CHAPTER 14

MAINTENANCE

Electronics maintenance is a broad field of endeavor. Maintenance includes both measures to reduce or eliminate failures and prolong the useful life of the equipment (preventive maintenance) and measures taken to correct damage incurred through long use, accident, or other causes (repair, also called corrective maintenance).

The subdivisions of electronics maintenance are defined as follows:

Operational maintenance consists normally of inspection, cleaning, servicing, preservation, lubrication, and adjustment, as required, and may also consist of minor parts replacement not requiring high technical skill or internal equipment alignment. Operational maintenance on communication-electronic equipment is done by Radiomen.

Technical maintenance usually is limited to maintenance consisting of replacement of unserviceable parts, subassemblies, or assemblies and the alignment, testing, and internal adjustment of equipment. Technical maintenance customarily is done by Electronics Technicians.

Tender/yard maintenance is maintenance that requires a major overhaul or complete rebuilding of parts and assemblies. Maintenance beyond the capacity of ship or station forces is performed by tenders or naval shipyards and industrial managers or by contractors responsible to the maintenance yard.

The electronics material officer, one of the assistants to the operations officer, is responsible for the administration of the electronics maintenance program. The trend in recent years is toward increased maintenance responsibilities for Radiomen and other operational ratings. Although the line is not always clearly drawn between operational and technical maintenance, and there may be certain exceptions, it is the intent of the Bureau of Ships that operational maintenance be done by the operational ratings and technical maintenance by the technical ratings. The duties of the two ratings are summarized as follows:

1. Operational ratings—operational use, manipulation, and operational maintenance of electronic equipment associated with the technical specialties of the rating, and such portions of preventive maintenance as do not require realignment after accomplishment.
2. Technical ratings — manipulation, technical and tender/yard maintenance, repair of electronic equipment, and preventive maintenance that requires realignment after accomplishment.

POMSEE PROGRAM

To overcome weaknesses in local maintenance programs, the Bureau of Ships instituted the POMSEE program. The expression POMSEE stands for Performance, Operation, and Maintenance Standards for Electronic Equipment. The POMSEE consists of two publications. They are the Performance Standards Sheet and the Maintenance Standards Books.

Performance Standards Sheets provide the operational performance data and basic technical measurements indicative of the minimum acceptable level of performance for electronic equipment. A binder, titled "Electronics Equipment Performance Standards Sheets, NavShips 93000," is provided for incorporating all sheets required on a ship under one cover.

Maintenance Standards Books describe and illustrate standard procedures and tests for measuring the performance of a specific equipment. They include a list of test equipment required for taking these measurements, and provide space to record the results of the measurements. In addition, the books set forth a sound preventive maintenance schedule that ensures proper equipment performance.

Certain procedures (tests) in the Maintenance Standards Books are designated "Reference Standards Tests." These tests are accomplished by the installing activity when the equipment is operating properly. The recorded results provide a series of reference standards that collectively represent the equipment's normal performance. Comparison between the results of the scheduled preventive maintenance tests and the reference standards quickly reveals any significant change in the equipment's performance. Reference standards are reestablished by experienced technical personnel after each equipment overhaul.

Routine (preventive) maintenance tests of circuits and components are required at regular intervals (daily, weekly, quarterly, and so on.) Other routine maintenance, such as lubrication, also is required. The Maintenance Standards Books specify when and how the maintenance is to be performed.

Figure 14-1 shows opposing pages from the URC-32 Maintenance Standards Book. The procedures are presented in procedural tables. At the top of each procedural table is a list of operating conditions and control settings that apply to the entire table unless noted otherwise in the procedure of a given step. Step numbers on accompanying illustrations correspond to the procedural step numbers to which they relate.

In general, the same steps required for determining reference standards are repeated later by the ship's force in making routine checks for entry in the Maintenance Standards Books. The daily and weekly tests conducted by Radiomen include all items designated as routine or operational in the preventive maintenance checkoff list, plus increasingly technical items as your training and experience increase. The individual ship's electronics material officer determines which of the routine tests are done by the ETs.

The POMSEE program is being revised and incorporated into the Planned Maintenance System, which comprises maintenance of all types of equipment (hull, machinery, and the like). Main features of the present POMSEE program will be carried into the new program. Instead of employing Maintenance Standards Books, however, the System utilizes Maintenance Requirement Cards (MRCs) for the detailed guidance of personnel performing a specific preventive maintenance task on a particular item of equipment. Accompanying the MRCs are forms for scheduling the preventive maintenance and for recording the results. Descriptions of the MRCs and the various scheduling forms are contained in OpNav Instruction 4700.18.

EQUIPMENT TECHNICAL MANUAL

Two copies of the equipment technical manual are supplied with each new equipment. The technical manual contains the usual front matter (table of contents, for example), an index, and 6 sections entitled as follows: (1) General information, (2) Installation, (3) Operation, (4) Troubleshooting, (5) Maintenance, and (6) Parts list.

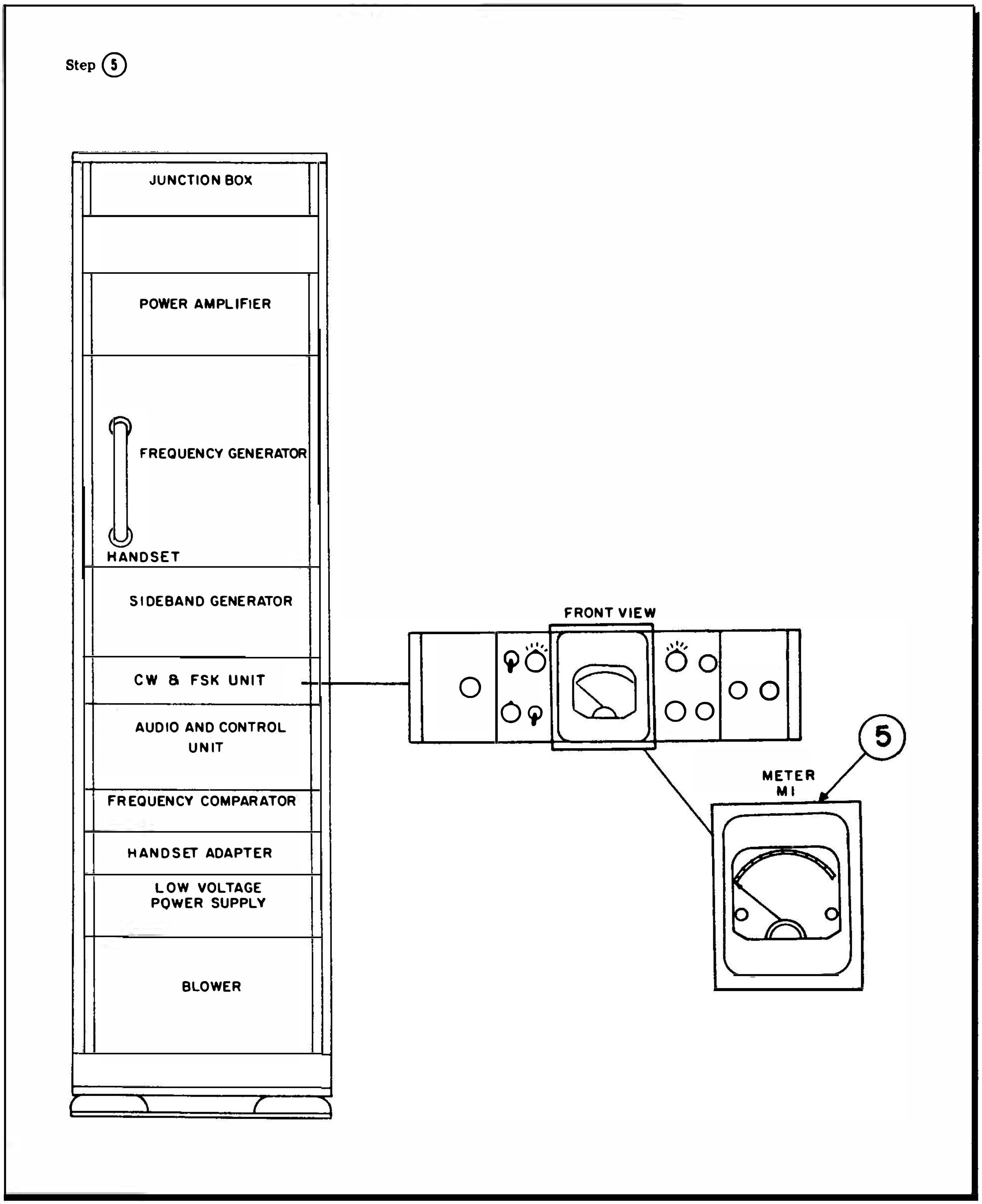
Section 3—Operation—is the section of most concern to you. It contains a description of the equipment's controls, tuning adjustments, and operating procedures. Always study this section before attempting to tune or operate any equipment with which you are unfamiliar. It also is a good idea to read section 1, which contains a general description of the equipment and its capabilities.

ELECTRONIC EQUIPMENT FAILURE/ REPLACEMENT REPORTS

It is extremely important that the Bureau of Ships be informed promptly of all failures and deficiencies of certain electronic equipment. The Bureau selects the equipment on which it desires reports, and publishes a list of the equipment in the Electronics Information Bulletin (EIB) NavShips 900,022A. Only the equipment so designated is reported on.

Electronic Equipment Failure/Replacement Report, BuShips 10550-1, DD 787 (proposed), is the form on which failures are reported. (See fig. 14-2). This report serves several excellent purposes. It (1) provides the Bureau with a comprehensive presentation of the overall performance of electronic gear, (2) points out the weakest parts of any particular equipment, and (3) forms the basis on which to procure repair parts. Because new models (or modifications of old models) usually are in some stage of development, prompt receipt of failure reports enables BuShips to initiate immediate corrective action to eliminate similar or related deficiencies in subsequent production.

The forms must be filled out in conformity with the instructions printed on the covers and flaps of each pad of forms. The instructions include the following types of information:



36.101(76)
Figure 14-1.—Opposing pages from URC-32 Maintenance Standards Book.

Step (5)

Operating Conditions and Control Settings:

Radio Set AN/URC-32 in full operation.

STEP		
NO.	ACTION REQUIRED	PROCEDURE
(5) O.M.	Record meter (M1) reading.	With the Radio Set AN/URC-32 in normal operation (CW, FSK, or phone) note the peak indication of VU meter (M1) on the CW and FSK Unit. Set range switch (S2) to USB TRANS. If that type of operation is in use record the reading. NOTE: When using meter (M1) on the CW and FSK Unit add range 0 dbm or +8 dbm to meter reading to give total in dbm.

Time Schedule: Record and initial.

1st Year of Operation

DAY	19___	19___	19___	19___	19___	19___	19___	19___	10___	19___	19___	19___
1												
2												
3												
4												
5												
6												
7												
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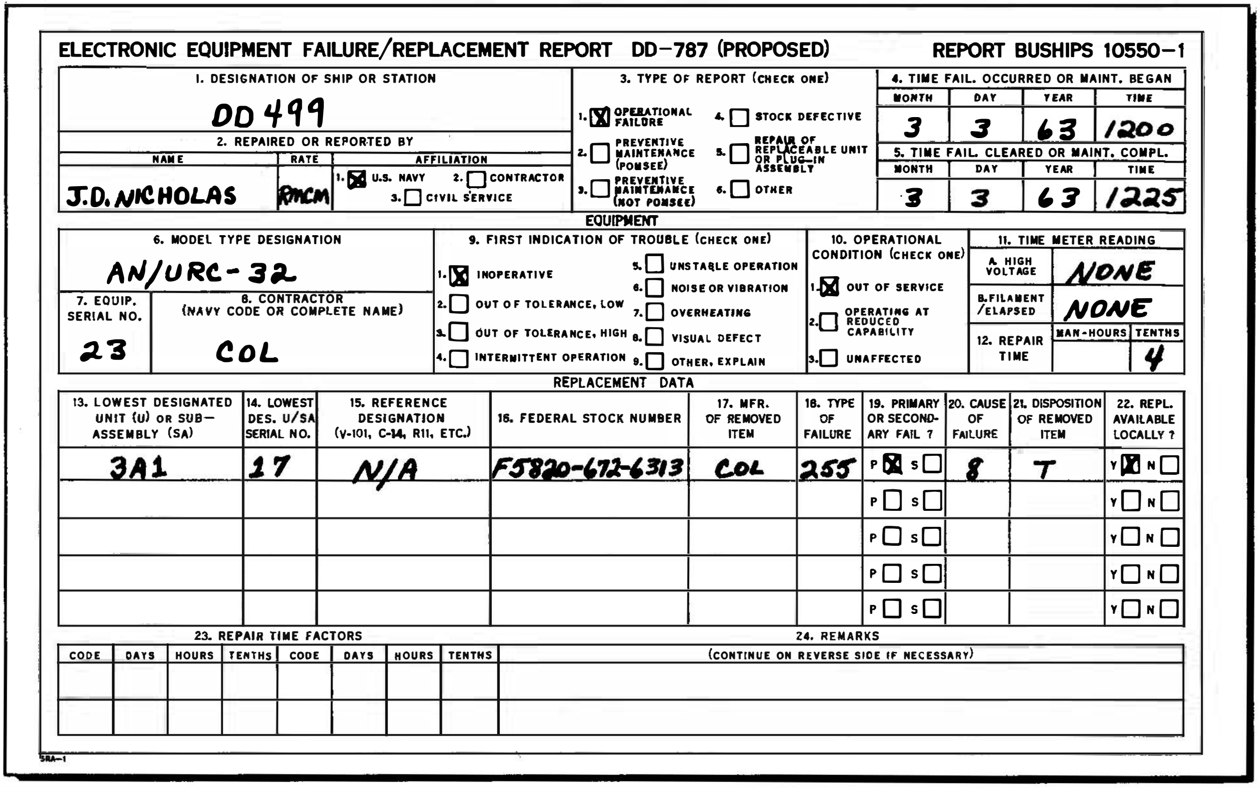
31												
Initial												

Figure 14-1. —Opposing pages from URC-32 Maintenance Standards Book—Continued.



ELECTRONIC EQUIPMENT FAILURE/REPLACEMENT REPORT DD-787 (PROPOSED) REPORT BUSHIPS 10550-1

1. DESIGNATION OF SHIP OR STATION: DD 499

2. REPAIRED OR REPORTED BY — NAME: J.D. NICHOLAS; RATE: RMCM; AFFILIATION: 1. [X] U.S. NAVY 2. [ ] CONTRACTOR 3. [ ] CIVIL SERVICE

3. TYPE OF REPORT (CHECK ONE): 1. [X] OPERATIONAL FAILURE 2. [ ] PREVENTIVE MAINTENANCE (POMSEE) 3. [ ] PREVENTIVE MAINTENANCE (NOT POMSEE) 4. [ ] STOCK DEFECTIVE 5. [ ] REPAIR OF REPLACEABLE UNIT OR PLUG-IN ASSEMBLY 6. [ ] OTHER

	MONTH	DAY	YEAR	TIME
4. TIME FAIL. OCCURRED OR MAINT. BEGAN	3	3	63	1200
5. TIME FAIL. CLEARED OR MAINT. COMPL.	3	3	63	1225

EQUIPMENT

6. MODEL TYPE DESIGNATION: AN/URC-32

7. EQUIP. SERIAL NO.: 23

8. CONTRACTOR (NAVY CODE OR COMPLETE NAME): COL

9. FIRST INDICATION OF TROUBLE (CHECK ONE): 1. [X] INOPERATIVE 2. [ ] OUT OF TOLERANCE, LOW 3. [ ] OUT OF TOLERANCE, HIGH 4. [ ] INTERMITTENT OPERATION 5. [ ] UNSTABLE OPERATION 6. [ ] NOISE OR VIBRATION 7. [ ] OVERHEATING 8. [ ] VISUAL DEFECT 9. [ ] OTHER, EXPLAIN

10. OPERATIONAL CONDITION (CHECK ONE): 1. [X] OUT OF SERVICE 2. [ ] OPERATING AT REDUCED CAPABILITY 3. [ ] UNAFFECTED

11. TIME METER READING: A. HIGH VOLTAGE: NONE; B. FILAMENT /ELAPSED: NONE

12. REPAIR TIME: MAN-HOURS: ; TENTHS: 4

REPLACEMENT DATA

13. LOWEST DESIGNATED UNIT (U) OR SUB-ASSEMBLY (SA)	14. LOWEST DES. U/SA SERIAL NO.	15. REFERENCE DESIGNATION (V-101, C-14, R11, ETC.)	16. FEDERAL STOCK NUMBER	17. MFR. OF REMOVED ITEM	18. TYPE OF FAILURE	19. PRIMARY OR SECONDARY FAIL ?	20. CAUSE OF FAILURE	21. DISPOSITION OF REMOVED ITEM	22. REPL. AVAILABLE LOCALLY ?
3A1	17	N/A	F5820-672-6313	COL	255	P [X] S [ ]	8	T	Y [X] N [ ]
						P [ ] S [ ]			Y [ ] N [ ]
						P [ ] S [ ]			Y [ ] N [ ]
						P [ ] S [ ]			Y [ ] N [ ]
						P [ ] S [ ]			Y [ ] N [ ]

23. REPAIR TIME FACTORS

CODE	DAYS	HOURS	TENTHS	CODE	DAYS	HOURS	TENTHS

24. REMARKS (CONTINUE ON REVERSE SIDE IF NECESSARY)

5RA-1

15.2

Figure 14-2.—Electronic Equipment Failure/Replacement Report (DD-787).

1. General instructions stating who is responsible for completing forms; what maintenance activities are covered; when, how, and why forms must be completed; and where forms are sent.
2. Lists of "type of failure" codes arranged for ease of use.
3. Explicit block-by-block instructions.
4. Sample completed forms.

The report forms are filled out in sets of three. The white original is submitted to BuShips; the yellow second copy is packaged with items forwarded to another activity for repair or analysis; and the pink third copy is retained by the originator.

Reports must be mailed promptly to the Bureau of Ships. No covering letter is necessary.

ELECTRONIC EQUIPMENT OPERATIONAL TIME LOGS

Another important source of equipment performance data is the Electronic Equipment Operational Time Log, NavShips 4855 (5-61), shown in figure 14-3. This log, maintained by the equipment operator, is a record of the periods of time an equipment actually is energized during a given month. At the end of each month, a copy of the log is forwarded to BuShips. There, it is used for evaluating equipment reliability and failure/replacement reports, and for other maintenance programing. It also keeps BuShips informed of the number of equipments actually in use.

Detailed instructions for completing and forwarding the Electronic Equipment Operational Time Logs are printed on the front and rear covers of each pad of forms. You can contribute toward better and more reliable equipment by carefully following these instructions.

Logs are required only for selected equipments, and these are listed periodically in the Electronics Information Bulletin.

TESTING ELECTRON TUBES

The leading cause of failure or poor operation of electronic equipment (transmitters as

ELECTRONIC EQUIPMENT OPERATIONAL TIME LOG
NAVSHIPS 4855(5-61)

SUBMIT MONTHLY FOR EACH APPLICABLE EQUIPMENT WHETHER IN USE OR NOT IN USE

1. MONTH	YEAR	2. DESIGNATION OF SHIP OR STATION
6	63	DD 499

3. EQUIPMENT MODEL TYPE DESIGNATION	4. EQUIP. SERIAL NO.
AN/URR-35	64

COMPLETE THIS SECTION IF EQUIPMENT HAS TIME METER(S)

READ DATA ON COVER	5. FILAMENT OR ELAPSED TIME METER READINGS		6. LEAVE BLANK	7. HIGH VOLTAGE (PLATE) TIME METER READINGS		8. LEAVE BLANK	9. NO. OF OPERATIONAL FAILURES THIS MO.
	1st DAY OF MO.	LAST DAY OF MO.		1st DAY OF MO.	LAST DAY OF MO.		

COMPLETE THIS SECTION IF EQUIPMENT DOES NOT HAVE TIME METER(S)

10. DAY OF MONTH	11. STANDBY		12. LEAVE BLANK	13. FULLY ENERGIZED		14. LEAVE BLANK	15. CHECK (✓) IF OPR. FAIL. OCCURRED
	TIME ON	TIME OFF		TIME ON	TIME OFF		
1	N/A			1500			
5					1800		✓
5				1900			
18					1427		

DO NOT WRITE BELOW THIS LINE — CONTINUE ON REVERSE SIDE IF NECESSARY

SRA-2

15.3

Figure 14-3.— Electronic Equipment Operational Time Log, NavShips 4855.

well as receivers) is the electron tube. If all tube failures could be eliminated, the maintenance load would be reduced considerably. Tubes do not always fail completely. Their performance may deteriorate gradually but not to the extent that it will be apparent in a tube tester.

One reason for the failure of the average tube tester to give a full indication of the capabilities of a tube is the 60-cycle sine wave that is applied to the grid of the tube under test. In electronic equipment, all kinds of waveshapes may be applied at frequencies varying from a few cycles to several billion cycles per second.

The usual shipboard tube tester cannot determine accurately the ability of a tube to act as an oscillator or as an ultrahigh frequency amplifier.

The practice of wholesale removal and test of electron tubes on a periodic basis is no longer authorized by the Bureau of Ships. Action is being taken to revise equipment technical manuals that specify such routine. If routine test of an electron tube in a designated application is necessary, the manual will specify an exception to the rule.

The following maintenance routine is strongly recommended:

1. When a performance deficiency is detected, make an attempt to isolate the specific cause.

2. When the trouble is localized and a tube is suspected, remove and test that tube. If found good, replace in the same socket. Interchange of tubes between sockets should be avoided.

3. If repair by tube substitution is necessary as a last resort, test the new tube (within the capability of the tube tester) before placing it in service.

4. If a new tube tests good but does not work in a particular socket, make a note about it, and save the tube for use in another application where it will work. The Bureau of Ships is particularly interested in receiving information in instances where extensive selection of tubes for a particular socket is necessary for proper operation.

MAINTAINING AIR FILTERS

The cleaning of air filters is exceedingly important for the proper operation of electronic equipment. The lack of proper servicing (cleaning or replacing) of air filters causes an enormous amount of trouble. For some reason (perhaps their importance is not fully recognized), air filters often are neglected or disregarded until excessive heating causes a breakdown of the equipment.

Forced air cooling is used in most modern transmitters, such as Models TED, AN/SRT-14, -15, and -16, AN/URT-7, and AN/GRC-27. Models AN/URR-13, -27, and -35 receivers, and AN/URA-8 converters also use forced air cooling, and this means moving a large volume of air over the hot portions of the equipment. The air is filtered to keep dust and other foreign particles out of the equipment. If the filters are efficient, they remove most of this foreign material from the air that passes through them. This dust and dirt tends to clog the filter and prevent the air from moving through. The result is that the equipment gets too hot and may be ruined.

An analysis of the failures of parts in electronic equipment indicates that the majority of failures can be traced to excessive heat caused by dirty air filters. This condition cannot be overemphasized; and on the basis of this alone, it would appear that the maintenance man can reduce his workload substantially by ensuring that air filters are serviced properly.

MAINTAINING HEADSETS AND MICROPHONES

The best way to maintain headsets and microphones is to ensure that they are handled properly. Proper handling includes, for example, hanging up earphones by the straps, not by the cord; removing a plug from a jack by grasping the plug, not the cord; avoiding kinks or other strains in the cord; avoiding rough handling of microphones and earphones, and avoiding exposure to moisture.

Repair consists largely of replacing or repairing plugs, jacks, and cords. In any event, do not place defective equipment with the ready spares. It should be repaired first.

MOTORS AND GENERATORS

Keep interior and exterior of motors and generators free of metal dust, dirt, oil, or water. Take particular care to prevent metal dust from collecting inside the end windings of the armature—that means both the coupling and commutator ends. Dirt, aside from restricting the air flow, is a heat insulator. An excessive accumulation eventually grounds the coils and burns them out.

Compressed air, if dry, is the most effective means of cleaning interior parts of motors and generators. The hand bellows is preferred to a pressure hose for there is less chance that small particles will be driven into the insulation. When cleaning a machine, take care not to crowd dirt into the air ducts or into narrow spaces between conducting parts. Carefully wipe and clean brush holders, studs, and leads to remove all traces of metal dust worn from the commutator. Also guard against accumulation of carbon dust from the brushes.

COMMUTATORS

The connection of the armature conductors to the individual commutator segments is made at the part of the segment referred to as the "riser." This connection is secured by hard solder or silver solder. Insulation of segments from each other and from the armature shaft and core is accomplished by thin sections of mica between each segment and between the segments and the clamps holding the segments to the shaft. The mica between the segments is cut to the same shape as the segments. That part of the mica directly under the brushes is cut below the surface of the commutator bars.

Commutators never should be lubricated. It is unnecessary for a commutator to present a bright, shiny appearance. During normal wear, a film develops on the commutator on the area spanned by the brushes. This film should show a dark brown or chocolate color. The film serves to lubricate the brushes and reduce the rate of wear. Therefore, it normally should not be disturbed.

Check for brush sparking as evidenced by rough and pitted commutator bars. Look for loose connections to the commutator risers. This condition may be indicated by specks of solder on the surrounding field coils and connections.

If the commutator is dirty, it must be cleaned. Remove the brushes, and pick up loose dirt with a vacuum cleaner, or blow it out with dry, compressed air, being careful not to blow it into the housing. Wipe out oil and grease with a lintless cloth moistened with cleaning solvent. Dirt can be removed from the commutator segments with canvas secured to a flat, thin stick and held in contact with the commutator. Rotate the shaft, moving the stick across the area of the commutator bars, applying a light, even pressure.

Oil and dirt tend to glaze the commutator surface with a high-resistance coating. If a high-resistance coating cannot be removed with the canvas stick, it can be removed with No. 0000 or finer sandpaper (not emery cloth) folded over a flat, thin stick to hold the sandpaper in contact with the commutator. Rotate the shaft slowly, moving the stick sideways to reach the entire width of the commutator bars. Do not hold the sandpaper in only one position, because this grooves the commutator. Use light, even pressure.

As the surface of the commutator gradually wears, the mica becomes flush with the brush surface of the segments. If this condition is not corrected by undercutting the mica, rapid brush wear results. Extreme care must be taken when undercutting, to prevent the cutting tool from leaving the slot and scoring the brush surface of the commutator. Also, great care must be exercised to avoid sharp edges on the commutator bars.

Excessive wear or grooving of the commutator is a serious trouble, requiring the services of qualified men in the electrical repair shop to redress the commutator.

BRUSHES

The following checks should be made when checking generator brushes and brush rigging. Remove any accumulation of dust and dirt from the brush rigging and surrounding parts by wiping with a clean, dry cloth. Dirt may form an electrical path and short out the generator. Look for cracks in the brush holder yoke and check for tightness. Check for loose brush holders and for security of jumper leads between holders of like polarity. Check to see that no brush holder is bent out of alignment. Check for broken brush springs. Move the brushes in and out of the holders to assure that they move freely. Brushes must move to maintain contact with the commutator as they wear; however, they should not be so loose that they can "chatter."

Visually inspect brushes for wear. Replace brushes when they wear down so that the brush spring or pressure arm comes within one-sixteenth inch of resting on the brush holder. If brushes wear beyond this point, sparking may occur and damage the commutator and rotor windings.

Check the brushes to see that they are not cracked or chipped. Check for pits caused by sparking. Also check for oil-soaked brushes. If the brush is oil-soaked, it must be replaced. Oil acts as an insulator, so that terminal voltage is lowered.

When replacing the original brushes, make certain that they are replaced in their original holders; otherwise, it may be necessary to refit the brushes. When new brushes are installed or old brushes are replaced after a commutator is dressed, it is necessary to fit or seat the brushes to the commutator before the machine is used. The best way to do this is to run the generator without excitation for at least one-half hour before placing into service. Use of sand paper or other abrasive to seat brushes is not recommended.

SLIPRINGS

The sliprings of a-c generators must be inspected periodically for smoothness of surface, diameter of the rings, and alignment of the rings on the shaft.

In routine maintenance of sliprings, cleaning and polishing are done by using canvas or No. 0000 sandpaper secured to a flat stick and held firmly against the sliprings as the shaft is turned. Never use emery cloth or coarse sandpaper. Emery cloth is a conductor and can cause shorts. Coarse sandpaper grooves the metal deeply. When the desired polish of the sliprings is achieved, remove all particles of dust and sand with dry, compressed air or a vacuum cleaner.

LUBRICATION OF MOTORS AND GENERATORS

You should be familiar with and be able to distinguish between grease-lubricated and permanently lubricated ball bearings.

The grease-lubricated type requires periodic lubrication with grease. The permanently lubricated type is sealed, has been lubricated by the manufacturer, and requires no additional lubrication throughout its life. Equipment furnished with sealed bearings can be recognized by the absence of grease fittings or provision for attaching grease fittings.

Cleanliness is of prime importance in avoiding ball bearing failure. Owing to the extremely high pressures and close fit between balls and races, even minute particles of dust may cause bearing failure. Dirt may be introduced into the bearing housing by careless handling, or by inclusion with the lubricant. Or it may work its way into the housing along the shaft.

Improper greasing procedures are a frequent cause of trouble in rotating electrical machinery provided with grease-lubricated ball bearings. The trouble in general is caused by an excessive quantity of grease being forced into the bearing housing. When grease is forced through the bearing seals and into the windings (or onto the commutator), deterioration of the insulation is a likely result. Excessive grease in the bearing housing itself results in churning, increased temperatures, rapid deterioration of the grease, and ultimate destruction of the bearing.

The stock numbers of grease for ball bearings are listed in chapter 60 of the <u>BuShips Technical Manual.</u> Machines that require special high-temperature silicone grease have a plate with the words "Use high temperature grease" attached near the grease fitting.

Motors and generators provided with bearings that should be lubricated with grease are installed with the grease cups removed from the bearing housings and replaced with pipe plugs. The grease cups are delivered with the onboard repair parts or special tools. BuShips instructions require that grease cups be attached to motors and generators only when the bearings are being greased. When the grease cup is removed from the bearing housing after a bearing is greased, the hole that remains must be plugged with a pipe plug. The grease cups should remain in the custody of maintenance personnel. Care should be taken to make sure that a grease cup is clean before it is used to add grease to a bearing and that the pipe plug used to replace the grease cup after greasing is also clean.

To avoid the troubles caused by an excessive amount of grease, grease should be added only when necessary; and, when grease is added, it should be done as follows:

1. Wipe outside of grease fittings and drain (relief) plug free of all dirt.
2. Remove bearing drain plug, and make sure the passage is open by probing with a clean screwdriver blade.
3. Remove pipe plug at top of bearing housing and install the bottom part of a clean grease cup.
4. Fill the bottom part of the grease cup with clean grease.
5. Put no more grease into the top part of the grease cup (the part that is to be screwed down) than will half fill it.
6. Screw the top part of the grease cup down as far as it will go.
7. Run the machine and let the grease run out of the drain hole until drainage stops (normally about 30 minutes). Remove grease cup and replace the pipe plug and the drain plug.

ANTENNA MAINTENANCE

The worst enemies of shipboard antenna installations are salt spray and soot. They cause corrosion that eats into the antennas, mounting brackets, and associated hardware. They also cover the installations with salt and soot deposits, which, if allowed to accumulate, may short the antennas to ground by providing a path for current flow across insulators.

Careless painting is another cause of trouble in antenna systems. Paint that has a metallic base is a good conductor of electricity, and if enough of this paint is smeared or spattered on an insulator, it will short the antenna in the same manner as salt and soot deposits.

Antenna maintenance is not complicated. It consists mainly of simple visual inspections for physical damage and resistance tests for leakage resistance or insulation breakdown.

VISUAL INSPECTIONS

At frequent intervals (usually during upkeep periods), lower all wire antennas to the deck and inspect them thoroughly for damage. Pay particular attention to points that are subjected to strain and chafing. These points are where supporting clamps attach to the antennas, and where the antennas connect to trunks or transmission lines. Insulators also are subjected to considerable strain and must be checked for cracks and other signs of deterioration.

While the antennas are down, they should be cleaned to remove salt and soot deposits. Uninsulated transmitting antennas are wire-brushed, whereas insulated-type receiving antennas are merely wiped clean with a cloth. (Insulator cleaning is discussed under a separate topic.) Take care not to nick or kink the antennas because this weakens them.

After each cleaning, antennas that are not covered with insulating material should be coated with a corrosion preventive compound. All antenna fittings, such as ringbolts, shackles, and turnbuckles, also should be coated with the compound. Hard-Film Corrosion Preventive and Gun Slushing Compound, Grade B are satisfactory compounds.

Whip antennas usually can be inspected without being lowered. Look for rust spots, loose mounting bolts, and loose or frayed connections. As with wire antennas, check all insulators for chips, cracks, and cleanliness.

Most whip antennas are hollow and may collect moisture inside, depending upon how they are mounted. This does not affect their efficiency, but it does contribute to their physical deterioration. To prevent whip antennas filling with water, drill a small drainage hole near their bases.

Maintenance of VHF and UHF antennas is complicated by their inaccessibility. It often is necessary to climb masts or stacks to inspect them properly for damage. For this reason, they sometimes are neglected until a major casualty occurs. These antennas are as susceptible to rust, loose mountings, and broken connections as are other antennas, and therefore must be inspected regularly.

Technical manuals for the various types of VHF/UHF antennas are available, and should be utilized when checking and maintaining these antennas.

RESISTANCE TESTS

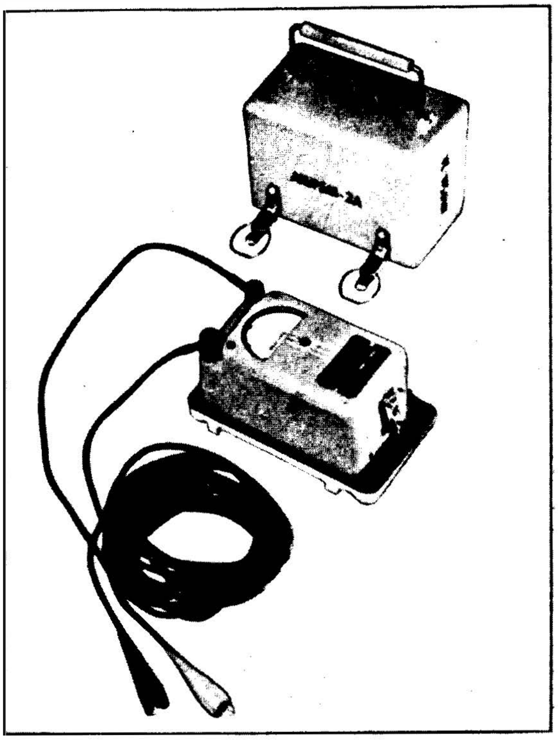
The most common fault in an antenna system is low resistance to ground. Moisture in trunks or coaxial lines, dirty insulators, and breakdown of insulation all cause varying degrees of shunting resistance. These faults must be guarded against if maximum efficiency is to be obtained.

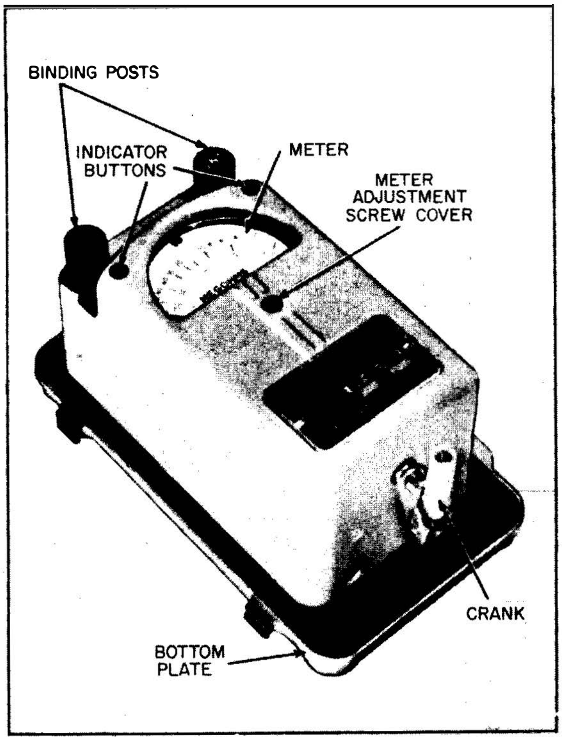
The megger is the test equipment commonly used for testing an antenna system. Essentially, the megger (fig. 14-4) is a hand-driven d-c generator and an ohmmeter combined. The ohmmeter measures the amount of resistance through which the generated current flows. The output of the megger should be approximately 500 volts. This voltage is sufficient to break down and reveal weak spots in the insulation if any exists. Chapter 12 of Basic Electricity (NavPers 10086-A) explains the megger in detail.

Before testing an antenna, the antenna should be inspected for intentional d-c shorts such as those in receiver protective devices. These protective devices, found in most general-purpose receiving antennas, usually consist of a fixed resistor of about 1/2 megohm connected from line to ground. This resistor protects the receiver by draining off any accumulated static charges on the antenna. To prevent a constant and misleading resistance reading from being obtained, the resistor must be disconnected before testing the antenna and transmission line.

After protective devices are disconnected from the antenna, proceed as follows:

1. Connect the ground lead of the megger to the hull of the ship (or other suitable ground).
2. Disconnect the transmission line at the equipment, and connect the high side (line





1.55
Figure 14-4.—The megger.

connection) of the megger to the inner conductor of the transmission line. (Do not connect the megger to the equipment at any time.)

3. Crank the handle of the megger until a steady reading is indicated on the ohmmeter. (Don't hesitate to crank the megger. It is equipped with friction clutches that slip when the rated output is exceeded.)

4. Record the resistance reading on the antenna's Resistance Test Record card.

Theoretically, an antenna and its transmission lines should read infinity on the megger, but it is impossible to obtain such a reading at all times. Abrupt changes in the weather, high humidity, or other natural causes often result in low readings. Any antenna indicating under 100 megohms to ground for several successive daily readings should be investigated. Insulation resistance may be raised in many instances by cleaning the insulators and couplings.

For insulation resistance, the following values are suggested:

1. A resistance of 200 megohms or more to ground indicates an antenna in good condition.

2. A resistance of from 5 to 100 megohms to ground indicates the need for cleaning the insulators.

3. A resistance of less than 5 megohms to ground indicates an excessive leak in the system. Immediate steps must be taken to locate the leak and restore the antenna system to its original condition.

The preceding values do not apply to VHF and UHF antenna systems that normally are short circuits to d-c voltages.

CLEANING INSULATORS

Antenna insulators have a glazed surface to which foreign material does not adhere readily, and which tends to wash clean during rainstorms. Although helpful, we cannot depend upon an occasional rain to keep insulators free of salt spray, soot, and dirt. For this reason, antenna insulators should be cleaned at least once a month, and more often when conditions warrant—such as after a prolonged period at sea.

Cleaning insulators is a simple process. Use a sharp knife and a small amount of paint thinner to remove any paint that may be on the insulators. Wash them with soap and water, and follow this with several rinsings with clean, fresh water. The insulators then should be polished with a dry, soft cloth to restore their glaze.

Although the cleaning is a simple process, the importance of doing a thorough job cannot be overstressed. Only one dirty insulator is needed to render an antenna useless.

PAINTING ANTENNAS

The main purpose of painting antennas and antenna hardware is to protect them against corrosion. If the paint is permitted to deteriorate, then its purpose is defeated and rust soon takes over. Usually, an occasional touchup job is all that is necessary to keep rust from getting the upper hand.

Isolated rust spots should be treated as follows: (1) wire-brush the spots to remove all rust and loose paint; (2) wipe the surrounding surfaces clean of all soot, salt, and dirt; (3) apply one coat of wash primer pretreatment (formula 117) to the bare metal surfaces; (4) apply one coat of zinc-chromate primer (formula 84) over the pretreatment paint; and (5) cover the preceding coats with not less than two coats of outside haze-gray No. 27 (formula 5H).

The foregoing procedure applies also when the extent of damage warrants complete repainting. When only the finish coat is damaged, and there is no sign of corrosion, a thorough cleaning and application of one or two coats of the outside haze-gray paint is sufficient to repair the damage.

Never paint an antenna with a metallic paint. Paint containing metallic flakes attenuates (weakens) electromagnetic energy. Along the same line of thought, never paint, varnish, shellac, or grease any insulating material forming a part of an antenna system—especially insulators. As pointed out previously, metallic paint provides a path for current flow across the insulating material, or attracts foreign substances.

TROUBLESHOOTING ELECTRONIC EQUIPMENT

Any troubleshooting job you are required to do should be performed in the following order:

1. Analyze the trouble.
2. Detect and isolate the fault.
3. Correct the fault and test your work.

In troubleshooting, as in most other matters, there is no substitute for commonsense. A mistake made by most beginners is to remove units from the equipment unnecessarily. The first thing to do is to determine if the equipment in question is actually faulty. Very often a preliminary check of the system discloses a faulty remote control box, frayed or broken wiring, and, in some instances, improper operating procedure—especially with new equipment. Occasionally, you will find an absence of power to the unit to be the cause of the trouble.

If there is an absence of power, you can assume temporarily that the set may be all right, and start checking the power source. The first and most important step is to check the condition of fuses and circuit breakers. Their condition determines your next move. If a circuit breaker is tripped or a fuse blown, power should be turned off immediately, because this indicates a circuit malfunction, and power should not be reapplied until the malfunction is corrected. If a short, ground, or overload condition is not indicated, continue to take power readings at the circuit checkpoints. The most common faults that interrupt power through a circuit are broken wiring, loose terminal or plug connections, faulty relays, and faulty switches. Be alert for these conditions when checking the successive points along a circuit.

Frequently, headsets or microphones are faulty. Assure yourself that the equipment in question actually is faulty before beginning any wholesale removal of components.

VISUAL INSPECTION

The visible condition of a unit is usually the first detail to check in any process of troubleshooting. If certain parts obviously are not in proper condition, correct these faults before going any further in your tests. Such conditions include parts burned, loose from mounting, disconnected, dented, or any other obviously improper condition.

Crude as it may seem, your nose can be a good pinpointing device for certain troubles. A part that overheats usually gives off an odor that is readily detectable, and sometimes can be located by the combined use of eyes and nose only. Of course, location of a burned part does not necessarily reveal the cause of the trouble.

In determining the cause of the trouble, it usually is necessary to refer to the equipment technical manuals. These manuals will be your constant reference when performing maintenance on electronic equipment.

The technical manual for a particular piece of equipment contains a detailed explanation of the theory of operation of each circuit in the unit. Also it has innumerable block diagrams, wiring diagrams, and schematic drawings of each circuit. It gives the location of test points and the readings that should be found on them, and it shows what voltage, resistance, and (sometimes) what waveshapes appear on each pin of every vacuum tube. The technical manual also contains directions for troubleshooting.

SIGNAL TRACING

The following procedure is given for tracing signals in communication receivers and audio amplifiers. This general procedure, with modifications, can be applied to most electronic troubleshooting.

Signal tracing is a very effective method for locating defective stages in many types of electronic equipment. It is especially useful when servicing communication receivers, audio amplifiers, and other equipments that normally contain no built-in meters. In signal tracing, a signal voltage similar to that present under operating conditions is taken from a signal generator and then is applied to the input of the circuit in question. The signals that result from this application then are checked at various points in the stage, using test instruments such as voltmeters, oscilloscopes, output meters, or other appropriate devices.

By signal tracing methods, the gain or loss of amplifiers can be measured. In the same way the points of origin of distortion and hum, noise, oscillation, or any abnormal effect can be localized.

The gain measurement can be used as an example of an important method in signal tracing. By this procedure, a defective stage can be found quickly in a radio receiver or audio amplifier. A signal generator (with the output attenuator calibrated in microvolts) and an output meter are used. It is helpful to have data concerning the normal gain of the various stages of the device. These data are found in the equipment technical manual for the receiver under test.

The output meter may be connected across the voice coil of the speaker or across the primary of the output transformer. The output of the signal generator is applied to the grid circuit of the stage under test. Then the attenuator of the signal generator is adjusted until the output meter reads an appropriate value that will serve as a reference figure. The output of the signal generator then is applied to the output of the stage under test (or to the grid of the next stage), and the attenuator is adjusted until the same reference value is again registered on the output meter. The gain of the stage is found by dividing the second value of the signal (taken from the calibrated attenuator) by the value of the signal applied to the input of the stage.

As an example, suppose the signal generator applies a voltage of 400 microvolts to the grid of an i-f amplifier. This voltage causes the output meter to indicate some value to be used as a reference. When the generator signal is applied to the following grid, the signal strength must be increased to 4000 microvolts to cause the output meter to indicate the same reference value. The gain of the stage is 4000 divided by 400, or 10.

If similar measurements made in the remaining stages of the receiver reveal one in which the gain is lower than normal, or is zero, that stage can be thoroughly checked by voltage measurement, by resistance measurement, or by simple replacement of parts until the defective one is found.

When making stage gain measurements in receivers, the value of the applied signals must be low enough to prevent the automatic volume control system from functioning; otherwise, the measurements are inaccurate. In equipment technical manuals, the recommended signal values usually are stated in terms of the reference value to be used at the output meter.

VOLTAGE CHECKS

Voltage measurements are made at various points in the stage suspected of being at fault, and the observed voltage values then are compared with the normal voltage values given in the equipment technical manual. From this comparison, the defect often can be isolated. Voltage checks are most effective when applied within a single stage, and after previous checks are made to localize the defect partially. This is true because modern electronic equipment is complex, and a great deal of time is required to check all the voltages present in all the stages.

Some electronic equipments have built-in meters or plugs for front panel application of meters. These meters usually work in conjunction with a selector switch, and read values of voltage or current at designated points. A defective stage very often can be isolated in this manner.

When the defective stage is isolated, it becomes a matter of point-to-point checking to isolate the fault within the stage itself. A voltmeter pinpoints the trouble, but it often becomes necessary to use an ohmmeter to determine the exact cause of trouble, such as shorted capacitors, open resistors or transformers, or wires grounded to chassis.

RESISTANCE CHECKS

The method of making resistance checks is similar to voltage checking except that the power is removed from the set and resistance values are measured with an ohmmeter. The resistance values then are compared with the normal values given in the technical manual. This method, like voltage measurement, is used most effectively after the trouble is isolated to a particular stage, because reliance on resistance measurement alone is too time-consuming to be efficient. After the trouble is isolated, the ohmmeter is a useful instrument and often quickly leads the troubleshooter to the cause of the trouble.

A typical example of a routine resistance check applied to a single part is the ohmmeter method of checking electrolytic capacitors. A resistance measurement is made on the discharged capacitor, using the high-resistance range of the ohmmeter. When the ohmmeter leads are first applied across the capacitor, the meter pointer rises quickly and then drops back to indicate a high resistance. Then the test leads are reversed and reapplied. The meter pointer should rise again—even higher than before—and again drop to a high value of resistance. The deflections of the meter are caused when the capacitor is charged by the battery of the ohmmeter. When the leads are reversed, the voltage in the capacitor adds to the applied voltage, resulting in a greater deflection than at first.

If the capacitor is open-circuited, no deflection is noted. If the capacitor is short-circuited, the ohmmeter indicates zero ohms. The resistance values registered in the normal electrolytic capacitor result from leakage being present between the electrodes. Because the electrolytic capacitor is a polarized device, the resistance is greater in one direction than the other.

Should a capacitor indicate a short circuit, one end of it must be disconnected from the circuit, then another resistance reading is made to determine if the capacitor actually is at fault.

Unless your ohmmeter has a very high resistance scale, you will not see a deflection of the meter when checking small capacitors. Even a scale of R x 10, 000 is insufficient for very small ones: the smaller the capacity the less leakage across the plates, therefore more resistance.

When making resistance checks, be sure to determine what circuits are connected to the points where the checks are made. The equipment technical manual indicates what resistance should be found at various checkpoints throughout the set, and contains a complete schematic diagram of the set as well as a circuit schematic of the stage under test. The schematics may set up conditions under which voltage and resistance measurements are to be made, such as positions of switches and control knobs, relays energized or deenergized, tube in socket, and so forth. These conditions duplicate the conditions under which the measurements first were made. A typical condition might be: "Power switch off--all controls fully CCW (counterclockwise.)" It is important that you follow these instructions to obtain accurate values to compare with specified values. Otherwise, incorrect values may be obtained.

SOLDERING

New designs and new techniques in the manufacture of electronic equipment require that some of the old standards be revised. Among the new techniques are methods of soldering special parts, such as transistors and crystal diodes. Unless a heat shunt is used, these conductors cannot safely withstand the heat that even the pencil-type soldering irons must produce to melt the solder that connects them in a circuit.

Another change that new design dictates is the method of soldering wires or parts to terminal posts or connectors. The discussion that follows sets forth the recommended soldering procedures developed by the Navy Electronics Laboratory.

SOLDERING SEMICONDUCTORS

Much new circuit design is based on the use of semiconductors. Although some devices operate safely at high temperatures, the majority of transistors and crystal diodes are particularly sensitive to temperature.

For the most part, transistors are mounted in sockets. They should be removed from the sockets before any soldering of the socket terminals takes place. Some transistors and most crystal diodes in printed circuits are soldered directly in place. In these instances, it is best to use a heat shunt clipped on the lead being soldered, between the joint and the transistor, diode, or resistor, to dissipate the excess heat. Pointed nose pliers can be used for the heat shunt. Better still are surgical hemostats, which can be clamped in place, eliminating the need for continuous holding by hand. (Hemostats may be obtained from the sick bay or hospital when they no longer are usable for surgical purposes. You will find them an invaluable addition to your toolbox.)

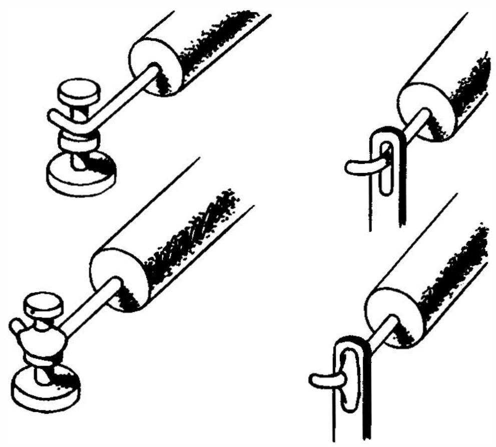
STRENGTH OF SOLDERED CONNECTIONS

For years, the various radio and electronics handbooks have emphasized the necessity of wrapping wires tightly around terminals before soldering. This practice is required by Federal specifications, but efforts are now being made to revise the requirements in the light of recent investigations on solder strength.

The Navy Electronics Laboratory tested many standard capacitors and resistors soldered to terminals of various types. These devices were subjected to vibrations far in excess of those encountered in military ships, aircraft, and armored vehicles. Although the connections deliberately were made with no wrapping of wires around terminals, but instead with reliance for support placed in the soldered joint, there were no failures. Similar tests, with equally encouraging results, were made by a number of commercial electronic firms.

The advantages to be gained from using connections that depend on solder for strength are: ease of assembly; ease of removal for test or replacement; less chance of poor soldering (lack of solder in joints or rosin joints), because faulty soldering is detected more readily by visual or electrical inspection methods than when the wire is wrapped before soldering; less heat required in soldering and unsoldering; and less strain on parts because their leads do not get as much pulling and twisting as with the conventional wrapping technique.

Recommendations have been made to revise Federal specifications to require that small parts be connected with no more than one-half turn of wire around the terminal, followed by a simple and neat soldering job. (See fig. 14-5.)



76.39

Figure 14-5.—Soldering method recommended by Navy Electronics Laboratory.

TEMPERATURE OF SOLDERING IRONS

All high-quality irons operate in the temperature range of 500° to 600° F. Even the little 25-watt midget irons produce this temperature. The important difference in iron sizes is not temperature, but the capacity of the iron to generate and maintain a satisfactory soldering temperature while giving up heat to the joint to be soldered. Naturally you would not try to solder a heavy metal box with the 25-watt iron. But you would find that iron quite suitable for replacing a small resistor in a small resistor in a printed circuit. A 150-watt iron is satisfactory for use on a printed circuit, provided proper soldering techniques are used. One advantage of using a small iron for small work is that it is light and easy to handle and has a small tip that is inserted easily into close places. Also, even though its temperature is high, it does not have the capacity to transfer large quantities of heat.

One type of iron is equipped with several different tips that range from 1/4 inch to 1/2 inch (diameter) in size and are of various shapes. This feature makes it adaptable to a variety of jobs. Unlike most tips that are held in place by setscrews, these tips are threaded and screw into the barrel. This feature provides excellent contact with the heating element, thus improving heat transfer efficiency. A pad of antifreeze compound is supplied with each iron. This compound is applied to the threads each time a tip is installed in the iron, thereby enabling the tip to be removed easily when another is to be inserted.

A special feature of this iron is the soldering pot that screws in like a tip and holds about a thimbleful of solder. It is useful for tinning the ends of large numbers of wires.

SOLDERING GUN

Because it heats fast and cools fast, the soldering gun has gained great popularity in recent years. It is especially well adapted to maintenance and troubleshooting work where only a small part of your time is spent actually soldering. A continuously hot iron oxidizes rapidly and is difficult to keep clean.

A transformer in the gun supplies about 1 volt at high current to a loop of copper that serves as the tip. It heats to soldering temperature in 3 to 5 seconds, but heats to as high as 1000° F. if left on longer than 30 seconds. Because it operates for relatively short periods of time, very little oxidation is allowed to form. Thus, it is one of the easiest soldering tools to keep well tinned. On the other hand, this tip is made of pure copper with no plating, so pitting can occur easily as a result of the dissolving action of the solder. Offsetting this disadvantage, however, is the low cost of replacement tips--about 13 cents.

If delicate wires or printed circuits are to be soldered with a gun, remember that overheating can occur easily. With practice, heat can be controlled accurately by pulsing the gun on and off with its trigger switch. For most jobs, even the LOW position of the trigger overheats the tip after 10 seconds. The HIGH position is only for fast heating and for soldering to especially large terminals.

REPAIRING PRINTED CIRCUITS

Printed circuits are appearing more and more in electronic equipment. They have proven to be equal in operation to conventional-type construction, with savings in space and weight, as well as economy of manufacture. A few simple machine operations automatically produce circuits that formerly required a production line of workers performing the same jobs by hand.

Even printed components or parts are no longer unusual, the most common being resistors and capacitors. Printed components have not yet gained wide or extensive use, hence this discussion is confined to printed circuits and methods of repairing them.

One method of manufacturing a printed circuit is the photoetching process. A plastic or phenolic sheet with a thin layer of copper coating is used. The copper coating is covered with a light-sensitive enamel, and a template of the circuit that ultimately will appear on the plastic sheet is placed over it. The entire sheet is then exposed to light. The area of the copper that is exposed reacts to the light. This area then is removed by an etching process. The exposure of the printed circuit is similar to a photographic exposure. The enamel on the unexposed circuit protects the unexposed copper from the etching bath that removes the exposed copper. After the etching bath, the enamel is removed from the printed circuit. This leaves the surfaces in a condition for soldering parts and connections.

Some manufacturers use machinery to mount standard parts like capacitors, resistors, and tube sockets, further speeding manufacture. Circuits thus produced operate as well as conventional circuits and are repaired as easily.

Should a printed circuit become broken, it is repaired easily by placing a short length of bare wire across the break and soldering both ends to the print. If the break is small, simply flow solder across it. When performing these operations, do not apply too much heat, and do not permit solder to flow to other printed areas. The soldering gun, if used properly, is an excellent device for making these repairs because it affords constant and instantaneous control of the heat of the tip. If a conventional soldering iron must be used (one larger than a "pencil" iron), it is advisable to wrap a length of heavy copper wire around the tip of the iron and let one end of the wire extend as the soldering tip. This procedure reduces the size of the tip, and therefore the heat transfer.

Many maintenance men think that printed circuits are very delicate and cannot be heated without danger of burning the baseboard or causing the conducting strips to separate. This attitude stems from lack of experience in soldering printed circuits. It is true that both of these conditions can happen, but with a little care and commonsense, satisfactory repairs can be made to any printed circuit. In most instances, repairs can be made as easily as in conventional assemblies.

The phenolic boards used for printed circuits are similar to the phenolic strips for conventional terminal strips and mounting boards. There has been no difficulty in soldering to the metal connectors on these terminal strips and mounting boards, so there should be none in soldering printed circuits. In rare instances, where excessive heat causes separation of printed conductors from the phenolic board, repairs can be made by using jumper wires.

Parts such as resistors and small capacitors are removed most conveniently if first cut free of their leads. Much less heat is required to remove a part if the leads are free. Where it is inconvenient to remove a board for access to the wiring side, it usually is possible to cut the leads of small resistors and capacitors so that a small portion of the lead is exposed. The new part then can be soldered to the old leads.

Should it become necessary to remove a tube socket or any other part that requires simultaneous movement of several soldered connections, the following procedure should be observed:

1. Remove all excess solder from each connection with a soldering iron or soldering gun.

2. While heating a connection, use a scribe or other pointed instrument to scrape away remaining solder.

CAUTION: Do not "rock" or pry the part to loosen solder. "Rocking" can damage the printed circuit.

3. When all connections are free, simply lift the part from the board.

When a part is removed from a printed circuit board, the holes left in the board should be cleaned of excess solder before the new part is installed. A small fiber glass brush is useful for brushing away the excess solder while it still is soft.

A metal probe, slotted at one end and pointed at the other, is useful in manipulating wires and lugs on parts to be removed from printed wiring boards. These devices, known as soldering aids, are made of chrome plated steel to which solder does not adhere readily. They are also quite useful for handling wires to be soldered in conventional circuits.

Some printed circuit boards are coated with lacquer that must be removed before repairs can be made. Acetone or lacquer thinners are satisfactory solvents. New lacquer should be painted on the board after the repairs are completed.

CLEANING ELECTRONIC EQUIPMENT

All electronic equipment should be cleaned, not just for appearance, but to assure good performance. Be sure to secure the power to the equipment before starting any kind of cleaning. The safest and best method of cleaning inside transmitters and receivers is to use a vacuum cleaner with a nonmetallic hose. A small typewriter brush is handy for getting dust out of congested areas where the vacuum cleaner will not reach. A hand bellows can be used for blowing out dust particles, but is not as satisfactory as the vacuum cleaner because of the likelihood of blowing dust into inaccessible spaces where it is harder to remove.

During routine transmitter cleaning periods, the contacts of rotating inductors should be checked, as well as the surface of these parts. Poor operation of these contacts is disclosed sometimes by erratic "jumping" of the plate current meters as the circuit is tuned through resonance. The contacts and the surface of the inductors must be clean and smooth. If necessary to prevent scoring the copper surface, a tiny amount of vaseline may be applied.

Steel wool or emery in any form must not be used on electronic equipment. Sandpaper and files are to be used only on competent advice, or not at all.

Uses of solvents and their necessary safety precautions were discussed in chapter 13.

TELETYPEWRITERS

The most important consideration in maintenance of teletypewriter equipment is proper lubrication and cleaning of the machines. Lubrication does not mean drenching the teletypewriter with oil or swabbing it with grease. Too much lubricant will, in a short time, collect dust and grit and oil-soak the wiring. A machine in this condition will be subjected to excessive wear and deterioration of insulation. Such machines are a fire hazard as well as a source of constant trouble.

It is important that you understand your cleaning and lubricating responsibilities. On most shore stations the operators are not required to clean or lubricate equipment. These duties are assigned to the station's maintenance force. On small stations or on some ships, however, it may be necessary for the operator to clean and lubricate. You should not attempt the job alone until you have done it several times under supervision of an experienced hand. Even so, be sure to consult references that give exact lubrication specifications.

Before beginning to clean or lubricate a machine, be sure that you remember: ALWAYS DISCONNECT THE POWER.

At this point, you must consult the equipment technical manual for instructions in disassembling the equipment into its major units (such as removing the printing unit from its base).

After you have the equipment broken down, begin by wiping all old grease, oil, and dirt from the machine. Use a clean, dry piece of cheesecloth or other lint-free cloth for wiping. The cloth may be wrapped around a screwdriver or stick to reach points not readily accessible. Take care not to disturb springs or adjustments. Troubles frequently develop as a result of careless cleaning.

If a cleaner (solvent) is used to remove hardened grease, be sure that any unit on which you use it is not allowed to stand more than 1 hour before grease or oil is applied to the cleaned surfaces. A good cleaning mixture is kerosene and SAE-10 oil. This mixture leaves a rust-preventing residue of light oil on the metal. NEVER use a paraffin base oil, for it leaves the parts gummy and results in sluggish action of moving parts.

To clean the type on model 15 and 19 machines, insert a doubled piece of cheesecloth between the type bars and backstops to catch dirt and excess cleaning fluid. Clean the type thoroughly with a piece of cheesecloth moistened with Varsol or patented type cleaner. Use the cleaning fluid sparingly to avoid getting it on other parts of the machine. Then brush the type with a dry typewriter brush.

Do not use cleaning fluid on the model 28 type box. Remove the type box from the machine and clean the type with a dry typewriter brush or soft cloth. Should it be necessary to disassemble the type box, be careful not to lose the small springs that are inside the box.

Clean key caps with a cloth slightly moistened with water. Do not use solvent on key caps.

After a thorough cleaning, the equipment is ready for lubrication. Here, again, you will have to consult the technical manual for explicit instructions on points to lubricate and the type and quantity of lubricant to use.

In general, Teletype KS-7470 oil and type MIL-C-3278 grease are used to lubricate teletypewriter equipment. The grease is applied to wearing surfaces, gears, and heavy moving parts, and the oil is applied to bearings and small moving parts. All springs, wicks, and felt washers must be saturated thoroughly in oil.

When lubricating, exercise special caution to prevent any oil or grease from getting between the armatures and the pole pieces of the magnets. Electrical contacts must be kept free of oil.

A teletypewriter must be lubricated more frequently as the operating speed increases. Thus, a machine geared for an operating speed of 100 wpm requires lubrication oftener than one operating at 60 wpm. Here is the recommended lubrication schedule:

Operating Speed (words per minute)	Lubricating Interval (whichever occurs first)
60	3000 hours or 1 year
75	2400 hours or 9 months
100	1500 hours or 6 months

Regarding the lubricating interval, an important point to remember is the expression "whichever occurs first." To illustrate, a machine in continuous use at 100 wpm accumulates 1500 operating hours in only 2 months. For machines used occasionally or intermittently, you need a log to keep track of the total operating hours. The Electronic Equipment Operational Time Log (NavShips 4855), described and illustrated earlier in this chapter, is for this purpose.

TYPEWRITERS

A typewriter that is used with care will give many years of service. Typewriter manufacturers claim that the modern typewriter never really wears out if it is not dropped or otherwise abused. The fact is that with ordinary careful use, and with regular cleaning and adjustment, typewriters can be counted on for about 10 years of satisfactory service.

A typewriter should be brushed out by the operator at the end of each day. Type should be cleaned often with one of the various cleaners available for the purpose. Nothing looks worse than messages written up for delivery with the letters o and e filled up because dirt in the characters is printing through the ribbon. Any commercial type cleaner procured by the Navy is satisfactory. Put out your cigarette before you start.

Eraser waste must be cleaned away often if the typewriter is to stay in good condition. It can be removed with a long-handled brush. The best way to prevent accumulation of rubber crumbs is to move the carriage far enough to left or right that the point of erasure is not over keys or other mechanical parts of the typewriter. The waste then will drop on your desk from where it can be brushed away.

The cylinder and rollers should be cleaned occasionally with alcohol. This prevents their leaving streaks of dirt on paper inserted in the typewriter. In this connection, it is best to use only one typewriter in the office for cutting and correcting stencils; otherwise the rollers of all your typewriters will become coated with wax from the stencils.

The typewriter should be oiled occasionally, but do it carefully. Apply oil only at friction points, and don't use too much. When finished, wipe away excess oil; otherwise, it will drip on other parts and in time form a gummy mass with dust and eraser crumbs. Keep oil from getting on rubber parts, the ribbon, and any place in the machine where it might stain the paper.

Keep your typewriter covered when not in use. No matter how clean the office, a certain amount of dust is always in the air. When the machine is uncovered for long periods, dirt gets into the moving parts of your machine and causes wear.

FREQUENCY MEASUREMENTS

It is very important to keep Navy transmitters on their assigned frequencies. To aid you in keeping the transmitters within the frequency tolerances, the Navy provides each ship and station with accurate frequency meters. Of course, the frequency meter is of little value unless it is calibrated accurately against the primary frequency standard.

The primary frequency standard is supplied by the National Bureau of Standards through its radio stations WWV at Boulder, Colorado, and WWVH on the island of Maui, Hawaii.

DNC 5 requires that frequency meters be checked against radio stations WWV or WWVH at least once weekly and a log kept of the checks conducted. You must consult the equipment technical manual for your particular model frequency meter for instructions on adjusting the frequency to coincide with the primary standard.

RADIO STATION WWV

The technical radio services broadcast by radio station WWV include:

1. Standard radiofrequencies. Six frequencies are broadcast continuously, day and night—2.5, 5, 10, 15, 20, and 25 mc.
2. Time announcements.
3. Standard time intervals.
4. Two standard audiofrequencies, 440 and 600 cycles per second, alternated each 5 minutes.
5. Radio propagation disturbance warning notices for the North Atlantic area.

Standard Radiofrequencies

Any desired radiofrequency may be measured accurately in terms of the standard frequencies, which are accurate to better than 1 part in 100,000,000. Any of the 6 radiofrequencies can be used for checking your frequency meters.

Time Announcements and Standard Time Intervals

When you tune in WWV you will hear the audiofrequency of 440 or 600 cycles as a steady tone. Superimposed on the tone is a series of clocklike ticks. You can determine time and intervals of time to the finest degree through (1) regular interruptions of the audiofrequency, (2) regular interruptions of the ticking, and (3) Morse code and voice time announcements.

The audiofrequencies are interrupted at exactly 2 minutes before the hour and resumed exactly on the hour and each 5 minutes thereafter. Each 5-minute period therefore consists of 3 minutes of tone and 2 minutes of no tone around the clock. You can see that, by listening, an operator is given exact time intervals of 2 minutes, 3 minutes, and 5 minutes.

The time in GMT is broadcast in telegraphic code each 5 minutes, and is followed by a voice announcement of the eastern standard time. These transmissions are made near the end of the 2-minute period when the audiofrequency is off, and refer to the time it will be when the audiofrequency, or tone, returns. For example, just before 1655Z, or 11:55 a.m. eastern standard time, you will hear 1655 in Morse code followed by a voice: "This is radio station WWV; when the tone returns it will be 11:55 a.m. eastern standard time; 11:55 a.m." If you were correcting the message center clock, you would preset hour, minute, and second hands to exactly 1655 while the announcements were going on; you would start the clock the instant the tone resumed.

The ticking is a pulse on the carrier frequency of 0.005-second duration, which occurs at intervals of precisely 1 second. "Time ticks" are used by Quartermasters in determining the rate of gain (or loss) of the ship's chronometers. The Radioman's duties in this regard are limited to tuning the receiver and making the switchboard connections that pipe the sound to earphones in the charthouse.

Standard Audiofrequencies

The two standard audiofrequencies of 440 and 600 cycles per second are of no particular interest to the Radioman. Other users of the technical broadcast services find them useful for accurate measurement or calibration of instruments operating in the audio or supersonic regions of the frequency spectrum.

Radio Propagation Disturbance Warnings

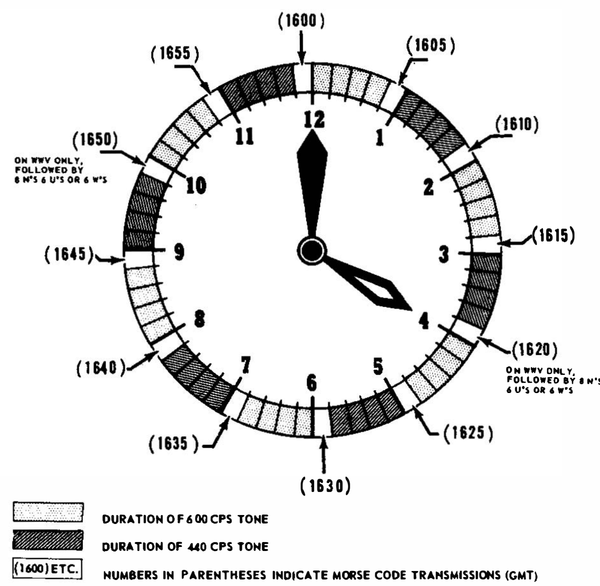
Radio propagation disturbance warnings are notices that tell users of radio transmission paths over the North Atlantic the condition of the ionosphere at the time of the announcement, and also how good or how bad communication conditions are expected to be for the next 12 hours. They are prepared four times daily and are sent at 19.5 and 49.5 minutes past the hour. Report of current conditions is made by one of the letters N, U, and W, signifying normal, unsettled, or disturbed, respectively. A digit is the forecast of expected quality of transmitting conditions on a scale of 1 (impossible) to 9 (excellent), as in the accompanying table.

Digit (forecast)	Propagation condition	Letter (current)
1	Impossible	W
2	Very poor	W
3	Poor	W
4	Fair to poor	W
5	Fair	U
6	Fair to good	N
7	Good	N
8	Very good	N
9	Excellent	N

If, for example, propagation conditions at time of forecast are normal, but are expected to be only "fair to poor" within the next 12 hours, the forecast notice would be broadcast as N4 in Morse code, sent five times: N4 N4 N4 N4 N4.

RADIO STATION WWVH

Station WWVH, on the island of Maui, Hawaii, is WWVs sister station serving the Pacific.



76.40

Figure 14-6.— Structure of WWV and WWVH signals.

Station WWVH broadcasts on three radiofrequencies—5, 10, and 15 mc. Reports indicate that station WWVH may be usefully received at many locations not served by station WWV and that simultaneous reception of WWV and WWVH does not interfere with ordinary use of the standard frequencies and time signals. Except for propagation warnings, services are the same as those offered by WWV, but schedules are somewhat different. Further information about both stations may be found in Radio Navigational Aids, H. O. Pubs. 117A and 117B.

Figure 14-6 shows the structure of WWV and WWVH signals.

OTHER STATIONS

Many of the Navy radio stations rebroadcast the signals of WWV. In addition, radio stations in several other countries broadcast signals comparable to those broadcast by WWV and WWVH. The system employed by the foreign stations may differ somewhat from that of the United States, but usually you can obtain time signals from them without too much difficulty.

A complete list of all stations broadcasting time signals, the time of broadcasting, and the system employed by each are contained in H. O. Pubs. 117A and 117B.