BUSHIPS FEBRUARY 1952

ELECTRON

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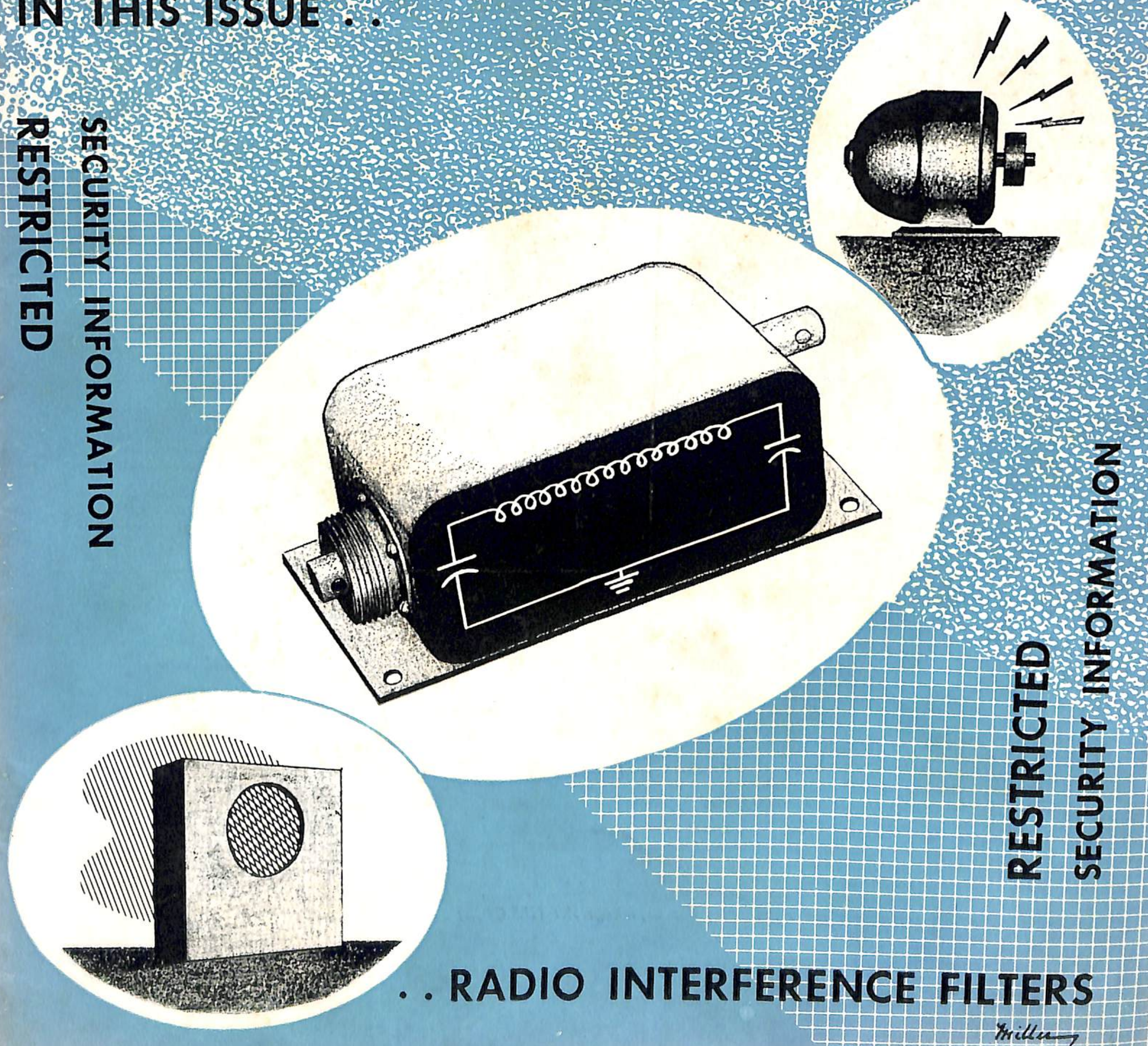

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. . RADIO INTERFERENCE FILTERS

BUSHIPS
ELECTRON
VOLUME 7
NUMBER 2

February
1952

A
MONTHLY
MAGAZINE
FOR
ELECTRONICS
TECHNICIANS

THIS ISSUE

THE PRINTING OF THIS PUBLICATION HAS BEEN APPROVED BY THE DIRECTOR OF THE BUREAU OF THE BUDGET 13 JANUARY 1950

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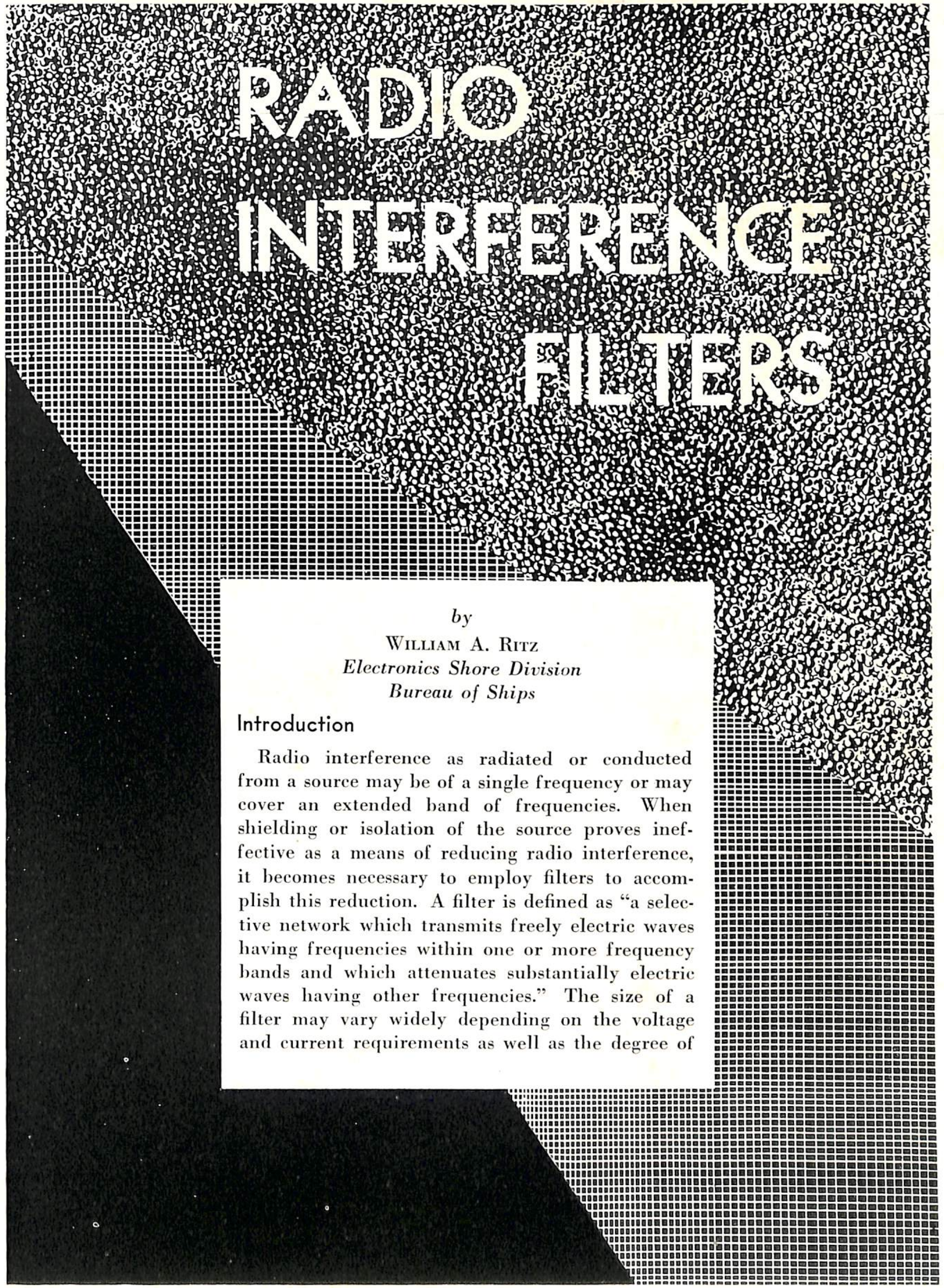


RADIO INTERFERENCE FILTERS

by
William A. Ritz
Electronics Shore Division
Bureau of Ships

Introduction

Radio interference as radiated or conducted from a source may be of a single frequency or may cover an extended band of frequencies. When shielding or isolation of the source proves ineffective as a means of reducing radio interference, it becomes necessary to employ filters to accomplish this reduction. A filter is defined as "a selective network which transmits freely electric waves having frequencies within one or more frequency bands and which attenuates substantially electric waves having other frequencies." The size of a filter may vary widely depending on the voltage and current requirements as well as the degree of

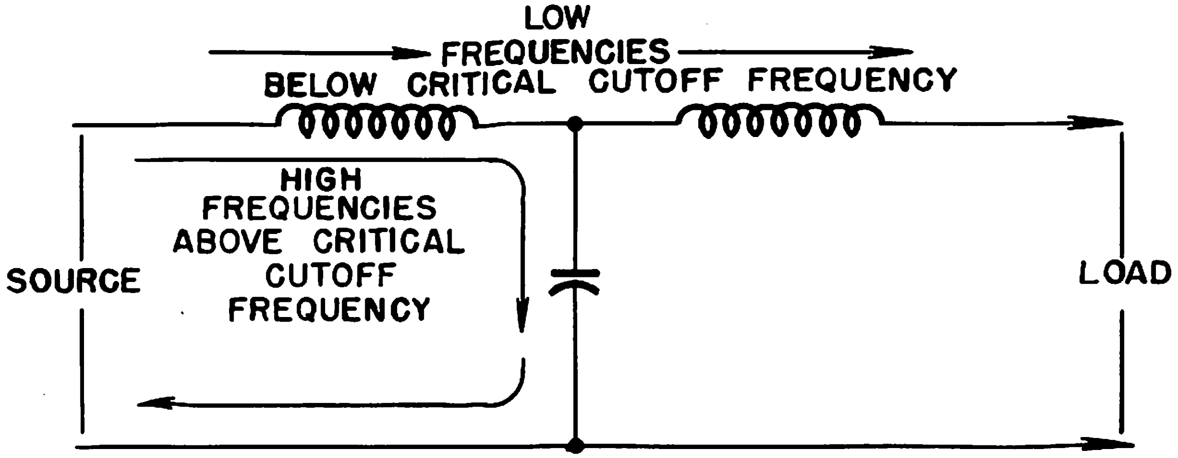


FIGURE 1—Low-pass filter.

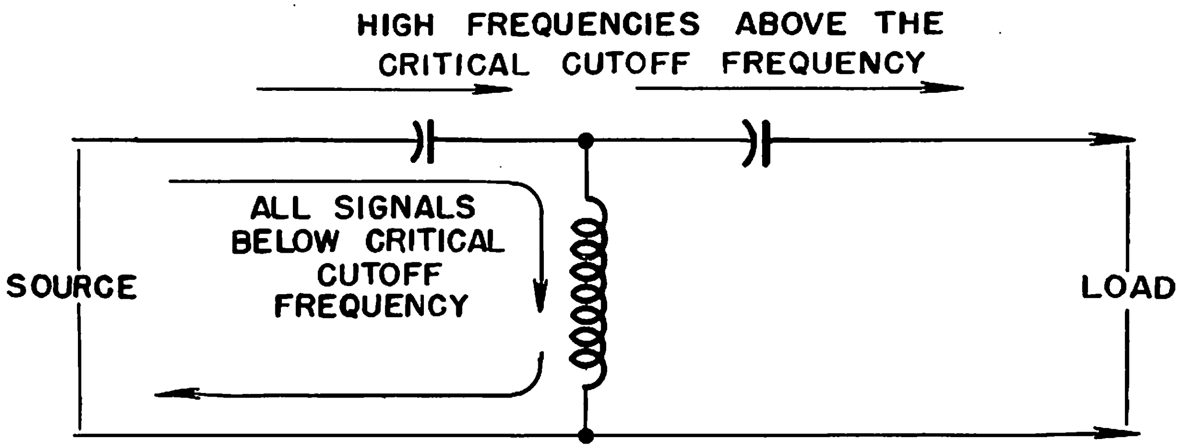


FIGURE 2—High-pass filter.

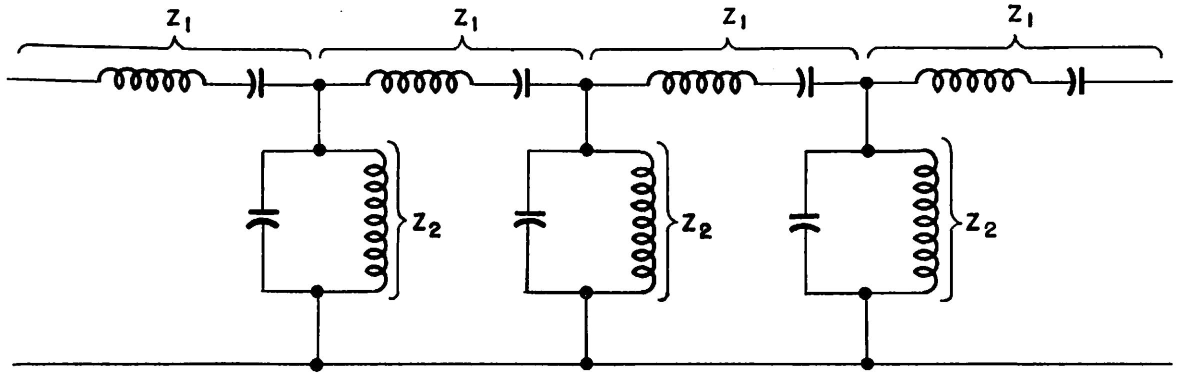


FIGURE 3—Band-pass filter of the constant-K type. At the pass frequency Z1 offers zero impedance and Z2 offers an infinite impedance.

attenuation desired. Filters are usually incorporated in equipment known to generate radio interference, but these filters are often inadequate, and in many cases it is necessary to add filters external to these equipments. This is especially true if the source of interference is coupling interference to paths of entry to a receiver other than the power line. The types of filters used in the reduction of radio interference vary with the application, but each of the general filter types may be found to be particularly adaptable to some specific situation. Most of the electrical devices connected to power lines have features required for their operation, which are conductive to the generation of radio interference. The interference generated by these devices, unless properly attenuated, is impressed upon the power lines and conducted to the receivers. It may also be conducted into the receivers by inductive coupling to other wiring associated with the receivers.

Motors, dynamotors, inverters, fluorescent lights, business machines, coding machines, electrical appliances, electric razors, and electric erasers are among the many common sources of radio interference coupling interference into the power lines serving them. This interference unless attenuated by means of filters, is then transmitted along these power lines, entering the receivers at the power line input or this interference may be radiated somewhere along the power lines and enter the receiver by means of the antenna system.

Availability of Navy Approved Filters

At the present time there is no Bureau of Ships or "MIL" specification applicable to the construction or performance of radio interference filters in general, but such a specification is being written by a joint service committee, and it is expected it will be available for use in approximately one year.

The number of radio interference filters that have been tested and have received Naval approval are few and of specific types. The requirements for radio interference filters cannot be fulfilled by the use of the presently approved radio interference filters. Use must therefore be made of nonapproved radio interference filters until such time that additional filters are tested to determine their suitability for Naval use.

The proposed joint service filter specification incorporates the following application tests and requirements for filters:

1—Attenuation or insertion loss measurements.

a—The proposed military standard prescribes that measurements of filter characteristics be made in a 50-ohm line.

2—Voltage drop.

a—The maximum voltage drop across the series element of a radio interference filter should not exceed 1% of the rated voltage at rated current. Filters having over 1/10 of 1 volt drop across the series element are undesirable for use in applications wherein the system of voltage is below 50 volts.

3—High voltage and insulation resistance tests..

a—Filters intended for use on Naval electrical equipment must withstand an application of twice working voltage plus 1000 volts between the circuit elements and the case of the filter, which usually is one part of the circuit elements. In no case shall the voltage rating of the filter to be applied in a

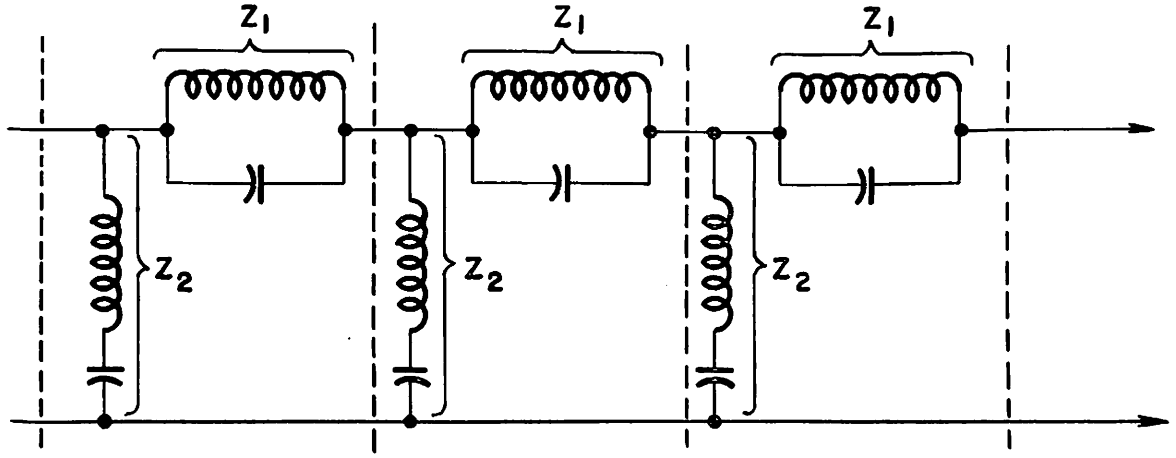


FIGURE 4—A band-elimination filter of the constant-K type. At the reject frequency Z1 offers infinite impedance and Z2 offers zero impedance.

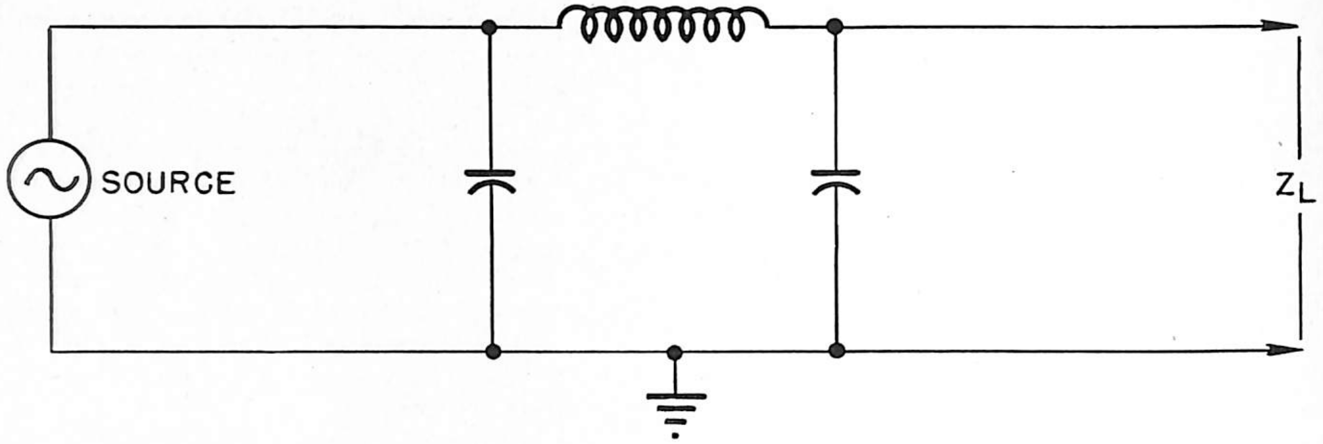


FIGURE 5—Popular pi-type filter.

specified piece of equipment be below that of any part of the equipment in which the filter is intended for use.

Kinds of Filters

Filters are of four kinds and are defined as follows:

1—Low-pass filter, which introduces negligible attenuation at all frequencies below a certain frequency, called the cut-off frequency, and relatively high attenuation at all higher frequencies.

2—High-pass filter, which introduces negligible attenuation at all frequencies above a certain frequency, called the cut-off frequency, and relatively high attenuation at all lower frequencies.

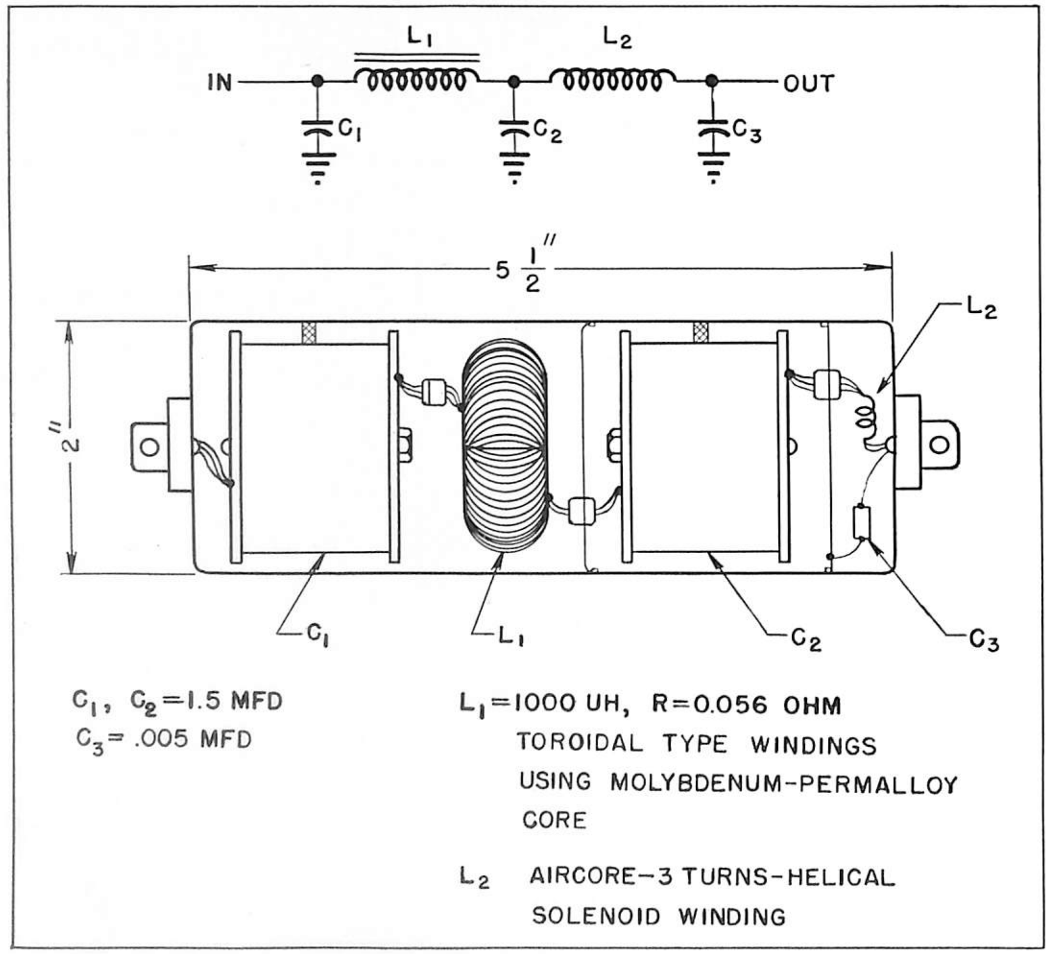


FIGURE 6—Constructional details, schematic of a typical filter developed by the Hopkins Engineering Company under terms of Bureau of Ships Contract NObsr 52350 for radio interference filter development.

3—Band-pass filter, which introduces negligible attenuation at all frequencies within the range between two frequencies, and relatively high attenuation at all other frequencies.

4—Band elimination filter, which introduces negligible attenuation at all frequencies outside a certain range, and relatively high attenuation at all frequencies inside that range.

The normal characteristics of a filter are obtained only when the filter is properly terminated

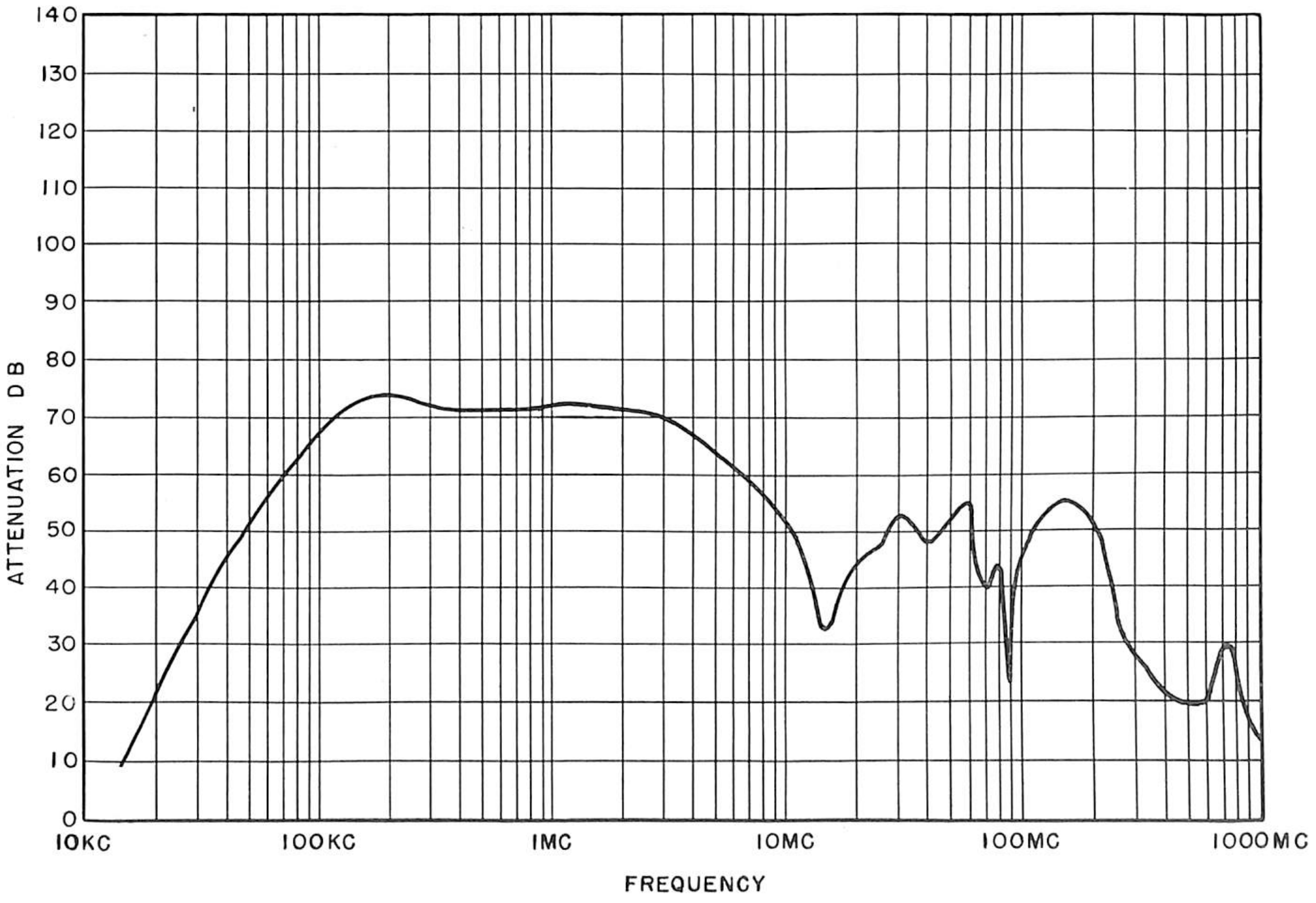


FIGURE 7—Attenuation curve for a radio interference filter.

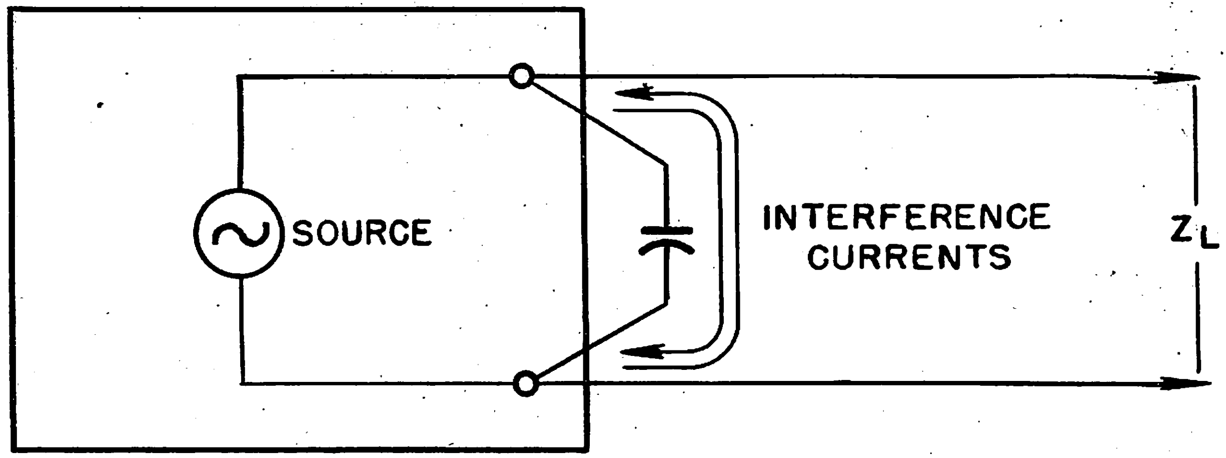


FIGURE 8—A simple capacitor filter connected across the terminals of an interference source.

in its characteristic impedance.

A wave trap is a filter, or network especially designed to reject certain frequencies, or bands of frequencies. Networks of this type may be installed at the antenna of the transmitter or receiver in order to attenuate frequencies outside of the assigned frequency range of the equipment. All such networks must have low insertion loss, or attenuation, for the pass frequencies. In the design and construction of wave traps, the insertion loss is usually below 2 db.

There are two basic circuit configurations for filter networks, the pi-section and the T-section. Each may be broken down into half sections which have an inverted L shape and are known as L-section filters. If a number of pi or T-sections are connected in series to form a filter, the resultant network is called a ladder network. Any of the above circuit configurations may be used for radio interference elimination.

Factors Determining the Attenuation Properties of Filters

It is recognized that the actual theoretical design of filters to meet certain specifications as to cut-off frequency, attenuation, current-carrying capacity, and insertion loss is fairly simple and can be done by means of long-available formulas and design data; the actual physical construction of the filter itself is quite another matter. The non-existence of such items as *pure inductors*, capacitors, or even resistors, especially at the higher frequencies are complicating factors which make it extremely difficult to reduce design to practice. Therefore, each filter component, whether it actually be a coil, capacitor, resistor, or even short interconnecting leads must be considered as complex combinations of capacitance, inductance and resistance. An additional complicating factor is the interaction or effect of such components upon each other when grouped compactly inside a metal container. In many applications it is necessary to use filters composed of resistance and capacitance or of capacitance and inductance. In the case of filters employing capacitance and inductance, the filter effectiveness depends on the ratio of shunt impedance of one element with respect to the series impedance of the other for attenuation of the interfering frequencies. Capacitors play an important role in filtering, having the property of low impedance at certain radio frequencies, while allowing the desired direct current or power frequency to flow on to the load. Capacitors may be used alone, or in combination with inductances or resistors to form a filter unit. All capacitors possess inductance as well as capacitance, and due to these properties there is no ideal capacitor any more than there is an ideal resistor or inductor. In large paper capacitors the internal inductance is high. This fact is of considerable importance when the capacitor is used as a filter, because if it is not properly installed, or the inductance calculated and consideration given to the lead lengths, the attenuation characteristics of the filter will suffer.

The Capacitor as a Filter

In general, the use of simple capacitor filters is to be preferred over that of the more complicated network filters in cases where this type of filter provides the required degree of radio interference attenuation. A given capacitor is effective in *by-passing* only a limited range of radio interference frequencies because of its internal inductance and the inductance of the connecting leads. The inductance of the capacitor depends upon its capacity, the material of which it is fabricated and the length of the connecting leads. The capacitor leads are the major contributors to the inductance of capacitors. For these reasons, small mica capacitors with short leads are more effective as filters at high frequencies than large paper capacitors with normally long leads. *Electrolytic capacitors should never be used as filters because of the danger of dielectric breakdown.* In connection with the use of capacitors as filters on generators, it is necessary to observe a few precautions in the selection of the proper capacitor for filter uses. These precautions are necessary for the following reasons:

1—Generator excitation is increased by the leading current drawn by a capacitor when connected in parallel. The automatic voltage regulator of the generator will tend to offset this increase in excitation, by varying the generator field current. If more field resistance is required than the voltage regulator is capable of providing, the voltage regulator will be impaired, with resultant overvoltage output from the generator.

2—If a parallel connected capacitor resonates with the internal reactance of the generator, currents and voltage much higher than the rated output of the generator will result, with the attendant danger of capacitor failure or flash over.

3—If the parallel capacity increases the generator current materially so as to increase the generator heating, the safe output rating of the generator will be decreased.

The above detrimental effects may be minimized by the use of as small a value of capacitance as possible, consistent with attaining the required degree of attenuation of the radio interference. Usually it is possible to employ capacitors possessing low enough capacity to have little or no effect on the performance of a-c generators and at the same time furnish the required attenuation of interference on the power lines. The filter capacitors should be located inside the case of the generator, near the output terminals. At very high frequencies a capacitor cannot be regarded as a pure capacitance due to the inductance of the capacitor and the leads thereto. The capacity existing between the capacitor and its associated leads and the sides of the filter enclosure must be

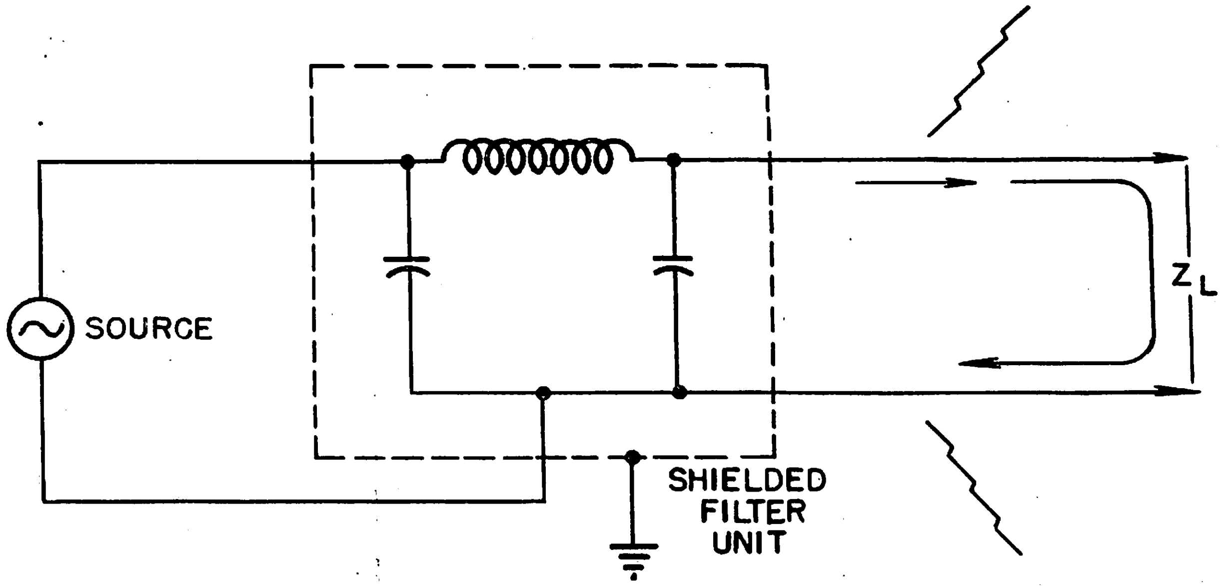


FIGURE 9—Interference picked up by excessively long unshielded leads between filter unit and load.

considered in determining the choice of capacitors for use as filters at these frequencies. The proximity of the metal walls of the filter enclosure will in many cases act to tune the filter coil. However, modern design methods have produced many types of capacitors possessing low values of inductance. The important considerations in the installation of filter capacitors are the points of installation, mechanical security, and the proper arrangement of leads and connections. If a source of interference operates at high temperatures, it may not be safe to mount the capacitor directly at the source. In this case the capacitor should be installed as close to the source as practicable, with the connecting leads between the source of interference and the capacitor as short as possible and effectively shielded.

In addition the following are also essential for satisfactory performance of simple capacitor filters:

1—All capacitor leads must be as short as possible.

2—The best possible ground must be provided. This ground must offer low impedance to radio frequency currents.

3—There must be minimum coupling between the leads of the capacitor; never looped together.

4—The single terminal type of capacitor encased in a hermetically sealed metal container which also constitutes the ground terminal is the preferred type.

In connection with the installation of capacitors across vibrating contacts special care is necessary. The capacitor discharges when the contacts close, and a large surge current may pass through the contacts causing them to become fused or to become pitted. *This may be avoided if a resistor is connected in series with the capacitor to control the rate of discharge.* In cases of ac currents, large capacitors may bypass part of the current when the contacts are open and alter the circuit characteristics. The attenuation obtainable from capacitor filters varies with frequency, the capacity and the method of installation. The attenuation obtainable with capacitors is always less than that obtained with network filters. The frequency range through which attenuation is obtainable with capacitor filters depends upon the capacitor chosen and its resonance properties. The obtainable frequency range throughout which appreciable attenuation is possible with capacitor filters is always less than with network filters.

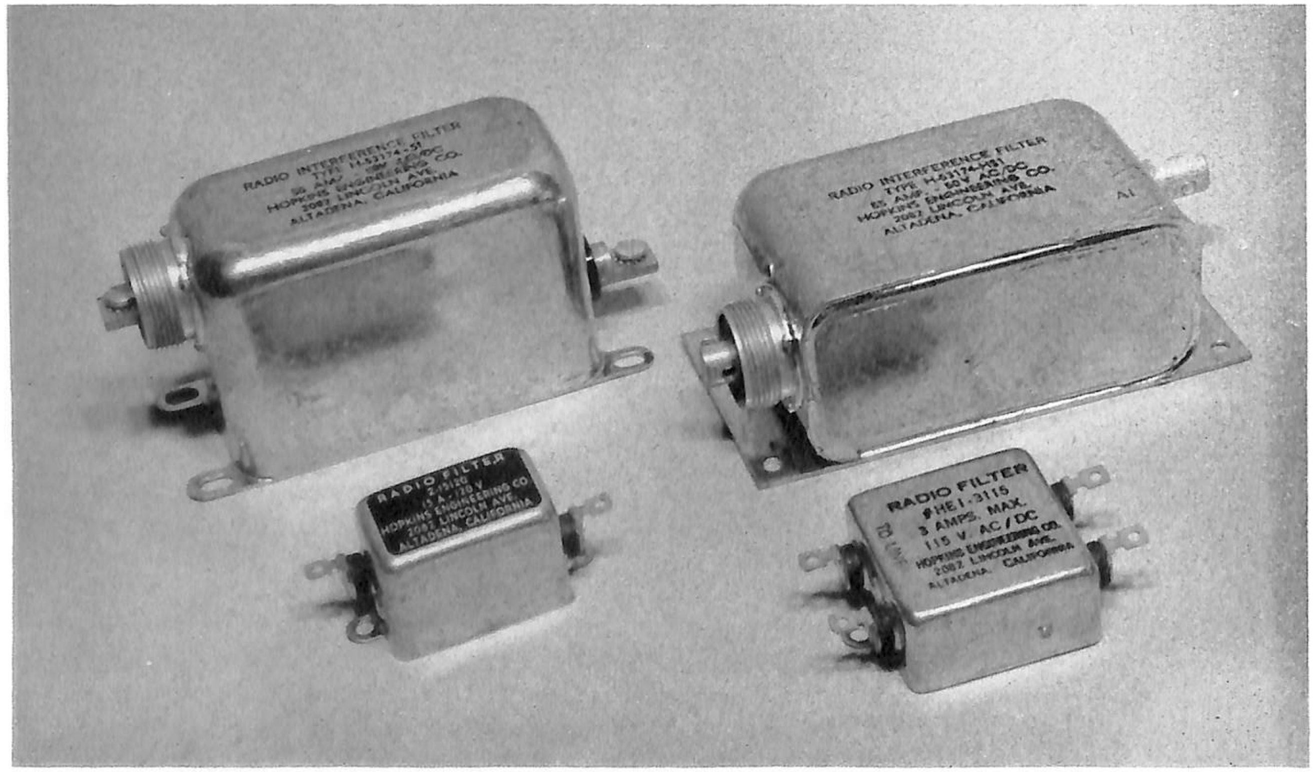
Filter Selection

The choice of a filter for a specific application is usually governed by the following requirements:

1—Current, capacity, voltage and frequency limitations.

2--Temperature and humidity and other factors involved in the installation.

3—Amplitude and frequency range of the radio interference to be attenuated.



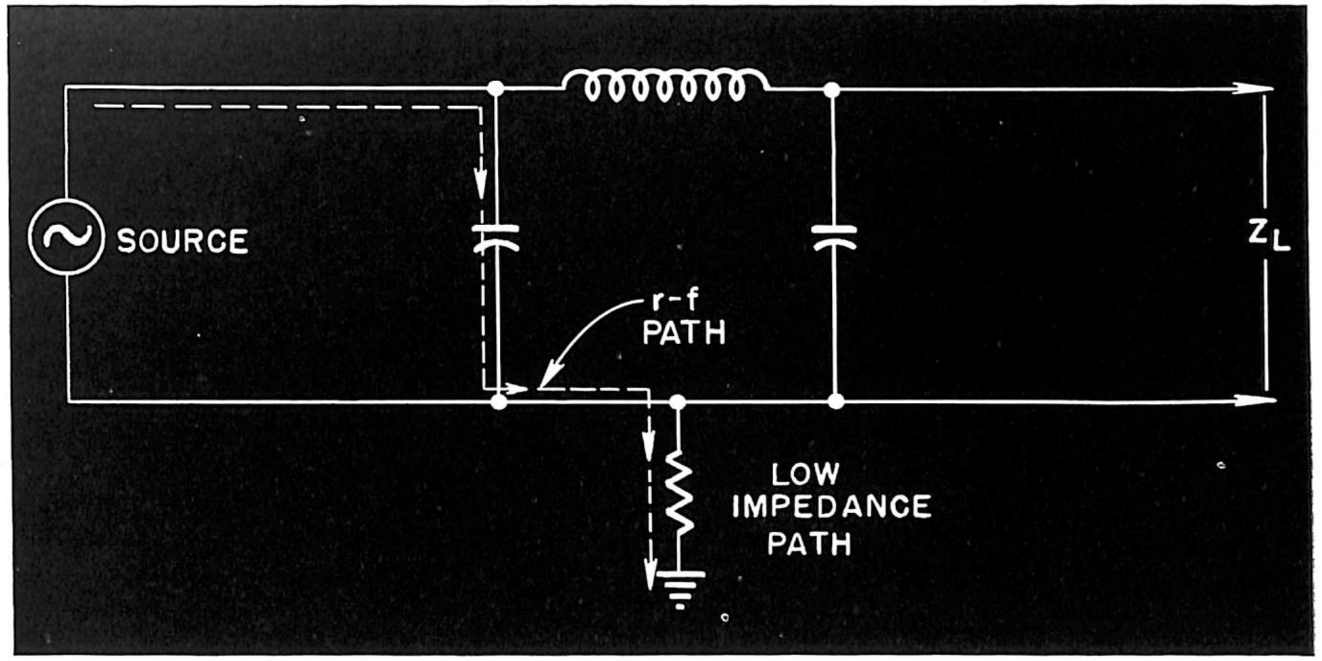


FIGURE 10—Passage of r-f current through a filter when the unit is connected to a good (low impedance) ground.

4—Degree of attenuation desired.

5—Space and weight limitations.

6—Costs.

The filter must be rated to carry the desired current without overheating or introducing an excessive voltage drop. If an inductor having an iron core is used, it is important that the filter be operated within current limitations in order to avoid the detrimental effects of core saturation which would impair the effectiveness of the filter. In connection with the use of a capacitor, the voltage rating is the most important factor in its selection.

In choosing a filter, considerable thought should be given to its constructional details. The filter should be well shielded with the output leads

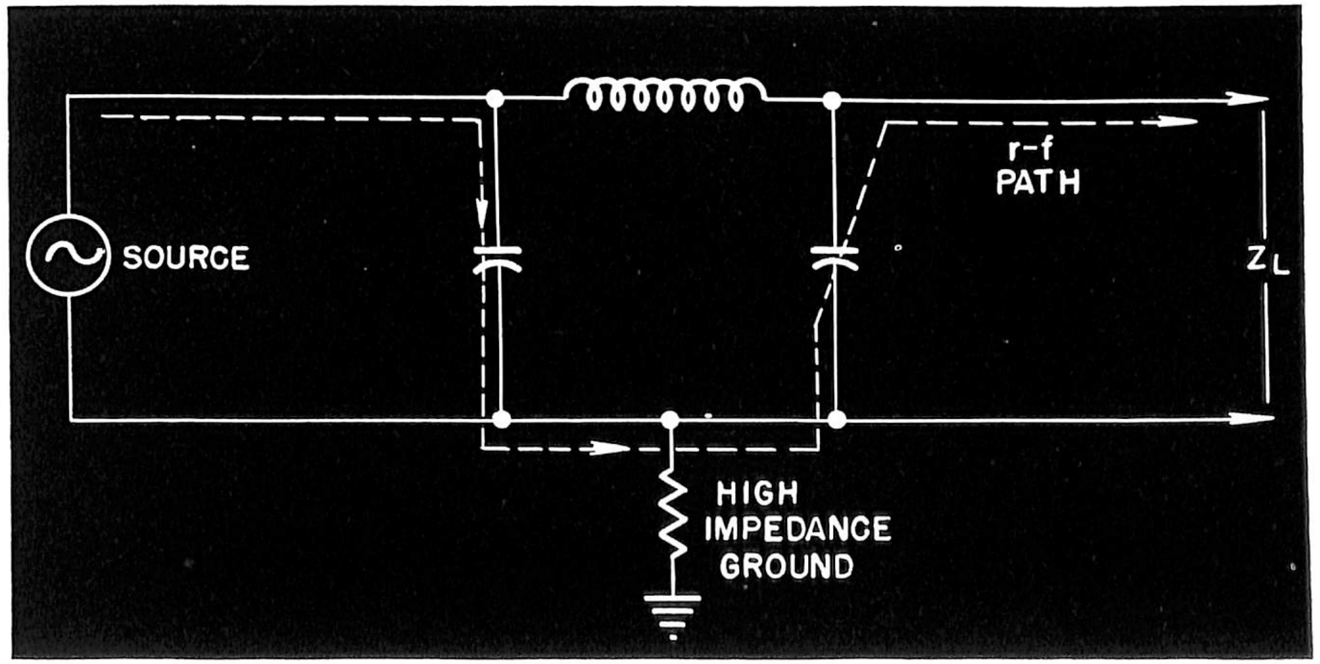


FIGURE 11—Passage of r-f current through a filter when the unit is connected to a poor (high impedance) ground.

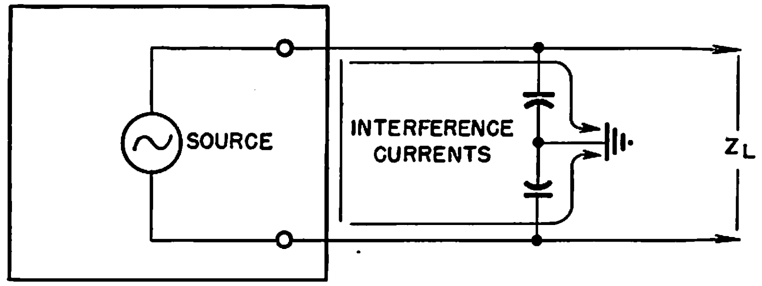


FIGURE 12—Filter connecting both sides of an interfering source to ground.

isolated from the input leads. The shielded enclosure cover must make perfect electrical contact with the rest of the shielded enclosure. The filter terminals must be of sufficient size to carry the rated current. When capacitors are used, the leads should be as short as possible. The use of powdered iron toroidal coils makes it possible to obtain a larger amount of inductance within a much smaller space than possible with conventional iron core coils. All points of grounding within the filter must be of low impedance at radio frequencies. Coupling between the leads should be avoided by routing all leads close to the ground plane, in opposite directions, never looped together.

If the required attenuation cannot be obtained throughout the specific frequency band, it is always preferable to use capacitor type filters instead of network filters for the following reasons:

1—Less weight.

2—Ease of application.

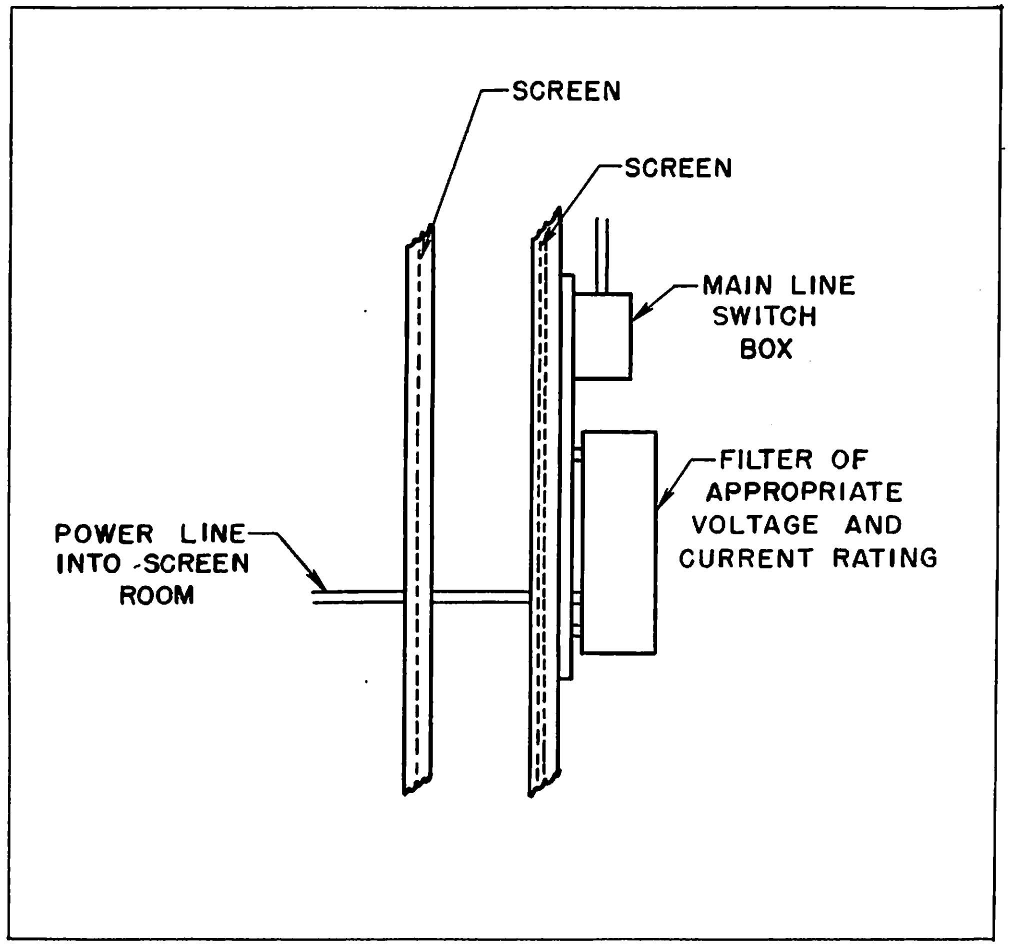


FIGURE 13—Typical installation of a screen room filter.

3—The line current does not pass through the capacitor filter.

4—Replacement parts are more readily obtained.

5—Fewer parts are involved, lessening the danger of short or open circuits.

Wide-band network filters with series inductive elements are generally used when the radio interference is of high amplitude and covers a wide range of frequencies. Most power line filters are broad-band pi-type configurations consisting of two capacitors and a choke. Although the larger the choke, the higher will be the attenuation, care must be taken not to make the inductance value too large. If the reactance of the choke at the line frequency is too high, the resultant voltage drop may prevent the equipment from operating properly. Care must also be exercised to prevent resonance at a frequency within the rejection band of the filter. The coil and second capacitor form a series-resonant circuit and at the resonant frequency, a high r-f voltage may be developed across the capacitor. If there is an impedance of any kind between the filter ground connection and the actual ground, r-f energy will be fed through the filter back into the line. It is important to shield the input of the filter from the output. If this is not done, the unfiltered portion of the line will radiate, and this radiation will be coupled into the filtered side and thus nullify the effectiveness of the filter.

The filter chosen must furnish satisfactory attenuation throughout the entire frequency band over which the receiver is affected by radio interference and all network filters must pass the full load current of the device being filtered with a voltage drop of not more than 1% of the rated voltage. Filters having over 1/10 of one volt drop across the series element are undesirable for use in applications wherein the voltage is below 50 volts.

Filter Installation

In the case of each problem of radio interference where filtering is a requirement, a decision must be made as to the desirability of locating the filter in question at the source of interference, at the affected receiver, or at some point along the power line. The decision will depend upon the method whereby the interference is coupled to the receiver. If it is found that the interference is coupled into the receiver along the power line, the most effective location for the filter is at the receiver power line input. If the interference is radiated from the source or from the wiring serving the source, to another path of entry into the receiver, the most effective location for the filter is at the source. It is considered good engineering practice to locate an effective filter at the power line input of each receiver. This procedure is necessary due to the usually impossible task of filtering all sources of radio interference that may be interfering with receivers. Locating filters at the power line inputs of receivers also reduces the number, weight and size of the filters that may be required at a Naval activity. This reduction in filter size and weight is due to the fact that network filters located at the receiver are required to carry only the current required by the receiver itself. The reduction in the number of filters is due to the necessity of attenuating only the range of frequencies to which a particular receiver is interfered with. In most cases, a simple capacitor type filter located at the receiver power line input, will serve to provide the required degree of attenuation. In general, such a filter is provided in most receivers. A source filter is most practical when a single item of equipment is found to cause interference in a number of receivers. A single filter installed at the source then eliminates the need for additional filtering at each receiver. In general, a filter at the source is advantageous only when it is necessary to reduce interference at its source and thereby eliminate coupling occurring by radiation or induction to some path of entry to the affected receiver other than the power line. A network filter located at the source of radio interference must be designed to carry the total current generated or consumed by the source, thus adding considerable weight, size and cost to the filter over that required for filtering the interference at the receiver. The filter inductance is made excessively large so as not to exceed the specified voltage drop at rated current. Coupling from the wiring on one side of the filter to that on the other side may be minimized by running the leads in a straight line in opposite directions from the filter and as close to the metal structure as possible and by shielding all filter leads wherever possible.

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USN USL notes

SLOTTED LINE CORRECTION CHART

When conducting antenna-impedance measurements using slotted line equipment, it is often necessary to take into account the effects of the cable between the antenna under test and the slotted line if accurate results are to be obtained. Typical problems which arise in connection with such measurements are outlined below.

Because of cable attenuation, the VSWR measured at the slotted line will always be less than the VSWR actually present on the antenna feed cable at the antenna termination of the cable. This departure of measured VSWR from true VSWR will depend on the type and length of cable used. If the departure is appreciable, it is necessary to apply a correction factor to the measured VSWR in order to derive accurate antenna-impedance information from the slotted line test data.

In cases where the antenna under test must be located at some distance from the slotted line because of physical or electrical limitations, or where the cable attenuation is relatively high, the above-mentioned correction factor on the measured VSWR may become very high. The correction factor increases at such a rapidly accelerated rate with increasing cable attenuation that normal tolerances for the accuracy of determination of cable attenuation are inadequate for determining the magnitude of the correction factor with acceptable accuracy. Consequently, for each particular test set-up there exists a maximum usable cable length between antenna and slotted line beyond which reasonably accurate impedance data cannot be readily obtained. For practical purposes, it is convenient to limit the cable length to that at which the VSWR correction factor reaches a value of approximately 2.

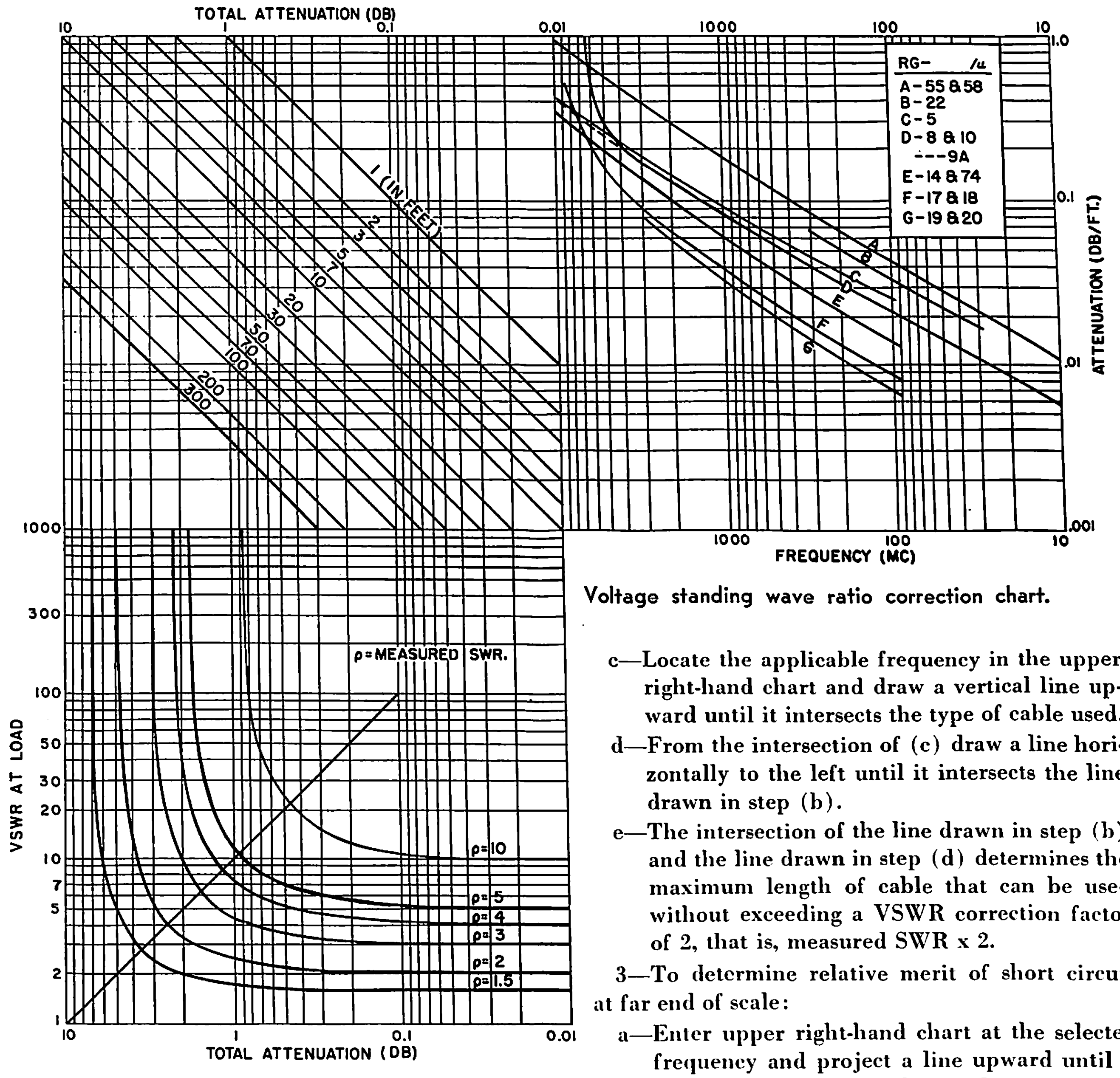
Reference positions on the slotted line for measuring shifts in position of voltage minima are usually determined by means of a short circuit applied at the far end of the feed cable. The short circuit is obtained by using a shorting plug or by immersing the end of the cable into a pool of mercury. Occasionally, poor contacts, corrosion, or oily film deposits at the termination cause the apparent short circuit to introduce an extraneous impedance into the measurement; this gives rise to an error in the position of the reference point, which, in turn, detracts from the accuracy of the impedance measurement. Consequently, it is desirable to determine the relative merit of the short-circuit arrangement employed with the slotted line.

The attached chart was devised by S. Galagan and K. K. Miller of the Laboratory staff. It can be used as follows:

1—To correct measured VSWR for attenuation of cables:

a—Enter upper right-hand chart at the selected frequency and project a line upward until it intersects the type of cable used.

b—From the intersection of (a), run a line horizontally to the left until the proper cable length is intersected. (Incidentally, the position of this intersection determines the total attenuation of the particular cable length under condition of matched load, in DB.)



Voltage standing wave ratio correction chart.

c—Run a line vertically down until it intersects the applicable VSWR curve in the lower portion of the chart.

d—From the intersection in step (c) extend a line to the ordinate at the left and read true SWR.

2—To determine maximum usable cable length in making slotted line measurements:

a—Enter lower right-hand portion of the lower chart along a given measured VSWR curve and proceed toward the left along the curve until the diagonal line is reached. (The area to the right of the diagonal line projected up into the upper left-hand chart encloses the region of usable cable lengths.)

b—From the intersection in step (a) run a line vertically upward into the upper chart.

c—Locate the applicable frequency in the upper right-hand chart and draw a vertical line upward until it intersects the type of cable used.

d—From the intersection of (c) draw a line horizontally to the left until it intersects the line drawn in step (b).

e—The intersection of the line drawn in step (b) and the line drawn in step (d) determines the maximum length of cable that can be used without exceeding a VSWR correction factor of 2, that is, measured SWR x 2.

3—To determine relative merit of short circuit at far end of scale:

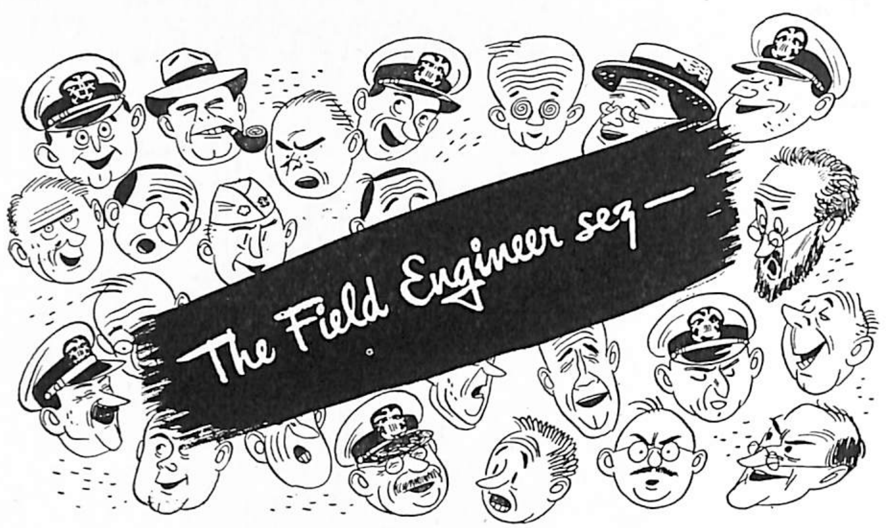
a—Enter upper right-hand chart at the selected frequency and project a line upward until it intersects the type of cable used.

b—Project a line horizontally at the left from the intersection of step (a) until it intersects the length of cable used.

c—From the intersection of step (b), draw a line vertically down into the lower chart.

d—The position of the vertical line in step (c) relative to the vertical portions of the measured VSWR curves determines the value of VSWR which should be obtained on a slotted line with a true short circuit on the far end of the cable.

Example: The measured SWR at the end of a 100-foot length of short-circuited cable of RG-8/U at 100 mc should be between 4 and 5, interpolated to be 4.4.



MK 57 MOD 3

USS New Jersey (BB–62)

Mark 4 Model 2

The Elevation Lead Angle (V's) Dials on the Computer Mark 16 did not respond when various test problems were set into the Wind Transmitter Mark 4 Mod. 2. The Wind Transmitter Mark 4 Mod. 2 was found to be receiving no three-phase excitation voltage from the stator of the (fine) E'g Synchro Generator SG–203 in the second compartment of the Computer Mark 16 Mod 1.

The metal brush cover on the rear of Synchro Generator SG–203 had been installed improperly, causing the rear brush to be pushed against the rear rotor slip ring, and one side of the rotor to be shorted to ground. As a result, not only did the rear rotor slip ring become badly damaged and thereby ruin SG–203, but the short to ground caused overheating and burnout of the unfused 115-volt rotor supply lead, between Terminal 151 on the second compartment terminal board and Terminal 151 on the main terminal board in the base of the Computer Mark 16 Mod. 1.

The Synchro Generator SG–203 (Navy Type 6G–Mk 2–Mod. 5) was replaced; a new lead was run along the cable from the main terminal board to the second compartment terminal board, and connected to Terminal 151 on both boards. After zeroing SK–203 normal operation of the wind correction system was observed.

C. W. Hunter
H. N. Hodges
J. W. Johnson

After performing Ordalt 2505, it was found that neither the Elevation Lead Angle (V's) Dials nor the Traverse Lead Angle (D's) Dials could be turned through their normal range of values.

The clamps added to the leads in the lead angle potentiometers by Ordalt 2505, were found to be so positioned as to come into contact with the insulated feed through bushings in the stationary covers of the potentiometers. When the clamps were repositioned, the trouble was remedied.

C. W. Hunter

Stock Equipment (Norfolk, Virginia)

A visual inspection of the Amplifier Mk 1 Mod 1 showed the two high voltage rectifier tubes, V–321 and V–322 (both 866's) did not have the characteristic blue glow which indicates normal operation of this type of tube. Voltage checks at Terminal No. 142 on terminal panel in the second compartment of the amplifier showed 35 volts d.c. instead of the normal 380 volts d.c.

Investigation revealed weak emission in these tubes; cathode surfaces had been damaged by arcover.

Both tubes were replaced with new 866A's and preheated for 3 minutes before applying the high voltage. The power supply output voltage was then found to be normal.

C. W. Hunter

SJ–1

U.S.S. Manta (AGSS–299)

The resistors R–31 and R–36 in the transmitter-receiver were found burned open. The trouble was traced to the potentiometer R–30, "magnetron filament voltage adjust", which was shorted to ground internally. This condition was intermittent, and therefore trouble in the modulation network was suspected. After replacing resistors R–30, R–31 and R–36, and after adjusting the magnetron filament voltage, normal transmitter operation was restored.

The i-f gain was fluctuating; this was indicated by grass jumping in amplitude on the indicator "A" presentation. The trouble was traced to a faulty Type 6AK5 tube, V–1, in the i-f amplifier in the Type CW–24AAH selector unit. With the replacement of V–1, a stable i-f amplification was restored.—G. H. McBride

MK 34 MOD 2

U.S.S. Moale (DD–693)

Nutator trap repairs to the MK 4 Antenna CW66AKU necessitated the dismantling of the antenna motor housing and reflector dish to permit removal of the motor, 2-phase generator and feed horn. The extent of corrosion was not sufficient to prevent repairs, although the lack of new traps prevented replacement. The corrosion was machined off and the remaining pitting was acid etched. The cleaned surface was then built up to its original thickness by electro-plating with tin. The resultant job looked reasonably good. Zinc chromate and a non-metallic paint were then used to protect the metal surfaces.

The antenna was then installed in a MK25/0 antenna mount as per Ordalt 2664 with Field Change #23. Since the physical mounting of the MK4 antenna on a MK 25/0 mount is 90 degrees rotated from the MK 19 mount position, an attempt was made to realign the 2-phase generator in the shop. This proved inadequate when the antenna was rechecked during subsequent boresight adjustments and radar dot alignment aboard ship. Physical and electrical alignment between the nutator position and 2-phase generator position is not the whole story. Final alignment with a live system was necessary.

J. M. Kinn

CXFU(SV–1)

U.S.S. Remora (SS–487)

It was observed that the RADAR-KEYING switch was in KEYING position instead of RADAR. Of course, this kept the transmitter from firing. This switch is normally found on the console, but on this CXFU, the switch was on the key/jack box: also it was wired into the circuit in an unconventional manner and not in accordance with field change instructions. The associated wiring diagrams had not been corrected, and the ET's were somewhat hazy about the switch action and were understandably confused. The switch had been turned off unknown to the ET's during search for other troubles and this most certainly contributed greatly to the basic troubles. This is a very common trouble when the transmitter cannot be made to fire. It can result in literally days of search for trouble. Many expert ET's have been fooled in this manner.—O. R. Beach

MARK 34 MOD 2

U.S.S. Leyte (CV–32)

The absence of any spot in the director-indicator was traced to very low resistance readings on most of the leads entering the director pedestal. This was caused by the presence of very high moisture content and mold in the director base. Ship's personnel were advised to dry all leads and apparatus located in the pedestal. Voltages at the cathode-ray tube socket indicated low voltages on the —472-volt line and the filament; other voltages were about normal. The low resistance to ground on the filament leads, about 50,000 ohms, was entirely due to moisture. This load reduced the —472-volt line resistance to ground which, paralleled with the high voltage supply resistance network, reduced the voltage available, as found.—H. H. Bernhard

MODEL NMC

U.S.S. Beatty (DD–765)

It was noted that the high voltage in this equipment was excessive. Investigation revealed that bleeder resistor R–107 (25,000 ohms) was open circuited. Replacement of this resistor restored normal high voltage.

Relay K–101 was found holding in continuously because of wear. Replacing the worn out copper shim stock over the face of the armature stop to break up the magnetic path and saturation under light coil currents restored operation to normal.

Ship's force reported that the recorder would not zero and was acting in a peculiar manner. Investigation revealed that the idler gear was adrift and skipping teeth, resulting in loss of calibration of the recorder. It was found that the threads on the idler gear study were worn and jammed and it was necessary to disassemble the entire recorder mechanism to correct the difficulty. After reassembly, rezeroing and calibration the recorder operated satisfactorily.

—W. B. Sheldon and J. W. Crowe.

CHECKING PERCENTAGE OF MODULATION OF TDZ TRANSMITTER

by

R. Roman, J. Dailey *and* J. Kienlen
Philco Field Engineers

The following procedure is a simplified method to check and adjust the percentage of modulation of a TDZ transmitter. The following checks can be made with test equipment readily available on most Naval vessels. The trapezoidal pattern utilized is a comparison of instantaneous audio (modulating) frequency with instantaneous RF output.

Equipment:
1. Model ME–11/U wattmeter.
2. Oscilloscope.
3. UG–28/U or UG–107/U coaxial tee connector.
4. RG–8/U, RG–9/U or RG–10/U coaxial interconnecting cables.

Procedure:
1. Connect equipment as in figure 1. Direct connection, thru a dc blocking capacitor, to deflection plate terminals must be made, because the vertical amplifier will not pass high RF and the horizontal amplifier will cause audio plate distortion. Audio sidetone level can be varied with "Volume" control on TDZ front panel.
2. Key equipment for MCW operation. Power output on ME–11/U will decrease from approximately 20 watts with no modulation, to approximately 15 watts with 90-95% modulation. A pattern similar to figure 2 should appear on scope.
3. R–116, MCW gain control, can be adjusted for proper trapezoidal pattern for 90-95% modulation. If proper pattern is not obtainable, test all modulator tubes and check modulator bias adjustment R–143 for —30 Vdc on the grids of V–104 and V–105.
4. After obtaining proper MCW indications, check phone operation by whistling shrilly into microphone; this will overdrive modulator and a pattern similar to figure 3 will be obtained. The overmodulation "tail" should disappear with AGC on and pattern and power indications should agree with those noted during MCW operation. If improper phone and AGC indications are observed, it will be necessary to adjust R–106, R–176, R–122 and R–123 as outlined on page 7–157 of TDZ Instruction Book, NavShips 900,809.

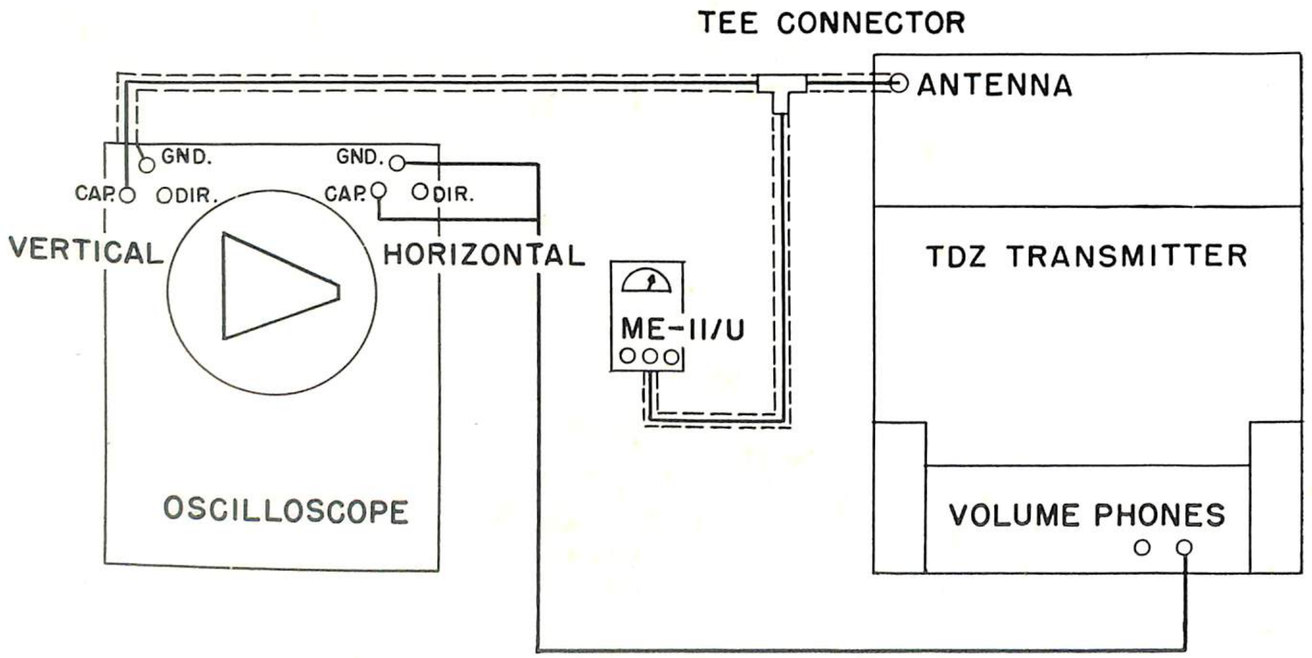


FIGURE I—Interconnection diagram.

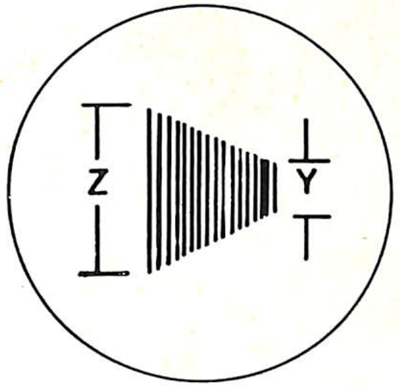


FIGURE 2—Less than 100% modulation

$$\% \text{ Mod.} = \frac{Z-Y}{Z+Y} \times 100$$

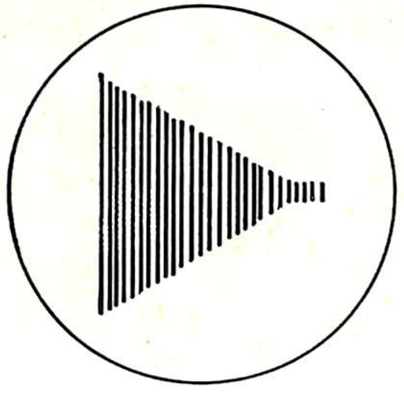


FIGURE 3—Over 100% modulation.

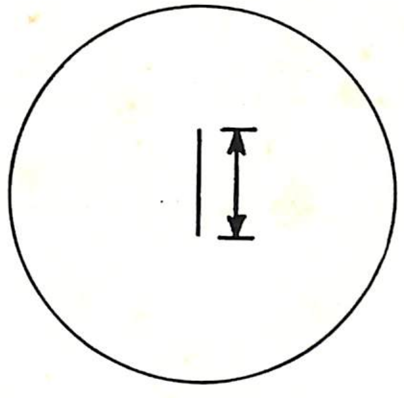


FIGURE 4—No modulation.

FUSES!! FUSES!! FUSES!!

Fellows, we are all taxpayers and *we* buy those costly transformers, tubes and other components that are burned out during a circuit failure because someone in a hurry, while servicing, has jammed in a nameless fuse—any fuse as long as its current value is *greater* than that specified.

Remember, a fuse has only ONE PURPOSE—PROTECTION!!

SubFlot One Electronics Newsletter

TEST CABLES FOR AN/URR–13 RECEIVERS

Test Cables for Model AN/URR–13 Receivers procured under Contract NObsr–43176 are available in stock at SSD, ESB, NSC, Norfolk, Virginia, and SSD, NSC, Oakland, California. All activities and ships that received Model AN/URR–13 less Test Cables are advised to requisition this item through the nearest supply activity. As required, one cable for each receiver will be furnished. Receiver Serial Numbers 1–1281 incl., under NObsr–43176 are applicable.

ENVELOPES FOR ELECTRONICS FAILURE REPORT

In the past special franked envelopes, NavShips 383A, have been used when submitting electronic failure report, NavShips 383. Stocking of this type of envelope has been discontinued, but they will be issued until the present supply is depleted. When submitting failure reports, personnel should utilize the standard envelopes as found in the supply system. These failure reports should be submitted to the Bureau of Ships; Attention Electronics Division.

THE HYBRID RING

by
Engineering Section
Government Service Division
RCA Service Company, Inc.
Camden, New Jersey

Since the article "Waveguide Hybrids" appeared in the September 1950 BuShips Electron magazine, numerous combinations have occurred, resulting in the Hybrid Ring discussed here. Though a recent development, the hybrid ring already has proven its value and is expected to be commonly used in future radar equipment. Study of field maintenance problems for a new height finding radar produced by RCA, has indicated the need for a detailed analysis of the hybrid ring's operation.

Purpose of the Hybrid Ring

1—To couple the magnetron to the antenna.

2—To couple the antenna to the receiver.

3—To provide T-R tubes to prevent transmitted power from entering the receiver and damaging the crystals and other components.

4—To block power from being dissipated in the magnetron.

5—To provide automatic frequency control signal.

6—To mix the reflected signal with the local oscillator output to yield i-f which is channeled to the i-f amplifiers. The local oscillator is an integral part of the duplexer.

Advantages of the Hybrid Ring

The advantages of this type of duplexer are:

1—Low standing wave ratio.

2—Ability to transfer high power.

3—The use of two T-R tubes and no anti-T-R tube.

Theory of the Hybrid Ring

The hybrid ring may be considered to be a ring of rectangular wave guide with the shorter dimension of the guide in the plane of the ring. The mean circumference of the ring is $1\frac{1}{2}$ wave lengths. Four additional rectangular waveguides are secured to the outer wall of the ring one quarter wave length apart, as shown in Figure 1.

For analysis of what occurs at the T junctions of the ring, let us consider T junctions on a straight waveguide.

Figure 2 shows the electric intensity vectors at the center of the waveguide for energy entering one leg and leaving by the other two legs. This holds for energy entering on any leg.

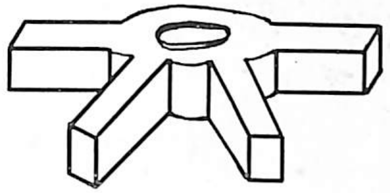


FIGURE 1—Hybrid Ring.

Considering energy entering the T junction by leg Z, note that the electric vectors leaving the junction in legs X and Y are in opposite phase.

Consider the case where energy enters the T junction from both legs X and Y with the E vectors out of phase (See Figure 3).

The electric intensity in a typical position of the wave front is indicated vectorially at two points A and B, symmetrically disposed with respect to the junction. At A, the local field has components 1 upward and 2 to the right while at B the components are 1 downward and 2 to the right. From symmetry the magnitudes of the components at A and B are equal. Thus, A1 and B1 induce equal and opposite voltages making it impossible for energy to be present in this direction. Vectors A2 and B2 reinforce each other so energy is present in this direction and will be transferred to the downward leg.

Consider the case where power enters the T junction from both legs X and Y with the E vectors in phase (see Figure 4).

At A the local field has components 1 upward and to the right while at B the components are 1 upward and 2 to the left. A1 and B1 reinforce each other. A2 and B2 induce equal and opposite voltages so no energy will be present in this direction and no energy will enter the downward leg.

There is a concentration of electric vectors at L. The voltage across L-M and L-N are equal. There is no voltage across M-N as the polarity here is the same. Only voltage vectors are present near L so there will be no energy transfer or dissipation.

Conclusions to be drawn from this are:

1—Energy entering the junction in leg Z will leave in legs X and Y with the E vectors out of phase.

2—Energy entering the junction in legs X and

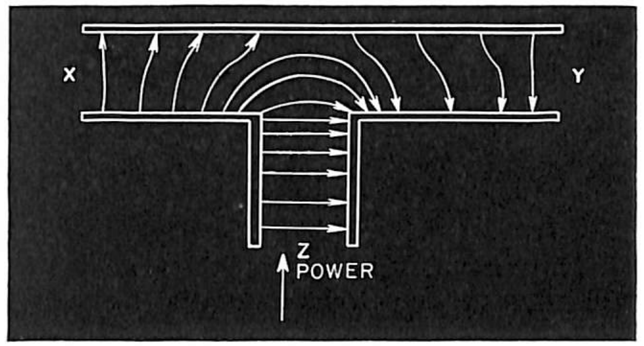


FIGURE 2—Power enters at Z. Power out X and Y.

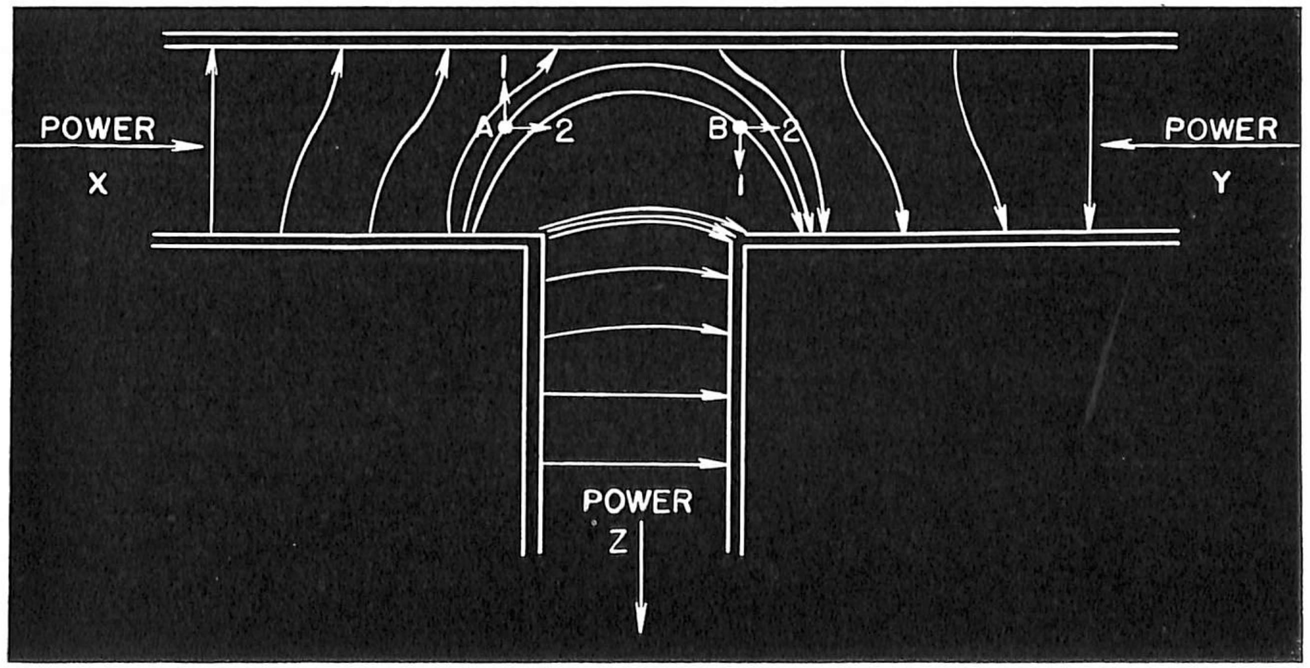


FIGURE 3—Energy enters T junction out of phase from X and Y. Power out Z.

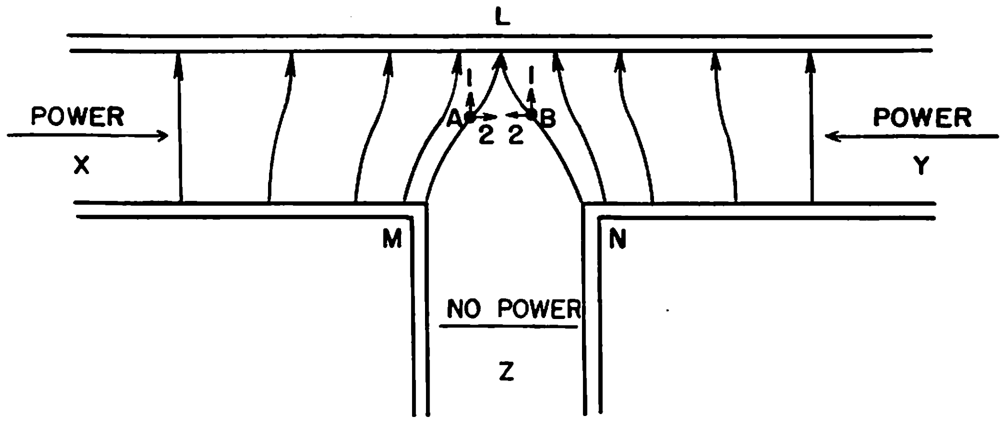


FIGURE 4—Energy enters T junction in phase. No power out.

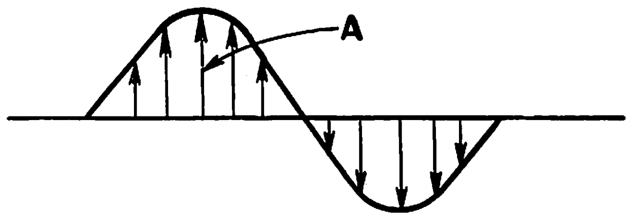


FIGURE 5—Electric field wave front.

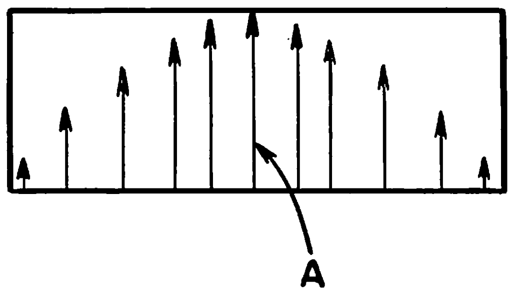


FIGURE 6—Electric intensity in waveguide.

Y with the E vectors out of phase will leave in leg Z.

3—Energy entering the junction in legs X and Y with the E vectors in phase will not leave in leg Z.

The use of Electric Intensity Vectors or E vectors is based on the moving electric field wave front at the maximum point of the sine wave as shown by A in Figure 5.

The electric intensity is distributed in the waveguide as shown in Figure 6.

The electric intensity is maximum at the center of the waveguide. The discussion is based on vector A.

Assume two wave fronts, X and Y moving toward each other from opposite ends of the guide. When X and Y meet at the T junction, their forward motions cease because X and Y are in phase, and equal in amplitude as shown in Figure 7. Since both X and Y are in phase at the junction, there is no current flow, therefore no power dissipated.

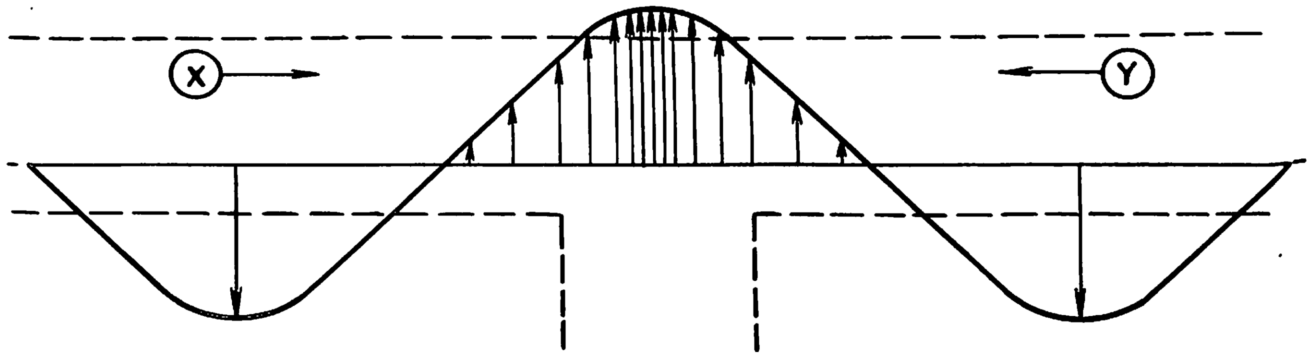


FIGURE 7—Forward motion stops when X and Y are in phase and equal in amplitude.

Construction of the Ring

To understand the operation of the hybrid ring duplexer, first become familiar with the shape, dimensions, and construction of the ring. In Figure 8, the circular part of the unit may be considered a ring made of waveguide with the shorter dimension of the waveguide in the plane of the diagram. The mean circumference of the ring is 1½ wave lengths. There are four waveguides secured to the outer wall of the ring, one quarter wave length apart. Actually the unit is made of solid metal with the waveguides shaped out as large grooves. Waveguide M is connected to the magnetron, L and R to the receiver, and A to the antenna. In waveguide L, the T-R tube is located several wave lengths plus ½ wave length from the ring. In waveguide R, the T-R tube is located several wave lengths plus ¼ wave length from the ring. The T-R tube in waveguide L is ¼ wave length farther from the ring than the T-R tube in waveguide R.

Transmitting Action of the Ring, Part I

When energy is delivered to the ring from the magnetron the E vectors at any one instant will be as shown in Figure 8. The energy enters the ring at M and divides toward L and R. The phase of the E vectors towards L is opposite to that towards R. Waveguides L and R may be considered to be infinite lines to the ring as the T-R tubes

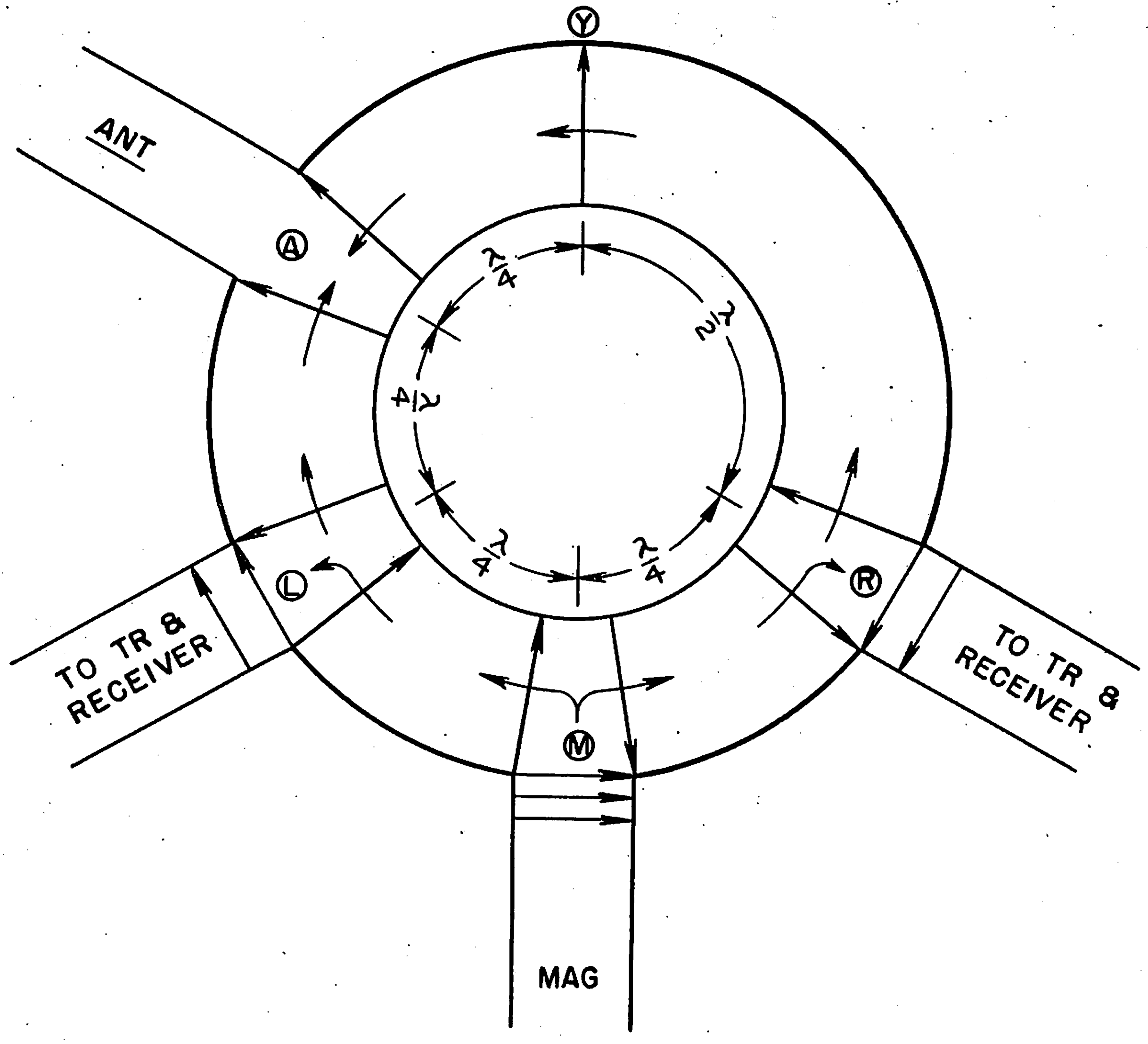


FIGURE 8—Transmitting Part I. Energy enters at M and leaves at L and R.

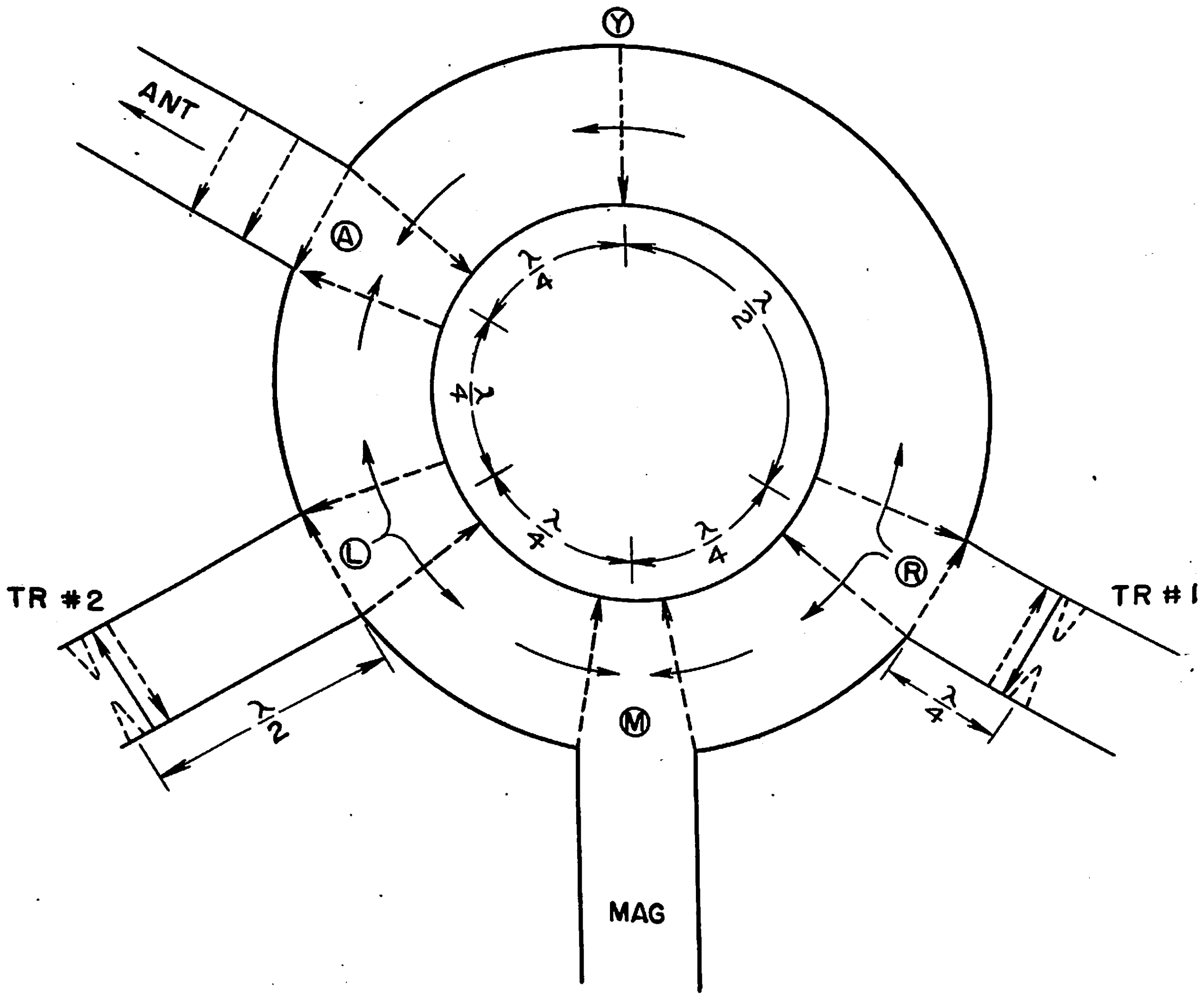


FIGURE 9—Transmitting Part II. Energy moves down guides "L" and "R" causing Tr's to fire. Reflected energy leaves Ring at "A."

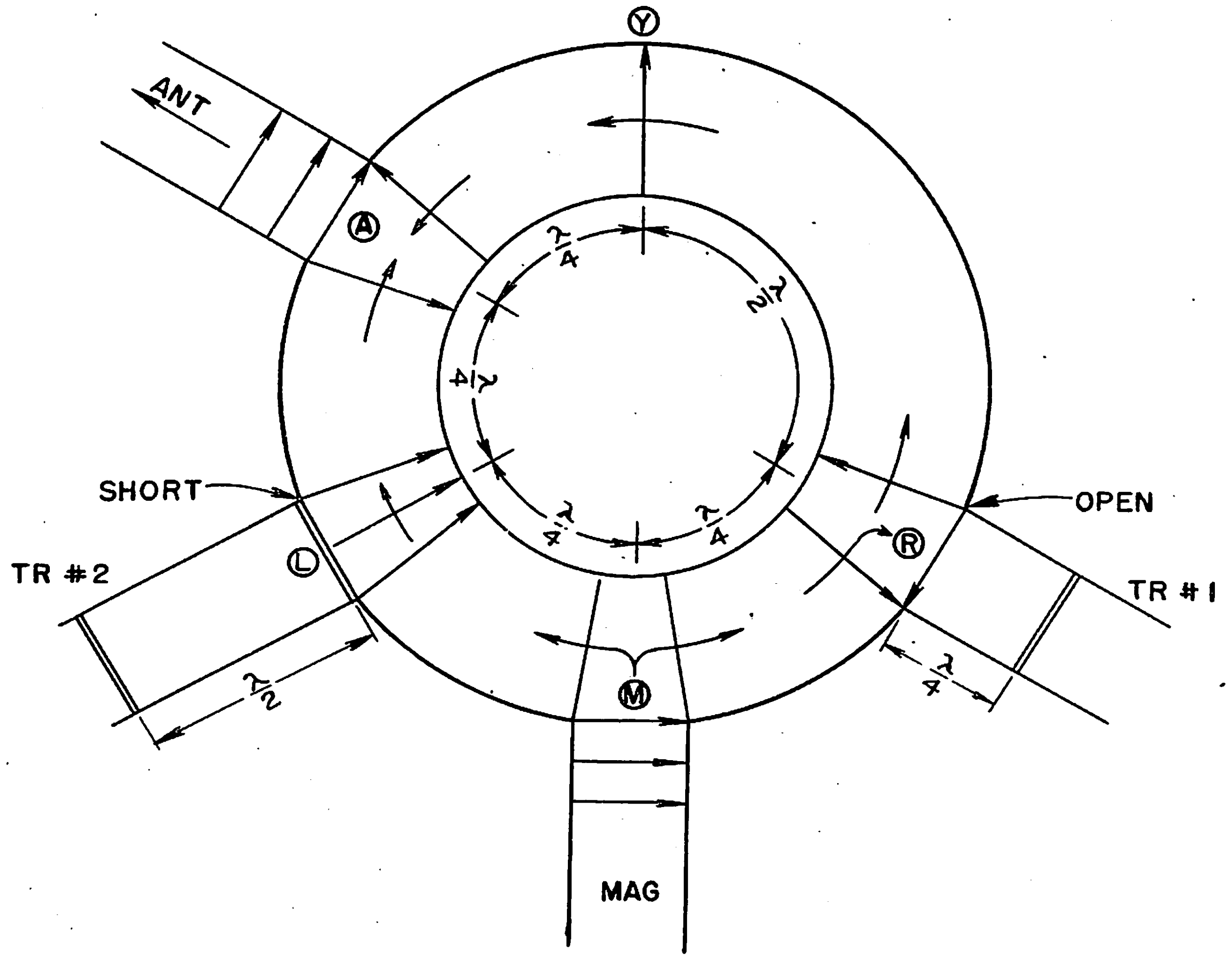


FIGURE 10—Transmitting Part III. Energy moves around the ring and out the antenna at "A."

have not yet fired. Energy enters both waveguides L and R and proceeds towards their T-R tubes. Energy also continues around the ring past L and R, the E vectors reversing as they pass the T junctions. Point Y is ½ wave length from R so it may be considered that energy will be present at Y with the E vectors in the opposite phase to that at R. This energy reaches A from L and Y with the E vectors in phase so no energy will enter waveguide A. Therefore, energy entering the ring at M will leave the ring at L and R but not at A.

Transmitting Action of the Ring, Part II

Figure 9 shows the path of the reflected energy. The energy in waveguides L and R will fire their T-R tubes which appears as a shorted line. The energy will be reflected back to the ring. Waveguide L may be considered ½ wave length long and waveguide R ¼ wave length long. The phase of a reflected wave from a short circuit is opposite to that of the incident wave. The dotted arrows indicate the reflected energy. The total travel distance in waveguide R is ½ wave length so in the time the energy in R has gone up and back in R, the energy in L has just reached the T-R tube. Reflected energy will be present at L and R with the E vectors in phase. Energy from L and R will move to M but since the E vectors are in phase, no energy will enter waveguide M and there will be no power dissipated by the magnetron. Energy will be present at Y with the E vectors in opposite phase to that at R. Energy reaches A from L and Y with the E vectors out of phase so they will reinforce each other and energy will be transmitted to the antenna. Therefore, reflected energy entering the ring at L and R will leave the ring at A but not at M.

Transmitting Action of the Ring, Part III

Figure 10 shows the path of the major part of the transmitted energy in the ring. With the T-R tube in waveguide L firing, a short will be reflected to the ring at L as the T-R tube is ½ wave length from the ring. Energy from the magnetron will pass around the ring toward A past short circuited waveguide L without changing phase of the E vectors. When a short is reflected to the ring junction from a leg, it will appear to the ring that no leg exists. With the T-R tube in waveguide R firing, an open will be reflected to the ring at R as the T-R tube is ¼ wave length from the ring. Energy from the magnetron will pass around the ring toward Y past open circuited waveguide R with a change of phase of the E vectors. When an open is reflected to the ring from a leg, E vectors will have maximum amplitude at the leg entrance. As energy passes around the ring, the E vectors will reverse in phase at the open circuit in the ring. Energy will be present at Y with the E vectors in opposite phase to that at R. Energy reaches A from L and Y with the E vectors out of phase so they will reinforce each other. Energy will be transmitted to the antenna in waveguide A.

Summary of Transmitting Action of the Ring

The path of the transmitted power from the magnetron is first into the ring, then up waveguides L and R to the T-R tubes, firing the T-R tubes, then back to the ring and finally to the antenna. Once the T-R tubes are fired and the short and open circuits are reflected into the ring,

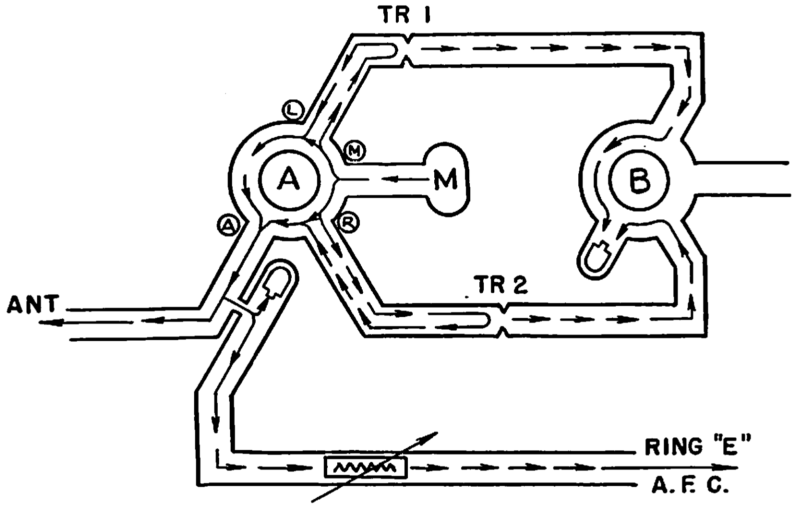


FIGURE 11—Transmitted signal path in hybrid ring assembly.

the major part of the power goes directly from the magnetron around the ring to the antenna waveguide (see Figure 11).

Receiving Action of the Ring

Figure 12 shows the E vectors for the received signal. No signal will enter waveguide M as the signal vectors are of the same amplitude and in phase; therefore, it will not excite the M leg. Waveguides L and R will transmit the signal to the receiver. The received signal is not strong enough to fire the T-R tubes so they will not affect the operation of the waveguide. Waveguide legs L and R without T-R tubes firing appear as infinite lines. All received energy will therefore travel down the waveguides with no reflections.

Operation of Coupling Ring B

The function of ring B is to dissipate the transmitted power that leaks through the T-R tubes and to couple the received signals from ring A and deliver them to ring C. See Figure 13. Waveguides L and R couple ring A to ring B. Waveguide L is $1/2$ wave length longer than waveguide R so there is a phase shift of the E vectors between the two guides at ring B. The leakage power from the T-R tubes will enter ring B with the E vectors in opposite phase and will arrive at leg 4 with the E vectors in phase. Therefore no leakage power will enter leg 4 and appear at the crystals and receiver. The leakage power will enter waveguide 3 as the E vectors are out of phase and will be dissipated in the resistor therein. The received signals will reach ring B in phase and will enter waveguide 4 out of phase and will be delivered to ring C. No received signal will enter waveguide 3 as they arrive in phase at this point.

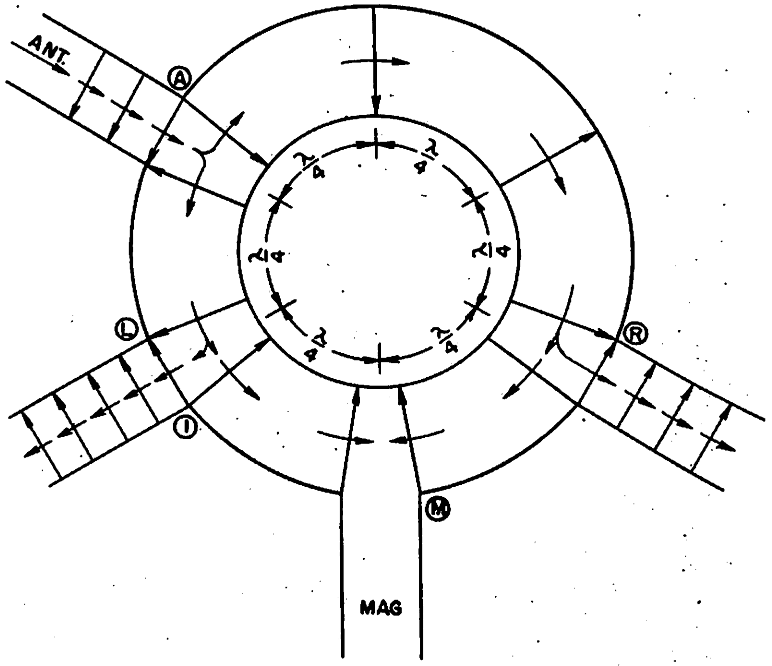


FIGURE 12—Receiving energy enters at "A" and leaves the ring at "L" and "R."

Operation of Mixer Ring C

The function of ring C is to mix the received signal with the local oscillator output to produce the i-f signal. The received signal enters ring C from ring B in waveguide 4. The signal will enter waveguides 1 and 2 but not 3. The oscillator output enters ring C from ring D in waveguide 3. The oscillator output will enter waveguides 1 and 2 but not 4. Crystals are located in the ends of waveguides 1 and 2. Mixing takes place in the crystals which produce the i-f signal. The i-f is delivered to the i-f amplifier. E409 is a sliding vane variable attenuator. The vane is a strip of resistive material that can be moved from the narrow side of the waveguide toward the center. Maximum attenuation occurs when the strip is nearest the center of the waveguide.

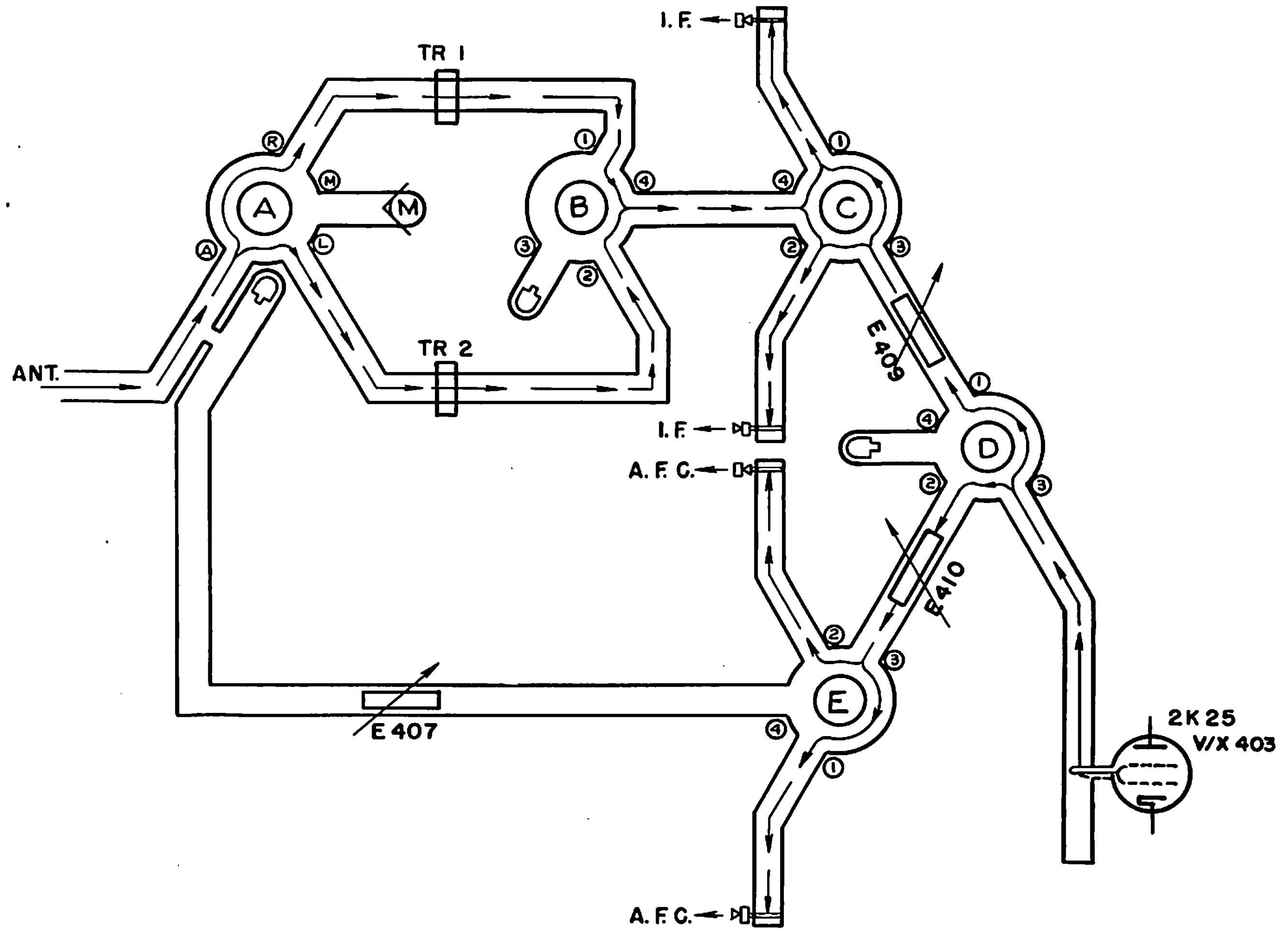


FIGURE 13—Received signal path in hybrid ring.

Advantages of the Hybrid Ring Mixer

The hybrid ring mixer with balanced output has advantages over the ordinary single ended mixer. There is complete isolation of the local oscillator from the i-f inputs so there is no loss of oscillator power through radiation from the antenna. Also, there will be cancellation of side band and other noises introduced by the oscillator.

Operation of Isolation Ring D

The function of ring D is to deliver oscillator output to mixer ring C and to AFC mixer ring E and to isolate ring C from ring E. Oscillator output enters ring D in waveguide 3 from the local oscillator, a Klystron tube, and is delivered to ring C through waveguide 1 and to ring E through waveguide 2. If the frequency of the oscillator should shift radically enough to cause energy to enter leg 4, it will be dissipated by the resistor therein.

Operation of AFC Mixer Ring E

The function of ring E is to mix a small portion of transmitted power from the antenna waveguide with the local oscillator output to produce the i-f signal for the automatic frequency control circuits. There is a small port in the antenna waveguide which delivers a very small portion of the magnetron power to ring E in waveguide 4. A dummy load is near the port to dissipate some of this power. E407 is a variable attenuator for the transmitted signal. The oscillator output is delivered to ring E in waveguide 3. E410 is a variable attenuator for the oscillator signal. The small sample of transmitted power and the oscillator output will enter waveguides 1 and 2. Crystals at the ends of these waveguides will mix the two signals and produce the i-f which is delivered to the AFC chassis.

New Books

The following is a list of all Instruction Books distributed from 1 April 1951 to 10 July 1951. The previous list of Instruction Books distributed appears in the October 1951 issue of the BuShips Electron. The key to the abbreviations listed under the heading "Edition" appears below.

All requests for Instruction Books and other NAVSHIPS publications shall be made to the nearest District Publications and Printing Office. Requests for Instruction Books shall state the reason they are required.

Abbreviation	Edition	Abbreviation	Edition
C	Commercial Publication	MI	Maintenance Instructions
Ch.	Change	OH	Operators' Handbook
CI	Complimentary Instructions	P	Preliminary Instruction Book
DB	Descriptive Booklet	RS	Revision Sheets
FC	Field Change	S	Supplement
IB	Instruction Book	SIG M-8	MarCor Parts List
IH	Installation Handbook	MP	Maintenance Parts Catalogue
IS	Instruction Sheets	T	Temporary
MH	Maintenance Handbook	TM	Technical Manual

Model	Short Title	Edition
AM-220A/MPQ-2A	NAVSHIPS 91408	IB
AN/FRC-19A	NAVSHIPS 91452	IB
(consists of the following sets of books)		
AN/FRC-19A	NAVSHIPS 91452.4	MP
BZ-24/CRC	NAVSHIPS 91462	MI
BZ-24/CRC	NAVSHIPS 91462.4	MP
C-388/CRC	NAVSHIPS 91560	MI
C-388/CRC	NAVSHIPS 91560.4	MP
CY-442/CRC	NAVSHIPS 91458	MI
CY-442/CRC	NAVSHIPS 91458.4	MP
ID-203/CRC	NAVSHIPS 91459	MI
ID-203/CRC	NAVSHIPS 91459.4	MP
ID-298/CRC	NAVSHIPS 91464	MI
ID-298/CRC	NAVSHIPS 91464.4	MP
AN/FRT-6	NAVSHIPS 91263	Ch 1
AN/MPN-B	NAVSHIPS 316A	T-5
AN/MPN-1A	NAVSHIPS 98077	ERRATA SHEET NO. 1 to FC #8
AN/MPN-1A, 1B	NAVSHIPS 98196	ERRATA SHEET NO. 1 to FC # 12
AN/MPN-1B	NAVSHIPS 98218	FC #20
AN/MPS-4	NAVSHIPS 91373	IB
AN/MPS-4	NAVSHIPS 91373	T-1
AN/MPS-4	NAVSHIPS 91373.2	OH
AN/MPS-4	NAVSHIPS 91373.3	MH
AN/MPS-4	NAVSHIPS 91373.4	MP
AN/MRC-5B, 6B, 7B, and 8B	NAVSHIPS 91398	IB
AN/MRC-5B, 6B, 7B, and 8B	————————	SIG M-8
AN/PDR-27C	NAVSHIPS 91444	IB
AN/TPS	————————	SIG M-8, FC #10
AN/UQS-T1	NAVSHIPS 91274(A)	Ch 1
AN/UQS-T1	NAVSHIPS 91274(A)	IB
AN/UQS-T1	NAVSHIPS 98216	FC #1
AN/URA-8A	NAVSHIPS 91278	T-1
AS-295A/UP	NAVSHIPS 91412	IB
AS-371/S	NAVSHIPS 91433	IB
CAN-55210	NAVSHIPS 91390	IB
CAN-55223, CAN-23550 and CAN-23550-A	NAVSHIPS 91358(A)	IB
CN-118/U	NAVSHIPS 91427	IB
CU-60/URR, AN/URA-8	NAVSHIPS 91339	T-3
FR-7(XN-1)/UP	NAVSHIPS 91446	IB
IP-88/UP	NAVSHIPS 91455	IB
IP-88(XN-1)/UQ	NAVSHIPS 91455	IB
IP-99/SP	NAVSHIPS 91443	IB
KY-44A/FX	NAVSHIPS 91441	IB
MBB	————————	SIG M-8
ME-25A/U	NAVSHIPS 91415	IB
OS-8/U	————————	SIG M-8
OZ	NAVSHIPS 95198	T-1
OZ	NAVSHIPS 95198-1	Supp. P.L.
OZ, OZ-1 and OZ-2	NAVSHIPS 98199	FC #1
OZ-1	NAVSHIPS 900,346-IB	T-1
OZ-1	NAVSHIPS 900,346-IB-2	Supp. P.L.
OZ-2	NAVSHIPS 95200	T-1
OZ-2	NAVSHIPS 95200-1	Supp. P.L.
PP-671/PD, DT-62/PD	NAVSHIPS 91382	IB
PP-86C/TXC-1, TT-41A/TXC-1B	NAVSHIPS 91442	IB
QHB, OHB-1	NAVSHIPS 900,976(A)	Ch 2
QHB-a	NAVSHIPS 91125	Ch 1
QHB-a	NAVSHIPS 91125	IB
QHB-a	NAVSHIPS 91125	T-1
QHB-a, QHB-1	NAVSHIPS 98217	FC #2
QHB-a, QHB-1	NAVSHIPS 98222	FC #3, FC #5
QHB-1	NAVSHIPS 900,976(A)	T-1
RD-92/UX	NAVSHIPS 91401	IB
RDZ	NAVSHIPS 98204	FC #6
RDZ-RDZ-1	NAVSHIPS 900,617	Ch 1
SG Series	NAVSHIPS 900,531	IB
SM-38/UQS-T1	NAVSHIPS 91425	IB
SM-39/UQS-T1	NAVSHIPS 91426	IB
SV-3	NAVSHIPS 91325(A)	IB
SV-3	NAVSHIPS 91325(A).1	IH
SV-3	NAVSHIPS 91325(A).2	OH
SV-3	NAVSHIPS 91325(A).3	MH
SV-3	NAVSHIPS 91325(A).4	Maint. Prints
TS-50/UP	NAVSHIPS 91191	IB
TS-186/UP	————————	SIG M-8
TS-275/UP	NAVSHIPS 900,825	Ch 2
TS-460/U	NAVSHIPS 91402	IB
VF-a	NAVSHIPS 900,858	T-1
VK	NAVSHIPS 900,986	Ch 2, Ch 3
VK-2	NAVSHIPS 91300	IB
VK-2	NAVSHIPS 91391	Maint. Prints
ZM-2/U	NAVSHIPS 91406	IB
185-A	NAVSHIPS 95554	IB

SS/SV-1 CONSOLE METER ILLUMINATION LAMPS

A number of the ships have had difficulty in finding and ordering these lamps under the designations given in the SS and SV-1 instruction books. The Navy stock number of the lamps is N17-L-6543-100 and can be ordered from supply. This lamp can also be bought commercially as GE#322.

SUBFLOT ONE Electronics Newsletter

EQUIPMENT LOG BOOKS OBSOLETE

The "Radio Equipment Log"—NAVSHIPS 900,039—and the "Sonar Equipment Log"—NAVSHIPS 900,023—are obsolete and are no longer in stock. The "Radar Equipment Log"—NAVSHIPS 900,065 is available *only* to GCA units.

Electronic Equipment History Card (NAVSHIPS 536), Record of Field Changes (NAVSHIPS 537) and the Tube Performance Record (NAVSHIPS 538) are to be used. They are described in Chapter 6 of the BuShips manual and in the February 1948 issue of Electron.

ST INSTABILITY WHEN SWITCH-OVER FROM SJ-1 IS MADE

As time goes on more boats with SJ-1/ST combinations will be re-activated. One of the biggest gripes by operators of these equipments is the fact that in switching from SJ-1 to ST a period of ten to fifteen minutes passes before the ST transmitter/rec. (which has no AFC) settles down in tuning stability.

FC#9 for the ST will correct this situation. The schematic and procedure for accomplishing this field change (in the interim to ordering the FC#9 kit) can be found in Electron for Oct. 1945. As this publication is still classified confidential it will not be found lying about but can be obtained from Tender files.

This field change applies beam and repeller voltages to the B.O. and plate voltage to the pre-IF stages when in standby, thus allowing the oscillator/amplifier ass'y to be warmed up to stability during operation of the SJ 1.

SUBFLOT ONE Electronics Newsletter

CARE OF ELECTRON TUBES

Electron tubes are fragile pieces of material. All tubes unpacked for testing or for any other reason should be repacked when not in use in their original cartons. Why? Because these cartons have been designed for maximum tube protection. Also when you return tubes to their packings, be sure to repack them the way they were originally.

Humidity is another angle. Tubes must be protected from moisture. Watch out for this—especially if you keep tube stocks aboard ship—because the salt air causes rapid corrosion. Some tubes are shipped to you in moisture-proof containers designed to absorb excess moisture in the air. Watch for damage to these containers and keep an eye on that silica-gel for discoloration showing excess moisture.

If there is a doubt in your mind about how to repack a tube in its original package, do not run the risk of jarring the tube in an inadequate container. Obtain and study a copy of Military Spec. MIL-P-75A and all amendments thereto. This is issued by the U. S. Government Printing Office. The Long Title is Military Specifications—"Packaging, Packing and Container-Marking—Tubes, Electron."

At the present time, tube allowances are based on estimated requirements for three months only. The availability of many of these tubes is bound to become more critical if the emergency intensifies, particularly until pending contracts can be completed and the material shipped to advance bases. Consequently, it is necessary for all storekeepers and technicians to take extra care in handling and stowing electron tubes in order that existing stocks may be maintained and preserved in the best possible condition.

You've been stowing your tubes carefully and then after they're issued the ET comes and tells you they are no good? Well, it's hard to say where the fault lies; it might be defective manufacture, or poor packing. The best procedure, if practicable, is to turn all tubes over to the Electronics Officer immediately upon receipt, and have his boys test and return them to supply.

Rotation of Stock

Since tubes do deteriorate to a certain extent, always issue the oldest tubes on your shelf first.

Implosion

Due to the vacuum maintained inside the electron tube envelope, there is an always-present tendency for it to collapse. This tendency is restrained, however, by the strength of the material of which the envelope is made. When the envelope is weakened by some external shock, such as dropping the tube, the envelope may give way and a sudden collapse, or *implosion,* will occur. Implosion is the opposite of explosion. (Explosion is, as we know, caused by excessive or high pressure being forced *inside* an enclosed space, such as blowing too much air into a toy balloon).

Greatest implosion danger, of course, is in glass tubes rather than in metal types.

One might think that, due to the fact that all broken parts tend to fly toward the center of the enclosed space, implosion is not hazardous. This is not altogether true, for although the broken parts *tend* to fly inward, the unequal forces will combine to cause certain parts to fly outward. Some of these, usually the top of the tube and the base, may be propelled at considerable velocity.

Radioactive Tubes

Radioactive tubes properly stowed in cartons present no radiation hazard, nor does normal handling of them. Concentrated stowage of large quantities of radioactive tubes, however, is to be avoided as you would avoid a rattlesnake. For instance, a stack of 1B22 or 1B29 tubes can cause injury by radiation, just as exposing the body for too long a time under an X-ray.

Caution must be observed when handling broken radioactive tubes to obviate the serious danger of radioactive particles or gases entering the body by breathing, eating, or through cuts in the skin. Where available, the services of a Radiological Safety Officer should be requested in any case of suspected contamination.

Disposal of Radioactive Tubes

Recommended procedures for the disposal of radioactive tubes, broken and unbroken, and the cleaning-up of the tube fragments, were outlined in the 25 January 1950 issue of the Electronics Installation Bulletin.

Here's a brief on these procedures:

Dead, unbroken tubes should be treated as any other radioactive waste materials. They should be sunk intact at sea beyond the 100 fathom line. At shore installations, it is best to collect the tubes in special containers. Then the tubes, weighted and sealed, may be sunk at a convenient time. A plot of land may be set aside near the shore station to be used as a burial ground; however, the sinking method is recommended. If a burial plot is used, it should be adequately posted and supervised.

Tubes containing radon gas may be broken-up under a ventilated hood, since radon gas is heavier than air. However, burial of such tubes intact or sinking them at sea is the optimum disposal method. When possible, radioactive material to be junked should be encased in concrete to insure that no parts will float to the surface. Equipment or tools used in crushing the tubes or in handling radioactive junk should be thoroughly cleaned before using for other purposes, or if possible, such equipment or tools should be buried or sunk. It should be remembered that any buried material may be exposed eventually by land excavation and cause radium poisoning exposure.

Clean the Area Thoroughly

Recommended procedures for clearing contaminated areas are as follows:

1—Wet method: First pick up large fragments with forceps; then, with wet cloth, wipe across the area. Make one sweep at a time and fold the cloth in half, keeping the clean side out at all times. When the cloth becomes too small, start again with a clean piece of cloth. Do not rub the radio-activity into the surface being cleaned but use a back and forth motion. All cleaning material should be collected in a container such as a plastic bag, heavy wax paper, ice cream carton or glass jar and disposed of in the same manner as the unbroken tubes.

2—Dry method: Pick up large pieces with forceps, then clean the area careful with vacuum cleaner. If breakage of tubes is a frequent occurrence, the vacuum cleaner exhaust should be analyzed and the appropriate collector used. Collecting bags should be disposed of in the same manner as the debris in method (1).

Prevent Spread of Contamination

The following rules apply to disposal and handling of any contaminated material:

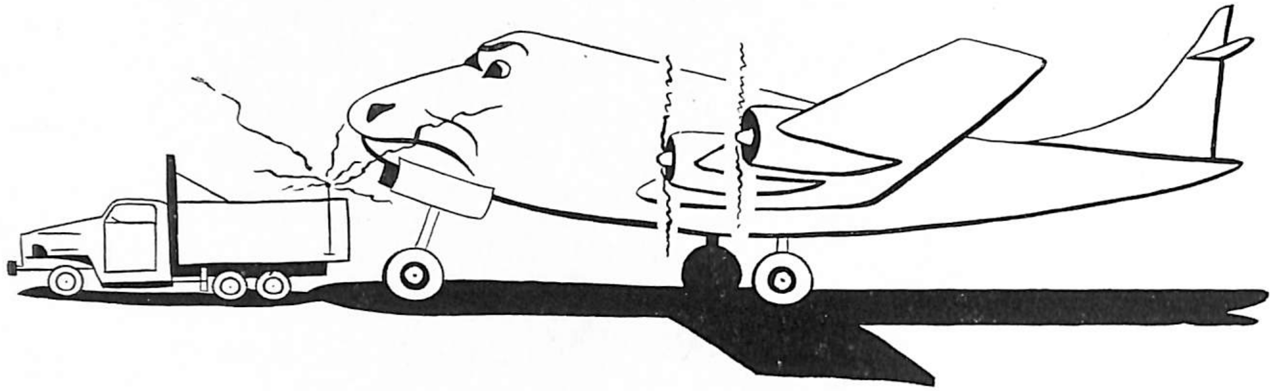
1—No material contaminated by radioactivity should ever come in contact with any part of the body. Protective gloves should be worn at all times in the handling of radioactive wastes and broken radioactive parts.

2—No food or drink should be brought into the contaminated area or near any radioactive material.

3—Hands and arms should be washed and all clothing removed after any direct contact with contaminated materials.

Packaged Magnetrons

When magnetrons are tested for shipboard use, in repacking, a minimum of four inches should be provided between the center of the magnetic field and the outside of the individual carton. This is applicable for all tube types having magnets attached, thus protecting both the magnets and other magnetically susceptible instruments.



A shipment of packaged magnetrons was to be shipped by air, Priority A. The magnetrons were delivered to the air station by the supplier's truck which parked under the plane's nose. The plane wasn't scheduled to leave for awhile so the truck driver had lunch and went leisurely back to his truck. The crew had checked the equipment thoroughly, but when the pilot got in he noticed his magnetic compass had been misdirected. After the pilot had spent considerable time in swearing at the crew and in estimating their worth, a man from the electrical department who had been called to repair the damaged compass decided that it must be interference from some nearby magnetic body. When the magnetrons were put aboard the plane, the mystery of the misdirected compass was solved but the repair wasn't so easy. As a consequence of this and similar reports, an embargo has been placed on air shipments of packaged magnetrons.

The Electronic Supply Office has advised all stocking activities not to ship packaged magnetrons by air and to mark all packaged magnetrons "Not Shipable by Air—Keep away from Delicate Instruments."

Electronic Supply Office

LOSS OF SS CRYSTAL CURRENT

Two items which cause loss of crystal current can be easily checked and eliminated by the technician.

The first is damaged chucks in the crystal assemblies. Only 1N23B crystals and 1N23Bs should be used as signal and AFC crystals in the SS transmitter/rec. Not only are other crystals the wrong type electrically but some are longer physically than the 1N23Bs and will bend the chuck fingers mounted in J5 and J6. Consequently when the proper crystals are later installed there is a lack of contact between the crystals and the chucks.

Continuity can be checked by inserting an old used crystal and measuring with an ohmmeter from the center conductor of J5 or J6 to ground. These jacks will be found screwed into the waveguide in the back of the rec. and B.O. ass'y. If there is no continuity unscrew the jacks and, with heavy tweezers, bend the chuck fingers back into place.

The second condition is no signal or AFC crystal current but good grass and a transmitter pulse on the monitor scope. If the measured beam, repeller and filament voltages to the B.O. tube are normal, check the cathode resistor, R1 (270 ohms) of the B.O. This resistor is mounted under the socket of the B.O. tube and can be measured by pulling the B.O. and making an ohmmeter check from pin #8 to ground.

If it is found necessary to replace, unscrew the 3 large machine screws around the edge of the tube socket, grasp the round B.O. tube housing, gently pry until it comes loose, exposing the under side of the socket. After the screws are removed the housing is held to the rec./B.O. ass'y by friction only.

SUBFLOT ONE Electronics Newsletter.

MODEL TEB TIME INTERLOCK FAILURE

It has been brought to the attention of the Bureau that the time interlock mechanism of relay K–801 incorporated in the Model TEB transmitter has on occasion failed to short out filter condensers C–612 and C–613 when the high voltage was off at the 7–kv rectifier. To prevent a serious hazard due to such a failure, it is stressed that these mechanisms be given periodic maintenance inspections to insure that all mechanical parts are clean and free acting. Relay K–1126 of Model TEC transmitters should be similarly checked.

FAILURES MODEL SG–1b ANTENNA

Pearl Harbor Naval Shipyard reports that two ships have recently arrived with trouble in their Model SG–b or SG–1b radar antennas caused by improper accomplishment of Field Change No. 61. In both cases, the microswitches had been inserted too far into the synchro housing, causing undue drag on the cam. This in turn had caused failure of the coupling between the synchro and the drive motor. With backlash present in this coupling, the antenna will hunt to an alarming extent.

In both of the known causes of this trouble, the ships had been advised that there was trouble in the antennas which would necessitate removal for overhaul. In both cases, however, the trouble was cured by replacing the damaged portion of the coupling, which is the peculiarly shaped washer which locks the motor half of the coupling to the motor shaft. The part is not clearly described in the equipment instruction book (NavShips 900,531), but is shown as "motor clip" on Page 2 of Bulletin 53 of SG series Radar Field Engineers' Service and Installation Bulletins (NavShips 900,635). Since the part could not be obtained readily from the supply system, it was manufactured in each case.

It is believed that a warning should be issued to all personnel concerned, that serious trouble may be caused by improper installation of the field change microswitches. It is believed also that all personnel concerned should be alerted as to this possible cause for otherwise unexplainable antenna hunting. It is also possible that this trouble may be occurring in antennas even though Field Change 61 has not been accomplished.

MODEL NMC–1/2 REPLACEMENT TRANSDUCERS

Forty AT–229/SQ transducers (SNSN F16–T–24792–3621) were furnished by the Bendix Aviation Corporation, Pacific Division, under Contract Nobsr 43092 for use with NMC–1 and NMC–2 equipments. These transducers contain an impedance matching network which converts the input impedance of the transducer to 100 ohms, unity power factor, at 18 kc. Therefore, the capacitors in the CBM–62071 projector junction box shown on Figure 7–29 of the NMC–2 instruction book (NavShips 900,595(A)) are unnecessary and should be disconnected upon installation of the new type transducer in an NMC–1 or NMC–2 equipment.

The new type transducer's internal impedance matching network consists of three parallel-connected .022 microfarad capacitors in series with one transducer input lead. Therefore, normal testing procedure must be modified as follows:

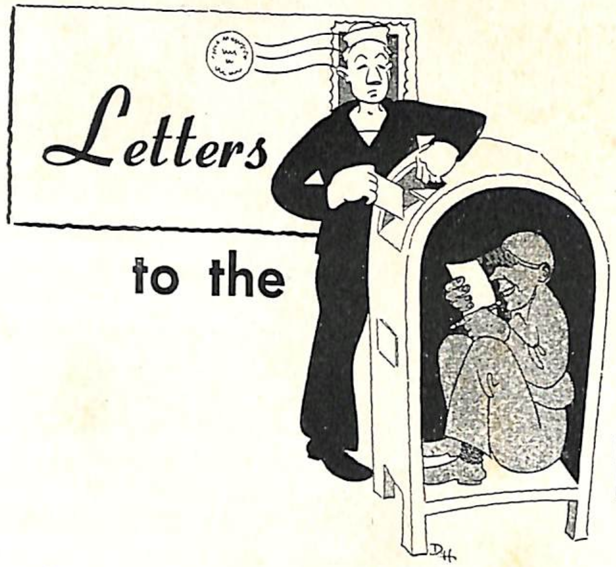
1—Megger continuity tests of the transducer should show an open circuit.

2—Ohmmeter continuity tests of the transducers should show a typical condenser kick before indicating an open circuit.

3—The impedance of the transducer should be 100 ohms when measured at the transducer resonant frequency, which is approximately 18 kc. One method of checking this value is to measure both current through the transducer and voltage across it when the transducer is driven at its resonant frequency by an audio oscillator.

F.C. NO. 1 FOR THE MODEL OKA–1

Field Change No. 1—OKA–1 modifies the control circuits of the cursor scale change relay, and the stylus speed scale change relay, to assure that the two scales are always in correspondence. This field change applies to all Model OKA–1 equipments and should be accomplished concurrently with Field Change No. 4–OKA, which changes the Model OKA to the Model OKA–1. The field change is equivalent to a repair and should be accomplished by ship's force personnel. Ships requiring this field change should request it from the Bureau of Ships (Code 983), Navy Department, Washington 25, D. C.



Letters to the EDITOR

This new feature is the answer to numerous suggestions and requests from fleet and shore personnel for a medium of presenting their individual problems, gripes and questions on electronics matters and obtaining answers to such queries.

As a matter of convenience, it is suggested you write directly to:

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

Editor
BuShips Electron
Dear Sir:

Most Senior Radiomen, Communications Officers, and Electronic Officers are dubious about rearranging radio equipment, even though they feel it will show a marked improvement in efficiency of radio spaces. Aboard a destroyer one must learn to take every advantage of available space. On Class 692 destroyers the bulky metal framework situated in Radio Central can be cut down considerably. Through proper analysis, proper handling, and strict technical supervision the receivers can be re-arranged for a much neater appearance and easier access.

CAB

The equipment rack in 692 Class DD's was designed to hold equipments, most of which will shortly become obsolete. A further rearrangement of Radio Central will be necessary in order to accommodate more UHF and teletype equipment. Studies are being made at present toward improving the arrangement in Radio Central on these vessels.

The Bureau has no objection to rearrangement of radio receivers within a metal rack or framework if it is felt that serviceability and efficiency will be improved. However, the rack should not be removed or altered without authority from BuShips.

Editor

Editor
BuShips Electron
Sir:

With reference to NavShips 900,135 "Instructions for Maintaining Ship Electronic Equipment Inventory System," it is noted that copies currently being received from DPPO's do not reflect Change No. 1 as promulgated in the 15 November 1949 issue of the Navy Department Bulletin. Further, as Change No. 1 was omitted from the Cumulative Edition of the NDB, it is not presently available to ships being activated under the current activation program, as they receive only Cumulative Editions of back numbers of the NDB.

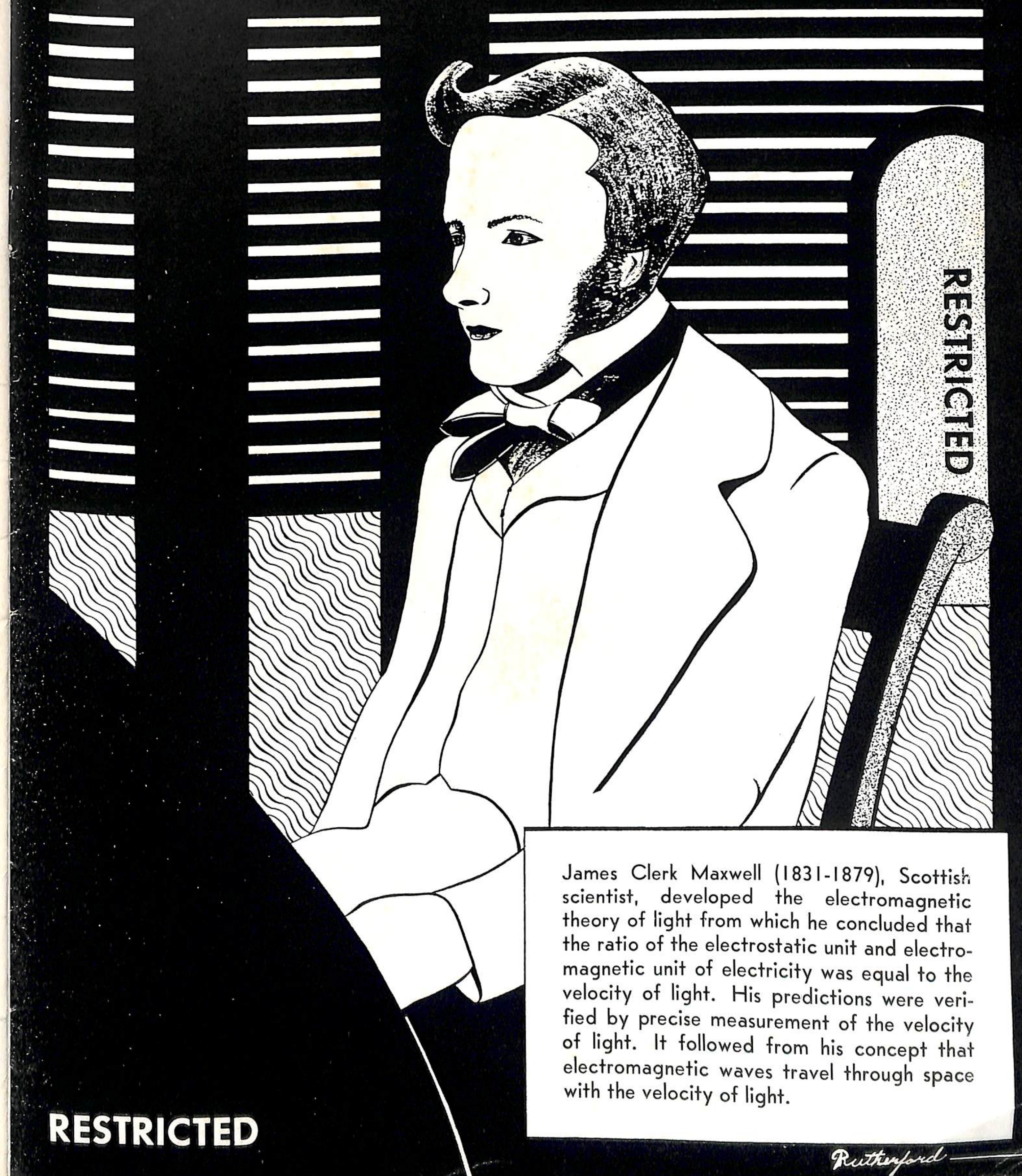
RDM Chrele

Copies of Change No. 1 to "Instructions for Maintaining Ship Electronic Installation Record System," NavShips 900,135 are available through the local District Printing and Publications Office.

A revised edition of Navships 900,135 incorporating Change No. 1 will be distributed near the end of March 1952. This revision will require submission, to the Chief of the Bureau of Ships (Code 971), of a single corrected copy of NavShips 4110 marked OVERHAUL six months prior to the commencement of a regularly scheduled overhaul.

Editor

FAMOUS FIRSTS IN ELECTRONICS

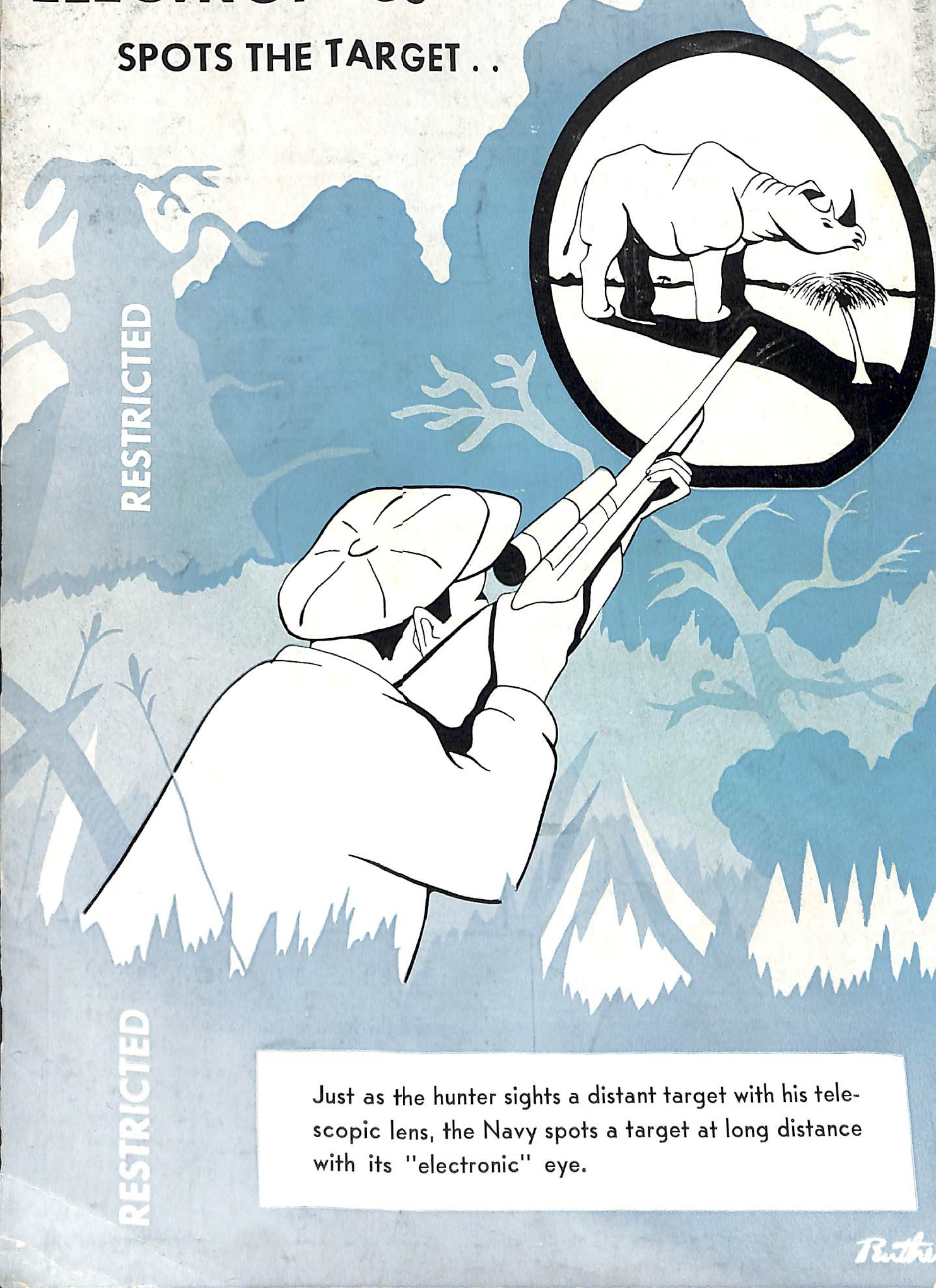


James Clerk Maxwell (1831-1879), Scottish scientist, developed the electromagnetic theory of light from which he concluded that the ratio of the electrostatic unit and electromagnetic unit of electricity was equal to the velocity of light. His predictions were verified by precise measurement of the velocity of light. It followed from his concept that electromagnetic waves travel through space with the velocity of light.

ELECTRONICS

SPOTS THE TARGET . .

RESTRICTED



Just as the hunter sights a distant target with his telescopic lens, the Navy spots a target at long distance with its "electronic" eye.

RESTRICTED