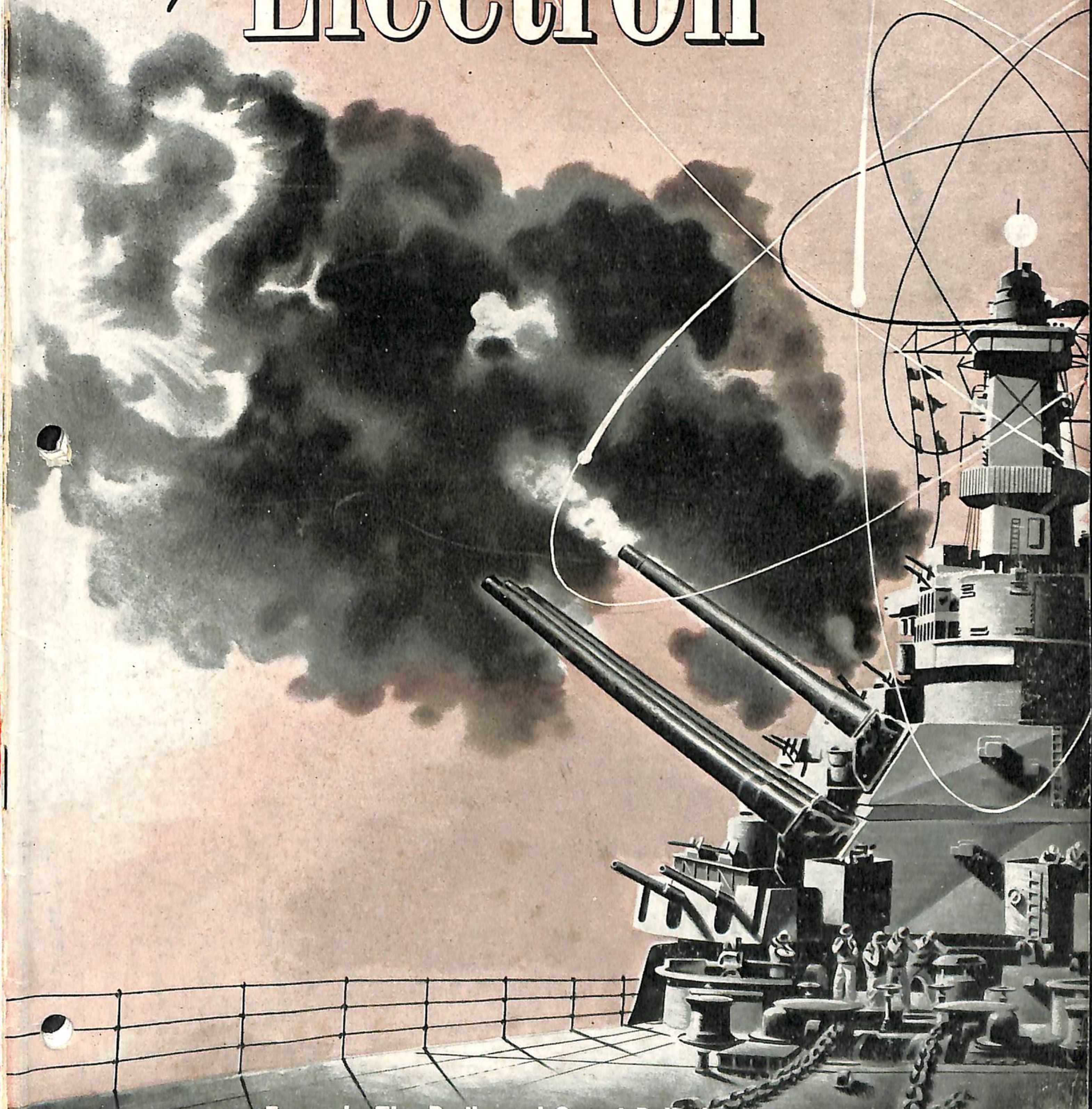
July, 1945 CONFIDENTIAL

BuShips Electron



NAVSHIPS 900, 100 Formerly The Radio and Sound Bulletin

BuShips Electron

A monthly magazine for radio technicians

JULY 1945 **Vol.1, No. 1**

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

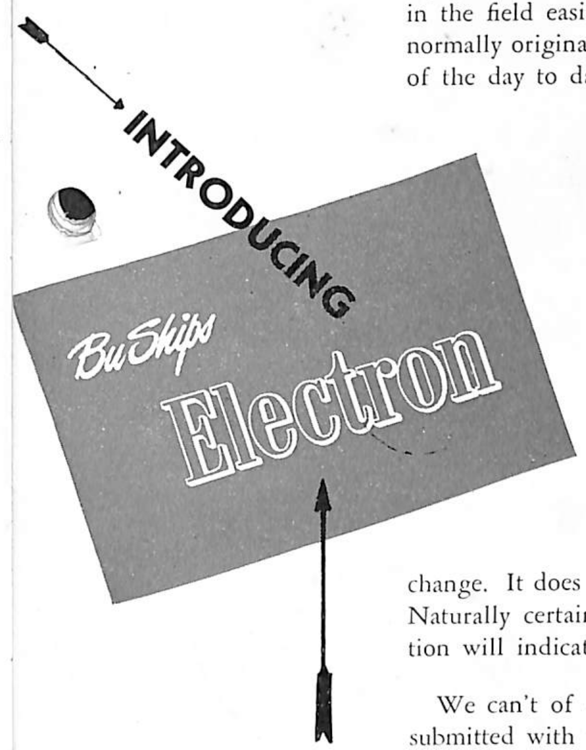
The Editor, BuShips ELECTRON
Bureau of Ships (Code 993)
Navy Department
Washington 25, D. C.

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 the latest information on all types of electronic gear may be included. But "confidential" does *not* mean limited circulation among concerned personnel. Unless this magazine is easily available to all who need it, most of its value is lost. Don't forget, "concerned personnel" includes enlisted men and civilian employees of the Navy!!

BUREAU OF SHIPS · NAVY DEPARTMENT

CAPTAIN J. B. DOW, Director of Electronics, Bureau of Ships



■ You are now looking at the first edition of BuShips Electron, the Electronics Division's monthly news magazine. Whether Electron is "new" or just an old acquaintance with its face lifted depends on how you look at it. The Radio and Sound Bulletin will no longer be printed in its old form. The material which it carried plus new features will now appear in Electron. You can think of Electron as a new magazine, or merely as the Radio and Sound Bulletin in a different form and coming out more often.

The purpose of Electron is to bring to the technical personnel of the Navy, the latest information in the field of electronics. There is nothing inconsistent between sound technical writing and interesting presentation. Therefore, more accent will be placed on "readability" than was the rule in the Radio and Sound Bulletin.

The magazine will be a combination of articles prepared in the Bureau and material submitted from the field. In the first group will be found such items as previews of new equipments, changed procedures, and such other matters as will make the duties of those in the field easier by reason of being better informed. The second type of article will normally originate in the service—maintenance short-cuts, new techniques and other stories of the day to day problems which people have found a way to lick. The magazine will serve as clearing house and a means by which the word can be passed quickly and effectively.

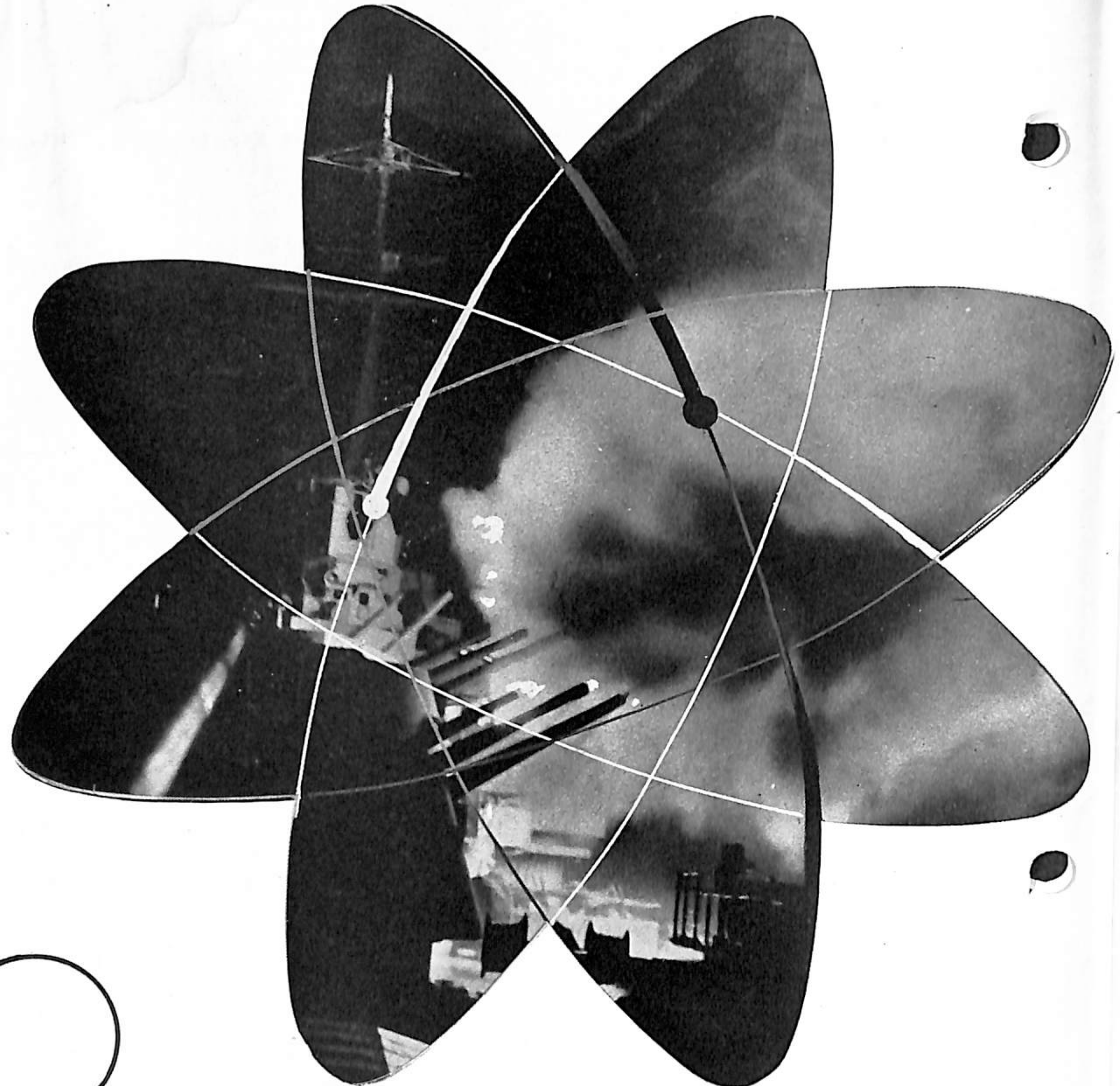
It is much too early in the life of Electron to set down any rigid editorial policies. In fact, just the opposite seems desirable. By experimenting around a bit, we hope to keep improving it. The important thing is to produce a magazine that is what you want it to be; we can't accomplish this unless you tell us what's wrong and the type of articles you need.

One important difference between Electron and the Radio and Sound Bulletin is that the accent will be on informality. The Electron is a means of exchanging information within the service. A certain ship reports how it made an emergency repair. We print it. That doesn't mean that every activity in the Navy should rush in and make this change. It does mean, "Here's an idea that worked for one ship. Maybe it will help you." Naturally certain articles will contain information of official character, but the presentation will indicate this quite clearly.

We can't of course promise to print everything that is sent in. Some ideas, although submitted with the best intentions, are not suitable for publication. However, *all contributions will be acknowledged,* and a good part of them will find their way into print.

This informality business brings up the question of "How informal?" Remember this is still the U.S. Navy and the much maligned word "channels" doesn't always mean just red-tape. So we don't think we're getting too formal when we say, "Let it come via the Commanding Officer." We don't care in what form it comes, but it should come with his approval. We believe that a CO will be happy to forward ideas which will enhance the reputation of his ship and show that his men are on their toes.

While we have tried to make this first issue a good one, we recognize that any new publication learns as it goes along. So with your help we'll keep working to make each month's Electron better than the preceding issue.



MARK 13 SCORES...

LT. EARL F. SAUBLE, USNR
Bureau of Ordnance

■ The new Mark 13 X-band fire control radar for main batteries is now making its appearance after three years of development. After witnessing the operation of the Mark 13 aboard the U.S.S. *Alabama,* Capt. D. P. Tucker made the following statement in his report: "Its performance has either met or exceeded all the writer's expectations."

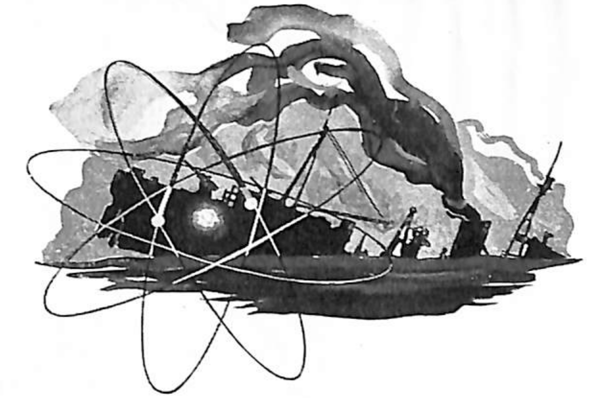
A descriptive proposal of the Mark 13 was submitted 6 June, 1942 by the Bell Telephone Laboratories, and shortly after, a letter of intent was issued by the Bureau of Supplies and Accounts. Development was begun and continued until October 1944 when Bell Telephone Laboratories exhibited the first models on test as a complete system. The first production equipments were delivered in January 1945, two of them being installed at various training activities.

At the present time shipboard installations have been completed on BB's 60, 61, 62 and CA's 69 and 70. In the near future the Mark 13 will be installed on CA's 74, 131 and 135.

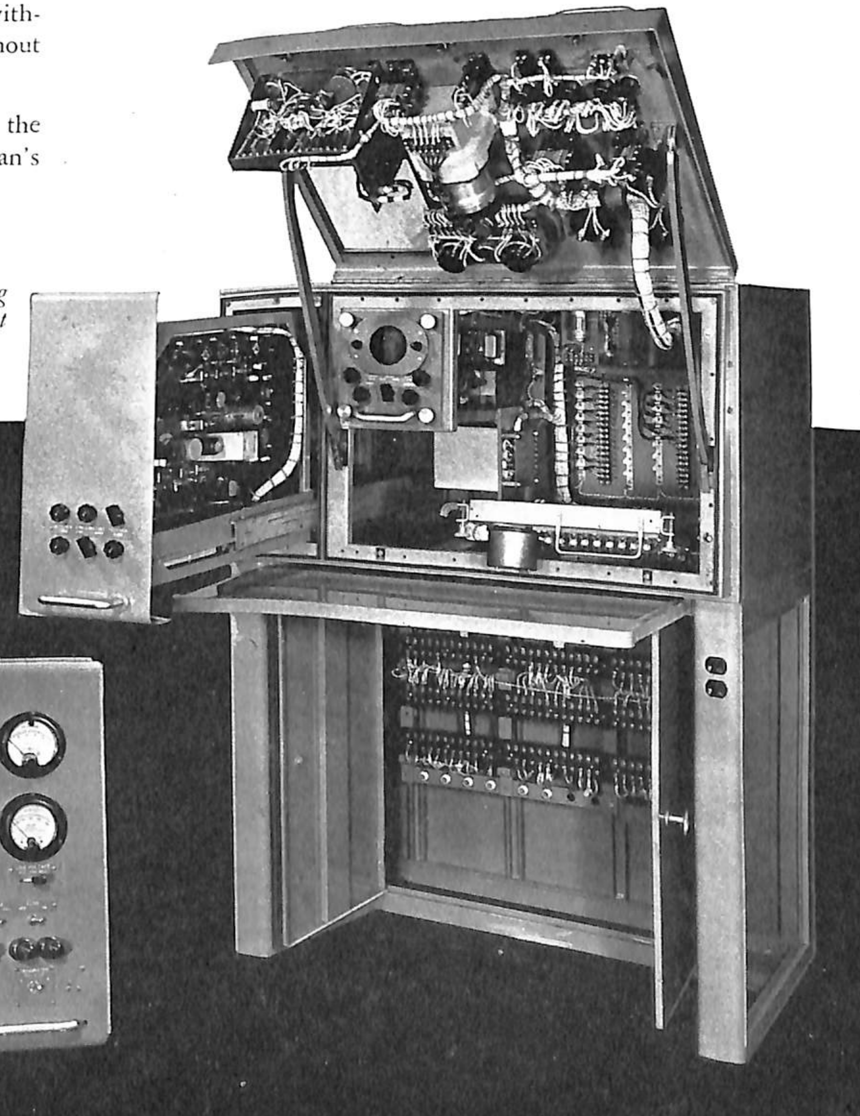
The principal differences between the Mark 13 and its predecessor, the Mark 8, are the mechanical design, ease in maintenance, and construction and weight of antenna.

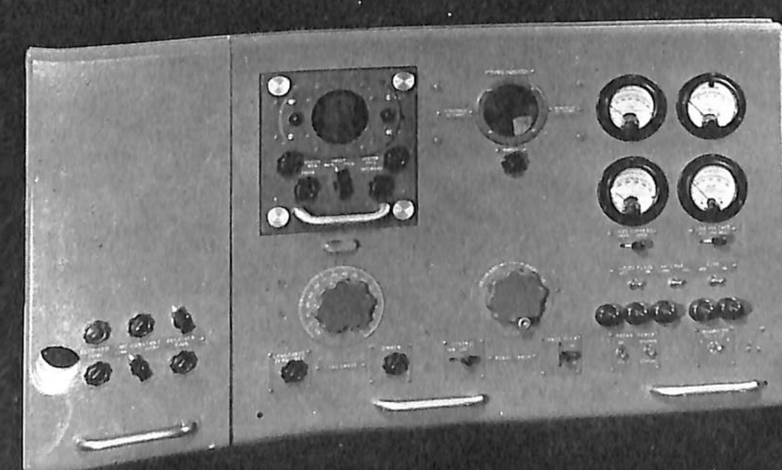
The console is of modern design and lacks the familiar "Veronica Lake" assortment of cables which extends from the front of the Mark 8 units. The amplifier and rectifier cabinets are designed and constructed to fit on either side of the console, thus forming a symmetrical series of units. This positioning is entirely optional, and arrangements more suited to space conditions are equally satisfactory. The ruggedness of the equipment can be seen by reading further in Captain Tucker's report which states, "The equipment has withstood over 1500 rounds of 16″ and 5″ firing without failure of any kind."

When the front panel of the console is raised and the cabinet doors in the lower portion opened, a technician's

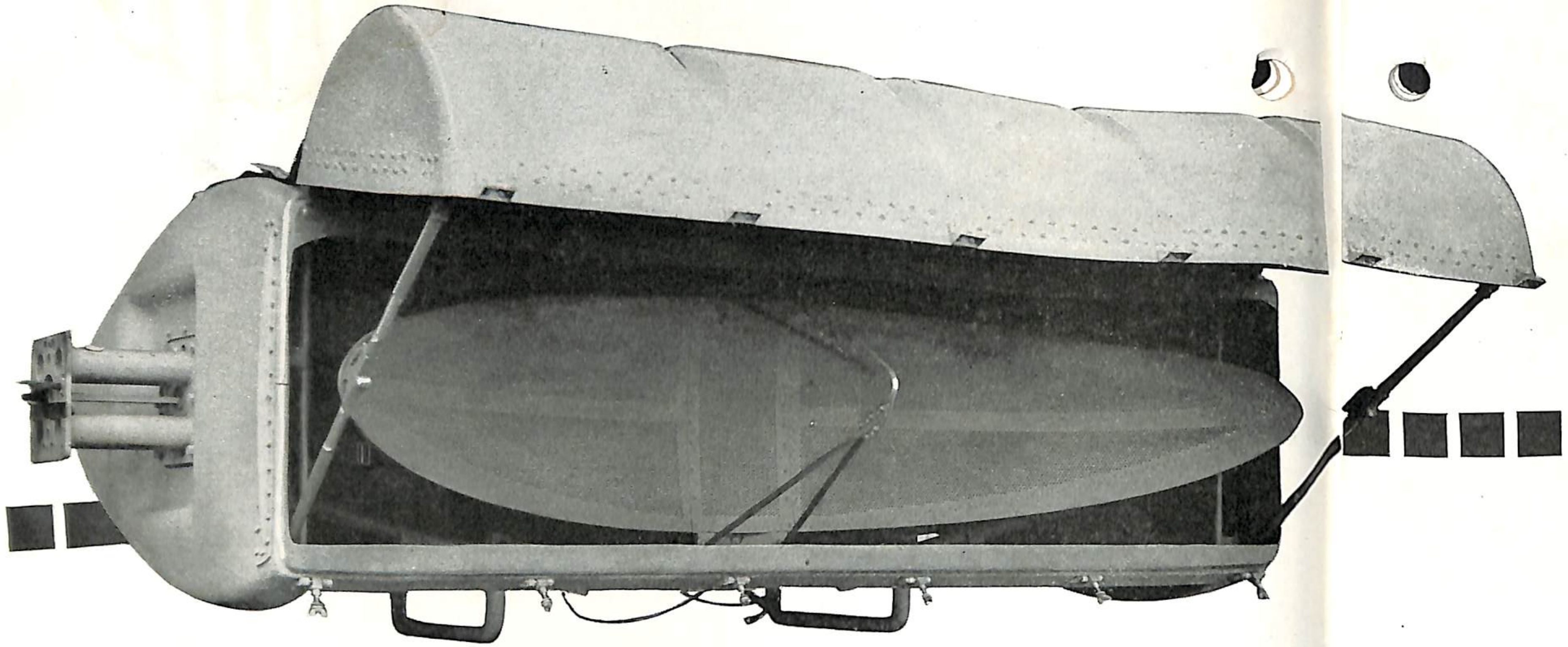


dream is apparent . . . the refrigerator or dome lighting reveals hundreds of wires so expertly laid out on terminal boards that maintenance of any section is greatly facilitated. Two outlets can be seen on the lower right side for supplying power to oscilloscopes, jo-pots, meters, etc. Both the amplifier and rectifier cabinets are similarly designed. Provisions are made for servicing each of the inside units without removing them from the cabinets. This is accomplished by loosening knurled screws which hold an individual chassis in place and dropping it down on hinges. In this position, it is pos-





When the Mark 13 radar console is opened, servicing is mde simple by expertly designed wiring. The inset is a close-up of the controls on the console.



sible to check voltages on terminals and tube sockets.

The monitor scope, located in the upper portion of the amplifier cabinet, is a dual purpose scope. It may be used either as a stationary auxiliary remote scope, or as a test instrument. A selector switch controls the presentation on the monitor so that principal wave forms throughout the indicator control panel may be observed quickly for checking trouble. There are jacks on the front panel of this monitor which permit the use of the scope for checking trouble in other parts of the equipment. Power outlets are also located inside the top of both the amplifier and rectifier cabinets and are readily accessible.

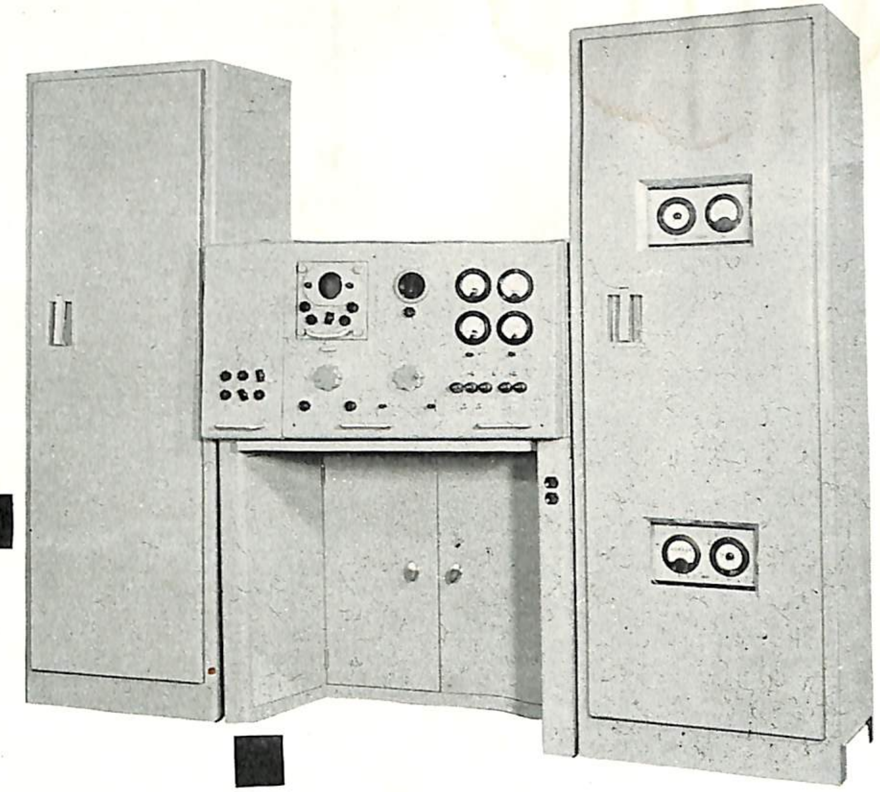
A unique feature of the Mark 13 is seen in the range and train indicators. These are equipped with 3-inch scopes and plug in as a unit. There are six of these indicators in each installation, with an extra unit supplied as a spare part. In case of failure of any indicator the spare may be installed in a few seconds by virtue of the plug-in feature. The range and train indicators are located as follows: one in the operating console, one at each rangekeeper, one in the main battery fire control station, and two in the director. Casualty to any indicator or cables leading to the indicator does not affect the operation of any other part of the system as each indicator is fed by a separate amplifier channel. This also makes possible the independent selection of either main or precision sweep at each indicator by a switch located in the unit.

The presentation on the range and train indicators is of the "B" type. Three bearing lines are generated, one corresponding to the director line-of-sight and one on each side at ± 50 mils. A new feature of the Mark 13 is that these bearing lines are composed of dots spaced accurately at 200-yard intervals. These are an invaluable aid when spotting by means of shell splashes.

Another improvement in the design of the Mark 13 is the inclusion of a long-range unit capable of measuring range to 80,000 yards in addition to the standard Meacham precision-range unit. This makes it possible in main sweep to range on two targets simultaneously since both range lines appear on the scope at the same time and are independently controlled. Precision sweep may be controlled by either range unit so that it is possible to have an expanded presentation at any range out to 80,000 yards.

The antenna of the Mark 13 is considerably different in design from that of the Mark 8, Mods 1 and 2. It is lighter by 1500 pounds and is of the "rocking-horse" type which delivers a sinusoidal sweep at the rate of five cycles per second, or ten scans per second (one cycle being two scans). The horizontal beam width is 1°, which considerably improves bearing discrimination over that of the Mark 8's 2° beam width.

The following data on ranges of various objects is taken from Captain Tucker's report. The antenna height was 120 feet:



The radar equipment Mark 13 Mod. 0 console in center with amplifier and rectifier cabinets at the sides.

(Illustration page 4) The hood of the Mark 13 radar antenna may be raised and supported in the position shown above while inspecting or servicing.

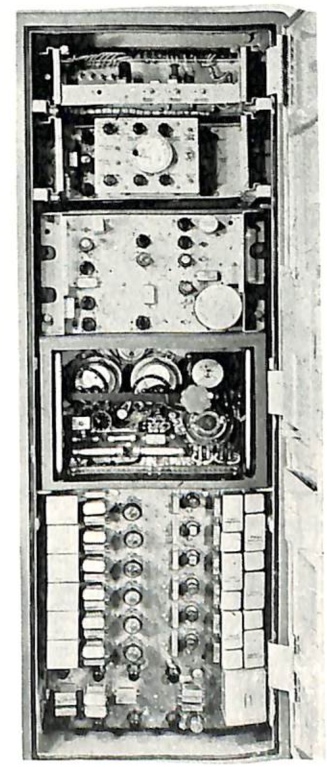
(Lower Left) The separate channel amplifiers are shown in the lower part of the Mark 13 amplifier cbinet. The test scope in the upper part of the cabinet and can also be used as an auxiliary remote range scope.

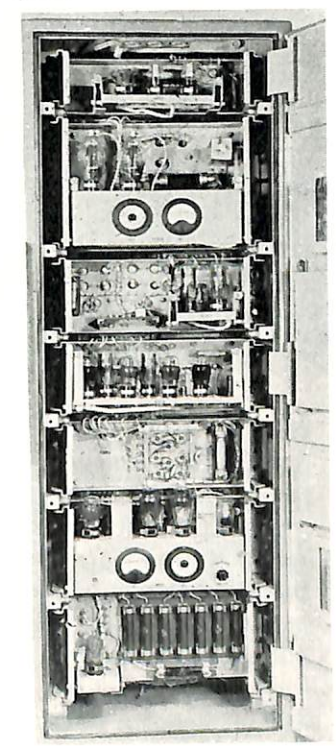
(Lower Right) The open door of the Mark 13 radar rectifier cabinet reveals the well designed interior characteristic of all Mark 13 units.

Small target towing vessel	48,500 yards
Series 60 sled, damaged	47,500 yards
16″ shell splash	35,000 yards
5″ shell splash	21,000 yards
5″ AA Common air burst	10,000 yards
40mm shells in flight	2,000 yards
JM-1 twin engine airplane	78,000 yards

From the above, it is safe to say that the Mark 13 will pick up any type of ship target out to line-of-sight ranges, and that it will range on all 5″ to 16″ single splashes beyond maximum range of the battery. Maximum aircraft ranges have not yet been determined, but 40,000 yards appears probable.

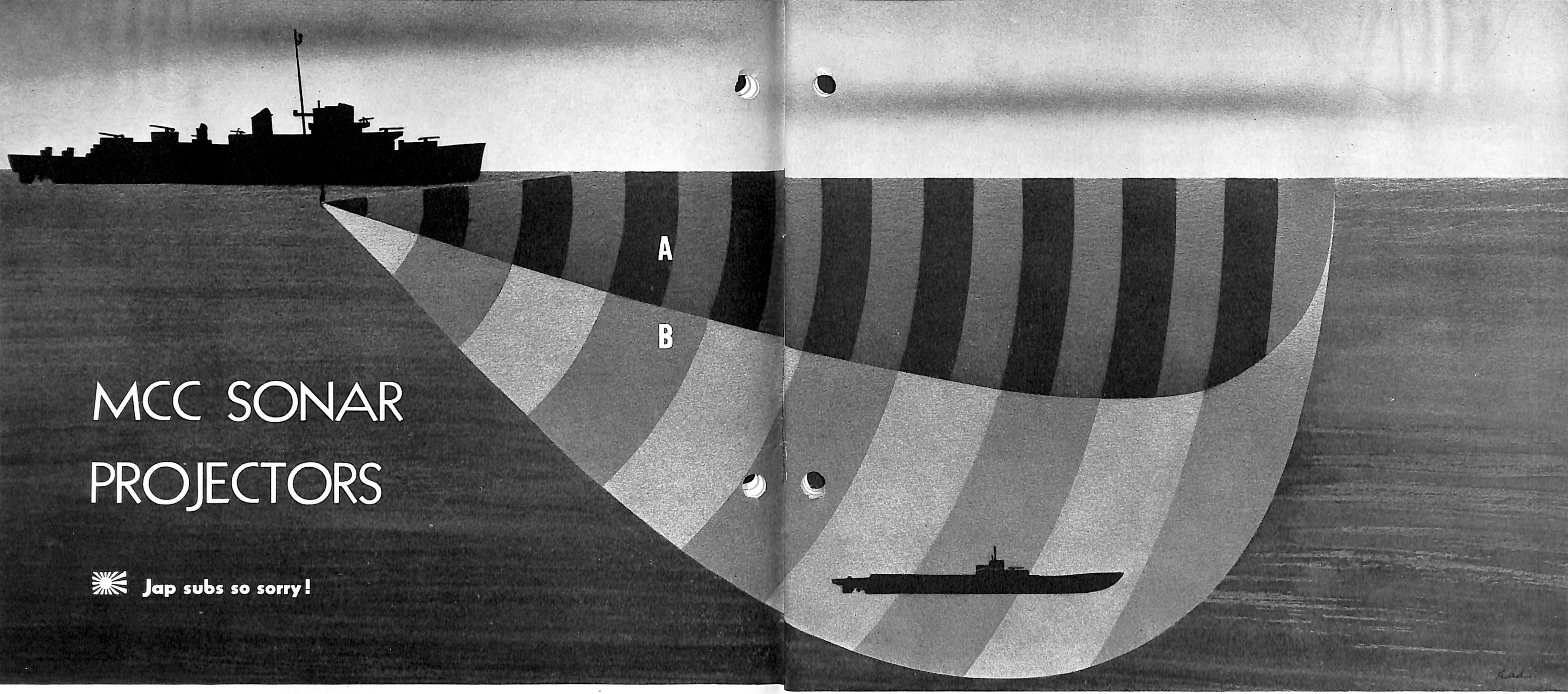
From the early tests it looks as if the Mark 13 will answer many of the present problems.





MCC SONAR PROJECTORS

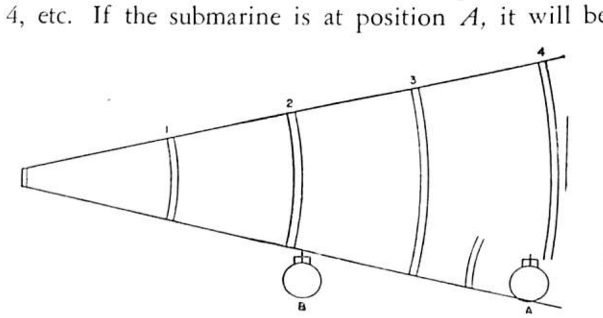
Jap subs so sorry!



■ With most sonar equipment, contact with the target is usually lost when the attacking vessel comes into close range with the submarine. There is a rule of thumb which states that contact is lost with the submarine at a range in yards equal to its depth in feet. This means that a submarine submerged to 500 feet cannot be detected when the projector-to-target distance is less than 500 yards. In order to understand why this dead space exists, it is necessary to review the directional characteristics of standard projectors.

The projector sends out a beam of sound, probing the water in search of any object which will reflect sound. This beam is shaped like a cone with the vertex at the projector. The pattern would look something like A (above).

The pulse of sound energy leaves the projector as shown below, and travels outward to points 1, 2, 3, 4, etc. If the submarine is at position *A*, it will be

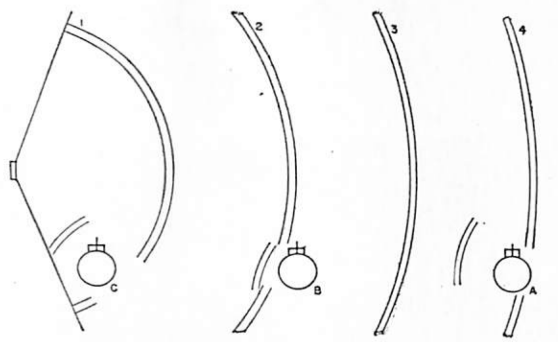


hit by the beam, and some sound energy will be reflected. However, if the submarine is at position *B*, the sound beam will pass over, and no energy will be reflected. It is clear, therefore, that as the projector approaches the target, a point will be reached where the transmitted sound will pass over it.

There are two methods now being used to eliminate this blind spot. One way is by tilting the projector downwards, following the target as the distance decreases. This is done in the QGA, and in some experimental equipments. The second way to maintain contact is by use of an equipment in which the projector beam covers a much larger vertical area.

This method has been called "Maintenance of Close Contact" or, in abbreviated form, "MCC." In order to understand the basic principles of MCC, let us examine the directional characteristics of projectors. The beam width in a given plane decreases as the dimension of the vibrating diaphragm increases in that plane. Thus a wide projector radiates a narrow beam, while a narrow projector radiates a wide beam.

In the problem of maintaining contact at close range we are interested in securing a beam that is wide in the vertical plane. To see the effect of this, examine the sound pattern presented by an MCC projector as shown in B above. With the broad beam a submarine will still be in the area covered by the sound transmissions even when it is as close to the projector as shown in position *C* below. Thus the shadow area is greatly reduced.



It should be noticed that although MCC decreases the directivity of the projector in the vertical plane, it does not affect the horizontal pattern. Thus we are able to achieve the advantages of maintaining close contact and still retain bearing accuracy.

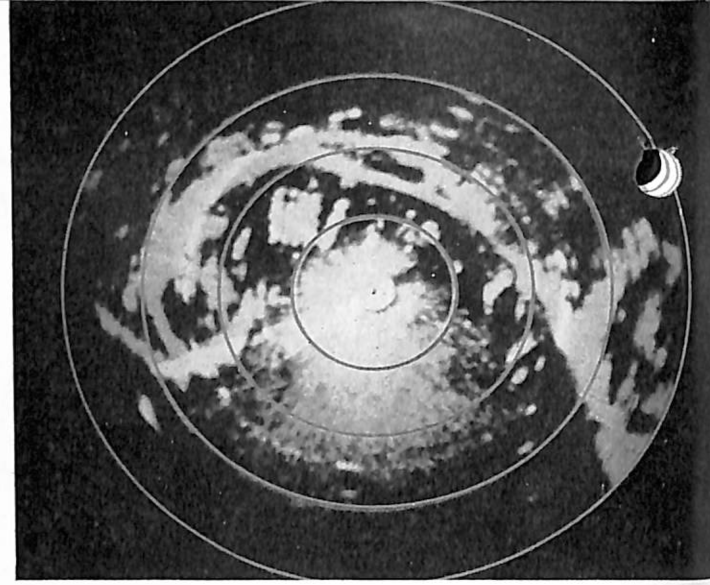
In actual practice it is not desirable to use the MCC pattern at all times for two reasons; first, the amount of energy reaching the target is greatly reduced by the abnormally spread signal; second, there are reverberations and water noise from the considerably larger sea-area covered by the extended MCC beam. Both conditions contribute to an undesirable decrease in signal-to-noise ratio.

In order to retain the advantages of the conventional pattern and still achieve the benefits of MCC, the equipment is so designed that it may be operated with the normal narrow beam for search, and quickly converted to the expanded MCC pattern for close ranging. This is accomplished by a switch which connects the coils in the projector so that only a center horizontal row is used. This connection makes the projector act as if it was of standard width but only a single row of coils in height. Therefore the projector radiates a beam covering the same horizontal area, but a much greater vertical area. The inside of the projector diaphragm is grooved along both edges of the center row of coils to permit the center section to vibrate independently of the rest of the diaphragm.

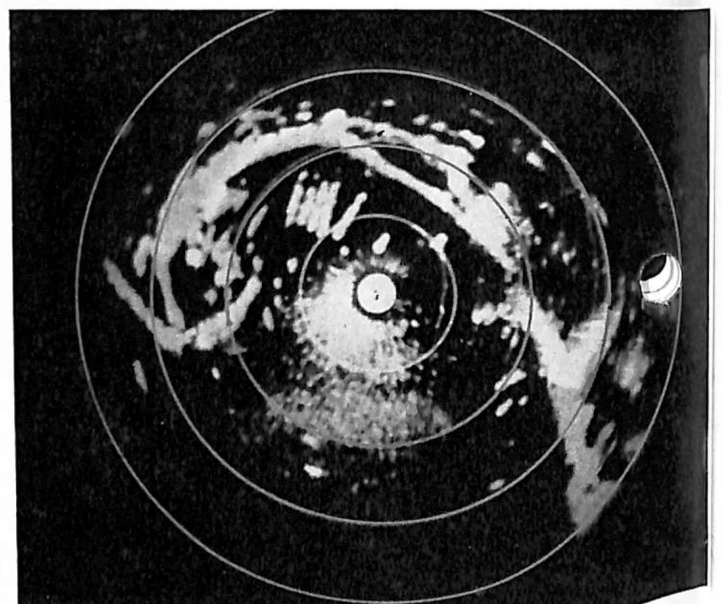
MCC FIELD CHANGES

Equipment	F. C. Number	Delivery
QCQ-2	8—QCQ-2, 12—QCQ-2, 14—QCQ-2.	July, 1945
QGB	7—QGB, 12—QGB	July, 1945
QCU[1]	4—QCU/QCU-1	July, 1945
QJA	8—QJA	Fall, 1945
QJB	5—QJB	Fall, 1945

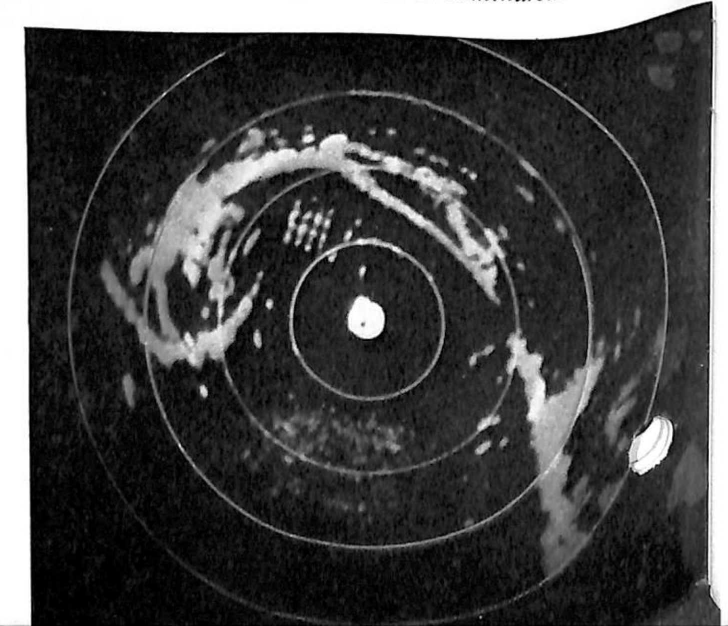
[1] QCU-1 equipment will include MCC feature when shipped from the factory.



(Above)—PPI scope without STC showing considerable sea return. (Below)—Effect on scope picture when sensitivity time control is introduced.



When a larger capacitor value is switched into the RC circuit almost all sea return is eliminated.



Sensitivity Time Control for SU Radar

ELIMINATING THE SEA RETURN

■ Considerable sea return is apparent on the scopes of radars whose beams are directed almost parallel to the surface of the water. This sea return, which brightens the scopes for several thousand yards, sometimes causes considerable confusion when taking bearings and ranges on fairly close targets. An example of this is shown top left.

This problem can be solved in SU series radars by a simple authorized modification. The method introduces a sensitivity time control, or STC as it is commonly abbreviated.

In effect the STC is a means of electronically turning the gain control down and then gradually advancing it to its normal setting. The actual time interval during which this action takes place is, of course, measured in millionths of a second.

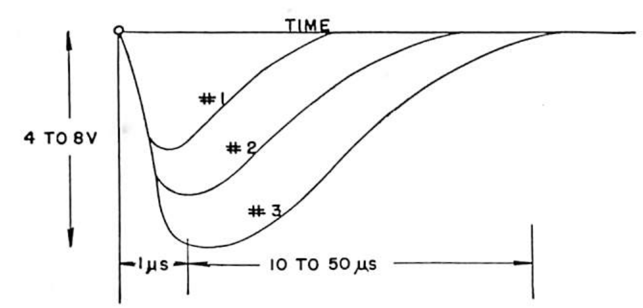


FIGURE 1—*Curves illustrating voltages that are applied to the i-f strips of the receiver to accomplish sensitivity time control. The curves shown are for three different capacitor values.*

STC in a system such as an SU is achieved by applying voltages as represented in figure 1, to at least two control grids in the i-f strip of the receiver. These voltages are obtained by charging a capacitor by a pulse from the blocking oscillator. This charge then reduces exponentially through a resistance-capacitance network as shown in figure 2. The voltage thus developed increases the bias voltage developed across the gain control resistor R-720. This has the effect of reducing the sensitivity of the receiver for a period of time depending upon the time-constant of the RC network. The time constant is varied by selecting different capacitor values by means of the switch shown in figure 2.

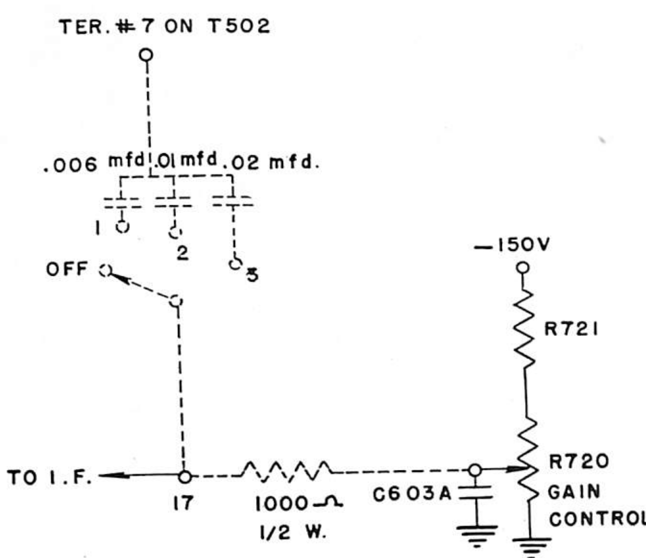


FIGURE 2—*Schematic diagram of the STC circuit. Added portions are indicated by dotted lines.*

The middle photograph at the left shows the scope presentation with the STC in operation. The bottom illustration shows the effect of increasing the length of time during which the sensitivity is reduced.

The STC circuit does not alter the operation of the original circuit in any manner and may be completely removed by turning the switch to the OFF position. Interim modification by ship's force is authorized until modification kits are available.

Behind the Sonar Scenes

THE DEVELOPMENT OF ADP CRYSTALS

If a baseball umpire calls every ball and every strike exactly right, no one even notices that he is on the field. But let him make one bad decision and both teams are on his neck like a ton of bricks. It may seem a little far-fetched to compare the crystals in your sonar projector to a baseball umpire, but there is a parallel. So long as they function properly, you don't care what they are made of or how they work. But let your ship go into drydock on a hot summer day with the thermometer hovering around 100. As a result you find your sonar gear doesn't work when the ship is again afloat. Then there will be plenty to say about those projector crystals.

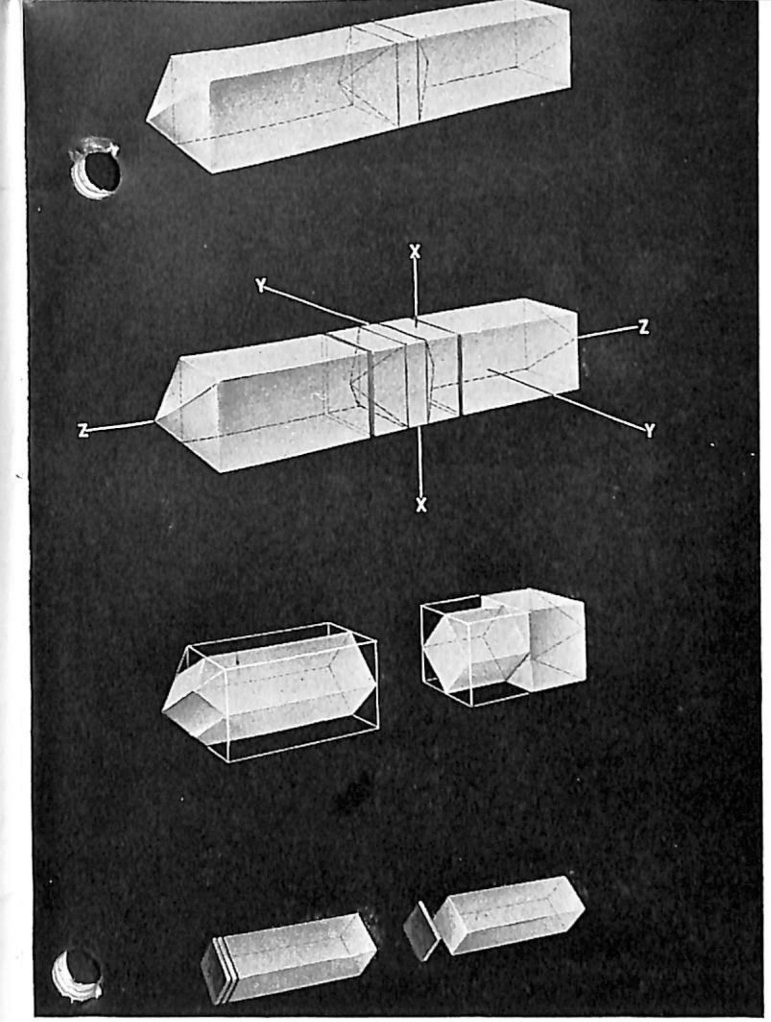
To lick problems like this, the Bureau, its contractors and the Naval Research Laboratory are constantly working to find better and more reliable crystals. One of the most recent developments is the ADP crystal—an abbreviation of the much fancier name Ammonium Dihydrogen Phosphate. This is the story of what they are and how they will make your job easier.

ADP crystals offer increased dependability for underwater sound gear. The new crystals are more rugged in several respects. They will handle more power, withstand higher temperatures, and are somewhat less easily broken than the Rochelle salt crystals which they will replace.

When the first underwater sound projectors were built by Langevin in 1918, quartz was the only piezoelectric crystal on which there was much information. For many purposes such as oscillator control, where the principal requirements are stability and low temperature coefficient, quartz is still the best material. But for sending a directed beam of sound waves with considerable amplitude a long distance through water, quartz requires excessive power and matches the characteristic impedance of water poorly. Furthermore the supply of usable quartz is limited and should be reserved for the applications where its peculiar properties are essential. Physicists have known since an investigation by Curie in 1880 that a great many crystals developed an electrical charge when they were mechanically strained, but none of them except quartz occur naturally in sufficient size and quantity to be of any value. Tourmaline is used to a limited extent, but it is relatively insensitive and good quality material is not available in large quantities.

The first synthetic crystal that was carefully investigated was Rochelle salt. An experimental hydrophone of this material was tested at the Naval Research Laboratory in 1923 shortly after its properties were made known. Several limitations were recognized immediately. In the first place, in Rochelle salt crystals each molecule of sodium potassium tartrate is hooked to four molecules of water, and these water molecules start to break off (thus destroying the crystal) at temperatures as low as 120° F. Furthermore they can be burned out rather easily by too much power and their properties change rapidly with temperature under ordinary operating conditions. Nevertheless they offered a big improvement because they were much more active than quartz and could be obtained synthetically in any necessary size and quantity. The Navy consequently adopted them exclusively for all its crystal projectors.

Research on new crystals proceeded slowly because most commercial applications could be adequately handled by use of quartz or Rochelle salt. The first mention of ADP was made in 1935 by Bush in Switzerland in connection with an investigation of KH_2PO_4 (potassium dihydrogen phosphate), which is closely related to $NH_4H_2PO_4$ (ammonium dihydrogen phosphate). While the Swiss continued to work on the potassium phosphate, work was started in this country on the ammonium phosphate. Late in 1942 Dr. Jaffe of the Brush Development Co. had collected enough information to prove conclusively that this material was better



Steps in the formation of the finished crystal. The crystal is grown onto "planted" caps. Final plates are cut at 45 degrees to the X and Y axis and normal to the Z axis.

than the potassium phosphate and also was superior in several respects to Rochelle salt for use in projectors. The Bureau of Ships then sponsored the development and production of the new crystals and their application in Navy gear.

This discovery of a better crystal stimulated the research on other new crystals. ADP, although a considerable improvement over Rochelle salt, still has serious limitations. Consequently at the present time an intensive search is being made of many types of crystals by the Naval Research Laboratory and cooperating industrial laboratories so that the Navy is assured of constantly improved crystals for all their applications.

The Brush Development Co. which introduced ADP was the same company which had furnished the Navy with Rochelle salt, and their process was adopted for the growth of the new crystal. The first step in the process is to make up a concentrated solution of the chemical in water. The ammonium phosphate is the same chemical that otherwise might be used in baking powder or as a fertilizer except that it must be con-

siderably purer for crystals. Even a few parts per million of certain contaminants cause serious difficulties in the electrical properties. All the salt that will dissolve in water at 50°C is added and the solution, after mixing and careful filtering is pumped into large trays. A piece cut from a previously grown crystal is mounted in the solution to act as a seed. Growth ordinarily takes place only in one direction so that the seed used is a plate of the full cross section of the crystal. New material is caused to deposit on the seed by slowly lowering the temperature of the solution. As the temperature drops less of the chemical will remain dissolved, and under proper conditions will deposit on the seed as solid clear crystal material. Throughout the run constant smooth stirring must be provided and the temperature can be lowered only about six tenths of a degree in twenty four hours. If the control mechanism varies even a tiny amount at any time during the run, a flaw is developed which makes the crystal valueless.

Starting with a plate as the seed, the first thing that forms as growth begins is the cap face. These faces can be formed in about a week, and the process is stopped at this point because even with the best conditions, not all of the caps form perfectly, and once a flaw has started it is never healed over. Consequently, the caps are taken out of the solution and the perfect ones are replanted in a new batch of solution. The temperature is again slowly lowered and clear material deposits on the caps at such a rate that a crystal about ten inches long is formed in about two months.

The crystal bars are sawed and ground to the finished size and orientation determined by the application. Nearly all projectors use 45° Z-cut expander plates. That is, the plates are cut out normal to the Z axis of the crystal at 45° to the X and Y axis as shown in the illustration. The clear section beyond the original cap is first cut off by a thin radial carborundum wheel. The corners are then ground off by a dry disc sender, and adjusted precisely to dimensions within .002" by a less coarse abrasive disc kept wet with a coolant. The bar thus obtained is then sliced into the finished plates by a precision carborundum disc. The large parallel faces are then electroded by gold evaporated in a high vacuum, or by a metal spray, either melted or powered and suspended in an adhesive.

When an alternating voltage is applied to the crystal electrodes, the plate alternately expands and contracts in length and width but does not change in thickness. The properties of ADP are such that plates cut in the manner just described are the only ones of any value in projectors. Rochelle salt crystals may be either 45° X-cut or 45° Y-cut depending on the characteristics desired.

Either Rochelle salt or ADP can be cut in such a manner that the plates vibrate only in the thickness direction, but these are useful only in specific applications such as accelerometers. Neither can be cut so as to give zero temperature coefficients as is possible with quartz.

For quartz some twenty-odd differently oriented cuts have been developed for specific use as circuit elements and oscillator controls.

The principal use for ADP crystals is in underwater sound projectors where it replaces both X-cut and Y-cut Rochelle salt. Since the electric and elastic properties of ADP are very similar to Y-cut Rochelle salt the substitution for ADP for Y-cut Rochelle salt is comparatively simple requiring only slight changes in the dimensions of the crystals used. Replacing X-cut Rochelle salt with ADP is more of a problem, principally because of the much lower dielectric constant of ADP which results in a higher impedance so that an impedance matching device must be inserted between the driver and projector. The same problem was encountered when Y-cut Rochelle salt was first introduced.

The most important advantages of ADP crystals over Rochelle salt crystals are:

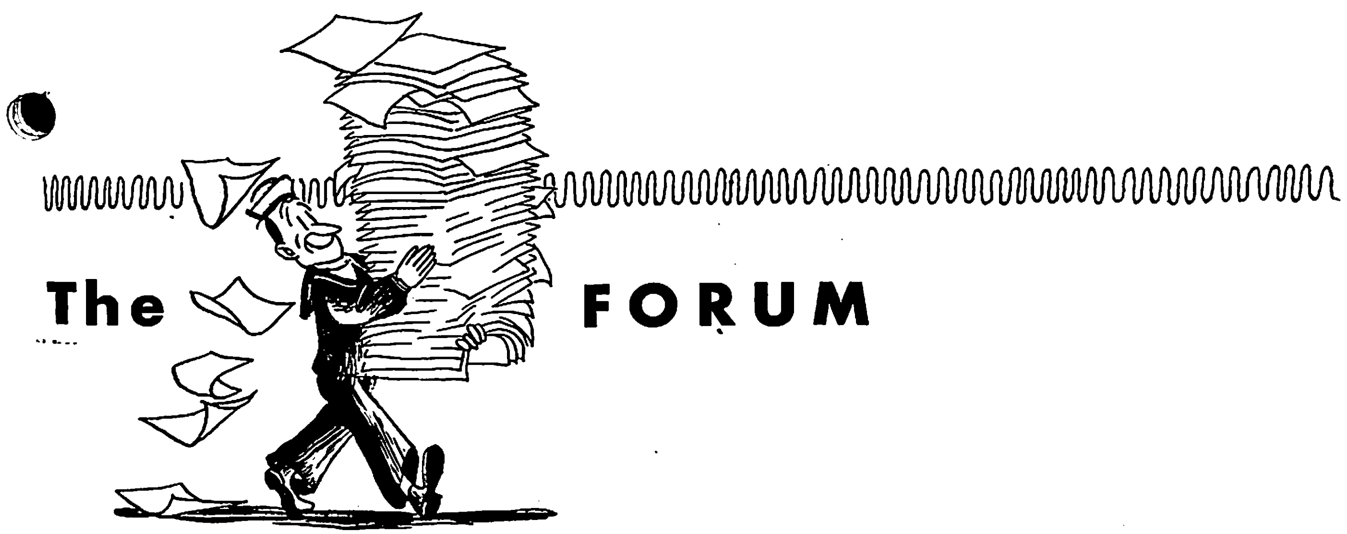
1. ADP crystals are not damaged by temperatures up to 220°F. and have no low temperature limit. Rochelle salt is damaged when subjected to temperatures above 120°F.

2. The power-handling capacity of ADP crystals is enough higher than that of Rochelle salt crystals so that projector breakdown is no longer a limiting factor in equipment design.

These advantages are gained without a sacrifice of efficiency. Both ADP and Rochelle salt crystals are effectively 100% efficient but due to projector design requirements the final efficiency result is in the same range for ADP crystal, Rochelle salt crystal, and magneto-striction projectors.

ADP crystals are not well suited for oscillator frequency-control or for crystal filters, principally because of the comparatively large change of frequency with temperature, but they have been used successfully in measuring devices such as blast gages. Thus it is obvious that the development of ADP has increased the dependability of projectors, but it has not lessened the circuit difficulties nor has it relieved the diminishing supply of quartz. Since there is good reason to believe that there are other crystals which are better, it is the responsibiliy of Navy scientists to provide them. Thousands of crystals are known to be piezo-electric, but quantitative measurements have been made on only a very few.

The investigation is now proceeding rapidly and new developments may soon be expected.



The FORUM

NOISE SUPPRESSOR FOR RBH-1

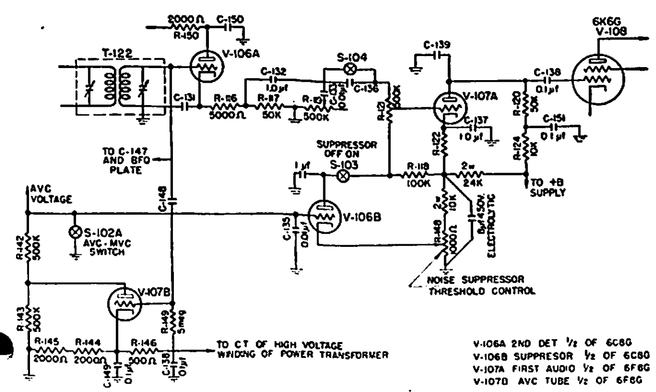
Henry L. Fletcher, CRT, U.S.S. *Eichenberger*

The following modification provides carrier-control noise-suppressor action in the model RBH-1 radio receiver. This modification blocks the audio system so that no sound is heard in the loudspeaker until a carrier is received. The AVC voltage developed by the carrier in the AVC tube then unlocks the audio, thus permitting reception of the signal.

In the original modification, resistor R-148 and switch S-103 which were employed in the S-Meter circuit have been used, thereby removing the S-Meter from the circuit. If it is desired to retain the S-Meter feature, an additional potentiometer of 1000 ohms and an SPST switch must be procured and mounted on the front panel of the receiver. Other parts required are:

1 8 μf. 450 v. d-c electrolytic capacitor
1 1 μf. 400 v. paper capacitor
1 10,000 ohm, 2 watt resistor
1 24,000 ohm, 2 watt resistor

The wiring in the receiver is rearranged as shown in the accompanying schematic, utilizing components already in the receiver as required. Resistor R-148 functions as a noise-suppression threshold-control or an adjustment which determines the strength of the incoming carrier necessary to unlock the audio system. Switch S-103 is used to remove the noise-suppressor feature if so desired. The circuit is adjusted by setting the suppressor-threshold control so that atmospheric disturbances are just barely eliminated with the r-f gain full on and no carrier being received. The suppressor circuit is highly sensitive and only a very weak signal is required to trigger it. Sensitivity of the receiver may be reduced by the r-f gain control, although too much reduction in gain will decrease or eliminate the AVC voltage and as a consequence the suppressor circuits will not unlock the audio system.



MODIFICATION OF RBH-1 TO PROVIDE CARRIER CONTROLLED NOISE SUPPRESSION ACTION

Bureau Comment: This modification is authorized where operating conditions make noise-suppression desirable.

RESISTOR CHANGES IN RAK/RAL-5 RECEIVERS

J. J. Fusco, RM1/c, U.S.S. *Williamsburg*

It has been found that the carbon resistors used in the bleeder and screen-dropping circuits of the RAK-5 and the RAL-5 receivers are notorious for changing value. This is apparently due to the fact that they are incapable of withstanding the excessive amount of heat that is generated in these units. If this drift is to a lower value of screen-dropping resistor, plate potential of the receiver may be caused to drop as much as 30 volts, resulting in decreased performance.

This condition is eliminated by changing the 20,000-ohm bleeder resistor R-202 from a 2 watt carbon to a 5 or 10 watt wirewound, and the two parallel-connected 6200-ohm screen-dropping resistors R-203 and R-204 to a single 10 watt 3100-ohm wirewound resistor. There is adequate space for the larger resistors above the bakelite mounting strip from which the original carbon resistors were removed.

FREQUENCY CHANGE DIFFICULTIES —MODEL TDH-3 TRANSMITTER

U. S. Naval Air Station, Quonset Point

The TDH-3 transmitter was found to vary slightly in frequency with each dialing operation i.e., if it were dialed to one channel, dialed off and then back to the original channel, it would vary from the correct calibration. The following exact measurements were made for eleven successive resettings to 4105.00 kc:

4105.320 kcs	4105.000 kcs	4105.500 kcs
4105.420 kcs	4105.450 kcs	4105.480 kcs
4105.520 kcs	4105.500 kcs	4105.500 kcs
4105.480 kcs	4105.400 kcs	

Upon examination of the master oscillator Autotune it was found that excessive grease had collected on the clutch and the MO shaft was bent slightly, apparently due to excessive pressure being exerted when locking the dial. It is pointed out that due to the location of this dial inexperienced personnel may have a tendency to bring the weight of the body to bear on the dial during the locking operation. In addition the bent shaft caused the MO Autotune dial to stick at "zero" on the reverse side of the dialing cycle.

Bureau comment: The Bureau has received other reports of similar difficulty and it is suggested that all activities having similar equipment be on the lookout for this trouble. The manufacturer has been advised of the situation and is conducting an investigation which should lead to steps for correction.

•

Do you ever get an idea that you think will help someone else in the upkeep and operation of his equipment? This column is the place for such ideas. And don't forget that sketches and photographs will help get the story across. Send your contributions via your commanding officer to The Editor, BuShips Electron, Bureau of Ships (Code 993), Navy Department, Washington 25, D.C.

OK? Then the *other* terminal must be the high side.

Idea contributed by Lt. G. D. Greenwood.

Is it Grounded??

In the past few months it has been found that the specifications for several different types of radar and radio equipment have omitted some of the bonding points. Though this fault is easily corrected, it has been causing considerable trouble. One case in particular was that of an SR radar which was interfered with to such an extent that the usefulness of the equipment was greatly impaired. When the units were properly grounded and bonded, the operation was restored to normal.

Radio technicians should be sure that all units of the equipment which they maintain are properly bonded together and grounded to the ship. Particular attention should be paid to shock mounts, as some of these mounts completely insulate the unit from ground. To accomplish the above, a low resistance, flexible braid or other conductor should be used.

Emergency Modifications Permitted

A long-standing Bureau of Ships rule has been that no electronic equipment was to be altered in any manner, either electrically or mechanically, without prior approval by the Bureau. Even the radically changed situation of wartime operations has not altered the fundamental soundness of this policy. An equipment tampered with by personnel with little experience may not only damage the equipment, but may impare its operation to the point of endangering the entire ship and its crew.

In order to explain the situation better it may be well to insert here a case in point. On one of our ships which carried the SG radar equipment, it was desired to have the direction of the ship shown on the remote PPI's by a brightened sweep once every rotation of the antenna. This was accomplished by the radio technicians aboard, and the desired information was presented on the remote units. One night while in convoy the modification became inoperative. If the result had been merely a loss of the flashing light, nothing serious would have resulted. But the entire pattern was caused to rotate to some random point on all of the scopes. Had the situation not been discovered early, and corrected, a collision might have resulted.

However, we are all aware that emergencies arise, and sometimes modifications are necessary. Unfortunately, the very emergency that requires the change does not permit sufficient time to secure approval. So it is obvious that some exception has to be made to the "ironclad" rule.

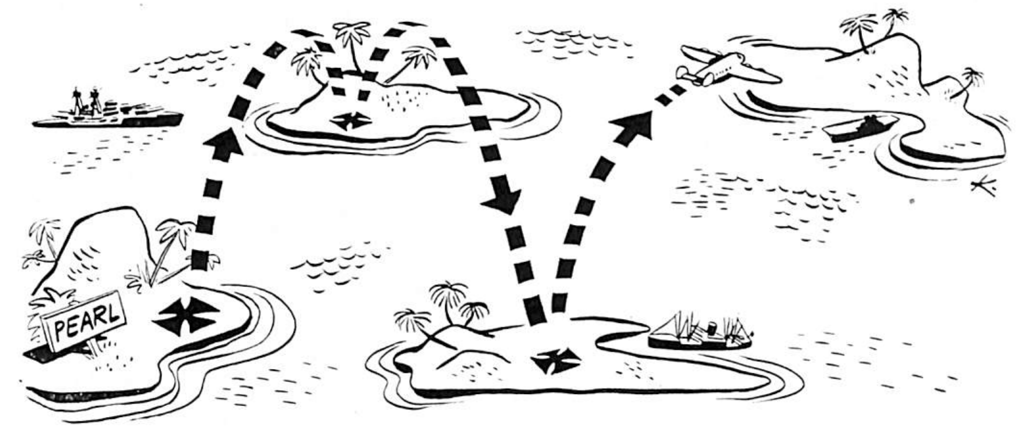
A recent letter from Buships to all ships and stations (U-159) (970-900 of 7 April 1945) states in effect that when there is insufficient time to contact the Bureau in advance, "authority for alterations must be obtained from the commander of the service force involved, or from his authorized representative, or, in an emergency, from the commanding officer of the vessel or activity involved." In all such cases an immediate report must be forwarded to Buships.

With this new rule, we think a workable compromise results.

A final word of caution. There will be others to work on the equipment after you. At least give them the advantage of knowing what you have done and how it was accomplished by making a written record that they can understand.

Flying D/F Service in the Pacific

Submitted by the Electronic Field Service Group.



To alleviate the great need for facilities for calibration of high frequency direction finders in the Pacific an emergency calibrating team consisting of one officer, one technician and three RM2/c has been formed. This group is stationed at Pearl Harbor under Commander Service Force, Pacific Fleet, and its services are available to ships in the forward areas. The team uses a portable transmitter for emergency calibrations and travels by air to any area in the Pacific where the services are required.

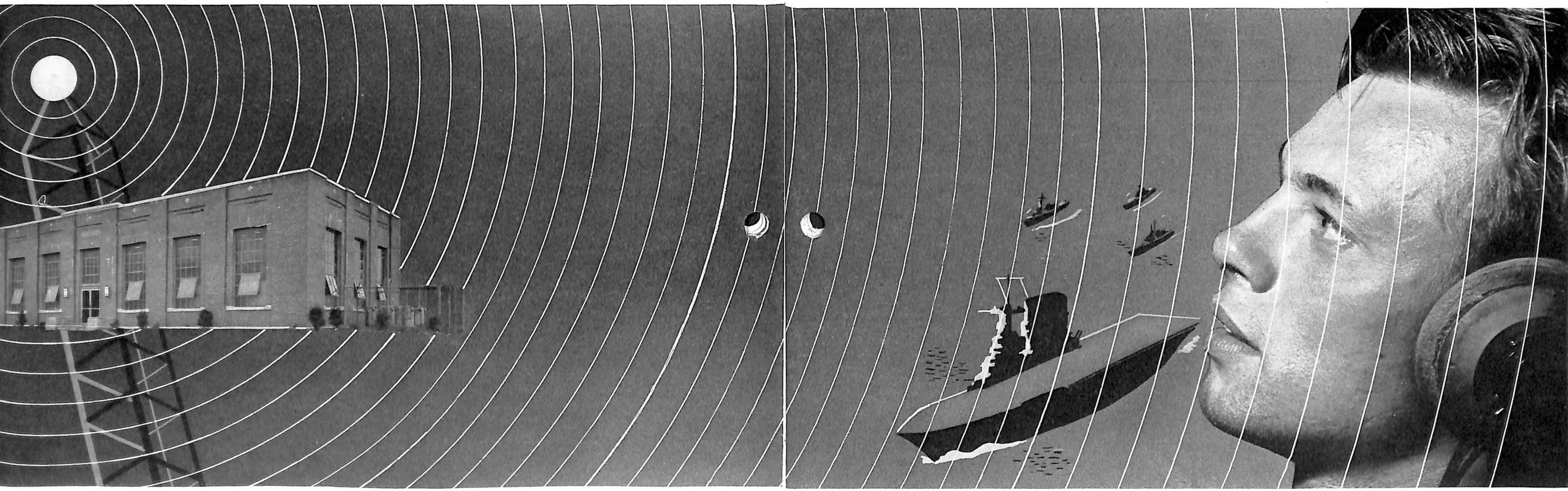
Requests for the services of this team should be addressed to Fleet Maintenance Officer, Commander Service Force, U.S. Pacific Fleet and should contain the date, location, and period of availability of the vessel or vessels to be calibrated. Requests from the forward areas should, if possible, reach ComServFor at least two weeks in advance to permit the preparation of orders, procuring of priorities, and transportation for the team.

Calibration of high frequency direction finders requires certain considerations not encountered in medium frequency calibrations. Reflecting and reradiating objects in the vicinity of the calibration range cause errors that are neither constant nor predictable. Rough water causes reflection, blurring and swinging of the pattern, in addition to the errors caused by gyrations of the antenna on the calibrating boat. Therefore, officers contemplating calibration should take these factors into consideration and attempt to obtain anchorage in as clear an area as possible.

Prior to the arrival of the calibration team, the officer controlling the calibration should arrange for a power boat at least 36 feet long, equipped to communicate on VHF, obtain assignment of a frequency for communication between calibrating boat and ship, and have equipment tested. Army SCR 610 equipments, which are usually available, are ideal for emergency setups.

Responsible officers in the fleet can insure obtaining the high degree of reliability of which this equipment is capable by calibrating equipment properly. Ships are urged to take the few precautions mentioned above and make the maximum use of the calibrating officer's knowledge and experience.

One Part in 10,000,000



A story on how to use the Standard Frequency Broadcasts

R. F. TSCHANNEN, Bureau of Ships

■ A vital message goes on the air! The safety of a whole force may depend upon its proper reception. But there can be no assurance of getting that message through if the transmitter is off frequency, or of intercepting the transmission if the receiver is off frequency. It is for this reason that you are provided with an instrument for checking frequency—it is the *frequency meter*. But a frequency meter is not in itself a "primary" standard of accuracy. Like any other piece of equipment it will cease to be reliable if not carefully maintained and checked. Fortunately we have available nearly all over the world a standard of unquestioned accuracy against which we can check our frequency meters. This standard is the frequency broadcast service of the National Bureau of Standards. Use this service regularly and properly, and you need never worry about the reliability of your frequency meter.

The Service[1]

The National Bureau of Standards provides a continuous day and night broadcast of standard frequencies and related services from its radio station WWV at Beltsville, Md., near Washington, D.C. This makes widely available at all times the following services: (1) standard radio frequencies, (2) standard time intervals accurately synchronized with basic time signals, (3) standard audio frequencies, (4) standard musical pitch, 440 cycles per second, corresponding to A above middle C.

Radio carrier frequencies currently in use are transmitted in accordance with the following schedule

Frequency	Schedule
2.5 Mc.......	1900 to 0900 EWT. (2300 to 1300 GMT).
5.0 Mc.......	Continuous.
10.0 Mc.......	Continuous.
15.0 Mc.......	Continuous.

Two standard audio frequencies, 440 cycles per second and 4000 cycles per second, are broadcast on the radio carrier frequencies. Both are broadcast continuously on 10 and 15 Mc. Both are on 5 Mc during the daytime, but only 440 is on 5 Mc from 1900 to 0700 EWT. Only 440 is on the 2.5 Mc carrier.

The accuracy of all the frequencies, radio and audio, is better than one part in 10,000,000. Transmission effects in the medium (Doppler effect, etc.) may result in slight fluctuations in the audio frequencies as received at a particular place, but the average frequency received is as accurate as that transmitted. The time interval marked by the pulse every second is accurate to better than 10 microseconds. The modulation frequencies, 440 and 4000 cycles per second, are broadcast continuously except during the first minute of each five minute period starting on the hour. This marks time intervals of 1 minute, 4 minutes, 5 minutes, and longer which are accurate to a part in 10,000,000 and whose beginnings and ends are synchronized with the seconds pulses. The beginning of the periods when the audio frequencies are off are so synchronized with the basic time service of the U.S. Naval Observatory that they mark accurately the hour and the successive 5-minute periods. In making use of the broadcast, one should select the carrier frequency that gives the best reception at that time.

How to Use the Broadcasts

The accuracy of various frequency measuring equipments, audio oscillators, and signal generators may be

[1] Reprinted from Bureau of Standards Letter Circular LC-780.

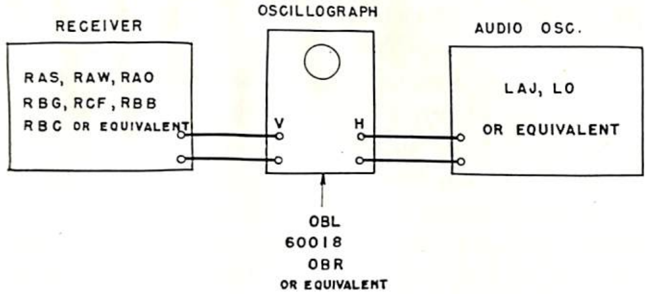


FIGURE 2—*Block diagram indicating connections for the method of calibrating audio oscillators by the use of WWV modulated frequencies.*

checked and many times improved when broadcasts from station WWV are properly utilized. Additionally, when appropriate audio oscillators and oscilloscopes are associated with standard frequency meters, some improvement in interpolation accuracy may be obtained.

The most popular heterodyne frequency meters in the communications equipment ranges are the LR, the LM and the TS–173/UR equipments. The following table outlines briefly the characteristics of these equipments:

Equipment	Frequency Range	Equipment Accuracy	Crystal Frequency	Crystal Accuracy
LR..........	160-30,000 kc.	[1]±100 cps or 0.003%....	100 kc.	0.001%
LM..........	[2]125-20,000 kc.	0.02% up to 2,000 kc....; 0.01% above 2,000 kc....	1000 kc.	0.001%
TS-173/UR...	90-450 mc...	0.005%......	5 mc.	[3]0.001%

[1] Whichever is the greater number of cycles.
[2] The LM through LM-9 have the low range beginning at 195 kcs.
[3] Zero beat at factory. 0.001% is nominal value at room temperatures.

If the over all accuracy specified in column three of the above tabulation is sufficient for the measurement application, additional equipment and frequency standardization may not be required. A frequency check of crystal accuracy, however, will give assurance that equipment is operating properly.

Present WWV frequencies and schedules will provide reception in nearly all parts of the world. If any of the standard transmissions can be received, a quick check will enable the operator or the maintenance man to correct or note frequency differences between the frequency meter and WWV standard frequency transmissions.

Checking the LR Series:

The LR crystal may be set to zero beat in a very simple manner, as follows:

(1) The four fasteners on the corners of the equipment are released and the equipment is drawn forward.

(2) The short service-cable provided within the LR is connected between the units.

(3) The equipment is allowed to warm up for about an hour (the longer the better).

(4) The calibrator output of the LR is then coupled loosely to the antenna of the receiver which is to be used for picking up the WWV transmission. This may be accomplished by wrapping a few turns of wire around the antenna lead to the receiver, and connecting this to the calibrator output jack, or by merely placing a lead from the LR calibrator output near the receiver input connector or terminals. The coupling should be sufficient to allow the calibrator or crystal signal frequency of the LR to be clearly heard in the receiver, but not so great that the incoming WWV signal is seriously attenuated.

(5) Unlock the dial of variable capacitor C-102, located at the rear of the top shelf of the LR.

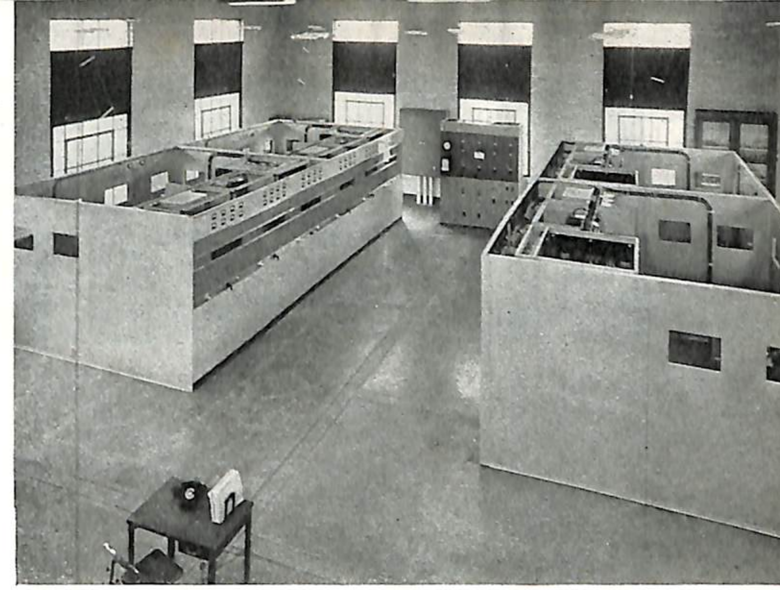
(6) The receiver is then tuned to a WWV signal which can be heard clearly. The calibrator is then turned on and the coupling between the LR and the receiver is adjusted until a clearly audible beat is obtained. The receiver beat frequency (cw) oscillator should be turned *off* for these checks. If the frequency output of the LR calibrator and that of the received WWV signal are not the same, a beat tone or a waxing and waning sound will be heard. Turn he capacitor C-102 until the beat frequency or waxing and waning becomes very slow or stops. This is known as zero beat. The adjustment mentioned is quite critical and normally does not require more than a fraction of a turn. The initial position of the dial of capacitor C-102 should be noted before and after the adjustment, and both settings recorded for reference. Care should be taken so as not to zero beat with the 440-cycle modulation rather than zero beating the crystal frequency with the WWV carrier. This can be ascertained positively by waiting until the next minute-period when the 440-cycle WWV modulation frequency is removed and noting if a beat tone continues. If a 440 cycle tone persists, the adjustment of the crystal is *incorrect* and capacitor C-102 should be adjusted to obtain zero beat with the WWV carrier. It may sometimes be found simpler, therefore, to wait until the 440-cycle tone is *off* before making the initial adjustment. In this way, the operator will be assured that he is not confusing the WWV 440-cycle modulation with the frequency generated locally by the beating of the LR calibrator frequency and the WWV carrier frequency.

(7) The capacitor C-102 may then be locked, the service-cord removed, and the equipment returned to its normal operating condition. Because of a difference in capacity when the equipment is withdrawn from the case, some slight shift of the crystal oscillator frequency may be noticed when the equipment is pushed back into the case. To overcome this, it may be necessary to adjust the capacitor C-102 to slightly off zero beat so that when the unit is replaced, zero beat will then be obtained.

As a general rule, it is desirable to use the highest WWV carrier frequency which can be heard. The reason is because, by audible beating, crystals may be set to within the same fraction of one cycle, but since the carrier frequency used is higher, the fractional value of frequency to which the crystal can be set will be smaller, and the error thereby decreased in proportion.

The LM Series

LM equipments are not provided with shunt crystal trimmers, or other means to correct the calibrator frequency to WWV standards. However, simple checks can be made in order to ascertain whether or not the crystal is within tolerance limits. With the operating range of temperature of the LM equipment, the crystal should be accurate to within 10 cycles per second. Note that if checked with WWV on 5, 10 or 15 mc, the maximum beat frequency should not exceed 50, 100 or 150 cps, respectively.



The main WWV transmitting room, showing position of transmitters.

The check of the LM with WWV is accomplished by loosely coupling the equipment to the antenna of the receiver to be used for picking up the WWV transmission, as described above. The LM is turned on and allowed to warm up for about 30 minutes to an hour. The crystal switch is then turned on, and coupling between the LM and the receiver adjusted so that a suitable beat is obtained. If the beat is sufficiently slow to be counted, the frequency may be counted over a 10 second interval; the number of beats divided by ten will give the cycles per second that the LM crystal harmonic frequency is off from the WWV transmission. Since no provision has been made for crystal frequency variation, it will not ordinarily be possible to ascertain whether the crystal is higher or lower than the standard frequency. The check, however, will tell definitely whether the crystal is within normal tolerance.

If, when checking LM crystals the beat note obtained is too rapid (high pitched) to count, an arrangement similar to the following may be employed for checking this audio frequency.

Connect the equipments as shown in figure 1.

The LAJ, LO or equivalent audio oscillator frequency is adjusted until a circle is obtained on the oscilloscope. The frequency is then read from the audio oscilllator dial.

If operating properly, the frequency difference between the LM crystal and WWV standard transmission should not be more than 50 cycles if the WWV frequency used is 5 mc, 100 cycles if the WWV frequency is 10 mc, or 150 cycles if the WWV frequency is 15 mc.

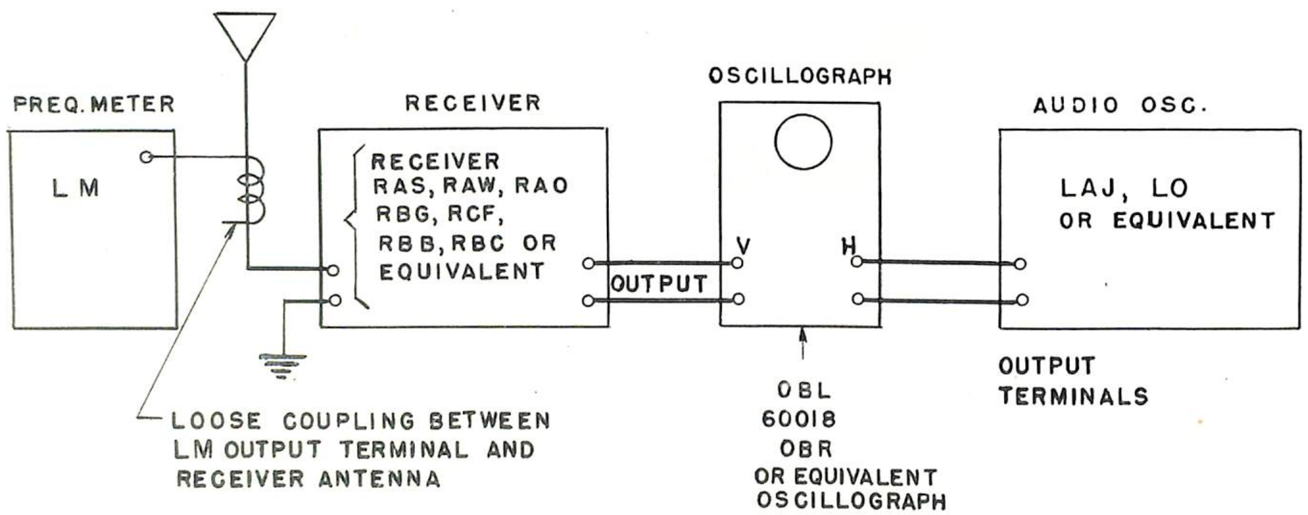


FIGURE 1.—*Block Diagram showing the use of standard pieces of Navy test equipment to check the frequency difference between WWV and the LM calibrator crystal.*

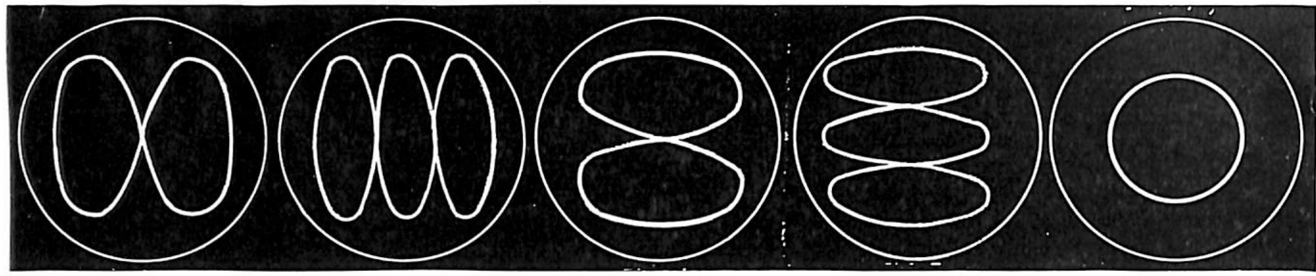


FIGURE 3.—*Common Lissajous figures used in frequency determination. (a) Frequency on vertical plates equal to twice frequency on horizontal plates. (b) Frequency on vertical plates equal to three times frequency on horizontal plates. (c) Frequency on vertical plates equal to 1/2 time frequency on horizontal plates. (d) Frequency on vertical plates equal to 1/3 of frequency on horizontal plates. (e) Frequencies equal.*

The TS-173/UR

Adjustment of the TS-173/UR equipment can be made in a manner similar to that for the LR equipment. The same precautions in coupling should be observed. A shunt crystal trimmer accessible through a screw plug in the rear of the case will enable exact zero beat adjustment of the 5 megacycle calibrator crystal.

Using WWV Audio Standards for Calibrating Audio Oscillators

The 440 and 4000 cycle audio modulation transmitted on WWV carrier frequencies will enable accurate calibration of the LO, LAJ, or equivalent audio oscillators. The arrangement for making such frequency comparisons is shown in figure 2.

If the signal to noise ratio and other receiving conditions are satisfactory, Lissajous figures may be obtained when beating WWV audio modulation frequencies with audio oscillator frequencies. Note that it is best to use head-telephones or a speaker as a monitor when making these checks. This will enable the operator to tell conveniently whether he is listening to the modulated portion of each 5 minute transmission period. The frequencies such as 220, 440, 880, 1320, 4000, 8000, 12,000 cycles per second, as well as many others may be accurately ascertained by the Lissajous figure method. The specific frequencies mentioned above can be ascertained by using only patterns similar to those in figure 3.

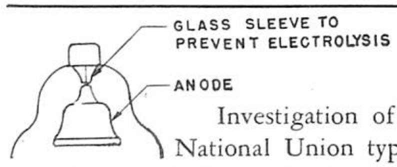
The 4000 cycle audio modulation will probably be heard best when the receiver is tuned slightly to one side or the other of the carrier frequency. It will be noted that the 440 cycle modulation will be more clearly audible when the receiver is tuned precisely on the carrier frequency.

Additional Comments

(1) The LR direct reading interpolator meter is accurate only to ± 100 cycles per second—the LAJ will normally be accurate to within a few cycles in the range of 20 to 200 cycles. Considerable improvement in accuracy may thus be obtained if the LAJ or equivalent is used as the a.f. interpolation device for small frequency differences.

(2) The LM will normally be found to be more accurate than the LR on frequencies below 500 kc. The 100 cps accuracy of the LR interpolator provides an accuracy of only 0.02% at 500 kc and decreases to 0.0625% at 160 kc.

FAULTY 2X2 TUBES



Investigation of excessive failures of National Union type 2X2 rectifier tubes has developed the following information:

(*a*). Tubes manufactured for the 3-month period prior to 30 June 1944 and shipped up to January 1945 are identified by the letters HU, HR, HC or IN on the tube base. It is recommended that all National Union type 2X2 tubes bearing this coding be considered unreliable for shipboard radar use. They should be used in emergency only.

(*b*). An improved National Union type 2X2, coded 2X2A, is being made available to equipment manufacturers and will be available to the field in a short time. This improved tube can be recognized by a glass sleeve around the anode lead, extending downward from the seal toward the anode as shown in the figure.

When the present tubes are operated for a period of time at, or near, maximum ratings, electrolysis will occur at the anode glass seal causing tubes to gradually become gassy, eventually going to air if kept in service. As the tube gets gassy it draws more current and will cause transformer burnouts if circuits are not properly fused on the secondary side of the transformer. Radar personnel are requested to weed out the type 2X2 tubes on hand when the new type becomes available.

The Directional Coupler

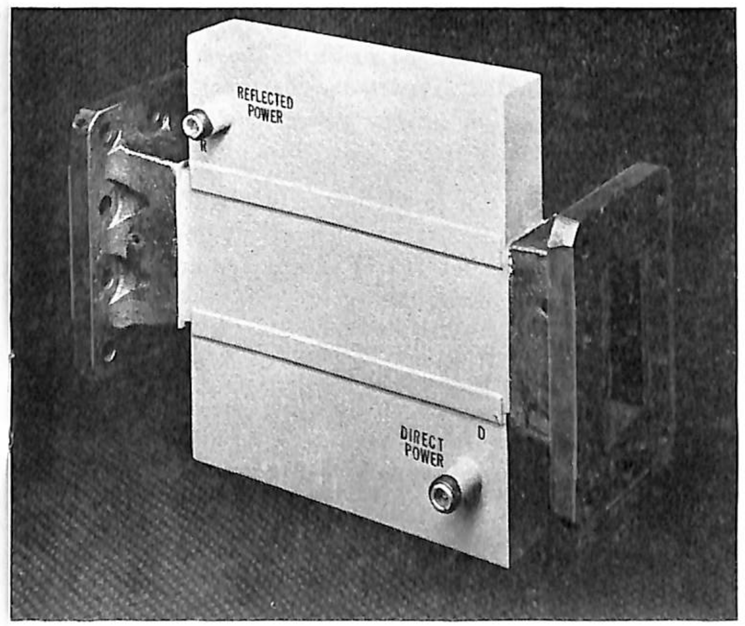
WHAT IT DOES AND WHY YOU NEED IT

LT. D. M. MAY, Bureau of Ships

■ In the early days of radar it was considered quite an accomplishment to keep a radar system operating and little attention was given to the question of *how well it was operating*. Now that systems have been improved and many technicians have become real experts, it is realized that the increased range which good overall system performance makes possible should no longer be considered an idle dream but something which is actually obtainable. The only way to determine whether the overall performance is good enough is by the use of adequate test equipment, and the device which makes the use of test equipment practicable is the *directional coupler*.

Test Antennas and Probes Are Inferior

One of the greatest problems in the use of test equipment has been the method of connecting (or coupling) to the radar system. One method which is widely used is to locate a small test antenna near the radar antenna. This method has three serious disadvantages: (1) The radar antenna always must be pointed in a fixed direction which may make it impossible to eliminate objectionable signals, particularly at bases where most work is done. (2) Unless some method is devised to place the test antenna at the identical point in the radar antenna beam each time a test is made, it is very difficullt to reproduce test conditions and results. (3) There is often a long cable run required from the test antenna to the test equipment. This cable run will introduce a loss which may be large and difficult to determine.



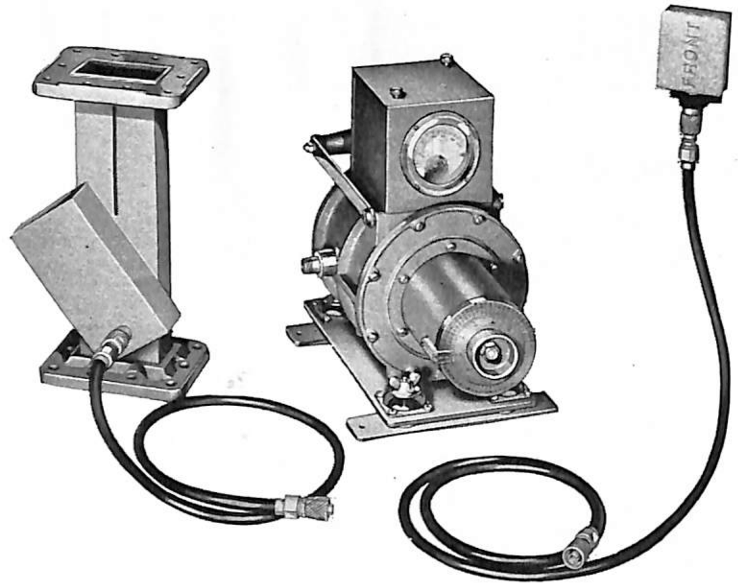
This bi-directional coupler can be used on S_S-band, radars, having 1-1/2″ x 3″ waveguide transmission lines and where 27 db. coupling is required. Similar couplers can be made using other values of coupling. Different values of coupling are used with various models of radars to enable the same echo boxes to be used.

Another method of coupling to the radar system is to use a probe placed in the transmission line. The most serious disadvantage of this method is that the amount of coupling loss from the probe to the line depends upon its position with respect to the standing wave pattern in the line which may change with antenna position.

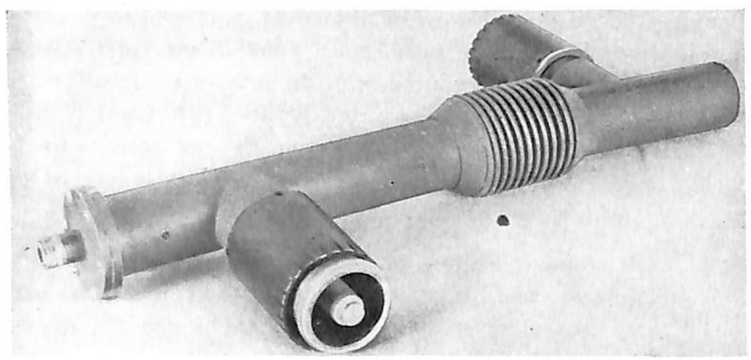
To eliminate the objectionable features of these two methods the directional coupler is now being used wherever possible. A directional coupler (sometimes referred to as a "wave selector" or "directional tap") is a device which provides for coupling to a transmission line with a *fixed* coupling loss which is relatively independent of the standing wave condition in the line.

There Are Many Types of Couplers

Directional couplers are built in a wide variety of sizes and shapes. Many are being shipped out along with the latest type echo boxes and newly designed systems will have them built permanently into the waveguide. Whatever peculiarities the external appearance of the coupler may present, fundamentally it is an auxiliary section of waveguide fastened to the main waveguide and electrically coupled to the main waveguide by a small opening or series of openings (even for coaxial lines). The auxiliary section of waveguide has a combined output and input fitting on one end and a power absorbing material, which you cannot see from the out-



From left to right: CABV-47AAN directional coupler, CABV-14ABA-1 echo box and CABV-66AJG pickup dipole.
This type directional coupler is for use with S_3-band radars having 1-1/2" x 3" wave guide transmission line. It may be seen that in this case the auxiliary wave guide section is fastened to the longest side of the main wave guide and is set at an angle. The auxiliary line fitting will connect to a flexible cable for coupling to the echo box.



A directional coupler for use with radars having coaxial transmission line. The auxiliary line fitting is seen at the extreme left. The center accordion section is a flexible section to insure fitting and reduce shock and vibration and is not part of the directional coupler as such. At the extreme right end is a stub support for the center conductor. This type of coupler has been called an "inside out" coupler as it is a coax line within a coax line, the center conductor of the auxiliary line being within the center conductor of the main coax line.

side, at the other end. The size of the coupling openings and their location with respect to the fitting and absorbing material determine the "coupling" and "directivity" of the coupler. "Coupling" and "directivity" may sound like high-powered technical terms but they provide a simple means of describing certain important characteristics of a directional coupler. "Coupling" merely means the fraction of the main waveguide power which is obtainable at the auxiliary line fitting of the directional coupler. This is always expressed in db. For instance, if the power obtainable at the fitting of the directional coupler is 1/100 of the main power in the transmission line, the coupling is 20 db. The term "coupling" is usually applied in connection with the power traveling from the transmitter toward the antenna. To indicate to what extent the directional coupler is independent of reflected power and the resulting standing wave pattern, the term "directivity" is used. It is a measure of the ability of the coupler to reject power traveling in the main waveguide in the reverse direction toward the receiver. It is measured by inserting the coupler in the line in the reverse direction and comparing the power at the auxiliary line fittting with that obtained when the coupler is insalled in the normal direction. The ratio, expressed in db, is the directivity. The better the directivity the less the effect that standing waves will have on the incident power coupled out.

In addition to sampling system power, the directional coupler may be used to supply power to a system. For instance, power may be fed into the auxiliary line fitting of a 20 db coupler and 1% of it will appear in the main line traveling toward the receiver.

The foregoing discussion applies to a single directional coupler which, as stated before, is a device for coupling to power traveling in only one direction and for discriminating as much as possible against power traveling in the reverse direction. Where it is desired to measured the reflected power, an additional directional coupler may be installed in the reverse direction. This makes it possible to measure both incident and reflected power. A combination of couplers for this purpose is usually referred to as a bi-directional coupler and permits measurements of standing wave ratio in the transmission line without taking the system to a bench for the usual traveling probe method. Used with an echo box the directional coupler provides an accurate and reproducible measure of the overall system performance.

CHECK YOUR RADAR CRYSTALS

One of the greatest problems which parallels the development of electronic equipment is that of designing new test equipment. This is of utmost importance if the units are to be kept in tune, and aligned properly. And certainly there is no piece of equipment which will give maximum performance unless each unit and circuit is operating as it was designed to operate.

Until recently there was no positive means of testing crystals of the S- and X-band radars. The Crystal Rectifier Test Set TS-268/U, shown in the figure has been developed to fill this long-felt need. Thousands of crystals have been tested by this circuit and the results show that this tester is very reliable. Types 1N21, 1N21A, and 1N21B crystals for the S-band and types 1N23, 1N23A, and 1N23B for the X-band may be tested. In addition, this tester may be used for L-band crystals (1N26) by the same procedure as for the 1N21.

Special features of this tester are:

1. Automatic off-switch (center of MTR ADJ knob) that disconnects the 1-1/2 volt self-contained battery when the lid is closed.

2. Static discharge wire in crystal rectifier jack. This wire must be pushed down with the fingers before inserting crystal, thereby discharging the body static.

3. Rubber gasket and watertight case. The test set is submersion proof when case is properly closed.

4. The meter is a specially selected American War Standards movement in a square case, and with a special scale. The d-c resistance of the meter is 100 ohms.

5. The unit is very small and compact, being only 6" x 7" x 2-3/4". It weighs 2 pounds.

Crystals may easily be tested by inserting them into the jack on the tester and carrying out the following procedure:

1. Turn selector switch to MTR ADJ and adjust meter for full scale.

2. Turn selector switch to FWD RES, and read the forward resistance on the kilohm scale. *Discard the crystal if reading is higher than 0.5 kilohms.*

3. Turn the selector switch to BKWD RES and read the backward resistance on the kilohm scale. Discard the crystal if the *back resistance* is not at least 10 times as great as the *forward resistance.*

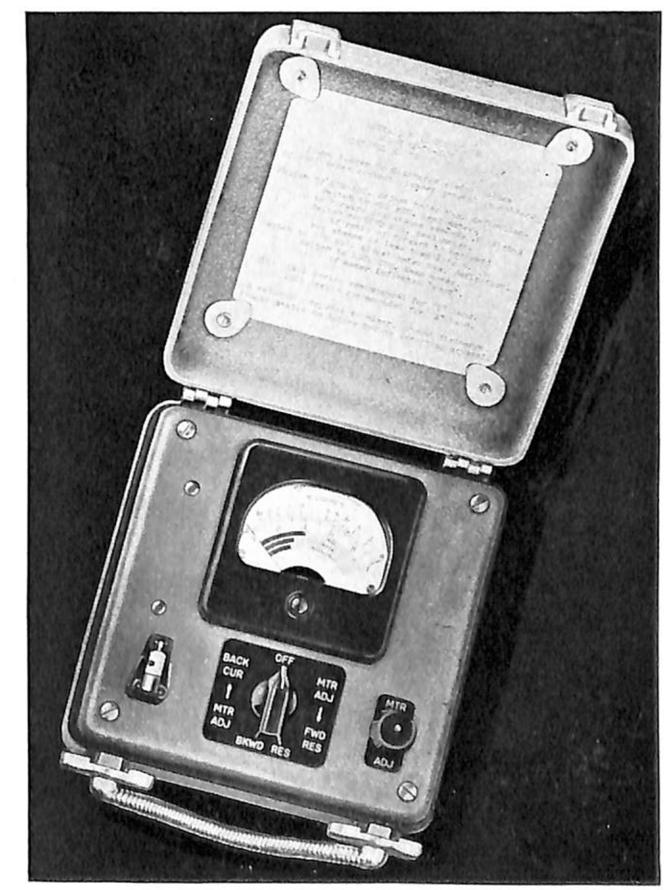
4. Turn selector switch to MTR ADJ and adjust for full scale again.

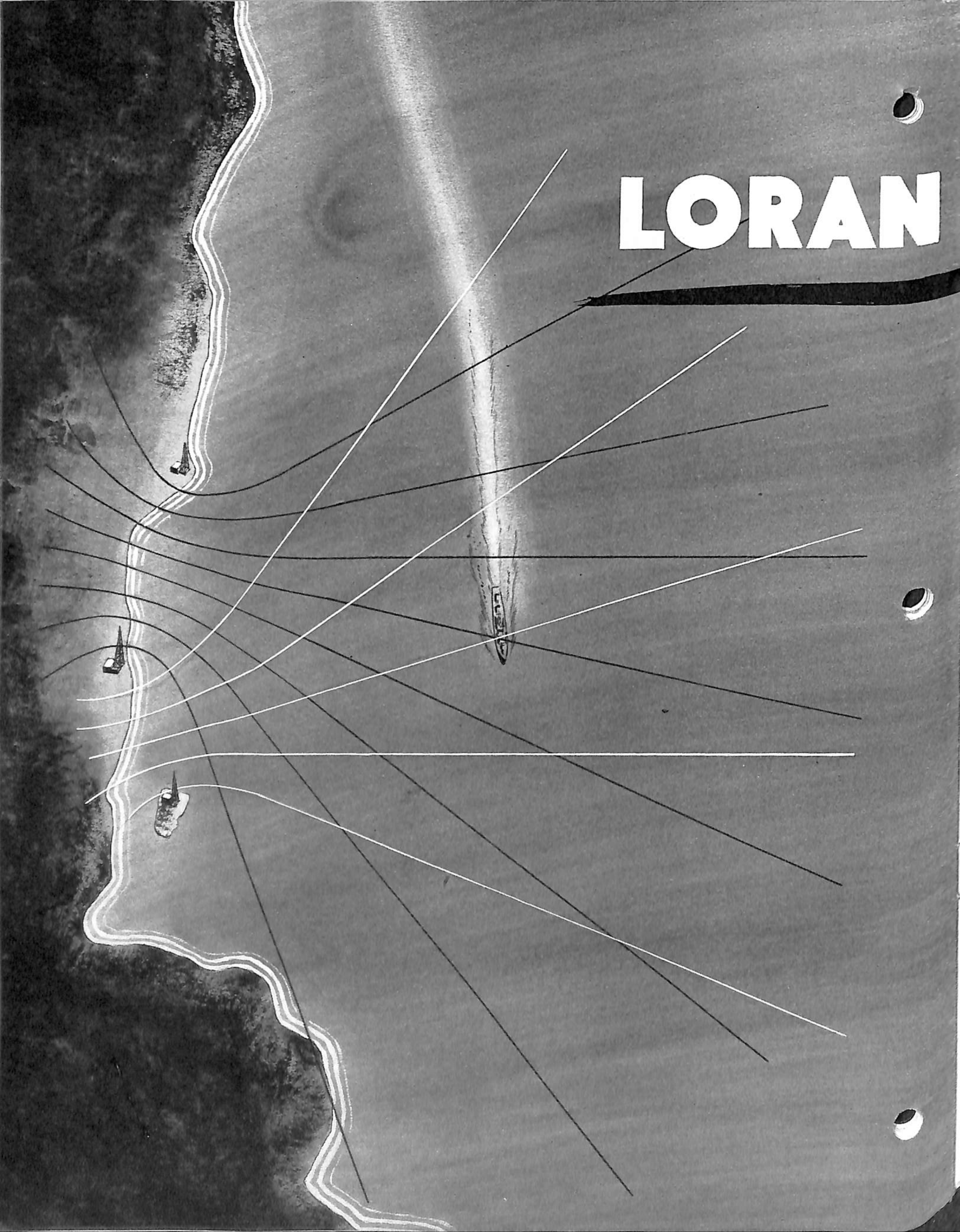
5. Turn selector switch to BACK CUR, and read back current on appropriate "Good-Poor" Scale. *Discard if crystal indicates "poor."*

It has been found that British crystals for S- and X-bands are the same mechanical size as the American crystals but that *polarity* is reversed. With careful thought, however, they may be tested with this test set. The procedure would differ in the following ways:

1. FWD RES indicates *backward resistance.* 2. BKWD RES indicates *forward resistance.* 3. BACK CUR is used for adjusting meter. 4. MTR ADJ is used for measuring reverse current on Good-Poor scale.

Production and delivery of this equipment has begun.





LORAN Streamlined

LT. ROBERT L. FRANK, USNR
Bureau of Ships

A PREVIEW OF THE DBE RECEIVER-INDICATOR

■ Operational experience during the past two and a half years has definitely proved that Loran is an extremely valuable aid to shipboard as well as aircraft navigation. The great demand for Loran equipment has necessitated the continued production of the DAS series radio navigation equipment (Loran receiver-indicator), even though the Bureau of Ships recognized the many design deficiencies of those models, which were adapted from early semi-experimental Models LRN-1 and LRN-1A. However, early in 1944, the Sperry Gyroscope Company contracted to develop for the Bureau of Ships a radically new and improved equipment, known as Model DBE. This model incorporates the results of many field comments on earlier equipments, and features operating ease, unusual mechanical layout, and new circuit design and reliability.

The receiver-indicator unit is deck mounted, and is 43 inches high by 15 inches square. The bulkhead braces may be attached to the back or to either side. The power and antenna input connections are through the bottom. All operating controls are on the top panel and are protected when not in use by a hinged cover. Entire access to the equipment for adjustment and maintenance is through a removable front cover plate.

The antenna coupling unit mounts on an exterior bulkhead at the base of the antenna, and connects to the receiver-indicator with RG-10/U coaxial cable. As in all Loran installations, the antenna consists of an ordinary vertical wire 35 feet or more in length.

The equipment has 45 tubes and a maximum power consumption of 300 volt-amperes at 115/230 volts, 50/60 cycles. The weight installed, not including spare parts, is 232 pounds.

Delivery of Model DBE is scheduled to begin in the late summer of 1945. The large demand for any type of Loran means that the equipment will be used at first mainly for new installations, rather than to replace ex-

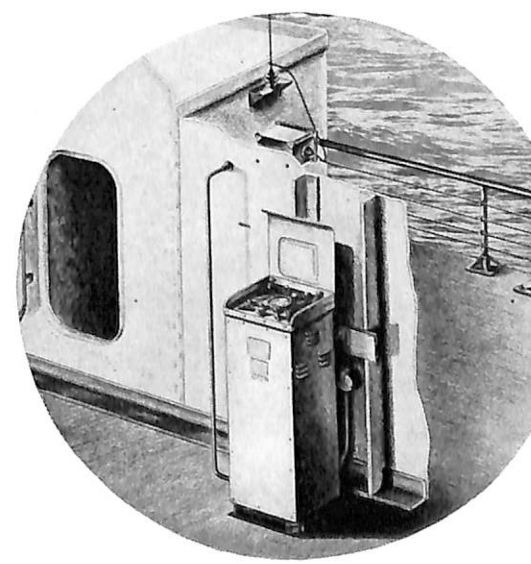
BASIC PRINCIPLE OF LORAN

(1) *Radio signals consisting of short pulses are broadcast from a pair of medium-frequency, shore-based Loran transmitting stations. The signals from the two stations are rigidly synchronized by a radio link between them. Different pairs of stations broadcast on different radio frequency channels or at different pulse recurrence rates.*

(2) *The signals are picked up aboard ship by the Loran receiving equipment and displayed as pips on a cathode ray tube. Using the equipment, the shipboard operator measures the* difference *in time of arrival of the two signals, in microseconds.*

(3) *This time-difference establishes a single line-of-position, by reference to Loran charts or tables. The ship must be somewhere on that line.*

(4) *Two or more lines-of-position, from two or more pairs of stations, fix the ship's location as their intersection.*



isting insallations of other models. It is not expected that a separate type allowance for Model DBE will be established, but rather that it will be pooled with other models and insalled as available.

Simplified Operation Featured

The operating control panel is shown in detail in figure 1. The cathode-ray tube face is recessed below the panel for light shielding; the equipment may, therefore, be operated under normal cabin illumination levels. The most unique feature is the TIME-DIFFERENCE meter, of the "veeder-counter" type, which indicates the time-difference reading directly to the nearest microsecond. Thus no time-markers are required on the oscilloscope face as in all previous Loran receiving equipments, and operation is facilitated to a great extent.

Also important is the simple and completely functional grouping of controls. The three station selecting controls, radio frequency CHANNEL, BASIC PRR (pulse recurrence rate), and SPECIFIC PRR, are arranged in a line and appear in the same order as the identifying symbols on Loran charts and tables. The complete sequence of cathode-ray tube sweep speeds is controlled by progressive positions of the single OPERATIONS switch, as shown in figure 2. The coarse and fine DELAY controls, which affect movement of the *B* pedestal and the TIME DIFFERENCE meter, are concentric and arranged for convenient gripping by the right hand in heavy seas. The GAIN control, which affects the amplitude of both signals, and the AMPL. BALANCE control, which equalizes the amplitude of the two signals, are likewise concentric and arranged for convenient gripping by the left hand. The left-right switch and DRIFT (oscillator frequency) control are a concentric lever and disk, and arranged in easy reach of the left hand also.

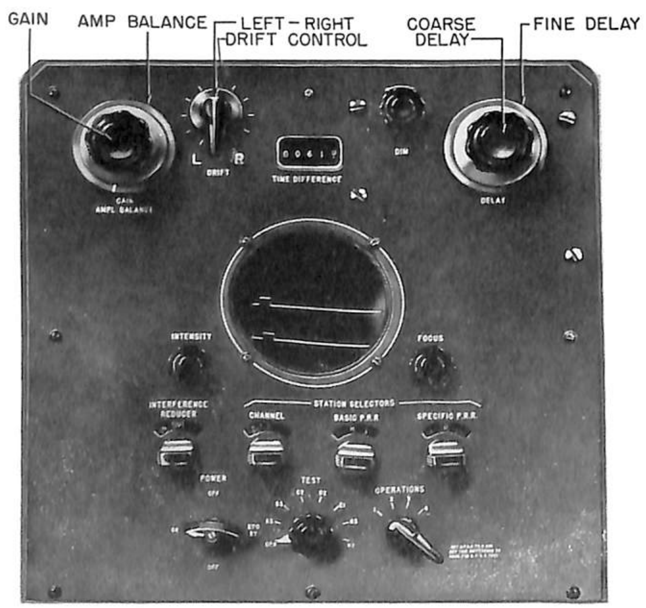


FIGURE 1.—*Improved control panel of DBE Loran indicates time difference directly in microseconds.*

In the design of the receiver and oscilloscope circuits considerable care has been exercised to provide a steady trace which is disturbed to a minimum extent by noise and by drifting signals of various recurrence rates. The receiver has been made as selective as possible consistent with the requirements of pulse reception, and all receiver channels are crystal controlled to reduce frequency drift. The INTERFERENCE REDUCER switch introduces a high-pass filter into the video circuits to minimize phone and c-w interference.

The TEST switch provides oscilloscope patterns which the operator may use to completely check the alignment and calibration of the equipment in about three minutes. A summary card inside the top cover eliminates the need for memorizing the check procedure.

In the STANDBY position of the POWER switch all tube filaments are lit and the equipment operates immediately when then turned ON. The TIME DIFFERENCE meter and STATION SELECTORS are illuminated to facilitate operation in the dark.

Provision is made in the equipment for a basic pulse recurrence rate of "S" corresponding to 20 pulses per second. This is in addition to the present standard basic pulse recurrence rates of "L" (25 per second) and "H" (33 1/3 per second). This additional rate is for possible future expansion of the Loran System.

A feature of the instruction book is the inclusion in the Operation section of all material in the *Loran Handbook for Shipboard Operators* (SHIPS 278), in suitably revised form.

Installation and Maintenance

The receiver-indicator unit mounts to the deck and bulkhead by S-shaped semi-hard steel straps which act as shock mounts. Since no access to the sides or back is required for maintenance the equipment may be mounted in a space only 18 inches wide, and it projects from the bulkhead only 17-1/4 inches. The mounting bolts and antenna and power inputs are carefully arranged so that actual installation within this space limitation is possible (with a little squeezing!).

All adjustments requiring routine maintenance alignment, including all divider and multivibrator adjustments, all oscilloscope adjustments, and all receiver r-f adjustments, are located for easy access on the vertical front surface of the equipment, and are protected against unauthorized tampering by a removable front panel. Maintenance testing is facilitated by the use of a second test switch located behind the front panel, in addition to the TEST switch on the top control panel.

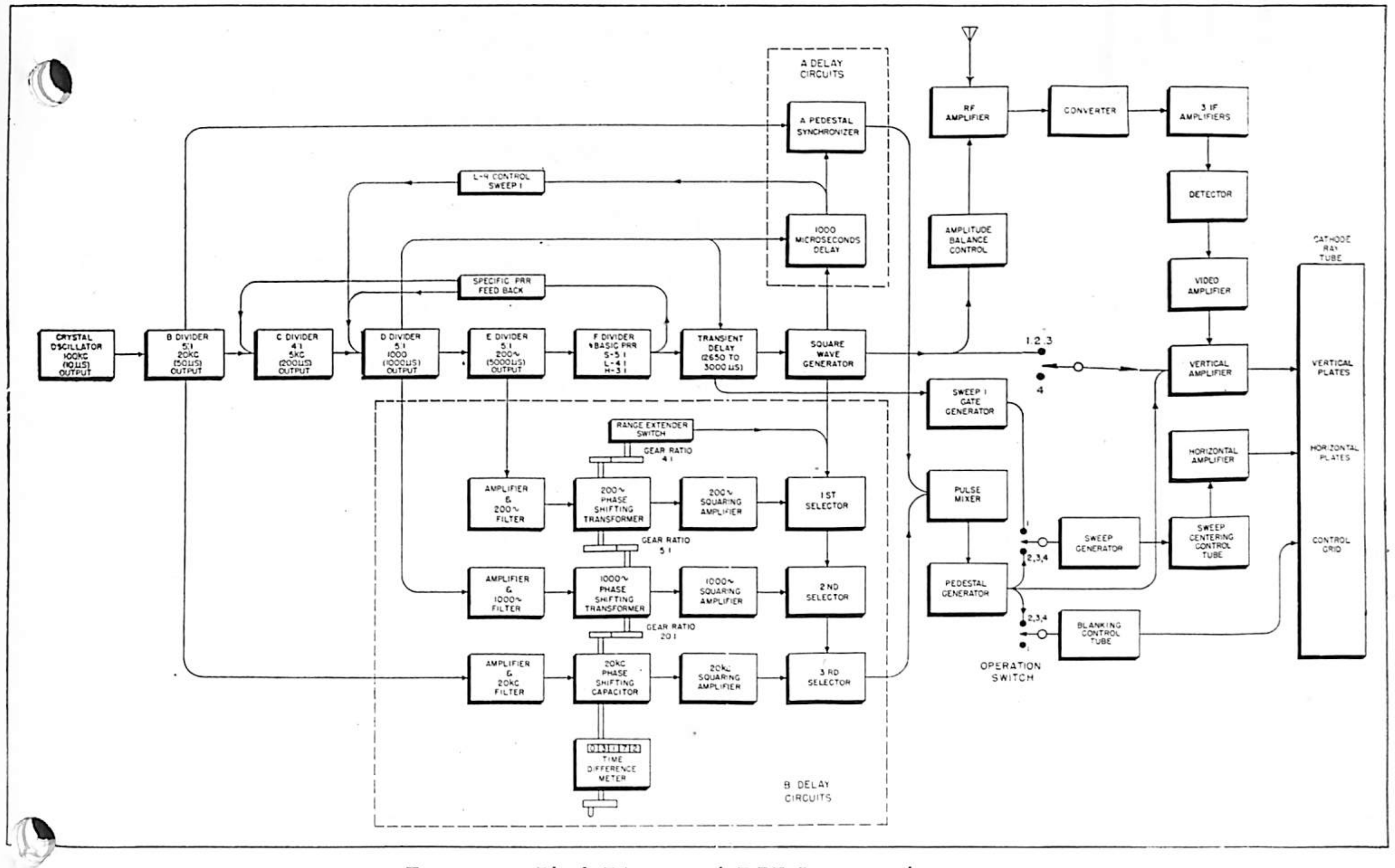


FIGURE 3.—*Block Diagram of DBE Loran equipment.*

Removal of four captive bolts permits the entire chassis assembly, including the top panel, to slide on rails out of the cabinet, as shown in figure 5. Catches firmly hold the chassis in the withdrawn position. In this position all adjustments of a more permanent nature, including receiver i-f transformers and factory adjustments, are accessable. The majority of the circuit component mounting boards are pivoted to permit easier access to recessed parts and tube bases, and receiver shielding may be easily removed.

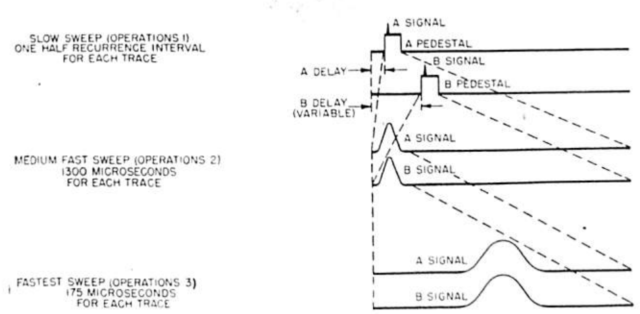


FIGURE 2.—*Graphical representation of a signal on the three different sweep speeds available. Position 4 of the operations switch eliminates the trace separation.*

The chassis frame consists of a central column containing the cathode-ray oscilloscope tube; extensions from this column engage the two sets of sliding rails. The control panel assembly mounts on top the central column and can be completely removed by loosening several bolts and disconnecting wires at screw terminal boards. The rest of the circuit is contained on four U-shaped sub-chassis which fit around the central column, and these likewise may be individually removed for major repairs. The cathode-ray tube is accessible through a removable protective shield at the rear of the central column.

Release of a set of catches allows the entire chassis to be removed from the rails. Flexible antenna input and power cables connect the chassis assembly to the antenna input connector and power input terminal box, which are located in the bottom rear of the cabinet, as shown in Figure 4. The chassis assembly can then be laid on the deck, on any side, for further access for servicing, with power and antenna connected. All cathode-ray tube accelerating voltages are protected by shields to prevent accidental contact while testing with power on.

As shown in figure 4, antenna input and power input are accessible from the front through the interior of the cabinet, and no access to the sides or back of the equipment is required. The cables are fed up through loose-fitting tubes set in the bottom of the cabinet. The plug may be assembled on the coaxial cable from the antenna coupling unit before the cable is inserted into the cabinet; the equipment is furnished with a length of power cable already wired into the power input box. Thus access to the interior may be restricted to skilled Loran technicians, yet all installation wiring may be done by regular electricians.

Circuits To Do the Job

A simplified block diagram of the Model DBE is shown in figure 3. The 100 kc crystal oscillator, divider circuits, feedback circuits, square-wave generator, pedestal generator, sweep generator, cathode-ray tube amplifier and control circuits, and receiver circuits function similarly to those in previous Loran equipments of the DAS and LRN series, and will not be considered in detail here. However, the following specific improvements and difference in these circuits are notable:

(1) The divider circuits all have ratios of five to one or less, for greater stability, and an improved circuit with cathode coupling is used. (The Specific PRR feedback must go to two different dividers, but the basic principle is unchanged.)

(2) A transient delay circuit before the square-wave generator stabilizes the operation of the more complex *B*-delay circuits in the Model DBE.

(3) The Left-Right control on sweep 1 (OPERATIONS switch position 1) is applied to the third (*D*) divider instead of the first, and operates in an absolutely stable and non-critical manner.

(4) The amplitude balance control is applied to the r-f amplifier instead of the last i-f amplifier, which results in much greater range of control (up to 1000 to 1 signal strength ratio) and lessened distortion.

(5) A single hard-tube sweep generator is used for all sweep speeds.

The *B*-delay circuits do the actual time-measuring. The heart of these circuits is the 200-cycle and 1000-cycle phase-shifting transformers and the 20-kilocycle phase-shifting capacitor. Amplifiers and low-pass filters extract the fundamental frequency sine waves to excite the phase shifters from the output pulses of appropriate frequency divider circuits. The three phase shifters are mechanically coupled through a gear chain to the DELAY knobs and the TIME DIFFERENCE meter, and the phase shifters turn in the ratio of their frequencies. Thus a given rotation of the fine DELAY knob produces the same *time-shift,* in microseconds, in

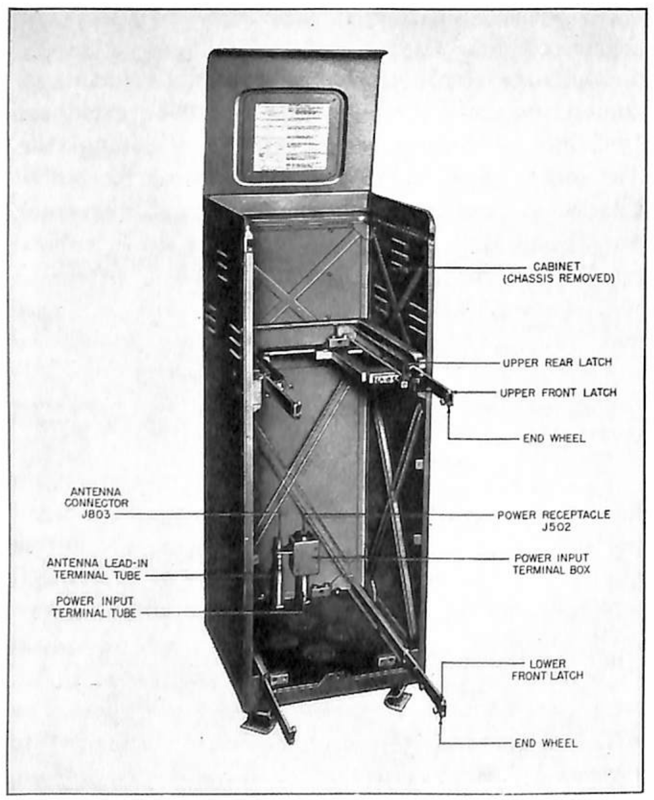


FIGURE 4.—*The chassis may be removed and serviced while power and antenna remain attached.*

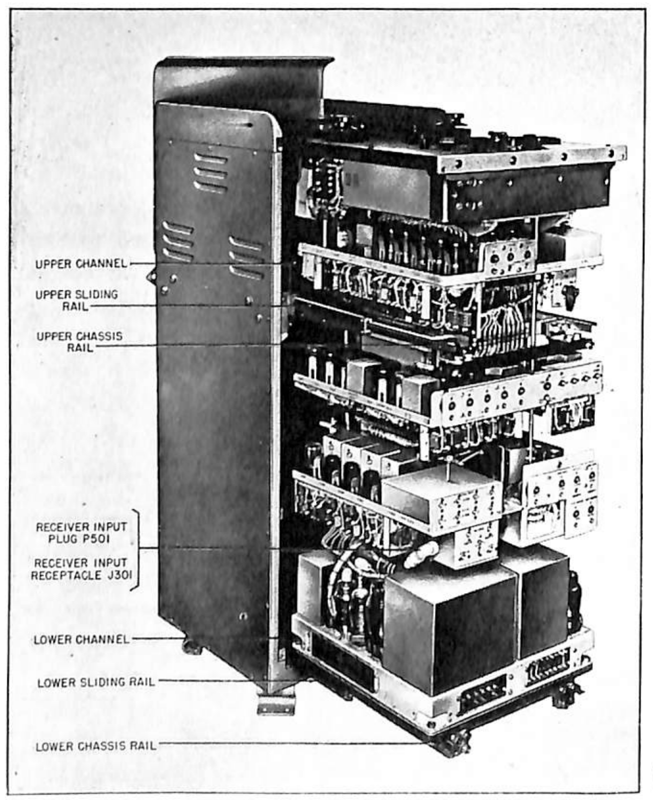


FIGURE 5.—*The entire chassis, including the top panel, may be slid on rails out of the cabinet.*

all three frequencies. The sine-wave outputs of the three phase shifters are then squared and peaked to form triggers for the multivibrator selector circuits. The first selector is triggered *on* by a pulse derived from one-half of the square-wave generator output; it is triggered *off* by the first, second or third following phase-shifted pulse from the 200-cycle chain, depending upon the bias level established by the range extender switch. Thus the first selector will be *on* for a length of time which may be smoothly varied by the fine DELAY knob from less than 1000 to more than 18000 microseconds. When the first selector goes *off* it triggers the second selector *on,* and this selector is triggered *off* by the next following phase-shifted pulse from the 1000-cycle chain. When the second selector goes *off* it triggers the third selector *on* and this selector is triggered *off* by the following phase-shifted pulse from the 20-kilocycle chain. When the third selector goes *off* the pedestal generator is triggered *on* through the pulse mixer

Since the time-shift of the three sets of phase-shifted trigger pulses is the same, the first selector in effect keeps track of a particular 200-cycle pulse, the second selector keeps track of a particular 1000-cycle pulse, and the third selector keeps track of a particular 20-kilocycle pulse, through many revolutions of the respective phase shifters. The accuracy with which the *B*-pedestal and consequently sweeps 2, 3 and 4 are triggered is thus determined solely by the accuracy of the 20-kilocycle phase-shifting circuits, while the range of time measurement is extended in increasing amounts by the 1000-cycle phase shifter, the 200-cycle phase shifter and the range-extender switch. An overall accuracy of better than one microsecond in 18000 or 0.005 percent is thus achieved by the combined use of phase shifters which individually do not have a potential accuracy of much better than one percent. (In the Model DBE the actual accuracy of the 1000-cycle and 200-cycle phase shifters is much less than this because of transients introduced into the sine waves by the feedback in the divider circuits.) Those familiar with the Mark 4 radar will recognize a basic similarity, insofar as the use of multiple phase shifters is concerned, between the range-measuring circuits in that equipment and the *B*-delay circuits in the Model DBE; the detailed operation of the circuits, however, is quite different.

The coarse DELAY knob provides for a rapid movement of the B-pedestal through a differential gearing and detent system which moves only the 200-cycle phase shifter, range-extender switch and thousands and ten-thousands dials in the TIME DIFFERENCE meter, yet maintains all elements of the complete system in correct alignment.

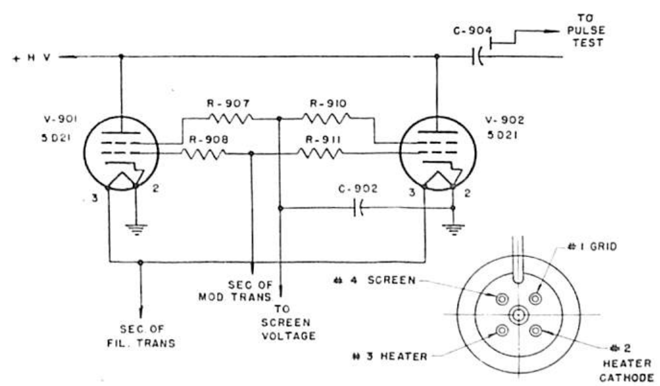
The *A*-delay circuits are similar to the selector circuits, but introduce fixed delays. The 1000-microseconds delay is triggered *on* by the opposite half of the square wave which triggered the first selector, and is triggered *off* by the next following pulse from divider *D.* When that circuit goes *off* it triggers the *A* pedestal synchronizer *on,* and the synchronizer is triggered *off* by the next following pulse from divider *B.* When the synchronizer goes *off* the pedestal generator is triggered *on* through the pulse mixer. Thus divider *B,* through the *A* pedestal synchronizer and the 20-kc phase-shifting circuits and the third selector, forms a common timing basis for both the *A* and *B* pedestals, which result from the output triggers from the *A* and *B* delay circuits respectively. This common timing basis reduces the possible sources of time-measurement errors.

WIRING ERROR IN AN/CPN-6 RACON

The EFSG reports that there have been several cases noticed of an error in the wiring of the transmitter-modulator T-79/CPN-6, and the following changes in the schematic diagram and equipment are necessary:

(a) The external connections to pins 2 and 3 of V-901 in the transmitter-modulator unit are reversed. This error was not made in the schematic diagram, and may not be found in all equipments. However, it is advisable to check all units to determine if they conform with the illustration.

(b) Correct the transmitter-modulator T-79/CPN-6 schematic diagram in the instruction book by reversing the connections to pins 2 and 3 of V-902. This error was found only in the schematic diagram and not in the equipment.



The Field Engineers say—

EXCERPTS FROM THE REPORTS OF THE FIELD ENGINEERS

MARK 8 MOD 3

Western Electric has found that in order to improve receiver tuning of the D-152516 Control Indicator in the Mark 8 Mod 3 Radar, it is necessary to change resistor R-202 from 0.12 megohms to 0.47 megs. A field change incorporating this change will be prepared soon under title, "Control Indicator Resistor Change", Field Change No. 40.

—*E. F. S. G.*

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INTERMITTENT FADING IN MARK 8

A condition has been noted in several Mark 8, Mod 2 and 3 Auxiliary Indicators which causes the scope pattern to gain and lose intensity intermittently. In every case the trouble has been traced to R-42 touching R-41, thereby damaging R-42 and causing erratic performance. This situation may easily be corrected by bending the resistors apart. Check yours!

—*Western Electric*

•

AVOID OVER-COUPLING SR OSCILLATOR

In tuning the transmitter, if the matching stubs are adjusted so that the oscillator is overcoupled, a double trace may appear on the monitor and range scopes. This over-coupling gives the effect of a double-humped resonance curve for the cathode-tuned circuit of the oscillator, so that it may oscillate at either of two frequencies separated by a few megacycles. Some of the output pulses, therefore, will be at one frequency and some at a slightly different frequency. If the receiver is tuned to one of these two frequencies, then the response from the set of pulses at the other will be much less, and the two traces will appear on the scopes. By changing the receiver tuning, the response can be maximized on either trace. The division of the energy output between the two frequencies may be seen from the echo box response. The grid voltage waveform is normal except that a slight ripple is apparent. This occurs since the oscillator is not equally loaded for the two modes of oscillation, so that for one frequency the grid is not driven as far negative during the pulse as it is for the other.

—*E. F. S. G.*

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REPLACEMENT TRANSFORMER FOR QJB UNITS

A rather high failure rate is being experienced at present with the high-voltage transformer T-401 in QJB equipments. Corrective action will be taken in the very near future. In the meantime it may be well to know that T-402 of the SL equipment (Item 44T) is an exact duplicate of T-401 in the QJB, and may be used in case QJB spares are not on hand.

—*Western Electric*

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TUNING THE AJ RECEIVER IN SC/SK RADARS

A series of tests on the AJ receiver were run to determine just what effect changing 446A r-f tubes would have on its over-all performance. The data taken is too voluminous to be included here, but a sample has been chosen to indicate the results obtained.

First the receiver was tuned to peak, both by tuning the front panel controls and by tuning the compensating capacitors C-4004 and C-4013 With a fixed receiver gain, a signal to noise ratio of four E units was obtained on the *A* scope.

Another 446-A was substituted for V-4002 and, without touching any of the tuning adjustments, gave a gain of 1.94 db.

Next, the front panel adjustments were peaked, and this resulted in a gain of 2.766 db. This was, of course, to be expected.

Tuning the side panel capacitor C-4013 gave a gain of 3.522. As you can see, this side panel adjustment was fully as important as adjusting the front panel controls.

The importance of tuning C-4013 will vary with the characteristics of the 446-A tubes used. However, in any case it should be peaked not only when 446-A's are replaced, but also as they age in use.

The tuning of C-4004 is not so critical, but it is a good idea to touch it up too at the same time C-4013 is adjusted.

Previously, these side panel controls have not been mentioned in receiver tuning instructions. They will be included in the new SC-5 instruction book soon to be issued.

—*General Electric*

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MARK 28 MOD 2 AND MARK 34 MOD 2

An engineer had a close call last week when he was standing under the 40mm guns working on a Mark 34 transmitter and some one turned on the synchro switch with the gun elevation control in AUTOMATIC. The director was depressed and the guns elevated. Things happened very fast as the guns came into position with the director, and he got away with only a bruised shoulder. There is only one simple safeguard to avoid this happening, and that is to turn the gun mount switch *off* and hang a tag on it saying DO NOT OPERATE THIS CONTROL UNTIL TAG IS REMOVED. Also, make sure the train and elevation control levers are in MANUAL or LOCAL before going near the transmitter.

—*Western Electric*

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DAQ DIRECTION FINDERS

Calibrations of HF direction finders are showing excessive reentries that are not uniform throughout the frequency spectrum. It was noticed that poor sense-angle on HF was ofen greatly improved simply by installing a new antenna assembly, although in most cases nothing radically wrong was found with the old assemblies. The adjustment of the balancing capacitor was very critical in most of the DAQ units. In one case the smallest fraction of a degree error in setting meant the difference between good and poor sense over a considerable portion of a critical band of frequencies from 4 to 7 mc.

Experiments are now being made with modifications in the antenna assembly of the DAQ in an effort to obtain better sense-angle and less reentry.

—*E. F. S. G.*

•

MARK 13 LONG-RANGE LINE

At times the circuit which produces the dotted Long-Range Line does not function properly. The following is a method of correcting this condition:

(a) Cut the lead from terminal 1 of T-1 at the junction of R-15 and C-8, and reconnect it from terminal 1 of T-1 to ground.

(b) Disconnect R-14 from pin 6 of V-3 and run a new connection from pin 6 of V-3 to the junction of R-15 and C-8.

This modification has the effect of reducing the steady current through the primary of T-1 and R-5 and results in increased amplitude of the range line.

—*Western Electric*

•

INSULATION BREAKDOWN IN MARK 8 RADAR

A serious situation in the D-152271 transmitter has come to light. The dropping resistor R-13, in series with the Peterson coil is mounted on the top of the pulser box, on the end nearest the front panel. The lead between terminal 5 of the pulser box and the resistor clip runs over the screw which mounts the assembly, forcing the lead against the under side of the resistor. This resistor runs hot under normal operation. One breakdown with a resultant loss of a pulser box, resistor, and cable, has resulted. This lead has been found to be dressed in the same manner in a number of transmitters and should be checked on all equipments of this series.

—*Western Electric*

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SD-5 ARCING AT RECEIVER INPUT

In some installations it has been found impossible to stop arcing at the antenna tuning capacitor in the receiver. Proper overall tune-up will aid in minimizing this. Some aid may be obtained by making certain that the capacitor plate-spacing is uniform. In stubborn cases, a slight de-tuning of the capacitor on the side of resonance which gives minimum decrease in signal and freedom from arcing, will correct the condition.

—*RCA*

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QJB GYRO CONNECTIONS

QJB installations have been found in which a foreign ground appears on the gyro system. Investigation reveals that this is due to the R1-R2 gyro leads being connected to terminals 8 and 12 of the QJB terminal board instead of connecting to terminals 27 and 28. This arrangement by-passes the gyro isolation transformer, thus defeating its purpose.

The probable cause of this miswiring is the use of an earlier type wiring diagram.

—*Western Electric*

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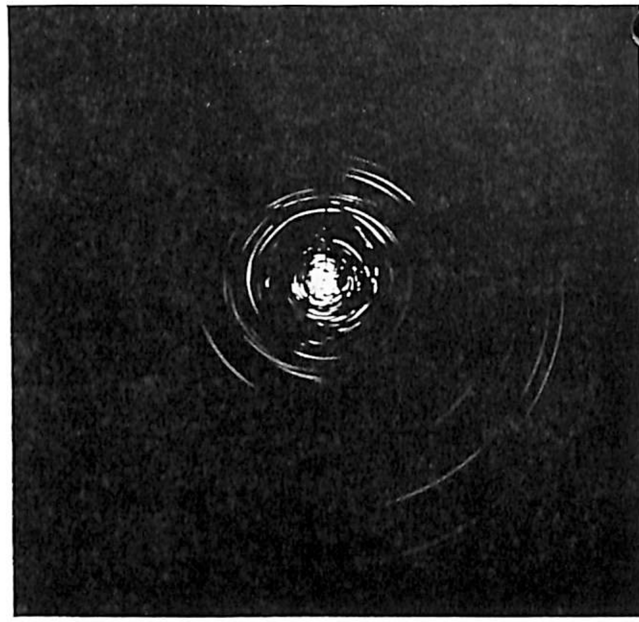
SIAMESE JACK FOR MARK 28

Although the SL wavemeter is normally used for testing Models 2 and 3 of the Mark 28 radars, no test cables are furnished and a special siamese coupling jack is necessary. This my be ordered separately through regular Navy channels as a Coupling Jack per ESO-690438, Western Electric Co. New D-152858 Test Equipment Kits containing all the necessary cables are available and are now being distributed.

—*Western Electric Co.*

FIGURE 1.—*When FTC is not used land masses appear solid on PPI Scopes, and targets are hard to track.*

FIGURE 2.—*Solid mass is broken up by FTC and tracking of moving targets is made comparatively easy.*



Tracking Planes Through Land Masses

THE FTC MODIFICATION

■ The problem of tracking planes over land masses is simplified by the use of a fast time constant circuit, called FTC.

In the SC/SK radar, the normal video coupling time constant of about 5000 microseconds causes land to appear solid on the PPI, as shown in figure 1. If the video time constant is reduced to a value equal to, or less than, the pulse length, the solid mass is broken up (see figure 2) and moving targets are much easier to detect and track.

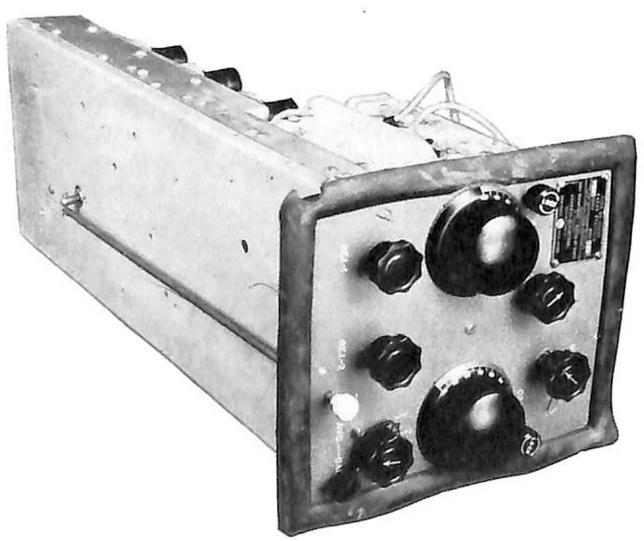


FIGURE 3.—*Photograph showing remotely controlled switch for FTC circuit. The control shaft for the switch runs up the underside of the chassis.*

The FTC in the present AJ SC receiver is incorporated in the AVC circuit rather than in the video circuit.

The nominal value of the added series coupling capacitor is 50 $\mu\mu$f, with a 50,000 ohm resistor between grid and cathode. This RC product give a FTC of 2.5 microseconds. The actual FTC is about 5 microseconds due to additional stray capacity. This stray capacity must be kept at a minimum by employing very short leads, and a remotely controlled switch. Installation may be made similar to that illustrated in figure 3. The diode clipper is not necessary if the resistor is connected as shown in figure 4.

Materials required for this circuit are:

C-4081: 50 $\mu\mu$f mica capacitor (C-622 in SC-2/SK series equipment spares).

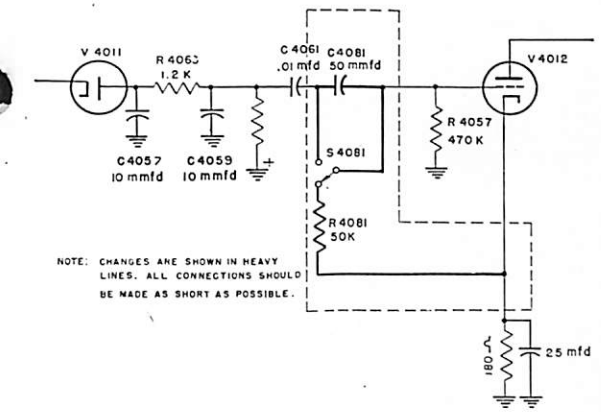


FIGURE 4.—*Schematic diagram for incorporating FTC circuit.*

R-4081: 50,000 1/2 watt resistor (R-322 or R-2032 in SC/SK series equipment spares).

S-4081: SPDT switch (S-110 in SC/SK series equipment spares).

The same technique is applicable to all radar receivers. On equipments utilizing shorter pulses, the resistance should be reduced so that the RC product, including stray capacity, is equal to, or less than, the pulse length.

This circuit is being incorporated in all new radar receivers and has been intiated as a modification to existing equipments. Ad interim addition in the field by ship technicians is authorized.

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Hickok Model RFO-5 Oscilloscope Modified

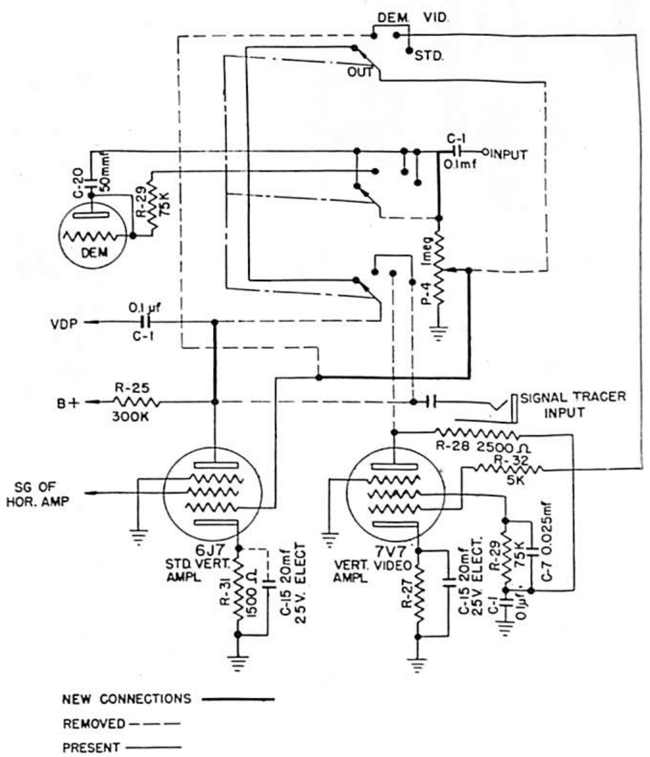
The Naval Training School, Chicago, has developed the following modification to improve the frequency response of the vertical deflection amplifier in the Hickok model RFO-5 cathode-ray oscilloscope.

(a) The grid of the vertical deflection amplifier, formerly connected to the attenuator through the "In-Out" (vertical function selector) switch, connected directly to the attenuator.

(b) The plate of the vertical deflection amplifier, originally connected to the plate load through the "In-Out" switch, is connected directly to the plate load.

(c) The cathode bypass capacitor of the vertical deflection amplifier is removed.

Elimination of the "In-Out" switch and cathode bypass capacitor reduced the gain at lower frequencies but extended the useful range of the amplifier up to 100 kc. Changes in wiring are shown in the diagram. It should be noted that modification removes the "signal tracing" and "video" functions of the instrument.



MODIFICATION OF HICKOK OSCILLOSCOPE MODEL RFO-5

Naval activities having Hickok model RFO-5 oscilloscopes are authorized to modify them in this manner provided that equipments so modified are suitably tagged or otherwise identified. Attention is invited to the fact that Navy model OBL series oscilloscopes have a nearly flat response to above 100 kc and therefore do *not* require modification.

PUBLICATION NEWS

NEW BOOKS

Recently distributed Electronics Division publications are listed below. Books needed by your activity may be obtained by writing to the Bureau of Ships.

Installation and Maintenance of Transmission Lines, Waveguides, and Fittings—
Restricted—NAVSHIPS 900,081. A complete description of cables, waveguides, and fittings together with standard installation and maintenance practices. Distributed to ships, and installation and maintenance activities. 186 pages.

Insulation and Maintenance of Submarine Cable for U.E.P. Net Gate Detection Units—
Confidential—NAVSHIPS 900,084. Distributed to activities having the equipment. 22 pages.

Installation of the Army-Navy Instrument Approach System SCS-51—
Restricted—NAVSHIPS 900,086. Describes installation problems and suggested practices. Distributed to activities concerned with the equipment. 26 pages.

List of Naval Radio, Radar, and Sonar Equipment—

Confidential — SHIPS 242A. Replaces earlier edition (SHIPS 242). Distributed to commands, schools, tenders, and maintenance activities. 141 pages.

Maintenance Manual for WCA/WCA-1 Sonar—

Restricted—NAVSHIPS 900.045. Describes in detail maintenance of the equipment. Distribution to ships having the equipment. 472 pages.

TRANSMISSION LINES AND WAVEGUIDES

Elsewhere in this section you will see an announcement on a recently published book entitled "Installation and Maintenance of Transmission Line, Waveguides and Fittings" (NAVSHIPS 900,081). We believe this publication will fill a long felt need in the Fleet for a complete story on that important subject.

NAVSHIPS 900,081 was given a wide initial distribution. If you didn't get one at your activity or if you need more, contact the nearest R.M.O. or write the Bureau. *A suggestion:* Before you conclude that you got left out of the distribution, check your ship or station carefully. Many a publication that "wasn't received" has been found in someone's file or safe.

RECENT INSTRUCTION BOOK DISTRIBUTION

The instruction books listed below have been distributed during the period 15 December, 1944 to 15 May, 1945. Those books which have "SHIPS" short titles are available at the Registered Publications Issuing Offices and the others may be obtained from Radio Material Officers.

Preliminary editions should be replaced with final editions where they are indicated as available.

MODEL	SHORT TITLE	EDITION[1]
AN/SPR-1/AN/APR-1		F
AN/TPS-1B	SHIPS 296	P
BDI Adapter QCQ-2, QCJ-2/QCL/QCJ-8/QCL-7.	NAVSHIPS 900,372	P
BDI for CBM-55105, CDI-55136,CQA-55098.		MM
BM/BO	SHIPS 262	F
BM/BO-SM IFF Coordination Assembly.	NAVSHIPS 900,340A	Inst. Instr.
BM/BO-SM IFF Coordination Assembly.	SHIPS 279A	F
CXGA-1		P
DAU	SHIPS 301 & 302-1	F
DAW-1/2	SHIPS 303	F
JM-1/3	NAVSHIPS 900,322	F
LAE	NAVSHIPS 900,311	F
LAF		P
LM-15		F
LM-16		F
LM-17		F
LM-18	NAVSHIPS 9C0,002	F
LR-2		F
MAH Submersion Kit	NAVSHIPS 900,420	F
MARK 3 and 4	NAVSHIPS 900,362	MP
MARK 8 Mod 1	NAVSHIPS 900,300	MP
MARK 8 Mods 2 & 3, Stable Element.		P
MARK 8 Mod 3	NAVSHIPS 900,364	MP
MARK 8 Mod 3	SHIPS 325	F
MARK 12 Mod 1	SHIPS 270A	F
MARK 26 Mods 3 & 4	SHIPS 250	F
MARK 26 Mods 3 & 4	SHIPS 312	MM
MARK 27 Mod 0	SHIPS 315	F
MARK 28 Mod 2	SHIPS 297	F
MARK 28 Mods 0 & 3	SHIPS 274	F
MARK 29 Mod 2	SHIPS 286A	F
NJ-4		P
NJ-7		P
NK-6		F
NK-7	NAVSHIPS 900,407	P
OAO-2	SHIPS 269	F
OAX-1	NAVSHIPS 900,308	F
OBL-3	NAVSHIPS 900,224	F
OBU-1/2	SHIPS 310A	F
OF-1		F
QBC-1	NAVSHIPS 900,313	F
QBE-3A		P
QBD		P
QCQ-2	NAVSHIPS 900,046	MM
QCW/QCX/QCY/QCZ	NAVSHIPS 900,309	F
QFF		F
QFJ	NAVSHIPS 900,230	F
QFL		P
QGB	NAVSHIPS 900,341A	F
QGB/QCQ-2 Dome Retracting Gear.		P
RAO-3/4	NAVSHIPS 900,359	F
RBA-1/2/3		F
RBB-2/RBC-2	NAVSHIPS 900,374	P
RBF-1	NAVSHIPS 900,293	F
RBL-3/4	NAVSHIPS 900,292	P
RBL-5/6/8	NAVSHIPS 900,349	P
RBP		F
ST	NAVSHIPS 900,336	P
TAB-7		P
TAJ-8	NAVSHIPS 900,295	F
TBA-12/13		F
TBK-11/15, TBM-6/8		P
TBK-13/TBM-5/7		P
TBK-19	NAVSHIPS 900,482	P
TBL-11		P
TBS-8	NAVSHIPS 900,483	P
TBW-5		P
TCB-1		F
TCE-2		F
TCS-7/9/10/11/12	NAVSHIPS 900,291	F
TDE-3		P
TDH-3		P
TDO		F
TDT		P
Trigger Delay Line Equipment.	SHIPS 292	P
TS-34/AP	SHIPS 284	F
TS-34/AP	NAVSHIPS 900,331	F
TS-120/UP	SHIPS 319	P
TVG Modification Kit for SubSig Receiver-Amplifiers.		P
Type CBM-55105		P
Type CLP-10335 Panoramic-Coupling Kit.	NAVSHIPS 900,051	F
Type CML-62154 Relay Terminal Box.	NACSHIPS 900,488	F
Type COAD-10345 Miller Computor.	NAVSHIPS 900,476	F
Type COQ-23403 Line Control Unit.		TM
Type CQV-46ACU	SHIPS 338	F
Type CTB-40141A Bathythermograph.	NAVSHIPS 900,234	P
Type 50UFS Frequency Modulated Station Equipment.		F
VE		P
VG/VG-1	SHIPS 261	P
VG-E	SHIPS 326	P
WEA-2a		P
WEA-2b		P
YJ/YJ-1	SHIPS 241	F

F = Final
P = Preliminary
MM = Maintenance Manual
MP = Maintenance Print
TM = Technical Manual

Aligning Link FM Receivers

BY LT. EDWARD D. SWEENEY, USNR, Bureau of Ships

■ Many Link FM receivers (11UF-12UF) in the field have been found to be improperly tuned, thus losing many of the advantages of FM reception and greatly reducing the range.

A method of alignment, which has proven itself in practice, will be outlined in step-by-step progression. No signal source other than an FM transmitter is necessary. The instruments and tools needed are as follows:

(a) 0-1 d-c milliammeter

(b) 0-100 d-c voltmeter

(c) 50-0-50 d-c galvanometer or microammeter

(d) Non-metallic screwdriver (This may be a neutralizing tool)

Two types of instruments incorporating the above meters and mounted in small portable oak cases are available. They are Link type 1288 and 1617. (They may also be used for the transmitter adjustment, and type 1617 includes a wavemeter.)

The following tuning procedure is recommended:

1. Allow a 15-minute warm-up period.

2. Using the 0-100 d-c voltmeter as an indicator, *carefully* adjust the oscillator trimmer T9 to maximum voltage, by taking a reading between the condenser shaft and ground. This should be about 60-80 volts. No signal is necessary for the adjustment. This completes oscillator tuning.

3. Plug the 0-1 milliammeter into jack T5A (J1 in mobile receiver) which is the first limiter grid. Use a fairly strong signal of the exact frequency. Tune T1 (antenna trimmer), T2 (RF Stage), T3B, T4B, and T5A for maximum reading of the 0-1 milliammeter.

4. Plug the 0-1 milliammeter into jack T6A (J2) which is the second limiter grid and tune T6A for maximum reading using a fairly strong signal.

5. No signal used. Visually set the primary trimmer of T7 (discriminator) so that the factory painted red lines coincide. The primary trimmer is the one nearest the 6AC7 tube. Should the red line be missing, set the trimmer midway in its travel as any mis-adjustment of the primary may be compensated for by the secondary tuning. This completes the primary tuning of the discriminator.

6. Use a fairly strong input signal. Plug the galvanometer into BALANCE jack. Tune the secondary trimmer of T7 so that the galvanometer reads zero. This may be checked by cutting off the input signal in which case the meter will read several divisions off zero. The meter should return to zero when the same input signal is re-applied. Discriminator tuning (T7) is now complete and no further adjustments need be made.

7. To obtain the utmost in performance it is necessary to realign T1, T2, T3B, T4B and T5A using a very weak input signal. Plug the zero center galvanometer into T5A (J1) and tune all these carefully for maximum deflection.

8. Still using a very weak signal plug the 0-1 milliammeter into jack T6A (J2) and tune T6A for maximum deflection. Sometimes the added sensitivity of the galvanometer may be taken advantage of in this jack but unless the signal is very weak it will go off-scale.

9. Setting the SQUELCH is the final adjustment. It is plainly marked and is located directly below T10. The proper adjustment is slightly beyond the point at which the rushing noise stops, and it must be adjusted without any input signal. The receiver is now properly tuned.

The equipment should be retuned at weekly intervals for a month until it has heat cycled and "settled down." Thereafter semi-monthly tuning is adequate.

Always have the motor in the vehicle operating at a fast idle speed when adjusting mobile stations.

Two grounds are advisable in vehicular installations, one of which should be one-half inch copper braid running from the mobile station ground to the car battery cable ground. The other should be a conventional ground with Belden braid to eliminate interference.

Note that T2 and T9 are calibrated from one to ten, so their approximate frequency can be interpolated from the position of the red line marked on the condenser shaft. This reading (expressed in megacycles) is determined from the *second number* of the frequency. Example settings are as follows: 36.140 mc, six; 38.300 mc, eight; 30.300 mc, zero; etc.

Should a signal generator be used for alignment, let it warm up for an hour and zero beat it frequently against a signal of the known proper frequency before proceedings.

Other things being equal, antenna height is the deciding factor in 30-40 mc communication. Strive for in-the-clear antenna locations in both fixed and mobile stations. It is always well to locate the fixed-station antenna in a high electrically-quiet location, and remote control the station itself.

Remote controls require an a-c source (60 watts 110v) and a telephone pair. They will operate the fixed station up to twelve miles. Any number of remote controls can be used and they furnish complete operation (transmitting and receiving) and occupy much less space than the fixed station.

Modification of TBS Equipment

The following modification of the Model TBS equipment was submitted by the Puget Sound Navy Yard and approved by the Bureau for inclusion in all TBS equipments. The purpose of the modification is to improve the reliability of relay K-101.

The adjustment of K-101 is very critical since its operation is dependent upon the reduction of the plate current of the type 6A6 relay control tube to zero when the m-c-w telegraph key is pressed. In the original equipment, variations in 6A6 tubes, drain on the power supply, etc. cause the minimum plate current to be as high as 3 ma. instead of zero. This variation in minimum plate current causes erratic operation of relay K-101.

The modification consists of adding a 5000 ohm resistor which bleeds current through the biasing resistors for the 6A6 tube thus insuring at least cut off bias for the 6A6 tube at all times. It should be noted that the new resistor is in the circuit only when K-104 is not energized. When the transmitter is keyed, K-104 removes the resistor from the circuit.

The modification is made as follows:

(a) Remove the three leads to the movable contact of K-104.

(b) Remove the +300 volt lead and lead from R-125 from the normally open stationary contact of K-104.

(c) Connect the +300 volt lead and lead from R-125 to the movable contact of relay K-104.

(d) Connect the three leads to R-102, R-132, R-133 to the normally open stationary contact of K-104.

(e) Connect a 5000 ohm, 40 watt resistor from the normally closed contact of relay K-104 to ground. The contact is not shown in the instruction book diagrams.

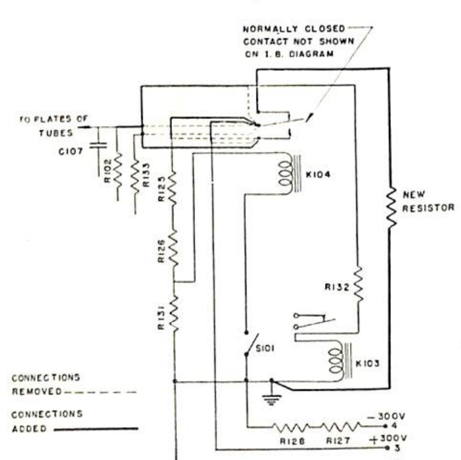
(f) Connections are shown in the attached diagram.

Attention is invited to the following requirements for the new resistor:

(a) Only a grade 1, class I resistor such as Sprague Koolohm type 40F or equivalent (JAN type RW 14F 502) may be used.

(b) The resistor should be mounted in suitable mechanical manner to resist shock and vibration.

(c) Due consideration should be given to the effects of heat from the resistor on adjacent components.



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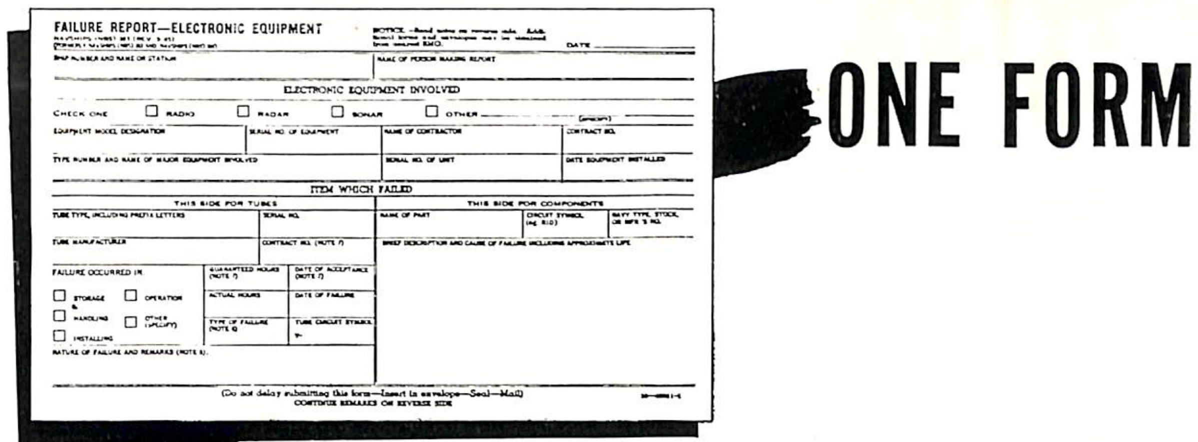
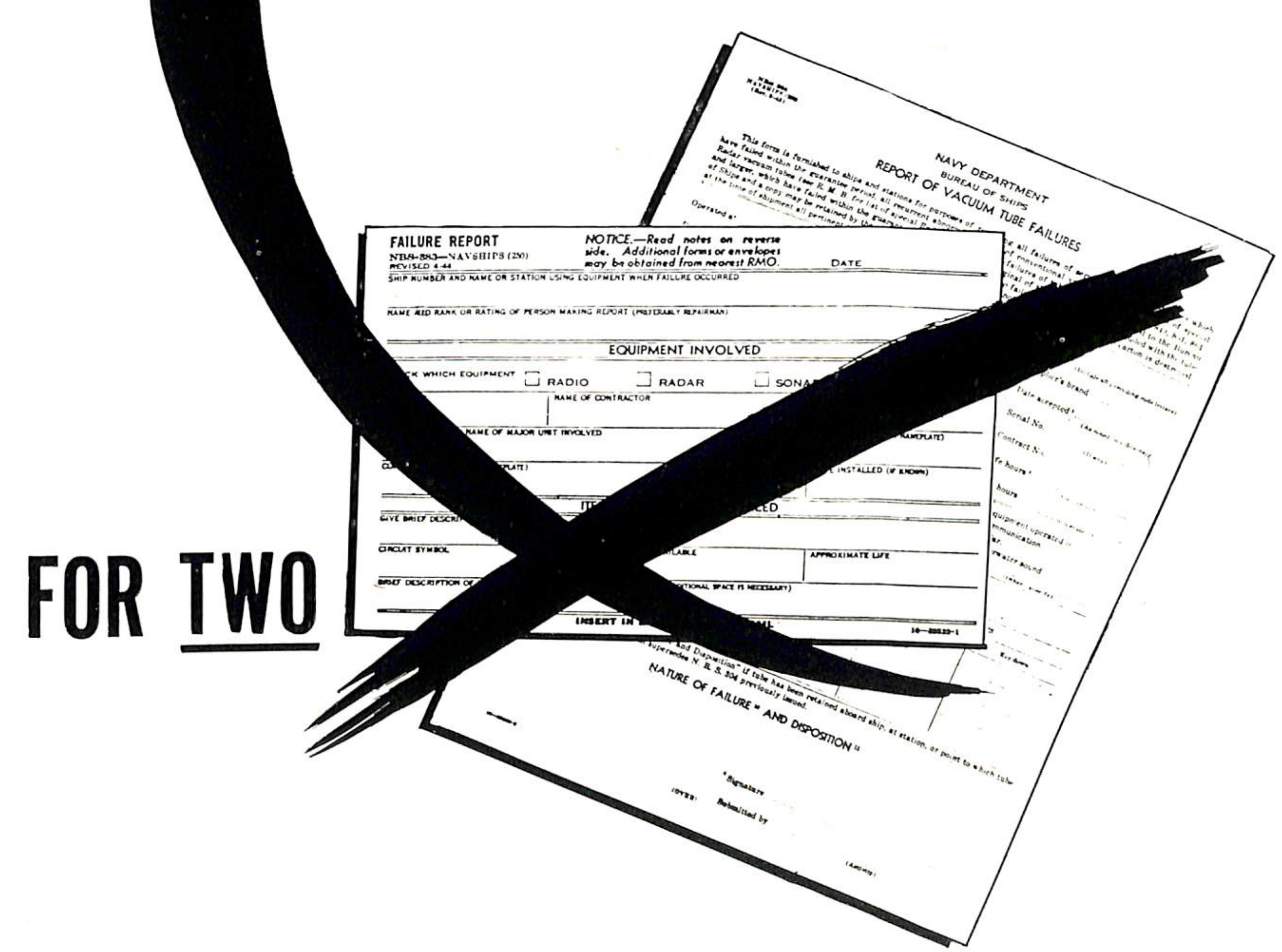


A new failure report form is out. It is a single card known as Navships 383 (Rev. 3-45). The new form replaces the older report card (N.B.S. 383) and the vacuum tube failure report known as N.B.S. 304. One form replaces two. It's more convenient to stock—quicker to fill out.

The failure report form you send in today means less trouble tomorrow



Don't Stow it—

GIVE IT A CHANCE!

The justification of any publication is best measured by the number of people who read it. We will do our best to make this a magazine worth reading, but we are soliciting your help in its distribution after you have finished with it. May we say further that the principle object of this publication is to furnish information to the Radio Technicians as soon as possible. You can assist them in maintaining equipment at peak efficiency by putting ELECTRON at their disposal promptly.