition rate of 1800 per second and a pulse length of 0.5 microseconds. The peak power output is in the order of 35 kw. The intermediate frequency of the receiver is 30 Mc. Approximate ranges that may be expected are 15,000 yards on small aircraft and 25,000 yards on large aircraft. The overall beam diameter (elliptical) is 5 degrees in the horizontal axis and 20 degrees in the vertical axis. The conical beam diameter is 5 degrees. The slewing range rate is 300 yards per second.

Radar Equipment Mark 39 Mod 3 has seen no service in the fleet to date but it is expected that its ease of installation and maintenance, its operational characteristics, and its general ruggedness of construction will enable it to take its place among the fire control equipments already installed, and that it can adequately do the job for which it was intended.

SS RADAR—INSTRUCTION BOOK ERROR

The Transmitter-Receiver schematic diagram 7-159, 7-160, upper left-hand corner (Modulator Chassis No. 1) shows R-43, a 10,000-ohm resistor, connected across R-46, a 0.27-megohm resistor. R-43 should be shown connected between terminals 75 and 78,—*not* between terminals 75 and 77. The present diagram (with the error) leaves the grids of the 5D21 modulators floating.

The technician is further informed and duly cautioned that SS System Stock List contains Item 581K, a coaxial cable made up of RG-55U. This coaxial is for use between the AFC pickup and the AFC input and contains plugs T-1C and T-5A. This cable is 69¼″ long, a little greater than a half wavelength at 60 Mc. The cable should not be used for any other purpose than that just described.

*

POPULAR BOOKS DE-CLASSIFIED

The Bureau of Ships has declassified its publications "Radar Electronic Fundamentals" (NavShips 900,016) and "Radar System Fundamentals" (NavShips 900,017) to UNCLASSIFIED. These books have previously been restricted.

It will, perhaps, be bad news to those who covet personal copies of these publications that the Bureau must still consider these "For Official Use Only". In other words, it will not be possible to fill individual requests.

CNO POLICY ON ALTERATIONS

The Chief of Naval Operations has established the following policy relative to alterations on ships:

1—No alterations of any kind will be undertaken which affect the military characteristics of the ship until they have been approved by the Chief of Naval Operations.

2—Alterations not affecting military characteristics will not be undertaken until approved by the cognizant Bureau.

3—Responsibility for determining whether or not military characteristics may be involved will be with the Bureau concerned.

This policy pertains to ships of the Active and Reserve Fleets. No alterations of any description will be considered on vessels in the inactive fleet.

U. S. Navy Electronic Laboratory

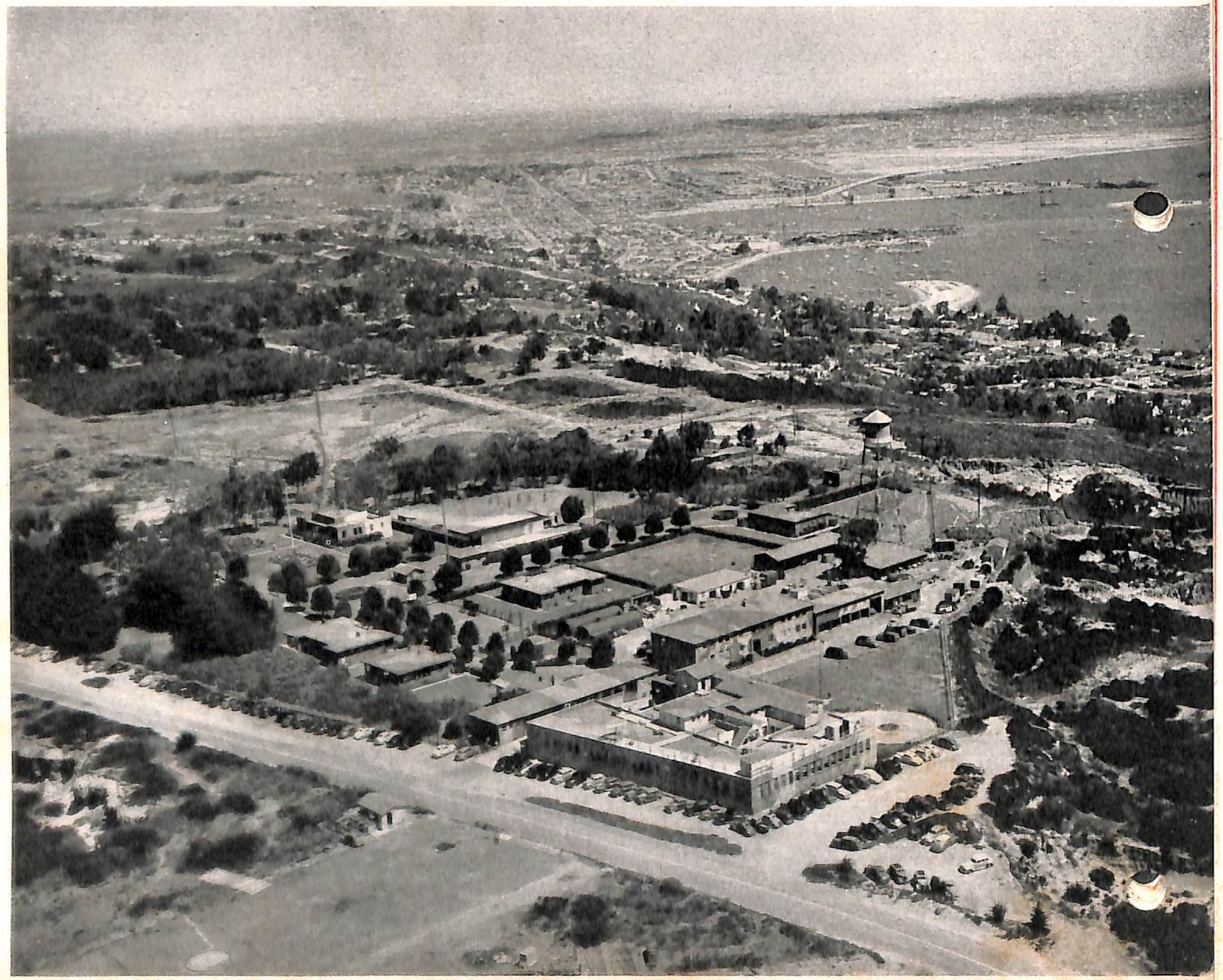
The widely-known U. S. Navy Radio and Sound Laboratory at San Diego will henceforth carry on under a new official title—*U. S. Navy Electronics Laboratory*.

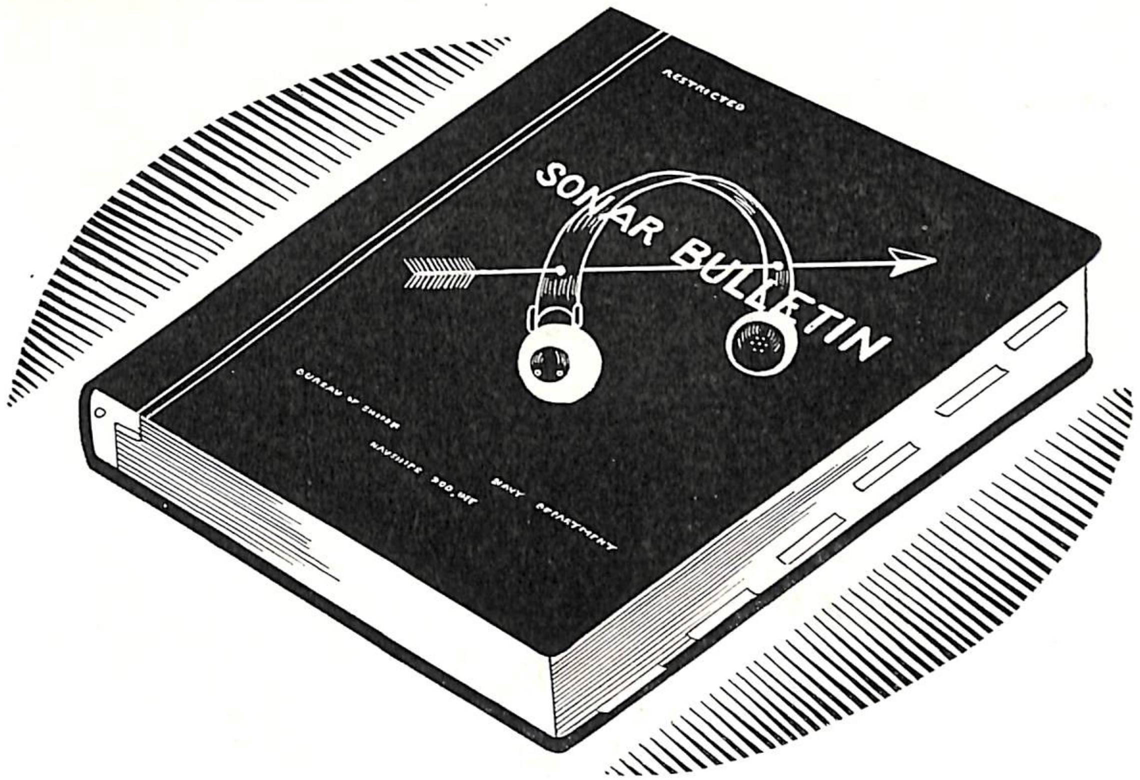
This laboratory functions under the technical direction of the Bureau of Ships for the purpose of conducting special investigations and developments where close relation with units of the Fleet is required.

Planning, development, and installation of new equipment gives rise to many questions. Because of its strategic location inside a great west-coast naval base and because it is close to busy anchorages and ocean areas ideally suited for operational tests, the laboratory can supply the kind of answers which the Bureau needs in working out the Navy's electronics problems.

This close relationship between Fleet and laboratory is especially valuable in the development of an effective systems-engineering program. As the number and variety of electronic equipments have increased, systematized installations become increasingly important. A special Systems Engineering Department at the laboratory is well equipped to handle problems of this type.

Thus, although its name is changed, the Laboratory will carry into peacetime operations its old traditions of service to the Fleet.

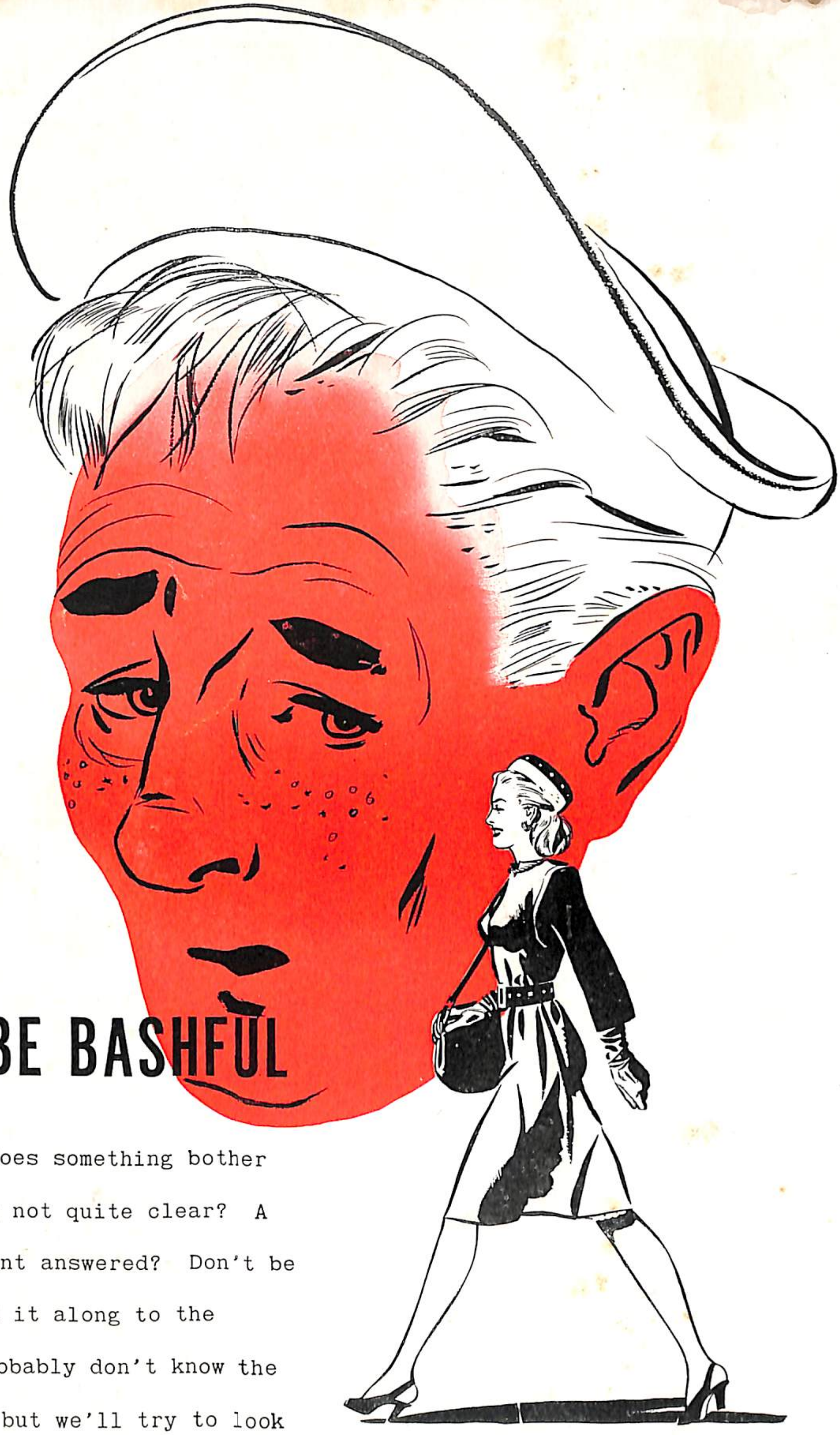




NEW SONAR BULLETIN

A NEW edition of the Sonar Bulletin has just been distributed. It is an entirely new book containing a wealth of new material, plus all the useful information culled from the last edition and its ten monthly supplements. This new sixth edition has been entirely rearranged in order to group together the listings of all similar equipments and field-change information, which should make it a welcome addition to your service library.

The Sonar Bulletin and its monthly supplements are prepared especially for YOU, the Technicians, as an aid in the maintenance of your equipment. The new edition and the monthly supplements should be kept where they will be available to you at all times. If you receive too few or too many copies of these publications, please notify the Bureau of Ships of your proper requirements.



DON'T BE BASHFUL

Technicians: Does something bother you? Something not quite clear? A question you want answered? Don't be bashful, --send it along to the ELECTRON. We probably don't know the answer either, but we'll try to look it up for you. This is your magazine Make good use of it.

Send it to the ELECTRON