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*Teletype Is Here to Stay* 1
*Frequency Shift Keying* 5
*The Trigger Delay Line* 9
*AN/TPS-1B Mobile Radar Unit* 10
*FM Sonar Joins the Fleet* 13
*Some Notes on the SP* 16
*The RDZ Receiver* 19
*The Forum* 21
*Service Difficulties with 723-A/B* 23
*Tube Topics* 25
*Automatic Bearing Indicator Circuits* 26
*Oils and Greases for Radio Equipment* 28
*Eliminating Radio Interference* 30
*New Books* 32
*Measurement of Standing Wave Ratio* 33
*The Field Engineer Sez* 35
*Sonar Projector Maintenance* 38
*Shock and Vibration Testing* 41
*Keeping Up Your Amplidyne* 45
*Harmonic Suppressors for TDQ* 47
*Linearity Control Adjustment* 47
*Mark 13 Long-Range Line* 48



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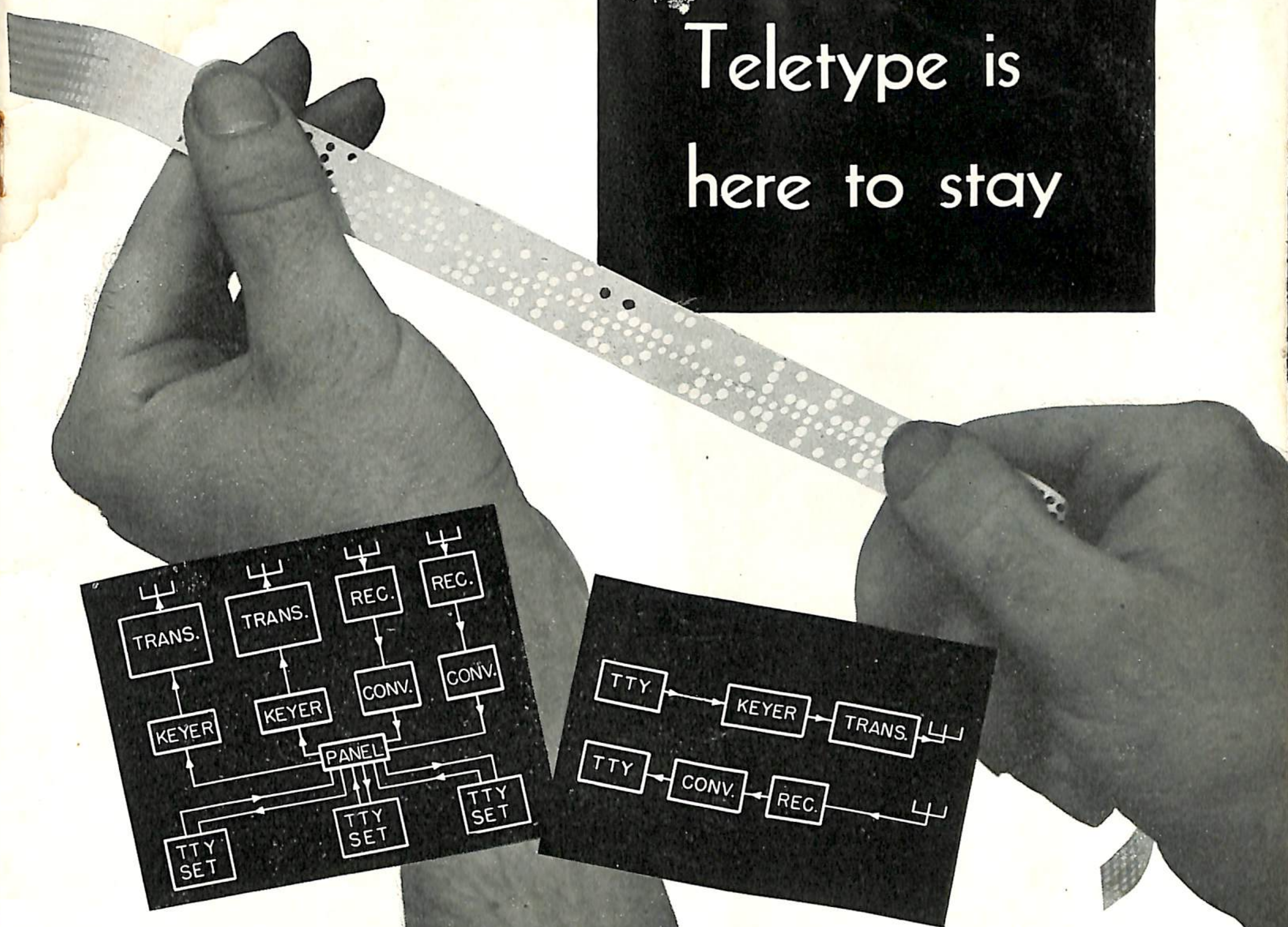
# Teletype is here to stay



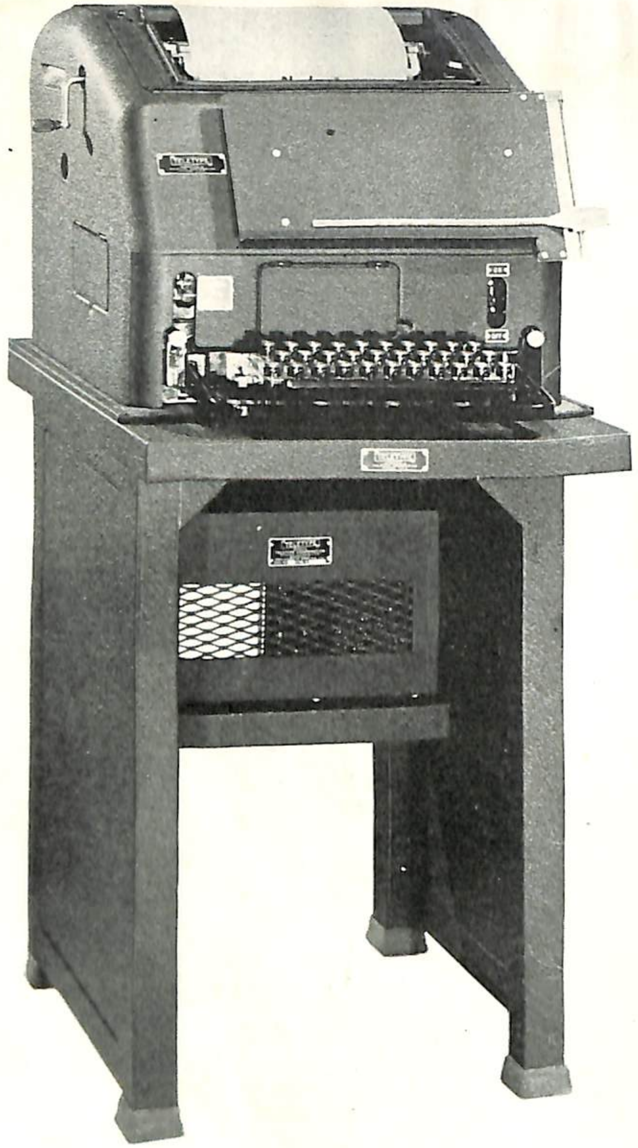

*Typical large-ship installation includes a transfer panel to permit independent use of all units.*

*Simple radio-teletype system for shipboard use. Separate transmitting and receiving frequencies are employed.*

■ Seldom has any piece of communication equipment gained as rapidly in importance as the radio operated teletypewriter. Teletypewriter equipment is not new, nor is the idea of operating it over a radio link. The equipments have been giving excellent service for many years over land lines, that being the primary purpose for which they were designed. Only recently, however, has it been possible to operate the teletypewriter (TTY for short) in a thoroughly dependable manner over long-haul radio circuits. This is because the TTY printer is a mechanical device and is therefore not always able to discriminate between the desired signals and those introduced by interference or static. New high-performance radio equipment and techniques developed during the last few years are now capable of furnishing satisfactory TTY signals. A system of "frequency-shift" keying (see p. 5) increases signal-to-noise ratio and greatly reduces certain types of interference. Modern receivers having exceptional frequency stability and other refinements were necessary before the full benefits of this system could be realized.

## TTY AND THE NAVY

The first large-scale use of radio TTY by the Navy was to take over the steady grind of long-haul point-to-point administrative traffic between major shore stations. Here a truly prodigious amount of traffic is handled in a very orderly manner by a minimum of equipment and operating personnel. These are the cir-



*This No. 15 page printer is the basic teletypewriter unit.*

cuits that have proved the efficiency and reliability of the system. Later, the service was extended to advanced base headquarters and to most AGC's. Although many TTY installations were only temporary and experimental, there has been sufficient information concerning them to precipitate a veritable deluge of requests for equipment. Elaborate plans are being made for the future of TTY in the Navy, and a program is already underway to automatically provide ships and stations with equipment as rapidly as it becomes available. The sudden demand for equipment so exceeds production, however, that no quantity shipments can be made until after November. By next year many ships will probably be able to copy all their Fox schedules by TTY, and special UHF harbor circuits employing TTY will provide all communication while in port.

## ADVANTAGES OF TTY

Most obvious of all the advantages of the TTY is its speed. Although some operators can receive plain language at 60 words per minute, they cannot do it for long periods of time. On a circuit where traffic is mostly code groups, the average speed over a long period seldom exceeds 15 w.p.m., and is often as low as 5 w.p.m. A teletypewriter, with its inherent speed of 60 w.p.m., will therefore move at least four times as much traffic as an operator sending by hand. More important is the fact that the addition of a TTY at each end of a circuit would increase the traffic capacity at least as much as adding three or four additional transmitters, receivers, and operators at each end. Actually, two TTY's would usually be installed at each end to permit simultaneous sending and receiving on two different frequencies (*duplex* operation), this arrangement again doubling the capacity of the system.

As far as accuracy is concerned, TTY sending is as subject to operator errors as any other system. But when transmissions (or tape perforating) are monitored by the operator, it permits him to see, in plain language, an exact replica of the transmission. The TTY printer is inherently accurate, and will not introduce garbles unless they are present in the input signals. However, under conditions of difficult radio reception the TTY will naturally fail to produce perfect copy, as is the case with any other system. By the use of frequency-shift keying, the TTY is probably as good under these

*The No. 19 TTY Set includes facilities for perforating and transmitting tape.*



severe conditions as conventional radio telegraphy, and may at times be even better.

An important advantage of TTY is that traffic can be relayed automatically by means of perforated tape. A tape perforating machine can be operated by the incoming signal, and this tape can then be retransmitted over as many circuits as necessary by mechanical means.

An advantage of TTY over certain other means of high-speed communication is that the copy is produced in a form which can be used immediately, and does not have to be transcribed by hand before it is of any value.

## THE EQUIPMENT

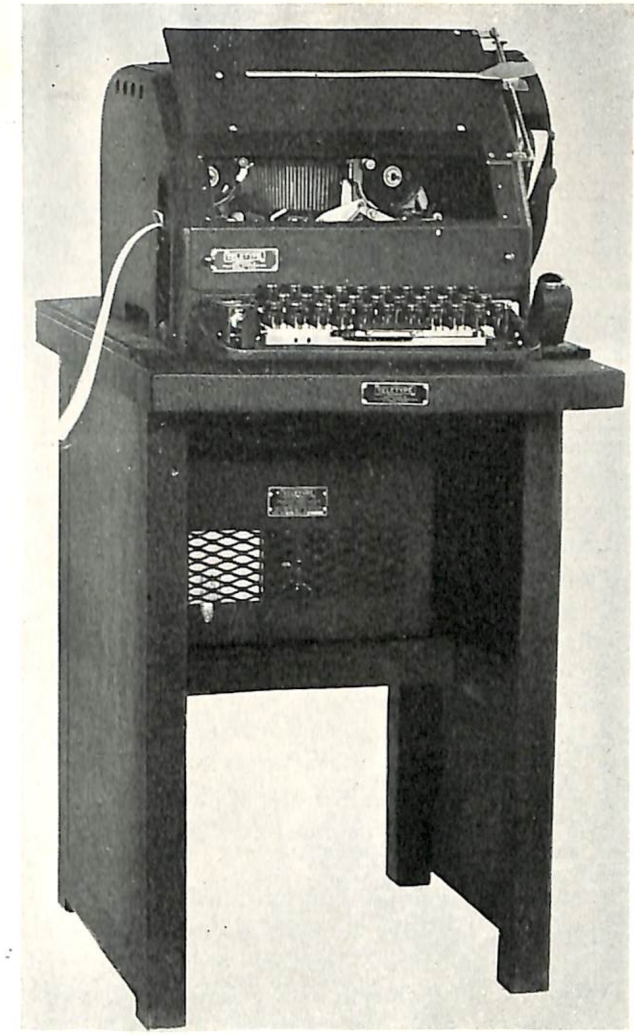
Navy TTY equipment differs only slightly from the time-proven commercial models you have seen in newspaper and telegraph offices. They will be provided with a few new features and refinements, and will be protected against shock and vibration. Internal parts will be protected against corrosion. But they look about the same.

Probably the most basic of the equipments is the Model No. 15 Teletypewriter shown in the illustration. It is a page-printer (prints copy on a *page,* rather than on a narrow *tape*) equipped with a keyboard, and may be used for either sending or receiving. The page-printer will monitor outgoing transmissions so that the operator will not have to send "blind," and the resulting copy provides an ideal log. Actually, separate machines are used for sending and receiving so that both operations can be accomplished simultaneously on different frequencies, thereby utilizing the full traffic-handling ability of every unit in the system.

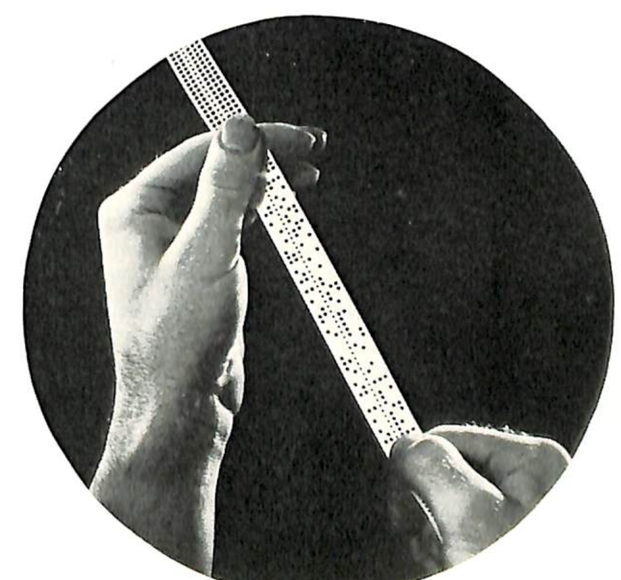
The simplest possible shipboard installation would therefore consist of two TTY's with their associated operator's tables and power supplies, a keyer, a converter, and a suitable transmitter and receiver, as shown in the small block diagram.

The keyer just mentioned provides the method for frequency-shift keying of the transmitter. This unit is known as the Model FSA Frequency-Shift Keyer, and must be located adjacent to the transmitter. To permit attachment of a keyer, however, the transmitter must first be modified by installing a Coupler Unit and associated Interconnections Panel. At present these kits of attachments may be installed only in TBA, TBK, TBM and TBL transmitters, but adapters are being designed to permit their use with the TCK, TCZ and TDE.

The converter serves an opposite function to the keyer, in that it converts the received frequency-shift signal back to the DC telegraph signal necessary to operate the TTY printer. Models FRA and FRG Frequency-Shift Receiver Converters are not yet available in final form, although an interim equipment, the FRC, is available in limited quantity. These equipments are



*The No. 14 TTY is used to relay messages. The table illustrated is for shore-use only, as special anti-shock and vibration mountings are required aboard ship.*



*Perforated tape produced by the No. 19 TTY Set can be transmitted automatically.*

associated directly with the receiver, Models RBB and RBC being the ones most suitable for this purpose at present.

Using the keyboard, it is impossible to transmit by hand with sufficient rhythm and accuracy to attain the full 60 w.p.m. speed limit of the No. 15 TTY. To permit continuous operation at synchronous speed, therefore, a system of machine-transmitting by means of a perforated tape is provided. Although the tape perforator is a built-in accessory to a special No. 15 TTY, it does not impose an upper limit on the speed of the operator as in the case of keyboard hand-sending. The tape may then be transmitted automatically at 60 w.p.m. by a Transmitter-Distributor. The No. 19 set provides these features, and is a complete equipment consisting of an XRT 114 Operator's Table, REC 30 Rectifier, a Transmitter-Distributor, and the No. 15 page-printer equipped with Tape Perforator.

Stations relaying a large amount of traffic would ordinarily be required to make up tapes for all incoming messages that are to be relayed. But this may be done automatically by employing a No. 14 send-receive Typing Reperforator, which simultaneously perforates and types the corresponding characters along the edge of the same tape. This unit is also necessary when using Sigtot or off-line cryptographic devices with TTY systems.

The various standard units described above were designed to offer extreme flexibility in establishing systems to fill all requirements. Transfer panels permit independent use of all parts of every equipment, thus assuring maximum utility for the system. This is illustrated in the block diagram of a typical installation for a large ship. Here the TTY equipment may be patched to operate in any manner required.

## PERSONNEL

The large-scale introduction of shipboard TTY will certainly not make Radiomen unnecessary, although it may often make their work somewhat easier. Radiomen should have no particular trouble in learning to tune and adjust the receivers to give optimum performance. As these adjustments are rather fussy and have to be done more or less scientifically, it is necessary actually to understand the principles involved. Receiving equipment requires rather constant attention, making it imperative that Radiomen remain alert and pay particular attention to details at all times. The TTY printer is almost entirely mechanical in its operation, but requires a great amount of knowledge and skill in order to maintain it properly. The machine is a marvel in perfection of design, and is built to operate continuously and for a lifetime. Regular servicing and adjustment are essential. And it is one piece of gear that you just can't blunder into. Tinkering is out! Practically every part is provided with adjustments, and many of these must be made with micrometer precision. Many Radiomen will probably go to special schools for a course in TTY maintenance.

The Radio Technician need not be unduly alarmed about the maintenance of the electrical portion of the TTY and associated apparatus, as it does not differ greatly in this respect from other electronic equipments.



## DEHYDRATOR FIELD CHANGE

■ To prevent the compressor from running continuously after the initial duty cycle in the event that the unloader valve fails to close after releasing the pressure from the check valve on the initial air charge, the Bureau of Ships has released the following information to radar personnel using Model 2200/22 Dehydrators:

Removal of the unloader valve from air circuit affects SC/SK/SA/SR installations. No kit is needed.

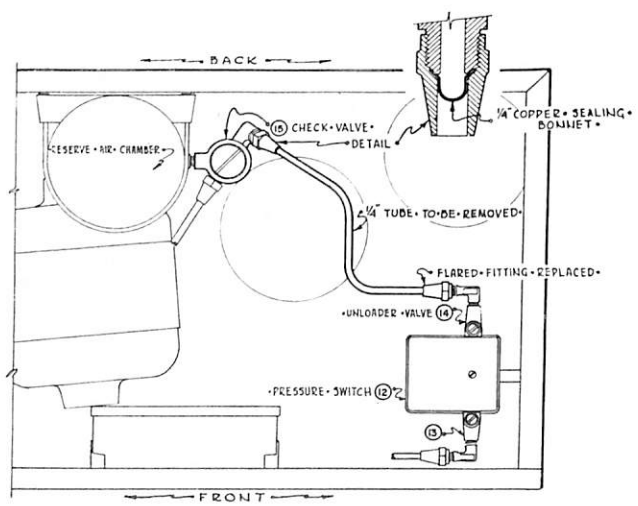
One ¼″ copper sealing bonnet will be required. These are the steps to follow: 1. Remove the ¼″ copper tubing which extends from the back side of the unloader valve (14) to the bottom side of the air check valve (15), as shown in the figure. 2. Replace the flared-fitting nut on the unloader valve to prevent the thread from becoming burred. 3. Seal off the outlet on the bottom side of the air check valve, which was opened by removing the ¼″ copper tubing, with a ¼″ sealing bonnet and the flared-fitting nut removed in step 1.

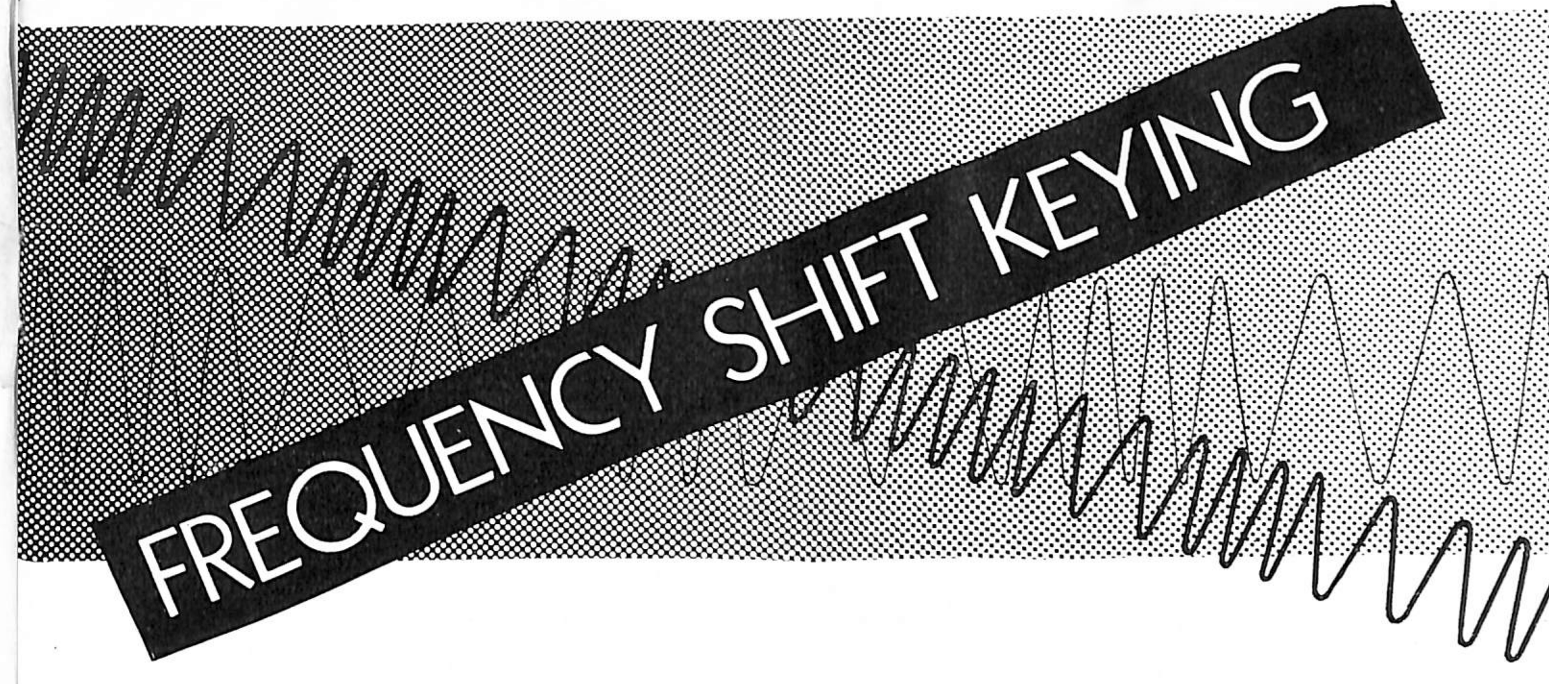
With the unloader valve removed from the air circuit, the air check valve will not seat as quickly as before. However, the removal of the unloader valve will prevent the compressor from running continuously which was the result of the unloader valve sticking in the open position.

The above change does not eliminate the possibility of the compressor running continuously should the unloader valve (13) fail to close. Since the unloader valve (13) is necessary to release the working pressure from the compressor on starting, it should be checked periodically to make sure that the valve is closed to the atmosphere when the compressor starts running.

The air check valves should be checked periodically to see that they seat properly.

*—E. F. S. G.*




## FREQUENCY MODULATION PRINCIPLES APPLIED TO RADIO TELEGRAPHY

Lieut. Myron E. Beard, USN

■ Practically everyone has read or heard of the new radio technique known as "FM" (frequency modulation), and the vast improvement expected when FM stations supplement or eventually supersede the present amplitude-modulated broadcasting stations.

Radio technicians also are aware of the fact that FM systems of voice communication have been in use on fleet circuits and amphibious-force circuits for some time. Their opinion of this new technique is invariably highly colored by their own experiences with such equipment, its performance, reliability, and ease of maintenance. Unfortunately, the reliability and performance are a direct function of the ease of maintenance, and easy maintenance is only possible when the technical personnel have a thorough understanding of the principles involved. This is not a common case, since the visualization of FM principles is usually difficult.

Although this new development in radio communication applies basic FM principles to radio telegraphy, it is as easy to understand as ordinary CW telegraphy. In fact, its principal features are most clearly illustrated by a direct comparison of the signals with conventional CW signals.

Using as a basis of comparison the Morse letter *S* (three dots) the graphic representation is shown in figure 1. A third dimension, that of frequency, has been added in this illustration. But, since CW signals are of constant frequency, there is no variation along the frequency axis. In order to receive the intelligence carried by such a signal, the receiving equipment must be able to scan the signal along the time axis, plus the axis which carries the intelligence (the amplitude axis in this case). This is shown graphically in figure 2. When scanned along the amplitude and time axes, figure 2 (l), the intelligence appears as large changes in signal amplitude. In a theoretically perfect circuit, this variation would be from zero amplitude for the intervals when the key is open, to a maximum value when the key is closed. But extraneous components of energy due to atmospherics, interfering stations, etc., appear as additional variations along the amplitude axis, and when these extraneous components of energy approach or exceed the value of signal variation, the signal is "blanked out by interference." Figure 2 (r) represents the same signal as scanned along the frequency and time axis. Variations in signal amplitude have no effect on this figure, so no intelligence can be received, but neither is the effect of noise and interference apparent.

This leads to a logical conclusion that if the intelligence variations could be made to appear as changes along the *frequency* axis, and the receiving equipment designed to respond to this type of signal, the variations in amplitude due to noise and interference would be eliminated as a factor affecting communications, since these components cause amplitude variations only.

Frequency-shift keying accomplishes the first of these conditions; that is, a shift of the signal frequency between key-closed and key-open intervals, with signal amplitude remaining essentially constant. In addition, the constant-amplitude carrier permits the use of AVC and other refinements in the receiver.

New terms are used in conjunction with frequency-shift keying, and in order to make them familiar they will be defined here. The intervals when the key is open are referred to as spacing intervals, while the in-

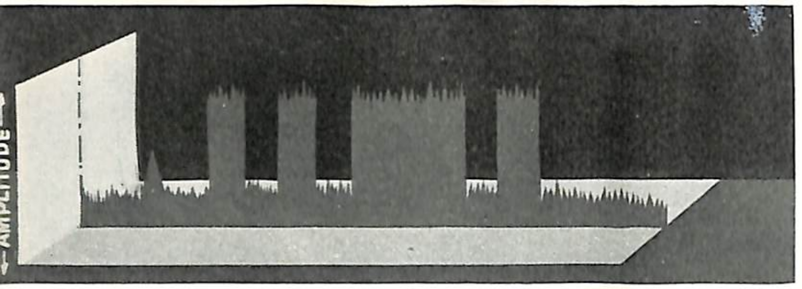


FIGURE 1.—*Three-dimensional representation of a conventional telegraph signal.*

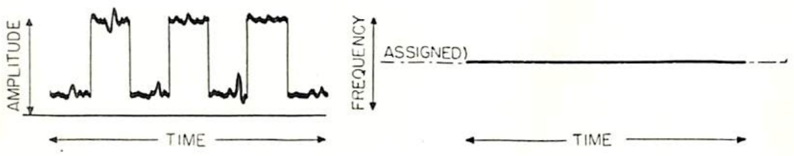



FIGURE 2.—*Receiver response to on-off keyed signals when converted by (left) a conventional detector and (right) by an FM discriminator.*

tervals during which the key is closed are called marking intervals. Thus, in the letter *S* there are three dots, and it may be referred to as "mark-space-mark-space-mark" preceded and followed by a continuous space signal to separate it from other letters. Letters containing dashes, such as *A* could be designated as "mark-space-long mark" or, more correctly, "mark-space-mark-mark-mark," since a dash is equivalent on the time axis to three dots. The shift of amplitude or frequency from space to mark condition is known as a space-to-mark *transition* and, similarly, the return shift is called a mark-to-space transition. These transitions occur almost instantaneously, and are usually considered instantaneous for practical purposes.

Frequency-shift keying systems (abbreviated FSK) impress the desired intelligence on the radio wave as a change in the radiated *frequency*. This is illustrated in figure 3, and again the letter *S* is used as an example. Note that the normal circuit condition is the space-frequency (key-up) condition. When the key is closed the frequency changes instantly and remains during the dot or marking interval, returns to the space frequency when the key is opened, etc. Midway between these two frequencies is the assigned channel frequency, but the only time the transmitter radiates the assigned frequency is during the initial tuning of the equipment. Also shown in figure 3 is the variation along the amplitude axis caused by noise and interference, but this is eliminated on a portion of the drawing to illustrate its actual elimination by the limiter-amplifier in the receiving equipment.

A look at figure 3 makes it apparent that if the signal is scanned along the amplitude and time axes, the amplitude variations due to the signal intelligence will be zero, as illustrated in figure 4 (l). However, if the scanning is accomplished along the frequency and time axes, the intelligence is reproduced as shown in figure 4 (r). By this system, then, the intelligence can be reproduced at the receiving station exactly in its original form and will be largely unaffected by conditions in the radio path other than the complete loss of signal due to ionospheric variations. This condition, of course, also eliminates ordinary CW signals. As a matter of fact FSK, because of its characteristics, considerably reduces the effects of fading, and will often maintain a usable channel on frequencies long after CW communications would have been impossible due to a low signal-to-noise ratio.

Several questions regarding frequency-shift keying present themselves:

1. How is the signal generated and received?
2. What improvement in circuit merit may be expected?
3. If this improvement is sufficient, how many Navy circuits will be changed over, and how soon may the change be expected?
4. What new electronic equipment is necessary?

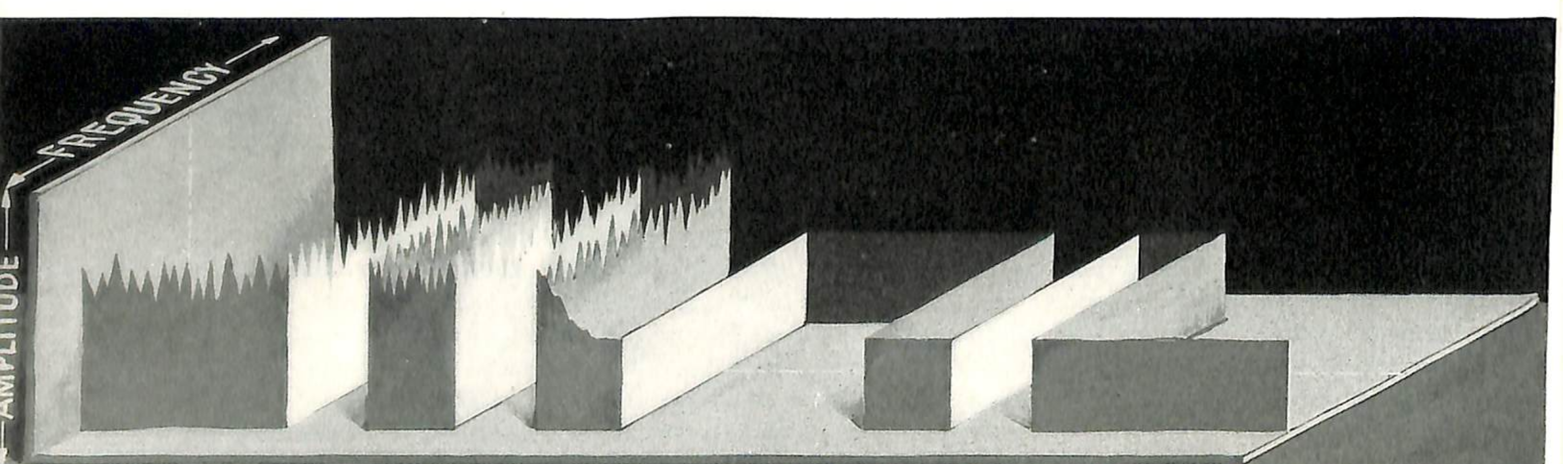



FIGURE 3.—*Three-dimensional representation of a frequency-shift keyed telegraph signal.*

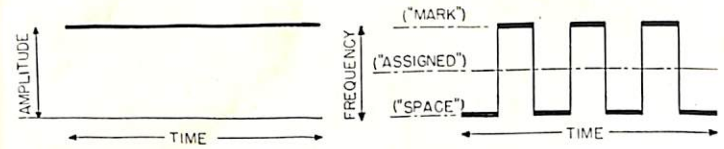



FIGURE 4.—*Receiver response to FSK telegraph signals converted by (left) a conventional detector and (right) by an FSK receiver-converter.*

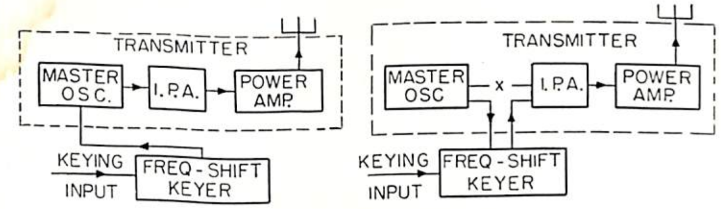



FIGURE 5.—*Two arrangements for frequency-shift keying a transmitter.*

5. How complicated is the new equipment?

Although this article will make no attempt to give detailed information on equipment, these questions are answered in the following paragraphs.

In its simplest form, frequency-shift keying of a transmitter could be accomplished merely by shunting a capacitor and key in series across the oscillator tank circuit, locking the normal key of the transmitter, and operating oscillator-circuit key. The shift in frequency between mark (key-closed) and space conditions would be determined by the effect of the additional capacity on the oscillator frequency, and the multiplication factor in the transmitter amplifiers. Thus, if the desired shift is the conventional 850 cycles at the radiated frequency, and this frequency is four times the oscillator frequency (doubled in two stages), the effect of the additional capacity on the oscillator would have to be limited to 212.5 cycles. Frequency-shift keyers are, of course, more elaborate than this simple illustration, but the basic principles are the same. That is, the keyer operates to change the oscillator frequency by a certain number of cycles, and this change must be correlated with the multiplication factor of the transmitter and the desired shift in the transmitter output frequency. Some keyers also include a phase-modulation feature which minimizes undesirable effects caused by selective fading of the received signal.

All medium- and high-frequency transmitters now being designed and procured will contain FSK features as an integral part of the equipment, but a number of existing transmitters have been and will be converted for FSK operation by the use of an external unit. Transmitters such as the TBA, TBK, TBM, TCK and others lend themselves readily to such conversion.

In general, the units may operate on either of two principles. First, the keyer may take the transmitter master-oscillator frequency and, by modulating it with the output of an additional oscillator which is frequency-shift keyed, obtain two frequencies which are fed into the intermediate power amplifier stage of the transmitter and so up to the output circuit. One of these is the mark frequency and the other is the space frequency. This system is illustrated in the block diagram, figure 5 (right).

Figure 5 (l) illustrates the second method in which the master oscillator of the transmitter is itself shifted in frequency by the keyer or, in some instances, is replaced entirely as the frequency determinant by an oscillator in the keyer unit. In addition to the FSK units proper, necessary coupling systems are provided to make the complete conversion. These units employ strictly conventional modulation and filter circuits, and are therefore easily serviced and maintained.

At the Receiving end, the additional electronic equipment necessary for FSK reception is a little more complicated because it is here that the principle advantages of the system are derived. There are two methods by which the intelligence of an FSK signal may be used and, since either method may be encountered, both will be discussed briefly. Standard communication receivers are used, plus an additional unit called a Receiver Converter, it being the adaptor which determines the method employed.

Figure 6 is a block representation of one method, which utilizes the audio output of the receiver. Here the mark and space carrier frequencies are received in the conventional manner, the CW oscillator in the receiver causing separate mark and space audio frequencies to appear in the output. The receiver is normally adjusted in such a manner as to produce a mark frequency of 2125 cycles, and a space frequency of 2975 cycles. It is this two-tone audio signal that drives the converter. The signal is first fed through a band-pass filter to remove

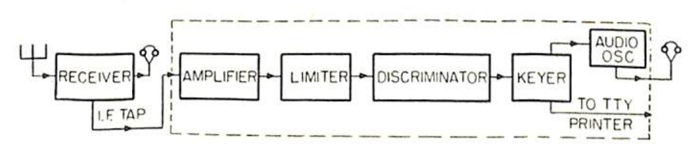



FIGURE 7.—*Arrangement of FSK receiver-converter for operation direct from the IF amplifier of a receiver which has been modified for the purpose.*

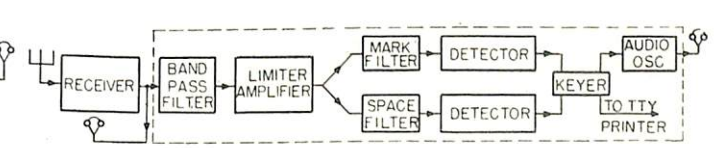



FIGURE 6.—*FSK receiver-converter for operation from two-tone audio output of a conventional receiver.*

interferance from adjacent frequencies, and then through a limiter-amplifier to eliminate amplitude variations in the signal. From the limiter output the signal passes through a pair of filters which separate the mark and space components. These frequencies are then separately detected, amplified and rectified, the resulting DC being used to operate a keyer. The keyer may then operate a high-speed recorder, an audio oscillator for manual reception, a relay for further transmission to a remote point, or the relay of a teletypewriter.

The second type of receiver converter is shown in figure 7. In this case the signal energy is taken from the receiver at the IF amplifier output. This energy enters the converter through an additional amplifier, a limiter and, in some cases, an additional frequency-conversion stage. It then passes into a discriminator, the output current of which varies in proportion to the frequency of the applied signal. This variation in current is used to operate a keyer to furnish the same services as above.

The advantage of frequency-shift keying may be summarized by its effect on the various factors which determine the merit of a circuit. A preliminary estimate of these effects is shown below, using conventional on-off keying as a standard.

| *Keying Method* | *Signal-to-noise* | *Selective Fading* | *Flat Fading* | *Total Improvement* |
|---|---|---|---|---|
| (a) on-off | 0 | 0 | 0 | 0 |
| (b) on-off, with phase modulation | −5 | +8 | 0 | +3 |
| (c) FSK | +4 | 0 | +13 | +17 |
| (d) FSK, with phase modulation | +1 | +8 | +13 | +20 |

The phase modulation feature is not always included, but if used is accomplished by a special keyer unit. It consists of phase-modulating the carrier at a rate of 200 cycles, the phase displacement being approximately one radian. Its effect is primarily a minimization of selective fading effects. No additional equipment is required at the receiving end.

It is apparent that FSK plus phase modulation may result in circuit improvement up to 20 db, or the same improvement which would result if a 100 kilowatt transmitter were substituted for a 1 kilowatt transmitter! Even without the phase modulation, FSK may give up to a 17 db improvement, which is equivalent to a fifty-fold increase in transmitted power.

This improvement makes practical the use of automatic printers on radio circuits, and for this reason radio teletype circuits are almost always frequency-shift keyed. It should be pointed out, however, that if a keyed circuit has a high signal-to-noise ratio and is free from selective or flat fading, perfect operation of a teletypewriter is possible, and FSK would offer no improvement. Its advantage is important only when the circuit deteriorates to marginal or near marginal conditions due to fading, noise or interference. In other words, FSK makes possible the use of a given channel for many more hours per day on otherwise difficult long-haul circuits.

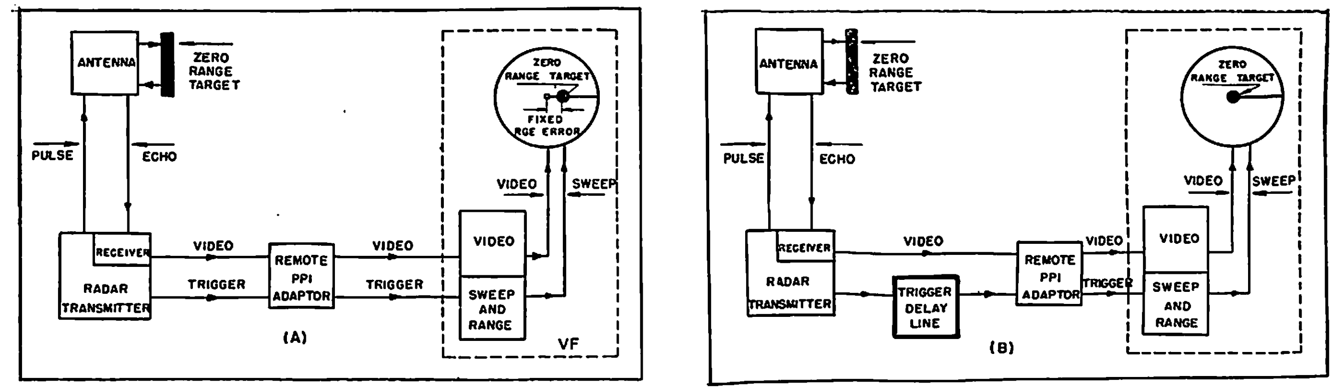
Much FSK equipment has already been installed at Navy shore radio stations and in Naval vessels; more is being installed as rapidly as it can be produced, and within a year much of the Navy's long-haul communications will probably be carried on FSK circuits.


## VG PROJECTION LAMPS

■ Whenever the erase time of a VG is too long, changing the projection lamp may remedy the condition. Tests made by the General Electric Company and by the Radiation Laboratory have shown that after 200 hours of life a deposit forms on the inside of the bulb. This deposit decreases the heat output to such an extent that the temperature on the face of the 4AP10 tube is lowered by as much as 30° C without decreasing the visible light output.

The resistance of the 4AP10 tube depends largely upon the temperature at which it is operated. If the heat controls are set at maximum and the erase time is too long, the projection lamp should be replaced as a possible solution.






*Block diagram showing location of the delay line to compensate for fixed range-error.*

# The Trigger Delay Line

## A MEANS OF INCREASING ACCURACY OF REMOTE PPI'S

Lt. (jg) MIRIAM K. STERN, USNR(W), BuShips

■ On scopes whose trace starts on zero range, the distance to the target is measured by the elapsed time from the beginning of the trace to the appearance of the target on the screen. But in order for this elapsed time to be presented correctly on the scope, delays in transmission must be taken into consideration.

Referring to the block diagram, it becomes apparent that the distance traveled by the returning video signal from the receiver to the remote PPI is substantially the same as the distance traveled by the trigger pulse from the transmitter to this same PPI. If no other delays were present in the system, range would not be affected. The video signal, however, arrives with the additional delay caused by the time of travel of the pulse from the transmitter to the antenna, the time of travel of the returning echo from the antenna to the receiver and the delay inherent in the radar receiver itself.

With the advent of precision remote PPI repeaters (Model VF), some form of compensation for this range error due to the delay in the video signal becomes necessary, since otherwise the full accuracy of the repeater is not realized. The Trigger Delay Line, installed as shown in the block diagram, accomplishes this correction by delaying the start of the sweep a sufficient time to compensate for the additional delay of the video signal.

A research problem was set up to determine the precise amount of delay which could be expected in search radar systems, then a delay line was designed to incorporate an adjustable delay of the radar trigger between the radar transmitter or modulator and remote PPI adaptor or junction box feeding and radar repeater.

The SR-2 and SG-3 Radars and later models now incorporate this delay line within the radar system itself, since, with the more accurate ranging circuits now in use, the trigger delay line has become an integral part of the equipment.

The trigger delay line, Navy Type CRP-14ABD, is actually a low-pass filter, consisting of a multiplicity of "T" sections in cascade, each section having the necessary amount of series inductance and shunt capacitance to provide a .05 microsecond delay. The trigger delay line contains six groups of eight identical sections, the 48 sections thus providing a total delay of 2.4 microseconds. In the radar system the time interval of .05 microseconds is approximately equal to 8 yards in range, the total available correction being then approximately 384 yards for each delay line. Newer trigger delay lines will have only five groups of networks providing a total delay of 2 microseconds, since 320 yards delay has been found sufficient.

The frequency response characteristic of the delay network is essentially flat to 7 Mc, thus providing undistorted transmission of the trigger signal.

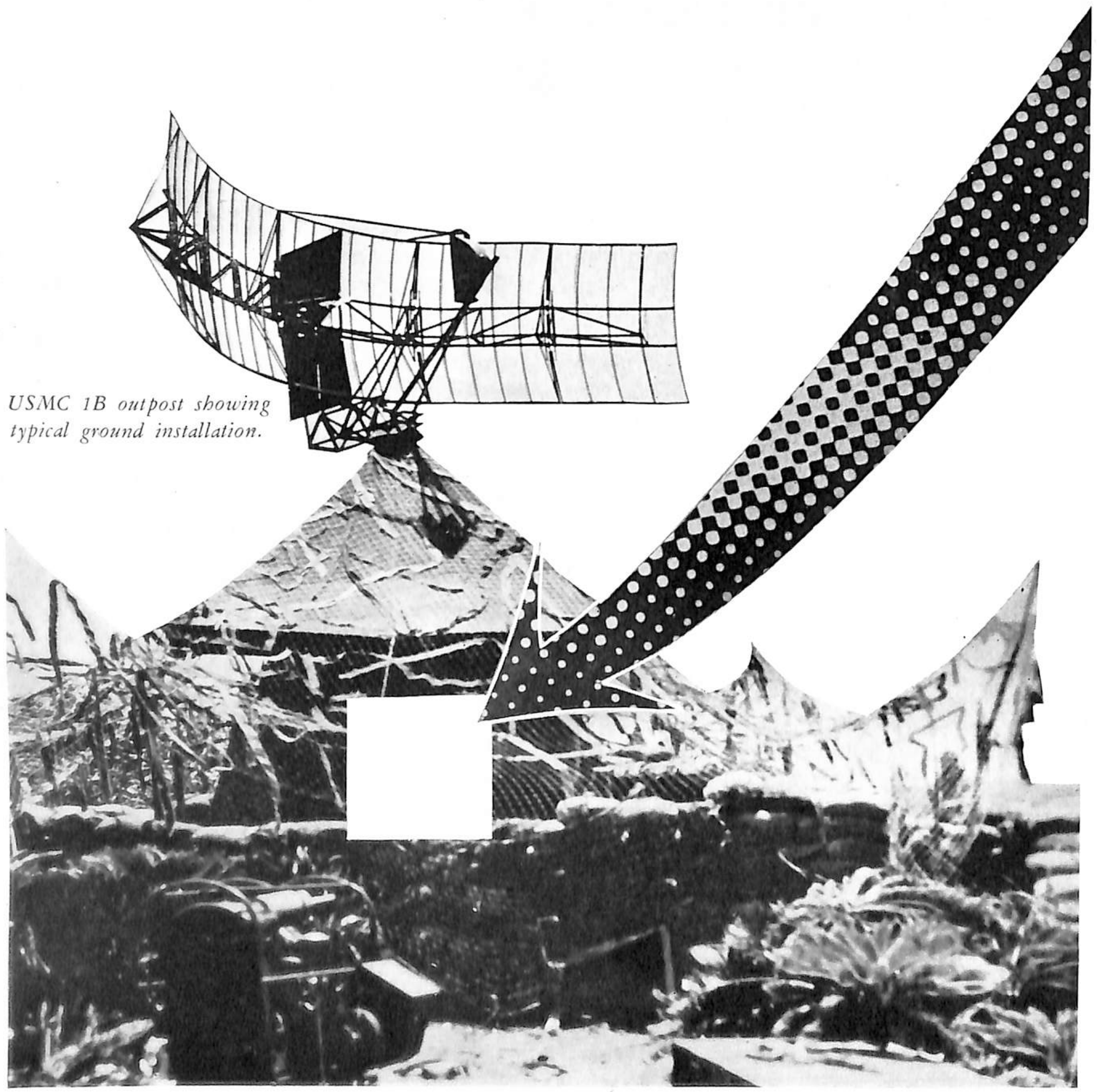
The unit is housed in a rectangular case with a removable front cover, and is designed for bulkhead mounting. It is 15¼" high, 8 27/32" wide and 4¼" deep, and weighs approximately 17 pounds. Its nominal impedance is 75 ohms and it should be used with the standard Navy RG-12/U coaxial cable.

In general, the method of adjustment is to insert the trigger delay line between the master radar transmitter and the feed to the repeater, using a portion of the delay network. The range as read on the radar repeater, with the experimental delay inserted, is then checked against some very accurately known standard. If in agreement, the adjustment of the line is completed. If in error, the difference in yards is divided by 8 to determine the number of delay sections to be inserted or removed.

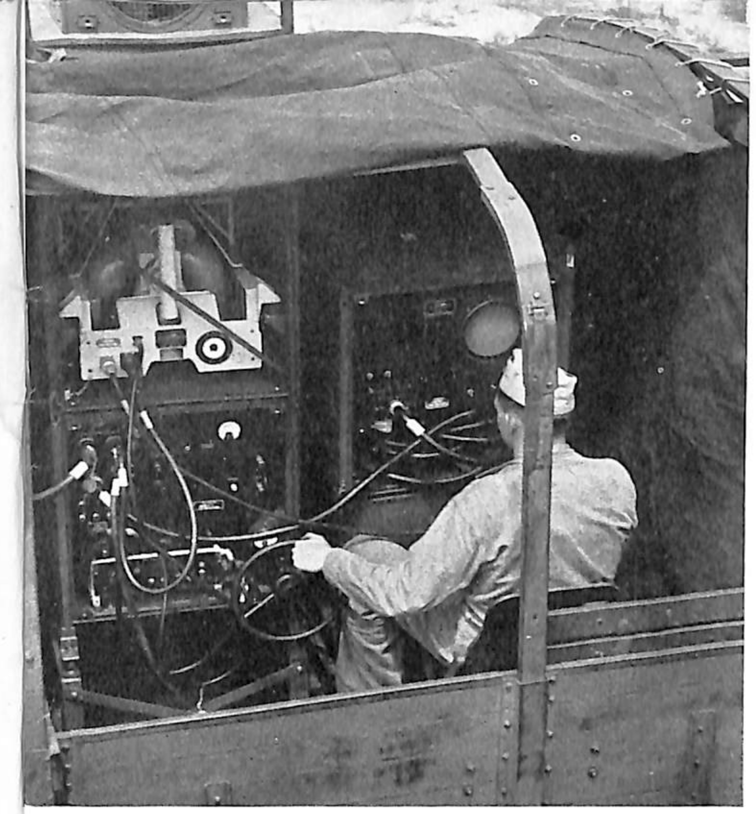
# AN/TPS-1B

# mobile radar unit

**BY LT. COL. F. A. RAMSEY, JR., USMC, BUREAU OF SHIPS**



*USMC 1B outpost showing typical ground installation.*



*The 1B mounted in a USMC 6x6 truck, showing position of operator and equipment.*

■ "Two AN/TPS-1B's came ashore very early and have been running ever since. Their coverage is excellent, and ranges are good. Planes are detected and tracked beyond the 200 mile range by displacing the sweep. Video discriminator and expanded *A*-scope make people go delirious with joy and praise. Between the two, operators can accurately count planes in the raids. With no other search set can we get more than a guess as to number. Everyone says the power units are the best ever supplied with any equipment. Operation is continuous for 23 hours a day except that the hour's rest isn't taken."

The AN/TPS-1B is a long-range search equipment. The original design called for transportable gear to be supplied in boxes. Subsequently it was decided to furnish vehicular mounting kits of two types for optional use in mounting the gear in either a truck or a trailer. The modified equipment may be removed and transported by land or air.

The first AN/TPS-1B production equipments rolled from the assembly line in December of last year. A few were flown out to combat areas in January and since that time the manufacturer is delivering 1B's at the rate of seventy per month, which will complete distribution in November of this year.

The AN/TPS-1B has been well liked by radar personnel who have worked with it. Its simplicity and ease of maintenance, its unusual range performance, and its good low-angle coverage compared with other long-range early warning sets, have proved its worth as a dependable air-warning radar. It is a "Rolls-Royce engine in a Model T body."

There have been some difficulties with this equipment in the field. Fortunately all of them have been minor troubles which have yielded readily to impromptu solutions by resourceful technicians and operators. In some instances field modification kits have been authorized to correct defects. In other cases changes in design were incorporated in production as early as practicable with no attempt to make field modifications.

## VEHICULAR MOUNTING KITS

The most important field change is the vehicular mounting kits which put the 1B on wheels. Type MX 463/TPS-1B kit permits the equipment to be installed in a standard 2½ ton, 6 x 6 cargo truck. The kit includes all necessary metal fittings for such an installation, plus a special tarpaulin and a light-proof rear curtain. Use of the kit permits the equipment to be transported to the site selected and to be operated from the truck. It adds greatly to ease of stowage and shipment. If desired, the equipment may still be operated from the ground as originally intended. By operating from the truck, the equipment may be kept out of the mud and water—a distinct advantage, especially during the assault stages of an operation.

When installed in the truck, the boxes containing the operating components are divided into two stacks placed side by side along the center of the truck, all front panels except one opening toward the port side of the truck. The forward stack contains (from the bottom unit upwards) the receiver, transmitter, antenna drive unit, and the antenna. This stack rests on a metal platform which is furnished as part of the kit. The second stack contains the modulator box (on the bottom with the front panel facing aft), the indicator box and the BN-2(BN) equipment, bolted in place if desired.

With the components in the positions indicated and the tarpaulin and rear curtain installed, operation under blackout conditions is possible. By extending the regular truck tarpaulin from the rear curtain aft, thus inclosing the rear of the truck, ample space for a field work shop is provided. In packing for transit, the stacks remain in the operating positions, only the antenna and the antenna drive unit being removed and stowed elsewhere in the truck.

Since 1 July about one hundred of these kits have been made available. The present contract calls for completion of a total of 530 kits by 1 September for distribution to the Army, Navy and Marine Corps.

The Type V 14/TPS-1B Trailer Mounting Kit has also been assembled in limited quantity for U. S. Marine Corps applications only. It consists of a one-ton, four-wheel equipment trailer, Navy Type CAHV

10343, welded chassis, all steel, tailgate, roof bows and tarpaulin covered, hydraulic brake control.

Both of the mounting kits are supplied complete with the necessary mounting fittings, and tarpaulin shelter for mounting the 1B. These fittings may be used to mount the equipment in a van. A crew of four men can accomplish the complete installation within a period of five hours.

## MODIFICATION KITS

Kits are furnished for the following modifications, these changes already having been incorporated in production models commencing with units having the serial numbers shown:

**MODULATOR UNIT MD 32/TPS-1B—1.** Change in filter for spark wheel motor governor, (Serial No. 160).

2. Replacement of formed high tension cables with wire in vinylite tubing to reduce possibility of voltage breakdown. (Serial No. 192.)

3. Change in connector on pulse cable, to provide proper seating and contact for the pin on the male connector.

**RECEIVER R 87/TPS-1B—1.** Addition of fuses in anode circuits of cavities, to avoid a tedious replacement problem, (Serial No. 200).

2. Connections to converter changed to eliminate local oscillator blocking, (Serial No. 98). No field kit has been furnished for this change.

**TRANSMITTER T 76/TPS-1B—1.** Substitution of direct spring coupler for capacity coupler in the center conductor to the magnetron, to eliminate burning of the magnetron, (Serial No. 226).

2. Magnetron filament transformer changed to provide greater margin of overvoltage and better tap insulation, (Serial No. 43). No field kit has been furnished for this change.

**ANTENNA AS 120/TPS-1B—1.** Kit for reducing antenna rotation speed from approximately 5.3 to 4 rpm.

2. A kit for blowing warm air through the transmission line from the antenna drive unit to the projector.

3. Breakable link for synchro generator G801 to prevent damage to the synchro if the shaft becomes frozen.

## KITS NOW BEING DEVELOPED

In addition to the kits described above, the Bell Telephone Laboratories are developing two major kits for the AN/TPS-1B. These kits are as follows:

1. Antenna kit to improve the vertical coverage of the present antenna.
2. Moving target identification (MTI), employing the coherent pulse doppler system.

## CHANGES WITHOUT KITS

No kits are furnished for the following changes:

**INDICATOR UNIT 1D 84/TPS-1B—1.** Resistors added to reduce range-mark jitter (Serial No. 107).

2. Capacitors added to equalize range adjustment, (Serial No. 80).

3. Intensity controls changed to increase range of brightness control, (Serial No. 260).

**RECTIFIER AND JUNCTION BOX PP 91/TPS-1B—1.** Location of safety switch changed (Serial No. 73).

2. Capacitor of 2 uf added to rectifier filter to reduce "A" scope jitter (Serial No. 73).

3. Capacitor of 2 uf and a resistor of 1600 ohms added to rectifier filter to reduce ripple interference on the PPI scope (Serial No. 166).

**ANTENNA DRIVE UNIT MX 191/TPS-1B—1.** Resistors added to reduce zeroing current in the synchro motor (Serial No. 225).

## WHERE'S YOUR RADAR SERIAL NUMBER?

■ Often when filling out reports on completed radar field changes, the different serial numbers on the various units cause confusion, and the question arises, "Which one is the equipment number?"

The following chart indicates the unit of each radar equipment which bears the complete equipment serial number.

| Radar | Unit | Radar | Unit |
|---|---|---|---|
| SA | Transmitter | SV | Transmitter |
| SC | Transmitter | Mk. 3/4 | Main Frame |
| SD | Transmitter | Mk. 10 | Main Frame |
| SF | Transmitter | Mk. 12 | Main Frame |
| SG | Main Frame | Mk. 13 | Console |
| SJ | Power Control Unit | Mk. 18 | Main Frame |
| SK | Transmitter | Mk. 19 | Power Control |
| SL | Transmitter | Mk. 22 | Main Frame |
| SM | Transmitter | Mk. 26 | Power Control |
| SO | Indicator Unit | Mk. 27 | Main Frame |
| SP | Transmitter | Mk. 28 | Power Control |
| SR | Transceiver | Mk. 29 | Power Control |
| ST | Transmitter | Mk. 34 | Power Control |
| SU | Transmitter | | |

## QJA TRAINING SYSTEM

■ In case of emergency, the electronic training system in the QJA Indicator and Control Unit can be by-passed provided the locking magnet K-311 is held in the operated position. If this is done, rotation of the handwheel will drive directly through the gearing to the commutator transmitter.

The Pawl DU (Drawing #39, ES-649322) may be locked in the operated position by tightening the screw 27D and lock nut 35D. When the electronic system is repaired and again placed in operation, it will be necessary to readjust the screw 27D in order to restore the system to its original operating condition.

*—Western Electric*

## C.E.M.B. REVISED

■ The Communication Equipment Maintenance Bulletin has been completely revised and is now being distributed. The old typewritten copy has given way to print with the result that the book is smaller and easier to use.

Another important change is in the arrangement. All information on a given equipment now appears together, and index numbers at the top corners make it easy to find your way around. The new edition replaces all existing pages, so these may be destroyed.

## REPLACING 5D21 TUBES

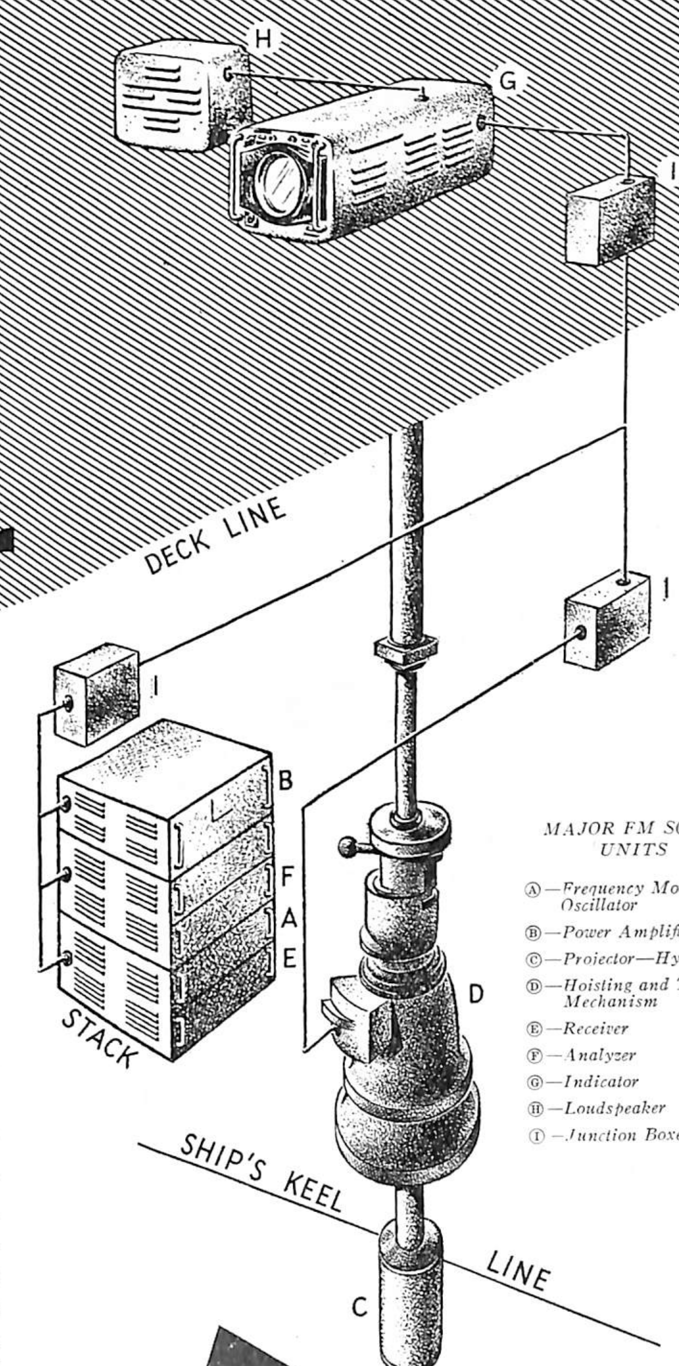
■ Failure reports indicate that difficulty has been experienced with type 5D21 tubes used in AN/CPN-6 transmitter-modulators. An investigation resulted in the replacement of this tube in all future shipments of equipment spares by type 715-C which gives better performance and has a longer life expectancy. No circuit change is necessary for the replacement as the tubes are very similar.

*—E. F. S. G.*



# FM Sonar JOINS THE FLEET

Lt. J. J. Crowley, USNR




*MAJOR FM SONAR UNITS*

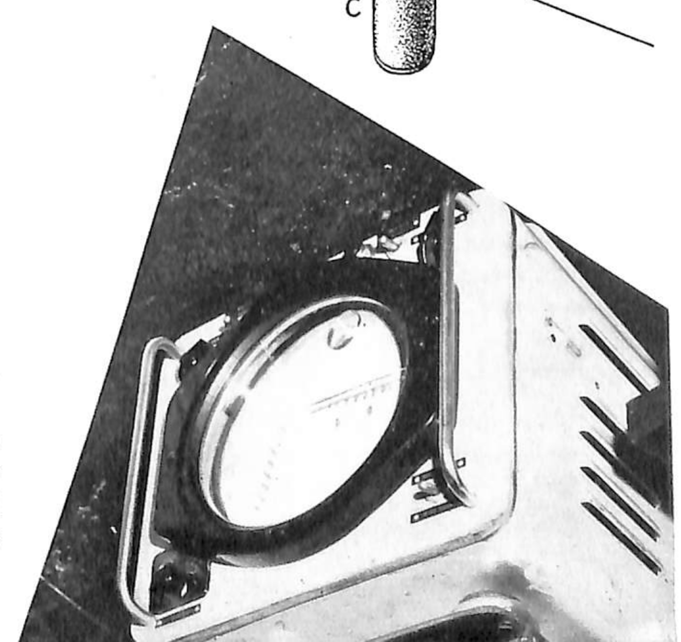
*Ⓐ—Frequency Modulated Oscillator*
*Ⓑ—Power Amplifier*
*Ⓒ—Projector—Hydrophone*
*Ⓓ—Hoisting and Training Mechanism*
*Ⓔ—Receiver*
*Ⓕ—Analyzer*
*Ⓖ—Indicator*
*Ⓗ—Loudspeaker*
*Ⓘ—Junction Boxes*

■ Frequency-modulated sonar equipment providing a nearly continuous plan position indication of underwater objects within the supersonic range is now making its appearance in the Pacific. The installations, designated as Model QLA Echo Ranging Equipment, were developed by the University of California, Division of War Research, at the U. S. Navy Radio and Sound Laboratory at San Diego, and are being manufactured by Western Electric. Their primary function is the detection of mines. Although designed for both surface and submarine vessels, present installations are submarine.

A frequency-modulated signal of short duration called a sweep frequency has been employed in most models of sonar echo-ranging equipment. Its purpose is to give the returning echo a characteristic "chirp," thereby enabling the operator to distinguish it from a high background of noise and reverberation.

The QLA is the first equipment to employ a signal of continuously varying frequency to determine the range of an object. It projects its signal into the water and at the same time feeds it into the mixer of the receiver. When an echo returns, it heterodynes with the projected frequency, and the frequency difference between the projected signal and the returning echo can then be interpreted as range.

Submerged objects which are good supersonic reflectors are represented on a cathode ray tube in their positions relative to the ship. Ranges can also be read directly on the scope. A long-persistency screen allows



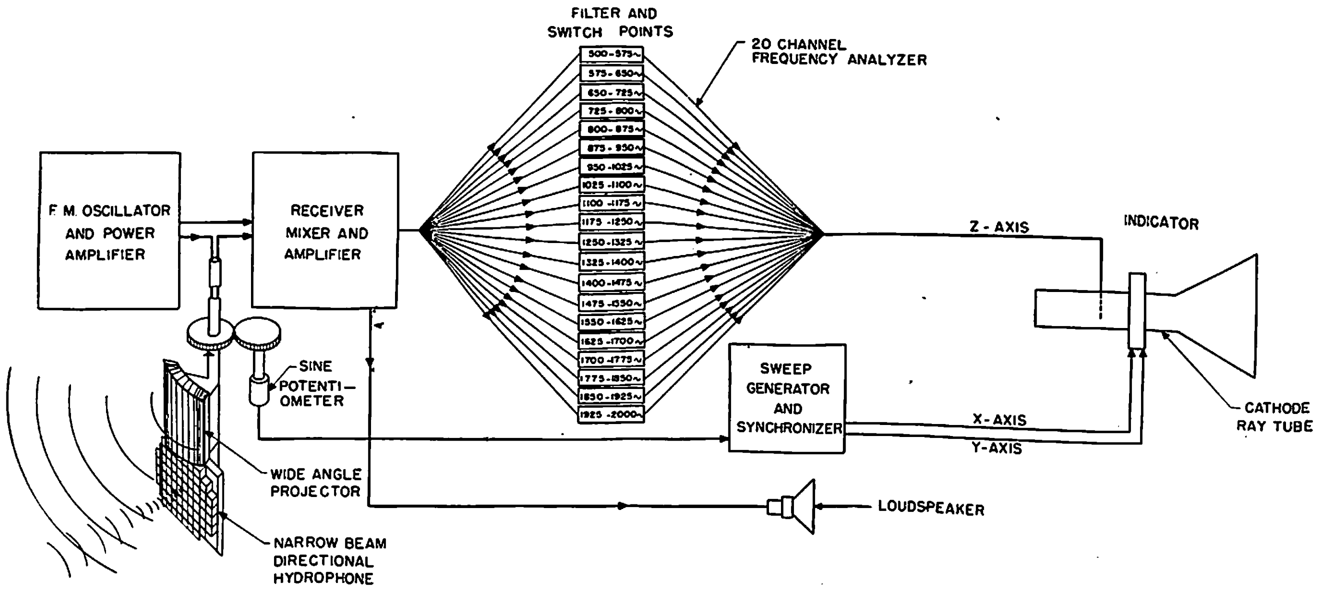



FIGURE 1—*Block Diagram of Model QLA Sonar Equipment*

the operator to study the movements of the object. Moreover, the pitch of the tone from a loudspeaker gives a good indication of ranges to the experienced operator.

Sound waves generated by the frequency-modulated oscillator (FMO) are amplified and then projected into the water by a projector producing a wide fan-shaped beam which floods the area in an arc of about 80°. The signal radiated is practically continuous, the frequency varying uniformly with time, beginning at a maximum of 46.7 kc and ending at a minimum of 36 kc. At the end of the cycle the signal returns to its maximum in a few milliseconds, during which time the RF amplifier is inoperative.

Ranges of 300 feet and 300, 600, 1200, and 3000 yards are provided. Minimum range on each scale is one fourth of the maximum range. The rate at which the frequency changes with time determines the frequency difference corresponding to a given range.

Range accuracy is limited to about 3% of maximum range. The directivity of the receiving hydrophone limits bearing resolution to about 5°, although more accurate bearings can be read by taking a center bearing on the visual indicator. A pronounced doppler effect will cause an error in the measurement of range. For each 2.5 knots of relative range rate, this error amounts to 75 cycles or one channel on the CRO screen. Thus, the measured range is too large when the target is closing and too small when it is opening.

## EQUIPMENT

The various units of QLA Sonar installation may be divided into three groups, all interconnected through junction boxes.

The Indicator, containing the CRO tube and all operating controls, together with a loudspeaker, comprise one group, generally located in the conning tower of the submarine.

The second group is composed of the following units usually stacked in the forward torpedo room: (a) Frequency Modulated Oscillator (FMO), (b) Power Amplifier, (c) Receiver, which mixes the returning echoes with a sample of the projected frequency and (d) the Analyzer, which selects the proper range-channel and time-sequence for the resulting difference frequencies.

The sound head and hoist-train mechanism make up the third group of units. The sound head consists of a wide-angle ADP crystal projector and a narrow-beam directional hydrophone.

## CIRCUIT FEATURES

A block diagram of the Model QLA is given in figure 1. Figure 2 shows how the signal of continuously-varying frequency is generated. Capacitor C-106 charges at a constant rate through V106. The grid of V108A (½ 6SN7) is connected to the plate side of C-106 and as it charges negatively it carries the grid with it. V108A is connected as a cathode follower. V109 and V110 are coupled as a multivibrator whose grids are connected to the high side of the cathode of V108 and are therefore always biased positively. The frequency of this multivibrator varies linearly as its positive bias. This positive bias decreases as the grid of V108A, tied to C-106, goes negative. When the cathode of V108A drops to a certain point the gas tube V107 fires, blanking the RF amplifier, discharging C-106 through V105, and starting the cycle over again.

A specially designed cathode-ray tube is used to set potentiometer R139 ("set high") for 46.7 kc, and to set potentiometer R144 ("set low") at 36 kc. The various ranges are obtained by using different-size resistors in the cathode of V106.

The output of the multivibrator is coupled to a cathode-follower triode V111. This output is fed via a filtering circuit to an RF amplifier. The output of the RF amplifier is coupled to the power amplifier and to the receiver mixer stage.

The receiver circuit of the QLA equipment is designed so as to give the same gain level regardless of the range of the target. The echo is picked up by the narrow-band hydrophone unit and then coupled to a balanced-bridge dry-rectifier-type mixer which is coupled to the output of the RF amplifier. The difference frequencies produced by heterodyning the two frequencies may be anywhere from 0 to 10.7 kc, but the band used is from 500 to 2000 cycles. The response of the first stage of amplification is peaked at 2400 cps so that its gain at 2000 cps is about 24 db above its gain at 500 cps. The remaining stages are equalized so that the overall gain rises approximately 12 db for each doubling in frequency from 500 to 2000 cps, and reduces the gain outside the band.

The output of the receiver is fed to the loudspeaker and to the analyzer.

The Analyzer is divided into two chassis. It contains 20 band-pass filter-networks with associated detectors and an electronic switch. Analyzer I has ten filters covering the band from 500 to 1250 cps and analyzer II has filters covering from 1250 to 2000 cps. For each of the 20 band-pass filters there is a corresponding concentric band on the CRO screen. Therefore a spot is brightened at a position whose distance from the center of the scope is proportional to the filter frequency and therefore the range. A 500 cycle frequency brightens the trace ¾" from the center and a 2000 cycle brightens it 3" from the center.

The cathode ray sweep is made to start out from the center at a radius corresponding to one-quarter of the outer radius of the sweep, the minimum range being one-fourth the maximum range for each scale.

A network composed of a sine potentiometer geared to the hydrophone column, a sweep generator, and a synchronizer, orients the trace on the screen so that it is at the same angle with respect to the center line of the screen as the hydrophone bearing is with respect to the center line of the ship. The sine potentiometer consists of a card wound with resistance wire mounted on a shaft perpendicular to the card at its center. As the card is rotated, the voltage picked up by brushes will go through a sinusoidal variation, with the phases of the voltage varying at intervals corresponding to the sine, cosine, negative sine and negative cosine of the angular position of the shaft. Four sawtooth voltage generators feed the four deflection coil driver tubes. This causes the spot to be deflected outward from the center in a direction corresponding to the orientation of the sound head.

Training in the operation and maintenance of QLA sonar gear is now an integral part of the Fleet Sound Schools training programs, and action reports indicate its usefulness in the overall tactical conduct of the war in the Pacific.

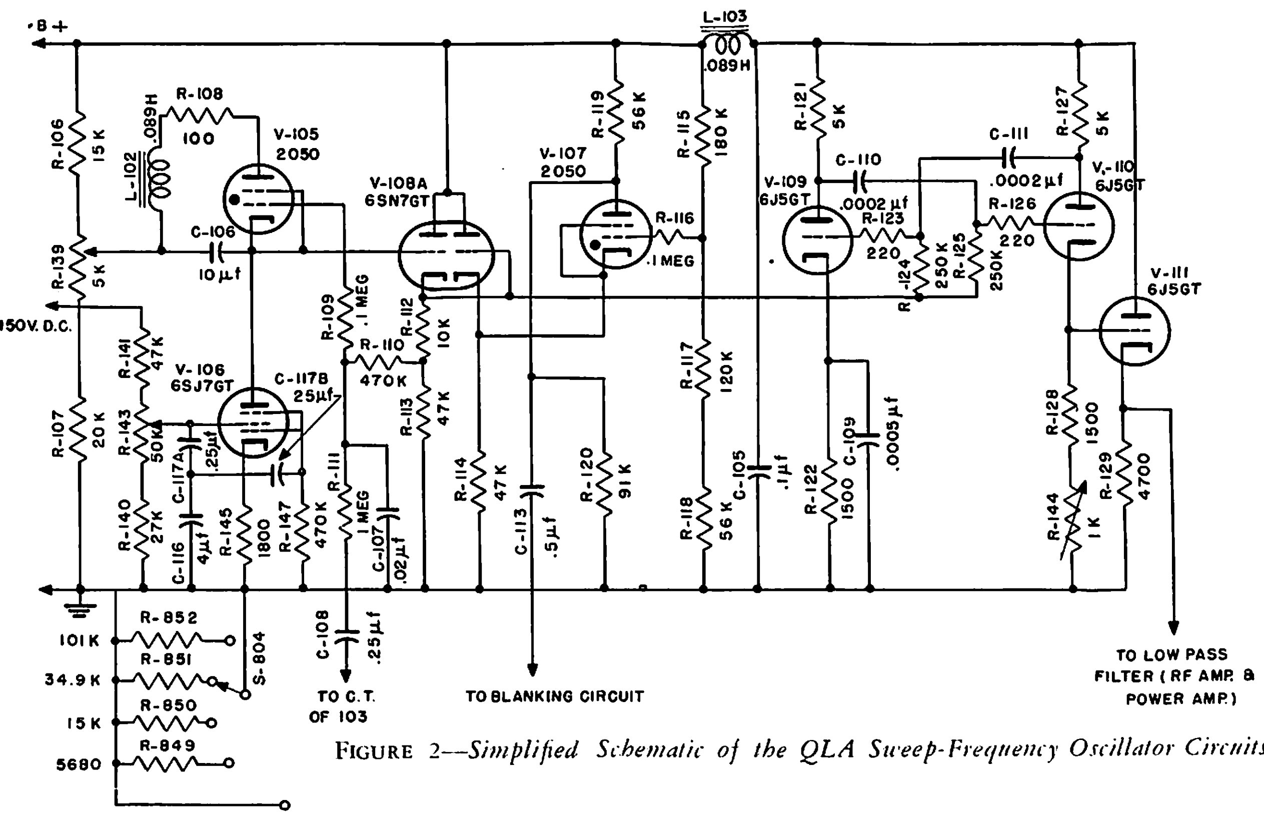



FIGURE 2—*Simplified Schematic of the QLA Sweep-Frequency Oscillator Circuits*

# Some notes on the SP

*The Model SP-1M is an SP mounted in a trailer.*

■ For those who are not familiar with the SP radar, it is a simplified and smaller version of the SM. It is an S-band, general air and surface search set which may be used in conjunction with fighter direction. The principal function of this equipment is to provide range, azimuth, and altitude information on aircraft. The first units made their appearance in the fleet about the first of the year, going to the islands with the Marines as a trailer mounted mobile GCI set, the SP-1M. Although no radical changes or modifications have been made in the SP since its introduction, many minor changes have occurred and will continue to be announced to keep the gear in step with increased knowledge and field experience.

The SP has three types of echo presentation: a PPI, an *A*-scope and an *R*-scope. Delayed PPI is also available. The PPI has five range scales presenting maximum ranges of 4, 20, 50, 100, and 200 nautical miles. The *A*-scope presentation is fixed at 100 miles, while the *R*-scope allows any five-mile portion of the *A*-scope to be examined in detail. A "strobe" is applied to the *A*-scope to indicate what portion of the *A*-scope is being viewed on the *R*-scope.

The antenna supplied with the SP has a paraboloidal "dish-type" reflector approximately 8 feet in diameter which is stabilized to compensate for the roll and pitch of the ship. The beam width is about 4° at the half-power points. To obtain accurate bearing and altitude information, the antenna must be accurately directed at the target. This is accomplished by a scanner which rotates the effective antenna position around the focal point of the reflector. As the waveguide is shifted around this point, the beam is shifted, a complete revolution describing a hollow cone in space. A single echo is "gated" by the receiver, and applied to the Precision Alignment unit along with information from the scanner. The Precision Alignment unit senses the change in echo strength with a change in beam direction and sends this information to the cathode ray tube in the Target Alignment indicator, which provides a "moving spot" type of presentation. True beating accuracy is within 45 minutes of arc. The controls which vary the elevation and bearing setting also control the mechanical-electrical height computer, and altitude is read directly from a meter in thousands of feet above sea level. A potentiometer which compensates for the curvature of the earth in altitude determination is being installed at the factory. This change is being made retroactive for units already installed.

The SP was originally supplied with two modulators. The "A" modulator pulsed the magnetron for 1 microsecond at the rate of 635 pps. The power drain is 12 kw, and the peak power output is between 500 and 700 kw. Modulator "B" is not used in the present installations, and is being modernized. This modernization will be known as Field Change No. 26, soon to be distributed.

The following paragraphs include field changes and information for guidance and help to the technicians who maintain the SP gear.

Field change No. 20 supplied a separate keep-alive power supply unit. Before this change is made, the keep-alive potential of 600 volts is taken from the synchroscope.

The trigger-delay junction box should be checked against a highly accurate fire control radar, and not by use of the optical range finder. The initial setting for delay can be determined from the time delay of the receiver and the waveguide. According to NRL figures, the delay inherent in the SP receiver is 1.1 $\mu s$ for the wide band and 1.4 $\mu s$ for the narrow band. Delay in the waveguide is .14 $\mu s$ per 100 feet of transmission line. Remember that twice the length of the waveguide is used in computing this delay to allow for the delay in the pulse plus the delay in the returning video signal.

Concerning the 600 cycle alternator, reports have been received of abnormal slip ring wear and pitting. The manufacturer's field representatives have been instructed to check the brush pressure, which should be about 24 ounces. RTs can make this check if a spring scale is available. The check is made by inserting a piece of paper between the spring and brush. A scrap of tin may be fitted around the spring holding the brush and then connected to the spring scale. The scale is lifted and a reading taken when the paper can be moved. As an interim measure, some new brushes have been supplied to ships having this trouble. The manufacturer is presently working on a field change which will include new slip rings and brushes.

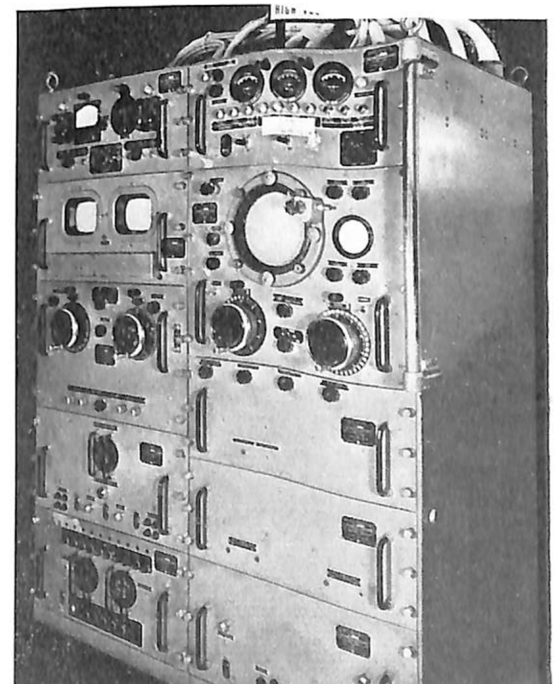
For proper video intensification of the PPI scope, the *A*-scope is operated with approximately ½ inch of grass. To decrease the video level on the *A*-scope and *R*-scope, in order to reduce eyestrain on the operators, and provide more room on the scope faces for IFF display, the following changes are authorized: (1) Remove connection between C-129 and R-142 and connect C-129 to the junction of R-140 and R-142. (2) Solder a bus wire jumper across L-114. (3) Change the schematics to agree with the wiring changes. The change is being made at the factory on all SP radars after No. 112.

A wiring change in the servo amplifier which will eliminate internal parasitic oscillations and pickup from external wiring is authorized. This change requires the use of three capacitors as follows: A .05 $\mu f$, 600 V capacitor is wired across the 1-speed input (terminals 3 and 4 of the main terminal board). 0.1 $\mu f$, 600 V capacitors are connected between grids and cathodes of V-3355, a 6SL7GT (current limiter tube), between pins 1 and 3 and between pins 4 and 6.

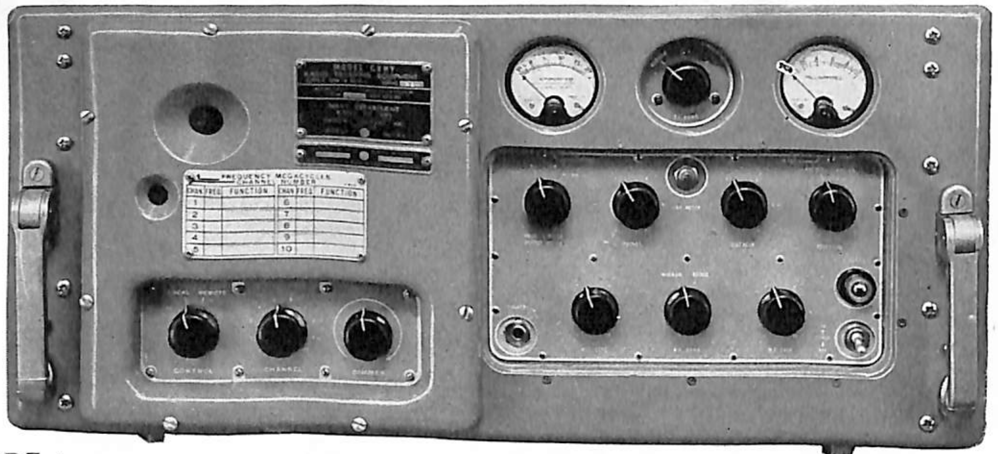
Another kit presently being prepared will provide locks for the eight controls on the front of the SP console.

Perhaps the newest addition to the SP is the Speed and Course Computer, type CT 10-AEX. A few of these units have already been shipped, along with instructions for operation and adjustment. It will be noticed when using this computer, that the true target course indicator dial is jumpy. This is normal and should not cause concern. The bearing synchro follows the bearing dial by ± 5°, which means that the synchro can jump by as much as 10°. Inertia of the system also aggrivates this condition.

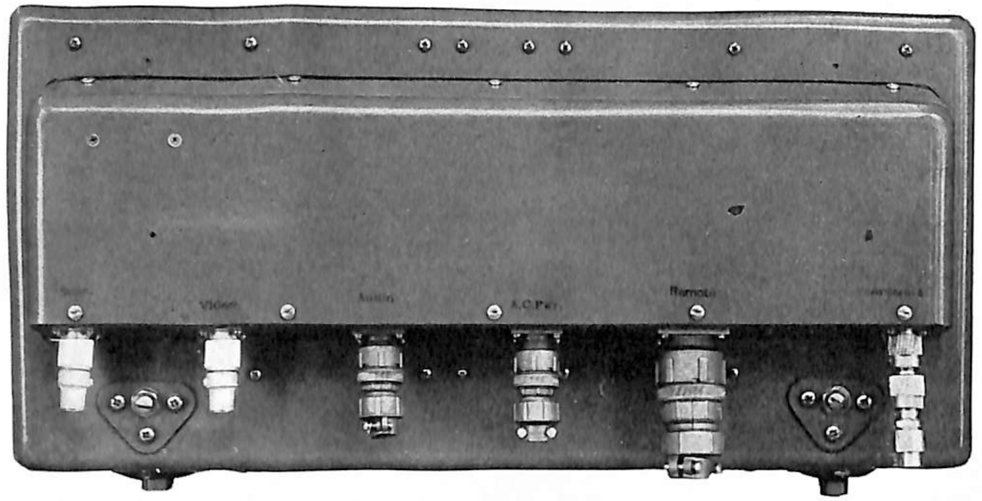
All of the sets having the Speed and Course Computer also have the Earth's Curvature Adjustment added. This potentiometer, R-423, is located directly under the course range synchro and can be adjusted only by pulling out the chassis.



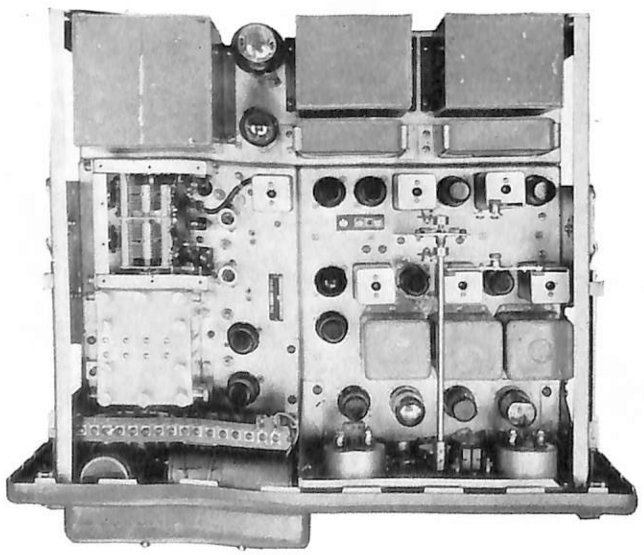
*Main Indicator Console of the SP.*



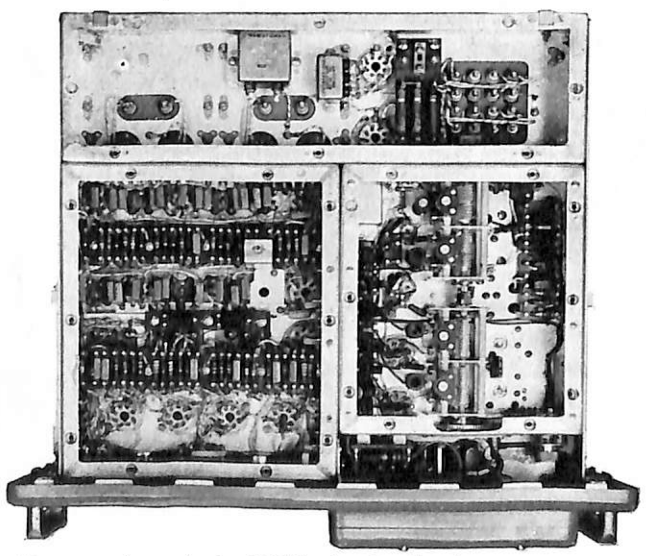
*The front panel of the RDZ presents a very neat appearance. Note the rounded corners and recessed controls.*



*Rear view of the Model RDZ cabinet showing the cable filter blister and location of the various cable connectors. The blister cover can be removed from the back to provide access to the filter components, or the complete filter may be removed through the front of the cabinet.*



*Top view showing the preselector chassis (left front), the IF/AF chassis (right front), and power supply (rear). The automatic tuning mechanism is located behind the front blister.*



*Bottom view of the RDZ chassis showing arrangement of components to provide maximum accessibility.*



# The RDZ Receiver

■ The model RDZ receiver, companion equipment to the model TDZ transmitter, will shortly be in large-scale production. This set will be the forerunner of an entirely new series of equipments designed for maximum utility and serviceability, but still retaining the sound basic engineering principles and features of the RBA, RBB, and RBC series equipments that have proven seaworthy under battle conditions.

This model RDZ is a 21-tube superheterodyne, employing crystal frequency control, to permit reception of amplitude-modulated signals on any one of ten pre-determined channels within the frequency range of 225 to 440 Mc. An automatic tuning unit is employed in the equipment to permit selection of channels either by local or remote control. Connections to and from the receiver are filtered to prevent possible interference from nearby electronic equipment.

The receiver chassis assembly consists of three separate sub-chassis assemblies secured together and affixed to the operating panel to form a composite receiver chassis-panel assembly. The three sub-chassis assemblies referred to above consist of an RF Amplifier Unit with associated crystal oven and automatic tuning unit, an IF/AF Amplifier Unit, and a Power Supply Unit. All input and output connectors and associated RF filters are contained in an assembly located in the rear of the cabinet.

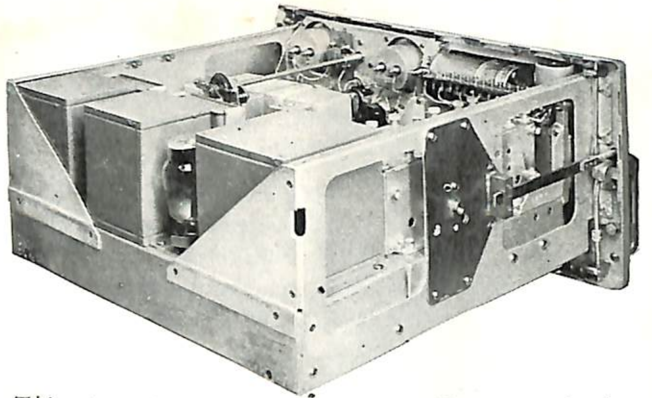
The RDZ has been designed and constructed to offer many mechanical features not found in previous shipboard communication receiving equipments. The cabinet and panel are devoid of all sharp edges and corners, giving the equipment a modern streamlined appearance and offering considerable protection to operating personnel. All front panel controls are contained in recesses in the panel as a protection against accidental movement or damage. The chassis assembly is mounted on file-cabinet-type drawer slides incorporating provisions for tilting and locking the chassis in the horizontal, vertical, or approximately 35-degree tilt positions, thus providing complete access to all component parts for servicing at the point of installation. The use of captive, quick-acting fastening devices for securing shield and cover plates precludes the loss of screws and expedites servicing operations. By the employment of specially designed panel-operated locking devices, thumb screws have been eliminated from the panel. The method employed for the attachment of the connecting cables permits the ready installation of two or more equipments in a common supporting frame in locations which do not provide wide clearances for access to cable connectors either at the sides or rear of the equipment.

The preselector unit of the model RDZ equipment consists of a double-tuned RF amplifier stage, a mixer or first-detector stage, and a crystal oscillator with the necessary frequency-multiplier stages required to produce the desired frequency at the mixer or first detector grid. Also mounted on the preselector unit are the automatic tuning mechansim and the crystal oven. The automatic tuning mechanism connects the desired crystal, located in the crystal oven, and tunes the receiver to provide reception on the desired pre-determined frequency. An intermediate-frequency transformer containing the primary of the first IF transformer circuit is located on the preselector chassis so that the coupling circuit between the RF unit and the IF/AF unit carries only intermediate-frequency currents.

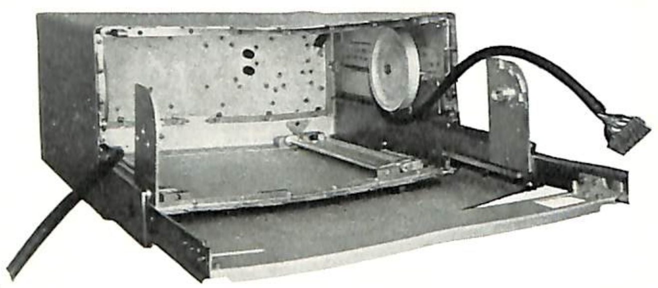
The IF/AF unit consists of a cathode follower for connection of a panoramic adapter, five stages of intermediate-frequency amplification at 15.1 Mc, a second detector, noise limiter, automatic volume control, silencer, silencer-amplifier, band-pass filter, a cathode follower for video output, and three stages of audio amplification. The panel of the IF/AF unit also contains a tuning-indicator meter and an output-power (db) meter.

The power unit employs a transformer, rectifier tube, B-supply filter network, and a voltage-regulator tube. These circuits are conventional and supply all the voltages required by the receiver when connected to a source of 110, 115, or 120 volts, 50 or 60 cycles, AC.

The input of the RDZ is designed to operate from either the antenna of the TDZ transmitter or the antenna



*This view of the chassis-panel assembly shows the handle-operated locking device. Chassis may be locked when fully extended and, if desired, may then be tilted up 35 or 90° and locked in that position for servicing.*

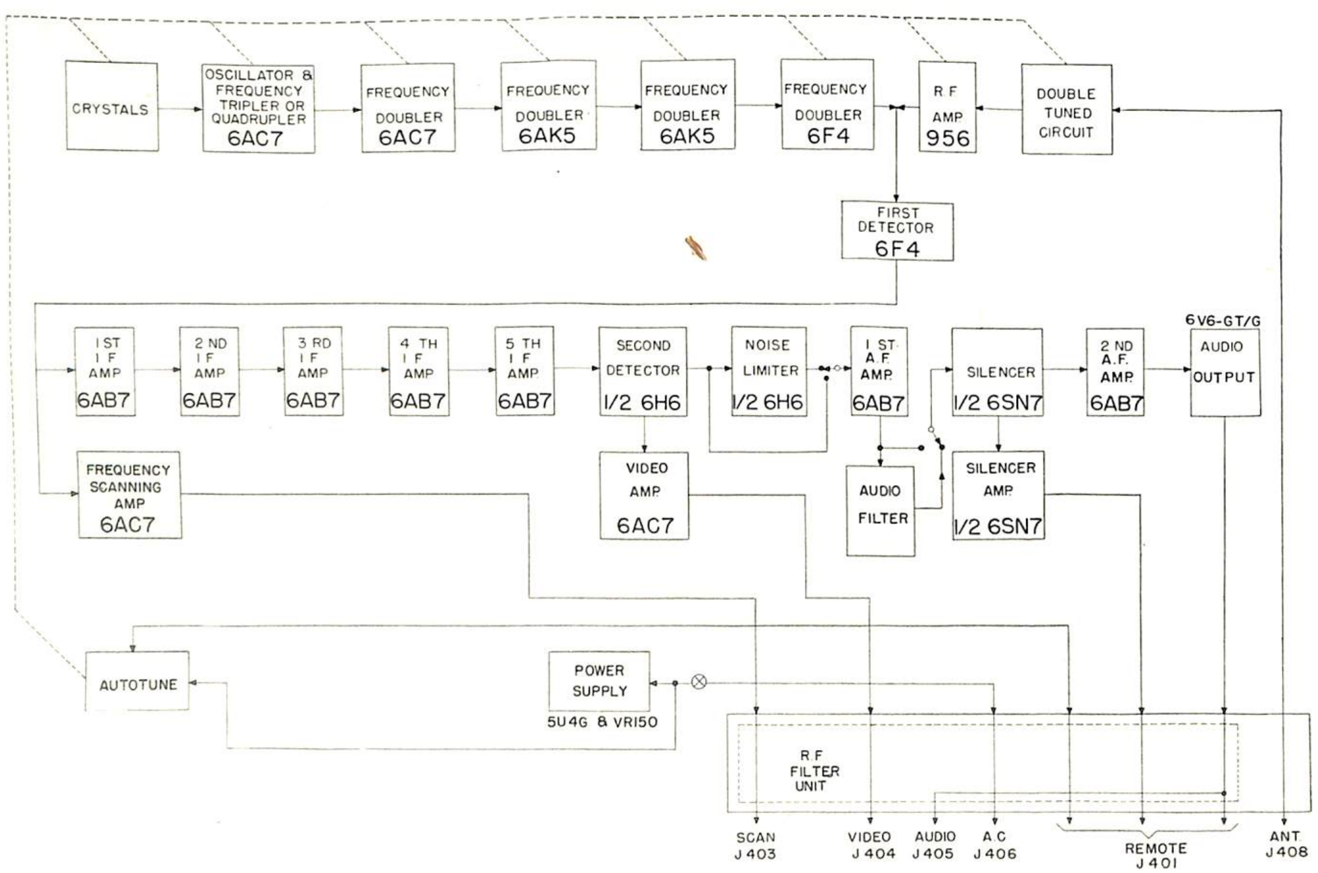


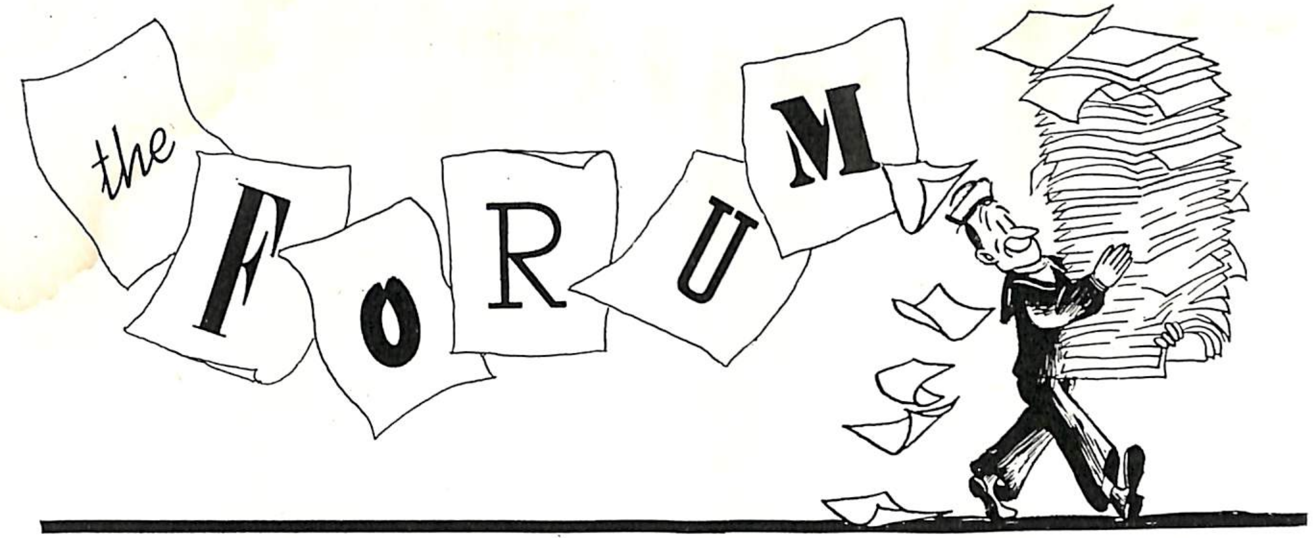
*Front view of the RDZ cabinet with chassis-panel assembly removed to show details of the slide mechanism and cable take-up wheels. The cable filter assembly is shown in position at the rear of the cabinet.*

furnished as an accessory with the equipment. The sensitivity of the receiver is less than 10 microvolts over its range. Two degrees of intermediate frequency selectivity provide for operation with either 200 or 400 kc minimum channel-spacing. The overall frequency instability does not exceed .015 per cent when employing CR-1 crystals or .007 per cent when employing CR-7 crystals in the crystal oven.

The nominal audio output impedance is 600 ohms, but the inclusion of degeneration in the audio amplifier permits a number of 600-ohm loads to be connected in parallel across the output terminals without serious reduction in volume.

An interesting sidelight to the development of this equipment lies in the fact that the majority of components employed in the preselector unit had to be specially designed for this receiver. The range between 200 and 400 Mc has proved to be too high for standard components normally employed in lump circuits and too low for practical use of tuned stubs or lines. The RDZ employs lumped tuned circuits. The variable tuning elements are a special form of butterfly (floating-rotor) capacitors with the frame elements arranged to reduce inductance to a minimum. Note to RT's: Please respect this capacitor as you would your lungs, because this particular megacycle separator costs $40 per section!




## Interference in Loran Receivers

**The Commanding Officer, *USS BREMERTON* (CA-130)**

■ During the shakedown cruise considerable difficulty was encountered in making adjustments to and taking readings with the DAS-3 Loran Receiver. Investigation disclosed interference from stray 60-cycle currents causing fluctuations in the trace.

Personnel from the EO's Office, Navy Yard Boston, traced the difficulty to the voltage-regulating transformer (Type CRP-301222) for the VD RPPI located in the chart house. The transformer was located about 18 inches below the loran receiver. Instructions for installation of the transformer required that it be located at least six feet from the VD RPPI but no mention was made of the necessity of locating it at least six feet away from other equipment fitted with cathode ray tubes.

Ship's force, assisted by the navy yard, relocated the transformer, placing it nine feet from the loran receiver. The 60-cycle fluctuations disappeared and operation is now normal.

*Bureau Comment:* NRL tests show a maximum of 5 gauss at 24 inches and 10 gauss at 18 inches from the right side of this transformer. The ends and other side exhibit less field. As a result of this report, the bureau is recommending that a distance of at least 6 feet be maintained between transformer CRP-301222 and any equipment with a cathode ray tube.

■

## Emergency Repairs to TDQ Transmitter

**Commanding Officer, *USS SHUBRICK* (DD 639)**

■ During a night engagement, this vessel's TBL and TCS transmitters were destroyed by enemy action, and the TBS and TBK were dropped overboard when the communication jettison bill was carried out. On the same night the following damage was inflicted to the TDQ Radio Transmitter:

1. In the RF unit numerous ceramic insulators were broken, the third tripler stage tuning dial was smashed, all tuning meters were damaged, both coax antenna cables from the antenna relay to the frame were cut and the connectors smashed, and the front panel was slightly bent.

2. The modulator unit was completely destroyed and dropped overboard in deep water.

3. The power unit suffered only slight damage. Several tubes were smashed and terminal board "D" was cracked.

As a result of these events the vessel was in urgent need of some sort of transmitter to carry on normal voice radio communications. The ship's force turned to and made the following emergency repairs and alterations to the remaining TDQ equipment:

1. The modulator unit was completely rebuilt from equipment spares.

2. In the RF unit the coax antenna cables were replaced from spares, the ceramic insulators were replaced by plexiglass insulators constructed by the ship's force, the third tripler stage tuning dial was repaired so as to be usable, the tuning meters were repaired, the damaged inductances were removed from the equipment and replaced by coils designed and constructed by the ship's force.

3. As the TDQ transmitter output frequency is the ninth harmonic of the crystal frequency, a crystal ground to 811 kc was required to have an output frequency of 72.1 Mc. Since an 811 kc crystal was unobtainable, an 825 kc crystal was taken from a set of SCR-61 crystals and given several coats of Higgin's india ink to slow down its oscillations. Approximately six coats of india

ink were required to bring the frequency of the crystal to the desired frequency of 811 kilocycles.

As the ship has no instruments for measuring crystals and none were obtainable, a calibrated RAL-6 receiver was employed in conjunction with the TDQ oscillator unit to provide a means of following the change of frequency of the crystal as it was inked. This expedient proved to be inaccurate, but was sufficient means for our needs. An LR-1 frequency meter would have been a much better means of measurement but this had been destroyed.

While an "inked" crystal does not provide a very stable oscillator, under the circumstances this procedure was the only means to an end and the crystal proved to be very reliable during the period of its use.

No means were available to measure the range on the TDQ after this alteration was made, but the equipment proved to be an efficient means of voice communication while this ship was in the area.

The transmitter was watched closely and was frequently inspected. It is believed that the equipment suffered no harmful effects as a result of the alteration.

*Bureau Comment:* The ingenuity on the part of the ship's force in making these emergency repairs is a good example of what a trained electronic team can accomplish when such occasions arise. ELECTRON Magazine welcomes similar reports.

■

## Preventive Maintenance Scores Again

Commanding Officer, U.S.S. Frank Knox

■ The QGA Sonar Equipment on this ship, installed in January 1945, has been in operation over 3000 hours. During this period, it has been inoperative *less than half an hour*. The only repeated failure has been the illumination lights found in the console. Sufficient spares were carried to replace these.

This performance record is due in a large measure to the intensive preventive maintenance program carried out by the ship's technicians. Thus far, weak tubes, defective contacts, relays and switches have been found *before* complete failure. Furthermore, the technicians check all electronic equipment upon entering port before shutting down.

## Improved Seals for SC Radars

■ SC-1 and SC-2 Field Changes #23 and #30 respectively are for the purpose of replacing troublesome Garlock oil seals with an improved type known as the Reich seal. Some of the first field change kits were supplied with the older type of seals. Before making the change, therefore, be sure a new Reich seal is available instead of installing another Garlock seal. The improved seal utilizes two sealing rings as shown in the drawing. Before installation, these rings should be sprung apart and the space between them filled with lubricating oil.

*Cross-sectional drawing of the new Reich oil seal (right) compared with the Garlock seal which it replaces.*

■

## Test for Thermo-Setting Cable

■ A ship reported its Depth Charge Direction Indicator (DCDI) flooded out. It was found that not only the JB box, but also the 14-wire cable through the hull was flooded. New MHFF-14 (thermo-setting) cable was installed.

If cable is to go through the hull, it should be thermo-setting and not thermo-*plastic*. A quick and sure test to determine the type sheath the cable has is to put a match to a piece of it. If it chars, it is thermo-setting; if it stretches and gets soft, it is thermo-plastic. Thermo-plastic cable has a shiny black rubber sheath, while thermo-setting is a dull black.

—*E. F. S. G.*

■

## AN/MPN-1A Instruction Book

■ The final instruction book for the AN/MPN-1A equipment has been made available and is being distributed by Registered Publications. It is designated as SHIPS 316A. It contains complete lists of equipment and stock spare parts. Preliminary spare parts lists should be disregarded and inventories maintained in accordance with the new lists. All statements contained in SHIPS 316A relating to the use of IFF equipment with Radio Set AN/MPN-1A should be disregarded.



■ As a general rule tubes causing trouble are thrown away or surveyed if a new tube of the same type corrects the trouble. However, there are a few types of tubes which, in some cases, require circuit adjustment to insure their proper operation.

If the 723-type local oscillator seems to be guilty of sabotage, it should be given a fair trial. Sometimes the guilt may be pinned on circuit maladjustment which can be remedied with little difficulty.

Before surveying the misbehaving 723 tube, read these hints on causes and cures. The hints are taken from an Engineering Report prepared by the Sperry Gyroscope Company.

One difficulty sometimes encountered with the tube is *double moding*. Double moding is indicated by the presence of two adjacent crystal current peaks, with AFC unstable, tending to lock on both peaks or locking on one peak short of peak signal. The phenomenon is caused by either of two unrelated effects.

One effect is that the tube may be considered "too good"; that is, the reflector voltage-versus-frequency characteristic is so broad that the available AFC sweep may, within one mode of 723 oscillation, move the frequency through a range of the magnetron frequency ±30 megacycles, so that the IF beat frequency is reached at two points of local oscillator tuning. In some cases, adjustment of the mechanical tuning may shift the frequency sweep so that only the *plus* 30 Mc response is crossed. Otherwise, a tube of less megacycles-per-volt range must be selected.

The second effect is due to the waveguide impedance at the point where the 723 probe couples in. This impedance is reflected into the 723 oscillating circuit, depending on the amount of coupling. Given certain conditions of reflected impedance and frequency, the 723 will not oscillate. If, under these conditions, the frequency band of non-oscillation falls within the desired operating mode, two apparent crystal peaks will result, both part of the same mode, but with an intervening point of no oscillation between. Generally, it is possible to decouple the 723 far enough from the guide so that, regardless of other conditions, the point of non-oscillation is not reached. Therefore, the condition may be considered a result of over-coupling of the 723 into the mixer. In equipments in which the plumbing can be tuned a cure sometimes results from retuning the plumbing. If necessary, substitute a crystal giving greater crystal current and then recouple the local oscillator to give about 0.4 ma. of crystal current. If this fails, the 723 should not be rejected as it will be entirely satisfactory under different conditions of frequency and load. The condition is often an indication of a burned-out or low-gain crystal which requires over-coupling to get normal current.

Over-coupling may also result from the use of a crystal current meter of greater than 50 ohms internal resistance. A meter with internal resistance higher than 50 ohms will read low by as much as 75%, this percentage varying with the meter resistance and that of the crystal. This results in over-coupling to obtain an indicated current of 0.4 to 0.5 ma. which, when the meter is removed, may actually be as high as 1 or 2 ma. All crystal current meters higher than 50 ohms must be shunted down to 50 ohms with appropriate correction of scale calibration.

# Service Difficulties With 723 A/B Local Oscillator

Any tendency towards double-moding should be cause for rejecting a system, the general criterion being that, tuning manually around peak crystal current, the current shall drop to zero on both sides of peak with no tendency to reverse direction before reaching zero. This is important since a change in conditions during operation can make a slight case of double moding into a severe case if the tendency exists at all.

In general, any change in impedance into which the 723 is coupled and in the degree of this coupling will have an effect on the tube, the end effect being complete failure to oscillate, the intermediate effect being frequency pulling. Thus any change in TR cavity tuning, crystal impedance, or coupling will change the 723 frequency. For this reason, 723s are often blamed for drifting frequency characteristics when the source of the drift is external. There is one cause of drift due to the tube itself which, with the principal external causes, may be handled as follows:

(a) Crystal impedances are now closely grouped and any good crystal may be used without retuning. However, if the impedance changes considerably from burn-out, the 723 frequency will shift.

(b) TR cavity drift is minimized with the 724-B tube, but the 724-A caused not only signal loss in the cavity but also 723 frequency pulling to introduce further conversion loss.

(c) There is a technique to be observed in mechanically tuning 723s so the tuning will stay and not creep with vibration. In tuning in one direction, tension is built up opposing this direction; the bows are set from their previous position and the screw threads are jammed on one side. Thus, if the final position desired is reached from one direction of tuning only, the stresses and tensions will tend to relieve under vibration and the tuning will mechanically shift. To avoid this trouble, tune on past the desired tuning setting, then tune back through it again, but not so far—then back again, etc. This results in "rocking in" to the final setting, relieving all strains which tend to shift the tuning. Frequency shifts up to 6 megacycles have been measured due to this cause alone. The above procedure reduced this shift to less than 1 megacycle.

(d) The greatest single source of 723 frequency shift is change in coupling. Under critical conditions, a coupling change as small as 1/32″ will jump the frequency 50 megacycles. The effect on AFC is obvious, and it follows that it is essential to hold the coupling to a fixed mechanical quantity.

With a 724-B TR tube, with no conditions present tending to cause double moding, and with the mechanical adjustment "rocked in," the 723 will show up as a much better worker in your equipment.

## MARINE CORPS FAILURE REPORTS

■ Many technicians believe that a Signal Equipment Failure Report form is just another piece of paper for the "round file." Contrary to this belief, the Marine Corps Division of Plans and Policies and the Bureau of Ships analyze each report. The analysis of all reports results in the development of field changes, modification of stock levels, and the publication of informative material based on field experience.

However, it is impossible to get a true overall picture of needs in the field unless a high percentage of these failures are reported. Do you report all troubles encountered as soon as possible?

## TUNABLE MAGGIES

■ The type 2J61 tunable magnetron should not be used with the SJ and Mark 8 equipments due to tuning difficulties encountered and a reduced power output. Adequate stocks of the 706Y type magnetrons are available at Naval activities, and these activities have been requested to earmark 706AY magnetrons for use with SJ radar equipments. Similarly the 706BY magnetrons are to be set aside for use with Mark 8, Model 0, 1, and 2.

—*Western Electric*

## MARK 13 MOD 0

When switching transmitters, crystals may be damaged if power is applied to the TR assembly with no keep-alive voltage. This possibility can be eliminated by the following change which provides continuous keep-alive potential on both transmitters.

1. Connect terminals 3 and 13 to terminal 8, and connect terminal 52 to 61 in the Transmitter Switching Unit.

2. Replace R-1, R-2, and R-3 in the rotating HV Junction Box with 1.5 megohm resistors of the same power rating.

—*Western Electric*

## INTERFERENCE FROM SJ/ST RADARS

■ Reports indicate interference to sonar equipment by SJ and ST radars. This interference is in the form of a high pitched hum at the repetition-rate frequency of the radars. The *USS Threadfin* (SS410) eliminated this interference by putting a lead sheathing on the radar cables which cross the sonar leads in the conning tower bilge near the lower conning hatch coaming. About four feet of shielding was necessary.




## CARE OF 2050 TUBES

■ A QJB training control amplifier had excessive failures of type 2050 tubes. Upon investigation the plate voltage of the unit was found to be about 320 volts dc. It was lowered to the recommended 260 volts by changing the ac input to T-2803 from tap 2 to tap 3. The 2050 types were lasting approximately 40 hours before this change was made. After the change no failures were noted in 60 hours of operation.

Another way to prolong the life of these 2050's is to allow the tubes to warm up fully before a training voltage is applied. If the training wheel has been moved since the equipment was last shut down, or before it warms up, there will be a signal voltage on the 2050's which will cause a large current flow before the filaments are properly heated. This will cause rapid deterioration of the 2050's.

Furthermore there is a tendency in QJA and QJB sonar models for the gear-train mechanism to become stiff unless properly lubricated. This results in a heavier load on the spinner motors which, in turn, causes a higher plate current to be drawn from the 2050 tubes in the training control amplifier. For this reason, proper lubrication of this gear train mechanism is essential.

—*Lt. (jg) Wm. C. Wilkinson, E. F. S. G.*

## IMPROVED DUPLEXER

■ An improved type duplexing tube, type 721B, has been developed. The life expectancy is better than 1000 hours compared with the 300-hour safe limit established for the 721A tube. The 721B can replace the 721A in any unit. The Bureau of Ships authorizes operation of the new duplexers beyond the 300-hour limit in all SG-A and SG-1 radars. In addition the 721B's are made to closer tolerance, thereby saving much retuning time upon replacement. Tests are being made to determine the length of operation in other equipments.

## 2C40 REPLACES 446A AND 446B

■ The 2C40 tube was designed to replace the 446A and 446B tubes and is considered desirable for retroactive replacements. The minimum power output of the 2C40 represents a 2.5-to-1 improvement over the 446B. Frequency drift has been limited to 2 megacycles for a change from 6 to 6.6 in filament voltage, while that of the 446-type was about 8 megacycles. Mechanically the new tube has been manufactured to much closer tolerances so that it can now be inserted more easily in the cavity without risk of tube breakage or cavity distortion. This tube should provide much more efficient operation.

## TUBES "RUGGEDIZED" FOR WAR

■ A ruggedized tube is one which is especially designed to withstand the abnormal shock and vibration produced by gunfire, explosions, etc. These tubes are designed for war use and bear the letter "W" immediately following the type designation; i.e., 6L6WGA. The 6AC7W and 6SN7W are now being distributed. The types listed below are being developed under high priority.

| | | | |
|---|---|---|---|
| 2A3 | 6SA7 | 6SG7 | 3BP1 |
| 5U4G | 6SJ7 | 807 | 5CP1 |
| 6AG7 | 6SK7 | 6X5GT/G | 5CP7 |
| 6L6GA | 6SL7 | 2AP1 | 7BP7 |

## ASSEMBLY OF SC RING OSCILLATOR

■ Disassembly and cleaning of the ring oscillator in SC-series radars is necessary when the gearing becomes loose. It has been noted that in several installations this oscillator was reassembled improperly. The following information may be used for guidance in correct assembly:

The spacing between the moving part of capacitor C314 (butterfly) and the flat surface of sockets X305, 306, 307, and 308 should be 5/16″ ± 1/32″. If it is not, loosen the two set screws on the hub of the capacitor, adjust for correct spacing, and tighten the set screws.

Turn the frequency control dial "A" until capacitor C314 is fully meshed with the flat surfaces of sockets X305, 306, 307, and 308 and lock the shaft. If the dial does not read zero, loosen the two set screws on the knob of control "A" and adjust the dial until it does read zero. Tighten the set screws again.

Unlock control "A," turn it until the dial reads 100, and lock the control again. The capacitor C314 should now be completely unmeshed from the flat surfaces of the oscillator sockets.

With C314 completely unmeshed and the dial reading 100, check the position of the grid tuning disks (lollipops) with respect to the grid coils. The disks and coils should be in the same plane. If they are not, loosen the set screws on the disks and adjust the disks until they are in the same plane with the coils. When these disk set screws are tightened again, the alignment is completed.

For a quick summary: with a capacitor spacing of 5/16″ and "A" dial reading 100, the capacitor should be completely unmeshed and the grid disks should be in the plane of the grid coils.

# Automatic Bearing Indicator Circuits

**BASIC THEORY OF THE BEARING INDICATOR AND GONIOMETER OF MODELS DAQ, DAU, DAK-1 AND DAK-2 DIRECTION FINDERS.**

■ The action of the electronic circuits of direction finders equipped with automatic bearing indicators is not well understood by many technicians. Because better understanding means better maintenance, this article describes in some detail just how these circuits operate.

It is not always convenient to rotate a loop antenna, especially in shipboard installations, because of the size of the loop, its location, or for other considerations. However equivalent results may be obtained from a pair of stationary loops at right angles to each other, connected by any desired length of RF transmission lines to a *goniometer*. The goniometer type of loop eliminates mechanical rotation of the loop and bearings are taken directly from a bearing indicator.

In figure 1 a deflection amplifier and cathode ray tube (CRT) with two pairs of deflection coils are shown. The position of the dot is in the center of the scope when receiving a signal. But with no signal applied to the detector V1 of the deflection amplifier, grid bias is removed from V2. Consequently V2 will pass current, energizing one pair of the deflection coils and causing the dot to be deflected to the outer edge as shown in figure 2a.

The goniometer has two stator windings at right angles to each other and a rotatable secondary search coil, or rotor. The goniometer output alternates between zero and maximum for every 90° turn of the rotor. The zero positions relative to a fixed scale depend upon the relative magnitude of the stator currents, which in turn depend upon the direction of arrival of the radio wave. To permit the transfer of energy from the rotor without the use of brushes, a rotating transformer primary is wound on the same form with the motor winding of the goniometer. The fixed secondary winding of this transformer is assembled around the rotating primary and is connected to the output receptacle. Coupling between the primary and secondary is independent of the position of the rotor.

With the dot deflected to the outer edge of the CRT as shown in figure 2a (i.e., at right angles to the magnetic field) the dot may be caused to trace the circular pattern of figure 2b by rotating the deflection coils rapidly. As a matter of fact, the deflecting coils are rotated at 1140 r.p.m., or 19 revolutions per second. The deflection (radius of the circle) may be manually adjusted by varying the deflection amplifier cathode bias control .

The goniometer has a separate primary coil for each of the stationary loops, as shown in figure 1. If a transmitted signal arriving from the direction of "Y" is received, there will be a voltage developed across stator 1, while stator 2 will have no induced voltage. Then if the goniometer secondary is rotated until its coils are at right angles to those of stator 1, there will be no voltage induced. In this condition there will be no signal voltage applied to the input of the receiver, and the instantaneous position of the dot will still be as indicated in figure 2a.

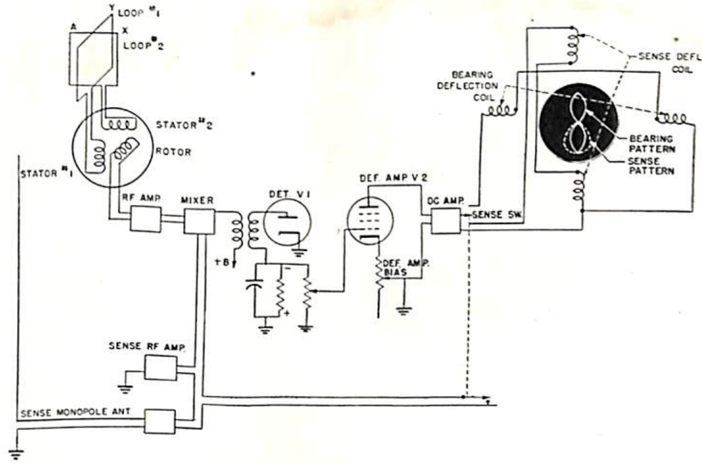
The goniometer rotor and the deflection coils of the GRT operate on a common shaft. With the signal applied at "Y," the rotor at right angles to stator 1, the deflection amplifier cathode bias adjusted so the dot will be as indicated in figure 2a, the rotor is turned slowly in a clockwise direction. The voltage induced into the rotor will reach a maximum when it has been rotated 90 degrees. This voltage is applied to the input of the receiver which is tuned to the incoming signal frequency. The receiver output will cause the detector V1 to pass current, thereby causing a bias to be applied to the grid of the deflection amplifier V2. This grid bias is sufficient to block the tube, de-energize the deflection coils, and cause the dot to move to the center of the scope. Because the deflection coils are revolved simultaneously with the goniometer rotor, the dot will generate a trace as indicated in figure 2c.

When the rotor is rotated another 90 degrees there will again be a voltage null and the dot will return to the outer edge of the scope as shown in figure 2d, 180 degrees from its original position. As the revolution is completed the dot will describe the course shown in figure 2e in returning to its original position.

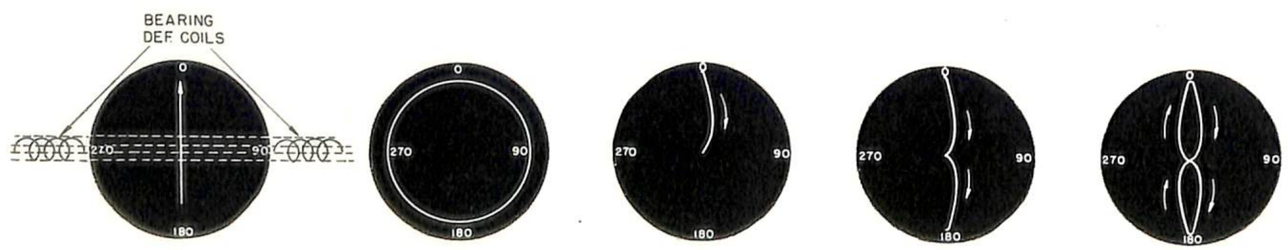
Had the signal come from the direction of "X" the result would have been identical except that stator 2 would have been energized instead of stator 1. If the signal had come from the direction of "A" then both stators would have been energized. The null voltage would occur when the rotor had equal voltages induced from stators 1 and 2, for then the two voltages would cancel. Regardless of the direction of the transmitted signal, the goniometer rotor will ascertain its null point and thereby indicate the direction of the signal automatically.

## SENSE DIRECTIVITY

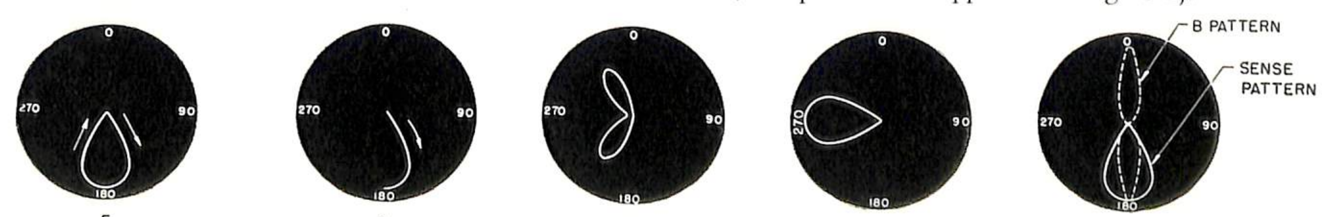
The pattern shown in figure 2e has an ambiguity of 180 degrees. To eliminate this possible error, the voltage from the sense antenna is combined with the loop antenna voltage. To explain how the "sense" pattern in figure 2f is obtained, assume a signal from the direction of "Y," place the rotor at the null-voltage point, and throw the sense switch. The dot will instantly move to the center of the CRT because this continuous sense voltage will cause V1 to conduct and V2 to be blocked. As the rotor is rotated, its voltage will alternately be in phase and 180 degrees out of phase with the sense voltage, due to the action of the sense-amplifying components. If they are in phase, the two voltages will add and the dot will remain in the center because V1 will continue to conduct. As the rotor revolves through the second half of the revolution its voltage will be 180 degrees out of phase with the sense voltage, and as the amplitude of the rotor voltage gradually rises to a maximum (i.e., when the revolution has reached 270 degrees) the sense voltage will be completely cancelled and the dot will return to the outer edge, describing the course indicated in figure 2g. As the revolution continues, the amplitude of the rotor voltage will decrease, the current through V1 will increase until there is sufficient grid bias to block V2 when the revolution is completed. The dot thereby returns to the center describing a figure similar to that indicated in 2f.




To explain the function of the sense deflection coils, let us assume that only one pair of deflection coils is used. With the sense gain set at zero, only the bearing pattern will appear on the CRT. See figure 2e. As the sense gain is increased the pattern will bend as indicated in figure 2h. When the sense gain is adjusted so that the amplitude of the sense voltage is equal to the amplitude of the goniometer voltage, the resultant voltage will describe a pattern as indicated in figure 2i. However, this pattern would involve an error of 90 degrees if interpreted as bearing indication. Consequently a second pair of deflection coils are added to compensate for this error. Therefore, using the sense coils, the pattern will appear as in figure 2j.




A B C D E




F G H I J

# Oils and Greases for Radio Equipment

■ The following lubrication chart for radio equipment supplements the radar lubrication chart carried in the August issue of ELECTRON.

If any omissions are noticed in this chart or if any information on lubrication can be published which will benefit radio technicians, BuShips ELECTRON would appreciate your calling the fact to its attention.

A future issue of ELECTRON will include a similar chart for sonar equipments.

### Chart 1—Radio Equipment

| Instruction Book Designation | Navy Specification Designation (or Nearest Navy Equivalent) | Equipments In Which Used |
|---|---|---|
| Andok C. Grease | 14-L-3 Grade III | AN/ARC-1, AN/ARC-4, BC-638, BC-639, RBM, SCR-522, SCR-542, TCO, TCP, TCS |
| Aviation Instrument Oil per WS-429 | 14-O-12 or OS-1362 | AN/ARC-1, DBM |
| Colloidal Graphite (Trade Name Aquadag) | Dry Graphite SS-G-659 Fine, Mixed in Water | TDH |
| D.T.E. BB Mineral Oil | N.S. 3080 | YL |
| Essoleum Chassis Lubricant "H" | OS-1350 | YG |
| F-297 Grease | 14-L-3 Grade II | RBM |
| "Gargoyle Artic C" | N.S. 2075 | TCB, TCC |
| Grease #66 | 14-L-3 Grade II | TCJ |
| Grease M-285 | OS-1350 | SCR-522, SCR-542, SCR-624 |
| HD-38G Oil | | AN/ARC-1 |
| Industrial White Oil #313 | Medicinal White Oil USP Grade | YG |
| Light Lubricating Oil | N.S. 2075 | SCR-299, SCR-399, SCR-499 |
| Light Weight High Grade Machine Oil | N.S. 3050 | TCQ |
| Lubrico M-6 Grease | 14-L-3 Grade II | RBM, SCR-274-N, TAJ, TBA, TBX, TCK, TCO, TCP |
| Lubriplate 105 | | AN/ARC-1 |
| Lubriplate (Ball Bearing Type) | 14-L-3 Grade II | TCO, TCP, TDT |
| M-285 Grease | OS-1350 | AN/ARC-1, AN/ARC-5 |
| Marfak #3 Grease | 14-L-3 Grade II | TAJ |
| Medium Fiber Grease | 14-L-3 Grade II | TDQ |
| Mobil Fluid HFW | OS-1113 | SCR-522, SCR-542, SCR-624 |

### Lubrication Chart

| Instruction Book Designation | Navy Specification Designation (or Nearest Navy Equivalent) | Equipments In Which Used |
|---|---|---|
| Mobil Grease PD-535-A | OS-1350 | AN/ARC-1 |
| Neatsfoot Oil | C-O-388 | DP |
| Non Fluid Oil | 14-L-3 Grade I | TBO, TDX |
| North Star 000 Oil | Transformer Oil 14-O-12 | AN/ARC-1 |
| Nujol | Medicinal White Oil USP Grade | RCO |
| PD 535 | OS-1350 | YG |
| Petrolatum | 14-P-1 | YG |
| Pioneer Instrument Oil #1 | 14-O-12 or OS-1362 | AN/ARC-1, SCR-624, SCR-522, SCR-542 |
| Royco #6 A Grease | 14-L-3 Grade II | BC-638, BC-639 |
| Royco #94 | OS-1350 | AN/ARC-5 |
| S-58 Grease | 14-L-3 Grade II | SCR-508, SCR-528, SCR-538, SCR-608, SCR-628 |
| SAE-20 | N.S. 2190T or 9250 | TDN, PE-75, PE-95 |
| SAE-30 Medium | N.S. 2190T or 9250 | TDN |
| "Superla 4X" Grease | 14-L-3 Grade II | TBU |
| "Temprite Sub Zero" | OS-1350 | DP |
| Typewriter Oil | N.S. 2075 | TBL, TBM, TBP, TBU, TBW, TBY, RBM |
| Univis #34 | 14-O-12 or OS-1362 | AN/ARC-5 |
| Univis #40 | OS-1113 | DAH, DAJ, DAK, DAQ, DAU, DBM |
| Univis #48 | OS-1113 | TCJ, TCK |
| U.S. 505 Grease | 14-L-3 Grade II | TBM |
| Vactra Oil, Extra Heavy X | N.S. 3065 | TDH |
| Viscolite Lubricant #10 Grease | VV-L-751 Grade II | TDH |
| W.S. 334 | AN-G-3 or OS-1350 | YG, YL |
| White Petroleum Jelly | 14-P-1 | RCO |
| White Vaseline | 14-P-1 | TDT |

### CHART II

### Ordering Information

| Navy Specification Designation | Federal Standard Stock Catalog No. | Standard Package |
|---|---|---|
| **Greases** | | |
| 14-G-1 Grade I | 14-G-1160 | 10 lbs |
| 14-G-1 Grade II | 14-G-1080 | 10 lbs |
| 14-L-3 Grade I | 14-L-131 | 1 lb |
| 14-L-3 Grade II | 14-L-90-15 | 1 lb |
| 14-L-3 Grade III | 14-L-85-5 | 1 lb |
| 14-P-1 | 14-P-100 | 5 lbs |
| OS 1350 | 14-G-715 | 10 lbs |
| SS-G-659 | 14-G-570 | 5 lbs |
| VV-L-751 Grade II | 14-L-165 | 25 lbs |
| **Oils** | | |
| C-O-388 | 14-O-3105 | 1 qt |
| N.S. 2075 | 14-O-2586 | 5 gal |
| N.S. 2135 | 14-O-2610 | 5 gal |
| N.S. 2190T | 14-O-2879 | 5 gal |
| N.S. 3050 | 14-O-2662 | 5 gal |
| N.S. 3065 | 14-O-2663-8 | 5 gal |
| N.S. 3080 | 14-O-2670 | 5 gal |
| N.S. 9170 | 14-O-2170 | 5 gal |
| N.S. 9250 | 14-O-2187 | 5 gal |
| OS 1113 | 14-O-884-10 | 5 gal |
| OS 1362 | 14-O-2833-65 | 5 gal |
| 14-O-12 | 14-O-3530 | 5 gal |

# Eliminating Radio Interference from motors and generators

*This is a continuation of the series of articles on Radio Interference which appeared in recent issues of the Radio and Sound Bulletin.*

■ Small motors and generators usually present more of a problem in obtaining adequate interference suppression than larger machines. There are several reasons for this; first, their inherent electrical characteristics are usually poor in comparison with higher-power machines; second, a large proportion of them are of inferior quality; third, there is less space available for suitable filtering; fourth, they are usually located much closer to equipment susceptible to the interference.

Small motors and generators are frequently built-in as integral parts of radio, radar or other electronic equipments. Units so installed must be thoroughly suppressed; otherwise nearby and connecting circuits will have large interference voltages induced into them.

For suppression over a limited frequency band, the installation of small capacitors from each brush to ground is often effective, but for suppression over the range usually specified for naval equipment (150 kc to 150 Mc) it is necessary to resort to *LC* filters.

## FAN AND BLOWER MOTORS

Figure 1 shows the application of small capacitors to the brushes of small commutating machines. The capacitor leads should be as short as possible and connected to the nearest part of the frame of the machine. The capacity value to be used depends on the space available, the voltage rating and the frequency at which suppression is most desired. The greatest amount of suppression will be obtained at the frequency at which the capacity and lead inductance becomes series resonant. This can therefore be shifted by changing either the value of the capacitor or the length of the connecting wires. It is best, however, to keep the lead-length short and change only the value of capacity. For suppression above 10 Mc, mica capacitors are recommended; below this frequency, paper capacitors are usually effective. Further suppression of radiated interference may be obtained by using shielded leads to the motor, the shielding around the leads being grounded to the motor frame.

More effective filtering may be obtained by using an *LC* filter as shown in figure 2. The prime requisites in this case are that the filter should be properly designed for good suppression over a wide frequency range, that the input and output leads of the filter be isolated from each other, that the filter ground return be short and effectively connected to the frame of the motor, and that the filters be designed for operation at the voltages and currents required in the installation.

In practice it is desirable to have the filter meet other requirements such as immersion, shock and vibration specifications, etc. If the filter is effective it will be unnecessary to use shielded leads to the motor terminals from the source of power unless direct radiation from the motor itself is so bad as to cause interference voltages to be picked up by the leads. In this case, however, it is best to eliminate the radiation by proper motor shields. In other words, always kill the interference *at the source* when possible.

In case of ball- or roller-bearings, it is very often necessary to provide grounded brushes to bear on the rotating shaft at the bearings to bypass and eliminate static discharges which would otherwise jump through the bearing grease to arrive at the potential of the machine frame. When encountered, this form of interference is very severe and is more difficult to eliminate than that from the commutator. It sometimes sounds similar to brush noise, and may at times be modulated by a characteristic commutator whine.

In general, the same treatment can be applied to small generators as that used with small motors. Motor-generators naturally require *two* sets of filters, one for the motor input and another for the generator output. They can be mounted in the same filter box if proper precautions are observed in isolating the filter input and output leads.

## MEDIUM-SIZED MOTORS AND GENERATORS

For purposes of interference suppression, this category includes units from about ¼ kw up to about 10 kw since units in this range usually require the same suppression technique. In general, the same methods are used as with the smaller machines but the additional leads for starting and field controls require special consideration. In addition, motors are sometimes equipped with vibrating-contact speed regulators, and generators are sometimes equipped with vibrating voltage and current regulators, both of which are notoriously bad sources of interference and must receive special treatment.

Figure 3 shows a diagram of filters applied to a common type of motor generator. The same idea is followed when separate filter boxes are used for the motor and the generator. In obstinate cases it may help to connect small capacitors from brushes to frame, although this should not be necessary if good filters are used in the leads. It is very essential to make sure that filter cases have good electrical connections to the filter box and that the box has an equally good connection to the frame of the machine. Mica capacitors connected across the input and output lines may also be necessary in certain cases. Figure 4 shows the arrangement of the filters and field resistance inside the box.

A more complicated example is shown in figure 5. In this case, filters are installed in the input, field, and output leads as before; a capacitor (about 0.01 $\mu$f) is connected across the speed regulator contacts; shaft grounding brushes are shown at each end of the shaft. If speed- or voltage-control resistors were to be located external to the unit, it would also be necessary to filter these leads as they leave the machine.

A summary of the procedure for filtering units of this type is given here:

a. Use filters that are properly designed for the application.
b. Install filters in each lead that leaves the unit.
c. Provide low-resistance current paths from filters to frame.

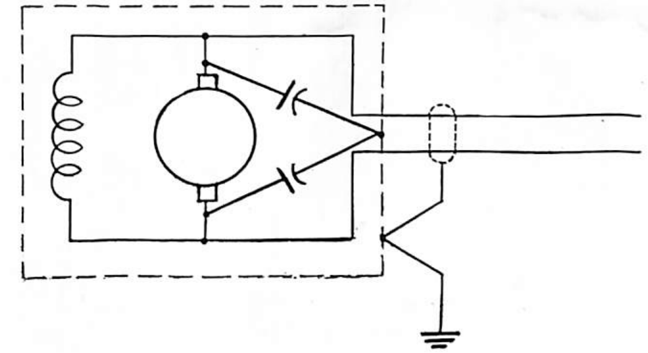


FIGURE 1—*Simple filter consisting of small capacitors connected between brushes and motor frame.*

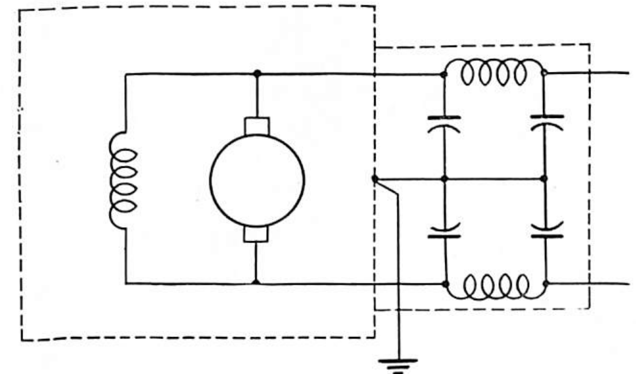


FIGURE 2—*More effective interference suppression is obtained with this inductance-capacitance filter.*

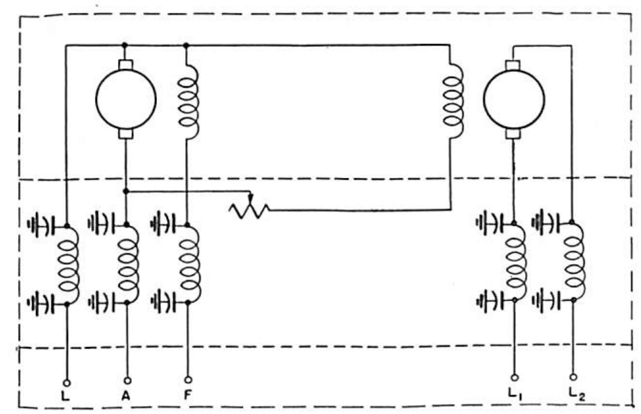



FIGURE 3—*All external connections to this motor-generator unit are filtered.*

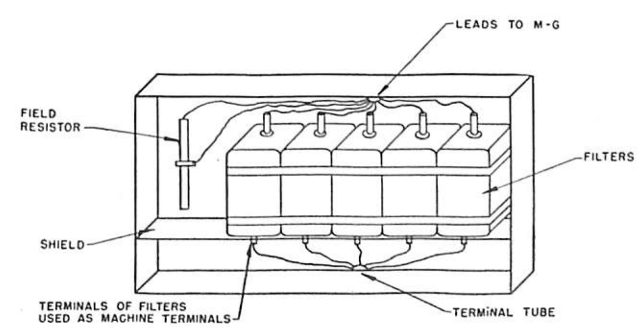



FIGURE 4—*Arrangement of components inside shield case of filter unit.*

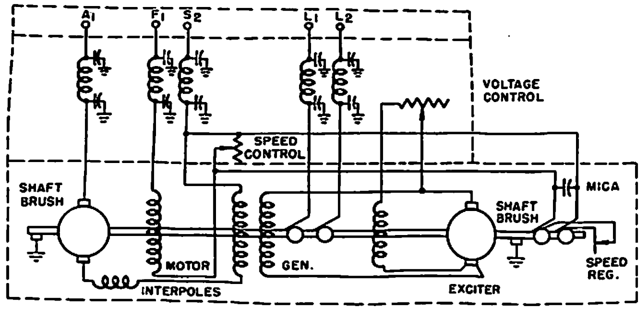



FIGURE 5—*A more elaborate filtering system for motor-generators includes shaft-grounding brushes and a capacitor across the speed-regulator contacts as shown.*

d. Isolate (or shield) the clean leads from the noisy leads.
e. If necessary, install shaft-grounding brushes.
f. Make sure that unit is in good electro-mechanical condition.

## LARGE MOTORS AND GENERATORS

It is often impractical to use *LC* filters on machines having very high current ratings since the size of the filter required may be objectionable. Since the interference created by the larger machines is frequently of lower value than that from small machines, because of better commutation and other electrical characteristics, sufficient suppression can often be obtained by connecting low-inductance capacitors of several microfarads capacity from each terminal of the machine to the frame.

Experiments are being conducted in reducing the interference by innovations in the design of brushes and the application of capacitors from various points along the commutator windings to ground, but there are no conclusive results available from these experiments at the present time.

## PERSONNEL ALLOWANCES

■ BuPers is revising the electronic personnel allowances to conform with the rapid expansion of the electronic program in the fleet. As soon as this revision is complete, detailed information will be transmitted to all ships. In general, the revision will conform to the table published on page 36 of the July 1945 issue of *C.I.C.* Magazine and will be in line with the Radio Specialist Officer and CIC Personnel Allowances established by ComInCh Serial 01387 of 15 May. It should be pointed out that ComInCh Serial 01387 of 15 May 1945 and BuPers confidential letters Pers-2141-LN of 27 January 1945 are inter-Navy Department documents concerning detailed and voluminous studies of electronic personnel requirements and are *not available* for distribution.

# New Books

■ Here are some thumb-nail book reviews of the Electronic publications recently distributed by the Bureau.

*U. S. Navy Synchros*—Unclassified—This is a joint Bureau of Ships—Bureau of Ordnance publication and is a complete text and reference on the subject. Besides explaining how synchros work, the book contains a great deal of practical information on such topics as standard connections, characteristics, zeroing, and maintenance. A wide initial distribution was made to all ships and concerned shore stations. Additional copies are available through Ordnance Publications Distribution Centers under the short title OP 1303. 166 pages.

*Calibration of Shipboard Direction Finders*—Confidential—Navships 900,101. This publication provides all the details necessary to calibrate such medium- and high-frequency direction finders as the DAE, DAK, DAQ, and DAU. Facilities required, adjustments, procedure, data, and necessary forms are all discussed. This pamphlet was distributed to all Calibration Officers and principal installation and maintenance activities. 24 pages.

*Herald Ranges* — Confidential — Navships 900,070. This profusely illustrated booklet is designed to acquaint personnel with the various factors which affect the ranges of herald (Harbor Echo Ranging and Listening Device) equipment. 44 pages.

*Use of Submarine Bathythermograph Observations*—Confidential — Navships 900,069. This publication, when complete, will consist of seven parts. So far, four parts have been printed, covering the following topics: Part 2, Sound in the Sea; Part 3, Prediction of Sound Ranges; Part 4, Diving; Part 5, Tactics. Distribution has been made to submarines and submarine activities.

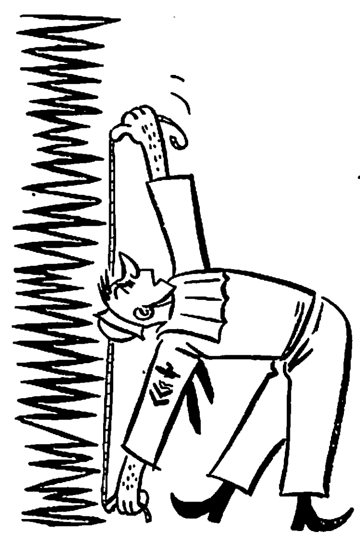
*Mobile Electronic Units* — Confidential — Navships 900,099. This is a collection of brief descriptions and photographs of mobile equipments now being procured by the Navy. Copies have been distributed to force commanders and other planning activities. 71 pages.

*Supplement No. 1 to Ships 242A*—Confidential. This supplement adds additional equipments to the "List of Naval Radio, Radar, and Sonar Equipment." Available to holders of Ships 242A through RPIO's.

*Maintenance Manual for Crystal Projectors*—Restricted—Navships 900,042. Another in the series of sonar maintenance manuals. Distributed to ships having the equipment. 292 pages.

*Maintenance Manual for Crystal Projectors*—Restricted—Navships 900,044. Distributed to sonar installations and maintenance activities. 171 pages.





# Measurement of Standing-Wave Ratio on X-Band Radars

■ If all the impedances are matched in an *RF* system, a constant load will be impressed on the magnetron. However, if there is a mismatch, energy will be reflected back and set up standing waves. The result is a loss of radiated power, and frequency pulling. This, in turn, might result in a poor spectrum and faulty AFC operation, so it becomes highly important to keep the standing wave ratio as low as possible.

## METHODS OF MEASUREMENT

The directional couplers now being supplied with a number of radars can be used in the measurement of the standing wave ratio in the waveguide. The source of power used may be from the system's transmitter or from a signal generator such as the TS-35/AP. The former source will show a high standing-wave ratio if there is a breakdown in the transmission line. On the other hand, it will give a ratio only for the frequency of the magnetron at the time of the test. The two methods of measurement are outlined below. It is extremely important that all connections be tight, with no change in orientation of waveguide couplings during the measurements. There should be no sharp bends in flexible cables. When using the signal generator as a source of power, there should be at all times at least 10 db of attenuation in the generator to avoid changes in frequency as the attenuator is varied.

## USING THE MAGNETRON AS A POWER SOURCE

1. Measure power level from direct (D) jack of directional coupler, using the TS-35/AP signal generator, TS-230/AP frequency power meter, or similar device. See instructions for instrument used. It is not necessary to know the exact power. Record the attenuator setting for a given meter deflection. Call this value $X_1$.
2. Measure power level from the reverse (R) jack of directional tap; i.e., set the attenuator for the same meter reading as in (1). Call this value $X_2$.
3. Note the attenuation values stamped on the directional coupler. Call the value on the direct (D) jack $X_D$ and the value on the reverse (R) jack $X_R$.
4. Calculate $X_D + X_1 - X_R - X_2$. This is the difference in power level between direct and reverse power expressed in db.
5. Using the value of power level difference obtain standing wave ratio from the table.

## METHOD USING TS-35/AP SIGNAL GENERATOR

1. Pull the transmitter far enough out of its case to make both halves of the air gap coupling accessible. Using the waveguide-to-waveguide patch cord (supplied with the signal generator) connect the signal generator output to the half of the air-gap coupling on the waveguide run to the antenna.
2. Using the waveguide-to-coaxial patch cord, connect the direct output jack of the directional coupler to the half of the air-gap coupling on the transmitter receiver.
3. Set the frequency of the oscillator in the signal generator at the high-frequency end of the band to be tested. If the signal level indication is to be visual, i.e., the system's *A*-presentation or an oscilloscope in the video channel, set the signal generator for square-wave output. If the indication is a meter on the second detector of the IF amplifier, set for CW operation.
4. Set the gain control of the radar system to a position where a very small amount of noise shows on the *A*-presentation.
5. Tune the beating oscillator and TR tube for maximum signal indication either on the oscilloscope or meter. Keep the attenuator on the signal generator set so that overload does not occur. The pattern on the

oscilloscope need not be synchronized; amplitude is the only thing that is to be measured.

6. Adjust the attenuator of the signal generator for some measured value of deflecion on the oscilloscope or meter. This should be below the overload point but great enough that it can be reset with an accuracy of 0.2 db on the attenuator. Record the attenuator reading. Call this value $X_D$.

7. Move the patch cord to the reverse-power jack of the directional coupler. Be very sure that there is no moving of the waveguide couplings and that no sharp bend is put in the coaxial cable. Readjust the attenuator to give the same deflection as in (6). Call this value $X_R$.

8. Calculate $X_D + X_1 - X_R - X_2$. This is the power difference in decibels between the forward and reverse jacks.

9. Obtain the standing-wave ratio from the table.

10. Repeat for a number of different frequencies, e.g., 25 Mc. spacing through the band.

*Table for Converting Power Level Difference to Standing-Wave Ratio*

| Power Difference (db) | Standing Wave Ratio | Power Difference (db) | Standing Wave Ratio |
|---|---|---|---|
| 1.0 | 25. | 16. | 2.7 |
| 2.0 | 19. | 17. | 2.4 |
| 3.0 | 15. | 18. | 2.2 |
| 4.0 | 13. | 19. | 1.9 |
| 5.0 | 11. | 20. | 1.7 |
| 6.0 | 9.5 | 21. | 1.5 |
| 7.0 | 8.1 | 22. | 1.35 |
| 8.0 | 7.1 | 23. | 1.2 |
| 9.0 | 6.2 | 24. | 1.05 |
| 10. | 5.6 | 25. | 0.95 |
| 11. | 5.0 | 30. | 0.54 |
| 12. | 4.4 | 35. | 0.46 |
| 13. | 3.9 | 40. | 0.17 |
| 14. | 3.5 | 45. | 0.10 |
| 15. | 3.1 | 50. | 0.056 |

## TUNING CW-43AAF-1 TRANSMITTER-RECEIVER

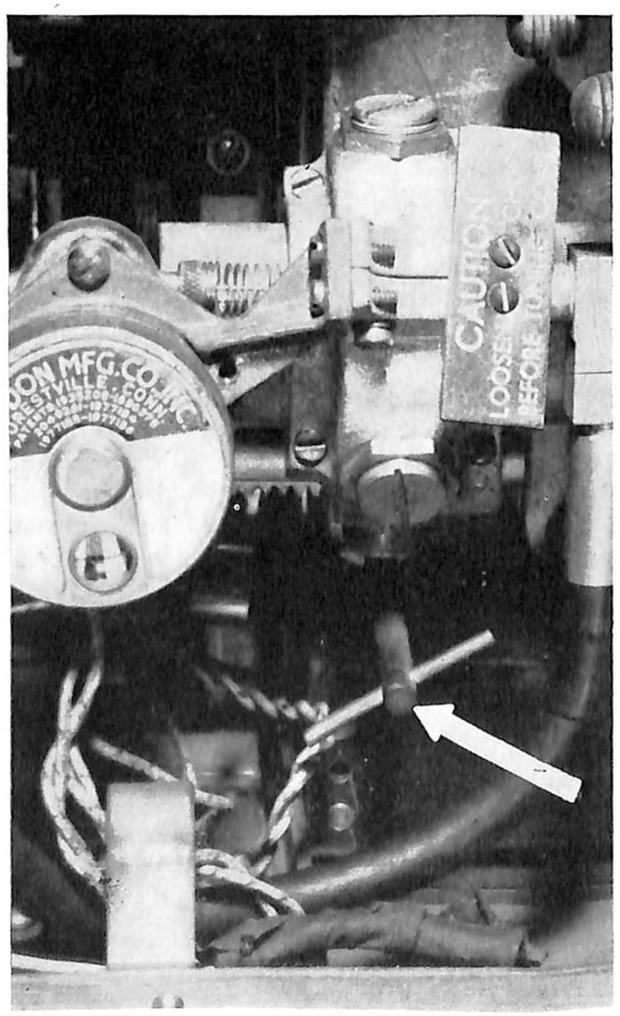
■ In the CW-43AAF-1 Transmitter-Receiver used for Mk 8 Mod 1, Mk 8 Mod 2, Mk 16, SJ-1, and other systems, frequent tuning has caused damage to the pinion head of the rack-and-pinion adjustment of TR cavity position.

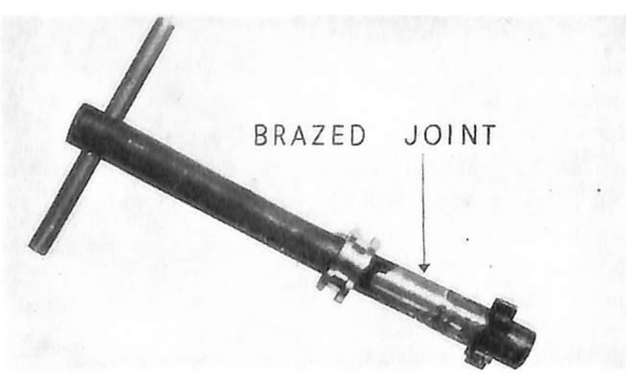
This failure may be eliminated and tuning made somewhat more convenient by the addition of an extension shaft to the pinion. This modification is shown in the photographs.

The pinion may be removed by loosening the two Allen set screws that hold it in place. A 1/4″ diameter steel shaft, 2 1/4″ to 3″ long is then brazed to the head of the pinion. Details of this change are shown below. Care should be exercised to prevent excessive overheating of the pinion.

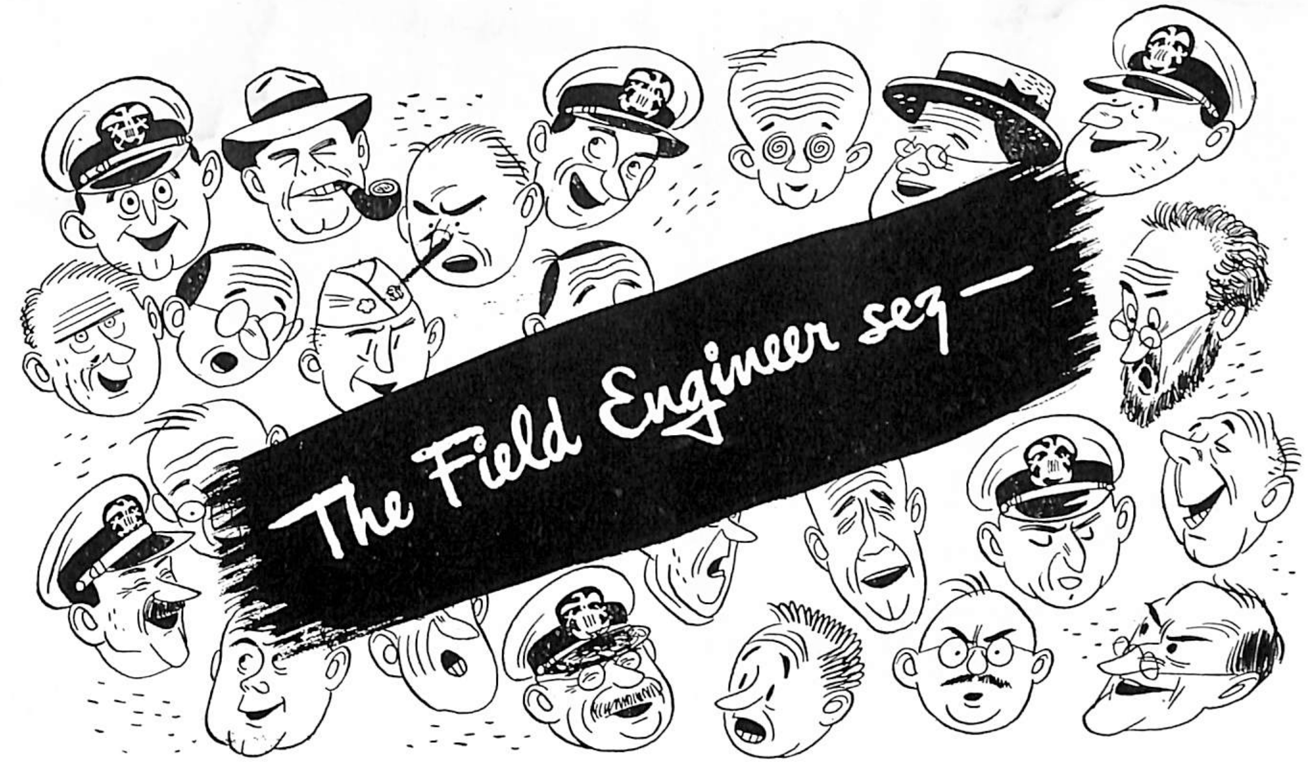
With a knob fitted to its end, this shaft makes the adjustment easier and more positive than formerly.

This modification was designed at the Radar Maintenance School of the Pacific Fleet Radar Center.








### SC/SK Resistor Failure

■ Several cases have been noted in the SC-2, 3, 4, and SK equipments where the *A*-scope saturation level lowered approximately 1/2″ when the Master PPI was turned on. In nearly every case the trouble was traced to R-2600, a 22,000-ohm, 1-watt resistor in the cathode-follower video circuit of the coupling unit. This resistor decreases in value, thereby loading the vertical deflection circuit of the indicator excessively.

Another serious effect is the overload that is introduced into the Master PPI video circuit, causing a blocking action when the receiver gain is increased to a normal operating level. This condition exists only when the value of R-2600 drops to 300 or 400 ohms. The effect is a blanking out of video signals to the scope and a very hashy appearance of the sweep on the same scope.

Under normal conditions, R-2600 operates very near its 1-watt rating. The answer to this problem is simply to replace the 1-watt resistor with a 2-watt resistor of the same value.

—*General Electric*

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### A.J. Receiver Sensitivity

■ Many A. J. receivers have been very erratic as to gain just at the point where operation is the best. Just a touch on the gain control will make the level jump sharply up or down. Different 6AC7's in the first two IF stages affected this some, but not enough to cure the trouble. Adding resistance between R4021 and ground so that the potentiometer would operate at a different point gave approximately the same conditions, although the jump in gain occurred at a different spot on the potentiometer. The trouble was found to be due to uneven windings on the potentiometer resistance element. The movable contact bridges several windings. The contact also rocks. Both conditions add up to jumpy operation.

Low sensitivity on the A. J. receivers has been found to be due to low voltage on the plate of the second RF tube. This was traced to the high side of ceramic capacitor C4015 shorting to the shield. Pushing it away cured the trouble.

Incidentally, did you know that an 8-volt drop in line voltage will cause a 50% drop in the A. J. receiver signals? That's another point to keep in mind, and one good reason for having a voltage-stabilizing transformer in the later equipments.

—*General Electric*

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### Anti-Hunt Control

■ The "anti-hunt" control in the remote training control unit, Model QCU, R-228 has been adjusted at the factory for optimum results. It is quite critical. Its readjustment requires considerable care. The normal position occurs at about 7/8ths counter clockwise. The follow-up is not quite as snappy as amplidyne. The factory limits are as follows:

(a) Maximum oscillation after stop: One degree
(b) Maximum undamped oscillation: ± 1/4 degree
(c) Dynamic error: ± one degree

These limits hold for ten-degree steps, during which the training mechanism should not be rotated at a speed greater than four revolutions per minute.

—*RCA*

### Mark 26 Mod 4

■ There have been scattered reports of trouble with the high voltage transformer T301 in the high voltage power unit. The primary difficulty is with the terminal seals of these transformers. They break open, leak oil, and allow voltage breakdown between the terminal bushings and the transformer case. This weakness was picked up in production tests of these transformers and has now been corrected. At the present time it is planned to replace the T301 transformers in *A*-Spares, item 114, with new transformers. Policy as to additional replacement will be determined by analysis of failure reports, and early receipt of such reports will expedite further replacement if this is found to be necessary.

There is one thing to watch closely if T301 is changed. It is only natural when putting in a new transformer to install it exactly like the the old one. Don't do it without consulting the circuit diagram first. Some of these transformers now in the fleet may be wired incorrectly. The low-voltage rectifiers are of the half-wave type. The primaries of these transformers should be connected so that the tubes will conduct on the same half of the cycle.

*—E. F. S. G.*

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### B.F.O. Adjustment

■ It is possible that some misunderstanding exists in the range and adjustment of the beat frequency oscillator on single-control tuning systems such as the QCU and QCQ-2. The front panel control C-423 should adjust the beat note to maximum with the peak filter *in* at 800 cycles. The range of the panel control is such that it will change the beat note when properly peaked at 800 from approximately 200 cycles minimum to 1500 cycles maximum. Some go through zero beat. This is O.K.

The B.F.O. oscillator cores of Z-404 should not be adjusted to give zero beat at the *low* end of panel control C-423.

*—RCA*

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### Mark 12 Motors

■ Some ships have experienced trouble in the lobing and spark-gap motors of the Radar Equipment Mark 12. If these motors are operated continuously they should be lubricated quarterly, instead of annually as stated in the instruction book. The life expectancy of these motors, when lubricated properly, is two to three years of continuous operation.

*—Bell Labs.*

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### A Mark 12 Time Saver

■ The DD-874's technicians experienced trouble in adjusting the Selected Signal Amplitude control, R(10)56, to give three volts at J(10)11.

In order to adjust R(10)56 it was found necessary to turn the Spot Disabling Adjust potentiometer, R(10)87, counter clockwise. Evidently there is an interaction between the enabling circuit and the selected signal A.G.C. circuit, and much time can be wasted by changing tubes and looking for non-existent faults when all that is necessary to correct the deficiency is a simple twist of the wrist. The RMO of the *USS Banner* (DD 807) had a similar experience and wasted considerable time and effort (as will anybody unless he has had the experience before) until the spot disable potentiometer was rotated counter clockwise.

*—E. F. S. G.*

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### Sp Servo Amplifier

■ Sometimes it becomes necessary to adjust the servo amplifier of the SP radar, due to a change of tubes, change of value in circuit elements, etc. However, do *not* change the torque limit control setting. This control is set at the factory and provides correct bias for the driver of the 6L6's. If this bias is too high, the antenna torque will be small enough to permit hand turning of the antenna. If the bias is too low, sufficient torque may be developed to strip the antenna gears if the electrical stop fails to function.

*—General Electric*

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### Give the Blower a Chance

■ Blower motors are installed in units of radar equipment to circulate the air which is heated by the tubes and circuit elements inside the units. The purpose of this circulation is to carry the heat to the metal of the case itself where it may be carried off on the outside of the unit by normal compartment ventilation. Failure due to overheating can frequently be traced to charts, books, boxes, etc., piled around the equipment preventing the air from taking up excess heat from unit covers.

*—E. F. S. G.*

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## CLASSIFICATION OF SHIPBOARD LORAN REDUCED

■ CNO restricted letter OP-25-A14/dm Serial 30525A of 1 May 1945 to all ships and stations reduced the classification of Loran Receiving Equipment to RESTRICTED. This applies likewise to the following books for Loran shipboard receiving and training equipments:

| Title | Short Title |
|---|---|
| Loran Handbook for Shipboard Operators | SHIPS 278 |
| AN/APN-9 Supplementary Shipboard Instructions | NAVSHIPS 900, 640 |
| CME-60069/CME-60069A Instruction Book | SHIPS 269 |
| DAS/DAS-2 Instruction Book | SHIPS 225A |
| DAS-1 Preliminary Instruction Book | NAVSHIPS 929-1 |
| DAS-3 Preliminary Instruction Book | SHIPS 263 |
| DAS-3 Temporary Instruction Book | NAVSHIPS 900, 254 |
| DAS-4 Instruction Book | SHIPS 322 |
| X-DBE and CXJD Instruction Book | SHIPS 321 |
| LRN-1/LRN-1A Instruction Books | — |

Activities holding copies of any of these publications should therefore mark the front covers RESTRICTED.

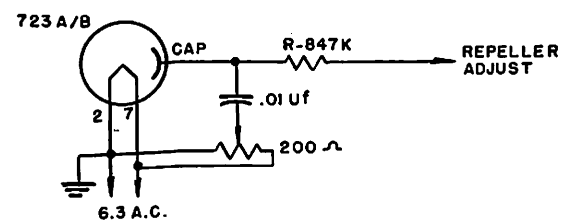
## ALCOHOL, ALIBI FOR USE OF

■ Technicians have learned by experience that the fins of 721A duplexers must be clean to insure maximum sensitivity of the radar, and that a common typewriter brush will do a good job. However, when cleaning the duplexer, do not overlook the glass portion of the tube between the fins. If this section is dirty, a marked decrease in performance will result. Alcohol is a good fluid to use . . . on the duplexer!


■

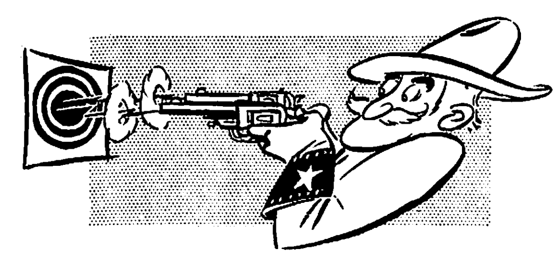
## IMPROVED OPERATION OF ST RADAR

■ Of the submarine radars now in use, the ST is the only one that is particularly unstable or hard to tune. Western Electric has completely re-designed the RF plumbing, but until this change actually gets into the field there is another scheme we have tried at New London which improves the operation considerably. This scheme, which we have dubbed the "World's simplest AFC," consists of superimposing a small amount of 60-cycle voltage on the repeller of the local oscillator, thereby swinging the frequency of the L.O. It was found that the tuning was more stable and that varying the length of the periscope adapter did not cause the echoes to disappear as they had formerly. As might be suspected, the echoes will be lacy if too much ac is used, but it was found that adding 1.5 to 2 volts gave good results.




*E. F. S. G.*

■



## TWO GUNS

■ The Electronic Tube Corporation has developed a special oscillograph utilizing a single 5-inch cathode ray tube containing two electron guns whose operations are completely independent of each other. The tube was developed for the simultaneous investigation of two independent phenomena or the study of a single phenomenon with a timing trace. The scope is well suited for photographic work, each trace having the brilliance of a separate tube, and can be supplied with any type of tube screen desired. The tube is designed so that each trace can be moved about the screen or the traces superimposed one upon the other. One gun may be operated alone if desired and no change in the equipment is necessary. At the present time no use of this tube is being made by the Navy.

■

## SERVO MAINTENANCE IN SU RADAR

■ The Motor-Generator Servo, B-405, which is mounted on the yoke of the Antenna Assembly, 974 and 974A of the SU Radar, is a vital part of the line-of-sight stabilization system, and because it rotates at very high speed (approx. 14,000 r.p.m.) the following maintenance schedule must be maintained:

1. After each 1000 hours of operation, replace both brushes on the generator end of the machine.
2. After each 2000 hours of operation, disassemble the machine and carefully clean it to remove all small brush particles which have accumulated. Carbon tetrachloride or its equivalent may be used for this purpose.

If this maintenance schedule is followed, continuous operation of the machine is virtually assured for many thousands of hours.

■

## DIM YOUR LIGHTS

■ Some Navy equipments are provided with a variable resistance for adjusting the brilliance of dial and indicator lights. As a decrease in voltage will greatly increase the life of the lamps, there is good reason to operate them at reduced brilliance where possible. This is especially desirable in cases where the lamps must be depended upon for some critical indication, or where they are difficult to replace.

In the RCK receiver, for example, the four red indicator lamps above the dial are inter-connected with the crystal selector switch, and therefore assist in setting the receiver on frequency. This puts a premium on long life of indicator lamps, and makes it worth while to turn down the dimmer control at least half way when full brilliance is not actually required.

# Sonar Projector Maintenance in the Pacific


■ It will soon be possible to repair and overhaul sonar projectors in the Pacific areas. There will also be made available to the Advance Base personnel the same test equipments which are used by the Naval Inspectors at the factories to determine whether the projectors are meeting BuShips' specifications. Once these facilities are operating, it will not be necessary to send a damaged projector back to the factory for repairs or tests.

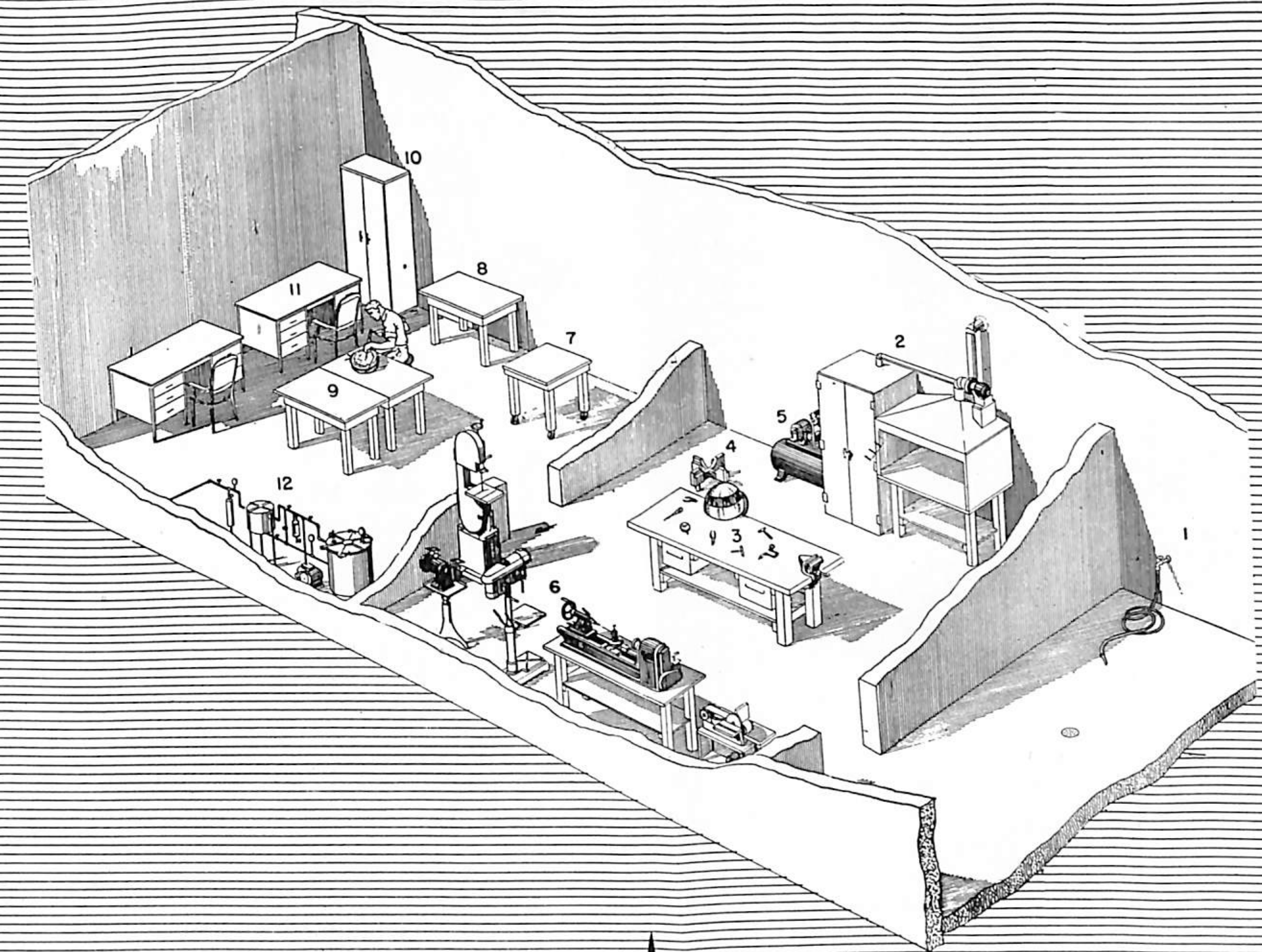
At present, Navy Yards Mare Island and Pearl Harbor are repairing and testing projectors of all types by the latest methods. In accordance with a recent CINCPAC request, two additional land-based repair facilities are being set up and should be in operation the latter part of this year. The new installations will be made at Guam and at another unnamed location. In these land based sonar repair stations it will be possible not only to fix and renovate all types of projectors, but there will also be means for completely testing any projectors, new or reconditioned.

These repair stations are provided with air conditioning and humidity control units capable of keeping the temperature between 70 and 80 deg. F. and the relative humidity between 30 and 50 percent. The temperature and humidity controls are necessary only when repairing crystal projectors. Figure 1, taken from the Maintenance Manual for Sonar Crystal Projectors (NAVSHIPS 900,044), shows a typical arrangement of the repair laboratory. From the washing platform (1) on the right, the damaged projector is taken inside the laboratory and disassembled on the large work bench (3) in the center of the room. This room is essentially used for disassembly, reassembly, and for repairing and cleaning the projector case. It is here also that machine tools (6) and the spray booth (2) are located. The air compressor (5) furnishes air for crystal spraying and cleaning purposes.

The more delicate operations of testing and repair are carried on in the room to the left. It is here that the crystal array of crystal projectors is repaired or rebuilt (9). Following repairs to the crystal array, the projector is reassembled and refilled with technical castor oil. This filling operation is carried on in special evacuating apparatus (12). It is in this room also that magnetostriction projectors are repaired and refilled with $CO_2$ gas.

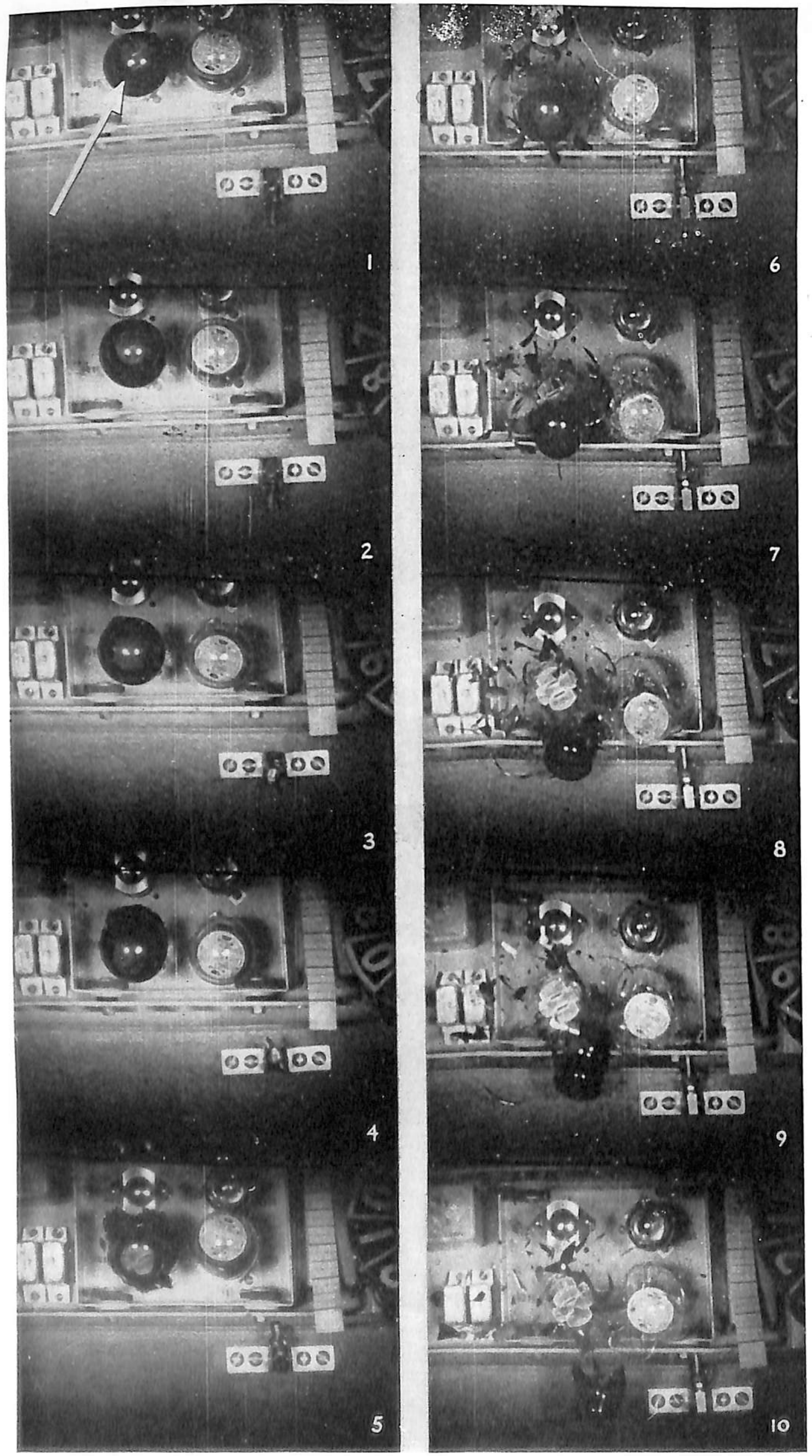
After the mechanical processes of repair are completed, the projector is tested. It is given a megger test, transmitting response, receiving response, and directional response test (beam pattern). The latter three tests are made in a test tank. The inside dimensions of this tank are approximately 16′ x 16′ x 16′. The usual construction for the tank is concrete and the top is boarded over. A 2½-foot wide opening extends across the top to accommodate the raising and lowering of the training shaft and projector. The tank is filled with water to within a foot of the top.

This testing equipment, identified as Model XCG, has been developed for determining the open-sea performance of a projector under actual service conditions. It has been in use for over two years and has proved of great value to the Navy. At manufacturer's plants, at development and reference laboratories, at Navy Yards and advanced bases, the sound output, beam pattern and sensitivity of a projector will be measured in the same way and the results will have a standard meaning. Thus by quantitive measurements and skillful repairing, the service performance of the sound gear will be increased and unified.



Personnel for these projector repair facilities will be specially trained in all phases of projector maintenance. In addition to the officer in charge of each unit, six Radio Technicians, under a Chief or First Class RT will be on hand to keep the projectors in first class condition. All six of these RT's have received special training in the latest methods of projector testing and repair. Special training courses have been set up at Radio Matériel School, NRL, to train these maintenance personnel. The highly specialized nature of the work requires that special emphasis in procedures be given to all men responsible for the upkeep of the projectors. Two of the RT's will be specially trained in the operation and maintenance of the Model XCG test equipment. Many of the personnel have had previous experience in the various phases of projector maintenance at the Navy Yards at Mare Island and Pearl Harbor.

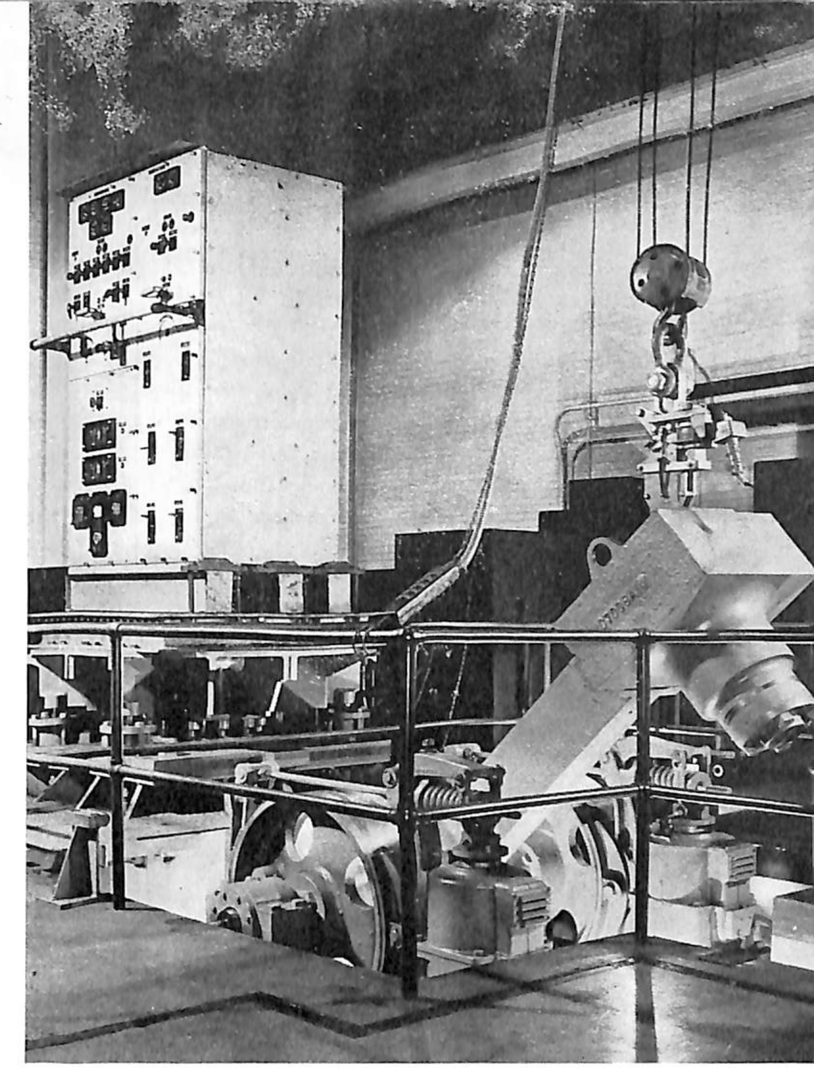
In addition to the increased facilities in equipment for repair and testing, detailed information on the repair of sonar projectors is available in Maintenance Manuals published by the Bureau of Ships. The projector section in the Maintenance manuals for QCS/S-1/T/T-1/Q-1/R-1 (NAVSHIPS 900,026), QCQ-2 (NAVSHIPS 900,046), WCA/A-1 (NAVSHIPS 900,045), and WEA-2 (NAVSHIPS 900,042) deals primarily with the repair of magnetostriction projectors. Instructions for the repair of crystal projectors can be found in NAVSHIPS 900,044. Detailed maintenance and operating procedure for the testing equipment mentioned above is contained in the Maintenance Manual for Model XCG Projector Testing Equipment being prepared by the Naval Research Laboratory.



*High-speed motion pictures showing the breaking of a vacuum tube during a shock test.*

# Shock and Vibration Testing of Electronic Equipment

LT. CDR. G. L. MACLANE, U.S.N.R., BUSHIPS



*The medium-weight shock-testing machine at Westinghouse. When released, the hammer starts downward, then swings upwards to strike the anvil plate from beneath.*

■ The problem of building electronic equipment sufficiently strong to stand up under the shock and vibration of naval service has been accentuated by the extensive use of such equipment and the many and varied service conditions encountered. In the files of the Electronics Division there are volumes of reports on equipment failures ascribable to shock and vibration. The following are typical:

*From a CA:* "FD regulated rectifier. Tubes are sheared off and jump out of their sockets each time the guns are fired. On one occasion the whole internal assembly jumped completely out of its box."

*From a DD:* "One main radio jack box was shattered and wires leading to it were snapped off. Inside the TBL itself, in a protected location, output leads were broken at terminals by the shock of gunfire. Glass meter windows in TBL and TBK were shattered during one heavy bombardment."

*From a DE:* "SL equipment. The operators on the DE-type ships complain of unusual vibration of the equipment making it difficult for them to read the screen."

*From a BB:* "TDY equipment. After firing the main battery subsequent to the new installation, the antenna reflector had ripped loose from its mounting bracket and was jammed inside the housing. During the same firing the port transmitter antenna was also damaged, the synchro gear-train being jammed and the synchros jarred loose from their seats."

All these casualties resulted from own ship's action, not from any action of the enemy. An obvious remedy is to locate equipment where the shock and vibration is not severe, and this is done wherever possible. However, it is the responsibility of the Electronics Division to supply equipment which is inherently shock proof, and can stand up when installed in locations most convenient for use.

To this end it is necessary that we be able to subject equipments which are proposed for fleet use to tests which duplicate the shock and vibration damage encountered in service. The efforts of mechanical engineers of a number of service and industrial laboratories have been devoted to the problem of setting up suitable tests and of building equipment which will pass the tests. The Taylor Model Basin and the Naval Research Laboratory have made extensive field surveys of the shock and vibration characteristics of typical warships. Engineers of the Bureau of Ships, working with these groups and with the research laboratories of the major suppliers of electronic equipment, have designed test machines and set up specifications which insure equipment of a high degree of reliability. A constant check is made on damage reports from the fleet to determine what types of damage are encountered and whether the tests should be modified to duplicate that damage.

Analysis of the data obtained on field shock tests shows that shock motion may occur in an enormous number of ways. There is no such thing as "simple shock," nor is there any simple way to measure it. There are certain general features, however, which can be described. Damaging shock is a motion characterized by a sudden start or stop, followed by a decaying complex vibration. The extent of the motion and the nature of the vibration depend on what causes the shock and on the particular structure involved.

## TESTING MACHINES

A shock-test machine, then, must reproduce the essential characteristics of shipboard shock, and in the laboratory must duplicate failures known to occur in service. Navy type high-impact test machines have been built to do just that, and several years of experience enables us to say that they duplicate service damage in a satisfactory manner.

The light-weight machine will handle loads up to 400 pounds. Its two hammers and swinging anvil plate make it possible to strike blows from three directions. The hammers weigh 400 pounds and have a maximum fall of five feet. The medium-weight machine can handle equipment weighing up to approximately 5000 pounds. Its 3000-pound hammer strikes a blow from the bottom of the anvil plate. Standard machines of these types are available in several naval laboratories and navy yards, as well as in the plants of many manufacturers.

When tests are made, the equipment under test is attached to the anvil plate by means of mounting adaptors which simulate the resiliency of a ship. The distance of hammer travel and the number of blows depend upon the machine used and the weight of the equipment being tested.

A number of instruments are used to obtain test information—strain gages, accelerometers, and travel recorders are typical. But the most useful device for finding out how damage occurs is the high-speed motion picture camera. Pictures can be taken at a rate as high as 800 frames per second. (Ordinary movies are taken at a rate of 24 per second.) When these high-speed movies are projected at normal speeds, engineers can see clearly just how their designs can be improved.

## PROCEDURE

A shock test on a piece of large equipment is interesting to watch. Cover plates and doors are taken off the cabinet so that the components can be seen. Powerful Hollywood-type lamps provide illumination for the movie cameras. Test engineers adjust elaborate measuring equipment. When everything is ready, the hammer is released and the blow is struck. The test is over in a fraction of a second. The equipment is then carefully examined. What broke? Why did it break? How shall the equipment be modified so that the same failures will not occur in service? The answers are frequently very easy. Tubes usually break because they sway in their sockets and collide with other components. Wires snap off because no slack was provided. The tests always show ways in which the equipment can be improved, and these improvements are made in the production models.

Complete and detailed damage reports from the fleet are invaluable in that they make it possible to obtain close correlation between shock casualties in the fleet and test results in the laboratory. The SC and SA radar antennas were reported to be failing from shock. High-impact shock tests duplicated the failures and showed a means to prevent them. Tests on the FD regulated rectifier mentioned earlier duplicated the failures in the fleet. On the other hand, tests on the SG antenna showed it to be practically indestructible—in line with its excellent service record.

The Mark 13 radar was reported in the July issue of the ELECTRON to have withstood the shock of firing over 1500 rounds of 16″ and 5″ without failure of any kind. High-impact shock tests were made extensively throughout the development of this equipment.

The shock program is not limited to the testing of complete equipments. Careful studies have been made of the design and application of shock mounts. The problem of finding satisfactory synthetic rubber has been solved. An extensive program of tube improvement has been underway. We now have some types of electron tubes that will withstand the full five-foot blow of the shock machine without damage.

## INSTALLATION

There are a number of older equipments in service which are not as reliable under shock as modern designs. Modification kits are available for some of these. For others, minor changes in installation and construction will help materially. Hints on installation are as follows:

1. Do not attach equipment to bulkheads exposed to gunblast.

2. Provide flexibility between the foundation and the equipment. Whenever possible, the recommendations of "Shock Mounts for Naval Shipboard Service" NAVSHIPS 250-600 should be followed. If this cannot be done, equipment should be attached to the ship by means of mild steel straps which will bend under shock. A clearance of at least one inch should be allowed around the equipment if this method is employed. Do not use shock mounts which are too soft or permit metal-to-metal bottoming. Properly shock-mounted equipment is quite stiff to the touch.

3. Provide ample slack in all cables attached to flexibly mounted apparatus.

4. Make sure that apparatus is firmly secured to its supports, and that desks and tables are firmly secured to the ship.

It is usually more difficult to modify equipment internally. When possible, the following steps are helpful:

1. Clamp tubes to prevent ejection from sockets and collision with other components.

2. Provide a lock or tie to prevent fuses and resistors from jumping out of their clips.

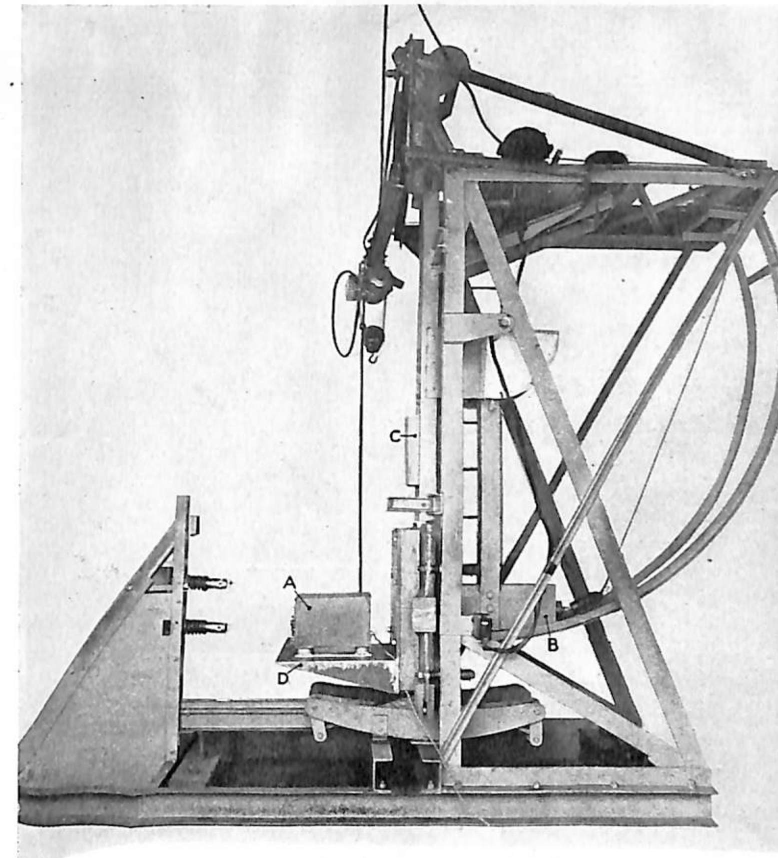
3. Provide stronger hold-down bolts for heavy components.

4. Lengthen leads so that flexing of the chassis will not snap them off.

5. Use shock-proof tubes in critical sockets. These can be identified by the "W" in the type designation.

## VIBRATION

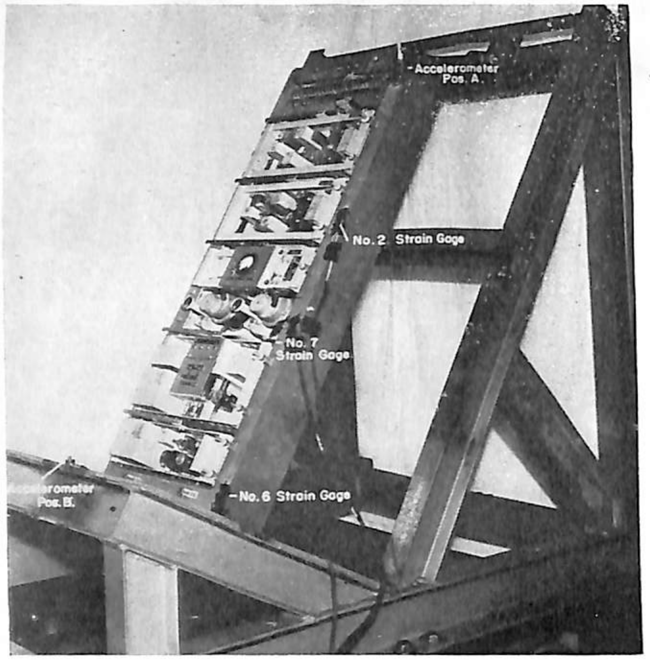
Parallel to the problem of shock is that of vibration. Shock damage is sudden and obvious; vibration damage occurs over a long period. Screws loosen, tubes work out of sockets, and finally the equipment is inoperative for no obvious reason—it just doesn't work.




*Light-weight shock-testing machine at N.R.L. The equipment under test is shown at A, mounted on fixture D, which is attached to the anvil plate. B and C are the 400-pound horizontal and vertical hammers.*

The propellers cause most of shipboard vibration. The frequency is one sixtieth of the product of the tail shaft speed and the number of blades. Frequencies from about 3 to 25 cycles per second may be encountered depending on the type and speed of the vessel. The amplitudes may vary from a negligible thousandth of an inch or so, up to 20 or 30 thousandths.

Unfortunately, some equipments have been supplied to the fleet which are equipped with rubber mounts that become resonant in this frequency range. If there is an appreciable disturbance, the resulting equipment vibration may be quite large, to the annoyance of the operators and the deterioration of the equipment. The only practicable means of correcting this condition, when it exists, is to replace the mounts with stiffer ones, and if there is still considerable rocking motion, to install head-braces which support the equipment at the top. Present vibration test specifications reject equipment which is resonant in the range of shipboard vibration frequencies.




*Typical arrangement of jigs and gauges for shock-testing equipment with the medium-weight shock-testing machine.*

Unlike the shock test, the vibration test takes a long time—a total of 9 hours. With the large amplitudes used on test, defects in construction or design are immediately apparent. Fortunately, the problems of vibration measurement are not so difficult as those of shock measurement. But vibration-test machines are more difficult to design and construct than shock-test machines. Only recently, through the efforts of the Naval Research Laboratory, the Bureau of Ships, and one of the large commercial laboratories, have satisfactory machines become available. These latest test machines provide frequencies of 3 to 60 cycles per second, have automatic amplitude control, and provide vibration in both horizontal and vertical directions.

While very considerable progress has been made in establishing satisfactory performance standards and machines for shock and vibration tests, there is still much to be done. Recognizing this need, the Naval Research Laboratory established the Shock and Vibration Division a year ago. Progress has been rapid since the establishment of this group. The Division has outgrown its quarters several times so that there is now being constructed a new laboratory building. It will house the most modern equipment for the study of shock and vibration problems and the improvement of naval equipment.

The shock and vibration tests given to equipment prior to its acceptance by the Navy are significant only if they help us design equipment which will perform satisfactorily when installed aboard ship.

The final and really significant test is the test of battle. We in the Bureau know how the equipment stands up in battle only by the reports from the fleet. It is of greatest importance that reports of damage to equipment be made to the Electronics Division whenever practicable. The more detail there is in these reports the better—cause of the shock, location of guns, location of equipment, analysis of damage. Reports of vibration trouble should state, if possible, the frequency of the forcing vibration, the location of the equipment, how it is supported, and whether the vibration of the equipment is greater than the vibration of the ship. A photographic report can speak volumes. Information on successful remedial measures is also valuable.

With adequate reports from the fleet the Bureau frequently is able to make helpful suggestions immediately. And these reports enable the Bureau to modify its test specifications to insure that weaknesses in existing equipment are not duplicated in equipment which is now being designed.

## NOW RESTRICTED

■ The publication "Radar System Fundamentals" (Navships 900,017) has been reclassified from confidential to restricted. This book is widely distributed throughout the fleet and all holders are requested to mark their copies accordingly. The new classification will simplify the handling and use of the publication, so pass the word around.

■

## KEEPING YOUR MARK 22 DRY

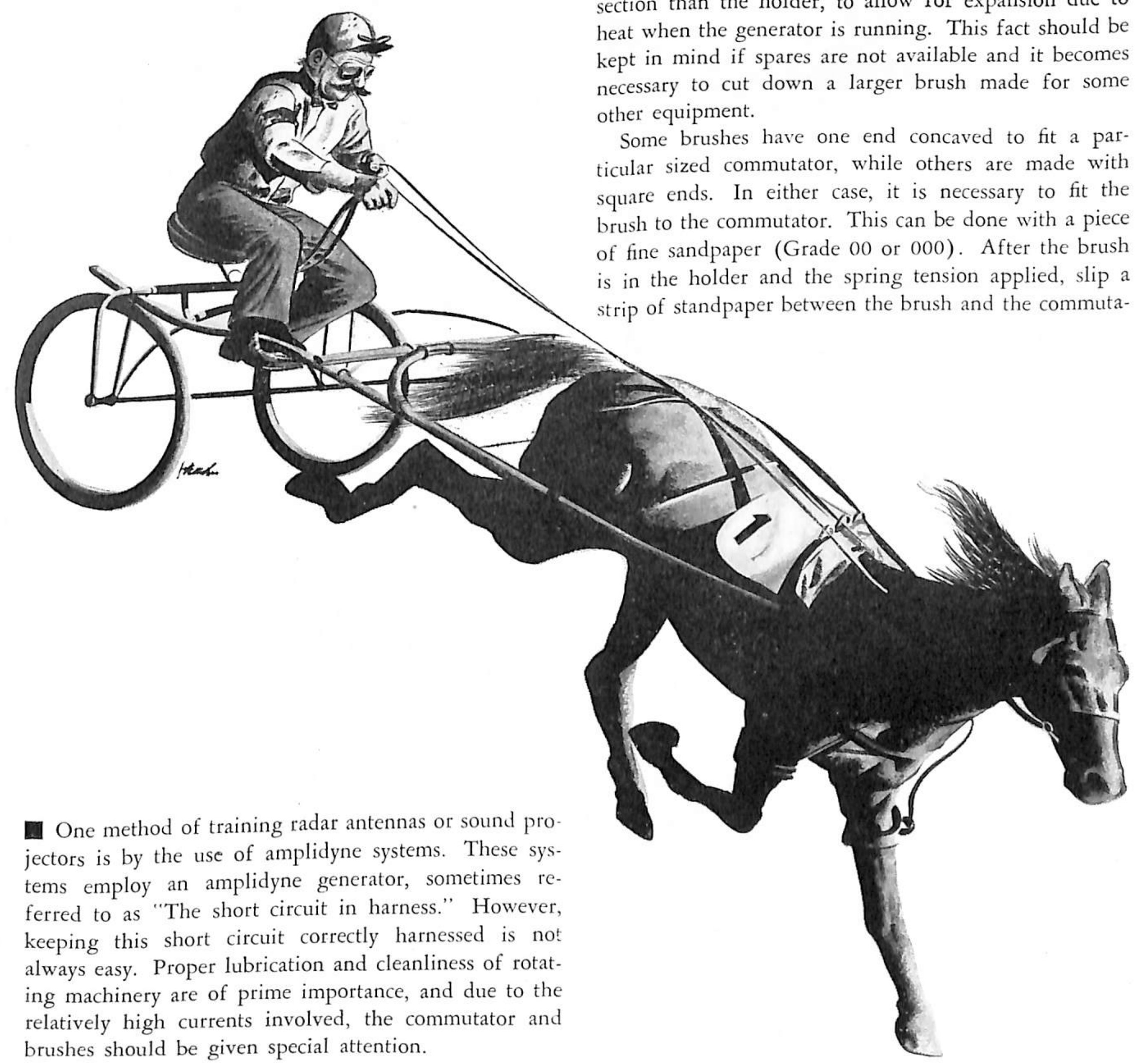
■ Field reports have indicated that water often damages the Mark 22 transmitter-receiver unit, mounted topside on the director. This is usually caused by the cover not being tight against the gasket.

A cruiser reports that stack gas had so corroded the cover fastenings that they could no longer hold the cover down sufficiently tight to prevent the entrance of water. To remedy this situation, the sailmaker rigged up a canvas cover for the whole transmitter-receiver unit. Apparently the heat radiation characteristics are not sufficiently altered to cause any damage. Tuning is greatly facilitated by drilling holes in the cover so that it is unnecessary to remove it in order to tune the gear. The cover also eliminates the trouble of drift, often caused by the wind cooling the local beating oscillator.

—*Western Electric*



# Keeping UP Your Amplidyne



■ One method of training radar antennas or sound projectors is by the use of amplidyne systems. These systems employ an amplidyne generator, sometimes referred to as "The short circuit in harness." However, keeping this short circuit correctly harnessed is not always easy. Proper lubrication and cleanliness of rotating machinery are of prime importance, and due to the relatively high currents involved, the commutator and brushes should be given special attention.

## INSPECTION OF BRUSHES:

Brushes should be inspected at fifty-hour intervals. By removing the spring and sliding the brush back and forth in the holder, any stickiness or roughness can be felt. This trouble is often caused by a small amount of grease or a chip from the brush collecting between the brush and its holder when cleaning is neglected. If an inspection reveals chipped or broken brushes a replacement should be made, or when, as a result of normal wear, brushes become so short that they should be replaced with new brushes.

## REPLACEMENT AND FITTING OF NEW BRUSHES:

Normally, brushes are replaced from the equipment spare parts. These brushes are slightly smaller in cross section than the holder, to allow for expansion due to heat when the generator is running. This fact should be kept in mind if spares are not available and it becomes necessary to cut down a larger brush made for some other equipment.

Some brushes have one end concaved to fit a particular sized commutator, while others are made with square ends. In either case, it is necessary to fit the brush to the commutator. This can be done with a piece of fine sandpaper (Grade 00 or 000). After the brush is in the holder and the spring tension applied, slip a strip of standpaper between the brush and the commutator with the rough side toward the brush. By moving the sandpaper back and forth as though to shine the commutator with the smooth side, the correct fit may be attained. Another method is to hold the paper to the commutator and move the armature back and forth. The space available in the particular installation being worked on will determine which method is easier. All carbon dust should be removed from the unit after this operation.

## BRUSH TENSION:

The tension on brushes should be maintained at about 1½ pounds per square inch of brush cross sectional area unless otherwise specified by the manufacturer. Equal tension should be applied to all brushes in order to insure correct contact resistance. Light tension will result in sparking and erratic operation, and heavy tension will cause excessive wear of the brushes.

## CARE OF THE AMPLIDYNE COMMUTATOR:

A commutator in good condition will have a dull bronze color and be very smooth. Carbon deposits from the brushes, if present, may be removed by the use of carbon tetrachloride on a lint-free cloth. A very slight roughness of the commutator may be corrected by rubbing with an ordinary piece of sandstone. If this is not available, a piece of fine sandpaper over a block of wood will suffice. If the commutator is pitted, grooved, not round, or otherwise in bad condition, it will have to be centered in a lathe and turned down a few thousandths of an inch. Under no circumstances should files or emery cloth be used on the commutator.

In the amplidyne generator, good insulation between the commutator segments is essential. The insulation material most commonly used is mica, which is harder than the commutator bars themselves. Consequently, after the bars have worn down slightly the mica may protrude, causing arcing. This protruding mica must be cut down to the level of the commutator bars, or even slightly lower. This process is known as undercutting the commutator, and unless the help of someone skilled in this work is employed, considerable damage to the commutator may result. These jobs are ordinarily given to repair ships, which have the necessary tools and trained personnel.

When armatures are stored, they should be wrapped in a piece of cloth or protective material to prevent damage to the commutator and other parts.

## OVERHAUL OF AMPLIDYNE UNITS:

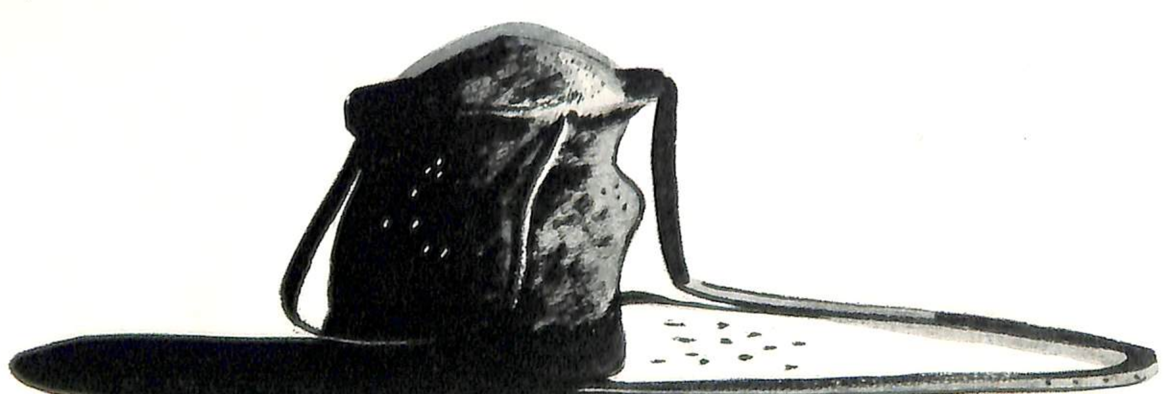
After approximately one thousand hours of operation the amplidyne generator should be given a complete overhaul as outlined in the instruction book. This overhaul involves complete disassembly, cleaning, and replacement of defective parts.

## EFFECTS OF DUST ON THE GENERATOR:

On windings, dust acts as a layer of heat insulation, interfering with proper ventilation. On slip rings and commutators, dust acts as an abrasive, and once inside bearings it can be as harmful as sandpaper to their highly polished surfaces. Wherever dust collects in the casing and windings it acts as a sponge to soak up oil, grease, fumes, etc. Carbon tetrachloride and a low pressure air hose can be used to remove this collection.

## LUBRICATION:

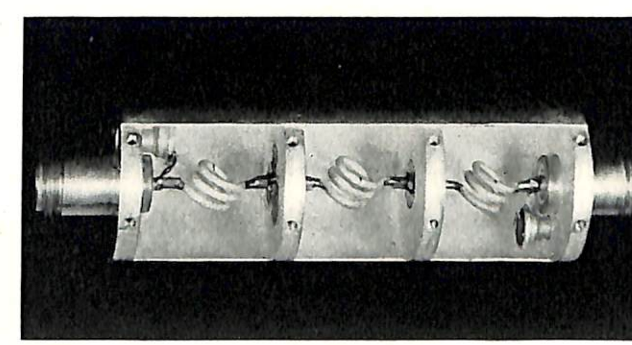
Specified lubricants in the correct amounts are the "lifeblood" of the amplidyne, but stray oil and grease are poison to the unit. The manufacturers' lubricant or the Navy Specification Designation lubricant, whichever is in spare parts or specified in the instruction book, should be used. The frequency of lubrication as given in the instruction book is figured on the basis of normal operating time. If your equipment is run almost continuously, lubrication should be somewhat more frequent. It is well to keep in mind, however, that overlubrication is worse than underlubrication, due to the excess heat created. The best advice that can be given on this subject is: Use good judgment, Navy and manufacturers' information, and a regular schedule for maintenance.






## HARMONIC SUPPRESSOR FOR TDQ

■ Harmonic frequencies radiated by the antenna system of Model TDQ Transmitters are likely to interfere with other equipments on the same ship, or even on nearby ships. A small filter has therefore been developed to suppress these harmonics. Known as TDQ Field Change No. 2, the filter is coupled into the transmission line quite simply by means of cable connectors and accessories furnished with the kit. The filter consists of three low-pass $\pi$-sections designed to attenuate all frequencies above about 171 Mc. Ships having early equipments which were received without this filter may obtain them by requisition from supply activities at NYNYK, RADOAK, or FRAY-32. A number of filters was obtained under contract NXss-29644 for this purpose. Detailed installation instructions appear in C.E. M.B. Supplement No. 2.



*Cross-sectional view of the filter unit.*

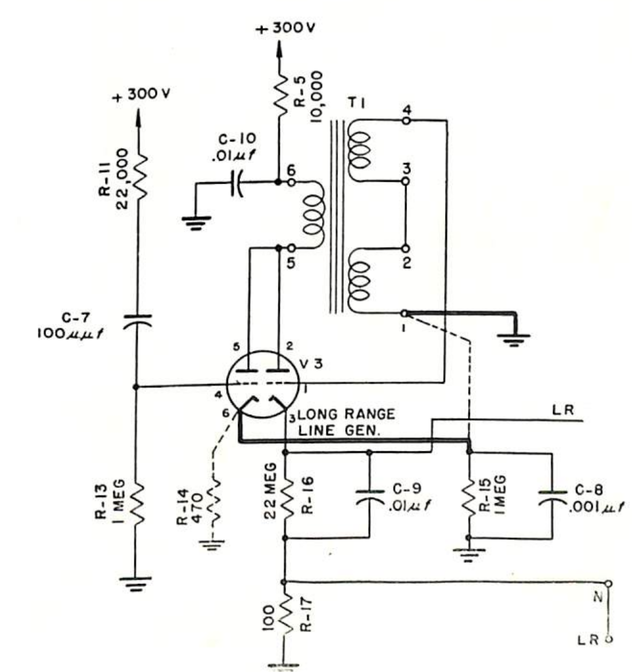
## LINEARITY CONTROL ADJUSTMENT

■ When the VF trigger delay line is installed in an SG system, the sweeps on the indicator are delayed so that the zero marker is not completely visible on the *A*-scope, and the range offset cannot be run back to this marker. With this condition it becomes impossible to properly adjust the 15,000 yard linearity control, R-9109, at zero yards.

If it becomes necessary to adjust or check the setting of this linearity control, the zero range maker can be made visible by adjusting the trigger delay line for zero delay. Adjustment of the control can then be made in accordance with SG Field Change No. 35. After the completion of this adjustment the trigger delay line should be reconnected to its original terminals.

## MARK 13 LONG-RANGE LINE

■ It has been found that every 6SN7 will not function properly as a long-range line generator. The circuit change shown below has the effect of reducing the steady current through R-5 and the primary of T-1,




*Circuit changes for increased long-range line brilliance. Added wires are shown heavy, and dashed lines indicate wires removed.*

resulting in an increased amplitude of the range line. This change has been incorporated in production beginning with serial #21. Equipments now in the field are authorized to be changed in the following manner: Remove the wire which connects terminal 1 of T-1 to the junction of C-15 and R-8. Ground terminal 1 of T-1. Disconnect wire from pin #6 of V-3 and discard R-14. Run a new connection from this pin to the junction of R-15 and C-8.

## GCA SPARE PARTS

■ The procedure for obtaining spare parts for AN/MPN-1A equipments is not fully understood by all activities using the gear. Since the equipment has no airborne components, all procurement should be referred to the Electronics Officer of the cognizant maintenance yard or fleet maintenance activity. This is in accord with Chapter 67, BuShips Manual.

Stock spare parts for AN/MPN-1A equipments have been distributed to the following activities for further distribution by the Electronics Officer: (1) CONSERON 10 Repr. B (Roger 2); (2) Supply Officer for Radio, Radio Supply Branch, NSD Oakland, Calif.; (3) Supply Officer for Radio, Charleston, S. C.

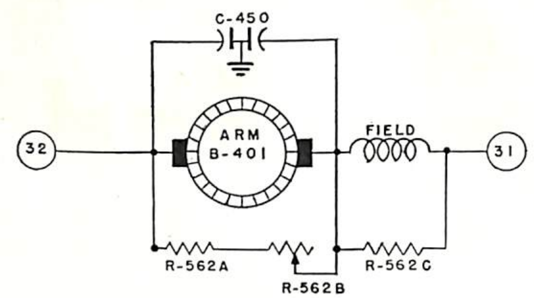
*Then he said, "There must be radar equipment around here . . . I feel a strong impulse!"*

## PPI DRIVER MOTOR

■ Numerous reports from the field have indicated the need for an improved speed control of the SF/SF-1 PPI drive motor. The following method is approved by the Bureau of Ships as an interim measure, and a field-change kit will be shipped to all installations in the near future:

(a) Connect the field of B-401 as a series motor.

(b) Connect a 2000-ohm 15-watt wire-wound resistor in parallel with the field.




(c) Connect both a 250-ohm 10-watt wire-wound resistor and a 1500-ohm 25-watt variable potentiometer (if available) in series. This combination should then be connected in parallel with the armature as shown in the figure.

This circuit has sufficient range to vary the speed of the sweep from approximately 5 to 15 r.p.m., and will therefore compensate for the mechanical wear of the gears and bearings in the PPI rotating assembly.

## YG FREQUENCY DRIFT

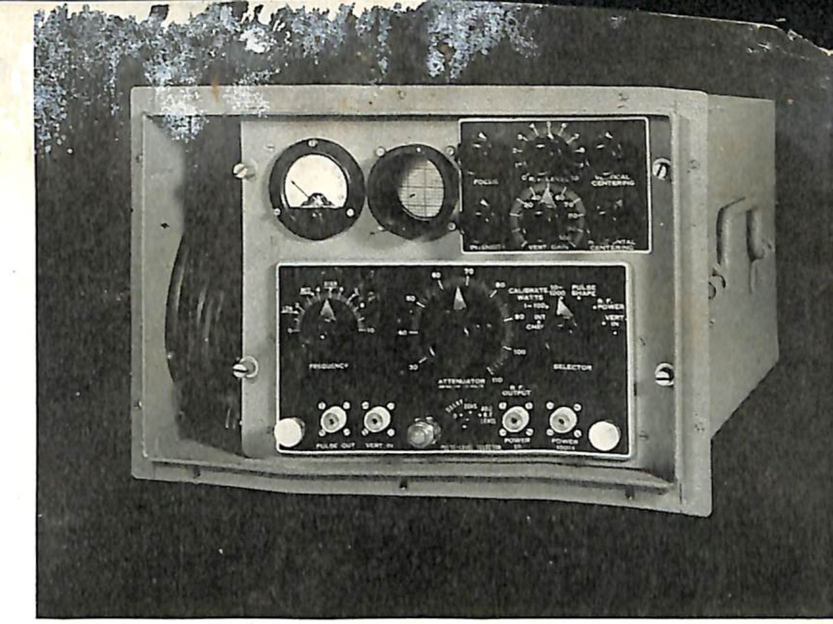
■ Reports received by BuShips indicate that frequency drift in YG transmitters is causing difficult reception in some instances. This is probably due to maladjustment in initial tuning. The normal frequency drift can be overcome by tuning the transmitter to the precise frequency with the wave meter supplied with the equipment. When the receiver has been pretuned to the YG transmitter signal it cannot be returned or adjusted by the pilot. Therefore, if the model YG transmitter is not tuned precisely to the initial frequency any subsequent frequency deviation will cause weak reception or no reception at all. Extreme care should be taken when tuning the YG beacons, and the frequency checked periodically.

## PROGRESS

■ Helium for radiosonde balloons now costs less than two cents a cubic foot, compared with $2500 only 25 years ago.

—*Electronics*





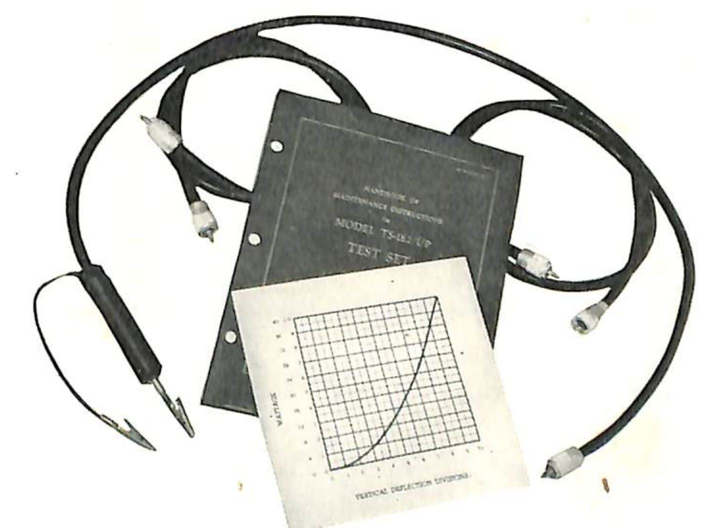
# IFF tester

■ A portable test set capable of measuring the overall performance of IFF Mark 3 euipments is now available in the Fleet. This tester was initially designed by the Radio Matériel School, Bellevue, D. C., and later a contract for 5600 sets was let to the Hickok Electrical Instrument Company and the Air King Products Company. This equipment is on the allowance list of all DE's, DD's and larger ships, and approximately 700 equipments have been shipped.

The TS-182/UP is designed to perform the following tests:

1. Check transpondor or interrogator receiver sensitivity and stability.
2. Check transpondor or interrogator transmitter power output.
3. Check coding of transpondor.
4. Check transpondor output pulse shape and width.
5. Determine roughly frequency range of transpondor.
6. Check operation of transpondor suppressor.
7. Check waveforms at various points throughout IFF equipment.

The TS-182/UP is shipped from the factory with an instruction book classified restricted. This book describes the test set, its operation and maintenance. However, it does not provide detailed procedures for its use with the IFF equipments. This information has been compiled by the Radio Matériel School into a confidential pamphlet entitled "Servicing IFF Mark 3 Equipment with the Model TS-182/UP Test Set" (NAVSHIPS 900,104), which is now being published by the Bureau.



# LET THE "ELEC[illegible]" HELP CURE YOUR

# headache

The same idea that helped cure your last electronic headache may be just the thing to prevent the same headache from driving another radio technician half crazy. While your ideas or experiences may not seem important to you, they may be of great value both to other electronic technicians and to the Bureau. Don't be the judge of their importance. Send them in and let the ELECTRON pass them on to all concerned.

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