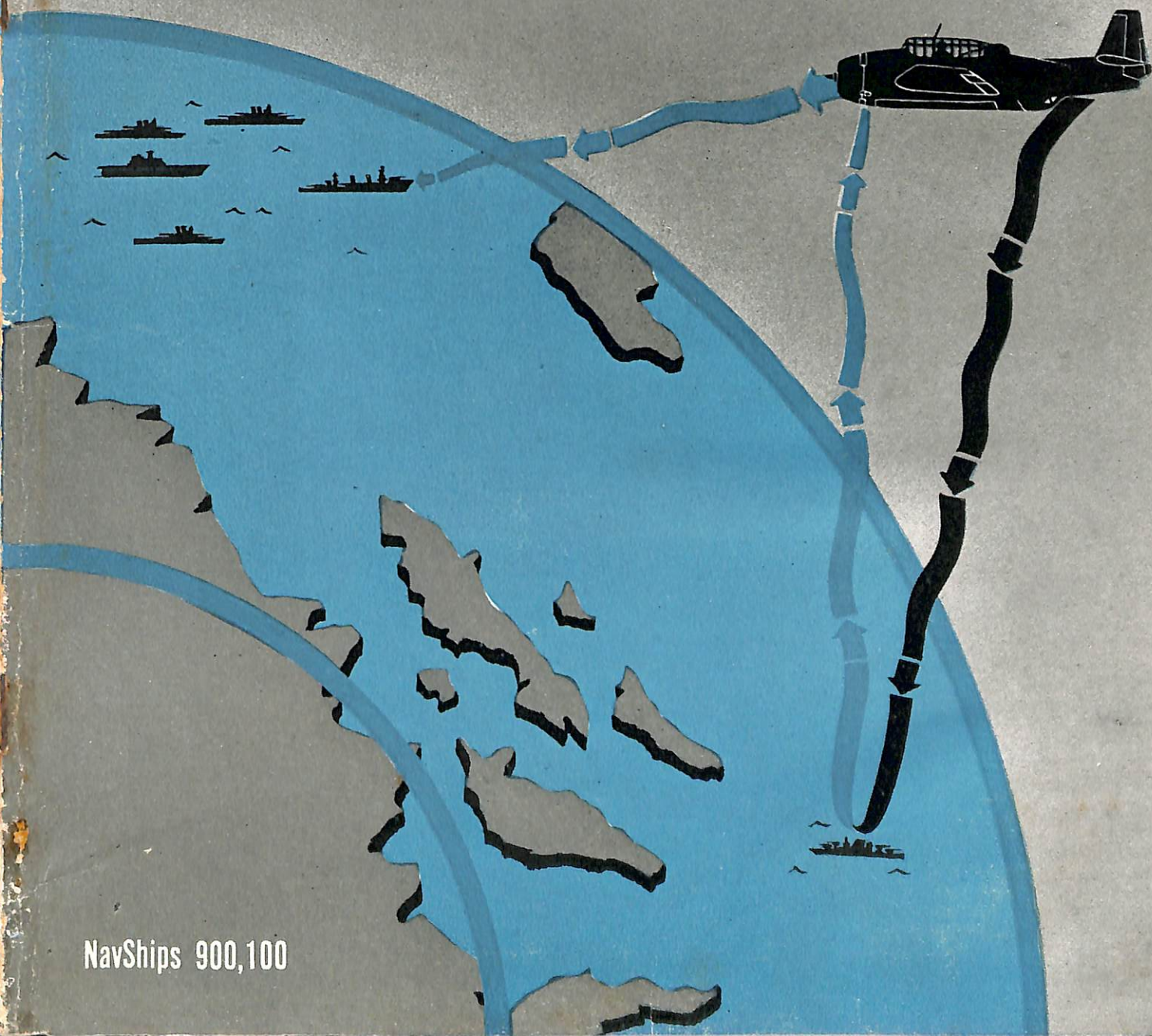


CONFIDENTIAL

JULY 1946

BUSHIPS

Electron



NavShips 900,100

Putting the Fox on Teletype..... 1
 Electronic Line-Voltage Regulator..... 5
 New Type Sonar Crystals..... 6
 Anti-Clutter Circuits 7
 Technical Publications Get a New Home..... 14
 The Forum 15
 Tuning the Mark 22..... 16
 Short Cuts in Radar Calibration..... 18
 Model OCT Monitor for FSK..... 19
 Terminal Equipment Modified for UHF Teletype..... 20
 The Field Engineer Sez:..... 23
 Modulator Exhaust on SP-1M Trailer..... 24
 Replacement Preamplifier for the SCR-584..... 26
 Index to Volume I..... 27

BUSHIPS

ELECTRON

A MONTHLY MAGAZINE FOR RADIO TECHNICIANS

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

CONTRIBUTIONS: Contributions to this magazine are always welcome. All material should be addressed to

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

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

CONFIDENTIAL: BuSHIPS ELECTRON has been classified confidential in order that information on all types of equipment may be included. It should be shown only to concerned personnel as provided in the U.S. Navy Regulations. Don't forget this includes enlisted personnel!!

BuSHIPS ELECTRON contains information affecting the national defense of the United States within the meaning of the Espionage Act (U.S.C. 50; 31, 32) as amended.

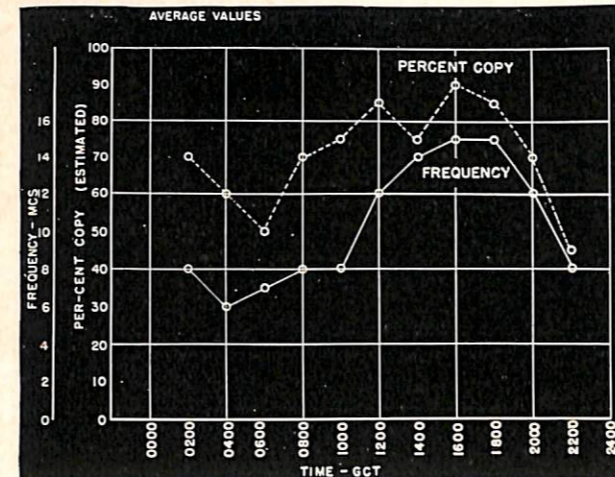
Putting the Fox on Teletype

■ The Chief of Naval Operations has just released a report on a subject which should be of great interest to both Technicians and Radiomen throughout the fleet. *Is it feasible and practicable to replace manually operated Fox circuits with automatic systems on board ship?* Many factors enter into the final conclusions and recommendations arrived at by the tests which were conducted between 10 and 15 December, 1945.

Elaborate plans and arrangements were necessary for a completely comprehensive test in which all the points in question could be checked and all possible obstacles brought to light. Immediately following the regularly scheduled International Morse Washington Fleet Primary Broadcast, a retransmission was made, using frequency-shift-keyed radio-teletype code. The prime purpose of this test was to obtain data to provide a basis

encrypting. But it increases shipboard weight unless the operating table and typewriter are eliminated, and it requires specialized maintenance personnel, with complete reliance upon continuous performance of a mechanical system.

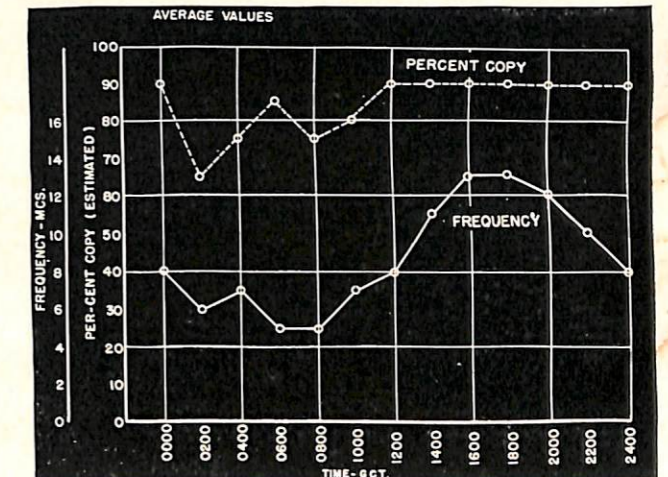
During the tests the first retransmission began at 1432 GCT on 10 December 1945 and the last retransmission at 1825 GCT on 15 December 1945, using the regular Washington Fox frequencies of 4045, 8090, 12135, and 16180 kc. The very low frequency of 18 kc was not keyed during the tests. At the time the tests were being conducted, approximately thirty ships in all fleets and a number of shore stations were equipped to receive frequency-shift-keyed radioteletype transmissions. The shore stations in the Atlantic area were requested to participate, simulating shipboard receiving conditions as



A report by the USS Lake Champlain, in the vicinity of the English Channel, showing percent of copy at a peak in the vicinity of 1600 GCT.

for the study and investigation of the possibility of replacing the manual copy of these broadcasts with radioteletype. It is a matter of record that radioteletype has been used on ship-shore circuits with a certain degree of satisfaction in the Pacific. This test was primarily made to study the problems involved in the north Atlantic area where conditions are not as favorable.

Radioteletype has several advantages as well as some disadvantages. It affords a speed in the vicinity of 54 words per minute after deducting time required for such functions such as *line-feed*, *carriage-return*, and *figures*, and on the assumption that no repeats are necessary. A reduction in the number of operating personnel may result. It permits semi-automatic relay from the guardship by VHF/UHF radioteletype. It permits automatic decryption as well as automatic tape perforation while



Curve of results obtained by the USS Wisconsin in San Pedro, California. Note solid 90 percent from 1200 to 2400 GCT as compared with copy submitted by USS Lake Champlain for same period.

nearly as possible; that is, to utilize shipboard-type receiving antennas rather than directional diversity equipment. Some ships in the eastern Pacific were invited to participate in order to provide information on the quality of reception in that area and at that distance. These ships were in ports on the West Coast. Their findings contributed beneficially to the tests. Of the total number of ships equipped to receive frequency-shift-keyed radioteletype transmissions, the following six contributed to the test: USS *Lake Champlain* (CV-39), USS *Enterprise* (CV-6), USS *Wisconsin* (BB-64), USS *Adirondack* (AGC-15), USS *Iowa* (BB-61), and USS *Missouri* (BB-63).

In addition to the ships, shore radio stations at Argentina (NWP), Londonderry (NST), San Juan (NAU), Trinidad (NYS), Azores (NBP), Balboa (NBA), and

Bermuda (NWU) assisted materially by sending in their radioteletype copy.

A careful analysis of the copy and notes submitted by the above stations was made. Although some of the shore stations did not simulate shipboard receiving conditions, their copy was useful in that it was analyzed separately for comparison. The copy made by the shore stations that did simulate shipboard conditions was combined with that submitted by the ships for the ultimate analysis. To insure a thorough check, various combinations of receivers, converters, and antenna assemblies were used at different locations. The *Lake Champlain* and *Enterprise* employed an FRC Converter, Vertical and Whip Antennas, and RBC receivers, while the *Adirondack* substituted a horizontal antenna for the whip. The *Wisconsin* used horizontal antennas with the FRC and RBC combination. The shore stations employed combinations of converters with inverted-L, vertical, and horizontal antennas. Londonderry and Bermuda used

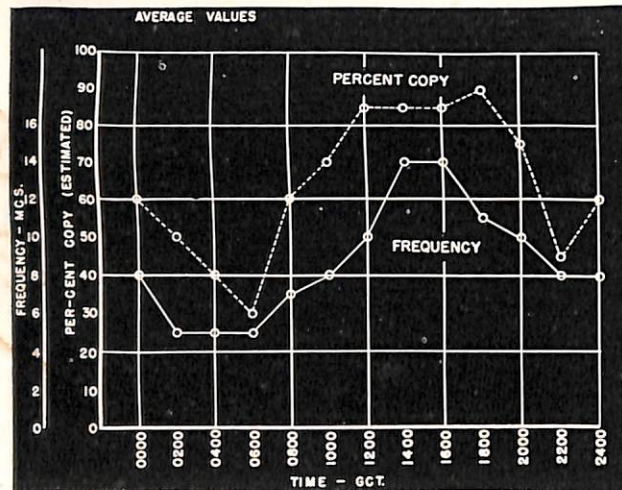


Chart of percent of copy by the USS Enterprise in the vicinity of the English Channel. Note similarity to graph submitted by USS Lake Champlain in same area.

receivers of the AN/FRR and AN/FRR3A-type respectively, while San Juan employed an HQ120-type receiver. Balboa, Azores, and Bermuda used directional antenna systems with various combinations of converters and receivers.

Because of the many variables encountered, the analysis was made on a very broad basis. Accurate determination of exact percent copy was very difficult due to the nature of the text material transmitted. In view of the problems, the analysis was made on an estimation based on the following categories:

- (a) 20 to 60 percent copy—Unreadable
- (b) 60 to 80 percent copy—Fair
- (c) 80 to 90 percent copy—Good
- (d) 90 to 100 percent copy—Very Good

Figure 1, a graph of percent of copy versus frequency and time, submitted by ships and shore stations simulating shipboard receiving conditions over a 24-hour period of each day, indicates a minimum average copy of 55 percent and a maximum of 85 percent. A total over-all average of 75 percent was made by these stations. No adjustment was made for longitude of the receiving stations, which should have a smoothing effect on the curves. It may be seen from the graph that the best average copy was made between 1600 and 1800 GCT. It is apparent that the percentage of copy was far below an acceptable standard. It should be noted that many ships recorded perfect copy for several hours each day, but the categories used and the averaging with other ships holds the maximum to 85 percent.

The frequency curves on these charts do not reveal much information since, due to the constantly-changing ionospheric propagation conditions during the test, plus local conditions, the best frequencies as well as fre-

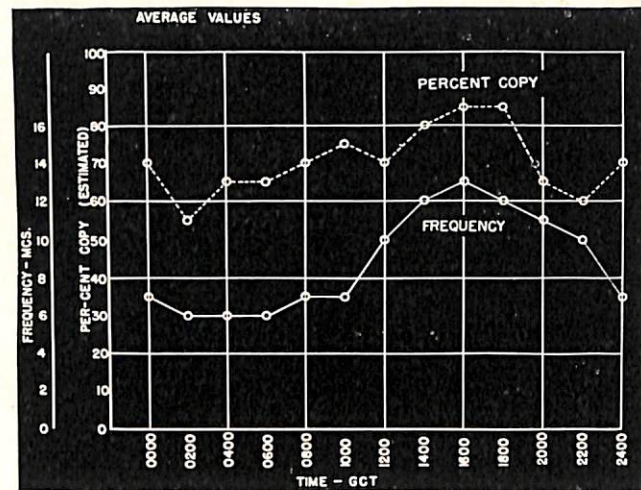


FIGURE 1—Graph of copy submitted by USS Lake Champlain, USS Enterprise, USS Wisconsin, USS Adirondack, Radio Bermuda, Radio Londonderry, and Radio San Juan, showing percent of copy as a function of both frequency and time.

quency-diversity reception were utilized. They do indicate, however, that frequencies were selected in close agreement with the predictions in Navy Registered Publications Memoranda, and that poor copy coincided with the necessity to use lower frequencies while best copy was made when the higher harmonics could be received.

A graph of the copy obtained by the shore stations that employed directional antennas is shown in figure 2. It will be noted that the minimum average copy obtained was 80 percent, and the maximum was 90 percent (between 1400 and 1800 GCT), an average of 85 percent. Comparison of figures 1 and 2 indicates graphically the difference in average copy as the result of the use of directional antennas for reception. Here again, solid copy was received by many stations for the best hours,

but when averaged with poorer copy, difficulties encountered on days of ionosphere storms and the use of broad categories in the averaging process, the figure was kept from being 100 percent in the best hours. These results compare with a low-power, point-to-point circuit, because the transmitting antennas were not directional.

Many problems were encountered during the test, the more important ones being low signal-to-noise ratio, fading, interference from other stations, round-the-world echo, existing ionospheric and atmospheric conditions, interference from shipboard radar and radio transmitters, shipboard noise level, and various printing difficulties.

It was borne out conclusively by the participants in the test that a signal level at least 20 db above the noise level passing through the filters was necessary in order to attain a high percent of copy. By high percent of copy is meant an acceptable ultimate minimum of 99 percent perfect copy with unbunched errors. The statement has often been heard that it is possible to make perfect copy

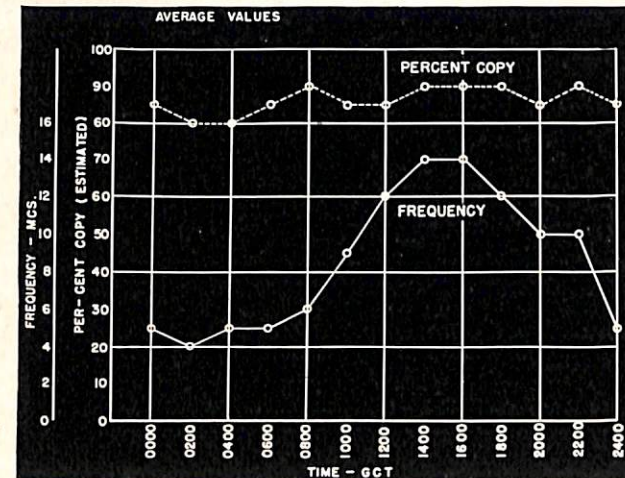


FIGURE 2—Graph showing increase in percent copy by Radio Azores, Radio Balboa, and Radio Trinidad when directional receiving antennas were used.

on a frequency-shift-keyed circuit when the signal cannot be heard by ear. Very likely the comparisons were made under unequal conditions, such as the failure to use, for reception by ear, an audio filter which is as selective as the audio filter in the FSK receiver converter. After several weeks of experience with this equipment, there was no doubt left that acceptable copy could be made manually on the NSS Fox circuit when only extremely poor copy could be made by radio teletype. On the other hand, when there was difficulty with the manual circuits there never was a time when the radioteletype equipment had a chance of making any copy at all. The signal definitely had to exceed the noise for teletype reception, whereas it did not for manual reception.

The problem of low signal level with respect to a high noise level, although of long standing, was again proved

to be the main factor encountered. Frequency-shift keying has similarities to voice frequency-modulation since noise, both man-made and that created by the elements, is mainly of an amplitude form, it has been claimed that it will not create as much interference to FSK reception. The participants in the test reported, from direct observation utilizing an oscilloscope to monitor the frequency-shift-keyed signal, that the *mark-space* pattern would disappear when subjected to noise crashes. Simultaneously with this, the radioteletype invariably printed errors. Many suggestions were made to increase in effectiveness and reduce the errors. These suggestions are for increased transmitted power, the use of a wide-angle directive transmission, use of shipboard diversity reception, use of frequency-diversity transmission, and taking measures to reduce the noise level on board ship.

The effects of fading on the copy received by a station or ship is obvious, the result being misprints and unreadable garbles. Reception at the bottom of fades is a measure of the reliability of the system. Most of the participants utilized a system of space diversity reception with "whip" antennas or a combination of a standard wire antenna and a "whip" in order to reduce the depth of fades. Frequency diversity reception was also utilized on numerous occasions to good advantage although it doubles the vulnerability to interference, and was not always possible when one harmonic of the series was clearly superior.

Considerable interference was experienced as a result of echo. At times the round-the-world echo completely obliterated the keying, making teletype copy impossible and manual copy very difficult. One of the main reasons for this in the FSK system is the use of limiters in the receiver converter, which have the effect of leveling off the direct signal to the same volume as the round-the-world signal. One recommendation made was to rearrange the NSS antennas so that they will create less field strength on a bearing of about 240 true, which probably can be done without making any material reduction in signal in the Atlantic extending between Argentia and Balboa. The transmission of a fifth harmonic of the series may also provide a cure inasmuch as this frequency may be less likely to carry both ways around the world. The echo phenomenon is reported by commercial companies to be encountered regularly in this area in November through February from about 1300 to 1600 GCT. Careful observation of this region on a globe will make clear the conditions that bring about round-the-world echo. It requires an approximately twilight path both ways around the earth. This occurs when the great-circle path of the signal reaches a maximum northern latitude within about five or ten degrees of the Arctic Circle, when the sun is about 90° from the Arctic Circle (midwinter), and when the

longitude of the sun is within an hour or so of the longitude passing through the northernmost latitude of the great-circle signal path. In view of this fact, it is considered possible to design a "null" in the transmitting antenna pattern ashore so that it will fall on the bearing that will create a larger difference between the "direct" signal strength and the "round-the-world" signal strength.

It was noted that 14 December was a particularly bad day insofar as ionospheric propagation conditions were concerned. All long-range North-Atlantic communication circuits experienced operating difficulties on that day. Inasmuch as long-range high-frequency communication is solely dependent upon reflection from the layers of the ionosphere, the importance of this factor, and the difficulties experienced as a result of ionospheric disturbances, were recognized.

Considerable interference was experienced in various forms due directly to the elements. The radioteletype copy occasionally was completely obliterated by interference caused by snow and sleet electrostatic discharges and ordinary lightning crashes. Interference of this nature is expected in ordinary communications and is a problem of long standing. Although it is mainly of an amplitude form, it does interfere with reception of frequency-shift-keyed transmission as explained previously.

A nominal amount of interference from radar pulses, spurious emissions from radio transmitters, key clicks, etc., was encountered. Among forms of shipboard noise, ignition interference from aircraft on flight decks has been reported. In view of this, it was recommended that new aircraft standards be set, giving consideration to interference suppression. Other noises such as intermittent contacts between loose metallic bodies, and from many electrical accessories, was objectionable and action should be taken to eliminate or drastically reduce it in order to lower the general level of shipboard radio interference.

As a result of the analysis of the test material submitted, it was concluded that the maximum overall percent copy obtained by the participants is below the acceptable standards. Before automatic transmission and reception of the Fleet Primary Broadcasts by radioteletype can be accepted, this system must equal or surpass the present manual system of transmission in fidelity and reliability, producing not more than one percent errors during the least favorable hours of the day. On the basis of the information and data obtained from this test, it is believed that the many problems encountered can ultimately be overcome to the degree necessary to render reliability and fidelity, if aggressively attacked.

Copies of the complete report may be obtained from the Chief of Naval Operations (Op-20-E), Room 2547, Navy Department, Washington 25, D. C.



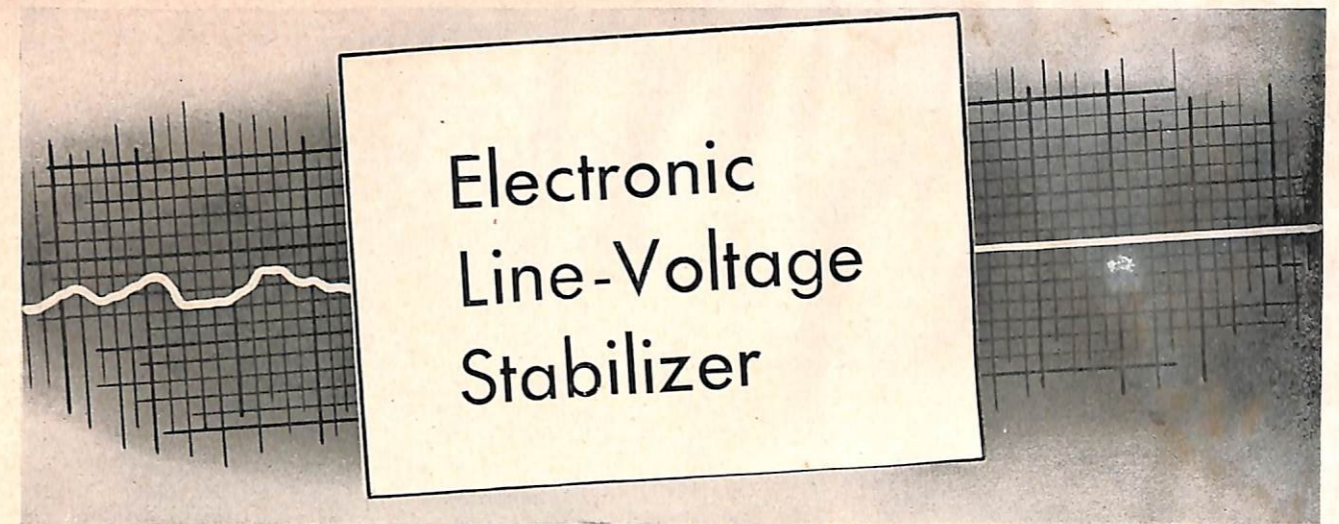
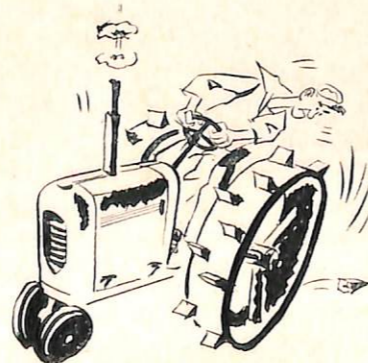
CHECK YOUR LAF SPARES

The Bureau has been advised that many sets of LAF Signal Generator spare parts were shipped without bolometer elements. This part, symbol F-103, stock No. -38149, and listed as "Fuse, 1/100 amp., #8AG 1/4" diameter, ferrule 1" long with lug soldered on one end for handling", is packed in an envelope marked "Bolometer Element". If this envelope is present in spare parts it should be opened and checked, as some activities report that it contains only the brass lugs. If this condition exists, new replacements should be requisitioned at the earliest opportunity. These parts have now been supplied by the contractor and should be available at the Electronic Pools.

BROKEN LUGS ON TBS FILTER CHOKE

Sometimes during the removal of the receiver chassis from TBS-Series equipments, the connecting lugs to r-f filter chokes L-407 and L-408 have become broken. This has occurred when these lugs have not been provided with sufficient clearance from the receiver housing.

A visual inspection of all TBS-Series equipments aboard should be made to determine whether these lugs will clear the housing during handling of the receiver chassis. Greater clearance may be provided in some cases by bending the lugs closer to the choke case. Adequate care should be taken to preclude damage to the chokes while doing this.



Until recently line-voltage stabilization systems have been divided into three categories; those utilizing a tuned circuit, those utilizing capacity and reactance, and those utilizing a motor-driven *variac*. These systems have adequately filled the requirements placed upon them with the exception of a very few cases where strict adherence to a pure sine wave was necessary. With the increasing number of gasoline-driven a-c generator installations delivering power to electronic equipments, the stabilization requirements became more acute. These electronic equipments required a steady input voltage for their successful and correct operation. Since most gasoline-driven a-c generators have inherently poor frequency and voltage regulation there was a demand for a voltage stabilizer which would operate under such conditions and still maintain steady voltage output.

The requirements for this stabilizer centered on three frequency coverages, 50 to 70 cycles, 360 to 440 cycles, and 400 to 1600 cycles. There was, and still is, a limited demand for operation from 800 to 2400 cycles but this coverage seems to be extreme at the present time. To meet these requirements it was necessary to develop a device which would take a fluctuating-frequency input voltage with a variation of from 90 to 140 volts and furnish an output with less than 1% variation from the desired voltage. The unit eventually designed and developed is known as the Electronic Line-Voltage Stabilizer. This unit consists of two distinct circuits, a regulating transformer and saturable reactor, and an electronic system to control the saturable reactor.

The action of the circuit may be followed in figure 1. The secondary of the regulating transformer aids or bucks the line voltage in such a manner that the minimum voltage at which control is to be established, when added to the aiding or bucking voltage, is equal to the

required voltage output. Thus, if the desired output voltage is 115 and the line voltage varies from 95 to 135, the controlling element must be able to develop a resultant voltage of plus or minus 20 volts.

To control the regulating transformer and force it to deliver the proper secondary voltage, a variable reactance is used in series with the primary circuit. It consists essentially of an iron core reactance with an additional coil so situated that, by increasing or decreasing the flow of direct current through it, the iron core becomes more or less saturated, thereby affecting its reactance to a-c. The reactance of this saturable reactor must approach zero for the transformer to give its full boost and must have maximum reactance to obtain full buck. The saturable reactor is controlled by a direct current which is altered by any slight change in output voltage. Since the output voltage is to remain within 1 volt, this control must be such that the d.c. fed into the saturable reactor is sufficient to maintain supply to the reactor for the required range of reactance variation. It becomes obvious then that the greater the amplification of the output voltage variation, the less the output voltage variation will be.

The method of feeding this variation of output voltage into an amplifier tube is shown in figure 2. The emission tube is a diode having a pure tungsten filamentary-type cathode which is emission-sensitive to any change in voltage. The emission of a filament varies as the fourth power of the temperature, so that a change of filament voltage causes a considerable change in the emission. Thus the voltage of point "A" in figure 2 rises and falls with the line voltage change, and is fed into the amplifier. The output of the amplifier is fed back to the saturable reactor d-c coil in such a manner

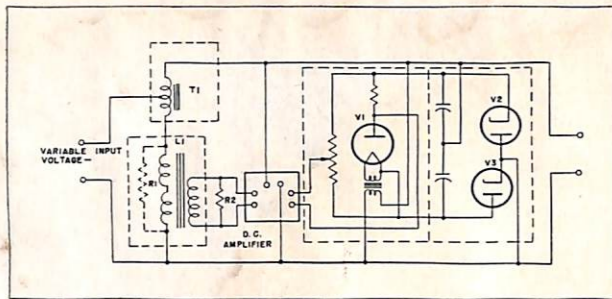


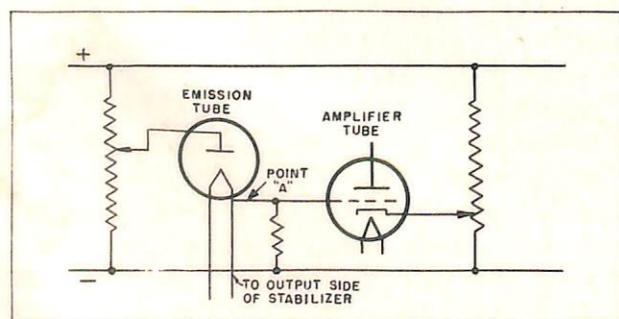
FIGURE 1—Schematic diagram of the Electronic Line-Voltage Stabilizer. T-1 is the regulating transformer and L-1 is the saturable reactor.

that an increase in output voltage causes a decrease in direct current output from the amplifier.

Referring to figure 1, assume that the circuit has been adjusted to give an output voltage of 115 volts with an input variation from 95 to 135 volts. Now assume that the output tends to increase, thereby increasing the potential on the filament of the diode. This will cause a decrease in voltage on the grid of the d-c amplifier, the resulting negative swing on the grid tending to cause a decrease in current through the d-c amplifier, and thereby causing a decrease in current through the saturable reactor. As the current in the d-c winding of the reactor decreases, the reactance through the a-c winding increases. This will cause a decrease in current through the branch with a consequent voltage drop across one leg of the transformer. This will induce a voltage in the secondary which will tend to buck the applied voltage, thus preventing the original tendency to rise. If the original tendency is toward a decrease in voltage, the entire process is reversed and the induced voltage tends to reinforce the applied voltage, thus keeping the output always constant.

The Electronic Line-Voltage Stabilizer described above is now only in the laboratory stage and is not yet in production. It is therefore impossible to supply any of this equipment at the present time.

FIGURE 2—Partial schematic diagram of emission tube and d-c amplifier employed in the Electronic Line-Voltage Stabilizer.



New Type Sonar Crystals

One of the promising new piezoelectric crystals under development, which will be available for use in a short time, is lithium sulphate monohydrate, $\text{LiSO}_4 \cdot \text{H}_2\text{O}$. Its value as a piezoelectric crystal was discovered by Spitzer of Gottingen University in 1936, and first announced in this country in 1944. At first only about 1% of all crystals grown were usable, since minute cracks and flaws almost invariably were present.

Growth of these crystals by the usual process of slowly lowering the temperature of a saturated solution was impossible because lithium sulphate is one of those rare materials which are more soluble at low temperatures than at higher temperatures. Unfortunately, this decrease of solubility with rising temperature is too slight to be usable by reversing the process.

The procedure now in use involves using a very pure solution, and slowly increasing the saturation by controlled evaporation at a constant temperature in the range of 95° to 100° Centigrade. With this technique, 100% yields have been obtained.

Lithium sulphate is of piezoelectric interest principally because it responds to hydrostatic pressure. It has a piezoelectric constant of 40×10^{-8} esu charge/dyne, as compared to approximately 7×10^{-8} for tourmaline and quartz. The dielectric constants of both tourmaline and lithium sulphate are approximately the same, so that the sensitivity of lithium sulphate will be about six times that of tourmaline. It is only about one-fourth as sensitive as ADP (see p. 10, July 1945 ELECTRON). However, since quartz, ADP, and Rochelle salt crystals do not respond to hydrostatic pressure, they are used in different applications than are lithium sulphate and tourmaline, and should not be compared to them.

The stability and performance of lithium sulphate under conditions of varying temperature and humidity are about the same as those of ADP crystals, and better than those of Rochelle salt crystals.

The frequency constant of lithium sulphate for thickness vibrations parallel to the Z-axis is 274 kc per cm and the density is 2.06. The coupling coefficient of lithium sulphate for this mode is about 0.35, and that of tourmaline less than 0.1. Hence lithium sulphate can replace tourmaline to advantage in blast gauges, standard hydrophones, and other devices requiring response to hydrostatic pressure.

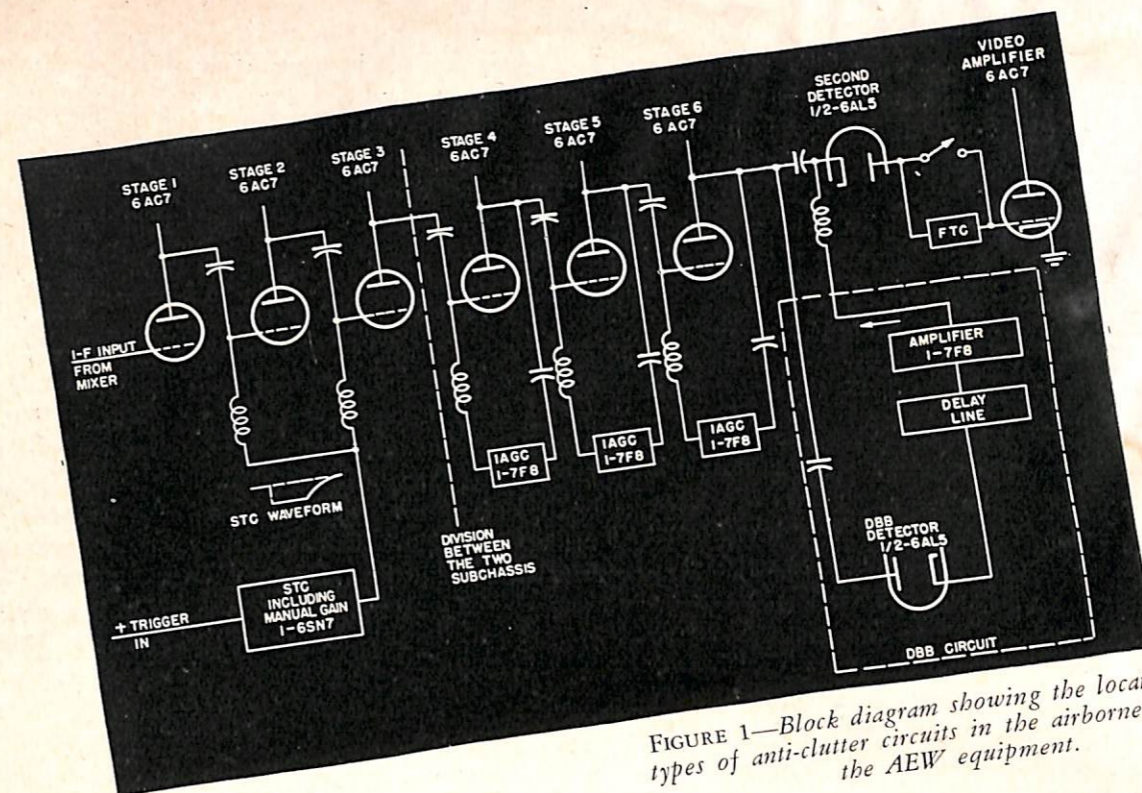


FIGURE 1—Block diagram showing the location of four types of anti-clutter circuits in the airborne receiver of the AEW equipment.

Anti-Clutter Circuits

The usefulness of any radar system can be adversely affected by the presence of sea return, cloud return, and land return, all of which are referred to as "clutter". In addition to adverse affects from clutter, the equipment may also be subject to window jamming and/or electronic jamming in one or more of its various forms, such as noise jamming, c-w jamming, mcw jamming, railings, etc. In the early receivers no provision was made to combat either clutter or jamming, but with the advent of enemy countermeasures and further development of our own countermeasures program certain new circuits began to be incorporated into our radar receivers in an effort to reduce the effects of various types of clutter and jamming. The degree to which these types of interference affect a radar receiver, thus reducing its usefulness, is dependent upon the methods provided to counteract such interference and the intelligence employed in their use. These circuits, designed to reduce the effectiveness of clutter and jamming, are known as anti-clutter circuits.

The present ranges of shipboard sets are seriously limited because of the earth's curvature, and because over water the reflection from the water surface interferes with the direct beam, thus setting a minimum elevation angle for the radar beam. In an airborne set it was found experimentally that when the radar is at an altitude of 10,000 feet, the sea return from a rough sea may be as much as 60 db above noise and may extend with diminishing intensity to more than 100 miles. A small amount of sea return makes the detection of an

aircraft difficult, and returns of about 20 db or more will obscure large ships even at short ranges. This type of interference, commonly called sea clutter, greatly reduces the usefulness of both shipborne and airborne sets.

Another type of interference, very common in the Pacific but not so common in the Atlantic, is that of cloud return. This interference is caused by echoes from cloud formations and is referred to as cloud clutter. It is not so detrimental to efficiency as is sea clutter but its presence will cause a certain amount of confusion to the operator. In designing the anti-clutter circuits for a certain type of airborne equipment, all forms of clutter and jamming were taken into consideration.

An equipment is said to be jammed when its efficiency is reduced by causes external to the system. This condition may be the result of clutter caused by sea return, cloud return, or land return. It may also be directly due to reflections from window or other objects used to give spurious echoes. However, one of the most efficient types of jamming is that caused by the generation of radio waves which interfere with the reception of the desired radar signal, commonly called electronic jamming.

These jamming signals usually interfere with the radar operation by producing saturation somewhere in the receiving system. As soon as saturation is approached in any stage, the desired signal is either greatly reduced in visibility or entirely lost. Thus one of the principal purposes of all anti-jamming circuits is to prevent or at least minimize effects of saturation.

In systems using intensity-modulated indicators, the most common being the plan position indicator (PPI), there must be video limiting at a level not many times the average noise power. Therefore, any signals, either jamming or target-echo, of about 10 to 20 db above noise, will saturate the video amplifier and consequently the PPI. Smaller amounts of jamming will make the PPI screen so intense that even though the desired target signals do saturate, they will appear with less contrast than they would in the absence of clutter. This makes the task of locating and tracking the targets more difficult and fatiguing to the operator.

Clutter and window have a common characteristic in that they consist of reflections of the system's transmitted power, and thus contain the frequencies present in the transmitter output. The returned echo, whether desired signal or from clutter, when amplified under the usual conditions by an optimum-bandwidth i-f amplifier and then detected, will show very nearly the same frequency spectrum as does receiver noise. If the reflecting object is an isolated target, the phase relations in the returning signal are essentially the same as in the transmitted pulse and, when properly detected and displayed, a pulse is seen. If, however, the reflecting object is a distribution of many small reflectors arranged more or less at random in a large volume of space, the same average frequency spectrum is returned but the phase relationships found in the pulse are destroyed. In the limiting case of an infinite number of small reflectors, the return would appear, on any single sweep, like receiver noise. Thus all forms of clutter, desired target signals, and receiver noise have essentially the same video-frequency spectrum, and therefore a frequency-separation filter cannot help to remove clutter without at the same time removing approximately the proportionate amount of desired signal. In some radars, particularly airborne search types, sea and cloud clutter constitute a very serious problem. Thus in these types

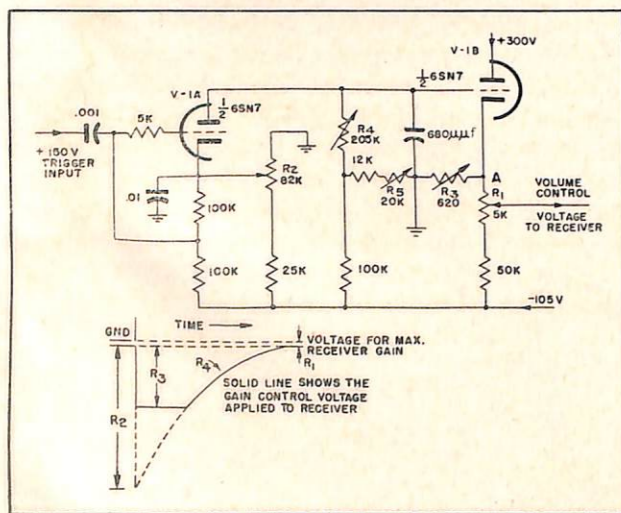


FIGURE 2—Simplified schematic diagram of the Sensitivity Time Control circuit used in the airborne receiver of the AEW.

strong emphasis has been placed on anti-clutter circuits to combat clutter and jamming.

CIRCUIT ACCOMPLISHMENTS

Most electronic jamming transmissions can be expected to contain a considerable portion of c-w carrier components. In such cases the output of the second detector is a d-c term plus any modulation frequency or frequencies present. A high-pass filter between the second detector and the video amplifier will eliminate the d-c term and attenuate the low frequencies. Thus, because of the different frequencies involved, such a filter makes it possible to observe individual targets whose echo power is small compared with the power of the jamming signal. However, this supposition does not hold true if the jamming contains primarily the frequency spectrum present in the pulses of the radar system, as in the case of noise or railing jamming. Nor is the supposition true in the case of clutter, because, as pointed out above, clutter often contains all the frequencies present in the pulse. In such cases, simple filter action cannot make improvements in the signal-to-clutter ratio, and thus only target signals about as great in amplitude or greater than the clutter will be seen. This signal-to-clutter ratio can be improved by increasing the antenna gain and reducing the pulse length.

In the presence of clutter the optimum gain is a function of the azimuth and range being presented. Automatic circuits are therefore needed in scanning systems. These circuits cannot be expected to do more at any one point on the indicator than could be done by the optimum adjustment of a good manual gain control. However, since no manual gain control can possibly follow the rapid gain changes required in a scanning system, anti-clutter circuits are used to set the gain as nearly at the optimum value as possible for each instant, and to do this automatically. It should be remembered that without the anti-clutter circuits or manual gain control a 70-db signal would be lost in 40 db of clutter due to saturation. It is further pointed out that the expression "clutter removal" means the removal of clutter by a reduction in gain, with a consequent loss in signal output power.

To illustrate the latest innovations in anti-clutter circuits, with the exception of MTI (Moving Target Indicator), the AEW (Airborne Early Warning) receiver will be used. The AEW was designed for the purpose of obtaining longer ranges than was previously possible on aircraft, particularly low-flying aircraft, and on surface targets.

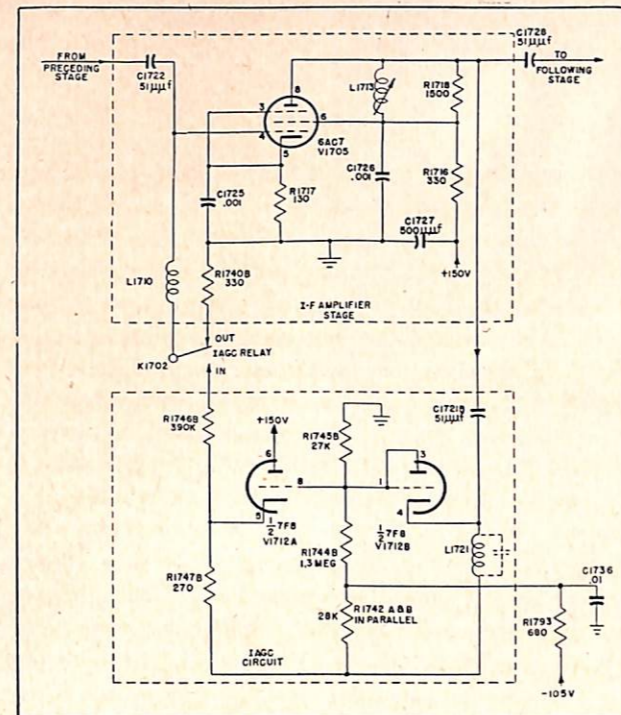


FIGURE 3—One of three IAGC stages in the AEW receiver. This is the fifth i-f amplifier with accompanying IAGC circuit.

Four different types of circuits, all designed to aid in clutter removal and anti-jamming, are used in the AEW. In operation, one, two, and frequently three of these circuits will be used simultaneously. The reasons for this simultaneous operation are two-fold: 1—It has been found necessary to use specially-designed circuits to prevent saturation in the i-f amplifier. Attempts to make these circuits capable of eliminating partial video saturation have not been successful and therefore other circuits are necessary between the i-f amplifier and the limiter stage in the video. 2—The dynamic range over which most of these circuits operate under optimum conditions, and in some cases under satisfactory conditions, is limited. Thus it is usually better and frequently necessary to use several circuits, each carrying a part of the load, than to use one circuit. Figure 1 shows the position of the four types of circuits used in the AEW. From left to right they are STC (Sensitivity Time Control), IAGC (Instantaneous Automatic Gain Control), FTC (Fast Time Constant) and DBB (Detector Balanced Bias).

The STC is a circuit used to make the gain control voltage a function of the time after the initial pulse. The ordinary gain-control potentiometer is included in this circuit. In practice, the gain is lowered at the time of the initial pulse and then allowed to recover to its normal value, following some pattern determined by the circuit constants, several of which may be made adjustable. The IAGC circuit is a type of i-f back-bias circuit. These back-bias circuits reduce the grid voltage,

and therefore the gain, of the protected i-f amplifier stage when the output of that or some following stage gets above a value determined by the circuit components. This prevents saturation of the i-f stages so protected. An FTC circuit is a type of coupling between the second detector and the video amplifier which acts as a high-pass filter for removing the d-c and low-frequency terms commonly arising from electronic jamming. A DBB circuit is designed to bias the detector by an amount sufficient to keep noise jamming or the high-frequency components of clutter from saturating the video amplifier and making the PPI screen too bright for good observation.

SENSITIVITY TIME CONTROL

The STC, as stated above, is used to make the gain a function of range and independent of azimuth. Thus it may be seen that this circuit can be used effectively if the clutter to be removed has a radial pattern that is nearly independent of azimuth. This condition is most frequently found in sea clutter. Under some conditions such a circuit might be useful in mapping built-up sections of extended land areas. This circuit would rarely be of use in cloud or window return. There must always be a compromise between circuit complexity, with its accompanying difficulty of adjustment, and the accuracy with which observed clutter patterns can be matched. The circuit chosen for use in the AEW is one in which the gain of the receiver is reduced to some adjustable value, held constant for an adjustable length of time, and then permitted to recover to normal with an adjustable time constant. This principle is true in general in all STC circuits employed in radar equipments. The waveform necessary to control the receiver gain is produced by the simple circuit shown in figure 2, which requires only one 6SN7. The same voltage that triggers the modulator (+150 volts) is also applied to the input of the STC circuit. This pulse makes V-1A highly conductive during the time of the pulse, thus charging the 680 μf capacitor to a potential very near that of the cathode. The potential of the cathode is variable in steps between zero and -82 volts by R-2. This resistor controls the value of the negative voltage charge that can be placed on the capacitor during V-1A conduction; thus it is said to control the "depth of drive" in the output waveform, as shown in figure 2. Since the negative charge on the capacitor is also applied to the grid of V-1B it will drive that tube to cut-off. The rate at which the capacitor discharges, after the pulse is removed from V-1A, depends to a large extent on the value of R-4. This rate of discharge determines the rate of voltage change on the grid of V-1B, thus sloping the recovery curve in the output waveform. When the STC switch is OFF, the cathode of V-1B is at ground potential. This is adjusted by R-5, which sets the bias on the grid in

such a manner that the drop across the tube is 300 volts, thus giving zero voltage at the cathode. This may be explained by considering the tube as a resistance in series with R-1 and the 50,000-ohm resistor between the positive 300-volt and the negative 105-volt supplies. In the complete voltage-divider circuit, the tube resistance is such as to make the cathode voltage zero. In this condition no current flows through R-3. Immediately after the trigger, when V-1B is not conducting, the voltage at point A is determined by R-1, R-3, and the 50,000-ohms resistance between -105 volts and ground. If R-3 is set to its maximum value, point A will be sufficiently negative (during cut-off of V-1B) to reduce the gain of the receiver to a low value. This voltage is held fixed during the time that the tube is cut off and therefore the gain of the receiver is at a low value. As the charge leaks off the capacitor through R-4, the voltage at point A starts to rise and increases the gain of the receiver, the maximum gain of which is determined by the setting of the gain control R-1.

Controls must be adjusted intelligently to give the best results when using an STC circuit. The great danger in its use is that the receiver gain will be set too low for some part of the area to be searched, and in such areas signals will be lost that should have been seen. Thus the adjustments should be made to fit the clutter pattern in the azimuth in which the clutter is minimum. The remaining clutter can then be reduced by other circuits. Operationally, it has been found best to stop the antenna at the azimuth at which the STC is to be adjusted. Then by using the A-scope, the circuit is adjusted so that the clutter is as low as possible consistent with the requirement that at no important range is the clutter small compared with normal noise.

INSTANTANEOUS AUTOMATIC GAIN CONTROL

There are many types of IAGC circuits. The purpose of so-called "back bias" circuits is to reduce the possibility of saturation in any of the stages so protected. In the presence of any kind of jamming the aim of the back-bias circuit is to keep the amplifier operating in such a way that the desired signals will be found in the linear operating range of the amplifier tubes. In most types of jamming and in clutter, the desired information "rides" on top of the jamming, and the back-bias voltage should shift the amplifier sufficiently far into class-C operation that these tops do not saturate the amplifier. Experience shows that the back-bias circuits without either FTC or DBB circuits are not very effective against clutter.

The IAGC circuit chosen for the AEW (figure 3) was the result of many experiments. It was found that the back-bias circuit should be around only one stage

because such a circuit is degenerative, and if the phase shift in a complete loop is more than 180 degrees at any frequency, the circuit will oscillate. Since there is a certain video phase shift in each i-f stage and also in the back-bias circuit, the chances of oscillation are much greater if the circuit is around two stages. A two-stage circuit has also been found to be inherently less stable. The AEW receiver has a gain of about 20 db per stage; thus with a single circuit around two stages, either the first is biased off too far and pulse-gain lost, or the first is operated correctly and the second approaches saturation. Further, a given maximum amplitude of c-w interference in the amplifier is much more effective at producing a back-bias voltage than is clutter of the same maximum amplitude. Since there is at present no efficient method of making the pulse and c-w gains different in the back-bias circuits, the desired information which rides the top of clutter or jamming will be in a different region of the amplifier characteristic depending on whether the interference is essentially like clutter or is c-w jamming. In c-w jamming alone, the operating range of the i-f amplifiers is too small to allow two

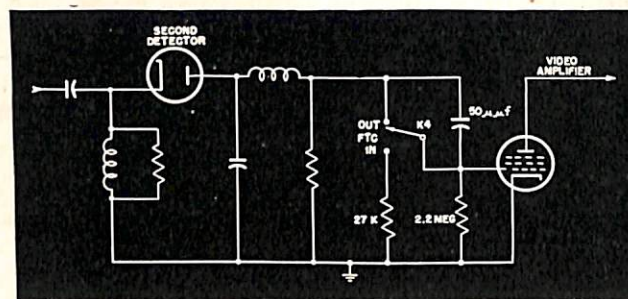


FIGURE 4—Fast time constant circuit utilized between second detector and video amplifier in AEW receiver. The 50 μ f capacitor and the 27,000-ohm resistor are the FTC elements.

successive stages to be protected by biasing only one grid. To allow optimum operation in the presence of c-w jamming and clutter, the additional operating range required is not available unless every stage is biased. Tests have shown that i-f amplifiers having a gain of 20 db per stage should have back-bias on successive stages, not alternate ones. It has been recommended that the last half of the i-f amplifier stages be protected with back-bias circuits. The reason for not protecting alternate stages is that an unprotected stage, following a protected stage, will operate too near saturation and the input to the following protected stage is too great for optimum operation of the IAGC circuit.

Plate detectors and cathode followers have been used in some cases as IAGC circuits but are not as efficient as the type used in the AEW. In order to keep the phase shift in the plate detector small, the gain is

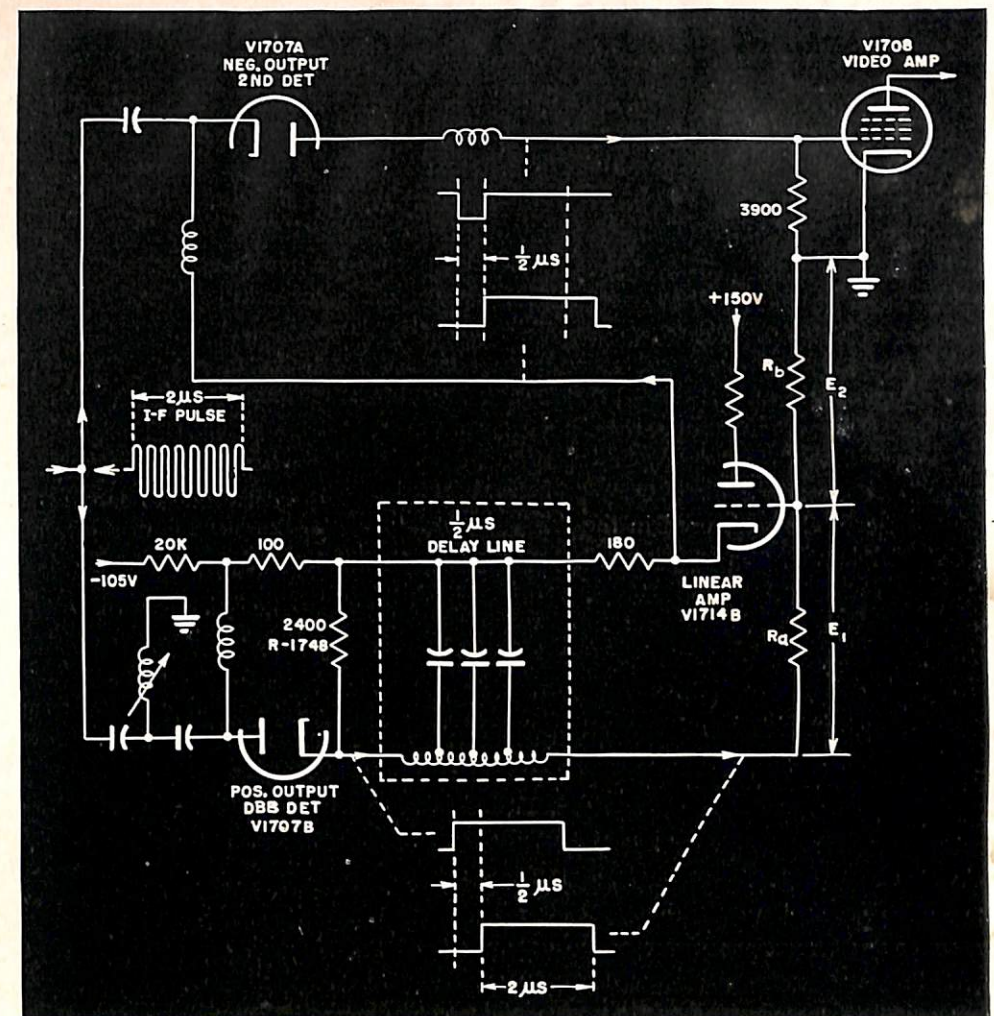


FIGURE 5—Schematic diagram of the Detector Balanced Bias as applied in the AEW receiver.

definitely limited. If the gain is increased, the phase shift in the detector plus the phase shift in the circuit coupling the cathode follower to the amplifier grid is sufficient to produce oscillation. To avoid this undesirable phase shift effect, a diode detector followed by a cathode follower with positive feedback through the detector was chosen.

In figure 3 the IAGC circuit consists of a 7F8 tube with one section operating as a diode and the other section as a cathode follower. In a quiescent state, the cathode of V-1712A will be at ground potential. This is true because R-1744B and R-1745B form a voltage divider between ground and -105 volts such that there will be -2 volts on the grid of V-1712A. With -2 volts on the grid and +150 volts on the plate, the tube will pass a current which will produce the correct voltage to hold the cathode at zero potential ± 0.3 volts.

When negative signals (negative peak of the i-f pulse output) are applied to the cathode of V-1712B, the tube conducts, making the plate and grid also more negative. This results in the grid of V-1712A becoming more negative and the cathode following in a more negative direction. This negative drop on the cathode is coupled back to the cathode of V-1712B and tends to

make the negative pulse on its cathode stronger, thus driving grid and cathode of V-1712B more and more negative. The whole circuit is, therefore, a sort of bootstrap or positive-feedback arrangement wherein a given signal tends to reinforce itself. The output of the IAGC circuit is taken off the cathode of V-1712A. With stronger and stronger signals, this cathode becomes more and more negative, and since this voltage is delivered to the grid of the protected i-f stage, the gain is reduced almost in proportion to the strength of the signal. R-1746B, and C-1722, with the wiring and tube capacitance, form a time constant for this circuit of about 30 microseconds, which has proven experimentally to be a satisfactory average for most conditions. It is apparent that it is impossible to cut off the i-f stage with this IAGC circuit, but it does reduce overloading and prevents tube saturation from strong signals, which would make discrimination of small signals quite impossible. C-w or low-frequency mcw jamming is materially reduced by the use of IAGC circuits.

FAST TIME CONSTANT

The FTC circuit is usually used in conjunction with IAGC, its main function being to remove certain effects of jamming from the output of the second detector.

The circuit is particularly effective against the d-c component resulting from rectified c-w input, low-frequency terms resulting from jamming which has been modulated at a low frequency, and the low-frequency terms involved in clutter. The circuit consists essentially of an R-C peaker or differentiating circuit which may be connected between the second detector and the video amplifier. The time constant of these circuits is usually in the order of 1 to 1.5 microseconds. With this short time constant, long signals (corresponding to low frequencies) will not pass the FTC circuit and enter the video amplifier. In this manner the circuit prevents overloading of the video and any following amplifier by c-w or low-frequency mcw electronic jamming. Figure 4 shows the FTC circuit used in the AEW. When the FTC is not in use, the coupling between detector and the video amplifier is a 2.2-megohm resistor, allowing the circuit to pass d-c. If the FTC is in use, the 2.2-megohm resistor is shunted by the 27,000-ohm resistor which, with the 50- μ f capacitor, gives a time constant of 1.3 microseconds.

DETECTOR BALANCED BIAS

The DBB circuit was developed in an attempt to design a circuit which would satisfactorily reduce the gain of a receiver in the presence of clutter. Noise and the high-frequency components of clutter can saturate the video for a sufficient length of time to brighten the entire PPI, thus causing the loss of targets. IAGC circuits help, but circuits of that type, sufficiently rapid in action and with sufficient high-frequency gain to keep the noise-like peaks from saturating, have too much gain in the presence of c-w jamming. An attempt was made to apply a bias to the last stage which was proportional to the input to that stage, with the expectation that the fluctuations in the input due to clutter could be balanced out. However, due to the gain of the last stage, any departure from perfect balancing resulted in large changes in the output of the stage. As an alternate method the idea of biasing the second detector was tried and proved successful.

In DBB operation, figure 5, the output of the i-f amplifier is divided between two detectors; the regular second detector with negative output, and the DBB detector with positive output. This positive output is delayed by a 0.5-microsecond delay line and then fed into a positive-output linear amplifier, the gain of which is different for d-c input and for high frequencies. The amplifier output, taken from the cathode of V-1714B, is used to bias the second detector V-1707A by an amount sufficient to remove the d-c term from c-w interference or an amount sufficient to keep any but the highest peaks of clutter or noise jamming from saturating the video. The circuit is made linear over a sufficient dynamic range to afford satisfactory operation when

protected by good IAGC circuits. Since the DBB circuit is non-degenerative, a delay line can be used without danger of oscillation. This delay line allows the unimpeded passage of any signal for the delay time, and thus the output signal amplitude is not necessarily impaired. But when a signal is being received in the presence of clutter, the first part of the signal will be reduced by the same absolute amount as is the clutter, and the ratio of signal to clutter will thus be improved. With an FTC circuit in operation, each frequency component of clutter and of the signal will be reduced in amplitude by approximately the same ratio.

In figure 5, R-1748 is a termination of the input of the delay line to suppress multiple reflections of pulses in the line, since the termination of the output is not sufficiently good to absorb the entire energy of the pulse.

The active element in the circuit is V-1714B, which is acting as a linear amplifier coupled as a cathode follower and having very nearly unity gain. This assures that the cathode and grid maintain a fixed voltage difference; that is, they go up and down together. In a static condition (no signal) there will be two current paths in the DBB circuit; one from -105 to ground through R_a and R_b , and the other from -105 through V-1714B to +150. These two current paths will be referred to as path #1 and path #2 respectively. Components are so chosen that in a static condition the grid will be at a potential of -1 volt which, in turn, will establish zero voltage on the cathode. This means that with no signal impressed on the DBB detector there is no change in gain of the receiver. From observation of the circuit it is evident that the cathode of the diode will be slightly positive with respect to its plate, thus prohibiting any current flow through the tube when no signal is present. The delay line will be charged to a certain value, with polarities as shown in figure 6.

Assume that an i-f pulse of positive voltage is impressed on the plate of the diode, and having sufficient amplitude to cause a flow of electrons from cathode to plate in the tube. It is now evident that there will be a third current path in the circuit, that from cathode to plate in the diode. This will cause a decrease of current through path #1. If the delay line were not present in the circuit the voltage on the grid of V-1714B would immediately change to a less negative value or, to be specific, a more positive value. This increase in grid voltage would be followed by a similar change in cathode voltage due to increased current in path #2, and because the stage is acting as a linear amplifier.

When the delay line is considered, the voltage change on the grid is identical in amplitude but occurs at a predetermined time after the diode starts to conduct. This time is adjusted to 0.5 microsecond by the lumped constants of the delay line. It will be recalled that the

delay line was charged during the period of no signal input. When the diode conducts, the current in path #1 will tend to decrease, but the current through R_c (figure 6) will increase due to the diode acting as a low-impedance path effectively shunting path #1. This increase in current will cause an increase in voltage drop across R_c . The delay line will immediately start to charge to this new value, and in so doing will tend to keep the current flowing through R_a and R_b due to electrons leaving the capacitor plates and traveling to ground. This flow of electrons from the delay line through R_a and R_b will continue for 0.5 microsecond, which is the designed delay-time of the line. As soon as the line has charged to this new voltage, there will be no further electron flow from the delay line and the current will drop to a new lower value. This decrease in current will cause the voltage on the grid of V-1714B to become less negative, which is the effect desired for correct operation of the circuit.

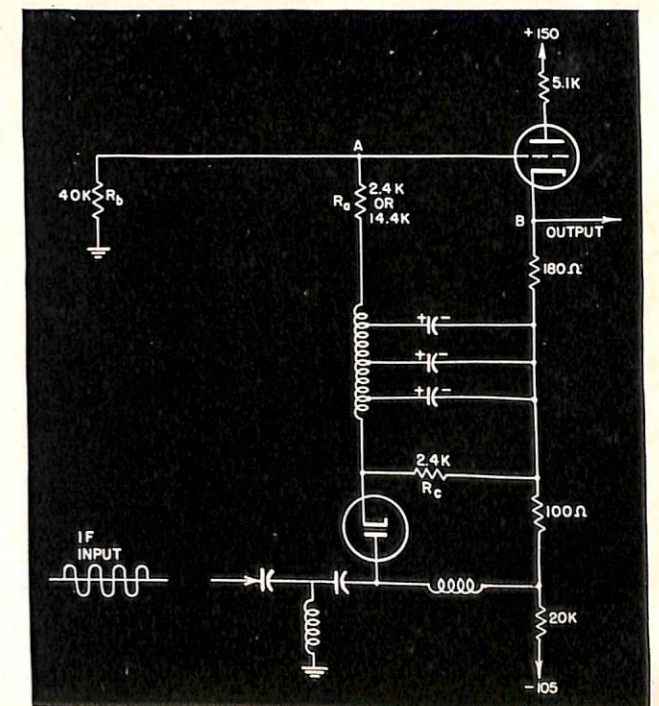
Since V-1714B is a linear amplifier, the potential difference between cathode and grid will remain substantially constant over the range of operation of the circuit. In other words a change in grid voltage will be accompanied by a similar change in cathode voltage. Under these conditions the pulse gain of the circuit as an amplifier is R_b/R_a . R_b is a 50,000-ohm potentiometer usually set at 40,000-ohms, and R_a is a complex impedance consisting of a 2400-ohm resistor in series with the parallel combination of a 0.5- μ f capacitor and a 12,000-ohm resistor. The d-c gain is $R_b/(2400 \text{ plus } 12,000)$ since the 0.5- μ f capacitor offers an infinite impedance to d-c terms. In figure 5 the gain can also be stated as the ratio of E2/E1 since the same current flows through both branches and the grid draws no current.

For practical purposes, as determined experimentally, the best results are obtained from the DBB circuit if the signals fed back to the second detector are about equal in amplitude to those applied for very-low-frequency modulated or c-w jamming. For higher frequencies, such as exists in pulses, the best results are obtained when the signals fed back are about six times the voltage of those applied. In the receiver the signal on the second detector is approximately 2.75 times greater than on the DBB detector. This is due to coupling elements in the DBB circuit that are not used in the second detector. The voltage applied to the delay line is directly dependent upon the amount of signal applied to the DBB detector. The low frequency gain of the amplifier as given by the ratio of R_b/R_a is therefore adjusted to about 2.75 and the high-frequency gain to about 16. This results in a c-w gain of unity and a pulse gain of about 6 in the DBB circuit.

FIGURE 6—Simplified diagram of the DBB circuit illustrated in figure 5.

Several refinements and adjustments are required in the DBB for most satisfactory operation. A d-c restorer (not shown on diagram) is provided to prevent the overshoot from the discharge of the 0.5- μ f capacitor (a part of R_a) at the end of a long block of signals as from clouds, sea return, etc., which would cause the grid of the linear amplifier to be driven to cut-off. This would result in the application of -105 volts to the cathode of the second detector V1707A, causing it to be completely paralyzed. Also when a strong signal is applied to the receiver a large biasing pulse from V-1714B is applied to the second detector V-1707A. Besides biasing the detector, it also charges the inter-electrode and stray-wiring capacities which are in parallel with the detector, so that there is a differential biasing pulse added to the regular detector output giving a spurious negative output at the plate of the detector. To compensate for this spurious pulse a 5100-ohm resistor is placed in the plate circuit of V-1714B. Since this resistor is one fourth the value of the 20,000-ohm cathode resistor of V-1714B the output of the plate circuit is one fourth the amplitude of the cathode circuit and 180 degrees out of phase with the cathode circuit. This plate output is coupled through a capacitor having a value four times greater than the inter-electrode capacity of the detector, thus causing a cancellation between the spurious output and the voltage fed back from the plate circuit.

As was pointed out in the early paragraphs of this discussion, the circuits described above are those employed in the AEW equipment. However, their mode of operation and employment can be considered as typical of other circuits designed to perform similar functions in other electronic equipment.



Technical Publications Get A New Home

■ Action is now being taken by the Navy Department, Executive Office of the Secretary, to transfer all non-registered electronics publications to newly established District Publications and Printing Offices. Approximately 170 Bureaus of Ships non-registered publications (electronics) which are now being stocked by Registered Publications Issuing Offices as well as all Electronics Officers stocks at naval shipyards will be included in this transfer.

The present intention is to establish a Publications and Printing Office in all Naval Districts except the Tenth, Fifteenth, and Seventeenth. In addition to these district offices there will be established two regional offices to be known respectively as the East Coast Naval Publications Distribution Center and the West Coast Naval Publications Distribution Center.

Publications in the Seventeenth Naval District will be transferred to the Thirteenth Naval District Stock Section. Publications at Guam, Subic Bay, Manila, and Guinan will be transferred to the Fourteenth Naval District Stock Section. Publications in London, England, and at the Tenth and Fifteenth Naval Districts, will be transferred to the East Coast Naval Publications Distribution Center. In most cases these transfers have already been made, but in the case of the First, Third, Seventh, and Ninth districts the move will probably take longer. Notification will be made when these four districts are prepared to receive requisitions. Until such notification is made activities which would normally requisition from any of these four districts will requisition from the Bureau of Ships.

In the future, when any activity requires any of these publications the proper procedure is to requisition them from the nearest District Publications and Printing Office using form NavGen-47 (Rev. 12-45). To avoid confusion and delay, the following list of correct mailing addresses of District Publications and Printing Offices should be adhered to when making requisitions:

Officer in Charge
Publications and Printing Office
First Naval District
150 Causeway St., Rm. 601A
Boston 14, Mass.

Officer in Charge
Publications and Printing Office
Third Naval District
Room 630-B, 90 Church Street
New York 7, N. Y.

Officer in Charge
Publications and Printing Office
Fourth Naval District
1st Floor, Bldg. 4
U. S. Naval Base
Philadelphia 12, Pa.

Officer in Charge
Publications and Printing Office
Fifth Naval District
Bldg. U-6
Naval Station
Norfolk 11, Virginia

Officer in Charge
Publications and Printing Office
Sixth Naval District
U. S. Naval Base
Navy Yard, Charleston, South Carolina

Officer in Charge
Publications and Printing Office
Seventh Naval District
Room 1043, Dupont Bldg.
Miami, Florida

Officer in Charge
Publications and Printing Office
Eighth Naval District
New Orleans 12, La.

Officer in Charge
Publications and Printing Office
Ninth Naval District
Bldg. 1, Room 300
Great Lakes, Illinois

Civilian Officer in Charge
Publications and Printing Office
Eleventh Naval District
730 West Market Street
San Diego 1, California

Officer in Charge
Publications and Printing Office
Twelfth Naval District
Room 113, Adm. Bldg.
Treasure Island
San Francisco, Calif.

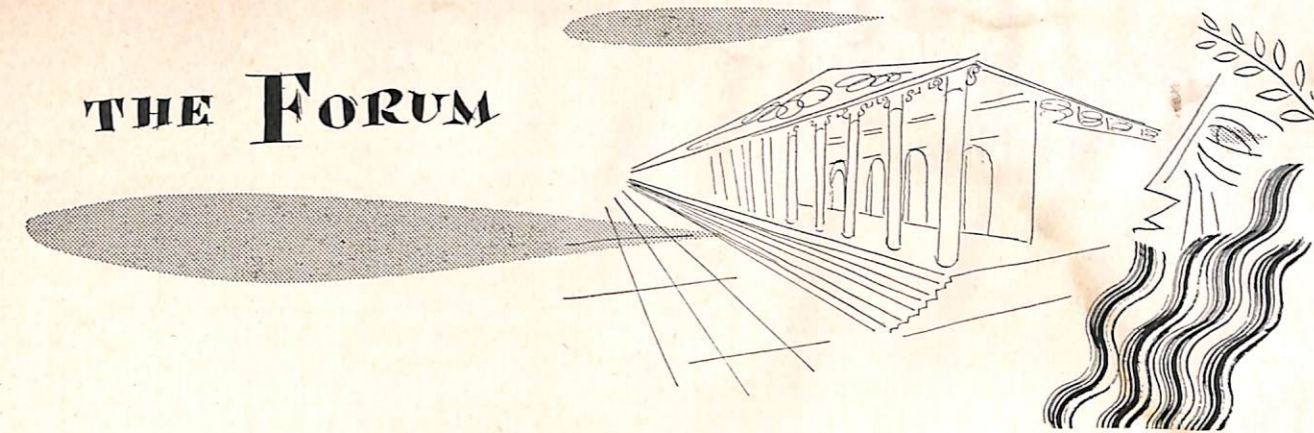
Officer in Charge
Publications and Printing Office
Thirteenth Naval District
Bldg. 480, Puget Sound Naval Shipyard
Bremerton, Wash.

Officer in Charge
Publications and Printing Office
Fourteenth Naval District
c/o Fleet Post Office, Navy No. 128
San Francisco, California

East Coast Naval Publications Distribution Center
(Cheatham Annex)
Williamsburg, Virginia

West Coast Publications Distribution Center
Naval Supply Depot Annex
34th Street
Oakland 4, California
Attention: Officer in Charge, Publications and Printing

THE FORUM



FREQUENCY METER TROUBLE

By JOHN W. BLOW, RM3/c, USS PC-484

During a test in which the LM-8 Frequency Meter was being used as a signal generator an unusual incident occurred. The unit had been set up to generate a 9050-kc signal but the received signal was on 950 kc. Although the receiver (RAO-2) acted normally on all other frequencies, we suspect that it may have been at fault as the frequency meter had been recently checked and reported to be operating satisfactorily.

William Bridgman and myself are the only two Radiomen aboard and, being only operators, are unable to diagnose this trouble. Would you please send us an explanation?

Bureau comment: It is believed that the trouble is not in the receiver as suggested, but in the LM-8 Frequency Meter. The symptoms described lead to the belief that the band switch was defective and was actually in the LOW position. To check this the following test is suggested:

- 1—Set up a frequency in the low-frequency band and note the dial setting.
- 2—Tune the receiver to this frequency.
- 3—Without changing the dial setting used in step (1) above, operate the band switch to "high" position.
- 4—In the high-band section of the LM-8 calibration book, look up the frequency corresponding to this dial setting.
- 5—Retune the receiver to this new signal.

If the frequency at which this latter signal is received is not approximately the same as that taken from the calibration book, the band switch is definitely faulty and should be checked. The trouble could be as simple as a loose control knob.

PORTABLE SPEAKER AMPLIFIER

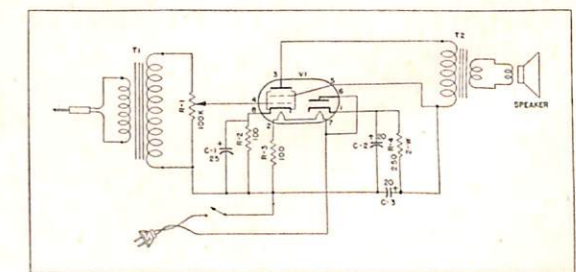
By CLAUDE L. PYLE, RT2/C, USS *Achernar* (AKA-53)

One method of monitoring a Navy receiver is to plug a speaker with a matching transformer into the phone jack. This is very convenient but, due to output limiting in that circuit, the volume is likely to be insufficient. This condition and the need of a speaker for monitoring purposes led the USS *Burias* (AG-69) to the development of a simple, compact speaker-amplifier.

It is a one-tube unit utilizing a single 117L7/M7-GT tube, and will operate from any 115-volt a-c or d-c source. It can be plugged into any standard 600-ohm output jack and will deliver 0.75 watt of audio power. The circuit is simple and most of the parts are easily obtained.

The equipment uses an input transformer similar to the Navy type 30765, an output transformer of the universal type and a 4- or 6-inch PM dynamic speaker. It may be noted from the wiring sketch that a 100-ohm 1-watt resistor (R3) is in series with the filament. This resistor is not necessary but will lengthen the tube life without noticeably effecting the overall output.

Bureau Comment: The Bureau has no objection to the use of this unit and considers it to be a very handy portable speaker for general purposes.



Schematic diagram for general-purpose speaker-amplifier.

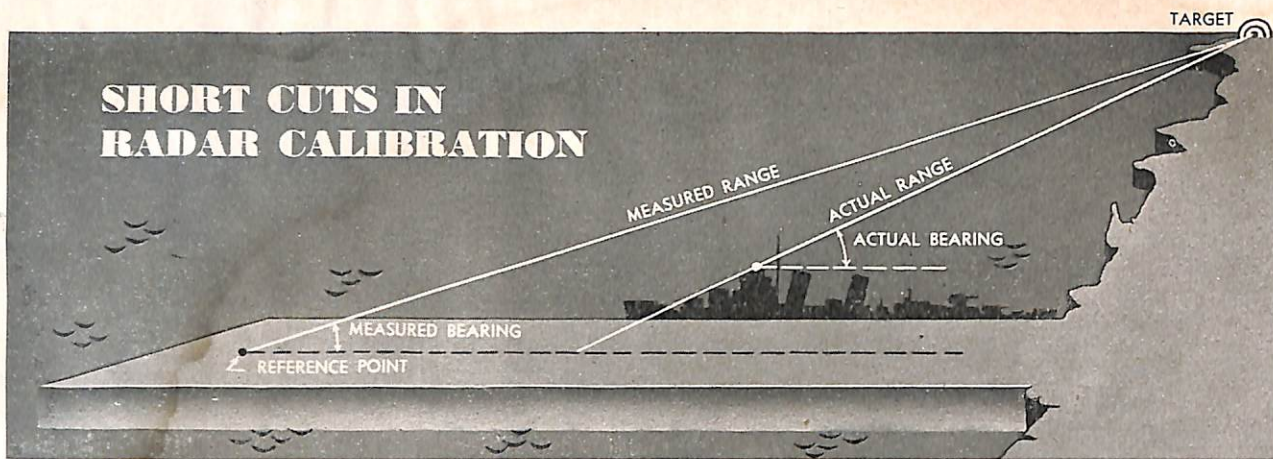


FIGURE 1—The range and bearing of calibration targets vary with the mooring position of the ship.

From Mare Island Naval Shipyard comes word that they have been successfully using a short cut in the calibration of fire-control and search radars that has saved them many hours and has paid dividends in increased accuracy of the final calibration. The idea is due to Chester L. Decker, civilian employee of the yard.

The short cut is in the form of a set of graphs which provide the exact bearing and range of the calibration

target regardless of where the ship under test may be moored along the wharf. Ordinarily the bearing and range of a calibration target is accurately fixed by survey from a given reference point. However, these values vary with the actual position of the antenna to be calibrated depending upon the mooring position of the ship. This condition is illustrated in figure 1. By means of the Mare Island curves it is only necessary to know the antenna's distance down the wharf from the refer-

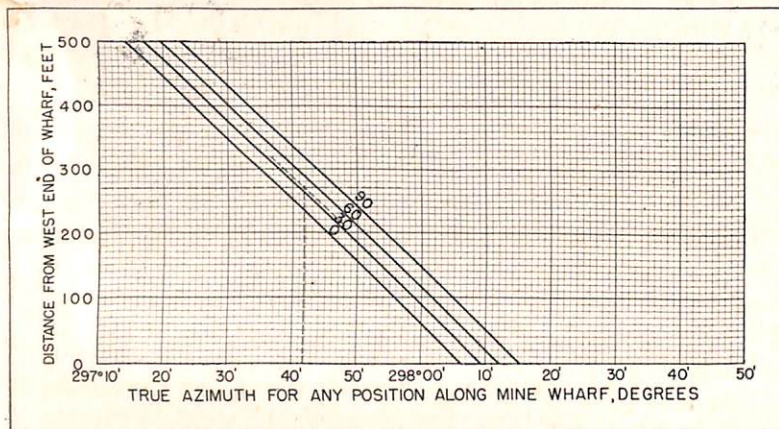
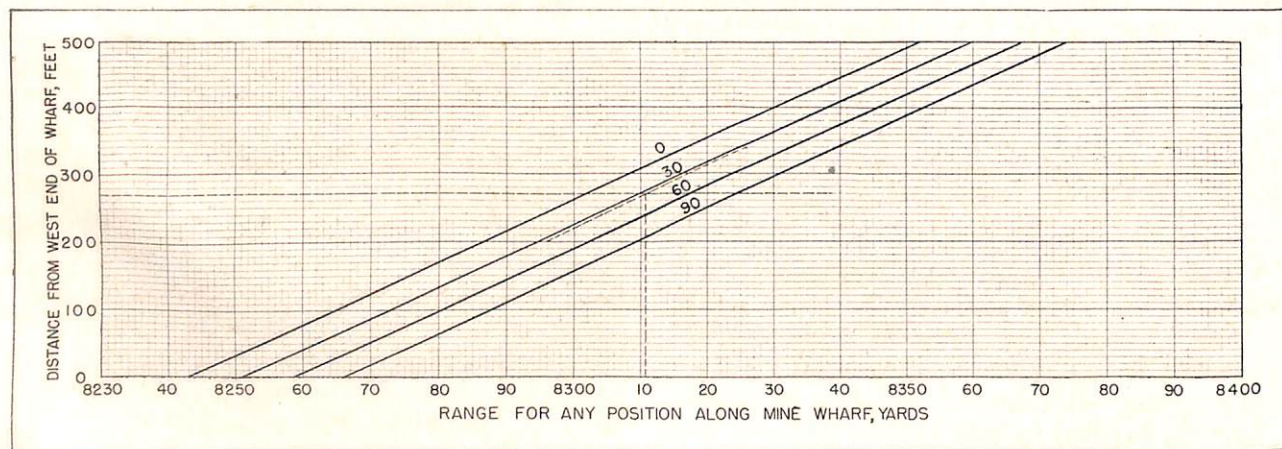


FIGURE 2—Calibration curves used for Mine Wharf Mare Island Naval Shipyard. Dotted lines illustrate use of the curves for a ship moored 270 feet from the reference point at the West end of the dock, and displaced 35 feet laterally from the reference line.



ence point in order to determine the exact range and bearing of the target.

A typical set of curves is shown in figure 2. These are the actual charts in use at Mare Island for calibrations at Mine Wharf. A family of curves is drawn in order to compensate for the varying lateral distances of the antenna from the edge of the wharf. The figures on each plot indicate the distance of the antenna from the south edge of the wharf. The dotted lines on the figures demonstrate the application of the curves for a ship

having an antenna 270 feet down the wharf from the zero station, and 35 feet laterally from the south edge of the wharf. The calibration target is seen to be at bearing $297^{\circ} 42'$, range 8311.

Actual measurement of the position of the antenna is not critical since a five-foot error causes a difference of only one yard in range and one minute in azimuth.

"These charts enable an engineer to obtain results in a few minutes which would have taken hours to calculate", says Mare Island.

Model OCT Monitor for FSK

When using a frequency-shift keyer a *mark* impulse causes the transmitter to emit one frequency, while a *space* impulse causes it to emit a slightly different frequency. Thus, although the carrier is on at all times, its frequency depends upon whether a mark or space impulse is being transmitted. On radio frequencies above 2000 kc the separation of these mark and space frequencies has been standardized at 850 cycles. As a specific example, assume that the nominal (center) frequency is 3000 kc. The mark frequency would then be 3000.425 kc, while the space frequency would be 2999.575 kc.

The OCT frequency-shift keyer monitor is an instrument used to determine the shift in carrier frequency of any transmitter in the 2-26 megacycle range. It will measure the shift between mark and space frequencies if the shift is not less than 300 cycles or more than 1400 cycles. The 7 basic circuits of the OCT together with its 5 external connections are indicated in the block diagram.

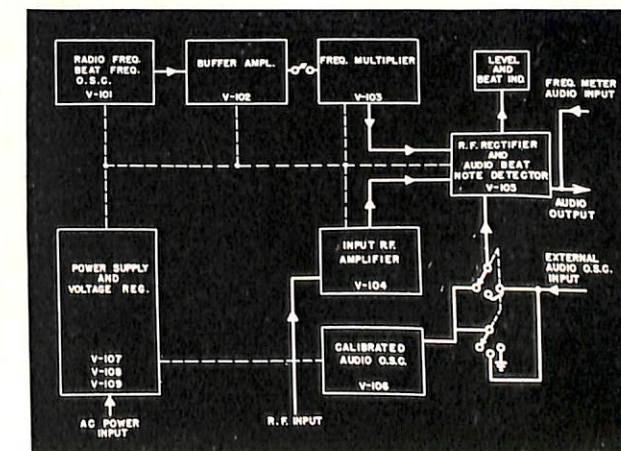
The frequency-shift key is set in the mark position and an r-f sample from the output stage of the transmitter is fed into the input r-f amplifier. This sample continues to the rectifier and audio beat-note detector. The beat frequency oscillator in the OCT supplies another signal which, after passing through a buffer amplifier and the proper frequency multiplier stage, also appears at the rectifier and beat-note detector. The OCT beat frequency oscillator is now adjusted so that its frequency (after multiplication) is the same as the one from the transmitter. In other words, the OCT is now generating the same frequency as the mark frequency of the transmitter.

The frequency-shift keyer is now set to the space posi-

tion. The space frequency from the transmitter will beat with the mark frequency from the OCT. This audio beat-note will have a frequency equal to the frequency shift of the transmitter, and may be determined by comparing it with a frequency generated by the calibrated audio oscillator in the OCT. If the shift is not of the proper magnitude, the calibrated audio oscillator may be set at 850 cycles and the frequency-shift keyer adjusted accordingly.

Although either headphones or built-in level and beat-indicator meter may be used to determine zero-beat when comparing the various frequencies, the meter should be relied upon for the final adjustment.

An external audio oscillator may be connected to the OCT to be used in lieu of, or as a check on the calibration of, the OCT audio oscillator.



Terminal Equipment Modified for UHF Teletype

The TH-1/TCC-1 telegraph terminal equipment was originally designed to provide, simultaneously, one voice channel and a duplex carrier-telegraph or teletype channel over a single voice-frequency telephone circuit. It provides the necessary ringing features for the voice channel, modulation equipment for conversion of the d-c telegraph or teletype signals to audio-frequency tones for transmission, and demodulation of the received tones to d-c telegraph or teletype signals.

Hurriedly in 1944, in order to provide short-haul radio teletype service between ships and from ships to shore, a group of TH-1 equipments were modified to provide the necessary features to operate in this service, using AN/TRC-1 transceivers and Model 1498 Link transceivers. The original features of speech-plus-telegraph were retained, but since the line side of the TH-1 was a two-wire circuit, it was necessary to furnish a special hybrid adaptor unit to connect the four-wire radio circuit (one pair for transmitting and one pair for receiving) to the two-wire line (used for both transmitting and receiving) of the TH-1 equipment. Such a unit was built in a separate case for use with the AN/TRC-1 transceiver and built into the 1498 transceiver as a modification.

It has now become necessary to vacate the radio frequencies on which the AN/TRC-1 and 1498 operate, and to move this service to the UHF band. This entails the use of different radio equipment. The Bureau of Ships has determined the necessary modifications to the TH-1/TCC-1 to make it suitable for use with the TDZ and MAR transmitters and the RDZ receiver. The receiver in the MAR will not be used for teletype.

Because of the fundamental characteristics of the TDZ, MAR, and RDZ equipments, some of the original operating features of the TH-1 cannot be retained. The modified system will provide the following features:

a—Two-way teletype communication (duplex) will be available if two radio frequencies are used. If only one radio frequency is used, half-duplex or one-way reversible operation is possible.

b—No speech channel is provided. If it is desired to talk over the associated radio equipment, it will be necessary to disconnect the TH-1 from the radio transmitter and receiver, and connect the microphone and headphones or speaker in the normal manner.

FIGURE 1—Modification of TH-1/TCC-1 for UHF teletype use.

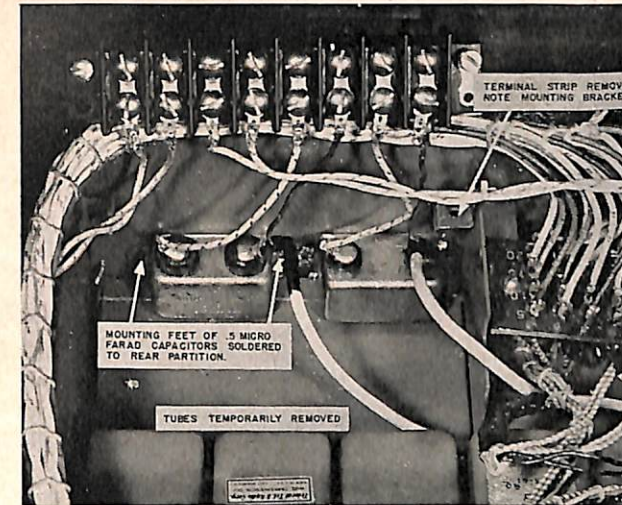
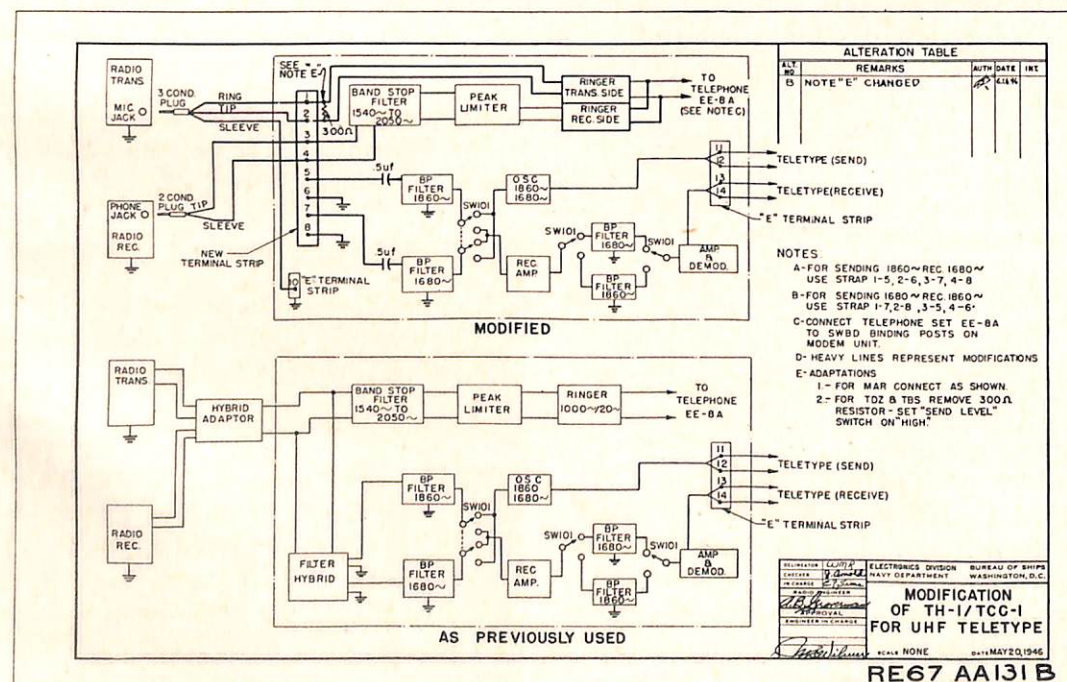


FIGURE 2—View showing placement of capacitors.

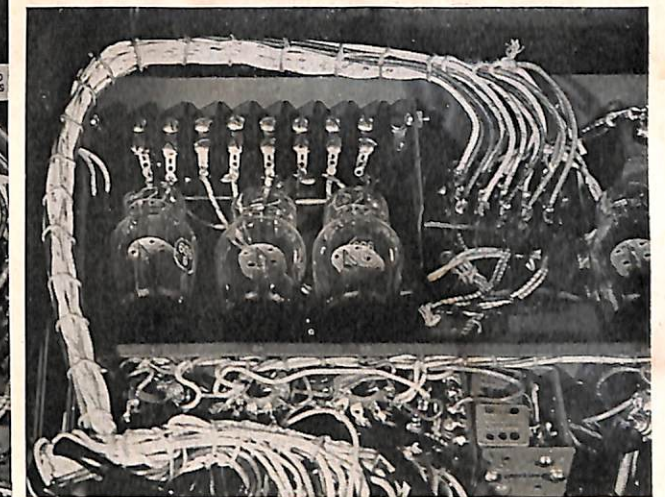


FIGURE 3—Tubes and terminal strip in place—straps not shown.

c—The hybrid adaptor is not required and cannot be used. The TH-1 will be modified for direct connection to the transmitter input and receiver output.

d—Because no carrier-controlled relay is provided in the RDZ receiver (this existed in both AN/TRC-1 and 1498) no provision is made to prevent the receiving teletype from "running open" when the distant transmitter is off the air. Hence it will be necessary to turn off the teletype motor during such periods.

e—Since the teletype will not respond to incoming signals with its motor not running, provision is made to notify the receiving operator when a message is to be sent. The use of the EE8A hand telephone set has been retained for this purpose. Although the voice channel of the TH-1 cannot be used for speech, the ringing circuit is modified so that cranking the magneto of the EE8A set at the transmitting end of a circuit will ring the bell in the EE8A set at the receiving end, thus indicating to the receiving operator that he should turn on his teletype motor.

f—A switch and pilot light were added to the modem panel of the TH-1/TCC-1 to operate the transmitter control circuit. (This was added when the equipment was modified for shipboard radio teletype use.) It is also possible, when full duplex operation is employed, to keep both transmitters on the air and sending a marking signal. In this case it would not be necessary to use the ringer.

Before the TH-1/TCC-1 can be modified for use with the UHF equipments, it must previously have been modified for radio teletype shipboard use, as outlined in a pamphlet entitled "Radio Teletype—Speech Plus Duplex" dated 15 December 1944. This pamphlet was widely distributed when first printed. Additional copies,

if required, can be obtained from Code 982, Bureau of Ships.

Figure 1 illustrates the general circuit layout of the TH-1/TCC-1 before and after modification for use with the TDZ, MAR and RDZ equipment. Emphasis, by means of heavy lines on the drawing, is placed on the new terminal strip and added wiring of the modified unit. The modification details follow:

FILTER HYBRID

Removal of Filter Hybrid (T-9) (See figure 52, page 107 of TM 11-2206).

1—Remove wires from lug 8 of T-9, solder together and tape.

2—Remove wires from lug 9 of T-9, solder together and tape.

3—Remove wires from lug 10 of T-9, solder together and tape.

4—Remove shielded lead from lug 2 of T-9 and its shield connection from lug 3 of T-9 and label them "lead A" and "shield A" respectively.

5—Remove shielded lead from lug 4 of T-9 and its shield connection from lug 5 of T-9 and label them "lead B" and "shield B" respectively.

6—Remove entire filter hybrid T-9.

7—In the space from which T-9 was removed, mount two 0.5-microfarad 600-volt capacitors, labeled "A" and "B" (bathtub type preferred), and a terminal strip with eight lugs. Preferably, each lug should have provisions for soldering two wires and screw connections for two wires (Jones #8-142). See figures 2 and 3 for location of the parts.

8—Number the lugs on the new terminal strip 1 to 8, inclusive.

9—Connect "lead A" to one terminal of capacitor "A". Connect the other terminal of capacitor "A" to lug 5 of the new terminal strip, and connect "shield A" to lug 6.

10—Connect "lead B" to one terminal of capacitor "B". Connect the other terminal of capacitor "B" to lug 7 of the new terminal strip, and connect "shield B" to lug 8.

RINGER MODIFICATION

1—Remove wire (wh) from lug 16 of modem "B" terminal strip and tape end (see fig. 52, page 107 of TM 11-2206).

2—Remove wire (wh-rd) from lug 17 of "B" terminal strip and tape end.

3—Connect lugs 16 and 17 of modem "B" terminal strip to lugs 3 and 4 on the new terminal strip.

4—Lift wires from upper lug 1 of relay RB in ringer (see fig. 47, page 97 of TM 11-2206). Solder these wires together and label them "junction A".

5—Lift wires from lower lug 1 of relay RB in ringer. Solder these wires together and label them "junction B".

6—Lift wire (wh-yel) from lug 13 of ringer terminal board "C" and solder it to "junction A" and tape (see fig. 48, page 97 of TM 11-2206).

7—Lift wire (wh) from lug 14 of ringer terminal board "C" and solder it to "junction B" and tape.

8—Run twisted pair from lugs 13 and 14 of ringer terminal board to lugs 1 and 2 on the new terminal strip.

9—Connect a 300-ohm 2-watt resistor from lug 1 to lug 2 on the new terminal board. (Not required when used with TDZ.)

MONITORING RELAY

1—Remove and tape the wire from terminal 2 of the monitor relay socket. Strap lug 3 to lug 4 (see figure 53, page 109 of TM 11-2206).

Note: The monitor relay in the TH-1, as originally modified for shipboard radio teletype use, is actuated by the carrier-controlled relay in the radio receiver and functions to keep the teletype from running *open* when the distant transmitter is off the air. Since no carrier-controlled relay is provided in the RDZ, the monitor relay in the TH-1 must be disabled or the teletype will be held continuously "closed" and will not print.

FREQUENCY SELECTION

The SEND FREQUENCY switch no longer completely controls the selection of sending and receiving audio frequencies. It is also necessary to make several strap connections on the new terminal strip.

1—For sending on high frequency (1860) and receiving on low frequency (1680):

- Set SEND FREQUENCY switch on high.
- Strap lugs 1 to 5, 2 to 6, 3 to 7, and 4 to 8.

2—For sending on low frequency and receiving on high frequency:

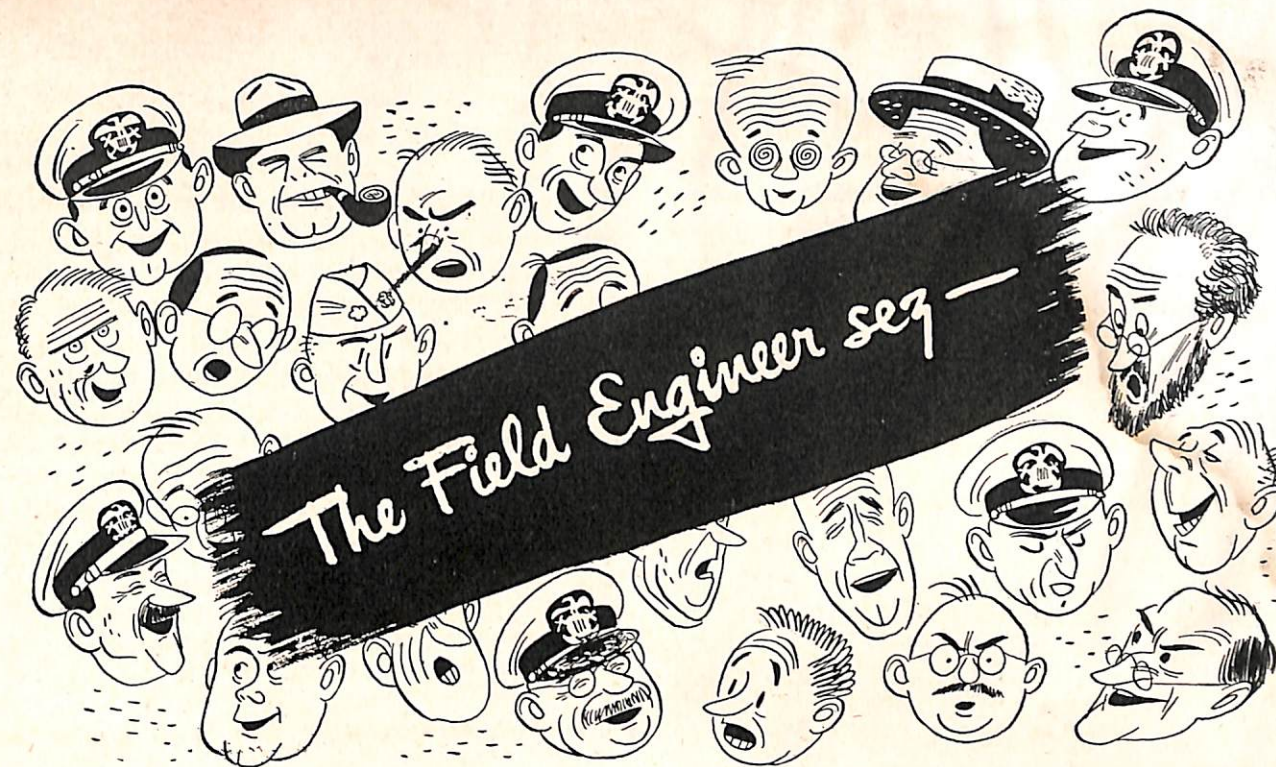
- Set SEND FREQUENCY switch on low.
- Strap lugs 1 to 7, 2 to 8, 3 to 5, and 4 to 6.

Interconnection of the TH-1/TCC-1 and the TDZ, MAR, and RDZ is as shown in figure 1. Connections from the TH-1/TCC-1 to teletypewriters are the same as previously used.



NEED SOME WIRE?

If you do, look on top of your radar antenna pedestal. The following comes from Rad. Elec. Wm. P. Dingman, USN: "Recently while the USS *Holland* (ARG-18) was moored in the Whangpoo River, it was discovered that two ravens were building a nest atop the SG radar pedestal. Although the birds had been working for only a few hours, the nest had already become quite sizeable. Upon inspection, the nest was found to be constructed largely of steel wire, some of it barbed. Altogether, eighteen pieces of wire were found, ranging in length from three to eighteen inches, and in size from #30 to #10 A.W.G. While they made vociferous protest to the destruction of their nest, the birds have made no attempt to rebuild".



REPAIR THAT SHORTED TRANSDUCER

One Model NMC shallow transducer and two Model NMC deep transducers were tested and found short-circuited. They were removed to the shop, opened up and inspected. Salt water was found inside all three of them. Further examination showed that the sea water had leaked through the three threaded holes in the transducer diaphragms past the three machine screws used for securing the coil plate assembly E-301. On these transducers the threaded holes went all the way through the transducer diaphragms, and only the tightness of the fit of the machine screws made them waterproof.

The transducer parts were washed thoroughly with fresh water and dried. The coil plate assemblies were soaked in boiling water for about four hours to rid them of all traces of salt. Then they were baked for four hours and placed in an evacuating chamber for several hours. Next, clear Glyptal was applied to the coils and the assemblies were again baked for about four hours. When the repaired coil-plate assemblies were again mounted on the transducer diaphragms, permatex thread compound was applied to the three machine screws to waterproof them. The transducers showed no leaks when tested in water after being closed up and gassed.

—E.F.S.G.

Bureau Comment: The writer of this report is to be commended since by repairing these transducers the in-

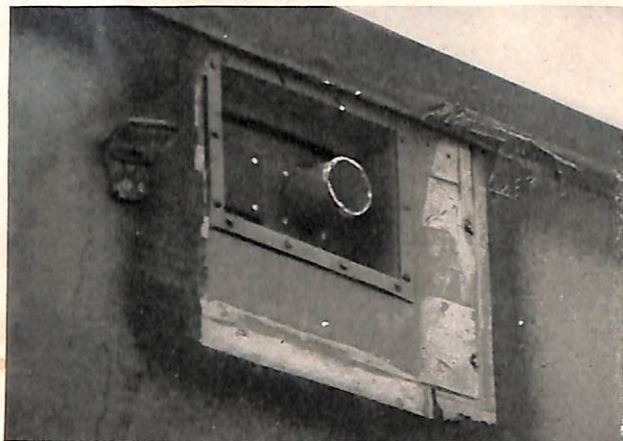
stallation of three new transducers was avoided, thereby helping to conserve the supply of new units. This report shows what can be accomplished in the field.

INTERFERENCE FROM SR-a RADAR

The USS *Gyatt* experienced severe interference on all bands of the RBS-1 receiver up to 12 Mc. This interference was in the form of a low-frequency buzz, presumably at the PRF of the SR-a Radar, decreasing above 12 Mc and not being audible on any of the higher frequency receivers with the exception of a hissing sound heard on the MN. As the level of this interference varied with the rotation of the SR-a antenna, it was believed to be caused by the normal r-f pulse of the radar which was being picked up by the receiving antenna system. Various checks were made that led to the confirmation of this belief. In the opinion of the reporting engineers the amplitude of the 196-Mc radar pulse applied to the grid of the first r-f tube through the antenna system was high enough to drive this tube into the non-linear region of operation where it acted as a detector. Certain frequency components were then transmitted through the remaining stages and appeared in the output as a video pulse. On frequencies above 12 Mc the interference was hardly noticeable because the input stage, being more frequency selective, tended to decrease the amplitude of the radar signal to a point where it was insufficient to cause non-linear operation.

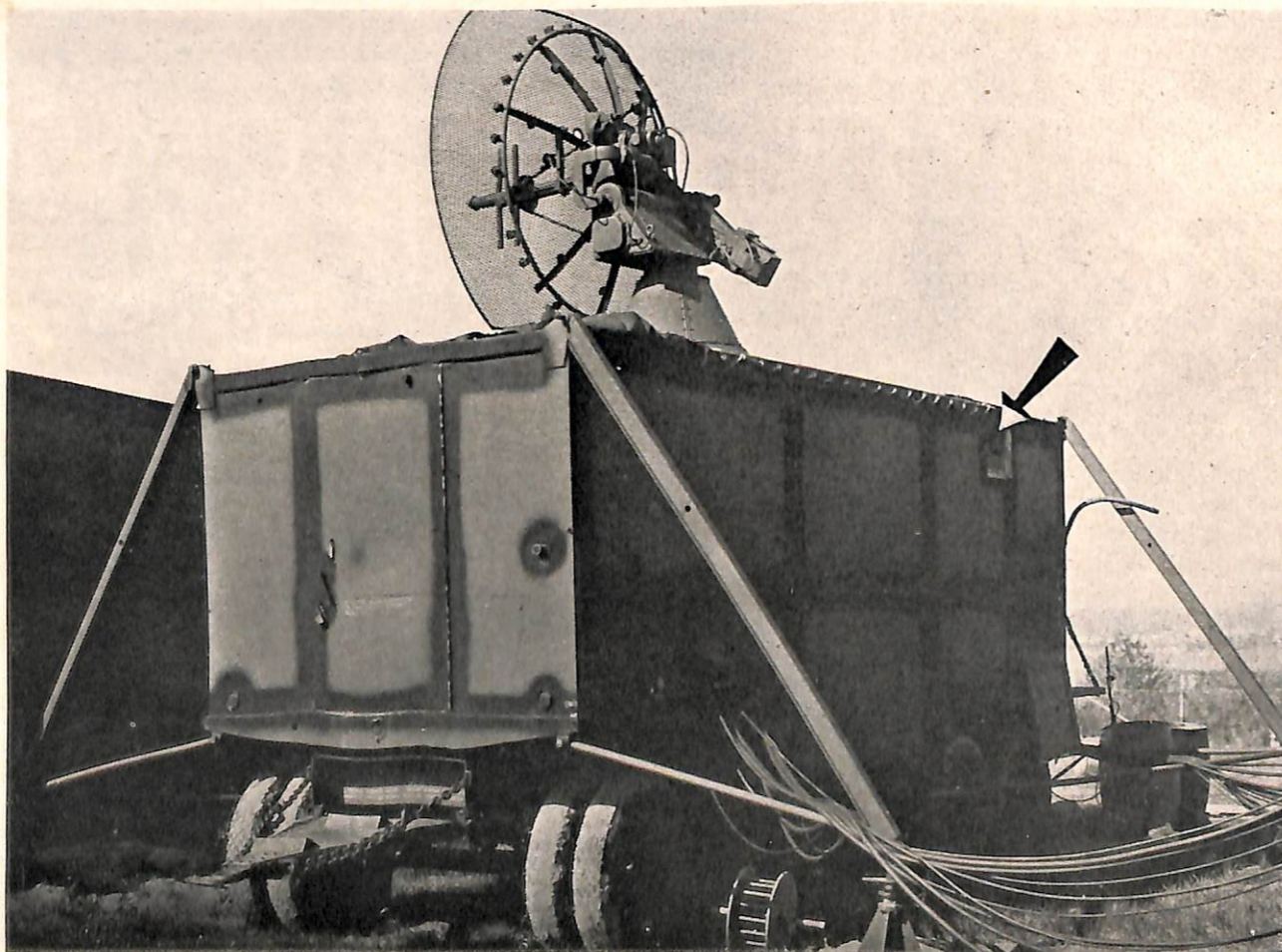
To combat this situation an Interference Filter Assembly, Navy Type-53153, was used. This filter, which is tunable over a 30-40-Mc band at the SR-a frequency, was mounted at the receiver and connected between its input and the antenna lead. The results were very good. SR-a interference was completely blanked out and the signals that were formerly unintelligible were heard clearly.

—E.F.S.G.



◀ Closeup view of the outlet.

SP-1M equipment trailer showing modulator exhaust outlet located at upper rear corner of roadside wall.



MODULATOR EXHAUST ON SP-1M TRAILER

The installation by the manufacturer of Field Change No. 34 on SP-1M equipments bearing serial numbers 48, 50, 53, 54, 55, and 61 to 107 inclusive, has caused trouble in the field. This was caused by failure of field personnel to unseal the "B" modulator exhaust outlet, resulting in the prevention of proper ventilation of the spark gap with consequent high failure rate of the modulator.

When Field Change No. 34 is installed in the field, the accompanying instruction booklet contains instructions for unsealing the modulator exhaust outlet. The equipments that had the field change installed at the factory did not contain these instructions. Accordingly, it is pointed out that prior to putting any of the aforementioned SP-1M equipments into operation, the overseas packing cover must be removed from the modulator exhaust outlet. The outlet is located on the trailers roadside near the upper rear corner.

QUEER THINGS IN SYNCHRO SYSTEMS

This could be called the "Case of the Reversing TDM (*Torpedo Detection Modification*) Feature" of the WFA sonar equipment installed aboard the USS *Pomodou* (SS-486).

The *Pomodou* complained that the TDM feature of their WFA equipment had never operated as it should. It would train smoothly and normally for five or six revolutions and then would stop, train in the reverse direction for fifty or sixty degrees, stop again and then train in the correct direction for five or six revolutions. This cycle of events recurred continuously.

At first it was believed that at installation there was a tight spot somewhere in the training system and that eventually it would "wear in". It seemed reasonable to assume this, since hand training was normal. When this condition failed to clear up, investigation revealed that a small synchronous motor driving a 5G synchro would stop every time the system reversed. Because of this discovery, it was believed that the cause of the trouble was the fact that the TDM units were mounted vertically instead of horizontally, as recommended. But removing the units and laying them flat on the deck did not help the situation.

Next it was thought that the 5CT synchro common to both TDM control units was at fault, although this did not seem entirely reasonable since hand training was normal. However, it was found that a small movement of the 5CT caused enough displacement current in the 5G to slow down the small synchronous motor appreciably. This led to the belief that the tight spot was in the selsyn gear train. Therefore all readily-accessible gears were removed and examined. These gears, while not perfect, were in good enough condition to serve their purpose. However, it was found that the main selsyn drive gear had a spot on it where the gears appeared to have worn excessively. Since this gear is not removable without completely disassembling the training mechanism, the other gears were replaced and adjusted for the maximum possible clearance between gears. The system now operates without reversing, but still halts periodically before continuing on in the correct direction.

MAINTENANCE NOTES ON THE MARK 34 MOD 2

Shock tests performed on Radar Equipment Mark 34 Mod 2 at the Engineering Experiment Station, Annapolis, indicate that the shock mounts provided with this equipment are in general sufficient to provide reasonable protection for the equipment under normal conditions.

However, certain failures were reported which should be brought to the attention of maintenance personnel in the Fleet.

The retaining devices for the horizontally mounted vacuum tubes in the Radar Indicator (control) are particularly susceptible to failure. A careful periodic check of these devices will lessen the possibility of troubles from this source. To ensure as thorough a check as possible, particular care should be taken to see that there is sufficient tension in the springs of the wire clamps on V-312, V-313, and V-314 and that such clamps are properly formed to retain the tubes in their sockets. Determine that tubes having a cam-type base clamp, such as that securing tube V-304, are well seated in their sockets before tightening the clamp screw. The clamp lug will hang down when the screw is loose and in the case of V-304 will fail to touch the tube unless held in the correct position while being tightened. Ascertain that the two clamps at the base of the cathode ray tube are tight. The clamp which holds the tube base is almost completely dependent upon to prevent the tube moving forward, since the clamps around the ends of the tube shield are insufficient in themselves to prevent this movement.

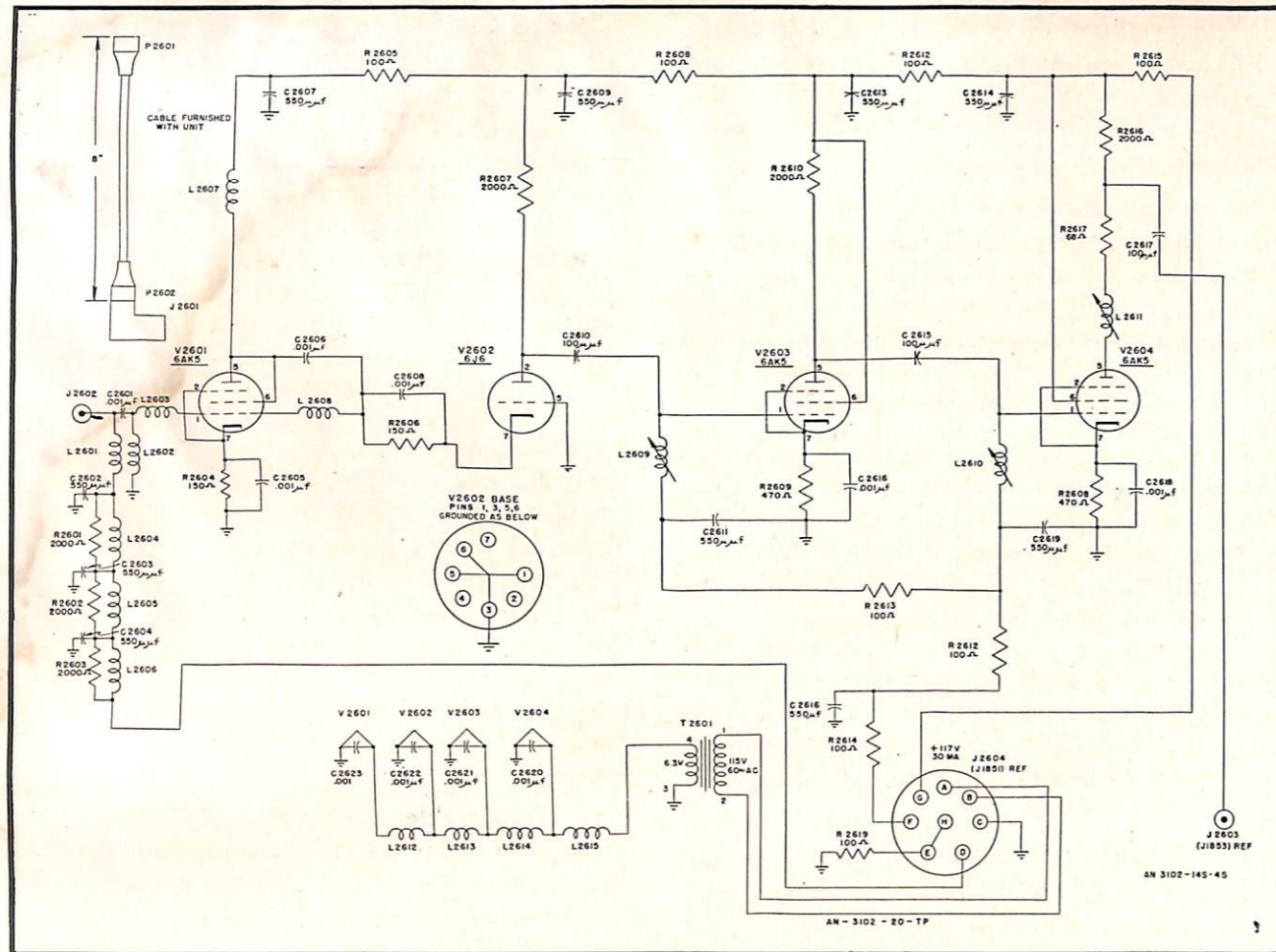
The vertical panel of the Regulated Power Supply carries so great a weight of heavy components that the six #10-24 screws are sometimes unable to withstand the shearing stresses which accompany extreme shock. There is space available for the use of at least five more screws. These additional screws as well as the original six should be of a larger size. Care must be taken to avoid damage to potted components during drilling and tapping. Screws used should not be longer than $\frac{3}{8}$ inch.

ERROR IN MARK 22 MOD 0 INSTRUCTION BOOK

Certain components of Radar Equipment Mark 22 have alternate wiring connections for application with the Mark 4 and the Mark 12. The Mark 22 as shipped from the factory was wired for Mark 4 applications but required wiring changes when associated with the Mark 12. These wiring changes are indicated on the schematic and wiring diagrams of the units involved and are also tabulated in the instruction book for Radar Equipment Mark 22 Mod 0, SHIPS 252A, Section II, paragraph 5. However, there is an error in the tabulated instruction book information.

Section II, paragraph 5 of the instruction book, should be corrected to indicate that when the Mark 22 is associated with the Mark 12, R-603-2 should be strapped to terminal #3 of the tube socket V-601-8 instead of to terminal #8 as stated.

PART 1 • ALPHABETICAL



Replacement Preamplifier for the SCR-584 Radar

A new preamplifier has been designed to replace the one now being used with the SCR-584 radar. It is completely interchangeable with the standard unit and effects an improvement in minimum signal sensitivity of approximately 3 db. This change increases the B— drain from 24 ma to 30 ma and requires a small change in the receiver voltage regulator. R-1718 must be shunted by a 28,000-ohm 2-watt resistor. The circuit consists of a double-tuned input transformer followed by four single-tuned stages. It includes certain improvements, such as chain-filtering in the B+ filament, crystal-current and gain-control paths, plus a well-grounded input connector, and 70-ohm output impedance. The first two stages provide a low-noise input circuit of new design, while the last two provide additional gain by the use of two conventional pentode amplifiers. The input circuit, which consists of a triode with the cathode grounded,

feeding into another triode with the grid grounded, provides a stable and non-critical method of operating triodes so as to realize their inherent advantage over pentodes of contributing less noise for the same gain. The stability of the first tube is due to the low load impedance (approximately 200 ohms) presented by the cathode of the second tube, while the stability of the second results from the screening which its grounded grid interposes between input and output. The gain in these input stages is simply the product of the triode transconductance of the first tube times the load impedance in the plate of the second tube. The output of this input circuit is fed through the two pentode amplifiers and the result is a nominal full gain of 45 db. Measurements on the SCR-584 equipment using this new preamplifier in place of the standard type showed an improvement of about 3 db in overall system noise.

	No. & Page	No. & Page	
AGC—A Concentration of Electronic Equipment.....	5-24	Eliminating Radio Interference From Motors and Generators.....	3-30
Air-Search Radar Ranges.....	7-21	Emergency Modifications Permitted.....	1-14
A-J Receiver Sensitivity.....	3-35	Emergency Repairs to TDQ Transmitter.....	3-21
Aligning Link FM Receivers.....	1-35	Equipment Spares.....	8-11
Allowances For Test Equipment.....	4-38	Error in Field Changes No. 4-WFA and No. 1-NGA....	12-20
AN Connectors for Frequency-Shift Keying Equipment..	2-40	Error in QBE-3 Instruction Book.....	5-30
AN/MPN-1A Instruction Book.....	3-22	Errors in WFA Instruction Books.....	12-21
AN/TPS-1B Mobile Radar Unit.....	3-10	Failure of 323-A Tubes.....	5-30
Anti-Hunt Control—QCU.....	3-35	Failure Reports—Their Use and Importance.....	4-18
Arc-Over in BM Equipment.....	6-31	Faulty 2X2 Tubes.....	1-20
Assembly of SC Ring Oscillator.....	3-25	Field Change No. 2 For Leland Motor Generators.....	7-32
Automatic Bearing Indicator Circuits.....	3-26	Field Engineer in the Field, the.....	2-44
Avoid Overcoupling SR Oscillator.....	1-30	Fighter Direction Goes High Hat.....	6-14
Better Performance From Your VG.....	2-1	Flash on VF PPI.....	6-30
B.F.O. Adjustment—QCU/QCQ-2.....	3-36	Fleet Training Center on Mark 28.....	5-40
Bleeder Resistor Failure in QCJ-9 Sonar.....	2-19	Flight Checking Radar Beacons.....	4-22
Bonding and Grounding of Electronic Equipment.....	12-1	Flying D/F Service in the Pacific.....	1-15
Booby Trap.....	12-28	FM Sonar Joins the Fleet.....	3-13
Broadcast Receivers.....	8-29	Fouled Domes, Transducers, and Sea Chests.....	11-6
Calculating Loudspeaker Impedance.....	5-32	Frequency and Wavemeters.....	7-28
Care of 2050 Tubes.....	3-25	Frequency Change Difficulties—Model TDH-3 Transmitter.....	1-13
Carrier Control Approach.....	4-16	Frequency Shift Keying.....	3-5
Carrier-Control System With VHF Radio.....	10-12	FSA Frequency-Shift Keyer, the.....	6-11
C.E.M.B. Revised.....	3-12	FSB Crystal Frequency.....	7-34
Check Your Radar Crystals.....	1-23	GCA Spare Parts.....	3-48
Checking and Aligning SR-2 Synchros.....	11-12	German Fighter Direction.....	11-9
Checking Tropicalization.....	5-32	Getting The Most Out of Your RBO.....	8-12
Classification of Shipboard Loran Reduced.....	3-36	Give The Blower A Chance.....	3-36
Classification of Sonar Recorder.....	10-3	Handling Fungus-Proofed Wire.....	5-29
Classification Of Test Equipment.....	11-27	Harmonic Suppressor for TDQ.....	3-47
Classifications Drop Again.....	7-36	Height Marker Alignment In The SX.....	12-21
Classifications Reduced.....	5-32	Hickok Model RFO-5 Oscilloscope Modified.....	1-33
Cleaning Silver-Plated Plugs.....	6-30	High-Frequency Direction-Finders.....	8-19
CNO Policy on Alterations.....	9-31	Hints on the VG.....	2-40
Color Coding.....	4-36	How It's Done—Crystal Cutting.....	5-14
Components Affecting Radar Ranges.....	11-1	Improved Duplexer Type 721-B.....	3-25
Copper Oxide Instrument Rectifiers.....	12-22	Improved Operation of ST Radar.....	3-37
Correct That AN/UPM-1B Antenna Error.....	2-20	Improved Seals for SC Radar.....	5-22
Correcting Hunting in SP.....	12-20	Improved TBX Antenna Mount.....	5-21
Correcting VHF Crosstalk.....	5-18	Improved TR Tube.....	7-34
Cosecant Squared Antennas.....	6-27	Improvised TCS-15 Antenna.....	7-32
CVE-91 Reports YE-2 Troubles.....	2-39	Incorrect Ranges on Mark 12 Radars.....	7-34
DAQ Counterpoise Rods.....	5-21	Insulation Breakdown in Mark 8.....	1-31
DAQ Direction Finders.....	1-31	Interchangeability of Synchros.....	8-20
DBM Calibration Station.....	5-23	Interference from SJ/ST Radars.....	3-24
DBM-1 Incorrectly Marked.....	5-29	Interference in Loran Receivers.....	3-21
DBM-1 Radar Direction Finder Equipment, the.....	5-6	Intermittent Azimuth Marks on VF's.....	8-18
DBM-1 Scope Spot Intensity.....	5-32	Intermittent Fading in Mark 8.....	1-30
DD's Converted to Picket Ships.....	4-35	Introducing BuShips Electron.....	1-1
Declassification of Sonar BDI Attachments.....	11-24	Is it Grounded?.....	1-14
Definition Of Gun Control Functions.....	11-26	Isolating Trouble in Loran Receivers.....	2-19
Dehydrator Instruction Books.....	5-1	JT Bearing Repeater.....	4-26
Determining Depth By Stabilized Sonar.....	1-10	Keep 'Em Covered—Crystals.....	5-40
Development of ADP Crystals, the.....	6-6	Keep Your Records Straight.....	12-4
Directional Antennas for IFF Equipments.....	1-21	Keeping The Sonar Driver Tuned.....	4-20
Directional Coupler, the.....	8-36	Kinks on Links.....	8-25
Disposal of Magnetrons.....	12-4	Know Your Test Equipment—OZ, OCL, OQ and OAW Series.....	5-18
Disposition of SL Antennas.....	4-30	Latest Classifications.....	9-6
Down Go Classifications.....	5-20	Lightweight Loran—Model DBS.....	8-23
Dual Purpose Dehydrator.....	9-25	Linearity Control Adjustment—SG.....	4-47
Echo Box Data.....	2-34	Loran as a Frequency Source.....	4-32
Echo Box Means Better Performance, the.....	4-38		
Echo Box Training Film.....	2-44		
Electron Tube Types 2K25 and 723 A/B.....	10-1		
Electronics At the Crossroads.....	6-20		
Electronics Division Grows UP, the.....			

PART 1 • ALPHABETICAL

	No. & Page		No. & Page
Loran Declassifications	8-24	Old Age Pension for Maggies	10-22
Loran Field Changes	5-40	Operation of RAL Receiver on Voice Channels	4-15
Loran Streamlined	1-25	Organization of Fleet Training Activities	5-37
Loran Questions	10-23		
Magic Eye Tuning For Model QGA Sonar	2-32	Parts Lists Soon Available	12-4
Maintenance of Electrolytic Capacitors	9-22	Pass The Bad Word Along—Fill Out Those Failure Reports	4-24
Maintenance of Transmission Lines and Wave Guides	2-10	Personnel Allowances	3-32
Marine Corps AA Gets A New Radar	11-30	Phantastron Circuit, the	5-38
Mark 8 Mod 3—Improved Tuning	1-30	Popular Books Declassified	9-31
Mark 8 Mod 3 Schematic	4-27	PPI Driver Motor	3-48
Mark 8 Transmitters	2-42	P.P.M.—A New Technique	10-26
Mark 12 Adjustment	5-36	Preferred List of Army-Navy Electron Tubes As Of 1 Nov. 1945	10-32
Mark 12 Field Change No. 14	9-20	Preventive Maintenance Scores Again	3-22
Mark 12 Motors	3-36	Publications Downgraded	9-26
Mark 13 Long Range Line	1-31	Pulse Modulation	11-19
Mark 13 Long Range Line	3-47		
Mark 13 Mod 0—Keep-Alive Voltage	3-24	QAA Portable Echo Ranging Equipment	10-24
Mark 13 Range Jitter	4-35	QHA Scanning Sonar	7-12
Mark 13 Scores	1-2	QJA Training System	3-12
Mark 22 Coaxial Connections	2-42	QJB Gyro Connections	1-31
Mark 22 Field Change No. 5	10-3		
Mark 22 I-F Amplifier	4-12	Radar Picket Ships	4-1
Mark 22 R-F Tuning	4-27	"Radar System Fundamentals" Now Restricted	3-44
Mark 22 Tuning at Sea	2-43	Ranging With The SU Radar	9-18
Mark 26 Mod 4—High Voltage Transformer	5-36	RCK Tuning System	5-9
Mark 28 Mod 2 and Mark 34 Mod 2—Gun Mount Switch	1-30	RCM Equipment	6-26
Mark 28 Unstable Sweep	5-30	RCU—A New Service	5-35
Mark 28/34 Duty Cycle	5-28	RDZ Receiver, the	3-19
Mark 28/34 Duty Cycle Adjustment	9-21	Readiness of Equipment on Inactive Vessels	12-11
Mark 29 Mod 2 Aided Tracking Motor	6-26	Receiver Sensitivity	4-5
Mark 32 Mod 1 Radar Equipment	9-16	Recent Instruction Book Distribution	1-34
Mark 34 Mod 2 Junction Boxes	6-30	Recent Instruction Book Distribution	2-48
Mark 34 Mod 4 Repeller Voltage	10-22	Recent Instruction Book Distribution	5-34
Mark 39 Mod 3, the	9-29	Reclaimed Maggies	12-21
MAW Portable Transceiver, the	12-14	Rectox Failures	4-38
MCC Sonar Projectors	1-6	Reduced Gain on Mark 34 Mod 2	7-33
Measurement of Standing-Wave Ratio On X-Band Radars	3-33	Reducing Glare From Radar Indicators	4-13
MHF Radio Interference	4-39	Remote Control Box For SCR-508	5-20
"Mighty Jeep" Takes To Water, the	11-14	Repeater Terminations	12-5
Mistakes in SR Tuning	7-33	Replacement Transformers for QJB Units	1-30
Model FRF Frequency-Shift Receiver Converter	9-1	Replacing 5D21 Tubes	3-12
Model JT Talkback Amplifier	12-20	Report Your Field Changes Correctly	8-35
Model QFN Advanced Listening Teacher, the	10-17	Reporting Field Changes	6-29
Model 2200/22 Dehydrator Field Change	3-4	Resistor Changes in RAK/RAL-5 Receivers	1-13
Modification of TBS Equipment	1-36	Review on Crystal Protection	7-9
Modification of TDT Transmitter Reduces Excessive Current	2-48	RMA Preferred Numbers	2-9
More on Tuning the SR-2	12-19	Rubber Caps On Headsets Of Model QAA Sonar Gear	12-21
Multivibrator For Signal Tracing, A	7-32		
Nancy Communication Systems	9-7	SA, SC, and SK Antennas	5-31
Naval Research Laboratory	6-32	Safety Shields For Mark 34	7-34
Navy Type Number Information	9-26	SC-3 PPI Centering	4-32
New Applications For Ultrasonic Waves	4-28	SC-4 Tuning	4-32
New Books	1-33	SC/SK Resistor Failure	3-35
New Books	3-32	SD-5 Arcing at Receiver Input	4-31
New BT—Model CXJC	6-1	Search and Detection For the Post War Fleet	4-31
New Electron Gun	4-40	Security of Electron Tubes	10-32
New Field-Change Policy	8-22	Sensitivity Time Control for SO Radar	1-9
New Field Changes	11-28	Service Difficulties With 723A/B Local Oscillator	3-23
New Glare Reducing Coating	4-14	Servo Maintenance in SU Radar	3-37
New Projectors	4-27	SG Blower Motor	5-20
New Synchro Tester	7-11	SG Repetition Rate	5-29
New Tube Base Material	4-35	Shock and Vibration Testing of Electronic Equipment	3-41
New UHF Communication Program, the	2-5	Siamese Jack for Mark 28	1-31
NGA Projector Leads	12-20	Signal Generators	8-9
NLM Keeps the Sub Quiet	4-34	Silent Tune-Up	12-29
Noise Suppressor for RBH-1	1-13	Silica Gel	4-4
Nomograms For Use With SG/SL Radars	8-26	SJ, and Marks 8, 16, and 27—Oscillations in Rectifiers	4-26
		SL Tube-Centering Washer	6-31
		SO Complaints	6-26
		SO Tuning	6-31
		Some Notes on the SP	3-16
OBU Adapted for Mark 26	5-22	Sonar Lubrication Chart	7-27
OBU With Mark 28	12-28	Sonar Projector Maintenance In The Pacific	3-38
OE Adapter Kit	5-23	Sonar Servicing Requires Cooperation	7-18
Oils and Greases for Radio Equipment	3-28		

PART 1 • ALPHABETICAL

	No. & Page		No. & Page
Sonar Slang	2-41	Tube Declassification	7-35
Sonar Transducer Cable	12-4	Tube Testers May Need Testing	7-35
SP B-Modulator Modification	5-31	Tubes "Ruggedized" For War	3-25
SP Radar Fade Charts	5-30	Tunable Magnetrons	3-24
SP Radar Screen Burning	5-31	Tuning CW-43AAF-1 Transmitter-Receiver	3-34
SP Servo Amplifier	3-36	Tuning the AJ Receiver in SC/SK Radars	1-30
SP Wobbler Window	12-20	Tuning The SR-2	11-25
SP/SM Height Errors	8-1	Two Gun Oscillograph	3-37
Spare 323A's For TTY Equipments	8-34	Type-D Nancy Communication System, the	10-9
Spark Wheel Removal On SL	9-24	Type-E Nancy Communication System	11-16
SR Modernization Program	4-7		
SR/SRA Receiver Adjustment	9-23	UHF/VHF Installation Program	10-4
SRA Modified Echo Box and Tuning Procedure	7-25	Unstabilized True Bearing SP Operation	12-10
SR-2-a Modern Aircraft Search Radar	5-10	Unstable Pulse Rate in Mark 13	7-33
SS Radar Instruction Book Error	9-31	Untuned Echo Boxes Criticized	8-36
ST Field Change No. 9	4-12	Up Keeping Your Amplidyne	3-45
ST Field Change No. 14	6-13	U. S. Navy Electronics Laboratory	9-32
Stack Gas Can Be Harmful	9-21	Using the OBU Echo Box With Mark 27	5-40
Standard Patching System	5-40		
Story on How To Use the Standard Frequency Broadcasts, a	1-16	VF Horizontal Scan	9-10
Streamlined Electronic Equipment Records	12-8	VG Projection Lamps	3-8
SU Control and Range Unit Troubles	12-13	VH—A New Compact Radar Repeater	2-26
SO/SU-1 Antenna Modification	4-26	VJ Radar Repeater, the	6-21
SU-1 Motor Generator Servo	7-40	Volume Control for 49546-Type Speakers	12-17
Sweep Jitters—Mark 8 Mod 3	4-26	VTVM In Radar Distribution Switchboard	10-6
SX Consoles	7-1		
Systematic Designation of Lubricants	2-29	WCA Power Supply Diagram	2-43
		WFA—Something New in Sonar	2-21
TBL-8 Instruction Book Error	10-23	Where's Your Radar Serial Number?	3-12
TCZ Generator	4-38	Wide Band Single End to Push-Pull Transformer, a	5-33
TDE Radiating When Not Keyed	8-25	Wiring Change In Mark 29 Radar	9-24
TDY RCM Transmitters	6-9	Wiring Error in AN/CPN-6 Racon	1-29
Teletype Is Here To Stay	3-1	Wiring Error In SO-1/SO-8	9-21
Test Equipment For Search Radars	9-13		
Test For Thermo-Setting Cable	3-22	XTEJ Radio Transmitting Equipment	5-16
Testing the 2C40 and 446A	4-40		
Testing 6AK5 and 6J6 Tubes	6-29	YG Frequency Drift	3-48
Testing 832A's in the OZ	11-5	YG Interference	7-19
Tracking Planes Through Land Masses—The FTC Modification	1-32		
Transducer for WFA	12-4	Zenith Watch Radar	2-46
Trigger Delay Line, the	3-9		
Tropicalize Your Equipment	2-15	5J29 Magnetrons	5-29
TS-35A/AP Signal Generator	9-22	6AB7's For Multicoupler	4-40
TS-239/UP Oscilloscope	8-29	255-A Telegraph Relay	11-29
Tube Declassification	4-40	327-B Tubes	4-40
		931-A Electron Multiplier, the	5-36

PART 2 • CLASSIFIED

COMMUNICATIONS EQUIPMENT

	No. & Page		No. & Page
Model Letters:		XTEJ Radio Transmitting Equipment	5-16
MAW Portable Transceiver	12-14		
RAK-5, Resistor Changes In	1-13	Teletypewriter:	
RAL, Operation on Voice Channels	4-15	AN Connectors For Frequency-Shift Keying Equipment	2-40
RAL-5, Resistor Changes in	1-13	Frequency Shift Keying	3-5
RBH-1, Noise Suppressor for	1-13	FRF Frequency-Shift Receiver Converter, the	9-1
RBO, Getting The Most Out Of Your	8-12	FRX Transmitter-Receiver, Maintenance of	8-25
RCK Tuning System	5-9	FSA Frequency-Shift Keyer, the	6-11
RDZ Receiver, the	3-19	FSB Crystal Frequency	7-34
SCR-508, Remote Control Box for	5-20	Repeater Terminations	12-5
TBL-8 Instruction Book Error	10-23	Teletype Is Here to Stay	3-1
TBS, Modification of	1-36	TTY Equipments, Failure of 323A's In	5-30
TBX Antenna Mount, Improved	5-21	TTY Equipments, Spare 323A's For	8-34
TCS-15 Antenna, Improved	7-32		
TCZ Generator	4-38	Nancy:	
TDE Radiating When Not Keyed	8-25	Nancy Communication Systems	9-7
TDH-3 Frequency Change Difficulties	1-13	Type E Nancy Communication System, the	11-16
TDQ, Emergency Repairs To	3-21	Type D Nancy Communication System, the	10-9
TDQ, Harmonic Suppressor For	3-47		
TDT, Modification of, Reduces Excessive Current	2-48	General:	
		Bonding and Grounding of Electronic Equipment	12-1

	No. & Page		No. & Page
C.E.M.B. Revised	3-12	Mark 34 Mod 2, Operation of Gun Mount Switch	1-30
Classifications Drop Again	7-36	Mark 34 Mod 2, Reduced Gain On	7-33
Field Changes, New	11-28	Mark 34 Mod 4 Repeller Voltage	10-22
Field Changes, Reporting	6-29	Mark 39 Mod 3, Story on the	9-29
FM Receivers, Aligning Link	1-35	SA Antennas	5-31
Give Your Successor a Break	7-31	SC Antennas	5-31
Inactive Vessels, Readiness of Equipment On	12-11	SC, Assembly of Ring Oscillator	3-25
Leland Motor Generators, Field Change No. 2 To	7-32	SC, Improved Seals For	3-22
MHF Radio Interference	4-39	SC Resistor Failure	3-35
Parts Lists Soon Available	12-4	SC Tuning	4-32
Pulse Position Modulation—A New Technique	10-26	SC, Tuning the AJ Receiver in	1-30
Receiver Sensitivity	4-4	SC-3 P.P.I. Centering	4-32
Receivers, Broadcast, Restrictions On Use Of	8-29	SD-5 Arcing at Receiver Input	1-31
Records, Streamlined Electronic Equipment	12-8	SF P.P.I. Driver Motor	3-48
Relay, Telegraph, 255-A	7-32	SF-1 PPI Driver Motor	3-48
Signal Tracing, A Multivibrator For	12-17	SG Blower Motor	5-20
Speakers, Volume Control for Type 49546	12-17	SG, Check Relay K-104 To Extend The Life Of The Magnetron In The	10-22
Standard Patching System	5-40	SG—Linearity Control Adjustment	3-47
Transformer, A Wide Band Single End to Push-Pull	5-33	SG, Nomogram For Use With	8-26
Transmission Lines and Wave Guides, Maintenance of	2-10	SG Repetition Rate	5-29
Tune-Up, Silent	12-29	SG-1, Fuse Trouble in The	12-28
UHF Communication Program, The New	2-5	SJ, Interference From	3-24
UHF/VHF Installation Program	10-4	SJ—Oscillation in Rectifier	4-26
VHF Crosstalk, Correcting	5-18	SK Antennas	5-31
VHF Radio, Carrier-Control System With	10-12	SK Resistor Failure	3-35
		SK, Tuning The AJ Receiver In	1-30

RADAR

Model Letters:			
AN/MPN-1A Instruction Book	3-22	SL, Cleaning Silver-Plated Plugs On the	6-30
AN/MPN-1A Spare Parts	3-48	SL, Nomogram For Use With	8-26
AN/MSG-1 Radar Fire Control Equipment	11-30	SL, Spark Wheel Removal On	9-24
AN/TPS-1B Mobile Radar Unit	3-10	SL Tube Centering Washer	6-31
BM, Arc-Over In	6-31	SM Height Errors	8-1
CW-43AAF-1 Transmitter-Receiver, Tuning	3-34	SO, Complaints About Field Change No. 58 To the	6-26
Mark 8, Insulation Breakdown	1-31	SO Tuning	6-31
Mark 8, Intermittent Fading	1-30	SO-1, Wiring Error In	9-21
Mark 8—Oscillation in Rectifier	4-26	SO-8, Wiring Error In	9-21
Mark 8 Transmitters	2-42	SP B-Modulator Modification	5-31
Mark 8 Mod 3, Improved Receiver Tuning	1-30	SP, Correcting Hunting In	12-20
Mark 8 Mod 3 Schematic	4-27	SP Fade Charts	5-30
Mark 8 Mod 3, Sweep Jitters	4-26	SP Height Errors	8-1
Mark 12 Adjustment	3-36	SP Operation, Unstabilized True Bearing	12-10
Mark 12 Field Change No. 14	9-20	SP Screen Burning	5-31
Mark 12, Incorrect Ranges On	7-34	SP Servo Amplifier	3-36
Mark 12 Motors	3-36	SP, Some Notes on the	3-16
Mark 13, Long-Range Line	1-31	SP Wobbler Window	12-20
Mark 13 Long Range Line	3-47	SR, Mistakes in Tuning	7-33
Mark 13 Range Jitter	4-35	SR Modernization Program	4-7
Mark 13 Scores	1-2	SR Oscillator, Avoid overcoupling	1-30
Mark 13, Unstable Pulse Rate in	7-33	SR Receiver Adjustment	9-23
Mark 13 Mod 0—Keep-Alive Voltage	3-24	SRA Modified Echo Box and Tuning Procedure	7-25
Mark 16—Oscillation in Rectifier	4-26	SRA Receiver Adjustment	9-23
Mark 22 Coaxial Connections	2-42	SR-2, Checking And Aligning Synchros	11-12
Mark 22 Field Change No. 5	10-3	SR-2—Modern Aircraft Search Radar, A	5-10
Mark 22 I-F Amplifier	4-12	SR-2, More on Tuning the	12-19
Mark 22 R-F Tuning	4-27	SR-2, Tuning the	11-25
Mark 22 Tuning At Sea	2-43	SS Instruction Book Error	9-31
Mark 26, OBU Adapted For	5-22	ST Field Change No. 9	4-12
Mark 26 Mod 4—High Voltage Transformer	3-36	ST Field Change No. 14	6-13
Mark 27—Oscillation in Rectifier	4-26	ST, Improved Operation of	3-37
Mark 27, Using the OBU Echo Box With	5-40	ST, Interference From	3-24
Mark 28 Duty Cycle	5-28	SU Antenna Modification	4-24
Mark 28 Duty Cycle Adjustment	9-21	SU Control and Range Unit Troubles	12-13
Mark 28, Fleet Training Center Notes On	5-40	SU, Ranging With The	9-18
Mark 28, Siamese Jack for	1-31	SU Sensitivity Time Control	1-9
Mark 28 Unstable Sweep	5-30	SU, Servo Maintenance In	3-37
Mark 28, Using the OBU With The	12-28	SU-1 Antenna Modification	4-26
Mark 28 Mod 2, Operation of Gun Mount Switch	1-30	SU-1 Motor Generator Servo	7-40
Mark 29, Wiring Change In	9-24	SX Consoles	7-1
Mark 29 Mod 2 Aided Tracking Motor	6-26	SX, Height Marker Alignment In The	12-21
Mark 32 Mod 1 Radar Equipment	9-16	SX, The Story on the	6-14
Mark 34 Duty Cycle	5-28	VF Horizontal Scan	9-10
Mark 34 Duty Cycle Adjustment	9-21	VF, Intermittent Azimuth Marks On The	8-18
Mark 34, Safety Shields For	7-34	VF PPI, Flash On	6-30
Mark 34 Mod 2 Junction Boxes	6-30	VG, Better Performance from your	2-1
		VG, Hints on The	2-40

	No. & Page		No. & Page
VG Projection Lamps	3-8	QGA, Preventive Maintenance Scores Again	3-22
VH—A New Compact Radar Repeater	2-26	QHA Scanning Sonar	7-12
VJ Radar Repeater, the		OJA Training System	3-12

General:

Amplidyne Maintenance	3-45	WCA Power Supply Diagram	2-43
Antennas, Coscant Squared	6-27	WFA, Error in Field Change No. 4	12-20
Antennas for IFF Equipments, Directional	6-6	WFA Instruction Books, Errors In	12-21
AN/UPM-1B Antenna Error, Correct That	2-20	WFA—Something New In Sonar	2-21
Bonding and Grounding of Electronic Equipment	12-1	WFA, Transducer for	12-4
Carrier Control Approach	4-16		
Classifications Drop Again	7-36		
Crystal Protection, Review On	7-9		
Crystals—Keep 'Em Covered	5-40		
Directional Coupler, the	1-21		
Distribution Switchboard, VTVM In Radar	10-6		
Echo Box Data	9-25		
Echo Box Means Better Performance, the	2-34		
Echo Box Training Film	4-38		
Echo Boxes Criticized, Untuned	8-36		
Fast-Time-Constant Modification, the	1-32		
Field Changes, Reporting	6-29		
Fighter Direction, German	11-9		
Give Your Successor A Break	7-31		
Glare From Radar Indicators, Reducing	4-13		
Inactive Vessels, Readiness of Equipment On	12-11		
Magnetrons, Disposal Of	8-36		
Magnetrons, Reclaimed	12-21		
Parts Lists Soon Available	12-4		
Phantastron Circuit, The	5-38		
Pulse Modulation	11-19		
Radar Beacons, Flight Checking	4-22		
Radar Picket Ships	4-1		
Ranges, Air-Search Radar	7-21		
Ranges, Components Affecting Radar	11-1		
Receiver Sensitivity	4-5		
Records, Streamlined Electronic Equipment	12-8		
Search and Detection For the Post-War Fleet	4-31		
Search Radars, Test Equipment For	9-13		
Synchro Tester, New	7-11		
Synchros, Interchangeability of	8-20		
Transmission Lines and Wave Guides, Maintenance of	2-10		
Trigger Delay Line, the	3-9		
Ultrasonic Waves, New Applications For	4-28		
Where's your radar serial number?	3-12		
X-Band Radars, Measurement of Standing Wave Ratio on Zenith Watch Radar	3-33		
2C40 Tubes, Testing the	2-46		
2J61 Tunable Magnetrons	4-40		
2K25 and 723A/B, Electron Tube Types	3-24		
5J29 Magnetrons	2-44		
446A Tubes, Testing The	5-29		
721B Improved Duplexer	4-40		
721B, Improved TR Tube Type	3-25		
723A/B and 2K25, Electron Tube Types	7-34		
723A/B Local Oscillator, Service Difficulties With	2-44		

SONAR

Model Letters:			
CXJC, Bathythermograph, A New	6-1	AP/CPN-6 Racon, Replacing 5D21 Tubes In	3-12
JT Bearing Repeater	4-26	AN/CPN-6 Racon, Wiring Error in	1-29
JT Talkback Amplifier, Model	12-20	YE-2 Troubles, CVE-91 Reports	2-39
NGA, Error in Field Change No. 1	12-20	YG Frequency Drift	3-48
NGA Projector Leads	12-20	YG, Interference From	7-19
QAA Portable Echo Ranging Equipment	10-24		
QAA Sonar Gear, Rubber Caps On Headsets Of	12-21		
QBE-3 Instruction Book, Error in	5-30		
QCJ-9, Bleeder Resistor Failure in	2-19		
QCQ-2, B.F.O. Adjustment	3-36		
QCU—Anti-Hunt Control	3-35		
QCU, B.F.O. Adjustment	3-36		
QFN Advanced Listening Teacher, The Model	10-17		
QGA, Magic Eye Tuning For	2-32		

General:

ADP Crystals, The Development of	1-10
Amplidyne Maintenance	3-45
BDI Attachments, Declassification Of Sonar	11-24
Bonding and Grounding of Electronic Equipment	12-1
Classifications Drop Again	7-36
Determining Depth By Stabilized Sonar	5-1
Domes, Transducers, and Sea Chests, Fouled	11-6
Field Changes, Reporting	6-29
Give Your Successor A Break	7-31
Inactive Vessels, Readiness of Equipment On	12-11
Interchangeability of Synchros	8-20
Keeping the Driver Tuned	4-20
MCC Sonar Projectors	1-6
New Projectors	4-27
NLM Keeps the Sub Quiet	4-34
Parts Lists Soon Available	12-4
Records, Keep Your, Straight	12-4
Records, Streamlined Electronic Equipment	12-8
Sea Chests, Transducers and Domes, Fouled	11-6
Sonar, Abbreviations In	2-41
Sonar Lubrication Chart	7-27
Sonar Projector Maintenance In The Pacific	3-38
Sonar Recorder, Classification of	10-3
Sonar Servicing Requires Cooperation	7-18
Synchro Tester, New	7-11
Transducer Cable, Sonar	12-4
Transducers, Domes and Sea Chests, Fouled	11-6
2050 Tubes, Care Of	3-25

MISCELLANEOUS

Direction Finders:			
Automatic Bearing Indicator Circuits	3-26		
DAQ Counterpoise Rods	5-21		
DAQ Direction Finders, Calibration of	1-31		
DBM Calibration Station	5-23		
DBM-1 Incorrectly Marked	5-29		
DBM-1 Radar Direction Finder Equipment, the	5-6		
DBM-1 Scope Spot Intensity	5-32		
D/F Service in the Pacific, Flying	1-15		
Direction-Finders, High-Frequency	8-19		

Homing:

AP/CPN-6 Racon, Replacing 5D21 Tubes In	3-12
AN/CPN-6 Racon, Wiring Error in	1-29
YE-2 Troubles, CVE-91 Reports	2-39
YG Frequency Drift	3-48
YG, Interference From	7-19

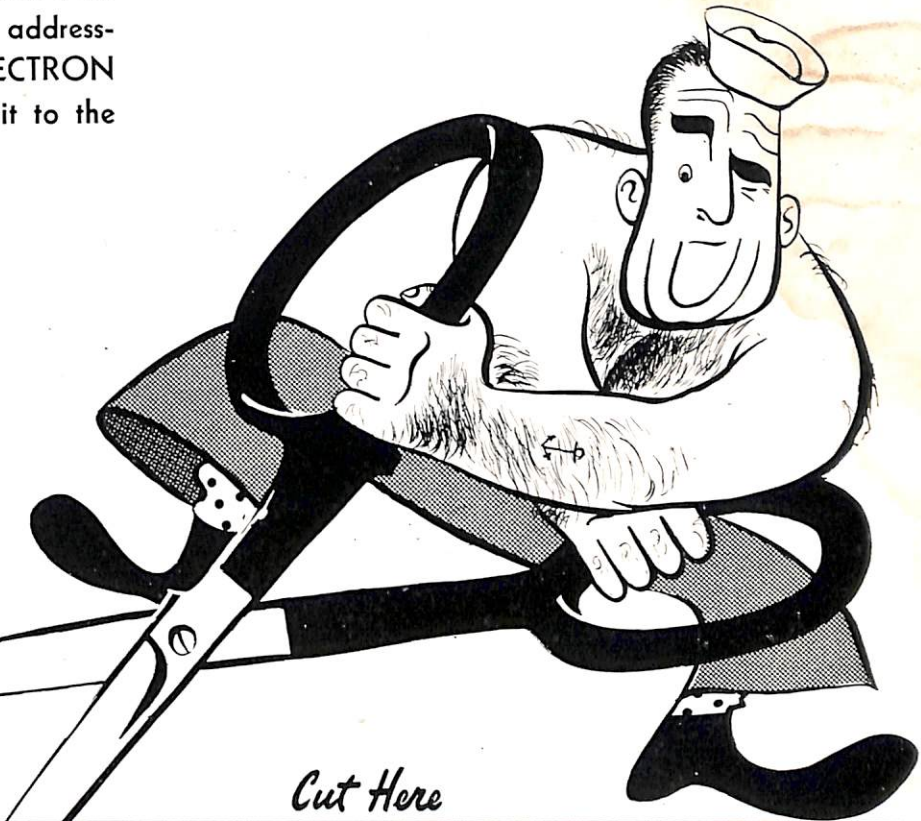
Loran:

DBE Loran Receiver-Indicator, A Preview of	1-25
DBS, Lightweight Loran Model	8-23
Loran as a Frequency Source	4-32
Loran, Classification of Shipboard, Reduced	3-36
Loran Declassification	8-24
Loran Field Changes	5-40
Loran, Hints On	10-23
Loran Receivers, Interference in	3-21
Loran Receivers, Isolating Trouble In	2-19

Publications:	No. & Page	Army-Navy Electron Tubes, Preferred List Of (1 Nov. 1945)	No. & Page
Books Declassified, Popular.....	9-31	Electron Gun, New.....	10-32
Books, New	1-33	Magnetrons, Disposal Of.....	8-36
Books, New	3-32	Tube Base Material, New.....	4-35
Instruction Book Distribution, Recent.....	1-34	Tube Declassification	4-40
Instruction Book Distribution, Recent.....	2-48	Tube Declassification	7-35
Instruction Book Distribution, Recent.....	5-34	Tubes "Ruggedized" For War.....	3-25
Publications Downgraded	9-26	Tubes, Security Classification of.....	10-32
"Radar System Fundamentals" Now Restricted.....	3-44		
RCM:			
A-J Receiver Sensitivity.....	3-35	General:	
RCM Equipment	6-26	AGC—A Concentration of Electronic Equipment.....	5-24
TDY RCM Transmitters.....	6-9	Alterations, CNO Policy On.....	9-31
Test Equipment:			
AN/UPM-1B Antenna Error, Correct That.....	2-20	Amplidyne Maintenance	3-45
Copper Oxide Instrument Rectifiers.....	12-22	Blower, Give The, A Chance.....	3-36
CW-60ABM Frequency Meter.....	7-28	Bonding and Grounding of Electronic Equipment.....	12-1
Echo Box Data.....	9-25	Classifications, Down Go.....	4-30
Echo Boxes Criticized, Untuned.....	8-36	Classifications Drop Again.....	7-36
Hickok Model RFO-5 Oscilloscope Modified.....	1-33	Classifications Reduced	5-32
LAG Series Signal Generators.....	8-9	Classifications, the Latest.....	9-6
LP Series Signal Generators.....	8-9	Color Coding	4-36
LX Series Signal Generators.....	8-9	Crossroads, Electronics At The.....	10-1
Oscillograph, Two Gun.....	3-37	Crystal Cutting	5-14
OAA Series Meters.....	7-28	DD's Converted to Picket Ships.....	4-35
OAJ Series Meters.....	7-28	Dehydrator, Dual Purpose.....	5-20
OAP Series Meters.....	7-28	Dehydrator Field Change, Model 2200/22.....	3-4
OAW Series Test Equipment.....	5-18	Dehydrator Instruction Books.....	12-4
OBU Adapted for Mark 26.....	5-22	Electrolytic Capacitors, Maintenance Of.....	9-22
OBU Echo Box With Mark 27, Using the.....	5-40	Electronics Division Grows Up, the.....	6-20
OBU With The Mark 28, Using The.....	12-28	Emergency Modifications Permitted.....	1-14
OCL Series Test Equipment.....	5-18	Equipment Spares	8-11
OE Adapter Kit.....	5-23	Failure Reports, Fill Out Those.....	4-24
OQ Series Test Equipment.....	5-18	Failure Reports—Their Use and Importance.....	4-18
OZ Series Test Equipment.....	5-18	Field-Change Policy, New.....	8-22
OZ, Testing 832A's in the.....	11-5	Field Changes, New.....	11-28
Test Equipment, Allowances For.....	4-38	Field Changes, Report Your, Correctly.....	8-35
Test Equipment, Classification Of.....	11-27	Field Changes, Reporting.....	6-29
TS-35A/AP Signal Generator.....	9-22	Field Engineer in the Field, The.....	2-44
TS-239/UP Oscilloscope	8-29	Fleet Training Activities, Organization of.....	5-37
TS-268/U Test Set.....	1-23	Fungus-Proofed Wire, Handling.....	5-29
Tube Testers May Need Testing.....	7-35	Give Your Successor A Break.....	7-31
Tubes:			
2C40, Testing the.....	4-40	Glare Reducing Coating, New.....	4-14
2J61 Tunable Magnetrons.....	3-24	Gun Control Functions, Definition Of.....	11-26
2K25 and 723A/B, Electron Tube Types.....	2-44	Inactive Vessels, Readiness of Equipment On.....	12-11
2X2 Tubes, Faulty.....	1-20	Jeep, The Mighty, Takes To Water.....	11-14
5D21 Tubes, Replacing.....	3-12	Loudspeaker Impedance, Calculating.....	5-32
5J29 Magnetrons	5-29	Lubricants, Systematic Designation of.....	2-29
6AB7's for Multicoupler.....	4-40	Naval Research Laboratory.....	6-32
6AK5 Tubes, Testing.....	6-29	Oils and Greases for Radio Equipment.....	3-28
6J6 Tubes, Testing.....	6-29	Parts Lists Soon Available.....	12-4
323-A Tubes, Failure of.....	5-30	Personnel Allowances	3-32
323A's For TTY Equipments, Spare.....	8-34	Radio Interference, Eliminating, From Motors and Generators	3-30
327-B Tubes	4-40	Records, Streamlined Electronic Equipment.....	12-8
446A, Testing the.....	4-40	Rectox Failures	4-38
721B Improved Duplexer.....	3-25	Requisition Control Unit—A New Service.....	5-35
721B, Improved TR Tube Type.....	7-34	RMA Preferred Numbers.....	2-9
723A/B and 2K25, Electron Tube Types.....	2-44	Shock and Vibration Testing of Electronic Equipment.....	3-41
723A/B Local Oscillator, Service Difficulties With.....	3-23	Silica Gel	4-4
832A's, Testing, In The OZ.....	11-5	Speakers, Volume Control for Type 49546.....	12-17
931-A Electron Multiplier.....	5-36	Stack Gas Can Be Harmful.....	9-21
2050 Tubes, Care Of.....	3-25	Standard Frequency Broadcasts, A Story On How to Use the.....	1-16
		Thermo-Setting Cable, Test for.....	3-22
		Tropicalization, Checking	5-32
		Tropicalize Your Equipment.....	2-15
		Type Number Information, Navy.....	9-26
		U. S. Navy Electronics Laboratory.....	9-32

GETTING ELECTRON OK?

We do our best to see that everyone gets the correct number of copies of ELECTRON, and that the envelope is properly addressed. That isn't always an easy job, particularly when activities are changing as rapidly as they are right now. Even when our lists are correct, mistakes creep in during the actual mailing process. But one thing is sure . . . if you don't tell us about the errors, we can't guess them. So if your ELECTRON isn't properly addressed, or if the number of copies should be changed, clip the card from the bottom of this page and send it in. If possible, cut out the actual addressograph imprint from the ELECTRON mailing envelope and paste it to the card.



QUANTITY NOW BEING RECEIVED _____ DATE _____
 QUANTITY DESIRED IN THE FUTURE _____

CUT OUT MAILING LABEL FROM
 YOUR ELECTRON ENVELOPE AND
 PASTE IT HERE

ABOVE ADDRESS SHOULD BE CORRECTED AS MARKED

 SIGNATURE

NOTE: DON'T MAIL THIS CARD IF ELECTRON IS NOW REACHING YOU CORRECTLY

CORRECTION May ELECTRON, page 24, second column, 21st line from top of page, the word optimum should be changed to effective. In the next sentence, change 1.2 to 2.

Write Electron a Letter

Like everyone else, the Editors of ELECTRON like to get mail. So drop us a line. It may be a question, a suggested topic for an article you'd like to see printed, or an idea for improving the magazine. In any event, when you're catching up on your correspondence, don't forget ELECTRON.



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

PENALTY FOR PRIVATE USE TO AVOID
PAYMENT OF POSTAGE, \$300
(GPO)

EDITOR, BUSHIPS ELECTRON
BUREAU OF SHIPS (CODE 9936)
NAVY DEPARTMENT
WASHINGTON 25, D. C.

*Send it
to this
address*

