# SECTION I. GENERAL

## MAINTENANCE OF THE CEMB BINDER

There is a common tendency to "force" the locks at each end of the binder by depressing them too firmly. It is advised that these locks may be operated correctly with the lightest pressure. The handles are not supposed to go all the way down, but are to be depressed only enough to cause a light grip. A simple trial will demonstrate the amount of depression required of the handles in order to lock the binder sufficiently to prevent its falling apart.

In case any binder is forced to the extent that it finally does not lock, a repair may be effected by squeezing the guide lips slightly with pliers.

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## CATALOGUE OF ELECTRON TUBE TYPES

A publication entitled "Catalogue of Electron Tube Types in Use by the Navy" (NAVSHIPS 900,075) has been published and distributed to all ships and shore stations concerned with electronic equipment.

This pamphlet lists vacuum tubes by their approved designations. To be sure you get the tube you want, *use the approved designation.*

If you don't have a copy of this publication, you can get one by writing the Bureau of Ships.

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## TREATMENT OF STORED TUBES

When tubes are removed from storage for installation in equipment, it is suggested that contact pins and caps be cleaned with fine (00 or 000) sandpaper. This procedure removes all traces of dirt or oxide which may have collected on the pins and produces a clean but slightly rough surface thus assuring good contact in the sockets.

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## CARE OF MERCURY VAPOR TUBES

Certain equipments such as the LR frequency meter and the TBM and TBM–2 transmitters employ mercury vapor rectifier tubes such as types 872, 866, 82, 83, etc. When these equipments are turned on after a period of disuse there may be violent arcing inside the tube due to the collection of metallic mercury on the filament and walls of the tube. This may damage associated transformers as well as ruin the rectifier tube.

This condition may be avoided and the life of mercury vapor rectifier tubes considerably increased by adherence to the following suggestions:

(1) Before putting a tube in service, always wipe the bulb clean to avoid surface leadage and the resultant heating effects.

(2) Maintain the filament voltage at its rated value to provide the proper amount of barium at the surface of the cathode.

(3) In tropical climates or under high temperature conditions, forced ventilation may be necessary to obtain the specified ambient temperatures as recommended by the manufacturer for certain mercury vapor tube types. The temperature of the condensed mercury in the base of any mercury vapor tube should be kept within the specified limits to insure proper vapor pressure for optimum operation. Low condensed mercury temperature decreases the mercury vapor pressure and raises the potential at which the tube starts to conduct. This causes deterioration of the filament because of the higher voltage drop across the tube. On the other hand, high condensed mercury temperature reduces the peak inverse voltage that the tube can stand and may cause arc-backs with consequent destruction of the tube. Either condition reduces tube life. The temperature of the condensed mercury may be measured with a thermometer attached with a small amount of putty to the bottom of the glass bulb.

(4) Whenever a new mercury vapor rectifier tube is installed or when equipment is to be used after standing idle for a month or more, the tube must be conditioned. This is accomplished by running the tube for one-half hour at rated filament voltage and *without* any plate voltage applied. This procedure assures the evaporation of all mercury from the tube bulb and mount before plate voltage is applied. The reasons for this operation are:

(*a*) Liquid mercury clinging to any part of the mount may cause excessive mercury pressure at that point with resultant local arcs.

(*b*) Mercury globules that adhere to the plate may act as a pool cathode and cause arc-backs.

(*c*) Mercury condensed on the glass may cause mercury vapor streamers which can produce excessive heating of the bulb.

(5) If at all possible, plate voltage should not be applied to mercury vapor tubes until 30 seconds after filament voltage has been applied. This insures adequate time for pre-heating the filament to insure proper mercury vapor pressure for best operating conditions. Should plate voltage be applied too soon, the cathode will be bombarded and harmed because of the resulting high voltage drop through the tube.

## REMOVAL OF TUBES FROM EQUIPMENTS

In some sets tubes are mounted very close to other parts and their removal is often very difficult. Such tubes may be removed by making a "lasso" out of a few feet of hook-up wire and slipping the noose over the tube down to the base. With assistance from one hand on the top of the tube, a slight vertical tug on the wire with the other will remove the tube. Care should be taken not to use the lasso on the glass portion of tubes as the glass may come loose from the base.

"Loktal" tubes cannot be removed by this method as they lock into the socket. They may be removed by rocking the tube circularly in its socket until its release from the socket lock is evidenced by a slight click. The tube may then be removed by a vertical pull. When being inserted in the socket they must be located in the proper position by the key on the locating plug in the center of the base, in the same manner as octal based tubes. The tube is then pressed down until locked in the socket which is evidenced by a slight click.

## TESTING TYPE CWL–861 ELECTRON TUBES

Figure 1 shows the recommended method of opening the waterproof paper containers used for shipping type CWL–861 electron tubes. In order to conveniently test this tube type for continuity, the Westinghouse Electric and Manufacturing Company recommends that the bottom of the case (end opposite the handle) be opened and the tube tested as shown in Figure 1.

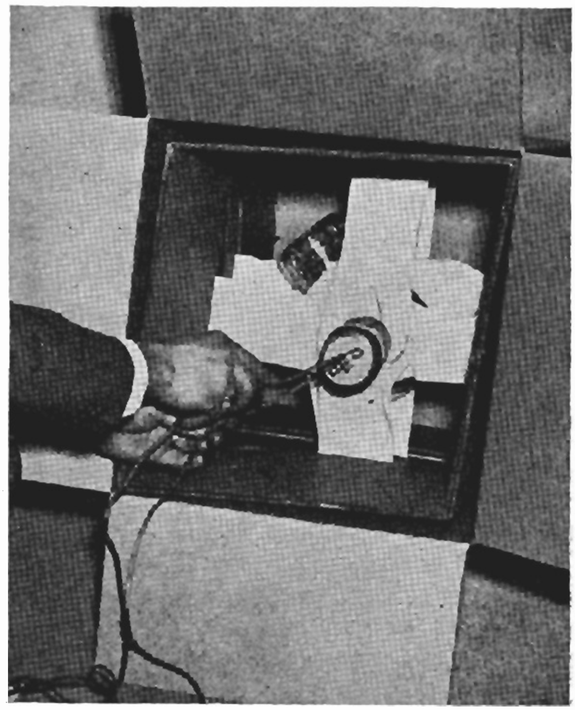

FIGURE 1.—Testing type CWL–861 tubes.

For testing in this manner, it will not be necessary to remove the tube or packing material from the container. After testing, the container should be resealed with the proper kind of tape.

## NOTES ON INSTALLING ACORN TUBES

Acorn tubes are usually installed in ring-shaped sockets. When installed in such sockets they should always be inserted so that the short-tipped end rests in the mounting hole. This places the large end on the same side of the socket as the clips.

The design of the socket will not prevent the tube from being accidentally inserted *upside down*. If this should occur, the tube and probably a plate circuit resistor would burn out. With some sockets it is also possible to insert the tube *backwards*, i. e., with the two-grouped tube prongs inserted in the three-grouped socket clips and the three-grouped tube prongs inserted in the two-grouped clips.

It is obvious that there is but one correct way to mount acorn tubes in their sockets. A simple rule to remember is to *always grasp the large end of the tube* in the fingers and insert the *two-grouped* tube prongs in the *two-grouped* socket clips.

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## MAINTENANCE OF TRANSMITTING VACUUM TUBE SPARES

In radio communication equipment where the transmitters are not used continuously a rotation of spares is undesirable. However, the quarterly tests as outlined in BuShips Manual 67–151 should be modified to include spare tubes and the test on shipboard should include an operational test of at least one hour, the main purpose of which is to clean up any gas present. The tube should be operated as near its maximum ratings as possible. This is particularly true of tantalum plate tubes as no clean-up is obtained unless the plate is operated at a white color in the center.

Types which should be given this operation test include the 203–A, 204–A, 211, 217–C, 803, 805, 809, 811, 812, 813, 814, 833–A, 838, 845, 849, 851, 852, 860, 861, and 38111A.

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## NEW RMA TYPE DESIGNATIONS FOR TRANSMITTING AND SPECIAL PURPOSE TUBES

In the fall of 1942 a new system of type designations for transmitting and special purpose tubes was evolved by the Radio Manufacturers' Association in collaboration with the Army and the Navy. Its purpose is to make type numbers somewhat descriptive of the tube as well as to prevent duplication of type numbers. In general, these designations comprise three symbols: the first (a number) indicates the approximate heater power of the tube; the second (a letter) designates the general class of tube structure; and the third (a second number) gives the serial order in which the type designation has been assigned (beginning with the number 21 in order to avoid conflict with receiving tube designations).

Ranges of heater power and classes of tube structure, with the assigned symbol contemplated for inclusion in this system are given below:

| *First number* | *Range of heater (watts)* | *Letter* | *Tube structure* |
|---|---|---|---|
| 1 | 0 | A | Single element. |
| 2 | 0 to 10 | B | Diode. |
| 3 | 10 to 20 | C | Triode. |
| 4 | 20 to 50 | D | Tetrode. |
| 5 | 50 to 100 | E | Pentode. |
| 6 | 100 to 200 | F | Hexode. |
| 7 | 200 to 500 | G | Heptode. |
| 8 | 500 to 1000 | H | Octode. |
| 9 | over 1000 | J | Magnetron. |
| | | K | Velocity-modulated. |
| | | N | Crystal rectifiers and crystal detectors. |
| | | P | Photo-emissive. |

When an old commercial type is changed to the new system, double branding will be used for some time.

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## INTERELECTRODE LEAKAGE IN TYPE 6X5 AND 6X5GT RECTIFIERS

* Certain equipments such as models RBO, DAE, DAK–1, DAK–2, DAQ, MN, etc. use a type 6X5 or 6X5GT/G rectifier tube. This tube has an indirectly heated cathode, the heater being rated at 6.3 volts AC or DC at 0.6 ampere. In order to reduce the d-c voltage drop across the tube to as low a value as possible, the elements are very closely spaced and frequently, under conditions of mechanical shock such as gunfire, they short-circuit either momentarily or permanently, causing damage to power transformers.

Inasmuch as the heater is rated at 6.3 volts, it is often connected in parallel with the heaters of other 6.3-volt tubes. In the usual heater circuit either the electrical center or one side of the circuit is connected to ground, and, if a heater to cathode short circuit develops, a very heavy overload is placed on the high-voltage winding of the power transformer. The overload may cause burnout of the high-voltage winding or the primary winding. Fuses in the primary circuit are supposed to afford protection against such conditions, but experience has shown that even the proper fuses do not always protect the power transformer.

It is strongly recommended that all type 6X5, 6X5G, and 6X5GT/G rectifier tubes be frequently checked for inter-electrode leakage in a tube tester employing a neon lamp leakage checking circuit. Models OD, OQ and OZ tube testers are satisfactory. The tube should be tapped with the finger during the test. If a power transformer has failed in an equipment employing a 6X5, 6X5G or 6X5GT/G rectifier, the tube should be very carefully tested for inter-electrode leakage before replacing the transformer.

## POWER TRANSFORMER FAILURES

The majority of power transformer failures are directly traceable to troubles originating in other components of the equipment. By means of a few simple tests much of this trouble can be avoided.

Frequent tests should be made to determine the line voltage, and in those cases where the voltage is found to exceed the rating of the equipment by more than 5 percent, steps should be taken to reduce it to within the allowable limits. For optimum results the line voltage should not vary more than ±5 percent. High line voltage will cause transformers to heat excessively, causing the insulation of the windings to char. When this happens flash overs, burnouts, and shorted turns are the result.

If a watt-meter is available the equipment may be checked, and compared with the rating in the instruction book. In the absence of a watt-meter, a rough check may be made by feeling the case of the power transformer. If the transformer is so hot that a hand cannot be held on it indefinitely (the transformer will be *warm* in normal operation) there is too much current being drawn and the equipment should be turned off until the trouble can be located and corrected.

Shorted tubes, condensers, reactors and grounded terminals should ordinarily be found easily. Direct shorts can be determined quickly by removing the rectifier tube and measuring the resistance from filament or cathode (some rectifiers are indirectly heated) to ground. Reference to the instruction book will give the correct resistance. Small variations will occur, but the resistance should not vary more than 10 percent.

Frequently a piece of equipment will operate to all appearances normally, but the transformer overheats. In such cases it is well to test for tubes which partially short, condensers with high resistance leaks, resistors which ground—things causing an increased excessive drain, but not sufficient to prevent operation of the equipment. Point-to-point resistance charts furnished in the instruction books for each equipment should be used to facilitate the work and increase the efficiency of the units.

It should be borne in mind that any abnormal current drain on the secondary side of a power transformer will cause a correspondingly heavier drain on the primary side, and that heavy and abnormal current drains will heat the windings of the transformer causing eventual burnouts, shorts, etc. Defects of power transformers are rare; their failure is usually caused by some other component in the equipment.

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## RADIO EQUIPMENT LOG

A new log book for maintaining a complete history of a ship's or station's communications and direction-finding equipments is available. It is known as the "Radio Equipment Log" (NAV-SHIPS 900,039). The purpose of this book is to make the radio technician's job easier, and if the entries called for in the log are carefully made, we believe it will accomplish this purpose.

The logs are distributed on the basis of one for each radio space. However, it is up to each activity how the record is maintained. You can keep more or less logs going depending on which suits your purpose better. If you need additional copies they may be obtained from one of the Radio Pools or from the Bureau of Ships.

Incidentally an error occurred in the printing. The heading of page 16 should read "Record of Test Equipment."

The sample on page 226 shows the corrective maintenance logged in a strictly chronological manner. Radio Material School, NRL, has suggested that it might be better to enter all items pertaining to a given equipment on one page. This is offered as a suggestion. Whichever method suits your needs best is the one to use.

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## CORRECTIONS TO THE "LORAN HANDBOOK FOR SHIPBOARD OPERATORS"

The following corrections should be made in the "Loran Handbook for Shipboard Operators":

*Page 8:* Interchange the second line from the bottom of the first column and the ninth line from the bottom of the second column.

*Page 12:* In the second line of the first column of the table, change "LRN" to "LRN–1".

*Page 26:* In the 5th line of the second column, change "–E" to "–F".

*Page 27:* At the top of the page change "770" to "310".

*Page 28:* At the top of the page change "310" to "770".

*Page 29:* In the 12th line from the bottom of the first column, change "of" to "as".

*Page 43:* At the top center of the insert only change "B′" to "B" and "C′" to "C".

*Page 49:* Delete the 12th line of the first column and substitute "and manipulation of NDRC Model LRN–1".

*Page I–12:* In the eleventh line from the top of the second column, change "500" to "50".

In a second printing of this book, these errors were corrected.

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## ISSUE OF PUBLICATIONS TO INDIVIDUALS

The Bureau gets letters from time to time from individuals requesting publications for their personal use. While we appreciate the interest and enterprise of these people who are anxious to improve their understanding of radio, unfortunately it is not possible to print enough copies for personal issue. Therefore, if you find your ship or station hasn't enough copies of some publication for convenient use, ask the commanding officer to make an official request for what you need. A good policy is to *establish a library or central reference point where everyone can read and study radio publications.*

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## FINAL INSTRUCTION BOOKS

Final instruction books are available on the equipments listed below. Activities holding preliminary editions should request final books on the basis of two per equipment from the nearest Radio Material Officer.

| | |
|---|---|
| DP–14/15/16/17 | LR–2 |
| DP–18/19 | MAN |
| DAG–1/2 | OF–1 |
| DAQ (RPS) | RAK–6 |
| DAS/DAS–2 (RPS) | RAK–7 |
| DAU (RPS) | RAK–8 |
| DAW–1/2 (RPS) | RAL–6 |
| LM–11 | RAL–7 |
| LM–12 | RAL–8 |
| LM–15 | RAS–4 |
| LM–16 | RAS–5 |
| LM–17 | RBA/1/2/3 |
| LM–18 | RBG/1/2 |
| LO–3 | RBJ–1 |
| LP–3 | RBJ–2 |

| | |
|---|---|
| RBJ–3 | TCA–1 |
| RBJ–4 | TCC–3 |
| RBK–12 | TCE–2 |
| RBO | TCP–2 |
| RBO–1 | TCS |
| RBO–2 | TCS–4 |
| RBP | TCS–5 |
| RCB–1 | TCS–6 |
| RCK | TCS–7/9/10/11/12 |
| TBA–8 | YE–1 |
| TBK–8/10 | YG |
| TBK–12 | YG–1/2 |

## FAILURE REPORT FORM NBS–383 (REVISED 4-44)

Valuable information is being omitted from numerous of these forms being received by the Bureau. In order to make the best use of the form it is requested that the items be completed as follows:

(1) Date: This is the date the card is filled out and should be as soon as possible after the failure.

(2) Ship Number and Name or Station: Both the name and number of the ship should be given or the name of the station.

(3) Name and Rank or Rating of Person Making Report: Preferably this should be the repairman who is familiar with the equipment.

(4) Check type of equipment involved.

(5) Model No.: This should include the series number as well as the letter designation of the complete equipment, such as TBL–5.

(6) Name of Contractor: The name of the contractor of the complete equipment as shown on the nameplate.

(7) Serial No.: The Serial number of the complete equipment.

(8) Type Number and Name of Major Unit Involved: The major unit involved is the transmitter, receiver, modulator, power unit, control unit, power supply, motor starter, etc. The type number is the Navy type number of the major unit involved.

(9) Serial Number: This is the serial number of the major unit involved, if given.

(10) Contract No.: The contract number is very essential and can be secured from the nameplate on the equipment.

(11) Date Installed: This refers to the date the complete equipment was installed and should be stated approximately if not definitely known.

(12) Description of Part: The name and description of the part should be the name as it is given in the parts list of the instruction book.

(13) Circuit Symbol: This should also be the same as it is given in the instruction book, such as C–105.

(14) Navy Type: When a part has a Navy type number it is shown in the instruction book for the equipment.

(15) Approximate Life: This information is valuable when the part which failed has had a very short life.

(16) Brief Description of Failure: This should include brief information as to what caused the failure, how the operation of the equipment was affected by the failure and how the failure occurred, such as: "Receiver dead; R394 burned out due to short in C–318". Do *not* say "Failed in normal service". A description of conditions surrounding failures as well as the symptoms exhibited by the defective apparatus are very valuable for preparing trouble shooting notes and for the elimination of "bugs" in future equipment.

It should be remembered that the function of the failure report is to secure data for:

(1) Procurement of spare parts.

(2) Location of design defects in equipment.

(3) Development of modifications and modification kits.

(4) Making adjustments with contractors under guarantees.

(5) Preparation of trouble shooting notes and service data.

(6) Avoidance of "bugs" in future designs.

These functions cannot be performed unless:

(1) A failure report is sent in for *each* and *every* failure, regardless of whether the equipment is made under Navy, Army or Coast Guard contracts. Commercial equipments in the Naval service should also be covered by failure reports.

(2) Each report is completely and accurately filled out.

The Bureau is ready, willing and able to help the forces afloat, but it can accomplish this purpose only when supplied with the necessary data.

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## SUBMISSION OF QUARTZ CRYSTAL RECORDS

Several destroyers have recently submitted to the Bureau of Ships record sheets of radio crystals and crystal holders on DesAt form No. 91 (c). In accordance with the program for the elimination of forms no longer necessary for Bureau purposes, these quartz crystal records no longer need be submitted to the Bureau of Ships.

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## SUBMISSION OF TRANSMITTER TUNING RECORDS

As transmitter tuning records are still being received in the Bureau from the field, attention is directed to BuShips letter serial no. 340 (925B) over EN28/A2–11 dated 5 January 1944 addressed to all Navy ships and several other Naval activities. This letter is reprinted here for the information of all cognizant activities:

"Subject: Radio—Transmitter Tuning Records.
Ref: (a) Manual of Engineering Instructions, Chapter 31 (mimeograph form).
(b) Form NBS–342 Transmitter Tuning Records.

1. Reference (a), paragraphs 31–225 to 31–229, inclusive requires preparation and submission to the Bureau of Ships of Transmitter Tuning Record Form NBS–342.
2. In the interest of reduction in paper work, addressees are advised that preparation and submission of transmitter tuning records is no longer required.
3. Each ship and station shall maintain sufficient transmitter tuning data to permit competent personnel inexperienced with the particular station to adjust any transmitter, and to serve as a guide to the expected performance of the transmitter installation."

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## SPARE PARTS FOR NON-STANDARD TYPES OF RADIO EQUIPMENT

By previous correspondence, the Chief of Naval Operations established allowances for VHF equipment. The standard Navy type for this is known as the TDQ transmitter and RCK receiver. Pending the availability of the TDQ/RCK, the Bureau of Ships procured the Army types BC–639/BC–640 as "stop-gap" equipment. The delivery rate of the BC–639/BC–640 was not sufficient to meet urgent needs and such deliveries as were made were without spare parts for ten months after initial deliveries. Observing that the supply of BC–639/BC–640 would not meet vital requirements, the Bureau obtained, through the Bureau of Aeronautics, approximately 500 sets of the Army type SCR–274N as additional "stop-gap" equipment. This equipment could be obtained only in an incomplete condition and without spare parts, but the immediate need was so urgent that it was accepted and distributed to the forces afloat in an effort to give the forces afloat everything which was available as quickly as possible. It was never intended that the 274N would serve other than as a temporary substitute to be replaced at the earliest opportunity by the TDQ/RCK. Spares could not be obtained and are still not available. Inasmuch as the TDQ/RCK production has begun the Bureau is taking no further action to obtain spare parts for the SCR–274N.

By numerous requests to the Bureau for spare parts for miscellaneous types of equipment, it is apparent that many sets of the types SCR–522, SCR–624 and WE–233A have been installed by the forces afloat. This material was obtained, not through the Bureau, but from the Army or other activities in the operating areas. Inasmuch as the Bureau was not advised to anticipate spares for this equipment, no action has been taken to have such spares made available to the Bureau. The only source of such spares is from the activity which originally furnished the material to the ship.

Recently Army types SCR–508, 608, 609, 610, 619 and the BuAer type WE–233A have been authorized as part of the allowance for certain ships. The Bureau is procuring this equipment and will distribute it to the various installation activities in the same manner as standard Navy types of equipment. In order to clarify the procurement and distribution of spare parts for Army equipments, the Bureau has sent out a pilot letter which is reproduced here for the information and guidance of all concerned:

NAVY DEPARTMENT

BUREAU OF SHIPS

Washington 25, D.C.

Serial No. 1028(970)
EN28/A2-11

29 May 1944

To: Commandant, Navy Yard:
New York, N. Y. Navy #128
Mare Island, Calif.
Supply Officer in Command, Naval Supply Depot, Mechanicsburg, Pa.
Supply Officer in Command, Naval Supply Depot, Clearfield, Utah.
Commander Service Force, Seventh Fleet, c/o Fleet Post Office, San Francisco, Calif. (Att: RMO)
Commander, Eleventh Amphibious Force, c/o Fleet Post Office, New York, N. Y. (Att: RMO)

Subj: Radio—Maintenance Material for Servicing Army Type Radio Equipment in Use by the Navy.

1. The Navy will, in the immediate future, start receiving maintenance material for servicing Army type radio sets in use by the Navy. This material is being delivered to the Navy in two forms, i.e., "Depot" and "Third (3rd) Echelon" maintenance.

2. With the exception of Naval Supply Depot, Mechanicsburg, action addressees should, on receipt of "Depot" spares, place this material in bins by stock number, and issue as required to fill requisitions. Stock is to be maintained by requisition on the Bureau of Ships. Naval Supply Depot, Mechanicsburg, is to retain "Depot" maintenance intact for future distribution as directed by the Bureau of Ships.

3. Third (3rd) echelon maintenance corresponds to Navy tender spares, however, it must be repackaged for adaption to the Navy's needs. Naval Supply Depot, Clearfield, has been designated as the repackaging center. All third (3rd) echelon maintenance as received from the Army will be sent to Clearfield for repackaging after which it will be distributed as directed by the Bureau of Ships. The repackaged third (3rd) echelon sets are not to be broken open but are to be retained intact for further distribution as directed by the Bureau.

4. It must be kept in mind that there is no single list of "Depot" maintenance for a complete equipment but several lists, determined by the number of components comprising the complete equipment.

*For example*:

Army type SCR-608 consists of:

BC-683 (receiver)
DM-34 (dynamotor)
RM-20 (control unit)
A-83 (antenna) etc.

It is also to be kept in mind that all the components will not necessarily come from the same Army Supply Depot. Therefore, it is to be expected that the components making up a set of "Depot" spares will be received as separate shipments, from several sources, at different times. It is not anticipated that this will present any difficulty since the material all goes into the stock bins.

5. The Ground Maintenance Activities (G.M.A.) lists covering this material are being reproduced and will be distributed as rapidly as they become available.

E. L. FRYBERGER,
*By direction of*
*Chief of Bureau.*

CC:
CINCLANT
COMSERVLANT
CINCPAC
COMSERVPAC
COMNAVEU
COMNAVNAW
COM 11th PHIB
COMSERVRON 3rd Flt.
COMAIRCENTPAC (RMO)
COM 7th Flt.
RMO, NYBoston
RMO, NYNYK
RMO, NYPHILA
RMO, NYNOR
RMO, NY Charleston
RMO, NYPuget Sound
RMO, NY Mare Island
RMO, NYPEARL
RMO, INDMAN 7th N.D.
RMO, INDMAN 11
RMO, INDMAN 17
RMO, INDMAN 8

## INSTRUCTIONS FOR OBTAINING CLASS 16 MATERIAL

The numerous requests from the forces afloat addressed for action to the Bureau of Ships indicate that many commanding officers are unfamiliar with the proper procedure for obtaining Class 16 material.

All requests improperly addressed to the Bureau for action not only burden the Naval communication facilities and place an unnecessary work load on the personnel clearing these requests, but, more important, are inherently subject to the delays incident to rerouting the request to the appropriate action activity.

In order to clarify this situation, an outline of Bureau policy and practice is given herewith. Attention is invited that details are purposely omitted in order to keep this as brief as possible All pertinent Naval regulations, all necessary

Bureau of Supplies and Accounts paper work, and any effective service force or type command instructions must be carried out.

Ships radio, detection radar, IFF, sonar and test equipment material is not distributed directly by the Bureau of Ships to building yards (except in some special cases for sonar) but is distributed to the Radio Material Officers in the various Naval districts who in turn distribute it to the building yards for installation in ships under construction. This material is under the control of the Bureau of Ships but is administered by the Radio Material Officers at their discretion. In addition to the material distributed for new construction, an additional amount of material is allocated to the Commander-in-Chief, Pacific Fleet and Commander-in-Chief, Atlantic Fleet for installation in operating vessels. This latter material is controlled and administered by the Commander Service Force, Pacific Fleet and Commander Service Force, Atlantic Fleet.

Due to production difficulties certain major equipments and test equipment may be delayed, and in extreme cases the ship may leave the building yard without the equipment. If the building yard is not the fitting-out yard, then every effort is made to get the equipment aboard at the fitting-out activity before the ship puts to sea. *If all efforts fail and the ship leaves the fitting-out activity without some particular equipment, this equipment then should be obtained by application to the nearest Radio Material Officer from any port the ship may be in, or to the appropriate Service Force Commander via Type Commander.* Thus, if a ship which has joined the fleet has a shortage of items of major equipments or test equipment, the proper procedure is to advise the appropriate Service Force Commander who will provide the missing equipment. The Service Force Commander will forward such requests to the Bureau only when he is unable to provide the requested material.

Due to temporary non-availability of certain materials, it has been necessary in some cases to permit manufacturers to ship spare parts boxes without certain items. This has been done in order to give the vessel as much as was available, as soon as possible. It is obvious, also, that various spare parts will be consumed from time to time. The proper procedure to obtain a part which is missing (i.e. due to expenditure or non-receipt) from a set of spare parts is to apply to the nearest Radio Material Officer, tender or Naval supply activity at whatever port the ship may be in. The Radio Material Officer is authorized to issue this material to the ship to complete the set of spare parts. If the material is not available at the particular port in which the vessel may be, the Radio Material Officer can request Navy Yard, New York or Navy Yard, Mare Island as appropriate to supply the material.

If the Radio Material Officer or Naval supply activity contacted is unable to fill a requisition from material on hand, he will attempt to obtain and furnish the material before the vessel leaves his vicinity. If he is unable to obtain the material prior to the vessel's departure he will return the unfilled portion of the requisition to the ship and advise the commanding officer that no further action can be taken by him to supply the missing items and that the unfilled portion should be cancelled. The commanding officer will then submit a new requisition on his next arrival in port, or next contact with any supply activity. This is to prevent the situation of having many items following the ships, which in many cases will never get delivered, resulting in waste of shipping space and loss of components, many of which are very scarce.

In regard to changes of allowances which have been established by the Chief of Naval Operations, the proper procedure is to refer the subject first to the appropriate Service Force Commander via the Type Commander. All changes in the standard allowances can be effected only by the Chief of Naval Operations. Therefore, a request for change in allowance should be addressed to the Chief of Naval Operations via the Type Commander and Service Force Commander.

It is the intention of the Bureau to replace all "stop-gap" models of equipment as soon as a sufficient quantity of the later "standard" models are available over and above the requirements for new construction. Vessels having obsolete or "stop-gap" equipment should address requests for replacement to the appropriate Service Force Commander.

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## CORRESPONDENCE CONCERNING DISTRIBUTION AND ALLOCATION OF MATERIAL

It has been noted that occasionally communications are received from the forces afloat concerning requests for the allocation of certain electronic material. These requests should normally have been received from the local RMO as representative of the Electronics Division, Bureau of Ships and should have been evaluated by that officer so that the Electronics Division would have the benefit of his experience and his first-hand knowledge of the situation.

It is not desirable that such requests be returned for resubmittal, as this procedure would result in a considerable delay and in many cases a worthy request would be delayed to such an extent that compliance becomes difficult if not impossible.

However it is considered desirable that in all such cases, communications be addressed to the nearest RMO in order that he, as the Electronics Division's representative may be kept informed of all such transactions, and that we may have the benefit of his first-hand knowledge. The above policy includes, where circumstances dictate, communication with the service force commanders concerned as well.

●

## IMPORTANCE OF PROPER DESCRIPTION ON REQUISITIONS FOR CLASS 16 MATERIAL

To insure prompt delivery of Class 16 replacement parts on requisition, it is imperative that all items be clearly identified. Many instances have been reported where supply activities have been unable to furnish items requested because of insufficient part descriptions.

When ordering Class 16 replacement parts as much of the following information should be given as pertains:

(1) Federal standard stock number, if any.

(2) Navy type number of the part itself; if not available, the equipment manufacturer's part or drawing number, together with the names of the manufacturer of the equipment and the part.

(3) Navy model letter of the equipment in which used, and circuit symbol describing it; or if not a Navy model, the manufacturer's type number on the whole equipment and the name of the manufacturer.

(4) A description of the part itself including its capacity, resistance, rating, power supply or other characteristics.

(5) If an equivalent item instead of an exact replacement is satisfactory, state so and indicate whether the supplied part should be equivalent as to size, weight, capacity, function, rating, or some other characteristics. This information is extremely helpful in deciding whether an available part is sufficiently close to the desired characteristics to justify sending it.

(6) Whether in equipment, tender or stock spares.

(7) Vacuum tubes should be ordered in accordance with the approved Navy designations as set forth in "Catalogue of Electron Tube Types Used by the Navy" and published by the Bureau of Ships, Electronics Division (copies are available on request).

Requests will specify the quantity required for immediate delivery and also the additional quantity required for stock. If part of the order must be delivered by a certain date, or directly to another supply activity, this fact will be stated.

●

## USE OF STANDARD FREQUENCY BROADCASTS FOR CHECKING FREQUENCY METERS

The Bureau of Ships Manual, Chapter 67 requires that all activities check their frequency meters for accuracy against Bureau of Standards standard frequency transmission (WWV) and that a record of each check shall be made in the material log.

The following information, based on Bureau of Standards Letter Circular LC–780 of 26 February, 1945, is presented to assist in securing the maximum benefit from WWV transmissions:

The National Bureau of Standards provides a continuous day and night broadcast of standard frequencies and related services from its radio station WWV at Beltsville, Md., near Washington, D. C. This makes widely available at all times the following services: (1) standard radio frequencies, (2) standard time intervals accurately synchronized with basic time signals, (3) standard audio frequencies, (4) standard musical pitch, 440 cycles per second, corresponding to "A" above middle "C". Radio carrier frequencies of 2.5, 5, 10, and 15 megacycles per second are currently in use as stated in the announcement "Standard frequency broadcast service of National Bureau of Standards," obtainable on request. Address request to National Bureau of Standards, Washington 25, D. C.

As stated in the announcement, the accuracy of all the frequencies, radio and audio, as transmitted, is better than a part in 10,000,000. Transmission effects in the medium (Doppler effect, etc.) may result in slight fluctuations in the audio frequencies as received at a particular place; the average frequency received is, however, as accurate as that transmitted. The time interval marked by a pulse every second is accurate to better than 10 microseconds (0.00001 second). The modulation frequencies, 440 and 4000 cycles per second, are not broadcast during the first minutes of each five minutes starting on the hour and each five minutes thereafter. This marks time intervals of 1 minute, 4 minutes, 5 minutes, and longer, which are accurate to a part in 10,000,000 and whose beginnings and ends are synchronized with the seconds pulse. The beginning of the periods when the audio frequencies are off are so synchronized with the basic time service of the U. S. Naval Observatory that they mark accurately the hour and the successive 5-minute periods.

The broadcast on 5, 10, and 15 megacycles per second is from 10-kilowatt transmitters having power outputs, when modulated, of 9.4 kw for 5 mc/s, 9.1 kw for 10 mc/s, and 8.9 kw for 15 mc/s. The power output on 2.5 mc/s is 1.0 kw. Peak amplitude modulation is 100 percent. Two or more carrier frequencies are on the air at all times, and reasonably good 24-hour service is provided over much of the world.

In making use of the broadcast, one should select the carrier frequency that gives best reception at a particular time in a given locality. This can be done by tuning to the different frequencies and selecting the most suitable, or by making a study of conditions that affect the propagation of radio-frequency waves. The latter is a fairly involved procedure because of the large number of variables. Also, a separate calculation must be made for each transmission path, this being applicable only for a particular time of day, season, and year, and certain phenomena, as yet unpredictable, are involved. Fortunately, these variations are not rapid and it is possible to give an approximate guide to choosing the carrier frequency for best reception. The following tabular data are for radio receivers located in the northern hemisphere between latitudes of approximately 20 and 50 degrees and local times of noon and midnight at Washington. Reception conditions at other times of day may be estimated by assuming a gradual change from one condition to the other. The ground wave from the transmitter

*Table 1.—Approximate distance ranges, Summer 1945 and 1946*

| Local time | Frequency, kc/s | Tone reception, miles | Carrier frequency reception, miles |
|---|---|---|---|
| Midnight | 2,500 | 0 to 1100 | 0 to 1900 |
| Midnight | 5,000 | 300 to 2500 | 300 to 3000 |
| Midnight | 10,000 | 1200 to 10,000 | 1200 to 12,000 |
| Midnight | 15,000 | 2000 to 10,000 | 1800 to 12,000 |
| Noon | 5,000 | 0 to 350 | 0 to 600 |
| Noon | 10,000 | 450 to 1300 | 400 to 2200 |
| Noon | 15,000 | 800 to 3500 | 700 to 6500 |

*Table 2.—Approximate distance ranges, Winter 1945–46*

| | | | |
|---|---|---|---|
| Midnight | 2,500 | 0 to 2000 | 0 to 5000 |
| Midnight | 5,000 | 400 to 8000 | 300 to 8500 |
| Midnight | 10,000 | 900 to 9500 | 800 to 11,000 |
| Midnight | 15,000 | (1) | (1) |
| Noon | 5,000 | 0 to 900 | 0 to 1400 |
| Noon | 10,000 | 0 to 2600 | 0 to 3700 |
| Noon | 15,000 | 200 to 4300 | 150 to 8000 |

1 Sporadic propagation.

may be received on each of the frequencies out to distances of about 50 miles. Beyond this distance, a skipped area is usually found, and beyond this, the area in which good reception is normally possible. There are times of poor reception because of ionospheric storminess or transient effects which disturb the upper-air regions through which high-frequency radio waves travel.

## VERY-HIGH FREQUENCY MEASUREMENT METHODS

Standard Navy radio equipment now in operation, such as the models TDQ, TDT, RCO and RCH etc., have carrier output frequencies beyond the normal usable range of the Navy models LM and LR frequency measuring equipments. The fundamental frequency of the crystals employed in the crystal oscillators of these receivers and transmitters are, normally, never in excess of 17 megacycles.

Satisfactory transmitter measurements above 17 megacycles can be obtained by first turning on only the oscillator of the transmitter. The output frequency of the oscillator may then be readily identified and measured directly on the Navy models LM or LR equipments. The LR is accurate to within 0.003 percent and the LM is accurate to within 0.01 percent. The actual carrier frequency can then be found by the equation $f_m \times n$ where $f_m$ is equal to the fundamental frequency of the crystal which has been determined by measurement with either the LM or LR equipment, and "n" is equal to the frequency multiplication in the transmitter. The frequency multiplier or buffer amplifier stages may sometimes drag or shift the crystal frequency by a small amount. Where this difficulty is encountered, it may be overcome by checking the oscillator frequency of the transmitter when only the oscillator is on; then turning on the entire transmitter, completing any necessary tuning of the various stages, and rechecking the crystal frequency with all of the transmitter stages running. Since the heterodyne frequency meter has been set up on the first measurement, changes of the original settings would be small and the correct signal should be identified easily and quickly.

Satisfactory receiver measurements, greater than 17 megacycles, may also be obtained by following the general method outlined in the preceding paragraph. Each receiver of a different type is in itself a special problem. First, if the harmonic or fundamental frequency output (dependent on whether the LR or LM equipment is used as the testing medium) is sufficient to drive through the i-f stages of the receiver, maximum i-f output may be shown by connection of an output meter or oscilloscope to the output of the RCO, for the purpose of measuring variations in output signal strength; or by observing an upward indication of the "input" meter located on the front panel of the RCK. In either the RCO or the RCK, maximum output will occur when true IF is being passed. This frequency meter reading should be recorded. Second, the crystal oscillator frequency should be measured after all multiplier and buffer stages have been tuned. This frequency meter reading should also be recorded. Third, use the oscillator and i-f values obtained above to calculate two frequency response points. This can be done by inserting these values in the formula: local oscillator frequency $\times$ frequency multiplier $\pm$ i-f frequency. Fourth, through the use of the highest available fundamental frequency band obtainable on the LM or LR equipments, ascertain dial settings of either equipment which will produce a harmonic first at the high and then at the low response point previously calculated. Maximum response of the receiver will enable the operator to determine whether the local oscillator is above or below the incoming signal frequency, and, therefore, which response point is the actual received frequency.

A heterodyne frequency meter and crystal controlled calibrator, Joint Army and Navy Nomenclature TS–173/UR, is now being developed to cover the frequency range of 90–450 megacycles. The TS–173/UR is to be accurate within 0.005 percent.

## CLASSIFICATION OF RADIO FREQUENCIES

A new classification of radio frequencies, divided into seven major bands, is announced by the FCC to become effective immediately. As a result of the Commissions action, Section 2.5 of the FCC General Rules and Regulations on the "Useful radio spectrum" means the total number of frequencies or wavelengths which may be used for the transmission of energy, communications, or signals by radio.

At the present development of the art the useful radio spectrum is considered to extend from 10 kc to 30,000 mc or from 30,000 meters to 0.01 meters. These frequencies are classified into bands with designations and abbreviations as follows:

| *Frequency* | *Designation* | *Abbreviation* |
|---|---|---|
| 10 to 30 kc | Very-low | VLF |
| 30 to 300 kc | Low | LF |
| 300 to 3,000 kc | Medium | MF |
| 3,000 to 30,000 kc | High | HF |
| 30 to 300 mc | Very-high | VHF |
| 300 to 3,000 mc | Ultra-high | UHF |
| 3,000 to 30,000 mc | Super-high | SHF |

## ALIGNMENT OF INTERMEDIATE-FREQUENCY AMPLIFIERS

In the alignment of intermediate-frequency amplifiers in radio receivers it is important that the connection of the signal generator have no effect on any d-c voltages that may be applied to the grid and that no incoming signals be fed into the mixer tube.

The network shown in Figure 1 has been found highly satisfactory as a means of coupling a signal generator into an intermediate-frequency amplifier. No specific details for its construction are given as no special precautions are necessary. The condensers should be of the bakelite encased mica type (Cornell-Dubilier type 4 or equivalent) and the resistor should be rated at ½ watt (IRC type BT ½ or equivalent). The two condensers may be stacked one on the other and the resistor connected between them at one end. It may be tucked between the terminals of the condenser. Flexible test lead wire may be used for connection to the receiver; battery clips may be used to connect the wires to the tube top cap and its connecting wire. The whole "gadget" may be covered with rubber tape, leaving the condenser terminals exposed so as to permit clipping on leads from the signal generator. The tape forms a durable and insulating protective cover.

In use, the wire leading to the top cap (signal grid) of the mixer tube is removed and the wire from the 0.005-mfd. condenser is clipped to the top cap of the tube. The wire from the 0.02-mfd condenser is clipped to the wire which was removed from the mixer tube's top cap. It will be noted that the resistor $R_1$ is substituted for the tuned circuit in the grid circuit of the mixer and that any signals coming from the tuned circuit are bypassed to ground through $C_2$. $R_1$ also provides a path for any d-c grid bias on the mixer. The signal from the signal generator is coupled to the mixer tube through $C_1$. No d-c voltages in the receiver are disturbed.

This network is not easily adaptable for use with single-ended mixer tubes such as the type 6SA7. In such cases the signal from the signal generator may be fed into the mixer through $C_1$ by clipping the lead from $C_1$ to the signal grid of the mixer or to the stator of the variable condenser tuning the signal grid circuit of the mixer. This latter connection is often more accessible than the connection to the signal grid. The variable condenser should be adjusted to its maximum capacity in order to provide a high impedance at the intermediate frequency. Care should be taken to adjust the tuning condenser to a "quiet spot" i.e. one that is free from received signals and/or heterodynes between the signal generator signal and its harmonics and the local oscillator in the receiver and its harmonics. If extreme difficulty is encountered in finding a "quiet spot" near maximum capacity, the local oscillator in the receiver may be "killed" for alignment purposes by clipping a large condenser (0.05 mfd. or larger) across the oscillator section of the variable condenser.

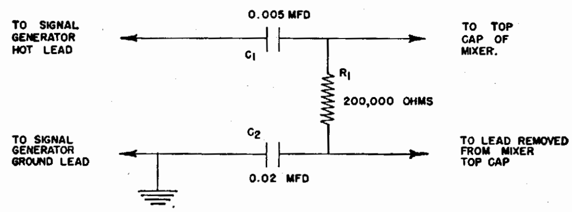


FIGURE 1.—Network for coupling a signal generator to an i-f amplifier.

All connections should be restored to their original status following the completion of the alignment.

## CALIBRATION AND COMPENSATION OF MEDIUM-FREQUENCY DIRECTION-FINDING EQUIPMENT

Under proper conditions of installation and calibration it has been demonstrated conclusively that very good results can be obtained with medium-frequency direction finders. Optimum location of the crossed loop assembly is not always possible but large values of deviation can be greatly reduced by installation and proper adjustment of compensation loops.

Maximum permissible deviation hereafter shall be that deviation which exists when the deviation at 300 kc has been reduced, by means of required correction, to not more than two degrees. Normally, a calibration of direction-finding equipment without application and adjustment of compensation is not considered to be satisfactory. The DAK series direction finders can and will give excellent results when properly installed and calibrated.

Each individual installation must be treated as a "tailor-made" job and compensation must be applied and adjusted for optimum performance regardless of plans. Compensation loops should, in general, be as small as possible consistent with proper operation of equipment in order that they will not act as absorption loops which adversely affect the efficiency of transmitting and receiving antennas. However, if the loop is made too small, overcoupling may result which will produce a severe reduction of sensitivity in the instrument.

Curves received by the Bureau of Ships indicate that a very common cause of poor operation is over-compensation. This not only results in an unsatisfactory calibration, but also reduces the voltage pickup of the loop and leads to a generally unstable condition. Over-compensation is caused by coupling the compensating loop and the direction finder loop too closely. This applies more correction than is necessary for zero deviation. This condition can be recognized by the deviation in the first and third quadrants being negative instead of positive or by the entire curve being negative in sign, increasing in value as the curve approaches 90 degrees, then decreasing until 180 degrees is reached. It can usually be assumed that the sign in the first and third quadrants will be the same. Where considerable deviation exists over the bow, however, this may not always be true and it is advisable to make a check. Figure 1–A indicates the first condition and Figure 1–B the second.

An expedient method of placing the corrector in the proper location must therefore be found to provide an indication of what may be expected in the way of deviation throughout the frequency range of the receiver. Approximately, the deviation will increase in proportion to the square root of the frequency change. The following procedure should be followed:

(1) Without the compensation loop in place a curve should be made with the receiver on 300 kc, and the point of maximum deviation noted. The compensation loop should then be placed in a position that will result in a minimum of coupling and bearings taken through maximum points of deviation in the first, second and third quadrants.

(2) By the process of trial and error and checking the points of deviation after each adjustment, the coupling of the compensation loop should be adjusted until not more than a two-degree deviation exists at 300 kc. The calibration may then be carried out on the higher frequencies.

From the study of results on file at the Bureau of Ships, it has been found that at certain frequencies (varying with the type of vessel on which the equipment is installed, but usually somewhere between 800 and 1200 kc) the deviation suddenly departs from the expected proportionate increase and may reach a value as high as five times that normally expected. It has been the practice on many vessels to adjust the compensation loop at this point, a procedure which, though it reduced the deviation, also reduced the sensitivity at lower frequencies to such a degree that at these frequencies the receiver was useless. This method of compensation should be discontinued and the procedure outlined above should be followed.

Extreme care must be exercised in securing and bonding compensation loops to the ship's structure. It is believed that too little attention is now being given to this important factor in the calibration procedure. The following methods, listed in order of preference are considered most satisfactory:

(1) Cable brazed directly to the ship's structure.

(2) With lugs soldered to each end of the cable, secure to a clean flange welded to the ship's structure by means of a 3/8″ brass machine bolt, using a double nut for securing. A brass washer should be placed on top of each lug and on the opposite side of the flange, tightened as much as possible and then coated with Glyptol.

The practice of welding steel buttons to the ship's structure to be used in conjunction with iron screws for securing the lugs is not approved, since rust and corrosion eventually set in, changing the overall resistance of the loop. The practice of using resistors of any type in the compensating circuit is not approved and should be discontinued.

In addition, certain precautions must be observed to insure accuracy of the equipment both before and after calibration. The models DAK–1, DAK–2 and DAK–3 sense amplifier and directional amplifier input channels must be properly aligned. The balanced modulator tubes must be properly adjusted to insure tracking of the ABI and the matched line system of the DAK–1 and DAK–2. To a certain degree, unbalance is caused by the use of the set in "search" position for long periods of time. In this position only one of the tubes is operative, and therefore use of the equipment in this position over too long a period should be avoided.

In the interest of simplification of the detail work involved in calibrations, the Bureau requests that no further copies of calibration data be sent to the Bureau except those which:

(1) Reflect unusual deviations, lack of symmetry, inverted deviations, erratic performance, etc.

(2) Are calibrations of pilot installations.

(3) Are calibrations specifically requested by the Bureau.

When calibration data are submitted which cover one or more of these items, the letter of transmittal should contain complete and competent comment by the officer in charge of the calibration.

In the past, "half scale" calibration has been specified as the standard method of calibration for all Navy direction finders. This system provides some distinct advantages for equipments such as the DP series and the DAE series direction finders which operate on the principle of manual rotation of the loop to a null position.

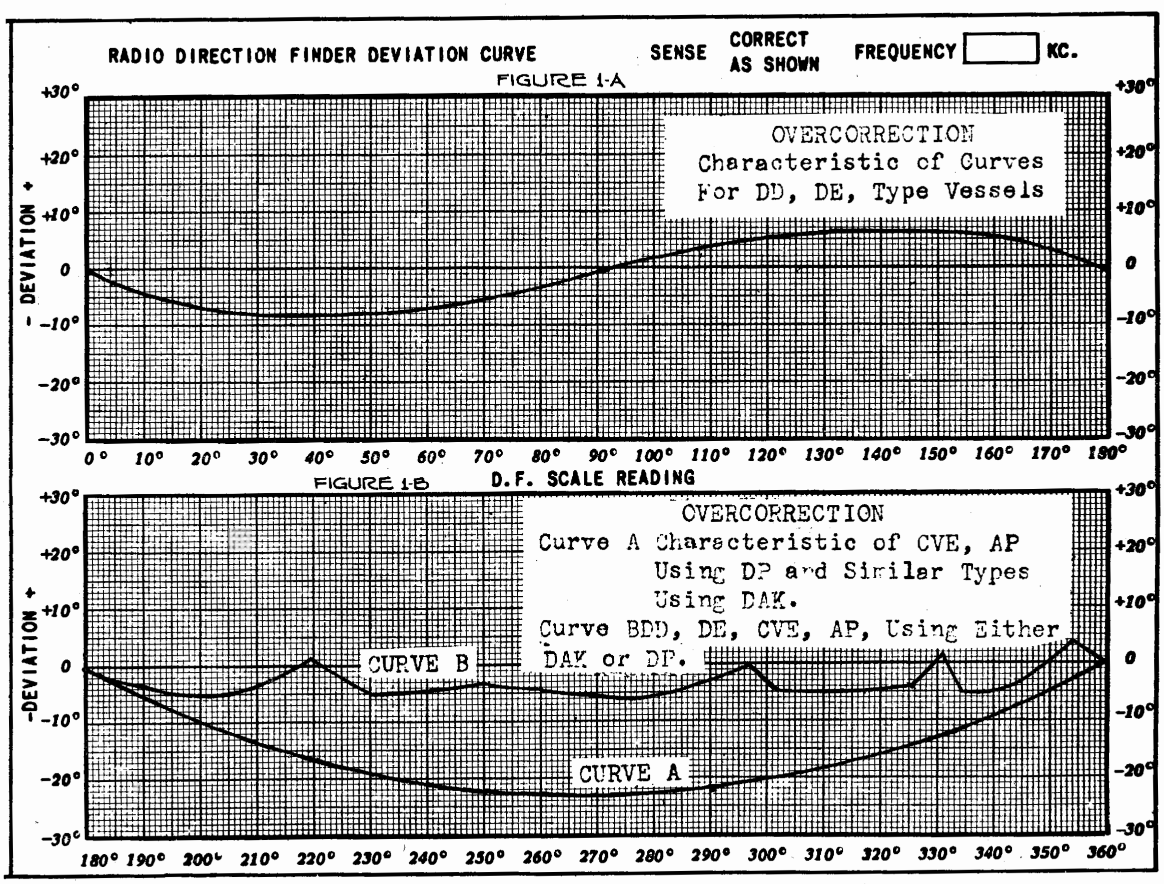


Figure 1.—Calibration curves for direction-finding equipments.

However, half scale calibration is of no benefit or advantage for fixed loop direction finders which have the goniometer marked for direct indication of bilateral bearings. Some equipments now under procurement, such as the DBD series MF/DF, give direct reading unilateral bearings, and these equipments cannot be calibrated by the half scale method.

In the future, the following procedure shall be followed in the calibration of direction finding equipments:

(1) All direction-finding equipments with manually rotated loops (such as the DP series, the DAE series, commercial direction finders, etc.), shall be calibrated by the half scale method. Calibration data should be plotted on form NBS 329.

(2) All direction-finding equipments with fixed loops or automatically rotated loops which give automatic or semi-automatic bearing determinations (such as the DAK series, the DAQ series, the DAU series, the DBD series, etc.), shall be calibrated by the *full scale* method. Calibration data should be plotted on form NBS 331.

## QUICK NEUTRALIZING TESTS

Transmitters that are on the air for long periods of time, or continuous 24-hour operation, can be checked for neutralization while operating. This is accomplished by tuning the plate controls slightly off resonance and observing the action of the grid meters. This procedure is based on the assumption that the circuit is operating as a pure amplifier, with the deviation from normal readings indicating some irregularity. It also assumes that the Q of the circuit is constant over the tuning range. Theoretically the Q is constant for only one frequency in a given circuit; however, for the small tuning change the Q is virtually the same.

Figure 1 illustrates the condition under investigation while tuning the r-f amplifier. At "A" is a block diagram of a neutralized amplifier, the r-f input to the grid circuit alone being used to obtain the power output. Almost the same condition exists at "B" of the same figure, an r-f oscillator. It is merely an r-f amplifier with some of its own plate power fed back, usually in the neighborhood of 5 percent of the output and in the proper phase for sustained oscillations. Thus in the grid circuits of "A" and "B" only one r-f current flows to vary the bias voltage. In "C" of Figure 1, we have the case of the unneutralized amplifier, where r-f is fed from a preceding stage, but some r-f is also fed back from a spurious frequency in the plate circuit. This is really a combination of an r-f amplifier and an oscillator that results not only in poor efficiency but also produces undesirable frequencies.

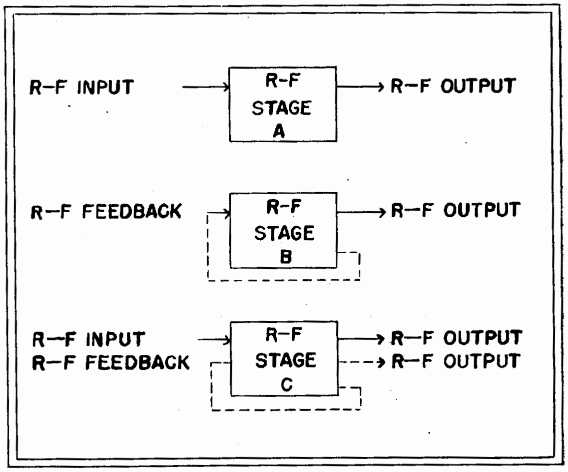


FIGURE 1.—Typical conditions of operation of an r-f amplifier stage in a transmitter.

In the cases illustrated at "A" and "B," an ammeter in the grid circuit will show the current flowing during resonance, and this current will fall off in about the same degree either side of resonance, as illustrated by curve "AA" of Figure 2.

Some operators prefer to watch the plate and

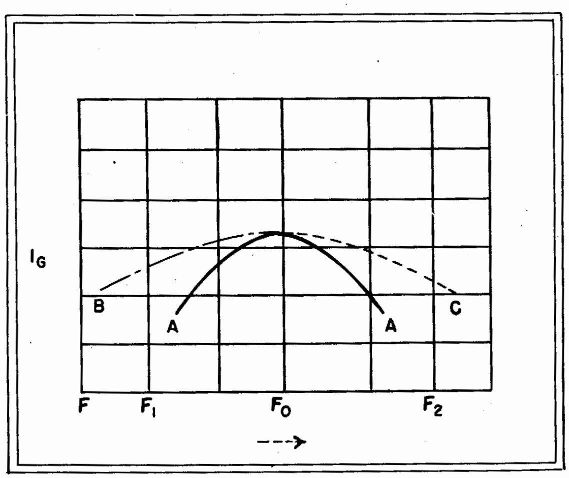


FIGURE 2.—Graph showing the possible changes in the grid current of an r-f amplifier when the plate tank circuit is tuned through resonance.

grid ammeters at the same time, the one rising and the other falling about the same degree either side of resonance. However, in tightly coupled circuits, especially at high frequencies, these two relationships may not hold even though the amplifier is perfectly neutralized.

When another current is present in the grid circuit due to extraneous oscillations, the current will not fall off at the same angle, but one side will have a steeper dip than the other. Thus, if in tuning from $F_0$ to $F_1$ and $F_2$, the curve "AC" results, it may be an indication of unbalance, possibly caused by bad neutralization. Curve "AC" might indicate instability at frequencies above resonance, which would call for reduction of inductance (in inductance neutralization). Curve "BA" would show possible instability below resonance, requiring more inductance or capacitance in the neutralization circuit.

While this system may indicate an unbalance in the tank circuit, it is not to be used to obtain neutralization. Even if an unbalance is noticed, it is no assurance that the circuit is not neutralized. Furthermore, only operators thoroughly familiar with their transmitters should use this method, since off-resonance operation can raise the plate current to the point where the over-load circuits would operate. It would then be difficult to bring controls back to normal to get the transmitter back on the air. Observing the grid ammeters should be used only to determine normal conditions, with any unusual changes warning the operator of some kind of irregularity.

Another way of checking neutralization rapidly is by cutting off excitation. (This may require recording a carrier break in the transmitter log.) This is done by shutting off the auxiliary oscillator's plate supply and then switching the oscillator transfer switch to the dead oscillator, killing the r-f supply to all succeeding tubes. If the tubes are all biased to cut-off or beyond, the grid and plate ammeters should all drop to zero in a perfectly neutralized transmitter and the carrier should go off the air. Any flow of plate and grid current will indicate possible oscillation in the earliest stage and should be checked through the regular neutralization procedures.

This process of checking takes only a couple of seconds, long enough for the technician to observe that the particular ammeters read zero, while plate and grid voltmeters remain at normal readings. Amplifiers with self-bias are so biased that, with all excitation removed, a safe amount of plate current flows. Such a stage would seem to have regeneration or oscillation, but the skilled technician will be familiar with his circuits.

Where plate current flows with excitation off, the difficulty may be traced not only to improper neutralization but to spurious oscillations, caused generally by similar r-f chokes resonating in the plate and grid circuits at some far removed low frequency. Parasitics of high frequency due to long r-f leads may also cause irregular operation and may show up with this check.

If the operator has more time available and his transmitter is off the air he has two other easy ways of checking roughly for neutralization. With the filament of the amplifier tube lit, but the plate voltage off, r-f voltage is fed to the amplifier. While observing the grid current meter, the plate tank tuning capacitor is rotated through resonance (with no plate voltage). In a perfectly neutralized stage, the grid ammeter reading should remain steady, since the plate circuit is supposed to have no reaction upon the grid circuit.

In a badly neutralized stage, there will be a violent dip of the grid meter while tuning through resonance. There will generally be some slight reaction on the meter, especially on the higher frequencies, even though the amplifier is neutralized, but the operator will easily recognize this flutter of the needle from the more pronounced dip caused by poor neutralization.

Another quick check is good for all but the final stage. This requires that two stages have no plate voltage while checking, although the filaments remain on. With a preceding stage tuned to resonance (but no plate voltage) the succeeding amplifier is likewise tuned to resonance and its plate meter observed for current. The presence of current will be a fairly sure sign of RF leaking through the preceding amplifier tube and being rectified in the succeeding stage.

Obviously the final stage cannot be checked in this manner since there is no following stage in which to detect the presence of RF. At higher frequencies or due to stray couplings, some RF may still feed through but the engineer is conscious of these peculiarities.

It must be stressed that the technician must be fully acquainted with the circuits he tests by these methods, to avoid damage and trouble. These checks should serve to indicate that everything is operating normally, any deviations from usual readings only warning the operator that more careful checking is needed. Even after these tests have been completed, there may be extraneous oscillations due to shock excitation, transients, or other strays developed by long operation of circuits, which will escape notice. Such special conditions require treatment with extensive and elaborate equipment.

—Reprinted from *Electronics*

## NEW NAME AND NAVY MODEL DESIGNATION FOR RADIO-COMMUNICATION CONTROL LINKS

These communication control links consist of Navy model TDG transmitters, RBQ receivers and a large variety of 42A1 carrier telegraph equipments. The 42A1 carrier telegraph and telephone equipments have never had a Navy model designation and, therefore, the following has been assigned for the system:

NAVY MODEL UN
CARRIER CONTROL SYSTEM

## REVISED SYSTEM OF CABLE AND WIRE MARKING

An amendment to General Specifications for Machinery S28–2, "Designating and Marking Electrical Installations," has been initiated to provide a new and standardized method of designating cable and wire marking in electronic installations. This amendment will cover cable marking standardization of wire terminal marking, and the use of synthetic sleeving for identification purposes.

### Cable Marking

All shipboard electronic installations are to be marked as follows:

*Radio Communications (R–R)*

| | |
|---|---|
| R–RA | Transmitting and receiving antenna (radio-frequency) |
| R–RB | Broadcast distribution (audio-frequency) |
| R–RF | Frequency meter extension (radio-frequency) |
| R–RP | Power (between distribution panels and equipments and between units of equipments) |
| R–RR | Receiver output (audio-frequency) |
| R–RT | Transmitter, keying and controls |
| R–RV | Radiophone (audio-frequency and control) |

*Radar (R–ER)*

| | |
|---|---|
| R–ER | Repeaters |
| 1R–ER | Air search |
| 2R–ER | Surface search |
| 3R–ER | IFF equipment |
| 4R–ER | Main battery fire control |
| 5R–ER | Secondary battery fire control |
| 6R–ER | Auxiliary anti-aircraft battery |
| 7R–ER | Heavy machine gun battery |
| 8R–ER | Torpedo director circuits |
| 9R–ER | Beacon circuits |

*Sonar (R–S)*

| | |
|---|---|
| R–SA | Attack aids |
| R–SD | Depth determination |
| R–SL | Listening |
| R–SR | Ranging |
| R–SS | Sounding |
| R–ST | Shipboard anti-sub attack teacher |

*Countermeasures (R–C)*

| | |
|---|---|
| R–CA | Antennas |
| R–CC | Control circuits |
| R–CM | Modulators |
| R–CP | Power circuits |
| R–CT | Trigger circuits |

Where more than one unit of a particular type is installed, an additional number is added following the general specification letters as listed above, to represent such additional units. For example, for four radio transmitters the designations would be R–RT1, R–RT2, R–RT3 and R–RT4. Where only one unit is involved, the "1" after the classification letter may be omitted.

Numbers designating the various equipments are to be selected in accordance with the section of the General Specification S28–2–D.

Following the general designation and classification numbers just described, additional numbers will be added to indicate the particular cable in the classification. Particular cables will be numbered consecutively. Some examples of this are:

| | |
|---|---|
| 1R–ER–14 | Electronics—Radar—Air search no. 1 unit (starboard forward) cable no. 14. |
| R–RV12–70 | Electronics—Radio—Voice control no. 12 unit (port) cable no. 70. |
| R–SR2–3 | Electronics—Sonar—Ranging no. 2 unit (port) cable no. 3. |
| R–CA3–3 | Electronics—Countermeasures antenna no. 3 antenna (starboard) cable no. 3. |

### Terminals

Wire terminals (lugs) shall be marked or tagged to correspond to the marking of the terminal board terminals to which they are to be attached.

The stamping of the wire marking on the tongue of the terminal is the preferred method of designation. Where this is impractical, due to the size of the terminal, either fibre tags or branded synthetic sleeving may be used for material under the cognizance of the Bureau of Ships.

In all cases where wires or cables are fanned out a distance of 6 inches or more from the wire terminals, fibre tags or synthetic sleeving shall be used and marked to indicate the cable designation as well as the terminal designation—the terminal designation following the cable designation.

Pending reprinting of the specification or the issue of a supplement, the instructions above are to be considered in effect. It is important that all installation, maintenance and training activities concerned with these changes be made familiar with them.

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## COLOR CODE FOR TRANSFER PANEL PATCHCORDS

The standard types of receiver, transmitter and radiophone transfer panels are supplied with from five to forty-five patchcords, depending upon the size and type of panel. For purposes of applying the following color code and for standardization among identical panels, the patchcords with each panel are arbitrarily assigned numbers beginning with number one. This means that the cords of a five-cord panel would be assumed to be numbered 1 to 5; of a ten-cord panel, 1 to 10; etc. In case the patchcords for any one type of panel have been graduated in length by ship's force the shortest cord should be considered as number 1 and the balance consecutively numbered according to length. With the assumed numbering system (no actual numbers are applied to the cords) established, the following color coding can be applied to patchcords by any activity or ship's force with reasonable assurance that all panels of a type throughout the service will be color-coded alike.

The standard Bureau authorized color code for "RR", "RT" and "RV" patchcords is as follows:

*Patchcord Color Code*

| *Cord No.* | *Color* | *Cord No.* | *Color* |
|---|---|---|---|
| 1 | Black | 24 | Brown & black |
| 2 | White | 25 | Blue & orange |
| 3 | Gray | 26 | Blue & green |
| 4 | Red | 27 | Blue & red |
| 5 | Green | 28 | Blue & gray |
| 6 | Orange | 29 | Blue & white |
| 7 | Blue | 30 | Blue & black |
| 8 | Brown | 31 | Orange & green |
| 9 | Yellow | 32 | Orange & red |
| 10 | Yellow & brown | 33 | Orange & gray |
| 11 | Yellow & blue | 34 | Orange & white |
| 12 | Yellow & orange | 35 | Orange & black |
| 13 | Yellow & green | 36 | Green & red |
| 14 | Yellow & red | 37 | Green & gray |
| 15 | Yellow & gray | 38 | Green & white |
| 16 | Yellow & white | 39 | Green & black |
| 17 | Yellow & black | 40 | Red & gray |
| 18 | Brown & blue | 41 | Red & white |
| 19 | Brown & orange | 42 | Red & black |
| 20 | Brown & green | 43 | Gray & white |
| 21 | Brown & red | 44 | Gray & black |
| 22 | Brown & gray | 45 | White & black |
| 23 | Brown & white | | |

The paints should be of good quality and the colors brilliant. Such paints are usually carried aboard vessels for marking piping and flag gear. The paints should be applied to the knurled, cable-securing gland of each plug and *not* on the rubber cable. The paint will not adhere satisfactorily to the rubber and there is also a possibility of a deteriorative effect. The single colors identifying cords #1 to #9 shall be applied to the entire external surface of the gland nuts of both plugs as indicated in Figure 1. Each color



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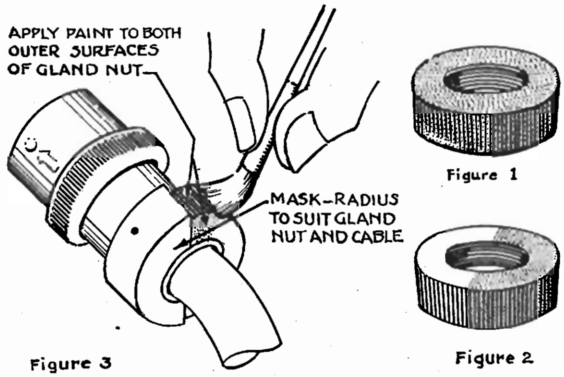
of the dual colors identifying cords #10 to #45 shall be applied to one half of the external surface of both plugs as indicated by Figure 2. The separation of the two colors should be accurate and neat. This can be facilitated by the use of a small half-circular metal masking template, as illustrated in Figure 3.




FIGURES 1, 2, and 3.—Methods of painting gland nuts.

The foregoing color coding may be applied to existing equipment by forces afloat as requirements dictate.

●

## CONNECTION OF RECORD PLAYERS TO SHIPBOARD BROADCAST RECEPTION SYSTEMS

The Bureau of Personnel is procuring and furnishing to the Service a number of portable (suitcase type) record players for training and entertainment purposes. These units are primarily for shore-based personnel, but a number of them are finding their way aboard vessels of the fleets. Once aboard a vessel it is natural that they be utilized in a manner whereby they will serve the greatest number of personnel; this immediately dictates that the output of the record players be connected to the vessel's radio broadcast distribution system. This is entirely permissible and feasible due to the fact that from two to four spare channels were provided in the original design of the distribution system just for such anticipated purposes. However, the two types of record players being distributed by BuPers at the present time were not designed with this particular use in mind and, therefore, are not provided with exactly the proper output circuit for coupling into one of the broadcast distribution channels. This fact has resulted in a number of unsatisfactory lash-ups, and in an attempt to improve conditions, inexperienced personnel will unnecessarily modify or mutilate either the record players or the distribution system or both. On the other hand, if the very simple interconnections between the record player units and distribution channels are accomplished as indicated herein, the results will be very satisfactory and the normal functions of neither the phono units nor the broadcast system will be adversely affected.

The two record player units being furnished by BuPers are identified as Sandwick model MC–364 and Birch "Flagship" model. Both units are very similar and both give excellent results. The internal wiring diagrams of both types are reproduced herein as Figures 1 and 2 respectively. Both have dual speed ($33\frac{1}{3}$ and 78 RPM) motors and will accommodate any size or style of disc.

The interconnections between the record players and the standard shipboard model RBO broadcast distribution system should be accomplished as indicated in Figure 3. It should be noted that the connections are to be made to the low impedance output circuit of the amplifier, to which the speaker is normally connected, and not to the high impedance PHONO OUTPUT jack located on the front panel. The latter connection will not produce satisfactory results. A 4-prong plug should be used for the connections to the record player if it is desired to retain the portability feature of the unit; otherwise, the connections can be made internally in a permanent manner. It is preferable to install a double throw switch adjacent to the record player unit and connect this switch in a manner that will permit instant change-over from the distribution system to the record player's speaker and vice versa. Particular note should be made of the fact that the two record player manufacturers utilize different terminals of the 4-prong connectors. The output of the Sandwick model is connected to terminals No. 1 and No. 3; whereas, the output of the Birch model utilizes terminals No. 1 and No. 4. One side of the secondary winding of the output transformer is grounded in the early models of both types of record players, as indicated in Figures 1 and 2. If this ground connection exists in any record player being connected to the RBO distribution system, it must be removed before the record player is operated with the system. The ground connection within the unit is made in such a manner that it can be easily removed. Unless this ground is removed from the output winding, the reproduction will not be satisfactory as the completed circuit results in one-half of the center-tapped speaker-amplifier input being grounded. The Bureau understands that this ground connection has been omitted on both types of record players of recent manufacture.

Connection to the distribution system should be made to channel No. 5 in the standard 10-wire connection box located near the model RBO

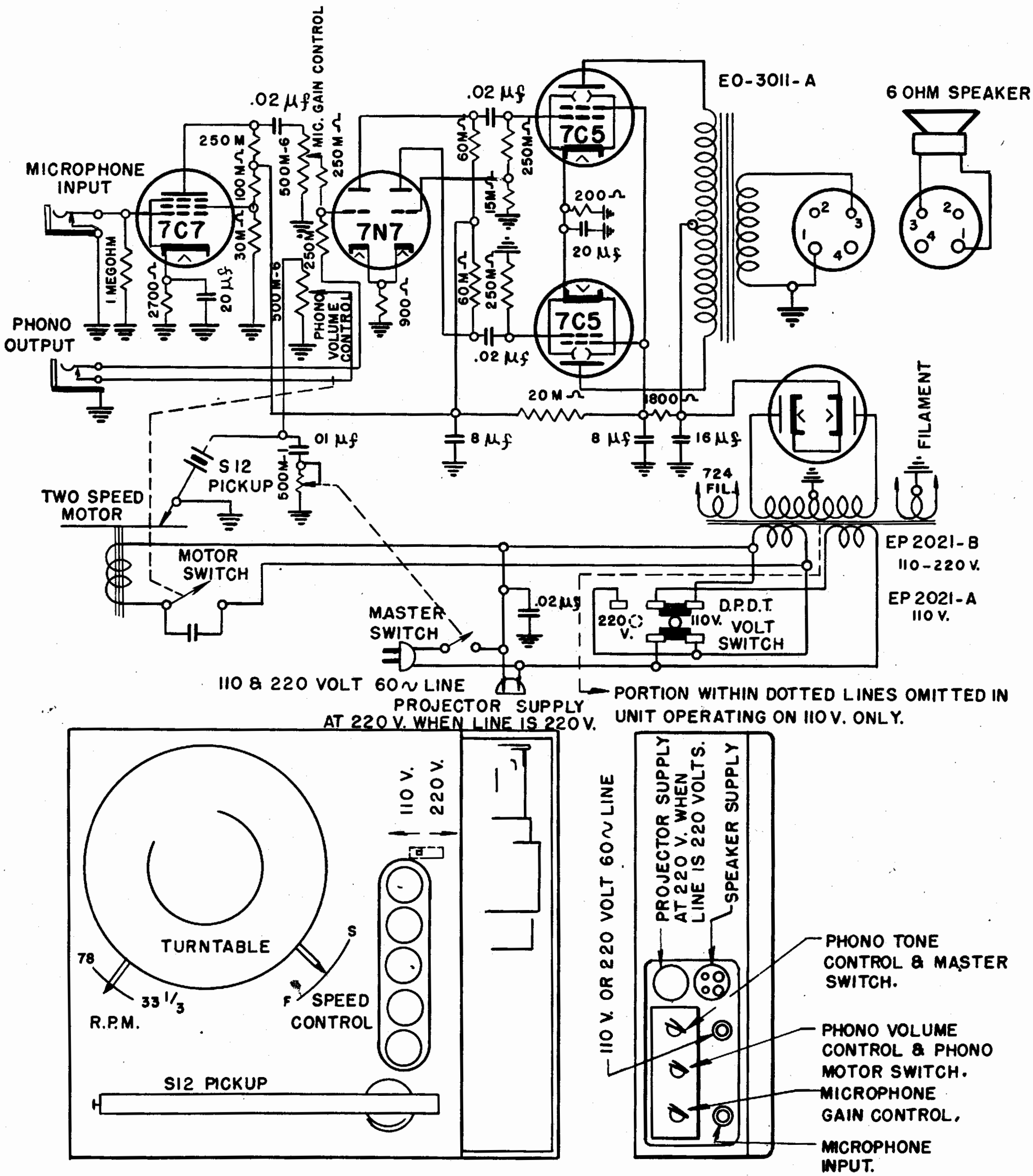



FIGURE 1.—Sandwick model MC-364 reproducing equipment.

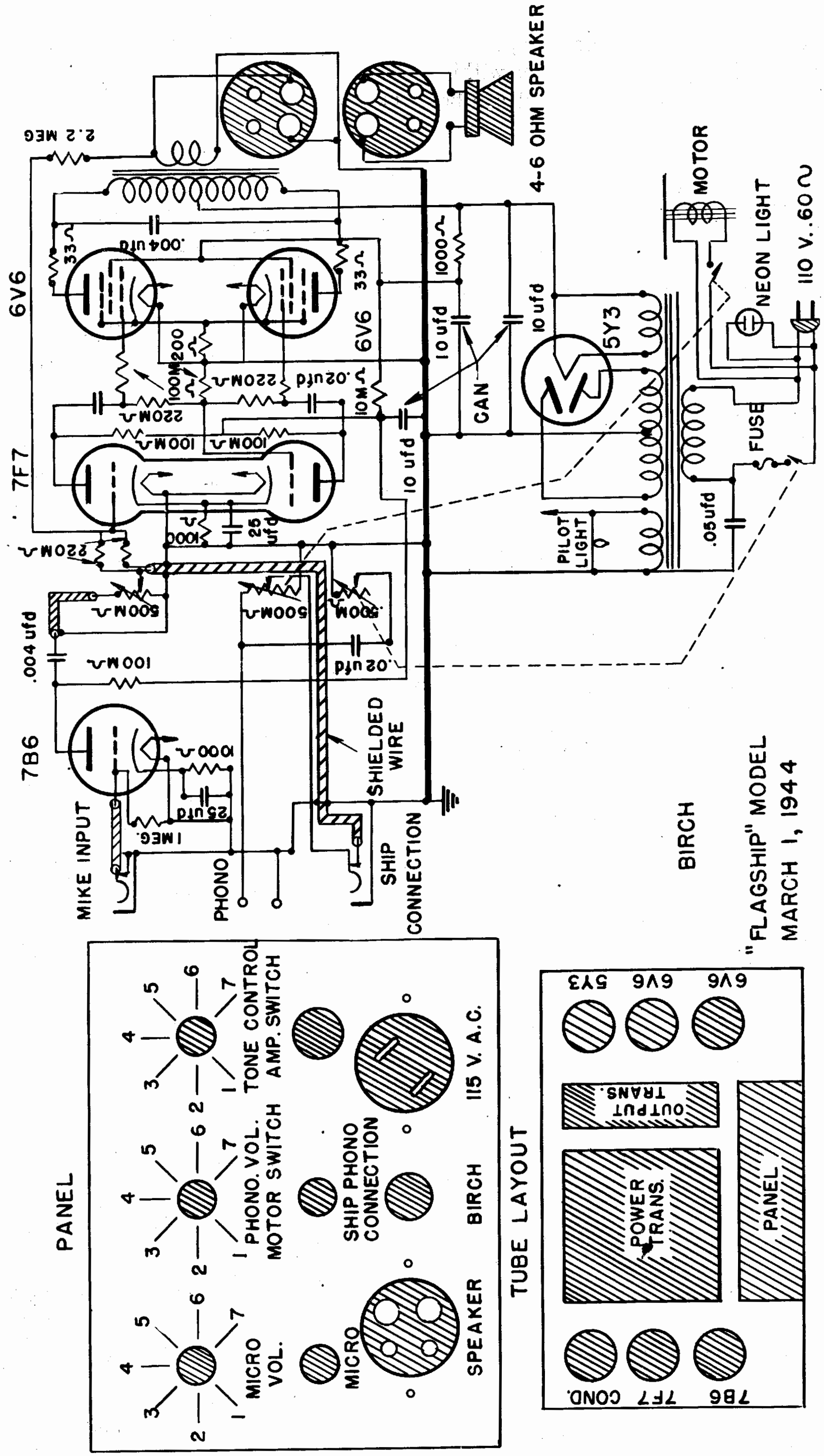



FIGURE 2.—Birch "Flagship" model reproducing equipment.

receivers, as indicated in Figure 3. However, if the record player unit is to be located in a space removed from the receivers, as is frequently the case, the connection may be made to the same channel (No. 5) at the terminal block in any speaker-amplifier unit along the line. If two record players are installed and connected to the RBO system, the second unit should be connected to channel No. 4.

The 10-ohm 10-watt loading resistor indicated in Figure 3 should be used in all such installations. Any resistor possessing the specified characteristics may be used in lieu of the specific type indicated in the diagram.

If "stops" have been installed on the channel selector switches of the type 49131 series speaker-amplifier units of the distribution system to blank-off spare channels, it will be necessary to remove them from all units before placing the system in operation.

Record players (either the above types or any others which may find their way aboard Naval vessels) shall not be connected to any model RBO series receiver or the associated distribution channel. A phono connection is provided in these receivers but shall not be used in shipboard installations as separate channels are provided for such purposes in the distribution system. When record players are connected through a receiver unit, it deprives personnel of the broadcast reception normally available on that particular channel.

Some operating notes for these record players are:

(1) The equipment is turned on by rotating the tone control in a clockwise direction.

(2) Volume is controlled by the control marked "Phonograph".

(3) After allowing the tubes to heat for 30–45 seconds, run the ball of the thumb gently across the point of the needle. A clicking or rasping sound indicates that the equipment is ready for operation.

(4) Ordinary commercial phonograph records are played at 78.26 RPM and the groove runs from the outside toward the center. Transcriptions are played at 33⅓ RPM and may begin either at the inside or outside. The label on the transcription will indicate the correct starting point.

(5) Motor speed may be changed by gently moving the RPM arm from 78 to 33⅓ or vice versa while the motor is running. CAUTION: Do not force or jam the arm or the motor will be

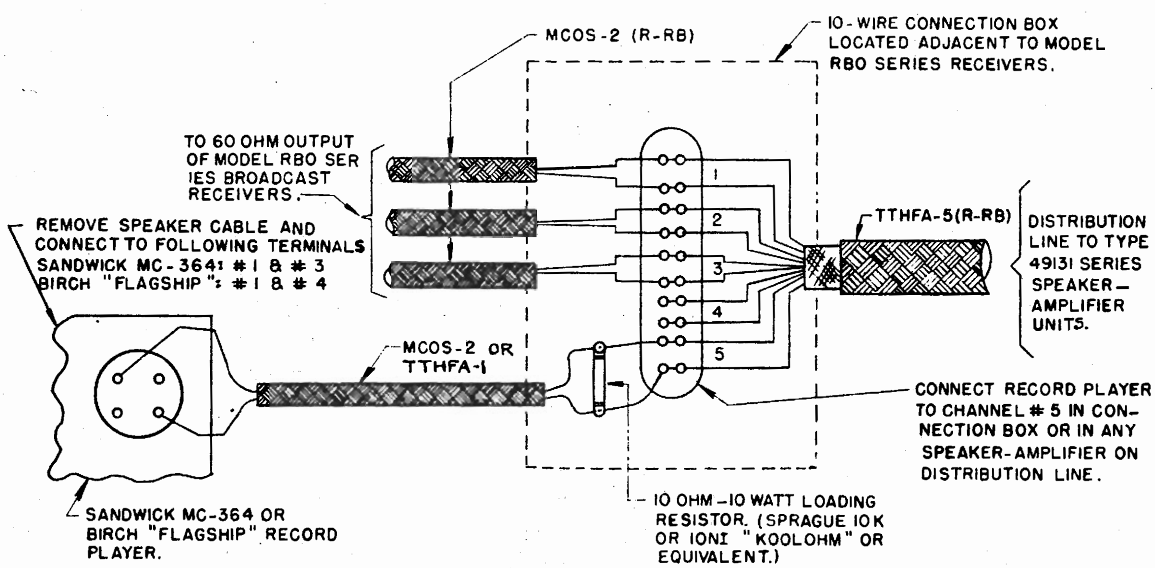



FIGURE 3.—Connections between record players and model RBO distribution system.

locked with consequent damage. Never changed speeds unless the motor is running.

(6) Keep the microphone control set at zero unless it is in use as considerable hum will be produced otherwise.

(7) Make sure that the needle is secure in the needle chuck. It should be tightened with thumb and forefinger only—NEVER with pliers or other tools. Type 36N535 steel needles are recommended. These are available in packets of 100 for 15¢ at most recreational supply activities. If a permanent needle is used, it should never be removed or turned until it is ready for replacement.

Some maintenance notes for these record players are:

(1) The following spare parts are furnished with each unit:

Two crystal cartridges
Three fuses
One set of tubes
Five packages of needles
One pilot lamp (Birch record player only)

(2) The phonograph motor should be lubricated every 60 days. Navy oil symbol 2075 is recommended.

(3) The speed of the turntable may be adjusted by moving the lever arm marked "speed control." It should be adjusted to run at 78.26 RPM or 33⅓ RPM and should be checked with the stroboscope and neon lamp which are supplied with the instrument. A stroboscope disc is being published in this bulletin for use in the event that the original disc becomes lost or damaged.

(4) *Important*—An Astatic type S–12 crystal pickup is supplied with the unit. Two replacement crystal cartridges are supplied as spares. Crystal microphones, headphones and phonograph pickups are easily and quickly damaged by exposure to excessive heat. Under NO circumstances should the pickup itself or the replacement cartridges be subjected to temperatures of 120° F. or above. Should there be any question of the ambient temperature exceeding this level, a thermometer should be placed alongside the pick-up and if 120° F. or above is reached, immediate steps should be taken to cool the unit. Should it become necessary to replace the crystal cartridge or connecting wires, a minimum of heat should be used when soldering connections at the cartridge. Cool the joint with a swab of cotton dipped in alcohol immediately after removing the soldering iron. Heavy-handed sweating in of soldered joints at the cartridge terminals is practically certain to ruin the crystal. Quick soldering with minimum heat, a clean iron, low-melting-point solder and immediate cooling of the joint is absolutely safe. Should extra crystal cartridges be required, the proper unit is Astatic type B–2 replacement cartridge.

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## INSTRUCTIONS FOR USING A STROBOSCOPE DISC

The stroboscope disc reproduced herewith as Figure 1 may be used to check the speed of any phonograph recording or reproducing turntable at either 78.26 or 33⅓ RPM, which are the correct operating speeds.

Carefully cut out the disc and mount it on stiff cardboard or on a 10-inch phonograph record using rubber cement or any other adhesive that will not shrink or stretch the paper. *Do not use ordinary paste.* Extreme care should be taken not to distort the drawing. If the disc is mounted on a phonograph record, make sure that the drawing is truly centered over the record spindle hole; if it is off center it will affect the accuracy of the stroboscope disc, resulting in a backward and forward movement of the segments even though the turntable speed may be constant. By the same token, care must be exercised in punching or cutting out the center hole in the stroboscope disc. The white dot is the exact center; the small black area the part to be removed. A sharp-pointed scriber compass will do the job nicely.

With the turntable in motion and the stroboscope disc in place, cast the light from a neon lamp directly on to the rotating disc segments, shielding the disc from extraneous light. The neon lamp must be energized from a 60-cycle a-c supply. If the turntable is operating at the correct speed, one set of the segments will appear stationary—the inner set for 78.26 RPM and the outer set for 33⅓ RPM. It should be pointed out that the accuracy of the device is dependent upon the exactness with which the frequency of the a-c supply is kept at 60 cycles per second. A backward or forward motion of the segments indicates that the turntable is running below or above the correct speed and its speed should be

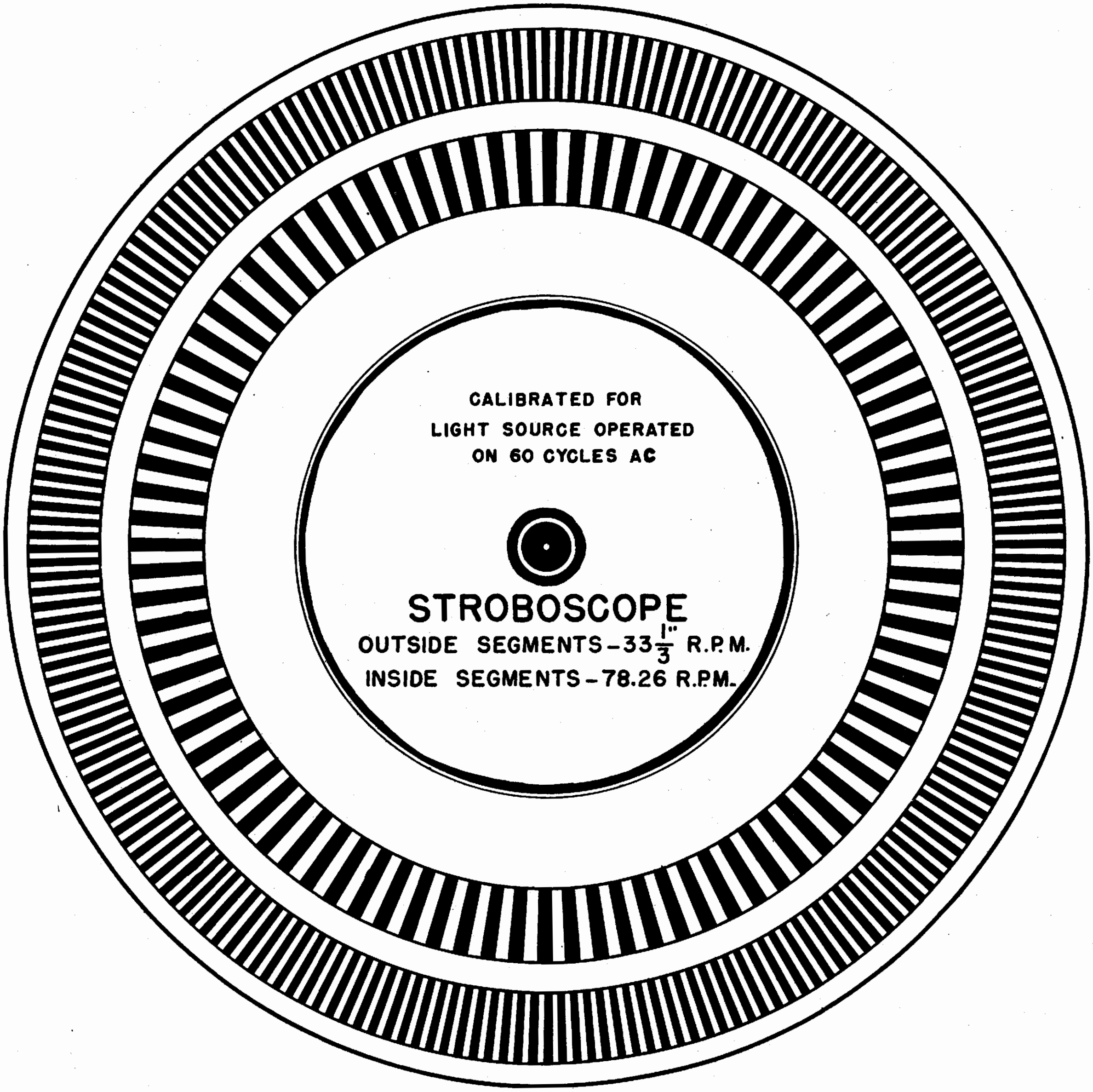


FIGURE 1.—Stroboscope disc.

adjusted until the proper set of segments appear stationary.

In using the stroboscope, it is preferable to simulate actual operating conditions by checking the turntable speed with a normal load. This may be accomplished by checking the speed with the pickup traversing the outer grooves of a 10-inch record placed on the turntable underneath the stroboscope disc—or the outer grooves of the record on which the stroboscope disc is mounted as the case may be.

In an emergency an ordinary incandescent lamp may be used in lieu of a neon lamp. However, the incandescent lamp is not nearly as satisfactory due to the thermal inertia of the filament preventing it from cooling below the temperature of incandescence during each cycle of AC. This effect causes the segments to appear blurred although their movement is easily observed. When viewed with light from a neon lamp, the segments appear sharp due to the lack of thermal inertia in a neon lamp, the light flashing off and on 120 times a second. A single fluorescent lamp operated on a 60-cycle a-c line also makes a satisfactory light source for viewing the stroboscope.

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## NON-SHATTERABLE NITROGEN FLASKS

Maintenance activities should check all available vessels to determine if the nitrogen flasks used in conjunction with the receiving antenna transmission line systems are of the non-shatterable type. All flasks which do not meet these specifications should be replaced with the approved non-shatterable type.

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## COLLECTION OF EXPLOSIVE GASES FROM BATTERIES

The Federal Communications Commission has been informed by the U. S. Coast Guard of an explosion of a portable lifeboat radio transmitter aboard a merchant vessel when an attempt was made to test it. In this instance, it appeared that an explosive gas had accumulated inside the airtight case and that it was ignited by an electric spark after the cover had been removed and the set placed in operation. It has been reported also that portable lifeboat transmitters stored in warehouses have exploded owing to the presence of gases generated by recently charged batteries.

The danger of explosions can be eliminated if proper precautions are taken. It is suggested that batteries be removed from the portable radio equipment containers for charging and that the batteries be allowed to stop gassing before being placed in the radio sets after charging. If the electrolyte has accidently leaked into the container from the battery, the case should be cleaned. It should also be left open to the air for an adequate period after removing the cover, before proceeding to test the equipment.

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## PROLONGING THE LIFE OF DRY BATTERIES

Many dry batteries are arranged so that contact with the negative terminal is made by a brass or copper spring pressing against a portion of the zinc case of one of the cells which make up the battery. Since current flows through this contact while the battery circuit is closed, there is opportunity for electrolytic action to occur at the contact surface. Such electrolytic action is greatly increased by large amounts of moisture in the air. A slight drop in temperature causes the moisture to condense to water, and the wet contact acts exactly like an electrolytic cell. Two damaging conditions result:

(1) The electrolytic action causes the zinc to oxidize, forming zinc oxide. This is indicated by a white coating on the zinc surface, powdery when dry, and wet and sticky when damp. The layer of zinc oxide acts as an insulator, and reduces the current which can be drawn from the battery.

(2) If the battery is still operated while the layer of zinc oxide is damp, holes will be eaten in the zinc and the battery ruined.

When the battery output falls off, as evidenced by the effects noted in (1) above, the battery is usually condemned and thrown away, although it may actually have more hours of serviceable life remaining. These service hours can be obtained by cleaning the contact as follows:

(1) Scrape the zinc surface with a knife to remove the layer of white material, being careful not to gouge into and remove scraps of the zinc metal itself.

(2) Polish the scrape surface with fine sandpaper until it is bright.

(3) Wipe dry the batteries, the contact springs, and the inside of the battery compartment.

Dry batteries should be examined daily, paying particular attention to the contacts, and cleaned as necessary. This precaution will increase the service obtained from batteries, and will in many cases prevent unexpected failures of communication equipment. The presence of white powder, soggy white deposits, and corroded spots on the zinc shells of batteries is evidence of electrolytic action. It calls for immediate cleaning and drying.

—*Signal Corps*

## RADIO BATTERY CHARGING FACILITIES IN LANDING CRAFT

The following are excerpts from a BuShips (Codes 660–819) letter which may be of general interest to all radio installation and maintenance activities concerned with landing craft:

"Landing craft will receive models TCS, SCR–610, SCR–508, and SCR–608 transmitting and receiving radio equipment. The Bureau is purchasing individual motor-generator sets to be used with each SCR radio and eventually all newly installed SCR equipment will be provided with these motor-generator sets which will operate from the ship's service system. However, due to production difficulties, a number of installations of SCR radios will be made without the motor-generator sets. For such installations, when the proper voltage is not available on board the vessel, it will be necessary to supply batteries as a source of power.

SCR radio equipment as installed will in most cases be suitable for 12-volt operation although there may be some cases where 24-volt equipment is installed. Insofar as battery operation is concerned, when 12-volt battery-operated SCR radios are installed, the following equipment should likewise be provided:

(1) For the SCR–610:

(*a*) Two complete sets of 12-volt SBM 100-ampere-hour batteries, each set to consist of two 6-volt SBM 100-ampere-hour trays. One complete set of 12-volt batteries is for normal use and the other complete set is for standby use.

(*b*) One two-pole double-throw transfer switch, 10-ampere, 9–S–5191–L, type SS–2.

(*c*) One 7- to 14-ampere battery charging panel, Bureau plan No. S6201–649406, Contract Nos. NObs–16164 and 16782.

(2) For the SCR–508:

(*a*) Two complete sets of 12-volt SBM 200-ampere-hour batteries, each set of batteries consisting of two 6-volt SBM 200-ampere-hour trays. One complete set of 12-volt batteries is for normal use and the other set is for standby use.

(*b*) One transfer switch, two-pole double-throw, 30-ampere, Plan No. 9000/S6202/70350, type XXVI–1S.

(*c*) One 15- to 30-ampere battery charging panel Bureau plan No. S6201–649405, Contract Nos. NObs–16164 and NObs–17497.

(3) For the SCR–608:

(*a*) The same equipment is to be supplied for SCR–608 as indicated above for SCR–508.

It is to be noted that the above listing of material is on the basis of a 12-volt SCR radio installation. If 24-volt SCR radios are installed, it will be necessary to double the number of batteries furnished. The transfer switches and the battery charging panels listed will be satisfactory for either 12 or 24 volts.

The transfer switch is to be used to transfer the SCR radio from the normal set of batteries to the standby set and vice versa. The battery charging panel is of the bulkhead mounted type with 30 feet of flexible cable and clips for charging the battery which is not being used by the radio.

In regard to TCS radios, where adequate charging facilities have not previously been provided, the same charging panel provided for the SCR radio batteries, as listed herein, should also be used to charge the TCS radio batteries."

## RELAY MAINTENANCE

Relays should be carefully inspected regularly. They should be cleaned periodically with carbon tetrachloride and the contacts dried immediately. A small piece of chamois leather mounted on a thin strip of bakelite makes a convenient cleaning and drying tool. Do not use paper, cloth or other fuzzy materials. Films forming on the contact surfaces cause the greatest amount of trouble. Films will form through the action of air and various other gases on the contact metal, but most troubles of this type are due to grease films. Carbon formations due to the burning of grease and other substances can be troublesome. The carbon will form rings on contacts, eventually building up the rings so that the contacts will be held open.

When current always flows in one direction through a relay, the contacts may "cone and crater". The crater is formed by the metal being transferred to the other contact and deposited there in the form of a cone. When filing contacts to remove carbon, cones, or craters, it is not desirable to polish them too smoothly. The slight roughness left after filing with a good file helps to break through any films that form. It should be remembered that most files will be greasy. Therefore, after filing, the contacts should be cleaned with carbon tetrachloride. When ball-shaped contacts are found, they should not be flattened. In many applications ball-shaped contacts are better than flat ones, since dust does not collect on them so readily and the ball points break through film more easily.

For a more complete article on relay maintenance, the reader is referred to the "Radio and Sound Bulletin No. 17".

## RMA PREFERRED VALUES FOR RESISTORS

The RMA standard list of preferred values for resistors has been adopted by the majority of the leading manufacturers of radio and electronic equipment. The primary purpose of the list is to limit the number of different types of resistors to be manufactured. The basic values increase nearly logarithmically and are multiplied by powers of ten; for example: $1.8 \times 10^4 = 18{,}000$ ohms, $4.7 \times 10^5 = 470{,}000$ ohms, $5.6 \times 10^6 = 5.6$ megohms, etc. Where values such as 20,000, 50,000 or 75,000 ohms would normally be encountered in circuits, probably 22,000, 47,000 or 82,000 ohms would be found instead.

The basic list of RMA preferred values for resistors follows:

| | |
|---|---|
| $1.0 \times 10^x$ ohms | $2.2 \times 10^x$ ohms |
| $1.2 \times 10^x$ ohms | $2.7 \times 10^x$ ohms |
| $1.5 \times 10^x$ ohms | $3.3 \times 10^x$ ohms |
| $1.8 \times 10^x$ ohms | $3.9 \times 10^x$ ohms |
| $4.7 \times 10^x$ ohms | $8.2 \times 10^x$ ohms |
| $5.6 \times 10^x$ ohms | $10.0 \times 10^x$ ohms |
| $6.8 \times 10^x$ ohms | |

## SENSE DETERMINATION IN DIRECTION-FINDING EQUIPMENTS

When making "sense" determinations with a direction finder it is of extreme importance that the correct procedure for that particular model be followed as outlined in the instruction book. On ships having commercial direction finders, such as the Radiomarine AR–8700 series or the corresponding Mackay equivalent, a bearing in the correct sense is one in which the signal level increases when the loop is rotated 90° toward lower scale readings. It should also be noted that this "Pullman car rule" of "the higher the lower" also applies to the Navy model DAE direction finder, prior to its modification as described below.

On Navy standard models such as the model DP series, a bearing in the correct sense is one in which the signal level increases when the loop is rotated 90° toward higher scale readings.

It should be pointed out that some model DAE direction finders have been modified in order to make the sense determination procedure conform to Navy standard practice. This modification is accomplished by removing the scale from the bottom of the loop mounting and reinstalling it after rotating it 180°.

It is suggested that instructions for correct sense determination be posted near the direction finder for ready reference by personnel operating the instrument who are not thoroughly familiar with the correct method for the instrument.

## PROTECTION OF WIRING DIAGRAMS ON RADIO EQUIPMENT

It has been reported that considerable damage is being done by insects to wiring diagrams on radio equipment. The following method for protecting wiring diagrams is recommended.

As part of the moisture-proofing kit (Army type 68Q5) being supplied to Advanced Bases, there is included a quantity of G.E. Glyptol type No. 1200–F. This is a clear resinous varnish having adhesive properties. In order to secure and protect wiring diagrams, the Glyptol should first be sprayed or brushed on the clean metal surface. Then place the wiring diagram on the wet surface. After the diagram has been attached to the varnished surface it should be sprayed over completely with Glyptol thereby protecting the diagram from moisture and insects.

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## FUNGUS GROWTHS

Mildew molds and bacteria that cause decay develop rapidly on textiles and wax in impregnated wire insulations and on fibrous insulating materials such as vulcanized fiber under suitable conditions of temperature and humidity. They will also form on phenolic materials although not as readily, which is believed to be due to some antiseptic action of the phenol compounds. Polished surfaces of phenolic materials are not attacked to the same extent as sawed or punched edges where fibers are exposed. It has even been observed that fungus will form on porcelain or glass and will in time etch the surface. The start of a fungus growth on surfaces of this character is explained by the prior accumulation of a thin film of organic matter on which the fungus feeds. The presence of fungus on insulating surfaces will often reduce the insulation resistance to prohibitively low values. The surface resistance of porcelain is reduced, resulting in flash-overs in radio equipment employing high frequencies and potentials. In an atmosphere near saturation and under other favorable tropical conditions, fungus will start to form in a day or two. Experience has shown that once such a growth begins, even though the insulator is immediately and thoroughly dried, growth will continue more rapidly as soon as the high humidity reappears. This indicates that where heaters are provided in enclosed equipments for drying purposes, it is advisable to operate them continuously rather than intermittently.

For the removal of fungus growths, wiping the surface with a cloth saturated with a 50 percent to 70 percent volumetric mixture of ethyl alcohol and fresh water has been found to be effective. The cloth should preferably be of chamois, continuous-filament artificial silk, or other lint-free material. (This treatment, however, should not be applied to textile insulating materials.) Considerable experience with wire having plasticized cellulose acetate coated insulation in damp locations within the United States and in the laboratory, has indicated that this type of insulation has definite fungus-inhibiting qualities.

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## FAILURE OF LOW-FREQUENCY A-C AND D-C TRANSMITTER METERS

Transmitter meters frequently are shunted by a small condenser to protect them from high r-f currents. In case of burnout, test this condenser before replacing the meter and replace the condenser if it is found to be faulty. It may be well to replace this condenser with one of a higher voltage rating if the original has failed and it may be helpful to substitute one of higher capacitance if the original is still good, but of insufficient capacitance to protect the meter.

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## WIPING-CONTACTS ON TUNING CONDENSERS

After long periods of use, wiping-contact fingers used for making connection to variable condenser rotors sometimes loose their springiness and make poor contact. When this condition is encountered, the wiping-contact should be replaced with a bonding connection securely soldered to the rotor and to the frame of the condenser. Suitable "pigtail" material for bonds is phosphor bronze dial cable. One turn should be placed around the shaft so as to allow the rotor to turn freely. When cutting phosphor bronze dial cable the strands often have a tendency to unravel. This may be prevented by tinning the cable with a drop of solder for a short distance in the vicinity of the point at which the cable is to be cut. The cable should then be cut through the tinned portion.

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## ERRATIC PERFORMANCE OF VHF EQUIPMENT

One cause of erratic performance in VHF equipment has been rain entering the microphone. A thin rubber cover has proven satisfactory for keeping the microphone dry, and does not interfere with normal operation of the equipment.

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## SUMMARY OF NAVY TYPE LOUDSPEAKERS

| Navy designation | Mfg. | Used with | Audio power (watts) | Input impedance (ohms) | Type magnet | Shape and description | Model or mounting | Description of loudspeaker |
|---|---|---|---|---|---|---|---|---|
| 49061.... | ........ | TBM, TBN, General use. | ....... | 600 | PM...... | Height 13″, Width 10″, Depth 8″, (maximum). | Bulkhead.. | Includes an amplifier. Operates from 115 volts AC or DC, ±6 volts. Volume control. Jensen PM6C Marine type speaker. 6″ cone, splash-proof and blast-proof. Speaker output 10 bars. RE 13A 563A. |
| 49091.... | CRD... | V.H.F., CXAC. | ....... | 600 | PM...... | Top 9$\frac{3}{16}$″, Base 3$\frac{3}{16}$. | Bulkhead.. | Complete with volume control and transformer for operation from 600 ohm line. |
| 49092.... | CNA... | RAO..... | 2..... | 20,000 | PM, dynamic. | Standard relay rack panel, 19″ x 7″. | Rack...... | Speaker is standard Jensen PM dynamic type with a 6″ cone. Fitted with a 20,000-ohm input transformer to match the speaker output of the RAO receiver. |
| 49101.... | CRV... | TBS-3... | 4 (normal), 20 (maximum). | 700 | PM...... | Cylindrical.... | Bulkhead.. | 20-watt speaker, limited by "L" pad to 4 watts. Transformer primary impedance 700 ohms minimum at 3 volts, 60 cycle AC and 0 amperes DC. Matching transformer. |
| 49102.... | CMX.. | XAJ..... | ....... | ....... | ......... | ............... | ........... | |
| 49105.... | CNA... | RAS-1, RAS-2, RAS-3, RAS-4, RAS-5, RAW. | 2..... | 5000 | PM...... | Rack panel 19″ by 8¾″. | Rack...... | Loudspeaker is Rola., Inc. speaker PMK8. Cone diameter is 8″. Fitted with a 5000-ohm coupling transformer to match receiver output. Voice coil impedance 2.8 ohms. |
| 49106.... | CNA... | RAO, RAS, general use. | 2..... | 5000 | PM...... | Cabinet – height 9⅜″, width 10¼″, depth 7¼″. | Table..... | The loudspeaker chassis and matching transformer are identical with those of the Type CNA-49106. Electrical characteristics are the same. This cabinet model purchased under same contract as the Type CNA-49105 for use when table mounting is desired. |
| 49108.... | CRA... | DT, DY.. | ....... | ....... | PM...... | ............... | ........... | Permanent magnet, dynamic type loudspeaker with impedance matching transformer. 5″ cone diameter. |
| 49131, 49131A, 49131B, 49131C, 49131D. | CRV, CRV, CRV, CMX, CRV. | TBT, RAQ, RBO. | 1.75... | 600 | PM...... | Approximately 16″ in height, 14″ in width and 8″ in depth. | Bulkhead.. | All models are loudspeaker-amplifier units and include an integral amplifier and a power unit for 115 volts, 60 cycle AC or 115 volts DC, supply 40 watts. Input to amplifier 6 milliwatts. These models vary as to switch, terminal board, metal construction, and minor changes. |
| 49139.... | CJS.... | TCQ..... | ....... | ....... | PM...... | ............... | ........... | 5″ permanent magnet, dynamic, Jensen type PM5D. |

| Navy designation | Mfg. | Used with | Audio power (watts) | Input impedance (ohms) | Type magnet | Shape and description | Model or mounting | Description of loudspeaker |
|---|---|---|---|---|---|---|---|---|
| 49140.... | CNA... | RBE..... | 1.75... | 600 | PM...... | Rack panel 19″ by 8²³⁄₃₂″. | Rack...... | Mounts on standard relay rack. Operates from 115 volts, 50/62 cycles AC. Rated input 6 milliwatts, 600 ohms at 1000 cycles. Rated output 1.75 watts to the voice coil at 1000 cycles. Uses two 6V6GT and one 5U4G tubes in amplifier. Speaker is Jensen type PM6C. Voice coil impedance 6 ohms. 6″ cone diameter. RE 13A 605A. |
| 49141.... | CJS.... | RBE in connection with CNA-49140 speaker/amplifier. | ....... | ....... | PM...... | Diameter of cone 6″. | ........... | Jensen type PM6C. Voice coil impedance 6 ohms at 400 cycles. RE 13A 605A. |
| 49149.... | CHL... | RBJ, RBK. | 3..... | 5000 | .......... | Overall height 9¼″ width, 10¼″, depth 7″. | Cabinet for table mounting. | Accessory for RBJ. |
| 49154.... | CHC... | RBG..... | 2..... | 5000 | PM...... | ............ | Metal cabinet. | Jensen dynamic speaker having permanent magnet field, matching transformer, 8″ diameter cone. |
| 49155, 49155. | CMX, CRV. | TCS-7, TBS. | 20.... | 500 | PM...... | Circular, metal housing approximately 10″ in diameter. | Bulkhead.. | Speaker proper will handle 20 watts speech. Includes transformer in case to match voice coil to 640-ohm line. Similar to CRV-49101 except is equipped with a blast plate and includes an attenuator, with maximum attenuation of 40 db continuously variable, mounted on the case. Dynamic with permanent magnet field. RE 13A 936. |
| 49166.... | CUL... | CXBO... | 25.... | ....... | PM...... | ............... | .......... | Dual type, high fidelity 60 to 500 and 300 to 10,000 cycles. 50% efficient. Weather proof. |
| 49172.... | CHL... | RBK-2, RAK-8. | ....... | 5000 | PM...... | ............... | Cabinet.... | 10″ permanent magnet speaker. Flat response from 80 to 5000 cycles. Resistance 4.80 ohms. Transformer primary 3000 turns #36 wire, secondary 65 turns #20 wire. Matching transformer. Voice coil impedance 6 ohms. Jensen C-4065. |
| 49175.... | CUL... | MN...... | 12.... | 8 | PM...... | Double, re-entrant horn type bell 8″, depth 7″. | Special angle bracket-roof, table, bulkhead. | Weather-proof, uniform response over frequency range of 400 to 5000 cycles per second and an audio power handling capacity of 12 watts, 8 ohms impedance. |

| Navy designation | Mfg. | Used with | Audio power (watts) | Input impedance (ohms) | Type magnet | Shape and description | Model or mounting | Description of loudspeaker |
|---|---|---|---|---|---|---|---|---|
| 49183.... | CWQ | RBF-2... | ....... | ....... | PM...... | .............. | .......... | The unit consists of a loudspeaker mounted in an enclosure. Frequency range 600 to 10,000 cycles per second. |
| 49186.... | CNA... | RBT-1... | ....... | 7000 | PM...... | .............. | Cabinet.... | 8″ cone diameter. Frequency response 200 to 5000 cycles. Voice coil impedance 6 ohms at 400 cycles. Matching transformer. |
| 49207.... | CJS.... | DAQ..... | 2..... | ....... | PM...... | Overall diameter 5″, overall depth 2⅝″ maximum. | .......... | Cone speaker. |
| 49228.... | CNR... | ML-3.... | ....... | 5.5 | PM...... | .............. | .......... | Includes dynamic loudspeaker, volume control, and terminals mounted on a terminal strip. For remote use. Input 2.34 volts, 0.426 amperes. Frequency response within ±2 db from 100 to 4500 cycles. |
| 49239.... | CJS.... | PD-1.... | 6..... | ....... | Electromagnetic dynamic. | .............. | .......... | Electromagnetic dynamic. Completely dustproof. Rated 6 watts. Voice coil impedance 6 ohms at 400 cps. 1″ diameter field coil. DC resistance 280 ohms, wound with #30 wires. |
| 49240.... | CRA... | PH, PJ, mobile equipment. | 2.5.... | ....... | PM...... | 3½″ cone housing. | Especially suitable for mounting in portable equipment. | Completely dustproof. 5-ounce magnet, 3″ cone. Voice coil impedance 4 ohms. |
| 49282.... | CJS.... | PE-1..... | 5..... | 4 | Electromagnetic. | .............. | .......... | Cone diameter 6″. Field coil rated 1800 ohms, 4 watts, tapped at 300 ohms. |
| 49437.... | CJS.... | TCS-6... | ....... | 6 | PM...... | .............. | .......... | Cone diameter 5″. Natural frequency of diaphragm is 275 ± 10 cps. Voice coil made up of two layers of #35 wire. |
| 49442.... | RQ.... | OAY..... | 8-10.. | ....... | PM...... | Cone diameter is 12″. | .......... | Speaker-amplifier unit. Operates horn 110/1/60 AC, 105 watts. Consists of a bridging power amplifier, Thordarson Electric Co. type T-31W10 and a high fidelity loudspeaker, Jensen type JCP-40. Amplifier gain is approximately 82db. Unit has bass and treble controls. Jensen type JCP-40. Voice coil impedance 6 ohms, 12″ cone. |
| 49478.... | ........ | Never used. | 12 (maximum). | 600 | PM...... | Bell 8″....... | Universal mounting provision. | 8″ bell. Frequency range 200 to 3500 cps. Designed for use under adverse conditions. This Navy type loudspeaker has never been contracted for. |

| Navy designation | Mfg. | Used with | Audio power (watts) | Input impedance (ohms) | Type magnet | Shape and description | Model or mounting | Description of loudspeaker |
|---|---|---|---|---|---|---|---|---|
| 49493.... | CJS.... | RAO-5......... | | 600 | PM...... | Metal cabinet 8¼″ by 8¼″ by 4⅜″. | Table..... | Speaker unit is 6″ in diameter and has a 19 ounce permanent magnet. Impedance matching transformer, primary has terminals for connection to circuits of 20000, 10000, 5000, 2000, 600 ohms. Volume control. 5-foot input cable. Frequency range 200 to 5000 cps. |
| 49545.... | ........ | RBO..... | 3..... | 600 | PM...... | Height 20″, width 16″, depth 12″ maximum. | Bulkhead, table. | Speaker-amplifier. Operates from 115 volts, 50-60 cycles AC. Five channel input. Volume control. Tone control. Frequency range 100 to 5000 cps. High quality cone speaker for entertainment purposes. New. Has not been contracted for yet. |
| 49546.... | CUL... | General communication use. | 10 (normal operating range will probably not exceed 2 to 4 watts.) | 15 | PM...... | Reflex horn. Mounting base is approximately 7½″ by 3¾″, overall depth of horn and base 10¼″. | Any vertical surface or to the overhead if suitable right angle bracket is secured. | Submergence-proof and blast-proof loudspeaker for open bridge installations and other locations exposed to the weather. Includes T-pad volume control and hermetically sealed transformer with primary tapped at 600, 1200, 1800, 2400, and 3000 ohms to permit paralleling of from one to five speakers across a standard 600 ohm audio line. Frequency range 200 to 3500 cycles per second. In production at the present time. |
| 49587.... | CZC... | .......... | 10.... | ....... | PM...... | Cabinet....... | Bulkhead.. | 12″ cone diameter. Matching transformer to match 6-ohm voice coil to 600-ohm line. Frequency range 300 to 5000 cycles per second. |
| 49597.... | CCI.... | RCO, RDF. | ....... | ....... | PM...... | Panel 19″ by 7″. | Rack...... | Cone diameter 6″. Contractor's commercial model #132. Impedance matching transformer to match 500-ohm voice coil to 600-ohm line. Complete with cord and plug. |
| 49620.... | CMX.. | Identical with the CMX–49131C in every respect except the loudspeaker cone in the CMX–49620 is not blast-proof. Formerly the CMX-49131E. | | | | | | |
| 49624.... | ........ | General use. | 15.... | 15 | PM...... | Double re-entrant type. Approximately 7½″ in diameter and 6″ in depth. | On or through the bulkhead. | Submergence-proof and blast-proof loudspeaker for general exterior use on small craft such as PT boats. Frequency range 500 to 5000 cycles. Complete with impedance matching transformer with the primary tapped at 600, 1200, 1800, 2400, and 3000 ohms. New. Contract to be let in the near future. |

| Navy designation | Mfg. | Used with | Audio power (watts) | Input impedance (ohms) | Type magnet | Shape and description | Model or mounting | Description of loudspeaker |
|---|---|---|---|---|---|---|---|---|
| 49645 | CRV | RBM | 2 | 600, 3300, 5300. | PM | | Mounted in portable case. | Monitor amplifier mounted in portable submergence-proof and blast-proof case complete with speaker. Self contained a-c operated power supply, 115 volts ±10%, and an alternate 12 volt d-c operated vibrapack. Source impedance 600 ohms; input impedance 600, 3300, and 5300 ohms. Rated output 2 watts at 400 cps and 4% distortion. Frequency range 500–4000 cps. |

## LITZ WIRE

Since high "Q" means in general better selectivity and greater gain, coils are usually designed to secure the highest "Q" compatible with other practical construction and circuit factors. Since "Q" is the ratio of inductive reactance to effective resistance, the "Q" may be increased by either increasing the inductance or reducing the effective resistance of the coil. The inductance of a coil is fixed by the frequency range to be covered and the maximum and minimum capitance of the circuit (assuming variable capacity tuning) so that any efforts to increase the "Q" must be directed toward a reduction in effective resistance.

It will be noted that the term "effective resistance" has been used. The term is used to denote the increase in resistance at high frequencies due to coil losses and skin effect. The effective resistance is the ratio of the power dissipation in a coil to the current squared. Alternating current at high frequencies tends to flow on the surface of conductors rather than uniformly through the cross section area of the wire as is the case with DC or power frequency AC. Since the thin outside shell has a smaller area than the wire, the current density is increased at high frequencies with a consequent increase in losses and effective resistance.

At low and medium frequencies (30 to 3000 kc) the surface area of a conductor may be increased without increasing the cross section of the copper by dividing the conductor into strands and insulating each strand from the others by a thin enamel coating. Wire in this form is known as "Litzendrabt" or "Litz" wire. Litz wire consists of many strands of fine wire, each strand individually insulated with enamel and the whole group covered with a protective textile wrapping. Furthermore, the strands are so arranged that each occupies a place on the surface of the conductor an equal percentage of the time so that the radio-frequency current will divide equally among the many strands and thereby give the lowest radio-frequency resistance. Originally, the strands in Litz wire were braided so as to give this effect. Recent Litz wire is merely twisted so as to bring the different strands to the surface at different points, giving a result approaching that of braided Litz, but at far less cost. If stranded wire without twisting is used the results are inferior to those obtained with twisted Litz.

Litz wire comes in a variety of combinations of number of strands, wire gauges of individual strands and types of covering. The more commonly used combinations are 5, 6, 7, 8, 9 and 10 strands of #38, 40, 41, and 42 B & S gauge wire. The number of strands used is a rough function of frequency; in general, the higher the frequency the greater the skin effect and the greater the number of strands employed. The gauge of the strands is determined by the overall wire diameter which is dictated by winding space, coil size, etc.

When soldering Litz wire to coil terminals, it is of great importance that a *good,* permanent electrical contact be made to *each* and *every* strand of wire. Otherwise some of the strands will not be conducting their share of the current with a consequent increase in radio-frequency resistance.

Before soldering, the insulating enamel must be cleaned from each strand. This is best done by heating the end of the wire in an alcohol lamp until red hot, and then plunging the wire into a bath of alcohol. This operation completely removes the enamel insulation from the individual strands, leaving them clean and ready for soldering. A less satisfactory emergency method is to fold a scrap of 000 sandpaper between the thumb and forefinger with the abrasive inside and draw the wire through several times, rotating the wire axially after each draw. Care must be exercised not to break any strands as this is easily done. This method removes the cloth insulation as well as the enamel from the strands.

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## MASTER-OSCILLATORS FOR ADVANCED BASES

The Bureau is purchasing 1,000 small self-excited stabilized oscillator units capable of delivering, under continuous operating conditions, a minimum of 0.75 watts with continuous coverage of the frequency spectrum from 0.75 to 10.0 mc. inclusive. The complete equipment will include a rectifier power unit for taking power from a 115/230 volt, 50–60 cycle, single-phase supply line. The oscillator, rectifier power unit, oscillator coils, and buffer coils will be contained in a single cabinet that is capable of being mounted in a standard 19″ relay rack.

These oscillators are intended for use with such transmitters as the TCB, TCC, TCR, and TDF series to provide continuously variable operation on frequencies for which crystals are not available.

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## EMERGENCY FREQUENCY CONTROL

There are many occasions in field operations or at advanced base radio stations when there is a need for a stable, continuously variable means of frequency generation to drive a normally crystal-controlled radio transmitter. Changes in communication plans at the last moment will render a transmitter idle until crystals of the proper frequencies are obtained or reground to the redesignated channels. The allowance lists for advanced base stations usually contain a few Navy type LM frequency meters. Similar types such as the Army SCR–211 may also be obtainable. One of these units may be used as a variable frequency oscillator by connecting it to a fabricated exciter, the circuit of which is shown in Figure 1. This arrangement will deliver ap-

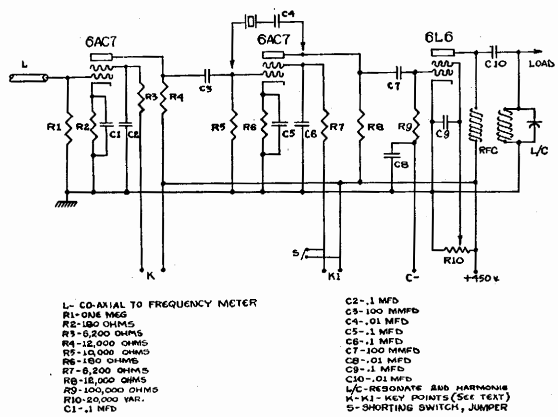


FIGURE 1.—Continuously variable master-oscillator arrangement.

proximately eight watts output. All screen and plate resistors are ten-watt types. Key the first 6AC7 when using it as a variable frequency oscillator. Crystal control may be obtained by connecting the crystal across the second 6AC7 as shown in the diagram. Keying is then accomplished in the second 6AC7.

The output of the exciter may be connected directly to the grid of the isolation stage or doubler. When the transmitter is equipped for a frequency-shift keyer, the output may be plugged directly into this receptacle.

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## HOW TO LOAD THE TRANSMITTER

The material to follow is published for the instruction of those members of ships' personnel who are not entirely familiar with the tuning of transmitters.

An antenna will not radiate all the power available from the transmitter unless the impedances of the antenna and transmitter are properly adjusted by a method of "loading". Loading generally consists of two parts: The tuning of reactances which are connected to the antenna for the purpose of changing or "transforming" the impedance of the antenna; and the adjustment of coupling reactances which are connected between the transmitter and the antenna loading reactances.

The tuning procedure almost always starts with the loosening or decreasing of the coupling in order to protect the transmitter. This is necessary because overcoupling of the tuned antenna might reduce the impedance of the final stage's tuned circuit to such an extent that the final stage tube would conduct an unsafe amount of current.

After decoupling, the final stage is tuned. This process usually involves tuning a parallel resonant circuit which is in series with the plate of the output tube. The tuned circuit is the load impedance for the output stage and is tuned to parallel resonance by rotating the condenser and observing the final plate current meter (or cathode current meter). When it reads a minimum value, the plate load impedance has been maximized and is correctly adjusted.

Next, the antenna is tuned so that it will draw a maximum amount of power from the transmitter. This is done by varying the loading reactances as described in the instruction book, meanwhile observing that the antenna ammeter indicates in a manner described in the article "What Does Antenna Current Mean," page ANT:3, with the magnitude of the current dependent upon the adjustment of reactance described in this paragraph. When the adjustment is correct, the antenna ammeter will indicate a maximum current (providing such current is readable) and the final stage plate current will also reach a maximum. In other words, the tuning apparatus is adjusted until these two meters indicate maximum value.

At this point in the adjustment schedule, the coupling apparatus is still arranged for loose coupling. The last step is therefore a tightening of the coupling, accomplished by closing the plates of a coupling condenser, or by bringing the two windings of a radio-frequency coupling transformer closer together. The proper degree of coupling is obtained when the plate current meter of the final stage indicates the rated value, or that value of current which the instruction book describes as "rated" or "normal".

If the frequency establishes enough current in the antenna standing wave at the antenna ammeter to permit an ammeter indication, then the antenna current can be observed during the coupling process. Usually, the antenna current will rise as the coupling is tightened (increased), but, of course, the operator ceases to increase the coupling when the final plate ammeter shows rated current.

Sometimes, usually at high frequencies, the instruction book mentions overcoupling. In such cases, the rated value of plate current is reduced from its usual or normal value so that the tuning may be accomplished by observing the final plate ammeter. In such cases, if the antenna current can be observed it will rise during the tightening of coupling until the plate current reaches rated value, and will then decrease if the coupling is tightened enough to draw more than rated final plate current.

Summary: Loading is almost always accomplished with these several simple steps:

(1) Decrease coupling.

(2) Tune final plate circuit to the dip in plate current.

(3) Tune antenna circuit to maximize final plate current. (Antenna ammeter will pass through a maximum reading, which reading may be too small to see.)

(4) Tighten coupling until final plate ammeter shows rated current. (Antenna ammeter will again increase, but may not be large enough to observe.)

(5) If so directed by the instruction book, the operator should loosen the coupling slightly and repeat steps (2), (3), and (4).

(6) If the coupling cannot be satisfactorily decreased for step (1), then it may help to disconnect the antenna, and reconnect it between steps (2) and (3).

The reader is referred to the article "What

Does Antenna Current Mean," page ANT:3, for further information on antenna current.

There are frequent reports of difficulties in properly loading transmitters on certain frequencies. On a few transmitting equipments the output coupling devices do not have sufficient range to load the antenna with the above procedures. The trouble can usually be cleared up by adding a controllable amount of reactance to the antenna circuit, either inductive or capacitive reactance being used as required. It has been found that a 250-mmfd. variable condenser suitably mounted and protected is usually all that is required. A type 481640 auxiliary tuner has been developed by the Bureau to eliminate tuning difficulties with the model TCE series transmitters. These tuners consist of a 250-mmfd. condenser suitably enclosed for mounting either on a bulkhead or atop the TCE, and may be secured by application to the nearest Radio Material Officer.

## FAILURE OF TRANSMITTER TO LOAD

When a transmitter fails to load properly, check the antenna system for open or poor contact at the feed-through insulators. A simple trunk continuity check can be made by connecting with a jumper the antenna wire to the ship's hull outside the external feed-through insulator. Then disconnect the antenna from the transmitter and check the d-c resistance from antenna bus to ground. Zero (or very low) resistance indicates satisfactory continuity. *Be sure to remove the jumper after the test.*

—U. S. S. *Haverfield*

## MAINTENANCE OF VOLUME CONTROLS

Noise in a receiver is frequently traced to a faulty volume control. If the control is suspected, it may be checked by tapping and/or rotating the shaft while listening for a change in the nature of the noise.

If the volume control is of the wire-wound type, it may be cleaned with an eraser or crocus cloth. See the article "Relay Maintenance," page GEN:28, for directions on cleaning contacts. After cleaning, the contact surface may be washed with carbon tetrachloride or alcohol and lubricated with a light coat of vaseline.

Worn out carbon resistance elements need replacement. In an emergency, they often can be repaired by smearing the contact surface with pencil lead. If no exact replacement is available, but one of higher resistance is, a replacement may often be made by utilizing the available one and shunting it with enough fixed resistance to bring the paralleled resistance down to the desired value.

## EMERGENCY TREATMENT OF ARC-OVERS

Arc-overs often call for a permanent replacement of a component or insulator, or for increasing the separation between arcing points if air is the insulator, or for some other type of repair that cannot always be made during an emergency.

Although arcs are always due to the same general causes, there is enough difference in radio equipment arcs to permit several types of emergency repair. An arc between one or more sharp points might be eliminated by filing down the points (provided such points are not functional). An arcing contact calls for dressing the contact and testing any associated arc-reducing resistors or reactors. An arc along the surface of a ceramic insulator calls for cleaning and/or drying the insulator surface; such failures are most likely to appear in hot, damp climates.

Some arcs can be cured by a slight revision in the circuit. For example, in a transmission line circuit, an arc might be eliminated by moving the offending spacer to a position of lower voltage, or even temporarily removing it. Occasionally, a haywire suspension of an offending connection might permit temporary removal of a punctured insulator. In a few instances, the arc can be eliminated by shunting the impedance of the arc path with a resistor of sufficiently low impedance to reduce the potential across the arc path; although this can only be done where it is known that no deleterious overload or detuning will occur as a result of the added impedance. An example might be the failure of a modulation transformer's insulation. Temporary replacement of an arcing component can sometimes be effected by utilizing some combination of other components; for example, an arcing rheostat might be replaced by another of larger resistance, shunted by a fixed resistor of such size as to bring the combined resistance to the right value. This can only be done when there are no critical requirements of the original component such as taper, calibration, capacity to ground, etc.

## OPERATION OF START-STOP SWITCHES

Most start-stop switches of the momentary type are so connected that the depressing of both buttons simultaneously would throw a direct short across the line, and blow one or more fuses. This condition is considered normal, and it is therefore suggested that all radiomen be familiar with it, and avoid blowing fuses by irregular operation of the momentary start-stop switches.

## TREATMENT OF RADIO EQUIPMENT AFTER SALT WATER IMMERSION

The following procedure is suggested for the treatment of radio equipment after salt water immersion:

(1) Dismount transmitters, receivers, frequency indicators, direction finders, etc., removing all covers, access and mounting plates, vacuum tubes, fuse covers and fuses, and armatures from dynamotors or motor-generator sets. Disconnect and remove all meters from equipment and cases. Break the dial glass, if required, to drain off water.

(2) Flush all parts of the equipment thoroughly, using warm fresh water under slight pressure. Do not subject the internal parts of pressure-sealed units to the water treatment without first ascertaining that salt water is present inside the pressure-sealed portion; then remove the salt water from the exposed parts only. Place the equipment in a tank and soak it not less than four hours in circulating warm water. If non-circulating, change the water at intervals of one hour. As an added precaution against corrosion, if the material is available, it may be desirable to add a minute quantity of potassium dichromate to the fresh water solution in the strength of ½ oz. to every 10 gallons of water.

(3) Remove the equipment from the water and drain it. Blow out all moisture with low pressure air and place the equipment in any available oven. Dry it thoroughly for 24 hours at a temperature of approximately 150° F.

(4) If storage is required prior to overhaul, spray all exposed metal parts slightly, using light clear oil.

Experience indicates that if equipment is treated as outlined immediately after immersion, a minimum of replacement parts and overhaul work is required. It has not been found practical, however, to attempt to salvage vacuum tubes, meters or externally shielded cables (except plugs, which are removed and included with the equipment being preserved). Power transformers in transmitters, likewise, must practically always be replaced, even though megger tests after baking may show normally high insulation resistance to ground. It has likewise been found that replacement of sockets, relay contacts, etc., may be required, particularly if immersion took place before power voltages were removed from the equipment. Glass tubes having their leads coming directly out of the glass envelope without a tube socket will not need to be replaced unless proven defective. On tubes of this type, it will be necessary to remove all corrosion from the tube leads. Cathode-ray tubes can possibly be salvaged by removing the plastic base from the tube, removing all corrosion and salt water and replacing the plastic base.

Rewiring of equipment is not normally required, the criterion used being a check of circuit resistance to ground from the various terminals, using a megger, after removing normal circuit grounds or resistor shunts. An insulation resistance in excess of 50 megohms is taken as satisfactory evidence that rewiring is not required. Rewiring, replacement of parts, refinishing of cases and final testing of equipment is accomplished as with other types of overhaul procedure.

If the immersion was for a prolonged period or if the equipment has not been properly washed and preserved, it is usually found that so much corrosion of the cases and mechanical parts has taken place that it cannot be economically overhauled.

*—Airborne Coordinating Group*

## ELECTRONIC CORD AND CABLE TESTER

The electronic cord and cable tester shown in Figure 1 is said to take the guess work out of checking portable cords and cables for breaks, and

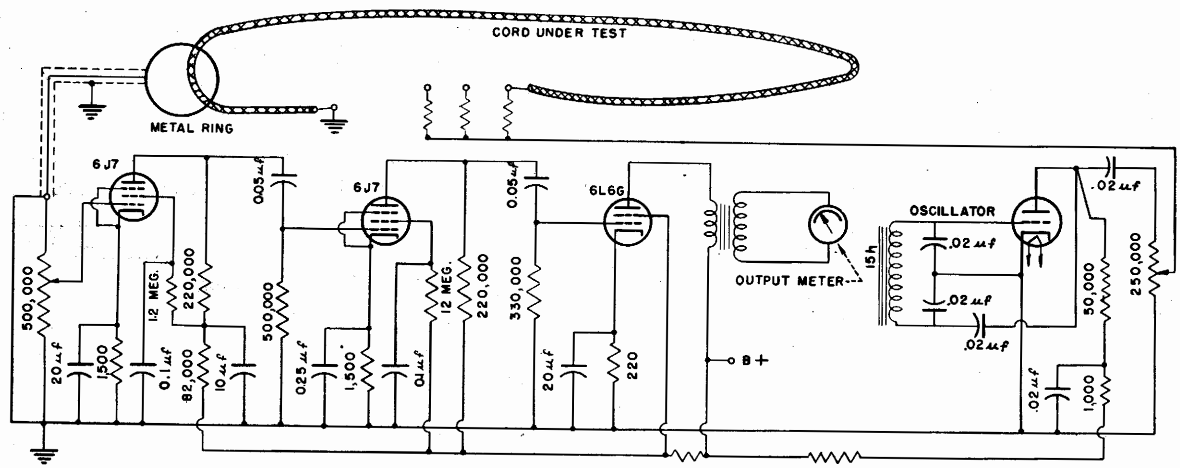


FIGURE 1.—Electronic cord and cable tester.

to save time and material. It was developed by Consolidated Vultee Aircraft Corporation and is presented here for the benefit of Naval activities who have occasion to check portable cables and who may wish to construct the device.

The circuit is shown in Figure 1. One tube is connected as a self-excited oscillator operating on a frequency of about 400 cycles. The output of the oscillator is applied to the cord.

A small amount of the signal energy is picked off the cord by a metal ring through which the cord is passed. Fed to a high-gain amplifier, the signal amplitude is increased sufficiently to operate the output meter shown. When a break in the conductor passes through the ring, a sudden change in the meter deflection occurs and the broken spot can be quickly and accurately ascertained. Thus, the necessity of cutting the cord to locate the break is eliminated.

The metal pick-up ring is mounted inside an assembly of fibre insulation material. A short shielded lead is provided for connecting the ring to the amplifier. The ring is mounted on top of the test unit. Input and output potentiometers are provided to permit adjustment of the circuit so that the meter reading occurs at a convenient portion of the scale when a good cable of the type to be tested is inserted in the ring. An additional provision for this purpose is the use of different values of resistance in the output circuit.

In addition to the output terminals shown in the diagram, the electronic tester may be modified if desired to accommodate various male and female cable and cord plug receptacles.

—*Electronics Magazine*

## STARTING NUTS IN TIGHT PLACES

When the available space is too small for the use of fingers and the nut won't stick to needle nose pliers and the profanity is exhausted, try this stunt:

Place the nut on a metal plate and lay a piece of wire solder across the nut, placing the nut near the end of the solder. A hammer blow will force the solder down into the threads and cause the nut to stick to the solder. Using the solder as a handle, place the nut in position and turn the screw. As the nut travels down the screw, the solder will be forced off and an end wrench or long nose pliers will hold the nut for tightening.

## CARE OF BALL BEARINGS

The production of bearings cannot keep pace with bearing requirements. Therefore, the authorized maintenance procedures for the care of bearings should be followed religiously. Some of the things that can be done to improve the situation are:

(1) Keep bearings clean. One speck of sand or grit can ruin a bearing. Watch out for dirty hands, tools, benches, rags, cleaners and lubricants.

(2) Clean bearings thoroughly. Always use a clean dry cleaning solvent, and also a brush if necessary. Place the bearing on a clean surface, such as a sheet of paper, to drain and dry. Never use compressed air to dry a ball bearing. Keep new bearings in the original wrappers until actually ready to install. All bearings, except prelubricated bearings that are sealed, must be cleaned before installation.

(3) Install bearings properly. Be sure all parts of a bearing assembly—spindles, hubs, and cups—are cleaned and free from sand and grit. Be sure the bearing itself is clean. Install, adjust and lubricate according to instructions.

(4) Lubricate bearings correctly. Bearings that are going to be grease packed, such as wheel bearings, must not be oiled before installation. Keep sand and grit out of lubricants. Lubricate bearings in accordance with the instructions in the appropriate radio equipment instruction book.

(5) Bearings that are not going to be reinstalled immediately, after they are removed and cleaned, should be oiled to prevent rusting. They must be cleaned again to remove oil and dirt before installation.

—*Signal Corps Technical Information Letter #27*, February 1944.

## FAILURE OF POST TYPE FUSE HOLDERS

Considerable trouble has been experienced with post type fuse holders, such as those used with models RAO, RBH, RBO, etc. The usual trouble is failure of the spot weld between the lug on the side of the holder and the internal metal sleeve, causing loss of input power to the receiver.

As an emergency measure, broken fuse holders may be "sweat soldered," tinning the metal sleeve and carefully working solder into the hole in the soldering lug on the side of the holder. A permanent repair may be made by replacing the defective holder with one of improved construction, such as Littelfuse catalog #1075F. It should be remembered that post type fuse holders are not "built like a battleship" and hence can be easily damaged by heavy handed twisting with a screwdriver. The fuse holder should be screwed in until just tight and *no more* and secured.

## SOME NOTES ON THE USE OF FUSES

A fuse is electricity's safety valve. It is placed in a circuit to protect equipment and if it "blows" it is an indication of trouble. Fuses of reliable design do not deteriorate with age. They will protect a circuit indefinitely if not overloaded or subjected to poor contact.

If a fuse has been making good contact in its clips, it will be clearly indicated by the condition of the contact terminals. If the contact has been tight, very little or no air can get to the portions that were making contact. Hence, very little or no oxidation can occur and the portions in intimate contact will be clean and bright. If, however, the contact has been poor, air gets to the contact surfaces and the heating of the fuse (due to either excessive current density in the contacts or to the voltage drop across the oxide or other agent introducing resistance between the contact surfaces) produces oxidation which is evidenced by discoloration of the contact surfaces. No matter how badly a fuse might be heated, there will be a clean, nonoxidized space if good contact has existed. If the washer or end ring on a renewable fuse is burned or partially melted, it indicates that the cap was not screwed down tightly. Charring of the fibre tube or inside fibre strip in a renewable fuse always indicates poor contact or over-fusing, i.e., installing a renewable link of greater capacity than called for. Poor contact is to be especially avoided, as the heat produced by current flowing through this contact is conducted to the fuse, melting the link prematurely or damaging the case.

When renewing the link in a renewable fuse, it is important that a link of the correct current rating be installed. Overloading a renewable fuse or a fuse block is no different than overloading anything else. If an attempt is made to make a fuse carry a current greater than that for which it was designed, the terminals and current carrying parts of the fuse will overheat, damaging the fuse case and taking the spring out of the fuse clips. Furthermore, a renewable fuse that is overfused may explode if subjected to a heavy short circuit. The pressure developed by the volatilization of the extra metal will be greater than the fuse case was designed to handle. Drilling holes in the sides of a fuse tube to keep down the temperature where a renewable fuse is over-fused makes a real hazard out of the fuse because a fuse with holes explodes more readily than a totally enclosed fuse. Pressure inside the fuse case helps to extinguish the arc and this pressure is lost when a fuse is mistreated in this manner. Such holes will also permit the expulsion of molten metal and hot vapors which may ignite inflammable material and cause serious burns.

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## COLD-SOLDERED JOINTS IN EQUIPMENTS

High resistance soldered connections, especially in fuse holders, have been reported in several receiving equipments, including models RAO, RBL, RBO, RAK and RAL.

The cold-soldered connection should be reformed by the application of a hot soldering iron. Replace bakelite fuse holders if they have been damaged by an arc across a cold-soldered joint.

It is well to look for other cold-soldered joints on components such as certain types of fuse holders, components potted in tar, etc., which are so constructed that only a small amount of heating is permitted in soldering them.

—*Commander Service Force, Atlantic Fleet*

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## SOLDERING

In the maintenance of radio equipment, too much emphasis cannot be laid on good soldering as an appreciable portion of equipment failures can be directly traced to poorly soldered joints, especially on shipboard where apparatus is subjected to continual shock and vibration. In this connection, attention is invited to the following suggestions on soldering:

(1) The parts to be soldered must be absolutely clean, i.e., free from oxide, corrosion and grease.

(2) The only satisfactory flux for radio and electrical work is rosin. Either a paste or thick solution of rosin in alcohol or carbon tetrachloride ("Carbona") or rosin core solder may be used. Soldering paste is satisfactory for assistance in tinning and soldering power cables to lugs, provided it is used judiciously and sparingly, and any excess is removed as soon as the joint is cool. Acid or "killed acid" flux should *never* be used except in cases of absolute necessity.

(3) All wires should be mechanically fastened to soldering terminals or each other. Solder has very little mechanical strength and should not be used for fastening purposes. Mechanical rigidity should be obtained by bending the wire into a small hook at the end, and nipping it firmly with a pair of pliers around the other part to be soldered. Wrapping or twisting of wires around lugs should be avoided as it is very difficult or impossible to satisfactorily remove connections made in this manner.

(4) The soldering iron must have its tip properly cleaned and tinned. Satisfactory soldering cannot be done with a tip that is oxidized.

(5) The work must be heated to a temperature slightly higher than the melting point of the solder. This allows the solder to penetrate to all fine crevices of the joint and form the alloy with the other metals essential to a good joint. It also causes the rosin flux to be burned out of the joint, as is evidenced by the white rosin smoke or globules of rosin floating on the solder.

(6) If possible, the iron should be held below the joint to drain off excess solder. It is a common fallacy that the strength of a soldered joint depends upon the amount of solder used. It does not. Experience shows that "piled up" joints usually have one or more layers of rosin sandwiched between the solder preventing good electrical and mechanical joining.

(7) The joint must be kept perfectly still until the solder has had time to solidify. Premature motion produces a so-called "cold" joint which has a dull "white" appearance instead of a shiny "silvery" one. Cold joints tend to have a high resistance, and the cure is to reheat the joint until the solder remelts and then allow it to cool without motion.

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## CARE OF THE SOLDERING IRON

From time to time the tip should be removed from each soldering iron and the black scale removed from the tip and from inside the barrel of the iron. This procedure accomplishes two things:

(1) It provides for better heat transfer between the barrel of the iron and the tip by removing the layer of heat insulating scale.

(2) It prevents the tip from "freezing" in the iron. A frozen tip is an unfortunate circumstance as its removal is a matter of great difficulty, and, once a frozen tip has worn away through use, the iron must be discarded. A light application of penetrating oil around a frozen tip may be of assistance in its removal.

When an iron is new, or a new tip is installed, coating the inside end of the tip shank with dry flake graphite will prevent sticking or freezing. A threaded tip should not be screwed in too tightly when the tip and iron are cold.

When finished with a soldering job, wiping excess solder from the tip while it is still hot will prevent erosion and pitting, requiring less frequent filing and thereby increasing the life of the tip.

Tips with deep pits that would require considerable filing to smooth down should be removed from the iron and carefully hammered down to the desired shape and surface.

The insulation resistance of the iron should be measured when it is new and monthly thereafter; irons with low insulation resistance and grounded irons should be removed from service for repairs.

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## CONSTRUCTION OF A "HEAT STRIPPER" TO REMOVE COPALENE AND RUBBER INSULATION

Knife or tool stripping of tough copalene or rubber insulation has been a tedious and difficult job. Improper use of tools has resulted in nicked inner conductors (particularly single conductors) that break when vibrated or bent in operation. Such breaks cause trouble that is hard to trace and usually makes the equipment inoperative. Increased use of copalene-insulated coaxial cable and the use of added plugs, fittings, junction boxes and switches have multiplied the danger from improper stripping and the time involved in the operation.

The idea offered herewith has been used with excellent results at Mare Island. An edged "V" (with a 1/8" wire slot in the bottom of the "V") is fashioned on the end of a piece of copper strip and secured around the heating portion of an ordinary soldering iron. (See Figure 1.) The cable insulation to be stripped is laid in the "V" and rotated. The "heat stripper" rapidly melts a clean break that permits the end insulation to be easily removed with a slight pull. This method

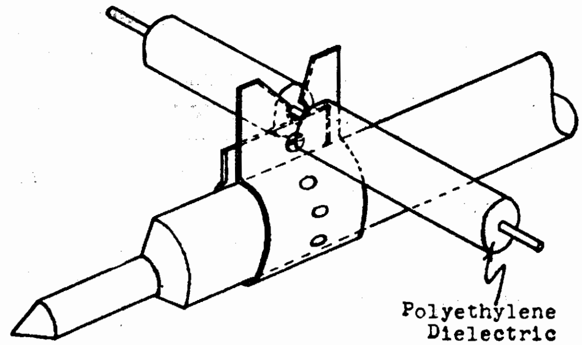


FIGURE 1.—A method of stripping tough insulation.

can be used for lateral cuts on thinner external layers as well, and can also save time on rubber insulation such as Tyrex.

—*Navy Yard, Mare Island*

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## NOTES ON THE CARE OF HAND TOOLS

*Pliers.*—Good pliers are forged of high grade steel, tempered to provide the proper spring in the handle, with knives sharpened to assure a smooth clean cut. If properly used they will give years of satisfactory service. Like any tempered tool they can be quickly ruined by being placed in a flame or near excessive heat. The practice of using pliers to hold objects in a blowtorch flame is almost certain to draw the temper from the pliers. An old cheap pair of pliers should be retained for this use exclusively.

Another common form of abuse is using pliers as a hammer. Pliers may be easily cracked or broken under such treatment and there is the added danger of nicking the blades, making the pliers unfit for cutting. The few seconds necessary to pick up a hammer for such a job are well repaid by the protection afforded the pliers.

There are many sizes and types of pliers, each designed for a specific use. While pliers are flexible in their adaptability and a single pair can be used for a large number of jobs, care should be taken to see that the proper size is used, as pliers can be overloaded and ruined by such practices as extending the length of the handles to secure greater leverage and trying to cut too large a wire with too small a pair of pliers. Long nose pliers can be spoiled by trying to bend too large or too stiff a wire with the tips of the pliers.

When cutting wire with diagonal cutting pliers, particularly high strength strand or steel core wire, the cut should be made around the wire with the cutter knives perpendicular to the wire. The pliers should never be rocked from side to side or the wire bent back and forth against the knives, as there is great danger of nicking or chipping them as they were never intended to take this side strain. If cutters will not cut a wire with a straight compression with the hand, it is a clear indication that a heavier cutter is required.

If the cutting edges of the blades become dull, they should not be filed or ground, but may be touched up with a fine grained carborundum stone.

When not in use, pliers should be rubbed with an oily cloth. When so treated they will remain rust free for a long time. An occasional drop of oil at the hinge will lengthen their life and assure easy operation.

Pliers should not be used for loosening or tightening hex nuts as the nut is almost certain to be battered. A wrench is the only satisfactory tool for use on hex nuts.

*Adjustable Wrenches.*—An adjustable wrench is a sturdy tool which is designed to do one job—to tighten and loosen bolts and nuts. However sturdy they are, wrenches can easily be abused, and the most common causes of failure are abuse and neglect. Wrenches should be kept clean and a drop of oil should be placed occasionally on the moving parts. Dirt and rust accumulating on the knurl make the wrenches hard to operate. Keep them clean.

It is not uncommon to see a wrench used as a hammer. This not only batters the head of the wrench, but also is liable to break it or damage it beyond repair.

Wrench handle lengths are computed to provide safe leverage for the size of the wrench. Extending the length of the handle by slipping a piece of pipe over it increases the leverage but also increases the danger of breakage. If the wrench being used is not of sufficient leverage when used with its own handle, a larger wrench should be used.

Whenever possible, wrenches should be used in the correct position, i.e. when the handle is to the right of the nut being tightened, the sliding jaw should be on the bottom of the nut. The wrench should be turned over from this position to loosen a nut. This procedure puts the greatest load on the solid part of the wrench instead of on the sliding jaw. In tight quarters, however, where it is unavoidable, the wrench may be reversed, but too much pressure in this position is likely to cause damage.

It is important that the jaws of the wrench be tight on the nut that is being turned. This not only prevents battering the head of the nut, but is also a safeguard against the wrench slipping and will prevent bruised knuckles, skinned fingers or perhaps more serious injury to a fellow workman nearby.

Wrenches should be wiped with an oily cloth when not in constant use.

*Screwdrivers.*—Probably no tool in the electrician's kit is more abused than the screwdriver. Screwdrivers are designed for one purpose—to drive or back out screws. Using them as a pinch-bar or crow bar is apt to bend the shank or blade or loosen the handle as they are not designed for this kind of work. Screwdrivers should never be placed in flame or in hot solder as it draws their temper and renders them useless. Screwdrivers should never be used as chisels. This is liable to chip the blade or bend the shank. Hammering on the handle is apt to split or batter it, making the tool dangerous for further use. It is important to select the proper size screwdriver so that the bit is right for the screw it is to tighten or loosen. If the tip is too narrow, the screwdriver is almost certain to climb out of the slot and damage the screw slot. If the tip is too thin, it will bend and possibly break. Use of a screwdriver with a broken tip is dangerous as well as likely to cause further damage to the screw slot. If the screwdriver has a blade which is too wide, it will scrape around the edge of a countersunk screw head and prevent it from being driven home. The proper size screwdriver is one having a tip that is wide enough to just fill the slot in the screw head and just thick enough to fit the slot without wobbling.

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## SOME EMERGENCY "TRICKS"

*Emergency Socket Wrench.*—In an emergency, a socket wrench may be improvised when a nut of equivalent size and a block of wood are available. Hammer the nut into the wood until it is flush with the surface. Then remove the nut with a screw run a few turns into the nut. The impression of the nut in the wood will serve as an emergency socket wrench.

*Emergency Phone Tips.*—Phone tips may be put on the end of a piece of wire by winding bare or scraped wire of about #28 to #30 gauge around the end and up over the outside insulation. Roll tight and apply a thin even coat of solder.

*Testing Paper Capacitors.*—Paper capacitors may be checked for "opens" and approximate capacity by connecting the capacitor to a 110-volt 60-cycle a-c source, in series with a lamp, the wattage of the lamp being selected to give a glow. In general, the lower the wattage of the lamp, the smaller the capacity which will give a glow. A neon glow lamp may be used for very small capacitors. By noting the intensity of the glow and comparing it with that produced by known capacitors, an approximate idea of the capacity may be obtained. If the capacitor is "open" no glow is obtained.

*Illumination in Receivers.*—It is often desirable to illuminate the interior of a receiver to facilitate work in dark quarters. A satisfactory trick is to fasten a dial lamp socket on a fiber tube such as an alignment wrench, connect flexible test leads several feet long to the socket, and at the other end to a base from an old burned out lamp after removing the glass and contents of the base. In use, the lamp is removed from any convenient pilot lamp socket and inserted in the socket of the test lamp, the old base being inserted in the now vacant pilot lamp socket. Thus, illumination is furnished by the receiver's own power transformer, eliminating extra transformers, dropping resistors, etc.

*Emergency Top Cap Connector.*—An emergency top cap connector for tubes employing top caps may be improvised from a Fahenstock clip. The spring is bent until a snug fit is obtained on the top cap.

*Emergency Capacitors.*—A capacitor of 1 to 50 micromicrofarads may be made by twisting together two pieces of hookup wire. The capacity is adjusted by varying the tightness and number of twists.

*Magnetized Screwdriver.*—Every repair shop has use for a magnetized screwdriver in picking up iron or steel nuts, screws and lock washers that fall into tight places. A screwdriver may be magnetized by placing it near the pole-piece of a field coil dynamic speaker while the speaker is in operation. Another method is to wrap several layers of hook-up wire around the blade and pass several amperes of d-c current through the coil. By the same method a screwdriver may be demagnetized, if desired, by passing 60-cycle AC through the coil and slowly withdrawing the blade from the coil while the AC is passing through it.

*Alignment Meter.*—When aligning a receiver employing automatic volume control, a satisfactory output meter is a low range d-c voltmeter (1,000 ohms per volt) connected across the cathode bias resistor of a radio- or intermediate-frequency stage whose grid is biased from the AVC system. The bias voltage is produced by the plate current which is controlled by the AVC voltage. Hence, correct alignment is indicated by minimum bias voltage as read on the meter. When using this system sufficient signal must be fed into the receiver to provide some AVC voltage.

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## TUNING WAND

If a receiver is suspected of being out of alignment in the radio-frequency stages, it may be quickly and easily checked for alignment by means of a tuning wand. Furthermore the trimmers are not disturbed by this process.

A tuning wand consists of a fiber or bakelite rod or tube on one end of which is fastened a slug of finely divided iron ("polyiron") and on the other a short length of brass rod. It may be easily made from parts found in the "junk box", using a core from an old i-f transformer, an alignment wrench or bakelite rod, and a piece of 3/8″ or 1/2″ brass rod about 1″ long.

Alignment of tuned circuits is checked by inserting first the iron, then the brass end into a coil. The iron increases the inductance, while the brass decreases it. If both the brass and iron cause a decrease in output, then the circuit is correctly tuned. If the iron end causes an increase in output, then *either* the inductance or capacity must be increased to bring the circuit into alignment. Conversely, if the brass end causes increased output, then *either* the inductance or the capacity must be decreased for proper alignment.

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## ELECTRICIAN'S AND RADIOMAN'S SERVICE TOOL KITS

The Bureau of Ships has available, under Contract NXsr-46919, a total of 2,500 tool kits. These kits, most of which are now on hand, can be made available to the field on request to the Bureau of Ships, Code 977. The kit consists of the following material:

1 pr. Kracuter 6″ long-nosed pliers #1671
1 pr. Kraeuter 6″ side-cutting lineman's pliers #1830
1 pr. Kraeuter 6″ diagonal cutters #4501–6
1 electrician's tweezers
1 5″ point file
1 6″ Vaco screwdriver, insulated handle, type C–36
1 canvas roll (tool)
1 electrician's knife

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## ELECTRONIC REPAIR KIT

With the recent increase in the number of pieces of electronic apparatus in service, there arose a need for a tool kit which is compact, readily portable and sufficient to effect most of the emergency repair work that will be required on radio, radar and sonar equipment.

In order to meet this need, the Bureau has developed the type CZY–10223 emergency electronic repair kit. This kit has been furnished to ships as a part of their radar test equipment, but in the future additional kits will be furnished to permit their use for radio and sonar maintenance. The kit will also be included in advance base functional components.

The kit is contained in a steel box having a hinged top and carrying handle. The weight is about 30 lbs. Its general external appearance is shown in Figure 1 and its contents in Figure 2. The following items are furnished with the kit:

(1) One portable volt-ohm-milliammeter. Three types of meters are being included in the kits and all are comparable in quality and accuracy. These types are:

(*a*) Hickok model 4955–S.
(*b*) Simpson model 215.
(*c*) Triplett model 66H.

(2) One pair of four-foot kinkless rubber-covered test leads, complete with insulated test prods and phone tips suitable for use with item (1) above.

(3) One insulated two-cell flashlight complete with batteries and spare lamp.

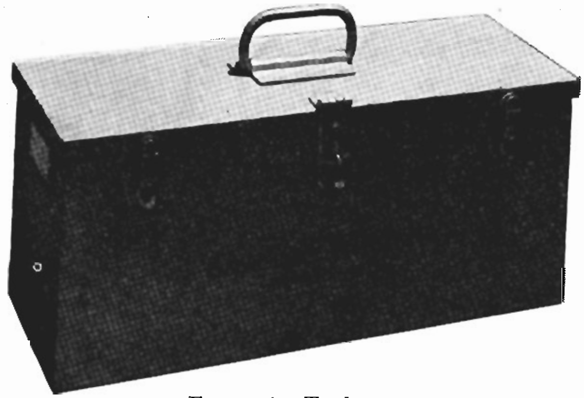

FIGURE 1.—Tool case.

(4) One 100-watt 120-volt electric soldering iron, complete with stand.

(5) One set of nine sizes of hexagonal sockets in sizes ranging from 1/4″ to 3/4″ by sixteenths, complete with "T" handle, universal joint and steel box.

(6) One fibre neutralizing and alignment tool kit.

(7) One neon bulb circuit tester.

(8) Four 25-foot rolls of #20 B & S gauge stranded hook-up wire.

(9) One pound of rosin core solder.

(10) One set of seven Allen set screw wrenches.

(11) One non-magnetic screwdriver, 16″ long, insulated handle.

(12) One book, "Allied Radio Data Book".

FIGURE 2.—Contents of tool case.

(13) One canvas tool roll containing:
- (*a*) Five double-ended wrenches ranging from 5/16″ to 19/32″ by thirty-seconds of an inch.
- (*b*) One double-ended adjustable end wrench, jaws similar to those on a 4″ and 6″ wrench.
- (*c*) One flexible shaft screwdriver.
- (*d*) One 6″ medium screwdriver.
- (*e*) One 4″ medium screwdriver.
- (*f*) One 2″ medium screwdriver.
- (*g*) One 8″ insulated shaft screwdriver.
- (*h*) One #1 Phillips head screwdriver.
- (*i*) One #2 Phillips head screwdriver.
- (*j*) One offset screwdriver.
- (*k*) One pair diagonal cutting pliers, 6″.
- (*l*) One pair long needle nose pliers, 6″.
- (*m*) One pair long nose "duck bill" pliers, 6″.
- (*n*) One pair side cutting pliers, 6½″.
- (*o*) One 6″ steel rule with wire gauge scale.

The kits are being distributed through the various RMO pools, and activities desiring kits may secure them by making application to the nearest radio material pool.

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## SOURCE OF ENTERTAINMENT RECEIVERS FOR SHORE USE

The Radio Material Organization is often faced with requests for model RBO series or other types of radio receivers, particularly in advanced base areas, for entertainment purposes ashore. In general, the requested equipments were not procured for such purposes, nor are they particularly satisfactory because of the problem of obtaining an entirely satisfactory loudspeaker. A better solution to this need is described below.

The Bureau of Naval Personnel has procured through the Bureau of Ships a substantial quantity of models RCT and RCU radio and phonograph combinations, with spare parts, which are designed for satisfactory recreational and entertainment use ashore in tropical as well as continental locations. These combinations, as well as record kits, are described in the "Sports-Games-Music Catalog" and may be procured with welfare and recreational funds or ships' stores profits, as described in page three in the catalog and in Bureau of Supplies & Accounts memorandum #494 of November 1943.

A revision of this catalog, to be distributed this month to all ships and stations, will indicate that officers' clubs and similar activities which do not have access to welfare funds or ships' stores profits, may obtain the radio sets through the welfare fund by making a cash contribution to it.

It should be clearly understood that the models RCT and RCU equipments are not approved for shipboard installations. These receivers do not meet the specified radiation limitations for shipboard equipment and, therefore, should not be installed aboard any vessel.

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## RECEIVER SECURITY

The U. S. Navy Radio and Sound Laboratory, San Diego, has invited the attention of the Bureau to the fact that in some cases the local-oscillator-radiation-reducing properties of the type CME–50063 preselector are being impaired by locating the preselector at a considerable distance from the receiver and connecting it to the receiver with a long unshielded wire.

Great care should be taken to locate the preselector close to the receiver and to connect the two units with a shielded conductor, the shield of which is grounded. A coaxial type conductor is to be preferred as its capacity from conductor to ground is low and it provides excellent shielding.

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## OSCILLATOR RADIATION—A SUMMARY OF SAFE AND UNSAFE RECEIVERS

The following information was compiled at the Naval Research Laboratory. It was gathered from the records of tests conducted at the laboratory. The receivers are grouped in two sections—those operating in the frequency range above, and those operating below 30 megacycles. Two columns are entered for all receivers. The first lists those frequencies which are "safe"—i.e., on which operation would present no hazard to security. The other column lists the "unsafe" frequencies—i.e., on which security would be endangered by oscillator radiation. In all cases the frequency listed is the oscillator frequency.

All receivers listed are rated in accordance with a safety limit of 400 micromicrowatts power appearing from antenna to ground at optimum load resistance.

Low-Frequency Receivers (below 30 mc.)

| *Type rcvr.* | *Safe frequencies* | *Unsafe frequencies* |
|---|---|---|
| REa | All, except with regen. max. | 72–130 kc. with max. regen. |
| RFa | All, except with regen. max. | Above 240 kc. with max. regen. |
| RAB-1 | Up to 23 mc. | 23–38 mc. |
| RAC-1 | All | |
| RAL-4 | All | |
| RAO | All | |
| RAO-2 | All | |
| RAO-3 | All | |
| RAS | Bands 1–5 | Part of band 6, Band 7. |
| RBA | All | |
| RBB | All | |
| RBC | All | |
| RBG | Band 2. Band 1 very close to limit just above at 540 and 1300 kc. | Bands 3, 4, 5. |
| RBH | All | |
| RBL | All | |
| RBL-3 | All | |
| RBM(hf) | Bands 1, 2, 3, Band 4 (14–19 mc). | Band 4 (13–14 and 19–22 mc). |
| RBM(mf) | All | |
| RBO | All | |
| DP-9 | All | |
| TBX-4 | | All. |
| TCS | | All. |
| TCS (with Majestic "wonder box". | All | |
| Hallicrafter SX-28 (now RCF) | | Definitely above 3 mc. |
| RMCA 8505 (now RCG) | | All. |
| Scott SLR-F (now RCH) | All | |
| Bendix BC-348-Q | 2 lowest freq. bands | 3rd band 3.5–5 mc. 4th band 6–9 mc. 5th band 9.5–13 mc. 6th band 13.5–17 mc. |
| Emerson 413 | | All. |
| Farnsworth C-138 | 3 lowest freq. bands | 3 high bands. |
| Hallicrafter Ht-11. | | All. |
| Magnavox CR-155 | | All. |
| National HRO (Bakelite ant. block) | Up to 26 mc. | Above 26 mc. |
| National HRO (Styrene ant. block) | 2 low-freq. bands | 2 high bands. |
| Philco 42-788T | | All. |
| Philips 512 | Up to 3 mc. | Above 3.5 mc. |
| Philips 513AN | Up to 18 mc. | 18–22.5 mc. |
| Philips 595AM | Broadcast band 1–2.1 mc. | Elsewhere: 2.1–23 mc. |
| RCA 8506B | All | |
| RCA AR88 | All | |
| RCA Q-33 | | All. |
| Scott SLR-C | Up to 21 mc. | Above 22 mc. |
| Sparton 842 SX | | All. |
| Zenith 8W 645At | | All. |

High-Frequency Receivers (above 30 mc.)

| | | |
|---|---|---|
| RAQ | 70–153 mc. | 153–190 mc. |
| RBQ (with shielded crystal)[1] | Harmonics up to 126 mc. | Above 126 mc (except 132 mc). |
| BL-2 | | All. |
| CXBG | | All. |
| TBS[1] | All, if trimmers are not peaked by mistake to oscillator; then only on one frequency is unsafe. | |
| TBY-2 | | All. |
| Hallicrafter S-27 (now RBK) | | All. |
| Bendix BC-639-A | | All. |
| Communications Co. model 132[1] | 23–67, 100–120. Above 146 mc. | Harmonics below. 23 mc., 90 mc., 135, 146 mc. |
| Hallicrafter NS-27-C | 108–113 mc. | 113–195 mc. |
| RCA (rcvr. freq.: 200–400 mc) | | All. |

## UNAUTHORIZED RECEIVERS

From time to time the Bureau receives information—usually via the "scuttlebutt"—that commercial receivers are being installed aboard Navy ships for both entertainment and communications. A case in point is a certain destroyer having a Hallicrafter SX-28 receiver which was borrowed from or installed by the Army.

[1] Measured on crystal harmonics.

Tests by the Federal Communications Commission and the Naval Research Laboratory have shown repeatedly that all commercial Hallicrafter receivers have local oscillator radiations far in excess of the safe limit. It should be remembered that the Army does not have the receiver security problem that the Navy does and that it is useless and foolish to put safe receivers aboard a ship only to have the ship's security violated by a commercial receiver.

Commercial *broadcast* receivers can *not* be made safe merely by the use of preselectors due to their usual "spread-out" construction and wooden or plastic cabinets, which provide excellent opportunities for radiation. See the following article for a list of authorized commercial receivers.

## COMMERCIAL RADIO RECEIVING EQUIPMENT ABOARD U.S. VESSELS

A number of commercial shipbuilding yards have continued to follow an old peacetime practice of presenting broadcast entertainment receivers to the crews of vessels that were built in their yards. For a number of reasons, this practice should be discouraged and Navy shipbuilding representatives at the various yards involved should take steps to insure that unauthorized receivers are not placed aboard new construction vessels.

The presence of "crew" or "individually" owned receivers on board certain vessels has recently been the subject of an unusual amount of official correspondence which should not have been necessary. In view of this correspondence, certain decisions have been necessitated which were not entirely satisfactory to all parties concerned. Therefore, the cause of such situations should be eliminated at the source.

Practically all available stocks of commercial non-radiating broadcast receivers have been exhausted and replacements are not being manufactured. Therefore, the majority of receivers being presented to vessels at the present time are of the unapproved radiating types which cannot be used while the vessels are at sea. Certain of the various methods used to secure these receivers, while at sea, are somewhat uncertain and, therefore, unsatisfactory from an overall standpoint. In view of the approved type of broadcast entertainment equipment being supplied by the Bureau as a part of each vessel's allowance, it is considered that any additional broadcast receivers are unnecessary and that the practice of placing them aboard Naval vessels should be terminated.

The following types of radio receiving equipment have been approved by the Federal Communications Commission as capable of being used and operated on board ships of the United States in accordance with the limitation regarding the radiation of energy imposed by the rules of the commission, i.e., that the electromagnetic field created does not exceed 0.1 microvolt per meter at one nautical mile from the receiver:

### AUTHORIZED COMMUNICATION RECEIVERS

| *Manufacturer* | *Freq. range (kilocycles)* | *Type or model number* |
|---|---|---|
| Arnessen Electric Company | 841LW | 80–550 |
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | 117–C | 16–40 |
| | | 100–200 |
| | | 300–530 |
| | 128–A | 16–650 |
| | 128–AX | 15–650 |
| | 130–A | 300–500 |
| | 138–A | 80–560 |
| | | 1900–25000 |
| Globe Wireless or Heintz & Kaufman | 936 | 70–210 |
| | | 350–515 |
| Hallicrafters, Inc. | SX–28A[1] | 540–40000 |
| National Company | D. C. SW–3RM | 100–600 |
| Radiation Products Corporation | R–96–SR | 140–500 |
| | | 1500–12000 |
| Radio Corporation of America | AR–88 | 535–32000 |
| | AR–67–X | 75–1500 |
| | CR–91 | 75–550 |
| | | 1500–30000 |
| Radiomarine Corporation of America | AR–8503 | 15–600 |
| | AR–8506–A | 210–550 |
| | | 1900–25000 |
| Radiomarine Corporation of America | AR–8506–B | 90–550 |
| | | 1900–25000 |
| | AR–8507 | 70–515 |
| | AR–8510 | 15–650 |
| E. M. Sargent | AH–10X | 34–550 |

[1] When used with Radiation Suppressor Unit No. 1X381.

| Manufacturer | Freq. range (kilocycles) | Type or model number |
|---|---|---|
| E. H. Scott Radio Labs. | SLR–C | 80–520 |
| | | 3600–24000 |
| | SLR–D | 500–24000 |
| | SLR–F | 80–550 |
| | | 1900–24000 |
| | SLR–H | 530–15600 |
| Technical Radio Company | LRR–4 | 1500–18000 |
| Western Electric Company | Standard receivers incorporated in radiotelephone equipment types | |
| | 224–A | 2100–2800 |
| | 224–B [2] | 2100–2800 |
| | 226–A | 2100–2800 |
| | 226–B | 2100–2800 |
| | 226–C | 2100–2800 |
| | 226–D | 2100–2800 |

### AUTHORIZED BROADCAST RECEIVERS

| | | |
|---|---|---|
| Herbach and Rademan Company | AR–93 | 540–1600 |
| | AR–93–A | 540–1600 |
| Maritime Radio Corporation | MA–1 | 540–1600 |
| | MA1–A [3] | 540–1600 |
| | MA1–B [3] | 540–1600 |
| Radio Corporation of America | ER–88 | 535–32000 |
| E. H. Scott Radio Labs. | SLR–12–A | 540–1600 |
| | | 5550–15600 |
| | SLR–12–B | 540–1600 |
| | | 5550–15600 |

### AUTHORIZED DIRECTION FINDERS

| Manufacturer | (kilocycles) | Type or model number |
|---|---|---|
| Bludworth, Inc. | Standard Binnacle | |
| | DF–1009 | 280–520 |
| | DF–1011 | 280–520 |
| | DF–1012 | 280–520 |
| | DF–1013 | 280–520 |
| | DF–1014 | 280–520 |
| | DF–1015 | 280–520 |
| | DF–1016 | 280–520 |
| | DF–1017 | 280–520 |
| | DF–1018 | 280–520 |
| | DF–1019 | 280–520 |
| | DF–1020 | 280–520 |
| | DF–1022 | 280–520 |
| | DF–1023 | 280–520 |
| | DF–1024 | 280–520 |
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | 102–A & B | 250–540 |
| | 103–A & B | 250–540 |
| | 104–A & B | 250–540 |
| | 105–A & B | 250–540 |
| | 106–A & B | 250–540 |
| | 102–BD | 250–540 |
| | 103–BD | 250–540 |
| | 104–BD | 250–540 |
| | 105–BD | 250–540 |
| | 106–BD | 250–540 |
| | AM–4490–DM | 250–540 |
| | AM–4490–EM | 250–540 |
| | AM–4490–F | 250–540 |
| Radiomarine Corporation of America | AR–8700–S | 270–520 |
| | AR–8701 | 270–520 |
| | AR–8702 | 270–520 |
| | AR–8702–A | 270–520 |
| | AR–8703 | 270–520 |
| | AR–8704 | 270–520 |
| | AR–8709 | 270–520 |
| | AR–8700–ASX | 270–520 |
| | AR–8701–AX | 270–520 |
| | AR–8703–AX | 270–520 |
| | AR–8703–BX | 270–520 |
| | AR–8073–BX1 | 270–520 |
| | AR–8707–X | 270–520 |
| | AR–8707–X1 | 270–520 |
| | ER–1445–A | 200–525 |
| | ER–1445–B | 200–525 |
| | ER–1445–R | 200–525 |

### AUTHORIZED AUTO ALARMS

| | | |
|---|---|---|
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | 101–B | 500 |
| Radiomarine Corporation of America | AR–8600–X | 500 |
| | AR–8601 | 500 |

This approval was given upon the condition that normal circumstances of operation, including applied voltages and electron tubes, will be maintained whenever the equipment is in use or operation.

### UNAUTHORIZED COMMUNICATION RECEIVERS

The following equipments *do not* comply with FCC limitations and their use aboard U.S. vessels is *not authorized*:

| Manufacturer | Freq. range (kilocycles) | Type or model number |
|---|---|---|
| | IP–501 | 37.5–1200 |
| | IP–501–A | 37.5–1200 |
| | SE–143 | 92–970 |
| | SE–1220 | 45–600 |
| | **SE–1420** | |
| Arnessen Electric Company | 841 | 80–31000 |
| Ecophone Radio Company | EC–2 | 550–30000 |

[2] When modified in accordance with manufacturer's instructions and such modification is designated by the addition of the letter "M" to the serial number of the modified receiver.

[3] Models MA1-A and MA1-B are identical in electrical design to the model MA-1.

| Manufacturer | Freq. range (kilocycles) | Type or model number |
|---|---|---|
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | 104–B | 500–23000 |
| | 105–A | 16–1500 |
| | 117–A | 16–35 |
| | | 100–200 |
| | | 300–550 |
| | | 5200–19500 |
| | 117–B | 16–40 |
| | | 100–200 |
| | | 300–550 |
| | | 5200–19500 |
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | 122–A & B | 300–500 |
| | 129–A | 540–30000 |
| Hallicrafters, Inc. | S–22R | 110–1530 |
| | | 1715–11500 |
| | SX–24 | 545–43500 |
| | SX–25 | 540–42000 |
| Hammarlund Manufacturing Company | SXR–200 | 535–20000 |
| National Company | NC–44 | 550–30000 |
| | NC–45 | 550–30000 |
| Philips | 614VN | 550–5550 |
| Radio Holland | UO | 15–21000 |
| Radio Corporation of America | AR–67 | 75–1500 |
| Radiomarine Corporation of America | AR–8501 | 5000–18000 |
| | AR–8504 | 300–900 |
| | AR–8505 | 540–30000 |
| E. M. Sargent | AH–10 | 34–14000 |
| | 12–D | 34–14000 |
| | 12–UD | 34–14000 |
| | 12–F | 34–14000 |
| | 12–UF | 34–14000 |
| | 11–51–TR | 80–31000 |
| Western Electric Company | Standard receivers incorporated in radiotelephone equipment type | |
| | 227–A | 2100–2800 |

### UNAUTHORIZED DIRECTION FINDERS

| | | |
|---|---|---|
| Federal Telephone & Radio Corp. | Mackay Radio & Telegraph Co. | |
| | AM–3800 | 300–500 |
| | AM–4490–A | 250–540 |
| | AM–4490–D | 250–540 |
| | AM–4490–E | 250–540 |
| Radiomarine Corporation of America | AR–8700–AS | 270–520 |
| | AR–8701–A | 270–520 |
| | AR–8703–A | 270–520 |
| | AR–8703–B | 270–520 |
| | AR–8707 | 270–520 |

### UNAUTHORIZED AUTO ALARMS

| Manufacturer | Freq. range (kilocycles) | Type or model number |
|---|---|---|
| Radiomarine Corporation of America | AR–8600 | 500 |

## SPURIOUS RADIATIONS WHILE TUNING TRANSMITTERS

There is a possibility of spurious radiations being emitted, unintentionally, during transmitter tuning processes. Such radiations would have two main sources:

(1) If the transmitter oscillator is operating, then judgment must be exercised to ascertain that there is no form of coupling between this oscillator and the antenna.

(2) If a signal generator is connected to a receiver antenna trunk for the purpose of checking the receiver frequency, or for any other purpose, then radiation from the signal generator will occur.

Elimination of these radiations may be accomplished as follows:

(1) It is feasible to tune the transmitter completely without radiating. A suitable method is described in the article "Tuning Transmitters Under Conditions of Radio Silence," page ANT:5.

(2) Elimination of radiation from signal generators is simply a matter of refraining from coupling the antenna to a signal generator during radio silence. To insure that coupling does not exist, it may be useful to seal off the receiver antenna, and to use a direct connection to the receiver instead of a radiating connection because of the possibility of pickup of this radiation by other antennas.

## NEED FOR CAUTION WHEN USING REPAIR SHOP ANTENNAS

Users of repair shop antennas should exercise caution to insure the absence of receiver radiation when testing and aligning receivers while the ship is in restricted areas.

## ELECTRIC RAZORS AS A HAZARD TO SECURITY

The Commander Service Force, U. S. Atlantic Fleet, and the San Diego Radio and Sound Laboratory recently conducted a series of tests to



638971—45——5

determine the hazard to the security of a ship caused by the radiation of radio-frequency noise from electric razors. Tests were conducted using razors having vibrator motors and razors having commutator motors, and measurements were made over the frequency range of the model OF noise locator and the models RAK/RAL–5 receivers.

The results of the tests may be summarized as follows:

(1) A field strength of less than one microvolt per meter is produced outside a ship's compartment at a distance of ten feet from the vessel by an electric razor used inside the compartment.

(2) Electric razors when used inside metal enclosed compartments on a ship do not radiate enough energy into the ship's antennas to be detected, provided that no antenna extends out of the compartment in which the razor is operated.

(3) The signal radiated by an electric razor operated outside the compartment of a ship is of such strength that it cannot be detected by a sensitive receiving system at any frequency at a distance of 1000 feet.

As a result of the tests, it may be concluded that the operation of electric razors inside compartments creates no radio hazard to security.

It should be noted that local noise may be produced aboard ship by electric razors. This noise is usually conductively coupled to receivers through power wiring as distinguished from radiation. If this noise is bothersome it may be eliminated by connecting a 400-volt 0.01- to 0.05-mfd. condenser across the power line feeding the shaver. A number of commercial filters, such as the Solar type AE or its equivalent, are on the market which are excellent filters and do not require cutting the shaver attachment cord.

•

## TREATMENT OF RIGGING ON SHIPS EQUIPPED WITH DIRECTION-FINDING EQUIPMENTS

When a direction finder is installed in a ship it is necessary to treat the rigging to reduce deviation. Wires not used as electrical conductors should have their conductivity interrupted at 5- to 8-foot intervals by the insertion of strain insulators. This practice will reduce the reradiation of energy at or near the frequencies to which the direction finder will be tuned and should be applied to whistle cords, signal halyards, triatics, standing rigging, etc. Compression type strain insulators should be used as failure of this type of insulator will not cause the line to part.

In cases where wires cannot be properly insulated, permanent bonds should be attached so that the object is grounded. Large objects such as derrick booms which may not have a constant low-resistance ground connection should also be bonded to ground.

The use of copper for external bonding is unsatisfactory due to its chemical and electrolytic reaction with the steel of the ship. 7/18 or 7/32 steel wire should be used for bonds and corrector loops and should be welded or brazed to the stay and deck. The resistance of the bonds is, and should be, low and any small change in the resistance of the end contacts will produce serious changes in deviation. Bolts, lugs and clamps cannot be depended upon to give a constant low resistance connection.

It is important that a periodic inspection be made of these bonds, employing a check list if necessary to insure that none are overlooked. The breaking or corroding of these bonds will, in most cases, cause an error in calibration which may be either constant or variable. For maximum accuracy in direction-finding work, all rigging must be in the same condition as when the instrument was calibrated.

Care should be taken to see that no closed loops of appreciable size (larger than about one foot in diameter) are constructed near the direction finder, and that none already existing there are removed without a recalibration of the direction finder. The usual closed loop aboard ship is formed by stanchions, rails, decks, stays and by the post, boom and topping lift of cranes. The continuity of these loops may often be broken by insulating material, and this should be done wherever possible. A sheet of conducting material acts as a closed loop, but one that cannot be broken to prevent the flow of circulating currents. It is generally impossible to break up all closed loops aboard ship. The greatest attention should be paid to those of considerable size and those adjacent to the direction finder. In general, when a loop is more distant from the direction finder than twice its largest dimension, it will have little effect on deviation.

It should be emphasized that insulating material used to break up closed loops should *not* be painted with a metallic base paint. A clear insulating varnish such as Pabco No. 2478 or equivalent followed by Glyptol No. 1217 (machine tool gray) or equivalent may be used on wood spacers or other insulating material requiring protection. Special attention should be paid to the insulated joint in the metal shield around the direction finder loop. This joint should *not* be painted, and any paint already on the joint should be removed.

Immediately after accomplishing the above changes, the direction finder must be recalibrated. No change should be made in the present corrector system until facilities are available for recalibration.

The above changes have been authorized for vessels now under construction by Bureau of Ships letter DE(GMT)/S67(981Ce–514) over DE(DET)/S67 over DE(FMR)/S67 over DE (TE)/S67 over EN28/A2–11 dated 31 December 1943.

## DIRECTION-FINDING EQUIPMENTS IN ESCORT VESSELS

It has come to the attention of the Bureau that the model DP series direction finders are not providing optimum performance in destroyer escort (DE) vessels. The principal difficulties encountered are deviations in the calibration curves up to seventy-five degrees, and insufficient balance voltage from the sense antenna.

In order to correct this condition, the following procedure is recommended:

(1) Remove the three corrector wires running from the whistle platform to a point approximately six feet above the upper level of the loop. These correctors were installed by the building yard.

(2) Install a single corrector wire from the whistle platform on the stock to a padeye on the mast approximately 10 to 15 feet below the yardarm.

(3) Rig the sense-balance antenna from the lead-in insulator to an insulator attached to the base of the model SL platform and thence down to an insulator attached to a padeye at the anchor light on top of the echo range-finding station on the flying bridge. This makes the sense-balance antenna an inverted "V" approximately 80 feet in length.

The corrector wire should be made of phosphor bronze seven strand #18 antenna wire. Connection to the steel structure should be made by welding a lug to the structure and brazing the wire rope to the lug. The termination should be so arranged that all strain will be on a tightening turnbuckle rather than the electrical connection.

## KEYING RELAYS

Several failure reports have been received concerning sticking of keying relays of the type used in models TCE, TDE, TBL, etc. It is believed that this is due to the use of oil or other lubricants on the relays. Keying relays operate best when *perfectly dry*, and in the event that oil has been used, it should be removed by thorough washing in carbon tetrachloride.

Keying relays should be checked once a week for freedom of action, burned or pitted contacts, etc., as required by Chapter 67, Bureau of Ships Manual, and adjusted in accordance with the instruction book for the equipment. Needless to say, the weekly inspection should also include dusting!

## FAULTY TYPE 2X2 RECTIFIER TUBES

Investigation of excessive failures of National Union type 2X2 rectifier tubes has led to the following information:

(1) The type of construction used by National Union during the period from October 1942 to February 1943 cannot be relied upon for satisfactory operation in equipments subject to conditions of shock and vibration. Tubes manufactured in the above period are characterized by the code dating EC or GN applied to the base. A portion of the tubes with the code marking GN were of a type of construction employing mica bracers on the anodes; these tubes may be considered to be satisfactory and may be mounted in any position with safety.

(2) All tubes code dated EC and those code dated GN but without mica bracers should not

be used in equipments where shock and vibration may be encountered. However, these tubes may be used in experimental equipments or in other applications where continuity of operation is not necessary or where shock and vibration are not expected to be encountered.

(3) The type 2X2 tubes manufactured for the 3-month period prior to 30 June 1944 and shipped up to January 1945 are identified by the letters HU, HR, HC, or IN on the tube base. It is recommended that all National Union 2X2 tubes bearing this coding should also be considered unreliable after 200 hours operation. It is believed that these tubes were used in the following series of equipments:

DAU, DAK, DAQ, DAS, DAW, LRN, OBL, OBM, RCC, RDJ, RDP, RBY, RBU, RBV, RBW, TBT, TBW, TDP, etc.

An improved type 2X2 will be available in a short time which will also be coded IN. The improved tube can be recognized by a glass sleeve around the anode lead, extending downward from the seal to the anode.

## SUBSTITUTION OF TYPE 884 ELECTRON TUBES FOR TYPE 6Q5G TUBES

Recent tests at the Naval Research Laboratory indicate that the type 6Q5G electron tube can be satisfactorily replaced by using the type 884.

Tests in a model 241 Dumont oscilloscope indicate that the sweep frequency range of the type 6Q5G is from 18 to approximately 39,000 cycles while the sweep frequency range of the type 884 used in the same oscilloscope is from 22 to approximately 58,000 cycles. The change of calibration upon substitution of an 884 is not enough to be noticeable on the sweep frequency dial.

As there will be no further procurement of the type 6Q5G electron tube, it is requested that the type 884 electron tube be used as replacement in all applications stipulating the type 6Q5G when the supply of the latter is exhausted.

## SYMPTOMS AND CAUSES OF TROUBLE IN MOTORS AND GENERATORS

The following symptoms and some of their causes are given here for the assistance of personnel responsible for the maintenance of motors and generators:

| Symptoms | Causes |
|---|---|
| Sparking at brushes | (1) Overload. |
| | (2) Brushes set wrong. |
| | (3) Poor brush contact. |
| | (4) Commutator rough or off center. |
| | (5) Weak field. |
| | (6) Armature winding broken or short-circuited by ground or cross. |
| *Noise* | (1) Excessive vibration—unbalanced armature. |
| | (2) Rattle—loose parts. |
| | (3) Bumping—too little end play. |
| | (4) Rubbing and pounding—armature hitting pole. |
| | (5) Squeaking—dry brushes. |
| Hot armature coils | (1) Overload. |
| | (2) Damp windings. |
| | (3) Short-circuited coils. |
| Hot field coils | (1) Too large field current. |
| | (2) Moisture in windings. |
| Hot bearings | (1) Too little or improper oil. |
| | (2) Grit. |
| | (3) Not enough end play. |
| | (4) Bearing too tight. |
| | (5) Poor alignment. |
| | (6) Crooked shaft. |
| | (7) Hot commutator. |
| | (8) Rough shaft. |
| Hot commutator | (1) Near some hotter part of machine. |
| | (2) Sparking under brush. |
| | (3) Poor brush contact. |
| Fails to build up | (1) Field connections reversed. |
| | (2) Brushes not in proper position. |
| | (3) Wrong direction of rotation. |
| | (4) Speed too low. |
| | (5) Field circuit open. |
| | (6) Not enough residual magnetism. |
| | (7) Machine short-circuited. |
| Too low voltage | (1) Too much resistance in field. |
| | (2) Overload. |
| | (3) Brushes too far forward. |
| | (4) Speed too low. |
| | (5) Some reversed poles. |
| | (6) Some poles short-circuited. |

| SYMPTOMS | CAUSES |
|---|---|
| Too high voltage | (1) Too strong field. |
| | (2) Brushes too far backward. |
| | (3) Speed too fast. |
| Motor fails to start | (1) Wrong connections. |
| | (2) Open circuits in connecting wires. |
| | (3) Field weak. |
| | (4) Overload. |
| | (5) Friction excessive. |
| Too high speed | (1) Too much field rheostat resistance. |
| | (2) Brushes too far forward. |
| | (3) Connections wrong. |
| | (4) Open field circuit. |
| Too low speed | (1) Overload. |
| | (2) Too little field resistance. |
| | (3) Brushes set wrong. |
| | (4) Excessive friction. |
| | (5) Short or ground in armature. |

## PREVENTIVE MAINTENANCE OF POWER CORDS

The cordage used to connect component parts of Navy equipment constitutes one of our most important maintenance problems. The following types of faults are frequently found:

(1) Frayed conductors, causing intermittent or unreliable operation.

(2) Broken conductors, causing shutdown of the equipment.

(3) Chafed insulation, causing short circuits between conductors or from conductors to ground.

(4) Short circuits between the contact prongs of plugs because of moisture.

(5) Cables and plugs broken by rough handling.

(6) Insulation damaged by oil, gasoline, acid, and other harmful materials.

Many failures of cordage are caused by normal wear received during the rough usage to which all military equipment is inevitably exposed. Since cordage failure may occur at a time when dependable communications are vitally necessary to the success of a tactical operation, *it is of utmost importance to insure against such failure by frequent periodic inspections*. Operators should be on the watch continually for defects which may develop into failures, and should have equipment repaired or replaced at the first sign of trouble. The following inspection points are important:

(1) Cuts, cracks and bruises in the outer covering of the cordage.

(2) Bent contact prongs on plugs.

(3) Loose contacts in sockets.

(4) Worn gaskets or washers in sockets of power cords which might permit entrance of water.

(5) Stripped threads on screw-type connections.

(6) Burned spots on contacts, which are evidence of short circuits or poor connections.

Most of the plug connections on Navy equipment fit tightly. Great care must be taken when uncoupling such connections. A large number of these plugs are of molded rubber, and a considerable surface of rubber is in contact to make a watertight seal. Such tight-fitting plugs must be disconnected by working back and forth while applying a steady pull. A quick jerk hard enough to separate the plugs will usually result in breaking the cord.

A good example of a frequent source of trouble is the cordage in Signal Corps radio sets SCR–409, SCR–510, SCR–609, and SCR–610, used to connect the power supply to the set. Some failures of this cable are definitely the result of using it as a carrying handle—for which it was never intended! The continual flopping back and forth, while traveling in a vehicle or aboard small Naval vessels, eventually results in fraying insulation and conductors. This cordage should be held securely to prevent its swinging about.

Some plugs are equipped with rubber washers through which the cordage must be threaded before attachment to the plug insert. Repairmen making up these cords have been known either to ream out the washer or to whittle down the cord insulation to make an easier fit, thus making an easy path for water to enter and weakening the cord. When passing the cord through the washer in this type plug, soap suds should be rubbed on the rubber cord jacket. The cord will then slip through the washer easily. Vaseline, grease, oil, or other petroleum products should never be applied for this purpose, since they will deteriorate the rubber.

—*War Dept. TB–Sig–25*

## INTERIM METHODS OF CHECKING THE SENSITIVITY OF VHF AND UHF RECEIVING EQUIPMENT

One of the most effective measures of overall receiver performance is a sensitivity check. A given audio output for a given signal input is not considered the only or the best method of sensitivity measurement; rather a measure of the audio output with a given signal-to-noise ratio is considered to be the best method, as it penalizes a receiver with a high noise level and gives credit to equipments with high sensitivity.

There are no signal generators in production for the Navy at the present time covering the VHF and UHF ranges which are entirely suitable for accurate sensitivity measurements. The Navy models LX and LX–1, the General Radio 804B, and the Federal 804–CS–1 and 804–CS–2 signal generators all cover a range from 7.6 to 330 megacycles. The frequency modulation in all of these signal generators is too great for communication receivers sensitivity measurement applications. Also, the attenuator accuracy is not sufficient for these uses. The LAF series signal generators covering from 90 to 600 megacycles have the same disadvantage of frequency modulation; however, their output voltage calibration is very good.

Because of the frequency modulation present in these signal generators, there is no simple method of checking the absolute sensitivity of VHF and UHF receivers. When the degree of FM present in the signal generator is comparable with the receiver's i-f band width, large errors occur, apparently due to discriminator action of various i-f amplifier stages. This action is usually accompanied by confusing modulation-frequency components appearing in the audio output which are twice the signal generator modulation frequency. Signal generators having excessive frequency modulation may not successfully be used for sensitivity measurements.

The Bureau has under development the TS–331/UR signal generator covering a range of 40–500 megacycles. This signal generator is especially designed for VHF and UHF work and will have a maximum of less than 0.002-percent frequency modulation with 50-percent amplitude modulation applied. It is expected that these generators will be in production in 5 to 6 months.

Although rather complicated, the following substitution method of absolute sensitivity measurement may be employed by using an LP, an LAF, and a 60107 microammeter or an OBQ vacuum tube voltmeter:

(1) An LP signal generator is tuned to the i-f frequency and connected into the mixer grid (or to the cathode of the diode first detector or to the crystal detector). The preferred method of connection for i-f testing may normally be obtained from the receiver instruction book.

(2) The receiver audio output is connected to an output meter (such as CV–22195 or suitable equivalent). Care should be taken to terminate the output terminals as directed on the bottom of the CV–22195 or in the receiver instruction book. The model OCR will replace the CV–22195 and CV–22196 on the Shipboard Test Equipment Allowance Chart and accomplishes both of their functions.

(3) A multi-range microammeter such as the Navy type 60107 is connected in series with the second detector diode load resistor. (Terminals for this purpose are sometimes supplied.) Alternately, an OBQ operating as a d-c vacuum tube voltmeter, may be connected in parallel with the second detector diode load resistor. A 1-megohm isolating resistor is included in all OBQ probes and normally an additional isolating resistor will not be required.

(4) The LP is allowed to warm up and a 30-percent modulated carrier of the i-f frequency is applied. The generator is tuned until maximum receiver output is obtained.

(5) The LP output voltage is adjusted to the point where the standard audio output of 6 milliwatts is obtained.

(6) The audio modulation of the LP is turned on and off and the receiver's i-f gain control is adjusted until a 10 db ratio in output power is obtained. The adjustment is accomplished simultaneously with (5) above and ultimately the 6-milliwatt output when the signal generator is on must be maintained. The microammeter or vacuum tube voltmeter read-

ing should then be noted and recorded for the "modulation off" condition.[1]

(7) The receiver gain control is left at the final setting obtained in (6) above. With the LP still connected but turned completely off, the microammeter or vacuum tube voltmeter reading is again noted and recorded.

(8) Disconnect the LP from the mixer input and connect the LAF to the input terminals of the equipment through an appropriate dummy antenna. With the LAF connected but turned off, the gain of the receiver is adjusted to obtain the same reading as in (7) above.[1]

(9) The LAF is then turned on and the unmodulated output voltage is adjusted until the microammeter or vacuum tube voltmeter reading is the same as obtained from (6) above. This represents the approximate absolute receiver sensitivity.

The above method is a substitution method and gives reasonably accurate results when carefully performed. It should be noted that it is not necessary to modulate the LAF in this method of sensitivity measurement.

## → REQUISITIONING OF RADIO ELECTRON TUBES

The Bureau of Ships, Electronics Division, is responsible for the procurement, allocation, and disposition of electron tubes for the entire Navy. In order to expedite the flow of material, equalize the stocking of electron tubes at various activities and to provide a ready supply on demand, the Bureau of Ships, Electronics Division, has established stocking activities. Requiring activities should requisition through their normal chain of command, who, in turn, will draw on its nearest stocking activity. Except under extreme emergency conditions, requests for electron tubes should not be made direct to the Bureau of Ships.

[1] This system appears to be usable with all receivers having a gain control system controlling the i-f amplifier stages. It should be noted that many VHF and UHF Navy receivers have gain controls of this type. Many times the control is termed r-f gain instead of i-f gain. Examination of the circuit will always clarify this point. Noise limiters in receivers should be turned off for these measurements.

## SUBSTITUTION OF TYPE 6J7G FOR TYPE 7000 VACUUM TUBES

The Bureau has received several requests from forces afloat for type 7000 vacuum tubes made by the Kenrad Corporation and used in the Sprague tel-o-mike condenser tester and the Televiso vibrometer.

The type 7000 tube is electrically and mechanically identical with the JAN type 6J7G tube and is selected by the manufacturer from production tubes which have low microphonics and hum. Another similar type is RCA type 1620 which is the same as the 6J7, except for its special selection for low hum and microphonic properties. Due to the limited number of these tubes required, no special procurement will be made and field activities requiring them should select from JAN types those tubes which have a low microphonic and hum level.

## TYPES OF SETS OF SPARE PARTS

Requests have come from the field for clarification of terminology in connection with spare parts. Spare parts and accessories are classified in four types as follows:

### Equipment Spares

Equipment spare parts are those sets of spares which are to be retained near the equipment in the case of shipboard and shore establishments or those parts to be held at the base to which portable equipment is subject to immediate return.

### Tender Spares

Tender spare parts are those sets of spares which are to be placed on tenders in accordance with allowances or placed at advance repair bases which do not have facilities for binning parts. Components thereof are issued as individual components as and when required to replenish equipment spares, effect repairs of equipment and supply certain repair parts not carried in equipment spare parts either due to low casualty of the parts or because of being too large physically.

### Stock Spares

Stock spares are those sets of spare parts which contain a considerable quantity of all of the replaceable items of an equipment. They are distributed to all major supply activities including major overseas supply activities and are normally to be held by the Supply Officer for Radio (SOFR). Stock spares should normally be broken down by components and binned. However, it is desirable for each continental pool to retain at least one set of stock spares complete for issue as a set. Radio Supply Branch (NSD Oakland) and Radio Supply Annex (Navy Yard New York) should have in inventory several complete sets of stock spares for each model or model-series of equipment for issue, while at the same time, they should break down at least one set by components. BuShips will retain at NSD Mechanicsburg and NSD Clearfield a reserve of sets of stock spares after distribution has been made to pools. The number of *complete* sets of stock spares to be retained in overseas pools is at the discretion of the cognizant Service Force. Requisitions for replenishment of items issued from stock spares should be placed through the normal supply chain.

#### Extra Equipment Spares

Extra equipment spare parts are the same as equipment spare parts and are shipped to maintenance activities for replacement of complete sets of equipment spares that have been lost or completely damaged. Extra equipment spares are not to be cannibalized to replenish individual parts in depleted equipment spares, nor are they to be issued for replacement of only partially depleted equipment sets which have not suffered damage, except in emergencies. However, where it is necessary to issue parts from extra sets of equipment spares, and when it is apparent that almost immediate replenishment of the parts issued will not be possible, then the incomplete set of extra equipment spares should be broken down and binned along with stock spares. Every effort should be made to maintain extra sets of equipment spares in a complete condition.

In the past, equipment spares were sometimes known as ship individual spares or "on board" spares; tender spares as base spares; and stock spares as replenishing spares or Navy Yard spares. For the attack plotter equipment spares are sometimes still called ship spares. Moreover, attack plotter equipment spares are sometimes known as Repair Ship spares and attack plotter stock spares as Shore Base spares.

Equipment spares are usually made up of components such as relays, fuses, small motors, capacitors and resistors. Tender spares contain quantities of these items plus larger components and components which do not fail frequently. Stock spares contain all of the above items, for this is the pool from which the fleet draws its reserves.

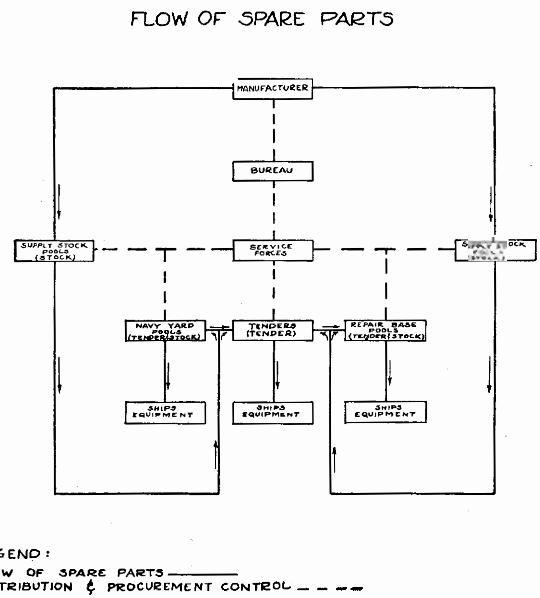


FIGURE 1.—Chart showing the allocation and flow of spare part items.

Figure 1 is a chart to clarify the theory of the allocation and the flow of spare part items.

Spares are purchased in a fixed ratio to equipments produced. Stock spares are stored in the supply stock pools and are requisitioned by Navy Yards, Repair Bases and Tenders to replenish equipment and tender spares.

Tender spares are stored in Navy Yards, Repair Bases and Tenders, and are to be held to fill requisitions from ships and stations for components to replenish equipment spares.

As can be seen from the chart, Navy Yard and Repair Base Pools may contain both tender and stock spares. To keep these in order, adequate record keeping is the only solution.

When tender spares are forwarded, replenishment can be made from either the pool's own stock spares or from the stock spares of a supply stock pool. Whenever a requisition is forwarded to a supply stock pool it is for items of stock spares to replenish either items of stock spares or items of tender spares of the Navy Yard or Repair Base.

The original supply of spares is procured by the Bureau. If failure reports indicate danger of depletion of spare part reserves, the Bureau will instigate procurement of additional items. After the original distribution of parts, it is primarily the duty of the Service Forces to maintain adequate reserves in each pool. The Service Forces may transfer stock spares from one pool to another as the need arises. Moreover, they may request that the Bureau procure additional stock spares as required.

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## SERVICE AND MAINTENANCE INFORMATION ON THE SLIP RINGS AND BRUSHES OF THE TYPE A, AM and AS ABI INDICATOR UNITS

The information contained in this article has been compiled after considerable experience with this type of equipment. In compiling it, we have attempted only to pass on the benefit of the experience of others. Please read this article carefully, use it often, and keep it near the equipment so that it may be referred to at once in case of trouble. While every attempt has been made to build a rugged piece of equipment, some of the parts are necessarily delicate. Maintenance of high precision and reliability is the responsibility of the service and maintenance personnel.

Bad bedding of brushes is undoubtedly the greatest cause of flat spots and excessive slip ring and brush wear. When installing new brushes, it is advisable to "grind in" the surface of the brush so as to fit the slip ring contour. A good job can be made of this by wrapping a piece of fine sandpaper around the slip ring with its abrasive side out and rotating the slip ring and sandpaper back and forth while the brush pressure spring holds the brush lightly against the abrasive surface of the sandpaper. *This is one of the most important jobs in fitting brushes.* Nine-tenths of all the troubles with slip rings and brushes are due simply to bad bedding. New brushes taken from the spare parts kit have been ground to a contour that closely fits the slip ring when it is new, but it is impossible for them to fit the contours exactly, because of normal wear that has occurred while the indicator has been in use. Therefore, we urgently recommend that this final bedding "touch" be incorporated in any brush replacement job.

Thoughtlessness is another factor responsible for an unsuccessful brush servicing job. A very common and not easily detected mistake is changing brushes from one holder to another, or in reversing the postion of a brush in its holder. It is quite obvious that an interchange of brushes can only result in a change of contact position on the contour of the slip ring. To avoid this, make sure that a brush, removed from its holder for cleaning or other service, is returned to that same holder and in the same relative position as before removal.

The brushes should be kept at the pressure recommended in this article. This optimum pressure has been selected, after careful experimentation and observation, to give the longest life and best contact with a minimum of maintenance. A decrease in pressure will not allow reliable contact. Increase in pressure will only result in excessive heating of the brush, and rapid wear of both the brush and the slip ring.

Above all, keep the slip rings and brushes clean through periodic inspection and cleaning with carbon tetrachloride. Do not use any "lubricants" on either the brushes or the slip rings. Use abrasives only as indicated in this article.

Experience with a number of these equipments has proven the maintenance and service practices set forth here. Strict adherence to these procedures will result in long life and maximum efficiency for the indicator. It will also decrease the number of repairs you will be required to make.

The rotating slip ring section and brush assemblies of the indicator have been machined to a very high precision and assembled in their


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places with extreme care and attention by skilled technicians.

Thorough maintenance and servicing of these parts is essential to the indicator operating, at all times, at its peak efficiency. Neglect of these parts will result in the slow deterioration of its efficiency and ultimately in its decommissioning and return to the manufacturer for complete overhauling.

The maintenance personnel should be responsible for seeing that these parts are carefully serviced and never abused and that the servicing equipment, as enumerated, is kept on hand at all times.

The following material will treat the common troubles that occur to the slip rings and brush assemblies together with the manufacturer's recommended methods of servicing and practices in maintenance.

The slip rings are mounted on the outside of the rotating housing, Figure 1. They are insulated from ground, and each other by bakelite spacing rings of appropriate size and form. Their brush contact surfaces have been machined to a smooth, highly polished surface and a fine degree of concentricity.

The brush assemblies are mounted by two machine screws and spacers of appropriate height on projections brought to the outside of the rotating unit mount, Figure 1. They are fixed at such a height that the brushes contact the slip rings radially.

Since the use of high voltages, which are dangerous to human life, are necessary to the successful operation of the indicator, certain reasonable precautionary measures must be carefully observed by the maintenance personnel during its servicing. It should be borne in mind that if the cover of the slip ring section is opened, it will allow access to circuits carrying voltages dangerous to human life. Under no circumstances should any person open this cover before throwing the master or amplifier switch to OFF position.

The attention of officers and maintenance personnel is directed to the Bureau of Ships Manual, Chapter 67 on the subject of "Radio Safety Precautions to be Observed."

### Slip Rings—General

Any appearance of etching, scoring, pitting, or undue wear to the brush contact surfaces, indicates the immediate need of servicing.

The appearance of a light brown oxide film on

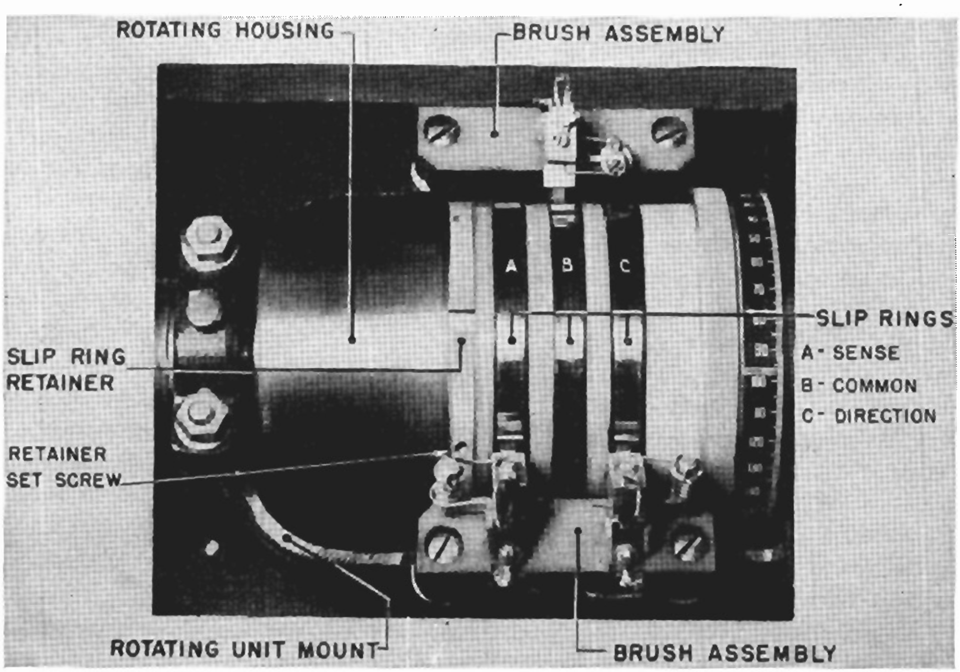


FIGURE 1.—Rotating unit mount.

the brush contact surfaces should not be construed as requiring service and cleaning. This oxide coating is beneficial to the operation of the slip rings and should not be removed. However, in diagnosing this trouble, care should be taken to be certain that it is a brown oxide film and not a combination of etching and tarnishing.

### Slip Rings—Loose

If the slip rings at any time, appear to be loose by reason of mechanical inspection or pattern phenomena, the slip ring retainer, Figure 1, should be tightened until all the rings are held firmly in place. The procedure for tightening slip rings is:

(1) Turn master switch to OFF position.

(2) Unloosen two set screws in periphery of slip ring retainer.

(3) Tighten the retainer until the slip rings are firmly held in place. (To tighten, turn counterclockwise as viewed from operator's position.)

(4) Tighten set screws.

(5) Check for concentricity and, if necessary, follow thru with procedure outlined under the sub-title "Slip Rings—Concentricity."


FIGURE 2.—Method of improving the concentricity of the slip rings.

### Slip Rings—Concenticity

WARNING.—Because of the delicate nature of the adjustments and servicing in this section, only approved maintenance personnel should be allowed to execute them.

At least once every month the slip rings should be inspected for concentricity. A simple field test may be made by observing the protruding arm of the brush pressure spring while the indicator is running. If the spring remains stationary in its slot, this will indicate that the slip ring is concentric and within the allowable tolerance approved by the manufacturer. Any perceptible up and down movement of the brush pressure spring arm, is an indication of eccentricity, and immediate steps should be taken to restore the slip ring to its original concentric position. Figure 2 illustrates the procedure to follow for adjusting slip rings, which is as follows:

(1) Turn master switch to OFF position.

(2) Rotate slip rings until "high spot" of eccentricity is located. Rotate this high spot to a point where it is accessible.

(3) Place the end of a rod of Bakelite, or other non-metallic material, with a square smooth end on the high spot of the ring and lightly tap the other end of the rod as shown in Figure 2.

(4) Recheck high spot and, if necessary, repeat above procedure until it is eliminated.

(5) Recheck entire slip ring for concentricity and repeat above procedure until there is no movement of brush spring arm during the full rotation of slip ring.

(6) Check other two rings for concentricity and, if necessary, follow thru with the above procedure until all three rings register concentric.

CAUTION.—Do not use any metal rods or bars on the slip rings when tapping end of Bakelite bar. As a further precautionary measure, use a rawhide or other soft-faced mallet. Be careful that no damage is done to the contacting surface of the slip rings. Carelessness in this operation may result in a damaged slip ring or in decommissioning, and shipment back to the factory for replacement, and remachining of the rings.

### Slip Rings—Etched, Pitted, Scored or Worn

Slip rings should be serviced as soon as any appearance of pitting, scoring, or wear upon the brush contact surfaces makes itself manifest. In order to obtain the best results from the indicator, the contact surfaces should be restored to their original bright mirror-like finish, leaving no pits or scores. The procedure, as outlined below, must be followed carefully, and applied continually until all pits and scores have been eliminated:

(1) Turn amplifier switch to OFF position.

(2) Lift brushes from slip rings and secure in place, letting brush spring pressure arm ride on underneath side of brushes. See Figure 3.

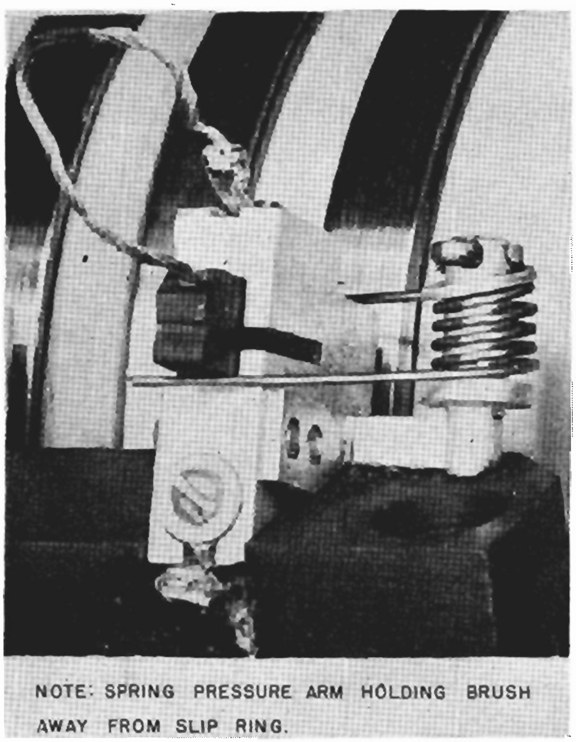


FIGURE 3.—Method of securing brushes.

(3) Start indicator running. Wrap a piece of crocus cloth approximately 2″ x 1¼″ around a 2″ x ¾″ x ⅛″ thick block of Bakelite or other smooth-surfaced, stiff material, and place it across the three rotating rings parallel to the axis of the indicator, Figure 4. Firm pressure upon the block should be used above the ring that is to be smoothed out. This operation should be continued while the indicator is running, until all pits, scores, and etchings disappear.

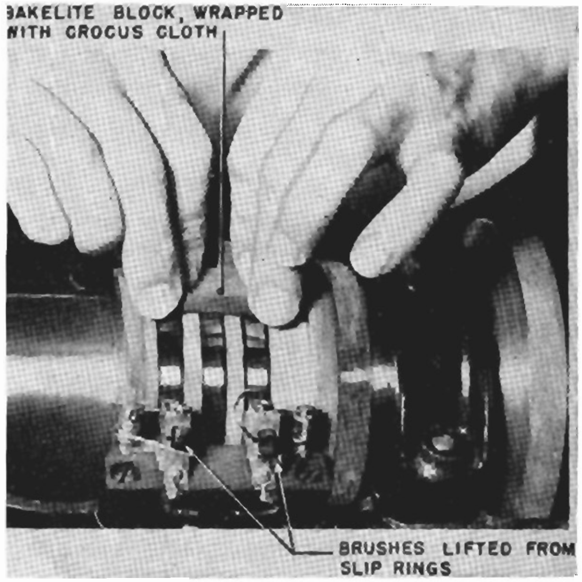


FIGURE 4.—Method of smoothing out slip rings.

(4) While indicator is still running, clean the slip rings by saturating a small pad with carbon tetrachloride placed firmly upon the rotating rings as in Figure 5.

(5) Replace brushes in their running position.

(6) If the above procedure has been carefully followed, the slip rings will be restored to their original mirror-like smoothness.

CAUTION.—Do not touch any rotating part of the indicator with the bare fingers! Use only carbon tetrachloride for cleaning rings. Use only Armour Sandpaper Works crocus cloth, or a crocus cloth of equal fineness for smoothing rings.

### Brushes—Periodic Inspection

Every week the brushes should be withdrawn from their holders and inspected for wear and cleanliness. If the brushes show any appreciable signs of wear, they should be replaced

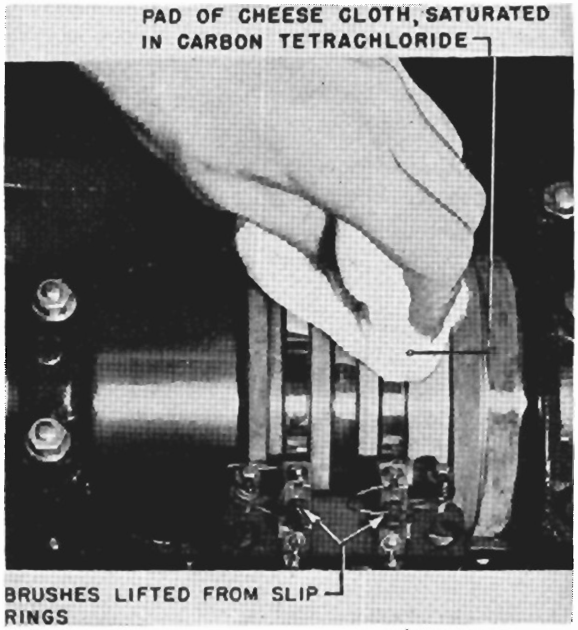


FIGURE 5.—Method of cleaning slip rings.

from the spare parts kit. In replacing the brushes, care should be exercised when handling the brush pressure spring arm so as not to bend it, thereby disturbing the original pressure. When inserting new brushes, it is advisable to check the pressure with a spring tension gauge, Figure 6, before setting indicator in operation. Figure 6 indicates a practical method of checking the pressure, which, for the best operation, is 2½ oz. Gauge reading should be taken as the arm leaves the brush. The contacting surface of the brush should be carefully examined and if found to be dirty, it should be wiped clean with a pad of cheesecloth saturated in carbon tetrachloride.

#### Brushes—Freeness

Brushes should be checked weekly for freedom of movement in their respective holders. If the brush has a tendency to bind in its slot, or be in any way restricted in its motion, other than that force exerted by the spring pressure arm, it should be serviced and the cause of its impeded movement removed. In general, sticking brushes are usually caused by foreign particles lodging in the space between the brush and the wall of the brush holder. To correct this condition, withdraw brush and wipe it clean with a pad of cheesecloth saturated in carbon tetrachloride, then draw a thin strip of cheesecloth, moistened in carbon tetrachloride,

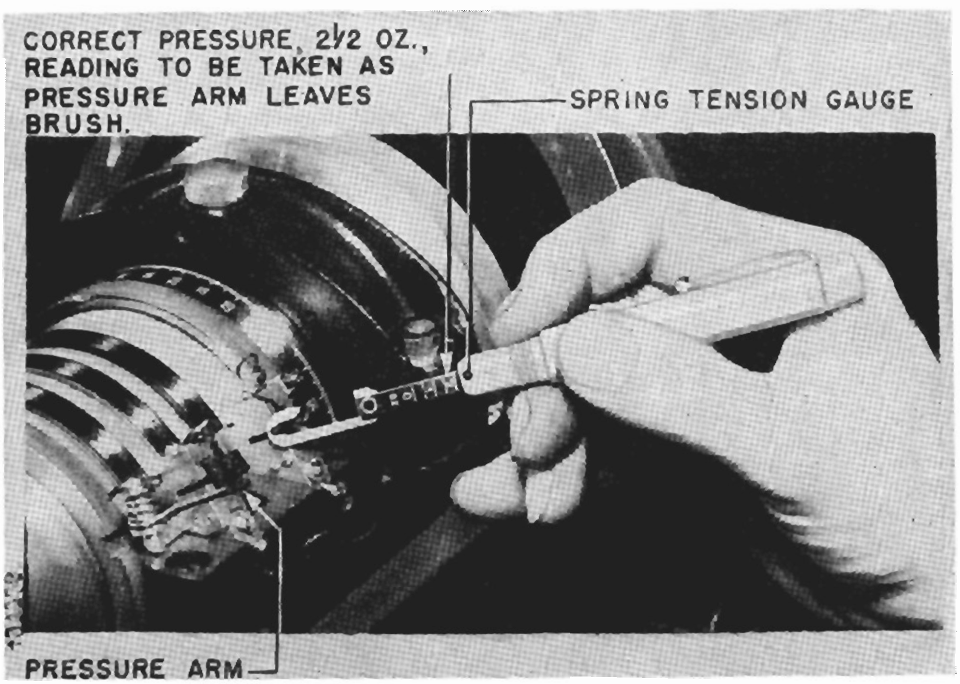


FIGURE 6.—Method of checking brush pressure.

back and forth in the square hole of the brush holder. Other causes of sticking brushes may be attributed to oversize brushes, crumbling edges, cracked brushes, etc. In any of these cases, the safest procedure is to replace them with sound, correctly fitting brushes from the spare parts kit.

### Brush Pigtails

Brush pigtails should be inspected monthly for fatigue, broken strands, flexibility, corrosion and good contact to the terminal screw on the brush holder. The pigtails should be long and flexible enough so as not to restrict the movement of the brush in its holder. Any signs of corrosion, fatigue, broken strands and brittleness should warrant their replacement.

### Brush Pressure

Brush pressure should be checked at least once a month. Figure 6 illustrates a convenient field method of checking the pressure. A spring tension gauge should be used graduated to ½ oz. The correct pressure for the best operation is 2½ oz. This should be read just as the arm leaves the brush. Before checking the pressure of the brush spring, the protruding arm should be examined and if found to be bent or scraping against the side of its slot, it should be repaired and straightened out so that it rides in the center of the slot freely and without touching the sides. Figure 7 illustrates two brush assemblies with their pressure springs arms shown in the correct and incorrect positions. The pressure spring arm should be adjusted to its required pressure by winding or unwinding the coiled portion. The arm should never be bent. All adjustments of pressure should be accomplished in the coils of the spring.

### Rotating Mount

Once every week the area underneath the slip rings should be cleaned of all accumulated dust, dirt, and grease. Failure to observe this rule faithfully will result in jeopardizing the performance of the indicator. Only if all its parts are scrupulously clean, can the indicator be expected to operate at its highest efficiency. The procedure for cleaning underneath the slip rings is:

(1) Turn master switch to OFF position.

(2) Remove Bakelite brush holder mount screws from both assemblies, and allow entire units to hang over side of indicator, Figure 8.

(3) Saturate a long narrow pad of cheesecloth approximately 4″ x 10″ in carbon tetrachloride and pass one end underneath the slip rings, while holding other end. Slowly rotate slip rings and feed pad until end of pad appears on other side.

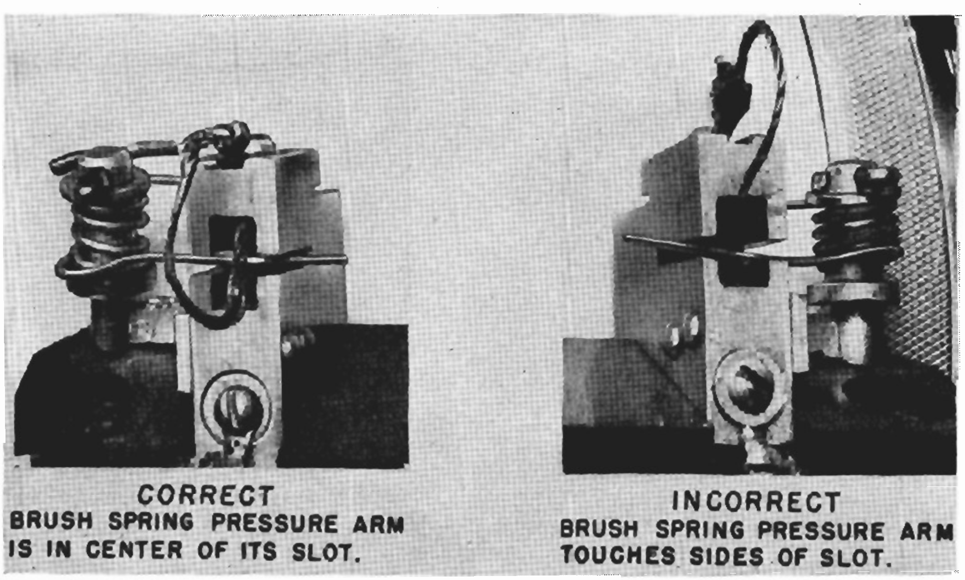


FIGURE 7.—Correct and incorrect positions for brush assemblies pressure springs arms.

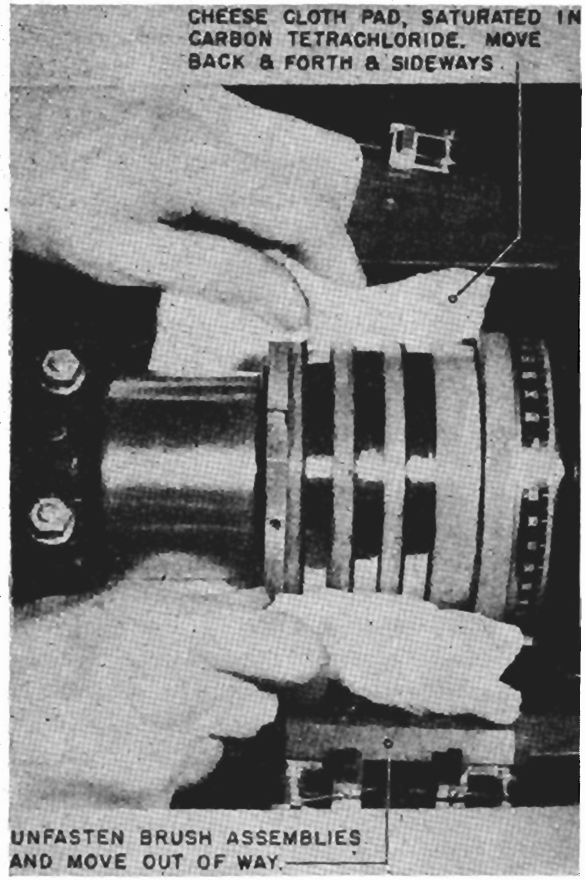


FIGURE 8.—Method of cleaning underneath the slip rings.

(4) Pull pad back, forth and sideways, Figure 8, until all dirt, dust and grease are removed from the portion of rotating unit mount underneath slip rings.

(5) Remove pad and replace Bakelite brush holder mount assemblies taking care that they are restored securely to their former position.

### Periodic Checks

For the convenience of the maintenance personnel, a checking schedule is given below. Adherence to this schedule will insure longevity of the slip ring section of the indicator, and help considerably toward keeping the indicator at its peak efficiency.

#### Weekly Check:

(1) Clean area underneath slip rings.
(2) Clean slip rings.
(3) Check brushes for wear, cleanliness and freeness.
(4) Check slip rings for etching, pitting scoring and wear.

#### Monthly Check:

(1) Check slip rings for concentricity and looseness.
(2) Check brush pressure.
(3) Check brush pigtails for fatigue, flexibility, corrosion, and contact.

### Equipment for Servicing Slip Rings and Brushes

The necessary equipment for servicing the slip rings and brushes is listed below and illustrated in Figure 9.

1 Pound—Carbon tetrachloride, technical.
5 Yards—Cheesecloth.
6 Sheets—Armour Sandpaper Works crocus cloth, or a crocus cloth of equal fineness.
1 —Spring tension gauge graduated in ½ ounces.
1 —Block Bakelite or other smooth-surfaced substance 2″ x ¾″ x ⅛″.
1 —Bakelite rod or other non-metallic substance ⅜″ dia. x 5″ long, both ends to be finished square, smooth and without burrs.

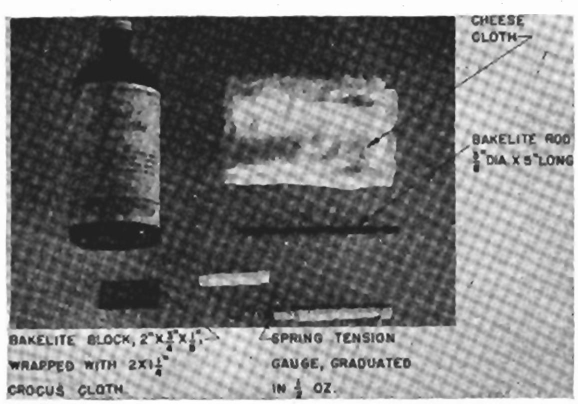


FIGURE 9.—Equipment needed for servicing slip rings and brushes.

## → FREQUENCY TOLERANCE OF RADIO COMMUNICATION EQUIPMENT

From time to time the Bureau receives inquiries as to the frequency tolerances of Navy radio communication transmitters.

Frequency tolerance is defined as the maximum permissable deviation of the actual carrier frequency from the prescribed carrier frequency, expressed in percent of the prescribed carrier frequency. In the case of emissions without a carrier this definition applies to the frequency of the carrier before its suppression.

The following frequency tolerances have been established for U. S. Navy radio communication equipments now under development:

| Frequency Range (kc.): | *Shore (percent)* | *Portable Mobile Aircraft (percent)* |
|---|---|---|
| 10–50 | 0.05 | -------- |
| 50–1,600 | .02 | 0.05 |
| 1,600–30,000 | .0025 | .01 |
| 30,000–400,000 | .005 | .005 |

The frequency tolerance for life boat and emergency transmitters operating on the distress frequency, 500 kc., shall be 0.5% or better.

## RMO'S GET NEW TITLE

The designations of "Radio Material Officer" (RMO) and "Assistant Radio Material Officer" (ARMO) have been changed to "Electronics Officer" (EO) and "Assistant Electronics Officer" (AEO) respectively. This change was effected by a multiple letter from the Chief of the Bureau dated 14 June 1945 (OB/P16–1 (902F–255)EN28/A2–11).

The purpose of this name change was to describe more accurately the duties of these officers in the fields of radio, radar, and sonar. It does not alter their duties and responsibilities.

## STANDARD PROCEDURE FOR ORDERING PIEZO-ELECTRIC QUARTZ CRYSTALS

The following procedure has been authorized by the Bureau for the expeditious ordering of piezo-electric quartz crystals. It is believed that much time and paper work will be saved through the use of form NBS 370 for the procurement of replacement crystals or crystals for newly assigned and authorized frequencies. A number of these forms bound in pads of 100 sheets each have been forwarded to the various Navy yards and other Naval activities. Additional quantities may be obtained upon application to the Bureau of Ships on form NBS 20–1 (ships) or NBS 20–2 (shore).

### REQUEST FOR CRYSTALS

The Navy Yard, Washington, is the supply yard for piezo-electric crystals. Crystals shall be requested from the Navy Yard, Washington, via the chain of command, with a copy to the Bureau of Ships (Electronics Division). These crystals are ground in the crystal laboratory, Navy Yard, Washington, D. C., or at other points when obtained commercially, to specifications given by the Bureau for the grinding of crystals. *Crystal orders shall be on form NBS 370* which provides for inclusion of information on the required crystals and holders, or where the above form is not available, information shall be in accordance with the following:

1. Date needed.
2. Shipment destination and suggested method of shipment.
3. Ship or station requiring the crystals.
4. (*a*) Navy model (or type number) and serial number of equipment for which required.

(*b*) If the equipment has not been assigned a Navy model or type designation through the Bureau of Ships, it will be necessary to give the manufacturer's name, address, and the designation of the equipment.

(*c*) Indicate whether the crystal is for use in a transmitter, receiver, CFI, or frequency meter.

5. Where crystals are required for transmitter or receiver frequency control, state the channel frequency; i. e., the transmitter output frequency, or the receiver input frequency. State the receiver intermediate frequency and whether the oscillator frequency applied to the detector or mixer tube is higher or lower than the incoming channel frequency. Where the

crystal is used in a filter circuit, state the filter frequency.

6. Actual frequency to which crystal should be ground. Where this frequency is different from the channel frequency, crystals will be furnished for the channel frequency. Consideration will be given to the proper circuit operation, i. e., whether doubling, tripling, etc., is employed and for the intermediate frequency in the case of receivers.

7. Indicate the method whereby the output frequency is obtained in the transmitter or the heterodyning frequency is obtained in the receiver, i. e., by doubling, tripling, etc., where the apparatus is not assigned a Navy model designation.

8. Accuracy in percent of crystal frequency to which the crystal should be ground. State whether crystal is to be operated at room or oven temperature. If the crystal is used in temperature compartment, state oven temperature.

9. Type of vacuum tube used in the crystal circuit and the voltage applied to the plate of the tube.

10. Navy type number of the holder, or if a Navy type number has not been assigned by the Bureau of Ships, give complete physical and electrical data on the holder including outer physical dimensions, spacing and number of pins, diameter of pins, electrical connections, size of crystal, and the method of holding the crystal.

11. Any special method of operation, e. g., operation of crystal at harmonic frequency (such as in model TBS).

### DISPATCH REQUESTS

The minimum data for dispatch request for crystals shall include:

1. Navy model designation *including suffix numbers* (e. g., TCB, TCB–2, etc., as in certain cases crystal holders and circuits have been changed in the later equipment).
2. Shipping information (as in 2 above).
3. Use of crystal (as in 4*c* above).
4. Channel frequency (as in 5 above).

**Warning:** This minimum data applies only to equipment assigned a Navy model designation. For other equipment information in conformance with form NBS 370 will minimize delays due to lack of sufficient data.

Note: Crystal controlled radio equipment furnished the Naval service is normally provided with the initial set of piezo-electric crystals required for operation and, in certain cases, with spare crystals. Any additional crystals that may be required subsequent to receipt of the equipment, due to changes in frequency allocation, will not be furnished until specifically authorized by proper authority.

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## TRANSMITTER CONTROL CIRCUITS

The transmitter control circuit diagrams which follow were prepared by the staff of the Radio Material School, Naval Research Laboratory. They are simplified schematic diagrams of the starting, stopping and keying circuits for

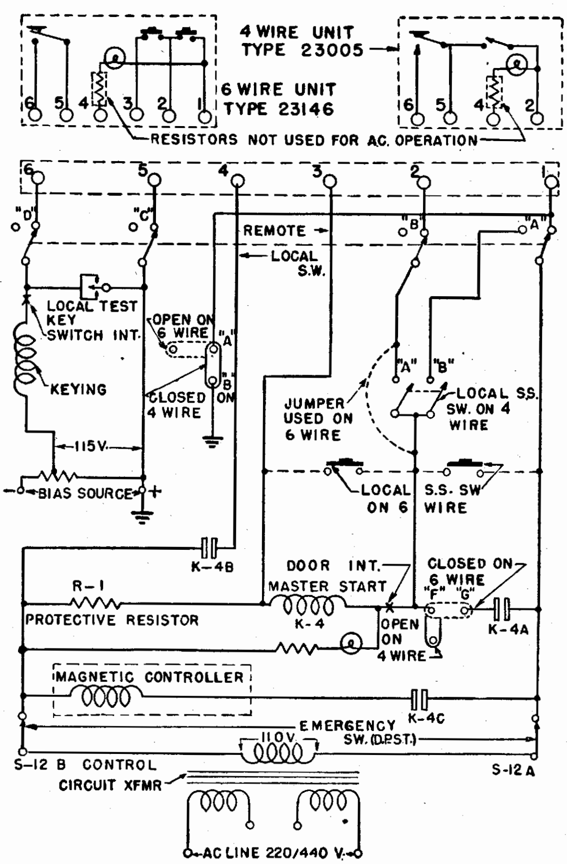


Figure 1.—Basic standard 4- and 6-wire remote control circuits for transmitters having a-c supplies.



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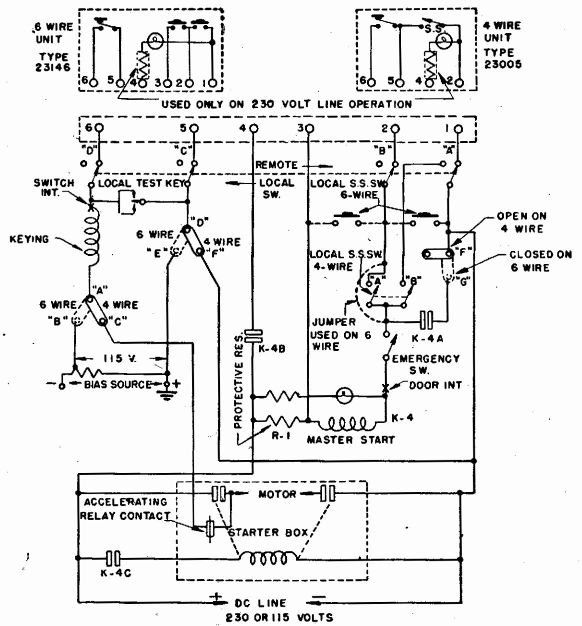


FIGURE 2.—Basic standard 4- and 6-wire remote control circuits for transmitters having d-c supplies.

various Navy transmitters. It is not intended for them to be complete schematic diagrams of the entire equipment, but it is believed that they will be a help toward the understanding and servicing of the control circuits of Navy transmitters.

Figure 1 shows the basic standard 4- and 6-wire remote control circuits for transmitters having a-c supplies. Figure 2 shows the same circuits for transmitters having d-c supplies.

As additional simplified diagrams are prepared they will appear in Section 9 of later supplements to this bulletin on the pages of the equipment they apply to.

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## → PREPARATION OF REQUEST FOR SPARE PARTS (NAVSANDA FORM 302)

A new form, request for spare parts (NAVSANDA Form 302), has been designed for use by all activities afloat and ashore, as a means of furnishing the requisitioning officer with sufficient detailed data accurately to identify the needed items. Lack of such information on requisitions has been a major source of difficulty in prompt procurement of spare parts.

The department within the activity requiring the material is considered to be in the best position to supply the information needed.

The request for spare parts will be prepared in triplicate in a legible manner by the department requesting the items. Only items pertaining to one type of equipment will be listed on one set of forms; if spares are requested for equipment of different types, a form will be required for each type. All identifying name plate data and/or instruction book information will be placed thereon. Further description can be entered in the space provided, or on the reverse of the form. All descriptive information entered on this form will be transcribed to the formal requisition. The original request for spare parts (NAVSANDA Form 302) will be securely attached to and forwarded with the original of the requisition submitted to the source of supply; one copy will be attached to and filed with the retained copy of the requisition; one copy will be returned to the head of the department requesting the material, endorsed as to the date and number of the requisition.

The NAVSANDA Form 302 may be obtained from the Supply Officer who can obtain a quantity from the Naval Supply Depots, Norfolk and Oakland if he does not already have a supply on hand.

A sample of NAVSANDA Form 302, properly filled out, is shown here as Figure 1.

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## SHORT TITLE FOR LORAN TRANSMITTING STATION MANUAL

The correct short title of the Loran Transmitting Station Manual is NAVSHIPS 900,060 and not 900,069 as shown on the enclosing envelope. Holders are requested to change their copies in ink.

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## REPLACEMENT DRAWINGS FOR LORAN TRANSMITTING STATION MANUAL

The three Coast Guard drawings in the Loran Transmitting Station Manual designated "R–2071D" are incorrect. Corrected drawings, des-

## REQUEST FOR SPARE PARTS
NAVSANDA FORM 302

| | |
|---|---|
| NAME OF ACTIVITY OR SHIP: AS-53 (USS BELLIGUSE) | REQUEST NO. 42 |
| DEPARTMENT: Communication | DATE: 7 August 1945 |
| SPARE PART BOX NO. 2 | ALLOWANCE LIST: GROUP NO. Buships 90099, See Inst. Book TXX-3 |
| STOREROOM NO. Radio III | PAGE NO. 47 |

| ITEM NO. | STOCK NO. OR PART NO. | DESCRIPTION | UNIT | QUANTITY | SPARE PART LIST NO. | ALLOWANCE LIST LINE NO. |
|---|---|---|---|---|---|---|
| 1 | C-401 | 500 MFD. +100% - 10%, 15 volt | | | | |
| | | Electrolytic Microphone Capacitor | | 1 | Item 72 | -- |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

ABOVE ITEMS TO BE USED ON/WITH: TXX-3 Transmitter

NAME PLATE DATA

| | | | |
|---|---|---|---|
| SERIAL NO. 1492 | TYPE NO. TXX | MODEL NO. 3 | STYLE -- |
| MFR.'S DRAWING NO. 23A17 347 | NAVY DRAWING NO. 48D73217 | P. C. NO. -- | CONTRACT NO. NXsr-78431 |
| HP. -- | R. P. M. -- | GPM -- | CFM -- |
| VOLTAGE 15 | A. C. OR D. C. DC peak | AMPS. -- | OHMS -- |
| PHASE -- | CYCLE -- | BORE -- | STROKE -- |
| SIZE 7" x 2" D | JOB ORDER NO. -- | CATALOG NO. -- | SPECIFICATION NO. -- |

ADDITIONAL NAME PLATE DATA

OTHER IDENTIFYING INFORMATION: or Sprague Spec. Co., - Cornell-Dubilier - Aerovox

| | |
|---|---|
| MANUFACTURER: Solar Mfg. Co. | LATEST ACCEPTABLE DELIVERY DATE: 1 September 1945 |

MANUFACTURER'S ADDRESS: Bayonne, N. J.

SOURCE OF SUPPLY: NYPEARL

| | |
|---|---|
| DRAWN OUT OF SPARE PARTS BOX BY: Jones, A. B., RT 2/c | UPON RECEIPT NOTIFY: CRE John Doe, USN |
| SUBMITTED BY: CRE John Doe, USN | APPROVED BY HEAD OF DEPARTMENT: Lt. John Smith, USNR |

| DATE ORDERED | ORDERED FROM | REQUISITION NO. |
|---|---|---|
| | | |

☆ U. S. GOVERNMENT PRINTING OFFICE : 1944 16—42008-1

Last line to be filled in by Supply Officer

FIGURE 1.—A sample of NAVSANDA Form 302 properly filled out.

ignated "R-2071E", have been printed and given the same distribution as the manual. If your activity has a copy of the manual but has not received the replacement drawings, they should be requested from the Bureau of Ships (Code 250F).

## PRACTICAL FACTS ABOUT TESTING ELECTRON TUBES

A tube tester is a very valuable aid in determining many common defects in electron tubes, and is absolutely necessary for speedy maintenance of most electronic equipment. With a tube tester it is possible to isolate definitely such tube faults as extremely low-emission tubes, shorts, open elements, and gassy tubes. Since these faults comprise a large percentage of tube failures, the need for intelligent use of a tube tester is self-evident.

However, there is only one hundred-percent reliable field test for tubes—put the tube in the socket of the radio set in which it will be used and see how it works. The set should be checked to be sure that other components are in proper condition and that the equipment is properly aligned.

Checking tubes with a tube tester is not a complete test, since a tube may test "high" in a tube tester and work poorly in a radio set. Another tube may test "low" in a tube tester but work very well in a set.

Figure 1 shows a typical r-f amplifier circuit and a tube tester circuit, illustrating the differences which exist in circuit constants.

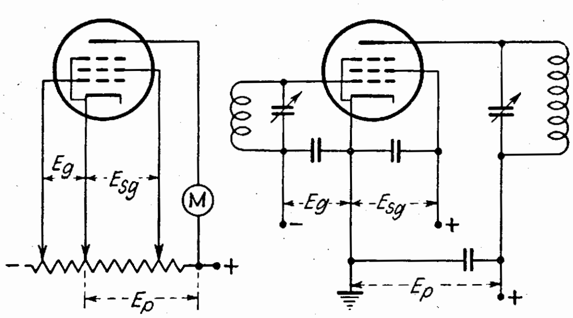


FIGURE 1.—Comparison of a typical tube tester circuit with a typical r-f amplifier circuit.

In general, tube testers do not completely indicate tube performance because:

(1) Different voltages are applied. A tube may read "low Gm" when tested at 25 volts $E_{sg}$, 35 volts $E_P$ and $-0.5$ volts $E_g$, and yet work perfectly in a radio equipment with 100 volts $E_{sg}$ and 200 volts $E_P$. Many tube testers check tubes at low filament, screen grid and plate voltages.

(2) Different impedances are used in plate and grid circuits. A tube with tuned circuits or choke coils in its grid and plate circuits performs altogether differently from the same tube with its elements connected directly to supply voltages. No tube checker can be expected to have grid and plate impedances duplicating those in radio gear.

(3) Different frequencies are used. Most, if not all, tube checkers use either AC at power line frequency or rectified d-c voltages and no high-frequency voltages are applied. The most serious difference here is in the operation of the grid-cathode circuit as the frequency increases. The grid-cathode circuit of a tube at low frequencies is a very high impedance, but as the frequency is increased, the grid acts like a lower and lower resistance. For example, a 6K7 r-f pentode tube has an effective grid loading equivalent to a 20,000-ohm resistor at 30 mc., while at 500 kc. it is several million ohms. The small r-f tubes, such as the 9000 series and the 6AK5's, were developed to lessen the grid loading on high-frequency tuned circuits.

An electron tube may be regarded as a series of variable resistors. Thus, changing the voltage applied to any element will change all its characteristics including not only mutual conductance, amplification factor and plate resistance, but also effective input capacity, output capacity and grid loading. At the high frequencies used in many equipments the interelectrode capacitance of the tube becomes a good portion of the circuit capacitance. For this reason circuits should be properly aligned to prevent selection of tubes that match certain incorrect capacitance conditions.

It is impraticable to design a complete testing instrument which will evaluate the performance of any tube in any circuit in which you happen to find it operating. Since tube checkers are so different from the r-f circuits in which tubes actually are used, it is recommended that:

(1) Only "dead", "shorted" or extremely weak tubes be discarded on the basis of a tube tester check.

(2) No tube working satisfactorily be replaced on the basis of a tube tester check, unless the test shows imminence of failure such as intermittent operation, evidence of gas, etc. Nevertheless, it should be repeated that a large percentage of faulty tubes can be detected by a tube tester and continued use of such equipment is a necessity.

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## FAILURE OF HANDSET CABLES IN RADIOPHONE UNITS

Several ships have reported frequent failure of the five-wire cable to the handset in the remote radiophone units. This failure is due to frequent sharp bending of the cable at the point where it enters the phone handset. The cure, of course, is to prevent sharp bends at this point, and may be effected in several ways. One way is to make a spiral spring out of steel spring wire and attach it to the handset so that the spring covers the cable at the point of entrance in much the same manner as the spring on a home type iron or coffee percolator heater cord. Another is to cover the cord with a piece of semistiff "spaghetti" or saturated cloth tubing. Other means of curing the trouble may be devised locally using such materials as may be at hand.

Specifications for new radiophone units will include protection for the cord at the points of sharp bending.

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## →MODIFICATION KIT FOR THE TIME DELAY RELAY OF RADIO TELEGRAPH TRANSMITTING EQUIPMENT

The purpose of this kit is to prevent signal emission while the keyer tube is heating to operating temperature. It has been found that the transmitter concerned will emit the carrier for a short period of time (seconds) when switching from relay keying to tube keying. This emission is caused by the method of connection of the keying circuit when using vacuum tube keying.

With the aid of a drill, a screw driver, a pair of pliers and a soldering iron, it should be possible to install this kit in a maximum period of several hours.

Modification kits, consisting of time delay relays complete with necessary installation material and instructions, are being shipped. Delivery will be completed in the next few months.

Distribution is being made as follows:

| Equipment to be used with | Power Supply | Activity |
|---|---|---|
| TAB–5/6/7 | 220/3/60 | Electronics Supply Annex, Long Island City. |
| TAB–5/6/7 | 220/3/60 | NYMI. |
| TAB–7 | 220/3/60 | NYNOR. |
| TAB–7 | 220/3/60 | 11 ND, San Pedro. |
| TAB–7 | 220/3/60 | NYPS. |
| TBK–11/15/16 | 220/3/60 | Electronics Supply Annex, Long Island City. |
| TBK–11 | 220/1/60 | Electronics Supply Annex, Long Island City. |
| TBK–11/15/16 | 220/3/60 | NYMI. |
| TBK–16 | 220/3/60 | NYNOR. |
| TBK–16 | 220/3/60 | 11 ND, San Pedro. |
| TBK–16 | 220/3/60 | NYPS. |
| TBM–6/8/10 | 220/3/60 | Electronics Supply Annex, Long Island City. |
| TBM–6/8/10 | 220/3/60 | NYMI. |
| TBM–8/10 | 220/3/60 | NYNOR. |
| TBM–8/10 | 220/3/60 | 11 ND, San Pedro. |
| TBM–8/10 | 220/3/60 | NYPS. |
| TBU–1/4 | 220/3/60 | Electronics Supply Annex, Long Island City. |
| TBU–1/4 | 220/3/60 | NYMI. |
| TBU–1/4 | 220/3/60 | NYNOR. |
| TBU–1/4 | 220/3/60 | 11 ND, San Pedro. |
| TBU–1/4 | 220/3/60 | NYPS. |

*10/1/45*

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## MEASURING THE IMPEDANCE OF LOUD SPEAKERS

At various times it is necessary to measure the impedance of spare loud speakers due to the fact that the data accompanying the speaker has been lost, or for various other reasons. The following data from the Jensen Radio Mfg. Co. will help accomplish this:

"If the speaker impedance is not known, it can be measured with the aid of an audio oscillator, calibrated variable resistor and high impedance rectifier type or vacuum-tube-voltmeter, as indicated in Figure 1.

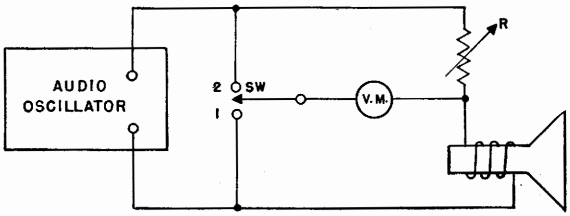


FIGURE 1.—Equipment set up to measure the impedance of a loud speaker.

"The oscillator output should be adjusted to give about full scale reading on the voltmeter when switched across the speaker voice coil (switch position 1), making sure that the signal level does not exceed the speaker power rating. The variable resistor is then varied until the voltmeter reads the same in positions 1 and 2. The value of R is then numerically equal to the impedance of the voice coil at the frequency of measurement.

"A single determination at 400 cycles will probably be satisfactory, although if desired, the impedance can be measured by this method over any desired range of frequencies.

"The principle is the same if the speaker is equipped with an input transformer; here the required impedance is that "looking into" the primary, with the secondary connected in the normal manner to the voice coil. In this case the circuit would be as shown in Figure 2.

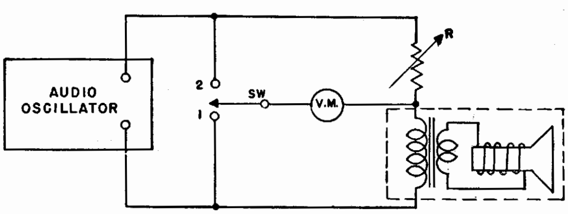


FIGURE 2.—Equipment set up to measure the impedance of a loud speaker equipped with an input transformer.

"The rated impedance of a moving coil loudspeaker is approximately the minimum impedance above the low resonant frequency and this minimum value is usually found at about 400 cycles."—*10/1/45*

## CHECKING TROPICALIZATION

In tropicalization, all the lacquers used, whatever the content, are colorless, or nearly so, in order that the numbers and the identification marks on the various instruments may be plainly read through them. The result is that it is not easy, by ordinary visual inspection, to check on the thoroughness and evenness of the spraying.

A simple field check which can be used in the forward areas to discover weak spots in the spraying of suspected parts is to try writing on the lacquered equipment with an ordinary lead pencil. If the pencil goes along smoothly as on glass the spraying is OK. However, if the pencil "starts writing", it has found the weak spot or spots. Then the tropicalization can be completed in the field by tropicalizing these spots.—*10/1/45*

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## CLASSIFICATION OF SHIPBOARD LORAN EQUIPMENT REDUCED

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

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

Activities holding copies of any of these publications should therefore mark the front covers *RESTRICTED—10/1/45*

## FAILURE OF BYPASS CAPACITORS IN ARMY EQUIPMENT

Large numbers of failure reports have been received on plate and screen circuit bypass capacitors used in Army equipment such as the BC–639, the SCR–608, etc. These capacitors usually are rated at 0.006 mfd., 300 volts. Experience has shown that these capacitors can not be depended upon. It is therefore desired that all such capacitors in all models of Army equipment be removed and replaced with capacitors rated at 0.006 mfd., 600 volts. Replacement of the original capacitors should be done on "general principles" before these capacitors fail at a critical time.—*10/1/45*.

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## REPORTING OF ELECTRONIC FIELD CHANGES

The usual method of reporting a field change to electronic equipment is to fill out and mail the self-addressed card contained in the field change kit.

For reporting those field changes in which no kit is supplied or in which no modification card is available, the Bureau suggests this easy and convenient procedure: Fill out the top half of a NavShips NBS 383 (Failure Report—Electronic Equipment) card and under "Remarks" note: "Navy Field Change ______ made".

If properly filled out, the card should contain the following information:

Equipment model and serial number.
Unit name and serial number.
Navy Field Change number.
Date Field Change made.
Name and rank, rating, or title of person making change.

When the card is filled out, enclose it in its self-addressed envelope, seal and mail. If no self-addressed envelope is available, mail the card to the Bureau of Ships, Code 980, Navy Department, Washington 25, D. C.—*10/1/45*

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## → PRECAUTIONS IN HANDLING FUNGUS PROOFED WIRE

There are certain precautions to be observed to avoid skin irritations when handling fungus proofed fiberglas insulated wire.

Insulation skinned from wires should, whenever possible, be placed directly into containers to keep it off the floors, benches and clothing. The dust liberated during the skinning and various other operations should be collected with a portable vacuum cleaner at whatever interval is found necessary to keep the benches, equipment and floors clean. Compressed air should not be used for removing dust from the benches, equipment or floors.

After skinning the wire or handling the skinned wire, wash the hands and arms thoroughly with soap and water. If an itching sensation on the hands and arms is experienced, refrain from scratching, and wash the hands and arms with water and a good hand cleaner to remove particles of fiberglas. Should skin irritation persist, obtain medical advice for "exposure to fiberglas treated with fungicide."—*11/1/45*

—*EFSG Notes 17–4*

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## REMOVAL OF FUNGUS GROWTH IN RADIO EQUIPMENTS

A considerable number of failure reports have been received which report arc-over and surface leakage on ceramic insulators used in radio equipments, especially models TDE and TBM. This condition is due to the collection of fungus growth on the surface of these ceramic insulators. The fungus growth collects moisture which provides a leakage path across the insulator with consequent arc-over and formation of a carbonized path or short across the insulator. This condition may be avoided by keeping the surface of insulators scrupulously clean and dry, and making the cleaning of the insulators a daily matter. Once the insulator has a leakage path across it, not much can be done except replacement, but the trouble can be entirely avoided by the preventive measure of keeping the surface of the insulators clean.—*11/1/45*

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## IDENTIFICATION OF OUTPUT TRANSFORMERS

Every radio repair shop has a "junk box" which usually contains, among other things, several output transformers from which the winding identification has long been absent. The impedance ratio of these transformers may easily be determined, using nothing more than a source of 115-volt 60-cycle AC and an a-c voltmeter. The procedure is based upon the fact that the impedance ratio is equal to the square of the turns ratio and that the ratio of primary to secondary voltage is equal to the turns ratio, thus:

$$\frac{Z_P}{Z_S}=\left(\frac{N_P}{N_S}\right)^2$$

and

$$\frac{N_P}{N_S}=\frac{E_P}{E_S}.$$

Therefore

$$\frac{Z_P}{Z_S}=\left(\frac{E_P}{E_S}\right)^2$$

where $\frac{Z_P}{Z_S}$ is the impedance ratio, $\frac{N_P}{N_S}$ is the turns ratio, and $\frac{E_P}{E_S}$ is the voltage ratio.

The first step is to determine which terminals or leads are for the primary and which are for the secondary. This is done with an ohmmeter. Since all output transformers are "stepdown," the secondary winding, especially in units which feed voice coils of dynamic speakers, will have a d-c resistance much lower than the primary. Once the windings have been identified, 115-volt AC is applied to the primary and, if possible, adjusted to exactly 115 volts. The secondary voltage is then measured and the impedance ratio determined by reference to the following table, which is calculated from the formula

$$E_S=\frac{115\sqrt{Z_S}}{\sqrt{Z_P}}.$$

| Primary impedance | SECONDARY IMPEDANCE | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 ohms | 4 ohms | 6 ohms | 8 ohms | 16 ohms | 250 ohms | 500 ohms |
| *Ohms* | *Volts* | *Volts* | *Volts* | *Volts* | *Volts* | *Volts* | *Volts* |
| 25000 | 1. 03 | 1. 45 | 1. 78 | 2. 06 | 2. 91 | 11. 5 | 16. 3 |
| 15000 | 1. 33 | 1. 88 | 2. 30 | 2. 66 | 3. 75 | 14. 8 | 21. 0 |
| 12000 | 1. 48 | 2. 10 | 2. 57 | 2. 97 | 4. 20 | 16. 6 | 23. 5 |
| 10000 | 1. 63 | 2. 30 | 2. 82 | 3. 26 | 4. 60 | 18. 2 | 25. 7 |
| 8000 | 1. 82 | 2. 57 | 3. 16 | 3. 64 | 5. 14 | 20. 3 | 28. 7 |
| 7000 | 1. 95 | 2. 75 | 3. 37 | 3. 90 | 5. 50 | 21. 7 | 30. 8 |
| 6000 | 2. 10 | 2. 97 | 3. 64 | 4. 21 | 5. 94 | 23. 3 | 33. 2 |
| 5000 | 2. 30 | 3. 26 | 3. 99 | 4. 61 | 6. 51 | 25. 7 | 36. 4 |
| 4000 | 2. 57 | 3. 64 | 4. 46 | 5. 15 | 7. 27 | 28. 8 | 40. 7 |
| 3000 | 2. 97 | 4. 20 | 5. 15 | 5. 95 | 8. 40 | 33. 2 | 47. 0 |
| 2000 | 3. 64 | 5. 15 | 6. 30 | 7. 29 | 10. 3 | 40. 7 | 57. 6 |
| 1000 | 5. 14 | 7. 28 | 8. 91 | 10. 3 | 14. 5 | 57. 6 | 81. 4 |
| 500 | 7. 27 | 10. 3 | 12. 6 | 14. 6 | 20. 5 | 81. 4 | 115 |

For example, a secondary voltage of 2.9 volts indicates an impedance ratio of 1500:1. This transformer could be used to couple a 2-ohm voice coil to a tube requiring a 3000-ohm load, a 4-ohm load to a tube requiring a 6000-ohm load, an 8-ohm load to a tube requiring a 12,000-ohm load, etc. It should be noted that a transformer is a "changer" or "reflector" of impedances and that it merely reflects to the primary an impedance which depends on the impedance connected to the secondary and the impedance ratio (turns ratio squared) of the transformer. The terms "primary impedance" and "secondary impedance" do not refer to the impedance of the appropriate windings. In the above example, the secondary voltage was found at the intersection of a primary impedance of 3000 ohms and a secondary impedance of 2 ohms. This meant that this transformer would present a 3000-ohm load to a tube when a 2-ohm load was connected to the secondary, or that it had an impedance ratio of 1500:1. Thus, any impedance connected to the secondary would be reflected to the primary multiplied by a factor of 1500.

There are several factors which limit the accuracy of this method of measurement. In the first place, the nominal impedances listed in catalogues for speakers and transformers are measured at 400 cycles. The above procedure assumes that the frequency response of the transformer is the same at 60 cycles as at 400 cycles. In practice this is no disadvantage as in a good transformer there is only a slight attenuation at 60 cycles, while in cheap or midget set transformers, mismatch is not serious due to the usually poor performance of associated equipment. In the second place, the accuracy is limited by voltmeter errors. The table is calculated to three significant figures which is much greater accuracy than that of the instruments employed. Finally, the table is calculated on the basis of exactly 115 volts applied to the primary. Any deviation from this value will, of course, introduce a proportionate variation in secondary voltage.

It is believed that this method is a practical means of determining the impedance ratio of output transformers. However, whether or not a transformer can be used in a certain application depends not only on the impedance ratio, but also on the power handling capability (which is determined by the gauge of wire used for the windings, core area, etc.), the size of the unit, mounting facilities and other factors which must be evaluated by the user.—*11/1/45*

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## STATUS OF GENERAL PURPOSE POWER SUPPLIES FOR ELECTRONIC EQUIPMENT

The present status of general purpose power supplies for electronic equipment is summarized in the following list. This list includes all types of general purpose power supplies which have been procured during the past five years. It is the ultimate aim of this Bureau to eliminate the existing confusion in the identification of power conversion equipment brought about by the procurement of many types of commercial units with identical electrical ratings and different mechanical characteristics which necessitated different Navy type numbers.

At the present time there is a variety of the above commercial motor-generator sets available in limited quantities at the various electronic material pools. Although a great many of these are obsolete insofar as further procurement is concerned, the Bureau desires that they be utilized whenever they adequately satisfy requirements.

| *Navy type number* | *Input* | *Output* |
|---|---|---|
| *211575 | 230 V DC | 115/1/60—0.5 KVA |
| 211762 | 230 V DC | 115/1/60—0.5 KVA |
| *211305 | 230 V DC | 115/1/60—0.5 KVA |
| *21431 | 230 V DC | 115/1/60—0.5 KVA |
| *211139 | 230 V DC | 115/1/60—0.5 KVA |
| *21807 | 230 V DC | 115/1/60—0.5 KVA |
| *21207 | 115 V DC | 115/1/60—0.25 KVA |
| *21207A | 115 V DC | 115/1/60—0.25 KVA |
| 211133 | 115 V DC | 115/1/60—0.25 KVA |
| *211260 | 115 V DC | 115/1/60—0.25 KVA |
| *211574 | 115 V DC | 115/1/60—0.5 KVA |
| 211761 | 115 V DC | 115/1/60—0.5 KVA |
| *211565 | 115 V DC | 115/1/60—0.5 KVA |
| *211141 | 115 V DC | 115/1/60—0.5 KVA |
| *211135 | 115 V DC | 115/1/60—0.5 KVA |
| *21806 | 115 V DC | 115/1/60—0.5 KVA |
| *21208 | 115 V DC | 115/1/60—0.5 KVA |
| *211304 | 115 V DC | 115/1/60—0.5 KVA |
| *21523 | 230 V DC | 115/1/60—2.5 KVA |
| *21576 | 230 V DC | 115/1/60—2.5 KVA |
| *21577 | 230 V DC | 115/1/60—2.5 KVA |
| *211246 | 230 V DC | 115/1/60—2.5 KVA |
| 211303 | 230 V DC | 115/1/60—2.5 KVA |
| 21701 | 32 V DC | 115/1/60—0.25 KVA |
| 21702 | 230 V DC | 115/1/60—0.25 KVA |
| 21800 | 115 V DC | 115/1/60—0.15 KVA |
| 21801 | 230 V DC | 115/1/60—0.15 KVA |
| 21813 | 115 V DC | 115/1/60—4 KVA |
| *21920 | 115 V DC | 115/1/60—4 KVA |
| *21870 | 115 V DC | 115/1/60—4 KVA |
| *21814 | 230 V DC | 115/1/60—4 KVA |
| *21923 | 230 V DC | 115/1/60—4 KVA |
| 211271 | 230 V DC | 115/1/60—4 KVA |
| *211256 | 230 V DC | 115/1/60—4 KVA |
| 211007 | 115 V DC | 115/1/60—2 KVA |
| *21914 | 115 V DC | 115/1/60—2 KVA |
| 211008 | 230 V DC | 115/1/60—2 KVA |
| *21917 | 230 V DC | 115/1/60—2 KVA |
| 211014 | 115 V DC | 27 V DC—250 W |
| *211338 | 115 V DC | 27 V DC—250 W |
| 211347 | 115 V DC | 115/1/60—1 KVA |
| *211204 | 115 V DC | 115/1/60—1 KVA |
| *211147 | 115 V DC | 115/1/60—1 KVA |
| *211234 | 115 V DC | 115/1/60—1 KVA |
| *21821 | 115 V DC | 115/1/60—1 KVA |
| 211151 | 230 V DC | 115/1/60—1 KVA |
| *211039 | 230 V DC | 115/1/60—1 KVA |
| 211437 | 115 or 230 V DC | 13 or 26 V DC—500 W |
| 211414 | 115 V DC | 13/26 V DC—500 W |
| *211444 | 115 V DC | 13/26 V DC—500 W |
| 211018 | 115/230/1/60 | 27 V DC—250 W |
| 211649 | 115/230/1/60 | 13/26 V DC—500 W |
| 211438 | 115 V DC | 13 V DC—150 W |
| *21698 | 115 V DC | 115/1/60—2.5 KVA |
| 211301 | 115 V DC | 115/1/60—2.5 KVA |
| 211275 | 115 V DC | 115/1/60—5 KVA |
| 211279 | 230 V DC | 115/1/60—5 KVA |

| *Navy type number* | *Input* | *Output* |
|---|---|---|
| 211336 | 115/230/1/60 | 27 V DC—250 W |
| 211514 | 230/3/60 | 115 V DC—2 KW |
| 211627 | 230/3/60 | 115/230 V DC—2 KW |
| 21820 | 230 V DC | 440/3/60—3.5 KVA |
| 21817 | 115 V DC | 440/3/60—7.5 KVA |
| 211037 | 230 V DC | 440/3/60—7.5 KVA |
| 211134 | 115/1/60 | 115 V DC—250 W |
| 21823 | 32 V DC | 115/1/60—1 KVA |
| *20350 | 115/1/60 | 13/26 V DC—500 W |
| Rectifier | | 6 V DC—250 W |
| *20341 | 115/230/1/60 | 7/14/28 V DC—750 W |
| Rectifier | | |

*Further procurement of this type unit will not be made. Present stocks, however, shall be utilized whenever possible.

*3/1/46*

## → CNO POLICY ON ALTERATIONS

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

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

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

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

This policy pertains to ships of the Active and Reserve Fleets, as no alterations of any description on vessels in the inactive fleet will be considered. *4/1/46* ←