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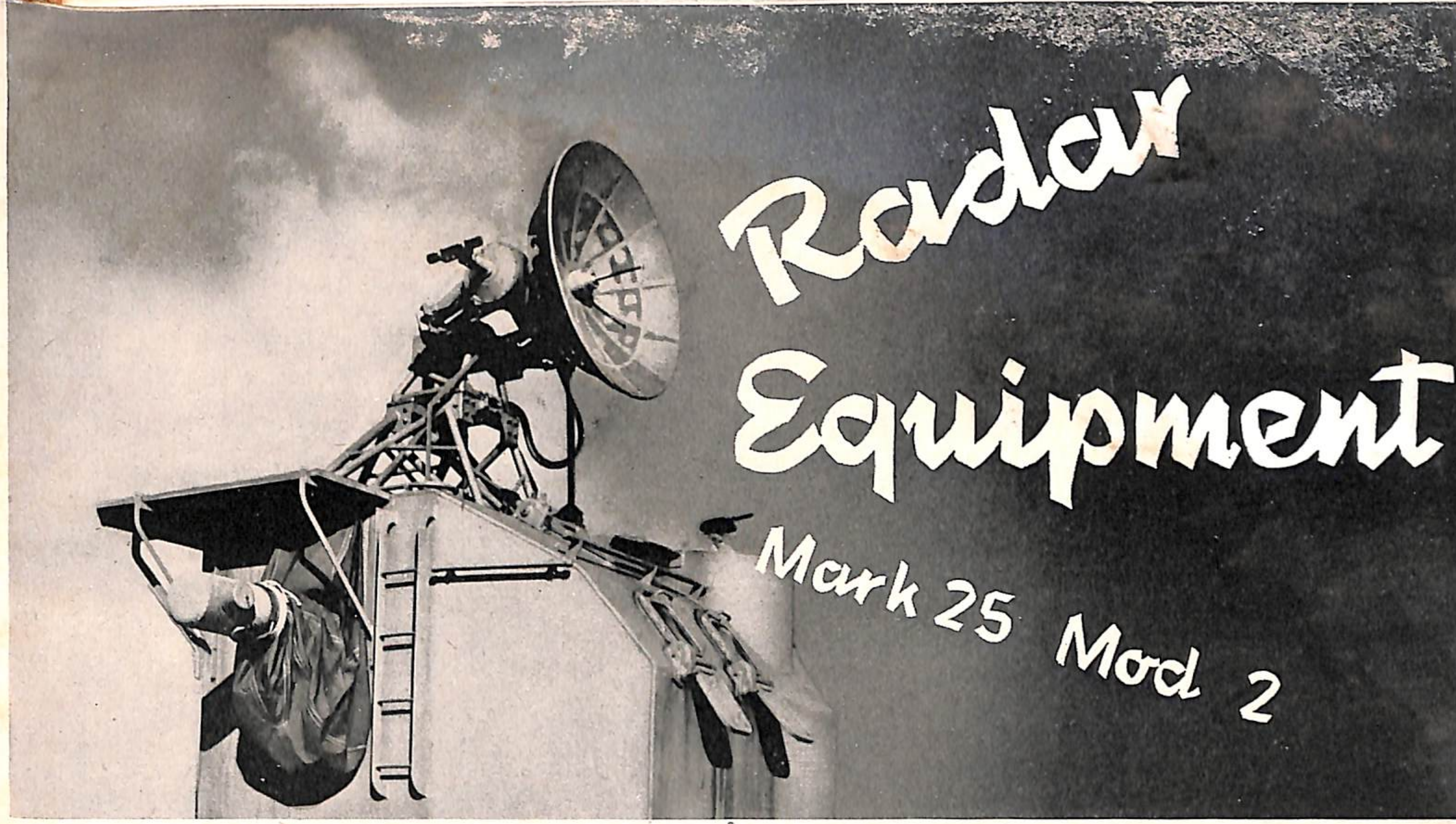


Radar Equipment Mark 25 Mod 2 antenna assembly mounted on a Gun Director Mark 37.

Radar Equipment Mark 25 Mod 2 is a replacement for the Mark 12 and Mark 22 on Mark 37 gun directors. This equipment will provide greatly improved angular and range resolution, thus overcoming one of the most serious limitations of the Mark 12, and will provide completely automatic tracking. Considerable attention has been devoted to the problems of target acquisition, ease of operation, and serviceability. This equipment is expected to be a major improvement over the Mark 12/22 combination and should materially increase the effectiveness of the 5″ 38-caliber batteries against both aircraft and surface targets under blind-firing conditions.

As early as 1942 the requirements for high resolution were appreciated and experimental systems operating in both *S* and *X* bands were built and tested at the Naval Research Laboratory. Tracking performance of these systems was excellent and the high degree of discrimination provided by narrow beam patterns permitted good low-angle accuracy and the ability to track low-flying aircraft over land. However, the price paid for this discrimination was an almost hopeless problem of target acquisition. Unless some means were available to put the director on target, the excellent tracking capabilities of the radar were of no value. Existing target designation systems were of little aid since the accuracy was poor and no data was provided in elevation. Some means for rapidly searching a limited region was necessary. A universal scanning mechanism was constructed which permitted rapid scanning using various patterns. Tests proved that needle-beam patterns were satisfactory and desirable if used in conjunction with some form of scanning which would rapidly search a field subtending an angle of ten to fifteen degrees at the antenna and provided that rough pointing could be maintained before range gating.

The progress of the war in the Pacific made it imperative that the Mark 12 be replaced by an equipment capable of rapid target acquisition, high resolution and automatic tracking, without delay. Accordingly certain compromises were made and a design, now designated Radar Equipment Mark 25 Mod 2, was frozen several months prior to V-J day. This design represents what was considered the best design capable of production in approximately 12 months.

The antenna assembly is mounted on the gun director. The five-foot parabolic reflector produces a radiation pattern approximately 1.8 degrees wide. The scanning mechanism provides a choice of three types of scan,—conical, for automatic tracking; spiral, for covering a field of view of approximately 10 degrees four times per second for target acquisition; and circular, in which the major lobe of the pattern is rotated so as to cause its axis to generate a cone having a vertex angle of 10 degrees measured at the antenna. This scan is expected to be superior to spiral scan for tracking surface targets and for spotting shell splashes.

Similar indicators are provided in the director for the control officer, pointer, trainer, and range operator. These indicators are provided with presentation selection switches permitting the operator to choose the type of indication desired. The control officer, trainer and range operator have a choice of a bearing-versus-range (type *B*) or elevation-versus-range (type *E*) presentation provided the antenna is in spiral or circular scan. In addition, the range operator is provided with a range indicator (type *A*). The pointer has available, in addition to the type-*E* presentation, a special "broad-field" elevation indicator. This type of indication presents the same information as type *E* but the vertical height of the elevation scan is compressed to about one-half inch and the whole pattern is positioned vertically to indicate true elevation of the antenna axis. A long-persistence tube allows the echoes to remain on the screen for a few seconds after the elevation field has been searched. The pointer, trainer, and range operators are each provided with a foot switch. Each switch controls its corresponding coordinate, permitting manual tracking in that coordinate in one position and setting up the automatic tracking circuits to allow automatic tracking (if a signal is gated) when in the other position.

The procedure in acquiring a target will depend upon the type of target and the amount and accuracy of information concerning its probable location. Assume that no designation is received from CIC and that the director is assigned to aircraft targets in a given sector. The antenna is placed in spiral scan, the pointer elevates to approximately five degrees, while the trainer sweeps the designated sector in train. Any targets included in the 10-degree scanned field will be indicated by spots on all scopes provided the signal strength is sufficient. If no targets are found, the pointer elevates to 15 degrees and the process is repeated. If a target is located, all three operators "get on" simultaneously; for example, the target range operator gates the target while the pointer and trainer center the spot on their respective cross hairs and then depress the foot pedal to go into automatic tracking with conical scanning. Alternately, if bearing and range designation is available, the train and range operators set their controls to the designated values while the pointer searches in elevation. Any targets within ± 5 degrees of this bearing will then appear in their true elevation positions on the pointer's broad-field indicator. After a target is located, the procedure is the same as outlined above.

Acquisition of surface targets is handled in the same manner as in the Mark 8 radar, with the antenna in spiral or circular scan. If spiral scan is used the director elevation is set at zero degrees. In circular scan the director line of sight is elevated to about four degrees so that the lower position of the circular scan sweeps the horizon. Tracking of surface targets should be manual using the type-*B* presentations at the trainer's and range-operator's positions, in which case the operation of the system is identical to that used in main-battery directors employing Mark-8 or -13 radar equipments. This does not mean that automatic tracking of surface targets is impossible but its use will undoubtedly result in rougher tracking and will make spotting impossible. An exception to this conclusion might be taken in the case of high-speed surface targets such as PT boats where the value of spotting is questionable and automatic tracking may prove superior to manual.

The more detailed description of the major units of the system which follows will provide a more complete picture of the over-all arrangement and explain more fully the tie-in between the radar, director, and computer. This description also shows the degree to which the director-computer system influences the design of the radar.

The antenna assembly is mounted on top of a Mark 37 gun director in an antenna mount which permits stabilization in level and cross-level in the same manner as in the Mark 12 radar. Radio-frequency power is brought up from the transmitter by means of a $1\frac{1}{4}'' \times \frac{5}{8}''$ wave guide and is fed through the elevation and cross-level axes by rotary joints. Provisions for alignment of the elevation axis of the mount with the director axis and for bore-sighting are included.

The transmitter, receiver, modulator, and wave-guide switch are included in a single housing installed in the blister which previously housed the amplifier assembly of the Mark 22 radar. The transmitter uses a tunable magnetron adjustable over a 12-percent frequency band and delivering approximately 50 kw peak power. All r-f components except the antenna feed are sufficiently broad-band to eliminate the need for any tuning adjustments over this band. Two antenna-feed sections are provided to cover the band. The modulator employs a 4C35 hydrogen thyratron switch tube and applies a 200-kw pulse having a duration of 0.20 to 0.25 microsecond to the magnetron. The repetition rate has a nominal value of 2000 cycles per second and is adjustable over a range of ± 10 percent. Random variation of the pulse interval between 400 and 600 microseconds is available, if desired, to combat certain types of electronic jamming.

The range operator's console is mounted in the right rear corner of the director in a position suitable for a seated operator. All radar operating controls except scan selection are available on this console as well as range tracking and slewing controls, the 5-inch *B* or *E* scope and the 3-inch *A* scope. Synchro dials indicate the radar range at 2000 and 72,000 yards per revolution, and range designation at 72,000 yards per revolution. Selection of range sweeps for all indicators is made at this position.

Just to the right of the trainer's position is placed a control panel for selection of the type of antenna scan. Additional controls have been added to this panel to permit complete one-man control of the system after the trainer has been provided with a director slew control. If this type of operation is desired, these controls may be energized by a transfer switch at the range console, permitting the trainer to switch the radar from "standby" to "on", to select range sweeps, and to slew the range gate by means of a smooth variable speed control. By observing both his own and the pointer's indicator, the trainer may then search any desired sector to locate a target, gate the target in range, and switch all three coordinates simultaneously to automatic tracking.

Below-deck equipment consists of a group of cabinets similar in design to those used in the Mark 13 radar. One cabinet contains most of the rectifier power supplies. Another contains sweep-generator and distribution circuits, modulation generator, coordinate detectors for the pointing channels, and other miscellaneous circuits. The automatic-tracking circuits and servos are in a third cabinet, and the fourth, a smaller cabinet, contains the remotely controlled range unit with its servo driver and synchro repeaters. Space requirements for these cabinets are quite flexible since they are normally unattended and need not necessarily be installed in the same space.

Complete data on the system performance is not yet available but preliminary observations indicate that acquisition of single-engine fighter aircraft is possible at ranges of approximately 25,000 yards, and large planes or groups of planes may be picked up at 35,000 yards using spiral scan. After tracking has been established, planes may be tracked out to 45,000 yards or more. Automatic tracking in elevation should be accurate down to position angles of about 1.5 degrees, while dependable manual tracking may be obtained below this elevation angle with the antenna in spiral scan. Performance in automatic tracking is difficult to describe due to the wide range of possible courses, but the following figures indicate the order of magnitude of the tracking errors when the system is used with an amplidyne drive director. With directors using the Arma drive, these figures should be approximately doubled.

Train rate to produce 2-mil lag . . . . . . 9°/sec.
Total error at crossover for 350-knot passing course with 1,000-yard minimum range . . . . 8 mils
Minimum passing range to track a 350-knot target on a straight-line course . . 600 yards

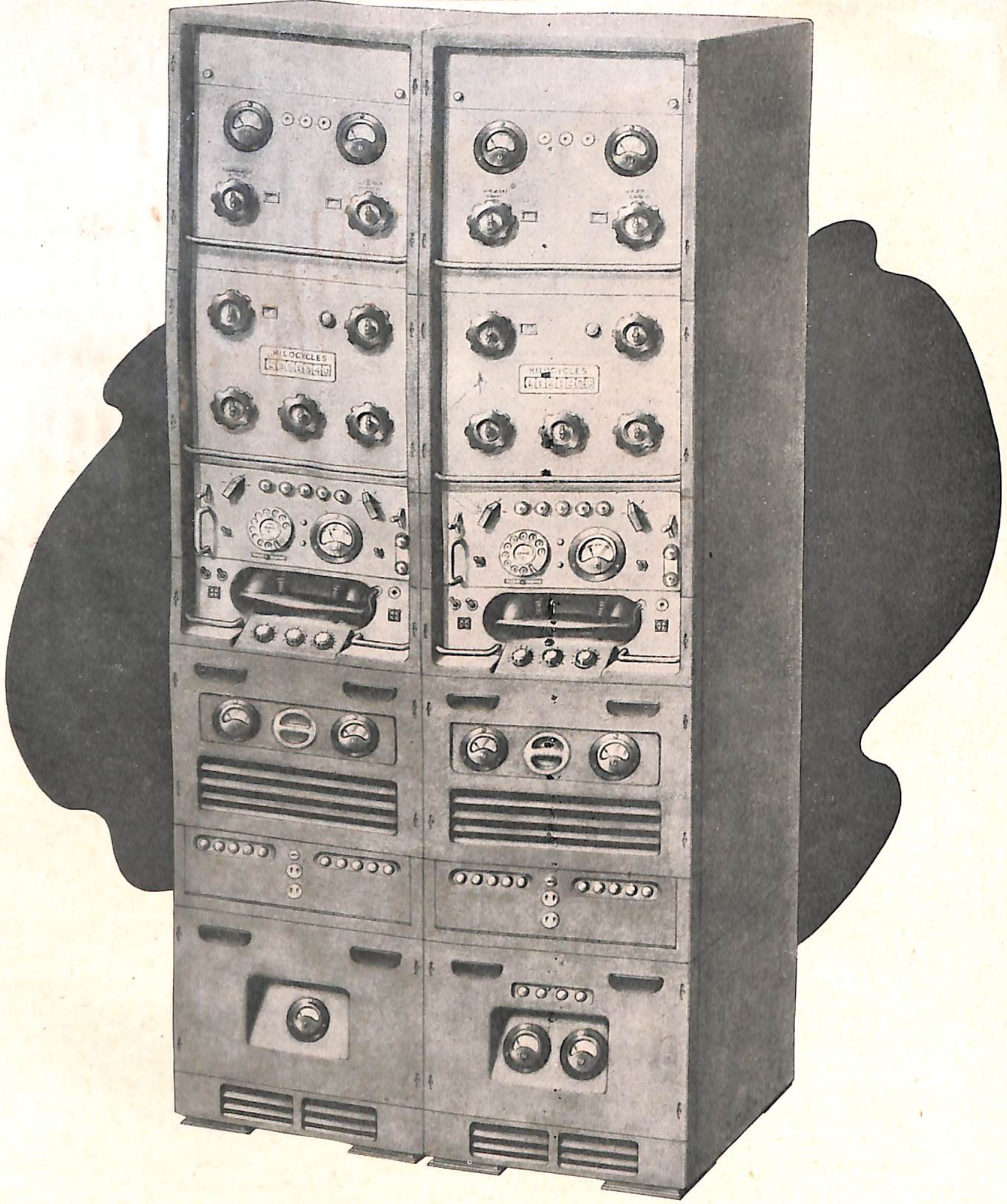
This performance is probably better than that obtainable using optical tracking with average operators.

SAFETY FIRST WITH CRO TUBES

A cathode ray tube can present many types of traces, scans, reproductions, etc. During the war, the most popular picture was that of an echo from an enemy ship slowly decreasing in amplitude as the target slipped beneath the surface of the sea after being slapped in the kisser with a stick of bombs, a couple of fish, or a good solid salvo from our own guns. Yes, the CR tube has become a vital link in our modern electronics equipment. However, it can sometimes inflict serious injuries if not handled carefully.

Since we are issued only one pair of eyes, it is only common sense that we should make every effort to protect them from injury. When handling these tubes there is always the possibility that one may be accidentally fractured, resulting in their exploding (or, more specifically, *imploding*), spraying glass in all directions. Personnel engaged in handling these tubes should wear a pair of reliable goggles such as Wilson Mono-Goggle No. 1 which has a clear lens and ventilated frame. If another type must be substituted it is recommended that they be tested for durability against a rigid impact, clearness of vision, and ability to provide protection against flying particles both from the front and side.

In addition to handling while crating, uncrating, or storing, there is great danger when fitting these tubes into sockets or mountings, or in removing them. Technicians should take care not to strike the envelope or jiggle the tube back and forth so as to subject the glass to strain.



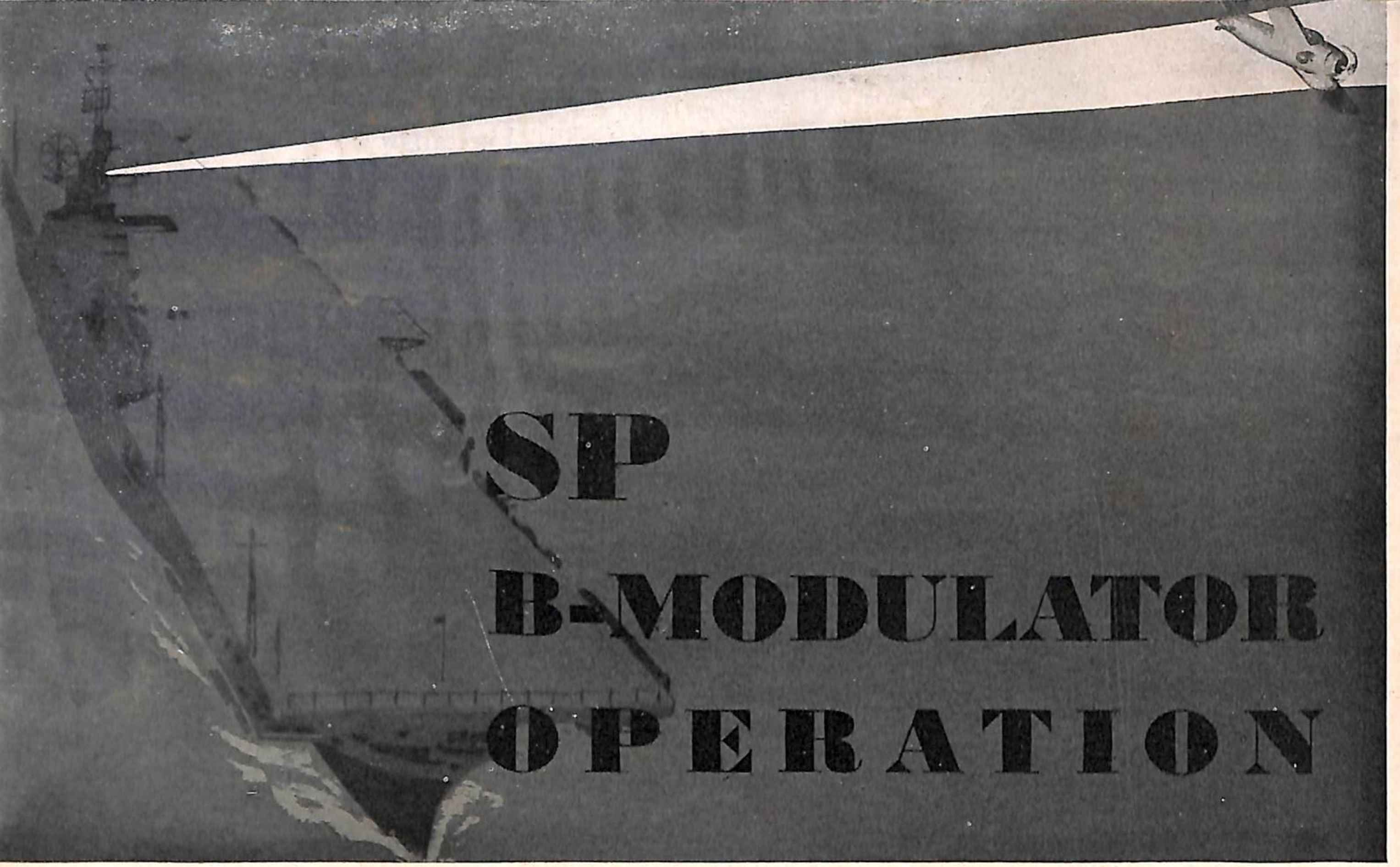
XTEJ Radio Transmitting Equipment

■ The XTEJ is proving to be one of the most progressive communication transmitting equipment development projects of this period. Because of the unusually interesting features of the project an article describing the proposed equipment was published in the November 1945 ELECTRON. This was a few months after the contract for development of the XTEJ had been awarded the Westinghouse Electric Corporation and therefore the article was based solely on the project requirements. Construction of the experimental model is now well under way and, although very few important departures from the original concepts of design have been made, a more accurate description of the equipment can be given at this time. The illustration represents the latest version of what the physical appearance of the XTEJ will be. The design problems have been worked out to the extent that, in all probability, the appearance of the actual production model will approximate it very closely.

The XTEJ is being constructed for use on both surface and under-surface vessels for low-power operation in the frequency range of 2000-26000 kc. It will be the first equipment released to the fleet to fill all present requirements for communication transmission within the specified power output and frequency range, and will demonstrate the knowledge gained through wartime research in bringing together the most desirable design features to obtain simplicity of operation, maintenance and installation. In general the XTEJ will eliminate the need for many diverse types of equipments now in use by the Navy.

The entire basic equipment will consist of a single assembly having four separable units—two identical 50-watt transmitters and a high-power modulator. The two 50-watt transmitters may be used for simultaneous operation, as each will be a completely self-contained and entirely independent unit. The H.P. rectifier and H.P. modulator are for use only when it is desired to increase the power output of either one of the two 50-watt transmitters to 500 watts. The equipment for 50-watt output will be operable from a 110-volt, single-phase, 50 to 60 cycle power source; when the H.P. rectifier and modulator are used an additional 220 or 440-volt, 3-phase, 50 to 60 cycle power source will be required. Each transmitter will operate at all times into a 50-ohm solid-dielectric transmission line and will be capable of utilizing a 35-foot whip or other conventional type of antenna. Provision will be made to employ a transmission-line-to-antenna coupling unit at the location of the antenna. Circuits for CW, MCW, voice and frequency-shift keying are included in the design of the model, and operation on any one of these emissions will not require the use of auxiliary equipment. In addition the frequency-shift keying circuits will be designed to permit use of the equipment for photo transmission. Vacuum-tube keying will be employed to provide keying speeds up to 500 words per minute for A1-type emission and up to 100 words per minute for A2 emission. The equipment will be continuously variable throughout the entire frequency range. No frequency-multiplying stages will be employed. Instead the desired operating frequency will be arrived at by a method of beating the various harmonics of a very highly stabilized crystal oscillator with the output of a highly stabilized short-range variable oscillator. The equipment will incorporate ganged controls to facilitate manual tuning and, in addition, telephone-dial rapid selection of ten preset channels will be provided for each transmitter. Four tuning controls will be employed for setting up a desired frequency and will be mechanically connected to a counter dial which will indicate the operating frequency to an accuracy of within ten cycles or better. The equipment will be capable of operation from the front panel position and from up to ten remote stations for each transmitter. Each remote position will provide selection of any one of the ten quick-shift preset channels, and indication of the channel selected. The equipment will also be capable of remote operation when connected into present ship's control systems and a proposed master ship's control system now under development.

Special emphasis is being placed on light-weight, compact construction. The type of construction being employed will permit a variety of arrangements at installation. Each of the 50-watt transmitters and the H.P. rectifier and H.P. modulator will be contained in separate units which will be designed to form a single assembly or to be separated to suit space or operational requirements. When installed as a complete assembly the H.P. rectifier and H.P. modulator will be placed side by side and will form a base to support the two transmitters. The entire assembly will be 72 inches high, 32 inches wide and 24 inches deep, and will weigh approximately 1500 pounds. This represents a reduction of approximately 70% in size and 65% in weight over that of other comparable types of standard Navy communication transmitters. The H.P. rectifier and H.P. modulator components will each be built into a single drawer-type chassis. Each 50-watt transmitter unit will incorporate four drawer-type chassis. From bottom to top these will contain, respectively, the low-power rectifier and modulator components, the control-circuit components, the frequency-determining and frequency-shift-keying components, and the power amplifier and transmission-line tuning circuit components. The various chassis will be designed to slide into the front of the units on runners and will be guided and positioned by stops and pins. Electrical connections will be made automatically by plugs and jacks when the chassis are positioned in the units. Complete accessibility to the components will be available when the chassis are removed from the sections. Under this condition electrical connections for test purposes will be completed by special cables furnished for the purpose. When positioned in the assembly, the top three chassis of the two 50-watt transmitters will be slightly recessed from the frame to afford protection against accidental disturbance of the controls. In order to reduce to a minimum the number of electrical indicating meters placed on the front panel, only those meters necessary for successful operation are visible. Other meters essential only for circuit adjustment are located inside the chassis proper.



SP B-MODULATOR OPERATION

■ SP and SP-1M radars are equipped with two modulators in order to secure optimum results for the two special functions of height-finding and long-range searching. The *A*-Modulator, which is employed while height-finding, has performed in a fairly satisfactory manner. Long-range search operation employing the *B*-Modulator, however, has been generally unsatisfactory due to instability. A modification to the original version of the *B*-Modulator was designed and tested, and has been incorporated in some of the later models. Field Change No. 26 made this modification available for equipments which have not been modified at the factory.

ORIGINAL CIRCUIT

Block diagram and simplified schematic drawings of the original circuit appear in figures 1 and 2, respectively. Modulator *B* is a line modulator which utilizes the capacity of an artificial transmission line (E-2301) as a small capacitor in which to store energy during each half cycle. This line is charged by a 60-cycle a-c supply and is discharged through the load by a rotary spark gap. The a-c source charges the storage capacitor through a step-up transformer T-2301. Resonant charging is obtained by having the charging inductance (leakage reactance of the step-up transformer) and storage capacitance resonant at the impressed 60-cycle frequency. A family of curves showing a variation of charging current and storage capacitor voltage increase as a function of time is presented in figure 3. The maximum value of current, and therefore the capacitor voltage, is limited only by the resistance of the circuit.

The speed of the rotary spark gap (1800 r.p.m.) is such that half-cycle operation gives a repetition rate of 120 cycles. For half-cycle operation, point A in figure 3 is used for the discharge of the capacitor into the load, as it is a point of fairly constant voltage. After the first charge and discharge, the charging current reverses polarity and the capacitor is charged to the opposite polarity on the second charge as shown in figure 4.

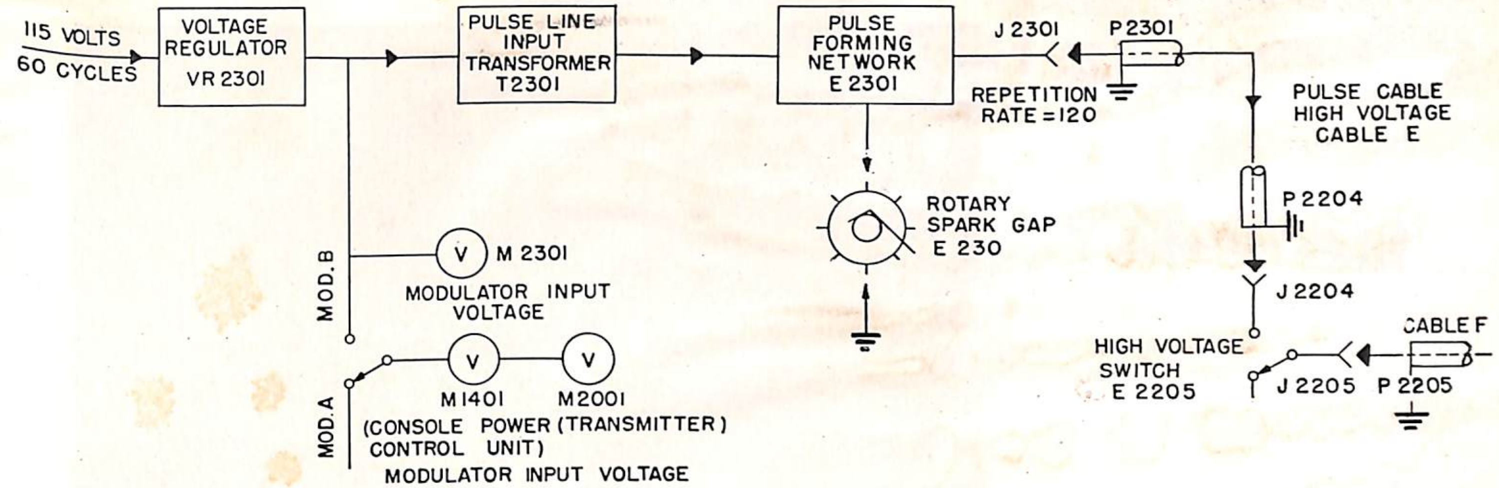
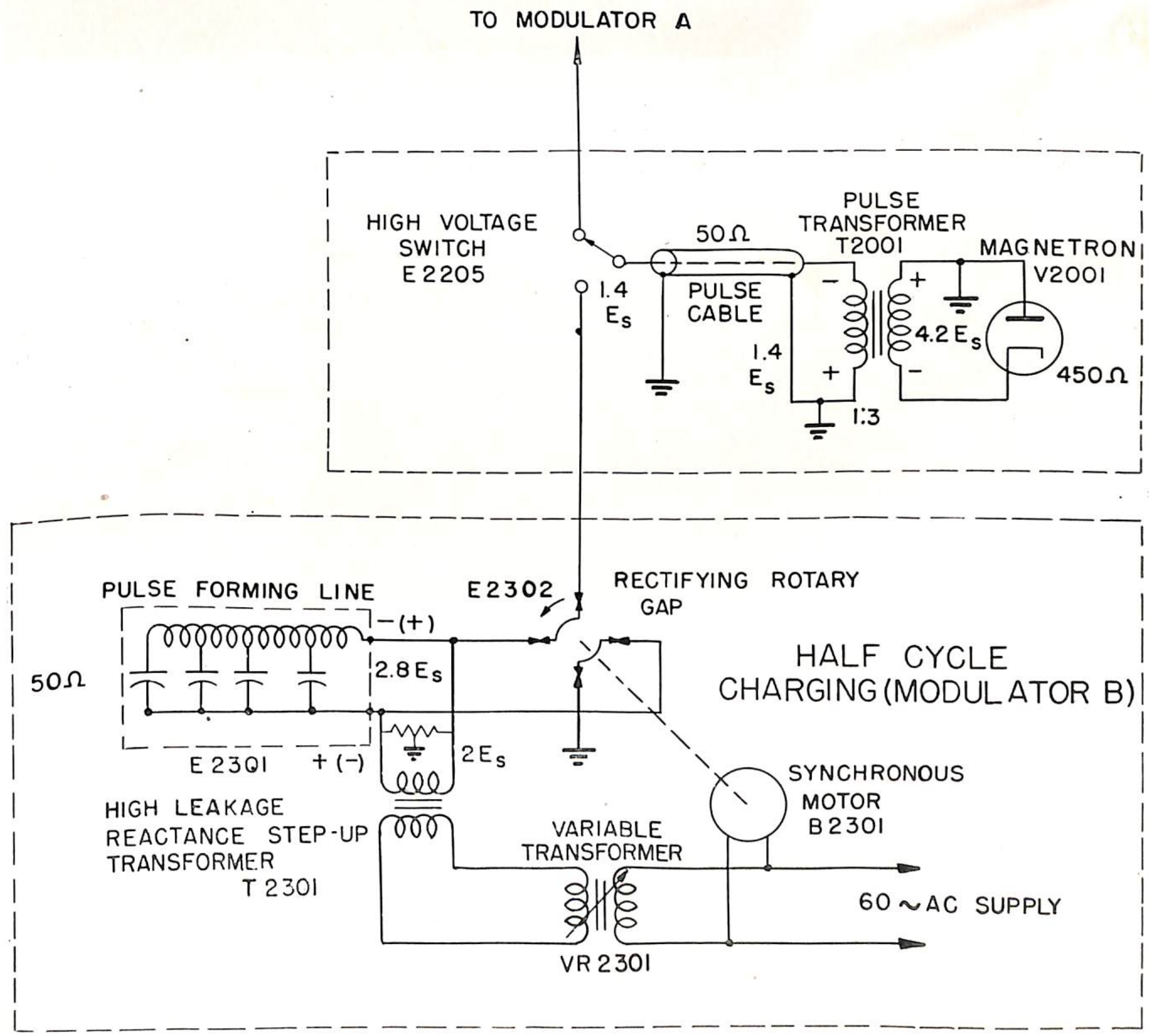


FIGURE 1—*Simplified block diagram of the original SP/SP-1M B-Modulator.*

FIGURE 2—*Simplified schematic diagram of the original B-Modulator.*



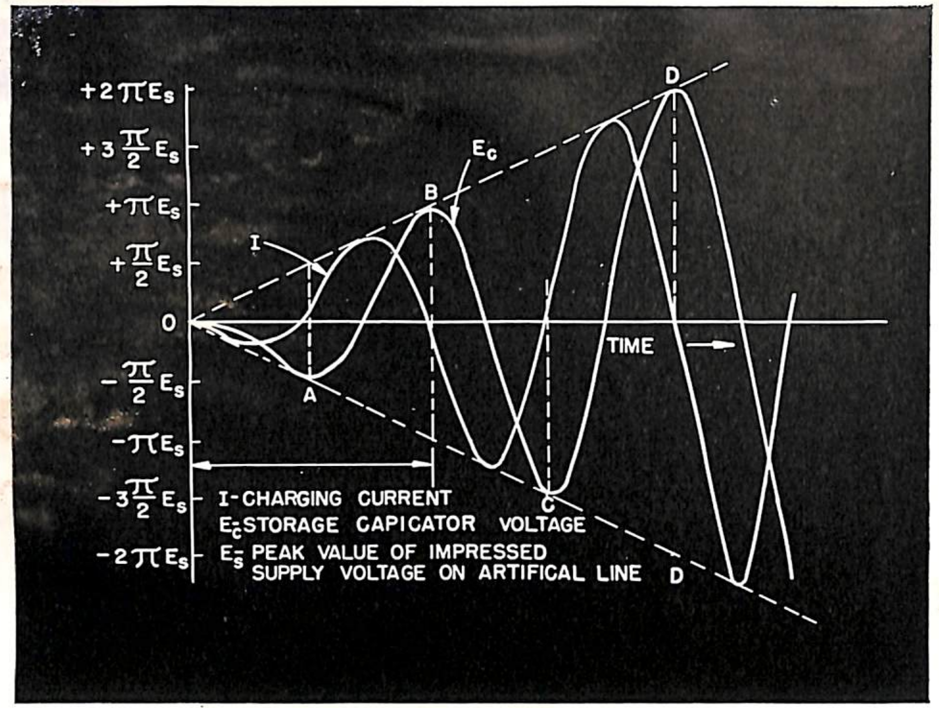


FIGURE 3—*Curves illustrating the variation of charging current and storage capacitor voltages as a function of time.*

Repeating this cycle results in successive charges and discharges of alternate polarity. As the magnetron load can only take negative pulses, rectifier or commutator action is supplied by the commutator-type rotary spark gap (E-2302A) to utilize both positive and negative discharges.

Pulse shaping is accomplished by having an artificial transmission line (E-2301) having an impedance equal to the load resistance. Under this condition, at the instant of discharge one-half the voltage on the line appears across the load resistance and the remaining voltage initiates a traveling wave of $-E/2$ that travels down the line. When this wave reaches the open end of the line, the line is charged to $E/2$. This traveling wave is reflected back without change of polarity. During the time the traveling wave was proceeding to the open end of the line and being reflected back to the starting point, a constant voltage of $E/2$ has existed across the load resistance as shown in figure 5. When the reflected wave of $-E/2$ reaches the starting point it cancels out the $E/2$ across the load resistance, thus terminating the pulse. Since an artificial line is used, the pulse is not quite rectangular but has a slight rise and fall time, rounded corners, and voltage variations on top of the pulse. The output is approximately 10,000 volts which is stepped up by the pulse transformer T-2001 to the necessary voltage for correct magnetron operation.

Voltage regulator VR-2301 permits adjustment of the modulator voltage by adjusting the voltage input to the primary of T-2301. The output of T-2301 is $2E_s$ where E_s is the peak voltage to ground of the transformer secondary. This charges the line to πE_s which is reduced to $2.8E_s$ by circuit losses. Pulse line E-2301 will then furnish a 5-microsecond pulse of $E/2$ or $1.4E_s$ to the transmitter.

Most of the modulator trouble is caused by failure of the rotary gap to fire. The gap is actually a rectifying device with 4 gaps in series, and is, in effect, a synchronous rectifier. The voltages across all gaps are about the same, and are equal to approximately ¼ of the charging voltage. When misfiring occurs, the resonant charging line goes to double voltage which, when shorted by the gap, applies a pulse of twice the normal voltage. This erratic operation is very objectionable and eventually ruins the magnetron.

MODIFIED MODULATOR

Field Change No. 26 adds a double-diode spark-gap stabilizer (V-2301 and V-2302), a despiker network (R-2310 and C-3404), and changes 3 of the 4 stationary pins of 120-mil diameter to new pins of 80-mil diameter. The addition of the double diodes causes the full charging voltage to be placed across 2 gaps in series instead of 4 as shown in figure 6. When point *A* is positive and point *B* is negative, diode 2 conducts, effectively grounding point *B* through a 1-megohm resistor and allowing point *A* to rise to full charging voltage E_c. This voltage is grounded through 2 rotary pins *C*, which places a negative pulse of value $E_c/2$ through pins *D* across the magnetron to ground. On

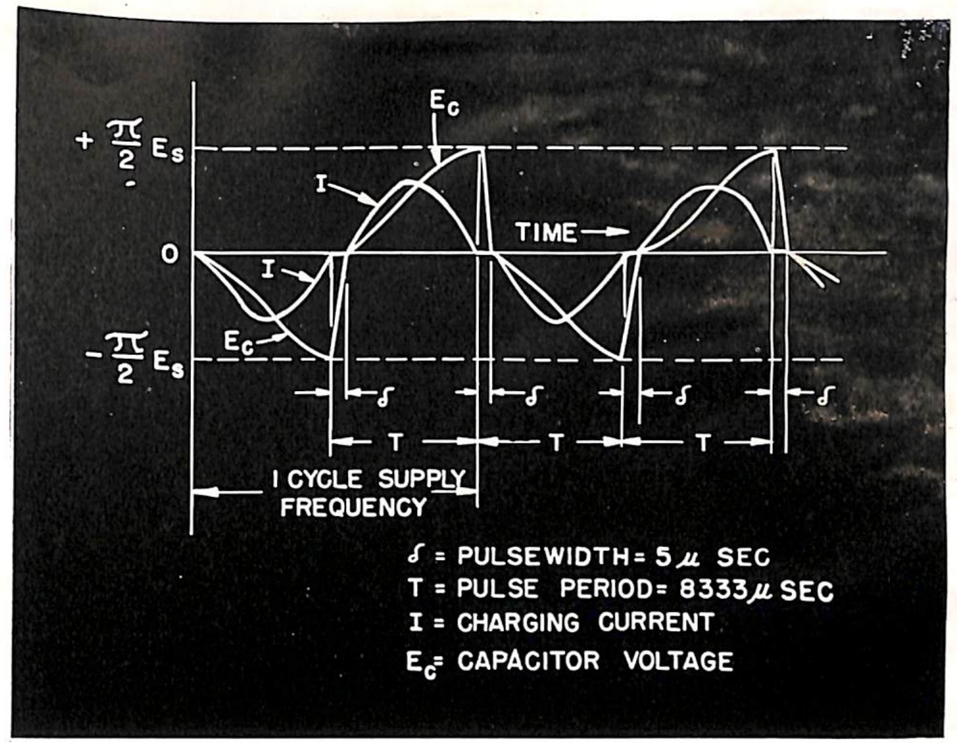


FIGURE 4—*Charging current and storage capacitor voltage waveforms during half-cycle operation, showing the reversal of polarity with each charge and discharge of the circuit.*

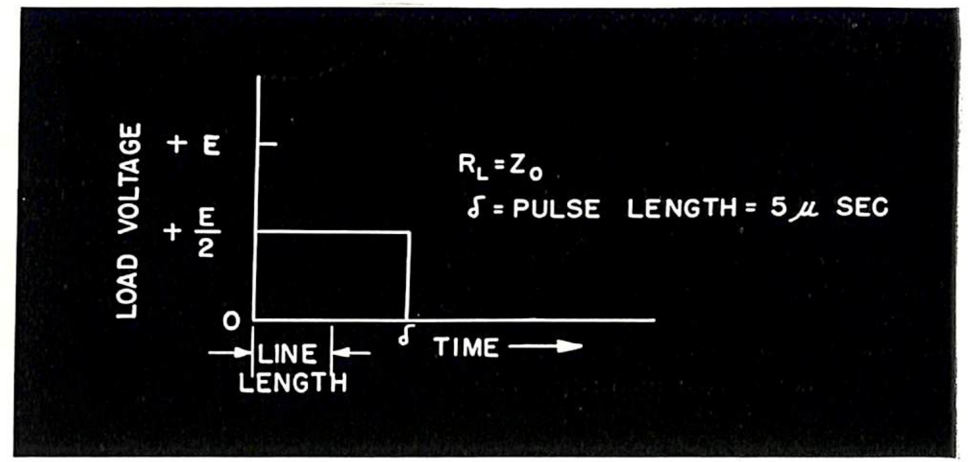


FIGURE 5—*Development of the pulse across the load resistance. During the time the impressed voltage wave travels the length of the line and back, a constant voltage of E/2 is impressed across the load resistance. The returning wave being equal to —E/2 cancels the impressed voltage, terminating the pulse.*

the next half-cycle the polarity of the transformer is reversed and tube 1 grounds point *A* through a 1-megohm resistor and point *B* rises to full E_c, is then grounded by pins *C* and the pulse line applies a negative pulse to the magnetron of value $E_c/2$ through pins *D*. Therefore it is seen that the cycle of breakdown is always started by a positive voltage of value E_c to ground, which permits stable arcing. Negative voltage polarity will not accomplish this.

The despiker consists of R-2310 and C-2304 in series, as shown in figure 6. This is placed so as to take energy out of the front of the pulse, thereby reducing its rate of rise. This is necessary since the magnetron is not a constant-impedance device but presents practically an open circuit to the front of the wave and, due to the time delay in firing of the magnetron, the voltage may exceed the normal operating voltage before the magnetron fires. This causes a spike on the front of the wave which, if large, will reduce the tube life. Slowing down the rate of rise reduces the height to which this spike can increase before the tube operates. Replacing the 120-mil pins with 80-mil pins increases the voltage gradient in the gap space and improves firing.

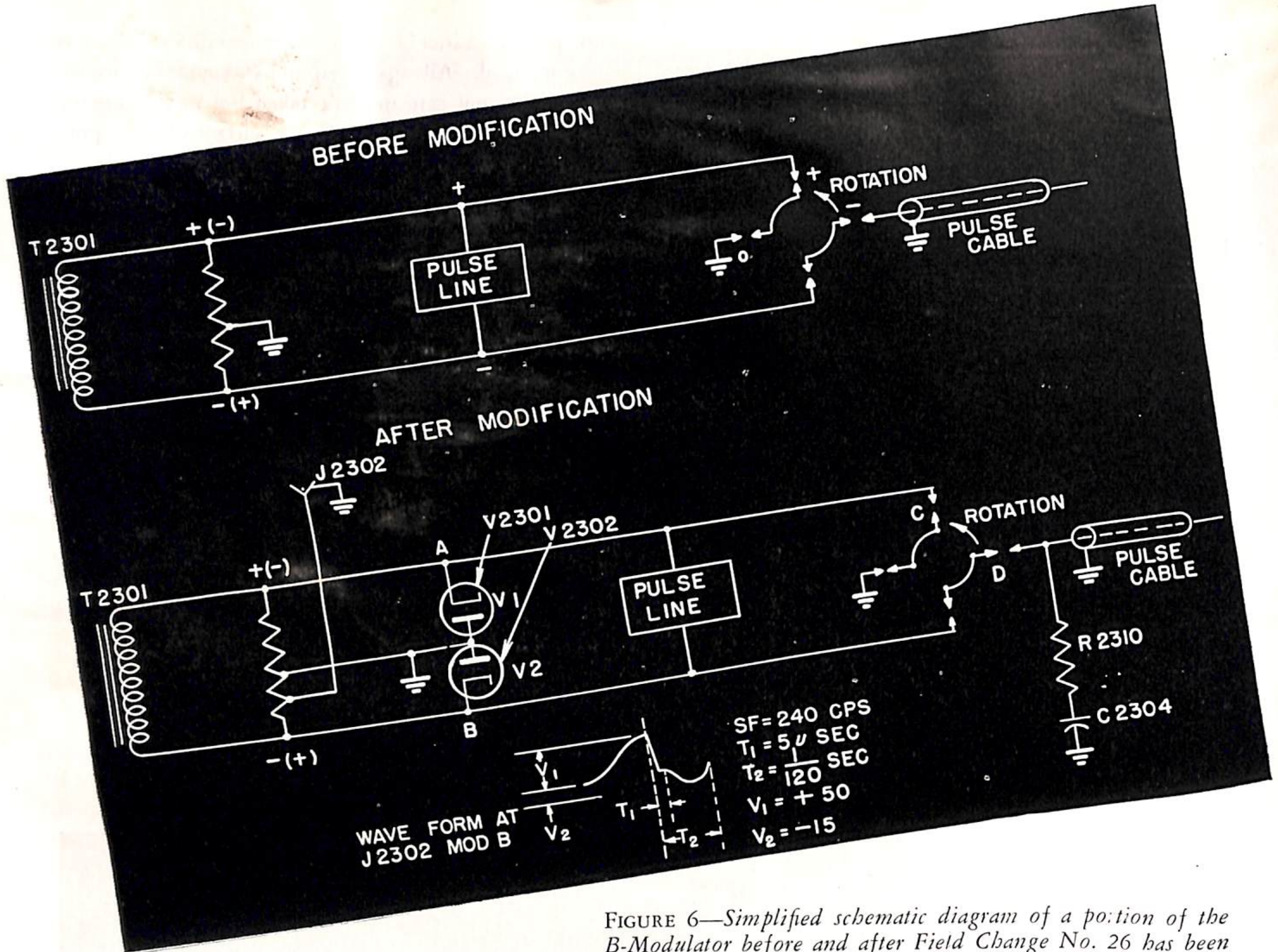


FIGURE 6—*Simplified schematic diagram of a portion of the B-Modulator before and after Field Change No. 26 has been installed.*

OPERATION

Some difficulty is still experienced in obtaining dependable operation even with this field change added. The following discussion results from tests conducted by E.F.S.G. and General Electric Co. engineers.

It is always necessary to use re-aged 4J47 magnetrons. These can be identified by either a red dot (General Electric) or a silver dot (Western Electric) above the serial number on the magnetron.

It is necessary to have all the pins set for exactly the same separation, which should be between 0.010″ and 0.020″, and preferably about 0.015″. This is accomplished by loosening, in the back plate, the screws which hold the stationary bushings. Each bushing is then rotated until the spacings are proper as indicated by a thickness gage. This adjustment is made possible by an eccentric mounting for each bushing. Tighten the bushing-plate screws, then turn the gap slowly by hand to see that none of the pins are touching. Apply power and check the phasing. Should re-phasing be necessary, it is also necessary to reset the pins to exact spacing after the re-phasing operation. The moving pins must all be in lateral alignment with the stationary pins to insure firing at the desired point on the charging cycle. In re-phasing, the stationary pin position is changed with respect to the stator of the gap motor.

Facilities have been provided for viewing wave shapes by using J-2302, which is attached to the monitoring resistor circuit near the pulse-forming line. Figure 7a illustrates correct phasing in the circuit. However, tests have indicated that the most stable operation is obtained when the gap is phased for slightly early firing. By firing too early is meant that the stationary pins are advanced too far against the direction of rotation.

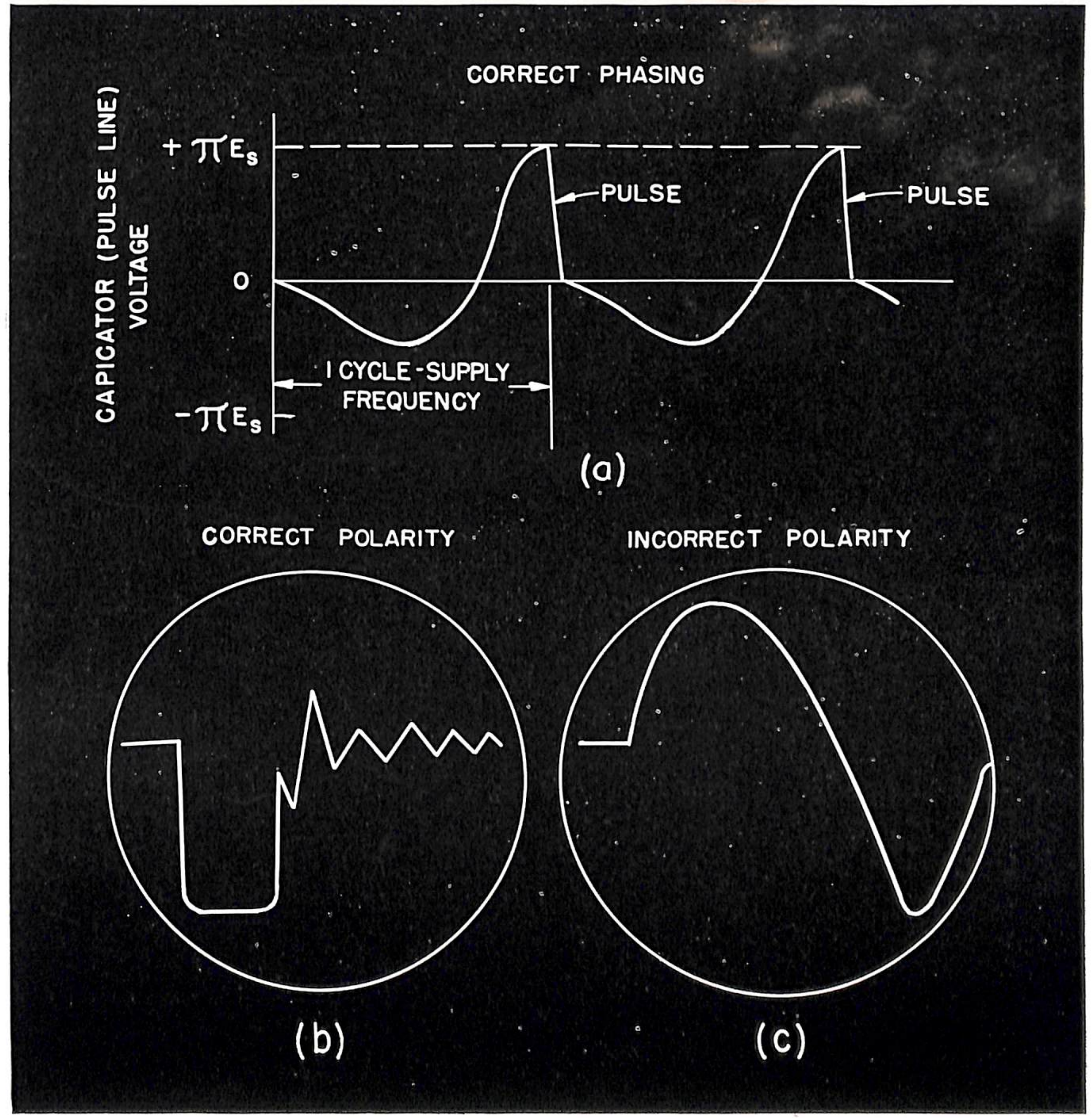
When checking polarity for the first time it is important that the proper polarity be applied to the magnetron. This should be checked by feeding the modulator output into a dummy load and observing the wave shape on an oscilloscope or on the synchroscope as shown in figures 7b and 7c.

One method of phasing is to place a signal from the magnetron current circuit on an oscilloscope. This can be taken at the under-current relay potentiometer R-2008. The phasing is then adjusted until the saw-tooth voltage at this point has the same amplitude on alternate voltage rises.

Rotor pins can be replaced by rotor pins from the A-Modulator. This permits the stationary pins to protrude an additional amount without excessive overlap and permits easier removal. An overlay of 1/8″ is recommended. All spark gap pins should be cleaned when dirty, but care must be taken not to cut through the special protective finish on the surface of these pins. When they become pitted they should be replaced.

It is necessary to allow at least five minutes for filament-heating time before radiating. It is then advisable to radiate first at 20 milliamperes, increasing the current slowly to 28 milliamperes over a period of 5 minutes. The magnetron should operate satisfactorily up to

FIGURE 7—*Wave shapes as viewed on the transmitter synchroscope showing (a) correct phasing, (b) correct polarity, and (c) incorrect polarity.*



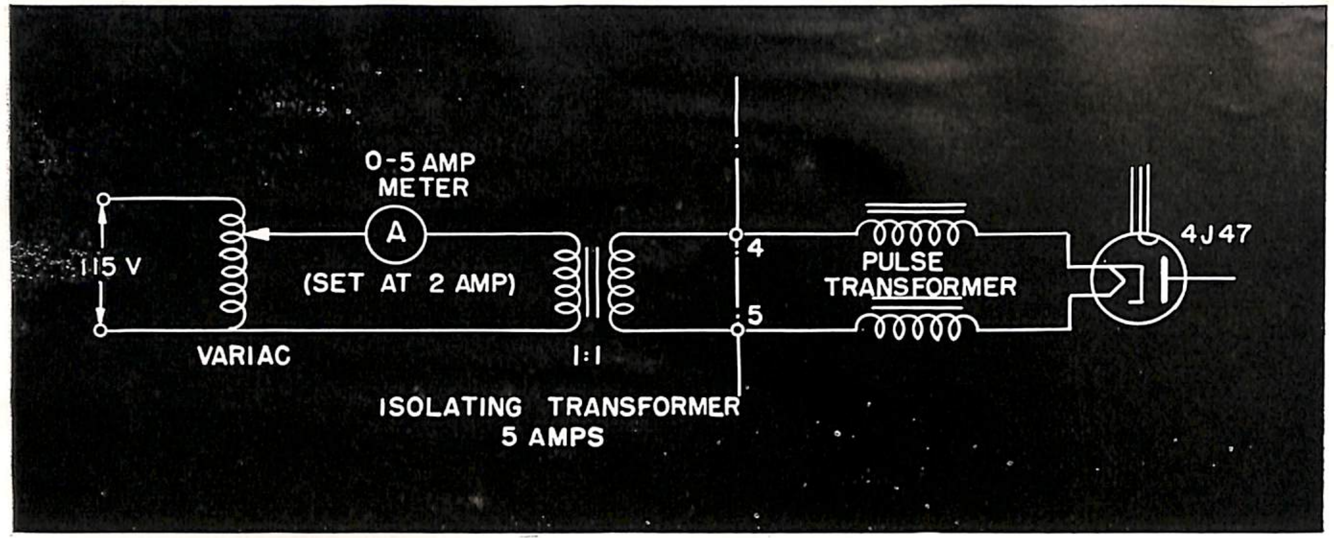


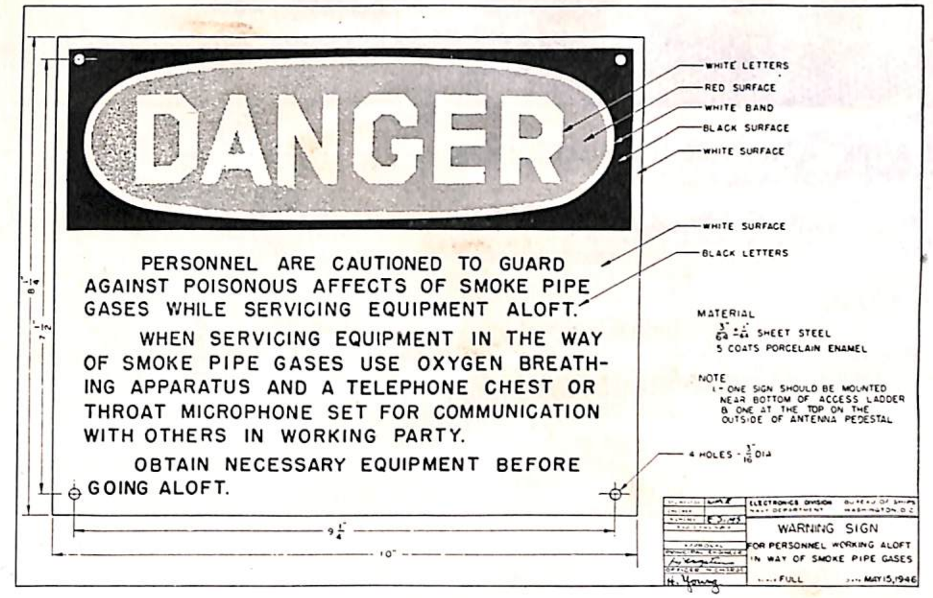
FIGURE 8—*Connections necessary for adding an isolating transformer and Variac in order to set filament current at 2.0 amperes for aging magnetrons. Note that leads from secondary of filament transformer must be disconnected and that secondary of isolating transformer is connected to pulse transformer where filament transformer leads were disconnected.*

28 milliamperes, although some will arc at that high a value. If this condition is present it indicates that the magnetron requires additional aging. Many magnetrons that fail in the *B*-Modulator will work satisfactorily in the *A*-Modulator. To reduce arc-over, the magnetron must be exactly centered in the magnet jaws. It is also very important to have adequate ventilation through the gap and over the magnetron.

The 4J47 magnetrons can be aged in the *B*-Modulator by raising the filament current to 2.0 amperes and plate current to 28 milliamperes. The excitation is then raised over a period of half an hour to a plate current of 40 milliamperes. This should be accomplished slowly, so that arcing inside the magnetron does not cause the transmitter to drop off the line. When 40 milliamperes is reached, it should be held for about one minute and then reduced to 28 milliamperes. To permit the filament current to be set at 2.0 amperes, it is necessary to add an isolating transformer and Variac as shown in figure 8.

The synchroscope in its present form does not reproduce some wave shapes correctly. A modification is in process of distribution which will improve this operation. The echo box should not be used with the *B*-Modulator.

Technical personnel charged with operation and maintenance of SP equipments should carefully study the above notes and endeavor to follow them in servicing the units in the future.



STACK GAS WARNING

The March 1946 issue of ELECTRON reported (on page 21) several incidents in which the dangerous effects of stack gas were emphasized, together with some Bureau recommendations designed to prevent personnel from being overcome by these gases.

Some further precautionary measures should be observed in connection with the servicing of equipment aloft and in the way of smokepipe gases. Warning signs like the one in the accompanying illustration should be posted and located so that they will be in full view of personnel required to service equipment. It is recommended that one sign be located below near the access ladder, and another aloft at the servicing platform. Signs are not available from the Bureau of Ships at this time.

The new Type-B oxygen breathing apparatus, BuShips #S-23-B-69855, due to its smaller size and weight is better suited for this work than the Type A-1 apparatus previously recommended in ELECTRON. Distribution of this new apparatus to all carriers is planned for the very near future. Ship's personnel and field engineers who are required to service equipment aloft in the vicinity of stack gas and who are not familiar with either the Type A-1 or the Type-B oxygen breathing apparatus should be instructed in their use by trained shipboard personnel. As a further precaution, the working party should always include at least one man stationed below who is required to wear his phones and stand watch on the X-6J sound-powered telephone circuit as long as there is a man working aloft.

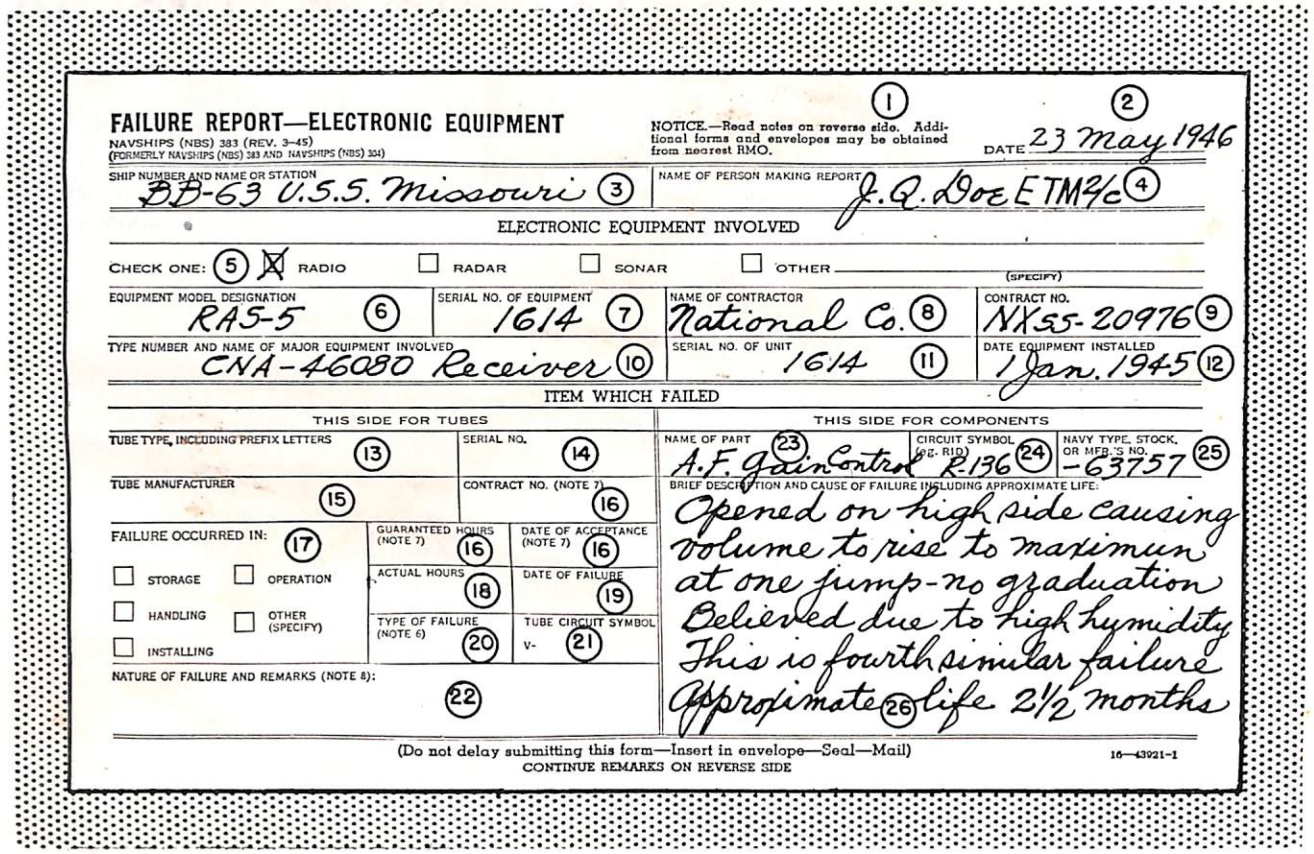
PROTECTION OF BARCO SLIP RINGS

Several instances have been reported of the shearing of transducer leads to "Barco" slip-ring assemblies installed on submarine sonar ranging equipments. These rings have been installed on the hoist of WCA-Series equipments to allow continuous training of the transducer and to eliminate the need for any complicated limit switches.

The installation of the slip rings requires that the leads be passed through slots in the azimuth ring and in the tube head. This means that any appreciable movement of the azimuth ring relative to the tube head will shear off these leads. The leads are soldered to the rings at the factory, and repair by field activities is a difficult operation.

To prevent damage, activities are cautioned to use great care when setting the azimuth ring. It should never be forced, as the leads are easily sheared off. If the ring turns hard or is to be rotated any appreciable distance, it is better to completely remove the Barco slip-ring assembly.

Future installations of slip-ring assemblies should leave at least an inch of each lead looped up between the bottom of the slip-ring assembly and the entrance openings on the azimuth scale. Under no circumstances should the leads be pulled up taut from slip rings to splicing point on transducer cables.



FAILURE REPORT—ELECTRONIC EQUIPMENT
NAVSHIPS (NBS) 383 (REV. 3-45)
(FORMERLY NAVSHIPS (NBS) 383 AND NAVSHIPS (NBS) 304)

NOTICE.—Read notes on reverse side. Additional forms and envelopes may be obtained from nearest RMO. ①

DATE 23 May 1946 ②

SHIP NUMBER AND NAME OR STATION: BB-63 U.S.S. Missouri ③
NAME OF PERSON MAKING REPORT: J. Q. Doe ETM2/c ④

ELECTRONIC EQUIPMENT INVOLVED

CHECK ONE: ⑤ ☒ RADIO ☐ RADAR ☐ SONAR ☐ OTHER ________ (SPECIFY)

EQUIPMENT MODEL DESIGNATION	SERIAL NO. OF EQUIPMENT	NAME OF CONTRACTOR	CONTRACT NO.
RAS-5 ⑥	1614 ⑦	National Co. ⑧	NXss-20976 ⑨
TYPE NUMBER AND NAME OF MAJOR EQUIPMENT INVOLVED: CNA-46080 Receiver ⑩		SERIAL NO. OF UNIT: 1614 ⑪	DATE EQUIPMENT INSTALLED: 1 Jan. 1945 ⑫

ITEM WHICH FAILED

THIS SIDE FOR TUBES

TUBE TYPE, INCLUDING PREFIX LETTERS ⑬ — SERIAL NO. ⑭
TUBE MANUFACTURER ⑮ — CONTRACT NO. (NOTE 7) ⑯
FAILURE OCCURRED IN: ⑰ ☐ STORAGE ☐ OPERATION ☐ HANDLING ☐ OTHER (SPECIFY) ☐ INSTALLING
GUARANTEED HOURS (NOTE 7) ⑯ — DATE OF ACCEPTANCE (NOTE 7) ⑯
ACTUAL HOURS ⑱ — DATE OF FAILURE ⑲
TYPE OF FAILURE (NOTE 6) ⑳ — TUBE CIRCUIT SYMBOL V- ㉑
NATURE OF FAILURE AND REMARKS (NOTE 8): ㉒

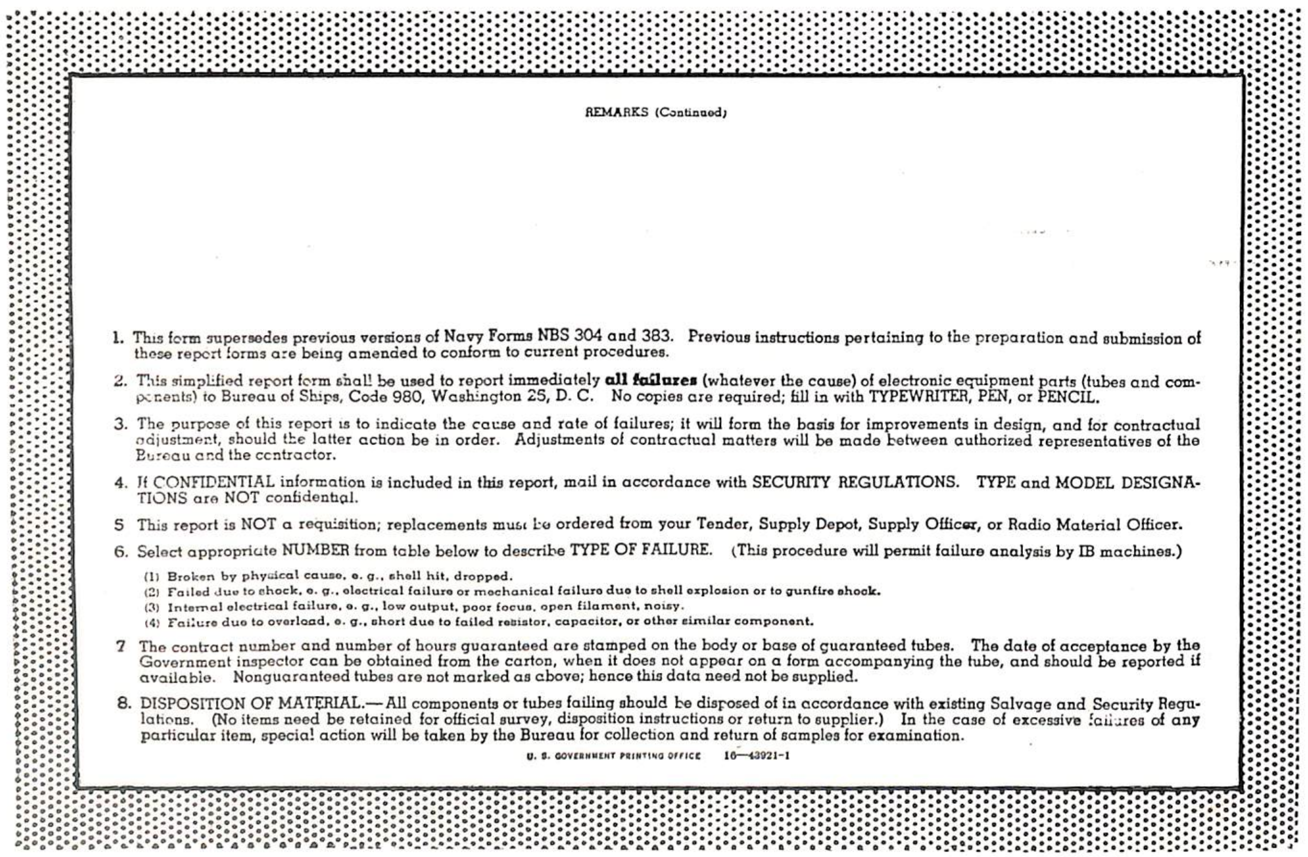
THIS SIDE FOR COMPONENTS

NAME OF PART: A.F. Gain Control ㉓ — CIRCUIT SYMBOL (eg. R10): R-136 ㉔ — NAVY TYPE, STOCK, OR MFR.'S NO.: -63757 ㉕

BRIEF DESCRIPTION AND CAUSE OF FAILURE INCLUDING APPROXIMATE LIFE:
Opened on high side causing volume to rise to maximum at one jump—no graduation. Believed due to high humidity. This is fourth similar failure. Approximate ㉖ life 2½ months

(Do not delay submitting this form—Insert in envelope—Seal—Mail)
CONTINUE REMARKS ON REVERSE SIDE

16—43921-1



REMARKS (Continued)

1. This form supersedes previous versions of Navy Forms NBS 304 and 383. Previous instructions pertaining to the preparation and submission of these report forms are being amended to conform to current procedures.
2. This simplified report form shall be used to report immediately **all failures** (whatever the cause) of electronic equipment parts (tubes and components) to Bureau of Ships, Code 980, Washington 25, D. C. No copies are required; fill in with TYPEWRITER, PEN, or PENCIL.
3. The purpose of this report is to indicate the cause and rate of failures; it will form the basis for improvements in design, and for contractual adjustment, should the latter action be in order. Adjustments of contractual matters will be made between authorized representatives of the Bureau and the contractor.
4. If CONFIDENTIAL information is included in this report, mail in accordance with SECURITY REGULATIONS. TYPE and MODEL DESIGNATIONS are NOT confidential.
5. This report is NOT a requisition; replacements must be ordered from your Tender, Supply Depot, Supply Officer, or Radio Material Officer.
6. Select appropriate NUMBER from table below to describe TYPE OF FAILURE. (This procedure will permit failure analysis by IB machines.)
   (1) Broken by physical cause, e. g., shell hit, dropped.
   (2) Failed due to shock, e. g., electrical failure or mechanical failure due to shell explosion or to gunfire shock.
   (3) Internal electrical failure, e. g., low output, poor focus, open filament, noisy.
   (4) Failure due to overload, e. g., short due to failed resistor, capacitor, or other similar component.
7. The contract number and number of hours guaranteed are stamped on the body or base of guaranteed tubes. The date of acceptance by the Government inspector can be obtained from the carton, when it does not appear on a form accompanying the tube, and should be reported if available. Nonguaranteed tubes are not marked as above; hence this data need not be supplied.
8. DISPOSITION OF MATERIAL.—All components or tubes failing should be disposed of in accordance with existing Salvage and Security Regulations. (No items need be retained for official survey, disposition instructions or return to supplier.) In the case of excessive failures of any particular item, special action will be taken by the Bureau for collection and return of samples for examination.

U. S. GOVERNMENT PRINTING OFFICE 16—43921-1

Failure Reports—The Technician's Lifeline

■ "How in h - - - can a piece of paper 5" x 8" be considered my lifeline?" you ask. In the following pages we will attempt to point out salient facts which will answer that question thoroughly, and in such a manner that all technical personnel will understand the important part these pieces of paper—NBS 383—assume in their maintenance program.

In order for any maintenance organization to function correctly it is first necessary that the personnel, both individually and collectively, from the electronics officer down to the "boot" strikers, whether regular or reserve, short-timer or long-timer, have the correct attitude concerning the equipment under their cognizance. By correct attitude we mean the desire to institute and faithfully carry out a maintenance program, both preventive and operational, which will ensure that all equipments will operate correctly at all times. Each member of a maintenance organization should develop the feeling that the equipments assigned to him for upkeep and maintenance are his "personal property" and as such he should zealously carry out the prescribed preventive maintenance program as well as all operational maintenance problems.

A good technician would never think of starting out on a service call without his favorite kit of tools and instruments, as he knows he will be seriously handicapped or inconvenienced without them. But this kit should also contain a supply of NBS 383 failure report forms, because the job is not considered to be actually completed until this form is properly filled out and in the mail. It should preferably be filled out at the scene of the job, immediately upon completion of the work. The man in charge *at the job* is responsible for filling out the form, and the senior technician should avail himself of a means to ensure that it is actually done. Many maintenance men return to the shop to fill out and mail the failure report before starting off on another project. There is nothing wrong with this procedure, of course. But every small delay increases the possibility that it will be delayed still more, with the result that it may never be done. Delay also increases the danger of overlooking important details of the job. This is why the Bureau recommends the placing of a supply of the forms in each repair kit, and requiring the technician to fill out the form before leaving each job.

Perhaps there are many technicians who are not aware of the importance of submitting failure reports on each and every tube and component failure in their respective equipments. There are many reasons for attaching such great importance to these reports. Balance of supply and demand is one reason, and is illustrated here by a hypothetical situation which has had its actual counterpart in many ships and stations during the past years.

Joe Doaks, ETM2c, is investigating a failure in "his" surface-search radar equipment. His ship is due to sail at midnight and the navigator desires to use the radar to assist in navigating the channel out of the harbor. After making routine checks and tests he locates the defective component, which we will call R-XXX. A quick check of the spare parts box reveals that no replacement is available due to the fact that the same component had failed before. The part was on order, of course, but had not yet been received on board. Joe hurriedly fills out a requisition form, gets it properly signed and, after much trouble for all hands, gets a boat to the nearest Electronics Supply Office. Upon arrival there he is informed that they are completely out of that particular component. Needless to say, Joe is disgusted and thinks to himself "Why does a major Electronics Supply Office run out of necessary components, especially those which are known to be subject to frequent failure?"

That's a good question, Joe, so let's see what the answer is. In the first place, at least half of the blame (if not more) rests upon your own shoulders. The ETM's keep ordering equipment, eventually depleting the ESO's stocks. You say that it is their responsibility to maintain adequate stocks and to furnish the necessary components to keep all equipment in operation. This is perfectly true, but a very vital point has been overlooked. All the components that are stocked by the ESO's must be first obtained from commercial organizations by the Bureau of Ships, based on information obtained from failure reports received by the Bureau. During the war years, money was secondary because the primary concern was to win the war. Great quantities of all components were obtained in advance of demand to ensure that enough of everything would be available. With the advent of peace, however, drastic cuts in expenditures have been necessitated. This means that equipment and components must be ordered in just sufficient quantities to provide replacements of defective material, with only a slight safety margin. Therefore the Bureau must depend on fleet reports of defective material and tubes in order to estimate the correct quantities to order from the contractors. And how would the Bureau know that R-XXX was a common source of failure if it had not been reported?

Now, Joe, do you begin to see the light? It is your responsibility, and a very important one, to ensure that a failure report for each defective component and tube is mailed to the Bureau, there to be catalogued and used in figuring out these quantities to be ordered for stock. If all the technicians had been conscientious in the prompt forwarding of their failure reports, Joe's very first requisition would have been filled immediately from stock and he would have been spared all his trouble.

The Bureau is gravely concerned over the failure report situation because many reports from ESO's indicate that their stock is extremely low, or completely depleted, in certain components and tubes due to a great number of requisitions from forces afloat. A check of these reported components reveals that only a small percentage of them have been reported on NBS 383, while in some cases not one failure report has been received on components which have been reported as drastically low. It should be obvious that, by the time the Bureau can contract for components in the above categories and deliver them to the various ESO's, the stock will be completely depleted and there will be several repetitions of the little drama that Joe went through when he found he had no replacement component for his search-radar equipment.

As a concrete example of the above situation we cite one particular equipment component. The Bureau was receiving numerous requests from ESO's for additional oil seals for the SK slewing motor. These requests were filled after considerable difficulty and delay. However, not a single failure report was received in the Bureau on this particular component. The situation became so out of proportion that the Bureau was forced to send a dispatch to all units having this particular equipment, requesting information as to failure of these oil seals. This entailed considerable work on the part of the Bureau, as well as putting an additional job on the technical personnel who maintained these equipments in that they had to check through all repair records to obtain the information. All this extra activity could have been avoided if each failure had been reported promptly to the Bureau.

In addition to assisting in the balancing of supply and demand of replacement parts as stocked by ESO's, the failure report plays other important roles in the over-all electronic program. The tabulation of these reports is passed along to the design branch of the Bureau for use in locating and correcting troubles in current equipments. When a sufficient number of reports of failure on a certain component are received by the Bureau, corrective action is taken which in many instances results in a Navy Field Change on all current equipments and a change in design in future equipments. Thus it can be seen that a large percentage of the refinements in design and production of equipment can be attributed directly to the technical personnel who are conscientious about submitting their failure reports.

Another use of the tabulated data obtained from failure reports is in the preparation of trouble shooting notes and service data. Many instruction books now contain a section devoted to trouble shooting and servicing. The information contained in these sections is not the result of idle guesses and theoretical deductions. They are concrete facts and instructions carefully coordinated and checked by engineers who placed considerable emphasis on the information contained in failure reports as well as actual checking on the equipment to ensure that incorrect or doubtful information and instructions would not be passed on to the technicians.

In the preceding paragraphs we have briefly explained why the technician should abide by existing directives and promptly submit NBS 383 on each tube and component failure. But there is still a very important point to be considered when submitting these reports. We all realize that any task worth doing is worth doing correctly. In the filling out and submission of NBS 383 this rule is particularly applicable. Reports which are inaccurate, incomplete, or otherwise incorrectly prepared can cause more confusion than no reports at all. Therefore it is imperative that the technician use good judgment and extreme care in filling out these reports. For the purpose of clarity and uniformity of style in the preparation of these reports, the technician should study figures 1 and 2. Figure 1 is a failure report form correctly and intelligently prepared, and the information contained thereon may be easily tabulated by the Bureau. Figure 2 shows the back side of the same form, which gives pertinent instructions and information which must be thoroughly understood by all hands in the maintenance organization.

As an aid in understanding what each division on the form is for, the following breakdown of the numbered portions is offered for study and compliance by the technical personnel charged with preparing NBS 383:

1—This notice refers to the notes on the reverse side as shown in figure 2. These notes must be thoroughly understood.

2—This is the date the form is filled out, and should be the same as the date of completion of the repair.

3—Both the name and number of the ship, or the name of the station should be given in this space.

4—The name appearing in this column should preferably be the man in charge of the job, but may be an assistant to whom he delegates the responsibility of preparing the form.

5—Place an "X" in the proper block. If the equipment is other than radio, radar, or sonar, indicate under "other", such as loran, RCM, etc.

6—This should include the letter designation and series number (if any) as shown on the nameplate; for example, TBL-5, RDJ-1, Mark 8, etc.

7—This is the serial number of the complete equipment, which usually may be found following the model designation on the master nameplate. For the location of serial numbers on radar equipment see page 16, July 1945 ELECTRON.

8—This is the name of the contractor of the complete equipment as shown on the nameplate, such as Western Electric Co., Raytheon Manufacturing Co., etc.

9—The contract number is very essential and can be secured from the nameplate, such as Nxr 62336, etc. Copy it exactly as it appears, including the code letters which precede the number.

10—The major equipment involved is either the transmitter, receiver, modulator, power supply, indicator, etc. The type number is the Navy type number of the unit involved, and can be secured from the nameplate on the unit. Thus if a man were working on the Mark-8 range unit, this would be described as a CW-23ACC Range Unit.

11—This is the serial number of the individual unit involved and can be found on the unit nameplate.

12—The date that the complete equipment was first installed should be entered here. If not definitely known, the technician should at least enter an approximate date.

Items (13) through (22) list the information required when reporting tube failures, and items (23) through (26) cover derangement of material and/or component failures.

13—The tube should be listed exactly as it appears on the tube or the tube carton (CRC-6J7: CWL-861, etc.).

14—The serial number of the tube can usually be obtained from the body or base of the tube. If no serial number is available, leave this space blank. It is suggested that the technician check each tube before placing it in the socket. If no serial number is shown on the tube he should check the carton before destroying it, or obtain it from the requisition. Transfer this number to the tube by some method so it will be available for future reference.

15—The name of the manufacturer is usually printed on the tube, or it may appear on the carton. It will often appear only in code form, represented by the two or three letters immediately preceding the type number. If you can't find the key to the code in some instruction book, just indicate the code number.

16—The contract number and number of hours guaranteed will appear on the carton, and also are sometimes stamped on the body or base of the guaranteed tubes. The date of acceptance by the government inspector is also stamped on the carton or will be found on a form accompanying the tube. To preserve these three items, the same procedure as outlined in (14) above should be followed, since all are important in replacing tubes which become defective before their guarantee expires. Non-guaranteed tubes are not marked as above, and this data need not be supplied.

17—Specify whether the tube failure occurred while in storage, operation, handling, etc. If possible, amplify these remarks with deductions as to what caused failure. For example, "Tube failed while in storage due to broken envelope suffered during gunfire". These remarks should be entered under (26).

18—The actual hours of operation is important, particularly in cases where the tube which failed has had only a few hours of operation. The Bureau utilizes this information to obtain a replacement tube from the manufacturer under the terms of the guarantee.

19—This is the date on which the failure occurred.

20—To indicate the type of failure select an appropriate *number* from the table in Note 6 on the reverse side of the form (see figure 2).

21—State the circuit symbol of the tube that failed (V-107, V-123, etc.)

22—This should include brief information as to what caused the failure, how operation was affected, and how failure occurred.

23—This is for the name of the component that failed (capacitor, resistor, motor, etc.), This should be the name as it is given in the parts list of the instruction book.

24—This is the symbol of the component that failed (C-104, R-238, B-102, etc.). This should be the same as it is given in the instruction book.

25—The Navy Type, Stock, or Manufacturers Number can be secured from the parts list in the instruction book.

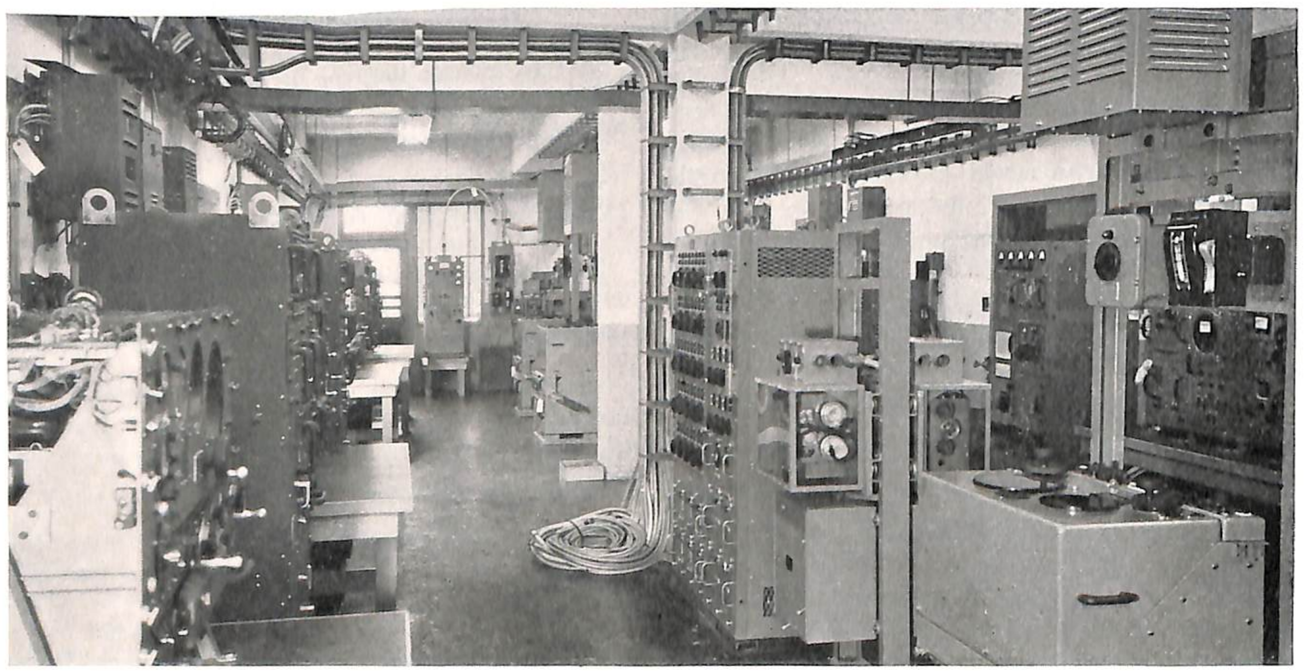
The Warrant Officers

Radio Engineering School

■ Navact 45 requested applications from certain officers, including Chief Radio Electricians and Radio Electricians, for a course of instruction at the Warrant Officers Radio Engineering School, Bellevue, D. C. To most of the old-timers in the Navy this school, founded in 1927, represents the ultimate in non-collegiate formal education in the electronics field. With few exceptions the prewar graduates of this school and many of the wartime graduates have made outstanding contributions to the progress, upkeep, and efficient operation of electronics equipment throughout the Navy. The Commanding Officer of the Radio Matériel School as well as the Officer in Charge and many of the staff of W.O.R.E.S. are graduates of this institution and therefore fully appreciate the student's position while under instruction at the school.

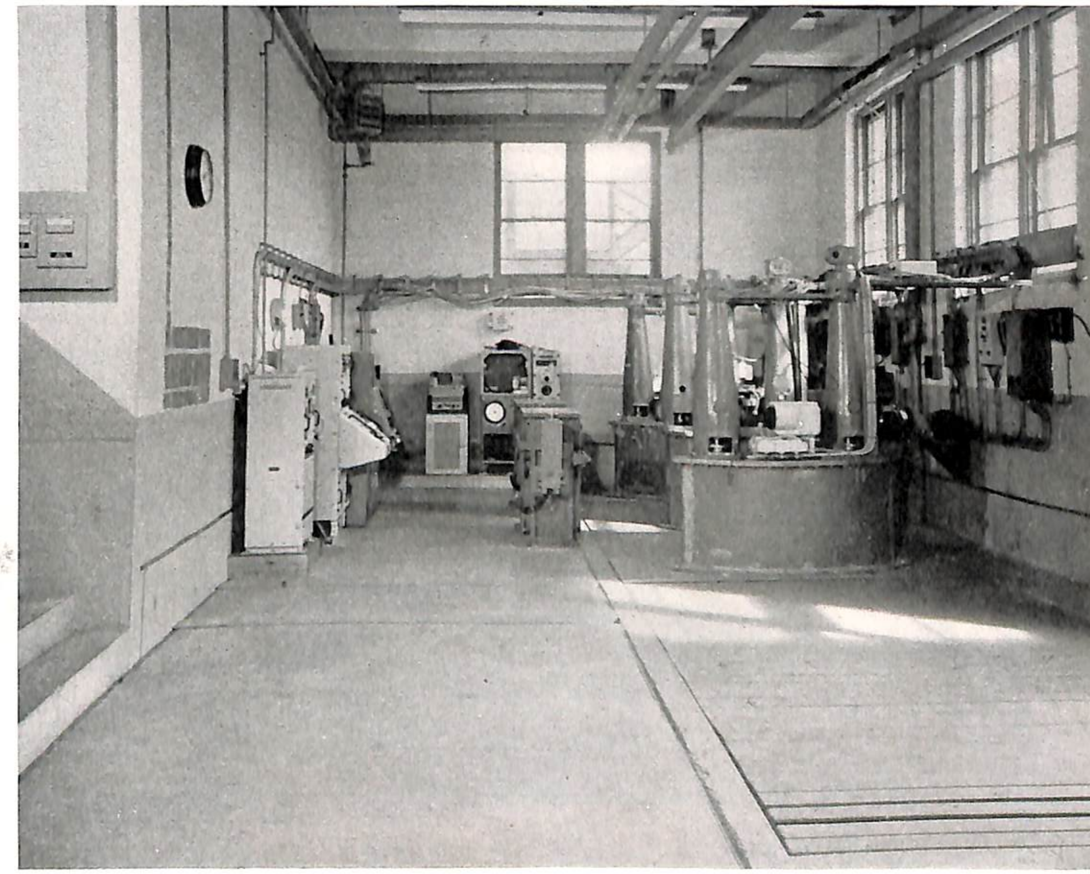
W.O.R.E.S. was originally established to provide an advanced course in mathematics and electronics. A great deal of the material was taught from textbooks only, due to the shortage of space and equipment for laboratory instruction. As the years passed, the trend of teaching from textbooks was continued but as more equipment became available the laboratory program was enlarged. At the outbreak of the war the school was graduating only one class of about six officers per year. It was immediately apparent that this number of graduates was inadequate to meet the rising demands for experienced personnel on ships and stations throughout the service. Plans were formulated to increase this output and at the same time it was decided to increase the amount of laboratory instruction to a point comparable to the formal instruction given from the lecture platform.

In the early days of 1944 the staff of the school was augmented by several new members and additional instructors have been added since that date to keep pace with the growth of the school. The student input was raised to approximately thirty per class, with a new class convening the first day of each quarter. With this increase in student body plus the large quantity of equipment made available, additional space was necessary to accommodate the larger school. A new building was therefore planned, and construction was completed in the fall of 1945. Installation of new equipment and moving of other equipment from the old school building started shortly thereafter. The school was officially transferred to its new quarters on 7 March 1946.



Search-radar laboratory with various types of equipment installed. Where practicable, units have been installed on jigs for convenience in servicing during laboratory assignments.

Communication transmitter laboratory, showing equipment, lighting, and floor space arranged for maximum convenience of the student.



A portion of the sonar laboratory located in the basement of the building. The hoist mechanisms are mounted on movable platforms so that the projectors extend down into the water tank below.

The year's course is divided into four terms of thirteen weeks each. The first term requires 655 hours and covers algebra, use of the slide rule, trigonometry, vector algebra, logarithms, hyperbolic functions, analytic geometry, d-c electrical engineering, physics, and shop practices. Approximately 28 percent of the time is devoted to formal lectures, 17 percent to laboratory assignments, and the remainder to study and preparation.

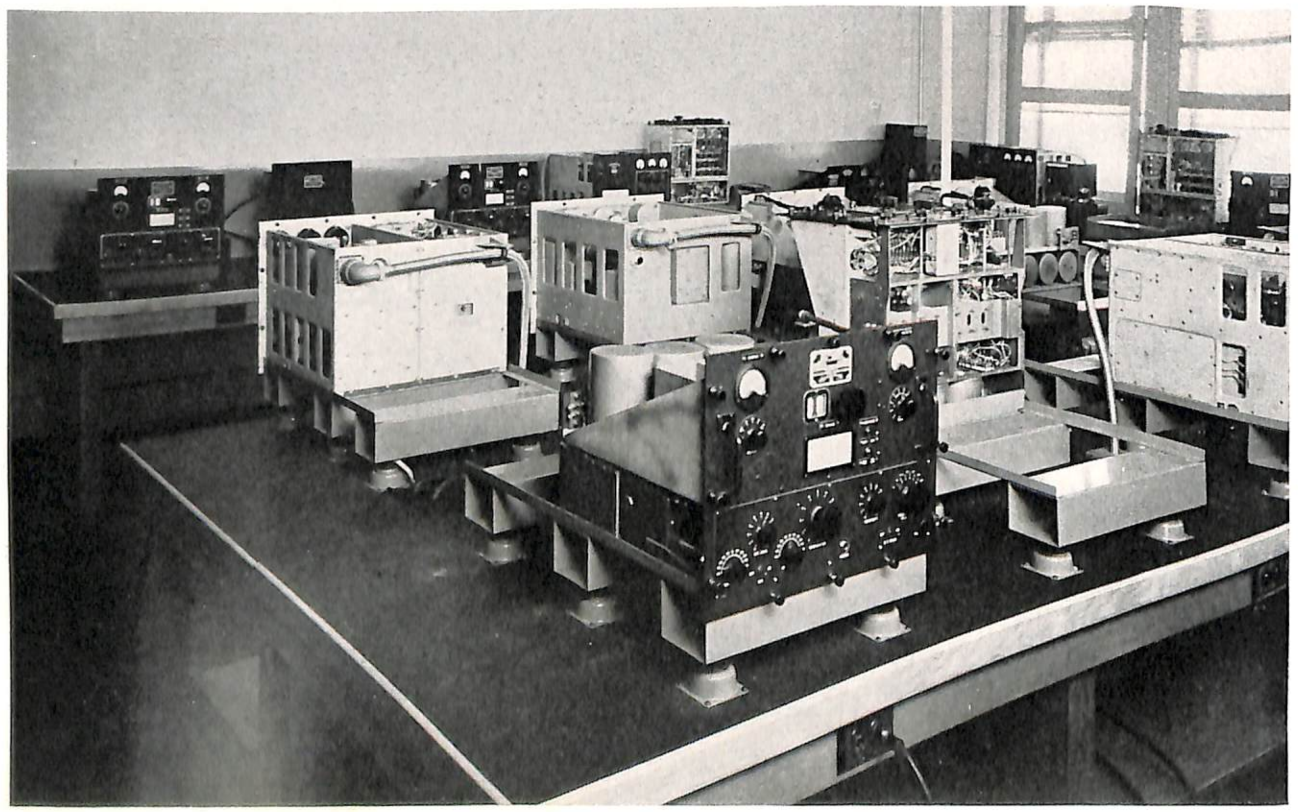
The second term is devoted to a-c electrical engineering, blueprint reading, the calculus, electronics engineering, special circuits, naval administration, naval communications, and classified communication devices. Of the total of 685 hours, approximately 25 percent of the time is devoted to formal lectures, 22 percent to laboratory instruction and the remainder to study and preparation.

The third term includes wave propagation, communication transmitting equipment, communication receiving equipment, radio direction-finding equipment, radio and radar defensive countermeasures equipment, and underwater echo-ranging and sounding equipment for a total of 673 hours. Approximately 25 percent of the time is utilized in formal lectures, 23 percent in laboratory instruction and the remainder for study and preparation.

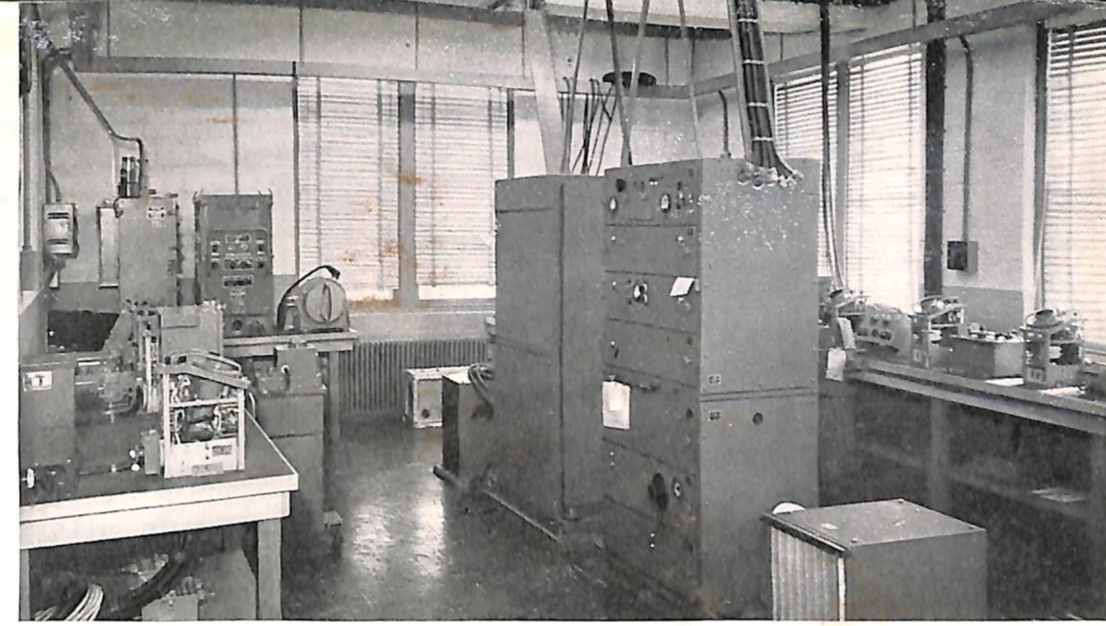
In the last term the curriculum includes such subjects as surface-search radar, air-search radar, radar repeaters, fire-control radar, IFF, offensive countermeasures equipment, loran, stabilized antenna systems, radar planning devices, and use of the maneuvering board, requiring a total of 695 hours. Formal lectures cover approximately 30 percent of the time, laboratory instruction 26 percent, and the remainder is devoted to study and preparation.

All instruction is delivered with emphasis on general concepts and principles. Particular attention is devoted to the exhaustive study of typical models of each of the various classes of equipment as a method of teaching current applications of engineering principles. For example, the instruction on fire-control radar is mostly devoted to the Mark 12 and Mark 22. However, previous instruction has been given on special circuits, many of which are common to all radar systems. Thus the instructions on these two equipments is in part training on current applications of certain special circuits as well as comprehensively covering these popular fire-control radar equipments.

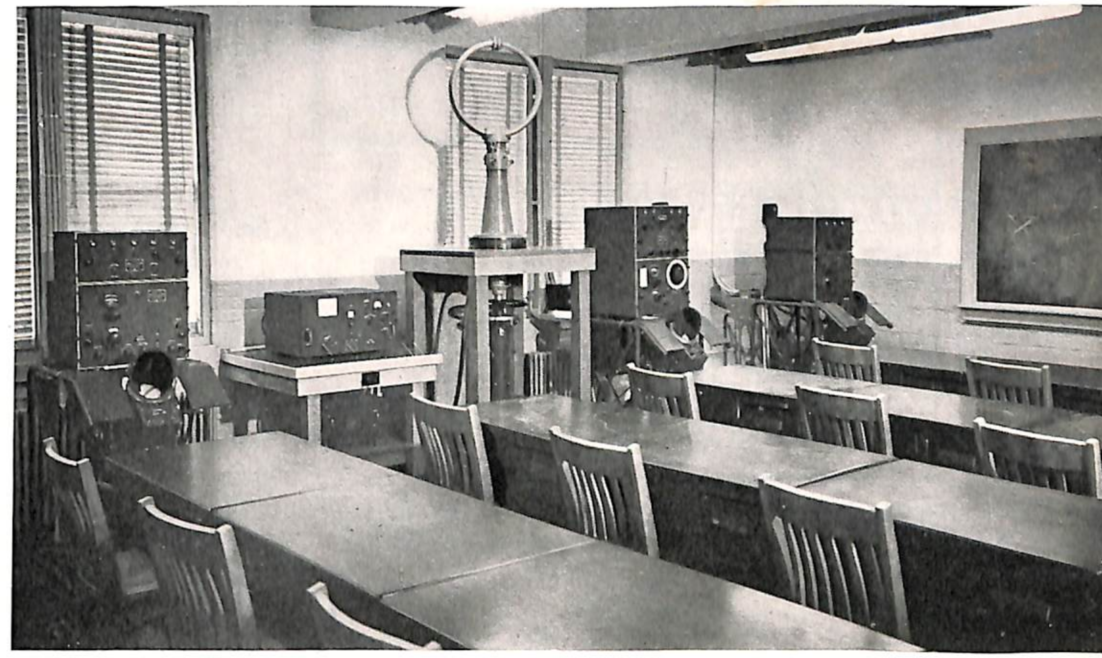
Those who contemplate attending the Warrant Officers Radio Engineering School should spend as much time as possible in familiarizing themselves with basic mathematics, including algebra, trigonometry, and logarithms, and in the use of the slide rule.



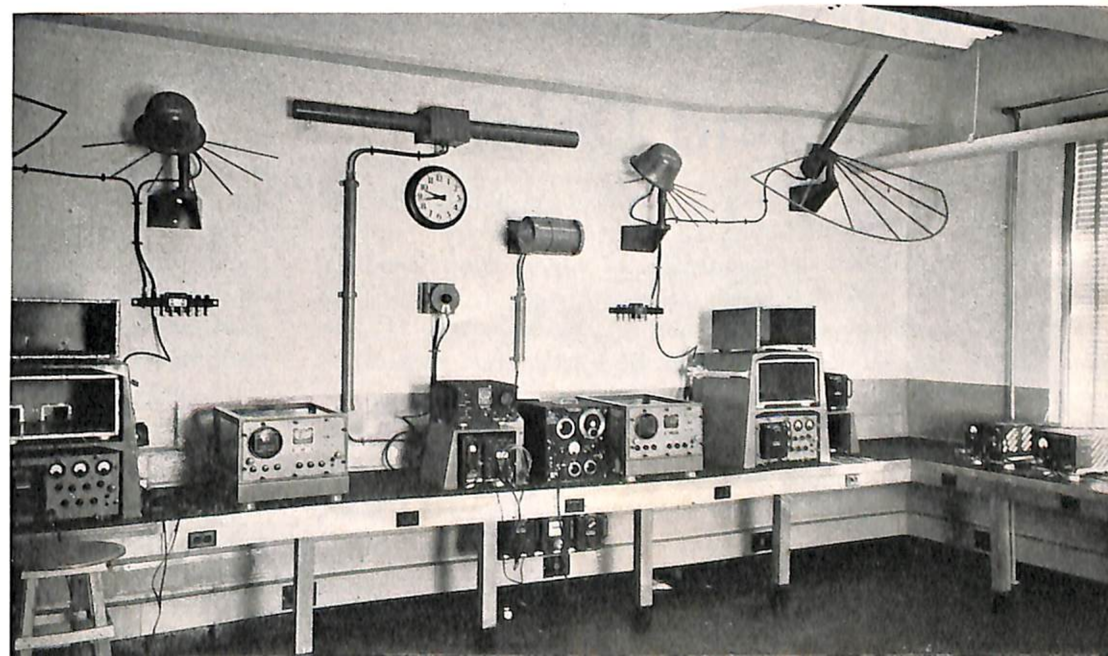
One corner of the communication receiver laboratory, showing various types of receivers mounted in jigs on tables. Note method of hinging after end of receiver to facilitate tilting back to expose component chassis for servicing.



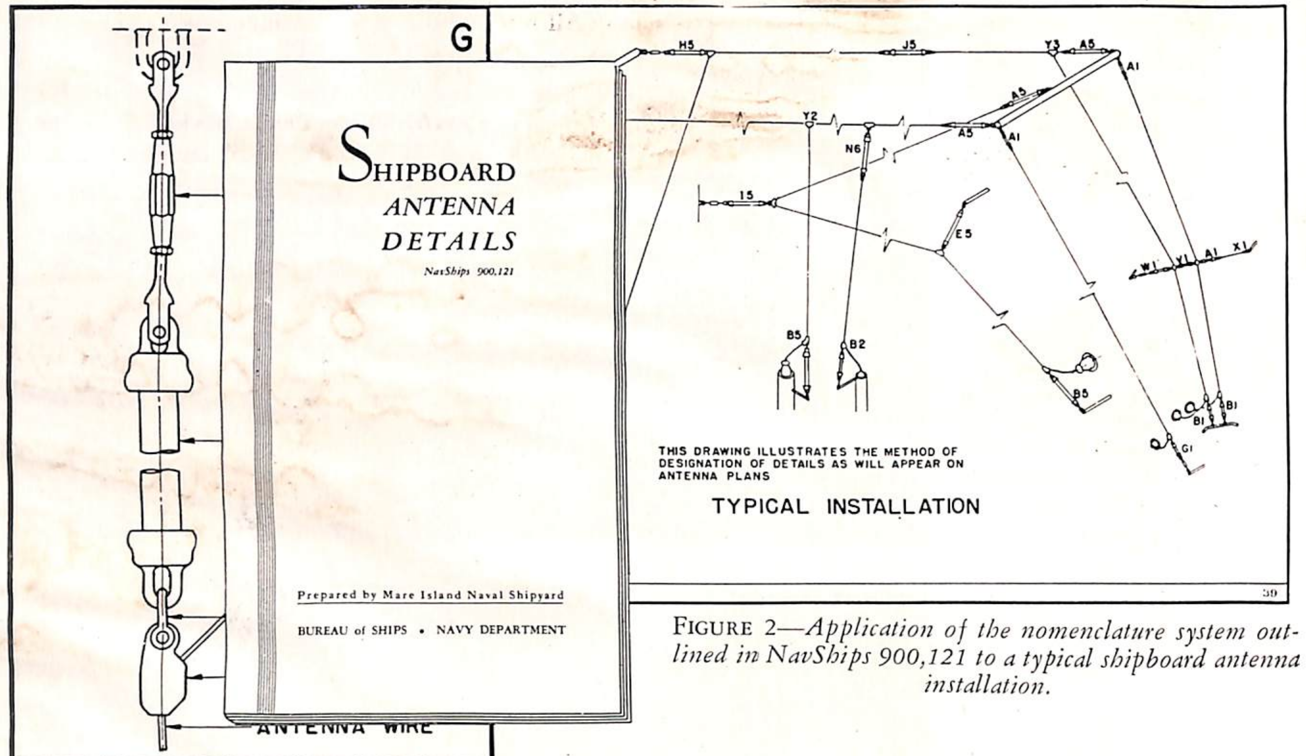
Two Mark 12/22 installations in the fire-control radar laboratory. The train indicators and control panels are bench-mounted for ease of observation and operation during laboratory assignments.



Radio direction finder laboratory and lecture room in penthouse of building. Note the large executive-type desks provided for students. These desks are standard in all lecture rooms, and provide ample space for study and lesson preparation.



One side of the defensive-countermeasures laboratory, showing uniformity of installation and layout, which is a feature of all the laboratories.



DTL.	G1		G2		G3		G4		G5			
SIZES NOM'L.	SIZE	PC. NO.	SIZE	PC. NO.	SIZE	PC. NO.	SIZE	PC. NO.	SIZE	PC. NO.		
TURNB.	1/8"	11	1/8"	11	5/16"	12	5/16"	12	5/16"	12		
INSUL'R.	5"	3	10"	4	10"	4	15"	5	20"	6		
SHACK.	5/16"	25	5/16"	25	5/16"	25	7/16"	26	7/16"	26		
CLAMP	1/8"	13	1/8"	13	5/16"	19	5/16"	19	5/16"	19		
WIRE	1/8"	1	1/8"	1	5/16"	2	5/16"	2	5/16"	2		

7

FIGURE 1—*A typical page from NavShips 900,121 illustrating the combination of turnbuckle, insulator, shackle, and 135° clamp.*

FIGURE 2—*Application of the nomenclature system outlined in NavShips 900,121 to a typical shipboard antenna installation.*

Shipboard Antenna Details

■ The Bureau has just published a pocket-sized booklet which should be a great help to all concerned with the installation and maintenance of shipboard wire antennas. The booklet is titled "Shipboard Antenna Details" and has been assigned the short title NavShips 900,121. The material and drawings in the booklet were prepared by the Mare Island Naval Shipyard.

This book is important for two reasons. First, it sets up an easy nomenclature system which, when uniformly applied, will greatly simplify drawings, specifications, correspondence, and any other written or verbal instructions relating to the rigging of antennas. Secondly, it is a convenient handbook of approved antenna fittings for design and installation personnel, because it describes and illustrates all approved antenna fittings.

The book is a series of separate drawings, each consisting of a different combination of details. Each of these combinations carries an identifying letter. Below the drawing is a table which further breaks down the components by size. Figure 1 is a typical page from the book and illustrates the combination of turnbuckle, insulator, shackle, and 135° clamp. It is known as "Detail G". Examination of the table beneath the drawing shows how the nomenclature is further broken down into the more specific details, G1, G2, etc., depending upon the size of the component parts. The piece numbers given in the table refer to more detailed information contained in a List of Materials in the back of the book.

Figure 2 shows the application of the system to a typical antenna installation. The numbers on the drawing refer back to the specific details in the booklet. It is apparent that great simplification is possible as compared with the conventional working drawing. The usual practice of showing each detail on a set of antenna plans may now be dispensed with and proper reference made to the applicable standard which is detailed in NavShips 900,121.

These books have been distributed in substantial quantities to the Electronics Officers at the principal naval shipyards. However, additional copies may be obtained from the Bureau of Ships.

TESTING SONAR TRANSDUCERS

There has been no established standard for preventive and corrective maintenance of transducers. Generally, each electronics repair activity has set up its own standard of requirements as a guide for determining when a transducer needs over-hauling. Such practice lacks uniformity and is inadequate for attaining a high standard of maintenance.

Accordingly, the Bureau has cancelled all existing instructions on insulation resistance of transducers given in sonar instruction books, maintenance manuals and the Sonar Bulletin. In lieu thereof, the Bureau directs that all sonar transducers be tested in accordance with the following requirements:

Always check the insulation resistance of sonar transducers, both crystal and magnetostriction, with a 500-volt megger. New and overhauled transducers must give an insulation reading of 100 megohms or better. When the insulation has deteriorated to less than 50 megohms the transducer should be repaired as soon as ship drydocking permits. This, however, is not to be construed as authority to drydock any ship. Frequently transducers of retractable-dome equipments can be overhauled without docking the ship.

Check the circuit continuity of magnetostriction transducers with a resistance bridge. The readings obtained should be within ±5% of the nominal resistance given in the Sonar Bulletin, Article 13.19, "Projector Characteristics Chart". Sub Sig BDI or split transducers must have their branches or halves read in parallel. Series readings will be four times the parallel or given value. RCA BDI transducers are read across their outside leads. Readings taken between the centertap and either outside lead will cut the nominal resistance in half. Transducers with resistances off by more than ±5% of the nominal values must be overhauled at the first availability.

Check the inductance of magnetostriction transducers with an inductance bridge. The inductance of transducers should be within ±5% of the nominal inductance as given in the respective instruction books. If the inductance of any transducer is off more than 5% of its nominal inductance, the transducer must be overhauled at the first availability.

Check the capacitance of crystal transducers with a capacity bridge. The battery with head telephones and megger methods are unsatisfactory. The capacity of a crystal transducer should be within 10% of its nominal capacity as listed in the respective instruction book and corrected correspondingly for temperature. Transducers with capacities reduced by more than 10% of the nominal capacity as corrected for temperature must be overhauled at the first availability.

All readings of continuity, inductance and capacitance must be corrected for the length of the cable between the point of test and the transducer. Transformer-coupled crystal transducers should be checked by opening the transformer housing at every opportunity to take readings on the transformer secondary and the crystal assembly.

Special tests for transducers which cannot meet the above requirements are:

Type CBM or CIP-78139 transducers: Conduct the insulation test with a Voltohmyst or an ohmmeter with a 10-megohm range. A minimum insulation of 5 megohms is satisfactory. The use of a 500-volt megger subjects the 78139 transducer insulation to excessive overload voltage since the maximum operating voltage is in the neighborhood of a millivolt.

JP series, JT, DCDI, DCRE, CI, NLM and STT: Hydrophone test data will be published in the near future. In the meantime, continue present practices based on the data at hand.

The use of 1000-volt meggers for testing sonar cables and transducers is forbidden. In general, most sonar transducer cables are tested for insulation in accordance with BuShips specifications which state that a battery voltage of not less than 100 volts nor more than 500 volts is to be used.

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ERROR IN NMC-2 INSTRUCTION BOOK

An examination of figure 2-3 on page 2-2 of the final instruction book for the Model NMC-2 sonar sounding equipment (NavShips 900,595A) will show that there are two meters marked M-402. The right-hand meter should be marked M-401. The left-hand meter is marked correctly. All instruction books should be changed accordingly.

"Is everything satisfactory, Sir?"

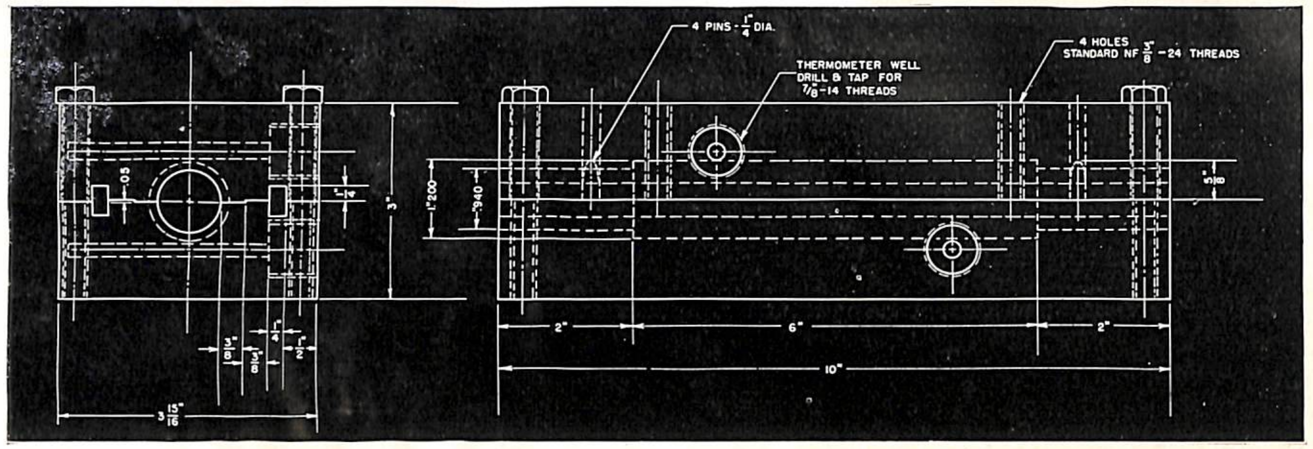


FIGURE 1—*Details of the mold for splicing RG-35/U Cable.*

Splicing RG-35/U Cable

■ This article is the result of an investigation undertaken by the U. S. Naval Rubber Laboratory, Mare Island Naval Shipyard. The purpose of the investigation was to develop a field method for making satisfactory splices in the jackets of Type RG-35/U cables intended for installation in wet ground. A future article will describe a method of splicing RG-84/U and RG-85/U cables.

This investigation was conducted by evaluation of molded specimen cable jacket splices prepared in a progressive development and leading to the procedure finally recommended. The jacket splices were evaluated in accordance with the characteristics desired in a completed splice. One such characteristic is that the adhesion of the splice to the original jacket of the cable should be without obvious flaws, and should be sufficient to require considerable force to effect any separation of the splice from the jacket. The splice should be free from obvious flaws endangering the watertight integrity of the cable, and the polyethylene primary insulation should not be forced into or through the interstices of the copper braid shielding of the cable.

During the early stages of the investigation, visual and manual examinations of the splices sufficed to form the bases for further operations. However, in order to arrive at the final refinements of technique, a special test was employed to check the watertight integrity of the splice.

The development of the cable jacket splicing technique progressed through several stages. Injection molding in accordance with the instructions on pages 51 and 52 of "Installation and Maintenance of Transmission Lines, Waveguides, and Fittings" (NavShips 900,081) was tried and found unsatisfactory. Injection molding at elevated temperatures was tried and also found unsatisfactory. Compression molding with a converted injection-type mold, however, proved satisfactory. Next, a compression mold for field use had to be designed, and a final revision of the splicing technique had to be made to fit the charactertistics of the new mold.

Details of the mold designed for field use are shown in figure 1. Several worth-while features are provided. The mold is semi-positive in action, the last 0.05 inch of closure being nearly positive. It can be closed by clamping or bolting, or both, and threaded additional holes in the upper block permit the closure bolts to be used to open the mold when it has cooled. Wells are also provided for the insertion of industrial dial-type thermometers for temperature control, although ordinary temperature-sensitive indicating crayons may serve as a temperature indicator for field use. The mold cavity is enlarged to provide a maximum wall thickness of 0.20 inch over a splice 6 inches long.

In order to arrive at the procedure finally recommended, it was necessary to determine the optimum molding conditions when using the mold shown in figure 1. An initial time-temperature study indicated that the major displacement of the polyethylene occurred approximately 16 minutes after insertion of the preform in the continuously heated mold. Accordingly, the principal problem was to determine the time during which heat could be applied to the mold without damage to the polyethylene primary insulation.

A group of four specimens were prepared, employing all the steps needed under field conditions, with a molding cycle of 10 minutes heating after the insertion of the preform into the mold, followed by natural cooling by convection in air. The watertightness of the splices was tested and found satisfactory. Upon cutting open the splices, however, the polyethylene was found to be extruded through the copper braid at either side of the splice. Because of this, another specimen was molded

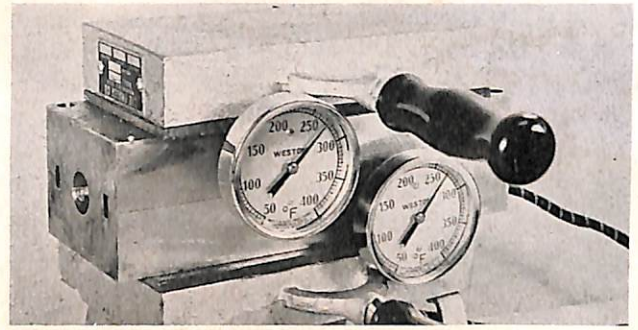


FIGURE 2—*Mold being preheated in a Shaler vulcanizer.*

and a thermocouple inserted at the site of the splice, which revealed that a maximum temperature of 232°F was present 15 minutes after removing the mold from between the hot plates.

The next step was to prepare some specimens and discontinue heating following closure of the mold. Under these conditions a maximum temperature of 212°F. was reached 21 minutes after closing the mold. No damage to the polyethylene was observed.

Based on the results of the experiments outlined above, the following procedure is recommended for the splicing of the jackets of Type RG-35/U cables:

1—The mold is placed between the hot plates of a Shaler vulcanizer, as shown in figure 2, and the heating of the mold begun. If a vulcanizer is not available, a blowtorch or similar source of uniform heat can be used.

2—The cable conductor is spliced, the splice insulated, and the copper shielding braid replaced and bonded, as shown in figure 3.

3—The paint is removed from the cable jacket with coarse sandpaper for a distance of six inches on both sides of the splice.

4—The cut ends of the jacket are drawn together over the braid splice and knitted together with a hot soldering iron. The gaps are partially filled by knitting in a small amount of E-252-40 splicing stock (made up of Vinylite VYNS resin 100 parts, Litharge 3.5 parts, and Paraplex G-25 50 parts). This step is shown in figure 4.

5—The entire region of the splice is painted with one coat of C-16-4 cement (made up of Vinylite VYNS resin 100 parts, Litharge 3.5 parts, Paraplex G-25 100 parts, and methyl isobutyl ketone 900 parts) and allowed to dry until barely tacky to the touch.

6—Strips of stock E-252-40 in the form of tape 1-inch wide by 0.02-inch thick, are freshened by wiping with a clean lintless rag dampened with methyl isobutyl ketone, and applied half-lapped in layers over the exact length (6 inches) of the splice, approximately in conformity with the shape of the mold. Strips of stock the length of the mold cavity are applied to the top and bottom of the preform. With due care, 70 to 75 grams of tape should provide for sufficient overflow and pressure stock. The completed preform is shown in figure 5.

7—The preform is placed in the mold, which has been preheated to 285°-290°F., and the mold is closed with bolts. No further heating of the mold is desirable. The mold is now set aside to cool by natural convection in the air, until cool enough to be handled easily.

8—The mold is opened, the splice removed from the mold, and the "flash" trimmed off.

Bureau Comment: Further work is being done on splicing methods. The results of such investigation will be promulgated in the future. On the basis of tests to date, this method of splicing jacket stock would appear to offer certain advantages over previous methods.

FIGURE 3—*Cable prepared for splicing of jacket.*

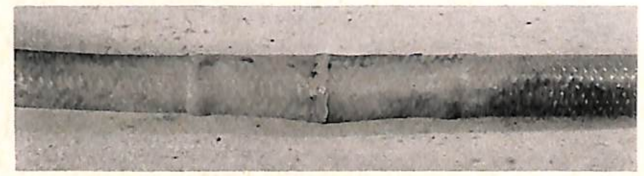


FIGURE 4—*Cable jacket knitted together.*

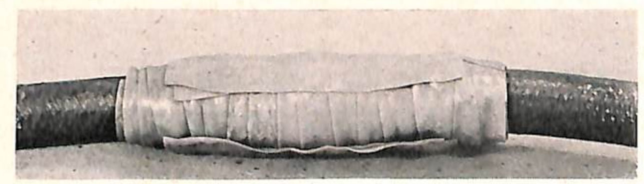
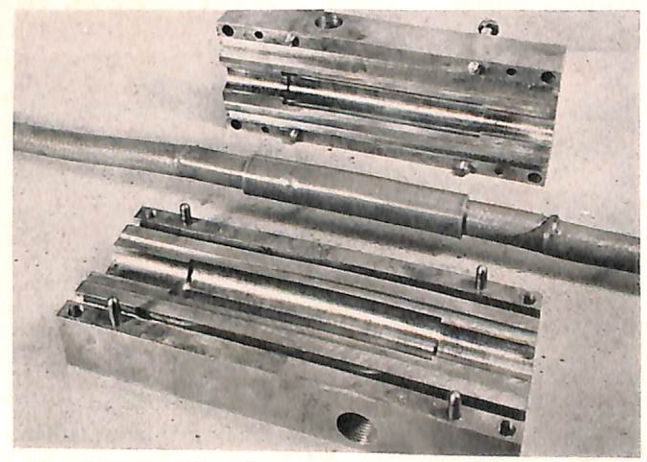


FIGURE 5—*Preform ready for insertion in the mold.*



Completed cable splice and view of interior of mold.

WFA BEARING-REPEATER CONNECTION

If the Model WFA Sonar equipment is connected in accordance with the present installation drawings, the bearing repeaters for the bottomside transducer will rotate in the wrong direction. This condition has already been noted by a number of installation activities and corrected in various ways. The proper way to make this correction is as follows:

As the synchro bearing generator SG-2502 (on the lower hoist-train) is now connected, S1 goes to #126, S2 to #127, and S3 to #128. S1 and S3 should be interchanged so that S1 connects to #128 and S3 connects to #126.

All installations should be checked to see that this change has been made at the proper place. If it has been made at any other point, it should be brought into agreement with these instructions. Otherwise difficulty will be experienced when installing Field Change No. 4 WFA, Modification of Training Control and Circuits.

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CHANGE IN SONAR TERMINOLOGY

Since the term "transducer" more accurately describes the underwater acoustical units of sonar equipment, it has been substituted for the formerly used term "projector".

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MODEL OCN BATHYTHERMOGRAPHS

Certain difficulties have arisen in connection with the installation and maintenance of the Model OCN bathythermograph. The following information should help to overcome these difficulties.

Soldered joints: Failures of soldered joints have occurred. However, the principal failures have occurred only among the first fifteen instruments constructed. The manufacturer reports that these instruments were less rugged than those built subsequently, and tests have indicated that the later instruments are better.

Since breakage in most cases has resulted from improper handling, care should be exercised in manipulation of the thermal element to guard against bending the soldered joints of the capillary and Bourdon tubes. When it is necessary to bend any of the tubing near a soldered joint, it should be so held that none of the bending stresses act on the solder.

Sea pressure line: Sometimes it is impossible to vent the sea pressure line. This deficiency can be rectified by replacing elbow H-109 where the line enters the recorder, with a T-connection equipped with a petcock. This arrangement offers a convenient method of venting the line.

Tubing between stuffing gland sleeve and recorder: The stuffing gland sleeve is a watertight fitting on the capillary tube of the thermal element. It is located five feet from the recorder. In the case of control room installations where the recorder is mounted amidships beside the sounding indicator, this length of tubing is inadequate. Since it is impractical to correct this difficulty without building new elements it is important that, when this condition exists, the recorder be located beside and forward of the deep-depth gauge or, alternatively, above the negative vent operating handle. These positions will permit satisfactory observation of the instruments.

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WHERE TO OBTAIN FIELD-CHANGE KITS

Normally, field change kits for all types of electronic equipment are distributed in arbitrarily assigned lots to Electronics Officers and Naval shipyards, and reserve lots are delivered to the Naval Supply Depot, Electronics Supply Branch, Oakland, California, and to the Naval Supply Depot, Electronics Supply Branch, Bayonne, New Jersey.

Each new field change (unless no kit is required) is stocked at the activities mentioned above before its authorization is published, so that Electronics Officers will have the material and be prepared to make the required changes and installations when authorization reaches the fleet.

When Electronics Officers have exhausted their initial stocks they are requested to requisition their additional requirements direct from the nearest electronics supply branch. A requisition sent to the Bureau of Ships is delayed because of routine clearance through the various sections before it is forwarded to the appropriate supply branch for action. Also, no requisitions should be sent to the Electronics Supply Annex, Long Island, New York, because that establishment has been discontinued.

Handy Sonar Wrench

By U. S. Naval Repair Base, San Diego

■ An easily built wrench has saved a lot of time and tempers at this base. The idea may help other sonar repair activities if they encounter the same trouble. The story centers about the wrench supplied as a part of the hoist-train assembly of QCS, QCT, QJA, QJB, QGB, QBF, and similar equipments. This wrench, shown in figure 1, is assembled into the pillar of the hoist-train mechanism over the packing gland nut. A socket protrudes through the aperture in the pillar and a handle inserted in this socket permits the nut to be tightened or loosened as necessary. If properly used, this wrench is entirely satisfactory, since the packing gland nut requires only a moderate force applied by hand to tighten it adequately. But sometimes an over-enthusiastic technician will take a hammer to this wrench. Result: one cracked wrench. Once broken, the wrench cannot be replaced except by complete disassembly of the hoist-train mechanism, a big job in any man's language. An entirely different source of trouble, but producing identical results, is when someone forgets to replace the wrench when the unit is reassembled after some major repair job.

Without this wrench in position there is no means of moving the nut except by brute-force methods. Figure 2 shows a nut after it has been subjected to a session with a cold chisel. Such practices are obviously not acceptable.

To solve the problem of the broken or omitted wrench, electronics personnel at this base have designed a new wrench which is both effective and easy to construct. It is made of one piece of 3/4-inch square stock bent into octagonal form to fit the packing gland nut. At opposite faces two ears made of 1-inch rod are welded in place, and the entire assembly then cut in half along its longitudinal axis. This makes it possible to slip each half of the wrench through the openings in the pillar, seat it over the nut, and then secure the wrench with 1-inch pipe handles placed over the split ends. These hold the wrench secure and provide the necessary leverage. Figure 3 illustrates the complete wrench.

If properly used the original wrench will give adequate service, but if one breaks or someone has left it out of a reassembly job, then fabricating a new one as described will solve your problem.

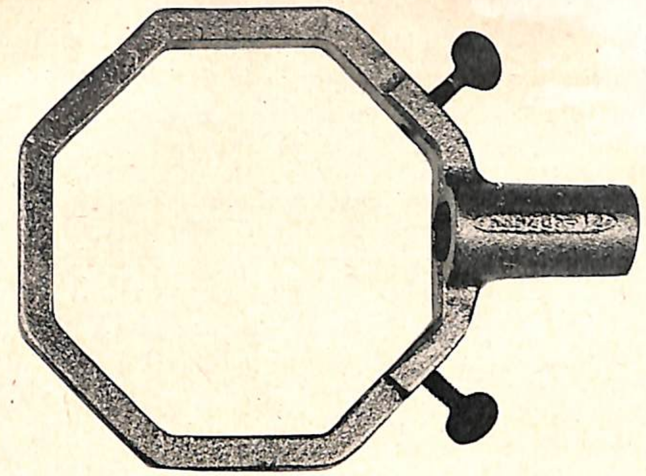


FIGURE 1—*Packing gland nut wrench as supplied with the equipment.*

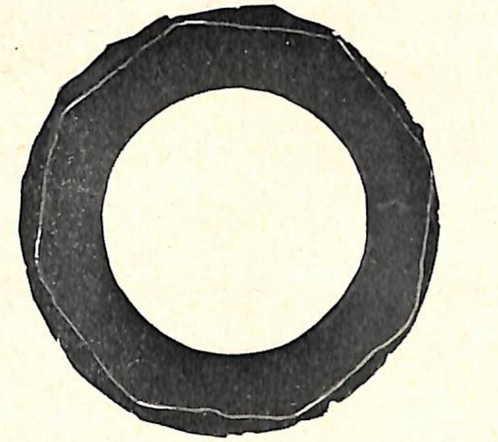


FIGURE 2—*Photograph of a packing gland nut that has been removed by means of a cold chisel. Note the damaged edges.*

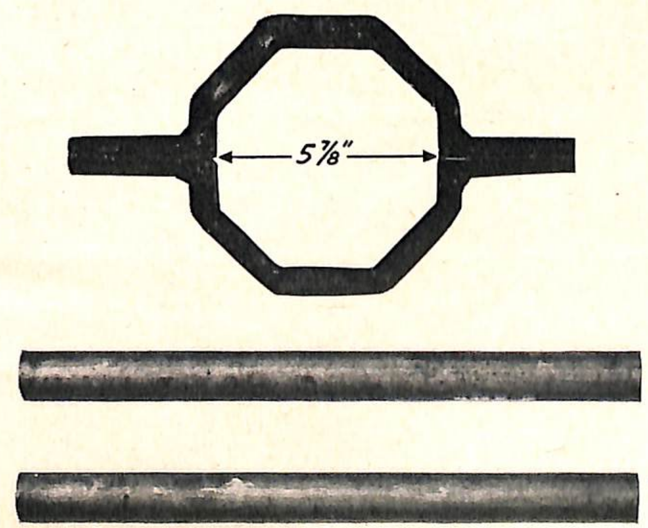
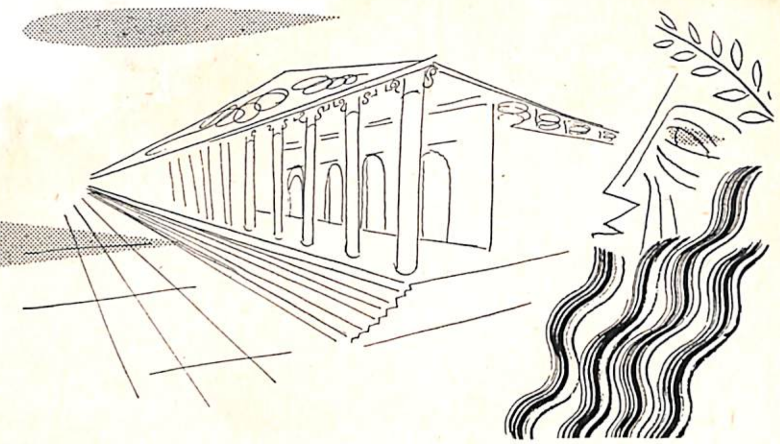


FIGURE 3—*The new wrench with handles removed. The split construction permits its use without disassembly of the hoist-train mechanism.*

THE FORUM



MOUNTING TCK-4 VOLTAGE REGULATOR

Norfolk Naval Shipyard

Considerable difficulty has been experienced in the mounting of the voltage regulator VR-301 in the Model TCK-4 transmitting equipment.

This voltage regulator is mounted on four metal cylindrical pillars tapped at both ends. It is located in the top section of the rectifier unit CG-20219. Sometimes vibration during transit from the manufacturer or in shipboard installations causes the mounting screws to become loosened, thereby leaving the voltage regulator free. Invariably it will drop to the shelf directly below its mounting position, causing considerable damage.

It is recommended that the metal pillars have holes drilled through them and a $\frac{1}{4}$-inch bolt, three inches long, be used to mount the voltage regulator.

It is further recommended that a lock washer and two nuts, one of them a lock nut, be used.

Bureau comment: No further procurement of the Model TCK-4 is contemplated at this time. However, it is recommended that all activities confronted with this problem correct it in the manner described above or in any other practicable way which will prevent the voltage regulator from falling out of position.

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MAGNETIZED BEARINGS

By J. F. Chandler,
Technician, Johns Hopkins University

Recently a peculiar trouble was encountered on the VF remote indicator. The PPI sweep could not be centered and there was a hole in the center of the presentation similar to that normally appearing when "center expand" is used. The center-expand control was checked and found to be normal but when it was set at its extreme counterclockwise position the trace was at a tangent to the center circle. The sweep coil was disconnected but this did not remedy the trouble as the spot was off center and moved in a circle about $\frac{1}{8}$ to $\frac{1}{4}''$ in diameter. It was then thought that the screws which hold the plate over the sweep coil had magnetized, but on inspection they were found to be non-magnetic. The spring-steel washers under these screws were next suspected, but their removal had no effect. The only thing left was the steel roller bearing. Several turns of heavy wire were wrapped around this bearing and connected in series with an a-c supply under a load of approximately 60 or 70 amperes. After this the sweep assembly was tried and it worked properly. The bearing had therefore been magnetized and the resulting field had produced the off-centering effect.

Bureau Comment: In normal shipboard installations the VF is not subjected to magnetic fields of sufficient strength to cause this trouble; however, it has occurred in laboratories where high magnetic fields exist. If your VF should show symptoms of this trouble the above procedure will provide a simple cure without requiring the disassembly of the sweep mechanism.

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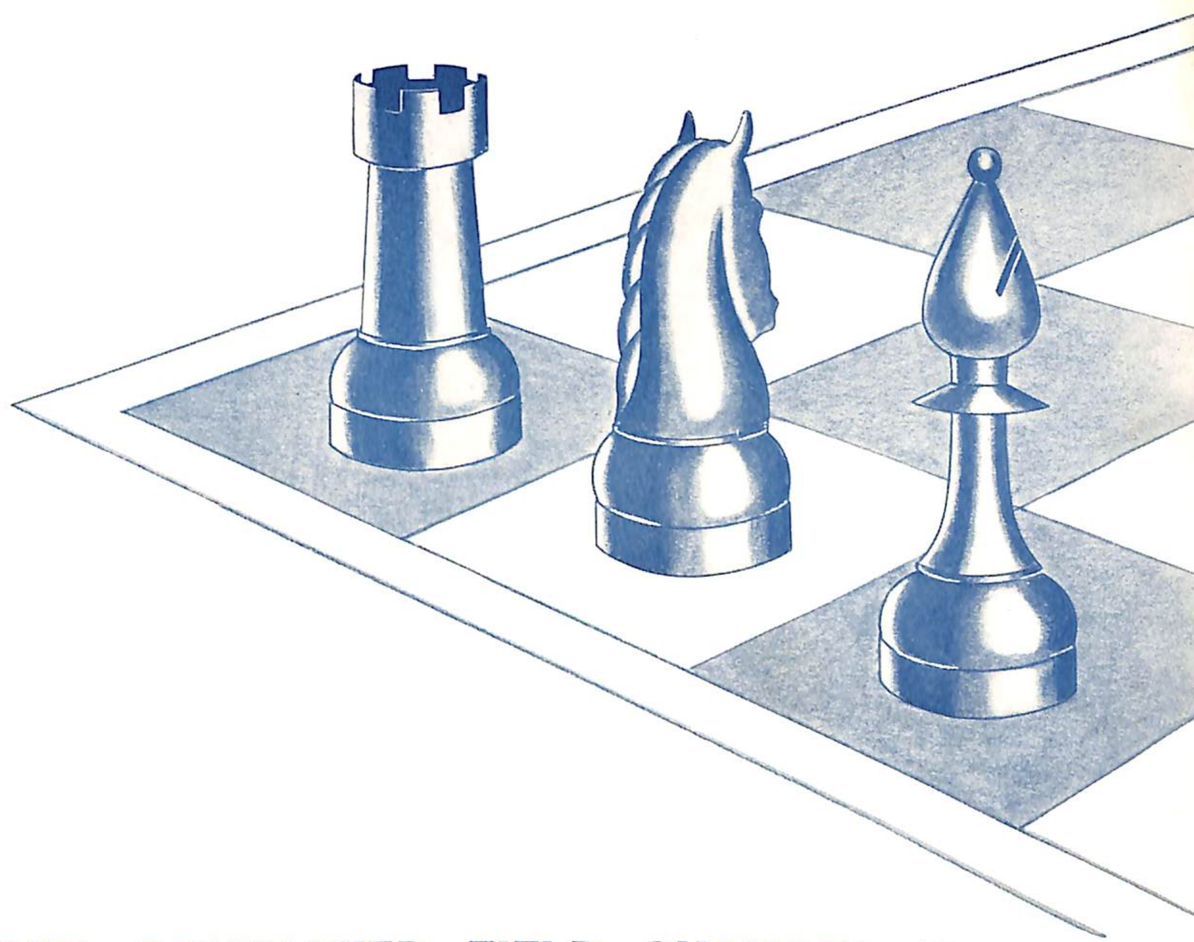
The ETM Sez:

The ETM is a peculiar bird
Who has lots of troubles but says not a word.
He surmounts many obstacles with the greatest of ease
And repairs his equipment while shooting the breeze.

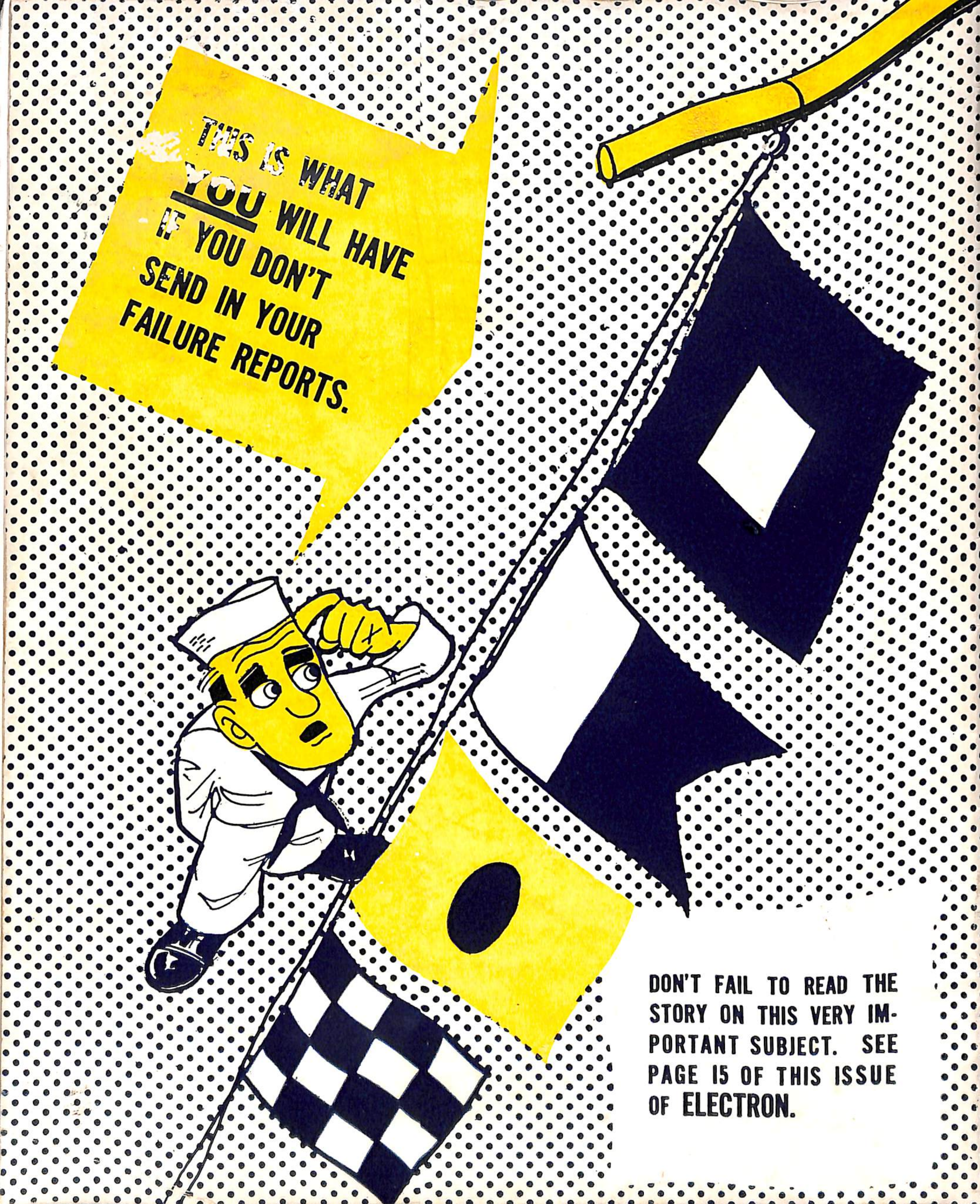
But into the life of each "tech" must come
An occasional problem beyond the humdrum.
He will tear his hair and bite his nails
And after much work, when his patience prevails,
He will repair the critter and remark with decorum,
"I'll help out the rest of you guys
By sending this in to the Forum!"

Make a move in the right direction

Have all authorized field changes been made to your equipment? Have they all been reported correctly to the Bureau? Check the appropriate maintenance bulletin (R.M.B., C.E.M.B., or the Sonar Bulletin) to find the answer.



REPORT YOUR COMPLETED FIELD CHANGES *TODAY!*


THIS IS WHAT YOU WILL HAVE IF YOU DON'T SEND IN YOUR FAILURE REPORTS.
DON'T FAIL TO READ THE STORY ON THIS VERY IMPORTANT SUBJECT. SEE PAGE 15 OF THIS ISSUE OF ELECTRON.