RADIO

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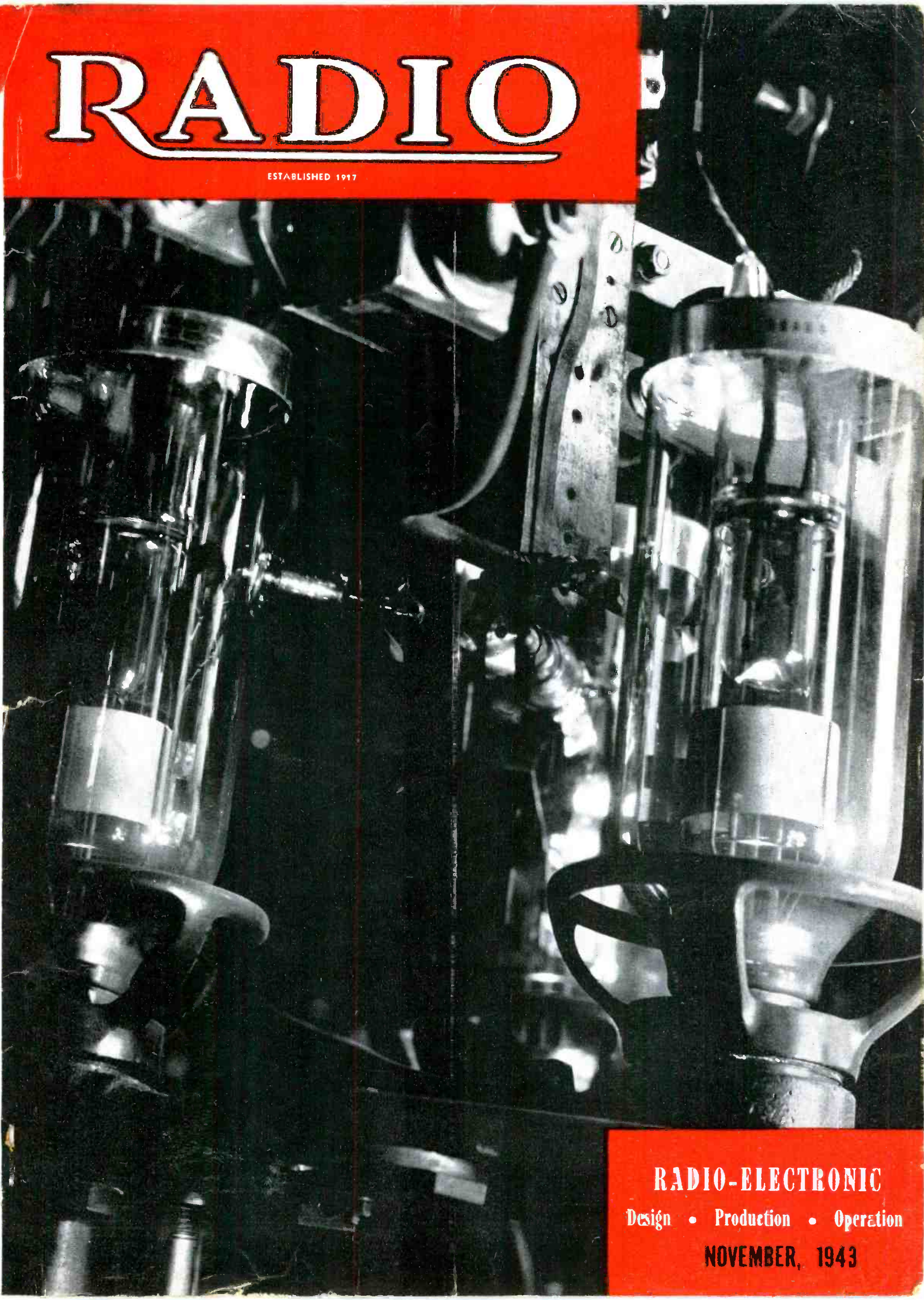

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NOVEMBER, 1943


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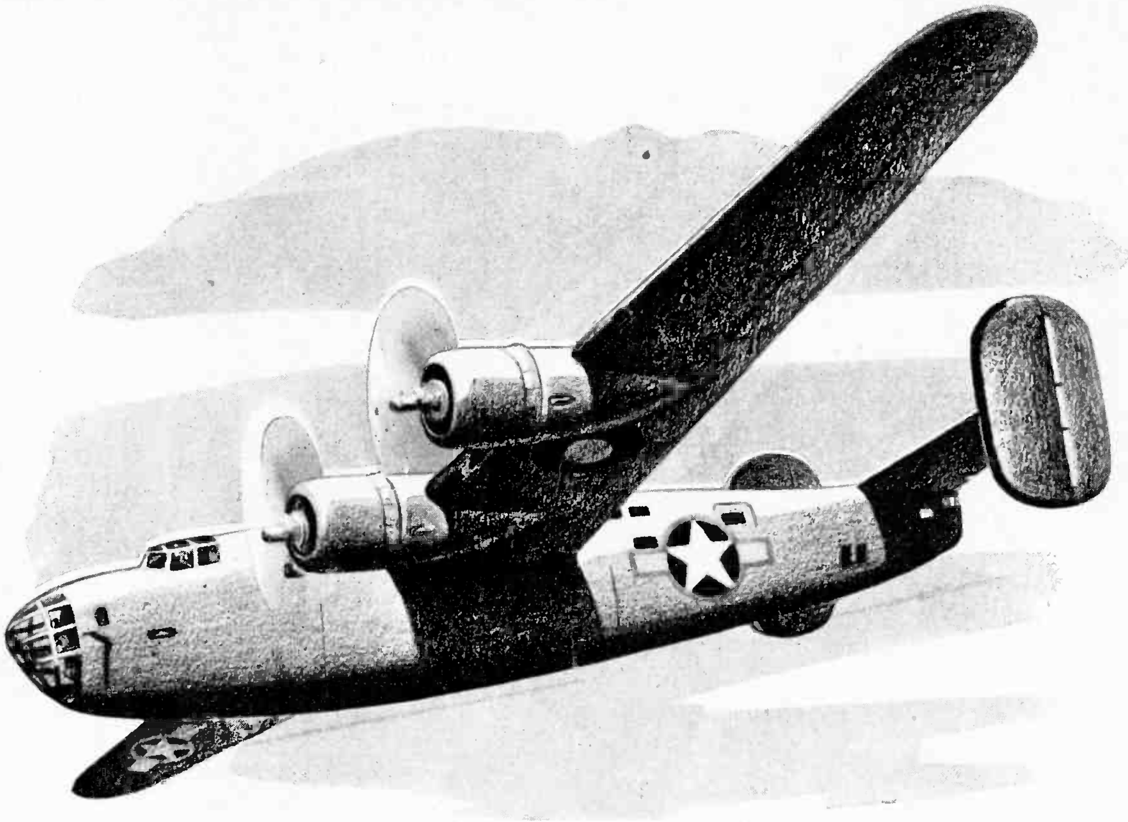

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NOVEMBER 1943 No. 286

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COVER

Today, electronic tubes have the ability to amplify, generate, control, transform or convert electrical energy in almost any manner desired. Shown are tubes doing a war job. Their job in peace will be far-reaching. (Photo courtesy Westinghouse)

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 18, 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.

Entered as Second Class Matter October 31, 1942, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.

EDITORIAL

THE ENGINEER'S ESTATE

★ As a result of the war, many engineers have taken on additional responsibilities bearing little if any relation to their original calling. The scope of the present-day engineer now includes such fields as production control, factory set-up, material procurement, cost analysis, distribution, and time study, to name a few. And, because his initial training in radio engineering, and his ability to deal with both facts *and* probabilities, makes him particularly fitted for this sort of work, the chances are that he will continue to assume many of these duties in the post-war period.

It is a foregone conclusion that the problems facing this country in the post-war world are decidedly complex. Distribution, as an instance, is a first-class headache in itself, and it is now the thought of many industrialists that the problems of distribution—which take in such matters as labor and materials costs, production control, and public psychology—can be solved only through an engineering approach. And in our own field, this will require the efforts of men who, above all, have a wide knowledge of radio and electronics to begin with. Fortunately, the war has provided the field with a group of executive engineers who will be thoroughly capable of tackling and solving the many inter-related problems of the future civilian economy.

For that matter, there is no saying how far the engineer may go in exercising a direct influence on domestic and world affairs. The post-war world will need a lot of new formulas, and if one is to judge by past experience, it is highly doubtful that working formulas will be forthcoming from political sources.

COMPETITION?

★ We understand that radio equipment now in use by the armed forces will be thrown into the civilian market after the war. If this is true, then many of the smaller radio manufacturers may find it extremely difficult to keep their heads above water.

If not directly usable, such equipment could be readily converted for use by amateurs and numerous commercial and municipal radio systems, and thereby wipe out a sizable market for new equipment upon which the small manufacturer must rely.

Unquestionably something will have to be done with the surplus equipment on government hands at the end of the war—but isn't there a possibility that it could be converted by U. S. manufacturers for subsequent sale in foreign countries where communication equipment will be in immediate demand?

Until foreign countries can get back into production, it would seem more logical to sell them our surplus equipment rather than to disrupt the domestic market by dumping the equipment here.

NEW PLASTICS

★ The successful application of technological advances in the plastics field to radio and electronic uses constitutes one of the major scientific accomplishments during the present war. While we may note, with regret, that nylon stockings less frequently adorn the limbs of the fairer sex, we can find some consolation in the fact that the relatively low dielectric constant and high melting point of nylon resin have adapted it to an ever-increasing number of electronic applications. The development of substitutes for rubber has brought forth a large number of synthetics, many of which have a wider field of application than the original material. For example, one of the limitations of natural rubber has been that it must not come in contact with mineral oil, which acts as a plasticizer, but the synthetics are immune to this effect. Vinyl resins, when extruded over wire, form an excellent non-hygroscopic insulation of high dielectric strength. Methyl methacrylate, otherwise known as Lucite or Plexiglas, has excellent low-loss characteristics and transmits light better than glass. It is beautiful stuff, too, and when used for dials and decorative trim it will increase the eye appeal of any instrument.

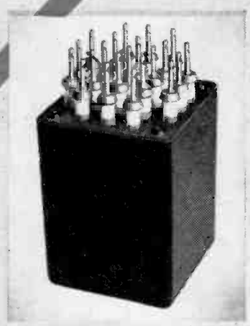
There are a great many other plastics, of course. Some, such as melamine, will withstand high temperatures without resoftening, which suggests its application, among others, as a cabinet for the midget receiver.

A good many executives are beginning to plan their post-war projects. It is becoming more and more apparent that the intelligent selection and utilization of modern plastics in electronic apparatus is bound to be of vital importance in the success of their products.

When will war production End?

Excerpt from "A Special Report on America's Industrial Future" by The Research Institute of America.

"At the end of the twelve-month period (July 1944), large areas of slowing down and actual cessation in war manufacture will be appearing. This will be a critical period for many companies . . . IT IS THE PERIOD TOWARD WHICH EXECUTIVE THINKING AND PLANNING SHOULD NOW BE DIRECTED"



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TECHNICANA

U.H.F. MEASUREMENTS

★ The *Journal of the Institution of Electrical Engineers,* Part III, devoted to Communication Engineering, and dated March 1943, contains an article on the Design of Ultra-Short-Wave Field-Strength Measuring Equipment which should be of value to the engineer working in this field. The article is divided into several parts, discussing in turn, the antenna and antenna coupling, the signal-frequency closed circuit, the frequency-change circuit, the intermediate-frequency amplifier, calibration and general considerations. For instance, the section on the signal-frequency closed circuit suggests a design for a variable-frequency tuned line circuit with means of coupling it to the antenna:

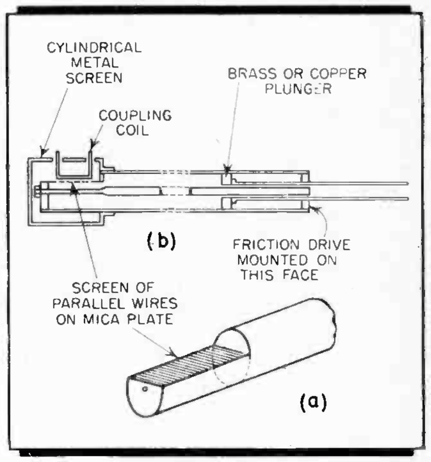

Fig. 1. Antenna coupling unit.

For wavelengths lower than one meter some form of tuned circuit is preferable. *Fig. 1* shows the details of one design that has been satisfactory. The tuned circuit is a concentric line closed at both ends. The difficulty is to couple the antenna to this without throwing away the electrical symmetry of the antenna system. The method employed is to cut away one end of the outer conductor, as shown in *A,* and to cover the rectangular opening so formed with a screen of parallel wires fastened to a mica base, the wires running perpendicular to the axis. The short transmission line from the antenna terminates in a loop which is inductively coupled to the inner conductor. This is shown in

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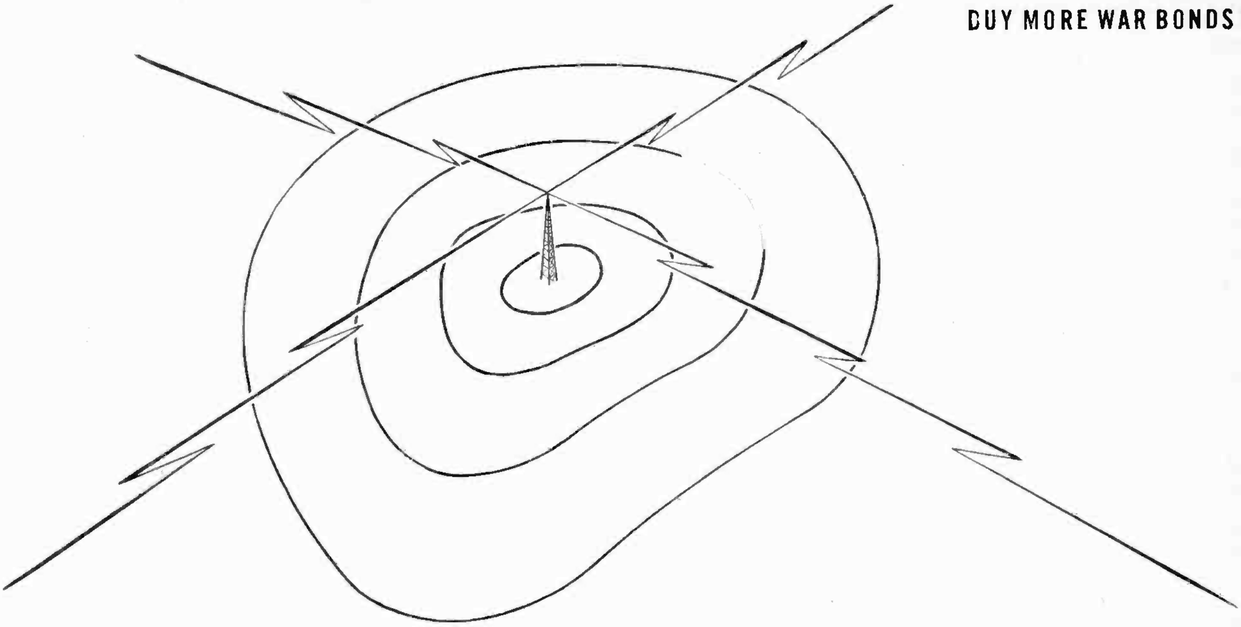

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Fig. 1-B. The inner conductor may be reduced in diameter where it lies under the screen. This reduces the extra electrical length due to the capacitance of the inner conductor to the screen.

The plate of the diode is coupled through a small capacitor to a point near the center of the inner conductor, this coupling being a short length of wire or rod extended through a small clearance hole in the outer conductor and terminating near to the inner conductor. The coupling can be altered by varying the separation between the end of this "probe" and the inner conductor.

In a line circuit of this type, developed commercially, the range of the tuner has been extended by introducing additional plug-in lengths of the concentric line between the ends and the central position.

GAS TUBE HARMONIC GENERATOR

★ A new circuit for obtaining standard high frequencies up to 25 megacycles by triggering gas-filled tubes is described by L. G. Kersta in the *Bell Laboratories Record* for October 1943. The new circuit consists chiefly of a means to reduce the inonization and deionization time so that a sharp current rise can be obtained which creates many harmonics.

"In the new harmonic generator circuit, the grid and plate are both supplied from the same alternating-current source. This makes the plate voltage not only decrease to the value required to extinguish the tube, but continue to

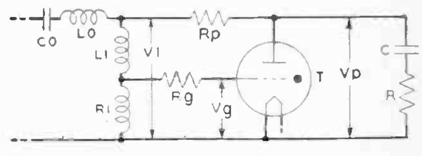

Fig. 2. Gas tube circuit.

a negative value. Likewise the grid voltage becomes negative. The negative potentials, primarily that on the grid, sweep the gas ions quickly from the tube, thus increasing the rate of deionization and the maximum frequency at which the tube can operate."

The circuit is shown in *Fig. 2* and the plate and grid-potentials are plotted against time in *Fig. 3*. An alternating voltage of several kilocycles is used. At each cycle, the capacitor *C* first

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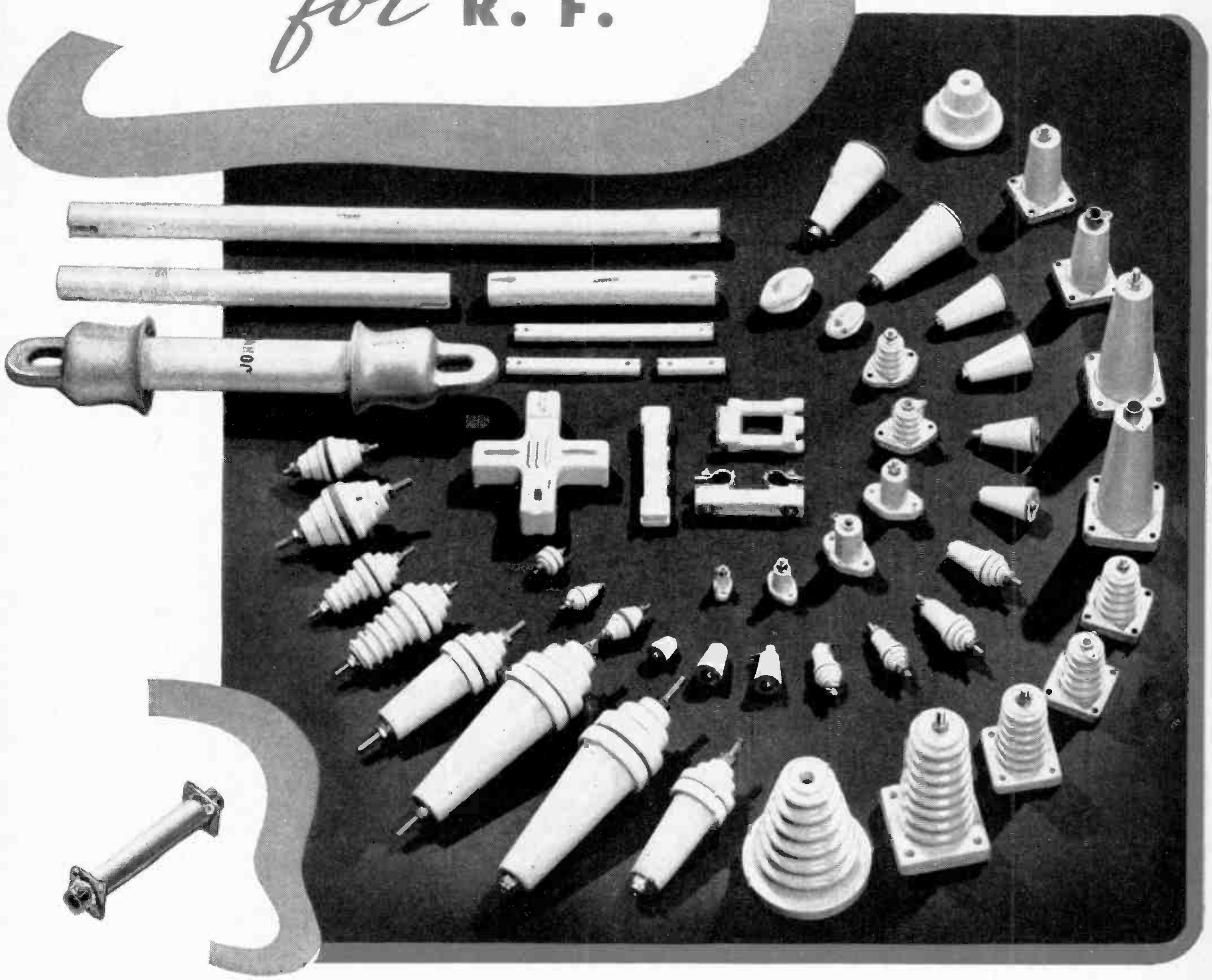
INSULATORS *for* R. F.



Many commonly used insulating materials function perfectly in low frequency circuits such as audio, 60 cycle power or even the lower radio frequencies. These same materials at medium or high radio frequencies act as high resistances to waste precious R. F. Many porcelains, steatites, glasses and similar materials have this fault and only tests under laboratory conditions will detect it. Johnson insulators were not only designed for high R. F. but the materials were selected only after exhaustive tests to determine the best. Can you afford to take chances? Demand the best—they cost no more—specify Johnson.

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charges through R and R_p until its potential is high enough to fire the tube. The capacitor then discharges through the tube and resistance R, producing a

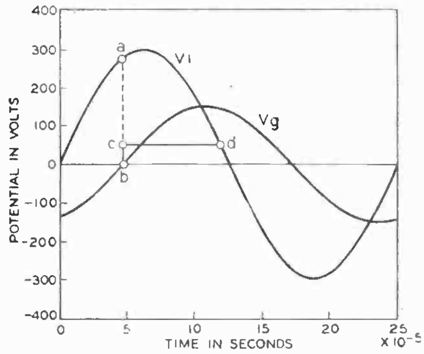

Fig. 3. Plate and grid voltages.

current pulse which increases very rapidly to its maximum value and then falls off expontentially at a rate determined by the product CR. This pulse generates the high-frequency harmonics.

FREQUENCY-DRIFT COMPENSATION

★ A comprehensive study of the subject of compensation for frequency-drift with temperature is found in an article by T. R. W. Bushby in the *A.W.A. Technical Review,* Vol. 6, No. 3, August 1943. In a fixed tuned circuit compensation can be obtained by employing a capacitor with a negative coefficient so as to counteract the positive coefficient of the coil. However, one does not readily obtain a capacitor with the right numerical value of coefficient to accomplish this end. Perfect compensation can then be obtained only by combining two capacitors, one with a positive and one with a negative coefficient, so that the resulting capacitance has both the right value and the desired negative temperature coefficient.

"The relation between the temperature coefficients and the capacity values may be expressed in the following way: If $C_1, C_2 \ldots C_n$ are the components of a *parallel* combination of C, and $\alpha_1, \alpha_2 \ldots \alpha_n$ are their respective temperature coefficients, then the temperature coefficient of C is given by

$$\alpha_c = (1/C)\ (\alpha_1 C_1 + \alpha_2 C_2 + \ldots \alpha_n C_n)$$

"It may be shown that the temperature coefficient α_c of a *series* combination, having an equivalent capaci-

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tance C and composed of n capacitors of values $C_1 \dots C_n$, and temperature coefficients $\alpha_1 \dots \alpha_n$, is given by

$$\alpha_c = C\left(\frac{\alpha_1}{C_1} + \frac{\alpha_2}{C_2} + \dots \frac{\alpha_n}{C_n}\right)$$

Thus either a parallel or a series combination of capacitors may be employed, as may be most convenient for the component values available.

In the case of tunable circuits, the problem becomes more complex because the above equations show that such a complex capacitor has a temperature coefficient which varies if the value of one component changes, although their individual temperature coefficients may remain constant. Also, the coefficient varies with frequency. However, the author applies his system to a tuned circuit and even a padded oscillator circuit, and shows that the problem is similar to tracking in a superheterodyne, and that a three-point solution can be obtained; that is, the net frequency drift due to temperature can be reduced to zero at three different frequencies in the range.

REMOTE CONTROL OF RECEIVERS

★ Remote control of a communications receiver by an operator is discussed by J. E. Benson and A. G. Brown in an article "Remote Control of Crystal-Locked Receivers," appearing in the *A.W.A. Technical Review,* Vol. 6, No. 3, August 1943. The problem is the following: In large radio-communications systems, the transmitter, receiver and operator may be in three different locations. It is required to provide remote control facilities so that the operator can select either one of two receivers, turn on or off the beat oscillator, and have fine control over the tuning within a narrow frequency band as well as have fine control over the gain—all of this is to be accomplished by employing the same pair of conductors which carry the output of the receiver.

The method finally adopted for the fine tuning and the control of gain may be of interest. The receivers consist of double superheterodynes, each with a fixed crystal-controlled first oscillator. The first i-f amplifier is sufficiently wide to pass the band over which the tuning is to be done. Hence, the tuning can be carried out by a slight variation in the frequency of the second oscillator. The second i-f amplifier has the required selectivity.

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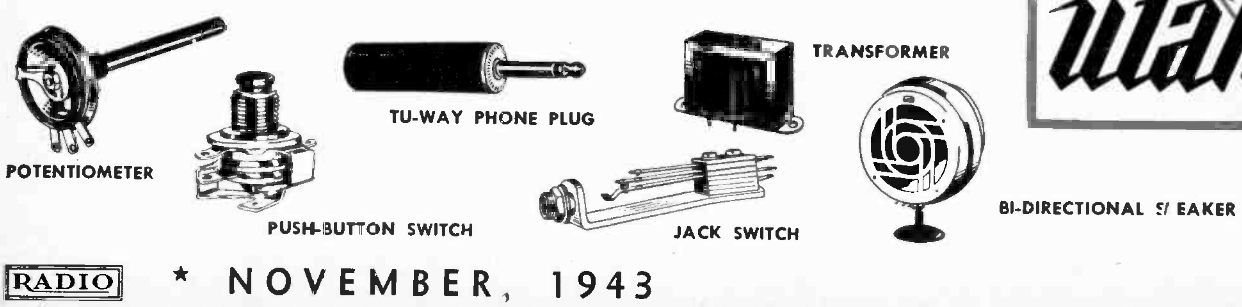

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The control is accomplished by means of alternating currents having frequencies above the pass-band of the audio channel. Three different audio-frequency signals are employed, all above 2500 cycles. One of these serves to control the gain, one controls the tuning and the third serves as a pilot. At the far end of the line, these three tones pass through a high-pass filter and are applied to an amplifier which is a.v.c. controlled by the pilot signal. After this they are separated and rectified so that they become bias signals. The amplitude of the signals controls the gain of the receiver by varying the bias on the i-f amplifier tubes, while the tuning is accomplished by varying the bias of a reactance-tube across the tuned circuit of the second oscillator. The third signal, after rectification, is used as an a.v.c. bias as mentioned previously.

INPUT ADMITTANCE COMPENSATION

★ In most high-frequency pentodes, the inductance of the cathode lead is reflected back to the input circuit as an increased loss. Ways of compensating for this loss and for keeping it constant with variations in gain due to a.v.c. are discussed in an article by C. E. Lockhart in the September 1943 issue of *Electronic Engineering*.

The first part of the article is devoted to a mathematical proof that the inductance in the cathode lead increases the loss in the input circuit and that capacitance in the cathode circuit decreases it. Thus it follows that by a suitable choice of the bias resistor

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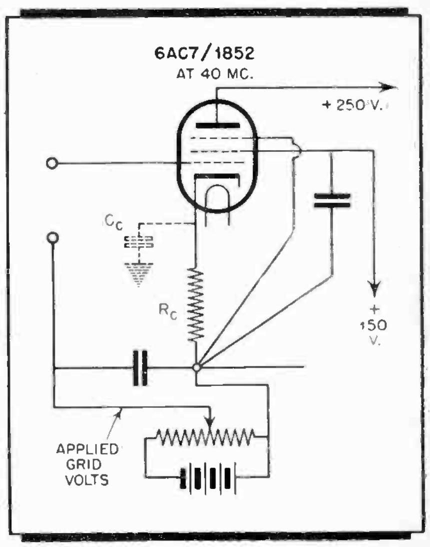

Fig. 4. Compensation circuit.

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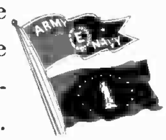

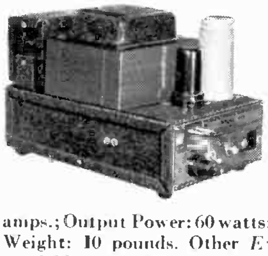

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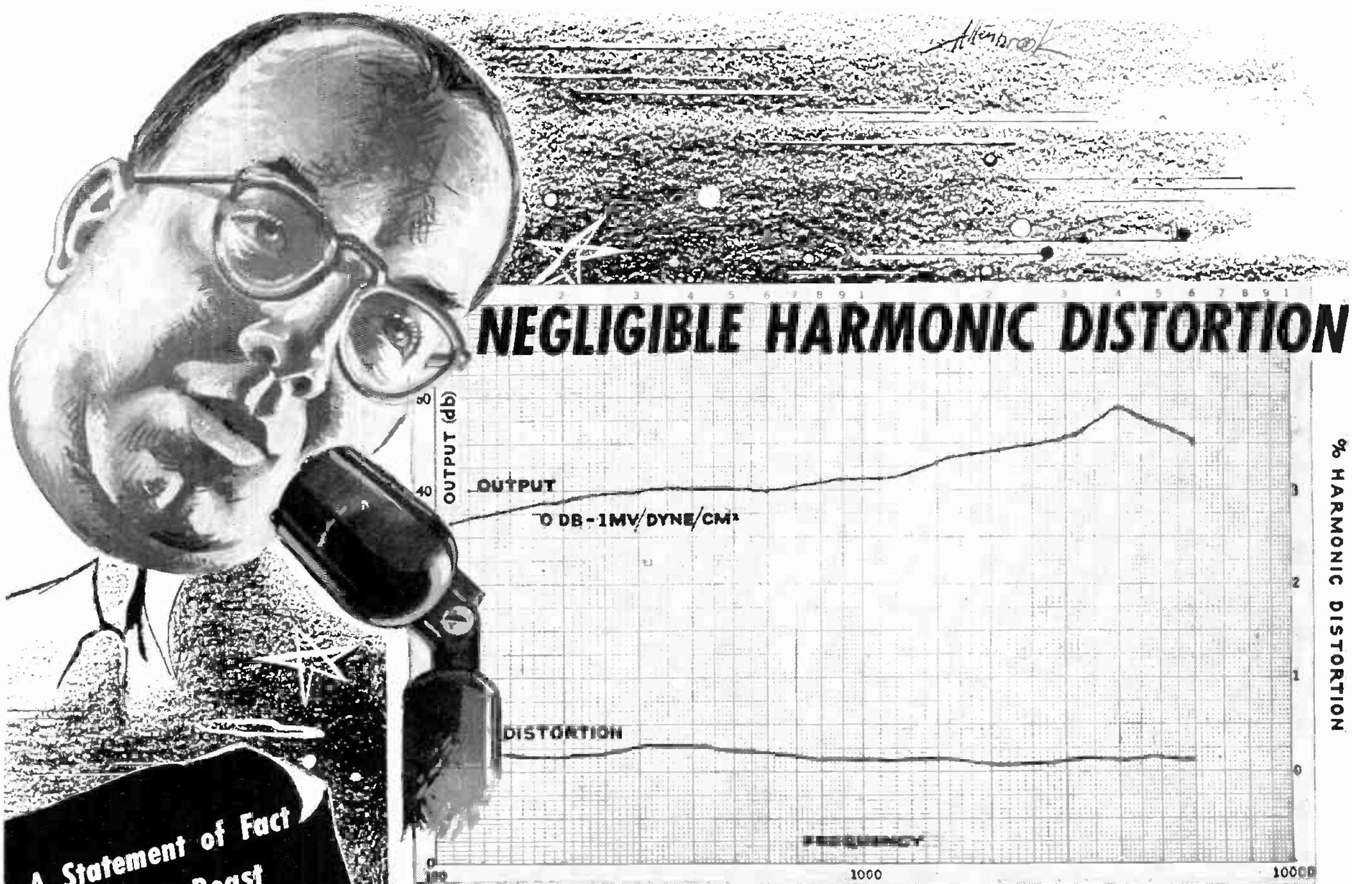

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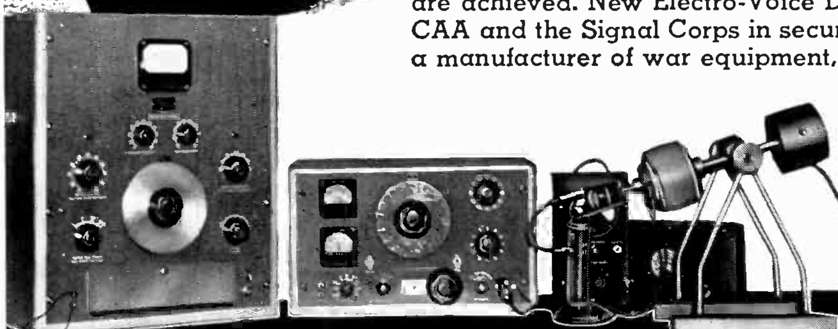

The Harmonic Wave Analyzer measures the presence of spurious frequencies introduced by microphone distortion. To the ear, such frequencies give the feeling of ragged and false speech quality that may be unintelligible under the stress and strain of battle.

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and the capacitance across it, it is possible to make the input resistance either rise, remain constant or fall with the application of bias. In the case of the 6AC7/1852 employed in the circuit of *Fig. 4,* a value of *Rc* of 45 ohms gives the most constant input impedance—about 7000 ohms. The capacitance between the cathode and the filament here serves to neutralize the inductance.

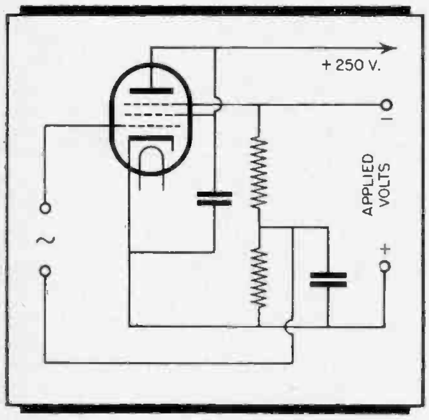

Fig. 5. Alternate compensation circuit.

Another method of accomplishing the same result is by applying the control bias for the variation of gain to both the control grid and suppressor grid in a definite ratio, which is to be determined for each tube. The suppressor grid receives the greatest bias. The circuit is shown in *Fig. 5.*

HIGH-FREQUENCY THERAPY

★ A series of articles on the physical aspects of diathermy is to appear in *Electronic Engineering.* The first is published in the September 1943 issue. The author, W. D. Oliphant, opens with the interesting statement that diathermy was first demonstrated by Arsène D'Arsonval in 1890!

The initial article deals with the production of heat by high-frequency currents, how it can be produced by conduction current, displacement current and convection current; also, how the heat can be transferred by conduction, convection, radiation and absorption.

There is the following explanation of how a physician can concentrate heat in a definite part of the body:

"In general the human body may be regarded (under the present heading) as an agglomeration of conductive paths of all shapes and sizes, and any attempt to resolve it into some simple

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equivalent circuit would be extremely difficult. We may, however, consider two very simple practical cases of electrode connections to a complex substance made up of slabs of material of different conductivity. These are shown in *Fig. 6*.

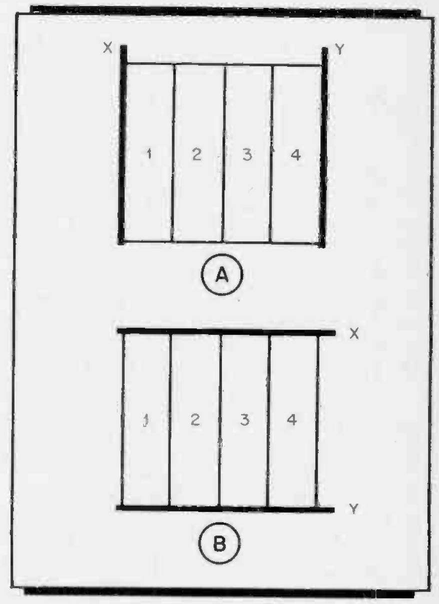

Fig. 6. Conductivity of slabs.

"We will assume that the conductivity increases progressively from slab *1* to slab *4*, that is to say, the resistance of slab *1* is greater than slab *2* and so on. In *Fig. 6-A* the electrodes *X* and *Y* are placed in such a manner that they contact the outer faces of slab *1* and *4*. In this arrangement the transverse current will be the same in each slab and so . . . it follows that the maximum heating effect will take place in slab *1* as it possesses the highest resistance. Consider now *Fig. 6-B*. In this case the electrodes *X* and *Y* are placed in contact with the edges of the slabs and so the current will be different in each slab."

The equation for heat developed in a circuit in terms of voltage may be written

$$Q = \frac{e^2 t}{r J}$$

J = Joule's equivalent
= 4.2 joules per calorie
e = applied potential difference between X and Y.

"It thus follows that the maximum heating effect will now take place in the slab of the least resistance or greatest conductivity, namely, slab *4*.

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[*Continued from page 20*]

Thus by suitable disposition of the electrodes relative to the body under treatment, we are more or less able to bring about the maximum heating effect where we wish it."

CATHODE-COUPLED PUSH-PULL AMPLIFIERS

AN ARTICLE BY THIS NAME by O. S. Puckle appeared in *Electronic Engineering* for July 1943. The cathode-coupled amplifier, employed as a phase inverter is especially suited for the cathode-ray tube with four independent deflecting plates. However, there seems to be no reason why it would not be equally adaptable to audio amplifiers and even direct-coupled amplifiers.

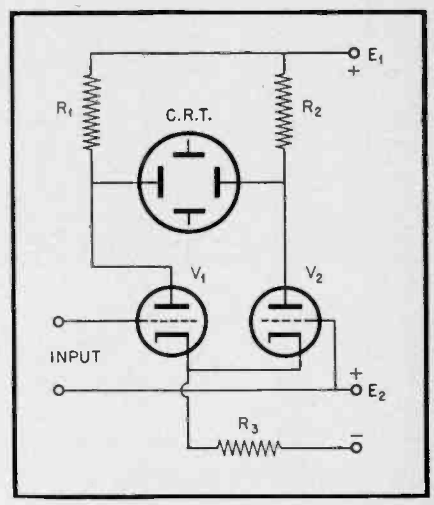


Fig. 7. Circuit of cathode-coupled push-pull amplifier used with oscilloscope.

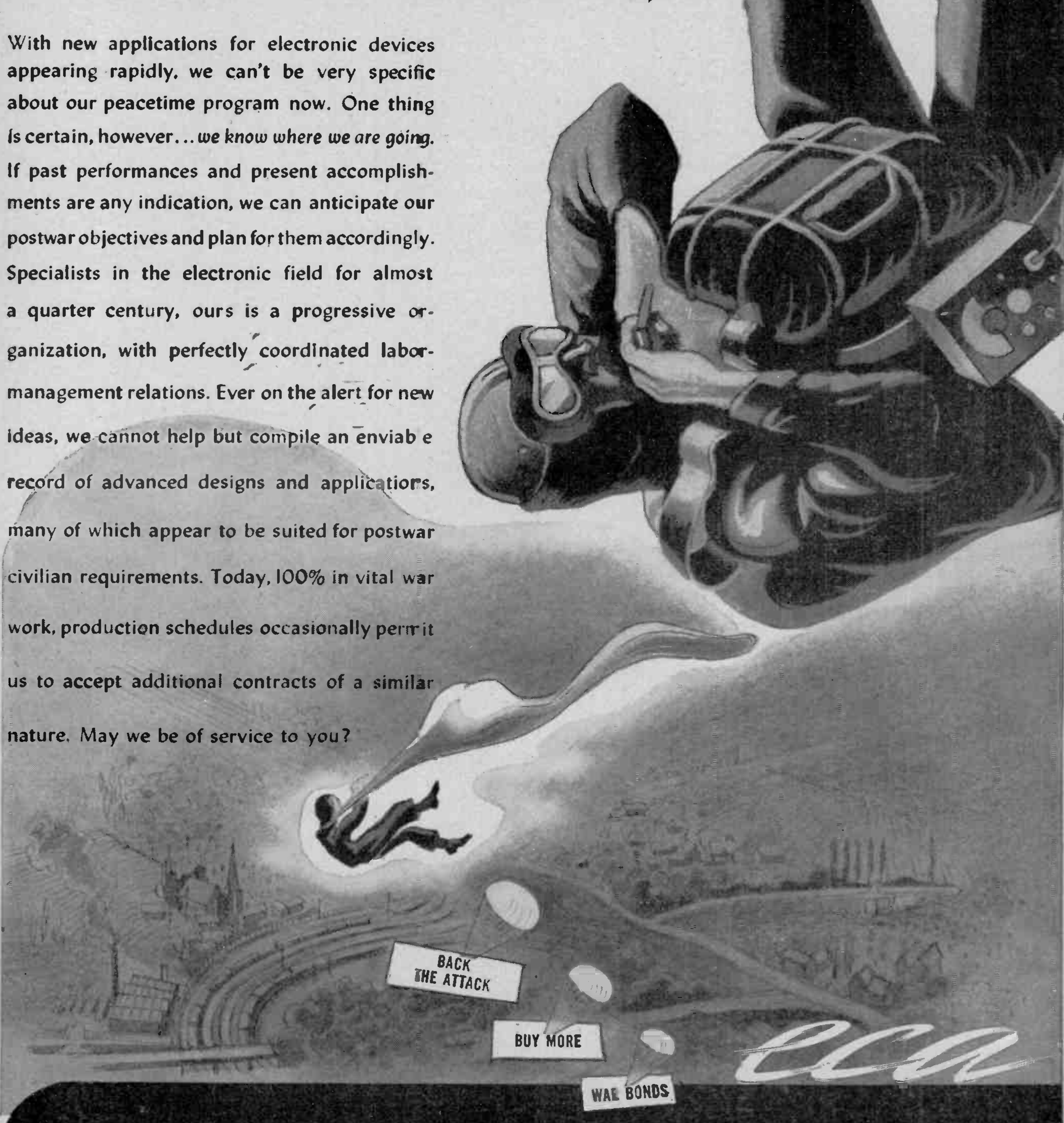
The cathode-coupled amplifier as shown in *Fig. 7* consists of two triodes which have a large cathode resistor in common but have separate plate loads. The input signal is applied between the two control grids, one of the grids being maintained at a fixed potential, *E2*. Due to the fact that the resistor *R3* is very high the total current of the two tubes is determined chiefly by its value. Therefore, the sum of the two plate currents stays practically constant and when the grid of *V1* is changed and its plate current varies accordingly there is an almost equal change in the plate current in *V2*, but in the opposite direction. Thus nearly perfect push-pull operation is obtained. In order to make the two sides balance exactly, *R2* must be

[*Continued on page 24*]

Destination Known

Somewhat at the mercy of the elements, a paratrooper can't always select the exact spot for his landing. But he will approach his objective.

With new applications for electronic devices appearing rapidly, we can't be very specific about our peacetime program now. One thing is certain, however... *we know where we are going.* If past performances and present accomplishments are any indication, we can anticipate our postwar objectives and plan for them accordingly. Specialists in the electronic field for almost a quarter century, ours is a progressive organization, with perfectly coordinated labor-management relations. Ever on the alert for new ideas, we cannot help but compile an enviable record of advanced designs and applications, many of which appear to be suited for postwar civilian requirements. Today, 100% in vital war work, production schedules occasionally permit us to accept additional contracts of a similar nature. May we be of service to you?



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TECHNICANA

[*Continued from page 22*]

slightly larger than *R1* as indicated by the equation

$$R_2 = R_1 \left(1 + \frac{R_{a2} + R_2}{R_3 (\mu_2 + 1)} \right)$$

where μ_2 and R_{a2} are the amplification factor and anode impedance respectively of *V2*.

Maintaining the balance between the two sides is dependent chiefly on the value of *E2;* this should be at least ten times the cut-off bias for the same tube with a plate voltage of $E1 - E2$. The distortion will be low if the plate loads are large compared to the plate resistances of the tubes. For this reason pentodes are not desirable in this circuit.

The gain is just half that which a single triode would deliver under similar circumstances. A novel way of volume control is possible:

If the resistance *R3* is split into two parallel sections, one in each cathode lead, and if a variable resistance is placed between the two cathodes which are now not directly connected together, the variable resistance will serve to control the gain of the amplifier.

Among the advantages claimed for this type of amplifier are: low distortion and a small value of grid current when overloaded; freedom from tendency to oscillation; absence of hum and "jitter" due to fluctuations in the B-supply. It also lends itself especially to cathode-ray work because it permits facilities to arrange d.c. coupling to the deflecting plates, facilities for providing shift, astigmatism correction and sweep expansion.

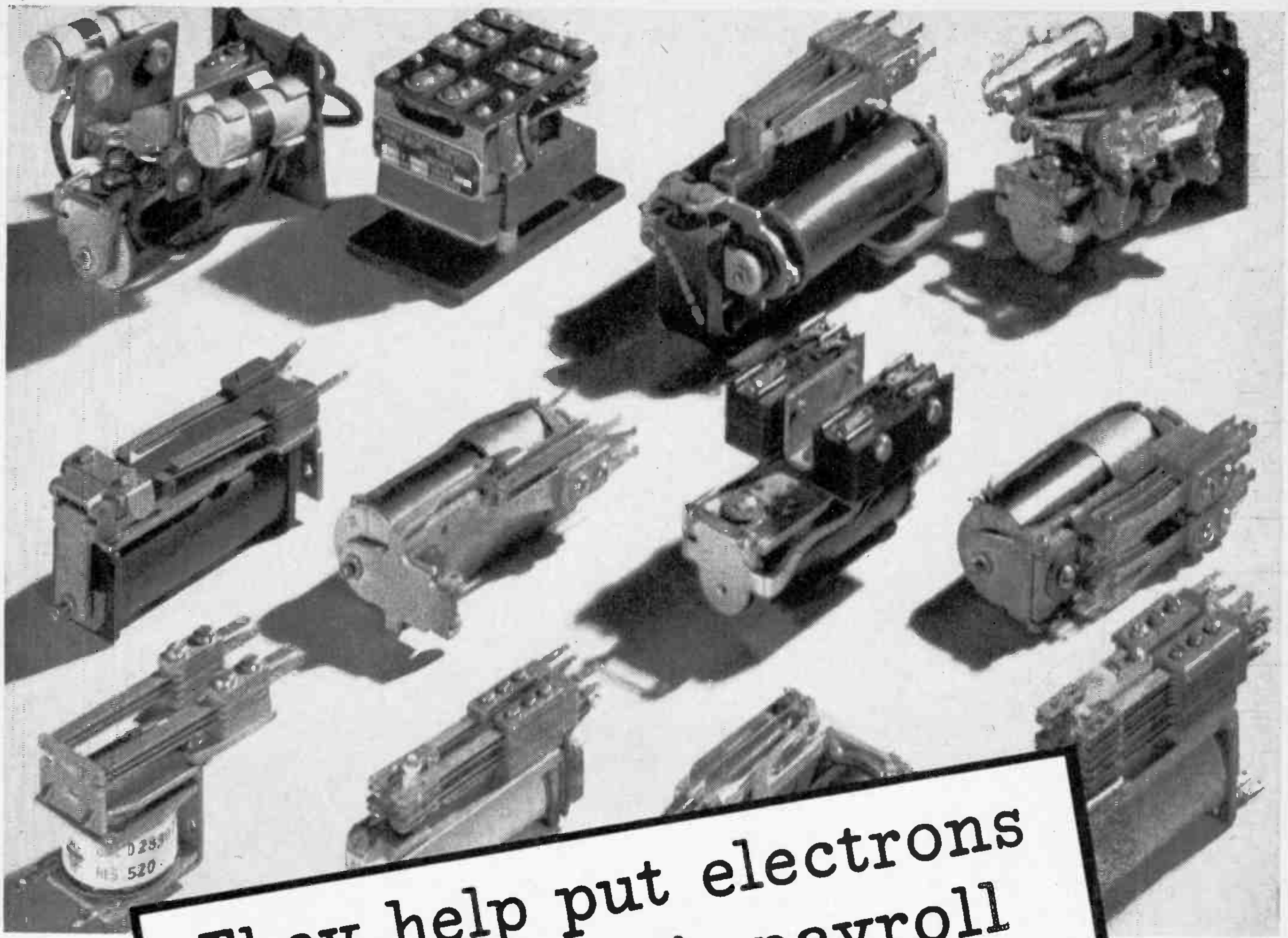
★

ELECTRONIC DESK

THOROUGH CHECKUP of each and every cathode-ray tube coming off the production line continues to be an essential requirement.

[*Continued on page 73*]

DuMont's Electronic Desk.



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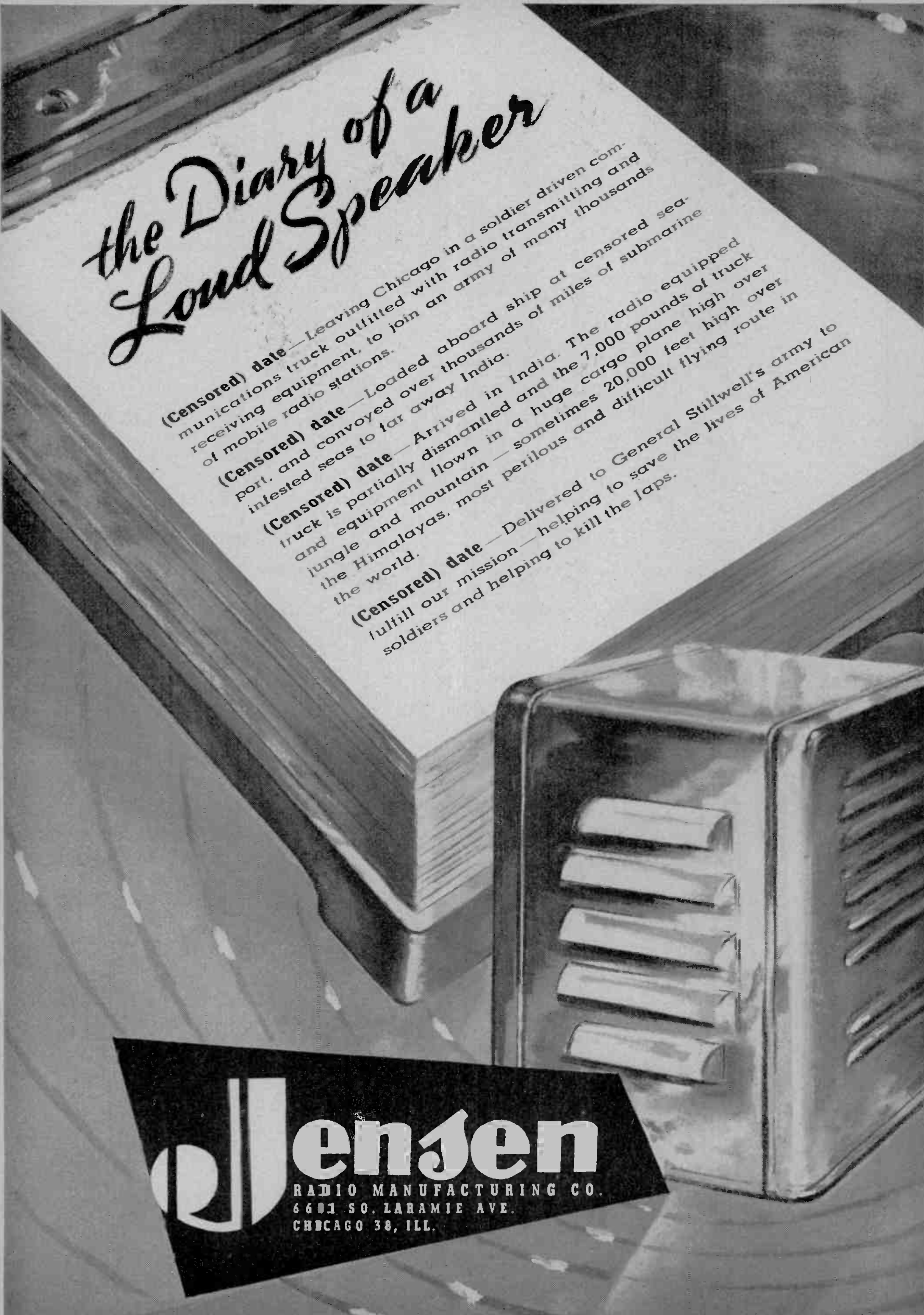

the Diary of a Loud Speaker
(Censored) date—Leaving Chicago in a soldier driven communications truck outfitted with radio transmitting and receiving equipment, to join an army of many thousands of mobile radio stations.
(Censored) date—Loaded aboard ship at censored seaport, and convoyed over thousands of miles of submarine infested seas to far away India.
(Censored) date—Arrived in India. The radio equipped truck is partially dismantled and the 7,000 pounds of truck and equipment flown in a huge cargo plane high over jungle and mountain—sometimes 20,000 feet high over the Himalayas, most perilous and difficult flying route in the world.
(Censored) date—Delivered to General Stillwell's army to fulfill our mission—helping to save the lives of American soldiers and helping to kill the Japs.
Jensen
RADIO MANUFACTURING CO.
6601 SO. LARAMIE AVE.
CHICAGO 38, ILL.

DIELECTRICS FOR RADIO AND ELECTRONIC APPLICATIONS

A. C. MATTHEWS

★ In addition to air, there are two general types of dielectric used in radio or electronic applications; the plastics and the ceramics. Notable among the ceramics are electrical porcelain, glass magnesium silicate porcelain, glass bound mica, fused quartz, magnesia and alumina. The plastics are likewise well represented by phenol, urea and melamine formaldehyde, cellulose acetate and nitrate, polystyrene, methacrylic and vinyl resins. Each have their special field of application, depending upon the electrical and mechanical nature of the problem.

Theoretical considerations will show under what circumstances dielectric loss in an insulator may be expected, and how the properties of a material can to some extent be predicted from a knowledge of its molecular structure and chemical composition. In general a low-loss material has a low dielectric constant.

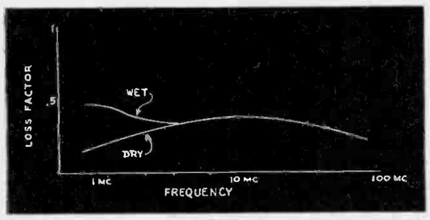


Fig. 1. Typical power loss vs. frequency characteristic for laminated bakelite.

Dielectric Constant

The dielectric constant of an insulating medium may be considered as a measure of electrical displacement for a given electric force. It is equal to the ratio of the capacitance of two condensers of equal size, one using the particular dielectric, and the other using vacuum as the dielectric.

Matter consists of positive and negative charges bound together by the forces of attraction between them. When an electric field is applied there is a tendency for the charges to move in opposite directions against these restoring forces of attraction. In the case of a molecule in which charges tend to become concentrated at opposite ends of the molecule, there is also a tendency for the molecule as a whole to rotate, and set itself in the direction of the field. These are called "polar molecules." They can be thought of as tiny dipoles which try to set themselves in the direction of the field at any instant. The charged portions do not separate, but only tend to rotate as a whole, depending on the magnitude of the charges, the size of the molecule, viscosity of the medium, temperature, etc.

The behavior of any dielectric as the frequency is varied depends upon the polarization of the molecules existing in that dielectric. The frequency at which maximum loss factor occurs, called the relaxation frequency, and the rates at which both loss factor and dielectric constant change with frequency, depend on the molecular structure of the material, in particular as to whether it is polar or non-polar.

Highly polar molecules have high dielectric constants as for instance water, (H-OH) with a dielectric constant of 80; while non-polar molecules have low dielectric constants as petroleum, for instance, with a dielectric

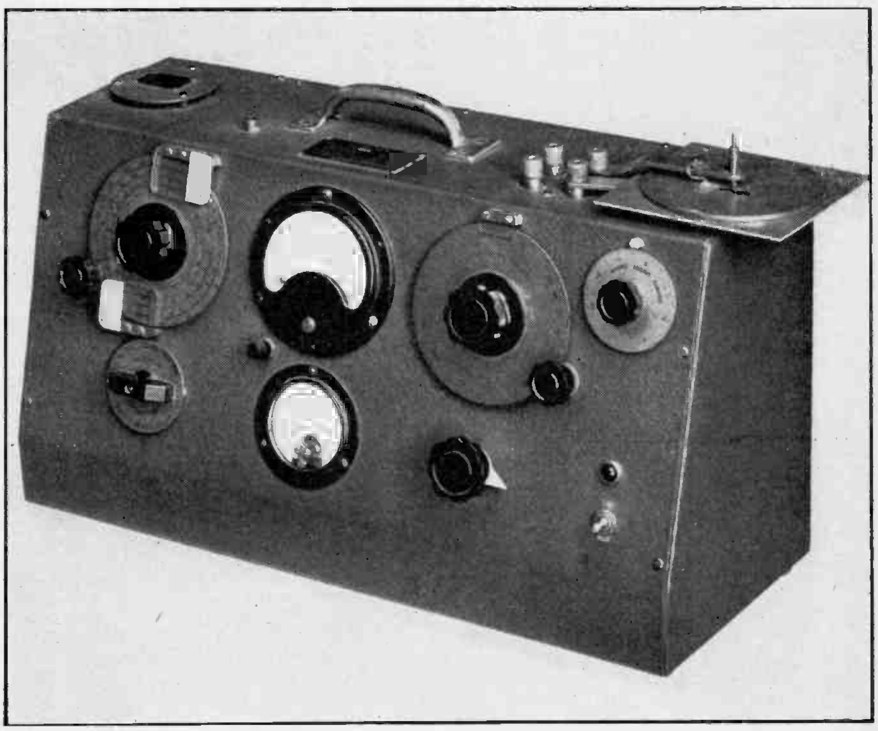


Fig. 2. Boonton Type 160-A Q Meter, with dielectric test assembly at top right.

PROPERTIES OF COMMONLY USED SOLID DIELECTRIC MATERIALS

MATERIAL	Dielectric Constant	% P. F. 1000 kc	% Water Absorp. 24 hours	Spec. Grav.	Softens at Deg. Cent.	Coef. Linear Exp. Parts 10^6/°C.	Strength, lbs. per sq. in. Tensile	Compressive
Casein	6.4	6	4-9	1.33	177	80	7000	
Cellulose Acetate	6-8	3-6	4.0	1.3	70	150	3000	4000
Cellulose Nitrate	4-7	5.0	2-3	1.5	85	140	4500	
Ethyl Cellulose	4-4.2	2.5-5	1.7-2	1.15	150			
Fibre	4-5	5.0	30	1.3	130	25	10,000	25,000
Glass—Pyrex	4.5	0.2	0	2.25	600	3.2		40,000
Glass—(Corning 790)	4.0	0.05	0	2.18	1500	0.78		
Glass—(Corning 790 Multiform)	4.0	0.18	0.01	2.15		0.85		
Methacrylic Resin	2.8	2.0	0.3	1.19	135	70	8500	12,000
Mica—Clear India	7-7.3	0.02		2.8	1200	3-7		
Mycalex	6-8	0.3	0.035	3.5	500	8-9	9000	32,000
Phenol (Laminated)								
Nema Class X	5.5	5.0	4.0		150	30	12,500	35,000
" " P	6.0	6.0	4.0	1.36	150	30	8000	22,000
" " XX	5.0	4.5	1.3		150	30	8000	34,000
" " XXX	4.8	3.5	1.0		150	30	7000	32,000
" " CE	5.5	5.5	1.4	1.38	150	25		36,000
" " LE	5.0	4.5	1.5	1.38	150	25		37,000
Phenol (Molded)								
Wood flour filler	5.5	3.5-8	0.31	1.35	130	30	7500	30,000
Fabric	5.5	5-8	0.68	1.38	140	25	11,000	35,000
Asbestos	5.0	5.0	0.015		230	20		
Mica	5.6	0.5	0.035	3.0			6000	
Porcelain—Wet process	6.5-7	6.0	Nil	2.4	1610	4-5	4500	40,000
Quartz—Fused	4.2	0.03	0	2.1	1430	0.45	8500	200,000
Rubber—Hard	2-3	0.5-0.9	0.02	1.15	70	70-80	5500	7000
" Alum. oxide filler	3.85	0.59		1.24	140	4.1		
" Mica filler	3.54	0.49		1.4	165	0.73		
Steatite (Low loss)	6.0	0.04	0.07	2.6	2550	7.0	9000	90,000
Styrene—Polymerized	2.4-2.9	0.03	0.01	1.05	90	70	7500	14,000
Urea-Formaldehyde	6-7	3.0	0.4	1.48	200		7500	60,000
Vinyl Resins	4.0	1.7	0.15	1.35	60	70	9000	

constant of 2. Water, already mentioned as an example of a highly polar molecule, is deleterious to an insulating material not only because of its polarity but also because of ionization.

A hydrocarbon (non-polar) group reduces the polar properties of a compound into which it is introduced, while the introduction of the -OH (polar) group increases the polar properties of the material and likewise its dielectric constant. As an example, take ethyl alcohol, C_2H_5OH, with a dielectric constant of 26.8 and add a hydrocarbon radical; we then have butyl alcohol, C_4H_9OH, with a dielectric constant of 17.8. Thus it is seen how the molecular structure of a material determines its dielectric characteristics.

In an alternating field the movement of charged electrons or the rotation of the polar molecule has to follow the alternations of voltage, and since the molecular and ionic movements are opposed by the forces of attraction between molecules and viscosity influences with the material, there is in general a lag behind the electric field. This causes a power loss in the material. As the frequency increases the loss becomes greater, up to a point at which the particles cease to respond to the frequency. Above this point the dielectric constant decreases. If the internal friction is low the peak takes place at high frequencies, while if it is high, as in glasses and many crystalline solids, the peak occurs at low frequencies.

The Loss Factor

The loss factor of an insulation material is approximately the product of the dielectric constant and the power factor, providing the power factor is less than 0.1. Actually, the loss factor of an insulating material is the product of its dielectric constant and the cotangent of its phase angle, and is an expression for the power loss per unit volume at a given frequency.

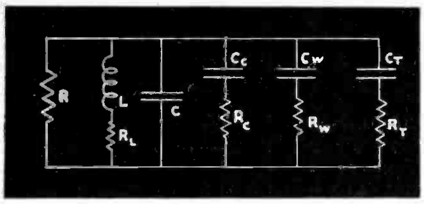


Fig. 3. Equivalent tuned circuit.

The curve of power loss versus frequency (*Fig. 1*) does not in general show any one well defined maximum as would be expected if one factor alone were responsible for loss. Usually the maximum is broad and not well defined; frequently there is more than one maximum. The laminated bakelites, for example, show a maximum just above 10 mc when quite dry, but when moist a low frequency maximum also appears. This is attributed to ionization in the absorbed water. The maximum at 10 mc appears to be common to all bakelites containing cellulose filler, whether paper, wood flour or fabric. The urea resins show the same effect. It is thought that this absorption is a function of the cellulose, as it largely disappears when the cellulose fill is replaced by a mineral such as mica or talc.

The introduction of such a filler has the added advantage of rendering the material less sensitive to moisture pickup, thereby reducing the low frequency absorption. This forms the basis of many of the low-loss materials now on the market.

Even though direct absorption of moisture is negligible, the formation of a film on the surface lowers the insulation resistance, and when subjected to alternating potentials, introduces a material loss. Among insulators there are great differences in moisture effect due to surface characteristics. In selecting an insulating material, it is necessary to consider the effect of moisture on the dielectric properties. If the material has a tendency to absorb an appreciable amount of moisture, the power loss may be increased to such an extent as to make the insulation worthless for use at radio frequencies. Roughness or pores of molecular dimensions are the important factors. An insulation which water will not wet is usually only slightly affected by surface moisture because the water collects in discrete drops and does not cover the whole surface. Glazing of the surface helps only to a small extent; however, it is often used where a self-cleaning surface is necessary.

Loss Factor vs. Mechanical Strength

The fact that the loss factor alone is not the sole standard for choosing a dielectric is generally overlooked. The total power loss in a dielectric is dependent on the total volume of insulation in the high-frequency field, which brings the mechanical properties of the insulation into the picture. The strength of a material is important not only from a purely mechanical standpoint, but also from an electrical point of view. It often happens that a dielectric material with comparatively poor electrical properties will produce a good insulator because its mechanical properties make possible a small volume and long length. Such a design produces low surface leakage because of its length, and minimizes the loss because of its smaller volume. It is evident, therefore, that choosing the proper insulator for a given application is a compromise between electrical and mechanical properties. A small piece of higher loss factor insulation which has adequate mechanical strength for a given job may be preferable to a lower loss factor material which must be of greater volume because it has less mechanical strength.

Impregnation

A further improvement in design may be obtained by treating the insulator with wax or other suitable insulating material. Several of the most common waxes are listed in Table 1.

Note that the lowest values of dielectric constant are found in the saturated hydrocarbons, paraffin, ceresin and Superla wax. Halowax, (chlorinated naphthalene) which has a higher dielectric constant than any of the naturally occurring waxes, is an example of a saturated hydrocarbon to which has been added a polar group (chlorine).

It is generally known that most waxes absorb moisture when subjected to high humidities. This results in a change in dielectric constant which shows up as an additional power loss. With the exception of bayberry wax and shellac in the table the absorption is not very great. After extreme exposure, however, even the best of waxes permits moisture to penetrate. This can be readily demonstrated by observing the variation in Q of a treated and untreated coil after they have been immersed in water until the Q has been substantially reduced, and then noting the time required for the Q to return to normal. The untreated coil will return

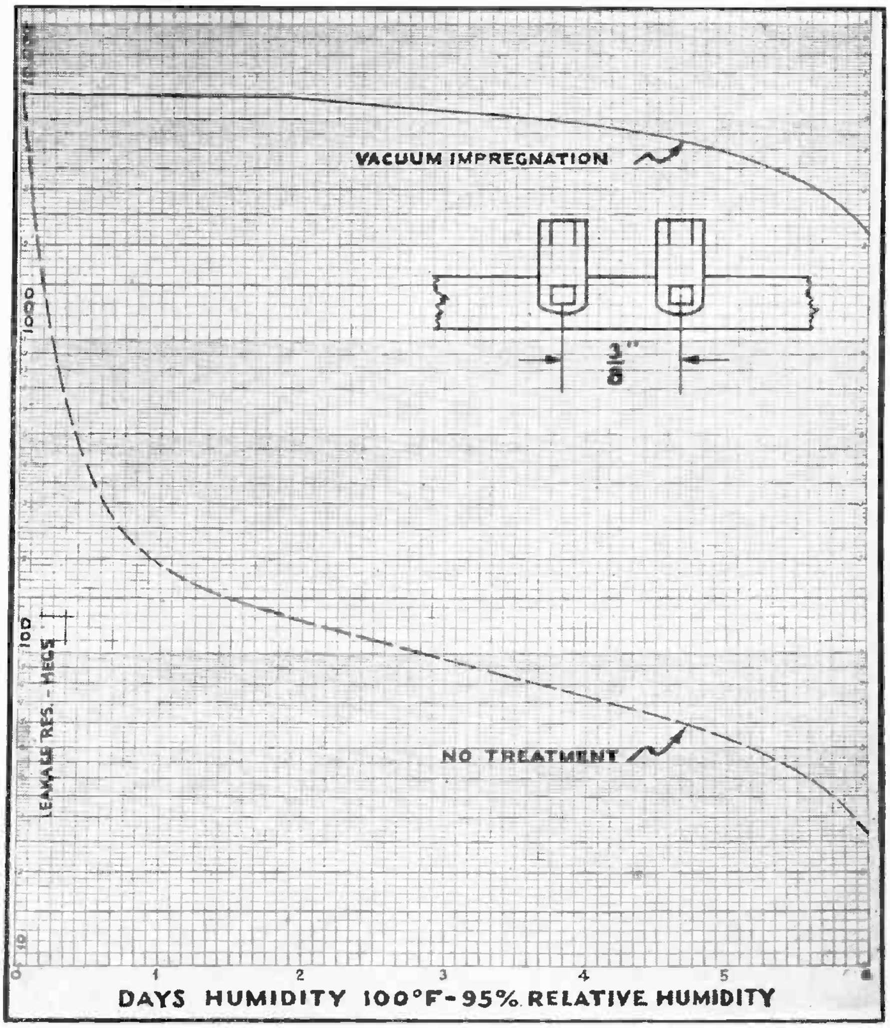


Fig. 4. Leakage vs. humidity of laminated bakelite terminal strip.

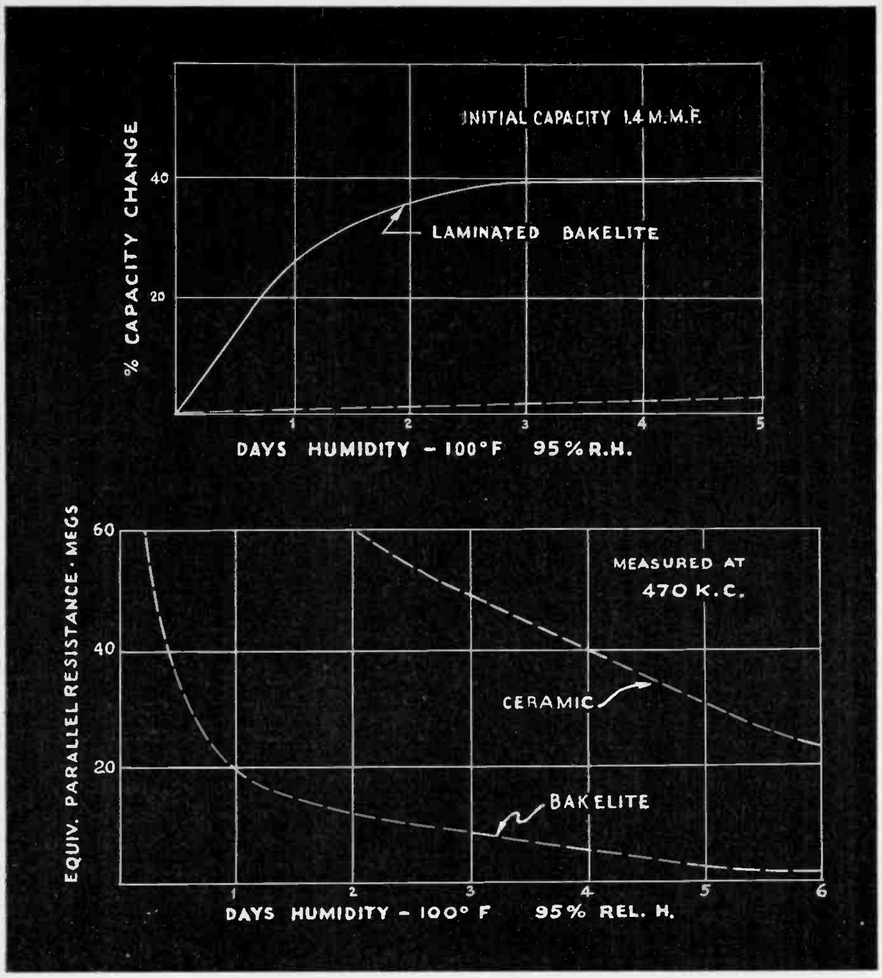


Fig. 5. Humidity characteristics of octal tube sockets.

to its original value within 24 hours, while the treated inductor may require several days to regain its original value. Were it not for the fact that wax impregnations when properly applied provide sufficient protection for most conditions it would be better to omit the treatment entirely.

The usual treatment for components fabricated principally of insulating materials, consists of a vacuum impregnation. A "flash dip" of the same wax for additional protection both mechanically and electrically is often applied after the regular vacuum treatment. The temperature for "flashing" is somewhat critical. It depends upon the particular type of wax and the size of the part being treated and can best be found by experiment. Obviously care must be taken to prevent pin holes from forming during this operation, as they would nullify the effect of the heavy coating.

The acid content of a wax must also be considered when it is used as an impregnant of coils, especially when the coil is connected to a positive d-c potential. In such cases any leakage to ground will be accompanied by an electrolytic action which will show up as a greenish salt deposit on the positive wire. This will eventually corrode the wire so that an open will occur. If the coil is connected to a negative potential, no corrosion will take place.

The effect of extremes in temperature must also be considered when specifying an external treatment of parts. The melting point should be at least 10°C. above the maximum operating temperature specified.

To meet unusual temperature requirements, it is sometimes necessary to specify materials other than waxes. Varnish or lacquer having a base of styrene has been found to give excellent results when properly applied. The parts to be treated must first be dried under infra-red lamps; then coated by either a dip or brushing on of the impregnant. The part is then allowed to dry thoroughly under infra-red lamps and the operation repeated until at least four separate coatings have been applied. It is important that the drying time be of sufficient length to volatize and drive off all of the solvent in the impregnant. This type of treatment requires much more time and handling and is seldom used except where the specifications are so stringent that waxes would not be satisfactory.

TABLE I

Wax	Dielectric Constant: Initial	Dielectric Constant: 2 Month Immersion	% Water Absorption	Acid Value	Melting Point °C
Carnauba	2.72	4.0	0.8	2.8	80
Bayberry	3.25	10.4	6.1	21.0	60
Beeswax	2.87	3.2	0.42	20.3	
Ceresin	2.2	2.3	0.04	Neutral	75
Paraffin	2.2	2.4	0.045	0	51.7
Superla	2.33	2.36	0.015	0	74
Shellac	3.68	15.0	4.7	0.2	
Halowax	3.63	5.3	0.24		86

Measurement

The measurement of insulating materials becomes quite a simple task when it is only desired to make a comparison between materials or to determine the effect on circuit Q. The insulation is treated as a small capacitor with the insulating material as the dielectric. Should the sample be obtainable in a flat sheet, it can be placed between two suitable electrodes, as shown in *Fig. 2*, and measurements made on a Q meter with and without the dielectric sample in place.

The choice of suitable electrodes is very important. The surfaces of the electrodes and the dielectric sample should be accurately plane and parallel. Any air space between the two results in an error which is a function of the thickness of the sample and its dielectric constant, becoming greater as the sample decreases in thickness and/or increases in dielectric constant.

Those chosen were made of one-eighth inch brass, five inches in diameter, ground flat and silver plated. Since samples of the same material often show considerable variation in characteristics, and the materials being compared usually have widely different loss factors, the method has been found quite satisfactory in spite of the small error existing because of the lugs and fringe effect. The capacity between the test electrodes in air must be quite accurately known and is given in equa-

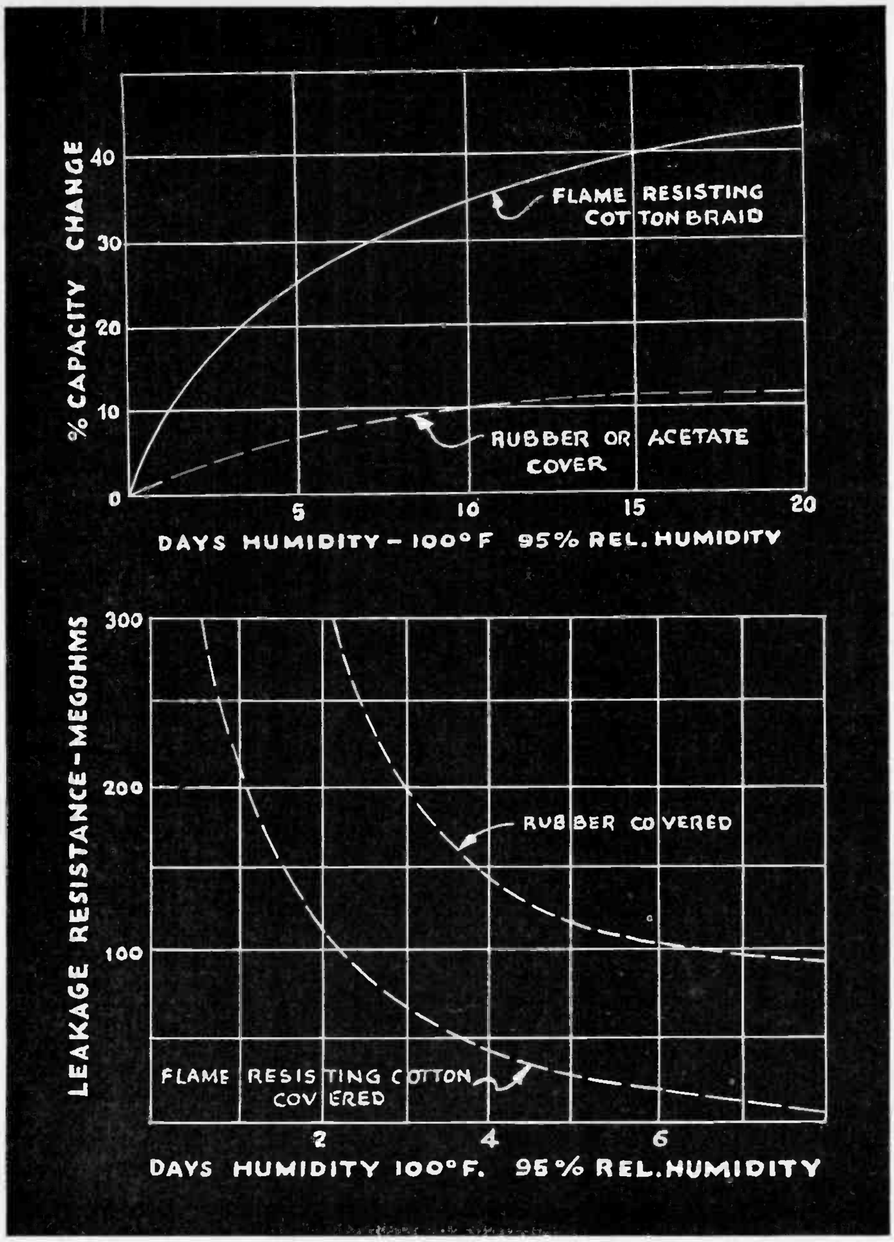


Fig. 6. Humidity characteristics of insulated wire.

tion (1), where C is expressed in micro-micro-farads, r is the radius of the electrode and t the spacing between electrodes in inches.

$$C = 0.706\ r^2/t \qquad (1)$$

To determine the power factor or Q of a sample, it is measured with the Q meter using the special electrodes. If C_1 and Q_1 are the capacitance and Q readings on the Q meter with air dielectric between the electrodes, and C_2 and Q_2 the capacitance and Q of the circuit with the sample between the electrodes, when retuned to resonance, then the Q of the dielectric sample is:

$$Q_x = \frac{(C_1 - C_2)\ Q_1 Q_2}{C_1\ (Q_1 - Q_2)} \qquad (2)$$

and the power factor in percent (for values less than 10%) is

$$\%\ \text{P.F.} = 100/Q_x \qquad (3)$$

The difference between C_1 and C_2 is the capacitance of the sample being measured. The coil used for the measurements should have as high a Q as possible and the measurements made with a fairly low value of tuning capacitance in the Q meter.

When the dielectric sample is not available as a flat sheet the Q may be measured much the same as before, except that Q_1 and C_1 now represent the readings on the Q meter without the sample (capacitor) component, and Q_2 and C_2 the readings with the sample in place and the Q meter retuned to resonance.

Effect on Circuit Q

A high-Q tuned circuit is generally thought of as a high Q coil and a good air dielectric capacitor. Most practical circuits, however, include other components which must also be considered. The air dielectric of the capacitor may be assumed to be without loss, but the solid dielectric stator supports, the coil form, terminal strips, insulating wire, tube, tube base and socket, all introduce losses. The higher the coil and capacitor Q the more noticeable is the effect of the other components. This is demonstrated in *Fig. 3* where L represents the coil and R_L its equivalent series resistance. In parallel with the coil we have the assumed perfect air dielectric capacitor C and the tube resistance R. Next we have C_t, C_c and C_w in series with R_t, R_c and R_w respectively, which represent the capacitor solid dielectric, terminal strip, insulated wire, tube base and socket, the C being the capacity and R the equivalent series resistance.

Suppose we now measure the Q and C of each of the components in the circuit. A typical example is tabulated below; where the tube resistance (ac) is one megohm, the frequency 1000 kc, the coil inductance 216 μh with a Q of 250. (This includes all coil and coil-form losses.)

We can then readily determine the effect of any of the components in the circuit on the overall circuit Q by substituting in equation (4).

$$\text{Resultant circuit Q} = \frac{1}{\dfrac{\omega L}{R} + \dfrac{1}{Q_L} + \dfrac{1}{C'}\Sigma\dfrac{C}{Q}} \qquad (4)$$

Thus it is seen that starting with a coil Q of 250, the losses contributed by the seemingly unimportant parts have reduced the circuit Q to 153.

The effect of vacuum impregnation

[*Continued on page 72*]

TYPICAL EXAMPLE FOR Q AND C MEASUREMENTS

			Q	C/Q Ratio
C_c	Tuning cond. supports	5 $\mu\mu$f	500	1×10^{-14}
C_w	Term. strip & wiring	2 $\mu\mu$f	30	6.6×10^{-14}
C_t	Tube base and socket	3 $\mu\mu$f	50	6×10^{-14}
C	Tuning condenser	107 $\mu\mu$f		
		$C' = 117\ \mu\mu$f		$\Sigma\, C/Q = 13.6 \times 10^{-14}$

$\omega L = 1356$ $\quad C' = 117 \times 10^{-12}$ $\quad 1/C' = 8540 \times 10^{6}$

$\omega L/R_T = 1356 \times 10^{-6}$ $\quad 1/Q_L = 4000 \times 10^{-6}$ $\quad \dfrac{1}{C'}\Sigma\dfrac{C}{Q} = 1161 \times 10^{-6}$

Circuit Q = 153

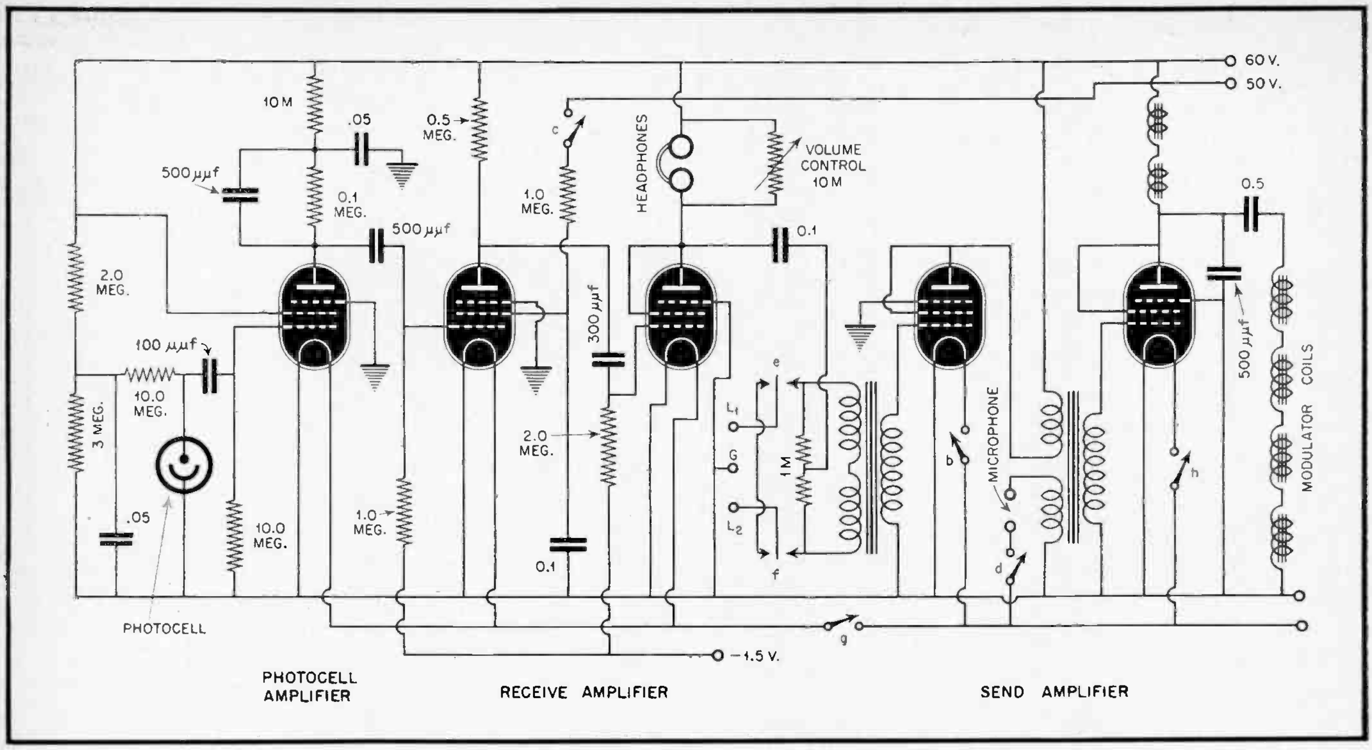


Fig. 1. Circuit diagram of amplifiers used with German Speech-on-Light Signaling apparatus.

GERMAN "SPEECH-ON-LIGHT" SIGNAL SYSTEM*

Apparatus Used by German Army to Supplement Field Telephones and U.H.F. Radio Equipment

D. GIFFORD
Captain, British Army

INTRODUCTION

★ The following article describes the speech-on-light signaling apparatus which has been in use in the German Army since about 1935. The technique of using a light beam for voice communication over visual distances is by no means new; but it was not evident that any fool-proof systems had been developed at the outbreak of the war.

For a number of years, experiments have been carried out on modulated light. There are two methods of applying the voice modulation, firstly, by directly modulating the light source by the a.f. signals, and secondly, by using a constant-intensity source and modulating the outgoing beam. No great successes have been achieved by modulating the source. With filament-type lamps, the thermal inertia of the filament presents some difficulty, especially at high speech frequencies, and gaseous discharge lamps do not seem to be the answer.

Certainly, the best method is to modulate the beam after the source, and for this, several methods, allied to sound-on-film technique, have been tried. But before the war speech-on-light signaling was still in the experimental stages, except for this German equipment.

In all such systems, the modulated beam must be sharply focused on to the distant station, at which a photocell is used to detect the changes in light intensity and to convert them into a.f. currents.

The German speech-on-light apparatus was kept a closely guarded secret, but relating documents were found during the first German Libyan Campaign. It was not until the Battle of Alamein of October, 1942, that the complete apparatus was found. (It is not known whether this applies to the Russian front.) The apparatus was investigated and tested in the laboratories of the Royal Corps of Signals in the Middle East, in November.

★ Briefly, the German apparatus consists of a transmitter-receiver head, which resembles an oversize pair of

* Reprinted by courtesy of *Electronic Engineering*, London.

binoculars. The head contains the lamp, the modulating device, the color filters, the transmitting lens, the receiving lens, the photocell, and its amplifier. A built-in telescope is included, and the head stands on a tripod. The a.f. amplifiers, one for transmitting and one for receiving, are contained in a box, together with the necessary batteries, which stands on the ground alongside the tripod. The entire equipment may be conveniently carried by one man.

An important feature of the device is that it may be operated on white, red, or infra-red light, merely by selecting the required filter by a knob. The use of infra-red light eliminates possibility of interception, and insures secret communication in the dark, while the range is not appreciably reduced.

Of course, for night operation, the instruments must either be lined up the previous day—or else at night by showing a red light.

The outgoing light is sharply focused to a parallel beam by means of the 80 mm. lens. The beam is six yards wide at a mile, and thirty yards wide at five miles.

The amplifier has a send-receive switch, hence duplex communication is not possible. However, provision is made for operation over a telephone line, and for this, the line works into a bridge input circuit, which permits both send and receive amplifiers to operate simultaneously without instability.

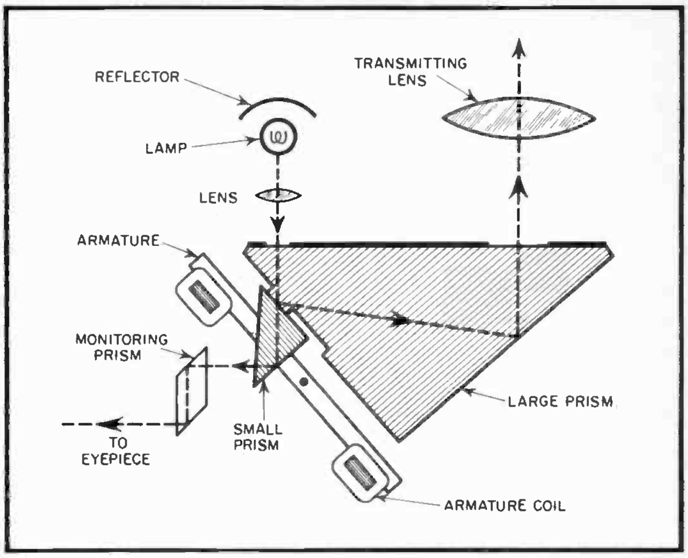


Fig. 3. Detail sketch showing method of modulating the light beam.

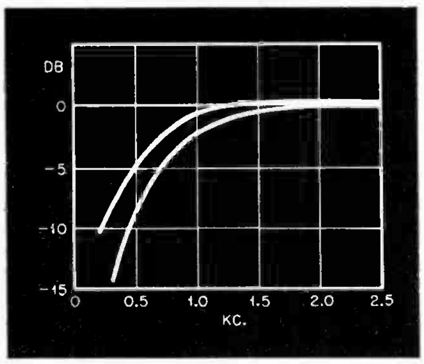


Fig. 2. Response curves of amplifiers: Upper—sending; lower—receiving.

It is appreciated that the instruments must be set up in view of each other, and that there must be no intervening objects. For this reason, it is desirable that the stations are sited on elevated positions, thus insuring that passing vehicles, etc., do not interrupt the light beam.

It is observed that shimmering heat currents rising from the ground (so common in hot deserts) give rise to interference, but the circuits are so designed to minimize this effect, as will be shown later.

The effective range of the apparatus depends largely on atmospheric conditions, but five miles is about the average. Of course, this range is considerably decreased in rain, and increased when the atmosphere is very clear. The apparatus was not tested in fog, but it is assumed that although the infra-red ray will to a large extent penetrate fog, the range is considerably reduced.

Provision is made for keying the lamp filament by means of a push button. This provides facility for code transmission, but reception must be visual. Under these conditions, greater distances are possible.

Principles of System

Considering the transmission system first, we start with the lamp. (See *Fig. 1.*) This has a coiled filament, is supplied with 4.8 volts, and consumes 4 watts. The lamp is held in an accurately made, detachable holder, the filament is pre-focused and the lamp base has a guide pin which engages with a groove in the holder. The lamp holder fixes into the lamp house, containing a mirror which focuses the light on to the modulator unit.

After the modulator, the light beam passes through a filter, which may be white, red, infra-red, or diffused, depending on the setting of the filter selector knob. The light beam, being now modulated and filtered, passes through the 80 mm. lens, which focuses it to a virtually parallel beam.

The modulated, filtered light (be it white, red or infra-red), is picked up on the 80 mm. lens of the distant receiver, and focused on to the photocell, located at the back of the head. The photocell changes the variations in light intensity into changes of electric potential, which are amplified by the one-stage photocell amplifier, located within the head. The a.f. output is fed by a cable to the main receiving amplifier, located in a box on the ground beside the tripod.

The Amplifier

Separate amplifiers are used for send and receive, but both are mounted as one unit in a box containing the associated batteries, cables, spare tubes, lamps and photocells. Tubes are of the standard type of German Army, high gain, directly heated pentodes, R.V.2P.800. These tubes resemble the British catkin type, but they are mounted upside down in a tubular holder, being supported at both ends. The photocell amplifier is conventional; the cell receives a positive voltage by means of a high resistance potentiometer from the high-voltage line. The anode circuit has a resistance-capacity network that attenuates at about 4,000 cycles, the purpose being presumably to minimize photocell hiss.

This amplifier uses two tubes in cascade, resistance-capacity coupled—and the last tube is triode connected to secure a low impedance for the phones. The output is also taken to the telephone bridge input circuit.

The sending amplifier normally uses but one tube, triode connected. This is fed by the microphone, and the anode is parallel fed by an a.f. choke, the anode load being the armature coils of the modulator.

The send-receive switch normally switches on the appropriate amplifier, thus duplex operating is not possible. But for the purpose of working into a telephone line, the switch is turned to "Telephone," and this places the bridge circuit in the sender amplifier input—and in the receiver amplifier output. The bridge is balanced, to prevent acoustic feedback over the entire system. Naturally, the bridge input circuit offers an attenuation to the microphone current—so in this condition the switch puts another tube in the sender amplifier circuit to compensate for the attenuation of the bridge.

The audio frequency response of the amplifiers is shown in *Fig. 2,* and it will be noticed that both amplifiers have a falling response commencing just below mean speech frequency. The attenuation at 300 cycles and below is very high—and this feature is very useful in that it minimizes low-frequency flutter due to hot air currents rising from the ground in the optical path.

The Photocell

The cell is small in size, resembling a button about one inch diameter. It is of the "Thalofide" type, and changes its resistance in accordance with variations of light intensity. The cell is very sensitive to red and infra-red light, and a built-in red filter is incorporated. The output of the cell is in the order of one ma. per lumen. It will be observed that the polarizing voltage is taken from the high-voltage line via a high-resistance potentiometer and about 30 volts is applied to the cell. This relatively low voltage is desirable in order to keep the noise down, since such cells tend to be very noisy. The output of the cell is applied to the amplifier through a 100 $\mu\mu$f capacitor, which, together with the 10-megohm grid resistor, affords considerable attenuation at low frequencies.

The Modulator

The action of the modulator is best understood by reference to *Fig. 3.* The light from the lamp-house strikes the

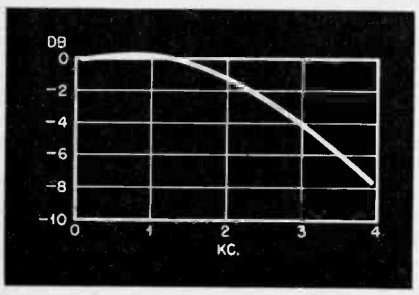


Fig. 4. Response curve of photocell.

hypotenuse side of a right-angle prism. The light beam is reversed in direction by two internal reflections of the prism. The other angles of the prism are not quite 45 degrees, so that at the point of first reflection the mean angle of incidence is approximately the critical angle for glass and air media. Under these conditions, partial reflection and partial refraction takes place. The area at which this first reflection takes

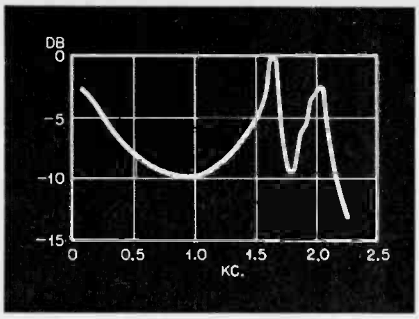


Fig. 5. Response curve of modulator.

place is a small rectangle measuring 3 by 1½ mm., the surrounding glass being blackened. The armature consists of a flat metal strip, pivoted at its center. Its ends are located closely between the pole pieces of the armature coils, which are so phased that one pushes and the other pulls. A small right angle prism is carried on the armature, near its center, and it is so positioned that one of its sides rests in contact with the small rectangle of the main prism. As the armature moves in accordance with the voice currents, so the pressure of the small, moving prism against the large prism, changes in accordance with the voice currents.

It will be appreciated that since the small prism is mounted close to the axis of rotation of the armature, its travel is small, but its pressure is great. It is necessary, then, when considering the analysis of the action of the device, to bear in mind that it is the pressure of the small prism on the large one that alters—not so much the air gap between the two. Let us consider the state of affairs that would exist if these two glass surfaces were truly optically flat and in perfect contact. Obviously there would be no change of medium at this point and no internal reflection would take place. Hence, no light would pass through the main prism. But as soon as the contact between the prisms becomes imperfect, a change of light media will occur—and internal reflection will result. In practice, the contact is never perfect, in fact, for all pressures of the prism, most of the light is reflected. But the varying pressure brings about a varying degree of contact, which, in its turn, varies the amount of light reflected through the main prism. This, coupled with the fact that the angle of incidence is nearly the critical angle, makes the modulator a relatively efficient device.

A device is incorporated to control the quiescent, no-signal pressure of contact. The operator is supposed to adjust this to give maximum sensitivity and minimum distortion. The action of this device is interesting, in that it controls, to some extent, the direction of modulation. It is paradoxical to say that overall upward modulation takes place, if one is considering the amount of light that enters the prism; but with respect to the quiescent light level leaving the prism (*i. e.,* taking into account the amount lost at the first reflection for zero signal) it appears that upward and downward modulation does occur.

No attempt has been made to measure the depth of modulation, but if the instrument is operated on white light, and an observer stands in the beam, a very marked flicker is noted when the operator speaks.

The Monitoring System

It has already been mentioned that a telescope is provided for aligning the station to the distant terminal. The telescope has a secondary function, in that it acts as a monitoring device to check the action of the modulation. This is done in the following manner. The hypotenuse side of the smaller prism has a clear space on it, which is placed close to another prism, which carries the light into the eye-piece of the telescope, being suitably focused by a small lens. We have already seen that the light that is lost at the first

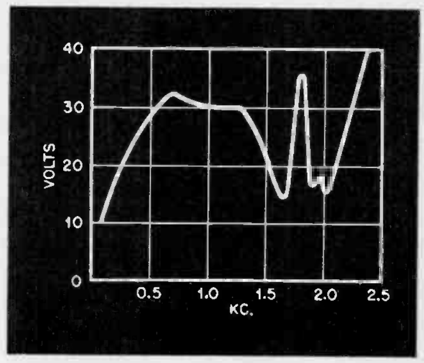


Fig. 6. Modulator overload curve.

reflection of the main prism, is passed on to the smaller moving prism. This light is in turn passed on to the eyepiece. The contact surface of the moving prism has a small grid mesh etched on it (not for the purpose of affecting the contact surface) and it is the image of this grid which appeared in the eye-piece. As modulation takes place, the image of this grid should become brighter and duller. In practice, it is noted that only on peak modulation does the grid image appreciably change in intensity. It will be observed that this monitoring system is entirely visual, and gives no indication as to the quality of the transmission. In any event, it is complementary to the true modulation, being, as it were, "inside out."

[*Continued on page 72*]

GRAPHICAL SOLUTION OF R-C NETWORKS

M. C. JONES
RCA Victor Division
Radio Corporation of America

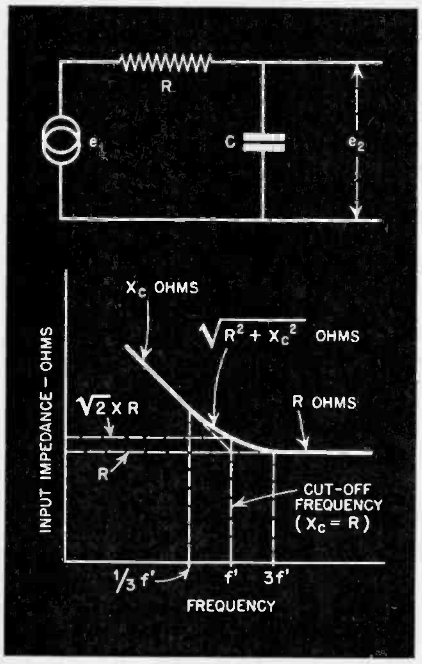


Fig. 1. Simple R-C series circuit and its characteristic.

★ The problem of determining the attenuation or response of R-C networks is one regularly encountered in radio engineering work. A rigorous analytical solution of some R-C circuits is a difficult, time-consuming, process which in many cases is more difficult than actually measuring the results. However, by proper use of known facts regarding simple R-C circuits, it is possible to shorten and simplify the analysis of more complex circuits.

Series Circuit

One of the most frequently encountered circuits involving R and C elements is that shown in *Fig. 1.* In general we are interested in the response of this circuit as a function of frequency or at some specific frequency. To obtain this it is necessary that we know something regarding its input impedance.

The input impedance of this circuit changes from capacitive reactance to resistance in the vicinity of the critical or cut-off frequency. This cut-off frequency is that frequency at which the capacitive reactance equals the resistance. The magnitude of the input impedance at this frequency is 1.414 times the value of *R.* At frequencies three times removed from this frequency the magnitude of the input impedance is determined almost entirely by the element with the larger impedance. Sum-

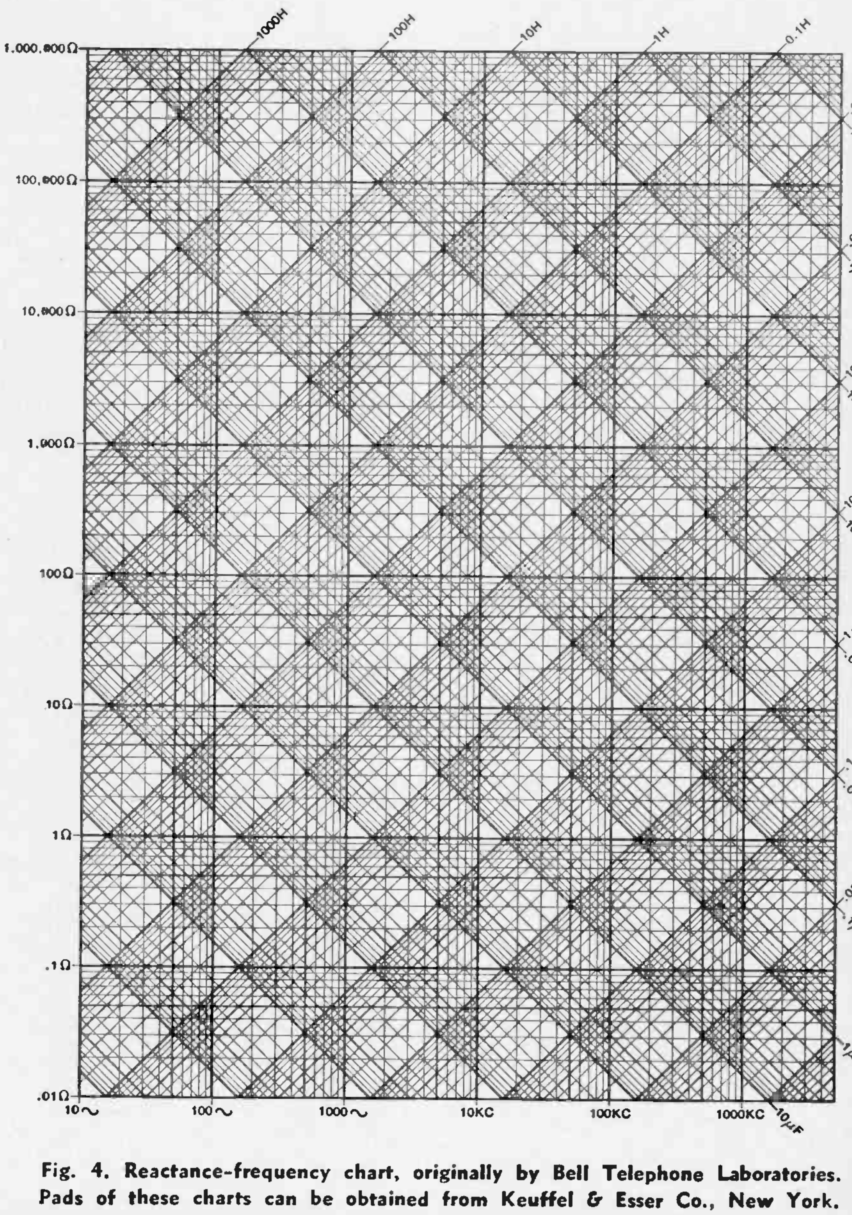


Fig. 4. Reactance-frequency chart, originally by Bell Telephone Laboratories. Pads of these charts can be obtained from Keuffel & Esser Co., New York.

marizing the above points we have:

1. The input impedance at the cut-off frequency is $1.414R$.

2. The input impedance at frequencies higher than three times the cut-off frequency is R within about 5%.

3. The input impedance at frequencies lower than one-third the cut-off frequency is the reactance of C within 5%.

From this we may determine the current flowing for a constant impressed voltage at the critical fre-

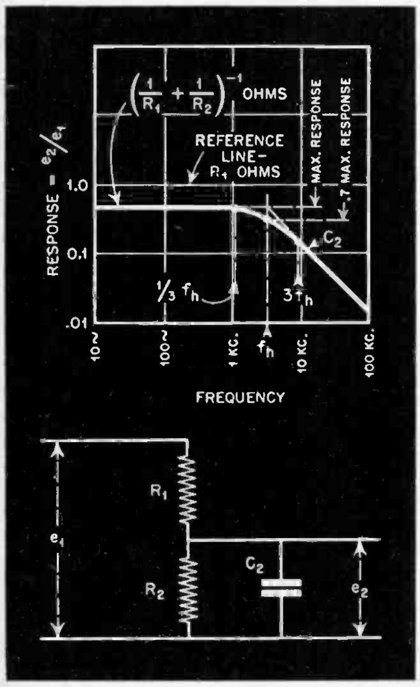


Fig. 2. Fidelity of simple R-C circuit.

quency and at frequencies in excess of three times or less than one-third the critical or cut-off frequency. The product of this current and the reactance of C is the output voltage.

Series-Parallel Circuit

The response of the circuit shown in *Fig. 2* may be found in the preceding manner by reducing e_1, R_1, and R_2 to an equivalent voltage and impedance using Thevenin's theorem. There is, however, a much simpler method of obtaining the response of this circuit as a function of frequency.

A piece of tracing paper is placed on the reactance chart shown in *Fig. 4* and two lines are traced. The horizontal line is traced along the parallel equivalent resistance of R_1 and R_2 and the slanting line is traced along the value of C. The intersection of these two lines is the cut-off frequency. At this point the response is .707 times the maximum response at lower frequencies. At frequencies three times removed from this cut-off frequency

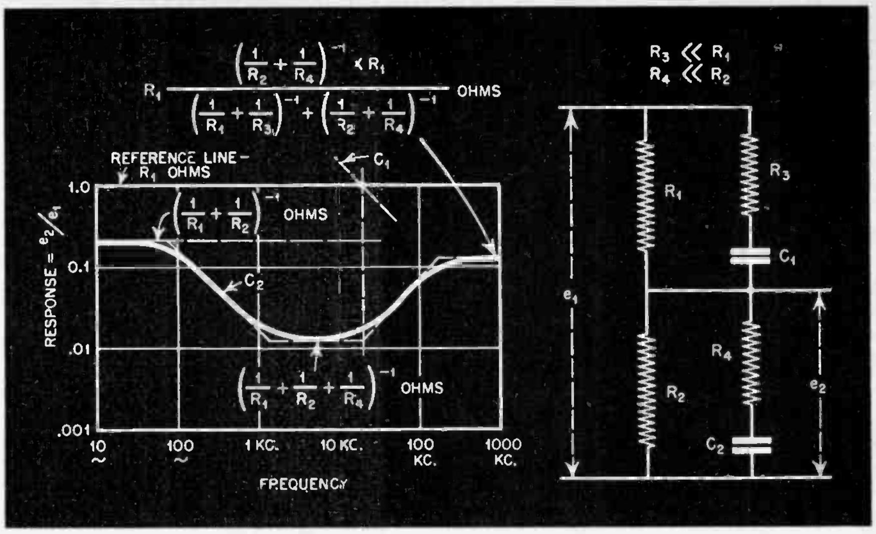


Fig. 3. Fidelity of complex R-C networks.

the response falls along the two previously drawn lines. The vertical ordinate is plotted as a voltage ratio with the value R_1 being unity. The horizontal abscissa is frequency and is taken from the reactance chart. The curve in *Fig. 2* shows the response of a typical circuit obtained in this manner.

Complex R-C Network

By extension of this method of analysis it is possible to determine the fidelity or response of the more complex circuit shown in *Fig. 3.* This type of circuit may be used to obtain any fidelity curve desired which is within the capability of simple R-C circuits. It is extensively used for audio-frequency compensation to correct for deficiencies in the human ear at different levels.

First the horizontal and sloping lines are drawn as shown. The rate of attenuation which may be obtained with

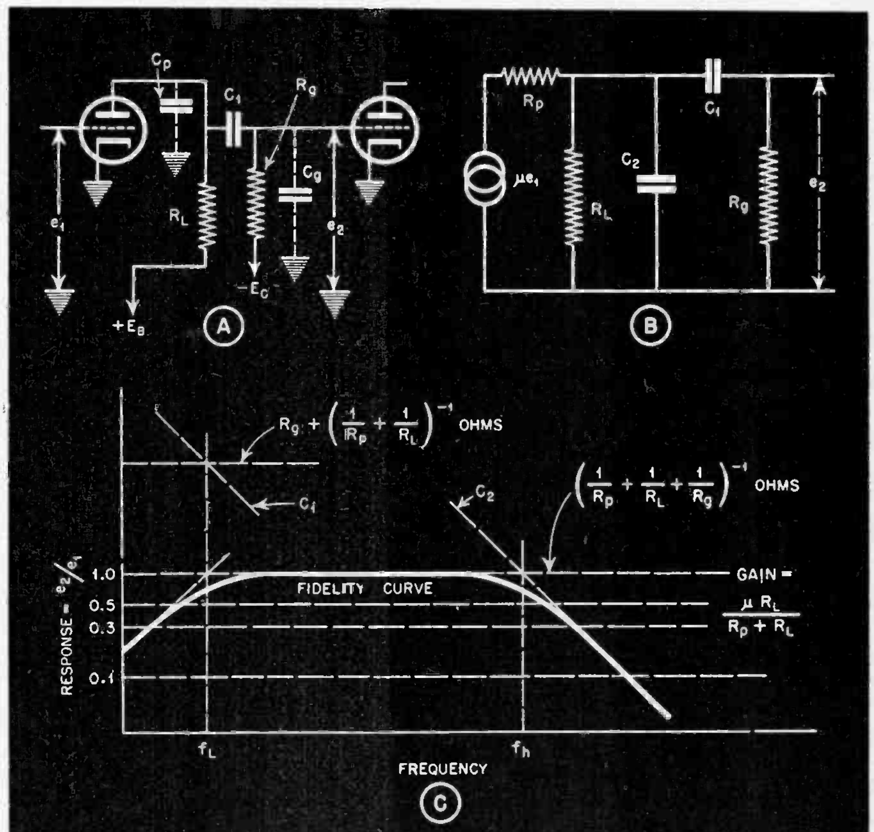


Fig. 5. Resistance-coupled amplifier, equivalent circuit, and fidelity curve.

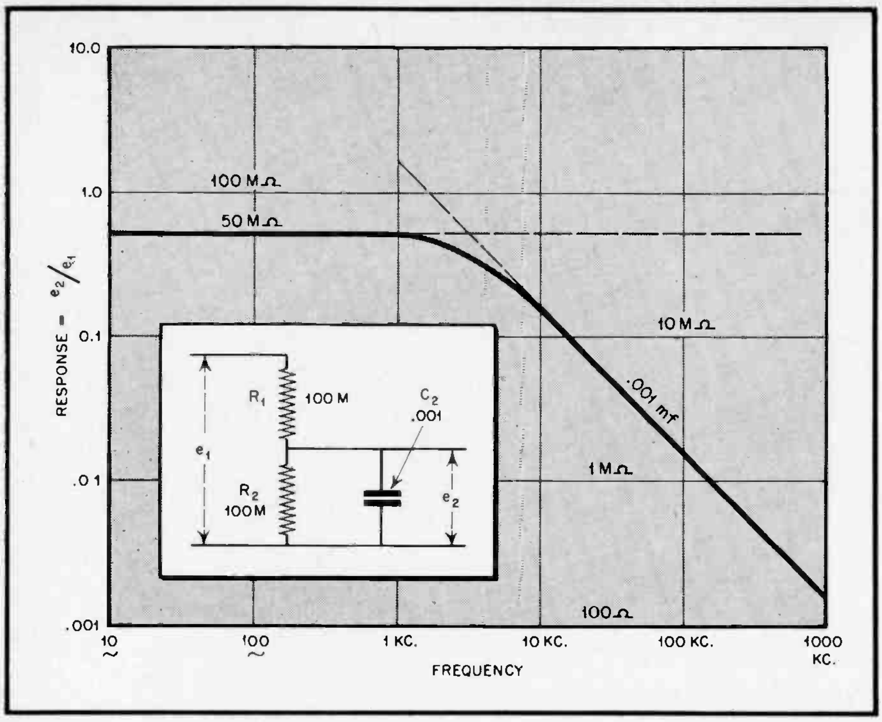


Fig. 6. Graphical solution of R-C network of Fig. 2, with values as given in text.

such circuits is two times, or 6 db, per octave. This rate corresponds to a line with unity slope on the log-log paper used. The curve is smoothed out using the three facts previously outlined.

Conversely, this method may be used to determine the circuit constants required to produce any desired fidelity curve within the capabilities of R-C circuits. The curve is plotted on tracing paper over the ordinates and abscissas of the reactance chart and by proper use of the method outlined, the circuit constants required to produce the curve may be determined. An infinite number of solutions exists for each problem so that it is necessary to select the one with the correct input or output impedance.

Fidelity of Amplifiers

It is possible by this method to determine graphically the fidelity of any single-stage resistance-coupled amplifier. The procedure for obtaining this fidelity is shown in *Fig. 5*.

Fig. 5-A shows a single-stage, resistance-coupled amplifier with stray capacities C_p and C_g (on the plate of the amplifier tube and the grid of the succeeding stage) tending to limit the high-frequency response. The coupling capacitor C_1, together with the grid resistor R_g, produces a low-frequency cut-off. The equivalent circuit of this amplifier stage is shown in *Fig. 5-B*. In this circuit the capacitors C_p and C_g are lumped in the capacitor C_2. This circuit is similar to the type previously analyzed, and the result of a typical graphical analysis of this circuit is shown in *Fig. 5-C*. Here the low-frequency cut-off is determined by the capacitor C_1 and by the resistance of R_g in series with the parallel equivalent of R_p and R_1. The high-frequency cut-off is determined by C_2 in parallel with the parallel equivalent resistance of R_p, R_1, and R_g. Having determined these two cut-off frequencies, it is a simple matter to plot the fidelity curve as shown. The gain through the mid-range can be determined by any convenient gain formula, and from this information and the fidelity curve, it is possible to determine the gain at any frequency.

Examples

Two examples of the manner in which such problems may be solved graphically are given below:

(1) Plot a response curve for the circuit shown in *Fig. 2* for the following constants:

R1	*R2*	*C2*
100,000 ohms	100,000 ohms	.001 μf

(2) Plot a response curve for the circuit shown in *Fig. 3* for the following constants:

R1	200,000 ohms	*R4*	10,000 ohms
R2	200,000 ohms	*C1*	20 $\mu\mu$f
R3	5,000 ohms	*C2*	.02 μf

Graphical Solutions

The graphical solution of Problem 1 is shown in *Fig. 6*. Suppose it is desired to determine the response of the circuit shown over a wide range of frequencies.

As previously described, a piece of tracing paper is placed over the reactance chart *(Fig. 4)* and two lines are drawn. The horizontal line is drawn at 50,000 ohms, which corresponds to the parallel equivalent resistance of the two 100,000-ohm resistors. The slanting line is drawn at the value of capacitance, in this case, .001 μf. The two lines are joined by a smooth curve and the response curve is complete. It is only necessary now to label the coordinates. The horizontal coordinate is frequency and is taken directly from the reactance chart. The vertical coordinate is response and is selected such that unity response corresponds to the top resistor or 100,000 ohms. The value of response is then taken in

[*Continued on page 70*]

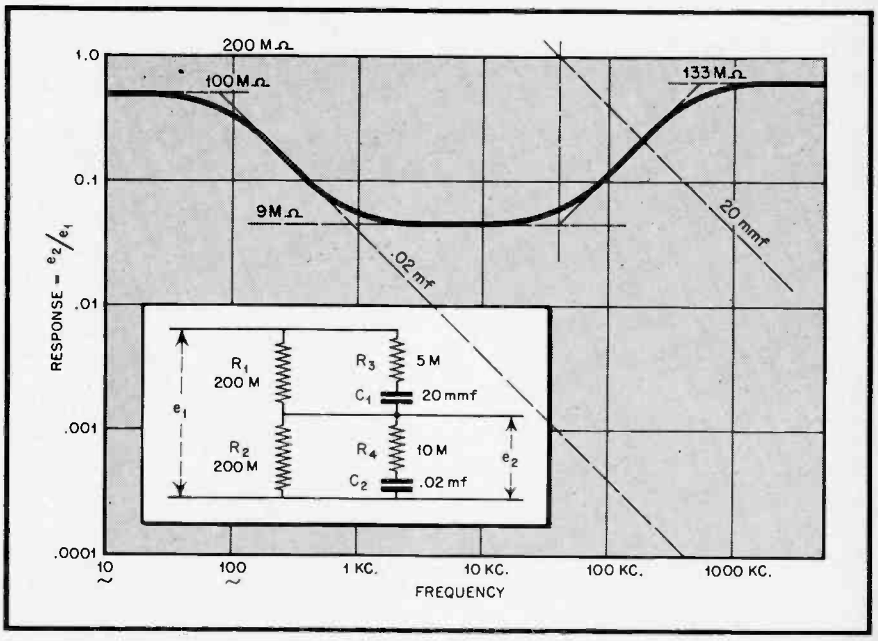


Fig. 7. Graphical solution of R-C network of Fig. 3, with values as given in text.

WAX IMPREGNATION OF COILS AT U. H. F.

S. YOUNG WHITE
Formerly of Loftin-White

Humidity Protection in Practice as Applied to Superstable Oscillators for the Range 50-400 mc, Where Extreme Temperatures are Encountered

★ In the design of u-h-f transmitters and receivers for mobile work wherein tuned circuits having a stability equal to that obtained with crystal control are called for, it is necessary that the components also be able to pass the standard tests for vibration, humidity and temperature. Since the frequency will be affected by all objects and materials in or near the circuits, due consideration must be given to every last item if one is to end up with a unit that can be put into quantity production.

The classical protection against moisture is impregnation, and a wax is usually employed. Such impregnation prevents cotton insulation on wire from acting as a wick, and a ceramic from acting as a blotter.

In u-h-f work, coils have only two or three turns, well spaced, so there is no need for insulation on the wire. In circuits of great secular stability it is necessary to use ceramics or glass, and for the present at least, ceramics of the steatite family.

Glazing is usually unsatisfactory, as all regular glazes have high losses at ultra-high frequencies; and in any case, it is usually impossible to apply such glazes without seriously changing the dimensions of the coil forms.

Hard and Soft Waxes

The hard waxes that melt around 400 degrees have, as a class, rather high losses. They provide good protection when the equipment is heated, but under extreme cold are very likely to crack, leaving the components unprotected.

The soft waxes have good u-h-f loss characteristics, but their melting point runs around 130 degrees. This is a very common temperature to encounter, so usually a drip point is formed, and if the part is under vibration, as it is very likely to be, some wax may drip off. In any case, redistribution of the wax will occur, and the wax may well shift from a low-potential point to a point of high potential, and a change in the frequency calibration of the circuit will result. This is illustrated in *Fig. 1-A* and *1-B*.

Fig. 2 shows the important role played by the capacitance introduced by the wax. L_1 is the true inductance of the coil, and R_1 its losses. C_1 is the distributed capacitance of the coil, partly through air and partly through the ceramic form, with its loss shown as R_2. This capacitance is cyclically very stable, and the change of dielectric constant with temperature is linear. In shunt is the capacitance through the wax, shown as C_2, with its losses in turn represented as R_3.

Now C_2 may be less than 1 $\mu\mu$f, but the total tuning capacitance may be only 10 to 40 $\mu\mu$f, so C_2 forms quite a large percentage of the overall capacitance of the circuit. Since this is a soft wax, its cyclic stability is subject to suspicion. Any material whose molecules are bonded together as loosely as wax may permanently change as the result of repeated meltings, and may also pick up impurities and some moisture content from the air, resulting in a slow change in the absolute calibration of the apparatus.

Using Thin Film

Now the value of C_2 obviously depends on how much wax is used. Through an investigation of the minimum thickness required to offer satisfactory protection, it has been deter-

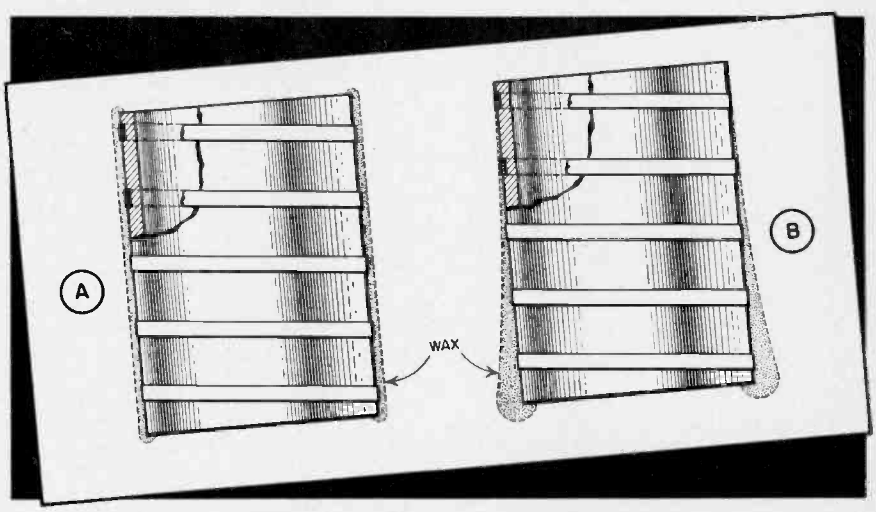


Fig. 1. Initial distribution of wax on coil form, as shown in (A), may be altered, as in (B), due to softening at high temperature.

mined that the wax film can be reduced to a thickness of one mil. With such a light film, the value of C_2 is obviously reduced. But more important is the fact that the resultant film no longer forms a drip point, as the surface tension of the wax causes it to be uniformly distributed, even when melted and in the presence of vibration.

It was experimentally determined that it was quite difficult to apply a very thin and uniformly distributed coat directly to the form, so a coating as thin as convenient was applied, say ten mils. A vacuum was first pulled on the ceramic and then the wax applied under pressure. A suitable solvent was then used to remove the excess wax, leaving a very thin and uniformly distributed coating. This coat was in general about one mil thick, although the exact thickness was difficult to determine.

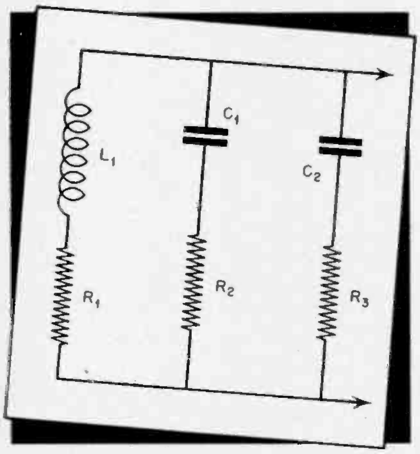


Fig. 2. Equivalent electrical circuit of coil when wax impregnated.

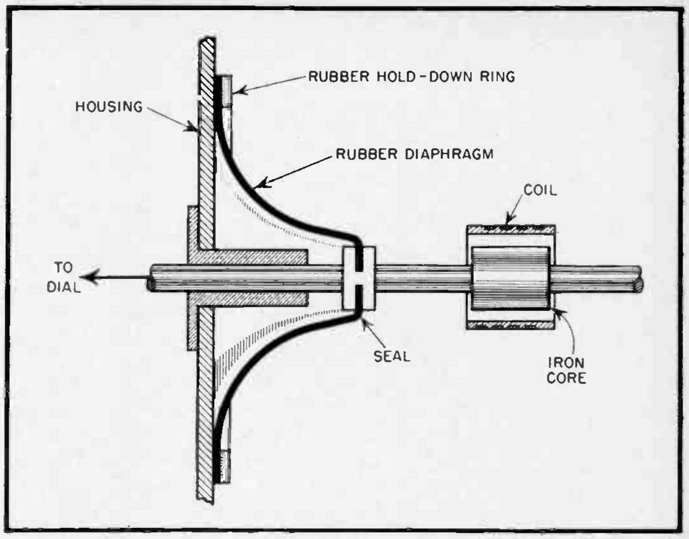


Fig. 3. Details of rubber diaphragm seal for iron- or copper-core tuning where push-rod is employed.

The impregnation was thus very thorough, and the resistance to water absorption seemed to be fully equal to the thicker coating of the same wax. The lessened capacity, C_2, showed up in improved frequency stability. The wax still had some noticeable effect, but seemed to be non-linear at about the melting point, as was to be expected. Violent vibration while at 160 degrees F. did not seem to redistribute the wax. Of course, care was used in handling the parts, and some tricks were originated to prevent the development of bald spots. This thin coat does not interfere much with soldering, either, and silver remains nice and bright under it, and thoroughly visible.

Air Seals

Another factor, however, is only too noticeable in service. It is very common, especially in aircraft service, to have the apparatus pass through the dew point where the moisture condenses out of the air and actually deposits droplets on all exposed surfaces. At low radio frequencies, where accuracy requirements are not too severe, this can be tolerated. At u-h-f, where an attempt is made to maintain frequency under all circumstances to the tolerance of 0.01%—not always with success, it is true, but we are getting there — the presence of these water globules affects the frequency many times that tolerance. Impregnation, of course, can only prevent the moisture from being absorbed by the ceramic; it cannot prevent the formation of water droplets on the coil and adjacent components. Heavy vibration will often break the large dew drops into tiny globules, but the same cubic volume of water will still be in the field of the coil, and severe frequency shift is bound to occur.

The answer lies, of course, in providing an air-tight seal, and then using a dessicator to absorb the moisture in the trapped air, and also in any small amount of air that might get inside due to "breathing" through the seal as the equipment is taken to high altitudes and then returned to sea level.

With permeability tuning, where the core is mounted on a rod which is given a reciprocating motion by the dial, this is comparatively easy. A diaphragm is let into the housing, and this diaphragm can have enough elasticity to be pushed in a quarter or half inch by the dial motion, and the other side can transmit this motion to the core push-rod. There is no necessity for a hole in the diaphragm, so this arrangement is air tight. It is somewhat more difficult to devise an inexpensive and trouble-free gland or seal for a rotating shaft, but the reciprocating motion brought to bear on the outside of the diaphragm could conceivably be translated into a rotating motion on the other side of the seal, where a condenser gang is used.

The designer who plans an enclosure of this nature for the first time may well be reminded that the air pressure at sea level is over 14 pounds to the square inch, and that modern planes climb to pressures of a few pounds, so the housing must resist at least ten pounds to the square inch, from the inside out. Even bearing this in mind, one may overlook the fact that the housing often has an effect on the frequency of the tuned oscillator, since it will consist of metal adjacent to the field of the coil, and that under this unequal pressure the sides may bulge a little and shift the oscillator frequency.

Desiccant

Silica gel is a very good desiccant to use in the housing. This material can absorb many times its weight in water, is quite cheap, and can be used in a container about the size of a pill box. A convenient form is a round metal box punched full of holes to allow the air to reach the silica gel, and about an inch in diameter and a quarter inch thick.

This desiccant has a very useful property. Assume that a plane using such a receiver reaches the tropics during the rainy season, and a tube burns out in that part of the receiver inside the housing. To replace the tube, the service man would, of course, open the housing. Upon replacing the cover there would be trapped a large amount of moisture condensed on the inside of the housing, and the silica gel might be well loaded with moisture already, due to minor leaks in the seal.

But silica gel can be completely reactivated by heating it to about 400 degrees. By the simple expedient of heating the container with a hot soldering iron, the moisture can be removed and the cover replaced. If, then, the receiver is placed into operation the air

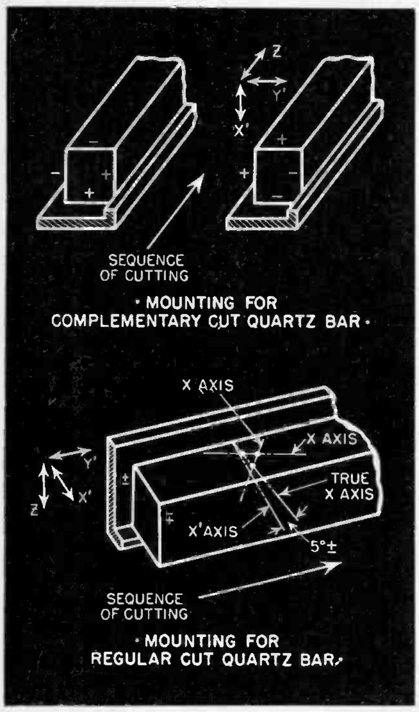
[*Continued on page 70*]

RADIO-ELECTRONIC

QUARTZ CRYSTAL FIXTURE

By JOSEPH ECKERT
RCA Manufacturing Co., Camden Plant

★ It is suggested that quartz bars prepared for cutting in the Crystal Manufacturing Section be mounted as shown in the accompanying illustration. Such a mounting system will permit every bar to be sampled during blank saw



Quartz Crystal Fixture

set-up without cutting intermediate wedge blanks. This standardization will save saw set-up time, X-ray measurement time, and much orientation time if the blanks are to be salvaged at all. This amounts to a considerable saving, as with the current limited production, an estimated 45 to 68 wedge blanks are cut each day.

★

SALVAGING CONDENSER PLATES

By J. M. CARR and I. J. MAY
Westinghouse Electric & Mfg. Co., Mansfield Plant

Condenser Plates Used in Radio Assemblies: Suggestion was that the plates could be straightened by clamping them between steel plates and subjecting them to 400° F. for one hour and fifteen minutes.

Results: Annual savings of nearly $1000.00.

★

MUSIC INCREASES PRODUCTION

★ Selected music in high-geared war industries lifts workers' morale, reduces fatigue and is a definite aid to production.

That's the word from War Production Drive Headquarters following an extensive survey of 100 war plants, undertaken for the WPB by Wheeler Beckett, well-known conductor and composer.

Beckett reported to WPB that planned industrial music is universally liked by the worker and, once given a fair trial, was equally liked by management.

In his nationwide tour Beckett learned that 76 of the 100 plants offered music by phonograph records. Improved morale was claimed by 87 per cent of these, while 57 per cent expressed belief music increased production.

The survey also shows that 50 per cent of the public-address installations in the 76 plants were made after July, 1942, and declared this indicated a new development in the American industrial scene. Throughout the country there are over 1000 leading war plants with broadcasting systems, according to a survey made by the Industrial and Sound Department of the Radio Corporation of America.

The principal value of industrial music in relation to efficiency, the WPB survey declared on the strength of its findings, is not in speeding up the worker to greater efforts, but in relaxing unnecessary tensions and creating a pleasant atmosphere for work.

Mr. Beckett also found an apparent relationship between the length of the music programs provided in factories and the claims of improved morale and increased production. Improved morale was reported by all the 39 plants using more than one hour of music per shift, while 66 per cent of this group claimed related increases of 5 to 10 per cent in production.

Commenting on the benefits of community singing by war plant employees, the report cites very favorable reactions to the current series of industrial sings and rallies conducted by Lucy Monroe, Director of Patriotic Music for RCA.

Other findings of the report are that music can be used as successfully in noisy departments as in quiet departments; that workers should be given some choice in the selection of music and should not be permitted to gain

Whistling to the music coming from the overhead loudspeaker, Kaye Grimm operates a coil-winding machine at the Camden plant of RCA Victor. According to WPB, music in war plants is a definite aid to production.

PRODUCTION AIDS

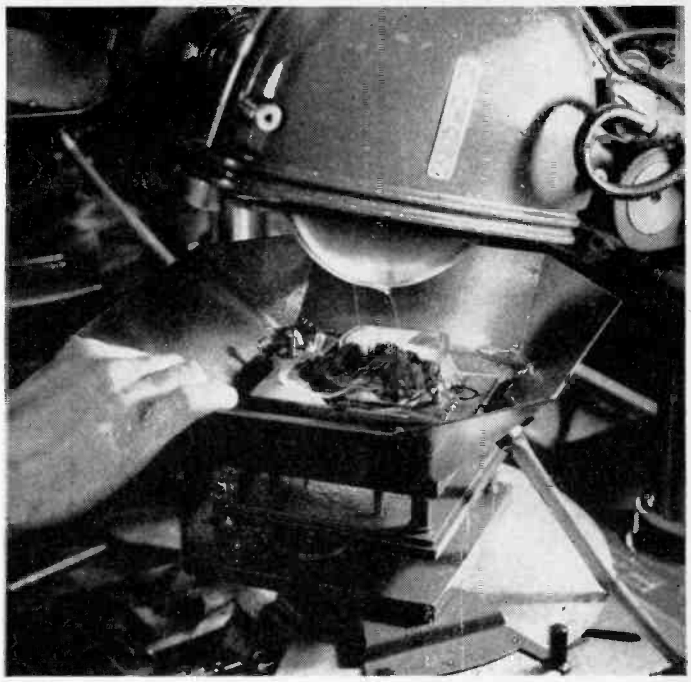
the impression they are part of a musical "experiment"; that plant broadcasting has incalculable value for uses other than music—such as paging, announcements, air-raid alarms, talks by visiting war heroes, and radio broadcasts of news and important speeches.

★

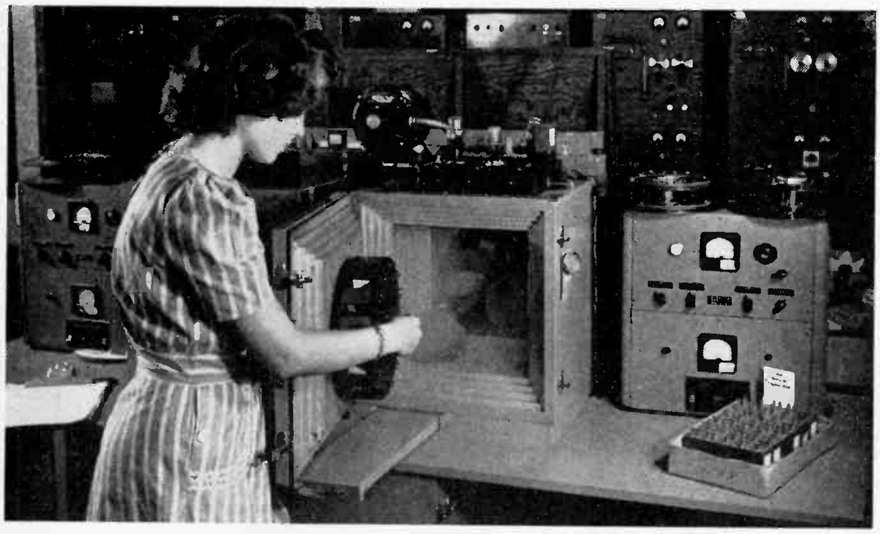
SALVAGING QUARTZ

John Meck Industries

★ Urgently needed walkie-talkie radio and electronic equipment for the Armed Forces is available in greater quantities through two new discoveries in the production of piezo-electronic quartz crystals at the John Meck Industries plant, Plymouth, Ind.



A newly developed diamond saw that, slicing crystals, saves cutting waste when working this critical war material.



A dry-ice test unit developed to transform radio quartz crystal production from a laboratory science to a mass-production industry. The unit is used to test crystals under temperatures as low as minus 10 degrees, Centigrade.

New cutting and salvage methods, employed in the Meck plant, are relieving the serious shortage of large, clear quartz crystals used to make oscillator plates for military transmitters and receivers, electronic devices, artillery range-finding and submarine-detecting gear.

Savings of the crystals, found only in Brazil, are now accomplished by employing thinner saws to slice the waferlike plates. Thus, much useless dust from sawing and grinding the virgin crystals is eliminated.

Salvage of formerly discarded inferior crystals for new special uses will make further economy possible.

Before these discoveries, supplies of the transparent, six-sided crystals were only half enough to fill orders of firms making military radio equipment.

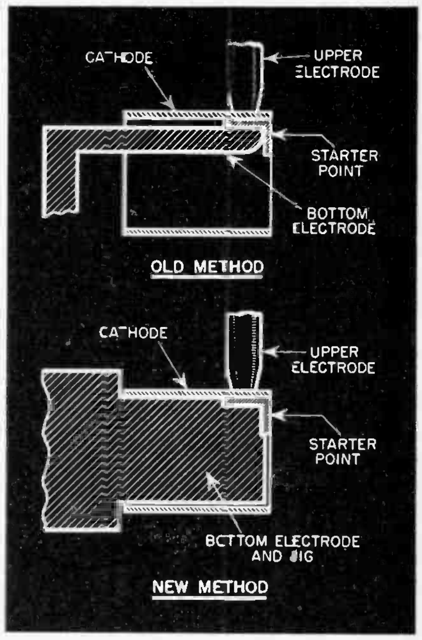
The two new production methods are part of the emergency developments which transformed quartz crystal production from a laboratory science to a mass production industry in less than a year.

Now, hundreds of thousands of crystal oscillator plates can be made from quartz formerly junked. Finer cutting saws, such as those used in the Meck plant, make it possible to utilize the good portions of a lower grade quartz that, before, accumulated into waste piles in Brazil.

VACUUM-TUBE WELDING JIG

By H. LIPSCHULTZ & F. STARESKI
Radio Corp. of America, Harrison Plant

★ This concerns the design of a positioning and welding jig for starter point and cathode. The old and new designs are shown in the accompanying illustration.



Vacuum tube welding jig.

Formerly, the welding of the starter point to the cathode was accomplished by holding the starter point with a pair of tweezers and holding the cathode by hand. The new jig makes this unnecessary and provides a more uniform product. Annual saving is estimated at $1120.

THEORY AND APPLICATION OF NOMOGRAPHS

PART I

R. G. MIDDLETON
Project Engineer, Templetone Radio Co.

★ Nomographs are mathematical short-cuts. The slide-rule is closely related to the nomograph, and operates upon the same basic principle. Both devices depend upon logarithms for their calculating power.

Semi-Log Paper

Fig. 1 shows a section of "semi-log paper." The axis of abscissas is uniformly divided into Cartesian intervals, but the axis of ordinates is divided into logarithmic intervals. Such a section of semi-log paper may be used as a slide-rule.

It will be noted in *Fig. 2* that we have multiplied successive decades above the X axis by ten, and that we have divided successive decades below the X axis by ten. In this manner the logarithmic relationship throughout the section is maintained.

It will also be noted that we have chosen the Y axis midway between the edges of the section, and that this axis carries the squares of the figures on the edges. Let us call the three vertical scales the *A*, the *B*, and the *D* scales.

If we lay a straight-edge from 0.1 on the *A* scale to 0.1 on the *B* scale, we may read 0.01 on the *D* scale. When we remember that we have laid off the *D* scale with the squares of the figures carried by the *A* (and

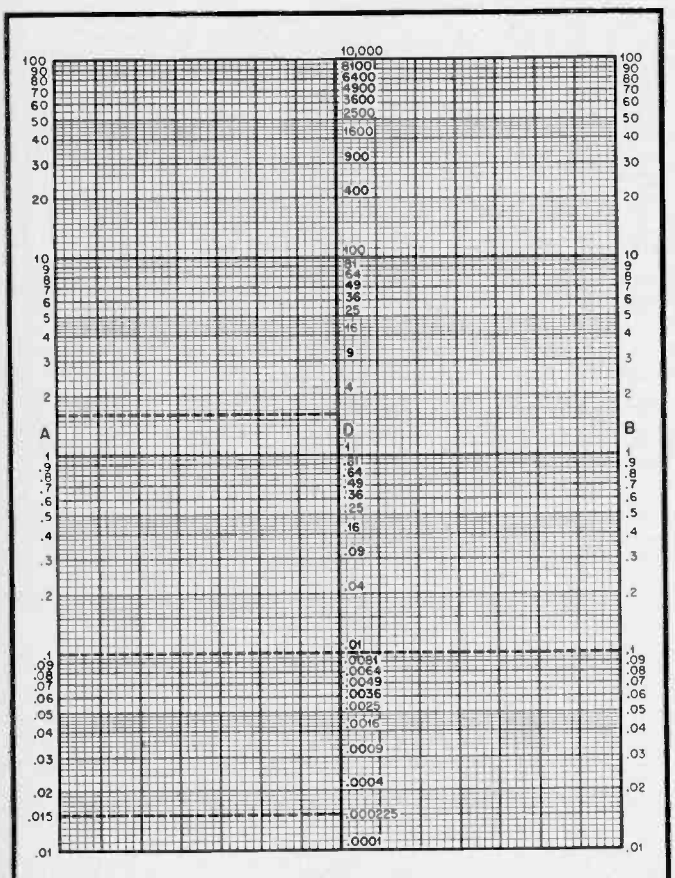


Fig. 2. By adding a D scale, graduated as shown, we may find the square or square root of any number. See text.

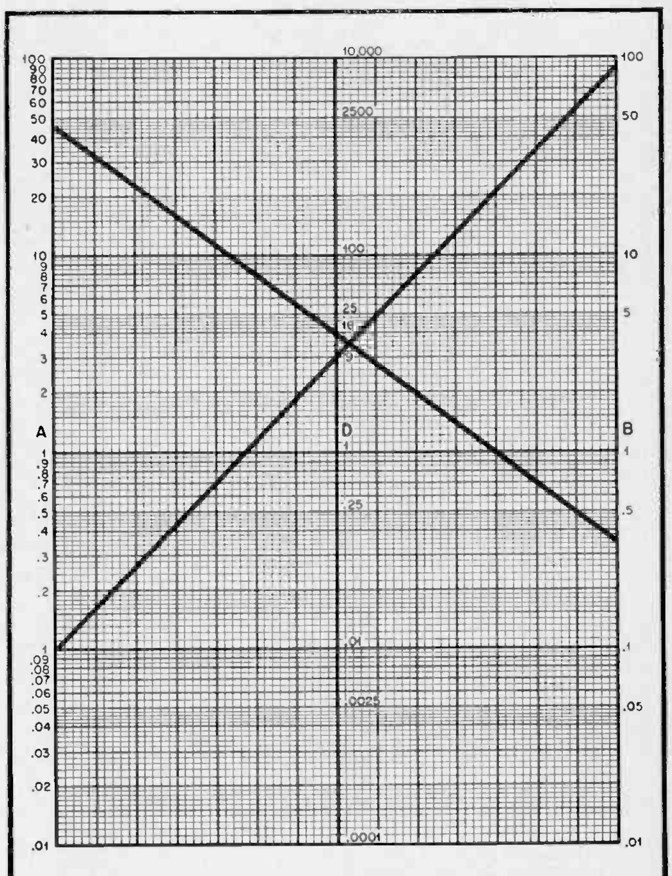


Fig. 3. A number may be multiplied or divided by any other number by drawing intersecting lines as shown. See text.

B) scales, we see that our answer follows immediately, since any number multiplied by itself is that number squared.

Thus we are able to square any number by finding this number on the *A* (or *B*) scale, and following its coordinate over to the *D* scale, where we may read its square. If we pick out 1.6 on the *A* scale and follow its coordinate to the *D* scale, we find its square, 2.56. (Note that the *D* scale is not a linear function of the *A* scale, and that the subdivisions of the *D* scale are to be assigned A^2 values in preparing the scale.)

The square root of a number is that number, which multiplied by itself, yields the original number. Therefore it is apparent that the nomograph will give us square roots as well as squares. If we wish to find the square root of 0.000225 *(Fig. 2)*, we may find this number on the *D* scale and read the corresponding root, 0.015 on the *A* scale.

Multiplication

This nomograph enables us to perform many other mathematical opera-

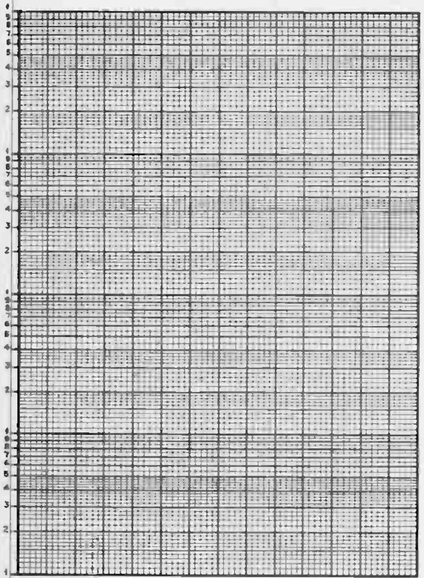


Fig. 1. A section of semi-log paper.

tions of greater difficulty, but first we may observe how to multiply and divide by this means.

We have seen in *Fig. 2* that we may multiply a number on *A* by the same number on *B* and get the square of the number on *D*. This is the operation of multiplying a number by itself. In *Fig. 3*, we see how a number on *A* may be multiplied by another number on *B*, and the answer read on *D*. Thus, 0.1 may be multiplied by 90 to yield 9 on *D*, as illustrated. Why is this the case?

We may call *D* the antilog scale; if

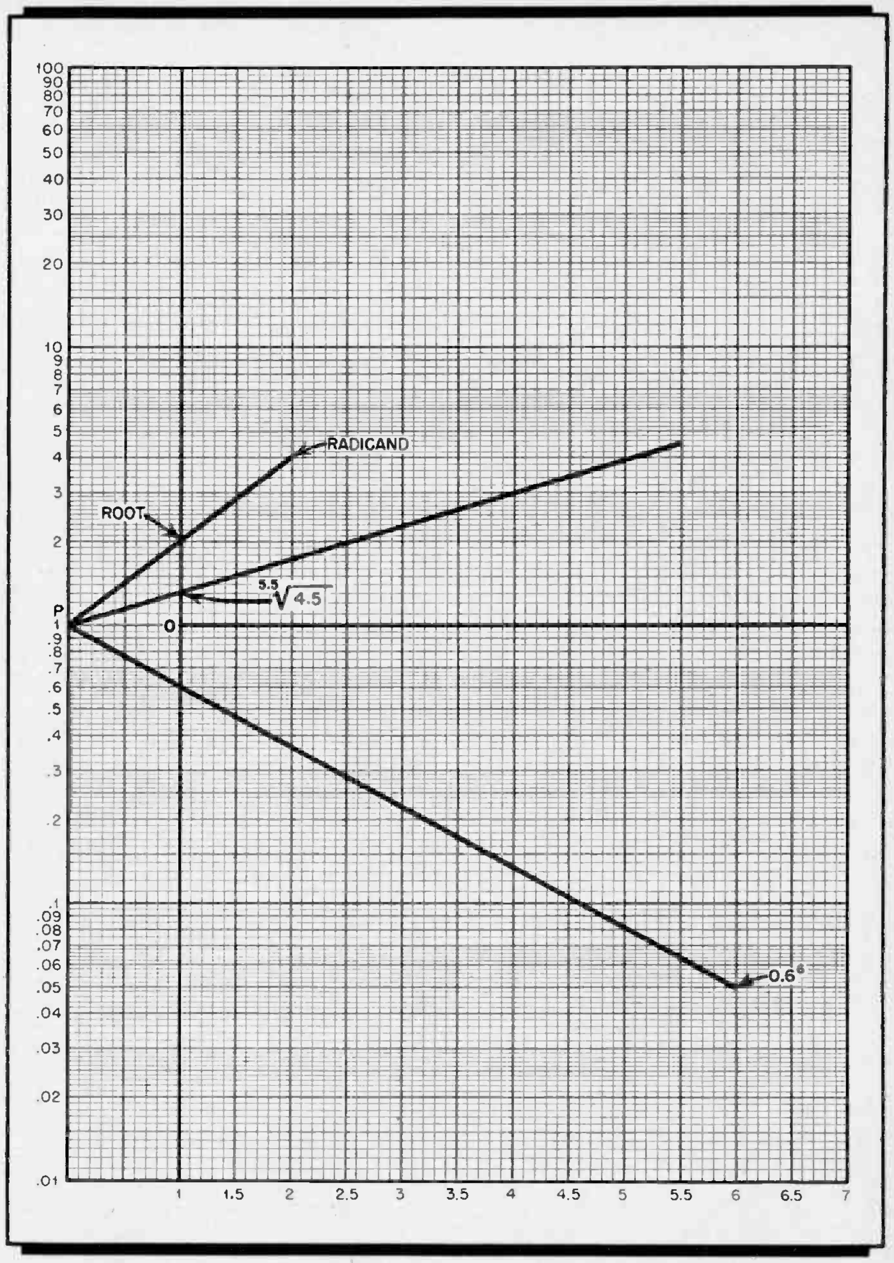


Fig. 4. This illustrates the application of semi-log paper to obtain any power or any root of a number.

we could add log *A* and log *B* as we do on the slide rule, antilog scale *D* could be graduated identically with *A* (or *B*). However, we may observe from elementary geometry that the projection of *B* on *D* is only one-half at the point of intersection of the straight edge on *D;* logarithmically, we must then square the "answer" as we otherwise obtain the square root. However, this property of the nomograph of yielding roots is useful, as we shall see how to extract any root whatever of any number.

To obtain any product, therefore, we may select the multiplier on the *A* scale *(Fig. 3)*, select the multiplicand on the *B* scale, and read the product on the *D* scale.

Division

The nomograph is equally useful for division, since numbers on *A* and *B* are factors of specified numbers on *D*. For example, to divide 16 by 45, we may lay a straight edge from 45 on *A*, through 16 on *D*, and read 0.355 on *B*. Of course, we could have taken 45 on *B* and have read 0.355 on *A*.

It is easy to see how we may work a problem such as:

$$X = \frac{0.31\sqrt{.785}}{(2.71)^2}$$

on the nomograph. We may start anywhere we like, obtaining one relation, and proceeding to operate upon the obtained relation to obtain the next relation. For example, we may take the square root of 0.785 and divide it by the square of 2.71, multiplying the quantity by 0.31 to obtain *X*. If the

[*Continued on page 71*]

G. E. REVEALS POST-WAR NETWORK PLANS

Institute Equipment Reservation Plan Centered Around Deposit of War Bonds. Complete Service Offered

★ The General Electric Company has announced a reservation plan for the purchase of post-war radio broadcasting equipment, requiring the deposit of United States war bonds with the company in sums varying with the amount of equipment reserved for post-war delivery.

The plan will help General Electric prepare for an orderly transition from wartime to peacetime manufacture, and help keep workers at their jobs, Paul L. Chamberlain, in charge of sales for the company's transmitter division, told a meeting of 50 General Electric sales executives, newspaper and magazine representatives at the Waldorf-Astoria hotel. "It will also support the war effort and enable broadcasters to make a definite reservation for equipment to be built and delivered as soon as conditions permit," he explained. The plan is being mailed by the company to the industry.

Pointing out that General Electric is building almost a million dollars worth of military radios every working day, Mr. Chamberlain said that the company in the post-war period will be able to furnish the broadcaster everything from microphone to antenna, including buildings, and will finance the whole transaction if the broadcaster's credit is good.

Future For FM

W. R. David, in charge of broadcast transmitter sales for the G. E. transmitter division, told the group that "FM radio stations will eventually supplant all local, most of the regional, and some of the high power AM stations now in operation." He predicted that five years after the war there will be 500 FM stations in operation (compared with about 50 today) and 750 AM stations. The United States also will have 100 television stations (compared with nine today) and 50 international shortwave stations in operation at that time, Mr. David said.

ST relay equipment, such as that shown above, will be used for setting up wireless FM networks. Such grids may be operated as public utilities.

He predicted further the extensive use after the war of "wireless" FM networks. Whereas their use is limited today because it is necessary for each station in the chain to pass the program along to the next station, Mr. David said that "tomorrow's wireless FM networks will differ from today's in that the relay transmitters will be operated on very high frequencies. They will be small units with highly directional antennas located at strategic high points and probably operated automatically," he explained. "Such stations may be set up as a public utility, similar to the telephone system, or they may be set up as an auxiliary operation of the major networks. In this type of wireless network, the intermediate broadcast stations will not be responsible for passing the program on to the next station."

FM Post-War Market

In the areas where FM stations are now operating, there is an immediate potential post-war market for 12,500,000 home radio receivers with the FM band, he said, and there is another big market in car radios with this same FM service. The American public after the war will probably consider a radio receiver without FM as being obsolete, and this will furnish a strong incentive for the purchase of sets with the new kind of reception service included, the group was told.

In elaborating on the broadcasting equipment reservation plan, Mr. Chamberlain said that the plan is not an order for equipment. "The broadcaster will not have to sign a contract to buy. Under the terms of the plan, he can place his order for equipment at any time up to 90 days following the date when the production and sale of commercial transmitters is authorized. To maintain his reserved position, he must enter into a mutually satisfactory sales contract within this 90-day period. The bonds remain the property of the broadcaster, of course, as well as all income from them. They will be returned when a contract is

[Continued on page 73]

RADIO DESIGN WORKSHEET

No. 18—BRIDGE BALANCE; CATHODE FOLLOWER; AMPLIFIER GAIN; TRANSFORMER VOLTAGE RELATIONS

WHEATSTONE BRIDGE BALANCE

Problem: *Determine the conditions of balance of a generalized Wheatstone Bridge circuit.*

Solution: Referring to *Fig. 1,* the con-

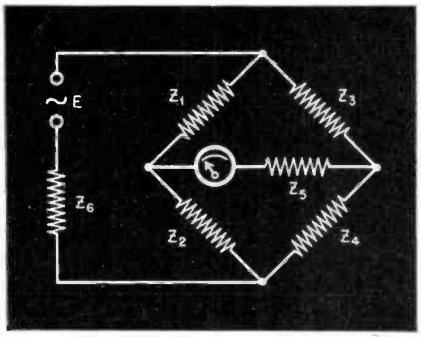


FIG. 1

dition of balance is: $Z_1Z_4 = Z_2Z_3$, which is equivalent to:

$$R_1R_4 - R_2R_3 = X_1X_4 - X_2X_3$$
$$R_1X_4 + R_4X_1 = R_2X_3 + R_3X_2$$

Let it be assumed that one of the arms is unknown and is to be determined in terms of the others.

$$R_1 = \frac{R_4\,(R_2R_3 - X_2X_3) + X_4(R_2X_3 + R_3X_2)}{R_4^2 + X_4^2}$$

If arm 4 is made up of a resistance and reactance in shunt, its impedance is:

$$Z_4 = R_4 + jX_4 = R\frac{X^2}{R_2^2 + X^2} + jR^2\frac{X}{R^2 + X^2}$$

And the conditions for balance thus become:

$$R_1 = \frac{R_2R_3 - X_2X_3}{R} + \frac{R_2X_3 + R_3X_2}{X}$$

$$X_1 = \frac{R_2X_3 + R_3X_2}{R} - \frac{R_2R_3 - X_2X_3}{X}$$

The current in any arm thus may be found from the generalized equations:

$$I_1 = E\,[Z_5(Z_3+Z_4) + Z_3\,(Z_2+Z_4] \div (Z_1+Z_2)\,(Z_3Z_4+Z_5Z_6) + (Z_3+Z_4)\,(Z_1Z_2+Z_5Z_6) + (Z_5+Z_6)\,(Z_1Z_4+Z_2Z_3) + Z_5\,(Z_1Z_3+Z_2Z_4) + Z_6\,(Z_1Z_2+Z_3Z_4)$$

$$I_5 = E\,(Z_2Z_3 - Z_1Z_4) \div (Z_1+Z_2)\,(Z_2Z_4+Z_5Z_6) + (Z_3+Z_4)\,(Z_1Z_2+Z_5Z_6) + (Z_5+Z_6)\,(Z_1Z_4+Z_2Z_3) + Z_5\,(Z_1Z_3+Z_2Z_4) + Z_6\,(Z_1Z_2+Z_3Z_4)$$

$$I_6 = E\,[Z_5(Z_1+Z_3) + (Z_2+Z_4)\,(Z_1+Z_3+Z_5)] \div (Z_1+Z_2)\,(Z_3Z_4+Z_5Z_6) + (Z_3+Z_4)\,(Z_1Z_2+Z_5Z_6) + (Z_5+Z_6)\,(Z_1Z_4+Z_2Z_3) + Z_5(Z_1Z_3+Z_2Z_4) + Z_6\,(Z_1Z_2+Z_3Z_4)$$

It is obvious from the above and may be proven by Thevenin's Theorem that the generator and detector may be interchanged without altering the balance. Also in any Wheatstone Bridge circuit, if every pure inductance and capacitance be replaced by a pure capacitance and inductance respectively, a new bridge circuit with the same balance conditions results.

Three interesting bridge structures of the type under discussion are shown in *Figs. 2, 3* and *4.*

In *Fig. 2* the balance conditions are:

$$R_1(R_4+R_x) = R_2R_3$$
$$L_2/C_3 = R_1R_4\,(1 - R_x/R_3)$$

where $R_3 + R_x$ = total resistance of arm 3.

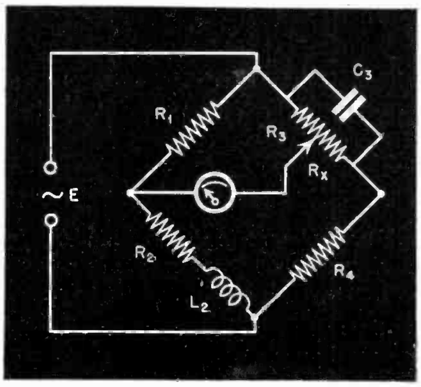


FIG. 2

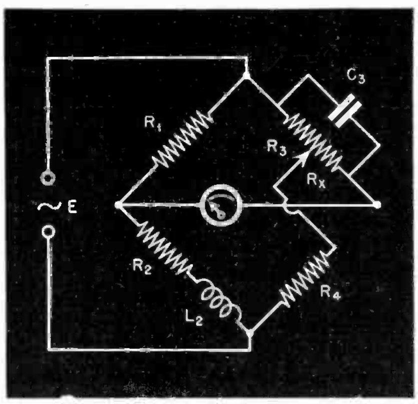


FIG. 3

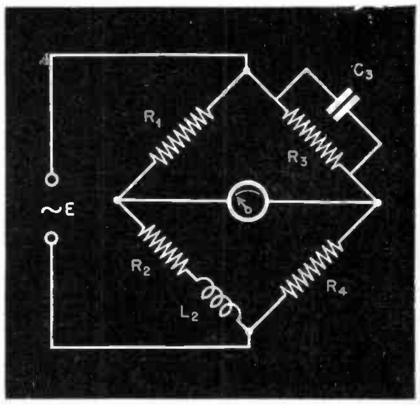


FIG. 4

In *Fig. 3* the balance conditions are:

$$R_1R_4 = R_2R_3$$

$$L_2/C_3 = R_1R_4\left(1 + R_x\frac{R_3 + R_4}{R_2R_4}\right)$$

where $R_3 + R_x$ = total resistance in arm 3.

In *Fig. 4* the balance conditions are:

$$X_1 = X_4 = 0$$
$$X_2 = \omega L_2$$
$$X_3 = -\frac{1}{\omega C_3}$$

whence:

$$R_1R_4 = R_2R_3$$
$$L_2/C_3 = R_1R_4$$

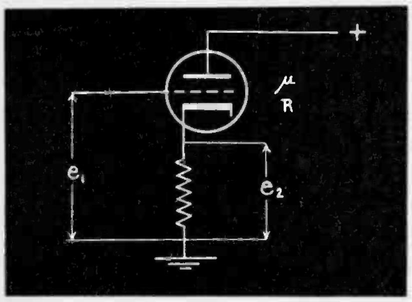
CATHODE FOLLOWER

Problem: *Determine the stage gain of a cathode-follower circuit.*

Solution: The schematic shows the circuit of a cathode follower. Let:

μ = amplification factor of tube
R = plate impedance of tube
r = cathode load resistor
e_1 = input voltage, grid to ground

[*Continued on page 46*]



Cathode follower circuit.

$e_2 =$ output voltage, cathode to ground
$I_c =$ a.c. passing through r

We have:

$$I_c = \frac{\mu(e_1 - I_c r)}{R + r}$$

$$I_c R + I_c r = \mu e_1 - \mu I_c r$$

Whence:

$$I_c\ (R + r + \mu r) = \mu e_1$$

And:

$$I_c = \frac{\mu e_1}{R + r + \mu r}$$

$$e_2 = I_c r = \frac{\mu e_1 r}{R + r + \mu r}$$

$$\frac{e_2}{e_1} = \frac{\mu r}{R + r\ (1 + \mu)}$$

which is the stage gain required.

STABLE AMPLIFIER GAIN

Some years ago, when tuned radio frequency receivers were in vogue, high-gain high-frequency amplifiers were quite common. The advent of the superheterodyne changed this to the extent that the high-gain amplifier (intermediate frequency) was operated at a lower frequency and was fixed rather than variable in frequency. Now intermediate frequencies of several megacycles have become common.

One of the early limits on amplifier gain was stability. This was improved by shielding, elimination of common ground paths, low-impedance bypassing and proper filtering. Later neutralizing, and the general use of screen-grid tubes improved the situation still further. However, maximum stable gain was still a problem.

In 1926 Hall and Williams showed that the limiting stable amplification of an amplifier stage was given by the relation:

$$\text{gain} = \sqrt{\frac{G_m}{\omega C} + 1} + 1$$

in which: $G_m =$ the tube transconductance in mhos
$C =$ the input to output capacitance in farads

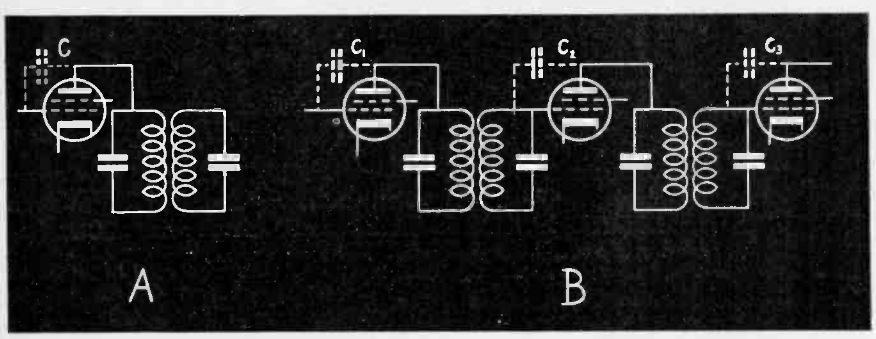
This formula may be applied to a multi-stage amplifier as well as to a single stage. In a carefully designed amplifier, as at A in the accompanying drawing, C is the effective grid-to-plate capacitance. For a multi-stage amplifier, as at B in the drawing, C can be replaced by C/N, where N represents the number of identical stages. If the stages are not identical, then C is the amplifier input-output capacitance resulting from all the grid-to-plate capacitances in series. Thus, in circuit B:

$$1/C = 1/C_1 + 1/C_2 + 1/C_3$$

If $C_1 = C_2 = C_3$

$$C = C_1/N$$

This is still a useful formula and one that should be kept in mind by every designer.



Grid-to-plate capacitance in single- and multi-stage amplifiers.

TRANSFORMER VOLTAGE RELATIONS

Problem: *Determine the conditions for maximum secondary current in a transformer.*

Solution: From the accompanying figure we have:

$$\text{Primary current} = I_1 = \frac{E}{Z_1 + j\omega L_1 + \dfrac{\omega^2 M^2}{Z_2 + j\omega L_2}}$$

where: $\omega = 2\pi f$
$j = \sqrt{-1}$
and: $I_2/I_1 = j\omega M/Z_2 + j\omega L_2$

Let Z_2 be fixed in magnitude and phase. Then maximum power will be delivered to Z_2 when I_2 is maximum. We have:

$$I_2 = \frac{E}{\dfrac{Z_1 Z_2}{j\omega M} + \dfrac{L_1 Z_2 L_2 Z_1}{M} + j\omega\dfrac{L_1 L_2 - M^2}{M}}$$

If the transformer neither stores nor dissipates power, maximum power will be delivered when:

$$\frac{Z_1 Z_2}{j\omega M} = j\omega\frac{L_1 L_2 - M^2}{M} = 0$$

and:

$$\frac{L_1}{M} = \frac{L_2}{M} = \infty$$

For this condition:

$$I_2 = \frac{E}{Z_2\sqrt{L_1/L_2} + Z_1\sqrt{L_2/L_1}}$$

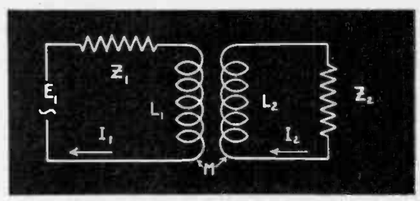
Let: $\sqrt{L_1/L_2} = K$
And let: $Z_2 = R_2 + jX_2$
$Z_1 = R_1 + jX_1$

Then:

$$I_2 = \frac{E}{(KR_2 + R_1/K)^2 + (KX_2 + X_1/K)^2}$$

in magnitude only.

Let the denominator of the above



Equivalent circuit of transformer.

expression be equal to $\sqrt{A}$. Then I_2 will be maximum when $\sqrt{A}$ is minimum which must satisfy:

$$\frac{\delta}{\delta K}\sqrt{A} = \frac{\delta}{\delta A}\sqrt{A} \times \frac{\delta A}{\delta K} = 0$$

But $\delta A/\delta A$ cannot be zero.

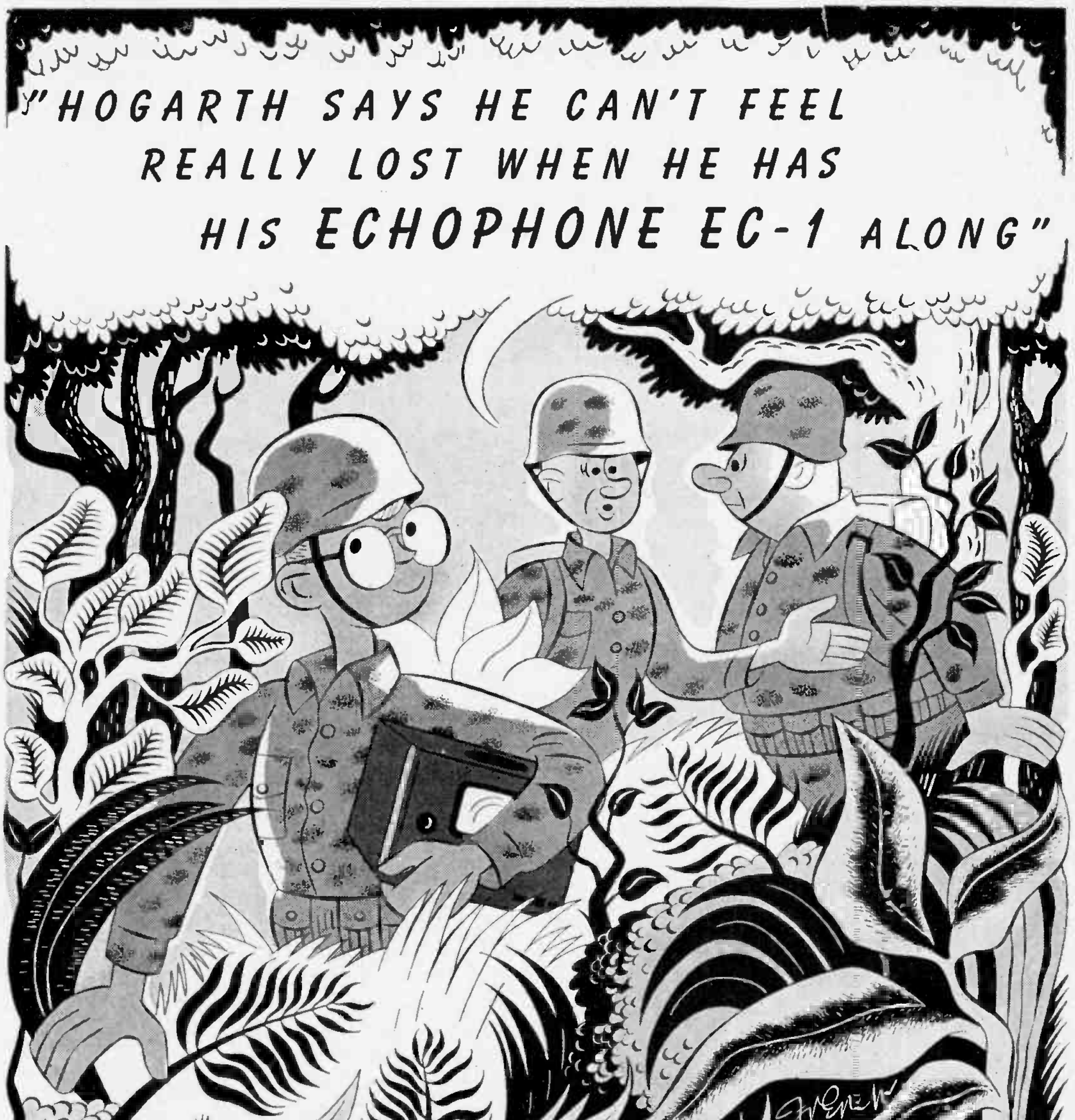
Therefore: $\dfrac{\delta}{\delta K} A = 0$

$$\frac{\delta A}{\delta K} = (KR_2 + R_1/K)\ (R_2 - R_1/K^2) + (KX_2 + X_1/K)\ (X_2 - X_1/K^2) = 0$$

$$K^2 = \frac{\sqrt{R_1^2 + X_1^2}}{\sqrt{R_2^2 + X_2^2}} = \frac{L_1}{L_2}$$

Whence:

$$I_2 = \frac{E}{\sqrt{2R_1R_2}} \div \sqrt{1 + \frac{X_1X_2}{R_1R_2} + \sqrt{\left(1 + \frac{X_1^2}{R_1^2}\right)\left(1 + \frac{X_2^2}{R_2^2}\right)}}$$



Echophone Model EC-1

(Illustrated) a compact communications receiver with every necessary feature for good reception. Covers from 550 kc. to 30 mc. on three bands. Electrical bandspread on all bands. Beat frequency oscillator. Six tubes. Self-contained speaker. Operates on 115-125 volts AC or DC.

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

BOOK REVIEWS

PRACTICAL RADIO COMMUNICATION (Revised second edition), by Arthur R. Nilson and J. L. Hornung. Published by McGraw-Hill Book Co., Inc., New York, N. Y., 927 pages. Price $6.00.

The authors of this handbook have done an excellent job in revising and bringing up to date the material in their well-known text. The first edition, printed in 1935, has been widely used in radio schools engaged in training men to become radio operators and technicians. Although the needed chapters on basic principles have been retained, their value for home-study purposes has been enhanced by the inclusion of problems and more detailed explanations of the application of fundamental laws.

The scope of the book has been widened to include the principles of high-efficiency radio-frequency amplifier design, as well as other receiver circuits. There are new chapters on frequency modulation, ultra-high-frequency theory and practice, aviation radio, antenna arrays, and the latest broadcast equipment. Marine radio is given extensive coverage, four chapters being devoted to this subject, which includes modern direction finders and automatic alarms.

Approximately two-thirds of the the text is new and up-to-the-minute. Even the new frequency-band designations, released by the Federal Communications Commission only last March, are included.

The book is simply and clearly written. The authors are to be congratulated for refraining from the common practice of bursting into highly complicated mathematical equations when they encounter points difficult to handle non-mathematically. Not that the book is non-technical; far from it. When it is necessary to use mathematics, equations are given—usually with numerical examples of their application which should help greatly those who have had no extensive background in this subject or, as is often the case, have forgotten through disuse, what they did learn at school.

The chapter on frequency modulation has been very well handled and contains much information which this reviewer has not found in other texts. However, the description of limiter action given on page 414-415 contains a minor error. The operating point of the limiter tube does not remain fixed at zero bias, as is shown in the diagram, so that the grid becomes highly positive on the positive swing of the input signal wave. Instead, the operating point changes as soon as the grid commences to draw current, due to the resulting voltage drop across the resistor in the circuit. In practice, the grid never becomes more than a few millivolts positive, using the circuit shown in the book. The description of limiter action should accordingly be altered to take cognizance of this condition. This same error has occurred in other published descriptions of limiter action.

There is much that is valuable not only to the technician and radio operator to whom this text is primarily directed but also to engineers, who will find it contains much-needed information which has been omitted in other reference books. We are glad to recommend it to all in the radio field.

J. H. P.

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BASIC ELECTRICITY FOR COMMUNICATIONS, by W. H. Timbie. Published by John Wiley and Sons, Inc., New York, N. Y., 603 pages. Price $3.50.

Professor Timbie states in the preface to this, his most recent book, that he has preferred to confine himself to a few fundamental ideas, adequately presented, rather than to a discursive treatment of many.- By selecting those basic principles which workers in the fields of communications and industrial electronics must know, and know thoroughly, the author has created a text which will be found invaluable for school or home study to those to whom it is directed.

This is a practical book. After a few pages on the physical theory, the author includes a long chapter on Ohm's law, with many problems carefully explained with which the worker is likely to be confronted. This is followed by a discussion of electrical power and energy, similarly handled. Magnets and magnetic circuits, generators and motors, inductance, capacitance, and an excellent chapter on alternating currents follow.

With this preliminary background, the student is then introduced to methods of circuit simplification for the purposes of analysis in which useful applications of Thevenin's theorem are given. The longest chapter, over one hundred pages, is devoted to vacuum tubes and gaseous conduction, with practical problems illustrating their application in modern circuits. The chapter on batteries, generally overlooked in other texts of this nature, contains much-needed information. The last chapter covers briefly the fundamentals of various electrical communication systems.

This book is already becoming widely used as a standard text on the subject and is recommended as such.

J. H. P.

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PRINCIPLES AND PRACTICE OF RADIO SERVICING (Second Edition), by H. J. Hicks. Published by McGraw-Hill Book Co., Inc., New York, N. Y. 391 pages. Price $3.50.

In this, the second edition of his well-known book, the author has almost completely revised the text of the first edition. Much new material, such as signal tracing, frequency modulation, and modern antennas, has been added and many new diagrams and original photographs have been included.

The author has had many years of experience in teaching men engaged in radio service work and vocational school students, and this is reflected in the clarity with which he explains fundamental principles and in the sound, practical viewpoint which he brings to this subject. He understands the problems with which the serviceman must contend, both technical and financial, and neither is overlooked; the last chapter is devoted to the business side of radio servicing and should be studied by every radio serviceman.

The circuit diagrams of typical commercial test equipment, most of which give circuit constants, will be found especially valuable these days when it is so difficult to get such apparatus repaired by the manufacturer.

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FUNDAMENTAL RADIO EXPERIMENTS, by Robert C. Higgy. Published by John Wiley and Sons, Inc., New York, N. Y. 95 Pages. Price $1.50.

This laboratory manual describes experiments showing the application of

[*Continued on page 70*]

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Q. & A. STUDY GUIDE

C. RADIUS

STUDIO EQUIPMENT—II

Attenuators

14. What is the purpose(s) of H or T pad attenuators? (IV-28)

15. What is the purpose of a "line pad"? (IV-30)

16. Why is a high-level amplifier, feeding a program transmission line, generally isolated from the line by means of a pad? (IV-39)

17. What is the purpose of a variable attenuator in a speech input system? (IV-36)

Pre-Amplifiers

18. What is the purpose of a pre-amplifier? (III-157)

19. If a pre-amplifier, having a 600-ohm output, is connected to a microphone so that the power output is —40 db, and assuming the mixer system to have a loss of 10 db, what must be the voltage amplification necessary in the line amplifier in order to feed +10 db into the transmitter line? (IV-65)

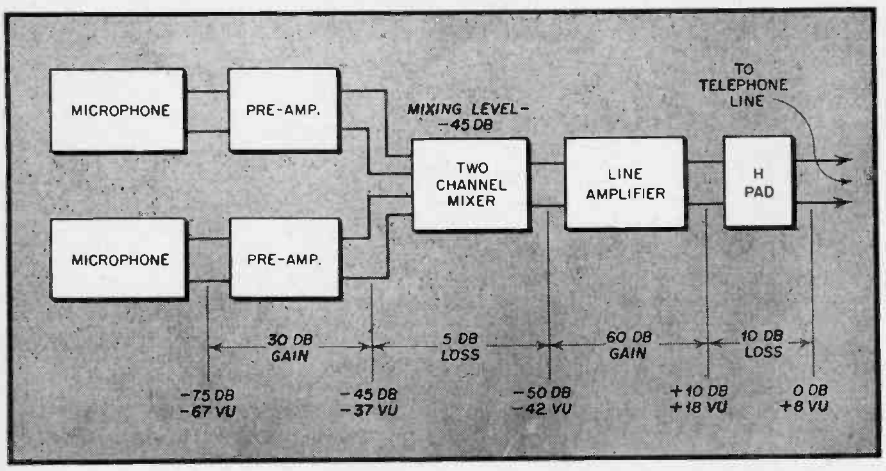


Fig. 1. Two-channel circuit using high-level mixing.

Mixers

20. Draw a simple diagram showing four mixers connected in series-parallel, using compensating resistors and feeding a balanced load with proper matching. (IV-32)

21. Why are pre-amplifiers used ahead of mixing systems? (IV-35)

Fig. 3-A shows a T type attenuator which is designed to be used in a matched circuit; that is, one having equal input and output impedances, $Z_1 = Z_2 = Z$, in order to give a logarithmic variation (decrease) in E_2 when E_1 is held constant. All three elements A, B, and C are resistances whose magnitude varies logarithmically with uniform rotation of the common shaft. In practice these networks will give an attenuation in steps of 1.5 or 2 db. For 10-db attenuation of the signal E_1 in a 500-ohm circuit, $E_2 = 0.316 \times E_1$, $A = B = 260$ ohms, $C = 351$ ohms.

If we consider the input impedance Z_1 when $Z_2 = 0$; that is, a short-circuited termination, we find Z_1 to be 409 ohms. Also, when Z_2 is infinite, (an open-circuit) we find Z_1 to be 611 ohms. Hence, for the maximum variation in the load impedance Z_2, the input impedance Z_1 is approximately 500 ± 100 ohms. The generator is thus "isolated" from the load; i. e., large variations in the load impedance cause only a small variation in the actual load on

[*Continued on page 52*]

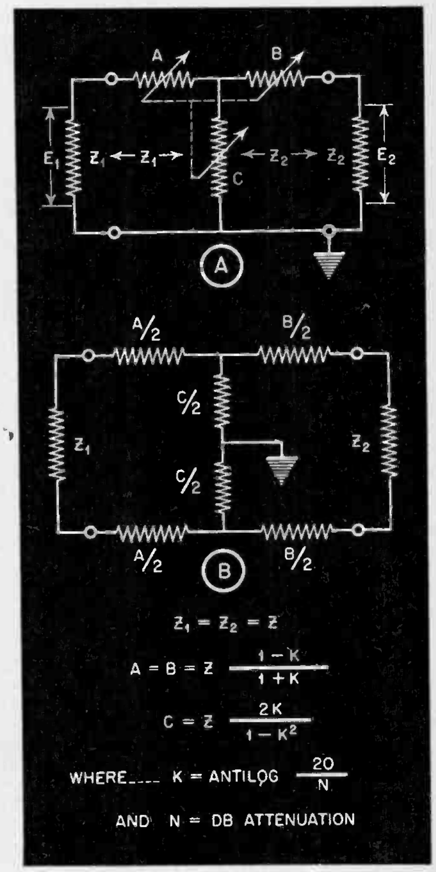


Fig. 3. T & H pad attenuators.

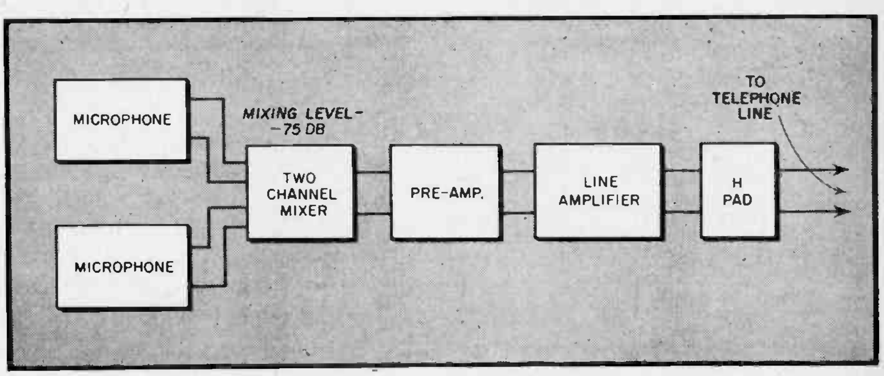


Fig. 2. Two-channel circuit using low-level mixing.

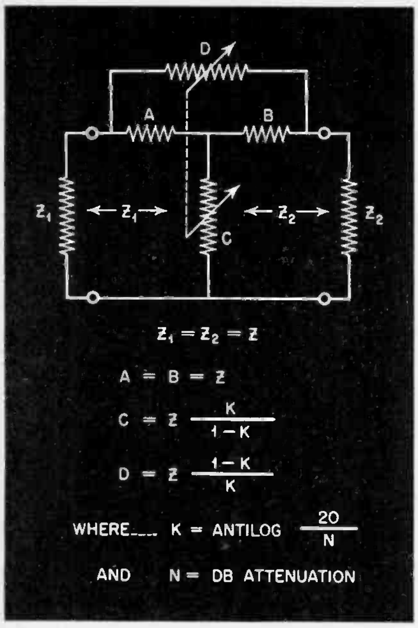


Fig. 4. Bridge T attenuator.

the generator. It is obvious that this degree of "isolation" will decrease as the attenuation decreases. This is one of the main reasons for the insertion of fixed attenuators in the studio speech equipment channels. See *Fig. 1.*

In the case of the T type attenuator, one line is at "ground" potential and the other above ground potential. Also, the impedance-to-ground on one line is zero, on the other line it is *C*. Both of these factors can be made equal for each line by the use of an H type attenuator, as shown in *Fig. 3-B*. Such an arrangement is called a balanced attenuator, indicating that both lines are at the same impedance and potential with respect to ground. This arrangement helps to reduce the effect of currents induced into the circuit from extraneous sources.

A more favorable signal-to-noise ratio can be obtained by the use of a Bridge-T type attenuator in which there are only two variable elements. This circuit, with its design equations, is given in *Fig. 4*.

Matching Pads

There are many applications for fixed attenuators (pads) in which the input impedance Z_1 is not equal to the output impedance Z_2. *Fig. 5* shows the unbalanced and balanced minimum loss matching attenuators with the design equations. These networks are used to transform impedances. For example, a 500-ohm incoming line may be changed to a 600-ohm line by the use of a 500- to 600-ohm fixed pad. Likewise, a 250-ohm output impedance of a microphone may be matched to a 600-ohm T type attenuator in a mixer circuit by the use of a 250- to 600-ohm fixed pad. For a minimum loss pad of this type where $Z_1 = 250$ ohms, $Z_2 = 600$ ohms; $B = 459$ ohms, $C = 328$ ohms. The voltage ratio $E_1/E_2 = 1.76$, which represents 4.9 db voltage attenuation. By the use of this pad we have provided the proper loading for the microphone and the proper source impedance for the attenuator. This will result in attaining the desired frequency response by causing the transmission of power to be uniform over a wide range of frequencies.

Mixing

In the broadcast station it is necessary to combine the outputs of two or more microphones or transcription pickups into a single circuit and to

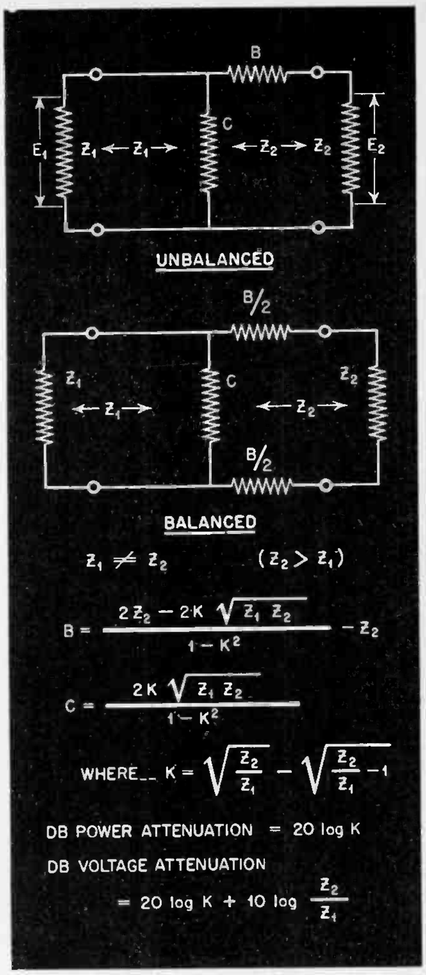


Fig. 5. Impedance-matching pads.

be able to vary the amplitude of each signal independent of the other. This process is known as "mixing" and may be of two types, as indicated in *Figs. 1* and *2*. High-level mixing has the more favorable signal-to-noise ratio but requires a pre-amplifier in each channel.

In question No. 19 the pre-amplifier is ahead of the mixer. This is high-level mixing. If the input to the mixer is —40 db, with a 10-db loss in the mixer, a line amplifier with 60 db gain is required to feed a +10-db signal to the telephone line. Since the input and output impedances of the line amplifier are the same, usually 600 ohms, 60 db represents the voltage gain as well as the power gain.

Mixer Circuit

Fig. 6 shows how four signals can be combined in a series-parallel arrangement and feed a composite signal into the balanced input circuit of a pre-amplifier or line amplifier. Since it is necessary to transmit a band of frequencies, say 30 to 10,000 cycles, uniform frequency response is the first consideration in the design of the mixing circuit. To accomplish this,

[*Continued on page 77*]

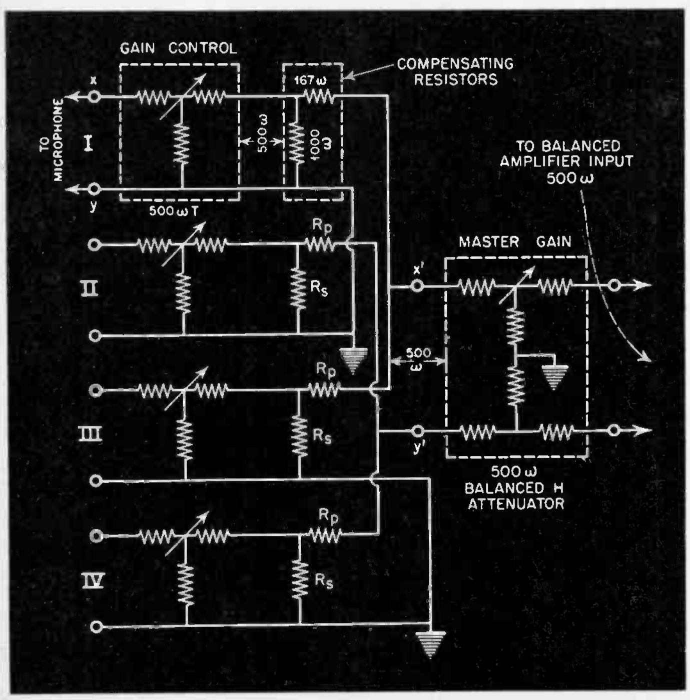
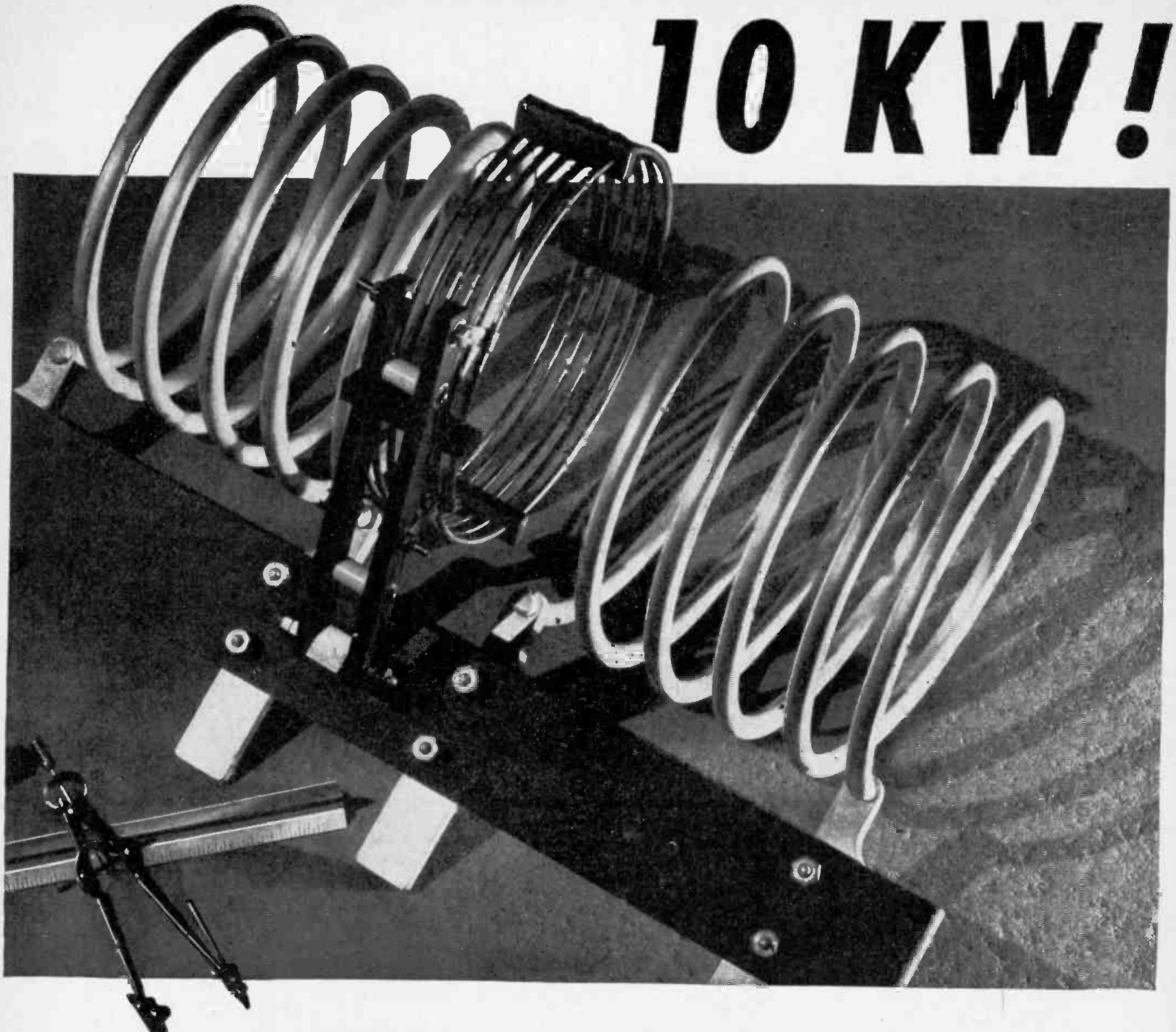


Fig. 6. A four-channel series-parallel mixer with balanced output circuit.

10 KW!



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[*Continued on page 56*]

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[*Continued on page 58*]


MORE SPEAKER FOR THE MONEY
-LESS MONEY FOR REPAIRS!
RACON
FOR VICTORY BUY WAR BONDS STAMPS
RACON loudspeakers and driving units generally cost less than competitive brands because a low power-rated (and lower priced) RACON will outperform higher power-rated units of other manufacture. In other words, catalog list prices are meaningless in comparing loudspeaker values.
RACONS are the finest that money can buy, afford greater operating efficiency, require less repairs. Receiver units are supplied with either metal or plastic diaphragms. There is a RACON horn, speaker, driver or trumpet for every conceivable sound application. Send for our catalog.
RACON is the world's largest manufacturer of air-column horns and speakers.
RACON ELECTRIC CO., 52 E. 19th St., New York, N. Y.
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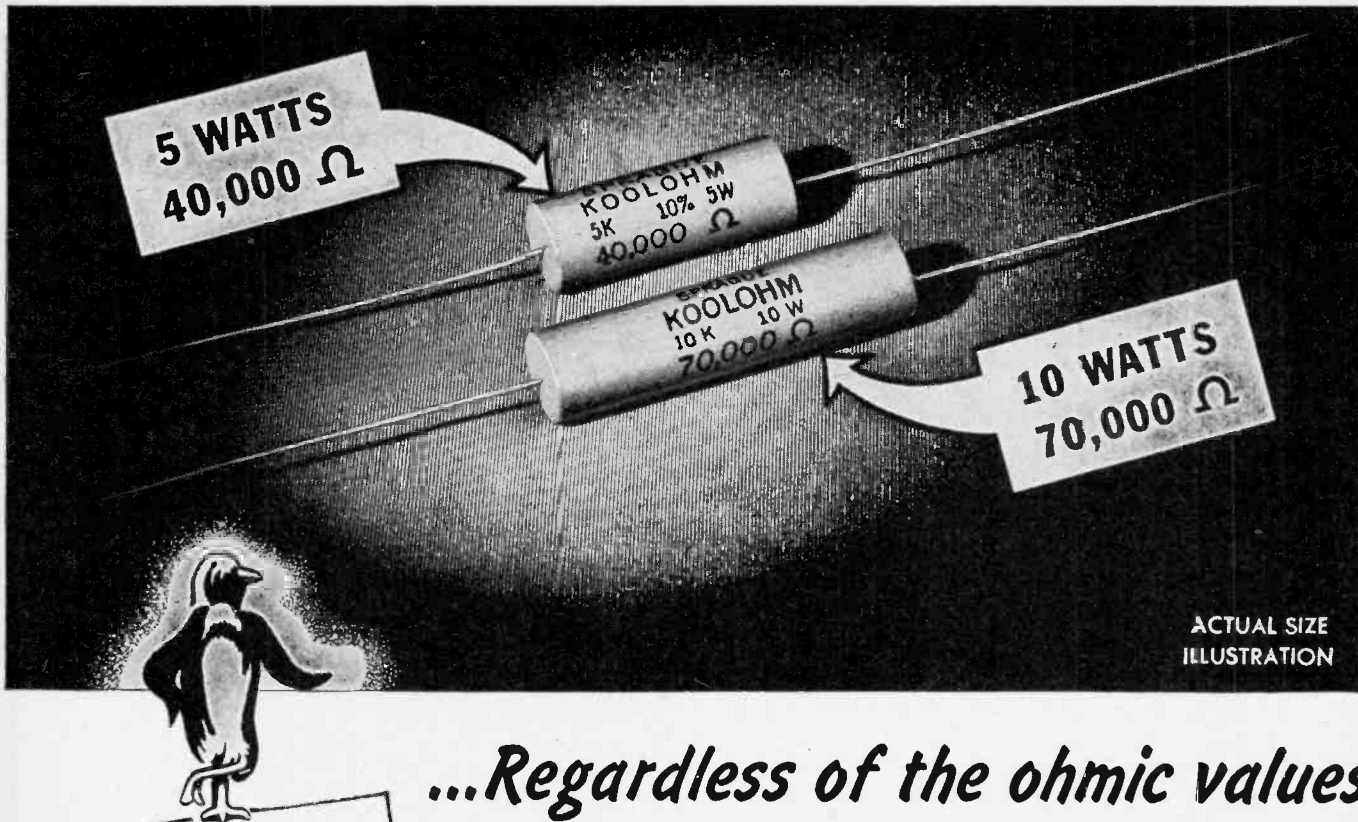
(*Conclusion*)

THESE RESISTOR WATTAGE RATINGS MEAN WHAT THEY SAY



ACTUAL SIZE ILLUSTRATION

...*Regardless of the ohmic values*

KOOLOHM WIRE IS 2¼ TIMES LARGER

Although Koolohm Resistors themselves are no larger—often smaller—than ordinary resistors, their wire is 2¼ times larger in actual cross-sectional area! This is especially important in the high resistance values where very fine wires so often fail to carry the currents involved in power resistor operation, or to withstand the corrosive effects of operation in high humidities *Play safe* with Koolohms

If it's a 5-watt Koolohm, use it at its full 5-watt rating—regardless of whether it has a 1 ohm or a 40,000 ohm value! If it's a 10-watt Koolohm you can count on it dissipating a full 10 watts whether the resistance value is 1 ohm or 70,000 ohms!

In brief, there's no need to "play safe" with Koolohms. You don't have to use a larger resistor than you actually require. You can forget your worries as to whether the wire size is big enough to carry the current and the resistor body large enough to withstand the temperature rise involved. *You can use any Koolohm at its full wattage rating—any time, anywhere!*

This freedom of use is made possible because Koolohm design is based upon a time-tested, inorganic insulating material. This is sintered on the wire *before it is wound*—at 1000° C.! The insulation is flexible, and has a dielectric strength of 350 volts per mil at 400° C.!

Samples free to industrial users. Catalog on request to all who are interested in better, more dependable resistors.

SPRAGUE SPECIALTIES CO., Resistor Division, North Adams, Mass.

KOOLOHM

"REGISTERED TRADE MARK"

POWER WIRE WOUND RESISTORS AND METER MULTIPLIERS

THIS MONTH

ACTIONS BY FCC

Diathermy Apparatus

The Commission has adopted Order No. 96-C so as to delete the paragraph from Order No. 96-B requiring manufacturers and dealers of diathermy apparatus to submit monthly inventory reports to the Commission. The submission of these monthly inventory reports does not now appear necessary, especially in view of the present requirement that manufacturers of and dealers in diathermy apparatus give the Commission notice of disposition in the event of transfer of possession of such apparatus to anyone other than another manufacturer or dealer. The other provisions contained in Order No. 96-B are incorporated in the amended Order No. 96-C.

Concurrently, the Commission adopted Order No. 99-B to require submission of quarterly reports by manufacturers of and dealers in radio transmitters not licensed, instead of monthly reports as were required by Order No. 99-A.

Radio Tower Lights

The Commission has made changes in its Rules and Regulations regarding the condition of radio tower lights and entries thereof in radio station logs. These changes, effective October 28, 1943, provide first, for visual observation and physical inspections of tower lights, to be followed by a report to the nearest Airways Communications station of the Civil Aeronautics Administration where any failure of tower lights which can not be readily corrected is observed; and second, entries in the station log indicating not only that regular checks have been made, but also showing where failure has occurred and the nature of steps taken to remedy the condition.

Network Ownership

The Commission on October 12, 1943, ordered that Regulation 3.107 relating to the ownership of more than one network serving substantially the same area by a single network organization, which had been indefinitely suspended, should become effective on April 12, 1944.

★

WPB ADVISORY GROUPS

The War Production Board has announced the formation of the following Industry Advisory Committees:

Mica Capacitor Conservation Industry Advisory Committee

Government Presiding Officer: *E. R. Crane;* Committee members: *G. M. Ehlers,* Centralab, Inc., Milwaukee, Wisconsin; *Jack Davis,* Galvin Manufacturing Co., Chicago, Illinois; *T. M. Gordon,* Radio Receptor Company, New York, New York; *M. R. Johnson,* General Electric Company, Bridgeport, Connecticut; *Byron Minnium,* Erie Resistor Company, Erie, Pennsylvania; *Dorman D. Israel,* Emerson Radio & Phonograph Corporation, New York, New York; *Herbert L. Spencer,* Bendix Radio Corporation, Baltimore, Maryland; *F. E. Hanson,* Western Electric Company, Kearny, New Jersey.

Mrs. Marie Mayer recently exchanged pictures with her husband, in Switzerland, over RCA Radiophoto . . . the first glimpses they have had of each other in 1½ years.

Coated Abrasive Industry Advisory Committee

Government Presiding Officer: *Franz T. Stone;* Committee members: *George Balcom,* Abrasive Products, Incorporated, South Braintree, Massachusetts; *James Jackson,* Mid-West Abrasive Company, Detroit, Michigan; *A. G. Bush,* Minnesota Mining & Manufacturing Company, St. Paul, Minnesota; *Charles Knupfer,* Carborundum Company, Niagara Falls, New York; *H. M. Elliot,* Behr-Manning Corporation, Troy, New York; *George Manning,* Armour & Company, Chicago, Illinois; *E. B. Gallaher,* Clover Manufacturing Company, Norwalk, Connecticut; *Austin M. Porter,* Wilmington Abrasive Works, Incorporated, Wilmington, Delaware.

★

TELEVISION BROADCASTERS ASSOCIATION PROPOSED

On a recent trip through the east Mr. Klaus Landsberg, representing the Society of Television Engineers, Box 2830, Terminal Annex, Los Angeles, Calif., discussed informally with a number of persons interested in the future of television broadcasting, the idea of forming a Television Broadcasters Association. This idea met with such uniform interest and approval that a proposed constitution and by-laws were prepared. Although this was done as a joint effort of the Society of Television Engineers, this Society (being primarily an engineering organization) feels that it can only suggest a possible format

[*Continued on page 62*]

F. A. Ray, of General Electric's Electronics Dept., using new model of magnetic wire recorder being built by G.E. for armed forces. Device will take 66 minutes of recording, and same wire can be re-used 100,000 times.

Centralab
CRL
Ceramic Trimmers
provide the ideal trimmer capacitor where controlled temperature coefficient and mechanical stability is required.
Temperature coefficients available:
Types 820,822,823,824
Maximum negative .0005 mmf/mmf/oC
Types 822, 823, 824 . . . . Zero
Type 823 . . . Positive .0002 mmf/mmf/oC
Write for Bulletin 695
Centralab
CRL
Division of GLOBE-UNION INC., Milwaukee

for a Television Broadcasters Association. Thus, it will be hereafter the joint effort of prospective members of the Association to effect the actual organization and the future actions of the Association.

★

G. E. POST-WAR RADIO SURVEY

As part of General Electric's post-war planning, an illustrated questionnaire asking the Company's 227,000 stockholders what type of a radio receiver they would like to buy after the war has been mailed with the Company's third quarter dividend check. This survey asks what kind of a radio is now owned, if and when they plan to buy a new receiver, the style and type preferred, and whether or not they know about or are interested in frequency modulation.

To make it easy and convenient for stockholders to reply, a postage prepaid postcard accompanies the folder on which the answers may be indicated. Returns will be referred to the Electronics Department's commercial research receiver division for consideration determining the trend of tomorrow's radio in post-war planning.

★

PHILIPS CO. TO NEW YORK CITY

North American Philips Company, Inc., Dobbs Ferry, N. Y., will move its commercial and administrative departments, late in November, to the Pershing Square Building, Park Avenue at 42nd Street, New York, under a long-term lease. This will provide space for increased production at the factory on important war work.

They will occupy the entire fourth floor together with two other Philips companies, Philips Metalix Corporation, 419 Fourth Avenue, New York, and Philips Export Corporation, which now has offices in the Hotel Roosevelt Building, New York.

The Industrial Electronics Equipment Division of North American Philips Company, Inc., which markets Norelco electronic products, will also move from 419 Fourth Avenue, New York, to the Pershing Square Building.

The change will not affect production personnel at the three plants in Dobbs Ferry and Mount Vernon, N. Y., and Lewiston, Maine, all now engaged entirely on war production.

Purchasing Department of North American Philips Company, Inc., will remain at Dobbs Ferry.

★

SUN RADIO RENAMED

In order to associate the firm's activities more closely with the rapidly developing electronic field, the Sun Radio Co., of 212 Fulton Street, New York City 7, has modernized its name and will henceforth be known as the Sun Radio & Electronics Co.

Established in 1922, the company is presently devoting its efforts to furnishing priority requirements for radio-electronic supplies to industrial organizations, research laboratories, schools, colleges, training centers, U. S. Army Signal Corps, U. S. Navy, telephone-telegraph companies, broadcasting stations, public utilities, civilian defense leagues, aircraft plants, shipyards, railroads and others engaged in the war effort.

★

PINKERTON JOINS REEVES

L. D. Ely, President of Reeves Sound Laboratories, Inc., announces the appointment of *Fred H. Pinkerton* as Director of Public Relations.

Mr. Pinkerton was formerly Manager of Sales Promotion and Advertising of the Industrial Division of United States Rubber Company.

★

"E" AWARD TO ESPEY

On November 5th, at the New York Times Hall, with Alois Havrilla presiding at the ceremonies, the Army-Navy "E" Award was presented to the Espey Manufacturing Co., Inc., of New York City. Representatives of the Army and Navy and various government agencies, were present.

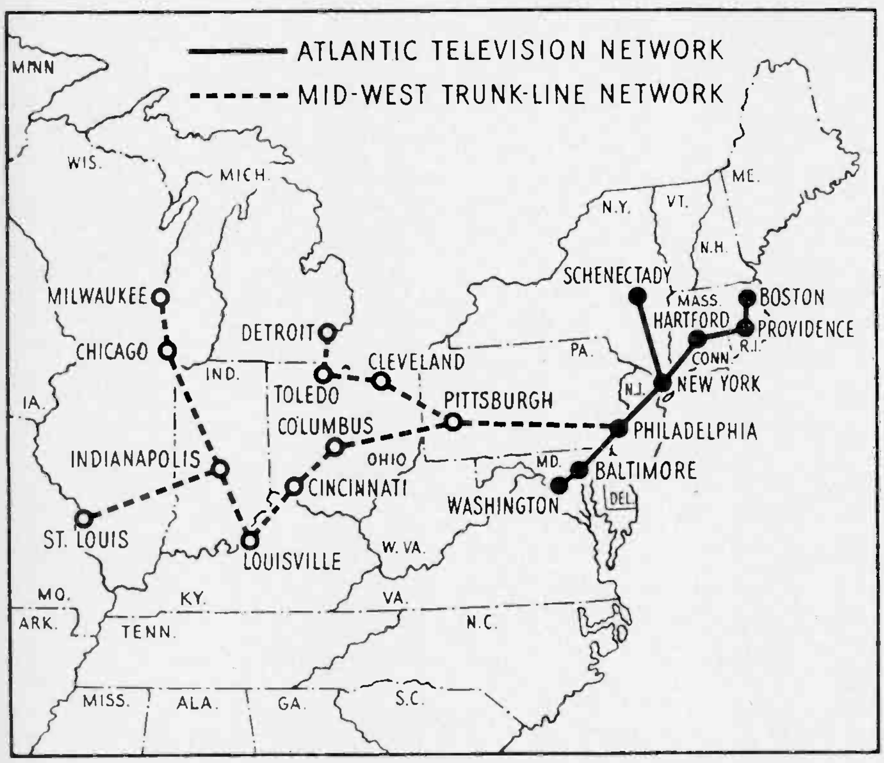
Lt. Colonel Walter B. Brown, Chief of Employees Relations Section, Office of the Chief Signal Officer in Washington, presented the "E" pennant to Harold Shevers, president of Espey.

★

MIDWEST GROUP ELECTS OFFICERS

At its August luncheon meeting, held at the Electric Club of Chicago, The Association of Electronic Parts and Equipment Manufacturers, a trade association comprised of over fifty manufacturers of radio and electronic equipment located in the Middle West, honored its Executive Secretary, Mr. Kenneth C. Prince, who attended his last meeting before leaving for Princeton University, where he will begin his training as a Lieutenant (j.g.) in the United States Navy. A large decorative

[Continued on page 77]



Assuming no radical change in broadcasting standards or allocations, these are the post-war television network developments outlined before a joint meeting of the American Television Society and the Advertising Club of New York by Thomas F. Joyce, Manager of the Radio, Phonograph and Television Department of RCA. The solid lines indicate the initial television network, with expansion shown by the broken lines.


ARMY E NAVY
EITEL-McCULLOUGH INC
Eimac TUBES
Eimac gets another "E"
Mass production of a device that has always been hand made in a laboratory is an achievement in itself. But when the whole nation gives pause to *recognize outstanding excellence in this mass production* the achievement becomes all the more striking.
Such honors have been bestowed upon the Eimac organizations not once but twice. First to the San Bruno, California, plant (September 1942) and second, less than a year later, to a plant in Salt Lake City, Utah, that is little more than one year old.
Where does the credit go?... to the men and women at the Salt Lake City plant now for their recent triumph... and to the men and women of both plants always for their collective cooperation and hard work.
Follow the leaders to
Eimac
REG. U. S. PAT. OFF.
TUBES
EITEL-McCULLOUGH, INC, SAN BRUNO, CALIF.
Plants Located at: San Bruno, Calif., Salt Lake City, Utah
Export Agents: FRAZAR & HANSEN, 301 Clay Street, San Francisco, California, U. S. A.

NEW PRODUCTS

CENTRALAB SILVER MICA CAPACITORS

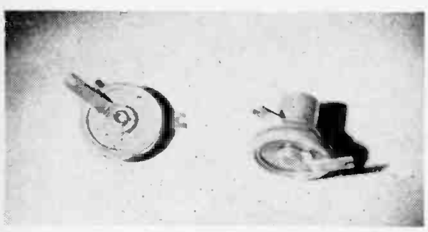
Centralab's types 830 and 831 are special purpose oil impregnated silver mica capacitors that are particularly useful in high-frequency applications. They are a new item and capacities now manufactured range from 65 mmf to a maximum of 500 mmf.

Both types are made of mica discs of the highest grade, individually silvered for maximum stability and stacked to eliminate any "book" effect. The assembly is vacuum impregnated with transil oil. The outside metal ring or cup connects to one plate of the capacitor, the center terminal connects to the other plate by means of a coin silver rivet. Other metal parts are silver-plated brass.

Type 830 has a metal cup holding the mica capacitor and is assembled to a threaded brass mounting stud with a terminal in the center. Stud, terminal and shell are electrically connected.

Type 831 is of "lead-through" construction. There is a center terminal on each side making contact to each other and to one plate of the capacitor by means of a coin-silver rivet. The other capacitor plate contacts the outside metal shell or ring.

General specifications of types 830 and 831 are: voltage 1300 v.d.c. test, 500 v.d.c. working. After 100 hours exposure to a relative humidity of 100% at 40° C., power factor is less than .1% and leakage at 1000 v.d.c. not less than 5000 megohms.

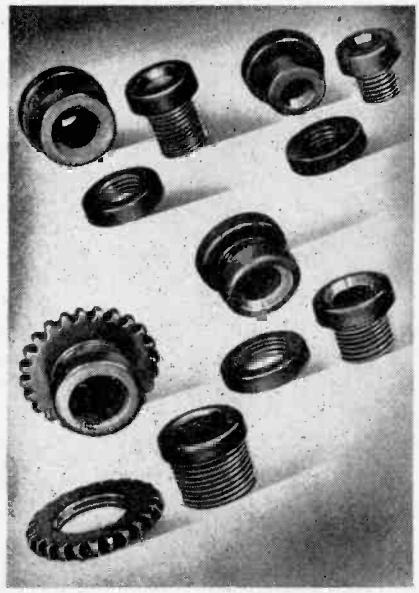


All units are color coded in mmf by means of colored dots on the metal rim arranged in accordance with the following: 0 Black, 1 Brown, 2 Red, 3 Orange, 4 Yellow, 5 Green, 6 Blue, 7 Violet, 8 Gray, 9 White.

★

PLASTIC INSULATING GROMMETS

Of special interest to production engineers seeking to cut down assembly time operations, Creative's new line of 100% phenolic plastic insulating grommets offers many important advantages. These new grommets, available in four standardized sizes, have been developed especially for use by radio, motor and electronics manufacturers. Holes are concentric, with all corners chamfered, avoiding wire chafing. All threads are clean and lubricated. To



promote easy gripping and conservation of assembly time, all parts are matte finished.

Samples, price lists, and other data available from Creative Plastics Corp., Sales Division, 970 Kent Avenue, Brooklyn 5, New York.

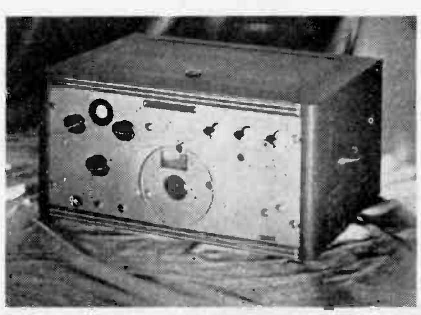
★

G-E RADIO-FREQUENCY CAPACITOMETER

A new radio-frequency capacitometer, designed for precision measurements of small capacitance and inductance, has been announced by the Specialty Division of the General Electric Company's Electronics Department.

The instrument weighs 55 pounds and is a completely self - contained portable unit in a steel case with a hinged cover and handles at the side. Indicating instruments, controls and fuse are conveniently mounted on the instrument panel. The front panel and base can be withdrawn from the cabinet as a unit for standard rack mounting.

The new capacitometer measures directly at radio instead of audio frequency, with measurements being performed with the aid of an oscilloscope



instead of earphones. The scale on the unit can be read from 0 to 1000 micro-microfarads when measuring capacitance, with inductance measured in the range of 0 to 1000 microhenries.

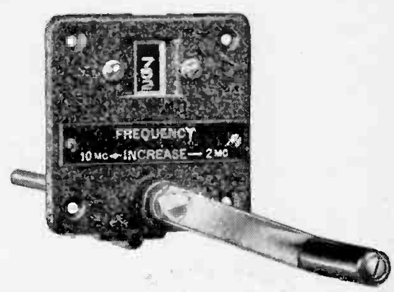
★

B & W CYCLOMETER TYPE COUNTER

Designed for registering rotary coil turns the B & W Cyclometer Type Counter Unit proves to have many additional uses and is now being produced as a separate item. It is adaptable to practically any application where a shaft must be turned a pre-determined number of times, or set at any pre-determined position. The exact number of turns, down to tenths of a turn, are recorded on the counter.

Standard Counters record 10 turns. Others, also available, record up to 100-1000 turns.

Used with rotary coils, the counters provide a quick, easy means of setting the contacts at any desired inductance value. Other uses range all the way from recording vertical and horizontal stabilizer adjustments on airplanes to practically any job where a shaft must be rotated more than 360°, and the exact rotation recorded.



B & W Cyclometer Counter assemblies have direct shaft drive (1:1 drive shaft to driven unit). Shafts can be any length. A Veeder-Root counter is used. The gear drive is direct, with precision cut steel gears. Units are light in weight, (8 oz.) extremely sturdy, and pass war-time specifications. They are available with either right or left hand rotation, and can be supplied with name plates to suit the application. For further details write Barker & Williamson, Radio Manufacturing Engineers, 235 Fairfield Ave., Upper Darby, Pa.

★

HIGH-ALTITUDE OIL CAPACITORS

Based on extensive tests and studies of terminal breakdown voltages in rarefied atmospheres, Aerovox Corporation of New Bedford, Mass., is now offering high - altitude oil capacitors to aircraft equipment builders.

One of these capacitors is similar to [Continued on page 66]

WHATEVER your resistance problems may be . . . you are sure to find the right answer at Ohmite. Our extensive range of types and sizes makes possible an almost endless variety of regular or special resistors to meet every requirement. Core sizes range from 2½" diameter by 20" long to 5⁄16" diameter by 1" long . . . and are produced with standard or special windings, terminals and other features. Many are stock units.

Because of their extra dependability under the most critical operating conditions, Ohmite Resistors are used today in all types of electronic and electrical applications . . . in planes, tanks, ships, in laboratory research and development, in scientific instruments and in the production tools of war.

Cut-away view of Ohmite Vitreous Enameled Resistor

The resistance wire is evenly wound on porcelain core, rigidly held in place, insulated and protected by Ohmite vitreous enamel. Dissipates heat rapidly—prevents hot spots and failures. Core sizes range from 2½" diameter by 20" long to 5⁄16" diameter by 1" long.

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the standard Aerovox Type '12 round-can barrier-cap units, except that one terminal is a short screw post. The other is a tall insulator post with corona shield at top. The cover assembly is a one-piece ceramic cap, with the can top spun over a rubber gasket and the cap for a perfect hermetic seal. The arrangement of terminals, corona shield and ceramic cap minimizes surface leakage, corona losses and probability of voltage breakdowns even at extreme altitudes.

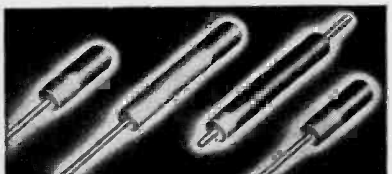
This aircraft Type '12 capacitor utilizes Aerovox Hyvol vegetable oil for the impregnant and fill. This special oil has the desirable characteristic of maintaining effective capacitance even at sub-zero temperatures, which is an important factor in high-flying applications.

★

STACKPOLE HIGH RESISTIVITY INSULATED IRON CORES

For applications calling for Iron Cores having high unit resistivity, the Electronic Components Division of the Stackpole Carbon Company, St. Marys, Penna., offers a special core material showing resistance of practically infinity. This is recommended for applications where a resistance of 150 megohms or greater is required, and where voltages do not exceed the breakdown value.

This Stackpole high resistivity material reduces leakage currents and their resultant noise troubles. Possibilities of voltage breakdown between coils and cores are also reduced. In applications using cup



cores, the high resistivity core material avoids the necessity for heavy insulation on lead wires.

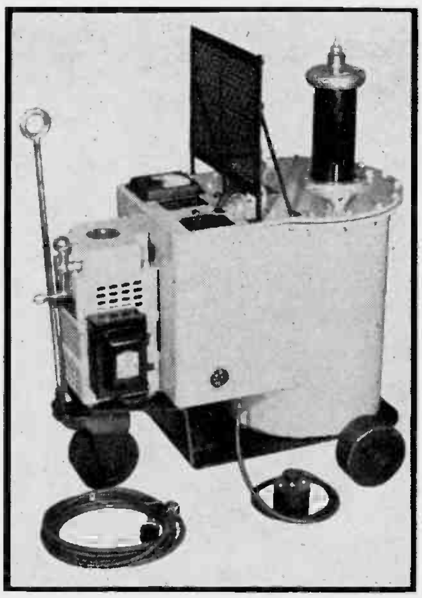
Other Stackpole Iron Core types are regularly supplied for a wide variety of uses, and for frequencies to 175 megacycles and better.

★

G. E. 50,000-VOLT PORTABLE TEST SET

A newly designed 50,000-volt portable test set for use on single-phase, 115- or 230-volt, 50- or 60-cycle circuits has been announced by the General Electric Company. The set is intended for application in cable factories, industrial plants, central stations, laboratories, and wherever high voltages up to 50,000 volts are required for testing electric apparatus or insulating materials.

This 50,000-volt (5-kva) portable set combines in a compact unit an oil-insulated testing set, a highly accurate indicating voltmeter, a voltmeter selector switch, and complete control equipment, such as air circuit breaker, line switch, foot switch, and induction voltage regulator. The testing transformer is designed with liberal safety factors to withstand the stresses



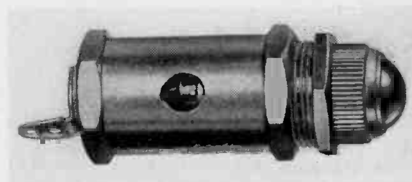
encountered in testing service. A screened safety guard separates the operator and the high-voltage bushing, and a red light warns the operator whenever the set is energized.

The indicating voltmeter has a large dial which shows the applied test voltage in kilovolts. For greater accuracy throughout the complete range, the meter has a double scale—one for voltages up to 25 kv and the other for voltages from 25 to 50 kv. The meter is connected to a voltmeter coil wound on the main transformer. It gives a highly accurate indication of the actual test voltage under all conditions.

The three-wheel truck on which the set is mounted is provided with roller-bearing mounted wheels, and a ball-bearing mounted swivel joint for the front wheel, providing easy portability.

GOTHARD SERIES 900 PILOT LIGHTS

This new series of Gothard Pilot Lights is designed for grounded pilot light panels, and presents many noteworthy installation and maintenance features. Measuring approximately 2" in length, they mount on 1" centers permitting a number of units to be incorporated within a very small space.



Body of hexagon design facilitates the use of a socket wrench in installation and, therefore, insures a solid mounting that will not work loose over a long period of operation.

Bulb change is accomplished from the front of the panel without disturbing body mounting or wiring. The bulb automatically comes out when the Jewel holder is unscrewed. Bayonet socket lamps (long or round) may be used. This Pilot Light is well ventilated for cool operation. Available with either faceted or plain jewels.

Complete information and prices may be had by writing direct to the manufacturer, the Gothard Manufacturing Company, 1300 N. Ninth Street, Springfield, Illinois.

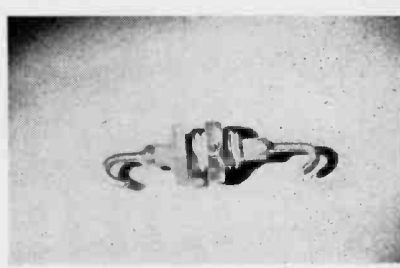
★

CENTRALAB BUSHING MOUNTED CAPACITORS

Centralab's new Bushing Mounted Capacitors are identified as type 817 and are used in high-frequency circuits where a capacity ground to the chassis and a "lead through" is desired.

The ceramic capacitor tube is plated internally and externally with silver and then with copper. The tube is a snug fit in the brass bushing and the external capacitor plate is soldered to the bushing. The tinned copper wire is also a snug fit inside the capacitor tube and is soldered to the internal plate. The entire unit is wax impregnated after assembly. Cadmium-plated brass mounting nut, 5/16" hexagon, Centralab part 395-239 can be furnished if required.

Dimensions, capacitance, temperature



coefficient and voltage breakdown are all closely related and changing any one of these details will change the others. The

[*Continued on page 68*]

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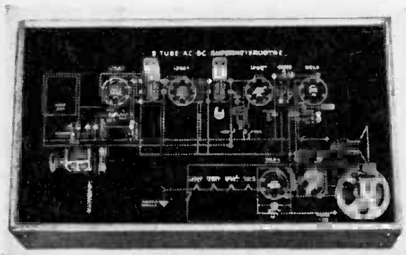
unit in current production is part 817-001. Capacitance is 55 mmf plus or minus 10%. Temperature coefficient is —.00052 mmf/mmf/° C., test voltage is 2000 v.d.c., working voltage is 1000 v.d.c.

Other capacities and sizes can be manufactured if the quantity needed justifies the tooling of special parts.

★

SCHOOL DEMONSTRATOR BOARD

This 5 tube ac-dc Superhet Demonstrator Board is a "must" for radio and physics classroom training programs and for lecture and demonstrating purposes.



It is laid out schematically in breadboard style with actual radio parts mounted in position for quick removal and replacement to demonstrate function at each part in the circuit. Terminals are provided at all tube elements for measurement of voltages and signals. Jumpers are provided to open condenser, resistor and coil circuits and to short out these circuits wherever no damage will result.

Schematic diagram is in color according to the R.M.A. code; grid circuits in green, plate circuits in blue, B positive circuits in red, and balance of circuits in black. Tubes are included.

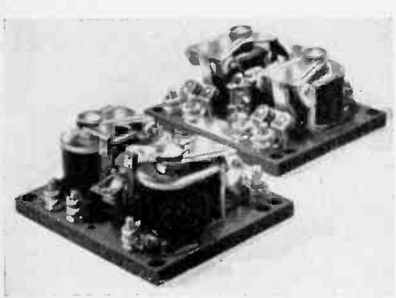
This and other training kits are offered by Lafayette Radio Corporation, 901 West Jackson Boulevard, Chicago, 7, Illinois, and 265 Peachtree Street, Atlanta, 3, Georgia.

★

STRUTHERS-DUNN DYNAMIC BRAKING RELAY

Instantaneous dynamic-braking with split-series field motors is provided in the new Struthers-Dunn relay types 68HX100 and 67HXX100.

Positive action, less weight, and simpler mechanisms are thus provided for a wide range of aircraft and other applications. These include the operation of retractable landing gears, wing flaps, trim tabs, bomb bay doors, hoists, and similar applications utilizing reversing motors. For winch operations, the relays permit the substitution of a simple locking dog for the conventional large magnetic brake.



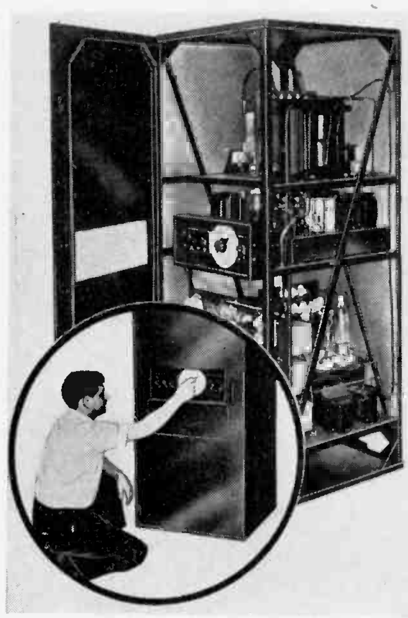
These new relays are of the well-known Struthers - Dunn "Nutcracker - construction" in a new, light-weight design having exceptionally strong contact pressure. There are no sliding contacts. Positive "memory" contacts select the proper field winding to give reverse torque for braking. All parts and contacts are readily accessible for inspection. The relays operate in all positions, and withstand salt-spray, vibration and altitude tests.

Full details will gladly be supplied by Struthers-Dunn, Inc., 1321 Arch Street, Philadelphia, Pa.

★

VARIABLE FREQUENCY ELECTRONIC GENERATOR

This unit, CML 1400, was developed by Communication Measurements Laboratory to fill the need for a versatile source of power, especially for engineers requiring test power at various loads through a wide frequency range. Research laboratories, and an increasing number of manufacturers in the electronic field find this Electronic Generator capable of delivering power with good regulation and waveform



over a frequency range of 300 to 3500 cycles.

CML 1400 is proving especially valuable where Government specifications call for complete tests on the production line through a wide range of power frequencies. In addition to factory and laboratory applications, maintenance and field service men have found CML 1400 extremely helpful in their work. With CML 1400 in use aircraft radio installations can be tested in the plane, or serviced in the repair shop, without resorting to aircraft power supply. May also be used for testing transformers and condensers.

This electronic generator includes variable-frequency oscillator, followed by several driver stages. The output stage employs a pair of 833-A tubes in Class B. Because of the high impedance of such a power source, the regulation of generators of this type is quite poor, ordinarily. CML 1400 overcomes this difficulty by means of a special control circuit which maintains output voltage at a substantially constant level from no load to full load. Power output of CML 1400 is 1400 watts at 120 volts R.M.S., with a load of unity power factor.

Descriptive bulletin available from the maker, Communication Measurements Laboratory, 120-24 Greenwich Street, New York.

★

SUNDSTRAND HAND SANDER

Designed and built for all practical hand sanding and finishing operations, the Sundstrand Sander manufactured by Sundstrand Machine Tool Company, Rockford, Illinois, is now available in a light-weight, hi-speed Model 1000.

This smaller and lighter machine weighs less than 6 pounds, has a speed of 3,500 oscillations per minute, can be equipped with different types of sandpaper attachments for large or small, wide or narrow, flat or curved abraiding surfaces on metal, wood, plastics, or composition.

Operation of the machine is obtained with pad movements started and controlled by a palm lever fitted at top of the machine housing. No turning of "on" or "off" switches is required. When machine is gripped to operate, the reciprocating action of pads starts. Upon release, the machine automatically stops.

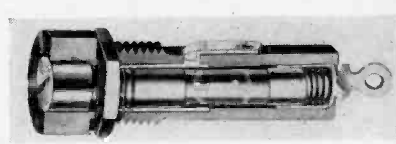
Uniformity of the stroke and the high speed of the reciprocating pads materially increase the life of abrasive paper by keeping the paper surface substantially free from material particles.

★

NEW LITTELFUSE EXTRACTOR POST

What is considered a most important advance in fuse extractor post construction comes from Littelfuse Incorporated, 4747 Ravenswood Ave., Chicago 40, Illinois. The new improvement is illustrated in Littelfuse Extractor Post for 3 AG (1¼" x ¼" dia.) fuses.

Anti-vibration side terminals are now mechanically connected by electrical welding to the metal shell inside the bakelite body and backed up by soft solder. The new welding process makes the terminal connection in effect one-piece, integral with the metal parts—permanent and unshakable against all forces. The terminal is proof against heat and severest vibration.



The new Littelfuse Extractor Post No.

[Continued on page 82]

WAX IMPREGNATION

[*Continued from page 39*]

inside the housing will be circulated by the heat from the tubes, and the relative humidity inside the housing quickly lowered below the danger point. The desiccant can be thus renewed indefinitely.

Fig. 3 shows in a general way how a rubber diaphragm can be used in permeability of copper core tuning. The diaphragm can be held down with a metal ring where it joins the housing. The seal on the push rod must be so designed that there is no motion transmitted through the rubber proper, as its dimension is too indefinite under pressure. Hence, the push rod is made in two parts joining each other through a narrow neck of reduced diameter. The washerlike pieces give a good seal if a suitable cement is used to make the seal air tight.

Conclusions

The general conclusion amounts to this: the use of soft wax in very thin films definitely improves frequency stability, and for ordinary home or laboratory use is thoroughly satisfactory. For coping with the dew point the only real solution is to make the critical parts submersion-proof by completely housing the units, and employing a suitable desiccator. In the latter case there is no advantage in impregnating the parts at all. Hence, the designer can dispense with this frequency-determining element which, even in small amounts, has some effect on secular and cyclic stability.

BOOK REVIEWS

[*Continued from page 48*]

fundamental principles of radio and electricity in radio communication systems. Although sufficient theory is presented to explain the tests to be performed, this book is not intended to be a complete textbook.

The circuits chosen for test are generally those frequently employed in modern communications equipment and the test apparatus set-ups are of up-to-date design.

This is a practical small handbook which should be of especial value in training workers in the electronic and radio field for laboratory work.

*

GRAPHICAL CONSTRUCTIONS FOR VACUUM TUBE CIRCUITS, by Albert Preisman. Published by McGraw-Hill Book Co., Inc., New York, N. Y. 237 pages. Price $2.75.

This book is intended to familiarize the reader with the application of graphical constructions for the solution of problems which are difficult or impossible to solve by analytical methods.

The author has handled his subject in a scholarly manner, weighing fairly the advantages and disadvantages of the graphical method in comparison with the analytical and experimental approaches. As a result, his text is a valuable contribution to the literature. It fills a definite need and should be added to the library of every radio-electronic engineer.

R-C NETWORKS

[*Continued from page 37*]

the same ratio as the values of resistance.

The graphical solution of Problem 2 is shown in *Fig. 7.* After placing a piece of tracing paper over the reactance chart as before, the response curve is started by drawing a horizontal line corresponding to the 200,000-ohm resistors in parallel, or 100,000 ohms. This is joined with the slanting line corresponding to the .02-μf capacitor. Another horizontal line is now drawn which corresponds to the parallel equivalent of 200,000, 200,000, and

10,000 ohms, or approximately 9,000 ohms. This line is joined by a horizontal line sloping upward to the right at 45 degrees. This line is located by first finding the intersection of the lines corresponding to 200,000 ohms and 20 $\mu\mu$f. This point is dropped at the same frequency until it intersects the horizontal line corresponding to 9,000 ohms. From this intersection the line sloping 45 degrees up to the right is drawn. The curve is completed by drawing another horizontal line. This line corresponds to a value of resistance equal to the product of the 200,000-ohm resistance and the response of the network with both capacitors short circuited. In this case that response is approximately .67 and the product is approximately 133,000 ohms. After rounding the corners of the curve as before the response over a wide frequency range is determined.

The coordinates are determined as before. The frequency is taken from the reactance chart. The response is taken as unity at 200,000 ohms and plotted in the same ratio as resistance, i. e., 200,000 ohms equals unity response, 20,000 ohms equals 0.1 response, 2,000 ohms equals 0.01 response, etc.

USING NOMOGRAPHS

[*Continued from page 43*]

reader takes the trouble to work out the problem suggested, he will note that since a square root is divided by a square, we come out on scales which do not give us the division relation; therefore we must transfer the square to the *A* scale and transfer the square root to the *D* scale so that we may divide. If we have a problem in which a square is divided by a square root, we do not have to transfer the relations, and the calculation is a "streamline" progression of two straight lines to obtain the answer.

Roots and Powers

In *Fig. 4* we see how to obtain any root or any power of a quantity. To find a root, *P* is always one point on the straight edge; the other point will lie on an abscissa which is the order of the desired root and on an ordinate which is the radicand from which the root is to be extracted. The point of intersection on the "1" axis is the root desired. For example, in *Fig. 4* we have taken the square root of 4 by laying a straight edge from *P* to the intersection of the "4" ordinate with the "2" abscissa, and noting that the intersection is at 2 on the "1" axis of abscissas. Thus, the square root of 4 is 2.

Likewise, we may extract the 5.5 root of 4.5 as shown.

Extraction of roots is the inverse process of raising to powers, and therefore this nomograph allows us to raise any number to any power. Thus we observe in *Fig. 3* how 0.6 may be raised to the 6th to obtain 0.047 approximately, as shown. We could as easily find the 4.25 power of a number, or the 0.2 power. Thus we see that powers and roots overlap one another since a fractional power may be regarded as a root in the denominator and a power in the numerator.

By superimposing the scales of *Fig. 4* upon the scales of *Fig. 3*, the reader will observe that he may quickly work such problems as:

$$X = \frac{0.2 \times 1.72^{.01}}{3 \times 1.29^{3} \times \sqrt{7}}$$

In communication work, the quantities π and ϵ assume great importance. In the next article we will show how one may work with these two irrationals nomographically, and how nomographs are constructed to quickly solve communication problems.

(To be continued)

"SPEECH-ON-LIGHT"

[*Continued from page 34*]

Fig. 4 shows the response curve of the photocell, and it is noted that the low-frequency response is good, but the curve falls off at the high-frequency end. In this respect, the cell is inferior to a caesium cell, which has a better high-frequency response. However, its sensitivity to red and infra-red light is better than that of a caesium cell. The signal-to-noise ratio is 30 db.

Fig. 5 shows the response curve of the modulator. While it is by no means flat, it is within 5 db. from zero to 2,200 cycles, when the response falls off rapidly.

Fig. 6 shows the overload characteristic of the modulator, plotted for different frequencies. As may be expected, this curve is complementary to the response curve. The effects of overloading, or over-modulating are to make the small moving prism lose all contact with the large one (on alternate half cycles); this makes the area of first reflection one of glass to air boundary. On the other half cycle, overloading causes the prism pressure to be so great that the contact becomes too perfect, and not enough light is reflected within the prism. Both these effects cause non-linearity, and show why, for best results, the modulator should be adjusted to give equal upward and downward modulation for alternate half cycles.

Mechanical Construction

The secret of the success of this instrument depends largely on its good mechanical design and construction. With a device of this sort, mechanical rigidity is of primary importance. The tripod is strongly constructed, and while the head is fixed to it by a single universal fixture, it is very rigid.

The head itself is made of aluminum, and optical technique is employed throughout the apparatus, which is made by Carl Zeiss. The lamp-house, while being detachable, is firmly held in position, and the modulator is mounted on a slotted platform, so that initially it may be located correctly with respect to the lamp and the transmitting lens. The modulator prism is housed in a heavy machined brass holder, located within the permanent magnet of the armature system. The photocell clips into its holder very simply, but perfect positioning is ensured by the holder, since it is necessary that the incoming light is focused dead on the center of the cell by the 80 mm. receiving lens. The whole apparatus weighs 54 pounds.

It is appreciated that while the speech-on-light apparatus provides yet another system of communication, its use is strictly limited. Firstly, the range is so small, secondly, it must be used over quasi-optical paths, and thirdly, it cannot be operated on the move. The salient advantages are security as compared to short range radio, its lack of wires as compared to telephones and its provision for speech as compared to ordinary lamp signalling. It will be interesting to observe whether the Allies bring out a corresponding model before the conclusion of the war.

DIELECTRICS

[*Continued from page 31*]

on the leakage resistance as measured between adjacent terminals on a terminal strip is shown in *Fig. 4*. Note that the leakage resistance of the treated strip decreases slowly but the untreated strip drops from several thousand megohms to approximately 100 megohms during a period of three days. *Fig. 5* shows the humidity characteristics of tube sockets made from different materials. The superiority of the ceramics over bakelite is readily discernible.

Typical characteristics of insulated wire are shown in *Fig. 6.* Note here the variation in capacity together with the leakage resistance. Both are of utmost importance in many applications.

These curves indicate the magnitude of changes to be expected under humid conditions, and clearly indicate the necessity of careful study before specifying the dielectric material to be employed in a component part.

To summarize briefly the following points should be considered:

1. *Mechanical strength versus loss factor.*
2. *Effect of C/Q ratio on tuned circuit.*
3. *Treatment or finish for specific operating conditions.*

A table giving the characteristics of dielectric materials commonly employed in radio and electronic applications is appended.

POST-WAR NETWORKS

[*Continued from page 44*]

signed, or at any time the broadcaster wishes to withdraw from the plan. In the latter case, the broadcaster loses his priority position for equipment."

Complete Service Offered

Expanding on the services General Electric will be able to furnish the broadcaster after the war, Mr. Chamberlain said that all a prospective broadcaster will need is an open mind and good credit. "If the customer desires it, we will purchase the land, and, in cooperation with a firm of architects, will take care of the construction of the necessary buildings. We will be prepared to take care of the wiring and sub-station equipment, of the lighting and air conditioning. We will supply everything from microphone to antenna, will train operators and program personnel if desired, and will finance the whole transaction if the broadcaster's credit is good."

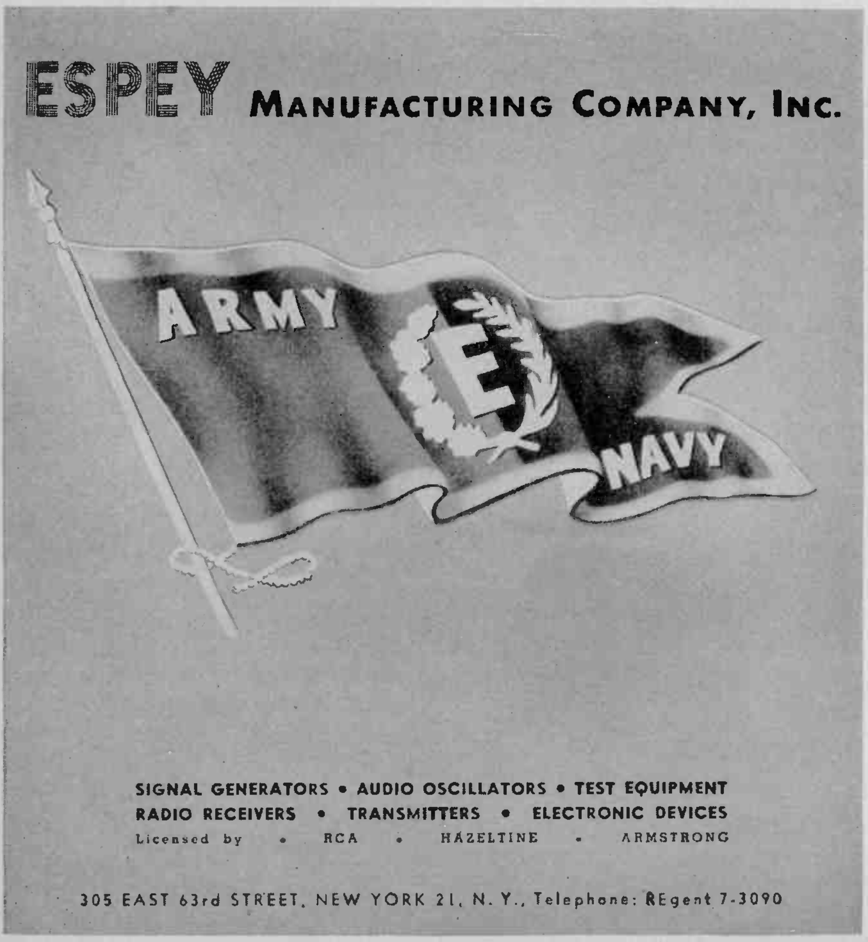
Mr. David explained that the leading radio manufacturing companies will continue to explain the advantages of FM radio to the public through advertising. Network support of FM, rather than interest from viewpoint of protection, is confidently expected, he said. Present war developments will facilitate establishment of high-fidelity radio relay facilities, and big name programs will come to FM stations through wholehearted network support, he predicted.

TECHNICANA

[*Continued from page 24*]

Faced with this problem of individual and critical checkup on a mass testing basis, and aggravated in no little measure by growing manpower shortage, the engineers of Allen B. Du Mont Laboratories, Inc., set to work some time ago evolving a satisfactory production test procedure and equipment. It was realized from the first that while the equipment would have to provide for several dozen readings of as many different characteristics, which requirement heretofore called for a maze of laboratory equipment and hookups, the procedure now would have to be simple enough to permit operation by average girl workers.

The result is the Du Mont "electronic desk" test position. Several of these units are now installed in the Du Mont plants, checking up the daily production flow of cathode-ray tubes. For routine production checkup, these units are operated by girls, but engineers too depend on these test positions in checking up the characteristics of new tubes and experimental runs.



Sitting at this comfortable "electronic desk" the operator sets the various voltages for the given type tube or tubes. The operator now checks for brilliance, focus, deflection, leakage resistance and other characteristics.

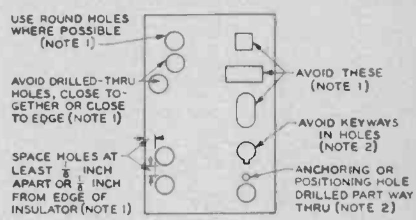
GLASS-BONDED MICA

WITH "INCREASED PRODUCTION" the loudest battle cry on the home front today, the recent approval of the American War Standard, Glass-Bonded Mica Radio Insulators (C75.6-1943), is welcome news to the radio industry. Maximum production with a minimum waste of time and material is expected with this standardization of performance requirements, test methods, and design practice for glass-bonded mica insulators.

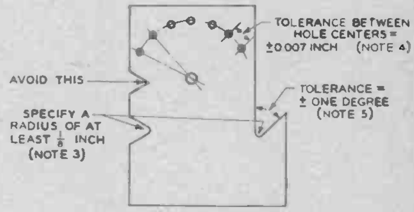
The chief feature of the standard is that it provides engineers and draftsmen with specific information about the machining of glass-bonded mica items. How holes are to be tapped, how corners are to be cut, and what thicknesses are available, are some of the design criteria set forth. Informative diagrams are included which indicate the correct and incorrect ways to machine glass-bonded mica.

Armed with this kind of information, the designer can now consult the insulator manufacturer or fabricator concerning specific design details applicable to the insulator under consideration. In this way the most desirable design is arrived at with a minimum of cost and production time.

The new standard differs from the other American War Standards on military radio components inasmuch as no standard shapes or type designations thereof are set up. Only the procedure



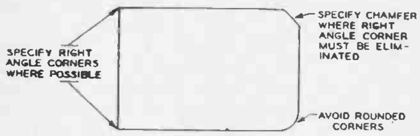
HOLES AND HOLE SPACING
FIG. 1



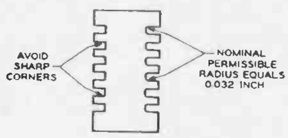
ANGLES AND ANGULAR DIMENSIONS
FIG. 2

for machining glass-bonded mica radio insulators and recommended practice for the handling and machining of such insulators are indicated.

It is expected that the Armed Forces and radio equipment manufacturers will use the standard in designing new equipment, and that replacement parts also will comply with the specifications so that greater interchangeability will result.



CORNERS (NOTE 6)
FIG. 3



SLOTTED BARS (NOTE 7)
FIG. 4

The new War Standard was prepared through the coordinated efforts of representatives of industry and the Armed Forces at the request of the War Production Board. The committee that developed this standard was headed by L. J. Cavanaugh, General Electric Company.

INDUCTION SOLDERING

OUTSTANDING AMONG the recent work passing through the Induction Heating Corporation's laboratory, and being set up in the field as a practical installation, was the soldering of covers on condenser cans. This soldering job formerly took sixteen minutes when performed by the usual method. But, with the introduction of Thermionic Induction Heating, the time was reduced to two and a half seconds, and permitted the use of unskilled labor instead of an experienced hand with a soldering iron.

Preliminary preparation of the cans and covers, which are stamped or drawn from terne plate, is simply to apply flux, to allow the solder to run freely and adhere to the base metal. The condenser element is inserted into the can, and its leads electrically fast-

ened to the terminals, which are brought through the cover of the can.

The assembled cans are then placed in a fixture which holds eight cans simultaneously in relation to each other. A ring of solder of the proper specifications, and having the same shape as the periphery of the joint is preplaced over the section to be joined. The fixture, with the cans in place, is now raised to a position which brings the joint area in proper relation to the copper work coil, this work coil being positioned directly above the fixture. The Thermonic Induction Generator is energized by pressing the start button and heat is immediately evolved in the joint section. Simultaneously to the energizing of the Generator, a timer starts its cycle, and at the end of the predetermined time of two and a half seconds, automatically shuts off the power. The joint cools and the work is lifted from the fixture fully soldered.

The adjacent photograph shows the relative position of the work coil with its energizing transformer, and the condensers in place in two positions of the coil.

Where large production is required, a two-position coil set-up is used, with eight positions in each coil. The transformers and switching equipment are included in the table holding the coils, which are so arranged electrically that when one position is heating and cooling, the other position is being loaded with condensers to be soldered; thereby keeping the production constant at all times, and obtaining a high resultant use-factor on the generating equipment. The process can be readily adapted to another size condenser can, or entirely dissimilar objects to be soldered or brazed, by simply attaching different size work coils to the terminals of the transformer. However, a wide range of sizes may be soldered with the one coil, thereby keeping the total number of coils to a minimum.

The work coil is usually made up of copper bar stock or tubing, shaped to accommodate the objects to be heated. These machined holes are slightly larger than the object and as is common with all induction heating, at no time make electrical contact with the work. The thickness of the coil is determined by the width of the heat pattern desired, and in this particular case the heat pattern is a narrow band restricted to the joint section. The cooling water which is used for the Thermonic Induction Generator also cools the work coil and the specially designed high-frequency transformer. This transformer operates at a terminal voltage across the coil of approximately 200 volts, and allows the coil to be grounded for safety of operation.

STUDY GUIDE

[*Continued from page 52*]

each generator (microphone or pickup) and the final load must see its own image impedance when looking into the mixer from its terminals. A velocity microphone with a 500-ohm output impedance connected across terminals x and y, must see 500 ohms when looking into the mixer. The 500-ohm T attenuator must then be terminated in 500 ohms. Similarly, impedance matching must be maintained at terminals x' and y'. To accomplish this it is necessary to insert compensating resistors. These resistors will introduce a fixed loss known as the insertion loss of the mixer. If the loss is compared to the simple circuit of a single generator and single load equal to the generator impedance, the insertion loss is given by the equation:

$$10 \log (2n_p - 1) + 10 \log (2n_s - 1) = 9.5 \text{ db}$$

where n_p is the number of channels in parallel and n_s the number in series. Channels I and II are in series; channels III and IV are in series; these two networks are connected in parallel. Shunt compensating resistors are used to provide impedance matching for the series channels; series resistors provided impedance matching for the parallel connection. The compensating resistors can be evaluated by the following equations—

$$R_s = Z \frac{n_s - 1}{n_s}$$

$$R_p = Z' \frac{n_p - 1}{n_p}$$

$$\text{where } Z' = Z \frac{n_s^2}{n_s^2 - 1}$$

THIS MONTH

[*Continued from page 62*]

cake was presented and consumed in honor of the occasion.

Lt. Col. John M. Niehaus, Labor Officer, United States Army Signal Corps, and Albert A. Epstein, Assistant Director of the Sixth Regional War Labor Board, friends of Lt. Prince, addressed the members and explained the functions of their respective offices in connection with labor problems and wage stabilization matters.

An election of officers for the ensuing year was held and P. H. Tartak, President of the Oxford-Tartak Corporation of Chicago, was elected Chairman of the Association. E. G. Shalkhauser, President of Radio Manufacturing Engineers, Inc.,

[*Continued on page 78*]

of Peoria, Illinois, was named Vice Chairman. Miss Helen A. Staniland, Vice President of Quam-Nichols Company of Chicago, was re-elected as Treasurer. Lewis G. Groebe, associated with Lt. Prince in the practice of law, was elected Secretary *Pro Tem* and will perform the functions of Executive Secretary pending the return of Lt. Prince from active duty in the Navy.

★

GHIRARDI SELLS PUBLISHING COMPANY TO FARRAR & RINEHART

After twelve years in the Radio book publishing business Alfred A. Ghirardi announces the purchase of his Radio & Technical Publishing Company by Farrar & Rinehart, Inc., Publishers, of 232 Madison Avenue, New York City, whose subsidiary the new Radio & Technical Division of Murray Hill Books, Inc., will continue to publish the present "Ghirardi" radio books as well as new ones that he will now have time to write.

★

WORNER PRODUCTS RENAMED

The Worner Products Corporation announces reorganization to meet demands for increased production. The new firm name is now Worner Electronic Devices. Mr. Leon Worner continues as Chief Executive.

New, enlarged laboratory and production facilities were occupied on November 1st. The new address of Worner Electronic Devices is 848 North Noble Street, Chicago 22, Ill.

BOMBER NAMED "KEN-RAD"

A brand new bomber—"Ken-Rad"—will soon take to the skies as a result of the record-shattering bond buying campaign of the employees of Ken-Rad Tube & Lamp Corporation, Owensboro, Kentucky, which topped the goal of $500,000 by $84,450.

Larry O'Brien, director of sales for the Ken-Rad Company, was in charge of the bond sales drive and impresario of the community promotion for Ken-Rad, which was credited with having subscribed nearly 25 per cent of the total of Ken-Rad's home county, Daviess County, Kentucky, as announced October 1st.

★

ANDREW APPOINTS EXPORTER

The Andrew Company of Chicago, pioneer manufacturers of gas-filled coaxial cables and other antenna accessories, announces the appointment of *Frazar and Hansen*, San Francisco, as export representatives, effective immediately.

★

G. E. APPOINTMENTS

E. F. Russell and *R. T. Pennoyer* have been appointed Manager and Assistant Manager, respectively, of the Easthampton, Mass., Tube Works of the General Electric Company's Electronics Department, according to a recent announcement.

I. R. Weir has been appointed Assistant to the Designing Engineer of the Transmitter Division of the General Electric Company's Electronics Department, according to *C. A. Priest*, Division Manager. In this capacity, Mr. Weir will assume complete responsibility for the engineering and drafting activities at the Syracuse, N. Y., Plant of the Division where he will be located.

★

W85A TO BECOME WGFM

In accordance with instructions received from the Federal Communications Commission, the call letters of General Electric's frequency modulation station, W85A have been changed to WGFM, effective November 1.

★

APCO ELECTIONS

Frank W. Walker, Mid-West's pioneer of state-wide FM police radio communication and Chief Engineer of the 44 FM station Michigan State Police Network, was elected President of the Associated Police Communication Officers, Inc., at the close of the Tenth Annual War Communications Conference at Madison, Wisconsin, on September 2, 1943.

Ero Erickson, Supervisor of the Illinois State Police Radio System at Chicago, was chosen Secretary-Treasurer, in recognition of his Chapter building work, succeeding James H. Teeter of the St. Louis police.

The successful three day meeting selected a large Post War Planning Committee to prepare a far-reaching program which would anticipate post-war police radio technical and frequency allocations requirements, in co-operation with the FCC, IRE and RMA. Recent priority developments affecting radio equipment were explained by Mr. Frank McIntosh of the War Production Board and representatives from the Office of Civilian Defense outlined the progress of the WERS program.

Mr. Ray Groenier, Conference Chairman, was elected 1st vice-president, Mr. R. M. Jones of Birmingham, Alabama, 2nd vice-president, and Mr. Wm. E. Taylor of the Baltimore, Maryland, Police as Sargeant-at-Arms. Mr. J. M. Wherritt, Communication Office of the Missouri State Highway Patrol, was again elected to fill the post of Bulletin Editor.

The response by the manufacturers of police radio equipment, both makers of component parts as well as complete systems, over-subscribed the scheduled space resulting in a complete sell-out. The local Army and Navy Radio schools threw open their doors to the visitors, who were allowed to observe the mass training of military radio personnel first hand.

★

NEW LITERATURE

G. E. ELECTRONIC HEATERS

Electronic heaters for heating metals are featured in a new, illustrated 8-page bulletin (GEA-4076) recently issued by the General Electric Company.

The publication describes the electronic method of heating metals, emphasizes its simplicity, and gives in detail the specifications of both the 5-kw and the 15-kw, 550-kilocycle electronic heaters.

Also included in the bulletin are illustrations of many important small parts which may be brazed, soldered, or surface hardened by electronic heating.

★

PRESSED STEATITE

As a practical contribution to speedier steatite production, Henry L. Crowley & Company, 1 Central Ave., West Orange, N. J., has just issued a detailed listing of standard pressed steatite parts for which tools are already available. The listings are in the form of detailed and dimensional drawings of bushings, trimmer-condenser bodies, terminal strips, tube sockets, tube parts, coil bases, variable-condenser end pieces, oscillating-crystal cases, etc., with corresponding part numbers.

Well over a hundred standard parts are listed, with more to follow in supplementary bulletins issued from time to time. It is pointed out that since no tooling-up is required, delivery time is greatly speeded up.

A copy of this Crolite Pressed Steatite Catalog is available to anyone designing or producing equipment utilizing steatite, writing in on his business letterhead.

★

NEW "UNIVERSAL" CATALOGUES

Universal Microphone Co., Inglewood, Cal., has just published its catalogue No. 961 with the caption of "U. S. Army Signal Corps Throat Microphone types T-30-S".

Diagrams include the operational circuits and the extension cord assemblies. Illustrations include the CD-318 cord assembly and a cutaway view of the microphone, neckband and component parts. A complete photograph illustrates the method of wearing the T-30-S.

Descriptive data includes the functions of the instrument, complete description, wearing methods, handling of the T-30-S, resistance, microphone current, repairing, dimensions and component weights.

The leaflet closes with current price list and it will be distributed through the usual trade channels. Last previous Universal catalogue, issued two months ago, was number 830, captioned "U. S. Army and Navy Specification Plugs and Jacks."

★

HAYDON TIMING MOTORS

Haydon Manufacturing Company, Forestville, Connecticut, headquarters for synchronous motor driven, and electronic timing devices, has just released a new type of catalog. This book constitutes twenty-four pages of illustrations, with descriptions of many of the more recent developments in the field of Timing Engineering.

New applications of Haydon timers, brought on by war-time demand, include radio keyers, time-delay mechanisms for the protection of vacuum tubes, various types of multiple circuit repeat cycle timers, etc.

The catalog contains an outline of the principles employed in Haydon Timing motors, both ac and dc, with cut-away views of the motor, brake unit, reset unit, and friction device.

Technical data is included on the full range of timing applications, which will prove helpful to any engineer with a timing problem.

Obtain your copy by sending a request for Catalog #112, to Haydon Manufacturing Company, Forestville, Connecticut.

★

"ROTOBRIDGE" FOLDER

Just issued by Communication Measurements Laboratory, New York, is a new folder dealing with the Rotobridge Automatic High Speed Mass Production Circuit tester. Offers interesting facts to makers of all types of electronic equipment. Bulletin describes how the Rotobridge detects trouble and errors automatically and swiftly.

Copies of the Rotobridge folder may be obtained from: Communication Measurements Laboratory, 116-118 Greenwich Street, New York.

★

NEW SPRAGUE "VICTORY LINE" FOLDER

A colorful new folder recently issued by the Sprague Products Company, North Adams, Mass., illustrates and describes "Victory Line" Sprague Atom Midget Dry Electrolytic Capacitors and TC Tubulars which will be supplied regularly through its distributors in conformity with wartime limitations on capacitor production for civilian use.

Although the Sprague "Victory Line" is necessarily limited to only nine Atom types and nine TC Tubulars, these have been carefully selected as to capacities and voltages to enable servicemen to handle practically any replacement job. Of utmost importance, is an article included as part of the folder "How to Use Victory Line Capacitors." This contains many helpful hints on how to substitute the few "Victory Line" Capacitors for the many varieties of standard types. Subjects covered include "Connecting Capacitors in Parallel to Make Capacity Values Not Available in a Single Unit"; "Replacing Filter Applications Higher than 450 V. D.C. with Victory Line 450 V. Capacitors"; and "Replacing Wet Electrolytics with Dry Electrolytics."

Copies may be obtained direct from Sprague Products Co., North Adams, Mass., or through authorized Sprague Distributors.

★

NEW G-E INSTRUMENT PUBLICATION

A new General Electric publication, "Electric Instruments, Principles of Operation," presents a concise discussion of the characteristics of instruments, what makes them operate, and the individual limitations of the various types. Designated GET-1173, it is available on request to the Company at Schenectady.

★

INCENTIVE GUIDE BOOK FOR INDUSTRY

Publication of a new booklet, "Ideas That Work To Win," a guide to management for establishing and conducting various incentive measures to stimulate production in Navy contract plants, has been announced by Rear Admiral C. H. Woodward, USN. (Ret.), Chief of the Navy Industrial Incentive Division.

Defining industrial incentives as "those ideas which rouse the fighting spirit of American workmen and translates that spirit into increased or improved war production," Admiral Woodward declared that the booklet deals with the "human factors affecting production."

The booklet catalogs various means whereby plants can on their own initiative or in cooperation with the Navy's Industrial Incentive Division, promote more and better production that will supply the men of the fleet with the necessary equipment for the conduct of the war.

★

"POSTWAR EMPLOYMENT"

On November 1, national headquarters of the Committee for Economic Development moved from the Department of Commerce Building, Washington, D. C., to 285 Madison Avenue, New York 17, New York.

Single copies of the Committee's report on "Postwar Employment and the Settlement of Terminated War Contracts," can be obtained by writing to: Committee for Economic Development, 285 Madison Avenue, New York 17, New York. Bulk copies can be obtained at a cost of $3 for 100.

★

WPB "SALVAGE MANUAL"

The first comprehensive practical manual on industrial salvage ever prepared has just been published by the Technical Service Section, Industrial Salvage Branch, Salvage Division, War Production Board, and is now being distributed to industry.

The new book, entitled "Salvage Manual for Industry," contains 245 pages of systematically organized and classified information and data—most of it of a "how-to-do-it" nature—on industrial salvage practice in all its ramifications. Material is presented in 26 chapters, grouped into 6 major sections. There are 2 chapters on organizing and planning the salvage department; 3 on the administrative factors; 12 on methods of handling (finding, identifying, segregating, collecting, reclaiming, storing, selling, etc.) metal scrap; 3 on non-metallic waste; 7 case histories demonstrating exemplary practice; a 17 page compilation of practical hints for handling specific waste materials; and a 9 page index.

The book has been described by one authority as "a combination management manual and technical guide for salvage operations." Although its major purpose is to speed Victory the "Salvage Manual for Industry" is certain also to have continued application in post-war industry because of its attention to the economic benefits of sound salvage practice.

The price is 50 cents per copy, and copies are procurable through the Superintendent of Documents, Government Printing Office, Washington, D. C.

★

CENTRALAB PARTS CATALOG

A new war-time parts catalog for jobbers is now being distributed by Centralab, manufacturer of radio parts in Milwaukee. It is a 12-page brochure divided into four sections—controls, capacitors, trimmers and switches—and includes all standard items available to the jobber trade at the present time. You may have a free copy by asking for catalog No. 24, Centralab, Division of Globe-Union, Inc., 900 East Keefe Avenue, Milwaukee 1, Wisconsin.

★

"POST-WAR PLANNING NOW"

American industry's blueprints for the giant task of converting a record wartime production back to civilian goods without loss of employment have just been summarized in "Post-War Planning Now," a new study published by the New York Journal of Commerce.

Actual peacetime projects already underway in 25 major industries bid well to startle the man on the street.

Much of the conversion task will depend on the government's policy of contract termination, inventory disposal and unloading the 1,753 war plants it has spent $9,000,000,000 to construct during the war. This has resulted in government ownership of 90% of all magnesium capacity and a high percentage of aluminum facilities.

Products of typical American ingenuity are expected to open a vast potential foreign trade. One chemical producer is already doing $10,000,000 annually in Latin America, selling drugs and cosmetics to Germany's onetime staunchest overseas customers. Smaller packages to meet smaller spending ability, along with the right kind of promotion did the trick in this instance.

"Post-War Planning Now" was obtained from interviews with key manufacturing executives and government officials throughout industrial America. Copies may be had at 25 cents each from The N. Y. Journal of Commerce, 63 Park Row, New York 15, N. Y.

★

NEW G. E. MYCALEX BOOKLET

An eleven-page publication describing properties, advantages and applications of G. E. mycalex has been published by the Specialty Division of the General Electric Company's Electronics Department at Schenectady, New York. This booklet is available on request.

★

GUARDIAN RELAY BULLETIN

The purpose of this bulletin is to provide the electrical engineer with a quick reference to standard relay types and assist him in making a preliminary selection without the necessity of sifting more detailed and time-consuming descriptions.

Thumb nail descriptions suggest applications, give contact ratings and combinations, power requirements, size and weight of 17 types of relays used in aircraft, radio, Signal Corps, and general industrial applications. A short explanation of two popular time delay methods is also included.

Another section tells about the new lightweight solenoid contactors built to U. S. Army Air Force specifications. Following this, is a paragraph on solenoids giving plunger stroke, lift, and power requirements for 8 standard types of intermittent and continuous duty a.c. and d.c. solenoids. Ask for Bulletin OF112. Guardian Electric Mfg. Co., 1605 W. Walnut St., Chicago, Ill.

★

FRIEND JOINS WRIGHT

H. H. Friend, who until recently was associated with Scintilla Magneto Division of the Bendix Aviation Corporation, is now Development Engineer of Electronics, Airplane Division Department, of the newly formed Development Division, Curtiss-Wright Corporation at Bloomfield, New Jersey.

★

REEVES ANNOUNCES SUB-CONTRACTORS

L. D. Ely, executive of Reeves Sound Laboratories, New York, N. Y., has announced that the signal Corps of the U. S. Army has authorized the company, a prime contractor for the production of high-frequency crystals for the Airborne Service, to appoint the following subcontractors: American Jewels Corporation, Attleboro, Massachusetts; Crystal Research Laboratories, Inc., Hartford, Connecticut; General Crystal Corporation, Schenectady, New York; Henry Manufacturing Co., West Los Angeles, California; P. B. Hoffman Co., Carlisle, Pennsylvania; John Meck Industries, Plymouth, Indiana.

NEW PRODUCTS

[*Continued from page 68*]

1075 for fuses to 15 amps., is used for radios, auto-radios, amplifiers, fractional h.p. motors, magnets, control circuits, relays, rectifiers, plate circuits, etc. Overall length is 2½". Length from front to panel 2⅛"; mounting hole ½"; maximum current, 15 amps. It is furnished for screwdriver operation meeting Underwriters' specifications, or for finger operation.

Knob and body are molded of black bakelite, impervious to temperature changes and corrosion, and are thoroughly insulated. Spacing between live parts gives adequate protection against electrical leakage. The tool-operated types have a red knob.

The fuse grip permits full visual shockproof inspection of fuse. A spring-activated cup at the bottom insures positive and continuous electrical contact.

The knob not only pulls the fuse, it holds it. A specially designed grip prevents the fuse from ever dropping out. The fuse can be taken from the knob only by hand.

ADVERTISING INDEX

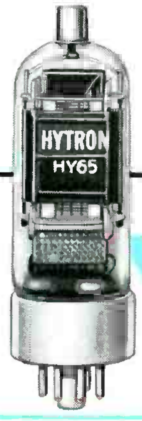
"It pays to have rigid specifications — eh boys?"...

HYTRON TOLERANCES ARE TIGHTER THAN CUSTOMER TOLERANCES . . . . .

When measuring aesthetic curves, or when conducting electrical and mechanical tests on vacuum tubes, the more stringent the adherence to accepted standards, the more desirable the resulting selection.

Impracticable as it is to manufacture all tubes of a given type exactly alike, it is possible to insure against slight meter inaccuracies and the human element by observing specification tolerances tighter than customers' requirements. Each Hytron tube is thus made to fit precisely the circuit constants with which it must operate. For example, strict observance of specifications for grid-to-plate capacitance makes easier the adjustment of tuned circuits to any Hytron tube of the chosen type.

Simplify your design problems for initial and replacement tubes by taking advantage of Hytron's insistence upon close tolerances. Specify Hytron.



OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

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Immediate and sustained communications are now playing the greatest role in the world's history. Precision crystals are a vital part of communications on all fronts . . . enabling the Allies to establish and maintain superiority in the present world struggle.
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