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BUSHIPS Electron

A MONTHLY MAGAZINE FOR ELECTRONICS TECHNICIANS

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

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Navy Department
Washington 25, D. C.

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

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BUREAU OF SHIPS — NAVY DEPARTMENT

Figure 1—*Front view of the size "A" Signal Distribution Unit.*

SIGNAL DISTRIBUTION UNIT

■ A Signal Distribution Unit has been developed to permit the standardization of components, methods of installation and wiring practice in both a-f and r-f distribution of signal energy and still provide the maximum in operational flexibility of all circuits when installed. This Signal Distribution Unit was designed with the intention of standardizing the distribution systems at Naval shore radio receiving stations with particular emphasis on the standardization of components. The design provides standardization of signal distribution methods from all types of antennas in current use, including r-f distribution to receivers and a-f distribution to load and signal circuits.

The Signal Distribution Unit is available in three sizes—"A," "B" and "C." The size "A" unit (see figure 1) is for use at large stations and can accommodate thirty-three antennas and thirty-three receivers. The size "B" unit is for use at medium-sized stations and can accommodate twenty-two antennas and receivers. The size "C" unit is for use at small stations and can accommodate eleven antennas and receivers. Provision is made for expansion of the Signal Distribution Unit to suit the varying needs of the different stations by addition of standard individual components, soon to be made available in Naval stocks. These components may be obtained upon submission of request and justification to the Bureau of Ships, Attention Code 976.

In addition to providing for expansion, the feature of interchangeability of components is also included. All components are constructed to mount in any standard 19-inch relay rack cabinet and can be arranged to suit the needs of the station. As part of the units, three Type CY-597/G cabinets are furnished with each "A" unit, two with each "B" unit and one with each "C" unit, for mounting components. A "normalling-through" wiring scheme for both r-f and a-f has been followed in order to reduce the amount of external patchcord "patching" required. When properly installed, patching should be necessary only when departing from normal routine.

One component of the signal distribution system is the Type SA-137/G antenna comparison switch. This switch when connected to an array of antennas allows rapid determination of the best antenna to employ for reception of a given signal, or of the rough azimuth bearing of a given signal or intense noise source, provided the directional antenna coverage is sufficiently large and the transmission lines introduce approximately equal attenuation. It also allows comparison of reception on various antennas without seriously interrupting communications.

A simplified schematic of the r-f wiring is shown in figure 2. The incoming transmission lines (RG-85/U, 4-wire, gas line or other) from the antennas are connected via a suitable adapter to an RG-12/U cable which then connects to a Type J-238/G r-f coaxial distribution jack panel which contains eleven Type -491729 jack boxes. Each jack box contains four Type -49120 jacks and three Type -49194 receptacles. The Type -49120 jacks are accessible for r-f patching on the front of the system. The Type -49194 receptacles are accessible for "normalling through" at the back of the panel. All of these jacks and receptacles are connected in parallel. The three connectors on the rear of the coaxial distribution jack boxes are connected to the incoming transmission line, the antenna comparison switch and the coaxial jack switch panel. The coaxial jack switch panel Type J-239/G contains eleven Type -491388 coaxial jack switches. Each coaxial jack switch contains two Type -49194

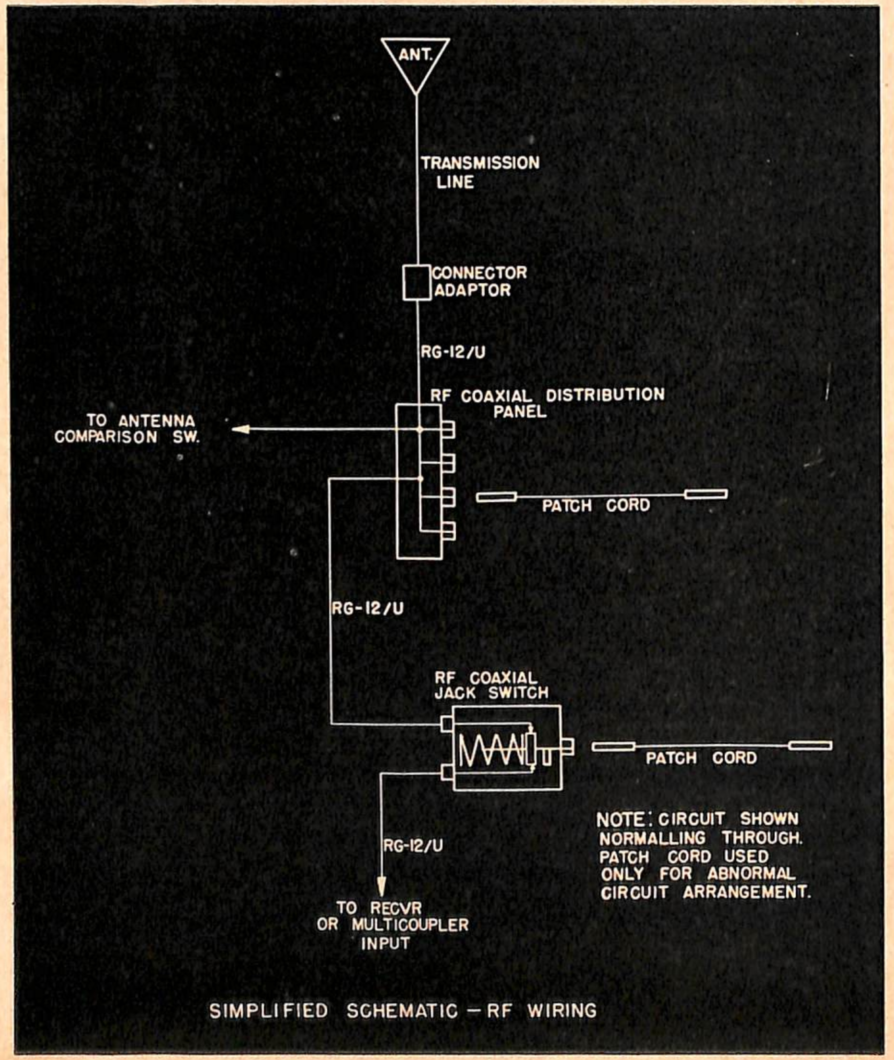


FIGURE 2—*Simplified schematic of the r-f wiring of the signal Distribution Unit.*

receptacles and one Type -49120 jack. The Type -49194 receptacles are accessible from the rear of the cabinet. One receptacle is connected to the coaxial distribution jack panel and the other to the multicoupler or the receiver with which the antenna is normally used. The Type -49120 jack is accessible from the front of the cabinet. When a patch cord is inserted in the Type -49120 jack in the coaxial jack switch, the normalling through connection is broken and a different antenna may be patched into the multicoupler or receiver, or the output of a multicoupler patched to the receiver.

Multicouplers should be mounted remotely and their jackfields mounted in the r-f cabinet of the Signal Distribution Unit or connected with RG-12/U cable to the rear of the Type J-239/G coaxial jack strip panels. The multicoupler outputs could be connected to the coaxial jack switches in the interests of normalling through, though this method of connecting multicouplers is not encouraged.

The coaxial jack strip panels contain eleven Type UG-294/U adapters, which accommodate a Type -49190 or -49195 connector at the rear and a Type -49121-A plug at the front. Receivers may be patched to the multicoupler by patching from the jack strip panel to the jack switch panel. Seventy-ohm unbalanced RG-12/U cable is used for all r-f wiring within the building.

A simplified schematic of the audio wiring is shown in figure 3. The audio wiring also follows a normalling-through wiring scheme in order to reduce patching and provide flexible operation. Type TTRS-4 cable should be used for external audio wiring. Double plug, tip-to-tip, balanced wiring is employed throughout.

The outputs of the receivers connect to the operator's position a-f distribution and control unit. This unit is designed to control two receivers. The operator may combine the outputs of the two receivers or select either. There is also a pair of

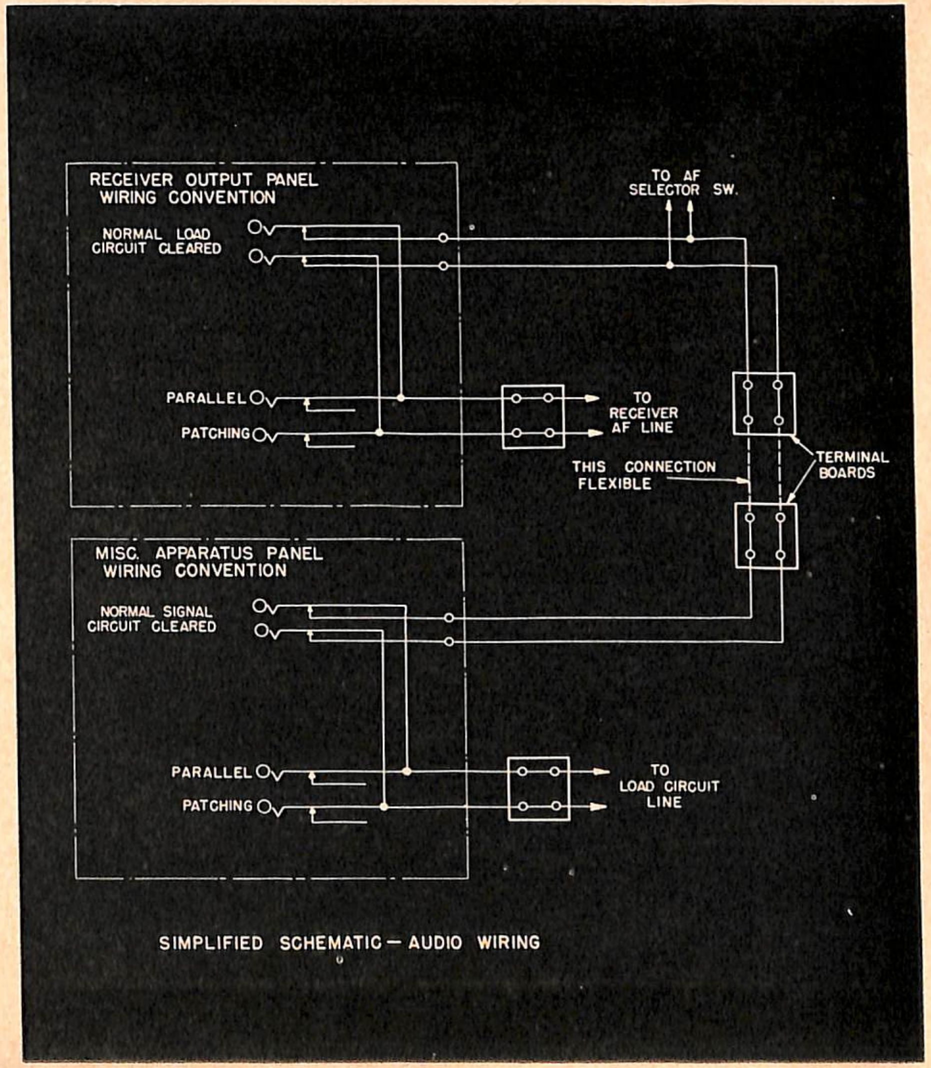


FIGURE 3 — *Simplified schematic of the audio wiring of the Signal Distribution Unit.*

utility jacks through which the output of another receiver or other audio signal may be heard but not controlled by the operator. The outputs of the receivers are also connected to the receiver output panel which is so wired that the normal load circuit (recorder, terminal equipment, monitor, etc.) is connected to the receiver without patching. The normal load circuit can be broken by plugging into the lower set of jacks, and the signal can be patched wherever desired, by plugging into the miscellaneous apparatus panel.

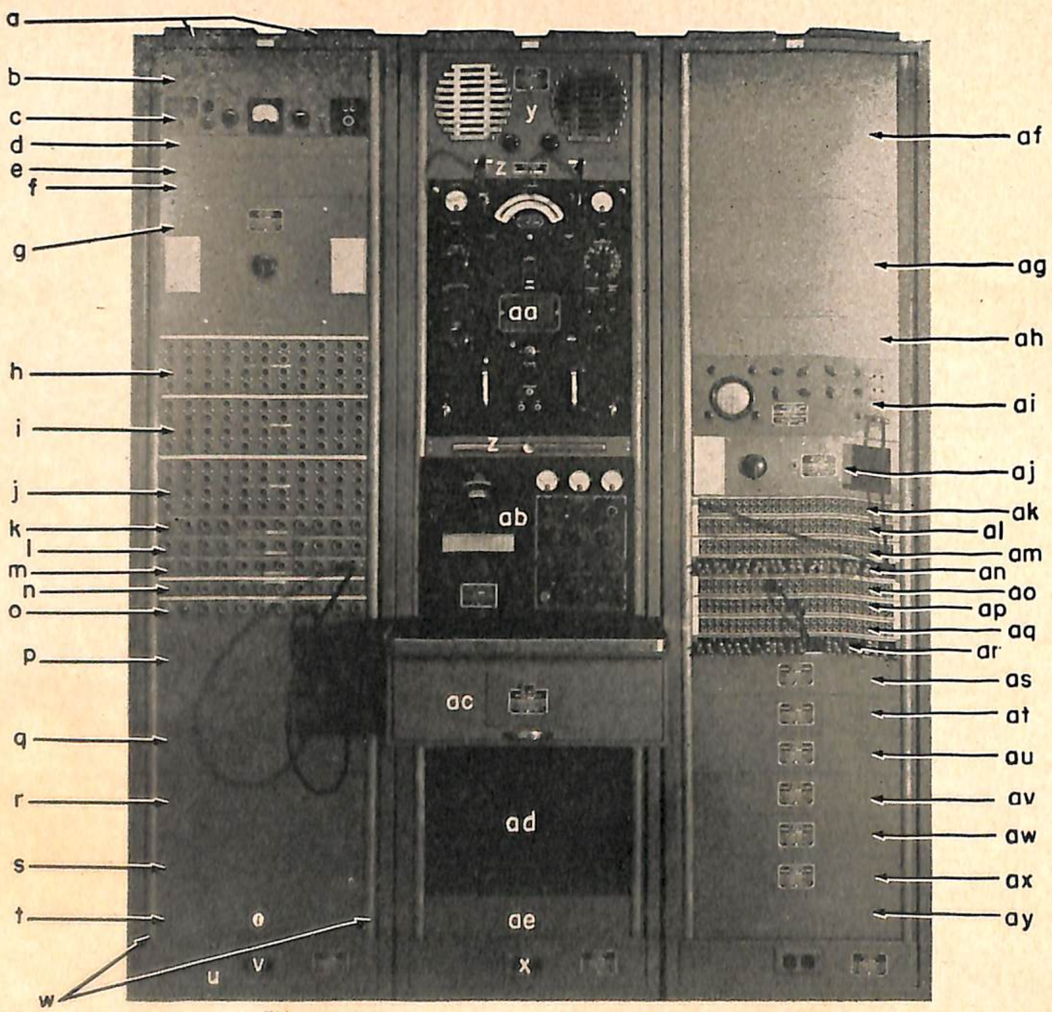
The miscellaneous lines panel contains jacks for patching receiver outputs or other audio signals to the set of utility jacks in the operator's position control unit or other remote point not covered by the normalling through arrangement. The miscellaneous apparatus panel contains jacks for patching miscellaneous test equipment or other equipment not covered by the normalling through arrangement.

The output of each receiver is connected to the a-f channel selector switch by connection to the receiver output panel. This channel selector switch allows rapid selection of channels for monitoring, testing, etc., without extensive patching and without serious interruption of reception.

The test equipment furnished with the Signal Distribution Unit includes a Model OBL-3a oscilloscope, a Model LM-15a frequency meter (or an adapter permitting a Model LR-1 frequency meter to be mounted in the system), a Model TS-629 volume level indicator, a Model OBQ-4 volt-ohm-milliammeter, and a Model ZM1/U ohmmeter (insulation-resistance tester). These equipments are all rack-mounted models which test or operate over balanced or unbalanced lines, and cover the range of impedances normally employed in communication work.

The photograph below is lettered to show the location of all components of the size "A" Signal Distribution Unit. Table I identifies these components and gives the navy type numbers, if assigned.

Delivery of this equipment to shore radio stations is expected to commence in January of 1948.



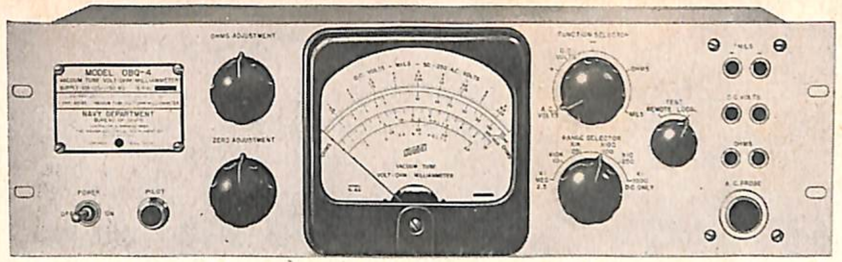


FIGURE 5—*Model OBQ-4 volt-ohm-milliammeter.*

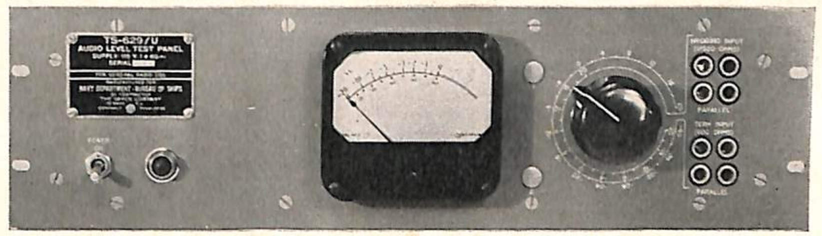


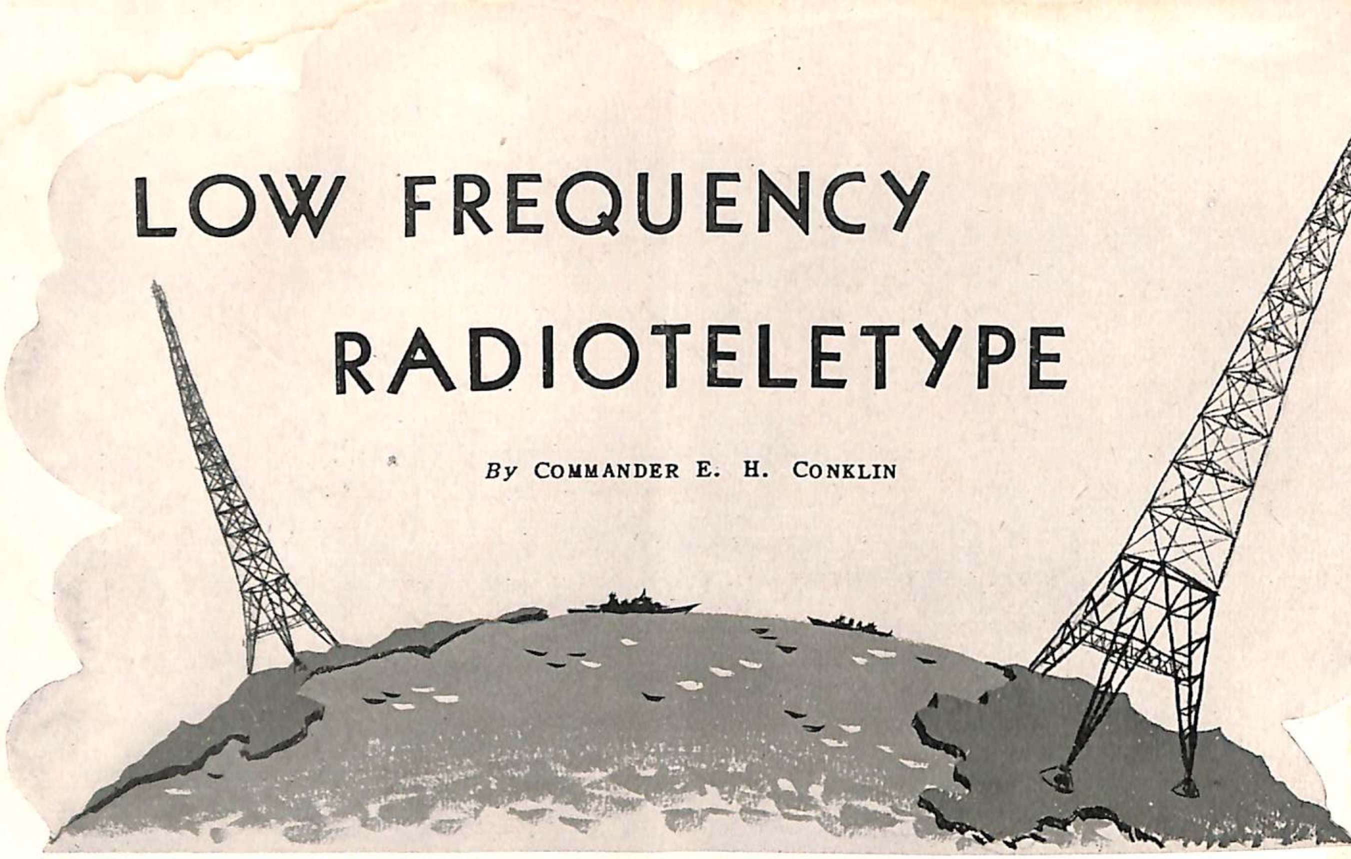
FIGURE 6—*Type TS-629/U audio level test unit.*

TABLE I—*Key to photograph on page 4.*

Desig.	*Description*	*Type No.*	*Remarks*
A	Ventilators (adjustable)	———	
B	Blank panel	———	
C	Ohmmeter	ZM1/U	
D	Blank panel	———	
E	Blank panel	———	Space for OBQ-4
F	Blank panel	———	
G	Antenna selector switch panel	SA-137/g	
H	Antenna distribution panel	J-238/g	
I	Antenna distribution panel	J-238/g	
J	Antenna distribution panel	J-238/g	
K	Coaxial jack switch panel	J-239/g	Contains 11 type 491388 switches
L	Coaxial jack switch panel	J-239/g	Contains 11 type 491388 switches
M	Coaxial jack switch panel	J-239/g	Contains 11 type 491388 switches
N	Coaxial jack strip	J-237/g	Employs UG-294/U in rear to permit use N.T. 49195
O	Coaxial jack strip	J-237/g	Employs UG-294/U in rear to permit use N.T. 49195
P	Blank panel	———	
Q	Blank panel	———	
R	Blank panel	———	
S	Blank panel	———	
T	Blank panel	———	
U	Filler panel	———	
V	Convenience outlet	———	
W	Trim strip	———	
X	Cabinet relay rack stand, 19″	CY-597/g	Cabinet, 24″ depth
Y	Speaker panel	LS-139/g	Attenuators included
Z	LR-1 mounting shelf	MT-571/g and J-265/g	

Desig.	*Description*	*Type No.*	*Remarks*
Aa	LR-1 freq. mtr.	LR-1	
Ab	RBC recvr.	RBC	For monitoring purposes
Ac	Desk panel with ash tray and drawer	FN-28/g	
Ad	RBC power supply	RBC	
Ae	Blank panel	———	
Af	Blank panel	———	
Ag	Blank panel	———	
Ah	Blank panel	———	Space for TS-629 volume level indicator
Ai	OBL-3a oscilloscope	OBL-3a	
Aj	A-F channel selector and key compartment	SA-135/g	
Ak	A-F jack strip	491394	
Al	A-F jack strip	491394	
Am	A-F jack strip	491394	
An	Patch cord storage panel	MX-813/g and MX-814/g	
Ao	A-F jack strip	491394	
Ap	A-F jack strip	491394	
Aq	A-F jack strip	491394	
Ar	Patch cord storage panel	MX-813/g and MX-814/g	
As	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
At	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
Au	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
Av	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
Aw	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
Ax	A-F terminal board (panel)	J-242/g	4 boards, 26 terminals each panel
Ay	Blank panel	———	

LOW FREQUENCY RADIOTELETYPE



By COMMANDER E. H. CONKLIN

■ The Navy's radioteletype program for shipboard operation may, for convenience, be considered as being of three parts—high-frequency inter-ship or ship-shore with frequency-shift keying, UHF modulated-tone for shorter ranges, and FOX reception. Of these, the latter presents the greatest problems and may be the last to enjoy widespread use because it demands the most perfect reception. It also may force the development of methods of receiving more accurate copy.

In attempting to perfect the reception of broadcast signals, it was necessary to consider the high-frequency skip-zone around the transmitting station. This region most frequently is encountered during winter nights when the sunspot cycle is at its minimum—about six years from now. At present, operators can always make use of the low-frequency transmissions in case high-frequency reception fails.

A similar approach to the radio-teletype FOX appears to be advisable. The skip-zone could be covered by a 2-megacycle transmission, but the Navy has no high-power transmitters in the 2-4 Mc region, and this frequency would be of little value at times when ionosphere irregularities make high-frequency reception impossible, such as frequently occurs in high latitudes.

Operators have experienced atmospheric noise which knocks the receiver's output meter against the pin, although the desired signal produces only a small deflection. The great intensity of static crashes led some engineers to question what the range of a radio-teletype transmission on low frequency might be, especially in the tropics. In order to determine the limitations of the system, the Commander Operational Development Force was requested to investigate it. This was done, with personnel assistance from the Chief of Naval Operations, Bureau of Ships and the Royal Canadian Navy as watch standers and technical help, involving as it does the use of equipment that has not previously been used by the service.

ComOpDevFor assigned the problem to the USS *Macon* (CA-132) which was scheduled for a type-training cruise to Guantanamo and return. Transmissions by 170-cycle frequency shift, using 40 kilowatts output from a Model TCG transmitter at Annapolis on 88.5 Kc, were provided. The first step was to bring the *Macon* to a position near the transmitter which provided an essentially line-of-sight salt-water transmission path immediately adjacent to a road ashore where a Naval Research Laboratory field truck could measure the radiated field strength accurately. The information given by the truck, together with receiver input measurements on the ship, provided reasonably accurate figures on receiving-antenna effective heights. It was found that they varied over a 15-to-1 ratio in effectiveness for low-frequency reception.

The ship then proceeded to the Guantanamo area, followed by an extension of the cruise to a point off Guadaloupe, and to San Juan, P. R. Many special tests were conducted during this period, including variation of frequency shift, use of on/off keying, changing frequency and power, and even radioteletype keying of the Model TBJ transmitter on 18.1 kilocycles.

It was learned that average copy was 97% to 98% accurate, over periods of weeks, at a distance of about 1500 miles. This was considered to confirm the utility of low-frequency transmission to fill in the skip-zone which might occur on high frequencies. It should be noted, however, that manual copy of somewhat greater accuracy, or perhaps 50% longer range, could be expected. The periods when very poor copy was received did not appear to be more frequent than on high frequencies. It was noticed that atmospheric noise crashes as heard through a Model RBA receiver were composed of several strong clicks each lasting 4 milliseconds, and that these did not create printing errors unless they reversed the mark or space signal at the time that the printer was making its selection. Inasmuch as this selection takes only four milliseconds out of a normal 22-millisecond band length, many of the clicks did not cause errors.

Figure 1 shows hourly averages of received signal strength, taken over a number of days. It is readily seen that 88.5 kilocycles is not sufficiently low to eliminate the noon-day absorption of field strength, which is commonly encountered on the standard broadcast band, but the dip is shorter and less intense. It was quickly noticed, though, that some of the best copy was made during periods of weakest signal strength, provided that the source of atmospheric noise is not local and, further, that the receiving antenna in use is adequate to bring outside noise up to the level of the receiver's internal noise. The first provision has been confirmed in other experiments, such as Loran reception in the Arctic, and appears to result from a greater drop in noise than in signal, due presumably to the fact that the noise if not from a local source comes from an *area* (a squared function) whereas the signal comes from a *point* (a linear function). The noise actually drops more than the signal. The second provision required that the receiving antenna during the *Macon* cruise have an effective height of at least 1.3 meters, which was obtained only from two on board, a foremast wire with a 3-inch air-dielectric "Boston" trunk and a high, clear whip on the stack, fed with flexible coaxial cable; other receiving antennas did not produce usable mid-day copy.

Field-strength measurements were made constantly, using a rectifier and Esterline-Angus recording voltmeter, and are plotted in figure 2. Each circle represents 10,000 or more counted characters in a single schedule. It will be seen that this form of counting of numerous short schedules discloses more information than a simple average of a large number of printed characters. The lower edge of the circles shows that there is a straight-line relationship between field-strength and percent errors in the copy. Double the field-strength (four times the transmitter power) will cut the errors in half. Sometimes a very low noise gave good copy during periods of weak signals, as discussed above, but this does not alter the validity of the general relationship of power to number of errors at all times except during severely adverse local receiving conditions. This relationship is said to hold true also

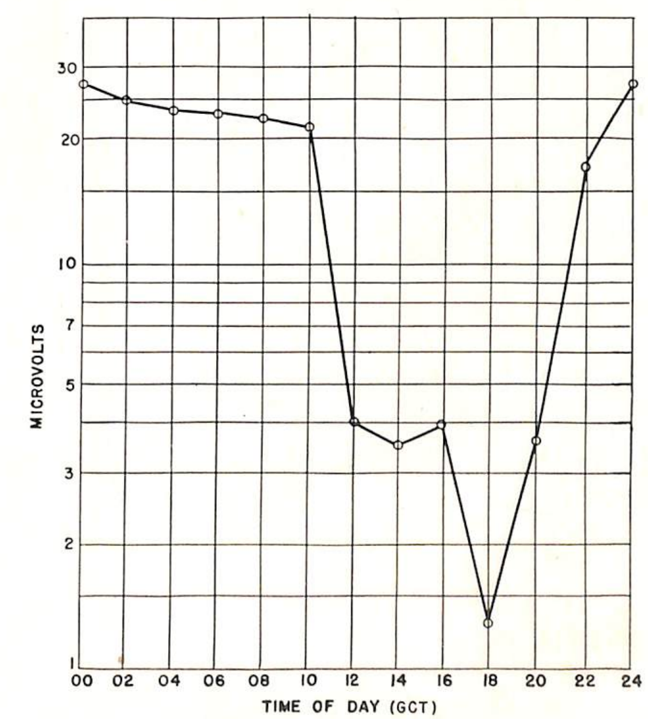


FIGURE 1—*Average receiver input on 88.5 kc from 4 to 9 December 1946, 40-kw input transmitting antenna. Distances varied from 1000 to 1500 miles. This clearly shows mid-day drop of signal strength but shows no decline around 0200 when noise slightly increases the received errors.*

on high frequencies, but it is harder to notice in view of the fading that normally is encountered.

TABLE I—*Model TCG Antenna Effective Heights and effective radiated power compared with Washington.*

Station	*Effective Height*	*Eff. H. squared*	*Ratio*	*Equiv. Power*
Washington (Inverted L)	146 feet	22,316	1	40 KW
Battle Point, Wash. (850 vertical)	320 feet	102,400	4.6	181 KW
Trinidad (valley span)	368 feet	135,424	6.0	240 KW
Haiku, T. H. (valley span)	680 feet (estimated)	462,400	20.7	828 KW

The transmitter was run at 40 kilowatts output, but the antenna is less effective than the 850-foot verticals and the valley-spans used at other stations. Table I shows a comparison of Model TCG antennas, which suggest that even lower percentages of error in copy, or longer ranges, should be expected from other shore-station transmissions.

Tests of on/off keying tended to confirm previous information that the advantage of frequency-shift keying in radioteletype operation is primarily that of reducing the *bias* distortion (unequal duration of the marking and spacing conditions) which changes during fading, because the transition between "off" and "on" is not instantaneous in radio transmitters.

As the *Macon* approached Norfolk the opportunity was taken to try out ship-to-ship low-frequency radioteletype. The USS *Adirondack* (E-AGC-15) at Norfolk was asked to use on/off radioteletype keying of a Model TAJ-series 500-watt transmitter, with no modification from normal operation. The receiver on the *Macon* was a Model RBA fitted with an audio-frequency rectifier tube and teletype relay. The results are shown in Table II at distances of 300 and 250 miles, for frequencies of 195 and 440 kilocycles. It is interesting to note that the *Macon* could not be heard by the *Adirondack*, presumably due to the small effective height of the *Macon's* transmitter antenna, which had no flat-top portion at all. The results suggest a suitable means of reliable task-force communication by automatic means and at distances of 200 miles or more, with only minor modification of existing equipments.

TABLE II—*Ship-to-ship on/off keyed radioteletype using model TAJ 500-watt transmitter.*

Distance (miles)	*Errors per thousand* 195 kc	440 kc
300	11.4	43*
250	10.61	none

* Through interference.

An important application for low-frequency radioteletype is on point-to-point shore circuits. Distances up to about 500 miles may be consistently obtainable with only a 2-kilowatt Model TAB-series transmitter, if good shore antennas are available. This application will tend to relieve the congestion of the 4-12 Mc frequencies and probably reduce interference now encountered on many high-frequency circuits which are difficult to keep clear.

The complete ComOpDevFor report of these tests, designated Op/S71/S67-1, has been reproduced by CNO (Op-20E) and distributed to Electronics Officers, ships with radioteletype, and others. A few additional copies are available for those interested in following the development of radioteletype methods.

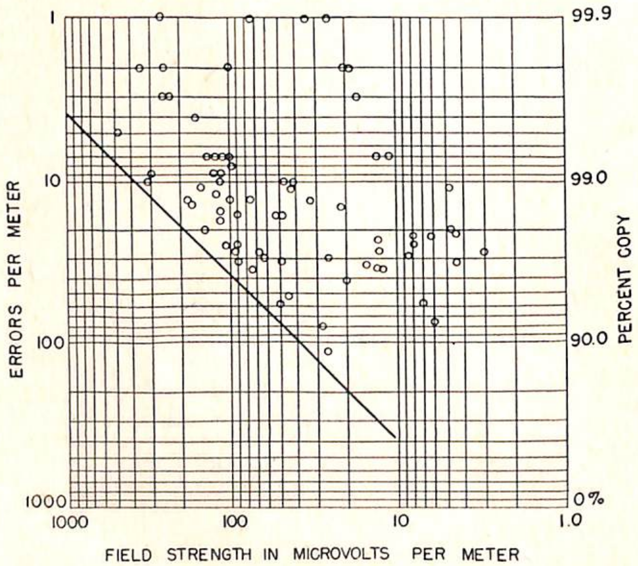
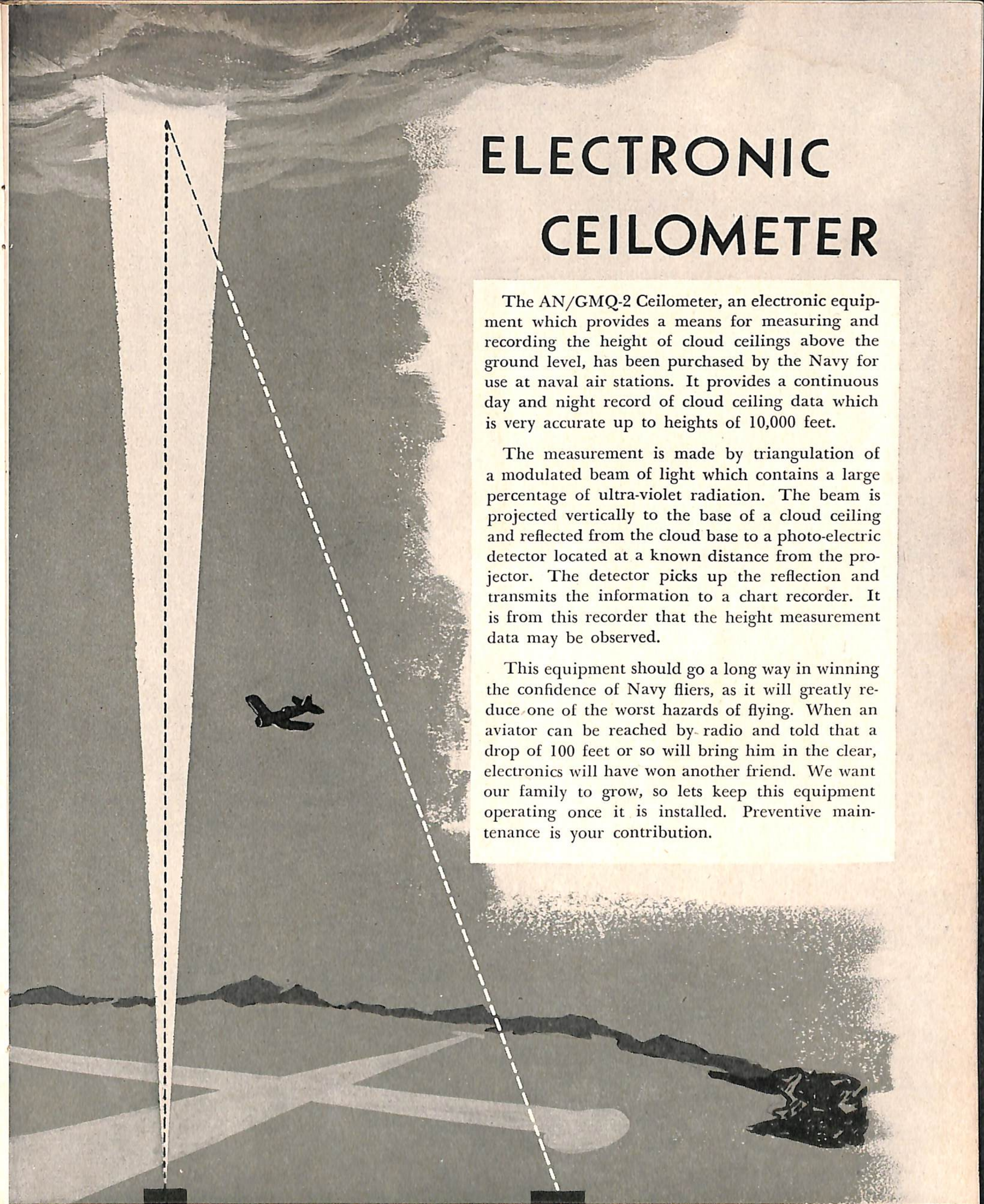


FIGURE 2—*Plot of percent perfect copy on 88.5 kc, at various distances, using Model FRG converter and Model RBA receiver on USS Macon, against field strength in microvolts per meter. This illustrates the relationship between received field strength and errors received.*

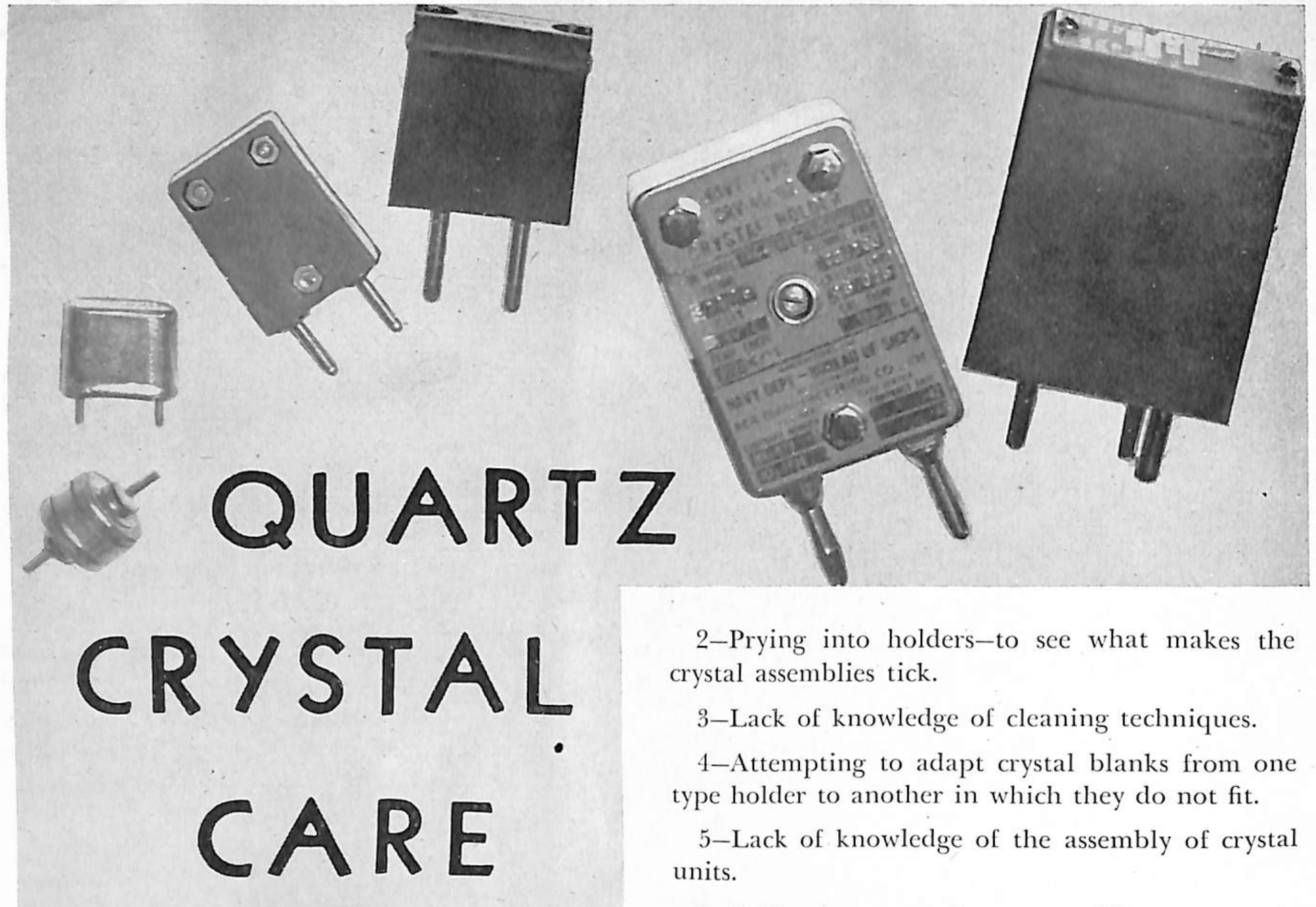
ELECTRONIC CEILOMETER



The AN/GMQ-2 Ceilometer, an electronic equipment which provides a means for measuring and recording the height of cloud ceilings above the ground level, has been purchased by the Navy for use at naval air stations. It provides a continuous day and night record of cloud ceiling data which is very accurate up to heights of 10,000 feet.

The measurement is made by triangulation of a modulated beam of light which contains a large percentage of ultra-violet radiation. The beam is projected vertically to the base of a cloud ceiling and reflected from the cloud base to a photo-electric detector located at a known distance from the projector. The detector picks up the reflection and transmits the information to a chart recorder. It is from this recorder that the height measurement data may be observed.

This equipment should go a long way in winning the confidence of Navy fliers, as it will greatly reduce one of the worst hazards of flying. When an aviator can be reached by radio and told that a drop of 100 feet or so will bring him in the clear, electronics will have won another friend. We want our family to grow, so lets keep this equipment operating once it is installed. Preventive maintenance is your contribution.



QUARTZ CRYSTAL CARE

■ In the past few years, extensive research and engineering has been carried out to improve the quality of quartz crystal oscillators as to frequency control ability, stability, activity, ruggedness, and general reliability. This was and is extremely important in view of the fact that quartz crystal oscillators are becoming more and more essential to the communication and electronics field as a whole. Millions of dollars are being spent by commercial and military activities, employing some of the world's best research engineers and industrialists, in order to approach the ultimate in frequency control. However, in spite of all of the effort, even the most carefully designed and manufactured product becomes a worthless and unreliable unit if improperly handled in the field.

In recent years, military repair activities have found by experience that the following field malpractices have resulted in unreliable operation of breakdown communication, and unnecessary expense:

1—Improper stowage of crystals—exposure to moisture.

2—Prying into holders—to see what makes the crystal assemblies tick.

3—Lack of knowledge of cleaning techniques.

4—Attempting to adapt crystal blanks from one type holder to another in which they do not fit.

5—Lack of knowledge of the assembly of crystal units.

6—Subjecting crystals to rapid temperature changes such as exposure to soldering iron heat.

7—Attempting to measure frequency tolerances with inaccurate equipment.

8—Improper adjustment of circuit oscillator components, such as vernier condensers.

9—Rough handling, resulting from dropping, etc.

10—Usual practice of assuming crystal failure without isolating other possible electronic failures.

11—Failure to provide complete specifications when ordering replacements.

It is extremely important to the proper operation of a crystal unit that the blanks be kept perfectly clean and free from moisture, to see that electrode spacing and spring tensions remain unchanged, and to insure that handling with the utmost care be a prime requisite. In view of all this, it must be emphasized that repairs to crystal units should be attempted by personnel in the field only under conditions of extreme emergency, and then only by competent technicians thoroughly familiar with proper procedure for crystal care. Wherever possible, repairs to these units should be made only by established shore activities possessing equipment and personnel which will insure reliable service.

TELETYPE PAMPHLET STOCKS

On page 20 of the May 1947 ELECTRON appeared an article relative to the large stock of pamphlets which the Bureau of Ships had entitled "Radio Teletype—Speech Plus Duplex." This pamphlet explains the modifications necessary to the TH-1/TCC-1 terminal equipment in order to make it operate with the AN/TRC-1 and 1498 transmitting-receiving equipments. It also gives detailed hook-up and operating procedure for this equipment.

A second modification to the TH-1/TCC-1 is necessary to make it operate with the MAR/TDZ/RDZ combinations. This information, plus new operating instructions, are embodied in an article on page 21 of the July 1946 ELECTRON.

Since the article appeared which mentioned the large stock of pamphlets, the Bureau has received so many requests for them that the stock is now completely exhausted. Although several requests have not been filled, the Bureau does not consider that the information in the pamphlet is now of sufficient value to warrant the expense of a reprint. At least one copy has been sent to all activities that would need the modification information and, inasmuch as the VHF equipment has been almost universally changed to UHF, the operating instructions contained therein no longer apply, but are superseded by the article in the July 1946 ELECTRON.

The latest electronics inventory shows that there are three TH-1/TCC-1 equipments in stock. The Bureau foresees no great demand for this equipment during the next year, and no additional procurement is contemplated. A new equipment is under development, known as the AN/SGC-1, which will supersede the TH-1/TCC-1. It is expected that delivery will begin after April 1948.

MAINTENANCE OF FILAMENT RHEOSTATS

The filament rheostats in the Model TCK series transmitter were designed for long life and with proper care and maintenance should give trouble-free operation over long periods of time. However, it has been reported that the contact arm surface has been burned and roughened in service due to improper pressure on the arm. The tension on this arm, depending on two factors, proper shaping and a coil spring arrangement, will vary according to the amount of use. It is recommended that all activities having this equipment set up a schedule for periodic inspections of these rheostats. If corrective measures are necessary adjust the shaping and coil spring until the arm rides firmly on the surface but is not so tight as to bind.

ELECTRONIC SUPPLY OFFICE

■ The responsibility of identifying and controlling maintenance repair parts for electronic materials which are described in ELECTRON magazine is invested in the Electronic Supply Office, Naval Supply Depot, Bayonne, N. J. This office, under the dual control of BuShips and BuSandA, is to administer the logistics support plan and serve as a supply-demand center for electronics.

The missions of the Electronic Supply Office are as follows:

1—To establish and operate an integrated system for stock and inventory control of such electronic stock as designated by BuShips.

2—Through supply and demand review to determine the desired levels of non-bureau-controlled components and items that are to be maintained at electronic distribution points.

3—Insure adequate stock levels of ESO-controlled stock for the support of logistics requirements in all areas by procurement, distribution and redistribution.

4—Maintain a centralized record and control of overall stock status of electronic material for the cognizant bureaus.

5—Serve as a supply and demand control point for such electronic stock as is designated by the bureaus and Marine Corps and when necessary make proper recommendations for programs to the cognizant bureau and to take such other action concerning program utilization and issue of stock as is agreed upon.

6—Compile electronic stock usage data as derived from all sources including end-line users.

7—Specify and coordinate the identification program and preparation of joint Army-Navy standard descriptions for the "Electronic Materials Cross Reference" publication.

8—Establish and operate a program to determine the most suitable stock levels of electronic material to be carried at electronic supply points.

9—To promulgate those policies required to implement the mission of the ESO as designated in the charter letter.

ESO compiles several publications which are of value to technical personnel for their direct application to maintenance. They are:

Spare Parts Breakdown Lists—prepared for specific electronic sets by model number. A listing of available lists, and the tabulations themselves, may be obtained by writing to the ESO. These lists present cross-references of known manufacturers, contractors, Navy Type, JAN, and other numbers to Navy-wide ESO stock numbers, as well as prose descriptions for those stock numbers.

Electronic Materials Cross-Reference—a compilation of approximately 85,000 reference numbers to 45,000 stock numbers, obtained from breakdowns of sets, plus prose descriptions for those stock numbers. Edition Number 8 consists of two volumes totaling 2400 pages. Distribution is limited to specified supply points.

An informational list on modification kits, field changes, and conversions is being prepared.

At the present time the majority of descriptions appearing in ESO publications are in a pattern of nomenclature and description standardized a number of years ago. Since the promulgation in February 1946 of a Navy-wide directive to use the Standard Item Names and description requirements of the "Joint Army-Navy Manual of Standard Descriptions JANP-109", the ESO has been engaged in a systematic conversion to the patterns of the document. During the conversion period, both types of descriptions appear in use.

Logistics of supplying electronics materials can be improved if personnel will prepare requisitions for maintenance repair parts to include ESO stock numbers and descriptions if available, or JANP-109 descriptions, all known reference numbers (manufacturer, contractor, Navy-Type, JAN, etc.) and as many sources of procurement as are known, and Navy model numbers of set (equipment) in which items are used. In short, a full electrical and physical description and the inclusion of all pertinent data for procurement will expedite the requisitioning of maintenance repair parts.

MODEL OBU COMPONENTS

■ Model OBU radar test equipments as formerly issued consisted of an echo box, a directional coupler, and a dipole antenna. Vessels requesting replacement of their Model OBU were furnished this entire assembly, thereby supplying the vessel with an extra directional coupler since the directional coupler furnished with the original OBU kit is usually attached to the waveguide.

In the future, all vessels requesting replacement of a Model OBU will receive one echo box and dipole antenna, but will not be issued the directional coupler previously incorporated in the OBU test kit. The extra dipole is still included, however, because it can be utilized for portable test purposes. Therefore, where directional couplers are required for replacement or when installing complete radar equipments, directional couplers must be requisitioned separately by their respective Navy type numbers. Naval supply activities have been instructed to issue OBU kits in accordance with this policy. Where excess couplers are already on board, activities should turn them in to the nearest Electronics Officer.

FAILURE OF PAPER CAPACITORS

A relatively large number of failures of capacitors in the Model SCR-624 radio equipment has been called to the attention of the Bureau of Ships. Investigation disclosed that most of the failed capacitors were of the paper type. These capacitors gather moisture and, after an idle period, fail rapidly. The capacitor failure will often result in the breakdown of associated components, and conditions may arise which make shipboard repair very difficult. When failures of these paper capacitors occur, they should be replaced with either mica or ceramic capacitors. All vessels and activities are cautioned to be on the alert to correct failures of this type.

PREVENTIVE MAINTENANCE AND THE ETM

■ The question has been raised as to whether all preventive maintenance work on electronic equipment aboard active vessels must be performed by ETM personnel. The Bureau of Ships feels that much of the preventive maintenance required on inactivated electronic equipment aboard active vessels can be performed by personnel other than ETM's, provided that this work involves only visual inspection of an equipment and minor corrective measures.

Any necessary corrective action which is within the capabilities of the inspecting personnel should be performed by them. In this connection, however, it should be emphasized that all safety regulations must be observed by personnel inspecting electronic equipment. When the necessary corrective measures are beyond the capabilities of the inspecting personnel, a report should be made to the cognizant Electronics Officer.

The Bureau is in receipt of letter FF12-2/3/S67 Serial 154 dated 27 Jan. 1947 from Commander Battleships-Cruisers, U. S. Pacific Fleet, concerning "Ship's Organization for the Maintenance of Electronic Material." Although this letter and the Bureau policy were developed independently, it is of interest to note that the substance of the letter closely agrees with the recommendations of the Bureau in the matter of maintaining electronic equipment by other than ETM personnel.

On the assumption that the equipment has been secured in a "standby" condition (space heaters and tube filaments energized where possible, and all sources of high voltage removed) it is recommended that the visual inspection procedures set forth in the following charts be established.

Check all units of an equipment WEEKLY for:

Item	*Comment*
Loose tubes	Replace in sockets and tighten tube clamps (if furnished).
Rust	Remove. Usually found on exposed components (antennas, hoist-train mechanisms, unpainted surfaces, etc.).
Fungus	Remove. Usually found on terminal boards and cables.
Corrosion	Remove and report.
Obviously defective components	Replace and/or repair. Examples are loose, broken or charred resistors, condensers leaking oil, cracked insulators, broken wires, loose connections, etc.
Chipped paint	Report location.
Moisture and water leakage	Report location.
Dirt	Clean equipment thoroughly with lint-free cloth and soft brush.

Check all items MONTHLY for:

Item	*Comment*
Lubrication	Check and report oil levels in antenna pedestals and sonar mechanisms. Report any obvious leaks.
Antennas	Check and report any rust or corrosion on arrays. Clean dirty insulators. Report cracked or broken insulators or elements.
Coaxial cable and waveguide runs	Check for physical damage (dents, cracks, leaks, etc.), and report location of damage.
Cables	Check exposed cabling for possible damage from heat, fatigue, or mechanical injury. Report any troubles found.

TCK RESET CAPACITOR

There have been several failures of the reset capacitor, C103, in the Model TCK series transmitters due to a condition described as "frozen" bearings. The difficulty probably arises due to the small clearance between the capacitor shaft and bearing together with the fact that the unit is located in the M. O. compartment where high temperatures cause expansion.

If the shaft and bearing were made of the same material the expansion would be uniform and the trouble would not exist. This is not the case, however, for unequal expansions occur which cause the two to bind together. This difficulty is troublesome but not serious; it can be corrected by polishing the bearing surface of the shaft with crocus cloth.

Due to the tendency of this capacitor to develop trouble, recommendations are made that it be inspected and maintained periodically in conjunction with the regular maintenance schedule.

TBY POWER SUPPLIES

Recently it was announced that the type -19018B battery used by the Model TBY transmitter was out of stock, the manufacturing assembly lines were dismantled, and no further procurement was contemplated. Therefore, vessels and Naval shore activities using Model TBY transmitters were advised to return them to the nearest EO pool when the local battery supply became exhausted.

After releasing this announcement, the Bureau of Ships located in stores Vibrator Power Unit -20144, Battery -19029 and Battery Charger -20145. This vibrator power unit, battery and battery charger can be used to replace the -19018B dry battery pack furnished with the Model TBY equipment. Accordingly, vessels and activities should contact the nearest Electronics Officer for these items when the local supply of type -19018B dry battery power units become exhausted.

SPARE HYDROPHONES AND BAFFLES

The type CQA-51074 hydrophone and the type CRV-10365 hydrophone baffle are suitable for use as spares with the Model JT sonar listening equipment. A total of 39 of these hydrophones and 49 baffles has been obtained for use by submarine sonar repair activities. Requests for these components should be addressed to the Supply Officer, Electronics Supply Base, Naval Supply Depot, Bayonne, N. J.

REQUISITIONS

■ The Electronic Supply Office of the Navy has, over a period of time, noted many errors in requisitions that pertain to electronic maintenance parts and wishes to point out that these errors often cause considerable trouble and introduce serious delays in the delivery of needed material. In the interest of clearing up these difficulties the ESO recommends that the following procedure be followed in the submission of all requisitions:

(1) Locate and use the ESO stock number.

(2) Supply a full description of the electrical and physical characteristics of the item. A complete JANP-109 description is the preferable form. ESO catalog descriptions are acceptable. If neither is available, use an adequate commercial or other description, but describe the item in detail.

(3) Give complete Navy Type Number of part itself.

(4) Give JAN type designations or Army-Navy Aeronautical type designations.

(5) Give manufacturer of the item and his part or drawing number (state which). Specify commercial designations if Navy, JAN, or AN-type designations have not been assigned.

(6) Give as many manufacturers and their numbers as are known. Avoid making items proprietary by referring to only one manufacturer.

(7) Give contractor's part or drawing number (state which) for the item.

(8) Give Navy type designation (including prefixes and suffixes) of component (major unit) of which item is used.

(9) Give Navy model letters of set (equipment) in which item is used. Be sure to supply all suffixes, such as TBL-1, TBL-2, etc.

(10) Activity local temporary stock numbers may be used for reference purposes only when ESO stock number does not exist.

(11) Give unit price for items not carrying ESO stock numbers.

(12) If the item has a Federal Standard Stock Number, use it in the requisitions.

(13) If an equivalent item instead of an exact replacement is satisfactory, state and indicate whether the supplied part should be equivalent as to size, weight, capacity, function, rating, or some other characteristic.

(14) State that equipment, tender and stock spares were checked to fill obligations.

(15) Items for Joint Army-Navy equipments should be researched for Army stock numbers and the stock number be listed on the requisition.

(16) If an item is for an equipment which is considered obsolescent to the Navy needs, surplus and unfit for issue, stocks should be checked at salvage depots before a purchase requisition is submitted. If any sources of supply are exhausted, quantities for repairs only should be requisitioned.

(17) Requests should specify the quantity required for immediate delivery and also the additional quantity required for stock.

(18) If the item is under the cognizance of BuShips, the request should be submitted directly to Bureau of Ships for action.

ELECTRONIC EQUIPMENT LUBRICANTS

The Navy is specifying the use of Army-Navy Aeronautical Specification lubricants in the maintenance of various electronic equipments. Some of these already specified, together with their Aviation Supply Office stock numbers, are shown in the following table.

Specification	*Item No.*	*Stock No.*	*Container Size*
AN-G-3	71	R14-G-981	8-oz. tube
	73	R14-G-982-15	1-lb. can
	75	R14-G-982-20	5-lb. can
	77	R14-G-983-250	25-lb. can
	79	R14-G-983-255	35-lb drum
	81	R14-G-983-275	100-lb. drum
AN-G-10	29	R14-G-983-400	$\frac{1}{2}$-lb. tube
	31	R14-G-983-420	10-lb. can
AN-G-25		R14-G-982-20	1-lb. can
AN-O-6a	121	R14-O-2405	1-qt. can

Usually these lubricants are found only aboard carriers and other ships carrying aircraft, but they may be obtained by other activities through requisitions to the nearest Naval Aviation Supply Depot or Annex. For a list of aviation lubricants and their ASO stock numbers refer to the Aviation Supply Office Catalog, Section 1401 Class 14, Lubricants and Preservatives. This catalog may be obtained from:

Aviation Supply Officer,
US Naval Aviation Supply Office,
Navy Aviation Supply Depot,
Oxford Ave. and Martins Mill Road,
Philadelphia, Pennsylvania.

RADAR PERFORMANCE AND OPERATIONAL REPORTS

Originally, the Bureau of Ships required that duplicate monthly performance and operational reports be submitted covering all existing operating radar equipments. Later this policy was amended to require duplicate monthly reports on only those equipments listed in Section 1 Page 3-4 of the Radar Maintenance Bulletin. Recently this list has been revised, and the Bureau has decided that only one copy (no duplicate) of these reports need be submitted. The list below includes all radar equipments on which reports must still be submitted.

Mk 22 Mod 1	AEW	SO-6	ST Series
Mk 25 all Mods	SG-3	SR-2	SU-2
Mk 34 all Mods	SG-6	SR-3	SV-1
Mk 35 all Mods	SO-4	SR-6	SX
Mk 39 all Mods	SO-5	SS	

It is not required that a report be submitted on an equipment in this list that has not been in operation, or on which there is no operational or material data to be reported. Vessels are requested, however, to furnish the Bureau of Ships with essential information on the equipments listed.

All activities, of course, should continue to report all failures of electronic equipment (components and tubes) on the NBS-383 Failure Report Card, whether or not a monthly operational report is submitted.

TYPE AM-215/U AMPLIFIERS

The type AM-215/U audio-frequency amplifier was listed previously as Navy type No. 50210. It is a ten-watt unit designed for use with the Navy type No. 49546 loudspeaker. It is six inches deep, twelve inches wide and eight and three-eighths inches high. Its weight will not exceed 30 pounds. It will operate from 110, 115 or 120 volts a.c. and consume approximately 30 watts of power.

These amplifiers are in all cases to be installed in protected locations convenient to operating personnel for power on/off and volume adjustments. A quantity of 2216 of these amplifiers is under procurement on Contract NObsr-39055.

SP/SP-IM FIELD CHANGE BULLETINS

The instruction bulletins for "Field Change No. 50—SP/SP-IM—Pedestal Control Power Indicator Circuit" were released with figures 1a, 1b, 2, 3 and 4 (pages 3 through 6) omitted. The contractor has shipped complete bulletins to replace these incomplete ones.

TYPE CMX-49545 SPEAKER-AMPLIFIER

■ The Navy Type CMX-49545 equipment pictured in the photo is a new speaker-amplifier unit designed for use with the Model RBO series radio receivers. It is essentially a two-stage audio amplifier with associated power supply and PM speaker. The rated audio output is 3 watts over a frequency range of from 100 to 5,000 cycles per second. This speaker-amplifier operates from a 115 v a-c., 50-60 cps, 50 w, single-phase source. It is arranged for selection of any one of five 600-ohm input channels by proper setting of the channel selector switch. Unused channels are terminated in resistors. If less than five input circuits are employed, the switch stop should be adjusted so that the number of switch positions will correspond to the number of input circuits connected to the amplifier.

This equipment is $19\frac{15}{16}$ in. high, $14\frac{1}{2}$ in. wide, and 11 in. deep, and weighs 60 pounds. It may be mounted either on a bulkhead or on a table, according to the installation procedure furnished in the instruction manual.

If the output of the central radio receiving equipment incorporates a balanced line, it is suggested that the speaker-amplifier be modified. To do so, place a jumper wire between terminal No. 12, the input center tap and terminal No. 7, the ground connection, and make a-c line connections to terminals No. 13 and 14.

FIGURE 1—*The Navy Type CMX-49545 Speaker-Amplifier.*

ERROR IN FIELD CHANGE

Faulty procedure was specified on the conversion drawing applying to Field Change No. 16 for Radar Equipment Mk 34, Mods 2, 3 and 4. Paragraph 5.2 of the specified procedure, which contains the error, reads as follows: "Remove the 'Hum-Balance' potentiometer (R-368) on the sweep chassis assembly and remove its associated wiring as shown in figure 2. Wires in cables shall be cut back to cable and taped". The outside terminals of this potentiometer were used as junction points for the filament supply and the removal of this unit and the cutting back of the wires result in an open filament circuit.

As a corrective measure, BTL and BuOrd have authorized the deletion of Paragraph 5.2 and substitution of the following:

"5.2—Refer to figure 2.

"Remove wiring from the Hum-Balance potentiometer (R-368) on the sweep chassis assembly and remove this potentiometer. Remove the WH-BLK lead running from C-334 to the center terminal of the potentiometer. Solder together the two WH leads and also the two WH-BLK leads (outside potentiometer terminals) making good mechanical and electrical connections. Then tape these connections and tape the leads to the cable."

In figure 2 at potentiometer R-368, indicate upper pair of wires as WH, WH, and the lower pair as WH-BLK, WH-BLK. Delete note "remove these wires" and substitute "solder together in pairs".

All shipments of the kits for this field change contain issue 3 of the drawing containing this error.

REPLACEMENT SWITCH FOR THE SV

Reports have been received in the Bureau of Ships that Field Change No. 58 for the Model SV radar equipment is difficult to install. Investigation has disclosed that the shaft on switch S-2 (item #10 of stock list BL-62492) is too short to permit proper assembly.

Replacement switches for S-2, built to correct specifications, will be distributed in the near future to all activities having already received "Field Change No. 58—SV" kits. The outside of each switch package will be marked "Replacement Component for Completion of Navy Field Change No. 58—SV". All activities are cautioned not to install Field Change No. 58—SV until the replacement switch has been distributed and is available for installation with the original kit.

ERI? NO, IFF

Belay that word on changing IFF terminology. The information released in the July 1947 ELECTRON was a bit premature as the change is still in the anticipation stage. The term in question, ERI only came into being a few months ago when it was considered as a probable designation for a committee handling electronic recognition and identification matters. Later various agencies and committees did consider the advisability of adopting this term as standard nomenclature, but to date there have been no official directives authorizing such a change.

REPORT YOUR FIELD CHANGES

Although it is a well known fact that many field changes have been and are being accomplished on electronic equipment, many reports of completion of these changes are not being received by the Bureau of Ships. On one particular equipment model a field change was authorized and published over a year ago. To date only one report of completion of this change has been received, whereas nearly 4000 equipments are affected. This lack of reports is hard to understand because correspondence received by the Bureau indicates that this particular change is being accomplished on the equipments, and Bureau personnel have seen modified equipments in the field.

In order to carry out the field change program in an effective manner, it is absolutely necessary that reports of completion of all field changes be sent to the Bureau as promptly as possible.

On field changes in which kits of parts or bulletins of instructions are furnished, a self-addressed report card, NavShips 2369, is included. This card should be filled out and mailed immediately after completion of the change.

Completion of field changes which do not require kits of parts and for which the instructions are disseminated by Navy Publications (CEMB, RMB, ELECTRON, etc.) should be reported on NBS-383 Failure Report Card, which can be obtained from Electronics Officers, or on Field Change Report Cards, NavShips 2369, if available. Naval activities may request small quantities of these cards from the Chief of the Bureau of Ships, Code 982. Since the cards are not available at District Publications and Printing Offices, requests for cards should not be forwarded to those activities.

WRONG CRYSTALS IN TCS

It has been discovered that on the Type TCS Transceiver one of the frequency-control crystals has been supplied ground to an incorrect frequency. The Bureau of Ships desires to bring this error to the attention of all activities, so that appropriate corrective action may be carried out.

The incorrect unit is one of the four crystals in Group "A" employed for reception, and is the one covering reception on the 4385 kilocycle channel. The other channels, incidentally, are at 2716, 3045, and 5335 kilocycles. Possessing an intermediate frequency of 455 kilocycles, the TCS must use a crystal operating at a fundamental frequency of 2420 kilocycles in order to provide optimum reception at 4385 kilocycles, utilizing the second harmonic. The faulty crystals were ground to a fundamental frequency of 2415 kilocycles (which would correspond to reception at a frequency of 4375 kilocycles instead). To aid in identifying the crystals, the figure showing the nameplate has been included. It is labelled to correspond to the frequencies to which the crystals are ground, and, since one crystal is incorrect, the label consequently is, too. These TCS crystals were procured under Contract NXsr 39229.

If the faulty crystals are used in the TCS equipments, very poor sensitivity and low output will result. It is recommended that, should these symptoms occur on the 4385 kilocycle band, the crystal be checked before any maintenance is undertaken. Furthermore, the faulty units should be returned as soon as possible—on the West Coast to the Mare Island Naval Shipyard, and on the East Coast to the Naval Gun Factory at Washington, D. C. All shipments should include a description of the unit, together with the cause for return.

BATHYTHERMOGRAPH REPAIRS

A recent contract (N5Sr-10548) has been awarded the Bristol Company, Waterbury, Conn. for repair and recalibration of all types of surface vessel bathythermographs. This contract also includes submarine type bathythermographs, such as the Model OCN, manufactured by the Bristol Company.

Activities in the Atlantic area should forward damaged instruments to the Inspector of Naval Material, in care of the Bristol Co., Waterbury, Conn. marked "for repair under Contract N5Sr-10548". A copy of the shipping papers should be sent to the Inspector of Naval Material, Hartford District, Hartford 3, Conn. Pacific activities may forward damaged instruments to the above activity, or to the Navy Electronics Laboratory (formerly the USN Radio and Sound Laboratory), San Diego, Calif. if it is a surface type bathythermograph.

It is important that each surface type instrument forwarded be accompanied by its own viewer and grill, since these grills are hand-calibrated to fit the lever arm movement of only the one instrument. Winches, however, are to be repaired by the local activity and not sent to the Bristol Co. or NEL.

CHECK YOUR FREQUENCY METERS

If you are one of those technicians who like to go ashore regularly, it will pay you to spend some time checking the accuracy of your frequency meters. During a recent two-month period, Navy radio security activities reported a total of 2777 radio-frequency measurements of transmissions from Naval radio stations. Of these, a total of 399 exceeded the authorized tolerance limit of 0.02% specified for mobile units. This represents 14.36% of off-frequency operation, and is a most unsatisfactory record.

It is believed that a substantial reduction in the present undesirably high level of off-frequency operation by Naval vessels can be obtained if responsible electronics personnel make a sustained effort to maintain transmitters within authorized tolerance limits. One means of assisting Naval radio stations to keep within specified limits is to notify them, whenever feasible, of off-frequency operation, so that they may take corrective action. Unfortunately, however, it is virtually impossible to notify all offending radio stations before they may have caused interference to legitimate users of adjacent channels.

A better method is for the electronics personnel at the transmitter to keep their secondary frequency standards (frequency meters) accurate. Experience in frequency measuring has shown that secondary frequency standards retain their accuracy only when checked regularly against standard radio frequencies, such as those transmitted by the National Bureau of Standards by radio station WWV. The recommended methods of checking most Naval frequency meters through the use of the WWV broadcasts are given in great detail in the article on page 16 of the July 1945 ELECTRON. To facilitate using these broadcasts, the latest WWV transmitting schedule is given in the article appearing on page 16 of the August 1947 ELECTRON.

SEARCHING WITH TDY-1 ANTENNA

When a ship is equipped with a Model TDY-1 radio countermeasures equipment, it is generally an easy matter to use the TDY-1 rotating directional transmitting antenna for search intercept work without impairing the use of the jamming transmitter. This is usually accomplished by running a connecting lead from one of the antenna jack box connectors to one of the connectors in the TDY-1 antenna lead, such as the one at the line stretcher, where the regular connector can be temporarily removed to permit use of the special lead.

In some installations a modification has been made so that the TDY-1 antenna can be used in place of the DBM-1 search antenna. The purpose of this is to permit searching at frequencies below those usually covered by the DBM-1 antenna. The procedure to search from 90 to 800 Mc with the TDY-1 antenna then becomes:

1—Plug the RDO lead into the antenna jack box thus attaching it to the TDY-1 connecting lead.

2—Connect the other end of the TDY-1 connecting lead to the TDY-1 antenna.

3—Check to see that the two TDY-1 antennas that might be needed are in place on the antenna mount, are polarized correctly, and that the one to be used is connected.

4—Set up the TDY-1 antenna control unit to provide antenna rotation for target observation. Observe the panoramic adapter and pulse analyzer scope, and listen to the receiver headphones to obtain the point of maximum amplitude.

5—When ready to jam, reconnect the TDY-1 antenna to the TDY-1 equipment, and the regular receiving antenna to the receiver.

MOUNTING RBS-SERIES RECEIVERS

Originally, the Model RBS series receiving equipment was contained in a special splash-proof rigid cabinet having a hinged cover, and attached to a special mounting bracket. Later it was decided that the rigid cabinet and cover should not be considered an integral part of the receiver, and that it is not necessary to use these items when an RBS receiver is installed. Accordingly, the stocking of the cabinet and cover as a separate item apart from the receiver was authorized.

The receiver and amplifier-power units may be separated from the mounting bracket and installed in a normal manner on a standard operating table or shelf. At the time of installation, however, provision must be made for connecting the antenna coaxial cable to the equipment. This can be accomplished by installing a Navy type -49120 concentric jack on a bracket mounted as close to the antenna and ground terminals of the receiver as possible, and connecting the jack to the terminals with short jumpers. With Model RBS-2 equipments, antenna connection adapter assembly J-506 is furnished, and can be installed on the receiver regardless of whether the cabinet and cover are used or omitted.

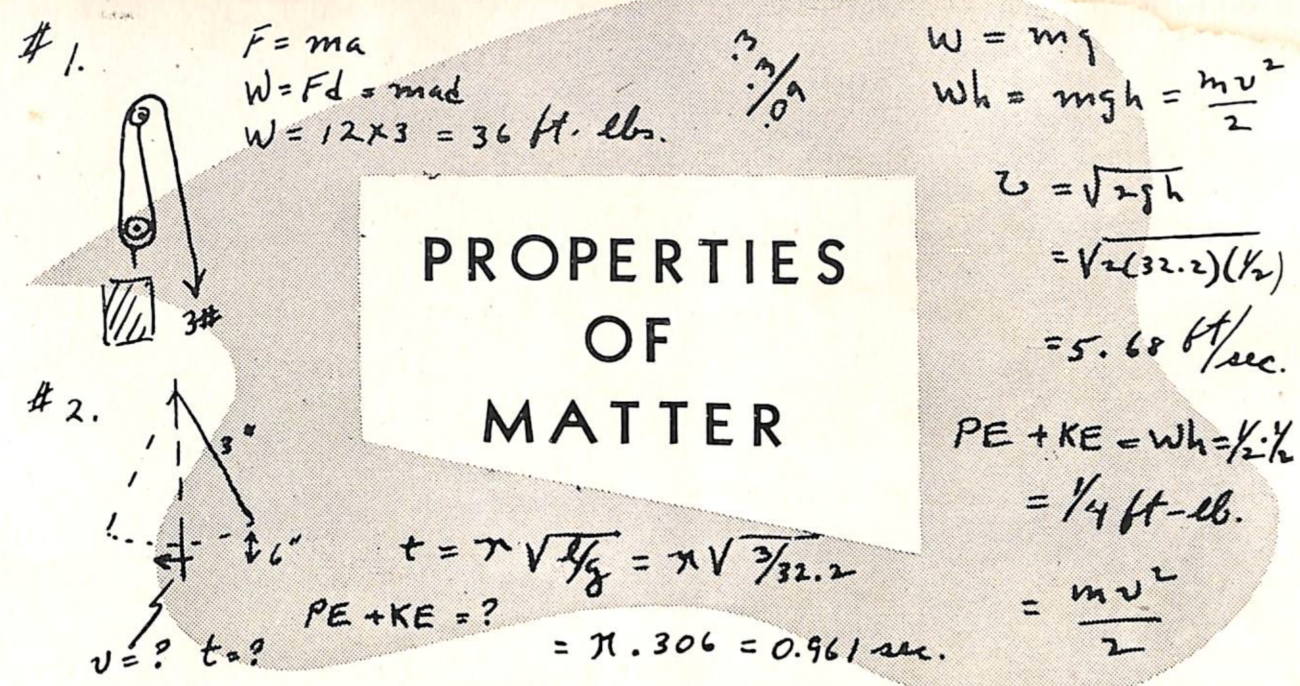
QGA HOIST-LOWER MECHANISM

■ Operating personnel have been advised to leave the transducers of the Model QGA sonar equipment in the fully-lowered position while underway, operational considerations permitting. The existence of excessive vibration when underway with the transducers in the hoisted position has necessitated this measure.

If the transducers are left in the lowered position indefinitely, however, the jack screws may freeze to the gear-box cover bushings. It is recommended, therefore, that the hoist-lower mechanism be operated once each week. For operation underway, it is sufficient to hoist the transducers only approximately six inches. At this time a few drops of SAE 20 or SAE 30 oil should be applied to each jack screw just above the gear box cover. After determining that the hoist-lower mechanism operates freely, make sure that the transducers are returned to the fully-lowered position.

TYPE ALLOWANCE BOOK

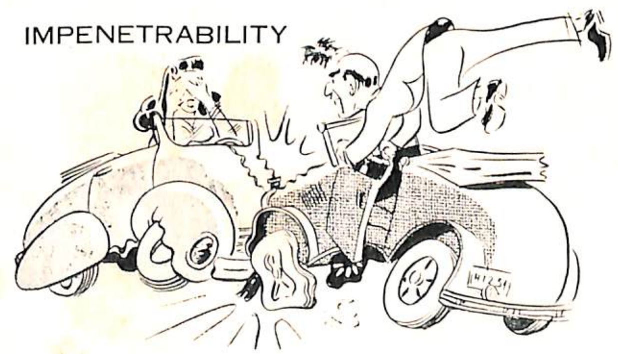
The "Electronic Equipment Type Allowance Book" (NavShips 900,115) is the correct title for the former "Type Allowance Booklet" (RE-11A-100). This book lists the complete electronic equipment allowances for all ships. Since any particular ship is concerned only with the allowances for ships of its own type, the TAB is not sent to all ships and stations. The very small printing of the complete book is intended for only the higher commands and certain major planning, installation, and maintenance activities which have already received copies. All other ships and activities are entitled to and have been furnished only those pages of TAB that apply to them. Since many requests are being received by the Bureau of Ships for the TAB, the above information is offered in the hope that it will prevent future requests for the TAB from activities not already on the mailing list.



PROPERTIES OF MATTER

Basic Physics—Part 3

The general definition of matter, "that which occupies space," does little more than state an obvious characteristic of matter. Although most of the physical properties discussed in preceding chapters are applicable to all types of matter, if matter is to be described accurately and in detail, however, it is necessary to make use of numerous special properties. In general, these special properties apply only to certain types of matter, and may be classified in the same manner as energy, namely, chemical, mechanical, electrical, thermal, etc. The number of special properties is very large and is steadily increasing, particularly in recent years, because research is developing large numbers of synthetic materials. This chapter is primarily concerned with the more important special properties of maximum interest in electrical and electronics engineering. A few additional physical properties will also be discussed.



Impenetrability.—The physical property of certain types of matter which prevents two bodies from occupying the same space at the same time is known as impenetrability. Two automobiles are wrecked by collision because matter is impenetrable. Many collisions between different kinds of matter, of course, pass unnoticed because one body gives way to another. On a calm day a person does not notice the air his body is displacing as he moves along, but on a windy day the effect of the moving mass of air is strongly evident.

Porosity.—Common to all types of matter is the property of porosity. Here the word "porosity" does not refer to the porousness of a sponge, for example, but rather is descriptive of the fact that matter is mostly empty space containing a very large number of very minute particles called atoms. This will be shown later in the study of the atomic structure of matter. It has been estimated that if 250,000,000 tons of average matter could be compressed so that no empty space were left in it, the resultant solid material would have a volume of about one cubic centimeter. It has furthermore been suggested that the tremendous pressures existing at the center of some stars may cause the matter there to have nearly absolute solidity or zero porosity. It should be explained at this point that a material can be both porous and impenetrable at the same time. It is porous because of the empty space between the constituent atoms, yet in bulk is impenetrable because of the nature of the forces which in such a material act between the atoms.

Compressibility.—Because all matter is porous it possesses the property known as compressibility. Gases are highly compressible, whereas liquids and solids are only slightly so. A column of water one mile long under a pressure of ten pounds per square inch is compressed about two inches, a fact of considerable importance in the study of hydraulics.

Density.—An important property of matter in engineering work is density. It stems from the ideas concerning the porosity and compressibility of matter. Density is defined as the ratio of the mass of a body to the volume of space it occupies. Absolute density is defined quantitatively

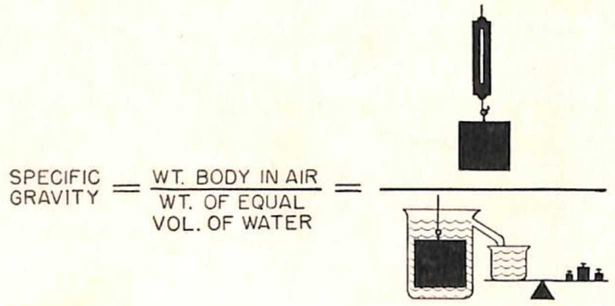
$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

The engineer, however, sometimes prefers to define density, especially in the FPS system of units, as

$$\text{Density} = \frac{\text{weight}}{\text{volume}}$$

$$D = \frac{W}{V}$$

because weight is a property easily measured. Common units of density are pounds per cubic foot, grams per cubic centimeter, and kilograms per cubic meter.



Density is an important factor in the design of structures. The specifications for the foundation of a building cannot be written until the total weight of the building is known. The design engineer calculates this value by determining the volume of each type of material to be used in the structure. Knowing the volume, it is a simple matter for him to calculate the weight from the density of each material used. The density of any material may be determined by measuring the weight and volume of a selected sample. For many purposes this is rarely necessary, for density tables covering a wide variety of materials are available in various engineering publications.

Specific Gravity.—Specific gravity is defined as the ratio of the weight of any substance to the weight of an equal volume of some selected standard. The student will do well to remember that the word "specific" as used in physics has the meaning "ratio with respect to a known standard." Such terms as specific resistance, specific heat, specific inductivity, specific conductivity, etc., will be encountered in later work.

For solids and liquids the selected standard of density is water. At 4° Centigrade and normal atmospheric pressure water has a density of 62.43 pounds per cubic foot. Under these conditions water is said to have a specific gravity of 1.000. Aluminum has a specific gravity of 2.7 which means that one cubic foot of aluminum will be 2.7 times heavier than one cubic foot of water.

The basic equation for specific gravity is

$$\text{Specific gravity} = \frac{\text{weight of body in air}}{\text{weight of equal volume of water}}$$

Another method of expressing specific gravity is

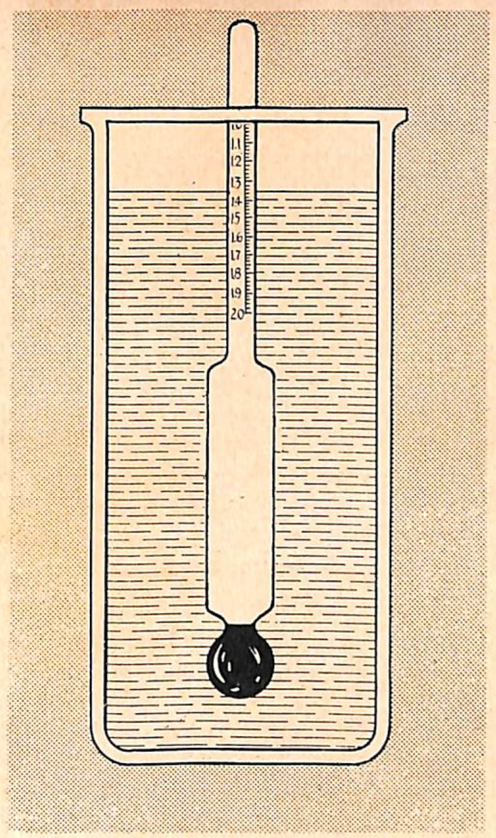
$$\text{Specific gravity} = \frac{\text{density of material}}{\text{density of water}}$$

For example, the density of gold is 1200 pounds per cubic foot. Since water has a density of 62.4 pounds per cubic foot, then the specific gravity of gold is

$$\text{Specific gravity} = \frac{1200}{62.4} = 19.3$$

Although density and specific gravity stem from the same concept, they represent different values, and should be carefully distinguished from each other. Density is measured in terms of mass or weight per unit volume, whereas specific gravity has no dimensions; specific gravity is a ratio, and is represented by an abstract number.

For measuring the specific gravity of liquids, an instrument called a hydrometer is employed. It consists of a hollow glass tube with a narrow calibrated stem, sealed and weighted at the lower end. By proper selection of the weight at the lower end, it is possible to calibrate the device so that the specific gravity of liquids either heavier or lighter than water can be measured. A common type of hydrometer is the one used to measure the specific gravity of the electrolyte in storage batteries. The



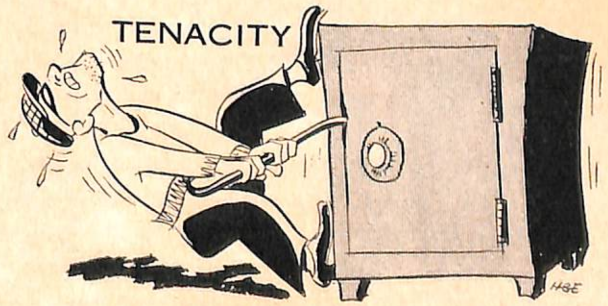
electrolyte in such batteries is a mixture of sulphuric acid and water of such proportions that, when the battery is fully charged, the specific gravity will measure between 1.250 and 1.300. As the battery discharges, the sulphuric acid is slowly removed from the solution as a result of chemical action with the lead plates, thus lowering the specific gravity. When the solution is depleted to a point where the specific gravity is of the order of 1.100 to 1.150, the battery is discharged. Intermediate values of specific gravity indicate intermediate values of charge.

MECHANICAL PROPERTIES

The electronics engineer needs some knowledge of the mechanical properties of matter because many electrical components are selected on the basis of mechanical as well as electrical properties. An antenna strain insulator, for example, in addition to having excellent electrical insulation properties, must also have qualities which offer high resistance to weather deterioration, sufficient tensile strength to support the antenna under all conditions, resistance to shock, etc.

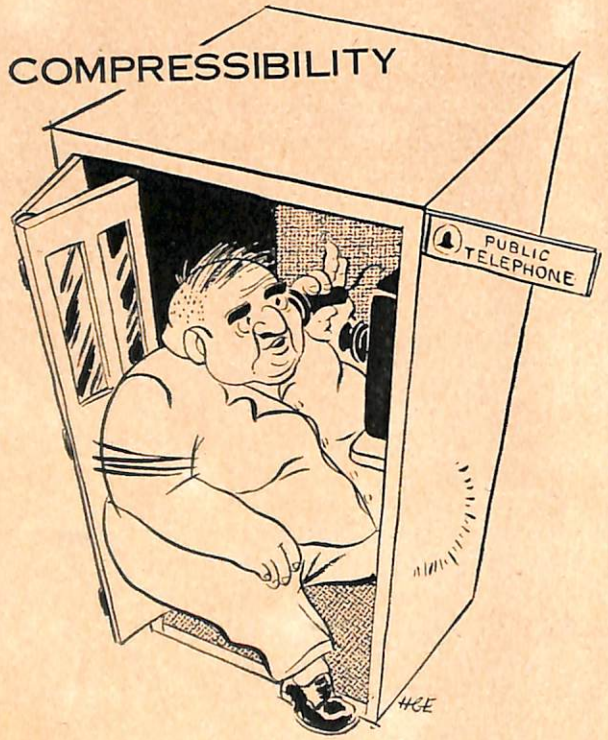
Hardness.—Hardness is a property of matter determined by the rigidity with which each individual particle of the substance is held in position. Hardness is important when judging the machinability and resistance to wear and abrasion of a material. A simple qualitative method of checking relative hardness is the scratch test. A diamond, for example, will scratch glass because it has a greater degree of hardness than glass. Indentation hardness is a measure of the opposition offered by a material to penetration. In the Brinnell Hardness Test, a hardened steel ball, ten millimeters in diameter, is pressed under a known pressure or weight into the surface of the material to be tested. Standard loads are 3000 kg for very hard materials, 500 kg for medium hard materials, and 100 kg for soft materials. The load in kilograms divided by the area in square millimeters of the indentation made by the steel ball is called the Brinnell number.

Tenacity.—That property of matter by virtue of which it resists any force tending to fracture or disrupt it is known as tenacity. Tenacity is allied to hardness as well as other mechanical properties; more exact and distinguishing definitions would carry us beyond the scope of this work. Tenacity and elasticity are important properties of matter in mechanical and construction engineering work. Such factors as tensile, compression, shear, and torsional strengths depend upon the tenacity of a material. When a body is strained beyond the elastic limit a certain amount of "plastic deformation" occurs before the body actually breaks or fractures. Broadly speaking, tensile strength is a measure of the maximum stretching force that can be applied to a material before plastic deformation occurs. Compression strength is similarly defined, except that the applied force tends to crush the sample rather than to stretch it. Tensile and compression strength are usually expressed in pounds per square inch of cross-sectional area. In general, tensile and compression strengths are very nearly equal for a given material. The compression yield point, however, of a material is usually quite different from the tensile yield point, since a tensile force acts to decrease the cross-sectional area by elongating the material, whereas a compression force acts to increase the cross-sectional area. The yield point is the maximum force that can be applied to a material before it actually fractures.



A shear force is one that tends to fracture a material by sliding the molecules over each other. Shear strength is the maximum shear force that can be applied to a material without causing plastic deformation. It is a rather difficult quantity to evaluate accurately.

Torsional strength is the maximum twisting force that can be applied to a material without causing plastic deformation. It is a composite stress, consisting of compression, tension, and shearing. It is important in the design of axles and shafts for rotating equipment. In most steels, brasses, and some aluminum alloys, the shear strength is approximately 0.6 to 0.7 times the tensile strength, whereas the torsional strength ranges from 0.8 to 0.9 times the tensile strength.



Ductility.—When a tensile strain causes a considerable amount of plastic deformation before a fracture occurs, the material is said to be ductile. The property of ductility is commonly associated with metals. Copper, gold, aluminum, and lead are metals of high ductility. Tungsten, normally a hard brittle metal, when properly worked becomes quite ductile, and can be drawn into wires or filaments less than 0.0001 inch in diameter. This property in combination with the high melting point of tungsten (approximately 6100° Fahrenheit), makes it an ideal material for use in incandescent lamps.

Brittleness.—Brittleness is an important property of matter, when resistance to shock is considered. Porcelain and pyrex insulators have relatively high tensile and compression strength, but frequently fail when subjected to the shock of gunfire. Metals like vanadium steel and monel metal are very tough; that is, they have a very low degree of brittleness. Cast iron has a comparatively high degree of brittleness, and cast iron castings are easily broken by sudden shocks.

Malleability.—A property similar to ductility is called malleability. If a large amount of plastic deformation occurs when a material is subject to a compression force, the material is said to have a high degree of malleability. Gold is very malleable for it can be beaten or rolled into sheets less than 0.001 inch thick. Aluminum, lead, and tin are very malleable and are used in large quantities in industry in the form of thin foils, as in cigarette packages and boxes of candy.

Viscosity.—The phrase "slower than molasses in January" refers to a special property of gases, liquids, and semi-liquids known as viscosity. This property is a measure of the internal friction between molecules as they flow or roll over each other. Viscosity is of greatest interest in the field of lubrication; practically all lubricating oils and greases carry a viscosity number or rating.

The range of viscosity values is quite large, a gas being capable of flowing a thousand or more times more readily than a liquid. The lower the viscosity the more readily a material will flow. Ether, a highly volatile liquid, has a very low viscosity rating in comparison with other liquids.

Viscosity is closely associated with temperature and pressure. The Saybolt Universal Viscosity Meter is a device which measures the time required for a fixed quantity of a liquid or semi-liquid at a specified temperature and pressure to flow through a tube of known dimensions. The viscosity is expressed in seconds, Saybolt. In the automotive lubrication field, the Society of Automotive Engineers has established a series of S.A.E. numbers, each number representing a limited viscosity range in seconds, Saybolt. For example, S.A.E. 10 oil has a viscosity range of 90 to 120 seconds, Saybolt at normal atmospheric pressure and a temperature of 130° F. Under the same conditions S.A.E. 20 oil falls within the range 120 to 185 seconds. Oils heavier than S.A.E. 30 are tested at 210° F, S.A.E. 40 oil having a viscosity less than 80 seconds at this temperature. Other factors of importance in judging lubricating oils and greases are cloud and pour points, flash and fire points, carbon residue, ash content, oxidization, corrosion, neutralizing number, and oiliness.

Oiliness is a complex phenomenon that has a strong influence on friction when the oil film separating the rubbing surfaces becomes very thin. In films a few molecules thick viscosity is of minor importance when compared to oiliness. Under such conditions the amount of friction occurring in bearings of different materials will vary over a wide range, even though lubricants of the same viscosity are used under identical conditions of pressure and temperature.

The U. S. Navy has established rigid specifications for lubricating oils and greases. When time permits the student should familiarize himself with these specifications, for the lubrication of equipment is assuming greater and greater importance in the life of the electronics engineer.

Density of Common Materials

Solids

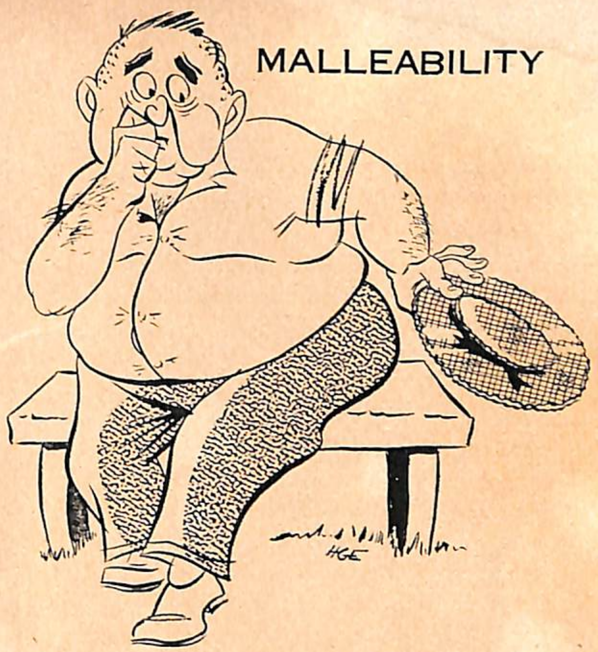
Name	*Density gm/cm³ 20° C*
Aluminum	2.70
Brass, yellow	8.6
Carbon, graphite	2.25
Copper	8.9
Glass, common	2.4-2.8
Glass, flint	2.9-5.9
Gold	19.3
Iron	7.9
Lead	11.3
Magnesium	1.74
Osmium (heaviest solid)	22.48
Platinum	21.4
Quartz	2.65
Tin	5.75
Tungsten	19.3
Uranium	18.68
Wood, balsa	0.11-0.14
Wood, ebony	1.1-1.3
Wood, oak	0.6-0.9
Zinc	7.1

Liquids

Name	*Density gm/cm³ 20° C*
Alcohol, ethyl	0.79
Carbon tetrachloride	1.59
Ether	0.72
Gasoline	0.7-0.8
Glycerine	1.260
Mercury (heaviest liquid)	13.6
Oils, lubricating	0.9-0.93
Oil, crude	0.8-1.0
Water, distilled	1.000 (4° C)
Water, sea	1.026

Gases

Name	*Density gm/cm³ NTP*
Air, dry	0.001293
Carbon dioxide	0.001977
Helium	0.0001785
Hydrogen	0.0000899
Nitrogen	0.001251
Oxygen	0.001429
Radon (heaviest gas)	0.00973



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EXERCISE PROBLEMS

PART 3

1. A battleship has a rated displacement of 35,000 tons. What volume of sea water in cubic feet does this represent? (Long ton = 2240 lbs.)

2. A hard-drawn copper wire is 0.128 inch in diameter. If the elastic limit of hard-drawn copper is 28,000 lb/in², what is the maximum tensile load that can be applied to the wire without exceeding this limit?

3. What pressure in lb/in² is exerted by a column of mercury 76 cm high?

4. A body weighs 4.2 gm in air, 3.5 gm in water, and 3.64 gm in alcohol. What is the density of the alcohol?

5. The deepest known depth in the Pacific Ocean is the Emden Depth off the coast of the Philippine Islands. If the water is 35,400 feet deep at this point what is the pressure in tons per square foot on the ocean floor?

6. A hydrometer weighs 18.2 gm and has a calibrated stem 1 cm in outside diameter. When immersed in distilled water, the length of the stem below the water surface is 15 cm. What length of stem from the 1.00 mark on the scale should project above the liquid surface when the hydrometer is placed in glycerine?

CORROSION IN MODEL JT SONAR

The Bureau of Ships has received reports of corrosion in the gear box to the Mare Island type training shaft of the Model JT listening sonar equipment. This corrosion is due to seepage of salt water through the training shaft packing into the drip shield assembly. When water fills the shield (which may occur often because the shield's capacity is limited) the overflow drips down the housing and enters the gear box, causing corrosion of the gears.

A drain plug is provided on the outside of the housing of the training shaft to remove the water in the drip shield. Frequent removal of this plug will allow the water to flow out and prevent its entering the gear box and corroding the gears. Another solution is to remove the drain plug and connect the drain hole to the bilge through a hose, thus permitting the water to drain off as fast as it accumulates in the drip shield.

Excessive seepage can be corrected by tightening the nuts fastening the packing glands. These glands should not be tightened, however, until no moisture seeps through at all. There should be a slight weeping in order to keep the packing moist and prevent binding of the shaft.

GASKETS FOR WAVEGUIDE FLANGES

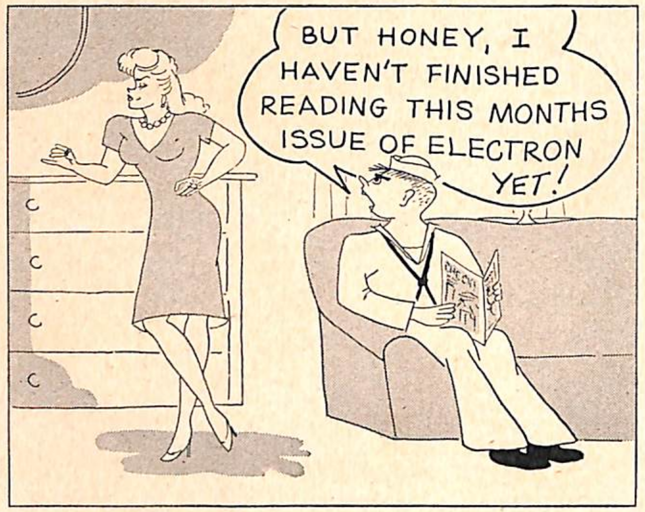
A recent report received from a naval shipyard indicated that a particular model SP radar had not operated with any degree of efficiency for months.

Investigation by engineers led to the conclusion that a defective rotary joint existed in the antenna. Removal of the antenna revealed that hard asbestos gaskets were installed between the vertical waveguide and the angle connector to the stub tuner section. Further inspection of the waveguide run below the antenna revealed similar gaskets located in each of four successive waveguide flange connections. The rotary joint was in good condition, but deposits were found between the waveguide flange and gaskets. After the proper gaskets were installed the operating efficiency of the equipment was greatly improved.

The proper gaskets for use on model SP waveguide flange are made of neoprene. As emphasized by the above incident, it is inadvisable to install substitute gaskets except as an emergency measure. If such a measure is taken, it is requested that a tag indicating the type of gasket used be wired to each waveguide junction where a substitute gasket is installed.

ZEROING MODEL SR-3 SYNCHROS

All Model SR-3 radar equipments bearing serial numbers 1 to 25, and spare antenna pedestals bearing serial numbers 1 to 10 were shipped from the factory with the synchros zeroed between terminals S-2 and S-3. Navy standard practice requires that synchros be zeroed with zero volts between terminals S-1 and S-3, as set forth on page 111 of "U. S. Navy Synchros" (Ordnance Pamphlet No. 1303). It is therefore requested that all synchros in these antenna pedestals be re-zeroed in accordance with Navy standard practice. Any of the methods for zeroing synchros outlined on pages 111 to 123 of OP-1303 will be satisfactory for this purpose. This operation has been assigned the title "Field Change No. 4—SR-3 Radar."



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ANSWERS TO EXERCISE PROBLEMS
BASIC PHYSICS, PART 2

1. $P = \frac{ml^2}{t^3}$.
2. 2200 lb.
3. 3.27 ft; 0.82 ft.
4. 4 hp.
5. 0.19 hp.
6. 31,400 ft-lb.
7. 637,000 ft-lb; 159,000 ft-lb.
8. 21 hp.
9. $2.42.
10. $13.88.

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ADDRESS NAVY DEPARTMENT
BUREAU OF SHIPS

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NAVY DEPARTMENT
BUREAU OF SHIPS
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

1 September 1947

AN OPEN LETTER TO ALL COMMANDING OFFICERS

Subject: The FORUM

1. The FORUM is a department in BuShips ELECTRON which is intended for use by all technical naval personnel in asking questions, making recommendations and discussing in general their technical problems. Behind The FORUM lie the various sections of BuShips, always obligingly prompt to answer questions, review suggestions and advise the field on proper repair and maintenance procedures not outlined in the instruction books. Backed in that manner by technical and engineering skill, The FORUM constitutes an ideal medium through which all kinds of questions and ideas may be aired and problems solved.

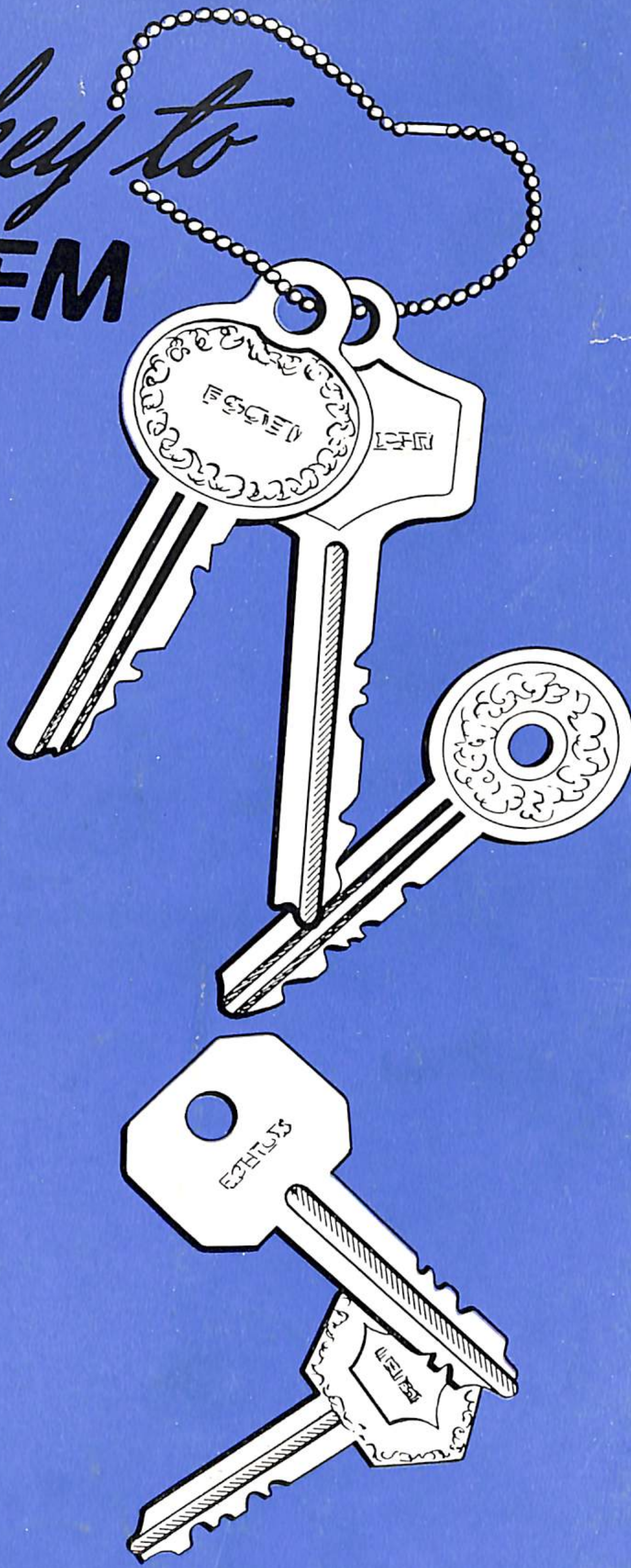
2. The FORUM is published because the Bureau recognizes that the field of electronics is so vast that no man can be expected to know all about it; that many types of equipment are so complicated that all of the features can not be thoroughly understood by any but graduate engineers. Frequently, because of the complexity of some forms of electronic equipment, things happen which were not conceived of when the instruction books were published.

3. Official correspondence may at times appear to offer a solution to the difficulties, but means of surmounting the difficulties may or might not be given in the replies. The FORUM, on the other hand, gets immediate results and gets it to all personnel concerned.

4. In the electronics field of the navy the fastest and most all-inclusive way to get results from questions and beneficial suggestions is through BuShips ELECTRON. In this magazine the department handling such things is The FORUM. Personnel should therefore be encouraged to write to the ELECTRON, via their commanding officers, and contribute their problems and ideas to The FORUM.

EDITOR, BuShips ELECTRON

We may have the key to
YOUR PROBLEM



Is all of your equipment performing in top-notch manner? Are there no abnormalities which you can not correct? Is your E. O. perfectly satisfied with the equipment as presently maintained? If you can answer YES to each of these questions, you need not read further.

If, however, you are not a genius, but just an expert who does have problems, submit the problems to ELECTRON. We may not be able to help you, but we know people who can and will.

DON'T DELAY · WRITE TODAY