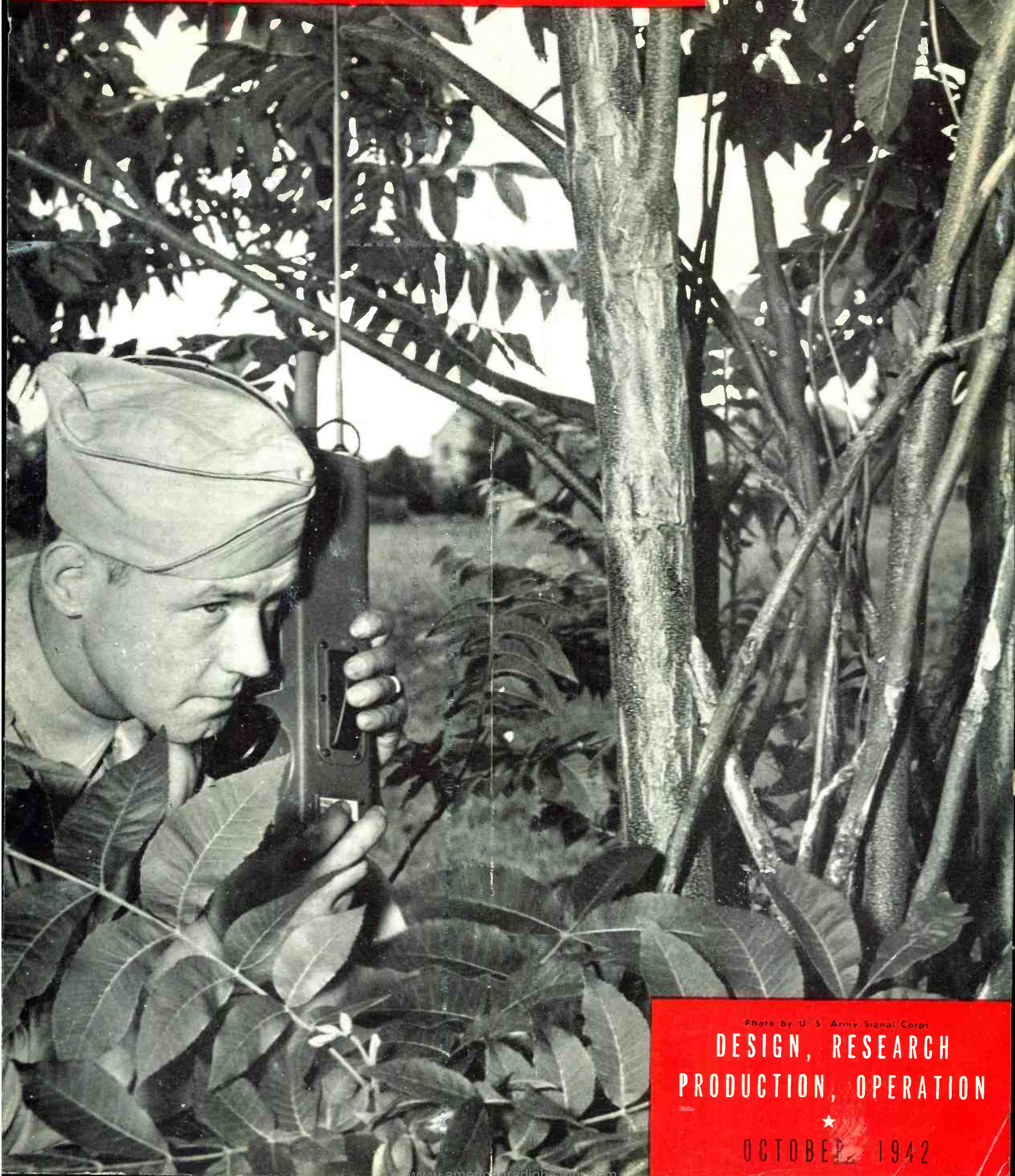
RADIO

ESTABLISHED 1917



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DESIGN, RESEARCH
PRODUCTION, OPERATION

★

OCTOBER, 1942

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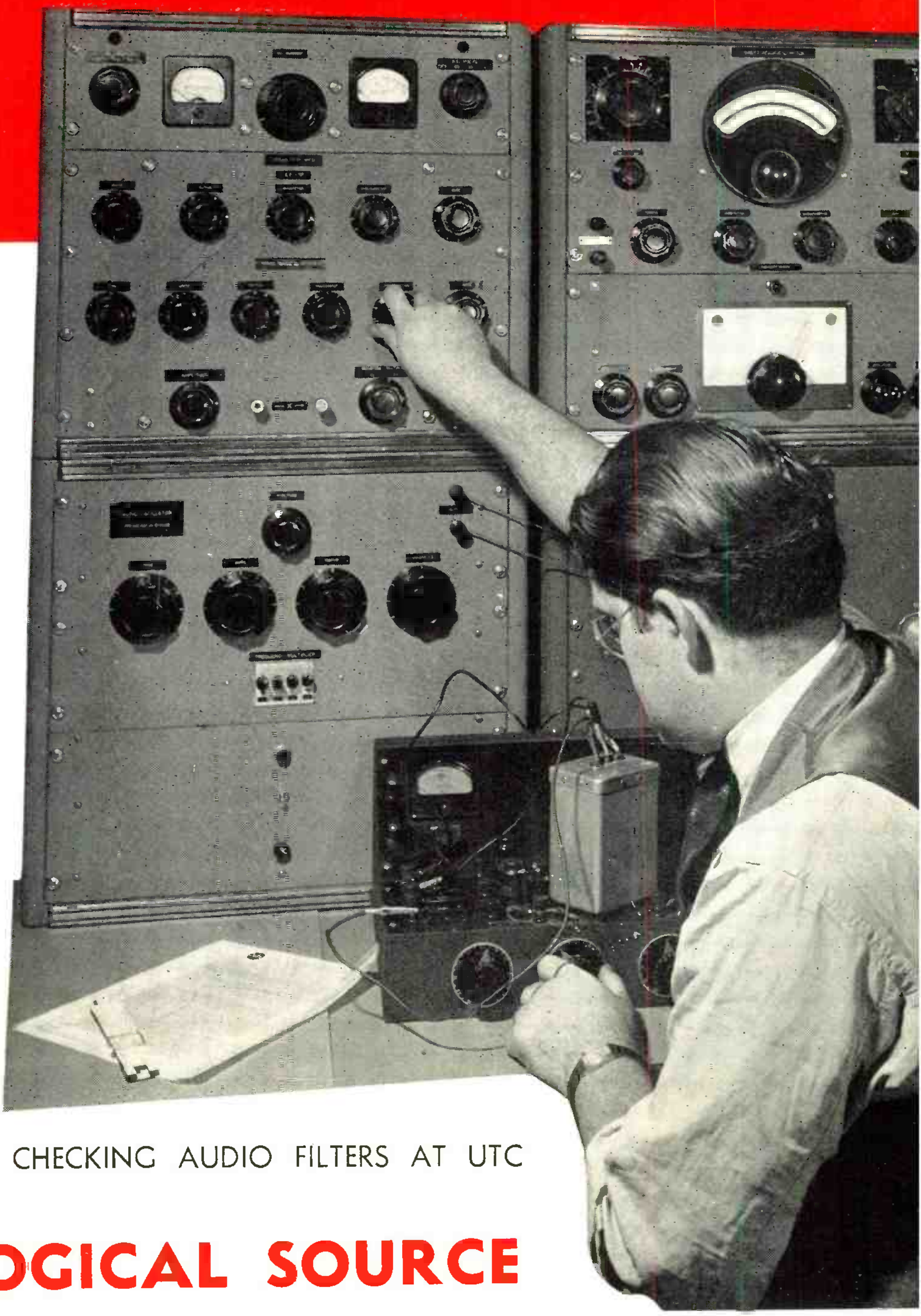

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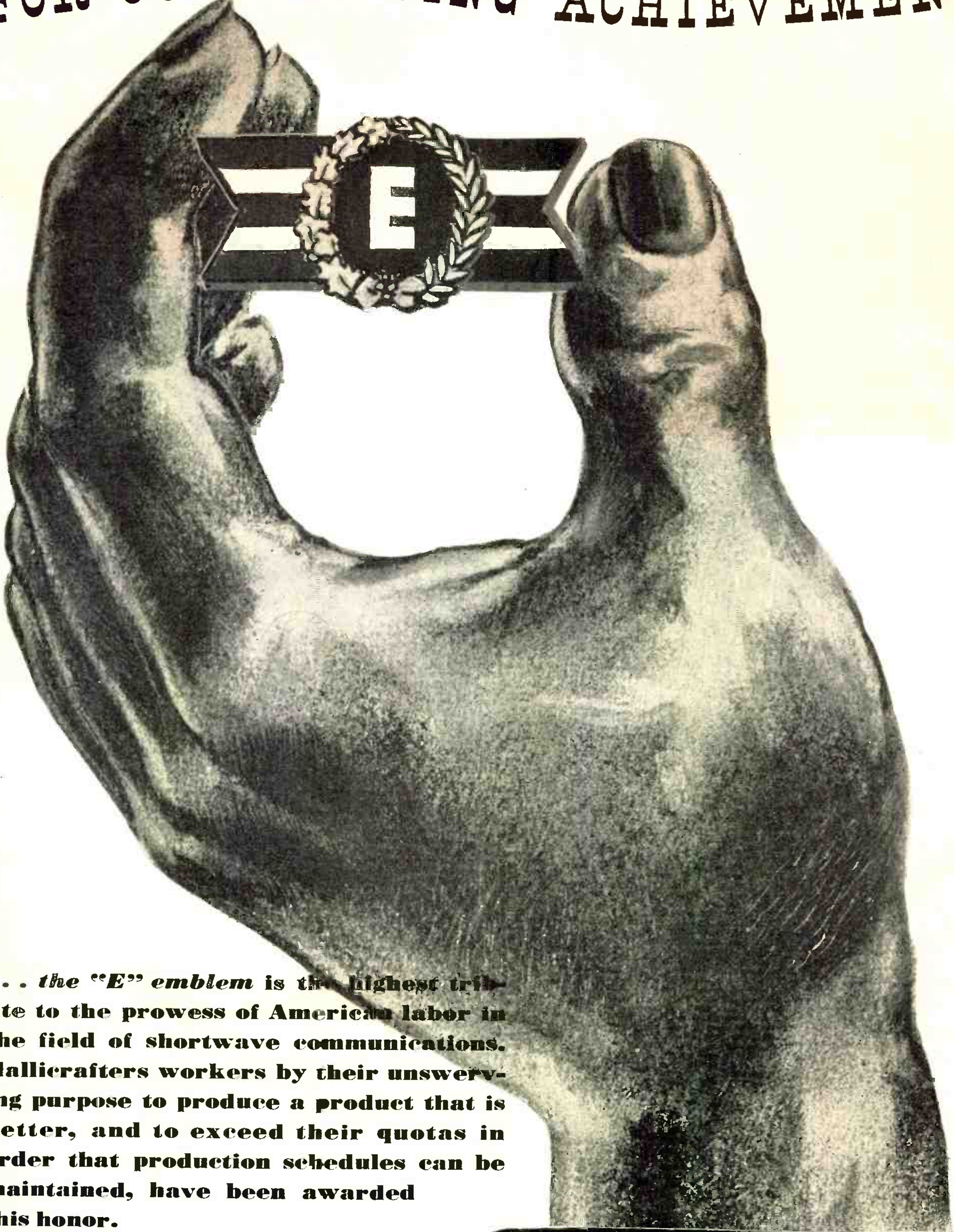

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RADIO

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COVER

Staff Sergeant Thomas W. Gloystein is shown in the field with a portable "Handy-Talkie" transceiver. He was formerly a fireman from Cincinnati and is now an instructor of radio communication at Fort Benning, Ga.

ARTICLES

MISCELLANEOUS

RADIO (title registered U.S. Pat. Off.) is published monthly at 34 N. Crystal Street, East Stroudsburg, Pa., by Radio Magazines, Inc., Executive and Editorial Offices at 132 West 43d Street, New York, N. Y. Subscription rates—United States and Possessions, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U.S.A. All rights reserved, entire contents Copyright 1942 by Radio Magazines, Inc. Application Pending for transfer of Second Class Entry from Santa Barbara, Calif., to East Stroudsburg, Pa.


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EDITORIAL

JEEP FREQUENCIES

★ We have received a very engaging letter from Mr. G. Parr, editor of the English journal *Electronic Engineering,* with regard to our editorial on ultra-high frequency terminology, in the May issue.

Mr. Parr assures us that the English are not using the abbreviation U.H.F.I. (Ultra High Frequency Indeed) as we intimated, which leaves us holding the bag and chalks up one for *Electronics,* who attributed the origin to a group of American college professors.

But—since when have Americans been using the word "indeed" as an expression of emphasis? It's too typically British.

Or, is it an example of lend-lease in reverse? If that is the case, then we offer to the radio engineers of Great Britain a good Yankee counterpart—Jeep Frequencies!

Mr. Parr has called our attention to a suggestion offered by Dr. Fleming-Williams in a letter to the editor of *The Wireless Engineer.* He proposes that the whole frequency spectrum be divided up into a number of bands defined in the following manner.

If a frequency is expressed in cycles per second, it will lie in a band whose number is equal to the logarithm of the frequency to base 10. The band number is therefore given by expressing the frequency as a number between 1 and 10 multiplied by a power of 10, and using that power as the band number.

For example 50 megacycles is 5×10^7 cycles, and the band number is 7.

It is pointed out that the present terminology does not correspond to the band numbers exactly, but this should not bring up difficulties. And the method can be extended into the light waves, which would be associated with band 14.

IMAGINEERING

★ Said the Aluminum Company of America in a recent advertisement *"Dream a Dream Every Day.* Remember that the kind of peace we all want depends on how many jobs we think up for the boys coming back. New jobs come out of new things to make. Let your imagination soar; engineer it down to earth; then file the plans away, ready for the day when. *That's Imagineering!"*

The promise this good advice holds for now and the future is best expressed by the slogan in the same advertisement—So Much So Soon.

RADIO-NEUROSIS

★ It is reported from Washington that the Office of War Information is about to apply inverse feedback to the Axis Powers' war of nerves. The plan has the approval of the War Communications Board; and OWI contemplates the development and operation of 36 short-wave transmitters for the purpose of reaching audiences in enemy territory.

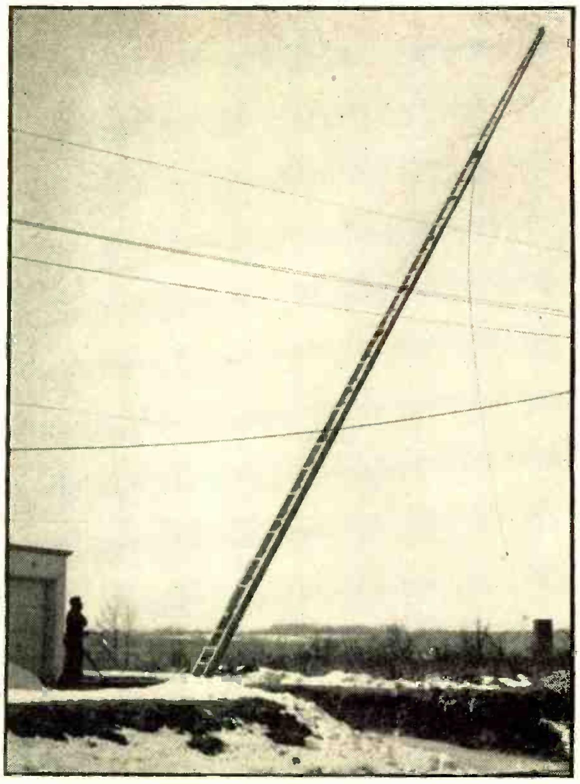
A radio barrage is difficult to dodge in localities where a curiosity born of fear has emerged, and no power can completely remove the desire to listen. The enemy and the subjugated alike will bend an ear to what the United States has to say.

Facts and figures will strike deep; but we rather hope that our strategists of the air turn to the technique of the dentist, who is never so terrifying as at the moment he so untruthfully says, Now, this isn't going to hurt.

HAM SCRAP

★ Towering above White Plains, New York, were two 76-foot, self-supporting masts made of welded channel iron. They had held up the sky-wire at W2IKV, owned and operated by L. B. Keim. Below you will see one of the masts about to bite the dust, on its way to the scrap pile with the other.

A part of this mast may end up in a Jap's belly or a German's brain pan. So, we need more masts like it. Is yours on the way? *M.L.M.*



MAY SINK A SUB OR DOWN A ZERO

U. H. F. ANTENNAS

C. R. STOLL

★ Someone once said that antennas, like women, may be had in so many shapes and sizes that choosing becomes difficult.

Generally speaking, however, any one type will be an effective radiator if properly excited.

The purpose of this text, therefore, is to explain the operation and adjustment of various antennas and feeder systems. Thus, a prospective user will be able to pick, more satisfactorily, the system most readily applied to the conditions at hand.

There are basically, two different methods of antenna operation; these are Marconi and Hertz. The latter is used almost exclusively on u.h.f. and consists of a half-wave radiator, or some multiple thereof, operated in free space. The Marconi on the other hand is always a quarter wave long or some odd multiple of this. It is worked against ground and with this connection an image, similar to the antenna, is set up in the earth. Both systems have desirable qualities depending on requirements.

Zepp Types

Figs. 1 to *9* illustrate Hertzian types, the most common of which is the Voltage Fed Zepp (*Fig. 1*). This type and also *Fig. 2*, the current-fed version, have many qualities that are ordinarily overlooked. For extreme simplicity of adjustment they are hard to beat. The actual efficiency of the feeder, compared foot for foot with an impedance line, is lower. However, in many cases a tuned line will give excellent results since it can be adjusted at the transmitter. It might be added here that it is the only common type that can be tuned at the feed-end, a factor which often is not considered.

Where long runs of feeders are necessary, over two or three wavelengths for example, other types begin to show a definite improvement. Consequently, tuned feeders should be used only where the run is under this length.

Highest efficiency from the Zepp may be achieved by keeping the feeder spacing small. A satisfactory distance for most purposes is 1½ to 2 inches. Since high voltage loops are present, it is advisable to "barrel - roll" the line by turning the bottom end several times so that first one wire, then the other, is nearer ground. This gives the line a balanced capacity effect with respect to ground. Needless to say, porcelain, glass, or polystyrene spreaders should be used.

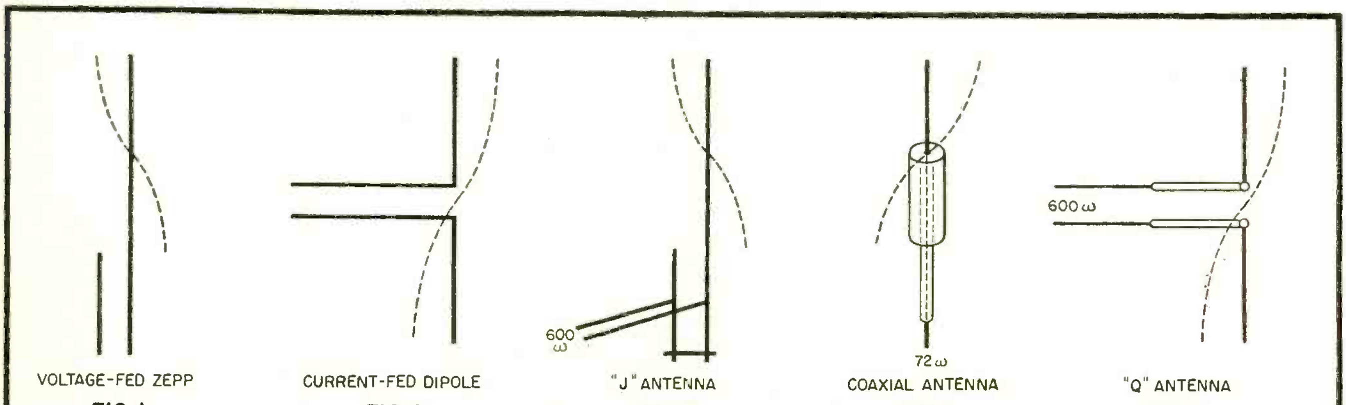
"J" Antenna

The "J" antenna, one version of which is shown in *Fig. 3*, has also given a good account of itself in the past. The bottom quarter-wave section is a balanced transformer, consequently no radiation takes place from this part. The transformer may be considered as a folded half-wave antenna with feeders tapping away from the low-impedance center as in the Delta type (*Fig. 7*).

The open-wire transformer may be substituted with a concentric version and fed with an open-wire line by cutting a slot in the outer conductor to permit connection to the inner conductor.

Another system would be to feed either the open wire or concentric transformer with a low-impedance line at the bottom, thus eliminating the shorting bar.

Adjustment of the "J" is best accomplished by shunt-exciting it from another antenna, as in *Fig. 11*. Connect a 50- or 200-milliampere bulb across the shorting bar and slide the bar up or down for maximum brilliancy of the bulb. It will not be necessary to break the shorting bar to insert the bulb, since the current flowing at this point is high. If 10 or 20 watts are available to excite the shunt antenna, a good indication should be obtained. Next, prune the length of the antenna,



VOLTAGE-FED ZEPP
FIG. 1

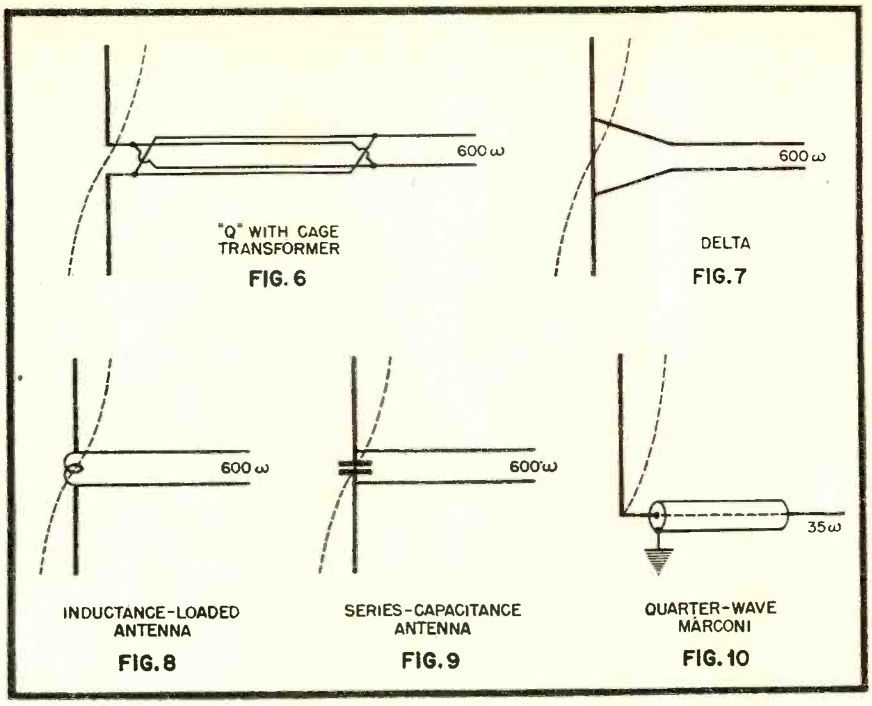
CURRENT-FED DIPOLE
FIG. 2

"J" ANTENNA
FIG. 3

COAXIAL ANTENNA
FIG. 4

"Q" ANTENNA
FIG. 5

Antenna types which work well on high frequencies. All radiator dimensions are half-wave long.



More u.h.f. antennas. All are half-wave except Fig. 10, which is quarter-wave. Impedance of feeders may be any convenient value provided proper termination is obtained.

still watching the bulb. When a maximum is indicated, clip on the feeder and test the line for standing waves, as illustrated in *Fig. 12*. With this method three 200-milliampere bulbs, with wire leads soldered to their bases, are shunted across a small portion of the line. The first two connect to alternate wires exactly one-quarter wave from where the feeder connects to the transformer. The third bulb should be positioned an additional quarter wave down either wire.

With the line loosely coupled to a source of r.f. power, slide the clips up the line until all bulbs are of equal brilliancy. The wire with the two bulbs will indicate the absence of standing waves, whereas the other bulb will show balance between both wires.

Coaxial Type

A more complicated antenna system, the Coaxial type, is portrayed in *Fig. 4*. Fundamentally this is a standard dipole with the bottom half hollowed-out to permit a feeder to contact the low-impedance center of the antenna.

Where a pipe mast is to be used to support the antenna, the Coaxial type finds almost immediate acceptance. No insulation other than at the center need be used. The metal mast becomes the feeder if so desired. At any rate, the outer sheath of the feeder, if a separate one is used, can be grounded to the mast. Thus the entire system is at ground potential with respect to r.f. and possesses excellent lightning protection. Furthermore, it makes a very neat structure since it appears as an extension to the mast and is not as obvious as other types.

Tune-up is straightforward, consisting only of pruning to the proper length with a small bulb shunted across the base of the upper section.

"Q" Antenna

A simple method for matching a low-impedance balanced line to a dipole is illustrated in *Fig. 5*. The "Q" antenna, as it is called, exhibits excellent characteristics and is quite simple to adjust. The quarter-wave transformer differs from the one in *Fig. 3* since it is a low-impedance device, whereas the "J" transformer is extremely high impedance at the antenna end.

The method of operation of the "Q" transformer may best be explained by comparing it to a mechanical see-saw. If we weight it down at one end the other end goes up. So it is electrically; if we connect a 200-ohm, quarter-wave line to a 70-ohm impedance, the other end of the line becomes 600 ohms. This is shown in the formula

$$Z_T = \sqrt{Z_a Z_L}$$

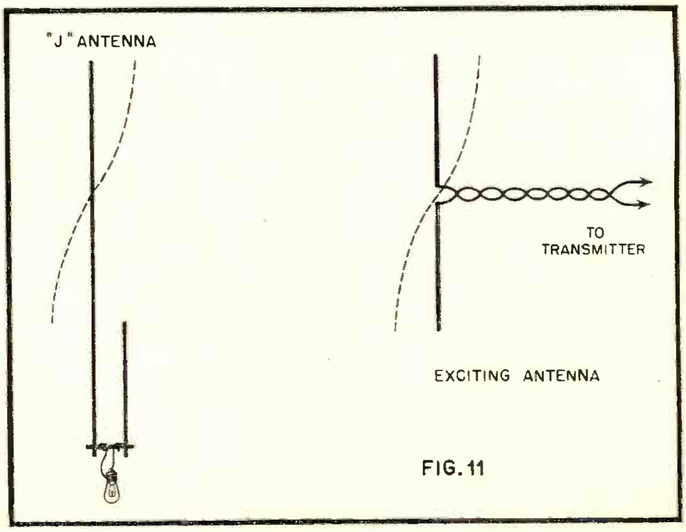
where Z_T is the transformer impedance, Z_a is the antenna impedance and Z_L the line impedance. This is exactly what takes place when standing waves appear on a line. However, in this case, the ratio of the standing waves is small.

Large conductors are necessary with relatively close spacing to obtain the required low impedance for the transformer. However, any other construction could be employed providing the proper impedance is obtained. A concentric transformer could be used but not as good a balance would result. A cage transformer, made up of several pairs of wires in parallel, as in *Fig. 6*, could be employed with good results. Full details of this system are described by Carl J. Madsen, April 1937 RADIO; and Leigh Norton, November 1938 RADIO.

A transformer of this construction is light in weight and certainly worth considering in these days of priorities on aluminum or copper tubing.

Inductance Loaded Type

Several years back the Delta matched antenna of *Fig. 7* was crowned with considerable popularity. This has dwindled recently since it was found that the wide opening of the "Y," where it joins the antenna, seriously interferes with the antenna field. This trouble can be eliminated by coiling up the center of the antenna, as in *Fig. 8*. The inductance of this coil is quite critical and must be carefully determined. To do this, support both halves of the antenna and clip the inside ends



Method for shunt-exciting an antenna while tuning up. Distance between antennas should be about a half wave.

on a coil which has a higher inductance than that required to give 600 ohms. Carefully slide the clips in on the inductance while checking for standing waves on the feeders by the method described in *Fig. 12*. At the same time it will be necessary to keep resonating the antenna to compensate for the change in inductance caused by varying the coil. The antenna will be shorter than a usual half-wave radiator by the amount of inductance added at the center.

A similar system to the above is a Series Capacitance antenna, shown in *Fig. 9*. Here the feeders connect across a condenser, the value of which is chosen to give an impedance of 600 ohms.

This is considerably easier to adjust since the condenser may be a variable type. The adjustment is identical to the inductive loaded system, except the condenser is varied while checking standing waves on the feeders. Likewise, the antenna must be resonated with each capacity change. Because of the series capacity effect, the antenna will be longer than normal for a half-wave type.

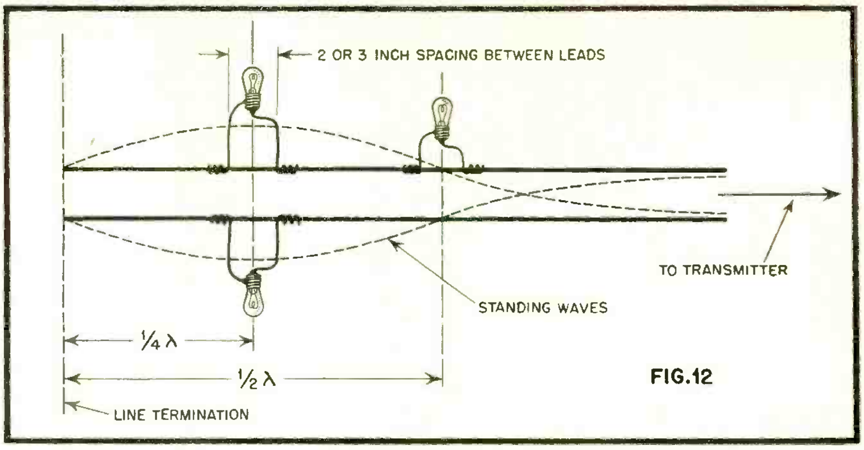


FIG.12

Checking for standing waves on u.h.f. is best accomplished by use of pilot bulb. Average thermocouple meter unbalances feeders sufficiently to give inaccurate reading.

Simple Marconi

Leaving the Hertz antennas, *Fig. 10* shows a simple Marconi type. The base impedance of this system is approximately 35 ohms, consequently a concentric feeder of this impedance is used. On the higher frequencies, in the region of 400 mc., a quarter wave becomes quite small. Often it is desirable to use a ¾-wave antenna because of this. If such is the case, the feeder impedance should be increased to 100 ohms or slightly greater.

For mobile use the Marconi type appears to give slightly better results than the usual half wave. This is providing it is worked against a well-conducting metal surface such as a turret-top of an automobile.

Lacking a suitable concentric feeder, the antenna may be shunt-fed by a higher impedance open line. The base of the antenna is grounded as is one side of the line. The other side of the line taps on the antenna at some point above ground which will reduce standing waves on the line to a minimum. This unbalances the line however, and optimum results can not be obtained.

ARMY-NAVY PREFERRED LIST OF VACUUM TUBES

To those concerned with the design and manufacture of Army or Navy equipment utilizing vacuum tubes:

1. The accompanying Army-Navy Preferred List of Vacuum Tubes sets up a group of unclassified general purpose tubes selected jointly by the Signal Corps and the Bureau of Ships. The purpose of this list is to effect an eventual reduction in the variety of tubes used in Service equipment.

2. *It is mandatory that all unclassified tubes to be used in all future designs of new equipments under the jurisdiction of the Signal Corps Laboratories or the Radio and Sound Branch of the Bureau of Ships be chosen from this list. Exceptions to this rule are hereinafter noted.*

3. The term "new equipments", as

[*Continued on page 38*]

RECEIVING

Filament Volts	Diodes	Diode Triodes	Triodes	Twin Triodes	Pentodes		Rectifiers	Converters	Power	Indicators
					Remote	Sharp				
1.4	1A3	1LH4	1G4GT 957 958A	1291 3A5	1T4	1S5 959 1LN5 1L4		1LC6 1R5	3A4 1299 3Q4 3Q5GT	991
5.0							5U4G 5Y3-GT			
6.3	6H6* 9004	6SQ7* 6SR7*	6J5* 1201 955 7193 9002	6SL7GT 6SN7GT	6SG7* 6SK7* 956 9003	6AC7* 6AG7* 6SH7* 6SJ7* 717-A 954 9001	6X5-GT 1005	6SA7*	6L6-G 6V6-GT 6N7-GT 6B4-G 6G6-G 6Y6-G	6E5
12.6	12H6*	12SQ7* 12SR7*	12J5-GT	12SL7-GT 12SN7-GT	12SG7* 12SK7*	12SH7* 12SJ7*		12SA7*	12A6	1629

TRANSMITTING / **MISCELLANEOUS**

Triodes	Tetrodes	Twin Tetrodes	Pentodes	Rectifiers		Grid Cont. Gas Rectifiers	Voltage Regulators	Phototubes
				Vacuum	Gas			
801-A 811 826 833-A 838 1626 8005 8025 304TH	807 813 814 1625	815 829 832	803 837 2E22	2X2 836 1616 8020 (451) 705A 371A	83 866A 872A 4B25	2050 884 394-A C1B C5B	VR-90-30 VR-105-30 (38205) VR-150-30 (38250)	918 927

* Where interchangeability is assured GT counterparts of the preferred metal tubes may be used.

THEORY AND LIMITATIONS OF

UNIVERSAL A. C. BRIDGE

J. H. ELLISON*
Lieutenant Commander, U.S.N.

★ This article is not intended to be a general exposition of the theory of a.c. bridges on which volumes have been written, but rather to shed additional light on the theory and limitations of the "Universal A.C. Bridge" as described in the June issue of RADIO, by A. K. McLaren. The basic circuit is

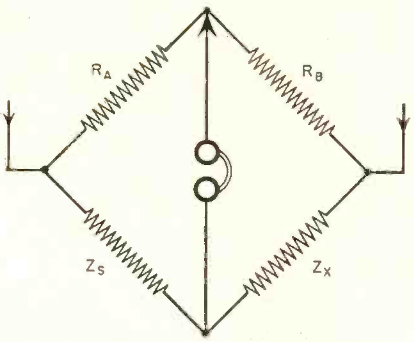


Fig. 1. R_A and R_B are resistance ratio arms (single potentiometer). Z_S is standard impedance and Z_X the unknown impedance. Potentiometer arm indicated by arrow.

that of the four-impedance bridge, *Fig. 1.*

The signal source may be connected across any pair of arms and the detector across the other pair, but for the applications of this particular circuit it is more desirable that the signal generator and detector be connected as shown in *Fig. 1.*

Capacity Measurements

Considering the bridge for application to capacity measurements we have *Fig. 2.* The approximate equation of balance is

$$C_X = \frac{R_A}{R_B} C_S.$$

Now, let us consider the major sources of error in this bridge circuit. There are minor capacitances shunting both R_A and R_B which produce only second-order errors and therefore they may confidently be disregarded. Similarly, there may be minor capacitances shunting C_S and R_S which also may be disregarded if C_S is not very small (50 $\mu\mu$f or less), and if R_S is not large compared to $2\pi f C_S$. Considering next C_X, any capacitance not having one terminal grounded is effectively a three- or four-terminal capacitance; see *Fig. 3-A* and *3-B.*

Cmn is the unknown capacity whose value is sought, and it is desired to evaluate the effects of *Cmg* and *Cng*. *Fig. 3-A* applied to *Fig. 2* now appears as in *Fig. 4* (omitting extraneous detail).

We see that by grounding the junction of R_A and R_B, *Cmg* is across the output whence the balance is unaffected. Similarly, *Cng* being across R_B produces only negligible effect on the accuracy of measurement. It will be noted that if the shield in *Fig. 3-B* is grounded, it is identical with *Fig. 3-A.* Considering the source of input signal it should be matched to the bridge impedance by a double-shielded coupling transformer, if possible, in order to reduce unwanted capacity coupling. The secondary voltage is governed by the impedance match required which, *contrary to the statement in the June issue,* preferably should be a step-up ratio of about 1:4 from signal source to bridge for average capacity measurements and a step-down for inductance measurements. A shielded audio transformer is a satisfactory substitute for the expensive double-shielded transformer. There is also a question

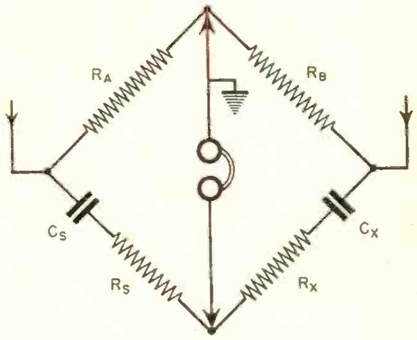


Fig. 2. Either R_S or R_X may be zero depending on whether losses in the unknown or losses in the standard are greater. Junction of R_A-R_B is grounded for reasons explained in text.

of polarity which has an appreciable effect and should be determined experimentally by measuring "known unknowns" with the signal source connected both ways. It is worth noting that the bridge sensitivity (i.e. output voltage to detector divided by input voltage to bridge) will be

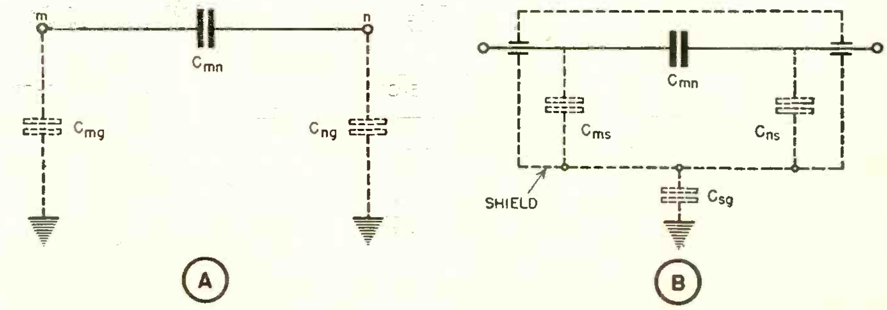


Fig. 3. Shunting capacitances in bridge circuit of Fig. 2, and their relation to the circuit (Fig. 4).

*This article expresses the opinions of the author and does not reflect the opinion of the Navy or the Navy Department.

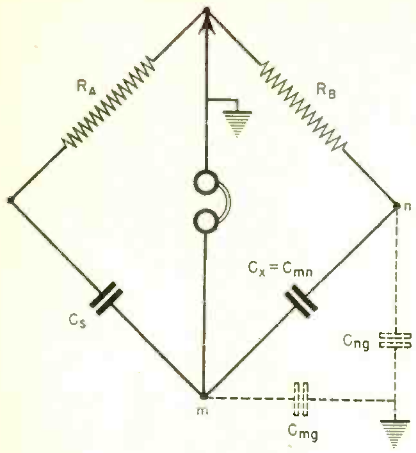


Fig. 4. Appearance of Fig. 3-A applied to Fig. 2.

$$\frac{E\ out}{E\ in} = \frac{\dfrac{R_A}{R_B}}{\left(1 + \dfrac{R_A}{R_B}\right)^2} \times d$$

where R_A and R_B are ratio arm resistances, and d = fractional change in C_X from the true balance condition.

(This is strictly true only for a detector of infinite impedance).

The commonest form of detector (the telephone) can detect a signal of about 400 microvolts. For greater sensitivity, a vacuum-tube amplifier should be used which also satisfies the requirement for an essentially infinite impedance detector.

The Wagner Ground

For the elimination of the effects of unwanted couplings, some form of guard circuit may be utilized. The "Wagner ground" is one of the oldest and simplest forms of guard circuit and its operation is very simply explained.

If we consider a four-impedance bridge with a fifth terminal connected to each corner of the bridge, we have *Fig. 5.*

Despite the four additional impedances, Z_C, Z_D, Z_E, and Z_F, the main bridge network may be balanced and the equation of balance for our application is

$$\frac{Z_A}{Z_B} = \frac{Z_C}{Z_D} = \frac{Z_S}{Z_X} \qquad (1).$$

Here Z_A, Z_B, Z_S and Z_X represent our original bridge network with *no point* grounded, and Z_C, Z_D, Z_E and Z_F represent the various stray impedances from the four points of the bridge to a common point, the ground.

If we take our original *Fig. 2,* remove the ground and add the Wagner ground circuit R_C and R_D, we have *Fig. 6-A.*

The presence of R_C and R_D does not affect the preliminary balance made by adjusting R_A and R_B. Then by switching to the circuit of *Fig. 6-B* we balance the auxiliary circuit by means of the potentiometer arm on R_C and R_D, leaving the arm between R_A and R_B untouched. The circuit is then switched back to *Fig. 6-A* and rebalanced, then to *Fig. 6-B* and rebalanced, and so on. The number of trials necessary is usually very few. In this manner the effect of coupling from the signal input generator, as well as stray couplings to ground may be largely balanced out. This switching arrangement from *Fig. 6-A* to *Fig. 6-B* is obvious. Thus, there are two means of overcoming the effect of stray coupling, (1) the simple bridge with the adjustable ratio arm grounded, *Fig. 2,* and (2) the bridge with the Wagner ground circuit *Fig. 6-A.*

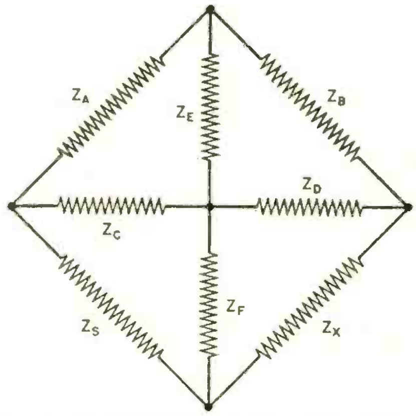


Fig. 5. Four-impedance bridge with stray impedances.

Inductance Measurements

For inductance measurements, essentially the same bridge and guard circuit may be used if it is realized that inductance measurements will not be as accurate as capacity measurements, and that for the same circuit arrangements $L_X = L_S \times \frac{R_B}{R_A}$. For wide-range inductance measurements of high accuracy the Owens bridge is perhaps the most satisfactory. Another general observation worth noting is that accuracy of measurement, both for inductance and capacity, is greatest when the ratio arms R_A and R_B are equal or nearly so.

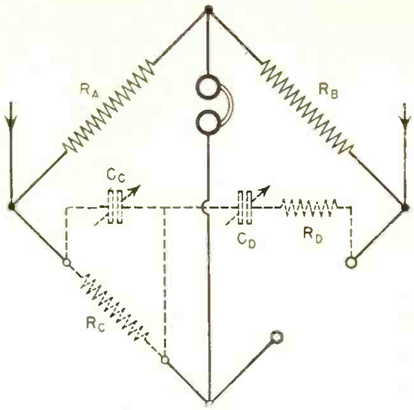


Fig. 7. Addition of Wein bridge for inductance measurements.

One interesting point about Mr. McLaren's circuit layout is that it may be very simply converted to a Wein bridge for measurement of audio frequencies. The basic bridge arrangement is shown solid in *Fig. 7,* while the additions for the Wein bridge are shown dotted.

If R_B is set to be twice R_A and if $R_C = R_D$ and $C_C = C_D$ the null point (bridge balance) will be at the frequency

$$f = \frac{1}{2\, R_C C_C} \qquad (2).$$

where R is in ohms, C in farads, f in c/sec. C_C and C_D can be any two-

[Continued on page 44]

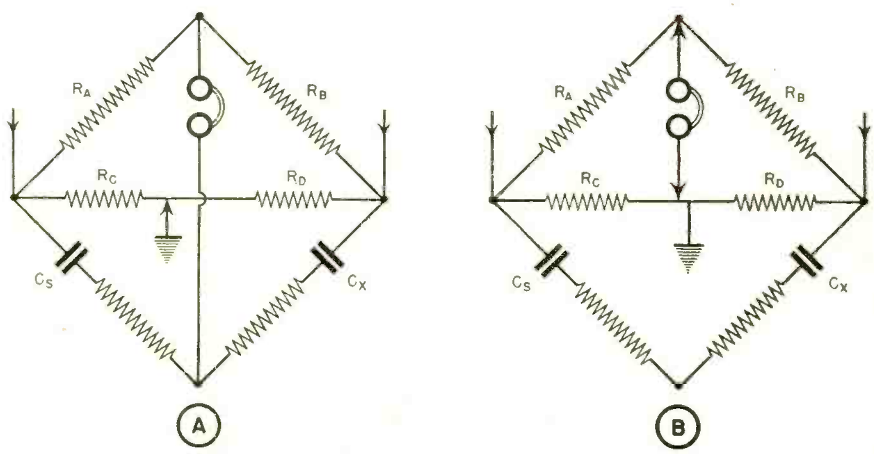


Fig. 6. Bridge with Wagner ground; and method of balancing.

GRAPHITE SHIELDING

GLASS, CARDBOARD AND SIMILAR MATERIALS AS ALTERNATE SHIELDS

B. H. PORTER

★ Metal and rubber shortages affect everyone in time of war. The use of non-metal shields for research and necessary construction is but one of the many ways to conserve scarce materials.

Here are some applications employing metal in prewar days but which now can use substitute materials: a) conduits, b) partitions, c) cabinets, d) cases, e) base boards, f) chassis, g) vacuum tubes, h) tube shields.

The Substitute

The non-metal substance that makes these applications possible is an interesting one. It is graphite — not the earth-mined ingredient of certain pencil leads, but the artificial electric-furnace variety — that is best suited to radio uses. Subdividing the flat particles to permit suspension in liquids, facilitates the spraying and painting of non-conducting surfaces. The result is an even, electrical-conducting film of grey-black color. Polishing forces the graphite particles together, reducing the electrical resistance of the coating.

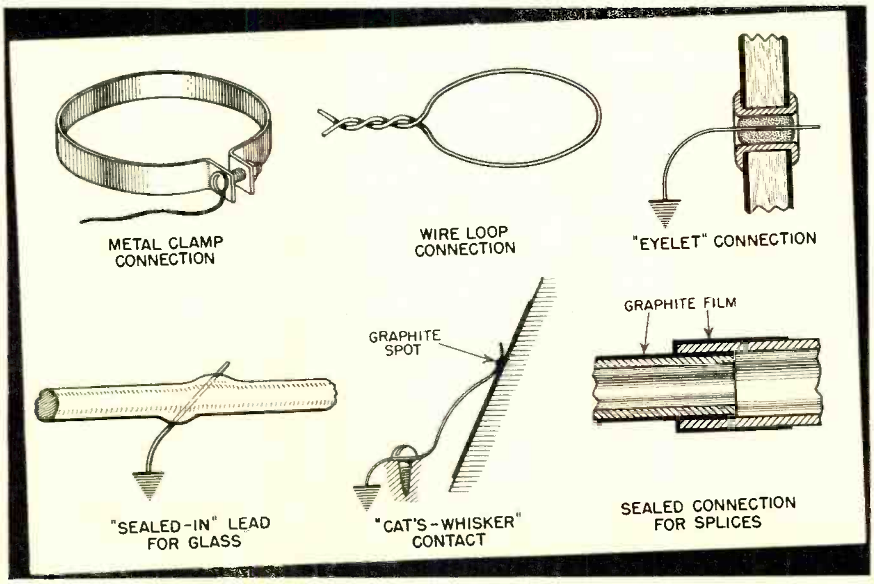
When using this *colloidal* graphite, dilute the heavy black paste as sold with distilled water. This is done by slow addition to the paste while stirring thoroughly. Any masses that do not go into solution are removed by straining through silk or other closely woven cloth.

The prepared mixture is then ready for application to many grease-free surfaces. Glass, for example, is first cleaned with chromic acid; i.e., one part potassium dichromate in ten parts of concentrated sulphuric acid. Thorough water rinsing and air drying must follow. Metals, wood and plastics are cleaned by abrasion with sandpaper or scouring powder. Wherever the dried films appear to need extra protection, apply overall coats of nitrocellulose varnish.

Sometimes the graphite layers are baked or thoroughly dried with heat to exclude moisture. The amount of heating, of course, depends upon the nature of the base material to which the graphite is applied.

Conduits

In normal times, metal-shielded power feeds and similarly protected leads were commonly used. When unavailable, their equivalents can be made from glass or plastic tubing.



Showing various methods whereby suitable contact can be made to a graphite-treated surface to be grounded, and how splices should be treated.

In the case of glass, cleanse its surface thoroughly, warm slightly and paint immediately with one part of colloidal graphite thoroughly mixed with two parts of water. A lead-off connection can easily be made by heat-embedding a wire in the glass itself. Metal clamps, wire loops and "cat-whisker" connections are also feasible. Always apply a film of graphite over and around the connecting body.

Artificial rubber and plastic tubing are usually painted cold, though warming the graphite solution sometimes facilitates application.

The flexibility of both natural and artificial rubber is in no way decreased by these graphite films. Actually the minute particles fill the pores of natural rubber surfaces and build up to a homogeneous covering. More than one coat may be necessary to do this, depending upon porosity of the material coated.

Grounding is made on soft types of tubing with a metal eyelet having a soldered-in lead well sealed on all sides with the graphite coating.

When it becomes necessary to splice or join graphite-covered glass and rubber tubes, proper electrical connection is made by coating both the exterior and interior (up to the length of splices) with colloidal graphite before joining. A second coat applied over the joint is recommended.

The accompanying illustration depicts these various methods for making electrical contact to graphite films.

Partitions and Cases

Shield partitions or planes used in separating and shielding stages or set components are prepared in the same way. Here sheets of glass, bakelite, plastic or wood veneer can be used. Simply paint them with a concentrated graphite dispersion and use metal eyelets or "cat-whisker" contacts to make the electrical connection.

Fibrous materials like card, bristol, and beaverboard are best treated by impregnation or saturation with colloidal graphite. This is done by immersing the specimens several times in a 1-5 solution. Simple warming of the sheets will hasten penetration, while

[*Continued on page 44*]

THIRTEEN WAYS TO

PROLONG TUBE LIFE

★ Because transmitting tubes are the heart of many instruments of war, our Armed Forces need all the tubes present manufacturing facilities can produce. Hence every transmitter engineer has a duty to nurse his tubes along, and obtain from them their maximum useful life.

The following suggestions have been prepared by the Engineering Department of Heintz and Kaufman, Ltd., in the hope that they will be of value in assisting vacuum tube users and America's war effort.

Most of the suggestions may be applied to the many tube types ordinarily used in radio telegraph and telephone transmitters, and broadcast stations; a few apply particularly to tubes having thoriated tungsten filaments. All are pertinent to the continuation of civilian radio services.—**Editor.**

ONE

The life of a tube in normal service depends upon the number of watts it is required to dissipate on the plate. If the plate loss in watts is reduced, the life goes up proportionately. In other words, tube life may be expressed as "watt-hours of plate dissipation," and any reduction in *watts* results in a gain in *hours*. Therefore, it is advisable to adjust every circuit so that the highest efficiency is obtained.

TWO

Keep circuits properly tuned. A small amount of detuning in the plate circuit causes a rapid increase in the plate dissipation of the tube. Circuits often detune as the transmitter heats up, and readjustment is then necessary.

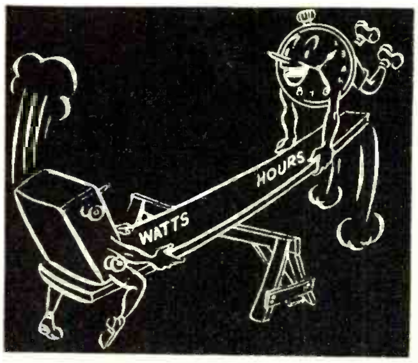
THREE

In Class B audio amplifiers, the "no-signal" plate current can often be reduced without resulting in harmful distortion. This reduction saves precious "watt-hours."

FOUR

Minimize stray circuit losses in Class C r. f. stages, and make sure that the loading on the tube is useful loading. To test for this, disconnect the useful load and check the unloaded plate current.

Because the grid current will rise under the unloaded condition, it is advisable to lower the excitation to get



normal or less-than-normal grid current during this test. The unloaded plate current should fall to such a point that the remaining d.c. plate input power is only enough to supply the tank circuit losses, as well as the small incidental plate dissipation at the time of the test.

FIVE

If the unloaded plate current seems unreasonably high, it is advisable to vary the physical arrangement of the coil, shielding, L/C ratio, design of choke coils, amount of tube bias, etc., until the unloaded plate current is brought to a reasonable value. In many cases this value can be made to approach one-tenth the loaded plate current.

SIX

The grid current of a triode is a good indicator of the amount of r.f. grid driving voltage required. In ordinary Class C r.f. amplifiers the grid current should be roughly one-quarter to one-sixth the d.c. plate current of the tube. For doubler or tripler service, where large grid leaks on the order of 50,000 ohms are employed, the ratio of grid to plate current may fall off to nearer one-tenth.

A good experimental way to adjust to the proper amount of grid drive, is to reduce the drive until the efficiency of the tube starts to fall off. This will be indicated by a visible increase in plate heating. The grid drive should then be restored somewhat above this fall-off point.

SEVEN

When the tube is idle the filament should be turned off. When both the plate and filament voltage can be turned on simultaneously, the filament may be turned off in stand-by service also, since a thoriated tungsten filament is ready to operate in less than one second after the voltage is applied.

EIGHT

In these days no one can afford the luxury of an experimental set-up or a slightly "hay-wire" condition in the circuits and power supplies of a vacuum tube transmitter. Accidental circuit failures and accidental failures of component parts, will often destroy the tube.

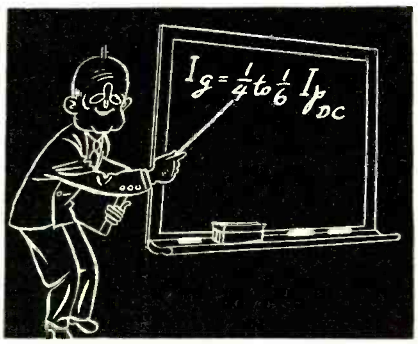
Don't take the chance of not having circuit connections solid, and all parts in top mechanical shape. Don't cut corners on the factors of safety in any electrical parts, including tubes. Circuit protective devices are always wise.

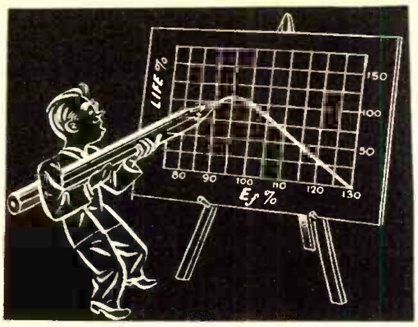
NINE

Avoid excessive grid drive. Excess grid drive (grid current) wastes driving power, and shortens the life of the driver tube by making it do extra work. Excess grid current also overheats the grid of the tube, and shortens its life either by damaging the grid permanently, or by increasing the number of watts the tube must dissipate.

TEN

It is essential that the rated filament voltage be maintained at the tube. This





voltage should be measured at the socket, and should not deviate more than plus or minus 5% from the rated value.

The life of a thoriated tungsten filament will be reduced to two-thirds of normal if the filament voltage is permitted to run 10% above its rated value. At 10% below rated value, the emission from the filament may fall off due to failure to diffuse enough thorium to the surface of the filament to maintain emission. A drop in emission may cause severe overheating of the plate, with a consequent reduction in the life of the tube, or even complete failure.

ELEVEN

Make good electrical connections to the tube. At ordinary frequencies, the standard connector clips are satisfactory. At ultra-high frequencies the charging currents into the inter-electrode capacities become large enough so that special care must be taken. A split connector of aluminum or plated brass, with the two halves held together by a silver or similarly plated external spring, which will remain good at 200 to 300 degrees C., will prove most satisfactory.

TWELVE

The efficiency of a Class C r. f. amplifier is largely dependent upon the conditions in the grid circuit. The d.c. bias voltage is the total of the voltages developed in the grid-leak resistor, the cathode resistor and the voltage supplied by the fixed bias source.

The grid bias voltage should be considerably greater than that required for cut-off. The exact value of total bias voltage is not critical so long as it is ample. A good value to approximate is that listed on the data sheets for the particular type of tube and type of service.

In ordinary Class C amplifier service, a very desirable arrangement of d.c. grid bias voltage is one consisting of enough fixed bias to prevent the flow of plate current when all r. f. excitation voltage is removed—with the balance of the bias supplied by the IR drop in the resistor.

Such an arrangement provides adequate protection, and at the same time gives the highly desirable automatic action of a grid-leak resistor.

THIRTEEN

The electrical instability of r.f. circuits increases the probability of damage and overload to a tube. Parasitic oscillations can also cause damaging overloads, as well as inconvenience. Nearly any parasitic oscillation can be prevented. A good way to isolate and cure parasitics in an amplifier is to:

a—Remove the normal excitation

b—Remove all fixed bias

c—Lower the plate voltage until the plate loss due to the static plate current flowing does not exceed the rated tube dissipation.

Under these conditions there should be no parasitic oscillation at any position of the tuning dials. A parasitic oscillation will be readily indicated by the presence of grid current. If such oscillations occur, then:

a—Find the frequency of the parasitic

b—Determine the parasitic circuit superimposed on the normal r.f. circuits.

c—Adjust the parasitic circuit, decreasing its excitation voltage until the oscillation ceases. Such changes need not seriously affect normal circuits.

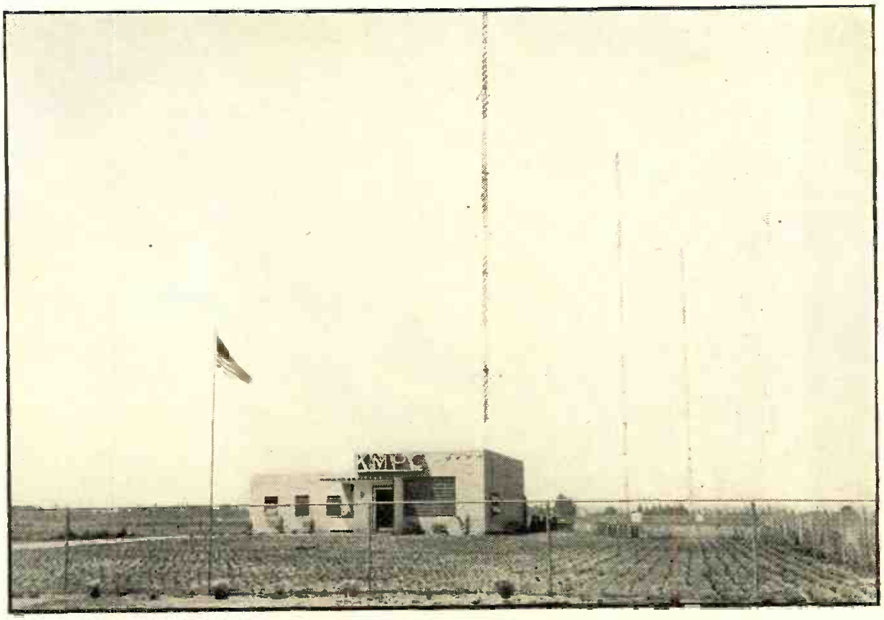
(Reprints of "Thirteen Ways to Prolong Tube Life" in booklet form are available for the asking, from Heintz & Kaufman, Ltd., South San Francisco, Calif.)

GROUND SYSTEM AT KMPC

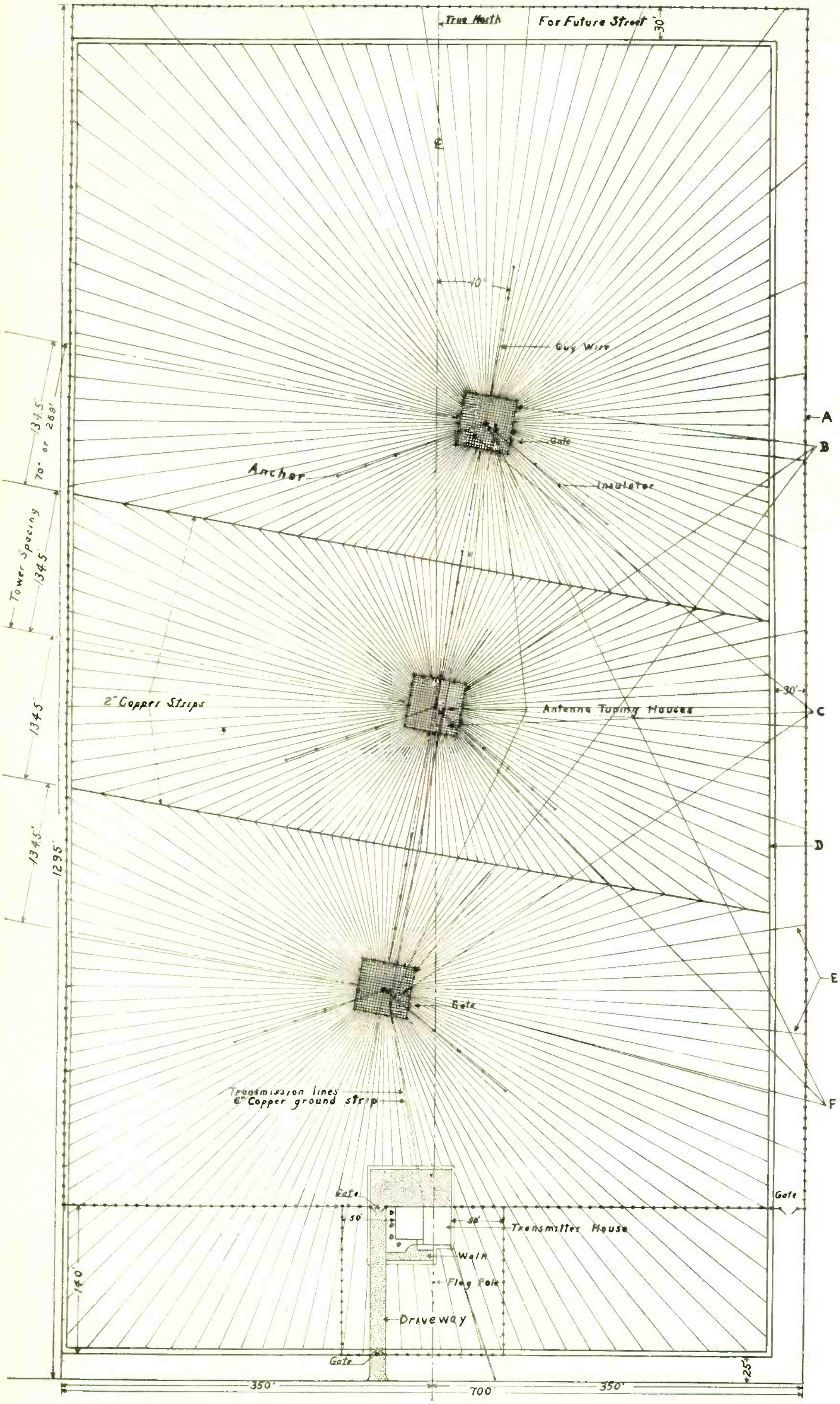
★ KMPC's new transmitter plant, in North Hollywood, California, employs a ground system (shown on the opposite page) having approximately 23 miles of No. 8 copper wire plowed in the ground at a depth of from 6 to 9 inches. The wires leave the towers at an angle of 3 degrees. In addition to the 23 miles of copper wire there has been driven in the ground one hundred 5-foot copper weld ground rods. The outer wires of the entire ground system have been connected to a ring consisting of two No. 8 copper wires. Every sixth copper wire radial has been connected to the galvanized fence that surrounds the 21 acres that KMPC's directional antenna system is located on.

Under each of the three towers has been placed a galvanized netting 55 ft. by 55 ft. over crushed rock, in order to increase the dielectric constant of each tower. All vegetation has been

[*Continued on page 38*]



Take-off view of KMPC, showing towers and galvanized netting fence.



KMPC's GND. SYSTEM

Galvanized netting fence surrounds the plot and each tower (See A and B). C points out galvanized netting ground screen under each tower. D shows points where all radials are welded to 2 strands of No. 8 copper wire. Each 6th radial is extended and grounded to fence, as at E. The towers (F) are 300 feet high above insulators.

Q. & A. STUDY GUIDE

—Theory and Practice

228. A transformer having a center-tapped secondary is used with a full-wave rectifier with the transformer center tap for the common negative return; if the same transformer were connected for full-wave bridge rectification, what would be the effect upon the output voltage?

With the same transformer connected for full-wave bridge rectification, the output voltage would be doubled; in this case, with the center tap unused, the total transformer voltage is available for the load, rather than one-half its voltage when the center tap is used as the common negative return.

229. If a high-voltage rectifier system were changed from a full-wave, center-tapped transformer connection to a bridge-connected, full-wave rectifier system using the same high-voltage transformer, what changes in the filter components would be necessary?

With a change to the bridge connection, the output voltage would be doubled; therefore it would be required that filter condensers be used having double the working voltages of those originally employed.

230. List the main advantage of a full-wave rectifier as compared to a half-wave rectifier.

The output voltage of the full-wave rectifier is twice the line frequency, the current is more uniform, and is therefore more easily filtered and regulated. Also, the tendency of a power transformer in a half-wave rectifier to become saturated is eliminated.

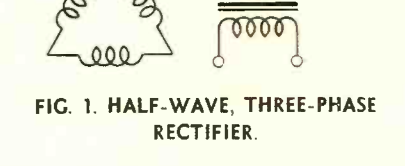


FIG. 1. HALF-WAVE, THREE-PHASE RECTIFIER.

231. Using a plate transformer having a secondary voltage of 500 volts r.m.s. in a single-phase half-wave rectifier working into a condenser input filter, what should be the minimum allowable d.c. working voltage rating for the filter input condenser?

The safe *minimum* working voltage for the input condenser in a condenser-input filter is equal to 1.4 times the r.m.s. voltage output of the rectifier. As an additional safety factor, neglect the drop in voltage in the rectifier tube. Thus the working voltage of the condenser should be 1.4 × 500, or 700.

232. A single-phase power transformer, with secondary center tapped, has a total secondary voltage of 2000 volts r.m.s. When used in a full-wave rectifying circuit with condenser input filter, the filter input condenser should have what continuous d.c. working-voltage rating?

The transformer voltage available for the load is one-half the total transformer voltage in the manner used. The condenser working voltage should therefore be 1.4 × 1000, or 1400 volts.

233. Why may a transformer not be used with direct current?

A transformer will not operate when supplied with direct current, since a circuit has the property of induction only when the e.m.f. set up in the circuit is due to a *change* in current through the circuit. A varying current is therefore essential.

234. Draw a simple schematic diagram of a half-wave, three-phase rectifier system.

The diagram of such a rectifier system is shown in *Fig. 1*.

235. What are the primary advantages of a high-vacuum rectifier as compared to the hot-cathode mercury-vapor rectifier?

The high-vacuum rectifier is less apt to be damaged due to current overload, as an increase in load current increases the voltage drop within the tube, thus decreasing the load current. This type of tube is also less susceptible to arc-back, and does not generate r.f. hash.

236. What are the primary characteristics of a gas-filled mercury-vapor rectifier tube?

The internal voltage drop is low (approx. 15 v.) and of constant value; the efficiency is therefore high and the voltage regulation exceptionally good.

237. What are the primary advantages of a mercury-vapor rectifier as compared to the thermionic high-vacuum rectifier?

The mercury-vapor tube has a low voltage drop that is substantially independent of load current, and therefore has better voltage regulation than the high-vacuum rectifier. Uses less filament power, and plate heating is reduced.

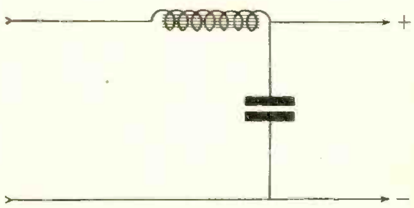


FIG. 2. SCHEMATIC OF CHOKE-INPUT FILTER.

238. Why is it desirable to have low-resistance filter chokes?

To avoid excessive voltage drop in the filter circuit with consequent reduced output voltage; and to provide good voltage regulation.

239. Why is it necessary to use choke-input filter systems in connection with mercury-vapor rectifier tubes?

The (low) voltage drop in the mercury-vapor tube is substantially independent of current load, and is therefore not self-regulating. Hence the tube is highly susceptible to current overload and consequent damage to the filament. If a condenser-input filter were used, the peak charging current of the first condenser would subject the rectifier to overload (unless a series protective resistor were employed). As a matter of safety, it is customary to use a choke-input filter as a current-limiting factor.

240. What are the primary characteristics of a choke-input filter? (Fig. 2).

The available output voltage is reduced at the expense of better voltage

[*Continued on page 40*]

BROADCAST STATION

MAINTENANCE & OPERATION

C. H. WESSER

Chief Engineer, W45D

PART II

★ The daily routines for the six operator shifts were covered in Part I of this series. In addition to these routines, periodic checks are made weekly, the checks being spread out over the seven days, as follows:

"C" and "F" Shift, First Week

Sunday:

30. Measure a-m and f-m noise, swing versus 1A panel input meter readings, and distortion.
31. Check and clean mikes, mike stands, mike jacks and connectors.
32. Check and clean faders, pots and selector switches in Speech Input Equipment.
33. Check and clean relays, monitor selectors, and keys.

Monday:

34. Check and clean targets in water hose fittings, replace when necessary.
35. Check all mechanical controls of 50-kw stage, and grease and oil same.

Tuesday:

36. Check for scale formation on 899-A filament studs and connectors. Clean *only* when necessary.
37. Check and clean filament connections of 869 Rectifiers.
38. Check and clean all air filters, and replace when necessary.

Wednesday:

39. Clean and polish all patch cords.
40. Polish all panels and clean tops of Control Desk and Turntable Desk.
41. Dust all equipment on 46th floor.

Thursday:

42. Clean 23-B, Bays 1 through 8, with vacuum cleaner and dust cloth.

Friday:

43. Check all electrical and mechanical connections on 46th floor.
44. Check all electrical and mechanical connections on 45th floor.
45. Clean, grease and oil the following items: a) filament m.g. set, b) blower motor and blower, c) fan motor and fan, d) spray motor and pump, e) pump motors and pumps, f) damper motors and dampers, g) voltage regulator.

Saturday:

46. Operate Transmitter for 30 minutes with a.c. on filaments instead of d.c., and on spare water pump.
47. During this 30-minute period, do the following: a) check pump switch door interlock in Sub-Control panel, b) check for leaks in air blower radiator, c) check cut-in and cut-out points of Fan and Spray thermostats, c) run recycling check *once*, with ground on positive high-voltage terminal.

"C" and "F" Shift, Second Week

Sunday: Same as first week.

Monday:

48. Check and clean all turntables.

Tuesday:

49. Test tubes in Turntable Console, Turntable Q Amplifiers, 23-B, and Line Amplifiers, including all associated Power Supplies.

Wednesday: Same as first week.
Thursday: Same as first week.
Friday: Same as first week.
Saturday: Same as first week.

"C" and "F" Shift, Third Week

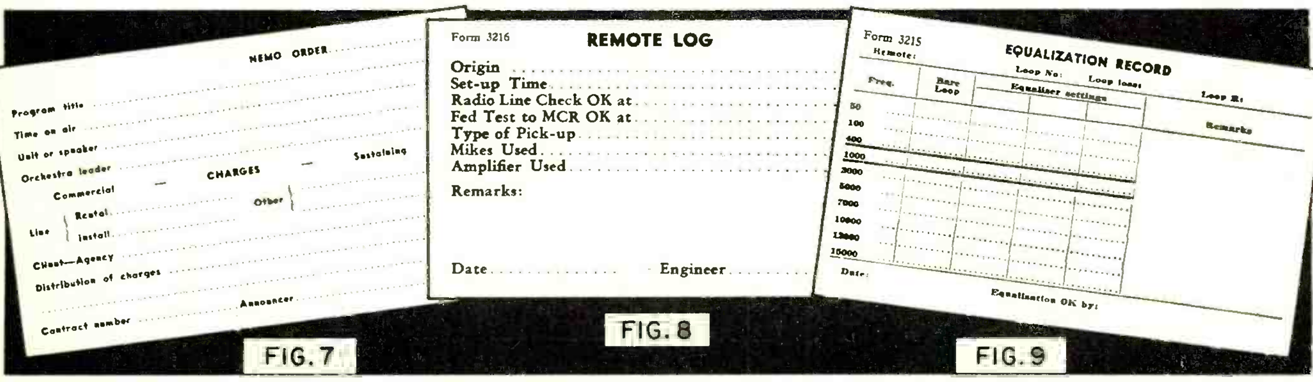
Sunday: Same as first week.

Monday:

50. Test Electrolytics in Turntable Console, Turntable Q Amplifiers, 23-B, and Line Amplifiers, and all associated Power Supplies.

Tuesday:

51. Test all tubes not tested on Tuesday of second week, except modulator tubes.



Three of the special forms used in conjunction with Remote Routine, covered on page 20.

Wednesday: Same as first week.
Thursday: Same as first week.
Friday: Same as first week.
Saturday: Same as first week.

"C" and "F" Shift, Fourth Week

Sunday: Same as first week.

Monday:

52. Test all Electrolytics, except those tested on Monday of third week.

Tuesday:

53. General maintenance.

Wednesday: Same as first week.
Thursday: Same as first week.
Friday: Same as first week.
Saturday: Same as first week.

Quarterly Maintenance

Quarterly Maintenance items, to be performed on Tuesday of fourth week period of the following months: November, February, May, August:

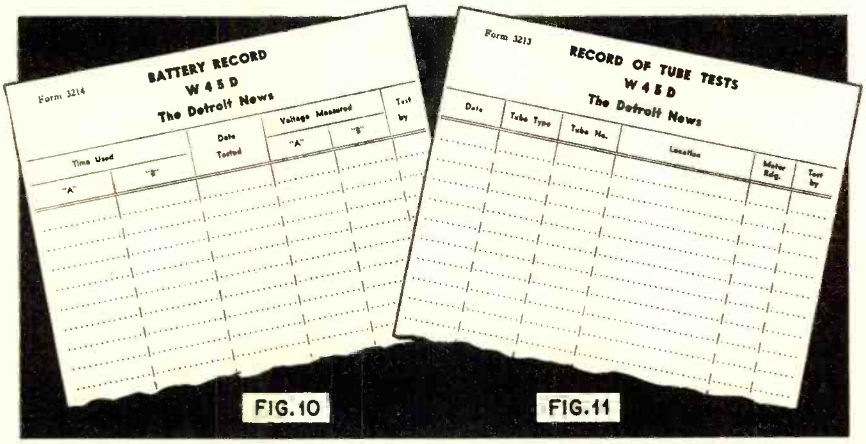
54. Check and clean Spray water reservoir.
55. Check entire water-cooling system for scale formation. *Note:* If formation is excessive, and cannot be cleaned completely, take water sample for analysis.
56. Thoroughly clean all insulators in Doghouse.
57. Thoroughly clean Doghouse.
58. Check for leaks in Doghouse, and repair if necessary.

Figs. 2, 3, 4, 5, and *6* in Part I show, respectively the Daily Log, Modulator-I.P.A.-Driver Log, 50-kw Amplifier Log, Speech Input Meter Readings Log, and Frequency-Measurements Log.

Remote Routine

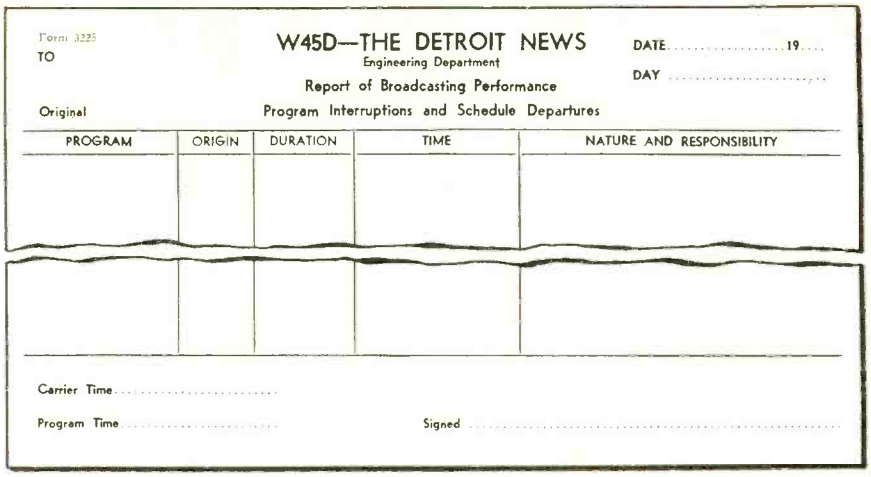
The handling of remotes is covered by the following routine. The forms referred to are shown in *Figs. 7, 8, 9, 10,* and *11.* All prescribed rules, as well as logs and forms that must be kept, are considered the absolute minimum that will insure safe and consistent operation without too much red tape to cause the men to lose interest in radio operation and maintenance.

1. Program Department turns over to C.E. a form 3191 with essential information about the pick-up to be established.
2. An office car will be made available for the purpose of transporting equipment. If it seems desirable to do so, the Station may request that the Remote Engineer use his own car, in which case he will be paid at the rate of five cents per mile for the mileage between the Station and the remote point, and return, as determined on the first trip to that point. Mileage is to be logged on the preliminary test log.
3. The C.E. instructs the Remote Engineer to go to pick-up point to determine the best spot for pick-up equipment and line termination, availability of power, etc. This information should be logged on the preliminary remote log, form 3216.
4. Lines are to be ordered in by C.E. By M.B.T. Co., including information of termination, date and time circuits are to be ready for service.
5. As soon as circuits are installed and ready for test, Remote Engineer will go to pick-up point with remote equipment, beat frequency oscillator, etc., for the purpose of making equalization runs and the feeding of preliminary test to MCR, if possible with mike test from mikes in locations to be used regularly on the pick-up.
6. Before leaving the Station, the Remote Engineer must notify MCR so that an amplifier and loudspeaker will be patched up on the remote loop to allow the Remote Engineer to call MCR from the remote point as soon as he is ready to start testing.
7. When equalization and preliminary tests have been completed, a remote log, form 3216, is to be turned over to C.E., together with whatever remarks and comments are in order. A copy of this log is to be kept on file by Remote Engineer, for the Remote Department's future reference. This log is to include a brief report on testing of Q receiver at the remote point.
8. A complete log on form 3216 is to be turned over to the C.E. after each and every remote pick-up.
9. Except in cases where it is desirable to leave equipment at a remote point at all times, all remote equipment is to be returned to the station at the end of each and every remote shift. The Remote Engineer's quitting time is to be determined by the time he can return said equipment to the station, after his shift's last remote.
10. Remote Engineer must be at the remote point, and ready to feed the first test to MCR, at least *one-half hour* before scheduled start of program.
11. All time checks must be made during the period of 20 minutes and 10 minutes before the scheduled starting time of the remote program, but *not* at the 15 minute stand-by period.
12. Start all remote programs *three* seconds after completion of the Q, whether air or wire one is used, unless otherwise arranged ahead of time.
13. Final fade of all remotes is to be made at Station, unless otherwise arranged. If fade is made at Station, remote should be continued for a safe period after scheduled remote ending time.
14. As soon after conclusion of remote pick-up, MCR must report to Remote Engineer on the quality of transmission.
15. In case of restricted music being started by a performer or performers, it will be the Remote Announcer's duty to instruct the Engineer to cut. In case where there is no announcer at the remote point, the Station Announcer will instruct the MCR Engineer to make that cut.
16. In case of remote equipment failure, Remote Engineer will attempt to clear trouble as soon as possible, then call MCR on program or order loop and inform MCR that remote can now be started. If equipment cannot be repaired in time to save remote, the Remote Engineer must call MCR by means of outside phone or on the order loop as soon as possible.



Battery and Tube Test Record Forms as used at W45D. These forms are also used in conjunction with the Remote Routine, explained above.

17. In the case where lines stay in service for more than *four weeks,* a check on equalization must be made on such lines every *four weeks* from day the original equalization was made.
18. All movement of remote equipment must be *at once* recorded on the board provided for that purpose.
19. No defective equipment is to be returned to stock without first having been repaired.
20. Each and every tube should be checked at least once every two weeks, and test readings logged on form 3213, and kept in ring binder provided for that purpose.
21. Faders, switches, etc., must be cleaned with carbon tetrachloride, and given a thin coat of white vaseline, at least once each month. Tubes of vaseline should be used for cleanliness.
22. An accurate log of time of actual use of all batteries must be kept on form 3214, and filed in a ring binder provided for that purpose.
23. All twist-lock fittings (male and female) must be cleaned with carbon tetrachloride at least once a month, and a thin coat of white vaseline applied.
24. Remote Engineer who returns remote equipment to stock must clean all such equipment before doing so.
25. All electrical and mechanical connections should be checked at least once a week.
26. Frequency runs must be made through each and every channel of each remote amplifier at least once every two weeks, and on same frequencies on which equalization runs are made. Frequency runs must be recorded on form 3215 and filed by Remote Engineer in file provided for that purpose.
27. Remote Engineer will at all times, when loop is not in use, keep a short on same at remote point, for the purpose of making resistance checks on loops by the MCR Engineer. Also make sure that remote loop, even when shorted, is not grounded at remote end.
28. It will be the duty of the MCR Engineer to check remote loops for resistance, shorts, opens and grounds, and record such checks on the form provided. This should be done on new loops at the time of installation, and rechecks made every *four weeks* thereafter. Similar checks should be made on each loop immediately prior to setting up a remote. On loops to be used on Sunday, these checks should not be made later than the preceding Saturday. On weekday remotes the checks should be made while the Remote Engineer is en route from the station to the remote. If loop is out of order, or unsatisfactory in any way, Michigan Bell Telephone Company should be notified at once.



Form 3225
TO
Original

W45D—THE DETROIT NEWS
Engineering Department
Report of Broadcasting Performance
Program Interruptions and Schedule Departures

DATE..................19....
DAY ....

PROGRAM	ORIGIN	DURATION	TIME	NATURE AND RESPONSIBILITY

Carrier Time........................
Program Time........................
Signed ....

FIG. 12

Engineer's Report Form, covering program interruptions and schedule departures.

The routines presented are based on the following operating schedule:

Weekdays:
Air time ....5:00 AM-12:00 MN
Program time ...6:00 AM-12:00 MN

Sundays:
Air time ....7:00 AM-12:00 MN
Program time ...8:00 AM-12:00 MN

Engineer's Reports

Each day the Chief Engineer completes a "Report of Broadcasting Performance," based upon the logs of the previous day. This report is made out in triplicate; one copy each for the Organization's Director of Radio, the Station Manager, and the Chief Engineer's files. *Fig. 12* shows the form of that report.

At the end of each month the Chief Engineer writes a report on items of interest and importance as taken from various logs (both program and technical). Among the items that appear on this report are: total air time, program time, local studio time, local E.T. time, wire remote time, radio remote time, network time, program time taken from WWJ (The Detroit News' AM Station), total time of programs fed to others, number of remotes handled, number of program interruptions and their total time, and whatever items seem of interest and importance.

Close check on items in the last column of the Performance Report frequently indicates flaws and weaknesses in both program scheduling and technical department routines, and assist greatly in the correction and improvement of these routines. Occasional get-togethers of all engineers to discuss their problems, and periodic meetings with the Program Department personnel aid materially in improving the overall performance of the station.

Other Duties

Certain of the engineers have small duties in addition to the "Daily Routines," such as keeping an accurate record of all receiving and transmitting tubes in use at the station. On a simple form is entered such information as the tube life, reason for removal from service, location of tube in equipment, date of purchase, cost of tube, final disposition, etc. Tube life in all cases is measured on two time meters that cover all tubes and equipment in use. A separate card is kept for each and every tube in service, as well as spares. These cards are kept on file in the MCR and eventually provide an extremely good check on the life of all tubes in their respective socket positions. Already these records have helped in cutting down tube replacement in certain instances. Methods of prolonging tube life have recently been covered very completely in several technical publications, which obviates the necessity of covering them here.

As was stated at the beginning, this paper is merely an outline of practices and routines followed at W45D, and are not intended to indicate the only way in which a station may be operated efficiently. Rather, it is intended to show a well detailed outline of all main duties to be performed, the time when such work items should be done, and the logs and records to be kept. If it will help someone in solving or simplifying his operation and maintenance problems, if only a little, its purpose will have been attained.

NOTES ON RECEIVER DESIGN

DAVID EBY, Jr.

★ The prime requisites of a communications receiver designed for reception at high- and ultra-high frequencies are: sensitivity, stability, high signal-to-noise ratio, and ease of control. A few ideas with regard to improving these essential characteristics are incorporated in this article.

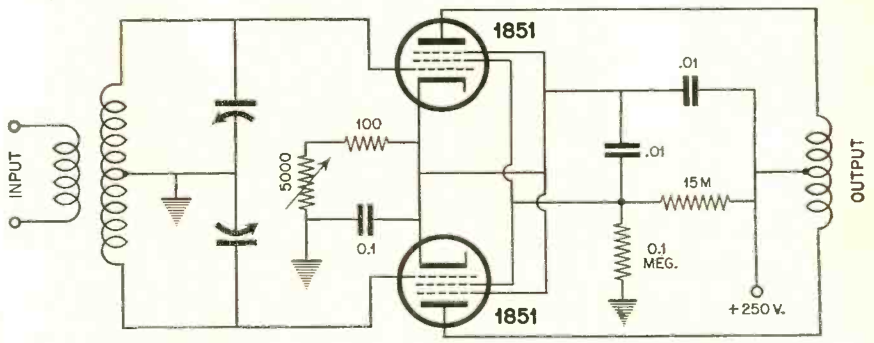


Fig. 1. Push-pull tuned r.f. circuit for s-w and u-h-f reception.

Sensitivity and Noise

The sensitivity of many communications receivers is far below the ideal, and there are numerous factors that impair the ability of the r.f. stages to bring weak signals up to a useful level. In this respect, the first tuned circuit is the most important insofar as signal-to-noise ratio is concerned, and the first r.f. stage must operate at optimum efficiency for good weak-signal sensitivity. The tube used in the first r.f. stage must have a low inherent noise output, and the antenna and first tuned circuit must provide a high degree of selectivity. If the tuned grid circuit has low Q, the discrimination against noise in the entire receiver is reduced considerably.

From the viewpoint of low noise output, the type 1851 tube or its equivalent is best suited for use in the first r.f. stage; but this tube has the unfortunate characteristic of loading the grid circuit, due to its low input resistance. If it were not for this detail, the 1851 would prove its worth in a single-ended tuned r.f. stage.

Push-Pull Circuit

Grid-circuit loading may be reduced by the use of a push-pull tuned r.f. stage, as shown in *Fig 1,* and by this means the excellent low-noise characteristics of the 1851 may be realized. In this circuit, the grid input resistance is increased, the Q is raised, and the gain lifted above that of a single-ended stage.

This circuit has been incorporated in a receiver having a tuned antenna circuit and an antenna with matched line. The push-pull r.f. stage feeds a push-pull mixer—also using 1851's—and is used in conjunction with a triode-connected 6F6 oscillator. The oscillator plate operates at 105 volts, with the plate supply controlled by a VR-105-30. This arrangement provides exceptionally low drift. The output of the oscillator is coupled to the grid circuit of the mixer by virtue of the capacity between the tuning condensers and such stray capacity as exists. Coupling is optimum over a wide range of frequencies.

In a push-pull tuned r.f. amplifier of this sort, symmetry is very important. Lead lengths on either side of the circuit must be uniform, and capacities kept equal. If there is unbalance in the circuit, the input resistance of one tube predominates and decreases the Q of the circuit by an amount greater than the increase in the opposite circuit. Therefore, rather than making grid leads as short as possible, it is more to the point to keep them the same length and in the same relation to chassis and other components.

Intermediate Amplifier

If tuned r.f. stages of high sensitivity, selectivity, stability and low noise output are assumed, it is equally as important that stability be built into the intermediate amplifier; for if the i.f. amplifier is off peak or drifts off peak, the weak signal gain will be less than a strong signal gain below a certain level.

If 1851's are used in the r.f. and mixer stages, high gain should not be incorporated in the i.f. stages; it is preferable here that lower voltages be used, and the job of bringing a signal up to a useful level left to the a.f. amplifier. In a two-stage transformer-coupled i.f. amplifier of the usual type, the plate voltage should preferably not exceed 50 volts. At this low voltage, there is sufficient gain, but instability due to heating of tubes and adjacent components is reduced, and there is less likelihood of drift off a sharp peak.

If a higher plate voltage is required (50 to 250 volts), it is preferable to revert to a band-pass amplifier, in which case a higher plate voltage will be required in any event; but an immediate advantage is gained by the flat-top resonance curve, for in this case drift, if not too extensive, has little if any effect on gain. It is still preferable, however, to use as low a plate voltage as is consistent with the i.f. amplifier gain requirements in relation to the audio amplifier and a useful signal.

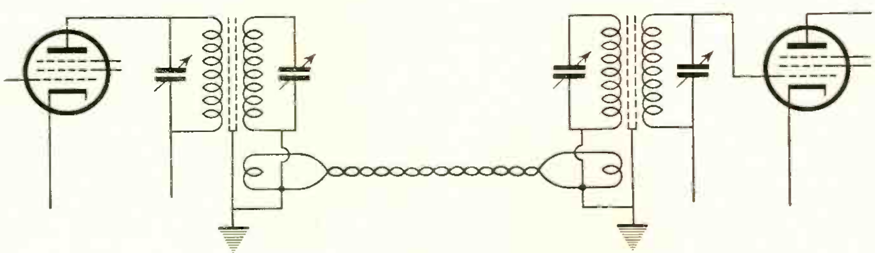


Fig. 2. Link-coupled i-f band-pass amplifier with 1-kc. flat-top.

[*Continued on page 40*]

RADIO DESIGN WORKSHEET

No. 6—THEVENIN'S THEOREM

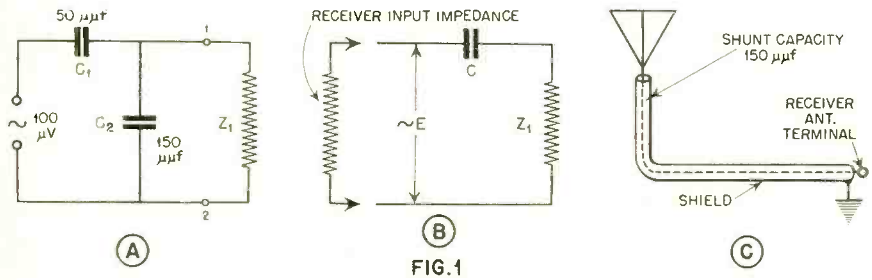


FIG. 1

RECEIVER INPUT

Problem 1: *Using Thevenin's Theorem, determine the equivalent voltage and impedance (Fig. 1-B) which should be connected in series with the receiver input to produce the same results as that of Fig. 1-A.*

Solution: Thevenin's Theorem for a network containing a single source of voltage may be stated as follows: Any network with a load impedance connected across two terminals may be replaced so far as the load impedance is concerned by a voltage connected in series with an impedance. This voltage is the one which would appear across the load terminals with the load removed, and the impedance is that looking into the load terminals with the source of voltage short-circuited.

The voltage appearing across the load terminals with receiver input impedance disconnected would be one-fourth of 100 microvolts since 150 μμf represents an impedance which is one-fourth that of the capacity potentiometer represented by *C1* and *C2*. The voltage across *C2*, and hence across the terminals *1* and *2*, is therefore one-fourth of 100, or 25 microvolts. $E = 25$ μv.

The impedance looking back into the antenna network from terminals *1* and *2* with the voltage source short-circuited, is composed of *C1* and *C2* in parallel, or 200 μμf. $C = 200$ μμf.

This is a common problem in an auto receiver with a 50-μμf antenna connected to a receiver input through a shielded lead-in having a capacity of lead to shield of 150 μμf. Such an arrangement is shown in *Fig. 1-C*.

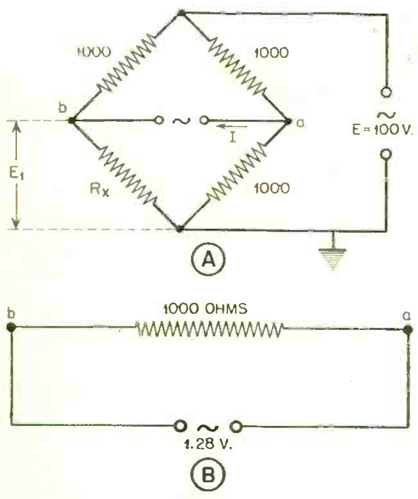


FIG. 2

WHEATSTONE BRIDGE CURRENT

Problem 2: *In Fig. 2-A is shown the schematic of a simple Wheatstone Bridge. If R_x has a value of 950 ohms, determine the current through the galvanometer using Thevenin's Theorem. Assume the galvanometer is a pure resistance of 1000 ohms.*

Solution: The current through the galvanometer will be due to the difference of potential between points *a* and *b*. Voltage between *a* and ground will be 50 volts. Voltage between *b* and ground will be:

$$\frac{950}{1000 + 950} \times 100 = \frac{95{,}000}{1950} = 48.72 \text{ v.}$$

$$50 - 48.72 = 1.28 \text{ volts}$$

Current through 1000-ohm galvanometer $= \frac{1.28}{1000} = 1.28$ ma.

The equivalent circuit for Thevenin's Theorem is shown in *Fig. 2-B*.

TRANSFORMER LEAKAGE REACTANCE

Problem 3: *In a transformer (Fig. 3) having a coefficient of coupling K, mutual inductance M, primary inductance L_1, and secondary inductance L_S, derive the expression for the leakage reactance referred to the secondary circuit.*

Solution: On the basis of the question, and L_L the leakage reactance referred to the secondary circuit:

$$K = \frac{M}{\sqrt{L_1 L_S}}$$

Whence: $L_S = \frac{M^2}{L_1}$ when K is unity

$L_S = \frac{M^2}{K^2 L_1}$ when K is not equal to unity

$$\text{Whence } L_L = \frac{M^2}{K^2 L_1} - \frac{M^2}{L_1} = \frac{M^2}{L_1}\left(\frac{1 - K^2}{K^2}\right) \qquad (1)$$

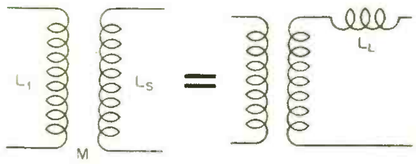


FIG. 3

Substituting in (1) various values of K yields the following *(Fig. 4)*:

$K =$	1.0	.9	.8	.7	.55	.5	.4	.3	.2	.1
$\frac{1-K}{K^2} =$	0	.235	.56	1.0	2.35	3.0	5.25	10	24	99

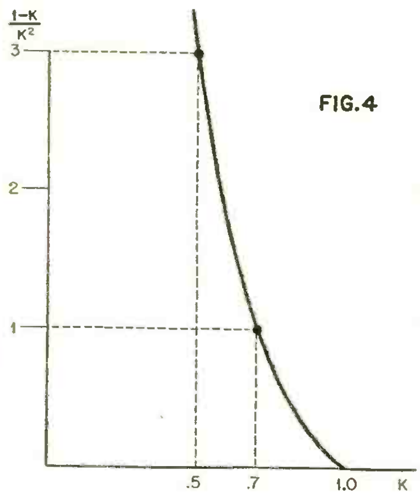
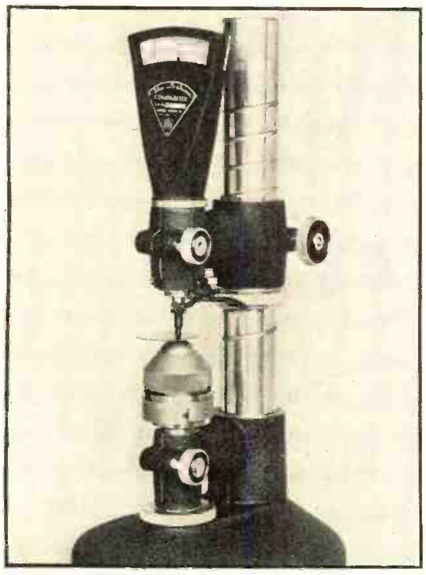


FIG. 4

NEW PRODUCTS

BALL MEASURING ANVIL

The George Scherr Company has just developed a ball measuring anvil for use on the Scherr Comparitol designed to speed up, simplify and guarantee accuracy for the measurement of thin work. The inspection and measuring of extremely thin pieces, such as crystals, laminations, shims, extremely



small gages and other flat work can be accomplished rapidly and with accurate results by the use of the Scherr Comparitol with special ball measuring anvil.

The extreme thinness of this class of work makes it difficult, impractical and frequently impossible to obtain accurate readings in .0001″ or .00005″ by the use of the standard flat or serrated measuring anvil.

With the ball anvil the work is placed between the flat feeler point and the round ball surface and absolutely dependable results are obtained regardless of which part of the thin piece under inspection is being measured. All danger of distorting or bending the shim or lamination out of size a few ten-thousandths due to measuring pressure of the instrument is eliminated by the use of the measuring ball anvil.

Another outstanding feature is that with the use of the ball anvil the instrument may also be used to check the flatness or parallelism of long thin pieces in all positions and on all parts of the work. The Comparitol column when used with this ball anvil is provided with an index line so that the ball point and feeler point can be lined up accurately from left to right as to center distance.

This new development has solved a number of very difficult measuring problems involving the uses of extremely thin pieces. Full information may be obtained from the George Scherr Co. Inc. 128 Lafayette Street, New York, N. Y.

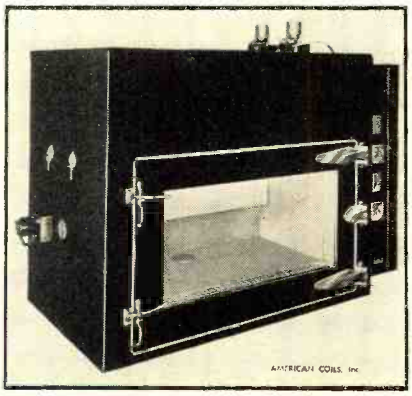
★

TEMPERATURE TEST CHAMBER

Many precision instruments today must function equally well in chilly Iceland and sun-baked Libya. With just such requirements in mind, a new chamber for testing instruments under extremes of cold and heat has been developed and is now manufactured by American Coils, Inc., Newark, N. J. Its range of operating temperatures extends from minus 55 degrees C. to plus 70 degrees C. It includes apparatus for mechanical refrigerating and electrical heating.

The model illustrated is known as Model RTC-1, and consists of a two-stage condensing unit, heat exchanger, liquid sub-cooler, coil or evaporator, expansion valves, cabinet and forced draft strip heater, along with thermostats and other controls and connections for each. The entire operation of the Model RTC-1 is completely controlled from a front panel board, where the master switch is located along with the off-fan control, light switch and receptacle switch.

Observation of instruments being tested is provided by an inner door with five glasses sealed and dehydrated against future passage of moisture. The inner glass is Tuf-flex Tempered



Plated Glass. The visible opening is 46″ wide by 21½″ high. These five thicknesses of glass form part of the steel-framed door which has a clear opening of 51½″ wide by 26½″ high.

The all-steel cabinet occupies space 83″ wide by 56½″ high by 42″ deep. The usable interior is 59″ by 28″ high by 30″ deep, with an interior cubic content of 28.7 cubic feet. The cabinet contains six inches of fiberglas insulation.

★

NEW PHONO NEEDLE

Peter L. Jensen, one of the country's foremost audio authorities, has recently marketed a new type of phonograph needle.

The peculiar design of this new needle was arrived at after a most

painstaking period of careful research. It was the aim to produce a very long life needle which possessed the highest degree of fidelity, while, at the same time, reduced the scratch and the wear on the records to a minimum.

The compliance of the Jensen Concert Needle gives it a shock absorbing characteristic which permits it to glide along smoothly in the groove and also reduces materially the needle scratch.

By making the needle rigid in a cross-wise plane, all the frequencies in the record are transmitted without loss to the mechanism in the pickup, but the flattened cross section causes less air to

[*Continued on page 41*]

Echophone Model EC-1

6 tubes, 3 bands. Tunes from 550 kc. to 30 mc. Beat frequency oscillator. Bandspread logging scale. Self-contained speaker. Electrical bandspread on all bands. AC/DC. 115-125 volts.

ECHOPHONE RADIO CO., 201 EAST 26TH ST., CHICAGO, ILLINOIS

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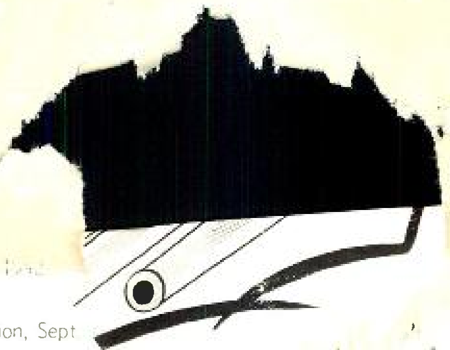

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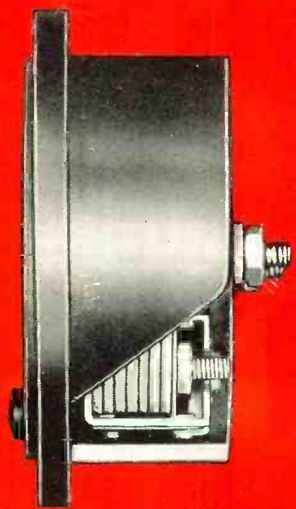
When Space is at a Premium

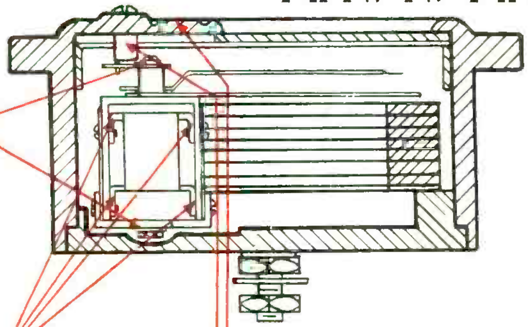
TRIPLETT *Thin Line* INSTRUMENTS

Full size of Instrument. Note deep shroud for glass protection—and "Quick-Look" Scale.



This molded case contains *full size* Triplett Mechanism. Rugged Construction—Compact Convenience.

THIS IS THE INSIDE STORY



1 Four-point Core Support

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3 Bezel Shroud Eliminates Unwanted Glare

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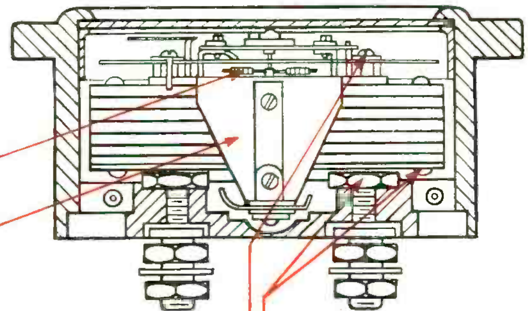

5 Balanced Frame Construction

6 Solid Balance Cross with Screw-type Balance Weights

7 Four-point Rigid Magnet Clamping

8 Separate Dial Mounting Independent of Top Bridge

Thin-Line Instruments also have Standard Large Coil Triplett Movements. Furnished with Osmium pivots for special requirements. All these features make for greater rigidity under vibration; greater permanence of calibration; greater user satisfaction.

TRIPLETT *Thin-Line* memo

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FOR CIRCULATION TO . . .

Triplett Thin-Line Instruments meet rigid requirements for dependable performance. Though occupying minimum space they are *not* miniatures. Mechanisms are standard size with emphasis on excellent performance over long periods. Standardized installation. Made in three styles of cases — Molded, Metal Wide Rim and Metal Narrow Rim.

Triplett Thin-Line Instruments, available for many industrial applications, can be depended upon for precision performance in limited space. For full details write for "Triplett Thin-Line Bulletin".

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DESIGNED AND ENGINEERED TO FIT SPECIAL NEEDS
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Another Eimac Achievement

Illustration shows typical application of electromagnet actuating coil to Vacuum Relay. In certain installations outside flash-overs are eliminated by use of ball type connectors.

Solves a Tough Electrical Problem

Handling 20,000 volts RF potential with this Eimac vacuum relay is as easy as turning on your living room lights.

Over two years ago Eimac engineers developed this strange looking vacuum tube which has been seeing service ever since. It is a single pole double throw relay used for many high voltage switching applications. Although the contact spacing is only .015″, no arc-over is experienced inside the tube. Changes in air pressure and humidity, such as encountered in aviation, have no effect on the breakdown within the relay, because the contacts are in vacuum. Actually a flash-over will occur across the outside terminals before breaking down within. A tribute to the high degree of vacuum attained on Eimac pumps.

This development is a direct outcome of the far-reaching advancements made possible through the Eimac technique of vacuum tube construction. A typical example of why Eimac transmitting tubes are first choice of leading engineers throughout the world.

Follow the leaders to Eimac Tubes

Eimac

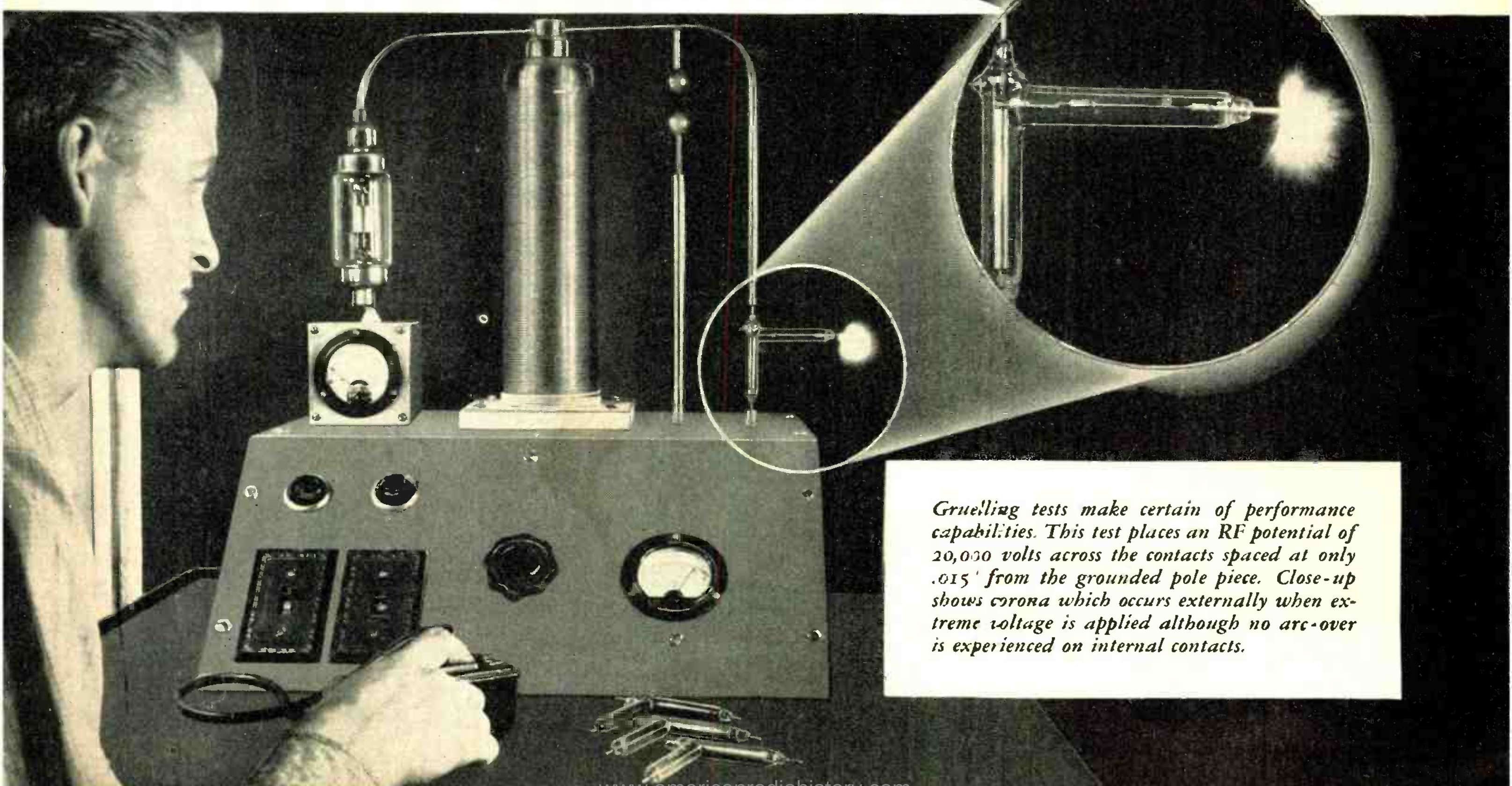
VACUUM RELAY

Manufactured by

EITEL-McCULLOUGH, INC.

San Bruno, California, U. S. A.

Export Agents: FRAZAR & CO., LTD., 301 Clay St., San Francisco, California, U. S. A.



Gruelling tests make certain of performance capabilities. This test places an RF potential of 20,000 volts across the contacts spaced at only .015″ from the grounded pole piece. Close-up shows corona which occurs externally when extreme voltage is applied although no arc-over is experienced on internal contacts.

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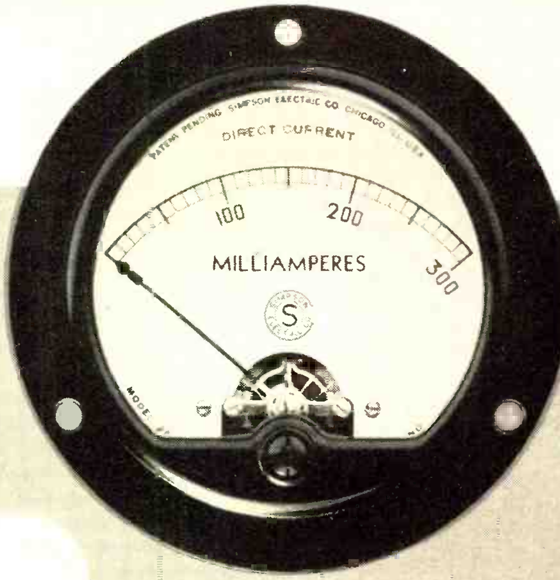

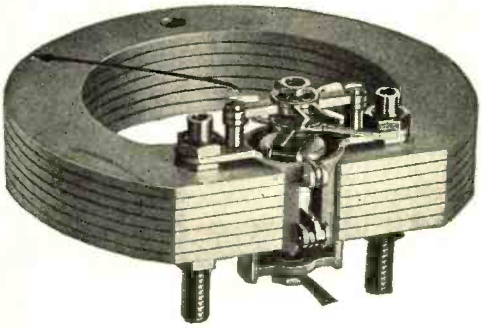

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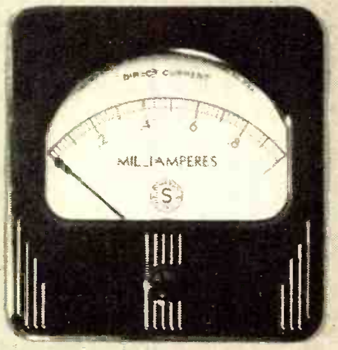

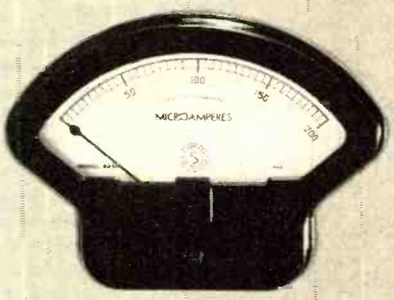

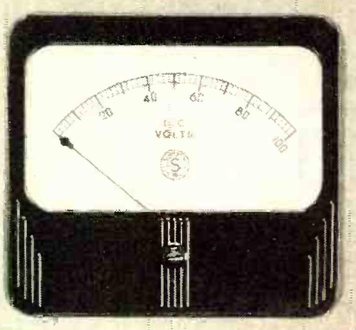

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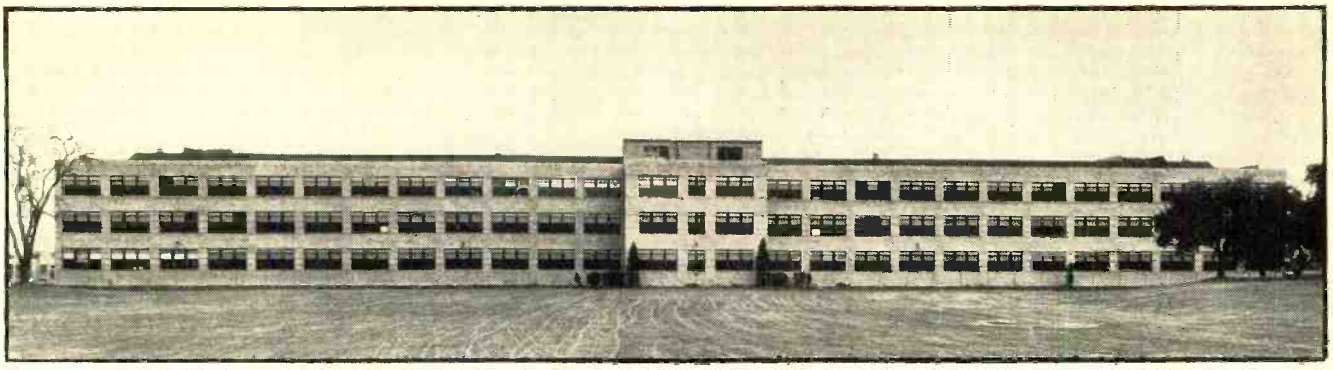
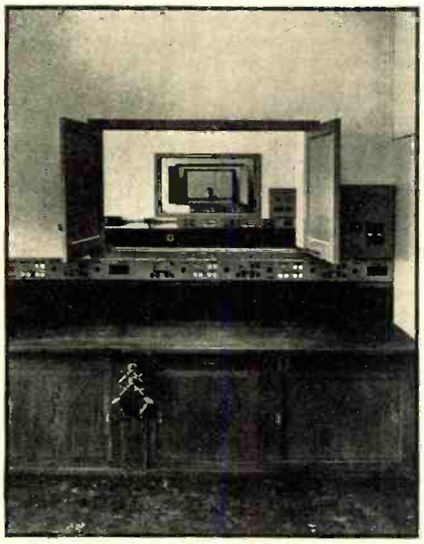


NEW RCA LABORATORIES DEDICATED

★ The new RCA Laboratories built by the Radio Corporation of America, at Princeton, New Jersey, were dedicated September 27th to serve the country and its fighting forces in war, and to help build a stronger nation through scientific research.

Tour of the Laboratories

A tour of RCA Laboratories reveals their size, magnificence, efficiency and promise. It is not only a radio laboratory, but many laboratories which reveal that modern radio is a science spreading into many fields—electronics, sound-acoustics, chemistry, physics, mechanics, and optics, from which grow many by-products and branches—cathode-ray tubes, fluorescent materials, lenses and photography.



The bays of the Optic Laboratory are connected by door-like windows in the walls, making possible long focuses through the rooms. Note the convenient electric service outlets on the panels atop the work benches, and the spigots for air, gas, water, hydrogen and oxygen supply, on front of bench.

The Laboratories building is a three-story structure with long corridors into which open 150 laboratory bays. To understand what is behind them, the inspection must begin in the basement. It is the nerve center. Into it, through underground arteries of conduits and pipes, are fed the electric power, gas and water supply. Alongside huge water tanks and air-conditioning apparatus are transformers and vault-enclosed power regulators, while the compressed air and steam is supplied from the heating plant. From two 300-foot wells, 600 gallons of water are pumped in a minute.

All the services of electricity, water and gas flow in conduits on the basement ceiling under the main corridor. There are 104 vertical shafts, which rise from basement to penthouse, with outlets on each floor. From these, wires and pipes carry the vital services to 420 workbenches, each 6 feet long. These unique service shafts are described as a most important feature and development—an original contribution to laboratory construction. In the words of a scientist, they are "a copy of nothing."

Standing at the point where the "T" of the Laboratories structure is crossed, on each of the three floors one looks to the right and left down the 244-foot corridors, or wings. The total length of a corridor from end to end is 488 feet. That is the span across the top of the "T". The doors on both sides of these spacious hallways on all three decks open to the many laboratory bays, and to nine administrative research offices and workshops. On the main floor, the general office section is near the entrance. Executive offices are located in a section on the third floor.

The corridors on each floor of the new 3-story RCA Laboratories building are 488 feet long. Into them open 150 laboratory bays.

On entering one of the laboratory bays, one is impressed with the spaciousness and broad daylight exposure, supplemented by modern indirect lighting, which casts no shadows. The work benches are so designed and arranged as to be a joy to any worker. A wiring trough extends along the top of each bench, and the markings on the panel outlets indicate that almost any character of electricity—a.c. or d.c., and at various voltages, is at the fingertips of the researcher. In addition, there are taps on the bench for air, gas and water, as well as hydrogen and oxygen in the bays where they are used. And, of course, there are convenient electric plugs for soldering irons and other electrically-operated tools. Flexibility in construction is the keynote.

The many Laboratory bays indicate

[*Continued on page 39*]

ARMY-NAVY TUBE LIST

[*Continued from page 11*]

mentioned in Paragraph 2 above, is taken to include:

a. Equipments basically new in electrical design, with no similar prototypes.

b. Equipments having a similar prototype but completely redesigned as to electrical characteristics.

c. New test equipment for operational field use.

4. The term "new equipments", as mentioned in Paragraph 2 above, *does not* include:

a. Equipments either basically new or redesigned, that are likely to be manufactured in very small quantity, such as laboratory measuring instruments.

b. Equipments that are solely mechanical redesigns of existing prototypes.

c. Equipments that are reorders without change of existing models.

d. Equipments in the design stage before the effective date of adoption of this Preferred List.

Note: The foregoing statements in Paragraphs 3 and 4 above are explanatory in nature and are not intended to be all-inclusive.

5. In the event that it is believed that an unclassified tube other than these included in the Preferred List should be used in the design of new equipments for either the Signal Corps or Navy, specific approval of the Service concerned must be obtained. Such approval, when Signal Corps equipment is concerned, is to be requested from the Signal Corps Laboratory concerned with such equipment; the said Laboratory will then make known its recommendations in the matter to the Office of the Chief Signal Officer where the final decision will be made and returned to the laboratory for transmittal to the party requesting the exception. When Navy equipment is concerned, the request for exception shall be addressed to the Bureau of Ships, Navy Department.

6. The publication of the attached Army-Navy Preferred List of Vacuum Tubes has no application to the use of vacuum tubes classified as to security status, or to tubes which have no functional counterparts in the preferred list. The choice of vacuum tubes not covered by the preferred list is to be made with the approval of the Signal Corps or the Bureau of Ships, for Signal Corps or Navy equipment respectively as outlined in Paragraph 5 above.

7. The publication of this list is in no way intended to hamper or restrict development work in the field of vacuum tubes or vacuum tube applications.

8. This list is to take effect immediately.

September 28, 1942.

Office of the Chief Signal Officer,
Headquarters, Services of Supply,
War Department.
Chief of the Bureau of Ships,
Navy Department.

KMPC's GROUND SYSTEM

[*Continued from page 16*]

killed by spraying with Diesel oil. Each tower is individually surrounded by a 7-foot high galvanized fence and again grounded to the individual ground systems.

Extending from the far tower to the transmitting building is a 6-inch copper strip. This is connected to all ground wires and equipment, and follows directly beneath the transmission line which is mounted on rollers to allow for expansion and contraction. The transmission line is divided into three sections, the sections terminating

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at each tower. This allows for the individual expansion of each line between the transmitter building and the three towers; also giving the additional advantage of emergency use in the event of individual transmission-line or tower failure.

All the reinforcing steel used in the transmitter building has been individually grounded and also has been included as part of the main ground system.

NEW RCA LABORATORIES

[*Continued from page 36*]

a great variety of activity within the Laboratories. The Television Laboratory is described as "the last word in facilities for television research." Other laboratory bays are devoted to research in chemistry, especially fluorescent materials; acoustics, radio facsimile, centimeter-wave transmission and reception, receiving tubes, cathode-ray tubes, transmitter tubes, underwater sound, and various activities associated with the future of radio and electronics.

The Model Shop is considered to be the most modern of its kind and most splendidly equipped in the world. For example, the Meter Room has complete calibrating equipment and 3000 different meters available for covering voltage, current, temperature and speed. The Technical Library of the Laboratories is cataloged as "complete in the communication field." The Laboratories has an ultra-modern kitchen which adjoins a cafeteria with a capacity to serve from 180 to 200 persons at a time.

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NEW A.S.A. STANDARDS

The American Standards Association has approved standard methods of testing and tolerances for fabric tubular sleeving and braids. The new standard specifies permissible variations on inside diameter and wall thickness of sleevings and braids, and also governs tolerances as to weight, number of carriers, ends on bobbin, yarn number and imperfections.- Testing methods for these factors are specified and referee conditions are set forth in case of dispute.

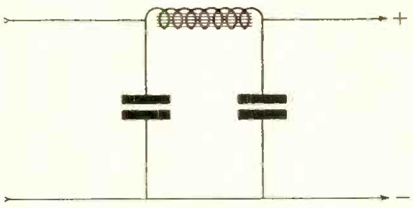
These standard methods were developed by the American Society for Testing Materials.

Q. & A. STUDY GUIDE

[*Continued from page 18*]

regulation. The permissible load current is greater for any given power transformer and rectifier. Ripple percentage is generally between 3 and 10 percent for a simple choke-input filter.

241. What are the primary characteristics of a condenser-input filter?



CONDENSER-INPUT FILTER

The available output voltage is increased, being slightly higher than the transformer voltage with a light load. Some sacrifice in voltage regulation as compared with choke-input filter. Provides low-pass filter with cutoff frequency below that of the rectified output. Can deliver a peak current considerably larger than the load current.

242. What is the primary purpose of a "swinging choke" in a power-supply filter system?

With an increase in load, the inductance and the voltage drop across the choke decrease. Thus, soaring of the output voltage at light loads is prevented by the high inductance of the choke at low current values, and vice versa, thus providing good voltage regulation under varying load conditions.

(To be continued)

RECEIVER DESIGN

[*Continued from page 22*]

For c.w. reception, the flat-top portion of the curve should be kept narrow, but not necessarily peaked. If the circuits are peaked, then it will be found that the curve of the crystal filter is far too sharp to be practical in conjunction with anything but a highly stable oscillator, and the chances of holding a signal may be slim. If the top of the i.f. amplifier curve has a width of about 1 kc., there is sufficient selectivity for all practical purposes, and the bandwidth provided will compensate for moderate drifts to the extent of offering uniform gain over the limits of 1000 cycles. With this arrangement it is possible to hold weak signals indefinitely, except where the signal fades below the noise level.

An ideal system consists of six ordinary i.f. transformers rebuilt to provide twelve link-coupled circuits in a two-stage amplifier. The circuit of a single stage is shown in *Fig. 2*. The link windings are close-coupled and consist of about 25 turns of No. 36 solid copper wire. Litz wire is not recommended unless special care is taken to see that all strands are soldered and make good connection.

The author has an i.f. amplifier of this type using 1853 tubes with 100 volts on the plates. The pass-band is 2 kc. at the base and less than 1 kc. on the flat top. For phone use, one of the stages may be cut out or, preferably, the transformers so tuned by the switching in of small shunt condensers as to provide two peaks fairly close together. The additional condensers can be conveniently thrown in and out of circuit by means of a switch ganged with the b.f.o. on-off switch.

Beat Oscillator Stability

In the usual beat-frequency oscillator a coil-condenser unit is used as the frequency-controlling element. Though operating at a comparatively low frequency, the beat oscillator can, and often does, drift to such an extent as to require constant adjustment for the purpose of maintaining an audible signal of a desired pitch.

There are instances in commercial work where a steady pitch is desirable, and in all instances a signal of steady pitch is easier to copy. If a crystal-controlled beat-frequency oscillator is employed, drift can be kept very low. The receiver can be shaken without altering the pitch of the beat note, providing, of course, the high-frequency oscillator is also stable.

The crystal used must be of the zero drift type, and the i.f. amplifier must be aligned to the desired beat frequency. The i.f. frequency must be kept to one side of the crystal frequency by a degree equal to the beat note desired. These adjustments are not difficult if a good signal generator is available.

In a receiver incorporating these features, it is possible to use the dial calibrations to an accuracy better than 250 cycles one minute after the receiver is turned on. A large part of the stability is attributed to the low plate voltages employed.

★

NEW PRODUCTS

[*Continued from page 24*]

be directly agitated, and the result is a noticeable reduction in needle talk.

The needle point itself is made from an alloy of precious metals having great wear-resisting qualities rather than extreme hardness.

The offices of the Jensen Industries, Inc. are located at 737 North Michigan Ave., Chicago. In their factory they are at present also producing pivots and bearings tipped with the same wear-resisting alloy used in the needles. These special products are used in high quality measuring instruments used by our Army and Navy.

★

NEW METAL ETCHER

The Ideal Commutator Dresser Company, 4027 Park Avenue, Sycamore, Illinois, announces a new Electric Etcher that permanently marks anything made of steel, iron or their alloys.

To etch small tools and parts simply place them on the work plate, turn switch "on" to proper heat and start writing. A ground clamp conveniently attached to the work plate is provided

[*Continued on page 43*]

[*Continued from page 41*]

for etching large, heavy parts and castings.

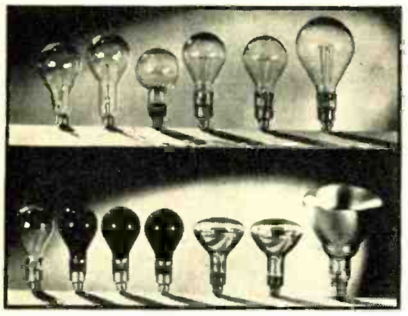
"Hi-Lo" taps and a seven point switch give 14 etching heats between 115 to 1300 watts. A red lamp on front of Etcher indicates when power is "on" and burns brighter as each higher heat is used. Depth of mark can also be controlled by speed of writing.

The No. 18 Machine Shop Model supplements the present line of Ideal Electric Markers and Etchers, which includes five sizes from "Thin Line" to "Heavy Duty".

★

INFRA-RED HEAT LAMPS

A complete new line of infra-red heat lamps, designed in keeping with the limitations imposed by the War Production Board, has just been announced by the Birdseye Division of the Wabash Appliance Corp., Brooklyn, N. Y. The new line includes six clear types, three ruby types, and four



reflector types. All feature the M-type tungsten filament for uniform heat distribution and have their bases reinforced with asbestos-lined mechanical straps to withstand the terrific temperatures of tunnel installations. The reflector types have built-in reflector linings of pure silver sealed inside the bulbs for protection against dimming and tarnishing by fumes or dirt. Average burning life on all is in excess of 6000 hours.

Advantages claimed for infra-red are speed, ease of operation, and economy. Savings in time, in many instances, are said to be up to 95% faster baking and drying time than with older baking systems.

The entire subject is covered in new literature being issued by the Wabash Appliance Corp., 345 Carroll Street, Brooklyn, N. Y.,

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SOLDER POTS

Small capacity Solder Pots are being manufactured by Lectrohm, Inc., 5125 W. 25th Street, Cicero, Illinois, for continuous operation in radio, motor and similar electrical equipment plants where individual soldering melting pots are desired for each operator or for small repair and homecraft shops.

They are sturdily constructed, consisting of a cast iron pot mounted, by a single screw, on a plated steel stand. A single heat, porcelain nickel-chrome heating element, which can be quickly and inexpensively replaced when necessary, heats the pot.

These pots are available in two Models (Model No. 200—1¾ pound capacity and Model No. 250—2 pound capacity) for operation on 110 v., ac or dc. A six foot Underwriters ap-

proved cord and attachment plug is furnished with each unit.

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GRAPHITE SHIELDING

[*Continued from page 14*]

slow heat drying under pressure will discourage any curling. Surfaces, if necessary, may be coated after such treatment.

Numerous non-conducting materials used for enclosing radio or similar equipment can be readily painted on the inside for shielding purposes. This practice, already common to makers of electronic musical instruments, may soon be adapted by commercial radio producers as metal becomes unavailable for chassis forms.

Vacuum Tubes

When metal radio tubes and metal shields for glass tubes are unavailable, shield the glass types by covering the outside with colloidal graphite. One part of the paste mixed thoroughly in three to five parts of water will serve the purpose. Apply by painting or spraying.

If the tubes are the type that generate considerable heat during operation, apply the graphite film in a lattice or screen fashion. Overlap the strips well at the intersections and make them as continuous as possible with sizeable portions of the glass surface untouched. A fine camels' hair brush will be found useful.

Both types of coatings may be grounded by continuing the covering wholly or in a single narrow strip down over the walls of the tube base to touch a lead mounted on the top of the baseboard or chassis. Tubes having grid connections at the top are coated only to within half an inch of the metal.

Grounding may also be made by fitting a loop of copper wire or strip about the tube, clamp fashion. Do this before applying the colloidal graphite solution, and seal the connection well at the edges with the concentrated graphite paste. If the graphite coating should be applied first, paint both sides of the metal clamps before placing them in position. A third coat overlapping the coated metal and the graphited glass will insure good electrical contact.

The "cats' whisker" method shown in the illustration likewise offers possibilities. A single, small gauge copper wire, appropriately anchored at one end with a wood screw or bolt, is bent to touch lightly the graphited surface of the tube. A spot of concentrated colloidal graphite will hold the wire or "whisker" in place. Varnish or shellac applied over the dried mass will further strengthen the connection.

Shields

Cardboard mailing tubes of sufficient length and diameter to accommodate the tube within, make ideal shields when impregnated and surface-coated with colloidal graphite. A solution containing one part of this material and ten parts by volume of water is recommended for the initial saturating treatment by simple immersion. Fibrous materials of a porous nature particularly benefit. Where hard, glazed, or not too porous surfaces are involved, a more concentrated dispersion (1 to 2) can be applied directly to the substitute shield by painting.

Ordinary metal eyelets common to the leather trade, make good ground connections for cardboard shields bearing graphite films. A lead is soldered into the opening before the piece is inserted in the shield walls. The usual precautions for sealing around the contact apply. Clamp and whisker type connections are likewise feasible for these enclosures. Eyelets, in turn, make good angle strip fasteners for supporting the shield on the chassis.

Other applications involving the once abundant metal supplies may suggest themselves from the foregoing remarks. In such instances the electrical conducting properties of colloidal graphite films are worth investigating.

UNIVERSAL A.C. BRIDGE

[*Continued from page 13*]

gang equal-section variable condenser and may be calibrated directly in frequency depending on the values of R_C and R_D to satisfy equation (2). If a ten-to-one capacity range can be secured with C_C and C_D, then values of R_C and R_D can be found to cover the audio spectrum in three ranges; 20-200, 200-2000 and 2000-20,000 cycles, for a single calibration scale on the condenser.

For an exhaustive treatment of a.c. bridges the reader is referred to *"Alternating-Current Bridge Methods"* by B. Hague, published by Pitman Publishing Corp., and numerous articles in the *General Radio Experimenter*.

NEWS

NEW WPB PREFERENCE RATING

Assignment of preference ratings to facilitate the acquisition of equipment and supplies for the maintenance and repair of radio communication and commercial sound-recording facilities is provided in Preference Rating Order P-133, issued October 5th by the War Production Board.

The order may not be used for any expansion, improvement or change of design of equipment. It covers only materials needed for maintenance and repair and assigns the preference rating A-1-j to all operators of radio communication facilities, including broadcasting, police, direction - finding and aviation facilities, as well as all commercial sound-recording studios. The rating, however, is assigned only after the operator has complied with nine conditions stipulated in the order.

These include:

The rating may not be used to replace in inventory more than one spare tube for each active tube socket.

The rating may not be used to replace in inventory any spare parts except those subject to frequent failure, deterioration, or other exhaustion and those which are so special that failure would inevitably result in long delay in resumption of essential operations.

The rating may not be used in any case to increase the value of an operator's inventory of repair parts, other than tubes, above the value of such inventory as of October 5th.

The rating may not be used to replace in inventory a new part if the defective part can be repaired with a smaller consumption of raw material.

The tube which has been replaced from operator's inventory or for which replacement is required must be operated to failure.

The operator must return to the manufacturer any power tube rated at 25 watts or more which has failed, unless the tube is to be repaired.

Equipment which has failed must have been operated within the ratings specified by the manufacturer.

The ratings must not be used to build up inventory of operating supplies other than tubes, in excess of requirements for a three-month period.

The operator must be actively engaged in one of the activities listed on schedule A, attached to the order, or must receive specific authorization for his installation from the Director General for Operations of WPB.

Schedule A lists three categories: radio communication, including broadcasting; sound recording for commercial purposes, and radio direction-finding.

Preference ratings for maintenance and repair of radio communication equipment formerly were assigned by P-129, which expired September 30. The new order replaces this one, and extends the field somewhat, since P-129 was primarily designed to cover maintenance of telephone equipment.

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NAVY NEEDS TECHNICIANS

Among the most urgent needs of new officer personnel in the United States Navy is for professional technicians in engineering fields, the Director of Naval Officer Procurement, Chicago, has announced.

Perhaps first in the list are graduate electrical engineers, those mainly between 21 and 50 years who have followed electrical engineering since their graduation, and who have a knowledge of ultra-high frequencies, electronics and television. Those more familiar with power engineering likewise may find a place in the Navy which is interested in these men in ages up to 50 years. Electrical engineers are needed especially in the Navy's fields of radio and detection devices. Men with radio or communication engineering degrees may qualify for officers' commissions as well. Waivers for minor physical defects often are obtainable.

A Petty Officer rating is offered to men with sufficient experience in radio to instruct classes in Radio Theory, Practical Operation, Code, or Maintenance.

The Navy has schools in several parts of the country to instruct enlisted men in radio, and it is for these schools that instructors are needed.

In some cases men with B.S. degrees in mechanical or other engineering subjects and who have had experience in radio and electrical work may qualify for officer assignments in radio or

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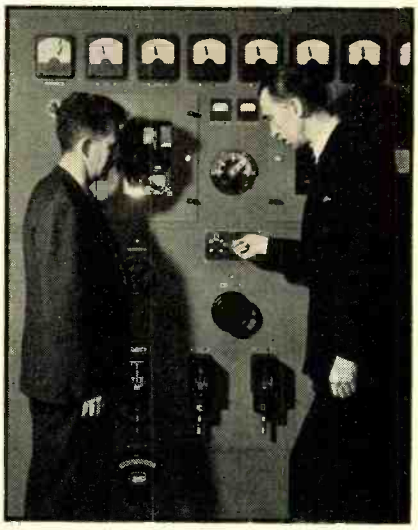

Robert E. Sherwood, director of the overseas branch of the Office of War Information, throws the switch setting into operation the new 100 kilowatt transmitter of General Electric's short wave-station WGEC in Schenectady, making it one of the most powerful in the western hemisphere. Standing beside him is W. J. Purcell, left, engineer of G-E broadcasting.

electrical lines. Usually, however, degrees in engineering other than electrical tend to fit the applicant for other duty. For instance, Navy activities in ordnance, construction, and ship operation use mechanical, civil, and chemical engineers. Here again physical waivers often are possible and the age range is usually between 30 and 45 years, or beyond those two limits in some cases.

Another special officer procurement program under way is for college teachers of physics, or chemical, Diesel, electrical, mechanical, and radio engineering at Naval Reserve Midshipman Schools. Private school and junior college teachers and others qualified to teach those subjects in colleges also are being sought.

Either Ensign W. W. Hall, Room 300, or M. G. Miller, Room 1184, both in the Board of Trade Building, Chicago, will answer all requests for information.

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PLUG ASSEMBLIES

Universal Microphone Co., Inglewood, Cal., is now delivering complete plug assemblies for types PL-54, PL-55, PL-68, JK-26, JK-48 and companion plug and SW-141 for government orders through regular purchasing channels. They are not merely plug shells, but the complete assembly for land, sea and other field communications devices.

★

BOOKLET ON TUBE LIFE

A booklet just released by the Radio, Television and Electronics Department of General Electric Company, Schenectady, N. Y., tells how to make radio transmitting tubes last longer. These include the pure tungsten-filament tubes, mercury vapor tubes, and thoriated tungsten tubes. The booklet is available on request.

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NEW SOLAR CATALOG

Latest catalog to be issued by Solar Manufacturing Corporation of Bayonne, N. J., describes in full the Solar line of D.C. Type Electrolytic Capacitors.

The new catalog, consists of 32 pages, profusely illustrated, and the data has been especially arranged for design engineers. It is listed as Catalog 12—Section A and may be had only on letterhead request.

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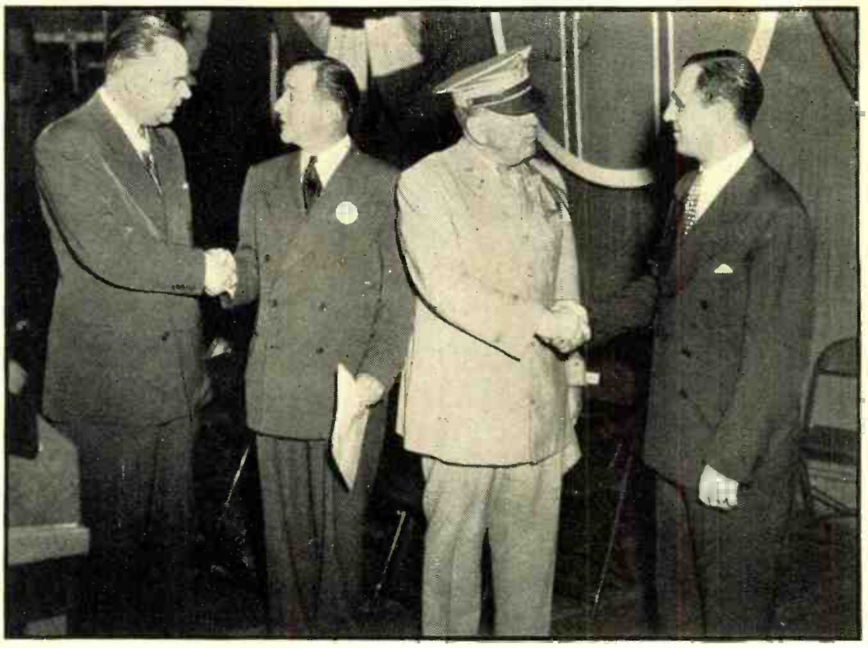
SIGNAL CORPS WAIVER

Until further notice, approval by Signal Corps General Development Laboratory of preproduction samples of



Joseph L. Overlock, Regional Director of W.P.B., W. J. Halligan, President of The Hallicrafters Company, Col. Thomas L. Clark, Officer in Charge, Chicago Signal Depot, and Raymond Durst, Sales Manager of The Hallicrafters Company photographed during the presentation of the Army and Navy "E" Award to The Hallicrafters Company.

electrical indicating instruments (meters) is not required for those instruments and accessories such as shunts, thermocouples, etc., which have been approved after January 1, 1942, provided the approved instrument is identical to the design and construction of current production instruments for other than conservation directives on finishes. Where that instrument has been approved after January 1, 1942, components of that instrument, such as the basic movement, shunts, multipliers, thermocouples, scale, etc., are approved for use in any combination with other previously approved components in that general case size and construction.

To carry out the foregoing, all procurement agencies and their representatives have been instructed to accept instruments for use in Signal Corps equipment when the instrument manufacturer or equipment manufacturer furnishes evidence in writing that the instrument to be furnished complies with the requirements of the preceding paragraph. Instruments and accessories, which have not been approved after

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

of RADIO, published monthly at East Stroudsburg, Pa., for October 8, 1942.

State of New York }
County of New York } ss.:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Sanford R. Cowan, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Radio Magazines, Inc., 132 W. 43rd St., New York, N. Y.; Editor, M. L. Muhleman, Bronxville, N. Y.; Managing Editor, None; Business Manager, S. R. Cowan, Brooklyn, N. Y.

2. That the owners are: Radio Magazines, Inc., 132 W. 43rd St., New York, N. Y.; Lee Robinson, New York, N. Y.; M. L. Muhleman, Bronxville, N. Y.; and Sanford R. Cowan, Brooklyn, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities, are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock, and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) SANFORD R. COWAN, Business Manager.

Sworn to and subscribed before me, this 8th day of October, 1942.

(Seal.) RAY F. WIESEN, Notary Public.

Kings County, Kings Co. Clk's No. 208. Reg. No. 4245, N. Y. N. Y. Co. Clk's No. 694, Reg. No. 4-W-398. Commission expires March 30, 1944.

January 1, 1942, shall be handled as required by the applicable specification. The foregoing action is designed for current production only.

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10 SUGGESTIONS FOR GETTING OUT INDUSTRIAL SCRAP

1. Head up the campaign by appointing an able executive of the company, armed with authority to act.
2. Use posters, illustrations, pay-envelope stuffers, and all other publicity means to enlist all employees in scrap campaign.
3. Comb plant and yards for dormant scrap and unusable and abandoned equipment.
4. Survey all plant equipment, particularly idle, standing or discarded machines.
5. Classify and segregate scrap and supervise its handling.
6. Make each foreman responsible for preventing spoilage and waste in his department.
7. Report promptly equipment which is obsolete. If the equipment has not been used in three months, and it can't be proved that it will be used in the next three, turn it over where it can be used . . . or scrap it.
8. Salvage usable parts from equipment marked for scrapping.

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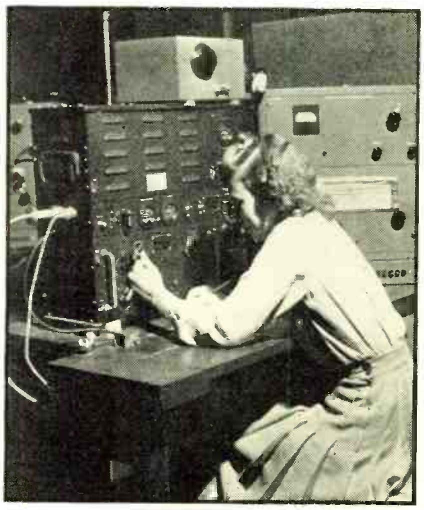


Billie Brooker, an Iowa State graduate, calibrates a radio transmitter in one of the war plants of the General Electric Radio, Television, and Electronics Department. For years such jobs as this one have been looked upon as a man's stronghold. Now, under the stress of war conditions and the consequent shortage of manpower, the famous G-E training course for graduate engineers is opening its doors to women. Test girls will replace Test men on some of the work, and in other cases they will give highly skilled assistance to the engineers in laboratories and factories.

ADDRESS CHANGE?

Notify RADIO's Circulation Department at 132 West 43rd Street, New York, N. Y., of your new address two or three weeks before you move. The Post Office Department does not forward magazines sent to a wrong address unless you pay additional postage. We cannot duplicate copies mailed to your old address. Thank you!

ADVERTISING INDEX

9. Speed return of scrap to mills and refineries through existing channels. Report regularly on collections of scrap to the Industrial Salvage Committee set up by the War Production Board in your community.

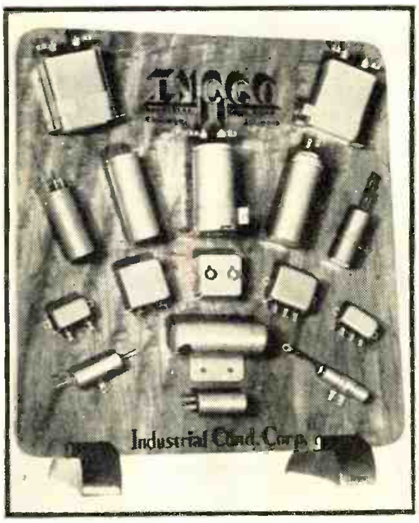
10. Enforce monthly re-checks in every department to find scrap material previously overlooked.

★

NEW CONDENSER DISPLAY

In accordance with their plan of distribution, Industrial Condenser Corp., of Chicago, has issued a new counter display to their distributors.

The new counter display stands 18 inches wide by 20 inches high and is of light colored wood with two wood supports which hold the display upright. Sixteen representative types of condensers are mounted on the board which permits a permanent display of Incco products.



Industrial Condenser Corporation's new plans call for distribution through distributors with stocks being carried at each point to insure immediate delivery on small lots thereby speeding up shipping of these orders and giving immediate delivery in each distributor's locality.

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UNIVERSAL MIKE PROTECTIVE SYSTEM

Andrew J. Meagher, in charge of guards and fire forces of the plants of the Universal Microphone Co., at Inglewood, Cal., has been appointed personnel director of the company. The entire patrol force of the factory was recently sworn into U. S. Army service as auxiliary military police.

Mr. Meagher has a background of 25 years in peace circles as special investigator for the post office and treasury departments, as well as a U. S. intelligence unit. He also conducted his own investigation office, and at one time was investigator for the Santa Cruz county grand jury and the district attorney's office in Stockton, Cal.

Expansion of the personnel division includes the installation of an identification bureau with facilities for finger printing and photographing new employees. As an additional feature, Universal will also record the voices of personnel, using paper covered discs which do not use any restricted material.

Universal's expanded program includes centralized employee hiring through the U. S. Employment Service; the installation of a teletype machine to surrounding administrative areas and gas masks for the entire force of auxiliary firemen.

HALF PRICE SUBSCRIPTIONS . . .

for Men in the U. S. Armed Services

Subscriptions to "RADIO" addressed to men in the U. S. Army, Navy, Marine Corps, or Coast Guard will be accepted at the below-cost rate of $1.50 per year. Subscriptions at this rate (whether ordered by the addressee or a donor) should be accompanied by a remittance in full; addressee's rank and military address must be given. This rate applies wherever domestic U. S. postal service extends, including naval units at sea and overseas army postoffices. No cancellations or refunds.

Simply write rank, name, and military address on a slip of paper and send, accompanied by remittance, to

Radio Magazines, Inc., 132 W. 43rd St., New York, N. Y.

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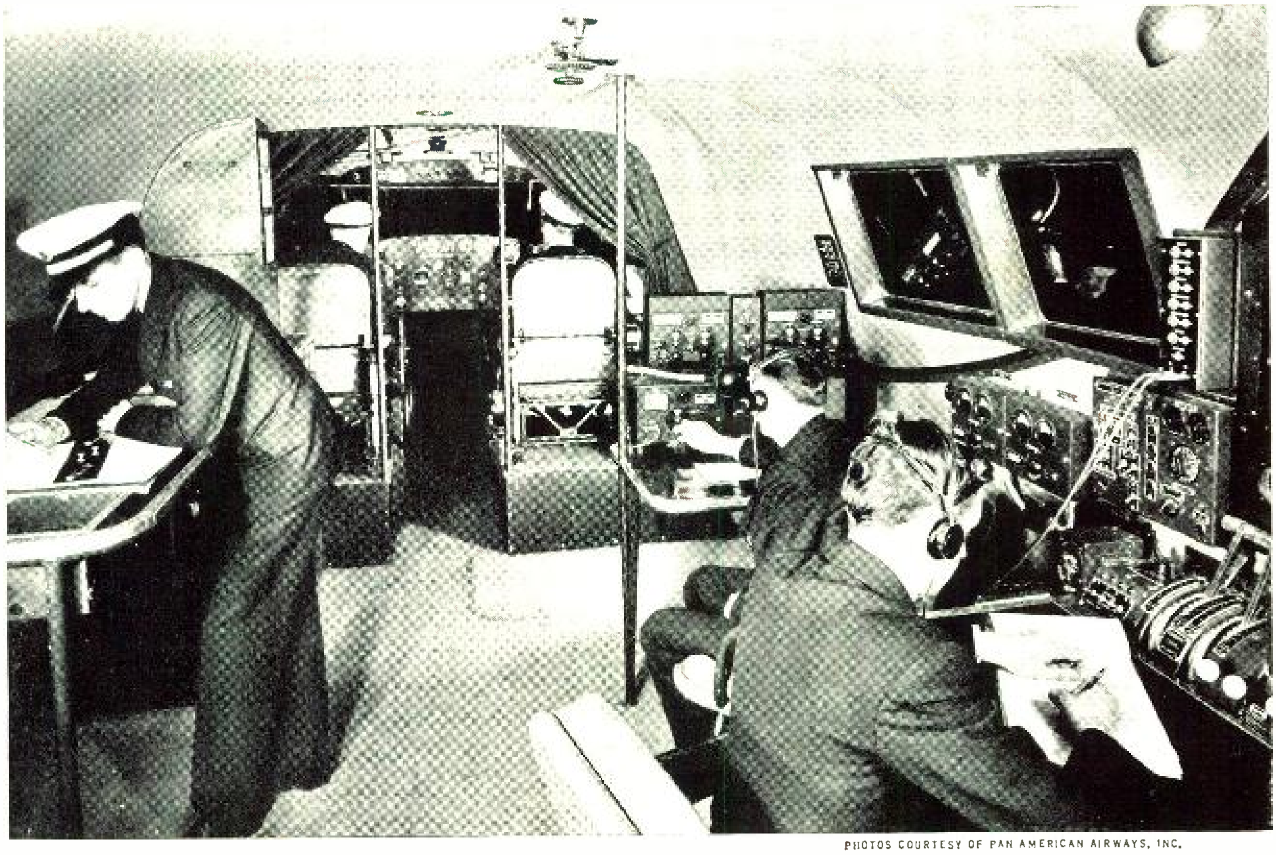
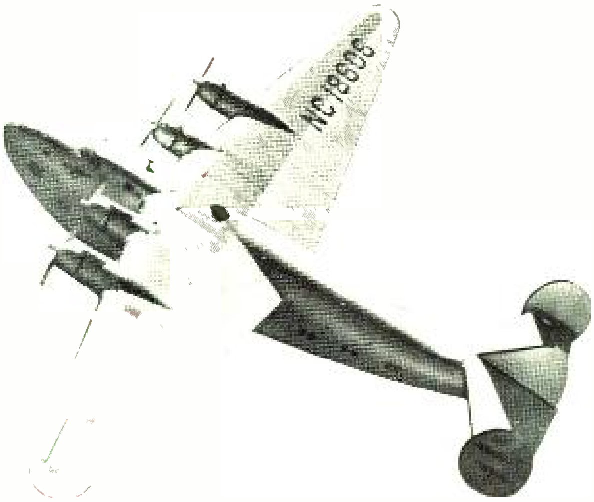


PHOTOS COURTESY OF PAN AMERICAN AIRWAYS, INC.

WHAT IS INSIDE A CLIPPER?

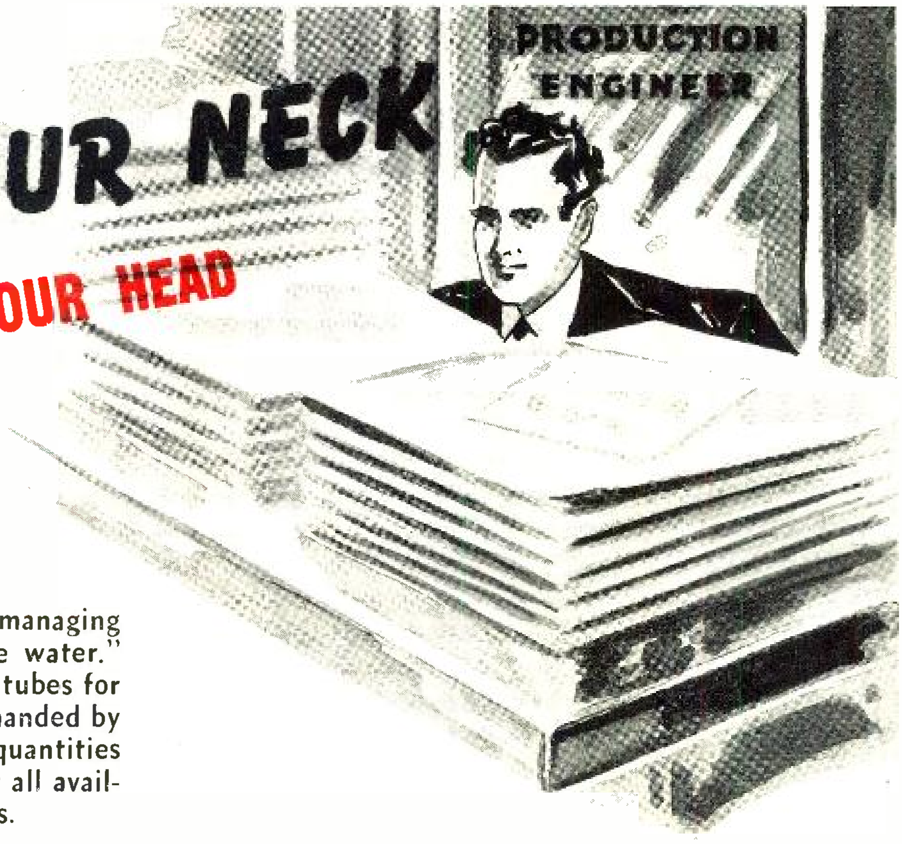
Well, take a look at the picture above. Most of a Clipper's equipment is unfamiliar to the uninitiated, but the clean efficiency revealed in every detail needs no description here. For in a Clipper, no detail is too small to be important, and no alibis are accepted. High as Pan American Airways' standards are, National parts "measure up."

NATIONAL COMPANY, Inc., Malden, Mass.



UP TO OUR NECK

BUT NOT OVER OUR HEAD



HYTRON is still managing to keep its head "above water." As you know, electronic tubes for this "radio war" are demanded by the armed forces in quantities which tax to the utmost all available productive facilities.

HYTRON has been called upon to do a job which has no end. The challenge has been met by expansion, emphasis upon types Hytron is best fitted to make, long-range production planning,—but, primarily, by not taking on more work than can be successfully handled. In this way, assurance can be given to all customers that their tubes will be delivered on time.

HYTRON
TRADEMARK REG.

EXPANSION—Cooperating fully with the Army and the Navy, Hytron is now realizing a plan of expansion to quadruple its size. New high-speed equipment, newly-recruited operators are being correlated by Hytron engineers into a production team at the Newburyport, Mass., plant, even as ever-increasing quantities of tubes are rolling off production lines at the Salem plant.

PRODUCTION PLANNING — Far-sighted planning which devotes Herculean efforts to the material procurement obstacle, and to concentration upon fewer, similar types, keeps production lines running smoothly, constantly, with the least possible, time-wasting changeovers.

SELECTION OF TYPES— By sticking to its last, by concentrating upon special purpose tubes which for it are "naturals," Hytron is making a maximum contribution toward winning this war. All of its long years of experience in engineering specialized tubes are now at the service of the armed forces and their equipment suppliers.

HOW YOU CAN HELP— By placing your orders well in advance, by ordering now the tubes you will need this winter, next year, you can help Hytron to fit your tube needs into its production plan—can assure yourself that you will receive your tubes on schedule.

HYTRON CORP., Salem and Newburyport, Mass.

. . . Manufacturers of Radio Tubes Since 1921 . . .