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ELECTRON

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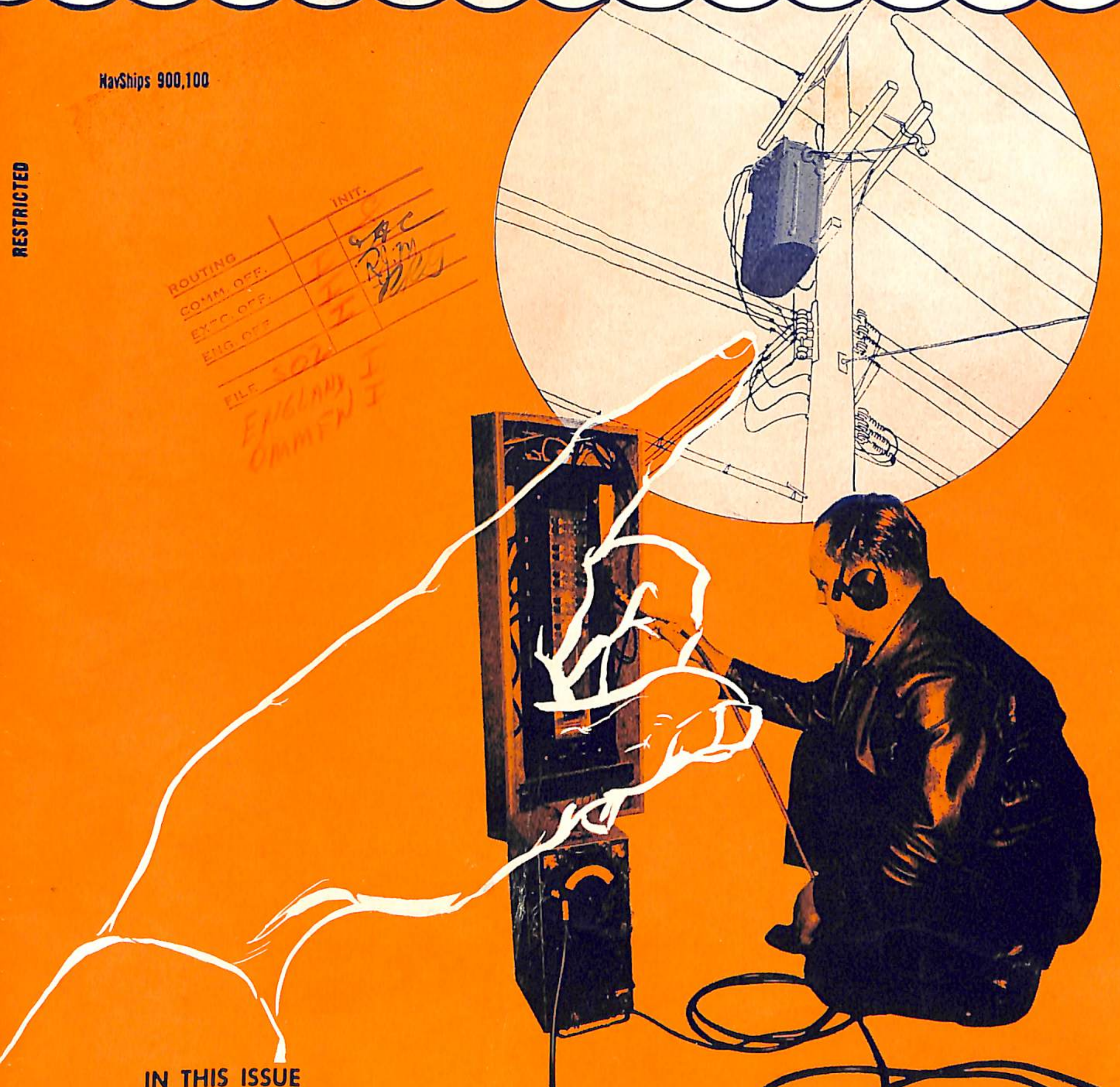

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IN THIS ISSUE

ELECTRONIC INTERFERENCE SURVEYS

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THIS ISSUE

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ELECTRONIC INTERFERENCE SURVEYS

The Bureau of Ships in the past two years has completed electronic interference surveys at many Naval Shore Communication Stations and Naval Air Stations as an important phase of this Bureau's comprehensive program for the improvement of receiving conditions by the reduction or elimination of electronic interference. The prime purpose of an electronic interference survey is to locate wherever possible all sources of interference; to determine the method by which the interference is coupled to the affected receivers or electronic equipments; and finally to determine the best practical method for reducing the interference, within the limitations of the present state of the art. That this program has been eminently successful in improving Naval Communications is attested by reports concerning the hundreds of sources of electronic interference eliminated as a result of these surveys. The prompt corrective action by cognizant personnel in following the recommendations contained in the final survey reports has resulted in highly satisfactory receiving conditions at many Naval Shore Activities where previously high electronic interference levels had created intolerable operational conditions.

The Bureau of Ships electronic interference reduction program was initiated several years ago through the untiring efforts of Mr. L. Thomas, Captain T. Rogers and Captain A. Becker of this Bureau. Mr. Thomas has been largely responsible for the design and development of the Navy's electronic interference and field intensity test equipment, considered the best available anywhere. The efforts of Captain Rogers and Captain Becker in originating and implementing this program were responsible for the highly efficient manner in which it has been conducted. This program, based on the highly beneficial results obtained, was expanded, and presently three coordinated electronic interference reduction programs are in progress under the cognizance of the Electronics Shore Division, the Electronics Ship and Amphibious Division and the Electronics Design Division.

The Electronics Shore Division under the command of Captain Hedley B. Morris is vigorously conducting an electronic interference reduction program at all Naval Shore Communication Stations and Naval Air Stations through the medium of field surveys and by the dissemmination to Shore Activities of advanced engineering data concerning interference reduction methods. At all Naval Districts where surveys have been conducted, the enthusiastic cooperation of cognizant personnel has resulted in improved receiving conditions. Most of the surveys to date have been conducted by engineering services contractors, operating under Navy contracts. The engineering services contractor's personnel, all experienced engineers, specializing in the measurement and elimination of electronic interference, have as a phase of their duty during surveys at Naval Shore Stations, provided instruction to assigned personnel at these activities, in the techniques of locating, measuring, and eliminating sources of electronic interference. Improved measurement techniques and methods of compiling and reporting interference data have been developed as a result of these many surveys. It is the purpose of this and articles to follow, to clarify these survey techniques in order that cognizant personnel in the various Naval Districts may conduct electronic interference surveys in the most effective and efficient manner. Important as are field electronic interference surveys, the old adage "that an ounce of prevention is worth a pound of cure," should be kept in mind, when installing equipment likely to cause interference at a receiving activity or when choosing the physical location of a receiving station. Navy communication receivers are the most sensitive and efficient obtainable, yet it is common practice, as noted from survey reports, to locate these same receivers in areas of high interference levels or to permit the encroachment of known sources of interference on Naval Receiving Activities, with the result that the receiver gain controls may not be operated over more than a fraction of their possible range. The sole purpose of a receiving station is to consistently receive intelligible signals and every effort should be made to insure that optimum condition.

The major problem involved in the measurement of electronic interference has been to obtain a true picture of a given interference condition. This difficulty stems from the highly complex nature of the electrical disturbances which constitute electronic interference. These

Use of the AN/PRM–1 and Antenna AT–211/PRM–1 in measuring electronic interference levels at transformers located in a sub-station supplying power to a receiving activity.

electrical disturbances vary so greatly and so rapidly in phase, amplitude, frequency distribution and rate of repetition that they are often exceedingly difficult to measure. It is therefore a difficult task to select from the many measurements that might be made, the ones that are most significant for the desired purpose. It is comparatively easy to obtain numerical values of electronic interference, but the difficult part lies in understanding just what the measurements mean. This can be particularly confusing, especially when analyzing the results of multiple electronic interference surveys at Naval Shore Stations and Naval Air Stations, unless the measurements are obtained in a standard manner, using identical measuring instruments and techniques. The measuring instruments presently in use by Naval Activities are designed for the measurement of field intensities and electronic interference levels throughout the radio frequency spectrum from 14 kilocycles to 400 megacycles. These instruments are as follows:

1—AN/URM–6—14 kc to 250 kc
2—AN/PRM–1—150 kc to 25 Mc
3—TS–587/U—15 Mc —400 Mc

In addition to the above instruments, one other type of measuring equipment is currently in production and will be available shortly. This new equipment is designated the AN/URM–17 and covers the radio-frequency spectrum from 375 Mc to 1000 Mc.

Through the usage of the above equipment and standard survey procedures it will be possible to obtain maximum results at every Naval activity.

Before proceeding with a survey, cognizant personnel should first provide themselves with printed data sheets with which to record interference conditions. When making electronic interference measurements, the amount of information recorded on the data sheets is very important. *All the information pertaining to measurements should be recorded at the time of measurement.* Failure to do this often results in questioning the validity of the data at a later date. Some of the important information to be recorded when making radiated or conducted electronic interference measurements is as follows:

1—Complete description of tested equipment on location undergoing investigation. When tested equipment is a major item, list type, serial number, manufacturer and use.

2—Record all three values of measurement, average (FI), weighted value (QP), and peak at each frequency.

3—Complete description of the audio headphone response as observed by aural monitoring.

4—Notations of atmospheric static conditions at time of measurement.

5—Any other pertinent facts affecting measurements.

The following is typical of an efficient electronic interference source data sheets which may be prepared in quantity in advance of a survey.

ACTIVITY______________________ NAVAL DISTRICT______________________

NAVAL SHORE STATION
ELECTRONIC INTERFERENCE SOURCE DATA SHEET

1. Source of interference, description of:
   a. Type______________.
   b. Model______________.
   c. Input voltage______________.
   e. Actual use______________.
2. Conducted interference in UV at input__________at frequency__________.
3. Radiated interference in UV/M at 3 feet__________at frequency__________.
4. Test equipment used for measurements.
5. Frequencies measured at source__________. Intensities__________.
6. Wind velocity__________humidity__________sky__________.
7. Atmospherics__________.
8. Approximate location of source of interference______________________.
9. Cognizance of source______________________.
10. Approximate distance of source from nearest receiving antenna______________.
11. Approximate distance from nearest receiver input______________.
12. Type wiring serving source______________.
13. Extent to which source interferes with communications or electronic equipment:
    a. Interference level radiated from the source as measured in UV/M at the receiver signal input system.
    b. Interference level in UV as conducted through power line and measured as follows:
       (1) On receiver side of line filter______________.
       (2) On line side of line filter______________.
14. List of frequencies at which measurements were made at receiving activity______________________.
15. Interference levels at above frequencies______________.
16. Corrective measures taken:
    a. Components used (values, types and complete description). ______________________.
    b. Was interference eliminated______________?
    c. If merely reduced, then degree of reduction accomplished______________.
17. Corrective measures taken:
    a. Explanation as to reason for failure to take corrective action______________________.
    b. Recommendations as to corrective measures to be taken in detail______________________.
18. Further comments ______________________________
19. Signature of engineer or technician______________________________.
20. Date______________________.
21. Activity ______________________________.
22. Date forwarded to cognizant code or activity______________________.

Note: Three each of this type form to be completed immediately in the case of every source of electronic interference disclosed and distributed as follows:

1 Copy—Bureau of Ships Code 932
1 Copy—COMNAVSHIPYD of District Involved (Code 125)
1 Copy—Commanding Officer of Naval Shore Station Involved

In completing the electronic interference data sheets it has been found that personnel are often at a loss as to the method of describing adequately a certain type of interference being measured so that personnel other than themselves may be able to intelligently interpret the data obtained. It is with this thought in mind that the following suggestions are submitted:

SOURCE	CAUSE	SUGGESTED DESCRIPTION
D-C Motors and generators.	Commutator and brush arcing.	Random type commutator interference.
Radar: Transmitter-Modulator—Pulse cable radiation.	Modulator pulse.	Pulse type modulator interference, ( ) PRF.
Radar: Receiver internal conversion, thermal and shot effect reradiation.	Radar receiver video amplifier outputs.	Random radar video interference.
Fluorescent lamp fixtures.	Gas filled tubes.	60 and 120 cycle complex pulse type interference (fluorescent lamps).
Power supplies.	Gaseous rectifiers.	60 and 120 cycle complex pulse type interference (rectifier).
Transmitters.	Harmonics and parasitic oscillations.	Recurrent wave interference ( ) source when identified.
Gasoline engines.	Ignition.	Pulse type ignition interference ( ) PRF, if possible.
Thermostats.	Bad contacts arcing.	Complex random arcing type interference.
Contact type buzzers on alarm systems.	Arcing contacts.	Complex arcing interference (buzzer or bell).

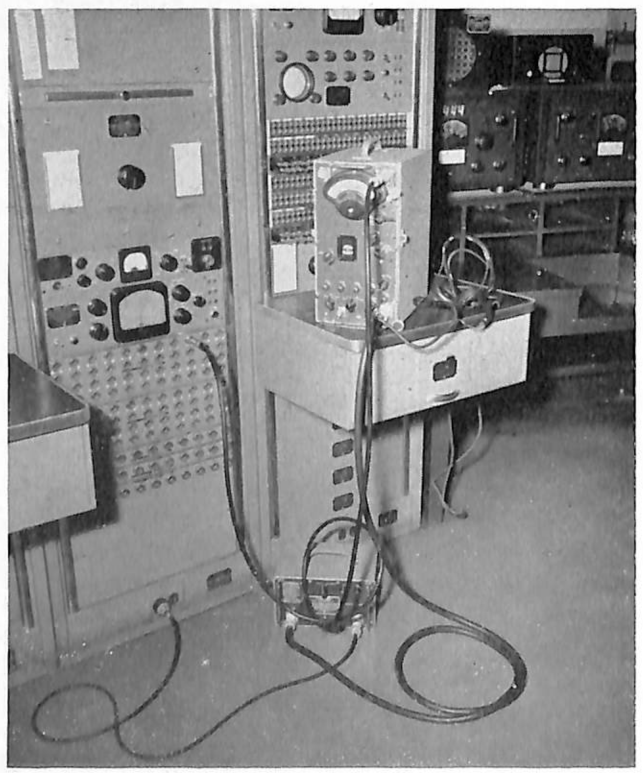
Descriptions such as those above will enable personnel interpreting such data to more readily understand the conditions existing at the time of measurement.

In conducting electronic interference surveys, careful advance planning is a prerequisite for obtaining optimum results. The entire Naval Activity, whether it be a Naval Shore Communication Station or a Naval Air Station should first be reviewed with the purpose of determining an order of priority for the various areas to be surveyed. For example, at a Naval Air Station, the control tower would be the place ordinarily chosen to start measurements, with other receiving activities following in order of importance. To secure meaningful and interpretable results a survey must be further planned so that the necessary schedules may be arranged and coordinated with all participating units and personnel well in advance of the date of the tests.

Because of the difference in the manner in which field intensity surveys and electronic interference surveys are conducted, each will be treated separately.

Field Intensity Survey Considerations

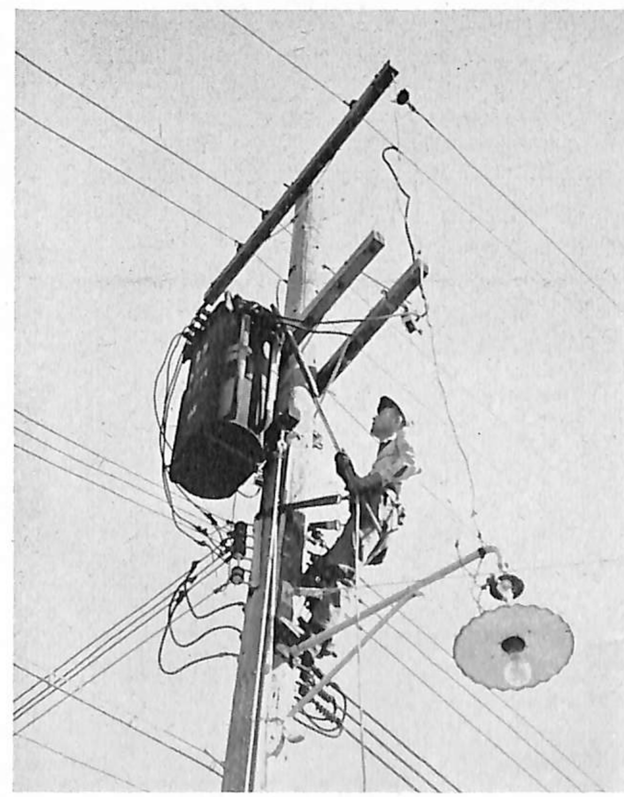
It is often necessary to make field intensity measurements at a specific location, and it is then necessary to consider the effect of surrounding objects on the received signal strength. Often, however, the choice of a measurement site is optional, and the observer must know just what constitutes a good site for a given set of conditions. True radiation field measurements are made at a distance more than two wavelengths from the measured transmitter in order to avoid the influence of the induction field.



AN/PRM–1 with impedance matching network CU–197/PRM–1 (50 ohm) connected to an antenna switching system.

In selecting a site for field intensity maesurements, the following considerations should be remembered: The radio-frequency voltage induced in an antenna is proportional to the intensity of the electro-magnetic field in the space surrounding the antenna. The intensity at this point will depend upon the radiated power; the frequency of the received signal; the distance from the transmitter; the attenuation over the path between the transmitter and the receiver; reflections and reradiations from nearby conductors, such as power lines, wire fences, water towers, and steel buildings; absorption by trees; and the effects of hills, valleys or cliffs.

The ideal site would be an open, flat terrain at a considerable distance from buildings, electric lines, fences, etc. Even buried cables can cause serious effects on the measurement of low frequencies, since the lower the frequency, the greater the depth of ground penetration. Another important consideration in making field intensity measurements is the possible presence of local electrical interference sources which may render field intensity measurements very difficult to obtain. When measuring frequencies in the low, medium and high frequency bands, there are two major factors to consider. The more important of these factors is the distance of the measuring site from the transmitting antenna. There is an area wherein the ground wave of the transmitting antenna is too weak to be detected and the sky wave is not present, dependent upon the angle of radiation from the transmitting antenna and the angle of reflection of the transmitted signal from the Ionosphere. This area, at a distance from the transmitting station depending upon the transmitting frequency, is called the "Skip Distance." The extent of this area is dependent to a great degree upon the conditions of the Ionosphere at the time of measurement. Therefore, the distance of the recording site from the transmitting antenna and the exact time of measurements are vital and this information should always be noted on the survey sheets at the time measurements are made in order to avoid confusion at a later date when the results of the survey are analyzed.



Lineman measuring power line interference by use of Antenna AT–211/PRM–1 mounted on a wooden stick and connected to the AN/PRM–1 by means of cable CG–444/U.

The next factor in order of importance is known as the area of fading. This condition is common in the lower portion of the medium frequencies and in the upper portion of the low frequency band. This is the area where the ground wave and the sky wave begin to equal each other in intensity. This again, is a problem of wave propagation and the extent of the area in which this phenomena occurs is greatly dependent upon conditions prevailing in the Ionosphere at the time. In this area, large variations in field intensity may be observed within a short period of time. This large variation in field intensities, most commonly referred to as fading, is due to the phase relationship of the sky wave to the ground wave at the receiving site. There are two functions affecting this phase relationship; one is the difference in the disturbances travelled by the two types of wave fronts, and the other is the shift in phase of the sky wave when reflected from the Ionosphere.

Abnormal propagation conditions cause the measured field intensity values to be higher or lower than would be obtained under normal conditions. Low-frequency signals are, as a rule, much less subject to fading and other irregularities than higher-frequency signals. Abnormal conditions do however exist at times and this data should always be entered on the survey data sheets. These data sheets will naturally differ from the one previously suggested for use as an electronic interference survey data sheet. The following is typical of a data sheet for use in reporting results of field intensity measurements:

FIELD INTENSITY SURVEY DATA SHEET

Date ____________________ Transmitting Station ____________________

Test Set

AN/PRM–1, Serial # ________________ Measuring site ______________________________

On back list all pertinent data such as site description, distances from buildings, etc.

Observers ______________________________

Distance from transmitter ______________________________

Time measurements started ______________________________

Time measurements completed______________________________

Time	Freq.	Cal set	Ind uv	Att Set	Corr. Fact	Rcvg Ant	Field Intensity		Remarks
							uv/m	db	

When graphic records are made with an Esterline Angus Recorder over a period of time, each recorder chart must be carefully identified and complete information supplied for each series of measurements. This information should include the date, start and finish time, the test identification, the location (very carefully described as to geographical position and to the presence of disturbing objects or conditions), the equipment used, the measurement frequency, the calibration, the attenuator setting, the function—switch position, the antenna used, the chart speed, erratic conditions, and type of ground connection when using a vertical antenna. The following data in convenient form shoud appear on the recorder chart and should be completed by the observer:

RECORDER DATA

Date ____________________

Test ____________________

Location ____________________

Equipment ____________________ Serial # ____________________

Freq ____________________ Calibration ____________________

Attn. setting ____________________ Function Switch ____________________

Antenna type ____________________ Height above ground____________________

Ground ______________ Recorder Serial # ______________ Chart Speed ______________

Time: Start ____________________ Stop ____________________

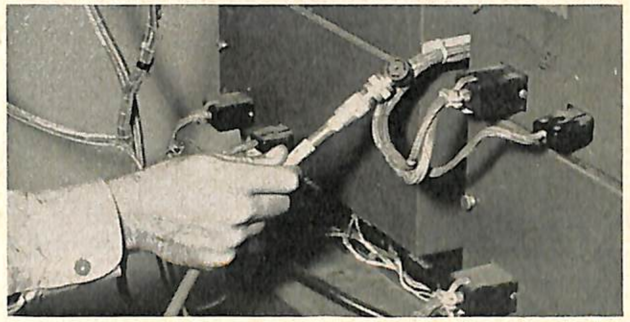
Observers ____________________ Naval Shore Station ____________________

Additional Notes ______________________________

Electronic Interference Survey Considerations

Prior to commencing the actual measurement of electronic interference levels, a visual inspection should always be conducted of the receiving activity and nearby areas in order to note the obvious sources of interference such as fluorescent lamps, overhead unshielded power lines, unsuppressed motor vehicles, etc., and the contributing factors such as poor grounding, painted or dirty insulators, unused antennas, etc.

An electronics interference survey of a receiving activity should begin with a series of measurements at the frequencies under investigation, made with the appropriate pick-up. The measurements of radiated interference should always be followed by measurements of conducted interference at the power line input to the receivers. It is usual practice to make measurements at at least five frequencies in each band of equipment, with sufficient overlap to insure complete coverage of all bands. Should a station or service be found operating on the frequency selected for measurement, move sufficiently away in frequency to avoid the side bands of the station. The survey report should note the frequency and field intensity from the particular station. Certain types of interference require scanning an entire band of frequencies for evidence of peaks or minima. Any such peaks or minima observed must be measured and noted on the source data sheet.



Use of the Antenna AT–211/PRM–1 in probing for electronic interference.

In discussing measuring techniques for the conduct of both electronic interference surveys and field intensity surveys each of the three measuring equipments will be described in turn.

The AN/PRM–1

The AN/PRM–1 is basically a meter intended for intensity measurements of all types of radio frequency energy in the low and medium radio frequency spectrum between the limits of 150 kilocycles and 25 megacycles. The AN/PRM–1 includes a sensitive receiver and a vacuum tube voltmeter. It also contains internal means of standardizing the receiver gain, thus permitting direct readings in indicated microvolts or microvolts-per-meter.

By special input design, provision has been made for use of the equipment in the following ways :

1—A field intensity measuring equipment operating from a vertical antenna of convenient size.

2—A field intensity measuring equipment operating from a loop antenna with directional properties.

3—A field intensity measuring equipment operating from a small probe responsive to an induction field.

4—A two-terminal voltmeter making both symmetrical and asymmetrical measurements with respect to ground.

With the various input provisions incorporated in the system, r-f voltage from one microvolt to one volt may be measured. In terms of field intensity, two microvolts per meter to two volts per meter may be measured, depending on the type of antenna used.

In operation, the type of measurement is selected by means of the function switch.

The FI (field intensity) function of the meter affords measurement in terms of the average value, the QP (quasi-peak) function derived by the use of a weighted detector circuit, and the peak function in terms of the peak value effect of the signal or interference at the second detector.

The RI—FI meter measures the effect of the peak of an interfering pulse. It does not measure the absolute peak value of the pulse because such response is dependent upon the effective bandwidth, the energy of the impulse (product of amplitude and duration), and the second detector characteristics of the measuring equipment. The duration of the impulse, after passing through the various tuned circuits, is roughly proportional to the reciprocal of the RI—FI meter effective bandwidth. The envelope of the pulse applied to the second detector differs from the input impulse envelope. Its peak amplitude is less than that of a sine wave signal having the same peak value as the original impulse. The tuned circuits in the RF—FI meter shape the pulse so that its peak amplitude is decreased and its duration is lengthened. The RF—FI meter integrates the spectrum of the impulse over the pass-band around the signal frequency and measures the peak value of the shaped impulse. This value can be converted to a per kilocycle bandwidth basis by application of a factor depending upon the bandwidth of the RI—FI meter at the measured frequency. When expressed in terms of per kilocycle bandwidth, the result may be correlated with similar readings obtained from other measuring equipments expressed in the source units.

The initial requirement for suitable field intensity measuring equipment is a high order of sensitivity combined with complete stability of operation in order that accurate results may be obtained. This high sensitivity necessitates that a reasonable degree of selectivity be provided so that measurements of the weaker signals may be made without serious interference from nearby transmitters. These requirements have generally been met by the use of superheterodyne circuits, especially where it is desired to measure the field intensity of very high frequency signals. The use of the superheterodyne circuit permits the inclusion of an intermediate frequency amplifier having very high gain with complete stability. The procedure for making measurements requires the adjustment of sensitivity of the measuring equipment in known steps, over a wide range. Utilizing the superheterodyne circuit, this is readily accomplished in the intermediate frequency circuits, where the accuracy of the adjustment is independent of the frequency of the received signal. These desirable characteristics, with the addition of attenuation in the input circuits to prevent over-loading of the input stages of the equipment, have been included in the AN/PRM–1 Electronic Interference—Field Intensity Meter.

The frequency range of the AN/PRM–1 Radio Interference—Field Intensity Meter is 0.15 to 25 megacycles. This frequency range makes the selection of a measurement site much more critical than for a site for measurements in the low frequency range. Antennas should be kept as far away as possible from overhead power and telephone lines, large trees, and tall buildings, especially buildings constructed of metal or re-enforced concrete. These objects may cause large errors due to their absorption or reradiation of the signal measured. A method for checking to determine whether adverse conditions exist, is given in the recommended procedure for making field intensity measurements. Objects, such as cars and trucks, should be kept at least 25 feet from the antenna. The effects of the body in the vicinity of the loop antenna are negligible except where a person leans over the loop antenna, completely shadowing the loop with the body while measurements are being made. When making field intensity measurements with the loop antenna, the AN/PRM–1 may be set on a table or a similar support for convenience of operation without affecting measurements. There are no observable body effects on the vertical rod antenna at distances greater than two feet when the AN/PRM–1 is setting on the ground and the operator keeping all portions of his body below the center portion of the antenna. Use of the vertical rod antenna without the AN/PRM–1 setting on the ground is not recommended.

Measurement Site Selection

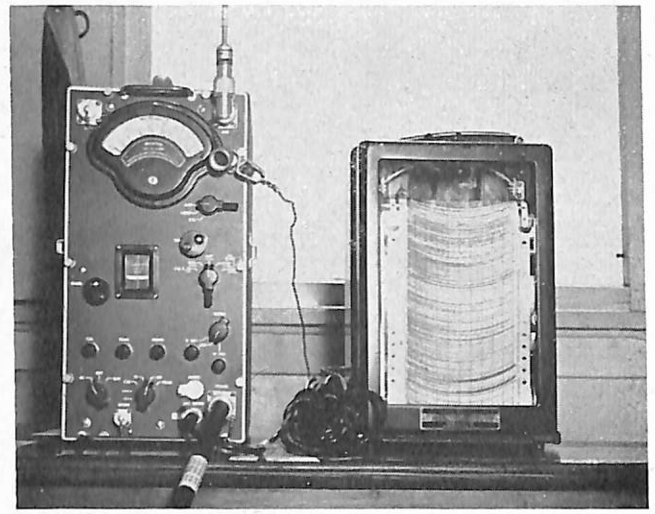
1—The AN/PRM–1 Electronic Interference—Field Intensity Meter should be set up in accordance with Section 3 of the instruction book, exercising care in handling of the equipment. Rough handling of the equipment will greatly decrease the reliability of the data obtained.

2—Means should be available for monitoring the primary power to the equipment. If internal batteries are used, periodic voltage checks of the A and B batteries should be made to prevent erroneous measurements. When 115-volt a-c 60-cycle commercial power is used, only an a-c voltmeter is required to observe any unusual voltage fluctuations.

3—Care should be exercised in the selection of the antenna to be used when making measurements. There are three antennas available, namely:

a—A large loop antenna AT–212/PRM is connected directly to the Measuring Unit.

b—A one inch diameter loop antenna AT–211/PRM–1, (herein referred to as the "Loop Probe")



The AN/PRM–1 shown connected to an Esterline-Angus Recorder.

which is connected to the Meter Unit by a 20 foot 95 ohm twin axial cable, CG–444/U (20′0″).

c—A vertical rod antenna AT–213/PRM–1 with an approximate effective height of ½ meter. When used with measuring unit on a table with the panel vertical, the rod antenna is attached to the panel receptacle marked "ANT," utilizing a right angle adapter (E–318). When used with the measuring equipment panel facing upward, the rod antenna is attached directly to the "ANT" panel receptacle. The range in field intensities over which the respective antennas may be used, when the AN/PRM–1 is standardized, are as follows:

Antenna	[2] Calibrated Effective Height	Range: Minimum Microvolts Per Meter	Range: [1] Maximum Volts Per Meter
AT–212/PRM–1 Loop Antenna		10 microvolts	10,000 microvolts
AT–211/PRM–1 Loop Probe Antenna		1000 microvolts	+ Approximately 1000 volts
AT–213/PRM–1 Vertical Rod Antenna	½ meter	2 microvolts	2 volts

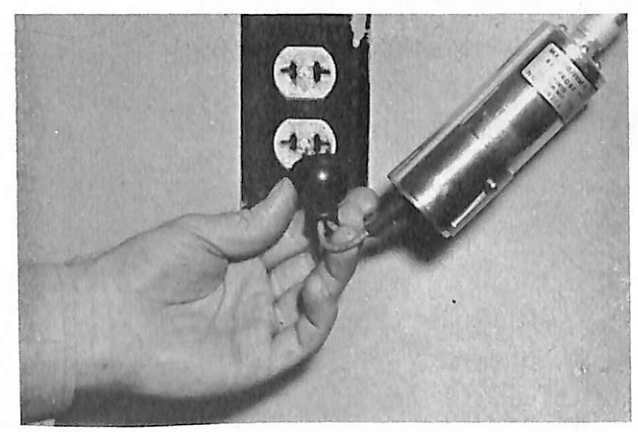
[1] By setting the gain of the AN/PRM–1 below normal or standardizing gain setting, even greater field intensities than those indicated above, can be accurately measured.

[2] The effective height of the vertical rod antenna of this equipment is dependent on the ground conductivity and the height of the antenna above the ground, and therefore, should be checked against the loop antenna at the measurement site to establish the true effective height and this value used to compute the true value in microvolts-per-meter. This check does not have to be made on the same frequency at which measurements are to be made if the carrier is of insufficient intensity, but should be as near as practicable (not greater than plus or minus one (1) or two (2) megacycles) depending upon the frequency of a carrier of sufficient field intensity to effect this comparison.

CAUTION: One must pay close attention when making the comparison checks to observe the proper calibration practices for the respective antenna since there is a separate calibration curve for the loop and rod antenna. The change in the effective height of the loop antenna with frequency is compensated for in the loop calibration data chart for the equipment. This eliminates the need for correction of readings for this effect.

Field intensity measurements should be made with the loop antenna unless otherwise specified or conditions do not permit its use. Factors to be taken into account in the selection of another antenna to be used for measurement are:

a—Location of the recording site with respect to the transmitting antenna, along with the power of the transmitting station.



Method of connecting the AN/PRM–1 into an a-c receptacle for measurement of conducted electronic interference levels by use of the R-F Probe MX–980/PRM–1.

b—Directional characteristics of the loop antenna, if desired.

The loop antenna AT–212/PRM–1 may be used to obtain reasonably accurate bearings of received signals by turning the loop until a sharp null or minimum pickup is indicated in the intensity of the received signal and adding 90° to the azimuth reading thus obtained. Since the loop antenna is electrostatically shielded, it picks up the electromagnetic component of the measured signal while the rod antenna picks up, primarily, the electrostatic component of the measured signal.

4—Calibration of the AN/PRM–1 Radio Interference—Field Intensity Meter immediately prior to taking measurements *is necessary.* This procedure is as follows:

a—Set the equipment up according to Section 3 of the instruction book.

b—Before turning the equipment on for the first time after setting up for measurement, or before changing from 115-volt AC to internal battery operation, or vice versa, or *if new batteries have just been installed, turn "A" and "B" voltage adjust controls counterclockwise before turning equipment on.*

c—Turn the power switch to the "AC" or "BAT" position, whichever is desired. If the equipment is operated from 115-volt a-c power, allow at least five minutes for equipment to stabilize. If operated from batteries, only a few seconds are necessary unless new batteries have just been installed.

d—Turn the "Meter Selector Switch" to the "A" adjust position and turn the "A" adjust control slowly clockwise until the meter indicator reaches the red mark on the scale.

e—Turn the "Meter Selector Switch" to the "B" adjust position and turn the "B" adjust control for the proper meter indication as designated by a red mark on the meter dial.

f—Turn the "Meter Selector Switch" marked "Meter" to the "USE" position.

g—Turn the "Antenna Selector Switch" to the "CAL" position.

h—Turn the "Attenuator Control" to the "CAL XI" position.

i—Turn the "Function Switch" to the "CAL" position.

j—Tune the Meter Unit to the desired frequency.

k—[1]Adjust the "Calibrate Control" marked "CAL" for the proper indication on the "DB" scale as shown in the calibration data for the proper serial numbered equipment.

l—This procedure completes the calibration for the one frequency and the instrument is now ready for setting up for measurement. This calibration procedure (Steps "g" through "k") must be repeated for each frequency at which measurements are to be made.

5—Care should be exercised in the order in which the respective controls are operated from the "CALIBRATE" positions to the positions for making measurements. Even though the equipment is well protected against overloads burning out the microvolt meter, excessive banging of the meter movement against the upper limit stops for long periods of time, may result in inaccurate indications of the meter which cannot be compensated for in the calibration of the equipment. The procedure for setting the controls for making field intensity measurements and the order in which these controls should be operated from the "CALIBRATE" positions, is as follows:

[1] If direct readings in microvolts are desired, the calibration chart in the back of the instruction book should be used. If, for any reason, the calibration chart is not available at the time measurements are to be made, the "CALIBRATE" control may be adjusted until the meter indicates 10 on the microvolt scale, (20 on the DB scale). The factors shown in the calibration chart, when available, are then used to evaluate "CORRECTION" factors for the indicated values thus obtained. By using the setting of 10 on the microvolt scale or 20 on the DB scale, for calibration, the required time for operations in the field, when a large number of frequencies are to be observed, may be reduced.

a—Turn the "Attenuator Control" to the "X10⁴" position.

b—Turn the "Antenna Selector Switch" to the desired "ANT" or "LOOP" position.

c—Turn the "Function Switch" to the desired "FI" (Field Intensity), "QP" (Quasi Peak) or "PEAK" position.

d—Turn the "Attenuator Control" from "$X10^4$", to "$X10^3$", then "$X10^2$" positions, etc. until an indication on the meter is obtained. If the meter indication is below 10 on the microvolt scale, the "Attenuator Control" should be turned to the next lower step in order to obtain, if possible, a meter indication in the upper two-thirds portion of the meter scale.

The meter dial has two scales. The upper scale is calibrated in "Microvolts" and the lower scale is calibrated in *"DECIBELS ABOVE ONE MICROVOLT."*

6—In certain instances intense radio frequency fields may penetrate the shielding provided by the case and front panel and induce radio frequency energy into the equipment input circuits, thus producing erroneous readings. A test for this condition may be accomplished as follows:

a—Turn the "Antenna Selector Switch" to the "CAL" position.

b—Turn the "Attenuator Control" to the 'CAL XI" position.

c—Turn the "Function Switch" to the "CAL" position.

d—Adjust the Calibrate Control for normal calibration indication on the meter as specified by the calibration chart for the specific frequency.

e—Turn the "Function Switch" to the "FI" position.

f—Observe the meter indicator for any indication of signals. The meter indicator should drop to zero. If there is an indication above one microvolt, case leakage is indicated and this condition should be corrected, if possible, before quantitative measurements are made.

7—Before making field intensity measurements of the station desired, a test should be made of the measurement site. This test is to determine the effect, if any, of hidden objects in the vicinity which may make the site undesirable for field intensity measurements. This test is very important at the higher frequencies.

The test is accomplished as follows:

a—Using the loop antenna (AT–212/PRM–1) make a series of measurements over an arc of not less than 180 degrees at 10 degree intervals.

b—Plot the results for any irregularities in the pattern. If the loop pattern results in a smooth figure eight, when plotted through 360 degrees, no serious effects from nearby objects are indicated. Any irregularities in the pattern, if checked and found authentic, indicate undesirable characteristics of the sit.

Recording of Data

A sample data sheet recommended for use in recording field intensity measurements is illustrated in this article. This sample data should be completely filled out with all pertinent information *at the time of measurements. Lack of sufficient data often results in measurements that have no value.* Filling out all of the information necessary for the sample data sheet at the time of measurements also acts as a reminder to perform all of the functions necessary for the maximum useable information which greatly increases the reliability of the data obtained.

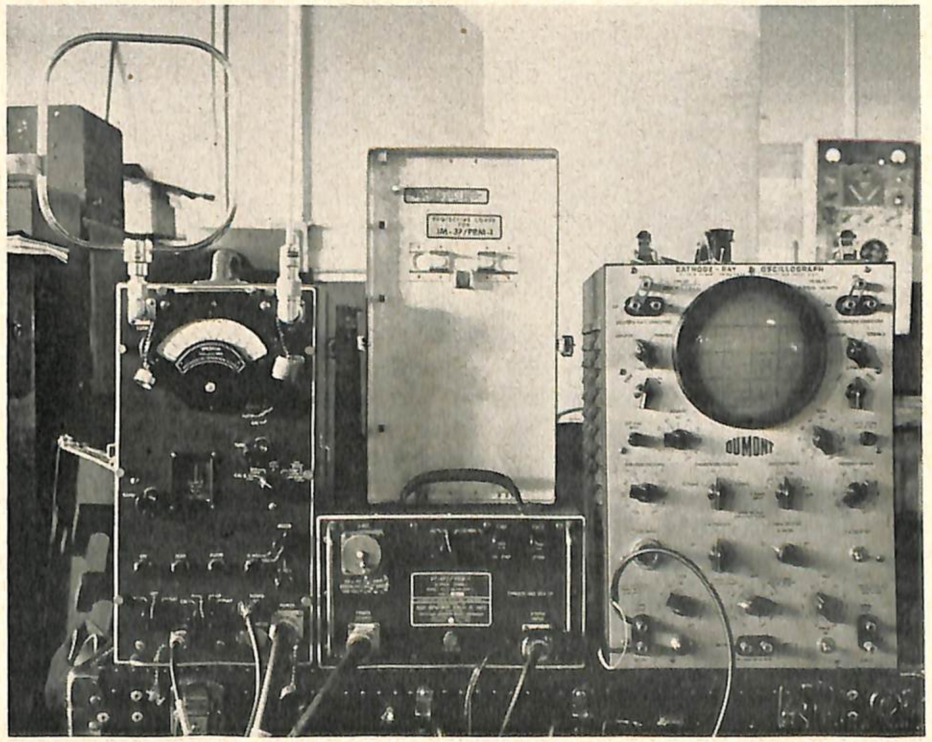
Occasional checks should be made of both "A" and "B" voltages, the calibration voltage, and the optimum tuning of the signal. Appropriate information at the time of these checks should be entered in the data sheet. These checks should be made at least once every fifteen (15) minutes for the first hour of measurements and at least once every two (2) or three (3) hours throughout the day. The frequent checks for the first hour of measurements are to correct for any slight drift which may occur while the equipment is becoming stabilized. The remainder of the checks are for assurance that the equipment is operating normally and that the recordings are valid.

Information pertaining to any irregularities should be written on the data sheet *AS SOON AS THEY ARE OBSERVED.* Failure to do this often results in questioning the validity of the data obtained.

8—Field intensity measurements may be made of stations transmitting intelligence by keyed continuous wave (CW) only if the code speed is at a constant rate (such as that accomplished by mechanical or electronic keying of the transmitter by use of a tape recording) or if the transmitter key is held closed for a short interval of time, in the order of 5 seconds, at predetermined intervals over the recording period.

9—The Slide Back Voltage measurement method normally used for making Peak measurements, may be used for accurate tuning of keyed carriers transmitting intelligence by code, by turning the "FUNCTION SWITCH" to the "PEAK" position and adjusting the "PEAK" control clockwise while adjusting the "TUNING" control, until the signal can just be heard with the audio gain control set at maximum. At the point where the signal can be heard only faintly in the earphones, with the audio gain set at maximum, the signal can be observed at only one narrow spot on the tuning dial. This narrow spot on the dial is the optimum tuning for the desired signal.

10—The use of Peak and Quasi Peak positions of the function switch for making measurements of carriers transmitting intelligence by code, are found not to be reliable. A person, after considerable practice, may learn to use the peak voltage method for measuring keyed carriers transmitting intelligence by code with fair results, but this procedure is not recommended where any other arrangement of transmission can be made.



The AN/PRM–1 shown connected to an oscilloscope for visual observation of interfering waveforms.

11.—Where data of the variations in field intensity of a transmitting station in terms of decibels is desired, a range of approximately 30 DB with reasonable accuracy may be obtained without changing attenuator steps. This is an advantage where data is desired over long periods of time by having a minimum of adjustments to make during measurements. The "CALIBRATE" control of the equipment in reality is an r-f gain control for the receiving portion which may be used as a vernier attenuator control for adjusting the indicating meter for full scale indication of the signal. This use of the "CALIBRATE" control does not appreciably affect the accuracy of the change in indicated value in terms of decibels for the upper 2/3 of the indicating meter scale but is not recommended for indications in the lower 1/3 portion of the scale unless a calibration curve for this portion has been made. When the calibrate control is set at a point other than that for normal calibration, the indicated values may be converted into true values by use of the following formulas:

$$\frac{X_1}{X_2} e = E \text{ in microvolts}$$

X_1 = Calibration Value from chart in back cover of the instruction book computed for equivalent microvolts.

X_2 = Indicated value on microvolt scale with controls turned to their respective appropriate calibrate positions.

e = Meter indication in microvolts of field intensity measurement.

E = True value of field intensity

$$e' + 20 \log \frac{X_1}{X_2} = E \text{ in DB}$$

or

$$e' + X'_1 - X'_2 = E \text{ in DB}$$

e' = Meter indication in DB of field intensity measurement.

X'_1 = Calibration value in DB found in the calibration data chart located in the back of the instruction book.

X'_2 = Indicated value on DB scale with controls turned to their respective appropriate calibrate positions.

If e' is expressed in indicated DB, taking into account the attenuator setting, then E will be the true value of DB above one microvolt. Viz: A loop calibration value of 34 DB, the normal calibration value at a given frequency, will limit the maximum field intensity with the loop to 10,000 microvolts. However, reduction of calibration value with respect to standardizing the equipment will likewise enable measurements of field intensities of higher values in linear DB relationship with respect to reduced calibration (standardizing) values. Example:

At a specific frequency, the calibration chart shows a value of 34 DB which restricts the maximum indicated value to 10,000 microvolts. Use of a calibration value of 28 DB will enable measurement of a field intensity of 20,000 microvolts or approximately 6 DB above the previously obtainable maximum. Likewise, the use of a calibration value of 22 DB at this specific frequency will enable measurements of field intensities up to 40,000 microvolts or approximately 12 DB above the previously obtainable maximum. In the event that rotation of the Calibrate Control (R123) will produce a value of 20 DB below the calibration value obtained from the calibration chart, or an indication of 14 DB on the meter scale, such setting may be used, when necessary, to obtain readings of field intensities in the order of + 20 DB or a factor 10 times the maximum values obtainable with normal calibration which is 100,000 microvolts.

12—If field intensity measurements are made in an area where there is a high ambient electronic interference of random type at the frequency being observed the following chart may be used to correct the meter indications obtained:

WHERE AMBIENT RADIO INTERFERENCE IS *RANDOM* TYPE USE CONVERSION CHART ON:

1—"Field Intensity" readings of all signals.

2—"Quasi Peak" readings of Random Interference and Impulse Interference of low repetition rate.

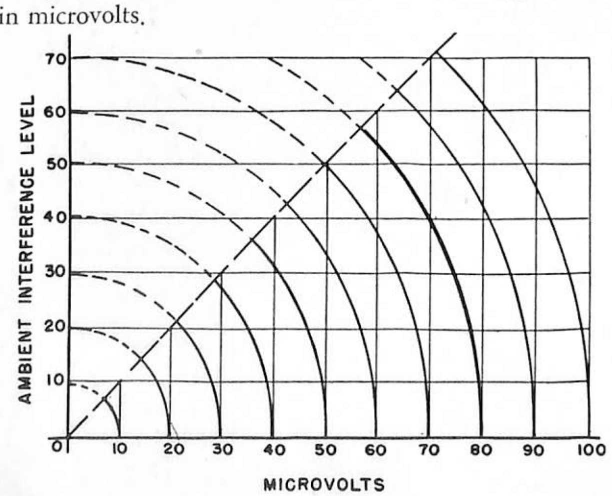
NOTE: For weighting circuit used in AN/PRM-1, ambient interference adds directly to "Quasi Peak" readings of sine wave signals and impulse signals of high repetition rate above 600 cps.

Directions for Use

1—Standardize set and determine ambient interference value in microvolts.

2—Take interference measurement, providing a "signal plus interference" meter reading.

3—Locate ambient interference on vertical scale and meter reading on horizontal scale. Follow arc upward above meter reading to point of intersection with horizontal line from ambient interference. Directly below this point on the horizontal scale will be the signal value in microvolts.



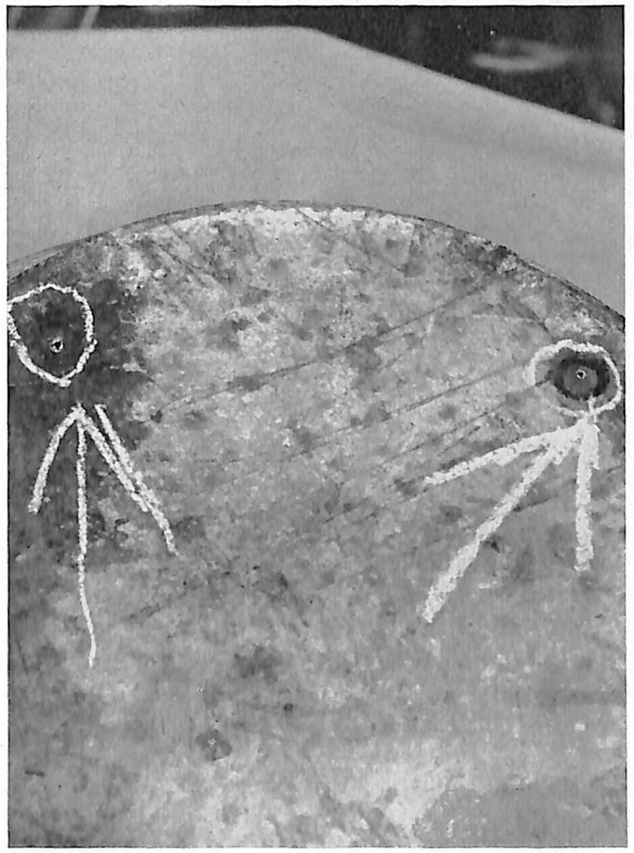
Conducted Electronic Interference Measurements

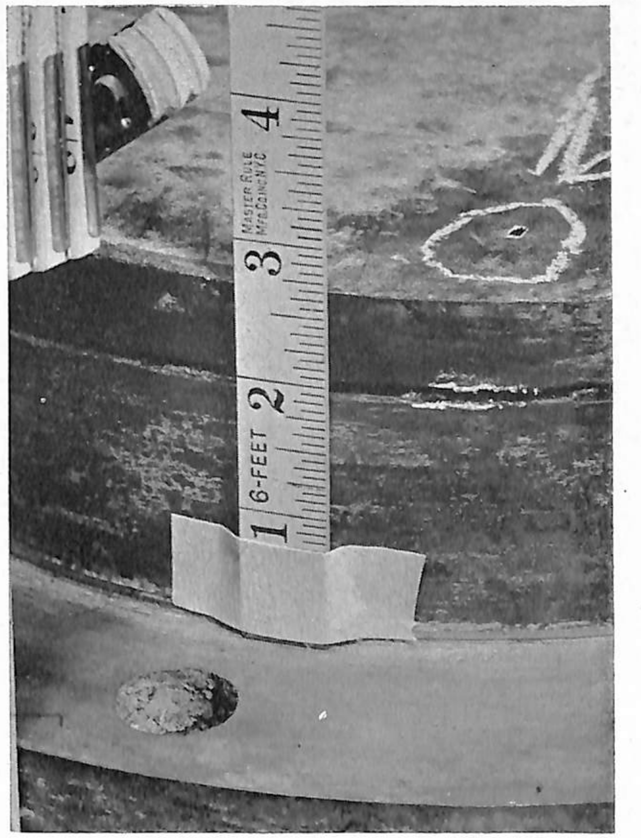
The AN/PRM-1 may be used as a selective two-terminal voltmeter to measure conducted electronic interference voltages from one microvolt to one volt over the frequency range of 0.15 to 25 megacycles. There are three impedance matching networks and an r-f line probe supplied with this equipment which may be used for conducted electronic interference measurements. R-F line probe (MX—980/PRM-1) is used for making conducted electronic interference measurements on power lines and voltage generating equipments when a voltage isolating network is desired to protect the measuring equipment. Impedance matching networks, CU-197/PRM-1 (50 ohms) and CU-196/PRM-1 (20 ohms) may be used to terminate transmission lines on signal generators or antennas of those characteristic impedances. CU-195/PRM-1 is an unterminated impedance matching network for use with signal generators and antennas with high impedance characteristics. The CU-195/PRM-1 is also used for making asymmetrical (line to ground) measurements of electronic interference on power lines and voltage generating equipments where the peak voltage does not exceed 350 volts to ground. It is recommended that the CU-195/PRM-1 be used only when a line stabilizing device is used. All three of these impedance matching networks are externally identical, therefore, a careful check must be made to make sure that the proper unit is being employed for the desired measurements.

An analysis of the characteristics and usage of the AN/URM-6 and the TS-587/U and the proper method of conducting an electronic interference survey at a Naval Air Station, will be described in a future issue of ELECTRON magazine.

NMC TRANSDUCER DIAPHRAGM REPAIRS

Attention has recently been called to the fact that the faces of several Model NMC transducers appeared to have been reduced in thickness. Further investigation disclosed that there were slight pin hole leaks through the diaphragm in the bottom of the bolt holes. This condition in several transducers is shown in the accompanying photographs. In some cases approximately one-eighth of an inch has been removed from the face of the transducer and since the bottom of the bolt holes in a new transducer plate are approximately one-tenth of an inch from the face, the removal of ⅛ inch exposes the bottom of the bolt holes.





The attention of all activities is called to the supply of F.C. No. 8—NMC Kits at all stock activities. In all cases of excessive pitting, replacement of diaphragms should be made and in no instance should the diaphragm be reduced in thickness.

A NEW RADAR TRAINER

AN/SPN-T1 (XG-1)

The U.S. Navy Electronics Laboratory has designed and recently completed an operational evaluation of a new Radar Navigation and Shore Bombardment Trainer AN/SPN-T1 (XG-1). This equipment was developed to fill a need for a Combat Information Center (CIC) trainer which would present land echoes and maneuverable targets realistically on a shipboard search radar equipment with its associated repeaters. The trainer consists of the following individual equipment:

1—A modified ultrasonic trainer formerly identified as AN/APS-T3, device 15Z-1, shown in Figures 1 and 2.

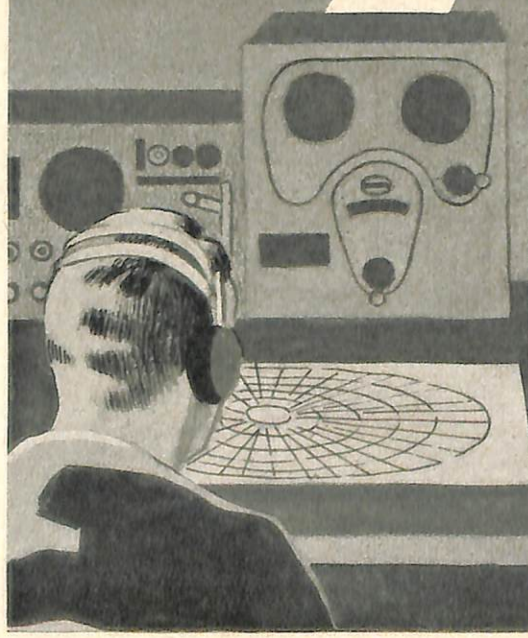
2—A modified OBJ radar trainer which is shown in Figure 3. The signal generator assembly is shown in Figure 4.

3—A modified SG-1B radar.

4—Models VH and VD-2 remote indicating equipments.

5—A modified NEL-Annapolis-type conning unit shown in Figure 5.

The flexibility of the trainer permits it to be used in three major functions: 1) Radar navigation and shore bombardment training. 2) Provide coordinated anti-submarine attack training. and 3) Training in maneuvering a ship in the vicinity of land mass. The trainer generates realistic radar information consisting of land mass, two own-ship escorts, and three independently maneuverable targets. The land mass is generated by a modified ultrasonic trainer (formerly AN/APS-T3 Radar Training Set). This equipment is designed so that a crystal transducer, energized at an ultrasonic frequency (15 Mc) and operating in a tank of water, "sees" a scale-model topographic map of the land mass being simulated. The crystal transducer, which serves as own ship, is maneuverable over a large portion of the tank representing an ocean area of approximately 4,000 square miles (roughly 50 x 75 miles). Own ship move-



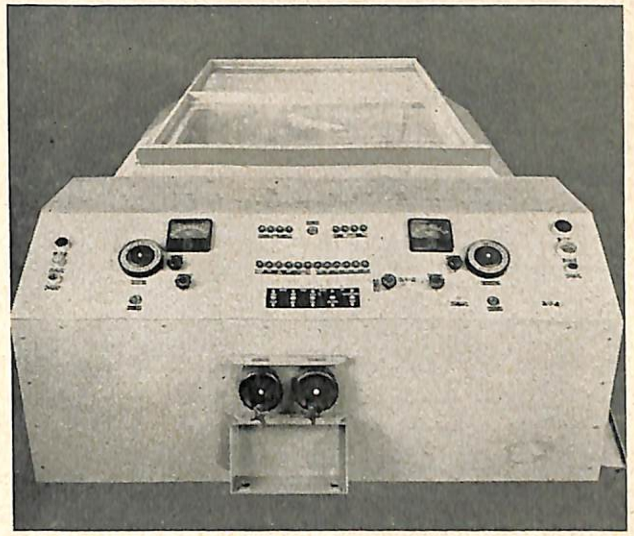


FIGURE 1—End view of the modified ultrasonic trainer (formerly AN/APS-T3).

ment is controlled locally from the ultrasonic tank instrument panel, or remotely from a conning unit.

The output of own-ship's movement drives the DRT in the CIC mockup and one bug of the double DRT in the problem room. The second bug of the double DRT is driven by a separate course and speed input. This bug may be used to represent the movement of the

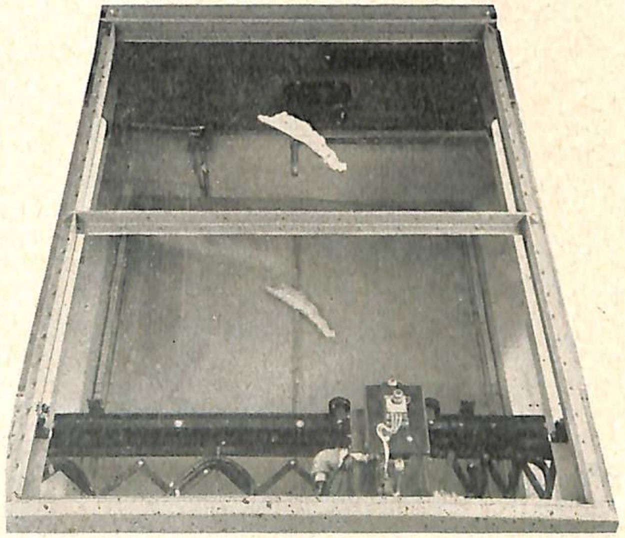


FIGURE 2—Top view of the modified ultrasonic trainer shown in Figure 1.

assisting ship in coordinated anti-submarine exercises. For this use the "sonar operator" reads ranges and bearings from the second bug to the submarine, the position of which is indicated by a predetermined track.

The modified OBJ radar trainer generates three independently maneuverable targets and two own-ship

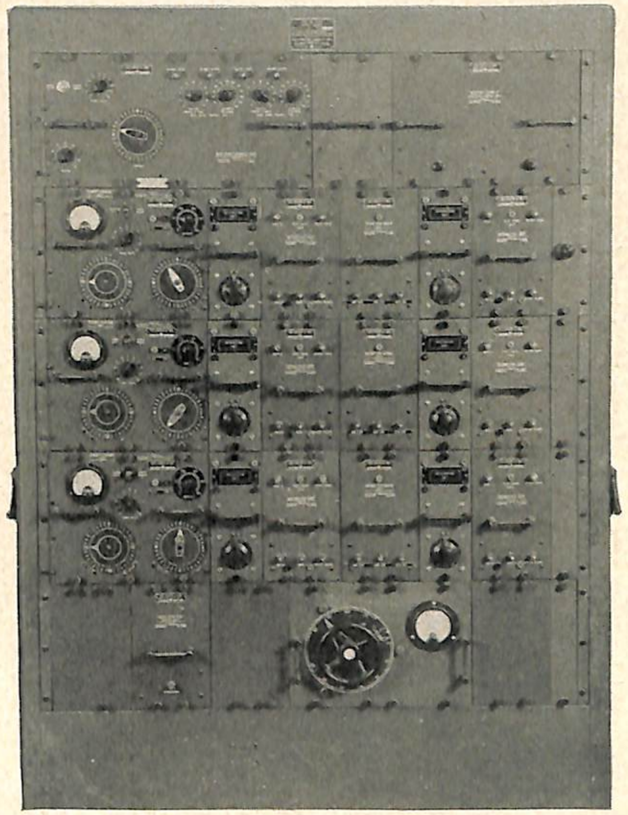


FIGURE 3—Front view of the modified OBJ radar trainer showing controls, etc.

escorts which maintain a fixed range and true bearing with respect to own ship. These signals are combined with those generated by the modified ultrasonic trainer to furnish realistic land mass and movable target echo information to the SG-1B surface search radar and to various repeaters.

The operational evaluation of the AN/SPN-T1 (XG-1) was conducted by the Laboratory to determine the adequacy of the trainer for instructional purposes. Accordingly a series of tests was administered to determine the accuracy of the over-all system and to observe the human engineering features of the trainer. The data obtained from these tests was utilized in formulating conclusions and recommendations for future action on the project. These conclusions and recommendations are listed for information and to furnish the reader with an idea of the acceptability of the present system as well as to point out the desirable and undesirable features.

Conclusions

1—The trainer is satisfactory for instructional use, provided that the operating procedures outlined in the

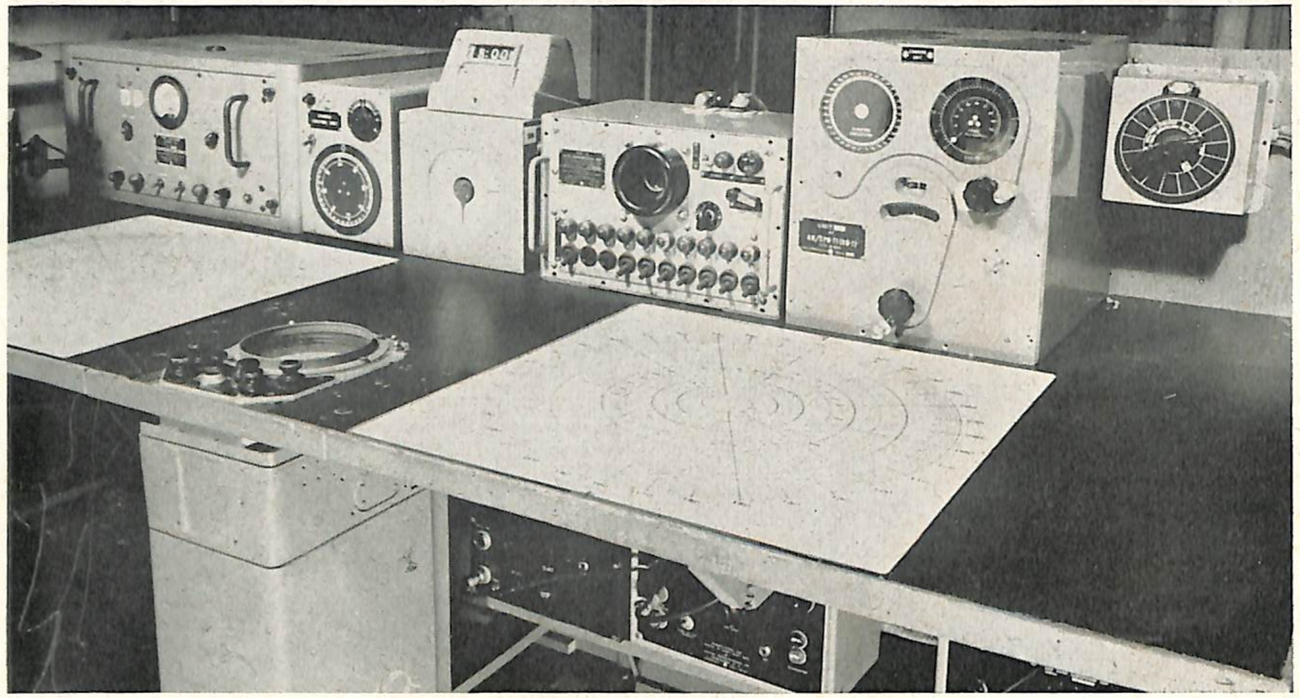
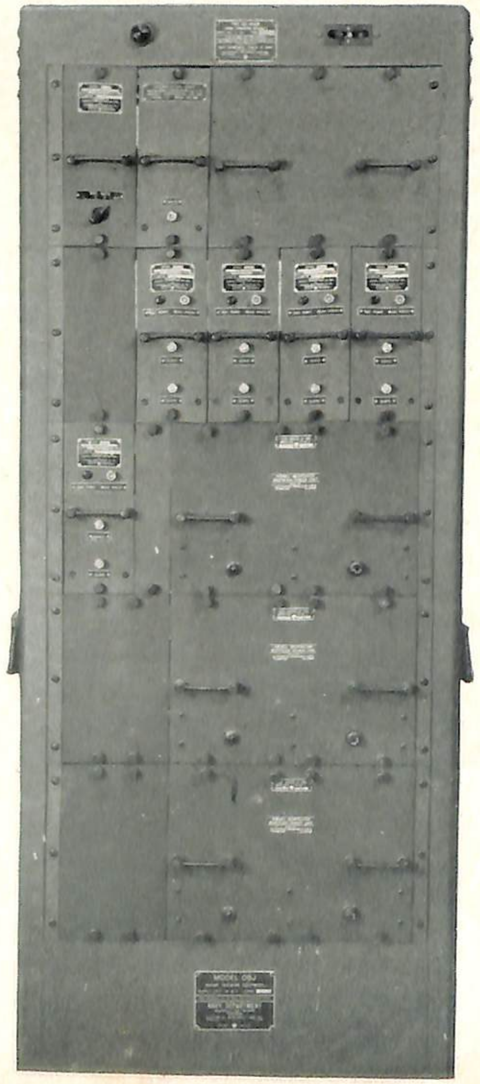


FIGURE 4—Front view of the signal generator assembly utilized with the OBJ radar trainer.

FIGURE 5—Instructor's desk showing the NEL Annapolis-type conning unit.



instructor's manual (now in preparation by NEL) are followed rigorously.

2—The ultrasonic tank is entirely satisfactory with respect to range and bearing accuracy.

3—Bearing resolution of the radar presentation is coarser than that of the operational radar.

4—OBJ controllable targets cannot be positioned accurately and cannot be controlled with precision.

5—OBJ escort targets are satisfactory with respect to positioning accuracy.

6—Controls and displays are poorly arranged on the OBJ panels and on the ultrasonic tank.

Recommendations

1—The present equipment can be used more advantageously if the following precautions are observed:
  a—Establish the position of the targets by means of the VD–2 remote indicator rather than by means of the calibrated positioning dials.
  b—In training, emphasize correctness of procedures, not precision of results.

2—A redesigned equipment of this type should provide the following:
  a—Narrower beamwidth and a smaller transducer assembly in the ultrasonic tank.
  b—Target generating equipment which will achieve greater accuracy in target positioning and target movement.
  c—Complete redesign of all control and display panels; provision for a monitor scope and displacement-type target controls.

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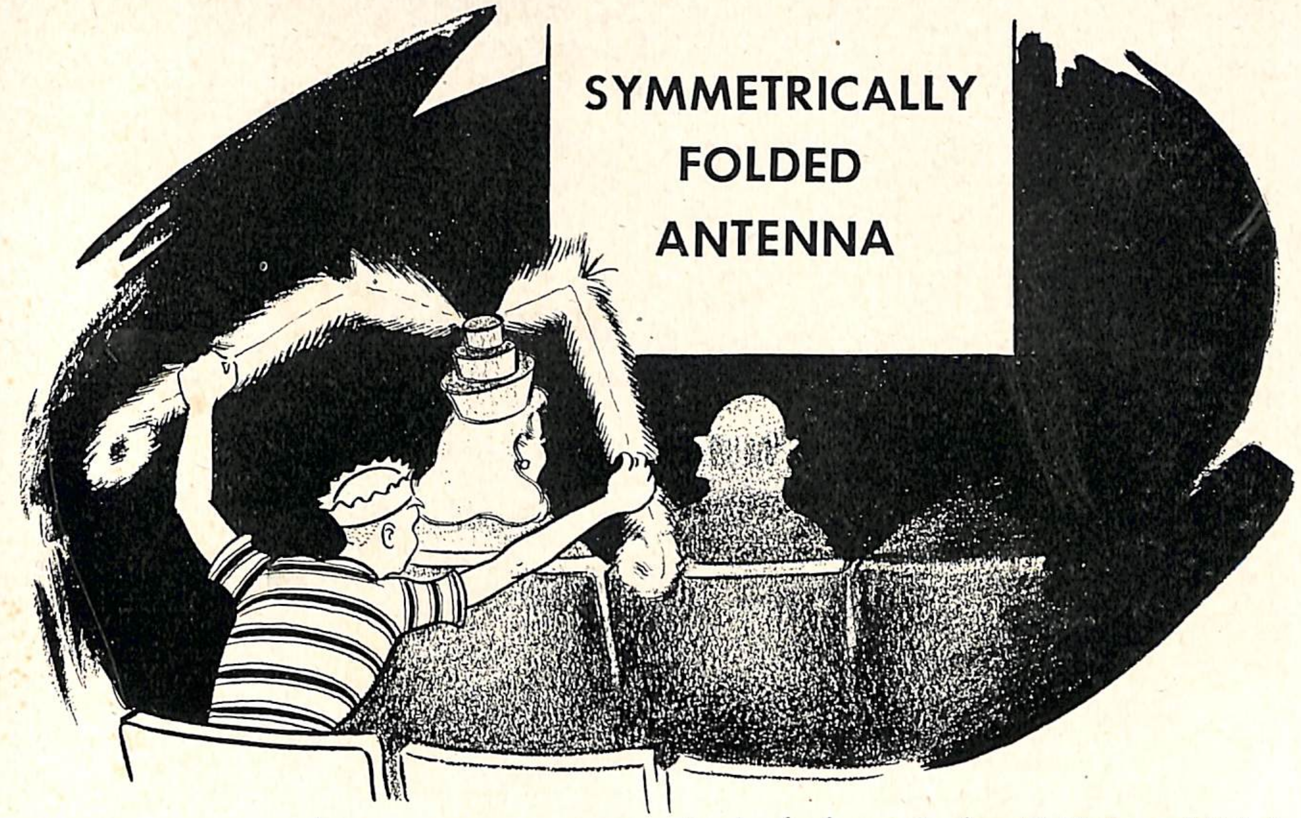
SYMMETRICALLY FOLDED ANTENNA



by
CDR. CHARLES W. HARRISON, JR., USN
Electronics Program Officer
U. S. Naval Research Laboratory

Recently the writer received a letter from Cdr. G. L. Graveson, USNR, of the Western Electric Company containing brief constructional and operational details of a symmetrically folded antenna he terms a "three-wire open-ended dipole." It is believed that readers of BUSHIPS ELECTRON will be interested in a qualitative discussion of this type of folded dipole as a sequel to the paper "Qualitative Analysis of Folded Dipoles" appearing in the March 1949 issue of the magazine.

The circuit diagram for the three-wire open-ended dipole is shown in Figure 1. In practice each end of

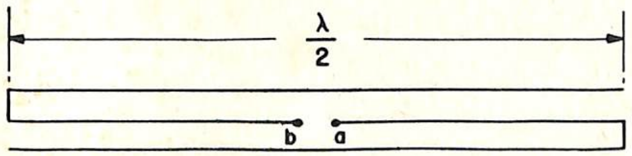


FIGURE 1—Isolated "series-fed" three-wire open-ended dipole. Each wire is of the same radius, and the over-all length of the antenna approximates one-half wavelength. The feeding transmission line is connected to the Terminals a and b. The magnitude of the input impedance of the antenna is the rms voltage applied across the Terminals a and b divided by the rms current flowing at a or b.

the antenna is supported by an insulator in the form of an equilateral triangle. The spacing between wires is 6 inches for frequencies above 10 Mc/sec. and 10 inches for frequencies in the band 3 to 10 Mc/sec. The distance between insulators (over-all length of the radiating portion of the structure) is estimated from the relation

Length (in feet) = 468 (feet) divided by frequency (in Mc/sec)

The antenna is usually supported in a horizontal position at a distance of about one-half wavelength above the earth's surface.

Cdr. Graveson points out that when this type of folded dipole is properly installed the magnitude of the input impedance (which is predominantly resistive) approximates 600 ohms. The band width is 7% on both sides of the design frequency for a maximum standing wave ratio on the feeding transmission line of two to one. He reports that he employed this antenna extensively at communication stations he erected in England and elsewhere during the war.

Returning now to Figure 1 it would appear that a qualitative analysis of the "series fed" three-wire open-ended dipole would be a formidable undertaking, and that a quantitative analysis would be virtually impossible. Actually it turns out that both analyses are relatively simple, but only a qualitative discussion of the way this antenna performs will be given here.

The first step in the solution of the problem is to replace the lower half of the antenna by a large perfectly conducting plane surface (or earth), as shown in Figure 2. This procedure is effective in visualizing the operation of folded dipoles. Provided no auxiliary conductors are located in the vicinity of either antenna, the input impedance of the antenna illustrated in Figure 1 is precisely twice the input impedance of the antenna shown in Figure 2. For purposes of analysis the three-wire open-ended dipole has now been replaced by a folded unipole (discussed in the March 1949 issue of ELECTRON) in proximity to a base-grounded parasitic element. It is a relatively simple matter to determine quantitatively the input impedance of this antenna by setting up the applicable circuit equations and employing the graphical data now available in the literature for mutual and self-impedance of close spaced wires. The answer thus obtained, when multiplied by a factor of two, gives the input impedance of an isolated three-wire open-ended dipole. So much for the quantitative analysis.

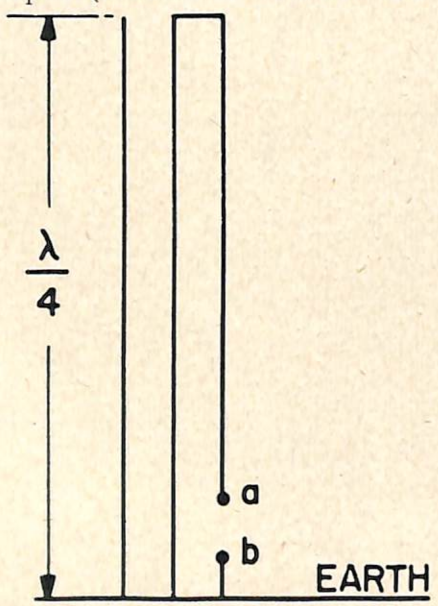


FIGURE 2—Two-wire folded unipole in proximity to a base-grounded parasite. This antenna is exactly the same as the antenna shown in Figure 1 except that the earth takes the place of one half of the three-wire open-ended dipole.

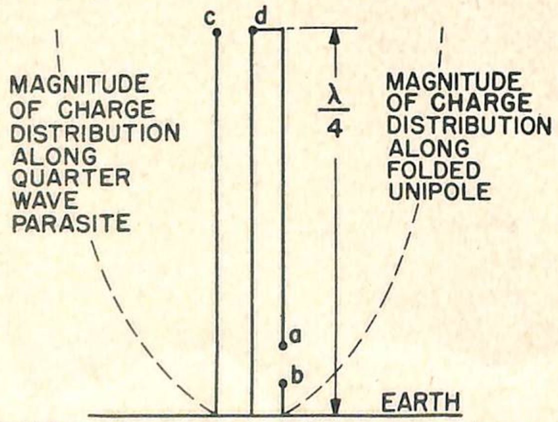


FIGURE 3—The antenna of Figure 2 is redrawn. The dotted curves represent the magnitude of the charge distribution along the folded unipole and the parasitic antenna at an appropriate instant in time. Notice that these distributions are similar, so that one might regard the "pontential" of Point c to be roughly equivalent to the "potential" of Point d.

To obtain a visual concept of how a folded unipole operates in proximity to a base-grounded parasitic antenna, one notices that the charge distribution along the conductors are similar (at least in magnitude[1]), for all wires in the antenna are tightly coupled. It is to be observed that large changes in the phase relationship between the magnitude of the charge distribution along the parasitic element and the magnitude of the charge distribution along the folded unipole may be effected by changing slightly the length of the parasite. It is assumed that wires of identical radius are used.

In Figure 3 is sketched the magnitude of the charge distribution along the folded unipole and along the parasitic antenna at an appropriate instant in time.

[1] An antenna which is precisely self-resonant has flowing on its surface one component of current in time phase with the driving voltage. Accordingly there is but one component of charge along such a radiator. An antenna which is not precisely self-resonant (including the anti-resonant case) has two components of current flowing on its surface. One of these is in phase with the driving voltage; the other is in time phase quadrature. It follows that there must be two components of charge along such an antenna also in time phase quadrature. When one speaks of "charge distribution" along an antenna he should be careful to point out what component he is talking about, or whether he is speaking of the charge distribution curve obtained by taking the square root of the sum of the squares of the quadrature components of charge at discrete points along the radiator, as is usually the case.

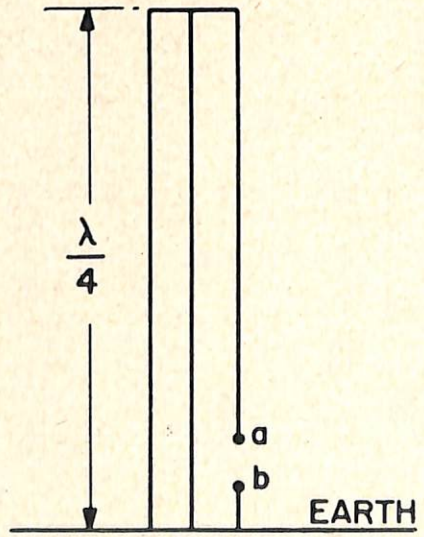


FIGURE 4—Three-wire folded unipole. By connecting together two points of roughly the same potential, i.e., connecting Terminal c to Terminal d in Figure 3, one obtains a folded unipole. The fact that current of considerable amplitude may flow in the shorting bar (due to the possible existence of a small potential difference) does not significantly alter the amplitude or phase of the current flowing at the input Terminals a, b, and hence the input impedance of the antenna remains virtually uneffected.

These distributions are similar, so that one might regard the potential of Point c to be roughly equivalent to the potential of Point d. These two points might well be connected together. The currents flowing along the wires (defined in the previous article as "symmetrical currents") which are effective in setting up the radiation field are not altered significantly by this connection. The "transmission line" current (defined in the previous article as "antisymmetrical currents") will be changed by use of the shorting bar between Points c and d of Figure 3. Fortunately the transmission line component of current is small near the input terminals of the antenna when operated in the vicinity of self-resonance. Hence one may regard input impedance of the antenna to be essentially independent of the antisymmetrical component of current, i.e., the input impedance is not influenced greatly whether c is connected to d, or left open-circuited.

The antenna shown in Figure 4 is equivalent to the antenna shown in Figure 3 when a shorting bar is connected between Terminals c and d. The result is a three-wire folded unipole which has been discussed in a qualitative way earlier.

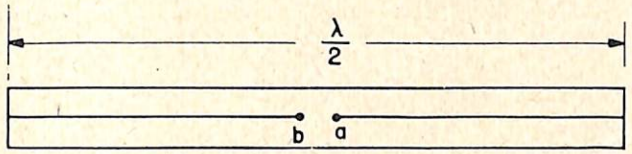


FIGURE 5—Isolated "shunt-fed" three-wire folded dipole. The three-wire open-ended dipole portrayed by Figure 1 and this antenna are identical twins (which have small but usually insignificant differences). The magnitude of the input impedance to both antennas approximates 600 ohms, a fact which tends to substantiate their kinship.

Figure 5 shows what might be termed an isolated "shunt excited" three-wire folded dipole. It is equivalent to the antenna shown in Figure 4 except that the lower half of the antenna replaces the large conducting plane surface. The reader is reminded that the input impedance of the latter antenna is precisely twice the input impedance of the former antenna.

A direct correlation between the properties of the antenna shown in Figure 1 and the antenna shown in Figure 5 is now possible. These antennas, like the writer's beautiful and sweet nine year old nieces—are identical twins. Even identical twins have small but insignificant differences! The magnitude of the input impedance of both antennas approximates 600 ohms, a fact that tends to substantiate their kinship.

Dr. Oscar Norgorden, of the U. S. Naval Research Laboratory, who has pioneered in communication antenna development for the Navy concurs in the qualitative analysis presented here for the series-excited three-wire folded dipole.

IMPORTANCE OF SUBMITTING CHANGES TO THE SHIP ELECTRONIC INVENTORY SYSTEM

It appears desirable to call to the attention of all ships the importance of submitting a revised copy of NavShips 4110 as soon as possible after a change has been made in a ship's electronic installation. The submission of the revised NavShips 4110 should be made when any change in the electronic equipment installation is made by the ship's force, tender force, or shore based activity (except a scheduled overhaul by a Naval Shipyard which has the responsibility of submitting the revised NavShips 4110 in that case). The ship's copies of the Installation Record (NavShips 4110) shall be removed from file and revised by the ship to agree with the new installation. Pertinent instructions covering this procedure are given in the "Instructions for Maintaining Ship Electronic Equipment Inventory System (NavShips 900,135)" and "Change No. 1 to Ship Electronic Equipment Inventory System (NavShips 900,135)". Change No. 1 was promulgated as 49–827 of Navy Department Bulletin Volume XV Number 9 of 15 November 1949.

As an example of the need for revised NavShips 4110, a recently authorized change to the RAU–2 and AN/FMQ–1A equipments changes the operating frequency, necessitates the removal of the original receiver and the installation of a new receiver. This change converts the equipment and changes its nomenclature to AN/FMQ–2. The Bureau of Aeronautics must be notified by the Bureau of Ships, upon completion of the AN/FMQ–2 alteration, in order that the necessary radiosonde transmitter can be distributed. This is just one of the many typical cases where up-to-date NavShips 4110's become the crux of the completion of a vital change-over and compliance with fleet characteristic directives.

Whenever an electronic equipment change is effected, immediately submit your corrected copies of NavShips 4110. You will benefit, programs will be completed in shorter time, and the equipment program and money allocation for same will be properly carried out.

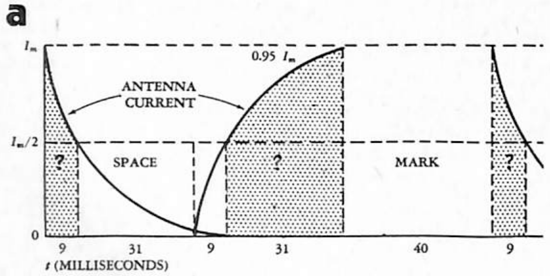
AN/SPN–3 DESIGN

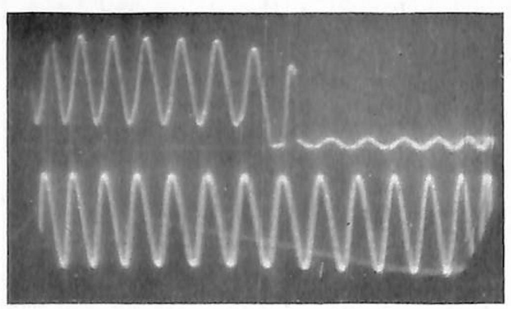
To eliminate any possible ambiguity in the last paragraph of the first column of Page 28 of the November 1950 ELECTRON, NRL designed the AN/SPN–3, and NANEP designed a new EPI indicator for use with the AN/SPN–3.

nel notes:

high-speed keying of vlf radio circuits

a





b

FIGURE 1—(a) Time variation of antenna current for 50 per cent ON-OFF keying, indicating energy storage in the antenna circuit. (b) Oscillograms of keying current (upper trace) and constant-amplitude antenna voltage (lower trace) for frequency-shift keying. Mark-to-space transition occurs within one r-f cycle.

The reliability of low and very low frequencies has long been utilized by the Navy to maintain continuous contact with ships at sea through scheduled Fox broadcasts. Effective as these broadcasts have been, they have suffered the restrictions of the low transmission speeds inherent in conventional LF and VLF on–off keying. A solution to the problem of increasing transmission speeds to permit automatic keying seems to lie in a unique frequency-shift keying method developed by the U. S. Navy Electronics Laboratory.

On-off keying at LF and VLF is necessarily slow because, in antennas such as those used at many existing Navy LF and VLF shore installations, the ratio of the energy radiated to energy stored is very small. The energy stored in a VLF antenna system can be several hundred times that which is being radiated. When the key is opened, the energy which has been stored in the antenna system continues to be radiated until it is gradually dissipated by radiation and circuit losses. When the key is closed, the antenna circuit starts storing energy again while the antenna current is gradually built up to the level where power is radiated at a rate equal to that supplied by the transmitter.

In receiving on-off keyed transmissions, it is necessary to distinguish with reasonable certainty two amplitudes, one representing mark and the other space. Assuming a given noise level, the power for mark must be approximately 6 db over that for space to fulfill this requirement. The intervals required for the antenna power to build up and decay during on-off keying are shown in figure 1A. Between each space and mark there is a "region of uncertainty" during which a mark cannot be reasonably distinguished from a space. A maximum limiting keying speed will be reached above which the region of uncertainty becomes too large a fraction of the total keying period. Calculations made for one VLF shore station indicate that at 15 kc the maximum keying speed will be limited by a mark or space time duration of about 40 milliseconds, allowing equal times for mark, space, and uncertainty. Ascribing one-half the uncertainty to mark and one-half to space, the dot length of 60 milliseconds is then equivalent to a keying speed of about 18 (Morse) words per minute. The build-up and decay times thus determine the permissible keying speed of the antenna circuit.

By the frequency-shift keying method developed at NEL, power level is not varied. Instead, the reactance of the antenna circuit is varied in synchronism with the frequency-shift modulation of the carrier frequency. In tests made with an experimental 100-watt transmitter keyed by this method, successful tranmission of 60-wpm teletype was realized, and two-condition speech transmission was accomplished under conditions of negligible noise.

Subsequently, a 10-kw frequency-shift keyed transmitter and antenna modulating equipment (operating at 28.5 kc with 100 cps shift) were used in conjunction with the low frequency antenna at NCS, Chollas Heights, California. Successful 60-wpm printing telegraph transmissions were made using this transmitter. Radio San Francisco (approximately 500 miles away) reported S5, R5. Signals were entirely suitable for frequency-shift keyed teleprinter operation.

Development has been underway to apply high-speed keying to the Chollas Heights transmitter. The maximum keying rate so far achieved with this method is 460 wpm (see fig. 2). Thus, it is possible to predict performance for such applications as time-division teletype multiplex.

Adaptation of existing LF and VLF shore stations for the proposed method of frequency-shift keying will be economical. Traffic handling capabilities can be at least tripled, while the cost of the modulator should approximate not more than ten per cent of the cost of the transmitter. Standard Navy RBA receivers and AN/URA–8A converter equipment can be used with modification for high-speed Morse and teletype reception.

When Navy LF and VLF shore stations can be adapted to high-speed frequency-shift keying, less time will be required for transmission and reception of Fox schedules, and automatically keyed transmission and teletype reception will greatly reduce operator error and fatigue.

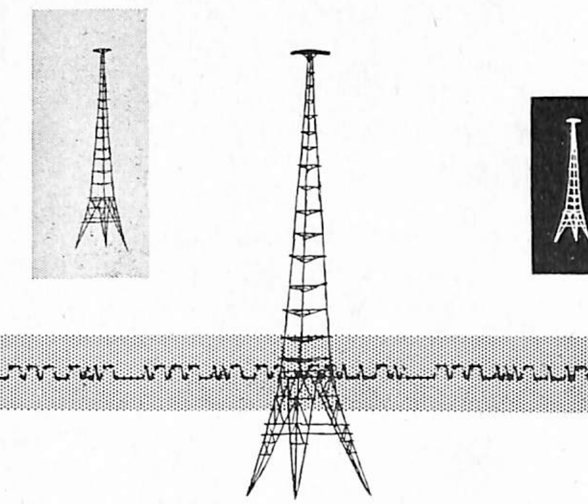
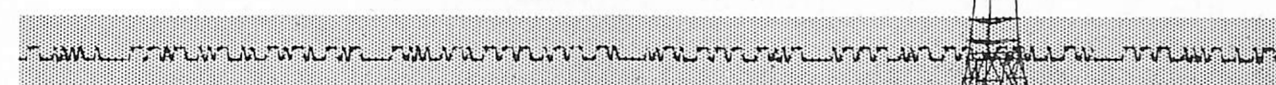


FIGURE 2—Sample of Morse tape signal received at a speed of 460 words per minute. Transmission made at 28.5 kc with a power of 10 kw.



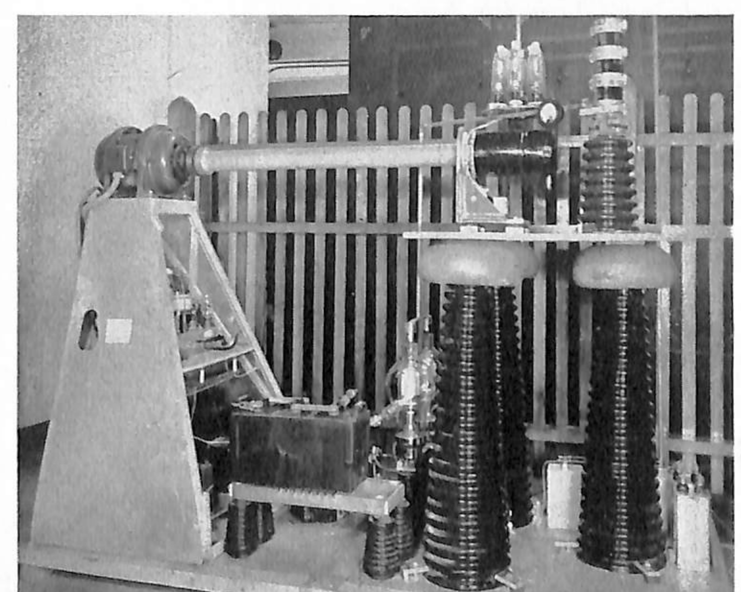
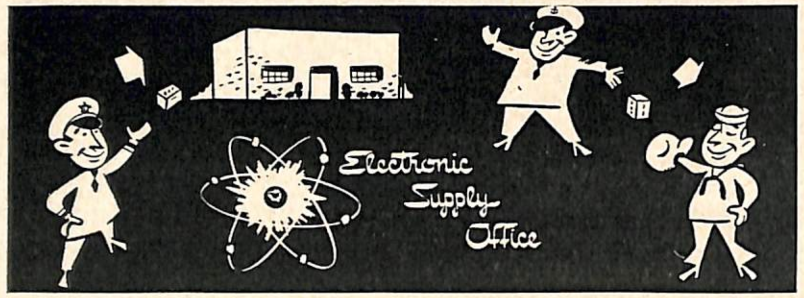


FIGURE 3—Antenna keyer unit of 10-kw transmitter used in frequency-shift keying experiments at NCS, Chollas Heights, California.



E.S.O. MONTHLY COLUMN

ADDITIONAL RESPONSIBILITIES ASSUMED

Several additional functions, including the preparation of Allowance Lists and Parts Lists, certain inventory responsibilities in connection with electronic equipments, coordination of stock numbering of parts for new equipments, and direct participation in provisioning actions, have been or are being transferred to the Electronic Supply Office by the Bureau of Ships.

The function of preparing Allowance Lists is part of the Bureau of Ships Electronic Repair Parts Program which provides for the shipboard binning of electronic maintenance repair parts under Standard Navy Stock Numbers. It is anticipated that ESO will prepare its first Allowance List on or about 1 September 1950.

The responsibility of developing Parts Lists has already been assumed by ESO. Before transfer of this operation, the Bureau of Ships had developed more than 800 Parts Lists for electronic equipments, the bulk of which were types appearing aboard ships of the Active Fleet. It is estimated that an additional 800 to 1,000 must be developed by ESO, so that Parts Lists are available for all ship and shore equipments. Parts Lists for equipments appearing in the Active Fleet are being prepared first, so that the Allowance Lists incident to the Electronic Repair Parts Program can be constructed without delay. When these have been completed, Parts Lists for shore equipments will be developed so that Shore allowances may be distributed.

Certain responsibilities in connection with the inventory control of electronic components have already been assumed by ESO. These include the assignment of stock numbers to components, the use of stock numbers in reporting stock status, the consolidation of Components Stock Status Reports, and the redistribution of electronic components subsequent to BuShips' approval of requirements indicated by system activities. The changeover to the use of stock numbers for storage, stock control, issue, and reporting by Electronic Supply System activities has already been accomplished. In addition, stock numbers were employed for the Electronic Components Inventory Report which had a cut-off date of 20 May 1950. ESO commenced preparing component shipment orders, after BuShips' approval, on 21 May 1950.

The same type of responsibilities in connection with the inventory control of equipments will be assumed in the near future. Equipments and associated spares are already being stock numbered, and these numbers will be utilized for all inventory control operations.

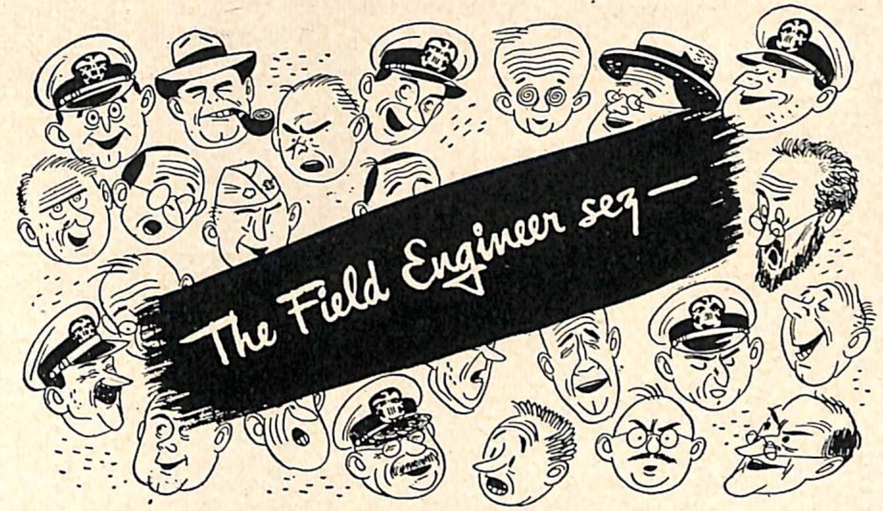
The function of coordinating the mechanics of assigning stock numbers to parts contained in new equipments has already been assumed by ESO. The results of this operation provides for the inclusion of stock numbers in instruction books, and the assurance that all new parts entering the system incident to the procurement of equipments are stock numbered.

The function of direct participation in electronic equipment provisioning is of high importance. The accurate determination of stock requirements during the provisioning process results in the Electronic Supply System's receipt of ample stocks to insure full supply support of the new equipments.

A TWO WAY STREET

The Supply Officer, in many instances, will be called upon to furnish material for installation and maintenance of vessels and stations without prior information as to probable need. If a good and timely job is to be done, it is important that the Electronics Officer of Industrial Yards and the Supply Officer work together in planning for future requirements in connection with scheduled overhaul and replenishment of shop stores.

It is advantageous for the Supply Officer to attend staff meetings held by the Electronics Officer and other conferences held with his technical officers. This affords the Supply Officer an opportunity to develop a clear understanding, within the Electronics Officers' staff, of the problems and procedures of maintenance in relation to supply. Likewise, the staff Electronics Officers should be made to feel welcome to discuss the supply phase at any time. Thus, two way communication is established. In many instances, the staff of the Electronics Officer can be of great assistance to the Supply Officer in screening the condition of material and in analyzing and assisting in the problems of research and other matters which require technical assistance.



MARK 34 MOD 6

U.S.S. Forest Royal (DD–872)

The ship reported frequent blowing of the high-voltage primary fuse F1011. The duty cycle current was observed to be erratic and the duty cycle control R623 had no effect. Investigation disclosed that the cathode bias potentiometer R19 was set at 18,000 ohms to ground and the coarse frequency adjust potentiometer R9 set at 120,000 ohms. These were reset to 33,500 ohms and 155,000 ohms respectively. The duty cycle control still had no effect on the operation of the pre-knock multivibrator V602. Further investigation revealed that coupling capacitor C606 (24mmf) was leaking. This capacitor was replaced from spare parts and the operation of the duty cycle control was restored to normal. However, the duty cycle current was still somewhat erratic. R13 (18,000 ohms) had changed value and exhibited several burned spots near one end which were due to arcing through the resistor coating to the resistor clip board mounting screw head. This resistor was Navy Type 63094E which is larger in diameter than the replacement resistor Navy Type 63094F contained in the spares. The body of the Navy Type 63094F cleared the clip board mounting screw sufficiently to prevent arcing of the 1,200 volts in the circuit, therefore it is believed that no more trouble of this nature will occur. After replacing this resistor the duty cycle current became stabilized and operation of the equipment returned to normal.

—R. A. DALTON

MODEL SRa

Excessive hunting of the antenna and PPI was noted when the equipment was operated in the NORMAL training position. From the symptoms present a check of the phasing of the synchro control excitation and the training servo amplifier reference voltage was made with an oscilloscope. The findings from these checks indicated that these two voltages were definitely not in phase with each other, which is one requirement that is necessary in preventing hunting. Further wiring checks disclosed that the excitation to the 5CT training control synchro in the console was obtained from the "AC" phase of the 3-phase ships power supply and that the reference voltage to the servo training amplifier was obtained through the SRa power line which was connected to the "AB" phase of the ships power. Because of the possibility of other system troubles (hunting) which might occur, the power to the SRa equipment was changed from the "AB" phase to the "AC" phase. This corrected all traces of the complaint of antenna hunting.—B. E. BURGRAFF.

MARK 34/2 AND MARK 2/2 TACU

Use of Oil Filter in Mark 34/2 Antenna Drive System

At least one case has recently been observed in which the removable oil filter used for cleaning the oil in the Mark 34/2 antenna drive system, had been incorrectly used. Normal procedure for using the oil filter (located at pump output lines) is to fill system with oil and install clean filter. Antenna is then made to search in high "nod" condition for approximately one hour. During this time all of the oil in the system should have circulated through the filter and been cleaned. The filter is then removed and stowed away. Normal operation is without filter installed. This procedure was determined when, while servicing a Mark 2/2 TACU recently, it was discovered that the nod adjustments were very sluggish. Maximum obtainable high nod angle was plus or minus 6°. Close inspection of oil system revealed that the oil filter was still installed and was cutting down on oil pressure in lines. Antenna nodding was restored to normal when the oil filter was removed. —W. S. MCLEAN, *ComServLant.*

by
E. Bradley, *Philco Field Engineer*

Description

This equipment generates 3000-megacycle r-f energy, pulsed at 400 pulses per second in one-microsecond pulses. Received energy displayed on plan position indicator and bearing read directly as true or relative (depending on setting of True-Relative Switch in Bearing Control Unit). Range is determined approximately by four concentric range marks on PPI, generated by circuits in PPI Unit. Accurate Range is determined by a Range spot appearing on PPI, generated by circuits in Accessory Control Unit. This spot varied in range by rotation of hand crank of ACU. Range Switch on PPI varies maximum range in Three steps; 4, 20, and 80 miles (modified equipments have additional switch for two mile range used only when normal range switch is in 4-mile position). Ships head is indicated by momentary Bearing Control Unit Switch when on True, or at 0 degrees when operating at Relative.

Operation

1—Press "Start-Stop" Switch on bulkhead beside indicator. Hold down for 5 seconds. (Meter in ACU will rise to near 90 Volts, then after several seconds will rise to 115 Volts.)

2—Wait two minutes, press red "Start" button on PPI Unit. Sweep and Echoes should now appear on PPI (with proper adjustment of "Int" and "Gain" Controls on PPI Unit.)

Description of Units

Motor Alternator Modulator

Consists of 115-volt d-c drive motor, 115-volt 400-cycle alternator (supplies all a-c used in equipment), spark gap wheel to key transmitter; and a modulator. Modulator includes charging transformer, one rectifier tube (Type 705), and a 3-tube electronic voltage regulator for alternator which controls output a-c.

Plan Position Indicator Unit

Houses PPI tube, with associated deflection coil, synchro drive, mechanical bearing indicator dial and handwheel and electronic circuits for production of sweep, video, and markers. Houses high voltage supply for PPI tube. Contains switch and relay for automatic correction of discrepancy between antenna and PPI bearing.

Accessory Control Unit

Main purpose is to produce movable range mark on PPI and indicate range on direct reading dial. Also indicates on voltmeter the output voltage of the alternator, controls IFF equipment (when used), and controls ship's head flash by means of "On-Off" switch.

Rectifier Power Unit

Furnishes plate voltage for receiver and local oscillator, and receiver screen voltage. Contains fuses, a relay controling the modulator, and acts as a junction box for several cables.

Magnetic Controler

Contains main line contactor, starter resistance shorting relay, and overload relay.

Echo Box

Gives artificial echo when tuned, which causes increase in intensity of trace from zero range out to a maximum of about 5000 yards, or some range measured when equipment is known to be in good condition (will vary on each vessel). As equipment lowers in efficiency, this maximum range will drop. Box is tuned to resonance by watching neon lamp on top of echo box, tune for maximum glow.

List of Controls by Units

Plan Position Indicator

Marking	*Type Control*	*Function*
Start-Stop	Push Button	Applies high voltage to transmitter.
Off-On	Knob	Not used in SO series radar.
N-E	Knob	Shorts out thermal overload switch in transmitter for emergency operation. This overload switch removes high voltage from transmitter when transmitter compartment temperature rises to danger point.
Gain	Knob	Varies Receiver Gain.
Marks	Knob	Varies intensity of 4 range marks.
Tune	Knob	Vernier receiver local oscillator.
Tune Set	Screwdriver	Coarse receiver local oscillator tuning. Both Tune and Tune Set vary local oscillator plate voltage.
Center	Knob	Varies point of sweep on PPI.
CW OFF CCW	Toggle	Controls direction of rotation of antenna.
4-20-80	Knob	Range switch.
Pilot	Knob	Varies pilot light brilliance.
SW–L	Knob	Controls effective length of the sweep. (sweep speed)
2-4	Toggle	Puts maximum range at 2 miles when "4-20-80" is in 4-mile position.
Int	Knob	Controls intensity of PPI.
Focus	Knob	Controls Focus of PPI.
R–429 (In PPI chassis)	Screwdriver	Multivibrator bias control, adjust when sweep is jittery.

Accessory Control Unit

Ship heading flash ON	Toggle	Causes ship's head flash to appear when on. Disappears when off.
IFF	Toggle	Causes IFF to operate continuously when up, momentarily when down.
Mark	Knob	Varies intensity of range spot.
40,000 yard set	Screwdriver	Sets mark on PPI to coincide with PPI fixed marks on 20-mile range. First mark "low," last "High."
8,000 yard set	Screwdriver	Same as above—4-mile range.
Pilot	Knob	Varies illumination level in range window.
Tune		Not used in SO–1 or SO–8
Gain		"
Tune		"
AFC Manual		"
Line Volts or resonance		Reads only line voltage in SO–1 and SO–8

Motor Alternator Modulator (Inside Unit)

R–113	Screwdriver	Excitation to #1 alternator field.
R–114	"	Speed control.
R–115	"	Speed control.
R–167	"	Adjusts voltage regulator.
R–125	"	Adjusts voltage regulator filter.

List of Fuses

Motor Alternator Modulator

F–104 Opens primary to voltage regulator supply.
F–105 Starter holding circuit fuse.
F–106 Antenna heater and motor fuse.

Rectifier Power Unit

F–201 Magnetron and receiver filament, a-c blower (when used).
F–202 D-C blower motor (in transmitter).
F–203 Plate and filaments in rectifier power unit.
F–204 Waveguide shutter and PPI zero relay.
F–206 Opens primary to high voltage supply to Magnetron.

PPI Unit

F–401 High voltage fuse to PPI.
F–402 D-C control circuits.
F–403 All synchros.
F–404 Indicator power supply.

Accessory Control Unit

F–701 Entire ACU.

Trouble Shooting Chart

IF	*CHECK*
Bulkhead "start-stop switch" won't operate.	1. F–105 in motor alternator modulator. 2. Interlock in rectifier power unit. 3. Interlock in transmitter receiver. 4. N-E switch on indicator. 5. Thermal overload in magnetic controller.
Indicator "start" button inoperative.	1. Overload thermostat in transmitter unit. (Turn "N-E" to "E" as quick check. 2. F–206. 3. F–404 (in PPI). 4. F–401 (in PPI). 5. F–201 (in rectifier power unit). 6. Interlock in motor alternator modulator.
PPI sweep jittery.	1. Adjust R–429 (in PPI, multivibrator control). 2. V–401, V–402. 3. Deflection coil and brushes.
PPI spot appears but no sweep.	1. Trigger input to indicator. 2. V–401, V–402, V–407, V–408 (in PPI). 3. D-C supply in rectifier power unit. 4. Deflection coil and brushes.
No sweep and no spot on PPI but xmtr seems OK.	1. F–401, F–404 (in PPI). 2. V–409, V–408, V–407 (in PPI).
No video.	1. F–203 (in rectifier power unit). 2. V–301 to V–308 (in receiver) V–406 (in PPI unit). 3. Check crystal current, local. 4. TR tube for blue glow. *See last paragraph of chart.
No range mark.	1. Trigger to ACU. 2. V–401 (in PPI). 3. F–701 (in ACU). 4. V–701, V–702, V–703, V–704 (in ACU). 5. Relay supply voltage (in ACU). 6. K–701 contacts (in ACU).
No indicator range marks, echoes OK.	1. V–401, V–402, V–404, V–405 (in PPI). 2. R–462 (in PPI). 3. S–401 (range switch). If out on one range check TC 401, 402, or 403 depending on range out (in PPI).

IF	*CHECK*
Antenna won't rotate.	1. F–106 (in motor alternator modulator). 2. F–403 (in PPI). 3. S–402 (motor switch). 4. mechanical binding. 5. synchro voltages. 6. servo systems.
PPI sweep locks momentarily at "0" degrees relative each revolution.	Alignment of S–408 (in PPI) and S–501 (in antenna). Each should be in center of cam when antenna is stopped on ship's head flash.
PPI bearings inaccurate by large error, does not correct.	Stop antenna, rotate PPI deflection coil manually about 46 degrees, start antenna. If PPI sweep does not stop at "0" degrees relative and wait for antenna to catch up, check switches S–408 (in PPI) and S–501 (in antenna) to see that S–408 closes when cam strikes it, and S–501 opens when its cam strikes. If each operates normally, check F–204 (in rect. power unit), if OK check relay K–401 (in PPI) for normal voltage and contacts.
PPI bearing inaccurate by small error.	If bearings are only a few degrees off, and above check shows PPI waits for antenna when displaced, stop antenna on ship's head flash and turn body of Synchro B–501 in antenna until sweep is at "0" degrees relative with switch on bearing control in the "Rel." (Be sure differential gear is locked. Consult book for location of differential gear.) Normally operating systems have switch S–408 in center of its cam and closed, S–501 in center of its cam and opened, and ship's head flash at "0" degrees rel. (with equipment in "relative") All occuring simultaneously.
Loud arcing from transmitter unit.	Usually caused by failure of wave guide switch to open. Check F–204 (in rectifier power unit) before opening the transmitter.
Receiver tuning.	Insert meter into jack at left end of receiver strip (covered jack) set receiver tune control on PPI in center of range. Adjust "Tune Set" control on PPI for maximum crystal current. Adjust coupling on mixer cable till crystal current reads one-half ma. Insert low impedance handset into video output jack on right end of receiver. Tune L.O. cavity screw for loudest buzz. Turn screw to T.R. cavity for loudest buzz. Gain should be at maximum for this procedure.

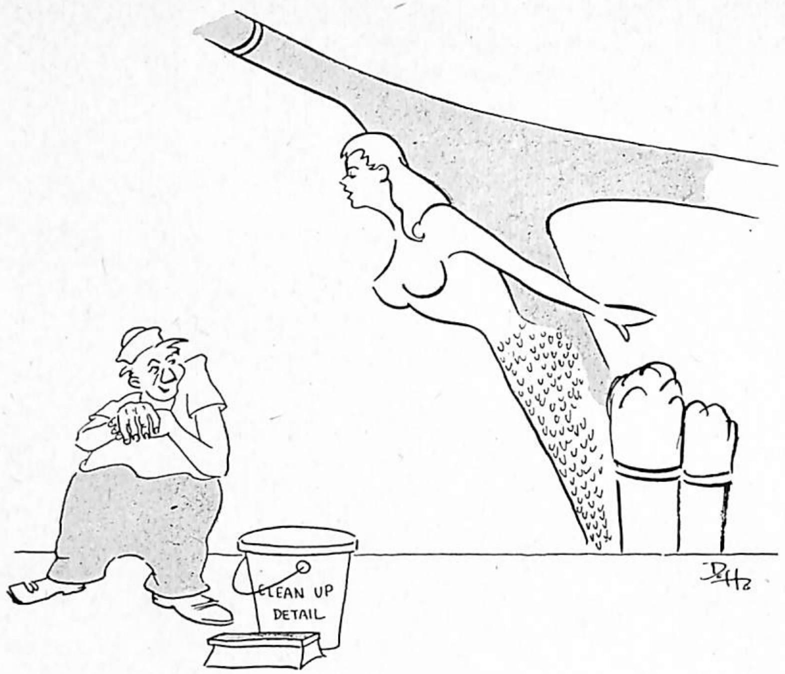
SHIPBOARD AND SUBMARINE COUNTERMEASURES INSTALLATIONS

The present radar countermeasures installations in various ship class types are similar. This follows for submarine types also. The following drawings are examples of typical installations showing equipment requirements to fulfill shipboard allowances. Copies may be obtained from the Chief, Bureau of Ships, Code 960.

Operational use of the equipment in these installations is covered in the publication Radar Bulletin No. 11, OpNav 34–P–802, called "The Shipboard Radar Countermeasures Operator's Manual." General information is available in Confidential publication Radar Bulletin No. 7, OPNAV 34–P–0802, called "The Radar Countermeasures Manual."

BUSHIPS NO. RE100J 166	Typical arrangement of RAD CM space (shipboard)
BUSHIPS NO. RE100J 190	Interconnection and PWR wiring for combined RCM transmitter and receiver room (shipboard)
BUSHIPS No. RE100F 2004	Interconnection diagram for small combatant vessels and submarines

MAINTENANCE PARTS FOR REACTIVATED VESSELS



In view of the increased requirements for electronic maintenance parts and in order to obtain the benefits of the new integrated Electronic Maintenance Parts Allowance Program for activating vessels of the reserve fleet, the Bureau of Ships is furnishing each vessel a new allowance in lieu of attempting to fill the present on board sets of equipment spares now stowed in metal boxes. While it will not be possible in many cases to supply stowage cabinets and bins for the new allowance upon activation, it is planned to install such cabinets and bins as soon as possible. In the meantime, each vessel will be supplied its new type Electronic Maintenance Parts Allowance and will be expected to restow its maintenance parts in Standard Navy Stock Number sequence in its present equipment spart parts boxes.

The Electronic Maintenance Parts Allowance will be supplied in two parts, Electronic Maintenance Parts (less electron tubes) and Electronic Maintenance Parts (electron tubes only). The Electronic Maintenance Parts Allowance (less electron tubes) will be a composite listing in stock number sequence of the maintenance parts for all equipments supported. This allowance will also give noun name, equipment application, total number of each item in use and number allowed. To further assist the ships' personnel while operating with the above allowance, a Stock Number Identification Table to be placed in the instruction book is supplied for every equipment supported by the allowance. This table is a cross reference from the equipment circuit symbol to the Standard Navy Stock Number. The Electronic Maintenance Parts Allowance (electron tubes only) will be a composite listing in numerical-alphabetical order of all electron tubes for electronic equipments (including intercommunication) supported. Equipment application, total number of applications and number allowed will also be on the allowance.

To assist the ships' personnel in accomplishing the change from the equipment spare parts box system to the integrated maintenance parts system, contractor teams will be furnished by the Electronic Supply Office, Great Lakes, Ill. These teams will also assist in preparing requisitions, if necessary, and returning excess material to the nearest supply activity. Deficiencies should be marked on one copy of the allowance and this copy should be used as a blanket requisition to the supply activity for those deficient items.

The Electronic Supply Office will not attempt to fill existing reserve fleet requisitions except in those cases where the Bureau of Ships is unable to furnish the Maintenance Parts Allowance. Active fleet conversions will proceed as scheduled.

MODEL TDZ/RDZ TESTING

The October 1950 BuShips Electron carried an article on "Communication Tests For Naval Vessels Being Overhauled." Mare Island Naval Shipyard suggests, in this connection, that the most suitable frequencies for testing shipboard radio equipment can be determined from a study of JANAP 195A. Also, Channel No. 9 for the RDZ/TDZ is 385.0 Mc.

Want some recognition for your activity? Why not submit a feature article to the Editor of BUSHIPS ELECTRON?

date. . your priority equipments and material requests

Information received in the Bureau of Ships indicates that electronic supply activities and Naval shipyards, particularly crystal grinding activities, continue to receive requests for equipment and material with priorities assigned but no delivery dates shown.

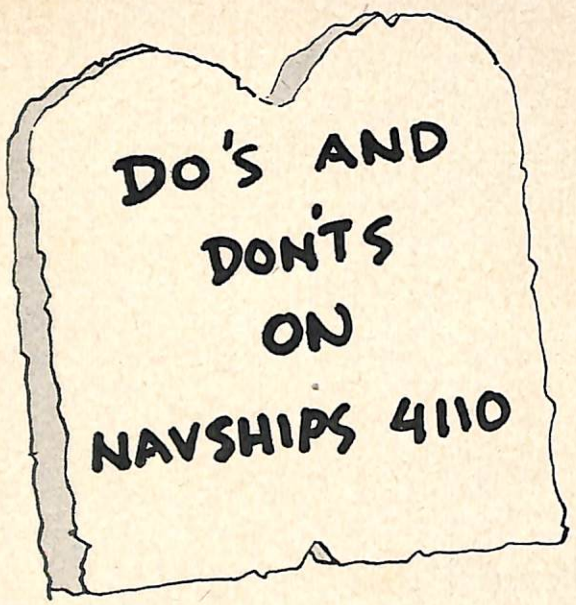
With the demand for equipment and material constantly increasing, it is imperative that priority requests show realistic delivery dates in order to permit the supply activity to establish an orderly processing schedule. Further, the subject activity indicators is covered in ALNAV 70, reprinted below:

"Attention directed to paragraphs 23004, 33021–7, 81206–7, BuSandA Manual. Addressees directed insure assignments of A and B priority indicators are correctly applied and explicitly justified and that realistic deadline delivery dates for priority A, B, and C requests are assigned. Imperative reviewing authorities critically review A and B requests for justification and realistic deadline delivery dates. In addition to priority A and B requests, supplying activities are enjoined in process priority C requests and ship material in accordance with realistic specified deadline delivery dates obtaining authorization for appropriate transportation as may be required. To preclude misconsignments of shipments made after expiration of realistic deadline dates, supplying activities are cautioned to verify location of mobile units."

MARINE CORPS NOTES

The Marine Ground Control Intercept Squadron 17, U.S. NAS, Willow Grove, Pa. reports overheating of the magnetron in an SP–1M. Although the voltage and current were normal and stable and the ventilating blower was in operation, the magnetron overheated and melted internally. Further investigation revealed that the air filter was clogged. When the air filter was cleaned and replaced and a new magnetron installed, the equipment functioned satisfactorily.

Squadron 17 also reported arcing in the transmission line of an AN/TPS–1B causing carbonizing of the transmission line and the spark gap container. It was found that the index joint in the antenna portion of the transmission line at the finger contacts of the center conductor was particularly badly pitted with carbon. The carbon was removed and the coupling was built up with solder and filed down to approximately its original dimensions. When the unit was tuned up after repairs were made, performance was found to be excellent, with targets detected as far away as 125 miles.



A number of ships have been negligent about properly maintaining and correcting the "Ship Electronics Installation Record" (NAVSHIPS 4110).

A word of explanation may clarify the purpose of this form and the importance of keeping it up-to-date. The following points are excerpts from NAVSHIPS 900,135 (Instructions for Maintaining Ship Electronics Installation Record System).

The Ship Electronics Installation Record (NAVSHIPS 4110) is the only record of installed shipboard electronic equipment maintained in, or available to, the Navy Department. The information and data provided by this form are essential to the operation of various divisions, bureaus and offices of the Navy Department and to field activities such as Fleet and Type Commanders, Service Force Commanders and shipyards. It is imperative that an up-to-date record of the installed electronic equipment in all ships be available to the activities.

This brief summary from NAVSHIPS 900,135 is quoted for ready reference:

DO check all inventory forms immediately upon receipt by ship.
DO make all corrections, changes and additions in red pencil or red ink.
DO correct first line only under *Ship* heading.
DO delete entries by drawing one red line through entire item.
DO write in new items in any available space on form—machine will place in order.
DO use complete model letters and type numbers.
DO use letters "SOB" when listing units which have been separated from equipments.
DO report all electronic equipments on board.
DO list all serial numbers of all items. If none, indicate by asterisk (*).
DO check and complete or correct all items marked by letters "CR" in voltage column.
DO list model letters and serial numbers of complete equipments . . . not individual units (except control and indicator units).
DO list serial number of the major unit if no equipment serial number is available.
DO list location Code "900" for all portable equipment.
Do date all returned inventory forms.
DO code only actual voltages used.
DO code location of major unit of an equipment unless otherwise stated in Section VI.
DO include prefix letters indicating manufacturer on all commercial model and type numbers.
DO submit reports for reserve and Naval Reserve ships.

Do NOT change data under *ship* heading unless positive that change is official.
DO NOT ignore items marked "CR"—check and correct.
DO NOT re-type inventory forms.
DO NOT change the position of any entry to place in proper order on form—machine will do this.
DO NOT omit slants and dashes from applicable model letters and type numbers.
DO NOT list units of complete equipments separately (except control and indicator units).
DO NOT use incomplete model letters.
DO NOT omit letters "SOB" from type numbers of separated units.

Mail corrected inventory forms directly to the Bureau of Ships addressed:

Navy Department
Bureau of Ships (Code 980)
Washington 25, D. C.

A forwarding letter is not necessary nor desirable—just place in a properly addressed envelope and mail.

—*ServPac Information Bulletin*

MODEL SR-6 ANTENNA DIPOLES

The Charleston Naval Shipyard reports that during recent overhauls of Model SR-6 antennas of the line array type, it was discovered that several dipoles had fallen off completely from most of the antennas undergoing overhaul. In one case as many as 50% of the dipoles were covered by plastic dome covers at the bottoms of which the broken dipoles were found resting.

It is understood that wherever structural design permits, Field Change #5 (the parabolic antenna) is replacing the present line array type. However for those ships still having the old antenna, it is recommended that inspection for the possibility of this defect be accomplished during overhaul period.

UNUSUAL SU RADAR TROUBLE

The *U.S.S. E-PCE(R) 852* reports a very unusual trouble recently encountered by R. W. Maynard, ETC, of the subject ship and J. B. Drew and C. L. Alger of the U.S. Navy Underwater Sound Laboratory, New London, Conn. A considerable amount of investigation and trouble shooting by these three men was necessary to solve this baffling problem.

When the SU was in operating condition, the A-scope presented 'veiling' effects and fluttering of target pips and transmitter pulse. Magnetron and modulator current were normal. The local oscillator was retuned several times, with no results. The receiver appeared to be working normally in both manual and AFC operation, except for the veiling effects mentioned above. Targets were received out to ranges of approximately fifty-two miles.

The magnetron was replaced as were all tubes in the receiver, with no change in the erratic operation. Next replaced all modulator tubes and checked all indicator tubes that were in the affected circuits. The oscillograph of the outgoing pulse of the modulator appeared normal. Voltage measurements (20,000 ohms-per-volt voltmeter) of the local oscillator and receiver were within requirements.

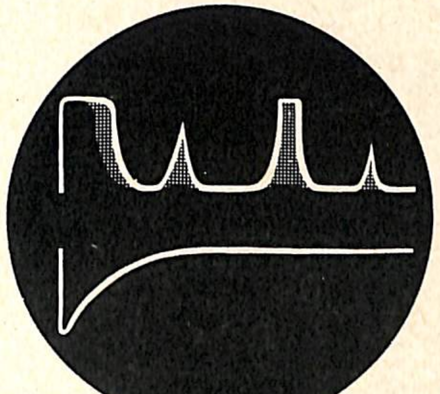


FIGURE 1—Artist's conception of the A-scope of the SU radar showing veiling effects. This effect was most noticeable when the receiver gain was low, or when the echo box was tuned and the ring time appeared on the upper sweep.

After considerable testing and measuring, it was suspected that the minus 255-volt supply, which supplies the plate of the local oscillator, was being modulated with an a-c ripple. An oscilloscope check of Terminal 16 indicated the suspected a-c ripple was present in the 255-volt supply. In the process of isolating this trouble, the lead to the receiver on Terminal 16 in the indicator was disconnected. While disconnecting this lead it was discovered that the lug on Terminal 16 had been twisted until it was contacting Terminal DD which is almost directly below it on the same panel. A-c voltage, measured from DD to ground was 65 volts. When this condition was corrected the picture on the A-scope returned to normal and the equipment worked correctly.

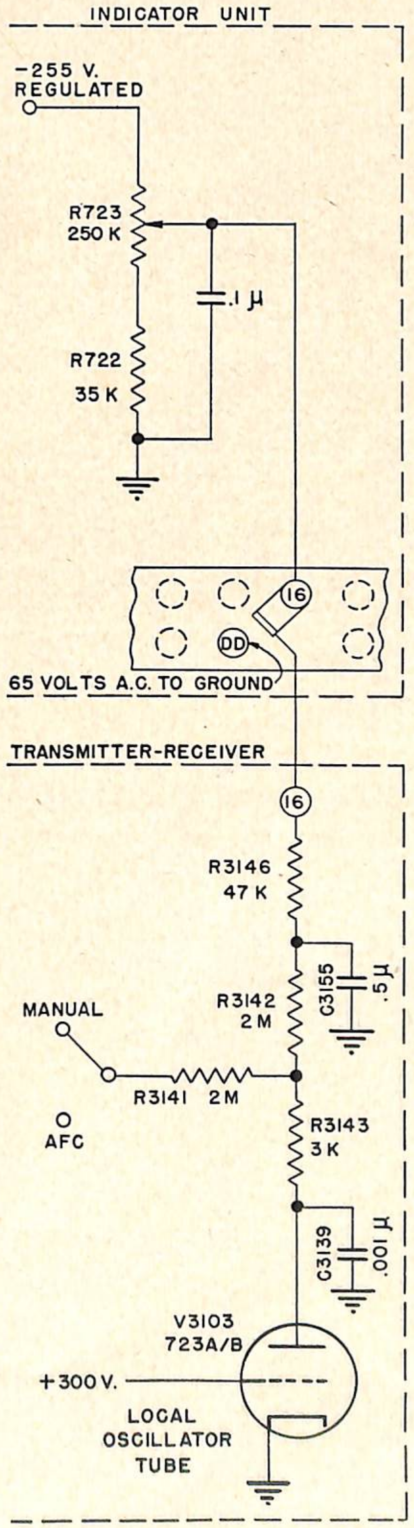
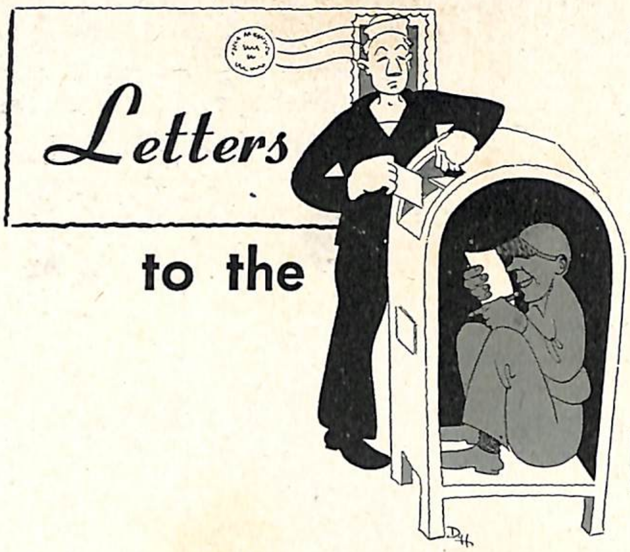


FIGURE 2—Diagram showing a portion of the SU radar and indicating troubles encountered while servicing the equipment.

Letters to the EDITOR



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

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

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

Editor
BUSHIPS ELECTRON
SIR:

In reference to the "ELECTRON Magazine" binders. I have received binders for the fiscal years 1946, '47, '48, and '49 but no binders for fiscal 1950 and '51. I think the binders are excellent and serve a very useful purpose in that all the magazines can be kept in a group, thus enabling quick reference to same. Does the Bureau contemplate providing binders for fiscal 1950 and '51?

Respectfully
R. E. T. Lt(jg) USNR

Binders for the fiscal 1950 and '51 ELECTRON *are now available. These binders may be obtained by shore stations and other activities from either the Officer-in Charge, Publications Division, Bldg. 222–1, General Supply Depot, Code 668, Naval Supply Center, Oakland 4, Calif., or from the Officer-in-Charge, Publications Supply Depot, Naval Supply Center, Bldg. 101, Naval Station, Norfolk 11, Va. Ships will be supplied the binders for Volumes V and VI automatically under the same distribution given Volumes I through IV. It is pointed out that Volume VI is an 18-issue volume covering the period July 1950 through December 1951.*

Editor

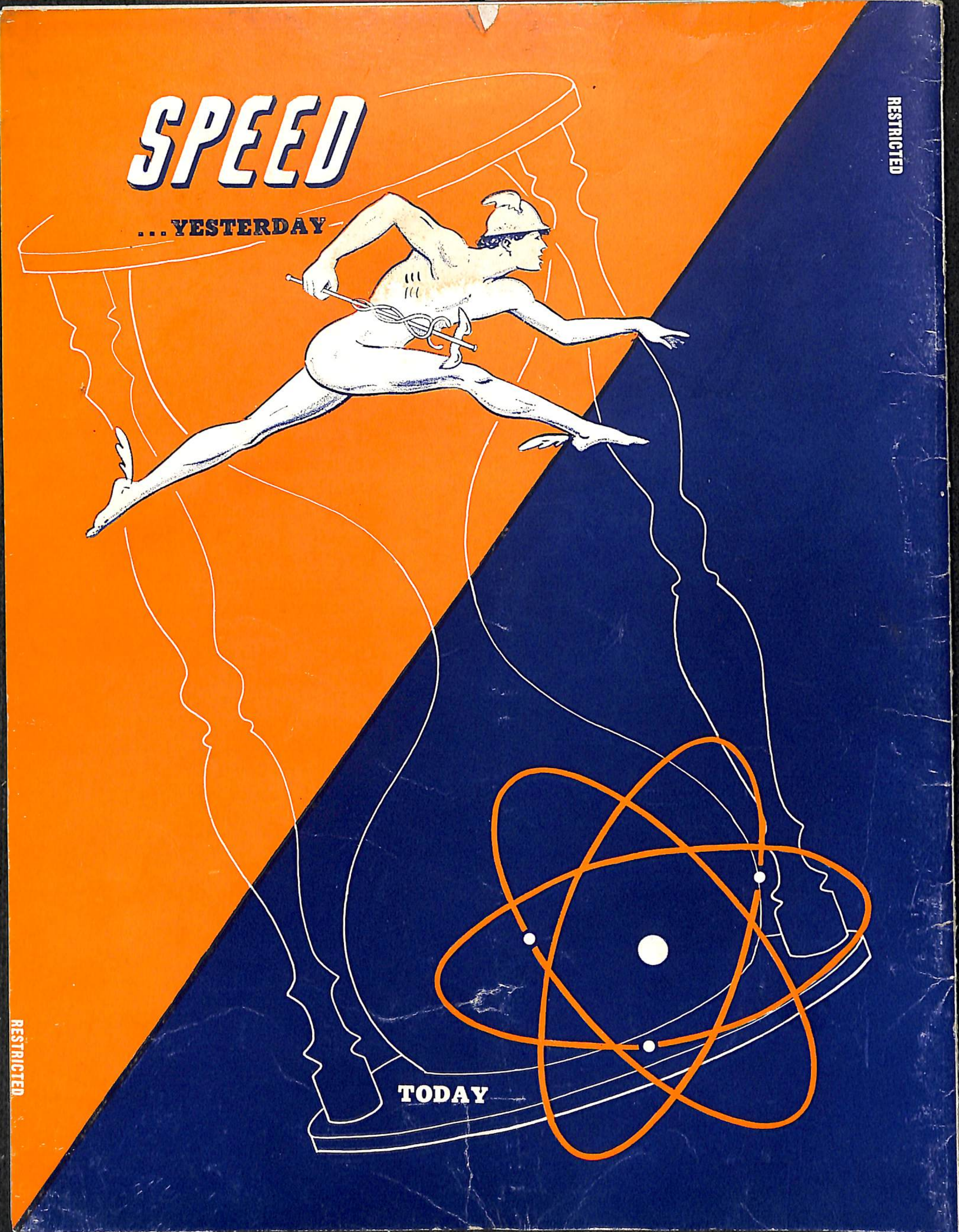
Editor
BUSHIPS ELECTRON
SIR:

I have observed, over a period of several months, many instances where surface targets (particularly land mass) have been detected on our search radar at extremely long ranges—occasionally out to 175 miles. Will you please explain why these extremely long ranges occur and also advise if there is any way I can insure obtaining such ranges consistently.

L. A. W. ET3, USN

The extremely long ranges are a result of "Anomalous Propagation" which is the general term for all non-standard propagation. Your questions will be answered in full in an early issue of ELECTRON *since we are now preparing a discussion of this phenomenon and its effect on radar ranges.*

Editor


RESTRICTED
SPEED
...YESTERDAY
TODAY
RESTRICTED