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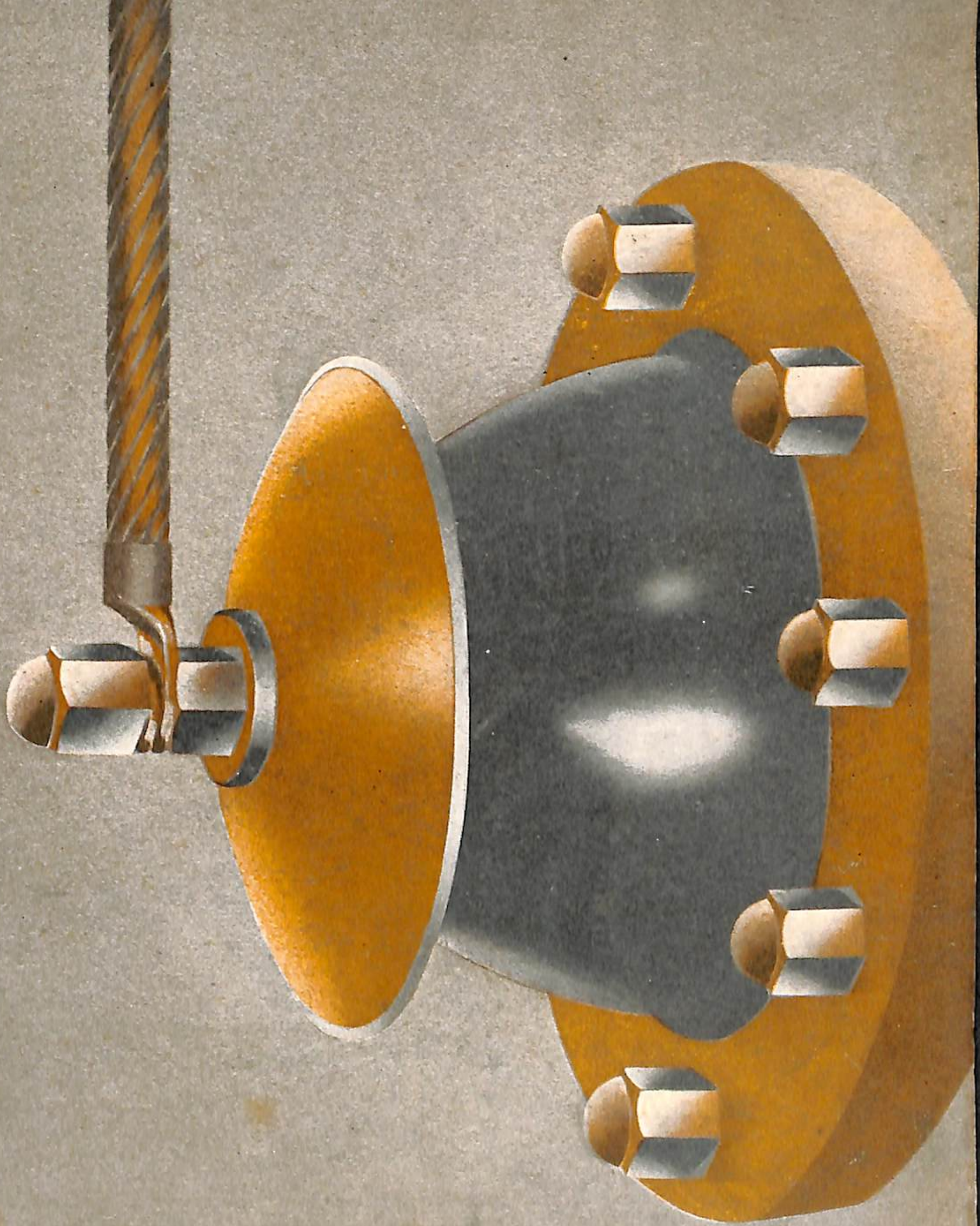
JUNE 1946

BUSHIPS

Electron



NavShips 900,100

JUNE 1946 • VOLUME 1 • NUMBER TWELVE

BUSHIPS Electron

A MONTHLY MAGAZINE FOR RADIO TECHNICIANS

DISTRIBUTION: BuShips Electron is sent to all activities concerned with the installation, operation, maintenance, and supply of electronic equipment. The quantity provided any activity is intended to permit convenient distribution—it is not intended to supply each reader with a personal copy. To this end, it is urged that new issues be passed along quickly. They may then be filed in a convenient location where interested personnel can read them more carefully. If the quantity supplied is not correct (either too few or too many) please advise us promptly.

CONTRIBUTIONS: Contributions to this magazine are always welcome. All material should be addressed to

The Editor, BuShips ELECTRON
Bureau of Ships (Code 993)
Navy Department
Washington 25, D. C.

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

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BUREAU OF SHIPS — NAVY DEPARTMENT

BONDING and GROUNDING of ELECTRONIC EQUIPMENT

Shipboard electronic equipment has not followed as rigid a doctrine as is employed in aircraft in the technique of bonding and grounding. In order that interference may not be prohibitive in aircraft, every metal joint of the entire ship is electrically bonded. All control cables, joints, etc., have low resistance bonds and do not depend on mechanical joints for electrical conductivity. All pulse and video cables are carefully shielded and each of the numerous shock mounts is electrically bonded by flexible braided jumpers to ground.

In high-power radar equipment it is impossible to state that the equipment is "grounded" or at zero potential. Points located one-half wavelength from ground can be at extremely high potentials. This is especially noticeable in the transmitter and results in hot spots or sparking at the doors, sliders, shields, or other mechanical joints. The result is interference to other electronic services, instability, spurious echoes, loss of power, decreased tube life, and poor performance.

Each installation presents problems of varied nature and some careful study is required in order to correctly install the equipment. However, there are certain fundamental rules which, if followed, will cure or prevent most of the troubles. The following precautions should be observed very closely on each installation.

1—Assure that all shock mounts are jumpered to ground with low-resistance flexible conductors. Connections shall be locked to prevent loosening due to vibration, and enough slack or loop allowed in the ground strap for deflection of entire structure under shock without impairing the action of the shock mounts. At least two such grounds, symmetrically spaced at diagonally-opposite corners, shall be provided for equipment frames housing high-frequency oscillator circuits.

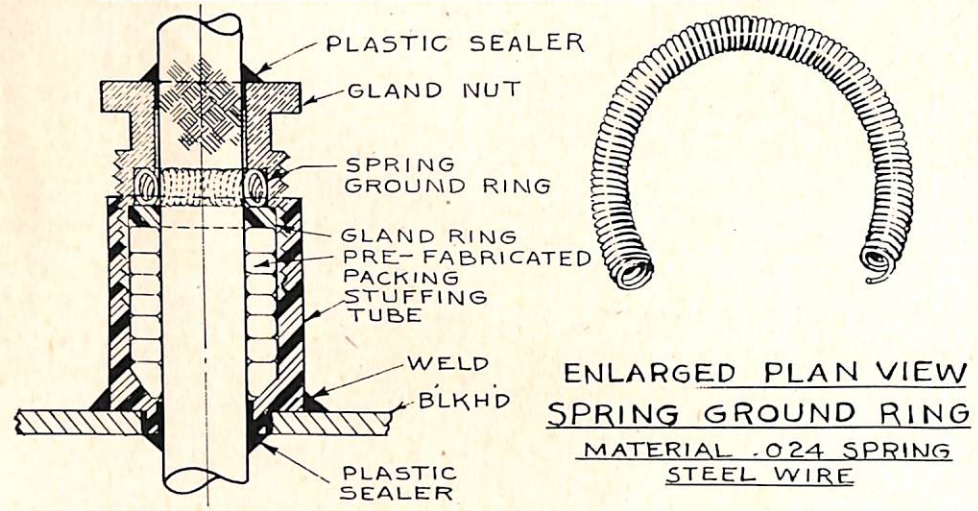
2—All shields should be tightly fastened, making good metal-to-metal contact. Remove all paint which might prevent metal-to-metal contact on shields or doors.

3—Check for arcing at hinges, sliders, shafts, bearings, or other mechanical linkages and bond if necessary.

4—Check for proper connection of shielded cables to ground and make certain that numerous grounds are made along the entire length of the cable to prevent pickup. The following paragraphs taken from a proposed amendment to the General Specifications for Machinery S62-2, dated 1 December 1945, will serve to clarify grounding requirements for shielded cables:

"Armor and metallic shielding of all cables within electronic spaces (all spaces in which are located units of electronic equipment which contain circuits for production or detection of radio frequencies) shall be grounded to the ship's structure closely adjacent to the fixtures or appliances to which they are connected, and also closely adjacent to the stuffing tubes which penetrate decks and bulkheads. Where two electronic spaces are adjacent and

RELATIVE ARRANGEMENTS OF PACKING GLAND RING, AND GROUND SPRING



SECTION VIEW
METHOD OF GROUNDING CABLE ARMOR OR SHIELD

ENLARGED PLAN VIEW
SPRING GROUND RING
MATERIAL .024 SPRING STEEL WIRE

TAKEN FROM SKETCH 981B-1 (REVISION OF 981A-1)

PROPOSED SPRING SIZES

TUBE SIZE	TYPE CABLE (1)	CABLE O.D. 95% MAX.	UNDERCUT O.D.	SPRING DIAMETER
A	SHFA-3	0.337	.625	3/16"
B	DRLA-3	0.413	.750	3/16"
C	SHFA-4	0.475	.875	1/4"
D	TRLA-9	0.587	1.000	1/4"
E	TTHFA-15	0.700	1.000	3/16"
F	TTHFA-20	0.742	1.062	3/16"
G	DHFA-9	0.798	1.187	1/4"
J	TTHFA-40	0.885	1.312	1/4"
K	THFA-23	0.991	1.406	1/4"
L	THFA-30	1.109	1.500	5/16"
M	THFA-50	1.228	1.656	1/4"
N	THFA-60	1.346	1.750	1/4"
P	SHFA-650	1.458	1.875	1/4"
R	SHFA-800	1.563	2.000	1/4"
S	MHFA-44	1.648	2.125	5/16"
T	DHFA-150	1.761	2.312	5/16"
V	THFA-200	1.988	2.437	5/16"
W	THFA-250	2.163	2.562	1/4"
X	THFA-300	2.310	2.750	5/16"
Y	DHFA-400	2.383	2.844	5/16"
Z	THFA-400	2.540	3.031	5/16"

NOTES:
1-SMALLEST CABLE IN RESPECTIVE TUBES.
2-THIS METHOD OF GROUNDING CABLES IS APPLICABLE TO ALL ELECTRONIC SYSTEMS CABLES, (RADIO, RADAR, COUNTERMEASURES, SONAR ETC., CIRCUITS (R-R), (R-E), (R-C), (R-S) ETC.)

DELINEATOR	G. HAYS
CHECKER	J.O.A.
IN CHARGE	E. Sims
RADIO ENGINEER	
APPROVAL	
ENGINEER IN CHARGE	
RADAR OFFICER	

ELECTRONICS DIV. NAVY DEPARTMENT — BUREAU OF SHIPS WASHINGTON, D.C.

METHOD OF GROUNDING CABLES

NO. FEB. 18. 1946

RE 49 A 444-B

ALT. B. RETRACED 4/3/46

are separated by a non-watertight bulkhead, it is not necessary to ground cables running through this bulkhead provided the cables are grounded at the place where they pierce the watertight bulkheads. Where two electronic spaces are adjacent to one another and are separated by a watertight bulkhead, cables penetrating this bulkhead need be grounded only on one side of the bulkhead. Where radar repeaters, loud speakers, receiver jackboxes, transmitter motor-alternators, and remote control panels or any combination of these are the only electronic units in a space, grounding of cables at these units only is sufficient. It is considered that cables installed below the metallic false deck in a compartment are in a separate space so far as the requirements of this paragraph are concerned. Where cables enter an electronic space and are not in excess of five feet in length, a single ground at either end of the cable is satisfactory".

Continuity of shielding must be maintained through junction boxes. The conventional ground strap applied to the cable near the terminal or stuffing tube with jumper connection between the ground clamp and nearest ship's structure, has proven an effective ground. However, when used in installations involving coaxial cables there is a great possibility that injurious crimping and distortion of the coaxial cable dielectric will result. Another objection to this method is that it is costly in man-hours to fabricate and install. One shipbuilder estimated that 7,000 to 9,000 man-hours are required for a CL or CA type ship.

Because of the above objections the Bureau of Ships has developed a new method of grounding shielded or armored cables within the terminal or stuffing tube by using a spring-type grounding ring as shown on drawing RE 49A 444A, and reproduced here. Various methods of positioning this ring have been investigated, but the best results are obtained when the spring grounding ring is installed in an undercut of the gland nut as shown in the drawing. In this position the resistance of the armor-ground varied from 0.002 to 0.005 ohm when subjected to several heating and cooling cycles under the same conditions as used in testing stuffing-tube packing materials.

There is an objection to this method in that once the installation is completed it cannot be readily inspected. However, the nature of the assembly is such that the ground connection may be expected to be a firm one. Proper installation will securely seat this spring in place, where it should remain under pressure due to the spring action and, because of the spring's confined position, will probably remain in good contact despite vibration. The spring is not exposed and should not be subject to corrosion or injury. The installation may be made fairly easily with the result that honest installation should obviate installation defects.

Only three sizes of spring diameters, 3/16", 1/4", and 5/16") are required for all tube sizes from "A" to "Z" inclusive. The material required is ordinary 0.024" spring steel wire and is easily formed by closely winding on a mandrel of the proper size. It may be made up in continuous lengths and then cut to suit the size cable. Repair activities should furnish this spring to meet installation requirements.

At present this method is authorized for use with electronic systems cables only. Its general application to all other systems cables is reserved until its effectiveness has been definitely established or until a cheaper, more easily installed or more simplified method can be devised. With this objective in mind, the Bureau would appreciate any constructive comments or suggestions for further simplifying grounding methods and procedures.

5—Inspect all metal fittings, pipes, etc., located in the vicinity for resonant pickup. Bond or break up such resonant sections as required.

6—Check all openings and screen them if necessary.

7—Check bonds or continuity at all coaxial transmission line joints. Shield open choke joints if radiation is causing interference. In the case of certain equipments Bureau field changes will provide for the addition of suitable shields over the choke coupling joint in order to minimize r-f output leakage (for example, Field Change No. 2 for SV and SV-1 radars).

8—Spark gaps, duplexers, rectifiers, motors, and thyratrons require careful checking as sources of interference.

A recent case brought forth the following troubles: Excessive arcing in the transmitter, erratic tuning, many false echoes, communication interference, and receiver oscillations. By carefully bonding the transmitter at several points (around shock mounts) and tightly securing all shields, normal operation was again realized. Another case of excessive interference was traced to sparking between the joints of the brass angle on a table adjacent to the transmitter. Soldering the joint and bonding to the ship's structure eliminated this difficulty. Several external duplexers were made interference-free by copper shielding enclosures.

Filters to prevent spurious r-f radiation are being designed. Although attenuations up to 60 db are realized, the voltage breakdown presents a problem. It appears that the standing-wave ratio must be kept better than 2:1. Filters at the receiving equipment may help and can be low-voltage devices.

For additional information on filtering devices and elimination of radio interference, attention is invited to Section 3, Communication Equipment Maintenance Bulletin, NavShips 900,020.

CW-78207 TRANSDUCER FOR WFA

Several WFA submarine sonar equipments were shipped with a type CW-78207 hull transducer. This is the same type of transducer as is used in the model QJB sonar equipment.

When using this transducer with model WFA equipment, it is important to remove the ground on terminal *R* of relay K-608 in the transfer relay and BDI amplifier CBM-50209. This is necessary because the center taps of the transducer transformers are connected internally to the cable shields. If this change is not made, the shields will be at half the driver output voltage above ground during the keying interval.

PARTS LISTS SOON AVAILABLE

The March issue of ELECTRON carried a story on the Bureau's activity in making a parts lists in instruction books complete through the addition of Navy Type Numbers where this information has been omitted in the original printing. Twenty-four new parts lists covering some sixty-one equipments are now being printed and will be available shortly through electronics pools. These new lists are as follows:

BL-1, -2, -3, -4, -5, -6	OBL-2
DAB, -1, -3	OBL-3
JR-1	OBQ
LAE-3	OBQ-1
LAG-1	OBQ-2
LO-1, -2, -3, -4	RAO-3, -4, -5
LP, -1, -2, -3, -4	SL, SLa, SL-1
LR, -1, -2, -3	TBS-1 through -8
MARK 8 Mod 3	TCO-1, -2
MARK 12 Mod 1	TCP, -1, -2, -3
OAH, -1	TDE, -1, -2, -3
OBL	TDQ

Activities having any of these equipments should apply to the nearest pool for the new parts list.

DEHYDRATOR INSTRUCTION BOOKS

Numerous reports received indicate that adequate operating theory and maintenance information is not available at Naval activities to service and maintain the CPD-10137 Auto-Dryaire Model 2200/22 Dehydrating Units. Attention is invited to the fact that a new instruction book for this equipment, NavShips 900517, has been distributed in bulk quantities to Electronics Officers at all naval shipyards. All ships maintaining Model 2200/22 Dehydrators should request a copy of this publication for maintenance information.

CORRECTION—Page 29, April ELECTRON, in figure 3, change VS2A, VS2B, and R275, to V52A, V52B, and R278, respectively.

DISPOSITION OF SL ANTENNAS

The Bureau has terminated the SL Radar rehabilitation program whereby SL antennas were to be returned to the manufacturer to have Field Change Nos. 25 and 46 installed.

Unmodified SL antennas should henceforth be disposed of as surplus material and not returned to manufacturer for reconditioning. Electronics Officers are advised that SL antennas previously modified at the factory and returned to maintenance bases should be installed in SL-equipped vessels of the Active (including Reserve) fleet when such vessels are available for overhaul and on vessels destined for the inactive fleet.

KEEP YOUR RECORDS STRAIGHT

By F. J. Schiffhauer, SoM 2/c, USS Bivin

The following letter has been received by the Installation and Maintenance Branch, Bureau of Ships:

"When I assumed the duties of Sonar repairman aboard this ship I was not told by the Sonarman who was leaving as to whether he had been sending in the failure reports as per orders. I have taken the liberty of checking through the sonar maintenance logs and sending in reports on failures since I first came aboard as an assistant repairman. Some of these reports may have been turned in already but for the sake of keeping up the records I have included them. I am getting ready to be discharged and would like to get everything squared away as much as possible. I sincerely hope that these reports will not cause you any extra trouble".

Bureau comment: The conscientious attitude displayed in this letter is highly pleasing to the Bureau of Ships. It is our wish that all technicians be as "record conscious" and thorough in all their duties as is evidenced in the above letter.

SONAR TRANSDUCER CABLE

An investigation of 26 sonar transducers returned as defective to one manufacturer during the year 1945 disclosed that 18 had received cable damage which permitted the entry of moisture. In three cases, the cables were pulled entirely out of the cable seals.

The general conclusions to be drawn from this are that many failures are not due to any deficiency in design, material or assembly, but are probably the result of improper handling. The equipment instruction books and installation instructions emphasize the fact that care should be exercised in handling transducer cable. Installation and maintenance activities should heed this advice.

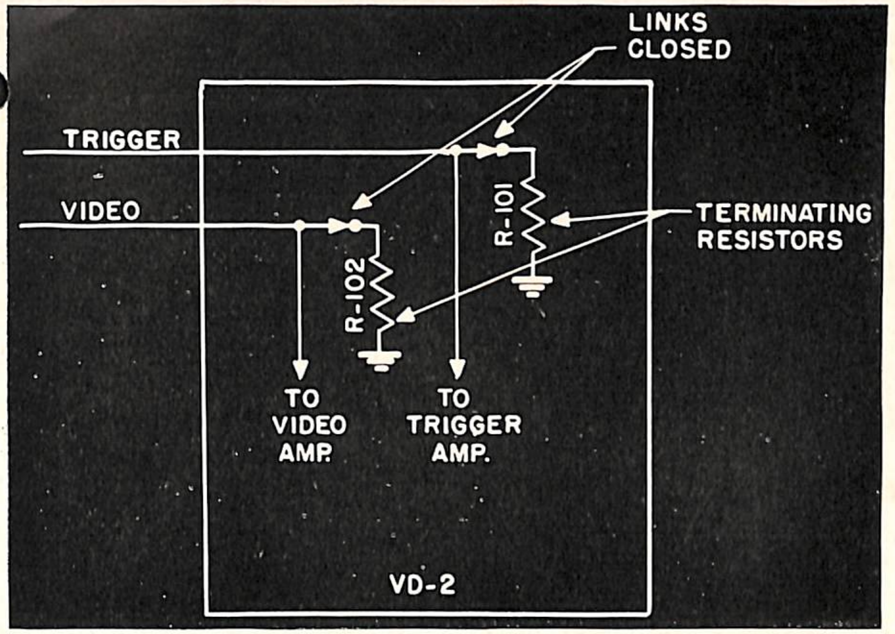


FIGURE 1—*Single VD-2 repeater with single radar system, showing terminating resistors in use.*

Repeater Terminations

By RODNEY D. CHIPP, *Lt. Comdr. USNR, Bureau of Ships*

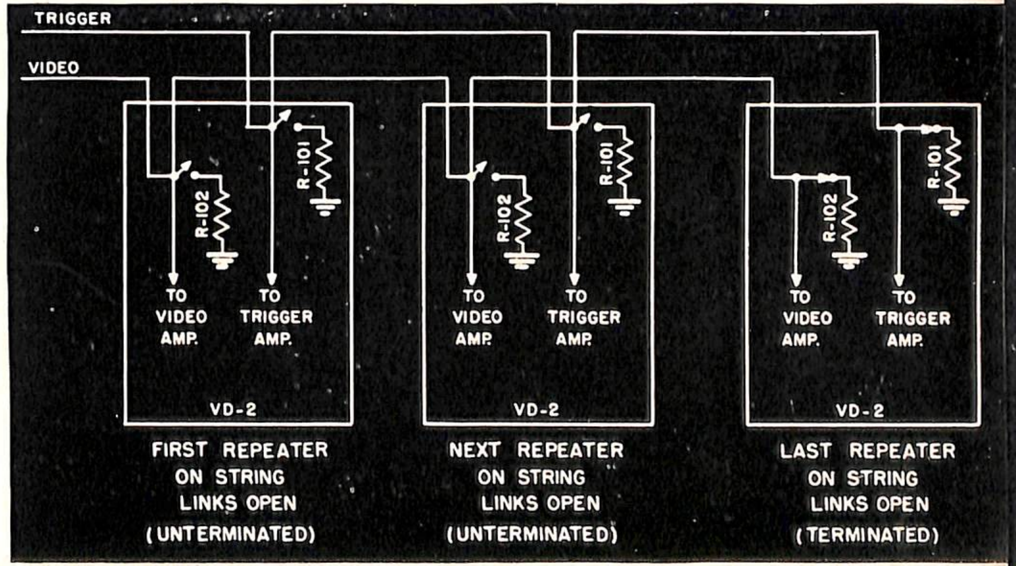
Transmission lines which are terminated in a resistance equal to the characteristic impedance of the line are known as non-resonant lines. Such lines possess certain properties necessary for satisfactory transmission of video-frequency signals. For example, the voltage and current remain in phase with each other, there are no resonant peaks of voltage since the voltage decreases uniformly in an exponential manner, and there is complete absorption of energy at the receiving end. It is therefore important that the video and trigger cables feeding radar repeaters be terminated so as to operate as non-resonant transmission lines.

To afford flexibility and to provide adequate repeater facilities for the numerous classes of ships in the Navy repeater installations have been divided into five types.

1—Single repeater with single radar system.
2—String of repeaters with a single radar system.
3—Single repeater with two or more radar systems.
4—String of repeaters with two or more radar systems.
5—Radar Distribution Switchboard system.

In order that any type of repeater may be suitable for any of the above installations, the repeater specifications require that the video and trigger inputs connect to a

FIGURE 2—*Correct termination when employing a string of repeaters with one radar system.*



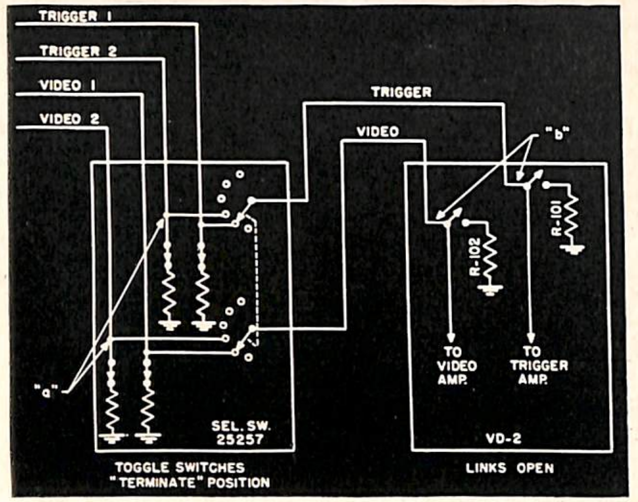


FIGURE 3—*Single repeater with two radar systems employing a selector switch.*

75-ohm terminating resistor with a link arrangement to permit disconnecting this resistor when required. The specification for a 75-ohm termination is due to the fact that the type of cable used (RG-12/U) has a characteristic impedance of 75 ohms. In addition, the selector switches which have been designed for use with repeaters have 75-ohm terminating resistors which may be cut in or out of the video and trigger input circuits by means of toggle switches. Since these switches need not be operated once they are properly positioned during original installation, they are placed inside the cabinet and can be reached only through a door. At the time a repeater installation is made, the installing activity should see that each repeater in a string of repeaters is properly terminated as prescribed hereinafter. For purposes of illustration in this discussion the VD-2 repeater and the CG-24257 Selector Switch will be used.

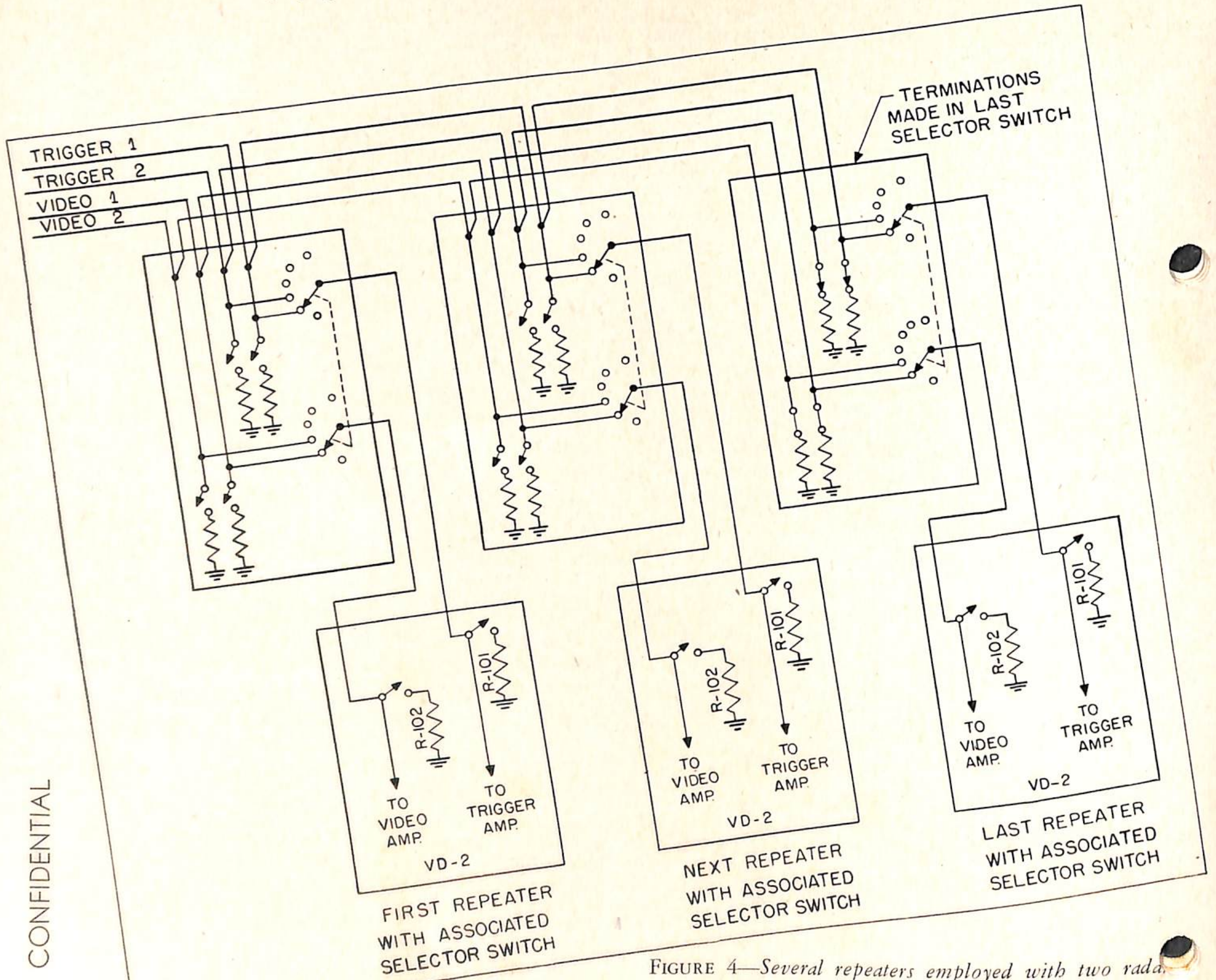


FIGURE 4—*Several repeaters employed with two radar systems and utilizing selector switches with termination made in last selector switch.*

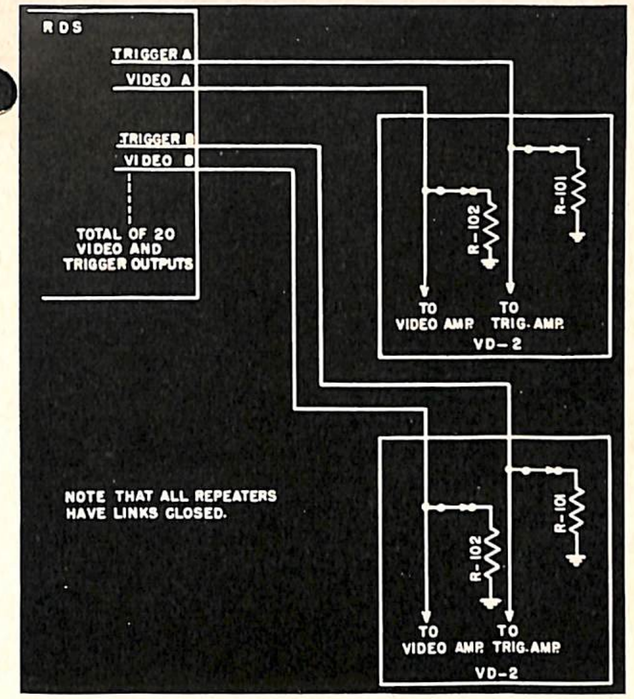


FIGURE 5—*Typical Radar Distribution Switchboard feeding two repeaters. Note that a total of 20 repeaters can be furnished video and trigger signals from one RDS.*

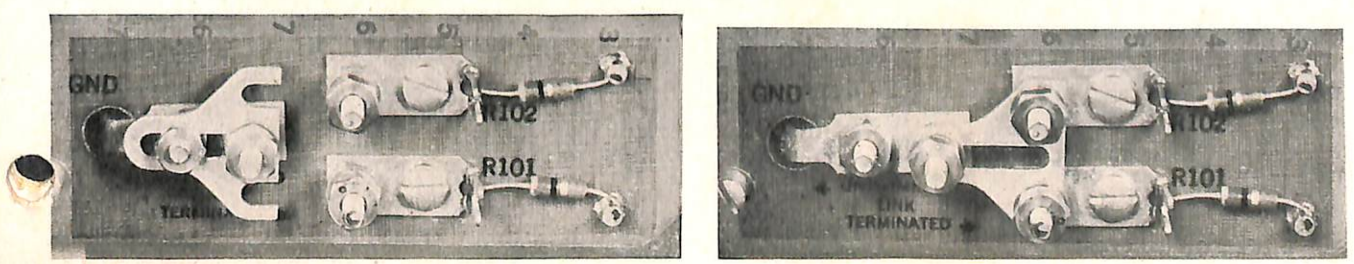
In the case of a single repeater operating from a single radar system, it is readily apparent that the video and trigger lines should be terminated within the repeater, as shown in figure 1, since no selector switch is used.

When an installation has two or more repeaters operating in parallel from a single radar system the termination procedure will be as shown in figure 2. It will be noted that the video and trigger lines are terminated in the repeater farthest from the radar and all the other repeaters are left unterminated and *bridged* across the line. In this manner, the repeaters that are not terminated present a very high impedance to the line and do not alter the load on the line, or the effective termination resistance. By inspection of figure 2 it becomes obvious that, if all the terminating resistors were in the circuit, the load imposed on the source would be 25 ohms instead of 75, and would require three times the current at the source to develop the necessary voltage at each repeater input. In addition, reflections and phase-shift effects might prove to be very objectionable.

When only one repeater is installed and it is necessary to accept information from more than one radar, a selector switch is employed. To keep the unused lines properly terminated, special terminating resistors in the selector switch are used instead of those in the repeater. This method of connecting is shown in figure 3, in which only two radar systems are shown.

When making this type of installation it is mandatory that the length of coaxial cable from the termination in the selector switch to the repeater input, between points "a" and "b" in figure 3, be kept as short as possible. This is necessary since this portion of the cable represents a capacity load shunted across the terminating resistor, which passes the lower frequencies and shunts the higher ones. It must be borne in mind that voltage pulses used in radar consist of a fundamental frequency and many harmonics, and that it is the higher harmonics which cause the pulses to appear with straight sides. These stray shunt capacities therefore introduce a deterioration of the pulse. For example, assume an installation with 20 feet of RG-12/U coaxial cable between the selector switch and the input to the video amplifier. RG-12/U cable has a capacity of 21 $\mu\mu f$ per foot, thus there would be a capacity load of 421 $\mu\mu f$, plus the stray input capacity of the video amplifier which is in the neighborhood of 50 $\mu\mu f$. From the formula for capacitive reactance $X_c = 1/2\pi fC$, it is found that this total capacity of 470 $\mu\mu f$ represents a shunt reactance of 85 ohms at 4 Mc. Therefore it can be seen that the higher frequency components of the video pulses will look at a reactance of 75 ohms (the termination) in parallel with 85 ohms, or a total of 40 ohms. Following the above procedure, one can calculate that the 500-kc component of the video pulses will look at a reactance of 75 ohms in parallel with 680 ohms, or a total of 69 ohms, etc. Therefore the 500-kc component of the video signal will develop a voltage nearly double that of the 4-Mc component at the input to the video amplifier. When it is considered that one-microsecond pulses with a rise time of 0.1 microsecond contain frequencies up to 5 Mc, it is evident that the amount of capacity across the terminating resistor becomes a major factor in determining the shape of the

FIGURE 6—*Model VD-2 repeater showing termination resistors with coupling link open (unterminated) for "bridging" connection. Right: Link closed, placing termination resistors in the circuit.*



reproduced video signals. For this reason the Bureau of Ships has specified a maximum total length of *seven feet* between the selector switch and the repeater.

The fourth type of repeater installation is an extension of the third, where a string of repeaters is arranged to accept signals from two or more radars, as shown in figure 4. Note that all of the links in the repeaters are open and that the termination is made at the last selector switch in the string. Obviously, as in the foregoing case, the same limitations as to length of coaxial cable from the selector switches to the repeaters apply.

The fifth and last type of repeater installation is the RDS *(Radar Distribution Switchboard)*, which ultimately will be used on combat ships of the light cruiser and larger classes of vessels. One of the advantages of the RDS, which will be described in more detail at a later date, is that it permits termination within the repeater itself, as in case 1 above, and thus eliminates the necessity of considering cable capacity at the repeater. Each repeater on the ship is furnished with video and trigger voltages from individual cathode-follower isolation amplifiers in the switchboard, and carried on individual cables from the RDS. Selection of the radar system desired is made at the switchboard in accordance with requests received from the repeater stations on a separate order circuit. Figure 5 shows a typical installation, with the proper terminations made at the repeater.

It should be emphasized that improper terminations in a repeater system often go unnoticed because they do not make the system inoperative. However, proper terminations and good connections to ground may make the difference between optimum performance and less-than-average performance of the entire repeater system on board ship.

FIGURE 7—*Front view of Selector Switch type CG-24257 with termination toggle-switches exposed.*

STREAMLINED ELECTRONIC EQUIPMENT RECORDS

What Electronic Equipments Are Aboard the U.S.S. Neversail? *How Many Electronic Windmills Are There On Submarines? Who Has All The XYZ Equipments?*

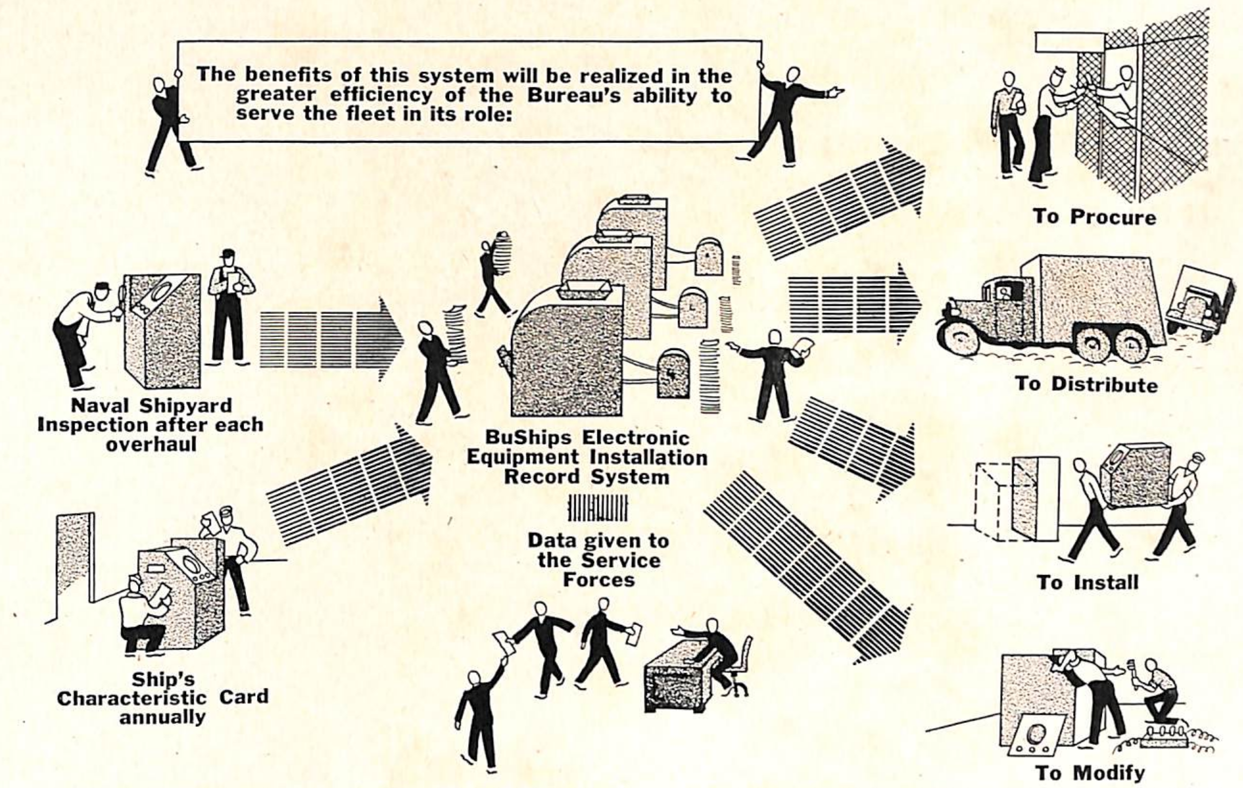
■ The answer to these and many other questions concerning the whereabouts of the estimated 200,000 major items of electronic equipment representing better than a thousand common varieties that will be aboard Navy ships will be supplied by the new Electronic Equipment Installation Record System shortly to be inaugurated by the Bureau of Ships.

The Electronic Equipment Installation Record System is the application of modern business-machine methods to the inventorying of electronic equipment. No longer are hand accounting methods adequate to cope with a problem of this magnitude.

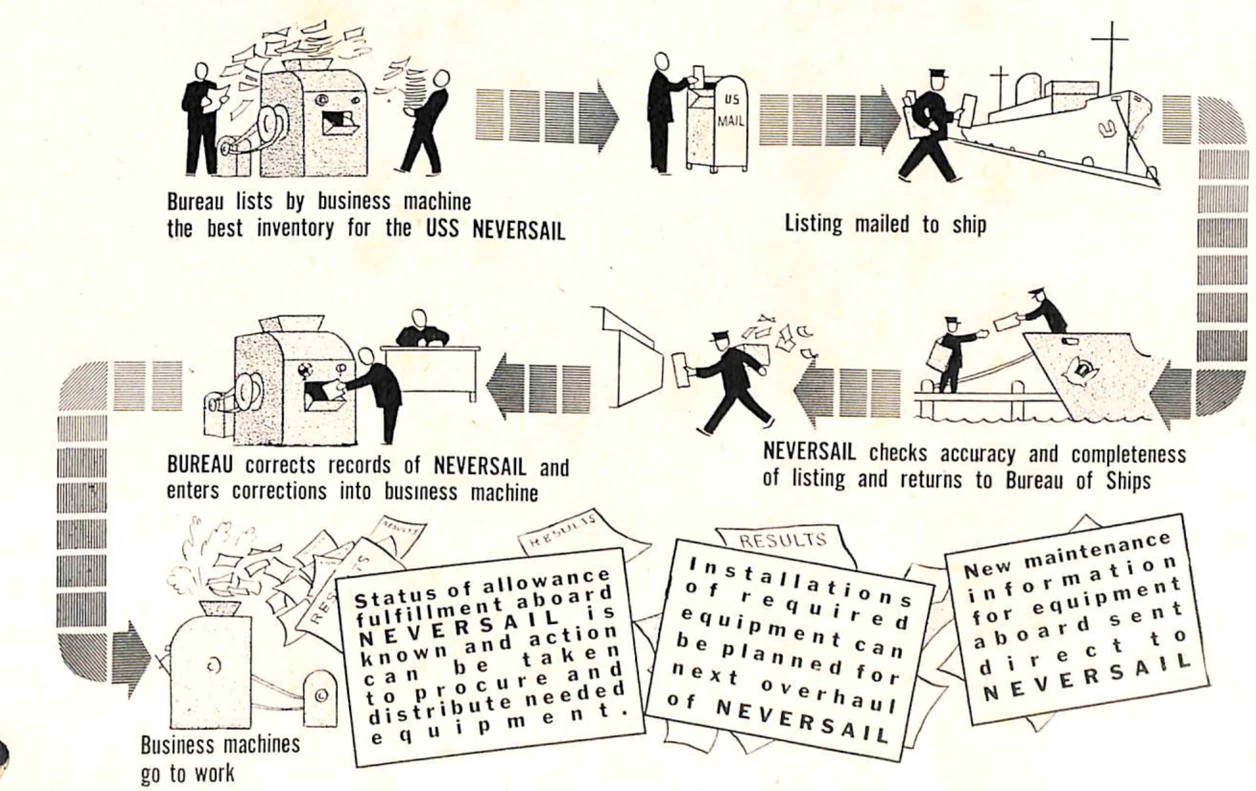
But supplying the answers which the Bureau needs is only one of the benefits derived from the Electronic Equipment Installation Record System. The system reduces all present methods of collecting information concerning what is aboard vessels to only two complete reports: one from the Naval shipyards, and one from the ships. Thus a ship need submit an inventory only once each year. Reasons for special reports and inventories are eliminated. The upper drawing shows diagrammatically how these two inventories can enable the Bureau to better serve the fleet.

As stated above the nucleus of the system is the business-machine. Machines are not subject to human mistakes, and, what is more, they can perform in two or three days additions and listings which formerly required months. But machines cannot do everything; they can only give answers as accurately and completely as the data supplied to them. Hence the Bureau seeks full cooperation from the fleet in rapidly and carefully checking the listings they receive for correction. This is especially important at this time, for the information received in this manner from the fleet will not only serve as a guide for future ship changes but also will supply the Bureau with accurate totals of how many equipments of each model are required by the fleet. These totals must be known if the Bureau is to make optimum use of the funds allocated for procurement and distribution.

The lower drawing shows briefly the mechanics involved in starting the new system, and illustrates the following major points:



HOW THE E. E. I. R. S. SERVES BOTH BUREAU AND FLEET



ESTABLISHMENT OF E. E. I. R. S. FOR USS NEVERSAIL

Step 1—The Bureau has made an exhaustive search for the best electronic inventories available on the vessels to be retained in the peacetime Navy. These have been selected, edited, and listed by business-machine methods.

Step 2—The listings prepared in step 1 are mailed to the ships for correction.

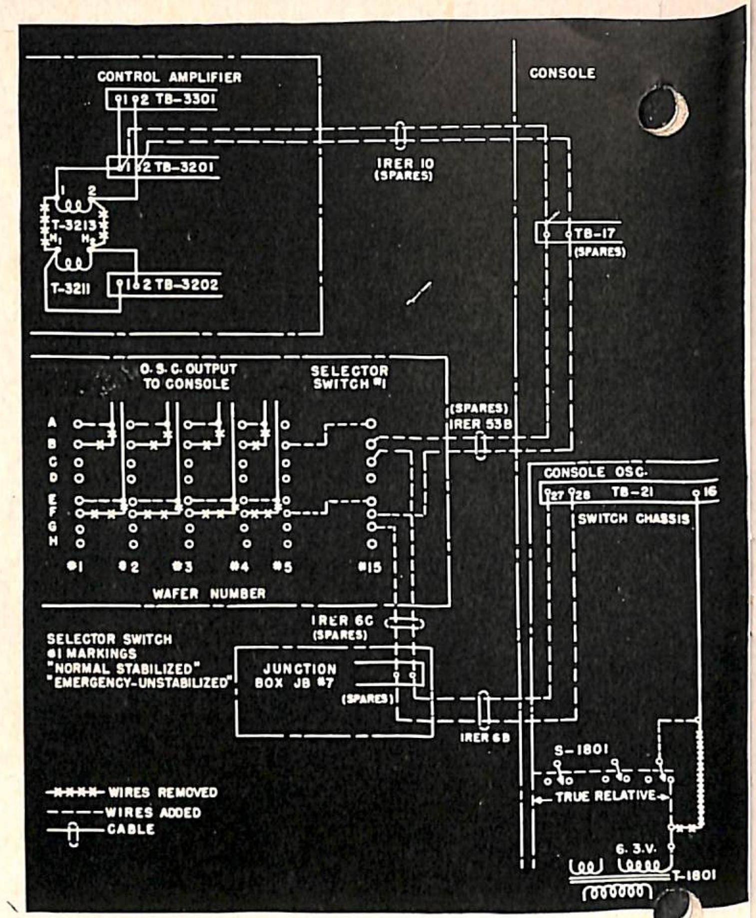
Step 3—It is known that this data will often be found inaccurate or incomplete by the ship, but it is the best that the Bureau has, and it is expected that the ships will give the best that they have to its correction.

Step 4—The Bureau corrects records to conform with information furnished by ships.

Step 5—Business-machines are put to work.

Step 6—Results.

The Electronic Equipment Installation Record System means better information for everyone. The Fleet's co-operation in setting the system up will pay big dividends in fewer and better records.



Schematic wiring diagram of SP Selector Switch No. 1 and accompanying components showing method of making changes necessary to accomplish unstabilized, true-bearing operation.

Unstabilized True-Bearing SP Operation

By Lt. John A. Weber, *USNR, E.F.S.G.*

When a failure occurs in the stable element of the SP Radar, it is necessary to shift to "emergency" operation, which places the equipment in an unstabilized, relative-bearing, operting condition. When operating in this condition, one of the main features of the SP, the height determining ability, is lost. In addition, its usefulness as a long-range surface-search radar is limited. Unfortunately the loss of the height-determining feature must be acknowledged, but the decrease in usefulness as a long-range surface-search radar can be eliminated. A simple alteration of the wiring, well within the capabilities of the technician, will afford a condition of true-bearing operation even when the unit is operated in the "emergency" position. When this wiring change is made no equipment additions are necessary, and component loadings are substantially the same as when operating normally.

This alteration places selector switch No. 1 in control of stabilization only. Control of true-relative bearing operation is vested solely in the true-relative switch on the console. Through the use of these two switches, plainly marked, any of four conditions of operation may be achieved. The red relative-bearing pilot lamp is lighted only under relative-bearing operating conditions. By affecting this change in the wiring, an "unstabilized-true-bearing" condition of operation permits stable element maintenance and balancing without sacrificing the search value of the equipment.

To accomplish the necessary alteration in wiring proceed as follows:

With the entire system de-energized, remove jumper between T3213-1 and T3211-H1 and between T3213-2 and T3211-H2. Energize the entire system including antenna. Measure the normal voltage at terminals 1 and 2 on elevation and cross-level amplifiers (TB3351) using a 150-volt a-c voltmeter. Zero voltage should be obtained at terminals 1 and 2 on azimuth amplifier (TB3301), at TB3201 terminals 1 and 2, and at T3213 terminals 1 and 2. This is to insure isolation of azimuth amplifier and T3213 from previous a-c power supply.

De-energize the equipment and proceed as follows: At selector switch No. 1, transfer the leads carrying bearing information to the console direct to OSC leads entering the selector switch (leads on wafers 1, 2, 3, and 4, contacts B and F to contacts A and E respectively). This places console switch S-1801 in sole control of bearing information. Next rewire wafer 15 (spare) to switch the power supply for the azimuth amplifier to the source of azimuth synchro excitation in accordance with the mode of operation.

Remove the console OSC switch assembly and break the jumper between TB21-16 and T-1801. Rewire this connection through one of the two spare micro-switches on S-1801, the switch half-closed in relative position to be used. This change permits a relative bearing pilot indication only in relative bearing. Replace the switch assembly. To complete the rewiring, utilize the spare wires in the present inter-unit cables.

After the wiring changes are completed, energize the system and test for proper azimuth positioning. If any 180-degree errors are present and new wiring is correct in terminal to terminal inter-connections, examine old wiring to locate double errors that were formerly self-compensating.

Bureau Comment: The information contained in the report submitted by Lieut. Weber has been checked and found to be in good order. Lt. Weber has worked out a definite improvement to system operation that should result in easier maintenance and more effective use of the equipment during stable element maintenance.

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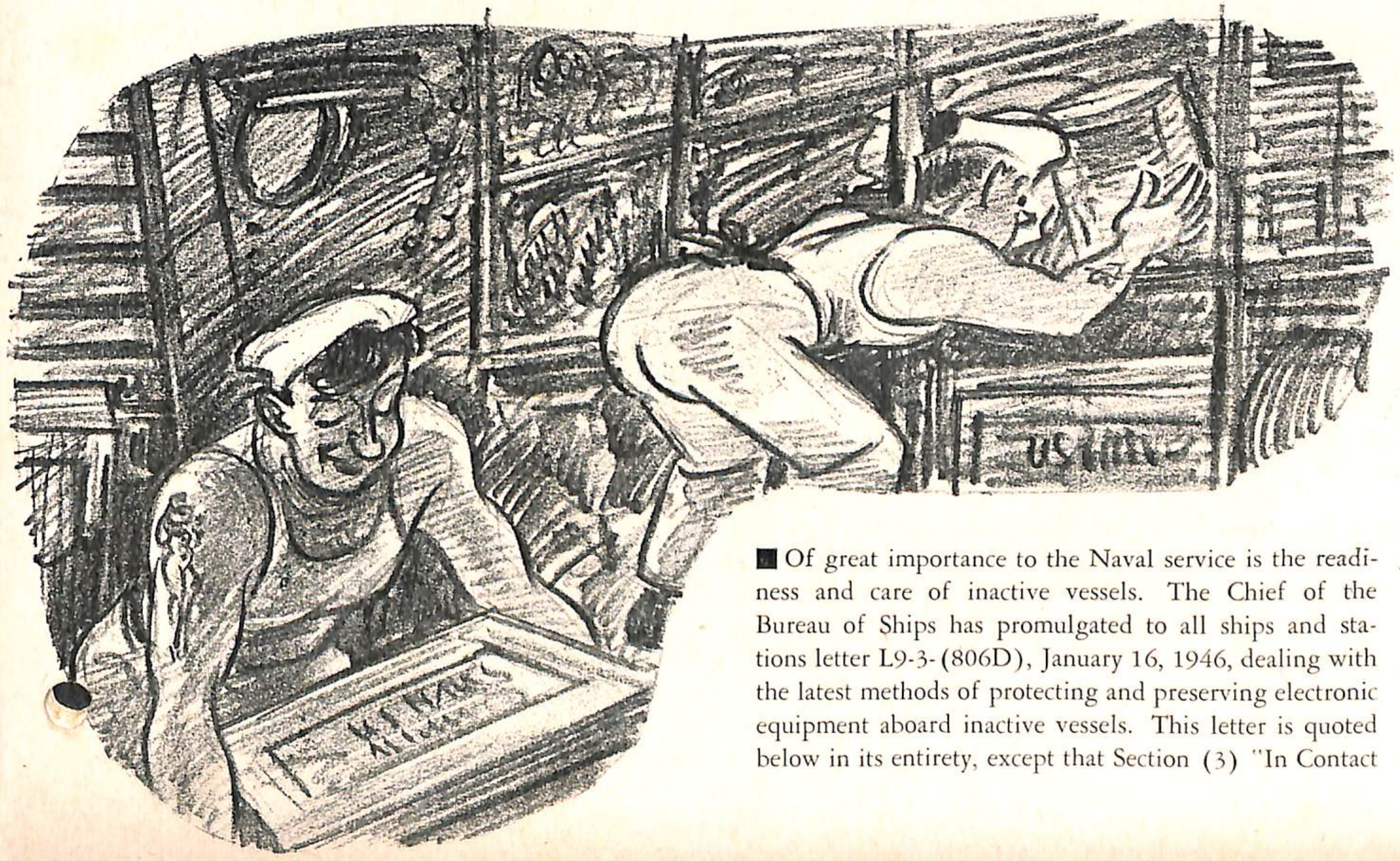
Readiness and Care of Electronic Equipment Aboard Inactive Vessels



Of great importance to the Naval service is the readiness and care of inactive vessels. The Chief of the Bureau of Ships has promulgated to all ships and stations letter L9-3-(806D), January 16, 1946, dealing with the latest methods of protecting and preserving electronic equipment aboard inactive vessels. This letter is quoted below in its entirety, except that Section (3) "In Contact

With Water—At First Docking" has been omitted because it is being revised. The italics in Section (2) (b) and (2) (f) indicate changes to the original letter which are being promulgated by official correspondence.

From: The Chief of the Bureau of Ships.
To: All Ships and Stations.
Subj: Bureau of Ships Manual—Chapter 9—Readiness and Care of Inactive Vessels—Change No. 2.

1. Effective upon receipt, the following change will be made in Chapter 9, Bureau of Ships Manual.
(a) Change article 9-180 to read as follows:

9-180 ELECTRONIC EQUIPMENT — RADIO, RADAR, SONAR AND COUNTERMEASURES.

(1) Inside Vessel:

(a) Service as necessary to place all equipment in good operating condition. In general, preservation measures shall include inspecting, cleaning, and replacing any damaged or broken parts, where practicable.

(b) Secure equipment in the usual manner and open power switches at power distribution panel. Ground antennas where disconnect switches are provided. Also disconnect patch cords at antenna and remote control panels.

(c) Treat motor-generators as described in article 9-178.

(d) Treat wet and dry batteries as described in article 9-181.

(e) Do not use Thin-Film Rust-Preventive Compound on electronic equipment when installed in a dehumidified compartment.

(2) Exposed to Weather.

(a) *Radar and Countermeasure Antennas:* Service as necessary to place in good operating condition. Service, paint and lubricate in accordance with equipment instruction books and the Radar Maintenance Bulletin. Fill oil wells in antenna pedestal with lubricant, taking care not to fill chambers high enough to immerse and cause damage to motors and windings located in those pedestals. Use Thin-Film Rust-Preventive Compound on bare metal corrodible surfaces outside of the pedestal chamber. *Caution: This compound is deleterious to electrical insulation.* Wherever possible, junction boxes and water-tight pedestals should be sealed as described in article 9-178(1) (d) and desiccant placed therein (art. 9-123). Antenna assemblies should be locked in place or braced so as to prevent motion of the antenna. When practicable, package antennas according to Section II, Part 4, or provide suitable cover.

(b) *Radio Wire and Wire-Rope Antennas:* Check antennas and lead-in connections for wear and corrosion and replace if necessary. Clean antennas and insulators as necessary, apply three coats of thin-film rust-preventive and re-install the antennas in place. Do not apply thin-film rust-preventive to insulated wire antennas.

(c) *Radio Whip Antennas:* Clean and paint the antenna in accordance with article 9-155(1). Clean the base insulator. Special care should be taken not to get any of the paint on the insulator.

(d) *Radio Direction Finder Loop Antennas:* Service and lubricate loops in accordance with existing instructions. Paint the exterior of loop shields according to article 9-155(1) except for the fibre insulating joint. Put two coats of insulating varnish on this joint. Open cable parts and put two coats of insulating varnish on all exposed connections, wires, screws, etc., in the base of the loop. For rotating loops clean and inspect the collector rings and brushes, and lock the loop in place. Coat all gaskets with Joint-and-Thread High-Temperature Compound, Navy Department Spec. 52C14, (Federal Standard Catalog Number 52-C-3114, Five-ounce tube cement), 52-C-3116 (One-quart can, cement), 52-C-3120 (Five-ounce tube liquid), 52-C-3122 (one-quart can, liquid).

(e) *Water-tight Enclosures:* Clean and paint water-tight enclosures containing electronic equipment. Seal these enclosures as described in article 9-178(1) (d) enclosing desiccant if practicable (article 9-123).

(f) *Waveguides, Flexible and Coaxial Cables:* Break waveguides at lower end and seal in order to prevent the entrance of moisture and dirt. Cover exposed flexible cables with a suitable covering such as Grade-C paper wrapped spirally starting from the lowest point. Specification JAN-P-121 (Heavy Duty Moldable Material Barrier), (Standard Stock Catalog Number 53-B-3040-50, 36 inches by 100 yards). The ends of multiconductor cables where equipment has been disconnected shall be sealed by suitable means. The ends of the individual leads should be taped and tagged prior to sealing the cable. Air or gas-filled coaxial lines should remain in place. Where, for any reason, the seals on these lines are broken due to equipment or antenna being disconnected, the cable should be re-sealed. Leave gas-tight coaxial systems under normal pressure.

(g) *Topside Units of Submarine Equipment:* Remove topside rochelle salt projectors and stow in a cool dehumidified compartment. Paint metal parts of magnetostriction line hydrophones with a thin coat of dull black paint of the type used for painting submarine superstructure. *Leave rubber baffle unpainted.* Package in accordance with Section II, Part 4.

(h) *Other Electronic Equipment:* Leave everything in place. Use normal preservative measures; i.e., Thin-Film Rust-Preventive Compound (Section III) and packaging (Section II, Part 4). Where it is impracticable to preserve equipment in place and excessive deterioration will result from exposure to the weather, it may be removed to the nearest dehumidified space.

(3) In Contact With Water—At First Docking. *(being rewritten).*

(4) Spare Parts:

Retain spare parts in their original containers in customary stowage space when this space is dehumidified. Move material from non-dehumidified space (article 9-244). Spare parts may be stowed in electronic spaces with equipment for which they are provided if this can be accomplished without interfering with the operation of equipment. Ordinarily, spare parts are satisfactorily packaged for storage when received from the manufacturer. Where packages have been sealed and contain a desiccant, care should be taken to ascertain whether or not the desiccant has become saturated. This will naturally depend on length of time spare parts have been on board, where stowed, etc. Spare parts should be inventoried and replacement made of missing items (article 9-27).

(5) Tools, Test Equipment and Accessories:

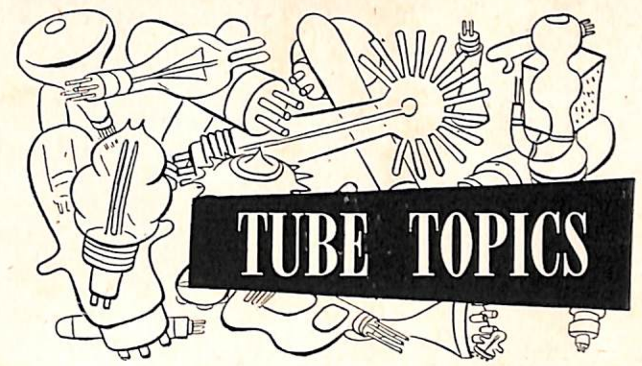
Retain the tools and test equipment in customary drawers and lockers. Preservation measures should be applied to tools which have corrodible surfaces (article 9-27). Headphones, chest microphones, patch cords and other operational accessories should be stowed or hung in dehumidified spaces in their customary location, readily available for use.

(6) Electronic Equipment Logs:

Make notations in the various electronic equipment logs of the condition of all material, repairs made, preservation measures taken and any special precautions necessary to place the equipment in operation. Make special notes of any equipment, spare parts, or tools moved from their normal location.

(7) Instruction Books:

Restricted and unclassified instruction books shall be retained on board available for use with the equipment. Secret and confidential instruction books shall be stowed in identifiable packages on board a vessel in commission, in reserve, of a division or sub-division in the group organization.

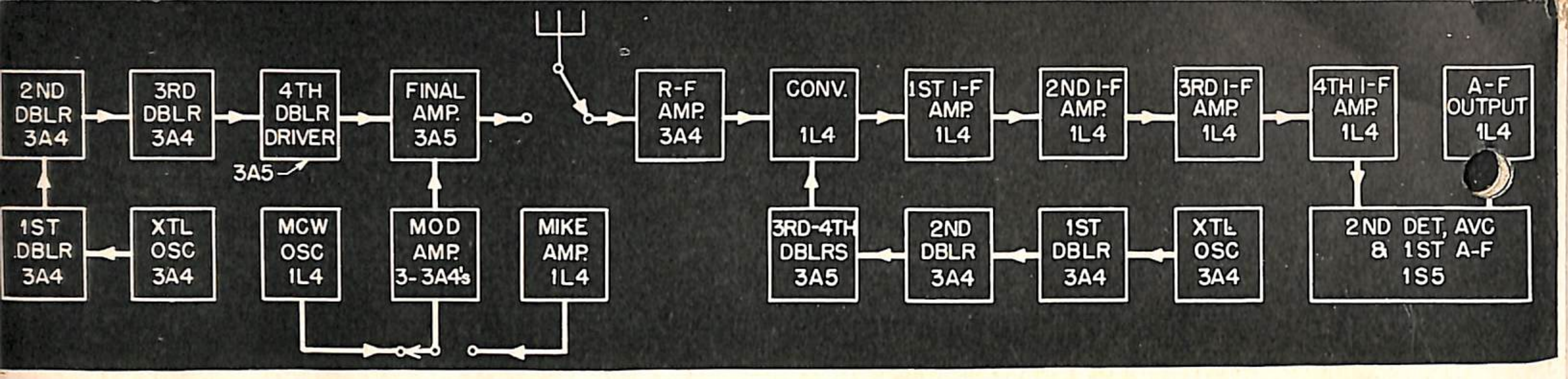


SU CONTROL AND RANGE UNIT TROUBLES

A representative of the Electronics Field Service Group reports a unique instance of difficulty in an SU Indicator. The overall operation of the unit was very unsatisfactory. V-543 (5R4GY) appeared gassy and was replaced. After replacing this defective tube it was found that the pulse repetition rate was too high, the marker counter adjustment was such that only four 2000-yard markers appeared for each five-mile marker, and the IFF gate operation was unstable. The marker counter adjustment R-509 was corrected, but the repetition rate could not be corrected by adjusting R-512. V-531 (6SN7GT) was given a thorough test and found to have abnormally low emission in both sections. Both sections of this tube operate as blocking oscillators, the first as marker counter and the second as repetition rate generator. As a result of the low emission both sections were running too fast, which accounted for the high pulse repetition rate and unstable marker counter adjustment. After replacing V-531 with a tube of normal emission, adjustments of R-509 and R-512 could be made and the equipment worked normally.

—*E.F.S.G.*

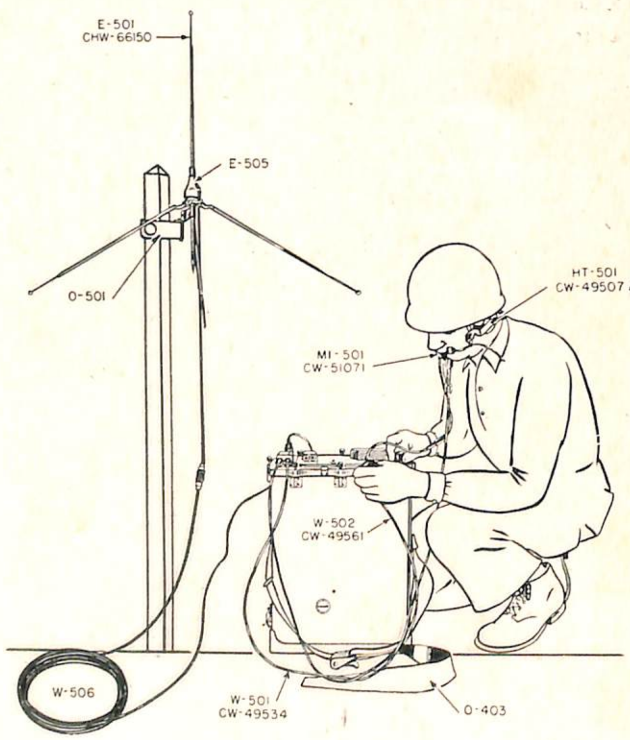
Bureau Comment: The very complex circuits of the SU Control and Range indicator are so designed that all components must operate at very close tolerances. This close tolerance is also applicable to vacuum tubes. Tubes should be checked periodically and accurate records kept to facilitate replacement before their deterioriation affects the operation of the equipment.



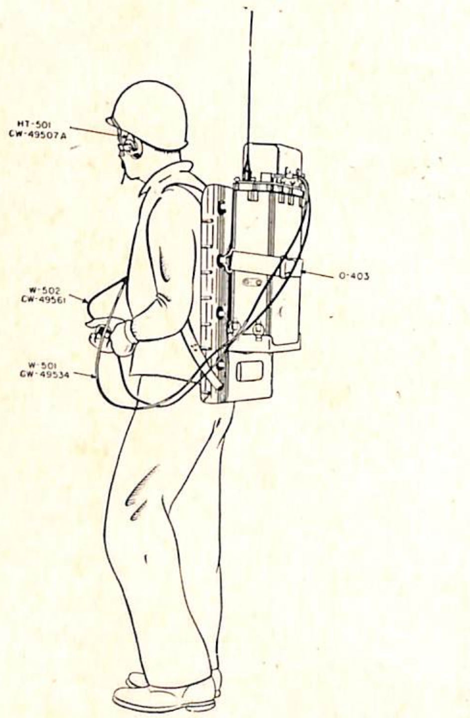
The *MAW* Portable Transceiver

■ The Navy Model MAW Transmitting and Receiving Equipment is a new member of the VHF family, capable of operation in the frequency range 115 to 156 megacycles. It consists of a ten-channel crystal-controlled transmitter and receiver employing a battery-operated vibrator power supply. The equipment is intended primarily for back-pack transportation and may be operated while being carried. Provision is also made for use at outposts where the antenna can be installed in an elevated location to improve the operating characteristics of the equipment. Submergence-proof in the operating condition has been accomplished by effective gasketing between the panel cover and the case, and the use of packing glands around control shafts.

Control of the operating frequency of both transmitter and receiver is by means of crystals; selection of an operating frequency in both transmitter and receiver is made simultaneously by manipulating a ten-position rotary switch. Both type A_2 and A_3 emission are available from the transmitter.



MAW set up for operation with antenna mounted on wood support for additional height.



Back-pack operation of the MAW equipment with antenna projecting from top of pack.

This pack set represents the ultimate in ease of operation. In addition to the frequency selector switch, the only other control on the operating panel is a combination *on-off* and *volume* control.

The equipment is designed for standard pack-board mounting, and when used as a "walkie-talkie" the antenna is the vertical portion of the "chair leg" antenna detached from its ground plane and connected directly to the antenna terminal on the top panel of the equipment. When not in operation the antenna is stored in a tube built into the control panel. The antenna radiators are collapsed against spring pressure and therefore should be held together until the antenna is completely removed before releasing the radiators one at a time.

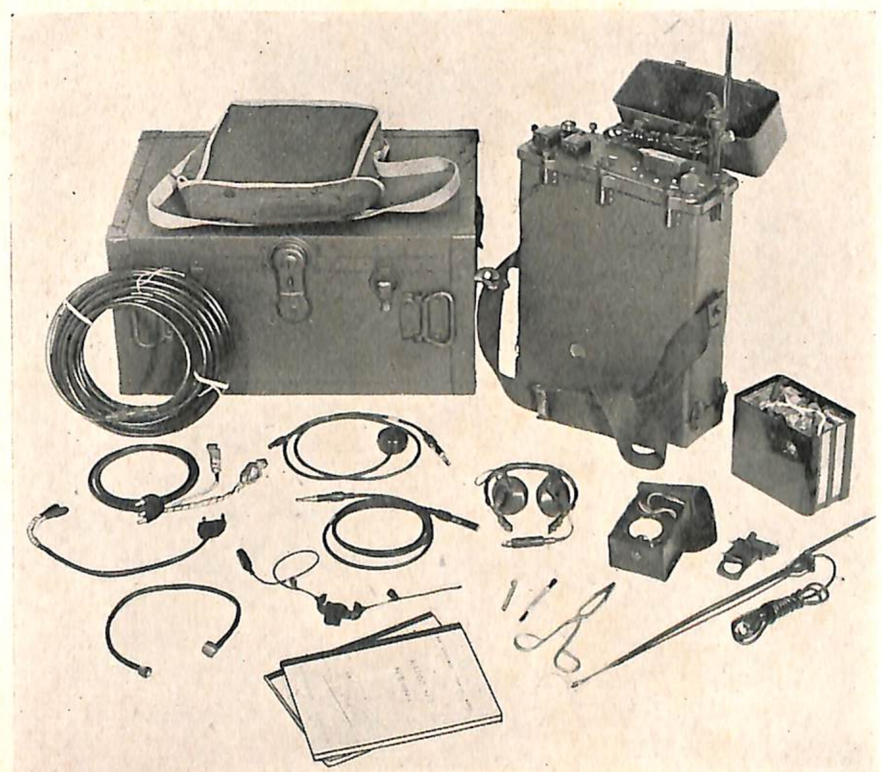
The transmitter and receiver are entirely independent, each having its own crystal and frequency-multiplying circuits as shown in the block diagram. The power supply is self-contained, uses two Signal Corps Type BB-54A lead-acid storage cells, and supplies power to both the transmitter and receiver. The three sub-assemblies (transmitter, receiver, and power supply) are mounted on the chassis frame which is secured to the operating panel. The storage cells are not mounted on the chassis frame but are contained in a separate isolated compartment, access to which may be had from the exterior of the equipment housing through a door in the bottom. Push-to-talk operation is provided by the microphone switch, and MCW break-in is effected by holding down the microphone switch and using the key mounted on the panel under a rubber diaphragm. The complete equipment uses a total of twenty-three tubes, all of the miniature type. Only types 1L4, 1S5, 3A4, and 3A5 are used.

The equipment is supplied in a plywood shipping chest which contains the equipment and accessories. A Navy Type -49507A headset, Type -51071 lip microphone, and Types -49534 and -49561 extension cords, are stowed inside a removable cover mounted on the top panel of the equipment. The remaining accessories are carried in a canvas carrying case. These additional accessories comprise the following: an antenna extension cable consisting of fifty feet of RG-8/U coaxial cable plus connectors, an alignment meter in a metal case which also contains alignment tools, battery charging cable, and a battery test cable.

No battery-charging equipment is available at the present time, but the following recommendations are made for charging the two BB-54A batteries in series from a 6-, 12-, or 24-volt source:

Battery Voltage of Motorized Equipment	*Resistance Ohms*	*Resistance Watts*	*Charging Rate*	*Connection*
6 volt	0.8	5	2.5 amp.	Connect resistor
12 volt	3.2	20	2.5 amp.	in series with one
24 volt	8.	50	2.5 amp.	lead of charger cable.

A universal battery charger is under development which will provide facilities for charging the MAW batteries from 12, 24 and 32 volts d.c. and 115 volts a.c. There will be included a hand charger for use in the



Complete MAW equipment, with extension cable, battery case, headphones, microphone, test meter, etc. Shipping chest is in background.

field when no power sources are available. In addition, two Signal Corps type BB-54A storage cells will be supplied with each battery charger.

In order to determine the communication capabilities of the MAW equipment a field test was made with an F6F aircraft equipped with an AN/ARC-1 and the following is quoted from the report of that test:

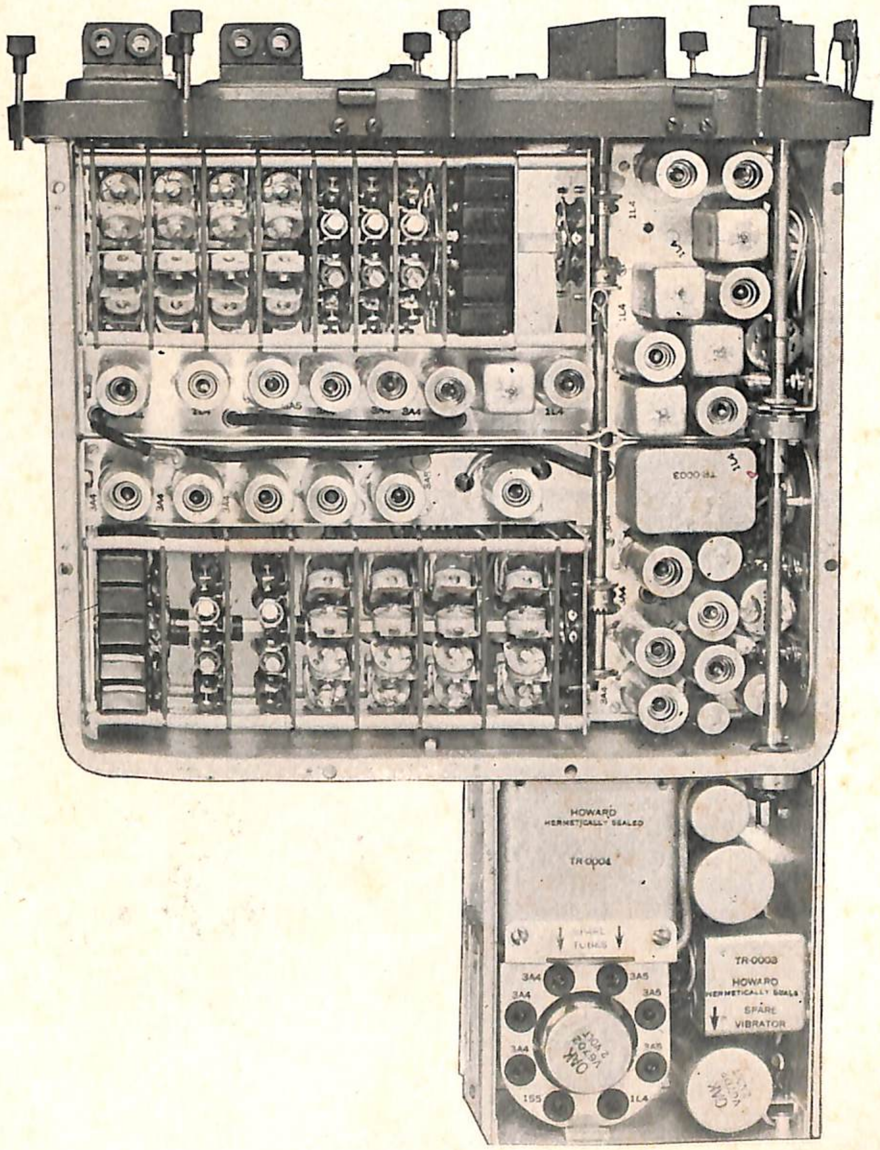
"Tests were made to determine the maximum range at which solid, 100-percent intelligible signals could be transmitted to the plane at 500 feet, 1,500 feet, and 5,000 feet altitude, first with practically zero effective antenna height, and then with approximately 10 feet of effective antenna height. A run was then made directly over the equipment to determine the extent of the "cone-of-silence" effect.

"With the whip on the set, the latter resting on the ground, the range was 3½ miles at 500 feet, 10 to 12 miles (depending upon aspect) at 1,500 feet, and 19 miles at 5,000 feet.

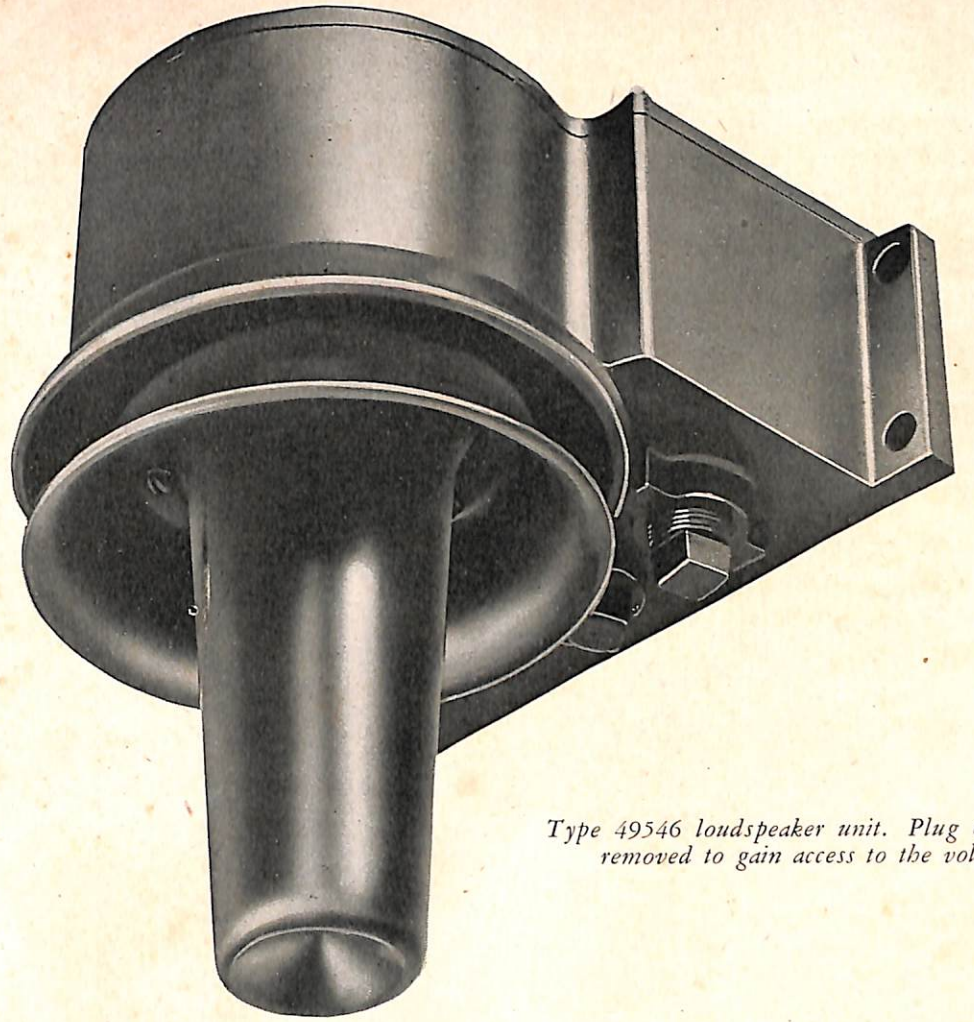
"With the antenna clamped to the top of a 10-foot stick, altitude at 500 feet, the range was extended to 12 miles. At 5,000 feet altitude the signal so impressed the pilot that he requested permission to fly out to complete extinction of the signal, but he was instructed to return at the 30 mile point because of time limitations.

"The pilot then flew directly over the MAW at slightly under 5,000 feet. He reported that the signal was solid, with no cone of silence.

"Because of time limitations no test runs were made with the equipment operating from the back-pack position, but it is reasonable to assume that the results would be intermediate to those obtained with the antenna at virtually zero effective height and with the antenna at 10 feet."



Side view of Model MAW with cover removed. Spare tubes and vibrator can be seen in lower right.



Type 49546 loudspeaker unit. Plug on right must be removed to gain access to the volume control.

VOLUME CONTROL

For 49546-Type Speakers

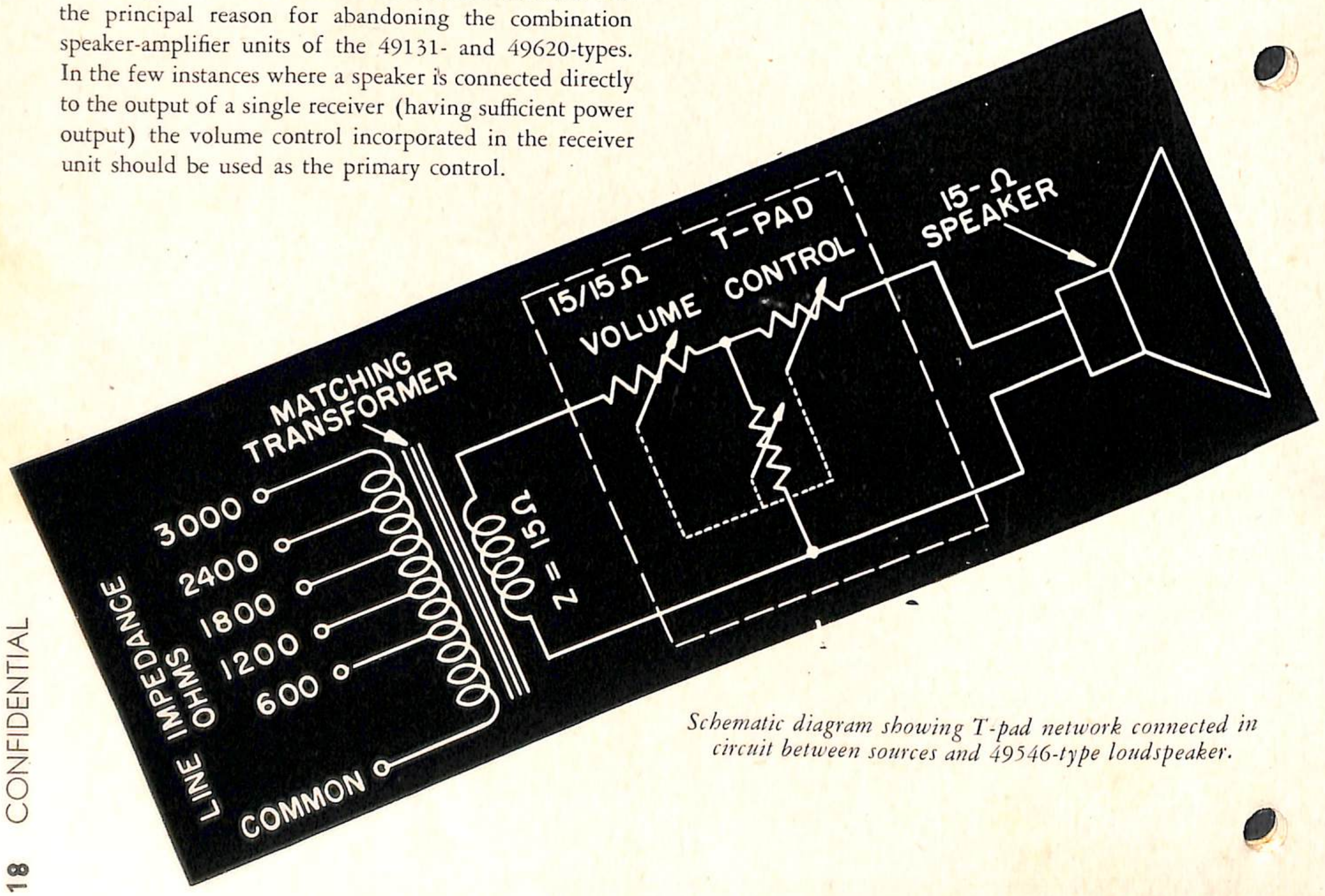
■ Several activities have suggested a modification of the type -49546 loudspeaker unit to eliminate the necessity for removing the threaded plug in order to gain access to the volume control. In view of these suggestions, it is believed that the intended ultimate installation of these units is not generally understood by the field.

The type -49546 unit is provided with a built-in T-pad volume control connected between the matching transformer and the driver unit as shown in the photograph. The shaft is slotted for screwdriver adjustment and is accessible upon removal of a ½" pipe plug. This control was provided only as a secondary means of controlling speaker volume and is not intended for use as the primary or regular control. This secondary control will be found convenient, and in some cases essential, for limiting the maximum volume to the desired valve at certain locations. In a location such as an open bridge, the volume would be set at maximum level. Conversely, if a speaker is mounted in a very small, relatively quiet space, the level would be correspondingly lower. The proper control setting for each individual speaker installation should be determined by trial under actual or simulated operating conditions. After the desired setting has been determined, the plug should be installed and the primary volume control used thereafter for all normal adjustments. The recessed shaft and pipe plug was adopted in lieu of a protruding shaft and packed gland to insure a permanent, trouble-free control which would not be tampered with, and to maintain the watertight integrity of the unit.

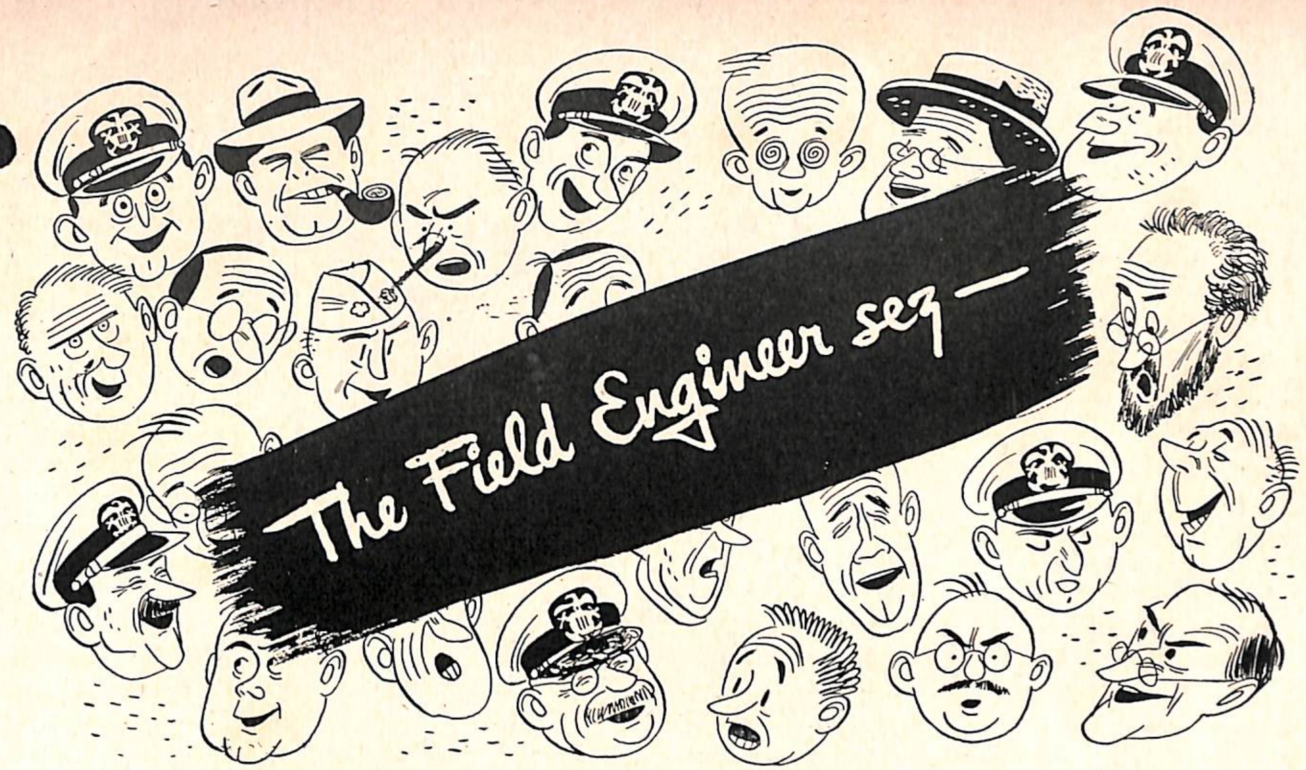
All standard shipboard installations of the type -49546 loudspeaker unit as originally and presently planned call for a small, compact audio amplifier (type -50210 or equivalent) to be placed in the circuit between the source of signal and the speaker unit. The source will be either a remote control unit, radiophone control unit, or a basic receiver. The amplifier in each case is to be installed in a protected location convenient to the proper operating personnel for power on/off and volume adjustments. The conveniently located amplifier with all the necessary controls permits installation of the speaker unit in the most efficient location without regard to accessibility. This feature is of particular importance when it becomes necessary to locate a speaker at a considerable height on an open bridge or other inaccessible location. The ever increasing number of installations in such locations was the principal reason for abandoning the combination speaker-amplifier units of the 49131- and 49620-types. In the few instances where a speaker is connected directly to the output of a single receiver (having sufficient power output) the volume control incorporated in the receiver unit should be used as the primary control.

A summation of the foregoing indicates that the T-pad incorporated in the 49546-type unit should be used only as a secondary or fixed-setting control and that the volume adjustment provided in the associated amplifier unit, control unit, or receiver unit should be used as the primary or regular control.

The above represents the general intended use of the -49546 loudspeaker unit and will be applicable in practically all installations. However, the Bureau recognizes the fact that there may be a small number of special installations wherein it will be desirable to utilize the volume control in the loudspeaker unit as the "primary" control. For these special cases, the Bureau has prepared a sketch to indicate the preferred method of extending the volume control shaft through the housing in order to make it readily accessible. This method permits retention of the weatherproof features and does not require any modification of the speaker housing or the volume-control assembly. Vessels and activities finding it necessary to make this modification should advise BuShips (Code 982) of the fact and request instructions covering the approved method.



Schematic diagram showing T-pad network connected in circuit between sources and 49546-type loudspeaker.



MORE ON TUNING THE SR-2

In view of the difficulty being encountered in tuning the SR-2, the manufacturer is making every effort to inform technicians of the correct method of tuning this equipment. In line with this policy R.C.A. has issued the following bulletin to its field representatives, supplementing the information published in the May 1946 ELECTRON.

"Operating personnel have at various times reported that it was necessary to retune the transmitter when pulse length was switched. This condition has been carefully investigated on existing shipboard installations. In all cases it was found that maximum output and freedom from frequency shift with pulse change were obtainable at any frequency within the range of the equipment when correct tuning procedure was employed.

"To insure maximum stability, particular attention should be given to load stub adjustments. One of these stubs, No. 1 in particular, can be shifted several dial divisions out of tune, yet cathode tuning will peak up the output reading on the reflectometer to practically normal value; but change of pulse length will require re-peaking. To tune the equipment correctly the company recommends that the technician comply with the following instructions:

1—Make all tuning adjustments on the long pulse length.

2—Set anode dial approximately to frequency desired, as read from the chart.

3—Tune cathode for maximum incident reading of the reflectometer.

4—Further maximize the reflectometer reading by tuning load stubs.

5—Repeat steps (2) and (3) until no improvement in output can be made.

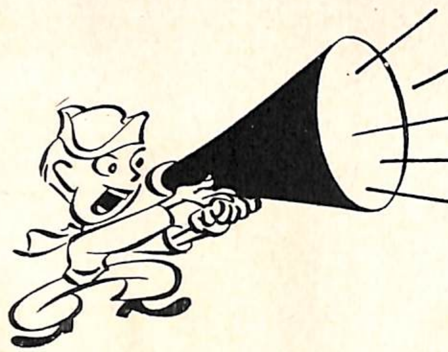
6—Tune the Receiver and duplexer cavities for maximum echo response. In case of doubt about duplexer operation, remove side shield of transmitter and assure that the gaps are firing properly.

7—Switch to short pulse length. First check receiver tuning to see whether any change is necessary to maximize echo response. Next check tuning of the transmitter cathode circuit to determine whether any change is necessary to get maximum reading on the reflectometer.

8—If any change of tuning is indicated in step (7), the load stubs (particularly No. 1) should be shifted to other settings. After each of these shifts the cathode, receiver, and duplexer should be retuned and the test of step (7) repeated. By this procedure, the correct setting should be quickly determined.

9—Should some paradoxical condition exist whereby the above procedure does not give desired stability, a slight change of frequency can be made, and the entire procedure repeated."

It was noted in one installation that data on load stub settings had been recorded on the adjustment card on the front of the transmitter by the factory test group. Such data should be ignored on new installations or re-installations, as the correct settings are dependent upon characteristics of the transmission line. —*RCA.*



ERROR IN FIELD CHANGES

The instructions accompanying Field Change No. 4-WFA and No. 1-NGA "Repositioning of Interrupter Cam and Addition of Resistor and Capacitor to Eliminate False Flashes on Indicator Dial" contains an error that should be noted and corrected by installing activities. On Page 4, Figure 1, resistor R-338 should be R-337.

—*E.F.S.G.*

SP WOBBLER WINDOW

An inspection of a shipboard installation of SP radar by a GE Co. engineer resulted in a recommendation that the mica window in the wobbler be replaced as it was chipped. Upon investigation it was revealed that no windows were available from spare parts, so the yard maintenance man ordered one made of plexiglas, this being substituted for the mica window. During the trial run the equipment did not work normally, signals being inferior to those received on the SG. The standing-wave ratio was exceptionally high and could not be lowered by adjustment of the tuning stubs. It was discovered that the plexiglas window had been badly warped by the heat of the r-f energy after only one day's operation. To remedy this condition, a mica window was removed from a spare wobbler assembly and used to replace the plexiglas. As soon as the substitution was complete, the signals became normal and it was possible to adjust the tuning stubs to produce a satisfactory standing-wave ratio and frequency spectrum.

At a later date the manufacturer (General Electric) published the following information to their field representatives: "The window can be made of any good grade of mica, 10 mils in thickness. There is also a new material which can be used, called DuPont 1114-F, or *Poly-F.* If this material is used it should be 40 mils in thickness. Plexiglas and similar materials cannot be used, since they will burn. This cover also acts as an impedance-matching device".

—*E.F.S.G.*

MODEL JT TALKBACK AMPLIFIER

In the Model JT talkback amplifier, Navy Type CRV-50200, the contacts of relay K-401 may get out of adjustment. When the relay is energized the contact connected to terminal #1 on transformer T-401 may close to the movable arm of potentiometer R-403 before a second contact on the relay opens the circuit from terminal #2 on T-401 to chassis ground. When this occurs the floating ground will be connected through R-403 and the primary of T-401 to the chassis ground, causing R-403 to burn out and contacts on K-401 to arc and burn. It is therefore necessary to be very careful in adjusting the contacts of K-401 to insure that they all open and close simultaneously, with some movement in between while all the contacts are open.

Another fault that has been found is the grounding of the arm of R-403 to the chassis. When replacing R-403, a potentiometer should be chosen which does not have its shaft connected to the movable arm. If the only potentiometers available have the arm connected to the shaft, it is necessary to carefully insulate the shaft from the chassis when making the installation. This requires reaming the mounting hole in the front panel of the amplifier to accommodate a pair of insulating shoulder washers.

—*E.F.S.G.*

CORRECTING HUNTING IN SP

If your SP antenna *hunts* in azimuth, you may have trouble similar to that experienced on board the USS *Pensacola.* A condition was encountered in which the antenna hunting could be corrected while equipment was operating, but after shutting down for a few hours and starting up again it would resume hunting. This necessitated re-adjustment of the synchro amplifier each time the equipment was started from a cold start. The low-speed cut-in relay K-3301 would oscillate. The adjustment was very critical and could not be set so that it would operate all the time. The synchros had been checked with a 5,000-ohms/volt meter and apparently were on zero. A re-check with a 20,000-ohms/volt meter revealed a 0.4-volt error in the 1-speed synchro B-3126 in the antenna. It was at first thought this error was not sufficient to cause any trouble; however, after re-adjusting the synchro amplifier and adjusting the entire system to exact zero, the hunting disappeared entirely.

—*E.F.S.G.*

NGA PROJECTOR LEADS

Many NGA projectors examined recently have been found with twisted leads in the plug input to the transformer housing. To prevent this, the keyed spacers and washers in the neck of this housing should be slid into final position only after tightening the packing nut. This will prevent the leads from becoming twisted, broken, or damage to insulation.

—*E.F.S.G.*

RUBBER CAPS

The type CTE-49016 headsets supplied with QAA sonar gear are equipped with waterproof rubber caps. When a rubber cap is placed over an earphone, air is trapped between the cap and the phone. When the phone is held against an operator's ear this air is compressed and applies pressure against the diaphragm of the phone, preventing it from responding properly.

If the cap is pushed in towards the phone while the rim of the cap is pulled loose from the rim of the phone, much of the trapped air will be expelled. If the rim of the cap is then snapped back against the rim of the phone while the cap is still held pressed in against the phone, normal operation will be restored.

—*RCA*

ERRORS IN WFA INSTRUCTION BOOKS

Field activities should note the errors in resistor values affecting 1018 and 1018A (CBM-20334) Listening Amplifier power supplies in all existing WFA and all previously-distributed WFA-1 schematics and instruction books. Resistor R-2403 shown as 1000 ohms should be 51,000 ohms, and resistor R-2404 shown as 51,000 ohms should be 1000 ohms. In other words, resistors R-2401 and R-2404 are equal and 1000 ohms each, and resistor R-2403, which is in series with B+, is 51,000 ohms.

In the second printing of the WFA instruction book, on page 2-12, paragraph 2b-(1), the first sentence of the second paragraph should be corrected to read "The junction of R-2401 and R-2404 is used as a center tap on the heater supply".

—*Sub. Sig. Co.*

HEIGHT MARKER ALIGNMENT IN THE SX

One of the major functions of the SX Radar absolute height finding can be seriously affected by the failure or misadjustment of the height-rate, height-zero, and/or earth's-curvature circuits. Experience on board the U.S.S. *Franklin D. Roosevelt* revealed that the earth's-curvature compensation circuit components are affected by temperature, changing of tubes, and component changes. This necessitates alignment of the *RHI* height-marker system. A method of accomplishing this alignment was evolved which may prove very helpful to other technicians engaged in SX maintenance.

1600 feet of earth's curvature was set in at 50 miles at 10,000 feet of elevation. The scanner was then stopped at 3° and the height-rate and height-zero controls adjusted until the height of the marker corresponded to calculated values for 10, 20, 30, 40, and 50 miles. When making the calculations, earth's curvature and normal atmospheric refraction were taken into account. The elevation angle of 3° was used as it covered the center of the area in which most accurate readings are desired by CIC personnel.

—*E.F.S.G.*

RECLAIMED MAGGIES

In the life of most technicians there comes a time when the last spare tube has given up the ghost and the equipment is out of operation. Such a catastrophe struck the personnel on board the *Franklin D. Roosevelt,* as indicated in a report received from an *E.F.S.G.* representative. The last spare magnetron for the search section of the SX radar began showing indications of erratic operation. Several had already been used and replaced due to unstable or otherwise unsatisfactory operation. When the last spare was removed, it was decided as an emergency measure to try one or more of those which had previously been replaced, so one which had given only 197 hours of operation was again tried in the equipment. The results obtained were very gratifying. Excellent ranges were obtained on surface targets, flights of planes, and on single planes. Interceptions were made at ranges from 30 to 50 miles, and at altitudes from 5000 to 12,000 feet with steady reliable returns. The reinstated magnetron was still operating satisfactorily after 45 hours of its second run.

The moral is to use initiative when an emergency arises. If in doubt as to whether a tube (particularly a magnetron) is defective, give it a second try. Obviously, if its failure had caused other components to break down on its original run, it should not be re-used. But if symptoms were only spurious oscillations or otherwise erratic operation without serious consequences, don't give it up without a second try.

—*E.F.S.G.*

COPPER OXIDE INSTRUMENT RECTIFIERS

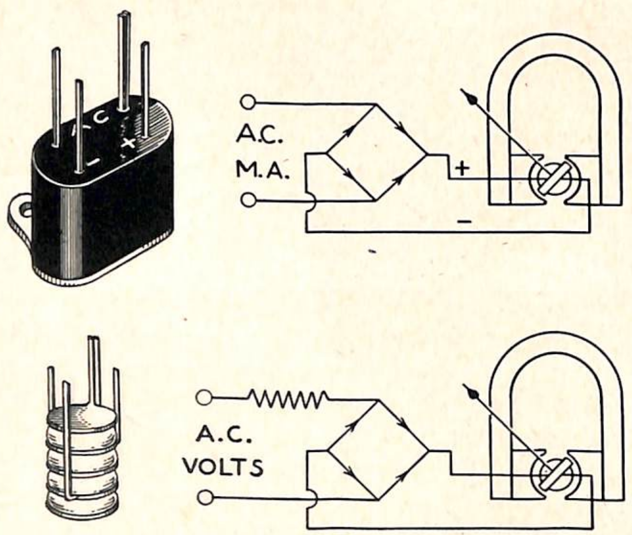


FIGURE 1—*The Rectifier Assembly and Typical Circuits*

By JOHN H. MILLER,

Weston Electrical Instrument Corp.

■ The copper oxide rectifier, while dating back only 20 years in terms of practical use, actually is the result of a great deal of study many years ago. Rectification phenomena in copper oxide and selenium layers was reported in 1874 but apparently in those early days it was impossible to rationalize these phenomena to produce a useful device. Even today we do not know the details of how rectification occurs, although it appears that the interface between the mother copper and the oxide is the layer which allows current to pass freely from the oxide to the copper, and presents a high resistance to reverse flow.

RECTIFIERS WIDELY USED

Rectifiers today are used widely with ratings as high as many thousands of amperes for electro-plating and electrolytic use generally. They are made as small as the size of a pin head for currents of the order of a few milliamperes and such rectifiers of the copper oxide type are manufactured in large quantity for specific use in instruments.

Figure 1 shows the Weston instrument, rectifier assembly, the stack of 4 discs with their terminals, and typical circuits as used for current and voltage measurement.

Copper oxide units are generally preferred to the selenium type for instrument applications simply because of their lower resistance. Selenium rectifiers may be operated up to the order of 10 volts per disc, whereas copper oxide units are limited to about 2 volts. But since most instrument applications involve loading the rectifiers to only a few hundred millivolts, single copper oxide discs have adequate voltage limits, and the lower resistance means better overall efficiency.

It might be noted here that in 1921 in the Weston Laboratories the first full-wave bridge rectifier-type instrument was developed for the special laboratory measurement of some low level audio frequency currents. This instrument used molybdenum sulphide rectifiers.

There was little commercial requirement at the time for such a combination, however, but in 1925 a rectifier type Weston portable instrument was developed for commercial application in which carborundum rectifier units were used in the bridge, again for the measurement of currents in audio frequency transformers. A patent application on this combination resulted in patent 1,746,935, issued in February, 1930, as the basic patent on the rectifier instrument as used today.

With the advent of the first disclosure of the copper oxide rectifier in 1927, arrangements were made to use them and the first rectifiers of this type used in commercial instruments were fabricated in furnaces in the Weston plant for this specific application, and were applied to instruments shipped that year.

DISCS VARY IN SIZE

The Weston Corporation makes several sizes of discs in order to obtain the best characteristics for a given measurement problem. The d-c characteristics of three of the disc sizes are shown in the curves of figure 2 where current is plotted against voltage applied.

In the manufacture of the discs a special grade of copper made specifically for rectifiers is obtained and given a lot number. Impurities of the order of a few parts per million, particularly silver, play a rather important part in the final rectifier characteristics. This assigned lot number is carried through all processing to the final assembly and marked on the assembled rectifiers so that all rectifiers of a given lot number have been processed in exactly the same manner from the same material and show similar characteristics.

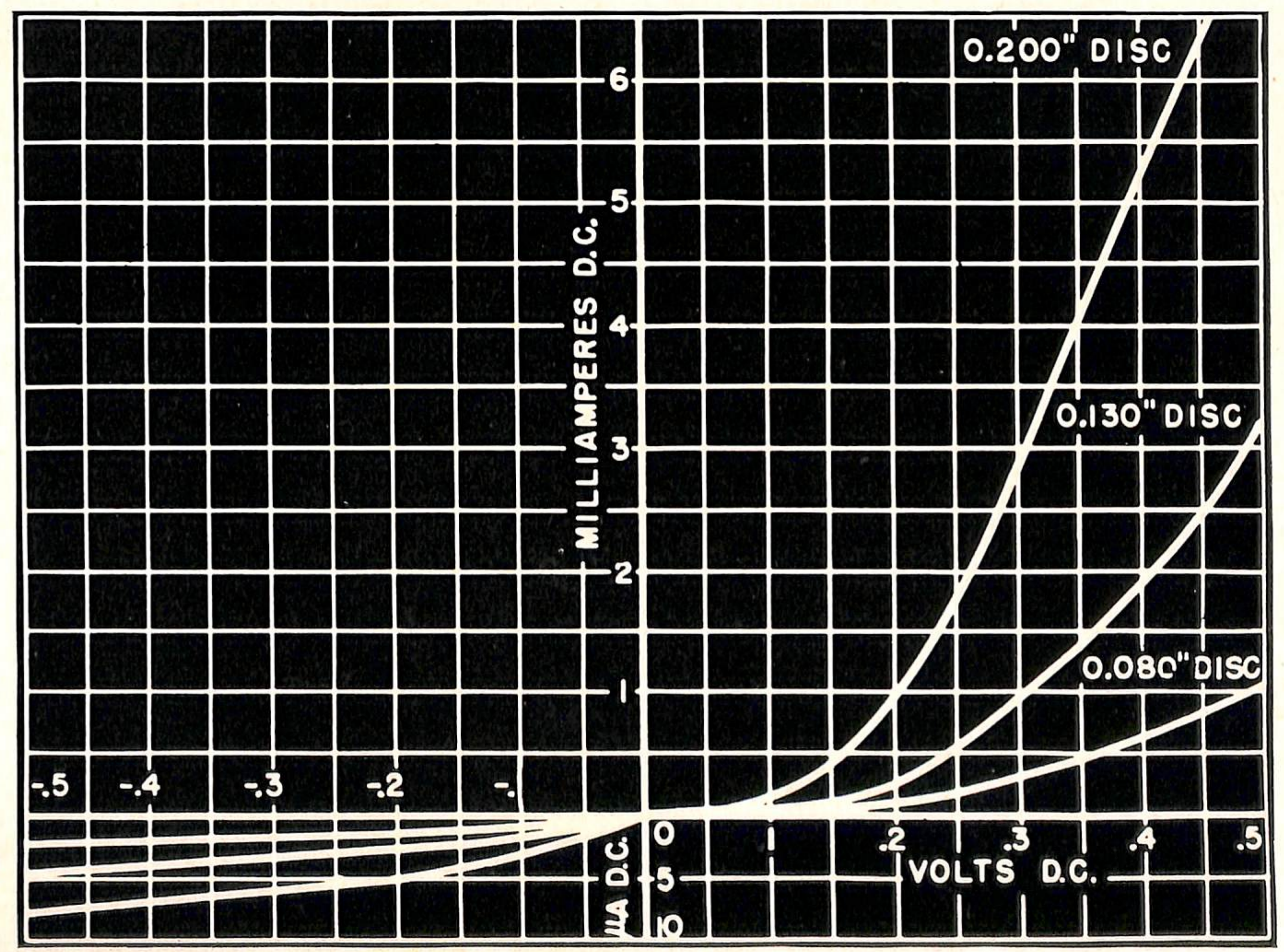
Discs of the desired size are punched from the special copper and, for each lot, a particular oxidizing and annealing cycle is determined to give the optimum characteristics for use in instruments. From one lot to another the time cycles vary slightly to the end that the final rectifiers vary as little as possible between lots.

PROPER OXIDIZATION IMPORTANT

The discs are oxidized in electric furnaces at a temperature near the melting point, passed through annealing procedures, and are quenched. They then pass through a series of acid treatments to clean off the surface black oxide and also to etch out the tiny filaments of mother copper at the edges of the cuprous oxide which, if not removed, tend to lower the back resistance.

Next they are placed in trays under suitable masks and introduced into a vacuum chamber where pure gold is cathode sputtered onto the surface. This gold sputtering procedure, developed in the Weston Laboratories, gives a superior surface to conduct the current into the oxide than the older procedures using graphite and soft metal discs. Gold is applied both to the front and the rear

FIGURE 2—*The Direct Current Characteristics of Weston Copper Oxide Rectifiers*



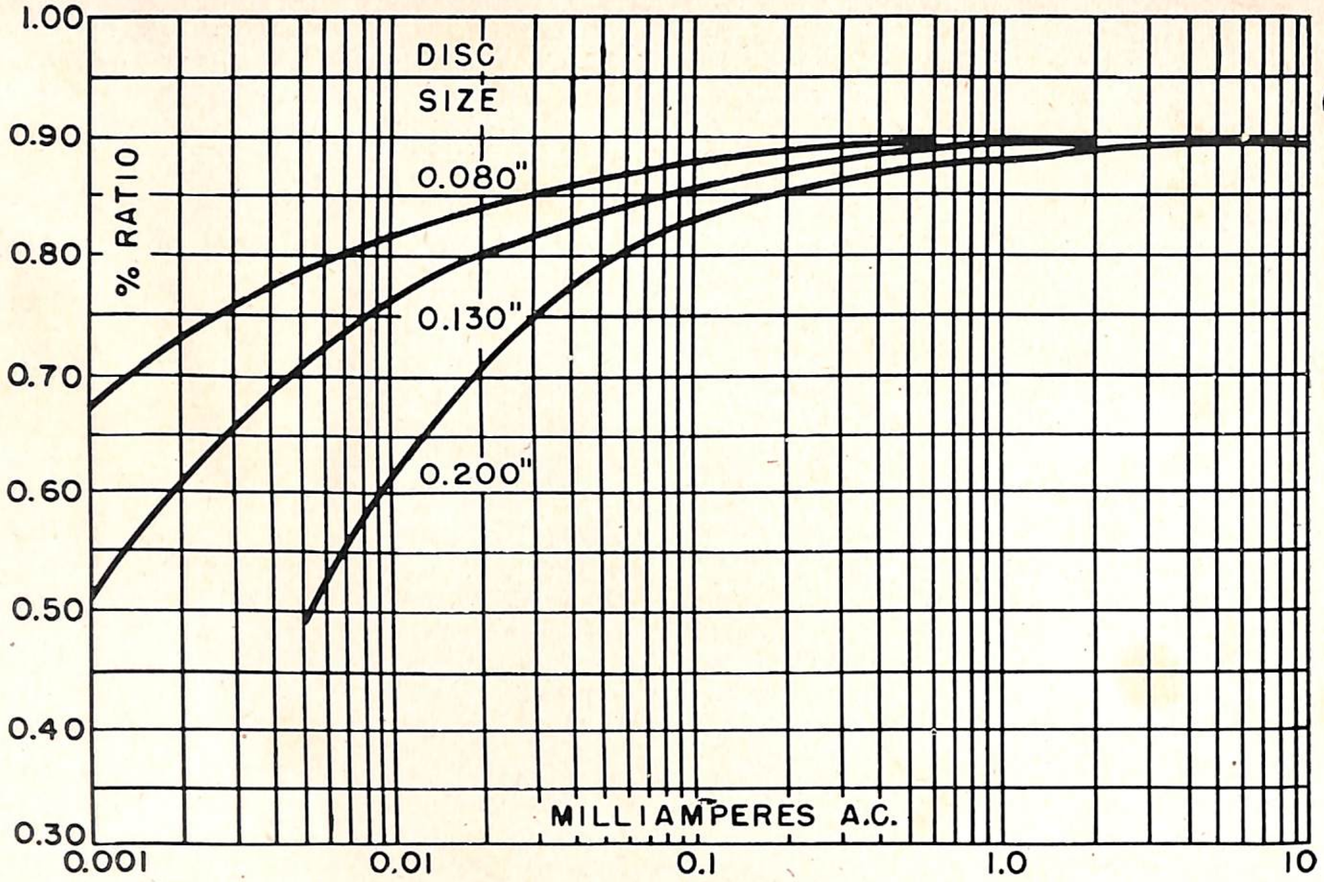


FIGURE 3—*The Direct Current and Alternating Current Ratio of the Weston Copper Oxide Rectifier*

faces of the discs and the terminals with which they are finally associated are also gold plated.

INSPECTION AND SELECTION PRECEDE AGING

The discs are then individually checked in a fixture to established limits of forward and back current under specific values of applied voltage. The current flowing at any particular voltage, forward or backward, varies in accord with a general distribution law, and about 10% of the discs are rejected in order to maintain as great uniformity as is possible. For special applications discs may be selected with tolerances closer than normal as for rectifiers used in the VU meter.

Acceptable discs and terminals are then assembled in the tiny bakelite housing along with the spring arrangement for applying the optimum pressure, and the assembled rectifier is again tested. Rectifiers are aged at an elevated temperature for a period of 30 days to develop long term stability and are checked again before being placed in stock against requirements for use in assembled instruments.

Rectifiers are also used in combinations other than the conventional 4 disc bridge, and assemblies are stocked using the modulator bridge, half wave and half bridge assemblies for special purposes and surge protectors where the curvature of the characteristics serves to protect an instrument against high overloads.

MUCH APPLICATION DATA REQUIRED

In the application of the rectifier to measuring instruments a great deal of data is needed and, unfortunately, the data must be made available to the instrument designer in terms of so many parameters that it becomes quite unwieldy. As an example, we may consider the design of a 1 ma instrument of rectifier type as commonly used for voltmeters.

To obtain a full scale sensitivity of 1 ma a-c requires a somewhat more sensitive d-c instrument. Since the d-c instrument operates on the average rectified value, but presumably we wish to measure a-c on an rms basis, we are faced immediately with the ratio of the average to the rms value which, with a perfect rectifier and on a sine wave basis, will be 0.9. In other words, with a perfect rectifier the d-c instrument must give full scale deflection on 0.9 ma. Actually the rectifier is not perfect and the output current depends on a great many things. It will vary somewhat with temperature. It will vary with the load resistance, in this case the moving coil of the instrument. It will vary with the frequency of the alternating current applied. Since the current flowing does not follow the voltage because the rectifier is a non-linear resistance, the resulting d-c/a-c current ratio actually varies with the resistance in series with the rectifier itself. From available engineering data and for a moving coil having a resistance of approximately 100 ohms, we find that 0.89 ma d-c will be fed from a 0.2" diameter rectifier to the instrument with 1 ma a-c applied to it through a moderate resistance and we can so design the d-c instrument mechanism.

SELECTING THE RECTIFIER

While this current ratio applies at 1 ma input, it does not apply at lower currents where the ratio is somewhat less, and is a function of the current density in the rectifier. The three curves of figure 3 show the current ratio of full wave 4 disc rectifier assemblies and it will be observed that at low currents this ratio is highest with the smallest rectifier having the highest current density. The effective resistance of the smaller rectifier is higher, however, and its overload capacity is less so that here engineering judgment comes into play and the rectifier usually selected is one which will handle an overload of several times full scale value.

The data in the curve will thus allow us to lay out the scale for a 1 ma instrument or a very high range voltmeter where the series resistance effectively swamps out the resistance variation of the rectifier and gives a pure current characteristic.

But low voltage instruments, say 10 volts and below, and having a resistance of 10,000 ohms and less, cannot be so treated because the variation in effective resistance of the rectifier is not masked by the series resistance and, accordingly, the current applied to the moving coil of these lower range voltmeters is a function of both the rectifier current ratio and the rectifier resistance. In the practical sense, such voltmeters are hand calibrated against a voltage standard or, if quantities warrant, average data is taken and the scales may then be printed. To show this series resistance effect the scale of a Weston Model 301—1.5 kv instrument is shown in figure 4 in comparison with that of a 1.5 volt instrument and the contraction of the divisions at the left hand end of the scale in the 1.5 volt instrument will be noticed in comparison with the high voltage scale. This difference is due purely to the increasing rectifier resistance at lower a-c currents reducing the d-c current applied to the mechanism.

THE VOLTAGE DOUBLING METHOD

The customary method of measuring the resistance of rectifier instruments, known as the "voltage doubling method" might be explained here. It was the method used in early experiments and has been standardized in

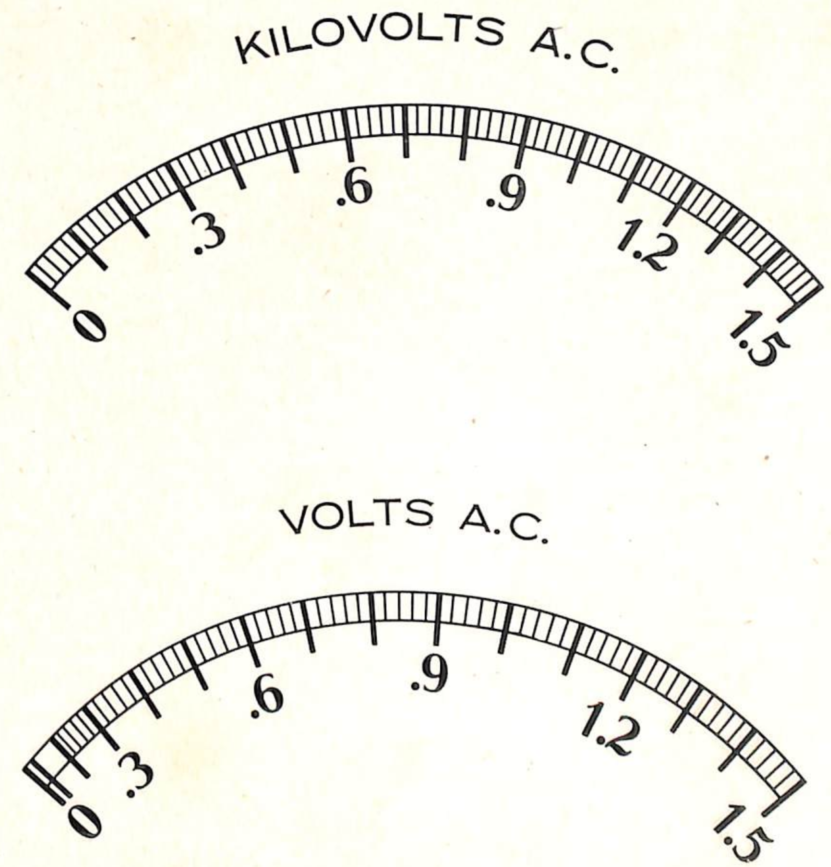


FIGURE 4—*Typical High Voltage and Low Voltage Weston Model 301 Rectifier Type Instrument Scales.*

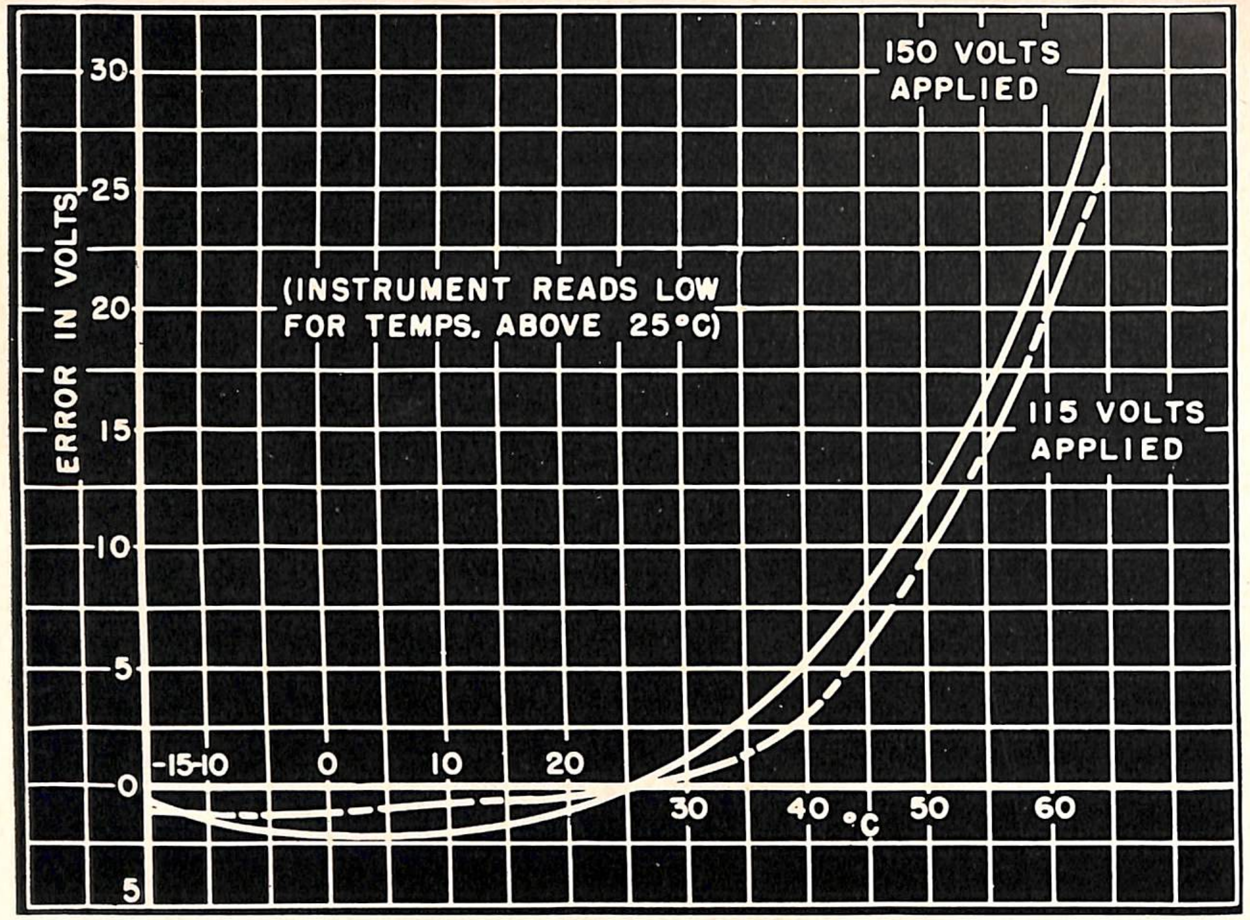


FIGURE 5—*Temperature Errors for Weston Model 301 A-C Rectifier Type Voltmeter, Range 150 Volts, 1000 Ohms per Volt, with 115 Volts and 150 Volts Applied.*

various specifications, such as JAN-I-6. The instrument is placed in parallel with a standard electrodynamometer instrument, a-c voltage applied from a low impedance source such as a variable transformer, and the voltage indicated on the standard recorded for a given deflection on the rectifier type instrument at which the resistance is desired. A decade box is then placed in series with the rectifier instrument and the voltage across the combination as previously measured by the standard electrodynamometer is doubled. The resistance in the decade box is adjusted until the rectifier instrument reading is the same as before. The resistance value indicated on the decade box is then considered as the resistance of the rectifier instrument. Note that this effective resistance will vary with the deflection of the instrument; the resistance of the instrument is usually stated in literature at full scale for voltmeters if not otherwise specified; in db and VU meters it is usually stated at zero level.

Having the instrument presumably calibrated on some definite frequency, say 60 cycles, sine wave, and at some temperature such as 25 C, a discussion of errors appears next in order.

WAVE FORM ERRORS

Wave form errors come into the picture because of the fact that a rectifier instrument reads average value, whereas we normally read a-c in terms of rms value. The instrument is calibrated to indicate the same as a true rms instrument on 60 cycles sine wave. Any harmonic content will cause an error of greater or lesser degree and as an extreme example let us assume a square or rectangular wave which might be produced by commutating the voltage of a battery. Since the wave has a rectangular shape the rms and average values are the same, whereas, on a sine wave basis there is an 11% difference. As a result the rectifier type instrument as normally calibrated will read 11% high on square topped waves or on d.c.

In terms of harmonic content, a third harmonic having a magnitude 30% of the fundamental and in phase with it will cause the indication to be 5% high; if 180° out of phase the instrument will read 14% low. 10% of a fifth harmonic in phase will cause the reading to be about 4% high, whereas, if 180° out of phase, it will be 10% low.

A combination of 30% of third harmonic with 30% fifth harmonic, both in phase, will give a reading 6% high and if both are 180° out of phase the instrument will read 22½% low. Actually these harmonic contents are rather large and the resulting waves very distorted.

On voice frequency and with a completely random distribution of harmonics the error is far less and indications are usually within a few percent of the rms value. Nevertheless, if errors are believed present on a sharply distorted wave, the data given will be representative of what may have occurred, and will indicate the type of problem involved.

FREQUENCY ERRORS

Frequency errors are due to the capacity in shunt with the rectifying layer of the disc and essentially in parallel with the rectifying layer itself. Obviously, at low frequencies the effect of shunt capacity is small, whereas at high frequencies it begins to be important in the overall results. Since the resistance of the rectifier is reduced at higher currents, reduction of frequency errors demands operation of the small rectifier at the highest current density consistent with reasonable overload capacity. Conventional instruments as listed in the catalog may read low as much as ½ of 1% per thousand cycles, but such standard instruments have been designed for a rather high overload capacity and with somewhat less concern as to response at the higher frequencies. On the other hand, for special purposes voltmeters have been designed which are substantially flat up to 30 kc and by minor compensation can be made flat, at least for higher voltage ranges, up to 100 kc. Under still more special conditions it is occasionally possible to design for a frequency as high as 1 Mc and compensate for a band around that frequency. All such designs, however, involve a rather complete knowledge of all of the factors involved and it is usually necessary that they be processed by an instrument designer having data applicable to the problem.

TEMPERATURE EFFECTS LARGE

The effects of temperature on rectifier instruments are, unfortunately, rather large and the results of wide temperature changes are likely to be surprising to one not familiar with rectifier instruments. Very broadly, the rectification efficiency of a copper oxide rectifier drops somewhat as the temperature rises but, at the same time, the resistance also reduces. As a result there is a compensation to a degree since the two effects tend to cancel; both effects, however, vary in degree at different temperatures and the result appears to be always a curve, concave downward, when plotting instrument response against temperature.

The change in ratio of d-c fed to the instrument from the rectifier in terms of the a-c current passed through the rectifier network appears to be involved with the leakage current on the reverse half of the wave and the better the rectifier in terms of leakage, the less change in rectifier efficiency with temperature. Very detailed treatments of the discs are required to maintain the lowest possible leakage current and, in turn, to minimize the temperature effect on ratio.

As to the temperature effect of resistance, this can be minimized by using as thin a copper oxide layer as is reasonable since the series resistance is effectively that of the copper oxide itself and has but little to do with the rectifying layer. However, the copper oxide cannot be allowed to be thinner than certain values as otherwise there would be danger of leakage or complete failure and the necessary result is a compromise between the two factors.

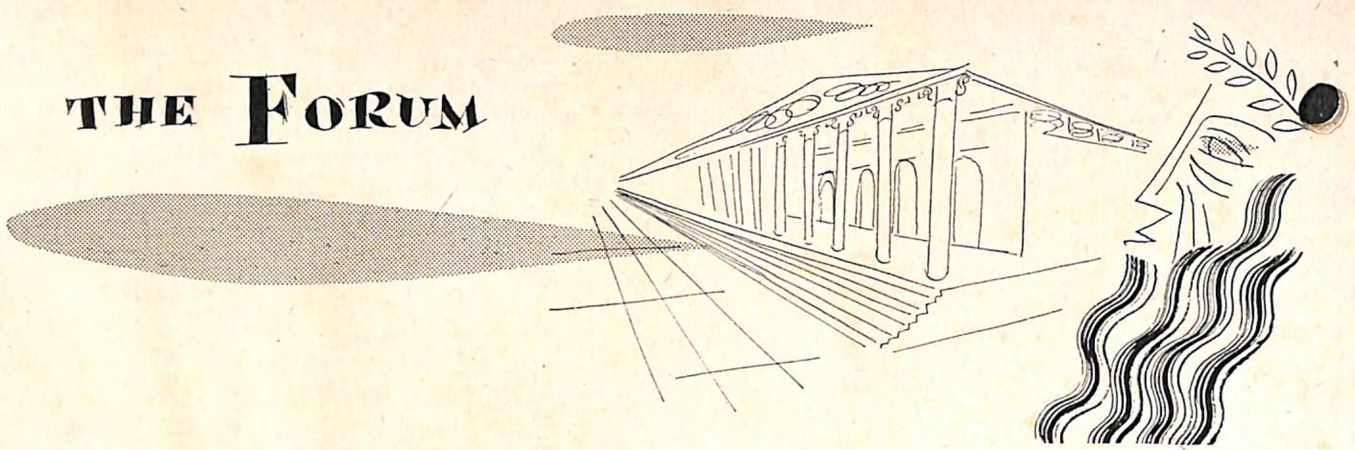
Change in ratio with temperature is important in a milliammeter or microammeter. Change in resistance is important where the instrument is in a low voltage circuit and in low range voltmeters. High range voltmeters, by and large, have sufficient series resistance to swamp out the resistance change of the rectifier unit and the net effect is that of ratio change only. Figure 5 shows the change in indication of a 150-volt rectifier type, having a sensitivity of 1000 ohms per volt both at full scale and at 115 volts; since the current is different at 115 volts than at full scale the shape of the curve changes and here again we have an indication of the complexity of the situation whereby we must necessarily analyze every factor if we are to have full knowledge of the expected results.

SUMMARY

Summarizing the error picture we have the three important effects: (a)—wave form errors, (b)—frequency errors, and (c)—temperature errors.

In the last analysis, these errors appear to be the inevitable price paid for the very much higher sensitivity in terms of current and power which we obtain in the rectifier instrument as opposed to the iron vane or thermocouple types. Fortunately, in communications we are more interested in the average level, our temperature does not vary widely, and the wave form is sufficiently random to be suitably summed so that this type of instrument is very useful where the low energy taken from the system is of paramount importance. Rectifier instruments should be applied to systems with intelligence, however, and with a knowledge that some errors may result. In general, if a watt or so is available the conventional iron vane or thermocouple types would be preferred because of their lesser errors and the rectifier type should be used only when the very small extraction of current from the system measured is more important than the errors which arise.

THE FORUM



BOOBY TRAP

James H. Whitley, ETM1c, USS Virgo

We were troubled with fuses blowing in the d-c line feeding a 4-kva motor generator furnishing a-c power to an SG-1 radar. The MG would run nicely for an indefinite length of time with no detectable signs of overload or faulty operation. Then one of the line fuses would blow for no apparent reason, except that it occurred only when the generator was supplying power to the radar. This led to the assumption that the radar was at fault. All power circuits and wiring were checked and inspected and were found to be in order. The generator and all primary wiring were given Megger tests.

The clue that led to the solution of the trouble, however, was almost overlooked. It was noted that it was always the same line fuse that went out—that is, the one in the same position in the fuse block. Inspection of the block revealed that one set of clips was badly corroded and burned, and that the fuses were being blown by the heat developed at the poor connection rather than by excess current. Replacement of the defective clips, and cleaning and tightening all the remaining fuse clips, completely cured all our fuse troubles.

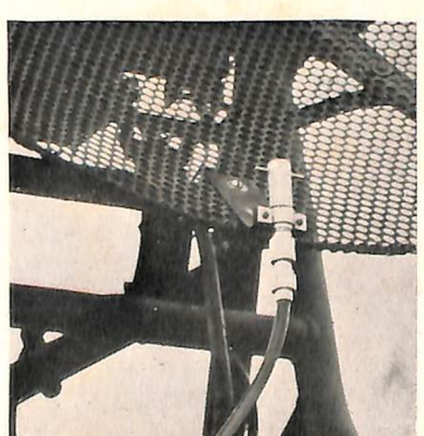
OBU WITH MARK 28

Contributed by the USS Boxer

In order to make checks on the operation of the Mark 28 receivers on this ship the possibility of using the OBU for testing ring time was investigated. It was immediately apparent that if the OBU were to be used on all the Mark 28 equipments, some sort of detachable mounting assembly for the test dipole was necessary. Mounting of the dipole on the edge of the dish gave a good ringing time which varied inappreciably as the dipole was moved several inches from its mounting position in any of several directions. Thus the dipole could be removed and replaced without danger of changing the coupling conditions. A clamp was made to be used with the dipole as shown in figure 1.

To obtain a good reading on the OBU meter, the crystal coupling in the OBU was adjusted to maximum. In operation the OBU was used conventionally; the tuning was adjusted for maximum meter reading and the ringing time was measured at the main frame. Since the lobing was on, the ringing time had a fuzzy trailing edge but the point of maximum ringing time was clearly defined. This resulted in a good check on the receiver and a fairly good check on the transmitter; however, the latter was subject to variations in the crystal of the meter circuit. Ringing times from 3000 to 4000 yards and meter readings from 0.3 to 0.6 were obtained with the set operating normally.

FIGURE 1 — *Test dipole mounted on Mark 28 dish. Note method of making and mounting holding clamp.*



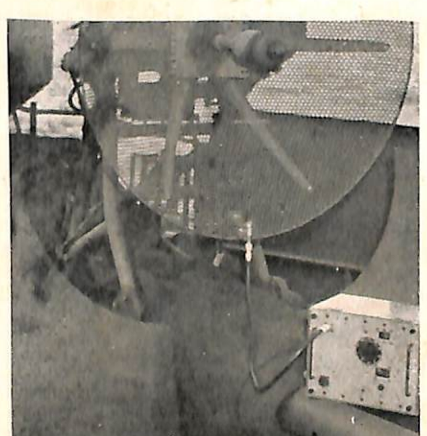


FIGURE 2 — *Hookup of OBU echo box to test dipole mounted on Mark 28 dish.*

Silent TUNE-UP

■ CNO reports that considerable confusion is being caused on the 4235 (NERK) series by tuning of transmitters, allowing the transmissions to go on the air rather than using a dummy load or other suitable means. Very few ETM's in the fleet today, particularly those in the lower rates, have had the opportunity or have been required to stand watches on radio operating circuits. For this reason they do not appreciate the troubles and problems encountered by an operator when trying to copy a station with a weak signal or through interference. Radio operating through interference caused by nature can be very trying on the patience of the operators, but when additional interference is created by some man-made contrivance it becomes increasingly irritating. One of the most flagrant violations in the matter of man-made interference is the tuning of transmitters on a frequency that is being used, thus breaking up any operation on that frequency.

The Radio Matériel School, Bellevue, D. C. has devised a method of tuning all the stages of a standard communication transmitter without the necessity for radiation from the antenna, and it is offered here for information. The system does not require any apparatus other than that already provided aboard ship.

Warning: Personnel are cautioned to exercise safety precautions and good judgment in carrying out the steps described in the following paragraphs.

With all antennas grounded and trunk openings in the radio room sealed off, adjustment of the master oscillator and intermediate power amplifier stages to the correct frequency and resonance can be checked with the transmitter in operation. At the same time the power amplifier stage may be resonated, although antenna tuning and coupling adjustments may subsequently require readjustment. The transmitter is then shut down and the antenna connected in the normal manner.

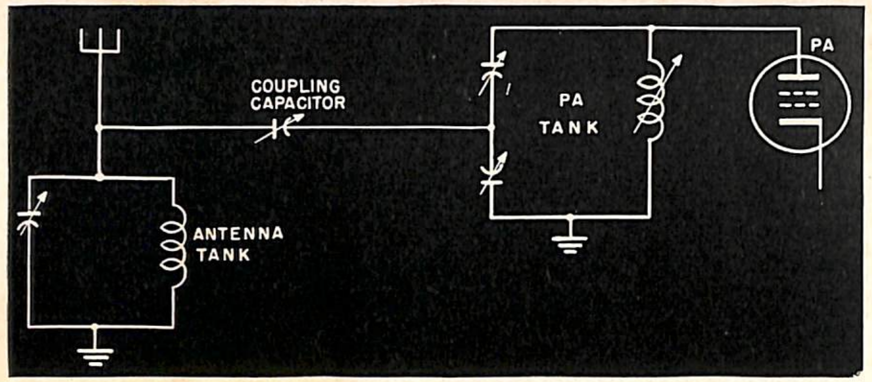


FIGURE 1—*Typical antenna circuit as used in communication transmitters.*

Adjustment of the antenna circuits to resonance and determination of the proper coupling is accomplished by utilizing the static noise picked up by the antenna. A receiver tuned to the desired output frequency and lightly coupled to the transmitter power amplifier tube plate is employed to measure the noise level reaching this point. The noise level is indicated by the receiver input meter or, in the case of older equipment, by a suitable audio output voltmeter connected to the receiver output. Circuit resonance is obtained by using the transmitter output circuits to produce maximum noise output from the receiver. Proper antenna coupling may be determined by adjusting the antenna coupling and tuning controls until the receiver audio output voltage drops to about one-half when a resistor equal to the load resistance required by the power output tube is connected from the power amplifier plate to ground.

The theory of operation can best be explained with the aid of an actual antenna circuit and its equivalent circuit as shown in figures 1 and 2. By tuning the antenna circuit to resonance at the desired frequency, the simplified circuit shown in figure 3 is obtained, where R_1 is a function of R_a and the ratio of L to C in the tuned circuit. E_1 is the noise voltage at the desired frequency.

When the power amplifier tank circuit is tuned to resonance, the circuit simplifies to a resistance R_2 in series with the noise voltage E_2 as shown in figure 4. Note that R_2 and E_2 are both dependent on R_1, E_1, and the coupling capacitor.

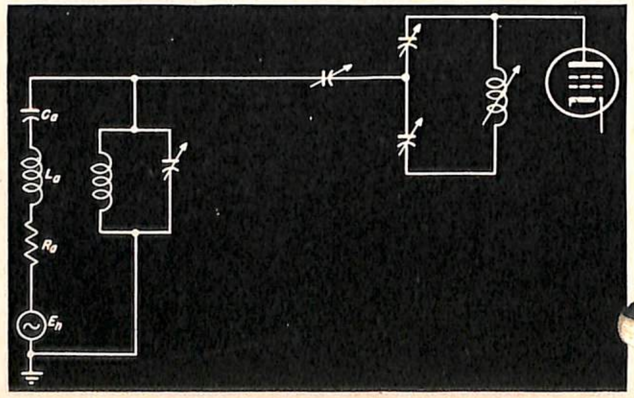
With the equipment operating normally as a transmitter, the antenna reflects the proper resistance R_2 to the tube to provide proper power-amplifier loading. If it is assumed that the proper resistance is R_L *and is known,* then the correct adjustment of the antenna tuning and coupling circuits which will make R_2 equal to R_L (figure 5) can be determined in the following manner. With the switch *S* open and the receiver tuned to the proper frequency, the gain control is adjusted to give a convenient value of noise voltage. Closing switch *S* should now give a value one-half the previous reading if R_L equals R_2. If the second reading is greater than one-half, then R_2 is less than R_L and the coupling must be decreased.

The limitations of this method should be realized. For instance, when the noise level fluctuates intermittently it will be hard to make adjustments because of the unreliability of the output voltage readings from the receiver for various adjustments made during the procedure. However, antenna resonance can be quickly obtained and the degree of coupling between the antenna and power amplifier tank can be approximated. Even if full power output is not obtained when the transmitter is used, sufficient power will be radiated, in all probability, to accomplish the desired communication.

QUIPMENT REQUIRED

A good receiver with a shielded antenna lead, a small toggle switch, coupling capacitor, and a half-watt carbon resistor are all that is required. If the receiver has no signal-input or audio-output meter, a fairly high-impedance 1- or 2-volt a-c voltmeter will also be required. The receiver must naturally cover the range of the transmitter. On the lower frequencies the length of the antenna lead is unimportant; however, above 10 Mc the length should be kept to four or five feet or less so that it does not approach a quarter wavelength. The coupling capacitor is connected as shown in figure 6. This prevents the capacity of the shielded line from detuning the power amplifier circuit. On the high frequencies, 2 to 18 Mc, sufficient coupling may be obtained by twisting an inch or so of insulated wire around the power amplifier plate lead, while at the low frequencies, 175 to 600 kc, more capacity may be required, such as a small 50- or 100μμf mica capacitor. The coupling arrangement should be made so that it can be easily connected and disconnected. It is also important to have it arranged so that it is impossible to operate the transmitter with the receiver and resistor attached. It might be mentioned that it is necessary to hear the output of the receiver as well as to see an indication of the noise voltage produced.

FIGURE 2—*Equivalent circuit of the antenna system shown in figure 1.*



Determination of the correct value of R_L (figure 5) to use with any particular transmitter can be best accomplished when conditions permit operation of the transmitter into an actual antenna. If this course is not permissible, a determination can be made if the transmitter can be fed into a dummy antenna, or if a careful calibration of the transmitter with its antenna is available for any frequency. The values in the following table can be used if time and circumstances do not permit an individual check on the ship's transmitters.

TBK (Westinghouse	5000 ohms
TAJ (Westinghouse)	5000 ohms
TBL-4 (RCA)	2800 ohms
TAQ-5 (GE)	1000 ohms
TCK (GE)	2200 ohms

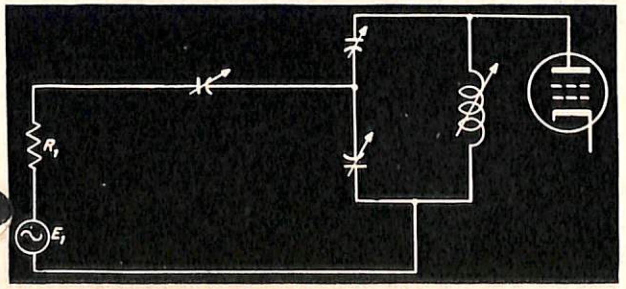
In those instances where emission of power is permissible the proper value of resistance for R_L can be determined as follows:

1—Tune the transmitter to any frequency and load the power amplifier to the proper value.

2—Tune the receiver to the frequency of the transmitter.

3—Shut down the transmitter and couple the receiver to the power amplifier stage as described in the preceding paragraphs.

FIGURE 3—*Equivalent of circuit shown in figure 2 when the antenna is tuned to resonance.*



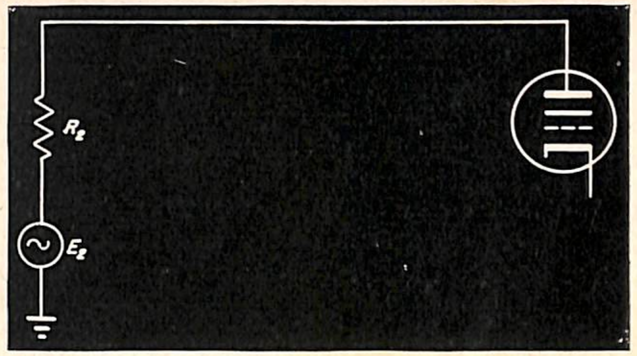


FIGURE 4—*Same circuit as shown in figure 3 but with the tank circuit tuned to resonance.*

4—Try connecting different values of resistance from the power amplifier plate to ground until the audio noise voltage obtained with the resistor is one-half of that obtained without it.

Step 4 can be accomplished with greater ease and accuracy if a signal generator (such as a model LP) is tuned to the same frequency and connected to a wire near the antenna. This produces a steady MCW signal to work with rather than the more erratic static noise.

In those cases where emission is not permissible, the transmitter may be set to any previously calibrated frequency and steps 2 to 4 of the preceding instructions followed. The LP, of course, cannot be employed under these conditions.

TUNING THE TBK WITHOUT RADIATING

1—With all antennas entering the transmitter room grounded and all trunks closed, start up the transmitter and tune all stages, including the power amplifier, to resonance.

2—Tune a receiver of approved low oscillator radiation to the transmitter output frequency, being careful not to damage the receiver. Connect an audio voltmeter with about a 1- or 2-volt range to the output of the receiver, or use the receiver's input meter or output meter.

3—Shut down the transmitter and reconnect the antenna.

4—Make sure that the voltage is actually removed from the power amplifier by using a discharge probe, shorting it to ground momentarily. Couple the receiver to the power amplifier tube plate by wrapping two or three turns of insulated wire around the plate lead. A more permanent method of coupling can be devised when time permits so that the receiver may be readily attached or disconnected. The receiver antenna lead should be a four- or five-foot length of shielded wire.

5—If calibrations are available for the transmitter with the particular antenna, set the antenna controls to the positions indicated for the nearest frequency. If no calibration is available for a frequency reasonably close, set the coupling control at mid-scale and proceed.

6—With the receiver AVC off, tune the power amplifier tank circuit until maximum noise output is obtained from the receiver. The correct point is usually quite sharp.

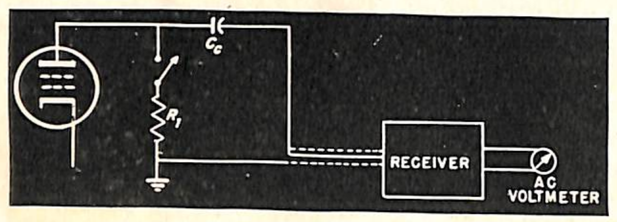


FIGURE 5—*Method of connecting receiver and an external output meter for tuning.*

7—Connect R_1 from the plate of the power amplifier tube to ground. Then adjust the antenna tuning circuit for maximum noise. The correct point may not be sharp and will require later adjustment. Do not change the coupling adjustment.

8—Remove R_L and adjust the receiver sensitivity to give an output of one volt or some other convenient value on the signal indicating meter.

9—Connect R_L from the plate of the power amplifier tube to ground and note the receiver output voltage. If it is near one-half the first value the loading is approximately correct. Care should be taken in obtaining the reading to get the average noise voltage and not the peaks.

10—Finer tuning of the antenna circuit can now be obtained by shifting the antenna tuning dial a few divisions in one direction and repeating steps 8 and 9. If the ratio of voltage increases over that previously obtained, try a few more divisions and repeat the process until a maximum ratio of "voltage with R_L in" to "voltage with R_L out" is obtained.

11—If the final ratio of step 10 is greater than 0.5 (or a previously determined value), the coupling is too tight and should be decreased. If the ratio is less than 0.5, the coupling should be increased.

12—If the coupling is changed appreciably, repeat steps 6 through 10 until the final ratio of voltage is correct.

13—Since the possibility exists that exact resonance will not be attained and the power amplifier may overload when an attempt is made to put the transmitter on the air, it is suggested that the power amplifier plate voltage be decreased about 25% to preclude operation of the overload relay. Any necessary trimming adjustments can be rapidly made and the power increased to normal during the first few moments of operation.

Reference to the transmitter instruction book should be made in the case of all intermediate-frequency equipments to determine whether the power amplifier is adjusted for maximum output as a final step. On most transmitters in the 175-600 kc range, this is not the case and the power amplifier tank should not be retuned after setting it to initial resonance. Whichever the procedure, the instructions should be followed in making the adjustments with the receiver. Since the intermediate-frequency equipments such as the TAJ or TAQ work only with capacitive antennas, the antenna tuning and coupling system is considerably simpler and rapid adjustment is possible. With any transmitter, care should be taken to follow step 10 of the above procedure very closely since the correct resonance point of the antenna circuit cannot be determined by step 7 alone. Since the final result depends upon the receiver output being proportional to the applied static voltage, it is important that overload of the receiver be avoided.

Considerable improvement in accuracy can be obtained after a few trials; therefore it is suggested that personnel take every opportunity to practice the procedure when

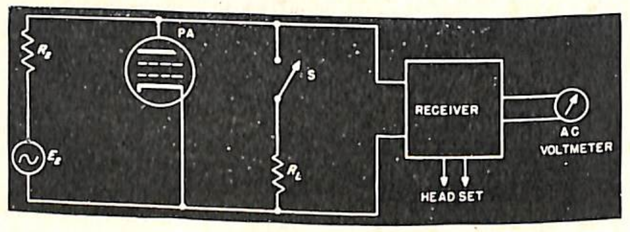


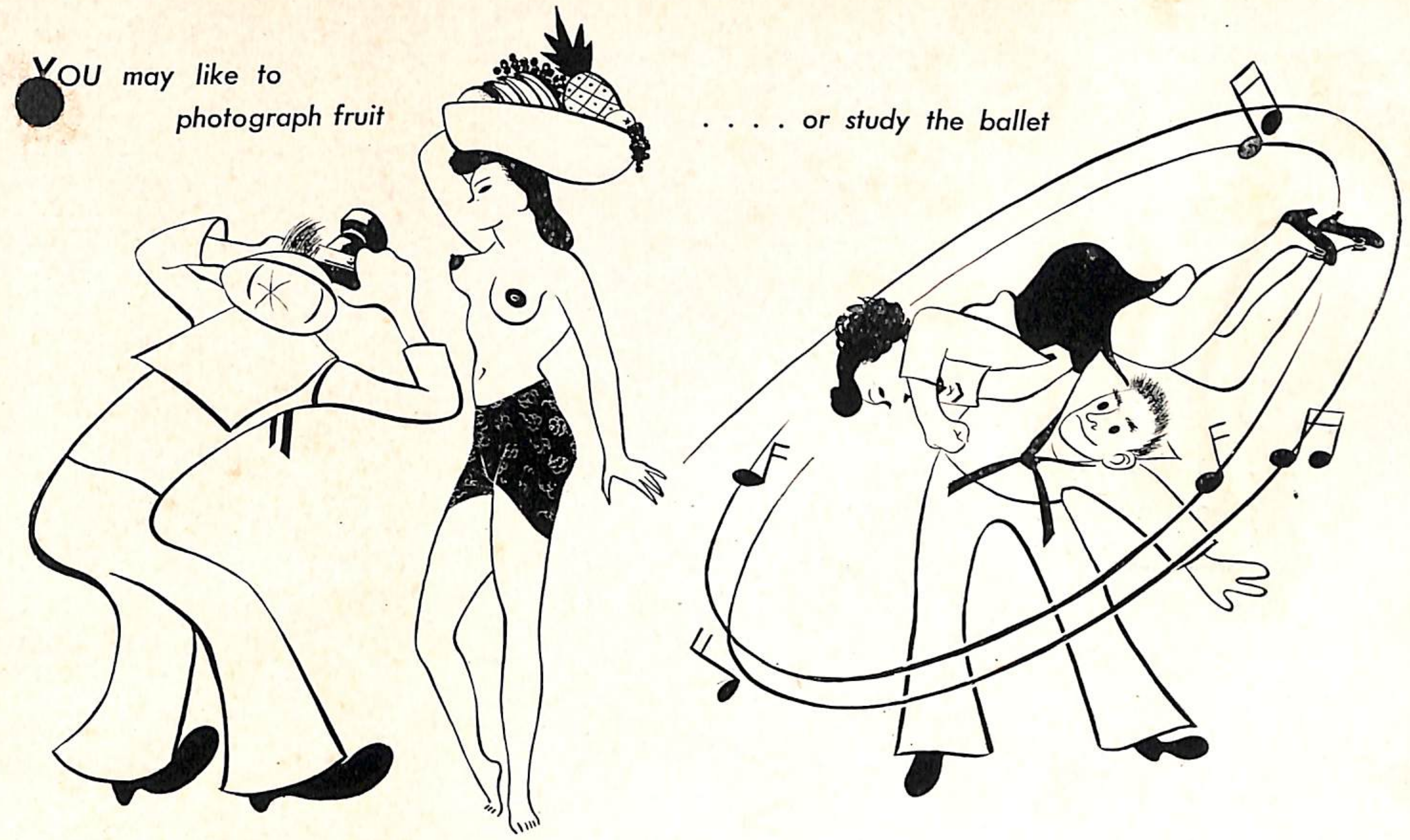
FIGURE 6—*Addition of an isolating capacitor to figure 5, and ultimate connections of receiver for use.*

conditions permit operation of the transmitter to check the results.

This article is an enlargement of a similar article which appeared last year in the Communication Equipment Maintenance Bulletin.

Bureau Comment: The necessity for having a method of tuning transmitters without radiating a signal on the air is urgent. The procedure offered above is one method of accomplishing this, but it is not necessarily the best. Suggestions and ideas concerning this problem will be welcomed by the Bureau. Correspondence should be addressed to the Bureau of Ships, Code 980.

YOU may like to photograph fruit *. . . . or study the ballet*



HOBBIES ARE A GOOD IDEA

. . . . or make new contacts

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