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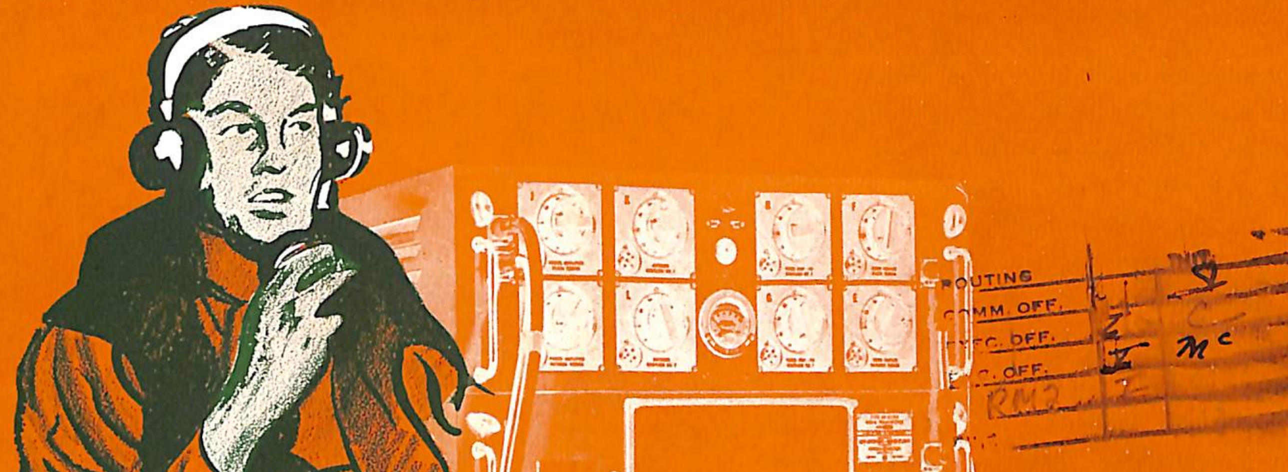

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IN THIS ISSUE

SHIPBOARD UHF CAN WORK

BUSHIPS
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VOLUME 6

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THIS ISSUE

BACK COVER:

In spite of man's need from early times to communicate on the field of battle, for countless years we see little sign of any attempt at control by signal. We learn in "The Song of Roland" how, during the war between Charlemagne and the Saracenes, as Charlemagne marched north out of Spain he heard the horn of Roland, one of his lieutenants, blown for help in the mountains behind him; how he heard the signal twice; misread it; grasped its meaning the third time; but turned back too late to save Roland.

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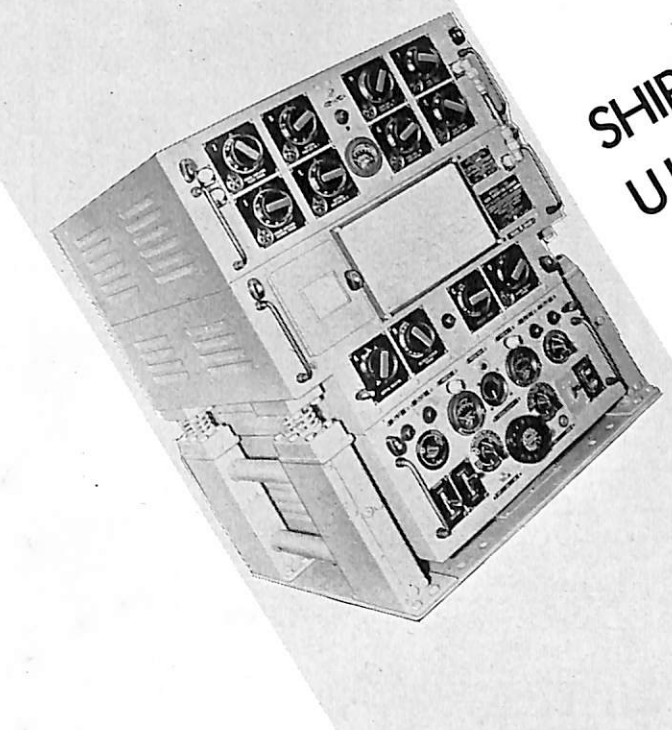


SHIPBOARD UHF CAN WORK

by
H. W. Wolff,
U. S. Navy Electronics Laboratory
San Diego, California

"The TDZ is no good. Give it the deep 6!" How many times have you heard those words? How many times have you said them yourself? Before deciding to use our TDZ's for small boat anchors, let's see whether application of a little common sense will save Uncle's investment of $10,000 in each transmitter.

In order to protect that investment, we shall have to be able to make the TDZ and the rest of the *u-h-f system* work, and keep it working. How can we tell when the u-h-f equipment is functioning properly?

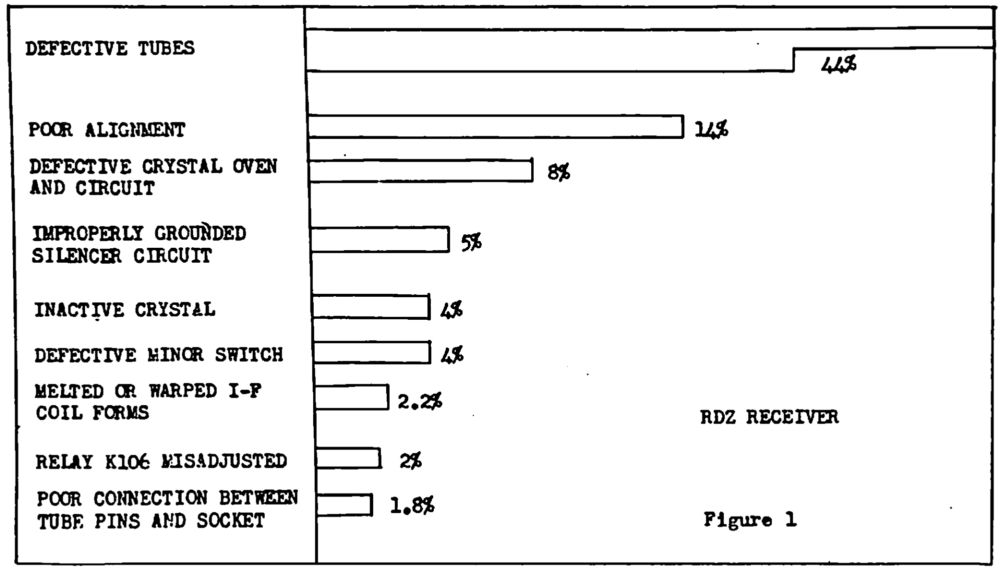
First, in order to see whether the u-h-f system is satisfactory, we must know what to expect as a reasonable range of communications for the type of ship concerned. Originally, CNO specified a u-h-f range of 25 miles or line of sight, whichever was less. As a result of a lot of hard work and to the disappointment of many, it was found that communication over that specified distance can not be accomplished under normal atmospheric conditions.

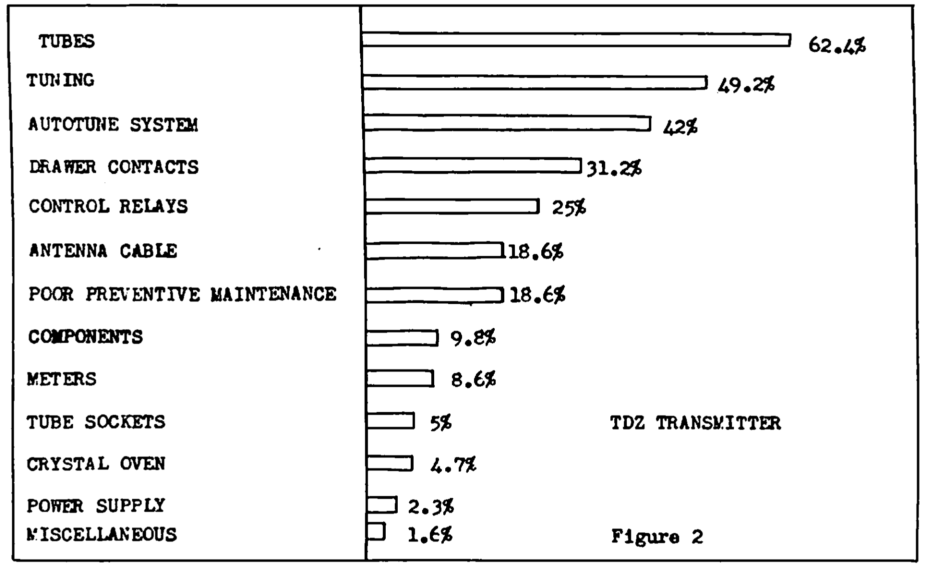
Then, we ask, what should we be able to do? The Naval Research Laboratory ran some shipboard tests to see whether calculated expected ranges could be achieved. In general, they found that 60% of line of sight is the maximum range which can be expected even when all equipment is in the best operating condition. This does not mean that on a few occasions, we will not achieve very long ranges. These occasions are usually caused by atmospheric "temperature inversions" during which a layer of moist, warm air lies over a cool layer of air at the sea's surface. This condition forms a "duct" which can extend range many times the normal value.

In a recent issue of Electron (Sept., 1950) a list was given of ranges considered acceptable for u-h-f performance. These vary from 8 miles between small landing craft or patrol craft, to 18 miles between large combatant class vessels.

However, in order to achieve maximum range consistently there are several things we'll have to consider. We have become used to being careful on h-f circuits because of our long association with them. However, u-h-f is relatively new to the communicator, and a few extra pitfalls have been found.

A condition that was found in one ship is practically guaranteed to prevent u-h-f operation. The compart-





FIGURES 1 and 2—Percentage of system failures caused by items indicated. (Based on 144 reports of troubles in systems).

ment in which the RDZ's and TDZ's were located had its door closed, ventilator shut off, and the steam heat turned on. The temperature in the compartment was about 140°F! This high ambient temperature, if the equipment had been operating, would probably have melted the RDZ i-f coil forms. In your ship be sure that adequate ventilation is provided to keep temperatures of equipment within safe limits.

Hundreds of reports of u-h-f failure have been investigated. One of the things which has come to light is the number of times a supposedly competent ET misses checking for bad tubes in the r-f stages of the RDZ. Many cases of 1000-microvolt (or worse) sensitivity have been found, where no action had been taken by shipboard personnel to remedy the trouble. *You can't work a u-h-f circuit with bad tubes in the receiver.*

Other troubles with the RDZ are the same that would be expected in any receiver. Figure 1 shows how a large group of failures found aboard ships fell into a few classes. From this simple chart you can see that it is usually not necessary to exert too much effort to keep your RDZ going.

Figure 2 shows the story for the TDZ. This set is a complicated piece of gear, and a lot of things can happen to it. However, *with a few precautions*, good service can be had from it. The percentages on this chart add to more than 100% since many equipments had more than one fault, and all faults are listed. The first three, and largest, of the items listed can be largely avoided *if you are careful*, and follow these instructions:

1—Tune carefully, using CEMB procedure and your ME–11 wattmeter. *Never* allow the total grid currents of the third tripler or final amplifier to exceed 50 milliamperes, *and*, do not allow their plate currents to exceed 125 milliamperes at any time.

2—Dial channels *at the transmitter* and peak the output by careful adjustment of dials "B" and "C." Be sure the rest of the dials correspond to their proper logged readings. *Do not change channels remotely.*

Limiting the plate and grid currents will result in a slightly lower output, but your 2C39 tubes at about $25 per copy are worth saving. Following these instructions should give about 20 watts out of the transmitter as well as many weeks of tube life.

Well, we now have a good receiver, a transmitter putting out 20 watts, so there's no doubt that the reason we can't raise that LST 5 miles to port is that he's asleep. Or is he? *A transmitter and a receiver do not in themselves comprise a communication system!* What about our transmission lines? Do we have good antennas on transmitter and receiver? Are we trying to communicate with a ship who is in a null of our radiation pattern? There are a lot of links to this chain. The failure of any one means a complete loss of use of the system.

Aboard many ships u-h-f transmission lines have been installed with RG–10/U cable with consequent loss in power efficiency. If that is what your ship has, let the skipper know about it, and have it changed to the larger sized RG–18/U the next time you go into a yard for overhaul. This applies to receivers as well as transmitters. Checks of your transmission lines to determine whether they are shorted or open circuited will pay big dividends. Sharp bends or clamp pinches can short out the r-f cable, and no power will get to the antenna.

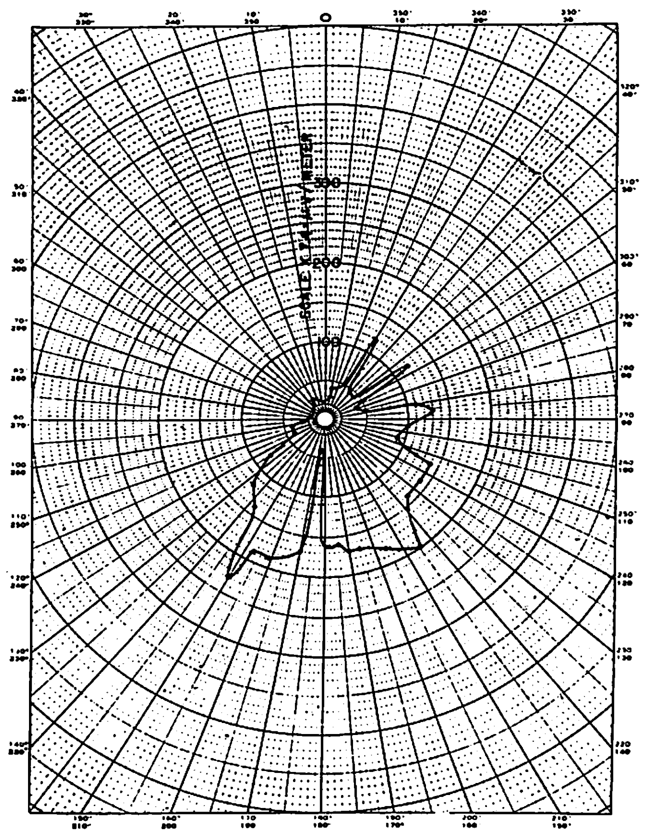


FIGURE 3—Pattern of *USS Peregrine* Starboard No. 2 Antenna at 328.2 Mc.

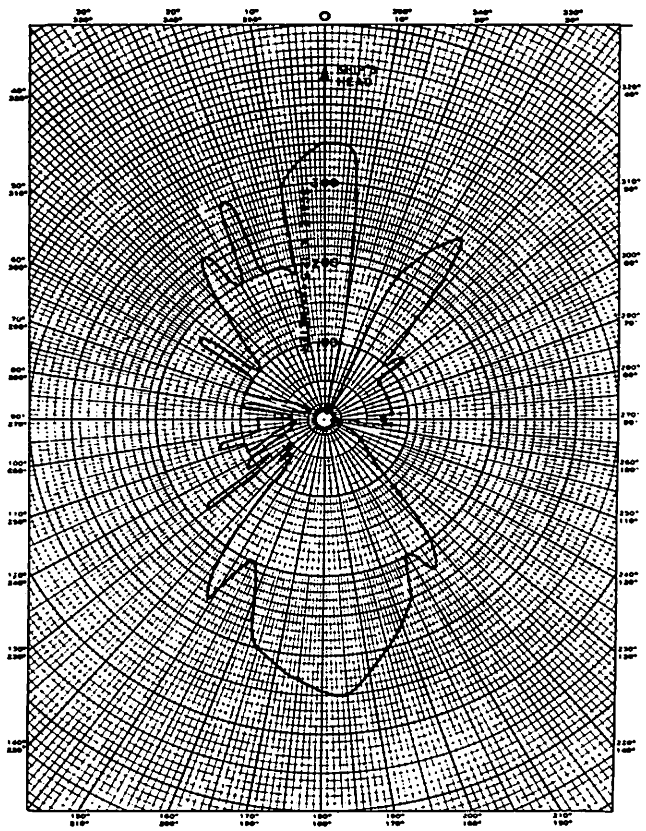


FIGURE 4—Pattern of *USS Adirondack* Antenna No. 5 (Port TDZ From Radio IV) at 285.0 Mc.

Many u-h-f failures are caused by the antenna itself. If your antenna is full of water, or if its insulator is painted, it will not work. In certain cases, enterprising installation mechanics have had a flash of originality and placed the u-h-f dipoles horizontally. If this condition exists on your ship, you are entitled to blow your top, and then rotate the dipoles 90 degrees. Vertically polarized radiation is used for all u-h-f communication in the Navy, and antennas must be vertical.

The antenna presently provided for u-h-f use has a few undesirable features. At the time it was developed, it was the best that existing experience could provide. Since then, two new antennas have been developed and are being procured. These are the AT–150/SRC and AT–390/SRC. As soon as supplies are available, these antennas will be placed on all ships. These new antennas

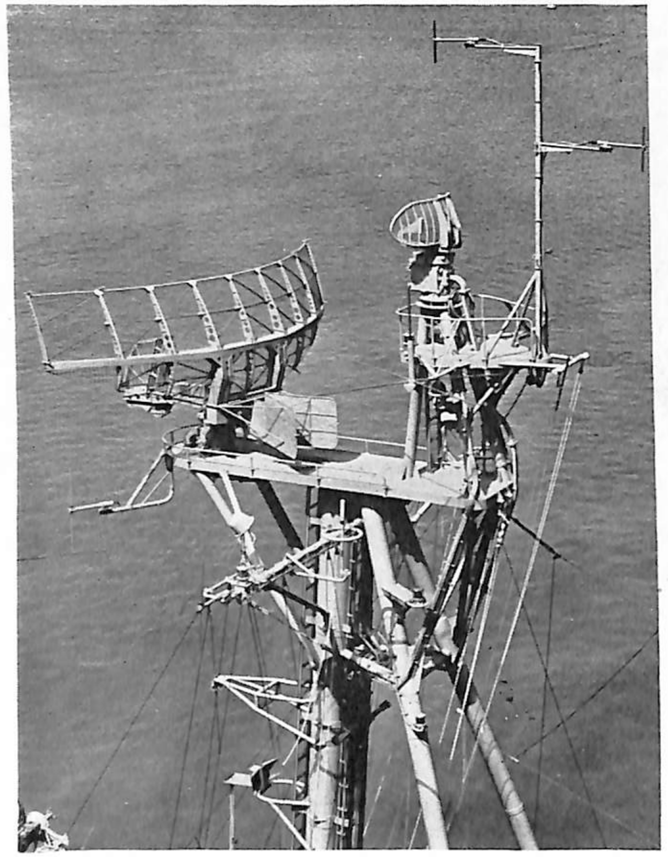


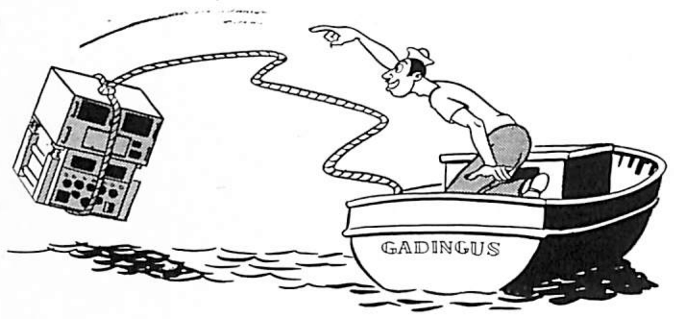
FIGURE 5—Installation on the *USS Hamner (DD–718).*

offer a much better impedance match to the transmission line throughout the band; the power transfer and efficiency of the entire system is therefore improved. By reducing transmission line sheath current, they also produce a much more uniform radiation pattern. That is, patterns more nearly approach ideal circularity throughout the 225 Mc to 400 Mc band than those of the presently used antenna.

However, *having* a good antenna is not enough. It must be mounted in a location that permits it to radiate uniformly. Take a look at Figure 3. Can you imagine yourself aboard the *Peregrine,* and trying to communicate with a ship lying 10 miles off your port bow? Or if you are in column, how about trying to raise the lead ship? Not much chance if you use Starboard Antenna No. 2, is there? The same kind of a situation exists in the *Adirondack,* Figure 4. Here it is not quite so bad, except where the radiation goes to zero at 20° and 105°.

Unfortunately this condition is found on most ships in the fleet. This is probably one of the major faults in the system, and one which has made many people dislike it. In many ships this condition is being alleviated by relocating u-h-f antennas so that they can be in the clear. Figures 5 and 6 are photographs of u-h-f antenna installations on the *Wiltsie* and the *Hamner.* Here, mast extensions permit the u-h-f antennas to look over the top radar, yet they do not spoil the radar display. Figures 7 and 8 reveal what a difference this type of installation means in antenna patterns. These patterns are not directly comparable with those of Figures 5 and 6, since decibels were used instead of a linear microvolt scale. However, it is easily seen that no deep minima exist.

These installations are still not ideal. Locating several u-h-f antennas in one place causes them to interfere with each other. A method has been developed which provides one antenna for use with several transmitters and receivers. The device which permits this is called a 'multicoupler". How soon this device will be available to the fleet is not yet known, as it is still in the development stage. When it does come into general use, topside will look a little less like a porcupine. Until then, we shall have to get the best out of the present system.



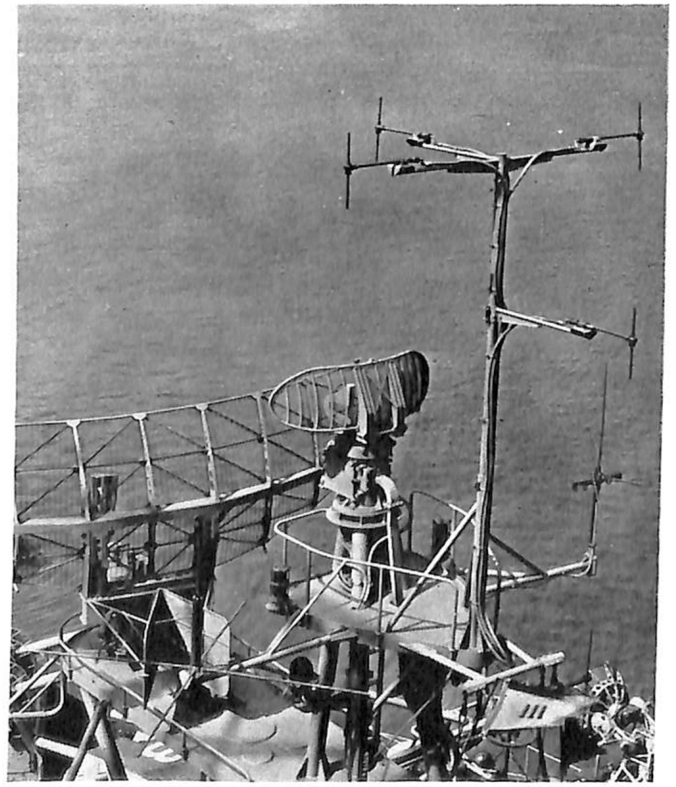


FIGURE 6—Installation on the *USS Wiltsie (DD–716).*

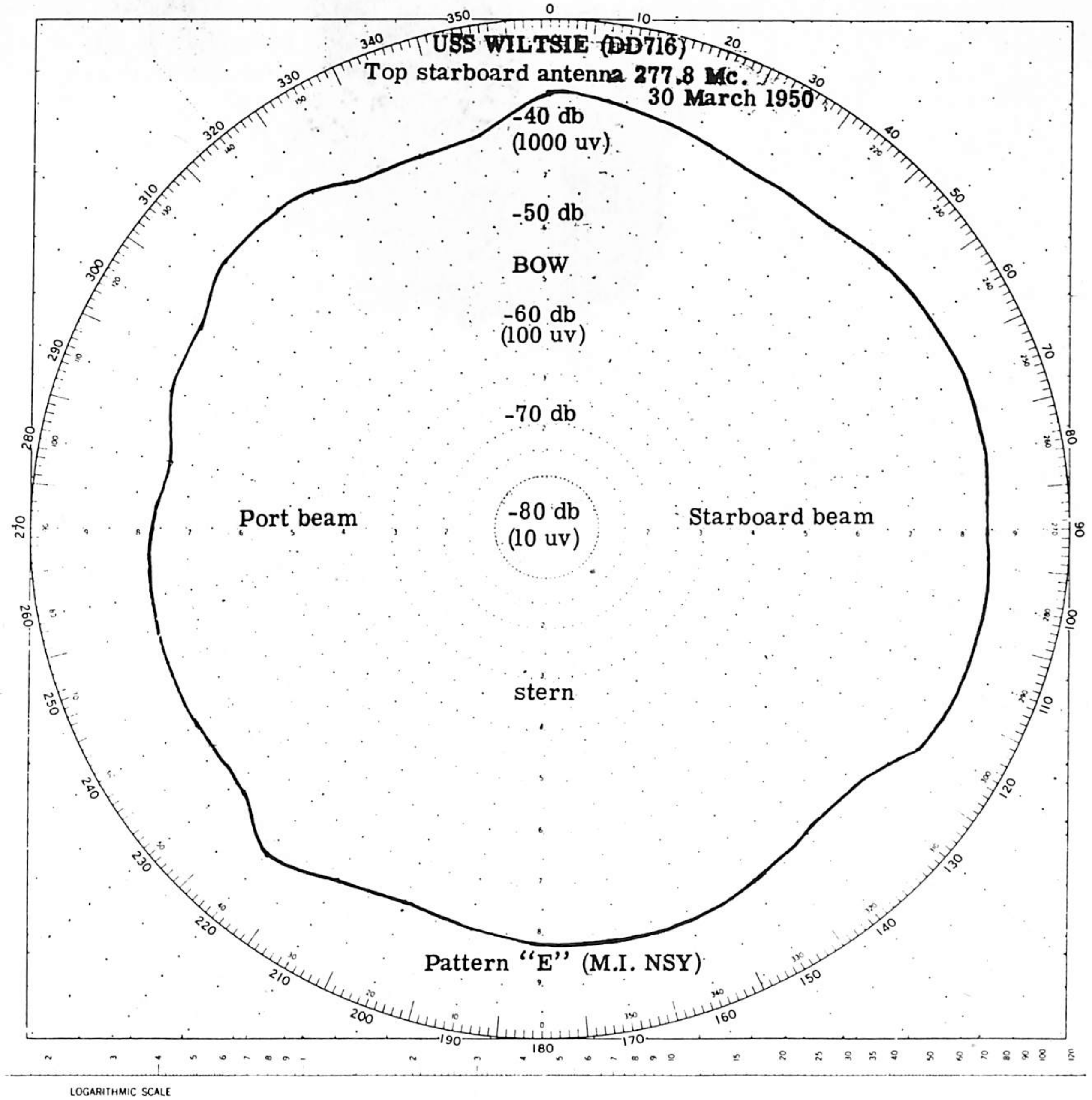


FIGURE 7—Antenna pattern from *USS Wiltsie (DD–716),* top, starboard antenna, 277.8 Mc.

It will pay to have good u-h-f performance. Using new teletype auxiliary equipment such as the AN/SGC–1, the system offers a fast method of transmitting large volumes of information without a lot of human errors creeping in. During the "Portex' operation, reams of fire control data were transmitted by teletype over the u-h-f. According to those who used it, no other method could have accomplished the job so well.

Ships in which the "bugs" have been conquered are enthusiastic about u-h-f. This enthusiasm comes from experience. The more the system is used, the better it becomes. In ships where the use of u-h-f is required for the primary tactical circuit, excellent results are being achieved. In other vessels where u-h-f is used only for

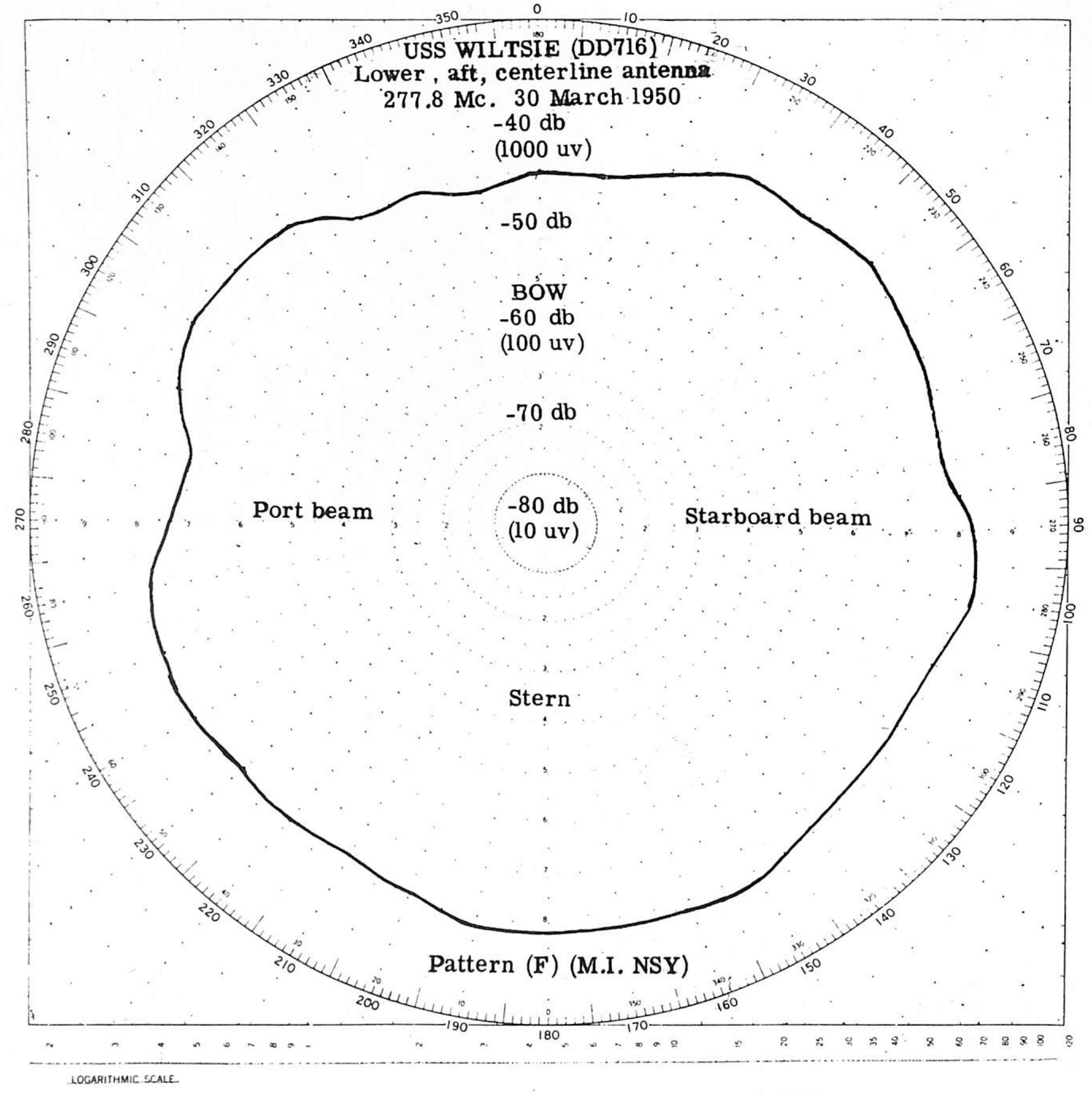


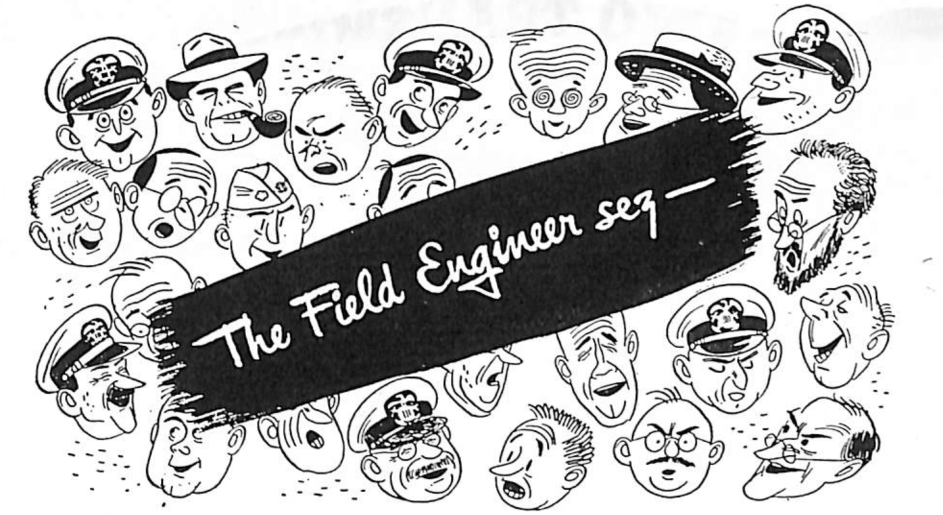
FIGURE 8—Antenna pattern from the *USS Wiltsie (DD–716)*, lower, aft centerline antenna, 277.8 Mc.

auxiliary circuits, generally poor results are reported. The penguin did not use his wings—now he can't fly. Does this apply to *you* and *your* u-h-f system?

Bureau Comment—The material contained in this article is based on the findings of the author while engaged in a u-h-f systems improvement study at N.E.L. for the Bureau. The opinions expressed therein are those of the author and do not necessarily express the official attitude or policies of the Bureau.

The antenna multicouplers mentioned by Mr. Wolff are expected to be available sometime during the fall of 1951.

The Editor of ELECTRON is pleased with your response to "Letters to the Editor." Keep YOUR problems rolling in—we will try to solve them.



MODEL QCS

U.S.S. Hemminger (DE–746)

The QCS transducer was hunting and creeping. The creeping was corrected by balancing the 2A3 electron tubes in the amplidyne control unit. To correct the hunting, a 15,000-ohm, 2-watt carbon resistor was placed in series with the phase shifting capacitor C–803 in the amplidyne control unit.

—N. D. Laster, *Fifth Naval District*

MODEL QDA

U.S.S. Philip (DDE–498)

It was reported that there was no output from the QDA driver amplifier. The trouble was traced to a short circuit in the shielded output leads from the power amplifier output transformer T–1002 to Terminals 18 and 19 of terminal strip E–1002. The trouble was corrected by installing a new shielded pair for this connection; the balanced output to the dummy load after repair was made was normal.

The tilt control thumbwheel on the QDA console was binding and difficult to turn. Investigation revealed metal filings in the gear train connecting the thumbwheel with the ID's. Cleaning the gear train of the filings corrected this difficulty.

A loose spur gear which drives the depth cursor caused the cursor to follow erratically. It was found that the locking washer in use was too small to fit over the shoulder of the synchro shaft and it was therefore impossible to secure the gear to the synchro. Use of a larger lock washer permitted the gear to be firmly locked to the cursor synchro, and restored cursor operation to normal. —N. D. Laster and R. E. Carpenter, *Norfolk Naval Shipyard*

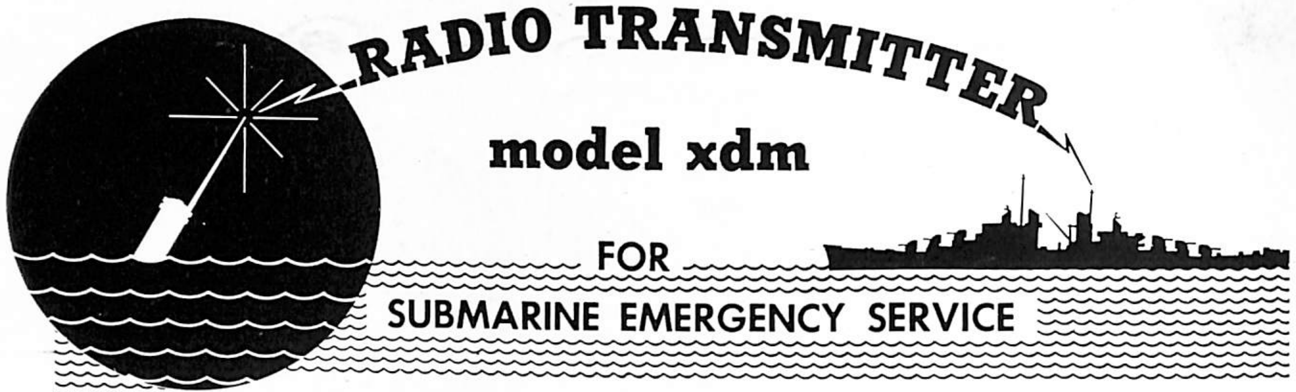
MODEL QHB-a

U.S.S. Philip (DDE–498)

The main ON–OFF power switch inside the QHB–a console did not remove power from the QHB–a and the data converter. Investigation revealed that the trouble was in the main terminal board in the data converter, where excitation 7GR51 and 7GRR51 was not lifted from Terminals 55 and 56 as shown on altered GR print S7101–664918 Alt. 10N1. At the same time excitation 4GR210 and 4GRR210 was also applied to Terminals 55 and 56 by jumpers from Terminals 68 and 69. Operation was restored to a normal condition by lifting the excitation leads 7GR51 and 7GRR51 to Terminals 55 and 56.

It was noted that the QHB-a audio cursor remained on continuously with the CURSOR TIME switch S–203 thrown in the long position. Relay K–104 (cursor hold) failed to open towards the end of the sweep cycle. The trouble was caused by the transposition of wires between the OKA recorder and the QHB–a console. Terminals 1A35, 1A36 and 1A37 were transposed resulting in loss of 150-volt d-c plate voltage on VR201 (2050 thyratron) in the cursor time extension circuit. Reversal of Leads 35 and 37 restored operation to normal.

The gyro transfer relay K–1203 (CRY 291577-873-902) in the data converter arced to ground when the gyro ON-OFF switch S–109 in the QHB–a console was thrown. This difficulty was eliminated by inserting a sheet of insulating paper around the inside of the relay can. —N. D. Laster, *Norfolk Naval Shipyard*



RADIO TRANSMITTER model xdm FOR SUBMARINE EMERGENCY SERVICE

The Model XDM Radio Transmitting Set, developed by the Naval Research Laboratory for submarine emergency service, was designed to facilitate the location of sunken submarines by enabling ships or aircraft to determine the general vicinity from which sonar and visual search should be initiated. The Model XDM is a self-contained radio transmitting buoy having a cylindrical form and overall dimensions of 3 inches in diameter and 39½ inches in length. The buoy is launched from submerged submarines by means of the 3-inch signal ejector, at any depth up to 1,000 feet. Upon launching, the buoy ascends to the surface, floats in a vertical position, erects its antenna, and automatically transmits pre-determined radio signals on "spot" frequency anywhere within the range of 115 Mc to 145 Mc, to indicate the presence of the submerged submarine. The transmitter was designed to deliver ½ to ¾ watts of telegraphic-keyed mcw r-f power for a period of approximately 3 hours. Provision is made to key the transmitter with certain selected characters by use of a cam system.

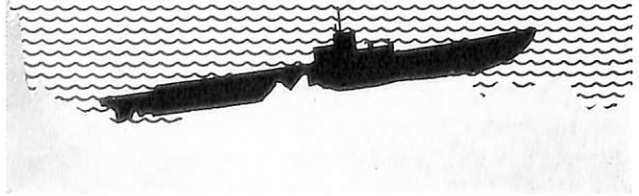
The XDM equipment uses a dry magnesium-silver sea water type of battery. The XDM antenna consists of a folded, tapered, flat 20-inch strip of metal that snaps to its erect position immediately after the buoy is fired from the signal gun.

To discourage surface motion while floating and to keep the cylinder erect the XDM equipment has a lead weight attached to its lower part.

Commander Operational Development Force has recently completed an operational evaluation of the XDM. The results of this evaluation, as reported by COMOPDEVFOR and on which this discussion is based, indicate that the XDM is well suited for its designed purpose and may also have some value in connection with emergency aviation rescue efforts.

For test purposes a Model SCR–624A receiver was used to receive the mcw signals transmitted by the XDM equipment; a Noise Field Intensity Meter TS–587/U was employed to locate and measure field strength and a Model AN/ARC–1 transceiver was used by aircraft cooperating in the tests to receive the signals transmitted by the XDM at altitudes up to 10,000 feet.

The radiation field pattern of the unit was determined by placing the XDM in quiet waters at a distance of approximately 150 yards from the TS–587/U and rotating the XDM by hand. The tests revealed that the radiation field pattern was practically uniform throughout 360°.



Two Model XDM equipments were released from depths of about 400 feet by submarines. Upon the appearance of each buoy after launching, one of two reference vessels (the *USS EPC–628* and the *USS Albatross (E–AMS–1)*) took position close aboard to act as a radar target for the monitoring ships *(USS Robinson (EDE–220)* and the *USS Jack W. Wilke (EDE–800))* and planes. The reference vessels also served to note failure of the buoy or the end of transmission. Runs were made away from and towards the buoy to determine the maximum range of the signal. The monitoring vessel made runs in mutually perpendicular directions and thereafter circled the transmitting buoy at maximum range to listen for null points. The planes made runs at altitudes of 2500, 5000, and 10,000 feet. The RCM equipment of the plane was used on each run to determine the bearing of the buoy.

The results of these tests are shown in Tables 1 and 2 and indicate that the XDM equipment is well suited for its designed purpose.

One unit was ejected by hand from the signal gun, all other launchings were made using 250 psi. pressure. No difficulty was experienced with any launchings.

As shown by Figures 1, 2, and 3, the buoyancy of the units was sufficient to bring them to the surface and permit them to float in a vertical position with about 4 to 6 inches of the case projecting out of the water. The units remained vertical in calm water but in the more turbulent sea states encountered in the tests, wind and sea at times tilted the buoys as much as 60° from

TABLE I

	SURFACE MEASUREMENTS (Note 1)			AIR MEASUREMENTS (Note 2)						
	TEST UNIT	RANGE/TIME (Note 3)		TYPE PLANE	RANGE/TIME (Note 3)					
		OUTBOUND	INBOUND		OUTBOUND (Mi/Hr/Min)			INBOUND (Mi/Hr/Min)		
		Yd/Hr-Min	Yd/Hr-Min		2500′	5000′	10000′	2500′	5000′	10000′
EVENT I	XDM #1	7300/1–26	7000/1–41	PB4Y #43	30/0–56	55/2–26	60/3–21	30/1–00	42.5/2–50	————
	XDM #1	6000/2–37	6080/2–41	PB4Y #43	16/4–04	Plane returned to base after 6 hrs. in air.				
	XDM #1	5240/3–41	5380/3–47							
	Transmission ceased at 4 Hr. 08 Min.									
EVENT II	XDM #2	7300/0–36	8100/0–49	PB4Y #44	61/0–15	15/0–40	21.8/1–40	28.4/0–25	33.1/0–55	————
	XDM #2	7600/1–25	————							
	Transmission ceased at 1 Hr. 44 Min.—loose battery lead.									
EVENT III	XDM #1	10500/0–33	10000/0–48	PBM	16/0–12	19/0–40	22/1–01	16/0–16	18/0–44	12/1–09 (Note 4)
	XDM #1	10000/1–55	6500/3–05							
	XDM #1			PBM	————	28/3–13	86/1–31	————	————	68/2–00
	Transmission ceased at 3 Hr. 30 Min.									

Notes: 1. A destroyer escort was used, equipped with a SCR624A receiver antenna 80 feet above the waterline.
2. AN/ARC–1 receiver used in all planes.
3. All times measured from the time of the first signal emitted.
4. These ranges short due defective receiver; switch shifted to "Both" position and new run started.

TABLE 2

TYPE BUOY	LAUNCHING DEPTH (FT)	SEA STATE	WIND (KTS.)	VISIBILITY	ASCENT TIME	RATE OF ASCENT (FT/SEC)	TIME TO "ENABLE" (Note 2)	TOTAL OPERATING TIME
XDM #1	305	2½	15	Unl.	1 Min-19 Sec	5	1 Min-10 Sec	4 h. 08m.
XDM #2	400	2-2½	18-20	Unl.	1 Min-20 Sec	5	1 Min-20 Sec	1h. 44m. (Note 3)
XDM #1	400	3-4	10	Unl.	1 Min-20 Sec	5	1 Min-20 Sec	3h. 30m.

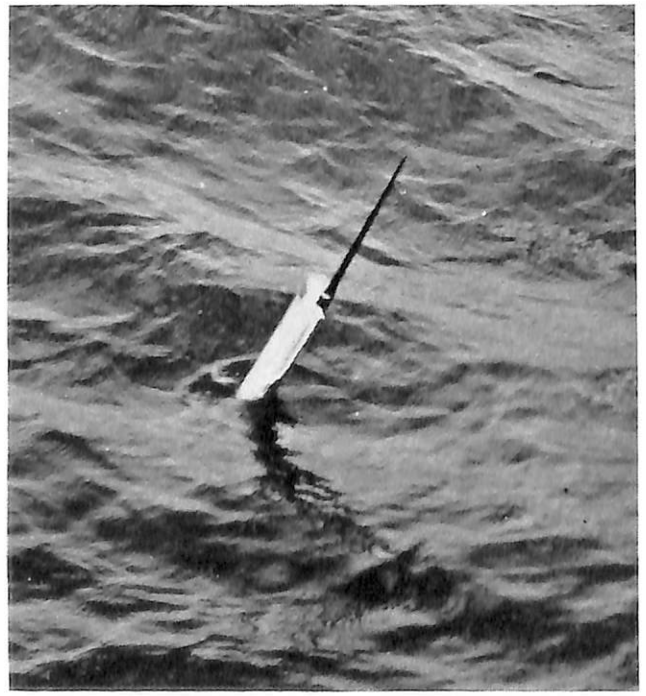
Notes: The horizontal movement during ascent of the buoy could not be observed.
2. Period from launching to first radio emission.
3. Loose battery lead in transmitter.
4. The trajectory of the equipment upon reaching the surface could not be determined.

the vertical and rotated them as much as 360° before starting opposite rotation.

Observers reported that the signals from the XDM were sharp and consistent and signal strength remained near the initial level until approximately 5-10 minutes prior to the complete exhaustion of the battery. The XDM antenna erection occured shortly after ejection and there was no tendency for the antenna to fold at any time after erection.

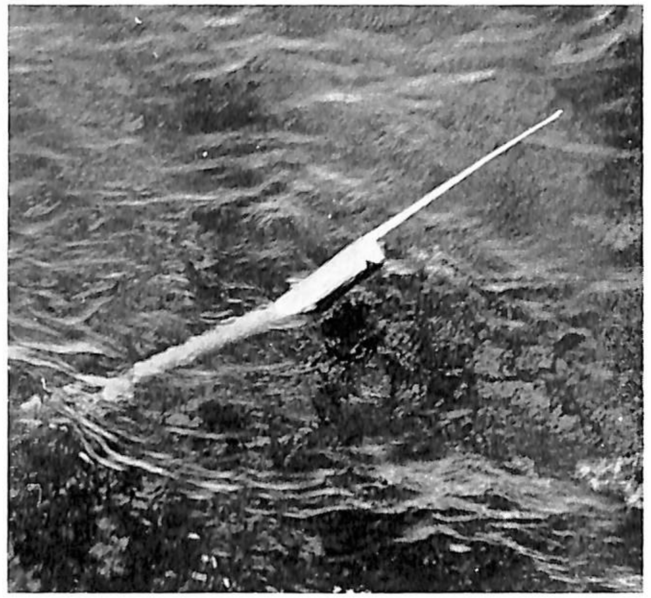
The units appeared to be in satisfactory condition after the tests and one unit was used 3 times with no trouble other than replacement of the one-shot battery. Any difficulties in operation were of a very minor nature and COMOPDEVFOR concluded that the XDM would be of value to a submarine in distress and would greatly facilitate initial location by rescue forces. It is to be noted that aviation personnel evidenced considerable interest in the equipment tested, as a possible aircraft rescue aid. The opinion was offered that similar transmitter sets could be attached to life rafts of aircraft or be released automatically from a plane in case of crash or emergency landings in the water.

XDM in upright position.



XDM starting movement to right.

The XDM equipment proved to be generally adequate in design and construction and no difficulty was encountered in the maintenance and servicing of the units tested. Each unit was provided with a special plug and leads for test purposes, which provided a simple and quick method of ensuring that the units were operating properly. The tuning and shifting of frequency is simple, since the unit uses an electron-coupled oscillator. With proper care and minor reconditioning procedures, providing a new one-shot battery is installed each time the equipment is used, the units may be used repeatedly. The placement of the battery in a separate watertight compartment facilitates its replacement without disturbing the watertight integrity of the transmitter compartment.



XDM at extreme angle to right.

COMOPDEVFOR has recommended that the XDM be accepted in its present design and be made standard emergency equipment for submarines. It has also recommended further investigation of the use of this equipment for aviation emergencies.

NOISE GENERATOR SG–23/U

The contractor has informed the Bureau of Ships that many of the SG–23/U noise generators returned in accordance with previous instructions were simply not adjusted correctly and agrees that the instructions given in the instruction book for this equipment were somewhat ambiguous. Figure 5-13a, Buzzer Adjustment, Interference Generator SG–23/U from this instruction book is reprinted below as Figure 1 together with a revised procedure for information. Only those noise generators which cannot be made operable when these instructions are followed should be forwarded to the contractor. If, however, a unit does not remain operative, but requires constant readjustment, it should be forwarded as a unit which has failed, with the notation that the unit fails to keep in adjustment.

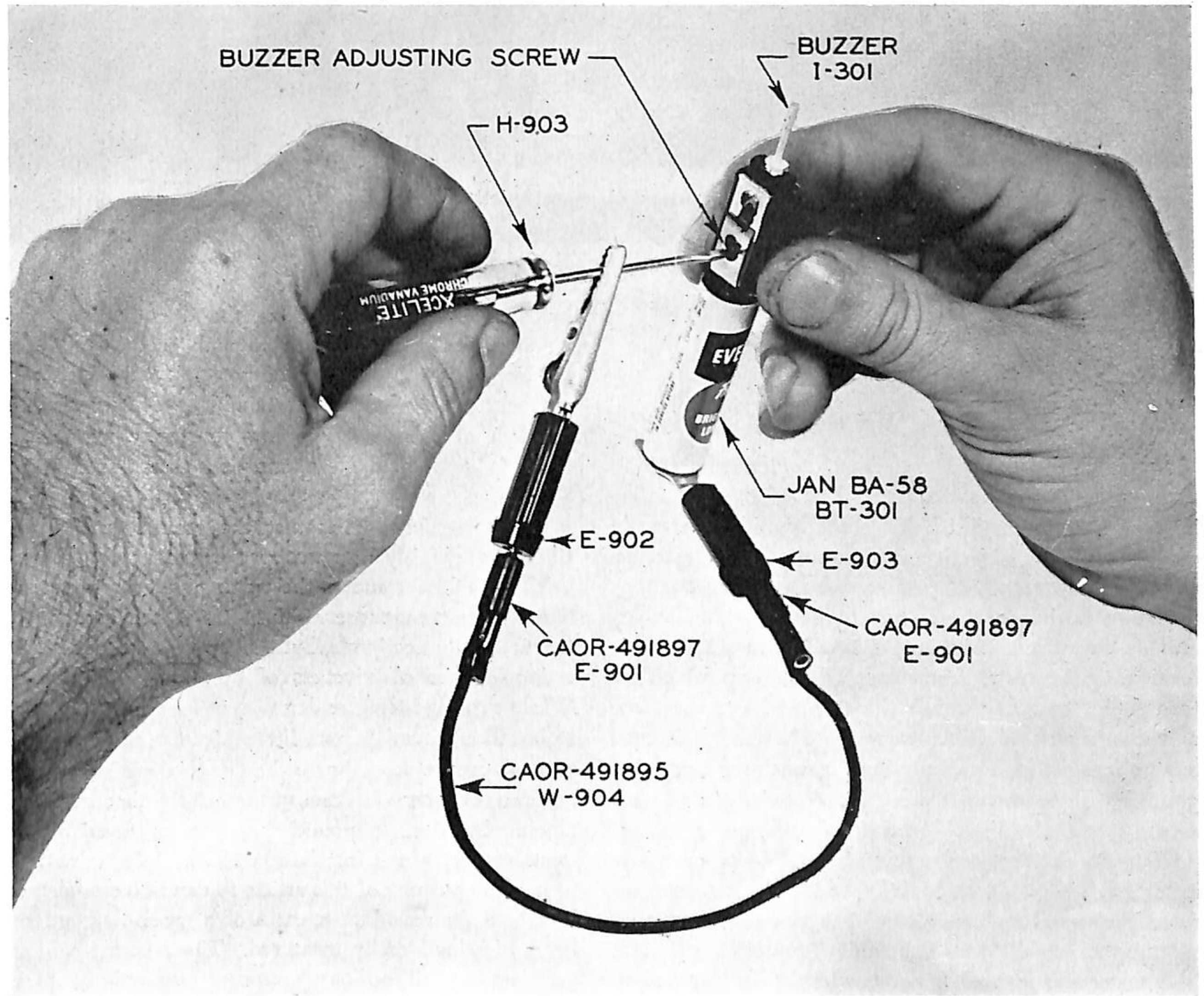


FIGURE 1—Buzzer adjustment for Interference Generator SG–23/U.

Interference Generator SG–23/U will not function when its BUZZER I–301 is out of adjustment. Readjustment of the buzzer can easily be made with AN/USM–3 test-tool set equipment. The accompanying illustration shows the equipment used and a convenient method for making the adjustment. With this method the buzzer is energized through the screwdriver and the battery terminal and will buzz when the adjusting screw is turned to the correct setting.

CAUTION: Pressure against the adjusting screw with the screw-driver bit will cause the buzzer to buzz at a false setting. Use very light touch with screw-driver.

Ground Resistance and its Measurement

by

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RCA Service Co., Inc.
Camden 2, New Jersey

Proper operation and protection of electronic equipment usually requires that some part of the circuit be "grounded." Ground in this sense signifies an earth connection. The objective is to connect the apparatus through a low resistance path to that portion of the surrounding earth—or water—which is highly conductive.

This objective can be readily attained at sea by connecting to the metal framework of the ship which in turn is "grounded" through the ship's hull to the salty and therefore conductive sea water. On land it is customary in small and medium installations to connect the ground wire to a cold water pipe or to a ground rod driven into the earth. A ground rod is simply a rod or pipe made of iron, copper-coated iron, brass or other metal having good conductivity and little tendency to corrode. Several such rods may be driven and connected together to establish an acceptable "ground."

A waterpipe ground is not always satisfactory and a ground rod system may or may not operate properly. When trouble is experienced, the cause will usually be too high a resistance in the path between the pipe or rod and the surrounding earth. We must remember that the aim is to establish contact with that portion of the earth which is highly conductive. The better this objective is attained, the lower will be the ground resistance of the system.

The conductivity of the earth depends upon the composition of the earth's crust, and is determined largely by the moisture content of the soil and by the nature and amount of raw or dissolved minerals in the soil. Considering these factors and the non-uniform distribution of rock, shale, sand, etc. it should be evident that the problem of establishing a low resistance path to the earth is somewhat more complex than it ordinarily appears.

Good practice decrees that the ground lead should consist of a fairly heavy copper wire securely fastened to the equipment and to the water pipe or ground rod. The inherent resistance of this part of the ground system is usually negligible, but there is no sure method for estimating the effectiveness of the overall installation. While existing literature describes at length various ways to install a ground system, little information is available to explain how to compare the effectiveness of existing grounds or how one can quantitatively determine the amount by which a ground system is improved by soil treatment or by the installation of multiple rods.

It is the purpose of this article to describe one method by which the resistance-to-earth of a ground system can be quickly and easily measured. The accuracy will be sufficient for all ordinary purposes and only standard and readily available equipment will be required.

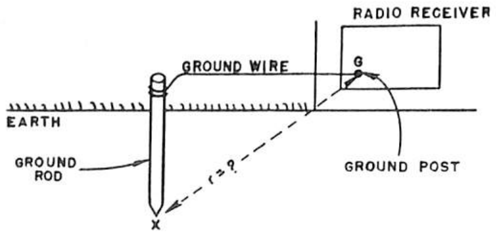


FIGURE 1

Figure 1 shows a simple ground system for a radio receiver. If we were able to connect an ohmmeter between the bottom end of the ground rod at point "x" and the ground post "G" at the receiver, we would measure only the circuit resistance of the rod plus the ground wire. The indication would ordinarily be less than one ohm. Since conventional grounds range in value from ten to five-hundred ohms, it is obvious that the circuit of Figure 1 shows only a portion of the overall ground system.

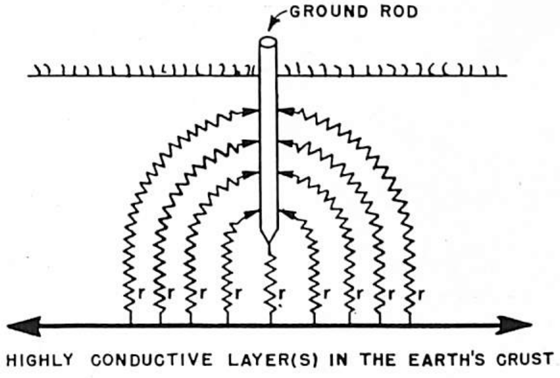


FIGURE 2

Figure 2 will illustrate the fact that each and every portion of the surface of the ground rod is connected through a separate path to one or more highly conductive layers in the earth's crust. Each path will have its own value of resistance, "r". All of these paths are in parallel with each other, and the number of such paths is nearly infinite. Our problem consists of determining the joint resistance of a nearly infinite number of parallel resistors, each having an arbitrary and varying value of resistance. Skipping the more involved mathematics, it can be shown that the summation for an *infinite* number of such parallel paths would be numerically equal to zero. This is the value for ground resistance that we try to obtain in our ground system, *zero*. While this figure cannot be fully attained, it can be approached. Note that if the ground rod in Figure 2 is increased in length, or in diameter, or if more rods are driven and connected in parallel, the number of parallel paths to the true earth will be increased and the joint resistance of the system will more closely approach zero.

Now that we understand the problem more clearly it is possible to make certain assumptions which are entirely valid for the purpose at hand, and which will greatly simplify the matter. Let us assume that the joint resistance of all the possible earth paths from a single ground rod can be represented by a single resistor, r_g, connected from the bottom tip of the rod to a zero-resistance conductive layer in the earth, located some distance below the rod. The value in ohms of the resistor, r_g, is the resistance to ground of the rod in question. This is represented by Figure 3.

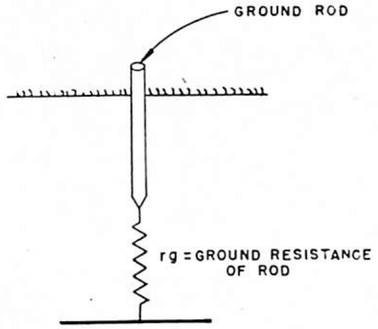


FIGURE 3

Any other ground rod may be similarly assumed to have its individual value of ground resistance, essentially unaffected by the presence of any additional rods, provided these other rods are placed a reasonable distance apart. This is illustrated by Figure 4.

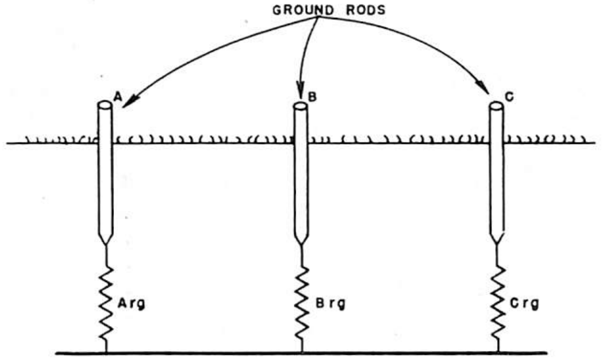


FIGURE 4

For all practical purposes, the internal resistance of a rod having a diameter of one-half inch or more is negligible. Also, since one thousand feet of #10 copper wire has a resistance of about one ohm, it is apparent that a short and heavy ground lead between the equipment and the grounding system can have but negligible resistance. Thus our ground resistance is concentrated in the earth itself, and the additional circuit resistance of the rod and its connecting lead can be disregarded. We can now redraw Figure 4, leaving out unnecessary elements, as in Figure 5.

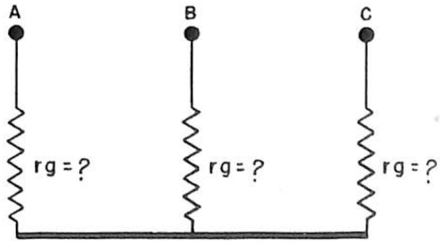


FIGURE 5

Figure 5 in turn may be pictorially shown as in Figure 6, where three unknown resistors are strapped together at one end. If these resistors were placed on a test bench and a technician were provided with an ohmmeter, he could determine the value of each resistance simply by connecting his meter to the terminals marked A, B and C. By reading the values for different combinations he could easily determine the resistance of any one unit. Let us see how this can be done.

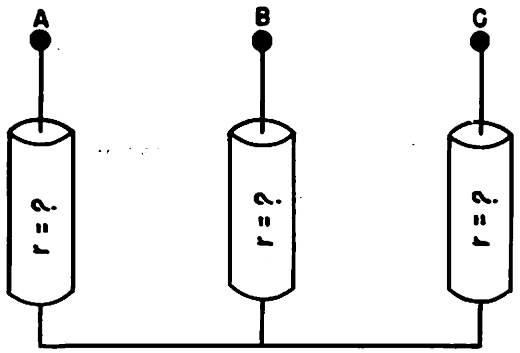


FIGURE 6

Assume three resistances of 2, 4 and 6 ohms connected with one end common as in Figure 7. The resistance from A to B will total 6 ohms. B to C totals 10 ohms and A to C equals 8 ohms. The problem may now be solved by simple algebra, as follows:

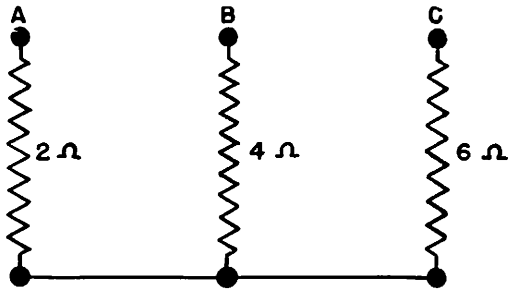


FIGURE 7

$$\begin{array}{rl} & A + B \quad\;\; = 6 \\ & A \quad\;\; + C = 8 \\ \hline & 2A + B + C = 14 \\ \text{(subtracting)} & \quad\;\;\; B + C = 10 \\ \hline & 2A \qquad\quad\;\; = 4 \\ & A \qquad\quad\;\;\; = 2 \text{ ohms} \end{array}$$

In exactly the same manner it is possible to measure the ground resistance of any water pipe or ground rod system. Let us proceed to determine the ground resistance of a single rod. It will first be necessary to drive at least two and preferably three auxiliary test rods. These rods should be placed in a rougly symmetrical disposition around the master rod. Two test leads made of #14 insulated wire, terminated with heavy clips, will be needed to connect in sequence each two rods to an ohmmeter, as in Figure 8. The series resistance of each pair of rods will be measured and recorded as in Table 1.

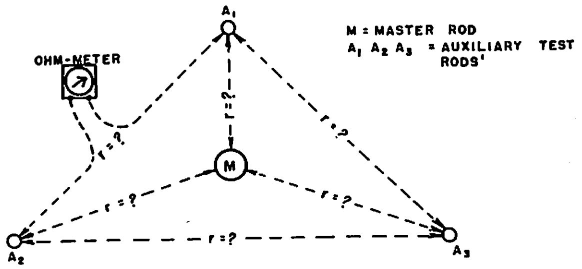


FIGURE 8

Table 1 lists actual values measured on one ground system tested.

Table I

A_1 and A_2 in series: $A_1 + A_2 = 33$ ohms
A_2 and A_3 in series: $A_2 + A_3 = 33$ ohms
A_1 and A_3 in series: $A_1 + A_3 = 29$ ohms
M and A_1 in series: $M + A_1 = 12$ ohms
M and A_2 in series: $M + A_2 = 19$ ohms
M and A_3 in series: $M + A_3 = 28$ ohms

The ground resistance of the master rod can now be found in the same manner used for solving the resistor network of Figure 7.

$$\begin{array}{ll} M + A_1 \qquad\;\; = 12 & M + A_1 \qquad\;\; = 12 \\ M \qquad\;\; + A_2 = 19 & M \qquad\;\; + A_3 = 28 \\ \hline 2M + A_1 + A_2 = 31 & 2M + A_1 + A_3 = 40 \\ \qquad\; A_1 + A_2 = 18 & \qquad\; A_1 + A_3 = 29 \\ \hline 2M \qquad\qquad\; = 13 & 2M \qquad\qquad\; = 11 \\ M \qquad\qquad\;\; = 6.5 & M \qquad\qquad\;\; = 5.5 \end{array}$$

$$\begin{array}{l} M + A_2 \qquad\;\; = 19 \\ M \qquad\;\; + A_3 = 28 \\ \hline 2M + A_2 + A_3 = 47 \\ \qquad\; A_2 + A_3 = 33 \\ \hline 2M \qquad\qquad\; = 14 \\ M \qquad\qquad\;\; = 7 \end{array}$$

Averaging the three solutions, we find the ground resistance of the master ground rod, M, to be:

$$\frac{6.5 + 5.5 + 7}{3} = 6.3 \text{ ohms}$$

By similarly combining the indicated readings for rods A_1, A_2 and A_3, we could determine their three values and their overall average to be:

Rod $A_1 = \;\; 7,\ 10.5,\ 6.5 = 11.8$ ohms average
Rod $A_2 = 11,\ 12.5,\ 12 = 21.8$ ohms average
Rod $A_3 = 22,\ 22.5,\ 21 = \;\; 8$ ohms average

The accuracy of the above readings can be estimated by noting how closely the three separate values agree. Any set of readings indicating a major discrepancy should be discarded and a new set of readings taken. Measurements should be made in opposite directions and the results averaged before tabulating.

Rods should be driven a reasonable distance apart. Results have been found to be good if the separation is anywhere between ten and fifty feet. If rods are too close, the accuracy of the readings may be affected. If too far apart, excessive ground potential may be encountered, causing the readings to fluctuate over a wide range.

After rods have been driven there will usually be a gradual rise in resistance measurements taken over a period of a few days as moisture and chemicals in the earth attack the surface of the rod. After several days this rise will taper off and subsequent measurements will remain relatively stable for fairly long periods of time. However, no ground system should be neglected for a period greater than a year without rechecking the system's resistance. This should preferably be done in the spring of the year just before the lightning season, to insure adequate protection.

In some locations the use of the d-c ohmmeter becomes unsuitable because of large d-c or a-c components in the earth currents. For such cases the measurements can be readily made by using a Wheatstone Bridge excited by a tone source of several hundred cycles or more and balancing the bridge for the lowest or null indication in a telephone headset indicator. This arrangement is shown in Figure 9. If a Wheatstone Bridge is not available, an acceptable substitute can be improvised by using two exactly equal resistors of about 1,000 ohms for legs A and B shown in Figure 9. A rheostat or pot having a range from zero to one hundred ohms can be substituted for bridge arm C, and the amount of resistance cut in by the rheostat at the point of balance determined by a subsequent ohmmeter test. When the null indication is achieved the bridge is balanced, and C is equal to the unknown resistance R.

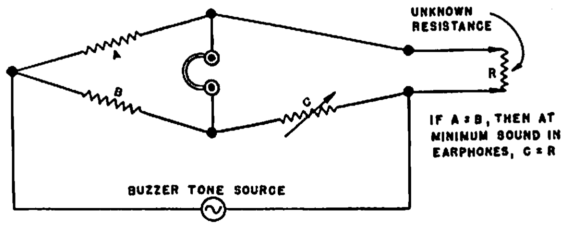


FIGURE 9

Variation of Ground Rod Resistance with Depth

Using the method described above, measurements were recently taken on a number of ground rods driven to a depth of twelve feet. These rods were used to form the grounding system for a steel tower erected in an exposed location. Due to the rocky and dry type of earth encountered, it was necessary to connect five rods in parallel to the central tower before the overall ground system resistance was reduced to a reasonable figure.

Since the variation of ground resistance with rod depth is of interest, the actual values measured are tabulated in Table 2 and plotted in Figure 10. The variation in resistance as the different rods were driven to various depths is shown in Table 3.

Table 2—Ground Resistance vs. Rod Depth

Depth in Feet	Ground Resistance in Ohms				
	Rod #1	#2	#3	#4	#5
4	200	175	125	110	75
5	115	106	80	70	52
6	82	78	65	55	41
7	60	66	55	46	35
8	50	58	45	39	30
9	42	50	40	34	26
10	35	45	38	30	23
11	30	42	36	27	21
12	28	40	35	26	20

Table 3—Ground Resistance Variation vs. Rod Depth

Rod Depth in Feet	Resistance of Five Rods	
	Max. Variation	Average Resistance
4	125 ohms	137 ohms
5	63	84.6
6	41	64.2
7	31	52.4
8	28	44.4
9	24	38.4
10	22	34.2
11	21	31.2
12	20	29.8

It will be noted from Figure 10 and Table 3 that there was a wide range in the values measured for different rods at identical depths. This variation was most evident at shallow levels and decreased as the rods were driven deeper into the earth. At a six-foot depth the rate of decrease in resistance began to taper off. At ten feet all rods had a nearly uniform resistance. Readings at the twelve-foot level indicated that a practical limit had been reached. Driving the rods to greater depths would not decrease the obtainable resistance sufficiently to warrant the increased labor and expense.

Summary

The procedure given above enables a fairly accurate measurement to be made of the ground resistance of a rod, water pipe or other grounding system. The measurements may be rapidly taken using conventional equipment in most cases.

Tests will show that a considerable variation may exist in the resistance measurements of ground rods driven to shallow depths. These variations will normally decrease in magnitude as the rods are driven more deeply into the earth.

It would appear that in order to be effective and uniform from day to day, ground rods should be driven at least eight feet deep. However, the improvement achieved beyond the eight-foot level will taper off so rapidly that there is little point in sinking a ground rod below a twelve-foot depth.

Still further improvement in reducing the ground resistance of a system can most simply be achieved by driving a number of rods to the desired depth and then connecting the rods in parallel, using heavy copper conductors.

The grounding capability of any ground rod system may be improved by conventional methods of treating the adjacent soil with dissolved rock salt or similar agent. However, the immediate improvement achieved may be at the expense of more rapid deterioration of the rod itself, necessitating frequent replacement.

When available for use, brass pipe or copper-plated iron rod will give superior results from the viewpoints of initially low resistance and long trouble-free life. For really low resistance ground systems totalling less than one ohm, an entirely different technique is called for.

Cold water pipe grounds should measure less than twenty ohms. Single ground rods may range from twenty to five hundred ohms. When short rods are used or where dry soil is encountered, it may be necessary to parallel several rods. Of two grounds being compared, the one showing the lowest resistance usually will be superior in performance. Although satisfactory results may be expected if the measured ground resistance is below ten ohms, every effort should be made to reduce this value as much as practicable.

The reader is cautioned to note that this article has dealt exclusively with the d-c resistance aspect of a grounding system. The dissipation of r-f energy in the ground is an entirely different matter. Where an effective r-f ground plane is required at or near the earth's surface, the use of an elevated counterpoise or a buried radial system may be required. However, where space limitations are paramount, or where circuit operation depends upon a d-c or low-frequency a-c ground return, the water pipe or ground rod system is a logical choice.

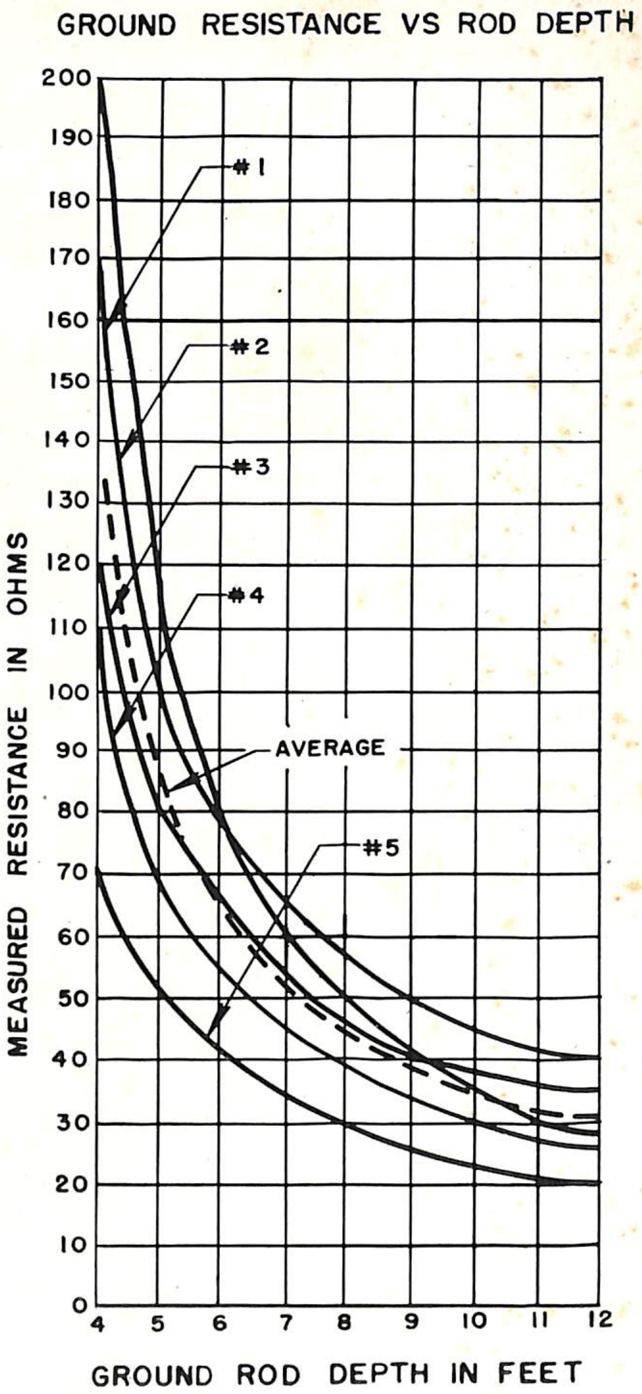


FIGURE 10

From the foregoing, it is evident that if a water pipe or driven rod system is to be used, the resistance of the system should be determined. The procedure described in this article will enable the required measurements to be accurately and quickly made.

CORRECTIONS TO TDZ/RDZ SERVICE & REPAIR MANUALS

The following typographical errors were found in the subject publications.

TDZ Service and Repair Manual (NAVSHIPS 91328)

On Page 2-11, Figure 2-12, change polarity of bridge rectifier circuit at points "a" and "c" to read —, + respectively instead of as now indicated.

On Page 3-56, Chart 6, Step 8, Column headed "Normal Indication", change —65v to +65v. in two places.

RDZ Service and Repair Manual (NAVSHIPS 91331)

On Page 4-39-40, Figure 4-16 "B", cable from TB15 on radio transmitter TDZ unit should go to terminals T1, 2, 3, 4, 5, on remote indicator unit type 23496, and cable from TB14 leads 1, 2, 3, 4, 5, 6 should go to corresponding terminals on bottom terminal strip of remote indicator. These two cables were erroneously transferred. These cables are correctly drawn in Figure 4-24 of NAVSHIPS 91328.

ARCING TUBES IN QDA RECTIFIER POWER UNIT

Reports received in the Bureau of Ships indicate that tube sockets have been failing because of arcing between pins. A typical situation and suggested remedy is quoted as follows:

"Continued material casualties have occurred in the Rectifier Power Unit (CAIU–20423) of the QDA Depth Sonars as a result of failure of the rectifier tube sockets X1601, X1602, and X1603. The trouble in each case resulted from arcing between pins (8) or (2) and pin (1), the latter being grounded. No internal tube connections are made to pin (1), and this ground connection is not shown on the wiring diagram of the unit on Page 7-153 of NAVSHIPS 900,700. Pins (1) of sockets X1602, X1603 are grounded to terminal E1613; pin (1) of socket X1601 is grounded to terminal E1605. Removal of these connections has eliminated socket failures in every case and is very easily accomplished. It is suggested that this modification be performed on all service QDA equipments."

The author further recommended the "removal of ground leads from pin (1) of sockets X–1501 and X–1502 to tie point on pin (7) of socket X–1509," shown on Figures 7–147 and 7–149 of the instruction book.

OKA RANGE RECORDER ADJUSTMENT

Reports received in the Bureau of Ships indicate that the calibration of the Integrated Sonar System may be improved as follows:

Exact zero range adjustment of the OKA Sonar Range Recorder CAN–55199 following NAVSHIPS 900,791 is difficult. Errors as large as thirty yards have been observed after calibration by shipboard maintenance personnel. These errors are due to the action of the TVG circuit of the QHBa which suppresses the audio amplitude of the transmitted pulse to a level comparable to pre-pulse noise and post-pulse reverberation. When the QHBa/OKA gain is advanced to a point where the pulse is visible on the recorder, these noise and reverberation markings prevent pulse definition. The removal of the TVG control tube V713 in the QHBa receiver during this adjustment results in clear, well-defined outgoing pulse traces with no other confusing indications presented. It is suggested that this additional step be included in the OKA calibration procedure.

IMPROVED TYPE JT HYDROPHONE AND BAFFLE ASSEMBLY

Drawings RE78C2031A and RE78D2032A describe the improved JT hydrophone and baffle assembly which will be used for replacement of the present RCA-type JT hydrophone.

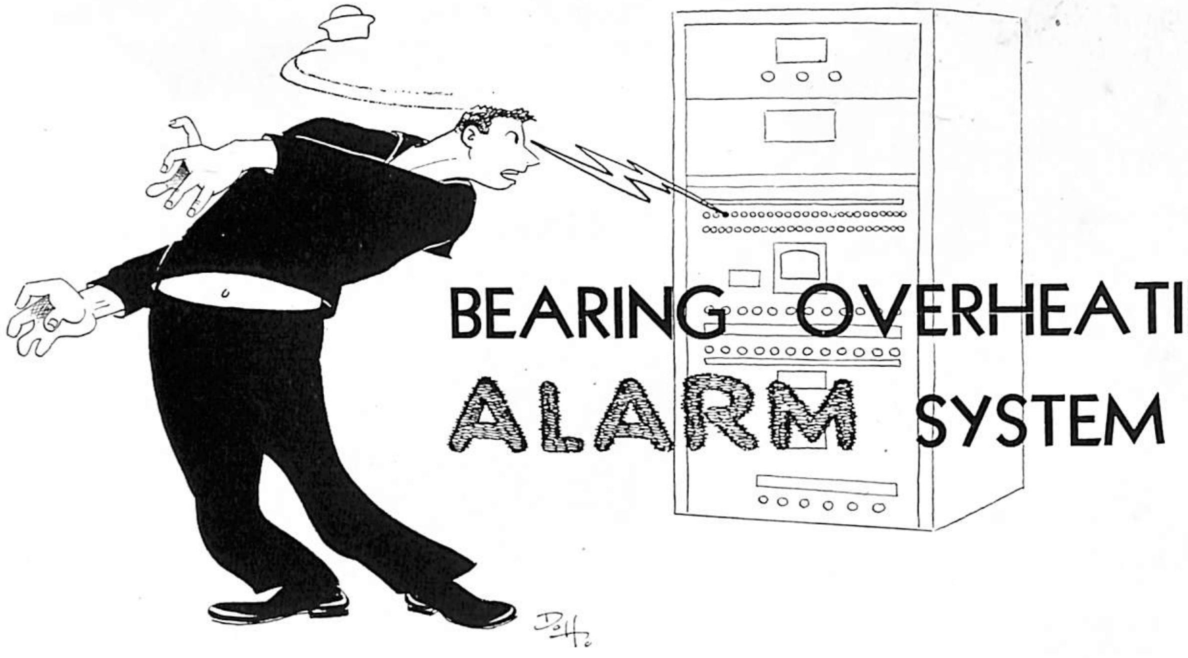
The new type incorporates minor changes as follows:

1—The hydrophone cable is permanently sealed to the hydrophone.

2—The construction of the new type hydrophone and baffle assembly eliminates the use of the sound absorbing coupler unit, Navy Type no.–10365.

It is intended that this hydrophone and baffle assembly will be used as a replacement only, as the present RCA-type becomes inoperative beyond economical repair.

The present stock of the improved type is not sufficient to allow indiscriminate replacement.



BEARING OVERHEATING ALARM SYSTEM

by

Charles E. White, *Electronics Engineer*
Electronics Design and Development Division
Bureau of Ships

The fundamental purpose of Industrial Electronics is to contribute to the increased productivity and efficient operation of industrial equipment. The ability of this branch of electronic science to contribute to more efficient performance of shipboard equipment is borne out in the development of an electronic bearing temperature scanner which will be used on the latest designs of Naval vessels to give an early warning of overheated bearings on precision turbines and reduction gears.

Proposals to employ such a device have been advanced by development groups engaged in the study of bearing performance under the direction of the Bearings Branch, Bureau of Ships. In observing conditions under which bearings fail in service, it has been determined that improper lubrication for a period of less than 5 seconds may produce bearing failure. The primary need then is for a temperature measuring system which will give an indication of rising temperature within this time. The relatively slow heat flow in journals and bearing material will not permit the use of temperature inserts in the material adjacent to the bearing. An acceptable system has been developed utilizing thermocouples of smallest practicable dimensions inserted in bearings so that they are exposed to the temperatures of the oil film in the load zone of the bearing. The temperatures measured in this manner are obtained with sufficiently rapid time response to gain an advance indication of an impending failure, which will presumably allow sufficient time to reduce the load on the machinery or take other corrective measures.

The method so far will permit the monitoring of a single bearing but is not adapted to the measurement of a number of bearing temperatures in a large machinery installation. A number of individual instruments would be required which makes it preferable to measure the temperatures in rapid succession by means of a scanning device. The use of such a scanner further suggests the need for an indication of any particular bearing showing overtemperature and a means for monitoring its temperature to observe the results of any corrective measures taken. These considerations and others which follow constitute the general requirements for a bearing temperature scanning system:

1—Indication of bearing or bearings exceeding a prescribed temperature, by means of signal light.

2—Scanning of 24 bearing temperatures in less than 5 seconds per scanning cycle.

3—Actuation of an audible alarm.

4—Temperature indication system for connection to any bearing showing overtemperature.

5—Calibration of each channel for setting the alarm temperature (range 100°F—400°F.)

The general method which has been developed to meet these requirements is to switch the thermocouples sequentially, obtain a voltage pulse and amplify this for triggering a thyratron.

In developing a scanning switch it was determined that an assembly of individual snap action switches worked the best. The lack of any wiping action is an advantage in holding contact-generated voltages to a minimum. The switches are assembled in a circular frame and are actuated sequentially by a motor-driven cam. Since the scanning switch performs several other operations in addition to switching thermocouple inputs, the assembly actually consists of a stack of 3 levels. The first two levels are for switching each wire of the thermocouples (double-pole switching). These switch units are also double throw for the purpose of connecting each thermocouple to a separate measurement channel at any time that the particular thermocouple is not being scanned.

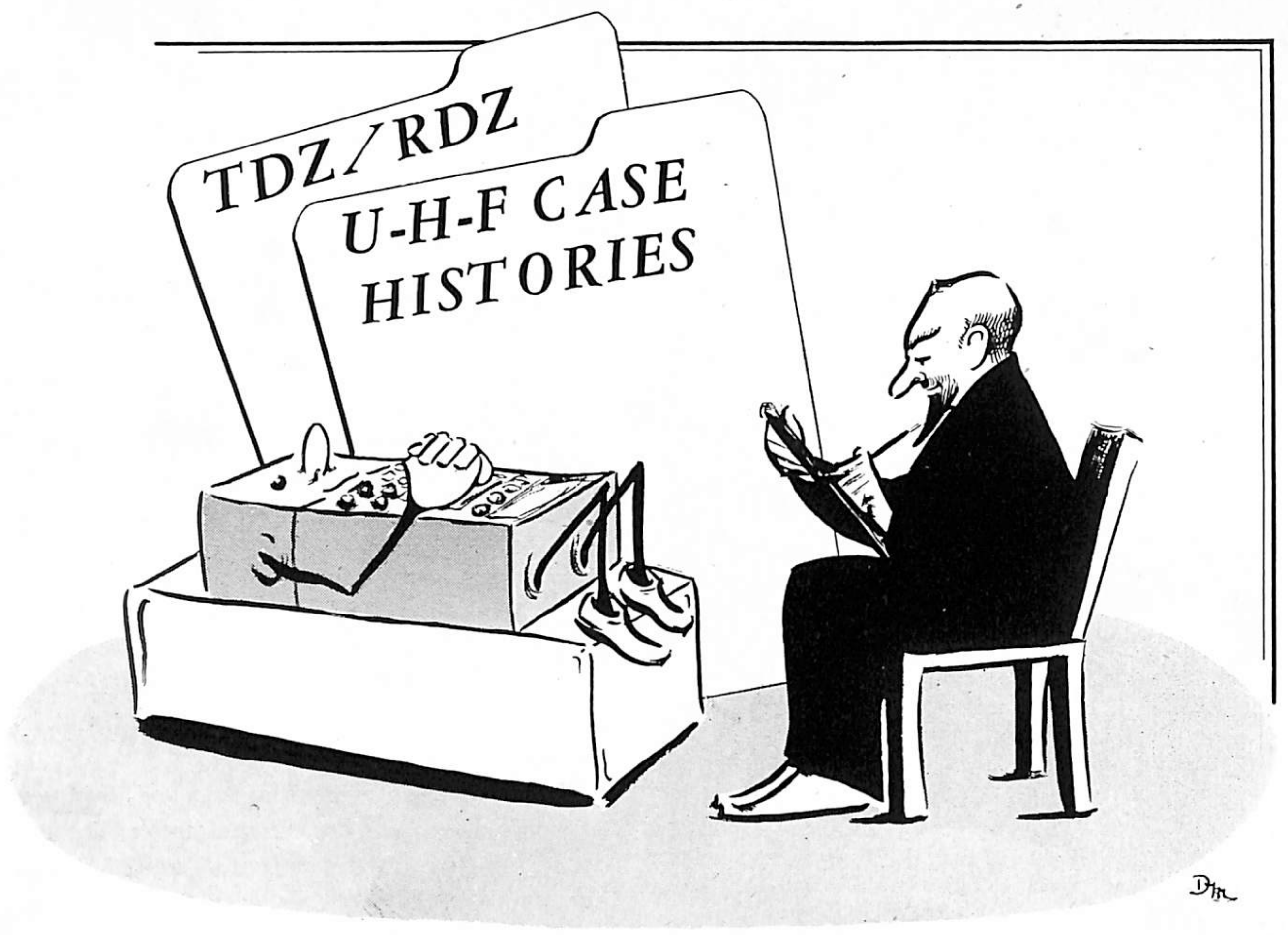
Front view of laboratory model of the multiple temperature monitor.

The third level is used for operation of the indicating light associated with each thermocouple and serves the further purpose of inserting the proper calibrating voltage in each channel which will determine the temperature for any particular channel at which an alarm will be sounded.

The rapid operation of the scanning switch tends to create voltage peaks at each make and break of contacts due to inductive constants of the circuit. These surges will cause erratic action of the warning circuits unless measures are taken to modify their effect. The method employed in this equipment is to actually accentuate the pulse formed on "make" by means of a pulse forming circuit and to eliminate the effect of the voltage obtained on the "break" by switching the alarm system off in the third switch level before the "break" voltage occurs, thereby preventing any effect on the operation of indicating lights.

The pulsed output of the thermocouples is fed through an audio amplifier and this output is applied to the grid circuit of a thyratron. Since the third switching level is simultaneously applying a bias voltage to the cathode of the thyratron the resultant voltage to the grid obtained by comparison of these two voltages determines the firing of the thyratron and the resultant indication of overtemperature. In order to maintain reliable operation of this device and prevent false indications the amplifier must possess an extreme degree of stability with variations occurring in line voltage or frequency and under all ambient conditions of temperature and humidity. A general alarm indication is also obtained from the plate circuit of the thyratron in this system.

A demonstration model operating as described has been developed by the National Bureau of Standards, Engineering Electronics Section, for the Bureau of Ships. All details of design and any reports on construction and operating performance are a matter assigned to this development group. This article is concerned chiefly with the reasons for initiation of this development and the function of Industrial Electronics in fulfillment of the performance requirements of this problem. The Bureau of Ships is continuing other investigations covering commercially available equipment and has initiated new development projects in a program intended to utilize all types of industrial electronic devices for improvement of industrial processes in the Naval establishment.



A total of 144 field reports of Model TDZ/RDZ transmitting-receiving equipment failures reveals that approximately 92% of all the failures encountered are chronic troubles. These troubles are listed in the first column of the following charts in the order of their frequency of occurrence. The second and third columns give the exact nature of these troubles and the symptoms they produced.

TYPICAL OPERATIONAL FAILURES

Radio Transmitter TDZ

TYPE OF FAILURE	SYMPTOM	CAUSE
Tubes.	Low output or no output. No modulation or poor modulation.	V–107—V120; most likely V115—V119. V101—V102 V110.
Tuning.	Low output or no output. Tube failure. Failure of R–122–R124.	Tuning to harmonic. Improper locking of heads. Faulty tuning.
Autotune System.	Controls not stopping at preset positions. Slipping, unable to lock, no rotation. Master or slave Autotune system inoperative.	Worm gear not meshed. Limit-switch circuit broken. Clutch too tight. Improper synchronization. Lack of lubrication. Set screws not tightened.
Drawer contacts.	Starting light out. No channel indication. Unable to key. No power output.	Drawer not centered and tightened. Dirty or broken contacts.
Control relays.	Wrong channel selected. Wrong channel indication. START button inoperative. Unable to key. High antenna current. Overload reset inoperative.	S114 worn or making poor contact. K106, M103, K108, or K106 antenna relay.
Antenna, cable, and couplings.	No or weak power output.	Damaged antenna. Open or loose couplings. Open transmission line. Short in transmission line due to moisture or corrosion.
Poor preventive maintenance.	Faulty and inefficient operation. Equipment dirty, No field changes completed.	Lack of training. Improper supervision.
Components.	Smoke or odor. Hum on carrier. Unable to balance tubes. Phone inoperative.	C118, C119, C120B, or C104. R172—R174 burned by improper tuning. Winding 1–2 of T101.
Meters.	Indicator inoperative. Abnormally high reading.	Open meter coil M103. Defective V119. Antenna relay.
Tube sockets.	Low or no output.	X115—X119 easily damaged by rough handling or by improper removal and insertion of tubes. Heater and cathode diameters vary for various manufacturers.
Crystal oven.	Cold oven. Improper heating.	Short or open thermostat. Oven loose in socket, T107, winding 9-10.
Power supply.	No primary blower. Blower motors inoperative. Microphone voltage failure. No 115-volt power. No high voltage.	Drawer contacts. 12-volt supply. Defective rectifier. F104, F105, F103, T107. V107—V110. T104, winding 3–11.
Miscellaneous.	Vibration. Harmonic interference.	Loose drawers or shock mounts. R-f Improperly terminated SCAN jack Tube clamps not tightened.

Radio Receiver RDZ

Low emission, shorted or intermittent.	Weak output, no output, or intermittent operation.	Defective tubes.
I-f alignment, r-f alignment, or both required.	Weak output or no output.	Poor alignment.
Cold oven, broken wires connecting crystal socket to pin, poor connections on oven receptacle, or dirty or poor contacts on S601.	Weak output, no output, or excessive frequency drift.	Defective crystal oven or circuit.
Silencer circuit ungrounded when not using remote units, grounded when using remote, or defective resistors.	No silencing action.	Silencer circuit inoperative.
Inactive or weak crystals.	Weak output or no output on one or more channels.	Defective crystals.
Lubrication or replacement required.	Remote dial selected higher channel than desired.	Defective minor switch.

TYPE OF FAILURE	SYMPTOM	CAUSE
Forms melted or warped.	No output or poor i-f selectivity.	Defective i-f coil forms.
Armature misadjusted or coil shorted.	Autotune motor ran continuously.	Defective relay K106 in Navy Type CQC–23497.
Broken ceramic shaft or broken coupler on Autotune unit.	No output and no tuning.	Faulty coupling between Autotune unit and tuning capacitor.
Bent pins or pin holders on sockets.	Intermittent operation.	Poor connections between tube pins and sockets.
Fuse missing or open.	No output.	Defective fuse.
No panoramic adaptor or dummy load plugged into J403.	I-f oscillation present.	Improperly terminated SCAN jack J403.
Open control or poor contact of rotor.	Noisy output when control was turned, or intermittent operation.	Defective RF GAIN control.
Loose coupling with excessive play, or damaged linkage.	Poor i-f selectivity.	Faulty linkage between IF BAND control shaft and i-f transformers.
Locknut not tightened sufficiently.	Dial failed to indicate proper frequency.	Loose locknut on tuning dial.

RELOCATION OF PP–338/U RELAY USED WITH MODEL TDE

A Beneficial Suggestion submitted by William W. Beam of the Puget Sound Naval Shipyard proposed remounting relay K–101 of power supply PP–338/U.

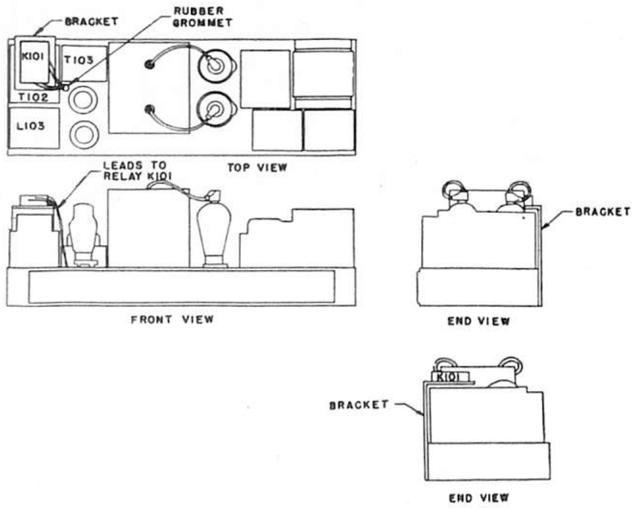


FIGURE 1

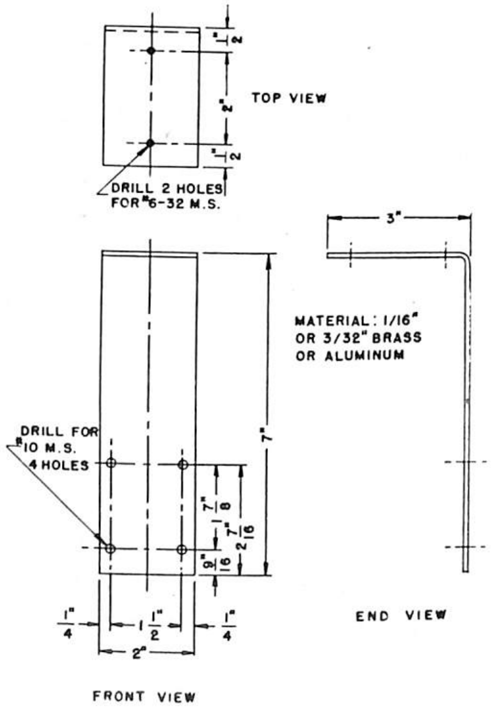
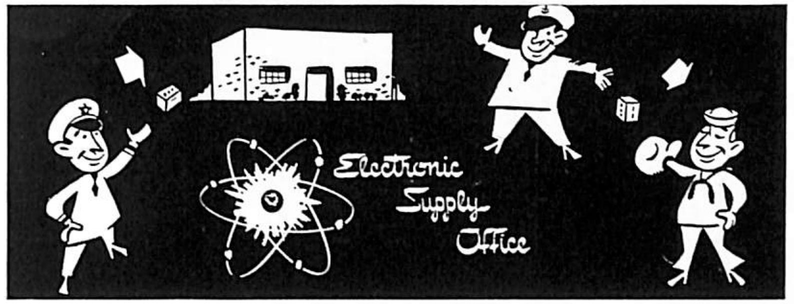


FIGURE 2

Presently this relay is mounted on the underside of the chassis which renders it extremely difficult to maintain and inspect. Mounting this relay on the upper side of the chassis as shown in Figure 1 will effect a saving of time and personnel in the maintenance and repair of this unit. The modification requires construction and installation of a simple angle bracket, as shown in Figures 1 and 2. The leads to the relay may be brought up through a rubber grommet as shown in Figure 1. The modification may be performed by Navy Yard personnel using standard stock material. No special tools are required.



E.S.O. MONTHLY COLUMN

TRANSFER OF INVENTORY CONTROL COGNIZANCE

The Bureau of Ships and the Bureau of Supplies and Accounts have given blanket approval for the transfer of inventory control cognizance of an item between the Electronic Supply Office and the General Stores Supply Office without prior authorization, provided that the system stocks of the items are valued at $200 or less. The two Bureaus must be informed of all such transfer actions, however, and, if the value of the item exceeds $200, specific approval must be obtained from both Bureaus before the item can be transferred.

PURCHASE OF DESTROYER ALLOWANCE ITEMS

During the past year the Electronic Supply Office purchased for stock the complete range of allowance items used in equipments aboard submarines. A submarine tender allowance list was used to do this because it was assumed that such a list contained practically all allowance electronic maintenance repair parts in all types of equipments used by submarines. This office is now engaged in a similar project for destroyers.

Quantities to be procured are determined on the total number of equipment applications for each particular stock numbered part; in this, the uses of the part in equipments aboard all classes of vessels in the active fleet are considered. Thus provision is made not only for destroyer requirements for that item, but also for potential allowance changeovers for other classes of vessels.

MAJOR EQUIPMENT STOCK NUMBERING

A plan has been developed for stock numbering BuShips-controlled sets and equipments.

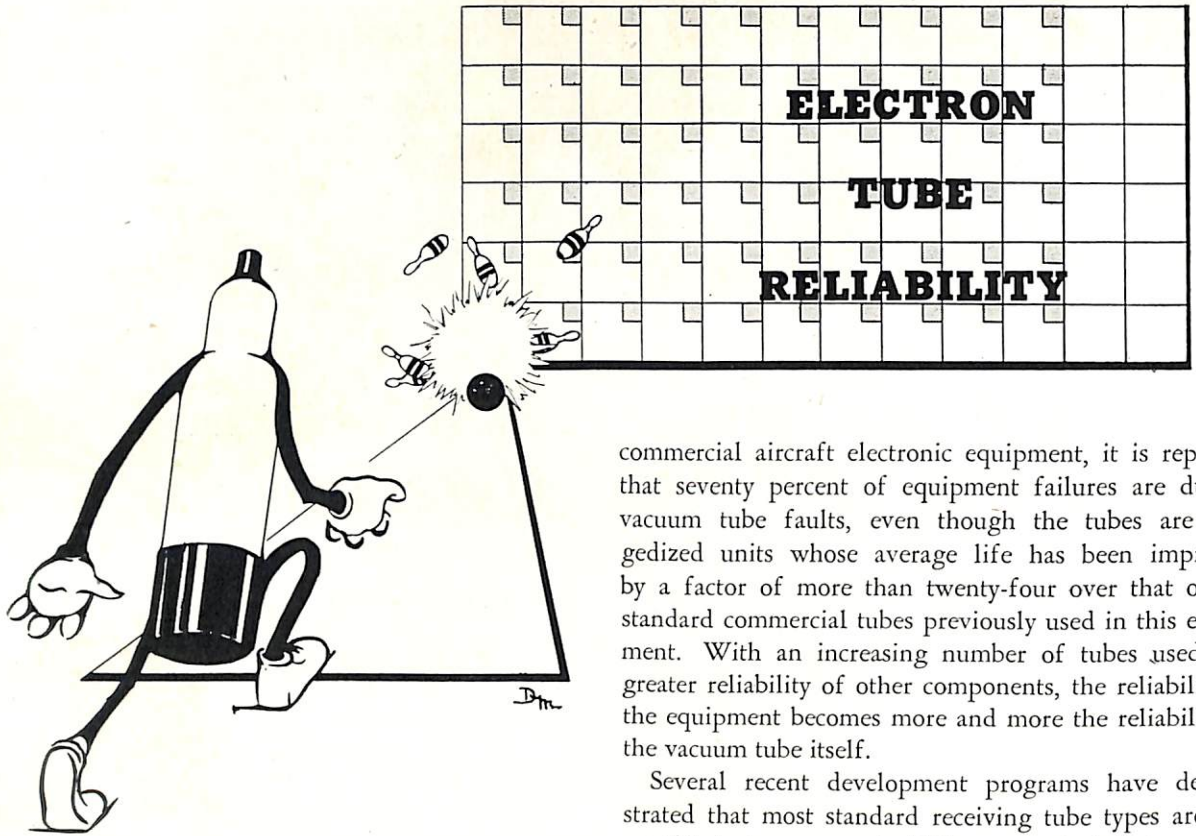
The three digit portion of the numbers in the example below is significant, with 100 denoting "less equipment spares"; 200, "with equipment spares"; 300, "extra equipment spares"; 400, "tender spares," and 500, "stock spares."

The letter "Q" has been selected as the alphabetical designator for equipments and combinations of spares associated with these equipments. "Q" was chosen because it has no usage elsewhere in the Hicks system. (In the examples of the QFA cited herein, there is, of course, no relationship between the Q in QFA and the Q alphabetical designator in the stock number; the similarity is a coincidence.)

An example of a stock number and the pattern it follows is presented herewith:

BASIC DESCRIPTION	NOMENCLATURE	STOCK NUMBER
QFA, less Equipment Spares	QFA	F16–Q–230380–100
QFA, with Equipment Spares	QFA	F16–Q–230380–200
Extra Equipment Spares for QFA	QFA–EES	F16–Q–230380–300
Tender Spares for QFA	QFA–TS	F16–Q–230380–400
Stock Spares for QFA	QFA–SS	F16–Q–230380–500

ELECTRON TUBE RELIABILITY



A survey of available information on the status of vacuum tubes for military service has been made, and the findings are discussed herein. The vacuum tube is considered here as a circuit element whose reliability under military service conditions, as compared to that of other electronic components, is analyzed. Analyses have been made of data which contribute information on what is now available, and what can be expected in the near future. No concerted effort has been placed on analyses of the many manufacturing techniques and construction practices of the various manufacturers, and no attempt has been made to evaluate the relative merits of these techniques and practices for use in military electron tubes. In most cases, detailed information on the reliability and suitability of the new "Ruggedized" and "Long-life" tubes may be obtained from the manufacturers whose names are mentioned herein.

The developing complexity of electronic circuits, such as radars, sonars, and computers, make the tube problem a serious one. Data gathered for this study indicate that in equipments using components which meet military specifications or best commercial grades, the vacuum tube accounts for more than fifty percent of the circuit failures. Indeed, in one case an analysis of service calls on a number of early electronic computers over an eight-week period showed that seventy-two percent of the breakdowns were due to vacuum tube failures. In commercial aircraft electronic equipment, it is reported that seventy percent of equipment failures are due to vacuum tube faults, even though the tubes are ruggedized units whose average life has been improved by a factor of more than twenty-four over that of the standard commercial tubes previously used in this equipment. With an increasing number of tubes used and greater reliability of other components, the reliability of the equipment becomes more and more the reliability of the vacuum tube itself.

Several recent development programs have demonstrated that most standard receiving tube types are susceptible to improvement. This was particularly true when the tube type was redesigned to make it suited for a specific application. Cooperation between manufacturer and customer has in several recent cases resulted in modifications to certain standard tubes which have greatly increased their life expectancy under the operating conditions of electronic computers, pulse circuits, or aircraft vibration, and for applications imposing conditions of heater "on-off" switching, mechanical shock, or high temperatures. It is interesting to note that in several cases the manufacturers first tried, with little success, to separate tubes from standard stock which would meet the customer's specifications. In each instance, a redesigned tube was needed to successfully meet the added specifications imposed by the customer's application.

The commercial airlines, having been troubled by an inordinate number of failures of vacuum tubes in an aircraft communications equipment, sponsored a project with Aeronautical Radio Incorporated for the purpose of improving the life of the tubes. The project was successful, and the improved version of the tube, the 5654, proved to have an average life of more than twenty times that of the 6AK5. Nine other types have been so treated for such service conditions, and they are listed in Table 1. The manufacturer has stated that the main improvements which were made in these tubes were the choice of a more rugged heater assembly and the use of better material quality controls in their manufacture. In addition to standard JAN type tests, the specifications on these new tubes called for a heater-cycling test, and it is thought that this additional test was a good quality check on the new heater units which were used.

The high ratio of tube failures to those of other electronic components indicates that it is not at this time desirable or economical to embed or "pot" tubes, or otherwise place them in inaccessible places in military equipment except when an assembly or an equipment as a whole is meant to be short-lived and expendable as a unit. However, the "potted" circuit may be practicable for many other applications when it incorporates tube types of proven dependability under the conditions of use planned for the equipment.

TABLE I

RELIABLE LONG-LIFE MINIATURE TUBES
DEVELOPED FOR AIRCRAFT EQUIPMENT

Tube Type	*Standard Equivalent*	*Use*	*Heater Current at 6.3 volts*
5654	6AK5	u-h-f and wide band i.f.	175ma
5670	2C51	r.f. and a.f.	350ma
5726	6AL5	Detector-discriminator	300ma
5725	6AS6	Dual-control r.f. and i.f.	175ma
5749	6BA6	r.f. and narrow band i.f.	300ma
5686	(Pentode)	r.f. oscillator and a.f.	350ma
5751	(12AX7 is similar)	a.f. and limiter	350ma
5750	6BE6	h.f. converter	300ma
5814	(12AU7 is similar)	a.f. amplifier	350ma
5727*	2D21	Thyratron	600ma

* Not yet available.

The subminiature vacuum tube, while progressing rapidly, has not been in service long enough to allow gathering conclusive information on life-expectancy. Reports of 5000 and 10,000 hour average life on certain types are available. Some manufacturers report satisfactory service results on their hearing aid types on a one year factory-guarantee basis. There are many current research and development programs in the field of subminiature vacuum tubes. They include developments of types which will dissipate plate powers of the order of twenty-five watts, research and development on high-temperature bulbs and seals, and work on types specifically intended for high-shock and vibration applications. Many of these programs are government-sponsored while some are privately sponsored for commercial applications. Sylvania Electric Products Incorporated is furnishing to the military services a line of ruggedized, long-life subminiatures which are guaranteed to meet a specification "that an average life percentage of any group of these tubes at the end of 5000 hours shall not be less than eighty percent." The manufacturer reports, with respect to this line of tube types, that "the actual tube life obtained varies to some extent for individual tube types, but it is in all cases better than the eighty percent specified at 5000 hours. It is not unusual to find a large percentage of the tubes operating within limits for periods well in excess of 10,000 hours." These new Sylvania subminiature tubes have now been advertised by the company.

There is very little published information on the factors which contribute to longevity in vacuum tubes. Each manufacturer has developed data and conclusions of his own, but little of this is available in concrete form to others. There is general agreement, however, that very close material controls, through mechanical inspection and test, rugged heater assemblies, good mechanical construction practices, and keeping a trained production "team" together continuously on a tube type all contribute to making better tubes with longer life expectancies. Careful and thorough processing, particularly of coated cathodes, and good vacuum techniques are also worthy of mention. Sylvania reports that development of long-life subminiature tubes is accomplished principally by improvement in quality. "Life-test results on earlier tubes had shown that mechanical failures were the most prevalent cause of early life failure. Consequently, emphasis was placed upon the elimination of mechanical defects. This program was partially effected by design changes made to improve shock and vibration resistance, but the greatest benefit came from enforcement of rigid quality control methods in production. As an additional precaution, all tubes are subjected to 50 hours of regular life operation before final test. In this way, early life failures are rejected before release of tubes for shipment."

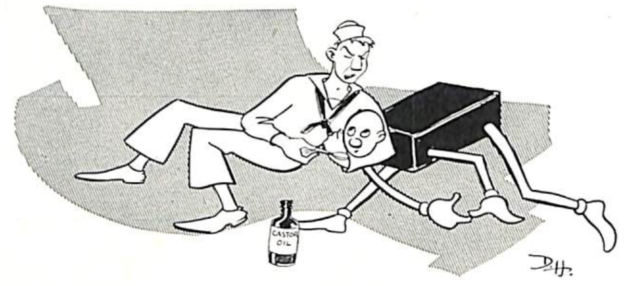
The General Electric Company in England has also noted that the largest percentage of mechanical failures were in the early life of tubes, and they have independently concluded that a minimum of fifty hours normal operation are required to stabilize the characteristics of quality tubes and to eliminate the "weaker" ones. The Engineering Department of the British Post Office Department has attempted with some success to "burn-in" tubes or to accelerate the stabilization of characteristics and the elimination of inferior tubes by running them for a short time at double the rated heater voltage and triple the rated plate dissipation. The Sylvania Company in the United States is currently experimenting with the 6SN7–GT dual triode tube for the same purpose.

Our information shows that the operating conditions which contribute most to premature failures in vacuum tubes include the following:

1—Excess switching on and off of heater power often leads to mechanical breakage of the heater element. In this respect, some heater types have been found to be superior to others. The British reported that failures were ten-to-one greater on certain of their tube types when switched on and off ten to twenty times per day during life tests. The personnel on Project Whirlwind at M.I.T. concerned about this problem, introduced a gradual five minute warm-up cycle on filaments in their electronic computers.

2—Cathodes or filaments have an optimum temperature of operation. The incidence of failures rises rapidly as this optimum temperature is exceeded. Not much data exist on the effect of under-temperature operation. It is known that, although the latter condition is not as serious as the other, it does shorten tube life. It is desirable to run heaters at nominal or just under nominal ratings from regulated power supplies when long and stable service is required of the tubes.

3—The operation of many tube types for extended periods under conditions where tube current is cut off by negative grid potential, or by lack of plate and/or screen voltage, contributes to a form of cathode deterioration which has been named "sleeping sickness." This effect is serious in some computer and pulse-circuit applications. Tube types should be tested for this trait before being chosen for such application. R.C.A. and others have developed and manufactured special tubes for such applications. Pure nickel cathode sleeves do not seem to exhibit this effect, but sleeves of nickel containing a very small percentage of silicon or of other materials appear to contribute to the development of an "interface" layer between sleeve and coating. This "interface" has been shown to develop an average resistance of 100 ohms with a parallel capacitance of as much as 2000 mmfd. This can add serious delay and decay time constants to circuits using such tubes. The effect is temperature dependent and has been shown to develop more rapidly under "cut-off" conditions than under class-A operation.

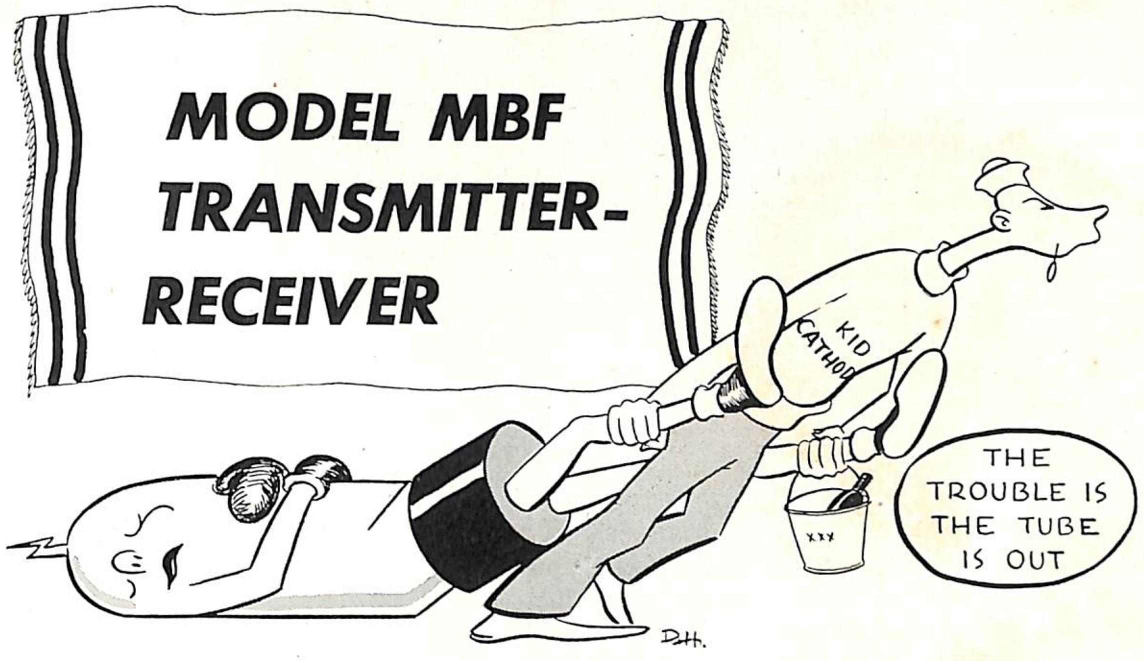


4—Conditions of unusual vibration or shock may break heater elements, bend or break tube elements and supports, and even break the bond of the coating on the cathode sleeve. The latter fault has been found by Sylvania to be improved by avoiding the use of large particle sizes in cathode compounds and by controlling carefully the amount of coating applied to the cathode sleeve.

Some general additions to JAN specifications are suggested. These include heater cycling tests to eliminate the vulnerable heater types, life tests under long-time grid-cut-off conditions to show up cathodes which are susceptible to the spoilage which occurs in some tubes when the cathode is heated for long periods with no current flowing, and a high-temperature (1½ to 2 times nominal heater voltage) test for ½ to 1½ hours with pulsed cathode current to show up tube lots which show excess cathode damage by gas-arcs at the cathode surface. These suggestions are prompted by evidence of the wide variations in life-expectancy and characteristics from lot to lot and among lots from various manufacturers, and they would serve to minimize these variations in the tubes which are supplied to the military by the manufacturers.

It appears conclusive that almost all the common receiving tubes used by the services can be improved if incentive is applied to the manufacturers for better tubes. Although the program would be an expensive one, the saving of service-man-hours during time of war would much more than pay this development cost. As an example of this, it is reported that more than $240,000. per year was cut from service costs on one aircraft communications equipment commonly used in commercial aircraft by the development of one special tube to replace the 6AK5 in airborne service. (Reprinted from *Stanford Research Institute Terminal Report* dated 1 June 1950.)

MODEL MBF TRANSMITTER-RECEIVER



by

L. G. CRUMBAKER, ETC, *ComServLant*

Recently the files of ComServLant were reviewed with particular attention to the Model MBF transmitter-receiver in an attempt to determine the most common troubles to be found in this type of equipment.

As job after job was reviewed, it became evident that, as in most electronic repair, electron tubes were responsible for the greater number of failures. However, and here is where the rub comes, at least one third of the "tube troubles" were caused by the removal of tubes, apparently for testing, and their replacement in the wrong sockets! In most cases, it has been merely necessary to remove the offending tubes and replace them correctly, with reference to the chassis markings or to the schematic. Other instances of the wrong tube in a given socket have resulted in repairs being necessary due to resistors having burned out or changed value because of unintended overload. Damage has also been caused the 25Z6 rectifiers because of the excess current drawn by the short when the elements of a misplaced tube have grounded the plate and screen supplies. The advice of testing tubes one at a time and replacing them in the sockets from which they were removed is pertinent not only to practically all equipment, but especially to the MBF. In the MBF, so many tubes are fitted into so small a space, it becomes hard to determine what type of tube goes where in the somewhat unhandy receiver and transmitter sockets.

Capacitors are the second most common trouble source, in particular the .002mfd and .0005mfd mica bypass capacitors in the V–108—V–112 string of receiver filaments. These components have been found shorted in an amazing number of receivers, causing practically full line voltage—Yes, the MBF is an AC/DC job—to appear across several six-volt tubes. The result is that one or more tubes, (generally 6AK5's) expire with a brilliant blue-white flash, opening the string of filaments and putting the receiver and most of the transmitter out of operation. Usually, the 25Z6 rectifiers and the 28D7's continue to glow, as they are in a separate series filament string across the line, in parallel with the six-volt tubes.

In tracing down the defective bypass capacitor, it is usually necessary to remove V–112 –108, –120 and –113 from their sockets. This prevents the resistance of the remaining filaments from interfering with the ohmmeter check. The faulty capacitor is inevitably located in the middle of a pile of three or four, and is almost impossible to remove without cutting or unsoldering the leads to the remainder.

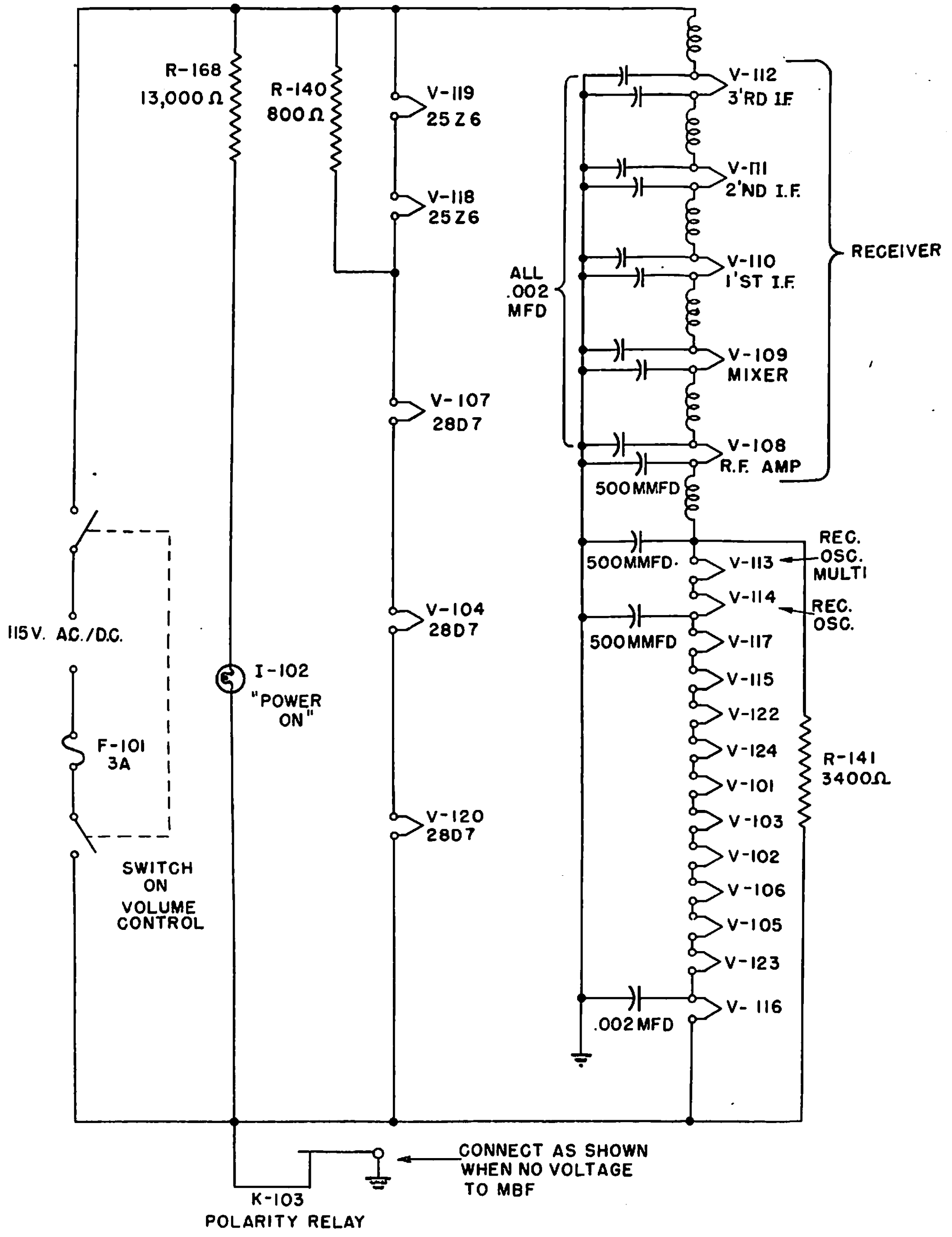
At the frequency on which the MBF operates, it is better to bring all r-f grounds to a common point, as is originally done. However, it has been found that soldering the ground lead of the replacement capacitor as close as possible to the original common ground on the shield partition, causes no reaction on the stage in question. Should an apparent 3400-ohm short show up while checking some of the six-volt filaments for shorted bypasses, it may be disregarded. The shorted capacitor will check almost zero ohms, and the 3400 ohms is due to the presence of R141 which is in parallel with the lower half of the six-volt series filaments. This resistor provides a path for the difference between the somewhat higher filament current drawn by V–108 to V–112, inclusive, and that drawn by the remainder of the six-volt tubes with which R–141 is in parallel.

R–140, an 800-ohm resistor is in parallel with the filaments of the 25Z6 rectifiers for the same purpose. These two resistors may cause an ambiguity in ohmmeter readings when checking thru the filament circuits, and should be remembered as a probable cause.

Should tests on a inoperative MBF disclose a six-volt tube with an open filament, it would be wise to check through the filament circuits to remove the possibility that a shorted bypass capacitor was the cause. This will save blowing replacements, which could lag enough before opening so that the overload would blow one or more other tubes also. Sets with series filaments are quite sensitive to line voltage changes occasioned when a ship is using machinery that draws a heavy current such as loading winches, electric cranes and hoists. In such a cirmumstance, a tube filament may open because of a momentary rise in voltage, but it will be safer to check the bypass capacitors "just in case."

Resistors have proven fairly dependable in this equipment. The few that have changed value or burned, have in most cases, been due to an internal short of the tube in the circuit concerned. Replacement of the tube and resistors after a check thru the circuit to eliminate the possibility of capacitor failure, has always served to restore the set to operation. Cathode-bias and screen-dropping resistors have been found to raise in value over a period of time. This is due to ageing or instability, possibly because a good many resistors in MBF's were manufactured under wartime standards, which often left much to be desired. The only cure for this trouble is to replace the effected parts with new units from spares. This trouble will show up either as a loss of gain or instability of the stage concerned, or can be located by a voltage check at the tube socket, comparing the readings with those given in the instruction book.

"Across the line" filament diagram for the Model MBF Radio Transmitting-Receiving equipment.



Distortion of received signals has often been found to be caused by the voice coil of the speaker rubbing on the magnet core. If this is suspected, a check should be made thru the audio amplifier stages with a pair of headphones in series with a .01 mfd capacitor, starting at the low level stages and working up to the speaker. Often, too, the speaker may be checked by inserting two fingers from the rear of the speaker and *gently* pushing against the cone. If the voice coil is rubbing, a slight scratching noise will be heard and the rubbing can be felt with the fingers. Replacement is practically the only possible repair, and can be effected easily by removing the Phillips screws holding the front panel to the subchassis' and dropping the panel.

Speaker on-off switches account for a few repair jobs, being either corroded, broken or failing to throw. It must be remembered that some of the earlier MBF's do not have speaker on-off switches that completely cut the speaker off from the receiver. The switch in this case disconnects the speaker when it is desired to use the microphone in the hand-set only for transmission. Some receiver noises will come thru the speaker regardless of the position of the switch when the MBF is in the "receive" position.

The antenna thermocouple was listed three times as being burned out. This may have been caused by the r-f pickup from a nearby transmitter, and should be considerd a possibility if the thermocouple of a given MBF has a habit of requiring replacement every so often. If no replacement is on hand, the unit can be bridged with a short piece of wire until the new unit is received. This will effect the performance of the set only to the point where it will be impossible to read transmitting antenna current. In this case, the plate current of the transmitter output stage must be consulted if the antenna tuning condenser has been mis-adjusted. Tune for maximum plate-current dip, increasing the loading if necessary to bring the current up near the red line on the tuning meter scale. The plate tuning capacitor may have to be readjusted for plate current dip, and then it would be well to go thru the antenna adjustments again, as they are interacting. For proper operation, the plate tuning capacitor must be the last adjustment made, and it must be tuned for plate current dip.

One other trouble occasionally noted, is the tendency of filaments of series-connected tubes to increase in resistance. This may be checked by reading the filament voltage across the tube sockets and comparing the reading with that of others of a similar type. The tubes most susceptible to failures of this type are the 28D7's, with some of the six-volt tubes either increasing or decreasing filament resistance on rarer occasions. Due to the small space into which the MBF components are jammed, it may be more practical, in the interests of safety, to turn the set off, remove the tubes one at a time and check their cold filament resistance against that of similar tubes. It is very easy for meter probes to slip off filament prongs and short the plate or filaments to ground. This results either in a tube or the line fuse blowing, leaving the ET feeling rather silly. The author knows whereof he speaks!

In conclusion, from the number of MBF job orders studied, it became apparent that over half of the requests were solely due to tube troubles, either low emission, open, or in the wrong socket. This leads to the conclusion that ships turning these equipments in for repair either had not even tried to repair them, or had run into a mental vacuum in the ET department, with consequent outages of the gear.

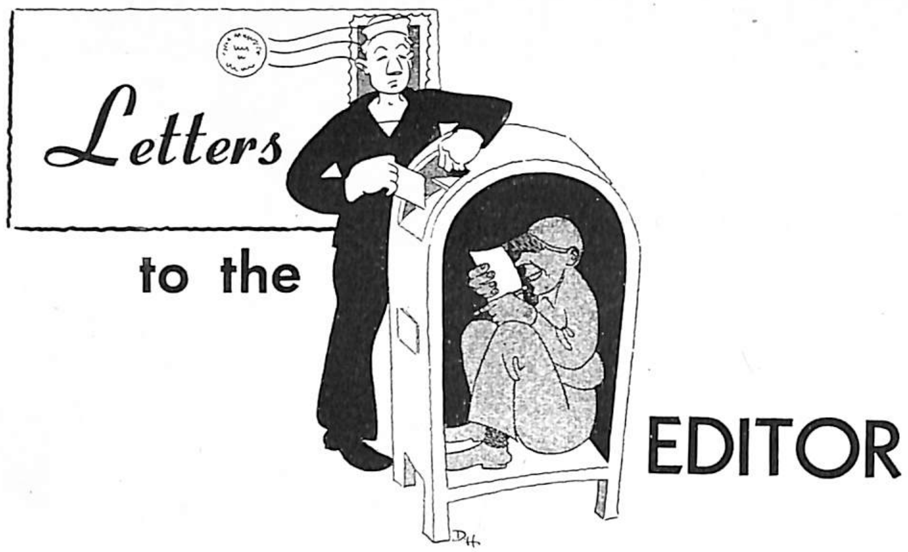
The MBF, for all its apparent complexity and admitted cramming of parts into a very small space can, and has proven to be, a reasonably dependable piece of equipment. Given intelligent and careful maintenance, your unit will prove this to your own satisfaction much more capably than this article can.

—*ServLant Monthly Bulletin*

ERROR IN CHAPTER 67, BUREAU OF SHIPS MANUAL

Chapter 67 of the Bureau of Ships Manual recently distributed contains an error due to a transposition of a line of type, according to Lt. Comdr. Lester Harlow, Ass't. Electronics Officer, Norfolk Naval Shipyard. The line at the top of the second column on Page nine (Paragraph 67-43(2)) should have been placed at the top of the first column on Page nine where it is properly a part of Paragraph 67-39(4).

When this is done, Paragraph 67-39(4) will read as follows: "(4) Upon completion of any electronics installation, it shall be the responsibility of the installing activity to test the system or equipment involved, to correct all installation deficiencies noted, and to advise the commanding officer of the ship regarding the final status and the work accomplished."



Letters to the EDITOR

Continuing a new, and it is sincerely hoped, a permanent feature of your magazine—ELECTRON. This new feature is the answer to numerous suggestions and requests from fleet and shore personnel for a medium of presenting their individual problems, gripes and questions on electronics matters and obtaining answers to such queries. This section is not to be confused with the FORUM which has been a regular part of the ELECTRON since its inception in 1945. The continuance of this new feature depends entirely on you—the personnel in the field—since we must first receive correspondence from the field before we can search out the answers and print them. As a matter of convenience, it is suggested you write directly to:

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

> *The following is typical of the type of letters received to date for inclusion in this column:*

Editor
BUSHIPS ELECTRON
SIR:

When may vessels of the Fleet expect to receive Chapter 67 of the Bureau of Ships Manual, and Standardized Electronic Preventive Maintenance Checkoff Sheets?

J. T. W. Lt(jg) USNR

Chapter 67 of the Bureau of Ships Manual is now available for Fleet activities. We are forwarding one copy to you under separate cover. The Bureau has procured a quantity of Service and Repair Manuals for the TDZ and RDZ/RDZ–1 Radio Equipments—Navships 91328 and Navships 91330 respectively. These publications should be available at various Electronics Officers issuing office and other Naval activities. Service and repair manuals are also being prepared for the AN/SPS–6, –6A, and 6B and the QHB–1 and QHBa equipments. In addition Performance Standards and Maintenance Checkoff Lists are being initiated for all of the above equipments. These latter publicationss will be available in 6 to 9 months. For further information on maintenance checkoff lists attention is invited to the three maintenance bulletins.

Editor

Editor
BUSHIPS ELECTRON
SIR:

I would like to receive some information about BK IFF equipment. From information in the RMB the color marking on the chassis for Field Change No. 3 is a blue dot one half inch in diameter; for field change number 4 it is a red square.

My problem is what does a yellow triangle signify? I am unable to find any information as to what it stands for.

W. R. P., ET 1

As far as can be determined at the present time, it appears that the yellow triangle signifies the removal of the detonator from the equipment.

Editor

Editor
BUSHIPS ELECTRON
SIR:

It has been observed that many ET's do not know the proper channels for obtaining quartz crystals. This has been noted especially on ships having no Electronics Officer, and on craft recently commissioned.

I believe the latest information concerning the proper methods of obtaining these crystals would be of great help to all ET's if published in ELECTRON, or, if the methods themselves are classified, if a reference or references could be published concerning the proper channels to go through in obtaining crystals.

L. N., ET1, USN

Stock crystals are requisitioned via regular Electronics Supply Office channels. The Electronics Supply Office will establish the procedures governing the distribution and issue of the stock crystals, both hermetically sealed and reworkable. The use of Form NBS–370 Revised is required except when dispatch action is necessary.

Full details on procurement of piezo-electric crystals can be found in the Navy Department Bulletin dated 31 March 1950.

Editor

Editor
BUSHIPS ELECTRON
SIR:

Is it at all possible for ships in the Fleet that have not been converted to the "bin stowage" system for electronic spares, to obtain breakdown lists, containing standard navy stock numbers, for individual equipments? If so, will you please print the necessary information needed to obtain same.

G. B. McF., ET3

It is considered unnecessary for ships in the fleet to have breakdown lists, containing standard navy stock numbers, for individual equipments before the ships are converted to the "bin stowage" system. Before conversion, electronic spares must be ordered under the existing system, rather than by standard navy stock number. Also, these lists are in the process of being revised. Accordingly, it is not possible for "unconverted" ships to request these lists.

Editor

USN USL notes

OPEN-KEY VOLTAGES IN H-F TRANSMITTERS

As a result of analyzing the keying circuits of several transmitters while developing an antenna break-in relay for h-f communications, the Underwater Sound Laboratory found that voltages in excess of 100 volts may appear at the exposed contacts of the telegraph hand keys. These voltages exist during periods in which the transmitter power supply is in operation and occur across the key terminals and, in some instances, between one key terminal and ground when the key is in the up position.

The following are the open-key voltages for some h-f transmitters in general use by the Navy:

Type of Transmitter	*Open-Key D-C Voltage*
TBL	85-150
TDE	110
TCF (remote keying)	115-135
TCK	120-150

Inasmuch as the voltages mentioned above are derived from power sources of good regulation (motor generators, for the most part), they must be considered to be potentially dangerous. Since the Bureau of Ships has specified that provision shall be made to prevent personnel from accidentally coming into contact with voltages exceeding 50 volts, efforts are being made to eliminate this potential hazard. In this connection, the Underwater Sound Laboratory is now developing a break-in relay with low key voltages for the SS–563 and SSK class submarines. It is felt that with some modifications, this device may be applied to other transmitters commonly used by the Navy.

countermeasures information

LATEST FIELD CHANGE DOPE

Field Changes

The following field change information supersedes all previously published information. Field Change No. 1 for Model RAO–9 is now available for fleet use. It is applicable only to those Model RAO–9 equipments used in countermeasures installations having a Model REM Dual Panoramic Adaptor installed. This field change provides an outlet for the high frequency oscillator circuit. This oscillator output is required by the Model REM to produce marker pips on its oscilloscope. The field change may be obtained by requisition from the Bureau of Ships with an information copy to Electronic Supply Office, Great Lakes.

Field Change No. 2—RDP—Improvement of Visual Presentation. Due to alignment procedure difficulties, the availability date is not known.

Field Change No. 2—AN/SPR–2—This field change for improving the tuning units has been cancelled. New and improved tuning units are under procurement. An announcement will be made when they are available.

Field Change No. 1—R–223/SPR—Improvement of Signal Delay and Blanking Pulse Shape. An announcement will be made when this change is available.

AS–45A/APR Antenna

A number of failure reports have been received from the fleet regarding the loss or breakage of the Lucite waveguide and covers of the AS–45A/APR antennas. These and covers are part of the antenna radiation system and must be in good condition for proper operation using this antenna. The Lucite ends are listed as symbol designation L–801 in the AN/SPR–2 instruction book NAVSHIPS 900,654 and the replacement stock number is N16W2400–1000.

66132 Antenna

Replacement elements for the 66132 antenna are under procurement and will be available approximately June 1951. In the interim, all 66132 antennas deteriorated beyond economical repair should be replaced. The 66131 antennas should also be replaced under the same conditions.

Interference Between Model RDO and Model RDP

In the operation of the Model RDO receiver with Model RDP panoramic adaptor, an interfering beat note can be heard in the audio output of the Model RDO receiver when the Model RDP sweep width control is set at maximum clockwise position. At this setting of the sweep control a ±5-megacycle bandwidth sweep is available for oscilloscope presentation. The Model RDO receiver is capable of supplying only an approximate ±1 megacycle- bandwidth signal to the Model RDP. By reducing the sweep width control to mid-scale, the interfering beat note will stop and the oscilloscope presentation will be more representative of the true ±1-megacycle signal that is being observed from the Model RDO receiver.

Replacing of Coaxial Cables to Countermeasure Antennas

In the majority of shipboard countermeasure installations, it will be found that the coaxial cables to the 66132, 66131, and DBM–1 antennas are in very poor condition. All cables should be properly megged, connectors inspected, and the cable runs checked for possible preventive maintenance. All cables not in good condition should be replaced at the first opportunity.

Improved Lighting for Countermeasure Installations

To improve the lighting in these installations, a shielded spot light, Type M–8A, can be procured for placing in the compartment where required. The procurement stock number is 17–L–12958–650.

THE FLEET SPEAKS

Soap box orators with long-winded harangues are notoriously boring, but YOU can tell YOUR story in ELECTRON by sending it to the Editor, *BuShips* ELECTRON, before 15 June 1951, for the September "Fleet Speaks" issue.

Miller

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One of the earliest of man's attempts to communicate afar on the field of battle is told in "The Song of Roland" (see inside front cover). In modern times, stirring victories have been won when communications operated properly. This issue of Electron features the TDZ/RDZ — the Navy's modern u-h-f communication system.

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