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

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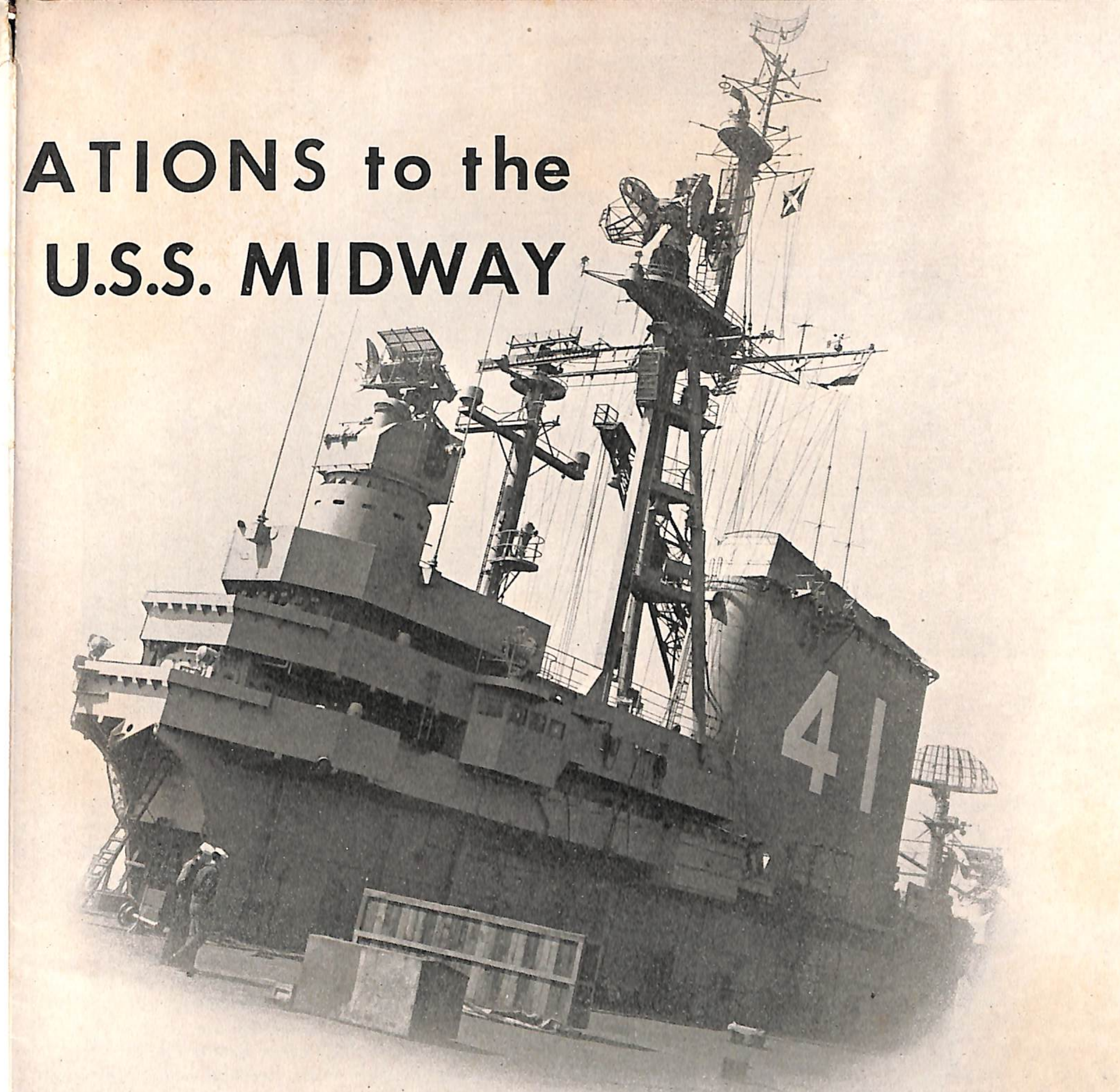
BUREAU OF SHIPS — NAVY DEPARTMENT

ALTERATIONS to the U.S.S. MIDWAY



■ After an overhaul period of nine months duration the USS *Midway* left the Norfolk Naval Shipyard late in March with her appearance radically changed due to extensive structural, electrical, ordnance and electronic alterations. The island structure was modified and practically every unit of electronic gear had been removed, replaced or relocated during this availability which resulted from the necessity for improving and expanding the conning area and the various radio and radar facilities. The job was so extensive that at one time practically the entire island structure, radar mast, tripod mainmast and forward flight-deck gun director had been removed.

The four antenna towers, a familiar feature of former carriers, which once soared nearly forty feet above the flight deck, were replaced by a series of some twenty individual tilting whip antennas located forward and aft on both sides of the ship. The island structure itself was enlarged and com-

View to port in the Combat Information Center. Note the new control desk layout with the CIC Officer's position facing the large Mark-4 plotting board.

pletely rearranged, the Mark-37 gun director and its associated Mark-12 radar antenna was raised thirty feet and is now situated on top of the island, the familiar SK-3 radar antenna was replaced by the new and more modest appearing SR-3. Completing the topside picture are the now accepted myriad rotating beacon, RCM, and search-radar antennas, including the SX radar with its igloo, the fixed IFF and beacon antennas, the HF, VHF, and UHF dipoles, the AEW link stubs and dipoles and the whip antennas. It is a collection which has revolutionized the appearance of every large Naval vessel.

Some extent of the vast electronic program may be realized from consideration of the following accomplishments: relocating Radio III nearly 200 feet away from its former location; establishing new electronic compartments or spaces consisting of a Teletype Room, Message Center and nineteen fire-control radar rooms; installing new teletype and UHF installations; completely rearranging the CIC Radar Transmitter Room, Radio VIII and PO radar room; replacing and adding various radar repeaters; installing the new SR-3 radar; adding a considerable number of radiophone units; revamping the radio remote-control system; adding radiophone, transmitter, receiver, antenna and remote channel-selector transfer panels in Radio Central.

Among the major changes listed above, certain represent slight deviations from previous concepts and policies while others represent radically new ideas and developments. Among these are the CIC arrangement, the UHF and teletype installations, the manually-operated tuner for the transmitting antenna whips, the SR-3 radar installation, the creation of a message center, and the establishment of the C.W.O. at a location remote from Radio Central.

COMBAT INFORMATION CENTER

The outstanding feature of the new CIC is the control desk layout which, in brief, consists of two specially built tilt-top consoles assigned to the Ship's-CIC Officer and the Group-CIC Officer. These desks, flanked and separated by three VJ repeaters tilted to conform, directly face the large Mark-4 vertical plot. Built in or attached to these desks are radiophone and telephone selector switches, jacks and handsets. Similar units are located adjacent to the above-mentioned repeaters as are MC units, radio speaker-amplifiers and target designation panels. To accommodate this layout it was found necessary to remove and relocate the SR-3 and SG-3 radar indicators. The remaining equipment in CIC differs but little from the former layout. It consists, in general, of four SX Radar Consoles, AEW control and indicating units, VG-2 and VF repeaters for surface plot and the usual radiophone selector switches and patch panel.

RADIO INTERCEPT ROOM

This compartment is located on the gallery deck level between frames 9 and 16. It contains the following equipment:

- 1 RBA Receiver
- 2 RBB Receivers
- 3 RBC Receivers
- 2 RBK Receivers
- 1 LM Frequency Meter
- 1 RBV Panoramic Adapter
- 1 VRW Recorder
- 2 RCF Receivers (To be installed later)

Five antennas are provided for these receivers and they are located on the port side of the ship between frames 29 and $37\frac{1}{2}$. These antennas as well as those installed for Radio II and Radio III are of the tilting whip variety. During flight operations is is necessary that they be lowered as they may obstruct aircraft. Ease of operation in lowering and raising antennas of this type is greatly facilitated by the use of carefully adjusted counterweights.

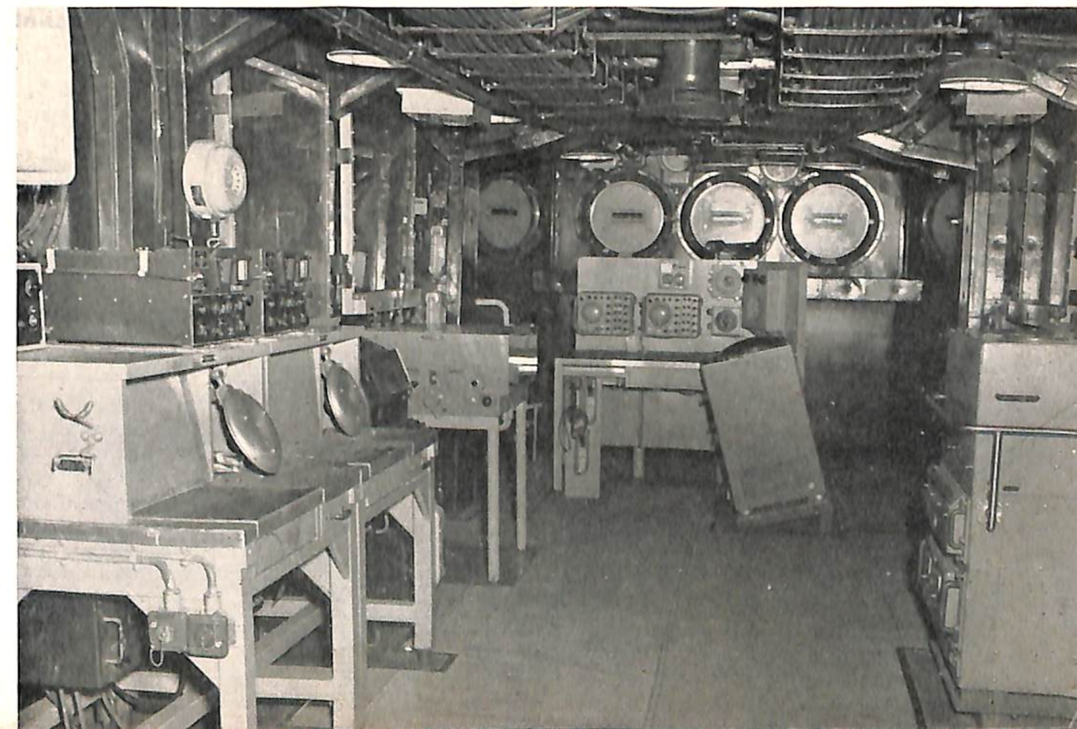
UHF EQUIPMENT

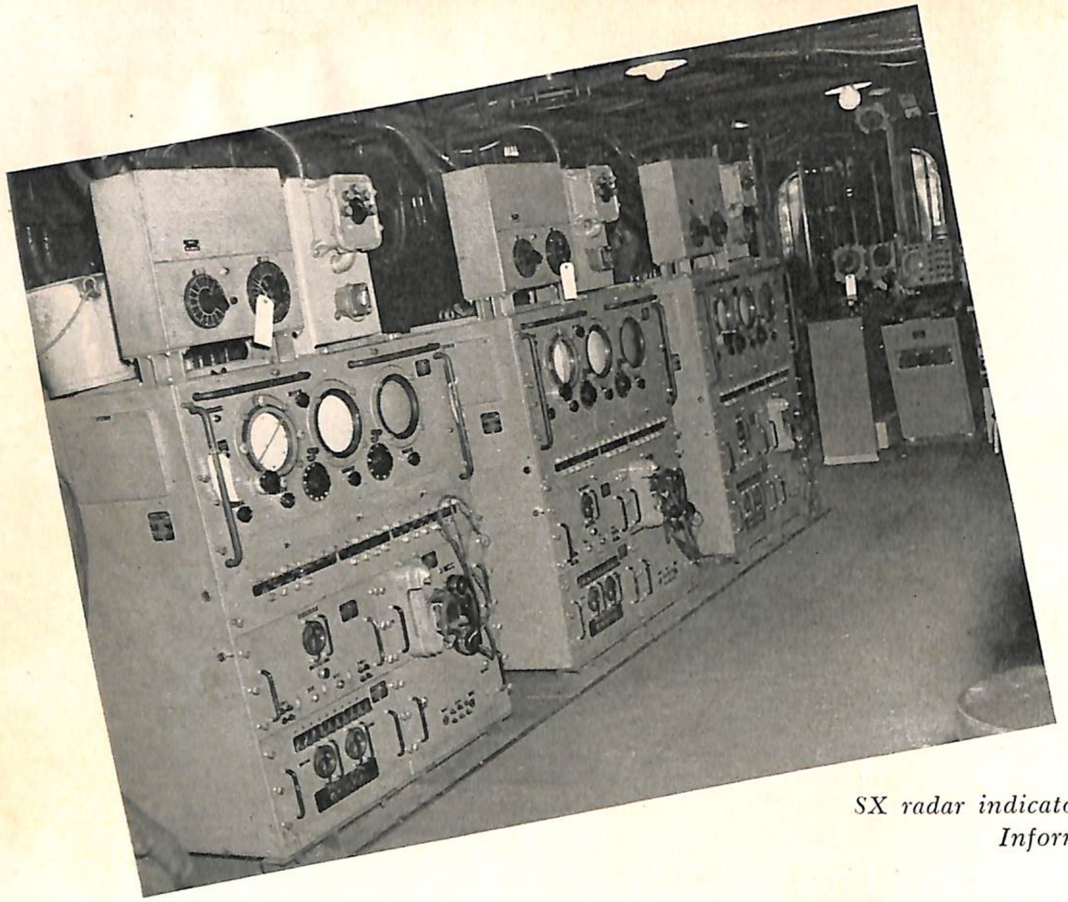
The Navy's UHF program includes the installation of eight Model RDZ receivers and three Model TDZ transmitters on this class of carrier. Two of the TDZ transmitters and six of the RDZ receivers are installed in the Message Center. The other TDZ and the two RDZ's are located in Radio VIII. The locations for these equipments were selected because there was no other suitable space available which would provide shorter cable runs. In Radio I, Flag Plot, and CIC there are remote selector control units which in conjunction with patch panel connections provide complete flexibility so that in case of failure of its TDZ no one of these control stations would be rendered impotent. In addition to this equipment the ship has one MAR Transceiver and an RDR Receiver for portable and emergency use.

VHF EQUIPMENT

In the VHF installation the interesting feature is the special antenna used on one of the TBS equipments. This specific equipment is the one installed in Radio III and has its antenna mounted on the Landing Signal Officer's Platform. The regular type 66015 TBS antenna could not be used since it is of the ground-plane type with a vertical radiator. As the plane of the LSO platform varies 90 degrees between its stowed and in-use positions, this type of antenna could not be used. A dipole antenna was manufactured, using two type 66044

Flag Plot, view looking forward.





SX radar indicator consoles in the Combat Information Center.

antennas, and was mounted on the top or outboard edge of the LSO platform. Although the antenna pattern obtained with a dipole is not circular, the pattern obtained with this type of antenna gives good coverage for all azimuths. Locating the dipole on the LSO platform is a disadvantage because of loss of height over locations on the superstructure, it is subjected to mechanical shock when the platform is released from the stowed position, and it is shielded to some extent from ships to starboard by the flight deck.

TELETYPE

The rather elaborate teletype system installed aboard during this period provides a degree of flexibility and utility which is believed to be higher than any previous shipboard installation. Teletype units are located in the Teletype Room, Flag Plot and the Message Center. By means of a teletype patch panel, connections to any one of the RDZ's can be provided in addition to the usual lines to the frequency-shift keyers in the radio transmitter rooms. Any machine can be patched for tone-channel operation of any A-3 transmitter as well as for FSK operation of the TBM's.

In the Teletype Room, a new communication space located adjacent to Radio Central, there are the following equipments:

6 Receivers
6 FSK Converters
1 No. 14 Teletypewriter
4 No. 15 Teletypewriters
2 No. 19 Teletypewriters
1 TTY Transfer Panel
2 TH-1/TCC-1 Terminals

The teletype lines of the two FSA Frequency-Shift Keyers located in Radio II and Radio III, respectively, are terminated in jacks on the transfer panel in this space. It is also possible to connect the output of any one of the six Model RDZ receivers and the microphone and keying leads of the two Model TH-1/TCC-1 Terminal Equipments since these connections also terminate in the teletype transfer panel. Such an arrangement provides the advantage of great flexibility.

ANTENNA TUNERS

Another point of interest is the installation of manual antenna tuners which are expected to improve transmission efficiency by providing the proper impedance match between transmission lines and antennas. At present these tuners are stop-gap devices because there is a remotely operated unit under development. However, they are a start in the Bureau's program of replacing antenna trunks with coaxial lines.

A major problem of long standing has been the need of a suitable method for efficiently transferring radio frequency energy from the transmitters to the antennas. The antenna tuner is one method, and it is now being given a trial. This unit has the advantage of requiring a 50-ohm transmission line rather than the metal antenna trunks with copper bus mounted on stand-off insulators. It affords a great reduction in weight and at the same time provides greater water-tight integrity. The tuners also, in providing proper termination for the 50-ohm line, can greatly reduce the standing waves on the line and thereby make possible the efficient transfer of energy. Preliminary tests indicate that this method is feasible and seems to be one solution to the problem of energy transfer to antennas in the frequency range of 2-18 Mc. On this ship two of these units are connected to the TCK transmitter and the third to a model TCS equipment.

COUNTERMEASURES

The radar countermeasures installation consists of the Models RDO and AN/SPR-2 Receivers, the Model RDP Panoramic Adapter, the Model RDJ Pulse Analyzer and the Model DBM-1 Direction Finder. All coaxial transmission lines are terminated in a type J1116/SPR Patch Panel. The special feature of the job was the manufacture of a coupler for use with the 1½" x 3" waveguide of the AS-45A/APR-6 "Y" antenna. The authorized coupler is not yet available. The plan RE 50F131A, which was reproduced on page 4 of the R.I.B. No. 168 (7 April 1946), was used in the manufacture.

RADAR

The extensive radar alterations presented a number of interesting problems but the one most worthy of note was in the installation of the relatively new SR-3 air-search radar. This equipment uses oversized waveguide which must be installed without twists, and considerable difficulty was encountered in routing it through the long path from the transmitter to the antenna. From the experience thus obtained it is apparent that future installations of this type of equipment will have to be designed with the waveguide run taking priority over the location of the transmitter.

The SG-3 radar installation was accomplished by converting the SG-4X previously installed on the ship. The Elevation Control Unit, Mk-8/4 Stable Element, DG Synchro Amplifier, Antenna Control Unit and Antenna Assembly of the SG-4X were removed and replaced by an SG-3 Antenna Control Unit and Antenna Assembly. The previous installation of the SG-4X had involved a stabilized antenna which was difficult to maintain. At the yard's suggestion the Bureau approved conversion of this to the SG-3 equipment with the standard broad vertical beam.

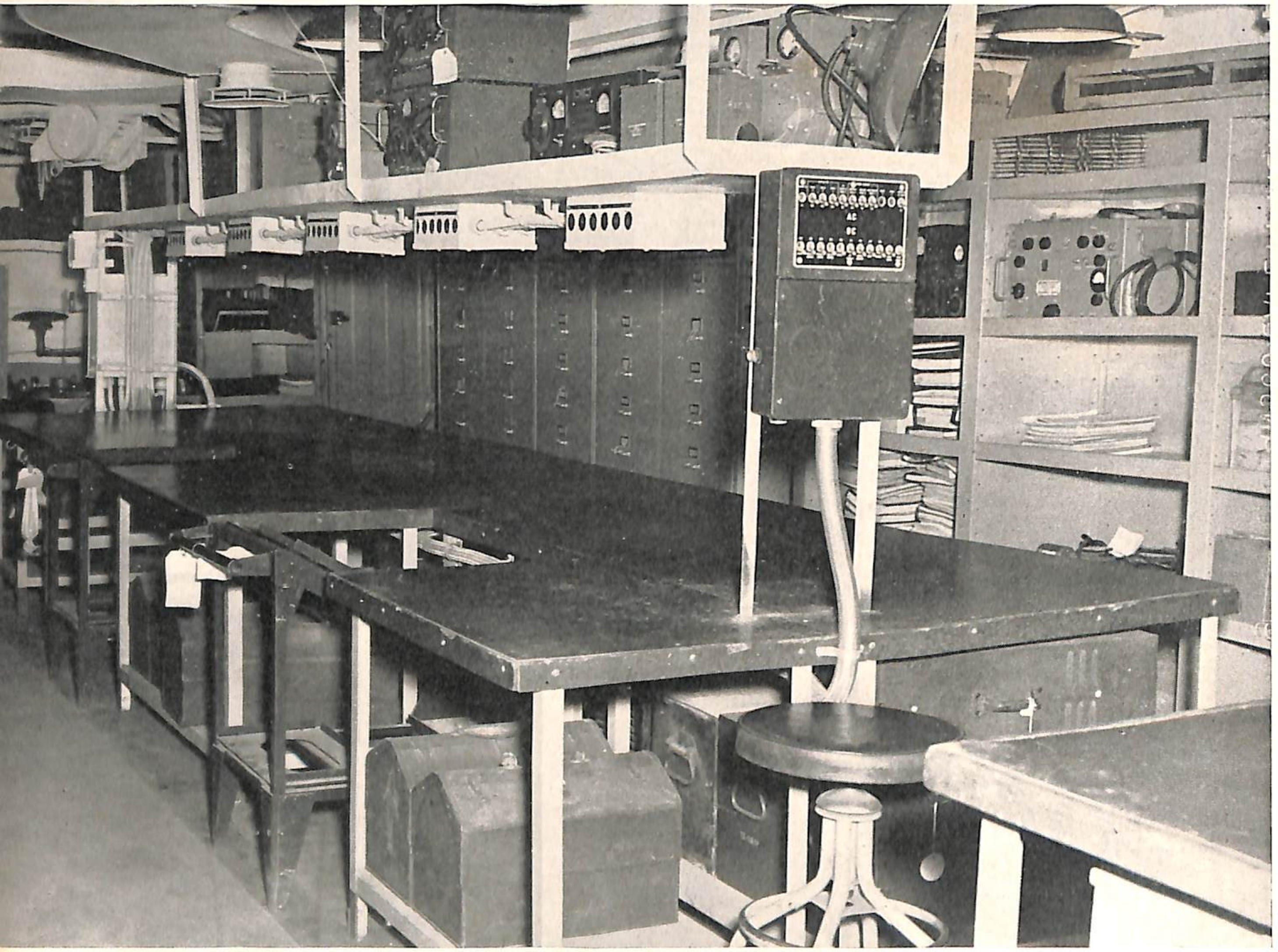
Remote repeater installations also presented problems. The installation plans used in rearranging the CIC were developed for the CVB-43, which used a Type CM-23AGU Radar Distribution

The new teletype room, looking toward the forward port corner.

Switchboard, while this ship had a Type CM-23AFL. The difficulty was that the VJ repeater selector switch, which was satisfactory for the -23AGU, would not operate satisfactorily with the -23AFL. It was necessary to either modify the VJ switch or to install Type CM-23316 train-order switches. It was decided to modify the VJ switch, as the installation of train-order switches was not feasible on this ship. The operation of the modified VJ remote system is similar to that using the CM-24316 switch, the only difference being that the indicator light in the selector switch incorporated in the VJ remote having this modification will light on any radar position or selector switch on the RDS board, while the light on a train-order switch will light only when the RDS radar switch is on the selected position.

It was found necessary to parallel two remote stations in this ship as the RDS board has 20 outputs, and 21 outputs were required. These 21 positions included the 16 Remote PPI's, 4 SX (CXHR) consoles (the SX console in flag plot was removed from this ship) and 1 AEW position.

Modifications to Aviation Electronics Workshop facilities were completed on this ship in order to provide bench space and power supplies for the continued operation of AEW carrier-based aircraft. This installation was accomplished in accordance with CV-33-type plans with a few minor alterations. These alterations are being incorporated in the type plan which will be used for the CVB-42 and CVB-43 installation.



The AEW radar workshop. Note the numerous facilities, convenience outlets, large work benches, test equipment, etc.

All radar search indicators were removed from CIC excepting the fighter-director radar consoles (SX) and the AEW indicators. CIC was rearranged to include 4 SX consoles, 3 AEW indicators (1 VD-2 and 2 VJ's), 3 VJ, 1 VF, and 1 VG-2 remote PPI's. The indicators for the SR-3 (which replaced the SK-3) and SG-3 equipments were installed in the PO Radar Room.

The fire-control radar installation on this ship is an interim installation. It consists of 3 Mk12/1-Mk22/0-Mk32/1; 8 Mk34/2, 2 Mk34/4, and 5 Mk34/7 radar equipments. On 4 of the Mk34/2 equipments it was necessary to replace the 500-ohm potentiometer R-588 in the range unit with a 5000-ohm potentiometer, as the Mk63 G.F.C.S. in these systems had a Mk4/2 range receiver in place of the Mk2/0 receiver. This potentiometer is supplied with the Mk4/2 receiver.

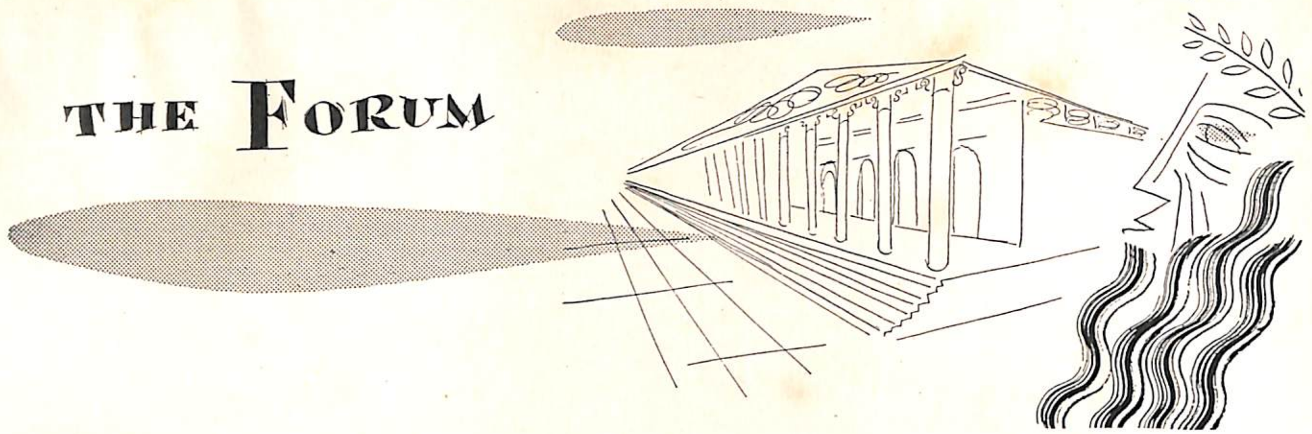
The Mk34/7 radars were converted from Mk34/4 by replacing R-591 (145 ohms) and R-592 (2800 ohms) in the range unit with 475-ohm and 1600-ohm resistors (1% tolerance) respectively. This change was required by the ballistics of the Mk57 G.F.C.S. The Mk34/4 radar is used when the Mk57 G.F.C.S. controls 40-mm and 5″/38 guns. In this case the Mk57 G.F.C.S. controlled 40-mm and 5″/54 guns.

There are five master control oscillators, Mk1 Mod 2 installed in this ship to control the firing order of the Mk34 equipments, one for each quadrant and one for main-battery control. These oscillators have four output channels at a frequency of $1800 \pm 10\%$ cycles per second, with variable amplitudes and a fixed phase displacement between outputs. The output triggers the modulation generator of the Mk34 equipments. The phase displacement of the oscillators is such as to reduce interference between adjacent Mk34 equipments. This process is similar to phasing the Mk12 equipments where the lobing and spark-gap motors are phased on each Mk12 installation to reduce the interference between the three installations. These radar and and radio alterations are being incorporated in the construction of the CVB-43 and will also be accomplished on the CVB-42.

In conclusion, it is interesting to note the quantity of electronic equipment installed aboard the *Midway:*

Quantity	*Equipment*	*Type*
1	Homing Beacon	YE-3
44	Radio Transmitters	(Various types)
72	Radio Receivers	(Various types)
1	Large Air-Search Radar	SR-3
1	Medium Air-Search Radar	SR-2
1	Large Surface-Search Radar	SG-3
1	Racon	CPN-6
1	Large Fighter - Director Radar	SX (CXHR)
1	Aircraft Early-Warning Radar	AEW (PO)
3	Fire Control Radar	Mk 12/1
3	Fire Control Radar	Mk 22/0
3	Fire Control Radar	Mk 32 (F.C.I.F.F.) /1
8	Fire Control Radar	Mk 34/2
2	Fire Control Radar	Mk 34/4
5	Fire Control Radar	Mk 34/7
1	Remote Indicator (PPI)	VG-2
4	Remote Indicators (PPI)	VF
11	Remote Indicators (PPI)	VJ
2	Interrogator Responsors	BM-1
1	Interrogator Responsor	BO-1
1	Nancy Equipment	X3A Beacon System
4	Nancy Equipment	AM Receivers
4	Nancy Equipment	C-3 Hand Held Receivers
4	Nancy Equipment	H Searchlight Hoods
3	Transponders	BK-5
1	RCM Receiver	RDO series
1	RCM Receiver	AN/SPR-2
1	Pulse analyzer	RDJ series
1	Panoramic Adapter	RDP series
1	Panoramic Adapter	RBV-1,
5	Panoramic Adapters	RBV series
2	Panoramic Adapters	RBW series
1	Direction Finder System	DBM-1
2	Recorders, Voice and CW	VRW
1	Echo Sounding Equipment	NMC-1
1	Loran Equipment	DAS-3
20	Radiophone Selector Switches	Type 24502
12	Teletype Machines	(Various types)
1	Radiosonde Equipment	FMQ-1
36	Radiophone Units	(Various types)
2	Frequency-Shift Keyers	FSA
6	Frequency-Shift Converters	FRA
2	Teletype Terminal Equipment	TH-1/TCC-1

THE FORUM



LOW SENSITIVITY ON THE SV-1 RADAR

Joe Bartholomew, ETM1c, USS Diodon *(SS-349)*

On recent Pacific maneuvers, I noticed that the sensitivity of my SV-1 radar had decreased, and I had a false echo at about 5000 yards on all bearings. With the mast on either one of the operating levels, the battle announcing equipment was highly modulated at the SV pulse rate. Operation was normal, however, on dummy antenna.

Snooping around the pump room where access can be had to the bottom of the mast, I found that the whole bulkhead was hot. I could draw a nice r-f arc from any part of it with a screwdriver while the transmitter was in operation.

We dropped the bottom of the mast and found a little oil in the waveguide. There was also quite a bit of pressure in the mast. The pressure probably had leaked in while we were on a deep dive. Upon correction of these two faults, my troubles disappeared. You can take your pick as to whether it was the oil or the pressure, or the combination, that caused my trouble.

Bureau Comment: The cause of the trouble cannot be determined without more specific information about the conditions that prevailed at the time. Past experience has shown, however, that oil leakage through polystyrene windows can cause large standing waves with a possible node at the base of the mast.

SU TROUBLES

W. L. Morris, ETM3, USS Edisto *(AG-89)*

Two weeks ago, when we were just out of Panama and navigating solely by radar, T-507 in our Model SU radar set burned out. We replaced T-507 in short order but couldn't figure the cause of its failing. A few days later I happened to read your ELECTRON article on defective 2X2 tubes causing this same trouble on other SU radars. Needless to say, we followed the advice of the article and installed a 2X2A, possibly averting a recurrence of this same failure.

I would be interested to know if other SU radars in the fleet are having trouble with their 300-volt supply failing due to overload. We have blown F-501 on several different occasions. On one occasion we found R-752 burned out, and on another, R-764, both for no apparent reason. After replacement with resistors with higher wattage ratings, we have had no further trouble.

Bureau Comment: Failure reports received to date by the Bureau of Ships do not indicate excessive failure of the 300-volt supply of the Model SU radar. It should be noted, however, that a defective or shorted tube V-538 could cause R-752 to burn out.

UNUSUAL RADIO CONDITION

USS Turner (DD-834)

At 2130 GCT on the 4th of February 1947 while operating off the coast of Lower California with the USS *Charles P. Cecil* (DD-835) and the USS *Agerholm* (DD-826) we picked up voice transmission from the USS *Hanson* (DD-832) on 39.4 megacycles (MN radio). The signals were very clear and of about strength three. A radio check was made with the *Hanson* and they reported that our signals were also being picked up strong and clear.

This seemed to be very unusual because the output power of the MN transmitter is only two watts and the distance between the *Hanson* and our ship was great. The *Hanson* was in the Atlantic in Lat. 34° 8′ and Long. 75° 5′ W, while we were in the Pacific in Lat. 32° 30′ N and Long. 118° 36′ W.

Bureau Comment: The Bureau greatly appreciates information on incidents of this nature. This one is strange indeed. Although the time and frequency are ideal for such a happening, the low power of the equipment would seem to reduce the probability of attaining this great range.

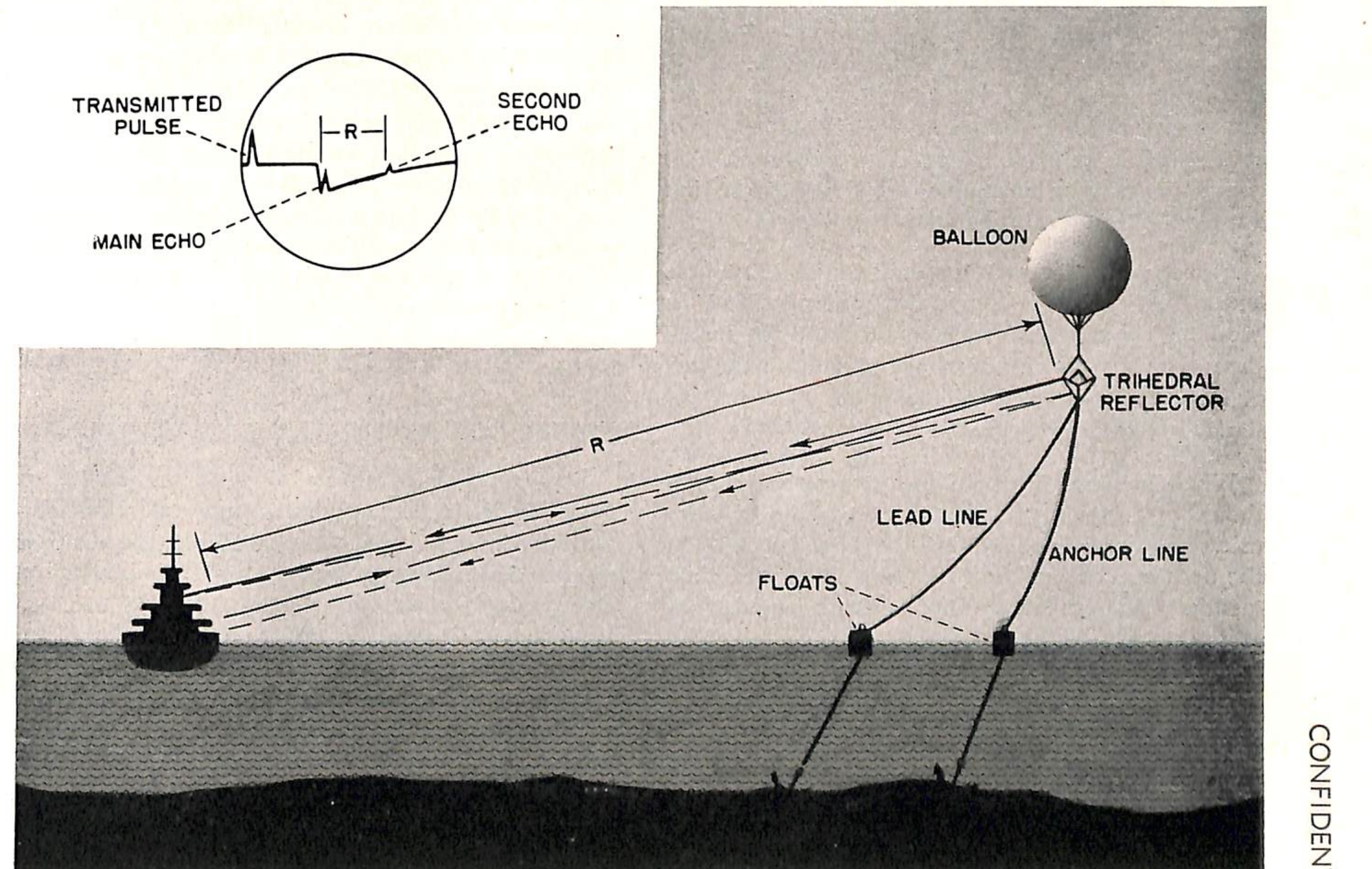
The ML-307A/AP Reflector . . . . .

The ML-307A/AP trihedral balloon-borne radar reflector was originally used in connection with radar equipments to obtain data on winds aloft. This reflector was later adopted for use as a target for boresighting fire control radar antennas with the optical systems of the associated guns and directors. A general description of this arrangement, method of operation, procedure for assembly, and preparation for release of balloon and reflector are contained in Ordnance Pamphlet No. 1652 (obtainable from the nearest District Publication and Printing Office).

For calibrating and checking the range of search and fire control radar equipments, a good stationary target is needed. The trihedral reflector, when used as described in OP 1652, provides an adequate target for checking the dynamic performance of fire control radar systems, and for aligning radar antennas with optics when only minor adjustments are necessary. Only a limited amount of time, however, is available for tracking, depending on the amount of balloon inflation and the wind velocity encountered at the time of the tests.

There are occasions arising while at sea, however, when it is necessary to check the radar equipments, and there are neither surface nor air targets available. In order to provide a stationary target above the surface of the water for checking the ranges of search and fire control radar equipments, the Pacific Fleet developed an ingenious method of using a balloon-borne radar reflector.

A type ML-307A/AP reflector supported by a 350-gram balloon is secured to an anchored float



Pictorial representation of a new system for calibrating radar equipments. Range R is independent of the zero-setting of the range unit of the radar set, as explained in the text.

by means of a small nylon line, as shown in the figure. A lead line, in addition to the anchor line, is needed to keep the balloon and reflector from drifting about due to wind currents.

Using the anchored balloon and reflector as a target, the zero-range setting of a radar set can be checked by the "double echo" method. This utilizes the fact that sufficient energy is returned from the target (reflector) to cause a secondary reflection from own ship. This secondary energy reflected by the ship strikes the target, is again reflected, and causes a second echo to appear on the radar indicator at approximately twice the range of the main echo. The range between the main echo and the second echo can be accurately measured, and can contain no error due to incorrect zero-setting of the range unit, because it is independent of this setting.

To perform the actual zero-setting adjustments and range calibration, the procedure outlined in the instruction book for the particular model radar set concerned should be followed.

For best results the target reflector should be anchored at 090 or 270 degrees relative bearing, since these are positions at which maximum secondary reflection occurs from own ship to the target reflector. Likewise, for most accurate results, the reflector should be anchored at the maximum range at which it is possible to receive a second echo of useable intensity and amplitude. This means that a range of 1000 yards or longer is preferred.

Although comparatively small in size, the trihedral reflector gives a good radar echo because its geometric figuration is such that a large portion of the radar signal is reflected back parallel to the line of incidence, regardless of the angle at which the signal strikes the reflector.

When used as shown in the figure, the reflector should give better results than those obtained when using another ship as a target for range checking by the double echo method. In addition, this arrangement has the advantage that it can be used while at anchor in clear areas when there are no other targets available, and has the further advantage that underway availability is not required for radar range calibrations.

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CORRECTION

May Electron, p. 7: The formula on the sixth line up from the bottom of the page should be changed to read $Z_o = \sqrt{Z_c \times Z_r}$.

UHF SELECTOR CONTROL UNIT

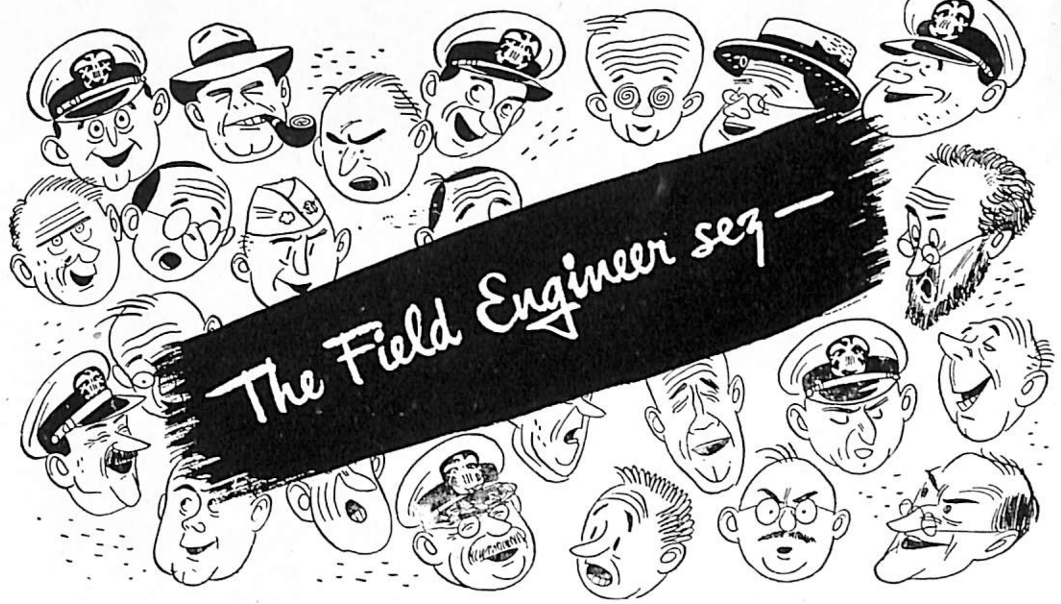
The Bureau of Ships has recently been advised of difficulty experienced in making the 23497 selector control unit operate with the Model TDZ transmitter when the 20409 power supply unit was not used. In this connection, some activities may be failing to note paragraph 4 (5) of the "Remote Control Instruction Book" (NavShips 900,777) which states "Insert the dummy plug P-102 (AN-3106-28-9P) provided with the selector control unit into socket J-102. This plug has jumpers soldered into it connecting pins J-A and K-L. This plug *must* be in place."

The instruction book has erroneously called this plug a "dummy" plug whereas actually it is the same one used in connecting the 20409 power supply unit to the 23497 selector control unit. Also in many instances the manufacturer has failed to solder the jumpers in place. This should be checked in each installation. The instruction book has also failed to note that when plug P-102 is used as a cable connector for connecting the power unit to the control unit, the jumpers must be removed.

Bureau of Ships drawings RE-65F-264E and RE-8F-788B, which show typical interconnection diagrams for TDZ-RDZ and MAR-RDR equipments respectively, are being modified to indicate the above important facts. These drawings show that the 20409 power supply unit is only required in MAR-RDR installations, in which case the jumpers in P-102 must be removed. An announcement listing the serial numbers of the equipments shipped minus jumpers will be published at a later date.

MODEL RCK ALIGNMENT CRYSTALS

Paragraph 4.13 of the instruction book for Model RCK radio receiving equipment (NavShips 900,228), specifies that a crystal for the channel frequency of 151.20 megacycles be used when aligning the oscillator-multiplier stages. Crystals for this frequency, however, are not available, and the Bureau of Ships does not contemplate any procurement of them. Accordingly, it has been decided that crystals for the channel frequency of 146.16 megacycles, which are available, should be used for alignment purposes. The alignment procedure as given in paragraph 4.13 of NavShips 900,228 remains unchanged except that crystals for the channel frequency of 146.16 megacycles are substituted for the specified 151.20-megacycle crystals. This change should be recorded in the instruction book.



HIGH-VACUUM RECTIFIERS

Many instances have been reported of fuses blowing in the high-voltage rectifier in the Mark 34 Mod. 2. Examination and experimentation by Western Electric engineers reveals that this condition is brought about by flaking of the cathodes of the type 836 tube in this unit. This has been determined to be a very common trouble in tubes of this type. Since this tube is a high-vacuum rectifier, the spacing between the cathode and the plate is very small and any flaking will usually result in a temporary short between cathode and plate. The usual cure has been to put in a new fuse and forget about it, since the tube has generally burned itself clear. However, it has been found desirable to attempt to jar other loose particles off by tapping with a wooden block or similar instrument before replacing the fuse, otherwise the cycle of events will probably repeat itself shortly after renewing the fuse.

This peculiarity of these tubes, which they share in common with most high-vacuum rectifier tubes, has no effect on their useful life and occurs only infrequently after the tube has been aged. However, on tubes which have just been put in service it can cause the ship's technicians a great deal of trouble looking for non-existent troubles, since flaking is much more pronounced until after all the loose particles have worked themselves off or have been jarred off. The useful life of these tubes is extremely long, and for the reasons mentioned above, it is inadvisable to make any replacement unless the equipment has had several thousand hours of use. —*Western Electric.*

TEST FOR PROPER IAGC OPERATION

IAGC (*Instantaneous Automatic Gain Control*) is incorporated in the new wide-band i-f amplifiers D-153034 for Mark 13, SS, etc., and D-153799 for Mark 25 Mod 2. The IAGC circuit is intended to permit signals to remain visible in the presence of CW jamming which would normally block out all targets. It also permits detection of signals through sea-return and low-frequency modulated jamming or railings. The circuit provides approximately 6 db improvement of the signal-to-jam or signal-to-sea-return ratio.

Under ordinary conditions the operation of the IAGC switch has little effect upon the indicator presentation and it is likely to leave one in doubt as to what constitutes proper operation of the circuit. For this reason the following special test has been devised. It has proven satisfactory, and is adaptable to most systems directly or through the use of a portable echo box.

1—Operate the waveguide switch to the ANTENNA position (in the case of the Mk25, to the ANTENNA AND ECHO BOX position).

2—By means appropriate to the system under test, couple an echo box into the r-f line.

3—With IAGC turned off, increase gain until the target echo is obscured by the ringing signal from the echo box.

4—Operate the IAGC switch to the ON position. The obscured target should again be discernible on the indicator.

This test has been proven to be satisfactory and is recommended for use where there is any doubt as to the proper operation of IAGC.

—Western Electric

DOUBLE RANGE SWEEPS ON THE MARK 8

In the course of servicing an old Mark 8 Mod 1 equipment, an engineer recently encountered a condition of two range sweeps on the control indicator. One sweep was about 10,000 yards in length and the other about 80,000 yards. As the range was increased the sweep progressed to the end of the 10,000-yard sweep then returned to the beginning of the 80,000-yard sweep and progressed out toward the end of it. Signals appeared at the same point on both sweeps. The cause was found to be double pulsing of the multi-vibrator occurring only when feedback was present since the sweep was single until high voltage was applied. Only the first pulse triggered the range unit, but both pulses were applied to the sweep and modulating circuits.

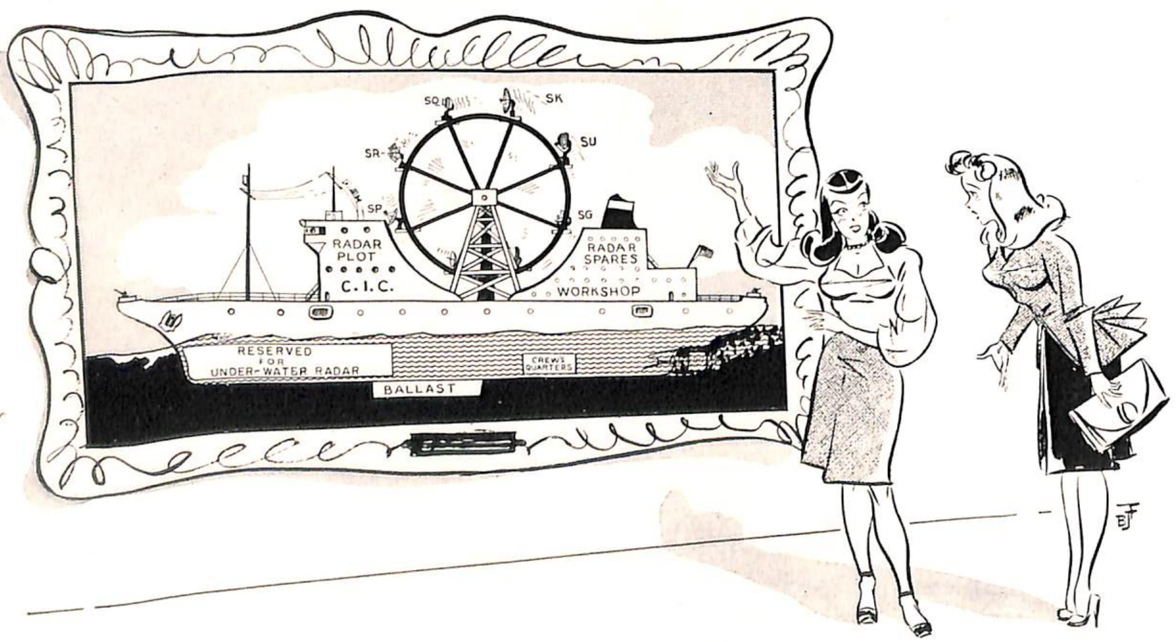
Two remedies were found to alleviate the situation: either the pre-knock time could be reduced to what appeared to be too short an interval, or the cathode feedback capacitor (C-28) could be increased, and the sweep reverted to normal. However, the trouble turned out to be related to another series of headaches in the range unit.

Three defective tubes, an open resistor, and a shorted capacitor in the range unit were causing a complete lack of 82-kc pips on the exponential voltage wave. This fact had made it impossible to put the transmitted pulse in the range step by normal means so, apparently, someone had misadjusted the pre-knock time in order to place the pulse in the step instead of correcting the range-unit troubles. After corrective measures were taken in the range unit the equipment returned to normal and the pre-knock time could be adjusted correctly without causing double pulsing. *—Western Electric.*

TEB TRANSMITTER TROUBLE

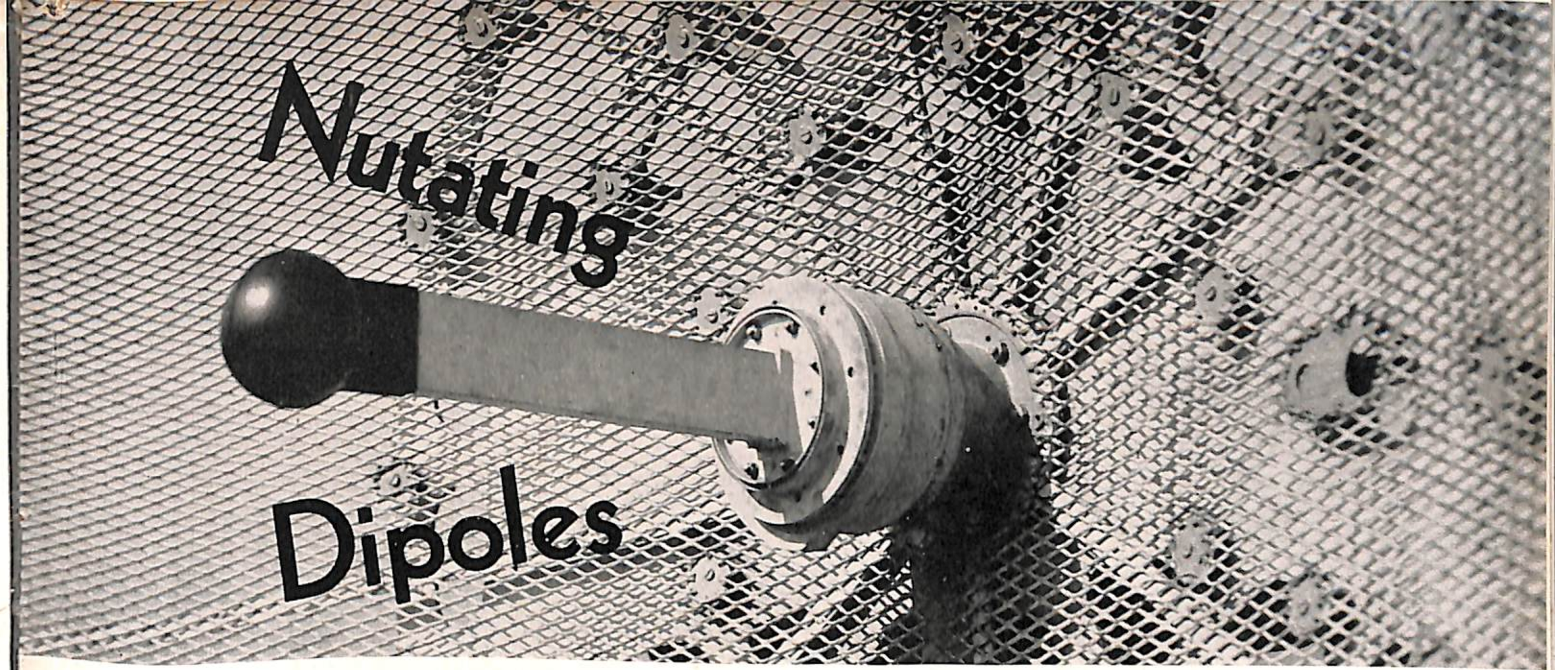
One Model TEB transmitting equipment at the Naval Radio Station, Manila, P. I., showed only 6400 volts on the main power supply rectifiers. Visual inspection of rectifier tubes V-25 to V-30 showed that they did not flash under load. Renewal of these tubes made no change in operation. Removal of the plate connection from V-29 permitted V-30 to flash, and removal of the plate connection from V-26 permitted V-25 to flash. It was apparent that a high-resistance connection existed some place in this circuit, either primary or secondary. The high resistance was located at the contacts of RL-5 and RL-6. These contacts were badly pitted, and the movable contact pigtail jumpers were badly burned due to the poor condition of the contacts. After the contacts were cleaned and readjusted, and the pigtail jumpers were renewed with appropriate Belden braid, the TEB operated satisfactorily.

—E. F. S. G.



"He says it's a secret, of course, but it's the new radar ship."

Nutating Dipoles



By A. E. Rist, *Design Section, BuShips*

■ Model SP radar equipments serial numbers 1-141 inclusive are affected by a new modification which changes the antenna feed from the wobbler type to the nutating type. This change, known as SP Field Change No. 61, should be accomplished as soon as practicable because the advantages of the new feed over the wobbler type feed are appreciable. The nutator employs a dipole type feed to the parabolic reflector dish in contrast to the original wobbler feed which illuminated the dish by reflecting the r-f energy into the dish from a splash plate. The two methods are represented in figure 1. The nutator feed more nearly approaches the ideal "point-source" illumination of the dish than does the wobbler feed.

Since the feed system must be displaced with respect to the center of the dish in order to provide precision target alignment, and since the nutator dipole must always remain in a horizontal position to maintain horizontal polarization of the electric field, the nutator dipole moves in a nutating motion rather than the rotating motion employed by the wobbler feed. The axis of the nutator dipole head moves in a circular orbit (whose center coincides with that of the dish), but the dipole does not revolve about its own axis.

The nutator feed results in an antenna gain of approximately twice that obtained with the wobbler feed, due to the fact that the energy from the side lobes of the antenna is concentrated into the main beam, resulting in a somewhat narrower beam width. For the same r-f power output from the transmitter, targets can be detected at ranges greater than those previously possible. The reduction in side lobes greatly improves the radiation pattern of the antenna.

Rectangular waveguide sections are used on the nutator instead of the circular sections employed on the wobbler feed. This illuminates the tapered transitional section of waveguide between the elevation axis and the elevation box, resulting in an overall reduction of the mismatch (measured by standing-wave ratio) of the antenna.

In order to prevent bearing errors when the nutator is stopped, it is desired that the nutator dipole automatically come to rest in the same position relative to the center of the dish each time the nutator power is turned off. The correct position of rest is such that the dipole stops at the top of its orbit of nutation. If any horizontal displacement were present, the electrical axis of the beam would be shifted from the mechanical axis of the antenna, resulting in bearing errors. This positioning of the nutator dipole is accomplished by a device called the Nutator Electrical Unit which contains various relays used to control the nutator motor so that the dipole is driven to the correct rest position when the Scanner Switch is turned off.

The operation of the nutator electrical unit may best be explained by referring to figure 2. When the Scanner Switch at the console is turned to the OFF position, relay K-3151 is de-energized and thereby causes relay K-3152 to open. This stops the nutator drive motor B-3189 by disconnecting one side of its 115-volt a-c supply voltage. As relay K-3151 closes, it connects the energizing coil of

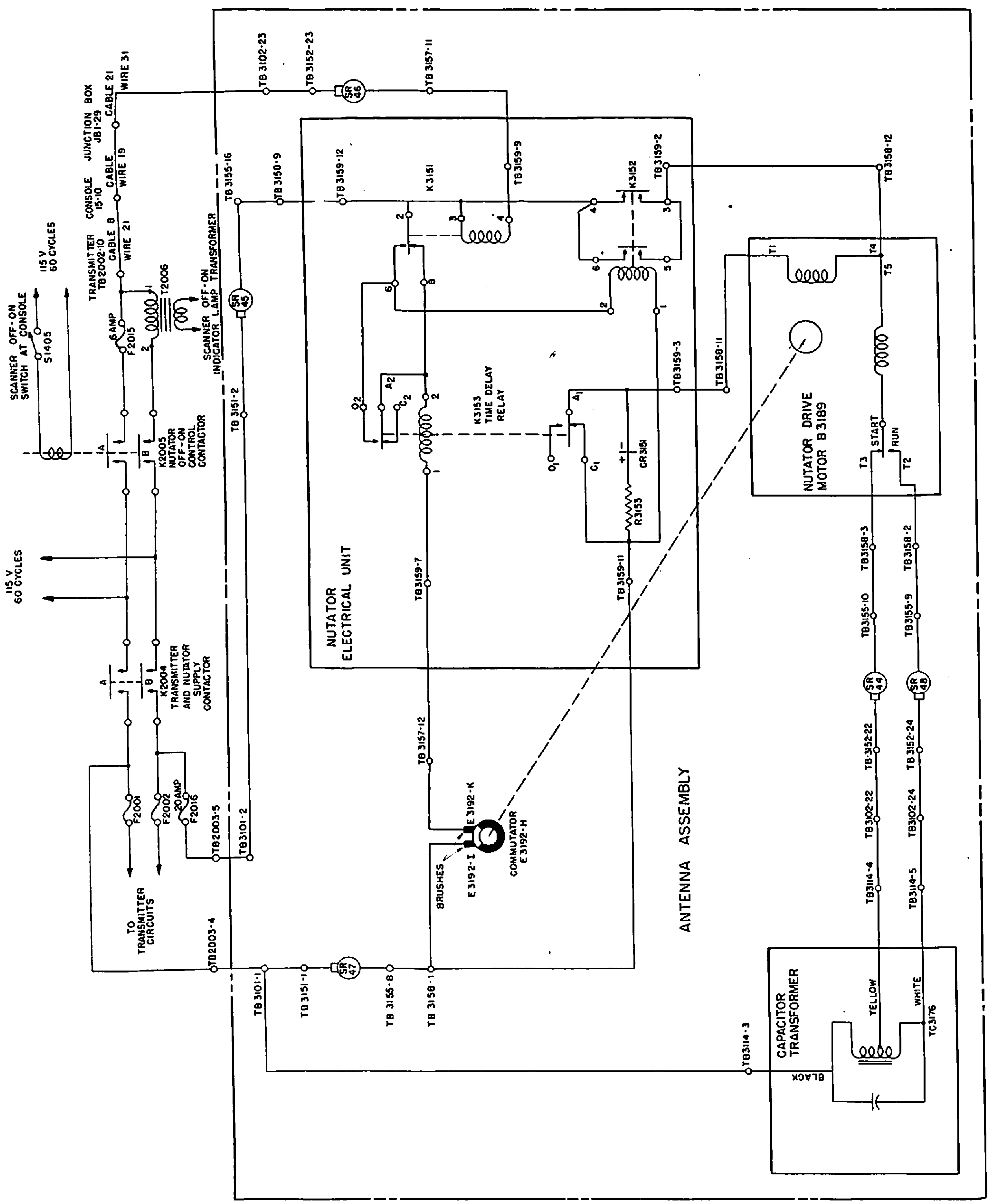


FIGURE 2—*Nutator control schematic wiring diagram.*

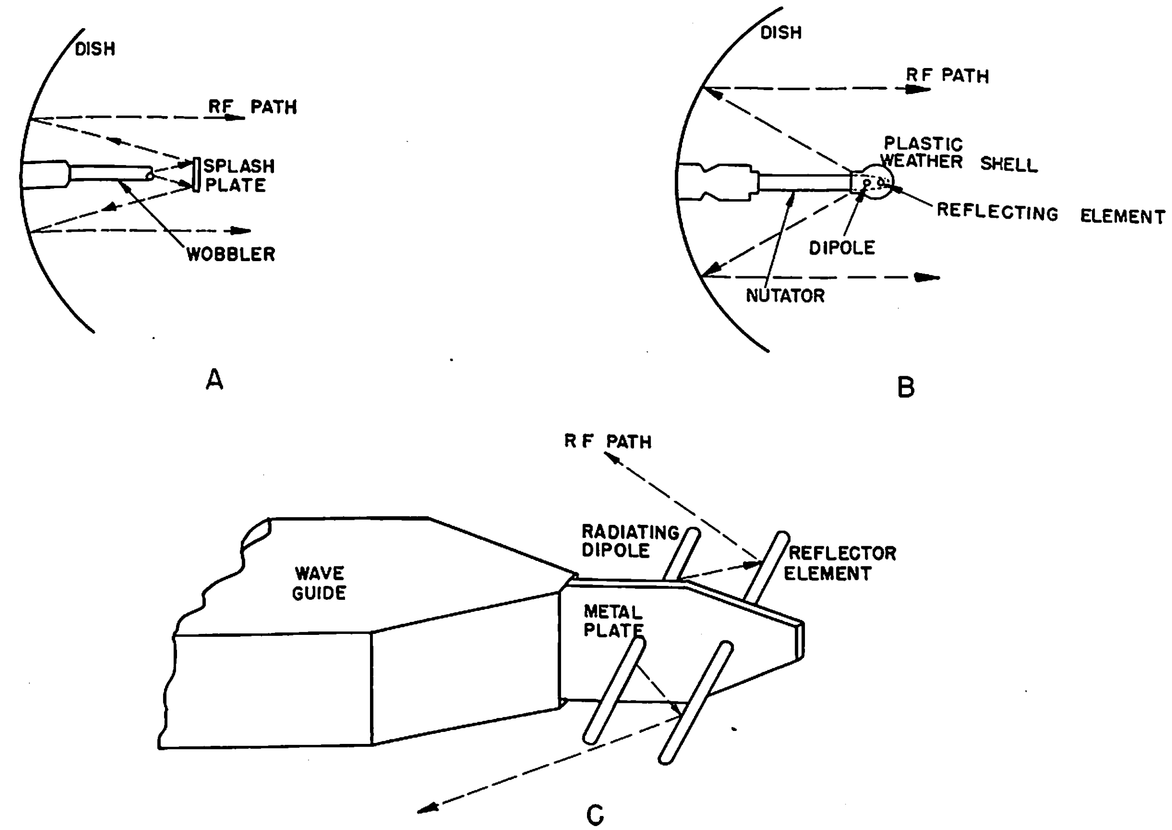


FIGURE 1—*(A) Wobbler Feed. (B) Nutator feed. (C) Nutator dipole with plastic shell removed.*

time-delay relay K-3153 in series with the positioning commutator E-3192-H. If the nutator motor does not stop in the correct rest position, electrical contact is maintained between the brushes E-3192-I and E-3192-K of the commutator E-3192-H, thus energizing time-delay relay K-3153 by connecting it across the line. Commutator E-3192-H is mounted on the drive shaft of reference generator B-3185 in a position such that when the nutator dipole is in the correct rest position, the commutator brushes ride the insulated segment. Approximately 15 seconds after time-delay relay K-3153 has been energized, its contacts actuate; one set of contacts connects the copper-oxide rectifier CR-3151 in series with one of the motor field windings, and the other set of contacts energizes K-3152, which connects line voltage to the motor. The nutator motor now has d.c. impressed on one of its field windings and a.c. on the other. The resultant field causes the motor to run very slowly, and will not permit it to obtain normal operating speed. When the motor is running in this manner, its operation is very noisy; the amount of chatter or growling is normal for this type of control and does not indicate faulty equipment or wiring. The motor thus slowly drives the nutator dipole around to the correct rest position, at which point the commutator brushes ride on the insulated segment, thereby de-energizing time-delay relay K-3153; the a-c supply-line relay K-3152 then opens and stops the nutator motor.

Starting the nutator motor is accomplished by placing the Scanner Switch at the console to the ON position. This closes contactor K-2005 (located in the top compartment of the transmitter), which, in turn, energizes relay K-3151 in the nutator electrical unit. Relay K-3151 then energizes the a-c line relay K-3152, which applies supply voltage to the nutator motor. A set of contacts on the time-delay relay K-3153 (which is not energized) shorts the copper-oxide rectifier CR-3151, and the nutator motor now has a.c. on both fields and therefore operates at normal speed.

Installation of the nutator kit on the SP 8-foot antenna pedestal is a major modification and it is recommended that the work be done while the ship is in dry dock or port. No attempt should be made to install the kit with the antenna pedestal mounted on top of the mast. Before any work is attempted, the complete antenna pedestal should be disconnected, removed, and lowered to the deck or to a position where ample working space is available.

NEW WWV STANDARD BROADCASTS

■ The importance of a reliable frequency meter was brought out effectively in the July 1945 issue of ELECTRON. It must be remembered that a frequency meter is not in itself a "primary" standard of accuracy. Therefore, these meters must be checked periodically to insure reliability.

All activities are required to check the accuracy of their frequency meters against the Bureau of Standards standard frequency transmission (WWV) in accordance with the Bureau of Ships Manual, Chapter 67.

Recently the number of radio carrier frequencies for the standard frequency transmission has been increased to 8 with 7 or more transmitters on the air at all times, day and night.

At present the services available are: (1) standard radio frequencies, (2) time announcements, (3) standard time intervals, (4) standard audio frequencies, (5) standard musical pitch, 440 cycles per second, corresponding to A above middle C, and (6) radio propagation disturbance warning notices. All of the frequencies are useful for field intensity recording by persons interested in studies of radio propagation. The four highest frequencies are broadcast particularly for this purpose.

In order that the Naval service may make the best use of the standard frequency broadcasts from the Bureau of Standards radio station WWV, the latest schedule of these broadcasts is given in the accompanying table. The basic story on these broadcasts, together with information on how to use them to calibrate Naval electronic equipment, appears on page 16 of the July 1945 ELECTRON. It is interesting to note, however, that in addition to the frequency and power output changes listed in the table, the accuracy of the frequencies broadcast has been increased. All carrier frequencies are now maintained to an accuracy of better than one part in 50,000,000, each 1-second time interval is accurate to one microsecond, and the audio frequencies vary less than one part in 50,000,000.

TABLE I—*Schedule of WWV services now in effect.*

Carrier Freq. (Mc)	*Time of Broadcast (GMT)*	*Power Output (kw)*	*Audio Frequencies (cycles)*
2.5	2400 to 1400	1.0	440
5.0	2400 to 1200	10.0	440
5.0	2400 to 1200	10.0	440 and 4000
10.0	Continuously	10.0	440 and 4000
15.0	Continuously	10.0	440 and 4000
20.0	Continuously	0.1	440 and 4000
25.0	Continuously	0.1	440 and 4000
30.0	Continuously	0.1	400
35	Continuously	0.1	400

The station call letters (WWV) and other announcements in voice are given each hour and half-hour.

STANDARD RADIO FREQUENCY

The national standard of frequency is of value in radio, electronic, acoustic, and other measurements requiring an accurate frequency. Any desired radio frequency, including microwave frequencies, may be accurately measured in terms of the standard frequencies. This may be done by the aid of one or more auxiliary oscillators, harmonic generators, and radio receivers. The accuracy of each of the radio carrier frequencies, as transmitted, is better than a part in 50,000,000.

TIME ANNOUNCEMENTS

The audio frequencies are interrupted precisely on the hour and each five minutes thereafter; after an interval of precisely one minute they are resumed.

The beginnings of the periods, when the audio frequencies are interrupted, are in agreement with the basic time service of the U. S. Naval Observatory so that they mark accurately the hour and the successive 5-minute periods.

Eastern standard time is announced in telegraphic code each five minutes. This provides a quick reference to correct time where a timepiece may be in error by a few minutes. The zero-to-twenty-four-hour system is used starting with 0000 midnight. The first two figures give the hour and the last two figures give the number of minutes past the hour. For example, at 4:55 PM, or 1655 EST, four figures (1, 6, 5, and 5) are broadcast in code. The time announcement refers to the start of an announcement interval, i. e., when the audio frequencies are interrupted. It occurs immediately after the beginning of each five-minute interval. At the hour and half-hour it is followed by the station announcement in voice.

STANDARD TIME INTERVALS

There is on each carrier frequency a pulse of 0.005-second duration which occurs at intervals of precisely one second. The pulse consists of five cycles, each 0.001-second duration, and is heard as a faint tick when listening to the broadcast; it provides a useful standard time interval, for purposes of physical measurements, and for quick and accurate measurement of calibration of timing devices or very low frequency oscillators. It may be used as an accurate time signal. On the 59th second of every minute the pulse is omitted. The 1-minute, 4-minute, and 5-minute intervals, synchronized with the seconds pulses, are marked by the beginning or ending of the period when the audio frequencies are off.

A time interval of one second marked by the pulse is accurate, as transmitted, to one microsecond (0.000001 second). A two-minute or longer interval is accurate to a part in 50,000,000.

The one-minute interval is provided in order to give time and station announcements and to afford an interval for the checking of radio-frequency measurements free from the presence of the audio frequencies.

STANDARD AUDIO FREQUENCIES

Two standard audio frequencies, 440 cycles per second and 4000 cycles per second, are broadcast. They are given on radio carrier frequencies as shown in the table.

The two standard audio frequencies are useful for accurate measurement or calibration of instruments operating in the audio or supersonic regions of the frequency spectrum. They may also be used for accurate measurement of short time intervals.

The accuracy of the audio frequencies, as transmitted, is better than a part in 50,000,000. Transmission effects in the medium (Doppler effect, etc.) may result at times in slight fluctuations in the audio frequencies as received; the average frequency received is, however, as accurate as that transmitted.

PROPAGATION DISTURBANCE WARNING

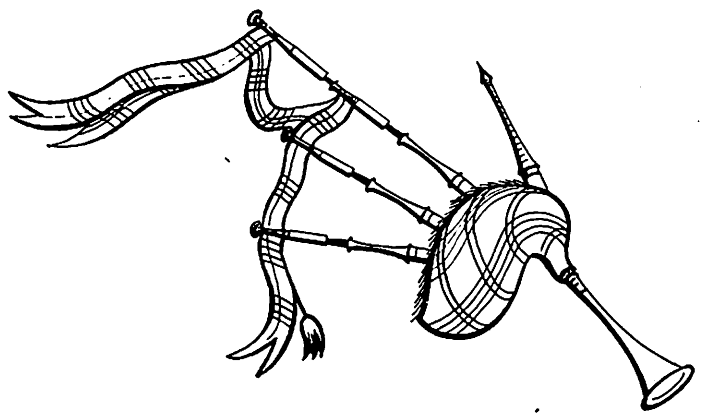
The Radio Propagation Disturbance warning is broadcast in code on each of the standard radio carrier frequencies at twenty and fifty minutes past each hour. If a warning is in effect, a series of W's (in Morse Code) follows the time announcement; if no warning is in effect, a series of N's (in Morse Code) follows the time announcement.

The presence of a warning means that radio propagation disturbance is anticipated within 12 hours, or is in progress, with its most severe effects on radio transmission paths crossing the North Atlantic; i.e., those paths for which the control points of transmission lie in or near the northern auroral zone. Radio propagation disturbance is characterized by low intensities, accompanied by flutter or rapid fading on the normal frequencies used at the different times of the day, or by complete blackout of signals. By shifting to lower than normal frequencies for that time of day, it may be possible to get signals through, although with lower than normal intensity. Owing to increased auroral-zone absorption during the disturbance, however, it may be impossible to have usable transmission on any high frequency. Also, during a period of radio propagation disturbances, direction-finder observations may be unreliable.

If no warning is in effect, satisfactory transmission should be possible on the normal frequencies for the different times of day.

The usual daily time for changing the announced warning is 2100 GMT. However, the warning is issued at any hour when disturbance becomes noticeable or anticipated. The announcement is returned to normal whenever conditions seem quiet. Thus any time a radio operator questions reception on North Atlantic paths, it would be advisable to check with the WWV announcement to see whether conditions are considered by the Bureau of Standards as sufficiently disturbed to make a warning desirable.

The radio disturbance warning does not apply to sudden ionospheric disturbances, which are unpredictable. These occur only at times when at least part of the transmission path is in sunlight. This type of disturbance is characterized by the received intensity dropping to zero very rapidly, usually within a minute or so, and remaining out from a few minutes to two hours. The effect is greater on the lower high frequencies, and on paths close to the equator or whose control points are close to noon. Usually the only transmission possible during a sudden ionospheric disturbance is by VLF or by ground waves over short paths. The use of the highest frequency available, as long as it is below the maximum usable frequency for the path in question, may shorten the duration of the fadeout. During the next few years, while approaching sunspot maximum, these sudden ionospheric disturbances will increase in intensity and frequency of occurrence. They are caused by eruptions on the sun, more of which are observed during the years around sunspot maximum.



REPLACEMENT OF SR-2 AIR PIPES

■ The phenolic air pipes (E-2575) which support the oscillator tubes (V-101, V-102) in the SR-2 Transmitter should be replaced if excessive play develops in the oscillator tube locking mechanism. The play can be determined by grasping the oscillator tubes (as though to release them from their normal operating position) and noting any circular motion without turning the assembly through the detent position. When the play exceeds approximately 20 degrees on either air pipe, that air pipe should be replaced. The replacement should be made according to the following procedure:

1. Remove the oscillator tubes (V-101 and V-102) as directed in the equipment instruction book page 7-57. Where space permits, remove the transmitter left side to provide easier access to the oscillator assembly.

2. Remove the tube access door and the hinged lower shield from the oscillator assembly.

3. Remove the flexible blower air duct from the flanges below the oscillator lower housing assembly.

4. Turn the anode tuning dial to zero.

5. Pull up the threaded portion of the tube socket and remove it; the tube socket is then exposed.

6. With the aid of a mirror and small screw driver, remove, from the inside of the tube socket holder, the keys which lock it to the top of the phenolic air pipe.

7. Replace the tube socket removed in step 5 over the tube socket holder. Insert the tube socket under anode contact fingers with a slight twisting motion. *CAUTION—Be sure to get all contact fingers over the tube socket sleeve before seating tube socket in detent position.*

8. Turn tube socket and holder assembly in the direction to unscrew it from the top of the phenolic pipe. Remove entire assembly.

9. Remove the 6-32 screw from the bottom of the phenolic pipe.

10. Turn anode dial to approximately 5.0. Then unscrew phenolic air pipe from the threaded flange at its bottom end.

11. Remove three screw holding flanges to the oscillator lower housing assembly casting. Drop air pipe through opening, thus removing it.

12. To replace the phenolic air pipe, insert its small end up through the bottom of the oscillator lower housing casting. Replace flanges on the lower housing assembly and screw bottom of the air pipe into the top flange.

13. Insert tube socket and tube socket holder assembly through the anode contact fingers and screw it to top of phenolic pipe. *NOTE—Be careful with anode contact fingers.*

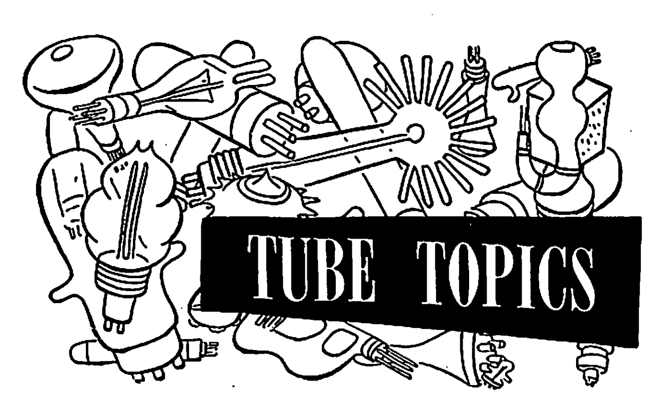
14. Remove tube socket as explained in step 5. Grasp the tube socket holder in one hand and turn the air pipe until it projects through the tube socket holder base the thickness of the retaining keys. Insert the keys into top slots of pipe. Rotate the pipe until the key holes are aligned, then replace screws.

15. Replace tube socket in the tube socket holder, inserting it under anode contact fingers with a slight twisting motion. *CAUTION—Be sure to get all contact fingers over the tube socket sleeve before seating tube socket in detent position.*

16. Place tube socket in the detent position of the tube socket holder. This position is determined by noting a spring action when the top of the tube socket is gently pushed down.

17. Screw the air pipe into the flange in a direction to obtain exactly 3.093 inches between the top outer edge of the tube socket assembly and the undeflected edge of the grid contact fingers.

18. When this critical dimension has been obtained, drill and tap a 6-32 thread in the phenolic pipe, using the hole in the flange as a pilot. Replace the 6-32 screw and complete the assembly of the oscillator performing steps 1, 2, and 3 in reverse.



6V6 INSTEAD OF 6K6

In the early production models of the RBO-series radio receiving equipments the design included the use of a type 6K6-GT tube as the power amplifier V-109. However, the specifications changed and in later models, especially the RBO-2, this tube was replaced by a 6V6-GT/G. Furthermore this new tube is now considered proper for this application in all models of the RBO series and in the future should be used to replace the 6K6-GT tubes which fail in operation.

The parts list and the spare-parts list in the equipment instruction book and its supplements should be corrected accordingly.

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REACTIVATING TV TUBES

To obtain maximum efficiency from television pickup tubes, such as the 1850A iconoscope and the 2P23 image orthicon, it is recommended that they be given alternate periods of active use and rest.

After the 1850A is operated for 200 to 300 hours, its sensitivity may diminish somewhat and it should be given an idle period of 2 or 3 months. During this time it generally will recover much of its original sensitivity. However, the tube should not be left on the shelf without being operated for a period of more than six months.

After 200 or 300 hours of use, the 2P23, too, should be taken out of operation for a period of 2 to 3 weeks in order that it may recover its original resolution and sensitivity. Spare tubes should be placed in service for several hours at least once a month to keep them free from any traces of gas which may be liberated within the tube during a prolonged storage.

—RCA

Perchloric Acid Type Batteries

■ There are in use two different types of small Willard 6-volt storage batteries encased in clear plastic containers. One type is the conventional lead-sulphuric acid type battery, and with the exercise of proper precaution in handling the battery and the electrolyte, it is entirely safe. The other type employs perchloric acid as an electrolyte and is potentially dangerous. Both types, when in operating condition, bear a close resemblance to each other in size, shape, and case material, but may be distinguished by the symbols embossed on the battery case. The lead-sulphuric acid type bears the designation NT-2, while the perchloric acid type bears the symbol P-5-6 Navy Type No. 19042. When new, before being placed into service, the perchloric acid type battery can be further distinguished by the fact that the acid container is made of a clear plastic, fitting on top of the battery case and strapped to it with blue cellulose tape.

Perchloric acid type batteries are dangerous in either the operating or non-operating condition because the electrolyte tends to seep out of either the container or the battery case by direct action on the case or the sealant. The seepage of this perchloric acid tends to char all carbonaceous materials, wood, paper, etc., forming with them explosive or spontaneously combustible material which in some cases may even be ignited by impact.

There is no warning of any kind or any statement as to the composition of the battery acid on the Navy type CWB-19042 cardboard battery container or on the battery case itself. Filling instructions for this battery caution against spilling acid on the hands or clothes, but do not give the reason or the type of acid used. The Bureau of Ships has published no previous safety regulations governing the handling or use of perchloric acid type batteries. Accordingly, it is pointed out here that any perchloric acid type battery must not be stowed adjacent to combustible material, must not be used in aircraft (pending the issuance of standard safety precautions), and must be destroyed if the electrolyte has turned dark or cloudy. Any organic material which has come into contact with perchloric acid is to be considered potentially dangerous.

MODEL TDZ MODIFICATIONS

Certain Model TDZ transmitting equipments have been found not suitable for shipboard installation (see p. 6, ELECTRON for February, 1947). In order to improve these equipments, four modifications to the automatic tuning system and the drawer mechanism have recently been authorized. The first replaces the automatic tuning control switches S-125 and S-127 with switches of improved design. The new design incorporates switches S-125C and S-127B as integral parts of the switch assemblies S-125 and S-127 respectively. S-125C and S-127B each consist of a single-pole breaker-type switch actuated by an accurately cut cam. These switches are connected effectively in parallel with, and function as a vernier control of, rotary switches S-125A and S-127A, respectively. The hold-in circuits of the tuning-motor control relays K-117 and K-118 are finally to be made and broken through the new added breaker switches S-125C and S-127B instead of through rotary switches S-125A and S-127A which now serve as distributors to route the circuits for the proper channel through the breaker switches. Since these added breaker switches have final control over K-117 and K-118, inconsistencies between the making and breaking points of the several contacts on rotary switches S-125A and S-127A do not affect relay operation. The cam-operated breaker switches are inherently more accurate than rotary switches and, since finer control is thus achieved, the system becomes more dependable.

The second modification is the installation of snubber assemblies, or sets of neoprene snubbers, at the rear of the sliding drawers in the transmitter. These snubbers serve to restrain relative motion between the drawers and the cabinet under conditions of severe vibration or shock. Also the rear wiring channel is secured to the cabinet frame at two additional points to give it additional support and to prevent its flexing between the original points of support.

The third modification consists of attaching auxiliary contact springs to the existing contacts at the rear of the sliding drawers and to the test harnesses which plug into the transmitter cabinet when the drawers are removed for servicing. These added contact springs provide greater contact pressure and limit the travel of the contact under accidental stress.

The fourth modification consists of replacing the lubricant in the gear box of the master automatic tuning system. The new lubricant has better adhesive properties and provides better lubrication of the motor drive worm and its mating gear.

These four modifications have been grouped together into Field Change No. 1 for the Model TDZ—"Modification to Automatic Tuning System and Drawer Mechanism" and can be obtained through regular channels. It should be realized, however, that accomplishment of this field change does not make these equipments suitable for shipboard installation unless specifically authorized by the Bureau of Ships.

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SUBMARINE LOOP ANTENNAS

Activities currently engaged in compiling ship electronics inventories of submarines are requested to be particularly careful in reporting the Navy type numbers and serial numbers of underwater loop radio antennas. Several submarines have special loop antennas aboard, and others have improved models of the Navy Type No. 66097 antennas, which can be identified only by their serial numbers. The Bureau of Ships is anxious to obtain all available information on the performance of the various types of loop antennas, and it is essential that accurate records of these installations be available in the Bureau.

STRIKER

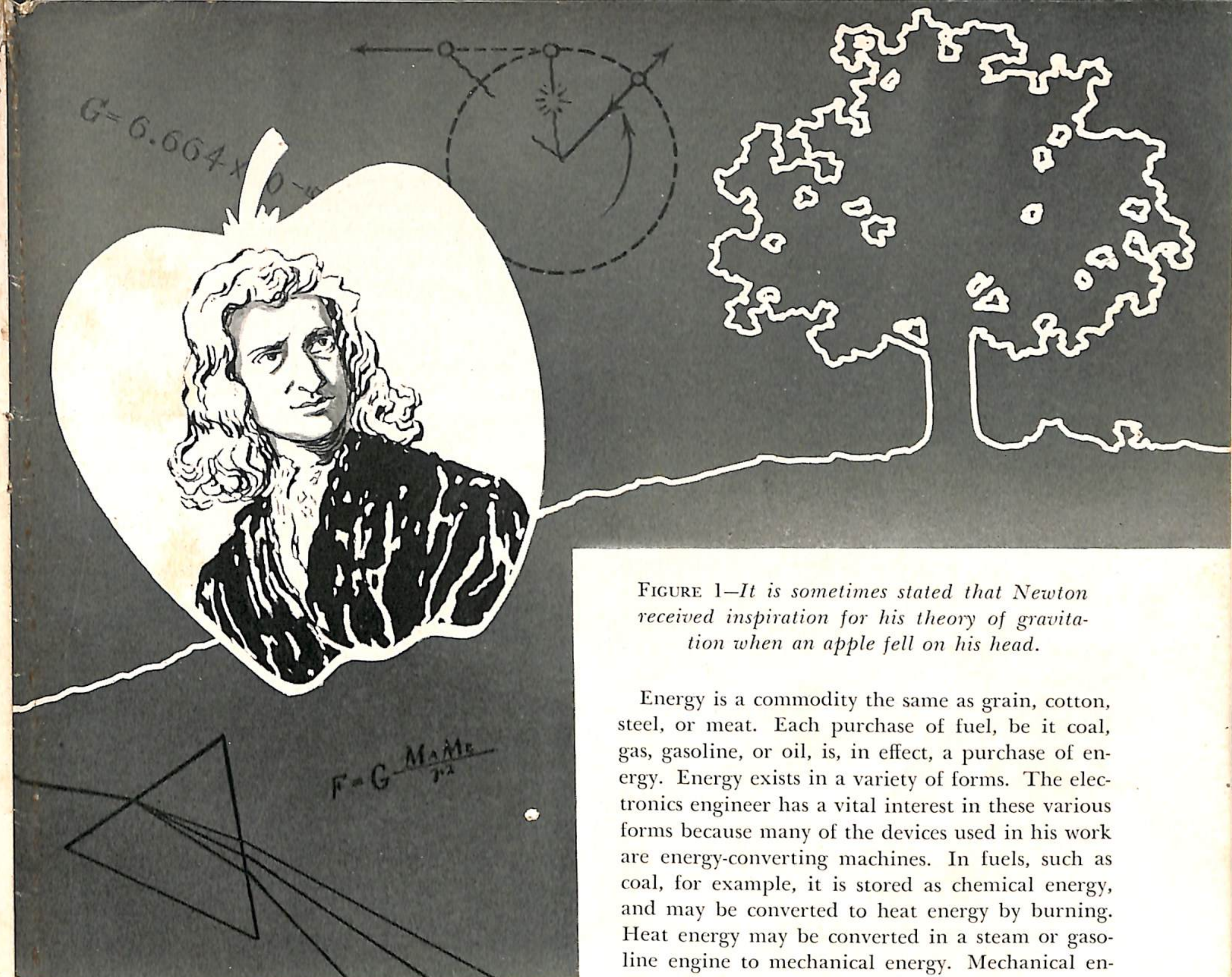

FIGURE 1—*It is sometimes stated that Newton received inspiration for his theory of gravitation when an apple fell on his head.*

CONCEPTS OF ENERGY

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Basic Physics—Part 2

Most of the fundamental ideas concerning energy, work, and power stem from Newton's work, and are based upon the application of mechanical forces. If the student thoroughly understands the basic mechanical concepts, he will have little difficulty in applying them to the principles of electrical energy, work, and power.

Energy is a commodity the same as grain, cotton, steel, or meat. Each purchase of fuel, be it coal, gas, gasoline, or oil, is, in effect, a purchase of energy. Energy exists in a variety of forms. The electronics engineer has a vital interest in these various forms because many of the devices used in his work are energy-converting machines. In fuels, such as coal, for example, it is stored as chemical energy, and may be converted to heat energy by burning. Heat energy may be converted in a steam or gasoline engine to mechanical energy. Mechanical energy may be converted to electrical energy, which in turn may be converted to light or sound energy. An electric motor converts electrical energy to mechanical energy, a generator reverses this process. The transformation of electrical energy to heat energy in an electric heater is the reverse of the energy transformation that takes place in a thermocouple. The familiar loudspeaker and microphone perform reverse transformations of energy. A storage battery, when being charged, stores electrical energy in chemical form, and then, during the period of discharge, reverses the process, converting chemical energy to electrical energy.

CONSERVATION OF ENERGY

A fundamental law of physics states that energy can be neither created nor destroyed. Energy is put to use by converting it from one form to another. For example, the incandescent lamp receives electrical energy and converts it to light and heat energy. The primary function of the lamp is to convert electrical energy to light energy. The incidental production of the heat energy is undesired, but must be accepted in order to obtain the light energy. In every energy conversion there are certain undesirable conversions, of which this is a typical example. Engineers refer to these by-product conversions as losses, not in the sense that energy is lost or destroyed, but to mean non-useful energy. In any energy-converting device

$$\text{Input energy} = \text{useful output energy} + \text{non-useful energy}$$

Non-useful energy is sometimes difficult to evaluate in terms of its different components. For example, in an electric motor some energy is converted to heat in overcoming bearing friction, some is converted to heat in overcoming air resistance, and still more is converted to heat in overcoming magnetic friction and the electrical resistance of the motor windings. It is customary simply to group all non-useful energy as a loss.

EFFICIENCY

Machines are rated in terms of the efficiency with which they convert energy in one form to useful energy in another form.

$$\text{Efficiency} = \frac{\text{useful output energy}}{\text{input energy}}$$

Efficiency is expressed most often in terms of per cent. An electric motor that is 85% efficient will produce 0.85 unit of mechanical energy for each unit of electrical energy delivered to the machine. The remaining 0.15 unit is converted to heat energy in overcoming the internal losses of the machine.

WORK

The qualitative definition of energy is "the capacity to do work." Energy is rarely apparent in a physical sense unless in the form of action—such action indicating that work is being accomplished. Work itself being the conversion of energy from one form to another, any method by which work can be measured is applicable to the measurement of energy.

The quantitative concept of work develops most naturally from experience in lifting a weight. A certain effort—a force—must be applied to lift a weight of one pound through a distance of one foot. We feel intuitively that in lifting the weight we have done a certain amount of work. Twice as much effort and hence twice as much work is done if the weight is doubled in size or the distance through which it is moved is doubled. Work, then, is proportional both to the effort or force applied and to the distance through which it acts.

$$\text{Work} = \text{force} \times \text{distance}$$
$$w = Fd$$

where the force F represents the effort exerted along the line of motion of the body.

The engineer considers force as a vector quantity because it has both magnitude and direction. More often than not, as we know, forces are applied at an angle with respect to the direction of the motion they produce. The total force exerted by a man pushing a wheelbarrow is made up of two components, one acting in a vertical direction to hold the legs of the wheelbarrow clear of the ground, the other acting in a horizontal direction to produce forward motion of the wheelbarrow. Only the horizontal component accomplishes actual work on the wheelbarrow. This is called the effective force, and represents the value that would be used for F in the formula $w = Fd$. The vertical component may tire the man, but once the wheelbarrow is elevated it does not perform work.

It is interesting to note that physics does not consider work as being done unless motion occurs. An Atlas supporting the world on his shoulders is doing no work in the sense in which physics defines the word.

WORK UNITS

In the M.K.S. system the absolute unit of work is the newton-meter. A newton is that force which imparts an acceleration of one meter per second per second to a mass of one kilogram—in other words, a newton-meter is the work done by a force of one newton acting through a distance of one meter. The newton-meter has been given the special name of *joule*. It is a unit of importance in electrical and electronics work. Public utility companies, it may be noted, sell joules of electrical energy. A joule of electrical energy accomplishes the same amount of work as a joule of mechanical or heat energy, even though the methods by which the work is measured may differ widely.

In the C.G.S. system the unit of work is the dyne-centimeter, referred to as the *erg*, and is the work done by a force of one dyne acting through a distance of one centimeter. The erg is a very small unit compared to the joule. Indeed,

$$1 \text{ joule} = 10{,}000{,}000 \text{ ergs}$$

The gravitational unit of work based upon F.P.S. units is the *foot-pound*. It is equivalent to the work done by a weight of one pound acting through a distance of one foot. Quantitatively,

$$\text{Work} = \text{weight} \times \text{height}$$
$$w = Wh$$

In the definitions of work note that the factor of time does not enter at all. The work done in lifting a weight of 100 pounds through a distance of 50 feet is the same whether it is accomplished in ten seconds or ten hours.

POWER

Power is the work accomplished in a given time. Many engineers use the word "power" as a synonym for "energy." This is a practice the student should avoid. Energy is measured in terms of *how much*, power is measured in terms of *how fast*. Failure to grasp this difference in meaning is often a source of trouble in advanced electronics instruction.

If Motor A hoists 1,000 pounds through a distance of 50 feet, and Motor B hoists a weight of 500 pounds through a distance of 100 feet, both motors accomplish 50,000 ft-lb of work. There is a temptation to assume that Motor A, because it moves the greater weight, can accomplish more work in a given time than Motor B. Actually, without a time factor in the statement, there is no way in which Motor A can be distinguished from Motor B. If Motor A accomplishes 50,000 ft-lb of work in two minutes, and Motor B takes one minute to accomplish the same work, then Motor B must accomplish work at a greater rate than Motor A. If both motors are operating at maximum work capacity, then Motor B is more powerful than Motor A.

Power, then, is defined as the *rate* at which work is done.

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

$$P = \frac{w}{t}$$

The unit of power in the M.K.S. system is the joule per second, which has been given the special name *watt*. A machine that accomplishes 500 joules of work in 20 seconds is working at the rate of 500/20 or 25 watts. In the F.P.S. system the unit of power is the foot-pound per second. However, in practice today, the *horsepower* finds greater application. James Watt, inventor of the steam engine, experimented with a large draft horse, and found that the animal could accomplish about 33,000 ft-lbs of work per hour. The standard horsepower is now defined as

$$1 \text{ hp} = 33{,}000 \text{ ft-lb/hr} = 550 \text{ ft-lb/sec}$$
$$1 \text{ hp} = 746 \text{ watts}$$

Electrical machinery is usually rated in terms of power output. It is plain that if the rate at which a machine can accomplish work is known, the amount of work that can be done in a given period of time is easily calculated. The output of an electric motor is frequently expressed in horsepower. A motor rated a 5 hp is capable of a power output of 5 × 550 or 2,750 ft-lb/sec under proper conditions of operation without serious overheating of the machine. The output of an electric generator is usually given in watts or kilowatts at a specified pressure or voltage. A 220-volt machine rated at 5 kw is one capable of delivering a power output of 5,000 watts at a line potential of 220 volts under proper operating conditions without serious overheating of the machine.

Note that the output of electrical machinery is usually limited by the maximum temperature the machine is designed to withstand. Some of the input energy is converted to heat in overcoming the internal losses of the machine, and causes the temperature of the machine to rise. This temperature increase must be small enough so that the internal insulation of the machine is not endangered. It is well to remember that the conditions under which an electrical machine is to be operated must be taken into account when applying the power rating. When electrical machinery is operated in spaces where the ambient temperature is high or ventilation is very poor, it is usually necessary to limit the power output to a value somewhat less than the rated value in order to avoid excessive temperature rise in the machine. On the other hand, when conditions are favorable, it is often possible to operate at a power output in excess of the rated value without excessive temperature rise.

PRACTICAL UNITS OF WORK

Because the joule and the foot-pound are comparatively small units, it is customary, in practical work, to use units of much larger magnitude. The kilowatt-hour represents the work done in one hour by a uniform power of 1,000 watts. Since one hour is equivalent to 3,600 seconds,

$$1 \text{ kw-hr} = (1{,}000 \text{ joules /sec}) \times (3{,}600 \text{ seconds}) = 3{,}600{,}000 \text{ joules.}$$

The horsepower-hour, used rather infrequently in electrical work, is equivalent to 1,980,000 ft-lb. One kilowatt-hour corresponds to about 1.34 horsepower-hours. By remembering that the horsepower-hour is representative of the work done by a large draft horse in one hour, the reader has some idea of the economy of electrical energy. Public utility companies sell electrical energy to the average family user at approximately five cents per kw-hr. Large industrial users may purchase such energy at less than one cent per kw-hr.

POTENTIAL ENERGY

The energy stored in a body as a result of the state or position of the body is called *potential* energy. The energy stored in a body as the result of the motion of the body is called *kinetic* energy. Potential energy is often called static or rest energy. Kinetic energy is often referred to as dynamic energy.

A body suspended above the surface of the earth possesses mechanical potential energy because work was done on the body in moving it about the surface of the earth. A stretched rubber band possesses elastic potential energy because work was done in stretching the band. The energy in a lump of coal is chemical potential energy resulting from the chemical condition or state of the coal.

Applying the formula for work to the case of lifting a weight of one pound a distance of one foot against the force of gravity, it is readily seen that one foot-pound of work has been performed. Moving the weight one foot has put it in a new position; the act that a new position has been achieved does not in itself mean that the weight has gained potential energy, but the fact that work was done on the weight in placing it in the new position does mean that it has potential energy—one foot-pound in amount. This potential energy is potentially available—hence the name—and will be regained if the weight is moved back to its original position. The amount the weight gives back, of course, will be exactly one foot-pound, since energy can be neither created nor destroyed.

The gravitational potential energy stored in a body by virtue of its position is given by

$$\text{PE} = \text{weight} \times \text{height}$$

$$\text{PE} = Wh$$

Since $W = mg$

then $\text{PE} = mgh$

where h represents the distance the body is elevated above a selected reference level.

REFERENCE LEVEL

This is an important concept. Full understanding of it will make clear the often difficult principle of positive and negative voltage drops in an electrical circuit. For instance, if a five-pound weight is raised from the floor to a table top three feet above the floor, it will gain 3×5 or 15 ft-lb of energy in reference to the floor. If the floor is fifteen feet above the surface of the earth, the weight when resting on the floor contains 15×5 or 75 ft-lb of energy with respect to the surface of the earth. When the weight is resting on the table, the energy stored in the weight in reference to the surface of the earth will be $15 + 75$ or 90 ft-lb. If the surface of the earth at the point at which the weight is raised is 1,000 feet above sea level, the energy stored in the weight on the table top in reference to sea level is

$$\text{PE} = (1{,}000 \times 5) + (15 \times 5) + (3 \times 5) = 5{,}090 \text{ ft-lb.}$$

It should be evident, then, that the potential energy stored in an elevated body is relative in nature—it depends upon the reference level established in making the measurement. When a reference level is not given, it implies that *the surface of the earth is to be used as a reference level.* In some cases the reference level is assumed to be the earth's surface at sea level. Instruments that function on the basis of pressure are often calibrated in terms of atmospheric pressure at sea level (about 14.7 lb square inch). This is the pressure exerted by a vertical column of mercury 29.92 inches (76 cm) high. A steam pressure or water pressure gauge reads pressure above atmospheric pressure. Absolute pressure is measured in terms of zero atmospheric pressure; that is, in terms of a perfect vacuum.

Electric pressure may be measured in electrical circuits with respect to any point in the circuit. If the pressure measures above the pressure at the reference point, it is said to be positive; if it measures below the reference pressure, it is said to be negative. When no reference level is given, it implies the pressure is measured with respect to the lowest potential point in the circuit or in reference to ground potential.

ELASTICITY

Elasticity is that property of matter which permits it to stretch, compress, or bend under the application of an external force and then to return to its original shape when the external force is removed. A body is strained beyond the "elastic limit" when it is unable to return to its original shape after the external force is removed. The applied force must do work in deforming the body; this work sets up internal stresses within the body. It follows, then, that these stresses are capable of accomplishing work when the body returns to its original shape. Familiar examples of phenomena involving the elastic property of matter are the vibrations of musical instruments, the transmission of sound, and the rustling of leaves. All matter is elastic to some extent—some substances being more so than others. A strip of steel, for instance, is more elastic than a similar strip of lead.

The fundamental law of elasticity is called Hooke's law and is given by

$$F = kl$$

where F is the internal force set up in opposition to the applied external force, l is the distance over which the strain takes place, and k is the "elastic constant" of the material. The elastic constant represents the deformation produced by a unit force. The ordinary spring scale is an example of a practical application of this law. In such scales the amount the spring stretches is always directly proportional to the weight (which is a force) being applied, provided the weight does not exceed the elastic limit of the spring.

Certain materials possess a property of electrical elasticity that is in many ways comparable to mechanical elasticity. A capacitor is a device in which electrical energy may be stored in potential form by virtue of the electrical elasticity of the materials in the device. Electrical elasticity, as would be expected, varies with the type of material. Mica, for instance, has a greater electrical elasticity than hard rubber. Again in analogy to mechanical elasticity: If a sufficiently high potential is applied across a capacitor, the elastic limit will be exceeded and the capacitor will break down. The mechanical elastic constant, represented by the symbol k in Hooke's law, has an electrical equivalent that is called the "dielectric constant" of the material.

KINETIC ENERGY

A body in motion possesses dynamic or kinetic energy by virtue of its motion because work was done on the body to establish the motion. This kinetic energy must be converted or transformed to some other form of energy before the body comes to rest. The kinetic energy of a body in motion depends on the mass and velocity of the body.

Because the formula for kinetic energy finds many uses in the study of electrical principles, it will be derived step-by-step here.

The force F required to impart acceleration a to mass m is

$$F = ma$$

The work done by force F in moving mass m through distance d is

$$W = Fd = mad \qquad (1)$$

A body starting from rest and accelerating at a uniform rate will, at the end of time t, have a final velocity of

$$v = at$$

from which

$$t = \frac{v}{a} \qquad (2)$$

The average velocity during time t is

$$v_{av} = \frac{\textit{initial velocity} + \textit{final velocity}}{2}$$

If the body starts from rest, the initial velocity is zero. Since the final velocity is at, the average velocity is

$$v_{av} = \frac{o + at}{2} = \frac{at}{2}$$

The distance d traversed in time t is

$$d = v_{av} \times t$$

Since $v_{av} = \dfrac{at}{2}$

then $$d = \frac{at\,(t)}{2} = \frac{at^2}{2} \qquad (3)$$

Since from (2) $t = \dfrac{v}{a}$, then $t^2 = \dfrac{v^2}{a^2}$. Substituting for t^2 in (3)

$$d = \frac{a}{2}\left(\frac{v^2}{a^2}\right) = \frac{v^2}{2a}$$

Multiplying by a

$$ad = \frac{v^2}{2}$$

Substituting this value for ad in (1)

$$w = mad = \frac{mv^2}{2}$$

But the kinetic energy of a body is equal to the work done in placing the body in motion; hence—

$$KE = \frac{mv^2}{2}$$

It is evident from this formula that velocity has a greater effect on the kinetic energy of a moving body than does mass. For example, if the velocity is constant and the mass is doubled, the kinetic energy is twice as great: but, if the mass is constant and the velocity is doubled the kinetic energy then becomes four times as great.

TRANSFORMATION OF POTENTIAL AND KINETIC ENERGY

The oscillating electric circuit is of primary importance in electronics engineering. In the following paragraphs will be established the basic principles of the operation of such circuits.

A weight of *W* pounds when raised *h* feet above the surface of the earth gains *Wh* foot-pounds of potential energy. If the weight is permitted to fall back toward its original position, the potential energy will decrease in direct proportion to the decrease in *h*. At the instant the weight strikes the earth the value of *h* is zero, and hence the potential energy must be zero. Therefore, the potential energy is maximum at the instant the weight begins to fall, and zero at the instant it strikes the earth.

Consider now the kinetic energy of the falling weight. At the instant the weight is released the velocity is zero; since $KE = \frac{mv^2}{2}$, the kinetic energy will be zero when the velocity is zero. As the weight falls, the velocity increases and brings an increase in kinetic energy. At the instant the weight strikes the earth the velocity is maximum; hence, the kinetic energy is maximum.

If the weight falls in a vacuum so that the effect of air resistance may be neglected, no work is done by the weight as it falls. By the law of conservation of energy the total energy—potential plus kinetic—possessed by the weight must be constant. Under these conditions potential energy at the instant the weight is first released must equal the kinetic energy at the instant of impact. At any instant of time between these two extremes, the total energy in the system must be a combination of potential and kinetic energy, and must satisfy the condition

$$PE + KE = Wh = \frac{mv^2}{2}$$

where PE and KE represent instantaneous values of potential and kinetic energy, *Wh* the maximum potential energy, and $\frac{mv^2}{2}$ the maximum kinetic energy.

There are many typical examples of transformations between potential and kinetic energy. Thus rainfall is trapped in reservoirs located above sea level. Such water storage is nothing more than a storage of potential energy. The water is released, and, as it flows toward sea level, the potential energy is converted to kinetic energy and used to drive water wheels and turbines. In the pile driver, the kinetic energy of an engine is converted to potential energy by hoisting a heavy weight. This weight is then permitted to fall, the potential energy being converted to kinetic energy during the fall. When the weight strikes the pile, the kinetic energy is converted to heat and mechanical energy in driving the pile into the earth. Other illustrations will come readily to the mind of the reader.

OSCILLATION

When energy is transformed from one form to another, and then back to the first form, it is said to be oscillating. The action of a pendulum is in nearly perfect analogy to the action of an oscillating electrical circuit. A careful study of the oscillating pendulum, with particular attention to the concepts involved, will make it much easier to understand the oscillating electrical circuit when it is encountered later on.

Now to consider the pendulum: In Figure 2, potential energy is stored in the pendulum bob W by elevating it to position A above the reference level XY. When the weight is released, it falls toward position B, gaining momentum as it falls. If the effects of air resistance and friction in the

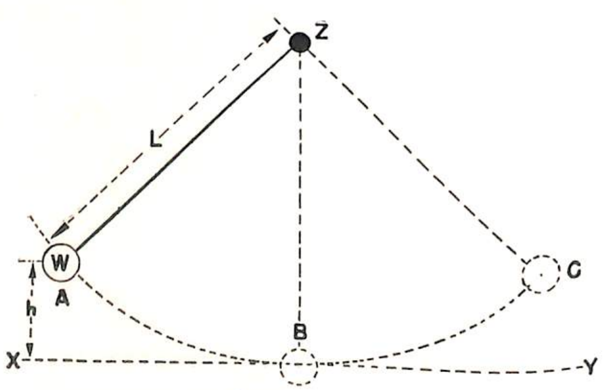


FIGURE 2—*The oscillating pendulum.*

bearing Z are neglected, the kinetic energy of the bob at point B should equal its potential energy at point A. The momentum of the bob at position B causes it to continue toward position C, but now the kinetic energy is being transformed to potential energy. At point C the bob pauses for an instant, the kinetic energy is zero, and the potential energy is again a maximum. The process is repeated as the weight returns to point A. It is important to note that the action taking place as the weight moves from A to C differs from that taking place from C to A only in one respect. The weight *reverses direction at each extreme of the swing.*

Moving from A to C the energy is transformed from potential to kinetic and then back to potential form. Such action, in which a change of direction occurs, is called an alternation. The next alternation differs from the preceding one only in the direction in which the bob moves. In passing from A to C and back to A again the pendulum completes one cycle of events. A cycle consists of two successive alternations in opposite directions. In order to identify any selected alternation from the one preceding or following it, a difference in direction is indicated by use of the plus and minus signs. Figure 3 is a representation of how the kinetic and potential energy varies in the pendulum. Movement from A to C is considered positive and from C to A negative. The solid curve representing kinetic energy begins at zero at position A, rises to a maximum at position B, decreases to zero at position C—at which point it reverses direction and repeats the variation. The broken curve, representing potential energy, is maximum at position A, decreases to zero at position B, and rises to maximum at position C—at which point it reverses direction and repeats the variation in amplitude. Note that both curves have the same maximum value, a condition that is true only if the losses in the pendulum system are eliminated.

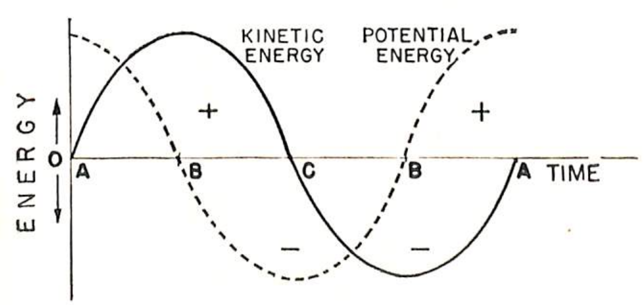


FIGURE 3—*Oscillatory exchange between kinetic and potential energy in the oscillating pendulum.*

The time required for the pendulum to complete one cycle (two successive alternations) is called the period of the pendulum. If this time is expressed in seconds the number of cycles completed in one second is

$$f = \frac{1}{t}$$

where f is the frequency of oscillation in cycles per second.

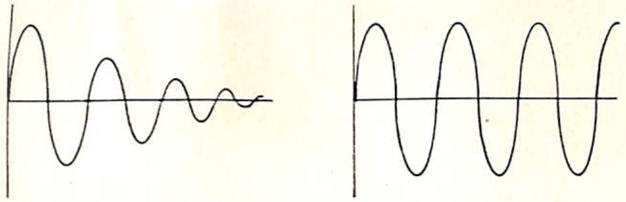
The pendulum traverses a certain horizontal distance in moving from A to C and back to A again. This distance may be considered for our purposes here as the wavelength of the pendulum and is represented by the Greek letter λ (lambda). Although the velocity of the pendulum varies from zero at points A and C to a maximum at point B, it has a certain average horizontal velocity. The average velocity, frequency, and wavelength are all related by the formula

$$Frequency = \frac{\text{average velocity}}{\text{wavelength}}$$

$$f = \frac{v_{av}}{\lambda}$$

This is an important formula in electronics engineering. Important, too, is the meaning of the word alternation, and especially of the words cycle, period, frequency, and wavelength.

The ideal pendulum (one without losses) exists only in theory. However, once the theory of such a pendulum is established, it is a simple matter to qualitatively predict the action of a practical pendulum. Air resistance plus friction in the pendulum fulcrum acts continuously to transform some of the energy in the system into heat energy. This loss causes the pendulum to swing in an arc that decreases steadily in length as energy is lost from the system. When all the original energy has been converted to heat, the pendulum comes to rest. Figure 4 represents the series of waves produced by a pendulum as the original energy in the system is permitted to dissipate. Such a series of cycles may be said to constitute a wave-train. An oscillation of this type in which the amplitude decays in this manner is said to be *damped.* The more rapidly energy is converted into heat in the pendulum, the less will be the number of completed cycles in any wave-train. Indeed, if the energy loss per cycle is made sufficiently great, it is even possible for the pendulum to be unable to complete a full cycle or to swing in the other direction at all. In such a case it is no longer an oscillating device.



DAMPED WAVE CONTINUOUS WAVE

FIGURE 4—*Continuous-wave and damped oscillations.*

The pendulum is an excellent timing device because the period is independent of the mass of the bob, and within reasonable limits is independent of the length of arc through which the pendulum swings. The period in seconds of a simple pendulum is given by

$$t = \pi \sqrt{\frac{l}{g}}$$

where l is the length of the pendulum and g is the gravitational constant. The period is affected only by the length, and not by the mass or length of arc.

In the pendulum clock a source of potential energy, usually the clock spring, supplies the energy that keeps the pendulum in motion. Through an escapement mechanism, small increments of energy are delivered to the pendulum at just the right instant of time to supply the energy lost from the system in the frictional losses. This impulse is usually delivered at the instant the pendulum is passing through the lowest position in the arc of swing. Under such conditions the pendulum generates continuous oscillations of equal amplitude and identical periods. Through a system of gears the pendulum drives the time-indicating mechanism.

In the oscillating electrical circuit three electrical quantities are involved: inductance, which stores energy in kinetic form, capacitance, which stores energy in potential form, and resistance, which converts some of the energy to heat energy. Like the pendulum in the clock, the circuit will generate continuous waves if energy impulses are delivered to it to just compensate for the energy converted to heat. The inductance and capacitance of the circuit in combination control the "electrical length" and hence the frequency of oscillations. This type of circuit will be discussed later in a considerably more detailed manner.

EXERCISES

1. What is the quantitative definition of power in terms of mass, length, and time?

2. A 20 hp elevator motor will lift what load in pounds through a distance of 100 feet in 20 seconds?

3. What must be the length of a pendulum in feet to have a period of one second? One-half second?

4. A 2.5 kilowatt generator is 83% efficient. What input in horsepower is required for full output?

5. A 10 lb force applied to a loaded pulley causes the pulley to rotate at 200 rpm. If the pulley is 1 foot in diameter what power is being delivered to the load?

6. A punch press exerts a pressure of 40 tons per square inch when punching a hole 2 inches in diameter through a sheet of steel 1.5 inches thick. How much work in ft-lb is done in punching one hole?

7. What kinetic energy in ft-lb is possessed by a 3000 lb automobile moving at 80 mph? At 40 mph?

8. If a gasoline engine develops a force of 200 lb in keeping a 3000 lb automobile moving at 40 mph, what is the power in hp developed by the motor?

9. A motor-driven pump having an overall efficiency of 70% pumps 600 gallons per minute of water (equivalent to 80 cu. ft. per min.) from a well 50 feet deep. At a cost of 3 cents per kw-hr, what will be the cost of operation for a ten-hour day?

10. A typical public utility rate schedule for electrical energy specifies a rate of 3.5 cents for the first 100 kw-hr, 3 cents for the next 150 kw-hr, and 2.5 cents for all amounts over 250 kw-hr. Compute the cost of 485 kw-hr of electrical energy under this schedule.

Answers to Exercises, Chapter 1.

1. (a) 17 cm.
   (b) 2500 ma.
   (c) 5.2 megohms.
   (d) 0.00031 v.
   (e) 40,000 kc.
2. (a) 1.915 ft.
   (b) 9.84 in.
   (c) 2.51 m^2.
   (d) 61 in^3.
   (e) 1.304 kg.
3. –0.5 ft/sec^2.
4. 9.75 m/sec^2, 24.4 m.
5. 3.2 newtons.
6. 980 dynes.
7. 4 ft/sec^2.

INDEX TO *Electron* VOLUME 2

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PART 1 • ALPHABETICAL

PART 2 • CLASSIFIED

COMMUNICATIONS EQUIPMENT

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SONAR

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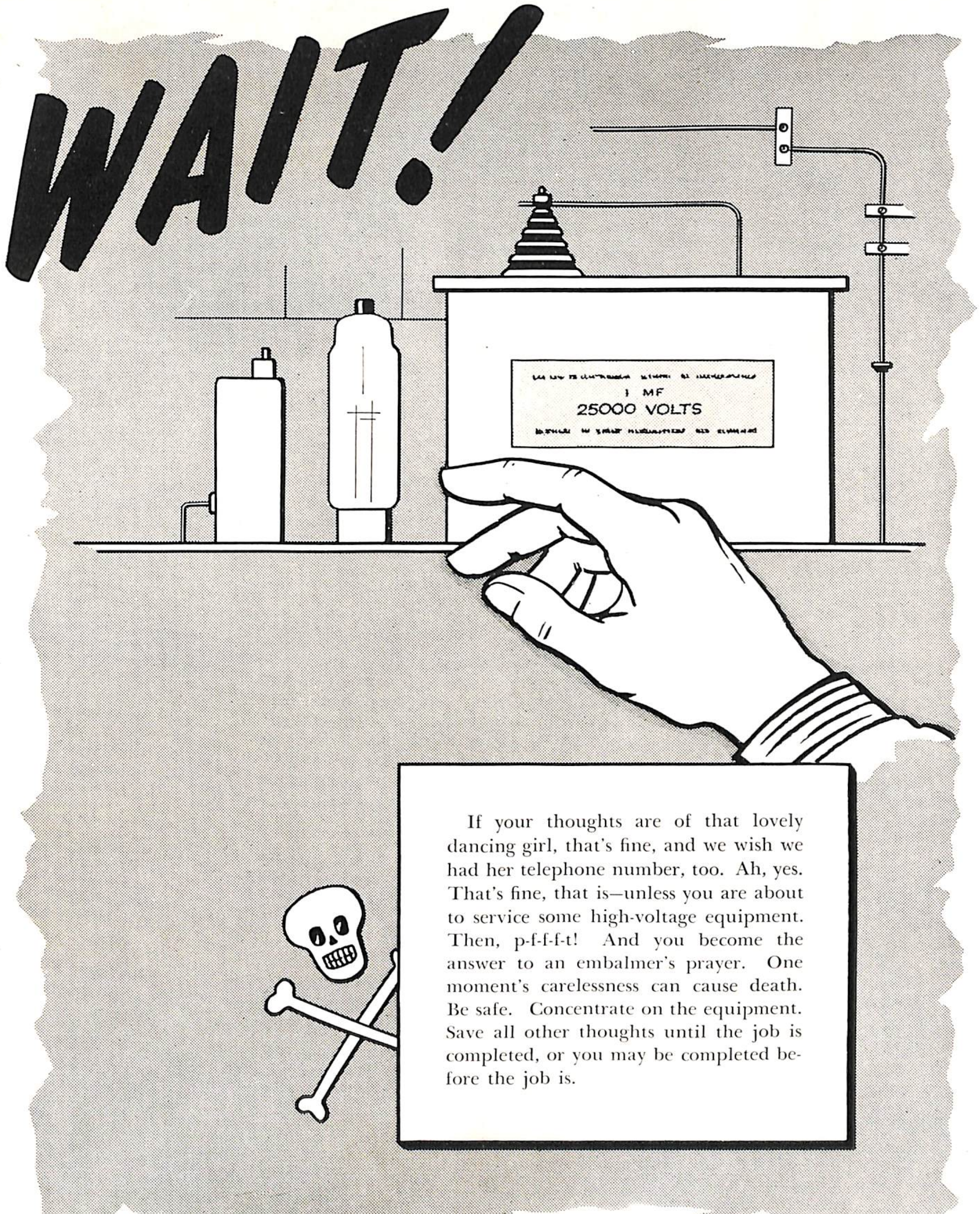
PART 2 • CLASSIFIED

TYPE 53349 ANTENNA FILTER FOR TDZ

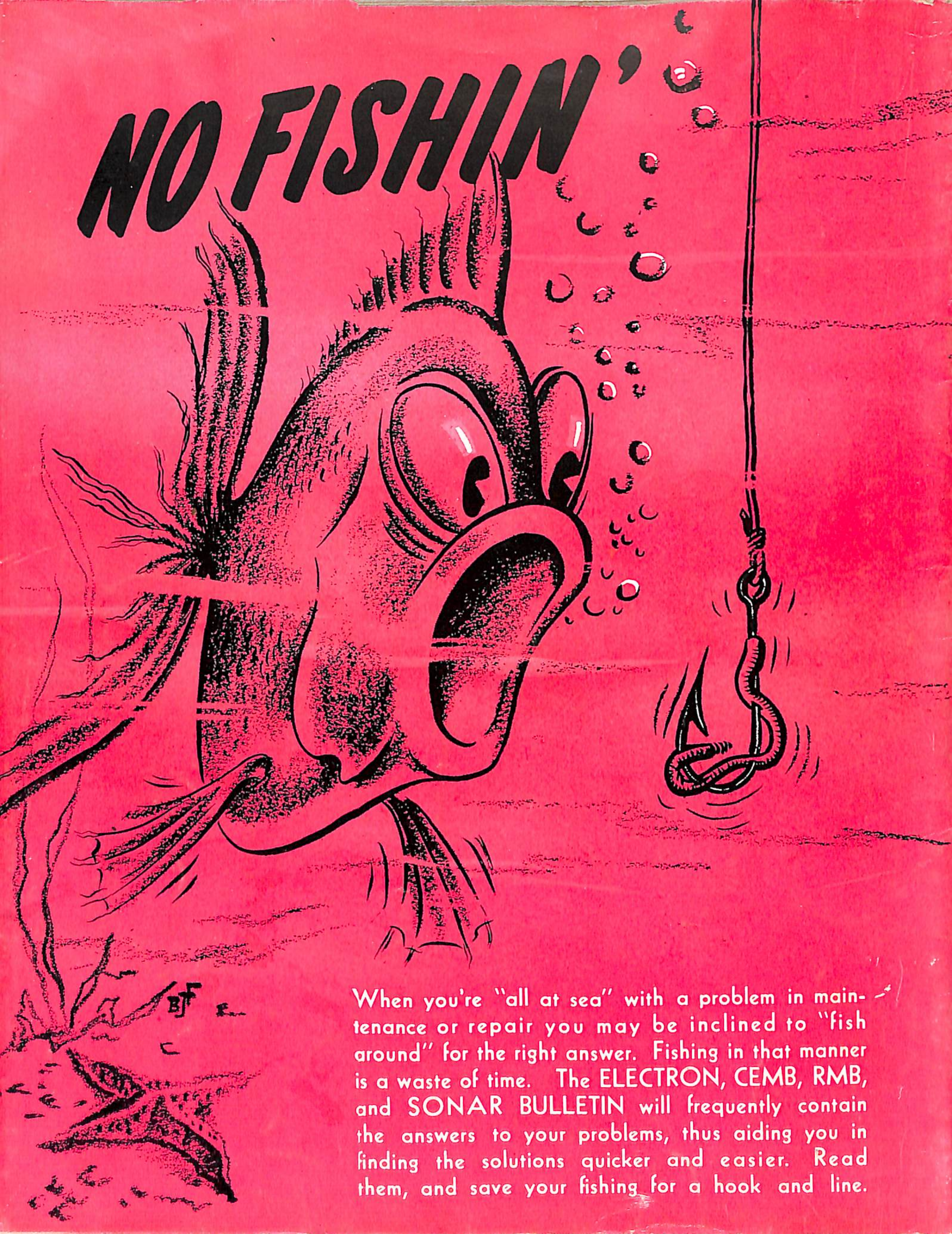
On page 1-6 of the Model TDZ transmitting equipment instruction book (NavShips 900,809) there occurs the statement in reference to the Type 53349 antenna filter that "The filter should be employed only when necessary, as the transmitter output is decreased when it is used." Another statement relative to the filter is made on page 2-17 where it is stated that "This filter should be used only when the harmonic output of the TDZ transmitter may interfere with the output of other transmitters aboard ship, such as radar systems. When the filter is employed, power output of the TDZ transmitter may be reduced as much as 25% because of reflection in the transmission line caused by the characteristic impedance of the filter unit." Still a third time, on page 3-9, the instruction book states that "This filter should not be used unless necessary, since power output of the TDZ transmitter will be reduced somewhat on certain frequencies when the filter is used. Before this unit is installed, consult the Electronics Officer for approval."

It is only to be expected that after reading these statements in the instruction book, many ETM's and installing activities would be hesitant about connecting and using the filter without first obtaining approval. It is also to be expected that many persons might interpret the 25% reduction of the power output as being a substantial loss, whereas it is actually equivalent to only about 1.3 decibels.

The Bureau considers that the advantages to be gained by eliminating spurious emissions above 400Mc outweigh the disadvantage of this small loss of radiated power. Accordingly, regardless of what the instruction book states about not using the 53349 antenna filter, the Bureau desires that this filter be used in every shipboard installation.



If your thoughts are of that lovely dancing girl, that's fine, and we wish we had her telephone number, too. Ah, yes. That's fine, that is—unless you are about to service some high-voltage equipment. Then, p-f-f-f-t! And you become the answer to an embalmer's prayer. One moment's carelessness can cause death. Be safe. Concentrate on the equipment. Save all other thoughts until the job is completed, or you may be completed before the job is.


NO FISHIN'
When you're "all at sea" with a problem in maintenance or repair you may be inclined to "fish around" for the right answer. Fishing in that manner is a waste of time. The ELECTRON, CEMB, RMB, and SONAR BULLETIN will frequently contain the answers to your problems, thus aiding you in finding the solutions quicker and easier. Read them, and save your fishing for a hook and line.